COMMUNITY ASSISTANCE
PLANNING REPORT NO. 345

MILWAUKEE COUNTY HAZARD MITIGATION PLAN UPDATE

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Prepared by the
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INTRODUCTION AND BACKGROUND 1

1.1 INTRODUCTION

In December 2021, the Southeastern Wisconsin Regional Planning Commission (Commission or SEWRPC), the City and the Milwaukee County Office of Emergency Management (OEM)[1] agreed to cooperatively prepare an update to the current (2017) Milwaukee County comprehensive hazard mitigation plan and incorporate the 2019 City of Milwaukee's hazard mitigation plan[2] through the Hazard Mitigation Grant Program (HMGP). The plan is designed to be consistent with the guidelines of the Wisconsin Department of Military Affairs, Division of Emergency Management (DMA, DEM), and the Federal Emergency Management Agency (FEMA).[3] As such, the plan aligns with the requirements and procedures defined in the amended Robert T. Stafford Disaster Relief and Emergency Assistance Act (Stafford Act) of Title 44 Code of Federal Regulations (CFR) Section 201 "Mitigation Planning" and Section 201.6, "Local Mitigation Plans."[4]

This Plan focuses on natural hazard mitigation which the Wisconsin Division of Emergency Management (WEM) and FEMA recommend as an option to single hazard mitigation planning. Natural hazard conditions, which include flooding, Lake Michigan coastal hazards, severe thunderstorms, windstorms, tornadoes, extreme temperatures, drought, and winter storms were specifically considered for the preparation of this hazard mitigation plan update. While the plan considered all of the potential hazards, it must be recognized that only limited mitigation actions were feasible for some of these hazards, since they are not site-specific or repetitive in nature. Additionally, this Plan highlights the importance of building community resiliency[5] through climate adaptation and social equity.

1.2 OVERVIEW OF STUDY AREA

Milwaukee County is located in southeastern Wisconsin, and is bordered on the north by Ozaukee County, on the south by Racine County, on the west by Waukesha County, and on the east by Lake Michigan. Milwaukee County covers about 243 square miles, making it the third-smallest county in Wisconsin by land area. It is both the most populous and most densely populated county in Wisconsin with the most populous city in the state (City of Milwaukee). Uniquely among Wisconsin counties, Milwaukee County is completely incorporated (i.e., no part of the county has the Town form of local government). There are 19 municipalities with 10 cities and nine villages (see Map 1.1). According to the year 2020 U.S. Census, about 939,500 people live in Milwaukee County. While the County is highly urbanized, some land remains in agriculture, mostly in the Cities of Franklin and Oak Creek. There are seven natural watersheds located wholly or partially within the County. These include the entire Kinnickinnic River and Oak Creek watersheds; portions of the Fox River, Menomonee River, Milwaukee River, and Root River watersheds, and the areas draining directly to Lake Michigan. The County includes approximately 1,551 acres of inland surface waters.

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[1] *Milwaukee County Office of Emergency Management (OEM) is a public safety organization comprised of the Emergency Medical Services (EMS), 911 Communications, Radio Services, and Emergency Management Divisions. OEM strives to create resilient communities through collaboration and increased access to public safety resources.*

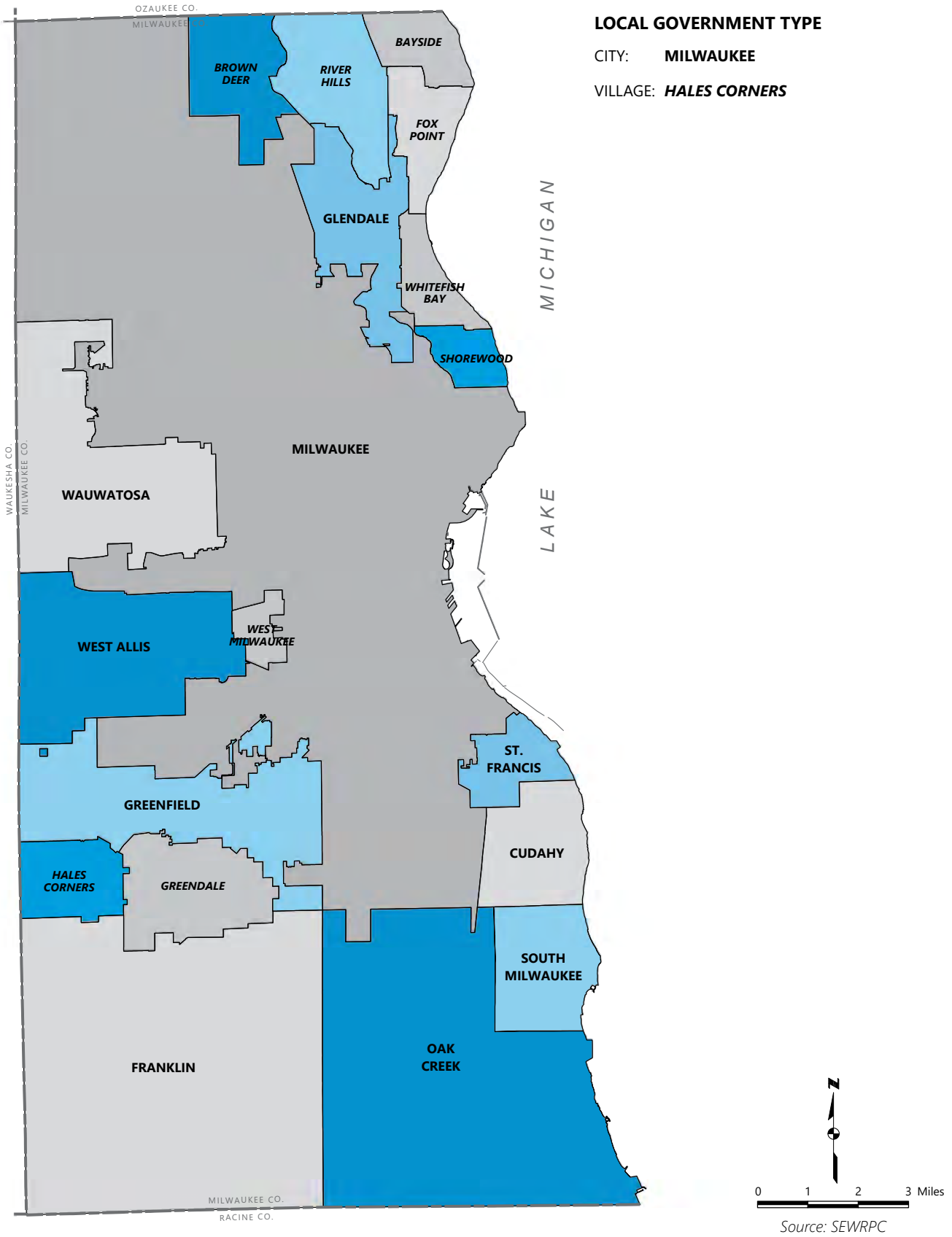
[2] *SEWRPC Community Assistance Planning Report No. 282 (3rd Edition),* City of Milwaukee All Hazards Mitigation Plan*, November, 2019.*

[3] *Federal Emergency Management Agency, State and Local Mitigation Planning How-to-Guide,* "Understanding Your Risks: Identifying Hazards and Estimating Losses," *Publication No. FEMA 386-2, September 3, 2015; Federal Emergency Management Agency,* Multi-jurisdictional Mitigation Planning*, March 10, 2009; Federal Emergency Management Agency,* Local Mitigation Planning Policy Guide*, April 2022.*

[4] *On April 19, 2022, FEMA updated the State and Local Mitigation Planning Policy Guides (policies). The policies are the official interpretation of the requirements in the Stafford Act, as amended, specifically Title 44 CFR Section 201.*

[5] *Resilience is the ability of people and their communities to anticipate, accommodate, and positively adapt to or thrive amidst changing climate conditions and hazard events. The term resilience is often used interchangeably with emergency preparedness and response.*

Map 1.1
Milwaukee County Municipalities: 2023



Source: SEWRPC

1.3 RELATIONSHIP OF HAZARD MITIGATION PLANNING TO EMERGENCY OPERATIONS PLANNING

The focus of this planning effort is developing mitigation measures for natural hazards. Such measures generally involve lasting, often permanent, efforts designed to reduce the exposure to, probability of, or potential loss from hazardous events. Such measures tend to focus on actions related to where and how to build structures, education to reduce losses or injury, establishing community resiliency, and continuing programs to improve the safety of identified hazard areas. A hazard mitigation plan outlines the strategy for mitigating the hazards potentially impacting a county or community, including those that are most vulnerable.

A mitigation plan should be distinguished from, but compatible with, an emergency response or operations plan. An emergency response plan is defined as a plan which describes how people and property will be protected in disaster and disaster threat situations; details who is responsible for carrying out specific actions; identifies the personnel, equipment, facilities, supplies, and other resources available for use in the disaster; and outlines how all actions will be coordinated. Numerous such plans have been developed at the jurisdictional level and often involve mutual assistance as well as cooperation agreements between local units of government in adjoining municipalities, both within and outside of Milwaukee County. Emergency response or operations is not directly considered in the planning program described herein. Plans for mitigating hazards are related to emergency operation activities involving short-term recovery decision-making, since such activities may highlight prospects for implementation of a mitigation strategy aimed at reducing long-term risk to human life and property.

With regard to the distinction between mitigation planning and emergency response or operations planning, the following definitions are noted for further clarification:

- **Emergency Response or Operations Services**—The actions of first responders, such as firefighters, police, and other emergency services personnel at the scene of a hazard event. The first responders take appropriate action to contain the hazard, protect property, conduct search and rescue operations, provide mass care, and ensure public safety. Emergency response or operations services are not the subject of the current planning program.

- **Hazard Mitigation**—Sustained actions or projects taken to reduce or eliminate long-term risk from hazards and their effects.

- **Mitigation Plan**—The document identifies results from the systematic process of identifying hazards and evaluating vulnerability, identifying goals, objectives, and actions to reduce or eliminate the effects of identified hazards, and sets forth an implementation plan for carrying out the actions. The mitigation plan is the subject of the current planning program.

Emergency Operations Planning

Milwaukee County has developed a comprehensive emergency management plan (CEMP) that sets forth an all-hazards action plan. The CEMP provides the framework for the Milwaukee County government and partner entities to respond to public emergencies within the local jurisdiction and regionally. The CEMP establishes a unified command and control structure for emergency response operations to ensure a coordinated and effective response. It also incorporates the concepts and processes of the National Incident Management System as the standard for emergency response operations. This plan is updated annually.

The CEMP includes procedures and protocols to respond to disasters or large-scale emergencies. The purpose and goal of the County emergency operations plan is to assist the government in protecting lives, property, and the environment from major emergencies by addressing the areas of mitigation, preparedness, response, and recovery. This CEMP is considered the core of the Milwaukee County emergency operations program. It provides policy for department and agency managers and emergency management professionals to use in planning and actual operations. In response to a disaster or large-scale emergency, all local government forces, including law enforcement, fire, medical, health, public works, and others, will be considered a part of the County's emergency management organization, and will be the first line responders to such an emergency. When an emergency or disaster exceeds the local governments and County's capability to respond, assistance will be requested from the State of Wisconsin. The Federal government will provide

assistance to the State of Wisconsin when all local and State resources have been exhausted. The CEMP includes elements on direction and control, warning and communications, and management of resources during emergency situations.

Many of the local units of government in the County, including the City of Milwaukee, have developed emergency operations plans (EOP) and/or programs which complement the County plan, and which also set forth procedures and actions to deal with a range of situations and events. Milwaukee County's CEMP notes that the County is vulnerable to exposure to many hazards that have the potential for disrupting the community, causing damage, and creating casualties. In addition to flooding, the plan recognizes that the County is vulnerable to other natural hazards, including tornadoes and severe weather; technological hazards; accidents involving hazardous materials; terrorism and civil disorder; and utility hazards, such as power failure and water shortages or contamination.

In addition, the Milwaukee Metropolitan Sewerage District (MMSD) has prepared an emergency action plan for the Milwaukee County Grounds Floodwater Management Facility, which is located at the confluence of Underwood Creek and the Menomonee River. This plan describes notifications to be made and actions to be taken in the event an unexpected failure of the facility's embankment occurs during an extreme flooding event.

In addition to EOPs, each municipality in the County has completed a Memorandum of Agreement (MOA) to help coordinate emergency management services within the Milwaukee County area. Also, Milwaukee County, along with Kenosha, Jefferson, Milwaukee, Ozaukee, Racine, Walworth, Washington, and the City of Milwaukee participate in the Southeast Wisconsin Mutual Aid Compact. This Compact allows the participating Counties to assist one another where an emergency involving a natural disaster or technological incident requires additional resource and knowledge beyond the effected County's control.

1.4 REVIEW OF RELATED EXISTING REGULATIONS AND PROGRAMS

The current ordinances and programs which are most directly related to hazard mitigation and plan implementation include general zoning, floodplain zoning, shoreland and shoreland-wetland zoning regulations, and stormwater management requirements. These ordinances and programs impact how and where development occurs in Milwaukee County and have a significant role in protecting and/or preventing development in potentially hazardous locations. Because Milwaukee County has no unincorporated areas, many of these regulations are promulgated and enforced by the cities and villages in the County. Table 1.1 and the following presents a summary of regulations adopted by the County and local governments.

General Zoning

Zoning is a tool used to regulate the use of land in Milwaukee County in a manner that serves to promote the general welfare of its citizens, the quality of the environment, and conserve its resources. Zoning is also used to implement a comprehensive plan. Zoning involves delineating areas or zones into specific districts, which provides uniform regulations and requirements that govern the use, placement, spacing, and size of land and buildings. As the County has no unincorporated areas, and as each city and village in the County has adopted and enforces its own zoning ordinance, general zoning has not been adopted nor administered by Milwaukee County.

Floodplain Zoning Ordinance

Section 87.30 of the *Wisconsin Statutes* requires that cities and villages (and counties, with respect to their unincorporated areas), adopt floodland zoning to preserve the floodwater conveyance and storage capacity of the floodplain areas and to prevent the location of new flood damage-prone development in flood hazard areas. The minimum standards that such ordinances must meet are set forth in Chapter NR 116 of the *Wisconsin Administrative Code*. The required regulations govern filling and development within a regulatory floodplain, which is defined as the area subject to inundation by the 1-percent-annual-probablity (100-year recurrence interval) flood event. Under Chapter NR 116, local floodland zoning regulations must prohibit nearly all forms of development within the floodway, which is that portion of the floodplain required to convey the 1-percent-annual-probablity peak flood flow. Local regulations must also restrict filling and development within the flood fringe, which is that portion of the floodplain located outside of the floodway

Table 1.1
Regulations and Programs Within Milwaukee County Related to Hazard Mitigation: 2023

Municipality	General Zoning	Floodplain Zoning	Stormwater Management Ordinance or Plan	Shoreland or Shoreland-Wetland Zoning	Emergency Management Department, Ordinance, Program, or Plan
Cities					
Cudahy	Adopted	Adopted	Yes	Adopted	Yes
Franklin	Adopted	Adopted	Yes	Adopted	Yes
Glendale	Adopted	Adopted	Yes	Adopted	Yes
Greenfield	Adopted	Adopted	Yes	Adopted	Yes
Milwaukee	Adopted	Adopted	Yes	Adopted	Yes
Oak Creek	Adopted	Adopted	Yes	Adopted	YEs
South Milwaukee	Adopted	Adopted	Yes	Adopted	Yes
St. Francis	Adopted	Adopted	Yes	--[a]	--[b]
Wauwatosa	Adopted	Adopted	Yes	Adopted	Yes
West Allis	Adopted	Adopted	Yes	Adopted	Yes
Villages					
Bayside	Adopted	Adopted	Yes	--[a]	Yes
Brown Deer	Adopted	Adopted	Yes	--[a]	Yes
Fox Point	Adopted	Adopted	Yes	--[a]	Yes
Greendale	Adopted	Adopted	Yes	Adopted	Yes
Hales Corners	Adopted	Adopted	Yes	Adopted	Yes
River Hills	Adopted	Adopted	Yes	Adopted	Yes
Shorewood	Adopted	Adopted	Yes	--[a]	--[b]
West Milwaukee	Adopted	Adopted	Yes	--[a]	Yes
Whitefish Bay	Adopted	Adopted	Yes	--[a]	Yes
County	N/A	N/A	Yes	N/A	Yes

Note: N/A indicates "Not Applicable."

[a] *The City of St. Francis and the Villages of Bayside, Brown Deer, Fox Point, Shorewood, West Milwaukee, and Whitefish Bay do not have any shoreland wetlands and were thus not required to adopt such ordinances.*

[b] *Municipalities that utilize Milwaukee County's Emergency Operations and Preparedness plans and procedures.*

Source: Milwaukee County's Municipal Webpages and SEWRPC

that would be covered by floodwater during the 1-percent-annual-probablity flood. Permitting the filling and development of the floodfringe area, however, reduces the floodwater storage capacity of the natural floodplain, and may thereby increase downstream flood flows and stages. As all cities and villages in the County have adopted floodland zoning ordinances (except for the Village of West Milwaukee, which has not officially identified flood hazard areas within its boundaries), Milwaukee County has not adopted, nor administers, its own floodland zoning ordinance. Note- the existing floodplains in the County are illustrated on Map 2.7 in Chapter 2 of this Planning Report.

Shoreland-Wetland Zoning Ordinance

Under Sections 62.231 and 61.351, respectively, of the *Wisconsin Statutes*, cities and villages in Wisconsin are required to place wetlands five acres or larger and located in statutory shorelands into a shoreland-wetland conservancy zoning district to ensure their preservation. Minimum standards for city and village shoreland-wetland zoning ordinances are set forth in Chapter NR 117 of the *Wisconsin Administrative Code*. The Cities of Cudahy, Franklin, Glendale, Greenfield, Milwaukee, Oak Creek, South Milwaukee, Wauwatosa, and West Allis and the Villages of Greendale, Hales Corners, and River Hills have adopted their own shoreland-wetland zoning ordinances pursuant to Sections 62.231 and 61.351, respectively, of the Wisconsin Statutes. The City of St. Francis and the Villages of Bayside, Brown Deer, Fox Point, Shorewood, West Milwaukee, and Whitefish Bay do not have any shoreland-wetlands and were thus not required to adopt such ordinances.

An important element of the Milwaukee County shoreland zoning ordinances relates to the regulation of land use activities and facilities along the Lake Michigan shoreline and bluffs. Municipalities within

Milwaukee County that are situated along the Lake Michigan coastline generally utilize an assortment of coastline management strategies to protect existing property and proposed development from potential bluff instability and erosion/recession hazards. Such methods include establishing bluff setbacks, conducting site specific bluff stability studies, and constructing coastline protection structures. In Milwaukee County, multiple municipalities that border Lake Michigan regulate development and related activities to lake bluffs within their jurisdiction.[6] Descriptions of existing coastline management strategies utilized by municipalities located along the County's Lake Michigan coast are in Chapter 5 of this Report.

Stormwater Management Regulations

With increases in urbanization and alterations to the natural landscape, many of the natural functions of land surface are greatly reduced or even lost causing large amounts and high velocities of stormwater runoff. As indicated in Table 1.1, all communities in Milwaukee County have stormwater management plans and/or regulations (i.e., ordinances) designed to minimize the adverse impacts caused by urban development.

In addition, *Wisconsin Administrative Code* Chapter NR 216, requires certain industrial facilities, construction sites, and municipal separate storm sewer systems (MS4s)[7] to obtain Wisconsin Pollutant Discharge Elimination System (WPDES) stormwater discharge permits to manage the quantity and quality of stormwater runoff before it enters streams and waterbodies.

In 2002, the WDNR issued Chapter NR 151 of the *Wisconsin Administrative Code*, outlining the performance standards governing stormwater runoff from both agricultural and nonagricultural lands. Those standards include controls for both the quantity and quality of runoff from newly developed and redeveloped lands. These rules are administered by the WDNR through Chapter NR 216 stormwater discharge permit system, although local municipalities have the option of adopting their own ordinances consistent with the *Administrative Code*. Chapter NR 152 of the *Administrative Code* contains model ordinances covering both agricultural and nonagricultural operations. Those communities that are required to obtain a WPDES stormwater discharge permit are required to have a stormwater management program (presented in a plan format) that most often results in adoption of a stormwater management ordinance. The Stormwater Management Plan describes how the permittee (MS4 community or group) will comply with the permit's requirements for each of the six minimum control measures, consistent with 40 CFR 122.34 (b). The six categories, or minimum control measures:

- Public Education and Outreach
- Public Involvement and Participation
- Illicit Discharge Detection and Elimination
- Construction Site Pollutant Control
- Post-Construction Storm Water Management
- Pollution Prevention

As indicated in Table 1.2, under Chapter NR 216, all communities in Milwaukee County, including Milwaukee County, have a stormwater ordinance or management plan through a WPDES Stormwater Discharge Permit. Sixteen Milwaukee County communities and Milwaukee County are covered under a group permit (either the Menomonee River Watershed Based Municipal Stormwater Discharge Group, the North Shore Group, or the Root River Group) and four Milwaukee County communities are covered under individual permits.

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[6] *Some municipalities' lake bluff regulations also relate to the bluffs of ravines that are tributary to Lake Michigan.*

[7] *What classifies as a Municipal Separate Stormwater Sewer System (MS4) is defined under* Wisconsin Administrative Code *Chapter NR 216.02. Generally, a MS4 is a conveyance or system of conveyances, including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, or storm sewers designed or used for collecting or conveying untreated stormwater, and is owned or operated by a state, city, town, county, district, association, or other public entity.*

Table 1.2
Stormwater Management Discharge Permits in Milwaukee County

MS4 Municipality	WPDES Stormwater Permit	Permit Expiration Date
Cities		
Cudahy	Individual Municipal MS4 Permit	01/31/2029
Franklin	Root River Group MS4 Permit	07/30/2027
Glendale	North Shore MS4 Permit	05/31/2026
Greenfield	Menomonee River Watershed MS4 Permit	03/31/2025
Milwaukee	Menomonee River Watershed MS4 Permit	03/31/2025
Oak Creek	Individual Municipal MS4 Permit	03/31/2028
St. Francis	Individual Municipal MS4 Permit	09/30/2028
South Milwaukee*	Individual Municipal MS4 Permit	06/11/2018
Wauwatosa	Menomonee River Watershed MS4 Permit	03/31/2025
West Allis	Menomonee River Watershed MS4 Permit	03/31/2025
Villages		
Bayside	North Shore MS4 Permit	05/31/2026
Brown Deer	North Shore MS4 Permit	05/31/2026
Fox Point	North Shore MS4 Permit	05/31/2026
Greendale	Root River Group MS4 Permit	07/30.2027
Hales Corners	Root River Group MS4 Permit	07/30/2027
River Hills	North Shore MS4 Permit	05/31/2026
Shorewood	North Shore MS4 Permit	05/31/2026
West Milwaukee	Menomonee River Watershed MS4 Permit	03/31/2025
Whitefish Bay	North Shore MS4 Permit	05/31/2026
County	Menomonee River Watershed MS4 Permit	03/31/2025

*****The City of South Milwaukee's permit expired in June of 2018. However, it is planned to be reissued in the beginning of 2025.

Source: SEWRPC

Milwaukee Metropolitan Sewerage District (MMSD) Stormwater Drainage and Flood Control Plan

MMSD's responsibilities for stormwater management are carried out within explicit policy guidelines set forth by MMSD's Commission. A comprehensive stormwater drainage and flood control system plan consistent with those policies was originally adopted in 1986. This plan consists of two parts: a policy plan and a stormwater drainage and flood control systems plan.[8]

The policy plan discusses the MMSD stormwater management and flood control responsibilities. Major elements include:

- Identification of streams and watercourses for which the MMSD should assume jurisdiction for the resolution of drainage and flood control
- Recommendations regarding the types of improvements for which the MMSD should assume responsibility
- Recommendations regarding how costs are to be shared

The 1990 stormwater drainage and flood control systems plan identified the types, general locations, and horizontal and vertical alignments of needed drainage and flood control facilities within MMSD's jurisdiction. Adopted in 2001 and last amended in 2023, Chapter 13 of the MMSD Rules, *Surface Water and Stormwater*, define MMSD's flood management role and currently the District has jurisdiction for 42 streams that are wholly or partially within Milwaukee County.

[8] *SEWRPC Community Assistance Planning Report No. 130,* A Stormwater Drainage and Flood Control Policy Plan for the Milwaukee Metropolitan Sewerage District, *March 1986; SEWRPC Community Assistance Planning Report No. 152,* A Stormwater Drainage and Flood Control System Plan for the Milwaukee Metropolitan Sewerage District, *December 1990.*

1.5 SCOPE AND PURPOSE OF PLAN UPDATE

This plan updates the 2017 Milwaukee County comprehensive hazard mitigation plan.[9,10] The scope of this plan is countywide, as such, the planning requirements identified in 44 C.F.R. of Section 201.6 "Local Mitigation Plans" requires all jurisdictions participating in a multi-jurisdictional hazard mitigation plan to participate in the planning process. Examples of participation include, but are not limited to, attending planning meetings, contributing research, data, or other information, and commenting and reviewing drafts of the plan.

This plan update is intended to set forth the most appropriate, feasible, and effective hazard mitigation strategy for Milwaukee County and the local units of government within the County. The plan complements and refines the *State Hazard Mitigation Plan of Wisconsin*[11] and focuses on local conditions and natural hazards likely to occur or be experienced within Milwaukee County and Southeastern Wisconsin. As such, the County and the Commission will evaluate, update, and revise existing mitigation strategies as well as develop new local mitigation strategies specific to a community's exposure and impacts from identified natural hazards.

Planning efforts will assess the status of implementation of recommended mitigation actions from previous editions of the County's hazard mitigation plan. Work will include reevaluation of the hazards identified to be addressed by the plan and include updating the descriptions and prioritization of the natural hazards that have occurred within the County and reevaluation of the risk posed to each of the participating municipalities by these hazards. Planning efforts will also include updating existing or development of new base maps of areas affected by multiple natural hazards and the associated comprehensive inventories related to issues such as hazard occurrence, critical facilities, repetitive flood loss and substantial damage structures, land use, and population. In addition, Milwaukee County will evaluate, revise, and update the overview of its vulnerability and the vulnerability of the municipalities located within the County to specific hazards and evaluate, update, and revise existing mitigation strategies.

As the City of Milwaukee will be participating in the planning process, Milwaukee County will also integrate the analyses and recommendations in the City's recently updated hazard mitigation plan into this updated County plan. The municipalities that participated in the development of this Milwaukee County hazard mitigation plan update included:

<u>Cities</u>
Cudahy
Franklin
Glendale
Greenfield
Milwaukee
Oak Creek
South Milwaukee
St. Francis
Wauwatosa
West Allis

<u>Villages</u>
Bayside
Brown Deer
Fox Point
Greendale
Hales Corners
River Hills
Shorewood
West Milwaukee
Whitefish Bay

This plan update was developed under the guidance of the Milwaukee County Hazard Mitigation Plan Local Planning Team (LPT), which was created by the County specifically for plan update purposes. This team was comprised of elected and appointed officials, agency representatives, and citizens from throughout the County knowledgeable in hazard mitigation matters. Table 1.3 summarizes municipal participation in the planning process. For more complete details on the level of participation of the LPT, local citizens and community groups in the public involvement process, and summary notes for each LPT meeting, see Appendix A.

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[9] *Milwaukee County Office of Emergency Management,* Hazard Mitigation Plan: 2016-2017, *January 2018.*

[10] *The City of Milwaukee Hazard Mitigation Plan was developed during the period 2003 through 2005, updated in 2011, and updated again in 2018 through a collective effort under the guidance of the City of Milwaukee All Hazards Mitigation Plan Local Planning Team, which was created by the City specifically for plan development purposes.*

[11] *Wisconsin Emergency Management,* State Hazard Mitigation Plan of Wisconsin*, December 2021.*

Table 1.3
Participation in the Milwaukee County Hazard Mitigation Plan Update Planning Process

Municipality	Attendance at Local Planning Team Meetings			Provision of Data[a]	Review of Report
	April 27, 2023	February 20, 2024	February 18, 2025		
Cities					
Cudahy	X	X	--	X	--
Franklin	X	X	--	--	--
Glendale	X	X	X	X	--
Greenfield	X	--	X	X	--
Milwaukee	X	X	X	--	X
Oak Creek	X	X	X	X	--
South Milwaukee	X	--	--	X	--
St. Francis	--	X	--	--	--
Wauwatosa	--	--	X	--	--
West Allis	--	--	X	X	--
Villages					
Bayside	X	X	X	X	--
Brown Deer	--	--	--	X	--
Fox Point	X	X	X	X	--
Greendale	X	--	X	X	--
Hales Corners	X	--	X	X	--
River Hills	X	--	X	--	--
Shorewood	--	--	X	--	--
West Milwaukee	--	--	X	--	--
Whitefish Bay	X	--	X	X	--
Milwaukee County	X	X	X	X	X
MMSD	X	X	X	X	X

Note: X indicates participation by at least one representative of the municipality or organization.

[a] *Provision of data includes providing information on hazards experienced, projects undertaken, and outreach efforts (i.e., participating in related surveys) as well as sharing of relevant plans, information, reports, and concerns outside of the LPT meetings.*

Source: SEWRPC

The plan development processes included the following steps:

- Collation and review of all pertinent reports relating to the hazard mitigation activities in Milwaukee County
- Inventory mapping and analysis of hazards pertinent to Milwaukee County
- Identification of the facilities and ongoing programs related to hazard mitigation
- Assessment of the vulnerability of County assets with an emphasis on those deemed a high risk to each hazard
- Identification of and prioritization of needed facilities and programs
- Consideration of issues relating to neighboring municipalities and units of government likely to be affected or influenced by natural hazards within Milwaukee County
- Development and evaluation of alternatives to address the identified needs
- The development of plan recommendations and an implementation plan
- Development of a public informational and educational program and program of public consultation to guide the plan development and implementation program, including a prioritization of the recommended plan elements

- Adoption of a strategy for monitoring and refining the plan

Additional activities conducted as a part of the updating process for the Plan update includes:

- Collation and review of all pertinent reports relating to the hazard mitigation activities in the City and County of Milwaukee since adoption of the initial plans
- Review of comprehensive planning material developed for each City and Village in Milwaukee County
- Review and updating of inventories developed from the previous planning efforts
- Review and updating of hazard and risk assessments
- Review of implementation activities
- Review and updating of plan recommendations and the initial implementation plans

1.6 PLAN MAINTENANCE AND IMPLEMENTATION ACTIVITIES

Outreach Activities

Since the adoption of the initial hazard mitigation plan, local municipalities in Milwaukee County have conducted outreach activities to educate the public about emergency preparedness, including hazard mitigation. Recent hazard mitigation related activities within Milwaukee County are summarized in Table 1.4. As shown in the table, the most common and efficient method(s) used by communities in disseminating information on extreme weather events and safety preparedness is through municipal websites which often include community online newsletters, a calendar of community meetings and events, and links to additional resources and different social media platforms (Facebook,® Instagram,® and X® (formally "Twitter")). Other known outreach activities related to hazardous weather awareness and safety include the distribution of educational and informational material (i.e. flyers, handouts, articles, available resources, etc.) at community facilities as well as participation in educational outreach and campaign events (i.e., classroom visits, local training, informational booth).

The Milwaukee County OEM as well as other county and local departments participate in numerous training programs and/or educational sessions associated with hazard mitigation, damage assessment, debris management, sheltering and functional needs, Incident Command System, National Incident Management System, and interoperable communications.

Implementation Activities

Since the adoption of the most recent hazard mitigation plan (2017), Milwaukee County and the local municipalities have conducted a number of projects intended to implement recommendations of the plan directly or indirectly. Such projects or activities related to hazard mitigation that have been implemented throughout Milwaukee County since the previous plan are summarized in Table 1.5. It should be noted that MMSD plays a major role and often works with the County and City in reducing flood risks by actively implementing flood mitigation projects throughout the County as a part of their Watercourse System Management Plans. To date, the MMSD has spent approximately $485.9 million (2023 dollars) since 1995 on removing structures from the floodplain and concrete on MMSD-owned concrete-lined channels.[12] The major flood control projects in the County completed by MMSD are summarized in Table 1.6.

[12] *Milwaukee Metropolitan Sewerage District,* 2023 Operation and Maintenance & Capital Budget Report*, 2023*

Table 1.4
Outreach Activities by Community in Milwaukee County Related or Beneficial to Hazard Mitigation

Community	Activity
City of Cudahy	City website City's Social Media platforms containing natural weather hazard education City's Social Media platforms used for natural weather hazards alerts and warnings City's online newsletters
City of Franklin	City website City's Social Media platforms containing natural weather hazard education City's Social Media platforms for natural weather hazards alerts and warnings City's online newsletters City's Notification System
City of Glendale	City website City's Notify Me Emergency Alert program City Newsletters
City of Greenfield	City website City's Social Media platforms containing natural weather hazards education City's Social Media platforms used for natural weather hazards alerts and warnings Severe weather awareness week exercise (e.g. tornado watch/warning system testing) City Newsletter City's Citizen Emergency Alert Program
City of Milwaukee	City's Office of Emergency Management website, plans, and outreach and educational resources City website City's Social Media platforms containing natural weather hazards education City's Social Media platforms used for natural weather hazards alerts and warnings City's E-Notify Text Alerts and Email Notification System
City of Oak Creek	City website City's Social Media platforms containing natural weather hazards education City's Social Media platforms used for natural weather hazards alerts and warnings City's mobile alert system City's eNotifications system City Newsletters and magazine
City of South Milwaukee	City website City's Social Media platforms containing natural weather hazard education City's Social Media platforms for natural weather hazards alerts and warnings City's mobile emergency alert system City's "Notify Me" alert system
City of St. Francis	City website City newsletters City's Social Media platforms containing natural weather hazard education City's Social Media platforms for natural weather hazards alerts and warnings
City of Wauwatosa	City website City's Social Media platforms containing natural weather hazards education City's Social Media platforms used for natural weather hazards alerts and warnings Smart911 emergency alert system City's eNews City's Newsletter
City of West Allis	City's website City's Social Media platforms containing natural weather hazards education City's Social Media platforms used for natural weather hazards alerts and warnings City's monthly e-Newsletter CivicReady emergency notification platform
Village of Bayside	Village website Village Social Media platforms containing natural weather hazards education Village Social Media platforms for natural weather hazards alerts and warnings Village newsletter

Table continued on next page.

Table 1.4 (Continued)

Community	Activity
Village of Brown Deer	Village website Village Social Media platforms containing natural weather hazards education Village Social Media platforms for natural weather hazards alerts and warnings Village "Notify Me" emergency alert system Village online community news link
Village of Fox Point	Village website North Shore Fire and Rescue Department website North Shore Health Department website Village "Notify Me" alert system
Village of Greendale	Village website Village Fire, Police, and Health Departments social media platforms Village's Code Red Emergency Alert program
Village of Hales Corners	Village website Village newsletter Village's Code Red alert system
Village of River Hills	Village website
Village of Shorewood	Village website Village Social Media platforms containing natural weather hazards education Village Social Media platforms for natural weather hazards alerts and warnings Village "Notify Me" alert system
Village of West Milwaukee	Village website Village newsletter Village Social Media platforms containing natural weather hazard education and outreach
Village of Whitefish Bay	Village website Village Social Media platforms containing natural weather hazards education Village Social Media platforms for natural weather hazards alerts and warnings Village "Notify Me" alert system
Milwaukee County	County website Social Media coverage on natural weather hazards Office of Emergency Management webpage and social media sites Participation in NWS Integrated Warning Team (IWT) Participation in Wisconsin Heat Health Network Continued participation in the ReadyWisconsin campaigns Continued participation in the NWS SkyWarn Program Continued participation in FEMA's Integrated Public Alert and Warning System (IPAWS) Continuing to encourage critical facilities to develop and maintain response and recovery plans Public informational and educational outreach projects, workshops, informational booths, and seminars on natural disaster preparedness Public awareness programs on winter, heat, tornado, hazardous materials, and family preparedness Continuation with the Milwaukee Extreme Weather Taskforce Providing in-depth hazard preparedness exercises and drills to County employees
MMSD	Placed danger/warning signs along concrete channels to keep citizens out of the streams Sends out Water Drop Alerts to urge residents to limit water use during storm events Greenseams Program Educational outreach and implementation on Green Infrastructure projects

Source: Community Websites, Milwaukee County, and SEWRPC

Table 1.5
Recent Hazard Mitigation Activities/Projects in Milwaukee County: 2018-2024

Community	Activity/Project
City of Cudahy	Updates to tornado sirens Stormwater improvement projects to alleys and parking lots (2018) Kingman Avenue/3800 Allerton-Van Norman Alley Reconstruction (GI project- 2019) Ace World Wide & Railroad Culvert Project (2020) Storm sewer improvements project (2020-2021) with catch basins
City of Glendale	Completed a North Shore CEMP Participated in a Tabletop exercise Kletzsch Park tornado siren repair
City of Milwaukee	Major street and bridge projects related to urban flood mitigation (i.e., Western Milwaukee Phase 2B earthen dam, floodwall, and storm sewer installations) Green Infrastructure projects
City of Oak Creek	North Bluff stabilization/revetment project Drexel Avenue pump station renovation Stormwater mitigation requirements on all new developments
City of South Milwaukee	In the process of writing and implementing a CEMP for Zone E Updating their Active Shooter Policy Hosted a 40-hour training for Arson Investigation Formulating a Zone E Fire Investigation team Requested more rescue rings in Grant Park from Milwaukee County Improving the City's Emergency Operations System (EOS) structure Training city employees in the Incident Command (IC) system
City of Wauwatosa	Numerous EOC/Emergency Management tabletop exercises Implementation of Rave notification system Numerous green infrastructure projects to detain stormwater Numerous large sewer projects to reduce likelihood of flooding Replace radio tower link between City Hall and Police with buried fiber optic connection Coordinating with Milwaukee Metropolitan Sewerage District on designs to raise portions of the flood levy adjacent to Menomonee River in Hart Park Numerous EOC/Emergency Management tabletop exercises
Village of Bayside	621 Brown Deer Road Pond dredged New village hall stormwater relief pond East side sanitary relief system project Brown Deer Road sewer expansion with MMSD Tennyson Drive stormwater infrastructure relief project New I43 stormwater pond installed by WIDOT. New stormwater ponds at Bayside Middle School as part of new building project.
Village of Fox Point	Beach Drive Coastal Resiliency Project 2022 Stormwater Improvement Projects: Bywater Lane, Boyd Lane, Links Way, and Portage Road 2022 Road and Utility Projects: Port Washington Road and Wye Lane (stormwater improvements) 2024 Bradley Road Utility Project (stormwater improvements)
Village of Greendale	Updates to Village's outdoor warning sirens Implemented reverse 911 (code RED) to alert community members Created contact lists with the Village's Health Department for secondary shelters Eastway storm sewer improvements
Village of Hales Corners	Updates to Village's outdoor warning sirens Implemented reverse 911 (code RED) to alert community members Upgrade to sewerage lift station at Lory Lane
Village of Shorewood	Southeast Combined Sewer Improvement Project
Milwaukee County	Designation of cooling and warming shelters Removal of concrete embankments in rivers Coastal and bluff erosion prevention projects McKinley Beach nourishment project Removal/acquisition of structures in floodplain Warning system tests and upgrades

Table continued on next page.

Table 1.5 (Continued)

Community	Activity/Project
Milwaukee County (continued)	Complete County Shoreline Resources and Assets Inventory and Risk Assessment Installation of green infrastructure projects (rain gardens, permeable pavers, bioretention ponds) Conducted an Emergency communications system tests Conducted an Emergency public information system tests Conducted an Emergency power tests Development and maintenance of plans and procedures Countywide tornado siren replacement project Dispatch training for 911 Communications Providing shelter for the homeless during an extreme cold weather event Technology updates to enhance the availability to serve socially vulnerable populations Development of a damage assessment dashboard Developed a stormwater training module for County Employees Text-to-911 services became available in 2022
MMSD	Purchased several flooded structures Completed a number of stormwater and floodplain management projects Addressed coastal flooding issues at the Water Reclamation facilities and MMSD headquarters GreenSeams Program

Source: Milwaukee County, Local Planning Team, Municipal Websites, and SEWRPC

1.7 REVIEW OF PLAN DEVELOPMENT EFFORTS, PROCESS AND ADOPTION

Review of the 2011 and 2017 Milwaukee County Hazard Mitigation Plans

Both the 2011 and 2017 Milwaukee County Pre-Disaster Hazard Mitigation Plans are the result of collaboration between the Milwaukee County Office of Emergency Management, appropriate county departments, and Milwaukee County municipalities. The City of Milwaukee was not included in these efforts as a separate hazard mitigation plan for the City was completed as described below. Each of the participating municipalities filled out hazard assessments of their own areas, which were used in addition to historical hazard data to calculate the county's risk for all hazards. This information was used by each municipality to focus on community projects that could help mitigate risks. The 2017 plan (County's current plan) gives a detailed community profile of Milwaukee County, including features and GIS maps of its land use, infrastructure, and population. The 2017 plan also includes separate sections for all hazards that could impact Milwaukee County, including descriptions of these hazards and historical records of when and where they occurred. That plan separates the 19 municipalities into separate sections, each containing specific hazard analyses, vulnerability information, and land use and floodplain maps pertaining to that jurisdiction. Most importantly, these sections contain lists of mitigation projects for each municipality, including what projects have been completed since the last plan and timelines for new projects. Lastly, the 2017 County plan used Integrated Solutions Consulting's Knowledge Management System to store both the 2011 and 2017 plan and administrative information for stakeholders to access.

Review of the City of Milwaukee Hazard Mitigation Plans

The initial City of Milwaukee all hazards mitigation plan (2005) was prepared under the guidance of a City advisory Steering Committee comprised of local official representatives, including police departments, fire departments, and MMSD. The Steering Committee met four times during the plan preparation period to provide input on the types of hazards to be considered, and the appropriate mitigation strategies, and to review the draft report chapters. The report chapters were then refined to reflect the comments and recommendations of the Steering Committee. Members of the Steering Committee included representatives from agencies that serve both the City and the County, including Milwaukee County Emergency Management staff and MMSD staff (a jurisdiction that extends beyond the County boundary). The City of Milwaukee Common Council formally adopted the plan on May 3, 2005. The first update of this plan followed a similar process and was completed in 2012.

The current City hazard mitigation plan update (2019) was prepared under the guidance of a Local Planning Team comprised of local official representatives, including representatives of City Departments, such as the police, fire, community development, and public works departments; County departments and agencies,

Table 1.6
Major Flood Mitigation Efforts by MMSD in Milwaukee County: 2023

Project	Project Description	Structures Removed from the Floodplain	Cost	Completion Date
	Kinnickinnic Watershed			
Kinnickinnic (KK) River Watershed Flood Management Plan - Acquisitions	This is a multiphase project to improve the KK River and tributary streams by removing concrete lining, adding storage, modifying bridges, and naturalizing the channel. The primary objective for the work is to reduce the flood risk, reduce the risk of drowning, improve habitat, and improve community access to the naturalized river corridor. The projects recommended in the plan will reduce flood risk to over 700 structures in the 100-year floodplain, remove concrete from over seven miles of stream-lined in concrete or enclosed in culverts, and make significant investments in community spaces, including several Milwaukee County Parks. The scope of one of the ongoing projects located on the KK River between 6th and 16th Street includes the acquisition and removal of 83 residential structures within this project area. The properties are needed to widen the channel cross section from 60 ft. to 200 ft. Approximately 53 of these homes were in the updated 100-year floodplain. The wider channel will improve the passage of flood flows through this section and reduce the risk of flooding to about 300 homes and businesses within the adjacent neighborhood. The total structures removed include two at-risk structures in another part of the KK River watershed.	~55	$402M (2024 dollars)	2024
	Menomonee River Watershed			
All Watershed Projects Completed So Far	Many of the Menomonee River Watershed projects work in concert to mitigate flooding. For instance, the Milwaukee County Grounds Detention Basin project described below makes downstream concrete removal and levee/floodwall projects possible.	280	--	--
Valley Park Levee and Floodwall	This project created a levee and floodwall to help protect about 130 homes along the Menomonee River. The project is part of a group of projects that work to reduce the risk of flooding on the Menomonee River, including: a seven-foot-high, 800-foot-long levee; five-foot-high, 750-foot-long floodwall; the acquisition of 18 homes for the construction of the levee and floodwall; an increase in Milwaukee County Parks land along the Menomonee River from 1.5 acres to 3 acres; and a new 15-foot-wide access road atop the levee for maintenance and security.	18	$12M (2001 dollars)	2001
Hart Park	MMSD completed the Hart Park Project along the Menomonee River to reduce the flood risk in the Cities of Milwaukee and Wauwatosa. As part of this project, 80 formerly flood-prone residences and business in the area east of the Hart Park stadium were acquired and removed; the area of the park was expanded from 20 acres to 50 acres; a system of earthen levees, concrete floodwalls, and road grade raises was installed to contain the one-percent-annual-probability flood; the overbank north of the channel was excavated to provide floodwater storage and conveyance; and a gravity flow interior drainage system was constructed to convey stormwater from the "protected" side of the levee/floodwall system to the River.	80	$48M (2007 dollars)	2007
Milwaukee County Grounds Detention Basin	The Milwaukee County Grounds detention basin is located in the City of Wauwatosa. This basin covers about 65 acres and has the potential to hold 315 million gallons of floodwaters from Underwood Creek and then slowly release the floodwaters to the Menomonee River. It provides flood relief benefits downstream in the Cities of Milwaukee and Wauwatosa.	--	$93M (2011 dollars)	2011

Table continued on next page.

Table 1.6 (Continued)

Project	Project Description	Structures Removed from the Floodplain	Cost	Completion Date
	Menomonee River Watershed (continued)			
Western Milwaukee Flood Management Projects	The fourth and final phase of these projects is currently being completed. The purpose of this project is to reduce the risk of overbank flooding in the vicinity of West State Street on the west side of Milwaukee and east side of Wauwatosa. The project scope is to design and construct a continuation of the floodplain levee and floodwall along West State Street, east from Hart Park project to at least the east side of the former Central Redi-Mix property (now owned by MMSD).	--	$90M (2026 dollars)	2026
	Milwaukee River Watershed			
Lincoln Creek Channel Restoration	This project included concrete channel lining removal, additional floodplain storage, and naturalizing the channel banks where possible within the public right-of-way corridor. Lincoln Creek is located in the City of Milwaukee.	~2,000	$120M (2000 dollars)	2002
Estabrook Dam Removal	In 2016, MMSD approved plans to acquire land in Estabrook Park for the demolition and removal of the Estabrook dam. The purpose of this project was to provide the benefits of flood risk reduction for at least 50 structures located in the floodplain, and to improve water quality, habitat, fish passage, river aesthetics and reduce sediment accumulation.	~50	$2.3M (2016 dollars)	2018
Structure Acquisitions	This is an ongoing effort to reduce the flood risk to structures in the Milwaukee River regulatory floodplain, focused on the City of Glendale, but MMSD is open to voluntary acquisition in other flood-prone areas in the Milwaukee River Watershed and recently acquired a clinic building in the Village of Brown Deer. Six structures were acquired for the Indian Creek project that was constructed in the early 2000s. The number of structures removed is the total as of 2023.	19	$5.5M (2023 dollars)	Ongoing
	Oak Creek Watershed			
Structure Acquisitions	MMSD has pursued voluntary acquisition and demolition for structures in the Oak Creek regulatory floodplain. As of 2023, three structures have been removed, with only five structures remaining in the floodplain. Two of these structures are on airport property and will be removed in future phases of airport redevelopment.	3	$1.6M (2023 dollars)	Ongoing
	Conservation and Green Infrastructure Projects			
Greenseams® Program	MMSD Greenseams program has acquired 5,290 acres as of 2023 within and upstream of Milwaukee County to help prevent future flooding and protect flood management infrastructure investments within Milwaukee County. The current total assessed value of the land acquired is $29M.	--	$23M (dollars)	Ongoing
Working Soils® Program	In collaborative cooperation with the Milwaukee River Watershed Conservation Partners (MRWCP), MMSD's Working Soils® Program will support the acquisition of approximately 15 agricultural easements across 1,500 acres by 2026. The District anticipates receiving $2.4 million from the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) as cost-share reimbursement after the District has paid for each easement. The MMSD Working Soils® Program staff work with agricultural landowners to place voluntary, permanent easements on undeveloped, private properties along streams, hydric soils, and wetlands. This flood management program helps to build and connect priority environmental corridors, in coordination with the District's Greenseams® program.	--	$8.9M (2026 dollars)	2026

Table continued on next page.

Table 1.6 (Continued)

Project	Project Description	Structures Removed from the Floodplain	Cost	Completion Date
Conservation and Green Infrastructure Projects (continued)				
Reforestation and Wetland Restoration Program	The purpose of this project is to identify and implement large scale natural flood management strategies that work to mimic the natural hydrologic process. The scope of this project is to plant six million trees and restore or enhance 4,000 acres of wetlands in the Greater Milwaukee Watersheds (Milwaukee, Kinnickinnic, Menomonee, Oak Creek, Root River, and direct drainage to Lake Michigan). The work is supported by a 2022 Congressional Community Project Funding award of $800,000.	--	$11M	2032

Source: MMSD, Milwaukee County, Local Planning Team, and SEWRPC

including the County emergency management office and transit system; MMSD; interested nongovernmental organizations; and the health care community. The Local Planning Team met four times during the plan preparation period to provide input on the types of hazards to be considered, the appropriate mitigation strategies, and to review the draft report chapters. Those chapters were then refined to reflect the comments and recommendations of the LPT. The 2019 plan was provided to all neighboring communities in order to continue the coordination of hazard mitigation activities as provided by the use of the Milwaukee County plan as a framework for the City plan. The City of Milwaukee Common Council formally adopted the plan on November 5, 2019.

This Milwaukee County Mitigation Plan Update

As previously mentioned, this Milwaukee County hazard mitigation plan update was prepared under the guidance of an LPT (formally known as the Steering Committee) which comprised of representatives of the County and all of the communities within the County, as well as County agency representatives and local stakeholders. The LPT met three times during the plan preparation period to provide input on the types of hazards to be considered, the appropriate mitigation strategies, and to review the draft report chapters. The report chapters were then refined to reflect the comments and recommendations of the Team.

As draft chapters of the plan were completed, copies of the chapters were placed in downloadable form on the Commission website. A hazard mitigation planning webpage was available on this website on which members of the public could ask questions and submit comments on the draft plan text. Following completion of the community profiles and the risk and vulnerability assessments sections of the plan and review by the LPT, a public informational meeting was held to review these sections of the plan with local officials, stakeholders, and citizens and to solicit their input.

After the plan was completed in draft form, an additional public informational meeting was held to review the entire draft plan with local officials, stakeholders, and citizens and solicit their input. In addition, copies of the draft plan were made available at the offices of the Milwaukee County Office of Emergency Management and on the Commission website.

Once FEMA determined that the plan was approvable upon adoption, copies of the plan were sent to each of the local units of government requesting that they adopt the plan in order to retain future eligibility for mitigation funding. Funding to complete this plan was provided by the Hazard Mitigation Grant planning program administered by WEM. In addition, County and Commission staff were available to meet with communities on an individual basis to review the plan update and consider adoption and implementation steps. Copies of the adopted resolutions approving the plan by the local units of government are included in Appendix B.

BASIC STUDY AREA INVENTORY AND ANALYSIS 2

2.1 INTRODUCTION

Prioritizing and identifying at-risk community assets, such as information on pertinent natural and built features, is essential in developing potential projects and mitigation strategies that will reduce natural hazard vulnerabilities within the County and its communities. Accordingly, the collection and collation of definitive information regarding basic geographic and demographic characteristics, existing and planned land use, surface water system characteristics, critical facilities, and climate change trends affecting the County constitute important steps in the planning process. The following in-depth information regarding the relevant conditions in the study area (Milwaukee County) is useful in formulating and evaluating sound mitigation approaches.

2.2 CIVIL DIVISIONS

The geographic extent and functional responsibilities of civil divisions and special-purpose units of government are important factors to be considered in hazard mitigation planning, since these local units of government provide the basic structure of the decision-making framework, within which such planning must be addressed. The boundaries of the 19 civil divisions in Milwaukee County are listed in Chapter 1 and shown on Map 1.1 of this report. The total land area and proportion of the County within each civil division is presented in Table 2.1.

2.3 DEMOGRAPHIC AND ECONOMIC TRENDS AND PROJECTIONS

Information on the size, characteristics, and distribution of population, household, and employment levels can assist the County in preparing for projected changes overtime. Mitigation measures, such as proper design and development that help reduce impacts from future hazard weather events and promote community resiliency throughout the various socioeconomic community groups is essential in hazard mitigation planning.

Note, demographic projections for the year 2050 were prepared and developed by the Southeastern Wisconsin Regional Planning Commission (Commission or SEWRPC) in support of the regional land use and transportation plan, which is documented in Planning Report No. 55 (2nd Edition), *VISION 2050: A Regional Land Use and Transportation Plan for Southeastern Wisconsin* (June 2020).[13]

Population

Historical population levels within Milwaukee County are provided in Table 2.2. Between 1850 and 1890, the total population in Milwaukee County increased rapidly from 31,077 to 236,101 residents. After 1970, the County has been experiencing a steady decline in population. Based upon the 2020 Decennial U.S. Census, the population for Milwaukee County was 939,489 people, or about a 1 percent decrease since 2010. Growth is anticipated in the future, as the projected population for the year 2050 in Milwaukee County is expected to increase by 8.5 percent from 2020 levels, or roughly to 1,019,100 people (Table 2.2).

As indicated in Table 2.3, in 2020 the City of Milwaukee was the most populous community with 577,222 residents, or about 61 percent (over half) of the County's population. The next most populous communities in Milwaukee County in 2020 were the Cities of West Allis, Wauwatosa, Greenfield, Franklin, and Oak Creek.

[13] *SEWRPC Planning Report No. 55 is available on the Commission website (www.sewrpc.org).*

Vulnerable Populations

Every community needs to be able to prepare for and respond to hazardous events, including natural disasters. A number of factors include poverty; lack of access to transportation, jobs, technology, and educational resources; age; health; language barriers; insufficient education; and crowded housing can disproportionately affect the ability of an individual, group, or a community' to reduce or prevent the risks associated with a hazardous event. These social and economic conditions, known as social or socioeconomic vulnerabilities, are often associated with populations who have been historically underserved or overlooked. Mitigation measures aimed at reducing risks associated with extreme weather events on vulnerable populations and communities, including those within Milwaukee County, play a major role in this hazard mitigation Plan update.

The Milwaukee County Office of Emergency Management (OEM) GIS Department has an interactive map with various demographic characteristics, including those considered vulnerable, throughout Milwaukee County. This interactive map is accessible through the OEM website. For this Report, a sampling of these maps that show different types of vulnerable population locations is provided in Appendix C. As such, communities associated with certain or multiple social vulnerabilities should be considered in hazard mitigation planning.

Table 2.1
Areal Extent of Civil Divisions in Milwaukee County: 2015

Municipality	Area (Acres)	Percent of the County
Cities		
Cudahy	3,054	2.0
Franklin	22,197	14.3
Glendale	3,817	2.5
Greenfield	7,389	4.8
Milwaukee	61,886	39.8
Oak Creek	18,229	11.7
St. Francis	1,647	1.1
South Milwaukee	3,104	2.0
Wauwatosa	8,466	5.4
West Allis	7,300	4.7
Subtotal	137,089	--
Villages		
Bayside[a]	1,480	1.0
Brown Deer	2,812	1.8
Fox Point	1,838	1.2
Greendale	3,564	2.3
Hales Corners	2,046	1.3
River Hills	3,412	2.2
Shorewood	1,022	0.7
West Milwaukee	720	0.5
Whitefish Bay	1,358	0.9
Subtotal	18,252	--
County Total	155,341	100.0

[a] *This table reflects the jurisdictional acres for the Village of Bayside that lies within Milwaukee County only.*

Source: SEWRPC

Additionally, the Centers for Disease Control and Prevention (CDC) and the Agency for Toxic Substances and Disease Registry (ATSDR) created a Social Vulnerability Index (SVI) database using U.S. Census data to determine the social vulnerability of every U.S. census tract.[14] The SVI ranks each tract on 16 social factors.[15] These social factors are grouped into four related themes to assess an area's social vulnerability including socioeconomic status, household characteristics, race and ethnic minority status, and type of housing and transportation.

As indicated in Figure 2.1, the overall SVI for Milwaukee County (using all 16 variables) ranges from high to low. There is a high degree of correlation between the themes, indicating that many areas of the County have populations who may be especially vulnerable due to multiple factors. Although socially vulnerable individuals live throughout the County, there are high concentrations of socially vulnerable residents in denser urban areas, specifically within and around the City of Milwaukee. The CDC/ATSDR overall 2020 SVI score for Milwaukee County is 0.84, indicating Milwaukee County has a high overall level of social vulnerability.

[14] *Census tracts are subdivisions of counties for which the Census collects statistical data.*

[15] *Socioeconomic Status: Populations Below 150% Poverty, Unemployed, Housing Costs a Burden, No High School Diploma, and No Health Insurance; Household Characteristics: Aged 65 and Older, Aged 17 and Younger, Civilian with a Disability, Single-Parent Household and English language proficiency; Race and Ethnic Minority Status: Hispanic or Latino (or any race); Black and African American, two or more races, American Indian and Alaska Native, Native Hawaiian and Other Pacific Islander and other races; Housing type/Transportation: Multi-Unit Structures, Manufactured Homes, Crowding, No Vehicle, and Group Quarters (www.atsdr.cdc.gov).*

FEMA also integrates the SVI into its National Risk Index (NRI) dataset and interactive mapping tool. The NRI tool enables public health professionals, emergency planners, and the general public to understand their risk to 18 natural hazards.[16] It was designed and built by FEMA in collaboration with various stakeholders and partners including academia; local, state, and federal governments; and private industry. The NRI uses available source data (i.e., the Social Vulnerability Index by CDC and the Baseline Resilience Indicators for Communities from the University of South Carolina) for natural hazard and community risk factors to develop a standard risk measurement for each county and Census tract in the United States. The NRI provides Risk Index scores and rating based on data for Expected Annual Loss due to natural hazards, Social Vulnerability, and Community Resilience. Milwaukee County has a Risk Index rating of 93.8, or "Relatively Moderate," and a Community Resilience rating of 99.0, or "Very High," when compared to the rest of the U.S. This interactive mapping tool, available through FEMA's website, can be used to support resilience building efforts and ensure that resources go where they are needed most.

Table 2.2
Historical Resident Population Levels in Milwaukee County: 1850-2050

Year	Population	Change from Preceding Census	
		Incremental	Percent
1850	31,077	--	--
1860	62,518	31,441	101.2
1870	89,930	27,412	43.8
1880	138,538	48,608	54.1
1890	236,101	97,563	70.4
1900	330,017	93,916	39.8
1910	433,187	103,170	31.3
1920	539,449	106,262	24.5
1930	725,263	185,814	34.4
1940	766,885	41,622	5.7
1950	871,047	104,162	13.6
1960	1,036,041	164,994	18.9
1970	1,054,249	18,208	1.8
1980	964,249	-89,261	-8.5
1990	959,275	-5,713	-0.6
2000	940,164	-19,111	-2.0
2010	947,735	7,571	0.8
2020	939,489	-8,246	-0.9
2050[a]	1,019,100	79,611	8.5

[a] *Population estimate based on projections from SEWRPC's* VISION 2050 Plan.

Source: U.S. Bureau of the Census (1950-2020 decennial censuses), Wisconsin Department of Health Services, and SEWRPC

Population by Age Distribution

Older adults (65 years of age or more) as well as infants and young children (under the age of 14) are more sensitive and vulnerable to natural weather hazard events, particularly extreme temperature incidents. In addition, people ages 60 and over tend to have more chronic health conditions which can be made worse by high temperatures because as the temperature rises, it becomes harder to cool off the body. Also, elderly people can have mobility issues, which can make it hard to help when it is needed during an extreme heat event. And they tend to live alone and be more socially isolated, which means other people may not know they are in distress.[17] According to the 2020 Decennial U.S. Census age distribution data for Milwaukee County (see Table 2.4), about 14 percent of the total population is aged 65 years or older, while nearly 20 percent is under the age of 14. In 2050, the projected population of older adults and young children in Milwaukee County is estimated to be about the same (about 19 percent for older adults and 19 percent for young children). Note, as shown in Appendix C (Map C.5), the elderly population (20 percent or greater) resides in areas throughout the entire County, with the least amount located within the City of Milwaukee. Accordingly, this vulnerable population will require a larger amount of emergency and health services during hazardous weather events.

Households

In addition to total population, the number of households, or occupied housing units, is of importance in land use planning in that it greatly influences the demand for land, as well as the demand for transportation and other public facilities and services. A household includes all persons who occupy a housing unit, which is defined by the Census Bureau as a house, apartment, manufactured home, or a group of rooms, or a single room that is occupied, or intended for occupancy, as a separate living quarters.[18]

[16] *The 18 natural hazards include: Avalanche, Coastal Flooding, Cold Wave, Drought, Earthquake, Hail, Heat Wave, Hurricane, Ice Storm, Landslide, Lightning, Riverine Flooding, Strong Wind, Tornado, Tsunami, Volcanic Activity, Wildfire, and Winter Weather.*

[17] *Anita Snow,* Milwaukee Journal Sentinel, Takeaway about Dangers that Affect Older Populations During Heat Waves, *May, 2023*

[18] *Separate living quarters are defined as those in which the occupants live separately from any other persons in the building, and which have direct access from the outside of the building or through a common hall.*

Table 2.3
Population Change by Municipality in Milwaukee County: 2010-2020

Municipality	Population 2010	Population 2020	Percent of Change	Percent of County (2020)
Cities				
Cudahy	18,267	18,204	-0.3	1.9
Franklin	35,451	36,816	3.9	3.9
Glendale	12,872	13,357	3.8	1.4
Greenfield	36,720	37,803	2.9	4.0
Milwaukee	594,833	577,222	-3.0	61.4
Oak Creek	34,451	36,497	5.9	3.9
St. Francis	9,365	9,161	-2.2	1.0
South Milwaukee	21,156	20,795	-1.7	2.2
Wauwatosa	46,396	48,387	4.3	5.2
West Allis	60,411	60,325	-0.1	6.4
Villages				
Bayside[a]	4,300	4,378	1.8	0.5
Brown Deer	11,999	12,507	4.2	1.3
Fox Point	6,701	6,934	3.5	0.7
Greendale	14,046	14,854	5.8	1.6
Hales Corners	7,692	7,720	0.4	0.8
River Hills	1,597	1,602	0.3	0.2
Shorewood	13,162	13,859	5.3	1.5
West Milwaukee	4,206	4,114	-2.2	0.4
Whitefish Bay	14,110	14,954	6.0	1.6
County Total	947,735	939,489	-0.9	100.0

[a] *Milwaukee County portion only. Total population for the Village of Bayside was 4,389 in 2010 and 4,482 in 2020.*

Source: U.S. Bureau of the Census and SEWRPC

Trends in the number of households in the County are shown in Table 2.5. The County experienced significant gain in the number of new households between 1950 and 1960 (26.3 percent increase). Along with the population rates, the number of households has been quite stagnant since 1970. As such, the projected number of households in 2050 is expected to increase by about eight percent. To note, the number of individuals per household is decreasing (see Table 2.5). This indicates smaller households with a smaller support network or more isolated individuals in the County, which is important information in hazard mitigation planning.

As indicated in Table 2.6 and on Map 2.1 there are 15 manufactured home parks in Milwaukee County. Almost all of these parks have close to, or more than, 100 homes. This is important to note because manufactured homes can be particularly vulnerable to natural hazards such as high winds, tornadoes, or flooding.

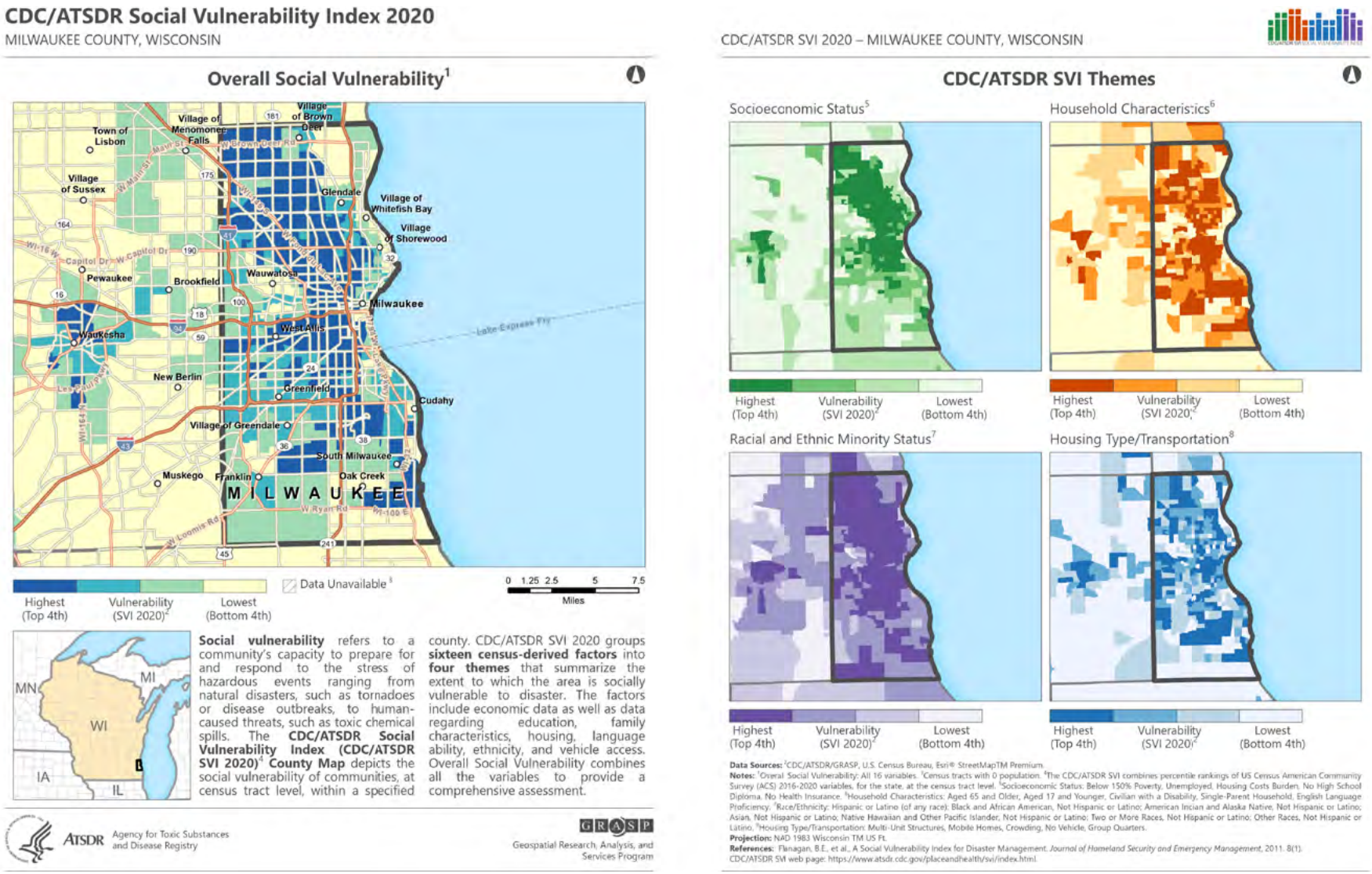
Employment

Trends in job growth are set forth in Table 2.7. The data reflect the number of both full- and part-time jobs within the County. A significant increase in the number of jobs may attract additional residents to the County, thus influencing population growth. As indicated in Table 2.7, employment growth rapidly increased between 1970 and 1980, with an increase in the number of jobs of 11 percent. From 1980 to 2000 there was a gradual job increase. Then the year 2010 experienced a job decrease of about 8 percent. After 2010 employment in Milwaukee County has generally increased. Between the year 2021 and year 2050 the total number of jobs in the County is projected to increase by about 8 percent. This translates to about a 3 percent increase per decade, which is comparable to historical employment growth rates.

Property Value

The value of real estate and personal property in a community reflects the upper end of the potential for property damage in each community. The equalized value of the real estate and personal property in Milwaukee County and each of the general-purpose units of government in the County as of 2022 totals $87 billion as shown in Table 2.8.

Figure 2.1
Social Vulnerability Impacts in Milwaukee County: 2020



Source: Agency for Toxic Substances and Disease Registry

Table 2.4
Actual and Projected Population by Age in Milwaukee County: 2020-2050

Age Group	Actual Population 2020	Percent of County	Projected Population 2050	Percent of County
Under 5	58,874	6.3	64,221	6.6
5 to 9	60,142	6.4	59,857	6.1
10 to 14	63,818	6.8	58,378	6.0
15 to 19	64,275	6.8	58,236	6.0
20 to 24	69,980	7.4	65,068	6.7
25 to 29	76,012	8.1	69,614	7.1
30 to 34	72,426	7.7	68,430	7.0
35 to 39	64,849	6.9	63,684	6.5
40 to 44	56,313	6.0	59,504	6.1
45 to 49	52,202	5.6	57,764	5.9
50 to 54	53,407	5.7	55,667	5.7
55 to 59	56,675	6.0	58,107	5.9
60 to 64	55,963	6.0	55,443	5.7
65 to 69	46,738	5.0	47,911	4.9
70 to 74	34,225	3.6	38,199	3.9
75 to 79	21,210	2.3	30,600	3.1
80 to 84	14,756	1.6	25,358	2.6
85 and Older	17,624	1.9	40,663	4.2
County Total	939,489	100.0	976,704	100.0

Note: Projected population by age data has not been updated to reflect numbers associated with the proposed Foxconn manufacturing campus. Because of this, the total projected population in this Table differs from the total projected population in Table 2.2, which considers the proposed Foxconn development.

The 2050 projected population by age data is derived from *SEWRPC Technical Report No.11 (5th Edition),* The Population of Southeastern Wisconsin, *2013.*

Source: U.S. Bureau of the Census and SEWRPC

Table 2.5
Number of Households in Milwaukee County: 1950-2050

Year	Number of Households	Change from Preceding Census		Household Size
		Number	Percent	
1950	249,232	--	--	3.49
1960	314,875	65,643	26.3	3.29
1970	338,605	23,730	7.5	3.11
1980	363,653	25,048	7.4	2.65
1990	373,048	9,395	2.6	2.57
2000	377,729	4,681	1.2	2.49
2010	383,591	5,862	1.5	2.47
2020	393,601	10,010	2.6	2.39
2050[a]	427,800	31,070	7.8	2.38

[a] *Number of households are projections from SEWRPC's* VISION 2050 Plan.

Source: U.S. Bureau of the Census and SEWRPC

Table 2.6
Manufactured Home Parks Located in Milwaukee County: 2023

City	Park Name	Address	Park Size (Number of Homes)
Cudahy	White's Mobile Home Estates	5926 S. Packard Avenue	Medium (51-100)
Franklin	Franklin Mobile, LLC.	6361 S. 27th Street	Medium (51-100)
	Badger Mobile Home Park	6405 S. 27th Street	Medium (51-100)
Milwaukee	Tower View Court, Inc.	700 W. Layton Avenue	Medium (51-100)
	Tower View Court, Inc.	4217 S. 6th Street	Large (>100)
	Tower View Court, Inc.	4157 S. 6th Street	Medium (51-100)
	College Mobile Home Court	6160 S. 6th Street	Large (>100)
Oak Creek	Oak Creek Estates, LLC.	2301 W. College Avenue	Large (>100)
	HyView Mobile Home Park	2331 W. College Avenue	Large (>100)
	Sunrise Shores Mobile Home Court	8481 S. 5th Avenue	Small (<50)
West Allis	Mayfair Village Mobile Home Court, LLC	1000 S. 108th Street	Large (>100)
	Hillside Properties	10211 W. Greenfield Avenue	Medium (51-100)
	Greenfield Terrace, LLC	10525 W. Greenfield Avenue	Medium (51-100)
	Lincoln Park Mobile Home Court, LLC.	10315 W. Greenfield Avenue	Large (>100)
	Mobile Estates of West Allis	10401 W. Greenfield Avenue	Small (<50)

Source: Wisconsin Department of Safety and Professional Services

2.4 LAND USE AND NATURAL RESOURCES

Land use (built or natural) is an important determinant of the potential impact a particular hazard may have, and of the actions which may or should be taken to mitigate the hazard impacts. Accordingly, an understanding of the amount, type, and spatial distribution of urban and rural land uses within the County is an important consideration in the development of a sound hazard mitigation plan. This section presents a description of the land uses in the County.

Existing Land Uses: 2015

Land uses in Milwaukee County are based on the COMMISSION land use inventory conducted in 2015, as shown on Map 2.2 and summarized in Table 2.9.

Urban land uses occupied 117,665 acres, or about 76 percent of the County, in 2015. Residential land uses comprised the largest urban land use category in the County, encompassing 51,868 acres, or about 44 percent of all urban land and about 33 percent of all land in Milwaukee County. The second largest urban land use in the County was transportation, communications, and utility services, which comprised of 34,104 acres, or about 22 percent of all land in Milwaukee County. Both these land use categories are important at-risk community assets which need to be considered for hazard mitigation planning.

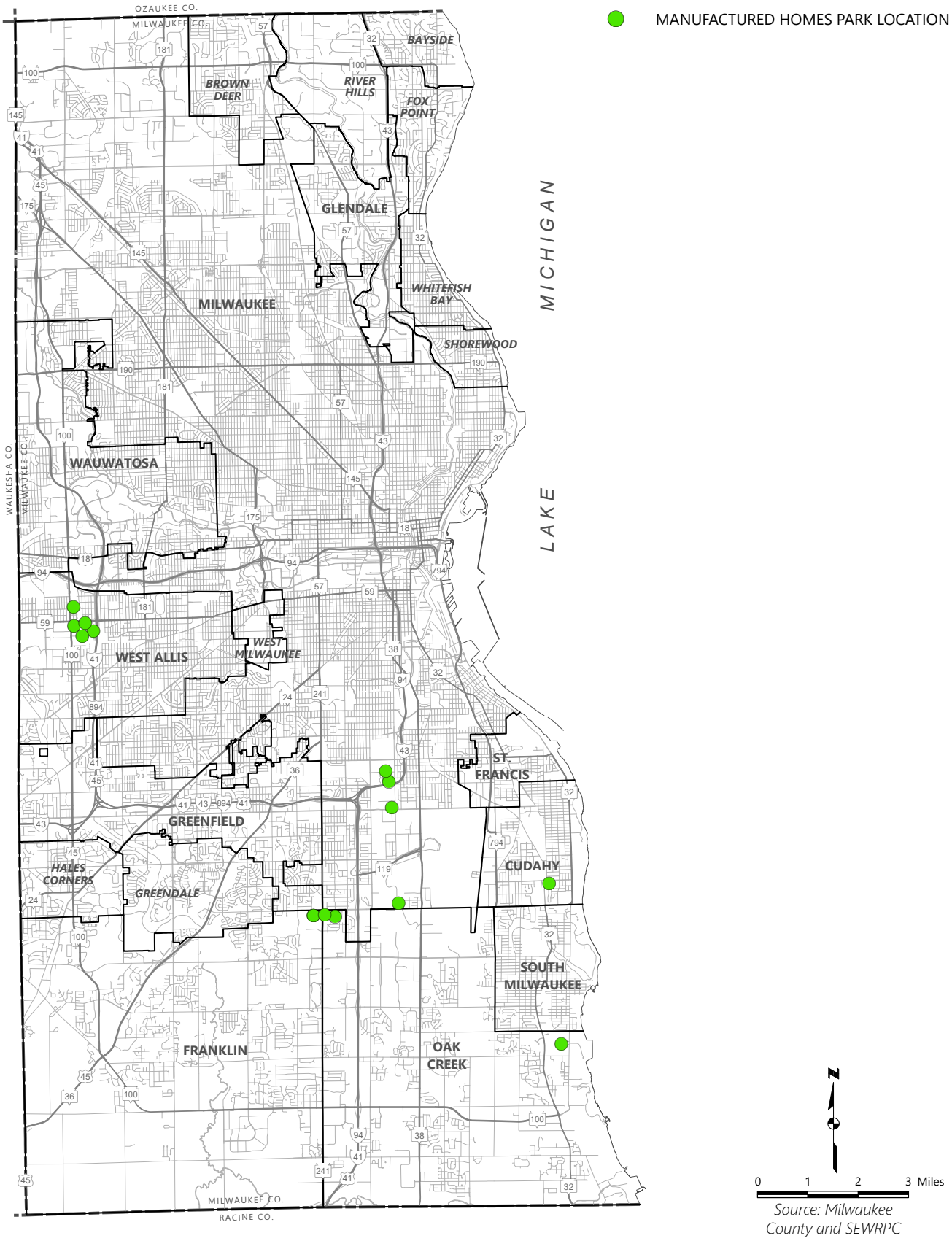
Nonurban land uses consist of agricultural lands; natural resource areas, including surface waters, wetlands, and woodlands; quarries and landfills; and open land. As indicated in Table 2.9 and on Map 2.2, nonurban land uses encompassed a total of 37,676 acres, or about 24 percent of the County, in 2015. As indicated in Tables 2.9 and 2.10, agricultural land encompassed 8,507 acres, or about 23 percent of nonurban land uses and only about 5 percent of all land in the County. As indicated on Map 2.3, most of the existing agricultural land is located in the southern portion of the County within the Cities of Franklin and Oak Creek, with a small amount also located at the very north end of the County.

Planned Land Use: 2050

Planned land use must seek to accommodate the impending demand for land within the Region, which primarily depends on future population, household, and employment levels. The Commission recently completed projections of land use, population, households, and employment from the period of 2015 to 2050 to provide a basis for preparation of VISION 2050.[19] The land use component of VISION 2050 recommends focusing development within planned urban service areas, preserving environmentally significant lands,

[19] *SEWRPC Planning Report No. 55 (2nd Edition),* VISION 2050: A Regional Land Use and Transportation Plan for Southeastern Wisconsin *(June 2020).*

Map 2.1
Manufactured Homes and Parks in Milwaukee County: 2023



Source: Milwaukee County and SEWRPC

and preserving highly productive agricultural lands. Existing local comprehensive plans, input from local planning officials, committed developments, and input from VISION 2050 public outreach activities were considered in allocating increases in regional population, households, employment, and associated land uses to develop the land use component of VISION 2050. Map 2.4 present the recommended development pattern from the VISION 2050 land use component as it pertains to Milwaukee County.

Planned development depicted on Map 2.4 include land uses such as city and traditional mixed-use development (commercial, housing, businesses, industry, and offices in densely populated areas); and, medium (larger lots) and high density (small lots) residential. Developed lands are located throughout the vast majority of the County, with the least amount of planned development located within the Cities of Franklin and Oak Creek as well as a small portion in the northwestern corner of the City of Milwaukee.

Urban (or developed) land uses in Milwaukee County is projected to continue to increase between 2015 and 2050. This urban growth comes predominantly at the expense of agricultural lands, open lands, and woodlands. Anticipating the needs of future populations, rather than responding to problems as they occur, is a main goal of hazard mitigation planning. Therefore, sound land use planning is a necessary tool for reducing or eliminating the costs of future hazard events.

Table 2.7
Number of Jobs in Milwaukee County: 1970-2050

Year	Number of Jobs	Change from Previous Time Period	
		Number	Percent
1970	525,142	--	--
1980	583,175	58,033	11.0
1990	609,787	26,612	4.6
2000	624,639	14,852	2.4
2010	574,458	-50,181	-8.0
2015	597,698	23,240	4.0
2020	578,605	19,093	3.2
2050[a]	634,600	55,995	9.7

[a] *Estimated jobs for the year 2050 as modeled in SEWRPC's* VISION 2050 Plan.

Source: U.S. Bureau of Economic Analysis and SEWRPC

Table 2.8
Equalized Value of Property in Milwaukee County by Municipality: 2022

Municipality	2022 Equalized Value ($)
Cities	
Cudahy	1,530,067,600
Franklin	5,423,303,100
Glendale	2,313,903,100
Greenfield	4,053,650,500
Milwaukee	39,432,998,900
Oak Creek	5,226,696,500
St. Francis	857,917,100
South Milwaukee	1,713,241,100
Wauwatosa	9,006,577,400
West Allis	5,518,411,300
Subtotal	75,076,766,600
Villages	
Bayside	782,030,400
Brown Deer	1,295,316,300
Fox Point	1,359,086,300
Greendale	1,778,430,400
Hales Corners	814,963,700
River Hills	509,420,400
Shorewood	2,047,163,700
West Milwaukee	459,054,300
Whitefish Bay	2,911,508,400
Subtotal	11,956,973,900
County Total	87,033,740,500

Source: Wisconsin Department of Revenue and SEWRPC

Surface Water Resources and Floodplains

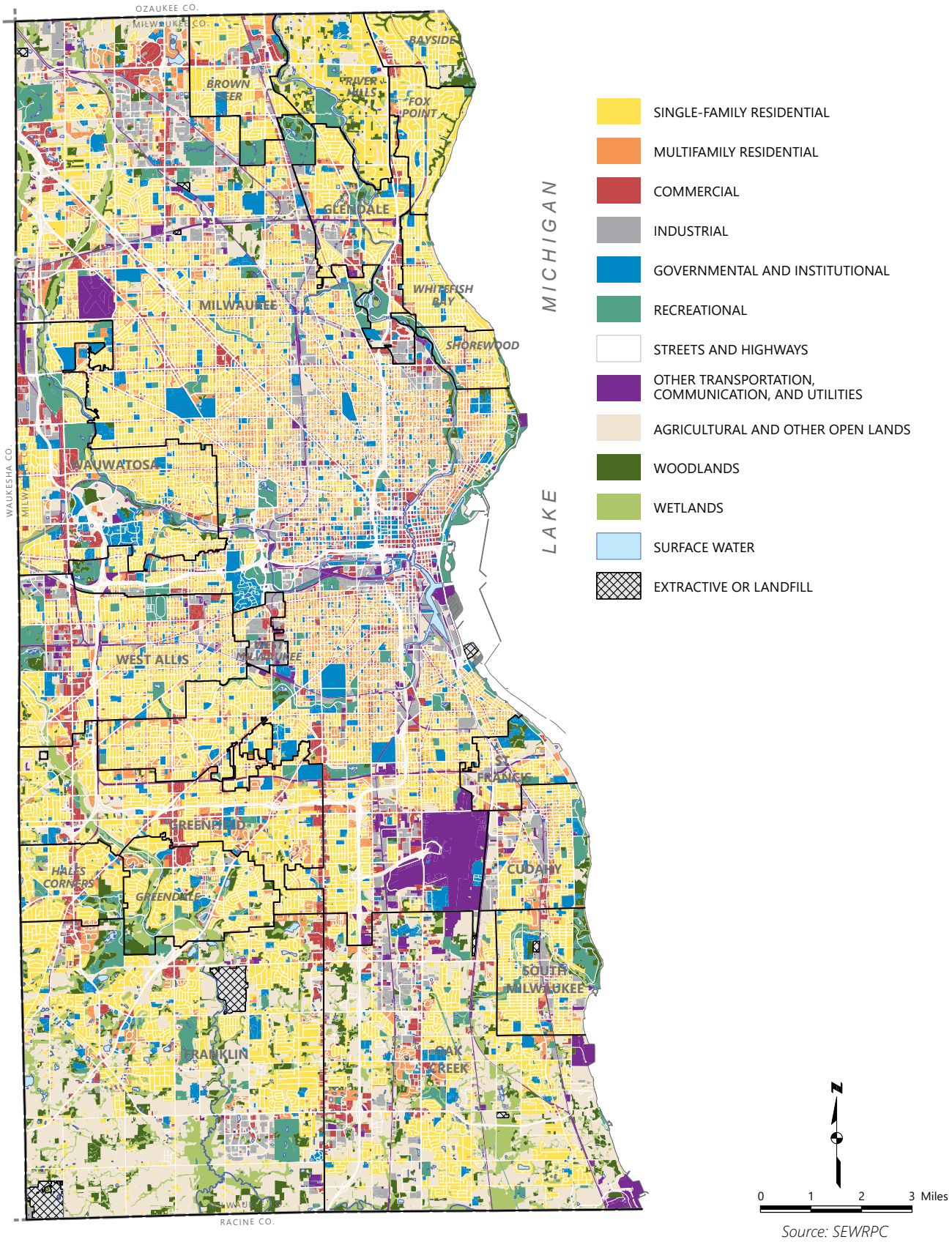
Surface water resources, consisting of streams and lakes, form a particularly important element of the natural resource base. Surface water resources provide recreational opportunities, influence the physical development of the County, and enhance its aesthetic quality. Understanding the protection, enhancement, and proper development of these invaluable resources constitutes a major role in hazard mitigation planning, particularly in flood and drought mitigation.

Watersheds

As shown on Map 2.5, there are seven major watersheds within Milwaukee County. With the exception of the Fox River watershed, all of the watersheds in the County are part of the Great Lakes-St. Lawrence River drainage system. The Fox River watershed is located in the extreme southwestern portion of the City of Franklin and ultimately discharges into the Mississippi River system.

The small part of the Fox River watershed within the County encompasses 1.3 square miles, or 0.5 percent of the County. The Kinnickinnic River watershed, which is entirely located within Milwaukee County, encompasses 24.5 square miles, or 10.1 percent of the County. Much of the Menomonee River watershed is located in Milwaukee County and encompasses 55.3 square miles, or 22.8 percent of the County. The lower portion of the Milwaukee River watershed in Milwaukee County encompasses 57.7 square miles, or

Map 2.2
Existing Land Use in Milwaukee County: 2015



Source: SEWRPC

Table 2.9
Existing Land Use in Milwaukee County: 2015

Land Use Category[a]	Acres	Percent of Subtotal	Percent of Total
Urban[a]			
Residential	51,868	44.1	33.4
Commercial	7,981	6.8	5.1
Industrial	6,993	5.9	4.5
Transportation, Communications, and Utilities	34,104	29.0	22.0
Governmental and Institutional[b]	8,719	7.4	5.6
Recreational[c]	8,000	6.8	5.1
Urban Subtotal	117,665	100.0	75.7
Nonurban			
Agricultural	8,507	22.6	5.5
Wetlands	7,440	19.8	4.8
Woodlands	5,691	15.1	3.7
Extractive, Landfills, and Other Open Lands	14,483	38.4	9.3
Surface Water	1,555	4.1	1.0
Nonurban Subtotal	37,676	100.0	24.3
Total	155,341	--	100.0

[a] *Parking lots are included with the associated use.*

[b] *Includes public and private schools, government offices, police and fire stations, libraries, cemeteries, religious institutions, hospitals, nursing homes, and similar facilities.*

[c] *Includes only land which is intensively used for recreational purposes.*

Source: SEWRPC

23.8 percent of the County. The Oak Creek watershed, which is entirely located within Milwaukee County, encompasses 27.4 square miles, or 11.2 percent of the County. Most of the upper portion of the Root River watershed is located within Milwaukee County and includes 57.7 square miles, or 23.8 percent of the County. A seventh watershed encompasses those areas adjacent to Lake Michigan that drain directly into the Lake through small perennial or intermittent streams or overland flow. This watershed totals 18.9 square miles, or 7.8 percent of the County. The Regional Planning Commission has developed comprehensive watershed plans for all of these watersheds except for the Lake Michigan direct drainage area.[20]

Streams

Major streams are defined as those which maintain, at a minimum, a small continuous flow throughout the year except under unusual drought conditions. There were 103 miles of named perennial rivers and streams in Milwaukee County.[21] As noted above, the County includes at least portions of seven major watersheds (Map 2.5). No major streams in the Fox River watershed are located in Milwaukee County. Streams in the Kinnickinnic River watershed, which is located in the central portion of the County, include the Kinnickinnic River, Wilson Park Creek, S. 43rd Street Ditch, Lyons Park Creek, Villa Mann Creek, Cherokee Park Creek, and Holmes Avenue Creek. Major streams in the Milwaukee County portion of the Menomonee River watershed, which includes the area in the northwestern portion of the County, include the Menomonee River, Woods Creek, Honey Creek, Underwood Creek, Grantosa Creek, and the Little Menomonee River. Major streams in the Milwaukee County portion of the Milwaukee River watershed, which includes the area

[20] *SEWRPC Planning Report No. 9,* A Comprehensive Plan for the Root River Watershed*, July 1966; SEWRPC Planning Report No. 12,* A Comprehensive Plan for the Fox River Watershed*, Volume One,* Inventory Findings and Forecasts*, April 1969, Volume Two,* Alternative Plans and Recommended Plan*, February 1970; SEWRPC Planning Report No. 13,* A Comprehensive Plan for the Milwaukee River Watershed*, Volume One,* Inventory Findings and Forecasts*, December 1970, Volume Two,* Alternative Plans and Recommended Plan*, October 1971; SEWRPC Planning Report No. 26,* A Comprehensive Plan for the Menomonee River Watershed*, Volume One,* Inventory Findings and Forecasts*, October 1976, Volume Two,* Alternative Plans and Recommended Plan*, October 1976; SEWRPC Planning Report No. 32,* A Comprehensive Plan for the Kinnickinnic River Watershed*, December 1978; and SEWRPC Planning Report No. 36,* A Comprehensive Plan for the Oak Creek Watershed, *August 1986.*

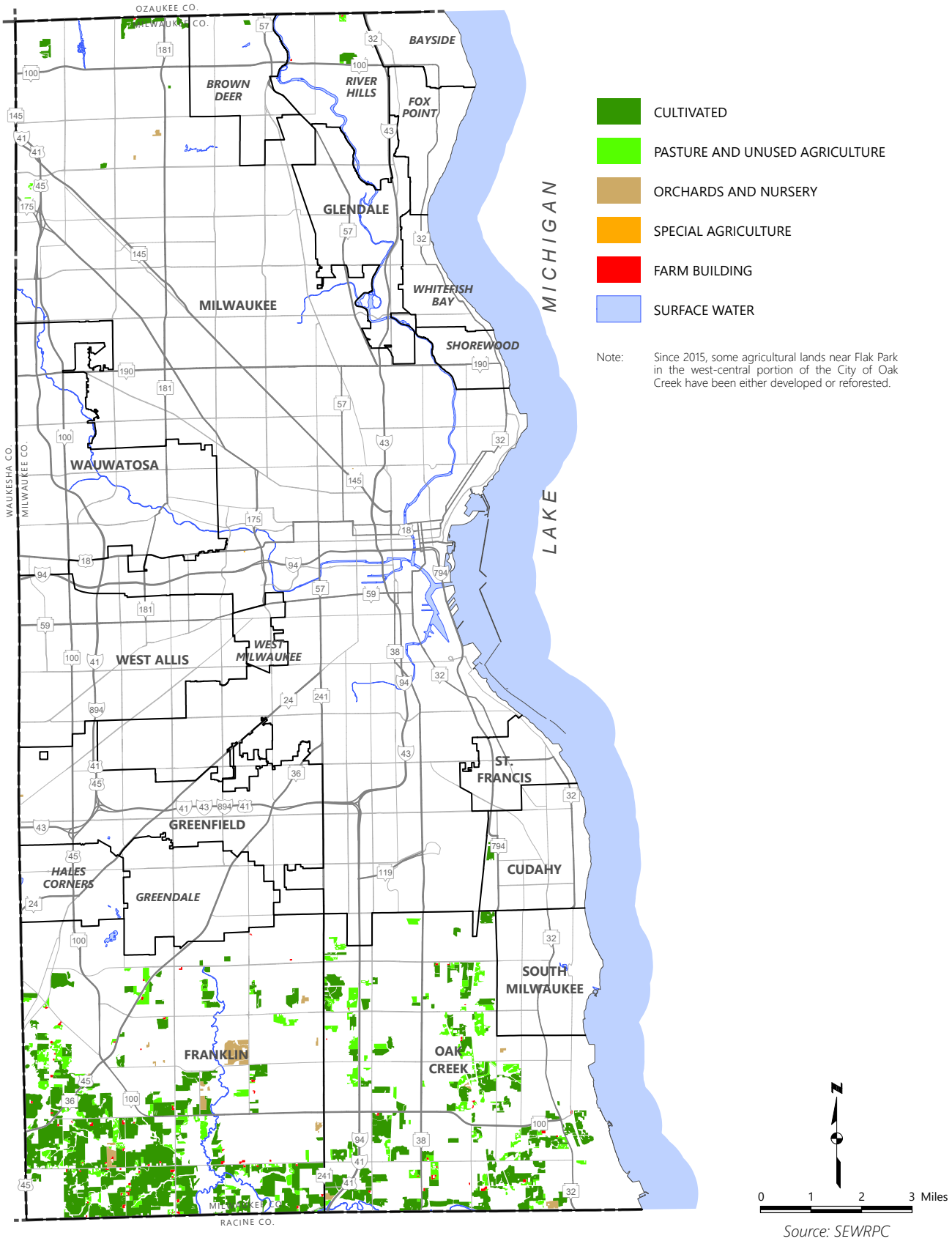
[21] *Wisconsin Department of Natural Resources (Wisconsin Conservation Department*), Surface Water Resources of Milwaukee County*, 1964.*

Table 2.10
Existing Agricultural Lands (Acres) in Milwaukee County: 2015

Municipality	Cultivated Lands	Percent of Agricultural Lands	Pastureland and Unused Agricultural Lands	Percent of Agricultural Lands	Orchards and Nurseries	Percent of Agricultural Lands	Special Agriculture	Percent of Agricultural Lands	Farm Buildings	Percent of Agricultural Lands	Total Agricultural Lands
Cities											
Cudahy	33.1	100.0	--	--	--	--	--	--	--	--	33.1
Franklin	4,203.4	79.7	761.1	14.4	238.0	4.5	--	--	72.2	1.4	5,274.7
Glendale	--	--	--	--	--	--	--	--	--	--	0.0
Greenfield	--	--	--	--	2.4	100.0	--	--	--	--	2.4
Milwaukee	149.0	87.7	7.1	4.2	11.9	7.0	0.7	0.4	1.2	0.7	169.9
Oak Creek	2,143.9	72.4	747.8	25.2	41.7	1.4	--	--	28.4	1.0	2,961.8
St. Francis	--	--	--	--	--	--	--	--	--	--	0.0
South Milwaukee	--	--	--	--	--	--	--	--	--	--	0.0
Wauwatosa	--	--	--	--	--	--	--	--	--	--	0.0
West Allis	--	--	--	--	--	--	--	--	--	--	0.0
Villages											
Bayside	--	--	--	--	--	--	--	--	--	--	0.0
Brown Deer	7.2	100.0	--	--	--	--	--	--	--	--	7.2
Fox Point	--	--	--	--	--	--	--	--	--	--	0.0
Greendale	--	--	--	--	--	--	--	--	--	--	0.0
Hales Corners	--	--	--	--	--	--	--	--	--	--	0.0
River Hills	42.7	74.0	13.3	23.1	--	--	--	--	1.7	2.9	57.7
Shorewood	--	--	--	--	--	--	--	--	--	--	0.0
West Milwaukee	--	--	--	--	--	--	--	--	--	--	0.0
Whitefish Bay	--	--	--	--	--	--	--	--	--	--	0.0
County Total	6,579.3	77.3	1,529.3	18.0	294.0	3.5	0.7	<0.1	103.5	1.2	8,506.8
Percent of Total Land	4.2	--	1.0	--	0.2	--	<0.1	--	0.1	--	5.5

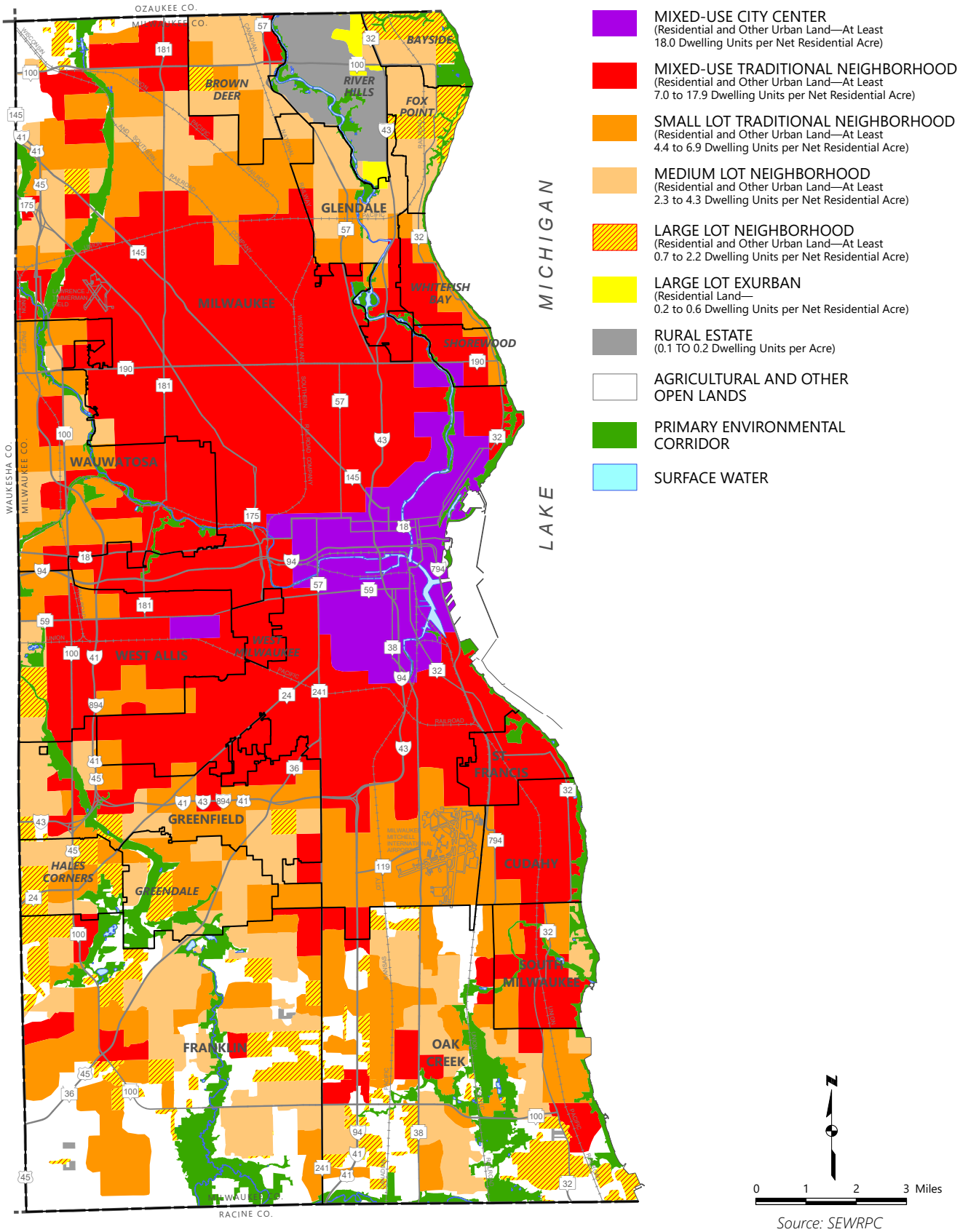
Source: SEWRPC

Map 2.3
Agricultural Lands in Milwaukee County: 2015



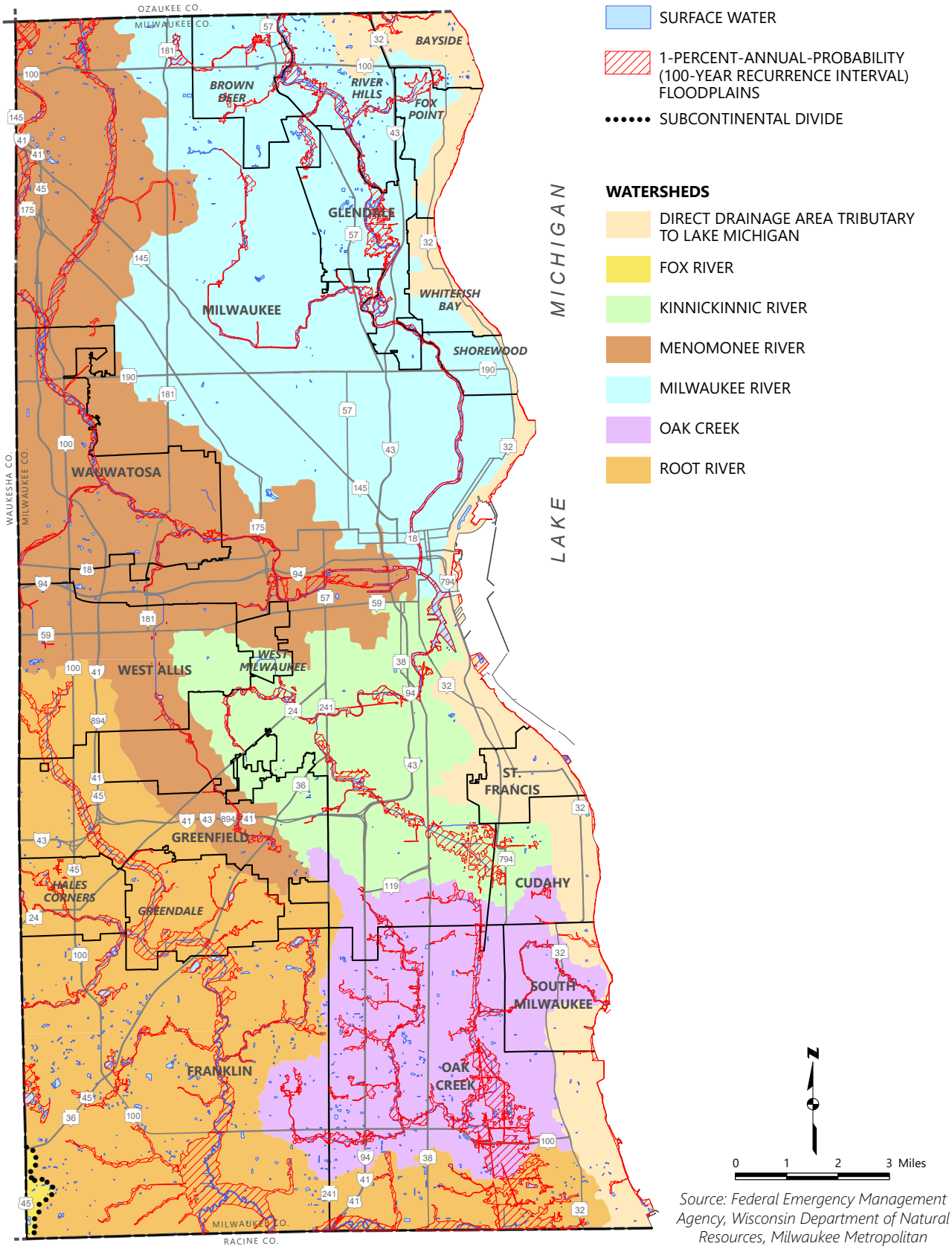
Source: SEWRPC

Map 2.4
VISION 2050 Land Use Development Pattern as it Pertains to Milwaukee County



Source: SEWRPC

Map 2.5
Watersheds and Surface Waters in Milwaukee County: 2020



Source: Federal Emergency Management Agency, Wisconsin Department of Natural Resources, Milwaukee Metropolitan Sewerage District, and SEWRPC

in the northeastern portion of the County, include the Milwaukee River, Lincoln Creek, Wahl Creek, Brown Deer Park Creek, Southbranch Creek, Beaver Creek, and Indian Creek. Streams in the Oak Creek watershed, which is located in the southeastern portion of the County, include Oak Creek, the Mitchell Field Drainage Ditch, and North Branch Oak Creek. Major streams in the Milwaukee County portion of the Root River watershed, which includes the area in the southern and southwestern portions of the County, include the Root River, Crayfish Creek, the Root River Canal, Ryan Creek, East Branch Root River, Legend Creek, Dale Creek, Tess Corners Creek, Whitnall Park Creek, Wildcat Creek, and Hale Creek. The Lake Michigan direct drainage area is located along the eastern margins of the County with Fish Creek being the only major stream located in the Milwaukee County portion of this watershed. Major streams in Milwaukee County are included on Map 2.5.

In the absence of mitigative measures, increased urbanization in a watershed may be expected to result in increased streamflow rates and volumes, with potential increases in flooding problems. In communities in Milwaukee County, the requirements of MMSD Chapter 13, "Surface Water and Stormwater,"[22] are applied to mitigate instream increases in peak rates of flow that could occur due to new urban development. The authority for MMSD to reduce the risk of flooding is in Wis. Stats., sec. 200.31(1).

Map 2.6 shows the channel bed conditions in streams within Milwaukee County as of 2019. Much of the stream network has been modified over time. Many stream reaches have been channelized and straightened, and some stream reaches have been enclosed in conduit. In addition, some sections of stream channel have been concrete lined. These modifications can be found on the mainstem of the Kinnickinnic River and Wilson Park Creek and small reaches of Edgerton Creek, Lyons Park Creek, and Villa Mann Creek in the Kinnickinnic River watershed; portions of Honey Creek, Underwood Creek, and Woods Creek in the Menomonee River watershed; reaches of Beaver Creek, Brown Deer Park Creek, Indian Creek, Lincoln Creek, Southbranch Creek, and Wahl Creek in the Milwaukee River watershed; and reaches along the mainstem of Oak Creek and a tributary to the North Branch of Oak Creek in the Oak Creek watershed.

Lakes and Ponds

While Milwaukee County contains no major lakes with surface areas over 50 acres, it has a number of small lakes, pond, and lagoons. Most of these waterbodies have less than 10 acres of surface area. Many of them are located within the County parks system. The lakes, ponds, and lagoons in the County are shown on Map 2.5.

Wetlands

Wetlands form at the transition between surface water, groundwater, and land resources. As such, these areas are inundated or saturated by surface water or groundwater at a frequency, and with a duration sufficient to support vegetation adapted for life in saturated soils. Wetlands generally occur in depressions and near the bottom of slopes, particularly along lakeshores and streambanks, and on large land areas that are poorly drained. They perform important natural functions that include water quality protection, stabilization of lake levels and streamflow, reduction in stormwater runoff by providing areas for floodwater impoundment and storage, and protection of shorelines from erosion.

The location and extent of wetlands in Milwaukee County are shown on Map 2.5. These wetlands are based upon the 2015 Wisconsin Wetlands Inventory. In total, the County's wetlands encompassed about 7,440 acres, or about 5 percent of all land in the County.

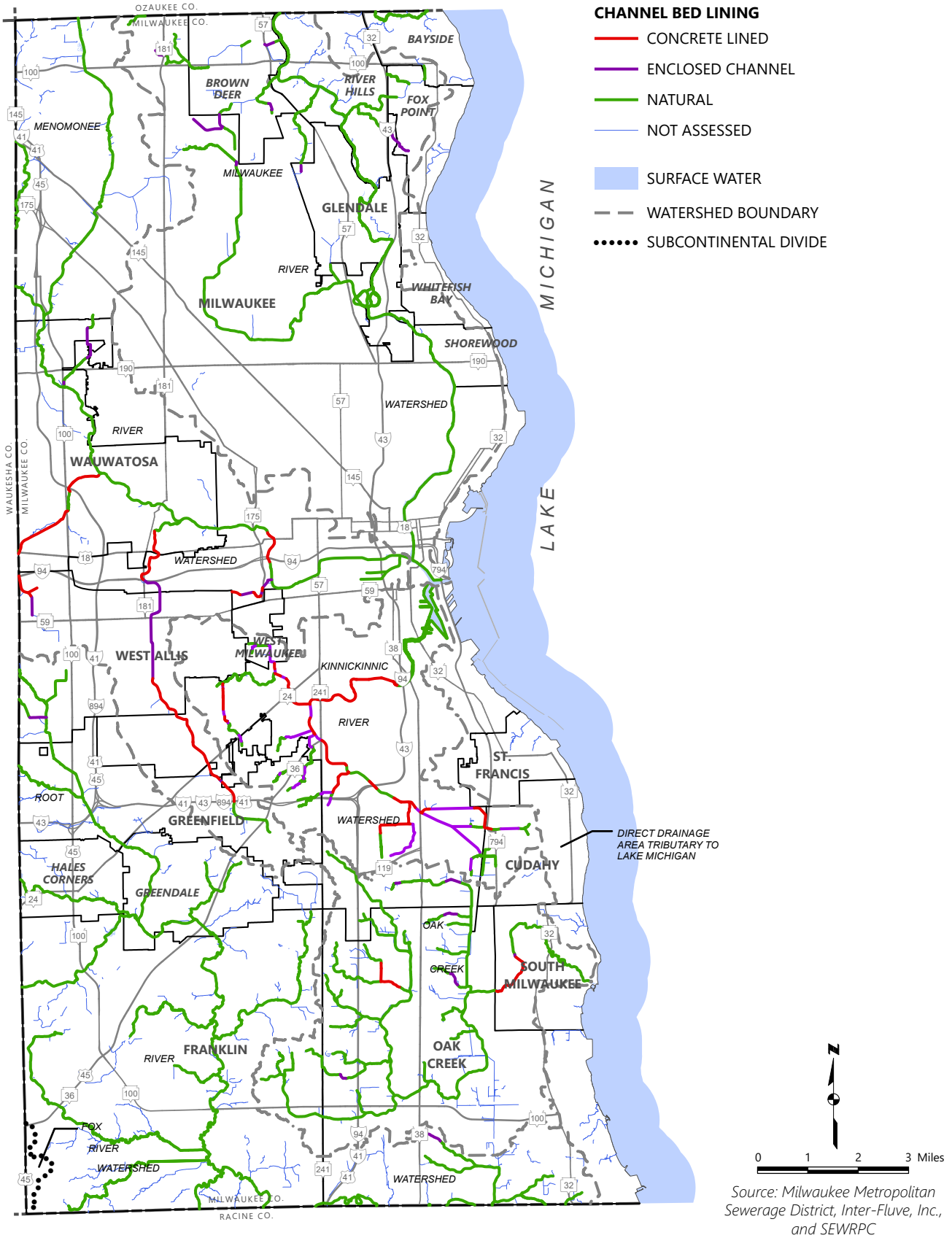
Floodplains

Floodplains are the wide, gently sloping areas contiguous to, and usually lying on both sides of, a stream channel. For planning and regulatory purposes, floodplains are normally defined as the areas excluding the stream channel, subject to inundation by a flood event. Throughout this plan the storm and flooding events will be described by a percent-annual-probability, which represents the percent chance the event will occur in any single year. Storm events can also be described by year recurrence interval. The relationship between the two descriptions is included below for reference.

---

[22] *Milwaukee Metropolitan Sewerage District,* Chapter 13, Surface Water and Stormwater*, Adopted: September 24, 2001; Amended October 25, 2010; Amended March 24, 2014; Amended December 19, 2016; Repealed and recreated March 25, 2019; Amended July 27, 2020; Amended March 27, 2023*

Map 2.6
Stream Channel Characteristics Within Milwaukee County: 2019



Source: Milwaukee Metropolitan Sewerage District, Inter-Fluve, Inc., and SEWRPC

- 0.2-percent-annual-probability event is equivalent to the 500-year recurrence interval event
- 0.5-percent-annual-probability event is equivalent to the 200-year recurrence interval event
- 1-percent-annual-probability event is equivalent to the 100-year recurrence interval event
- 2-percent-annual-probability event is equivalent to the 50-year recurrence interval event
- 4-percent-annual-probability event is equivalent to the 25-year recurrence interval event
- 10-percent-annual-probability event is equivalent to the 10-year recurrence interval event
- 50-percent-annual-probability event is equivalent to the 2-year recurrence interval event

Floodplain areas are generally not well suited to urban development, not only because of the flood hazard, but also because of the presence of high-water tables and, generally, of soils poorly suited to urban uses. Floodplain areas often contain important natural resources, such as high-value woodlands, wetlands, and wildlife habitat and, therefore, constitute prime locations for parks and open space areas.

Floodplains utilized in this Report were derived from a variety of sources and are shown on Map 2.7. The majority of the floodplains in Milwaukee County areas have been identified by the Federal Emergency Management Agency (FEMA) under the National Flood Insurance Program's (NFIP). The latest effective flood insurance study for Milwaukee County was approved in September 2008. Other sources include more recent floodplain work completed by WDNR, MMSD, and the Commission. In total, the 1-percent-annual-probability (100- year recurrence interval) floodplains, as shown on Map 2.7, encompass about 11,616 acres, or about 7 percent, of the County. The area of floodplains for cities and villages in the County is presented in Table 2.11. Additional sources related to the County's floodplain mapping, resources about property protection from flood events, and information about flood insurance and risks are provided on FEMA, WEM, WDNR, and Milwaukee County websites.

Lake Michigan Coastline

Wisconsin has several hundred miles of Great Lakes coastline composed of bluffs, beaches, and waterfront infrastructure. Structures (residential, commercial, municipal, and county infrastructure) and recreational lands and facilities along the Lake Michigan coastline are vulnerable to coastal hazards including shoreline erosion, bluff failure, lake level changes, waves, storm surge, floods, ice shove, and landslides. Portions of the Lake Michigan shoreline in Milwaukee County are highly susceptible to shore and bluff erosion because much of the coastal landforms are comprised of mixed, unconsolidated glacial materials such as gravels, lake-deposited clays, and tills.

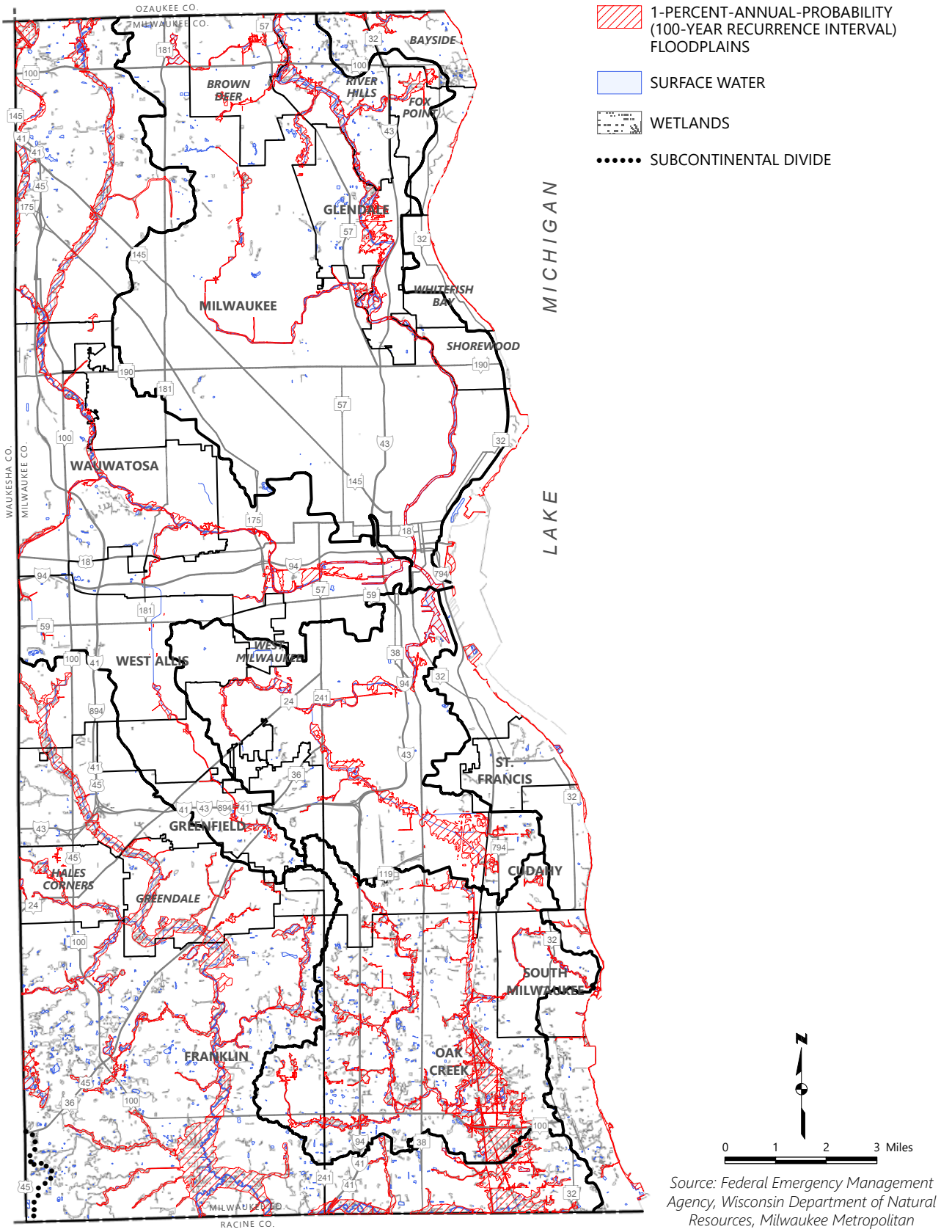
The Lake Michigan coastline in Milwaukee County spans 35 miles long encompassing portions of nine local units of government, including the Cities of Cudahy, Milwaukee, Oak Creek, St. Francis, and South Milwaukee; and the Villages of Bayside, Fox Point, Shorewood, and Whitefish Bay (see Table 2.12). Land uses along the coastline primarily include residential, recreational/open space, transportation, communications, and utilities (Map 2.2).

Since 1977 there have been a number of coastal studies and assessments on the Lake Michigan coastline in Milwaukee County on the condition and remediation of certain coastline assets.[23] These reports focused largely on shoreline and beach erosion; bluff stability and conditions; shoreline protection measures and structures along the shore. Examples of these reports are highlighted below.

- Wisconsin Coastal Management Program, *Wisconsin Shore Erosion Study*, *1977*

[23] *An asset is defined as a useful or valuable thing, person, or quality. A broad definition, so this can include anything from personal to public property, structures, equipment, recreational resources, wildlife habitat, natural areas, roadways, infrastructure, critical facilities, etc.*

Map 2.7
100-Year Floodplains in Milwaukee County



Source: Federal Emergency Management Agency, Wisconsin Department of Natural Resources, Milwaukee Metropolitan Sewerage District, and SEWRPC

- SEWRPC Community Assistance Planning Report No. 155, *A Lake Michigan Shoreline Erosion Management Plan for Northern Milwaukee County Wisconsin*, December 1988

- SEWRPC Community Assistance Planning Report No. 163, *A Lake Michigan Shoreline Erosion Management Plan for Milwaukee County Wisconsin*, October 1989

- SEWRPC Technical Report No. 36, *Lake Michigan Shoreline Recession and Bluff Stability in Southeastern Wisconsin: 1995* (published in December 1997)

- STS Consultants, *Shoreline Erosion Study for Warnimont Park in the City of Cudahy*, 2001

- SEWRPC Memorandum Report No 156, *Lake Park Bluff Stability and Plant Community Assessment, 2003*, September 2004

- Integrated Assessment on Water Level Variability and Coastal Bluff Erosion, 2015

- SEWRPC Memorandum Report No. 248, *Milwaukee County Coastline Management Guidelines*, February, 2021

Table 2.11
Area of 100-Year Floodplain by Municipality in Milwaukee County

Municipality	Acres of 100-Year Floodplain
Cities	
Cudahy	62
Franklin	2,632
Glendale	473
Greenfield	373
Milwaukee	3,124
Oak Creek	2,580
South Milwaukee	25
Wauwatosa	507
West Allis	283
Villages	
Bayside[a]	68
Brown Deer	135
Fox Point	87
Greendale	643
Hales Corners	156
River Hills	451
Shorewood	11
County Total	11,610

[a] *Floodplain acres for the Village of Bayside are for Milwaukee County only.*

Source: SEWRPC

Table 2.12
Lake Michigan Shoreline Length of Municipalities in Milwaukee County

Municipality	Lake Michigan Shoreline Length (miles)	Percent of County Total
Cities		
Cudahy	2.7	7.6
Milwaukee	13.5	38.1
Oak Creek	5.4	15.3
St. Francis	1.9	5.4
South Milwaukee	3.3	9.3
Villages		
Bayside	1.7	4.8
Fox Point	2.8	7.9
Shorewood	1.2	3.4
Whitefish Bay	2.8	7.9
Total	35.4	100.0

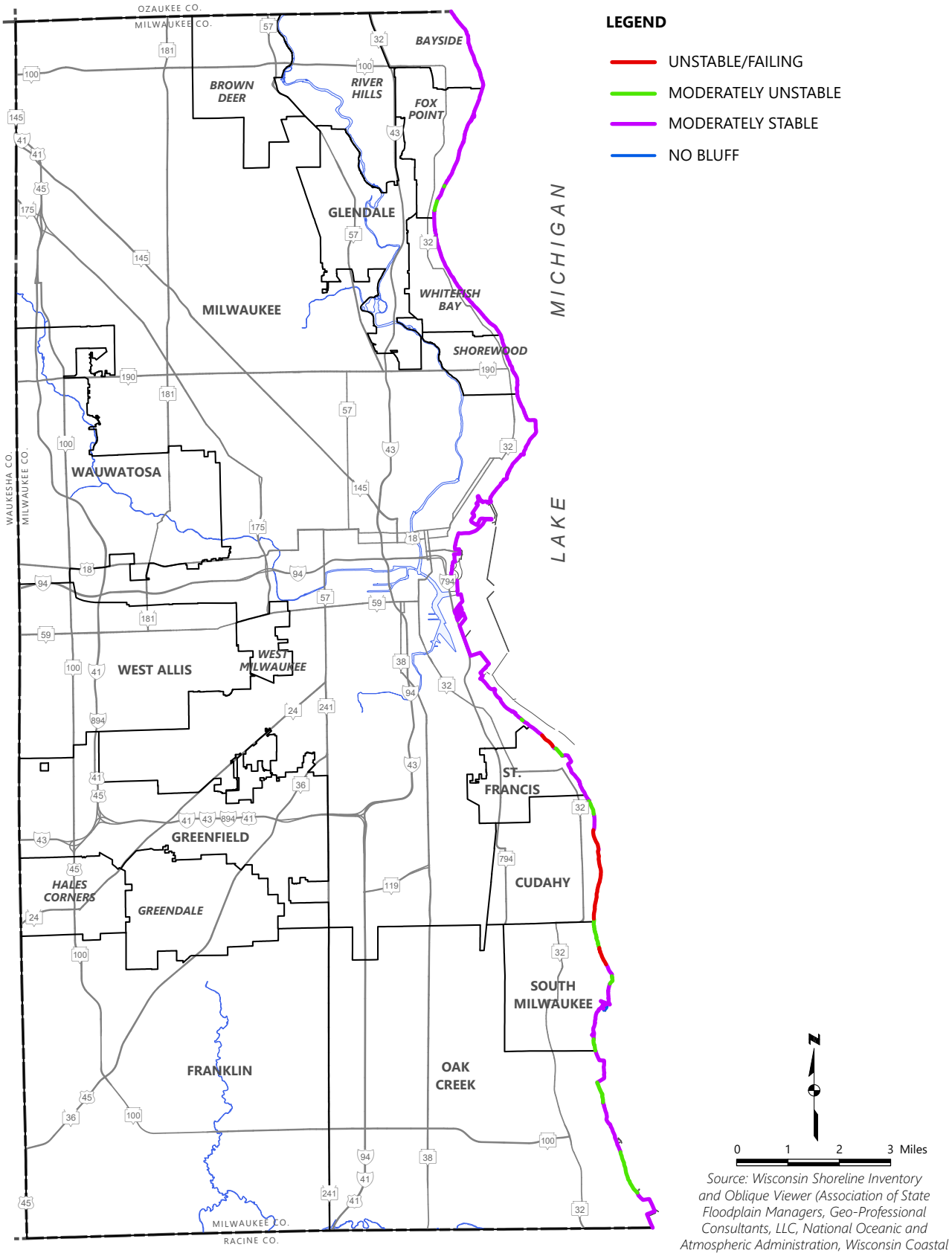
Source: SEWRPC

As shown in Map 2.8, in 2018 the general bluff conditions along the Lake Michigan Milwaukee County shoreline were primarily considered moderately stable with several locations being moderately unstable to failing. Bluff conditions are discussed in more detail in Chapter 3.

Additionally, in 2020, Milwaukee County, in partnership with Wisconsin Sea Grant, and the Commission completed a comprehensive report on County-owned facilities, assets, and infrastructure along the Lake Michigan shoreline.[24] The study was funded by a coastal resilience grant from the National Oceanic and Atmospheric Administration (NOAA), administered by WCMP, aimed at helping the County to plan and prepare for hazards like shoreline recession, bluff failure, beach erosion, coastal flooding, and damage to waterfront infrastructure. This was an important step in initiating the County's preparedness for extreme weather events. The project inventoried the resilience of Milwaukee County's coastal resources in five stages: asset inventory, condition assessment, vulnerability assessment, asset valuation, and risk score. The metrics used to evaluate the condition, vulnerability, risk, and value of each asset are explained in Chapter 3. As a result, 477 assets were inventoried and 90 of those inventoried assets are considered to be at high risk from coastal hazards impacts (i.e., storms, high water levels, and erosion). The type and location of high-risk assets are also explained in more detail in Chapter 3 of this Report. This assessment was also documented in Geographic Information System (GIS). As such,

[24] *Milwaukee County, Environmental Services Unit,* Milwaukee County Coastal Resources Inventory, *October 7, 2020.*

Map 2.8
Bluff Conditions Along Milwaukee County Shoreline: 2018



Source: Wisconsin Shoreline Inventory and Oblique Viewer (Association of State Floodplain Managers, Geo-Professional Consultants, LLC, National Oceanic and Atmospheric Administration, Wisconsin Coastal Management Program) and SEWRPC

the Milwaukee County Land Information Office (MCLIO) maintains an interactive map to easily review and interact with the data in a user-friendly format. The map highlights which areas of the bluffs are at risk, the assets ratings, and supporting data that can be used to gain understanding of the coastal area.[25]

Environmental Corridors

Preserving environmental corridors and isolated natural resource areas in essentially natural, open uses can help reduce flood flows, reduce noise pollution, and maintain air and water quality. The Commission has identified and delineated those areas of Milwaukee County having concentrations of natural, recreational, historic, aesthetic, and scenic resources that should be preserved and protected to maintain the overall quality of the environment. Such areas normally include one or more of the following seven integral elements of the natural resource base which are essential to the maintenance of both the ecological balance and the natural beauty of the Region: 1) lakes, rivers, and streams and the associated undeveloped shorelands and floodplains; 2) wetlands; 3) woodlands; 4) prairies; 5) wildlife habitat areas; 6) wet, poorly drained, and organic soils, and 7) rugged terrain and high-relief topography. There are five additional elements that are important considerations in identifying and delineating areas with scenic, recreational, and educational value. These additional elements are: 1) existing outdoor recreation sites; 2) potential outdoor recreation and related open space sites; 3) historic, archaeological, and other cultural sites; 4) significant scenic areas, and 5) natural and scientific areas.

In Southeastern Wisconsin, the delineation of these 12 natural resource and natural resource-related elements on maps result in an essentially linear pattern of relatively narrow, elongated areas which have been termed "environmental corridors" by the Commission. Primary environmental corridors include a wide variety of the aforementioned important resource and resource-related elements and are, by definition, at least 400 acres in size, two miles in length, and 200 feet in width.

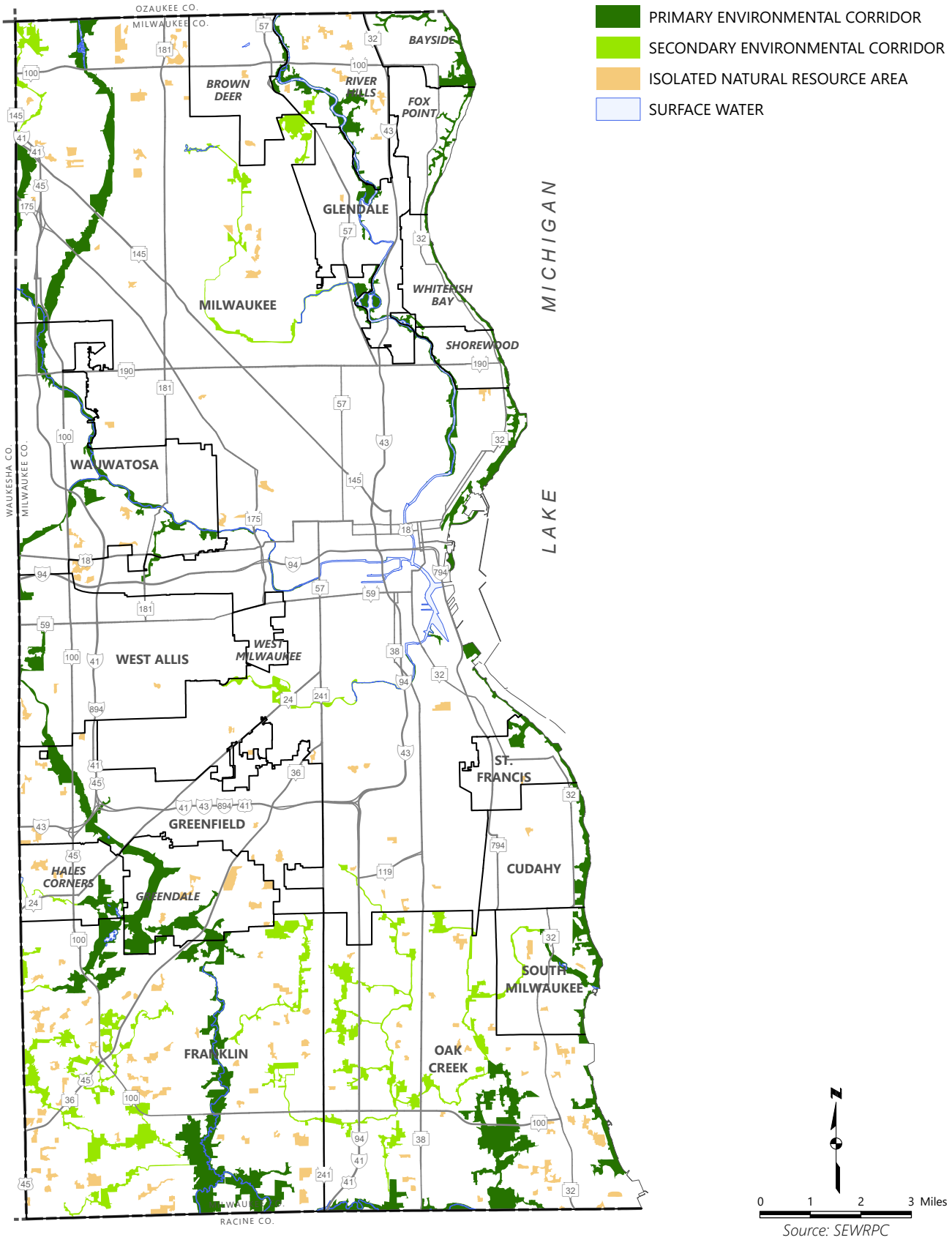
As shown on Map 2.9, the primary environmental corridors in the Milwaukee County planning area are primarily located along major stream valleys and along the Lake Michigan shoreline. These primary environmental corridors contain almost all of the best remaining woodlands, wetlands, and wildlife habitat areas in the County planning area, and represent a composite of the best remaining elements of the natural resource base. Primary environmental corridors encompassed approximately 10,078 acres (15.7 square miles), or about 6.5 percent of the County, in 2015.

Secondary environmental corridors are generally located along the small perennial and intermittent streams within the County. Secondary environmental corridors also contain a variety of resource elements, often remnant resources from primary environmental corridors that have been developed for intensive urban or agricultural purposes. Secondary environmental corridors facilitate surface-water drainage, maintain pockets of natural resource features, and provide corridors for the movement of wildlife, as well as for the movement and dispersal of seeds for a variety of plant species. In 2015, secondary environmental corridors encompassed approximately 3,734 acres (5.8 square miles), or about 2.4 percent of the County.

In addition to the primary and secondary environmental corridors, other smaller pockets of wetlands, woodlands, surface water, or wildlife habitat exist within the Region. These pockets are isolated from the environmental corridors by urban development or agricultural use, and although separated from the environmental corridor network, these isolated natural resource areas have significant value. They may provide the only available wildlife habitat in an area, usually provide good locations for local parks, and lend unique aesthetic character and natural diversity to an area. Widely scattered throughout the County (see Map 2.9), isolated natural resource areas encompassed approximately 2,514 acres (3.9 square miles), or about 1.6 percent of the County, in 2015.

[25] *Milwaukee County Land and Information Office,* Coastal County Data for Download*, September 2020. gis-mclio. opendata.arcgis.com*

Map 2.9
Environmental Corridors and Isolated Natural Resource Areas in Milwaukee County: 2015



Source: SEWRPC

2.5 CRITICAL COMMUNITY FACILITIES AND EMERGENCY SERVICES

FEMA generally defines a critical facility, infrastructure, or location as state-run resources that are vital to the health and welfare of the population and that are especially important following hazard events. Critical facilities include, but are not limited to emergency shelters, police and fire stations, dispatch centers, hospitals, nursing homes, daycares, schools, government administration buildings, financial institutions, utility services (i.e., electrical power generation stations, and wastewater or water treatment facilities), transportation resources (i.e., roadways, bridges, railways, and airports), communication systems (computers, radio, TV, phones), and hazardous materials storage facilities. The type and location of these facilities are important at-risk community assets that should be considered in hazard mitigation planning in that such facilities can have potential direct involvement in certain hazard situations and reduce the potential for additional resources required for emergency response and recovery.

Fire and Emergency Medical Services (EMS)

Throughout Milwaukee County there are a total of 13 fire departments and 53 fire stations, which are listed in Table 2.13. Many fire department personnel are cross-trained to provide both firefighting, emergency medical care, and/ or hazardous materials handling. Map 2.10 shows the locations of local fire departments in 2023.

Of the 53 fire stations in Milwaukee County, 29 belong to the City of Milwaukee. The City of Milwaukee Fire Department (MFD) is made up of 10 Battalions, or service areas, which consists of 29 fire stations, 29 engines, 8 trucks, 12 paramedic (i.e., ambulance) units, and one fire boat.[26] All Milwaukee firefighters are trained as basic emergency medical technicians (EMTs). The MFD Special Operations Division is responsible for marine operations, including the dive rescue team and fireboat; hazardous materials (HAZMAT); tactical emergency medical services (tactical EMS); and heavy urban rescue (HURT). HURT members are trained in the disciplines of confined space rescue, collapse rescue, and trench rescue, as well as in high and low angle rescue. All MFD fire fighters are full-time employees. The fire stations within the City of Milwaukee are also listed in Table 2.13 and also shown on Map 2.10.

All of the fire and rescue departments in Milwaukee County provide mutual aid to each other and numerous other State of Wisconsin fire and rescue departments through a Mutual Aid Box Alarm System (MABAS) agreement (MABAS Division 107). This agreement enables each department to render assistance to, and receive assistance from, other departments in the County as needed to respond to fire and rescue emergencies. Under the agreement, departments render assistance without charge by providing available resources not required for the protection of their own service areas. This agreement enables individual departments to significantly supplement their own personnel, apparatus, and equipment with that from other departments in responding to emergencies. Importantly, the agreement allows individual departments to access equipment, such as tankers, aerial trucks, and extrication equipment, which they themselves do not possess and which they may need infrequently.

Additionally, since 2013, MFD has participated in the "Shared Services Initiative" with many of its suburban neighbors. The premise of the initiative is to dispatch the closest most appropriate resources for fires and emergency incidents, regardless of municipal borders. The initiative has developed beyond its initial scope to include sharing and maintenance of emergency vehicles and equipment, training, and transfer of emergency vehicles into empty fire stations during fires and emergency incidents.[27] Current members include the Milwaukee Fire Department, the Greenfield Fire Department, the North Shore Fire Department, the Oak Creek Fire Department, the Wauwatosa Fire Department, and the West Allis Fire Department.

Milwaukee County also has a Fire Department (MCFD) at Milwaukee Mitchell International Airport (MMIA). MCFD at MMIA provides fire education and outreach and responds to all hazards. The MCFD consists of 24 full-time members, including one Fire Chief, five Assistant Chiefs, and 18 Firefighters. The MCFD operates under the direction of MMIA Airport leadership. The Milwaukee County Fire Department responds to nearly 1,000 calls per year, with the vast majority located on property. MCFD also responds to aircraft emergencies

[26] *A fire engine (i.e., Engine or Pumper) is equipped with a 500-gallon water tank, a pump and fire hose. A Fire Truck (i.e., Truck, Aerial, or Ladder) doesn't carry water or a hose. Trucks carry a steel ladder that stretches to 105 feet, with a nozzle at the tip to spray water onto a fire from above and have to be connected to an Engine.*

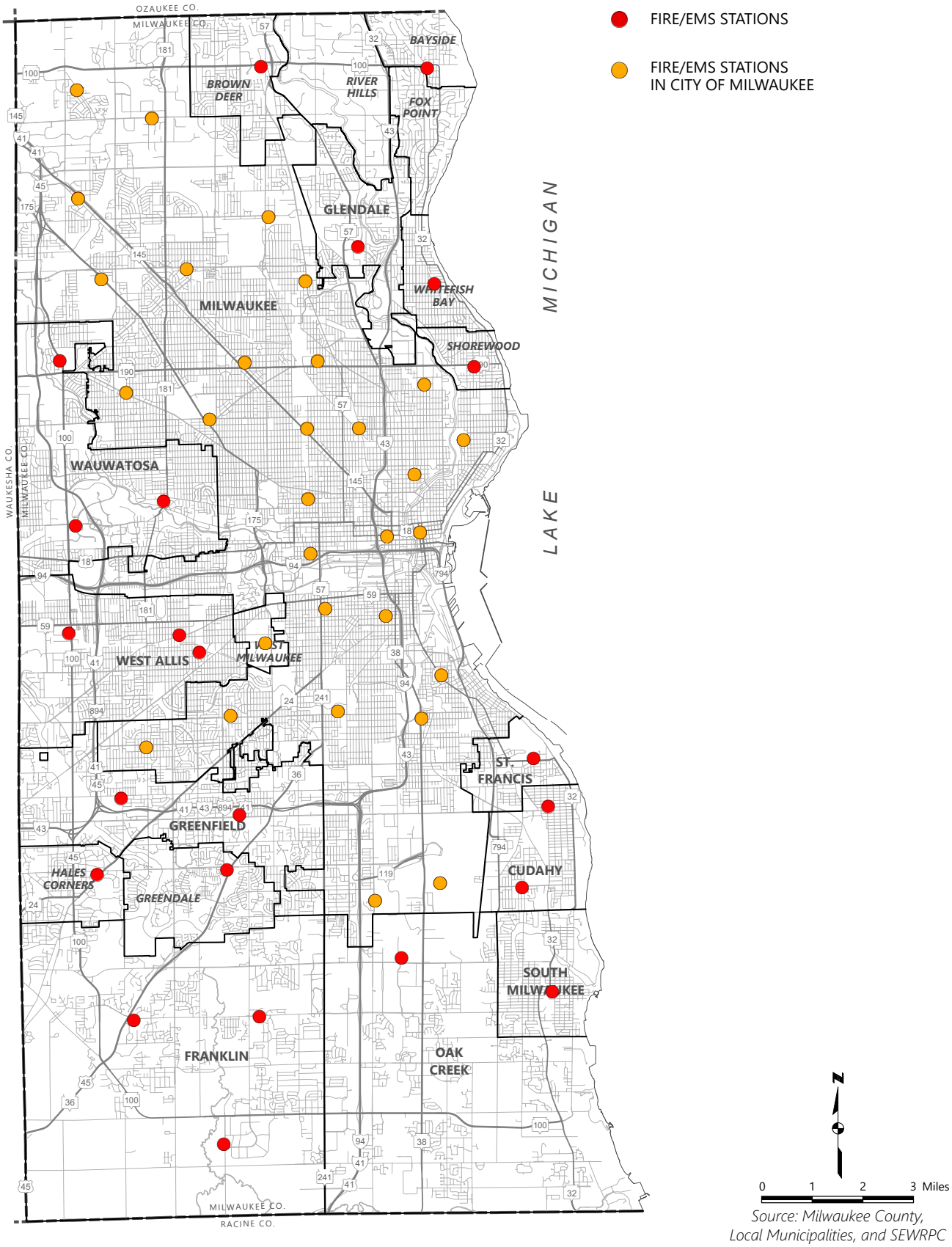
[27] *city.milwaukee.gov.*

Table 2.13
Fire and Emergency Medical Service (EMS) Stations in Milwaukee County: 2023

Department	Fire/EMS Station	Address	Municipality
Milwaukee County Airport	Station 1	5800 S. Howell Avenue	Milwaukee
Northshore Fire	Station 81	4401 W. River Lane	Brown Deer
	Station 82	5901 N. Milwaukee River Parkway	Glendale
	Station 83	3936 N. Murray Avenue	Shorewood
	Station 84	825 E. Lexington Boulevard	Whitefish Bay
	Station 85	665 E. Brown Deer Road	Bayside
Cudahy Fire Department	Station 1	4626 S. Packard Avenue	Cudahy
	Station 2	3115 E. Ramsey Avenue	Cudahy
Franklin Fire Departments	Station 1	8901 W. Drexel Avenue	Franklin
	Station 2	9911 S. 60th Street	Franklin
	Station 3	4755 W. Drexel Avenue	Franklin
Greendale Fire Department	Station 1	5911 W. Grange Avenue	Greendale
Greenfield Fire Departments	Station 91	5330 W. Layton Avenue	Greenfield
	Station 92	4333 S. 92nd Street	Greenfield
Hales Corners Fire Department	Station 1	10000 W. Forest Home Avenue	Hales Corners
City of Milwaukee Fire Departments	Station 1	784 N. Broadway	Milwaukee
	Station 2	755 N. James Lovell Street	Milwaukee
	Station 4	9511 W. Appleton Avenue	Milwaukee
	Station 7	3174 S. Chase Avenue	Milwaukee
	Station 8	5585 N. 69th Street	Milwaukee
	Station 9	4141 W. Mill Road	Milwaukee
	Station 10	5600 W. Oklahoma Avenue	Milwaukee
	Station 11	2526 S. Kinnickinnic Avenue	Milwaukee
	Station 12	2130 W. Oklahoma Avenue	Milwaukee
	Station 13	2901 N. 30th Street	Milwaukee
	Station 14	6074 S. 13th Street	Milwaukee
	Station 16	10320 W. Fond du Lac Avenue	Milwaukee
	Station 18	3628 N. Holton Street	Milwaukee
	Station 21	2050 N. Palmer Street	Milwaukee
	Station 22	8814 W. Lisbon Avenue	Milwaukee
	Station 23	1400 S. 9th Street	Milwaukee
	Station 24	4927 W. Fiebrantz Avenue	Milwaukee
	Station 26	1140 S. 26th Street	Milwaukee
	Station 27	2647 N. Bartlett Avenue	Milwaukee
	Station 28	424 N. 30th Street	Milwaukee
	Station 29	3529 S. 84th Street	Milwaukee
	Station 30	2903 N. Teutonia Avenue	Milwaukee
	Station 32	1551 N. 30th Street	Milwaukee
	Station 33	4515 W. Burnham Street	Milwaukee
	Station 34	6205 W. Burleigh Street	Milwaukee
	Station 36	4060 N. 27th Street	Milwaukee
	Station 37	5335 N. Teutonia Avenue	Milwaukee
	Station 38	8463 N. Granville Road	Milwaukee
	Station 39	8025 W. Bradley Road	Milwaukee
Oak Creek Fire Department	Station 1	255 E. Centennial Drive	Oak Creek
	Station 2	3950 E. Oakwood Road	Oak Creek
	Station 3	7000 S. 6th Street	Oak Creek
South Milwaukee Fire Department	Station 1	929 Marshall Court	South Milwaukee
St. Francis Fire Department	Station 1	3400 E. Howard Avenue	St. Francis
Wauwatosa Fire Departments	Station 51	1601 Underwood Avenue	Wauwatosa
	Station 52	4187 N. Mayfair Road	Wauwatosa
	Station 53	10525 W. Watertown Plank Road	Wauwatosa
West Allis Fire Departments	Station 61	7332 W. National Avenue	West Allis
	Station 62	2040 S. 67th Place	West Allis
	Station 63	10830 W. Lapham Street	West Allis

Source: Milwaukee County Office of Emergency Management and SEWRPC

Map 2.10
Fire Stations and Emergency Medical Services in Milwaukee County: 2023



Source: Milwaukee County, Local Municipalities, and SEWRPC

and vehicle accidents in the vicinity of the Airport. The one Fire Station is strategically located near the middle of the airfield, close to the intersection of the Airport's two longest runways. MCFD is also a full participating member of MABAS Division 107 (Mutual Aid Box Alarm System), which allows the MABAS partners to call upon the large supply of Firefighting Foam and unique application devices.

Law Enforcement

The Milwaukee County Sheriff's Office (MCSO) is located in the City of Milwaukee and is shown on Map 2.11. MCSO maintains the county jail, provides bailiff services for the circuit court, patrols the freeway, provides law enforcement at Milwaukee Mitchell International Airport and the Milwaukee County Institutions Complex.

The City of Milwaukee law enforcement is divided into seven police districts. The location of each City of Milwaukee police station is shown on Map 2.11. and listed in Table 2.14. Milwaukee County communities (outside the City of Milwaukee) and their corresponding police department locations are also shown on Map 2.11 (red dot) and listed in Table 2.14.

Milwaukee County's Sheriff's Department as well as the City of Milwaukee and other local community police departments operate under mutual aid provisions of Section 66.0313(2) of the *Wisconsin Statutes*. As such, the City Police Department and County Office of the Sheriff routinely provide or receive assistance from other community personnel in law enforcement matters. Because of the relatively high level and specialization of law enforcement capabilities that exist at the City and County level, mutual aid is often provided to other communities when specialized capabilities are needed.

Dispatch Services

The Milwaukee County OEM 911 Communications Division serves as the Public Safety Answering Point (PSAP) for the County. Milwaukee County OEM provides cellular 911 call-taking services for West Allis, West Milwaukee, Wauwatosa, South Milwaukee, Greenfield, Cudahy, Greendale, and occasionally from other PSAPs within the County. Table 2.15 also lists the different 911 emergency services provided in Milwaukee County.

In 2022, Text-to-911 services became available for Milwaukee County. This gives residents near county cellphone towers the option to text 911 for emergency assistance instead of making a voice call which is essential for deaf and hard-of-hearing citizens. Table 2.15 also lists the jurisdictions that participate in this service.

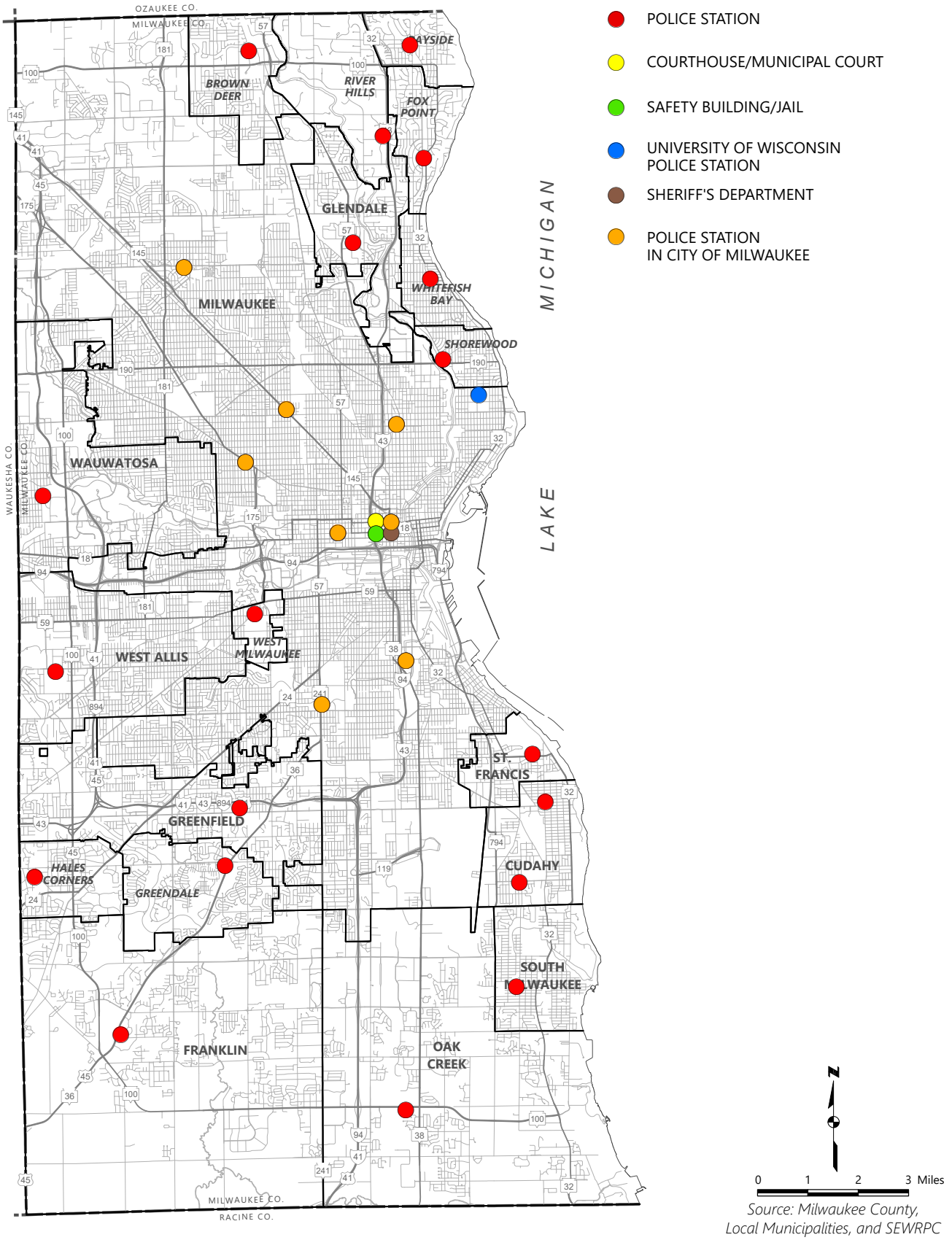
Telecommunications and Alerting Services

Telecommunication services include the following categories: 1) Voice Transmission Services; 2) Data Transmission Services, including the internet; 3) Multimedia Services, including video, imaging, streaming video, data, and voice; and 4) Broadcast Services, including: AM/FM radio, satellite radio and television, television, and cable television. As listed below, telecommunication services help facilitate communication, coordination, and intelligence among emergency responders, government officials, and citizens before, during, and after emergency situations, including natural disasters.

- **Before** a disaster, these systems provide early warnings through alert systems, sirens, or mobile notifications that help communities prepare for disasters
- **During** a disaster, telecommunications enable real-time communication among first responders, government agencies, and affected communities
- **After** a disaster, telecommunication systems provide citizens with the ability to connect to important resources or declare their safety through emergency calls, text messages, or social media updates

Communication infrastructure and services provide the dissemination of public safety information which can help reduce the loss of life or substantial loss of property. As noted in the Milwaukee County OEM Comprehensive Emergency Management Plan, County residents receive notification or warning information of hazardous weather events through a number of services, including outdoor warning sirens, local broadcasts or printed media, mobile phone public address systems, and/or weather alert radios. Functional needs groups also receive extreme weather alerts or warnings through door-to-door for the handicapped,

Map 2.11
Law Enforcement Stations in Milwaukee County: 2023



Source: Milwaukee County, Local Municipalities, and SEWRPC

Table 2.14
Police and Sheriff Departments Located in Milwaukee County: 2023

Municipality Police Department(s)	Address
Village of Bayside	9075 N. Regent Road
Village of Brown Deer	4800 W. Green Brook Drive
City of Cudahy	4626 S. Packard Avenue 3115 E. Ramsey Avenue
Village of Fox Point	7300 N. Santa Monica Boulevard
City of Franklin	9455 W. Loomis Road
City of Glendale	5909 N. Milwaukee River Parkway
Village of Greendale	5911 W. Grange Avenue
City of Greenfield	5300 W. Layton Avenue
Village of Hales Corners	5635 S. New Berlin Road
City of Milwaukee	749 W. State Street (Police District 1) 245 W. Lincoln Avenue (Police District 2) 2333 N. 49th Street (Police District 3) 6929 W. Silver Spring Drive (Police District 4) 2920 N. 4th Street (Police District 5) 3006 S. 27th Street (Police District 6) 3626 W. Fond du Lac Avenue (Police District 7) 2100 W. Wells Street (Police District 8) 951 N. James Lovell Street (Municipal Court)
City of Oak Creek	301 W. Ryan Road
Village of River Hills	7650 N. Pheasant Lane
Village of Shorewood	4057 N. Wilson Drive
City of South Milwaukee	2424 15th Avenue
Village of St. Francis	3400 E. Howard Avenue
City of Wauwatosa	1700 N. 116th Street
City of West Allis	11301 W. Lincoln Avenue
Village of West Milwaukee	4755 W. Beloit Road
Village of Whitefish Bay	5300 N. Marlborough Drive
Milwaukee County Courthouse	901 N. 9th Street
Milwaukee County Jail	949 N. 9th Street
Milwaukee County Sheriff	821 W. State Street
University of Milwaukee Campus	3410 N. Maryland Avenue

Source: Milwaukee County Office of Emergency Management and SEWRPC

visually and hearing impaired; foreign language media messaging, and/or close-caption Emergency Alert System (EAS) television messaging. Alerting services and the infrastructure that supports them are important community assets that should be considered in hazard mitigation planning.

Emergency alert or warning notifications and functions used within Milwaukee County are listed in Appendix D. Examples of these systems and functions are highlighted below.

Interoperable Communications

Milwaukee County OEM Radio Services Division administers and maintains the County's digital radio system, or "OASIS" (Organization of Affiliated Secure Interoperable Radio Frequency (RF) Subsystems). Oasis is an upgraded P25 digital, 800MHz regional radio system that provides critical and interoperable communications for public safety agencies and first responders in Milwaukee and Waukesha counties. Each county has its own radio tower and infrastructure equipment (i.e., transmitters and dispatch consoles). The Milwaukee County Emergency Alerting System's (EAS) RF infrastructure was also upgraded and is now integrated into the OASIS radio system. All of Milwaukee County is now provided with an Emergency Alert System, including the most underserved communities. Additionally, the City of Milwaukee recently linked their OpenSky system to the Countywide OASIS system through an Inter-RF Sub-System Interface (ISSI) gateway.

Table 2.15
Emergency Dispatch Centers Located in Milwaukee County: 2023

Public Safety Answering Points (PSAPs)	Emergency Medical Dispatch Centers	Text-to-911 Centers
West Milwaukee Police	Cudahy	Franklin
Fox Point Police	Franklin	North Shore
South Milwaukee Police Department	Greendale/Hales Corners	Milwaukee County OEM
Brown Deer Police	North Shore	
Oak Creek Police	South Milwaukee	
Franklin Police Department	Wauwatosa	
Wauwatosa Police Department	West Milwaukee	
St. Francis Police	Milwaukee County OEM	
Bayside Village Police Department		
Glendale Police Department		
Hales Corners Police		
North Shore Public Safety Communications		
Cudahy Police		
Greendale Police & Fire		
Milwaukee Police Department		
Greenfield Police Department		
West Allis Police Department		
West Allis Police & Fire		

Source: Milwaukee County Office of Emergency Management

Emergency Alert System (EAS) and Wireless Emergency Alerts (WEA)

The Emergency Alert System (EAS) is a national public warning system that requires radio and TV broadcasters, cable TV, wireless cable systems, and satellite to address the public during emergency situations, including hazardous weather events (see Appendix D). WEA is also a public safety system that allows compatible mobile devices to receive geographically targeted, text-like alert notifications or warnings about critical situations. Citizens and government employees have the responsibility to monitor severe weather alerts via television, radio, and weather alert radios – text alerts. Warning to the affected populace will be made by any expeditious methods available at the time to include, but not limited to, sirens, telephone, fax, radio, EAS, amateur radio, media, and police and fire mobile units.

In Milwaukee County, The National Weather Service (NWS) sends out all messages related to weather events, alerts, and warnings directly to the general public via FEMA's Integrated Public Alert and Warning System (IPAWS),[28] Wireless Emergency Alerts, and NOAA Weather Radios.[29]

Outdoor Warning System

During a tornado watch or warning, outdoor warning sirens are sounded throughout Milwaukee County. Milwaukee County owns all 58 outdoor warning sirens which were in the process of being updated or completely replaced during the draft phase of this Report. These sirens are tested on the second Wednesday of each month at noon (weather permitting). County OEM has the capability to activate the sirens in communities that do not have local dispatching.

Other Critical Community Facilities

In addition to fire, emergency medical services, law enforcement stations, and emergency communication systems, other community facilities which are of importance in hazard mitigation planning include schools,

[28] *The Integrated Public Alert & Warning System (IPAWS) is FEMA's national system for local alerting that provides authenticated emergency and life-saving information to the public through mobile phones using Wireless Emergency Alerts; to radio and television via the Emergency Alert System; and on the National Oceanic and Atmospheric Administration's Weather Radio.*

[29] *NOAA Weather Radio (NWR) is a nationwide network of radio stations broadcasting continuous weather information directly from the nearest NWS office. NWR broadcasts official Weather Service warnings, watches, forecasts, and other hazard information 24 hours a day, seven days a week.*

government buildings, public works facilities, hospitals, daycares[30] and adult assisted living facilities. The importance of being able to access and prevent damage to these facilities, especially during a hazard event, is discussed in detail in Chapter 3. A listing of these critical community facilities and precise locations are included in Appendix E.

Transportation Systems

The major transportation systems of Milwaukee County (see Maps 2.12 and 2.13) provide the basis for the movement of goods and people into, out of, though, and within the County. Disruptions to critical transportation system(s) due to extreme weather events can potentially create economic and sometimes life-threatening impacts. As such, having a good understanding of the existing transportation infrastructure network and how to make it more resilient in the event of extreme weather events is important in hazard mitigation planning.

Major Roadway Systems (Interstates, U.S Highways, and County Highways) in Milwaukee County

As indicated on Map 2.12, the major highway systems serving Milwaukee County include Interstate Highways (IH): 41, 43, 94, 794, and 894; U.S. Highways (USH): 18, 41, and 45; Wisconsin/State Trunk Highways (STH): 24, 32, 36, 38, 57, 59, 100, 119, 119, 145, 175, 181, 241, and 794; and, County Trunk Highways (CTH): A, D, E, G, H, J, N, S, T, U, V, W, BB, MM, NN, OO, and ZZ. This roadway grid pattern in the County provides good alternative route options during a hazard event.

Railway Facilities

Amtrak's passenger Hiawatha line runs between Milwaukee and Chicago via the Canadian Pacific and the Metra Milwaukee District North tracks with three Wisconsin stations: Milwaukee Intermodal Station, Milwaukee Airport Railroad Station, and Sturtevant Station. Railroad freight services, as shown on Map 2.13, are also provided within the County by four major railway companies, including the Union Pacific Railroad (UP), the Canadian Pacific Kansas City Railway (CPKC), Canadian National Railway (CN), and the Wisconsin & Southern Railroad (WSOR).

Airports

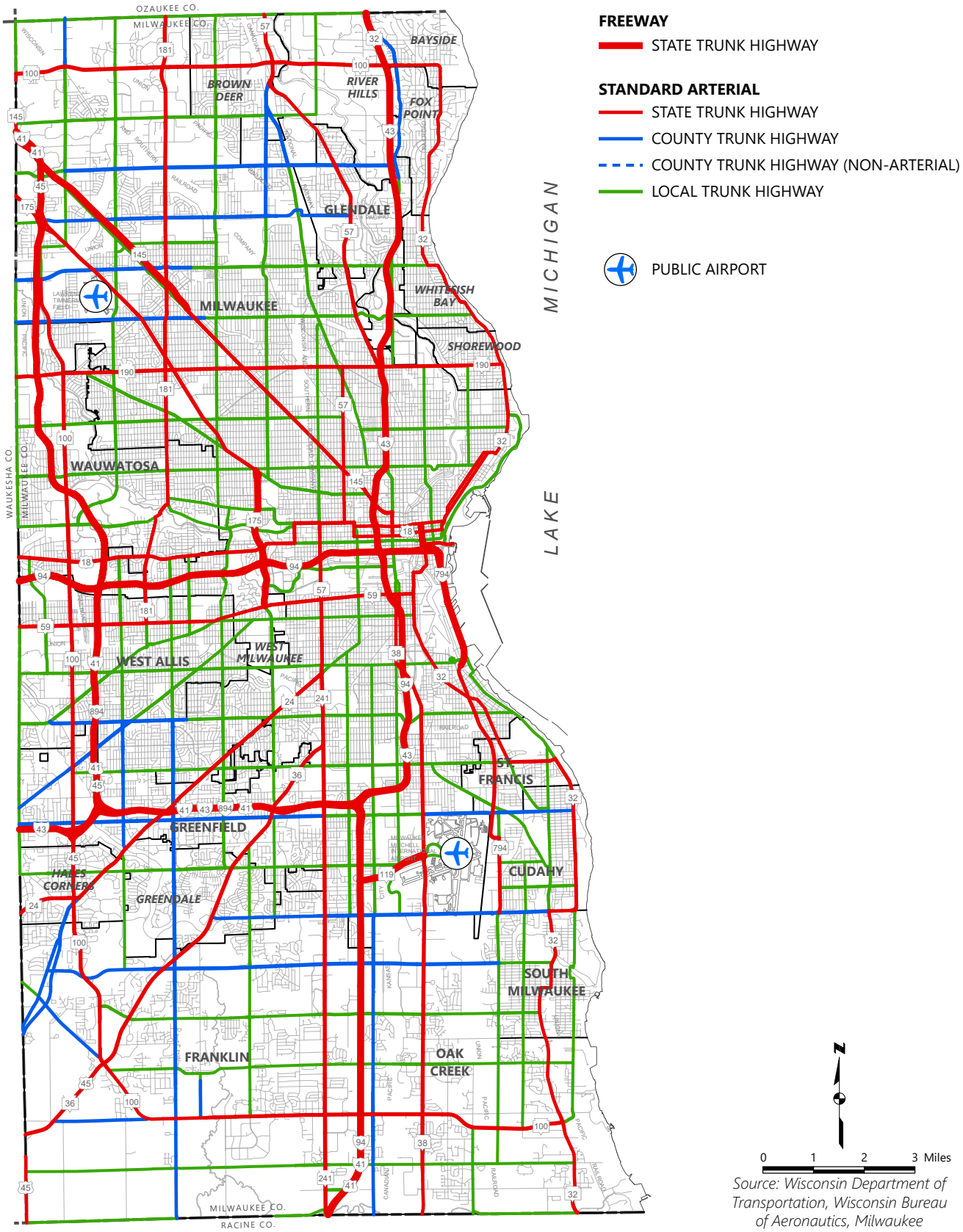
Milwaukee has two airports which serve the public—Milwaukee Mitchell International Airport and Lawrence J. Timmerman Field (see Map 2.12). Both airports are owned and operated by Milwaukee County. Milwaukee Mitchell International Airport is a medium-hub airport and is the largest in Wisconsin. The airport hosts 9 airlines, and approximately 310 departures and arrivals occur each day. Located on Milwaukee's northwest side, Timmerman Field serves private and corporate aviation. In addition to this, there are several private airports, heliports, and helipads within Milwaukee County.

Historic Sites

Historic sites in Milwaukee County often have important recreational, educational, and cultural value. As such, preserving and protecting these sites are an important consideration in hazard mitigation planning. In 2023, there were 309 historic places and districts listed on the National Register of Historic Places and the State Register of Historic Places for Milwaukee County. The inventory can be accessed through the State of Wisconsin Historical Society (*wisconsinhistory.org/ahi*) and on the Milwaukee County Historical Society websites.

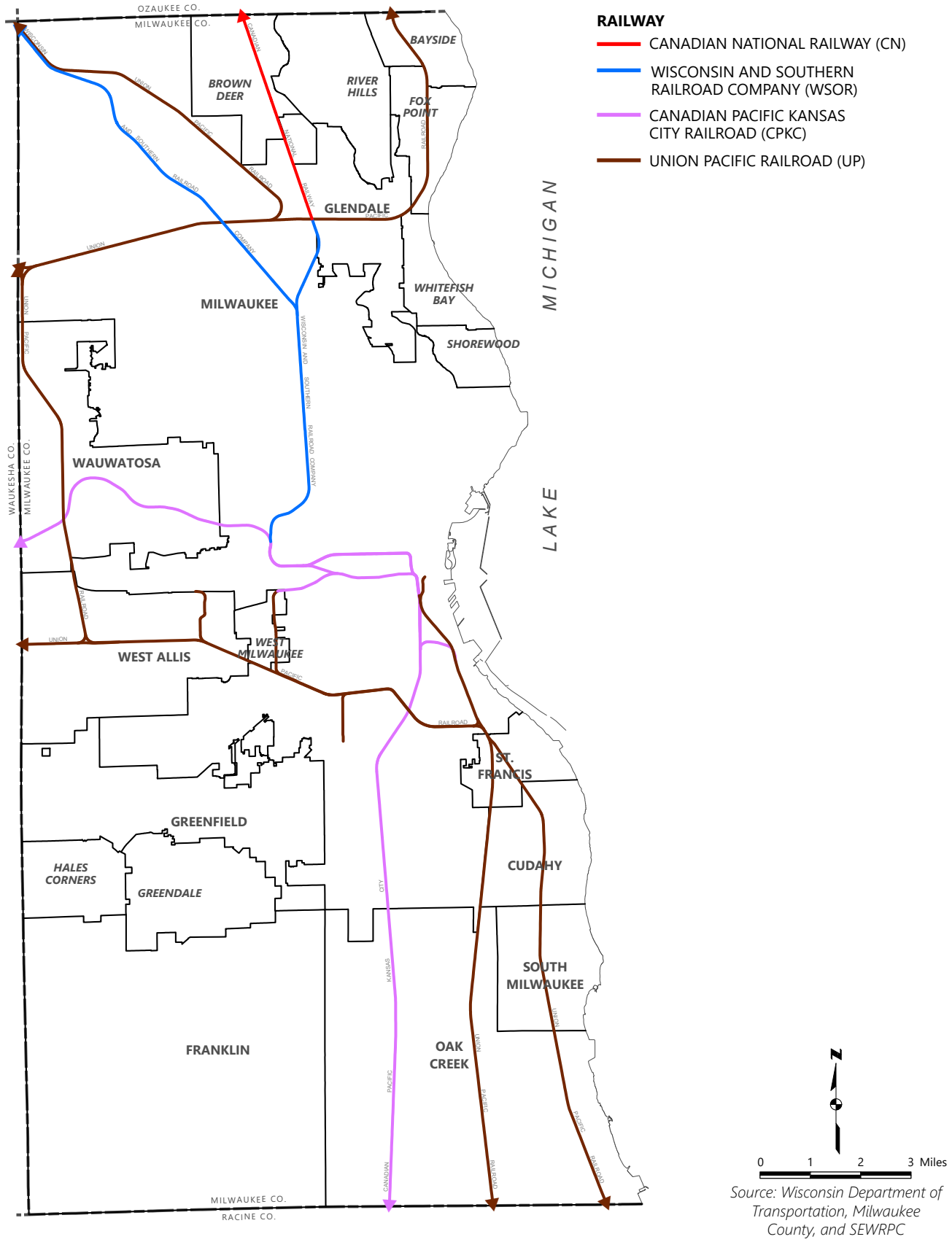
[30] *A listing of current daycare facilities in Milwaukee County is provided through Wisconsin Department of Children and Families or childcarefinder.wisconsin.gov.*

Map 2.12
Major Transportation Systems in Milwaukee County: 2023



Source: Wisconsin Department of Transportation, Wisconsin Bureau of Aeronautics, Milwaukee County, and SEWRPC

Map 2.13
Railways in Milwaukee County: 2023



Source: Wisconsin Department of Transportation, Milwaukee County, and SEWRPC

2.7 CLIMATE AND CLIMATE CHANGE

Climate, which is the long-term weather conditions in an area, is significant for hazard mitigation planning. Wisconsin's climate continues to change. All Milwaukee County residents are affected by these changes; however, those communities and individuals that are considered socially and economically vulnerable (see Figure 2.1 and Appendix C) that are more likely to be adversely affected and therefore at a higher risk to the potential impacts of an increasingly changing climate. In the ten years since the initial 2011 Wisconsin Initiative on Climate Change Impacts (WICCI) Assessment Report, new data continues to show increases in warming, rain and snow, and more frequent extreme rainfall events. Statewide temperatures have warmed by about 3°F (Fahrenheit), and precipitation in southern Wisconsin has increased by nearly 20 percent since 1950.[31] For example, Southern Wisconsin has experienced the highest increase in precipitation over the last decade and nearly every region of the state has recently experienced extreme rainfall events that led to flooding of roads, homes, businesses, and farm fields. New analyses reaffirm previous projections indicating that many of these trends will continue with wide ranging consequences throughout Wisconsin's natural and built environments.[32]

The risk posed to Milwaukee County by many of the natural hazards profiled in this plan have been estimated largely upon the historical occurrence of, and impacts attributed to, the hazard within the County. Over longer periods of time, however, climate change may render these risk estimates and impacts less reliable. The following subsections describe the changes that have occurred in Wisconsin's climate since 1950, and the changes that are projected to occur by the middle of the 21st century. For those hazards whose frequency of occurrence or impacts are likely to be affected by the changes in climate, these descriptions will form the basis of evaluating potential long-term changes in hazard conditions.

Historical Climate Change Trends

Average annual temperatures in Wisconsin have increased over the last half of the 20th century and into the 21st century. In the period of 1950 to 2018, the average annual temperature increase in Milwaukee County was about 2°F, as can be seen in Figure 2.2.[33] Much of this increase in average annual temperature can be attributed to warmer winters and higher night-time low temperatures in summer. It should be noted that this warming trend for Wisconsin is not evenly distributed between night-time low temperatures and daytime high temperatures, and from season to season. Around this same time period (1950-2020), the average winter night-time temperatures increased by about 4°F in Milwaukee County.[34]

Average annual precipitation in Wisconsin has also increased over the last half of the 20th century and into the 21st century. Over the period of 1950 through 2018, Milwaukee County experienced an estimated 15 percent increase in precipitation (see Figure 2.3).[35] Most of the increase in average annual precipitation, in the form of both snow and rainfall, occurred during winter months. In Milwaukee County, and throughout most of the state, average precipitation during winter months increased by about 15 percent during this time period. The same percentage of increases also occurred during the spring and autumn months in the County. Average precipitation during the summer months increased by about 10 percent in Milwaukee County.

Climate Change Projections

The consensus of downscaled results from climate models indicate that average annual temperatures will continue to increase through the 21st century.[36] Depending on location (see Figure 2.4), it is projected that average temperatures in the State of Wisconsin will increase by between 4.0°F and 5.0°F over the period 2041 to 2060. During this time, it is projected that Milwaukee County will experience an increase of about 4.0°F. The greatest temperature changes are projected to occur during winter months, with average winter

[31] *Wisconsin Initiative on Climate Change Impacts, Wisconsin's Changing Climate: Impacts and Adaptation, Nelson Institute for Environmental Studies, University of Wisconsin-Madison and Wisconsin Department of Natural Resources,* 2021.

[32] *Wisconsin Initiative on Climate Change, 2021,* op. cit.

[33] *Wisconsin Initiative on Climate Change website, wicci.wisc.edu.*

[34] *Wisconsin Initiative on Climate Change, 2021,* op. cit.

[35] *Wisconsin Initiative on Climate Change, website, wicci.wisc.edu.*

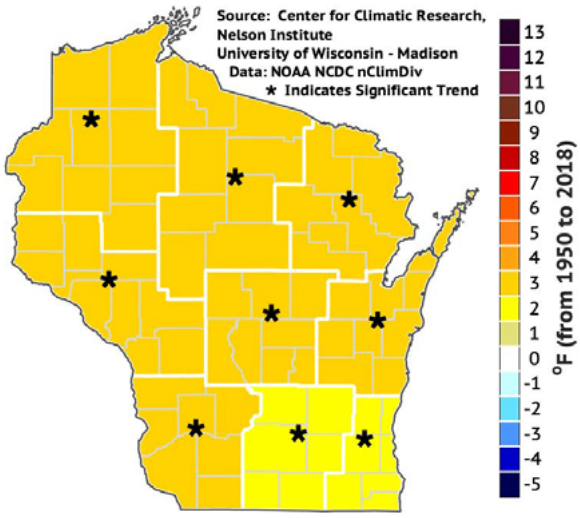
[36] *Wisconsin Initiative on Climate Change Impacts, 2021,* op. cit.

temperatures projected to increase by about 5.0°F in Milwaukee County. Changes in extreme temperatures will accompany these changes in average temperature and the frequency of extreme daily high temperatures is projected to increase. The average number of days per year with daily high temperatures greater than 90°F is currently about 12 in southern Wisconsin.[37] This is likely to triple to about 36 days per year by 2060. In Milwaukee County, the number of extremely hot days per year is projected to increase to about 20 to 30 days.[38] By contrast, the frequency of extreme daily low temperatures is projected to decrease. The average number of days per year with daily low temperatures below 0°F is currently about 15 in southern Wisconsin. This is projected to decrease to about nine days per year by 2060[39]

The consensus of downscaled results from climate models projects several changes in precipitation through the 21st century.[40] There is a projected increase in annual precipitation in the whole State of Wisconsin by about 5 percent (see Figure 2.5). The projections indicate that the amount of precipitation falling during winter is likely to increase by about 10 percent. Due to the predicted increase in temperatures, it is assumed that a greater amount of precipitation occurring during the winter will fall as rain rather than snow.[41] This will be accompanied by both an increase in the likelihood of freezing rain events and decreases in snow depth and snow cover. Model projections also show that Wisconsin will receive more precipitation and more frequent intense precipitation events during the spring, especially during early spring. As in winter, it will be more likely for early spring precipitation to fall as rain rather than snow.

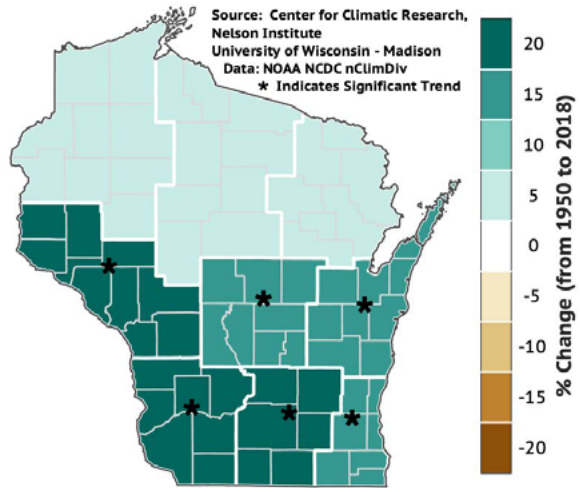
Based on downscaled climate models, the total amount of precipitation occurring during the summer is not projected to change much, however the frequency of intense rainfall events will increase. In southern Wisconsin, the frequency of precipitation events in which two or more inches fall in a 24-hour period is expected to increase from about 12 events per decade to 15 events per decade by the middle of the 21st century. These intense rainfall events will be concentrated in the spring and fall. The heaviest rainfall events are also projected to increase in magnitude. The magnitude of a 100-year storm event (five to seven inches of

Figure 2.2
Change in Annual Average Temperature from 1950 to 2018



Source: Wisconsin Initiative on Climate Change Impacts, Trends and Projections, wicci.wisc.edu

Figure 2.3
Change in Annual Precipitation from 1950 to 2018



Source: Wisconsin Initiative on Climate Change Impacts, Trends and Projections, wicci.wisc.edu

[37] *Wisconsin Initiative on Climate Change Impacts, 2011,* op. cit.

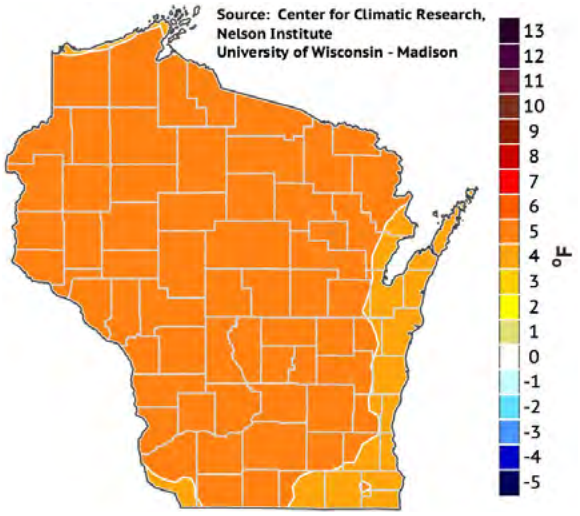
[38] *Wisconsin Initiative on Climate Change Impacts, 2021,* op. cit.

[39] *Wisconsin Initiative on Climate Change Impacts, 2011,* op. cit.

[40] *Wisconsin Initiative on Climate Change Impacts, 2021,* op. cit.

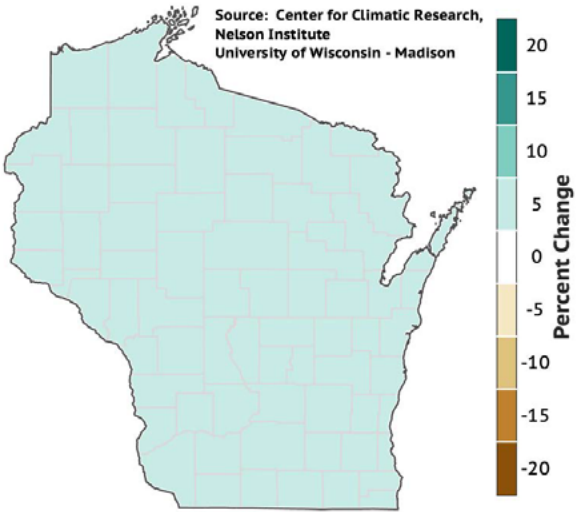
[41] *Michael Notaro, David J. Lorenz, Daniel Vimont, Stephen Vavrus, Christopher Kucharik, and Kristie Franz, "21st Century Wisconsin Snow Projections Based on an Operational Snow Model Driven by Statistically Downscaled Climate Data,"* International Journal of Climatology, *Volume 31, pages 1615-1633, 2011.*

Figure 2.4
Projected Change in Annual Average Temperature from 2041 to 2060



Source: Wisconsin Initiative on Climate Change Impacts, Trends and Projections, wicci.wisc.edu

Figure 2.5
Projected Change in Annual Precipitation from 2041 to 2060



Source: Wisconsin Initiative on Climate Change Impacts, Trends and Projections, wicci.wisc.edu

precipitation in a 24-hour period) is expected to increase by about 10 percent in the State of Wisconsin.[42] It should be noted that in the decade from 2010 to 2019, Wisconsin experienced at least 21 extreme rainfall events that exceeded the 100-year event. The shift to more heavy rainfall events, but little change in total summertime precipitation, implies that more dry days will occur in Wisconsin during the summer. More dry days, coupled with higher summer temperatures and the increases in evapotranspiration that are likely to result from higher temperatures, will lead to an increase in the likelihood of summer droughts.

[42] *Wisconsin Initiative on Climate Change Impacts, 2011,* op. ct.

ANALYSIS OF HAZARD CONDITIONS 3

To evaluate various potential hazard mitigation alternatives for Milwaukee County and select the most effective and feasible hazard mitigation strategies, the existing potential natural weather hazard problems in the County must first be analyzed and the vulnerability to such hazards documented. Accordingly, this chapter provides the following:

- Identification of the hazards likely to affect Milwaukee County
- Profiles of the extent and severity of recent hazard events which occurred in the County
- Assessment of the vulnerability and risk associated with each type of hazard
- Identification of the potential for changes in hazard severity and risk under future conditions, such as climate change

The vulnerability assessment focuses on the County and community assets described in Chapter 2.

3.1 HAZARD IDENTIFICATION

The process of identifying those natural hazards that should be specifically addressed in the Milwaukee County hazard mitigation plan was based upon consideration of a number of factors. The process included input from the Milwaukee County Hazard Mitigation Local Planning Team (LPT), including a priority ranking of hazards; review of the hazard identification set forth in the State hazard mitigation plan;[43] review of documentation of past hazard events; and review of related available mapping, plans, and assessments. It is important to note that both the City of Milwaukee Hazard Mitigation Plan and the previous Milwaukee County Pre-Disaster Mitigation Plan were reviewed and utilized as a resource as part of the hazard identification and assessment in terms of the natural hazards analyses relevant to the County. As part of the updating process, the identification of hazards likely to affect Milwaukee County was reviewed and reevaluated. This reevaluation included additional input from the Milwaukee County Hazard Mitigation LPT. As such, the LPT reevaluated the hazards using a hazard and vulnerability assessment tool in the form of an online survey called "Survey123."[44] In this survey, members of the LPT indicated the likelihood of each hazard occurring in Milwaukee County and evaluated the severity of each hazard on the basis of possible impacts to people, property, and businesses. In the survey the LPT also evaluated the relative state of preparedness for each hazard. The ratings given by the LPT for each hazard were used to derive a perceived level of risk posed by each hazard which were then ranked as shown Table 3.1.

Summary of Hazard Vulnerability and Risk Assessment Survey Results

Methods

The online assessment survey was presented at the April 27, 2023 LPT online meeting, with a total of 15 surveys returned and analyzed (see Appendix A). For each of the hazards, a risk was computed for each survey using the formula:

Risk (in weighted average) = [Probability) x (Human impact + Property impact + Business impact - Preparedness)]

[43] *Wisconsin Department of Emergency Management and Military Affairs, State of Wisconsin Hazard Mitigation Plan, December 2021.*

[44] *ArcGIS "Survey123" is an online tool that collects data through web or mobile devices which can be used to create, share, and analyze surveys.*

Table 3.1
Perceived Risks of Hazards as Determined by the Milwaukee County Hazard Vulnerability and Risk Assessment Survey: 2022

Hazard	Probability[a] *Likelihood this will occur*	Human Impact[a] *Possibility of death or injury*	Property Impact[a] *Physical losses and damages*	Business & Agency Impact[a] *Interruption of services*	Preparedness[a] *Mitigation or pre-planning*	Total Risk[b] *Relative threat*	Rank[c]
Tornado	2.133	2.667	2.733	2.533	1.933	12.798	1
Straight-Lined Winds	2.800	2.333	2.333	1.933	2.133	12.505	2
Ice Storm	2.667	2.400	2.000	2.267	2.133	12.092	3
Blizzard	2.733	2.733	1.667	2.267	2.267	12.025	4
Stormwater Flooding	2.667	2.133	2.067	1.733	1.733	11.201	5
Extreme Cold	2.933	2.467	1.533	1.667	2.200	10.169	6
Heavy Snowstorm	3.000	2.133	1.533	2.067	2.400	9.999	7
Extreme Heat	2.667	2.333	1.533	1.667	2.067	9.244	8
Hail	2.733	1.867	2.000	1.400	2.067	8.746	9
Thunderstorm	2.933	1.867	1.800	1.467	2.400	8.019	10
Lightning	2.733	2.000	1.800	1.467	2.400	7.836	11
Riverine Flooding	2.067	1.333	1.733	1.400	1.333	6.476	12
Fog	2.600	1.667	1.333	1.000	1.800	5.720	13
Lake Michigan Bluff Failure	1.733	1.467	1.533	1.000	1.067	5.083	14
Drought	2.067	1.667	1.067	1.000	1.467	4.686	15
Lake Michigan Erosion	1.800	1.200	1.400	0.933	1.133	4.320	16
Earthquake	0.733	1.200	1.200	1.200	0.800	2.052	17
Land Slide	0.867	1.133	1.133	0.800	0.867	1.907	18
Wildfire	1.000	0.933	1.000	0.933	1.000	1.866	19
Land Subsidence	1.000	1.000	0.933	0.800	1.000	1.733	20
Coastal Flooding	0.667	0.933	1.133	0.733	0.667	1.422	21
Dam Failure	0.600	0.800	0.733	0.800	0.733	0.960	22
Inland Lake Flooding	0.600	0.733	0.933	0.533	0.800	0.839	23
Dust Storm	0.600	0.600	0.533	0.533	0.600	0.640	24

Note: Value is based on the weighted average of the number of votes received for each score of No Available information (NA), low (1), moderate (2), or high (3).

[a] *Severity = Sum of Impact – Preparedness*

[b] *Total Risk = Probability x Severity*

[c] *Perceived threat/rank is based on Total Risk score.*

Source: SEWRPC

Probability (likelihood that an event would occur), Human impact (possibility of death or injury), Property impact (physical losses and damages), Business impact (interruption of services), and Preparedness (mitigation or pre-planning) were each assigned a number from 0 to 3 by LPT members, with 0 indicating "not applicable," 1 indicating low, 2 indicating moderate, and 3 indicating high.

The interpretation of the results returned by this formula is that the perceived threat increases with increasing weighted average risk. For each hazard, an average risk was calculated using the results of all the returned surveys. The hazards were then ranked by average risk, with a rank of 1 indicating the highest perceived risk.

Results

The results from the assessment survey are summarized in Table 3.1. Hazard events are listed in order of highest perceived risk to lowest perceived risk. As listed in Table 3.1, the highest perceived risks are associated with tornado, high straight-line winds, stormwater flooding, winter events (i.e., ice storms and blizzards), and extreme temperature events with riverine flooding and coastal hazards perceived as moderate risks (middle of the ranking order).

Summary and Ranking of Hazards

There are several ways the Milwaukee County hazards can be ranked and summarized to be considered in the County hazard mitigation plan. Current guidance for all hazard mitigation plans promotes comprehensive consideration of all natural hazards. These hazards have been ranked by consideration of their frequency, amount of damage, and death and injuries incurred, as well as by concerns of, and degree of importance assigned by, the collective judgment of the Milwaukee County Hazard Mitigation LPT.

The hazards to be considered in this plan are summarized in Table 3.2,[45] along with qualitative information on the hazard severity. Natural hazard severity can be assessed and ranked in a variety of ways. The purpose of ranking hazards is to help set priorities and direct more resources to address those hazards of the greatest severity. However, the kinds of mitigation actions that will be needed and warranted depend on the type of vulnerability to be addressed. Some hazards, such as excessive heat and lightning, are unlikely to cause a disaster, but they can be fatal and, therefore, are serious hazards. Vulnerability to such hazards can best be addressed by preventative measures, such as public information to encourage hazard awareness and personal protection. Other hazards, such as flooding, are pervasive and devastating, and may require a variety of tools—mapping, building codes, zoning laws, insurance, elevation or acquisition of flood-prone structures, and public awareness—to effectively reduce the risk of disaster. However, flooding might not result in more fatalities than a heat wave. In general, ranking hazards by the number of deaths that they cause shifts the focus away from major and largely avoidable disasters, such as floods. Weather hazards that have caused past Milwaukee County disasters are likely the hazards that will cause future disasters. However, the types of natural hazards that result in fatalities remain a public health and safety concern.

The summary listing of natural hazards in Tables 3.1 does include some hazards that have been found to have a minimal chance of occurring or offer only limited applicable mitigation options. In addition, the hazards listed below will receive less emphasis in the subsequent sections of the report or are incorporated as sub-elements among existing categories, as summarized in Table 3.2.

Fog

Fog is low-level moisture caused by many contributing factors, including ice or snowmelt, moist air from Lake Michigan, or rain evaporation with light winds, which may reduce visibility levels, especially in river valleys and other low spots. Dense fog is often seen with clear skies the day following a heavy rainstorm. Fog is a widespread natural hazard event that usually covers several counties during an episode. There have been 61 fog events reported in and around Milwaukee County from 2000 through 2022. Although no deaths or injuries were recorded during that period, fog can affect mobility. Dense fog may persist for

[45] *The rankings in Table 3.2 were assigned by combining rankings of the natural hazards listed based upon the number of occurrences, number of damages, numbers of fatalities and injuries reported since 2000, and the perceived risk associated with each hazard as identified by the Local Planning Team and summarized in Table 3.1. It is important to note that some of the natural hazards listed in Table 3.2 represent combinations of hazards listed in Table 3.1. For example, while specific risks associated with thunderstorms, such as hail and lightning are listed separately in Table 3.1, they are combined into one category in Table 3.2.*

Table 3.2
Summary of Hazards to be Considered in the Milwaukee County Hazard Mitigation Plan

Hazard	Risk of Occurrence[a]	Damage to Property[a]	Threat to Life Safety[a]	Duration of Impact[b]	Size of Area Affected[c]
Flooding and Stormwater Drainage Problems	Medium	High	High	Moderate	Large
Thunderstorm, High Winds, Hail, Lightning	High	Medium	High	Long	Large
Tornadoes	Medium	High	High	Short	Small
Winter Storms	High	Medium	High	Medium	Large
Temperature Extremes	High	Medium	High	Long	Large
Drought	Low	Low	Low	Long	Large
Coastal Hazards	Medium	Medium	Medium	Short	Medium

Note: Some of the natural hazards listed in this table represent combinations of hazards listed in Table 3.1. For example, while specific risks associated with thunderstorms, such as hail and lightning are listed separately in Table 3.1, here they are combined into one category.

[a] *High, medium, or low*

[b] *Long, moderate, or short*

[c] *Large, medium, or small*

Source: Milwaukee County LPT and SEWRPC

several hours or days, reducing visibility and leading to vehicle accidents, flight delays, or cancellations at airports. This natural hazard event does not offer significant mitigation alternatives to warrant individual examination.

Wildfires

A forest fire is an uncontrolled fire occurring in forest or woodlands outside the limits of incorporated villages or cities. A wildfire is any instance of uncontrolled burning in brush, marshes, grasslands, or field lands. Such incidents are normally responded to by local fire suppression departments in accordance with established response procedures and no specific mitigation actions are deemed warranted. Wildfires in Wisconsin are primarily caused by humans burning yard debris, arson, or campfires, for example. They can also be caused by natural events like lightning. Land use, vegetation, amount of combustible materials present, and weather conditions, such as wind, low humidity, and lack of precipitation, are the chief factors determining the number of fires and acreage burned.

Less than 4 percent of the land area in Milwaukee County is woodland (see Table 2.9). Urbanization has reduced the threat of a large-scale forest or wildfire event. In addition, no wildfires are reported in the NCEI database for Milwaukee County. It should be noted that the Wisconsin Department of Natural Resources (WDNR) online dashboard for Wisconsin wildfires indicates six reported smaller wildfire events in Milwaukee County from the period of 2012 through 2023.[46]

Based on guidance from the National Association of State Foresters, the WDNR, in conjunction with its Federal and tribal partners, developed a Statewide assessment of communities at risk from wildfires. None of the communities in Milwaukee County were determined to be a concern or at high or very high risk. Considering the low risk and lack of historical significance, forest and wildfire hazards will not be addressed in later chapters.

Dust Storms

There have been no dust storm events reported in Milwaukee County from 2000 through 2022. Natural hazard events that occurred in the past are likely to recur in the future, providing the opportunity to plan for them. A dust storm event in Milwaukee County would be atypical, therefore, mitigation strategies will not be recommended for this hazard in the current plan.

[46] *dnrmaps.wi.gov/WAB.*

Land Subsidence

Land subsidence is the lowering of the land-surface elevation from changes that take place underground. Common causes of land subsidence from human activity are pumping water, oil, and gas from underground reservoirs; dissolution of limestone aquifers (sinkholes); collapse of underground utilities or mines; drainage of organic soils; and initial wetting of dry soils (hydrocompaction). Due to the limited threat from physical injury and death incidences from subsidence in Milwaukee County, this hazard will not be considered further in subsequent sections of this report.

Inland Landslide

The term "landslide" includes a wide range of ground movement, including rock falls, deep failure of slopes and shallow debris flows. The most frequent and damaging landslides in the U.S. are started by prolonged or heavy rainfall. The majority of rainfall-induced landslides are shallow, small, and move rapidly. Many rainfall-induced landslides transform into debris flows (fast-moving slurries of water, soil, and rock) as they travel down steep slopes, especially those that enter stream channels where they may mix with additional water and sediment. Due to the lack of bare (no plants or trees to hold the soil in place) hills or steep slopes in the County, inland landslides are considered to have very low potential in Milwaukee County. As such, there have been no inland landslides reported in the County from 2000 through 2022. Thus, mitigation strategies for this hazard will not be recommended in the current plan.

Earthquake

An earthquake is a shaking or sometimes violent trembling of the earth that results from the sudden shifting of rock beneath the earth's crust. These sudden shifts release energy in the form of seismic waves or wave-like movement of the land surface. Earthquakes can strike without warning and may range in intensity from slight tremors to great shocks lasting a few seconds or over five minutes. The actual movement of the ground during earthquakes is seldom the direct cause of injury or death. Casualties may result from falling objects and debris, and disruption of communications, electrical power supplies, and gas, sewer, and water lines should be expected from earthquakes. The severity of an earthquake can be measured by comparing the peak acceleration associated with the horizontal shaking. It produces to the normal acceleration a falling object experiences due to the force of gravity. This is usually expressed as a percentage of g, the acceleration due to gravity. The level of risk due to earthquake can be expressed as the percentage of g, for which there is a 2 percent probability of being exceeded in a 50-year period. Depending on location, sites in Milwaukee County have a 2 percent probability of experiencing earthquakes in a 50-year period in which the peak acceleration associated with horizontal shaking exceeds between 4 percent and 8 percent of g.[47] These are low values. While these levels of shaking can be noticeable, they are rarely associated with damage to structures. The earthquake threat to the State and Milwaukee County is considered low, therefore earthquakes will not be considered further in subsequent sections of this report.

Past Hazard Experience

Past experiences with disasters are an indication of the potential for future disasters to which Milwaukee County would be vulnerable. Accordingly, a review was made of the hazards that Milwaukee County has faced in the past. Tables 3.3-3.5 detail the history of estimated disaster damages caused by federally declared emergencies, the total number of weather hazard events recorded, and the severe weather history in the County.

As shown in Table 3.3, Milwaukee County has had 18 major disaster declarations and 3 emergency disaster declarations between 1969 and 2022. The total documented estimated damages of these 18 events exceeded $380 million. It should be noted that the reported damage estimates generally underestimate the actual damage that occurred.[48]

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[47] *U.S. Geological Survey, "2008 United States National Seismic Hazard Maps", USGS Fact Sheet 2008-3018, April 2008.*

[48] *Major declarations are made by the President, when the President determines, assistance is needed to supplement State and local efforts in providing services such as the protection of lives, property, public health, and safety, and to lessen the threat of a disaster. Agriculture-related disasters and disaster designations are quite common. A Secretarial disaster declaration occurs when the USDA Secretary of Agriculture authorizes a county (or counties) as a disaster area (or "designation") to make available emergency loans for agricultural producers that have suffered severe production losses due to a natural disaster.*

Table 3.3
Summary of Estimated Disaster Damages and Assistance in Milwaukee County for Federally Declared Disaster Emergencies: 1969-2022

Date of Disaster and Event(s)	Event	Fatalities	Estimated Damages ($)[a]
1969 – July (DR-264)	Severe Storms, Flooding	--	--
1973 – April (DR-376)	Flooding	0	--
1976 – March (DR-496)	Ice Storm	--	--
1979 – January (EM-3069)	Snow Emergency	0	--
1986 – August (DR-770)	Flooding	2	36,387,696
1986 – September (DR-775)	Flooding and Wind Damage	0	10,852,489
1993 – April-May (DR-994)	Flooding, Severe Storms	0	--
1996 – August (DR-1131)	Flooding	0	--
1997 – July-June (DR-1180)	Flooding and High Winds	0	139,645,725
1998 – August 12 (DR-1238)	Flooding, Severe Storms	0	19,470,567
2000 – June (DR-1332)	Flooding, Severe Storms	0	11,331,235
2001 – January (EM-3163)	Snow Emergency	0	--
2004 – May (DR-1526)	Severe Storms, Tornadoes, and Flooding	2	1,554,612
2008 – February (EM-3285)	Severe Storms, Tornadoes, and Flooding	0	--
2008 – June (DR-1768)	Severe Winter Storm and Snowstorm	0	107,306,625
2010 – July (DR-1933)	Severe Storms, Flooding	1	46,745,603
2011 – January-February (DR-1966)	Flooding	0	13,882
2020 – January (DR-4477-WI)	Severe Winter Storm and Flooding	0	10,036,467
	Total – 18 Disaster Events	5	383,344,901

[a] *Dollar values are adjusted to year 2022 by using the annual Consumer Price Index (CPI) values from the U.S. Department of Labor, Bureau of Labor Statistics.*

Source: Milwaukee County Pre-Disaster Mitigation Plan, National Climate Data Center, Wisconsin Emergency Management, Federal Emergency Management Agency, and SEWRPC

Table 3.4
Natural Hazard Events Recorded in Milwaukee County: 2000-2022

Event	Number of Events	Average Number per Year	Deaths	Injuries	Property Damages ($)[a]	Crop Damages ($)[a]
Dust Storms	0	0.00	0	0	0	0
Wildfires/Forest Fires	0	0.00	0	0	0	0
Tornadoes	3	0.13	0	16	10,550,567	20,715
Drought	14	0.61	0	0	0	322,369
Lightning	20	0.87	0	2	1,964,126	0
Flood	45	1.96	4	0	170,829,985	155,615
Fog	61	2.65	0	0	0	0
Temperature Extremes	83	3.61	45	69	29,169	2,043
Hail	111	4.83	0	0	11,481,820	3,516
Winter Weather	187	8.13	0	0	144,418	22,548
Thunderstorms/High Winds	208	9.04	1	2	10,752,089	771,986
Total	732	2.89	50	89	205,752,174	1,298,792

[a] *Dollar values were adjusted to year 2022 by using the average Consumer Price Index (CPI) values from the U.S. Department of Labor, Bureau of Labor Statistics.*

Source: The National Climatic Data Center (NCDC), National Oceanic and Atmospheric Administration (NOAA), and the National Environmental Satellite, Data and Information Service (NESDIS), and the U.S. Department of Agriculture Risk Management Agency

Table 3.5
Milwaukee County Severe Weather Watches and Warnings History: 2000-2022

Year	Flash Flood Warning	Flood Warning	Severe Thunderstorm		Tornado	
			Watch	Warning	Watch	Warning
2000	4	0	14	0	0	2
2001	0	0	4	0	0	1
2002	1	0	5	0	0	0
2003	0	0	4	0	0	0
2004	0	0	9	0	0	0
2005	1	0	9	0	0	0
2006	3	0	16	17	2	0
2007	2	2	9	5	3	0
2008	6	20	14	9	6	3
2009	3	8	3	7	1	2
2010	5	7	8	6	7	3
2011	1	1	11	12	1	0
2012	0	0	12	7	0	0
2013	1	5	7	5	2	2
2014	3	1	10	8	1	0
2015	0	2	9	5	2	0
2016	2	0	2	8	0	0
2017	0	0	6	8	2	0
2018	1	5	8	4	1	0
2019	2	4	3	7	0	0
2020	2	8	0	0	2	0
2021	1	1	8	4	0	1
2022	2	3	10	5	1	1
Total	40	67	181	117	31	15

Source: Iowa State University, Iowa Environmental Mesonet

Since 2000 (the "historical range" for this Plan update), Milwaukee County has experienced 732 weather hazard events resulting in 50 fatalities and 89 injuries reported, as shown in Table 3.4. To illustrate the broader hazard damage potential, these records indicate that an estimated $207 million (2022 dollars) in property and crop damages occurred over this time period.

The events summarized in Table 3.4 show that thunderstorm and related high wind events were the most frequent recorded weather hazards in Milwaukee County, followed by winter weather and extreme temperature occurrences. However, it is important to note that flooding is the most damaging weather hazard. In addition, temperature extremes have resulted in all but five of the reported 50 fatalities during this time period.

To demonstrate the potential frequency of thunderstorms, tornadoes, and flooding events a review was made of the warnings historically issued by the NWS, as shown in Table 3.5. Over the period of 2000 through 2022, there have been 46 tornado-related watches or warnings, 298 severe thunderstorm watches or warnings, and 107 flash flood and flood warnings.

3.2 DESCRIPTION OF ANALYSIS, METHODS, AND PROCEDURES

In the previous section of this Report, the natural hazards considered applicable to Milwaukee County were identified and ranked (Table 3.1). This section of the report develops a vulnerability assessment procedure for the identified hazards. This vulnerability assessment provides the basis for developing mitigation strategies that address the identified vulnerabilities.

The procedures utilized in the vulnerability analyses are based upon guidance provided by the Federal Emergency Management Agency (FEMA) and the Wisconsin Department of Military Affairs, Division of

Emergency Management (WEM).[49] The analysis includes three components: 1) profile of weather hazard events, 2) inventory of assets (Chapter 2 component), and 3) estimation of losses. In addition, where applicable, potential changes in vulnerability under future conditions and the variance of vulnerability among the populations of the 19 municipalities within Milwaukee County are analyzed. The profiling of these weather hazard events was developed by utilizing the HAZUS methodology, data available on the FEMA and NOAA National Climatic web sites, USDA-RMA, data provided by the WEM, file data available from the Milwaukee County Office of Emergency Management, MMSD, and the Southeastern Wisconsin Regional Planning Commission (Commission or SEWRPC).

Data and estimated losses and vulnerability were developed utilizing standard risk assessment methodology as set forth in FEMA and WEM guidelines for hazard mitigation planning where hazards can be estimated spatially and by order of magnitude over a range of events. For hazards which cannot be quantified, alternative approaches have been used relying on qualitative measures. A vulnerability description has been included for each of the applicable hazards listed in Table 3.2.

3.3 HAZARD VULNERABILITY AND RISK ASSESSMENTS

Flooding and Stormwater Drainage Problems

Floods are natural events that provide many environmental benefits, such as enriching soils and recharging aquifers. Floods are only considered hazards when development occurs in the floodplain, exposing people and/or property to the risk of flood damages. Nationwide, hundreds of flood hazard events occur each year, making it one of the most common natural hazards. The type of flooding that threatens a community is dependent on a variety of factors including terrain, geologic conditions, watershed characteristics, natural features, and human interaction. The characteristics of flooding events differ significantly from a controlled engineered urban community to that of a more natural rural environment. For Milwaukee County, flooding is considered a significant hazard.

In addition to riverine (or overbank) flooding, stormwater drainage (urban flooding) problems occur throughout the County. Stormwater drainage problems are a result of a community's stormwater infrastructure capacity being exceeded by a storm or series of storms.[50] Most storm water infrastructure systems are designed to handle the amount of water expected during a 5-year or a 10-year storm. The distinction between stormwater drainage, stormwater management, and flood control is not always clear. For the purpose of this Report, flood control is defined as the prevention of damage from the overflow of natural streams and watercourses. Drainage is defined as the control of excess stormwater on the land surface before such water has entered stream channels. The term "stormwater management" encompasses both stormwater drainage and stormwater control measures. While the focus of this section of the plan is on the flooding hazard, the related stormwater drainage hazards are also considered because of the interrelationship between these two hazard conditions.

Other types of flooding concerns prone to Milwaukee County are highlighted below.

Flood Hazards Related to Dam Failure

A consideration in flood hazard mitigation is the potential for increased flooding due to dam failures. As indicated in Table 3.6 and Map 3.1, there are nine dams identified by the WDNR in Milwaukee County. Dams built according to accepted engineering principles at the time of construction and dams built without application of engineering principles can both equally fail. When a dam fails, or is subject to overtopping, large quantities of water can rush downstream with great destructive force.

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[49] *Federal Emergency Management Agency,* State and Local Mitigation Planning How-to Guide*,* "Understanding Your Risks, Identifying Hazards and Estimating Losses," *Publication No. FEMA 386-2, August 2001; Federal Emergency Management Agency,* State Mitigation Planning Policy Guide*, April. 2022; Federal Emergency Management Agency,* Local Mitigation Planning Policy Guide, *April 19, 2022.*

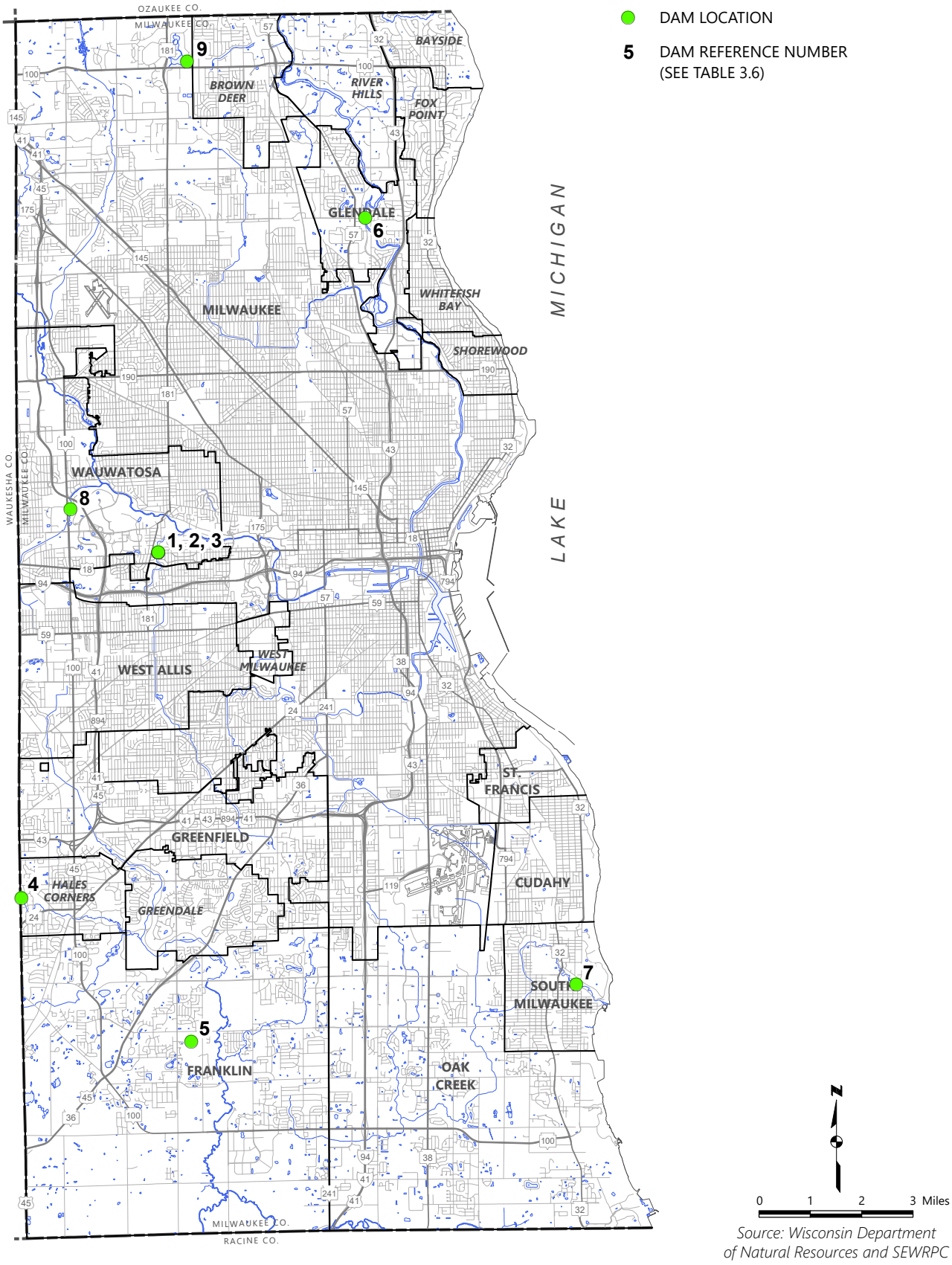
[50] *An urban drainage system is comprised of altered natural channels and engineered ditches, storm sewers, retention ponds, and other facilities constructed to store runoff or carry it away from residential areas to a receiving stream or lake.*

Table 3.6
WDNR Dam Inventory for Milwaukee County: 2023

Map ID	Official Name	Owner Type	Water Feature	Size	Hazard Potential	Structure Type
1	Milwaukee General Hospital 3	County	Unnamed Tributary to Honey Creek	Small	Low	Earth
2	Milwaukee General Hospital 2	County	Unnamed Tributary to Honey Creek	Small	Low	Concrete, Earth
3	Milwaukee General Hospital 1	County	Unnamed Tributary to Honey Creek	Small	Low	Earth
4	Kurtze Lake	Private	Kurtze Lake Outlet	Small	Low	Gravity, Earth
5	Tuckaway Country Club	Private	Legend Creek	Small	Low	Earth
6	Kletzsch Park	County	Milwaukee River	Large	Low	Gravity, Concrete, Masonry
7	South Milwaukee Mill	County	Oak Creek	Small	Low	Gravity, Earth, Other
8	Milwaukee County Grounds	MMSD	Underwood Creek	Large	High	Earth, Concrete
9	Northridge Lakes Residential Department	Private	Unnamed	Large	Low	Concrete, Gravity, Other

Source: Wisconsin Department of Natural Resources

Map 3.1
Dam Locations in Milwaukee County: 2023



Source: Wisconsin Department of Natural Resources and SEWRPC

The WDNR inspects and assigns hazard ratings to large dams within the State. Two factors are considered when assigning hazard ratings: existing land use and land use controls (zoning) downstream of the dam. Dams are classified, by law, in three categories that identify the potential hazard to life and property.[51]

- A **low hazard** rating is assigned to those dams that have no development beyond the allowable open space use in the hydraulic shadow where the failure or mis-operation of the dam would result. There would be no probable loss of human life, low economic losses (losses are principally limited to the owner's property), low environmental damage, and no significant disruption of lifeline facilities. Land use controls are in place to restrict future development in the hydraulic shadow.

- A **significant hazard** rating is assigned to those dams that have no existing development in the hydraulic shadow that would be inundated to a depth greater than 2 feet and have land use controls in place to restrict future development in the hydraulic shadow. The potential for loss of human life during failure is unlikely. Failure or mis-operation of the dam would result in no probable loss of human life but may cause economic loss, environmental damage, or disruption of lifeline facilities.

- A **high hazard** rating is assigned to those dams that have existing development in the hydraulic shadow that will be inundated to a depth greater than 2 feet or do not have land use controls in place to restrict future development in the hydraulic shadow. This rating is assigned if loss of human life during failure or mis-operation of the dam is probable.

Of the nine existing (or active) dams in Milwaukee County, one dam (Milwaukee County Grounds) is listed as having a high hazard rating while the remaining are listed as a low hazard rating (see Table 3.6).

Ice Jams

Flows that would normally be conveyed within stream and river channels with little problem can become flood hazards when an ice jam forms downstream. Likewise, ice jams can intensify flooding from streams that are already swollen from large storm events or spring melt. Ice jams occur when chunks of ice clump together to block the flow of a waterway, creating a temporary dam made of ice. The waterway backs up and floods adjacent land—often with swiftly moving water. Ice jams can develop near bends in a river, places where topography flattens, or around bridges. Jams usually occur when there are large temperature swings that cause snow melt to swell a river before the ice has a chance to thaw. The volume and speed of water released from an ice jam can be a highly destructive combination. Ice jams have been known to occur on the Milwaukee River, including a 2019 event in Ozaukee County (just north of Milwaukee County) in which 20 homes, two businesses, a fire station, and a baseball field were damaged. In total, this event caused $165,000 (2019 dollars) in damages to public facilities.

Flash Floods

Flash floods typically occur within hours of heavy rains, ice jams or dam failures. With that, flash floods usually involve a rapid rise in water level, high velocity, and large amounts of debris, which can lead to significant damage including the tearing out of trees, undermining of buildings and bridges, scouring of new channels, and creation of sink holes. The intensity of flash flooding is dependent upon the intensity and duration of rainfall, steepness of the watershed, stream gradients, watershed vegetation, natural and artificial flood storage areas, and configuration or manipulation (i.e., concrete lining) of the streambed and floodplain. Urban areas, such as Milwaukee County, are increasingly subject to flash flooding due to the removal of vegetation, installation of impermeable surfaces, and construction of drainage systems. As indicated in Table 3.7, between 2011 to 2022 of the 20 reported flood events, 14 were considered a flash flood, making this type of flooding event very common throughout Milwaukee County.

Recent Flood Events

As shown in Table 3.7, from 2011-2022 a total of 20 flood events were reported in Milwaukee County, and several have caused significant damage. These flood events ranged from one event per year up to five events per year, which demonstrates the likelihood and unpredictability of these events. In total, these flood events have resulted in three casualties, no injuries, and over $12 million (2022 dollars) in property damages within Milwaukee County. Examples of these more recent significant flood events are noted below. Note, the January 11, 2020 lakeshore flood event is described in the "Lake Michigan Coastal Hazards" section.

[51] Wisconsin Administrative Code*, NR 333.06*.

Table 3.7
Recent Flood Events in Milwaukee County: 2011-2022

Date	Location	Type[a]	Deaths	Injuries	Property Damages ($)[a]	Crop Damages ($)[a]
June 21, 2011	Franklin	Flash Flood	0	0	656	--
October 5, 2013	St Martins	Flash Flood	0	0	0	--
May 12, 2014	Butler	Flash Flood	0	0	0	--
August 30, 2016	West Milwaukee	Flash Flood	0	0	61,485	--
September 7, 2016	West Allis	Flash Flood	0	0	12,294	--
February 19, 2018	Granville	Flood	0	0	1,139	--
August 26, 2018	Milwaukee Hoan Bridge	Flash Flood	0	0	29,365	--
May 28, 2019	Milwaukee Hoan Bridge	Flood	0	0	11,414	--
September 12, 2019	Franklin	Flash Flood	0	0	28,899	--
September 13, 2019	Franklin	Flood	0	0	0	--
January 11, 2020	Milwaukee Shoreline	Lakeshore Flood	0	0	12,099,213	--
May 17, 2020	Fox Point	Flood	0	0	34,201	--
May 18, 2020	Franklin	Flood	0	0	11,400	--
August 2, 2020	Hales Corners	Flash Flood	0	0	56,974	--
August 8, 2021	Fox Point	Flash Flood	0	0	1,083	--
October 24, 2021	Milwaukee Shoreline	Lakeshore Flood	0	0	0	--
June 13, 2022	West Allis	Flood	3	0	0	--
July 5, 2022	Greenfield	Flash Flood	0	0	10,000	--
July 23, 2022	Brown Deer	Flash Flood	0	0	5,000	--
September 11, 2022	Franklin	Flood	0	0	15,000	--
		Total – 20 Events	3	0	12,378,123	--

Note: Dollar Values were adjusted to year 2022 by the average annual Consumer Price Index (CPI) values from the U.S. Department of Labor, Bureau of Labor Statistics.

[a] *National Weather Service determines the type of event bason on report narratives from local officials.*

Source: The National Climatic Data Center (NCDC), National Oceanic and Atmospheric Administration (NOAA)

2018 – On August 27, 2018, there were multiple rounds of flooding and severe weather across southern Wisconsin. Significant flash flooding took place at times across parts of Milwaukee and Ozaukee Counties. Four to eight inches of rain fell over this area resulting in flash flooding in northern Milwaukee County. This event caused an estimated $30,000 in property damages (2022 dollars).

2020 – In August of 2020, three to seven inches of rain from persistent thunderstorms resulted in flash flooding of creeks, streets, parks, and residential yards in southern Milwaukee County. This mostly included the communities of West Allis, Hales Corners, Greenfield, Oak Creek, and Franklin. Many streets were impassable and closed. Numerous vehicles were stranded in 2 to 4 feet of floodwaters. Portions of I-43 were closed due to flooding. Many yards and basements were flooded especially when the floodwaters rose from the streets into the yards. Oak Creek in South Milwaukee rapidly rose and nearly reached moderate flood stage. An estimated $56,974 in property damages (2022 dollars) was reported as a result of this event.

Vulnerability and Community Impact Assessment Related to Flooding Hazards

People and property (residential structures, public facilities, and infrastructure) located within floodplains are susceptible to flood impacts. In addition, areas with poor stormwater drainage are more susceptible to short-term effects of flash flooding. To assess Milwaukee County for flooding hazards and related stormwater drainage problems, consideration was specifically given to structural assets throughout the County that would be impacted by a 100-year riverine flood event.

Damage Estimation Method: Parcel-Based Loss Analysis

Commission staff conducted a parcel-based analysis to estimate the damages that would be sustained by buildings (or structures) as the result of a 1-percent-annual-probability flood event. Milwaukee Metropolitan Sewerage District (MMSD) provided a database that identified structures located within the 1-percent-annual-probability floodplain across most of the county. For these parcels, on which a principal building (structure) was located wholly or partially in the floodplain, the 2022 assessed value of improvements, when

available, was obtained predominantly from the State Cartographer's Office.[52] Where tax year 2022 assessed values were not available, tax year 2023 assessed values were used. The information in the assessment along with reviewing imagery was used to classify each principal building as residential (including manufactured homes, apartments, and condominiums), commercial, parks and recreational, utility, or a critical community facility. For each principal building, the lowest elevation of the ground at the building was determined from 2015 one-foot contour topographic maps.

Standard assumptions were made as to the elevation of the first floors of the principal buildings. For a residential building, it was assumed that the first floor was 1.0 foot above the ground elevation. It was also assumed that all residential buildings had a basement unless evidence was seen to suggest otherwise. For manufactured homes it was assumed that the first floor was 2.0 feet above ground elevation. For all other building types, it was assumed that the first floor is 0.5 feet above ground elevation.

Flood elevations for the 1-percent-annual-probability flood event were derived from information in the source floodplain listed for each structure; the MMSD flooded structures dataset used a combination of the latest floodplain mapping sources across the county depending on specific location, which included FEMA effective floodplains, Commission floodplains, Menomonee River and Estabrook Dam LOMRs, and WDNR Risk Map floodplains. Flood elevation values were based on the location of the structure and adjacent cross sections, linearly interpolating between water surface elevations at cross sections.

A different methodology was used to determine the flood elevation for those buildings located in floodplains that were developed using approximate methods (Zone A on the DFIRM). A transect was drawn at the building through the mapped floodplain perpendicular to the stream, and the ground elevation was noted at both edges of the floodplain along the transect. Where the two ground elevations were similar, the higher contour elevation at the floodplain edge was used to estimate the flood elevation. In cases where the difference between the elevations at the two edges of the floodplain was larger, additional methods were used to estimate the flood elevation, such as assessing overtopping elevations of adjacent stream crossings, elevations of nearby structures known to be above the floodplain, and other similar approaches to determine bounding flood elevations.

For each building, the first-floor elevation and flood elevation were compared. The extent of direct damage, such as the costs associated with cleaning, repairing, or replacing the structure, its contents, and the land for each principal building was estimated as a percent of the value of improvements based on standardized flood loss depth-damage curves prepared by FEMA, U.S. Army Corps of Engineers, and the Commission (see Appendix F). Indirect damages, such as the costs associated with temporary evacuations, relocations, lost wages, lost production and sales, and the incremental costs of traffic detours, were estimated to be a percentage of direct damages for residential, commercial, and industrial buildings.

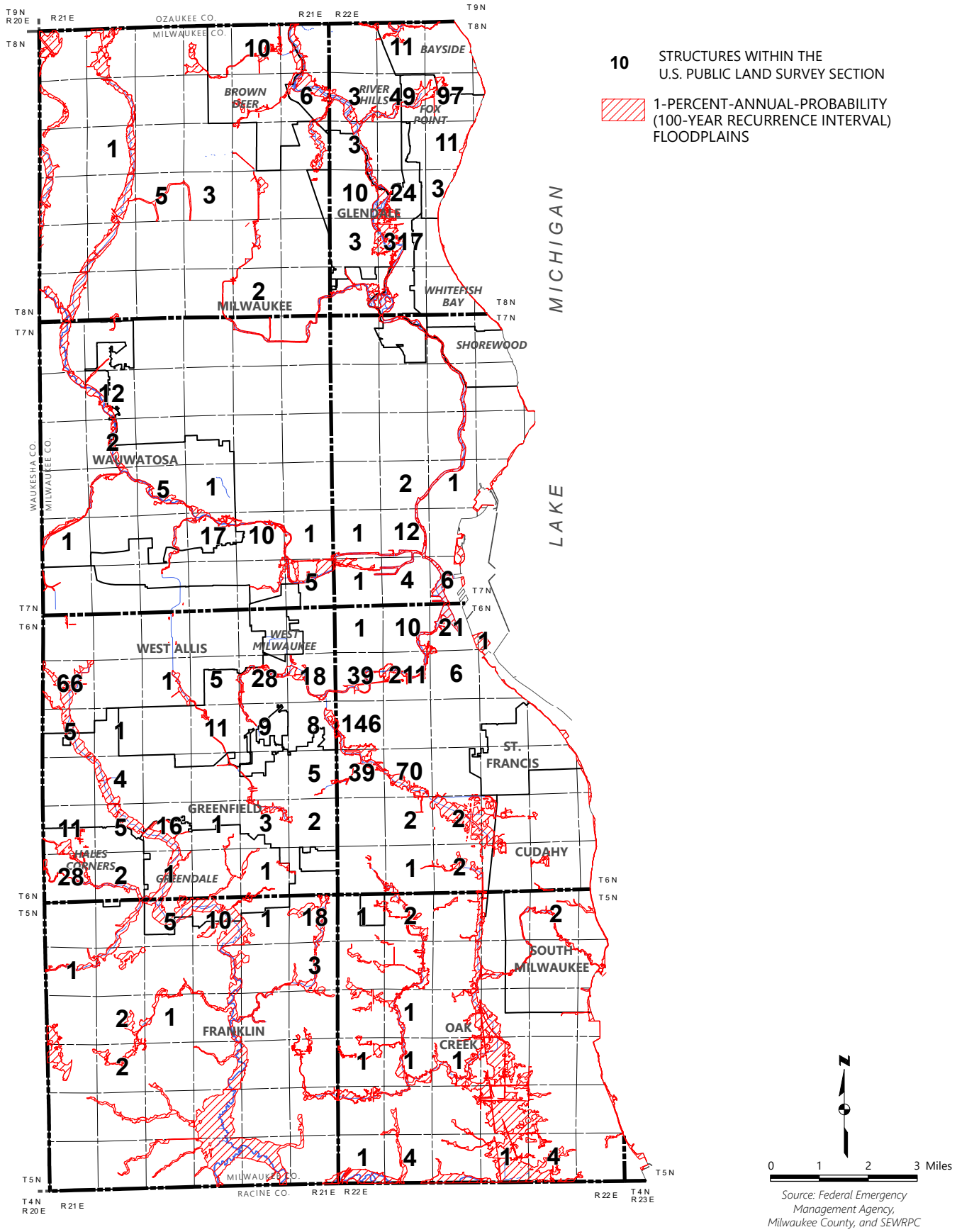
Impacts of a 1-Percent-Annual-Probability Flood

As noted above, the analyses estimating the damages that would result from a 1-percent-annual-probability flood were based on the same floodplains MMSD used to develop the database of structures at risk of flooding, as shown on Map 3.2.

Based upon the initial review of the parcel-based analysis, there are currently 1,483 insurable structures estimated to be located within the 1-percent-annual-probability (100-year recurrence interval) flood hazard areas of Milwaukee County (see Tables 3.8 and 3.9), including four critical community facilities. The amount and general location of these structures are shown on Map 3.2. As indicated in Table 3.9 and Map 3.2, the Cities of Glendale and Milwaukee and the Village of Fox Point have a significant number of parcels with structures located within the flood hazard areas of Milwaukee County. The largest type of flooded structure is residential (83 percent), followed by commercial structures (13 percent). There is one manufactured home park with 16 homes in the flood hazard area in the City of Franklin. Additionally, Table 3.8 reveals that the majority of these structures are within the Kinnickinnic River and Milwaukee River watersheds, followed by the Root River watershed.

[52] *For structures with no tax assessment information available, the structure value was estimated using a standard cost per square foot for the applicable building type based on construction cost reference materials.*

Map 3.2
Structures Located Within the 1-Percent-Annual-Probability Floodplain: 2023



Source: Federal Emergency Management Agency, Milwaukee County, and SEWRPC

Table 3.8
Estimated Structural Flood Damages for a 1-Percent-Annual-Probability Flood in Milwaukee County by Watershed: 2023

Watershed	Structures	Flood Damages[a]		
		Direct ($)	Indirect ($)	Total ($)
Kinnickinnic River	624	50,069,660	16,159,260	66,228,920
Lake Michigan Drainage Basin	28	853,790	128,070	981,860
Menomonee River	86	10,872,120	4,096,910	14,969,030
Milwaukee River	541	45,870,310	12,380,720	58,251,030
Oak Creek	10	4,234,470	1,681,310	5,915,780
Root River	194	14,506,190	5,103,920	19,610,110
Total	1,483	126,406,540	39,550,190	165,956,730

Note: Estimated damages are based on assessed improvement values in 2022.

[a] *Dollar values were adjusted to year 2022 by using the average annual Consumer Price Index (CPI) values from the U.S. Department of Labor, Bureau of Labor Statistics.*

Source: Federal Emergency Management Agency, Wisconsin Department of Natural Resources, Milwaukee County, Milwaukee Metropolitan Sewerage District, and SEWRPC

The total assessed value for the 1,483 structures, which were identified as being subject to flooding, is about $662 million. The total market value plus contents for these structures are estimated at nearly $930 million. Damages expected during a 1-percent-annual-probability flood event are estimated to be about $166 million (2022 dollars).

Repetitive or Severe Repetitive Loss Structures

Based on FEMA's NFIP program, as of October 2023, there are 267 structures considered to be repetitive- or severe repetitive-loss properties in Milwaukee County. Of these repetitive-loss properties, 18 of them were estimated to be located within the 1-percent-annual-probability-floodplain and were included in the Commission's parcel-based analysis. Repetitive-loss structures are those that have two or more flood insurance claims of at least $1,000 each. Severe repetitive-loss properties are those that either have four or more flood insurance claims for damages to building or contents of at least $5,000 each or two or more flood insurance claims for building damages that total more than the existing value of the building. All structures are listed as either single- and multi-family residential or as other-nonresidential. As indicated in Table 3.10, nearly all of these structures (231) are located in the City of Milwaukee.

Roadway Flooding

As can be seen by review of Map 3.2, the floodplain intersects a number of arterial and collector streets in the County. In some locations, this may indicate that floodwaters could potentially overtop these roads during a major flood event and potentially cause a washout or become inundated and/or covered by debris. This could disrupt portions of the transportation system, including emergency vehicle routes, in the County during flood events. Further examination on data related to water surface elevations and top-of-road elevations would need to be completed in order to identify and confirm specific roadway locations throughout Milwaukee County that continually experience flood overtopping during heavy rain events.

After review of the community assets described in Chapter 2, past flooding events, and the parcel-based analysis for Milwaukee County, the following County assets are considered a potential high risk and vulnerable to flooding hazard impacts: 1) a variety of flood-prone residential (including manufactured homes), commercial, and other developed land uses; 2) critical community facilities and infrastructure; 3) recreational use lands and facilities; and 4) transportation systems.

Future Changes and Conditions

Changes in land use can have a direct impact on flood flows and stages and, accordingly, can impact flooding problems. The continued increase in urban land use (i.e., impervious surfaces) through 2050 is expected to result in an increase in the amounts of impervious surface in the Milwaukee County watersheds. In the absence of mitigative measures, this could lead to increases in future flood flows and stages, especially in downstream areas and loss of vulnerable community and county assets. As is discussed previously in this

Table 3.9
Number of Structures in the 1-Percent-Annual-Probability Floodplain in Milwaukee County by Structure Type: 2023

	Number of Flooded Structures								Total Number of Flooded Structures
Municipality	Apartment	Condominium	Residential	Commercial	Critical Facility	Manufactured Homes	Parks	Utility	
Cities									
Cudahy	0	0	0	0	0	0	0	0	0
Franklin	1	0	8	2	0	16[d]	0	0	27
Glendale	0	0	350	3	0	0	0	0	353
Greenfield	0	4	11	5	0	0	0	0	20
Milwaukee	12	7	538	123	3[b]	0	1	1	685
Oak Creek	1	0	11	4	0	0	0	0	16
St. Francis	0	0	0	0	0	0	0	0	0
South Milwaukee	0	0	2	0	0	0	0	0	2
Wauwatosa	0	0	14	24	0	0	0	0	38
West Allis	8	0	48	16	0	0	0	0	72
Villages									
Bayside[a]	0	0	60	0	0	0	0	0	60
Brown Deer	0	0	3	10	0	0	0	0	13
Fox Point	0	0	109	0	0	0	0	0	109
Greendale	0	0	25	7	1[c]	0	2	0	35
Hales Corners	0	2	36	3	0	0	0	0	41
River Hills	0	0	10	2	0	0	0	0	12
Shorewood	0	0	0	0	0	0	0	0	0
West Milwaukee	0	0	0	0	0	0	0	0	0
Whitefish Bay	0	0	0	0	0	0	0	0	0
County Total	22	13	1,225	199	4	16	3	1	1,483

[a] *Milwaukee County portion only.*

[b] *The three critical facilities in the City of Milwaukee are St. Luke's Medical Center; Adult Day Services of Wisconsin, LLC; and the Lake Express High-Speed Ferry.*

[c] *The critical facility in the Village of Greendale is College Park Elementary School.*

[d] *The mobile (manufactured) home community in the City of Franklin is the Franklin Mobile Estates property.*

Source: Milwaukee Metropolitan Sewerage District (MMSD) and SEWRPC

Table 3.10
FEMA-Reported Repetitive or Severe Repetitive Loss Properties in Milwaukee County: 2023

Municipality	Number of Properties	Property Types Listed
City of Glendale	13	Single Family
City of Milwaukee	231	Single Family, Multi-Residential, and Other
City of Oak Creek	2	Single Family
City of Wauwatosa	4	Single Family
City of West Allis	2	Single Family
Village of Bayside	2	Single Family
Village of Brown Deer	8	Single Family
Village of River Hills	5	Single Family
Total	267	--

Source: SEWRPC

Report, there are a number of programs in place (i.e., floodplain regulations and stormwater management best management practices) that are intended to mitigate the potential for such increases in flood flows. Nevertheless, it is important that future condition flood flows and stages be considered as mitigative actions are being determined.

Based upon the above, it may be concluded that the extent and severity of the flooding problem within the County has the potential to become more severe to a limited extent in the near future. This conclusion highlights the importance of carrying out and implementing current floodplain and related ordinances, existing and ongoing stormwater management plans, and regulations.

Changes in climate are likely to affect the potential for flooding in Milwaukee County during the 21st century. According to the Wisconsin Initiative on Climate Change 2021 Report, since 1950 average precipitation in the State has increased 17 percent (about 5 inches) with average temperatures increasing by 3°F. As previously described in Chapter 2, model projections show Wisconsin receiving more precipitation and more frequent intense precipitation events. These models suggest that by 2060 annual average temperatures in Wisconsin will increase about 4°F -5°F (see Figure 2.4) and the frequency and magnitude of extreme rainfall events will be enhanced. By the mid-21st century, Milwaukee County may receive 12 to 14 more precipitation events of two or more inches in 24 hours per decade, roughly a 10 percent increase in the frequency of heavy precipitation events.[53] This is likely to increase the frequency of high flows and high-water levels and potentially increase the frequency and severity of flooding. In particular, the expected increases in the magnitude and frequency of large rainfall events will likely increase flood magnitudes for stormwater and in streams and rivers in Wisconsin, although the amount of increase will vary from place to place. In addition, the amount of precipitation that falls as rain during winter and early spring months is expected to significantly increase by the end of the 21st century. Winter rain can create stormwater management problems due to icing and runoff over frozen ground which may also lead to an increased risk of flooding.

These changes in climate may lead to several flood and stormwater related impacts. Increased rainfall and shifting precipitation patterns that favor more rain during periods of low infiltration and evapotranspiration may lead to more frequent and severe urban, stream, and river flooding events. Increased precipitation during winter and spring may result in increased occurrence of inland lake flooding. Increased cold-weather precipitation and increased variability in frost conditions may cause a rise in water tables in some areas leading to an increase in groundwater flooding.

The projected increase in the magnitude and frequency of heavy storms could also affect the performance of existing and planned stormwater management and flood mitigation systems. This increase could also expand flood hazard areas, such as the 1-percent-annual-probability flood hazard area, beyond their existing boundaries, potentially encompassing more existing development which could lead to an increase in the risk of flood damages and a future need for larger stormwater management facilities and updated programs.

[53] *Wisconsin Initiative on Climate Change Impacts,* Trends and Projections (*wicci.wisc.edu*).

The magnitudes of potential increases in flooding are unknown, and there is a complex interrelationship between the climatological factors that will be affected by climate change and the features of watersheds that produce runoff. In some cases, climate change-induced changes in certain climatological factors may offset the changes in other factors relative to their effects on flood flows. In other cases, the effects will reinforce one another. Thus, it is very important to continue to improve methods for downscaling climatological data, to expand the climatological parameters for which downscaled data can be developed, and to apply hydrologic and hydraulic simulation models to quantify the potential effects on flooding resulting from climate change.

Multi-Jurisdictional Risk Management

Flooding and associated stormwater drainage problems have been identified as a significant risk in Milwaukee County. As noted earlier and shown on Map 3.2, structures within flood hazard areas have been identified within all general-purpose local units of government in the County, however the Cities of Glendale and Milwaukee and the Village of Fox Point are at a higher risk to potential impacts caused by flooding due to the high number of structures mapped within the 100-year floodplain . In addition, there are a number of stormwater drainage related problems in selected areas of many communities. Based upon the number of structures potentially impacted (see Map 3.2), and the impacts caused by stormwater (or urban) flooding events, the entire County is at risk of being impacted by flooding.

Flooding Impacts on Vulnerable Populations

The Milwaukee Flood and Health Vulnerability Assessment (MFHVA) Tool

Moreover, a local organization in the City of Milwaukee known as "Groundwork Milwaukee," along with university professionals and state partners, put together an interactive mapping (or storymap) and data tool to help identify communities across Milwaukee where exposure to urban flooding may disproportionately impact vulnerable populations due to their socioeconomic and health conditions. The project intends to provide critical information on both flood exposure and social vulnerability to support community-based advocacy and future planning to mitigate potential flood and health risks. The assessment considers two indices: 1) a **flood exposure index** that considers neighborhoods that are most likely to flood and 2) a **flood vulnerability index (FVI)** that results from combining three vulnerability categories (health, socioeconomic, and housing) that predict residents' capacity to respond to a flood. By assessing exposure and vulnerability separately, the tool is able to identify locations in Milwaukee where high vulnerability and flood exposure occur at the same time. The indices are developed at the census tract level. Additionally, to assess flood exposure across Milwaukee, the flood exposure index considers two models: 1) the FEMA 100-Year Flood Hazard Zone which models riverine or coastal flooding (known as fluvial flooding) and 2) the hydrodynamic CityCAT model which considers inland flooding during heavy rain events (known as pluvial flooding).[54] As indicated from the FVI map layer shown in Chapter 5 Figure 5.4 (A), there is an overall vulnerability to flooding across the city of Milwaukee with the highest vulnerable communities concentrated within the central portions of the City.

Infrastructure Vulnerabilities to Riparian & Nuisance Flooding

Flooding can have significant impacts on county infrastructure, leading to various challenges and consequences for the county government and the community. From transportation networks and building structures to utility systems and ecological environments, the impacts of flooding are far-reaching. These challenges can disrupt travel, compromise the integrity of buildings, disrupt critical utility services, and disturb natural ecosystems. specific vulnerable infrastructures across Milwaukee County include:

Severe Weather Events (Thunderstorms, Strong Winds, Hail, and Lightning)

NOAA's National Center for Environmental Information (NCEI) defines severe weather as "destructive storm or weather" that is "usually applied to local, intense, often damaging storms such as thunderstorms, hailstorms, and tornadoes." While this definition can cover a variety of hazards beyond what is listed, thunderstorms, tornadoes, high winds, hail, and lightning are the most prevalent in Wisconsin. Thunderstorms and their related strong or straight-line winds, lightning, hail hazards, and non-thunderstorm high winds are covered within this section. Excessive rains that cause flash flooding and tornadoes are covered separately in other

[54] *Groundwork Milwaukee, Wisconsin Health Professionals for Climate Action, Medical College of Wisconsin, and the City of Milwaukee*

sections. Figure 3.1 from WEM's 2021 State Hazard Mitigation Plan shows the amount of recorded severe weather events in Wisconsin from 1844 to 2020. The majority of the counties with more than 300 severe weather events are located in southern Wisconsin for this period.

Thunderstorms

A thunderstorm is defined as a severe and violent form of convection produced when warm, moist air is overrun by dry, cool air. As the warm air rises, thunderheads (cumulonimbus clouds) form. These thunderheads produce strong winds, lightning, thunder, hail, and heavy rain that are associated with these storm events. The thunderheads may be a towering mass averaging 15 miles in diameter and reach up to 40,000 to 50,000 feet in height. These storm systems may contain as much as 1.5 million tons of water and enormous amounts of energy that often are released in one of several destructive forms, such as high winds, lightning, hail, excessive rains, and tornadoes. The NWS offices serving Wisconsin issue on average 5-10 Severe Thunderstorm Warnings per county per year in the southern counties where thunderstorms are more frequent.

According to the NWS, a typical thunderstorm lasts an average of 30 to 60 minutes and moves at an average velocity that ranges between 30 to 50 miles per hour. [55] Strong frontal systems may produce more than one squall line composed of many individual thunderstorm cells. In Wisconsin, these fronts can often be tracked across the entire State from west to east.[56] The peak season for severe thunderstorms in Wisconsin is April through August.[57] Thunderstorms may occur individually, form clusters, or as a portion of a large line of storms. Therefore, it is possible that several thunderstorms may affect one particular area in the course of a few hours, as well as larger areas of the State or County, within a relatively short period of time.

All thunderstorms are potentially dangerous. However, only about 10 percent of the thunderstorms that occur each year nationwide are classified as severe.[58] Severe thunderstorms can cause injury or death and can also result in substantial property and crop damage. They may cause power outages, disrupt telephone service, and severely affect radio communications, as well as surface and air transportation, which may seriously impair the emergency management capabilities of the impacted areas.

The NWS monitors severe weather for 20 southern Wisconsin counties, including Milwaukee County, from its Milwaukee/Sullivan office.[59] A thunderstorm watch indicates that conditions are favorable for severe weather, and that persons within the area for which the watches are issued should remain alert for approaching storms. A severe thunderstorm warning indicates that severe weather has been sighted in an area or indicated by weather radar and persons should seek shelter immediately. These severe thunderstorms watches, warning bulletins, and advisories are disseminated throughout Milwaukee County by the NWS[60] to the general public through local television and radio stations, cable television systems, cell phone apps, and NOAA weather radios.

To convey the severity and potential impacts from thunderstorms, the NWS recently added a new "damage threat" to Severe Thunderstorm Warnings. The summary of the three damage threat classifications is below:[61]

- **Destructive** damage threat is at least 2.75-inch diameter (baseball sized) hail and/or 80 mph thunderstorm winds. Warnings with this tag will automatically activate a Wireless Emergency Alert (WEA) on smartphones within the warned area.

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[55] Op. cit.

[56] *National Weather Service Forecast Office.*

[57] Op. cit.

[58] *www.nssl.noaa.gov*

[59] *National Weather Service, Milwaukee/Sullivan Weather Forecast Office.*

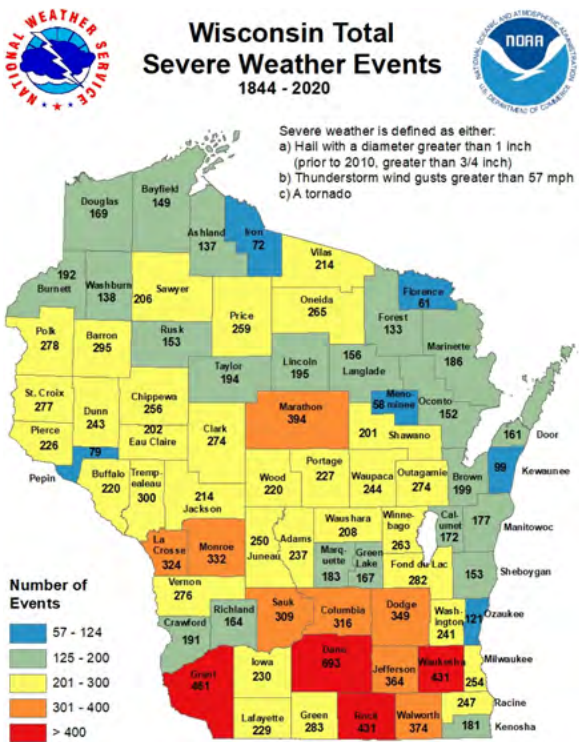
[60] *The NWS operates two 24-hour weather radio transmitters that serve all or portions of Milwaukee and Waukesha Counties.*

[61] *Wisconsin Department of Emergency Management and Military Affairs,* State of Wisconsin Hazard Mitigation Plan*, December 2021*.

- **Considerable** damage threat is at least 1.75-inch diameter (golf ball-sized) hail and/or 70 mph thunderstorm winds. This will not activate a WEA.

- **Baseline** or a **"base"** severe thunderstorm warning remains unchanged with 1.00-inch (quarter-sized) hail and/or 58 mph thunderstorm winds. This will not activate a WEA.

Figure 3.1
Severe Weather Events in Wisconsin: 1844 to 2020



Source: National Oceanic and Atmospheric Administration, National Weather Service, and Wisconsin Emergency Management

Types of Thunderstorm-Related Problems

Thunderstorm Winds (Straight-Line Winds)

High-velocity, straight-line winds that are produced by thunderstorms and widespread non-thunderstorm high winds are one of the most destructive natural hazards in Wisconsin and are responsible for most wind-related damages to property. A severe thunderstorm wind is defined as straight-line winds from a thunderstorm greater than 57 mph. As indicated in Figure 3.2, Milwaukee County experienced 150 severe thunderstorm wind events within the period of 1844 to 2020. Table 3.11 lists the recent severe weather events, including high and strong winds, in Milwaukee County from 2011 to 2022. During that period, Milwaukee County experienced three events with hurricane force winds (74 mph/64 knots or higher) and 64 thunderstorm wind events (greater than 50 mph/44 knots).

Although distinctly different from tornadoes, straight-line winds produced by thunderstorms can be very powerful, are common, and can cause damage similar to that of a tornado event. Depending upon their intensity, thunderstorm winds can uproot trees and crops, down power lines, and damage or destroy buildings and infrastructure. Flying debris can cause serious injury and death to humans, livestock, and wildlife in their path. Boats, manufactured homes, and airplanes are also extremely vulnerable to damage from thunderstorm winds. During the period from 1844 to 2020, in the State of Wisconsin, 16 fatalities and dozens of injuries were attributed to wind from severe thunderstorms.[62]

Non-Thunderstorm High Winds (or simply "High" and "Strong" Winds)

High winds are the most common form of severe weather in Wisconsin; thus, there is a high probability of an occurrence each year. Non-thunderstorm high winds tend to be less forceful than thunderstorm winds but are typically more sustained and widespread. These high winds can affect a region for hours, or even several days. Longer lasting windstorms have two main causes: large differences in atmospheric pressure across a region, and strong jet-stream winds overhead. Horizontal pressure differences can accelerate the surface winds substantially as air travels from a region of higher atmospheric pressure to one of lower pressure. Intense winter storms can also cause long-lasting and damaging high winds. Cold fronts associated with intense low-pressure systems can produce high winds both as they pass and for a period afterward as colder air flow overhead. High winds in the winter can produce dangerous wind chills when air temperatures are cold. Severe wind chills are discussed further in the extreme temperature section later in this Report.

Like thunderstorm winds, non-thunderstorm high winds can uproot trees and crops, cause widespread power outages, damage buildings, and make travel treacherous. Non-thunderstorm high winds tend to be more sustained and widespread, leading to more damage over a whole region, as compared to thunderstorm winds. During the period of 2011 to 2022, 32 non-thunderstorm high wind events were reported in Milwaukee County resulting in an estimated $377,168 in property damage (2022 dollars) and nearly $19,000 (2022 dollars) in crop insurance indemnities (Table 3.11).

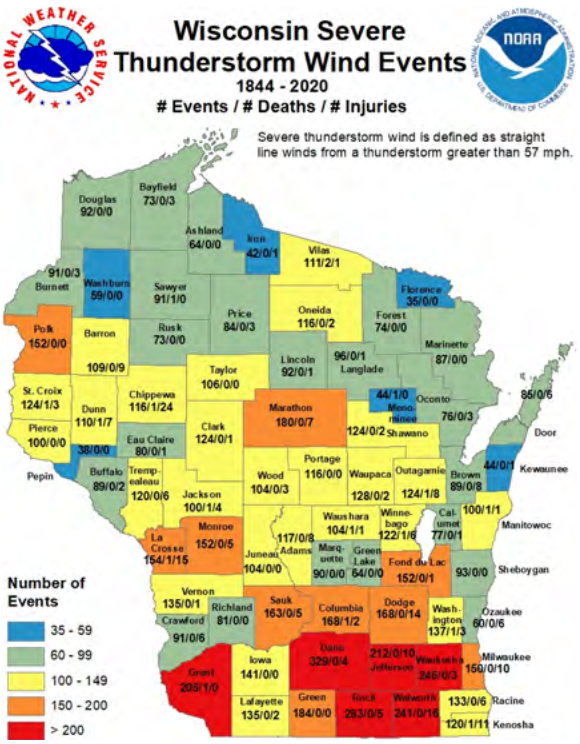
[62] *Wisconsin Department of Emergency Management and Military Affairs,* State of Wisconsin Hazard Mitigation Plan, *December 2021.*

Hail

From 2000 through 2022, 111 hailstorms and over $11.5 million (2022 dollars) in property damage and $3,500 (2022 dollars) in crop insurance indemnities were reported in Milwaukee County (Table 3.4). As indicated in Table 3.11, between the years 2011 to 2022, there have been no reported property and crop damages from the 57 hailstorm events in Milwaukee County.

Wisconsin averages between two to three hail days per year as recorded by NWS stations, although this may not be indicative of the number of hailstorms which occur within a county or larger area during any given hail season. According to the NWS, about 20 percent of all severe weather events in Wisconsin are hail events in which hailstones are at least 0.75 inches in diameter.[63] A hailstorm is a product of strong thunderstorms and unique weather condition where atmospheric water particles form into rounded or irregular masses of ice that fall to earth. Hail normally falls near the center of the moving storm along with the heaviest rain. In some instances, strong winds at high altitudes can blow the hailstones away from the storm center, causing unexpected hazards at places that otherwise might not appear threatened. Hailstones normally range from the size of a pea to the size of a golf ball, but hailstones 1.5 inches or larger in diameter are not uncommon in the State of Wisconsin. Hail tends to fall in swaths that may be 20 or more miles long and five or more miles wide and can fall continuously or sporadically in a series of hail strikes. Hail strikes are typically one-half mile wide and five miles long. Hail strikes may partially overlap but often leave completely undamaged gaps between them.

Figure 3.2
Severe Thunderstorm Wind Events in Wisconsin: 1844 to 2020



Source: National Oceanic and Atmospheric Administration, National Weather Service, and Wisconsin Emergency Management

Hailstorms are considered formidable among the weather and climatic hazards to property and farm crops because they dent vehicles and structures, break windows, damage roofs, and batter crops to the point that significant agricultural losses result. Falling hailstones can also cause serious injury and loss of human life and livestock, however these occurrences are rare. In addition to impact damage, thick hail combined with heavy rain can clog storm sewers and contribute to stormwater flooding. Hail sufficiently thick enough to cover a road will pose a traffic hazard. The peak season for hailstorms in Wisconsin is May through September with approximately 85 percent of hailstorms occurring during this period.

Lightning

In Wisconsin, there were 642 reported lightning events between 1996 and 2020. During this period, 22 deaths and 113 injuries from lightning were reported in the State. These numbers are likely underestimated because few people report suspected lightning deaths, injuries, and damages. More recently, from 2016 to 2021, there was 1 reported fatality and 9 injuries directly caused by lightning.[64] Lightning is a significant hazard associated with any thunderstorm and can occur during any season and at any time, but it is most frequent in the summer months between the afternoons and early evenings. In addition. it can cause extensive damage to buildings and structures, kill, or injure people and livestock, start forest fires and wildfires, and damage electrical and electronic equipment.

[63] *Buffalo County, Wisconsin,* Hazard Mitigation Plan*, 2021 (www.buffalocountywi.gov).*

[64] *Wisconsin Department of Emergency Management and Military Affairs,* State of Wisconsin Hazard Mitigation Plan*, December 2021.*

Table 3.11
Recent Severe Weather Events in Milwaukee County: 2011-2022

Date	Event Type	Magnitude	Reported Damages			
			Deaths	Injuries	Property Damages ($)	Crop Damages ($)
January 1, 2011	Strong Wind	43 kts.	0	0	5,391	--
February 18, 2011	Strong Wind	39 kts.	0	0	2,564	--
April 10, 2011	Thunderstorm Wind	61 kts.	0	0	--	--
April 10, 2011	Thunderstorm Wind	57 kts.	0	0	--	--
April 15, 2011	Strong Wind	39 kts.	0	0	6,427	--
May 15, 2011	Strong Wind	41 kts.	0	0	6,468	5,479
May 22, 2011	Thunderstorm Wind	53 kts.	0	0	--	5,479
June 8, 2011	Hail	1 in.	0	0	--	--
June 8, 2011	Thunderstorm Wind	57 kts.	0	0	--	--
June 8, 2011	Thunderstorm Wind	56 kts.	0	0	--	--
June 30, 2011	Thunderstorm Wind	55 kts.	0	0	52,509	--
September 3, 2011	Thunderstorm Wind	56 kts.	0	0	--	--
September 29, 2011	Strong Wind	39 kts.	0	0	2,616	--
October 19, 2011	High Wind	50 kts.	0	0	19,622	--
November 13, 2011	Strong Wind	39 kts.	0	0	1,316	--
November 29, 2011	Strong Wind	49 kts.	0	0	1,316	--
January 1, 2012	Strong Wind	39 kts.	0	0	3,721	--
March 10, 2012	Strong Wind	29 kts.	0	0	2,507	--
April 15, 2012	Strong Wind	40 kts.	0	0	1,257	--
April 16, 2012	Strong Wind	26 kts.	0	0	1,257	--
April 16, 2012	Strong Wind	43 kts.	0	0	1,257	--
April 16, 2012	Strong Wind	39 kts.	0	0	1,256	--
May 1, 2012	Thunderstorm Wind	57 kts.	0	0	2,544	3,178
June 18, 2012	Strong Wind	39 kts.	0	0	19,369	--
September 17, 2012	Hail	0.75 in.	0	0	--	--
September 17, 2012	Hail	1.25 in.	0	0	--	--
September 17, 2012	Hail	0.75 in.	0	0	--	--
September 17, 2012	Thunderstorm Wind	52 kts.	0	0	2,565	--
November 11, 2012	Strong Wind	43 kts.	0	0	6,466	--
January 18, 2013	Strong Wind	43 kts.	0	0	9,767	--
January 19, 2013	Strong Wind	42 kts.	0	0	6,104	--
April 11, 2013	Strong Wind	42 kts.	0	0	14,920	3,102
May 14, 2013	Thunderstorm Wind	61 kts.	0	0	62,739	2,740
June 27, 2013	Hail	0.75 in.	0	0	--	--

Table continued on next page.

Table 3.11 (Continued)

Date	Event Type	Magnitude	Reported Damages			
			Deaths	Injuries	Property Damages ($)	Crop Damages ($)
November 17, 2013	Hail	1 in.	0	0	--	--
November 17, 2013	Hail	1.5 in.	0	0	--	--
November 17, 2013	Hail	1 in.	0	0	--	--
November 17, 2013	Heavy Rain	--	0	0	--	--
April 12, 2014	Hail	1 in.	0	0	--	--
April 12, 2014	Hail	0.75 in.	0	0	--	--
April 12, 2014	Hail	0.75 in.	0	0	--	--
May 7, 2014	Hail	0.88 in.	0	0	--	--
May 12, 2014	Hail	0.75 in.	0	0	--	--
May 12, 2014	Hail	2 in.	0	0	--	--
May 12, 2014	Hail	0.75 in.	0	0	--	--
May 12, 2014	Thunderstorm Wind	52 kts.	0	0	--	--
June 17, 2014	Hail	1.25 in.	0	0	--	--
June 17, 2014	Hail	0.88 in.	0	0	--	--
June 17, 2014	Hail	1 in.	0	0	--	--
June 17, 2014	Thunderstorm Wind	65 kts.	0	0	37,296	6,763
June 18, 2014	Hail	1 in.	0	0	--	--
June 18, 2014	Hail	0.88 in.	0	0	--	--
June 28, 2014	Thunderstorm Wind	55 kts.	0	0	2,486	3,243
June 30, 2014	Thunderstorm Wind	53 kts.	0	0	6,216	3,243
June 30, 2014	Thunderstorm Wind	51 kts.	0	0	8,702	3,243
August 1, 2014	Hail	0.75 in.	0	0	--	--
August 1, 2014	Hail	1 in.	0	0	--	--
August 1, 2014	Hail	1 in.	0	0	--	--
June 22, 2015	Thunderstorm Wind	52 kts.	0	0	1,242	202
June 22, 2015	Thunderstorm Wind	52 kts.	0	0	1,242	202
June 22, 2015	Thunderstorm Wind	50 kts.	0	0	621	202
July 18, 2015	Thunderstorm Wind	55 kts.	0	0	1,241	--
August 2, 2015	Hail	1 in.	0	0	--	--
August 2, 2015	Hail	1 in.	0	0	--	--
August 2, 2015	Hail	1.25 in.	0	0	--	--
August 2, 2015	Hail	1 in.	0	0	--	--
August 2, 2015	Hail	1 in.	0	0	--	--
August 2, 2015	Hail	1.25 in.	0	0	--	--
August 2, 2015	Hail	1 in.	0	0	--	--
August 2, 2015	Hail	3 in.	0	0	--	--

Table continued on next page.

Table 3.11 (Continued)

Date	Event Type	Magnitude	Reported Damages			
			Deaths	Injuries	Property Damages ($)	Crop Damages ($)
August 10, 2015	Hail	1 in.	0	0	--	--
August 14, 2015	Hail	1 in.	0	0	--	--
December 23, 2015	Strong Wind	50 kts.	0	0	2,510	--
February 19, 2016	High Wind	55 kts.	0	0	119,655	--
March 16, 2016	High Wind	50 kts.	0	0	36,220	--
April 25, 2016	Hail	0.75 in	0	0	--	--
April 25, 2016	Hail	0.75 in	0	0	--	--
April 25, 2016	Hail	0.75 in	0	0	--	--
April 25, 2016	Hail	0.75 in	0	0	--	--
April 25, 2016	Hail	1 in.	0	0	--	--
June 5, 2016	Thunderstorm Wind	50 kts.	0	0	1,229	--
August 3, 2016	Thunderstorm Wind	50 kts.	0	0	6,148	--
August 3, 2016	Thunderstorm Wind	50 kts.	0	0	6,148	--
September 7, 2016	Thunderstorm Wind	50 kts.	0	0	3,688	--
September 7, 2016	Thunderstorm Wind	52 kts.	0	0	1,229	--
September 21, 2016	Hail	1 in.	0	0	--	--
March 8, 2017	High Wind	51 kts.	0	0	47,170	--
April 10, 2017	Hail	0.75 in.	0	0	--	--
April 10, 2017	Hail	0.75 in.	0	0	--	--
April 10, 2017	Hail	0.75 in.	0	0	--	--
April 20, 2017	Thunderstorm Wind	52 kts.	0	0	1,182	4,240
April 20, 2017	Thunderstorm Wind	52 kts.	0	0	5,912	4,240
May 15, 2017	Thunderstorm Wind	50 kts.	0	0	2,389	60,079
July 12, 2017	Heavy Rain	--	0	0	--	1,094
July 15, 2017	Hail	0.75 in.	0	0	--	--
July 15, 2017	Thunderstorm Wind	56 kts.	0	0	12,103	1,094
August 3, 2017	Hail	1 in.	0	0	--	--
August 3, 2017	Hail	0.88	0	0	--	--
December 4, 2017	High Wind	52 kts.	0	0	8,427	--
March 31, 2018	Strong Wind	39 kts.	0	0	1,152	--
May 9, 2018	Hail	0.75 in.	0	0	--	--
May 14, 2018	Lightning	--	0	0	34,854	--
June 18, 2018	Heavy Rain	--	0	0	--	--
June 18, 2018	Lightning	--	0	0	3,528	--
July 1, 2018	Thunderstorm Wind	61 kts.	0	0	5,878	--
July 1, 2018	Thunderstorm Wind	50 kts.	0	0	588	--

Table continued on next page.

Table 3.11 (Continued)

Date	Event Type	Magnitude	Reported Damages			
			Deaths	Injuries	Property Damages ($)	Crop Damages ($)
July 1, 2018	Thunderstorm Wind	50 kts.	0	0	2,351	--
August 17, 2018	Heavy Rain	--	0	0	70,476	1,197
September 4, 2018	Lightning		0	0	476,183	--
September 4, 2018	Thunderstorm Wind	50 kts.	0	0	11,758	833
September 4, 2018	Thunderstorm Wind	50 kts.	0	0	2,352	833
September 25, 2018	Lightning	--	0	0	11,758	--
October 20, 2018	Strong Wind	47 kts.	0	0	1,178	98
February 24, 2019	High Wind	55 kts.	0	0	2,245	--
May 19, 2019	Thunderstorm Wind	50 kts.	0	0	--	104,801
May 19, 2019	Thunderstorm Wind	50 kts.	0	0	--	104,801
June 27, 2019	Thunderstorm Wind	50 kts.	0	0	1,157	15,658
June 27, 2019	Thunderstorm Wind	50 kts.	0	0	2,314	15,658
June 27, 2019	Thunderstorm Wind	50 kts.	0	0	1,157	15,658
July 2, 2019	Thunderstorm Wind	50 kts.	0	0	577	--
July 2, 2019	Thunderstorm Wind	50 kts.	0	0	3,464	--
September 11, 2019	Thunderstorm Wind	61 kts.	0	0	8,092	--
October 1, 2019	Heavy Rain	--	0	0	--	--
October 21, 2019	Strong Wind	45 kts.	0	0	5,790	--
November 27, 2019	Strong Wind	46 kts.	0	0	11,575	4,470
April 7, 2020	Hail	1 in.	0	0	--	--
April 7, 2020	Hail	1 in.	0	0	--	--
April 20, 2020	Thunderstorm Wind	51 kts.	0	0	--	--
April 20, 2020	Thunderstorm Wind	60 kts.	0	0	--	--
June 20, 2020	Thunderstorm Wind	50 kts.	0	0	3,448	8,887
June 20, 2020	Thunderstorm Wind	50 kts.	0	0	3,448	8,887
June 20, 2020	Thunderstorm Wind	50 kts.	0	0	2,299	8,887
July 7, 2020	Heavy Rain	--	0	0	--	--
July 18, 2020	Thunderstorm Wind	56 kts.	0	0	5,717	--
August 10, 2020	Heavy Rain	--	0	0	--	--
November 10, 2020	Thunderstorm Wind	69 kts.	0	0	85,803	--
August 10, 2021	Thunderstorm Wind	52 kts.	0	0	5,697	5,697
August 24, 2021	Thunderstorm Wind	50 kts.	0	0	5,697	--
August 28, 2021	Heavy Rain	--	0	0	--	--
September 12, 2021	Hail	0.75 in.	0	0	--	--
September 13, 2021	Hail	0.88 in.	0	0	--	--
December 15, 2021	High Wind	55 kts.	0	0	10,645	--

Table continued on next page.

Table 3.11 (Continued)

Date	Event Type	Magnitude	Reported Damages			
			Deaths	Injuries	Property Damages ($)	Crop Damages ($)
April 14, 2022	Strong Wind	49 kts.	0	0	7,000	276
June 10, 2022	Hail	0.75 in.	0	0	--	--
June 10, 2022	Hail	0.75 in.	0	0	--	--
June 13, 2022	Hail	1.25 in.	0	0	--	--
June 13, 2022	Hail	1.25 in.	0	0	--	--
June 13, 2022	Thunderstorm Wind	50 kts.	0	0	4,000	--
June 13, 2022	Thunderstorm Wind	56 kts.	0	0	10,000	--
June 13, 2022	Thunderstorm Wind	56 kts.	0	0	12,000	--
June 13, 2022	Thunderstorm Wind	51 kts.	0	0	--	--
July 23, 2022	Hail	0.75 in.	0	0	--	--
July 23, 2022	Thunderstorm Wind	50 kts.	0	0	500	--
September 25, 2022	Thunderstorm Wind	50 kts.	0	0	8,000	--
September 25, 2022	Thunderstorm Wind	52 kts.	0	0	--	--
September 25, 2022	Thunderstorm Wind	52 kts.	0	0	8,000	--
September 25, 2022	Thunderstorm Wind	50 kts.	0	0	7,000	--
September 25, 2022	Thunderstorm Wind	50 kts.	0	0	1,000	--
October 12, 2022	Thunderstorm Wind	64 kts.	0	0	7,000	--
October 12, 2022	Thunderstorm Wind	50 kts.	0	0	8,000	--
October 12, 2022	Thunderstorm Wind	51 kts.	0	0	--	--
November 4, 2022	Hail	1 in.	0	0	--	--
November 4, 2022	Hail	1 in.	0	0	--	--
November 5, 2022	High Wind	53 kts.	0	0	10,000	--
November 5, 2022	Thunderstorm Wind	50 kts.	0	0	1,000	--
November 5, 2022	Thunderstorm Wind	50 kts.	0	0	--	--
November 5, 2022	Thunderstorm Wind	50 kts.	0	0	3,000	--
		Total	0	0	1,414,699	403,370

[a] *Deaths, injuries, and property damages reported were based upon a geographic area impacted by the hazard event, which affected Milwaukee County and, in some cases, a larger area of impact than the County itself, generally within the southeast regional area of Wisconsin.*

[b] *Dollar values were adjusted to year 2022 by using the average annual Consumer Price Index (CPI) values from the U.S. Department of Labor, Bureau of Labor Statistics.*

Source: National Centers for Environmental Information (NCEI), National Oceanic and Atmospheric Administration (NOAA), and the National Environmental Satellite, Data and Information Service (NESDIS), and the U.S. Department of Agriculture Risk Management Agency

Lightning is defined as a sudden and violent discharge of electricity from within a thunderstorm due to a difference in electrical charges and represents a flow of electrical current from cloud to cloud or cloud to ground. Water and ice particles also affect the distribution of the electrical charge. Lightning bolts can travel 20 miles before striking the ground. The air near a lightning bolt can be heated to 50,000 degrees Fahrenheit (°F), which is five times hotter than the surface of the sun. The rapid heating and cooling of the air near the lightning channel causes a shock wave that results in thunder.

Counties in southern Wisconsin experience a higher number of lightning events than other parts of the State due to higher thunderstorm frequency and more thorough documentation by the local media. The high number of lightning-related injuries in southeastern Wisconsin is likely related to the higher concentration of population, coupled with higher average lightning densities in these areas. According to the NCEI storm events database, Milwaukee County reported 20 lightning events during the period of 2000 to 2022 causing a reported $1.9 million in property damage (see Table 3.4).

Recent Events

Based upon recent data published by NCEI, a total of 167 severe weather events have been recorded in Milwaukee County between 2011 and 2022 (see Table 3.11). This total includes thunderstorm winds, non-thunderstorm high winds (high, strong, or straight-line winds), hail, and lightning. During this time period, there have been no reported deaths or injuries due to these events, however there is an estimated $1.8 million (2022 dollars) in reported property and crop damages (see Table 3.11). A few notable examples of these recent events are noted below.

2011 – On June 30, 2011, a large supercell thunderstorm over Lake Michigan produced strong winds that moved into far southeast Milwaukee County and eastern sections of Racine and Kenosha counties. Wind gusts up to 82 mph felled or caused extensive damage to numerous large trees that damaged homes, garages, and vehicles as well as dropped power lines across the affected areas. At one point, 26,000 customers were without power in southeast Wisconsin. A reported $52,500 (2022 dollars) in property damages were caused by this event.

2013 – On May 14, 2013, several lines of severe thunderstorms over southern Wisconsin produced wind gusts up to 70 to 75 mph. Widespread damage was reported in swaths up to 6 miles in width, which included structural damage, including a house fire to homes and farm buildings as well as downed trees and power lines due to the powerful winds. Damage caused by these thunderstorm winds created a path from Wauwatosa to Cudahy. WE Energies reported that 23,000 customers in Dodge, Jefferson, Waukesha, and Milwaukee counties were without power at the height of the storm. As a result, over $62,000 (2022 dollars) was reported in property damages.

2016 – On February 19, 2016, strong winds of 58 to 65 mph (or around 55 kts) over Southeast and Southern Wisconsin caused four semi-trucks to blow over blocking all or partial lanes on the Interstates; downed trees and branches were reported with some falling on power lines, homes, or parked vehicles; structural damage on homes and garages occurred; and power outages from the downed power lines impacted 26,000 customers. As a result, Milwaukee County reported about $120,000 (2022 dollars) in property damages.

2020 – November 10, 2020, a line of thunderstorms caused swaths of straight-line wind damage across southeast Wisconsin. As such, numerous trees and tree limbs were knocked down along with some structural damage and downed power lines. Milwaukee Mitchell International Airport measured wind gusts of 79 mph (69 kts) caused a power pole to snap, roofing material from a hangar was removed, the sliding doors to the main entrance of the airport were blown in, and several cars in an employee parking lot at the airport had windows blown in. Nearly $86,000 (2022 dollars) in property damage resulted from this thunderstorm wind event.

Vulnerability and Community Impact Assessment Related to Severe Weather Hazards

The National Weather Service can forecast and track a line of thunderstorms that may be likely to produce severe high winds, hail, lightning, and tornadoes, but where these related hazards form or touch down, and how powerful they might be, remains unpredictable.

In order to assess the vulnerability of the Milwaukee County to these severe weather hazards, a review of the community assets (described in Chapter 2) and reported severe weather events experienced throughout the County indicate the potential for significant thunderstorm and related hazard impacts to: 1) a variety of residential, commercial, and other developed land uses; 2) transportation systems and infrastructure; 3) telecommunications and utilities; 4) critical community facilities; and 5) historic sites. However, as noted in the 2018 Milwaukee County Pre-Disaster Mitigation Plan, thunderstorms and related hazards are one of the greatest risks to the residents and infrastructure within Milwaukee County.

Moreover, large outdoor gatherings (i.e., sporting events, concerts, campgrounds, etc.) are particularly vulnerable to lightning strikes that could result in injuries and deaths. Importantly, those who rely on the sound of thunder can oftentimes be misled as lightning can occur 20 miles away from the source thunderstorm. Additionally, individuals who are deaf or hard of hearing may have trouble identifying when to take shelter. As such, the slogan "Flash, Dash Inside," was created by and for people who are deaf and hard of hearing.[65]

Mobile and manufactured homes can also be particularly vulnerable to damage from high winds associated with severe thunderstorms. The light weight, flat-sided construction, and tenuous foundation connections of mobile and manufactured homes can make them highly vulnerable to wind damage. According to the Wisconsin Department of Safety and Professional Services and shown on Map 2.1, there are 15 manufactured home parks in Milwaukee County, with the majority containing at least 50 homes.

Future Changes and Conditions

Based upon recent data from the period 2011-2022 (Table 3.11), Milwaukee County can expect to experience averages of nine thunderstorm and related strong wind events per year, five hail events per year, and one significant lightning event per year somewhere in the County. It should be noted that the historical record shows considerable variation among years in the number of these events that occurred. While it would be expected that in some years the County will experience either fewer events or more events than the average number, the average annual number of events is not expected to change.

The likely effect of climate change on thunderstorm and high-wind events is not clear. While projections based upon downscaled climate model results indicate that the magnitude and frequency of heavy precipitation events are likely to increase by the middle of the 21st century, they do not address potential trends in wind, hail, or lightning conditions. Modeling studies utilizing the output of multiple climate models suggest that, between now and the end of the 21st century, there will be an increase in the number of days per year in which atmospheric environments will occur that are known to support the formation of severe thunderstorms.[66]

Changes in land use, such as the increase or expansion of development can have an impact on the potential for damage to occur from severe weather events. As shown in Map 2.2, the portions of the County that are less developed and have potential for growth include the Cities Franklin, Oak Creek, and Milwaukee. As such, these locations are at a potential increased risk of thunderstorm-related damage and related losses. Conversely, development within the City of Milwaukee is approaching "buildout" conditions with new development expected to be limited, indicating potential risks related to thunderstorm and related events to have similar or a slight increase of risk. In addition, it is important to note that due to the mitigation actions that have been taken by the County, local units of government, and individuals, the current vulnerability to thunderstorms and related hazards has decreased in recent years. These ongoing mitigation measures are described further in Chapter 5.

Multi-Jurisdictional Risk Management

Based upon a review of the historic patterns of severe thunderstorms, along with high straight-line wind, hail, and lightning events in Milwaukee County, there are no specific municipalities that have unusual risk. Rather, the events are considered to be relatively uniform and of countywide concern.

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[65] *Wisconsin Department of Emergency Management and Military Affairs,* State of Wisconsin Hazard Mitigation Plan*, December 2021.*

[66] *Noah S. Diffenbaugh, Martin Scherer, and Robert J. Trapp,* "Robust Increases in Severe Thunderstorm Environments in Response to Greenhouse Forcing," *Proceedings of the National Academy of Sciences, Volume 110, pages 16,361-16366, 2013.*

Tornadoes

Wisconsin lies along the northern edge of an area of the United States commonly known as "tornado alley." This area extends northeasterly along an axis extending from Oklahoma and Iowa in the west, to Michigan and Ohio in the east. This corridor accounts for one-fourth of the total tornadoes in a given year. Tracks of the tornadoes that occurred nationwide between 1950 and 2015 are shown in Figure 3.3. On average, Wisconsin has 23 tornadoes that occur throughout the full year. In 2022, there were 28 tornadoes reported in Wisconsin.[67]

A tornado is defined as a violently rotating column of air extending from the ground up to the thunderstorm base. It generally lasts for only a short period. The tornado appears as a funnel-shaped column with its lower, narrower end touching the ground and upper, broader end extending into the thunderstorm cloud system. In some cases, the visible condensation cloud may not appear to reach the ground, but meanwhile tornado-force winds may be causing severe destruction (rotating winds can be nearly invisible, except for dust and debris). Similar events, not reaching the land surface, are known as funnel clouds. Funnel clouds may be a precursor to a tornado event. In Wisconsin, tornadoes usually occur in company with thunderstorms formed by eastward-moving cold fronts striking warm moist air streaming up from the south. However, it is not possible to predict tornado activity based upon the occurrence of thunderstorms. But, occasionally, multiple outbreaks of tornadoes occur along the storm frontal boundaries, affecting large areas of the State at one time. Tornadoes generally occur near the trailing edge of a thunderstorm. It is not uncommon to see clear, sunlit skies behind a tornado.

Historically, tornadoes have been categorized based upon the most intense damage along their paths using the Fujita Scale. Since February 2007, the Fujita Scale has been replaced by the Enhanced Fujita Scale, which retains the same basic design as its predecessor with six tornado strength categories. This scale is shown in Table 3.12. The newer scale reflects more refined assessments of tornado damage surveys, more standardization, and consideration of damage over a wider range of structures.

The destructive power of the tornado results primarily from its high-wind velocities, wind-driven debris, and uplifting force. These characteristics probably account for 90 percent of tornado-caused damage. Since tornadoes are generally associated with severe storm systems, hail, torrential rain, and intense lightning usually accompany tornado events. In addition, tornadoes may be accompanied by downbursts, events which are characterized by strong downdrafts initiated by a thunderstorm that manifest as straight-line winds on or near the ground. These winds can be powerful, with speeds up to 70 to 100 mph. These winds interact with tornadoes and can affect the path of the tornado event in such a manner as to make tornadoes somewhat unpredictable. Depending on their intensity, tornadoes can uproot trees and crops, down power lines, and damage or destroy buildings and infrastructure. Flying debris can cause serious injury and death to humans, livestock, and wildlife in their path. An approaching cloud of debris can mark the location of a tornado, even if the classic funnel cloud is not visible. Before a tornado hits, the wind may die down and the air may become very still.

The NWS monitors severe weather nationwide from its Norman, Oklahoma office. This office is the only entity that can issue a tornado watch. The NWS office in Milwaukee/Sullivan, and the Milwaukee County Office of Emergency Management may issue tornado warnings.[68] A tornado watch means that tornadoes are possible, and that people within the area for which the watches are issued should remain alert for approaching storms. A tornado warning means that a tornado has been sighted in an area or indicated as likely to have occurred based on weather radar. When tornado warnings are issued for an area, people near and within that designated area are advised to move to a pre-designated place of safety. Tornado shelters are identified by appropriate signage in public buildings.

Recent Tornado Events

In the year 2000, two notable F1 tornado events occurred in Milwaukee County. The first was in March followed by another tornado in July. As indicated by Table 3.13, both these events caused an estimated $10.5 million in property damage (2022 dollars) as well as 16 reported injuries.

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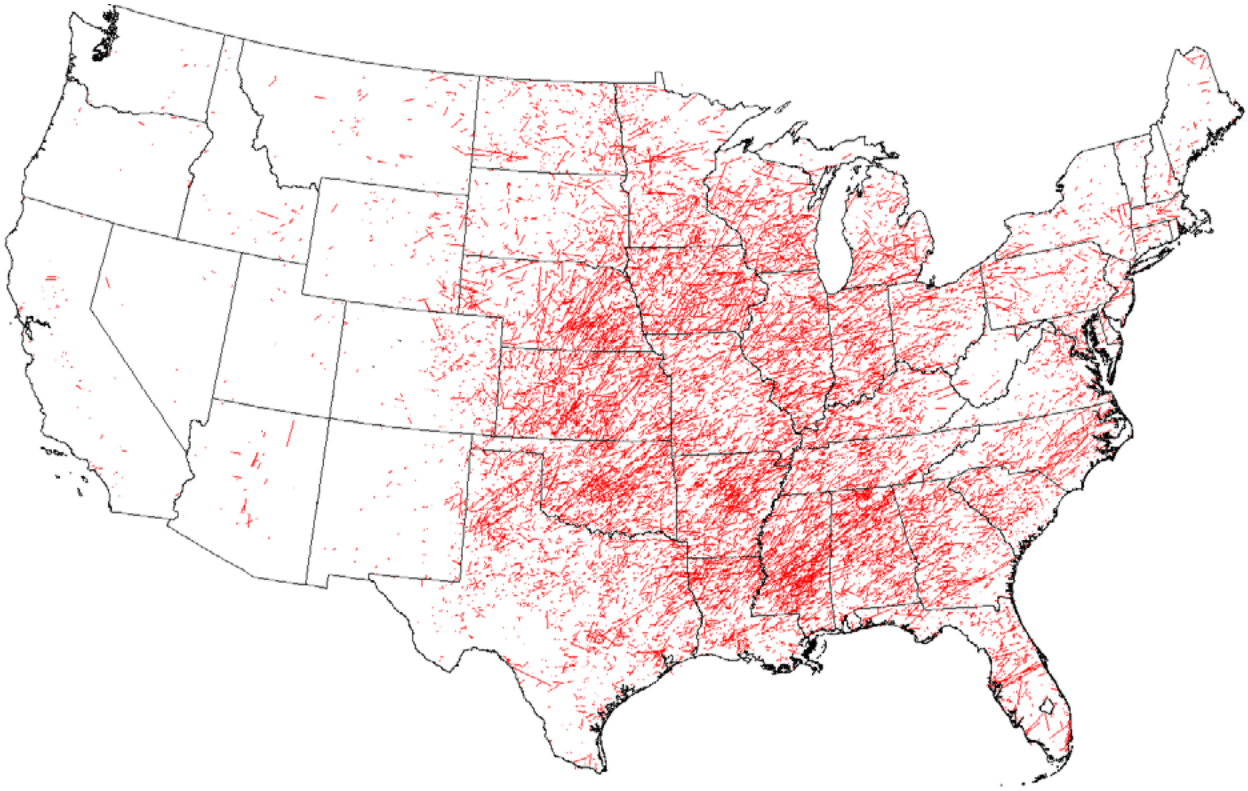
[67] *National Weather Service (weather.gov).*

[68] *All outdoor warning sirens in Milwaukee County are owned and operated by the local municipalities with the exception of the siren located on the county fairgrounds, which is owned and operated by the County.*

Figure 3.3
Recorded Tracks of Tornados Occurring in the United States: 1950-2015



Source: National Oceanic and Atmospheric Administration

Vulnerability and Community Impact Related to Tornado Hazards

In order to assess the vulnerability of the Milwaukee County area to tornado hazards, a review of the community and population assets, as described in Chapter 2, indicate that potential tornado impacts pose a threat to: 1) a variety of residential, commercial, and other developed land uses, specifically for at-risk manufactured homes and its vulnerable residents; 2) roadway transportation system; 3) utilities; 4) critical community and public safety facilities; 6) vulnerable residents including those that hard of hearing, deaf, disabled, elderly, and with limited to no access to a tornado/safe shelter, and 5) historic sites.

Table 3.12
Enhanced Fujita Scale Characteristics

F-Scale	Wind Speed (miles per hour)[a]	Character of Damage	Relative Frequency (percent)
FO (weak)	65-85	Light	53
F1 (weak)	86-110	Moderate	32
F2 (strong)	111-135	Considerable	11
F3 (strong)	136-165	Severe	3
F4 (violent)	166-200	Devastating	1
F5 (violent)	>200	Incredible (rare)	<1

[a] *Equivalent wind speeds associated with the Enhanced Fujita Scale represent a three-second gust of wind.*

Source: National Oceanic and Atmospheric Administration

Tornado prediction is not an exact science. The NWS can forecast that a line of thunderstorms may be likely to produce tornadoes, but where they form or touch down, and how powerful they might be, remains unpredictable. As can be seen from the distribution of historic F1 and F2 tornado events since 1950 in Milwaukee County, shown on Map 3.3, the locations of tornado impact points are widely scattered throughout the County.

Since 1958, a total of 18 tornadoes have been reported in Milwaukee County, or about one tornado every three years (Table 3.13). In total, these 18 tornadoes have resulted in about $22.5 million in reported property damages, about $24,000 in reported crop damages, no reported fatalities, and 176 injuries. It should be noted, as indicated in Table 3.13, it only takes a single tornado event to cause significant impacts. For example, as mentioned previously, between the 23 year period of 2000 and 2022, three tornado events were

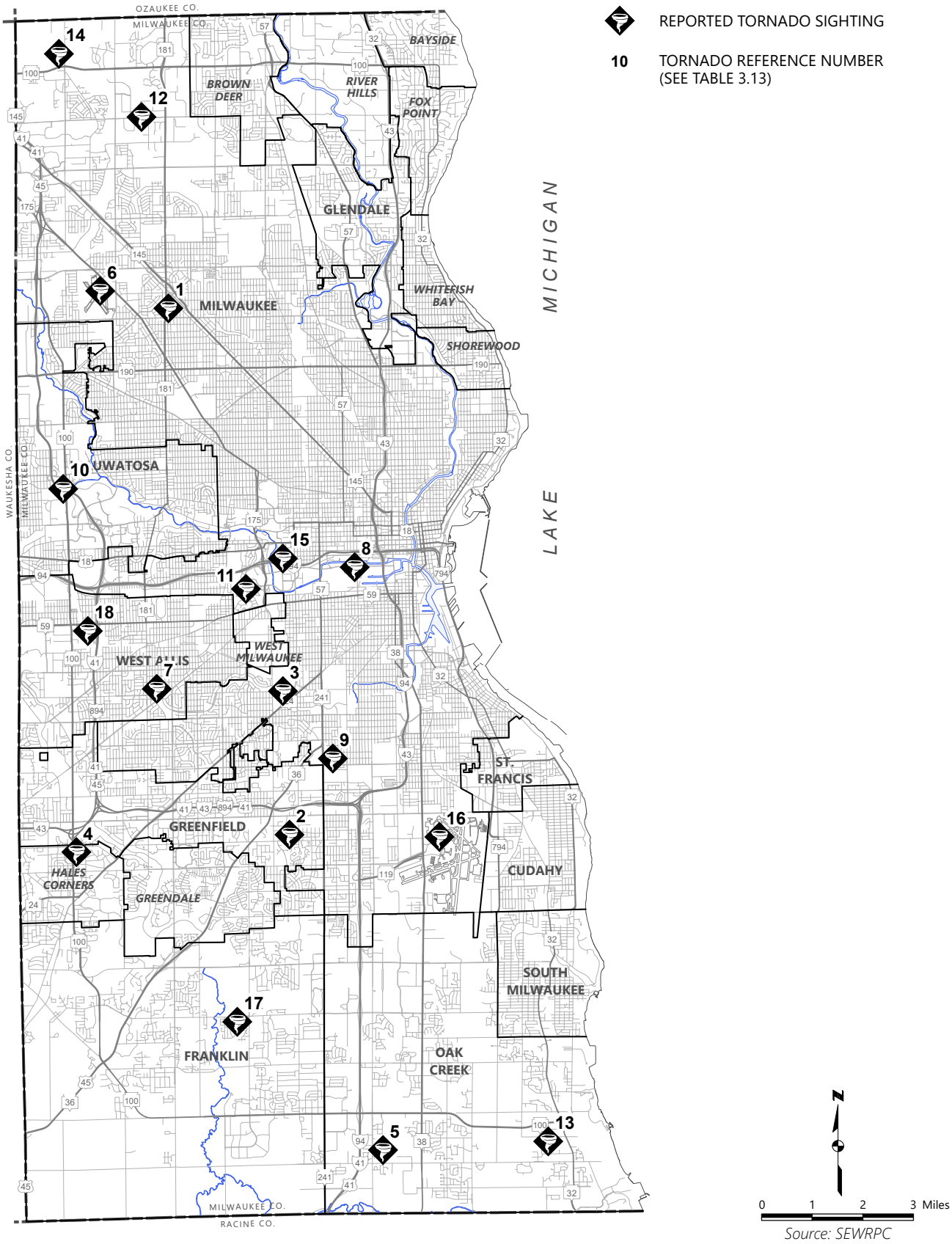
Table 3.13
Tornado Events in Milwaukee County: 1958-2022

Number on Map 3.3	Date	Location	Magnitude (Fujita)	Deaths	Injuries	Property Damage ($)	Crop Damage ($)
1	August 7, 1958	City of Milwaukee	F2	0	4	256,745	--
2	September 26, 1959	Milwaukee County	F2	0	3	2,532,398	--
3	July 22, 1962	City of Milwaukee	F2	0	0	244,882	--
4	October 4, 1962	Milwaukee County	F1	0	0	244,076	--
5	August 22, 1964	Milwaukee County	F1	0	0	2,393,524	--
6	September 3, 1964	City of Milwaukee	F2	0	0	2,385,828	--
7	August 11, 1969	Milwaukee County	F1	0	153	2,005,385	--
8	August 25, 1975	City of Milwaukee	F1	0	0	13,665	--
9	August 25, 1975	City of Milwaukee	F2	0	0	136,647	--
10	April 2, 1977	Milwaukee County	F2	0	0	123,665	--
11	August 4, 1977	City of Milwaukee	F1	0	0	--	--
12	August 4, 1980	City of Milwaukee	F2	0	0	890,747	--
13	July 20, 1981	City of Milwaukee	F1	0	0	81,004	--
14	August 17, 1985	City of Milwaukee	F1	0	0	--	--
15	May 24, 1989	City of Milwaukee	F0	0	0	599,348	3,565
16	March 8, 2000	Milwaukee County	F1	0	16	7,922,677	--
17	July 2, 2000	City of Milwaukee	F1	0	0	2,627,890	20,715
18	October 12, 2022	City of West Allis	EF0	0	0	--	--
			Total	0	176	22,458,481	24,280

Note: Dollar Values were adjusted to year 2022 by the average annual Consumer Price Index (CPI) values from the U.S. Department of Labor, Bureau of Labor Statistics. N/A indicates data not available. Also, "--" indicates data was not available. The dashed line is used to categorize past tornado events from recent events.

Source: National Centers for Environmental Information and U.S. Department of Agriculture Risk Management Agency

Map 3.3
Tornado Events Reported Within Milwaukee County 1950-2022



reported in Milwaukee County that caused over $10.5M in property and crop damages. Another example is the August 11, 1969 tornado that injured 153 people, or the July 2, 2000 event which caused over $7 million in reported property damage (2022 dollars). As such, five tornado events had at least $2 million (2022 dollars) in reported property damages.

The impacts caused by a tornado can pose a signification threat to certain populations including the elderly, frail, disabled, children, infants, and foreign or out-of-state guests. Additionally, community infrastructure such as power lines, telephone lines, and radio towers are often vulnerable to damage from tornadoes and high winds. The loss of radio towers that hold public safety communications repeaters can adversely impact the ability of first responders to mount an effective response; damage to towers that hold public media equipment may adversely impact the ability to distribute adequate public information. In an extreme tornado event, such as an F4 event, the force of the wind alone can cause tremendous devastation, uprooting trees, toppling power lines, and inducing the failure of weak structural elements in homes and buildings. Due to the unpredictability of tornado events, all buildings, infrastructure, and critical facilities within the County are considered at risk.

As discussed in the section of this chapter on thunderstorms, mobile and manufactured homes can also be particularly vulnerable to high wind and tornado events. Extreme winds can displace these homes from their sites, especially if they are not properly attached to the site or if such attachment fails. In addition, these structures usually lack basements. As a result, they offer their occupants little shelter in the event of hazardous winds. As of 2022, there were 15 manufactured home parks located in Milwaukee County (see Map 2.1). The majority of these parks have around 50 manufactured homes (Table 2.6). These structures and their occupants may be particularly vulnerable to impacts from tornadoes, especially without access to a storm shelter.

It should be noted that, because of the mitigation actions that have been taken by the County and local units of government and individuals, the current vulnerability to tornadoes and related hazards has generally decreased in recent years. These ongoing mitigation measures are described further in Chapter 5.

Future Changes and Conditions

Based upon historical data, Milwaukee County can expect to experience an average of 0.31 tornado events per year or about one tornado every three years. It should be noted that the historical record shows considerable variation over the years in the number of tornado events that occurred. While it would be expected that in some years the County will experience either fewer events or more events than the average number, the average annual number of events is not expected to change. Overall, the probability of Milwaukee County being struck by a tornado in the future is medium and the likelihood of damage from future tornadoes is high.

Changes in land use, such as urban development, can also have an impact on the potential for future damage impacts caused by tornado hazards. Because Milwaukee County is developed (or urbanized) with only small undeveloped portions, the impacts caused by tornado hazards are likely to only increase slightly by the additional planned land use development within the County.

The likely effects of climate change on tornado frequency and severity are not clear. The projections based upon downscaled climate model results do not address potential trends in tornado conditions. A recent study that examined the evolving contributors of risk and vulnerability for tornadoes found that growth in the human-built environment is projected to dominate the impact of future tornados. An increase in risk and exposure of tornadoes may lead to a significant increase in the magnitude and disaster impact of tornadoes on that built environment from 2010 to 2100.[69] Additionally, high-risk tornado regions may experience increased disaster probability and historically vulnerable regions may be at greater risk of tornado damages due to a combination of factors: increased tornado risk, rapidly amplified exposure, and pre-existing social and physical vulnerabilities.

Multi-Jurisdictional Risk Management

Based on the distribution of the 19 tornado events, as shown on Map 3.3, the tornado locations are widely scattered throughout the County indicating that there are no specific municipalities that have unusual or greater risks to tornado hazards. Rather, the events are considered to be relatively uniform and of a countywide concern.

[69] *Strader, S. M., Ashley, W. S., Pingel, T. J., & Krmenec, A. J. (2017). Projected 21st Century Changes in Tornado Exposure, Risk, and Disaster Potential. Climatic Change, 141(2), 301–313. doi.org/10.1007/s10584-017-1905-4.*

Severe Winter Storms

Winter storms can vary in size and strength and include heavy snowstorms, blizzards, freezing rain, sleet, ice storms, and blowing and drifting snow conditions. Extremely cold temperatures accompanied by strong winds can result in wind chills that cause bodily injury, such as frostbite and death. A variety of weather phenomena and conditions can occur during winter storms. For clarification, the following are National Weather Service approved descriptions of winter storm elements:

- **Heavy Snowfall**—The accumulation of six or more inches of snow in a 12-hour period or eight or more inches in a 24-hour period.
- **Blizzard**—An occurrence of sustained wind or frequent gusts of 35 mph or higher accompanied by falling or blowing snow, and visibilities of one-quarter mile or less, for three or more hours.
- **Ice Storm**—An occurrence of rain falling from warmer upper layers of the atmosphere to the colder ground, freezing upon contact with the ground and exposed surfaces, resulting in ice accumulations of one-quarter inch or more within 12 hours or less.
- **Freezing Drizzle/Freezing Rain**—The effect of drizzle or rain freezing upon impact on objects that have a temperature of 32°F or below.
- **Sleet**—Solid grains or pellets of ice formed by the freezing of raindrops or the refreezing of largely melted snowflakes. This ice does not cling to surfaces.
- **Wind Chill**—An apparent temperature that describes the combined effect of wind and low air temperatures on exposed skin.

Much of the snowfall in Wisconsin occurs in small amounts of between one and three inches per occurrence. Heavy snowfalls that produce at least six inches of accumulation in one county happen on average about ten to 12 times per winter statewide.[70] The northwestern portion of Wisconsin receives most of its snow during early and late season storms, while southwestern and southeastern counties receive heavy snows more often in mid-winter. Snowfall amounts in Milwaukee County average about 50 inches per year.

Blizzard-like conditions often occur during heavy snowstorms when gusty winds cause severe blowing and drifting of snow, even if the conditions did not last long enough to be considered a true blizzard. True blizzards are not common in Wisconsin. However, when they do occur, they tend to affect the eastern counties near Lake Michigan. This is due to a less frictional drag over Lake Michigan which allow northwest windstorms to reach higher speeds. Blizzards are more likely to occur in northwestern Wisconsin than in southern portions of the State, even though heavy snowfalls are more frequent in the southeast. Blizzard-like conditions often exist during heavy snowstorms when gusty winds cause severe blowing and drifting of snow. According to NCEI, and shown in Table 3.14, the most recent blizzard event recorded in Milwaukee County occurred on February 1, 2011. Prior to 2011, there have been five other reported blizzards in the County (1996, 1997, 1999, 2006, and 2007).[71]

Freezing rain, ice, and sleet storms can occur at any time from October into April in Wisconsin. In a typical winter season, there are three to five light freezing rain events in the southeastern Wisconsin region. On average, a major ice storm occurs about once every other year somewhere in the State and once every seven years over southeastern Wisconsin. If one-half inch of rain freezes on trees and utility wires, extensive damage can occur, especially if accompanied by high winds that compound the effects of the added weight of the ice. There are also between three and five instances of glazing (less than one-quarter of an inch of ice) throughout the State during a normal winter. The most recent recorded ice storm in Milwaukee County was in 2022.

Recent Events

Table 3.14 lists recent winter hazard events that occurred in Milwaukee County from 2011 to 2022. A few examples of these recent winter storm events are described below.

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[70] *Wisconsin Department of Emergency Management and Military Affairs, State of Wisconsin Hazard Mitigation Plan, December 2021.*

[71] *www.ncdc.noaa.gov.*

Table 3.14
Recent Winter Events in Milwaukee County: 2011-2022

Date	Type[a]	Deaths	Injuries	Property Damages ($)	Crop Damages ($)
January 17, 2011	Winter Weather	0	0	--	--
February 1, 2011	Blizzard	0	0	12,820	--
February 6, 2011	Winter Weather	0	0	--	--
February 20, 2011	Winter Storm	0	0	--	--
February 21, 2011	Winter Weather	0	0	--	--
March 9, 2011	Winter Weather	0	0	--	--
December 29, 2011	Winter Weather	0	0	--	--
January 12, 2012	Winter Weather	0	0	--	--
January 17, 2012	Winter Weather	0	0	--	--
February 23, 2012	Winter Weather	0	0	--	--
March 2, 2012	Winter Storm	0	0	--	--
December 20, 2012	Winter Storm	0	0	--	--
January 27, 2013	Winter Weather	0	0	--	--
January 30, 2013	Winter Weather	0	0	--	--
February 7, 2013	Winter Storm	0	0	--	--
February 22, 2013	Winter Weather	0	0	--	--
February 26, 2013	Winter Storm	0	0	--	--
March 5, 2013	Winter Weather	0	0	--	--
March 18, 2013	Winter Weather	0	0	--	--
November 25, 2013	Winter Weather	0	0	--	--
December 8, 2013	Winter Weather	0	0	--	--
December 19, 2013	Winter Weather	0	0	--	--
December 22, 2013	Winter Storm	0	0	--	--
December 31, 2013	Winter Weather	0	0	--	--
January 1, 2014	Winter Weather	0	0	--	--
January 10, 2014	Winter Weather	0	0	--	--
January 14, 2014	Winter Weather	0	0	--	--
January 24, 2014	Winter Weather	0	0	--	--
January 26, 2014	Winter Weather	0	0	--	--
January 26, 2014	Winter Weather	0	0	--	--
February 4, 2014	Winter Weather	0	0	--	1,753
February 13, 2014	Winter Weather	0	0	--	1,753
February 17, 2014	Winter Storm	0	0	--	1,753
March 4, 2014	Winter Weather	0	0	--	--
April 14, 2014	Winter Weather	0	0	--	--
November 22, 2014	Winter Weather	0	0	--	--
November 28, 2014	Winter Weather	0	0	--	--
December 18, 2014	Winter Weather	0	0	--	--
January 8, 2015	Winter Weather	0	0	--	--
February 1, 2015	Winter Storm	0	0	--	495
February 25, 2015	Winter Weather	0	0	--	495
March 3, 2015	Winter Weather	0	0	--	--
November 20, 2015	Winter Storm	0	0	--	--
December 28, 2015	Winter Storm	0	0	6,274	--
February 8, 2016	Winter Weather	0	0	--	--
February 29, 2016	Winter Weather	0	0	--	--
March 1, 2016	Winter Weather	0	0	--	--
March 24, 2016	Winter Weather	0	0	--	--
April 2, 2016	Winter Weather	0	0	--	--
April 8, 2016	Winter Weather	0	0	--	--
December 4, 2016	Winter Weather	0	0	--	--
December 10, 2016	Winter Storm	0	0	--	--
December 16, 2016	Winter Storm	0	0	--	--

Table continued on next page.

Table 3.14 (Continued)

Date	Type[a]	Deaths	Injuries	Property Damages ($)	Crop Damages ($)
December 19, 2016	Winter Weather	0	0	--	--
January 10, 2017	Winter Weather	0	0	--	--
January 11, 2017	Winter Weather	0	0	--	--
January 16, 2017	Winter Weather	0	0	--	--
February 24, 2017	Winter Weather	0	0	--	--
March 12, 2017	Lake-Effect Snow	0	0	--	--
January 12, 2018	Winter Weather	0	0	--	--
January 14, 2018	Winter Weather	0	0	--	--
January 22, 2018	Winter Weather	0	0	--	--
February 3, 2018	Winter Weather	0	0	--	--
February 5, 2018	Winter Weather	0	0	--	--
February 8, 2018	Winter Storm	0	0	--	--
February 11, 2018	Winter Weather	0	0	--	--
March 5, 2018	Winter Weather	0	0	--	--
April 3, 2018	Winter Weather	0	0	--	--
April 14, 2018	Winter Weather	0	0	--	--
April 18, 2018	Winter Weather	0	0	--	--
November 25, 2018	Winter Weather	0	0	--	2,309
December 28, 2018	Winter Weather	0	0	--	--
December 29, 2018	Winter Weather	0	0	--	--
January 18, 2019	Winter Storm	0	0	--	--
January 22, 2019	Winter Storm	0	0	--	--
January 27, 2019	Winter Storm	0	0	--	--
February 5, 2019	Winter Weather	0	0	--	--
February 7, 2019	Winter Weather	0	0	--	--
February 11, 2019	Winter Storm	0	0	--	--
February 17, 2019	Winter Weather	0	0	--	--
February 26, 2019	Winter Weather	0	0	--	--
April 14, 2019	Winter Weather	0	0	--	1,193
April 27, 2019	Winter Weather	0	0	--	1,193
October 30, 2019	Winter Weather	0	0	--	--
November 6, 2019	Winter Weather	0	0	--	--
November 10, 2019	Winter Weather	0	0	--	--
January 10, 2020	Winter Weather	0	0	--	--
January 17, 2020	Winter Weather	0	0	--	--
January 31, 2020	Winter Weather	0	0	--	--
February 9, 2020	Winter Weather	0	0	--	--
February 12, 2020	Winter Weather	0	0	--	--
December 12, 2020	Winter Weather	0	0	--	--
December 29, 2020	Winter Storm	0	0	--	--
January 1, 2021	Winter Weather	0	0	--	--
January 25, 2021	Winter Storm	0	0	--	--
January 30, 2021	Winter Storm	0	0	--	--
February 4, 2021	Winter Weather	0	0	--	--
February 11, 2021	Winter Weather	0	0	--	--
February 13, 2021	Winter Weather	0	0	--	--
February 15, 2021	Winter Storm	0	0	--	--
December 6, 2021	Winter Weather	0	0	--	--
December 28, 2021	Winter Weather	0	0	--	--
January 1, 2022	Winter Weather	0	0	--	264
January 22, 2022	Winter Weather	0	0	--	264
January 24, 2022	Winter Weather	0	0	--	264
February 6, 2022	Winter Weather	0	0	--	--
February 18, 2022	Winter Weather	0	0	--	--

Table continued on next page.

Table 3.14 (Continued)

Date	Type[a]	Deaths	Injuries	Property Damages ($)	Crop Damages ($)
February 22, 2022	Winter Weather	0	0	--	--
February 24, 2022	Winter Weather	0	0	--	--
March 6, 2022	Winter Weather	0	0	--	--
March 31, 2022	Winter Weather	0	0	--	--
December 9, 2022	Winter Weather	0	0	--	--
December 22, 2022	Winter Weather	0	0	--	--
Total		0	0	19,094	11,736

Note: The data presented in this table only accounts for damages, injuries, and deaths that are directly caused by each winter storm event. Damages, injuries, and deaths that occur indirectly as the result of traffic accidents, slips and falls, or health issues associated with winter storms are not included in this table.

Dollar values were adjusted to year 2022 by the average annual Consumer Price Index (CPI) values from the U.S. Department of Labor, Bureau of Labor Statistics

[a] *NWS defines the following types of events:*

- *Blizzard as a winter storm which produces the following conditions for three consecutive hours or longer: (1) sustained winds or frequent gusts 30 knots (35 mph) or greater, and (2) falling and/or blowing snow reducing visibility frequently to less than 1/4 mile.*
- *Winter Storm is an event that has more than one significant hazard (i.e., heavy snow and blowing snow; snow and ice; snow and sleet; sleet and ice; or snow, sleet, and ice) and meets or exceeds locally/regionally defined 12 and/or 24-hour warning criteria for at least one of the precipitation elements.*
- *Winter Weather as an event that causes a death, injury, or a significant impact to commerce or transportation, but does not meet locally/regionally defined warning criteria. Such an event could result from one or more winter precipitation types (snow, or blowing/drifting snow, or freezing rain/drizzle). The Winter Weather event can also be used to document out-of-season and other unusual or rare occurrences of snow, or blowing/drifting snow, or freezing rain/drizzle.*

Source: National Centers for Environmental Information and U.S. Department of Agriculture Risk Management Agency

2011 – During the overnight hours of February 1 and 2, 2011, a powerful low-pressure center produced blizzard conditions across much of southern Wisconsin. Prior to the blizzard, several inches of snow fell on January 31st with light lake effect snow through the day on February 1. Snow associated with the system began in the mid-afternoon hours on February 1 in far southern Wisconsin and pushed northward into the State through the evening. Very strong winds were associated with the storm for an extended period of time. Two-day snowfall totals in the City of Milwaukee ranged between 12 and 20 inches, with 16.1 inches reported at MMIA. Peak wind gusts of 60 miles per hour were reported at MMIA. Snow drifts of three to 12 feet were common, with reports of some drifts reaching 12 to 15 feet in open rural areas. Drifting snow closed Interstate 94 (I-94) from the Illinois border north to Milwaukee, and I-43 from Beloit to Mukwonago, with many stranded motorists having to be rescued from vehicles buried in the drifting snow. In response to this, the Wisconsin Division of Emergency Management issued a Civil Danger Warning concerning the hazardous driving conditions. The storm, known as the Groundhog's Day blizzard, had several impacts. Most flights in and out of MMIA were canceled until later on February 2. Milwaukee area law enforcement reported 24 vehicle accidents, with two injuries and 47 disabled vehicles. Emergency rooms across southeastern Wisconsin reported dozens of heart attacks and injuries from snow blower accidents. Three Milwaukee area men, two with heart problems, died while shoveling snow. Numerous businesses were closed as a result of this winter storm. At the height of the storm, We Energies reported 5,200 customers were without power across southeast Wisconsin. Wind gusts damaged at least five metal panels, siding, and a roll-down door on a large storage pole shed at the Port of Milwaukee. The Governor issued an emergency declaration for 29 counties and ordered the mobilization of about 100 National Guardsman to rescue stranded motorists and run emergency shelters at armories.

2013 – Low pressure and lake enhanced snow brought three to six inches of powdery snow to southern Wisconsin on December 8, 2013. Hundreds of vehicle accidents occurred, especially in the Milwaukee metropolitan area. These included several pile-ups, including a 41-vehicle pile-up on IH-894 at Greenfield Avenue in the City of West Allis. The weather was cited as a contributing factor in three deaths.

2015 – On December 28, 2015, a winter storm affected southern Wisconsin as strong low pressure tracked from the Mississippi River Valley to northeast Illinois and southern Michigan. Most areas received five to 10

inches of wet snow and sleet combined, with sleet accumulations of up to two inches in some areas. East to northeast wind gusts of 30 to 45 mph occurred, restricting visibility to between one-quarter and one-half mile. As a result of this storm, more than 300 accidents occurred on interstate and State highways. These occurred mostly in the Milwaukee and Madison areas. Two men collapsed and died while shoveling on the afternoon of December 29th in Milwaukee County. A golf dome was damaged by the weight of the heavy snow in Milwaukee County.

2017 – On March 12-13, 2017 a significant lake effect snowstorm occurred over eastern Wisconsin with snowfall totals of 1 to 2 feet. Hundreds of vehicles were involved in accidents and slide-offs including several large chain-reaction accidents on the I-41 and I-43 on March 13th. Overall, there were 59 crash calls and 68 disabled vehicles during the daylight hours. Portions of Interstates were closed for hours for cleanup and removal. There were five deaths in southeast Wisconsin when older men collapsed while shoveling or snow blowing. Some schools and local governments closed due to the heavy snow.

2020 – During the period of January 10-12, 2020, a severe winter storm and flooding impacted communities in Kenosha, Milwaukee, and Racine counties. On January 10th a winter storm brought a wintery mix of snow, freezing rain, and ice to much of eastern Wisconsin. On January 11th, strong onshore winds gusting at 40-50 mph developed along the coast of Lake Michigan. These winds, when combined with record high Lake Michigan water levels, flooded significant areas of the Milwaukee lakefront south to Kenosha. The lakeshore flooding was amplified by an ice-free shoreline and the winds were oriented to the maximum lake fetch. The winter storm and flooding damaged the shoreline and community infrastructure in Kenosha, Milwaukee, and Racine counties. On March 11th, 2020, a presidential disaster declaration (DR-4477) was granted to Wisconsin. The declaration made Public Assistance and Hazard Mitigation Grant Program assistance available to state and eligible local governments and select private nonprofit organizations on a cost-sharing basis for emergency and mitigation work resulting from the severe storm and flooding in Kenosha, Milwaukee, and Racine counties.

Vulnerability and Community Impact Assessment Related to Severe Winter Storm Hazards

Between 2011 and 2022, 113 winter weather events have affected Milwaukee County. Based on this, it is estimated that Milwaukee County experiences an average of 9.5 winter weather events per year. It should be noted that during this time period there has been variation around this average, with the County experiencing as few as five winter storm events in some years and as many as 14 winter storm events in other years (Table 3.14).

A review of the community assets described in Chapter 2 indicates there is a potential for winter storm hazard events to impact: 1) residents at a countywide level, 2) roadway transportation system, 3) utilities, and 4) the operation of critical community facilities. In addition, the Milwaukee County Pre-Disaster Mitigation Plan concluded that winter storm hazards are one of the greatest risks to the population and infrastructure within Milwaukee County.

The NCEI database reports only about $19,000 of property damages and no crop damage for winter storms during this eleven-year period. For Milwaukee County, records of crop insurance indemnities from the U.S. Department of Agriculture Risk Management Agency show that about $12,000 have been paid out between 2011 and 2022 due to damage caused by winter related weather, such as frost, freeze, or snow.

Winter storms present a serious threat to the health and safety of affected citizens and can result in significant damage to property. Snow and ice are the major hazards associated with winter storms and are a destructive natural hazard in Wisconsin. Snow and ice can cause traffic accidents, bring down telephone and power lines, disrupt telecommunication services, damage trees, impede transportation, burst water pipes, and can tax the public's capabilities for snow removal during heavy storms. A major winter storm can have a serious impact on a community. Loss of heat and mobility are key complications that contribute to winter storm fatalities.

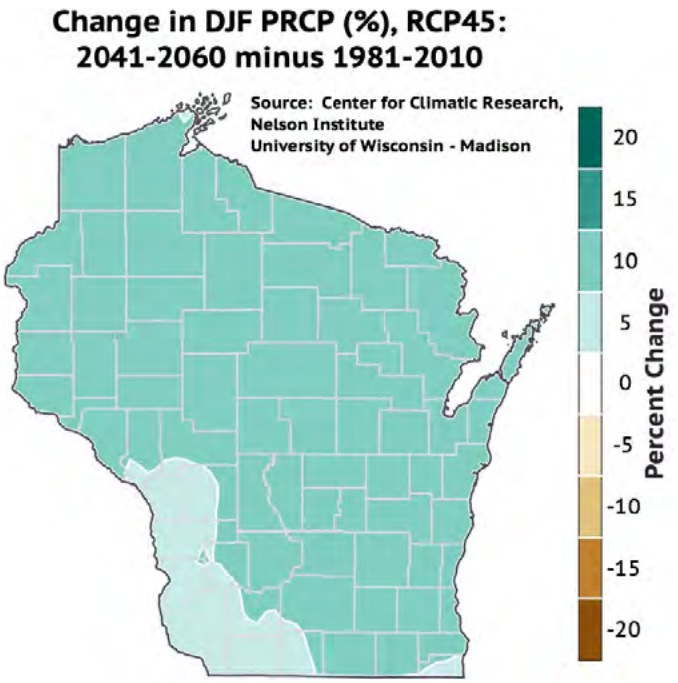
Ice storms and freezing rain are less common than snow for the County but produce road conditions that can make travel hazardous. Even fog or mist on cold roads can produce a glaze of ice that makes travel slippery and dangerous. Accumulated ice can cause the structural collapse of buildings, bring down trees and power lines, causing property damage, loss of power, and isolate people from assistance or services.

Future Changes and Conditions

As discussed in Chapter 2 of the Report, changes in the 20th century and projections based on downscaled results from climate models indicate that there will likely be changes in winter storm conditions affecting Milwaukee County over the 21st century. It is projected that by 2060 the average amount of precipitation that Milwaukee County receives during the winter will increase by about 0.5 to 1.0 inch (measured as water), an increase of about 10 percent (see Figure 3.4).[72] Due to increasing winter temperatures, the amount of precipitation that falls as rain during the winter rather than as snow is projected to increase significantly. It is also projected that freezing rain will be more likely to occur.

It should also be noted that the likelihood of lake effect snow occurring could be affected by climate change. A lack of ice cover over Lake Michigan during the winter promotes the development of lake effect snow. Rising temperatures during the winter will reduce the frequency and extent of ice cover over the Lake. Because the increase in temperature may also result in some of this precipitation falling as rain, it is not clear whether this will lead to an increase in the frequency of lake effect snow events.

Figure 3.4
Projected Percent Change in Average Winter Precipitation: 2040-2060



Source: Wisconsin Initiative on Climate Change Impacts, Trends and Projections, wicci.wisc.edu/wisconsin-climate-trends-and-projections

Multi-Jurisdictional Risk Management

Based upon a review of the historic patterns of winter storm events in Milwaukee County, there are no specific municipalities that have unusual risks. Rather, the events are of a uniform countywide concern.

Extreme Temperature Events

Average annual temperatures in the United States have increased by 1.3 to 1.9°F since record keeping began in 1895. Heat waves have become more frequent and intense, and cold waves have become less frequent across the nation. Heat and cold are two of the most underrated, least understood, and deadly of all the natural hazard events that impact Milwaukee County. In contrast to the visible, destructive, and violent characteristics associated with floods and tornadoes, extreme high or low temperatures are "silent killers." Days that are hotter than the average seasonal temperature in the summer or colder than the average seasonal temperature in the winter cause increased levels of illness and death by compromising the body's ability to regulate its temperature or by inducing direct or indirect health complications. Deaths from extreme heat and cold occur quietly, without headline-making destruction.

Extreme Heat

Excessive heat has become the deadliest hazard in Wisconsin, exceeding tornado, and other storm-related deaths. The Centers for Disease Control and Prevention (CDC) reports that nationwide between 2018 and 2020 a total of 3,066 heat-related deaths occurred.[73] In Wisconsin, a total of 22 heat-related deaths were reported from 2016 to 2020.[74]

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[72] *Wisconsin Initiative on Climate Change Impacts (wicci.wisc.edu)*

[73] *Merianne R. Spencer and Matthew F. Garnett.,* "Quick Stats: Percentage Distribution of Heat-Related Deaths, by Age Group – National Vital Statistics System, United States, 2018-2020". *MMWR Morbidity and Mortal Weekly Rep 2022; 71:808. June 17, 2022.*

[74] Op. cit.

Heat and humidity together can create the most severe problems for human health. High humidity makes heat more dangerous because it slows the evaporation of perspiration, which is the body's natural cooling process. The Heat Index (HI) is a measure of discomfort, and the level of risk posed to people in high-risk groups by heat and humidity. The HI is expressed in degrees Fahrenheit (°F) and incorporates an adjustment to the air temperature for relative humidity (RH). For example, if the air temperature is 94°F and the RH is 55 percent, the HI would equal about 106°F (see Table 3.15). Since HI values were devised for shady, light wind conditions, exposure to full sunshine can increase HI values by up to 15°F. The impact on people in high-risk groups associated with different levels of HI is shown in Table 3.16. The NWS will initiate alert procedures (advisories or warnings) when the Heat Index is expected to have a significant impact on public safety. The expected severity of a heat wave determines whether advisories or warnings are issued. High temperature periods are often also accompanied by the air quality problems related to ground-level ozone which can be harmful, especially to sensitive groups, such as active children and adults with respiratory problems.

The following heat event definitions/criteria are used for the 20 counties in south-central and southeastern Wisconsin served by the Milwaukee/Sullivan Weather Forecast Office:

- **Outlook Statement**—Issued two to seven days prior to the time that minimal Heat Advisory or Excessive Heat Warning conditions are expected. Serves as a long-term "heads-up" message.

- **Excessive Heat Watch**—Issued 24 to 72 hours in advance when Excessive Heat Warning conditions are expected.

- **Heat Advisory**— This is issued within 12 hours of the start of extremely dangerous heat conditions. The National Weather Service will issue a heat advisory for Wisconsin when the daytime heat index values are 100° to 104°F. A heat advisory will also be issued if heat indices are 95° to 99°F for four consecutive days.

- **Excessive Heat Warning**— This is issued within 12 hours of the onset of extremely dangerous heat conditions. It will be issued by the National Weather Service when the daytime heat index is 105°F or higher during the day and 75°F or higher at night for at least a 48-hour period. If heat indices are 100° to 104°F for four consecutive days, an excessive heat warning will be issued.

During extended periods of very high temperature, coupled with high humidity levels, individuals can suffer a variety of ailments, including heat cramps (muscular pains and spasms due to heavy exertion). Although heat cramps are the least severe heat-related ailment, they are an early signal that the body is having trouble with the heat. Heat exhaustion typically occurs when people exercise heavily or work in a hot, humid place where body fluids are lost through heavy sweating. Blood flow to the skin increases, causing blood flow to decrease to the vital organs. This results in the form of mild shock. If not treated, the victim may suffer heat stroke. Heat stroke is life threatening and requires immediate medical attention. The victim's temperature control system, which produces sweat to cool the body, stops working. The body temperature can rise so high that brain damage and death may result if the body is not cooled quickly. Sunstroke is another term for heat stroke. In addition to posing a public health hazard, periods of excessive heat usually result in high electrical consumption for air conditioning, which can cause power outages and brown outs.

Most heat-related deaths occur in cities. Large urban areas often become "heat islands." Brick buildings, asphalt streets, and tar roofs store and radiate heat like a slow burning furnace. Heat builds up in a city during the day and cities are slower than rural areas to cool down at night. The amount of sunshine is an important contributing factor in urban heat waves. In addition, the stagnant atmospheric conditions associated with heat wave trap ozone and other pollutants in urban areas. The worst heat disasters, in terms of loss of life, happen in large cities when a combination of high daytime temperatures, high humidity, warm nighttime temperatures, and an abundance of sunshine occurs for a period of several days. There are also socioeconomic problems that make some urban populations at greater risk. The elderly, disabled, and debilitated are especially susceptible to heat-related illness and death.

Table 3.15
Heat Index Chart

Relative Humidity (%)	Temperature (°F)															
	80	82	84	86	88	90	92	94	96	98	100	102	104	106	180	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129	137				
65	82	85	89	93	98	103	108	114	121	128	136					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

Likelihood of heat disorders with prolonged exposure or strenuous activity:

- Caution
- Extreme Caution
- Danger
- Extreme Danger

Source: National Weather Service and SEWRPC

Table 3.16
Level of Risk for People in High-Risk Groups Associated with the Heat Index

Heat Index (°F)	Category	Possible Heat Disorders for Persons in High-Risk Groups
80-90	Caution	Fatigue possible with prolonged exposure and/or physical activity
90-105	Extreme Caution	Sunstroke, muscle cramps, and/or heat exhaustion possible with prolonged exposure and/or physical activity
105-129	Danger	Sunstroke, muscle cramps and/or heat exhaustion likely. Heatstroke possible with prolonged exposure and/or physical activity
130 or above	Extreme Danger	Heat stroke or sunstroke likely

Source: National Weather Service

Recent Heat and Extreme Heat Events (2011-2022)

Table 3.17 lists 18 recent extreme heat events in Milwaukee County from 2011-2022, in which no property or crop damages were reported, however there were seven fatalities, and 29 injuries listed during that time period. Additionally, the NWS reported 55 heat-related deaths between 1982 to 2020 in Milwaukee County. Examples of recent extreme heat events in Milwaukee County are noted below.

2012 – During the days of July 1-7, 2012, a hot air mass settled over southern Wisconsin, bringing 100-degree heat to many locations for multiple days. Maximum heat indices climbed between 100° and 115°F during the hot spell. Based on news reports, hundreds of people received medical treatment at hospitals or clinics due to heat-related illnesses. Two fatalities were reported in Milwaukee County. Numerous new daily record highs were set as well as record high minimums. The long duration of this excessive heat period likely makes this one of the most dangerous heat waves to strike southern Wisconsin in recorded history.

2016 – In mid July 2016 southeastern Wisconsin experienced maximum heat index values ranging from 90° to 110°F. The Wisconsin Department of Health Services designated hundreds of cooling centers across the state. In addition, the Milwaukee Health Department, and the Housing Authority of the City of Milwaukee opened cooling stations. Hospitals reported 29 people in the Milwaukee area were treated for heat related illnesses.

Table 3.17
Recent Extreme Temperature Events in Milwaukee County: 2011-2022

Date	Type	Deaths	Injuries[a]	Property Damage ($)	Crop Damage ($)
January 21, 2011	Cold/Wind Chill	0	0	--	--
July 20, 2011	Heat	0	0	--	--
June 18, 2012	Heat	2	0	--	--
June 28, 2012	Heat	0	0	--	--
July 3, 2012	Excessive Heat	2	0	--	--
July 16, 2012	Heat	0	0	--	--
July 23, 2012	Heat	0	0	--	--
July 25, 2012	Heat	0	0	--	--
January 21, 2013	Cold/Wind Chill	0	0	--	--
July 16, 2013	Excessive Heat	0	0	--	--
August 30, 2013	Heat	0	0	--	--
January 3, 2014	Cold/Wind Chill	1	0	--	--
January 6, 2014	Extreme Cold/Wind Chill	0	0	--	--
January 27, 2014	Cold/Wind Chill	1	0	--	--
February 5, 2014	Cold/Wind Chill	1	0	--	--
March 16, 2014	Cold/Wind Chill	1	0	--	--
December 3, 2014	Cold/Wind Chill	1	0	--	--
December 5, 2014	Cold/Wind Chill	1	0	--	--
January 1, 2015	Cold/Wind Chill	1	0	--	--
January 7, 2015	Cold/Wind Chill	0	0	--	--
January 9, 2015	Cold/Wind Chill	0	0	--	--
January 8, 2016	Cold/Wind Chill	1	0	--	--
January 17, 2016	Cold/Wind Chill	1	0	--	--
July 21, 2016	Heat	0	29	--	561
July 27, 2016	Heat	1	0	--	561
December 10, 2016	Cold/Wind Chill	1	0	--	--
December 14, 2016	Cold/Wind Chill	0	0	--	--
December 18, 2016	Cold/Wind Chill	1	0	--	--
January 4, 2017	Cold/Wind Chill	1	0	--	--
January 5, 2017	Cold/Wind Chill	1	0	--	--
December 25, 2017	Cold/Wind Chill	2	0	--	--
January 1, 2018	Cold/Wind Chill	1	0	--	--
June 17, 2018	Heat	0	0	--	--
June 29, 2018	Excessive Heat	0	0	--	--
July 1, 2018	Excessive Heat	0	0	--	--
July 4, 2018	Heat	0	0	--	--
November 29, 2018	Cold/Wind Chill	1	0	--	--
December 28, 2018	Cold/Wind Chill	1	0	--	--
January 29, 2019	Extreme Cold/Wind Chill	1	0	--	--
February 1, 2019	Cold/Wind Chill	1	0	--	--
February 3, 2019	Cold/Wind Chill	1	0	--	--
March 3, 2019	Cold/Wind Chill	1	0	--	--
March 5, 2019	Cold/Wind Chill	1	0	--	--
July 19, 2019	Excessive Heat	0	0	--	--
November 6, 2019	Cold/Wind Chill	1	0	--	--
November 10, 2019	Cold/Wind Chill	1	0	--	--
February 11, 2020	Cold/Wind Chill	1	0	--	307
February 14, 2020	Cold/Wind Chill	1	0	--	307
February 17, 2020	Cold/Wind Chill	1	0	--	307
February 7, 2021	Cold/Wind Chill	0	0	--	--
February 13, 2021	Cold/Wind Chill	0	0	--	--
June 14, 2022	Excessive Heat	2	0	--	--
June 21, 2022	Excessive Heat	0	0	--	--

Table continued on next page.

Table 3.17 (Continued)

Date	Type	Deaths	Injuries[a]	Property Damage ($)	Crop Damage ($)
December 22, 2022	Extreme Cold/Wind Chill	0	0	--	--
	Total	35	29	--	2,043

Note: Dollar Values were adjusted to year 2021 by the average annual Consumer Price Index (CPI) values from the U.S. Department of Labor, Bureau of Labor Statistics.

[a] *No injuries were reported to NCEI or USDA RMA, but injuries may have occurred.*

Source: National Centers for Environmental Information and U.S. Department of Agriculture Risk Management Agency

2018 – On June 29, 2018, hot and humid conditions produced heat index values ranging from 100° to 110°F. Numerous cooling centers were opened by local communities throughout southern Wisconsin. Some public swimming pools hours were extended due to the heat. The heatwave continued into July 1st.

2019 – On July 19, 2019, the passage of a warm front brought a heat wave to southern Wisconsin with maximum heat index values of 99° to 106°F. The Milwaukee and Madison areas did experience an influx of emergency room visits due to heat exhaustion and/or heat stroke.

High demands for electricity during extreme heat events can result in blackouts and brown outs. Loss of water pressure can result from opening of fire hydrants in urban areas. Stagnant atmospheric conditions that occur with heat waves are also favorable for trapping ozone and other pollutants in urban areas. Pets and livestock can suffer from prolonged exposure to excessive heat. On average, there are about 1.5 extreme heat events per year in Milwaukee County that can have an impact on people, pets, and other forms of life.

Extreme Cold

Like extreme heat, extreme cold is also a deadly hazard. The CDC reports that the death rate of excessive cold as the underlying cause ranges from 1 to 2.5 deaths per million people and over 19,000 people have died from exposure to cold since 1979.[75] Exposure to extreme cold temperatures can also cause a number of health conditions and can lead to loss of fingers and toes, or cause permanent kidney, pancreas, and liver injury, and even death. These health impacts often result from a combination of cold temperatures, winds, and precipitation. As a result, winter storms can pose substantial risks because they can last for several days and be accompanied by high winds, freezing rain or sleet, heavy snowfall, and cold temperatures. In addition, when deaths and injuries due to cold-related events such as vehicle accidents and fatalities, fires due to dangerous use of heaters, carbon monoxide poisoning due to use of nontraditional sources of heat such as cooking ovens, and other winter weather fatalities are considered, the impact of severe cold periods becomes even greater.

Frostbite and hypothermia are two major health risks associated with severe cold. Frostbite is an injury caused by freezing of the skin and underlying tissues. Frostbite causes a loss of feeling and a white or pale appearance in extremities. Severe frostbite can damage skin and underlying tissues and requires medical attention. Potential complications of severe frostbite include infection and nerve damage. Frostbite is most common on fingers, toes, nose, ears, face, and chin. While exposed skin in cold, windy weather is most vulnerable to frostbite, this injury can also occur on skin covered by gloves or other clothing.

Hypothermia is a condition brought on when the core body temperature drops to less than 95°F. It occurs when the body loses heat more quickly than it is able to produce it. As with frostbite, wind or wetness can contribute to producing hypothermia. Symptoms of moderate to severe hypothermia include lack of coordination, slurred speech, confusion, drowsiness, progressive loss of consciousness, weak pulse, and shallow breathing. Hypothermia may cause lasting kidney, liver, and pancreas problems or death. Members of certain populations are particularly vulnerable to hypothermia. These include older adults, infants, and very young children, the homeless, persons consuming alcohol or other drugs, and persons taking certain medications.

[75] *CDC, 2018.*

Wind chill is an index used to evaluate the risk posed by the combination of cold temperatures and wind. It is based on temperature and wind speed. Table 3.18 shows the wind chill table used by the National Weather Service. Wind chill is not the actual temperature, but rather a measure of how the combination of wind and cold feel on exposed skin. As the wind increases, heat is carried away from the body at an accelerated rate, driving down body temperature. This combination can strongly affect the risks associated with exposure to extreme cold. For example, a wind chill of -20°F will cause frostbite on exposed skin in just 30 minutes.

NWS issues wind chill advisories when wind chill temperatures are potentially hazardous and wind chill warnings when wind chill temperatures are life threatening. The exact criteria of a wind chill advisory and warning varies from state to state. A wind chill advisory in Wisconsin is issued when wind chill values reach -20°F to -34°F, with wind speeds of 4 mph or more. A wind chill warning in Wisconsin is issued when wind chill values reach -35°F or colder, with wind speeds of at least four mph for three hours or more. In addition, a wind chill watch is issued 12 to 48 hours before these conditions are expected to occur.

What constitutes extreme cold varies in different parts of the country. In the south, freezing temperatures are considered extremely cold. Freezing temperatures can cause severe damage to citrus fruit crops and other vegetation. Pipes may freeze and burst in homes that are poorly insulated or without heat. In the north, extreme cold means temperatures are well below zero. Winter residents in Milwaukee County may see heavy snow, strong winds/blizzards, extreme wind chill, lake-effect snow, and ice storms. The public can stay informed by listening to NOAA Weather Radio, commercial radio or television for the latest winter storm warnings and watches.

Recent Extreme Cold Events (2011-2022)

Extreme cold that affects Milwaukee County are not localized events, as they usually encompass the entire south-central to southeastern portion of the State and may continue for several days or weeks. Between 2011 and 2022, as shown in Table 3.17, there has been no reported property damage and only an estimated $920 in total crop damages that have affected Milwaukee County as a result of extreme cold temperatures. Several of the extreme cold events listed in Table 3.17 are described below.

2013 – On January 21, 2013, arctic air spread into southern Wisconsin behind deep low pressure that tracked to the north of the state. High winds combined with surface temperatures in the negative single digits to produce wind chills between -20° to -30°F. The frigid wind chills began the morning of January 21st and continued into the morning hours of January 22nd.

2014 – On January 27, 2014, an arctic cold wave affected southern Wisconsin. West to northwest winds of 10 to 20 mph with the passage of an arctic cold front brought wind chill temperatures of -20° to -38°F beginning in the early morning of January 27th. These wind chills did not end until the morning of January 29th. The coldest period was the morning of January 28th when wind chills ranged from -30° to -38°F. Widespread school and business closings occurred during this time. The Governor declared a state of emergency due to a propane shortage across the state. Numerous water main breaks and frozen laterals continued to occur throughout the entire month of January. Two cold weather deaths occurred in the southeastern Wisconsin area.

2019 – During the end of January 2019, a dangerously cold air mass settled across the upper Midwest. It was the coldest air mass since 1996, and it brought three days of sub-zero temperatures with wind chills of -30° to -60° F. At first, schools were closed only due to the snow, but by the middle of the week the Governor declared a state of emergency because of the dangerous cold. Many businesses had to close, and postal services were suspended.

Vulnerability and Community Impact Assessment Related to Extreme Temperatures

Temperature extremes are primarily a public health concern, especially for those populations considered vulnerable including young children, the elderly, underprivileged, under educated, pregnant, and those with chronic health conditions. Also, communities within large and highly urbanized areas, such the City of Milwaukee, are considered vulnerable due to the "heat island" effect which can raise the area summer temperature by 3°F to 5°F degrees. Also, urban communities with substantial populations of elderly, disabled, and debilitated people could face a significant medical emergency during an extended period of excessive cold and heat.

Table 3.18
Wind Chill Temperatures[a]

Wind (mph)	Temperature (°F)																	
	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

[a] *Wind Chill (°F) = 35.74 + 0.6215T - 35.75($V^{0.16}$) + 0.4275T($V^{0.16}$), where T = air temperature (°F) and V = wind speed (mph). The wind chill temperature is only defined for temperatures at or below 50°F and wind speeds above 3 mph. Bright sunshine may increase wind chill temperature by 10°F to 18°F.*

Frostbite times associated with wind chills:

- 30 minutes
- 10 minutes
- 5 minutes

Source: National Weather Service

In 2014, the Building Resilience Against Climate Effects (BRACE) program in the Wisconsin Department of Health Services compiled heat vulnerability index maps for the State and each county. In addition, the Wisconsin Department of Health Services created a Milwaukee Heat Vulnerability Index report.[76] Results of the Milwaukee County heat vulnerability index are shown in Figure 3.5. The heat vulnerability index is based on multiple indicators associated with risk for heat-related illnesses and mortality including health factors, demographic and household characteristics, socioeconomic factors, natural and built environment factors, and population density. Because of its high population density, high poverty rate, and urban heat island effect, Milwaukee County has a high vulnerability to extreme heat events and has experienced many heat-related fatalities. As indicated in Figure 3.5, the largest area of high heat vulnerability identified in the Milwaukee County HVI map is the inner core of the City of Milwaukee. Areas of low heat vulnerability include the shoreline of Lake Michigan as well as the southern region of Milwaukee County.

Municipal water and electric utilities can also be impacted by extreme temperature events. Some older residents may become isolated with extreme temperatures due to lack of physical strength and larger number of health problems (physically and mentally). Education improved social awareness, and community outreach programs have likely helped to reduce the number of individuals killed or injured by extreme temperature events.

Although no property damages have been reported as a result of extreme temperature events, there have been several reported incidents of crop damages between 2011-2021, as previously noted (see Table 3.17) Based on this data, there are a total of 4.5 extreme temperature events per year in Milwaukee County with 1.5 of those events related to extreme heat and 3 events related to extreme cold.

Future Changes and Conditions

The historical record shows considerable variation among years in the numbers of extreme temperature events that occurred in Milwaukee County. While it would be expected that in some years the County will experience either fewer events or more events than the average number, the average annual number of events is not expected to change over the five-year term of this plan update.

[76] *ww.dhs.wisconsin.gov.*

Figure 3.5
Milwaukee County Heat Vulnerability Index: 2014

Milwaukee County Heat Vulnerability Index

The MilwaukeeCounty Heat Vulnerability* analysis was created by the Building Resilience Against Climate Effects program within the Wisconsin Department of Health Services. The data displayed in the map is meant to serve as an informational tool to better understand the spatial distribution of human populations most vulnerable to extreme heat related events.

Milwaukee County Vulnerability (county based quantiles)

by Census Block Group

Heat Vulnerability

- High (top 20%)
- Moderate High
- Moderate
- Moderate Low
- Low (bottom 20%)

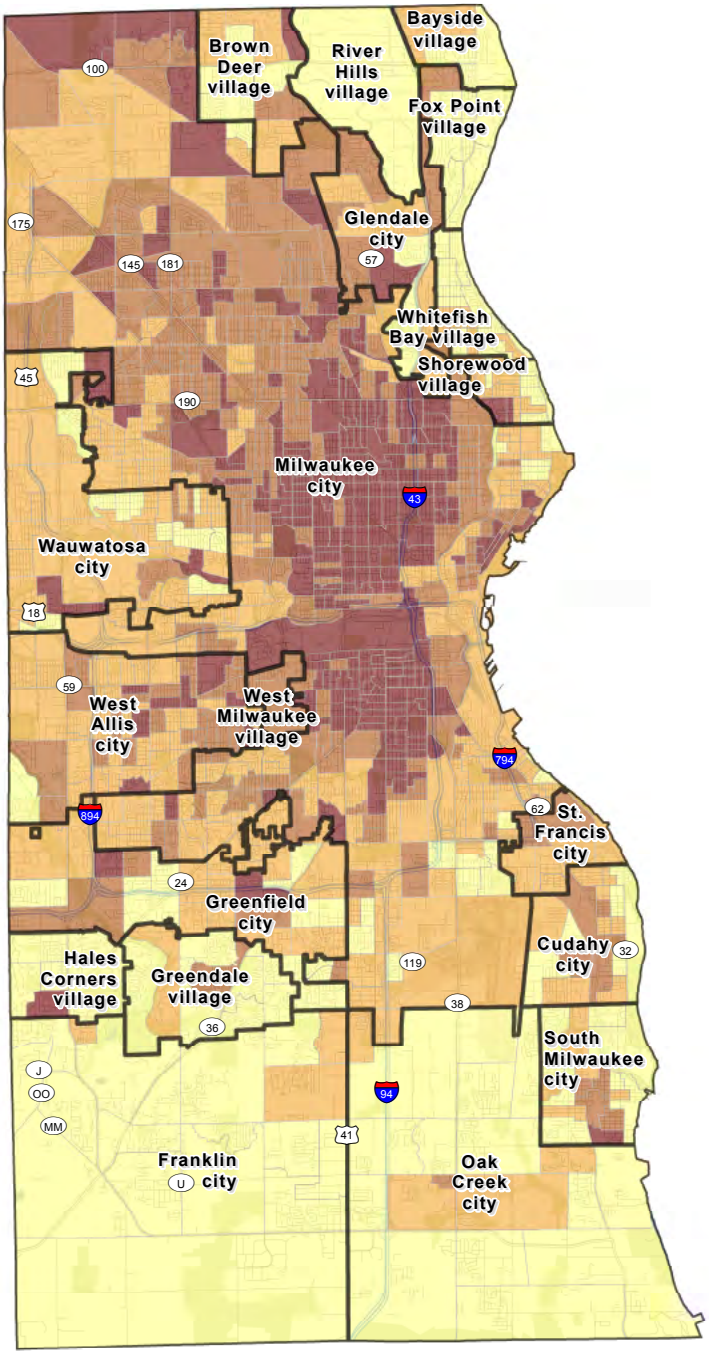
* The Milwaukee County Heat Vulnerability Index is based on the Wisconsin Heat Vulnerability Index** with slight alterations to account for risk factors specific to Milwaukee County. Additional data sets were made avilable for the Milwaukee study area and incorporated into the analysis. It is representative of the heat vulnerability in Milwaukee County, and is not representative of the vulnerability compared to the other counties in Wisconsin.

** The Wisconsin Heat Vulnerability Index is based on multiple indicators associated with risk for heat-related illness and mortality. The index analysis was created as a measure of vulnerability by U.S. Census block groups during an extreme heat event. The measure includes: health factors, demographic and household characteristics, natural and built environment factors (e.g., air quality, temperature, land cover) and population density.

Reference Data

- Park / Forest
- Water
- Municipal Boundary

0 N 2
Miles



Map created by the Bureau of Information Technology Services in cooperation with the BRACE Program, Bureau of Environmental & Occupational Health, Division of Public Health, Department of Health Services, State of Wisconsin - P-01084 (8/2015)

Maps and related information are provided as a public service for informational purposes only. We make no warranties on the accuracy of content. Use of information from this document is at your own risk.

Source: National Oceanic and Atmospheric Administration

The projections based on downscaled results from climate models indicate that there will likely be substantial changes in the frequencies of extreme cold and heat events over the 21st century.[77] The frequency of extreme cold events may decrease by the middle of the century as projected warming trends are expected to be greatest during the winter. Average winter temperatures in Milwaukee County are projected to increase by about 4.0°F. This may result in a reduction of some risks associated with extreme cold.

Extreme heat events are likely to occur more frequently and to be more severe by the middle of the century. As previously described, average summertime temperatures in Milwaukee County are projected to increase by 4.0°F by the year 2060. Heat waves are also expected to become longer and more intense over time, with a 1.5-7.5°F minimum rise in Wisconsin summer temperatures and an increase in the number of extremely hot days. By mid-century (2041-2060), the number of days over 90°F in Wisconsin is likely to triple.[78] A 2019 study on climate analogs for urban areas in the late 21st century predicts that in 2080, Milwaukee's climate will feel most like today's climate near Chester, Pennsylvania where the typical summer is 5.6°F warmer and 7.8 percent wetter than summer in Milwaukee. Given that much of the documented increases in average temperature since 1950 have occurred through increases in night-time low temperatures, it is likely that there will be fewer night-time breaks in the heat during extreme heat events in the future. This could result in some extreme heat events persisting longer.

Multi-Jurisdictional Risk Management

As noted above, during extreme heat events, the City of Milwaukee can potentially be more vulnerable due to the built environment creating a heat island effect. However, during extreme cold and most extreme heat events, there are no specific municipalities that have unusual risks. Rather, the events are of a uniform countywide concern.

Drought

Drought is the result of a natural decline in the expected precipitation over an extended period of time, and occurs in virtually every climate on the planet, including areas of high and low precipitation. The severity of drought can be aggravated by other climatic factors, such as prolonged high winds, high temperatures, and low relative humidity. Drought is a complex natural hazard which is reflected in the following four definitions commonly used to describe it.

1. **Meteorological drought**: The degree of dryness, expressed as a departure of actual precipitation from expected average or normal amount, based on monthly, seasonal, or annual time scales

2. **Hydrological drought**: The effects of precipitation shortfalls on streamflow, reservoir, lake, and groundwater levels

3. **Agricultural drought**: Soil moisture deficiencies relative to water demands of crop life

4. **Socioeconomic drought** (or water management drought): Occurs when the demand for water exceeds the water supply, resulting in a water shortage

Drought severity depends on several factors, including its duration, its intensity, its geographic extent, and the demands for water for use by both humans and vegetation.

Drought can be difficult to define in exact terms. This is partly due to its multi-dimensional nature and partly due to the ways it differs from other natural hazards. There is no exact and universally accepted definition of what constitutes a drought. The onset and end of a drought are difficult to determine due to the slow accumulation of its impacts and the lingering effects after its apparent end. The impacts of drought are less obvious than those of some other hazards and may be spread over a larger geographic area. These characteristics have hindered the preparation of drought contingency or mitigation plans by many governments and can make it difficult to perform an accurate risk assessment analysis.

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[77] *Wisconsin Initiative on Climate Change Impacts, 2021,* op. cit.

[78] Op. cit.

Droughts can have several impacts. They can reduce water levels and flows in surface waterbodies and groundwater. This can cause shortages of water for human and industrial consumption, hydroelectric power, recreation, and navigation. Water quality may also decline, and the number and severity of wildfires may increase during a drought. Severe droughts may result in reduced yields or the loss of agricultural crops and forest products, undernourished wildlife and livestock, and lower land values.

One method to measure the magnitude of a drought is by using the Palmer Drought Severity Index (PDSI). This method considers factors like temperature, soil moisture, and precipitation, which are entered into an algorithm that returns results between -5 (extreme drought) and 4 (extremely moist) with zero being normal conditions. The Crop Moisture Index was developed to measure soil moisture over shorter periods, up to four weeks, and has values between -3 (severely dry) and 3 (excessively wet), with zero as normal conditions. Further, the U.S. Drought Monitor (USDM), which incorporates both the PDSI and CMI, is an online map released every Thursday, showing where drought is and how bad it is across the U.S. The map uses six classifications: normal conditions, abnormally dry (D0), showing areas that may be going into or are coming out of drought, and four levels of drought (see Figure 3.6): moderate (D1), severe (D2), extreme (D3) and exceptional (D4).

It is important to note that although Milwaukee County itself is less susceptible to drought impacts, the state of Wisconsin, however, is indeed more vulnerable due to its approximate 14.2 million acres of farmland.[79] It's important to note however, that even small droughts of limited duration can significantly reduce crop growth and yields, adversely affecting farm incomes and local economies. Droughts significantly increase the risk of forest fires and wildfires. Additionally, the loss of vegetation in the absence of sufficient water can result in flooding, even from average rainfall.

Estimates of agricultural losses experienced in Milwaukee County due to drought over the period 2011 to 2022 are shown in Table 3.19. Because there are no crop damages reported in the NCEI database, these estimates come from records of indemnities paid to agricultural operators by Federal crop insurance programs.[80] The documented loss estimates reflect several factors. First, crop losses often go unreported. Second, Federal crop insurance policies offer coverage to only certain types of crops in any particular year. Third, agricultural operators generally insure only a portion of their crops when purchasing Federal crop insurance. Thus, crop loss estimates are likely to represent underestimations of actual losses. It should be noted that indemnities for drought related losses were paid out every few years. This probably reflects variability in rainfall causing localized crop losses. Based on these sources, it is estimated that Milwaukee County experienced crop damages of just over $66,000 between 2011 and 2022. Due to the variability in crop damages paid, an average loss cannot be calculated.

As indicated in Figure 3.7, small droughts of shortened duration have occurred in Wisconsin at an interval of about every 10 years since the 1930s. Extended, widespread droughts have been infrequent in Wisconsin. The most significant droughts, in terms of severity and duration were 1929-1934, 1948-1950, 1955-1959, 1976-1977, 1987-1989, 1995, and 2012.

Recent Events

The only recent drought event took place in 2012. A lack of rain over south-central and southeastern Wisconsin during June 2012 allowed a drought to slowly develop. The intensity of this drought increased rapidly and by June 26th the drought intensity was rated abnormally dry by the U.S. Drought Monitor. The drought continued through the month of July and by August the conditions were extremely dry across southeastern Wisconsin. Several rainfall and thunderstorm events occurred in August, but annual precipitation amounts were still below normal. The end of August ended with above normal temperatures, increasing the effects on the already stressed crops and water supply. Drought conditions improved by October with above normal precipitation. For many farmers across the region the drought conditions over the summer reduced crop yields.

[79] *State of Wisconsin Department of Agriculture, Trade and Consumer Protection, 2022 Wisconsin Agricultural Statistics.*

[80] *The U.S. Department of Agriculture Risk Management Agency report payments of crop insurance indemnities.*

Figure 3.6
U.S. Drought Monitor Classifications

Category	Description	Possible Impacts	Ranges				
			Palmer Drought Severity Index (PDSI)	CPC Soil Moisture Model (Percentiles)	USGS Weekly Streamflow (Percentiles)	Standardized Precipitation Index (SPI)	Objective Drought Indicator Blends (Percentiles)
D0	Abnormally Dry	Going into drought: • short-term dryness slowing planting, growth of crops or pastures Coming out of drought: • some lingering water deficits • pastures or crops not fully recovered	-1.0 to -1.9	21 to 30	21 to 30	-0.5 to -0.7	21 to 30
D1	Moderate Drought	• Some damage to crops, pastures • Streams, reservoirs, or wells low, some water shortages developing or imminent • Voluntary water-use restrictions requested	-2.0 to -2.9	11 to 20	11 to 20	-0.8 to -1.2	11 to 20
D2	Severe Drought	• Crop or pasture losses likely • Water shortages common • Water restrictions imposed	-3.0 to -3.9	6 to 10	6 to 10	-1.3 to -1.5	6 to 10
D3	Extreme Drought	• Major crop/pasture losses • Widespread water shortages or restrictions	-4.0 to -4.9	3 to 5	3 to 5	-1.6 to -1.9	3 to 5
D4	Exceptional Drought	• Exceptional and widespread crop/pasture losses • Shortages of water in reservoirs, streams, and wells creating water emergencies	-5.0 or less	0 to 2	0 to 2	-2.0 or less	0 to 2

Source: U.S. Drought Monitor Drought Classification (droughtmonitor.unl.edu/About/AbouttheData/DroughtClassification.aspx)

Vulnerability and Community Impact Assessment Related to Drought

A review of community assets, as described in Chapter 2, indicates that Milwaukee County is less susceptible to droughts because it is very urban and positioned on Lake Michigan, which serves as the main source of drinking water. However, it is important to note that during prolonged drought conditions the depletion of groundwater reserves can impact the amount of surface water available for recreational activities (i.e., boating and fishing) and for wildlife as well as those using private wells for drinking water.

Future Changes and Conditions

The future occurrence of a drought is highly unpredictable, as it impacts the state occasionally, but not annually. Drought may also be localized, making it difficult to determine probability with any accuracy; however, the NWS and National Integrated Drought Information System (NIDIS) are improving methodologies for accurately forecasting drought conditions. The statewide historical record indicates that severe droughts can be expected to occur at roughly 10-year intervals. As can be seen in Figure 3.7,

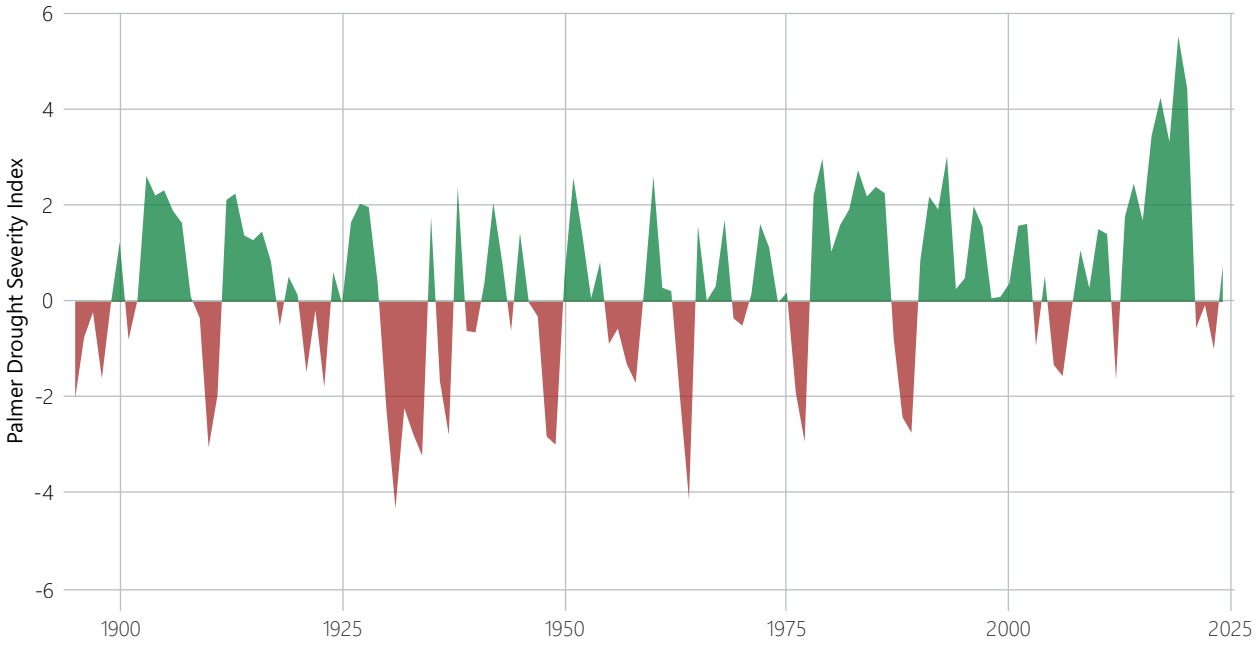
Table 3.19
Estimates of Recent Crop Losses Due to Drought in Milwaukee County: 2011-2022

Year	Crop Insurance Indemnity Paid ($)[a]
2011	5,369
2012	14,518
2013	--
2014	337
2015	16,083
2016	8,348
2017	--
2018	--
2019	--
2020	--
2021	11,500
2022	10,129
Total	66,284

[a] *Dollar values were adjusted to year 2022 by using the average Consumer Price Index (CPI) values from the U.S. Department of Labor, Bureau of Labor Statistics.*

Source: National Climatic Data Center (NCDC), the U.S. Department of Agriculture Risk Management Agency, and SEWRPC

Figure 3.7
Wisconsin Statewide Average Palmer Drought Severity Index: 1895-2024



Source: University of Wisconsin Atmospheric and Oceanic Sciences, Wisconsin State Climatology Office

Wisconsin regularly experienced drought to at least a moderate level two to three times every ten years from 1895 to 2021.[81] It is not expected that the probability of drought will change during the five-year term of this plan update.

Historical changes over the 20th century and projections based on downscaled results from climate models indicate that there will likely be changes in drought conditions affecting Milwaukee County over the 21st century. By mid-century, average temperatures are projected to rise, leading to longer summers and shorter winters. The temperature increase will also lead to a longer growing season and increased rates of evapotranspiration during summer and early fall months. While the amount of rain during the summer is not projected to change, a greater proportion of precipitation is projected to fall in heavy rainfall events. This will result in a greater number of dry days during the summer. More dry days, coupled with higher summer temperatures and increases in evapotranspiration rates, may increase the likelihood of summer droughts occurring.[82]

Multi-Jurisdictional Risk Management

Because Milwaukee County has little agricultural lands and the communities are served by public water supply that use Lake Michigan water as a source of supply, there are no areas of the County that are likely to experience unusual risks or major debilitating impacts of drought. Impacts from drought would be limited to a few individual farms and residents that may rely on private wells. Drought impacts to surface vegetation that is not irrigated may occur during a drought, but this result would be uniform across the County.

Lake Michigan Coastal Hazards

For the purposes of this Report, coastal hazard mitigation can be defined as a means by which the County may mitigate coastline impacts, such as coastal flooding, wave runup, shoreline and beach erosion or bluff recession and failure. Coastal mitigation measures may incorporate structural or nonstructural measures. Examples of structural coastline management measures include retaining walls within a bluff slope, shoreline revetments, and breakwaters. Examples of nonstructural coastline management measures include regulations or guidelines for land uses or development, such as promoting landscape management techniques that are

[81] *University of Wisconsin-Madison, Atmospheric and Oceanic Sciences, www.aos.wisc.edu.*

[82] *Wisconsin Initiative on Climate Change Impacts, 2021,* op. cit.

appropriate for bluffs. Whether located on-shore or near off-shore, structural and nonstructural coastline management techniques are intended to mitigate or prevent damage from the impacts of coastal hazards on life and property.

It is important to note that shoreline protection structures (i.e., seawalls, revetments, breakwater structures) have been known to contribute to coastal problems by decreasing, or preventing, natural erosion of littoral material (lake bottom near shore) such as sand and gravel from existing shorelines. Additionally, these structures can disrupt the natural flow and deposition of those sediments along the lake shore, affecting beach ecosystems. Some shoreline protection structures may redirect wave energy to adjacent shorelines, which can increase the potential for erosion at neighboring sites.[83]

There are five types of Lake Michigan coastal hazards of concern that pose risk to Milwaukee County:

- **Shoreline Recession and Bluff Failure**
- **Beach Erosion**
- **Coastal Flooding**
- **Damage and failure of shoreline protection structures** (revetments,[84] seawalls, marinas, ports, and groins[85]) from wave action, storm surge, and varying lake levels
- **Damage to shoreline structures** (residences, marinas, ports, businesses, and public facilities) from storm waves, including wave runup)

Nearly 80 percent of Wisconsin's Lake Michigan shoreline is affected by coastal erosion and bluff recession to some degree, and recurring erosion presents a significant risk in almost every coastal county. The terms recession and erosion are often used interchangeably. Recession is the landward movement of a land feature, such as a bluff crest, while erosion is the wearing a way of land. Recession is expressed as distance or a change in distance, while erosion is expressed as a volume or change in volume. Recession can be thought of as a consequence of erosion. Shoreline recession rates are usually determined by comparing aerial photographs taken on different dates.

The rate at which coastal erosion occurs is dependent on a variety of factors including Lake Michigan level fluctuations, disruption of the transport of beach-building sediments, elevated groundwater levels, storms, and surface stormwater runoff. Additional contributing factors to coastal erosion can include soil composition, vertical cracks in the upper slope of the soil, shoreline ice cover, freezing and thawing cycles, shoreline orientation, beach composition, beach width and slope, the presence or absence of shore protection, and the type of shore protection. Shores that have cohesive materials, such as clay, till, and bedrock have strong binding forces. Shores that have noncohesive materials, such as sand and/or gravel have weak or no binding forces. Like most of the Great Lakes Region, the soils in Milwaukee County are composed of sand, gravel, clay, and clay-like material known as glacial till. The bluffs along Milwaukee County's Lake Michigan coastline exhibit a variety of height, slope, composition, vegetative cover, and groundwater conditions, which affect the degree and rate of bluff recession. Much of the bluff heights along the Milwaukee County coastline ranged from approximately 25 feet to 140 feet. Bluffs within the northern and southern extents of the County were higher than the central portion of the County, where conditions ranged from the absence of natural bluffs to up to 25 feet in height.

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[83] *University of Wisconsin Sea Grant, Great Lakes Coastal Shore Protection Structures and Their Effects on Coastal Processes, 2013.*

[84] ***Revetments*** *are sloping structures placed on banks or cliffs in such a way as to absorb the energy of incoming water (i.e., wave impact). Many materials may be used such as wooden piles, loose-piled boulders (i.e., riprap), concrete shapes, or geotextile fabric sandbags.*

[85] *A* ***groin*** *is a narrow structure (i.e., breakwater and/or jetty) built out into the water from a beach in order to prevent beach erosion or to trap and accumulate sediments that would otherwise drift along the beach face. A groin can be successful in stabilizing a beach on the up-drift side, but erosion tends to be aggravated on the down-drift side.*

A portion of the Milwaukee County bluff in the City of Milwaukee is set back from Lake Michigan by fill placed for Lincoln Memorial Drive, various County parks, and facilities including the Jones Island and South Shore Water Reclamation Facilities, Milwaukee Water Works, and the Port of Milwaukee. The southernmost section of the Milwaukee County bluff in the City of Oak Creek is set back from Lake Michigan by fill placed for the We Energies Oak Creek Power Plant. Thus, these two coastal areas are not directly impacted by Lake Michigan processes and will not be discussed in as great a detail as the rest of the Milwaukee County coastline.

Lake Level Fluctuations

Lake level can be a significant factor in determining the rate of erosion along Wisconsin's coasts. As mentioned above, high Lake levels and increased wave action can worsen both coastal erosion and coastal flooding issues. As lake levels rise, bluff recession rates can also increase. Major storm events can also lead to high erosion rates because of increased wave action on the shoreline. The effects of wave-induced erosion are usually greater during periods of high Lake levels. Conversely, low Lake levels pose problems for facilities that are dependent on water depth, such as ports, marinas, and nearshore water utility intakes. Low water levels can also cause problems with shore protection structures, such as normally submerged timber pilings being exposed to air.

The Great Lakes have experienced both low and high-water levels over the past 25 years. Water levels in the Great Lakes fluctuate seasonally, annually, and over multi-decade cycles. Seasonally, the lakes are at their lowest levels during the winter, when much of the precipitation is held on land in the form of snow and ice, and evaporation occurs over open water. The highest seasonal levels are typically during the summer when snowmelt from the spring thaw and summer rains contribute to the Lake water supply. For Lake Michigan in the 30-year-period between 1992-2022, the average difference between summer high water levels and winter low water levels has been about one foot. Long-term variations in Lake levels (over multi decades) depend on climatic factors such as precipitation, the presence or absence of ice cover on the Lake during the winter, and evaporation of water from the Lake.

Coastal hazard problems have been most evident in southeastern Wisconsin and Milwaukee County during high water periods. As indicated in Figure 3.8, these have occurred in recent history on Lake Michigan in the early 1950s, the early 1970s, the mid-1980s and late 1990s, and again in 2020 with water levels reaching record highs. As of November 2021, Lake Michigan water levels continued their seasonal decline, decreasing by about 3 inches from October to November. Though Lake Michigan is about 25 inches below the highest monthly water level recorded for November in 1986, the Lake is still about 13 inches above the long-term average water level as of November 2021. Water levels are expected to continue their seasonal decline through the early winter but remain above the long-term average.[86]

Beach, Coastal, and Shoreline Erosion and Bluff Stability Conditions

Shoreline erosion and bluff stability conditions can change over time since they are related, in part, to changes in climate, water levels, the geometry of the onshore beach and nearshore areas, the extent and condition of shore protection measures, the type and extent of vegetation, and the type of land uses in shoreland areas, among other related factors. Bluff and beach erosion are the primary forms of erosion occurring along the Milwaukee County Lake Michigan coastline. Additionally, bluff slope failure along the Milwaukee County Lake Michigan coastline can occur. The most common forms of bluff slope failure in the County are translational slides, rotational slides, and creeping.[87] Beaches along the Milwaukee County coastline are also subject to erosion via littoral drift, where coastline sediment is transported via longshore currents.

As noted in Chapter 2, the reports below are studies and assessments on bluff stability and shoreline conditions along the Lake Michigan Milwaukee County coastline.

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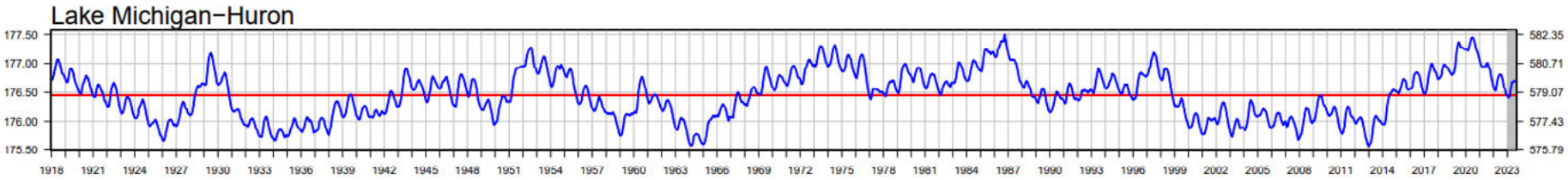
[86] *Collaborative Action for Lake Michigan (CALM) Coastal Resilience Monthly Newsletter, November 2021.*

[87] ***Translational slides*** *occur when a single mass or a few closely related masses of soil or rock move quickly downslope in a planar manner.* ***Rotational slides*** *(or slumps) are classified as a soil mass with a curved rupture surface moving slowly downslope.*

Figure 3.8
Lake Michigan-Huron Water Levels: 1918 to 2023



Source: United States Army Corps of Engineers

SEWRPC Technical Report No. 36, *Lake Michigan Shoreline Recession and Bluff Stability in Southeastern Wisconsin: 1995 and December 1997*

An inventory of the shoreline conditions and bluff stability within the entire Southeastern Wisconsin Region was conducted in 1977 by a number of coastal technical consultants under the Wisconsin Coastal Management Program (WCMP) and again in 1995 for a study published in 1997 by the Commission in conjunction with the WCMP. Information from the later study is summarized in Table 3.20 and includes bluff heights, bluff stability, shoreline recession, and beach width for each associated reach area.[88] Bluff stability, bluff recession rates, and beach width from that study are shown on Map 3.4. Within northern Milwaukee County, many bluffs were generally found to be stable based upon conditions during the 1995 survey; however, bluffs in two areas were found to be unstable. One of these areas was located along the shoreline in the Village of Bayside. The other was located along the shoreline in the Villages of Fox Point and Whitefish Bay. In central Milwaukee County, the 1995 survey found that bluffs were generally stable. The 1995 survey found that bluffs in several areas in the southern part of the County were unstable. These areas are located along the shoreline in the Cities of Cudahy, South Milwaukee, and Oak Creek.

Shoreline Erosion Study for Warnimont Park in the City of Cudahy, STS Consultants, 2001

In 2001, bluff stability and erosion conditions were assessed along approximately 2,000 linear feet of bluff in Warnimont Park.[89] This study found visible evidence of erosion along the toe of the bluffs; evidence of recent bluff failures, including translational slides and rotational slumps; and visible water seeps at mid bluff levels, some exhibiting relatively rapid discharge of water during field investigation.

SEWRPC Memorandum Report No 156, *Lake Park Bluff Stability and Plant Community Assessment*, 2003, September 2004

Bluff stability conditions were assessed within Lake Park in the City of Milwaukee.[90] While the bluff stability analysis conducted as part of this study found that most bluffs in the park were stable, it was concluded that bluffs in the southern portion of the park were marginally stable and less stable than bluffs in the other portions of the park. In addition, this study found evidence of active recession of the bluffs in the southern portion of the park, including evidence of top recession.

Integrated Assessment on Water Level Variability and Coastal Bluff Erosion, 2015

In 2015, coastal bluff conditions were analyzed along communities in northern Milwaukee County. While the bluff analysis conducted as part of this assessment found that most bluffs in this area of the County were stable prior to 2013, it concluded that there were some areas of continued bluff failure. The assessment found new bluff toe failures have occurred due to decreased beach widths and bluffs that were initially stable were failing because an adjacent property owner-built shoreline/bluff protection structures to stabilize their property, thus adversely affecting a neighboring property owner that didn't have protection structures in place. In addition, the assessment indicated that about 63 percent of the northern Milwaukee County shoreline was armored with a form of protection.

Wisconsin Shoreline and Oblique Photo Viewer

WCMP, the Association of State Floodplain Managers (ASFPM), and Geo-Professional Consultants, LLC have developed a web mapping tool to view shoreline conditions along most of Wisconsin's Great Lakes coast. The Wisconsin Shoreline Inventory and Oblique Photo Viewer (shoreline viewer tool) can be used to view and compare assessments on shoreline protection and shore and bluff conditions. Shoreline characteristics and conditions were derived from interpretation of oblique aerial photography of the Lake Michigan coastline taken in 1976-78, 2007-08, and 2018-19, and the analysis was performed by David M. Mickelson. It should be noted that these interpretations represent conditions on the date that these photographs were taken and are limited by what can be seen in the photos. In addition, geotagged oblique images can be viewed and compared on the shoreline viewer tool from 2012, 2016, 2017, 2018, 2019, 2020, 2021, 2022, and 2023. These images can be used with the interactive mapping tool to understand and evaluate how bluffs along the Milwaukee County coast have changed over time.

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[88] *A safety factor against sliding of less than 1.0 is considered unstable, a factor of 1.0 to 1.1 considered marginally stable, and a factor of greater than 1.1 is considered stable.*

[89] *STS Consultants,* op. cit.

[90] Ibid.

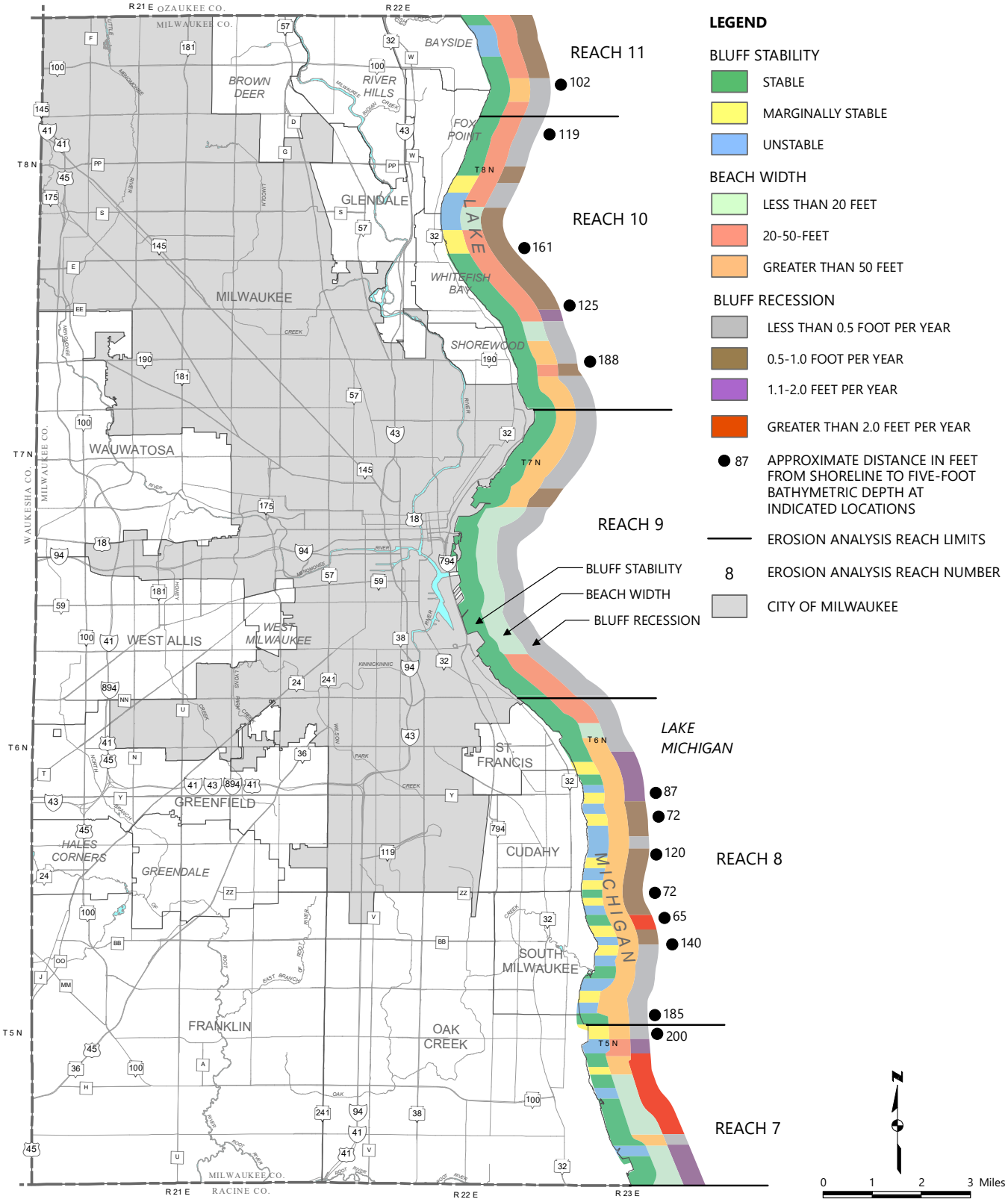
Table 3.20
Bluff Stability and Shoreline Recession Along Lake Michigan Shoreline of Milwaukee County: 1995

Shoreline Analysis (see Map 3.4)	Bluff Heights (feet)	Deterministic Bluff Stability Safety Factor		Shoreline Recession Data 1963-1995		Estimated Beach Width (feet)	
		1995 Conditions	1977 Conditions	Total (feet)	Annual Average (feet per year)	1995 Conditions	1977 Conditions
Reach 7	60-125	0.80-1.59 (Unstable to Stable)	0.54-1.38 (Unstable to Stable)	10-400	0.3-12.5	0-150	0-20
Reach 8	25-100	0.74-1.95 (Unstable to Stable)	0.33-1.69 (Unstable to Stable)	10-330	0.3-10.3	0-600	0-20
Reach 9	0-25	2.40 (Stable)	1.21 (Stable)	20-70	0.6-2.2	0-170	0-20
Reach 10	70-120	0.95-1.62 (Unstable to Stable)	0.45-2.97 (Unstable to Stable)	-90-50	-2.8-1.6	0-150	0-50
Reach 11[a]	80-140	1.07-2.34 (Unstable to Stable)	0.85-1.71 (Unstable to Stable)	10-50	0.3-1.6	5-170	15-30

[a] *Includes a portion of Milwaukee County.*

Source: Wisconsin Coastal Management Program and SEWRPC Technical Report No. 36, Lake Michigan Shoreline Recession and Bluff Stability in Southeastern Wisconsin: 1995, *December 1997*

Map 3.4
Summary of Lake Michigan Shoreline Erosion and Bluff Stability Analyses in Milwaukee County: 1995



Source: T.B. Edil, D.M. Mickelson, J.A. Chapman, and SEWRPC

Map 3.5 and Table 3.21 summarizes an assessment of the types of shore protection in the County in 2018-2019, as provided on the shoreline viewer tool. In 2018, about 36 percent of the shoreline in Milwaukee County was unprotected. The most common type of shore protection in the County was revetment (37 percent); followed by other armored areas (docks or marinas) (14 percent); seawall or bulkhead (9 percent); poorly organized riprap or rubble (3 percent); and offshore breakwater (1 percent).

The shoreline viewer tool also provides insight into the general conditions of Lake Michigan bluffs in 2018, as shown in Map 3.6. In 2018, about 17 percent of Milwaukee County's shoreline was considered to have moderately unstable to unstable or failing bluffs (as shown in black and red on Map 3.6). According to the dataset, some bluff areas considered to be unstable or failing were located in the same municipalities as the 1995-1997 assessment, especially in the southern portion of the County, which includes the Cities of Oak Creek, South Milwaukee, and Cudahy. As shown on Map 3.6, areas identified as having unstable or failing bluff conditions were located in the areas of three County-owned parks—Grant Park in the City of South Milwaukee and Sheridan and Warnimont Parks in the City of Cudahy. An area in the Village of Fox Point that was considered unstable or failing in the 1995-1997 assessment is now considered moderately unstable in the 2018 dataset and an area in the Village of Bayside that was also considered unstable or failing in the 1995-1997 assessment has been upgraded to moderately stable. However, an area along Bay View Park in the City of St. Francis was considered stable in the 1995-1997 assessment is now considered unstable or failing in the 2018 dataset. As shown on Map 3.6, the majority of bluff areas in Milwaukee County that are the most vulnerable to the effects of extreme weather conditions and are considered moderately unstable or unstable or failing are located in the southern portion of the County.

Map 3.7 specifies the types of bluff failure that was occurring at the time of the 2018 dataset. Shallow slides were the most observed type of bluff failure, occurring at 16 percent of the assessed County shoreline, followed by creep failure (10 percent), and deep-seated slumps (2 percent). As shown on Map 3.7, about 70 percent of the County's bluff shoreline was observed as having minimal or no obvious failures.

Long-Term (1956-2015) and Short-Term (1995-2015) Bluff Toe and Bluff Crest Recession

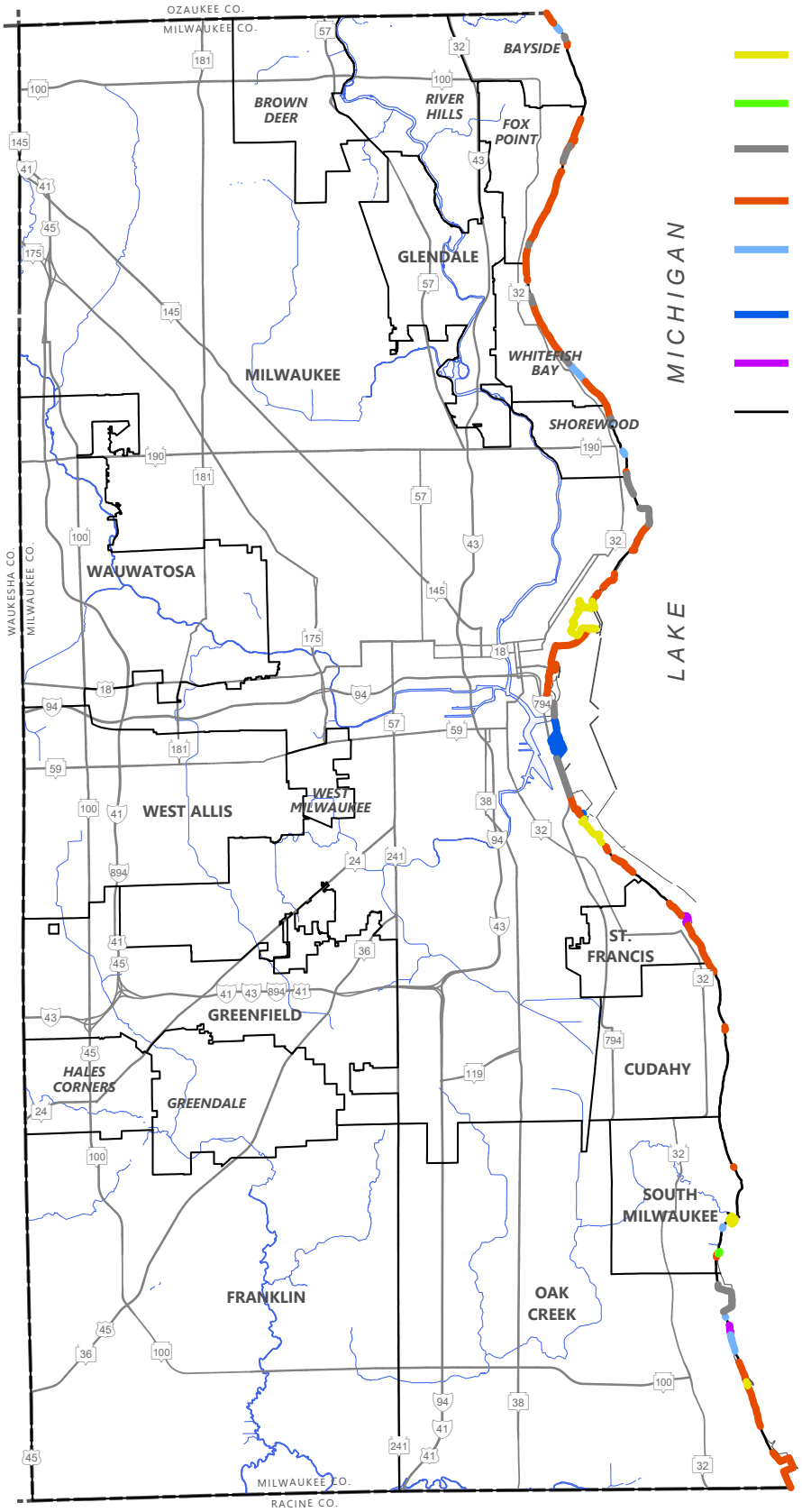
A recent analysis by the University of Wisconsin-Madison Coastal Sustainability and Environmental Fluid Mechanics Laboratory is also available to view on the shoreline viewer tool. The study measured long-term (1956-2015) and short term (1995-2015) bluff toe recession, bluff crest recession, and general shoreline recession along the shores of Kenosha, Milwaukee, Ozaukee, and Racine Counties. It should be noted that the analyses discussed below were for bluff conditions through 2015, thus do not include the higher water levels and storm events experienced in later years. Bluff recession distances were measured from historical aerial photos in Geographic Information Systems (GIS) software. The bluff crest, bluff toe, and shoreline were carefully traced on each aerial photo. As indicated in Figure 3.9, the bluff crest is identified as the break in slope between the upland and the bluff slope; the bluff toe is identified as the break in slope between the bluff slope and the beach; and the shoreline is defined as the location that appears as the interface between the water and land at the time the photo was taken. Once each feature was digitized, the Digital Shoreline Analysis System (DSAS) software was used to measure the location of each digitized feature along transect lines spaced at 10-meter intervals along the shoreline. Data in Maps 3.8 through 3.11 show recession distances that have been spatially averaged along 300-foot sections of coast. The data therefore represent average recession over a distance wider than a typical parcel or shoreline frontage and should not be interpreted as recession at a specific property.

This recession analysis can provide useful insights into the historic migration of the Lake Michigan coast in Milwaukee County. It should be noted that bluff recession can be sporadic. A bluff crest that remained unchanged for decades can recede many feet almost instantly due to a bluff collapse. This analysis represents how the bluffs have responded to historical environmental conditions and human actions over a specific time period. There will always be uncertainty in how bluff and shoreline recession will respond to future conditions.

Long-Term Bluff Toe and Crest Recession

As shown in Map 3.8, about 47 percent of the bluff toe in Milwaukee County has experienced at least some recession in the 59-year long term period from 1956 to 2015. Furthermore, about 9 percent of the County's bluff toe was estimated to have experienced significant recession of more than 60 feet. The most severe long term bluff toe recession has occurred in Whitefish Bay, St. Francis, South Milwaukee, and Oak Creek (see Map 3.8). It is estimated that about 53 percent of the bluff toe in the County has either experienced no

Map 3.5
Types of Shore Protection in Milwaukee County: 2018-2019



	(PERCENTAGE COUNTY SHORELINE)
PUBLIC MARINA	9.1
PERSONAL MARINA	0.3
SEAWALL/BULKHEAD	8.8
REVETMENT	36.7
POORLY ORGANIZED RIP-RAP/RUBBLE	2.8
COMMERCIAL/INDUSTRIAL DOCK	5.0
OFFSHORE BREAKWATER	1.4
NO PROTECTION	35.9

N

0 1 2 3 Miles

Source: Wisconsin Shoreline Inventory and Oblique Viewer (Association of State Floodplain Managers, Geo-Professional Consultants, LLC, National Oceanic and Atmospheric Administration, Wisconsin Coastal Management Program) and SEWRPC

recession or has moved towards the Lake (accretion). It should be noted that accretion or small bluff toe recession distances may represent areas where the bluff crest has slumped towards the shoreline or where the construction of shore protection structures has advanced the bluff toe lakeward.

Map 3.9 shows long term bluff crest recession distances in the County. About 27 percent of the bluff crest in Milwaukee County has experienced at least some recession through 2015, with 7 percent experiencing at least 20 feet of retreat, and 4.5 percent experiencing more than 60 feet of recession. The largest bluff crest recession distances have occurred in the City of Milwaukee, St. Francis, Whitefish Bay, and Oak Creek. About 73 percent of the bluff crest in the County have had no recession or has experienced accretion, possibly due to fill added to the bluff in a slope stabilization project.

Table 3.21
Shore Protection in Milwaukee County: 2018

Type of Shore Protection	Percent of County Shoreline
Public Marina	9.1
Private Marina	0.3
Seawall/Bulkhead	8.8
Revetment	36.7
Poorly Organized Rip-Rap/Rubble	2.8
Commercial/Industrial Dock	5.0
Offshore Breakwater	1.4
No Protection	35.9
Total	100.0

Source: Wisconsin Shoreline Inventory and Oblique Photo Viewer

Short-Term Bluff Toe and Crest Recession

As shown in Map 3.10, about 31 percent of the bluff toe in Milwaukee County has experienced at least some recession in the 27-year short term period from 1995 to 2015, with most of that percentage experiencing 0 to 10 feet of bluff toe retreat. A few reaches in Oak Creek, South Milwaukee, City of Milwaukee, and Bayside have experienced bluff toe recession distances greater than 20 feet. It is estimated that 12 percent of bluff toe in the County has not seen any recession and 56 percent has experienced accretion. Again, it should be noted that bluff toe accretion may represent areas where material has slumped from the bluff crest above. Map 3.11 shows short term bluff crest recession distances in Milwaukee County. Only about 4 percent of bluff crest data collected in the County has shown at least some recession in the 27-year short term period. Of those 4 percent, 2.6 percent has seen retreat of the bluff crest of more than 20 feet. Bluff crest recession distances greater than 20 feet have occurred in St. Francis and Oak Creek. Conversely, 96 percent of the bluff crest in Milwaukee County has either experienced no recession or accretion during this short-term period.

Because shoreline and beach erosion and bluff instability occur along the County's Lake Michigan coastline, hazard mitigation planning on coastal and bluff conditions should be considered important for the protection, sound development, and redevelopment on the lands located along the Lake Michigan shoreline.

Coastal Flooding

Coastal communities face flood risks from a combination of increased water levels and/or high-energy waves. Coastal flooding tends to be the most serious in the low-lying areas.[91] The risk of coastal flooding is reduced when lake levels are low, however other factors such as storm-induced winds and wave run-up can cause or exacerbate coastal flooding. Likewise, when lake levels are high, storm surge, wave height, and wave run-up also influence the severity of coastal flooding. Communities positioned on low terraces, including portions of the City of Milwaukee and Villages of Bayside and Fox Point are at a medium risk of flooding, whereas communities in the County located on high bluff areas are not vulnerable to coastal flooding.[92]

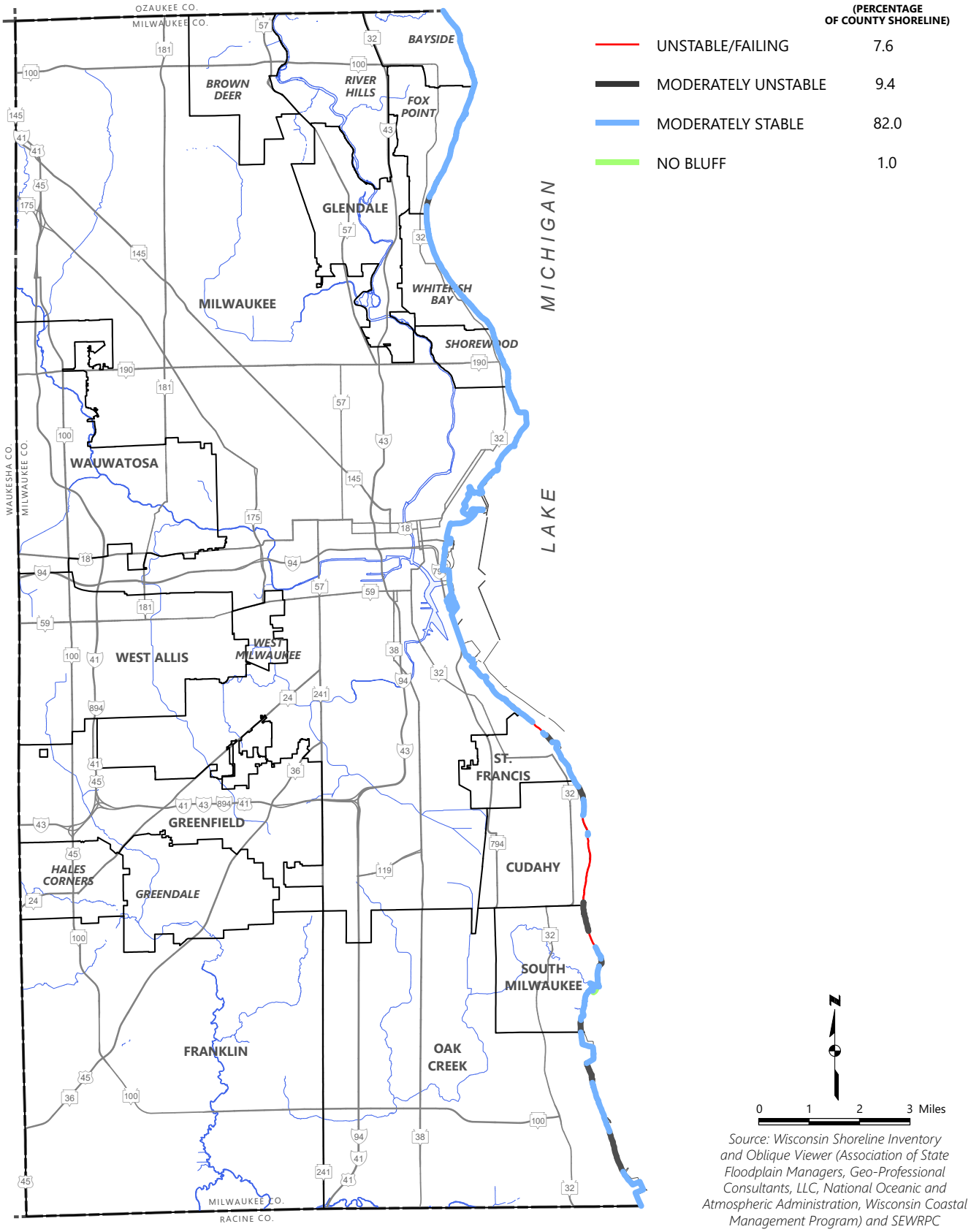
As indicated in Table 3.7, there have been two recent reported lakeshore flood events along the Milwaukee County shoreline, including the January 11, 2020, event, which was reported with an estimated $12 million (2022 dollars) in property damage. Details of this event are described under the "Recent Events" subsection. Because there are low-lying terraces along the Milwaukee County coastline and coastal flooding has occurred, coastal flooding is an important element in hazard mitigation planning.[93]

[91] *Wisconsin Emergency Management,* Hazard Mitigation Plan*, December 2016,* op. cit.

[92] Ibid.

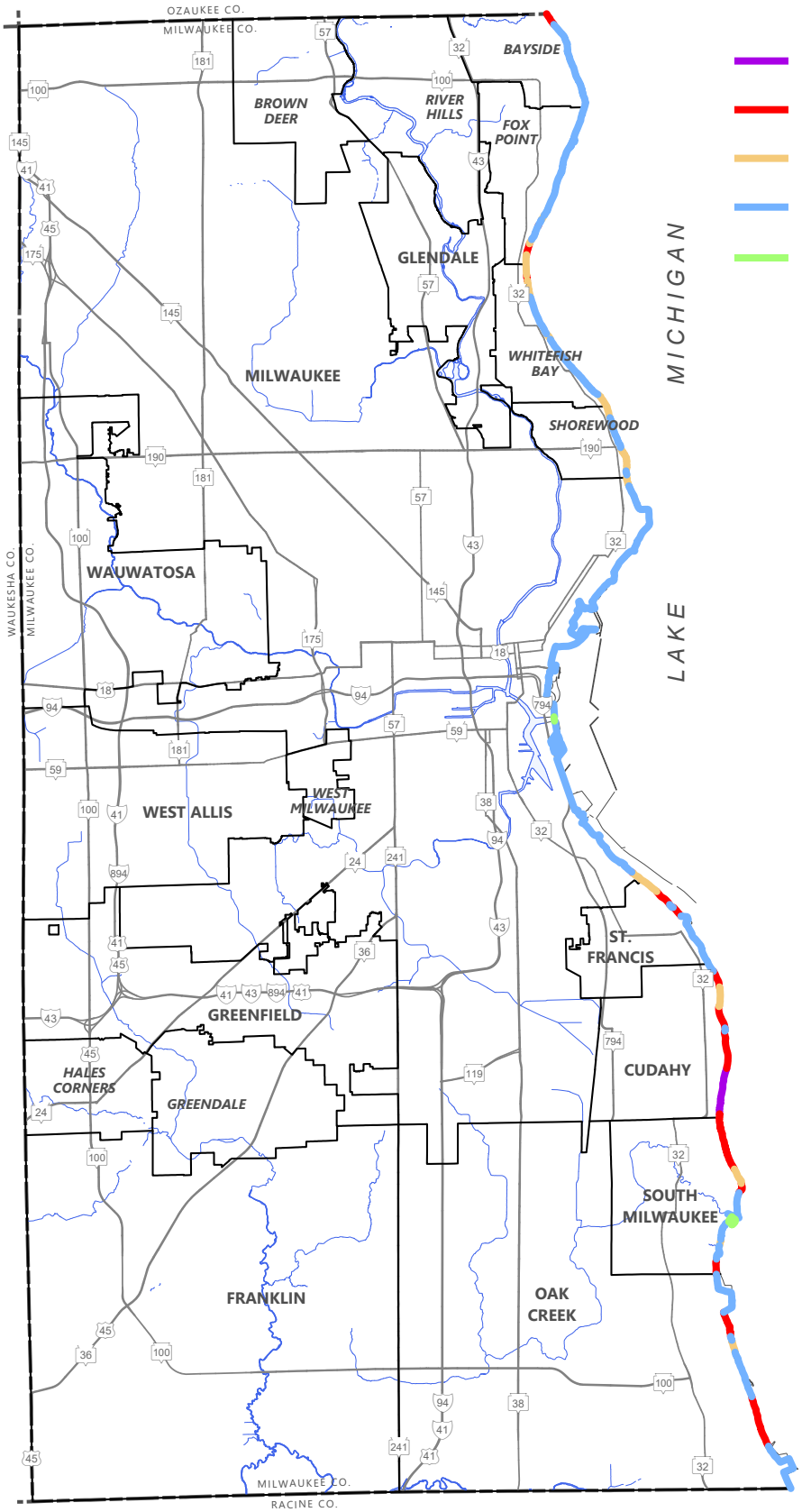
[93] *Wisconsin Emergency Management,* Hazard Mitigation Plan*, 2021*

Map 3.6
General Bluff Conditions in Milwaukee County: 2018



Source: Wisconsin Shoreline Inventory and Oblique Viewer (Association of State Floodplain Managers, Geo-Professional Consultants, LLC, National Oceanic and Atmospheric Administration, Wisconsin Coastal Management Program) and SEWRPC

Map 3.7
Types of Bluff Failure in Milwaukee County: 2018-2019



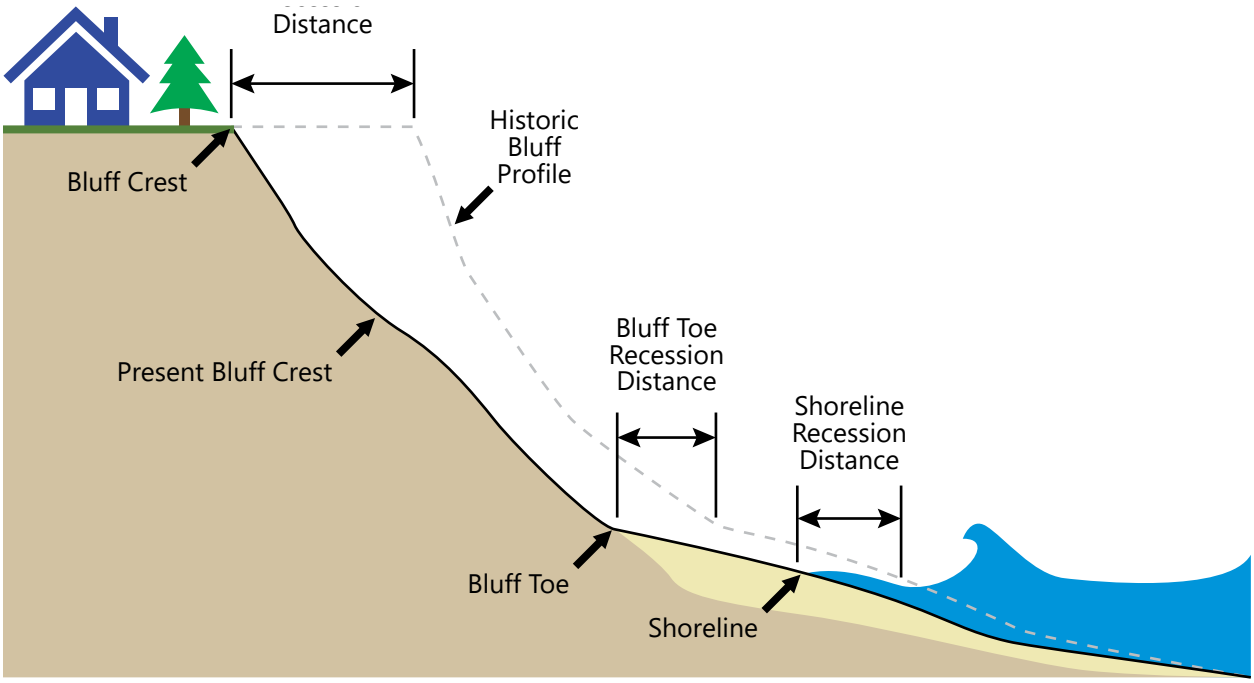
	(PERCENTAGE OF COUNTY SHORELINE)
DEEP SEATED SLUMP	2.4
SHALLOW SLIDES	15.6
CREEP	10.5
NO OBVIOUS FAILURES	69.8
NO BLUFF	1.7

N

0 1 2 3 Miles

Source: Wisconsin Shoreline Inventory and Oblique Viewer (Association of State Floodplain Managers, Geo-Professional Consultants, LLC, National Oceanic and Atmospheric Administration, Wisconsin Coastal Management Program) and SEWRPC

Figure 3.9
Bluff Recession Schematic



Source: Wisconsin Coastal Management Program and SEWRPC

Potential Flood Damage for Coastal Areas

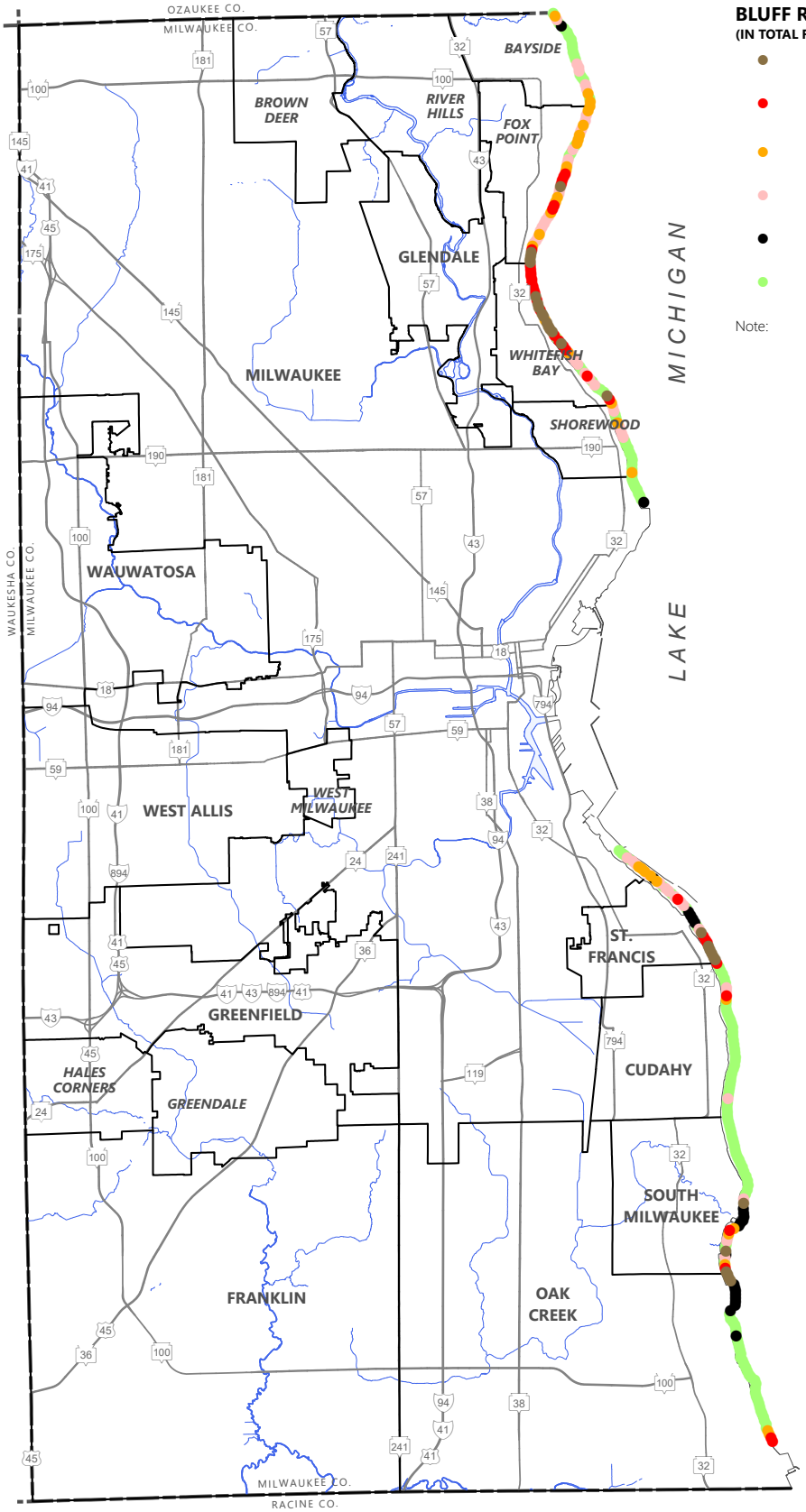
Based on the Commission's parcel-based analysis, as described earlier in this Chapter, an estimated 15 structures (mainly residential in the Village of Fox Point) were identified within Lake Michigan's 1-percent annual probability floodplain (special flood hazard area), including a large parcel in the Port of Milwaukee. The assessed value of these structures in 2022 was estimated at about $9.9 million and more than $12.4 million when the value of contents is considered. The location of the parcels with structures within the flood hazard areas are shown on Map 3.12 (and also included in Map 3.2). Because of their proximity to the Lake and low lying position, these identified structures are vulnerable to coastal flooding and its associated hazards such as storm-induced winds or wave run-up. It is estimated that for the 1-percent-annual probability flood event, these structures would sustain about $325,000 in damages.

The Great Lakes Coastal Flood Study (GLCFS)—an on-going collaboration between FEMA and the U.S. Army Corps of Engineers (USACE)—have produced preliminary FEMA maps for coastal flood velocity zones (V Zones) for the Great Lakes. The current FEMA maps include flood Zones A or AE along the Milwaukee County coast, including Milwaukee County. Zones A and AE are typically inland (i.e., lakes and rivers) flood zones that do not account for wave action greater than 3 feet or storm surge. Zones V and VE represent the area along the coast that is subject to inundation by the one-percent-annual-probability flood with additional hazards associated to wave run-up greater than 3 feet above the base flood elevation (BFE). Note, Zones AE and VE have detailed hydraulic studies to determine the BFE (i.e., elevation data), while Zones A and V do not and are approximate flood Zones. Digital Flood Insurance Rate Maps (DFIRMs) showing the new coastal V and VE Zones for the Great Lakes should move from preliminary to effective within the life span of this plan.

Recent Coastal Hazard Events

2019 – Water levels in the Great Lakes rose significantly in 2019, as water levels approached the lake's highest measured level, sections of bluffs along Milwaukee County's coastline collapsed. Bluff sloughs in Sheridan and Warnimont Parks carried away several trees and infrastructure in the County-owned parks near the new bluff edge. These properties and others along Milwaukee County's lakefront are becoming

Map 3.8
Long Term Bluff Toe Recession in Milwaukee County: 1956-2015



BLUFF RECESSION

(IN TOTAL FEET)	(PERCENT OF DATA)
GREATER THAN 60 (Greater than 1 Ft/Year)	8.9
40 TO 60 (0.7 to 1 Ft/Year)	10.8
20 TO 40 (0.3 to 0.7 Ft/Year)	10.2
0 TO 20 (0 to 0.3 Ft/Year)	17.2
NO RECESSION	7.4
ACCRETION	45.5

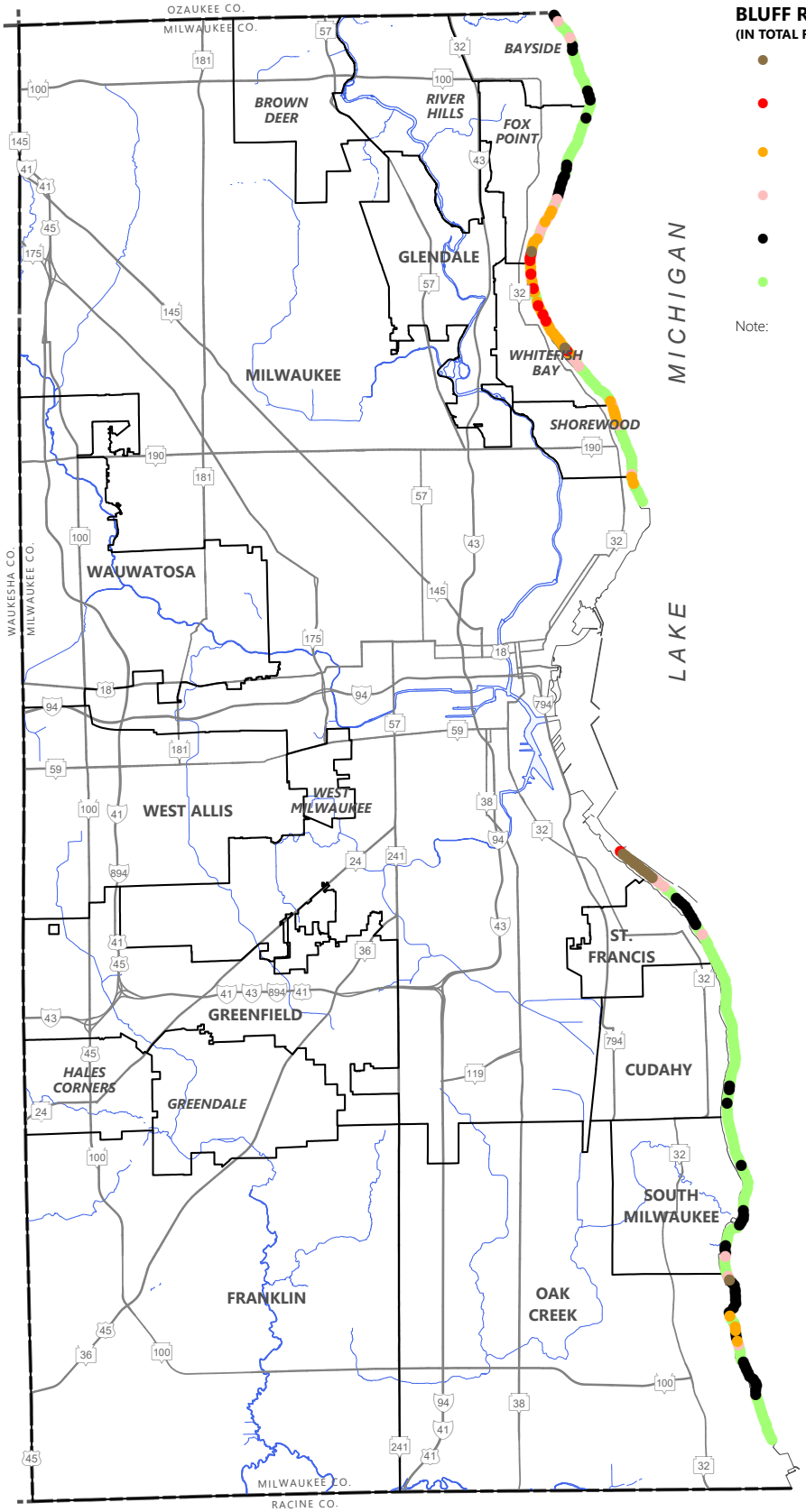
Note: Areas with no data points indicate locations where no nearshore bluff is present.

N

0 1 2 3 Miles

Source: Wisconsin Shoreline Inventory and Oblique Viewer (Association of State Floodplain Managers, Geo-Professional Consultants, LLC, National Oceanic and Atmospheric Administration, Wisconsin Coastal Management Program) and SEWRPC

Map 3.9
Long Term Bluff Crest Recession in Milwaukee County: 1956-2015



BLUFF RECESSION

(IN TOTAL FEET)	(PERCENT OF DATA)
GREATER THAN 60 (Greater than 1 Ft/Year)	4.5
40 TO 60 (0.7 to 1 Ft/Year)	3.2
20 TO 40 (0.3 to 0.7 Ft/Year)	11.5
0 TO 20 (0 to 0.3 Ft/Year)	7.4
NO RECESSION	18.9
ACCRETION	54.5

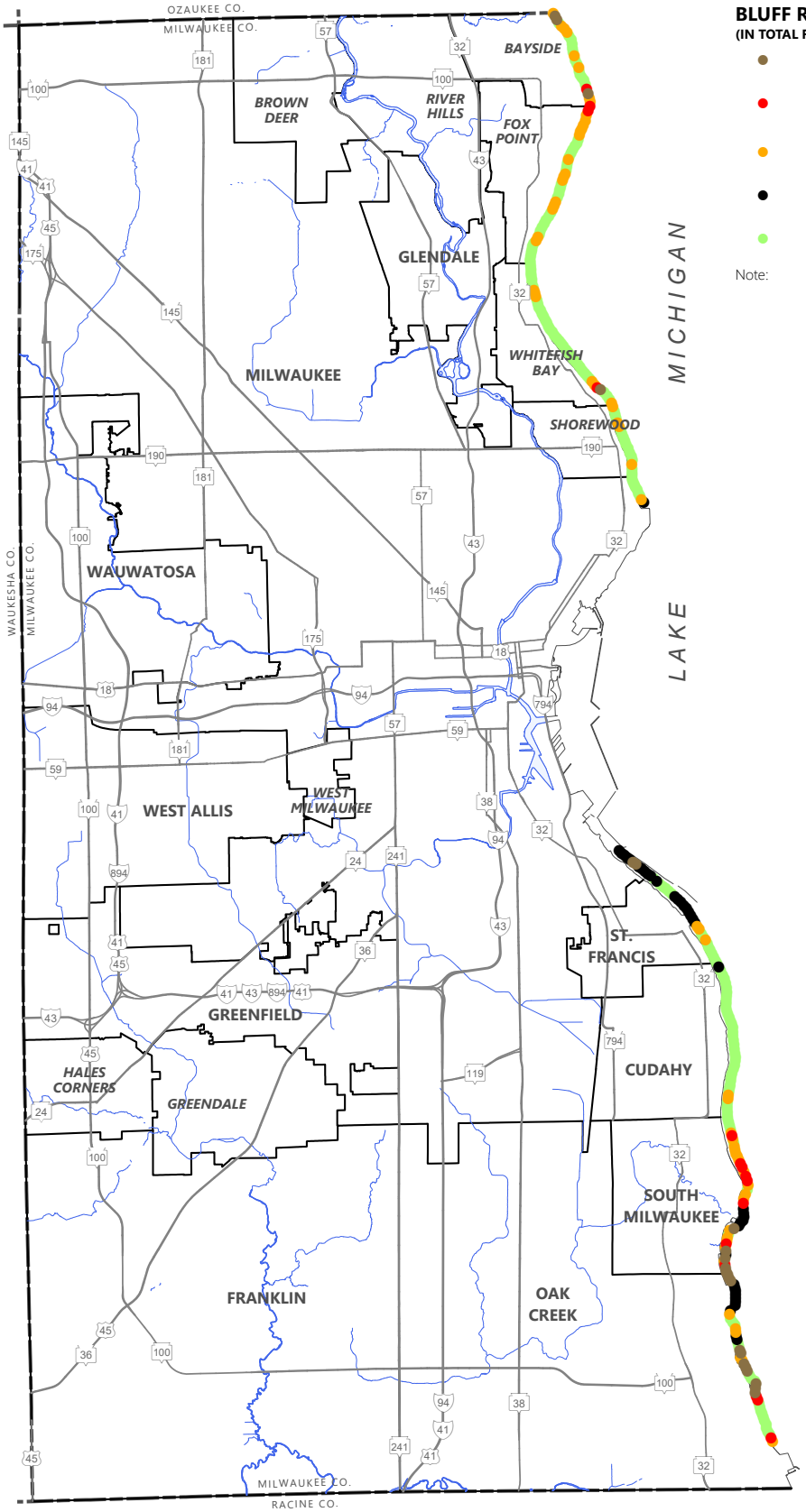
Note: Areas with no data points indicate locations where no nearshore bluff is present.

N

0 1 2 3 Miles

Source: Wisconsin Shoreline Inventory and Oblique Viewer (Association of State Floodplain Managers, Geo-Professional Consultants, LLC, National Oceanic and Atmospheric Administration, Wisconsin Coastal Management Program) and SEWRPC

Map 3.10
Short Term Bluff Toe Recession in Milwaukee County: 1995-2015



BLUFF RECESSION

(IN TOTAL FEET)	(PERCENT OF DATA)
GREATER THAN 20 (Greater than 1 Ft/Year)	7.0
10 TO 20 (0.5 to 1 Ft/Year)	4.8
0 TO 10 (0 to 0.5 Ft/Year)	19.4
NO RECESSION	12.4
ACCRETION	56.4

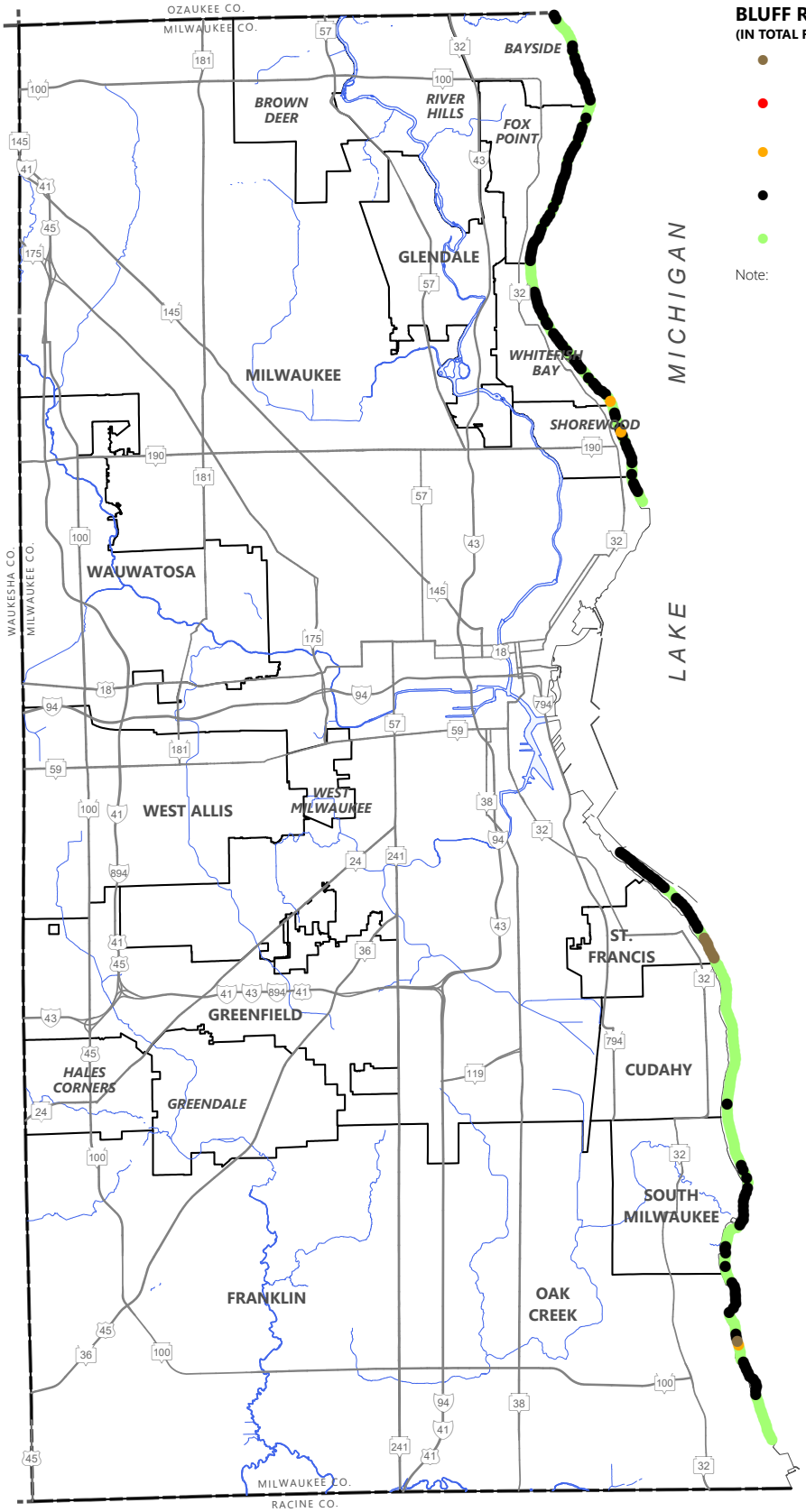
Note: Areas with no data points indicate locations where no nearshore bluff is present.

N

0 1 2 3 Miles

Source: Wisconsin Shoreline Inventory and Oblique Viewer (Association of State Floodplain Managers, Geo-Professional Consultants, LLC, National Oceanic and Atmospheric Administration, Wisconsin Coastal Management Program) and SEWRPC

Map 3.11
Short Term Bluff Crest Recession in Milwaukee County: 1995-2015



BLUFF RECESSION

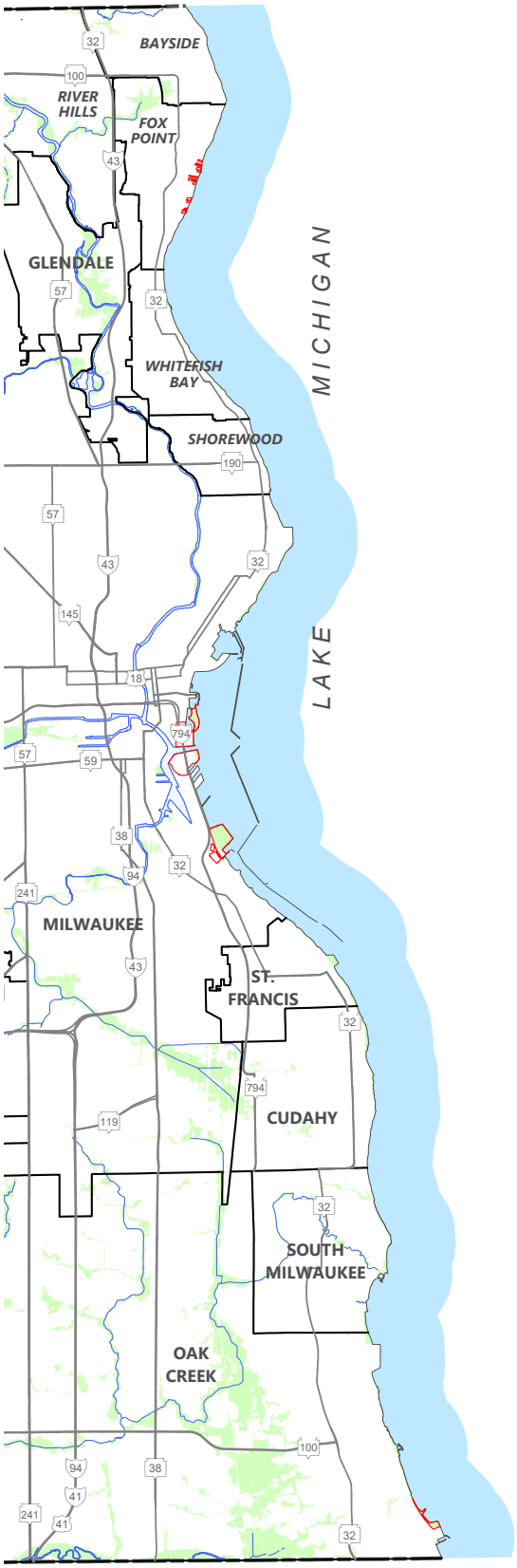
(IN TOTAL FEET)	(PERCENT OF DATA)
GREATER THAN 20 (Greater than 1 Ft/Year)	2.6
10 TO 20 (0.5 to 1 Ft/Year)	0.0
0 TO 10 (0 to 0.5 Ft/Year)	1.0
NO RECESSION	50.6
ACCRETION	45.8

Note: Areas with no data points indicate locations where no nearshore bluff is present.

0 1 2 3 Miles

Source: Wisconsin Shoreline Inventory and Oblique Viewer (Association of State Floodplain Managers, Geo-Professional Consultants, LLC, National Oceanic and Atmospheric Administration, Wisconsin Coastal Management Program) and SEWRPC

Map 3.12
Location of Structures Along the Lake Michigan Coast that are Within the 1-Percent-Annual-Probability Flood Hazard Area: 2023



PARCELS WITH STRUCTURES IN THE FLOOD HAZARD AREA

ONE-PERCENT-ANNUAL-PROBABILITY (100-YEAR RECURRENCE INTERVAL) FLOODPLAINS

N

0 1 2 3 Miles

Source: Federal Emergency Management Administration, Wisconsin Department of Natural Resources, and SEWRPC

increasingly vulnerable to coastline impacts. As indicated by the aforementioned studies and reports,[94] lakefront property may be best protected from future coastline impacts through the implementation of coastline management guidelines based upon best practices.

2020 – On January 11, 2020, strong onshore winds combined with near record high Lake Michigan water levels to produce severe lakeshore flooding and erosion at the Port of Milwaukee. Maximum wave heights were estimated to be between 10 to 18 feet. Flood waters due to high waves estimated to be 6 to 8 feet high caused flooding to spread across the Port of Milwaukee, causing the Port and Car Ferry to close for two days (see Figure 3.10). About 60 to 70 percent of Jones Island, where the Port of Milwaukee is located, was flooded. The floodwater stripped dock wall material and covered railroad tracks with a foot of ice. Flood erosion damage took place at other locations along the Milwaukee County shore, including South Shore Yacht Club and the Oak Leaf walking trail along South Shore Drive. Damage also occurred at the Riverfront boat launch, Veterans Park, McKinley Marina gas dock, Warnimont Golf Course, North Point Lighthouse, and portions of bluff collapse at Bay View Park and Lake Park. Damage as a result of this event was estimated at $12 million (2022 dollars).

It should be noted that numerous improvements were made to the City of Milwaukee lakefront as part of the creation of Lakeshore State Park and integration with Pier Wisconsin, Discovery World, and the Quadracci Pavilion, in addition to the Milwaukee Art Museum. The first phase of planned improvements was completed in 2007 for the 17-acre park at a cost of $17 million. Detailed coastal analyses were completed with physical models to assess water levels, wave conditions, design storm events, and water circulation. Improvements to the lakefront included reconstruction of the eastern shore of Lakeshore State Park and two new breakwalls. One 180 linear foot breakwater protects the Quadracci Pavilion addition from wave runup, and a 1,200 linear foot breakwater minimizes wave heights in a maritime basin just north of the State Park.[95]

Vulnerability and Community Impact Assessment Related to Lake Michigan Coastal Hazards

Wisconsin Emergency Management (WEM) Coastal Erosion Risk and Vulnerability Assessment

In 2021, Wisconsin Emergency Management (WEM) conducted a county-level coastal erosion risk and vulnerability assessment for the State as part of the Threat and Hazard Identification and Risk Assessment (THIRA). WEM used the statewide parcel inventory (Wisconsin Statewide Parcel Database) as the basis for estimating the existing potential losses from Lake Michigan coastal erosion. Each parcel contained information such as total parcel value, improvement value, and property class. A GIS buffer analysis was conducted to identify parcels within one-quarter and one-half mile of the Lake Michigan coastline. Parcels within one-quarter of a mile from the coast were considered to be in a High-Risk Erosion Zone, while parcels within one-half mile were considered to be in a Low-Risk Erosion Zone. As a result, a total of 23,869 parcels in Milwaukee County were determined to be within the coastal risk erosion zones (see Table 3.22). Of those 23,869 total identified parcels, 22,950 were classified as residential, 902 as commercial, and 17 as manufacturing. The low-risk zone has an estimated value of improvements of $7.2 billion, while the high-risk zone has a value of improvements of about $3.3 billion, for a combined total value of improvements around $10.5 billion. It should be noted that the high and low risk coastal zones are solely based on distance from the Lake Michigan shoreline. Location above a bluff as well as steps already taken, such as shoreline protection structures, likely have reduced the coastal hazard risk to many of these structures.

Milwaukee County Coastal Resources Inventory Report, 2020

As noted in Chapter 2, Milwaukee County recently completed a comprehensive study identifying its coastal resources, including facilities, assets, and infrastructure, to assess their vulnerability to extreme weather. Shoreline protection structures and erosion control measures intended to reduce coastal erosion, are among the County's assets inventoried in the study including breakwaters, bulkheads, groins, and revetments (or riprap). It was found that Grant and Warnimont Parks have the least structural shoreline protection. However, while numerous groins adorn the Sheridan Park shoreline, Sheridan and Warnimont Parks suffered extensive damage in 2019. This contrast can be attributed, at least in part, to the potential for shore protection

[94] *Including Community Assistance Planning Report (CAPR) No. 155,* A Lake Michigan Shoreline Erosion Management Plan for Northern Milwaukee County, Wisconsin, *1988; CAPR No. 163,* A Lake Michigan Shoreline Erosion Management Plan for Milwaukee County, Wisconsin, *1989*; *and Memorandum Report No. 156,* Lake Park Bluff Stability and Plant Community Assessment: 2003, Milwaukee County, Wisconsin*, 2004.*

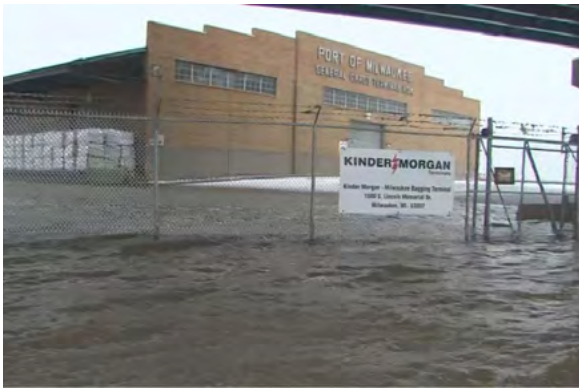
[95] *Fred Klancnik and William Brose,* "Lakefront Renaissance," Civil Engineering—ASCE, *Volume 80, July 2010.*

structures to adversely affect nearby coastline areas or to otherwise fail during extreme weather events or high lake levels.

Overall, the study found that approximately 13 percent of County assets were in poor condition and 22 percent were deemed highly vulnerable to further damage. The assets with the highest risk were the beaches, groins, and parking lots. The infiltration basins, revetment, and parking lots by McKinley Marina all appeared at the top for risk. The total asset valuation for Milwaukee County coastal assets was almost $3 billion, with approximately 50 percent of the value due to bluff stabilization.[96]

After review of Milwaukee County community and County-owned coastal assets, there is indication for potential coastal hazards to impact 1) flood prone residential, commercial, and other developed land uses, including the Port of Milwaukee's multi-modal transportation and distribution center, 3) roadway systems near the shoreline; 4) utilities and stormwater infrastructure located along the lakeshore, 5) County-owned recreational lands and facilities along the shorelines, and 6) shoreline protection structures deemed to be in fair or poor condition.

Figure 3.10
January 12, 2020 Lake Michigan Lakeshore Flooding: Port of Milwaukee



Source: storymaps.arcgis.com/stories (top)
Michael Sears via www.jsonline.com (bottom)

Future Changes and Conditions

Changes in land use can have an impact on the potential for coastal erosion hazards to occur. Such changes relate to the potential future increase in development within the erosion hazard areas, particularly when not accompanied by proper shore protection measures. Enforcement of the current zoning procedures that are in place in the coastal communities of Milwaukee County call for the use of shoreline protection, bluff stabilization structural measures, and bluff setbacks for new development along portions of the Lake Michigan shoreline where urban shoreline development exists, or is envisioned, and for areas of limited development where no structural protection measures are envisioned (Chapter 5 will detail current Milwaukee County shoreline communities' coastal ordinances).

As discussed in the sections above, Lake Michigan is about 13 inches above the long-term average water level as of November 2021, causing some residents to experience significant erosion and bluff recession issues. In addition, climate change may lead to more drastic fluctuations in Lake Michigan water levels. Over the five-year period covered by this plan update, Lake Michigan water levels are expected to continue to fluctuate. Potential future fluctuations in Lake Michigan water levels could lead to continued bluff failures, particularly in areas that have no shoreline protection, where shoreline protection structures are not maintained adequately, or where shoreline protection structures are not built to sufficient specifications to protect against fluctuating water levels. Mitigation measures to protect areas along the Lake Michigan coast are described further in Chapter 5.

Changes over the 20th century and projections based on downscaled results from climate models indicate that there will likely be changes affecting coastal conditions over the 21st century. Coastal areas have experienced, and are projected to experience, increases in air temperatures, increases in precipitation, especially during fall, winter, and spring months, and increases in the frequency of heavy precipitation events. Wind strengths have increased over the Great Lakes and are expected to continue increasing into the future. In addition, wind patterns over Lake Michigan have altered. Prevailing winds during summer months have shifted from predominantly coming from the southwest during the 1980s to coming from the east after

[96] *Milwaukee County, Environmental Services Unit, Milwaukee County Coastal Resources Inventory, October 7, 2020*

Table 3.22
Parcels Within the Low- and High-Risk Coastal Erosion Zones Along the Milwaukee County Coast: 2021

	Improved Parcels in Erosion Risk Zone				Value of Improvements ($)[a]			
Milwaukee County	Residential	Commercial	Manufacturing	Total	Residential	Commercial	Manufacturing	Total
Low-Risk Zone (within 0.5 miles)	16,633	764	15	17,412	5,542,023,107	1,661,681,300	10,981,800	7,214,686,207
High-Risk Zone (within 0.25 miles)	6,317	138	2	6,457	2,538,426,743	788,641,000	2,171,000	3,329,238,743
Total	22,950	902	17	23,869	8,080,449,850	2,450,322,300	13,152,800	10,543,924,950

[a] *2021 dollars.*

Source: Wisconsin Land Information Program and Wisconsin Emergency Management

1990. These climatic changes are expected to influence lake levels, coastal erosion, flooding, and shoreline stability, sometimes in complex ways. According to the NOAA Office for Coastal Management in 2015, "recent climate studies, along with the large spread in existing modeling results, indicate that projections of Great Lakes water levels represent evolving research and are still subject to considerable uncertainty."

For example, Lake Michigan is likely to be impacted by trends that act both to increase and to decrease water levels. Increased precipitation will increase water contributions to the Lake. At the same time, increases in temperatures will lead to increases in evaporation of water from the Lake. The projected temperature increase will also result in reduced ice cover over the winter. This affects evaporation because ice cover on the Lake acts as a cap, reducing evaporation by preventing water vapor from escaping into the air. As a result of both of these processes, evaporation from the Lake is projected to increase. It should be noted that water levels in the Lake vary widely around their average, with high-water and low-water decades occurring. This variability is expected to continue.

While the hazard impacts associated with water level variations should be similar in type to those impacts currently resulting from water level variations, there may be some increase in the magnitude of these impacts. While low water levels may allow beaches and beach ridges to build and beach-anchoring vegetation to move toward the Lake, they may also adversely impact shipping, power generation, and tourism. It should be noted that long periods of low water levels may lead to erosion of the lakebed, which may allow storm-generated waves to reach farther inland when water levels rise. While high water levels may benefit communities, businesses, and industries that depend upon Great Lakes waters for commercial shipping, hydropower, recreational boating, and tourism, higher water levels with increased storm frequency and intensity could increase shoreline and bank erosion. This could increase damages to lakefront property and reduce the area of beaches.

Several other elements of climate change may also act to intensify shoreline erosional processes. Increases in wind strength over the Lake and changes in prevailing wind direction would be likely to lead to greater offshore wave development. This would produce higher waves along the coast. Changes in several elements of climate may affect the stability of bluffs along the lakeshore. The amount of water contained in bluff soils is an important factor determining their stability. Friction between soil particles hold them in place. As water fills the spaces between these particles the friction between soil particles decreases, causing the soil to become more fluid and less stable. Higher lake levels and increases in 1) precipitation, 2) the frequency of heavy storms, and 3) the number of freeze-thaw cycles may all contribute to shoreline bluffs becoming less stable and more susceptible to slumping. Prolonged dry periods and droughts may also contribute to reduced stability of coastal bluffs. As bluff soils dry out, cracks in the soil can form, weakening the surface soil. During long-term droughts, these cracks can develop into deep fractures. Such fractures can allow surface water to penetrate deep into bluff soils. If heavy rainfall events occur following a drought, they may cause rapid saturation of dry, fractured bluff soils which could cause a major bluff slope failure.

Multi-Jurisdictional Risk Management

Shoreline erosion, bluff failure, and coastal flooding, when combined, present a moderate risk in Milwaukee County. Similarly, the Milwaukee County Pre-Disaster Mitigation Plan identified that several coastal communities are at risk from coastal erosion, but coastal erosion was not considered a primary concern relative to the potential damages to population and infrastructure within Milwaukee County.[97] As discussed above, coastal hazard risks are present in all nine local units of government in Milwaukee County along Lake Michigan. Those coastal risk communities include the Cities of Cudahy, Milwaukee, Oak Creek, South Milwaukee, and St. Francis and the Villages of Bayside, Fox Point, Shorewood, and Whitefish Bay.

[97] *Milwaukee County Office of Emergency Management,* Milwaukee County Hazard Mitigation Plan, *2016*

HAZARD MITIGATION GOALS 4

Planning is a rational process for formulating and meeting goals and objectives. Consequently, formulating goals and objectives is an essential task that must be undertaken before plans can be prepared. This chapter sets forth hazard mitigation goals and objectives when considering alternative hazard mitigation strategies for Milwaukee County and in selecting recommended strategies from among those alternatives. The Federal Emergency Management Agency (FEMA) defines goals and objectives as follows. Goals are general guidelines that explain what a community desires to achieve. Based on the selected goals, a community can develop specific objectives (or standards) needed to attain those goals.

4.1 RELATIONSHIP OF HAZARD MITIGATION GOALS AND OBJECTIVES TO OTHER RELEVANT PLANNING EFFORTS

The updated goals and objectives for this Milwaukee County hazard mitigation plan were built upon a combination of pertinent and relevant planning resources, including LPT input, the previous County and City of Milwaukee hazard mitigation plans [98] as well as local,[99] County, and Regional planning efforts. Also, watershed and Lake Michigan coastline plans and programs, as highlighted below, were essential in developing the updated goals and objectives included in this plan.

Regional and County Planning Efforts

- Southeastern Wisconsin Regional Planning Commission (Commission or SEWRPC) Planning Report No. 42, *Regional Natural Areas Plan*, September 1997 (amended 2010)
- SEWRPC Planning Report No. 55, *VISION 2050: A Regional Land Use and Transportation Plan for Southeastern Wisconsin*, June 2020
- SEWRPC Community Assistance Planning Report No. 312 (2nd Edition), *A Land and Water Resource Management Plan for Milwaukee County: 2022-2031*, December 2021
- SEWRPC Community Assistance Planning Report No. 132 (2nd Edition), *A Long- Range Park and Open Space Plan for Milwaukee County*, February 2022

[98] *Milwaukee County Office of Emergency Management,* Milwaukee County Hazard Mitigation Plan, *October 19, 2017; SEWRPC Community Assistance Planning Report No. 282,* City of Milwaukee All Hazards Mitigation Plan Update, *November 2019.*

[99] Each of Milwaukee County's nineteen jurisdictions, including the City of Milwaukee's 14 neighborhoods, have prepared and adopted independent comprehensive (or "smart growth") plans: *SEWRPC Community Assistance Planning Report No. 339,* A Comprehensive Plan Update for the City of Cudahy: 2050 (2nd Edition), *August 2021; PDI/GRAEF, R.A. Smith National, and Cedarburg Science,* City of Franklin 2025 Comprehensive Master Plan, *October 2009; Vandewalle & Associates, Inc.,* Glendale Comprehensive Plan: 2040, *August 2020; Vandewalle & Associates, Inc.,* City of Greenfield Comprehensive Plan, *December 2020; Conservation Design Forum,* City of Milwaukee Citywide Policy Plan, *March 2010, amended September, 2021; Houseal Lavigne Associates,* Comprehensive Plan City of Oak Creek, *March, 2020; Catalus, LLC.,* City of St. Francis 2016 Comprehensive Plan Update, *February 2016; Graef,* City of South Milwaukee 2035 Comprehensive Plan 2016, *amended in 2023; Vandewalle & Associates, Inc.,* City of Wauwatosa Comprehensive Plan: 2008-2030, *December 2008; Ayers Associates and GRAEF,* 2045 Comprehensive Plan: City of West Allis, *March 2024; Vandewalle & Associates, Inc.,* Village of Bayside Comprehensive Plan 2042, *April 2022; URS Consulting,* The Village of Brown Deer Comprehensive Plan Update 2023, *November 2009; Vierbicher,* Village of Fox Point Comprehensive Plan, *June 2021; PDI/GRAEF,* Village of Greendale Comprehensive Plan Update: 2020-2045, *November 2019; GRAEF,* Village of Hales Corner Comprehensive Plan Update 2050, *October 2021; Crispell-Snyder, Inc.,* Village of River Hills Comprehensive Plan Update 2019, *October 2019; Vandewalle & Associates, Inc.,* Shorewood Comprehensive Plan 2040, *April 2021; Vandewalle & Associates, Inc.,* Village of West Milwaukee – 2040 Comprehensive Plan Update, *December 2019; GRAEF,* The Village of Whitefish Bay Comprehensive Plan Update, *November 2019.*

Commission Comprehensive Watershed Plans

Beginning in the mid-1960s, the Commission developed comprehensive watershed plans for the Kinnickinnic River watershed, the Menomonee River watershed, the Milwaukee River watershed, the Oak Creek watershed, and the Root River watershed, all of which are within Milwaukee County. These plans included an evaluation of alternatives and recommended flood mitigation plans on a comprehensive watershed-wide basis. Most of the flood control recommendations in these plans are obsolete, but their goals and objectives are still valid today. These plans also formed the basis for later work as discussed below.

Kinnickinnic River Watershed

- SEWRPC Planning Report No. 32, *A Comprehensive Plan for the Kinnickinnic River Watershed*, December 1978

Menomonee River Watershed

- SEWRPC Planning Report No. 26, *A Comprehensive Plan for the Menomonee River Watershed*, Volume 1, Inventory Findings and Forecast, October 1976, and Volume 2, Alternative Plans and Recommended Plan, October 1976

Milwaukee River Watershed

- SEWRPC Planning Report No. 13, *A Comprehensive Plan for the Milwaukee River Watershed*, Volume One, Inventory Findings and Forecasts, December 1970, and Volume Two, Alternative Plans and Recommended Plan, October 1971

- SEWRPC Planning Report No. 37, *A Water Resources Management Plan for the Milwaukee Harbor Estuary*, Volume One, Inventory Findings, March 1987, and Volume Two, Alternative and Recommended Plans, December 1987

- SEWRPC Community Assistance Planning Report No. 261, *Flood Mitigation Plan for the City of Milwaukee, Milwaukee County, Wisconsin*, October 2000

MMSD Comprehensive Stormwater Drainage and Flood Control System Plan

Subsequently, in 1986 and again in 1990, at the request of MMSD, the Commission developed a Comprehensive Stormwater Drainage and Flood Control System Plan[100] which is built upon the findings in the comprehensive watershed system plans (listed above) within Milwaukee County. The Plan consists of two parts: a policy plan and a stormwater drainage and flood control system plan. Additionally, it discusses the District's stormwater management and flood control responsibilities, including the types, general locations, and horizontal and vertical alignments of needed drainage and flood control facilities within MMSD's jurisdiction.

MMSD Watercourse System Planning Program

Over the course of these planning efforts, MMSD's philosophy of flood "control" shifted to floodplain "management." As such, in 1996 MMSD began its environmentally responsible systemwide Watershed Planning Program. The program goals were to reduce current flood risk while putting policies and programs in place to mitigate future problems at the watershed level. Listed below are the watershed planning reports developed as part of this program.

Kinnickinnic River Watershed

- Milwaukee Metropolitan Sewerage District, *Kinnickinnic River Phase 1: Watercourse System Management Plan*, August 2000

- Milwaukee Metropolitan Sewerage District, *Kinnickinnic River Phase 2: Watercourse Management Plan*, May 2005

- Milwaukee Metropolitan Sewerage District, *Kinnickinnic River Watershed Flood Management Plan: Final Report*, May 4, 2017

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[100] *SEWRPC Community Assistance Planning Report No. 130,* A Stormwater Drainage and Flood Control Policy Plan for the Milwaukee Metropolitan Sewerage District, *March 1986; SEWRPC Community Assistance Planning Report No. 152,* A Stormwater Drainage and Flood Control System Plan for the Milwaukee Metropolitan Sewerage District, *December 1990*

Menomonee River Watershed

- Milwaukee Metropolitan Sewerage District, *Menomonee River Phase 1: Watercourse Management Plan*, August 2000

- Milwaukee Metropolitan Sewerage District, *Menomonee River Phase 2: Watercourse Management Plan*, July 2002

Milwaukee River Watershed

- Milwaukee Metropolitan Sewerage District, *Milwaukee River Watershed Phase 1: Watercourse System Management Plan*, August 2000

- SEWRPC Memorandum Report No. 172, *A Watercourse System Plan for the Milwaukee River in Milwaukee County Upstream of the Milwaukee Harbor Estuary*, December 2010

Oak Creek Watershed

- Milwaukee Metropolitan Sewerage District, *Oak Creek Phase 1: Watercourse Management Plan*, August 2000

- SEWRPC Memorandum Report No. 198, *Oak Creek Updated Phase 1: Watercourse Management Plan*, December 2011, Revised May 2019

Root River Watershed

- Milwaukee Metropolitan Sewerage District, *Root River Phase 1: Watercourse Management Plan*, August 2000

Lake Michigan Direct Drainage Area

- Milwaukee Metropolitan Sewerage District, *Lake Michigan Direct Drainage Area Phase 1: Watercourse System Management Plan*, August 2000

The overall goal of the MMSD Watershed Planning Program is to develop environmentally responsible, cost-effective flood management recommendations based upon the following fundamental objectives:

- Utilize and develop watercourse models that are consistent with SEWRPC methodology and anticipate future planning efforts

- Identify problems and design solutions for the FEMA regulatory event (1-percent-annual-probability)

- Utilize a watershed-based approach

- Utilize future land use conditions to identify problems and develop solutions

- Focus on environmentally sensitive and aesthetically acceptable engineering solutions

- Integrate local stormwater runoff control features

- Incorporate current regulatory requirements

- Identify costs and benefits of solutions

- Identify and resolve policy issues critical to the implementation of the watercourse plan

- Obtain community input to develop acceptable solutions

Other Watershed Planning Efforts

Other watershed planning efforts in the County have been completed over time and are listed below. These provide additional insights into goals and objectives for hazard mitigation planning.

- Milwaukee Metropolitan Sewerage District, *Kinnickinnic River Watershed Restoration Plan*, April 2010
- SEWRPC Community Assistance Planning Report No. 316, *A Restoration Plan for the Root River Watershed*, July 2014
- Milwaukee Metropolitan Sewerage District, *Kinnickinnic River Watershed: Green Infrastructure Plan*, 2018
- SEWRPC Community Assistance Planning Report No. 330, *A Restoration Plan for the Oak Creek Watershed*, December 2021

Coastal Planning

Listed below are a few planning efforts for the Lake Michigan coastline that impact Milwaukee County. These plans can provide additional ideas for goals and objectives for coastal hazard mitigation planning.

- SEWRPC Technical Report No. 36, *Lake Michigan Shoreline Recession and Bluff Stability in Southeastern Wisconsin: 1995*, December 1997
- Milwaukee County Environmental Services, *Milwaukee County Coastal Resources Inventory*, October 2020
- SEWRPC Memorandum Report No. 248, *Milwaukee County Coastline Management Guidelines*, February 2021

4.2 HAZARD MITIGATION GOALS AND OBJECTIVES FOR THE MILWAUKEE COUNTY HAZARD MITIGATION PLAN

Figure 4.1 presents the goals of the Milwaukee County hazard mitigation plan update. Complementing each of these goals is a set of objectives that can be used to define more specific actions or strategies to achieve the goals.

Figure 4.1
Goals and Objectives for the Milwaukee County Hazard Mitigation Plan Update

➤ **Goal 1: Preserve life and minimize the potential for injuries.**

- **Objective 1.1:** Identify natural hazards that threaten life in Milwaukee County.
- **Objective 1.2:** Identify populations within Milwaukee County that are particularly vulnerable to each identified hazard.
- **Objective 1.3:** Implement programs and projects that assist in protecting the lives of populations vulnerable to each identified hazard.

➤ **Goal 2: Preserve and enhance the quality of life throughout Milwaukee County by identifying potential property damage risks and recommending appropriate mitigation strategies to minimize potential damages.**

- **Objective 2.1:** Identify locations where property damages are vulnerable to each identified hazard.
- **Objective 2.2:** Improve and update hazard assessment information to be able to make informed recommendations that encourage adaptive and preventative measures for existing development in areas vulnerable to identified hazards, and to discourage new development in such areas.
- **Objective 2.3:** Protect life and property by implementing and enforcing modern standards, codes, ordinances, and construction procedures.
- **Objective 2.4:** The development of a stormwater management system, floodplain management system, dam safety system, and sanitary sewer system which reduce the exposure of people to drainage- and flooding-related inconvenience and health and safety hazards, and which reduces the exposure of real and personal property to damage through inundation and basement backup resulting from flooding, dam failure, inadequate stormwater drainage, or sewerage system capacity.
- **Objective 2.5:** Continue to participate in the National Flood Insurance Program (NFIP) and encourage participation in the Community Rating System (CRS) program for all communities within the County.

➤ **Goal 3: Promote Countywide coordination, planning, and training that avoids transferring the risk of hazards from one community to an adjacent community, where appropriate.**

- **Objective 3.1:** Identify and encourage uniformity across municipal boundaries in implementing modern standards, codes, ordinances, and construction procedures to mitigate hazard impacts, where appropriate, to strengthen desired outcomes (i.e.: stormwater management ordinances).
- **Objective 3.2:** Identify and encourage cross-jurisdictional and/or multiple property owner programs and projects where such cooperation would strengthen desired outcomes (i.e.: stormwater and Lake Michigan shore structure protection projects).
- **Objective 3.3:** Provide and maintain facilities necessary to maintain high quality fire and police protection and emergency medical services throughout the County.
- **Objective 3.4:** Provide for the capability to provide fire and police protection and emergency medical services and for adequate operation of wastewater treatment facilities during a one percent-annual-probability flood event.
- **Objective 3.5:** Continue developing and strengthening inter-jurisdictional coordination and cooperation in the area of emergency services.

Figure 4.1 (Continued)

- **Objective 3.6:** Continue to develop, maintain, and support comprehensive mutual aid agreements.

- **Objective 3.7:** Continue providing Milwaukee County and municipal emergency services with training and equipment to address all identified hazards.

- **Objective 3.8:** Identify and develop programs that complement County and local emergency operations plans to mitigate the potential exposure to health and safety risks and the exposure of property to damage from a broad range of hazards that are unpredictable and not geographically specific in nature.

- **Objective 3.9:** Continue to develop and maintain backup plans and communications interoperability and redundancy for emergency response throughout the County. Communications interoperability for other crucial public health, public works, dispatch, emergency management, and hospitals should also ensure adequate prevention and operations response.

➤ **Goal 4: Maintain a spatial distribution of the various land uses that preserves and protects the natural resources of the County, including its soils, inland lakes and streams, groundwater, wetlands, woodlands, wildlife, floodplains, and natural areas and critical species habitats.**

- **Objective 4.1** Urban development should not be located in areas which would cause or be subject to flood damage.

- **Objective 4.2:** No unauthorized structure or fill should be allowed to encroach upon and obstruct the flow of the floodway portion of stream channels.

- **Objective 4.3:** The types and distribution of land uses should be developed considering the potential impacts on flood flows, surface water quality, and groundwater quantity and quality. Considerations should be made to limit the amount of impervious surface in new or redeveloped areas.

- **Objective 4.4:** All remaining undeveloped lands within the designated primary environmental corridors in the County should be preserved in essentially natural, open uses.

- **Objective 4.5:** All remaining undeveloped lands within the designated secondary environmental corridors and isolated natural resource areas in the County should be considered for preservation as urban development proceeds.

- **Objective 4.6:** All wetlands adjacent to streams or lakes, all wetlands within areas having special wildlife or other natural values, and all wetlands having an area of five acres or greater should not be allocated to any urban development, except limited recreational use, and should not be drained or filled. In addition, County and local units of government may choose to preserve all wetlands.

➤ **Goal 5: The identification of high erosion risk Lake Michigan shoreline areas and the development of a coastal erosion control program which reduces the exposure of people and property to shoreline erosion and bluff recession.**

- **Objective 5.1:** Erosion risk areas and structure setback distances from the Lake Michigan shoreline should be established based upon the recommendations included in the Milwaukee County coastal erosion management plan.[a] This plan provided recommendations for structural setback distances from the top of the coastal bluff based on shoreline protection, a stable bluff slope, and bluff recession over 50 years.

- **Objective 5.2:** Publicly-owned assets along the Lake Michigan shoreline should be protected and preserved from future development and shoreline hazards.

[a] *SEWRPC, CAPR 163,* A Lake Michigan Shoreline Erosion Management Plan for Milwaukee County, Wisconsin*, October, 1989.*

➤ **Goal 6: Increase public awareness of hazards that threaten life and property.**

- **Objective 6.1:** Increase public awareness of existing threats and the means to reduce these threats by conducting educational and outreach programs to all the various community groups in the County.

- **Objective 6.2:** Increase public awareness of populations that are particularly vulnerable to certain hazard threats, and inform them of actions they can take, as well as programs available to them, to reduce the risk of injury, death, and property damage.

- **Objective 6.3:** Provide informational items, partnership opportunities, and funding resource information to assist in implementing mitigation activities.

➤ **Goal 7: Identify potential funding sources that can assist in the implementation of mitigation projects and programs.**

- **Objective 6.1:** Because funding programs and opportunities are constantly changing, the involved County and local units of government staffs should monitor and maintain the potential funding sources and programs.

- **Objective 6.2:** Whenever possible, seek funding programs that meet multiple objectives and recommendations made for this hazard mitigation plan as well as those of other County and local community planning efforts.

HAZARD MITIGATION STRATEGIES 5

5.1 PLANNING FOR HAZARD MITIGATION MEASURES

Hazard mitigation planning systematically evaluates the nature of vulnerability to existing hazards while developing continued actions that reduce or eliminate the long-term risks and their effects. Specific purposes of hazard mitigation include eliminating loss of life, lessening danger (or risk) to human health and safety, minimizing monetary damage or impacts to private and public property, reducing the cost of utilities and services, minimizing disruption in community affairs, and to increase community capability, resiliency, and equity. Hazard mitigation also involves avoiding the intensification of existing hazards and the creation of new hazards.

The preparation of the Milwaukee County hazard mitigation plan update involved developing and evaluating alternative mitigation measures, or actions to reduce risks, and to select the most effective elements of the alternatives to formulate an integrated plan. For planning purposes, the alternative mitigation measures for most hazards are separated into three categories: 1) **Nonstructural** and/or **Nature-Based Solutions**, 2) **Structural**, and 3) **Public Informational and Educational Programming**.

The mitigation measures identified in each hazard category were evaluated based on the relative cost and likely benefits (direct and indirect), as indicated in the cost-benefit analysis summary tables at the end of each reported hazard. Consideration was also given to the likelihood of occurrence of each hazard, as outlined in the Hazard Prioritization Analysis section of Chapter 3. The highest priority is recommended for the mitigation measures that directly or indirectly result in minimized loss of life or injury.

Estimated Cost of Implementation

Where possible, the cost-benefit analysis table for each reported hazard includes a summary of the estimated capital cost and average annual operation and maintenance cost for each mitigation measure. Many mitigation measures exist, other than for flooding, where a direct monetary cost was impossible or impractical to develop. Therefore, mitigation measures were also classified as low-, moderate-, or high- cost to categorize the relative expense of implementing the measure.

- Low-Cost (less than $100,000)
  - Educational and informational programming
  - Ongoing enforcement of ordinances
  - Plan development
  - Continued coordination/mutual aid/interagency agreements

- Moderate-Cost (greater than $100,000 and less than $1,000,000)
  - Addition of new staff
  - Additional staff hours budgeted
  - Additional equipment
  - New ordinance development
  - New programs/task force

- High-Cost (greater than $1,000,000)
  - Major construction
  - New buildings and infrastructure)
  - Capital programs

This cost assessment allows the mitigation measures to be prioritized with particular regard to cost-effectiveness by comparing the estimated low-, moderate-, and high-costs to the number of both direct and indirect benefits identified.

Benefits (Direct and Indirect)

The benefits of implementing a mitigation measure can be classified as direct (or measurable) and as indirect (or intangible). **Direct benefits** were defined as enhanced preparedness/protection of individuals or communities, reduced property damage, reduced injuries, and reduced mortalities. Although the exact number or amount of such benefits are often unknown, these would directly result from implementing a particular mitigation measure. In contrast, **indirect benefits** represent a range of potential benefits that may result from implementing specific management actions, such as increased environmental and recreational benefits and ecosystem services, and reduced loss of life and injury and the associated benefits for economic productivity. For this hazard mitigation plan, direct and indirect benefits are combined into one category within each cost-benefit analysis table for the profiled hazard.

Communities/Jurisdictions Affected

The cost-benefit analysis tables for each profiled hazard also indicate a list of the communities affected for each hazard and corresponding priority mitigation measure.

Some of the mitigative measures described are ongoing or committed actions which do not require the assessment of alternative measures but are still suggested to be incorporated into this mitigation plan. In other instances, applicable viable alternatives may be described and evaluated. This Chapter describes the hazard mitigation actions considered to resolve the identified hazard problems within Milwaukee County that were described in Chapter 3.

In preparing updates to the Plan, Commission staff, Milwaukee County Office of Emergency Management (OEM) and the Milwaukee County Hazard Mitigation Plan Local Planning Team (LPT) reviewed and reevaluated the current and past County and City of Milwaukee hazard mitigation plan goals and objectives (see Chapter 4). This review considered if those past and more recent goals were still applicable and whether additional goals should be added. In addition, hazard conditions within the County were reviewed and reevaluated (see Chapter 3). This review and reevaluation included the following.

- Updating the profile data of each hazard (i.e., extent and severity of hazard events)
- Reassessment of the vulnerability and risk associated with each hazard
- Reevaluation of potential changes in hazard severity and risk under future conditions

This review and reassessment process served as the basis for formulating viable mitigation measures to reduce vulnerability to hazards and to select priority mitigation actions recommended to address such hazards.

Vulnerable Populations

With more frequent and intense weather events, people and property are becoming increasingly vulnerable to natural disaster impacts (i.e., structural and/or vehicle damage and/or loss; injury, death, disruption to communication devices and infrastructure, etc.), most notably low-income, elderly, disabled, weak, under educated, and minority populations. Therefore, as part of this Plan update, individuals or populations deemed vulnerable (or at a higher risk) to natural disaster impacts within Milwaukee County, (see in Chapter 2 and Appendix C), played an integral part when formulating the following recommended mitigation alternatives and priority actions for each of the identified hazards.

5.2 HAZARD MITIGATION PLAN COMPONENT FOR MULTIPLE HAZARD TYPES

One of the bedrock principles of emergency management is to approach issues from a multi-hazards perspective. This is generally very cost-effective because it accomplishes mitigation goals and preparedness for *several* types of hazards with *one* resource or strategy. As such, this plan component includes mitigation strategies, actions, projects, or programs for multiple types of hazards. This approach helps reduce the repeating of similar mitigation measures that would otherwise be recurring for several or all of the hazards reported in this Plan. Mitigation measures that apply to multiple hazards are presented below.

Nonstructural

- Encourage the periodic review, updating, and/or exploration of new municipal and County development regulations and guidelines, especially in known hazard areas.

- Continue to enforce State building code regulations that aim to improve the ability of structures to withstand or become more resilient to the increasingly harsh weather conditions.[101]

- Encourage local municipalities to participate in the National Weather Service's (NWS) *StormReady* program.[102] Requirements for this program include:

  - Establishing a 24-hour warning point and emergency operations center

  - Having multiple ways to receive severe weather warnings and forecasts to alert the public

  - Promoting the importance of public readiness through community seminars

  - Developing a formal hazardous weather plan, which includes training severe weather spotters and holding emergency exercises

- Continue to support and encourage the participation in weather safety preparedness and training, (e.g., Milwaukee County SkyWarn[103] severe weather spotter training program).

- Continue to integrate and expand, along with periodic review and updating, of hazard mitigation planning into other County and local planning efforts (i.e., comprehensive, watershed, park, and local land use planning).

- Continue to collaborate and coordinate with other County and municipal departments (i.e., public health and human services, community outreach/public event planners, emergency management/ public safety, public works), local and regional volunteer groups, and NGOs on up-to-date emergency preparedness and response procedures.

- Promote and expand training through the Southeastern Wisconsin Community Organizations Active in Disaster (COAD) program.[104]

- Create and enhance local funding opportunities and mechanisms for hazard mitigation.

- Continue to update a list of potential funding sources associated with hazard mitigation planning.

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[101] *The State Uniform Dwelling Code (UDC) is a statewide regulation that sets standards for fire safety; structural strength; energy conservation; erosion control; heating, plumbing, and electrical systems; and general health and safety in dwellings constructed or altered after 1980. The UDC applies uniformly throughout the State, and local governments may not adopt a more or less stringent code. Consequently, should review of local ordinances reveal that a change in building code would be a viable mitigation measure, the County and the municipalities within the County would need to pursue a change in the UDC at the State level.*

[102] *The **NWS StormReady program** helps communities with the communication and safety skills needed to save lives and property--before, during and after the event. The Program includes communities, counties, Indian nations, universities and colleges, military bases, government sites, commercial enterprises and other groups. As of this plan the Village of Bayside and the University of Wisconsin-Milwaukee participate in the NWS StormReady program.*

[103] ***SKYWARN®** is a volunteer program with trained severe weather spotters that help keep local communities safe by providing timely and accurate reports of severe weather to the National Weather Service.*

[104] *The **COAD** program brings together leaders from emergency management, public safety, local government, volunteer organizations, and the private sector to collaboratively prepare for, respond to, and recover from emergencies or disasters impacting Southeast Wisconsin (sewicoad.org).*

Structural

- Continue to regularly maintain and update, as necessary, the County public early warning systems and communication networks, particularly the recently upgraded multi-governmental interoperable OASIS radio and communication system.

- Continue to regularly educate, train, and implement the use of various early public warning and safety communication techniques and devices to ensure adequate safety and warning is equally provided to all County residents, notably the elderly, homeless, disabled, hard of hearing, deaf, visually impaired, and/or to those that lack transportation or communication devices before and/or during a hazardous event.

- Continue to bury and protect power and utility lines, where feasible, to prevent damage from hazardous weather conditions.

- Promote the installation and maintenance of emergency on-site back-up power generation systems at critical community facilities and utility locations.

- Continue to increase public awareness and resources on the availability and location of emergency shelters before, during, and after extreme weather events (see Appendix G).

    - Collaborate with key stakeholders to strengthen community-partner relationships in developing and enhancing a reliable and accessible emergency shelter network to increase their capabilities in the County.

    - Consider the establishment of community resilience hubs.[105] Resilience hubs are community-serving facilities designed to support and provide residents, including those most vulnerable, with an accessible, reliable, and safe physical space (i.e., community center, recreation facility, or multi-family housing building) to gather for either: shelter/safety during a severe weather event, a community engagement/collaboration event, information and education resources on environmental or community health and safety resources, including mitigation recommendations.

- Establish safe and appropriate locations for temporary debris disposal sites.

- Routinely trim and maintain the health of trees, especially those near vulnerable infrastructure (i.e., utility lines and roads) and critical community facilities. Communities should also encourage private landowners to routinely inspect and remove dead or infected trees.

Public Informational and Educational Programming

- Maintain and regularly update County and community websites and other online resources with information related to extreme weather events and risk reduction measures (Appendix G).

- County and all public safety personnel should identify at-risk (or vulnerable) individuals or communities to better anticipate the needs and provisions of information and resources required before, during, and after disasters.

- Encourage and expand County and municipal collaboration and coordination efforts on public outreach programs and events that inform, educate, and assist County residents of all social, economic, physical, and educational backgrounds on the planning and preparation of severe weather events.

- Increase local and community partnerships and collaborations with government agencies, organizations and nonprofits, businesses, and local citizens to improve and enhance community resources and capability efforts before, during and after emergencies.

- Encourage and assist residents of all social, economic, and educational backgrounds to develop Severe Weather Emergency Preparedness Plans and Tool Kits (see Appendix G).

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[105] *resilience-hub.org.*

- Reach out and educate, as well as encourage *all* County residents, especially those that are vulnerable, on the installation and use of severe weather warning applications (apps.) and devices, such as FEMA's *ready.gov* app. and/or the *MKEALERT* app (Figure 5.1).[106]

- Continue to distribute information and educational resources and programs to County residents of all social, economic, and educational backgrounds on flood insurance as well as federal or state grant funding opportunities to assist during and after a severe weather event.

Current Programs and Ongoing Projects

Federal and State Programs

FEMA funds several programs that assist State and local governments with hazard mitigation efforts that are administered through WEM in the State of Wisconsin. Two of these programs fit best in this "multiple hazards" section because they address a broad array of hazard events. These programs include FEMA's Hazard Mitigation Grant Program (HMGP) and Building Resilient Infrastructure and Communities (BRIC) Program. These programs provide funding for both pre-disaster planning and on-the-ground projects and will be discussed in further detail in the hazard mitigation funding sources in Chapter 6. FEMA and WEM also provide additional online resources and tool kits, including *Climate.gov*, the Climate Risk and Resilience Portal (ClimRR), the FEMA National Risk Index (NRI), Grant Equity Threshold Tool (GETT), and the FEMA Resilience Analysis and Planning Tool (RAPT). These tools can assist the public in extreme weather preparedness, safety, and recovery.[107]

A number of additional federal and state agencies also have programs that offer awareness and educational resources and tools to enhance State and local hazard mitigation efforts, including the Department of Homeland Security's Ready Campaign (*Ready.gov*) program. Similarly, WEM developed *ReadyWisconsin*, with information, materials, and resources customized to Wisconsin's state, regional and local emergency preparedness landscape including Wisconsin's weather awareness events (see Appendix G). This is a national public service advertising campaign that provides educational resources on disaster preparedness, response, and mitigation measures for disasters.[108] These include Tornado Week April 8-12; Heat Awareness Day June 5; Lightning Safety Awareness Day June 18; and Winter Weather Awareness Week November 18-22.

Additionally, NOAA, in partnership with the Urban Sustainability Directors Network (USDN) created the Climate and Hazard Mitigation Planning (CHaMP) Tool. As a mapping tool, CHaMP displays climate metrics, hazard data, and hazard impacts for both historic and future climate information. It also is intended to assist planners in integrating climate information into existing and future planning efforts. The tool can also help planners communicate potential vulnerabilities to residents and to state and federal authorities responsible for allocating resources for hazard mitigation activities.[109]

NOAA's NWS also has extensive public information to educate local officials and residents about the dangers of severe weather, including data on associated damages, deaths, and injuries. The NWS issues warnings, watches, and advisories when there is a threat of severe weather conditions. Further, the NWS *StormReady* Program encourages communities, including Milwaukee County, to take a proactive approach to improving local hazardous weather operations by providing emergency managers with guidelines on how to improve their hazardous weather operations. Also The NWS-Milwaukee Weather Support for Outdoor Events Program provides free education and training to county and local officials and event coordinators in severe weather monitoring, alerting, and evacuation protocols.

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[106] ***MKEALERT*** *is a free, emergency alert system designed to keep the residents and visitors of the City of Milwaukee informed during potential hazards.*

[107] *www.fema.gov/about/reports-and-data/resilience-analysis-planning-tool.*

[108] *Department of Homeland Security's* ***Ready Campaign*** *was launched in February 2003 as a National public service campaign designed to educate and empower citizens to prepare for, respond to, and mitigate emergencies, including natural and man-made disasters. Go to Ready.gov to download the mobile app.*

[109] *champ.rcc-acis.org*

Wisconsin Department of Health Services (DHS), WEM, and other State and local government agencies provide the public with various information, resources, and educational material on severe weather preparedness, including recommended emergency supplies and toolkits, different emergency alerting systems and mobile applications ("apps"), and available public federal, state, or local programs and resources that can assist during and after a severe weather event (see Appendix G).

Figure 5.1
City of Milwaukee Alerting and Notification App.

Source: City of Milwaukee

Various federal, state, and local agencies and/or programs, including those in the state of Wisconsin and Milwaukee County, include data and information related to social and economic (socioeconomic) disparities such as vulnerable or at-risk individuals and populations into planning and policy programs to better ensure equitable services. The primary federal agency that provides information and resources related to vulnerable populations is the U.S. Department of Health and Human Services (HHS), which includes the Centers for Disease Control and Prevention (CDC). As noted in Chapter 2, and Appendix C, this Plan update utilized the CDC's online Social Vulnerability Index (SVI) database and mapping tool to identify and quantify communities experiencing social vulnerability within Milwaukee County. This information can help County and local public health and emergency officials better prepare for and respond to hazardous events. The CDC also developed an Environmental Public Health Tracking Program, in which it collects, integrates, analyzes, and disseminates health, environmental, and socio-economic data from various sources to help improve and enhance community health, equity, and resiliency.[110]

In 2004, the Department of Homeland Security set forth the National Incident Management System (NIMS) as a directive to increase efficiency and effectiveness in emergency incident management. The NIMS provides a set of standardized organizational structures, such as the Incident Command System (ICS), multi-agency coordination systems, and public information systems, as well as requirements for processes, procedures, and systems designed to improve interoperability among jurisdictions and disciplines in various areas. This includes training, resource management, personnel qualification and certification, equipment certification, communications and information management, technology support, and continuous system improvement. The NIMS integrates existing best practices into a consistent, nationwide approach to domestic incident management that is applicable at all jurisdictional levels and across functional disciplines in an "all hazards" context in terms of preparing for, preventing, responding to, and recovering from domestic incidents, regardless of cause, size, or complexity, including weather-related incidents. As of 2007, Federal preparedness assistance funding for State, territorial, local, and tribal jurisdictions is conditioned on full compliance with NIMS.

Local Programs

Milwaukee County OEM is responsible for developing, implementing, and managing the County's disaster prevention, preparedness, and response, recovery, and mitigation efforts. Milwaukee County OEM, The City of Milwaukee's Health Department and other county communities provide educational material via flyers, brochures, printed media, broadcasted media, social media, and/or local websites on disaster preparedness, safety, and recovery resources. In addition, Milwaukee County OEM, The City of Milwaukee's Health Department, and other county municipalities participate in a number of educational and informational public outreach events to promote, inform, and educate on different hazardous weather events and available resources.

[110] *www.cdc.gov/environmental-health-tracking.*

As detailed in Chapter 2, there are many modes of communication in which the residents of Milwaukee County are able to receive severe weather warnings including outdoor warning sirens, NOAA Weather Radios, local television and radio broadcasts, digital mobile alert systems, social media platforms, and even door-to-door notifications in certain situations. Milwaukee County also has the capability to issue emergency alerts through its Integrated Public Alert and Warning System (IPAWS). IPAWS provides the County with an effective way to alert and warn the public about emergencies using the Emergency Alert System (EAS), Wireless Emergency Alerts (WEA), NOAA Weather Radios, and other public alerting systems from a single interface. In addition to IPAWS, Milwaukee County has the ability to alert the public through reverse-9-1-1, Teletypewriter (TTY), and several subscription-based mobile alert text and email messaging application systems (i.e., "Notify-Me," "E-Notify," and "Hyper-Reach"). The City of Milwaukee also maintains and provides a free mobile alert notification app. called "*MKEALERT*" for missing persons, road closures, extreme weather, public health warnings, and more. Functional needs groups receive extreme weather alerts or warnings through door-to-door for the handicapped, visually and hearing impaired; foreign language media messaging, and/or close-caption (EAS television messaging). Maintaining and updating these public alerting services and the infrastructure that supports them is a vital component in hazard mitigation planning.

The County's updated multi-government shared early public safety radio system OASIS (Organization of Affiliated Secure Interoperable Radio Frequency (RF) Subsystems) provides critical and interoperable communications for public safety agencies and first responders throughout Milwaukee and Waukesha counties. In 2024, the OASIS interoperable radio and communication system was upgraded with the transition to the Wisconsin Public Safety Network (WiPSN). The transition allowed Milwaukee and Waukesha Counties to update and replace the radio system and infrastructure (tower support systems) that was outdated or at its end-of-life functionalities, including the upgrade of the OASIS 800 MHz microwave backhaul system and design, towers and supporting systems, and other operational updates. Ultimately this major upgrade eliminates the risk of system-wide failure and ensures constant communication capability for emergency responders and public safety officials. The completed cost of this project was $1.8 million (2023 dollars).

Milwaukee-Waukesha Counties Amateur Radio Emergency Service (Milwaukee-ARES)/Radio Amateur Civil Emergency Service (RACES), consists of licensed amateur radio operators (hams) that provide backup auxiliary communications for the County during a planned or emergency event if the County loses some, or all, of its radio communication systems. Volunteers are also trained in NIMS.

In addition, and as described in Chapter 1, Milwaukee County has developed a comprehensive emergency management plan (CEMP)[111] which sets forth an all-hazards action plan. Similarly, many of the local units of government have developed emergency operations plans and/or programs that complement the County's plan and also set forth procedures and actions to deal with a range of situations and events. To that end, this Plan recommends that Milwaukee County OEM and local units of government continue to regularly collaborate to review and update emergency plan components to ensure that all involved personnel are aware of plan recommendations, procedures, and tasks before, during, and after an emergency event.

Multi-Jurisdictional Considerations

The hazards addressed by mitigation measures in this multi-hazard plan component include multiple weather hazard events. These events have the potential to impact all municipalities within Milwaukee County and may cause damage or loss to a variety of assets including infrastructure (i.e., transmission lines, communication lines, and transportation routes), buildings (i.e., homes, businesses, critical facilities), and property. Hence, Milwaukee County, its municipalities, and relevant businesses and organizations should continue to coordinate hazard mitigation planning activities and procedures through a cooperative County and local government and organization partnership. Furthermore, when adapting to climate change, county and local officials must consider the priorities, needs, and challenges of vulnerable communities as a priority for hazard mitigation planning.

Evaluation of Alternatives and Identification of Priority Mitigation Measures

The best way to mitigate vulnerability to many hazards is to avoid them all together, when possible. Life and property are vulnerable to hazard events when they are in or near known hazard areas. For this reason, an important aspect to any hazard mitigation plan is continuing to enforce, review, and when necessary, enact

[111] *Milwaukee County Office of Emergency Management*, Comprehensive Emergency Management Plan (CEMP)*, 2021.*

new regulations and ordinances. The County and its municipalities should continue to review building code regulations and ordinances with consideration of future hazard events and the effects of a changing climate.

The continued use of various platforms (printed material, radio/tv broadcast, websites, social media, public outreach) to communicate with *all* Milwaukee County residents on the seriousness of severe weather events, associated impacts, and different preparedness recommendations is an integral part of this Milwaukee County hazard mitigation plan. Also, educational outreach events and programs should be conducted in a County-community partnership with Federal, State, and local officials to improve local networking and provide resources related to hazard mitigation planning and projects.

Furthermore, providing the public with advanced warning of an imminent hazard event is a major component of Milwaukee County mitigation planning. It is imperative that the County continue to use multiple means of communication to alert *all* citizens to the threat of various hazards, and to maintain and improve these early warning systems as means of effective and reliable public safety measures. The Milwaukee County OEM continued participation and coordination in disaster and emergency preparedness with other local, State, and Federal organizations is another key component of public safety mitigative action in order to help protect all citizens and assets of Milwaukee County.

Based upon the foregoing evaluation and consideration of risk, and review by the Milwaukee County Hazard Mitigation Plan LPT, there are 20 mitigation measures that apply to multiple types of hazards and were considered to be priority actions as part of this hazard mitigation plan update. These priority mitigation measures, along with a general cost-benefit summary are presented in Table 5.1.

5.3 HAZARD MITIGATION PLAN COMPONENT FOR FLOODING AND ASSOCIATED STORMWATER DRAINAGE PROBLEMS

As noted in Chapter 3, flooding and related stormwater drainage (or urban flooding) problems represent one of the most common and damaging types of hazards affecting Milwaukee County. Generally, the amount of damage from flooding is a direct consequence of the contributing drainage (or watershed) area land use. It is likely that flooding and related stormwater drainage problems will continue to be a major source of damage affecting the County in the future. As such, the following section describes alternative and priority flooding and stormwater mitigation strategies to consider for hazard mitigation planning in Milwaukee County.

Identification of Alternative Mitigation Strategies

Various structural, nonstructural (including nature-based solutions), and educational/informational measures are available for mitigating the impacts of flooding and stormwater drainage concerns in Milwaukee County. **Nonstructural measures** are most effective when the flooded structures are scattered throughout the watershed. In contrast, **structural measures** typically are most effective where impacted buildings are concentrated, such as in urban areas. **Educational and informational** flood mitigation-related material is effective for communities, homeowners, landowners, businesses, and local officials who repeatedly experience riverine and stormwater flooding events.

For purposes of organizing this extensive Plan component, flood mitigation strategies are grouped into four sub-plan elements:

- Preservation of Floodplains, Open Space, and Environmentally Sensitive Lands
- Floodplain Management
- Stormwater Management
- Public Information and Education Outreach

Table 5.1
Cost-Benefit Analysis for Hazard Mitigation Measures Within Milwaukee County: Multiple Hazards

Mitigation Measures	Estimated Cost[a]		Costs of Implementation[b]			Benefits						Community/ Jurisdictions Affected
	Capital	Average Annual Operation and Maintenance	Low	Moderate	High	Enhanced Preparedness/ Protection	Reduced Property Damage	Reduced Injuries	Reduced Mortalities	Enhanced quality of life/social benefits	Increased Environmental and/or Recreational Benefits/Ecosystems	
Nonstructural												
Continue to enforce State building code regulations that aim to improve the ability of structures to withstand hazardous weather conditions (i.e., strong winds hail, winter storms, extreme temps)	--[c]	--[c]	X			X	X	X	X			Milwaukee County and all local jurisdictions[d]
Encourage and enforce the periodic review of new and/or updated municipal and/or County development regulations, especially in known hazard areas	--[c]	--[c]	X			X	X	X	X			Milwaukee County and all local jurisdictions[d]
Encourage local municipalities to participate in the National Weather Service's (NWS) *StormReady* program	--[c]	--[c]	X			X						Milwaukee County and all local jurisdictions[d]
Continue the integration and expansion of hazard mitigation planning into other local planning efforts (i.e., comprehensive, watershed, and land use planning)	--[c]	--[c]	X			X						Milwaukee County and all local jurisdictions[d]
Create more local funding opportunities and programs for hazard mitigation	--[c]	--[c]		X		X						Milwaukee County and all local jurisdictions[d]
Continue to update a list of potential funding sources associated with hazard mitigation planning	--[c]	--[c]	X			X						Milwaukee County and all local jurisdictions[d]
Continue to regularly work with community event/outreach organizers on up-to-date emergency plans and procedures in case of severe weather	--[c]	--[c]	X			X						Milwaukee County, NGOs, and all local jurisdictions[d]

Table continued on next page.

Table 5.1 (Continued)

Mitigation Measures	Estimated Cost[a]		Costs of Implementation[b]			Benefits						Community/ Jurisdictions Affected
	Capital	Average Annual Operation and Maintenance	Low	Moderate	High	Enhanced Preparedness/ Protection	Reduced Property Damage	Reduced Injuries	Reduced Mortalities	Enhanced quality of life/social benefits	Increased Environmental and/or Recreational Benefits/Ecosystems	
Nonstructural (continued)												
Continue coordinating emergency response and operation plans among County and local governmental units and first responders	--[c]	--[c]	X			X						Milwaukee County and all local jurisdictions[d] and NGOs
Continue working with public departments, emergency personnel, volunteer groups, NGOs, and American Red Cross on natural weather hazard preparedness and procedures	--[c]	--[c]	X			X						Milwaukee County
Promote and expand training through the Southeastern Wisconsin COAD[e] program	--[c]	--[c]	X			X						Milwaukee County
Structural												
Regularly maintain and upgrade, as necessary, public early warning systems and communication networks (i.e., mobile apps, social media, broadcasting, etc.)				X		X						Milwaukee County and all local jurisdictions[d]
Continue to maintain and upgrade, as necessary, the County's shared interoperability radio communication network and infrastructure system "OASIS"	$3.6M (2023 dollars) OASIS upgrade	--[f]			X	X	X					Milwaukee County
Continue to bury and protect power and utility lines, where feasible and appropriate, to prevent damage from hazardous weather conditions	--[c]	--[c]			X	X		X	X			Milwaukee County and all local jurisdictions[d]
Promote and encourage emergency on-site back-up power generation at critical facilities and utility locations	--[c]	--[c]		X		X	X					Milwaukee County and all local jurisdictions[d]

Table continued on next page.

Table 5.1 (Continued)

Mitigation Measures	Estimated Cost[a]		Costs of Implementation[b]			Benefits						Community/ Jurisdictions Affected
	Capital	Average Annual Operation and Maintenance	Low	Moderate	High	Enhanced Preparedness/ Protection	Reduced Property Damage	Reduced Injuries	Reduced Mortalities	Enhanced quality of life/social benefits	Increased Environmental and/or Recreational Benefits/Ecosystems	
Structural (continued)												
Encourage residents and business owners to consider the purchase of backup power systems (i.e., generators) in case of hazardous conditions	--[c]	--[c]	X			X				X		Milwaukee County and all local jurisdictions[d]
Public Informational and Educational Programming												
Regularly update and maintain the County OEM website as well as other related county and local department and organization websites on hazardous weather events, preparedness, and resources	--[c]	--[c]	X			X						Milwaukee County and all local jurisdictions[d]
Continually increase participation in public outreach events that educate County residents, notably those in vulnerable situations, on severe weather events and preparedness resources	--[c]	--[c]	X			X						Milwaukee County and all local jurisdictions[d]
Encourage residents to develop a Family Emergency Preparedness Plan and Disaster Supply Kit (Appendix G).	--[c]	--[c]	X			X						Milwaukee County and all local jurisdictions[d]
Continue to publicize, through various modes of communication, to ensure all County residents, especially those that are most vulnerable, on the availability and accessibility of emergency shelter sites	--[c]	--[c]	X					X	X			Milwaukee County and all local jurisdictions[d]
Educate and encourage the use and importance of severe weather warning apps. (i.e., FEMA's *ready.gov* or Milwaukee's MKEALERT apps)	--[c]	--[c]	X			X						Milwaukee County and City of Milwaukee

Table continued on next page.

Table 5.1 (Continued)

Mitigation Measures	Estimated Cost[a]		Costs of Implementation[b]			Benefits						Community/ Jurisdictions Affected
	Capital	Average Annual Operation and Maintenance	Low	Moderate	High	Enhanced Preparedness/ Protection	Reduced Property Damage	Reduced Injuries	Reduced Mortalities	Enhanced quality of life/social benefits	Increased Environmental and/or Recreational Benefits/Ecosystems	
Public Informational and Educational Programming (continued)												
Continue to implement and train on the use of different alert/warning systems, so that those most vulnerable, such as hard of hearing, deaf, or blind are also provided with adequate and reliable warning before and during a hazardous event	--[f]	--[f]	X			X				X		Milwaukee County and all local jurisdictions[d]
Continue providing information on flood and severe weather insurance programs	--[f]	--[f]	X			X						Milwaukee County and all local jurisdictions[d]

[a] *All cost expressed in 2022 dollars unless otherwise noted.*

[b] *Cost of implementation is allocated among three categories of low (less than $100,000 dollars), moderate (greater than $100,000 and less than $1,000,000), and high (greater than $1,000,000) costs, which are generally defined as:*

Low
Educational and informational programming
Ongoing enforcement of ordinances
Plan Development
Continued coordination/mutual aid/ interagency agreements

Moderate
Addition of new staff
Additional staff hours budgeted
Additional equipment
New ordinance development
New programs/task force

High
Major construction
New buildings (infrastructure)
Capital programs

[c] *Costs covered under ongoing activity.*

[d] *Jurisdictions include general purpose units of government—Cities and Villages—and special purpose units of government such as School Districts.*

[e] *COAD stands for the Southeast Wisconsin Community Organizations Active in Disaster program. This program is a coalition that brings together leaders from emergency management, public safety, local government, volunteer organizations, and the private sector to engage the community in preparedness efforts and disaster response.*

[f] *Costs are site-specific.*

Source: Milwaukee County and SEWRPC

Preservation of Floodplain, Open Space, and Environmentally Sensitive Lands Plan Element

As mentioned in Chapter 2, natural landscape features such as floodplains, wetlands, and undeveloped (i.e., open space, forested, etc.) areas are essential for storing water and ultimately reducing the impact of flood events. With increasing urbanization, it is critical that these lands be preserved, protected from development, and enhanced when possible. The following sections detail recommended management actions to help preserve and maintain these essential open space lands within Milwaukee County.

Preservation of Floodplains and Wetlands

As detailed in Chapter 1, and listed in Table 1.1, municipalities within Milwaukee County have several pertinent floodplain management guidelines in place, most notably zoning regulations and ordinances. The floodplain zoning ordinances, described under Section 87.30 of the *Wisconsin Statutes* and Chapter NR 116, are intended to preserve the floodwater conveyance and storage capacity of floodplain areas and to prevent the addition of new flood-damage-prone development in flood hazard areas. Implementing and enforcing these ordinances on an ongoing basis is an integral part of flood mitigation.

With the increase of intense rain events, more restrictive floodplain zoning ordinances should be considered to enhance flood storage preservation throughout the County. Currently, floodplain zoning ordinances only apply to the Federal Emergency Management Agency's (FEMA) special flood hazard area (SFHA) or 1-percent-annual-probability floodplain. The FEMA 0.2-percent-annual-probablity floodplain (or 500-year floodplain) should be considered for new development or redevelopment to maintain or create additional flood storage areas and protect existing assets within the County. The effective FEMA 0.2-percent-annual-probability floodplains in Milwaukee County are shown in green on Map 5.1, which provides a larger floodplain footprint compared to the FEMA SFHA.

In relation to floodplain regulations and also described in Chapter 1 and listed Table 1.1, municipalities within Milwaukee County have relevant wetland management regulations in place, most notably in the form of shoreland-wetland zoning. The shoreland-wetland zoning ordinance, under Chapter NR 117 of the *Wisconsin Administrative Code,* is to help maintain the stormwater and floodwater storage capacity of wetlands and prohibits certain land uses detrimental to wetlands. Implementing and enforcing this regulation on an ongoing basis is essential to County and local flood mitigation.

Protection of Environmentally Sensitive Lands and Open Space Areas

Protecting environmentally sensitive lands, which may include environmental corridors, natural areas, and open space sites can help prevent increased flood flows and associated problems. As detailed in Chapter 2, and shown on Map 5.2, environmental corridors in Milwaukee County are primarily located along major stream valleys and along the Lake Michigan shoreline. These lands contain almost all of the best remaining woodlands and wildlife habitat areas, including significant floodplains and wetlands.

The regional land use and transportation plan[112] and park and open space plan[113] also carry forward fundamental land use recommendations, including reducing and containing urban sprawl and protecting and preserving environmentally sensitive lands, such as environmental corridors, open space lands, and isolated natural resource areas. These regional plans form the framework for ongoing local land use planning and plans carried out by local government units and Milwaukee County. As detailed in Chapter 4, the Milwaukee County park and open space plan[114] and the various local land use plans refine, detail, and extend on these regional plans.

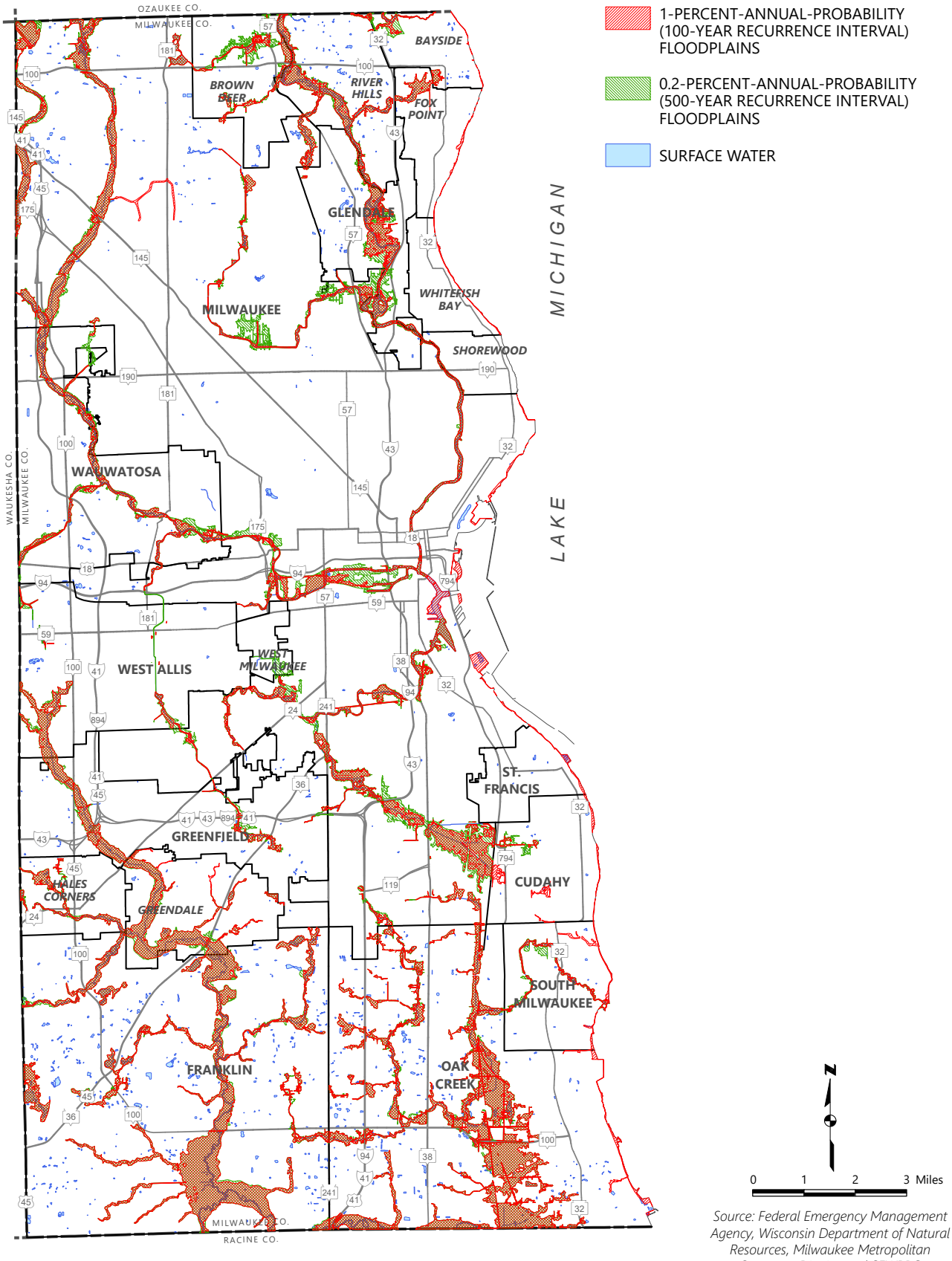
Milwaukee County has primary responsibility for parks and related open space areas within the County. The County has taken an active role in preserving environmentally sensitive lands and currently owns approximately 6,767 acres of park, parkway, and open space lands located in 159 sites, with the remaining 10 sites of 938

[112] *SEWRPC Planning Report No. 55 (2nd Edition),* VISION 2050: A Regional Land Use and Transportation Plan for Southeastern Wisconsin *(June 2020).*

[113] *SEWRPC Planning Report No. 27,* A Regional Park and Open Space Plan for Southeastern Wisconsin: 2000*, November 1977.*

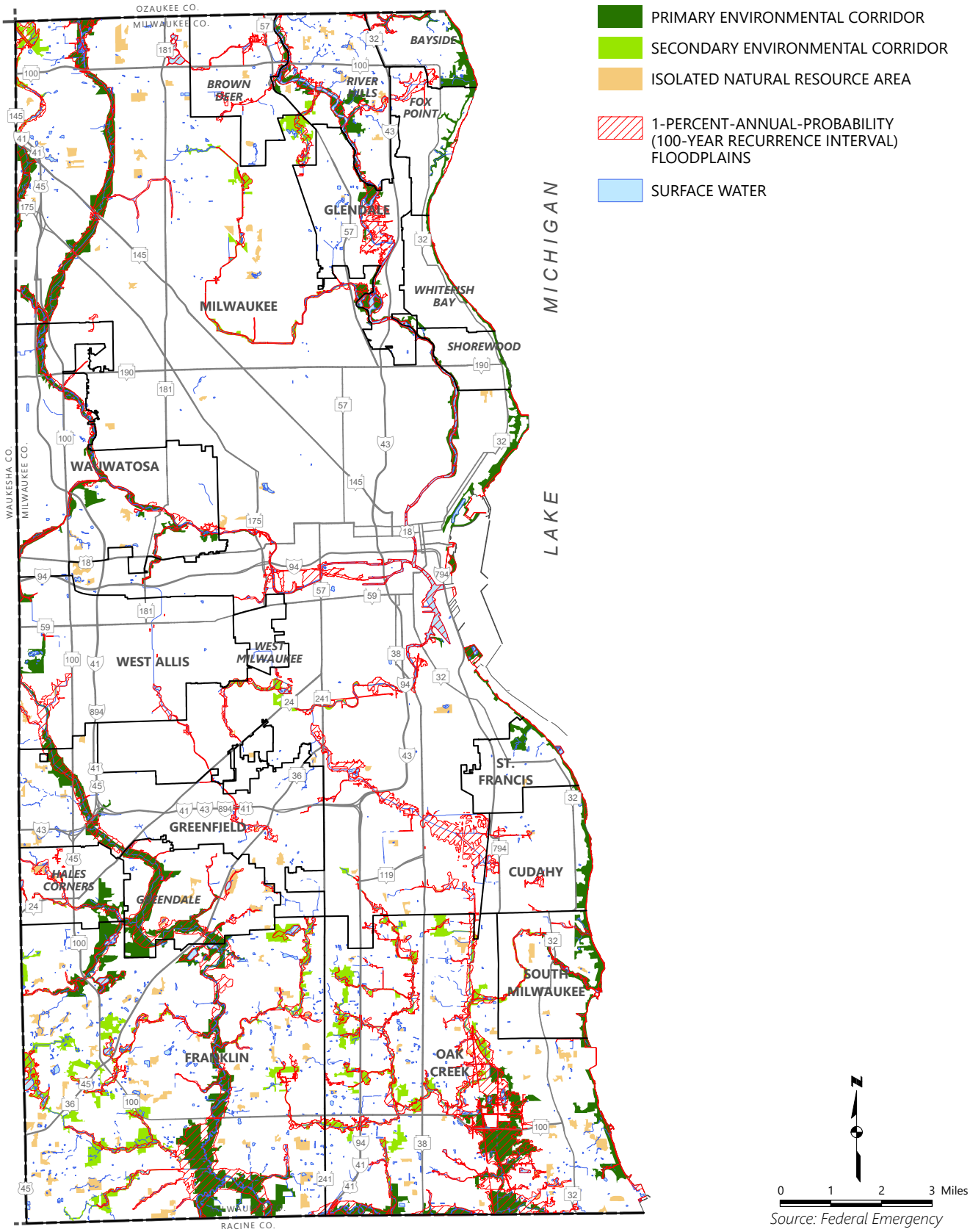
[114] *SEWRPC Community Assistance Planning Report No. 132,* A Long-Range Park and Open Space Plan for Milwaukee County (2nd edition)*, February 2022.*

Map 5.1
100- and 500-Year Floodplains in Milwaukee County



Source: Federal Emergency Management Agency, Wisconsin Department of Natural Resources, Milwaukee Metropolitan Sewerage District, and SEWRPC

Map 5.2
Environmental Corridors, Isolated Natural Resource Areas, and 100-Year Floodplains in Milwaukee County



Source: Federal Emergency Management Agency and SEWRPC

acres being state-owned. The current locations of these major parks, primary and secondary environmental corridors, and isolated natural resource areas[115] are shown on Map 5.3 and listed in Appendix E. As indicated by the maps, many of Milwaukee County Parks and environmental corridors are located along the streams of Milwaukee County. This Plan therefore recommends that these parks, parkways, and environmentally sensitive areas be preserved and maintained for flood mitigation efforts in Milwaukee County.

Participation in Milwaukee Metropolitan Sewerage District (MMSD) Greenseams® Program

In 2001, MMSD, with the assistance of The Conservation Fund, initiated the Greenseams® program. This Program was developed based on recommendations in the MMSD Conservation Plan[116] and Greenway Connection Plan.[117] The aim of the Greenseams® program is to protect significant lands, particularly those containing water-absorbing soils, to help prevent future flooding and water pollution, as well as manage wildlife habitat and recreational lands within watersheds contributing to the MMSD service area.[118] As shown on Map 5.4, approximately 611 acres of land in Milwaukee County has been acquired as part of this Program. This Plan recommends the continued support of Milwaukee County communities in the Greenseams® program for flood mitigation purposes.

Floodplain Management Element

Implementing floodplain management measures is a fundamental element of hazard mitigation planning. The identification, analysis, and recommendation of possible methods of mitigating flooding problems within the Region, including Milwaukee County, has been the subject of various planning efforts. As detailed in Chapter 4, current flood management efforts within Milwaukee County are being carried out under the Milwaukee Metropolitan Sewerage District (MMSD) Watercourse System and Flood Management Planning Program.[119] With the assistance of the Southeastern Wisconsin Regional Planning Commission (Commission or SEWRPC), County and local partners, this MMSD Planning Program has become a vital element in flood risk reduction efforts in the Region, especially for at-risk structures and critical community infrastructure located within the 1-percent-annual-probability flood hazard areas. Map 5.5 illustrates the MMSD service area and the major watersheds and watercourses within the District and Milwaukee County. Table 5.2 also lists the MMSD jurisdictional streams by watershed. This Plan considers the ongoing and planned flood risk reduction efforts by MMSD, and its partners as described below as priority mitigation measures for Milwaukee County flood hazard mitigation.

Milwaukee Metropolitan Sewerage District (MMSD) Watercourse
and Floodplain Management Project Recommendations

As watershed boundaries do not necessarily follow municipal boundaries, reducing the risk of flooding requires looking at the watershed as a whole, including the complete river system and its tributaries. The MMSD Watercourse Planning Program was developed using the watershed-based approach and the following major projects from that Program are recommended for this Plan element. All of these projects and estimated costs are listed in Table 5.3 and the major efforts are discussed in the sections below. The projected Watercourse Program total cost for floodplain projects planned through 2035 is about $340 million (2024 dollars).

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[115] *Isolated natural resource areas are physically separated from environmental corridors by intensive urban or agricultural land uses and are at least five acres in size.*

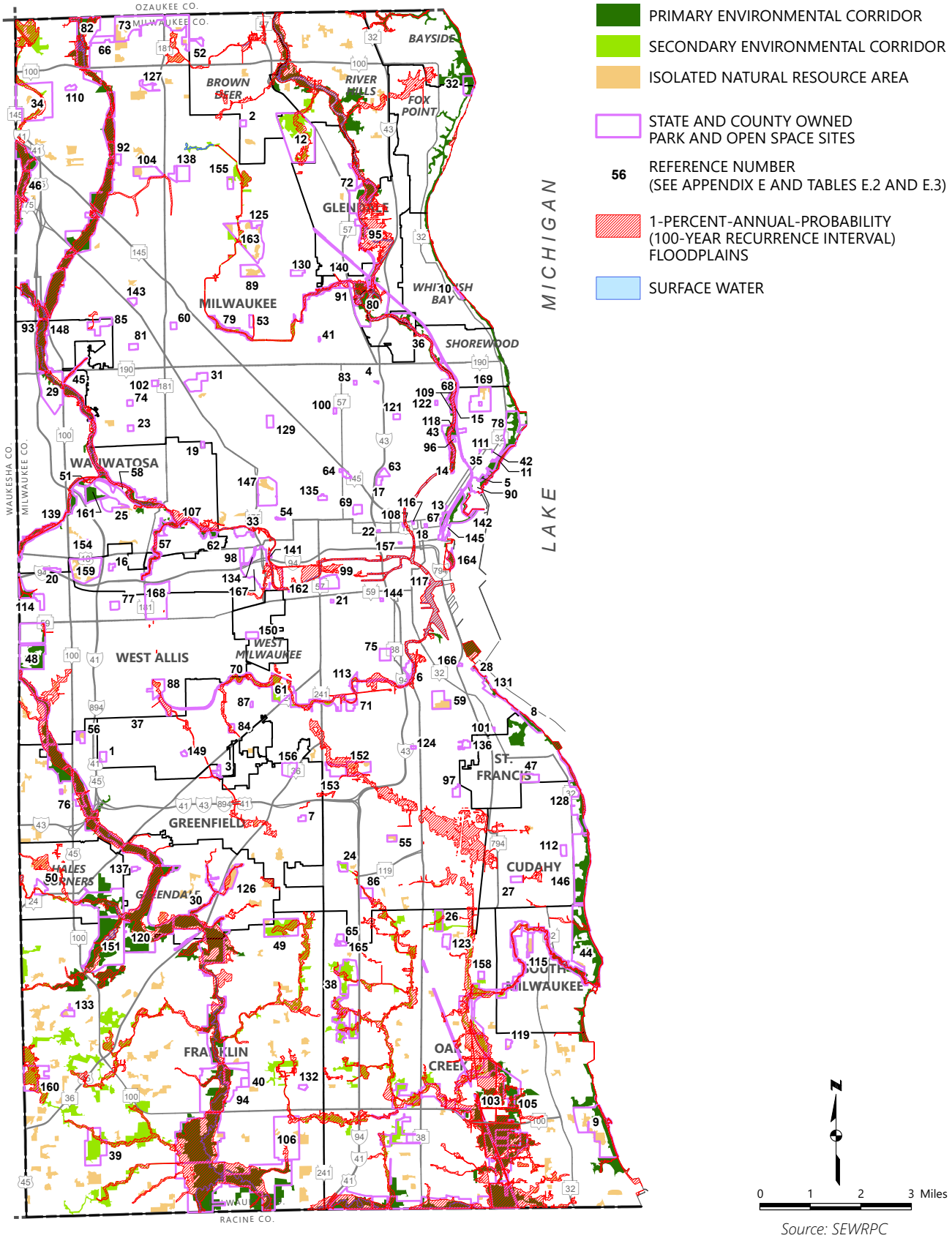
[116] *The Conservation Plan identified land parcels recommended to be protected for multiple purposes, including flood reduction potential and stormwater management benefits.*

[117] *SEWRPC Memorandum Report No. 152,* A Greenway Connection Plan for the Milwaukee Metropolitan Sewerage District, *December 2002.*

[118] *mmsd.com.*

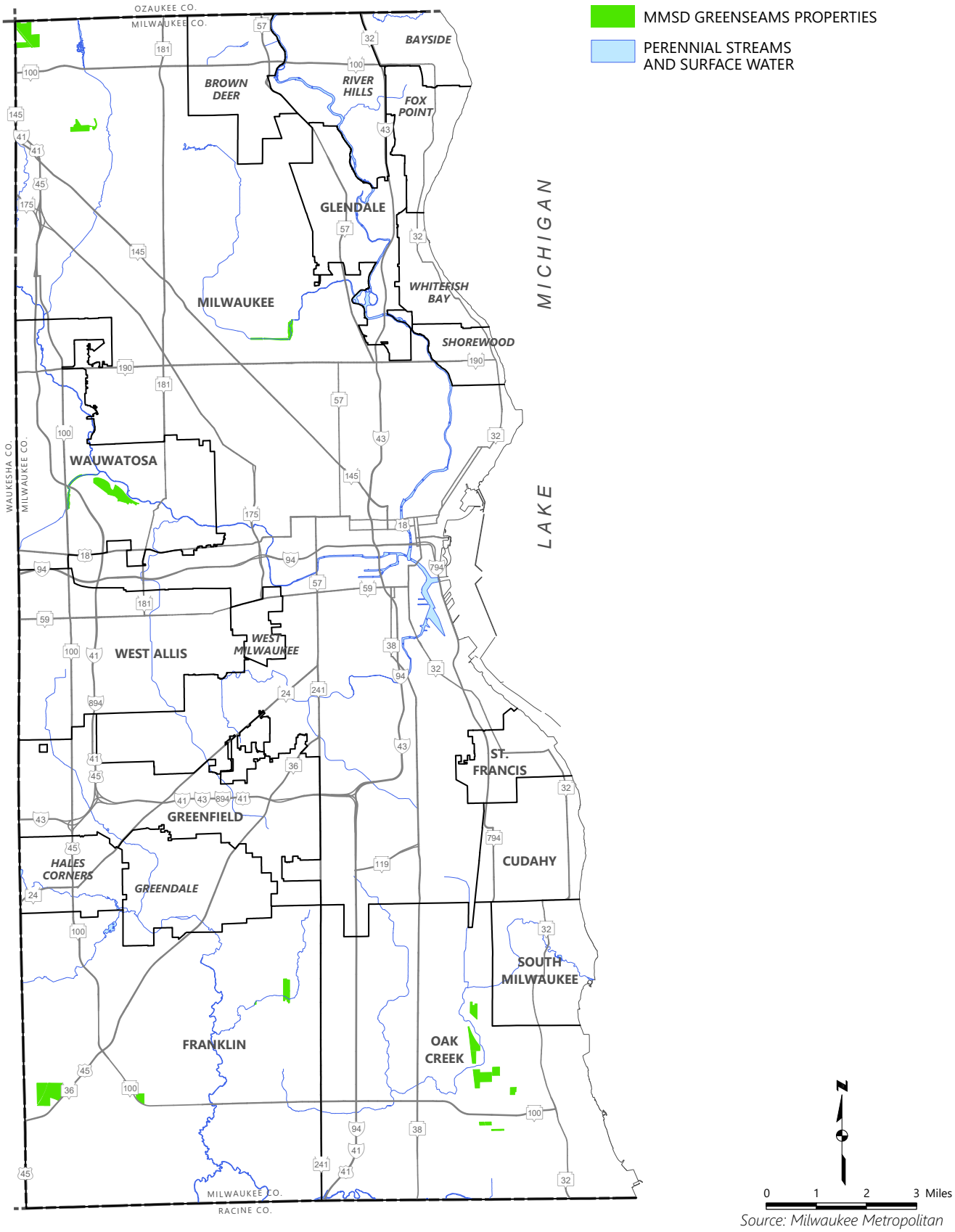
[119] *As a regional agency, MMSD is the most appropriate entity to address watershed issues that involve multiple municipalities. The District's authority to reduce the risk of flooding is documented in* Wisconsin Statutes, *sec. 200.31(1).*

Map 5.3
Environmental Corridors, Isolated Natural Resource Areas, and Park and Open Space Sites in Milwaukee County



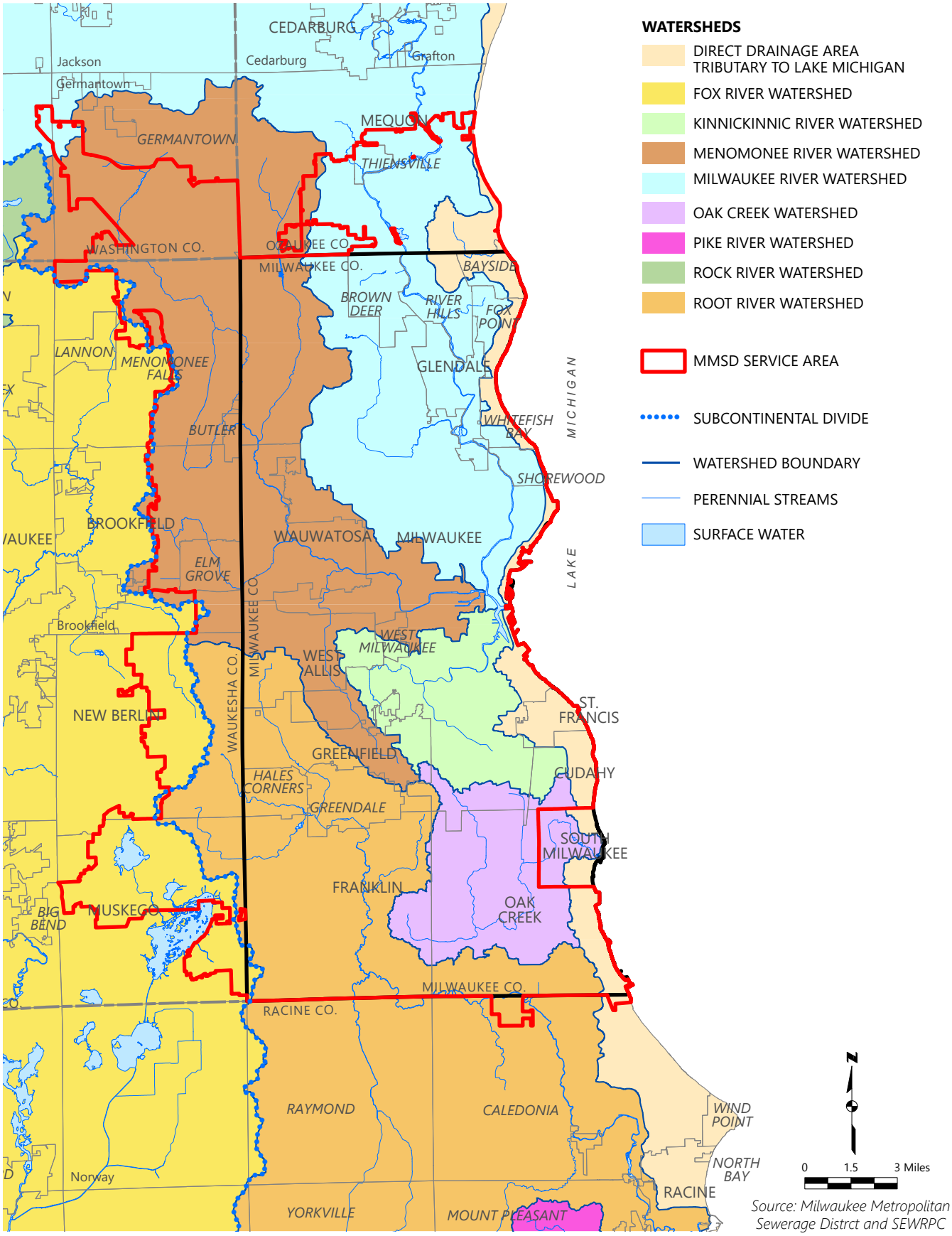
Source: SEWRPC

Map 5.4
Milwaukee Metropolitan Sewerage Distrct Greenseams Locations Within Milwaukee County: 2024



Source: Milwaukee Metropolitan Sewerage Distrct and SEWRPC

Map 5.5
Milwaukee Metropolitan Sewerage Distrct Service Area and Major Watersheds in Milwaukee County



Source: Milwaukee Metropolitan Sewerage Distrct and SEWRPC

Table 5.2
Milwaukee Metropolitan Sewerage District (MMSD) Jurisdictional Watercourses

Milwaukee River	Menomonee River (Mn.)	Kinnickinnic River (KK)	Oak Creek	Root River (RR)	Lake Michigan Tributary Drainage
Beaver Creek	Burnham Canal	43rd Street Ditch	Mitchell Field Drainage Ditch	104th Street Branch	Fish Creek
Brown Deer Park Creek	Grantosa Creek	Edgerton Channel	North Branch Oak Creek	Crayfish Creek	Fish Creek Southwest Tributary
Indian Creek	Honey Creek	KK River Mainstem	Oak Creek Mainstem	East Branch RR	Fish Creek County Line Tributary.
Lincoln Creek	Little Mn. River	KK River Estuary		Hale Creek	
Milwaukee River Mainstem	Mn. River Mainstem	Lyons Park Creek		Lower Crayfish Creek	
Milwaukee River Estuary	Mn. River Estuary	Villa Mann Creek		North Branch RR	
Southbranch Creek	Schoonmaker Creek	Villa Mann Creek Tributary		Tess Corners Creek	
	South Branch Underwood Creek	Wilson Park Creek		West Branch RR	
	South Mn. Canal			Whitnall Park Creek	
	Underwood Creek				
	Woods Creek				

Note: Maps of the jurisdictional stream extents can be found on the MMSD website in the Chapter 13 Rules section.

Source: MMSD and SEWRPC

Table 5.3
Major MMSD Watercourse Flood Mitigation Planning Projects and Studies in Milwaukee County: Up to Year 2035

Watershed	Watercourse Project or Study	2024 Estimated Cost (millions)
Milwaukee River	Indian Creek Improvements	0.21
	Beaver Creek Flood Management	0.30
	Milwaukee River Flood Management	1.18
	Milwaukee River Estabrook - Post Dam Removal	0.22
	N. 30th Street Corridor Project	70.80
	Milwaukee River/Lake Estuary Study	0.36
Menomonee River	Concordia Avenue Acquisition/Floodproofing	4.43
	Menomonee River - Western Milwaukee (Phase 2B)	49.15
	Menomonee River - FEMA Levee System Accreditation	15.67
	Menomonee River - Levee Sewer Rehabilitation	11.35
	Underwood Creek Reach 1 – Post Concrete Removal (Phase 2)	0.25
	Honey Creek Reach 1 - Concrete Removal	6.07
	Honey Creek- State Fair Culvert Rehabilitation (Phases 1 and 2)	30.40
	Menomonee River/Lake Estuary Study	0.10
Kinnickinnic (KK) River	KK River Watershed Flood Management Plan (Planning for KK Mainstem, Wilson Park Creek, Villa Mann Creek, Lyons Park Creek, and 43rd Street Ditch)	7.51
	KK River – Post Pulaski Park Project	0.74
	KK River - Jackson Park Project	70.00
	KK River- 6th to 16th Street	48.33
	43rd Street Ditch Reach 1	49.33
	Wilson Park Creek Projects	34.70
Oak Creek	Oak Creek Flood Management Plan - Floodproofing/Acquisition	6.66
Root River	Root River Floodplain Mapping Study	0.64
Lake Michigan Direct Drainage	Impacts of Lake and River Water Levels Study on MMSD Assets	0.17
	Coastal Flood Resiliency Improvements Projects (Jones Island and South Shore Water Reclamation Facilities)	1.82
All	Greenseams Projects 2025-2030	11.24
	Impacts of 1000-Year Flood	0.41
Totals	Floodplain-Related Projects	339.59
	Stormwater-Related Projects	82.45
	Total Project Costs	422.04

Note: Projects listed in table that focus more on stormwater management include the 30th Street Corridor Project, Greenseams, and 1000-Year Flood Impact Study.

Source: MMSD and SEWRPC

Milwaukee River Watercourse

- Milwaukee River Estabrook Dam Removal Follow Up Efforts
  The 81-year-old Estabrook Dam was removed in May 2018 due to deterioration and with the intent of restoring the natural functions of the river. Removing the dam also slightly reduced average and significantly reduced 1-percent-annual-probability water levels immediately upstream of the dam location as well as improved water quality, instream and riparian habitat, and recreational opportunities. Currently hydraulic and hydrologic modeling and floodplain mapping updates are being done to reflect the dam removal, which will impact areas of the Cities of Glendale and Milwaukee.

- Milwaukee River and Lake Michigan Estuary Study
  This study aims to develop mitigation alternatives to reduce flood risk to structures in the City of Milwaukee located in the 1-percent-annual-probability floodplain of the Milwaukee River Estuary using the updated Lake Michigan water-levels. Individual structure evaluations by private subcontractors may be considered for this plan.

Menomonee River Watercourse

- Menomonee River of Western Milwaukee (Phase 2B)
  This particular project, which ties together several other Menomonee River watercourse projects, will protect structures from the 1-percent-annual-probability flood along the Menomonee River in the Cities of Wauwatosa and Milwaukee (see Figure 5.2). These projects are a component of the *Phase II Watercourse Management Plan for the Menomonee River Watershed*, which identified overbank flooding in the vicinity of West State Street on the west side of Milwaukee. The project entails the design and construction of a levee and floodwall along West State Street to tie into the east end of a previously constructed levee.

- Menomonee River Levee System Accreditation
  This particular measure is to ensure the levees constructed along the Menomonee River in Hart Park and Valley Park meet WDNR NR 116 and FEMA 44 CFR 65.10 levee requirements.[120] This will allow identified structures within flood hazard areas to no longer be mapped in the Menomonee River SFHA.

- Sewer Rehabilitation for FEMA Levee Accreditation
  This project is intended to repair and rehabilitate certain points along the storm and sanitary sewer systems that penetrate the Hart Park and the Western Milwaukee Levee System on the Menomonee River. This measure is required to fulfill FEMA's accreditation requirements for certification of the levee system.

Kinnickinnic River (KK) Watercourse

- The KK River Watershed Watercourse and Flood Management Plan
  This includes two Preliminary Engineering (PE) studies and analysis work for portions of the KK River watershed. The purpose of this effort is to ultimately reduce flood risks to numerous residential and commercial structures located in the 1-percent-annual-probability floodplain in the KK River watershed. The first PE study refines the KK River Watershed Flood Management Plan (KKRWFMP)[121] recommendations for the Jackson Park and 43rd Street Ditch projects. The second PE study improves the KKRWFMP recommendations for the Wilson Park Creek, Villa Mann Creek, and Lyons Park Creek projects.

- Pulaski Park Project (Figure 5.3)
  This major project was recently constructed by MMSD to reduce flood risk just downstream for residential and commercial structures located in the KK River 1-percent-annual-probability floodplain between South 6th and 16th Streets in the City of Milwaukee and improve public safety (reduce drowning risk) from the high velocity concrete-lined KK River channel. To date, MMSD in partnership with Milwaukee County Parks and others, have removed over 1,700 feet of concrete lining from the KK River mainstem, constructed flood storage areas, and reconstructed the W. Cleveland Avenue bridge within Pulaski Park. This project will allow for slower stream velocities and reduce overall flood risks within this area.

- Jackson Park Projects
  This major watercourse project will reduce structural flood risk, improve public safety, as well as alleviate increased flood flows from future concrete channel lining removal projects on the KK River mainstem, Lyons Park Creek, and the S. 43rd Street Ditch. This project consists of acquiring properties, relocating the businesses and removing structures, creating flood storage, lowering and reshaping parkland and recreational fields, and dredging the lagoon to enhance flood storage. A new service yard building will be constructed to meet contractual requirements of the memorandum of understanding between MMSD and Milwaukee for using County-owned land for this and future flood mitigation projects.

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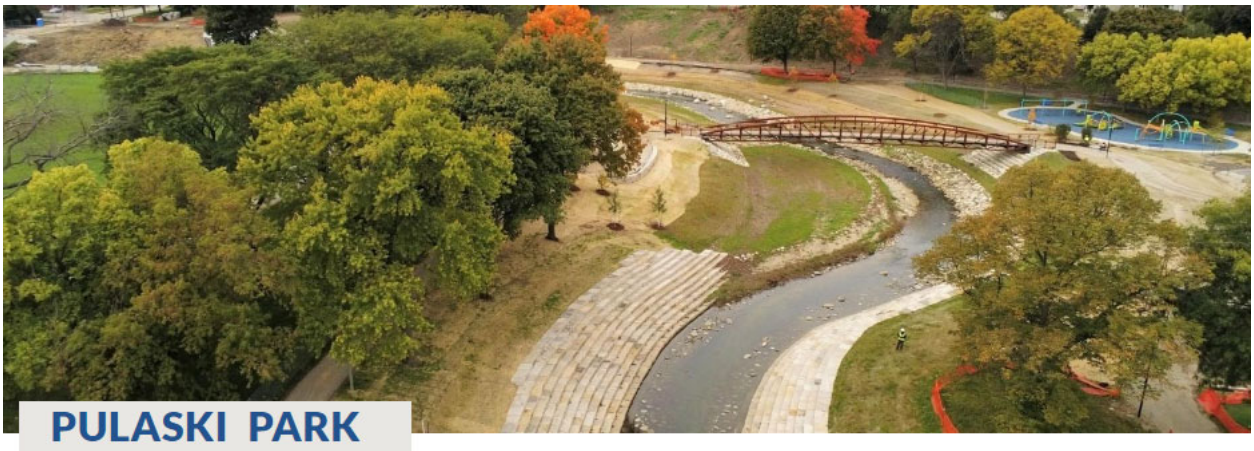
[120] *For purposes of the NFIP, FEMA only recognizes levee systems that meet, and continue to meet, minimum design, operation, and maintenance standards that are consistent with comprehensive floodplain management criteria. The Code of Federal Regulations, Title 44, Section 65.10 (44 CFR 65.10) describes the information needed for FEMA to determine if a levee system reduces the flood hazard from the 1-percent-annual-probability flood.*

[121] *GRAEF, Hey and Associates, Inc., and CDM Smith,* Kinnickinnic River Watershed Flood Management Plan*, May 2017.*

Figure 5.2
Menomonee River of Western Milwaukee Watercourse Project

Source: City of Milwaukee

Figure 5.3
Milwaukee Metropolitan Sewerage District, Milwaukee County, City of Milwaukee and Partners: Pulaski Park Kinnickinnic River Watercourse Project



Source: Milwaukee Metropolitan Sewerage District Project Page Website

- KK River – 6th to 16th Street Project
  The purpose of the project is to reduce flood risk on the KK River for approximately 300 residential and commercial structures located in the 1-percent-annual-probability floodplain between South 6th and 16th Streets in the City of Milwaukee. The project also improves public safety and improves aquatic and riparian habitat conditions. The project scope consists of the design and construction of a wider channel corridor from a width of 60 feet to approximately 200 feet within the project area. The wider channel will improve the passage of flood flows and allow the project to replace over 4,000 feet of concrete channel lining with a more naturalized channel. The project will modify City-owned bridges and utilities to create the wider channel section.

- 43rd Street Ditch Reach 1 Project
  This project reduces flood risk on the 43rd Street Ditch for nine commercial structures located in the 1-percent-annual-probability floodplain and reduce roadway flood depths at the intersection of two major arterial roads: W. Lincoln Avenue and S. 43rd Street. Working with the Jackson Park project, this project will also provide flood storage to reduce flood risk downstream on the KK River.

- Wilson Park Creek Projects
  Several projects are planned on Wilson Park Creek, pairing detention in Wilson Park and in Reach 3 with concrete removal to slow velocities and make the stream safer for the residents who live along it. The flood mitigation measures will reduce flow in the receiving stream, the KK River.

Oak Creek Watercourse

- Oak Creek Structural Acquisition and/or Floodproofing Study
  As of 2019, there are three identified structures remaining in the regulatory floodplain. The current proposal is to refine the Oak Creek Watercourse and Flood Management study to include structure acquisition, removal, or floodproof recommendations for the identified structures within the 1-percent-annual-probability floodplain.

Root River Watercourse

- Floodplain Modeling and Mapping Updates
  This effort will complete the Root River floodplain modeling and mapping efforts initiated under the Milwaukee County MCAMLIS (now MCLIO)[122] mapping program. Mapping updates for the upper part of the Root River mainstem and 27 tributaries in Milwaukee and Waukesha County will enhance the identification of structures at-risk of flooding from the 1-percent annual-probability event.

Lake Michigan Drainage Area-MMSD Facilities

- Impact of Water Levels on the MMSD Facilities and Assets Study
  The purpose of this Study is to determine the effects of high and low water surface elevations (Lake Michigan and the tributary rivers) on the MMSD Water Reclamation Facilities (WRFs) and conveyance assets, including flood and stormwater protection measures. It is intended to provide alternatives to reduce risks and provide cost estimates for each identified alternative. From this effort the two major projects listed below are envisioned.

- MMSD's Jones Island WRF Flood Resiliency Improvements
  The purpose of this project is to reduce the risk of flood damage to the Jones Island WRF and its assets, as well as confirm that staff will have safe access to and from the facility during a potential future flooding event.

- Flood Protection at the MMSD South Shore WRF
  The goal for this study is to mitigate flooding risks in low lying areas of the MMSD South Shore WRF. It is outlined to mitigate risks to safety, ongoing flood event repair costs, and operational effectiveness at the treatment plant.

Because floodplain modeling and mapping updates were in various stages during the drafting of this Plan, property owners of at-risk structures (Map 3.2) should consider additional on-site surveys from a private subcontractor or engineer to confirm the structure is indeed at risk to flooding. Subsequently, if confirmed, voluntary floodproofing or acquisition decisions should be made in collaboration with the local municipality and be consistent with the MMSD Flood Risk Reduction policy. Reducing structural risks, especially to critical community facilities and/or infrastructure, should be considered a high priority for flood risk reduction projects. Additionally, MMSD and its partners should continue to consider populations and assets most vulnerable to flooding impacts when developing mitigation projects.

[122] *MCAMLIS is now called the* Milwaukee County Land Information Office (MCLIO).

Actions to Address Structures Located in High-Risk Areas Based on Parcel-Based Analysis

In addition to the above MMSD Watercourse and Flood Management efforts, it is important to address the structures identified in the parcel-based analysis as potentially being in the 1-percent-annual-probability floodplain, as well as structures identified by FEMA that experience repetitive flooding issues.

As mentioned in Chapter 3, there are currently 1,483 insurable structures estimated to be located within the 1-percent-annual-probability flood hazard areas of Milwaukee County (see Tables 3.8 and 3.9), including four critical community facilities and 16 FEMA designated repetitive loss structures. The amount and general location of these insurable structures are shown on Map 3.2. The 16 repetitive loss structures are primarily residential along with three commercial structures. The combined estimated fair market value of these repetitive loss structures is $2.91 million (2022 dollars). The damages to the four critical community facility properties resulting from a 1-percent-annual-probability flood is estimated to be about $4.35 million (2022 dollars).

The following priority mitigation measures are recommended for the 1,483 at-risk structures identified in the parcel-based analysis:

- **Voluntary acquisition and removal** of up to 1,260 **residential structures** identified in the parcel-based analysis as potentially being in the 1-percent-annual-probability floodplains. Note, of the 1,260 structures, 28 are identified to be within the Lake Michigan coastal floodplain (see Map 3.12). These structures include *single-family residential* buildings, *apartment* buildings, and *condominiums* (note, manufactured homes were examined separately as these structures are considered highly vulnerable during extreme weather events). Following the demolition of the structures, the land should be kept as an open space for recreational and natural flood storage purposes. For any structure, this recommendation should be implemented following confirmation that the structure is indeed located within the 1-percent-annual-probability floodplain with additional in-field surveys. Again, this plan element is presented as a voluntary option, subject to the preference of the individual property owner. Also, voluntary acquisition should be in collaboration with the local municipality and consistent with the MMSD Flood Risk Reduction policy. As indicated in Table 5.4, the damages these properties would experience from a 1-percent-annual-probability flood are estimated to be about $76.1 million (2022 dollars). The estimated cost of acquiring and removing all 1,260 structures is approximately $508 million (2022 dollars).

    - As indicated in Chapter 3 and shown on Map 3.2 and in Table 3.9, the Cities of Glendale and Milwaukee and the Village of Fox Point have a significant number of parcels with structures located within the flood hazard areas of Milwaukee County. Further, Map 3.2 and Table 5.5 shows that the majority of these structures, specifically residential, are within the **Kinnickinnic** (530), **Milwaukee** River (515) and **Root** River (157) watersheds. With a significant amount of at-risk structures within the same vicinity (i.e., clusters), homeowners, municipalities, and MMSD should utilize the most up-to-date floodplain mapping and work together on the best flood mitigation alternatives. These would include voluntary structural acquisition and removal to provide open space (i.e., floodplain), park, and/or recreational opportunities. Potential 1-percent-annual-probablity flood damages to structures by watershed are listed in Table 3.8.

- **Voluntary removal** of 16 **manufactured homes and acquisition of the land** in the City of Franklin, as identified by the parcel-based analysis as being located in the 1-percent-annual-probability floodplains of the East Branch Root River. Following the removal of the manufactured homes, the land should be kept in open-space use. This recommendation should be implemented following confirmation with recent floodplain mapping updates and completing in-field surveys of the structures. This recommendation is presented as a voluntary option, subject to the preference of the individual property owner. The estimated cost of acquiring the land and relocating all 16 manufactured homes is about $3.52 million (2022 dollars).

- **Voluntary floodproofing**[123] of up to 207 **nonresidential structures**, including *commercial, critical community facilities, park,* and *utility* structures identified in the parcel-based analysis as potentially being in the 1-percent-annual-probability floodplains. This mitigation measure should only be implemented following further confirmation of the structure's location in relation to the flood hazard area. This can be done with additional in-field surveys by an engineer or surveyor.[124] Note, this plan element is presented as a voluntary option, subject to the preference of the individual property owner. Listed in Table 5.4, the damages these properties would experience from a 1-percent-annual-probability flood are estimated to be nearly $89.8 million (2022 dollars). The estimated cost of floodproofing all 207 structures is approximately $96.8 million.

    - Table 5.5 lists the number of nonresidential structures estimated to be within 1-percent-annual-probability floodplains by watershed. As indicated in Table 5.5, the **Kinnickinnic** River, **Menomonee** River, and **Root** River watersheds have the greatest amount of at-risk nonresidential structures in Milwaukee County. Potential damages to structures by watershed are listed in Table 3.8.

    - Priority mitigation measures to protect and floodproof **critical community facilities**, infrastructure, and utilities from flood hazard events is highly recommended for Milwaukee County. Based upon the parcel-based analysis and shown on Map 5.6, there are four identified critical community structures potentially located within the 1-percent-annual-probability floodplain. These structures include an adult day service facility and St. Lukes hospital located in the Kinnickinnic watershed within the City of Milwaukee; College Park Elementary School located in the Root River watershed in the Village of Greendale; and the Lake Express High-Speed Ferry terminal in the City of Milwaukee near the Lake Michigan shoreline. Listed in Table 5.4, the damages these properties would experience from a 1-percent-annual-probability flood are estimated to be about $4.35 million (2022 dollars). The estimated cost of floodproofing the four structures is approximately $4.95 million.

Actions to Address Flooding Hazards to Vulnerable Populations

Hazardous and extreme weather events including flooding are known to disproportionately impact communities of color, low-income, and disadvantaged populations, hence increasing their vulnerability to impacts caused by such events. As described in Chapter 2 of this Plan, the CDC created a Social Vulnerability Index (SVI) of every U.S. census tract. As indicated in Figure 2.1, the overall SVI for Milwaukee County ranges from high to low. Although socially vulnerable individuals live throughout the County, there are high concentrations of socially vulnerable residents in denser urban areas, specifically within and around the City of Milwaukee. Because of this, Milwaukee County and local community officials and agencies should work together on designing and implementing appropriate and beneficial flood mitigation measures within these denser urban areas to create a more resilient community.

Additional vulnerability assessments done within Milwaukee County that are highly recommended to use to implement this Plan are highlighted below.

The Milwaukee Flood and Health Vulnerability Assessment (MFHVA) Tool[125]

Described previously in Chapter 3, Groundwork Milwaukee, along with academia professionals and state partners, put together an interactive online mapping (or storymap) and data tool to help identify communities across the City of Milwaukee where exposure to urban flooding may disproportionately impact vulnerable populations due to socioeconomic and health conditions. The effort used a surface runoff model called

[123] ***Floodproofing*** *is a combination of structural and non-structural changes or adjustments made to the building that reduces or prevents flood damage to the structure and/or its contents. There are three main types of floodproofing: elevation, dry floodproofing, and wet floodproofing****. Elevation*** *is raising the first floor of the building above the 1-percent-annual-probability flood elevation, often with a factor of safety, and removing the use of the basement.* ***Dry floodproofing*** *is the practice of making a building watertight or substantially impermeable to floodwaters up to the expected floodwater height.* ***Wet floodproofing*** *reduces damage from flooding in three ways: allowing floodwater to enter and exit a structure to minimize structural damage, use of flood damage-resistant materials, and elevating important utilities. (FEMA, 2008).*

[124] *It is anticipated that the results of the floodplain map updating efforts, and the field surveys may reduce the number of structures that are confirmed to be in the flood hazard area and that may require floodproofing.*

[125] *Groundwork Milwaukee, Wisconsin Health Professionals for Climate Action, Medical College of Wisconsin, and the City of Milwaukee,* Milwaukee Flood and Health Vulnerability Assessment*, July 2023.*

Table 5.4
Structural Flood Damage Estimates From a 100-Year Flood Event in Milwaukee County

Structure Type	Damages (2022 Dollars)		Total
	Direct	Indirect	
Apartments	16,701,790	6,680,730	23,382,520
Commercial	60,875,080	24,350,060	85,225,140
Condominium	1,484,290	593,730	2,078,020
Critical Facility	3,104,410	1,241,770	4,346,180
Mobile Home	21,170	8,480	29,650
Parks	112,480	44,990	157,470
Residential	44,051,030	6,607,910	50,658,940
Utility	56,290	22,520	78,810

Source: MMSD and SEWRPC

Table 5.5
Estimated Number of Structures in the 1-Percent-Annual-Probability Floodplain by Watershed Within Milwaukee County

Major Watershed	Residential Structures	Nonresidential Structures
Kinnickinnic River	530	94
Lake Michigan Drainage Basin	27	1
Menomonee River	44	42
Milwaukee River	515	26
Oak Creek	3	7
Root River	141[a]	37
Total	1,260	207

[a] *The Root River residential structure total does* ***not*** *include the* ***16 manufactured homes in Franklin****, as they were examined separately for this portion of the Report.*

Source: MMSD and SEWRPC

CityCAT,[126] FEMA's 1-percent-annual-probability flood hazard zone, and U.S census tract data, with a focus on health, socioeconomic, and housing data to create an overall Flood Vulnerability Index (FVI) tool. As shown in Figure 5.4 (A), the FVI results indicate that overall, the majority of the City of Milwaukee is vulnerable to flooding, however the highest vulnerability values are concentrated in the City's central location. Census data gathered from this assessment was also used to generate flood exposure and vulnerability "hotspots." Locations identified as hotspots, shown in Figure 5.4 (B-D), should be considered priority locations to reduce the impacts of flooding as these are considered the most vulnerable communities.

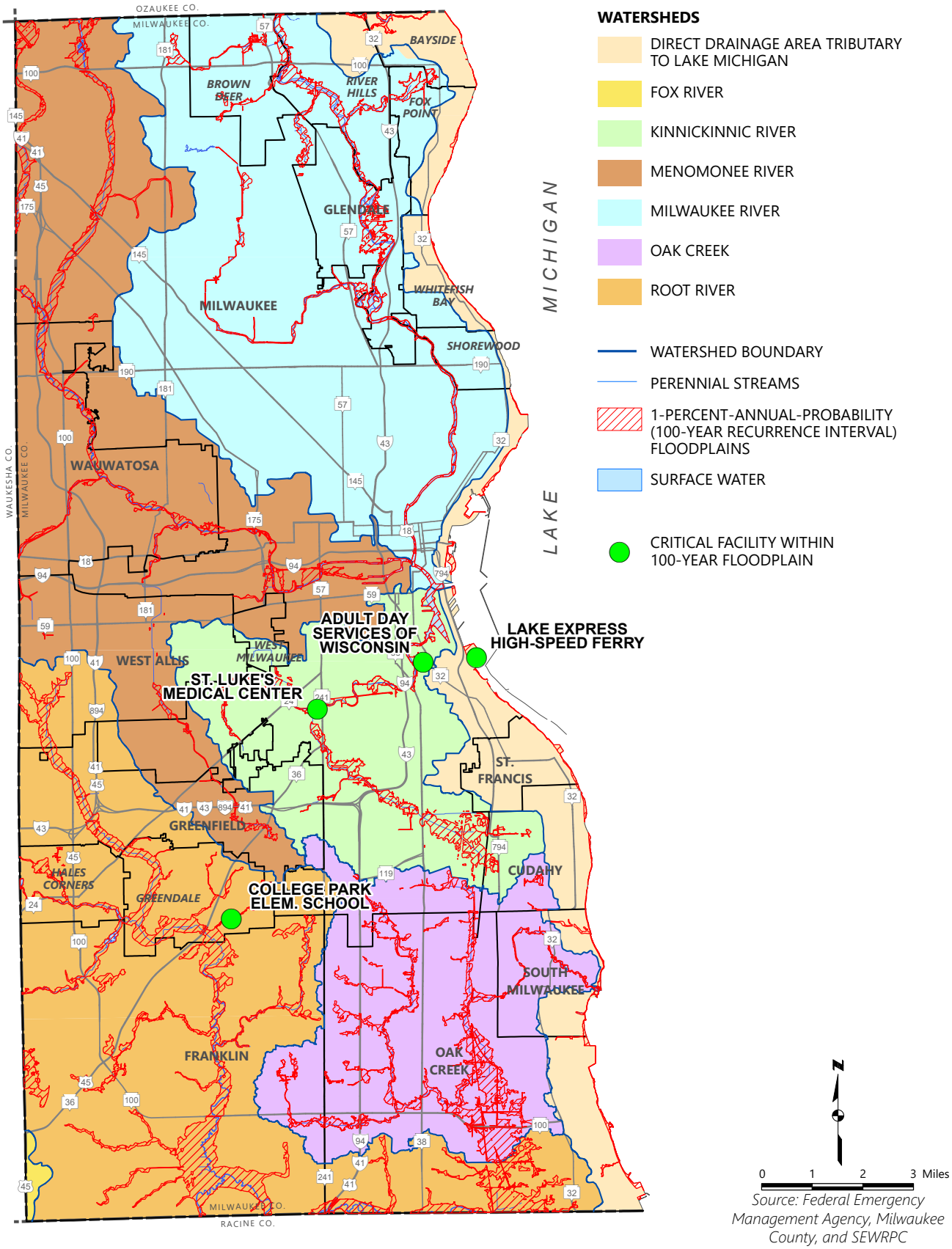
Milwaukee County Climate Action 2050 Plan Vulnerability Assessment[127]

During the drafting of this Plan, Milwaukee County conducted a comprehensive vulnerability assessment on the effects of climate change on Milwaukee County operations and residents. The assessment conducted a public survey for Milwaukee residents and when asked about their extreme weather concerns, community survey respondents reported road closures, damaged vehicles, sewage overflows, and flooded basements to be most impactful in their communities. The assessment also analyzed FEMA floodplains with the CDC SVI data and concluded there are four waterways which may disproportionately impact vulnerable communities due to a hazardous flooding event. These four streams include Wilson Park Creek, the Menomonee River, Lincoln Creek, and the Milwaukee River. These vulnerable communities in particular face strenuous economic challenges, exacerbating the risks associated with extreme flooding and ultimately impacting community resilience. Additionally, the assessment found high-priority assets deemed vulnerable or at-risk in the event of a 100- or 500-year flood. These sites are listed in Table 5.6.

[126] *The CityCAT model was used to compute the flow of water in real time accounting for infiltration based on the distribution of pervious and impervious surfaces for a 100-year, 1-hour storm in the City of Milwaukee.*

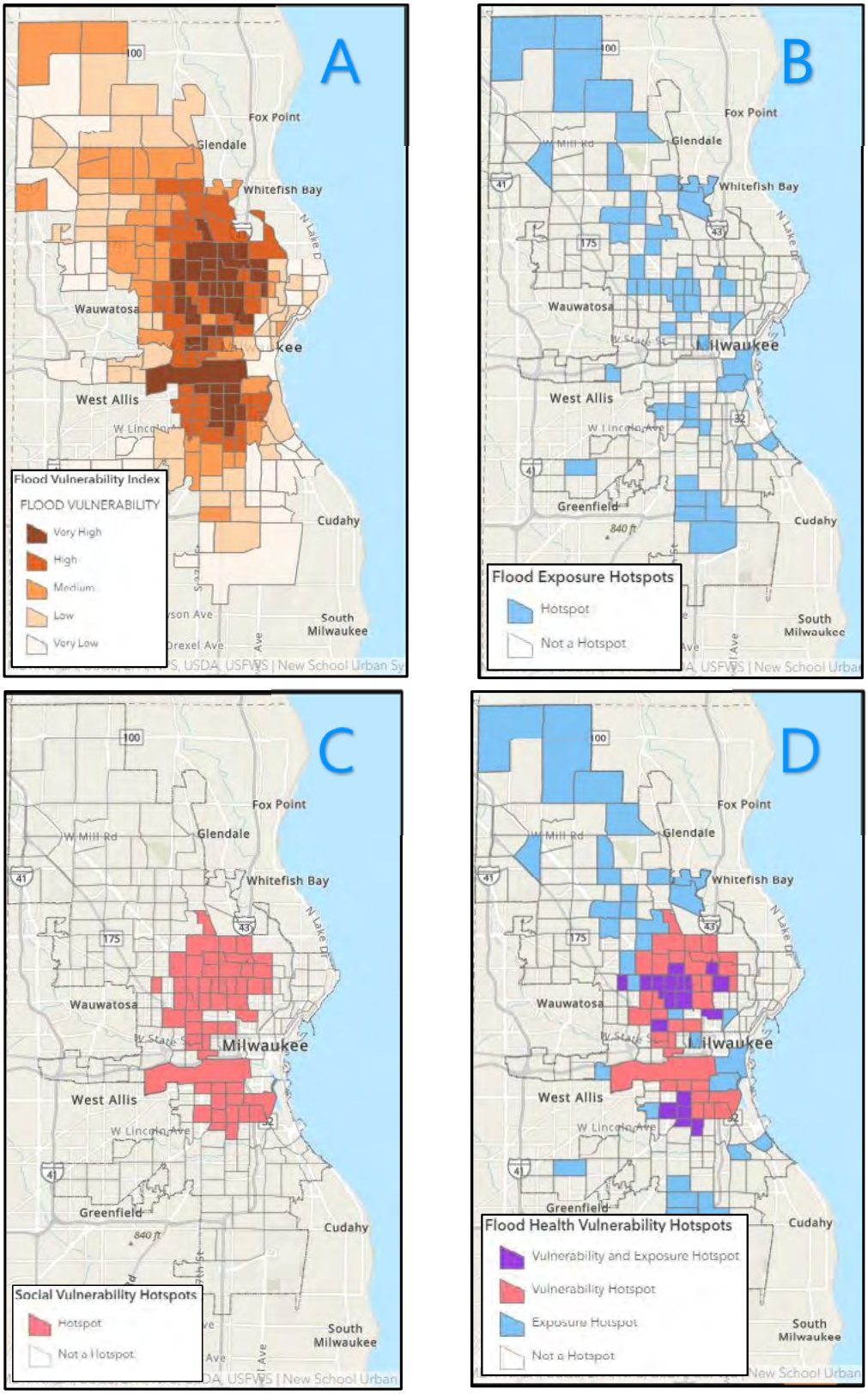
[127] *Milwaukee County,* Milwaukee County Climate Action 2050 Plan Vulnerability Assessment*, July 2023.*

Map 5.6
Critical Community Facilities Located Within the 100-Year Floodplain of Milwaukee County Via Parcel-Based Analysis



Source: Federal Emergency Management Agency, Milwaukee County, and SEWRPC

Figure 5.4
City of Milwaukee Flood and Health Vulnerability Assessment: Flood Vulnerability Locations



Source: Groundwork Milwaukee, Wisconsin Health Professionals for Climate Action, Medical College of Wisconsin, and the City of Milwaukee, Milwaukee Flood and Health Vulnerability Assessment, *July 2023.*

Table 5.6
Milwaukee County Climate Action 2050 Plan Vulnerability Assessment on County Assets to Flood Risks

Watercourse	Flood Event		Vulnerable Asset At-Risk
	100-Year	500-Year	
Menomonee River	X		Hart Park
	X		Public Transit Bus Route 31
	X	X	W. State Street
	X		S. 35th Street
		X	City of Milwaukee Forestry Department
		X	Senior living facility
		X	Potawatomi Gas Plant
		X	Muskego Rain Yard and Watertown Subdivision rail
		X	Miller Coors Facilities and other various commercial and industrial sites
		X	Piggsville residential neighborhood and State Street industrial and commercial corridor
		X	N. Port Washington Road
Milwaukee River	X		Kletzsch and Lincoln Parks
		X	Glendale and River Hills residential neighborhoods
Beaver Creek	X		Brown Deer Village Park
		X	Brown Deer Village Hall
		X	Public Transit Bus Routes 76 and 88
		X	Brown Deer residential neighborhood around Hwy 57 and W. Joleno Drive
		X	Commercial Districts in Brown Deer
	X	X	N. Green Bay Road
		X	N. 51st Street
Lincoln Creek		X	Ascension Family Health Center
		X	Residential neighborhoods: W. Villard Avenue, Harriet Tubman Park, 60th Street and Custer, and West Mills Road Crossing
		X	W. Hampton Avenue
Root River		X	West Oklahoma Avenue

Source: Milwaukee County, Milwaukee County Climate Action 2050 Plan Vulnerability Assessment, *July 2023.*

Actions to Address and Protect Vulnerable Infrastructure from Flooding Events

In addition to structural flooding, infrastructure such as major roadways and bridges within the County have been reported to experience frequent flooding problems. Flooding can have significant impacts on County and community infrastructure (such as transportation networks, building structures, and utility systems), including the disruption of travel (emergency vehicle response, public transportation routes or public mobility to access a safe location) and critical utility services (electricity, heat, power plants, water treatment facilities, etc.). For those reasons, this Plan recommends that community development or redevelopment plans incorporate resilient infrastructure designs to withstand the impacts of a 1-percent-annual-probability flood event.

Table 5.7 highlights specific areas within the County known to or mapped as overtopping during a heavy rain event. [128] A roadway is often considered impassable when flood depths reach one foot. Because of this, roadway flooding can pose a significant safety risk to residents of Milwaukee County, (i.e., driving through the flooded portion of the road not knowing water depths and/or velocity) as well as impede roadway accessibility for residents and emergency responders. This Plan recommends that known roadway flooding locations be evaluated for alternatives to reduce future flooding risks. It is further recommended that evaluations of flood risk be conducted on all major transportation systems including roadways, bridges, railroads, and airports in Milwaukee County that are located within or near the 1-percent-annual-probability floodplain. In doing so, County and local government officials, emergency responders, and public transportation and utility personnel will be provided with better information to help prepare and plan for alternate routes and facilities to use during hazardous flooding events.

[128] *SEWRPC Memorandum Report No. 259,* A Watercourse System Plan for Honey Creek: Milwaukee, Wisconsin, *October 2022; SEWRPC Community Assistance Planning Report No. 330,* A Restoration Plan for the Oak Creek Watershed, *December 2021; Milwaukee County Parks.*

Table 5.7
Roadway Flooding Concerns in Milwaukee County: 2024

Municipality	Roadway Flooding Locations	Resource
City of Franklin	Around Whitnall Park beer garden along Root River Parkway and College Avenue	Milwaukee County
City of Greenfield	The intersection of Layton Avenue and the Root River Parkway	Milwaukee County
	630-foot-long stretch of S. 43rd Street, just north of W. Edgerton Avenue	SEWRPC
	W. Loomis Road crossing	SEWRPC
	W. Layton Avenue crossing	SEWRPC
	West of Honey Creek on S. Placid Drive just south of W. Allerton Avenue	SEWRPC
	East of the Creek on W. Allerton Avenue just west of S. Honey Creek Drive	SEWRPC
City of Milwaukee	Between Morgan Avenue and Howard Avenue on the Oak Leaf Trail	Milwaukee County
	Lincoln Park on Hampton Avenue on north side of the road, just west of Milwaukee River Parkway	Milwaukee County
	W. Ohio Avenue east and west of Honey Creek	SEWRPC
	200-foot-long stretch of W. Honey Creek Drive and 500-foot-long stretch of S. Honey Creek Drive southwest of Honey Creek near S. 72nd Street	SEWRPC
	1,170-foot-long stretch of S. 72nd Street intersecting Honey Creek	SEWRPC
	600-foot-long stretch of W. Lakefield Drive north of Honey Creek	SEWRPC
	490-foot-long stretch of N. Honey Creek Parkway east of Honey Creek, 610 feet south of W. Bluemound Road	SEWRPC
City of Oak Creek	Stormwater pond adjacent to Howell Avenue (west side of road) floods during high rain events	SEWRPC
City of South Milwaukee	Stormwater flooding under railroad tracks at College Avenue due to inadequate inlet capacity at street level	SEWRPC
	Stormwater flooding along Rawson Avenue at the railroad tracks during extreme events	SEWRPC
	Stormwater flooding occurs at Marquette Avenue and UP railroad overpass during heavy rain events	SEWRPC
City of Wauwatosa	W. Wisconsin Avenue intersecting Honey Creek (bridge)	SEWRPC
	1,490-foot-long stretch of N. Honey Creek Parkway east of Honey Creek, 670 feet southwest of Portland Avenue	SEWRPC
	N. Honey Creek Parkway crossing, 250 feet southwest of Portland Avenue	SEWRPC
	860-foot-long stretch of W. Honey Creek Parkway north of Honey Creek, 1,400 feet west of N. 70th Street	SEWRPC
City of West Allis	Between Cleveland Avenue and Oklahoma Avenue on the west side	Milwaukee County
	Between National Avenue and Morgan Avenue	Milwaukee County
Village of Greendale	College Avenue across from College Park	Milwaukee County
	Intersection of College Avenue and 51st Street	Milwaukee County

Source: Milwaukee County Parks Department, SEWRPC MR No. 259, A Watercourse System Plan for Honey Creek, *2022 and SEWRPC CAPR No. 330,* A Watershed Restoration Plan for Oak Creek, *2014.*

Participation in the National Flood Insurance Program (NFIP)
and Floodplain Mapping Revisions and Updates

Based on a detailed countywide Flood Insurance Study (FIS), FEMA produces Digital Flood Insurance Rate Maps (DFIRMs) to identify areas in the county that are subject to flooding. Through FEMA's Map Modernization program,[129] Milwaukee County's effective countywide FIS was completed in September 2008 (see Table 5.8). As a result, Milwaukee County and communities are able to participate in the FEMA National Flood Insurance Program (NFIP), allowing residents impacted by flood events to purchase government backed flood insurance. As such, this Plan calls for homeowners in and near flood-prone areas to purchase flood insurance to provide some financial relief for flood losses. Hence, Milwaukee County and its communities should continue to participate in the NFIP and, as necessary, request that FEMA revise the FIS to reflect new flood hazard data. Finally, as recommended flood control measures are implemented, the impacted communities should submit map revisions to FEMA. Current FEMA effective floodplain maps for Milwaukee County are available and can be viewed on the FEMA, WDNR, and Milwaukee County websites.

As part of modernizing Milwaukee County's mapping, a cooperative agreement in 1990 was executed between Milwaukee County and three local utility companies for the development and maintenance of a Milwaukee County Automated Land Information System (MCAMLIS). Under that program, large-scale digital topographic mapping was prepared for all of Milwaukee County. The MCAMLIS Steering Committee also requested that the Commission carry out a digital floodplain mapping program. Hydrologic and hydraulic analyses and mapping completed under the MCAMLIS effort are now being refined for local zoning and FEMA flood insurance purposes. These more recent mapping modifications and updates are being incorporated in the DFIRMs through the Letter of Map Revisions (LOMR)[130] process. Current floodplain modeling and mapping updates that are underway include the Root River, portions of the Menomonee River mainstem and several of its tributaries, and Fish Creek.

As documented in Chapter 2, during the drafting of this Plan various floodplain modeling and mapping updates were ongoing or near completion through the FEMA process. As such, the floodplains used in this Plan consisted of a combination of the FEMA effective floodplains, the Commission developed floodplains on certain streams, Menomonee River and Estabrook Dam LOMRs, and maps on certain streams developed by WDNR as part of the Risk MAP effort.[131] It should be noted that updated Milwaukee County DFIRMs and an FIS report will become effective on October 24, 2024.

Participation in Community Rating System

The NFIP's Community Rating System (CRS) is a voluntary incentive program that recognizes and encourages community floodplain management activities that exceed the minimum NFIP requirements. As a result, flood insurance premium rates are discounted to reflect the reduced flood risk resulting from the community actions meeting the three goals of the CRS:

- Reduce flood damage to insurable property
- Strengthen and support the insurance aspects of the NFIP
- Encourage a comprehensive approach to floodplain management

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[129] *In 2003, FEMA implemented* the **Map Modernization program**. *This program was intended to upgrade and distribute FIRMs into a digital format, rather than on paper (i.e., Digital Flood Insurance Rate Maps or "DFIRMs"). This program used state-of-the-art technology and advanced engineering to increase the quality, reliability, and availability of flood hazard maps and data and employed a collaborative process to involve state, regional and local partners in mapping tasks.*

[130] **A Letter of Map Revision (LOMR)** *is FEMA's modification to an effective Flood Insurance Rate Map (FIRM). Letter of Map Revisions are generally based on the implementation of physical measures that affect the hydrologic or hydraulic characteristics of a flooding source and thus result in the modification of the existing regulatory floodway, the effective Base Flood Elevations (BFEs), or the Special Flood Hazard Area (SFHA). The LOMR officially revises the Flood Insurance Rate Map (FIRM) and modifies data in the Flood Insurance Study (FIS) report.*

[131] *In 2010, FEMA began its new* **Risk Mapping, Assessment, and Planning (Risk MAP) program**. *This refined program provides communities with both flood information and tools and updated DFIRMs that communities can use to make better informed decisions and to take action to reduce risk to life and property.*

Table 5.8
Participation in the National Flood Insurance Program by Milwaukee County Jurisdictions

Municipality	Participating in Milwaukee County Hazard Mitigation Plan	Participating in National Flood Insurance Program	Date Initial Flood Hazard Boundary Map Identified	Date of Initial Flood Insurance Rate Map (FIRM)	Current Effective Map Date[a]	Entry Date into National Flood Insurance Program
Cities						
Cudahy	Yes	Yes	06/07/1974	12/15/1978	09/26/2008(M)	12/15/1978
Franklin	Yes	Yes	01/09/74	09/30/1977	09/26/2008	09/30/1977
Glendale	Yes	Yes	12/17/1973	06/01/1978	09/26/2008	06/01/1978
Greenfield	Yes	Yes	12/17/1973	08/15/1979	12/16/2015[d]	06/01/1978
Milwaukee	Yes	Yes	06/28/1974	03/01/1982	10/19/2023[d]	03/01/1982
Oak Creek	Yes	Yes	03/22/1974	09/29/1978	09/26/2008	09/29/1978
St. Francis	Yes	Yes	06/07/1973	07/07/1978	09/26/2008(M)	07/07/1978
South Milwaukee	Yes	Yes	12/28/1973	04/15/1980	09/26/2008	04/15/1980
Wauwatosa	Yes	Yes	12/21/1973	12/01/1978	09/26/2008	12/01/1978
West Allis	Yes	Yes	04/12/1974	04/15/1981	09/26/2008	04/15/1981
Villages						
Bayside[b]	Yes	Yes	02/22/1974	06/15/1977	07/31/2024[c]	06/15/1977
Brown Deer	Yes	Yes	12/17/1973	03/28/1980	05/19/2014(M)	12/17/1973
Fox Point	Yes	Yes	03/01/1974	05/16/1977	09/26/2008	05/16/1977
Greendale	Yes	Yes	12/28/1973	08/02/1982	09/26/2008	08/02/1982
Hales Corners	Yes	Yes	05/03/1974	06/15/1979	09/26/2008	06/15/1979
River Hills	Yes	Yes	12/17/1973	04/15/1980	09/26/2008	04/15/1980
Shorewood	Yes	Yes	12/14/1973	08/11/1978	09/26/2008(M)	08/11/1978
West Milwaukee	Yes	Yes	--	09/26/2008	(NSFHA)[d]	09/28/1978
Whitefish Bay	Yes	Yes	02/22/1974	05/01/1987	09/26/2008(M)	05/01/1987
County Total	Yes	Yes	--	09/26/2008	10/24/24	09/26/2008

[a] *(M) No elevation determined- All zone A, C and X. Date will change to 10/24/24 when updated Countywide maps become effective.*

[b] *The Village of Bayside is in both Milwaukee and Ozaukee Counties, because of this the Village has decided to participate in Milwaukee County's All Hazard Mitigation Plan.*

[c] *Date of latest approved LOMR in the community*

[d] *NSFHA stands for Non-Special Flood Hazard Area.*

Source: Federal Emergency Management Agency

During the drafting of this Plan update, there were no municipalities within Milwaukee County participating in the CRS program. Therefore, it is recommended that Milwaukee County and its municipalities consider participating in the CRS program to directly provide a benefit to residents for flood hazard mitigation efforts.

Documentation of the Extent of Future Floods

It is recommended that when flooding occurs in Milwaukee County, the County and affected municipalities document the extent of the floods as well as damages incurred by the flood. A number of methods could be used to accomplish this, including aerial, satellite, or ground-based photography showing locations of flooded areas; surveying and mapping of the elevation of debris lines resulting from floods; or other documentation techniques. Data developed from documenting the extent of future floods can be used to periodically refine the hydrologic and hydraulic simulation models used to develop the DFIRMs and FIS. In addition, such data may also be useful in bridge and culvert design and in water quality management planning. A current example to reference is the ongoing MMSD Watercourse Corridor Study, in which time-lapse imaging is used to document the impacts caused during and after an intense rainfall event on stream conditions and the adjacent environment.

MMSD Watercourse Corridor Study

MMSD, the U.S. Geological Survey (USGS), and the University of Wisconsin-Milwaukee School of Freshwater Sciences are conducting a long-term study on the hydrologic, geographic, physical, biological, and chemical properties of the major waterways within the MMSD service area. Currently, the study is in its sixth phase

(2021-2025), which involves refining the earlier information and data collection methods, including streamflow. Streamflow measurements are being collected at seven sites, in which six of the sites are using time-lapse image capabilities using a mounted camera continuously capturing a photo at pre-set intervals. Stream monitoring sites with time-lapse imaging include the following.

- Little Menomonee River near Freistadt Road
- Little Menomonee River upstream of the confluence with the Menomonee River
- Honey Creek upstream of the confluence with the Menomonee River
- Menomonee River at 16th Street
- Milwaukee River at its mouth at Jones Island
- Root River at Grange Avenue

Employing this technique provides the ability to visually document and analyze real-time effects of an extreme rainfall event on stream channel and riparian conditions (example: Figure 5.5).[132] This available information, which is accessible on the USGS Water Data for the Nation (WDFN) website, should be considered for Milwaukee County flood hazard mitigation planning. Further, Milwaukee County and/or MMSD should consider deploying additional monitoring sites using the same capabilities (i.e., mounted cameras) within all the major watersheds of Milwaukee County. These additional monitoring sites can provide MMSD and the County with supplementary insight on the effects of rainfall and timing of flooding events, allowing for better flood mitigation planning.

MMSD Study on 1000-Year Storm Model

To evaluate stormwater ponding areas in the County, MMSD is working with a consultant to utilize hydrologic and hydraulic models with high resolution digital elevation models (DEMs) to analyze the potential impacts from larger storms events (i.e., 1000-year storm) within the MMSD service area. The intent of this modeling effort is to identify potential "hot spots" with a high stormwater flooding risk. With input from the affected municipalities regarding priorities, MMSD chose areas to study in more detail.

Stream Channel Maintenance Activities and Project Recommendations

As mentioned in Chapter 2 and shown on Map 2.6, sections of urban watercourses within MMSD's jurisdiction were channelized and lined with concrete to improve conveyance capacity. This practice has caused negative impacts including increases to flow velocities, increases to the severity of flooding downstream, reductions in flood storage, streambed and streambank erosion, decreases in water quality, and the loss of riverine and riparian habitat. Additionally, during flooding events the concrete lined channels experience a rapid increase in stream flows and velocities, which creates a major public safety concern (injury or drowning). In response to the negative impacts of concrete-lined channels, this Plan calls for MMSD, the communities, and Milwaukee County to continue their ongoing and planned efforts of restoring the Region's channels to more natural stream conditions and in turn, reducing flood risks within the County.

As indicated in Table 5.3 and highlighted below are major ongoing or planned MMSD channel concrete removal projects which play a critical role in flood risk reduction and are therefore considered a priority mitigation alternative for this Plan. Costs for implementing the planned concrete-channel removal projects are listed in Table 5.3.

Menomonee River Watershed

- Honey Creek Watercourse-Reach 1 Concrete Removal
  This watercourse plan includes removing approximately 3,900 feet of concrete-lined Honey Creek channel from W. Wisconsin Avenue to W. Fairview Avenue extended (Reach 1). It also includes constructing a more naturalized channel on nearly 1,100 feet of concrete channel and approximately 3,700 feet of heavily eroding natural channel from Wisconsin Avenue downstream to the Menomonee River.

[132] *MMSD,* Watercourse Corridor Study: Continuous Real-Time Streamflow | *U.S. Geological Survey (usgs.gov).*

Kinnickinnic River (KK) Watershed

- KK River Mainstem Watercourse-Jackson Park
  This project involves the removal of about 1,400 feet of concrete channel and enclosed culverts, lowering the floodplain, and naturalizing the channel. This project was part of a recommended alternative from the KK River Watershed Preliminary Engineering study.

- KK River Mainstem Watercourse-Pulaski Park
  To improve safety as well as stream and riparian habitat, this plan includes removing about 1,900 feet of concrete-lined channel within Pulaski Park. Additionally, this project will involve the removal of residential structures and widening of the channel to improve flood flows.

In addition to concrete-removal mitigation measures, this Plan recommends MMSD, Milwaukee County, and local municipalities remove objects (i.e., woody debris or trash) within the stream channel or culverts observed to be obstructing and/or potentially impounding flood flows.

It should be noted, that while MMSD would address the most severe problems associated with channel obstructions (i.e., blocking the floodplain), MMSD does not address the obstruction of storm sewer outlets. Those problems will need to be addressed by the County and its municipalities as appropriate. Overall, all stream channel maintenance projects, including concrete-removal, should be considered a priority mitigation measure for Milwaukee County hazard mitigation planning.

Figure 5.5
Milwaukee Metropolitan Sewerage District Watercourse Corridor Study: Real-Time Imaging Data Collection on Kinnickinnic River Mainstem at S.11th Street: 2022

Source: United States Geological Survey and Milwaukee Metropolitan Sewerage District

Lending Institution and Real Estate Agent Policies

The plan calls for lending institutions to continue their practice of determining the flood-prone status of properties before mortgage transactions. The principal sources of flood hazard information will be the most recent available studies for the watersheds and subwatersheds located partly or wholly within the County. Furthermore, real-estate brokers and salespersons are to continue to inform potential purchasers of property of any flood hazard that may exist at the site being traded in accordance with Chapter 707, "Disclosures by Owners of Real Estate," of the *Wisconsin Statutes*.

Installation and Continued Maintenance of U.S. Geological Survey (USGS) Stream Gages on Streams and Rivers of Milwaukee County

As listed in Table 5.9, Milwaukee County currently has 17 active USGS stream flow gages within its boundaries.[133] These gages are located on the Milwaukee River, Menomonee River, Kinnickinnic River, Oak Creek, and Root River mainstems, as well as on Holmes Avenue Creek, Honey Creek, Lincoln Creek, the Little Menomonee River, Underwood Creek, and Wilson Park Creek. Additionally, there are six active USGS gages monitoring flows for streams flowing into and out of the County (see Map 5.7). Streamflow data can act as an early warning for potential flooding events for those downstream by indicating rising water levels which ultimately can provide information to emergency responders about which areas may experience the worst flood conditions.

[133] *waterdata.usgs.gov/wi/nwis.*

Table 5.9
United States Geological Survey Active Stream Gage Locations in the Milwaukee County Area: 2023

Map 5.7 ID	Site Name	Site Number	Years of Operation	Watershed
1	Little Menomonee River at Milwaukee	4087070	2004 - Present	Menomonee River
2	Lincoln Creek at Sherman Boulevard at Milwaukee	40869416	2003 - Present	Milwaukee River
3	Milwaukee River at Milwaukee	4087000	1914 - Present	Milwaukee River
4	Menomonee River at 16th Street at Milwaukee	4087142	2008 - Present	Menomonee River
5	Menomonee River at Wauwatosa	4087120	1961 - Present	Menomonee River
6	Honey Creek at Wauwatosa	4087119	2004 - Present	Menomonee River
7	Underwood Creek at Wauwatosa	4087088	1980 - Present	Menomonee River
8	Wilson Park Creek at St. Lukes Hospital at Milwaukee	40871488	1997 - Present	Kinnickinnic River
9	Kinnickinnic River at 11th Street at Milwaukee	4087159	1982 - Present	Kinnickinnic River
10	Milwaukee River at Mouth at Milwaukee	4087170	2006 - Present	Milwaukee River
11	Wilson Park Creek at GMIA Outfall 7 at Milwaukee	40871475	1997 - Present	Kinnickinnic River
12	Holmes Avenue Creek Tributary at GMIA Outfall 1 at Milwaukee	40871476	1997 - Present	Kinnickinnic River
13	Wilson Park Creek at GMIA Infall at Milwaukee	40871473	1997 - Present	Kinnickinnic River
14	Oak Creek at South Milwaukee	4087204	1963 - Present	Oak Creek
15	Root River at Grange Avenue at Greenfield	4087214	2004 - Present	Root River
16	Root River near Franklin	4087220	1963 - Present	Root River
17	Root River at 60th Street near Caledonia	4087234	2016 - Present	Root River
18	Cedar Creek near Cedarburg	4086500	1990 - Present	Milwaukee River
19	Milwaukee River near Cedarburg	4086600	1981 - Present	Milwaukee River
20	Little Menomonee River near Freistadt	4087050	2007 - Present	Menomonee River
21	Root River Canal near Franklin	4087233	1963 - Present	Root River
22	Root River at Racine	4087240	1963 - Present	Root River
23	Menomonee River at Menomonee Falls	4087030	1979 - Present	Menomonee River

Source: United States Geological Survey and SEWRPC

As part of this Plan update, it is proposed to maintain the current USGS stream gages and to consider installing at least one additional gage in the upper portion of the Milwaukee River watershed. Continuous flow data collected at this additional location would provide information necessary to develop more precise floodplain modeling and more accurate flood event forecasting. The cost to install one USGS stream gage with all new equipment is about $15,000 (2023 dollars). After installation, operation and maintenance costs are about $13,000 per year.

Actions to Manage the Potential Flood-Related Impacts of Dam Failure

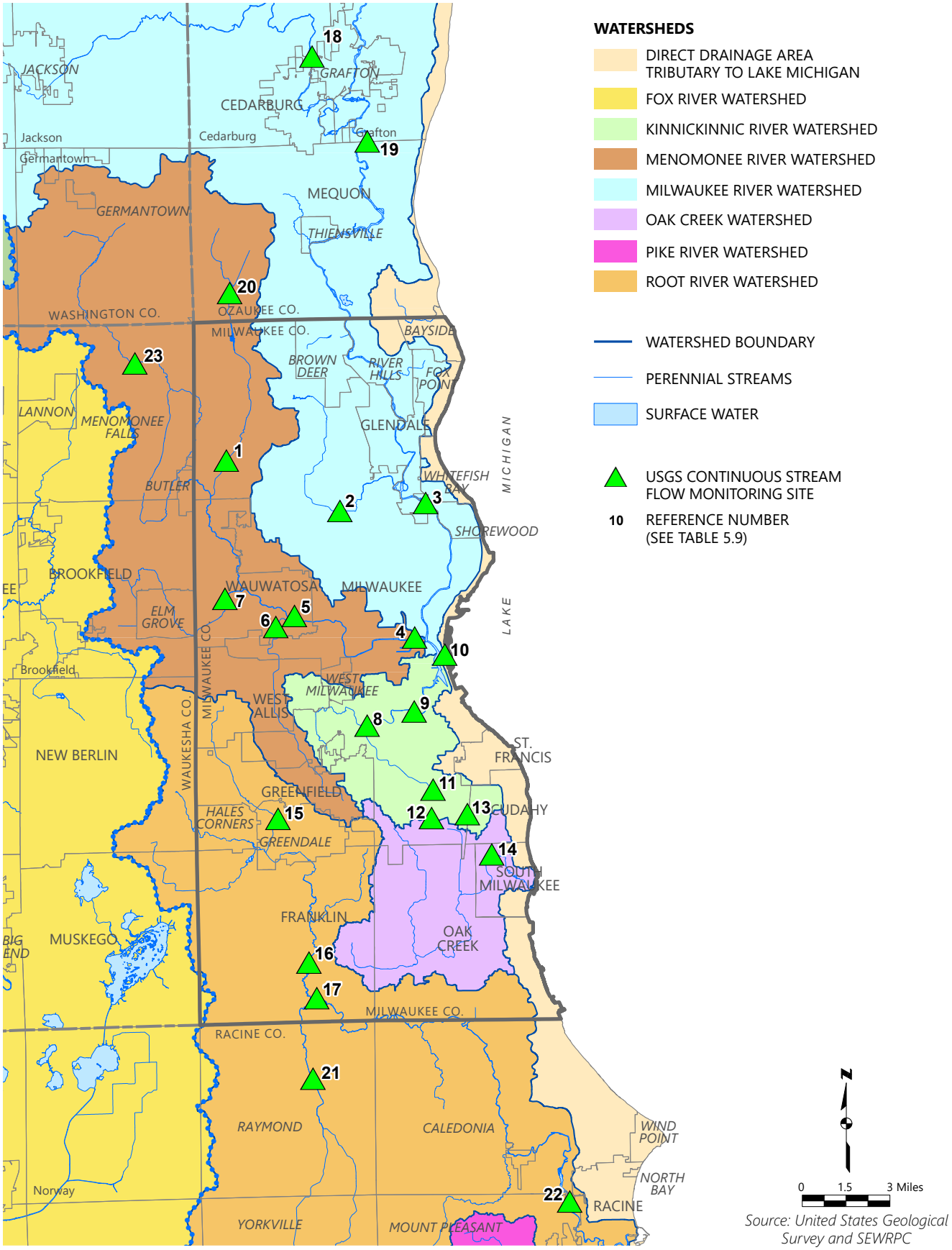
Flooding can also occur as a result of a dam failure. Dam failure flooding may occur when flood flows exceed the hydraulic capacity of the dam spillways, resulting in water overtopping the dam or abutments or when structural failure of the dam occurs. The potential impacts of such failure are related both to the size and configuration of the dam and to the amount, types, and locations of development downstream of the dam. The most at risk location for a dam failure is immediately downstream of a dam. Therefore, assessing the potential for loss in the event of a dam failure is an important part of flood hazard mitigation.

As discussed in Chapter 3 of this Report, the WDNR lists nine existing dams located in Milwaukee County (see Table 3.6 and Map 3.1) Based on the dam locations within Milwaukee County, The Milwaukee County Grounds dam on the County Grounds impoundment has been assigned a high hazard rating by the WDNR, indicating the potential for loss of human life as well as economic loss, environmental damage, or disruption of lifelines during failure or misoperation of the dam. The remaining dams in Milwaukee County are County-, MMSD-, or privately-owned low hazard rating dams.

The following mitigation measures are recommended to address the risk of flooding due to dam failure in Milwaukee County:

- All dams in Milwaukee County should be regularly inspected and maintained. Chapter 31, "Regulation of Dams and Bridges Affecting Navigable Waters," of the *Wisconsin Statutes*, requires inspection of dams by a professional engineer with experience in dams at a frequency based upon

Map 5.7
United States Geological Survey Stream Flow Gage Locations in Milwaukee County



Source: United States Geological Survey and SEWRPC

the dam's hazard rating. High hazard dams are required to be inspected every two years, significant hazard dams are required to be inspected every three to four years, and low hazard dams are required to be inspected every 10 years. In addition, it is recommended that owners and operators of dams inspect their dams both on a regular basis and following any high-water event.

- Owners or operators of dams should continue to monitor their dams during high water events.
- MMSD as the owner and operator of the high hazard dam should develop, maintain, and periodically update the emergency action plan for this dam.
- Owners and operators of dams of any hazard rating should consider developing, maintaining, and periodically updating emergency action plans for their dams. Requirements for emergency action plans as well as guidance and templates for developing such plans are available from the WDNR. Such a plan should include:
    - Procedures to be followed to warn the public in the event that a dam failure is likely to occur.
    - Procedures for evacuating areas likely to flood as a result of failure of the dam.
    - An identification of road closings and rerouting is needed to keep traffic and people out of danger areas in the event of flooding due to failure of the dam.
    - Dam failure analyses should be completed for those dams for which they are required and have not been done.
    - Hydraulic shadows from available dam failure analyses should be accessible and added to County and local government websites within their GIS map layers. Local units of government within the County should regulate and zone the hydraulic shadow areas as floodway, unless the shadow area is specifically mapped as floodway and flood fringe for the dam hazard designation.

Recent projects and plans associated with dam work within Milwaukee County include the following. Project costs can be found in Table 5.3.

Estabrook Dam Removal

MMSD removed the Estabrook Dam from the Milwaukee River in 2018. As a result, the water levels immediately upstream of the former dam site lowered and altered the regulatory floodplain. As result, the City of Glendale, with MMSD assistance, is preparing to revise the floodplain delineation near the former dam location. Updating the floodplains to reflect the dam removal should be considered a priority as part of this Plan update. This work will improve the estimated damages and structure count associated with a 1-percent-annual-probability event, particularly in the Cities of Glendale and Milwaukee.

South Milwaukee Mill Pond Dam Sediment Analysis and Mitigation Alternatives

As part of the Commission's comprehensive watershed restoration plan for Oak Creek (Report),[134] the Mill Pond and dam were analyzed for flooding, water quality, habitat, and recreational access. For this Plan, information related to flood mitigation is the main focus. The maintenance sluice gate for the dam is inoperable, and the WDNR is requiring the gate be repaired or other options be considered for the dam location. The Report concluded that the Mill Pond was not designed to provide flood storage but instead created for recreational and aesthetic purposes. Additionally, the Report states that under the current configuration of the dam, the regulatory FEMA floodplain overtops the adjacent Oak Creek Parkway and bypasses the dam abutments. The Report evaluated five alternatives for the dam and pond location, as well as an emergency spillway design to improve safety and lower flood elevations in the pond area. Additional dam alternatives to consider for flood mitigation, as listed in the Report, include sluice gate repair, sediment dredging to enhance the pond, or dam removal. Estimated costs of implementing the different dam alternatives can be found in the Report. In 2022 Milwaukee County performed sediment core sampling in

[134] *SEWRPC Community Assistance Planning Report No. 330*, A Restoration Plan for the Oak Creek Watershed (Volume 1-3), *December 2021*.

the Mill Pond and the lab analysis indicated high metal levels are present. This result will modify dredging costs that are in the Commission's report. Currently Milwaukee County is working with a consultant to get public input on a few alternatives from the Commission's planning report.

Ice Jams and Mitigation Measures

Ice jams occur when floating river ice accumulates at a natural or man-made structure that impedes the progress of the ice downstream with the river current. Ice jams can significantly block the flow of a river causing upstream flooding. Ice jam flooding events are not uncommon on the Milwaukee River in particular; therefore, it is recommended that the County and potential impacted communities implement mitigation measures to prevent potential ice jam impacts. Ice jam mitigation measures include:

- Development and maintenance of an ice jam event database such as:
  - Historical and recent records of ice jam events
  - Site-specific ice jam event data, including real time-lapse imagery, duration of freeze-up and ice cover breakup, and damage estimates
- Implement the use of the U.S. Army Corps of Engineers (USACE) Cold Regions Research and Engineering Laboratory (CRREL) database.[135]

Stormwater Management Element

With the expansion of impermeable surfaces in urban areas and alterations to the natural landscape, notably in Milwaukee County, many of the natural functions of floodplains and natural areas have been greatly reduced or even lost. Increases in urbanization and the accompanying impervious surfaces prevent rainwater from infiltrating into the ground, leading to increased surface runoff, and potentially flash flood events. Also, rainfall will accumulate in low-lying areas, causing ponding and inundation. Furthermore, the combination of urbanization and climate change has been shown to increase the number of extreme rainfall events, increasing the vulnerability of communities to experience small-scale (or "localized") flooding impacts. Because of this, stormwater management plays an integral part of flood hazard mitigation planning in Milwaukee County.

Enforcement and Updating of Stormwater Plans, Programs, and Regulations

As detailed in Chapter 1 and listed in Table 1.1, all Milwaukee County communities and Milwaukee County have stormwater management plans and/or regulations (i.e., ordinances) per *Wisconsin Administrative Code* Chapters NR 151 and 216, designed to minimize the adverse impacts caused by urban development. In addition, Chapter NR 216 requires larger municipalities with separate storm sewer systems (MS4s) to obtain a Wisconsin Pollutant Discharge Elimination System (WPDES) stormwater discharge permit to manage the quantity and quality of stormwater runoff before it enters a waterbody. All Milwaukee County communities meet this criterion, therefore are required to obtain and regularly update a WPDES MS4 stormwater discharge permit (listed in Table 1.2).

Also described in Chapter 1, communities within the MMSD service area are required to comply with MMSD's Chapter 13 , "*Surface Water and Storm Water Rules,*" in which governmental units under the MMSD service area are to do the following.

- Manage land use and activities in their jurisdictions to minimize debris and sediment from creating obstructions at outfalls or other structures in watercourses
- Remove debris and sediment that obstructs stormwater outfalls or other drainage structures
- Submit annual reports to the District that provide watershed, drainage, and development information
- Establish which developments and redevelopments must comply with the peak runoff management requirements set forth in Section 13.302 of the MMSD stormwater management rules
- Submit stormwater management plans for all eligible development and redevelopment projects

[135] *Department of the Army, U.S. Army Corps of Engineers,* Engineering and Design ICE ENGINEERING*, October 30, 2002.*

This Plan calls for Milwaukee County and its communities to continue to update, maintain, and enforce their stormwater management plans and regulations as a means of reducing stormwater flooding impacts and creating a more resilient community.

Stormwater Facilities and Conveyance Systems Maintenance

The effectiveness of stormwater management conveyance and detention facilities and other management measures can be sustained only if proper operation, repair, and maintenance procedures are carefully followed. Important maintenance procedures include the periodic repair of storm sewers, clearing of sewer obstructions, maintenance of open channel vegetation, clearing of debris and sediment from open channels, maintenance of detention facility inlets and outlets, maintenance of detention basin vegetative cover, and periodic removal of sediment accumulated in detention basins. This Plan calls for these maintenance activities to be carried out on a continuing basis to maximize the effectiveness of the stormwater management facilities and measures, and to protect the capital investment in the facilities. With more intense rainfall events predicted, it is recommended that Milwaukee County and its municipalities identify specific locations where major stormwater management systems are inadequate to handle the runoff from the 1-percent-annual-probablity (or greater) events and prepare stormwater management systems to address those deficiencies.

As described in the previous "Stream Channel Maintenance Activities" section, MMSD will only address the most severe problems associated with channel obstructions, and MMSD does not address storm sewer system problems, such as the obstruction of storm sewer inlets, outlets, or sediment and debris accumulation in sewers or open channels.

The MMSD North 30th Street Corridor Wet Weather Relief Project[136]

Because of repetitive stormwater flooding experienced within the 30th Street Corridor, this project in progress is an integral element of urban flood mitigation within the City of Milwaukee. The project encompasses the area within W. Townsend Street, W. Hampton Avenue, N. 27th Street, and N. 41st Street in the City of Milwaukee (see Figure 5.6). Historical flooding within this area has caused substantial property damage and significant disruption to the operation of MMSD facilities. To reduce future flooding impacts, the project includes three stormwater basins (East Basin, West Basin, and North Basin), of which the East and North Basins are built. The estimated costs of completing this major stormwater project is listed in Table 5.3.

Green Infrastructure (or Nature-Based) Integration

Certain green infrastructure (GI) practices manage smaller rainfall events to help reduce peak flows downstream. Bioretention can reduce flows into nearby streams by providing some stormwater storage and gradually releasing the water into groundwater through infiltration through the soil media underneath. Similarly, bioswales can hold back stormwater and slowly release it to surface water or groundwater drainage systems to reduce peak flows. Rain barrels and rain gardens can also help manage smaller rain events by capturing some stormwater for garden use. Permeable pavement also increases infiltration and reduces runoff. These practices can also provide additional benefits of improving water quality, providing resilience to climate change, and increasing aesthetics when they are properly maintained. In addition to providing reductions in the volume of stormwater runoff, these practices can help reduce urban heat island effects (through shading and convective shading) thereby improving the quality of life to those living in densely urbanized communities.

Green infrastructure practices can be used at the site or building scale, neighborhood scale, or County-wide scale. Examples of GI practices are listed below.

- Bioretention areas, such as plantings in parking lot islands
- Green roofs
- Downspout disconnections into rain barrels, planter boxes and permeable areas
- Rain gardens
- Streets and alleys with permeable surfacing

[136] *See the Milwaukee Metropolitan Sewerage District website for detailed project information (mmsd.com).*

Figure 5.6
Milwaukee Metropolitan Sewerage District North 30th Street Corridor Project

Source: Milwaukee Metropolitan Sewerage District (Left) and Reflo (Right)

- Bioswales
- Native plantings
- Wetland and floodplain preservation and restoration
- Conservation and protection of open lands, natural areas and green spaces
- Permeable and porous pavements and paved surfaces
- Urban tree canopy protection and restoration, tree planter boxes and tree trenches

Together the City of Milwaukee and MMSD, with assistance from organizations including the 1000 Friends of Wisconsin, Milwaukee Environmental Collaboration Office, HOME GR/OWN, Reflo, Groundwork Milwaukee, and Clean Wisconsin play a major role in the implementation of green infrastructure practices in Milwaukee County. These efforts include implementing codes and ordinances; hosting education and informational workshops; distribution of educational and informational material, including program and funding resources; and assisting in community projects (see Appendix H for example of Milwaukee GI resources and projects). Actions associated with GI practices should be considered as a priority mitigation measure as a means to reduce localized (or concentrated) stormwater flooding and improve the health and well-being of residents.

Key green infrastructure practices, regulations, programs, and plans in Milwaukee County are highlighted below.

- 1000 Friends of Wisconsin along with a private planning and designing firm assisted MMSD and the Milwaukee County Environmental Office to address the barriers to green infrastructure practices in community codes and ordinances including all the municipalities in the MMSD service area. The project addressed the concern that municipal codes and ordinances limit the implementation of green infrastructure.
- Under MMSD's Chapter 13, "Surface Water and Storm Water Rules," section 13.303 of "Site Development: Stormwater and Green Infrastructure Plans" municipalities under MMSD jurisdiction must submit a Green Infrastructure Plan during any new development or redevelopment project and conform within the guidelines associated with stormwater runoff.

- In 2018, the City of Milwaukee revised a city ordinance to require all large developments and redevelopments of an acre or more to capture at least the first 1/2 inch of rainfall using green infrastructure.
- Major green rooftops installments within the City of Milwaukee include: (see Appendix H).
    - Milwaukee Public Art Museum
    - Milwaukee Public Library
    - Rockwell Automation
    - Global Water Center
    - UWM School of Freshwater Sciences
    - Alverno College
    - Northwestern Mutual Building
- Milwaukee Public School's Green Schoolyards Program
- City of Milwaukee Green Streets Stormwater Management program and projects, which include:
    - N. 92nd Street Greet Street - W. Capitol Drive to W. Good Hope Road
    - W. Grange Avenue Green Street - S. 19th Street to S. 27th Street
    - N. 27th Street Green Street - W. Capitol Drive to W. Roosevelt Drive
- City of Milwaukee Green Infrastructure Geographic Information Services (GIS) Tool
- Milwaukee Harbor and North Avenue Redevelopment projects
- The "13th District Green Corridor" project
- MMSD Green Infrastructure Initiatives and Programs:
    - Fresh Coast Guardians program and Green Infrastructure Resource Center
    - Green Solutions program-incentivizing municipalities within the District to implement green infrastructure
    - Green Infrastructure for Schools guidebook
    - Green Highways program
    - Green Luminary Award recognizes projects that use green infrastructure to help protect rivers and Lake Michigan
- MMSD Fresh Coast Guardians and Resources Center program.
- Numerous GI plans completed by the City of Milwaukee and MMSD are listed in Appendix H.

Public Information and Education Outreach Element

Public information, education, and participation constitute an integral aspect of Milwaukee County's flood and stormwater mitigation efforts. This element includes activities, namely accessible public education and information outreach and resources for flood and stormwater management risk reduction purposes. Material related to flood mitigation resources are provided in Appendices G and H.

Current Federal, State, and Local Educational and Informational Activities

As discussed in the multiple hazards plan element, FEMA, the National Weather Service (NWS), and WEM provide many online resources and social media toolkits to assist the public with hazardous weather preparedness, safety, and recovery. FEMA's website provides a number of resources related to flooding hazards, flood insurance, and flood mitigation assistance programs (i.e., Hazard Mitigation Grant Program (HMGP), Building Resilient Infrastructure and Communities (BRIC) Program, and the Flood Mitigation Assistance (FMA) Program). As previously described, Milwaukee County is currently participating in FEMA's Hazard Mitigation Grant Program (HMGP), RiskMAP, and National Flood Insurance Program (NFIP) programming efforts. Continued outreach and educational efforts in promoting the importance of obtaining flood insurance through the NFIP program (*FloodSmart.gov* home of the NFIP), including to those not within the mapped flood hazard zones, is an important part of flood hazard mitigation. Further, it is encouraged that Milwaukee County, and its municipalities consider participating in the FEMA's Community Rating System (CRS) program.

FEMA's website also provides flood risk mapping services. The FEMA Flood Map Service Center (MSC) is the official online source for flood hazard information produced under the NFIP. All flood mapping products, such as Digital Flood Insurance Rate Maps (DFIRMs), Letter of Map Changes (LOMC), Letter of Map Revisions (LOMR), countywide Flood Insurance Studies (FIS), and National Flood Hazard Layer (NFHL) geodatabases are online and available to view and download.[137] FEMA has also produced an interactive online National Risk Index (NRI) mapping tool and application. The NRI is a user-friendly interactive tool that shows which communities are most at risk of natural hazards (i.e., flood events) with data on expected annual losses, social vulnerability, and community resilience at the county and Census tract level. Also, FEMA's Ready.gov provides a Flood Safety Social Media Toolkit with a number of additional resources and links on flood safety and preparedness.

Other good resources for flood hazard outreach include the Centers for Disease Control and Prevention (CDC) and the National Weather Service (NWS). The CDC website has additional information on how to prepare for a flood, stay safe during a flood, and protect your health after a flood. The NWS website also provides a number of informational and educational resources and links including an interactive flood map, description on types of flooding events, warning and safety resources, and available flood-related programs.

The U.S. Army Corps of Engineers (USACE) website provides informational and educational resources and links related to flood risk preparedness and management. The USACE National Flood Risk Management (NFRM) program was established to integrate and coordinate USACE flood risk management programs and activities with FEMA and other Federal, state, regional, and local agencies. The USACE NFRM program maintains and constructs public flood control structures such as dams, reservoirs, levees, floodwalls, and diversion channels. The USACE Disaster Preparedness program provides emergency management organization, planning, training, supplies, tools and equipment, and inspection for non-Federal flood risk management projects. The USACE website also has past, present (or daily), and forecasted Great Lakes water levels which can be used by Milwaukee County and its coastal municipalities for coastal flooding mitigation planning. Additionally, the USACE Cold Regions Research and Engineering Laboratory (CRREL) provides advanced science and engineering expertise to study complex environments, materials, and processes such as ice jam events. The CRREL ice jam database provides information and educational resources as well as known locations and descriptions of historical and current ice jam events.[138] This information may be useful for Milwaukee County and its municipalities to protect valuable and potentially vulnerable community assets along the major waterways within the County.

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[137] *msc.fema.gov/portal/resources.*

[138] *www.crrel.usace.army.mil/icejams.*

The Wisconsin Department of Health Services (DHS) has prepared a flooding toolkit for citizens. The toolkit provides general flood information, preparedness tips, and guidelines on clean up after a flood has occurred. In addition to providing flood preparedness information and resources, the Wisconsin DHS and its partners created an interactive online mapping tool called the Risk Assessment Flood Tool (RAFT, formerly the Wisconsin Flood Risk Map Application) to help local, regional, and state agencies prepare for and respond to floods. The RAFT interactive map includes GIS layers of FEMA floodplains, locations of emergency management and medical services, social vulnerability census data, as well as live rainfall information.[139]

As indicated in Appendix G, the University of Wisconsin-Extension, WEM, *ReadyWisconsin,*[140] and WDNR provide educational information on flooding preparedness (i.e., emergency toolkits), response, and recovery as well as examples of different flood management practices to help reduce flooding impacts. The WDNR website also provides an interactive mapping tool with FEMA floodplains and the FEMA mapping process.

The MMSD has prepared and distributed various public information and educational materials, including materials oriented toward local homeowners, local government agencies, and educators designed to help them consider and potentially undertake actions to mitigate damage caused by riverine and stormwater flooding as well as sanitary sewer backups. Additionally, the MMSD Fresh Coast Guardians program offers residents, educators, organizations, vendors, and municipalities within the District's service area a variety of information and resources on stormwater management including green infrastructure practices, programs, plans, and assistance for individual, group, and community members. This Plan encourages Milwaukee County and its residents to consider looking into these provided resources to help reduce potential flood risks.

The Milwaukee County OEM prepares and distributes, via the County website and social media platforms, a number of public educational materials and resources on extreme weather event preparedness and assistance, including flood events. The OEM also provides informational in-person learning and outreach sessions and educational resources for local property owners on preventive measures for homeowners to mitigate flood damages. Such resources also provide basic information about flood warnings, as well as the National Flood Insurance Program (NFIP) and various Federal and State aid programs that may be available to flood victims. In addition, the Milwaukee County Office of Emergency Management website provides an interactive online map of the FEMA effective 1-percent-annual-probability-floodplain layer.

Most of Milwaukee County city and village websites provide information on federal and state flood resources for flooding and stormwater impacts and preventative measures (i.e., emergency preparation toolkits, links to multiple federal and state resources, educational material, related ongoing projects, and funding opportunities). Also, most municipalities have online interactive municipal maps with FEMA floodplain layers.

Together, Root-Pike WIN and the Southeastern Wisconsin Watersheds Trust, Inc. (Sweet Water) developed the Respect Our Waters (ROW) program. This program educates area residents on stormwater best management practices, such as actions to improve water quality and quantity from a rainfall event. The ROW Program is supported by 50 municipalities across southeastern Wisconsin, including those within Milwaukee County. Educational and information outreach is presented at community or County events, in which native plants, rain barrels and Milorganite fertilizer are often distributed. Sweet Water also assists many of Milwaukee County communities with MS4 compliance by documenting best management practices and educational outreach material and instruction on stormwater-related management.

Multi-Jurisdictional and Watershed Considerations

According to the parcel-based analysis, structures within flood hazard areas have been identified in 14 of the 19 Milwaukee County municipalities and within all six major watersheds (see Tables 3.8 and 3.9). Based on the analysis, the jurisdictions with the greatest amount of vulnerable populations (i.e., identified parcels with structures in flood hazard areas) comprise the Cities of Glendale and Milwaukee and the Village of Fox Point (Map 3.2), including several structures located within the Lake Michigan coastal flood zone (Map 3.12). Note, information related to Lake Michigan coastal flooding is further discussed in the "Hazard Mitigation Plan Component for Lake Michigan Coastal Hazards" section of this Chapter. Also, there is one manufactured

[139] *This can be accessed at: www.dhs.wisconsin.gov/flood.*

[140] *readywisconsin.wi.gov/default.asp.*

home park with 16 homes in the flood hazard area in the City of Franklin. As mentioned in Chapter 3, the structures in this parcel-based analysis that are at risk of flooding during the 1-percent-annual-probabillty (100-year recurrence interval) event were identified by MMSD and used by Commission staff to compute flood damages.

As previously mentioned in this Plan, the City of Milwaukee was found to have a high socio-economic vulnerability index (SVI) score (see Chapter 3 and Appendix C) as well as high risk to flooding impacts (see Figure 5.4), notably within the northern and central portions of the City. Because of this, Milwaukee County and MMSD should consider implementing certain flood mitigation activities and projects aimed to benefit the different types of vulnerable populations and communities identified within the City of Milwaukee. Such flood mitigation activities may include more accessible educational and informational material and outreach activities as well as projects designed to remove/reduce impervious surfaces, thereby creating additional flood storage, green space, and recreational opportunities.

From a watershed-based approach, and as indicated in Map 3.2 and Table 5.5 the majority of flooded structures, specifically residential, are within the Kinnickinnic (530), Milwaukee River (515), and Root River (141) watersheds. Additionally, as shown in Table 5.5, these same watersheds (Kinnickinnic River, Menomonee River, and Root River) have the greatest amount of nonresidential structures at-risk to flooding within Milwaukee County.

Evaluation of Alternatives and Identification of Priority Mitigation Measures

The goal of flood mitigation activities is to reduce, in a cost-effective manner, the loss of lives and property due to these events. A full range of nonstructural and structural approaches were considered in the initial assessment of potential mitigation measures and their alternative approaches for reducing flooding impacts in Milwaukee County.

An important factor in selecting priority mitigation measures is to consider incorporating recommendations from other related County and local planning efforts (i.e., Milwaukee County's park and open space plan,[141] regional transportation and land use plan,[142] land and water resource management plan,[143] and comprehensive emergency management plan,[144] and the various watershed and flood management planning efforts, including the current MMSD Watercourse And Flood Management Program) that may help prevent flooding or act to mitigate the impacts of flooding when it occurs. Including such recommendations in this hazard mitigation plan furthers the goal of integrating the elements of the various plans that seek to provide guidance to the County for a variety of issues. Similarly, it was judged important that the set of priority mitigation measures incorporate existing regulations, programs, resources, and efforts that reduce the exposure of people and property to flood risks or that act to mitigate the impacts of flooding when it occurs. Examples of such programs include floodplain zoning, existing stormwater management policies and guidelines, continued and expanded participation in the National Flood Insurance Program (NFIP), updating of DFIRM maps, and educational and informational outreach programs.

Flood damages can be mitigated by limiting or restricting how development occurs in high-risk areas. These measures can limit the County's and municipalities' future vulnerability to flooding impacts and should be considered a primary element in any flood mitigation effort. Measures to implement this type of mitigation include incorporating recommendations from other related County and local planning efforts, enforcing regulations such as floodplain and wetland-shoreland zoning guidelines, and enforcing local and MMSD development and redevelopment policies and guidelines.

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[141] *SEWRPC Community Assistance Planning Report No. 132 (2nd Edition),* A Long-Range Park and Open Space Plan for Milwaukee County, *February 2022*

[142] *SEWRPC Planning Report No. 55,* VISION 2050: A Regional Land Use and Transportation Plan for Southeastern Wisconsin*, June 2020*

[143] *SEWRPC Community Assistance Planning Report No. 312 (2nd Edition),* A Land and Water Resource Management Plan for Milwaukee County: 2022-2031, *December 2021.*

[144] *Milwaukee County Office of Emergency Management,* Milwaukee County Hazard Mitigation Plan*, October 19, 2017.*

Another important measure that is strongly recommended for Milwaukee County is the preservation and conservation of open space and environmentally sensitive lands. This preservation can help improve and increase flood storage capabilities and functions, wildlife habitat, recreational opportunities and potentially improve the health and well-being of residents.

Another important flood mitigation component should be to focus on existing development located within high-risk areas, with an emphasis on vulnerable populations and critical community facilities and infrastructure. Recurring economic losses and distress from flooding can be reduced by either removing structures from the floodplain or by modifying and maintaining them to resist flood damage. This priority element includes acquisition and demolition, floodproofing, and retrofitting of structures located in high-risk areas. This component also includes further analysis and inventory on roadway flooding concerns throughout Milwaukee County.

Because Milwaukee County is heavily urbanized, actions that address stormwater conveyance and storage are vital for flood mitigation planning. Such actions include the improvement and maintenance of current and planned stormwater infrastructure, removing and rehabilitating concrete-lined channels, and increasing and maintaining green infrastructure or nature-based stormwater practices.

These priority mitigation measures, along with a general cost benefit summary are presented in Table 5.10.

5.4 HAZARD MITIGATION PLAN COMPONENT FOR SEVERE WEATHER EVENTS (THUNDERSTORMS, STRONG WINDS, HAIL, AND LIGHTNING)

Thunderstorms, high-winds, hail, and lightning are natural hazard events of significant concern to be considered in the Milwaukee County hazard mitigation plan. This section describes alternative and selected priority strategies to mitigate these types of hazards. As part of the updating process, these strategies were reviewed and reevaluated by the Milwaukee County Hazard Mitigation LPT in light of the updated hazard conditions and hazard mitigation goals documented in Chapters 3 and 4.

Identification of Alternative Mitigation Strategies

All thunderstorms and related hazard events are potentially dangerous and are common within Milwaukee County. Although there are about 100,000 thunderstorms each year in the U.S., only about 10 percent reach "severe" levels.[145] Severe thunderstorm fronts can often be tracked, providing ample warning for potentially affected areas to take precautionary actions. In addition, when severe thunderstorms and related hazard events occur, they generally last for short periods.

While it may not be possible to accurately identify specific areas where there is significant risk from thunderstorm-related hazard events or non-thunderstorm high-wind events, measures can be taken to reduce the potential damage caused wherever they may occur in the County. High-wind events associated with windstorms and thunderstorms are similar to tornadoes, except they are more common and usually less powerful.

Hailstorms tend to occur in conjunction with severe thunderstorms. A severe thunderstorm weather advisory or advance warning system may indicate that large or damaging hail is imminent. Personal safety is the first priority during a hailstorm, and people should seek shelter and stop driving to avoid accidents. Advance warning systems may allow some actions to reduce hail damage to vehicles and some property, but little can be done to protect structures or crops in the field.

Personal protection is paramount for lightning safety—many people suffer injuries or are killed due to misinformation and inappropriate behavior during lightning storms. A few simple precautions can reduce many of the dangers posed by lightning. The individual is ultimately responsible for their safety and should take appropriate action when threatened by lightning. Little can be done beyond electrical grounding to protect property from lightning strikes.

[145] *www.nssl.noaa.gov.*

Table 5.10
Cost-Benefit Analysis for Measures Included in the Milwaukee County Hazard Mitigation Plan Update: Flood and Associated Stormwater Drainage Problems Hazards

Priority Mitigation Measures	Estimated Cost[a]		Costs of Implementation[b]			Estimated Benefits (dollars)[c]	Benefits						Community/Jurisdictions Affected
	Capital	Average Annual Operation and Maintenance (thousands of dollars)	Low	Moderate	High		Enhanced Preparedness/ Protection	Reduced Property Damage	Reduced Injuries	Reduced Mortalities	Enhanced quality of life/social benefits	Increased Environmental and/or Recreational Benefits/Ecosystems	
Floodland and Environmentally Sensitive Land Preservation Element													
Maintain and potentially update floodplain and wetland zoning regulations and ordinances[d]	--[e]	--[e]	X				X	X	X	X	X	X	Milwaukee County and all cities and villages
Continuing to promote and improve the preservation and/or maintenance of environmentally sensitive, natural and open space lands[d]	--[f]	--[f]			X		X	X			X	X	Milwaukee County and all cities and villages
Continue participation in the MMSD Greenseams program	--[g]	--[g]			X		X	X			X	X	Milwaukee County and all cities and villages
Floodplain Management Element													
Implementation of MMSDs Watercourse and Flood Management Planning Program floodplain projects through planned year 2035 (see Table 5.2 for individual project costs)	$422M (2024 dollars)	--[f]			X		X	X	X	X	X	X	MMSD, Milwaukee County and all cities and villages
Remove up to 16 repetitive loss structures[d,j]	$2.9M (2022 dollars)	--[h]			X	$4.3M (per 100-yr flood event)	X	X	X	X	X	X	Milwaukee County and all affected communities
Surveys of up to 1,276 structures identified as being potentially located in flood hazard areas[d]	$2.6M[i] (2022 dollars)	--[h]			X	--	X						Milwaukee County and all affected communities
Floodproofing 207 structures identified as potentially located in flood hazard area[d, j]	$96.8M (2023 dollars)	--[h]			X	$89.8M (per 100-year flood event)	X	X	X	X	X	X	Milwaukee County and all affected communities
Acquisition and removal/demolition of 1,260 structures identified as being potentially located in flood hazard area[d]	$508M (2022 dollars)	--[h]			X	$76.1M (per 100-year flood event)	X	X	X	X	X	X	Milwaukee County and all affected communities
Removal of up to 16 manufactured homes identified as being potentially located in the flood hazard area.	$3.5M (2022 dollars)	--[h]			X	$29,000 (per 100-year flood event)	X	X	X	X	X	X	Milwaukee County and City of Franklin

Table continued on next page.

Table 5.10 (Continued)

Priority Mitigation Measures	Estimated Cost[a]		Costs of Implementation[b]			Estimated Benefits (dollars)[c]	Benefits						Community/Jurisdictions Affected
	Capital	Average Annual Operation and Maintenance (thousands of dollars)	Low	Moderate	High		Enhanced Preparedness/ Protection	Reduced Property Damage	Reduced Injuries	Reduced Mortalities	Enhanced quality of life/social benefits	Increased Environmental and/or Recreational Benefits/Ecosystems	
Floodplain Management Element (continued)													
Consider floodproofing and/or relocating critical facilities located within or nearby flood-prone areas (see Map 5.6)	$4.9M (2022 dollars)	--[h]			X	--	X	X	X	X	X	X	City of Milwaukee and Village of Greendale
Emphasize actions that address and protect vulnerable infrastructure (i.e., roadways and bridges) to flooding	--[h]	--[e]			X	--	X	X					Milwaukee County and all cities and villages
Continue participation in FEMA's National Flood Insurance Program and floodplain modeling and mapping updating efforts[d]	--[e]	--[e]	X			--	X	X					Milwaukee County and all cities and villages
Encourage County participation in FEMA's Community Rating System (CRS) Program	--[h]	--[h]		X		--	X	X				X	Milwaukee County and all cities and villages
Promote and encourage the implementation of using further documentation of the extent of future floods	--[h]	--[h]				--	X	X					Milwaukee County and all cities and villages
Continue and promote stream channel maintenance activities, including concrete and debris removal (see Table 5.2 for major channel concrete removal project costs)	--[e]	--[e]		X		--		X	X		X	X	Milwaukee County, MMSD, and all cities and villages
Lending institutions and real estate agent policies should continue and enforce their practice of determining and informing the public the floodprone status of properties before mortgage transactions are complete[d,e]	--[e]	--[e]	X			--	X	X					Milwaukee County and all cities and villages
Encourage the installation of new USGS stream gages, while maintaining and updating the current systems	$15,000[l] (2023 dollars)	$13,000[l] (2023 dollars)		X		--	X	X				X	Milwaukee County, MMSD, and all municipalities
Regularly inspect and maintain all dams within the County	--[e]	--[e]		X		--	X	X					Milwaukee County, MMSD, and private owners of the Kurtze Lake, Tuckaway County Club, and Northridge Lakes Residential Development dams
Continue to update and enforce the regular review of dam emergency action plans and procedures	--[h]	--[h]		X		--	X	X	X	X			All dam owners

Table continued on next page.

Table 5.10 (Continued)

Priority Mitigation Measures	Estimated Cost[a]		Costs of Implementation[b]			Estimated Benefits (dollars)[c]	Benefits						Community/Jurisdictions Affected
	Capital	Average Annual Operation and Maintenance (thousands of dollars)	Low	Moderate	High		Enhanced Preparedness/ Protection	Reduced Property Damage	Reduced Injuries	Reduced Mortalities	Enhanced quality of life/social benefits	Increased Environmental and/or Recreational Benefits/Ecosystems	
Stormwater Management Element													
Continue to develop and maintain stormwater management plans/programs[d]	--[e]	--[e]	X			--	X	X				X	Milwaukee County, MMSD, and all cities and villages
Continue to practice and enforce stormwater-related regulations, including installation of up-to-date stormwater drainage systems [d]	--[e]	--[e]	X			--	X	X				X	Milwaukee County, MMSD, and all cities and villages
Continue to participate and collaborate in MMSD's Watercourse and Flood Management Planning Program	$25.9M (2023 dollars)	--[f]			X	--	X	X	X		X	X	Milwaukee County, MMSD, and all cities and villages within the MMSD service area
Continue implementation and integration of green infrastructure and/or nature-based stormwater management practices	--[k]	--[k]	X			--	X				X	X	Milwaukee County, MMSD, and all cities and villages
Public Informational and Educational Element													
Continue to enhance public education and outreach activities on flood and stormwater management and safety/preparedness procedures	--[f]	--[f]	X			--	X						Milwaukee County and all cities and villages
Enhance the distribution of material related to Federal Flood Insurance Program (NFIP), including to those residents located outside the mapped floodplain	--[e]	--[e]	X			--	X	X					Milwaukee County and all cities and villages

[a] *All costs are expressed in 2022 or 2023 dollars unless otherwise noted.*

[b] *Cost of implementation is allocated among three categories of low (less than $100,000 dollars), moderate (greater than $100,000 and less than $1,000,000), and high (greater than $1,000,000) costs, which are generally defined as:*

Low
Educational and informational programming
Ongoing enforcement of ordinances
Plan development
Continued coordination/mutual aid/ interagency agreements

Moderate
Addition of new staff
Additional staff hours budgeted
Additional equipment
New ordinance development
New programs/task force

High
Major construction
New buildings (infrastructure)
Capital programs

Table continued on next page.

Table 5.10 (Continued)

[c] *The estimated benefits are based upon the reduction in flood damages during a 1-percent-annual-probability flood event. The damage estimates were developed by SEWRPC staff based upon structure values, flood stage, and depth of flooding as described in Chapter 3. Note, not all recommendations have a quantifiable benefit for the 100-yr floodplain, hence mitigation measures not having a cost associated to that column.*

[d] *This mitigation is related to, but not essential to, compliance with the requirements of the National Flood Insurance Program.*

[e] *Costs are covered under ongoing or day-to-day activities.*

[f] *Costs to be determined. Partially covered under ongoing programs.*

[g] *Budgeted capital costs for the Greenseams program are included under the MMSD Watercourse and Floodplain Management Planning Program.*

[h] *Costs are unknown.*

[i] *Survey costs were estimated using $2,000 per structure. Cost savings may be realized if surveys of clustered structures are done at the same time.*

[j] *Structure floodproofing, elevation, or removal will be evaluated on a site-by-site basis and be carried out at the discretion of property owners.*

[k] *Costs are site-specific, and additional investigation is needed for countywide estimate.*

[l] *Costs are estimates for installation and maintenance of one USGS stream gage.*

Source: Milwaukee County Division of Emergency Management and SEWRPC

Through review by the Milwaukee County Hazard Mitigation LPT, the following measures to reduce vulnerability to thunderstorm winds, non-thunderstorm high-winds, hail, and lightning have been identified as viable for this Plan update. In addition to the measures listed below, mitigation strategies that address *multiple* hazard types, including thunderstorms and related events, are discussed in the "Multiple Hazard Mitigation" section in this Chapter.

Nonstructural

- Continue to maintain and regularly update local fire department equipment to help detect or mitigate lightning-related fires, such as thermal imaging devices
- Maintain compliance with the National Incident Management System (NIMS)
- Enforce existing local ordinances requiring adequate electrical grounding in newly constructed buildings
- Continue to work with local fair/festival/entertainment district planning officials to create and regularly update emergency plans in the case of severe weather
- Provide information and urge the use of fire-resistant materials and surge protectors on critical electronic equipment

Structural

- Work with municipalities and businesses to explore installation or upgrading of community safe rooms and hardening projects[146] for public buildings, community facilities, major industrial and manufacturing sites, large businesses, manufactured home parks, neighborhoods with a concentrated amount of outdated and poor condition housing units, and fairgrounds/large outdoor public gathering locations to ensure adequate shelter from thunderstorm and high-wind hazards.
- Install and routinely update lightning grade surge protection devices for critical electronic components used by government, public service, and public safety facilities, such as warning systems, control systems, communications, computers, and data networks

Public Informational and Educational Programming

- Continue to enhance and expand public education and awareness of the potential severity of thunderstorms and related hazards with up-to-date emergency preparedness information to all County residents. Educational efforts should include promoting safety guidelines to reduce the risk of lightning hazards and the potential severity of hailstorms

Current Programs and Ongoing Projects

Federal and State Programs

The NWS issues warnings, watches, and advisories when there is a threat of severe weather conditions. Several categories of warnings, watches, and advisories apply to thunderstorms and associated hazards. The NWS Storm Prediction Center in Norman, Oklahoma will issue a severe thunderstorm watch when conditions are favorable for the development of severe thunderstorms in and close to the watch area.

The NWS Milwaukee/Sullivan office will issue a *severe thunderstorm* warning when:

- A thunderstorm is producing winds equal to or exceeding 58 miles per hour (mph)
- Hail of one inch or larger in diameter
- A severe thunderstorm is detected by Doppler radar

[146] *FEMA defines "hardening" as project-specific specialized design and construction methods which are applied to one or more rooms within a building and/or to an entire building envelope to allow portions of and/or the entire structure to resist wind pressures and windborne debris impacts during an extreme wind event and are capable of providing life-safety protection to the occupants of the room or structure.*

The NWS Milwaukee/Sullivan office will issue a *high wind* warning when:

- Sustained winds of 40 mph are expected to occur for an hour or more
- Wind gusts of 58 mph or more are expected to occur

The NWS Milwaukee/Sullivan office will issue a *wind* advisory when:

- Sustained winds of 30 mph are expected to occur for an hour or more
- Wind gusts of 45 mph to 57 mph are expected to occur

As mentioned in the "Multiple Hazards" section of this Chapter, a number of Federal and state programs include awareness and educational efforts and provide online resources including links to various networks and/or agencies as well as to different social media outlets with additional resources/programs, including toolkits or interactive mapping data to assist on hazardous weather preparedness, safety, and recovery. As such, the NWS has an extensive public information program to educate and to train citizens and emergency managers (via the *StormReady* program) to be aware of and spotting thunderstorms and related dangers. Also, the Wisconsin Department of Health Services (DHS) developed a severe thunderstorm and tornado toolkit to provide information to local governments, health departments, and citizens about preparing for and responding to severe thunderstorms and tornadoes. Similarly, WEM has educational resources regarding thunderstorms and related hazards including prerecorded radio public service announcements, scripts for radio public service announcements, social media announcements and information, short online educational videos, printed fliers, and educational materials for children. In addition, numerous other organizations including the American Red Cross, provide public safety information regarding lightning.

Local Programs

As discussed in detail in the multiple hazards plan component, Milwaukee County has a variety of methods to warn residents of emergencies, including thunderstorms and thunderstorm-related events. Severe thunderstorms watches, warning bulletins, and advisories are disseminated throughout Milwaukee County by the NWS[147] to the general public through its OASIS public warning safety radio network, local television and radio stations, cable television systems, cell phone apps, and NOAA weather radios. It is important that all County residents are able to receive or have access to such warnings or alerts.

In addition, the Milwaukee County OEM has various printed and online resources available for the public on severe weather safety and other general emergency management-related topics. Milwaukee County OEM participates in all State sponsored severe weather awareness campaigns.

Multi-Jurisdictional Considerations

Thunderstorms and their related hazards can potentially impact all municipalities within the County. In addition, these severe events can potentially cause multiple damages to a variety of infrastructure including transmission lines, communication lines, and transportation routes due to flooding, as well as damage to buildings from flooding, hail, and/or high winds. Hence, Milwaukee County, its municipalities, relevant businesses, and other organizations should continue to coordinate hazard mitigation activities through a cooperative County and local government partnership in countywide disaster planning and response. Such measures are already well underway through the comprehensive emergency management planning program involving the Milwaukee County OEM and coordinated local community emergency operations programs and should be continued.

Evaluation of Alternatives and Identification of Priority Mitigation Measures

Based upon the foregoing evaluation, consideration of risk and review and action by the Milwaukee County Hazard Mitigation LPT as part of the updating process (see Appendix A), the following mitigation measures related to thunderstorms, high-wind, hail, and lightning events are included in the Milwaukee County hazards mitigation plan:

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[147] *The NWS operates two 24-hour weather radio transmitters that serve all or portions of Milwaukee and Waukesha Counties.*

Based upon review of the above and the risk analysis given in Chapter 3, continuation and refinement of current early warning system programs represents a major component of the planned mitigation action for thunderstorm-related hazards and high-wind events. The existing warning systems should continue to rely upon the use of multiple means of communication to alert people, especially those that are most vulnerable, to the threat of severe weather (see Appendix G). In addition, informing the public of the significance of thunderstorm watches and warnings so that they take these events seriously, know where to seek shelter in emergency situations, and are prepared should such a storm cause a disaster is an important component for minimizing the risks associated with these natural hazards. Community-based informational programs should also continue to be conducted by the County and its communities in partnership with Federal, State and local authorities.

Providing and notifying, through various modes of communication, of adequate safe places for people to seek shelter, notably those that are most vulnerable, during severe storms constitutes an additional approach to mitigating impacts of severe storms in Milwaukee County. As detailed in Chapter 2 and shown on Map 2.1, there are 15 manufactured home parks in Milwaukee County, with the majority containing at least 50 homes. As these residents are highly vulnerable to high wind events, it is highly encouraged to investigate the need for community safe rooms. Implementing this recommendation constitutes an important element of this hazard mitigation plan.

Severe thunderstorm related events can also cause economic losses, especially to agricultural producers through damage to crops. Continuing to provide agricultural producers with information regarding Federal crop insurance programs and encouraging them to purchase crop insurance provides some protection against such losses. Other feasible mitigation actions include:

- Enforcement of building code regulations that improve the ability and reliability of structures to withstand severe wind and surge protection for sensitive electronic equipment
- On-site emergency backup power generation for critical infrastructure
- Other precautions that will limit possible injuries, deaths, or property damages due to severe weather events

The majority of these measures are currently in place to varying degrees, indicating an ongoing need for informational programming and enforcement.

Based upon the foregoing evaluation and consideration of risk and review by the Milwaukee County Hazard Mitigation LPT (see Appendix A), there are 5 actions determined to be priority mitigation measures for this hazard mitigation plan update that are specifically related to thunderstorm winds, non-thunderstorm high-winds, lightning and hail events.[148] These priority mitigation measures, along with a general cost-benefit summary are presented in Table 5.11.

5.5 HAZARD MITIGATION PLAN COMPONENT FOR TORNADOES

Tornadoes are natural hazard events of moderate concern to be considered in this update of the Milwaukee County hazard mitigation plan. This section describes alternative and selected priority strategies to mitigate tornado events. As part of the updating process, these strategies were reviewed and reevaluated by the Milwaukee County Hazard Mitigation LPT in light of the updated hazard conditions and hazard mitigation goals documented in Chapters 3 and 4.

Identification of Alternative Mitigation Strategies

All tornadoes are potentially dangerous hazards within Milwaukee County as discussed in Chapter 3. However, as indicated in Table 3.13, tornadoes have been shown to impact Milwaukee County about once every three years and these are most likely to be an EF1 (or F1) magnitude or less. In addition, when tornadoes and related

[148] *Priority mitigation measures that apply to multiple hazard types including thunderstorm winds, non-thunderstorm high-winds, lightning and hail events, are presented in the "Hazard Mitigation Plan Component for Multiple Hazard Types" section in this Chapter.*

Table 5.11
Cost-Benefit Analysis for Measures Included in the Milwaukee County Hazard Mitigation Plan: Severe Thunderstorm and Thunderstorm-Related Hazards (High-Winds, Hail, and Lightning)

Mitigation Measures	Estimated Cost[a]		Costs of Implementation[b]			Benefits						Community/ Jurisdictions Affected
	Capital	Average Annual Operation and Maintenance	Low	Moderate	High	Enhanced Preparedness/ Protection	Reduced Property Damage	Reduced Injuries	Reduced Mortalities	Enhanced quality of life/social benefits	Increased Environmental and/or Recreational Benefits/Ecosystems	
Nonstructural												
Maintain and regularly update local fire department and/or first responder equipment to help detect or mitigate lightning-related fires, such as thermal imaging devices	--[c]	--[c]		X		X						Milwaukee County and all local jurisdictions[d]
Continue to enforce existing local ordinances requiring adequate electrical grounding in newly constructed buildings	--[e]	--[e]		X		X	X					Milwaukee County and all local jurisdictions[d]
Provide information and encourage the use of fire-resistant materials and surge protectors on critical electronic equipment	--[e]	--[e]	X			X	X					Milwaukee County and all local jurisdictions[d]
Structural												
Install lightning grade surge protection devices for critical electronic components used by government, public service, and public safety facilities	--[c]	--[c]		X		X	X					Milwaukee County and all local jurisdictions[d]

Table continued on next page.

Table 5.11 (Continued)

Mitigation Measures	Estimated Cost[a]		Costs of Implementation[b]			Benefits						Community/ Jurisdictions Affected
	Capital	Average Annual Operation and Maintenance	Low	Moderate	High	Enhanced Preparedness/ Protection	Reduced Property Damage	Reduced Injuries	Reduced Mortalities	Enhanced quality of life/social benefits	Increased Environmental and/or Recreational Benefits/Ecosystems	
Public Information and Educational Programming												
Increase public education and awareness, especially to those considered vulnerable, of the potential severity of thunderstorm related hazards and non-thunderstorm high-wind hazards and distribute emergency preparedness information related to thunderstorm hazards	--[e]	--[e]	X			X		X	X			Milwaukee County and all local jurisdictions[d]

[a] *All costs expressed in 2022 dollars unless otherwise noted.*

[b] *Cost of implementation is allocated among three categories of low (less than $100,000 dollars), moderate (greater than $100,000 and less than $1,000,000), and high (greater than $1,000,000) costs, which are generally defined as:*

Low
Educational and informational programming
Ongoing enforcement of ordinances
Plan Development
Continued coordination/mutual aid/ interagency agreements

Moderate
Addition of new staff
Additional staff hours budgeted
Additional equipment
New ordinance development
New programs/task force

High
Major construction
New buildings (infrastructure)
Capital programs

[c] *Costs are site-specific.*

[d] *Jurisdictions include general purpose units of government—Cities and Villages—and special purpose units of government such as School Districts.*

[e] *Costs covered under day-to-day operations.*

Source: Milwaukee County and SEWRPC

hazard events occur, they generally last for short periods of time and impact relatively small areas of the County. However, when strong tornadoes do strike, they can cause extensive property damage, injuries, and death.

While it may not be possible to accurately identify specific areas where there is significant risk from tornado events, or the number or severity of the events, measures can be taken to reduce the potential damage caused by tornado-related hazards wherever they may occur in the County. Based upon review by the Milwaukee County Hazard Mitigation LPT, the following measures to reduce the vulnerability to tornadoes have been identified as practical for this hazard mitigation Plan update. In addition to the measures listed below, mitigation strategies that address multiple hazards, including tornadoes, are discussed earlier in the "Multiple Hazard Mitigation Measures" section of this Chapter.

Nonstructural

- Continue to monitor and update the usage policies and procedures of the County's public outdoor warning systems to improve public safety and warning effectiveness
    - Promote the use of "Wisconsin Outdoor Warning Siren Best Practices" recommendation guidelines.[149]
- Require construction regulations for safe rooms in new schools, daycares, nursing homes, hospitals, community centers, and large business/industrial facilities, and encourage the establishment of safe rooms in existing structures such as those listed that do not have basements
- Regularly conduct an inventory and inspection of municipal and County community facilities to ensure the quality, quantity, and accessibility of reliable and adequate tornado shelters are provided

Structural

- Consistently inspect and monitor the operational and structural functions of all 58 Milwaukee County outdoor tornado warning sirens to ensure of their effectiveness and reliability
- Routinely inspect manufactured homes and/or parks to ensure they are securely anchored or have adequate and accessible safety material (i.e., tie-downs) in case of a tornado or extremely strong wind event
- Recommend municipalities and businesses install or upgrade community safe rooms and hardening projects[150] for public buildings, community centers, major industrial and manufacturing sites, large businesses, manufactured home parks, beaches, fairgrounds, and large outdoor public gathering spaces

Public Informational and Educational Programming

- Increase public education and awareness of the potential severity of tornadoes and continue to produce and expand updated emergency preparedness information (e.g., the steps that should be taken when hearing a tornado siren), especially to those that are most vulnerable
- Make information available and understandable on where to go during a tornado event for those visiting a public open space such as a park or a beach

Current Programs and On Going Projects

Federal and State Programs

The NWS issues tornado watches when conditions are favorable for the development of thunderstorms that have a strong capability of producing tornadoes and issues tornado warnings when a tornado has been spotted by a trained observer or Doppler radar has indicated a developing tornado.

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[149] *S. Ziegler, G. Goodchild, and D. Janda, Wisconsin Outdoor Warning Siren Best Practices, 2019.*

[150] *FEMA defines "hardening" as project-specific specialized design and construction methods which are applied to one or more rooms within a building and/or to an entire building envelope to allow portions of and/or the entire structure to resist wind pressures and windborne debris impacts during an extreme wind event and are capable of providing life-safety protection to the occupants of the room or structure.*

Federal and State programs for tornados include awareness and education efforts. NOAA's National Severe Storms Laboratory (NSSL) website has educational material on severe weather, including tornadoes. In addition, the NWS has an extensive public information program to educate people about the dangers of tornadoes and related hazards that assist in preventing related deaths and injuries. WEM, in conjunction with the NWS and State and local government agencies, provides both preparedness information and severe weather information to the public. Similarly, WEM has produced several educational resources regarding tornadoes including prerecorded radio public service announcements, scripts for radio public service announcements, fliers, and educational materials for children.[151] The Wisconsin Department of Health Services has developed a severe thunderstorm and tornado tool kit to provide information to local governments, health departments, and citizens in Wisconsin about preparing for and responding to severe thunderstorms and tornadoes.[152] In addition, numerous other organizations, including the American Red Cross, provide public safety information regarding tornadoes.

Local Programs

Programs within Milwaukee County primarily include those conducted by the Milwaukee County OEM. Milwaukee County provides various printed (i.e., brochures, booklets, and pamphlets) and online material and resources available for the public on tornado safety and other general emergency management-related topics. Milwaukee County OEM participates in State sponsored severe weather awareness campaigns including Wisconsin Best Outdoor Siren Practices.

As discussed in detail in the Multiple Hazards section, Milwaukee County has a variety of methods to warn residents of emergency situations, including its 58 outdoor warning sirens, In 2018 Milwaukee County OEM upgraded the then 57 County- and municipal-owned tornado sirens with new encryption technology to keep the sirens safe from cybersecurity threats. This upgrade caused adverse impacts on a number of the tornado sirens existing equipment. As a result, in 2024, Milwaukee County OEM, with the assistance of ARPA Covid-19 funds,[153] initiated a complete update update and/or replacement project to all 58 now County-owned tornado sirens (24 being completely replaced). The cost of implementing this project I estimated at $1.8M (2024 dollars)[154]

Multi-Jurisdictional Considerations

Tornadoes and their related hazards can potentially impact all municipalities within the County. In addition, these events can potentially cause severe damage to a variety of infrastructure including transmission lines, communication lines, and transportation routes due to high winds and debris. Public and private buildings can also be destroyed. Hence, Milwaukee County, its municipalities, relevant businesses, and other organizations should coordinate tornado mitigation activities through a cooperative County and local government partnership in countywide disaster planning and response. Such measures are already well underway through the comprehensive emergency management planning program involving the Milwaukee County OEM and coordinated local community emergency operations programs and should be continued.

Evaluation of Alternatives and Identification of Priority Mitigation Measures

The best place to be during a tornado event is a building or room specifically designed to withstand the impacts of a tornado event (i.e., tornado shelters or community safe rooms). If lacking such shelters, taking refuge in a basement near supporting walls or pillars, and away from windows is appropriate. If there is no basement in a building, taking shelter in smaller interior, windowless rooms, such as hallways or closets, can offer some protection and is the next best option. Cars, manufactured homes, garages, and outbuildings are not safe shelters from tornadoes. Thus, promoting adequate and reliable safe places to seek shelter during tornadoes constitutes an additional approach to mitigating impacts of severe storms in Milwaukee County. Residents living in manufactured homes or poorly built residential conditions, in particular, represent a segment of the County's population that often lack access to adequate shelters.

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[151] *These can be accessed at Wisconsin Emergency Management's ReadyWisconsin website located at: ready.wi.gov/Resources/Manager_Resources.asp.*

[152] *Wisconsin Department of Health Services,* Wisconsin Severe Thunderstorm and Tornadoes Toolkit, op. cit.

[153] ***The American Rescue Plan Act****, signed into law on March 11, 2021, provides direct funding to cities, towns and villages throughout the United States in response to and recovery from the COVID-19 public health emergency.*

[154] *Milwaukee County,* 2024 Recovery Plan Performance Report, State & Local Fiscal Recovery Funds*, July 2024.*

Because of this, these communities or individuals bear additional risks from tornadoes. Encouraging and promoting the construction of adequate and reliable community safe rooms that provide shelter from tornadoes to County residents, especially those most vulnerable, constitutes an important element of this hazard mitigation plan.

In addition, informing the public of the significance of tornado watches and warnings so that they take tornado warnings seriously and know where to seek shelter, especially those that are the most vulnerable, are important, ongoing components for minimizing the risks associated with natural hazards. Community- and school-based informational programs on tornadoes should continue to be conducted and enhanced by the County and its communities in partnership with Federal, State and local authorities to ensure all county residents are receiving equal and reliable tornado safety information.

Finally, other feasible mitigation actions include enforcing building code regulations that improve the ability of structures to withstand severe wind and increasingly harsh weather conditions, on-site emergency backup power generation for critical community facilities and infrastructure and utility systems; and providing information and educational resources and material that is easily accessible for all County residents, notably those that are most vulnerable. The majority of these measures are currently in place to varying degrees, indicating an emphasis on informational programming and enforcement.

Based upon the foregoing evaluation and consideration of risk and consideration by the Milwaukee County Hazard Mitigation LPT (see Appendix A), there are 7 actions determined to be priority mitigation measures as part of this hazard mitigation plan update that are specifically related to tornado events. [155] These priority mitigation measures, along with a general cost-benefit summary are presented in Table 5.12.

5.6 HAZARD MITIGATION PLAN COMPONENT FOR WINTER STORMS

Winter storms are natural hazard events of moderate concern to be considered in the Milwaukee County hazard mitigation plan. This section describes alternative and selected priority strategies to mitigate this type of hazard. As part of the updating process, these strategies were reviewed and reevaluated by the Milwaukee County Hazard Mitigation Plan LPT in light of the updated hazard conditions and hazard mitigation goals documented in Chapters 3 and 4.

Identification of Alternative Mitigation Strategies

Severe winter weather can include blizzards, freezing rain, sleet, ice, and dangerous combinations of temperatures and wind. Winter storms may last a few hours or days, completely shutting down businesses and government, while isolating residents in their homes.

Impacts of heavy snow and ice accumulations include slippery roads and walkways; collapsed roofs from heavy ice and snow loads; and damaged trees, telephone poles and lines, electrical wires, and communications towers.[156] Additionally, indirect injuries and fatalities may occur , especially to those considered vulnerable (i.e., elderly, young, disabled, sick/weak, and/or low-income), from activities associated with winter storms such as heart attacks while shoveling snow, carbon monoxide poisoning, hypothermia, frostbite, automobile accidents, and improper use of space heaters. Severe winter storm fronts can often be tracked, which generally provides ample warning for potentially affected areas to take preventative actions.

While it may not be possible to accurately predict the number or severity of winter storm events, measures can be taken to reduce the potential damage caused by winter storms and their related hazards whenever they may occur in the County. High-wind, freezing rain, sleet, ice, and snow may be associated with a winter storm. Reviewed by the Milwaukee County Hazard Mitigation LPT as part of the updating process, the following measures to reduce vulnerability to these dangers have been identified as viable for this Milwaukee County hazard mitigation plan update. This section will present structural, nonstructural, and public outreach mitigation measures as well as current programs that apply to winter storm hazards. In addition to the

[155] *Priority mitigation measures that apply to multiple hazard types, including tornado events, are presented in the "Hazard Mitigation Plan Component for Multiple Hazard Types" section in this Chapter.*

[156] *Wisconsin Department of Emergency Management and Military Affairs,* State of Wisconsin Hazard Mitigation Plan, *December 2016.*

Table 5.12
Cost-Benefit Analysis for Measures Included in the Milwaukee County All-Hazards Mitigation Plan: Tornado Hazards

Mitigation Measures	Estimated Cost[a]		Costs of Implementation[b]			Benefits						Community/ Jurisdictions Affected
	Capital	Average Annual Operation and Maintenance	Low	Moderate	High	Enhanced Preparedness/ Protection	Reduced Property Damage	Reduced Injuries	Reduced Mortalities	Enhanced quality of life/social benefits	Increased Environmental and/or Recreational Benefits/Ecosystems	
Nonstructural												
Ensure usage policies/procedures of the County's public outdoor warning sirens are up-to-date and reflect the needs of public safety personnel (i.e., use of "Wisconsin Outdoor Warning Siren Best Practices")	--[c]	--[c]	X			X						Milwaukee County
Require and enforce construction regulations of safe rooms in new schools, daycares, community centers, hospitals, and nursing homes	--[d]	--[d]	X			X	X	X	X			Milwaukee County and all local jurisdictions[e]
Regularly conduct an inventory and inspection of municipal and County facilities to ensure the quality, quantity, and accessibility of tornado shelters	--[f]	--[f]	X			X		X	X			Milwaukee County and all local jurisdictions[e]
Structural												
Continue to maintain and upgrade the operational and structural functions of the County's outdoor warning sirens to ensure effective and resilient systems	--[d]	--[d]			X	X						Milwaukee County
Routinely inspect manufactured housing parks to ensure safety material (e.g., tie-downs) is provided and accessible during a tornado event	--[c]	--[c]	X			X	X	X				Milwaukee County and the Cities of Cudahy, Franklin, Milwaukee, Oak Creek, and West Allis

Table continued on next page.

Table 5.12 (Continued)

Mitigation Measures	Estimated Cost[a]		Costs of Implementation[b]			Benefits						Community/ Jurisdictions Affected
	Capital	Average Annual Operation and Maintenance	Low	Moderate	High	Enhanced Preparedness/ Protection	Reduced Property Damage	Reduced Injuries	Reduced Mortalities	Enhanced quality of life/social benefits	Increased Environmental and/or Recreational Benefits/Ecosystems	
Public Information and Educational Programming												
Increase public education and awareness of the potential severity of tornadoes and continue to produce and expand the distribution of emergency preparedness information related to tornado events, notably to those considered most vulnerable	--[f]	--[f]	X			X						Milwaukee County and all local jurisdictions[e]
Make readily available information on where to go during severe weather events at outdoor venues	--[f]	--[f]	X			X						Milwaukee County and all local jurisdictions[e]

[a] *All costs expressed in 2022 dollars unless otherwise noted.*

[b] *Cost of implementation is allocated among three categories of low (less than $100,000 dollars), moderate (greater than $100,000 and less than $1,000,000), and high (greater than $1,000,000) costs, which are generally defined as:*

Low	*Moderate*	*High*
Educational and informational programming	*Addition of new staff*	*Major construction*
Ongoing enforcement of ordinances	*Additional staff hours budgeted*	*New buildings (infrastructure)*
Plan Development	*Additional equipment*	*Capital programs*
Continued coordination/mutual aid/ interagency agreements	*New ordinance development*	
	New programs/task force	

[c] *Costs covered under ongoing activity*

[d] *Costs are site-specific.*

[e] *Jurisdictions include general purpose units of government—Cities and Villages—and special purpose units of government such as School Districts.*

[f] *Costs to be determined. Partially covered under ongoing programs.*

Source: Milwaukee County and SEWRPC

measures listed below, mitigation strategies that were found to address multiple hazard types, including winter storm events, are discussed in the "Multiple Hazard Mitigation" plan component in this Chapter.

Nonstructural

- Review the energy efficiency and winter readiness of critical community facilities and utility systems throughout the County
- Continue to work with agencies, such as the American Red Cross, to establish and maintain short-term community sheltering units (see Appendix G for current shelter locations), particularly for those most vulnerable during harsh winter conditions
- Pursue additional funding opportunities to assist with budgeting for overtime hours and extra governmental personnel needed during extreme winter events
- Ensure that the necessary amount of snow removal, anti-icing, and deicing equipment is available and routinely maintained

Structural

- Work with utility companies to assess and improve, as needed, electric service system dependability and/or redundancy and backup systems
- Continue to ensure reliable and resilient back-up emergency power sources at community warming centers
- Continue to promote and highly encourage the installation or purchase of back-up power systems at homes and businesses

Public Informational and Educational Programming

- Continue to maintain and promote, via various modes of communication, winter hazard awareness and resources for all County residents, including home and travel safety measures, such as avoiding travel during winter storms; having a shovel, sand, warm clothing, food, and water in the vehicle if travel cannot be avoided; and installing a back-up heating system in at least one room in the home
- Promote the availability of low-income energy assistance programs

Current Programs and Ongoing Projects

Federal and State Programs

Federal and State winter storm programs include awareness and education activities. The Department of Homeland Security's *Ready.gov* campaign provides online resources on snowstorms and extreme cold awareness and preparedness.

The NWS Storm Prediction Center provides or issues smaller, more targeted information, including warnings, watches, and advisories on rapidly approaching intense, heavy winter precipitation to the public, private sector meteorologists, and state and local governments. Several categories of warnings, watches, and advisories apply to winter weather conditions and associated hazards.

The Milwaukee/Sullivan office will issue a winter storm warning when one or more of the following weather events are expected to occur over a period of 12 or fewer hours:

- Snowfall greater than six inches
- Sleet accumulations of two or more inches
- Intermittent blowing snow that reduces visibility below one-half mile with winds of 25 to 34 mph
- Less than one-quarter inch of freezing rain accompanied by another winter event

The NWS Milwaukee/Sullivan office will issue a winter weather advisory when one or more of the following weather events are expected to occur within 12 to 36 hours:

- Snowfall of three to six inches
- Sleet accumulations of less than two inches
- Intermittent blowing snow that reduces visibility below one-half mile with winds of less than 25 mph
- Less than one-quarter inch of freezing rain accompanied by another winter event

The NWS office will also issue an advisory or warning for blizzard, ice storm, and lake effect snow events.

In November each year, Winter Awareness Week focuses on informing and educating people concerning the hazards presented by severe winter weather and information on preparation for extreme weather conditions during winter. The Wisconsin Department of Health Services (DHS) has developed a weather tool kit to provide information to local governments, health departments, and citizens in Wisconsin about preparing for and responding to winter storm events.[157] Similarly, WEM has produced several educational resources regarding winter weather, including prerecorded radio public service announcements, scripts for radio public service announcements, fliers, and educational materials for children.[158]

The Wisconsin Building Code specifies design requirements to minimize vulnerability to winter storms by setting the load capacity of roofs by region based on likely maximum snowfall. The U.S. Department of Transportation reports that 24 percent of weather-related vehicle crashes occur on snowy, slushy or icy pavement and 15 percent happen during snowfall or sleet, therefore, listening to weather advisories and avoiding travel during winter storms would significantly reduce risk.

Local Programs

Winter safety information is prepared and distributed to the public by Milwaukee County OEM during Winter Awareness Week in November. Preparedness information is also provided in County and municipal community buildings, such as the County courthouse and safety building, health and human services, library, the Milwaukee City Hall, libraries, as well as the other village or city halls, and police and fire departments structures within Milwaukee County.

In addition, Milwaukee County, its communities, and local emergency departments provide information via social media on winter road conditions in and around the County. The Milwaukee County website also provides residents with numerous links and resources pertaining to extreme temperature safety, preparedness, and education including public shelter locations throughout the county.

Community strategies for winter storms in Milwaukee County include snow removal, salting and sanding roads, maintaining the health of urban trees to minimize damage from ice storms, promoting and maintaining community warming shelters. Also, during a storm, the public is advised via local radio, television, and NOAA weather alert radios on up-to-date winter weather forecasts.

Furthermore, as described in Chapter 2, Milwaukee County has developed a comprehensive emergency management plan, which sets forth an all-hazards action plan. The Plan provides for coordination of public safety support agencies such as the American Red Cross and for additional resources provided during winter emergencies. Note, many of the local units of government have developed emergency operations plans and/or programs which complement the County plan.

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[157] *Wisconsin Department of Health Services,* Wisconsin Winter Weather Toolkit, op. cit.

[158] *These can be accessed at Wisconsin Emergency Management's ReadyWisconsin website located at ready.wi.gov/Resources/Manager_Resources.asp.*

Multi-Jurisdictional Considerations

Winter storms and their related hazards can potentially impact all municipalities within the County. In addition, these severe events can potentially cause multiple damages to a variety of infrastructure including transmission lines, communication lines, and transportation routes due to whiteout conditions, snow accumulations, and ice. Milwaukee County, local units of government, and relevant businesses need to coordinate hazard mitigation activities through local government participation in countywide disaster planning and response mechanisms.

Evaluation of Alternatives and Identification of Priority Mitigation Measures

Analysis of the vulnerability of humans, infrastructure, and economic production to winter storms and related hazard events demonstrates that providing advanced weather forecasts and warning systems, as well as public informational and educational programming, are the most important mitigation actions to be considered. In addition, informing the public of the significance of winter storm watches and warnings so that they take these events seriously and know where to seek shelter is important. Forming a neighborhood outreach program to locate isolated, vulnerable or special-needs populations likely to be affected by winter storms is an important element in ensuring that these groups are protected during these events. Community and school based informational programs are currently being conducted by the County and its communities in partnership with Federal, State and local authorities.

Based upon the foregoing evaluation and consideration of risk and consideration by the Milwaukee County Hazard Mitigation LPT there are 7 actions determined by the Milwaukee County Hazard Mitigation LPT to be priority mitigation measures as part of this hazard mitigation plan update that are specifically related to winter storm events.[159] These priority mitigation measures, along with a general cost-benefit summary are presented in Table 5.13.

5.7 HAZARD MITIGATION PLAN COMPONENT FOR EXTREME TEMPERATURE

Extreme temperatures are natural hazard events of reasonable concern to be considered in the Milwaukee County hazard mitigation plan. Extreme temperatures can cause disruption of normal activities for the population and even the loss of life, particularly among more vulnerable populations (i.e., urban heat island effect). More vulnerable populations for extreme temperatures include young children, the elderly, underprivileged, undereducated, pregnant, and those in poor health or have chronic health conditions. This section describes alternative and selected priority strategies to mitigate this type of hazard. As part of the updating process, these strategies were reviewed and reevaluated by the Milwaukee County Hazard Mitigation Plan LPT in light of the updated hazard conditions and hazard mitigation goals documented in Chapters 3 and 4.

Identification of Alternative Mitigation Strategies

Extreme heat and cold events combined are the number one most deadly natural type of weather in Wisconsin and is therefore considered a serious concern to Milwaukee County. Furthermore, as detailed in Chapter 3, and depicted in Figure 3.4, because of its high population density, high social vulnerability index rating,[160] and urban heat island effect, Milwaukee County has even a higher vulnerability to extreme heat events and has experienced many heat-related fatalities (Table 3.4). As shown in Figure 3.4, the largest area of high heat vulnerability identified in the Milwaukee County Hazard Vulnerability Index (HVI) map[161] is the inner core of the City of Milwaukee.

Based upon review by the Milwaukee County Hazard Mitigation LPT as part of the updating process, the following measures to reduce the vulnerability to extreme temperature events have been identified as

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[159] *Priority mitigation measures that apply to multiple hazard types, including winter storm events, are presented in the "*Hazard Mitigation Plan Component for Multiple Hazard Types*" section in this Chapter.*

[160] *Includes people who do not have health insurance, people without transportation or funds to reach a hospital, people with disabilities, and low-income and racially marginalized people.*

[161] *The Wisconsin DHS **heat vulnerability index** is based on multiple indicators associated with risk for heat-related illnesses and mortality including health factors, demographic and household characteristics, socioeconomic factors, natural and built environment factors, and population density.*

Table 5.13
Cost-Benefit Analysis for Measures Included in the Milwaukee County Hazard Mitigation Plan: Winter Storms

Mitigation Measures	Estimated Cost[a]		Costs of Implementation[b]			Benefits						Community/ Jurisdictions Affected
	Capital	Average Annual Operation and Maintenance	Low	Moderate	High	Enhanced Preparedness/ Protection	Reduced Property Damage	Reduced Injuries	Reduced Mortalities	Enhanced quality of life/social benefits	Increased Environmental and/or Recreational Benefits/Ecosystems	
Nonstructural												
Review the energy efficiency and winter readiness of critical facilities/utilities and housing throughout the County	--[c]	--[c]	X			X				X		Milwaukee County and all local jurisdictions[d]
Continue to work with agencies (e.g., American Red Cross) and/or other organizations to establish reliable short-term sheltering of vulnerable populations	--[c]	--[c]		X		X		X	X	X		Milwaukee County and all local jurisdictions[d] and NGOs
Pursue additional funding opportunities to assist with budgeting for overtime hours and extra governmental personnel needed during extreme winter events	--[c]	--[c]		X		X		X	X	X		Milwaukee County and all local jurisdictions[d]
Ensure that the necessary amount of snow removal, anti-icing, and deicing equipment is available and operational	--[c]	--[c]		X		X				X		Milwaukee County and all local jurisdictions[d]
Structural												
Work with utility companies to assess and improve, as needed, electric service system dependability	--[e]	--[e]		X		X				X		Milwaukee County and all local jurisdictions[d]
Public Information and Educational Programming												
Continue to maintain and promote, via various modes of communication, winter hazard awareness and resources to all County residents, including home and travel safety measures	--[c]	--[c]	X			X						Milwaukee County

Table continued on next page.

Table 5.13 (Continued)

[a] *All cost expressed in 2022 dollars unless otherwise noted.*

[b] *Cost of implementation is allocated among three categories of low (less than $100,000 dollars), moderate (greater than $100,000 and less than $1,000,000), and high (greater than $1,000,000) costs, which are generally defined as:*

Low	*Moderate*	*High*
Educational and informational programming	*Addition of new staff*	*Major construction*
Ongoing enforcement of ordinances	*Additional staff hours budgeted*	*New buildings (infrastructure)*
Plan Development	*Additional equipment*	*Capital programs*
Continued coordination/mutual aid/interagency agreements	*New ordinance development*	
	New programs/task force	

[c] *Costs are covered under day-to-day operations.*

[d] *Jurisdictions include general purpose units of government—Cities and Villages—and special purpose units of government such as School Districts.*

[e] *Costs to be determined. Partially covered under ongoing programs.*

Source: Milwaukee County and SEWRPC

viable for this update of the Milwaukee County hazard mitigation plan. In addition to the measures listed below, mitigation strategies that address *multiple* hazard types, including extreme temperature events, are discussed in the "Multiple Hazard Mitigation" section in this Chapter.

Nonstructural

- Organize and/or enhance reliable neighborhood outreach groups or networks that reach out and look after vulnerable individuals and populations during extreme temperature conditions
- Continue support of the Milwaukee Heat Task Force
- Continue to provide special arrangements for payment of heating and cooling bills for customers unable to pay due to financial restraints
- Continue to designate or update adequate sites to be used as public cooling/warming shelters throughout extreme temperature events. In addition:
  - Conduct an inventory and inspection of these facilities to ensure their quality, quantity, and accessibility for use as heating and/or cooling shelters
  - Extend hours at these sites during extreme temperature events
  - Promote transportation options to assist members of highly vulnerable populations to reach these sites during extreme temperature events
- Reschedule public events to avoid large outdoor gatherings during periods of extreme heat or cold
- Extend public swimming pool hours to increase the accessibility during extreme heat events
- Establish and promote a donation program of functional window air conditioner units and fans that are no longer in use and distribute these items to vulnerable populations
- Promote and expand winter weather clothing drives (coats, hats, mittens) where people can drop off gently used winter clothing for distribution to vulnerable populations

Structural

- Take measures to reduce heat island effects in dense urban areas. Examples of such measures include:
  - Increase the amount of green space throughout urban areas
  - Increase tree plantings around buildings, parking lots, and along public right-of-way to shade surfaces that contribute to heat island formation
  - Encourage the use of "cool roofing" products made of highly reflective and emissive materials
- Maintain warming and cooling public shelter sites

Public Informational and Educational Programming

- Continue to increase and enhance public education and awareness, especially to those with limited accessibility or at high-risk, (i.e., elderly, impoverished/low-income, disabled, or lacking communication or travel devices) of the potential severity and danger of extreme temperature events and distribute emergency preparedness information related to these types of events
- Increase public awareness of community cooling/warming shelters that are available during extreme temperature events through municipal, County, and public health department websites and interactive maps, use "2-1-1," and by sharing with appropriate local media outlets (see Appendix G on a list of Milwaukee County heating and cooling centers)

- Produce and distribute emergency preparedness information related to the safe operation of generators, space heaters, fireplaces, and wood stoves
- Ensure those that are living in poor conditions with minimal resources are aware of different local, State, and/or Federal assistance programs and toolkits related to extreme temperature safety and risk prevention

Current Programs and Ongoing Projects

Federal and State Programs

The NWS issues warnings, watches, and advisory statements to media, emergency management, and public health officials when there is a threat of severe weather conditions. Several categories of warnings, watches, and advisories apply to both extreme heat and extreme cold conditions and the associated hazards. The conditions necessary for each of these categories are presented in detail in Chapter 3 of this Report. Heat waves cannot be prevented; therefore, it is important to provide notice of adverse conditions so that the public can anticipate and avoid health-threatening situations. Excessive heat alert thresholds specific to major metropolitan centers are determined based on research results that link unusual amounts of heat-related deaths to city-specific meteorological conditions. The NWS also has a HeatRisk forecast tool that provides a color and numeric value for the level of heat concern for a specific location. HeatRisk considers factors like how much higher than normal the temperatures are, the time of year, and the duration of unusual heat. In addition, the NWS provides a Wet Bulb Globe Temperature (WBGT) which is an effective indicator of heat stress for active populations such as outdoor workers and athletes by using temperature, humidity, wind, solar radiation, and other weather parameters.

The Occupational Safety and Health Administration (OSHA) recommends protective measures for outdoor work:

- Acclimatize workers starting the first day working in the heat and after any extended absences
- Provide shade for outdoor work sites
- Schedule work earlier or later in the day
- Use work/rest schedules
- Limit strenuous work (e.g., carrying heavy loads)
- Use relief workers when needed

State programs include various awareness and education efforts. WEM, in conjunction with the National Weather Service and State and local government agencies, provide both preparedness and severe weather information to the citizens of Wisconsin. Prepared information is provided during three severe weather awareness campaigns conducted during the year, each focusing on the prevalent weather hazard at that time. The Wisconsin Department of Health Services (WI DHS) has developed an extreme heat tool kit to provide information to local governments, health departments, and citizens in Wisconsin about preparing for and responding to extreme heat events.[162] Also, as detailed in Chapter 3, WI DHS developed a Building Resilience Against Climate Effects (BRACE) Program, which includes a geo-spatial analysis of heat-related vulnerability in the State by County (see Figure 3.4). Further, WI DHS developed a winter weather toolkit to provide information about winter weather, including extreme cold (Appendix G).[163] WEM has produced several educational resources regarding extreme heat and winter weather, such as extreme cold, including prerecorded radio public service announcements, scripts for radio public service announcements, fliers, and educational materials for children.[164] In addition, numerous other organizations, such as the American Red Cross, provide public safety information related to extreme temperatures.

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[162] *Wisconsin Department of Health Services,* Wisconsin Extreme Heat Toolkit, *Publication P00632, March 2014.*

[163] *Wisconsin Department of Health Services,* Wisconsin Winter Weather Toolkit, *Publication P00652, April 2014.*

[164] *These can be accessed at Wisconsin Emergency Management's ReadyWisconsin website located at: ready.wi.gov/Resources/Manager_Resources.asp.*

Wisconsin 211 is a free 24-hour hotline (dial 2-1-1) and online database/dashboard of information on local or regional resources and services available such as utility assistance, emergency housing during extreme weather events, available resources during extreme temperatures, food, elder care, or crisis intervention. For southeastern Wisconsin counties, including Milwaukee, "IMPACT 211" is the regional central access point for local resources and information.

Local Programs

The Milwaukee County OEM and City of Milwaukee Health Department has information available for the public on extreme temperatures and other general emergency management-related topics (i.e., Figure 5.1). The Milwaukee County OEM participates in State sponsored severe weather awareness campaigns.

The City of Milwaukee Health Department maintains an updated list and interactive map of cooling/heating centers with available air-conditioned or heated environments to prevent adverse effects (see Appendix G). In addition, MHD leads the Milwaukee Metropolitan Area Heat Task Force which is a coordinated effort committed to reducing the public health threat from heat waves. The Heat Task Force is comprised of members from the Milwaukee County OEM, the Milwaukee/Sullivan regional office of the NWS, the Milwaukee County Department on Aging, as well as interested parties from local government and community organizations. The Milwaukee Heat Task Force partnership collaborated on and instituted a plan for excessive heat conditions.[165] This plan outlines the roles and responsibilities of each participating group during excessive heat conditions. This plan includes a list of public cooling sites and essential recommendations and additional considerations for organizations offering to publicize their facilities as cooling centers.

Finally, a variety of methods to warn the residents of Milwaukee County of emergency situations, including extreme temperatures, are described in detail in the "multiple hazards" plan component earlier in this Chapter.

Multi-Jurisdictional Considerations

Extreme temperature events are primarily a public health concern for all communities and can affect all individuals within the County; however, they are particularly dangerous for those that most vulnerable, including the elderly, sick or unhealthy, mentally ill, poor, and homeless. In addition, vulnerable residents living in portions of the City of Milwaukee are at a greater risk to extreme heat events and associated impacts due to the urban heat island effect. A coordinated effort involving the Milwaukee County OEM, local health departments, local community organizations, NGO, and local safety and emergency programs will be needed to identify and protect individuals vulnerable to temperature-related hazards.

Evaluation of Alternatives and Identification of Priority Mitigation Measures

Based upon review of the above, the ongoing informational and educational programs related to extreme temperatures represent a major component of the planned mitigation action. Milwaukee County and its communities should continue to promote and enhance basic strategies to reduce injuries and fatalities, hazard awareness, and community involvement. Temperature hazards are experienced by Milwaukee County residents annually and the ability to make positive decisions concerning exposure limits will depend on hazard safety awareness. Analysis of the vulnerability of humans, infrastructure, and economic production caused by extreme temperature events demonstrates that providing advanced weather forecasting systems; providing early warning systems to alert the public of extreme temperature situations; the availability of adequate shelter from the heat and cold in public buildings, major industrial sites, and other large businesses or complexes; and public informational and educational programming are the most important mitigation actions to be considered. Public service announcements regarding avoiding heat stress help to minimize exposure. Milwaukee County supports measures presently implemented by the NWS; Federal, State, and local health organizations; and the media preceding and during excessively hot and cold weather. Outreach to poor and homeless populations to inform them of the availability and location of warming and cooling shelters and available resources within the County is also an important component to keeping these vulnerable populations safe. Community and school-based informational programs and networks for extreme temperature awareness should continue to be conducted and improved in partnerships with other local organizations and Federal, State and local authorities.

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[165] *City of Milwaukee Health Department and Milwaukee Metropolitan Area Heat Task Force,* "Excessive Heat Event Coordination Plan," *June 2018*.

Based upon the foregoing evaluation and consideration of risk and review by the Milwaukee County Hazard Mitigation LPT (see Appendix A), there are 8 actions determined to be priority mitigation measures as part of this hazard mitigation plan update that are specifically related to extreme temperature events.[166] These priority mitigation measures, along with a general cost-benefit summary are presented in Table 5.14.

5.8 HAZARD MITIGATION PLAN COMPONENT FOR DROUGHT

Droughts are natural hazard events of minor to moderate concern to be considered in the Milwaukee County hazard mitigation plan. This section describes alternative and selected priority strategies to mitigate this type of hazard. As part of the updating process, these strategies were reviewed and reevaluated by the Milwaukee County Hazard Mitigation Plan LPT in light of the updated hazard conditions and hazard mitigation goals documented in Chapters 3 and 4.

Identification of Alternative Mitigation Strategies

A drought is a prolonged period of unusually constant dry weather that persists long enough to cause deficiencies in water supply (surface or groundwater). When drought events do occur, they often impact a relatively large area. The effects of drought are often grouped as economic, environmental, and social. Over time droughts can severely affect crops, municipal water supplies, recreational resources, human health, and wildlife. If drought conditions extend over a number of years, the direct and indirect impacts can be significant.[167]

Because Milwaukee County has very little agriculture (see Tables 2.9 and 2.10) and is positioned on Lake Michigan, which serves as its main source of drinking water, overall, it is less susceptible to droughts. However, certain stresses on the water resources of Milwaukee County such as increased competition for available water, loss of groundwater recharge areas due to development, and the potential effects of a changing climate may make drought conditions worse.

Although nothing can prevent a drought, certain measures should be considered and implemented to help reduce potential impacts. As reviewed by the Milwaukee County Hazard Mitigation Plan LPT, the following are considered as part of this Plan update to reduce drought vulnerability. In addition to the measures listed below, mitigation strategies that address *multiple* hazard types, including drought events, are discussed in the "Multiple Hazard Mitigation" section in this Chapter.

Nonstructural

- Encourage the development and maintenance of drought emergency plans for local water utilities and private well users. Such plans should include:
    - Development of criteria for triggering drought-related actions
    - Development of agreements for secondary water sources that may be used during drought conditions
    - Specification of water use regulations during drought conditions
- Encourage the development of local water conservation programs.[168] Such programs may include provisions such as:
    - Water supply system efficiency actions including meter testing, leak detection and repair, water main maintenance and replacement, water system audits, and water production system refinement
    - Public information and education programming and distribution of educational materials

[166] *Priority mitigation measures that apply to multiple hazard types, including extreme temperature events, are presented in the "Hazard Mitigation Plan Component for Multiple Hazard Types" section in this Chapter.*

[167] *FEMA,* Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards*, January 2013.*

[168] *SEWRPC Planning Report No. 52,* A Regional Water Supply Plan for Southeastern Wisconsin*, December 2010.*

Table 5.14
Cost-Benefit Analysis Summary of Measures Included in the Milwaukee County Hazard Mitigation Plan: Extreme Temperature Hazards

Mitigation Measures	Estimated Cost[a]		Costs of Implementation[b]			Benefits						Community/ Jurisdictions Affected
	Capital	Average Annual Operation and Maintenance	Low	Moderate	High	Enhanced Preparedness/ Protection	Reduced Property Damage	Reduced Injuries	Reduced Mortalities	Enhanced quality of life/social benefits	Increased Environmental and/or Recreational Benefits/Ecosystems	
Nonstructural												
Organize and enhance neighborhood outreach groups who look after vulnerable populations and promote the availability of shelters during extreme heat and cold (Appendix G)	--[c]	--[c]	X			X			X			Milwaukee County and all local jurisdictions[d]
Provide special arrangements for payment of heating and cooling bills for customers unable to pay due to financial constraints	--[c]	--[c]	X			X		X		X		Milwaukee County and all local jurisdictions[d]
Reschedule public events to avoid large outdoor gatherings during periods of extreme heat or cold	--[e]	--[e]	X			X		X	X	X		Milwaukee County and all local jurisdictions[d]
Extend public swimming pools hours during extreme heat events	--[c]	--[c]		X		X		X		X		Milwaukee County and all local jurisdictions[d]
Establish and promote a donation program of functional window air conditioner units and fans and distribute these items to vulnerable populations	--[c]	--[c]	X			X		X	X	X		Milwaukee County and all local jurisdictions[d]
Promote and expand winter weather clothing drives (coats, hats, mittens) where people can drop off gently used winter clothing for distribution to vulnerable populations	--[c]	--[c]		X		X		X	X	X		Milwaukee County and all local jurisdictions[d]
Structural												
Promote measures to reduce heat island effects in urban areas	--[c]	--[c]	X			X				X	X	Milwaukee County and all local jurisdictions[d]

Table continued on next page.

Table 5.14 (Continued)

Mitigation Measures	Estimated Cost[a]		Costs of Implementation[b]			Benefits						Community/ Jurisdictions Affected
	Capital	Average Annual Operation and Maintenance	Low	Moderate	High	Enhanced Preparedness/ Protection	Reduced Property Damage	Reduced Injuries	Reduced Mortalities	Enhanced quality of life/social benefits	Increased Environmental and/or Recreational Benefits/Ecosystems	
Public Information and Educational Programming												
Produce and distribute emergency preparedness information related to the safe operation of generators, space heaters, fireplaces, and wood stoves	--[c]	--[c]	X			X		X		X		Milwaukee County and all local jurisdictions[d]

[a] *All costs expressed in 2022 dollars unless otherwise noted.*

[b] *Cost of implementation is allocated among three categories of low (less than $100,000 dollars), moderate (greater than $100,000 and less than $1,000,000), and high (greater than $1,000,000) costs, which are generally defined as:*

Low	*Moderate*	*High*
Educational and informational programming	*Addition of new staff*	*Major construction*
Ongoing enforcement of ordinances	*Additional staff hours budgeted*	*New buildings (infrastructure)*
Plan Development	*Additional equipment*	*Capital programs*
Continued coordination/mutual aid/ interagency agreements	*New ordinance development*	
	New programs/task force	

[c] *Costs to be determined. Partially covered under ongoing programs.*

[d] *Jurisdictions include general purpose units of government—Cities and Villages—and special purpose units of government such as School Districts.*

Source: Milwaukee County and SEWRPC

- Outdoor watering reduction measures such as the use of rain barrels/cisterns or implementation of lawn and landscape plant watering restrictions when a severe drought is occurring
    - Development and use of water conservation rate structures
    - Fixture and plumbing system retrofits
- Promote regional activities to protect groundwater recharge areas within and outside of the County
- Identify areas with potential groundwater level problems and inspect wells in those areas for adequate depth and construction.
- Allow and encourage the use of drought-resistant landscaping practices using native plantings.
- Promote the use of green infrastructure and other stormwater management practices that facilitate aquifer recharge, such as rain gardens, permeable pavement, and soil amendments.
- Support ordinances to prioritize or control water use during drought conditions.
- Design and plan for water supply infrastructure systems that are not vulnerable to drought events.

Structural

- Consider implementing the recommendations made in the regional water supply plan for additional water supply facilities and programs to meet forecast water use demands[169]
- Continue operation and monitoring of stream gaging stations and groundwater monitoring wells by the WDNR, U.S. Geological Survey, NWS, and U.S. Army Corps of Engineers.

Current Programs and Ongoing Projects

Federal Programs

Interagency/Collaborative Efforts

The National Oceanic and Atmospheric Administration's (NOAA) National Integrated Drought Information System (NIDIS) Act is a comprehensive interagency program that coordinates and integrates drought research by building upon existing federal, tribal, State, and local partnerships in support of creating a national drought early warning information system. In addition, the NIDIS website[170] serves as the primary drought portal and clearinghouse for drought related resources. The NIDIS website provides regional drought early warning systems (DEWS)[171] links to research and resources for drought planning and preparedness, as well as links for recovery, education, news about drought, regional webinars and upcoming drought-related events. In addition, the website has a number of maps, tools, social media updates, and data related to drought at both the national and regional scale.

The National Drought Resilience Partnership (NDRP), a federal partnership between the U.S. Department of Agriculture (USDA), the U.S. Department of Energy (U.S. DOE), the U.S. Department of the Interior (U.S. DOI); and federal sub-agencies including NOAA, NWS, NIDIS, USGS, National Aeronautics and Space Administration (NASA), the Assistant Secretary of the Army for Civil Works, FEMA, and the U.S Environmental Protection Agency (EPA), provides technical and financial Federal resources on efforts to build, protect, and sustain long-term drought resilience capacity at regional and basin-level scales.

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[169] *See recommendations for Milwaukee County in Table 194 from SEWRPC Planning Report No. 52,* A Regional Water Supply Plan for Southeastern Wisconsin*, December 2010. These recommendations were made for water utilities to meet a "reliable capacity" based on forecast water use demands in the design year 2035.*

[170] *The NIDIS website can be found at www.drought.gov.*

[171] *The* ***Drought Early Warning System (DEWS)*** *utilizes new and existing networks of federal, tribal, State, local, and academic partners to make climate and drought science accessible and useful for decision makers. It also aims to improve the capacity of stakeholders to monitor, forecast, plan for, and cope with the impacts of drought.*

The National Drought Mitigation Center (NDMC) assists local officials, organizations, and institutions to build resilience to drought through monitoring and planning. The NDMC website offers abundant information on drought research, education, planning, and monitoring and is host of the U.S. Drought Monitor (USDM) map.[172] The NDMC assists State, Federal, regional, tribal, and local governments as well as individual ranchers and farmers involved in drought and water supply planning, mitigation, and policy making.

The U.S. Geological Survey (USGS) also monitors, assesses, studies, and presents information on water resources and associated conditions such as streamflow, groundwater, water quality, and water use and availability. The USGS website provides water quality and water level data through a number of interactive maps, such as, "Drought Watch", "Water Watch", and "Groundwater Watch." In addition, the website offers a number of additional drought-related resources and links available for public information and education.

Also, the USDA and the Natural Resources Conservation Service (NRCS) both provide information and educational resources on conservation practices as well as a number of financial, technical, agricultural, and natural resources programs that should be considered during and after a severe drought event.

The NWS also provides a number of informational and educational online resources related to drought and drought monitoring, including the NWS Climate Prediction Center, the National Climatic Data Center Drought Monitoring, and NOAA's experimental drought monitoring and early warning guidance tool known as Evaporative Demand Drought Index.[173]

Additional Federal Programs and Mitigation Resources

FEMA provides drought mitigation assistance through its Hazard Mitigation Grant Program (HMGP) and Building Resilient Infrastructure and Communities (BRIC) mitigation program as well as drought-related informational and educational resources and links available on the FEMA website. NASA's Gravity Recovery and Climate Experiment (GRACE) satellite integrates groundwater and soil moisture storage observations with modeling to generate drought indicators based on cumulative distribution of wetness conditions.[174] In 2013, the American Planning Association (APA), in collaboration with NDMC and NIDIS, published a guide to help decision-makers, resource managers, public agencies, land owners, local officials, and policy-makers assist communities for drought preparedness and mitigation.[175]

State Programs

The Wisconsin Geological and Natural History Survey (WGNHS), in collaboration with USGS, and WDNR, provide interactive online maps of statewide monitoring wells that include groundwater elevation and conditions.

Additionally, the Wisconsin DHS has developed a drought toolkit to provide information to local governments, health departments, and citizens in Wisconsin about preparing for and responding to drought events.[176] Similarly, *ReadyWisconsin* Drought provides drought-related information and resources to assist individuals and communities prior to and during a drought.[177] Also, Chapter NR 852, "Water Conservation and Water Use Efficiency," of the *Wisconsin Administrative Code* establishes mandatory water conservation and efficiency measures for withdrawals in the Great Lakes Basin and water loss approvals throughout the State.

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[172] *The **U.S. Drought Monitor (USDM),** a partnership between the NDMC, USDA, and NOAA, produces a weekly interactive online map and informational on current drought conditions. USDM provides an updated map every week with a general summary of current drought conditions, various indices, outlooks, field reports, and news accounts.*

[173] ***Evaporative Demand Drought Index (EDDI)** can offer early warning of agricultural drought, hydrologic drought, and fire-weather risk by providing near-real-time information. EDDI can capture signals of water stress at weekly to monthly timescales, which makes it a strong tool for drought preparedness.*

[174] *Drought.gov.*

[175] *James C. Schwab, American Planning Association-Planning Advisory Service Report No. 574,* "Planning and Drought," *October, 2013.*

[176] *Wisconsin Department of Health Services,* Wisconsin Drought Toolkit, *Publication P00884, revised May, 2019.*

[177] *Ready.gov/wisconsin.*

Local Programs

As described in Chapter 1, Milwaukee County has developed a comprehensive emergency management plan that sets forth an all-hazards action plan, including instances of drought related events. In addition, the City of Milwaukee helps water users in identifying and eliminating leaks in internal plumbing systems; the City of Oak Creek has implemented water treatment plant modifications to help reduce water usage; and the City of Franklin has instituted water sprinkling restrictions from May through September. Further, while not specifically reported, all County utilities strive to improve efficiency and minimize water losses within their systems, including meter testing for accuracy, leak detection programs, and repair of water main breaks and leaks. In general, most Milwaukee County municipalities have adopted water usage regulations during drought conditions and offer resources related to water conservation and drought related preparedness practices.

Multi-Jurisdictional Considerations

Ultimately, all areas in the County are at a uniform risk of drought events and associated impacts, as droughts occur regionally and not within specific locations, in which all vulnerable populations within the County would be impacted. In 2005 the Commission completed the regional water supply plan,[178] which included an inventory of all water supply sources in Milwaukee County. That plan indicated that over 100 private groundwater well systems existed in the county in 2005. These private well systems included over 50 high-capacity wells and served residential, industrial, commercial, institutional, recreational, and governmental land uses. In 2005 the majority of these private groundwater well systems were located in the Cities of Franklin and Oak Creek and the Villages of Bayside and River Hills. Also to note is that the majority of residents in the Village of River Hills have individual private wells as of 2024. Assuming all these areas still contain groundwater well systems, certain risk reduction measures should be considered during prolonged drought events.

Evaluation of Alternatives and Identification of Priority Mitigation Measures

Drought can have economic, environmental, and social impacts, especially to those populations and communities considered vulnerable, which include the elderly, low income, and/or disabled. Aside from the noted locations above, Milwaukee County receives its drinking water from Lake Michigan. Nevertheless, it is still important to consider the adverse impacts of drought within and around the County. Mitigation of the potential impacts of drought should be addressed through a multi-faceted approach. Important elements of such an approach include developing plans for responding to drought conditions for local communities and utilities; protecting local water supply sources that use groundwater as the main source; water conservation efforts; and encouraging residents to take advantage of Federal programs.

Based upon the foregoing evaluation and consideration of risk and consideration by the Milwaukee County Hazard Mitigation LPT (see Appendix A), there are 7 actions determined to be priority mitigation measures for this hazard mitigation plan update related to drought events.[179] These priority mitigation measures, along with a general cost-benefit summary are presented in Table 5.15.

5.9 HAZARD MITIGATION PLAN COMPONENT FOR LAKE MICHIGAN COASTAL HAZARDS

The Great Lakes coastline is a dynamic environment with shoreline conditions continually changing over time. Unlike ocean coasts, where sea level is gradually trending higher, Great Lakes water levels vary annually and over multi-decade cycles. It is important to note that such varying water levels have a fundamental influence on the portion of the shore face that is exposed to the force of wave energy. Further, the majority of these shorelines are highly vulnerable to shore erosion because of the unconsolidated glacial materials (i.e., gravels, lake-deposited clays, and tills) that make up the landforms. With the effects of a changing climate, these dynamic conditions are often exacerbated with human activity, including different shoreline management practices. And because of this, people, property, and structures along the Lake Michigan Milwaukee County coastline are becoming increasingly vulnerable to the impacts of the coastal hazards of shoreline erosion/recession, bluff failure, coastal flooding, storm surge, and ice shove.

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[178] *SEWRPC Planning Report No. 52,* A Regional Water Supply Plan for Southeastern Wisconsin, Vol. I, *2010.*

[179] *Priority mitigation measures that apply to multiple hazard types including drought events, are presented in the "*Hazard Mitigation Plan Component for Multiple Hazard Types*" section in this Chapter.*

Table 5.15
Cost-Benefit Analysis for Priority Measures Included in the Milwaukee County Hazard Mitigation Plan: Drought Hazards

Mitigation Measures	Estimated Cost[a]		Costs of Implementation[b]			Benefits						Community/ Jurisdictions Affected
	Capital	Average Annual Operation and Maintenance	Low	Moderate	High	Enhanced Preparedness/ Protection	Reduced Property Damage	Reduced Injuries	Reduced Mortalities	Enhanced quality of life/social benefits	Increased Environmental and/or Recreational Benefits/Ecosystems	
Nonstructural												
Encourage the development and maintenance of drought emergency plans for local utilities and communities	--[c]	--[c]	X			X						Milwaukee County and all local jurisdictions[d]
Promote regional activities to protect groundwater recharge areas inside and outside of the County	--[e]	--[e]	X			X					X	Milwaukee County and all local jurisdictions[d]
Promote and encourage the use of drought-resistant landscaping practices (i.e., native plantings)	--[f]	--[f]	X			X	X				X	Milwaukee County and all local jurisdictions[d]
Support ordinances to prioritize or control water use during drought conditions	--[c]	--[c]	X			X					X	Milwaukee County and all local jurisdictions[d]
Design and plan for water supply infrastructure systems that are effective and reliable during drought events	--[g]	--[g]		X		X	X			X		Milwaukee County and all local jurisdictions[d]
Structural												
Consider implementing the recommendations made in the regional water supply plan for additional water supply facilities and programs to meet forecast water use demands	--[c]	--[c]	X			X				X	X	Milwaukee County and all local jurisdictions[d]
Continue operation of stream gaging stations and groundwater monitoring wells	--[c]	--[c]		X		X	X			X	X	Milwaukee County, MMSD, and all local jurisdictions[d]

Table continued on next page.

Table 5.15 (Continued)

Mitigation Measures	Estimated Cost[a]		Costs of Implementation[b]			Benefits						Community/ Jurisdictions Affected
	Capital	Average Annual Operation and Maintenance	Low	Moderate	High	Enhanced Preparedness/ Protection	Reduced Property Damage	Reduced Injuries	Reduced Mortalities	Enhanced quality of life/social benefits	Increased Environmental and/or Recreational Benefits/Ecosystems	
Public Information and Educational Programming												
Increase public education and awareness of the potential severity of drought events	--[c]	--[c]	X			X	X			X	X	Milwaukee County and all local jurisdictions[d]

[a] *All costs expressed in 2022 dollars unless otherwise noted.*

[b] *Cost of implementation is allocated among three categories of low (less than $100,000 dollars), moderate (greater than $100,000 and less than $1,000,000), and high (greater than $1,000,000) costs, which are generally defined as:*

Low
Educational and informational programming
Ongoing enforcement of ordinances
Plan Development
Continued coordination/mutual aid/ interagency agreements

Moderate
Addition of new staff
Additional staff hours budgeted
Additional equipment
New ordinance development
New programs/task force

High
Major construction
New buildings (infrastructure)
Capital programs

[c] *Costs covered under ongoing activity.*

[d] *Jurisdictions include general purpose units of government—Cities and Villages—and special purpose units of government such as School Districts.*

[e] *Costs to be determined based on amount of funding allocated for program.*

[f] *Costs to be determined.*

[g] *Costs are site-specific. Partially covered under ongoing programs.*

Source: Milwaukee County and SEWRPC

To increase coastal resiliency in Milwaukee County and to protect shoreline assets, this Plan calls for the implementation of the following recommended alternative and priority mitigation measures which are both structural and nonstructural.

Identification of Alternative Mitigation Strategies

As reported in Chapters 2 and 3, a number of studies and planning programs have been carried out related to Lake Michigan coastal processes, including bluff failure and beach or shoreline erosion impacts. A review of those plans and programs comprise material developed under the Wisconsin Coastal Management Program (WCMP) and the University of Wisconsin Sea Grant Institute (WSGI). These plans include a range of alternative bluff, beach, and shoreline erosion control and flood mitigation measures and/or regulations that are considered priority coastal hazard mitigation measures for this Plan update.

As such, the recommended coastal mitigation measures are presented in five main categories for coastal Milwaukee County hazard mitigation planning.

- Coastline Regulations and Policy Measures
- Bluff Top and Ravine Mitigation Measures
- Bluff Face, Bluff Toe and Shoreline Mitigation Measures
- Coastal Flooding Measures
- Informational and Educational Outreach and Resources

Coastline Regulations and Policy Measures

The shores of the Great Lakes are subject to a multitude of federal, state, and local laws and standards.[180] Shoreline or coastal policies (i.e., zoning ordinances) and management guidelines often include development (or structural) setback regulations,[181] building relocation requirements, bluff, beach, and shoreline best management practices and guidelines, regulations for implementing shoreline protection structures/ devices, and requirements for engineering or geotechnical analyses of proposed shoreline site modifications. Implementing, maintaining, and enforcing these coastal management guidelines and regulations is essential for Milwaukee County and its coastal communities in hazard mitigation planning efforts.

Federal Regulations

Because the Great Lakes are navigable waters of the United States, permits are required from the U.S. Army Corps of Engineers (USACE) for the placement of piers, wharves, jetties, breakwaters, revetments, and similar shoreline structures.

The Federal Coastal Zone Management Act (CZMA) requirement is that any proposed federal actions (regardless of location) that have foreseeable effects on any land or water use, or natural resource of the coastal zone, must be conducted in a manner consistent with the policies of the coastal state's coastal management program. With that, the Coastal Resources Management Program (CRM), within each state, is responsible for ensuring such actions are being met.

State Regulations and Management Guidelines

Through the Shoreland Management Act, Wisconsin has shoreland setback regulations in unincorporated areas associated with all navigable waters. Additionally, a permit for coastal work is required from the Wisconsin Department of Natural Resources (WDNR) pursuant to Chapter 30 of the *Wisconsin Statutes*. Also, under *Wisconsin Administrative Code*, Chapter NR 115, the statewide setback in the shoreland zone is

[180] *Alan R. Lulloff, P.E., CFM, Science Services Program Director - Association of State Floodplain Managers and Philip Keillor, P.E., Coastal Engineer,* Wisconsin Coastal Management Program: Managing Coastal Hazard Risks On Wisconsin's Dynamic Great Lakes Shoreline, *2015*.

[181] *The distance from the edge of a coastal bluff or bank (or other reference point) to a building or other structure is called a* ***setback distance*** *(Source UW-Wisconsin Sea Grant Institute).*

75 feet from the Ordinary High Water Mark (OHWM) (See Figure 5.7).[182] Building and structure setbacks are established to conform to health, safety, and welfare requirements; preserve natural beauty; reduce flood hazards; and avoid water pollution. On coastal bluffs, the OHWM is generally the toe of the bluff (see Figure 5.8) and is often inadequate for safe shoreline development, especially at the top of the bluff.

- In response to both the impacts experienced from high water levels and the state setback standard mentioned above, the Wisconsin Coastal Management Program (WCMP), UW-Wisconsin Sea Grant Institute (WSGI), and WDNR developed recommendations to go above and beyond the State requirement, including a minimum setback distance for the structure(s) to be set back from the bluff crest or calculated stable slope instead of the OHWM (or the bluff toe).[183]

- Based on bluff setback recommendations developed by WSGI and others, the Commission drafted a model ordinance for Lake Michigan bluff setbacks (see Figure 5.9 and Appendix I). This model ordinance is intended to help protect structures and properties from bluff erosion and failure without reliance on shore protection measures. The model ordinance includes a bluff top setback distance based on a 60-year bluff recession, a stable bluff face slope, and an additional 100-feet. Milwaukee County coastal communities that have yet to adopt coastal setback regulations should consider implementing them for coastal hazard mitigation, including the protection of critical facilities, infrastructure, and new development.

<u>Local Regulations and Management Guidelines</u>

- Milwaukee County coastal communities including the City of Oak Creek, and the Villages of Bayside, Fox Point, Shorewood, and Whitefish Bay have developed their own coastline management strategies and regulations to protect existing and proposed development from potential bluff instability and erosion/recession hazards. These local coastal regulations and guidelines include bluff setback requirements, regulations for conducting site specific bluff stability analyses, and provisions for implementing shoreline protection structures (see Appendix I).[184] For coastal hazard mitigation purposes, this Plan encourages and recommends that these communities continue to maintain and enforce these regulations and guidelines.

- To prevent or reduce future damage to county-owned assets along the Lake Michigan coastline, Milwaukee County, with the assistance of Commission staff, developed and adopted coastline management regulations and guidelines which are to be enforced within the designated Coastline Management Zone (CMZ), as indicated on Map 5.8.[185] These management guidelines and regulations include coastal bluff and ravine setbacks requirements (see Figure 5.9), guidance on shoreline vegetation and best management practices, viewshed management, recommended bluff stabilization techniques, and stormwater management practices and regulations.[186] This Plan calls for Milwaukee County to promote and continue to enforce these guidelines and regulations as they relate directly to coastal hazard mitigation measures. Additionally, the Milwaukee County coastal municipalities are encouraged to adopt similar coastal goals and guidelines for future coastal work.[187]

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[182] ***OHWM****, as defined by the WDNR is "the point on the bank or shore up to which the presence and action of water is so continuous as to leave a distinct mark either by erosion, destruction of terrestrial vegetation or other easily recognized characteristic."*

[183] *Wisconsin Coastal Management Program,* Managing Coastal Hazard Risk on Wisconsin's Dynamic Great Lakes Shoreline*, 2015.*

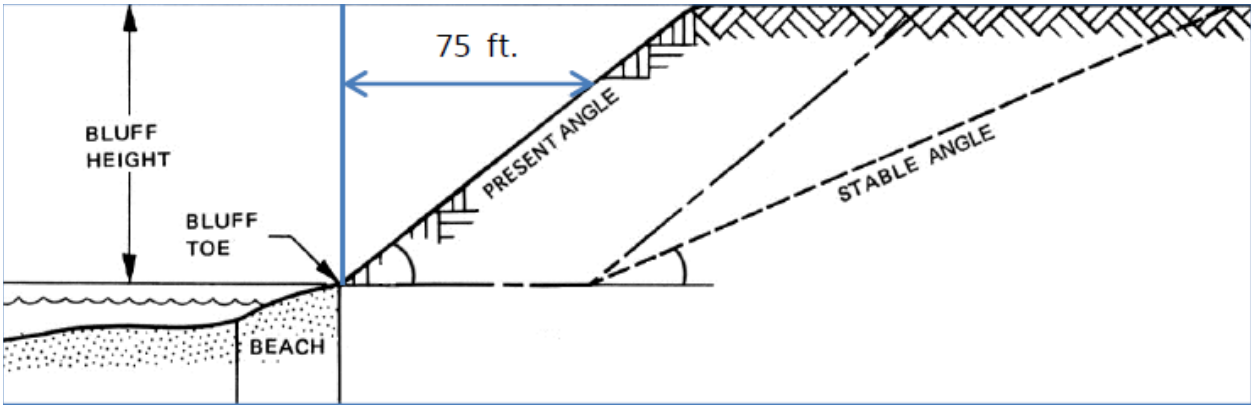
[184] *Some municipalities' lake bluff regulations also relate to the bluffs of ravines that are tributary to Lake Michigan.*

[185] *SEWRPC Memorandum Report No. 248,* Milwaukee County Coastline Management Guidelines*, February 2021.*

[186] *On February 4, 2021, the Milwaukee County Board of Supervisors authorized adoption of the coastline management guidelines for implementation by the County Parks Department for all pertinent land use actions, both County-initiated as well as third party projects.*

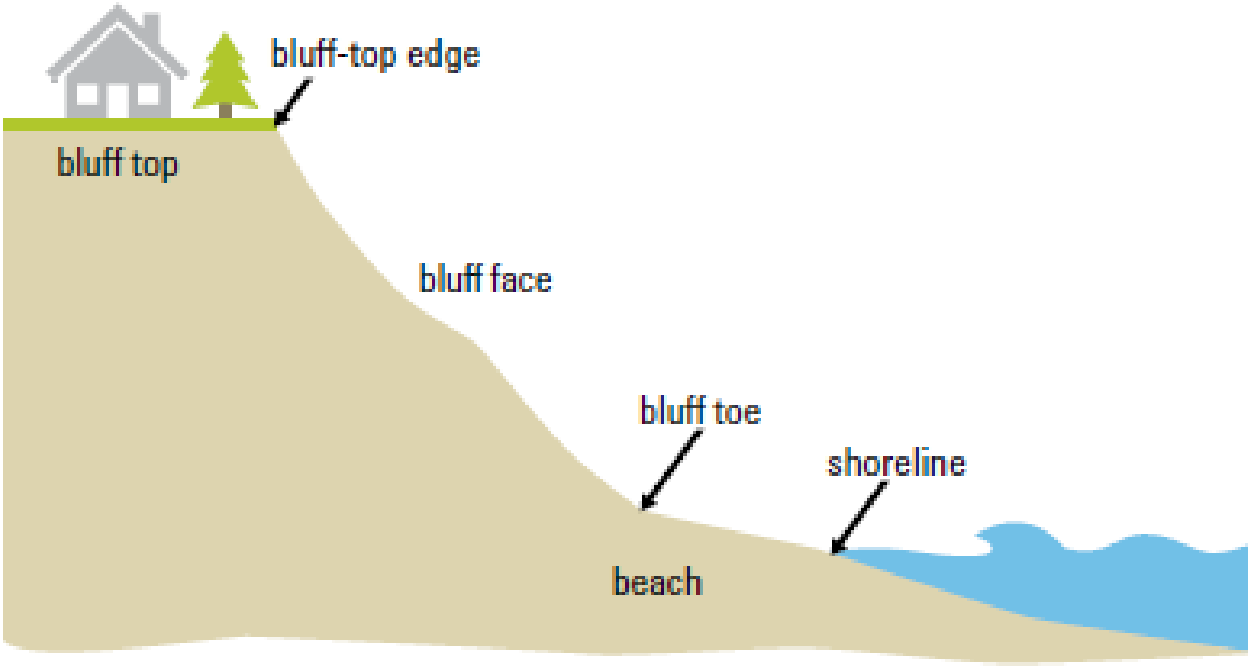
[187] *Milwaukee County requires proposals for a scope of work for all land-disturbing activities within the designated Lake Michigan Coastline Management Zone.*

Figure 5.7
Wisconsin Shoreland Setback Requirement of 75 Feet from Bluff Toe



Source: Wisconsin Coastal Management Program

Figure 5.8
Bluff Schematic

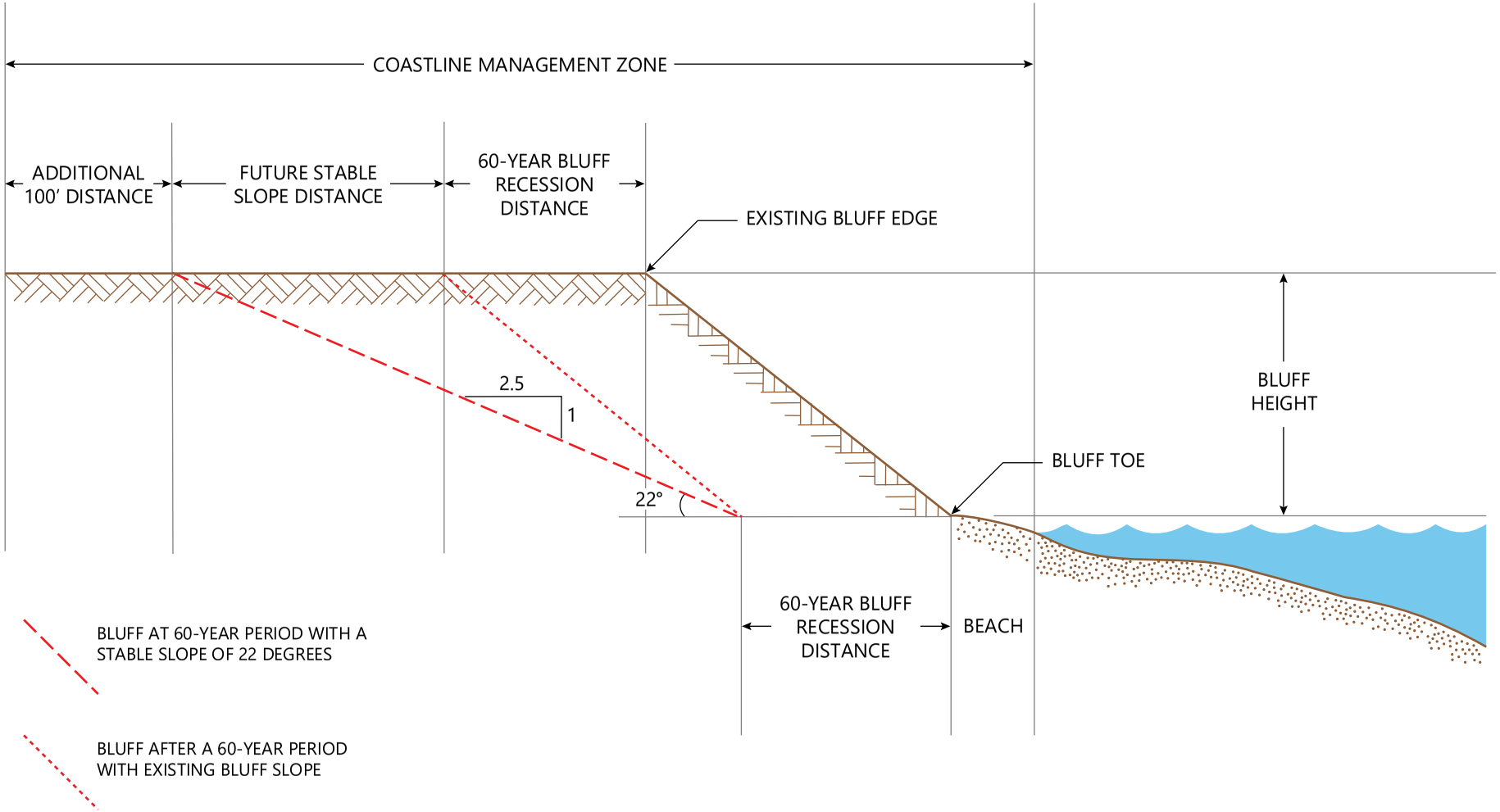


Source: University of Wisconsin – Sea Grant and SEWRPC

Bluff Top and Ravine Mitigation Measures

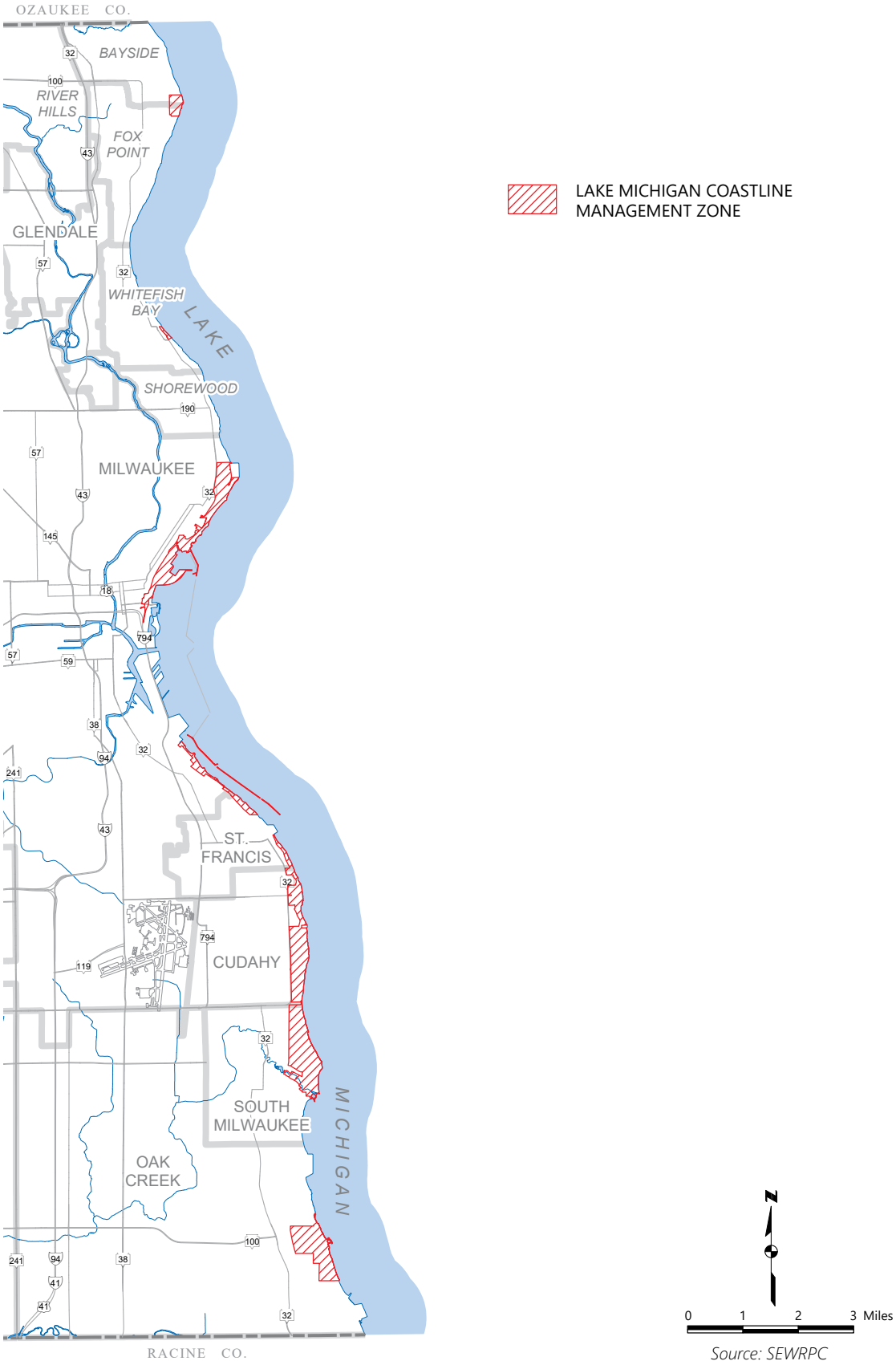
The bluff top (Figure 5.7) is where coastal assets like homes, businesses, and infrastructure are often located, and is greatly influenced by human activity. Bluff top management practices such as land use, surface water runoff, groundwater infiltration, and vegetation management play an important role in the overall stability of the bluff and therefore are an important element in coastal hazard mitigation planning. Note that a large portion of the Milwaukee County coastline is currently designated as environmental corridors and isolated natural resource areas (see Map 5.9 (North Half) and (South Half)). Most of these uses are in parks, which means the risk to buildings and infrastructure is relatively small for the County. Nevertheless, the recommended bluff top and ravine practices below will provide additional protection from coastal impacts.

Figure 5.9
Model Coastline and Ravine Setback Ordinance



Source: University of Wisconsin Sea Grant Program and SEWRPC

Map 5.8
Lake Michigan Coastline Management Zone: 2019



Source: SEWRPC

Map 5.9a
Environmental Corridors and Isolated Natural Resource Areas Along the North Half of the Milwaukee County Lake Michigan Coastline: 2015

Source: SEWRPC

Map 5.9b
Environmental Corridors and Isolated Natural Resource Areas Along the South Half of the Milwaukee County Lake Michigan Coastline: 2015

Source: SEWRPC

- Land use management – As recommended in the previous "Coastline Regulations and Policy Measures" section, structures should be an adequate distance away from the bluff top edge (or bluff crest) to reduce the risks of structural impacts from bluff failure hazards.

    - It is encouraged that Milwaukee County, and its coastal communities develop and promote bluff top best management practices (BMPs) along the Milwaukee County bluff shoreline. Implementing these practices is of particular priority in areas where significant bluff crest recession has been observed. As discussed in Chapter 3, and indicated on Maps 3.9 and 3.10, the largest bluff crest recession within the long-term period (1956-2015) were observed in the Cities of Milwaukee, St. Francis, Whitefish Bay, and Oak Creek, with both St. Francis and Oak Creek also experiencing the greatest amount of short-term (1995-2015) bluff crest recession.

    - Consider relocating buildings determined to be at high-risk for sustaining damages from bluff recession and/or failure. Detailed studies by a licensed engineer would be needed to determine if a building should be considered for relocation. This plan element is presented as an option, subject to the preference of the individual property owner.

    - For coastal risk reduction measures, it is suggested to avoid adding excess weight or other disturbances near the bluff-top edge.

    - As described in Chapter 3 and detailed in Table 3.22, WEM conducted a county-level coastal erosion risk and vulnerability assessment using a statewide parcel inventory database. Parcels within one-quarter of a mile from the coast were considered within the High-Risk Erosion Zone, while parcels within one-half mile were considered to be in a Low-Risk Erosion Zone. Of the 23,869 total parcels identified in Milwaukee County to be at risk (low and high), 6,457 were considered to be in the High-Risk Zone. For hazard mitigation purposes, this Plan calls for the structures identified within the High Risk Zone and/or near the coastal bluff edge to be further evaluated for coastal hazard risk.

    - In circumstances where buildings cannot be relocated safely or economically onsite, or where bluff recession has progressed to the point where the risk of catastrophic failure of the slope is imminent, or where there is an imminent threat of failure within five years, acquisition and demolition of the structures should be considered. Note, this plan element is presented as an option, subject to the preference of the individual property owner.

- Surface or stormwater management – Stormwater runoff can contribute to bluff and ravine destabilization and erosion. Paved surfaces and structures on the top of the bluff can prevent water from infiltrating into the soil, which may increase sheet and concentrated flows of water over the bluff crest causing erosion. It is recommended to limit or minimize the use of impervious surfaces and to have a well-designed and properly constructed drainage system to eliminate stormwater from flowing over the edge and down the face of the bluff.[188] These bluff top stormwater BMPs include the following.

    - Positioning stormwater ditches and roof gutters to *direct flow away* from the bluff-top edge

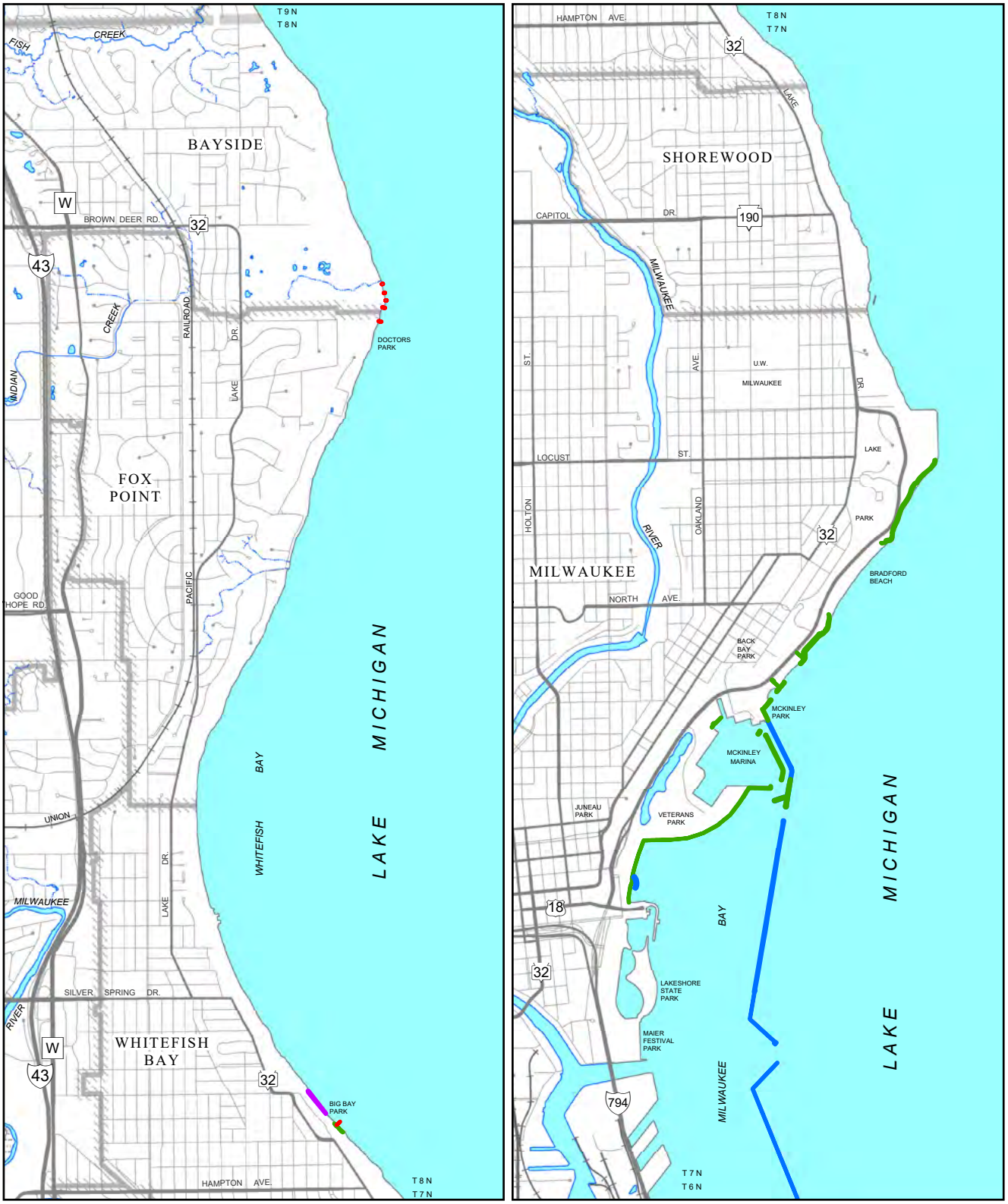
    - Use rain barrels to capture roof runoff

    - Route water into existing stormwater systems that move water away from the coastal bluff

    - Continue to monitor and maintain stormwater drainage systems and outfalls

[188] *A. Mangham, D. Hart, A. Belche, G. Clark, D. Peroff, J. Noordyk, B. Stitt, and L. Stitt, University of Wisconsin Sea Grant Institute,* Adapting to a Changing Coast, Options and Resources for Lake Michigan Property Owners, *August 2017.*

Map 5.10a
Shoreline Protection Structures Along the North Half of the Milwaukee County Coastline: 2019

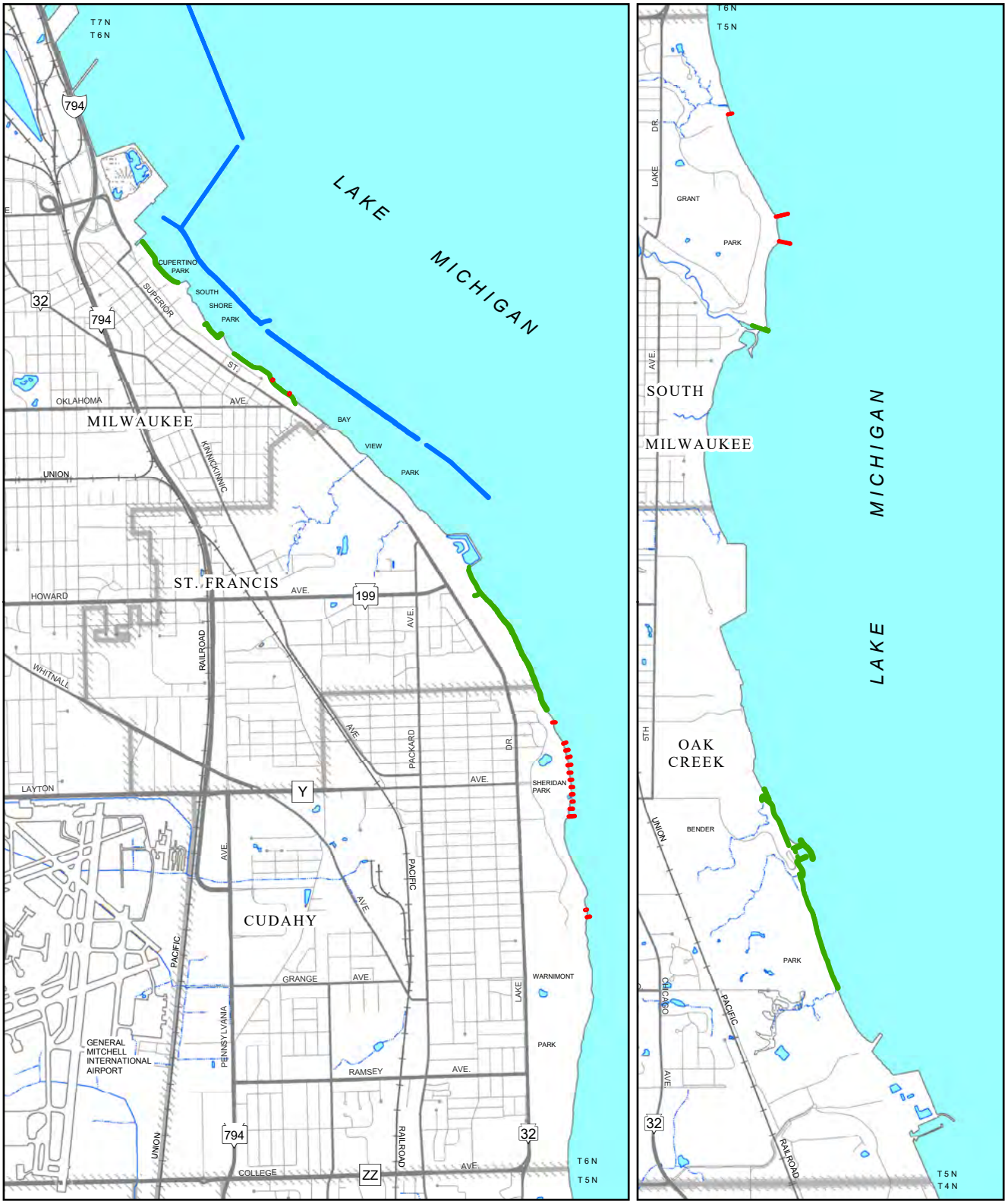


BREAKWATER
BULKHEAD
GROIN
REVETMENT (INCLUDING RIP RAP)

0 0.25 0.5 0.75 1 Miles

Source: Milwaukee County and SEWRPC

Map 5.10b
Shoreline Protection Structures Along the South Half of the Milwaukee County Coastline: 2019



BREAKWATER
BULKHEAD
GROIN
REVETMENT (INCLUDING RIP RAP)

0 0.25 0.5 0.75 1 Miles

Source: Milwaukee County and SEWRPC

- Stormwater infrastructure that discharges (or outfalls) into Lake Michigan, such as those shown on Map 5.11 (North Half) and (South Half), can potentially damage the shoreline or become damaged from coastline impacts. Further, coastal damage can be exacerbated during extreme rainfall events with the higher volume and velocity of discharges increasing the risk of erosive impacts within and along coastal bluffs and shorelines. Also, stormwater infrastructure is also susceptible to potential coastal damage impacts, particularly during high water levels in that natural debris from the Lake or a storm may damage the outfall or the area around the outfall. Milwaukee County and its coastal communities are encouraged to continue to monitor, maintain, and improve (as needed), their stormwater infrastructure systems, specifically during high Lake Michigan water levels.

Bluff Face, Bluff Toe and Shoreline Mitigation Measures

Bluff face, bluff toe (see Figure 5.7), and shoreline protection measures are often managed concurrently as many of the physical processes that affect these coastal features are connected. For example, addressing bluff toe problems frequently corresponds with stabilizing the bluff face. Therefore, bluff stabilization and shoreline protection highlighted within this Plan element are considered as mitigation alternatives for Milwaukee County and its coastal communities for its coastal hazard planning efforts.

- As mentioned in Chapters 2 and 3, a number of studies and assessments have been conducted on the Milwaukee County coastal characteristics and condition(s) including shore erosion and bluff stability. From the various assessments and reports, potential bluff hazards within Milwaukee County are highlighted below. Priority coastal mitigation measures should be considered for these locations.

- According to the 2020 Milwaukee County Coastal Resources Inventory report, detailed in Chapter 3, the vulnerability and risk assessment reported that the bluffs along Warnimont Park, Grant Park, Sheridan Park, Bay View Park, Big Bay Park, and Doctors Park have both a high vulnerability and risk rating.

  - In 2019 unstable Lake Michigan bluff conditions existed in the Cities of Cudahy, South Milwaukee, and St. Francis (Map 3.6). Moderately unstable bluffs were found in the City of Oak Creek and the Village of Fox Point.

  - A few examples of 2024 erosion areas along the Milwaukee County bluffs can be found in Figure 5.10. These photos were taken from the Wisconsin Shoreline Inventory and Oblique Photo Viewer which can be used by communities to review current bluff conditions.

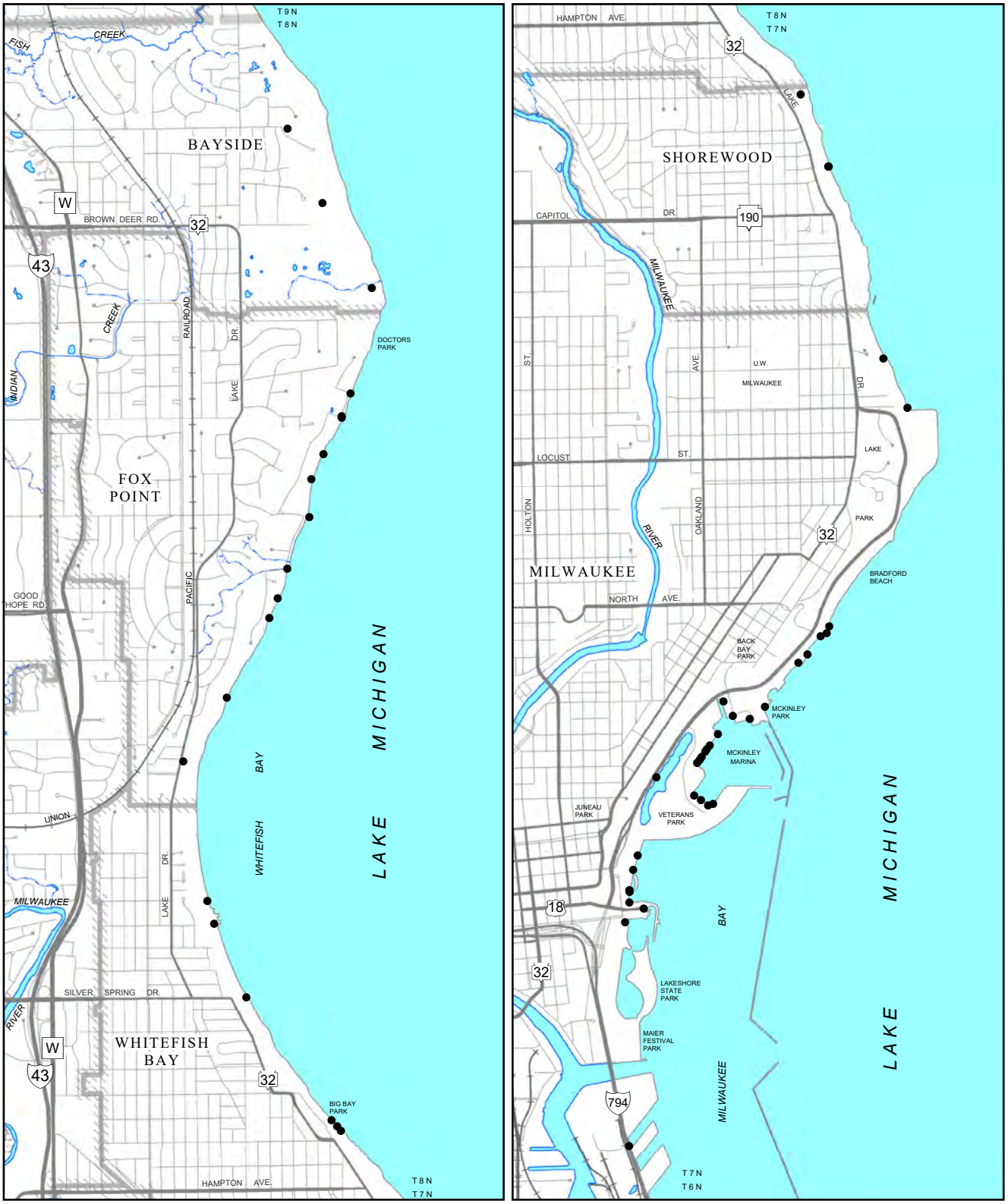
- Groundwater saturation can weaken the soil matrix, causing landslides or slumps on the bluff face (See Appendix I for examples of different bluff failure and/or erosion). Where groundwater saturation is known to be weakening bluff soils, it is recommended to investigate the suitability of installing a well-designed, appropriately located underground drainage system to help dewater the subsurface bluff soils. This system would help reduce groundwater saturation and increase bluff stability.

- Vegetation on coastal bluff slopes can stop surface erosion and may prevent shallow slides. Combining a variety of plants and root structures increases the strength and cohesion of soil even during saturated conditions, thus implementing this technique can slow stormwater runoff, reduce erosion, and increase bluff top and face stability. Guidance on selecting suitable plant species for bluff stabilization can be found in Appendix I or, "A Property Owner's Guide to Protecting Your Bluff".[189] Recommendations from this guide include limiting substantial digging or other ground disturbances near the bluff-top edge and avoiding unnecessary compaction of soil on the bluff top during landscaping or construction.

- As shown in Appendix I, and for mitigation purposes, Milwaukee County and its coastal communities should consider using visual cues to potentially help reduce or prevent future impacts caused by coastal bluff hazards. Visual signs on the bluff face or toe that indicate potential bluff instability include the following.

[189] *L. Salus, A. Bechle, J. Noordyk, G. Clark, and D. Carter, University of Wisconsin Sea Grant and SEWRPC,* A Property Owners Guide to Protecting Your Bluff, September 2021.

Map 5.11a
Stormwater Outfalls Along the North Half of the Milwaukee County Lake Michigan Coastline

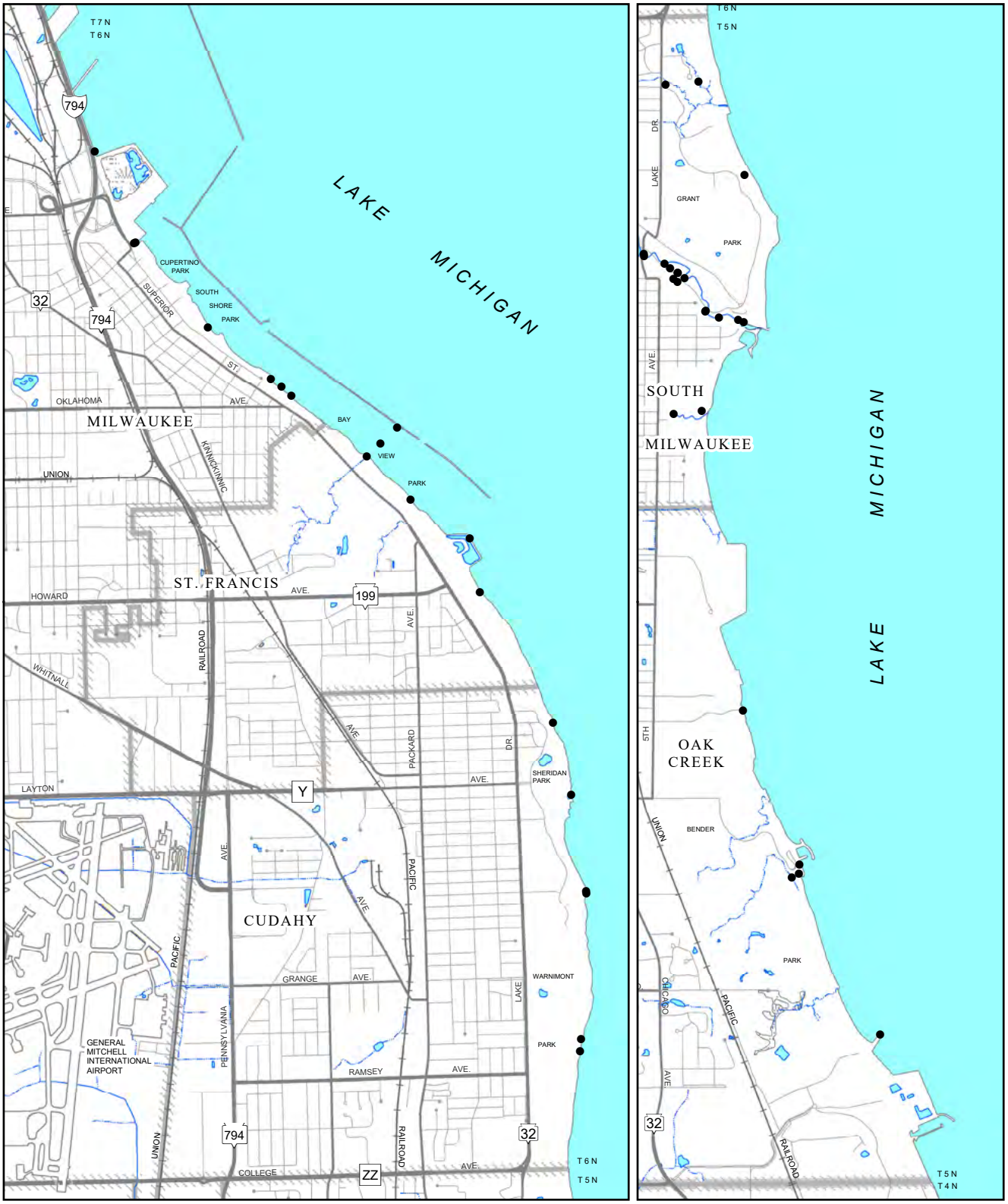


● STORMWATER OUTFALL

0 0.25 0.5 0.75 1 Miles

Source: Milwaukee County Municipalities, Milwaukee County, Wisconsin Coastal Management Program, and SEWRPC

Map 5.11b
Stormwater Outfalls Along the South Half of the Milwaukee County Lake Michigan Coastline



Source: Milwaukee County Municipalities, Milwaukee County, Wisconsin Coastal Management Program, and SEWRPC

- The formation of **rills or gullies** into the bluff face causing erosion on the bluff face.
- **Groundwater** seepage in the middle of an otherwise dry bluff face indicates saturated soils which can reduce bluff slope stability.
- **Tilted or curved trees/shrubs** signifies that the slope is unstable and beginning to move slowly toward the lake.
- **Slides or slumps** on the bluff face indicates a recent slope movement and that a large bluff failure event is likely.
- **Loss of vegetation** on the bluff face is another indication of recent slope movement. Furthermore, a completely bare bluff face implies erosion is too rapid for plants to establish.
- **Steep, near-vertical slopes** at the base of the bluff (i.e., "scarps") caused by waves eroding the bluff toe can destabilize the bluff slope and ultimately lead to bluff failure.

Figure 5.10
Examples of Potential Structural Coastal Hazard Concerns: 2024

Source: Wisconsin Shoreline Inventory and Oblique Viewer (Association of State Floodplain Managers, Geo-Professional Consultants, LLC, National Oceanic and Atmospheric Administration, Wisconsin Coastal Management Program) and SEWRPC

- Milwaukee County and its coastal communities are encouraged to review and implement up-to-date geotechnical engineering studies and assessments that include variables (i.e., soil, groundwater conditions, maximum groundwater levels, vegetative cover, surface drainage, bluff height, slope angle, and previous studies) to help determine bluff stability and shoreline recession concerns.
  - Bluff slope stability analyses should be based upon the highest groundwater conditions (when the bluff is most likely to fail), and safety factors appropriate for the consequences of failure.[190]
- If determined to be necessary by a licensed engineer, maintain bluff stability by regrading and terracing the angle of the bluff face to create a less steep slope between the top and toe of the bluff. Any bluff regrading project would need to be designed and overseen by a geotechnical engineer trained in slope stabilization and a qualified contractor should be involved throughout the project.[191]
- With the assistance of a certified engineer and/or a marine contractor, Milwaukee County and its coastal communities are encouraged to routinely inspect, monitor, and update an inventory and assessment of the condition and effectiveness of all shoreline protection structures, such as shoreline revetments, breakwater walls, commercial and industrial docks and marinas, and bulkhead/seawalls (see Map 3.5 and Maps 5.11 (North Half) and (South Half). Note, a certified engineer and/or qualified marine contractor will be required if a new or reconstructed shoreline protection project is needed.[192]

[190] Ibid.

[191] Ibid.

[192] Ibid.

As discussed below, there are a number of coastal mitigation projects planned or in progress in Milwaukee County and its coastal communities.

- With assistance from NOAA and the Fund for Lake Michigan, the City of Oak Creek is planning to conduct bluff toe and slope stabilization and habitat rehabilitation along a city-owned bluff that is on the Peter-Cooper brownfield site. The design includes construction of a revetment wall at the bluff toe, bluff slope regrading, and a drainage layer at the bluff face to stabilize the bluff slope. The 2,200 foot long revetment will be built from the seawall at the MMSD South Shore Water Reclamation Facility (WRF) to the existing revetment at the City of Oak Creek's water intake site. The goal of the revetment is to limit wave erosion at the base of the bluff. It should be noted that nature-based toe protection options were explored during the design phase of this project, however, with the high wave environment and sediment starvation from nearby shoreline protection structures, these options were impractical. The project also includes bluff regrading to mitigate bluff collapse and to allow public access.

- Another shoreline project considered a priority mitigation measure for Milwaukee County is the renovation work on the northern portion of the South Shore Breakwater wall. This breakwater structure protects the Milwaukee County coastal assets of Cupertino, South Shore, and Bay View Parks. It also protects the shore along the Oak Leaf Trail and Milwaukee's South Shore Yacht Club and boat launch. In 2020, after severe winter storms the breakwater structure was damaged, most likely due to undersized rocks. In 2023, several gaps within the structure had to be repaired, and beginning in 2024 sections of the northern breakwater wall began to be reconstructed. The renovated breakwater wall is designed to be 15 feet above the waterline, whereas now it is seven feet, in order to better protect County coastal assets. Construction is scheduled to be complete in 2025.

- The combination of the 2019-2020 high Lake Michigan water levels along with severe storms that included big waves, debris accumulation, and flooding, caused significant damage to portions of the Village of Fox Point. Shoreline impacts included extensive shoreline erosion and infrastructure exposure and damage. In 2020, the Village began a major shoreline protection and resiliency project along portions of Beach Drive. The project included the design of a robust and resilient revetment structure, the implementation of green infrastructure, the updating and replacement of existing stormwater outfalls, and the construction of more robust protection at existing sanitary sewer manholes. The project was completed in 2024 at a cost of $3.6 million.

- Milwaukee County and its coastal communities are encouraged to develop and/or maintain long-term protection measures for critical community, utility, and historical facilities located on the Lake Michigan shoreline.

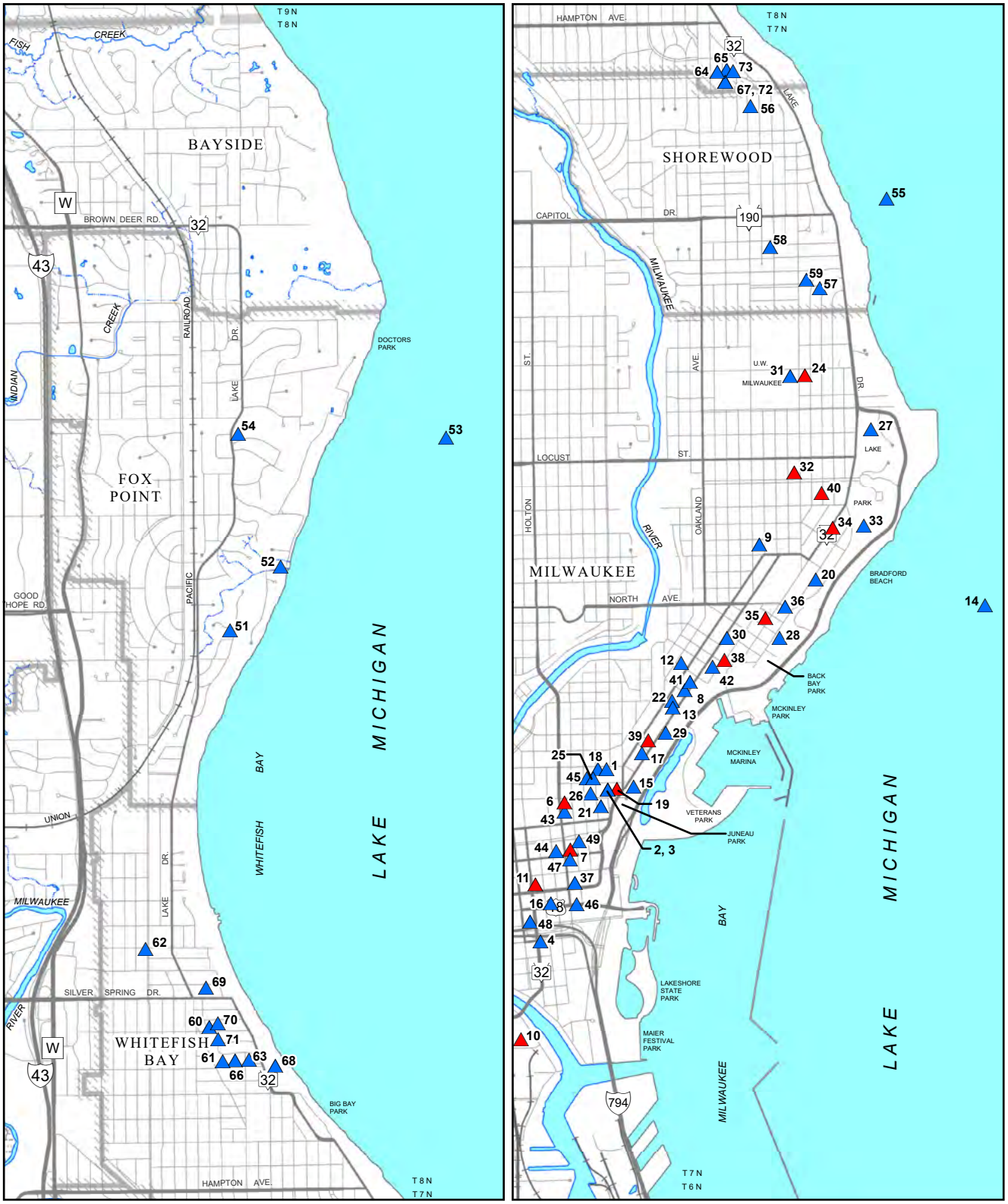
- Milwaukee County and the City of Milwaukee are to ensure the breakwater walls and piers within and around the Milwaukee Harbor, which includes the Jones Island WRF and the Port of Milwaukee, are routinely maintained and up-to-date to withstand the increasingly harsh conditions of extreme weather events in the Lake Michigan coastal environment (such as gale force winds, large waves, or flooding), particularly during periods high water levels.

- It is important that Milwaukee County and its coastal communities consider the adverse impacts that coastal processes can have on historic sites and districts (see Appendix E and Map 5.12 (North Half) and (South Half)). This Plan calls for mitigative and protective measures to ensure that these sites and districts are safe from the hazardous and damaging impacts of coastal processes.

The following measures are recommended for Milwaukee County and its coastal communities prior to conducting shoreline protection projects.

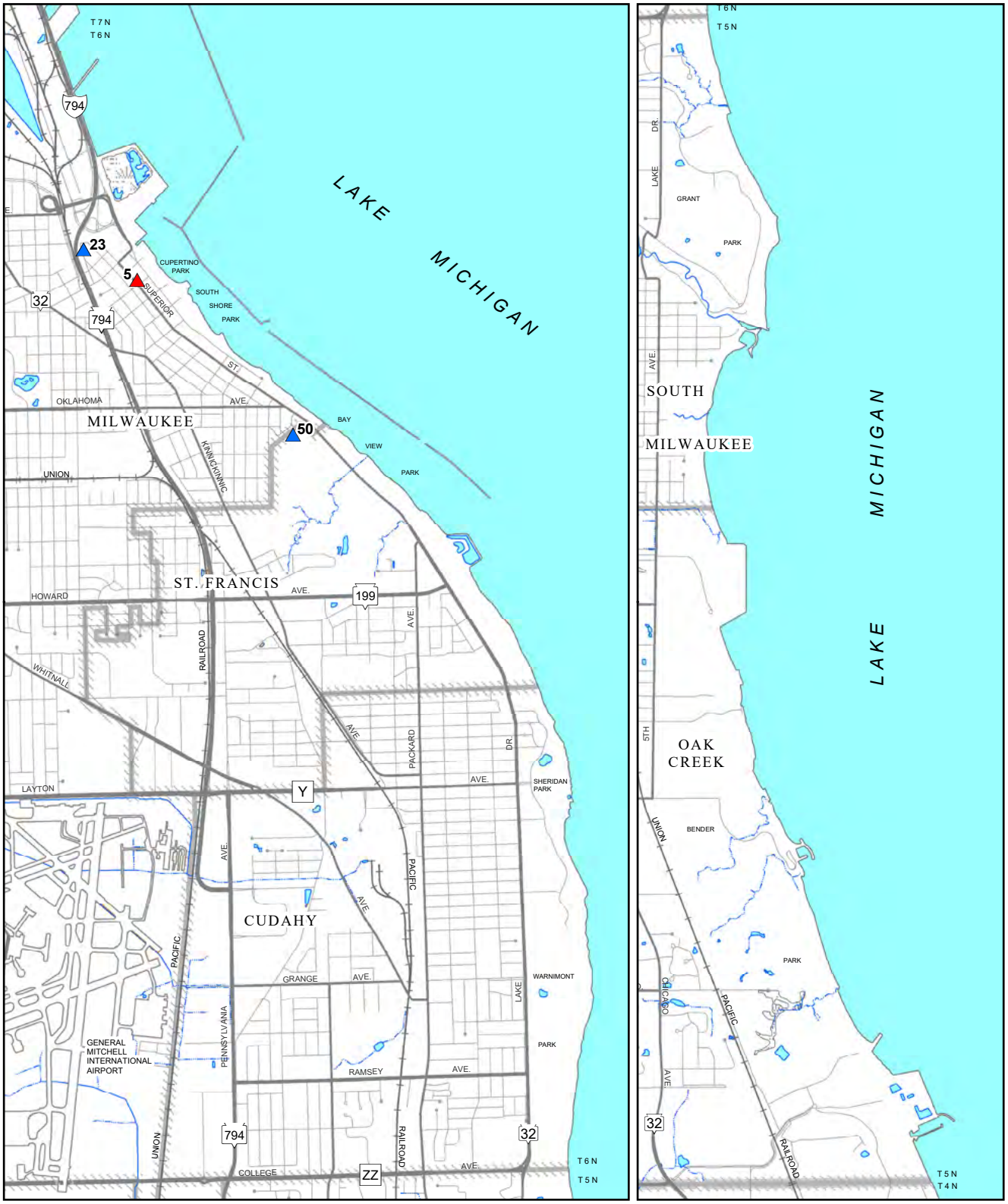
- Structural shoreline protection measures (i.e. jetties, groins, seawalls, and revetments) should only be installed if other less invasive measures are inadequate in reducing shoreline erosion and if it can be shown that such measures will effectively reduce shoreline erosion while not adversely affecting adjacent sections of the Lake Michigan shoreline.

Map 5.12a
Historic Sites and Districts Along the North Half of the Milwaukee County Lake Michigan Coastline



Source: SEWRPC

Map 5.12b
Historic Sites and Districts Along the South Half of the Milwaukee County Lake Michigan Coastline



HISTORIC SITE

HISTORIC DISTRICT

33 REFERENCE NUMBER (SEE APPENDIX E AND TABLE E.4)

Note: Historic sites and districts are only being shown within one-half mile from the Lake Michigan shoreline.

0 0.25 0.5 0.75 1 Miles

Source: SEWRPC

- To the degree practicable, landowners (private and public) along the Milwaukee County Lake Michigan coastline are encouraged to use nature-based shoreline protection measures, such as living revetments or seawalls, native plantings, dune and coastal wetland restoration, and beach replenishment over the use of traditional "hard" shoreline protection structures (i.e., jetties, groins, breakwaters, seawalls, and levees). Hard shoreline protection structures have been proven to intervene with natural coastal processes causing adverse impacts to nearby and downstream shoreline properties. Further, nature-based shoreline management is less intrusive and more beneficial in the long-term both aesthetically and ecologically. Costs for implementing nature-based shoreline measures vary depending on the project scale and material used. Some considerations for nature-based solutions are listed below.
    - Fish and wildlife preservation measures should be considered and implemented to limit any adverse impacts during construction.
    - It can often be more economical and effective to plan and implement shoreline protection or bluff stability projects in concert, with the design and implementation of projects along multiple neighboring properties and shorelines.[193]
- A 2015 coastal bluff analysis for the north shore of Milwaukee County is an example of the potential negative impacts of implementing hard-lined shoreline protection structures.[194] While the bluff analysis found that most bluffs along this reach were stable prior to 2013, it did reveal that some areas were beginning to experience bluff failure. The assessment concluded that these new bluff toe failures were a result of decreased beach widths and that these bluffs were failing in part because an adjacent property had constructed shoreline/bluff protection structures.

Coastal Flooding Measures

- Lower-lying shorelines are at a higher risk of being affected by the impacts of coastal flooding. In Milwaukee County there are small and scattered low lying shorelines along the coast, hence impacts to buildings and infrastructure are small. Nevertheless, Milwaukee County and its coastal communities are highly encouraged to continue to participate in the FEMA National Flood Insurance Program (NFIP). To note, Lake Michigan coastal V and VE flood hazard areas were added to the Milwaukee County regulatory floodplain maps in October 2024.[195]
    - The Lake Michigan 1-percent-annual-probability floodplain, prior to the October 2024 update, was used by the Commission in the parcel-based flood analysis discussed in Chapter 3. As indicated in Table 3.8 and Map 3.12, the analysis identified 28 structures potentially within the 1-percent-annual-probability coastal floodplain. The risk to these 28 structures should be confirmed utilizing the October 2024 updated FEMA coastal mapping. To reduce the potential impacts of a coastal flood event, structural acquisition and removal or relocation measures should be considered by the at-risk property owners. This is a voluntary option and is subject to the preference of the individual property owner. Also, prior to structural removal or relocation, on-the-ground field surveys by a certified land surveyor or engineer is highly recommended to confirm the structure(s) in question are indeed located within the coastal flood hazard area. Shown in Table 5.16, the estimated cost of implementing this recommendation is $34.4 million (2022 dollars). Note, this cost is also included in the floodplain and stormwater management section of this Chapter.

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[193] Ibid.

[194] *University of Wisconsin Sea Grant Institute,* Integrated Assessment on Water Level Variability and Coastal Bluffs and Shores in Northern Milwaukee County and Southern Ozaukee County, Wisconsin, Interdisciplinary Synthesis of Existing Research*, November 2016.*

[195] *A Coastal High Hazard Area is identified as **Zone V** or **Zone VE** on FEMA flood maps where wave heights are larger than three feet. "**Zone VE**" means that a detailed study has been done for the area, whereas "Zone **V**" means that a detailed study has not been done, but wave hazards are still expected. Structures in areas mapped as Zone V and Zone VE are subject to stricter building requirements because of the higher risk of damage from strong winds and waves.*

- Critical community facilities and/or infrastructure and utilities within or near the Milwaukee County Lake Michigan 1-percent-annual-probability flood hazard zone, such as the MMSD Jones Island and South Shore WRFs, the Port of Milwaukee, the Lake Express Car Ferry, the U.S. Coast Guard facility, and the City of Milwaukee Water Works facility should consider implementing priority mitigation measures to reduce flood risks and hazardous impacts to these vital community lifeline facilities that serve Milwaukee County and its surrounding area.

  - The January 2020 event produced severe lakeshore flooding and erosion at the Port of Milwaukee, causing the Port and Car Ferry to shut down for two days. In addition, this event flooded nearly 70 percent of Jones Island, which impacted access to and from the MMSD Jones Island WRF and caused some structural damage. As a result of this event, MMSD initiated a major flood hazard mitigation study and project aimed to increase safety and reduce structural and infrastructure flooding impacts from Lake Michigan events. The cost of this study is listed in Table 5.3.

  - A number of public facilities within the City of Milwaukee (Discovery World, War Museum, Art Center, Riverfront boat launch, Veterans Park, McKinley Marina, South Shore Yacht Club) are also located within or near the Lake Michigan 1-percent-annual-probability flood hazard zone and are therefore encouraged to plan mitigation actions that will reduce the impacts caused by Lake Michigan extreme weather events, such as flooding.

Public Information and Educational Resources and Outreach

Coastal hazard information should continue to be readily available to the public. Coastal erosion hazard assessments and associated erosion hazard maps have been developed for Lake Michigan's coast.[196] It is recommended, as a part of this Plan update, to inform and encourage Milwaukee County and its coastal communities and landowners to use the Wisconsin Shoreline Inventory and Oblique Photo viewer mapping tool to better understand long- and short-term shoreline processes and the natural or man-made impacts on individual properties.

This Plan calls for Milwaukee County and its communities to continue to work with WCMP and University of Wisconsin-Sea Grant Institute (WSGI) on public outreach and education assistance to support bluff and shoreline best management practices. This plan also recommends reviewing and re-examining, as necessary, the current community and County zoning ordinances, regulations, and comprehensive plans related to coastal hazards and coastal community resiliency. Other recommended outreach and education activities are listed below.

- Continue to promote and provide information related to online interactive maps and resources that illustrate and detail specific sites or reaches related to shoreline erosion or coastal bluff hazards to serve as a "fair warning" guide for realtors, shoreline property owners, developers, community officials, lending institutions, and prospective buyers.

- Promote the awareness of flood insurance to residents along the County's low-lying coastline located within the Lake Michigan coastal flood hazard zone, such as those parcels and community parcels mentioned previously (see Map 3.12).

- Milwaukee County and its communities should enforce priority mitigation measures to those structures considered critical community facilities, infrastructure, or utilities as well as popular public venues, within the mapped Lake Michigan 1-percent-annual-probability floodplain.

[196] *Wisconsin Coastal Management Program*, Managing Coastal Hazard Risk on Wisconsin's Dynamic Great Lakes Shoreline*, Alan R. Lulloff, P.E., CFM, Science Services Program Director - Association of State Floodplain Managers and Philip Keillor, P.E., Coastal Engineer, 2011, updated in 2015.*

Current Programs and Ongoing Projects

Federal Programs

U.S. Army Corps of Engineers (USACE)

Since formalizing the Federal government's role in unifying and coordinating the coastal management efforts of multiple states with coastal resources, USACE has become a leading environmental preservation and restoration agency that maintains a rigorous research and development program in support of water resources. USACE's Chicago District now has jurisdiction for Wisconsin's Lake Michigan coastline, providing technical expertise and assistance to address coastline impacts like erosion and flooding.

The USACE exercises some control over lake levels through the use of controls such as locks and dams between the Great Lakes. However, these impacts are minimal compared to the lake level impacts due to climatic influence. The USACE provides current, past, and forecasted average daily and monthly mean water levels for the Great Lakes. The USACE also provides technical, direct, and advanced measures assistance. In addition, the UW Sea Grant and USACE Report, "Living on the Coast" provides informational and educational guidance for local officials and coastal property owners.[197]

FEMA offers information and resources related to coastal flooding, including recommended measures for those living within coastal flood hazard zones. Additionally, FEMA conducted a comprehensive storm and wind study for the Great Lakes basin titled "Great Lakes Coastal Flood Study" (GLCFS). This study includes information and data on updating coastal flood hazard information and DFIRMs for Great Lakes coastal communities, including Milwaukee County. The recently updated Milwaukee County floodplain maps (as part of the FEMA Risk MAP program) include results from the GLCFS effort for the Lake Michigan coast which now include coastal wave velocity zones (V, VE).

State Programs

Wisconsin Emergency Management (WEM) provides coastal hazard mitigation education and information in the State hazard mitigation plan.[198] In addition, WEM administers Federal programs within the State to assist coastal communities and local governments in preventing coastal hazards. These programs include the Hazard Mitigation Grant Program (HMGP) and the Building Resilient Infrastructure and Communities (BRIC) pre-disaster mitigation program.

The University of Wisconsin Sea Grant is a statewide program of basic and applied research, education, outreach, and technology transfer dedicated to the stewardship and sustainable use of the Great Lakes. The Sea Grant staff has, over the years, provided substantial support to Milwaukee County and its communities in dealing with Lake Michigan shoreline management issues (See Appendix I).

The Wisconsin Coastal Management Program (WCMP), which is part of the Wisconsin Department of Administration, Division of Intergovernmental Relations, oversees management of the State's coastal resources and strives to maintain a balance between preservation and economic needs. Established in 1978 under the Federal Coastal Zone Management Act, the WCMP works to preserve, protect, and wisely use the resources of the Lake Michigan and Lake Superior coastline for this and future generations. The WCMP provides guidance and grants to encourage the management and protection of Wisconsin's coastal resources and to increase public access to the Great Lakes.

The Southeast Wisconsin Coastal Resilience Project was a collaborative effort to enhance community capacity in southeastern Wisconsin and to build resilience to coastal hazards. The Coastal Resilience project developed educational and outreach materials for bluff best management practices, bluff slope vegetation practices that can improve bluff stability, nature-based shoreline protection specifically for Great Lakes shorelines, and resilient beach restoration practices that increase resistance to erosion. This project developed an online website which provides an excellent resource for local officials and residents living in coastal communities. The website contains informational and education programs, a blog, and social media

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[197] UW Sea Grant and USACE Detroit District, *Living on the Coast: Protecting Investments in Shore Property on the Great Lakes,* 2003.

[198] Ibid.

outlets with updated news in regard to State and local coastal information.[199] This effort continued with the Collaborative Action for Lake Michigan (CALM) project. CALM aimed to continue the collaboration among Lake Michigan coastal communities and the WCMP and Wisconsin Sea Grant.

Local Programs

As stated previously in this report, Milwaukee County and some of its communities have adopted shoreland zoning ordinances that apply to the Lake Michigan coastal area (see Appendix I). A variety of methods are used to warn people in Milwaukee County of emergency situations, including Lake Michigan coastal hazards. These warning systems are described in the section of this chapter related to multiple hazards types.

Multi-Jurisdictional Considerations

The plan element for Lake Michigan shoreline erosion and related problems corresponds only to the Lake Michigan coastal communities. These include Milwaukee County, the Cities of Cudahy, Milwaukee, Oak Creek, South Milwaukee, and St. Francis, and the Villages of Bayside, Fox Point, Shorewood, and Whitefish Bay.

Evaluation of Alternatives and Identification of Priority Mitigation Measures

Based upon the foregoing evaluation and consideration of risk, and review by the Milwaukee County Hazard Mitigation LPT (see Appendix A), there are 13 actions determined to be priority mitigation measures as part of this hazard mitigation plan update that are specifically related to Lake Michigan coastal hazard events.[200] These priority mitigation measures, along with a general cost-benefit summary are presented in Table 5.16.

5.10 HAZARD RISK ANALYSIS AND PRIORITIZATION: 2024

The major hazards that have been identified as potentially affecting Milwaukee County have been ranked by risk to assist in developing a mitigation plan. Additional description of hazards as well as the vulnerability assessment to these hazards have been identified and summarized in Chapter 3. These priority rankings were based upon the number of incidences per year, number of mortalities, number of injuries, property damage, and crop damage inventories also set forth in Chapter 3. Specifically, this prioritization is based upon the protection of Milwaukee County assets, including human life and property. Therefore, the major indicators of hazard severity used to rank these hazards are based upon the deaths and injuries versus economic losses as summarized in Tables 5.17 and 5.18, respectively. It should be noted that no data on injury, death, or economic losses due Lake Michigan coastal hazards were available for Milwaukee County.

As identified in the vulnerability assessment of hazards in Chapter 3, the magnitude and consequent risk of a particular hazard is dependent upon a number of factors that include, but are not limited to, time (e.g., time of year for thunderstorm events or time in terms of how long an event may last such as drought), size or scale, frequency of occurrence, population size potentially impacted, economic and/or social position of populations at risk, and amount of urban growth or development potentially impacted. These factors do not indicate that rural, or less urbanized areas are any more or less *important* than densely developed areas within the County; however, it does indicate that the more densely urbanized areas have a *greater chance* of loss in terms of human death, injury, and property damage per hazard event. It is also important to note, as identified in Chapter 3, that many disaster events are often compounded in nature and not the result of a single event, such as flooding during a severe thunderstorm event. Nonetheless, since the causes of disasters of the past will likely be the best predictor of future disasters, an attempt was made to normalize all of the hazard incidences to an annual average in order to understand the relative potential level of risk each hazard poses to Milwaukee County on an annual basis (see Tables 5.17 and 5.18).

[199] *sewicoastalresilience.org/about/project-overview.*

[200] *Priority mitigation measures that apply to multiple hazard types, including Lake Michigan coastal hazard events, are presented in the "*Hazard Mitigation Plan Component for Multiple Hazard Types*" section in this Chapter.*

Table 5.16
Cost-Benefit Analysis for Priority Measures Included in the Milwaukee County All-Hazards Mitigation Plan: Lake Michigan Coastal Hazards

Mitigation Measures	Estimated Cost[a]		Costs of Implementation[b]			Benefits						Community/ Jurisdictions Affected
	Capital	Average Annual Operation and Maintenance	Low	Moderate	High	Enhanced Preparedness/ Protection	Reduced Property Damage	Reduced Injuries	Reduced Mortalities	Enhanced quality of life/social benefits	Increased Environmental and/or Recreational Benefits/Ecosystems	
Regulations and Policy Measures												
Continue to participate in FEMA's NFIP and RiskMAP floodplain mapping program for updated Lake Michigan coastal V and VE zones	--[c]	--[c]	X	--		X	X					Milwaukee County coastal communities
Develop and enforce consistent county and municipal shoreland regulations and policies (i.e., ordinances) relating to setbacks along bluffs and ravines	--[d]	--[d]	X	--	--	X	X	X				Milwaukee County coastal communities
Bluff Top Mitigation Measures												
Develop and encourage bluff top best management practices	--[d]	--[d]	X			X	X				X	Milwaukee County coastal communities
Continue to implement engineering studies that assess the variables influencing bluff stability and shoreline recession which determine the stable slope angle setback.	--[e]	--[e]		X		X	X					Milwaukee County coastal communities
Consider relocating buildings within high-risk bluff failure areas.	--[c]	--[c]		X		X	X	X	X			Milwaukee County coastal communities
Continue to promote or enforce local and County coastal ravine and bluff top setback regulations or recommendations	--[d]	--[d]	X			X	X					Milwaukee County coastal communities
Bluff Face and Near Shore/Shoreline Protection Measures												
Conduct an updated assessment of the condition and effectiveness of all shoreline protection structures in the County	--[e]	--[e]	X			X	X	X			X	Milwaukee County coastal communities

Table continued on next page.

Table 5.16 (Continued)

Mitigation Measures	Estimated Cost[a]		Costs of Implementation[b]			Benefits						Community/ Jurisdictions Affected
	Capital	Average Annual Operation and Maintenance	Low	Moderate	High	Enhanced Preparedness/ Protection	Reduced Property Damage	Reduced Injuries	Reduced Mortalities	Enhanced quality of life/social benefits	Increased Environmental and/or Recreational Benefits/Ecosystems	
Bluff Face and Near Shore/Shoreline Protection Measures (continued)												
Ensure breakwater walls and piers within and around the Port of Milwaukee/Harbor District are properly designed and constructed to withstand severe environmental conditions of Lake Michigan	--[e]	--[e]		X		X	X					City of Milwaukee
Construct and maintain shoreline protection structures and bluff stabilization measures where public and critical infrastructure is at risk	--[c]	--[c]		X		X	X	X				Milwaukee County coastal communities
Possible acquisition and demolition of up to 28 structures identified as potentially being located in the low-lying shores of Lake Michigan's 1-percent-annual-probability floodplain[g]	$34.4 million (2022 dollars)	--[f]			X	X	X					Village of Fox Point
Encourage the practice of non-structural or nature-based shoreline protection measures, such as living revetment or seawalls and artificial beach and beach nourishment.	--[d]	--[d]	X			X	X				X	Milwaukee County coastal communities
Public Informational and Educational Programming												
Work with WCMP to conduct public outreach and to provide technical assistance regarding BMPs to prevent shoreline erosion and bluff recession	--[d]	--[d]	X			X						Milwaukee County and all coastal communities
Promote flood insurance to residents along the County's low-lying coast located in Lake Michigan's flood hazard area	--[c]	--[c]	X			X	X					Milwaukee County and Village of Fox Point

Table continued on next page.

Table 5.16 (Continued)

[a] *All cost expressed in 2022 dollars unless otherwise noted.*

[b] *Cost of implementation is allocated among three categories of low (less than $100,000 dollars), moderate (greater than $100,000 and less than $1,000,000), and high (greater than $1,000,000) costs, which are generally defined as:*

Low	*Moderate*	*High*
Educational and informational programming	*Addition of new staff*	*Major construction*
Ongoing enforcement of ordinances	*Additional staff hours budgeted*	*New buildings (infrastructure)*
Plan Development	*Additional equipment*	*Capital programs*
Continued coordination/mutual aid/interagency agreements	*New ordinance development*	
	New programs/task force	

[c] *Cost covered under ongoing programs.*

[d] *Costs to be determined. Partially covered under ongoing programs.*

[e] *Costs are determined by individual evaluations and/or engineer studies conducted at the time of the survey.*

[f] *Costs to be determined.*

[g] *Acquisition and demolition costs of these structures are included in the parcel-based-analyses conducted by SEWRPC staff when determining potential damages caused from a 100-year probability flood as described in Chapter 3.*

Source: Milwaukee County Office of Emergency Management and SEWRPC

Table 5.17
Priority Ranking of Hazards Affecting Milwaukee County Based Upon Mortality and Injury

Order Based on Local Planning Team[a]	Hazards Identified in the Hazard Vulnerability Assessment Tool	Period of Record (23 Years)	Number of Events per Year (Average)	Total Number of Deaths and Injuries	Number of Mortalities per Year (Average)	Number of Injuries per Year (Average)	Sum of Mortality and Injuries per Year
6, 8	Extreme Temperatures (*Extreme Cold and Heat*)	2000-2022	3.6	114	2.0	3.0	5.0
1	Tornado	2000-2022	0.1	16	0.0	0.7	0.7
2, 9, 10, 11	Thunderstorms (*Hail, Lightning, and Strong Winds*)	2000-2022	14.7	5	0.0	0.2	0.2
5, 12, 22, 23	Flooding (*Stormwater, Riverine, and Inland Lake*)	2000-2022	2.0	4	0.2	0.0	0.2
15	Drought	2000-2022	0.6	0	0.0	0.0	0.0
3, 4, 7	Winter Storms (*Heavy Snow, Ice Storm, and Blizzard*)	2000-2022	8.0	0	0.0	0.0	0.0
14, 16, 21	Lake Michigan Coastal Hazards (*Bluff Failure, Coastal Erosion*)[b]	2000-2022	--	--	--	--	--

[a] *These numbers indicate the ranked order of the hazards assigned by the Milwaukee County Hazard Mitigation Local Planning Team (LPT) through responses given in the Hazard and Vulnerability Assessment Tool (HVA). For more details see Table 3.1 and the Hazard Identification section in Chapter 3 of this report.*

[b] *No available data for Milwaukee County.*

Source: National Oceanic and Atmospheric Administration, and National Environmental Satellite, Data and Information Service, and the U.S. Department of Agriculture Risk Management Agency

Table 5.18
Priority Ranking of Hazards Affecting Milwaukee County Based Upon Average Annual Damages

Order Based on Local Planning Team[a]	Hazards Identified in the Hazard Vulnerability Assessment Tool[b]	Period of Record (23 Years)	Number of Incidents Per Year (Average)	Total Property Damage Per Year (Dollars)[c]	Total Crop Damage Per Year (dollars)	Sum of Property and Crop Damages Per Year (dollars)	Priority Ranking Based on Analysis
5, 12, 22, 23	Flooding (*Stormwater and Riverine*)	2000-2022	2.0	7,427,391	6,766	7,434,157	1
2, 9, 10, 11	Thunderstorms (*Heavy Rain, Hail, Lightning, and Strong Winds*)	2000-2022	14.7	1,052,088	33,717	1,085,805	2
1	Tornado	2000-2022	0.1	458,720	901	459,621	3
15	Drought	2000-2022	0.6	0	14,016	14,016	4
3, 4, 7	Winter Storms (*Heavy Snow, Ice Storm, and Blizzard*)	2000-2022	8.1	6,279	980	7,259	5
6, 8	Extreme Temperatures (*Extreme Cold and Heat*)	2000-2022	3.6	1,268	89	1,357	6
14, 16, 21	Lake Michigan Coastal Hazards (*Bluff Failure, Coastal Erosion*)[d]	2000-2022	--	--	--	--	7

[a] *These numbers indicate the ranked order of the hazards assigned by the Milwaukee County Hazard Mitigation Local Planning Team (LPT) through responses given in the Hazard and Vulnerability Assessment Tool (HVA). For more details see Table 3.1 and the Hazard Identification section in Chapter 3 of this report.*

[b] *Similar hazardous events listed in the HVA tool (see Table 3.1)—as shown in parentheses—were combined into one category of similar nature for this hazard mitigation Plan. For example, "heavy snow," "ice storm," and "blizzard" in the HVA tool was combined into the "Winter Storms" for this hazard mitigation plan.*

[c] *Dollar values were adjusted to year 2022 by using the average annual Consumer Price Index (CPI) values from the U.S. Department of Labor, Bureau of Labor Statistics.*

[d] *No data available so not included in the Damage Ranking Assessment of this Report.*

Source: National Oceanic and Atmospheric Administration, National Environmental Satellite, Data and Information Service, and the U.S. Department of Agriculture Risk Management Agency

Ranking Severity of Hazards

Death and Injury

Using the data from the various sources summarized in the vulnerability assessment of Chapter 3, the priority hazards identified in Table 3.4 were ranked with respect to their severity in terms of the sum of the number of annual death and injuries they caused and then by frequency of occurrence of each type of hazard event as shown in Table 5.17.

As shown in Table 5.17, four of the seven identified hazards have documented deaths or injuries. These hazards include temperature extremes, tornadoes, thunderstorms events (including hail, lightning, and strong winds), and flooding events. The vulnerability and community impact assessment indicate that the entire County is at risk from these hazards and these events are highly unpredictable in terms of exactly where they may occur and how powerful they might be. It is important to mention that these numbers represent an *annual average* of the recent 23 year period, hence the low results.

The remaining identified hazards have not been recorded as causing mortality or injury in Milwaukee County, based upon known data. These include winter storms, drought, and coastal hazards. Note, there are significant differences in the ranking of hazards depending upon whether the rankings are derived by comparing hazards based on their impacts upon human life and injury, or by comparing hazards based on damages to property and/or crop loss (see Property Damage section below).

Property Damage

Another way to assess the vulnerability of Milwaukee County to hazards is to examine the resultant property damage. Again, using the data from the various sources summarized in the vulnerability assessment of Chapter 3, hazards in Milwaukee County were ranked with respect to their severity in terms of the average annual sum of damage caused and by frequency of occurrence of each type of hazard event. As shown in Table 5.18, annual average estimates of property and/or crop damages were determined for six of the seven priority hazards which include flooding; thunderstorms events (high winds, hail, and lightning), tornadoes; drought; winter storms; and extreme temperatures. Among these hazards, flooding was identified as resulting in the greatest amount of damage to property in Milwaukee County.

Because of the unpredictability of tornadoes and thunderstorm events, all buildings, infrastructure, community centers, and critical utilities and infrastructure within the County are considered at risk and therefore should be prioritized when planning implementation strategies and hazard priority hazard mitigation practices throughout Milwaukee County.

As summarized in the vulnerability and community impact assessment in Chapter 3, it is expected that for some years the County will experience more events than other years, but the average annual number is not expected to change over the span of this five-year Plan. In addition, future changes in climate and land use are anticipated to worsen impacts due to flooding, extreme temperatures, and coastal events. Subsequently, such changes will also continue to adversely impact public health and safety, especially to vulnerable populations.

PLAN ADOPTION, IMPLEMENTATION, MAINTENANCE, AND REVISION 6

The Hazard Mitigation Plan described in this report is designed to attain the goals and objectives outlined in Chapter 4, to the maximum extent practicable. However, the plan is not complete until the steps to convert the plan into actions, policies, and programs have been specified. This Chapter presents the Plan implementation strategies envisioned and includes information on plan adoption, maintenance, and revision.

6.1 PLAN REFINEMENT, REVIEW, AND ADOPTION

As described in Chapter 1, Milwaukee County initiated its hazard mitigation planning program in 2011. The plan set forth in this report began in 2021 and was conducted pursuant to the mitigation planning requirements of 44 *Code of Federal Regulations*, Section 201.6(d) (44 CFR 201.6(d)), which call for local hazard mitigation plans to be reviewed; updated to reflect changes in development, progress in local mitigation efforts, and changes in priorities; and reapproved every five years for local jurisdictions to be able to receive hazard mitigation funding. In 2002, the Federal Emergency Management Agency (FEMA) published rules for hazard mitigation planning in response to the Disaster Mitigation Act of 2000. These rules address State and local mitigation planning and are important for the Milwaukee County Hazard Mitigation Program in the following manner.

- The Wisconsin Department of Military Affairs, Division of Emergency Management (WEM), is directly involved in a partnership role for all-hazard mitigation planning. That agency is responsible for preparing and periodically updating a State all-hazard mitigation plan, providing technical assistance and guidance for local all-hazard planning, and administering planning grant programs for FEMA.

- The rules outline State and local mitigation planning guidelines for accessing hazard mitigation grant funds. For disasters declared after November 1, 2004, local government units must have a FEMA-approved mitigation plan to receive project grants from the Hazard Mitigation Grant Program (HMGP) and the Building Resilient Infrastructure and Communities (BRIC) Program. This element is important because it requires local adoption of a hazard mitigation plan to remain eligible for grants from specific mitigation funds. Communities can formally adopt the County Plan or create and adopt their own plan.

- The rules and related guidance provide more specificity and detail on the hazard mitigation plan content than the previous rules. The Milwaukee County Hazard Mitigation Plan has been structured to meet the 2002 guidance.

This Milwaukee County Hazard Mitigation Plan was prepared under the guidance of the Milwaukee County Hazard Mitigation Local Planning Team (LPT), comprised of representatives of all of the communities within the County knowledgeable in hazard mitigation matters. The LPT met three times during the plan preparation period to provide input on the types of hazards to be considered, the appropriate mitigation strategies, and to review and refine the draft report chapters to reflect the comments and recommendations of the LPT. The activities of the LPT are documented in Appendix A.

Each community has unique capabilities available to mitigate and reduce long-term vulnerability to natural hazard events. These capabilities include authorities, policies, programs, staff, technical knowledge, and funding. The Milwaukee County LPT participated in an online Community Capabilities Assessment. By gathering this input, communities will be able to better identify the capabilities currently effective in reducing disaster impacts and identify areas where increased capacity may improve their ability to reduce risk. A copy of the survey assessment provided to LPT members, as well as the results from the survey, are documented in Appendix J.

During the drafting of the Plan, public informational meetings were held to review the Plan following completion of the first three chapters and after completion of the Plan in draft form. In addition, as draft chapters of the updated Plan were completed, copies were placed in downloadable form on the Southeastern Wisconsin Regional Planning Commission (Commission or SEWRPC) website on which members of the public could ask questions and submit comments on the draft plan update.

Additionally, consideration of the input and needs of underserved and vulnerable populations was incorporated throughout the planning process. Public feedback on the draft plan was solicited online through the websites of both the Milwaukee County Office of Emergency Management (OEM) and the Commission, and public participation was encouraged through social media posts. Physical copies of the draft Plan were available to be printed on behalf of the public through the Milwaukee County OEM. An opportunity for in-person public comment was provided at public informational meetings, held in the evening to accommodate people who could not attend during normal business hours. Meeting notices were provided via local print, internet (i.e., email notifications), printed flyers, and social media. Note, public meeting flyers were distributed throughout the County at locations accessible to the general public, including those populations considered vulnerable (elderly, disabled, low-income, etc.).[201]

Following Plan finalization, the Plan was presented for consideration and adoption to the Milwaukee County Board of Supervisors on August 24, 2025. A copy of the signed Plan adoption resolution is included in Appendix B. Copies of the Plan were provided electronically to each of the local units of government in the County advising them of the need for adoption in order to retain future eligibility for mitigation funding from the FEMA HMGP and the BRIC Program administered by WEM. In addition, County and Commission staff have been made available to meet with communities on an individual basis to review the Plan and consider adoption and implementation steps. The Milwaukee County OEM maintains a status report on Plan adoption by the County and local government units.

6.2 PLAN IMPLEMENTATION STRATEGIES

An important first step in implementing the updated Hazard Mitigation Plan for Milwaukee County is its formal adoption by the County, the Cities of Cudahy, Franklin, Glendale, Greenfield, Milwaukee, Oak Creek, St. Francis, South Milwaukee, Wauwatosa, West Allis, and the Villages of Bayside, Brown Deer, Fox Point, Greendale, Hales Corners, River Hills, Shorewood, West Milwaukee, and Whitefish Bay. Upon formal adoption, the Plan becomes an important guide to hazard mitigation and related management decisions for the County and participating local units of government, including MMSD. Such adoption serves to signify agreement with and official support of the Plan recommendations and enables government officials and staff to begin integrating the Plan recommendations into the other ongoing County and municipal programs, such as land use and public works development planning and programming.

Realization of the Plan will require a long-term commitment to the objectives of the Plan and a high degree of coordination and cooperation among the following: County officials and staff; various County and community departments; MMSD; the Hazard Mitigation LPT; intergovernmental task forces or other committees that may be created in the future to help address common hazard mitigation issues; other concerned units and agencies of government and their respective officials and staffs; area developers and lending institutions; businesses, industry, and institutions; and concerned private citizens. Coordination and cooperation is vital to undertaking the substantial investments and the series of actions needed to implement the Plan. Close cooperation with WEM and FEMA is also essential.

A summary of the Plan elements and selected implementation strategy information, including current status, general priority assignments, designated management agencies, and schedules is included in Table 6.1. It is recommended that Milwaukee County, MMSD, and local units of government incorporate the analyses performed and mitigation strategies recommended into other local planning efforts, such as those related to stormwater management, stream and river protection, land and water conservation, and comprehensive planning, where appropriate.

[201] *Despite County and LPT outreach efforts, no public input was received on the Hazard Mitigation Plan Update.*

Table 6.1
Summary of Mitigation Measures and Funding Sources

Mitigation Measures	Status	Priority	Implementation Timetable	Designated Department, Management Agency, or Personnel	Potential Funding Programs (see Appendix L)
Multi-Hazards					
Continue to enforce State building code regulations that aim to improve the ability of structures to withstand increasingly harsh and/or hazardous weather conditions.	Implemented	High	Ongoing	Wisconsin Department of Safety and Professional Services (WSPS) Municipal-Building Inspector and/or Engineering/Development/Planning Department(s)	1, 2, 3, 6, 7, 8, 9, 21, 22, 23, 24, 26, 27, 29, 31, 34, 36, 37, 38, 40, 41, 42, 43, 44, 45, 43, 46, 50,53, 54, 55, 56, 57, 58, 59, 61, 63
Encourage and persistently enforce the review of new and/or updated municipal and County development codes and regulations, especially in known hazard areas.	Partially Implemented	Medium	Ongoing	Commission, OEM, CMOEM, and Municipal Planning, Development, and Engineering departments Municipal- Building Inspector and/or Engineering/Planning/ Development Department(s)	
Encourage local municipalities to participate in the National Weather Service's (NWS) *StormReady* program (i.e., weather spotter training).	Not Implemented	Low	As funding and opportunities become available	NWS, OEM, and CMOEM Municipal-Fire/Police, Health and Human Services, and/or Community Outreach and Event Department(s)	
Continue the integration and expansion of hazard mitigation planning into other local and County planning efforts.	Implemented	High	Ongoing	FEMA, WEM, MMSD, and Commission Milwaukee County-OEM, DHHS, Sheriff's, and/or Parks Department(s) Municipal-Planning/ Development/Engineering, Utility/Public Works, Health and Human Services, and/or Fire/Police Department(s)	
Create and promote local funding opportunities and mechanisms for hazard mitigation.	Partially Implemented	Low	As funding and opportunities become available	OEM and CMOEM	
Continue to update a list of potential funding sources associated with hazard mitigation planning.	Partially Implemented	Medium	Ongoing	FEMA, WEM, Commission, WCMP, OEM and CMOEM	

Table continued on next page.

Table 6.1 (Continued)

Mitigation Measures	Status	Priority	Implementation Timetable	Designated Department, Management Agency, or Personnel	Potential Funding Programs (see Appendix L)
Multi-Hazards (continued)					
Continue to regularly work with community event/outreach organizers on up-to-date emergency plans and procedures in case of severe weather.	Partially Implemented	High	Ongoing	WEM, SEWRPC, OEM, and CMOEM Municipal-Fire/Police, Health and Human Services, and Community Outreach and Events Planning Departments	1, 2, 3, 6, 7, 8, 9, 21, 22, 23, 24, 26, 27, 29, 31, 34, 36, 37, 38, 40, 41, 42, 43, 44, 45, 46, 50,53, 54, 55, 56, 57, 58, 59, 61, 63
Continue coordinating emergency response and operation plans among County and local governmental units and first responders.	Implemented	High	Ongoing	Milwaukee County-OEM, Sheriff's, GMIA, DHHS, and Parks Departments/Divisions Municipal-Fire/Police, Health and Human Services, and Public Works/Utility Departments	
Continue working with public health departments, emergency personnel, volunteer groups, NGOs, and American Red Cross on natural weather hazard preparedness and procedures.	Partially Implemented	High	Ongoing	American Red Cross, OEM, CMOEM, County Sheriffs, DHHS. Municipal EMS, Fire, and Police Departments	
Promote and expand training through the Southeastern Wisconsin COAD program.	Partially Implemented	Medium	Ongoing	OEM and CMOEM	
Continually maintain and upgrade public early warning systems and communication networks.	Partially Implemented	High	Ongoing	NOAA, NWS, OEM, and Municipal Fire and Police Departments	
Continue to maintain and update, as necessary, the County's shared interoperability radio communication network and infrastructure system "OASIS."	Partially Implemented	High	Ongoing and as needed	OEM	
Continue to bury and protect power and utility lines, where feasible and appropriate, to prevent damage from hazardous weather conditions.	Partially Implemented	Medium	Ongoing and as needed	We Energies, OEM, and Municipal Public Works, Engineering, Development, and/or Utility Departments	
Continually promote the importance of having reliable on-site back-up power (i.e., generators) at critical community facilities and utility locations.	Partially Implemented	High	Ongoing	OEM, MMSD, and Municipal Public Water/Wastewater Utilities Departments	

Table continued on next page.

Table 6.1 (Continued)

Mitigation Measures	Status	Priority	Implementation Timetable	Designated Department, Management Agency, or Personnel	Potential Funding Programs (see Appendix L)
Multi-Hazards (continued)					
Encourage residents and business owners to consider the purchase of backup power systems (i.e., generators) in case of hazardous conditions.	Partially Implemented	Medium	As needed	OEM	1, 2, 3, 6, 7, 8, 9, 21, 22, 23, 24, 26, 27, 29, 31, 34, 36, 37, 38, 40, 41, 42, 43, 44, 45, 46, 50,53, 54, 55, 56, 57, 58, 59, 61, 63
Regularly update and maintain the County OEM website as well as other related county and local department and organization websites on hazardous weather events, preparedness, and resources.	Partially Implemented	Medium	Ongoing	OEM, CMOEM, and DHHS	
Continually increase participation in public outreach events that educate County residents, notably those in vulnerable situations, on severe weather events and preparedness resources.	Partially Implemented	High	Ongoing	OEM, CMOEM, and DHHS Municipal-Fire/Police and Health Departments	
Encourage residents to develop a Family Emergency Preparedness Plan and Disaster Supply Kit (Appendix G).	Partially Implemented	Medium	Ongoing	FEMA, WEM, OEM, CMOEM, and DHHS Departments Municipal-Fire/Police, DHHS, and Community Outreach Departments	
Continue to publicize, through various modes of communication, to all County residents on the availability and accessibility of emergency shelter sites.	Implemented	Medium	Ongoing	OEM, CMOEM, and DHHS and Municipal Planning, Engineering, and Parks Departments	
Continue to educate and promote the use and importance of severe weather warning apps. (i.e., FEMA's *ready.gov* or Milwaukee's *MKEALERT*), especially to those most vulnerable.	Partially Implemented	Medium	Ongoing	FEMA, NWS, OEM, CMOEM and Municipal webpages	
Continue to implement and train on the use of different alert/warning systems, so that those most vulnerable, such as hard of hearing, deaf, or blind are also provided with adequate and reliable warning before and during a hazardous event.	Implemented	Medium	Ongoing	FEMA, NOAA, NWS, OEM, CMOEM, and Municipal Fire/Police Departments	
Continue providing information on flood and severe weather insurance programs.	Partially Implemented	High	Ongoing	WEM, OEM, CMOEM, MMSD, and Municipal Officials	

Table continued on next page.

Table 6.1 (Continued)

Mitigation Measures	Status	Priority	Implementation Timetable	Designated Department, Management Agency, or Personnel	Potential Funding Programs (see Appendix L)
Flooding and Associated Stormwater Problems					
Floodland and Environmentally Sensitive Land Preservation Element					
Maintain and update as necessary floodplain and wetland zoning regulations/ordinances.	Implemented	Medium	Ongoing	Milwaukee County, MMSD, and Municipal Engineering, Planning, and/or Zoning Departments	11, 21, 22, 23, 24, 25, 27, 28, 29, 30, 31, 33, 34, 35, 36, 38, 43, 48, 49, 50, 53, 54, 55, 56, 57, 62
Continued preservation and maintenance of floodplains, natural, and environmentally open space areas/sensitive lands.	Partially Implemented	High	As funding and opportunities become available	NRCS, The Conservation Fund, WDNR, Milwaukee County, MMSD, and County and Municipal Council/Board, Parks, Conservation, and/or Recreational, and Planning Departments	
Continue participating in MMSD Greenseams program.	Partially Implemented	Medium	As funding and opportunities become available	Milwaukee County Parks, MMSD, and Municipal Parks, Conservation, and/ or Planning Departments	
Floodplain Management Plan Element					
Continue the implementation of MMSD's Watercourse and Flood Management Planning Program floodplain projects through planned year 2035	Implemented	High	Ongoing	Milwaukee County, SEWRPC, MMSD, and Municipal Parks, Conservation, Public Works, and Engineer/Planning Departments	1, 2, 3, 4, 5, 7, 11, 14, 15, 16, 17, 18, 19, 20, 29, 30, 31, 35, 37, 39, 42, 44, 45, 49, 51, 52, 53, 54, 58, 59
Remove up to 16 repetitive loss structures	Partially Implemented	High	As funding and opportunities become available	FEMA, WEM, OEM, MMSD, Property Owners, and Municipal Council/Board, Engineering, Planning, and/or Zoning Departments	
Surveys of up to 1,276 structures identified as being potentially located in flood hazard areas.	Not Implemented	High	As funding and opportunities become available	OEM, MMSD, Property owners, and Municipal Engineering, Planning, and/or Zoning Departments	
Floodproofing 207 structures identified as potentially located in flood hazard area.	Not Implemented	Medium	As funding and opportunities become available	WEM, OEM, Property Owners, and Municipal Planning, Engineering, and/or Zoning Departments	
Acquisition and removal/demolition of up to 1,260 structures identified as being potentially located in flood hazard area.	Not Implemented	High-Medium	As funding and opportunities become available	FEMA, WEM, OEM, MMSD, Property Owners, and Municipal Council/Board, Engineering, Planning, and/or Zoning Departments	
Removal of up to 16 manufactured homes identified as being potentially located in the flood hazard area.	Not Implemented	Medium	As funding and opportunities become available	FEMA, WEM, OEM, Property Owners, and Municipal Engineering, Planning, and/or Zoning Departments	

Table continued on next page.

Table 6.1 (Continued)

Mitigation Measures	Status	Priority	Implementation Timetable	Designated Department, Management Agency, or Personnel	Potential Funding Programs (see Appendix L)
Flooding and Associated Stormwater Problems (continued)					
Floodplain Management Plan Element (continued)					
Emphasize actions that address and protect vulnerable infrastructure (i.e., roadways) to flooding.	Not Implemented	High	As funding and opportunities become available	WEM, OEM, CMOEM, City of Milwaukee Public Works Infrastructure Division, and other Municipal Engineering, Planning, and/or Zoning Departments	1, 2, 3, 4, 5, 7, 11, 14, 15, 16, 17, 18, 19, 20, 29, 30, 31, 35, 37, 39, 42, 44, 45, 49, 51, 52, 53, 54, 58, 59
Highly consider floodproofing and/or relocating critical facilities located within or nearby flood-prone areas.	Not Implemented	Medium	As funding and opportunities become available	FEMA, WEM, OEM, City of Milwaukee and Village of Greendale Council/Board Members, Port of Milwaukee Officials, and Municipal Engineering, Planning, and Zoning Departments	
Continue to participate in FEMA's National Flood Insurance Program (NFIP) and floodplain modeling and map updating efforts.	Implemented	High	Ongoing	FEMA, WEM, WDNR, OEM, SEWRPC, MMSD, and Municipal Engineering, Planning, and/or Zoning Departments	
Encourage County participation in FEMA's Community Rating System (CRS) program.	Partially Implemented	Medium	Ongoing	FEMA, WEM, WDNR, OEM, SEWRPC, and MMSD	
Promote and encourage implementation of further documentation of the extent of future floods.	Partially Implemented	High	As future flooding occurs	WDNR, OEM, MMSD, and Municipal Engineering, Planning, and/or Zoning Departments	
Continue to increase stream channel maintenance activities including concrete and debris removal projects.	Implemented	High	Ongoing	Milwaukee County, MMSD, and Municipal Parks, Recreation/ Conservation/Natural Resources, and/or Engineering/Planning Departments	
Lending institutions and real estate agent policies should continue and enforce their practice of determining and informing the floodprone status of properties before mortgage transactions are complete.	Partially Implemented	High	Ongoing	Lending Institutions, Real Estate Brokers	
Encourage the installation of new USGS stream gages, while maintaining and updating the current systems.	Partially Implemented	High	Ongoing	USGS, WDNR, MMSD, Milwaukee County, local municipalities, academic institutions, and SEWRPC	
Regular inspection and continued maintenance of dams .	Implemented	Medium	At a minimum, as required by WDNR	WDNR, Milwaukee County, MMSD, and Private Dam Owners	

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Table 6.1 (Continued)

Mitigation Measures	Status	Priority	Implementation Timetable	Designated Department, Management Agency, or Personnel	Potential Funding Programs (see Appendix L)
Flooding and Associated Stormwater Problems (continued)					
Floodplain Management Plan Element (continued)					
Continue to update and enforce the regular review of dam emergency action plans and procedures.	Partially Implemented	High	Ongoing	WDNR, Milwaukee County, MMSD, and Private Dam Owners	1, 2, 3, 4, 5, 7, 11, 14, 15, 16, 17, 18, 19, 20, 29, 30, 31, 35, 37, 39, 42, 44, 45, 49, 51, 52, 53, 54, 58, 59
Stormwater Management Plan Element					
Continue to develop and maintain stormwater management plans/programs.	Implemented	High	Ongoing	WDNR, Milwaukee County, and Municipal- Public Works and/or Engineering Departments	1, 2, 3, 4, 5, 7, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 29, 31, 33, 36, 39, 40, 42, 43, 45, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59
Continuation of stormwater-related regulations, including installation of up-to-date stormwater drainage systems.	Partially Implemented	High	Ongoing and as funds become available	WDNR, Milwaukee County, MMSD, and Municipal- Public Works and/or Engineering Departments	
Continued participation in MMSD's Watercourse and Flood Management Planning Program.	Implemented	High	Ongoing	SEWRPC, MMSD, and Municipal Conservation and Natural Resources and Engineering/ Planning/Zoning Departments	
Continue to implement and enhance green infrastructure and/or nature-based practices in stormwater management.	Partially Implemented	Medium	As funding and opportunities become available	WDNR, Milwaukee County, MMSD, and Municipal Engineering/Public Works Departments	
Public Informational and Educational Element					
Continue to enhance public education and outreach activities related to flooding and stormwater management.	Partially Implemented	High	Ongoing	UW-Extension, WDNR, OEM, CMOEM, MMSD, and Municipal Public Works/Engineering Departments	26, 33, 38, 40, 43, 54, 55
Promote and distribute information related to the NFIP, including those that live outside the mapped floodplain.	Partially Implemented	Medium	Ongoing	FEMA, WEM OEM, CMOEM, SEWRPC, MMSD, and Municipal Engineering/Planning/Zoning Departments	
Severe Thunderstorm and Thunderstorm-Related Events (Strong Winds, Hail, and Lightning)					
Maintain and regularly update County and local first responders' equipment, such as thermal imaging devices to help detect or mitigate lightning-related fires.	Implemented	Medium	As needed	County and Municipal Fire and Rescue Departments	1, 2, 3, 6, 7, 8, 9, 23, 24, 37, 38, 40, 42, 44, 45, 52, 54, 56, 58, 59, 63
Continue to enforce local ordinances that require adequate electrical grounding in newly constructed buildings.	Implemented	Medium	As needed	Wisconsin Department of Safety and Professional Services, Municipal Building Inspector and/or Engineer	

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Table 6.1 (Continued)

Mitigation Measures	Status	Priority	Implementation Timetable	Designated Department, Management Agency, or Personnel	Potential Funding Programs (see Appendix L)
Severe Thunderstorm and Thunderstorm-Related Events (Strong Winds, Hail, and Lightning) (continued)					
Provide information and encourage the use of fire-resistant materials and surge protectors on critical electronic equipment	Implemented	Medium	As needed	County and Municipal Fire and Rescue Departments	1, 2, 3, 6, 7, 8, 9, 23, 24, 37, 38, 40, 42, 44, 45, 52, 54, 56, 58, 59, 63
Install and upgrade, as needed, lightning surge protection devices on critical electronic components and facilities used by government officials and public safety personnel.	Partially Implemented	High	As needed	OEM, CMOEM, MMSD, GMIA, and County Officials/Directors at Critical Community Facilities Municipal-Council/Boards, and Public Works, Planning, and/or Development Departments, Fire/EMS/Police Departments, and Local Officials/Directors of Critical Community Facilities/Utilities Locations	
Increase public education and awareness, particularly to those considered vulnerable, on the potential severity and dangers related to thunderstorms and thunderstorm-related events.	Partially Implemented	Low	Ongoing	NWS, UW-Extension, WEM, and OEM and CMOEM	
Extreme Temperature Events					
Organize and enhance neighborhood outreach groups/networks who look after vulnerable citizens, especially during extreme heat and cold events.	Implemented	High	Ongoing	OEM, CMOEM and DHHS and Municipal Fire/EMS/Police	2, 3, 24, 26, 37, 38 40, 45, 47, 56
Provide special arrangements for payment of heating and cooling bills for customers unable to pay due to financial constraints.	Partially Implemented	High	As funding and opportunities become available	OEM, CMOEM, DHHS, and Municipal Council/Boards	
Reschedule outdoor public events during periods of extreme heat or cold.	Implemented	High	As needed	OEM, CMOEM, DHHS, Municipal Council/Boards, and Education, Sporting and/or Public Event Staff and/or Coordinator, and Health and Human Services Departments	
Extend public swimming pool hours during extreme heat events.	Partially Implemented	Medium	As needed	OEM, CMOEM, Milwaukee County Parks, DHHS, and County/Municipal Council/Board Members	

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Table 6.1 (Continued)

Mitigation Measures	Status	Priority	Implementation Timetable	Designated Department, Management Agency, or Personnel	Potential Funding Programs (see Appendix L)
Extreme Temperature Events (continued)					
Establish and publicize a donation program of functional window air conditioner units and fans and distribute these items to vulnerable populations.	Partially Implemented	Medium	As needed	OEM, CMOEM, DHHS, and County/Municipal Council/Board Members	2, 3, 24, 26, 37, 38 40, 45, 47, 56
Promote and continue to expand winter weather clothing drives (coats, hats, mittens) of gently used winter clothing to distribute to those with limited income and resources.	Partially Implemented	High	As needed	OEM, CMOEM, DHHS, and Municipal Health and Human Services and Council/Board Members	
Promote measures (i.e., green infrastructure practices) to help reduce urban heat island effects.	Partially Implemented	Medium	As funding and opportunities become available	USEPA, FEMA, NWS, WEM, WDNR, MMSD, Milwaukee County Parks, OEM, DHHS, CMOEM, and Municipal Health, Development, Emergency Management, Planning, and Public Works Departments, and Council Members	
Distribute safety information on safety precautions and potential dangers on the use of generators, space heaters, fireplaces, and stoves.	Partially Implemented	Medium	Ongoing	OEM, CMOEM, DHHS, and Municipal Fire Departments, and Public and Private Educators	
Tornadoes					
Ensure usage policies/procedures of the County's public outdoor warning sirens are up-to-date and reflect the needs of public safety personnel.	Partially Implemented	Medium	Ongoing	OEM	3, 9, 14, 16, 23, 24, 37, 38, 42, 44, 45, 47, 58, 59, 63
Require and enforce construction regulations of safe rooms in new schools, daycares, community centers, hospitals, and nursing homes.	Implemented	Medium	Ongoing	Wisconsin Department of Safety and Professional Services, Municipal Council/Board Members, and Planning, Development and/or Engineering Departments, Building Inspector, and/or Engineer	
Regularly conduct an inventory and inspection of municipal and County facilities to ensure the quality, quantity, and accessibility of tornado shelters.	Implemented	Medium	Ongoing	Wisconsin Department of Safety and Professional Services, OEM, CMOEM, and Municipal Planning, Development and/or Engineering Departments, Building Inspector, and/or Engineer	

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Table 6.1 (Continued)

Mitigation Measures	Status	Priority	Implementation Timetable	Designated Department, Management Agency, or Personnel	Potential Funding Programs (see Appendix L)
Tornadoes (continued)					
Continue to maintain and upgrade the operational and structural functions of the County's outdoor warning sirens for an effective and reliable warning system.	Implemented	High	Ongoing	OEM	3, 9, 14, 16, 23, 24, 37, 38, 42, 44, 45, 47, 58, 59, 63
Routinely inspect manufactured housing parks to ensure safety material (e.g., tie-downs) is provided and accessible during a tornado event.	Not Implemented	Low	As needed	OEM and Municipal Fire Departments	
Increase public education and awareness of the potential severity of tornadoes, notably to those considered most vulnerable.	Implemented	Medium	Ongoing	NWS, WEM, OEM, CMOEM, Municipalities and Public/Private Educators	
Ensuring safety information is readily available and maintained for all citizens visiting large/popular outdoor public venues before or during a severe or hazardous weather event.	Implemented	High	Ongoing	WEM, OEM, CMOEM, Milwaukee County Parks, DHHS, and Sheriff's Department, and Municipal Fire/Police and Parks/Recreation Departments	
Winter Storms					
Review the energy efficiency and winter readiness of critical facilities/utilities and housing throughout the County.	Partially Implemented	Medium	As needed	OEM, CMOEM, DHHS, and Municipal Development and/or Engineering Departments, Building Inspector, and/or Engineer	1, 3, 7, 24, 37, 38, 44, 45, 47, 58, 59, 63
Continue to work with agencies (e.g., American Red Cross) and/or other organizations to establish a reliable short-term sheltering network for vulnerable populations.	Partially Implemented	High	Ongoing	American Red Cross, OEM, CMOEM, and DHHS	
Pursue additional funding opportunities to assist with budgeting for overtime hours and extra governmental personnel needed during extreme winter events.	Partially Implemented	Medium	As needed	OEM, CMOEM, and Municipal Council/Boards	
Ensure that the necessary amount of snow removal, anti-icing, and deicing equipment is available and operational.	Partially Implemented	Medium	Ongoing	Milwaukee County DOT and Municipal Public Works Departments	
Work with utility companies to assess and improve, as needed, electric service system dependability.	Partially Implemented	Medium	Ongoing	We Energies, OEM, CMOEM, and Municipal Public Works and/or Utility Departments	

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Table 6.1 (Continued)

Mitigation Measures	Status	Priority	Implementation Timetable	Designated Department, Management Agency, or Personnel	Potential Funding Programs (see Appendix L)
Winter Storms (continued)					
Continue to promote and enhance, via various modes of communication, winter hazard awareness and resources to all County residents, including home and travel safety measures.	Partially Implemented	Low	As needed	OEM, CMOEM, Milwaukee County DOT, DHHS, and Municipal Public Works Departments	1, 3, 7, 24, 37, 38, 44, 45, 47, 58, 59, 63
Drought					
Encourage the development and maintenance of drought emergency plans for local utilities and communities.	Partially Implemented	Low	As needed	Municipal Water Utilities and Planning Departments	22, 24, 32, 34, 36, 38, 39, 40, 53, 55, 56, 57
Promote regional activities to protect groundwater recharge areas inside and outside of the County.	Partially Implemented	Medium	As needed	NRCS, SEWRPC, UW-Extension, and Municipal Development, Planning, and Water Utilities	
Promote and encourage the use of drought-resistant landscaping practices (i.e., native plantings).	Partially Implemented	Low	As needed	UW-Extension, Milwaukee County, and Municipal Development, Water Utilities, Planning, and/or Land and Water Resources/Conservation Departments	
Support ordinances to prioritize or control water use during drought conditions.	Partially Implemented	Low	As needed	Milwaukee County Water Works and Municipal Water Utilities	
Design and plan for water supply infrastructure systems that are effective and reliable during drought events.	Partially implemented	Medium	Ongoing	USGS, WDNR, Milwaukee County Water Works, Municipal Water Utilities and Planning Departments, and Property Owners	
Consider implementing the recommendations made in the regional water supply plan for additional water supply facilities and programs to meet forecast water use demands.	Partially Implemented	Medium	As needed	USGS, WDNR, SEWRPC, Milwaukee County Water Works, and Municipal Water Utilities and Planning Departments	
Continue operation of stream gaging stations and groundwater monitoring wells.	Partially Implemented	Low	Ongoing	USGS, WDNR, MMSD, SEWRPC, and Milwaukee County	
Increase public education and awareness of the potential severity of drought events.	Partially Implemented	Low	Ongoing	USDA, NRCS, UW-Extension, Milwaukee County, SEWRPC, and Municipal Water Utilities, Planning, and Land and Water Resources/Conservation Departments	

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Table 6.1 (Continued)

Mitigation Measures	Status	Priority	Implementation Timetable	Designated Department, Management Agency, or Personnel	Potential Funding Programs (see Appendix L)
Lake Michigan Coastal Hazards					
Regulations and Policy Measures					
Continue to participate in FEMA's NFIP and RiskMAP floodplain mapping program for updated Lake Michigan coastal V and VE zones.	Implemented	High	Ongoing	FEMA, WEM, WCMP, OEM, MMSD, and Municipal Development and/or Engineering and Utility Departments along Lake Michigan	3, 4, 7, 12, 48
Develop and enforce consistent county and municipal shoreland regulations and policies (i.e., ordinances) relating to setbacks along bluffs and ravines.	Implemented	High	Ongoing	WCMP, OEM, Milwaukee County Parks, and Municipal Development, Planning and/or Engineering and Utility Departments along the Lake Michigan coastline	
Bluff Top Mitigation Measures					
Develop and encourage bluff top best management practices.	Partially Implemented	Medium	As needed	WCMP, OEM, Milwaukee County Parks, Property Owners and Municipal Development, Planning and/or Engineering and Utility Departments along the Lake Michigan coastline	3,5, 7, 11, 12, 15, 36, 37, 38, 43, 48, 53, 54, 55
Continue to implement engineering studies that assess the variables influencing bluff stability and shoreline recession which determine the stable slope angle setback.	Partially Implemented	Medium	As funding and opportunities become available	WCMP, OEM, Milwaukee County Parks, Property Owners and Municipal Development, Planning and/or Engineering and Utility Departments along the Lake Michigan coastline	
Consider relocating buildings within high-risk bluff failure areas.	Partially Implemented	High	As needed and as funding opportunities become available	FEMA, WEM, WCMP, OEM, Milwaukee County, municipalities, and Property Owners	
Continue to promote and enforce local and County coastal ravine and bluff top setback regulations or recommendations.	Partially Implemented	Medium	Ongoing	OEM, Milwaukee County Parks, Property Owners and Municipal Development, Planning and/or Engineering and Utility Departments along the Lake Michigan coastline	

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Table 6.1 (Continued)

Mitigation Measures	Status	Priority	Implementation Timetable	Designated Department, Management Agency, or Personnel	Potential Funding Programs (see Appendix L)
Lake Michigan Coastal Hazards (continued)					
Bluff Face and Near Shore/Shoreline Protection Measures					
Conduct an updated assessment of the condition and effectiveness of all shoreline protection structures in the County.	Partially Implemented	Medium	As funding and opportunities become available	WCMP, OEM, Milwaukee County Parks, and Municipal Development, Planning and/or Engineering Departments along the Lake Michigan coastline	3,5, 7, 11, 12, 15, 35, 36, 37, 38, 43, 48, 53, 54
Ensure breakwater walls and piers within and around the Port of Milwaukee/Harbor District are properly designed and constructed to withstand severe environmental conditions of Lake Michigan.	Partially Implemented	High	As needed and as funding opportunities become available	City of Milwaukee OEM and Port/Harbor District Authority/Officials, and MMSD	
Construct and maintain shoreline protection structures and bluff stabilization measures where public and critical infrastructure is at risk.	Partially Implemented	High	As needed and as funding opportunities become available	FEMA, WEM, WCMP, OEM, Milwaukee County Parks, CMOEM, MMSD, City of Milwaukee Port/Harbor District and Municipal Engineering Departments along the Lake Michigan coastline	
Possible acquisition and demolition of up to 28 structures identified as potentially being located in the low-lying shores of Lake Michigan's 1-percent-annual-probability floodplain.	Partially Implemented	Medium	As needed and as funding opportunities become available	FEMA, WEM, WCMP, OEM, Municipalities, and Property Owners	
Encourage the practice of non-structural or nature-based shoreline protection measures, such as living revetment or seawalls and artificial beach and beach nourishment.	Partially Implemented	Medium	As needed and as funding opportunities become available	WCMP, OEM, Milwaukee County Parks, Municipalities and Property Owners	
Public Informational and Education Outreach and Programming					
Work with WCMP to conduct public outreach and to provide technical assistance regarding BMPs to prevent shoreline erosion and bluff recession.	Partially Implemented	Medium	Ongoing	WCMP, OEM, Milwaukee County Parks, Municipalities and Property Owners.	7, 11, 12, 13, 48
Promote flood insurance to residents along the County's low-lying coast located in Lake Michigan's flood hazard area.	Partially Implemented	High	Ongoing	FEMA, WEM, WCMP, OEM, and Property Owners and Municipal Development, Planning and/or Engineering Departments along the Lake Michigan coastline.	

Table continued on next page.

Table 6.1 (Continued)

Note: The following abbreviations are used for designated management agencies or departments:

CMOEM = City of Milwaukee Office of Emergency Management
COAD = Citizens and Organizations Active in Disasters
DHHS = Milwaukee County Department of Health and Human Services
DOT = Department of Transportation
FEMA= Federal Emergency Management Agency
MMSD = Milwaukee Metropolitan Sewerage District
NOAA = National Oceanic and Atmospheric Administration
NRCS= Natural Resources Conservation Service
NWS= National Weather Service
OEM = Milwaukee County Office of Emergency Management
SEWRPC = Southeastern Wisconsin Regional Planning Commission
USGS= U.S. Geological Survey
WCMP= Wisconsin Coastal Management Program

Source: SEWRPC

6.3 HAZARD MITIGATION FUNDING SOURCES

The ability of each participant in this Hazard Mitigation Plan to implement the proposed measures is most often limited by their ability to finance the projects and dedicate sufficient staffing time toward implementing projects while still providing other essential services. Financing the construction, operation, and maintenance of hazard mitigation measures may be accomplished through a number of means, including: establishing a stormwater utility; tax incremental financing (TIF) districts; local property taxes; reserve funds; general obligation bonds; private-developer contributions, including fees applied to construction of regional stormwater management facilities in lieu of providing onsite facilities; State grants or loans; and certain Federal and State programs.

Identifying potential funding sources, including sources other than solely local-level sources, is an integral part of implementing a successful mitigation plan and serves as one way for Plan participants to expand on and improve their capability to mitigate the impacts of hazard events in their communities. Successfully pursuing and receiving grant funding takes a considerable amount of time and effort and the lack of available staff time to pursue funding opportunities is often a major barrier to successful plan implementation. Having sufficient staff time dedicated to pursuing grant funding opportunities represents a way to expand a community's capability to implement the hazard mitigation measures recommended in this Plan, particularly with increasing funding becoming available through the Bipartisan Infrastructure Law.[202]

The following description of funding sources includes those that appear to be applicable for the County and local units of government as of 2025. However, because funding programs and opportunities are constantly changing, the involved staff of the County and local units of government will need to monitor the potential funding sources and programs. Nonetheless, the list of sources and programs provided below can provide a starting point for identifying possible funding for implementing potential hazard mitigation plan recommendations.

Some of the programs described in this Chapter may not be available under all envisioned conditions in the County or to its residents and/or property owners for a variety of reasons, including, for example, eligibility requirements or lack of funds at a given time in Federal and/or State budgets. Nonetheless, the list of sources and programs set forth in this Chapter should provide a starting point for identifying possible funding for implementing the Hazard Mitigation Plan recommendations in this report (see also Appendix K).

U.S. Federal Emergency Management Agency Programs (FEMA)

FEMA provides several pre-disaster or non-emergency disaster assistance programs to states, tribal governments, and to local governments. These preparedness grants support citizens and first responders, as well as improve the capability to prepare for, protect against, respond to, recover from, and mitigate high-consequence disasters and emergencies. These FEMA funding programs are administered through Wisconsin Emergency Management (WEM).

U.S. Army Corps of Engineers (USACE)

The Army Corps of Engineers programs are potential sources of funding for implementing the flood management recommendations of this plan. To be eligible for funding, the plan components must meet specific Corps economic feasibility and other criteria.

U.S. Department of Agriculture - Farm Service Agency (FSA)

The U.S. Department of Agricultural Farm Service Agency (USDA-FSA) oversees several voluntary conservation-related programs that provide direct and indirect hazard mitigation benefits. These programs work to address a large number of farming- and ranching-related issues including drinking water protection, reducing soil erosion, preserving wildlife habitat, preserving, and restoring forest and wetlands, and aiding farmers whose farms have been damaged by natural disasters such as flooding and drought.

[202] *U.S. Public Law No. 117-58 (2021),* Infrastructure Investment and Jobs Act.

U.S. Department of Agriculture - Natural Resources Conservation Service (NRCS)

The U.S. Department of Agricultural Natural Resources Conservation Service (USDA-NRCS) provides farmers and ranchers with financial and technical assistance to voluntarily install conservation measures to help the environment and agricultural operations concurrently.

U.S. Fish and Wildlife Service (USFWS)

The USFWS's *National Fish Passage Program* provides financial and technical assistance in support of fish passage projects. This program works to restore rivers and conserve aquatic resources by removing or bypassing barriers, including obsolete and dangerous dams, ultimately eliminating public safety hazards and restoring river ecosystems. The program also works with transportation agencies and others to improve road stream crossings for flooding and fish passage.

U.S. Department of Housing and Urban Development (HUD)

Community Development Block Grant (CDBG) programs, funded by the U.S. Department of Housing and Urban Development, are administered by the Wisconsin Department of Administration (DOA). The CDBG Emergency Assistance Program is a special program that the Wisconsin DOA Division of Energy, Housing and Community Resources activates to assist local units of government that have recently experienced a natural or man-made disaster.

U.S. Environmental Protection Agency (USEPA)

USEPA's mission is to protect human health and the environment. USEPA has several programs that provide grants to state environmental programs, local units of government, nonprofit organizations, and educational institutions.

Wisconsin Department of Transportation (WisDOT)

WisDOT programs assist local governments with the needed improvements to local roads, highways, and bridges.

Wisconsin Department of Natural Resources (WDNR)

The WDNR administers a number of grant programs that may serve as potential funding sources for flood mitigation efforts by the County and local communities.

Wisconsin Emergency Management

Under Wisconsin Act 265 and *Wisconsin Statute* 323.63 the WEM Pre-Disaster Flood Resilience Grant Program was initiated. This new program provides funding to applicants for the purpose of identifying flood vulnerabilities, identifying options to improve flood resiliency, and restoring hydrology in order to reduce flood risk and damages in flood-prone communities. The focus for this program is intended to be on wetland and floodplain restoration.

Other Potential Funding Sources

A variety of other potential funding sources exist which may provide funds for the implementation of elements of the Hazard Mitigation Plan recommendations. These are listed in Appendix K.

6.4 PLAN MONITORING AND REEVALUATION STRATEGIES

For a hazard mitigation plan to be successful it must not only be implemented but also monitored. Plan monitoring is best accomplished through a formal, periodic process designed to measure and assess progress in implementation, changes in outside circumstances that may affect the plan and efforts to implement it, and changes to the plan or the implementation process. The plan should also be reviewed following each hazard event to assess its continued viability and the need for revisions.

Plan Monitoring

Review

To ensure successful monitoring of the Hazard Mitigation Plan, it is recommended that the Milwaukee County All Hazards Mitigation Plan LPT meet periodically to review the Plan and the status of its implementation with a view toward enhancing and improving response to natural hazard events. Plan review meetings will be held following any disasters that affect the County and at the discretion of the Director of the County Office of Emergency Management. These meetings will provide the opportunity to develop and recommend any necessary revisions of the Plan to the Milwaukee County Board of Supervisors, as well as to the local units of government involved. The revisions would be proposed, considered, and adopted in the form of formal amendments to the Hazard Mitigation Plan. This review process will be coordinated and conducted by the County OEM, with input from, coordination with, and participation by all concerned County officials and staff, all units and agencies of government involved in plan implementation and concerned private parties. The LPT, in its review process, will periodically examine the Plan and the efforts to implement it with respect to the following:

1. Whether any hazards affecting the County and local units of government have changed, and if so, how they have changed

2. Whether any hazard mitigation goals and objectives have changed or need to be changed

3. The degree and extent of progress made in implementing previously identified hazard mitigation actions

4. Whether the plan elements and their priorities should remain unchanged or need modification

5. Whether any new plan elements are needed

6. Whether applicable funding programs and levels have changed

The meetings of the LPT will continue to be publicly noticed, and salient decisions will be recorded in the County Office of Emergency Management files and, where appropriate, on the County website and in press releases, among others. Meetings of the LPT are considered public meetings under Wisconsin Law and are open to all interested parties. County OEM staff will also continue to organize community-level events to increase public awareness, participation, and preparedness. The staff will ensure that appropriate notices, agendas, and other documentation are provided to interested people and LPT members in a timely manner. The venue and timing of these events shall be varied to ensure the widest possible participation and geographic spread across the County. Through these community-level events, staff will gain an understanding of issues of concern, encourage public involvement, and maintain hazard awareness and preparedness at a high level.

<u>Post-Disaster Review</u>

The plan monitoring and refinement strategy will include a post-disaster component whereby the Plan is reviewed and evaluated after any future major hazard event. Based upon this review, the Hazard Mitigation Plan will be updated or revised as needed based on the experiences, circumstances, and consequences of the hazard. In this regard, the post-disaster review effort will be coordinated with the emergency operations program administered by the County OEM in partnership with the local units of government. The experiences of emergency operations may indicate a need for refined mitigation actions that would then be incorporated into the plan. Any Plan updating found to be needed will be incorporated into the periodic plan update noted above.

<u>Reevaluation Strategy</u>

As a condition of eligibility for receiving project grant funding from its mitigation grant programs, FEMA requires that hazard mitigation plans be reviewed, revised, and resubmitted for approval every five years. The updated Plan should document changes that have occurred since the development of the Plan, such as implementing recommended mitigation measures, changes in development, occurrences of hazard events, and changes in local priorities. In addition, it should update the risk analysis. This should include both determining whether the risks posed by specific hazards have changed and reevaluating the identified

hazards to determine whether any changes need to be made in the set of hazards addressed by the Plan. Finally, the updated Plan should evaluate the relevance of the Plan's goals, objectives, and recommended strategies and update them as appropriate.

To meet these requirements, it is recommended that the Hazard Mitigation Plan be updated at a minimum of five-year intervals. The Director of the Milwaukee County OEM should lead updating efforts in partnership with other appropriate County and local community departments. Reevaluation, updating, and revision of this plan should be initiated approximately 24 months prior to its expiration. As part of the updating process, the Director will reconstitute the Hazard Mitigation LPT to oversee the development of the updated Plan. The team should include representatives of all of the municipalities that are covered under the Plan. The meetings of the LPT will be publicly noticed. In addition, at appropriate times during the updating process, members of the public and adjacent communities will be provided with opportunities to review and submit questions and comment on the Plan update. Plan updating will be conducted according to relevant guidance available from FEMA and WEM. Following completion of the updated Plan in draft form, it will be submitted to WEM and FEMA for review and approval. Following approval by FEMA, the updated Plan will need to be adopted by the Milwaukee County Board and by the governing bodies of the incorporated municipalities in the County.

Incorporating Existing Planning Mechanisms

The Hazard Mitigation LPT will meet periodically to provide a mechanism for ensuring that the actions identified in the Plan are incorporated into ongoing County planning activities. Milwaukee County and its communities currently utilize comprehensive land use planning, land use regulations, neighborhood planning, and building codes to guide and control development in the County. These existing mechanisms will have hazard mitigation strategies integrated into them where applicable.

APPENDICES

COUNTY, LPT, AND COMMUNITY PLAN PARTICIPATION EFFORTS

APPENDIX A

Figure A.1
Milwaukee County Hazard Mitigation Plan Update Local Planning Team (LPT) Members: 2025

Andy Pederson	Village Manager, Village of Bayside
Peter Nimmer	Chief of Police, Village of Brown Deer
Jeff Bloor	Fire Chief, City of Cudahy
Christopher Freedy	Chief of Police, Village of Fox Point
Scott Brandmeier	Public Works Director, Village of Fox Point
Adam Remington	Fire Chief (retired), City of Franklin
James Mayer	Fire Chief, City of Franklin
Mark Ferguson	Chief of Police (retired), City of Glendale
Rhett Fugman	Chief of Police, City of Glendale
Kenten Kais	Fire Chief, Village of Greendale
Jeffrey Scherzer	Fire Captain, Village of Greendale
Ryan Rosenow	Chief of Police, Village of Greendale
Thomas Konieczka	Fire Chief, City of Greenfield
Eric Cera	Chief of Police, Village of Hales Corners
Anthony Henner	Police Lieutenant, Village of Hales Corners
Patrick Pauly, P.E.	Superintendent, Milwaukee Water Works, City of Milwaukee
Ryan Zollicoffer	Director, City of Milwaukee OEM, City of Milwaukee
Michael Kressuk	Fire Chief, City of Oak Creek
Jesse Kimber	Police Sergeant, Village of River Hills
Tammy LaBorde	Village Manager, Village of River Hills
Ian Moss	Police Sergeant, Village of Shorewood
Andrew Mroz	Police Lieutenant, Village of Shorewood
John Litchford	Fire Chief, City of South Milwaukee
Nicholas Poplar	Fire Chief, City of St. Francis
Jim Case	Fire Chief, City of Wauwatosa
Karyn Rittenhouse	Water Works Superintendent, West Allis, City of West Allis
Jason Schaak	Risk Reduction Fire Chief, West Allis Fire Department, City of West Allis
Shaundra Randolph	Chief of Police, Village of West Milwaukee
Patrick Whitaker	Chief of Police, Village of Whitefish Bay
Paul Riegel	Director, Milwaukee County Office of Emergency Management
Tim Salamon	Milwaukee County Office of Emergency Management
Eduardo Santiago	Milwaukee County Office of Emergency Management
Barry Mitchell	Milwaukee County Office of Emergency Management
Natalie Meier	Milwaukee County
Sarah Toomsen	Assistant Director, Milwaukee County Planning and Parks Department
Susan Coyle	Senior Project Manager, MMSD, MMSD Service Area
Patrick Elliott	Senior Project Manager, MMSD, MMSD Service Area
Laura Herrick, P.E.	Chief Environmental Engineer, SEWRPC
Megan Shedivy	Planner, SEWRPC

Figure A.2
Instructions for Completing the Online Hazard Vulnerability And Assessment Tool

The purpose of this online Hazard Vulnerability and Assessment (HVA) Tool is to evaluate the potential that specific hazards may occur, the likely severity of impacts resulting from these hazards, and the extent to which these impacts may be mitigated by current levels of preparedness. The tool uses estimates of probability of occurrence, likely severity of impacts, and level of preparedness to estimate the risk posed by each hazard.

Please address all of the potential threats that are listed. Instructions for completing entries in each column are given below.

Probability
For each of the listed hazards, please indicate the likelihood that it will occur, with 1 indicating a low probability of occurrence, 2 indicating a moderate probability of occurrence, and 3 indicating a high probability of occurrence. Issues to consider for probability include, but are not limited to:

- Known risk,
- Historical data and experience, and
- Local government or agency experience.

Human Impacts
For each of the listed hazards, please indicate what you consider to be the likely level of impacts to human life if the hazard occurs, with 1 indicating a low level of impacts, 2 indicating a moderate level of impacts, and 3 indicating a high level of impacts. Issues to consider for human impacts include, but are not limited to:

- Potential of the hazard to cause death, and
- Potential of the hazard to cause injury requiring medical treatment.

Property Impacts
For each of the listed hazards, please indicate the likely level of physical losses and damages to property if the hazard occurs, with 1 indicating a low level of losses and damages, 2 indicating a moderate level of losses and damages, and 3 indicating a high level of losses and damages. Issues to consider for property impacts include, but are not limited to:

- The potential of the hazard to cause damage to property or crops,
- The cost to replace damaged property,
- The cost to set up a temporary replacement for damaged property,
- The cost to repair damaged property, and
- The time to recover from the property damage.

Business and Government Agency Impacts
For each of the listed hazards, please indicate what the likely level of impacts to the operations of businesses and government agencies is if the hazard occurs, with 1 indicating a low level of impacts, 2 indicating a moderate level of impacts, and 3 indicating a high level of impacts. Issues to consider for business impacts include, but are not limited to:

- Business or agency interruption,
- Employees unable to report to work,
- Customers or clients unable to reach facility,
- Company or agency in violation of contractual agreements,
- Imposition of fines and penalties or legal costs,
- Interruption of access to critical supplies,
- Interruption of product or service distribution,
- Financial impact or burden, and
- Interruption of critical care and emergency services.

Figure A.2 (Continued)

Preparedness
For each of the listed hazards, please indicate the current level of preparedness for dealing with the hazard and its impacts, with 1 indicating a high level of preparedness, 2 indicating a moderate level of preparedness, and three indicating a low level of preparedness or no preparedness. Issues to consider for preparedness include, but are not limited to:

- The status of current plans that address the hazard,
- The frequency of drills that address the hazard,
- The status of training related to the hazard and its impacts,
- Insurance,
- The availability of back-up systems, and
- The availability of community resources.

This survey will be compiled, and the results will be reported during the hazard identification phase of developing or updating the hazard mitigation plan.

Online Access:
https://arcg.is/XuTmP2

Figure A.3
Agenda and Summary Notes for Local Planning Team Meeting: April 27, 2023

Milwaukee County Office of Emergency Management
Southeastern Wisconsin Regional Planning Commission

Notice of Meeting and Agenda

MILWAUKEE COUNTY HAZARD MITIGATION PLAN LOCAL PLANNING TEAM

DATE: April 27, 2023

TIME: 1:00 to 2:00 p.m.

PLACE: Virtual via **GoTo Meeting** (see link below)

LINK: https://meet.goto.com/777755653
or by Phone: 1(669) 224-3412 Access Code: 777-755-653
If you have not used GoTo Meeting before, the application can be downloaded at
https://meet.goto.com/install

AGENDA:

1. Welcome and introductions: Mr. Paul Riegel, Director of the Emergency Management Division for the Milwaukee County Office of Emergency Management
2. Overview of hazard mitigation and planning process: Megan Shedivy, SEWRPC
3. Background on the previous Milwaukee County and City of Milwaukee Hazard Mitigation Plans: Megan Shedivy, SEWRPC
    a. Overview of previous planning efforts
    b. Main components to be reviewed and revised
    c. Schedule for the plan update (Attachment 1)
    d. Local Planning Team role
4. Review hazard mitigation goals from previous hazard plans (Attachment 2): Megan Shedivy
5. Hazard and vulnerability assessment exercise (Link or QR code below): Megan Shedivy
    a. https://arcg.is/XuTmP2

6. Adjourn

Megan A. Shedivy
Secretary

Enclosures

Figure A.3 (Continued)

Attachment 1

WORK SCHEDULE AND DIVISION OF RESPONSIBILITIES FOR UPDATING THE MILWAUKEE COUNTY HAZARD MITIGATION PLAN

Task	Estimated Completion Date	Responsible Agency
Update Local Planning Team Membership	January 31, 2023	Milwaukee County and SEWRPC
Local Planning Team Kickoff Meeting	April 26, 2023	Milwaukee County and SEWRPC
Initiate Public Participation and Outreach	April 2023	SEWRPC and Milwaukee County
Develop Updated Community Profile	June 2023	SEWRPC
Review and Update Identification and Description of Hazards	September 2023	SEWRPC
Update Risk and Vulnerability Assessments	December 2023	SEWRPC
Local Planning Team Meeting (Chapters 1-3 Review)	February 2024	SEWRPC and Milwaukee County
1st Public Meeting to Review Hazard Identification and Risk Assessment	February 2024	SEWRPC and Milwaukee County
Revise Draft Plan Based on Public Comment	March 2024	SEWRPC
Review and Update Established Hazard Mitigation Goals and Objectives	April 2024	SEWRPC
Develop Updated Mitigation Actions	August2024	SEWRPC
Develop Updated Plan Maintenance Process	November 2024	SEWRPC
Local Planning Team Meeting	December 2024	SEWRPC and Milwaukee County
2nd Public Meeting to Review Draft Plan	January 2025	SEWRPC and Milwaukee County
Revise Draft Plan Based on Public Comment	February 2025	SEWRPC
Submit Draft Plan Update to WEM for Review	April 2025	SEWRPC on Behalf of Milwaukee Co
Revise Plan Based on State Review	May 2025	SEWRPC
Submit to FEMA for Approval Pending Adoption	June 2025	SEWRPC on Behalf of Milwaukee County
Formal Adoption	August 2025	Milwaukee County
End of Performance Period	November 3, 2025	
Local Government Adoption	Within 1 year of FEMA approval	All incorporated municipalities

Source: SEWRPC

Figure A.3 (Continued)

Attachment 2

GOALS FOR MILWAUKEE COUNTY HAZARD MITIGATION PLAN UPDATE

The following goals were established from the previous City of Milwaukee City and Milwaukee County hazard mitigation planning efforts.[1] The goals have been established based, in part, upon goals previously established in watershed, park and open space, and land use planning programs:

2017 Milwaukee County Hazard Mitigation Goals and Objectives:

Hazard Goals and Objectives	
Hazard Goals	**Hazard Objectives**
1. To preserve life and minimize the potential for injuries or death.	1. Identify natural and man made hazards that threaten life in Milwaukee County.
2. To preserve and enhance the quality of life throughout Milwaukee County by identifying potential property damage risks and recommending appropriate mitigation strategies to minimize potential property damage.	1. Implement programs and projects that assist in protecting lives by making homes, businesses, essential facilities, critical infrastructure, and other property more resistant to losses from all hazards. 2. Improve hazard assessment information to make recommendations for discouraging new development and encouraging preventive measures for existing development in areas vulnerable to natural hazards. 3. Protect life and property by implementing state-of-the-art standards, codes and construction procedures.
3. To promote countywide coordination, planning, and training that avoids transferring the risk from one community to an adjacent community, where appropriate.	1. Continue developing and strengthening inter-jurisdictional coordination and cooperation in the area of emergency services. 2. Continue to support and develop comprehensive mutual aid agreements. 3. Continue providing Milwaukee County and municipal emergency services with training and equipment to address all identified hazards.
4. To identify potential funding sources for mitigation projects and form the basis for FEMA project grant applications.	1. NA
5. Increase public awareness	1. Increase public awareness of existing threats and the means to reduce these threats by conducting educational and outreach programs to all the various community groups in the County. 2. Provide informational items, partnership opportunities and funding resource information to assist in implementing mitigation activities.

2018 City of Milwaukee Hazard Mitigation Goals and Objectives:

1. A spatial distribution of the various land uses that minimizes hazards and dangers to health, welfare, and safety as well as further enhancing the economic base of the City, and which will result in a compatible arrangement of land uses properly related to the existing and proposed supporting transportation, utility, public safety, and public facility systems.
2. A spatial distribution of the various land uses which maintains biodiversity and which will result in the protection and wise use of the natural resources of the City, including its soils, inland lakes and streams, groundwater, wetlands, woodlands, wildlife, and natural areas and critical species habitats.
3. The provision of facilities necessary to maintain a high-quality of fire and police protection and emergency medical services throughout the City.
4. The development of a stormwater management system, floodplain management system, and sanitary sewer systems which reduce the exposure of people to drainage- and flooding-related inconvenience and to health and safety hazards and which reduces the exposure of real and personal property to damage through inundation and basement backup resulting from flooding, inadequate stormwater drainage, or sewerage system capacity.
5. The identification of high erosion risk Lake Michigan shoreline areas and the development of a coastal erosion management program which reduces the exposure of people and real and personal property to shoreline erosion and bluff recession.
6. The identification and development of programs which complement emergency operations plans from the County and adjacent municipalities, to mitigate the potential exposure to health and safety and the exposure of real and personal property resulting from a broad range of hazards which are unpredictable and not geographically specific in nature.

[1] *SEWRPC Community Assistance Planning Report No. 282,* City of Milwaukee All Hazard Mitigation Plan (3rd Edition): 2019-2024*, November 2019; Milwaukee County Hazard Mitigation Steering Committee, Milwaukee County Office of Emergency Management, and Milwaukee County Communities,* Milwaukee County, Wisconsin Hazard Mitigation Plan, 2016-2017*, 2018*

Figure A.3 (Continued)

SUMMARY NOTES OF THE APRIL 27, 2023 VIRTUAL MEETING OF THE MILWAUKEE COUNTY HAZARD MITIGATION PLAN UPDATE LOCAL PLANNING TEAM

INTRODUCTION

The April 27, 2023, kick off meeting of the Milwaukee County Hazard Mitigation Plan Update for the Local Planning Team (LPT) was convened via GoToMeeting online platform at 1:02 p.m. The meeting was called to order by Mr. Paul Riegel, Director for Milwaukee County's Emergency Management Division, Office of Emergency Management (OEM). Attendance was noted by SEWRPC staff and the GoToMeeting participant listing.

In attendance at the meeting were the following individuals:

Local Planning Team Members

Megan Shedivy, Secretary	Planner, SEWRPC
Eric Cera	Chief of Police, Village of Hales Corners
Susan Coyle	Senior Project Manager, Milwaukee Metropolitan Sewerage District
Natalie Czarkowski	Office of Emergency Management, Milwaukee County
Patrick Elliot	Senior Project Manager, Milwaukee Metropolitan Sewerage District
Mark Ferguson	Chief of Police, City of Glendale
Christopher Freedy	Chief of Police, Village of Fox Point
Anthony Henner	Police Lieutenant, Village of Hales Corners
Laura Herrick, P.E.	Chief Environmental Engineer, SEWRPC
Kenten Kais	Fire Chief, Village of Greendale
Michael Kressuk	Fire Chief, City of Oak Creek
Tammy LaBorde	Village Manager, Village of River Hills
John Litchford	Fire Chief, City of South Milwaukee
Barry Mitchell	Office of Emergency Management, Milwaukee County
Patrick Pauly, P.E.	Superintendent, Milwaukee Water Works
Andy Pederson	Village Manager, Village of Bayside
Justin Piper	Battalion Chief, City of Cudahy Fire Department
Adam Remington	Fire Chief, City of Franklin
Phil Reimer	Risk Manager, Milwaukee Metropolitan Sewerage District
Paul Riegel	Director, Milwaukee County Office of Emergency Management
Tim Salamon	Office of Emergency Management, Milwaukee County
Eduardo Santiago	Office of Emergency Management, Milwaukee County
Craig Schroeder	Superintendent, Department of Public Works, Village of River Hills
Erick Shambarger	Office of Emergency Management, City of Milwaukee
Dave Stabbe	Battalion Chief, City of Greenfield Fire Department
Zac Swingen	Office of Emergency Management, City of Milwaukee
Patrick Whitaker	Chief of Police, Village of Whitefish Bay

Ms. Laura Herrick welcomed all attendees to the first Local Planning Team meeting for the Milwaukee County hazard mitigation plan update (Plan). Ms. Herrick began the meeting with a brief explanation of features of the GoToMeeting platform, how to use the chat feature to submit questions or comments, and that the option of calling into the meeting is available. Ms. Herrick then handed the meeting over to Ms. Shedivy who again welcomed attendees, thanked them for their participation, and briefly explained the meeting agenda.

OVERVIEW OF HAZARD MITIGATION AND HAZARD MITIGATION PLANNING PROCESS

Ms. Shedivy presented an overview of hazard mitigation, why it is important, and examples of hazard mitigation measures. With no questions or comments regarding this discussion, Ms. Shedivy went on to explain hazard mitigation planning at the local level and the requirements needed for Wisconsin Emergency Management (WEM) and Federal Emergency Management (FEMA) approval and to receive funding for mitigation projects. Again, no questions or comments were given during this discussion.

BACKGROUND ON DEVELOPMENT OF THE HAZARD MITIGATION PLAN UPDATE

Ms. Shedivy continued with a brief background on the city and county's previous hazard mitigation plans, their main components, and the planning process that took place before the plans were approved. Ms. Shedivy then introduced material related to the hazard mitigation plan update including the efforts of combining both the City and County's previous planning efforts into this unified plan update. She also noted that this plan will focus on natural hazards only. She then went on to explain the plan update components and chapters and the role of the LPT during the plan updating process. No comments or questions were presented about the initial hazard mitigation plan or the plan update components or process.

HAZARD AND VULNERABILITY ASSESSMENT EXERCISE

Ms. Shedivy stated that as part of the hazard and vulnerability analysis for this plan update, it will be necessary to determine which natural hazards to continue to include in the plan update. She briefly mentioned that the hazard and vulnerability assessment survey is available online or by using a QR code for mobile phone devices. She noted that a link and QR code of the hazard and vulnerability assessment exercise and instructions are included with the agenda as well as on the presentation slide. Ms. Shedivy noted that the deadline for submitting the survey is May 10, 2023. She then stated to have the LPT provide recent hazard mitigation-related projects, by jurisdiction, that have been completed or in the process of being completed since the previous plans was finalized.

Ms. Shedivy explained that the results of this exercise would help reassess the natural hazards and their impacts that occur within the county and its communities, which are to be addressed in the hazard mitigation plan update.

AFTER MEETING DISCUSSIONS

After the meeting, Mr. Erick Schamberger asked if we should add a short section to the plan on how to take advantage of FEMA funding for community projects. He felt that the county sending out information to the communities may not be sufficient or getting to the right individual(s). Ms. Herrick acknowledged his remark and noted that perhaps this would be an email list of public works and planning staff in each community for Mr. Riegel to use and send out.

Mr. Eduardo Santiago asked Mr. Riegel if the County Risk Management Office should or is involved with this planning effort. Mr. Riegel indicated that he would discuss this with them to see if they would be interested.

-3-

ADJOURNMENT

There being no further business, the meeting was adjourned at 1:46 p.m.

EMAIL CORRESPONDANCE FOLLOWING THE MEETING

It should be noted that the GoToMeeting platform got disconnected several times during the beginning portion of the meeting. Mr. Riegel offered to host the remainder of the meeting using Microsoft Teams. Because of the GoToMeeting interruptions, some attendees may have had trouble logging back onto the meeting or missed portions of the presentation. As such, Ms. Laura Herrick sent out a follow up email for the LPT informing the members that the meeting material (agenda, minutes, presentation, and draft documents) will be available on SEWRPC's website and to contact either Ms. Shedivy or Mr. Riegel for any questions or comments regarding information related to the kick off meeting. The email also reminded the LPT to complete the online hazard and vulnerability assessment survey as well as to note if their attendance was in place of another staff member and to note which staff member they are referring too.

Additionally, Ms. Shedivy received an email on May 1, 2023, from Mr. Dave Stabbe, Battalion Chief for the Greenfield Fire Department, stating that he will be the Local Planning Team representative for the City of Greenfield during this plan updating process.

Also, on that same day, Mr. Chris Freedy, Chief of Police for the Village of Fox Point, emailed a question in regard to the hazard and vulnerability assessment survey. He asked if the questions related to hazard rankings were to represent the entire County or just the jurisdiction that he works and resides in. He then indicated that he feels it best that he answers for his jurisdiction only seeing that this is where he lives, works, and plays. Ms. Shedivy responded that he could answer the ranking questions in relation to his jurisdiction only.

MILWAUKEE CO HMPU KICK OFF MEETING SUMMARY NOTES 04/27/2023 (00268080).DOC
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05/02/23

Figure A.4
Agenda and Summary Notes for Local Planning Team Meeting: February 20, 2024

Milwaukee County Office of Emergency Management
Southeastern Wisconsin Regional Planning Commission

Notice of Meeting and Agenda

MILWAUKEE COUNTY HAZARD MITIGATION PLAN LOCAL PLANNING TEAM

DATE: February 20, 2024

TIME: 10:00 to 11:30 a.m.

LINK: Microsoft Teams meeting
Join on your computer, mobile app, or room device
Click here to join the meeting
Meeting ID: 231 856 628 725
Passcode: EVB6gN

AGENDA:

1. Roll Call

2. Consideration of Summary Notes of the April 27, 2023 Local Planning Team meeting

3. Consideration of Chapter 1, "Introduction and Background," of SEWRPC Community Assistance Planning Report No. 345 *Milwaukee County Hazard Mitigation Plan*

    a. Highlight the importance of community participation during the planning process as part of FEMA's new Local Mitigation Planning Policy Guide (i.e., LPT input on hazard mitigation outreach and activities)

4. Consideration of Chapter 2, "Basic Study Area Inventory and Analysis," of SEWRPC Community Assistance Planning Report No. 345 *Milwaukee County Hazard Mitigation Plan*

5. Consideration of Chapter 3, "Analysis of Hazard Conditions," of SEWRPC Community Assistance Planning Report No. 345 *Milwaukee County Hazard Mitigation Plan*

    a. Review of results from the online hazard and vulnerability assessment exercise

    b. Discuss any additional material (i.e. roadway flooding, coastal hazards) to add into the Plan.

6. Discussion of upcoming public meeting on February 21, 2024.

7. Adjourn

Megan Shedivy
Secretary

The summary notes and preliminary draft chapters can be found on the SEWRPC hazard mitigation webpage at www.sewrpc.org/hmp.

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SUMMARY NOTES OF THE FEBRUARY 20, 2024 VIRTUAL MEETING OF THE MILWAUKEE COUNTY HAZARD MITIGATION PLAN UPDATE LOCAL PLANNING TEAM

INTRODUCTION

The February 20, 2024, meeting of the Milwaukee County Hazard Mitigation Plan Update (HMPU) for the Local Planning Team (LPT) was convened via Microsoft Teams ("Teams") online platform at 10:02 a.m. The meeting was called to order by Mr. Paul Riegel, Director for Milwaukee County's Emergency Management Division, Office of Emergency Management (OEM). Attendance was tracked using the online software.

In attendance at the meeting were the following individuals:

Local Planning Team Members	
Jeffrey Bloor	Fire Chief, City of Cudahy
Susan Coyle	Senior Project Manager, Milwaukee Metropolitan Sewerage District
Natalie Czarkowski	Office of Emergency Management, Milwaukee County
Patrick Elliott	Senior Project Manager, Milwaukee Metropolitan Sewerage District
Mark Ferguson	Chief of Police, City of Glendale
Christopher Freedy	Chief of Police, Village of Fox Point
Laura Herrick	Chief Environmental Engineer, SEWRPC
Michael Kressuk	Fire Chief, City of Oak Creek
James Mayer	Fire Chief, City of Franklin
Natalie Meier	Milwaukee County
Barry Mitchell	Office of Emergency Management, Milwaukee County
Andy Pederson	Village Manager, Village of Bayside
Nicholas Poplar	Fire Chief, City of St. Francis Fire Department
Paul Riegel	Director, Milwaukee County Office of Emergency Management
Tim Salamon	Office of Emergency Management, Milwaukee County
Eduardo Santiago	Office of Emergency Management, Milwaukee County
Megan Shedivy, Secretary	Planner, SEWRPC
Ryan Zollicoffer	Director, City of Milwaukee Office of Emergency Management

Ms. Herrick began the meeting with a brief explanation of features on the Teams platform to submit questions or comments. She then handed the meeting over to Ms. Shedivy, who welcomed attendees and thanked them for their participation. She then briefly explained the meeting agenda and summary notes from the LPT kickoff meeting held on April 27, 2023. Ms. Shedivy pointed out that the kickoff meeting summary notes mention to follow up with Mr. Reigel regarding Mr. Shambarger's request on how to better take advantage of FEMA funding for community projects, such as a specific list of certain local staff deemed more knowledgeable for FEMA-related projects.

[Secretary's Note: After the meeting, Ms. Shedivy contacted Mr. Riegel requesting an email list of public works and planning staff in each community for future funding opportunities and additional input on potential FEMA funding projects.]

-2-

CHAPTER 1, "INTRODUCTION AND BACKGROUND"

Ms. Shedivy began her presentation with an overview of draft Chapter 1 of the Milwaukee County HMPU. She gave a brief description of the Plan background, study area (Milwaukee County), as well as the relationship of hazard mitigation planning to other County efforts. She noted that this Plan update is combining the County and City of Milwaukee hazard mitigation planning efforts. Ms. Shedivy then gave examples of community outreach and implementation activities related to hazard mitigation and highlighted notable MMSD flood mitigation projects listed in Table 1.5. She emphasized the importance of community participation during the preparation of this Plan update, as community participation is necessary in order to receive FEMA approval of the Plan. There were no questions or comments from the LPT on draft Chapter 1.

CHAPTER 2, "BASIC STUDY AREA INVENTORY AND ANALYSIS"

Ms. Shedivy continued with a short overview of the main components of draft Chapter 2 of the Milwaukee County HMPU. She briefly described the County inventory data collected and analyzed, including current and projected demographic trends, vulnerable populations, and current and planned land use characteristics. Ms. Shedivy emphasized that the background or inventory information for the County is an important element of the planning process.

While discussing critical community facilities, Mr. Kressuk noted that there are two additional fire stations that need to be included on Map 2.10 and Table 2.12 for the City of Oak Creek. Ms. Shedivy acknowledged Mr. Kressuk's comment and stated that she will correct Map 2.10 and Table 2.12 once the data is received.

Concluding Chapter 2, Ms. Shedivy gave a general overview on climate change and its relative importance for hazard mitigation planning. She also emphasized that FEMA considers this information essential and necessary for hazard mitigation. The source of climate change data and how it is presented throughout the Plan was explained to the LPT attendees. Ms. Shedivy stated that Figures 2.2 through 2.5 illustrate temperature and precipitation trends and projections for Wisconsin.

There were no further LPT questions or comments on draft Chapter 2.

CHAPTER 3, "ANALYSIS OF HAZARD CONDITIONS"

Ms. Shedivy began with a general overview of draft Chapter 3 of the Milwaukee County HMPU and its main components. She gave a brief discussion on the hazard identification and ranking process; the risk analysis portion; and how each hazard was profiled. Ms. Shedivy stated that as part of the hazard and vulnerability analysis, the results from the online survey helped to determine which natural hazards to continue to include in the Plan update. She then presented Tables 3.2 and 3.4 which provide a general summary and past impact results of the hazards considered for this Plan update.

With no questions or comments related to the layout and hazard identification process of draft Chapter 3, Ms. Shedivy continued on to discuss the profiled hazards. With respect to the allotted meeting time, Ms. Shedivy focused on three of the seven profiled hazards. The three higher risk hazards presented to the LPT attendees were flooding and stormwater drainage, extreme temperatures, and Lake Michigan coastal hazards.

-3-

Starting with flooding and stormwater drainage, Ms. Shedivy gave a brief review on the existing hydrological features within the County including the miles of major streams, the main watersheds, and the acreage of land considered to be within the 1-percent-annual-probability (100-year event) floodplain.

Ms. Shedivy then presented the different types of flooding concerns for Milwaukee County (i.e., riverine, stormwater, dam failure, ice jams, and flash floods) as well as recently reported flood events and the different County assets vulnerable to flooding impacts, including transportation and structural damages and vulnerable populations.

For structural impacts caused by flooding, Ms. Shedivy described the parcel-based loss analysis used to estimate potential damages caused by a 100-year flood event. Tables 3.8 and 3.9 as well as Map 3.2 were presented to illustrate and explain the results of the analysis. Municipalities and watersheds with a large number of structures estimated to be within the 100-year floodplain were noted along with the estimated direct and indirect structural flood damages. Ms. Shedivy added that four critical community facilities were determined to be impacted by the 100-year floodplain. Mr. Zollicoffer asked if there was a specific software program used for the parcel-based loss analysis, and Ms. Herrick replied that this analysis was done by hand using a combination of GIS, County provided parcel information, aerial photos, modeled floodplains, and digital contour data.

Ms. Shedivy noted that because transportation damages and/or roadway flooding (caused by stormwater flooding events) occur frequently and can impact a number of roadways across the County, a more detailed study would have to be done to determine and map locations known or potentially impacted by heavy rain events. She added that community provided information on certain roadway location(s) known to frequently flood and/or deemed hazardous due to heavy rain will be included into the Plan if sufficient data is provided.

With no further questions or comments related to the flooding and stormwater hazard analysis, Ms. Shedivy gave a brief overview of Lake Michigan coastal hazards. She explained the different types of coastal hazards; the impacts of lake level fluctuations; Milwaukee County bluff and shoreline conditions as provided by recent studies and the Wisconsin Shoreline and Oblique Photo Viewer mapping tool; coastal flooding impacts in the County; and recent coastal hazard events. Ms. Shedivy then briefly presented the vulnerabilities and community impact assessment which was derived from a combination of sources, including the Wisconsin Shoreline and Oblique Photo Viewer (Maps 3.6, 3.7, 3.9, and 3.11), SEWRPC's Parcel-Based Analysis for structures on the Lake Michigan coastline, WEM's Coastal Erosion Risk and Vulnerability Assessment, and the Milwaukee County Coastal Resources Inventory. No questions or comments were given by the LPT for the coastal hazards.

Ms. Shedivy continued with a brief overview of the impacts of extreme temperature events. She highlighted the impacts that these events (cold and hot temperatures) can have on certain individuals and communities. She noted the number of reported deaths in Milwaukee County associated with these events. Ms. Shedivy also presented Figure 3.4, "Milwaukee County Heat Vulnerability Index" to illustrate the impacts heat can have on vulnerable populations, which occur in high concentrations within the City of Milwaukee. There were no LPT questions or comments related to extreme temperatures.

Ms. Shedivy concluded the draft Chapter 3 review by listing the remaining profiled hazards that were not presented in detail during the meeting, along with a reminder of the Plan website which contains contact information, a place to leave comments, and the HMPU material as it evolves during the drafting phase.

Following the presentation, Ms. Herrick inquired about Table 3.6, "WDNR Dam Inventory for Milwaukee County: 2023" and asked MMSD staff to confirm if dams identified as, "1," "2," and "3" or, "Milwaukee General Hospital 1, 2, and 3" are mapped and labeled correctly per WDNR sources. Ms. Coyle responded that she is not sure as to why those dams are listed as being on Honey Creek knowing there are no dams within that portion of the stream.

Ms. Coyle added that she will look into this further after the meeting and provide any additional information found for the dams in question.

ADJOURNMENT

There being no further business, Ms. Shedivy thanked the participating LPT members for their attendance and noted any additional comments on draft Chapters 1-3 will be accepted through March 22, 2024.

The meeting was adjourned at 10:57 a.m.

EMAIL CORRESPONDANCE FOLLOWING THE MEETING

After the meeting on February 20, 2024, Mr. Kressuk emailed Ms. Shedivy the two additional fire stations to list and map for the City of Oak Creek. Ms. Shedivy updated Map 2.10 and Table 2.12 to reflect this information.

Additionally, Ms. Herrick and Ms. Shedivy received an email on February 20, 2024, from Ms. Coyle related to the dams listed on Honey Creek (near Froedtert Medical College Campus). As a result of Ms. Coyle's investigation, it is believed that these three dams are not on Honey Creek but are stormwater pond dams on a small tributary to Honey Creek just south of the Medical campus. As such, Ms. Shedivy updated Table 3.6 and Map 3.1 to reflect this updated information.

MILWAUKEE CO HMP MEETING SUMMARY NOTES 02/20/2024 (00272133).DOC
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Figure A.5
Agenda and Summary Notes for Local Planning Team Meeting: February 18, 2025

Milwaukee County Emergency Management Office
Southeastern Wisconsin Regional Planning Commission

Notice of Meeting and Agenda

MILWAUKEE COUNTY HAZARD MITIGATION PLAN LOCAL PLANNING TEAM

DATE: Tuesday, February 18, 2025
TIME: 10:00 to 11:00 a.m.
PLACE: Virtual via Microsoft Teams

Join the meeting now
Meeting ID: 229 556 362 098
Passcode: po7Xz9Kq
Dial in via Phone +1 414-436-3530,4671750#

AGENDA:

1. Housekeeping/Welcome
2. Consideration of the Summary Notes of February 20, 2024, Local Planning Team meeting
3. Consideration of draft Chapter 4, *Hazard Mitigation Goals*
4. Consideration of draft Chapter 5, *Hazard Mitigation Strategies*
5. Consideration of draft Chapter 6, *Plan Adoption, Implementation, Maintenance, and Revision*
6. Discuss the Community Capability Assessment – due March 7, 2025
7. Upcoming Public Meeting March 3, 2025
8. Adjourn

Megan A. Shedivy
SEWRPC, Planner
Secretary

NOTE: A copy of the summary notes and draft chapters will be available for download from the SEWRPC website two weeks prior to the meeting at: **http://www.sewrpc.org/HMP.**

SUMMARY NOTES OF THE FEBRUARY 18, 2025 MEETING OF THE MILWAUKEE COUNTY HAZARD MITIGATION PLAN UPDATE LOCAL PLANNING TEAM

INTRODUCTION

The February 18, 2025, Local Planning Team (LPT) meeting for the Milwaukee County Hazard Mitigation Plan Update was presented online through "Microsoft Teams" beginning at 10:03 am. The Milwaukee County Office of Emergency Management (OEM) Director, Mr. Paul Riegel, gave a brief introduction and then turned the meeting over to Ms. Megan Shedivy and Ms. Laura Herrick, staff at the Southeastern Wisconsin Regional Planning Commission (SEWRPC). Attendance was digitally recorded via Teams and documented by County and SEWRPC staff.

In attendance at the meeting were the following individuals:

Local Planning Team Members

Megan Shedivy, Secretary	Planner, SEWRPC
Peter Bratt	Milwaukee County, Parks Department
Jim Case	Fire Chief, City of Wauwatosa,
Eric Cera	Chief of Police, Village of Hales Corners
Susan Coyle	Senior Project Manager, MMSD
Patrick Elliott	Senior Project Manager, MMSD
Christopher Freedy	Chief of Police, Village of Fox Point
Rhett Fugman	Chief of Police, City of Glendale
Laura Herrick	Chief Environmental Engineer, SEWRPC
Jesse Kimber	Police Sergeant, Village of River Hills
Thomas Konieczka	Fire Chief, City of Greenfield
Michael Kressuk	Fire Chief, City of Oak Creek
James Mayer	Fire Chief, City of Franklin
Natalie Meier	Milwaukee County, Office of Emergency Management
Ross Milton	Milwaukee County, Department of Transportation
Barry Mitchell	Milwaukee County, Office of Emergency Management
Andrew Mroz	Police Lieutenant, Village of Whitefish Bay
Andrew Pederson	Village Manager, Village of Bayside
Ramsey Radakovich	Operations Manager, Milwaukee County Parks
Shaundra Randolph	Chief of Police, Village of West Milwaukee
Paul Riegel	Director, Office of Emergency Management, Milwaukee County
Karyn Rittenhouse	Water Systems Superintendent, West Allis
Timothy Salamon	Milwaukee County, Office of Emergency Management
Jason Schaak	Asst. Chief, Community Risk Reduction, Fire Department, City of West Allis
Jeffrey Scherzer	Fire Captain, Village of Greendale
Romi Shahib	Risk Manager, MMSD
Sarah Toomsen	Assistant Director of Planning, Milwaukee County Parks
Mark Wroblewski	Police Department, Village of Shorewood
Ryan Zollicoffer	Director, Office of Emergency Management, City of Milwaukee

Ms. Herrick welcomed the attendees and thanked them for their participation. She went over the meeting agenda and the previous (February 20, 2024) LPT meeting summary notes. There were no significant discussions, edits, comments, or concerns during this review. Ms. Herrick then handed the meeting over to Ms. Shedivy.

CHAPTER 4 "HAZARD MITIGATION GOALS"

Ms. Shedivy began her presentation with an overview on the importance of hazard mitigation planning and past and current related efforts in Milwaukee County. She then went into a synopsis of draft Chapter 4 with how the chapter is formulated and how it fits into the planning process. Ms. Shedivy reviewed the related planning efforts and Figure 4.1, "Goals and Objectives

for the Milwaukee County Hazard Mitigation Plan Update." Figure 4.1 lists goals and the objectives for each goal. No comments or questions were given from the LPT for draft Chapter 4.

CHAPTER 5 "HAZARD MITIGATION STRATEGIES"

Ms. Shedivy continued with an overview of draft Chapter 5, "Hazard Mitigation Strategies." She noted that because this particular chapter is comprehensive in nature and to stay within the allotted presentation time, only two of the seven hazards and associated strategies will be presented during the meeting ("coastal hazards" and "flooding and stormwater drainage concerns"). Ms. Shedivy also noted the "multi-hazard" section within this chapter of the report, which included strategies that were applicable to multiple natural hazards. No questions or comments were made about the topics to be discussed during the meeting.

Ms. Shedivy next presented the hazards profiled and the chapter background and outline, including how the mitigation strategies are categorized (i.e., structural, nonstructural, and educational outreach). Ms. Shedivy also highlighted the cost-benefit analysis tables and gave Table 5.1 as an example. Mr. Zollicoffer inquired about the cost-benefit analysis tables and how SEWRPC staff ensures or documents the implementation of each hazard strategy and/or related projects from the previous plan to the current plan update. Ms. Shedivy responded that during the planning update process, which is every five years, SEWRPC staff will research and seek input from both County and community officials about recent or newly implemented hazard-related projects or plans. Ms. Herrick added that this Plan incorporates more general or major project recommendations by County or community and that the County itself is responsible for tracking hazard-related projects, including project timelines and responsible agencies/organizations for each project, and Mr. Riegel agreed with this statement. Ms. Toomsen also asked about the footnotes in the cost-benefit analysis tables related to costs. Ms. Shedivy replied that another review will be completed after the meeting to ensure the cost information and sources are correct. With no further questions or comments, Ms. Shedivy handed the meeting over to Ms. Herrick to present the flooding and stormwater mitigation strategies.

Ms. Herrick briefly explained the flooding and stormwater section including major MMSD planned flood and stormwater-related projects, and roadway flooding concerns listed in Tables 5.3 and 5.7. She specifically asked the LPT if there are any additional roadway flooding concerns that should be added to the table. No additions were provided by the LPT. Ms. Herrick also presented the cost-benefit analysis table (Table 5.10). With no questions or comments for Ms. Herrick, she then handed the meeting back to Ms. Shedivy who concluded the chapter overview with the coastal hazard mitigation strategies. No additional comments or questions were given by the LPT for draft Chapter 5.

CHAPTER 6 "PLAN ADOPTION, IMPLEMENATION, MAINTENANCE, AND REVISION"

Ms. Shedivy gave a general overview of draft Chapter 6 and its main components. She presented the plan adoption, monitoring, and implementation process, including an overview of Table 6.1, "Summary of Mitigation Measures and Funding Sources." Ms. Shedivy also stated that Table 6.1 coordinates with Appendix K, which is a list of funding sources related to mitigation projects. There were no comments or questions from the LPT for draft Chapter 6.

Ms. Shedivy added that after FEMA approves the draft Plan, the County will need to adopt the Plan before the grant ends. She noted that County communities (cities and villages) have a year after FEMA approval to also adopt the plan to remain eligible for Federal hazard mitigation funding opportunities.

DRAFT PLAN APPENDICES OVERVIEW

Ms. Shedivy continued with an overview of the Plan Appendices. She noted that certain appendices, as highlighted, will not be complete until the Plan is finalized. She also noted that Appendix J, "Communities Capabilities Assessment," is a new requirement by FEMA in which LPT members are encouraged to complete a survey before the Plan comment period is finalized and closed. Mr. Riegel added that he sent requests via email to the LPT members prior to the meeting in which he received only a few responses in return. As such, he plans on sending out another reminder to the LPT members to participate in the Community Capabilities Assessment survey.

With no further questions or comments, Ms. Shedivy concluded the draft chapters 4-6 plan review presentation. She added that the draft plan text and meeting material is available on the SEWRPC website (www.sewrpc.org/hmp) with a comment

Figure A.5 (Continued)

screen and also provided her contact information (mshedivy@sewrpc.org) for any additional comments. Additional comments on the draft plan will be accepted until March 7, 2025.

ADJOURNMENT

There being no further business, the final Milwaukee County Hazard Mitigation Plan update LPT meeting was adjourned at 10:54 a.m.

MILWAUKEE CO HMPU LPT MEETING DRAFT CHAPTERS 4-6REVIEW-SUMMARY NOTESDOC
500-1151
MAS/LKH

Figure A.6
Notice Materials for Public Meetings

JOIN US!

at a public meeting for the 2025-2030 Update of the Milwaukee County Hazard Mitigation Plan

Wednesday, February 21, 2024
4:00 p.m. to 5:00 p.m.
Fox Point Police Department
Meeting Room
7300 N. Santa Monica Boulevard
Fox Point, WI 53217

Public Meeting Information

- Review draft plan, including: background/ introduction of the plan, study area inventory and analysis, and analysis of hazard conditions
- Open discussion to answer questions and take comments on plan update
- Visit **www.sewrpc.org/hmp** to view draft plan chapters and provide written feedback. Written comments may be provided through March 5, 2024

The Milwaukee County Hazard Mitigation Plan identifies areas of risk, assesses the magnitude of the risk, and develops strategies for reducing the risk natural hazards pose throughout the County. Completion and approval of the plan will maintain the eligibility of Milwaukee County and its communities to apply for FEMA disaster relief and mitigation project funds to implement mitigation strategies.

Figure A.6 (Continued)

Milwaukee County Hazard Mitigation Plan Update: Second Public Meeting Announcement

The 2025 Milwaukee County Hazard Mitigation Plan Update

Hazard Mitigation Planning Helps Prevent Future Damages, Promotes Disaster-Resilient Communities, and Reduces Response and Recovery Resource Requirements.

Public Meeting Announcement:

Citizens are welcome to attend an informational meeting on the third edition of the Milwaukee County hazard mitigation plan. Attending this meeting will provide residents with the opportunity to learn about hazard mitigation planning, why it is important, and to be able to ask questions and/or comments on the draft plan.

Meeting Time and Location:

- Monday, March 3, 2025
- 3:30-4:30 pm
- WDNR Office Building Located in Downtown Milwaukee at 1027 West St. Paul Avenue

The Plan:

The Southeastern Wisconsin Regional Planning Commission (SEWRPC) is assisting Milwaukee County on an updated version of their hazard mitigation plan. The plan includes a vulnerability analysis and risk assessment for potential impacts to the County and its assets from extreme/hazardous weather events. Such events include flooding, tornadoes, extreme temperature events, coastal hazards, winter storms, and drought. Based on the evaluated risks and potential impacts, the plan details hazard mitigation alternatives, priority measures, funding and programming resources, and the costs and benefits of the recommended priority mitigation measures.

It should be noted that this planning effort (i.e., hazard mitigation) is *required* by FEMA in order for local governments, such as Milwaukee County and its communities to receive Federal funding for mitigation projects.

#276373

PLAN ADOPTION FOR THE 2025 MILWAUKEE COUNTY HAZARD MITIGATION PLAN UPDATE

APPENDIX B

Milwaukee County

Signature Copy

Action Report: 25-440

File Number: 25-440

Office of Emergency Management request designation of the 2025 Milwaukee County Hazard Mitigation Plan as the official Hazard Mitigation Plan for the County of Milwaukee

The attached resolution or ordinance was adopted by the Milwaukee County Board of Supervisors on 7/24/2025 by the following vote: passed

Ayes: 16 Alexander, Bielinski, Capriolo, Eckblad, Gómez-Tom, Johnson Jr., Logsdon, Martin, Martinez, O'Connor, Rolland, Shea, Taylor (17), Vincent, Wasserman, and Nicholson

Excused: 2 Coggs-Jones, and Taylor (5)

Certification to County Board Passage Marcelia Nicholson — **Date** JUL 24 2025

Certification of County Board Passage George Christenson — **Date** JUL 24 2025

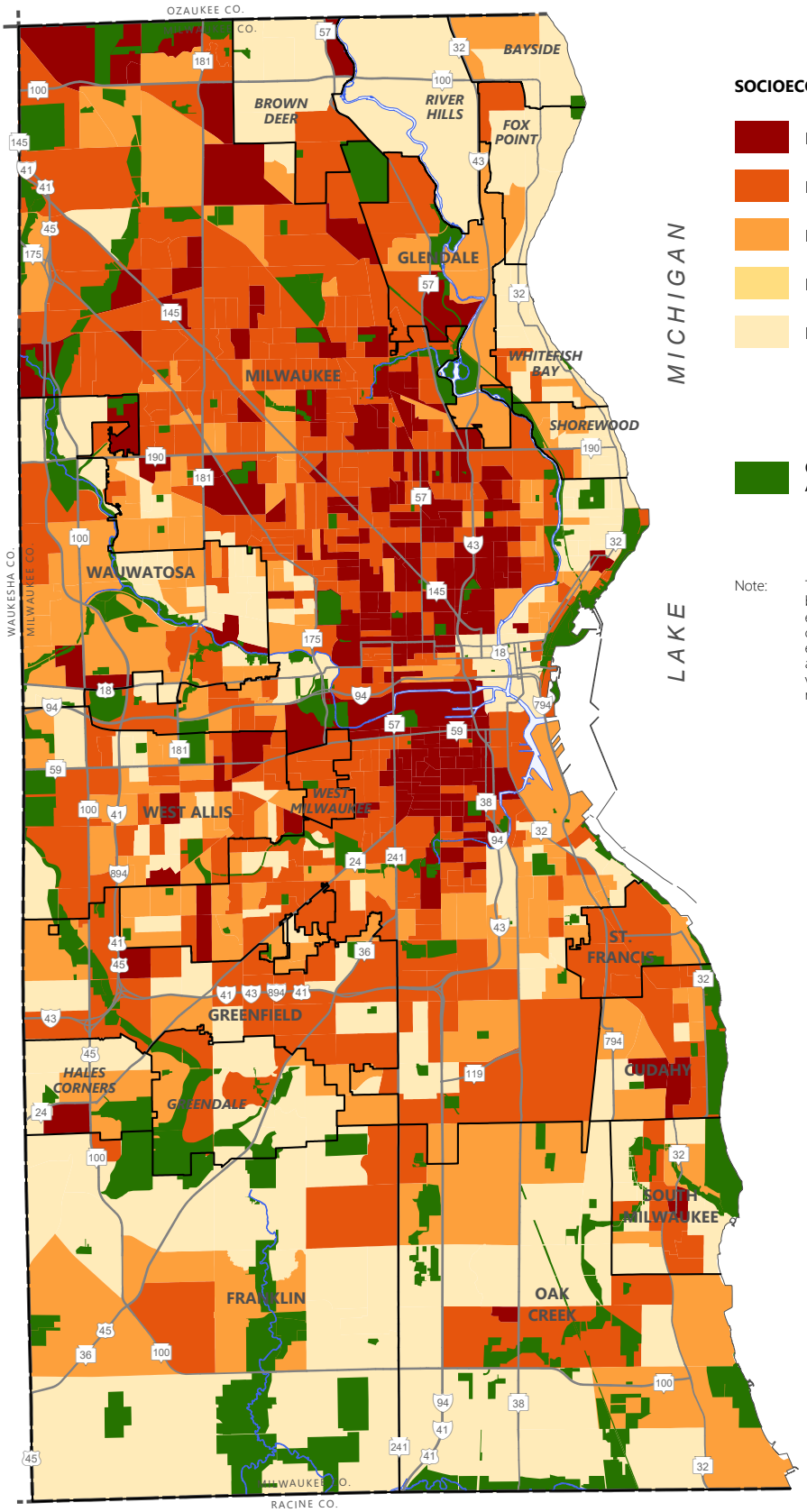
I approve the attached resolution or ordinance. David Crowley — **Date** JUL 31 2025 JUL 30 2025

Received by County Clerk's Office George Christenson — **Date** AUG 01 2025

MILWAUKEE COUNTY OEM DEMOGRAPHIC CHARACTERISITCS MAPPING FOR MILWAUKEE COUNTY

APPENDIX C

Map C.1
Milwaukee County Socioeconomic Factors: 2014



SOCIOECONOMIC FACTORS

- HIGH
- MODERATE HIGH
- MODERATE
- MODERATE LOW
- LOW

- COUNTY-OWNED PARK AND OPEN SPACE SITES

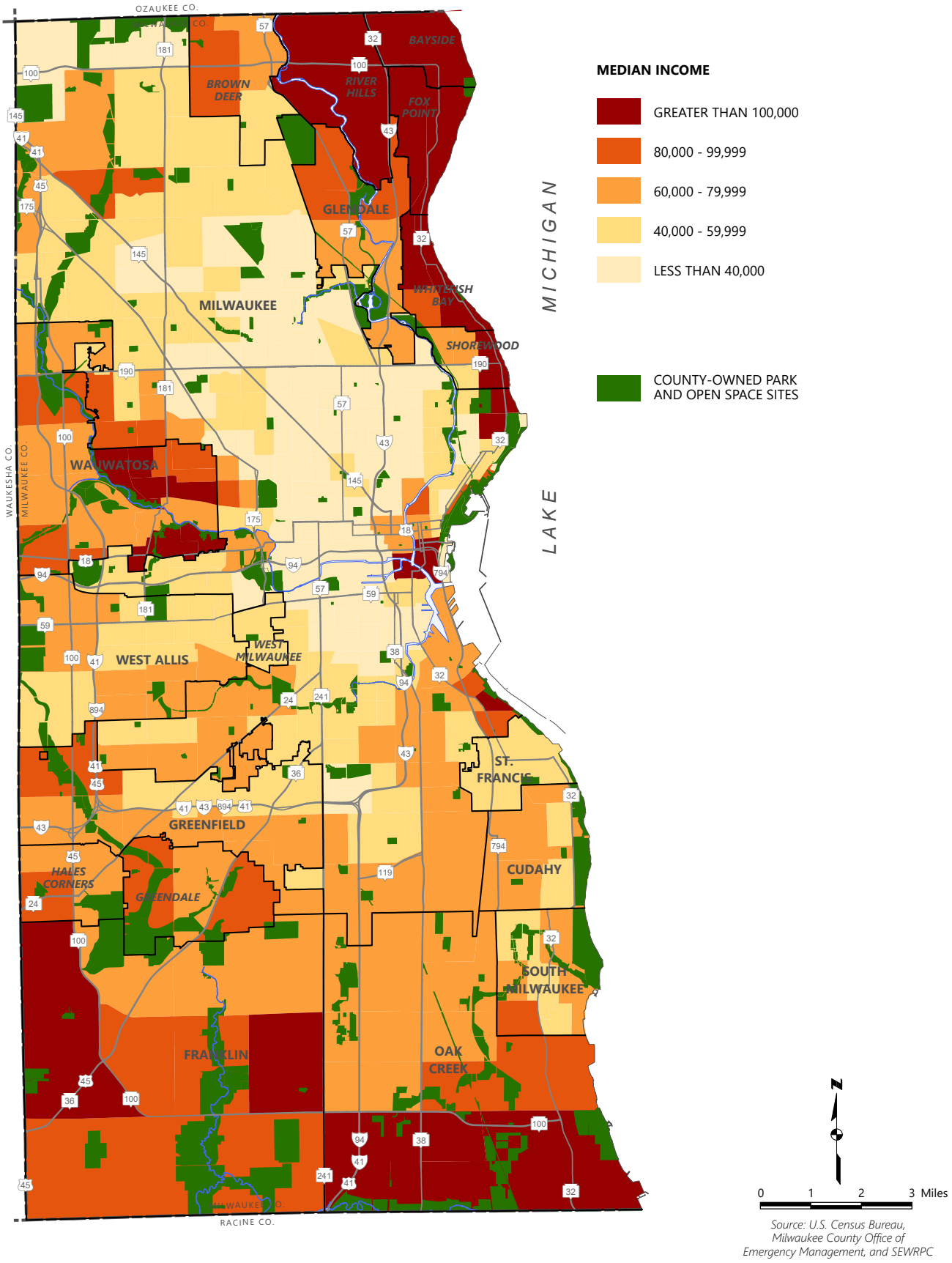
Note: The Socioeconomic Factor was calculated for each census block in the County. Based on the Socioeconomic Factor, each census block was placed in one of five vulnerability categories based on the level of vulnerability indicated, with each category consisting of 20 percent of the census blocks analyzed. It is important to note that the levels of vulnerability shown by the Socioeconomic Factor indicate relative levels of risk and do not indicate absolute risks.

N

0 1 2 3 Miles

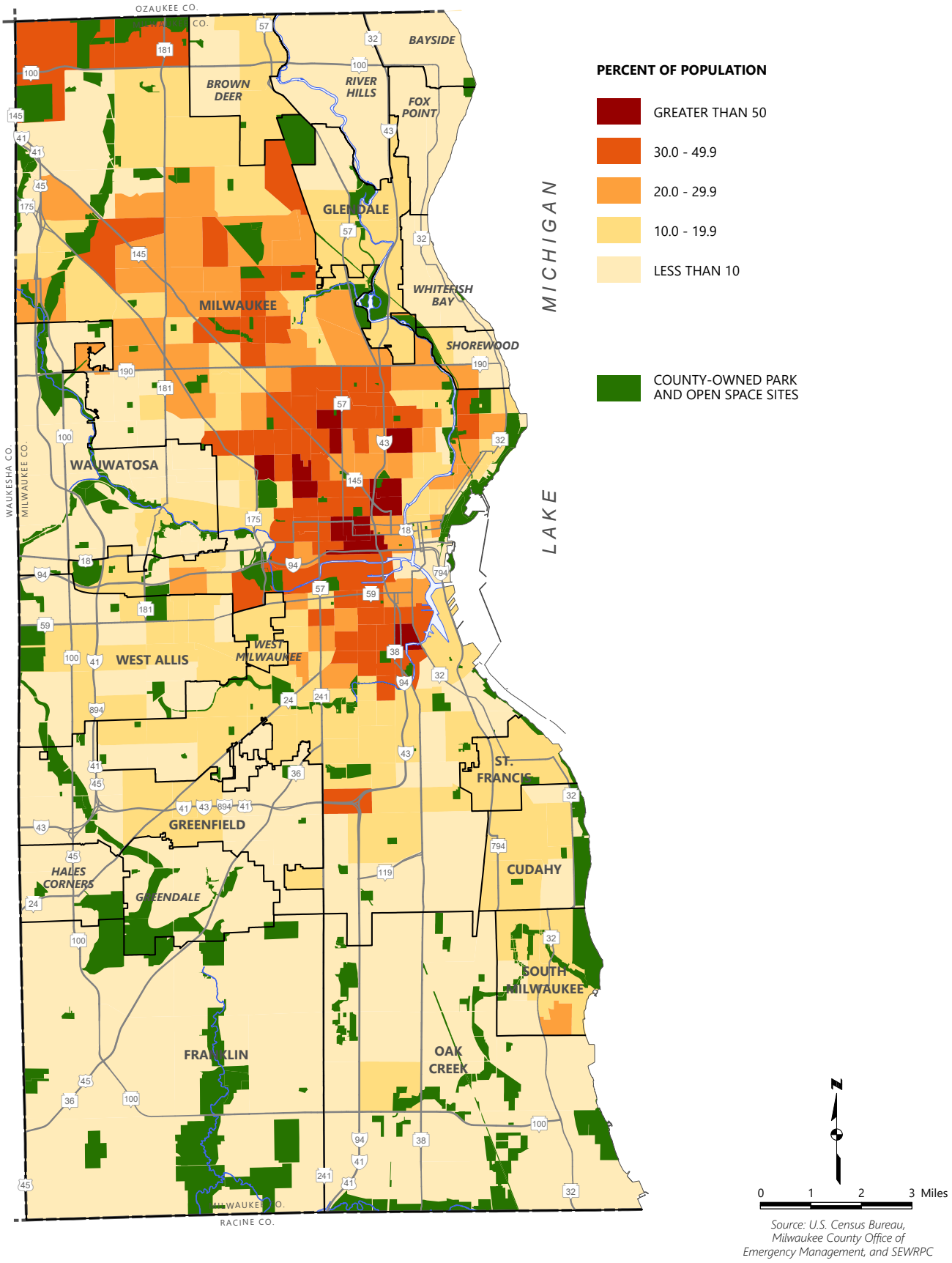
Source: Wisconsin Department of Health Services and SEWRPC

Map C.2
Milwaukee County Medium Income: 2023



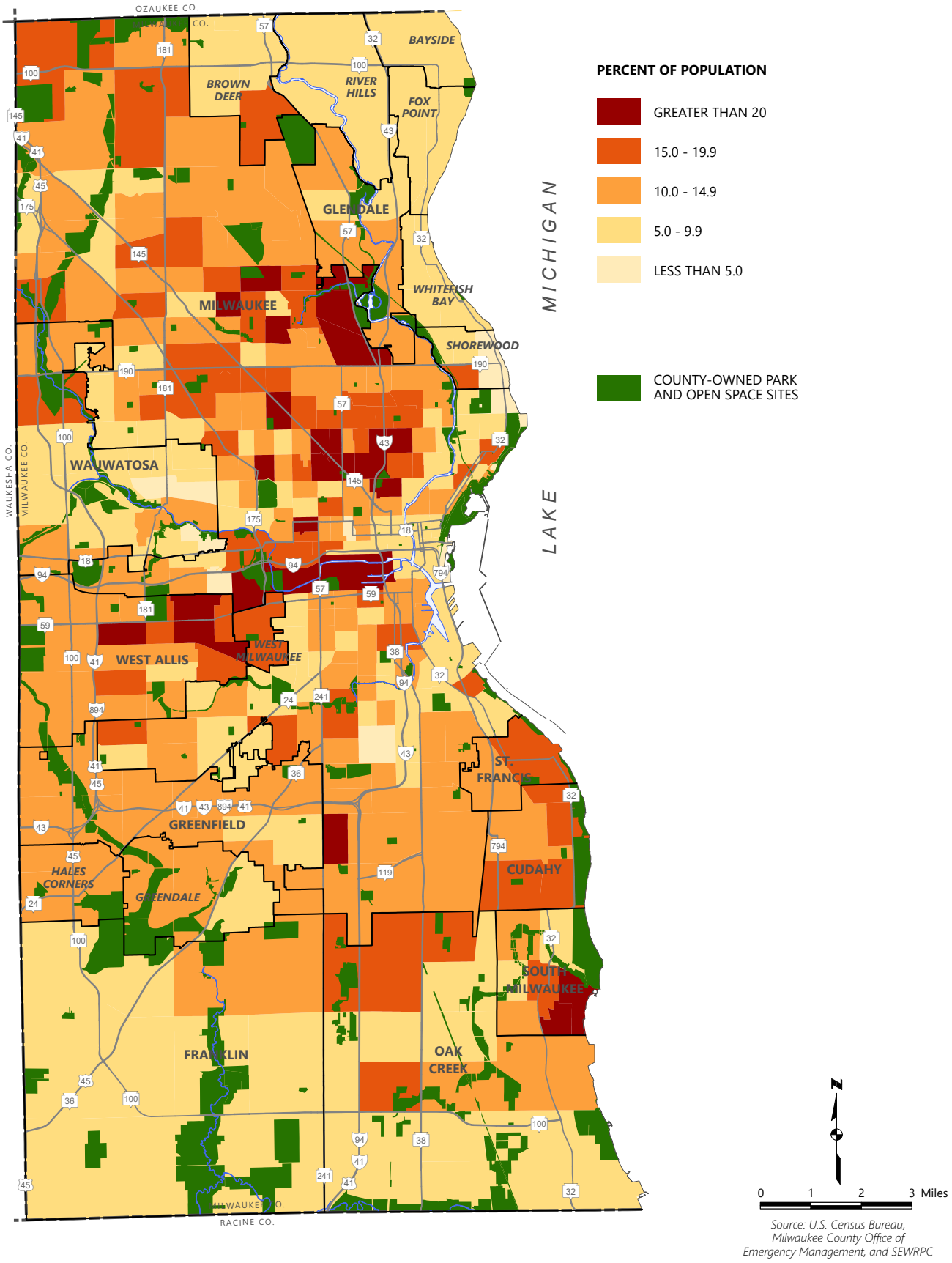
Source: U.S. Census Bureau, Milwaukee County Office of Emergency Management, and SEWRPC

Map C.3
Milwaukee County Percent of Population with a Below Poverty Income: 2023



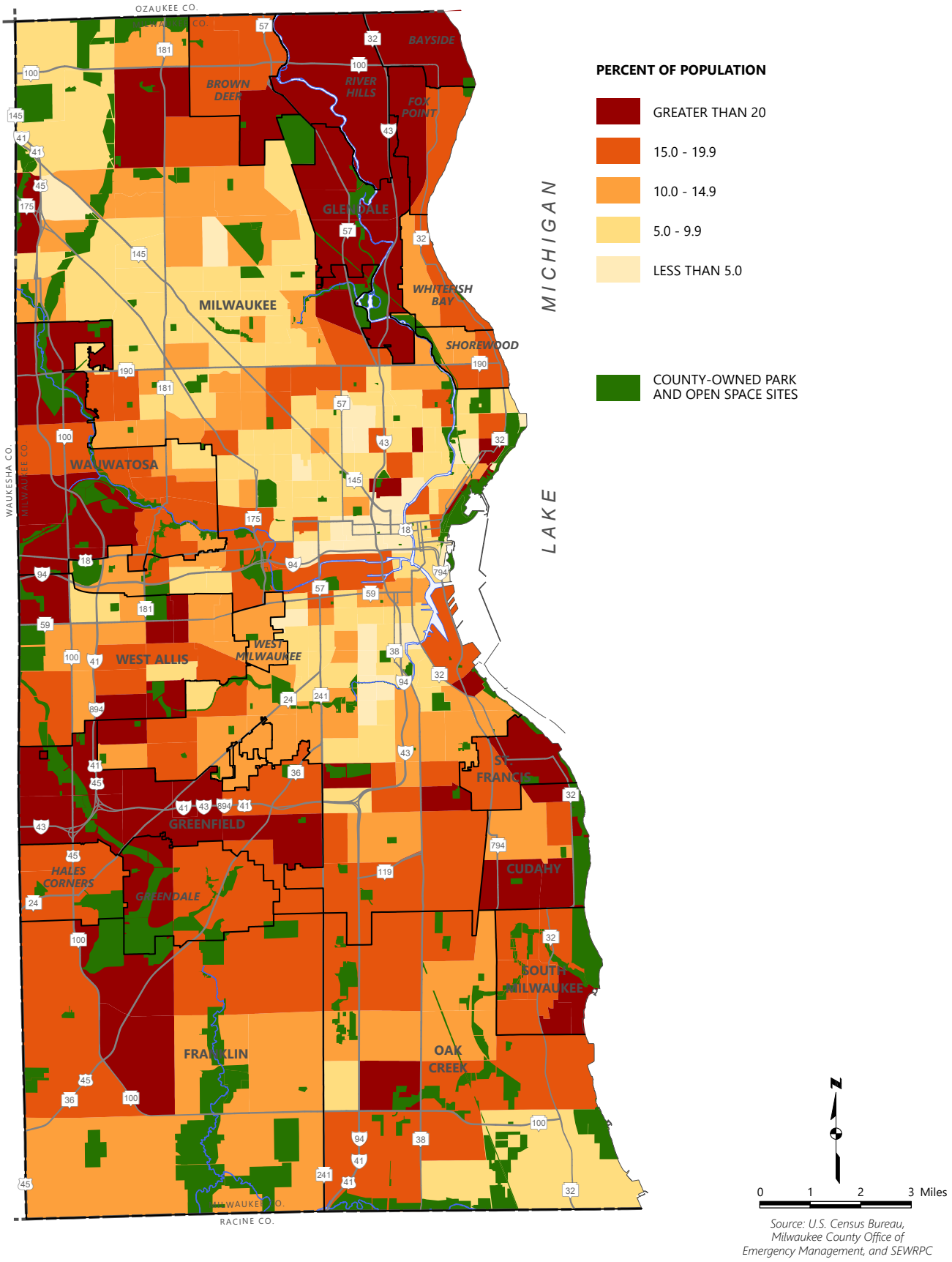
Source: U.S. Census Bureau, Milwaukee County Office of Emergency Management, and SEWRPC

Map C.4
Milwaukee County Percent of Population with a Disability: 2023



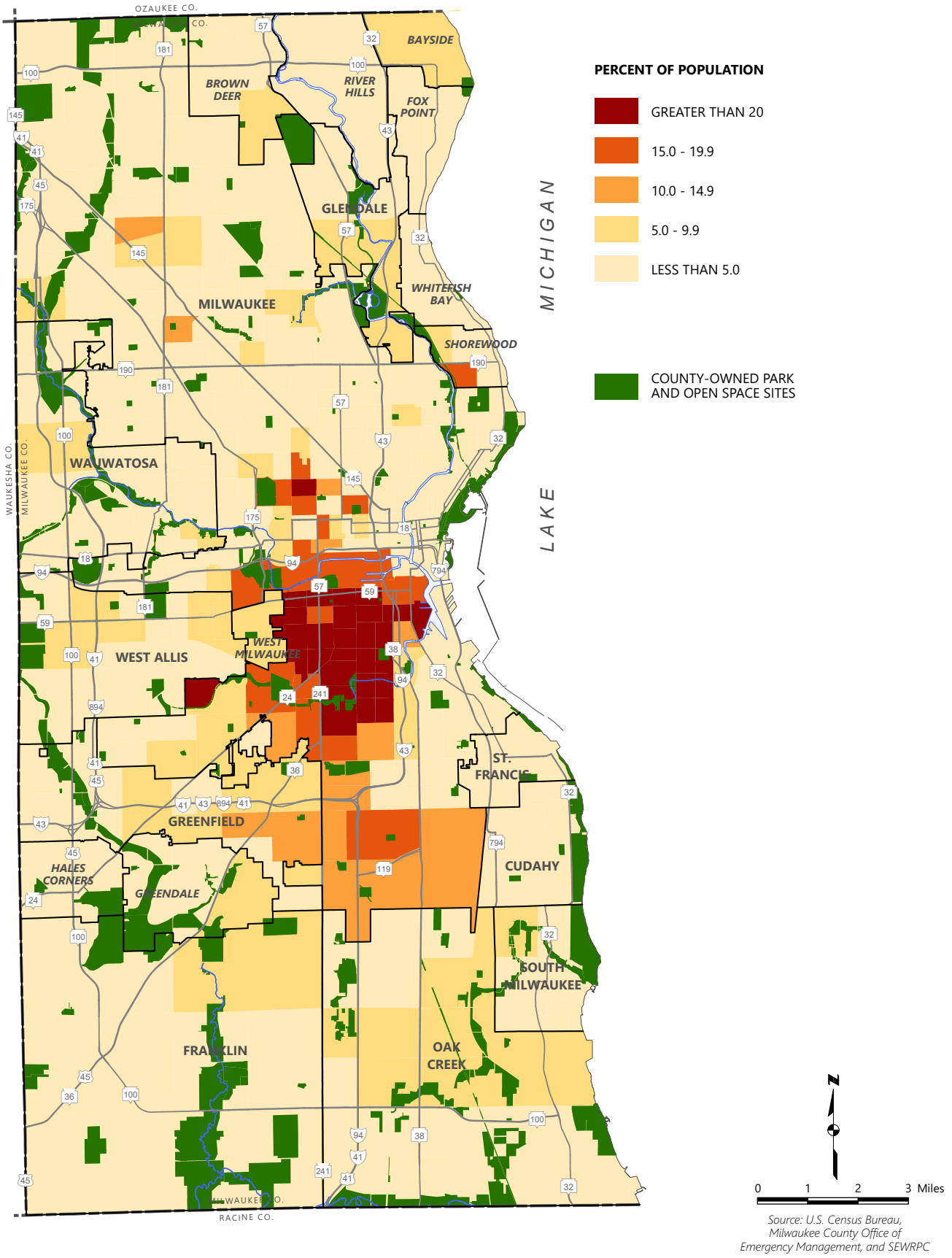
Source: U.S. Census Bureau, Milwaukee County Office of Emergency Management, and SEWRPC

Map C.5
Milwaukee County Percent of Population that are Elderly: 2023



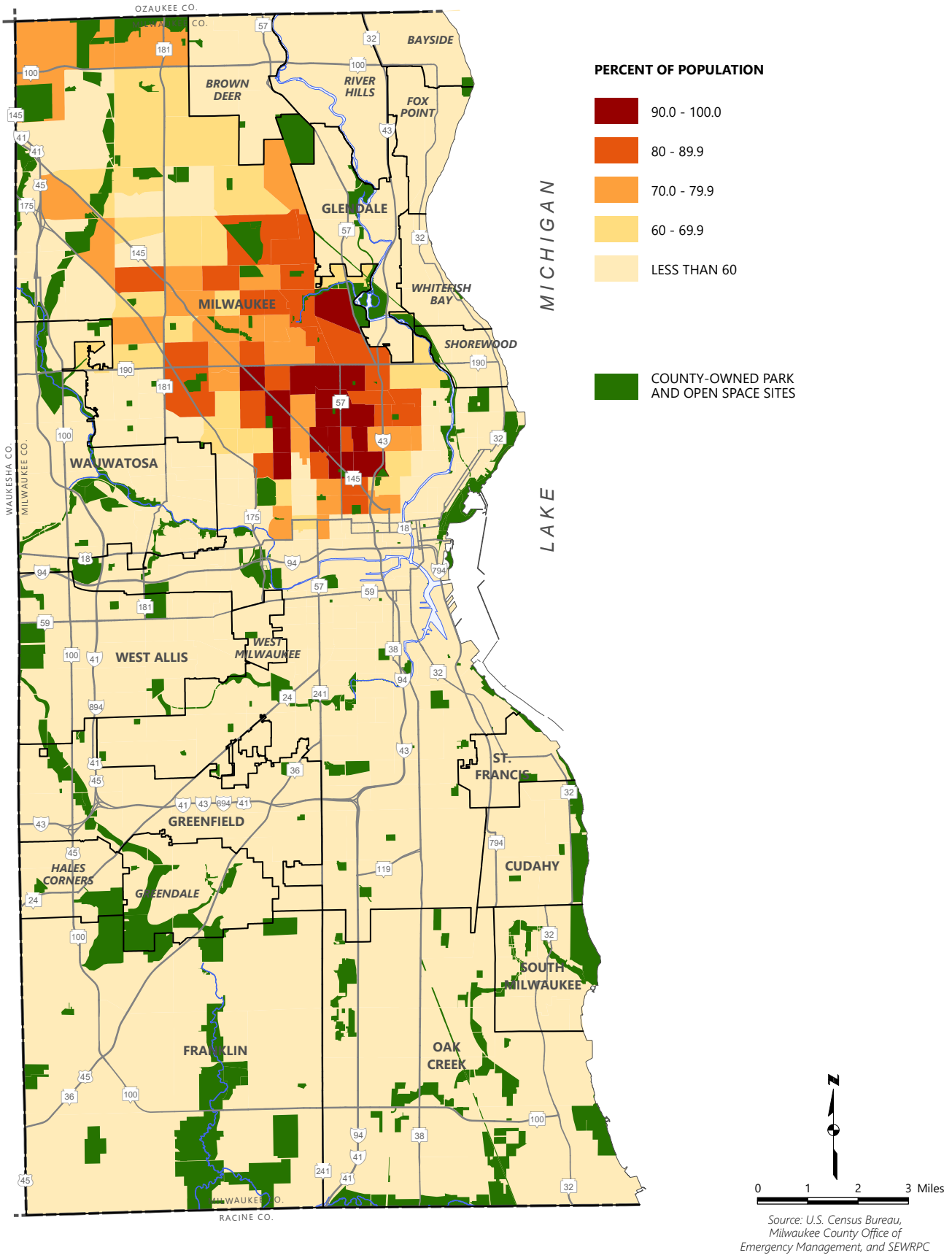
Source: U.S. Census Bureau, Milwaukee County Office of Emergency Management, and SEWRPC

Map C.6
Milwaukee County Percent of Population that Speaks English Less Than Well: 2023



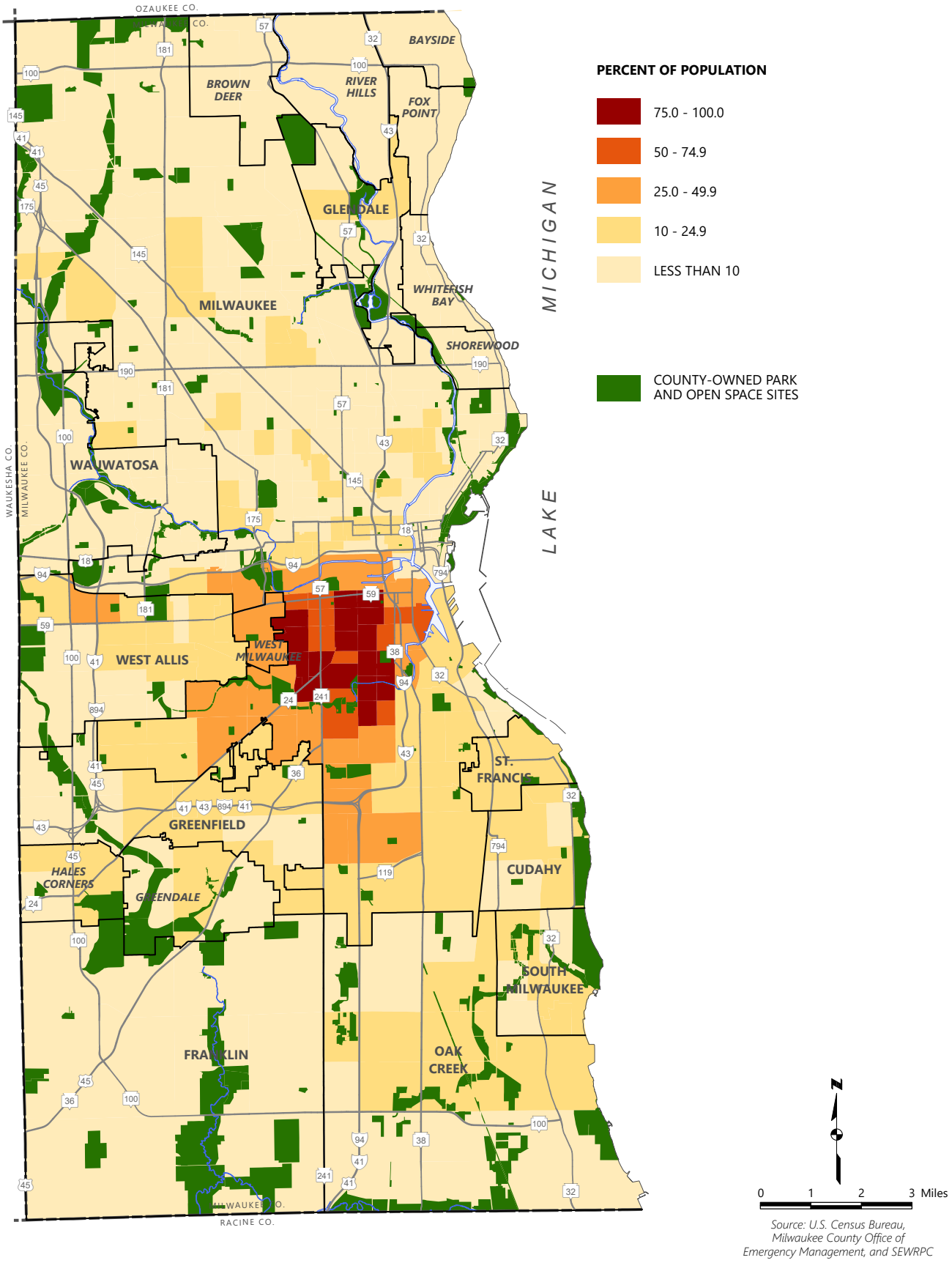
Source: U.S. Census Bureau, Milwaukee County Office of Emergency Management, and SEWRPC

Map C.7
Milwaukee County Percent of Population that are of African Decent: 2023



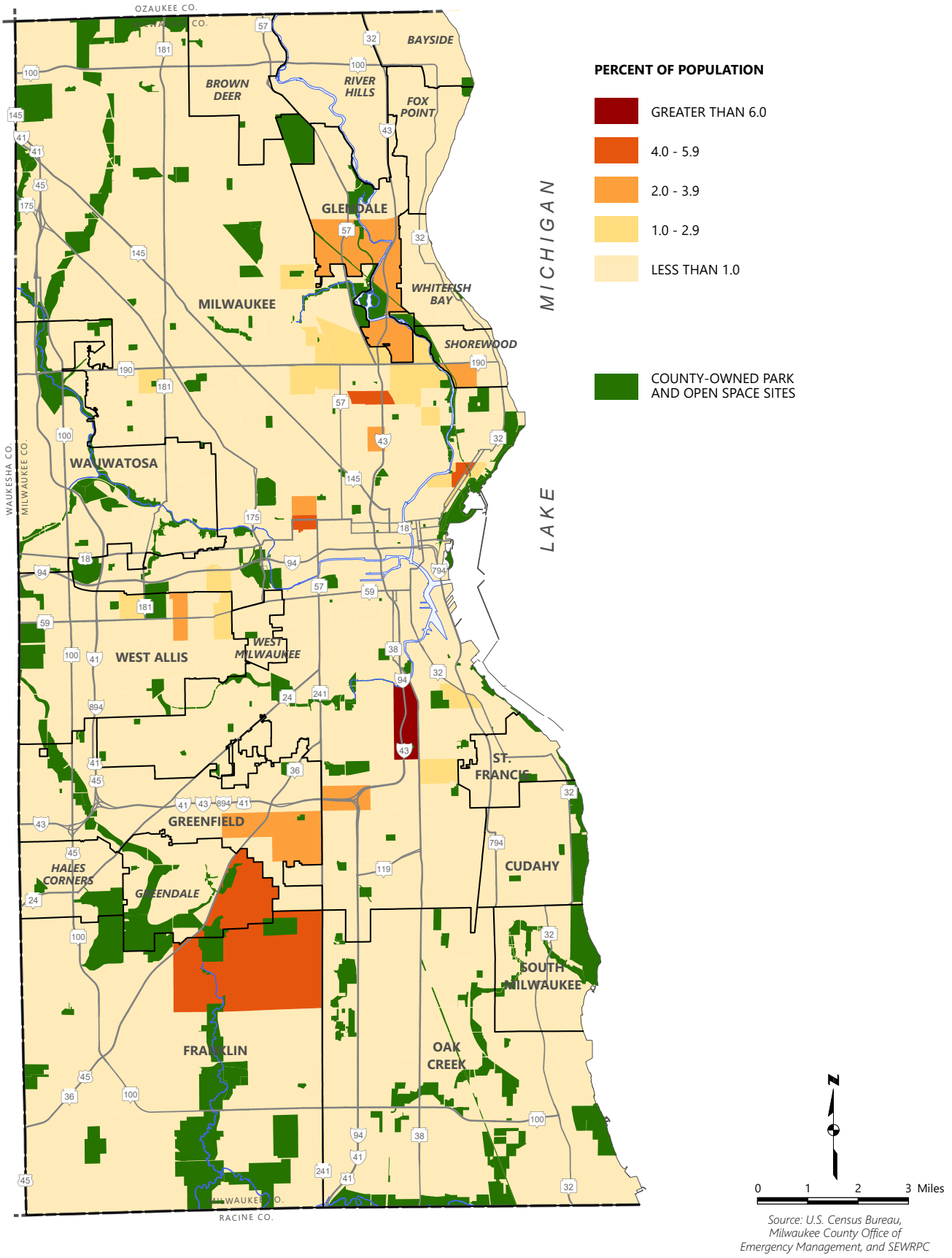
Source: U.S. Census Bureau, Milwaukee County Office of Emergency Management, and SEWRPC

Map C.8
Milwaukee County Percent of Population that are of Hispanic/Latino Decent: 2023



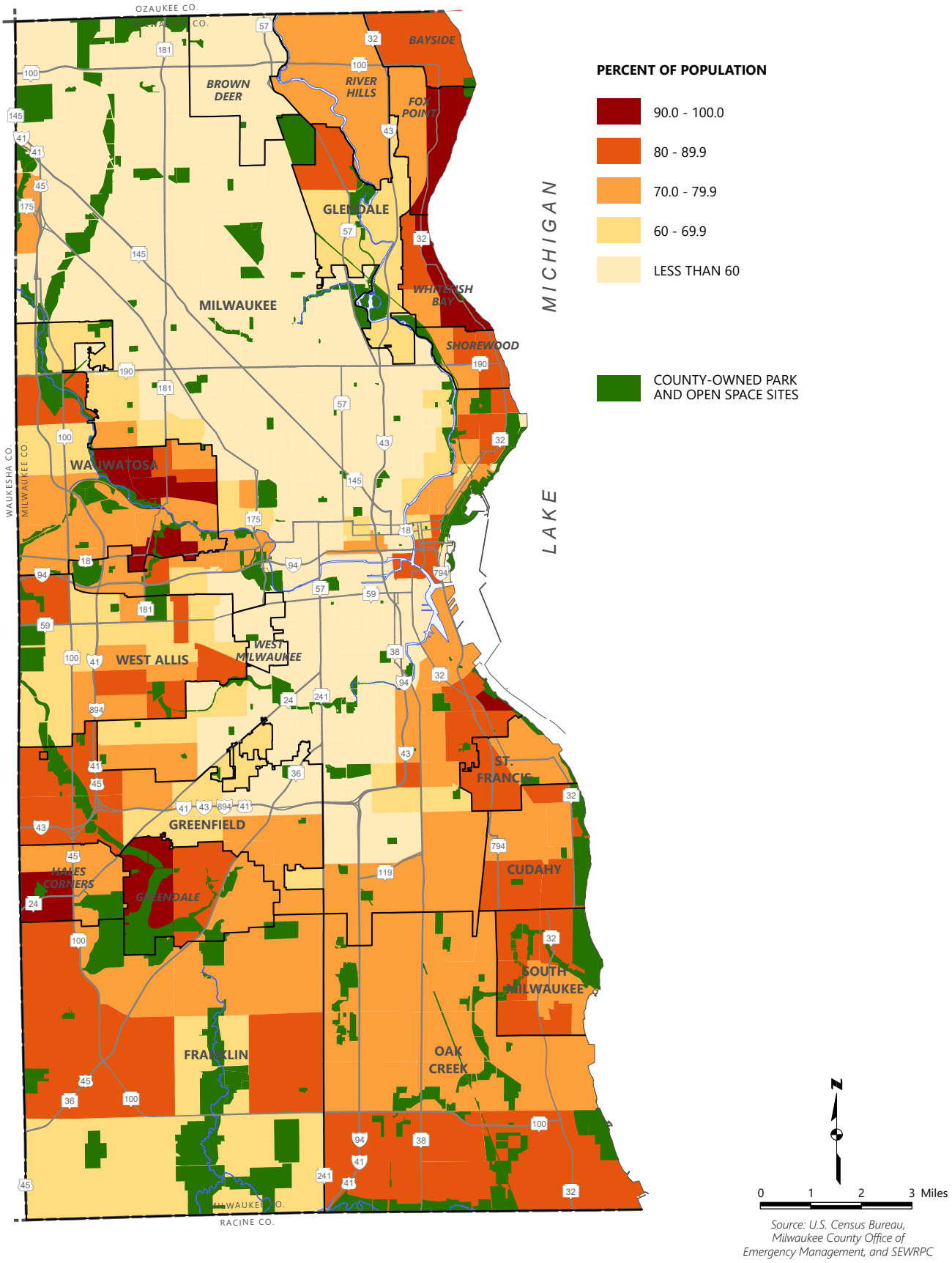
Source: U.S. Census Bureau, Milwaukee County Office of Emergency Management, and SEWRPC

Map C.9
Milwaukee County Percent of Population that are of Other Racial Decent: 2023



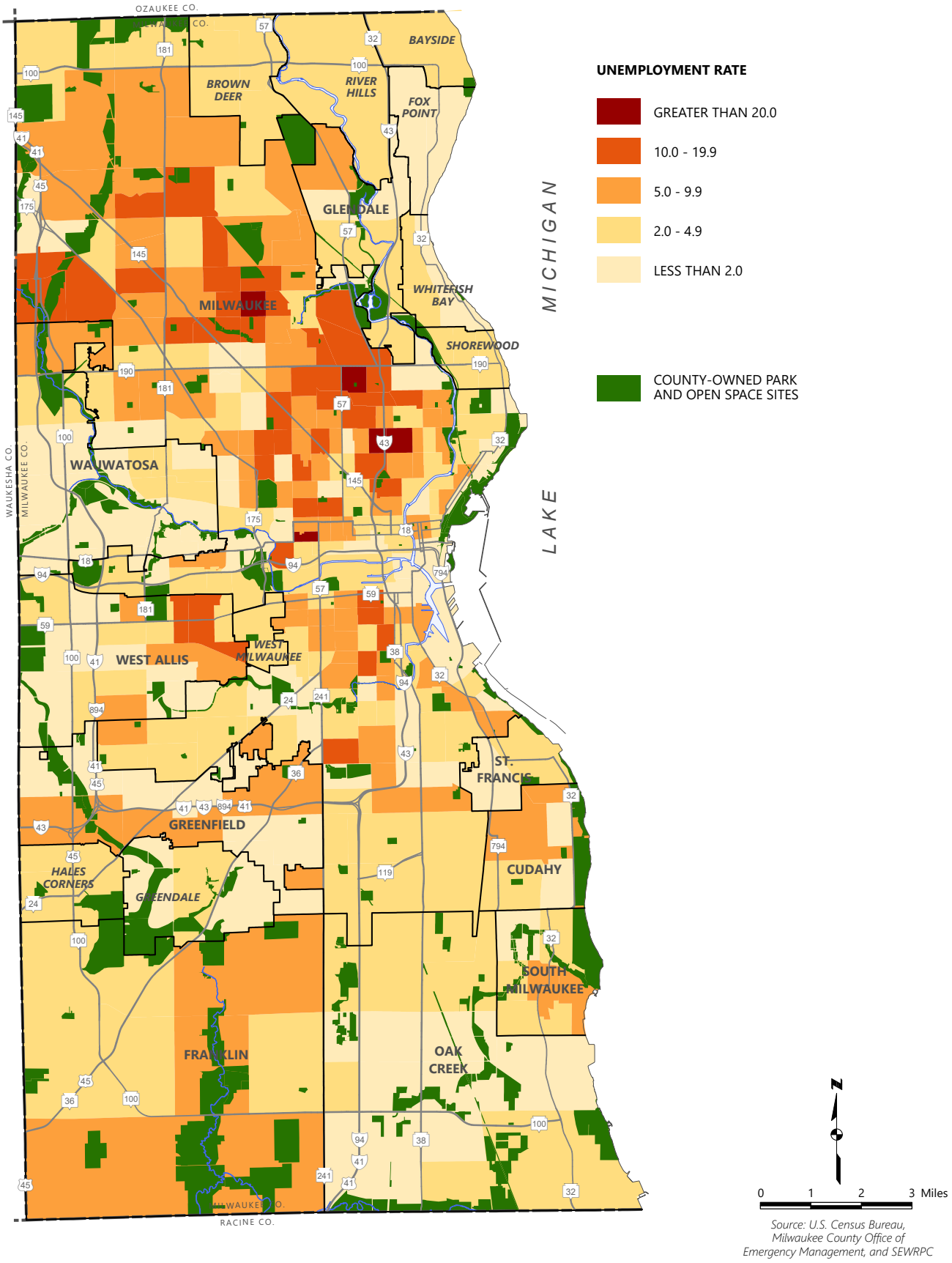
Source: U.S. Census Bureau, Milwaukee County Office of Emergency Management, and SEWRPC

Map C.10
Milwaukee County Percent of Population that are of Northern European Decent: 2023



Source: U.S. Census Bureau, Milwaukee County Office of Emergency Management, and SEWRPC

Map C.11
Milwaukee County Unemployment Rate Ages 20 to 64: 2023



Source: U.S. Census Bureau, Milwaukee County Office of Emergency Management, and SEWRPC

ALERT NOTIFICATION SYSTEMS AND FUNCTIONS

APPENDIX D

Alerts in emergency warning systems are notifications or signals designed to inform individuals or communities about imminent or ongoing emergencies. These alert systems serve to provide critical information swiftly, helping people take necessary actions to protect themselves and their property. Alerts can be delivered through various channels, including sirens, text messages, phone calls, social media, radio broadcasts, television announcements, and dedicated mobile applications.

Emergency alerts typically convey vital information such as the type of emergency, its severity, affected areas, recommended actions, and evacuation instructions if necessary. They may also include updates on the evolving situation and guidance on how to stay safe.

There are different types of alerts tailored to specific emergency scenarios, including:

- **Weather alerts:** These warn about severe weather events such as hurricanes, tornadoes, floods, or blizzards
- **Public safety alerts:** These cover a range of emergencies, including hazardous material spills, terrorist threats, active shooter situations, or public health crises
- **Natural disaster alerts:** These inform about earthquakes, tsunamis, wildfires, and other natural disasters
- **Amber alerts:** These are specifically for child abduction cases, notifying the public to be on the lookout for a missing child

Effective emergency alert systems are characterized by their speed, accuracy, and accessibility. They rely on advanced technology and coordinated efforts among various agencies and organizations to ensure timely and reliable dissemination of information, ultimately helping to save lives and minimize the impact of emergencies.

THE FEDERAL COMMUNICATIONS COMMISSION (FCC)

The FCC, in conjunction with the Federal Emergency Management Agency (FEMA) and the National Oceanic and Atmospheric Administration's (NOAA) National Weather Service (NWS), implements the Emergency Alert System (EAS) at the federal level. The President has sole responsibility for determining when the EAS will be activated at the national level and has delegated this authority to the Director of FEMA. The EAS provides an official means for supplying emergency information to the public. Local radio and television broadcast stations participate in EAS based upon a contractual agreement between the station and the FCC.

EMERGENCY ALERT SYSTEM (EAS)

- **Purpose:** The system that alerts the public through television and radio broadcasts about dangerous weather, missing children, or other threats
- **Functionality:** Broadcasts emergency alerts through radio and television stations
- **Examples:** Used for AMBER Alerts and severe weather warnings

WIRELESS EMERGENCY ALERTS (WEA)

- **Purpose:** Enables authorized agencies to send text-like messages to consumers with capable wireless devices, alerting them to emergencies in their area
- **Functionality:** Alerts are geographically targeted, so only those in the threat area receive the message

- **Examples:**
    - **"Imminent Threat"** alerts involving imminent threats to safety or life
    - **"AMBER Alerts"** about missing children
    - **"Public Safety Messages"** conveying recommendations for saving lives and property

Milwaukee County OEM is the only Wireless Emergency Alert (WEA) authorized agency in Milwaukee County. WEA messages are text message warnings, similar to AMBER alerts, sent to alert citizens who may be in harm's way without the need to subscribe to a specialized app or platform.

NATIONAL OCEANIC ATMOSPHERIC ADMINISTRATION (NOAA) WEATHER RADIOS

- **Purpose:** An "all hazards" warning system transmitting official National Weather Service warnings, watches, and forecasts
- **Functionality**: Operates 24/7, providing continuous weather and hazard information
- **Examples:** Used to alert people about natural disasters, environmental hazards, and public safety incidents
- **Additional Functionality:** Some models have AM/FM receivers and can be set to alarm by specific area and/or warning type
- Authentication and Issuance:
    - NWS authenticates by calling back and confirming message with the designated official or dispatch
    - NWS enters and sends out the message, activates EAS and broadcasts message over NOAA weather radio
    - Broadcasters receive message from NWS and can automatically broadcast the message over the radio and television networks, even those that are unattended
    - NOAA weather radios automatically alarm

NATIONAL WARNING SYSTEM (NAWAS)

NAWAS is a nationwide *private telephone* communications system funded by the Federal Emergency Management Agency (FEMA). It operates on three levels of government: Federal, State and Local. The system has network nodes located at strategic locations in each state. States, in turn, coordinate a system connecting system nodes in various counties. The primary warning point for Milwaukee County is the Wisconsin State Patrol and is monitored on a 24-hour basis.

SKYWARN

Project SkyWarn is a national program designed to place personnel in the field to spot and track severe weather and Milwaukee County participates in the program. These field personnel are trained by the National Weather Service in basic severe weather meteorology, and in how and what to report to the proper officials. During periods of severe weather, the spotters are dispatched to the field and relay reports to the NWS or the EOC. If the EOC is activated, it disseminates the appropriate warning.

OPENSKY RADIO COMMUNICATION

Used by the City of Milwaukee, OpenSky (trademark of Harris Corporation) is a wireless communication system. OpenSky technology uses Time Division Multiple Access (TDMA) technology in 25kHz bandwidth channels. TDMA enables multiple users to share the same frequency by dividing each cellular channel into different time slots.

SCHOOL WARNING SYSTEM

Some schools in Milwaukee County maintain NOAA weather radios. It is strongly encouraged that all schools within the County purchase and maintain a NOAA weather alert radio.

FLOOD WARNING SYSTEM

The NWS has a network of rain and river gauges strategically placed on regional rivers as a means to collect data for flood warning purposes. These gauges have automatic alarms that warn officials of threatening flood conditions.

NEIGHBORHOOD WARNING PROCEDURES

In some instances, additional warning must be provided to certain areas. Methods used include, but not limited to, vehicle mounted public address and door-to-door warning. Law enforcement and fire service vehicles, which are equipped with sirens and/or public address systems, will augment fixed warning devices.

AMATEUR RADIO NETWORK (ARES/RACES)

This network provides a means to disseminate emergency public protection messages to various local and statewide amateur users and groups. This system provides a vital radio communication link between the EOC and local governments throughout the state.

INTEGRATED PUBLIC ALERT WARNING SYSTEM (IPAWS)

IPAWS is a public notification system intended to alert residents to emergency weather, road closings, public safety advisories, and natural or man-made disasters through mobile telephone text messaging. The authorized administrators are Law Enforcement and the Office of Emergency Management.

EMERGENCY PREPAREDNESS NOTIFICATION SYSTEM (EPNS)

EPNS is operated by Intrado, a corporation that provides 911 operations support system services to incumbent local exchange carriers, competitive local exchange carriers and wireless carriers. The EPNS system is activated via web interface or by calling their emergency call relay center. EPNS calls the phone lines identified in the 911 database within a specified geographic area. EPNS is also capable of utilizing pre-loaded calling lists.

511 SYSTEM

The Wisconsin Department of Transportation operates a traveler advisory system accessible by calling 511. The system can be used to advise motorists on state highways of travel related information or warnings.

OASIS INTERGOVERNMENTAL RADIO SYSTEM

OASIS is a P25 digital, simulcast, trunked, 800MHz public safety radio system covering both Waukesha and Milwaukee Counties. Each county has deployed radio towers and infrastructure equipment (e.g., transmitters, dispatch consoles) within their boundaries. Within Milwaukee County (excluding the City of Milwaukee), the OASIS Intergovernmental Agreement (IGA) defines the responsibilities of the County (through OEM) as a system operator and those responsibilities of the user agencies as subscribers. OASIS's Milwaukee County subsystem serves 70 agencies, shown below. Mutual aid use continues to be extended to select non-governmental organizations that provide support to emergency-response efforts, and it is also extended to public safety agencies in neighboring counties to enable them to communicate, when necessary, with agencies in Milwaukee County.

THE OEM 911 COMMUNICATION DIVISION

This Division serves as the Public Safety Answering Point (PSAP) for Milwaukee County. Milwaukee County OEM provides cellular 911 call-taking services for West Allis, West Milwaukee, Wauwatosa, South Milwaukee, Greenfield, Cudahy, Greendale, and occasionally from other PSAPs within Milwaukee County.

SYSTEMS TESTING

Components of the warning system are tested on a regular basis, some daily, weekly, or monthly.

Source: FEMA and Milwaukee County Emergency Management, Comprehensive Emergency Management Plan, *2021*

A MESSAGE FROM

MILWAUKEE COUNTY

EMERGENCY MANAGEMENT

TORNADO ALERT PROCEDURES

- **TORNADO WATCH –** Conditions exist for the possible formation of a tornado.

- **TORNADO WARNING –** High possibility of tornado formation exists or a tornado has been sighted. When a tornado warning is issued, the *COUNTY OUTDOOR WARNING SIREN SYSTEM* will be activated, sounding a *STEADY WARNING TONE FOR 3 MINUTES.*

- **WHEN OUTDOOR WARNING SIRENS ARE SOUNDED** – *Be prepared to seek shelter and take cover.* Tune to local *TV* or *radio stations* for detailed information. *Do not call* local law enforcement or the Emergency Management Office <u>except</u> to report the *sighting* of a funnel cloud. Emergency Management's 24-hour phone number is 414-525-5770.

- **IF A TORNADO APPROACHES** – Seek shelter in the basement or an interior room on the lowest level of your home. Stay away from windows and exterior doors.

- **AT WORK, SCHOOLS, SHOPPING MALLS OR CENTERS, AND OTHER FACILITIES** – Follow the emergency plans or instructions provided. Move quickly to shelter areas. The best shelter area is usually an interior hallway on the lowest level.

- **ABOVE ALL** – Remain calm and do not panic. Panic often leads to unnecessary injury.

NOTE: The Milwaukee County Outdoor Warning Siren System is tested at 12-Noon on the second Wednesday of each month. The test will not be conducted if weather conditions are threatening. The sirens are designed to warn people that are outdoors in open areas. <u>The sirens are not designed to be heard inside of homes or buildings.</u> Stay alert during severe weather watches and warnings. Follow the procedures described above and you can avoid potential danger and reduce the risk of injury to you and your family.

KEEP OR POST THIS NOTICE IN A CONVENIENT LOCATION

05-2013

CRITICAL COMMUNITY FACILITIES, PARK AND OPEN SITES, AND COASTAL HISTORIC SITES AND DISTRICTS WITHIN MILWAUKEE COUNTY

APPENDIX E

Table E.1
Selected Critical Community Facilities Within the Milwaukee County Planning Area: 2023

Name	Community	Address
Public Works Facilities		
Bayside Public Works	Bayside	9075 N. Regent Road
Brown Deer Public Works Municipal Complex	Brown Deer	8950 N. Arbon Drive
Cudahy Public Works Department	Cudahy	3555 E. Pabst Avenue
Franklin Public Works Department	Franklin	7979 W. Ryan Road
City of Glendale Department of Public Works	Glendale	5930 N. Glen Park Road
Greendale Public Works	Greendale	6351 Industrial Loop
City of Greenfield Public Works Department	Greenfield	4551 S. 52nd Street
Hales Corners Public Works	Hales Corners	5635 S. New Berlin Road
City of Milwaukee Department of Public Works	Milwaukee	841 N. Broadway
Oak Creek Public Works	Oak Creek	800 W. Puetz Road
River Hills Public Works	River Hills	7650 N. Pheasant Lane
Shorewood Public Works Department	Shorewood	3801 N. Morris Boulevard
South Milwaukee Street Department	South Milwaukee	910 Marshall Avenue
St. Francis Civic Center	St. Francis	3400 E. Howard Avenue
Wauwatosa Public Works	Wauwatosa	11100 W. Walnut Road
West Allis Department of Public Works	West Allis	6300 W. McGeoch Avenue
West Milwaukee Public Works	West Milwaukee	4517 W. Burham Street
Whitefish Bay Department of Public Works	Whitefish Bay	155 W. Fairmount Avenue
Additional Public Works/Water Facilities		
Howard Avenue Water Purification Plant	Milwaukee	725 W. Howard Avenue
Jones Island Water Reclamation Facility-Veolia Water North America	Milwaukee	700 E. Jones Street
Linnwood Avenue Station Water Purification Plant	Milwaukee	3000 N. Lincoln Memorial Drive
Milwaukee County Public Works	Milwaukee	901 N. 9th Street
Milwaukee County Public Works Field Headquarters	Milwaukee	3850 N. 35th Street
Milwaukee Water Works	Milwaukee	2919 W. Cameron Avenue
Milwaukee Water Works Municipal Building	Milwaukee	809 N. Broadway, Room 406
Milwaukee Metropolitan Sewerage District	Milwaukee	260 W. Seeboth Street
North Point Pumping Station	Milwaukee	2275 N. Lincoln Memorial Drive
Riverside Pumping Station	Milwaukee	1311 E. Chambers Street
Texas Pumping Station	Milwaukee	2900 E. Texas Avenue
Transportation Facilities		
MCTS Fiebrantz Bus Garage	Milwaukee	1900 W. Fiebrantz Avenue
MCTS Fond du Lac Bus Garage	Milwaukee	3343 W. Fond du Lac Avenue
MCTS Hillside Administration Facility	Milwaukee	1942 N. 17th Street

Table continued on next page.

Table E.1 (Continued)

Name	Community	Address
Transportation Facilities (continued)		
MCTS Hillside Fleet Maintenance Facility	Milwaukee	1525 W. Vine Street
MCTS Kinnickinnic Bus Garage	Milwaukee	1710 S. Kinnickinnic Avenue
Milwaukee County Timmerman Airport	Milwaukee	9305 W. Appleton Avenue
Milwaukee Intermodal Station	Milwaukee	433 W. St. Paul Avenue
Milwaukee Mitchell International Airport	Milwaukee	5300 S Howell Avenue
Milwaukee Streetcar Operations and Maintenance Facility	Milwaukee	450 N. 5th Street
Milwaukee Streetcar Traction Power Station	Milwaukee	1647 N. Cass Street
Hospitals		
Ascension Colombia St. Mary's- Milwaukee Campus	Milwaukee	2323 N Lake Drive
Ascension Sacred Heart Rehabilitation Hospital- 8th Floor	Milwaukee	2301 N Lake Drive
Ascension SE WI Hospital-Franklin Campus	Franklin	10101 S 27th Street
Ascension SE Wisconsin Hospital- St. Joseph Campus	Milwaukee	5000 W. Chambers Street
Ascension St. Francis Hospital	Milwaukee	3237 S. 16th Street
Ascension Wisconsin Hospital- Greenfield Campus	Greenfield	4935 S. 76th Street
Aurora Psychiatric Hospital	Wauwatosa	1220 Dewey Avenue
Aurora Sinai Medical Center	Milwaukee	945 N. 12th Street
Aurora St. Luke's Medical Center	Milwaukee	2900 W. Oklahoma Avenue
Aurora St. Luke's South Shore	Cudahy	5900 S Lake Drive
Aurora West Allis Medical Center	West Allis	8901 W Lincoln Avenue
Children's Hospital of Wisconsin	Milwaukee	8915 W Connell Ct
Children's Hospital of Wisconsin	Wauwatosa	9000 W Wisconsin Avenue
Clement J. Zablocki Veterans Affairs Medical Center	Milwaukee	5000 W. National Avenue
Fresenius Medical Care and Kindred Hospital	Greenfield	5017 S. 110 Street
Froedtert Hospital	Milwaukee	900 N. 92nd Street
Froedtert Bluemound Clinics	Wauwatosa	10000 W Bluemound Road
Froedtert Community Hospital	Oak Creek	7901 S. 6th Street
Granite Hills Hospital	Milwaukee	1706 S. 68th Street
Mental Health Emergency Center, Inc.	Milwaukee	1525 N. 12th Street
Midwest Orthopedic Specialty Hospital	Franklin	10101 S. 27th Street
Milwaukee Rehabilitation Hospital-Greenfield	Milwaukee	3200 S. 103rd Street
Ministry Health Care	Glendale	400 W. River Woods Parkway
Orthopedic Hospital of Wisconsin	Glendale	475 W. River Woods Parkway
Rogers Memorial Hospital - Brown Deer	Brown Deer	4600 W. Schroeder Drive
Rogers Memorial Hospital - Milwaukee	West Allis	1101 W. Lincoln Avenue
Sixteenth Street Community Health Center Milwaukee	Milwaukee	1032 S. Cesar E Chavez Drive
Wheaton Franciscan Healthcare-Family Care Center	Milwaukee	2400 W. Villard Avenue

Table continued on next page.

Table E.1 (Continued)

Name	Community	Address
Adult Care Facilities		
Adult Center for Enrichment	Greenfield	4848 S. 76th Street
Adult Day Services of Wisconsin LLC	Milwaukee	206 E. Lincoln Avenue
Alexian Village Adult Day Care Grandview Room	Milwaukee	9225 N. 76th Street
Anchorage Homes Adult Day Center	Milwaukee	6435 W. Capitol Drive
Angel Hearts Adult Care Center	Milwaukee	6661 W. Mill Road
Another Chance 2 Adult Day Care LLC	Milwaukee	3916 N. 24th Place
Camdyn Care LLC	Glendale	2602 W. Silverspring Drive Ste100
Catholic Charities Adult Day Services	Milwaukee	1919 N. 60th Street
Community Care Adult Day Program Milwaukee	Milwaukee	3220 W. Vliet Street
Curtis Center	West Allis	344-346 S. Curtis Road
D&D Compassionate Activity Companions LLC	Milwaukee	3611 N. Teutonia Avenue
Disabilities Unlimited Day Program Services	Milwaukee	3808 W. Elm Street
Divine Living Adult Day Center LLC	Milwaukee	6843 W. Brown Deer Road
Epic Care Adult Day Care Inc	Milwaukee	4247 N. 35th Street
Guardian Angels Adult Day Services, LLC	Milwaukee	6816 W. Brown Deer Road
Harmony Senior Center	Milwaukee	3718 W. Vliet Street
Jewish Home & Care Center Adult Day Center	Milwaukee	1414 N. Prospect Avenue
Kajsiab Senior Center	Milwaukee	8421 W. Villard Avenue
Loving Elderly Adult Day Care Center	Milwaukee	7017 N. 58th Street
Lutheran Home Adult Day Services	Wauwatosa	7500 W. North Avenue
Mchc Sakina Senior Center	Milwaukee	803 W. Layton Avenue
New Hope Adult Community Care Center	Milwaukee	2433 W. Roosevelt Drive Lower
Northside Community Center	Milwaukee	5660 N. Teutonia Avenue
Options For Community Growth Inc	Hales Corners	11823 W. Janesville Road
Rosas Community Adult Center	Milwaukee	4240 N. 78th Street
St Ann Center For Intergenerational Care	Milwaukee	2450 W. North Avenue
St Gabriels Church of God In Christ	Milwaukee	2801 E. Morgan Avenue
Tswv Chao Vang Center LLC	Milwaukee	5363 N. 37th Street
United Communities Adult Daycare Services	Milwaukee	11010 W. Hampton Avenue
United Community Center Adult Day Center	Milwaukee	5330 W. Lisbon Avenue
Welshs Adult Day Services Hope Center	Milwaukee	1028 S. 9th Street
Nursing Homes		
Allis Care Center	West Allis	9047 W. Greenfield Avenue
Aria At Mitchell Manor	West Allis	5301 W. Lincoln Avenue
Ascension Living Alexian Village Milwaukee	Milwaukee	9255 N. 76th Street
Autumn Lake Healthcare at Greenfield	Milwaukee	5790 S. 27th Street

Table continued on next page.

Table E.1 (Continued)

Name	Community	Address
Nursing Homes (continued)		
Bedrock Hcs at Glendale	Glendale	1300 W. Silver Spring Drive
Bedrock Hcs at Greendale LLC	Greendale	5404 W. Loomis Road
Bradley Estates Nursing and Rehab LLC	Milwaukee	6735 W. Bradley Road
Chi Franciscan Villa	South Milwaukee	3601 S. Chicago Avenue
Clement Manor Health Care Center	Greenfield	3939 S. 92nd Street
Crossroads Care Center of Milwaukee	Milwaukee	3216 W. Highland Boulevard
Eastcastle Place Bradford Terrace Convalescent Center	Milwaukee	2505 E. Bradford Avenue
Edenbrook Lakeside	Milwaukee	2115 E. Woodstock Pl
Glendale Care and Rehab Center LLC	Glendale	6263 N. Green Bay Avenue
Hales Corners Care Center	Hales Corners	9449 W. Forest Home Avenue
Ignite Medical Resort Oak Creek	Oak Creek	2700 W. Honadel Boulevard
Jewish Home and Care Center	Milwaukee	1414 N. Prospect Avenue
Luther Manor	Milwaukee	4545 N. 92nd Street
Lutheran Home	Wauwatosa	7500 W. North Avenue
Maple Ridge Health Services	Milwaukee	2730 W. Ramsey Avenue
Maplewood Center	West Allis	8615 W. Beloit Road
Mercy Health Services	Milwaukee	2727 W. Mitchell Street
Milwaukee Catholic Home	Milwaukee	2330 N. Prospect Avenue
Saint Johns On the Lake	Milwaukee	1858 N. Prospect Avenue
Southpointe Care and Rehab Center LLC	Greenfield	4500 W. Loomis Road
St Ann Health And Rehabilitation Center	Milwaukee	2020 S. Muskego Avenue
St Anne's Salvatorian Campus	Milwaukee	3800 N. 92nd Street
St Camillus Health Center	Wauwatosa	10101 W. Wisconsin Avenue
St Francis Health Services	Saint Francis	1915 E. Tripoli Avenue
Sunrise Health Services	Milwaukee	3540 S. 43rd Street
Waterfall Health Of Brown Deer	Milwaukee	7500 W. Dean Road
Wheaton Franciscan HC - Terrace at St Francis	Milwaukee	3200 S. 20th Street
Willowcrest Health Services	South Milwaukee	3821 S. Chicago Avenue
City/Village Halls		
Bayside Village Hall	Bayside	9075 N. Regent Road
Brown Deer Village Hall	Brown Deer	4800 W. Green Brook Drive
Cudahy City Hall	Cudahy	5050 S. Lake Drive
Fox Point Village Hall	Fox Point	7200 N. Santa Monica Boulevard
Franklin City Hall	Franklin	9229 W. Loomis Road
Glendale City Hall	Glendale	5909 N. Milwaukee River Parkway
Greendale Village Hall	Greendale	6500 Northway

Table continued on next page.

Table E.1 (Continued)

Name	Community	Address
City/Village Halls (continued)		
Greenfield City Hall	Greenfield	7325 W. Forest Home Avenue
Hales Corners Village Hall	Hales Corners	5635 S. New Berlin Road
Milwaukee City Hall	Milwaukee	200 E. Wells Street
Oak Creek City Hall	Oak Creek	8040 S. 6th Street
River Hills Village Hall	River Hills	7650 N. Pheasant Lane
Shorewood Village Hall	Shorewood	3930 N. Murray Avenue
South Milwaukee City Hall	South Milwaukee	2424 15th Avenue
St. Francis City Hall	St. Francis	3400 E. Howard Avenue
Wauwatosa City Hall	Wauwatosa	7725 W. North Avenue
West Allis City Hall	West Allis	7525 W. Greenfield Avenue
West Milwaukee Village Hall	West Milwaukee	4755 Beloit Road
Whitefish Bay Village Hall	Whitefish Bay	5300 N. Marlborough Drive
Public Libraries		
Brown Deer Public Library	Brown Deer	4301 W. Brown Deer Road
Cudahy Public Library	Cudahy	3500 Library Drive
Franklin Public Library	Franklin	9151 W. Loomis Road
Greendale Public Library	Greendale	5647 Broad Street
Greenfield Public Library	Greenfield	5310 W. Layton Avenue
Hales Corners Library	Hales Corners	5885 S. 116th Street
City of Milwaukee Public Library	Milwaukee*	814 W. Wisconsin Avenue
North Shore Library[a]	North Shore Library*	6800 N. Port Washington Road
Oak Creek Public Library	Oak Creek	8040 S. 6th Street
Shorewood Public Library	Shorewood	3920 N. Murray Avenue
South Milwaukee Public Library	South Milwaukee	1907 10th Avenue
St. Francis Public Library	St. Francis	4230 S. Nicholson Avenue
Wauwatosa Public Library	Wauwatosa	7635 W. North Avenue
West Allis Public Library	West Allis	7421 W. National Avenue
West Milwaukee Public Library	West Milwaukee	7421 W. National Avenue
Whitefish Bay Public Library	Whitefish Bay	5420 N. Marlborough Drive
Milwaukee Public Library Branches		
Atkinson Branch	Milwaukee	1960 W. Atkinson Avenue
Bay View Branch	Milwaukee	2566 S. Kinnickinnic Avenue
Capitol Branch	Milwaukee	3969 N. 74th Street
Center Street Branch	Milwaukee	2727 W. Fond du Lac Avenue
Good Hope Branch	Milwaukee	7715 Good Hope Road
Martin Luther King Branch	Milwaukee	310 W. Locust Street

Table continued on next page.

Table E.1 (Continued)

Name	Community	Address
Milwaukee Public Library Branches (continued)		
Mitchell Street Branch	Milwaukee	906 W. Historic Mitchell Street
Tippercanoe Branch	Milwaukee	3912 S. Howell Avenue
Villard Square Branch	Milwaukee	5190 N. 35th Street
Washington Park Branch	Milwaukee	2121 N. Sherman Boulevard
Zablocki Branch	Milwaukee	3501 W. Oklahoma Avenue
Post Offices		
United States Post Office	Brown Deer	6825 W. Brown Deer Road
United States Post Office	Cudahy	5656 S. Packard Avenue #200
United States Post Office	Franklin	9575 Brenwood Park Drive
United States Post Office	Greendale	5741 Broad St
United States Post Office	Greenfield	7353 W. Forest Home Avenue
United States Post Office	Hales Corners	5444 S. 108th Street
United States Post Office	Milwaukee*	345 W. Saint Paul Avenue
United States Post Office	North Shore*	5651 N. Lydell Avenue
United States Post Office	Oak Creek	200 E. Centennial Drive
United States Post Office	Shorewood	1620 E. Capitol Drive
United States Post Office	South Milwaukee	2210 10th Avenue
United States Post Office	St. Francis-Bay View	1603 E. Oklahoma Avenue
United States Post Office	Wauwatosa	1655 N. Mayfair Road
United States Post Office	West Allis	7440 W. Greenfield Avenue
United States Post Office	West Milwaukee	4300 W. Lincoln Avenue
City of Milwaukee Post Office Branches		
United States Post Office	Milwaukee	3421 W. Vliet Street
United States Post Office	Milwaukee	1301 N. 12 Street
United States Post Office	Milwaukee	606 E. Juneau Avenue
United States Post Office	Milwaukee	1416 S. 11th Street
United States Post Office	Milwaukee	2650 N. Doctor MLK Jr Drive
United States Post Office	Milwaukee	11015 W. Oklahoma Avenue
United States Post Office	Milwaukee	5521 W. Center Street
United States Post Office	Milwaukee	6501 Fond du Lac Avenue
United States Post Office	Milwaukee	5995 N. Teutonia Avenue
United States Post Office	Milwaukee	5300 W. Fond du Lac Avenue
United States Post Office	Milwaukee	2656 N. Teutonia Avenue
United States Post Office	Milwaukee	5500 S. Howell Avenue
United States Post Office	Milwaukee	5555 N. 91st Street
United States Post Office	Milwaukee	5114 S. 27th Street

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Table E.1 (Continued)

Name	Community	Address
Milwaukee County Public and Charter Schools		
Brown Deer Elementary	Brown Deer	5757 W. Dean Road
Brown Deer Middle/High	Brown Deer	8060 N. 60th Street
Carmen Middle School South	Carmen High School of Science and	2433 S. 15th Street
Stellar Collegiate Charter School	Carmen High School of Science and	2431 S. 10th Street
Central City Cyberschool	Central City Cyberschool of Milwaukee	4301 N. 44th Street
Cudahy High	Cudahy	4950 S. Lake Drive
Cudahy Middle	Cudahy	5530 S. Barland Avenue
Jones Elementary	Cudahy	5845 S. Swift Avenue
Kosciuszko Elementary	Cudahy	5252 S. Kirkwood Avenue
Lincoln Elementary	Cudahy	4416 S. Packard Avenue
Mitchell Elementary	Cudahy	5950 S. Illinois Avenue
Darrell Lynn Hines Academy	Darrell L. Hines Academy Inc	7151 N. 86th Street
Downtown Montessori	Downtown Montessori Academy Inc	2507 S. Graham Street
Dr Howard Fuller Collegiate Academy	Dr. Howard Fuller Collegiate Academy	4030 N. 29th Street
Bayside Middle	Fox Point J2	601 E. Ellsworth Lane
Stormont Elementary	Fox Point J2	7301 N. Longacre Road
Ben Franklin Elementary	Franklin Public	7620 S. 83rd Street
Country Dale Elementary	Franklin Public	7380 S. North Cape Road
Forest Park Middle	Franklin Public	8225 W. Forest Hill Avenue
Franklin High	Franklin Public	8222 S. 51st Street
Milwaukee County Correctional Facility	Franklin Public	8885 S. 68th Street
Pleasant View Elementary	Franklin Public	4601 W. Marquette Avenue
Robinwood Elementary	Franklin Public	10705 W. Robinwood Lane
Southwood Glen Elementary	Franklin Public	9090 S. 35th Street
Glen Hills Middle	Glendale-River Hills	2600 W. Mill Road
Parkway Elementary	Glendale-River Hills	5910 N. Milwaukee River Parkway
Canterbury Elementary	Greendale	7000 Enfield Avenue
College Park Elementary	Greendale	5701 W. College Avenue
Greendale High	Greendale	6801 Southway
Greendale Middle	Greendale	6800 Schoolway
Highland View Elementary	Greendale	5900 S. 51st Street
Time 4 Learning Charter School	Greendale	5900 S. 51st Street
Edgewood Elementary	Greenfield	4711 S. 47th Street
Elm Dale Elementary	Greenfield	5300 S. Honey Creek Drive
Glenwood Elementary	Greenfield	3550 S. 51st Street
Greenfield High	Greenfield	4800 S. 60th Street

Table continued on next page.

Table E.1 (Continued)

Name	Community	Address
Milwaukee County Public and Charter Schools (continued)		
Greenfield Middle	Greenfield	3200 W. Barnard Avenue
Maple Grove Elementary	Greenfield	6921 W. Coldspring Road
Indian Hill School	Maple Dale-Indian Hill	1101 W. Brown Deer Road
Maple Dale School	Maple Dale-Indian Hill	8377 N. Port Washington Road
Academy of Accelerated Learning	Milwaukee	3727 S. 78th Street
ALBA - Academia de Lenguaje y Bellas	Milwaukee	1712 S. 32nd Street
Alcott Elementary	Milwaukee	3563 S. 97th Street
Allen-Field Elementary	Milwaukee	730 W. Lapham Boulevard
Alliance School of Milwaukee	Milwaukee	850 W. Walnut Street
Andrew S Douglas Middle	Milwaukee	3620 N. 18th Street
ASSATA High	Milwaukee	3517 W. Courtland Avenue
Audubon Technology and Communication	Milwaukee	3300 S. 39th Street
Audubon Technology and Communication	Milwaukee	3300 S. 39th Street
Auer Avenue Elementary	Milwaukee	2319 W. Auer Avenue
Banner Preparatory School of Milwaukee	Milwaukee	3517 W. Courtland Avenue
Barbee Elementary	Milwaukee	4456 N. Teutonia Avenue
Barton Elementary	Milwaukee	5700 W. Green Tree Road
Bay View High	Milwaukee	2751 S. Lenox Street
Bay View Montessori School	Milwaukee	357 E. Howard Avenue
Bethune Academy	Milwaukee	1535 N. 35th Street
Bradley Technology High	Milwaukee	700 S. Fourth Street
Brown Street Academy	Milwaukee	2029 N. 20th Street
Browning Elementary	Milwaukee	5440 N. 64th Street
Bruce Elementary	Milwaukee	6453 N. 89th Street
Bryant Elementary	Milwaukee	8718 W. Thurston Avenue
Burbank Elementary	Milwaukee	6035 W. Adler Street
Burdick Elementary	Milwaukee	4348 S. Griffin Avenue
Carmen High School of Science and	Milwaukee	1712 S. 32nd Street
Carmen High School of Science and	Milwaukee	2500 W. Oklahoma Avenue
Carmen Middle/High School of Science and	Milwaukee	5496 N. 72nd Street
Carson Academy	Milwaukee	4920 W. Capitol Drive
Carver Academy	Milwaukee	1900 N. 1st Street
Cass Street Elementary	Milwaukee	1647 N. Cass Street
Clarke Street Elementary	Milwaukee	2816 W. Clarke Street
Clemens Elementary	Milwaukee	3600 W. Hope Avenue
Clement Avenue Elementary	Milwaukee	3666 S. Clement Avenue

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Table E.1 (Continued)

Name	Community	Address
Milwaukee County Public and Charter Schools (continued)		
Congress Elementary	Milwaukee	5225 W. Lincoln Creek Drive
Cooper Elementary	Milwaukee	5143 S. 21st Street
Craig Montessori School	Milwaukee	7667 W. Congress Street
Curtin Elementary	Milwaukee	3450 S. 32nd Street
Doerfler Elementary	Milwaukee	3014 W. Scott Street
Eighty-First Street Elementary	Milwaukee	2964 N. 81st Street
Elm Creative Arts Elementary	Milwaukee	900 W. Walnut Street
Emerson Elementary	Milwaukee	9025 W. Lawrence Avenue
Engleburg Elementary	Milwaukee	5100 N. 91st Street
Fairview Elementary	Milwaukee	6500 W. Kinnickinnic River Parkway
Fernwood Montessori	Milwaukee	3239 S. Pennsylvania Avenue
Fifty-Third Street Elementary	Milwaukee	3618 N. 53rd Street
Forest Home Elementary	Milwaukee	1516 W. Forest Home Avenue
Franklin Elementary	Milwaukee	2308 W. Nash Street
Fratney Elementary	Milwaukee	3255 N. Fratney Street
Gaenslen Elementary	Milwaukee	1250 E. Burleigh Street
Garland Elementary	Milwaukee	3120 W. Green Avenue
Golda Meir School	Milwaukee	1615 N. Martin Luther King Drive
Goodrich Elementary	Milwaukee	8251 N. Celina Street
Grandview High	Milwaukee	2745 S. 13TH Street
Grant Elementary	Milwaukee	2920 W. Grant Street
Grant Gordon Learning Center	Milwaukee	921 W. Meinecke Avenue
Grantosa Drive Elementary	Milwaukee	4850 N. 82nd Street
Green Tree Preparatory Academy	Milwaukee	6850 N. 53rd Street
Greenfield Bilingual	Milwaukee	1711 S. 35th Street
Groppi High	Milwaukee	1312 N. 27th Street
Hamilton High	Milwaukee	6215 W. Warnimont Avenue
Hampton Elementary	Milwaukee	5000 N. 53rd Street
HAPA-Hmong American Peace Academy K3-12	Milwaukee	4601 N. 84th Street
Hartford Avenue Elementary	Milwaukee	2227 E. Hartford Avenue
Hawley Environmental School	Milwaukee	5610 W. Wisconsin Avenue
Hawthorne Elementary	Milwaukee	6945 N. 41st Street
Hayes Bilingual School	Milwaukee	971 W. Windlake Avenue
Highland Community School	Milwaukee	1706 W. Highland Avenue
Hi-Mount Elementary	Milwaukee	4921 W. Garfield Avenue
Holmes Elementary	Milwaukee	2463 N. Buffum Street

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Table E.1 (Continued)

Name	Community	Address
Milwaukee County Public and Charter Schools (continued)		
Honey Creek Elementary	Milwaukee	6701 W. Eden Pl
Hopkins Lloyd Community School	Milwaukee	1503 W. Hopkins Street
Humboldt Park Elementary	Milwaukee	3230 S. Adams Avenue
IDEAL Individualized Developmental	Milwaukee	1420 W. Goldcrest Avenue
Jackson Elementary	Milwaukee	2121 W. Hadley Street
Kagel Elementary	Milwaukee	1210 W. Mineral Street
Keefe Avenue Elementary	Milwaukee	1618 W. Keefe Avenue
Kilbourn Elementary	Milwaukee	5354 N. 68th Street
King International Baccalaureate Middle	Milwaukee	121 E. Hadley Street
King International	Milwaukee	1801 W. Olive Street
King Jr Elementary	Milwaukee	3275 N. 3rd Street
Kluge Elementary	Milwaukee	5760 N. 67th Street
La Causa Charter School	Milwaukee	1643 S. 2nd Street
Lad Lake Synergy School	Milwaukee	2820 W. Grant Street
LaFollette Elementary	Milwaukee	3239 N. 9th Street
Lancaster Elementary	Milwaukee	4931 N. 68th Street
Lincoln Avenue Elementary	Milwaukee	1817 W. Lincoln Avenue
Lincoln Middle	Milwaukee	820 E. Knapp Street
Longfellow Elementary	Milwaukee	1021 S. 21st Street
Lowell International Elementary	Milwaukee	4360 S. 20th Street
MacDowell Montessori School K3-12	Milwaukee	6415 W. Mount Vernon Avenue
James Madison Academic Campus	Milwaukee	8135 W. Florist Avenue
Manitoba Elementary	Milwaukee	4040 W. Forest Home Avenue
Maple Tree Elementary	Milwaukee	6644 N. 107th Street
Marshall High	Milwaukee	4141 N. 64th Street
Maryland Montessori	Milwaukee	2418 N. Maryland Avenue
Metcalfe Elementary	Milwaukee	3400 W. North Avenue
Milwaukee Academy of Chinese Language	Milwaukee	2430 W. Wisconsin Avenue
Milwaukee County Youth Education Center	Milwaukee	949 N. 9th Street
Milwaukee College Preparatory School	Milwaukee	2449 N. 36th Street
Milwaukee College Preparatory School	Milwaukee	2623 N. 38th Street
Milwaukee College Preparatory School	Milwaukee	1228 W. Lloyd Street
Milwaukee College Preparatory School	Milwaukee	1350 W. North Avenue
Milwaukee Environmental Science Academy	Milwaukee	6600 W. Melvina Street
Milwaukee French Immersion	Milwaukee	2360 N. 52nd Street
Milwaukee German Immersion	Milwaukee	3778 N. 82nd Street

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Table E.1 (Continued)

Name	Community	Address
Milwaukee County Public and Charter Schools (continued)		
Milwaukee High School of the Arts	Milwaukee	2300 W. Highland Avenue
Milwaukee Parkside School	Milwaukee	2969 S. Howell Avenue
Milwaukee School of Languages	Milwaukee	8400 W. Burleigh Street
Milwaukee Sign Language Elementary	Milwaukee	7900 W. Acacia Street
Milwaukee Spanish Immersion	Milwaukee	2765 S. 55th Street
Milwaukee Excellence Charter School	Milwaukee	4950 N. 24th Street
Mitchell Elementary	Milwaukee	1728 S. 23rd Street
Morgandale Elementary	Milwaukee	3635 S. 17th Street
Morse Mid	Milwaukee	6700 N. 80th Street
Neeskara Elementary	Milwaukee	1601 N. Hawley Road
Next Door Charter	Milwaukee	2545 N. 29th Street
Ninety-Fifth Street Elementary	Milwaukee	3707 N. 94th Street
North Division High	Milwaukee	1011 W. Center Street
NOVA-Northwest Opportunities Vocational	Milwaukee	2320 W. Burleigh Street
Obama School of Career and	Milwaukee	5075 N. Sherman Boulevard
Parkview Elementary	Milwaukee	10825 W. Villard Avenue
Pratt Elementary	Milwaukee	5131 N. Green Bay Avenue
Project STAY-Supporting Teachers and	Milwaukee	609 N. 8th Street
Pulaski High	Milwaukee	2500 W. Oklahoma Avenue
Reagan College Preparatory High	Milwaukee	4965 S. 20th Street
Riley Dual Language Montessori School	Milwaukee	2424 S. 4th Street
River Trail Elementary	Milwaukee	12021 W. Florist Avenue
Riverside High	Milwaukee	1615 E. Locust Street
Riverwest Elementary	Milwaukee	2765 N. Fratney Street
Rogers Street Academy	Milwaukee	2430 W. Rogers Street
Roosevelt Middle	Milwaukee	800 W. Walnut Street
Shalom High	Milwaukee	1749 N. 16th Street
Sherman Elementary	Milwaukee	5110 W. Locust Street
Siefert Elementary	Milwaukee	1547 N. 14th Street
South Accelerated Academy	Milwaukee	1515 W. Lapham Boulevard
South Division High	Milwaukee	1515 W. Lapham Boulevard
Southeastern	Milwaukee	4200 N. Holton Street
Starms Discovery	Milwaukee	2035 N. 25th Street
Starms Early Childhood	Milwaukee	2616 W. Garfield Avenue
Story Elementary	Milwaukee	3815 W. Kilbourn Avenue
Stuart Elementary	Milwaukee	7001 N. 86th Street

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Table E.1 (Continued)

Name	Community	Address
Milwaukee County Public and Charter Schools (continued)		
Thoreau Elementary	Milwaukee	7878 N. 60th Street
Thurston Woods Elementary	Milwaukee	5966 N. 35th Street
Townsend Street Elementary	Milwaukee	3360 N. Sherman Boulevard
Transition High	Milwaukee	1940 N. 36th Street
Trowbridge Street School of Great Lakes	Milwaukee	1943 E. Trowbridge Street
Victory Elementary	Milwaukee	2222 W. Henry Avenue
Vieau Elementary	Milwaukee	823 S. 4th Street
Vincent Accelerated Academy	Milwaukee	7501 N. Granville Road
Vincent High	Milwaukee	7501 N. Granville Road
Wedgewood Park School	Milwaukee	6506 W. Warnimont Avenue
Westside Academy	Milwaukee	1940 N. 36th Street
Whitman Elementary	Milwaukee	4200 S. 54th Street
Whittier Elementary	Milwaukee	4382 S. 3rd Street
WHS Information Technology	Milwaukee	2525 N. Sherman Boulevard
Wisconsin Conservatory of Lifelong	Milwaukee	1017 N. 12th Street
Zablocki Elementary	Milwaukee	1016 W. Oklahoma Avenue
Milwaukee Math and Science Academy	Milwaukee Math and Science Academy Inc.	2703 N. Sherman Boulevard
Milwaukee Scholars Charter School	Milwaukee Scholars Charter School Inc	7000 W. Florist Avenue
Milwaukee Academy of Science	Milwaukee Science Education Consortium	2000 W. Kilbourn Avenue
Nicolet High	Nicolet Union High School	6701 N. Jean Nicolet Road
Carrollton Elementary	Oak Creek-Franklin Joint	8965 S. Carollton Drive
Cedar Hills Elementary	Oak Creek-Franklin Joint	2225 W. Sycamore Avenue
Deerfield Elementary	Oak Creek-Franklin Joint	3871 E. Bluestem Drive
Early Learning Academy	Oak Creek-Franklin Joint	7630 S. 10th Street
Edgewood Elementary	Oak Creek-Franklin Joint	8545 S. Shepard Avenue
Forest Ridge Elementary	Oak Creek-Franklin Joint	2200 W. Drexel Avenue
Meadowview Elementary	Oak Creek-Franklin Joint	10420 S. McGraw Drive
Oak Creek East Middle	Oak Creek-Franklin Joint	9330 S. Shepard Avenue
Oak Creek High	Oak Creek-Franklin Joint	340 E. Puetz Road
Oak Creek West Middle	Oak Creek-Franklin Joint	8401 S. 13th Street
Shepard Hills Elementary	Oak Creek-Franklin Joint	9701 S. Shepard Hills Drive
Pathways High	Pathways High Inc	3022 W. Wisconsin Avenue
Penfield Montessori Academy	Penfield Montessori Academy Inc.	1441 N. 24th Street
Rocketship Southside Community Prep	Rocketship Education Wisconsin Inc	3003 W. Cleveland Avenue
Rocketship Transformation Prep	Rocketship Education Wisconsin Inc	5501 N. 68th Street
Deer Creek Intermediate	Saint Francis	3680 S. Kinnickinnic Avenue

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Table E.1 (Continued)

Name	Community	Address
Milwaukee County Public and Charter Schools (continued)		
Saint Francis High	Saint Francis	4225 S. Lake Drive
Willow Glen Primary School	Saint Francis	2600 E. Bolivar Avenue
Seeds of Health Elementary Program	Seeds of Health Inc	1445 S. 32nd Street
Tenor High	Seeds of Health Inc	918 Vel R Phillips Avenue
Veritas High	Seeds of Health Inc	3025 W. Oklahoma Avenue
Atwater Elementary	Shorewood	2100 E. Capitol Drive
Lake Bluff Elementary	Shorewood	1600 E. Lake Bluff Boulevard
New Horizons for Learning	Shorewood	1701 E. Capitol Drive
Shorewood High	Shorewood	1701 E. Capitol Drive
Shorewood Intermediate	Shorewood	3830 N Morris Boulevard
Blakewood Elementary	South Milwaukee	3501 Blakewood Avenue
E W Luther Elementary	South Milwaukee	718 Hawthorne Avenue
Lakeview Elementary	South Milwaukee	711 Marion Avenue
Rawson Elementary	South Milwaukee	1410 Rawson Avenue
South Milwaukee High	South Milwaukee	801 15th Avenue
South Milwaukee Middle	South Milwaukee	1001 15th Avenue
Escuela Verde	Trans Center for Youth Inc	3628 W. Pierce Street
Bruce Guadalupe	United Community Center Inc	1028 S. 9th Street
United Community Center Acosta Middle	United Community Center Inc	1038 S. 6th Street
East High	Wauwatosa	7500 Milwaukee Avenue
Eisenhower Elementary	Wauwatosa	11600 W. Center Street
Jefferson Elementary	Wauwatosa	6927 Maple Ter
Lincoln Elementary	Wauwatosa	1741 N. Wauwatosa Avenue
Longfellow Middle	Wauwatosa	7600 W. North Avenue
Madison Elementary	Wauwatosa	9925 W. Glendale Avenue
McKinley Elementary	Wauwatosa	2435 N. 89th Street
Roosevelt Elementary	Wauwatosa	2535 N. 73rd Street
Underwood Elementary	Wauwatosa	11132 W. Potter Road
Vel R Phillips School	Wauwatosa	10201 W. Watertown Plank Road
Washington Elementary	Wauwatosa	2166 N. 68th Street
Wauwatosa Montessori School	Wauwatosa	12121 W. North Avenue
Wauwatosa STEM	Wauwatosa	1060 N. Glenview Avenue
Wauwatosa Virtual Academy	Wauwatosa	12121 W. North Avenue
West High	Wauwatosa	11400 W. Center Street
Whitman Middle	Wauwatosa	11100 W. Center Street
Wilson Elementary	Wauwatosa	1060 N. Glenview Avenue

Table continued on next page.

Table E.1 (Continued)

Name	Community	Address
Milwaukee County Public and Charter Schools (continued)		
Central High	West Allis-West Milwaukee	8516 W. Lincoln Avenue
Deeper Learning Virtual Academy	West Allis-West Milwaukee	7815 W. Lapham Street
Frank Lloyd Wright Intermediate	West Allis-West Milwaukee	9501 W. Cleveland Avenue
Franklin Elementary	West Allis-West Milwaukee	2060 S. 86th Street
Hoover Elementary	West Allis-West Milwaukee	12705 W. Euclid Avenue
Horace Mann Elementary	West Allis-West Milwaukee	6213 W. Lapham Street
Irving Elementary	West Allis-West Milwaukee	10230 W. Grant Street
James E Dottke Alternative School	West Allis-West Milwaukee	7815 W. Lapham Street
Jefferson Elementary	West Allis-West Milwaukee	7229 W. Becher Street
Lane Intermediate	West Allis-West Milwaukee	1300 S. 109th Street
Longfellow Elementary	West Allis-West Milwaukee	2211 S. 60th Street
Madison Elementary	West Allis-West Milwaukee	1117 S. 104th Street
Mitchell Elementary	West Allis-West Milwaukee	10125 W. Montana Avenue
Nathan Hale High	West Allis-West Milwaukee	11601 W. Lincoln Avenue
Pershing Elementary	West Allis-West Milwaukee	1330 S. 47th Street
Shared Journeys	West Allis-West Milwaukee	1509 S. 76th Street
Walker Elementary	West Allis-West Milwaukee	900 S. 119th Street
West Milwaukee Intermediate	West Allis-West Milwaukee	5104 W. Greenfield Avenue
Wilson Elementary	West Allis-West Milwaukee	8710 W. Orchard Street
Cumberland Elementary	Whitefish Bay	4780 N. Marlborough Drive
Richards Elementary	Whitefish Bay	5812 N. Santa Monica Boulevard
Whitefish Bay High	Whitefish Bay	1200 E. Fairmount Avenue
Whitefish Bay Middle	Whitefish Bay	1144 E. Henry Clay Street
CORE4 Collaborating on Readiness	Whitnall	5000 S. 116th Street
Edgerton Elementary	Whitnall	5145 S. 116th Street
Hales Corners Elementary	Whitnall	11320 W. Janesville Road
Whitnall High	Whitnall	5000 S. 116th Street
Whitnall Middle	Whitnall	5025 S. 116th Street
Woodlands School	Woodlands School Inc	5510 W. Bluemound Road
Woodlands School - State Street Campus	Woodlands School Inc	3121 W. State Street
Milwaukee County Private Schools		
Inst of Technology and Acad Lower Campus	Brown Deer	5051 W. Bradley Road
Saint Paul's Lutheran School	Cudahy	3766 E. Cudahy Avenue
Victory Christian Academy	Cudahy	3244 E. College Avenue
Hillel Academy	Fox Point J2	6401 N. Santa Monica Boulevard
Milwaukee Jewish Day School	Fox Point J2	6401 N. Santa Monica Boulevard

Table continued on next page.

Table E.1 (Continued)

Name	Community	Address
Milwaukee County Private Schools (continued)		
Saint Eugene School	Fox Point J2	7600 N. Port Washington Road
Indian Community School	Franklin Public	10405 W. Saint Martins Road
Jubilee Christian School	Franklin Public	3639 W. Ryan Road
Saint Pauls Lutheran School	Franklin Public	6881 S. 51st Street
North Shore Montessori School	Glendale-River Hills	4650 N. Port Washington Road
Saint Francis Children's Center	Glendale-River Hills	6700 N. Port Washington Road
Martin Luther High School	Greendale	5201 S. 76th Street
Saint Alphonsus Grade School	Greendale	6000 W. Loomis Road
Our Father's Lutheran School	Greenfield	6023 S. 27th Street
Saint John the Evangelist	Greenfield	8500 W. Coldspring Road
Saint John's Lutheran School	Maple Dale-Indian Hill	7877 N. Port Washington Road
Academy of Excellence	Milwaukee	633 S. 12th Street
Atlas Preparatory Academy Inc	Milwaukee	1039 E. Russell Avenue
Atonement Lutheran School	Milwaukee	4224 W. Ruby Avenue
Believers in Christ Christian Academy	Milwaukee	4065 N. 25th Street
Blessed Sacrament Catholic School	Milwaukee	3126 S. 41st Street
Blessed Savior Catholic School	Milwaukee	5140 N. 55th Street
Carter's Christian Academy Inc	Milwaukee	5268 N. 35th Street
Catholic East Elementary	Milwaukee	2461 N. Murray Avenue
CERT School	Milwaukee	2224 W. Kilbourn Avenue
Christ St. Peter Lutheran School	Milwaukee	2229 W. Greenfield Avenue
Christian Faith Academy of Higher	Milwaukee	3965 N. 15th Street
Clara Mohammed School	Milwaukee	317 W. Wright Street
Cristo Rey Jesuit Milwaukee High School	Milwaukee	1818 W. National Avenue
Cross Trainers Academy	Milwaukee	1530 W. Center Street
Destined To Succeed Academy	Milwaukee	4429 W. Fond du Lac Avenue
Destiny High School	Milwaukee	7210 N. 76th Street
Divine Destiny School	Milwaukee	3782 N. 12th Street
Divine Savior Holy Angels High School	Milwaukee	4257 N. 100th Street
Early View Academy of Excellence	Milwaukee	7132 W. Good Hope Road
Eastbrook Academy	Milwaukee	5375 N. Green Bay Avenue
El Puente High School	Milwaukee	1127 S. 35th Street
Garden Homes Lutheran School	Milwaukee	2450 W. Roosevelt Drive
Granville Lutheran School	Milwaukee	8242 N. Granville Road
Greater Holy Temple Christian Academy	Milwaukee	9500 W. Allyn Street
Holy Redeemer Christian Academy	Milwaukee	3500 W. Mother Daniels Way

Table continued on next page.

Table E.1 (Continued)

Name	Community	Address
Milwaukee County Private Schools (continued)		
Hope Christian School Caritas	Milwaukee	8920 W. Brown Deer Road
Hope Christian School Fidelis	Milwaukee	4200 W. Douglas Avenue
Hope Christian School Fortis	Milwaukee	3601 N. Port Washington Avenue
Hope Christian School Prima	Milwaukee	2345 N. 25th Street
Hope Christian School Semper	Milwaukee	3040 W. Capitol Drive
Institute of Technology and Academics	Milwaukee	8940 N. 85th Street
Jo's Learning Academy	Milwaukee	4827 W. North Avenue
King's Academy Christian School Inc	Milwaukee	7798 N. 60th Street
Kingdom Come Academy	Milwaukee	11301 W. Lake Park Drive
Lash Academy	Milwaukee	5401 N. 76th Street
Malaika Early Learning Center	Milwaukee	125 W. Auer Avenue
Marquette University High School	Milwaukee	3401 W. Wisconsin Avenue
Messmer Catholic Schools	Milwaukee	742 W. Capitol Drive
Milwaukee Seventh Day Adventist School	Milwaukee	10900 W. Mill Road
Milwaukee Academy	Milwaukee	8915 W. Capitol Drive
Milwaukee Lutheran High School	Milwaukee	9700 W. Grantosa Drive
Milwaukee Montessori School	Milwaukee	345 N. 95th Street
Mother of Good Counsel School	Milwaukee	3001 N. 68th Street
Mount Calvary Lutheran School	Milwaukee	2862 N. 53rd Street
Mount Lebanon Lutheran School	Milwaukee	6100 W. Hampton Avenue
Mount Olive Christian Day School	Milwaukee	5301 W. Washington Boulevard
Nativity Jesuit Academy	Milwaukee	1515 S. 29th Street
New Testament Christian Academy	Milwaukee	10201 W. Bradley Road
Northwest Catholic School	Milwaukee	7140 N. 41st Street
Northwest Lutheran School	Milwaukee	4119 N. 81st Street
Notre Dame School of Milwaukee	Milwaukee	1420 W. Scott Street
Our Lady Queen of Peace	Milwaukee	2733 W. Euclid Avenue
Outlook University ISN	Milwaukee	633 S. Hawley Road
Pius XI Catholic High School	Milwaukee	135 N. 76th Street
Prince of Peace	Milwaukee	1114 S. 25th Street
Right Step Inc	Milwaukee	4050 N. 34th Street
Risen Savior Lutheran School	Milwaukee	9550 W. Brown Deer Road
Saint Adalbert School	Milwaukee	1913 W. Becher Street
Saint Anthony School	Milwaukee	1727 S. 9th Street
Saint Augustine Preparatory Academy	Milwaukee	2607 S. 5th Street
Saint Catherine School	Milwaukee	2647 N. 51st Street

Table continued on next page.

Table E.1 (Continued)

Name	Community	Address
Milwaukee County Private Schools (continued)		
Saint Charles Borromeo Catholic School	Milwaukee	3100 W. Parnell Avenue
Saint Charles Education Center	Milwaukee	151 S. 84th Street
Saint Coletta Day School	Milwaukee	1740 N. 55th Street
Saint Gregory the Great Parish School	Milwaukee	3132 S. 63rd Street
Saint Joan Antida High School	Milwaukee	1341 N. Cass Street
Saint John Paul II School	Milwaukee	3344 S. 16th Street
Saint John's Lutheran School	Milwaukee	4001 S. 68th Street
Saint Josaphat Parish School	Milwaukee	801 W. Lincoln Avenue
Saint Joseph Academy	Milwaukee	3027 S. 16th Street
Saint Lucas Lutheran School	Milwaukee	648 E. Dover Street
Saint Marcus Lutheran School	Milwaukee	2215 N. Palmer Street
Saint Margaret Mary School	Milwaukee	3950 N. 92nd Street
Saint Martini Lutheran School	Milwaukee	1520 S. Cesar E Chavez Drive
Saint Matthias Parish School	Milwaukee	9300 W. Beloit Road
Saint Peter Immanuel Lutheran School	Milwaukee	7801 W. Acacia Street
Saint Philip's Lutheran School	Milwaukee	3012 N. Holton Street
Saint Rafael the Archangel School	Milwaukee	2251 S. 31st Street
Saint Roman Parish School	Milwaukee	1810 W. Bolivar Avenue
Saint Rose Youth and Family Center	Milwaukee	3801 N. 88th Street
Saint Sava Orthodox School	Milwaukee	3201 S. 51st Street
Saint Sebastian School	Milwaukee	1747 N. 54th Street
Saint Thomas Aquinas Academy	Milwaukee	341 E. Norwich Street
Saint Vincent Pallotti Catholic School	Milwaukee	201 N. 76th Street
Salam School	Milwaukee	4707 S. 13th Street
Salem Evangelical Lutheran School	Milwaukee	6810 N. 107th Street
Shining Star Christian Schools Inc	Milwaukee	4050 N. 95th Street
Siloah Lutheran School	Milwaukee	3721 N. 21st Street
Tamarack Waldorf School	Milwaukee	1150 E. Brady Street
The City School	Milwaukee	8684 N. 76th Pl
Universal Scholars Academy	Milwaukee	5310 W. North Avenue
Victory Christian Academy	Milwaukee	2840 S. 10th Street
Wells Street Academy	Milwaukee	2020 W. Wells Street
Wisconsin Institute for Torah Study	Milwaukee	3288 N. Lake Drive
Wisconsin Lutheran High School	Milwaukee	330 N. Glenview Avenue
Word of Life Evangelical Lutheran School	Milwaukee	3545 S. 23rd Street
Yeshiva Elementary School	Milwaukee	5115 W. Keefe Avenue

Table continued on next page.

Table E.1 (Continued)

Name	Community	Address
Milwaukee County Private Schools (continued)		
Bader Hillel High Inc	Nicolet Union High School	2315 W. Good Hope Road
Torah Academy of Milwaukee	Nicolet Union High School	6800 N. Green Bay Avenue
Badger State Baptist School	Oak Creek-Franklin Joint	8519 S. 13th Street
Grace Lutheran School	Oak Creek-Franklin Joint	8537 S. Pennsylvania Avenue
Saint Matthew School	Oak Creek-Franklin Joint	9329 S. Chicago Road
Saint Thomas More High School	Saint Francis	2601 E. Morgan Avenue
Saint Robert School	Shorewood	2200 E. Capitol Drive
Divine Mercy School	South Milwaukee	695 College Avenue
Guidance Academy	South Milwaukee	1800 16th Avenue
Zion Lutheran School	South Milwaukee	3600 S. Chicago Avenue
Christ King School	Wauwatosa	2646 N. Swan Boulevard
Kingdom Prep Lutheran High School	Wauwatosa	2520 N. Wauwatosa Avenue
Kradwell School	Wauwatosa	1220 Dewey Avenue
Our Redeemer Lutheran School	Wauwatosa	10025 W. North Avenue
Pilgrim Lutheran School	Wauwatosa	6717 W. Center Street
Saint John's Evangelical Lutheran School	Wauwatosa	1278 Dewey Avenue
Saint Joseph School	Wauwatosa	2750 N. 122nd Street
Saint Jude the Apostle Grade School	Wauwatosa	800 Glenview Avenue
Wauwatosa Catholic School	Wauwatosa	1500 N. Wauwatosa Avenue
Good Shepherd's Lutheran School	West Allis-West Milwaukee	1337 S. 100th Street
Grace Christian Academy	West Allis-West Milwaukee	8420 W. Beloit Road
Lamb of God Ev Lutheran School	West Allis-West Milwaukee	2217 S. 99th Street
Mary Queen of Saints Catholic Academy	West Allis-West Milwaukee	1227 S. 116th Street
Richardson School	West Allis-West Milwaukee	6753 W. Rogers Street
Saint Paul's Lutheran School	West Allis-West Milwaukee	7821 W. Lincoln Avenue
Dominican High School	Whitefish Bay	120 E. Silver Spring Drive
Holy Family School	Whitefish Bay	4849 N. Wildwood Avenue
Saint Monica Grade School	Whitefish Bay	5635 N. Santa Monica Boulevard
Hales Corners Lutheran School	Whitnall	12300 W. Janesville Road
Journeys Lutheran School	Whitnall	5425 S. 111th Street
Messiah Lutheran School	Whitnall	12145 W. Edgerton Avenue
Saint Jacobi Lutheran School	Whitnall	8605 W. Forest Home Avenue
Saint Mary Parish School	Whitnall	9553 W. Edgerton Avenue
Other Critical Facilities		
Port of Milwaukee	Milwaukee	2323 S. Lincoln Memorial Drive
Car Ferry	Milwaukee	2330 S. Lincoln Memorial Drive

Table continued on next page.

Table E.1 (Continued)

Name	Community	Address
Henry S. Reuss Federal Plaza	Milwaukee	310 W. Wisconsin Avenue
Wisconsin State Office Building	Milwaukee	819 N. 6th Street
American Red Cross	Milwaukee	2600 W. Wisconsin Avenue
Valley Power Plant (We Energies)	Milwaukee	1035 W. Canal Street
Waste Management Transfer Facility	Milwaukee	6710 N. Industrial Road
Felmers O Chaney Correctional Center	Milwaukee	2825 N. 30th Street
Milwaukee Secure Detention Facility	Milwaukee	1015 N. 10th Street

[a] *North Shore Public Library is for the Villages of Bayside, Fox Point, and River Hills*

Source: Milwaukee County and SEWRPC

Table E.2
County-Owned Park and Open Space Sites in Milwaukee County[a]

Number on Map 5.3	Site Name[a]	Typology[b]	Location[c]	Size (acres)
1	Alcott Park	NP	T06N, R21E, Section 17	17
2	Algonquin Park	NP	T08N, R21E, Section 14	9
3	Armour Park	NP	T06N, R21E, Section 22	15
4	Atkinson Triangle	NP	T07N, R22E, Section 08	1
5	Back Bay[d]	RP	T07N, R22E, Section 22	7
6	Baran Park	CP	T06N, R22E, Section 08	24
7	Barnard Park	NP	T06N, R21E, Section 25	10
8	Bay View Park[e]	RP	T06N, R22E, Section 14	40
9	Bender Park	RP	T05N, R22E, Section 25	303
10	Big Bay Park	NP	T08N, R22E, Section 33	9
11	Bradford Beach[d]	RP	T07N, R22E, Section 15	28
12	Brown Deer Park	RP	T08N, R21E, Section 13	362
13	Burns Commons	MP	T07N, R22E, Section 21	1
14	Caesar's Park	NP	T07N, R22E, Section 21	3
15	Cambridge Woods	OS/NA	T07N, R22E, Section 09	21
16	Cannon Park	NP	T07N, R21E, Section 29	8
17	Carver Park	CP	T07N, R22E, Section 20	12
18	Cathedral Square	NP	T07N, R22E, Section 28	2
19	Center Street Park	NP	T07N, R21E, Section 15	5
20	Chippewa Park	NP	T07N, R21E, Section 30	11
21	Clarke Square	NP	T07N, R22E, Section 31	2
22	Clas Park	MP	T07N, R22E, Section 29	1
23	Cooper Park	NP	T07N, R21E, Section 16	8
24	Copernicus Park	NP	T06N, R22E, Section 31	20
25	County Grounds	OS/NA	T07N, R21E, Section 20	55
26	Cudahy Nature Preserve	OS/NA	T05N, R22E, Section 04	42
27	Cudahy Park	NP	T06N, R22E, Section 34	18
28	Cupertino Park[e]	RP	T06N, R22E, Section 10	7
29	Currie Park	RP	T07N, R21E, Section 07	195
30	Dale Creek Parkway	PW	--	45
31	Dineen Park	CP	T07N, R21E, Section 10	65
32	Doctors Park	CP	T08N, R22E, Section 10	55
33	Doyne Park	CP	T07N, R21E, Section 26	35
34	Dretzka Park	RP	T08N, R21E, Section 07	326
35	East Side Bike Trail	GW	T07N, R22E, Section 05	74
36	Estabrook Park	RP	T07N, R22E, Section 04	128
37	Euclid Park	NP	T06N, R21E, Section 16	9
38	Falk Park	RP	T05N, R22E, Section 07	258
39	Franklin Park	RP	T05N, R21E, Section 29	165
40	Froemming Park	NP	T05N, R21E, Section 23	17
41	Garden Homes Square	NP	T07N, R22E, Section 06	2
42	Gilman Triangle	MP	T07N, R22E, Section 15	--[f]
43	Gordon Park	CP	T07N, R22E, Section 16	24
44	Grant Park[e]	RP	T05N, R22E, Section 01	381
45	Grantosa Parkway	PW	--	16
46	Granville Dog Park	SUF	T08N, R21E, Section 18	25
47	Greene Park	CP	T06N, R22E, Section 23	36
48	Greenfield Park	RP	T06N, R21E, Section 06	282
49	Grobschmidt Park	RP	T05N, R21E, Section 01	152
50	Hales Corners Park	CP	T06N, R21E, Section 31	33
51	Hansen Park	SUF	T07N, R21E, Section 20	51
52	Hanson A.C. Park	NP	T08N, R21E, Section 03	14
53	Harriet Tubman Park[g]	NP	T07N, R21E, Section 02	12

Table continued on next page.

Table E.2 (Continued)

Number on Map 5.3	Site Name[a]	Typology[b]	Location[c]	Size (acres)
54	Highland Park	NP	T07N, R21E, Section 25	3
55	Holler Park	CP	T06N, R22E, Section 29	15
56	Holt Park	OS/NA	T06N, R21E, Section 17	21
57	Honey Creek Parkway	PW	--	114
58	Hoyt Park	CP	T07N, R21E, Section 21	20
59	Humboldt Park	CP	T06N, R22E, Section 09	70
60	Indigenous Peoples' Park[h]	NP	T07N, R21E, Section 03	10
61	Jackson Park	RP	T06N, R21E, Section 12	113
62	Jacobus Park	CP	T07N, R21E, Section 27	25
63	James W. Beckum Park	SC	T07N, R22E, Section 20	16
64	Johnsons Park	NP	T07N, R22E, Section 19	13
65	Johnstone Park	NP	T05N, R22E, Section 06	13
66	Joseph-Lichter Park	OS/NA	T08N, R21E, Section 05	34
67	Juneau Park[d]	RP	T07N, R22E, Section 28	16
68	Kern Park	CP	T07N, R22E, Section 09	30
69	King Park	CP	T07N, R22E, Section 19	21
70	Kinnickinnic River Parkway	PW	--	193
71	KK Sports Center	SC	T06N, R22E, Section 07	20
72	Kletzsch Park	RP	T08N, R22E, Section 19	141
73	Kohl Park	RP	T08N, R21E, Section 03	272
74	Kops Park	NP	T07N, R21E, Section 09	8
75	Kosciuszko Park	CP	T06N, R22E, Section 05	34
76	Kulwicki Park	CP	T06N, R21E, Section 19	28
77	La Follette Park	CP	T07N, R21E, Section 32	18
78	Lake Park[d]	RP	T07N, R22E, Section 15	138
79	Lincoln Creek Parkway	PW	--	102
80	Lincoln Park	RP	T08N, R22E, Section 31	313
81	Lindsay Park	NP	T07N, R21E, Section 04	13
82	Little Menomonee River Parkway	PW	--	866
83	Lucille Barrien Park[i]	NP	T07N, R22E, Section 07	3
84	Lyons Park	NP	T06N, R21E, Section 14	12
85	Madison Park	CP	T07N, R21E, Section 05	59
86	Maitland Park	CP	T06N, R22E, Section 31	33
87	Manitoba Park	NP	T06N, R21E, Section 11	4
88	McCarty Park	CP	T06N, R21E, Section 09	52
89	McGovern Park	CP	T08N, R21E, Section 35	61
90	McKinley Park[d,j]	RP	T07N, R22E, Section 22	102
91	Meaux Park	CP	T08N, R22E, Section 31	25
92	Melody View Preserve	OS/NA	T08N, R21E, Section 16	14
93	Menomonee River Parkway	PW	--	597
94	Milwaukee County Sports Complex	SC	T05N, R21E, Section 23	117
95	Milwaukee River Parkway	PW	--	111
96	Milwaukee Rotary Centennial Arboretum	SUF	T07N, R22E, Section 16	6
97	Mitchell Airport Park	NP	T06N, R22E, Section 21	19
98	Mitchell Boulevard	NP	T07N, R21E, Section 26	16
99	Mitchell Park	RP	T07N, R22E, Section 31	61
100	Moody Park	NP	T07N, R22E, Section 07	4
101	Morgan Triangle	MP	T06N, R22E, Section 15	1
102	Nash Park	NP	T07N, R21E, Section 09	9
103	North Shore Right of Way	GW	T05N, R22E, Section 09	70
104	Noyes Park	CP	T08N, R21E, Section 21	72
105	Oak Creek Parkway	PW	--	1,165
106	Oakwood Park	SUF	T05N, R21E, Section 25	276
107	Park Maintenance	SUF	T07N, R21E, Section 27	4

Table continued on next page.

Table E.2 (Continued)

Number on Map 5.3	Site Name[a]	Typology[b]	Location[c]	Size (acres)
108	Pere Marquette Park	NP	T07N, R22E, Section 29	2
109	Pleasant Valley Park	NP	T07N, R22E, Section 09	23
110	Popuch Park	NP	T08N, R21E, Section 08	12
111	Prospect Triangle	MP	T07N, R22E, Section 15	1
112	Pulaski Park (Cudahy)	NP	T06N, R22E, Section 26	16
113	Pulaski Park (Milwaukee)	NP	T06N, R22E, Section 07	26
114	Rainbow Park	CP	T07N, R21E, Section 31	26
115	Rawson Park	CP	T05N, R22E, Section 02	30
116	Red Arrow Park	NP	T07N, R22E, Section 29	1
117	Riverfront Launch Site	SUF	T07N, R22E, Section 33	--[f]
118	Riverside Park	CP	T07N, R22E, Section 16	25
119	Riverton Meadows	NP	T05N, R22E, Section 15	12
120	Root River Parkway	PW	--	4,045[k]
121	Rose Park	CP	T07N, R22E, Section 17	10
122	Rover West Dog Park	SUF	T07N, R22E, Section 09	3
123	Runway Dog Park	SUF	T05N, R22E, Section 04	26
124	Saveland Park	NP	T06N, R22E, Section 17	3
125	Schoenecker Park	NP	T08N, R21E, Section 26	18
126	Scout Lake Park	CP	T06N, R21E, Section 35	64
127	Servite Park Preserve	OS/NA	T08N, R21E, Section 09	20
128	Sheridan Park[e]	RP	T06N, R22E, Section 25	132
129	Sherman Park	CP	T07N, R21E, Section 13	21
130	Smith Park	NP	T08N, R21E, Section 36	19
131	South Shore Park[e,l]	RP	T06N, R22E, Section 10	48
132	Southwood Glen	NP	T05N, R21E, Section 24	9
133	St. Martin's Park	NP	T05N, R21E, Section 07	20
134	Story Parkway	PW	T07N, R21E, Section 26	8
135	Tiefenthaler Park	NP	T07N, R22E, Section 19	11
136	Tippecanoe Park	NP	T06N, R22E, Section 16	17
137	Trimborn Farm	SUF	T06N, R21E, Section 33	7
138	Uihlein Soccer Park	SC	T08N, R21E, Section 22	67
139	Underwood Creek Parkway	PW	--	179
140	UP Railroad Corridor	GW	T08N, R22E, Section 32	37
141	Valley Park	NP	T07N, R21E, Section 25	2
142	Veterans Park[d]	RP	T07N, R22E, Section 28	91
143	Vogel Park	NP	T08N, R21E, Section 33	12
144	Walker Square	NP	T07N, R22E, Section 32	2
145	War Memorial and Art Center	SUF	T07N, R22E, Section 18	7
146	Warnimont Park[e]	RP	T06N, R22E, Section 36	248
147	Washington Park	RP	T07N, R21E, Section 23	130
148	Webster Park	NP	T07N, R21E, Section 06	5
149	Wedgewood Park	NP	T06N, R21E, Section 15	6
150	West Milwaukee Park	CP	T06N, R21E, Section 02	21
151	Whitnall Park	RP	T05N, R21E, Section 05	627
152	Wilson Park	RP	T06N, R22E, Section 19	77
153	Wilson Recreation Center	RP	T06N, R22E, Section 19	54
154	Wisconsin Avenue Park	NP	T07N, R21E, Section 29	18
155	Wyrick Park	NP	T08N, R21E, Section 23	18
156	Zablocki Park	CP	T06N, R21E, Section 24	45
157	Zeidler Union Square	NP	T07N, R22E, Section 29	1
			Subtotal: 157 Sites	15,316

Table continued on next page.

Table E.2 (Continued)

Number on Map 5.3	Site Name[a]	Typology[b]	Location[c]	Size (acres)
County-Owned Sites Not Under the Jurisdiction of Milwaukee County Parks				
158	Camelot Park (leased to the City of Oak Creek)	NP	T05N, R22E, Section 10	10
159	Milwaukee County Zoo	--	T07N, R21E, Section 29	168
			Subtotal: 2 Sites	178
			Total County-Owned Sites: 159 Sites	15,494

[a] *Based on an inventory conducted in 2015 and updated in 2022 to account for the renaming of a number of County-owned parks.*

[b] *This plan uses the following typology for each County-owned park and open space site:*

RP – Regional Park: Large outdoor recreation site (typically 100 acres or more in size) serving multiple communities or counties
CP – Community Park: Intermediate size recreation site (typically 25 to 100 acres in size) serving a community or multiple neighborhood areas
NP – Neighborhood Park: Smaller park site (typically 3 to 10 acres in size) serving an individual neighborhood area
PW – Parkway: Linear park and open space site that consists of a natural resource corridor along the major rivers and streams in the County or a trail right-of-way linking neighborhoods or other park and open space sites
GW – Greenway: Typically a narrow trail right-of-way that links neighborhoods or other park and open space sites and facilities
OS/NA – Open Space/Natural Area: Natural resource preservation site with development typically limited to parking and trails
MP – Mini Park: Small green space site (typically 2 acres or smaller in size) with limited recreational facilities
SC – Sports Complex: Site dedicated to only intensive indoor or outdoor recreational facilities
SUF – Special Use Facility: Site that provides a single purpose recreational facility such as a golf course or dog park

[c] *Indicates location given in township, range, and section based on the U.S. Public Land Survey System (PLSS). Specific PLSS locations are not listed for linear sites that extend through multiple quarter sections.*

[d] *Back Bay, Bradford Beach, Juneau Park, Lake Park, McKinley Park, and Veterans Park comprise Lake Michigan North, which is classified as a major park. The total area of these six sites is 382 acres.*

[e] *Bay View Park, Cupertino Park, Grant Park, Sheridan Park, South Shore Park, and Warnimont Park comprise Lake Michigan South, which is classified as a major park. The total area of these six sites is 856 acres.*

[f] *Amounts to less than one acre.*

[g] *Formerly Wahl Park.*

[h] *Formerly Columbus Park.*

[i] *Formerly Lindberg Park.*

[j] *Includes Milwaukee Yacht Club, which is privately owned.*

[k] *Includes 38 acres in Racine County.*

[l] *Includes South Shore Yacht Club, which is privately owned, and nine acres of breakwater that is considered to be part of the park.*

Source: Milwaukee County Parks and SEWRPC

Table E.3
State Recreation and Open Space Lands in Milwaukee County: 2015

Number on Map 5.3	Site Name	Location[a]	Size (acres)
Wisconsin Department of Natural Resources Sites			
160	Big Muskego Lake Wildlife Area	T05N, R21E, Section 19	119
161	Forestry Education Center	T07N, R21E, Section 20	67
162	Hank Aaron State Trail Access	T07N, R21E, Section 36	--[b]
163	Havenwoods State Forest	T08N, R21E, Section 26	222
164	Lake Shore State Park	T07N, R22E, Section 28	20
165	Wetland Mitigation Site	T05N, R22E, Section 06	9
166	Wildlife Habitat	T06N, R22E, Section 09	2
		WDNR Sites Total: 7 Sites	439
Other State Sites			
167	American Family Field[c]	T07N, R21E, Section 35	221
168	State Fairgounds	T07N, R21E, Section 33	203
169	University of Wisconsin-Milwaukee - Downer Woods	T07N, R22E, Section 10	25
		Other State Sites Total: 3 Sites	449
		Total Sites: 10 Sites	888

[a] *Indicates location given in township, range, and section based on the U.S. Public Land Survey System.*

[b] *Less than one acre.*

[c] *Owned by the Southeast Wisconsin Professional Baseball Park District, a special purpose district established by the State.*

Source: Wisconsin Department of Natural Resources and SEWRPC

Table E.4
Historic Sites and Districts Located near the Milwaukee County Coastline: 2015

Number on Map 5.12	Local Government and Historic Site or District Name	Designation Type[a]	Year Listed
	Village of Fox Point		
1	Albert and Edith Adelman House	S	2005
2	Mary L. Nohl Art Environment	S	2005
3	Milwaukee Shipwreck (Steam Screw)	S	2015
4	Starke Meyer House	S	1985
	Village of Shorewood		
5	Appomattox Shipwreck	S	2005
6	George E. Morgan House	S	1985
7	Henry A. Meyer House	S	1985
8	Seneca W. and Bertha Hatch House	S	1985
9	Thomas Bossert House	S	1985
	Village of Whitefish Bay		
10	Barfield-Staples House	S	1985
11	Frank J. Williams House	S	1985
12	Fred W. Ullius Jr. House	S	1987
13	Frederick Sperling House	S	1985
14	G.B. Van Devan House	S	1985
15	George Gabel House	S	1985
16	Halbert D. Jenkins House	S	1985
17	Harrison Hardie House	S	1985
18	Herman Uihlien House	S	1983
19	Horace W. Hatch House	S	1985
20	John F. Mcewens House	S	1985
21	Paul S. Grant House	S	1985
22	Rufus Arndt House	S	1985
23	William Van Altena House	S	1985
	City of Milwaukee		
24	Abbott Row	S	1983
25	All Saints' Episcopal Cathedral Complex	S	1974
26	Astor on The Lake	S	1984
27	Baumbach Building	S	1983
28	Bay View Historic District	D	1982
29	Cass-Juneau Street Historic District	D	1988
30	Cass-Wells Street Historic District	D	1986
31	Charles Allis House	S	1975
32	Charles Quarles House	S	1979
33	East Oregon and South Barclay Industrial Historic District	D	2014
34	East Side Commercial Historic District	D	1986
35	Elias R. Calkins Double House	S	1990
36	Emanuel D. Alder House	S	1991
37	Emba (Self-Unloading Barge) Shipwreck	S	2013
38	Exton Apartments Building	S	1997
39	Federal Building	S	1973
40	First Church of Christ Scientist	S	1989
41	First Unitarian Church	S	1974
42	First Ward Triangle Historic District	D	1987
43	Frederick C. Bogk House	S	1972
44	Immanuel Presbyterian Church	S	1974
45	Joseph B. Oliver House	S	1990
46	Joseph Schlitz Brewing Company Saloon	S	1977
47	Kenwood Park-Prospect Hill Historic District	D	2002
48	Knapp-Astor House	S	1980
49	Knickerbocker Hotel	S	1988

Table continued on next page.

Table E.4 (Continued)

Number on Map 5.12	Local Government and Historic Site or District Name	Designation Type[a]	Year Listed
	City of Milwaukee (continued)		
50	Lake Park	S	1993
51	Lloyd R. Smith House	S	1974
52	Mcintosh-Goodrich Mansion	S	2000
53	Milwaukee Western Fuel and Oil Company	S	1992
54	Milwaukee-Downer Quad	S	1974
55	Newberry Boulevard Historic District	D	1994
56	North Point Light House	S	1984
57	North Point North Historic District	D	2000
58	North Point South Historic District	D	1979
59	North Point Water Tower	S	1973
60	Northwestern Mutual Life Insurance Company, Home Office	S	1973
61	Prospect Avenue Apartment Buildings Historic District	D	1990
62	Prospect Avenue Mansions Historic District	D	1990
63	Prospect Hill Historic District	D	2005
64	Sanford R. Kane House	S	1991
65	Shorecrest Hotel	S	1984
66	Sixth Church of Christ Scientist	S	1980
67	St. John's Roman Catholic Cathedral	S	1974
68	St. Paul's Episcopal Church	S	1974
69	The State Bank of Wisconsin/Bank of Milwaukee Block	S	1984
70	Wisconsin Consistory Building	S	1994
71	Wisconsin Leather Company Building	S	2005
72	Women's Club of Wisconsin	S	1982
	City of St. Francis		
73	Henni Hall	S	1974

[a] *Includes sites and districts listed on the National Register of Historic Places and located within one half-mile of the Milwaukee County coastline.*

[b] *Codes signify designation type as follows: D-District; S-Site*

Source: The Wisconsin Historical Society and SEWRPC

PERCENTAGE OF BUILDING DAMAGE BASED ON FIRST FLOOR FLOOD DEPTH

APPENDIX F

Table F.1
Percentage of Building Damaged Based on First Floor Flood Depth

Depth of Inundation Relative to the First Floor (feet)	Residential Buildings				Commercial Buildings	
	One Story		Two Story			
	Basement	No Basement	Basement	No Basement	Basement	No Basement
-8.0	0.000	--	0.000	--	0.000	--
-7.0	0.050	--	1.425	--	2.000	--
-6.0	1.000	--	2.850	--	4.000	--
-5.0	1.500	--	4.275	--	6.000	--
-4.0	2.040	--	5.700	--	8.500	--
-3.0	3.000	--	7.000	--	10.500	--
-2.0	4.080	--	8.500	--	12.500	--
-1.9	4.440	--	8.600	--	12.700	--
-1.8	4.900	--	8.800	--	12.900	--
-1.7	5.300	--	8.900	--	13.100	--
-1.6	5.600	--	9.000	--	13.300	--
-1.5	6.100	--	9.200	--	13.500	--
-1.4	6.500	--	9.300	--	13.700	--
-1.3	6.900	--	9.500	--	13.900	--
-1.2	7.300	--	9.600	--	14.100	--
-1.1	7.700	--	9.800	--	14.300	--
-1.0	8.110	0.000	9.900	0.000	14.500	0.000
-0.9	8.400	0.800	10.000	0.700	14.700	0.700
-0.8	8.800	1.600	10.200	1.300	14.900	1.400
-0.7	9.300	2.500	10.400	2.000	15.000	2.100
-0.6	9.600	3.300	10.500	2.700	15.300	2.800
-0.5	10.000	4.200	10.700	3.400	15.500	3.500
-0.4	10.400	5.000	10.800	4.000	15.600	4.200
-0.3	10.700	5.900	11.000	4.700	15.800	4.900
-0.2	11.200	6.700	11.100	5.500	16.000	5.600
-0.1	11.500	7.500	11.300	6.100	16.200	6.300
0.0	11.930	8.370	11.400	6.820	16.400	7.000
0.1	12.200	9.100	11.700	7.000	16.700	7.500
0.2	12.500	9.800	12.100	7.300	17.000	8.000
0.3	12.800	10.500	12.400	7.600	17.400	8.600
0.4	13.100	11.200	12.700	7.900	17.700	9.100
0.5	13.400	12.000	13.100	8.100	18.000	9.700
0.6	13.700	12.700	13.400	8.400	18.300	10.200
0.7	14.000	13.500	13.700	8.700	18.600	10.700
0.8	14.300	14.100	14.000	8.900	19.000	11.200
0.9	14.700	14.900	14.400	9.200	19.300	11.800
1.0	14.960	15.650	14.700	9.460	19.600	12.300
1.1	15.500	16.500	15.200	9.800	20.100	12.800
1.2	16.000	17.300	15.600	10.200	20.600	13.400
1.3	16.600	18.200	16.100	10.600	21.100	13.900
1.4	17.100	19.000	16.500	10.900	21.600	14.400
1.5	17.700	19.900	17.000	11.300	22.100	15.000
1.6	18.100	20.700	17.500	11.700	22.600	15.500
1.7	18.700	21.500	17.900	12.000	23.100	16.000
1.8	19.200	22.400	18.400	12.500	23.600	16.500
1.9	19.800	23.200	18.800	12.800	24.100	17.100
2.0	20.350	24.140	19.300	13.220	24.600	17.600
2.1	20.600	24.500	19.800	13.700	25.100	18.100
2.2	20.900	24.800	20.200	14.200	25.600	18.600
2.3	21.100	25.100	20.700	14.600	26.100	19.200
2.4	21.400	25.400	21.100	15.100	26.600	19.700
2.5	21.800	25.700	21.600	15.600	27.200	20.200

Table continued on next page.

Table F.1 (Continued)

Depth of Inundation Relative to the First Floor (feet)	Residential Buildings				Commercial Buildings	
	One Story		Two Story			
	Basement	No Basement	Basement	No Basement	Basement	No Basement
2.6	22.000	26.100	22.100	16.000	27.700	20.700
2.7	22.300	26.400	22.500	16.500	28.200	21.200
2.8	22.600	26.700	23.000	17.000	28.700	21.800
2.9	22.900	27.000	23.400	17.500	29.200	22.300
3.0	23.160	27.420	23.900	17.920	29.700	22.800
3.1	23.600	27.600	24.400	18.100	30.200	23.300
3.2	24.000	27.800	24.800	18.300	30.700	23.900
3.3	24.500	28.000	25.300	18.500	31.200	24.400
3.4	24.900	28.200	25.700	18.700	31.700	24.900
3.5	25.400	28.400	26.200	18.900	32.200	25.500
3.6	25.800	28.700	26.700	19.100	32.700	26.000
3.7	26.300	28.900	27.100	19.300	33.200	26.500
3.8	26.700	29.000	27.600	19.500	33.700	27.000
3.9	27.200	29.200	28.000	19.800	34.200	27.600
4.0	27.610	29.500	28.500	19.960	34.700	28.100
8.0	48.470	44.680	47.000	30.000	48.000	44.000

Source: Federal Emergency Management Agency, U.S. Army Corps of Engineers, and SEWRPC

HAZARD MITIGATION RESOURCES AND TOOLS

APPENDIX G

Additional Items to Consider Adding to an Emergency Supply Kit:

- ❑ Prescription medications and glasses
- ❑ Infant formula and diapers
- ❑ Pet food, water and supplies for your pet
- ❑ Important family documents such as copies of insurance policies, identification and bank account records in a portable waterproof container
- ❑ Cash and change
- ❑ Emergency reference material such as a first aid book or information from www.ready.gov
- ❑ Sleeping bag or warm blanket for each person. Consider additional bedding if you live in a cold-weather climate.
- ❑ Complete change of clothing including a long sleeved shirt, long pants and sturdy shoes. Consider additional clothing if you live in a cold-weather climate.
- ❑ Fire Extinguisher
- ❑ Matches in a waterproof container
- ❑ Feminine supplies, personal hygiene items and hand sanitizer
- ❑ Mess kits, Paper cups, plates and disposable utensils, paper towels
- ❑ Paper and pencil
- ❑ Books, games, puzzles or other activities for children

Ready

Prepare. Plan. Stay Informed.®

Emergency Supply List

FEMA

www.ready.gov

Recommended Items to Include in a Basic Emergency Supply Kit:

- ❑ Water and non-perishable food for several days
- ❑ Extra cell phone battery or charger
- ❑ Battery-powered or hand crank radio that can receive NOAA Weather Radio tone alerts and extra batteries
- ❑ Flashlight and extra batteries
- ❑ First aid kit
- ❑ Whistle to signal for help
- ❑ Dust mask, to help filter contaminated air and plastic sheeting and duct tape to shelter-in-place
- ❑ Moist towelettes, garbage bags and plastic ties for personal sanitation
- ❑ Non-sparking wrench or pliers to turn off utilities
- ❑ Can opener (if kit contains canned food)
- ❑ Local maps

FEMA's Ready Campaign
educates and empowers Americans to take some simple steps to prepare for and respond to potential emergencies, including those from natural hazards and man-made disasters. Ready asks individuals to do three key things: get an emergency supply kit, make a family emergency plan, and be informed about the different types of emergencies that could occur and appropriate responses. Everyone should have some basic supplies on hand in order to survive several days if an emergency occurs. This list of emergency supply kit items is only a starting point. It is important that individuals review this list and consider the unique needs of their family, including pets, for items to include. Individuals should also consider having at least two emergency supply kits, one full kit at home and smaller portable kits in their workplace, vehicle or other places they spend time.

Ready. FEMA

Federal Emergency Management Agency
Washington, DC 20472

List of Milwaukee County Cooling Sites

Milwaukee

Repairers of the Breach
1335 W Vliet St

Urban Ecology Center - Riverside Park
1500 E Park Place

Urban Ecology Center - Menomonee Valley
3700 W Pierce St

Greendale

Greendale Public Library
5647 Broad St

Southridge Mall
5300 S 76th St

Greenfield

Greenfield Public Library
5310 W Layton Ave

West Allis

West Allis Public Library
7421 W National Ave

West Allis Senior Center
7001 W National Ave

Franklin

Franklin Public Library
9151 W. Loomis Rd.

Hales Corners

Hales Corners Library
5885 S 116th St

South Milwaukee

Grobschmidt Senior Center
2424 15th Ave

South Milwaukee Public Library
1907 10th Ave

St. Francis

St. Francis Library
4230 S Nicholson Ave

Cudahy

Kelly Senior Center
6100 S Lake Dr

Cudahy Family Library
3500 Library Ave

Aurora St. Luke's South Shore
5900 S Lake Dr

West Milwaukee

Village of West Milwaukee Community Center
1345 S 47th St

Oak Creek

Oak Creek Public Library
8040 S 6th St

Salvation Army
8853 S Howell Ave

Discover Church
7311 S 13th St

Oak Creek Community Center
8580 S Howell Ave

Shorewood

Shorewood Public Library
3920 N Murray Ave

Glendale

North Shore Public Library
6800 N Port Washington Rd

Whitefish Bay

Whitefish Bay Public Library
5420 N Marlborough Dr

City of Milwaukee Health Department Webpage, city.milwaukee.gov/Health/Cooling-Sites; list updated 8/22/23

Are You READY WISCONSIN?

✓Get a Kit ✓Make a Plan ✓Be Informed

Floods

Know the Terms

Flood Watch
Flooding is possible. Tune in to NOAA Weather Radio All Hazards, commercial radio, or local television for information.

Flash Flood Watch
Flash flooding is possible. Be prepared to move to higher ground; listen to NOAA Weather Radio, commercial radio, or television for information.

Flood Warning
Flooding is occurring or will occur soon; if advised to evacuate, do so immediately.

Flash Flood Warning
A flash flood is occurring; seek higher ground on foot immediately.

Know What to Do

If a flood is likely in your area, you should:

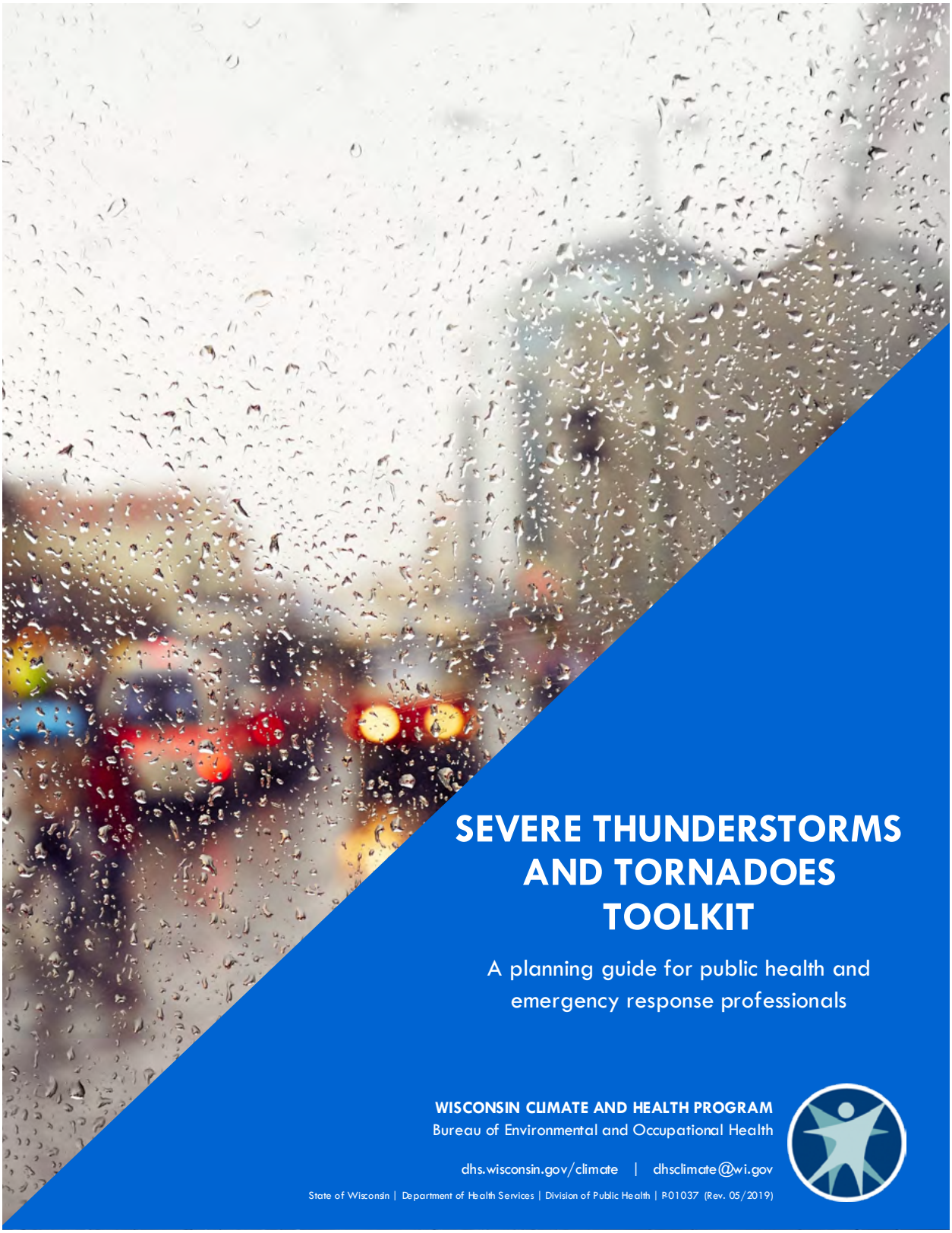
- Listen to the radio or television for information.
- Be aware that flash flooding can occur. If there is any possibility of a flash flood, move immediately to higher ground. Do not wait for instructions to move.
- Be aware of streams, drainage channels, canyons, and other areas known to flood suddenly. Flash floods can occur in these areas with or without such typical warnings as rain clouds or heavy rain.
- If you must prepare to evacuate, you should do the following:
- Secure your home. If you have time, bring in outdoor furniture. Move essential items to an upper floor.
- Turn off utilities at the main switches or valves if instructed to do so. Disconnect electrical appliances. Do not touch electrical equipment if you are wet or standing in water.
- If you have to leave your home, remember these evacuation tips:
- Do not walk through moving water. Six inches of moving water can make you fall. If you have to walk in water, walk where the water is not moving. Use a stick to check the firmness of the ground in front of you.
- Do not drive into flooded areas. If floodwaters rise around your car, abandon the car and move to higher ground if you can do so safely. You and the vehicle can be quickly swept away.

Driving Flood Facts

The following are important points to remember when driving in flood conditions:

- Six inches of water will reach the bottom of most passenger cars causing loss of control and possible stalling.
- A foot of water will float many vehicles.
- Two feet of rushing water can carry away most vehicles including sport utility vehicles (SUVs) and pick-ups.

Wisconsin Emergency Management
http://readywisconsin.wi.gov
Phone: 608-242-3000



SEVERE THUNDERSTORMS AND TORNADOES TOOLKIT

A planning guide for public health and emergency response professionals

WISCONSIN CLIMATE AND HEALTH PROGRAM
Bureau of Environmental and Occupational Health

dhs.wisconsin.gov/climate | dhsclimate@wi.gov

State of Wisconsin | Department of Health Services | Division of Public Health | P-01037 (Rev. 05/2019)

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INTRODUCTION

Purpose

The purpose of the Wisconsin Severe Thunderstorms and Tornadoes Toolkit is to provide information to local governments, health departments, and citizens in Wisconsin about preparing for and responding to severe storm events, including tornadoes. The toolkit provides background information, practical guidance, strategies, media releases, talking points, definitions, and useful reference materials on this topic. The guides in this toolkit may be copied onto agency letterhead for distribution to residents affected by tornadoes and other severe storms. Further resources can be found in Appendix B: Additional Resources.

Background

While not in an especially tornado-heavy part of the United States, Wisconsin still experiences, on average, 23 tornadoes per year.[1] The high winds and severe storms that can accompany tornadoes pose serious health hazards to the people of Wisconsin. In the summer of 2014, southwestern Wisconsin experienced severe damage from tornadoes, high winds, and hail, resulting in injuries and destruction of multiple buildings.[2] The National Weather Service issues, on average, one to two tornado warnings and five to 10 severe thunderstorm warnings per county per year in Wisconsin's southern counties, and fewer in the northern counties.

> Wisconsin averages 23 tornadoes per year.[1]

Climate Trends

Long-term trend analysis of Wisconsin's climate indicates that the state is becoming warmer and wetter.[3] After analyzing historical climate data from 1950-2006 and developing downscaled local climate models, University of Wisconsin climate scientists created potential climate projections based on historical trends and scientifically validated models. Several of the potential outcomes indicate that an increase in average annual precipitation and warmer annual average temperature may occur in the state. Severe storms and tornadoes need warm moist air to form, among many other factors. Climate surveillance has shown that within the past 60 years tornadoes are not occurring more frequently but rather are occurring on days that already had a documented tornado. This means that there is an increase in tornado density.[4]

Health Impacts

These trends suggest an increase in negative health impacts in Wisconsin as a result of greater intensity of severe thunderstorms, accompanying strong winds, and tornado occurrences. Potential health concerns include lightning fatalities and survivors with long-term mental and physical health effects.[7] Between 2004 and 2013, there were 329 lightning deaths in the United States, five of which were in Wisconsin.[4] Severe storms and tornadoes can cause significant damage to housing infrastructure and can injure or kill people in the areas affected by the storm. Intense storm events and tornadoes may also have negative effects on mental health as families and communities deal with storm damage and destruction.

DEFINTIONS

Funnel Cloud
A visible, rotating, funnel-shaped cloud that extends from a thunderstorm toward but not quite reaching the ground.

Heat Lightning
Lightning from a thunderstorm too far away to be heard.

Severe Thunderstorm Warning
Severe thunderstorms are occurring in the area.

Severe Thunderstorm Watch
Weather conditions suggest that severe thunderstorms are possible in the area.

Straight-Line Winds
Any wind generated by a thunderstorm that is not associated with rotation and can be considered severe if the winds exceed 58 mph. Damage from straight-line winds occurs in the same general direction due to lack of rotational wind.

Tornado Warning
An alert issued when a funnel cloud is sighted or indicated by weather radar. Shelter should be taken immediately.

Tornado Watch
An alert issued when weather conditions favor the formation of tornadoes—often during thunderstorms.

Tornado
A violently rotating column of air that extends from a thunderstorm to the ground and is often—although not always—visible as a funnel cloud. Lighting and hail are common in thunderstorms that produce tornadoes.

Wall Cloud
An isolated, often abrupt, lowering of a cloud that develops beneath the base of a thunderstorm. It is always rain-free and usually exists for 10-20 minutes before a tornado appears. A wall cloud may also persistently rotate.

Tornado definitions[5,6] | Storm definitions[7]

Tornado Categories

Tornadoes are characterized through the Enhanced Fujita Scale (EF-Scale). The scale is a set of wind estimates in three-second gusts, and is based on 28 different damage indicators. For more information on the EF-Scale, see spc.noaa.gov/faq/tornado/ef-scale.html. [9]

Weak Tornadoes

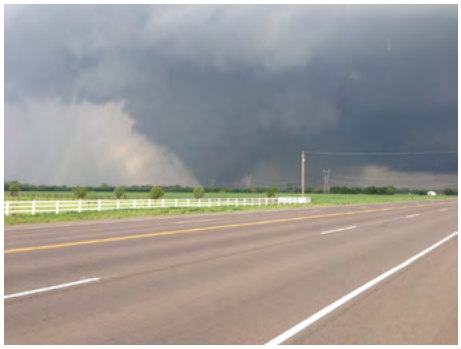
- 88% of all tornadoes
- Less than 5% of tornado deaths
- Lifetime 1-10+ minutes
- Winds less than 110 mph
- Produce EF0 or EF1 damage

Strong Tornadoes

- 11% of all tornadoes
- Nearly 30% of all tornado deaths
- May last 20 minutes or longer
- Winds 111-165 mph
- Produce EF2 or EF3 damage

Violent Tornadoes

- Less than 1% of all tornadoes
- 70% of all tornado deaths
- May last over one hour
- Winds greater than 166 mph
- Produce EF4 or EF5 damage



Recognizing tornado signs

Wisconsin's tornado season usually runs from May through July. During these months, it is beneficial to have a plan in place should a tornado be sighted in your area. The following information includes how to recognize tornado conditions, create a tornado emergency plan, and assemble a disaster emergency kit. For more detailed information, see the National Weather Service's Tornado Preparedness Guide: nws.noaa.gov/om/severeweather/resources/ttl6-10.pdf.[5]

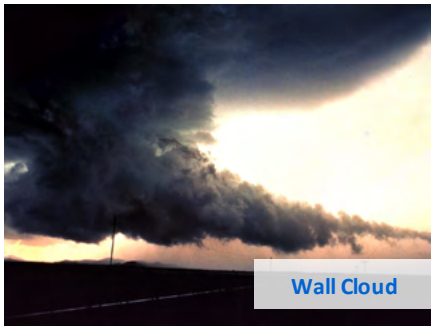
Tornado Conditions

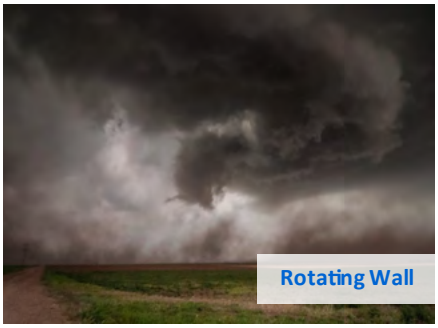
When there are thunderstorms in the area, pay attention to the radio or television for emergency information about the possibility of a tornado watch or warning. Research your community's warning system, and be prepared when the warning sounds.

Be alert for visible or audible signs of a tornado:

- Greenish or unusually colored clouds
- Low-hanging and rotating wall cloud
- Funnel clouds
- Hail in the absence of rain
- Loud, train-like roaring sound
- Swirling cloud of debris

Funnel Cloud


Wall Cloud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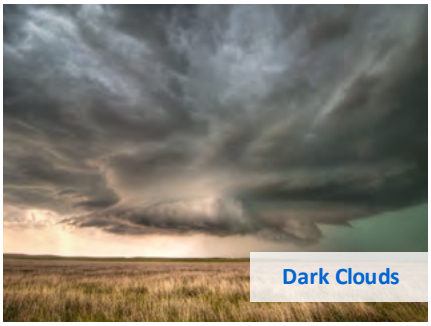
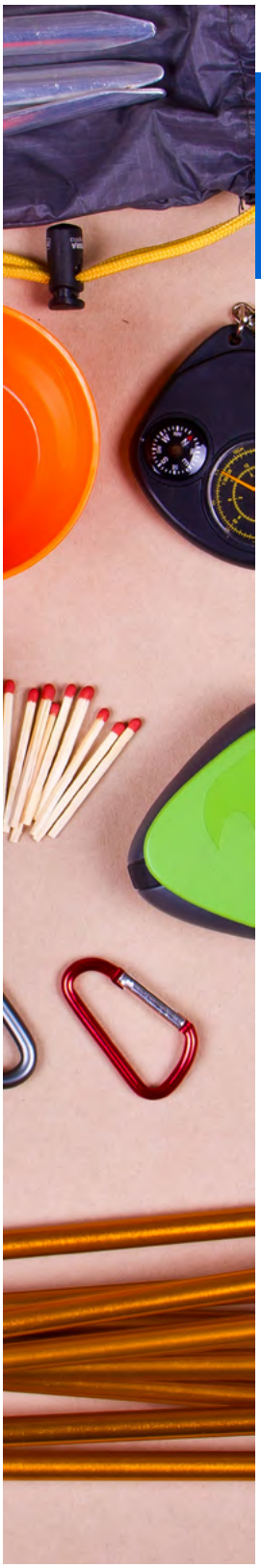

Dark Clouds



PLANNING FOR SEVERE STORMS

Create a Tornado Emergency Plan

- Sketch a floor plan of where you live, or walk through each room and discuss where and how to seek shelter.
- Show a second way to exit from each room or area. If you need special equipment, such as a rope ladder, mark where it is located.
- Make sure everyone understands the siren warning system, if there's such a system in your area.
- Mark where your first aid kit and fire extinguishers are located.
- Mark where the utility switches or valves are located so they can be turned off—if time permits—in an emergency.
- Teach your family how to administer basic first aid, how to use a fire extinguisher, and how and when to turn off water, gas, and electricity in your home.
- See FEMA for more information on identifying a proper pre-designated area to take shelter: ready.gov/tornadoes.[6]

Assemble a Disaster Emergency Kit

- ☐ 3-day supply of water (1 gallon of water per person, per day)
- ☐ 3-day supply of non-perishable food (and can opener)
- ☐ Battery-operated radio and extra batteries
- ☐ Cell phone and charger
- ☐ Flashlight and batteries
- ☐ First aid kit (bandages, gauze, tweezers, disinfectant, gloves, pain relievers, thermometer, etc.)
- ☐ Whistle to signal for help
- ☐ Dust mask
- ☐ Survival blanket (also known as a space blanket)
- ☐ Extra cash (about $50)
- ☐ Pocket knife
- ☐ Wrench to turn off utilities
- ☐ Medications, hand sanitizer, moist towelettes, plastic ties, and garbage bags
- ☐ Local maps for evacuation
- ☐ Change of clothes (including rain jacket, gloves, hat, etc.)

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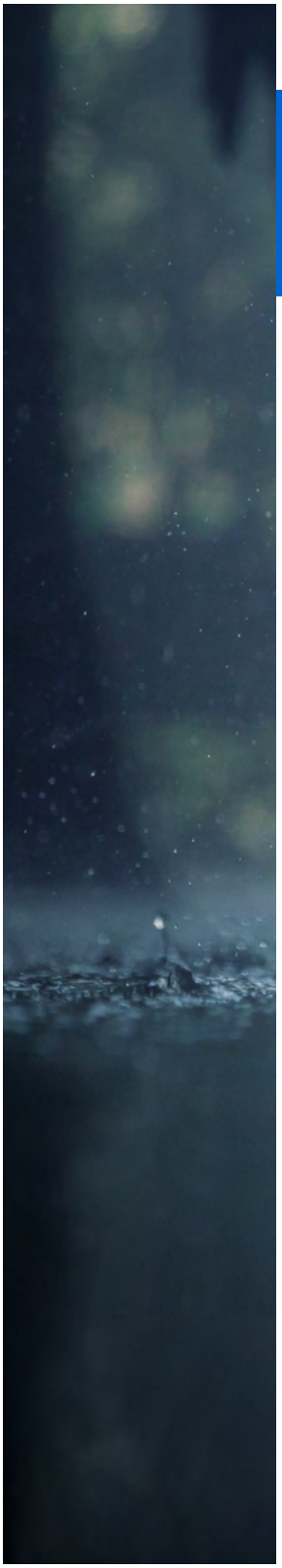

STAYING SAFE IN A SEVERE STORM

When there is a **severe storm** in your area, it is important to find shelter as soon as you can. The best option is a house or building with the windows and doors closed, and no open areas to the outside.

If you are…	Then…
Indoors A sturdy building with no open windows to the outside	• Take shelter in a sturdy building. Avoid isolated sheds or other small structures in open areas. • Avoid contact with corded phones and devices including those plugged into electrical outlets for recharging. Cordless and wireless phones not connected to wall outlets are OK to use. • Avoid contact with electrical equipment or cords. Unplug appliances and other electrical items such as computers, and turn off air conditioners. Power surges from lightning can cause serious damage. • Avoid contact with plumbing. Do not wash your hands, do not take a shower, do not wash dishes, and do not do laundry. Plumbing and bathroom fixtures can conduct electricity. • Stay away from windows and doors, and stay off porches. • Do not lie on concrete floors and do not lean against concrete walls. Avoid contact with anything metal—tractors, farm equipment, motorcycles, golf carts, golf clubs, and bicycles.
In a Forest	Seek shelter in a low area under a thick growth of small trees.
In an Open Area	• Go to a low place such as a ravine or valley. Be alert for flash floods. • Avoid hilltops, open fields, or the beach. • Avoid natural lightning rods such as a tall, isolated tree in an open area.
In Open Water	Get to land and find shelter immediately.
In a Car	• Try to safely exit the roadway and park. • Stay in the vehicle and turn on the emergency flashers until the heavy rain ends. • Avoid touching metal or other surfaces that conduct electricity in and outside the vehicle.

If a tornado warning is implemented, seek shelter immediately. Protect yourself by finding an area in the interior of a building. Below is information on how to proceed in different scenarios when a tornado is spotted.

If you are in…	Then…
A Structure (e.g., residence, small building, school, nursing home, hospital, factory, shopping center, high-rise building)	Go to a pre-designated area such as a safe room, basement, storm cellar, or the lowest building level. If there is no basement, go to the center of a small interior room on the lowest level (closet, interior hallway) away from corners, windows, doors, and outside walls. Put as many walls as possible between you and the outside. Get under a sturdy table and use your arms to protect your head and neck. • In a high-rise building, go to a small interior room or hallway on the lowest floor possible. • Put on sturdy shoes. • Do not open windows.
A Manufactured Home or Office	Get out immediately and go to a pre-identified location such as the lowest floor of a sturdy, nearby building or a storm shelter. Mobile homes, even if tied down, offer little protection from tornadoes.
The Outdoors with No Shelter	If you are not in a sturdy building, there is no single research-based recommendation for what last-resort action to take because many factors can affect your decision. Possible actions include the following: • Immediately get into a vehicle, buckle your seat belt and try to drive to the closest sturdy shelter. If your vehicle is hit by flying debris while you are driving, pull over and park. • Take cover in a stationary vehicle. Put a seat belt on and cover your head with your arms and a blanket, coat, or cushion if possible. • Lie in an area noticeably lower than the level of the roadway and cover your head with your arms and a blanket, coat, or other cushion if possible. • Do not get under an overpass or bridge. You are safer in a low, flat location. • In urban or congested areas, never try to outrun a tornado in a vehicle. Instead, leave the vehicle immediately for safe shelter. • Watch out for flying debris. Flying debris causes most fatalities and injuries from tornadoes.

Straight-line winds can cause damage similar to tornadoes and usually emerge from thunderstorms. The damage caused by straight-line winds is pushed in the direction the wind was moving.

If you are…	Then…
Inside a Building	• Move to the lowest floor and stay away from windows. • Taking shelter in a basement is strongly encouraged, especially if you are surrounded by trees that could fall onto the building or house. • If you are in a mobile home, move to a stronger building or storm cellar if winds reach speeds of 70 mph.
Driving	• Keep both hands on the wheel and slow down. • Pull over to the shoulder and stop, making sure you are away from trees or other tall objects that could fall on your vehicle. *DO NOT* stop in the middle of a lane under an overpass. This could lead to an accident. • Take extra care in a high-profile vehicle such as a truck, van, SUV, or when towing a trailer. ◊ These are more prone to being pushed or even flipped by straight-line winds. ◊ If possible, orient your vehicle so it points into the wind. • Stay in the car and turn on the hazard lights until the wind subsides.
Outside	• Take cover in a well-built building, or use this building to block the wind if you cannot get inside. • If no building is nearby, find the lowest spot and crouch low to the ground. • Stay away from trees or power lines since these are easily felled by straight-line winds. • If you are in the middle of a forest, move to the lowest/smallest stand of trees. • Stay clear of roadways or train tracks, as the winds may blow you into the path of an oncoming vehicle. • Watch for flying debris. Tree limbs, street signs, and other objects may break and become flying projectiles in the wind.

LIGHTNING SAFETY

As of November 2014, there were 26 lightning fatalities in the United States in 2014. Six were in Florida, three in Wisconsin, and two each in Arizona, Arkansas, Colorado, Georgia, and Massachusetts.[10] Knowing the facts about lightning can help you stay safe.

Lightning Fiction and Fact

Fiction: If it is not raining, then there is no danger from lightning.

Fact: Lightning often strikes in the absence of heavy rain and may occur as far as 10 miles away from any rainfall. This is especially true in the western United States, where thunderstorms sometimes produce very little rain.

Fiction: The rubber soles of shoes or tires on a car will protect you from being struck by lightning.

Fact: Rubber-soled shoes and rubber tires provide NO protection from lightning. The steel frame of a hard-topped vehicle provides increased protection if you are not touching metal. Although you may be injured if lightning strikes your car, you are much safer inside a vehicle than outside.

Fiction: People struck by lightning should not be touched because they carry an electrical charge.

Fact: Lightning-strike victims carry no electrical charge and should be helped immediately. Anyone who has been hit by lightning requires immediate professional medical care. Call 9-1-1 and begin CPR immediately if the person has stopped breathing. Use an automatic external defibrillator if one is available. Contact your local American Red Cross chapter for information on CPR and first aid classes.

Fiction: "Heat lightning" occurs after very hot summer days and poses no threat.

Fact: "Heat lightning" is a term used to describe lightning from a thunderstorm too far away for the thunder to be heard.

What You Can Do Before Lightning Strikes

Plan Ahead

- Develop a plan for you and your family at home, work, school, and when outdoors. Tips are available from the American Red Cross (redcross.org) and the Federal Emergency Management Agency at ready.gov.[7]
- Check the weather forecast. If thunderstorms are predicted, consider postponing outdoor activities.
- Have a Public Alert ™ certified NOAA Weather Radio or use a weather application for your cell phone to alert you if threatening weather arises.

Seek Safe Shelter

- Small outdoor buildings, including sports dugouts, rain shelters, garages, etc., are **NOT SAFE**. Substantial buildings with wiring and plumbing are the safest places. Office buildings, schools, and homes offer good protection.
- Once inside, stay away from windows, doors, and anything that conducts electricity.
- A hard-topped metal vehicle with the windows closed also provides good protection. Avoid contact with metal in the vehicle and try to keep away from windows.

If You Cannot Get to a Safe Shelter

- Avoid open fields, the top of a hill, or a ridge top.
- Stay away from tall, isolated trees or other tall objects.
- Stay away from water, wet items, and metal objects. Water and metal are excellent conductors of electricity. The current from a lightning flash will easily travel for long distances.

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AFTER A SEVERE STORM

Injury can result directly from the tornado or severe storm, and can also occur after the tornado when people are walking among damaged or destroyed buildings. Tornadoes often damage power lines, gas lines, or electrical systems. Because of this, there is an increased risk of fire, electrocution, or explosion.[5]

- Continue to monitor your battery-powered radio or television for emergency information.
- Only enter severely damaged buildings after they have been inspected for structural integrity.
- Be careful when entering any structure that has been damaged.
- Wear sturdy shoes or boots, long sleeves, and gloves when handling or walking on or near debris.
- Safely work in teams if possible during cleanup efforts.
- Be aware of hazards from exposed nails and broken glass.
- Do not touch downed power lines or objects in contact with downed lines. Report electrical hazards to the police and the utility company.
- Use battery-powered lanterns, if possible, rather than candles to light homes without electrical power. If you use candles, make sure they are in safe holders away from curtains, paper, wood, or other flammable items. Never leave a candle burning when you are out of the room.
- Never use generators, pressure washers, grills, camp stoves, or other gasoline, propane, natural gas, or charcoal-burning devices inside your home, garage, or camper—or even outside near an open window, door, or vent as these generate carbon monoxide (CO). CO is an odorless, colorless gas that can cause sudden illness and death if you breathe in high concentrations of it. CO from these sources can build up in your home, garage, or camper and poison the people and animals inside. **Seek prompt medical attention if you suspect CO poisoning and are feeling dizzy, light-headed, or nauseated.**
- Hang up displaced telephone receivers that may have been knocked off by a tornado, but stay off the telephone, except to report an emergency.
- Cooperate fully with public safety officials.
- Respond to requests for volunteer assistance by police, firefighters, emergency management, and relief organizations, and do not go into damaged areas. Your presence could hamper relief efforts, and you could endanger yourself.
- Be aware of damaged areas that may have controlled access.

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Talking Points for Severe Storms

Talking points and message maps for local health professionals

If you are approached by the media regarding a reported severe storm health risk in your jurisdiction, the following talking points may be used. Start with message A1 or A2, then follow the instructions within that box.

A1

We were notified by the medical examiner/coroner about a fatality possibly due to extreme weather conditions. Our condolences go out to the family.

Go to message B1 or B2.

A2

We have *not* been notified of any recent fatalities linked to severe storm conditions.

Go to message C.

B1

Out of respect for the family, we are unable to share any details.

Go to message C.

B2

On [insert date], a [gender] ["____ years old" or "between the ages of ___ and ___"] died during the storm.

Go to message C.

C

The after-effects of a severe storm can result in many adverse health effects. Please remain safe by:

a. Listening to safety messages of response teams that are assessing the damage.

b. Checking on family, friends, and neighbors who do not have air conditioning, who spend much of their time alone, or who are more likely to be affected by severe storms.

c. For more information visit *[insert relevant website].*

Message mapping is one of the most important risk communication tools that public health agencies can employ. The goal of a message map is to convey important information in a concise and easy to understand fashion.

General Guidelines for Completing a Message Map

- Stick to three key messages or one key message with three parts for each underlying concern or specific question.
- Keep key messages brief. The reader should ideally spend less than 10 seconds per line.
- Develop messages that are easily understood by the target audience. (For communications with the general public, use a 6th to 8th grade readability level.)
- Place messages within a message set. The most important messages should occupy the first and last positions.
- Develop key messages that cite credible third parties.
- Use graphics and other visual aids to enhance key messages.
- Keep a positive tone. Messages should be solution oriented and constructive. Try to balance negative messages with positive ones.
- Avoid unnecessary use of "absolute" words, such as no, not, never, nothing, and none.[5]

The following is a message map that could be used when addressing the general public regarding severe storm safety.

Key Messages *Three key messages*	**Supporting Information** *Three pieces of supporting information for each key message*
Message 1 Severe weather can happen at any time.	**Supporting Info 1** Severe storms can come with little warning. Follow your local radio stations and news channels for up-to-date information on incoming storms. **Supporting Info 2** Heed storm watches in our area, and take appropriate shelter when storm watches turn into storm warnings. **Supporting Info 3** Acting quickly and being informed on weather patterns in your area are important steps in being prepared.
Message 2 Develop a home emergency plan for your family before a severe storm hits.	**Supporting Info 1** Find an area in your home where your family can take shelter during severe storms. These rooms should have no windows to the outside. **Supporting Info 2** Identify two different ways to exit the house, should the need occur. Be sure to practice with your family. **Supporting Info 3** Develop an emergency communication plan, with important phone numbers and information. These include: medical and emergency contacts, work and school information, and insurance information.
Message 3 Check on your neighbors and those most vulnerable to injury from extreme weather.	**Supporting Info 1** People with limited mobility, those who live alone, the elderly, and children may be more vulnerable to injury during severe weather. **Supporting Info 2** Mental health can be affected during and after severe weather. Stay calm and follow your family's emergency plan. **Supporting Info 3** Call 911 or seek medical attention if you or someone you know has been injured.

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10. Retrieved May 8, 2015, from http://www.lightningsafety.noaa.gov/fatalities/fatalities14.shtml
11. Icons from The Noun Project

RESOURCES

Wisconsin Department of Health Services (DHS)
dhs.wisconsin.gov/climate/weather/tornado.htm
608-258-0099

Federal Emergency Management Agency (FEMA)
fema.gov

FEMA Spanish Language Portal
fema.gov/es/

List of Wisconsin Local Health Departments
dhs.wisconsin.gov/lh-depts/counties.htm

List of Wisconsin Tribal Health Directors
dhs.wisconsin.gov/lh-depts/contacts/tribal-health-directors.pdf

Ready Wisconsin
readywisconsin.wi.gov

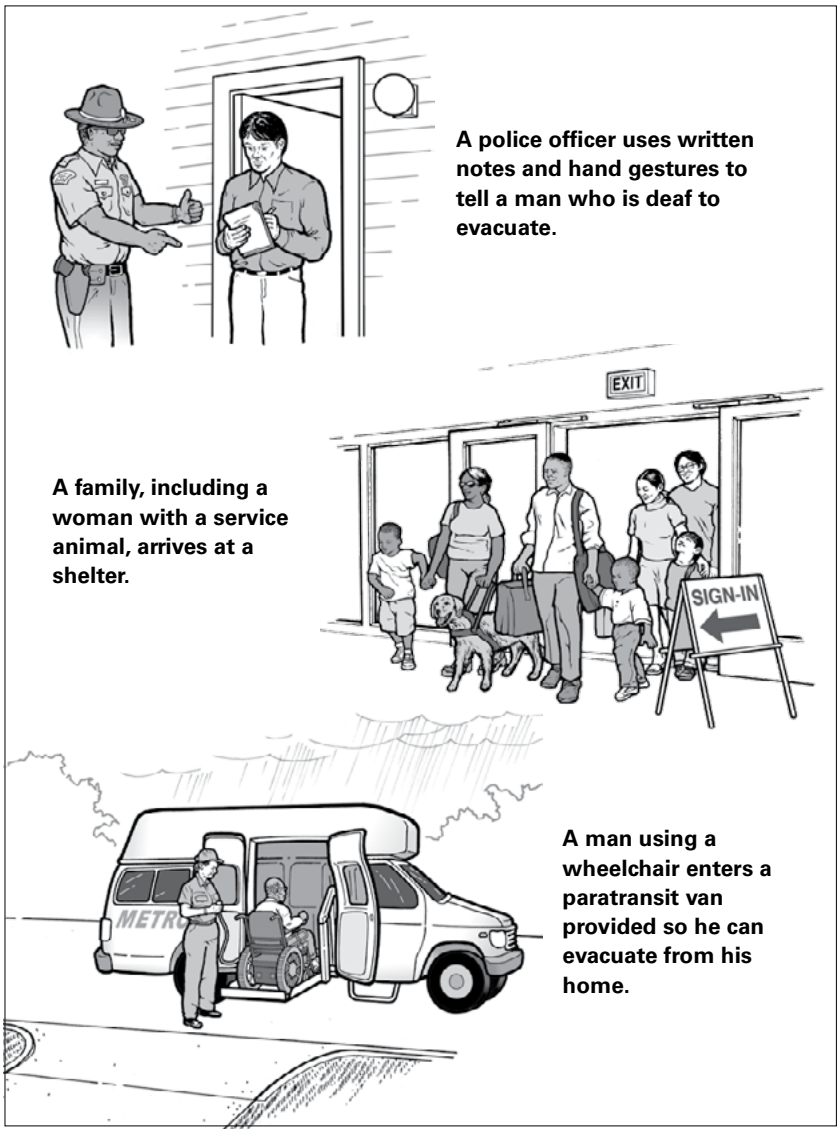
National Oceanic Atmostpheric Assocation (NOAA): Weather Safety
weather.gov/safety

U.S. Department of Justice
Civil Rights Division
Disability Rights Section

An ADA Guide for Local Governments

Making Community Emergency Preparedness and Response Programs Accessible to People with Disabilities

One of the most important roles of local government is to protect their citizenry from harm, including helping people prepare for and respond to emergencies. Making local government emergency preparedness and response programs accessible to people with disabilities is a critical part of this responsibility. Making these programs accessible is also required by the Americans with Disabilities Act of 1990 (ADA).



A police officer uses written notes and hand gestures to tell a man who is deaf to evacuate.

A family, including a woman with a service animal, arrives at a shelter.

A man using a wheelchair enters a paratransit van provided so he can evacuate from his home.

PLANNING

If you are responsible for your community's emergency planning or response activities, you should involve people with disabilities in identifying needs and evaluating effective emergency management practices. Issues that have the greatest impact on people with disabilities include:

- notification;
- evacuation;
- emergency transportation;
- sheltering;
- access to medications, refrigeration, and back-up power;
- access to their mobility devices or service animals while in transit or at shelters; and
- access to information.

In planning for emergency services, you should consider the needs of people who use mobility aids such as wheelchairs, scooters, walkers, canes or crutches, or people who have limited stamina. Plans also need to include people who use oxygen or respirators, people who are blind or who have low vision, people who are deaf or hard of hearing, people who have a cognitive disability, people with mental illness, and those with other types of disabilities.

Action Steps: Planning

Solicit and incorporate input from people with different types of disabilities (e.g. mobility, vision, hearing, cognitive and other disabilities) regarding all phases of your emergency management plan including:

- preparation;
- notification;
- response; and
- clean up.

NOTIFICATION

Many traditional emergency notification methods are not accessible to or usable by people with disabilities. People who are deaf or hard of hearing cannot hear radio, television, sirens, or other audible alerts. Those who are blind or who have low vision may not be aware of visual cues, such as flashing lights. Warning methods should be developed to ensure that all citizens will have the information necessary to make sound decisions and take appropriate, responsible action. Often, using a combination of methods will be more effective than relying on one method alone. For instance, combining visual and audible alerts will reach a greater audience than either method would by itself.

Action Steps: Notification

Provide ways to inform people who are deaf or hard of hearing of an impending disaster if you use emergency warning systems such as sirens or other audible alerts.

When the electric power supply is affected, it may be necessary to use several forms of notification. These might include the use of telephone calls, auto-dialed TTY (teletypewriter) messages, text messaging, E-mails, and even direct door-to-door contact with pre-registered individuals.

Also, you should consider using open-captioning on local TV stations in addition to incorporating other innovative uses of technology into such procedures, as well as lower-tech options such as dispatching qualified sign language interpreters to assist in broadcasting emergency information provided to the media.

A woman who is deaf reads a captioned evacuation notice on her television.

A police officer uses hand gestures and a printed note to tell a woman who is deaf that she needs to evacuate her home.

3

EVACUATION

Individuals with disabilities will face a variety of challenges in evacuating, depending on the nature of the emergency. People with a mobility disability may need assistance leaving a building without a working elevator. Individuals who are blind or who have limited vision may no longer be able to independently use traditional orientation and navigation methods. An individual who is deaf may be trapped somewhere unable to communicate with anyone because the only communication device relies on voice. Procedures should be in place to ensure that people with disabilities can evacuate the physical area in a variety of conditions and with or without assistance.

Action Steps: Evacuation of People with Disabilities

Adopt policies to ensure that your community evacuation plans enable people with disabilities, including those who have mobility, vision, hearing, or cognitive disabilities, mental illness, or other disabilities, to safely self-evacuate or to be evacuated by others. Some communities are instituting voluntary, confidential registries of persons with disabilities who may need individualized evacuation assistance or notification. If you adopt or maintain such a registry, have procedures in place to ensure its voluntariness, guarantee confidentiality controls, and develop a process to update the registry. Also consider how best to publicize its availability. Whether or not a registry is used, your plan should address accessible transportation needs for people who use wheelchairs, scooters, or other mobility aids as well as people who are blind or who have low vision.

A transit bus equipped with a wheelchair lift is used to evacuate individuals and families.

Both public and private transportation may be disrupted due to overcrowding, because of blocked streets and sidewalks, or because the system is not functioning at all. The movement of people during an evacuation is critical, but many people with disabilities cannot use traditional, inaccessible transportation.

Action Steps: Evacuation with Accessible Vehicles

Identify accessible modes of transportation that may be available to help evacuate people with disabilities during an emergency. For instance, some communities have used lift-equipped school or transit buses to evacuate people who use wheelchairs during floods.

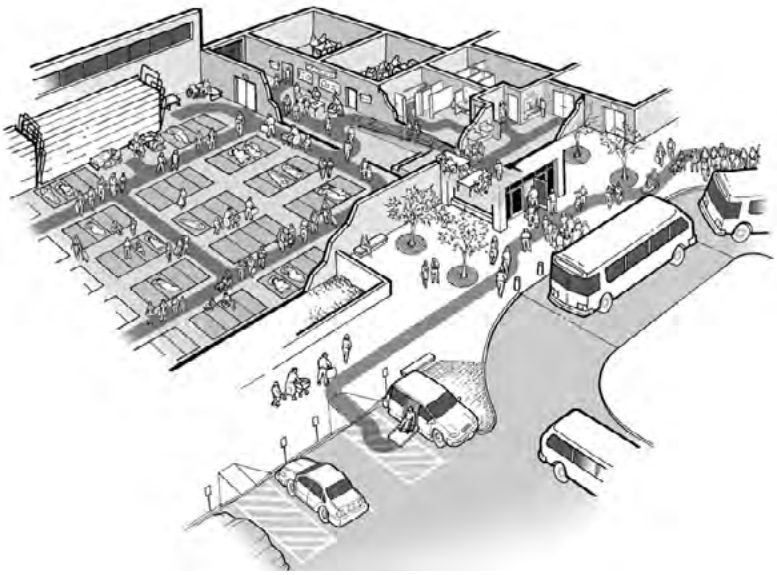
A lift-equipped school bus is used to evacuate an individual using a wheelchair and her family.

SHELTERING

When disasters occur, people are often provided safe refuge in temporary shelters. Some may be located in schools, office buildings, tents, or other areas. Historically, great attention has been paid to ensuring that those shelters are well stocked with basic necessities such as food, water, and blankets. But many of these shelters have not been accessible to people with disabilities. Individuals using a wheelchair or scooter have often been able somehow to get to the shelter, only to find no accessible entrance, accessible toilet, or accessible shelter area.

Action Steps: Accessible Shelters

Survey your community's shelters for barriers to access for persons with disabilities. For instance, if you are considering incorporating a particular high school gymnasium into your sheltering plan, early in the process you should examine its parking, the path to the gymnasium, and the toilets serving the gymnasium to make sure they are accessible to people with disabilities. If you find barriers to access, work with the facility's owner to try to get the barriers removed. If you are unable to do so, consider another nearby facility for your community sheltering needs.



A shelter with accessible features including parking, drop-off area, entrance, toilet rooms, and sleeping areas.

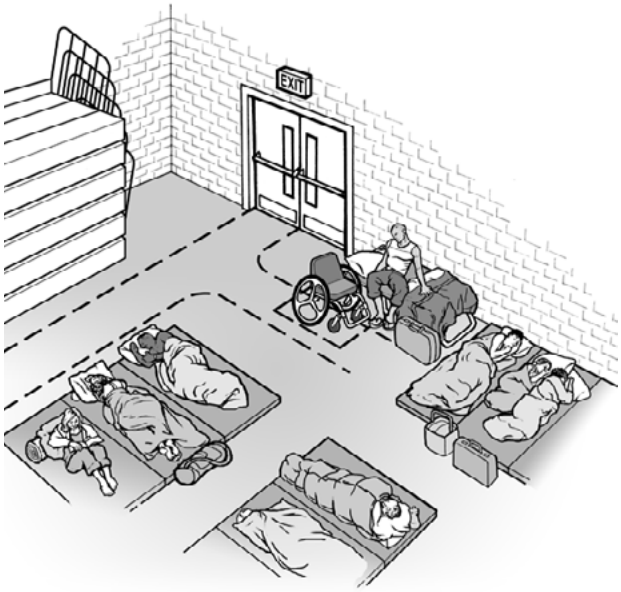
Until all of your emergency shelters have accessible parking, exterior routes, entrances, interior routes to the shelter area, and toilet rooms serving the shelter area; you should identify and widely publicize to the public, including persons with disabilities and the organizations that serve them, the locations of the most accessible emergency shelters.

Shelter staff and volunteers are often trained in first aid or other areas critical to the delivery of emergency services, but many have little, if any, familiarity with the needs of people with disabilities. In some instances, people with disabilities have been turned away from shelters because of volunteers' lack of confidence regarding the shelter's ability to meet their needs. Generally, people with disabilities may not be segregated or told to go to "special" shelters designated for their use. They should ordinarily be allowed to attend the same shelters as their neighbors and coworkers.

Action Steps: Input on Shelter Planning and Staff Training

Invite representatives of group homes and other people with disabilities to meet with you as part of your routine shelter planning. Discuss with them which shelters they would be more likely to use in the event of an emergency and what, if any, disability-related concerns they may have while sheltering. Develop site-specific instructions for your volunteers and staff to address these concerns.

A shelter worker helps a person onto a cot using a portable lift provided by the shelter.



A individual who uses a wheelchair sits on a cot that is placed against a wall. The height of the bed and the wheelchair seat are of similar height making it possible for this person to transfer from the wheelchair to the bed.

A shelter worker helps a man transfer onto a cot.

Many shelters have a "no pets" policy and some mistakenly apply this policy to exclude service animals such as guide dogs for people who are blind, hearing dogs for people who are deaf, or dogs that pull wheelchairs or retrieve dropped objects. When people with disabilities who use service animals are told that their animals cannot enter the shelter, they are forced to choose between safety and abandoning a highly trained animal that accompanies them everywhere and allows them to function independently.

Action Steps: Service Animals

Adopt procedures to ensure that people with disabilities who use service animals are not separated from their service animals when sheltering during an emergency, even if pets are normally prohibited in shelters. While you cannot unnecessarily segregate persons who use service animals from others, you may consider the potential presence of persons who, for safety or health reasons, should not be with certain types of animals.

A man using a wheelchair arrives at a shelter with his family and service animal.

A woman has a service animal lying on the floor next to her cot.

Individuals whose disabilities require medications, such as certain types of insulin that require constant refrigeration, may find that many shelters do not provide refrigerators or ice-packed coolers. Individuals who use life support systems and other devices rely on electricity to function and stay alive and, in many cases, may not have access to a generator or other source of electricity within a shelter.

Action Steps: Medications, Refrigeration, and Back-up Power

Ensure that a reasonable number of emergency shelters have back-up generators and a way to keep medications refrigerated (such as a refrigerator or a cooler with ice). These shelters should be made available on a priority basis to people whose disabilities require access to electricity and refrigeration, for example, for using life-sustaining medical devices, providing power to motorized wheelchairs, and preserving certain medications, such as insulin, that require refrigeration. The public should be routinely notified about the location of these shelters. In addition, if you choose to maintain a confidential registry of individuals needing transportation assistance, this registry could also record those who would be in need of particular medications. This will facilitate your planning priorities.

A person using a wheelchair picks up medication at the shelter.

People who are deaf or hard of hearing may not have access to audible information routinely made available to people in the temporary shelters. Individuals who are blind or who have low vision will not be able to use printed notices, advisories, or other written information.

Action Steps: Communications

Adopt procedures to provide accessible communication for people who are deaf or hard of hearing and for people with severe speech disabilities. Train staff on the basic procedures for providing accessible communication, including exchanging notes or posting written announcements to go with spoken announcements. Train staff to read printed information, upon request, to persons who are blind or who have low vision.

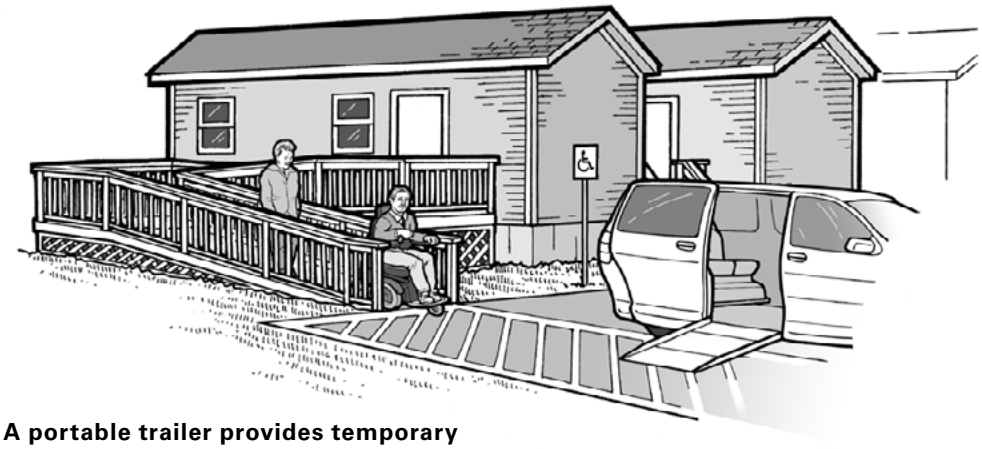
A shelter worker reads printed information to a woman who is blind.

RETURNING HOME

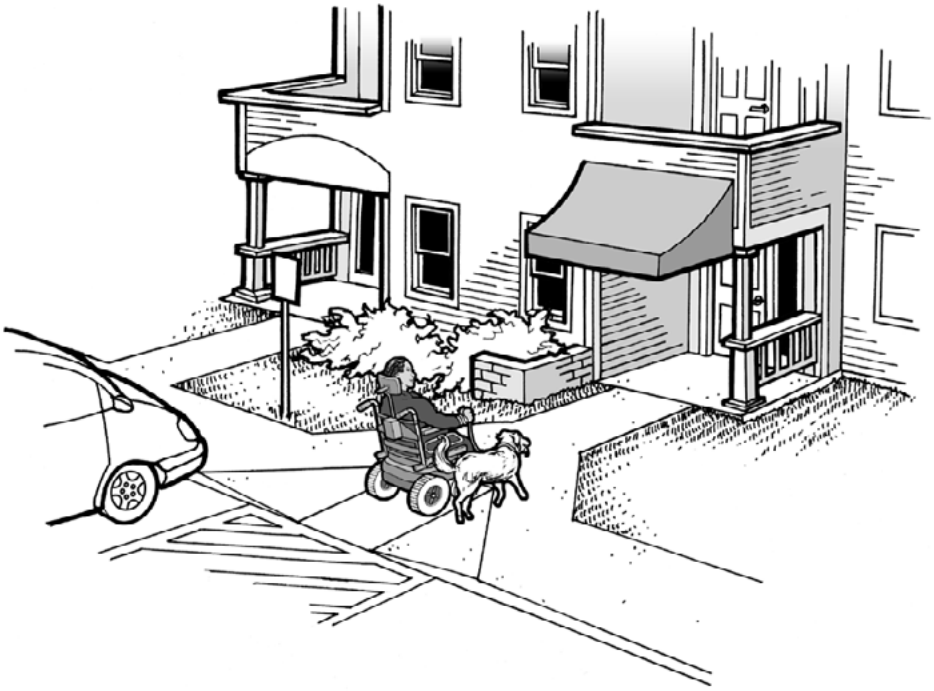
The needs of individuals with disabilities should be considered, too, when they leave a shelter or are otherwise allowed to return to their home. If a ramp has been destroyed, an individual with a mobility impairment will be unable to get into and out of the house. In case temporary housing is needed past the stay at the shelter, your emergency response plan could identify available physically accessible short-term housing, as well as housing with appropriate communication devices, such as TTY's, to ensure individuals with communication disabilities can communicate with family, friends, and medical professionals.

Action Steps: Planning

Identify temporary accessible housing (such as accessible hotel rooms within the community or in nearby communities) that could be used if people with disabilities cannot immediately return home after a disaster if, for instance, necessary accessible features such as ramps or electrical systems have been damaged.



A portable trailer provides temporary accessible housing for an individual who uses a wheelchair and his family. In addition to accessible features inside, the trailer also has an accessible entrance, accessible parking, and the trailer is located on an accessible route to other site features in the mobile home park.



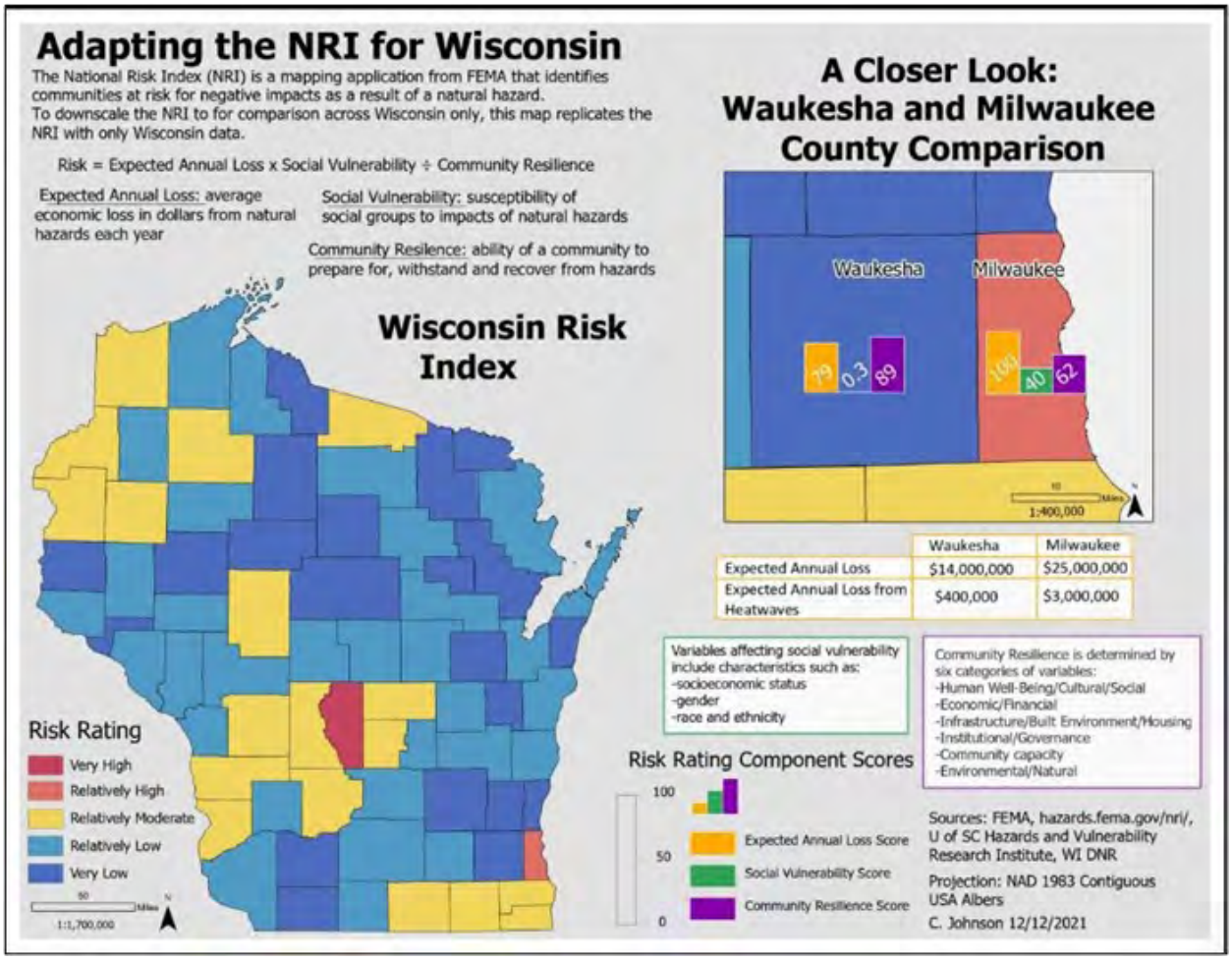
A man using a wheelchair and his service animal enters temporary accessible housing provided in an apartment building.

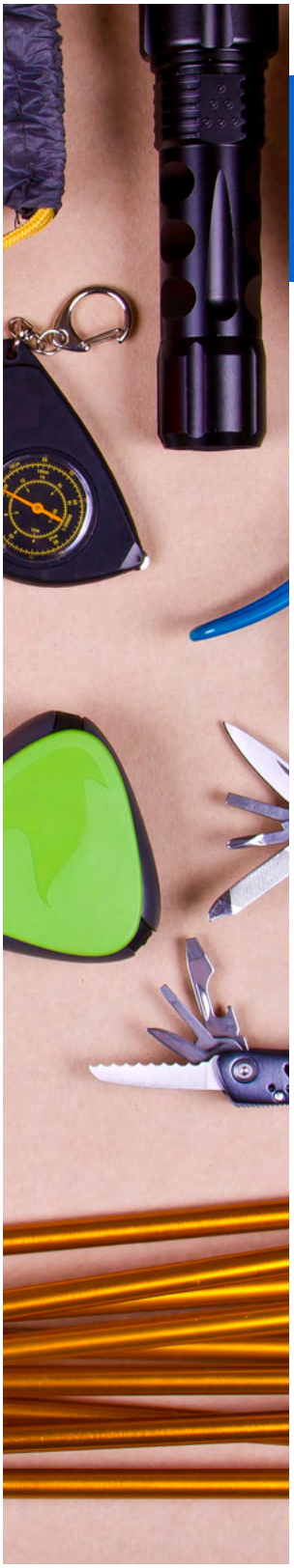
CONTRACTING FOR EMERGENCY SERVICES

Many local governments provide emergency services through contracts with other local governments or private relief organizations. These entities may not fully understand the role they need to play in meeting your obligation to provide accessible emergency services.

Action Steps: Contracting for Emergency Services

Make sure that contracts for emergency services require providers to follow appropriate steps outlined in this document. Review the terms of these contracts on a regular basis to ensure that they continue to meet the accessibility needs of people with disabilities. Provide training to contractors so that they understand how best to coordinate their activities with your overall accessibility plan for emergency services.


Adapting the NRI for Wisconsin
The National Risk Index (NRI) is a mapping application from FEMA that identifies communities at risk for negative impacts as a result of a natural hazard.
To downscale the NRI to for comparison across Wisconsin only, this map replicates the NRI with only Wisconsin data.
Risk = Expected Annual Loss x Social Vulnerability ÷ Community Resilience
Expected Annual Loss: average economic loss in dollars from natural hazards each year
Social Vulnerability: susceptibility of social groups to impacts of natural hazards
Community Resilence: ability of a community to prepare for, withstand and recover from hazards
Wisconsin Risk Index
Risk Rating
Very High
Relatively High
Relatively Moderate
Relatively Low
Very Low
1:1,700,000
A Closer Look: Waukesha and Milwaukee County Comparison
Waukesha
Milwaukee
19
0.3
89
100
40
62
1:400,000
Waukesha
Milwaukee
Expected Annual Loss
$14,000,000
$25,000,000
Expected Annual Loss from Heatwaves
$400,000
$3,000,000
Variables affecting social vulnerability include characteristics such as:
-socioeconomic status
-gender
-race and ethnicity
Community Resilience is determined by six categories of variables:
-Human Well-Being/Cultural/Social
-Economic/Financial
-Infrastructure/Built Environment/Housing
-Institutional/Governance
-Community capacity
-Environmental/Natural
Risk Rating Component Scores
100
50
0
Expected Annual Loss Score
Social Vulnerability Score
Community Resilience Score
Sources: FEMA, hazards.fema.gov/nri/, U of SC Hazards and Vulnerability Research Institute, WI DNR
Projection: NAD 1983 Contiguous USA Albers
C. Johnson 12/12/2021



FLOOD PREPAREDNESS

Take steps to protect you and your family before a flood hits.

Secure your home

- Contact your local or Tribal health department to familiarize yourself with community emergency plans.
- Contact to an insurance company about flood coverage as a renter or homeowner.
- Maintain a list emergency numbers in a contact list.
- If you live in a flood zone, raise electric components, furnace, and water heater above the flood zone level.
- Install backflow valves for drains, toilets, and other sewer connections.
- Install sump pumps with back-up power.

In the case of a flood watch or warning

- Gather emergency supplies (learn how on the next page!).
- Stay informed and listen to local weather reports.
- Turn off power.
- If time allows:
  - Bring outdoor possessions indoors and secure them.
  - Fill bathtubs, sinks, and plastic bottles with clean water.
  - **Do not walk through floodwater.** If water levels begin to rise, immediately go to higher ground.
  - Prepare for evacuation.
  - Make transportation arrangements and make sure the gas tank is full.
  - Check on friends, family, and neighbors that may be isolated or unaware of the conditions, or need help getting to a safe place.
  - Collect important documents like ID cards, insurance cards, and medical records.

In the case of an ordered evacuation

- Turn off the gas, electricity, and water.
- Disconnect appliances.
- Follow evacuation orders and evacuation routes.
- Take emergency supplies. (See a list on next page).
- Avoid flood zones and stay informed by listening to weather reports.
- Map a safe evacuation route in advance if you have access to a vehicle.

Transportation Planning

If you need transportation to a shelter, check with local agencies to find out if a contracted service or voucher is available. Call 211 to find a list of transportation options in your area:

- Urban, rural or regional public transit systems
- Transit services for elderly or disabled individuals (County Elderly and Disabled Transportation Programs, Tribal Elderly Assistance Programs, local senior centers, local human services agencies
- Private providers (cabs, Lyft/Uber, etc.)
- Neighbors, friends or relatives

Assemble a Disaster Emergency Kit

Gather the follow items if possible or call 211 or visit 211.org for available resources in your area:

- ☐ 3-day supply of water (one gallon of water per person, per day)
- ☐ 3-day supply of non-perishable food (and a manual can opener)
- ☐ Battery-operated radio and extra batteries
- ☐ Cell phone and charger
- ☐ Portable cell phone battery charger
- ☐ Flashlight and batteries
- ☐ First aid kit (bandages, gauze, tweezers, disinfectant, gloves, pain relievers, thermometer, etc.)
- ☐ Whistle to signal for help
- ☐ Dust mask
- ☐ Survival blanket (also known as a space blanket)
- ☐ Extra cash
- ☐ Pocket knife
- ☐ Wrench to turn off utilities
- ☐ Medications, hand sanitizer, moist towelettes, plastic ties, and garbage bags
- ☐ Local maps for evacuation
- ☐ Change of clothes (including rain jacket, gloves, hat, etc.)

Resources

- readywisconsin.wi.gov/make-a-plan/
- dhs.wisconsin.gov/climate

Wisconsin Department of Health Services
Division of Public Health
Climate and Health Program
P-00631A (02/2025)

GREEN INFRASTRUCTURE PRACTICES AND RESOURCES WITHIN MILWAUKEE COUNTY

APPENDIX H

Figure H.1
Reports Related to Green Infrastructure Practices Within Milwaukee County

Milwaukee Metropolitan Sewerage District, *Regional Green Infrastructure Plan*, June 2013.

Milwaukee Metropolitan Sewerage District, CH2M and Sweet Water, *Green Infrastructure Identification and Prioritization in the Menomonee River Watershed*, August 2015.

Milwaukee Metropolitan Sewerage District, GRAEF, *Stormwater Solutions Engineering, and Sixteenth Street Community Health Center Kinnickinnic River Watershed: Green Infrastructure Plan*, 2018.

Milwaukee Metropolitan Sewerage District, *2019 Resilience Plan*, 2019.

Milwaukee Metropolitan Sewerage District, Stormwater Solutions Engineering, LLC., Ruekert & Mielke, Inc., *Green Infrastructure Maintenance & Lessons Learned for Municipalities*, March 2020.

The Milwaukee Metropolitan Sewerage District (MMSD), US Army Corps of Engineers, City of Milwaukee, and Village of Shorewood, *Maximizing Stormwater Capture Using Green Infrastructure in the Combined Sewer Service Area*, 2020.

City of Milwaukee, *Green Streets Stormwater Management Plan*, March 2013.

City of Milwaukee, *Green Infrastructure Baseline Inventory*, April 2015.

City of Milwaukee, *Green Infrastructure Plan*, June 2019

Milwaukee Metropolitan Sewerage District, Stormwater Solutions Engineering, LLC., *Green Infrastructure Operations & Maintenance Standards Guide*, February 2020.

LAKE MICHIGAN COASTAL HAZARD MITIGATION RESOURCES

APPENDIX I

Figure I.1
Model Zoning Regulations for Bluff and Ravine Setbacks

These model regulations are primarily based on recommendations for bluff and ravine setbacks developed by Wisconsin Sea Grant. The regulations are intended to provide bluff and ravine setbacks along Lake Michigan for new development and, where lot depth is adequate, redevelopment to help protect structures and properties from bluff and ravine erosion and failure without reliance on shore protection measures. In addition to calculating a stable bluff slope, the model recommends including a setback equivalent to a 60-year bluff recession distance (twice the typical home mortgage loan period of 30 years and assumed useful life of a principal structure (i.e., house)) and a 100-foot setback from the top of the calculated bluff (including the recession rate and stable slope distance). The additional 100-foot setback is recommended to provide for uncertainties related to future stable slope angles, recession rates, the effect from nearby shore protection structures, and other factors. See Figure 5.9.

These regulations are not intended to be applied in areas of existing urban development, where deep setbacks would be difficult to implement. In such cases, bluff and ravine stabilization, subsurface and surface water control, bluff and ravine toe protection, or other measures may be needed in addition to maintaining existing bluff and ravine setbacks.

Additional recommendations and sources of information about bluff and ravine setbacks and other coastal protection measures are available from county hazard mitigation plans, Wisconsin Sea Grant, and the publication "*Protecting Coastal Investments*," published by UW-Extension and Wisconsin Sea Grant in 2008 (aqua.wisc.edu/publications/PDFs/ProtectingCoastalInvestments.pdf).

The attached model regulations are intended to be incorporated as a section in an existing county, city, village, or town zoning ordinance, including a county shoreland zoning ordinance. The attached regulations do not include provisions for appeals, variances, severability, nonconforming uses and structures, and similar considerations that would typically be addressed in other sections of a full zoning ordinance.

Please contact SEWRPC at (262) 547-6721 or sewrpc@sewrpc.org if you have any questions or would like a Microsoft Word version of this model section.

EROSION HAZARD SETBACK FROM BLUFFS AND RAVINES

(Note: Include in the "General Provisions" section of a zoning ordinance and number as appropriate.)

A. Purpose. Structures and soil absorption fields shall be set back from the top of bluffs and ravines along Lake Michigan in order to reduce erosion hazard and related damages to structures and property. These regulations do not guarantee nor warrant that development in compliance with its terms will be free from all erosion damage over the useful life of a structure.

B. Setback from Bluffs. The bluff setback shall be based upon the expected bluff recession distance over a 60-year period, plus the distance that would be needed to establish a stable slope, plus a minimum structure setback from the edge of the computed stable slope, as set forth below (See Figure 5.9):

1. The bluff recession distance for a 60-year period shall be calculated using a minimum recession rate of one foot per year, unless site-specific information justifying a greater distance is provided by the Zoning Administrator. The bluff recession distance shall be measured from the toe of the bluff.

2. The distance required to achieve a stable slope shall be a ratio of one foot vertical distance to 2.5 feet horizontal distance. The measurement shall be made from the landward edge of the bluff recession distance.

3. Soil absorption fields and structures, except those listed in paragraph 4 below, shall be set back a minimum of 100 feet from the landward edge of the stable slope distance.

4. Storage sheds, driveways, walkways, patios, and fences accessory to principal use may be permitted within the bluff setback area.

C. **Setback from Ravines.** All structures and soil absorption fields shall be set back from the top of a ravine. The ravine setback shall be based upon the distance that would be needed to establish a stable slope plus a minimum structure setback from the edge of the computed stable slope, as set forth below:

1. For ravines having a depth equal to or greater than 10 feet, as measured from the bottom of the ravine to the horizontal level of the land adjacent to the ravine, a distance required to achieve a stable slope using a ratio of one foot vertical distance to 2.5 feet horizontal distance shall be calculated. The measurement shall be made from the center of the deepest part of the ravine.

2. For ravines having a depth less than 10 feet as measured from the bottom of the ravine to the horizontal level of the land adjacent to the ravine, a distance required to achieve a stable slope using a ratio of one foot vertical distance to three feet horizontal distance shall be calculated. The measurement shall be made from the center of the deepest part of the ravine.

3. Soil absorption fields and structures, except those listed in paragraph 4 below, shall be set back a minimum of 100 feet from the landward edge of the stable slope distance determined in accordance with paragraphs 1 or 2 above.

4. Storage sheds, driveways, walkways, patios, and fences accessory to a principal use may be permitted within the ravine setback area.

D. **Modifications.** The Board of Zoning Appeals/Plan Commission may grant a conditional use permit as allowing a modification of the erosion hazard setback from bluffs or ravines upon presentation by the applicant of a detailed report by a registered Professional Engineer with demonstrable geotechnical expertise documenting lower recession rates, more stable slope conditions, plans for structural protection against wave attack, or plans for stabilization of the bluff or shoreline. Engineering studies evaluating slope stability shall use the top of the lake sediments or 0.75 the height of the bluff, whichever is greater, as the groundwater surface. The 100-foot setback from the top of bluffs and ravines required by Sections 2. B.3 and 2.C.3 above shall be provided from the landward edge of the modified stable slope distance.

RELATED DEFINITIONS

(Note: Include in the "Definitions" section of the zoning ordinance. Wisconsin Administrative Code or United State Code that define certain words or terms could be cross-referenced in place/instead of providing the definition herein as [illustrated by notes] noted in this Section where Sections (Sec.) of the Wisconsin Statues *(W.S),* Wisconsin Administrative Code *(WAC), and* United States Code *(U.S.C.) are cited.)*

Bluff

A hill, ridge, or similar landform significantly elevated above the surrounding landscape, having a broad, steep face or cliff, and adjoining the shoreline or coastal lowlands of Lake Michigan [or Lake Superior].
(Note: See Sec. NR 51.32 of WAC.)

[A landform whose upper elevation is at least *20* [*25*] vertical feet above the toe or base of a slope [the ordinary high-water mark] and which has a slope equal to or exceeding *20* percent.]

Bluff Recession Rate

The rate at which a bluff recedes because of erosion by the waters of Lake Michigan [and Lake Superior] and because of unstable slope conditions.

[***Bluff Line.*** A point where a significant change in slope on a visual horizon is viewed from a river or lake. This change in slope may take the form of a ridge protruding into a river valley or from a lake [ridge line overlooking a river valley or lake].
(Note: See Sec. NR 37.03(2) of WAC.)]

[***Bluff Zone.*** Land along a river or lake consisting of an area measured horizontally *100* feet behind the top of a *bluff line* to *100* feet outward from the bluff toe or base.
(Note: Also see Secs. 30.40(1r) of WS or NR 37.03(3) of WAC.)]

Coastal Waters. The waters within the territorial jurisdiction of the United States consisting of the Great Lakes, their connecting waters, harbors, roadsteads, and estuary-type areas such as bays, shallows, and marshes in the Great Lakes Areas, and, in other areas, includes those waters, adjacent to the shorelines, which contain a measurable quantity or percentage of sea water, including, but not limited to, sounds, bays, lagoons, bayous, ponds, and estuaries.
(Note: See 16 U.S.C. 1453(3).) [Title 16, Chapter 33, "Coastal Management Zone," Section 1453, "Definitions."]

Coastal Zone. The *coastal waters* and the adjacent shorelands including islands, transitional and intertidal areas, salt marshes, wetlands, and beaches.

[***Coastal Zone.*** The coastal waters (including the lands therein and thereunder) and the adjacent shorelands (including the waters therein and thereunder), strongly influenced by each other and in proximity to the shorelines of the several coastal states, and includes islands, transitional and intertidal areas, salt marshes, wetlands, and beaches. {The zone extends, in Great Lakes waters, to the international boundary between the United States and Canada and, in other areas, extends seaward to the outer limit of State title and ownership under the Submerged Lands Act (43 U.S.C. 1301 et seq.), the Act of March 2, 1917 (48 U.S.C. 749) [48 U.S.C. 731 et seq.], the Covenant to Establish a Commonwealth of the Northern Mariana Islands in Political Union with the United States of America, as approved by the Act of March 24, 1976 [48 U.S.C. 1801 et seq.], or Section 1 of the Act of November 20, 1963 (48 U.S.C. 1705), as applicable. The zone extends inland from the shorelines only to the extent necessary to control shorelands, the uses of which have a direct and significant impact on the *coastal waters*, and to control those geographical areas which are likely to be affected by or vulnerable to sea level rise. Excluded from the coastal zone are lands where the use is by law subject solely to the discretion of or which is held in trust by the Federal Government or its officers or agents.}
(*Note: See 16 U.S.C 1453(1).)*]

Coastal Zone Management. Managing *coastal zones* or areas to balance environmental, economic, human health, and human activities.

Ravine

A small, steep sided valley worn by running water (often tributaries flowing into Lake Michigan [and Lake Superior]) that opens onto a bluff located along the Lake Michigan [and Lake Superior] shoreline.

Figure I.2
Municipal Coastline Ordinances and Management Guidelines Within Milwaukee County

MUNICIPAL COASTLINE MANAGEMENT METHODS

Municipalities within Milwaukee County that are situated along the Lake Michigan coastline generally utilize an assortment of coastline management strategies to protect existing property and proposed development from potential bluff instability and erosion/recession hazards. Some such methods are establishing bluff setbacks, conducting site specific bluff stability studies, and constructing coastline protection structures.

In Milwaukee County, multiple municipalities that border Lake Michigan regulate development around and activity relating to lake bluffs within their jurisdiction.[201] Descriptions of existing coastline management strategies utilized by municipalities located along the County's Lake Michigan coast follow.

City of Oak Creek

The City of Oak Creek zoning ordinance includes requirements related to coastline management on development within the Lakefront Overlay District. Development within the Lakefront Overlay District is required to include coastline stabilization and lakefront access plans for Plan Commission review and approval. In addition, conditional use permits for lakefront development require that plans be provided for approval by the Common Council. Those plans should consider site topography, ordinary high-water elevations, and surface water flow and controls.

Village of Bayside

The Village of Bayside has established Land Development Ordinances related to coastline management that acknowledge the natural runoff patterns along ravines and lake bluffs. Per these ordinances, landscaping and construction of a building or structure on a lot along a ravine or lake bluff are subject to special requirements. These requirements include the location of the construction on the bluff, type and methods of construction, and restrictions on work below the bluff top.

Village of Fox Point

The Village of Fox Point municipal code, which acknowledges the potential for unstable soil conditions, underground water pressure, and disruptions to natural drainage patterns to compromise bluff stability along Lake Michigan and its tributary ravines, incorporates numerous requirements related to coastline management. To administer regulations relating to the Lake Michigan bluff slope or the bluff of tributary ravines, the code defines "top of the bluff" as the area on a lot that is up-slope of the Village of Fox Point bluff line delineated by SEWRPC.[202] Most of the regulations related to coastline management in the Village's municipal code are within Chapter 285, Stormwater Management, Erosion Control, and Bluff Regulation.

Village of Shorewood

Requirements related to coastline management as set forth in the Village of Shorewood zoning ordinance apply to properties located in Lake Drive Districts 1 (R-1) and 4 (R-4). Development is required to be set back from the bluff area at a distance sufficient to allow the natural runoff or percolation of water.

Village of Whitefish Bay

In the Village of Whitefish Bay, requirements related to coastline management apply to properties located on the bluff of Lake Michigan within District 1, the Lake Shore Residence District, or District 1A, Single-Family Residence District. These requirements necessitate that a registered professional engineer with certain qualifications[203] certify the safety of any proposed building or structure within 100 feet of the top edge of the bluff.

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[201] *Some municipalities' lake bluff regulations also relate to the bluffs of ravines that are tributary to Lake Michigan.*

[202] *The bluff line is the area where slopes steeper than six horizontal to one vertical (6H:1V) transition to slopes shallower than 6H:1V measured perpendicular to the one-foot contour lines across the entire parcel.*

[203] *Qualifications include a minimum of 10 years of geotechnical experience involving foundation investigation/engineering and shoreline slope stability evaluation.*

Figure I.3
Visual Signs of Coastal Erosion

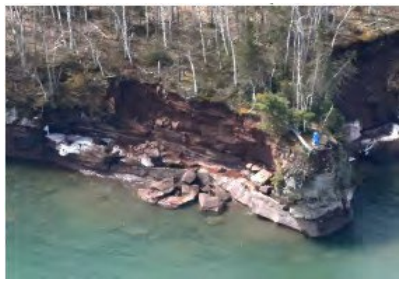
BLUFF AND BEACH FAILURES		
Exposed Infrastructure	**Loss of Vegetation**	**Ground Cracks**
An old pipe that has been exposed by beach erosion. *Photo: Ethan Theuerkauf*	*A sandy bluff has some remaining vegetation mats securing the slope surface.* *Photo: Wisconsin Shoreline Inventory and Oblique Photo Viewer.*	*Horizontal ground cracks at the top of the bluff that preceded a slope failure.* *Photo: Gene Clark*
Surface Water Drainage Rills or Gullies	**Groundwater Seepage**	**Curved Vegetation**
Rills on a bluff face caused by surface water drainage down the slope. *Photo: Hannah Paulson*	*Evidence of groundwater draining through slope of bluff face.* *Photo: Wisconsin Shoreline Inventory and Oblique Photo Viewer*	*Trees with curved trunks that are concave in the upslope direction.* *Photo: Adam Bechle*
Toe Erosion (Bank)	**Toe Erosion (Dune)**	**Slides or Slumps**
Toe Erosion on a sandy bank. *Photo: Adam Bechle*	*Toe erosion on a dune marked by loss of vegetation.* *Photo: Adam Bechle*	*A deep slump in sandy, mixed material bluff.* *Photo: PA Dept of Env Protection*

Figure I.3 (Continued)

ROCK BLUFF FAILURES

Fallen Debris, Exposed face

Debris piles and an exposed rock face indicate progressed erosion. Photo: Wisconsin Shoreline Inventory and Oblique Photo Viewer



Overhanging Vegetation

Overhanging and fallen trees and cracks in the rock face. show evidence of failure on the bluff top. Photo: Anne Iwata, Wisconsin Coastal

Structural Crack

Major cracks indicate a weak point in the rock bluff. Photo: Wisconsin Shoreline Inventory and Oblique Photo Viewer

Toe Undercutting

The toe of this bluff is starting to be undercut leaving an unsupported overhang. Photo: Wisconsin Shoreline Inventory and Oblique Photo Viewer.

Surface Water

Surface water flows over the bluff edge eroding carving out a small channel. Photo: Michigan Tech, EGLE

Freeze/Thaw Cycles

Water percolates into cracks, freezes, and expands creating instability. Photo: Wisconsin Shoreline Inventory and Oblique Photo Viewer.

Groundwater Seepage

Darkened areas in the clay cap over the bedrock bluff can indicate slope stability issues. Photo: Wisconsin Shoreline Inventory and Oblique Photo Viewer.

Deep Cracks

Major cracks spanning height of the rock face can indicate an imminent failure. Photo: Wisconsin Shoreline Inventory and Oblique Photo Viewer

Rockslide

Large fallen rock debris shows evidence of a rock slide. Photo: Michigan Tech, EGLE

CHAOS COASTAL HAZARDS OF SUPERIOR

Sea Grant MINNESOTA · DEPARTMENT OF NATURAL RESOURCES · Sea Grant · WISCONSIN COASTAL MANAGEMENT PROGRAM

Figure I.3 (Continued)

INFRASTRUCTURE FAILURES

Wave Overtopping

Overtopping of this revetment has led to erosion on the back side of the armor stone. Photo: Adam Bechle

Revetment Settling

Revetment stone has slid lakeward lowering the crest height. Photo: Adam Bechle

Unsuitable Materials

Flat pieces of concrete rubble do not interlock well and may be easily moved by strong waves. Photo: Adam Bechle

Roadway Washout

A road along Lake Superior is near failure from erosion. Photo: Rob Peterson

Breakwall washout

Breakwall flooding during high water levels. Photo: City of Conneaut

Overtopping resulting in a slide

High water overtopped this sea wall triggering an erosion slide. Photo: Toledo Bend Cabins

Overtopping resulting in scouring

Waves overtop a seawall and scour sediments and washout all vegetation. Photo: Adam Bechle

Cracked Seawall

Cracks and separations in the concrete cap of this sea wall. Photo: Biller Reinhart Engineering

Flanking

The Oak Creek Water Intake Structure with erosion flanking (redcircle). Photo: Wisconsin Shoreline Inventory and Oblique Photo Viewer

CHAOS COASTAL HAZARDS OF SUPERIOR

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Table I.1
Vegetation for Bluff Stabilization[a]

Common Name(s)	Scientific Name(s)	Typical Mature Height	Soil Type	Moisture	Sun/Shade Tolerance	Root Type	Usage Area
Herbaceous Plants							
Asters	*Symphyotrichum eurybia*	1-4'	Any	Wet to dry, depending on species	Full sun to shade, depending on species	Fibrous, some species spreading by rhizomes	Table, ravine, bluff face, toe
Bergamot	*Monarda fistulosa*	3-4'	Any	Moist to somewhat dry	Full sun to partial shade	Deep branched roots and shallow rhizomes	Table, face, toe
Blue Vervain	*Verbena hastata*	3-5'	Any	Wet to moist	Full sun	Fibrous	Table, toe
Common Milkweed	*Asclepias syriaca*	2-6'	Any	Moist to dry	Full sun to partial shade	Fibrous, spreading rhizomes	Table, bluff face, toe
Goldenrods	*Solidago* spp. and *Euthamia* spp.	2-6'	Any	Wet to dry, depending on species	Full sun to shade, depending on species	Fibrous, some species spreading by rhizomes	Table, ravine, bluff face, toe
Great Blue Lobelia	*Lobelia siphilitica*	2-4'	Any	Moist to medium	Full sun to light shade	Fibrous, shallow	Table, ravine, toe
Mountain Mint	*Pycnanthemum virginianum*	2-3'	Any	Moist to medium	Full sun to partial shade	Fibrous with shallow rhizomes	Table, face, toe
Sedges	*Carex* spp. and *Scirpus* spp.	0.5-3'	Any	Wet to dry, depending on species	Full sun to shade, depending on species	Fibrous, some species spreading by rhizomes	Table, face, ravine, toe
Tall Boneset	*Eupatorium altissimum*	3-4'	Any	Medium to dry	Full sun to partial shade	Fibrous	Table, face, toe
Warm-season grasses (Switchgrass, Big Bluestem, Little Bluestem, Indiangrass, etc.)	*Panicum virgatum, Andropogon gerardii, Schizachyrium scoparium, Sorghastrum nutans,* etc.	2-8'	Any	Moist to dry, depending on species	Full Sun	Fibrous, deeply penetrating root systems, some species spreading by rhizomes (esp. switchgrass)	Table, face, toe
White Snakeroot	*Ageratina altissima*	1-3'	Any	Moist to somewhat dry	Shade	Fibrous with shallow rhizomes	Table, ravine, toe
Wild Ryes	*Elymus* spp.	3-5'	Any	Moist to dry, depending on species	Full sun to shade, depending on species	Fibrous	Table, face, ravine, toe
Yellow Coneflower	*Ratibida pinnata*	3-5'	Any	Medium to dry	Full sun	Fibrous	Table, face, toe

Table continued on next page.

Table I.1 (Continued)

Common Name(s)	Scientific Name(s)	Typical Mature Height	Soil Type	Moisture	Sun/Shade Tolerance	Root Type	Usage Area
			Shrubs				
American Hazelnut	*Corylus americana*	10-12′	Any	Wet to dry	Full sun to light shade	Spreading	Bluff face
American Highbush Cranberry Viburnum	*Viburnum trilobum*	8-15'	Any	Moist	Full sun to light shade	Spreading, suckering	Table, ravine, toe
Arrowwood Viburnum	*Viburnum rafinesquianum*	6′	Any	Moist to dry	Shade to partial shade	Spreading, suckering	Ravine
Blackhaw Viburnum	*Viburnum prunifolium*	10-15'	Any	Somewhat moist to somewhat dry	Shade	Branching, woody, suckering	Table, ravine
Bladdernut	*Staphylea trifolia*	10-13′	Any	Moist, rich soils	Shade to full sun	Spreading, suckering	Ravine
Bush Honeysuckle	*Diervilla lonicera*	2-3′	Sandy to rocky	Dry	Shade to partial shade	Suckering	Bluff face
Common Ninebark	*Physocarpus opulifolius*	5-10'	Any	Moist to somewhat dry	Full sun to partial shade	Spreading, fibrous, extensive, suckering	Table, ravine, face, toe
Common Juniper	*Juniperus communis*	1-4′	Any	Wet to dry	Full sun	Spreading	Bluff face
Common Snowberry	*Symphoricarpos albus*	2-5'	Any	Moist to dry	Shade	Spreading, suckering	Table, ravine
Hop Tree	*Ptelea trifoliata*	10-20'	Any	Medium to dry	Full sun to partial shade	Extensive, but does not sucker from roots or rhizomes	Table, bluff face, toe
Leatherwood	*Dirca palustris*	5-7′	Any	Moist, rich soil	Shade to partial shade	Variable	Ravine
Maple-Leaf Viburnum	*Viburnum acerifolium*	4-6′	Any	Moist to dry	Shade to partial shade	Shallow	Ravine
Meadow Sweet	*Spiraea alba*	3-6′	Silt, clay, organic	Moist	Full sun	Suckering	Bluff face
Nannyberry Viburnum	*Viburnum lentago*	14-25'	Any	Moist to medium	Full sun to light shade	Spreading, fibrous, suckering	Table, ravine, toe
New Jersey Tea	*Ceanothus americanus*	1-3′	Sandy to silt	Dry	Full sun to partial shade	Extensive, fibrous, suckering	Bluff face
Pussy Willow, Missouri River Willow, and Bebb's Willow	*Salix discolor, Salix eriocephala, Salix bebbiana*	6-20'	Any	Wet to moist	Full sun to partial shade	Extensive, Fibrous, suckering	Table, ravine, face, toe
Red Elderberry	*Sambucus racemosa*	8-14'	Any	Moist to medium	Partial shade to light shade	Spreading, suckering	Table, ravine
Red-Osier Dogwood, Gray Dogwood, and Silky Dogwood	*Cornus sericea, Cornus racemosa,* and *Cornus amomum*	6-15'	Any	Wet to medium, depending on the species	Full sun to partial shade	Deep, extensive, suckering	Table, ravine, face, toe

Table continued on next page.

Table I.1 (Continued)

Common Name(s)	Scientific Name(s)	Typical Mature Height	Soil Type	Moisture	Sun/Shade Tolerance	Root Type	Usage Area
			Shrubs (continued)				
Round-Leaved Dogwood	*Cornus rugosa*	10-15'	Any	Medium to somewhat dry	Partial sun to light shade	Deep, extensive, suckering	Table, ravine, toe
Sandbar Willow	*Salix interior*	8-20'	Sands and loams	Wet to moist	Full sun to partial shade	Extensive, Fibrous, suckering to form large colonies	Table, ravine, face, toe
Soapberry	*Shepherdia canadensis*	3-9'	Neutral to Alkaline	Moist to dry	Full sun to partial shade	Spreading, suckering	Bluff face, toe (naturally occurs most often on exposed bluff headlands)
Sweet Fern	*Comptonia peregrina*	1-3′	Sandy	Dry	Full sun	Suckering, nitrogen fixing	Buff face
Winter Berry	*Ilex verticillata*	10-15′	Silt, clay, organic, prefers acidic	Wet to moist	Full sun to light shade	Spreading	Bluff face
Witch Hazel	*Hamamelis virginiana*	15-20′	Any	Moist to dry	Shade to partial shade	Variable	Ravine
			Trees				
Alternate-leaved Dogwood	*Cornus alternifolia*	15-25'	Loamy	Well drained, moist to medium	Full shade (understory tree)	Shallow, spreading root system benefits from leaf litter	Table, ravine
Balsam Poplar	*Populus balsamifera*	75-100′	Loamy	Well drained, moist to medium	Full sun	Shallow, spreading	Bluff face, ravine, toe
Basswood	*Tilia americana*	50-100'	Any	Moist to somewhat dry	Full sun to partial shade	Mostly lateral roots, can form adventitious roots when base is buried	Table, ravine
Black Cherry	*Prunus serotina*	45-80'	Any	Medium to dry	Full sun to partial shade	Tap root with shallow spreading roots, some roots up to four feet deep	Table, ravine
Bog Birch	*Betula pumila*	4-13′	Alkaline	Wet	Full sun	Shallow	Bluff face
Eastern Arborvitae	*Thuja occidentalis*	40-60'	Loams and clays	Moist to medium	Full sun to partial shade	Shallow, spreading root system	Table, ravine, bluff face

Table continued on next page.

Table I.1 (Continued)

Common Name(s)	Scientific Name(s)	Typical Mature Height	Soil Type	Moisture	Sun/Shade Tolerance	Root Type	Usage Area
Trees (continued)							
Hophornbeam	*Ostya virginiana*	25-50'	Any	Well drained, moist to somewhat dry	Full sun to light shade (understory tree)	Variable, shallow in heavy soils	Table, ravine
Oaks (esp. Bur Oak and Chinquapin Oak)	*Quercus spp.* (esp. *Quercus macrocarpa* and *Quercus muehlenbergii*)	40-120'	Any	wet to dry, depending on species	Full sun	Deep and wide-spreading roots, will re-sprout from stump or crown if top-killed	Table, ravine (where relatively stable)
Paper Birch	*Betula papyrifera*	50-70'	Any	Moist to somewhat dry	Full sun	Shallow, spreading root system, good for stabilization	Table, ravine, bluff face, toe
Peach-Leaved Willow	*Salix amygdaloides*	35-70'	Any	Wet to moist	Full sun	Dense, shallow roots, forms adventitious roots when base is buried	Table, ravine (especially along waterways), bluff face, toe
Red Maple	*Acer rubrum*	50-80'	All but the most high pH (>7.4) soils	Moist to medium	Full sun to partial shade	Shallow roots	Table, ravine
Speckled Alder	*Alnus incana*	15-30′	Silt, clay, organic	Wet to moist	Full sun	Spreading, suckering, nitrogen fixing	Bluff face
Wild Plum	*Prunus americana*	15-25'	Any	Medium to dry	Full sun	Spreading, shallow to medium depths.	Table, ravine, bluff face

[a] *As identified in* A Property Owner's Guide to Protecting Your Bluff, *a publication under preparation by the University of Wisconsin Sea Grant Institute and the Southeastern Wisconsin Regional Planning Commission as this report was being prepared, and adapted to suitability for local conditions.*

Source: Milwaukee County, University of Wisconsin Sea Grant Institute, and SEWRPC

Figure I.4
Coastal Resources

GREAT LAKES WATER LEVELS INFORMATIONAL MEETING

Coastal Hazard Resources

Sea Grant
University of Wisconsin

RESOURCES FOR GREAT LAKES COASTAL PROPERTY OWNERS

Coastal hazards like erosion and flooding along Wisconsin's Great Lakes coasts can be a threat to properties, particularly when water levels are high. Below is a list of available tools and resources to help individuals understand coastal hazards, weigh the risks coastal hazards pose to a property, understand options for addressing these hazards, and get started on implementing actions if necessary. While these tools can be helpful to gauge coastal hazard risk and develop a plan, major or immediate concerns should seek assistance from an engineer, geologist, or other qualified professional.

To find this document online, use web search Resources for Great Lakes Coastal Property Owners

UNDERSTANDING COASTAL PROCESSES

When dealing with coastal hazards like erosion and flooding, it can be helpful to understand how the forces of nature like water levels and waves can combine to threaten your property.

Living on the Coast

Booklet describing natural coastal processes and overall strategies to manage risk to coastal properties. It's essentially Coastal Engineering 101 and a go-to resource for helping people to get a broad understanding of the issues facing their property.
publications.aqua.wisc.edu/product/living-on-the-coast-protecting-investments-in-shore-property-on-the-great-lakes/

ASSESSING VULNERABILITY

Flood and erosion hazard mapping combined with a sense of historic water level conditions can be combined to help understand the risk a particular property may face from coastal hazards. While these tools can be helpful to gauge risk, any major and immediate concerns should seek professional assistance from an engineer, geologist, or other qualified professional.

Wisconsin Shoreline Inventory and Oblique Photo Viewer

View historic photos of the coast, assessments of bluff and shoreline conditions, and measurements of historic bluff and shoreline recession in a web-based, interactive map of Wisconsin coastal data.
floodatlas.org/asfpm/oblique_viewer/

FEMA Flood Map Service Center

A Search-By-Address tool to quickly see if a property is in a FEMA mapped floodplain, which indicates it is at high flood risk. Properties not in a FEMA mapped floodplain should still assume they are at a moderate to low flood risk.
msc.fema.gov/portal/search

WISCONSIN SEA GRANT COLLEGE PROGRAM seagrant.wisc.edu

Figure I.4 (Continued)

Great Lakes Water Level Dashboard

Interactive visualization of Great Lakes water level records to see historic highs & lows.
https://www.glerl.noaa.gov/data/dashboard/GLD_HTML5.html

Lake Level Viewer

Interactive map that visualizes the extent of rising and falling water levels along the shores of the Great Lakes from six feet above average lake levels to six feet below average lake levels.
coast.noaa.gov/llv/

REVIEWING YOUR OPTIONS

Many possible options exist to address coastal hazard issues. The appropriate actions for a particular property are often situational and site specific. The best option for a property experiencing coastal hazard issues can range from do-nothing, implementation of site management best practices, relocation of a house, and when absolutely necessary, construction of shore protection structures. The resources below offer some considerations when weighing these options.

Do I need flood insurance?

Wisconsin Department of Natural Resources website with information on flood insurance.
dnr.wi.gov/topic/floodplains/insurance.html

Adapting to a Changing Coast — Options and Resources for Lake Michigan Property Owners

Publication with an overview of 16 management options for adapting to changing bluffs and beaches. These options cover low-impact practices, bluff stability practices, structural shore protection, nature-based shore protection, and collaboration options.
publications.aqua.wisc.edu/product/adapting-to-a-changing-coast-for-property-owners/

Great Lakes Shore Protection Structures and Their Effects on Coastal Processes

Detailed fact sheet describing different types of shore protection structures and their potential impacts, both positive and negative, on the shoreline.
publications.aqua.wisc.edu/product/great-lakes-coastal-shore-protection-structures-and-their-effects-on-coastal-processes/

Stabilizing Coastal Slopes on the Great Lakes

Detailed fact sheet describing the coastal conditions and processes that can lead to bluff failure and some options for stabilizing the slope of a coastal bluff.
publications.aqua.wisc.edu/product/stabilizing-coastal-slopes-on-the-great-lakes/

IMPLEMENTING CONSTRUCTED MEASURES

If you decide that your best option is to proceed with constructed measures to protect your coastal property, then it's time to move forward and work with contractors, engineers, and potentially even your neighbors to consider, prioritize, and implement appropriate management actions.

Placing Erosion Control Structures on Great Lakes

Wisconsin Department of Natural Resources website with information on requirements and considerations for shore protection projects in Wisconsin
dnr.wi.gov/topic/Waterways/shoreline/GreatLakesErosionControl.html

Working with Engineers and Contractors on Shore Protection Projects

Fact sheet describing the process of finding and working with qualified coastal professionals (which can have unique challenges compared with working with engineers and contractors on typical projects).
publications.aqua.wisc.edu/product/working-with-engineers-and-contractors-on-shore-protection-projects/

Great Lakes Coastal Engineering Firms and Contractors

Partial list of known firms that have completed projects on Lakes Michigan or Superior. It is only a partial list and is in no way a list of "approved" or "recommended" firms.
seagrant.wisc.edu/our-work/focus-areas/coastal-processes-and-engineering/resources-for-property-owners/great-lakes-coastal-engineering-firms-and-contractors/

Sea Grant
University of Wisconsin

January 2020

COMMUNITY CAPABILITY ASSESSMENT

APPENDIX J

Figure J.1
Summary of Milwaukee County Community Capability Assessment Results

There was a total of nine participants in the Milwaukee County Community Capability Assessment. In the responses below, boxes highlighted yellow indicate the majority of the communities feel this item is needed to enhance hazard mitigation implementation.

1. Please indicate which community you are representing (include municipality and department/jurisdiction).

   The following communities and agencies participated in the Community Capability Assessment:
   - Milwaukee County
   - Village of Bayside
   - Village of Fox Point
   - Village of Greendale
   - Village of Hales Corners
   - City of Milwaukee
   - City of Oak Creek

2. **Planning:** What planning capabilities does your community have to implement hazard mitigation strategies?

	Responses		
	Yes	No	Unsure
Comprehensive Plan or Community Master Plan	8	0	1
Capital Improvement Plan	9	0	0
Economic Development Plan	4	4	1
Local Emergency Operations Plan	8	0	1
Continuity of Operations Plan	6	1	2
Transportation Plan	6	2	1
Stormwater Management Plan	8	0	1
Disaster Recovery Plan	6	2	1
Watershed Restoration Plan	5	1	2
Other (see below)	1	1	7

   Other: Land and Water Resource Management Plan

3. **Ordinances/Zoning:** What ordinances/zoning capabilities does your community have to implement hazard mitigation strategies?

	Responses		
	Yes	No	Unsure
General Zoning Ordinances	7	1	1
Building Code	7	2	0
Floodplain Zoning	7	2	0
Shoreland or Shoreland/Wetland Zoning	4	2	3
Farmland Preservation Programs	1	3	5
Other	1	3	5

Figure J.1 (Continued)

4. **Personnel/Technical:** What personnel/technical capabilities does your community have to implement hazard mitigation strategies?

	Responses		
	Yes	No	Unsure
Designated Emergency Management Manager	7	0	2
Planner/Engineer with land development knowledge	8	0	1
Engineer/other professional with building and infrastructure cost training	8	0	1
Planner/Engineer with understanding of natural hazards	8	0	1
Public Works	9	0	0
Building Inspector or Official	7	2	0
Floodplain Manager or Administrator	5	3	1
Grant writing	6	3	0
GIS analysis	8	1	0
Hazard data and information	6	0	3
Warning systems/services	7	1	1
Maintenance programs to reduce risk (e.g., tree trimming, clearing drainage systems)	9	0	0
Mutual aid agreements	7	0	2
Transportation/Infrastructure Services and/or Management	6	1	2
Human and Health Services	7	2	0
Other (see below)	1	2	6

Other:
Village of Fox Point- Many positions are a responsibility of a position and not an independent role.

5. **Financial/Funding:** What financial/funding capabilities does your community have to implement hazard mitigation strategies?

	Responses		
	Yes	No	Unsure
Capital Improvements Project Funding	8	0	1
Authority to levy taxes for special purposes	7	2	0
Stormwater Utility Fee	6	2	1
Community Development Block Grant	6	1	2
Fees for water, sewer, gas, or electrical services	7	1	1
Impact fees for new development	6	2	1
Other	1	3	5

Figure J.1 (Continued)

6. **Outreach/Engagement:** What outreach/engagement capabilities does your community have to implement hazard mitigation strategies?

	Responses		
	Yes	No	Unsure
Staff with knowledge in natural hazards to attend community gatherings	7	0	2
Ongoing public education or informational programs (e.g., household preparedness, fire safety)	6	2	1
Local citizen or nonprofit groups focused on vulnerable populations	3	1	5
Local citizen or nonprofit groups focused on environmental protection	3	2	4
Local citizen or nonprofit groups focused on emergency preparedness	2	2	5
Municipal newsletter	5	2	2
Emergency notification apps	4	4	1
Other	0	2	7

7. **Planning:** List specific planning capabilities that, if improved upon, would advance your community's ability to implement hazard mitigation projects or strategies.

   Responses:

   - Village of Fox Point- Community outreach is offered through different means and has historically a low impact.

8. **Ordinances/Zoning:** List specific ordinances/zoning capabilities that, if improved upon, would advance your community's ability to implement hazard mitigation projects or strategies.

   Responses:

   - City of Milwaukee Office of Emergency Management- Unsure. Would need to consult with City Development on this question.

9. **Personnel/Technical:** List specific personnel/technical capabilities that, if improved upon, would advance your community's ability to implement hazard mitigation projects or strategies.

   Responses:

   - City of Milwaukee Office of Emergency Management- A larger Citywide Emergency Management Department with a position focused on mitigation projects and tracking status.

Figure J.1 (Continued)

10. **Financial/Funding:** List specific financial/funding capabilities that, if improved upon, would advance your community's ability to implement hazard mitigation projects or strategies.

    Responses:

    - City of Milwaukee Office of Emergency Management- A dedicated infrastructure mitigation fund that could be set aside as part of the capital budget.

11. **Outreach/Engagement:** List specific outreach/engagement capabilities that, if improved upon, would advance your community's ability to implement hazard mitigation projects or strategies.

    Responses:

    - City of Milwaukee Office of Emergency Management- More community awareness brings our hazards to the forefront in efforts of increasing citizen preparedness efforts.

12. **Greatest Needs:** What do you consider the top three needs to improve your community's capacity to implement hazard mitigation projects and strategies?

    Responses:
    - City of Milwaukee OEM- More staff and more funding.
    - City of Oak Creek- Funding, staff, time.
    - Village of Bayside- Training, planning, funds.
    - Village of Greendale- Funding, staffing, training.
    - Village of Fox Point- Funding is the primary barrier to most mitigation efforts.
    - Village of Hales Corners- Staff. Time.
    - Milwaukee County OEM- Intergovernmental cooperation/agreement, consistent standards & implementation, prioritization strategy.
    - Milwaukee County Parks- Funding to implement this plan.

All of the responses and input provided by the participating Local Planning Team members in this assessment provided more context and information to the staff preparing this Milwaukee County Hazard Mitigation Plan Update.

POTENTIAL FUNDING PROGRAMS FOR PLAN RECOMMENDATIONS WITHIN MILWAUKEE COUNTY

APPENDIX K

Table K.1
Potential Funding Programs to Implement Plan Recommendations

Table 6.1 Reference Number	Administrator of Grant Program	Name of Funding Program	Eligibility	Types of Projects and Funding Eligibility Criteria	Assistance Provided
Federal Programs					
1	U.S. Economic Development Administration (EDA)	Disaster Supplemental Funding	Municipalities impacted by a Presidentially declared disaster	To plan and implement community resilience projects against future disasters	Varies, based on the circumstances of proposed projects; In general, 80 percent Federal cost-share; 20 percent local match
2	EDA	Public Works (PW) and Economic Adjustment Assistance (EAA) Programs	States, municipalities, tribal governments, higher education institutions, economic development districts, and nonprofit organizations	1. The PW supports the construction, expansion, or upgrade of public infrastructure and facilities 2. EAA supports the design and implementation of strategies to help communities that have experienced or are under the threat of serious damage to their underlying economic base	$150,000 to $1 million for EAA awards, with an average award of $650,000; $600,000 to $3 million for PW awards, with an average award of $1.4 million; Cost-share: 50 percent federal; 50 percent local
3	U.S. Department of Homeland Security, Federal Emergency Management Agency (FEMA)	Hazard Mitigation Grant Program (HMGP)	State agencies and participating National Flood Insurance Program (NFIP) communities; federally recognized tribes, tribal agencies, private nonprofits, and local government/communities	1. Floodproofing 2. Relocation of structures 3. Elevation of structures 4. Property acquisition 5. Conformity with approved state and local mitigation plan 6. Plan preparation 7. Safe room construction 8. Construction or modification of dikes, levees, floodwalls, seawalls, groins, jetties, breakwaters, and stabilized sand dunes	75 percent Federal cost-share assistance; 12.5 percent State match and 12.5 percent local match required[a]
4	FEMA	Flood Mitigation Assistance Grant Program	State agencies and participating NFIP communities; federally recognized tribes, tribal agencies, local governments/communities	1. Elevation, relocation, or demolition of insured structures 2. Acquisition 3. Dry floodproofing 4. Minor structural projects 5. Beach nourishment activities 6. Projects must be consistent with the goals and objectives identified in the State, tribal, or local mitigation plans	Funding is appropriated by Congress;[b] 75 percent Federal cost-share assistance; 25 percent local match required; two types of grants: Planning grant and project grant[c]

Table continued on next page.

Table K.1 (Continued)

Table 6.1 Reference Number	Administrator of Grant Program	Name of Funding Program	Eligibility	Types of Projects and Funding Eligibility Criteria	Assistance Provided
Federal Programs (continued)					
5	FEMA	Public Assistance Grant Program	State, tribal, territorial, and local governments; certain types of private nonprofit organizations	1. Rebuilding infrastructure damaged during a flood 2. Building infrastructure for portions of a community that are to be relocated outside of floodplains 3. Limited assistance with structural elevation and relocation	75 percent Federal cost-share assistance; the State determines the local match
6	FEMA	National Training and Education Division	State and local first responders; private sector and tribal entities	1. Provides preparedness training and exercise support to first responders in the event of a manmade or natural catastrophic event 2. Provides educational services in 18 professional disciplines	Provides over 150 training courses for first responders
7	FEMA	Building Resilient Infrastructure and Communities Program (BRIC)	Applicants: States, Territories, and Tribal governments Sub-applicants: Local and Tribal governments and State and Tribal agencies	1. Capability- and capacity-building activities 2. Hazard mitigation projects 3. Management costs	Funding is appropriated by Congress;[b] 75 percent Federal cost-share assistance provided (small, impoverished communities may be eligible for up to 90 percent federal cost-share); 25 percent State or local match is required
8	FEMA	Assistance to Firefighters Grant Program	City, County, Village, Tribal, and Township Fire Departments; nonaffiliated emergency medical services (EMS) organizations, State Fire Training Academies (SFTA)	1. Firefighter and EMT training 2. Firefighting and EMS equipment 3. Firefighter personal protective equipment	Cost-share matching fund requirements dependent upon size of population served by Fire Department
9	FEMA	Staffing for Adequate Fire and Emergency Response Grants (SAFER)	City, County, Village, Tribal, and Township Fire Departments (volunteer, combination, and career fire departments)	1. Hiring of new, additional firefighters to improve staffing levels 2. Recruitment and retention of volunteer firefighters involved with or trained in the operations of firefighting and emergency response	Salary and associated benefits for new firefighters and volunteer firefighters; Recipients of SAFER Recruitment and Retention of Volunteer Firefighters Activity grants are not required to contribute matching funds; Firefighters Activity grant recipients are required to contribute non-federal funds subject to a Position Cost Limit and a Cost Share (see program guidance)

Table continued on next page.

Table K.1 (Continued)

Table 6.1 Reference Number	Administrator of Grant Program	Name of Funding Program	Eligibility	Types of Projects and Funding Eligibility Criteria	Assistance Provided
Federal Programs (continued)					
10	National Fish and Wildlife Foundation	National Coastal Resilience Fund	Non-profits, state and local governments and agencies, educational institutions and commercial organizations	Nature-based solutions and restoration projects along the coasts	Up to $140 million in funding. Most awards range from $100,000 to $1 million Match is not required
11	National and Oceanic Atmospheric Administration (NOAA)	Coastal Habitat Grants Program	Institutions of higher education, nonprofit and for-profit organizations, State and local governments	1. Projects that help prepare coastal communities and ecosystems for extreme weather events 2. Helps communities recover	Federal funds awarded must be matched with non-federal funds at a 2:1 ratio
12	NOAA	Coastal Habitat and Resilience Grants for Tribes and Underserved Communities	State and county governments, special district governments, for and non-profit organizations, schools, tribal governments, and small businesses	Projects that will advance the coastal habitat restoration and climate resilience priorities of tribes and underserved communities	Award amounts range from $75,000 to $2 million for the entire award Match not required
13	NOAA	Transformational Habitat Restoration and Coastal Resilience Grants	State and county governments, special district governments, for and non-profit organizations, schools, tribal governments, and small businesses	1. Sustaining productive fisheries and strengthening ecosystem resilience 2. Fostering regionally important habitat restoration 3. Enhancing community resilience to climate hazards and providing other co-benefits 4. Providing benefit to underserved communities,	Match not required Award Ceiling: $10,000,000 Award Floor: $750,000
14	U.S. Army Corps of Engineers (USACE)	Snagging and Clearing for Flood Risk Management Program	State and local units of government	1. Removal of obstructions that restrict flood flows of navigable waters 2. Projects must be designed and constructed by the Corps	Federal share cannot exceed $500,000 for a given project; cost-share program with local match of 35 percent for design and preparation; construction cost varies between 30 percent and 65 percent federal share
15	USACE	Emergency Streambank and Shore Protection Program	Local governments	Bank protection of highways, highway bridges, essential public works, churches, hospitals, schools, and other nonprofit public services from flood induced erosion	Federal share cannot exceed $5 million for a given project; cost-share program with local match of 35 percent for design and construction required

Table continued on next page.

Table K.1 (Continued)

Table 6.1 Reference Number	Administrator of Grant Program	Name of Funding Program	Eligibility	Types of Projects and Funding Eligibility Criteria	Assistance Provided
Federal Programs (continued)					
16	USACE	Small Hurricane and Storm Damage Reduction Program	State agencies and local units of government	1. Beach nourishment 2. Floodproofing 3. Other structural and nonstructural storm damage reduction projects	Federal share cannot exceed $5 million for a given project; cost-share program with local contribution of 35 percent for design and construction required
17	USACE	Water Resources Development and Flood Control Acts	Local governments	1. Water resources planning assistance 2. Emergency streambank and shoreline protection	50 percent for studies and 65 percent for project implementation of Federal cost-share assistance; 35 to 50 percent local match is required
18	USACE	Flood Risk Management Program	Local governments and special authorities	Assistance for planning, design, and construction of structural and non-structural flood control projects. Projects are not limited to any particular type of improvement.	Feasibility study is 100 percent federally funded up to $100,000; 50 percent local match required for any costs exceeding $100,000; 65 percent federal cost share for project implementation with 35 percent local match required
19	USACE	Floodplain Management Services Program	State, regional, and local governments; federally recognized Native American Tribes; other non-federal public agencies	1. Floodplain delineation 2. Flood hazard evaluation 3. Dam break analysis 4. Stormwater management 5. Flood risk reduction	100 percent federal cost-share assistance provided; entities may provide voluntary contributions
20	USACE	Flood Damage Reduction Program	State and local units of government	1. Projects designed to reduce the impact of flood events 2. Projects must be designed and constructed by the Corps	50 to 65 percent Federal cost-share assistance above $100,000 and cannot exceed $10 million; 35 to 50 percent local match is required
21	U.S. Department of Agriculture-Farm Services Agency (USDA-FSA)	Conservation Reserve Program	Individual landowners in a 10- or 15-year contract. Farmer must have owned or operated the land for at least 12 months prior to the previous program sign-up period.	1. Riparian buffers 2. Trees 3. Windbreaks 4. Grassed waterways 5. Permanent grasses 6. Wetland development and restoration	50 percent Federal cost-share assistance; 50 percent local match from individual; an annual rental payment for the length of the contract is also provided

Table continued on next page.

Table K.1 (Continued)

Table 6.1 Reference Number	Administrator of Grant Program	Name of Funding Program	Eligibility	Types of Projects and Funding Eligibility Criteria	Assistance Provided
Federal Programs (continued)					
22	USDA-FSA	Emergency Conservation Program	Individual landowners	1. Grading and shaping farmland 2. Restoring conservation structures 3. Redistribution of eroded soil 4. Debris removal 5. Projects must be in response to a natural disaster	Up to 75 percent Federal cost-share assistance, the remaining is determined by the committee reviewing the application
23	USDA-FSA	Emergency Forest Restoration Program	Individual non-industrial private forest landowners	Restore privately owned forests damaged by natural disasters	Funding and technical assistance provided under a 10-15 year contract
24	USDA-FSA	Noninsured Disaster Assistance Program (NAP)	Landowners or tenants that experienced direct damaging weather or adverse natural occurrence to crops during the eligible crop coverage period before or during harvest	Protecting non-insurable crops against natural disasters, including drought, freeze, hail, excessive moisture, or excessive wind, flood, and excessive heat, or insect infestation.	NAP provides basic coverage equivalent to the catastrophic level risk protection plan of insurance coverage, which is based on the amount of loss that exceeds 50 percent of expected production at 55 percent of the average market price for the crop
25	USDA-FSA	Farmable Wetland Program	Individual agricultural landowners in 10- or 15- year contracts	Restore currently farmed wetland	One-time $100 per acre Federal signing incentive; up to 50 percent Federal cost share assistance for installation of practices plus one-time incentive payment of 40 percent of practice installation cost; annual rental payments based on the weighted average dryland cash rate
26	U.S. Department of Agriculture-Forest Service	Community Forest and Open Space Conservation Program	Tribal entities, local governments, and qualified conservation nonprofit organizations	Projects aimed to acquire and establish forests that will provide community and economic benefits through active forest management, clean water, wildlife habitat, educational opportunities, and public access for recreation	Program pays up to 50 percent of project costs and requires a 50 percent non-federal match
27	U.S. Department of Agriculture-Natural Resources Conservation Service (USDA-NRCS)	Agricultural Conservation Easement Program-*Wetlands Reserve Easements*	Local government and individual landowners	1. Purchase agricultural land easements that protect the conservation values of eligible land 2. Wetland protection, restoration, and enhancement	Permanent easement: NRCS pays 100 percent of easement value and 75 to 100 percent of restoration cost 30-year easement: NRCS pays 50 to 75 percent of easement value and 50 to 75 percent of restoration cost

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Table K.1 (Continued)

Table 6.1 Reference Number	Administrator of Grant Program	Name of Funding Program	Eligibility	Types of Projects and Funding Eligibility Criteria	Assistance Provided
Federal Programs (continued)					
28	USDA-NRCS	Conservation Stewardship Program	Individual landowners in a five-year contract	1. Filter strips 2. Riparian Buffers 3. Wildlife corridors 4. Stream habitat improvement	Payments for maintaining and/or enhancing natural resources not to exceed $40,000 per year or $200,000 over a five-year period
29	USDA-NRCS	Watershed Protection and Flood Prevention Program	State and local units of government; tribal governments	1. Watershed protection 2. Flood prevention measures 3. Benefits that are directly related to agriculture must be at least 20 percent of the total project benefits 1. Watersheds can be no larger than 250,000 acres	Cost-share rates vary depending on the type of measure and the purpose to which the cost is allocated; total average annual monetary benefits equal $2.2 billion
30	USDA-NRCS	Emergency Watershed Protection Program – *Floodplain Easement Option*	Individual landowners provided they have a local sponsor such as a local unit of government	1. Sale of agricultural flood prone lands to NRCS for floodplain easements 2. Land must have a history of repeated flooding (at least twice in the past 10 years) 3. Landowner retains most of the rights as before the sale 4. NRCS has authority to restore the floodplain function and value	The USDA pays the landowner the lowest of three options: a geographic rate, the fair market value of the land, or an offer made by the landowner; 75 percent Federal cost-share assistance; 25 percent local match is required[d]
31	USDA-NRCS	Emergency Watershed Protection Program - *Recovery Assistance*	Individual landowners provided they have a local sponsor such as a local unit of government	1. Debris removal 2. Reshaping and protection of eroded streambanks 3. Repair levees and structures 4. Repair damaged drainage facilities	Up to 75 percent Federal cost-share assistance; 25 percent local match is required
32	USDA-NRCS	Environmental Quality Incentives Program (EQIP)	Agricultural producers, owners of non-industrial private forestland, Indian tribes, and those with an interest in agricultural or forestry operations	1. Animal waste management practices 2. Soil erosion and sediment control practices 3. Nutrient management 4. Groundwater protection 5. Habitat improvement	Up to 75 percent Federal cost-share assistance; 25 percent local match is required
33	U.S. Department of the Interior-National Park Service	Rivers, Trails, and Conservation Assistance Program	Municipalities	Supports community-led natural resource conservation and outdoor recreation projects, including natural-based flood control measures, such as riverbank restoration	Free of service, no cost and no cost-share requirements

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Table K.1 (Continued)

Table 6.1 Reference Number	Administrator of Grant Program	Name of Funding Program	Eligibility	Types of Projects and Funding Eligibility Criteria	Assistance Provided
Federal Programs (continued)					
34	U.S. Fish and Wildlife Service (USFWS)	North American Wetlands Conservation Grants Program	Private or public organizations	1. Land acquisition 2. Restoration, management, and enhancement of wetland ecosystems and other habitat for migratory birds and other fish and wildlife	Applicants must match their grant request at no less than a 1-to-1 ratio; requests for small grants may not exceed $100,000
35	USFWS	Partners for Fish and Wildlife Habitat Restoration Program	Private landowners for a 10-yearminimum contract	1. Restoration of degraded wetlands, native grasslands, stream and riparian corridors, and other habitat areas	Full cost-share and technical assistance; individual projects cannot exceed $25,000
36	USFWS-National Fish and Wildlife Foundation (NFWF)	Five-star and Urban Waters Restoration Grant Program	Nonprofit organizations, local governments, municipal governments, Indian tribes, educational institutions	1. Wetland restoration projects 2. Riparian restoration projects 3. Coastal and forest restoration projects 4. Projects must be part of a larger watershed project 2. Projects must have at least five contributing parties	$2 million available nationally annually; project awards range from $20,000 to $50,000, average award $30,000; 1:1 non-federal match ratio required; higher local match preferred
37	U.S. Small Business Administration	Disaster Loan Program	Homeowners, renters, and businesses	1. Property repair 2. Property replacement 3. Meeting building code requirements 4. Involuntary relocations out of a special flood hazard area	Low interest loans
38	U.S. Environmental Protection Agency (EPA)	Environmental Education Local Grants	Local or State education agencies, colleges, and nonprofit organizations; State environmental agencies, tribal education agencies, and noncommercial educational broadcasting agencies	1. Improving environmental education teaching skills 2. Educating teachers, students, or the public about human health problems 3. Building capacity for environmental education programs 4. Education communities 5. Educating the public through print, broadcast, or other media	$3 million available nationally,[b] grants range from $50,000 to $100,000; up to 75 percent federal cost share assistance, 25 percent local match is required
39	EPA	Drinking Water State Revolving Fund (DWSRF)	States and municipalities	Construction of drinking water infrastructure projects, including modifications to ensure system capacity during flooding, and planning for flooding events	Individual states allocate funds to prioritized projects. Most assistance is for loans that have to be repaid 100 percent to the DWSRF

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Table K.1 (Continued)

Table 6.1 Reference Number	Administrator of Grant Program	Name of Funding Program	Eligibility	Types of Projects and Funding Eligibility Criteria	Assistance Provided
Federal Programs (continued)					
40	EPA	Environmental Justice Small Grants Program	Incorporated nonprofit organizations including, but not limited to, environmental justice networks, faith-based organizations, and tribal organizations	Community-driven projects that engage, educate, and empower communities to better understand local environmental and public health issues and develop strategies for addressing those issues	Up to $75,000 depending on availability of funds
41	U.S. Department of Health and Human Services, Health Resources and Services Administration	Emergency Medical Services for Children	State governments, public and private nonprofit institutions, U.S. territories, and schools of medicine	1. Aids with improvement and expansion of trauma and critical emergency medical services for children 2. Preferred programs aid populations with special needs (Native Americans, minorities, and the disabled)	No statutory matching requirements. Grants generally range from $130,000 to $3 million. Amounts awarded vary based on the scope of the project
42	U.S. Department of Transportation (USDOT)	Rebuilding American Infrastructure with Sustainability and Equity (RAISE) Transportation Grants	State, local, and tribal governments, port authorities, and educational institutions	Construction, design, and/or planning projects that will have a significant impact on roads, bridges, transit, rail, ports, or intermodal transportation systems	Greater than $10 million available; a match is required Match not required
State Programs					
43	Fund for Lake Michigan	Fund for Lake Michigan	Non-profit organizations, state, county and municipal governments and agencies, tribes, universities and other educational institutions	1. Stormwater 2. Green Infrastructure 3. Beach, coastal, and streambank restoration 4. Education/outreach 5. Watershed planning/monitoring	Award between $750,000 and $1,000,000 in grants each quarter Match not required
44	Wisconsin Department of Administration (DOA)	Community Development Block Grant Program-*Emergency Assistance Program*	Local governments that have low to moderate income populations	1. Repair of disaster related damage to dwellings 2. Assistance to purchase replacement dwellings 3. Repair and restore public facilities and infrastructure	For public facilities/infrastructure, funds are awarded as a grant, requiring a 25 percent local match for the total project expense For housing, funds are awarded as a grant For business assistance, funds may be awarded as a loan or a grant
45	DOA	Community Development Block Grant Program-*Public Facility Program*	Local governments that have low to moderate income populations	1. Improvements and repairs to public infrastructure 2. Construction, expansion, or improvement to community facilities	No matching requirements Amounts awarded vary based on assessed community needs

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Table K.1 (Continued)

Table 6.1 Reference Number	Administrator of Grant Program	Name of Funding Program	Eligibility	Types of Projects and Funding Eligibility Criteria	Assistance Provided
State Programs (continued)					
46	DOA	Community Development Block Grant Program-*Flexible Facilities Program*	Local governments	Construction, repair, or expansion of community facilities with the purchase and/or installation of digital technology infrastructure for remote high speed internet access	Maximum award amount per project: $4.25 million
47	DOA	Non-State Grant Program	Non-state organizations that can show: • Proof of not-for-profit status • Proof of grantee match of at least 50 percent of the total project cost • Proof of plans and specifications by an architecture/engineering firm of record	Funding to non-state organizations for construction projects that benefit the public	Up to 50 percent of total project cost
48	DOA	Wisconsin Coastal Management Program Grants	State, local, and tribal governmental agencies, schools, and non-profit organizations	1. Coastal wetland protection and habitat restoration 2. Nonpoint source pollution control 3. Coastal resource and community planning 4. Great Lakes education 5. Public access and historic preservation projects	Approximately $1.6 million of WCMP Grants will be available Nonfederal match required: • 50 percent of total project for projects < $60,000 • 60 percent of total project for projects > $60,000
49	Wisconsin Department of Natural Resources (WDNR)	Municipal Flood Control Grants	Cities, villages, towns, metropolitan sewerage districts	1. Acquisition and removal of structures 2. Flood proofing and elevation of structures 3. Riparian restoration projects 4. Acquisition of vacant land or purchase of easements 5. Construction of stormwater and groundwater facilities related to flood control and riparian restoration projects 6. Flood mapping	50 percent State cost-share assistance; 50 percent local match
50	WDNR	Knowles-Nelson Stewardship Grant Program	Local government and nonprofit conservation organizations	1. Streambank protection projects 2. Land acquisition of stream corridors for water quality improvement	50 percent State cost-share assistance; 50 percent local match is required
51	WDNR	Dam Removal Grant Program	Counties, cities, villages, towns, lake districts, and private dam owners	1. Dam removal planning 2. Dam removal 3. Restoration of impoundment	State covers 100 percent of project costs up to $50,000

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Table K.1 (Continued)

Table 6.1 Reference Number	Administrator of Grant Program	Name of Funding Program	Eligibility	Types of Projects and Funding Eligibility Criteria	Assistance Provided
State Programs (continued)					
52	WDNR	Municipal Dam Grant Program	Counties, cities, villages, tribes, inland lake protection and rehabilitation districts	1. Dam repair, reconstruction, or modification to improve safety 2. Dam abandonment and removal	For repair, reconstruction, or modification projects grant awards cover 50 percent of the first $1 million and 25 percent of the next $2 million of eligible project costs For abandonment and removal projects, grant awards will cover 100 percent of the first $1 million of eligible project costs
53	WDNR	Land and Water Conservation Fund Program	State agencies and local units of government	1. Planning for acquisition of parks 2. Land acquisition for parks and open space 3. Supporting facilities that enhance recreational opportunities	50 percent cost-share assistance provided
54	WDNR	Urban Nonpoint Source and Stormwater Grants Program	Local units of government, tribal governments, regional planning commissions, and special purpose lake, sewerage, and sanitary districts	1. Planning 2. Educational and information activities 3. Ordinance development and enforcement 4. Land acquisition and easement purchase 5. Storm water detention ponds 6. Streambank and shoreline stabilization	70 percent State cost-share assistance for projects not involving construction, requiring a 30 percent local match; 50 percent State cost-share assistance for projects involving construction, requiring a 50 percent local match
55	WDNR	Surface Water Grant Program	Counties, cities, local units of government, lake associations, natural resource agencies, and town sanitary districts	1. Habitat protection 2. Reduce runoff 3. Best management projects 4. Comprehensive planning 5. Education and outreach	Cost-share, DNR provides 67 percent cost-share for planning grants and 75 percent for management grants
56	WDNR	Urban Forestry Grant and Urban Forestry Catastrophic Grants	Cities, villages, towns, counties, tribes and 501(c)(3) nonprofit organizations	1. Depends based on whether Regular Grant, Startup Grant, or Catastrophic Storm Grant. 2. Community tree management, maintenance or education within Wisconsin cities, villages or other areas of concentrated development	Competitive cost-share grants of up to $25,000
57	WDNR	Wisconsin Forest Landowner Grant Program	Individual landowners with a Forest Stewardship Plan prepared by a forester	1. Stream buffer establishment 2. Streambank stabilization 3. Wetland restoration	Up to 50 percent cost-share assistance; 50 percent local match is required

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Table K.1 (Continued)

Table 6.1 Reference Number	Administrator of Grant Program	Name of Funding Program	Eligibility	Types of Projects and Funding Eligibility Criteria	Assistance Provided
State Programs (continued)					
58	Wisconsin Department of Transportation (WisDOT)	Disaster Damage Aids (DDA)	Local governments. Road must be closed or rendered impassable due to the disaster damage or damaged caused by government emergency response units.	Road repair and maintenance to any highway that is not on the State Trunk Highway System	For claims with final costs, applicant receives 75 percent of replacement costs plus 50 percent of improvement costs For claims ≤ $15,000, applicant may accept payment equal to 75 percent of WisDOT's estimate for all repairs (replacement and improvement), which may include final costs if available. For claims submitted for damage by any governmental unit in response to the disaster, applicant receives 70 percent of replacement. If Federal-aid is granted for damage reimbursement, it shall be in lieu of aid otherwise available under DDA
59	WisDOT	Emergency Relief Program	Roadway or roadway structure damage on Federal-Aid highways (Major collectors and above) resulting from a natural disaster. Governor's State of Emergency Declaration required.	1. Repair physical damage 2. Debris removal 3. Traffic control and detour signing	Emergency repairs are 100 percent covered if done within 180 days of the event, otherwise paid on a prorated basis. Match for permanent restoration projects are 90/10 (Interstate) or 80/20 (non-Interstate).
60	WisDOT	Local Bridge Improvement Assistance	Counties, cities, villages, and towns are eligible for rehabilitation funding on bridges with sufficiency ratings of 80 or less, and replacement funding on bridges with sufficiency ratings less than 50.	Rehabilitate and replace very deficient existing local bridges on Wisconsin's local highway systems	Awards made in 6 year cycles and next set of bridge applications will be due in 2029.
61	WisDOT	Local Roads Improvement Program	Local governments	1. Road construction 2. Road maintenance 3. Snow plowing 4. Shoulder grading 5. Pavement marking 6. Curb and gutter repairs	Pays up to 50 percent of total eligible costs, with local governments providing the balance

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Table K.1 (Continued)

Table 6.1 Reference Number	Administrator of Grant Program	Name of Funding Program	Eligibility	Types of Projects and Funding Eligibility Criteria	Assistance Provided
State Programs (continued)					
62	Wisconsin Emergency Management (WEM)	Pre-Disaster Flood Resilience Grant Program	Municipalities, Counties, Regional Planning Commissions, Tribal communities, and Nonprofits and private organizations	1. Identify flood vulnerabilities 2. Identify options to improve flood resiliency 3. Restore hydrology in order to reduce flood risk and damages in flood-prone communities	75 percent state funds 25 percent non-state funds; may be federal, local, private, or nonprofit; may include in-kind
63	Wisconsin Public Service Commission (WPSC)	Telecommunications, Water, Energy Divisions	Local governments	Incorporate disaster resilience into regulation development, land use practices and environmental impacts of public utilities	General Utility Assistance

Note: Cost-share and local match requirements reported in this table can vary depending on specific details for individual projects.

[a] *The non-Federal share is 25 percent. In Wisconsin, the State Division of Emergency Management pays 12.5 percent, and the local community pays 12.5 percent.*

[b] *Funding available on an annual basis.*

[c] *Municipalities must have a flood mitigation plan to be eligible for a project grant.*

[d] *In kind services are allowed as a part of the local cost-share assistance.*

Source: SEWRPC

SOUTHEASTERN WISCONSIN
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