COMMUNITY ASSISTANCE
PLANNING REPORT NO. 282
3RD EDITION

CITY OF MILWAUKEE ALL HAZARDS MITIGATION PLAN UPDATE

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CITY OF MILWAUKEE ALL HAZAARDS MITIGATION PLAN UPDATE

Prepared by the
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In Cooperation with the
City of Milwaukee Department of Public Works

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INTRODUCTION AND BACKGROUND 1

1.1 INTRODUCTION

In January 2003, the Southeastern Wisconsin Regional Planning Commission (SEWRPC) and the City of Milwaukee Department of Public Works agreed to cooperatively prepare an all hazards mitigation plan for the City of Milwaukee. The plan was designed to be consistent with the guidelines of the Wisconsin Department of Military Affairs, Division of Emergency Management, and the Federal Emergency Management Agency (FEMA). The plan utilized an "all hazards" mitigation approach which the Wisconsin Division of Emergency Management and FEMA recommend as an option to single hazard mitigation planning. As such, consideration was given to many hazard conditions, including flooding; lakeshore bluff failure episodes; severe weather conditions, including wind storms, tornadoes, periods of extreme heat or cold, and winter storms, as well as certain other human-induced or technical hazards. While the plan considered all of the potential hazards, it was recognized that only limited mitigative actions would be feasible for some of these hazards, since they are not site-specific or repetitious in nature.

This initial planning effort was focused upon activities which are most directly related to the City of Milwaukee government operations. However, because of the importance in developing a partnership approach to coordinate emergency mitigation programs, the plan also incorporated consideration of programs involving other agencies, units of government, and private interests both inside and outside of the boundaries of the City of Milwaukee.

The original City of Milwaukee all hazard mitigation plan was adopted and approved by the City in 2005. The plan was prepared by the staffs of the City of Milwaukee Department of Public Works and the Southeastern Wisconsin Regional Planning Commission. In preparing the plan, the City involved all appropriate City and Milwaukee County departments as needed. The planning was coordinated with the related activities of other concerned units and agencies of government and was developed under the guidance of the City of Milwaukee All Hazards Mitigation Plan Steering Committee, which was created by the City specifically for plan development purposes and was comprised of elected and appointed officials, agency and business representatives, and citizens from throughout the City knowledgeable in hazard mitigation matters.

The mitigation planning requirements of 44 *Code of Federal Regulations,* Section 201.6 (d) (44 CFR 201.6(d)) require that local hazard mitigation plans must 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. Thus, in November 2010, the City of Milwaukee and SEWRPC began preparation of an update of the initial hazard mitigation plan. The updated plan was prepared by the staffs of the City of Milwaukee Department of Public Works, the City of Milwaukee Office of Emergency Management and Homeland Security, and SEWRPC. In preparing the updated plan, the City involved all appropriate City departments as needed. In addition, the planning was coordinated with the related activities of other concerned units and agencies of government and was developed under the guidance of the City of Milwaukee All Hazards Mitigation Plan Steering Committee, which was created by the City specifically for plan development purposes and, once again, was comprised of elected and appointed officials, agency and business representatives, and citizens from throughout the City knowledgeable in hazard mitigation matters.

In May 2016, the City of Milwaukee and SEWRPC began preparation of a second update of the City of Milwaukee all hazards mitigation plan. The updated plan was prepared by the staffs of the City of Milwaukee Department of Public Works, the City of Milwaukee Office of Emergency Management and Homeland Security, and SEWRPC. In preparing the updated plan, the City involved all appropriate City and Milwaukee County departments as needed. In addition, the planning was coordinated with the related activities of other concerned units and agencies of government and was developed under the guidance of the City

of Milwaukee All Hazard Mitigation Plan Local Planning Team,[1] which was formed by the City specifically for plan development purposes and is comprised of elected and appointed officials, agency and business representatives, and citizens from throughout the City knowledgeable in hazard mitigation matters.

In assembling the City of Milwaukee Hazard Mitigation Plan Local Planning Team, the City Department of Public Works and the City Office of Emergency Management and Homeland Security sought representatives of law enforcement; the City's fire, public works, and community development departments; the County emergency management office and transit system; the Milwaukee Metropolitan Sewerage District; interested nongovernmental organizations; and the health care community.

For more complete details on the level of participation of local citizens and community groups in the committees, public involvement process, and the summary of minutes for each Local Planning Team meeting, see Appendix A.

The procedures utilized in the plan are based upon guidance provided by the FEMA and the Wisconsin Department of Military Affairs, Division of Emergency Management.[2] As such, the plan is consistent with the requirements and procedures defined in the Disaster Mitigation Act of 2000. The analysis includes three components: 1) profile and analysis of hazard events, 2) inventory of vulnerability assessment of community assets, and 3) development of hazard mitigation strategies.

1.2 OVERVIEW OF STUDY AREA

The City of Milwaukee is located in southeastern Wisconsin, and covers about 96 square miles as shown on Map 1.1. There are all or parts of six major river systems within the City, including the Milwaukee River, Menomonee River, Kinnickinnic River, Root River, Oak Creek, and the Lake Michigan direct drainage area encompassing a total of about 620 acres of inland surface waters. The City's natural resource base is primarily located among the environmental corridors associated with the main stems of these river systems, as well as the Lake Michigan shoreline.

Much of the land in the City is urban in character with residential land uses comprising the largest area. In addition, commercial and industrial land uses comprise a significant portion of the City's area. The majority of the City is developed and population centers can be found throughout the entire City. Urban area redevelopment activities are ongoing in several areas of the City.

1.3 RELATIONSHIP OF HAZARD MITIGATION PLANNING TO EMERGENCY OPERATIONS PLANNING

The focus of this planning effort is upon hazard mitigation measures. Such measures generally involve lasting, often permanent, measures 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, and 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 municipality.

The mitigation plan should be distinguished from, but compatible with, an emergency response or operations plan. Such a 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,

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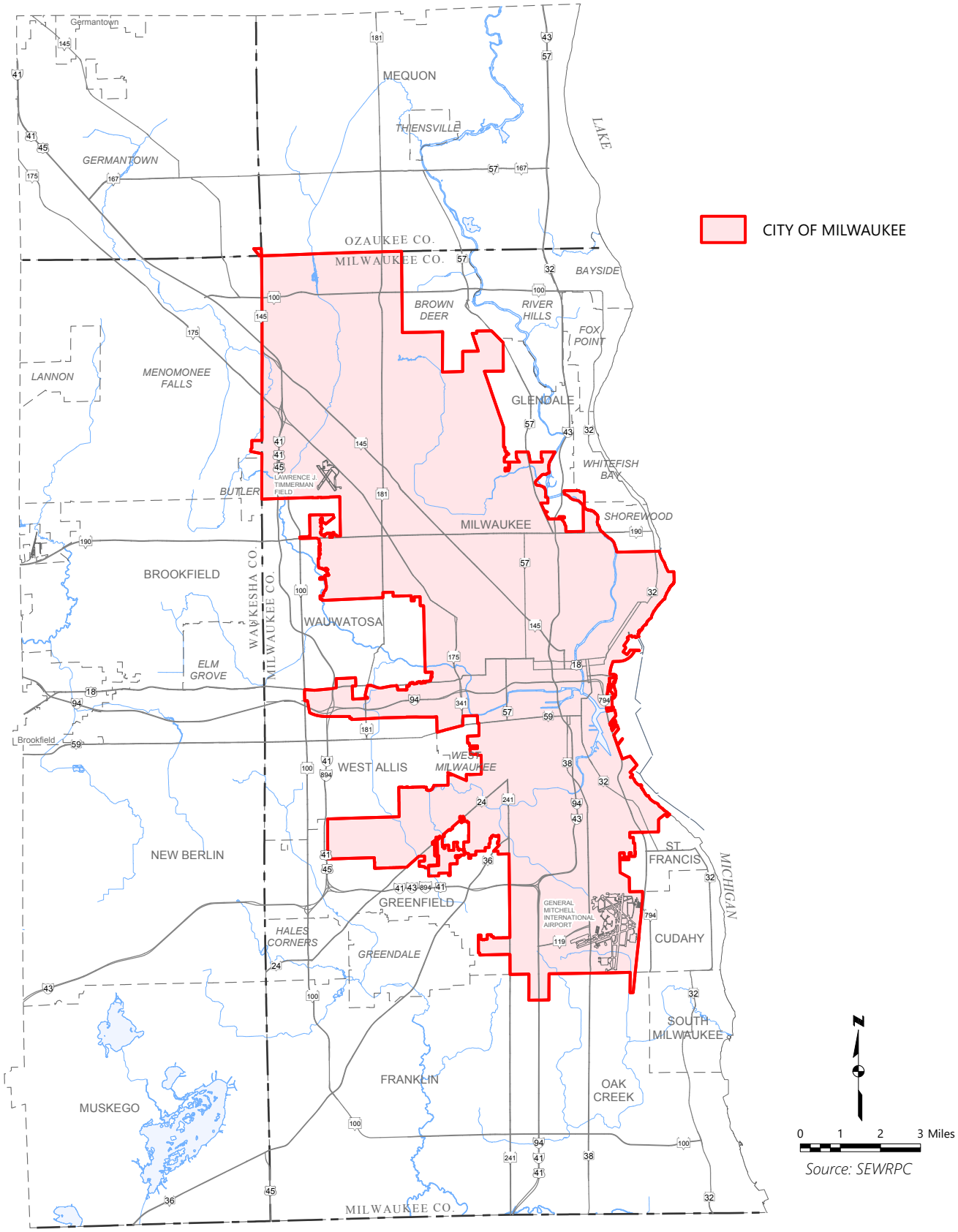
[1] *For the development of the initial plan and the 2010-2011 update, this group was called the City of Milwaukee All Hazards Mitigation Plan Steering Committee. For the current plan update, the name of this group has been changed to reflect the current terminology used by FEMA.*

[2] *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,* Local Multi-Hazard Mitigation Planning Guidance, *July 1, 2008; See also Federal Emergency Management Agency,* State and Local Plan Interim Criteria Under the Disaster Mitigation Act of 2000*, July 11, 2002.*

Map 1.1
Location of the City of Milwaukee



Source: SEWRPC

and often involve mutual assistance and cooperation agreements between local units of government in adjoining municipalities, both within and outside of the City of Milwaukee. 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 that identifies results from the systematic process of identifying hazards and evaluating vulnerability, identify 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.

1.4 SCOPE AND PURPOSE OF PLAN

This update of the initial 2005 and of the updated 2011 City All Hazard Mitigation Plan is a City Level Plan and is intended to set forth the most appropriate, feasible, and effective hazard mitigation strategy for the City of Milwaukee. However, the scope of this plan is countywide for some aspects of the plan and inclusive of the local units of government adjacent to the City, where appropriate. The plan complements, refines and focuses the *State Hazard Mitigation Plan of Wisconsin*[3] on local conditions and hazards likely to occur or be experienced within the City of Milwaukee.

While it is acknowledged that the City can be affected by hazardous incidents that occur outside of the City jurisdiction, the degree of impact—in terms of property damage, injury, and loss of life, and ability of the City to respond—is significantly limited, and frequently unquantifiable. Thus, while some hazards, such as weather-related events, can extend over a wide area, some affect the City of Milwaukee only tangentially, and many result in site-specific impacts. Nevertheless, where appropriate, areas of cooperation between the City and other jurisdictions have been noted, especially with respect to hazards, such as flooding, for example, which commonly affect entire river basins, as well as the specific communities located within them.

The City of Milwaukee Hazard Mitigation Plan was developed during the period 2003 through 2005, updated in 2010 and 2011, and updated again in 2016 and 2017 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. That committee is comprised of elected and appointed officials knowledgeable about, and directly involved in, hazard mitigation matters. The membership, formation, and active participation of the Local Planning Team is documented in Appendix A of this report. In addition to formation and active participation of the Local Planning Team, the plan development process included the following steps:

- Collation and review of all pertinent reports relating to the hazard mitigation activities in the City of Milwaukee

- Inventory mapping and analysis of hazards pertinent to the City of Milwaukee

[3] *Wisconsin Emergency Management,* State Hazard Mitigation Plan of Wisconsin*, December 2, 2016*.

- Identification of the facilities and ongoing programs related to hazard mitigation
- Assessment of the vulnerability of the City assets 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 the City of Milwaukee
- 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 both plan updates include:

- Collation and review of all pertinent reports relating to the hazard mitigation activities in the City of Milwaukee since adoption of the initial plan
- Review of materials developed as a part of the comprehensive planning process for the City of Milwaukee (elements of the City's comprehensive plan are listed in Table 1.1)
- Review and updating of inventories developed for the initial plan
- Review and updating of hazard and risk assessments
- Review of implementation activities
- Review and updating of plan recommendations and the initial implementation plan

1.5 PLAN MAINTENANCE AND IMPLEMENTATION ACTIVITIES

Outreach Activities

Since the adoption of the initial City of Milwaukee hazard mitigation plan, the City has conducted outreach activities to educate the public about emergency preparedness, including hazard mitigation. As part of these activities, the City Office of Emergency Management and Homeland Security makes information on hazards, emergency preparedness, and travel conditions available to the public through its pages on the City of Milwaukee's website. These web pages provide links to preparedness information provided by the Milwaukee Health Department, the Milwaukee County Office of Emergency Management, the American Red Cross, the Wisconsin Department of Transportation, the Wisconsin Division of Emergency Management, the National Weather Service, and FEMA. The City Office of Emergency Management and Homeland Security also provides news releases related to emergency preparedness, including hazard mitigation, to local media organizations. These news releases are also available on the City's website.

The City also provides outreach through its television facility, City Channel 25, which can be accessed through Time Warner Cable, AT&T U-verse, and directly through the internet. This station broadcasts meetings of the Common Council, Council committees, City boards, and commissions as well as other informational programming on City activities and services. Much of its programming is archived at the City Clerk's Legislative Research Center, which can be accessed through the internet. The City conducts additional outreach through an electronic mail notification service. City residents can subscribe to this service to receive notifications regarding a variety of events and City government activities. The City's Office of Emergency Management and Homeland Security conducts outreach related to seasonally occurring hazards via this service.

Table 1.1
City of Milwaukee Comprehensive Plan: Citywide Policy Plan, Area Plans, and Related Action Plans

Area	Plans	Adoption and Amendment Dates
Citywide	City of Milwaukee Department of City Development, *Milwaukee Comprehensive Plan: Citywide Policy Plan*, March 2010	Adopted on March 2, 2010
Downtown	City of Milwaukee Department of City Development, *Milwaukee Comprehensive Plan: Downtown—A Plan for the Area*, October 2010	Adopted on October 12, 2010; amended on November 27, 2018
Fond du Lac and North	City of Milwaukee Department of City Development, *Milwaukee Comprehensive Plan: Fond du Lac and North—A Plan for the Area*, March, 2004	Adopted on March 19, 2004
Harbor District	City of Milwaukee Department of City Development, *Milwaukee Comprehensive Plan: Harbor District Water and Land Use Plan,* December 2017[a]	Adopted on February 6, 2018; amended on November 27, 2018
Menomonee Valley	City of Milwaukee Department of City Development, *Milwaukee Comprehensive Plan: Menomonee Valley 2.0—A Plan for the Area*, June 2015	Adopted on June 2, 2015
Near North	City of Milwaukee Department of City Development, *Milwaukee Comprehensive Plan: Near North Side—A Plan for the Area*, December 2009	Adopted on December 22, 2009
Near South	City of Milwaukee Department of City Development, *Milwaukee Comprehensive Plan: Near South Side—A Plan for the Area*, May 2009, amended June 23, 2015 and March 1, 2016	Adopted on May 27, 2009; amended on June 23, 2015, March 1, 2016, February 6, 2018, and November 27, 2018
	City of Milwaukee Department of City Development, *Milwaukee Comprehensive Plan: Walker's Point Strategic Action Plan—A Plan for the Area*, June 2015	Adopted on June 23, 2015
	City of Milwaukee Department of City Development, Walker Square Neighborhood Association, *Milwaukee Comprehensive Plan: Walker Square Strategic Action Plan—A Part of the Near South Side Area Plan*, December 2015	Adopted on March 1, 2016
Near West	City of Milwaukee Department of City Development, *Milwaukee Comprehensive Plan: Near West Side—A Plan for the Area*, March 2004, amended March 3, 2009	Adopted on March 19, 2004 and amended on March 3, 2009
	City of Milwaukee Department of City Development, Near West Side Partners, *Milwaukee Comprehensive Plan: North 27th Street Corridor Strategy—A Part of the Near West Side Area Plan*, January 2018	Adopted January 29, 2017
Northeast	City of Milwaukee Department of City Development, *Milwaukee Comprehensive Plan: Northeast Side—A Plan for the Area*, July 2009	Adopted on September 1, 2009; amended on November 27, 2018
	City of Milwaukee Department of City Development, Riverworks Development Corporation, Riverworks Business Improvement Districts 25 and 36, *Milwaukee Comprehensive Plan: Riverworks Strategic Action Plan*, Summer 2012	Plan in final draft stage, pending adoption
Northwest	City of Milwaukee Department of City Development, *Milwaukee Comprehensive Plan: Northwest Side—A Plan for the Area*, December 2007, amended September 26, 2017	Adopted on February 5, 2008 and amended on September 26, 2017
	City of Milwaukee Department of City Development, Granville Business Improvement District, *Milwaukee Comprehensive Plan: Granville Strategic Action Plan and Land Use Study—A Part of the Northwest Side Area Plan*, October 2017	Adopted on September 26, 2017
Southeast	City of Milwaukee Department of City Development, *Milwaukee Comprehensive Plan: An Area Plan for the Southeast Side*, October 2008	Adopted on October 29, 2008; amended on February 6, 2018
	City of Milwaukee Department of City Development, South 27th Street Business Improvement District, *Milwaukee Comprehensive Plan: South 27th Street Strategic Action Plan—A Part of the Southeast and Southwest Side Area Plans*, March 2017	Adopted on June 15, 2017
	City of Milwaukee Department of City Development, Aerotropolis Milwaukee, The Gateway to Milwaukee Improvement District, *Milwaukee Comprehensive Plan: Milwaukee Aerotropolis Development Plan Summary—A Part of the Southeast Side Area Plan*, August 2017	November 7, 2017

Table continued on next page.

Table 1.1 (Continued)

Area	Plans	Adoption and Amendment Dates
Southwest	City of Milwaukee Department of City Development, *Milwaukee Comprehensive Plan: Southwest Side—A Plan for the Area*, December 2009	Adopted on December 22, 2009
	City of Milwaukee Department of City Development, South 27th Street Business Improvement District, *Milwaukee Comprehensive Plan: South 27th Street Strategic Action Plan—A Part of the Southeast and Southwest Side Area Plans*, March 2017	Adopted on June 15, 2017
Third Ward	City of Milwaukee Department of City Development, *Milwaukee Comprehensive Plan: The Third Ward—A Plan for the Neighborhood*, May 2005, amended July 12, 2006	Adopted on May 20, 2005 and amended on July 12, 2006
Washington Park	City of Milwaukee Department of City Development, *Milwaukee Comprehensive Plan: Washington Park—A Plan for the Area*, June 2006	Adopted on June 20, 2006
West	City of Milwaukee Department of City Development, *Milwaukee Comprehensive Plan: West Side—A Plan for the Area*, December 2009	Adopted on December 1, 2009
Multiple Areas	City of Milwaukee Department of City Development, *Equitable Growth through Transit Oriented Development Plan,* December 2018[b]	Adopted November 27, 2018

[a] *This plan amended the Southeast Side Area Comprehensive Plan and the Near South Side Area Comprehensive Plan.*

[b] *This plan amended the Near South Side Area Comprehensive Plan, the Harbor District Water and Land Use Plan, the Downtown Area Comprehensive Plan, and the Northeast Side Area Comprehensive Plan.*

Source: City of Milwaukee Department of City Development and SEWRPC

Implementation Activities

Since the adoption of the initial hazard mitigation plan, the City of Milwaukee and other entities with implementation responsibilities have conducted several projects and activities to implement recommendations of the plan.

Implementation of Measures to Mitigate Flooding and Associated Stormwater Drainage Problems

Preservation of Environmentally Sensitive Areas and Open Space

Relative to the plan's recommendations related to the preservation of environmentally sensitive areas and open space, the MMSD Greenseams program has acquired 3,383 acres of floodplains and environmentally sensitive lands, including about 104 acres within the City of Milwaukee.

Floodland Management Measures in the Kinnickinnic River Watershed

The City of Milwaukee replaced the S. 6th Street bridge along the Kinnickinnic River. This project was completed in 2010 at a cost of $2.8 million. Related to this project, MMSD conducted a bank stabilization project along about 1,000 feet of channel in the Kinnickinnic River between S. 6th Street and Chase Avenue. This project was completed in 2011. The cost of the project was about $2.45 million, with about $1.54 million of the costs being paid for through a grant from the Federal Great Lakes Restoration Initiative.

The Milwaukee Metropolitan Sewerage District (MMSD) is currently proceeding with removal of the concrete lining from the reach of the Kinnickinnic River between S. 6th and S. 27th Streets. Stakeholder involvement and preliminary design efforts for this project began in 2007. This project involves removal of 12,000 linear feet of concrete channel; replacement of four road bridges and four pedestrian bridges; widening and lowering of the floodplain overbank; restoration of the channel; and acquisition and removal of 82 residences and one commercial building that are currently within the floodplain. As of December 2016, 74 of the structures have been acquired by MMSD and removed. As of May 2015, the District estimated that the project will cost $80 million.

In May 2017, MMSD completed a flood management plan for the Kinnickinnic River watershed.[4] This plan recommends specific channel and floodplain improvements, bridge and culvert improvements, construction of and improvement to flood storage facilities, and voluntary floodproofing or acquisition and demolition

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

of structures in the floodplain at locations within the watershed along the Kinnickinnic River, Lyons Park Creek, Villa Mann Creek, Wilson Park Creek, and the 43rd Street Ditch. Specific details on elements of this plan are discussed in the section on flooding in Chapter 5 of this report.

The Kinnickinnic River was remodeled as part of a Milwaukee County floodplain mapping project conducted by the Milwaukee County Automated Land Information System (MCAMLIS) Steering Committed, MMSD, and SEWRPC. The Wisconsin Department of Natural Resources (WDNR) has reviewed and tentatively approved the model and resulting floodplain delineation. MMSD is using this model as a basis of its watercourse planning effort for the watershed.

Wilson Park Creek was remodeled as part of a Milwaukee County floodplain mapping project being conducted by the MCAMLIS Steering Committee, MMSD, and SEWRPC. MMSD is pursuing improvements to Wilson Park Creek to eliminate flooding. The improvements include four culvert improvements (S. 30th Street, S. 27th Street, W. Howard Avenue, S. 5th Street), offline storage at the Central Steel and Wire facility, concrete removal from W. Euclid Ave. to S. 20th Street and from S. 6th Street to S. 2nd Street, and channel rehabilitation near the Central Steel & Wire Company facility. As of December 2016, these improvements were still in the planning stage and under reevaluation.

In 2014, a consultant to MMSD completed an updated hydrologic model for the S. 43rd Street Ditch for the MCAMLIS Steering Committee and MMSD. In 2015, SEWRPC completed an updated hydraulic model for the S. 43rd Street Ditch for the MCAMLIS Steering Committee[5] and MMSD. Completion of these models has resulted in an updated one-percent-annual-probability floodplain for this tributary.

Floodland Management Measures in the Menomonee River Watershed

In 2007, MMSD completed the Hart Park Project along the Menomonee River to reduce the risk of flooding in the Cities of Milwaukee and Wauwatosa. As part of this project, 80 formerly floodprone 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.

In 2011, the MMSD completed construction of the Milwaukee County Grounds detention basin 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 slowly release them to the Menomonee River. It will provide flood relief benefits downstream in the Cities of Milwaukee and Wauwatosa. The basin became operational in 2011. The project cost was about $90 million.

In 2016, a Conditional Letter of Map Revision (CLOMR) was approved by FEMA for the Menomonee River from North Avenue downstream to its mouth. The CLOMR was issued based upon the completion of updated floodplain delineations related to completed and proposed flood mitigation projects.

Floodland Management Measures in the Milwaukee River Watershed

In 2016, MMSD approved plans to acquire land in Estabrook Park for the demolition and removal of Estabrook dam. Removal of this dam would be expected to lower the one-percent-annual-probability flood profile along the 3.2-mile reach of the Milwaukee River extending from the dam (1.4-foot decrease in one-percent-probability flood stage) upstream to Bender Road (0.03-foot decrease in one-percent stage). Demolition and removal is scheduled to be completed in 2017. The estimated cost of removing the dam is $1.7 million.

Floodland Management Measures in the Oak Creek Watershed

As of February 2011, SEWRPC was assisting the MMSD in a revision of its watercourse system plan for the Oak Creek Watershed. This study includes the North Branch of Oak Creek in the City of Milwaukee. A draft plan was completed in December 2011. Implementation of this plan is currently on hold pending adoption of a new MMSD policy regarding structure floodproofing and elevation.

[5] *In June 2016, the MCAMLIS Steering Committee was replaced by the Milwaukee County Land Information Council.*

Secondary Plan Element

As part of its Map Modernization program, FEMA incorporated the City of Milwaukee Flood Insurance Study (FIS) information into a countywide FIS that became effective on September 26, 2008.

Floodplain mapping revisions have been completed by SEWRPC for the Menomonee and Kinnickinnic Rivers and tributaries as part of the MCAMLIS effort. Once floodplain revision for the Kinnickinnic River watershed are approved by the Wisconsin Department of Natural Resources (WDNR), it is anticipated that SEWPRC will submit a letter of map revision (LOMR) to FEMA for revision of the flood insurance rate map (FIRM).

Private Property Inflow and Infiltration Reduction Program

In 2010 and 2011, the MMSD drafted a policy to reduce infiltration and inflow (I/I) in an effort to further reduce sanitary sewer backups into basements and sanitary sewer overflows both caused primarily by I/I into the sanitary sewer system. Infiltration is stormwater and groundwater that may enter the sanitary sewer system through such sources as defective pipes, pipe joints, connections or leaking manholes. Clearwater inflow to the sanitary sewer is stormwater from foundation drains, connected downspouts, catch basins, and leaking manhole covers. With the assistance of the Technical Advisory Team comprised of public works, engineering, and/or administrative staff from the MMSD's 28 member communities, a program was developed to fund projects to reduce I/I from the privately owned components of sanitary sewerage systems. As of April 2011, it was proposed that the program provide $151 million over a period of 10 years for design, inspection and activities to remove I/I from private sources. Funding of the program is based on the equalized value of the municipality. Each member community, including the City of Milwaukee, would control how the funds are used (within the eligible cost guidelines) and municipal staff could be responsible for managing the work. The program would fund activities such as foundation drain disconnection; sewer lateral repair or replacement; and design, planning, and investigation costs.

This program will assist the City in addressing the existing deficiencies in the private portion of the sewerage system. The City's sewerage system would benefit from this program by reducing flows within the system. City residents would benefit from the improvement of their laterals and increased protection from basement backups. The City is responsible for maintaining or reducing its flows to the MMSD. This will assist the flow reduction effort by becoming part of the City's long-term maintenance program.

From 2011 through 2013, MMSD and the City of Milwaukee completed the Cooper Park Sewer Lateral Demonstration Project. This project was intended to reduce the likelihood of sewage backups causing basement flooding in the Cooper Park neighborhood during heavy rainfalls. As part of this project, private property owners allowed inspections and rehabilitation or repair of sewer laterals, and City contractors lined private sewer laterals at 432 homes. The City had previously lined municipal sanitary sewers serving this area. The City reported reductions in peak flows of about 46 percent in sewers in this neighborhood during heavy rains.[6]

In October 2014, the City began a second project in the Cooper Park neighborhood, in which foundation drains were disconnected from sewer laterals.

Implementation of Measures Related to Other Hazards

Since the adoption of the first update to this all hazards mitigation plan, the Milwaukee Fire Department has upgraded its capabilities for responding to several types of incidents. In 2010, the Department's HAZMAT team purchased a PlumeRae monitoring system for rapid monitoring and assessment of situations involving the release of hazardous substances. The HAZMAT team also purchased a wireless handheld video camera that allows a member to monitor the hot zone of a fire and direct an entry team's actions, reducing the number of entries needed. This camera also allows the team to remotely monitor incidents and record them for later evaluation. The HAZMAT team has also purchased meters which provide the ability to identify unknown solids and liquids and to detect nerve agents, blood agents, and toxic industrial chemicals. A confined space simulator was constructed at the Department's training academy. The Department purchased a foam trailer capable of producing 1,000 gallons of fire-fighting foam per minute. The Department purchased water depth locators and search lights for conducting water rescues. The Department's Dive Rescue Team

[6] *Don Behm, "Milwaukee Proposes Preventive Sewer Maintenance for 50 Homes,"* Milwaukee Journal-Sentinel, *July 6, 2014.*

purchased new communication units which led to a significant increase in efficiency and operability. The Dive Rescue team also put two new ice rescue sleds into service, increasing the Department's capacity for conducting thin ice rescue operations. The Department put its Surge House into operation in late December 2013. This facility allows the Department's emergency medical services (EMS) system to expand capabilities beyond normal activity levels, to manage a sudden, unexpected increase in patient volume that would otherwise severely challenge or exceed the current capacity of the EMS system.

The Milwaukee Fire Department conducts several public residential, school, and workplace fire safety, extinguisher, and evacuation programs. In 2014, the Milwaukee Fire Department participated at 1,400 community outreach events. Between its inception in 1992 and 2014, the Department's Survive Alive House program has educated over 380,000 school children in fire safety and fire escape plans. In addition, as part of its Firefighters Out Creating Urban Safety (F.O.C.U.S.) and Smoke Detector Hotline programs, the Department installed over 5,300 smoke detectors in residences between 2012 and 2014. The Department has installed over 25,000 smoke detectors since the inception of F.O.C.U.S. in 1991.

County emergency management representatives from southeastern Wisconsin have worked with computer science students from the University of Wisconsin-Parkside's "App Factory" to develop the *Ready Badger* application (app) for wireless devices.[7] The app is designed to speed the process of sharing and gathering hazard-related information. This app allows emergency managers to send custom-made alerts for any type of emergency, including severe thunderstorm and high-wind related events. It also provides users with access to emergency preparedness information specific to their county. Users can also use the app to submit digital damage reports to County emergency managers, allowing them to assess damages and respond to disasters more quickly.

1.6 PLAN DEVELOPMENT REVIEW PROCESS AND ADOPTION

As previously noted, the initial City of Milwaukee all hazards mitigation plan was prepared under the guidance of a City advisory Steering Committee comprised of local official representatives, including representatives, such as police departments, fire departments, and the 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 with the report chapter then being refined to reflect the comments and recommendations of the Steering Committee (see Appendix A).

Members of this Steering Committee included representatives from agencies that serve both the City and the County, including Milwaukee County Emergency Management staff, and in the case of MMSD staff, serving a jurisdiction that extends beyond the County boundary. In effect, the City of Milwaukee Hazard Mitigation Plan is an extension of the aforementioned Milwaukee County Pre-Disaster Mitigation Plan which developed resources and information to assist Milwaukee County residents, organizations, local government, and others in the promotion of sound public policy designed to protect citizens, critical facilities, infrastructure, private property, and the environment from natural hazards. The County Plan offered the opportunity for members of neighboring communities within and adjacent to the City of Milwaukee, to provide input into hazard mitigation planning within the context of the County as a whole. The City of Milwaukee Hazard Mitigation Plan and review process continued this involvement of people and organizations representing jurisdictions and interests that extended beyond the City boundary, including County staff and MMSD staff on the Steering Committee.

Following completion of the City plan in draft form, a public informational meeting was held in conjunction with a City Committee meeting to provide the opportunity to review and provide input on the plan as part of the planning process. The plan was introduced to the Public Safety Committee on March 16, 2005, for Committee review. On April 21, 2005, the plan was formally presented to the City of Milwaukee at the Public Safety Committee meeting, which was broadcast live on television (City Channel 25), and online at www.milwaukee.gov/channel 25. Copies of the report were also provided to City officials for adoption of the plan and advising them of the need for such action in order to retain future eligibility for mitigation funding for the Hazard Mitigation Grant, the Pre-Disaster Mitigation Program, and other FEMA or related programs administered by the Wisconsin Department of Military Affairs, Division of Emergency Management. In addition, the plan was provided to all neighboring communities in order to continue the coordination of

[7] *The Ready Badger app can be downloaded for free from the Apple App Store and Android Google Play Store.*

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 at its May 3, 2005, meeting.

The 2019 hazard mitigation plan update was prepared under the guidance of a City 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, including the County emergency management office and transit system; the 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 Steering Committee (see Appendix A).

As draft chapters of the plan report were completed, copies were placed in downloadable form on the SEWRPC website. Downloadable copies of agendas and summary notes from Local Planning Team meetings and presentations related to this plan updating effort were also available on this webpage. Finally, a webpage was provided on the SEWRPC website on which members of the public could ask questions and submit comments on the draft plan update. Following completion of updates to the community profiles and the risk and vulnerability assessment sections of the plan and review of drafts of the corresponding chapters by the Local Planning Team, a public informational meeting was held to review these sections of the plan with local officials, business and industry, and citizens and solicit their input.

Following completion of the updated City plan in draft form, an additional public informational meeting was held to provide the public an opportunity to review and provide input on the updated plan as part of the planning process. The plan was introduced to the Public Safety Committee for Committee review. On October 24, 2019, the plan was formally presented to the City of Milwaukee at the Public Safety Committee meeting, which was broadcast live on television (City Channel 25), and online at www.milwaukee.gov/channel 25. Copies of the report were also provided to City officials for adoption of the updated plan and advising them of the need for such action in order to retain future eligibility for mitigation funding for the Hazard Mitigation Grant Program, the Pre-Disaster Mitigation Program, and other FEMA or related programs administered by the Wisconsin Department of Military Affairs, Division of Emergency Management. In addition, the updated 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 at its November 5, 2019, meeting.

BASIC STUDY AREA INVENTORY 2

2.1 INTRODUCTION

Information on certain pertinent natural and built features and aspects of the study area is an important consideration in sound hazard mitigation planning. Accordingly, the collection and collation of definitive information regarding basic demographic characteristics, existing and planned land use, surface water and Lake Michigan shoreline system characteristics, utility systems, critical community facilities, and existing hazard management programs constitute an important step in the planning process, since sound alternative plans cannot be formulated and evaluated without an in-depth knowledge of the relevant conditions in the study area.

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 hazard issues must be addressed. The boundaries of the City of Milwaukee and its surrounding municipalities are shown on Map 2.1. This includes 18 municipalities within Milwaukee County, including Bayside, Brown Deer, Cudahy, Franklin, Fox Point, Glendale, Greendale, Greenfield, Hales Corners, Oak Creek, River Hills, Shorewood, South Milwaukee, St. Francis, Wauwatosa, West Allis, West Milwaukee, and Whitefish Bay. In addition, Map 2.1 shows several neighboring municipalities in Ozaukee, Washington, and Waukesha Counties.

2.3 DEMOGRAPHIC AND ECONOMIC CHARACTERISTICS

Population

The area that is now the City of Milwaukee was first included in the Federal census in 1850. Historical population levels in the City of Milwaukee are provided in Table 2.1. Population growth in the City of Milwaukee from 1850 to 2010 is graphically summarized in Figure 2.1. In 1850, the City of Milwaukee had a resident population of about 20,000. The City's population rose from 1850 through 1880, and then began to increase at a greater rate until 1930, when population growth rate slowed. The population growth continued to climb until 1960 when it reached a peak of just over 740,000. From that time, it has slowly declined. The City of Milwaukee is the most populous community in Milwaukee County, with 594,833 residents, or about 63 percent of the County's population, in 2010. The population distribution by census block in the year 2010 ranges up to more than 2,300 people per census block, while most of the City of Milwaukee is dominated by densities of 50 to 300 people, as shown on Map 2.2.

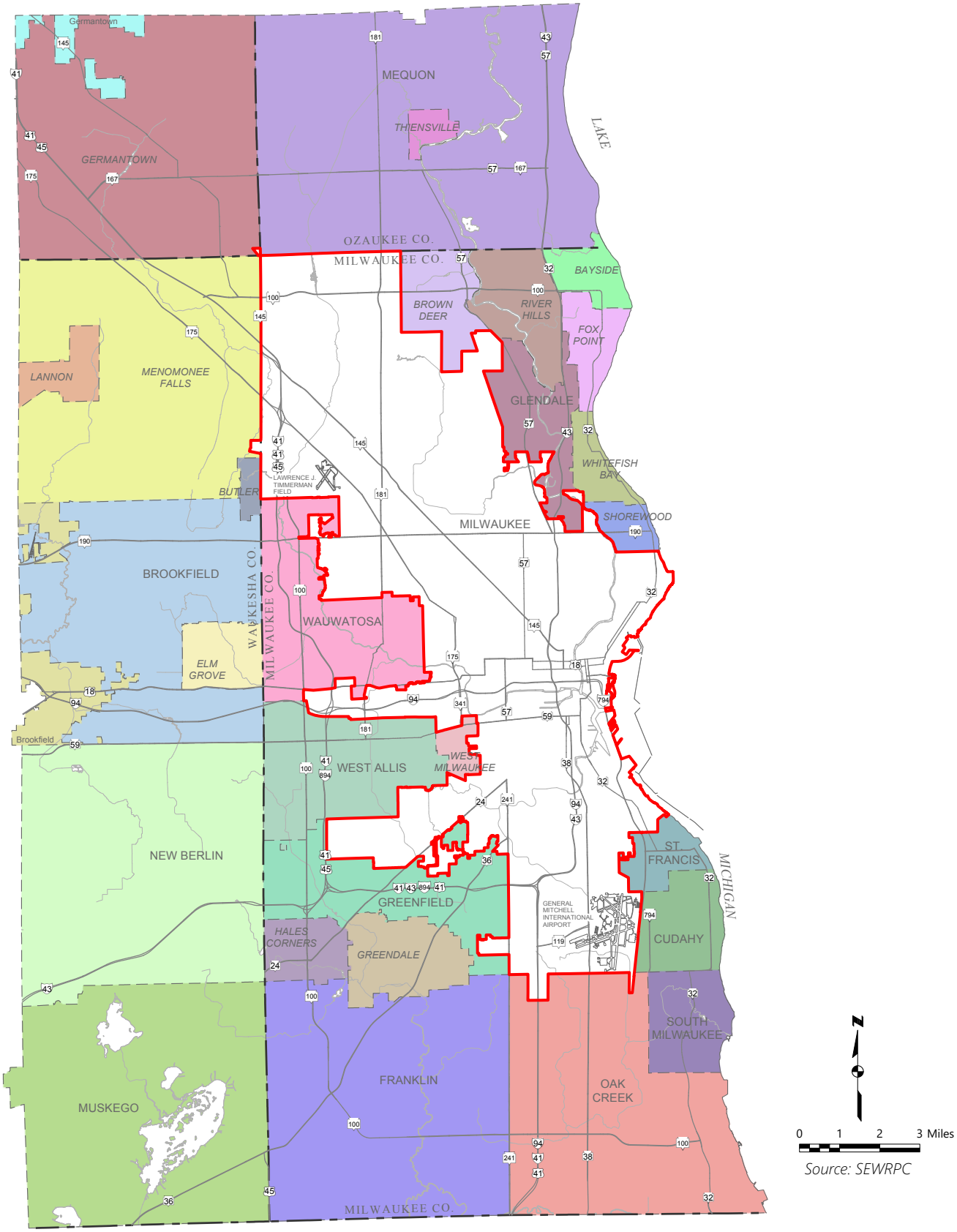
Households

Trends in the number of households in the City of Milwaukee are shown in Table 2.2. The City experienced an increase in the number of new households between 1970 and 1980, with a slight decline from 1980 through 2010. For most of that period, the rate of decrease in the number of households has been less than the rate of population decrease. Between 1980 and 2000, the number of households decreased by 4.0 percent, compared to a population decrease of 6.2 percent. Between 2000 and 2010, the number of households in the City decreased by about 0.8 percent, which represents a slightly faster rate of decrease than the 0.4 percent decrease in the population. The differences between these rates suggest that the number of people per household decreased between 1980 and 2000 and increased slightly between 2000 and 2010.

Employment

Trends in job growth in Milwaukee County are set forth in Table 2.3. The data in the table are presented through the year 2010, which is the most recent year for which data are available. The jobs are enumerated at their location and the data thus reflect the number of jobs within the County, including both full- and

Map 2.1
Civil Division Boundaries for the City of Milwaukee and Environs



Source: SEWRPC

part-time jobs. It should be noted, however, according to the 2000 census, approximately 42,600 employed Milwaukee County residents worked outside the County, and 1,420 worked outside of the State. As indicated in Table 2.3, between 1970 and 2000, employment growth was significant in the County, with a 16 percent increase in the number of jobs, from 524,900 to 624,600. Employment growth fell between 2000 and 2010, however, with an eight percent decrease in the number of jobs, from 624,600 to 575,400. This loss of employment reflects the Great Recession, which began in 2008.

Property Value

The value of the real estate and personal property in a community reflects the upper end of the potential for property damages in each community. The equalized value of personal property in the City of Milwaukee is estimated to be $25,125,196,637 for 2016, for residential, commercial, and manufacturing as shown in Table 2.4.

Table 2.1
Historical Population in the City of Milwaukee: 1850-2010

Year	Population	Change from Preceding Census	
		Absolute	Percent
1850	20,061	--	--
1860	45,246	25,185	55.66
1870	71,440	26,194	36.67
1880	115,587	44,147	38.19
1890	204,468	88,881	43.47
1900	285,315	80,847	28.34
1910	373,857	88,542	23.68
1920	457,147	83,290	18.22
1930	578,249	121,102	20.94
1940	587,472	9,223	1.57
1950	637,392	49,920	7.83
1960	741,324	103,932	14.02
1970	717,099	-24,225	-3.38
1980	636,212	-80,887	-12.71
1990	628,088	-8,124	-1.29
2000	596,974	-31,114	-5.21
2010	594,833	-1,141	-0.36
2040[a]	627,400	32,567	5.47

[a] *2040 projection from Wisconsin Department of Administration Demographic Services Center.*

Source: U.S. Bureau of the Census, Wisconsin Department of Administration, and SEWRPC

2.4 LAND USE

Land use is an important determinant of the potential impact a particular hazard may have, and of potential strategies which may 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 City should be considered in the development of a sound hazard mitigation plan. This section presents a description of the land uses in the City of Milwaukee. SEWRPC staff is currently updating the land use inventories in the Region to reflect 2015 land uses. This process will not be finished in time, therefore, 2015 data are not included in this plan update. Updated 2015 land use will be available for the next update of the plan.

Land uses in the City of Milwaukee in 2010 are set forth on Map 2.3 and in Table 2.5. Urban land uses occupied more than 84 square miles, or about 87 percent of the City in 2010. Intensive urban development, including commercial, industrial, and multifamily residential development, is located throughout the City, notably along the IH 94 and IH 43 corridors. Much of the single-family residential development surrounds the urban centers. Residential development is the largest single component of urban land uses, encompassing about 33 square miles, or about 39 percent of urban land use.

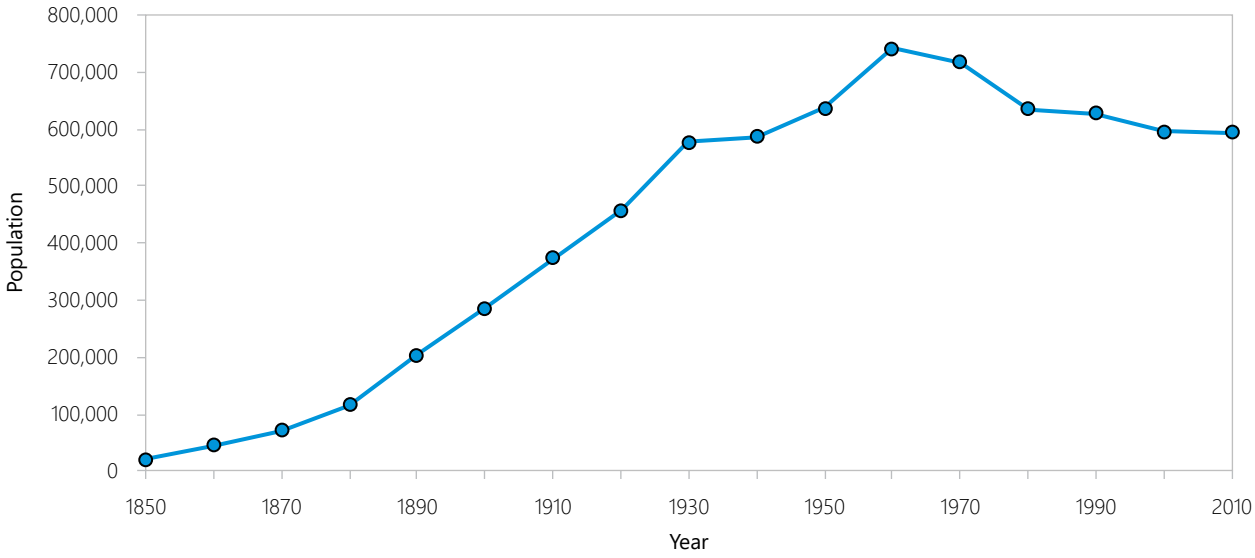
Land uses categorized as transportation, communication, and utilities constituted the second largest urban land use category in 2010, encompassing more than 27 square miles, or about 28 percent of the City. Major arterial highways serving the County include IH 41, IH 43, USH 41 and USH 45, which traverse the County in a north-south direction; IH 894 which provides a bypass, and IH 94, IH 794, and USH 18, which traverse the City in a generally east-west direction. Other uses in the transportation, communications, and utilities category within the City include four major railway freight service lines and two airports that serve the public.

There were few changes in land use in the City of Milwaukee between 2000 and 2010. Overall, urban land uses increased from 87.0 percent to 87.4 percent of the area of the City. For those hazards that could have potential impacts throughout the City, such as thunderstorms, tornadoes, and winter storms, this indicates that changes in development have not changed the City's vulnerability.

2.5 SURFACE WATER RESOURCES AND FLOOD HAZARD AREAS

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 City, and enhance its aesthetic quality. Major streams are defined as those which

Figure 2.1
Historical Population in the City of Milwaukee: 1850-2010



Source: SEWRPC

maintain, at a minimum, a small continuous flow throughout the year except under unusual drought conditions. Within the City of Milwaukee, these include all, or portions, of the Kinnickinnic River, Root River, Menomonee River, Oak Creek, and Milwaukee River and their major tributaries. A sixth watershed encompasses those areas adjacent to Lake Michigan which drain directly into Lake Michigan through intermittent streams. Aside from Lake Michigan, no other major lakes (those over 50 acres) exist in the City of Milwaukee. Map 2.4 illustrates the watershed boundaries of the six major streams systems that lie partly within the City of Milwaukee.

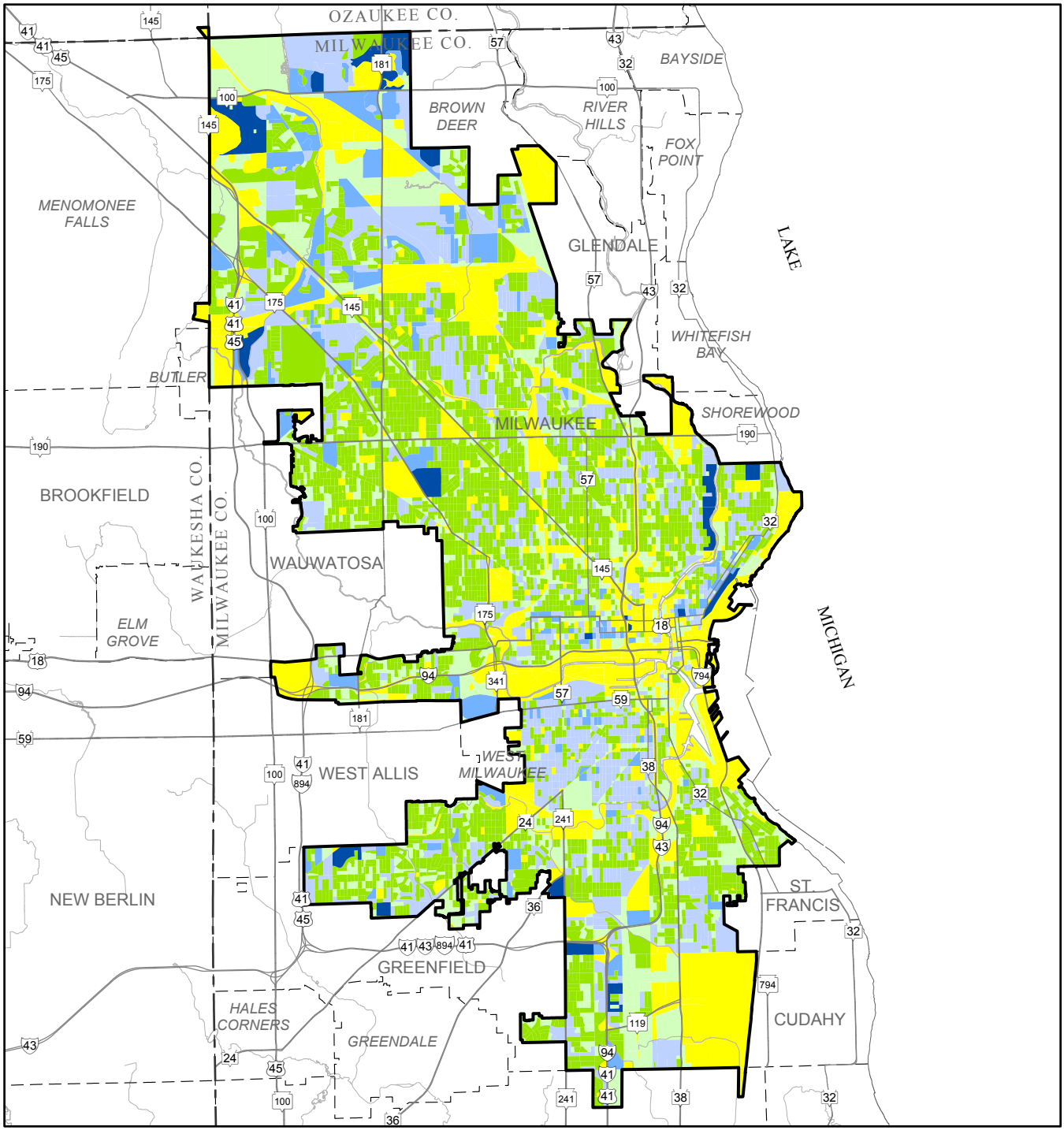
The City of Milwaukee lies entirely east of a major subcontinental divide that roughly bisects the Southeastern Wisconsin Region. The entire City is therefore tributary to the Great Lakes-St. Lawrence River drainage system. Except for those portions of the City that are located either 1) within the portion of the Lake Michigan direct drainage area or 2) within the Oak Creek and Root River watersheds, all stormwater runoff within the City ultimately enters Lake Michigan at the mouth of the Milwaukee River. Within the Oak Creek and Root River watersheds, runoff from the City proceeds out of the City in southern and southeastern directions.

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 the one-percent-annual-probability (100-year recurrence interval) flood event. There is a 1 percent chance of this event being reached or exceeded in severity in any given year. 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 identified by the City of Milwaukee, the Southeastern Wisconsin Regional Planning Commission (SEWRPC), and the Federal Emergency Management Agency (FEMA) are shown on Map 2.4.

Excluding surface water in lakes and existing stream channels, approximately three square miles, or about 3 percent of the total area of the City, are located within the one-percent-annual-probability floodplain. A consideration in flood hazard mitigation is the potential for increased flooding due to dam failures. Since there are several major and minor dams in the City of Milwaukee, future evaluation of floodplain areas related to dam failure should also be considered.

Map 2.2
Population Distribution by Census Block for the City of Milwaukee: 2010



NUMBER OF PEOPLE IN EACH CENSUS BLOCK

- 0
- 1-50
- 51-130
- 131-300
- 301-750
- GREATER THAN 750

N

0 0.5 1 2 Miles

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

All of the floodplain areas have been mapped on large-scale topographic maps compiled at a scale of one inch equals 200 feet, with a contour interval of two feet. The floodplain map is available as a digital file layer on the MCAMLIS[8] cadastral mapping system which covers the entire City and the rest of Milwaukee County.

2.6 LAKE MICHIGAN SHORELINE EROSION HAZARD AREAS

Shoreline erosion and bluff stability conditions are important considerations in planning for the protection and sound development and redevelopment of lands located along the Lake Michigan shoreline. Shoreline erosion and bluff stability conditions in southeastern Wisconsin were surveyed in 1977[9] and 1997,[10] and in the City of Milwaukee in 1978[11] and 1982.[12] In addition, bluff stability conditions were surveyed in Lake Park in 2002.[13] Such 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. As of May 2017, water levels in Lake Michigan were about 14 inches above the long-term month of May average.[14] In addition, the cyclic nature of the Great Lakes water levels indicates that a return to lower lake levels may occur in the future.

The 1997 Lake Michigan coastal erosion and bluff stability study in southeastern Wisconsin included evaluations of lands along the Lake Michigan shoreline in Kenosha, Racine, Milwaukee, and Ozaukee Counties that directly affect, or are directly affected by shoreline erosion, bluff recession, and storm damage processes. This relatively narrow strip of land along the Lake Michigan shoreline extends approximately 89 miles from the Wisconsin-Illinois state line to the Ozaukee-Sheboygan county line, including about seven miles in the City of Milwaukee. For analytical purposes, the Lake Michigan shoreline was divided into 17 reaches, including three reaches within, or partially within, the City of Milwaukee, as shown on Map 2.5. These reaches were selected so as to have relatively uniform beach and bluff characteristics. These reaches generally correspond to those utilized in the aforereferenced 1977 shoreline erosion study, with some refinement to reflect current conditions.

Table 2.2
Number of Households in the City of Milwaukee: 1970-2010

Year	Number of Households in the City of Milwaukee	Change from Preceding Census	
		Number	Percent
1970	236,981	--	--
1980	241,818	4,837	2.0
1990	240,540	-1,278	-0.5
2000	232,188	-8,352	-3.6
2010	230,221	-1,967	-0.8
2040[a]	258,467	28,246	12.27

[a] *2040 projection from Wisconsin Department of Administration Demographic Services Center.*

Source: U.S. Bureau of the Census, Wisconsin Department of Administration, and SEWRPC

Table 2.3
Number of Jobs in Milwaukee County: 1970-2010

Year	Number of Jobs in Milwaukee County	Change from Preceding Census	
		Number	Percent
1970	525,200	--	--
1980	581,700	49,800	11.0
1990	604,700	23,000	4.0
2000	624,600	11,300	1.8
2010	575,400	-42,900	-6.9

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

[8] *Ibid.*

[9] *D.M. Mickelson, L. Acomb, N. Brouwer, T.B. Edil, C. Fricke, B. Haas, D. Hadley, C. Hess, R. Klauk, N. Lasca, and A.F. Schneider, Shore Erosion Study, Technical Report,* Shoreline Erosion and Bluff Stability Along Lake Michigan and Lake Superior Shorelines of Wisconsin*, Wisconsin Coastal Management Program, February 1977.*

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

[11] *J.P. Keillor and R. DeGroot,* Recent Recession of Lake Michigan Shorelines in the City of Milwaukee, Wisconsin*, University of Wisconsin Sea Grant Program, 1978.*

[12] *SEWRPC Community Assistance Planning Report No. 163,* A Lake Michigan Coastal Erosion Management Study for the City of Milwaukee, Wisconsin*, October 1989.*

[13] *SEWRPC Memorandum Report No. 156,* Lake Park Bluff Stability and Plant Community Assessment: 2003, Milwaukee County, Wisconsin, *September 2004.*

[14] *U.S. Army Corps of Engineers,* Monthly Bulletin of Lake Levels for the Great Lakes, *June 2017.*

During 1995, field surveys were conducted to measure the geometry of the bluff slope at 192 sites in southeastern Wisconsin, including several sites within, or adjacent to, the City of Milwaukee. These measurements provided a basis for site-specific assessments of the bluff conditions at the selected locations. In addition, beach and nearshore lakebed conditions were measured for selected sites in Milwaukee.

Table 2.4
Equalized Value of Real Estate Property in the City of Milwaukee: 2016

Type of Property	Equalized Value 2016 ($)		
	Land	Improvements	Totals
Residential	2,368,980,602	12,069,068,666	14,438,049,268
Commercial	1,870,605,300	8,097,465,569	9,968,070,869
Manufacturing	153,134,500	565,942,000	719,076,500
Total	4,392,720,402	20,732,476,235	25,125,196,637

Source: State of Wisconsin Department of Revenue

Based upon the data collected and the assessment and analysis of that data, bluff stability and shoreline erosion conditions were developed and are summarized graphically on Map 2.5. Within the City of Milwaukee, the bluffs were generally found to be stable based upon conditions during the 1995 survey.

In 2002, bluff stability conditions were assessed within Lake Park in the City of Milwaukee.[15] While the bluff stability analysis conducted as part of this study found that most bluffs in the Park were stable, it 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.

The current Lake Michigan shoreline conditions indicate relatively stable conditions for the most part in areas where shoreline development exists within the City of Milwaukee. However, there is the potential for shoreline and bluff erosion to impact structures over time. In addition, during severe climatic conditions, such as high water levels or saturated ground conditions, large episodic bluff erosion events could occur. Accordingly, these conditions are an important consideration in the City hazard mitigation planning and are also an important element in the County Pre-Disaster Mitigation Plan.[16]

2.7 TRANSPORTATION SYSTEM

The transportation system provides the basis for movement of goods and people into, out of, through, and within the City of Milwaukee. An efficient transportation system is essential to the sound social and economic development of the City, the County, and the metropolitan area. An understanding of the existing transportation system is also a factor to be considered in the preparation of a hazard mitigation plan for the City. Accordingly, this section presents a brief description of existing transportation facilities in the City of Milwaukee. Included are descriptions of the existing arterial street and highway system, public transit facilities, railway facilities, and airport facilities.

Arterial Streets and Highways

The arterial street and highway system serving the City of Milwaukee is relatively densely spaced, with major arterials occurring at about one mile intervals in both the north-south and east-west directions.

Public Transit Facilities

Milwaukee County Transit System

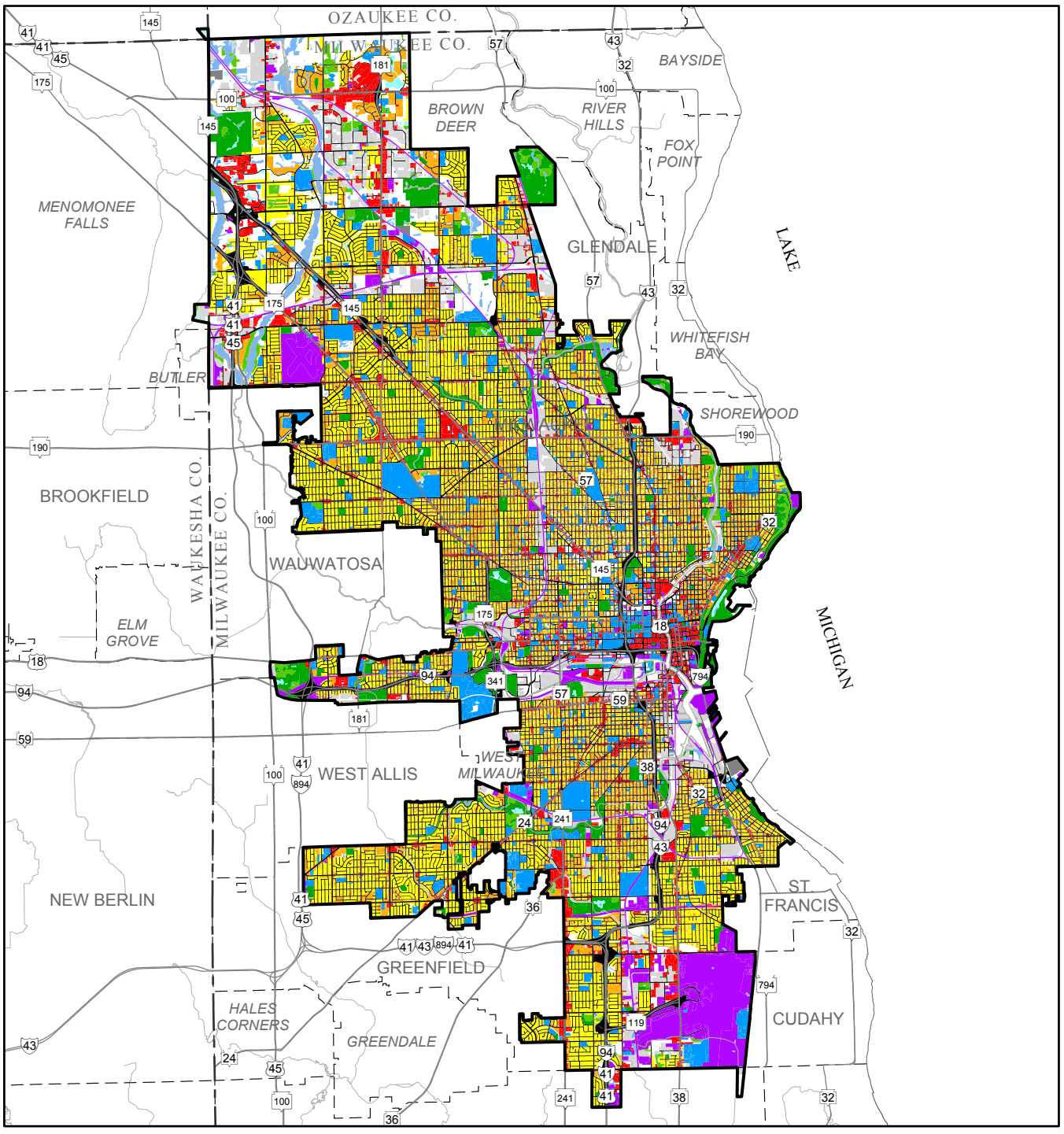
Milwaukee County provides a local fixed-route bus service, the Milwaukee County Transit System (MCTS). The system includes many routes throughout the City and County, with several routes to destinations in neighboring Waukesha County, and express freeway service to Ozaukee County. MCTS, in association with American United Taxicab Services, First Transit, and Transit Express, also provides paratransit services, which are designed to provide door-to-door transportation for individuals with disabilities who are unable to use the City's fixed-route bus service.[17]

[15] *SEWRPC Memorandum Report No. 156,* op. cit.

[16] *Milwaukee County Emergency Management,* Milwaukee County, Wisconsin, Pre-Disaster Mitigation Plan*, June 2011).*

[17] *The contractors providing paratransit service change regularly based on annual awarding of contracts.*

Map 2.3
Existing Land Uses in the City of Milwaukee: 2010



Source: SEWRPC

Table 2.5
Land Use in the City of Milwaukee: 2010

Land Use Category	Square Miles	Percent of Subtotal	Percent of City	Total Acres
Urban				
Residential	32.6	38.6	33.6	20,885
Commercial	5.7	6.7	5.9	3,628
Industrial	6.1	7.1	6.2	3,871
Transportation, Communication, and Utilities	27.5	32.7	28.4	17,674
Governmental and Institutional	7.2	8.5	7.7	4,635
Recreational	5.4	6.4	5.6	3,484
Urban Subtotal	84.5	100.0	87.4	54,177
Nonurban				
Agricultural	0.6	4.9	0.6	386
Woodlands	1.2	9.8	1.2	762
Wetlands	1.9	15.6	2.0	1,204
Water	1.0	8.2	1.0	607
Other[a]	7.5	61.5	7.8	4,808
Nonurban Subtotal	12.2	100.0	12.6	7,767
Total	96.7	--	100.0	61,944

[a] *Includes landfill, extractive, and unused lands.*

Source: SEWRPC

The MCTS and Milwaukee County are currently developing a nine-mile bus rapid transit (BRT) service connecting major employment, education, and recreation destinations through downtown Milwaukee, the City's near west side, Marquette University, Wauwatosa, and the Milwaukee Regional Medical Center. The County completed a feasibility study and identified a preliminary preferred route in 2016. As of 2017, the County has been performing initial engineering and submitted an application to the Federal Transit Administration for funding. Assuming that funding is approved, it is anticipated that construction would begin in 2019 and that BRT service would begin in 2021.

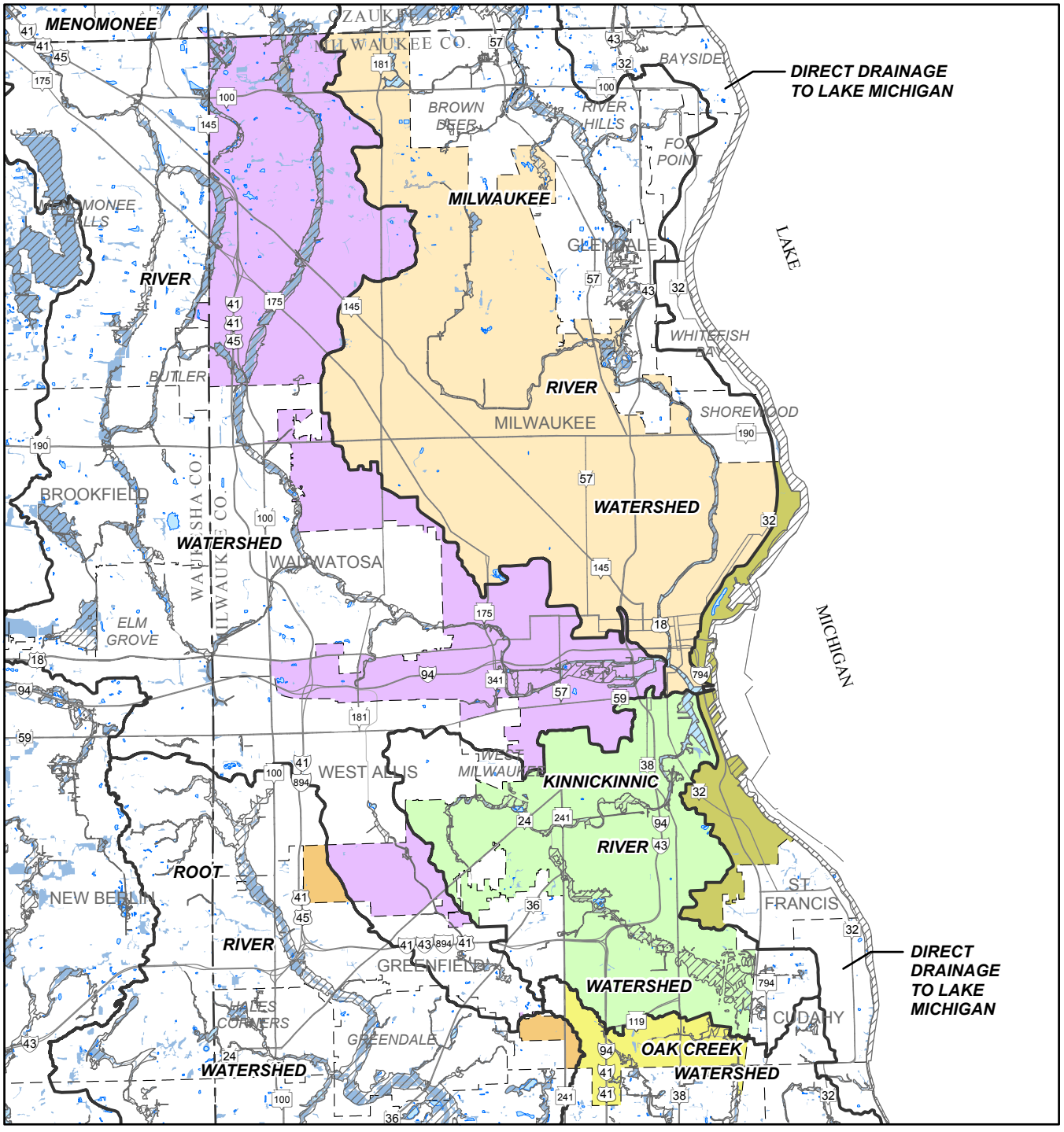
Regional Bus Service

Commuter bus service between downtown Milwaukee and outlying counties is provided by MCTS, as well as other public and private agencies. MCTS manages Ozaukee County Transit and the Express line. The Waukesha Metro Transit system connects with MCTS at certain locations in Waukesha County. Wisconsin Coach Lines and Badger Bus Lines provide commuter transit service between certain destinations in southeastern Wisconsin and Milwaukee.

Railway Facilities

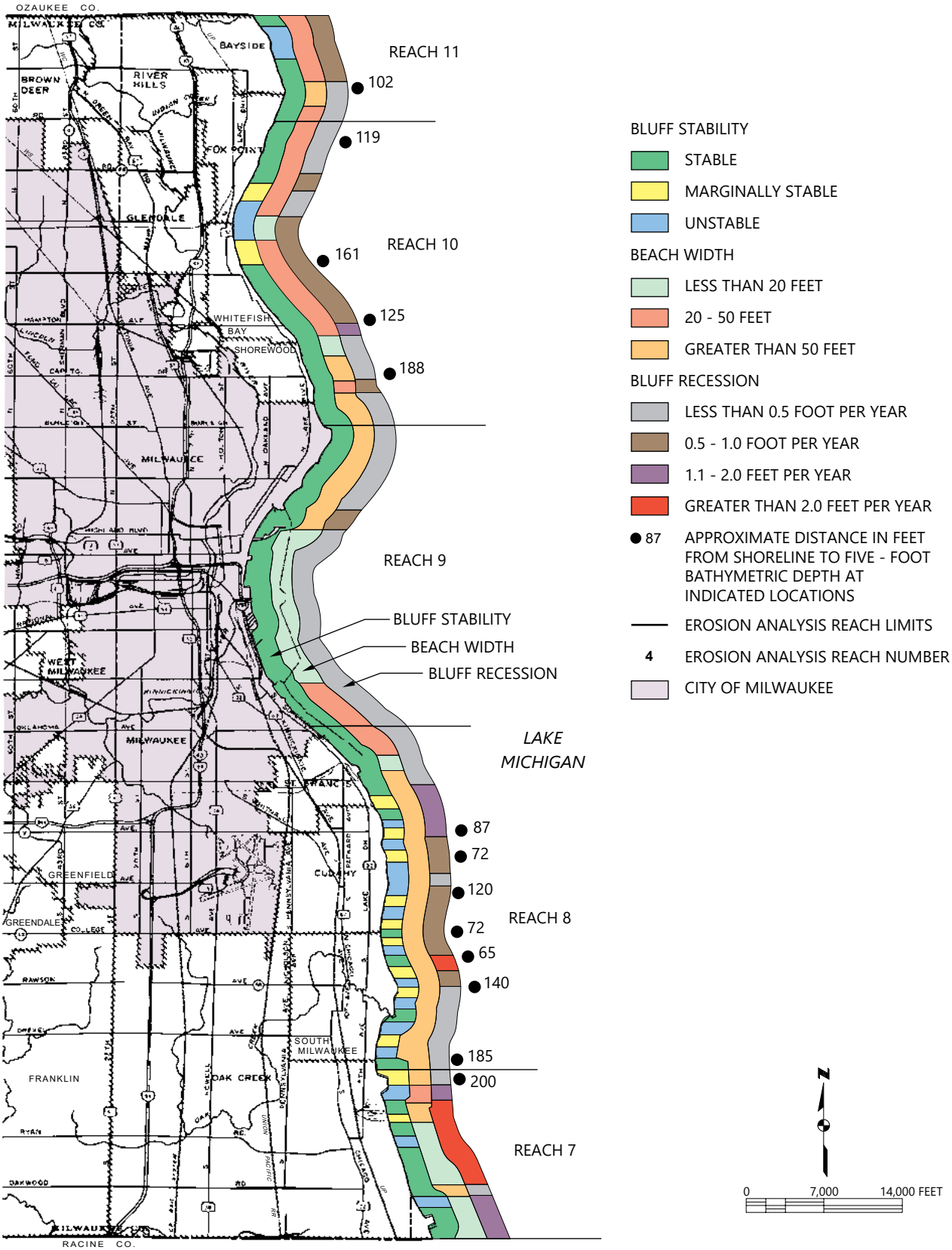
Currently, railway freight service is provided within the City of Milwaukee by four major railway companies operating active mainline railway lines. As shown on Map 2.6, the Union Pacific Railroad (UP) maintains the greatest length of track with a network that traverses the City in both north-south and east-west directions. Canadian Pacific Railway (CP) provides freight service over a line emanating from Chicago, which traverses the City from the south to the north, and with an east-west line that emanates from the central City to the west. The Canadian National Railway (CN) and the Wisconsin & Southern Railroad (WSOR) both have lines that originate in northern portions of the City, in a northwest-southeast direction. CN also provides freight service over a north-south line, originating in a northern section of the City. Several short spur lines serve joint uses or private facilities within the City. Two intercity passenger rail routes operated by Amtrak utilize the Canadian Pacific Railway line. The Amtrak Hiawatha Service provides seven daily roundtrips between Chicago and Milwaukee, with intermediate stops in Glenview, IL, Sturtevant, WI, and General Mitchell International Airport. The Amtrak Empire Builder provides one daily service between Chicago, Milwaukee, Minneapolis-St. Paul, MN, Seattle, WA, and Portland, OR, with an intermediate stop in Glenview, IL.

Map 2.4
Surface Waters, Wetlands, and Floodplains in the City of Milwaukee and Environs



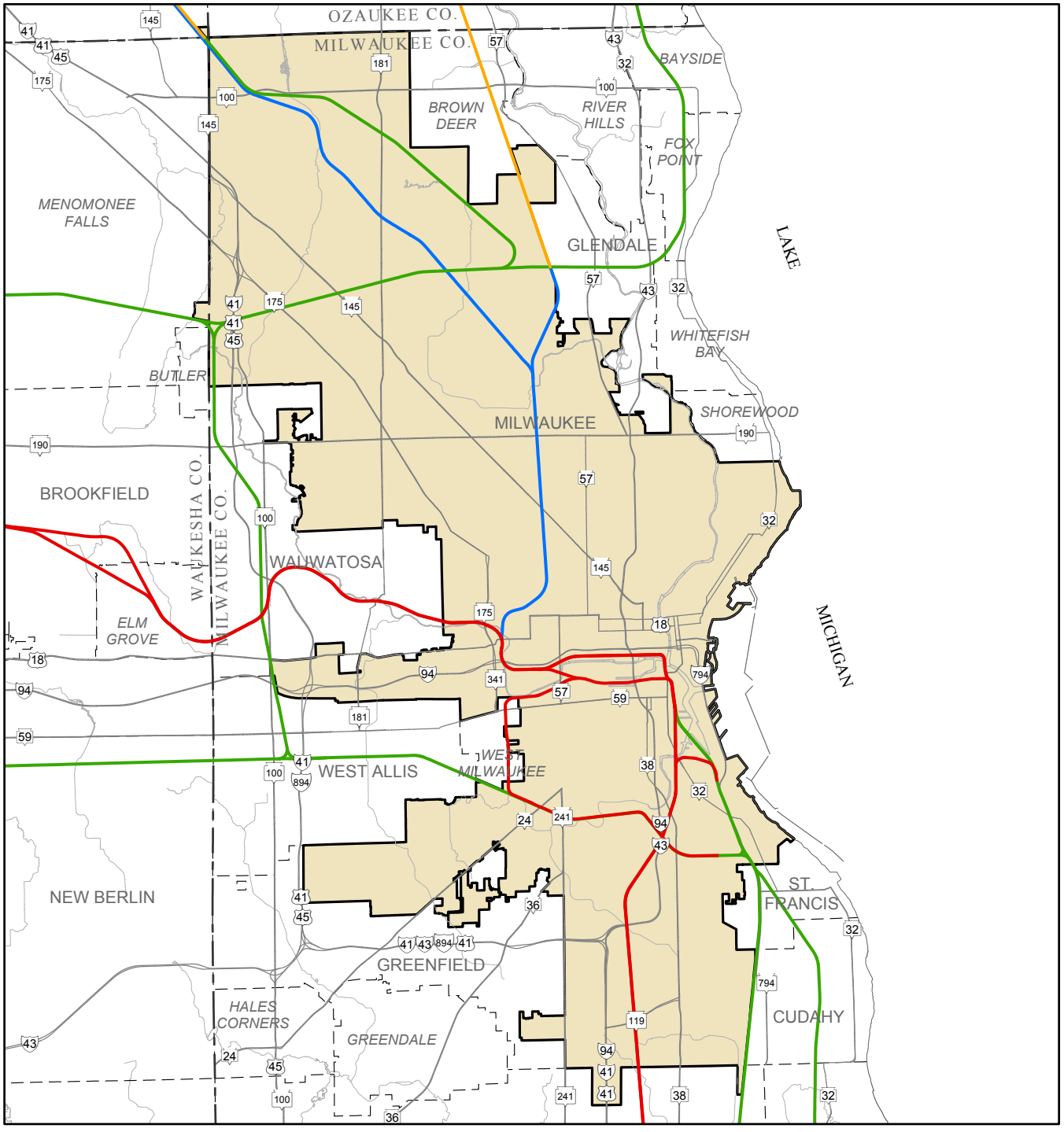
Source: Federal Emergency Management Agency and SEWRPC.

Map 2.5
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 2.6
Common Carrier Frieght Lines in the City of Milwaukee: 2015



Source: SEWRPC

Milwaukee Streetcar

The City of Milwaukee Common Council approved a plan in February, 2015, to commence the development of the Milwaukee Streetcar network. The Streetcar is expected to enhance the City's transportation system by providing a permanent, fixed-rail transit option that offers frequent stops and easy access to critical facilities and popular destinations in the downtown area. The implementation of the Streetcar network is also expected to generate economic development in the City by raising property values in the surrounding community and attracting more businesses, developers, and young professionals to the City. Construction of the streetcar network began in 2017. The Streetcar's Phase 1 Route began serving the public in 2018.

Airports

The City of Milwaukee has two airports which serve the public—General Mitchell International Airport and Lawrence J. Timmerman Field. Both are owned and operated by Milwaukee County. General 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. Currently, about 38 cities are served nonstop or direct from Mitchell International. Located on Milwaukee's northwest side, Timmerman Field serves private and corporate aviation. Public and private airports and airfields in the area are shown on Map 2.7. In addition to these, there are several heliports and helipads in and adjacent to the City of Milwaukee. Heliports that are located at hospitals are denoted on the map.

Port of Milwaukee

The Port of Milwaukee is the largest port in the State of Wisconsin. Milwaukee began as a Great Lakes port in the year 1835,[18] and the Port has been an integral part of the City throughout its development. It is managed by a Board of Harbor Commissioners, and serves as a regional transportation and distribution center. Its primary market includes Wisconsin, northern and western Illinois (including the City of Chicago) and eastern Minnesota, including the "Twin Cities" of Minneapolis/St. Paul. The Port is also capable of cost-effectively reaching Iowa, the Dakotas, Nebraska, Missouri and Indiana; and the western Canadian Provinces of Alberta, Saskatchewan, and Manitoba. The Port also houses a passenger ferry service that travels between the Port of Milwaukee and Muskegon, Michigan, daily during the spring, summer, and fall.

The Port maintains a heavy lift dock and facilities, which allow it to handle a diverse mix of general cargoes, including steel, forest products, bagged materials, heavy machinery, farm and construction machinery, dry and liquid bulk, among others. The Port handles an average annual tonnage of approximately 3.20 million tons.[19] The Port offers a variety of distributive services, including but not limited to, warehousing, sorting, recouping, decanning, palletizing, container stripping, and stuffing for the transference of shipments between rail, truck, and ship. The Port owns and maintains rail track within its boundary, and both the Union Pacific Railway and Canadian Pacific Railway retain access. Its location adjacent to IH 794 allows for easy entrance and egress of trucks. The location of the Port of Milwaukee is shown on Map 2.8.

2.8 UTILITY SYSTEMS

Utility systems are among the most important and permanent elements of urban growth and development, as urban development is highly dependent upon utility systems providing electricity, natural gas, communications, water, and sewerage service. Because of this reliance, utility systems are an important consideration in hazard mitigation planning.

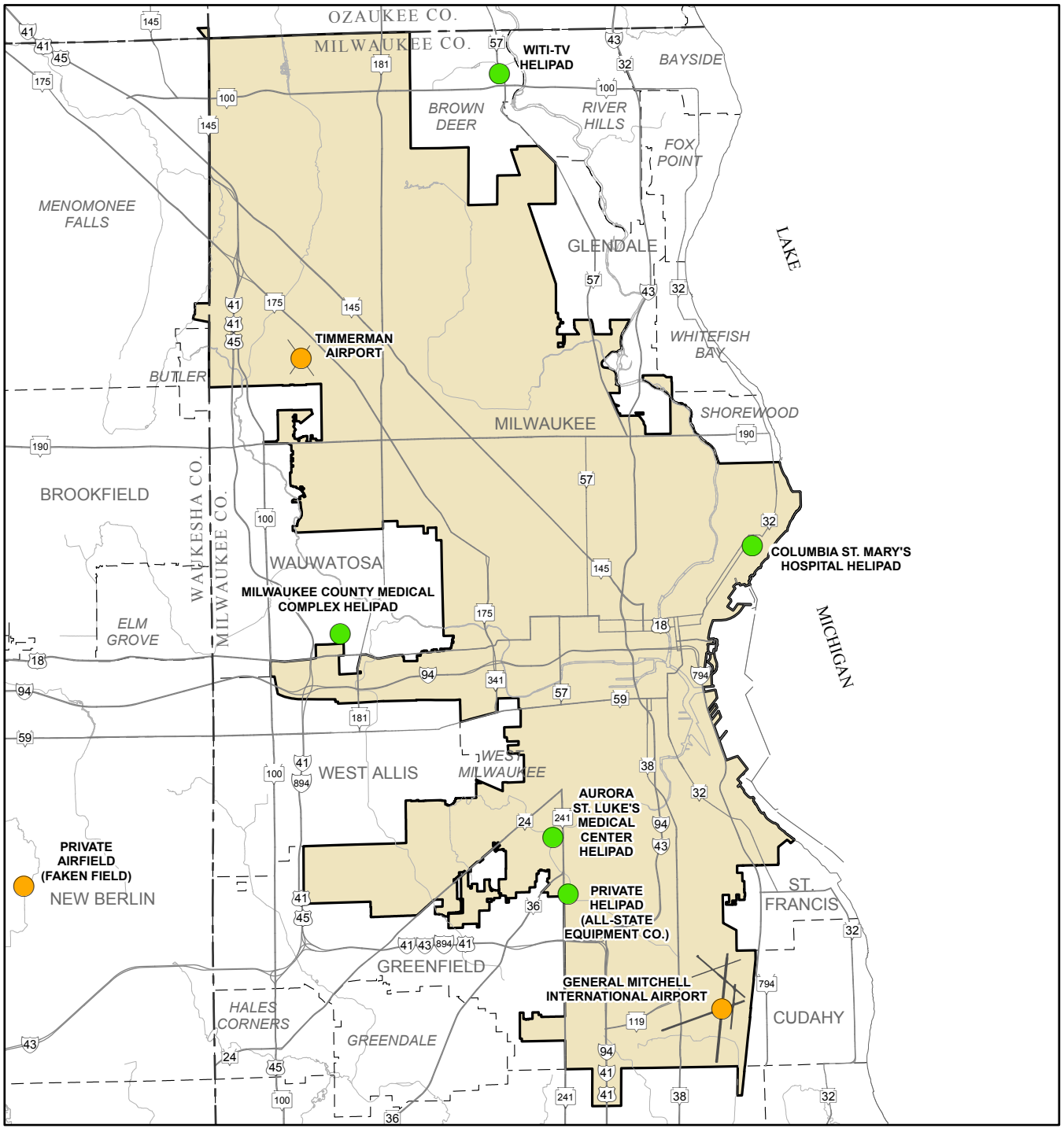
Public Water Supply Systems

As of 2016, nearly all of the City relied on the public water supply as its water supply source for domestic, commercial, and industrial use. The only portions of the City that are not served are small areas in the northwest that are undeveloped. As a division of the Department of Public Works of the City of Milwaukee, Milwaukee Water Works provides most of the public water supply for the City. The City of Milwaukee Department of Public Works operates two water treatment plants utilizing Lake Michigan as a source of

[18] *The Port of Milwaukee, 2323 S. Lincoln Memorial Drive, Milwaukee, WI 53207, www.port.mil.wi.us, www.port.mil.wi.us/directory.htm#RAILROADS, 2004.*

[19] *Wisconsin Department of Transportation,* Economic Impact of Wisconsin's Commercial Ports, *January 2014.*

Map 2.7
Airports and Helipads in the Metropolitan Milwaukee Area: 2016



AIRPORT

HELIPAD

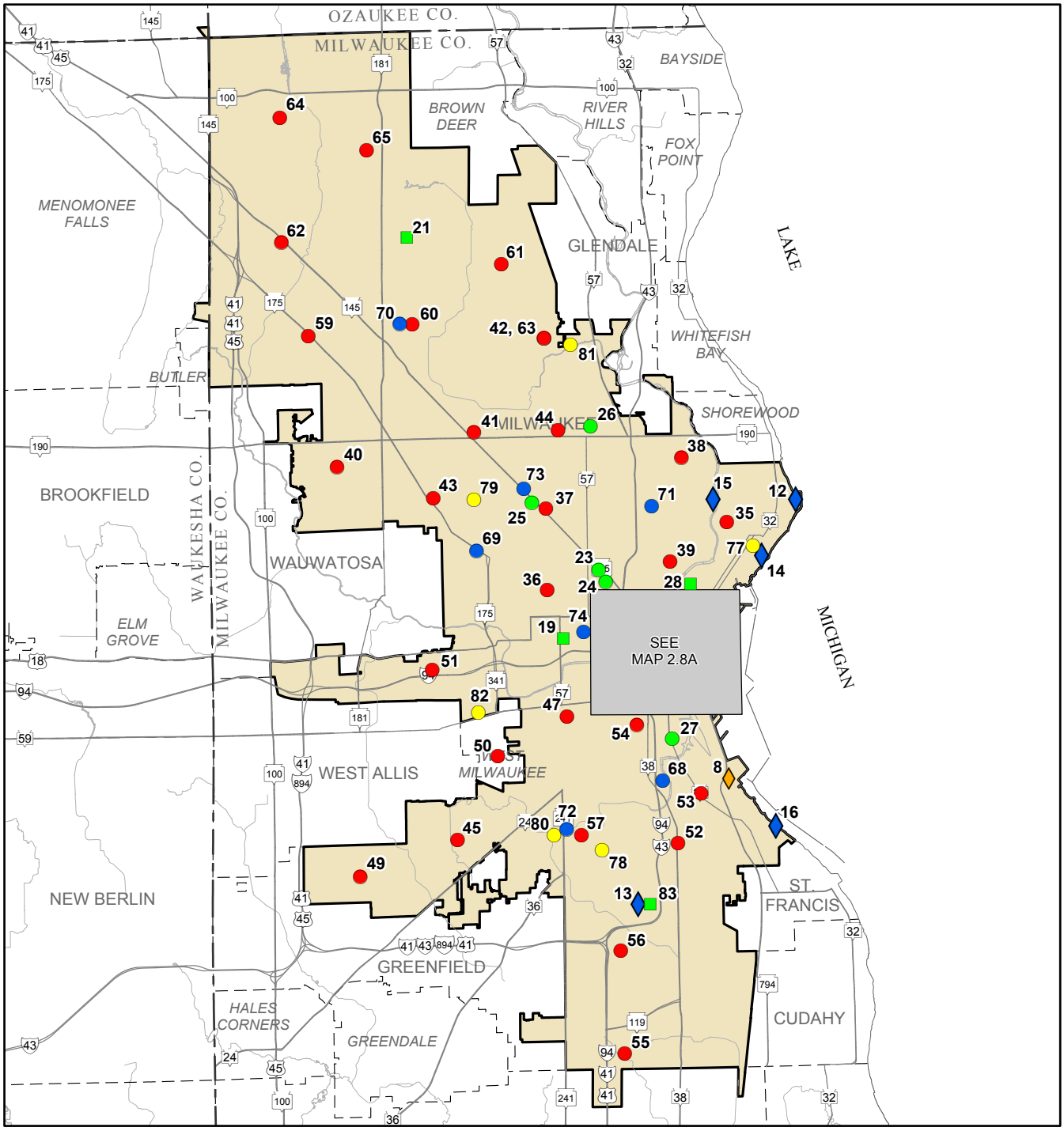
CITY OF MILWAUKEE

N

0 0.5 1 2 Miles

Source: SEWRPC

Map 2.8
Critical Facilities in the City of Milwaukee: 2016



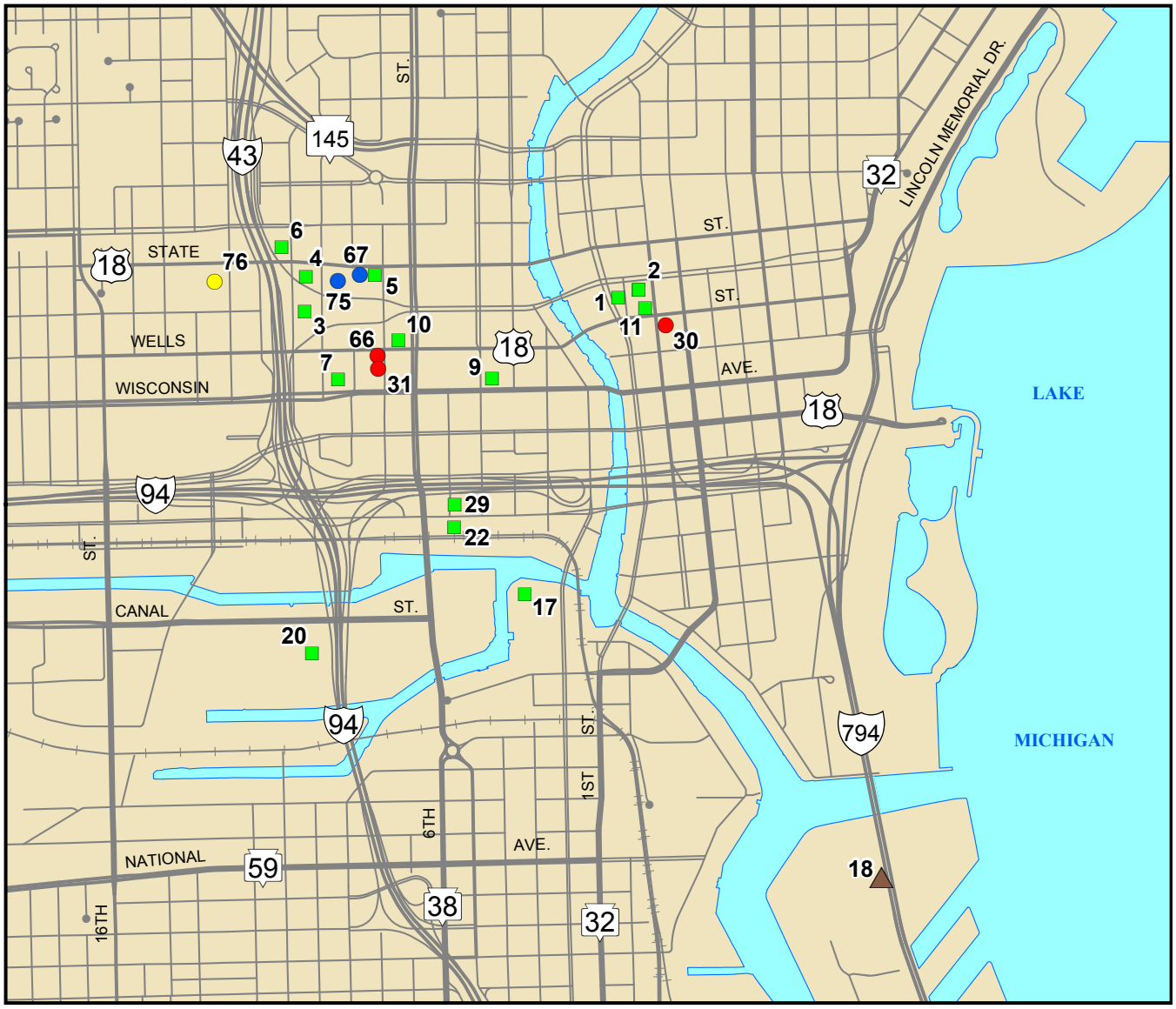
- CRITICAL GOVERNMENT FACILITY
- LAW ENFORCEMENT STATION
- FIRE STATION
- HOSPITALS AND MEDICAL CENTERS
- CITY OF MILWAUKEE
- MILWAUKEE COUNTY TRANSIT SYSTEM FACILITY
- PORT OF MILWAUKEE
- WATER PURIFICATION PLANT OR PUMPING STATION
- WASTEWATER TREATMENT PLANT
- 29 CRITICAL FACILITY REFERENCE NUMBER (SEE APPENDIX B, TABLES B-1 TO B-4)

N

0 0.5 1 2 Miles

Source: Milwaukee County Automated Mapping and Land Information System (MCAMLIS), City of Milwaukee Master Property File (MPROP), and SEWRPC

Map 2.8A
Critical Facilities in the City of Milwaukee: 2016



- CRITICAL GOVERNMENT FACILITY
- LAW ENFORCEMENT STATION
- FIRE STATION
- HOSPITALS AND MEDICAL CENTERS
- WASTEWATER TREATMENT PLANT
- 29 CRITICAL FACILITY REFERENCE NUMBER (SEE APPENDIX B, TABLES B-1 TO B-4)

Source: Milwaukee County Automated Mapping and Land Information System (MCAMLIS), City of Milwaukee Master Property File (MPROP), and SEWRPC

N

0 500 1,000 2,000 Feet

water supply that, combined, pump an estimated average of 98 million gallons per day (mgd).[20] These plants provide nearly the entire source of supply for the City. Some small uses of groundwater also exist.

A small portion of the City is served by a private, other-than-municipal community water system. This system is located in the northwestern part of the City west of Timmerman Airport. It utilizes groundwater from two wells as a source of supply. According to the most recent information available from the WDNR, it serves about 1,065 people through 342 service connections.

The protection of the public water supply facilities from potential contamination is a consideration for hazard mitigation planning. As such, well head protection planning and protection and monitoring of water supply intake, treatment, storage, and distribution systems is a potential plan element.

Sanitary Sewer Service Systems

Nearly all of the developed land within the City of Milwaukee is served by public sanitary sewer service. The City of Milwaukee owns and operates its own sanitary and combined sewer systems. That system is connected to the MMSD sewerage system through a network of interceptor sewers, known as the Metropolitan Interceptor Sewer (MIS) system. The sewage is conveyed through the MMSD sewerage system to either one of two wastewater treatment plants, the Jones Island plant or the South Shore plant.

Private Utilities

The City of Milwaukee is provided with electric power service by We Energies. Electric power service is available on demand throughout the City. One electric power generating facility is located within the City, and two additional facilities are located outside of the City, within Milwaukee County. Currently, an independent company, American Transmission Company, owns, maintains, and operates the major transmission facilities located in portions of the State of Wisconsin, including those in the City of Milwaukee.

Natural gas service is provided for most of the City of Milwaukee by We Energies-Gas Operations. A portion of the City is supplied by Constellation Energy through We Energies' distribution system. We Energies is the distributor of natural gas, and the main gas supply is primarily provided by ANR Pipeline Company which owns main and branch gas pipelines throughout southeastern Wisconsin. In addition, We Energies natural gas system is connected to other major gas pipelines outside of, but in the vicinity of, the City. Natural gas service is available on demand throughout the City.

Telephone service within the City of Milwaukee is provided through a number of telephone companies. In general, telephone service is available on demand throughout the City. There is also an extensive system of cellular and broadband PCS telecommunication facilities in the City of Milwaukee.

We Energies also provides steam for heating and industrial processes to about 300 customers in an area of the City approximately between Mitchell Street north to W. Vliet Street and from Lake Michigan west to 19th Street. The steam is cogenerated as part of electricity production at We Energies' Valley Power Plant.

Several natural gas transmission pipelines run near or along the City's boundaries, in northwestern, southeastern, southwestern, and west-central portions of the City. In addition, natural gas transmission pipelines run through northwestern and southeastern sections of the City. Petroleum pipelines run near or along the City's boundaries in northwestern and southeastern portions of the City.

Solid Waste Disposal

Landfilling and recycling are the primary methods of managing solid wastes generated in the City of Milwaukee. There are currently no active landfills located within the City. However, four licensed, privately owned and operated landfills are located nearby. The Metro Recycling and Disposal Facility is located in the City of Franklin in Milwaukee County, the Falk Landfill is located in the City of South Milwaukee in Milwaukee County, the Orchard Ridge Recycling and Disposal Facility is located in the Village of Menomonee Falls in Waukesha County, and the Emerald Park Landfill is located in the City of Muskego, Waukesha County. In

[20] *Milwaukee Water Works,* Annual Report of the Milwaukee Water Works to the Public Service Commission of Wisconsin for the Year Ending December 31, 2015.

addition, there are 36 inactive solid waste disposal sites located throughout Milwaukee County.[21] Most of these sites have gone through proper closure procedures specified by the Wisconsin Department of Natural Resources (WDNR). Two of these sites, the Moss-American site in the City of Milwaukee, and the Fadrowski Drum Disposal site in the City of Franklin, are classified as Superfund sites. The U.S. Environmental Protection Agency (USEPA) completed remediation activities at the Moss-American site in December 2009. The USEPA removed the Fadrowski Drum site from the National Priorities List in September 2005. Follow-up activities continue to be conducted at both sites.

Two additional sites in the City are being addressed through the Superfund. Neither are on the National Priorities List, and neither of these sites are landfills. These two Superfund sites are discussed below.

The Burnham Canal-Miller Compressing Company site consists of the Miller Compressing Company's former wire reclamation furnace area and a portion of Burnham Canal on the Menomonee River extending from the Canal's western end to the 11th Street Bridge. Activities on the site led to contamination of soil and sediment with copper and polycyclic aromatic hydrocarbons (PAHs). A remediation plan approved by the USEPA included excavating contaminated sediment and soil and covering the site with a cap of sand and gravel. Work on the remediation is ongoing.

The Solvay Coke and Gas site is a 46-acre site near the Milwaukee Harbor. It is bordered by E. Greenfield Avenue to the north, railroad tracks to the west and northeast, and the Kinnickinnic River to the east and south. A coke and manufactured gas facility operated on the property from about 1902 to 1983. From 1983 until early 2003 a scrap and salvage facility operated on a portion of the property. Most of the coke and gas manufacturing buildings on the site were demolished between 2003 and 2005. In 2003, a removal order signed by USEPA and the responsible parties required the responsible parties to address four primary sources of hazardous substances: 1) asbestos in many of the structures and on the grounds; 2) coal tar from the manufactured gas operations; 3) numerous above-ground storage tanks; and 4) other hazards on the site including drums containing hazardous substances and oil in old electrical transformers. Removal actions for the four sources were completed in 2005. Subsequent investigation indicated that soil and groundwater at the site contains a variety of contaminants including several metals, cyanide, and PAHs. In 2016, USEPA finalized a remedial investigation report for the site.[22] A feasibility study comparing different remediation options for the site is being prepared. It is anticipated that this study will be completed in summer 2018.

2.9 PUBLIC SAFETY FACILITIES AND SERVICES

The type and location of public safety facilities are an important consideration in hazard mitigation planning, because of the potential direct involvement of such facilities in certain hazard situations. The location of the fire stations, police stations, and important governmental and institutional facilities in the City of Milwaukee are shown on Map 2.8. A listing of these facilities is also included in Appendix B Tables B.1 through B.3. The locations of these facilities in relationship to floodplain areas are described in Chapter 4.

Fire Suppression and Rescue Services

The City of Milwaukee maintains 30 fire stations which are divided geographically into five battalions. Within the fire houses are 30 engine companies, eight ladder companies, two heavy rescue companies, and 12 emergency medical services paramedic units. The Milwaukee Fire Department 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 in the disciplines of confined space rescue, collapse rescue, and trench rescue, as well as in high and low angle rescue.

The location of each of the fire stations within the City of Milwaukee are shown on Map 2.8 and listed in Appendix B Table B.2. All fire fighters are full-time employees.

The Milwaukee Fire Department (MFD) has been a part of Milwaukee County's Emergency Medical System (EMS) since 1977. Milwaukee County provides each fire department in the County with medical oversight

[21] *SEWRPC Technical Report No. 37,* Groundwater Resources of Southeastern Wisconsin*, June 2002*.

[22] *Arcadis,* Milwaukee Solvay Coke & Gas Site: Remedial Investigation Report, *August 2016*.

and training. The system allows paramedics from any participating fire department within the County to respond to medical emergencies in neighboring municipalities when needed. For example, MFD Med No. 15 routinely responds to emergencies in St. Francis as their paramedic unit and Wauwatosa's Med 51 responds to emergencies in the "finger" area on the west side of the City of Milwaukee.

Since 1991, the Milwaukee Fire Department has had a service contract with the Village of West Milwaukee to provide full fire and emergency medical service to the Village.

Since 2006, the Milwaukee Fire Department has participated in the Mutual Aid Box Alarm System (MABAS). MABAS was originally formed in Illinois in the 1970s and eventually spread into Wisconsin. MABAS enables each member department to render assistance to and receive assistance from other departments without charge when incidents exceed local resources. MABAS Wisconsin currently covers 61 of Wisconsin's 72 counties. MABAS allows individual departments to access equipment such as water tenders, aerial trucks, and specialized equipment, which they do not possess and which they may only need infrequently.

Since 2012, the Milwaukee Fire Department has participated in a "Shared Services" with many of its suburban neighbors. Shared services allows for the closest, most appropriate resources to be dispatched regardless of municipal borders. Member fire departments do not routinely respond into neighboring communities. 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.

Law Enforcement

The City of Milwaukee is divided into seven police districts, and the locations of each district police station are shown on Map 2.8. The Office of the Milwaukee County Sheriff is also located in the City of Milwaukee, and is shown in the inset to Map 2.8. These law enforcement facilities are listed in Appendix B Table B.3.

The City of Milwaukee and other local community police departments, as well as the Milwaukee County Sheriff's Department, 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.

2.10 CRITICAL COMMUNITY FACILITIES

In addition to fire stations and law enforcement stations, as described above, other community facilities which are of importance in hazard mitigation planning include schools, hospitals and major clinics, and certain government administration buildings. It is important to note that these facilities identified herein are consistent with those critical community facilities identified in the initial Milwaukee County pre-disaster mitigation plan.[23] Map 2.8 shows the locations of police and fire stations, hospitals and major clinics within the City of Milwaukee, and locations of select government facilities, including the Milwaukee County Courthouse and the Milwaukee County Secure Correctional Facility, as well as water purification and treatment plants. Because of the need for access to and from these facilities, the hazard mitigation plan includes facility locations and shows the relationship to the flood hazard areas. This floodplain relationship is discussed in greater detail in Chapter 4 of this report. A listing of critical community facilities is included in Tables B.1 through B.5 in Appendix B. Although not mapped, there are 275 public, private, charter, choice, and partnership schools throughout the City of Milwaukee, and they are listed in Table B.5 in Appendix B.

Although not specifically identified as critical community facilities, City public works yards, cell towers, telephone land lines, and switching stations in certain emergency situations can also be considered critical. The importance of maintaining access to facilities like the City public works yards that house additional or specialized emergency response equipment and maintaining the ability of the fire and police departments to communicate can be critical in emergency situations, especially during situations involving power outages.

[23] *Milwaukee County Emergency Management,* Milwaukee County, Wisconsin, Pre-Disaster Mitigation Plan*, June 2011.*

2.11 HAZARDOUS MATERIAL STORAGE AND USE

Public Law 99-499, the Superfund Amendment and Reauthorization Act (SARA/Title III) of 1986, and Wisconsin Act 342 set forth requirements for hazardous material reporting and safety planning. The primary reporting and centralized recordkeeping related to hazardous materials is carried out under a partnership program involving the industries and other users of hazardous materials, the Wisconsin Division of Emergency Management, county emergency management departments, local emergency planning committees, and the local fire departments. Reporting facilities are any facility that uses, stores, or produces chemicals at or above 10,000 pounds. Because there is no "hazardous chemical" list, the general assumption is that anything requiring the completion of a material safety data sheet (MSDS) is included as a reporting requirement. Reporting facilities include manufacturers, warehouses, and petroleum storage site operators. Planning facilities include a wide range of users of limited amounts of hazardous materials. In addition to industrial materials, the agricultural industry routinely uses materials considered hazardous. These uses range from individual farm use materials to large chemical storage facilities.

The City of Milwaukee Fire Department (MFD) is one of seven units in the State of Wisconsin that hosts a Type I Regional Response Hazardous Materials Team. Type I teams are equipped with the highest level of skin and respiratory protective gear and are capable of responding to the most serious of spills and releases, including all biological, chemical, and radiological emergencies.[24] As one of the State's two Type I Teams, the MFD Hazard Materials Team is recognized as a leader in responding to Weapons of Mass Destruction (WMD) terrorist events in the state. Stationed in Milwaukee, this team also covers all of Ozaukee, Washington, and Waukesha Counties, and portions of Jefferson County.

Between 2014 and 2015, the City of Milwaukee averaged 90 hazardous material spills or releases per year, almost all of which were minor. The majority of these incidents involved gasoline, engine waste oil, diesel fuel, mineral oil, or other petrochemical substances. These spills have typically been properly handled through local emergency response actions.

2.12 HISTORIC SITES

Historic sites in the City of Milwaukee often have important recreational, educational, and cultural value. Certain sites of known historic significance are listed on the National Register of Historic Places. Currently, there are approximately 150 individual sites and about 46 historic districts[25] within the City listed on the National Register. The location of sites and districts in the City of Milwaukee listed on the National Register of Historic Places are presented in Table B.6 in Appendix B.[26] The City of Milwaukee Historic Preservation Commission designates sites of local interest. Table B.7 in Appendix B lists these locally-designated historic sites.

2.13 REGULATIONS AND PROGRAMS RELATED TO HAZARD MITIGATION

Regulations and programs perform critical roles in hazard mitigation planning and plan implementation. The current regulations which are most directly related to hazard mitigation include floodplain and stormwater management ordinances and emergency operations programs. The zoning ordinances and operations programs administered by the City of Milwaukee that are most related to hazard mitigation are summarized below.

Floodplain Zoning Ordinance

The City of Milwaukee has enacted a floodplain overlay zoning ordinance. This ordinance was updated in 2013 through adoption of the State's model floodplain ordinance. This ordinance is Subchapter 11 of Chatper 295 of the City's Code of Ordinances. This ordinance reflects the City's adoption of the WDNR's

[24] *Wisconsin Emergency Management,* 2010 Annual Report*, accessed on February 15, 2011 through the internet at emergencymanagement.wi.gov/resources/docs/2010AnnualReportfinal_1_12_2011.pdf.*

[25] *A historic district is a geographically definable area, urban or rural, that contains a concentration of significant historic sites or structures from the same period of time.*

[26] *National Register of Historic Places,* www.historicdistricts.com/wi/milwaukee/state.html

model ordinance for floodplain districts. It is intended largely to preserve floodwater conveyance and storage capacity of floodplain areas and to prevent the location of new flood-damage-prone development in flood hazard areas. Under the ordinance, designated floodplain areas within the City are divided into three overlay zones: 1) a floodway overlay zone, 2) a flood fringe overlay zone, and 3) a flood storage overlay zone. Under the City's zoning code, a "floodway" is defined as "the channel of a river or stream and those portions of the floodplain adjoining the channel required to carry the regional flood discharge."[27] The City zoning code defines a "regional flood" as "a flood determined to be representative of large floods known to have generally occurred in Wisconsin" and "is a flood with a one percent chance of being equaled or exceeded in any given year."[28] The code defines a "flood fringe" as "[t]hat portion of the floodplain outside of the floodway which is covered by flood waters during the regional flood and associated with standing water rather than flowing water."[29] The code defines flood storage as "those floodplain areas where storage of floodwaters has been taken into account during analysis in reducing the regional flood discharge."[30]

The City floodplain overlay zone ordinance states its purposes as follows: "This subchapter is intended to regulate floodplain development to:

1. Protect life, health and property
2. Minimize expenditures of public funds for flood control purposes
3. Minimize rescue and relief efforts taken at the expense of taxpayers
4. Minimize business interruptions and other economic disruptions
5. Minimize damage to public facilities in the floodplain
6. Minimize the occurrence of future flood blight areas in the floodplain
7. Discourage the victimization of unwary land and home buyers
8. Prevent the increase in flood heights that could increase flood damage and result in conflicts between property owners
9. Discourage development in a floodplain if there is any practicable alternative to locate the activity, use or structure outside of the floodplain"[31]

Development in the floodplain will vary, depending on the type of overlay zone. The ordinance prohibits floodplain development which will result in either the obstruction of flow or in any increase of the regional flood height due to floodplain storage lost by an amount equal to or exceeding 0.01 foot.

Under the ordinance, permitted uses in designated floodway overlay zones include several open space uses, functionally water-dependent uses, and uses or structures accessory to open space uses or classified as historic structures. Permitted structures in floodway overlay zones must meet conditions specified in the ordinance. Prohibited uses in designated floodway overlay zones include: dumping and filling not authorized by the WDNR, although incidental grading activities normally associated with the development of open space, outdoor recreation, yards, parking, or loading areas is permitted; storage of material that is buoyant, flammable, explosive, or harmful to human, animal, or plant life; solid waste disposal, soil absorption sanitary sewer systems, or construction of wells providing water for human consumption; and all fill, structures, or other development that would impair floodwater conveyance by adversely increasing flood stages or velocities, or would itself be subject to flood damages.

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[27] *Section 295-1107-67,* City of Milwaukee Code of Ordinances.

[28] *Section 295-1107-135,* City of Milwaukee Code of Ordinances.

[29] *Section 295-1107-47,* City of Milwaukee Code of Ordinances.

[30] *Section 295-1107-65,* City of Milwaukee Code of Ordinances.

[31] *Section 295-1105,* City of Milwaukee Code of Ordinances.

Under the ordinance, permitted uses in designated flood fringe overlay zones include uses permitted in floodway districts; residential, commercial, institutional, manufacturing, industrial, and accessory structures; public utilities, streets and bridges, parking and loading areas; and storage of materials. All permitted uses are subject to conditions specified in the ordinance.

As noted above, development in the flood storage overlay zone may not result in an increase of the regional flood height due to floodplain storage lost by an amount equal to or exceeding 0.01 foot.

Under the ordinance, development in floodway and flood fringe overlay districts may not adversely affect channels, floodways, or banks of any tributaries of the City's watercourses or land outside the floodplain. The ordinance bans the use of any structure or land or the erection, alteration, relocation, extension, or substantial improvement of any structure in a floodway or flood fringe overlay zone prior to the issuance of a City permit. The ordinance also declares that permit applicants have the responsibility for securing all necessary required local, State, and/or Federal permits. The ordinance also provides that no river or stream in the City may be altered or relocated until the City Common Council grants a floodplain district boundary amendment in accord with the City zoning code.

In October 2008, the City ratified FEMA Digital Flood Insurance Rate Maps (DFIRM) dated September 26, 2008 for various waterways within the City of Milwaukee, and made various revisions to the City floodplain zoning regulations to reflect the most current version of the *Model Floodplain Ordinance* prepared by the WDNR, as well as other changes requested by the WDNR or suggested by the WDNR and SEWRPC.

Stormwater Management Regulations

The City of Milwaukee's stormwater management regulations are set forth in Chapter 120 of the City code of ordinances. The stated purposes of that chapter seek to 1) promote public health, safety, and general welfare; 2) establish procedures to control the adverse impacts associated with stormwater runoff; 3) assist in the attainment and maintenance of water quality standards; 4) reduce the effects of development and redevelopment on land and stream channel erosion; 5) minimize damage to public and private property; 6) reduce nonpoint source water pollution by minimizing impervious cover on development sites; 7) promote the co-benefits of visible green infrastructure, including reduction of urban heat island effects, benefits to human health, City beautification, and protection of coastal areas; and 8) help the City adapt to climate change and become more resilient to climate threats. The regulations generally prohibit any person from discharging, spilling, or dumping substances or materials which are not entirely composed of stormwater into receiving bodies of water, storm sewers, or drainage facilities, or onto driveways, sidewalks, parking lots, or other areas that drain into the drainage system. The term "drainage system," as used in the regulations, is defined as "the collection and conveyance of storm water runoff, snow melt runoff, surface water runoff or other drainage from the land" and is declared to include "all drainage facilities, watercourses, waterbodies and wetlands." Certain activities are declared exempt from the general prohibition unless they are found to have an adverse impact upon stormwater. The exempt activities include 1) discharges authorized by a WDNR permit; 2) discharges resulting from fire-fighting activities, excluding training activities; 3) discharges in compliance with the City's construction site erosion control ordinance,[32] and 4) discharges from uncontaminated groundwater, potable water sources, roof drains, foundation drains and sump pumps, air-conditioning condensation, springs, lawn watering, individual residential car washing, water-main and hydrant flushing, landscape irrigation, diverted streamflows, irrigation water, flows from riparian habitats and wetlands, street wash water, and swimming pools if the water has been dechlorinated. The regulations prohibit connecting any wastewater building sewer or drain to the drainage system.

The regulations also generally prohibit any person from proceeding with any residential, commercial, industrial, or institutional improvement or subdivision of property without having provided for appropriate stormwater measures that control or manage runoff from such development or redevelopment or future development of the subdivided property. Unless exempted or waived as provided in the regulations and as summarized below, any such person must have a stormwater management plan prepared, submit the plan to the City for approval, and obtain such approval 1) before an existing drainage system is altered, rerouted, deepened, widened, enlarged, filled, or obstructed in preparation for improvement, 2) before or concurrent with the submittal and approval of an erosion and sediment control plan as specified in the City's

[32] *Chapter 290, "Erosion Control,"* City of Milwaukee Code of Ordinances.

construction site erosion control ordinance,[33] or 3) before the improvement in question is commenced. The person involved is responsible for the implementation of the plan.

Under the regulations, the following development activities are exempt from the stormwater management plan requirements: 1) development occurring within a gross aggregate area of less than one acre which is not part of a larger common plan of development or sale; 2) agricultural activities not associated with development; 3) maintenance of, alteration of, use of, or improvement to an existing structure or construction activity that does not significantly change or affect the water quality and hydrologic conditions of the surface-water discharge; 4) maintenance activities undertaken by any municipal, State, or Federal governmental agency; and 5) stormwater management measures to be undertaken by the City of Milwaukee on an outfall in a specific watershed when the City Engineer has determined that a stormwater management plan need not be prepared. The stormwater management regulations also provide that requests to waive the stormwater management plan requirements shall be submitted to the City Engineer. Under the regulations, the City Engineer is responsible for coordinating a review by City agencies of any such waiver request and may grant a waiver if the development in question is not likely to 1) increase or decrease the rate or volume of stormwater runoff, 2) have an adverse impact on a wetland, watercourse, or receiving body of water, 3) contribute to the degradation of water quality, or 4) otherwise impair attainment of the objectives of the City stormwater management regulations.

The regulations also prescribe what must be contained in any City-required stormwater management plan, including certain general information, as well as detailed descriptions of existing site conditions, proposed site alterations, predicted impacts from the proposed development on water quality and quantity, and best management practices proposed to be used for the protection of water quality. A City-required stormwater management plan, under the regulations, must also be accompanied by an irrevocable letter of credit, a certified check, or a surety bond to guarantee implementation and completion of the plan. The plan must also be accompanied by a second such guarantee to ensure that the facilities involved are maintained. This latter guarantee remains in effect until the facilities are recertified as required under the regulations.

The ordinance requires stormwater management plans for any developments or redevelopments that cause a land disturbing activity of one acre or more, cause the cumulative area of all land disturbing activities at a property to be one acre or more over a three-year period, or cause an increase of 0.5 acres or more of impervious area. For those developments or redevelopments that cause an increase of 0.5 acres or more of impervious area, the ordinance specifies that runoff management shall prevent increases in the regional flood and stream bank erosion rates. For developments or redevelopments that cause a land disturbing activity of one acre or more or cause the cumulative area of all land disturbing activities at a property to be one acre or more over a three-year period, the ordinance requires that the peak runoff release flow rates under post-development conditions shall be at least 10 percent less than those under predevelopment conditions, except that within the Milwaukee River Greenway Site Plan Review Overlay Zone, the peak runoff release flow rates under post-development conditions shall be at least 50 percent less than those under predevelopment conditions.

The MMSD has adopted and is implementing a comprehensive rule to minimize the potential to increase flood risk due to development or redevelopment in the District's service area. This rule, set forth in Chapter 13, "Surface Water and Stormwater," of MMSD's rules, applies to the City of Milwaukee and the communities within the MMSD service area which lie upstream of the City in the tributary watershed areas. The Chapter 13 rule became effective on January 1, 2002 and was amended on October 25, 2010, March 24, 2014, December 19, 2016, and March 25, 2019. It requires the management of the volume and peak rate of stormwater flows from new development and redevelopment in such a way that peak flows in a watershed do not increase downstream flooding. MMSD repealed and recreated Chapter 13 on March 25, 2019. The provisions of the revised chapter became effective on April 1, 2019. The District gave the municipalities it serves one year to revise their municipal codes to reflect the provisions of the revised chapter.

The MMSD operates a long-standing industrial waste and pretreatment program designed to substantially reduce the potential for contaminants entering Lake Michigan and local watercourses from industrial sources. The program is intended to minimize the toxic and hazardous substances entering the MMSD

[33] Ibid.

sewerage system and, thereby, ensures compliance in this regard with Federal, State, and local rules and regulations. To accomplish that objective, the MMSD has adopted rules which limit potentially harmful industrial wastewater contributions and works with industries connected to the public sewer system to achieve compliance with the rules.

Other Related Regulations and Programs

The floodplains in the City of Milwaukee are currently delineated and mapped as documented in the FEMA Flood Insurance Study (FIS) dated September 26, 2008. This FIS revised and updated the information on the existence and severity of flood hazards in Milwaukee County as set forth in a previous FIS dated November 1987. Residents of the City are eligible to participate in the National Flood Insurance Program (NFIP). There are a number of completed activities which have modified the floodplain conditions in the City of Milwaukee. These include the removal of the North Avenue Dam, the completion of the MMSD Lincoln Creek flood control project, the MMSD Menomonee River Valley Park flood control project, the Grantosa Creek detention basin, the MMSD Southbranch Creek flood control project, the MMSD Hart Park Menomonee River flood mitigation project, the Milwaukee County Grounds Floodwater Management Facility, and the Canal Street extension over the Menomonee River. In addition, other flood abatement projects are in the design stages. The City of Milwaukee Departments of Public Works and City Development continue to work cooperatively with the MMSD, the Milwaukee County Land Information Council, and SEWRPC to develop updated hydrologic and hydraulic analyses and floodplain mapping. The City staff will then work to obtain necessary approvals from the WDNR and FEMA, often with assistance from SEWRPC, with the goal of having the resulting floodplains as the basis for the applicable flood insurance maps and floodplain zoning maps. The City of Milwaukee has also enacted a construction site erosion control ordinance based on a State model ordinance.

In addition to the regulations and programs noted above, from 2000 through 2005 the MMSD, as detailed in Chapters 3, 4 and 5 of this report, engaged in comprehensive, detailed Phase 1 and 2 watercourse system planning efforts to update and implement its 1990 stormwater drainage and flood control system plan. These work efforts by the MMSD include significant flood mitigation planning efforts for areas within the corporate limits of the City of Milwaukee. These latter efforts constitute the current citywide flood mitigation planning program within the City. Additional planning is currently ongoing to refine and update these plans.

In undertaking the updating and implementation of its watercourse system plan, the MMSD has recognized the importance of achieving consensus from all the major stakeholders involved regarding the goals and objectives of the planning effort, as well as the need to obtain a final set of acceptable and implementable solutions for current flooding problems along each of the streams involved.

Accordingly, for each watershed located partly within the City of Milwaukee where flooding problems exist, the MMSD formed a stakeholder group to facilitate this aspect of plan development. The stakeholder groups include representatives of the City of Milwaukee and other concerned local units of government, as well as the WDNR and SEWRPC, and, as appropriate within particular watersheds, other public and/or private agencies and organizations, including environmental and neighborhood organizations and concerned private businesses. Stakeholder meetings have been held throughout the MMSD's process of developing alternatives for flood management within each area involved in order to obtain feedback regarding proposed solutions to flooding problems. Stakeholder meetings have been held for each area involved since 1998 and continue to be held through the plan development process.

In some municipalities, the MMSD has also held community workshops to obtain community input regarding possible solutions to flooding problems in the context of what kind of community resource area residents—not just flood victims, but all residents involved—desire regarding their watercourse as a community resource. In some cases, the MMSD has held a number of special technical meetings with technical representatives from concerned communities, as well as from the WDNR, SEWRPC, and Milwaukee County.

Throughout this public involvement process, potential solutions have been developed with input from major stakeholders. Various solutions and scenarios have been presented and feedback has been sought regarding their acceptability. The process has also considered and, as appropriate, incorporated the objectives of concerned local agencies and the authority and policy decisions made by the MMSD.

Emergency Operations Planning

Milwaukee County has developed a comprehensive emergency management plan (CEMP)[34] 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 County's plan 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 government in protecting lives, property, and the environment from major emergencies by addressing the areas of mitigation, preparedness, response, and recovery. This plan 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 the emergency or disaster exceeds the local government's 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 County plan includes elements on direction and control, warning and communications, and management of resources during emergency situations.

In addition, many of the local units of government in the County, including the City of Milwaukee, have developed emergency operations plans 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.

The MMSD has prepared an emergency action plan for the Milwaukee County Grounds Floodwater Management Facility, which is located near Underwood Creek in the Menomonee River watershed. 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 when the Facility is full and structures along the Menomonee River are already experiencing flooding.

The City of Milwaukee's emergency operation plan was updated and revised in 2015 as part of activities related to the Urban Area Security Initiative.[35]

[34] *Milwaukee County,* Comprehensive Emergency Management Plan (CEMP) for Milwaukee County, Wisconsin, *September 2015.*

[35] *City of Milwaukee,* City of Milwaukee Comprehensive Emergency Management Plan, *August 2015.*

ANALYSIS OF HAZARD CONDITIONS 3

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

- Identification of the hazards likely to affect the City of Milwaukee
- Profiles of the extent and severity of hazard events which occurred in the City
- 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

The vulnerability assessment focused on the City and community assets described in Chapter 2.

In preparing this updated plan, the analysis of the existing potential hazard problems and the documentation of vulnerability to such hazards were reviewed and updated as warranted. This review and updating included:

- Reevaluation of the identification of the hazards likely to affect the City of Milwaukee
- Updating of the data upon which the profiles of the extent and severity of hazard events that occurred in the City were based
- Reassessment in light of the updated data of the vulnerability and risk associated with each type of hazard
- Reevaluation as warranted by the updated assessments of the potential for changes in hazard severity and risk under future conditions

3.1 HAZARD IDENTIFICATION

The process of identifying those hazards which should be specifically addressed in the City of Milwaukee hazard mitigation plan was based upon consideration of a number of factors. The process included input from the City of Milwaukee Hazard Mitigation Steering Committee,[36] including a priority rank ordering of hazards; review of the hazard identification set forth in the State hazard mitigation plan; review of documentation of past hazard events; and review of related available mapping, plans, and assessments. It is important to note that the Milwaukee County Pre-Disaster Mitigation Plan was reviewed and utilized as a resource, as part of the hazard identification and assessment in terms of the natural hazards analyses relevant to the City of Milwaukee. As part of the updating process, the identification of hazards likely to affect the City of Milwaukee was reviewed and reevaluated. The reevaluation included additional input from the City of Milwaukee Hazard Mitigation Local Planning Team.

Local Input

The City of Milwaukee Hazard Mitigation Plan was developed through a collective effort of a number of agencies, organizations, and community representatives under the guidance of the City of Milwaukee Hazard Mitigation Steering Committee, which was created by the City of Milwaukee Department of Public Works

[36] *For the development of the initial plan and the 2010-2011 update, this group was called the City of Milwaukee All Hazards Mitigation Plan Steering Committee. For the current plan update, the name of this group has been changed to the City of Milwaukee Hazard Mitigation Local Planning Team to reflect the current terminology used by FEMA.*

(DPW) specifically for plan development purposes. That committee is comprised of appointed officials and public representatives from throughout the City and County knowledgeable about, and directly involved in, hazard mitigation matters (see Appendix A).

During the drafting of the initial plan, two meetings of the Milwaukee Hazard Mitigation Steering Committee were devoted, in part, to hazard identification. At the first meeting, an initial listing of hazards to be considered was presented. The Steering Committee was asked to expand upon that listing, and each Steering Committee member was asked to select the three hazards which were considered most important. The hazards identified in the Milwaukee County Pre-Disaster Mitigation Plan were also reviewed and incorporated for use in the City plan. The listing of the potential hazards identified at the initial and second meeting, along with the number of committee members who indicated the importance of each hazard, is shown in Table 3.1.

As part of the updating process, the Local Planning Team reevaluated the hazards to be considered using a hazard and vulnerability assessment tool. A copy of this tool is included in Appendix A. Members of the Local Planning Team indicated the likelihood of each hazard occurring in the City of Milwaukee and evaluated the severity of each hazard on the basis of possible impacts to people, property, and business. Finally, the Local Planning Team evaluated that relative state of preparedness for each hazard. The ratings given by the Local Planning Team for each hazard were used to derive a perceived level of risk posed by each hazard. Following this, the hazards were ranked by perceived level of risk. The results from this assessment tool are shown in Table 3.2 for the first plan update and Table 3.3 for the current plan update.

Summary of Hazard and Vulnerability Assessment Tool Results

Methods

The assessment tools were completed at the October 5, 2016 meeting of the City of Milwaukee Hazard Mitigation Plan Local Planning Team, with 13 surveys being returned and analyzed. For each hazard in each survey, a risk was computed using the formula:

$$\text{Risk(in \%)} = [(\text{Probability}/3) \times (\text{Human impact} + \text{Property impact} + \text{Business impact} + \text{Preparedness})/(4*3)]* 100$$

Where 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 (preplanning) were each assigned a number from 0 to 3, with 0 indicating "not applicable", 1 indicating low, 2 indicating moderate, and 3 indicating high.

The interpretation of the result returned by this formula is that the perceived threat increases with increasing percentage 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. For each hazard, minimum and maximum risks were calculated. The results from the assessment tool were analyzed for 39 hazards.

In order to assess the degree of agreement among Local Planning Team members in the assessment of average risk, the interquartile range was calculated for each hazard. This quantity indicates the range of the half of the responses that are in middle. A smaller interquartile range indicates greater agreement among Task Force members as to the level of risk, while a larger interquartile range indicates less agreement.

Results

The results from the assessment tool are summarized in Table 3.3. The average level of perceived risk for hazards ranged from a low of 9 percent for earthquakes to a high of 66.9 percent for stormwater flooding. The 10 highest average perceived risks belonged to hazards stemming from various causes. Five of the 10 highest ranked hazards were related to meteorological causes associated with winter weather or severe storms. The remaining five of the 10 highest ranked hazards were related to transportation-related events such as roadway accidents and railroad-related hazardous materials incidents, human behavior-related events such as civil unrest and workplace violence, and technological events such as cyber-attacks. The interquartile ranges for the 10 hazards with the highest average risks tended to be relatively large, indicating

Table 3.1
Hazard Identification Summary for the 2005 Plan Based Upon City of Milwaukee Hazard Mitigation Steering Committee Input

Hazard Types Considered	Number of Points Assigned to Hazards Identified by the Steering Committee[a]	Hazards Required by FEMA[b]
Natural Hazards		
Flooding	15	✓
Thunderstorms, High Wind, Hail, Lightning	7	✓
Winter Storms	7	✓
Tornadoes	3	✓
Temperature Extremes	0	✓
Coastal Erosion	0	✓
Drought	0	✓
Earthquake	0	✓
Other Hazards Human Induced/Technical Hazards		
Transportation Accidents	0	--
Arterial Street and Roadway	0	--
Railroad	0	--
Airport	0	--
Milwaukee Harbor Boating/Shipping	0	--
Contamination or Loss of Water Supply	1	--
Hazardous Materials Incident	--[c]	--
Medical/Health Risks	--[c]	--
Fixed Facility (storage/distribution centers)	0	--
Terrorism Incident	3	--
Major Fire and Emergency Incidents	--[c]	--
Power Outage Incident/Energy Grid Incident	0	--
Basement Backups (to be considered in conjunction with flooding)	--[c]	--

[a] *Points represent the number assigned by the Steering Committee at its August 10th, 2004 meeting during a nominal group hazard ranking process.*

[b] *U.S. Federal Emergency Management Agency Federal Code of Federal Regulations 44 CFR Parts 201 and 206 Hazard Mitigation Planning and Hazard Mitigation Grant Program; Interim Final Rule, February 26, 2002.*

[c] *Hazards identified to be included in the mitigation plan by the City of Milwaukee Hazard Mitigation Steering Committee meetings on August 10, and September 21, 2004.*

Source: City of Milwaukee Hazard Mitigation Steering Committee

a diversity of opinion among Local Planning Team members as to the level of risk posed by each of these hazards. The Local Planning Team members generally agreed, however, on risks being relatively high for hazards posed by snow storms and ice storms.

The 10 lowest average perceived risks were associated with a variety of hazards, including natural hazards related to geological and meteorological events such as earthquakes and droughts, utility-related hazards such as water contamination and sewerage system loss, transportation-related hazards such as aircraft accidents and railway accidents, hazardous material incidents, and hazards related to structural failures. The interquartile ranges for the 10 hazards with the lowest average risks tended to be low, indicating strong agreement among Local Planning Team members as to the level of risk posed by each of these hazards.

Past Hazard Experience

Past experiences with disasters are an indication of the potential for future disasters for which the City of Milwaukee could be vulnerable. Accordingly, a review was made of the hazards that have faced Milwaukee in the past and a ranking by risk was made based upon disaster history and emergency management experience. As part of this plan update, the review of hazards faced by the City was updated to include experiences that have occurred since the original plan was drafted and the ranking by risk was reevaluated in light of this updated disaster history.

Table 3.2
Perceived Risks of Hazards as Determined by Hazard and Vulnerability Assessment Tool: 2011

Event	Minimum (percent)[a]	Maximum (percent)[a]	Average (percent)[a]	Interquartile Range (percent)[b]	Rank
A1. Riverine flooding	13.9	75.0	42.9	35.4	6.5
A2. Stormwater flooding	33.3	91.7	67.2	14.3	1
A3. Tornado or high straight-line wind event	25.0	91.7	45.5	26.4	4
A4. Earthquake	0.0	33.3	12.1	20.8	39
A5. Lake Michigan coastal erosion	8.3	50.0	21.7	16.7	34.5
A6. Snow storm	33.3	58.3	42.9	16.7	6.5
A7. Blizzard or extreme snowfall	33.3	75.0	47.7	27.8	2
A8. Ice storm	33.3	83.3	46.2	19.5	3
A9. Extreme heat	11.1	50.0	28.0	25.0	23
A10. Extreme cold	13.9	34.6	23.6	21.5	28
A11. Lightning	13.9	83.3	34.9	22.9	14
A12. Thunderstorm	27.8	83.3	43.4	15.6	5
A13. Hail	5.6	44.4	31.6	21.5	19
A14. Fog	0.0	50.0	33.1	28.5	16
A15. Drought	0.0	50.0	21.7	23.6	34.5
A16. Dust storm	0.0	41.7	14.7	18.8	38
B1. Contamination or loss of water supply	13.9	44.4	23.5	4.9	29
B2. Loss of sewerage system	0.0	44.4	20.7	5.6	36
B3. Loss of telecommunication	13.9	44.4	27.8	22.2	24.5
B4. Electrical system outage	13.9	66.7	38.1	40.2	11
B5. Computer system incident/cyber attack	0.0	66.7	30.3	33.3	20
C1. Hazardous materials railroad incident	13.9	61.1	30.1	23.6	21
C2. Hazardous materials roadway incident	13.9	91.7	36.6	25.0	13
C3. Hazardous materials pipeline incident	0.0	61.1	22.2	7.6	32
C4. Hazardous materials fixed facility incident	16.7	55.6	32.1	27.1	18
D1. Aircraft transportation accidents	16.7	50.0	27.8	10.4	24.5
D2. Roadway transportation accidents	13.9	66.7	38.8	12.2	10
D3. Railway transportation accidents	11.1	66.7	28.3	19.4	22
E1. Correctional center incident	0.0	33.3	18.2	10.4	37
E2. Civil unrest	0.0	30.6	23.0	5.6	30
E3. Terrorism incident	19.4	50.0	27.5	4.9	26
E4. Biological contaminants (anthrax, smallpox, etc.)	13.9	25.0	22.0	4.9	33
E5. Workplace violence	13.9	75.0	28.9	37.5	9
E6. School violence	13.9	66.7	36.9	22.2	12
F1. Communicable disease outbreak or epidemic	13.9	75.0	32.3	25.7	17
G1. Major fire	16.7	66.7	41.2	31.9	8
G2. Explosion	11.1	50.0	34.6	26.4	15
G3. Mass casualty incident	13.9	50.0	24.2	7.6	27
G4. Building collapse or cave-in	11.1	44.4	22.5	14.6	31

[a] *Perceived threat increases with percentage.*

[b] *Interquartile range acts as a measure of agreement upon the perceived level of threat with a smaller interquartile range indicating stronger agreement and a larger interquartile range indicating weaker agreement.*

Source: SEWRPC

If disaster damages exceed the capabilities of local, County, and State agencies, Federal assistance will be requested. Federal disaster assistance may be offered through a variety of programs. Assistance may be directed to individuals and families, businesses, agricultural producers, or local governments. Table 3.4 provides a summary of estimated damages from Presidential declared disasters and emergencies that affected the City of Milwaukee, from 1969 through 2016. Information on estimated damages and fatalities is included where available.

Table 3.3
Perceived Risks of Hazards as Determined by Hazard and Vulnerability Assessment Tool: 2016

Event	Minimum (percent)[a]	Maximum (percent)[a]	Average (percent)[a]	Interquartile Range (percent)[b]	Rank
A1. Riverine flooding	19.4	91.7	51.7	31.3	7
A2. Stormwater flooding	33.3	91.7	66.9	29.1	1
A3. Tornado or high straight-line wind event	0.0	61.1	37.5	33.4	25
A4. Earthquake	0.0	33.3	9.0	22.2	39
A5. Lake Michigan coastal erosion	16.7	58.3	35.0	19.4	28
A6. Snow storm	41.7	83.3	52.1	16.6	6
A7. Blizzard or extreme snowfall	27.8	83.3	55.3	26.4	4
A8. Ice storm	16.7	75.0	51.4	22.2	9
A9. Extreme heat	27.8	66.7	45.8	25.0	16
A10. Extreme cold	33.3	75.0	50.2	19.4	11
A11. Lightning	25.0	75.0	43.5	12.5	19
A12. Thunderstorm	8.3	75.0	43.8	33.3	18
A13. Hail	5.6	66.7	38.4	15.3	23
A14. Fog	8.3	50.0	35.4	12.5	27
A15. Drought	0.0	38.9	17.6	13.9	37
A16. Dust storm	0.0	25.0	10.6	20.8	38
B1. Contamination or loss of water supply	8.3	66.7	31.0	25.0	33
B2. Loss of sewerage system	5.6	61.1	29.4	13.9	34
B3. Loss of telecommunication	11.1	75.0	32.5	20.9	29
B4. Electrical system outage	19.4	66.7	39.1	32.0	21
B5. Computer system incident/cyber attack	16.7	91.7	55.3	57.0	3
C1. Hazardous materials railroad incident	19.4	100.0	50.2	27.7	10
C2. Hazardous materials roadway incident	16.7	83.3	45.8	29.1	15
C3. Hazardous materials pipeline incident	0.0	66.7	21.8	11.1	36
C4. Hazardous materials fixed facility incident	13.9	66.7	38.9	38.9	22
D1. Aircraft transportation accidents	19.4	75.0	32.2	9.7	31
D2. Roadway transportation accidents	27.8	75.0	53.5	26.4	5
D3. Railway transportation accidents	11.1	75.0	31.9	18.1	32
E1. Correctional center incident	11.1	55.6	22.2	15.3	35
E2. Civil unrest	16.7	100.0	66.2	45.8	2
E3. Terrorism incident	13.9	91.7	45.7	33.3	17
E4. Biological contaminants (anthrax, smallpox, etc.)	8.3	83.3	38.0	31.3	24
E5. Workplace violence	19.4	75.0	51.4	27.8	8
E6. School violence	16.7	91.7	48.8	38.9	13
F1. Communicable disease outbreak or epidemic	8.3	83.3	43.4	32.7	20
G1. Major fire	22.2	83.3	49.5	30.6	12
G2. Explosion	16.7	83.3	48.1	30.5	14
G3. Mass casualty incident	8.3	83.3	36.5	23.6	26
G4. Building collapse or cave-in	13.9	55.6	32.4	13.9	30

[a] *Perceived threat increases with percentage.*

[b] *Interquartile range acts as a measure of agreement upon the perceived level of threat with a smaller interquartile range indicating stronger agreement and a larger interquartile range indicating weaker agreement.*

Source: SEWRPC

Between 1969 and 2016, the City of Milwaukee and environs had 13 presidential disaster declarations and three presidential emergency declarations. The total documented estimated damages of these events were five deaths and approximately $306 million as shown in Table 3.4. Since these estimated property damage totals were inclusive of the entire County, the actual amount of damages specifically within the City of Milwaukee is unknown.

It should be noted that this amount significantly underestimates the sum of all losses in the Greater Milwaukee Area from natural hazards. In some years there are significant weather events causing millions

Table 3.4
Summary of Estimated Disaster Damages that Affected the City of Milwaukee for Federally Declared Disasters and Emergencies: 1969-2016

Date	Event	Affected Area	Reported Damages	
			Fatalities	Property Damages (dollars)[a]
July 1969 (DR-264)	Severe storms, flooding	Milwaukee County		
April 1973 (DR-376)	Flooding	Milwaukee County	0	--
March 1976 (DR-496)	Ice storm	Milwaukee County	--	--
December 1978 – January 1979 (EM-3069)	Snow emergency	Milwaukee County	0	--
August 1986 (DR-770)	Flooding	Milwaukee County	2	29,841,628
September 1986 (DR-775)	Flooding	Milwaukee County	0	8,900,150
June 1993 (DR-994)	Flooding and wind damage	Milwaukee County	0	--
August 1996	Flooding, severe storms	Milwaukee County	0	--
July-June 1997 (DR-1180)	Flooding	Milwaukee County	0	114,523,762
August 12, 1998 (DR-1238)	Flooding and high winds	Milwaukee County	0	15,967,854
May-July 2000 (DR-1332)	Flooding, severe storms	City of Milwaukee and surrounding municipalities	0	9,292,770
December 2000 – January 2001 (EM-3163)	Snow emergency	Milwaukee County	0	--
May 2004 (DR-1526)	Flooding, severe storms	Milwaukee County	2	1,274,941[b]
February 2008 (EM-3285)	Snow emergency	Milwaukee County	0	--
June-July 2008 (DR-1768)	Severe storms, tornadoes, and flooding	Milwaukee County	0	88,002,396
July 2010 (DR-1933)	Severe storms, tornadoes, and flooding	Milwaukee County	1	38,336,170
January – February 2011 (DR-1966)	Severe Winter storm and snowstorm	Milwaukee County	0	11,385
		Total	5	306,151,056

[a] *Dollar values are adjusted to year 2016 by using the annual Consumer Price Index (CPI) values from the U.S. Department of Labor, Bureau of Labor Statistics.*

[b] *As of July 30, 2004, FEMA had received over 2,800 applications for assistance and had approved 668 grants related to the May flooding event. As of this date, FEMA had approved over $1.05 million in housing assistance, and over $0.5 million in other needs assistance for Milwaukee County (FEMA Disaster Summary, July 30, 2004).*

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

of dollars of damage for which no Federal disaster assistance was requested. Thus, losses from hazards in Milwaukee County are significantly greater than the $306 million estimate shown in Table 3.4. Major indicators of hazard severity are the deaths, injuries, and economic losses resulting from natural hazards and disasters. The National Oceanic and Atmospheric Administration (NOAA) National Climatic Data Center (NCDC) publishes National Weather Service (NWS) data describing recorded weather events and resulting deaths, injuries, and damages. To illustrate the broader hazard damage potential, since 1950 the Milwaukee County has experienced 763 weather hazard events resulting in 160 fatalities and 443 injuries reported, as shown in Table 3.5. These records indicate that just over $400 million in property damages accumulated over this time period.

As summarized in Chapter 2 of this report, less than 1 percent of the land area in the City of Milwaukee is agricultural land. Historical urbanization has reduced the threat of an agricultural related hazard event. Considering the low risk and lack of historic incidents, agricultural related damages from hazards will not be addressed further in this plan. The NWS data summarized in Table 3.5 shows that thunderstorms and high winds, followed by winter storms, hail storms, and temperature extremes, are the most frequent weather hazards. Flooding, followed by thunderstorms and high winds, and tornadoes, are the most damaging weather hazards; and extreme temperature, primarily heat, followed by winter storms and thunderstorms and high winds, are the most deadly weather hazards. In addition, it should be acknowledged that weather events are often complex and damages may occur from multiple hazards, such as when hail, rain, wind, and tornadoes strike during a single storm.

Table 3.5
Weather Hazard Events Recorded in Milwaukee County, Wisconsin from 1950 to December 2016 (Sorted by Number of Events)

Event	Total	Reported Damages		
		Fatalities[a]	Injuries[a]	Property Damage (dollars)[b]
Dust Storms	0	0	0	0
Wild Fires/Forest Fires	0	0	0	0
Tornadoes and Waterspouts	18	0	176	18,340,303
Lightning	27	0	2	2,760,414
Flood	51	1	1	329,286,411
Fog	62	0	0	0
Temperature Extremes	83	125	246	23,150
Hail	136	0	0	9,634,013
Winter Storms	152	32	9	122,505
Thunderstorms/High Winds	239	3	9	39,912,418
Total	763	160	443	400,079,214

[a] *Deaths and injuries reported were, in some cases, based upon a geographic area impacted by the hazard event which affected Milwaukee County and had a larger area of impact than the City itself.*

[b] *Dollar values are adjusted to year 2016 by using the average annual Consumer Price Index (CPI) values from the U.S. Department of Labor, Bureau of Labor Statistics.*

Source: Milwaukee County Pre-Disaster Mitigation Plan, the National Climatic Data Center (NCDC) a part of the Department of Commerce, National Oceanic and Atmospheric Administration (NOAA), and the National Environmental Satellite, Data and Information Service (NESDIS)

Improved weather forecasting and warning systems, as well as stronger building codes, help explain why tornado-related mortality has not been prevalent in the recent past, although tornadoes remain a very serious threat to human life. The emergence of temperature extremes as a leading cause of hazard-related mortality is most likely due to a combination of improved recordkeeping by health organizations and the longer life expectancy of individuals. Mortality from heat waves disproportionately affects the elderly.

To illustrate the potential frequency of thunderstorms and tornadoes, a review was made of the warnings historically issued by the National Weather Service, as shown in Table 3.6. Over the period 1982 through 2014, there were 468 thunderstorm-related watches or warnings and 111 tornado-related watches or warnings issued for Milwaukee County. On average, the National Weather Service offices in Wisconsin issue less than one tornado warning, and six to seven severe thunderstorm warnings for Milwaukee County per year.

A similar review can be performed for human-induced and technological hazards. As with the meteorological hazards summarized in Table 3.5, the major indicators of hazard severity are fatalities, injuries, and economic losses resulting from hazard events and disasters. Several agencies compile data on individual human-induced hazards and technological hazards and make it publicly available. For example, the U.S. Department of Transportation Office of Pipeline Safety complies and makes available data on hazardous material incidents involving pipelines and transportation. Based upon the two technological hazard categories for which data were available, the City of Milwaukee has experienced 1,750 technological hazard events since 1971. These events are summarized in Table 3.7. They are estimated to have caused three fatalities, 147 injuries, and over $20 million in economic losses.

Summary and Ranking of Hazards

There are several ways the list of specifically considered hazards can be ranked and summarized in the City of Milwaukee 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 and degree of importance assigned by the collective judgment of the City of Milwaukee Hazard Mitigation Local Planning Team.

In addition, selected hazards other than natural hazards have been identified for consideration in the City of Milwaukee hazard mitigation plan based upon input from the City Hazard Mitigation Local Planning Team. The hazards to be specifically considered in the plan and their ranking are summarized in Table 3.8, along with qualitative information on the hazard severity. As part of the updating process, the ranking of hazards to be considered in the initial plan was reevaluated giving consideration to the perceived risk associated with each hazard as summarized in Table 3.3 to data related to the occurrence of hazards since the original plan as summarized in Tables 3.5 and 3.7.

Clearly, 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 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 floodprone 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 City of Milwaukee disasters are probably 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 hazards in Table 3.8 does not include some hazards that were considered by the Local Planning Team, but found either to have minimal chance of occurring or causing damages, to offer only limited applicable mitigation options, or to be better addressed in some other context than hazard mitigation planning. The identified hazards listed below will not be addressed in the subsequent sections of the report.

Table 3.6
Milwaukee County Severe Weather History: 1982-2014

	Severe Thunderstorm		Tornado	
Year	Watch	Warning	Watch	Warning
1982	1	1	0	0
1983	5	3	1	0
1984	6	6	7	2
1985	5	1	6	1
1986	7	3	6	0
1987	5	8	2	2
1988	0	4	2	0
1989	10	6	2	1
1990	5	5	4	0
1991	10	4	2	0
1992	3	2	3	0
1993	10	5	4	0
1994	9	7	3	2
1995	10	6	1	0
1996	5	7	9	0
1997	9	5	2	0
1998	11	5	2	0
1999	8	7	0	0
2000	7	14	3	2
2001	10	4	1	1
2002	7	5	1	0
2003	7	4	3	0
2004	15	9	5	0
2005	11	9	0	0
2006	17	16	2	0
2007	3	9	3	0
2008	8	14	4	3
2009	6	3	1	2
2010	6	8	7	3
2011	12	11	1	0
2012	7	12	0	0
2013	5	7	2	2
2014	8	10	1	0
Total	248	220	90	21

Source: National Weather Service Forecast Office

Natural Hazards

Earthquakes

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. This sudden shifting releases energy in the form of seismic waves or wave-like movement of the earth's surface. Earthquakes can strike without warning and may range in intensity from slight tremors to great shocks lasting a few seconds to 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 the City of Milwaukee have a 2 percent probability of experiencing earthquakes in a 50-year period in which the peak

Table 3.7
Technological Hazard Events Recorded in the City of Milwaukee, Wisconsin from 1971 to December 2016 (Sorted by Number of Events)

Event	Total	Reported Damages		
		Fatalities	Injuries	Property Damage (dollars)[a]
Pipeline Hazardous Material Incidents	35	0	30	17,058,763
Transportation Hazardous Material Incidents	1,715	3	117	3,061,651
Total	1,750	3	147	20,120,414

[a] *Dollar values are adjusted to year 2016 by using the average annual Consumer Price Index (CPI) values from the U.S. Department of Labor, Bureau of Labor Statistics.*

Source: U.S. Department of Transportation, Office of Pipeline Safety; and SEWRPC

acceleration associated with horizontal shaking exceeds between 4 percent and 8 percent of *g*.[37] These are low values. While these levels of shaking can be noticeable, they are rarely associated with damages to structures. The earthquake threat to the State of Wisconsin and the City of Milwaukee is considered to be low. Because of this, the Local Planning Team decided to remove earthquakes from the set of hazards addressed by this plan.

Human-Induced Hazards

Civil Unrest

Civil unrest is a broad term that is typically used to describe one or more forms of disturbance caused by a group of people. It includes incidents which threaten public safety or disrupt community affairs. Examples of civil unrest include riots, labor disputes and strikes, and public demonstrations. These incidents may arise due to economic conditions, unpopular political actions, tensions between groups with opposing social or political viewpoints, shortages of critical supplies such as food or fuel, racial issues, or celebrations that get out of hand. Because these incidents usually involve large groups of people, they are more likely to occur in populated, urban areas.

Guidance for conducting planning processes to respond to and mitigate the impacts of civil unrest emphasize that these efforts should focus on developing broad community-wide relationships and encouraging extensive participation in processes to address the underlying problems that lead to civil unrest.[38] Such efforts require a collaborative planning process that identifies and engages public officials, community leaders, and other stakeholders. A comprehensive approach to dealing with civil unrest may need to address a variety of issues, including the responses to an incident, the immediate aftermath of an incident, and the long-term aftermath and impacts of an incident as well as the underlying issues which may cause or lead to such incidents. Because the focus of hazard mitigation planning is to reduce the impacts of hazard incidents when they occur, the scope of a hazard mitigation planning effort is too narrow to encompass the comprehensive approach required to address civil unrest. Given that addressing civil unrest is beyond the scope of what can be accomplished in a hazard mitigation plan, this plan will not address civil unrest as a hazard.

Cyber attack

The threat of cyber attack is an emerging threat to the security and reliability of information technology systems used by businesses, educational institutions, governments, and private citizens in many of their operations and activities. In information technology systems, computers are connected to one another through networks, such as local area networks in an office or larger networks like the internet. This places them at risk of cyberattack. The nature of such an attack may vary. In some instances, an attack may be a deliberate effort to gain access to an entity's systems or processes. In other instances, an attack may be the result of a randomly initiated threat, such as a computer virus or an electronic mail phishing attempt. Unlike physical threats that are often readily apparent and prompt immediate action, cyberattacks can be difficult

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

[38] *See, for example, The Ohio State University Moritz College of Law,* Planning in Advance of Civil Unrest, *2015 and The Ohio State University Moritz College of Law,* Key Considerations for Community Leaders Facing Civil Unrest: Effective Problem-Solving Strategies that Have Been Used in Other Communities, *2016.*

Table 3.8
Summary of Hazards to be Considered in the City of Milwaukee Hazard Mitigation Plan

Hazard	Risk of Occurrence (high, medium, or low)	Warning Time (short, medium, or long)	Damage to Property (high, moderate, or low)	Threat to Life Safety (high, medium, or low)	Duration of Impact (long, moderate, or short)	Size of Affected Area (large, medium, or small)
Natural Hazards						
Flooding	High	Medium	High	Low	Moderate	Large
Thunderstorm, High Wind, Hail, Lightning	High	Short	High	High	Long	Large
Winter storms	Medium	Medium	Low	Medium	Moderate	Large
Tornadoes	Low	Short	High	Medium	Short	Small
Temperature Extremes	Medium	Long	Low	High	Long	Large
Coastal Erosion	Low	Long	Medium	Low	Long	Small
Other Hazards						
Contamination or Loss of Water Supply	Low	Short	Moderate	Medium	Moderate	Medium to large
Hazardous Materials Incident	High	Short	Low	Medium	Moderate	Small
Medical/Health Risks	Low	Short	Low	High	Moderate to long	Small to large
Terrorism Incident	Low	Short	Moderate to high	High	Short	Small to medium
Major Fire and Emergency Incident	Low	Short	Low	High	Moderate to long	Small to large

Source: City of Milwaukee Hazard Mitigation Local Planning Team and SEWRPC

to identify and recover from. A cyberattack is a disruption of an information system. Such a disruption can take several forms, depending on the motives of the attacker, the technological means available to the attacker, and the weakness of the information system that is attacked. The forms that a cyber attack could take include: disabling an information system, stealing information or sensitive data, modifying outputs of the system, altering data stored within the system, or taking control of a system by an unauthorized user.

The options available to local government for mitigating the impacts of cyber-attacks are limited. While there are steps that the City can take to reduce the vulnerability of its information technology systems to cyber attacks, most of the information technology infrastructure within the City is privately owned and not under the control of any unit of government. Because of the limited mitigation options, cyber attack will not be considered further in subsequent sections of this report.

Lead Water Service Lines

One hazard addressed by this hazard mitigation plan is the contamination and/or loss of the City's water supply. Lead is one of several potential contaminants that could affect potable water in the City. Lead is a toxic metal that can cause health impacts that result in damage to peoples' nervous systems, kidneys, red blood cells, and reproductive systems. Children are especially sensitive to toxic effects of lead.

Release of lead from lead water service lines and lead-containing plumbing fixtures and fittings constitute the major sources of lead in drinking water in the City. Most homes in the City that were built prior to 1951 have lead service lines. In addition, plumbing installed prior to 1986 may include fixtures, fittings, and solder containing lead. To reduce the release of lead from plumbing, the Milwaukee Water Works adds anticorrosion agents to municipal water supplies as part of its treatment process.

People can be exposed to lead from sources other than drinking waters. The greatest potential for human exposure to lead results from two of its former uses, as an additive to gasoline and a pigment in paints.

The Milwaukee Water Works is currently conducting efforts related to addressing lead water services. In addition, the City of Milwaukee Health Department is conducting broader efforts related to lead poisoning within the City. The comprehensive approach required to address the sources and impacts of lead places this issue beyond the scope of what can be accomplished in a hazard mitigation plan. Because of this, the City of Milwaukee hazard mitigation plan will not address lead in drinking water.

3.2 VULNERABILITY ASSESSMENT ANALYSIS METHODS AND PROCEDURES

In the previous section of this report the hazards considered applicable to the City of Milwaukee were identified and ranked. This section of the report develops a vulnerability assessment for the identified hazards, including vulnerable asset description, hazard event profiling, and estimated losses information. This vulnerability assessment provides the basis for developing mitigation strategies which address the identified vulnerabilities.

This section of the report, which includes a description of the methods and procedures utilized in developing the vulnerability assessment, is followed by the assessment for each of the identified hazards. The vulnerability assessment for each hazard includes, where applicable, a profile of hazard events, a description of potentially affected assets, and estimates of potential losses. In addition, the potential for future changes in the vulnerability of the hazard to the City is included for each of the identified hazards. Since the hazard mitigation plan involves one municipality, no specific multi-jurisdictional variance of risk is included. Where there is a specific variance of risk involved within the City of Milwaukee, it is noted.

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.[39] The analysis includes three components: 1) profile of hazard events, 2) inventory of assets, and 3) estimation of losses. In addition, where applicable, potential changes in vulnerability under future conditions and the variance of vulnerability within the City of Milwaukee is analyzed.

In general, the procedures utilized in this analysis focused upon the methodology consistent with the Hazard U.S. (HAZUS) software as maintained by the Federal Emergency Management Agency. In many cases, the mapping of assets and problem areas was done utilizing the detailed mapping and orthophotography available for the City of Milwaukee in both hard copy and digital form, including general base maps, large-scale topographic and cadastral maps, and year 2010 and 2015 large-scale orthophotographs. All of the mapping was done utilizing geographic information system (GIS) ArcMap software.

With regard to the community assets, the basic City of Milwaukee inventory data set forth in Chapter 2 include data and mapping on existing and planned land use, demographics, and economic characteristics of the City; property value; flood hazard mapping; Lake Michigan coastal erosion hazard areas; transportation and utility systems; public safety facilities and services; and critical community facilities. These data have been used and supplemented with information obtained from the National Oceanic Atmospheric Administration (NOAA) National Climatic Data Center (NCDC); the Wisconsin Department of Military Affairs, Division of Emergency Management; and more hazard-specific local data, such as building-specific structure values, as the basis for the community asset data base. The profiling of hazard events was developed by utilizing HAZUS methodology, data available on the FEMA and NOAA NCDC web sites; data provided by the Wisconsin Department of Military Affairs, Division of Emergency Management; and file data available from the City of Milwaukee and the Southeastern Wisconsin Regional Planning Commission (SEWRPC).

Data and estimated losses and vulnerability were developed utilizing standard risk assessment methodology as set forth in FEMA and State Division of Emergency Management guidelines for hazard mitigation planning where hazards can be estimated spatially and by order of magnitude over a range of events. All damage estimates cited have been adjusted to constant 2016 dollars using the Consumer Price Index. 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 3.8.

Assessments of Potential Future Changes in Hazard Conditions Relative to Climate Change

The risk to the City of Milwaukee posed by many of the natural hazards profiled in this plan have been estimated based largely upon the history of occurrence of, and impacts attributed to, the hazard within the City. For example, the estimates given below for the number of thunderstorms and thunderstorm-related hazards that would be expected to impact the City and the amount of damages to property in the City reflect the average number of occurrences of these storms and the associated damages that were reported over a recent 25-year period. Over the short term, such as the five-year period covered by this plan, estimates of risk and damages derived in this manner should serve as reasonably reliable indicators of the degree of risk associated with various hazards. Over longer periods of time, climate change may render estimates of risk based on historical occurrences and impacts unreliable. Recent assessments have documented changes in Wisconsin's climate over the late 20th century.[40] Projections of Wisconsin's climate based on downscaled data from 14 global climate models indicate that additional changes will occur through the 21st century.[41] 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.

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[39] *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,* Local Multi-Hazard Mitigation Planning Guidance, July 1, 2008*. Federal Emergency Hazard Agency,* Local Mitigation Planning Handbook, *March 1, 2013; See also Federal Emergency Management Agency,* State and Local Plan Interim Criteria Under the Disaster Mitigation Act of 2000*, July 11, 2002*.

[40] *For example, Christopher J. Kucharik, Shawn P. Serbin, Steve Vavrus, Edward J. Hopkins, and Melissa M. Motew, "Patterns of Climate Change across Wisconsin from 1950 to 2006,"* Physical Geography, *Volume 31, pages 1-28, 2010*.

[41] *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, 2011*.

Average annual temperatures in Wisconsin increased over the last half of the 20th century. Between 1950 and 2006, average annual temperature in the State increased by an average of 1.1°F.[42] In the City of Milwaukee the increase was between 1.5°F and 2.5°F. Much of this increase in average temperature occurred in the form of higher night-time low temperatures. For example, over the period 1950 through 2006, the average number of days in the City of Milwaukee in which the daily low temperature fell below 0°F decreased by about 7 days per year. The greatest increase in temperatures occurred during winter and spring months. Depending on location, average winter temperatures in the City increased by 3.0°F to 3.5°F over this period.

The consensus of downscaled results from climate models projects that average annual temperatures will continue to increase through the 21st century.[43] Depending on location, it is projected that average temperatures in the State of Wisconsin will increase by between 4.0°F and 9.0°F over the period 1980 through 2055. This increase is projected to be on the order of 5.5°F to 6.0°F in the City of Milwaukee. The greatest changes are projected to occur during winter months, with average winter temperatures being projected to increase by about 7.5°F in the City. By contrast, average temperatures in the City during the summer are projected to increase by about 5.5°F. Changes in extreme temperatures will accompany these changes in average temperature. 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. This is likely to double to about 25 days per year by 2055. 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 2055.

Average annual precipitation in Wisconsin increased over the last half of the 20th century. Between 1950 and 2006, average annual precipitation in the State increased by an average of about 3.1 inches.[44] It should be noted that there was substantial variability in the change in precipitation across the State, with some areas experiencing increases of up to 7.0 inches and some areas in northern Wisconsin experiencing decreases. In the City of Milwaukee, annual precipitation increased over this period by between 3.0 inches and 7.0 inches, with smaller increases occurring in the northwestern portion of the City and larger increases occurring in the southeastern portion of the City. Much of the increase in average precipitation occurred during autumn months. In the City of Milwaukee, average precipitation during autumn months increased by between 1.5 inches and 2.0 inches over the period from 1950 through 2006. Increases in precipitation also occurred during winter, spring, and summer. The frequency and magnitude of heavy precipitation events has also been increasing in Wisconsin. Extreme rainfall patterns in the City of Madison illustrate this trend. In the decade between 2001 and 2010, there were 24 days per decade in which 2.0 inches or more of precipitation fell in a single event. This is twice the previous maximum of 12 days in the 1950s.

The consensus from downscaled results of climate models projects several changes in precipitation through the 21st century.[45] Most of the models project an increase in average annual precipitation in southeastern Wisconsin of about 1.5 inches to 2.0 inches. The projections indicate that the amount of precipitation falling during winter is likely to increase by about 25 percent. Due to the projected increase in temperatures, it is projected that a greater amount of precipitation occurring during the winter will fall as rain rather than snow.[46] 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 become more likely for early spring precipitation to fall as rain rather than snow.

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[42] *Kucharik and others, 2010,* op. cit.

[43] *Wisconsin Initiative on Climate Change Impacts, 2011,* op. cit. *Downscaling is an analysis approach that enables climatological data generated by Intergovernmental Panel on Climate Change general circulation models developed at a relatively coarse geographic scale (e.g., climate change data for several large regions in an entire state) to be modified to represent a finer geographic scale (e.g., at the scale of a county or smaller).*

[44] *Kucharik and others, 2010,* op. cit.

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

[46] *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.*

The amount of precipitation occurring during the summer is not projected to change much. The projections also indicate that 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 changes will be concentrated in the spring and fall. The projections indicate that the magnitude of the heaviest precipitation events will also increase. 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.

3.3 VULNERABILITY ASSESSMENT FOR FLOODING AND ASSOCIATED STORMWATER DRAINAGE PROBLEMS

Flooding is a significant hazard in the City of Milwaukee. As described in Chapter 2, there are approximately 61 miles of major streams in the City of Milwaukee, located within five watersheds: the Milwaukee River, Menomonee River, Kinnickinnic River, Oak Creek, and Root River watersheds. A sixth watershed encompasses those areas adjacent to Lake Michigan which drain directly into the Lake through intermittent streams. Aside from Lake Michigan, no other major lakes (those over 50 acres) exist in the City of Milwaukee.

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 subject to flood inundation by the one-percent-annual-probability (100-year recurrence interval) flood event. The floodplains shown on Map 2.4 in Chapter 2 of this report have been identified by the City of Milwaukee, the Southeastern Wisconsin Regional Planning Commission, and the Federal Emergency Management Agency. Approximately three square miles, not including surface water in existing stream channels, or about 3 percent of the total area of the City, is located within the one-percent-annual-probability flood hazard area.

In addition to flooding, stormwater drainage problems exist on a scattered basis throughout the City of Milwaukee. 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 nonpoint source pollution control measures. The focus of this section is on the flooding hazard, with stormwater drainage issues discussed as required for particular storm events.

In order to evaluate various potential flood mitigation alternatives for the City of Milwaukee and select the most effective and feasible flood mitigation strategies, the existing flooding problems in the City must first be analyzed. Accordingly, this section summarizes the extent and severity of the flooding problems within the City and the potential for these problems to increase in the future, and sets forth analyses of such problems as developed under detailed floodplain management system planning programs as described in the Flood Mitigation Plan for the City of Milwaukee revised in 2003,[47] various Milwaukee Metropolitan Sewerage District watercourse system plan reports, and subsequent analyses and reports.

Historical Flooding Problems

As noted earlier in this chapter, a number of major flooding events, including several that caused significant damage, have been recorded in the area now encompassed by the City of Milwaukee, as well as in the watershed areas partly encompassed within the City, since the areas involved were settled by Europeans in the 19th Century. Below is a list and brief description of the historical major flood events between 1897 and 1986 that have affected the City of Milwaukee as summarized in the Milwaukee County Pre-Disaster Mitigation Plan[48] and the City of Milwaukee Flood Hazard Mitigation Plan.[49] The descriptions of the

[47] *SEWRPC Community Assistance Planning Report No. 261,* Flood Mitigation Plan for the City of Milwaukee, Milwaukee County, Wisconsin*, October 2000, revised April 2003*.

[48] *Milwaukee County Office of Emergency Management,* Milwaukee County Hazard Mitigation Plan, *draft, October 19, 2017*.

[49] *SEWRPC Community Assistance Planning Report No. 261,* op. cit.

floods during that time period are presented chronologically by event, followed by watershed-specific descriptions. Those descriptions are followed by a review of more-recent floods that have occurred from 1993 to the present.

- March 1897—This flood event inundated approximately a 1.7-mile-long reach of the Menomonee River beginning just north of present-day W. Wisconsin Avenue in Milwaukee County and extending downstream into the Menomonee River industrial valley. Considerable economic loss was incurred.

- March 1912—This flood event occurred in the Kinnickinnic River watershed and is the earliest major flood of record within the watershed for which any significant amount of information is available. This flood was caused by snowmelt. Damage caused by this flood was concentrated in the 0.77-mile-long reach of the Kinnickinnic River between present-day S. 6th Street and present-day S. 16th Street. Damage to homes along that reach totaled thousands of dollars, with floodwaters reported above the windowsills of some of the structures.

- June 1917—This flood event caused extensive damage in the lower Menomonee River watershed, particularly in the Menomonee River industrial valley. The Menomonee River floodplain below what is now the Wisconsin Avenue viaduct was subjected to very serious flooding that drove almost every resident from the area. Several businesses with major facilities in the Menomonee River industrial valley, including the Chicago, Milwaukee, St. Paul & Pacific Railroad and the Falk Corporation, incurred significant flood damage. Serious flooding also occurred in the Kinnickinnic River watershed in an area encompassing several blocks near the eastern edge of the watershed immediately west of Humboldt Park. A portion of the roadway at the intersection of S. Howell Avenue and E. Oklahoma Avenue was washed out.

- January 1938—This flood event, while significant, is known to have affected only scattered areas along the lower Kinnickinnic River and along Wilson Park Creek. The Kinnickinnic River overflowed its banks near a railway bridge crossing at S. 18th Street extended, depositing large blocks of ice on the tracks, and flooded a railroad bridge located directly west of S. 20th Street. Although this flood occurred in January, it was attributed to the occurrence of heavy rainfall.

- June 1940—This flood event inundated and caused damage to areas primarily along the Menomonee River with scattered occurrences of flooding also reported along Honey Creek, Underwood Creek, and the Little Menomonee River. The S. 84th Street bridge over Honey Creek in the City of Milwaukee was washed out. Near the confluence of the Menomonee and Little Menomonee Rivers in Milwaukee, rising flood waters forced segments of what is now N. Mayfair Road and W. Hampton Avenue to close.

- March/April 1960—This flood event primarily occurred in the Kinnickinnic River and Menomonee River watersheds as the result of a snowmelt-rainfall event. The event caused widespread damage in the City of Milwaukee along the Kinnickinnic River and scattered problems in the City along Wilson Park Creek. The flood caused problems along the Kinnickinnic River as far west as S. 43rd Street and along Wilson Park Creek as far south as General Mitchell Field (now Milwaukee Mitchell International Airport). Basements of residential and commercial buildings were flooded, collapsing walls in some cases. At the time, the U.S. Department of Agriculture, Soil Conservation Service (now the Natural Resources Conservation Service) estimated flood damages in the Menomonee River watershed resulting from this flood at about $2.9 million (about $23.5 million in 2016 dollars).

- August 1960—This flood event caused extensive flooding along the Kinnickinnic River downstream of S. 43rd Street. A portion of the flood flow from the Kinnickinnic River was diverted from the stream at W. Montana Street extended and flowed five blocks in an easterly direction along the Chicago & North Western Railway right-of-way to S. 12th Street, where the flow turned northward, moving about two blocks along S. 12th Street to rejoin the Kinnickinnic River. Considerable flood damage occurred in basements located along this route, including damage to appliances and other contents. Farther upstream, residential structures along W. Manitoba Avenue again experienced flood damage and numerous basements were flooded and at least one incident of basement wall collapse was reported.

- September 1972—This flood event caused by a relatively large quantity of rainfall occurring under wet antecedent moisture conditions resulted in significant flood damage and disruption in the Kinnickinnic River watershed within the City of Milwaukee. Most of the damage and disruption involved was confined to the reach of the Kinnickinnic River between S. 6th Street and S. 16th Street in the City. The flood problems were restricted largely to this reach because of the considerable channel modifications that had been completed by this time within the watershed on the Kinnickinnic River, Wilson Park Creek, Lyons Park Creek, and other tributaries, thereby providing for the control of the relatively high flows that were experienced. Floodwaters overtopped the low point of the roadways of the 10 bridges that then crossed the Kinnickinnic River beginning with and including S. 7th Street and extending through S. 15th Street, extending as much as one city block away from the River. Floodwaters overtopped the S. 43rd Street bridge over the Kinnickinnic River in the City, damage occurred to residential and commercial buildings.

- April 1973—This major flood event caused flood problems throughout most of the seven-county Southeastern Wisconsin Region, with certain areas, such as the Kinnickinnic River and Menomonee River watersheds, experiencing severe flood damages. The flooding that occurred was somewhat more serious than what would ordinarily be expected under the relatively moderate levels of rainfall involved because of the existence of very wet antecedent moisture conditions.

- August 1986—This flood event centered in a one to four-mile-wide band extending northwesterly from the City of Oak Creek through Milwaukee Mitchell International Airport to the northern portion of the City of Wauwatosa. It resulted in a maximum rainfall of 6.84 inches in 24 hours, the single day record at the Milwaukee Mitchell International Airport recording station. As shown in Figure 3.1, widespread flooding occurred at the airport, which was shut down. Severe damage occurred especially along the reach of the Kinnickinnic River between S. 6th Street and S. 16th Street in Milwaukee. Flooding impacts occurred in other areas, including along Wilson Park Creek, located in the Kinnickinnic River watershed, and the near northwestern portion of Milwaukee along the Menomonee River and Woods Creek, where severe basement flooding occurred due to sewer backup. Impacts near the mouth of the Menomonee River are shown in Figure 3.2.

Kinnickinnic River Watershed

Measured by the spatial extent of the flood damage and disruption resulting from the event, the April 1973 flood (which within the Kinnickinnic River watershed had a 1.8 percent annual probability of occurrence) was not the most serious flood experienced in the watershed. In addition, by this time, as noted above, considerable channel modifications had been completed within the Kinnickinnic River watershed on the Kinnickinnic River, Wilson Park Creek, Lyons Park Creek, and other tributaries, thereby again providing for the control of the relatively high flood flows that were experienced. Within the watershed, major damage and disruption attributed to the flood were confined to the S. 6th Street to S. 16th Street reach of the Kinnickinnic River in the City of Milwaukee, although damage also occurred at Milwaukee Mitchell International Airport. Although major channel modifications had been completed throughout the aforementioned Kinnickinnic River reach in 1961, the modified channel in combination with the 13 stream crossings then in the reach did not have sufficient capacity to convey the 1973 flood flows within the channel banks. As a result, floodwaters overtopped the low point of the roadways of all 11 bridges then crossing the Kinnickinnic River beginning with and including S. 7th Street and extending through S. 15th Place. Accordingly, overland flooding occurred on both sides of the River between S. 6th Street and S. 16th Street, extending as much as 700 feet, or more than one city block, away from the River. The areal extent of the effect of flooding undoubtedly extended outside the area affected by the overland flooding in the form of secondary flooding. Many residential and commercial buildings in the area of overland flooding incurred both structural damage and damage to contents as a result of basement or first-floor flooding. Extensive monetary losses occurred in the case of some individual structures, including a $16,000 (about $86,500 in 2016 dollars) loss resulting from damage to the inventory of a pharmacy located less than one-half block from the Kinnickinnic River. In addition, an isolated incident of flood damage occurred at General Mitchell Field, where a concrete box culvert beneath a taxiway in the northwestern corner of the airport suffered serious damage as a result of high stormwater flows.

Except for the serious flood damage and disruption that occurred in the S. 6th Street to S. 16th Street reach of the Kinnickinnic River, no serious flood problems were reported in the Kinnickinnic River watershed as a

Figure 3.1
Flooding at General Mitchell International Airport, August 1986

Source: Wisconsin Division of Emergency Management

result of the April 1973 flood event. Significantly, the area along and near the River between S. 16th Street and S. 43rd Street, which had experienced serious flood damage and disruption during the major flood events of 1912, 1917, 1938, and 1960, did not exhibit any flood problems as the result of the April 1973 flood event, even though the flood flows generated by the earlier flood events were probably of the same order of magnitude as that of the April 1973 flood. As in the case of the September 1972 flood event, the absence of flood problems along the S. 16th Street to S. 43rd Street reach of the River in the April 1973 flood event probably reflects the effectiveness of the channel improvements made to the River in that reach between 1960 and 1965.

An August 1986 storm event centered in a one- to four-mile-wide band extending northwesterly from the City of Oak Creek through Milwaukee Mitchell International Airport to the northern portion of the City of Wauwatosa near Lawrence J. Timmerman Airport resulted in a storm total rainfall of 6.84 inches in 24 hours, the single-day record at the Milwaukee Mitchell International Airport recording station. The 24-hour rainfall recorded at the airport had about a 0.5 percent annual probability of occurrence. Widespread flooding occurred in the Milwaukee Mitchell International Airport area and closed the airport (see Figure 3.1). The overall flooding attendant to the storm event caused great damage, including severe damage along the reach of the Kinnickinnic River between S. 6th Street and S. 16th Street in the City of Milwaukee. However, the August 1986 rainfall event caused an area of inundation along this reach of the River that was substantially smaller than the area along the same reach that was inundated in the April 1973 flood event. The substantial differences in the areas of inundation may be attributed to the proper performance of significant channel improvements implemented between 1973 and 1986. A one-percent-annual-probability flood would have been contained within the limits of the improved channel. It is clear that the flood control improvements involved functioned as designed to significantly reduce flood damages in the August 1986 storm.

Figure 3.2
Flooding at the Cargill Meat Solutions Facility near the Mouth of the Menomonee River, August 1986

Source: Cargill Meat Solutions Corporation

In the August 1986 flood event, significant flooding impacts also occurred along Wilson Park Creek, located in the Kinnickinnic River watershed. Severe basement flooding due to sewer backup was also experienced in numerous areas in the Kinnickinnic River watershed that are remote from streams.

Menomonee River Watershed

The April 1973 flood event, which illustrates the extreme sensitivity of rainfall-induced floods to antecedent moisture conditions in the Menomonee River watershed, was the most severe flood event recorded in the watershed up to that time in terms of damage and disruption. In that flood event, moderate rainfall volumes occurred over the entire watershed under very wet antecedent moisture conditions. Although the event caused flood problems throughout most of the urban area of the watershed, which at the time encompassed about 54 percent of the total area of the watershed, the damage and disruption arising from the event were most serious along Underwood Creek in the Village of Elm Grove and along the Menomonee River in the City of Wauwatosa. In addition, significant damage and disruption and/or significant overland flooding occurred in the Cities of Mequon and Wauwatosa and the Villages of Germantown and Menomonee Falls. However, the flood had little impact on the other riverine-area communities in the watershed, including the City of Milwaukee. The general absence of significant flood problems in these communities in the April 1973 flood event is primarily attributable to the presence of structural flood control works that protected riverine-area residential, commercial, and industrial development. Thus, largely as a result of channel modifications and sheet steel floodwalls completed by the City of Milwaukee Sewerage Commission and the Metropolitan Sewerage Commission between 1962 and 1968 along the 1.5-mile-reach of the Menomonee River from the Chicago, Milwaukee, St. Paul & Pacific Railroad yard in the Menomonee River industrial valley upstream to about N. 45th Street in the City of Milwaukee, the April 1973 flood there was confined to the channel area. Similarly, a sheet steel floodwall constructed along the Menomonee River by the Falk Corporation in 1962 prevented flooding at the company's location, even though the peak stage of the April 1973 flood was about two feet higher than that of the March-April 1960 flood, which caused the Falk Corporation to suffer extensive losses. It is important, however, to recognize that there were areas in the Menomonee River watershed that continued to experience localized stormwater problems.

In the August 1986 flood event, significant flooding impacts also occurred near the northwestern portion of the City of Milwaukee, including the area along the Menomonee River and Woods Creek adjacent to Milwaukee County Stadium. Severe basement flooding due to sewer backup was also experienced in numerous areas in the Menomonee River watershed that are remote from streams.

Milwaukee River Watershed

With regard to the Milwaukee River watershed, the studies performed in the preparation of the initial comprehensive plan for the watershed adopted by SEWRPC in 1972, as well as research performed under subsequent related planning efforts, indicated that up to, and including, 1971, five major flood events occurred within the watershed since its settlement by Europeans: one in March 1918, one in August 1924, one in March 1929, one in March 1959, and one in March-April 1960. Although no significant widespread damage occurred as a result of these flood events in areas then or now located within the City of Milwaukee, the historical experience with flooding in the portion of the Milwaukee River watershed located within the City includes flooding along the 3.1-mile-long reach of the River extending from the site of the North Avenue dam to the mouth of the River. The damages associated with such flooding have been relatively very minor in the reach involved, being limited to minor damage due to basement seepage in structures along the River and to the backup of sewers within the downtown area of the City. Some shallow inundation of low-lying street intersections located relatively close to the Milwaukee River reach involved has also occurred.

No historical flood damages are known to have occurred along the approximately three-mile-long reach of the Milwaukee River extending from the North Avenue dam to Estabrook Park. The riverbanks along this reach are generally high, and a considerable proportion of the stream bank area is devoted to park or other open space uses.

In the August 1924 flood event, portions of the 2.1-mile-long reach of the Milwaukee River extending from Estabrook Park to W. Silver Spring Drive experienced very high water levels, as evidenced by reported high water marks. The peak flood stage of the River at the W. Silver Spring Drive crossing of the River, located in the present-day City of Glendale, was about 11 feet above normal and only about 2.4 feet below the crown of the road over the bridge. Much of the potential damage in the reach involved was eliminated, however, by the implementation in 1937 of channel improvements between Lincoln Park and N. Port Washington Road. Basement flooding has also been experienced in the past along this reach of the River due to stormwater drainage problems not directly related to the flood stages of the Milwaukee River. Remedial measures were implemented by the City of Milwaukee to alleviate the surface drainage problems that caused this basement flooding.

Floods of moderate severity occurred on the Milwaukee River in 1959 and in 1960, with the 1959 flood having a 10-percent-annual-probability of occurrence and the 1960 flood being slightly larger. The major floods that occurred in 1918 and 1924 in the City of Milwaukee each had annual probabilities of occurrence of about 1.3 percent.

Flooding, in various degrees, has long commonly occurred adjacent to Lincoln Creek, which is tributary to the Milwaukee River and whose subwatershed is located largely within the City. Flooding along Lincoln Creek has increased proportionally to the conversion of land within its subwatershed from open, rural use to urban use. Subsequently, channel improvements and bridge replacements were implemented to accommodate the increased flows. During the period from 1960 through 1981, the four largest flood events of record along Lincoln Creek occurred in 1964, 1968, 1972, and 1973. The major consequences of these and other runoff events along Lincoln Creek have been flooding of roadways and underpasses, first-floor flooding of buildings, and basement flooding caused by sewer backup. Over the period from 1960 through 1975, more than 1,300 separate flooding and water-related problems were reported to the City of Milwaukee by property owners in the Lincoln Creek area. The problems thus reported included first-floor inundation, yard flooding, and basement flooding, with the most common complaint being basement flooding. Studies and planning efforts completed subsequent to SEWRPC's preparation and adoption of its initial comprehensive plan for the Milwaukee River watershed, including a SEWRPC study undertaken to develop the detailed flood control plan for Lincoln Creek that was adopted by SEWRPC in 1983 as an amendment to the Milwaukee River watershed study, identified the Lincoln Creek subwatershed area in the City of Milwaukee as a specific problem area, with over 1,600 structures located within the flood hazard area.

In late 2001, MMSD completed a comprehensive flood control and stream rehabilitation project on Lincoln Creek which included bridge removals and conveyance modifications, in-line floodwater storage, floodplain lowering and widening, habitat enhancements, and two floodwater detention facilities. The detention facilities include the 26-acre Green Tree Detention Pond and the 11-acre Havenwoods wetland/detention facility which provide a total of 229 acre-feet of storage. The project spanned more than nine miles of stream channel and included bio-engineered stream restoration using native prairie and wetland plants. This project removed all 1,600 homes and businesses from the one-percent-annual-probability floodplain, and is reflected in the effective FEMA digital flood insurance rate map for Milwaukee County.

Oak Creek Watershed

Within the portion of the Oak Creek watershed that is located within the City of Milwaukee, historical flood damages have been limited to two areas: 1) one area along the North Branch of Oak Creek located east of S. 13th Street and north of W. College Avenue where two commercial buildings are currently located within the flood hazard area; and 2) an area in the southern portion of Milwaukee Mitchell International Airport where four governmental structures are located in the flood hazard area of the Mitchell Field Drainage Ditch.

Root River Watershed

Neither any historical flood damages nor any current flood problem areas have been identified within the portions of the Root River watershed that are located within the City of Milwaukee.

Lake Michigan Direct Drainage Area

Flooding problems are reported to be relatively minimal in the portion of the Lake Michigan direct drainage area that is located within the City.

Description of Recent Flood Events

Since 1993, there have been 34 flood events reported by the NCDC affecting the City of Milwaukee and some of the watershed areas that lie partly within its boundaries, or an average of 1.4 flood events per year. Those flood events were reported to the NCDC to have caused damages totaling about $330 million in property damage. The most severe recent events occurred in 1997, 1998, 2000, 2004, 2008, 2009, and 2010. These flood events, which are significant with regard to the current flood mitigation planning effort for the City, include the following:

- The event of June 20-21, 1997, when a period of moderate rainfall followed by intense thunderstorms centered in northern Milwaukee County resulted in at least four inches of rain across the County, with much of the County receiving at least six inches of rain. More than nine inches of rain was recorded in the Village of Brown Deer. Severe localized damage occurred in Brown Deer, the City of West Allis, and the Lincoln Creek area of the City of Milwaukee. The reach of Lincoln Creek between N. 37th Street and N. 60th Street in the City experienced significant flooding and stormwater drainage problems during the flood event. Of the total of 1,510 flooding complaints received by the City in the one-week period following the flood event, about 980, or 65 percent, occurred with regard to the Lincoln Creek subwatershed. Severe, direct overland flooding also occurred in several other areas, including areas along the Menomonee River in the Cities of Milwaukee and Wauwatosa (Figure 3.3). Sewer backup flooding was reported in the Kinnickinnic River watershed, but no damages resulting from overbank flooding along waterways in that watershed were reported. There were, however, numerous occurrences of stormwater drainage and sanitary sewer backup problems in communities located throughout the areas of heavy rainfall.

- Estimated flood damages during the June 1997 event were $117.7 million[50] in Milwaukee County. Assistance received by the City of Milwaukee through the FEMA and State Hazard Mitigation and Public Assistance programs administered by the Wisconsin Department of Military Affairs Division of Emergency Management associated with this event totaled about $1,122,000 under the FEMA Hazard Mitigation program and $1,412,000 under the FEMA Public Assistance program.

[50] *Damages adjusted to 2016 dollars using the Consumer Price Index.*

- The event of July 2, 1997, a "follow-up" storm to the June 20-21, 1997, storm event, involved as much as four inches of rain, but resulted in little additional property damage.

- The event of August 6, 1998, in which over six inches of rain fell in northwestern Milwaukee County and eastern Waukesha County, resulting in severe direct overland flooding for a second consecutive year along Lincoln Creek in the City of Milwaukee as well as along the Menomonee River in the City of Wauwatosa, Underwood Creek in the City of Brookfield and the Village of Elm Grove, and Southbranch Creek in the Village of Brown Deer. Significant property damage resulted from overbank flooding along Lincoln Creek and the Menomonee River. As in the 1986 and 1997 major storm events in the area, there were numerous occurrences of stormwater drainage and sanitary sewer backup problems in communities located throughout the areas of heavy rainfall.

Figure 3.3
Flooding near 42nd Street and Clybourn Street, June 21, 1997

Source: Milwaukee Metropolitan Sewerage Commission

- Estimated flood damages during the August 1998 event were $14.4 million[51] in Milwaukee County. Assistance received by the City of Milwaukee through the FEMA and State Hazard Mitigation and Public Assistance programs associated with this event totaled about $227,000 under the FEMA Public Assistance program.

- The event of July 2, 2000, in which as much as 6.5 inches of rain fell on portions of eastern Waukesha and southern Milwaukee Counties, including 4.42 inches recorded at Milwaukee Mitchell International Airport on the far south side of the City of Milwaukee. The storm associated with this event produced one tornado in southern Milwaukee County about three-fourths of a mile northwest of S. 27th Street and W. Ryan Road in the City of Franklin. The tornado moved east/northeast through the City of Oak Creek and into neighboring Racine County. In addition to damage from the tornado, significant damages due to flooding also occurred. The most severe flooding occurred in the communities south of Milwaukee, including the Cities of Franklin and Oak Creek and the Villages of Greendale and Hales Corners. In the City of Milwaukee, reported damages occurred mainly in the Kinnickinnic River and Oak Creek watersheds, with damages mostly limited to basement flooding due to either sewer backup or inoperable sump pumps caused by power outages.

- Estimated flood damages during the July 2000 event were $8.9 million[52] in Milwaukee County.

- The storms that occurred in the Region in May of 2004 occurred over relatively long periods of time and the probability of occurrence of the rainfalls at a given location generally decreased as storm duration increased. In the City of Milwaukee, widespread flood damage was not reported. The most severe five- and 10-day rainfalls in the City occurred at the City of Milwaukee gauge in the Menomonee River watershed at 8800 W. Lisbon Avenue where the annual probability of occurrence for both storm durations was estimated at 10 to 20 percent. The annual probabilities of the 15- and 20-day rainfalls at that location were in the range from 4 to 10 percent and the 25-day rainfall probability was about 2 percent. Despite the occurrence of relatively rare long-term rainfalls at the W. Lisbon Avenue gauge, the recorded peak flow on the Menomonee River at N. 70th Street in the City of Wauwatosa had a probability of only 20 to 50 percent. That flood probability is in

[51] Ibid.

[52] Ibid.

line with the estimated five-day rainfall probability over the entire Menomonee River watershed where rainfall amounts were generally less at locations other than the W. Lisbon Avenue gauge. Elsewhere, recorded peak flood flows on streams in the City of Milwaukee had annual probabilities of occurrence ranging from greater than 50 percent on the Kinnickinnic River at S. 11th Street to 10 to 20 percent on the Milwaukee River.

- The June 2008 rainfall events broke three records for Milwaukee. The 7.18 inch, 48-hour rainfall occurring on June 7 and 8 was the largest 48-hour total ever recorded and the monthly total rain of 12.27 inches set a new Milwaukee record for both June and for monthly maximum rainfall.

- Many areas in the City of Milwaukee experienced stormwater drainage flash flooding as a result of the June 7th rain, including vehicles stalling and floating at intersections and in some parking lots and 28 manhole covers/sewer grates being blown off from the water pressure. Just west of downtown Milwaukee, water up to two feet deep was reported in some intersections (N. 51st Street and W. Good Hope Road, Layton Avenue, S. Howell Avenue near Edgerton Avenue and to the south, W. Fond du Lac Avenue and W. Locust Street, S. 27th Street and W. Morgan Avenue), causing damage to buildings and abandonment of cars. A section of IH 894 had to be closed for a time near S. 27th Street due to the presence of water over the freeway and ramps. Milwaukee Mitchell International Airport closed at 8:00 p.m. on June 7th due to major flooding. Also, a state of emergency was declared in Milwaukee County. On June 8th more rain exacerbated flooding, with the Kilbourn Tunnel being closed due to flash flooding. Approximately 1,000 homes in the City of Milwaukee reported water in their basements and several neighborhoods reported downed trees. Two privately owned buildings on the near south side collapsed due to the weight of rain on their roofs. Flooding along the Kinnickinnic River for this event is shown in Figure 3.4.

- MMSD reported a 686 million gallon (MG) separate sewer overflow from June 7-9, 2008. MMSD also reported a combined sewer overflow June 7-15, 2008 of 2.9 billion gallons (BG), which was the largest combined sewer overflow since the deep tunnel opened in 1994.

- In the first half of June all the rivers in the City of Milwaukee reached flood stage, with the Milwaukee gage at the Milwaukee River cresting at 7.34 feet on June 14, 2008 which is the second highest stage recorded since 1914.

- On June 14th, disaster aid from FEMA was authorized under a major disaster declaration issued for the state by President Bush. Federal funding of $6 million was made available to affected individuals in 30 counties in Wisconsin including Milwaukee. Damage totals for Milwaukee County were estimated at $43 million, with $32 million for residences and $6 million to private businesses. It was estimated that 19,000 homes in Milwaukee County were damaged, with approximately 40 percent due to sump pump failures. Governor Doyle announced in September 2009 that the State still needed $1.22 billion to cover flood damage for housing, businesses, and infrastructure to the 30 declared counties. As of June 2009, the State had received about $124 million from the US Department of Housing and Urban Development.

- The June 18-19, 2009 event was a series of thunderstorms that dropped 6.02 inches of rain on the downtown Milwaukee area and 4.15 inches at the General Mitchell International Airport (GMIA). These thunderstorms dropped very heavy rain over a relatively short period of time (as much as two inches per hour), resulting in stormwater drainage flash flooding and basement backups, and even some river flooding in the Milwaukee metropolitan area. Sewage and stormwater seeped into a storage room in the Milwaukee County medical examiner's office at N. 9th Street and W. Highland Avenue, some flash flooding and flood damage occurred at the service level of Miller Park, two feet of standing/flowing water was reported at IH 894 near GMIA, there was an estimated one foot of water over the curb at IH 894 at S. 27th Street, several cars stalled in high water near S. 6th Street and W. Canal Street, and both directions of the 3200 block of W. Capitol Drive were closed due to high water and abandoned cars. The City of Milwaukee Environmental Engineering Section reported 658 calls for basement backups, 172 calls for surface ponding, and seven sanitary sewer overflows for the June 19, 2009 event.

Figure 3.4
Flooding Along The Kinnickinnic River at 9th Place and Cleveland Avenue: June 7, 2008

Source: Wisconsin Division of Emergency Management

- The 2010 flood event in Milwaukee included two events, one event on July 14 and 15 and a more severe event on July 22. The July 14-15 event dropped more than five inches of rain in parts of the City in less than six hours, causing stormwater street flooding at 157 locations, basement backups, and sewer overflows. The City of Milwaukee received 42 reports of manhole covers being blown off. Standing water was reported at N. 35th Street and W. Capitol Drive, N. 60th Street and W. Mill Road, and W. Juneau Avenue and N. Martin Luther King Drive. Approximately 1,200 basement backup complaints were called in to the City of Milwaukee Department of Public Works (DPW). MMSD reported a 2.75 MG separate sewer overflow and a 521 MG combined sewer overflow for the July 14-15 event.

  General Mitchell International Airport reported a rainfall total of 5.61 inches for July 22nd, which is the second highest one day rain for Milwaukee for the period of record behind only the 1986 rain event of 6.81 inches. Rainfall at the MMSD rain gage at 3600 W. Fond du Lac Avenue totaled 7.52 inches for the day. Rain gages on the City of Milwaukee north side measured rainfall amounts of more than 3.7 inches in one hour, which is less frequent than the one-percent-annual-probability (100-year recurrence interval) event. For the month through July 22nd, Milwaukee received 9.49 inches of rain, nearly three times the normal amount.

  The July 22 event caused stormwater drainage street and freeway ponding, basement backups, and closure of GMIA due to surface ponding. One person was injured when their vehicle was swallowed in a large sinkhole at Oakland and North Avenues (Figure 3.5), and one death was reported for the driver of a car that went into Lincoln Creek. Over 6,000 homes in the City reported water filled basements. IH 43 was shut down between Atkinson Avenue and Mequon Road in Ozaukee County and USH 45 was shut down at W. Hampton Avenue. Fond du Lac Avenue was flooded from W. North Avenue to N. 107th Street, and the ramps at IH 43 and Capitol Drive were closed. Water pressure blew off manhole covers throughout Milwaukee, with one at N. 68th Street seen blowing five feet out of the manhole. Streets surrounding the Bradley Center and the US Cellular Arena were under nearly a foot of water. Rushing water moved along both sides of Downer Avenue south of E. Edgewood Avenue at the University of Wisconsin-Milwaukee campus. Water rose quickly on Downer Avenue to cover hubcaps, then license plates of parked vehicles. Localized flooding caused at least five basements to collapse in the 5000 block of N. 19th Place, adjacent to Lincoln Creek. Two homes in the 1900 block of W. Eggert Place, also adjacent to Lincoln Creek, were demolished due to destroyed foundations. Examples of damages to building foundations are shown in Figure 3.6. MMSD estimated a total sewer overflow of 2.1 billion gallons (1.985 billion gallons combined sewer overflow, 171 million gallons separate sewer overflow).

For the July 2010 events the preliminary private damage estimate for the City of Milwaukee was $6.9 million[53] (5,496 residential and business properties affected, 17 with major damage and three destroyed). This estimate did not include property owned by the City and public costs. Nineteen Milwaukee homes became uninhabitable due to flood damage after inspection. Damage estimates included approximately $29.8 million in the private sector and $11.3 million in the public sector for Milwaukee County. Riverside University High School at 1615 E. Locust Street received nearly six feet of water in its lower level, causing more than $5.1 million in damage. Forty-two Milwaukee Public School properties sustained flood damage totaling $7.2 million. The Milwaukee Department of Public Works crews picked up more than 1,300 tons of flood debris. President Obama declared a Federal disaster for Milwaukee County on August 11, 2010, with $45.8 million approved for Individual Assistance to Milwaukee and Grant Counties on 31,600 total applications.

Figure 3.5
Sinkhole Resulting from Flooding near North Avenue and Oakland Avenue, July 21, 2010

Source: Milwaukee Metropolitan Sewerage Commission

Vulnerability and Community Impacts Assessment

The floodplain areas, as well as the subwatershed boundaries, within the City of Milwaukee are shown on Map 2.4 in Chapter 2 of this report. These areas are generally located along the major stream system throughout the City. The floodplains have been delineated for a total of about 61 miles of stream within the City. Most of the floodplain areas for which detailed studies are available have been mapped on large-scale topographic mapping prepared at a scale of one inch equals 100 feet with a contour interval of two feet. Flood flows and stages are currently readily available for about 58 miles of the total stream reaches involved, while the floodplain for about three miles of stream is delineated by approximate methods under the Federal Flood Insurance Study for the City. Under the Milwaukee County Automated Mapping and Land Information Program and its successor Milwaukee County Land Information Council, updated digital large-scale topographic maps for the entire City have been prepared, and Light Detection and Ranging (LiDAR) data were collected in 2010, enabling development of one-foot interval elevation contours for the entire County.

Kinnickinnic River Watershed

As of 2016, a total of 734 structures were identified as being located within the one-percent-annual-probability floodplain in the Kinnickinnic River watershed. Of these structures, 688 were identified through floodplain delineations conducted during development of MMSD's 2017 Kinnickinnic River watershed flood management plan.[54] Table 3.9 shows the distribution among subwatersheds of the watershed of these structures identified in this plan. Most of the structures identified as being located within the one-percent-annual probability floodplain are located along either the mainstem of the Kinnickinnic River, Wilson Park Creek, or Lyons Park Creek. Smaller numbers of these structures are located along either the 43rd Street Ditch and Villa Mann Creek. Table 3.9 also shows that average annual flood damages in the Kinnickinnic River watershed are estimated to be slightly less than $2.2 million per year (2016 dollars). The remaining 46 six structures are located near the mouth of the Kinnickinnic River, downstream of the area addressed by Kinnickinnic River watershed flood management plan. These structures were identified using floodplain delineations completed as part of a floodplain delineation project undertaken by SEWRPC for the Milwaukee County Automated Mapping and Land Information System (MCAMLIS) Steering Committee that was completed in 2016.

[53] *This estimate and subsequent damage estimates in the description of the July 2010 flood are given in 2016 dollars.*

[54] *Milwaukee Metropolitan Sewerage District,* Kinnickinnic River Watershed Flood Management Plan: Final Report, *May 4, 2017.*

Figure 3.6
Damage to Residential Property Caused by the July 2010 Flooding

Source: City of Milwaukee

Menomonee River Watershed

There are currently 43 identified structures in the floodplain along the Menomonee River in the City of Milwaukee. Completion of the Phase 2B of the Western Milwaukee Flood Management Project (see Chapter 5 of this report) will remove 37 of these from the floodplain, leaving six structures in the floodplain.

As of 2016, one structure was identified as being in the floodplain along the Little Menomonee River in the City. This is a residential structure along N. Granville Road north of W. Good Hope Road. The assessed value of this property was $166,400. One structure was identified in being in the floodplain along Woods Creek in the City and seven structures were identified as being in the floodplain along Honey Creek in the City.

Milwaukee River Watershed

Table 3.10 shows that a total of three structures were identified as being located within the one-percent-annual-probability floodplain in the Milwaukee River watershed upstream of the former North Avenue dam within the City of Milwaukee. These structures were identified as part of updated mapping of the floodplains along a 13.2-mile section of the mainstem of the Milwaukee River between the Milwaukee-Ozaukee County line and the upstream limit of the Milwaukee Harbor estuary at the site of the former North Avenue dam under existing channel conditions and planned 2020 land use.[55] These map updates were incorporated into the September 26, 2008 Flood Insurance Study. Table 3.10 also presents flood damage estimates for these structures. It is estimated that a one-percent-annual-probability flood would result in $64,100 (2016 dollars) in damages. Average annual flood damages in the portion of the Milwaukee River watershed upstream of the former dam in the City are estimated to be $14,100 (2016 dollars).

An additional 16 structures are currently located within the flood hazard area in Milwaukee River watershed in the City of Milwaukee. Thirteen of these structures are located along the mainstem of the Milwaukee River downstream of the site of the former North Avenue dam. Two structures are located within the flood hazard area along Lincoln Creek in the City. One of these is located at the confluence of Lincoln Creek with the Milwaukee River. The other is located at N. 60th Street and W. Custer Avenue. One structure is located within the flood hazard area along Beaver Creek.

Oak Creek Watershed

Currently, six structures are located within the flood hazard area in the portion of the City of Milwaukee that is located in the Oak Creek watershed. Two commercial buildings are located within the flood hazard area associated with the North Branch of Oak Creek in an area east of S. 13th Street and north of W. College Avenue. Four governmental structures are located in the flood hazard area associated with the Mitchell Field Drainage Ditch in the southern portion of Milwaukee Mitchell International Airport.

[55] *SEWPRC Memorandum Report No. 172,* A Watercourse System Plan for the Milwaukee River in Milwaukee County upstream of the Milwaukee Harbor Estuary, *December 2010.*

Table 3.9
Structures at Risk of Flooding and Estimated Average Annual Flood Damages in the Kinnickinnic River Watershed[a]

Subwatershed	Structures at Risk of Flooding at Annual Probabilities of Flooding (percent)					Estimated Average Annual Flood Damages (dollars)
	10	4	2	1	0.2	
Kinnickinnic River Mainstem	114	184	232	330	389	1,376,441
43rd Street Ditch	0	0	4	9	26	16,011
Lyons Park Creek	13	47	58	66	71	198,824
Villa Mann Creek	0	6	6	9	9	31,813
Wilson Park Creek	0	87	177	274	325	541,643
Watershed Total	127	324	477	688	820	2,164,192

[a] *Damage estimates are given in 2016 dollars.*

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

Table 3.10
Inventory of Buildings Within the 10- Through 0.2-Percent-Annual-Probability Floodplains and Estimated Total Flood Damages for the Portion of the Milwaukee River Watershed Located Upstream of the Former North Avenue Dam in the City of Milwaukee

Annual Flood Probability Floodplain	Structure Type			Estimated Total Flood Damages (dollars)[a]
	Commercial	Recreational	Residential	
10-percent	0	0	0	0
Two-percent	0	0	0	0
One-percent	0	0	3	64,100
0.2-percent	0	0	69	2,333,240

[a] *Damages have been converted to 2016 dollars using the Engineering News Record Construction Cost Index.*

Source: SEWRPC

Repetitive Loss Properties

FEMA and the NFIP define repetitive loss properties as those properties that have made two or more flood insurance claims of at least $1,000 each. FEMA has also defined a subset of those properties as severe repetitive loss properties. These are defined as NFIP-insured properties that have either: 1) experienced four or more claims over $5,000, including buildings and contents, each, or 2) experienced at least two claims with a cumulative amount exceeding the value of the building. For both of these criteria for severe repetitive loss properties, at least two of the claims must have occurred within any rolling 10-year period since 1978 and must be greater than 10 days apart. As of December 31, 2015, there were 230 repetitive loss properties located within the City of Milwaukee. These included 183 single family residences, 40 two to four family residences, three multifamily housing units, and four other nonresidential structures. None of these properties were severe repetitive loss properties.

Critical Facilities

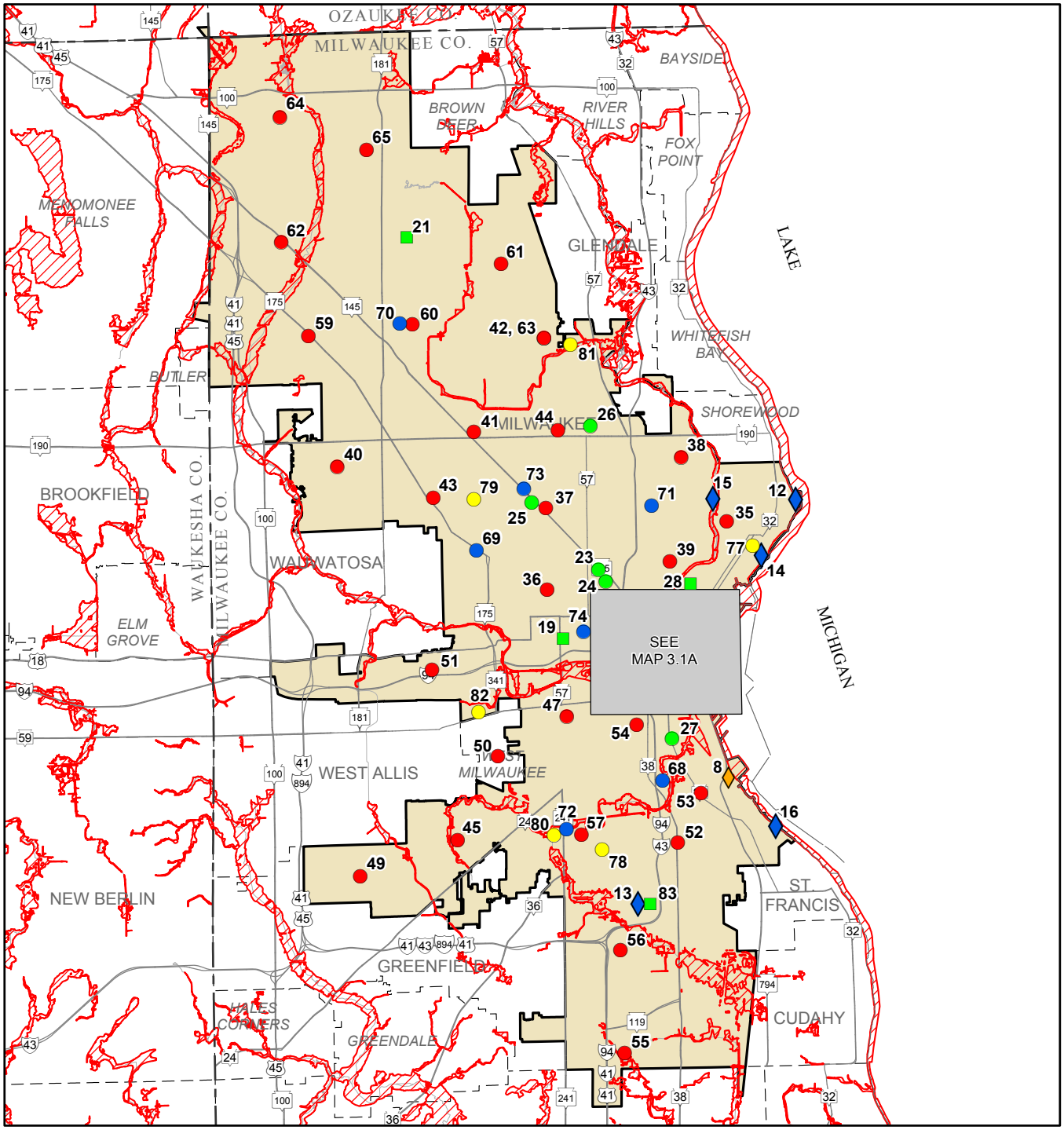
Map 3.1 shows the location of selected types of critical community facilities, including fire and police stations, hospitals, and community administration facilities within the City. None of these facilities are located within the flood hazard areas. However, because of the need for access to and from these facilities, the flood mitigation plan includes their location and shows the relationship to the flood hazard areas.

Flooding of Roadways

The Milwaukee River watercourse system plan identified potential street flooding locations and estimated maximum flooding depths during a one-percent-annual-probability flood in its study area.[56] Two of the areas identified are located in the City of Milwaukee. The first is a 2,000-foot section of N. Milwaukee River Parkway that is located west of the Milwaukee River and south of W. Silver Spring Drive that could be

[56] Ibid.

Map 3.1
Location of Critical Facilities in Relation to Floodplains in the City of Milwaukee: 2016



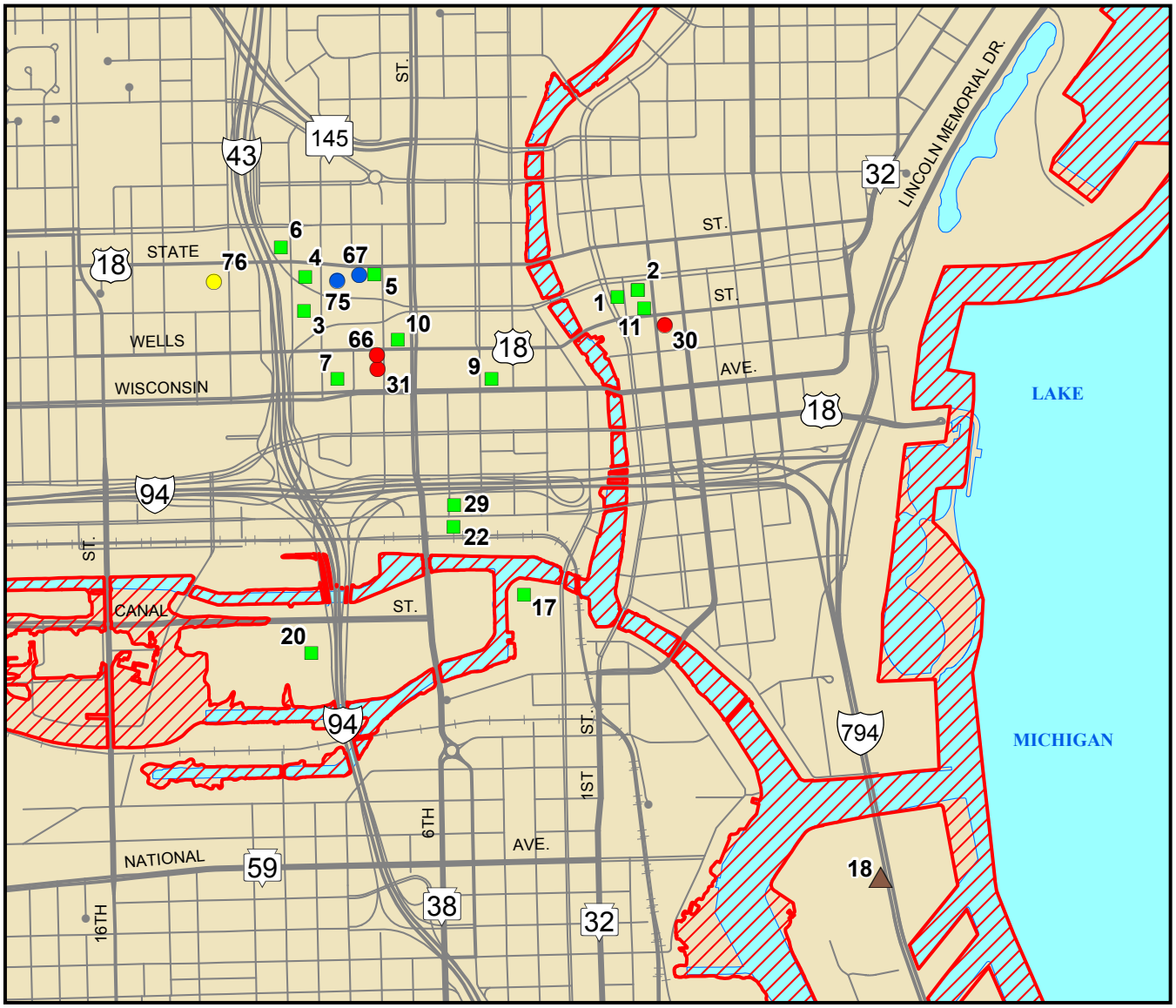
- CRITICAL GOVERNMENT FACILITY
- LAW ENFORCEMENT STATION
- FIRE STATION
- HOSPITALS AND MEDICAL CENTERS
- CITY OF MILWAUKEE
- MILWAUKEE COUNTY TRANSIT SYSTEM FACILITY
- PORT OF MILWAUKEE
- WATER PURIFICATION PLANT OR PUMPING STATION
- WASTEWATER TREATMENT PLANT
- 29 CRITICAL FACILITY REFERENCE NUMBER (SEE APPENDIX B, TABLES B-1 TO B-4)
- ONE-PERCENT-ANNUAL-PROBABILITY (100-YEAR RECURRENCE INTERVAL) FLOODPLAINS (FEMA (JAN. 2018), SEWRPC MCAMLIS)

N

0 0.5 1 2 Miles

Source: Milwaukee County Automated Mapping and Land Information System (MCAMLIS), City of Milwaukee Master Property File (MPROP), and SEWRPC

Map 3.1A
Location of Critical Facilities in Relation to Floodplains in the City of Milwaukee: 2016



- CRITICAL GOVERNMENT FACILITY
- LAW ENFORCEMENT STATION
- FIRE STATION
- HOSPITALS AND MEDICAL CENTERS
- WASTEWATER TREATMENT PLANT
- 29 CRITICAL FACILITY REFERENCE NUMBER (SEE APPENDIX B, TABLES B-1 TO B-4)
- ONE-PERCENT-ANNUAL-PROBABILITY (100-YEAR RECURRENCE INTERVAL) FLOODPLAINS (FEMA (JAN. 2018), SEWRPC MCAMLIS)

N

0 500 1,000 2,000 Feet

Source: Milwaukee County Automated Mapping and Land Information System (MCAMLIS), City of Milwaukee Master Property File (MPROP), and SEWRPC

flooded to a maximum depth of about 4.4 feet during a one-percent-annual-probability flood. This area includes a short portion of W. Lawn Avenue. The second is a section of N. Milwaukee River Parkway that is located in Lincoln Park west of the Milwaukee River and north of W. Hampton Avenue that could be flooded to a maximum depth of about 0.1 foot during a one-percent-annual-probability flood.

Basement Backwater Problems

A review of the extent and severity of flooding conditions within the City of Milwaukee indicates that there is a significant community impact primarily as a result of the damages caused by flooding of buildings, primarily basements, and disruption of the transportation system during extreme flooding events. In addition, sanitary sewer backup into basements is another important consideration. Flooding of streets and buildings, primarily basements, has been reported in the City as a result of storm events since June 20-21 and July 2, 1997.[57] From 1999 to 2010, there were a total of 14,622 reported basement backwater problems within the City of Milwaukee ranging up to 12,203 in one year as shown in Table 3.11. The greatest number of reported backwater problems occurred in 2010, with all of the incidents being reported during the month of July. Although total annual precipitation during 2010 was only 1.17 inches above average annual precipitation, precipitation for July 2010 was 7.35 inches greater than average July precipitation. In addition, precipitation for the month of June 2010 was 3.37 inches greater than average June precipitation. The second greatest number of reported backwater problems occurred in 2008, when total annual precipitation was about nine inches above normal and precipitation for the month of June was 8.71 inches greater than average June precipitation. Many of these backups were associated with storms that occurred on June 7 and 8, which deposited about 7.18 inches of rainfall at General Mitchell International Airport. Since 2010, only a few backwater problems have been reported.

Several types of structure flooding have been reported from 1997 to present. One major source of basement flooding problems has been surcharging of sanitary sewers and resultant backups into basements. Another source of basement flooding was sump pump failure and clear water overflow due to electrical power outages. Clearwater overflow into the sanitary sewer basement floor drain can quickly exceed the capacity of those relatively small-diameter sewers, leading to surcharging and backup of a combination of sanitary sewage and clear water into basements. Additional sources of clear water inflow to sanitary sewers were through: 1) flooding of basements due to surface runoff, 2) excessive amounts of water collecting in streets or roadside swales and entering sanitary sewer manholes through unsealed lids and frames, and 3) sanitary sewer manhole lids which were disturbed.

In 2010, the MMSD began development of a Private Property Infiltration and Inflow (I/I) Reduction Program with input from all communities in their service area, including the City of Milwaukee. The purpose of this program was to provide a funding mechanism for local communities to reduce private property I/I to the sanitary sewer system, through investigation, design, and construction of mitigation measures. The communities prioritize their basement backup areas of concern, and then develop solutions to eliminate infiltration and inflow of clear water to their local sanitary sewer system. MMSD has a budget of $62 million for 2011-2020 for the Private Property Infiltration and Inflow Reduction Program for all 28 member communities. The City of Milwaukee has to date completed $13.6 million of work on 1,260 properties.

Given the current flood control projects that have been carried out during the past 15 years under the MMSD watercourse management program, the flooding impacts on the City's infrastructure and the need to prepare for major evacuations and other emergency actions are not considered to be a major concern given the nature and the severity of the overland flooding problems. However, the Milwaukee County emergency operations planning program does have provisions for carrying out the latter if it would be needed. Furthermore, significant flood-related impacts on the community economy and businesses are of an infrequent and short-term nature. The major impact on City operations, which are relatively frequent, involve posting and closure of selected roadway locations where floodwaters frequently overtop bridges and culverts and cause short-term roadway flooding.

Stormwater Drainage Problems

Because of the interrelationship between stormwater management and floodplain management, stormwater management actions are an important consideration of the flood vulnerability assessment.

[57] Ibid.

Table 3.11
Reported Basement Sanitary Sewer Backwater Problems[a] and Annual Precipitation Summaries Within the City of Milwaukee: 1999-2016

Year	Backwater Complaints (number)	Annual Precipitation Departures from Normal (inches)	Number of Days with Precipitation			
			Greater than 0.01 to 0.1 Inch	Greater than 0.1 to 0.5 Inch	Greater than 0.5 to 1.0 Inch	Greater than 1.0 Inch
1999	187	+4.95	42	43	16	8
2000	112	+11.44	61	38	16	9
2001	2	+3.80	38	35	22	9
2002	60	-8.12	45	38	11	5
2003	0	-12.51	52	34	11	2
2004	86-400[b]	-1.87	45	48	14	6
2005	0	-8.89	43	50	9	3
2006	0	+3.12	42	46	18	9
2007	0	-1.75	47	46	14	6
2008	1,000	+8.71	44	50	13	11
2009	658	+1.00	36	49	14	7
2010	12,203	+1.17	50	31	17	6
2011	0	-2.22	40	45	18	7
2012	0	-5.52	33	43	15	3
2013	1	+5.21	48	37	15	11
2014	18	-2.70	59	40	16	6
2015	0	--	29	50	16	4
2016	1	-0.41	50	38	11	7

[a] *These are meant to illustrate rain-related basement backwater problems reported and does not include any backups that occurred due to clogged sewers or a problem in the building sewer.*

[b] *86 backwater complaints were reported by property owners during two community meetings held after the May 2004 rainfall period and are considered to be related to specific sanitary sewer problems. Newspaper reports indicate that over 400 basement backup complaints of various types were filed during the May 2004 rainfall events. There also were likely to have been more homes that were affected but not reported.*

Source: City of Milwaukee Department of Public Works, National Weather Service Milwaukee/Sullivan Weather Forecast Office, and SEWRPC

Stormwater drainage problems are known to exist throughout the urbanized portions of the City. The City has undertaken stormwater management planning programs or initial stormwater management system inventories as the first step in developing comprehensive stormwater management plans. The current status of stormwater management planning in the City of Milwaukee is described further in Chapters 2 and 5. The intense storm events of 2008 through 2010 caused significant surface flooding problems as the local storm drainage facilities were overwhelmed. The City of Milwaukee should identify specific locations where the major stormwater management system is inadequate to handle the runoff from storms with annual probabilities of occurrence of 1 percent or greater and prepare stormwater management plans to address those deficiencies.

Potential Future Changes in Floodplain Boundaries and Problems

As described in Chapter 2 of this report, the City of Milwaukee and communities in the tributary areas currently have in place land use controls and planning programs to preserve nearly all of the remaining environmentally sensitive areas, including wetlands and floodplains. Furthermore, development within the City itself is approaching "buildout" conditions with new development expected to be largely limited to infilling and isolated open space parcels outside of the environmentally sensitive areas. The City has an adopted stormwater management ordinance which requires sound stormwater management practices for new development and redevelopment sites which will limit any increases in future stormwater runoff peak rates of flow. Accordingly, there is not expected to be any significant changes in the flood flows and hydrologic characteristics of the stream system resulting from future land use changes in the City. Detailed analyses conducted under the MMSD watercourse system planning program, the Southeastern Wisconsin Regional Planning Commission comprehensive watershed plans for the watersheds tributary to the City of Milwaukee, and an ongoing floodplain mapping program being conducted by SEWRPC for the MCAMLIS Steering Committee and its successor Milwaukee County Land Information Council, and MMSD have documented the potential extent of increases in future flood flows within the City of Milwaukee. As part of this floodplain mapping effort, flood flows are also being updated to reflect physical changes in the

watersheds such as more current land use, more extensive stream gage information, and in some cases to reflect more recent rainfall events. For some of the City streams the change in flood flows is minimal, while in others it is more significant. The increased flood flows and updated topography used for the MCAMLIS effort had the greatest impact on the numbers of flooded structures for the Kinnickinnic River, Wilson Park Creek, and Lyons Park Creek.

The MMSD has also developed the Chapter 13 Rule, which applies to all member and contract municipalities, including the City of Milwaukee. Chapter 13 requires all new development or redevelopment beyond certain imperviousness or land disturbance thresholds to control peak rates of stormwater runoff. The Chapter 13 requirements were developed to maintain the effectiveness of MMSD flood mitigation projects in reducing flooding within the MMSD service area.

With regard to the impact of development beyond the City of Milwaukee limits, however, nearly all of the developing communities lying upstream of the City, have recently prepared, or have under preparation, detailed stormwater management plans and/or stormwater-related ordinances designed to minimize any negative downstream impacts on flood flows and stages. In addition, most of the developed and developing communities in the tributary subwatersheds are currently involved in the Wisconsin Department of Natural Resources (WDNR) stormwater permitting program as set forth under Chapter NR 216 of the *Wisconsin Administrative Code*. This program will eventually lead to the development of additional stormwater management practices.

In addition to the above and as described in Chapter 2 of this report, the City of Milwaukee's current floodplain zoning regulations are designed to prevent any new floodprone development, as well as to prevent any floodplain encroachment that would cause changes in the existing flood flows or stages.

If current floodplain and related land use regulations and existing and ongoing stormwater management plans and regulations are carried out and/or implemented in the future, the extent and severity of flooding problems within the City resulting from the overflow of streams would not be expected to become significantly more severe in the near term. However, given recent evidence that changes in climate may be increasing the frequency of intense rain storms, it is important that stormwater and floodplain management planning begin to consider such impacts. Discharge records at streamflow gauges show evidence that the frequency of large floods is increasing. For example, over the 36-year record for the USGS gauge along the Kinnickinnic River, six of the 10 largest flows occurred since 2000 and nine of the largest flows occurred since 1997. Similarly, over the 58-year record for the USGS gauge along the Menomonee River, six of the 10 largest flows occurred since 2000 and seven of the largest flows occurred since 1997. Future planning should utilize more reliable estimates of the magnitude of the effects of climate change on precipitation as they become available.

Changes in climate are likely to affect the potential for flooding in the City of Milwaukee during the 21st century. As previously described, model projections show Wisconsin receiving more precipitation and more frequent intense precipitation events. By the mid-21st century, the City may receive 2.5 more precipitation events of two or more inches in 24 hours per decade, roughly a 21 percent increase in the frequency of heavy precipitation events. At Milwaukee Mitchell International Airport, there is currently a 99 percent probability that a 24-hour rainfall equaling or exceeding 2.35 inches will occur in a year.

This increase in the frequency of heavy rainfall events 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 in streams and rivers in Wisconsin, although the amount of increase will vary from place to place. The amount of precipitation that falls as rain during winter and early spring months is expected to significantly increase. Winter rain can create stormwater management problems as well due to icing and runoff over frozen ground which may also lead to increased risk of flooding events.

These potential climate changes may lead to several flood- and stormwater-related impacts. Increased rainfall and shifting precipitation patterns that favor more rain during winter and early spring periods of low infiltration and evapotranspiration may lead to more frequent and severe stream and river flooding. 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-related 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 one-percent-annual-probability flood hazard area, beyond their existing boundaries, potentially encompassing existing development. This could lead to an increase in the risk of flood damages and a need for larger stormwater management facilities and programs. 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 Flooding and Stormwater Management Risk Assessment

Flooding and associated stormwater drainage problems have been identified as a significant risk in the City of Milwaukee and adjacent communities. In addition, the Milwaukee County Pre-Disaster Mitigation Plan assesses flooding as posing the greatest risk to both the population and to buildings and structures within Milwaukee County.[58] As noted earlier and summarized in the City of Milwaukee Flood Hazard Mitigation Plan, flood hazard areas have been identified throughout the City and adjacent communities. However, as noted above, nearly all of the developing communities lying upstream of the City, have recently prepared, or have under preparation, detailed stormwater management plans and/or stormwater-related ordinances designed to minimize any negative downstream impacts on flood flows and stages. In addition, most of the developed and developing communities in the tributary subwatersheds are currently involved in the Wisconsin Department of Natural Resources stormwater permitting program as set forth under Chapter NR 216 of the *Wisconsin Administrative Code*. In addition, all of the communities served by the MMSD are subject to the MMSD Chapter 13 rule, which requires that communities mitigate potential increases in peak rates of runoff from new development and re-development in a manner designated to limit increases in downstream flood flows and stages. These programs will eventually lead to the development of additional stormwater management practices.

As previously mentioned, improvements are being made as part of the MMSD's work and these efforts are reducing the overall flooding problems facing both the City and environs throughout Milwaukee County and beyond. In addition, the MMSD is currently conducting its fourth-generation wastewater facilities planning effort. This effort includes further development of its watercourse plans.

3.4 VULNERABILITY ASSESSMENT FOR THUNDERSTORMS, HIGH WINDS, HAIL, AND LIGHTNING

Thunderstorms

Compared to other natural hazards within the State of Wisconsin, thunderstorms are the most common type of severe weather event. A thunderstorm is defined as a severe and violent form of convection produced when warm, moist air is overrun by dry, cool air and as the warm air rises, thunderheads (cumulonimbus clouds) form. These thunderheads produce the strong winds, lightning, thunder, hail, and heavy rain that are associated with these storm events. The thunderheads formed 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. Thunderstorms and their related high winds, lightning, and hail hazards are covered within this section. However, excessive rains that cause flash flooding, such as occurred in the summer storm events in 1998 and 2000 when the request for Presidential disaster declaration was approved (see Vulnerability Assessment for Flooding and Associated Stormwater Drainage Problems) and tornadoes are covered separately from this hazard analysis (see Vulnerability Assessment for Tornadoes).

[58] *Milwaukee County Office of Emergency Management,* op. cit.

A thunderstorm often lasts approximately 30 minutes in a given location, because an individual thunderstorm cell frequently moves at an average velocity that ranges between 30 to 50 miles per hour (mph). However, 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.[59] Thunderstorms may occur individually, form clusters, or occur 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 all thunderstorms that occur each year nationwide are classified as severe. According to the National Weather Service, a thunderstorm is considered severe if it produces hail sizes at least one inch in diameter, generates wind speeds equal to or greater than 58 miles per hour (measured or implied by tree and/or structural damage), or produces a tornado.[60] A thunderstorm with wind speeds equal to or greater than 40 miles per hour or hail at least 0.5 inch in diameter is defined as approaching severe. Severe weather event statistics in the State of Wisconsin for the period 1982-2008 indicate that about 56 percent of these severe storm events are characterized by damaging straight-line winds, 38 percent are hail events, and the remaining 6 percent are made up of tornadoes. Severe thunderstorms can cause injury or death and can also result in substantial property damage. They may cause power outages, disrupt telephone service, and severely affect radio communications, as well as impact surface and air transportation, which may seriously impair the emergency management capabilities of the impacted areas.

The National Weather Service monitors severe weather for 20 southern Wisconsin counties, including the City of Milwaukee, from its Milwaukee/Sullivan office.[61] A severe thunderstorm watch indicates that conditions are favorable for severe weather and that people 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 people should seek shelter immediately. These severe thunderstorm watch and warning bulletins and advisories are disseminated over a number of telecommunication channels, including the NOAA Weather Radio, the NOAA Weather Wire and the State Law Enforcement TIME System. NOAA Weather Radio is available to any individual with a weather alert radio. This system and the other sources are routinely monitored by local media which rebroadcast the weather bulletins over public and private television and radio stations. In addition, the National Weather Service operates a 24-hour weather radio transmitter serving Milwaukee and Waukesha Counties, operating at a frequency of 162.400 megahertz (MHz), from a location in the Town of Delafield, Waukesha County. Southern portions of the Milwaukee County area, including portions of the City, are also served by a transmitter operating at a frequency of 162.450 MHz from a location at CTH KR and Wood Road in Racine County.

High Winds

High-velocity, straight-line winds that are produced by thunderstorms and widespread non-thunderstorm high winds are a destructive natural hazard in Wisconsin and are responsible for most thunderstorm wind-related damages to property. Thunderstorm winds can also be fatal. During the period from 1982 to 2016 in the State of Wisconsin, 30 fatalities and 211 injuries were attributed to wind from severe thunderstorms and non-thunderstorm high winds.[62] Although distinctly different from tornadoes, straight-line winds produced by thunderstorms can be very powerful, are fairly common, and can cause damages similar to that of a tornado event. Depending upon their intensity, high winds can uproot trees, down power lines, and damage or destroy buildings and infrastructure (Figure 3.7). Flying debris can cause serious injury and death to humans, livestock, and wildlife in their path. Boats and airplanes are also extremely vulnerable to damage from high winds.

[59] *National Weather Service Forecast Office.*

[60] *Prior to 2010, the National Weather Service criteria for severe thunderstorms were production of hail at least 0.75 inch in diameter, wind speeds equal to or greater than 58 miles per hour, or a tornado.*

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

[62] *National Climatic Data Center Database.*

Hail

Hailstorms are also associated with thunderstorms and are a destructive type of weather hazard. A hailstorm is a product of strong thunderstorms and unique weather conditions 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. However, 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 that of a golf ball. Hailstones 1.5 inches or larger in diameter are not common in the State of Wisconsin. Hailstones form when subfreezing temperatures cause water in thunderstorm clouds to accumulate in layers around an icy core. When strong underlying updraft winds no longer can support their weight, the hailstones fall earthward. Hail tends to fall in swaths that may be 20 to 115 miles long and five to 30 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. They may partially overlap, but often leave completely undamaged gaps between them.

Figure 3.7
Wind Damage Caused by the September 7, 2016 Thunderstorm

Source: National Weather Service

Hailstorms are considered formidable among the weather and climatic hazards to property, because they can dent vehicles and structures, break windows, and damage roofs to the point that significant losses result. Falling hailstones can also cause serious injury and loss of human life. These occurrences, however, are rarely associated with hailstorms. In addition to impact damage, thick hail combined with heavy rain can clog storm sewers and contribute to stormwater flooding. Hail sufficiently thick to cover a road will pose a traffic hazard. The peak season for hailstorms is April through August, although hail has been reported with thunderstorms in every month of the year.

Lightning

Every thunderstorm produces lightning, and lightning has been shown to kill more people within the United States each year than tornadoes.[63] 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 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 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.

Lightning is a significant hazard associated with any thunderstorm and can cause extensive damage to buildings, structures, electrical and electronic equipment, kill or injure people and livestock, and start forest fires and wildfires. Lightning is a major cause of damage to farm buildings and equipment, is responsible for more than 80 percent of all livestock losses, and is the number one cause of farm fires. Counties in southern Wisconsin report a higher number of lightning events compared to other parts of the State due to higher thunderstorm frequency and more thorough documentation by the local media. Statistics have also shown that 92 percent of lightning-related fatalities occur from May to September, and 73 percent of these events occur during the afternoon and early evening. National statistics indicate that approximately 30 percent of people struck by lightning die and 74 percent of lightning strike survivors have permanent disabilities. In addition, 63 percent of lightning-associated deaths occur within one hour of injury and people with cranial burns or leg burns from lightning are at higher risk for death than others struck by lightning.

[63] *National Oceanic and Atmospheric Administration.*

Historical Thunderstorm, High-Wind, Hail, and Lightning Problems

Historically, the State of Wisconsin averages over 30 days each year with thunderstorms across the northern region to about 40 days per year across the southern region. However, the City of Milwaukee averages only about six days per year in which thunderstorms generate winds over 50 knots, and averages only three days per year in which damaging hail (over three-fourths of an inch in diameter) is generated.[64] These thunderstorms and related high winds, hail, and lightning hazards can occur throughout the City during any month of the year, with little or no notice. However, the highest frequency has been shown to occur during the period of May through September, and between the hours of noon and 10:00 p.m. The City of Milwaukee is subject to damage caused by thunderstorms and related hazards, which can be severe and affect large portions of the City, as well as potentially cause substantial loss of life and damage to property.

Description of Recent Thunderstorm, High-Wind, Hail, and Lightning Events

The gravity of any particular thunderstorm and related wind, hail, and lightning hazard events is measured in terms of resulting deaths, injuries, and economic losses. Despite their relatively small size when compared with winter storms, thunderstorms and their related hazard events occur frequently and are dangerous. Thunderstorms and related hazard events are fourth only to temperature extremes, tornadoes, and winter storms in regards to both total number of deaths and injuries, compared to other natural hazards that impact southeastern Wisconsin, as shown in Table 3.5. In addition, thunderstorms and related hazard events are second only to damage associated with floods and stormwater as the most costly natural hazards to impact the City of Milwaukee.

A total of 216 thunderstorm and 239 high-wind events, have been recorded in the Milwaukee County during the 60-year period between July 1956 and December 2016. These events are documented in terms of their magnitude and impact in Table 3.12 based upon data published by the NCDC. As shown in Table 3.12, these storms can range from one or two events per year, up to 16 events per year, which demonstrates the high unpredictability of these events. Since 1993, in total, these thunderstorm and high-wind events have resulted in three deaths, 11 injuries, and over $52 million in property damages within Milwaukee County. Most of these damages occurred as a result of two storm events in 1998. The first was a thunderstorm and high-wind event that occurred on May 31, 1998, that resulted in over $25 million in property damage. The second event was a widespread, nonthunderstorm, high-wind event on November 10, 1998, which struck south-central and southeastern Wisconsin and caused four deaths, 14 injuries, and almost $15 million in damages to property. This storm caused nearly $700,000 in damages in the City of Milwaukee. Most recently, a severe thunderstorm impacted the City of Milwaukee on August 21, 2002, resulting in over $6.2 million in property damage.

Severe weather and flooding affected much of south-central and southeast Wisconsin on August 21, 2002, into the pre-dawn hours of August 22nd. This event was probably the most widespread and significant outbreak for the 2002 warm-season. Just about every type of weather phenomena was observed: a tornado; a funnel cloud; powerful, hurricane-force, downburst winds that uprooted trees and damaged buildings; torrential rains reducing visibilities to 100 feet; urban and small stream flooding; numerous lightning strikes—some that resulted in fire damage; and the early stages of a ground-based vortex that never made it to tornado status. Clusters and short lines of thunderstorms ahead of a cold front eventually merged into a single complex that moved west to east across southern Wisconsin. Surface dew points were in the lower 70s and maximum afternoon temperatures were in the mid to upper 80s. At least 56,000 customers in southeast Wisconsin lost electrical power due to lightning strikes, and tree damage to power lines. One of the worst lightning strikes was in Fox Point, where a lightning fire burned a home to the ground. Powerful winds associated with this storm affected Milwaukee County. An estimated wind gust of at least 70 knots (80 miles per hour or mph) ripped a 100-foot-long blimp from its mooring at Timmerman Airport, allowing the blimp to fly about six blocks and damage four homes on impact. In Cudahy an eight-car garage's roof was removed by the winds, and three stalls collapsed, based on Amateur Radio reports. A picnic shelter and several other garages and businesses on College Avenue near Lake Michigan also sustained some damage. In the City of South Milwaukee, a business's sign and fence were destroyed by the winds. This storm caused an estimated $6.2 million in property damages in Milwaukee County.

[64] *National Oceanic and Atmospheric Administration,* www.nssl.noaa.gov/hazard/totalthreat.html.

Table 3.12
Thunderstorm, High-Wind, Hail, and Lightning Events Reported in Milwaukee County from 1956 to September 2016[a]

		Event Type					Reported Damages[a]		
Date	**Affected Area**	Thunderstorm	High Winds	Hail	Lightning	**Magnitude**	Fatalities	Injuries	Property Damage (dollars)[b]
July 11, 1956	City of Milwaukee	--	--	X	--	0.75 inch	--	--	--
August 7, 1958	City of Milwaukee	--	--	X	--	0.75 inch	--	--	--
June 28, 1960	City of Milwaukee	--	--	X	--	1.75 inch	--	--	--
July 22, 1960	City of Milwaukee	X	X	--	--	0 knots	--	--	--
July 22, 1960	City of Milwaukee	X	X	--	--	0 knots	--	--	--
August 4, 1961	City of Milwaukee	--	--	X	--	0.75 inch	--	--	--
June 17, 1962	City of Milwaukee	X	X	--	--	55 knots	--	--	--
July 22, 1962	City of Milwaukee	X	X	--	--	52 knots	--	--	--
September 13, 1962	City of Milwaukee	--	--	X	--	1.0 inch	--	--	--
March 19, 1963	City of Milwaukee	--	--	X	--	1.0 inch	--	--	--
March 19, 1963	City of Milwaukee	--	--	X	--	1.5 inch	--	--	--
June 8, 1963	City of Milwaukee	X	X	X	--	63 knots/2.0 inch	--	--	--
June 9, 1963	City of Milwaukee	X	X	--	--	55 knots	--	--	--
July 31, 1963	City of Milwaukee	--	--	X	--	0.75 inch	--	--	--
August 1, 1963	City of Milwaukee	--	--	X	--	0.75 inch	--	--	--
April 6, 1964	City of Milwaukee	--	--	X	--	0.75 inch	--	--	--
June 19, 1964	City of Milwaukee	X	X	--	--	0 knots	--	--	--
June 19, 1964	City of Milwaukee	X	X	--	--	52 knots	--	--	--
July 22, 1964	City of Milwaukee	--	--	X	--	1.75 inch	--	--	--
July 22, 1964	City of Milwaukee	--	--	X	--	1.75 inch	--	--	--
September 3, 1964	City of Milwaukee	X	X	--	--	0 knots	--	--	--
May 8, 1965	City of Milwaukee	X	X	--	--	65 knots	--	--	--
June 27, 1965	City of Milwaukee	X	X	--	--	0 knots	--	--	--
July 13, 1965	City of Milwaukee	--	--	X	--	0.75 inch	--	--	--
July 26, 1967	City of Milwaukee	X	X	--	--	50 knots	--	--	--
June 11, 1968	City of Milwaukee	X	X	--	--	63 knots	--	--	--
June 18, 1968	City of Milwaukee	X	X	--	--	0 knots	--	--	--
June 29, 1968	City of Milwaukee	--	--	X	--	0 Knots/0.75 inch	--	--	--
June 30, 1968	City of Milwaukee	X	X	--	--	53 knots	--	--	--
April 17, 1969	City of Milwaukee	X	X	--	--	0 knots	--	--	--
June 29, 1969	City of Milwaukee	X	X	--	--	61 knots	--	--	--
August 11, 1969	City of Milwaukee	--	--	X	--	1.0 inch	--	--	--
June 19, 1971	City of Milwaukee	X	X	--	--	66 knots	--	--	--
September 16, 1972	City of Milwaukee	X	X	--	--	51 knots	--	--	--
September 18, 1972	City of Milwaukee	X	X	--	--	56 knots	--	--	--
June 16, 1973	City of Milwaukee	X	X	--	--	60 knots	--	--	--

Table continued on next page.

Table 3.12 (Continued)

Date	Affected Area	Event Type				Magnitude	Reported Damages[a]		
		Thunderstorm	High Winds	Hail	Lightning		Fatalities	Injuries	Property Damage (dollars)[b]
August 9, 1973	City of Milwaukee	X	X	--	--	70 knots	--	--	--
May 21, 1974	City of Milwaukee	X	X	--	--	65 knots	--	--	--
July 3, 1974	City of Milwaukee	X	X	--	--	52 knots	--	--	--
August 11, 1974	City of Milwaukee	X	X	--	--	50 knots	--	--	--
January 10, 1975	City of Milwaukee	X	X	--	--	0 knots	--	--	--
June 13, 1975	City of Milwaukee	X	X	--	--	0 knots	--	--	--
June 13, 1975	City of Milwaukee	X	X	--	--	0 knots	--	--	--
November 9 ,1975	City of Milwaukee	X	X	--	--	0 knots	--	--	--
June 13, 1976	City of Milwaukee	X	X	--	--	0 knots	--	--	--
July 30, 1976	City of Milwaukee	X	X	--	--	55 knots	--	--	--
July 30, 1976	City of Milwaukee	X	X	--	--	0 knots	--	--	--
June 24, 1977	City of Milwaukee	X	X	--	--	0 knots	--	--	--
July 6, 1977	City of Milwaukee	X	X	--	--	0 knots	--	--	--
July 6, 1977	City of Milwaukee	X	X	--	--	55 knots	--	--	--
August 4, 1977	City of Milwaukee	X	X	--	--	52 knots	--	--	--
September 4, 1977	City of Milwaukee	--	--	X	--	0.75 inch	--	--	--
June 7, 1978	City of Milwaukee	X	X	--	--	0 knots	--	--	--
June 17, 1978	City of Milwaukee	--	--	X	--	1.75 inch	--	--	--
May 18, 1979	City of Milwaukee	--	--	X	--	0.75 inch	--	--	--
June 20, 1979	City of Milwaukee	X	X	--	--	0 knots	--	--	--
June 5, 1980	City of Milwaukee	--	--	X	--	1.75 inch	--	--	--
June 5, 1980	City of Milwaukee	X	X	X	--	0 knots/1.0 inch	--	--	--
June 7, 1980	City of Milwaukee	--	--	X	--	1.75 inch	--	--	--
July 15, 1980	City of Milwaukee	X	X	--	--	52 knots	--	--	--
August 4, 1980	City of Milwaukee	X	X	X	--	0 knots/1.75 inch	--	--	--
August 4, 1980	City of Milwaukee	X	X	--	--	0 knots	--	--	--
September 9, 1980	City of Milwaukee	X	X	--	--	54 knots	--	--	--
July 12, 1981	City of Milwaukee	X	X	--	--	0 knots	--	--	--
July 20, 1981	City of Milwaukee	X	X	--	--	51 knots	--	--	--
July 6, 1982	City of Milwaukee	X	X	--	--	60 knots	--	--	--
August 3, 1982	City of Milwaukee	X	X	--	--	0 knots	--	--	--
July 19, 1983	City of Milwaukee	X	X	--	--	50 knots	--	--	--
July 19, 1983	City of Milwaukee	X	X	--	--	0 knots	--	--	--
August 16, 1983	City of Milwaukee	X	X	--	--	0 knots	--	--	--
June 17, 1984	City of Milwaukee	--	--	X	--	0.75 inch	--	--	--
July 10, 1984	City of Milwaukee	X	X	--	--	70 knots	--	--	--
July 10, 1984	City of Milwaukee	X	X	--	--	70 knots	--	--	--

Table continued on next page.

Table 3.12 (Continued)

Date	Affected Area	Event Type				Magnitude	Reported Damages[a]		
		Thunderstorm	High Winds	Hail	Lightning		Fatalities	Injuries	Property Damage (dollars)[b]
July 23, 1984	City of Milwaukee	X	X	--	--	53 knots	--	--	--
August 9, 1984	City of Milwaukee	--	--	X	--	1.0 inch	--	--	--
August 9, 1984	City of Milwaukee	--	--	X	--	1.25 inch	--	--	--
October 16, 1984	City of Milwaukee	X	X	--	--	0 knots	--	--	--
August 12, 1985	City of Milwaukee	X	X	--	--	50 knots	--	--	--
July 6, 1986	City of Milwaukee	X	X	--	--	52 knots	--	--	--
July 19, 1986	City of Milwaukee	X	X	--	--	0 knots	--	--	--
July 27, 1986	City of Milwaukee	X	X	--	--	0 knots	--	--	--
July 27, 1986	City of Milwaukee	X	X	--	--	0 knots	--	--	--
July 27, 1986	City of Milwaukee	X	X	--	--	0 knots	--	--	--
September 28, 1986	City of Milwaukee	X	X	--	--	50 knots	--	--	--
May 11, 1987	City of Milwaukee	--	--	X	--	0.75 inch	--	--	--
May 21, 1987	City of Milwaukee	--	--	X	--	1.0 inch	--	--	--
May 21, 1987	City of Milwaukee	--	--	X	--	0.75 inch	--	--	--
July 6, 1987	City of Milwaukee	--	--	X	--	2.0 inch	--	--	--
July 6, 1987	City of Milwaukee	X	X	--	--	0 knots	--	--	--
July 12, 1987	City of Milwaukee	X	X	--	--	0 knots	--	--	--
July 29 ,1987	City of Milwaukee	X	X	--	--	52 knots	--	--	--
August 15, 1987	City of Milwaukee	X	X	--	--	52 knots	--	--	--
August 16, 1987	City of Milwaukee	X	X	--	--	0 knots	--	--	--
August 16, 1987	City of Milwaukee	X	X	--	--	0 knots	--	--	--
August 21, 1987	City of Milwaukee	X	X	--	--	50 knots	--	--	--
May 8, 1988	City of Milwaukee	X	X	--	--	0 knots	--	--	--
August 4, 1988	City of Milwaukee	X	X	--	--	52 knots	--	--	--
August 4, 1988	City of Milwaukee	X	X	--	--	0 knots	--	--	--
August 8 ,1988	City of Milwaukee	X	X	--	--	0 knots	--	--	--
June 26, 1989	City of Milwaukee	--	--	X	--	1.0 inch	--	--	--
July 27, 1989	City of Milwaukee	--	--	X	--	0.75 inch	--	--	--
July 27, 1989	City of Milwaukee	X	X	--	--	52 knots	--	--	--
August 4, 1989	City of Milwaukee	X	X	--	--	56 knots	--	--	--
March 13, 1990	City of Milwaukee	--	--	X	--	1.75 inch	--	--	--
June 29, 1990	City of Milwaukee	X	X	--	--	0 knots	--	--	--
September 10, 1990	City of Milwaukee	X	X	--	--	55 knots	--	--	--
March 27, 1991	City of Milwaukee	X	X	--	--	77 knots	--	--	--
March 27, 1991	City of Milwaukee	X	X	--	--	67 knots	--	--	--
April 8, 1991	City of Milwaukee	--	--	X	--	0.88 inch	--	--	--
July 7, 1991	City of Milwaukee	X	X	--	--	63 knots	--	--	--

Table continued on next page.

Table 3.12 (Continued)

Date	Affected Area	Event Type				Magnitude	Reported Damages[a]		
		Thunderstorm	High Winds	Hail	Lightning		Fatalities	Injuries	Property Damage (dollars)[b]
July 22, 1991	City of Milwaukee	X	X	--	--	0 knots	--	--	--
September 9, 1991	City of Milwaukee	--	--	X	--	1.0 inch	--	--	--
September 9, 1991	City of Milwaukee	--	--	X	--	2.0 inch	--	--	--
June 17, 1992	City of Milwaukee	X	X	X	--	59 knots/1.0 inch	--	--	--
June 17, 1992	City of Milwaukee	X	X	--	--	50 knots	--	--	--
August 30, 1993	City of Milwaukee	X	X	--	--	0 knots	--	--	83,334
July 4, 1994	Milwaukee County	X	X	--	--	0 knots	--	--	8,125
July 4, 1994	City of Milwaukee	X	X	--	--	0 knots	--	--	--
July 4, 1994	Milwaukee County	X	X	--	--	0 knots	--	--	8,125
July 4, 1994	Milwaukee County	X	X	--	--	0 knots	--	--	8,125
July 4, 1994	Milwaukee County	X	X	--	--	0 knots	--	--	8,125
July 11, 1994	City of Milwaukee	X	X	--	--	0 knots	--	--	--
April 18, 1995	Milwaukee County	--	--	X	--	0.75 inch	--	--	--
April 18, 1995	Milwaukee County	--	--	X	--	0.75 inch	--	--	--
May 13, 1995	Milwaukee County	--	--	X	--	0.88 inch	--	--	--
June 6, 1995	Milwaukee County	X	--	--	X	N/A	--	--	12,642
June 7, 1995	Milwaukee County	--	--	X	--	0.75 inch	--	--	--
July 15, 1995	Milwaukee County	X	X	--	--	0 knots	--	--	--
July 15, 1995	Milwaukee County	X	X	--	--	0 knots	--	--	--
July 15, 1995	City of Milwaukee	--	--	X	--	0.75 inch	--	--	--
July 15, 1995	Milwaukee County	X	--	--	X	N/A	--	--	--
July 15, 1995	Milwaukee County	X	--	--	X	N/A	--	--	--
July 27, 1995	Milwaukee County	X	X	--	--	0 knots	--	--	--
August 28, 1995	Milwaukee County	X	X	--	--	0 knots	--	--	--
August 28, 1995	City of Milwaukee	X	X	--	--	52 knots	--	--	4,741
June 2, 1996	Milwaukee County	X	X	--	--	0 knots	--	--	18,419
July 18, 1996	Milwaukee County	X	X	--	--	0 knots	--	--	18,356
August 19, 1996	North Milwaukee County	X	X	--	--	0 knots	--	--	16,884
October 29, 1996	Milwaukee County	--	--	X	--	0.88 inch	--	--	--
April 6, 1997	Milwaukee County	--	X	--	--	0 knots	--	--	450,175
May 5, 1997	Southeastern Wisconsin	--	X	--	--	0 knots	--	--	8,703
June 24, 1997	Milwaukee County	X	X	--	--	52 knots	--	2	7,503
June 24, 1997	City of Milwaukee	X	X	--	--	50 knots	--	--	--
June 30, 1997	Milwaukee County	X	--	--	X	N/A	--	--	30,012
July 2, 1997	Milwaukee County	X	--	--	X	N/A	--	--	37,515
July 16, 1997	City of Milwaukee	X	X	--	--	0 knots	--	--	1,501
July 21, 1997	City of Milwaukee	X	--	--	X	N/A	--	--	1,500,584

Table continued on next page.

Table 3.12 (Continued)

Date	Affected Area	Event Type				Magnitude	Reported Damages[a]		
		Thunderstorm	High Winds	Hail	Lightning		Fatalities	Injuries	Property Damage (dollars)[b]
July 26, 1997	City of Milwaukee	X	X	--	--	0 knots	--	--	1,501
September 29, 1997	Milwaukee County	--	X	--	--	0 knots	--	--	1,501
March 8, 1998	Southeastern Wisconsin	--	X	--	--	0 knots	--	--	28,811
May 28, 1998	Milwaukee County	X	X	--	--	61 knots	--	--	5,910
May 28, 1998	Milwaukee County	X	X	--	--	0 knots	--	--	1,477
May 31, 1998	Milwaukee County	X	X	--	--	87 knots	--	--	28,367,417
June 18, 1998	City of Milwaukee	X	X	--	--	55 knots	--	--	--
June 18, 1998	Milwaukee County	X	--	--	X	N/A	--	--	4,432
June 28, 1998	Milwaukee County	X	--	--	X	N/A	--	--	29,549
July 20, 1998	City of Milwaukee	X	X	--	--	0 knots	--	1	1,477
November 10, 1998	Southeastern Wisconsin	--	X	--	--	53 knots	1	1	1,472,400
February 11, 1999	City of Milwaukee	X	X	--	--	61 knots	--	3	36,139
May 16, 1999	Milwaukee County	X	X	--	--	54 knots	--	--	1,446
May 16, 1999	City of Milwaukee	X	--	--	X	N/A	--	--	5,782
May 16, 1999	City of Milwaukee	X	--	--	X	N/A	--	--	5,782
May 17, 1999	Milwaukee County	X	--	--	X	N/A	--	--	72,277
June 6, 1999	City of Milwaukee	X	X	--	--	0 knots	--	--	289,110
July 20, 1999	Milwaukee County	X	--	--	X	N/A	--	--	108,416
July 23, 1999	City of Milwaukee	X	X	--	--	0 knots	--	--	43,366
August 10, 1999	City of Milwaukee	--	--	X	--	0.75 inch	--	--	--
March 8, 2000	Milwaukee County	--	--	X	--	1.25 inch	--	--	--
March 8, 2000	City of Milwaukee	X	X	X	--	58 knots/1.0 inch	--	--	--
May 8, 2000	Milwaukee County	--	--	X	--	1.0 inch	--	--	--
May 8, 2000	City of Milwaukee	X	--	--	X	N/A	--	--	6,993
May 11, 2000	City of Milwaukee	X	X	--	--	0 knots	--	--	1,399
May 11, 2000	City of Milwaukee	X	X	--	--	65 knots	--	--	69,927
May 18, 2000	Milwaukee County	--	--	X	--	0.75 inch	--	--	--
May 18, 2000	Milwaukee County	--	--	X	--	1.75 inch	--	--	27,971
May 18, 2000	Milwaukee County	--	--	X	--	0.75 inch	--	--	--
May 24, 2000	Southeastern Wisconsin	--	X	--	--	0 knots	--	--	4,196
June 1, 2000	City of Milwaukee	--	--	X	--	0.75 inch	--	--	--
July 2, 2000	Milwaukee County	X	--	--	X	N/A	--	--	20,978
July 2, 2000	Milwaukee County	X	--	--	X	N/A	--	--	13,985
August 26, 2000	Milwaukee County	X	--	--	X	N/A	--	--	69,927
September 11, 2000	City of Milwaukee	X	X	--	--	0 knots	--	--	2,797
September 11, 2000	City of Milwaukee	X	--	--	X	N/A	--	--	41,956
February 25, 2001	Milwaukee County	--	X	--	--	0 knots	--	--	55,757

Table continued on next page.

Table 3.12 (Continued)

Date	Affected Area	Event Type				Magnitude	Reported Damages[a]		
		Thunderstorm	High Winds	Hail	Lightning		Fatalities	Injuries	Property Damage (dollars)[b]
April 7, 2001	Southeastern Wisconsin	--	X	--	--	57 knots	--	--	--
May 14, 2001	Milwaukee County	--	--	X	--	0.75 inch	--	--	--
June 11, 2001	Milwaukee County	X	X	--	--	61 knots	--	--	67,996
June 11, 2001	Milwaukee County	X	--	--	X	N/A	--	--	33,998
June 18, 2001	Milwaukee County	--	--	X	--	0.88 inch	--	--	--
August 9, 2001	Milwaukee County	X	X	--	--	52 knots	--	1	101,994
September 19, 2001	Southeastern Wisconsin	--	X	--	--	0 knots	--	--	--
October 25, 2001	Southeastern Wisconsin	--	X	--	--	56 knots	--	--	--
December 5, 2001	Southeastern Wisconsin	--	X	--	--	0 knots	--	--	135,991
April 18, 2002	Milwaukee County	X	X	--	--	53 knots	--	--	--
June 10, 2002	Milwaukee County	X	X	X	--	56 knots/0.75 inch	--	--	--
June 15, 2002	City of Milwaukee, Timmerman Airport	--	--	X	--	0.75 inch	--	--	--
June 15, 2002	City of Milwaukee, General Mitchell Airport	--	--	X	--	0.75 inch	--	--	--
June 15, 2002	City of Milwaukee, General Mitchell Airport	--	--	X	--	0.75 inch	--	--	--
June 15, 2002	Milwaukee County	--	--	X	--	0.75 inch	--	--	--
July 8, 2002	Milwaukee County	X	X	--	--	56 knots	--	--	--
August 21, 2002	Milwaukee County	X	X	--	--	56 knots	--	--	66,934
August 21, 2002	City of Milwaukee, Timmerman Airport	X	X	--	--	70 knots	--	--	6,827,224
August 21, 2002	Milwaukee County	X	X	--	--	65 knots	--	--	133,867
August 21, 2002	Milwaukee County	X	--	--	X	N/A	--	--	669,336
August 21, 2002	Milwaukee County	X	--	--	X	N/A	--	--	1,339
May 11, 2003	Southeastern Wisconsin	--	X	--	--	0 knots	--	--	39,265
July 4, 2003	City of Milwaukee, Timmerman Airport	X	X	--	--	60 knots	--	--	--
July 4, 2003	Milwaukee County	X	X	--	--	56 knots	--	--	3,927
August 1, 2003	Milwaukee County	X	X	--	--	50 knots	--	--	--
August 3, 2003	Milwaukee County	--	--	--	X	N/A	--	--	13,088
November 12, 2003	Southeastern Wisconsin	--	X	--	--	0 knots	--	--	68,060
March 7, 2004	Southeastern Wisconsin	--	X	--	--	0 knots	--	--	42,073
March 14, 2004	Southeastern Wisconsin	--	X	--	--	43 knots	--	--	66,297
April 18, 2004	Southeastern Wisconsin	--	X	--	--	49 knots	--	--	356,983
May 10, 2004	Milwaukee County	--	--	X	--	1.0 inch	--	--	--
May 23, 2004	Milwaukee County	--	--	X	--	1.0 inch	--	--	--
May 23, 2004	Milwaukee County	--	--	X	--	1.5 inch	--	--	--

Table continued on next page.

Table 3.12 (Continued)

Date	Affected Area	Event Type				Magnitude	Reported Damages[a]		
		Thunderstorm	High Winds	Hail	Lightning		Fatalities	Injuries	Property Damage (dollars)[b]
June 23, 2004	Milwaukee County	--	--	X	--	1.0 inch	--	--	--
June 23, 2004	City of Milwaukee	--	--	X	--	0.75 inch	--	--	--
July 16, 2004	City of Milwaukee, General Mitchell Airport	X	X	--	--	50 knots	--	--	--
March 30, 2005	City of Milwaukee, General Mitchell Airport	X	X	--	--	50 knots	--	--	--
March 30, 2005	Milwaukee County	--	--	X	--	0.75 inch	--	--	--
March 30, 2005	City of Milwaukee	--	--	X	--	0.75 inch	--	--	--
March 30, 2005	Milwaukee County	--	--	X	--	0.75 inch	--	--	--
March 30, 2005	Milwaukee County	--	--	X	--	0.75 inch	--	--	--
June 4, 2005	Milwaukee County	--	--	X	--	0.75 inch	--	--	--
June 7, 2005	City of Milwaukee, General Mitchell Airport	--	--	X	--	1.5 inch	--	--	--
June 7, 2005	City of Milwaukee, General Mitchell Airport	--	--	X	--	0.88 inch	--	--	--
June 7, 2005	Milwaukee County	--	--	X	--	1.0 inch	--	--	24,662
June 7, 2005	Milwaukee County	--	--	X	--	2.0 inch	--	--	24,662
June 30, 2005	City of Milwaukee	X	X	--	--	56 knots	--	--	--
June 30, 2005	Milwaukee County	X	X	--	--	56 knots	--	--	--
June 30, 2005	City of Milwaukee	X	X	--	--	56 knots	--	--	--
August 4, 2005	City of Milwaukee	X	X	--	--	56 knots	--	--	24,662
September 13, 2005	Milwaukee County	X	X	--	--	56 knots	--	--	--
September 13, 2005	City of Milwaukee	X	X	--	--	52 knots	--	--	--
November 13, 2005	Southeastern Wisconsin	--	X	--	--	55 knots	--	--	26,358
March 13, 2006	Southeastern Wisconsin	--	X	--	--	56 knots	--	--	--
April 13, 2006	Milwaukee County	--	--	X	--	2.0 inch	--	--	2,389,179
April 13, 2006	Milwaukee County	--	--	X	--	1.0 inch	--	--	2,389,179
April 13, 2006	Milwaukee County	--	--	X	--	1.0 inch	--	--	2,389,179
April 13, 2006	City of Milwaukee	--	--	X	--	0.88 inch	--	--	--
April 13, 2006	Milwaukee County	--	--	X	--	1.0 inch	--	--	2,389,179
April 13, 2006	Milwaukee County	--	--	X	--	1.0 inch	--	--	--
April 13, 2006	City of Milwaukee	--	--	X	--	1.0 inch	--	--	--
June 21, 2006	Milwaukee County	X	X	--	--	56 knots	--	--	--
June 21, 2006	Milwaukee County	X	X	--	--	56 knots	--	--	23,892
June 21, 2006	Milwaukee County	X	X	--	--	56 knots	--	--	23,892
June 21, 2006	City of Milwaukee	X	X	--	--	56 knots	--	--	23,892
June 21, 2006	City of Milwaukee	X	X	--	--	56 knots	--	--	23,892
June 21, 2006	Milwaukee County	X	X	--	--	56 knots	--	--	11,946

Table continued on next page.

Table 3.12 (Continued)

Date	Affected Area	Event Type				Magnitude	Reported Damages[a]		
		Thunderstorm	High Winds	Hail	Lightning		Fatalities	Injuries	Property Damage (dollars)[b]
June 21, 2006	City of Milwaukee	X	X	--	--	56 knots	--	--	11,946
June 21, 2006	City of Milwaukee	X	X	--	--	56 knots	--	--	23,892
June 21, 2006	City of Milwaukee	X	X	--	--	56 knots	--	--	23,892
June 21, 2006	City of Milwaukee	X	X	--	--	52 knots	--	--	--
July 9, 2006	Milwaukee County	X	X	--	--	52 knots	--	--	--
July 9, 2006	Milwaukee County	X	X	--	--	56 knots	--	--	5,973
July 9, 2006	Milwaukee County	--	--	X	--	1.0 inch	--	--	--
July 9, 2006	Milwaukee County	--	--	X	--	1.0 inch	--	--	--
July 9, 2006	Milwaukee County	--	--	X	--	0.75 inch	--	--	--
July 9, 2006	Milwaukee County	--	--	X	--	1.0 inch	--	--	--
July 9, 2006	City of Milwaukee	--	--	X	--	1.0 inch	--	--	--
July 9, 2006	City of Milwaukee	--	--	X	--	1.0 inch	--	--	--
July 9, 2006	Milwaukee County	--	--	X	--	1.0 inch	--	--	--
July 9, 2006	Milwaukee County	--	--	X	--	0.75 inch	--	--	--
July 20, 2006	City of Milwaukee	X	--	--	X	N/A	--	--	17,919
July 22, 2006	Milwaukee County	--	--	X	--	1.0 inch	--	--	--
July 30, 2006	City of Milwaukee	X	X	--	--	61 knots	--	--	59,729
August 2, 2006	Milwaukee County	--	--	X	--	0.88 inch	--	--	--
August 23, 2006	City of Milwaukee	--	--	X	--	0.75 inch	--	--	--
October 2, 2006	Milwaukee County	X	X	--	--	52 knots	--	--	--
October 2, 2006	Milwaukee County	--	--	X	--	1.0 inch	--	--	--
October 2, 2006	Milwaukee County	--	--	X	--	0.75 inch	--	--	--
October 4, 2006	Milwaukee County	--	--	X	--	0.75 inch	--	--	--
October 4, 2006	Downtown Milwaukee	--	--	X	--	0.88 inch	--	--	--
March 21, 2007	Milwaukee County	--	--	X	--	0.75 inch	--	--	--
March 21, 2007	Milwaukee County	--	--	X	--	0.88 inch	--	--	--
March 21, 2007	City of Milwaukee, Timmerman Airport	--	--	X	--	0.75 inch	--	--	--
April 3, 2007	Milwaukee County	X	--	--	X	N/A	--	--	29,039
April 4, 2007	Milwaukee County	--	X	--	--	39 knots	--	--	5,788
June 7, 2007	Downtown Milwaukee	X	X	--	--	56 knots	--	--	11,616
June 7, 2007	Downtown Milwaukee	X	X	--	--	59 knots	--	--	11,616
June 7, 2007	Milwaukee County	X	X	--	--	56 knots	--	--	11,616
June 18, 2007	Milwaukee County	X	X	--	--	56 knots	--	--	11,616
August 22, 2007	Milwaukee County	X	X	--	--	52 knots	--	--	29,039
August 22, 2007	Milwaukee County	X	X	--	--	52 knots	--	--	17,424
August 22, 2007	City of Milwaukee, Timmerman Airport	X	X	--	--	68 knots	--	--	29,039

Table continued on next page.

Table 3.12 (Continued)

Date	Affected Area	Event Type				Magnitude	Reported Damages[a]		
		Thunderstorm	High Winds	Hail	Lightning		Fatalities	Injuries	Property Damage (dollars)[b]
August 22, 2007	Milwaukee County	X	X	--	--	56 knots	--	--	17,424
September 27, 2007	Milwaukee County	--	--	X	--	0.75 inch	--	--	--
September 27, 2007	Milwaukee County	--	--	X	--	0.88 inch	--	--	--
September 27, 2007	Milwaukee County	--	--	X	--	0.75 inch	--	--	--
September 27, 2007	City of Milwaukee, Timmerman Airport	--	--	X	--	0.75 inch	--	--	--
December 23, 2007	Southeastern Wisconsin	--	X	--	--	50 knots	--	--	2,323
June 6, 2008	Milwaukee County	X	X	--	--	50 knots	--	--	27,966
June 7, 2008	Milwaukee County	X	X	--	--	50 knots	--	--	--
June 8, 2008	Milwaukee County	X	X	--	--	56 knots	--	--	--
June 14, 2008	Milwaukee County	X	--	--	X	N/A	--	--	22,373
July 2, 2008	City of Milwaukee, Timmerman Airport	X	X	--	--	56 knots	--	--	11,186
July 7, 2008	Downtown Milwaukee	X	X	--	--	56 knots	--	--	11,186
July 16, 2008	Downtown Milwaukee	X	X	--	--	56 knots	--	--	11,186
August 4, 2008	Milwaukee County	X	--	--	X	N/A	--	--	11,186
August 8, 2009	Milwaukee County	X	X	--	--	39 knots	--	1	--
August 9, 2009	Milwaukee County	X	X	--	--	60 knots	--	--	16,839
August 9, 2009	Milwaukee County	X	X	--	--	56 knots	--	--	--
May 5, 2010	Southeastern Wisconsin	--	X	--	--	39 knots	--	--	11,007
June 18, 2010	City of Milwaukee, General Mitchell Airport	X	X	--	--	57 knots	--	--	--
June 21, 2010	Milwaukee County	X	X	--	--	56 knots	--	--	--
June 21, 2010	Milwaukee County	--	--	X	--	1.0 inch	--	--	--
July 22, 2010	Milwaukee County	X	X	--	--	53 knots	--	--	--
July 22, 2010	Milwaukee County	--	--	--	X	N/A	--	2	--
July 22, 2010	Milwaukee County	X	X	--	--	65 knots	--	--	2,201
August 9, 2010	City of Milwaukee, Timmerman Airport	X	X	--	--	54 knots	--	--	--
September 6, 2010	Downtown Milwaukee	--	--	X	--	0.88 inch	--	--	--
September 6, 2010	Milwaukee County	--	--	X	--	1.0 inch	--	--	--
September 6, 2010	Milwaukee County	--	--	--	X	N/A	--	--	3,302
September 7, 2010	Milwaukee County	--	X	--	--	42 knots	1	--	5,504
September 21, 2010	Milwaukee County	--	--	X	--	1.0 inch	--	--	--
September 24, 2010	Milwaukee County	--	X	--	--	47 knots	--	--	5,504
September 24, 2010	Southeastern Wisconsin	--	X	--	--	42 knots	--	--	1,101
October 26, 2010	Milwaukee County	--	X	--	--	53 knots	--	--	55,035
January 1, 2011	Milwaukee County	--	X	--	--	43 knots	--	--	4,268

Table continued on next page.

Table 3.12 (Continued)

Date	Affected Area	Event Type				Magnitude	Reported Damages[a]		
		Thunderstorm	High Winds	Hail	Lightning		Fatalities	Injuries	Property Damage (dollars)[b]
February 18, 2011	Milwaukee County	--	X	--	--	39 knots	--	--	2,134
April 10, 2011	City of Milwaukee, General Mitchell Airport	X	X	--	--	57 knots	--	--	--
April 10, 2011	Milwaukee County	X	X	--	--	61 knots	--	--	--
April 15, 2011	Milwaukee County	--	X	--	--	39 knots	--	--	5,335
May 15, 2011	Milwaukee County	--	X	--	--	41 knots	--	--	5,335
May 22, 2011	City of Milwaukee, General Mitchell Airport	X	X	--	--	53 knots	--	--	--
June 8, 2011	Milwaukee County	--	--	X	--	1.0 inch	--	--	--
June 8, 2011	Milwaukee County	X	X	--	--	57 knots	--	--	--
June 8, 2011	Milwaukee County	X	X	--	--	56 knots	--	--	--
June 30, 2011	Milwaukee County	X	X	--	--	55 knots	--	--	42,680
September 3, 2011	City of Milwaukee, Timmerman Airport	X	X	--	--	56 knots	--	--	--
September 29, 2011	Milwaukee County	--	X	--	--	39 knots	1	--	2,134
October 19, 2011	Milwaukee County	--	X	--	--	50 knots	--	--	16,005
November 13, 2011	Southeastern Wisconsin	--	X	--	--	39 knots	--	--	1,067
November 29, 2011	Milwaukee County	--	X	--	--	49 knots	--	--	1,067
January 1, 2012	Milwaukee County	--	X	--	--	39 knots	--	--	3,136
March 10, 2012	Milwaukee County	--	X	--	--	29 knots	--	--	2,091
April 15, 2012	Milwaukee County	--	X	--	--	40 knots	--	--	1,045
April 16, 2012	Milwaukee County	--	X	--	--	26 knots	--	--	1,045
April 16, 2012	Milwaukee County	--	X	--	--	43 knots	--	--	1,045
April 16, 2012	Milwaukee County	--	X	--	--	39 knots	--	--	1,045
May 1, 2012	Southeastern Wisconsin	X	X	--	--	57 knots	--	--	2,091
June 18, 2012	Southeastern Wisconsin	--	X	--	--	39 knots	--	--	15,681
September 17, 2012	Milwaukee County	--	--	X	--	0.75 inches	--	--	--
November 11, 2012	Milwaukee County	--	X	--	--	43 knots	--	--	5,227
January 18, 2013	Milwaukee County	--	X	--	--	43 knots	--	--	8,242
January 19, 2013	Milwaukee County	--	X	--	--	42 knots	--	--	5,152
April 11, 2013	Milwaukee County	--	X	--	--	42 knots	--	--	12,364
May 14, 2013	Milwaukee County	X	X	--	--	61 knots	--	--	51,515
June 27, 2013	Milwaukee County	--	--	X	--	0.75 inches	--	--	--
November 17, 2013	City of Milwaukee, General Mitchell Airport	--	--	X	--	1.0 inch	--	--	--
November 17, 2013	Milwaukee County	--	--	X	--	1.5 inches	--	--	--
November 17, 2013	Milwaukee County	--	--	X	--	1 inch	--	--	--
April 12, 2014	Milwaukee County	--	--	X	--	1 inch	--	--	--

Table continued on next page.

Table 3.12 (Continued)

Date	Affected Area	Event Type				Magnitude	Reported Damages[a]		
		Thunderstorm	High Winds	Hail	Lightning		Fatalities	Injuries	Property Damage (dollars)[b]
April 12, 2014	Milwaukee County	--	--	X	--	0.75 inches	--	--	--
April 12, 2014	Milwaukee County	--	--	X	--	0.75 inches	--	--	--
May 7, 2014	Downtown Milwaukee	--	--	X	--	.88 inches	--	--	--
May 12, 2014	Milwaukee County	--	--	X	--	0.75 inches	--	--	--
May 12, 2014	Milwaukee County	X	X	--	--	52 knots	--	--	--
May 12, 2014	Milwaukee County	--	--	X	--	2 inches	--	--	--
May 12, 2014	Milwaukee County								
May 12, 2014	Milwaukee County	--	--	X	--	0.75 inches	--	--	--
June 17, 2014	Milwaukee County	X	X	--	--	65 knots	--	--	30,414
June 17, 2014	Downtown Milwaukee	--	--	X	--	1.25 inches	--	--	--
June 17, 2014	Milwaukee County	--	--	X	--	0.88 inches	--	--	--
June 17, 2014	Milwaukee County	--	--	X	--	1 inch	--	--	--
June 18, 2014	City of Milwaukee, Timmerman Airport	--	--	X	--	1 inch	--	--	--
June 18, 2014	Milwaukee County	--	--	X	--	0.88 inches	--	--	--
June 28, 2014	Milwaukee County	X	X	--	--	55 knots	--	--	2,028
June 30, 2014	Milwaukee County	X	X	--	--	53 knots	--	--	5,069
June 30, 2014	City of Milwaukee, General Mitchell Airport	X	X	--	--	51 knots	--	--	7,097
August 1, 2014	Milwaukee County	--	--	X	--	0.75 inches	--	--	--
August 1, 2014	Milwaukee County	--	--	X	--	1 inch	--	--	--
August 1, 2014	Milwaukee County	--	--	X	--	1 inch	--	--	--
June 22, 2015	Milwaukee County	X	X	--	--	52 knots	--	--	1,013
June 22, 2015	Milwaukee County	X	X	--	--	52 knots	--	--	1,013
June 22, 2015	Milwaukee County	X	X	--	--	50 knots	--	--	506
July 18, 2015	Milwaukee County	X	X	--	--	55 knots	--	--	1,013
August 2, 2015	Milwaukee County	--	--	X	--	1 inch	--	--	--
August 2, 2015	Milwaukee County	--	--	X	--	1 inch	--	--	--
August 2, 2015	Milwaukee County	--	--	X	--	1.25 inches	--	--	--
August 2, 2015	Milwaukee County	--	--	X	--	1 inch	--	--	--
August 2, 2015	Milwaukee County	--	--	X	--	1 inch	--	--	--
August 2, 2015	Milwaukee County	--	--	X	--	1 inch	--	--	--
August 2, 2015	Milwaukee County	--	--	X	--	1.25 inches	--	--	--
August 2, 2015	Milwaukee County	--	--	X	--	3 inches	--	--	--
August 10, 2015	Milwaukee County	--	--	X	--	1 inch	--	--	--
August 14, 2015	Milwaukee County	--	--	X	--	1 inch	--	--	--
December 23, 2015	Milwaukee County	--	X	--	--	49 knots	--	--	2,025

Table continued on next page.

Table 3.12 (Continued)

Date	Affected Area	Event Type				Magnitude	Reported Damages[a]		
		Thunderstorm	High Winds	Hail	Lightning		Fatalities	Injuries	Property Damage (dollars)[b]
February 19, 2016	Milwaukee County	--	X	--	--	55 knots	--	--	100,000
March 16, 2016	Milwaukee County	--	X	--	--	50 knots	--	--	30,000
April 25, 2016	Milwaukee County	--	--	X	--	0.75 inches	--	--	--
April 25, 2016	Milwaukee County	--	--	X	--	0.75 inches	--	--	--
April 25, 2016	Milwaukee County	--	--	X	--	0.75 inches	--	--	--
April 25, 2016	City of Milwaukee, Timmerman Airport	--	--	X	--	0.75 inches	--	--	--
April 25, 2016	Milwaukee County	--	--	X	--	1 inch	--	--	--
June 5, 2016	Milwaukee County	X	X	--	--	50 knots	--	--	1,000
August 3, 2016	Milwaukee County	X	X	--	--	50 knots	--	--	5,000
August 3, 2016	Milwaukee County	X	X	--	--	50 knots	--	--	5,000
September 7, 2016	Milwaukee County	X	X	--	--	50 knots	--	--	3,000
September 7, 2016	Milwaukee County	X	X	--	--	52 knots	--	--	1,000
September 21, 2016	Milwaukee County	--	--	X	--	1 inch	--	--	--
	Total	216	239	142	27	--	3	11	52,308,845

Note: N/A indicates data not available.

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

[b] *Dollar values are adjusted to year 2016 by using the average annual Consumer Price Index (CPI) values from the U.S. Department of Labor, Bureau of Labor Statistics.*

Source: The National Climatic Data Center (NCDC) a part of the Department of Commerce, National Oceanic and Atmospheric Administration (NOAA), and the National Environmental Satellite, Data and Information Service (NESDIS)

During the 6-year period between May 2010 and December 2016, 28 thunderstorm and 55 high-wind events were recorded in the Milwaukee County. In total, these thunderstorm and high-wind events resulted in over $400,000 in property damages in Milwaukee County (2016 dollars). Many of these damages occurred as a result of two storm events that impacted the City in 2013 and 2016. The first event was a thunderstorm and high-wind event that occurred on May 14, 2013. Several lines of severe thunderstorms crossed southern Wisconsin during the evening. These storms produced damaging wind gusts of 70 to 75 mph. Widespread damage was reported in swaths up to six miles in width. The damage included structural damage to homes and farm buildings, downed trees, and power lines. We Energies reported that 23,000 customers in Dodge, Jefferson, Waukesha, and Milwaukee Counties were without power at the height of the storm. The severe thunderstorms formed along a warm front that extended from northwest Wisconsin to Chicago. While wind shear and instability were marginal, evaporative cooling from rain falling into dry air produced prime conditions for downbursts. A trained spotter reported numerous downed trees and power lines along a path from two miles west of the City of Wauwatosa to east of the City of Cudahy. A downed power line caused a house fire three miles southwest of downtown Milwaukee. This event resulted in over $51,000 in property damages in Milwaukee County (2016 dollars).

Another high-wind event impacted the City of Milwaukee on February 19, 2016. A strong low pressure system moved across northern Wisconsin, sweeping an occluded front across southern Wisconsin during the late morning and afternoon hours. This was accompanied by wind gusts of 58 to 65 mph, with a maximum gust of 63 mph being reported at General Mitchell International Airport. Damages that were reported as a result of this storm include downed trees and branches, damaged homes and vehicles, and downed signs. Four semi-trucks were blown over on the interstate, blocking lanes. A shelter at a bus stop blew over and was damaged in the Riverwest neighborhood. About 26,000 customers were affected by power outages. This event resulted in $100,000 in property damages in Milwaukee County.

From 1956 to 2016, 142 major hailstorms were reported in the Milwaukee County. Several of these events coincided with thunderstorm and high wind events. From 1956 to 2016, NCDC reported $9.6 million in property damages from hailstorm events that occurred in and around the City of Milwaukee. The costliest hailstorm occurred on April 13, 2005. This event consisted of three hailstorms associated with supercell thunderstorms that pushed east-northeastward through southern Wisconsin. This storm produced hailstones up to four inches in diameter. Throughout southern Wisconsin, thousands of motor vehicles, residential homes, businesses, and farms sustained hail damage. There were no reports of injuries or deaths. Vehicle damage consisted of broken windows and dented sheet metal. Roofs, windows, and siding of buildings were damaged. This episode was the most costly recorded hailstorm in the State of Wisconsin. Based on insurance company estimates provided to the National Weather Service, over $8.6 million in damages in Milwaukee County were associated with this event. Because it is covered under most homeowner's policies, hail damage is directly reported to insurance companies and is not usually publicly reported, unless it is extensive.[65]

From 1995 to December 2016, 27 lightning events were reported in Milwaukee County that resulted in significant property damage throughout southeastern Wisconsin. Most of the lightning events occurred during a thunderstorm or high wind event. In all, the NCDC has recorded about $2.8 million dollars in property damage due to lightning events in Milwaukee County, as shown in Table 3.12. Most of these damages occurred as a result of two lightning events: on July 27, 1997, lightning caused a massive fire at a towing business on the south side of Milwaukee, and on August 21, 2002, a lightning fire in the Village of Fox Point burned a home to the ground. During the 2002 storm event, at least 56,000 customers in southeastern Wisconsin lost electrical power due to lightning strikes and tree damage to power lines.

Vulnerability and Community Impact Assessment

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 City of Milwaukee to thunderstorms and related storm hazards, a review of the community assets described in Chapter 2 indicate the potential for significant thunderstorm and related hazard impacts to: 1) a variety of residential, commercial, and other developed land uses;

[65] *Rusty Kapela, Warning Coordination Meteorologist at Milwaukee/Sullivan NWS, personal communication.*

2) roadway transportation system; 3) utilities; 4) critical community facilities; and 5) historic sites. In addition, the Milwaukee County Pre-Disaster Mitigation Plan concluded that thunderstorms and related hazards are one of the greatest risks to the population and infrastructure within Milwaukee County.[66] Significant impacts may also be possible to other infrastructure or utility systems, or hazardous material storage sites. On average, between 1993 and 2016 reported damages have resulted in about $124,000 per event, or about $2.2 million per year. However, very few events have been responsible for a large percentage of the total damages. Thus, this average damage cost is considered to be a very approximate measure of potential damages.

Mobile and manufactured homes can 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. The U.S. Department of Housing and Urban Development (HUD) began regulating and governing their design and construction in 1974. Units manufactured before the HUD code was enforced federally in 1976 are the most vulnerable. Damage to mobile homes may be caused directly from wind or as a result of failure of the anchoring system for the home. Stronger winds can dislodge manufactured homes from their foundations or blow them over entirely if not properly anchored. Direct damage may include blown-off roof panels, loss of roof framing, loss of wall panels and framing and broken windows. Add-ons such as carports and garages are an additional source of wind damage to mobile and manufactured homes. Most of these add-ons are not built to the HUD code, and many are not designed to be attached to manufactured homes. Damage to these structures at high wind speeds can cause a breach of the manufactured home's envelope, resulting in significant additional damage to the host structure. Debris from disintegrating add-ons can also impact other homes in the vicinity. Licensing information collected by the Wisconsin Department of Safety and Professional Services indicates that there are five mobile home parks containing a total of 655 sites for mobile homes in the City of Milwaukee.

In 2016, the total equalized assessed property value in the City of Milwaukee was estimated at over $25.1 billion. About $20.7 billion of this total assessment is comprised of buildings and other improvements. Based on the current average estimate of $2.2 million in reported damages per year, it can be expected that approximately 0.01 percent of the value of all property, including buildings and infrastructure in the City of Milwaukee, will be damaged from these events each year. Due to the unpredictability of thunderstorm, high-wind, hail and lightning events, all buildings, infrastructure, and critical facilities within the City are considered at risk. Based on availability, the 2016 assessed values of the identified critical facilities are provided in Appendix B.

Potential Future Changes in Thunderstorm, High-Wind, Hail, and Lightning Conditions

Based upon historical data, the City of Milwaukee can expect to experience an average of 10.2 thunderstorm, high-wind, hail, and/or lightning events per year. It should be noted that the historical record shows considerable variation among years in the number of events that occurred. While it would be expected that in some years the City 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 under current climatic conditions.[67] It should also be noted that wind strengths over the Great Lakes have increased and are expected to continue increasing in the future.[68] Surface wind speeds above the Lakes are increasing by about 5 percent per decade, exceeding trends in wind speed over land.

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[66] *Milwaukee County Office of Emergency Management,* op. cit.

[67] *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.*

[68] *Ankur R. Desai, Jay A. Austin, Val Bennington, and Galen A. McKinley, "Stronger Winds Over a Large Lake in Response to Weakening Air-to-Lake Temperature Gradient,"* Nature Geoscience, *Volume 2, pages 855-858, 2009.*

Changes in land use can have an impact on the potential for thunderstorm and related hazards to occur. However, development within the City itself is approaching "buildout" conditions with new development expected to be limited, as documented in the adopted regional land use plan and summarized in Chapter 2, and indicate a limited potential increase in risk of weather related damage and related losses in the already developed urbanized areas within the City. Because of actions taken by the City, the County, local units of government and individuals, the current vulnerability to thunderstorms and related hazards have decreased in recent years. These ongoing mitigation measures are described further in Chapter 5.

3.5 VULNERABILITY ASSESSMENT FOR 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 is one of the most tornadoprone areas of the United States, reporting 29 violent tornadoes during the year 2001. 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 of time. 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 ground surface, are known as funnel clouds. A funnel cloud 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, and, occasionally, multiple outbreaks of tornadoes occur along the 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. This scale is shown in Table 3.13. Under this scale tornado intensities range from F0 events, representing the tornadoes doing the smallest amount of damage, to F5 events, representing the tornadoes doing the greatest amount of damage. Wind velocities necessary to produce the particular damage are often associated with ratings along the Fujita Scale, but that practice can be misleading. The wind estimates associated with the Fujita Scale are intended to be based upon the expected damage to a well-built residential structure. Poorly built structures can suffer significant structural damage under lesser winds than the Fujita Scale might suggest. Other sorts of structures may or may not experience the same failures under high wind speeds that a house might. Thus the Fujita Scale is largely a residential scale, with much more care required in assessment after wind damage to other sorts of structures. Since February 2007, the Fujita Scale has been replaced by the Enhanced Fujita Scale which retains the same basic design of its predecessor with six strength categories. This scale is shown in Table 3.14. The newer scale reflects more refined assessments of tornado damage surveys, more standardization, and consideration of damage over a wider range of structures. Because the National Weather Service has decided not to reclassify tornadoes that occurred prior to the implementation of the Enhanced Fujita Scale, the Fujita Scale classifications have been retained for those storms which occurred prior to February 2007.

The destructive power of the tornado results primarily from its high-wind velocities, wind-driven debris, and uplifting force. These tornado 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; these events are characterized by strong downdrafts initiated by a thunderstorm that manifests 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, 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.

Table 3.13
Fujita Scale Characteristics

F-Scale	Wind Speed (miles per hour)	Character of Damage	Relative Frequency (percent)
F0 (weak)	40-72	Light damage	29
F1 (weak)	73-112	Moderate damage	40
F2 (strong)	113-157	Considerable damage	24
F3 (strong)	158-206	Severe damage	6
F4 (violent)	207-260	Devastating damage	2
F5 (violent)	261-318	Incredible damage (rare)	<1

Source: National Oceanic Atmospheric Administration

Table 3.14
Enhanced Fujita Scale Characteristics

EF-Scale	Wind Speed (miles per hour)[a]	Character of Damage	Relative Frequency (percent)
EF0 (weak)	65-85	Light damage	53
EF1 (weak)	86-110	Moderate damage	32
EF2 (strong)	111-135	Considerable damage	11
EF3 (strong)	136-165	Severe damage	3
EF4 (violent)	166-200	Devastating damage	1
EF5 (violent)	>200	Incredible damage (rare)	<1

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

Source: National Oceanic Atmospheric Administration

The National Weather Service monitors severe weather nationwide from its Norman, Oklahoma, office. This office is the only entity that can issue a tornado watch. The National Weather Service office in Milwaukee/Sullivan, and Milwaukee County Emergency Management, may issue tornado warnings. 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 it is indicated as likely to have occurred by 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. The National Weather Service operates a 24-hour weather radio transmitter serving Milwaukee and Waukesha Counties, operating at a frequency of 162.400 megahertz (MHz), from a location in the Town of Delafield, Waukesha County. Southern portions of the Milwaukee County area, including portions of the City, are also served by a transmitter operating at a frequency of 162.450 MHz from a location at CTH KR and Wood Road in Racine County.

In addition to tornado watches and warnings, severe thunderstorm watches and warnings indicate severe weather conditions that may generate conditions in which tornadoes may occur. Such watches and warnings may be followed by tornado watches and warnings as weather conditions develop.

Historical Tornado Problems

Historically, a tornado with one of the longest tracks recorded in Wisconsin occurred on May 23, 1878.[69] This tornado tracked over 150 miles from Iowa County through Dane, Waukesha, and Milwaukee Counties, killing 19 and injuring 45 people throughout the four counties. Although such tornadoes are relatively rare natural hazards in the City of Milwaukee, they can cause substantial loss of life and damage to property.

Description of Recent Tornado Events

In the State of Wisconsin, tornado paths historically have averaged 3.5 miles in length and 50 yards in width, although tornado paths of a mile or more in width and 300 miles in length have been known to occur elsewhere in the United States. On average, tornadoes in southeastern Wisconsin move across the land surface at speeds between 25 and 45 miles per hour, although overland speeds of up to 70 mph have been

[69] *National Oceanic and Atmospheric Administration,* www.crh.noaa.gov/mkx/tortrack.htm.

reported. Tornadoes rarely last more than a few minutes over a single spot or more than 15 to 20 minutes in a 10-mile area, but, in those few minutes, significant damage may occur.

The gravity of any particular tornado event is measured in terms of resulting deaths, injuries, and economic losses. The magnitudes of the tornadoes recorded in southeastern Wisconsin have been low, primarily F0 or weak F1 events on the Fujita scale, as shown in Table 3.13. Nevertheless, tornadoes are the third most costly natural hazards to impact southeastern Wisconsin.

Since 1950, a total of 18 tornadoes have been recorded in or near the City of Milwaukee, or about one tornado every 40 months. These are shown on Map 3.2, and documented in terms of their magnitude and impact in Table 3.15. In total, these 18 tornadoes have resulted in no deaths, 176 injuries, and over $18.3 million in property damages, with the average damage estimated at almost $1,019,000 dollars. On average, there are approximately 23 tornadoes reported each year within the State of Wisconsin.

Of the tornadoes reported in Milwaukee County since 1950, seven were categorized as F2 events on the Fujita scale. These seven tornado events collectively resulted in over $5.4 million in property damage in Milwaukee County. However, two F1 tornadoes caused the greatest number of injuries and highest damage costs recorded. On August 11, 1969, an F1 tornado caused 153 injuries and over $1.6 million in damages, and on March 8, 2000, an F1 tornado caused over $6.4 million in property damage and 16 injuries near General Mitchell International Airport (Figure 3.8). Of the remaining tornado events, nine were classified as F1 tornadoes and one was classified as an F0 event. No magnitude information was available for one tornado.

Vulnerability and Community Impact Assessment

In order to assess the vulnerability of the City of Milwaukee to tornado and related storm hazards, a review of the community assets described in Chapter 2 was made which indicates the potential for significant tornado impacts to: 1) a variety of residential, commercial, and other developed land uses; 2) roadway transportation system; 3) utilities; 4) critical community facilities; and 5) historic sites. In addition, the Milwaukee County Pre-Disaster Mitigation Plan concluded that tornadoes are a major risk to people within Milwaukee County.[70] Significant impacts may also be possible to other infrastructure or utility systems, solid waste disposal sites, or hazardous material storage sites.

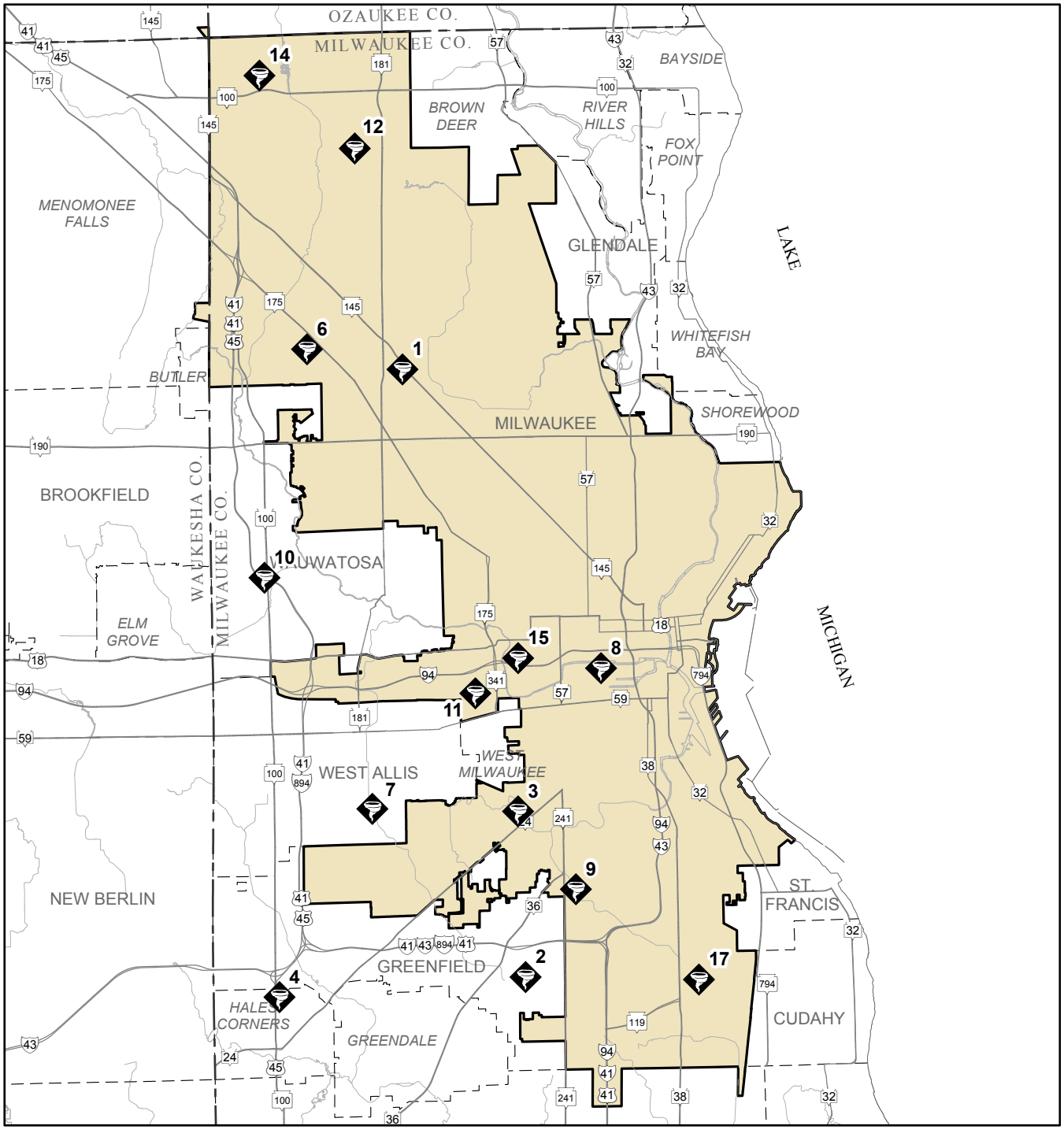
Tornado prediction is not an exact science. The National Weather Service can forecast that a line of thunderstorms may be likely to produce tornadoes, but where they form or touch down, and how powerful they might be, remains unpredictable. As can be seen from the distribution of historic F1 and F2 tornado events since 1950 in the City of Milwaukee, shown on Map 3.2, the locations of tornado impact points are widely scattered throughout the City and County. On average, historic tornado events have resulted in about $1,019,000 in property damages per event. However, one of the events have been responsible for over one third of the total damages. Thus, the average damages cost is considered to be only an approximate measure of potential damages. Based on a yearly average estimated from reported tornado damage between 1958 and 2016, tornadoes cause approximately $310,853 in damage each year.

During a tornado, homes, businesses, public buildings, and infrastructure may be damaged or destroyed by high winds, rain, and hail. Airborne debris carried by the tornado and associated high winds can break windows and doors, allowing winds and rain access to interior spaces. Fixed infrastructure, such as roads and bridges, also can be damaged by exposure to high winds, although more damage appears to result from washout associated with flash flooding and debris jams as opposed to direct damage due to contact with funnel clouds. Notwithstanding, in an extreme tornado event, such as a 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.

As discussed in the section of this chapter on thunderstorms, mobile and manufactured homes can be particularly vulnerable to some hazards such as high wind. 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 afford their occupants little shelter in the event of

[70] *Milwaukee County Office of Emergency Management,* op. cit.

Map 3.2
Tornadoes in the City of Milwaukee: 1950-2010



REPORTED TORNADO SIGHTING

10 TORNADO REFERENCE NUMBER (SEE TABLE 3.5)

CITY OF MILWAUKEE

N

0 0.5 1 2 Miles

Source: SEWRPC

Table 3.15
Tornado Events Reported in Milwaukee County: 1958- 2016

Number on Map 3.2	Date	Affected Area	Magnitude (Fujita)	Length (miles)	Width (yards)	Fatalities	Injuries	Property Damage (dollars)[a]
1	August 7, 1958	City of Milwaukee	F2	1	100	--	4	208,363
2	September 26, 1959	Milwaukee County	F2	2	33	--	3	2,069,095
3	July 22, 1962	City of Milwaukee	F2	--	33	--	--	199,337
4	October 4, 1962	Milwaukee County	F1	1	33	--	--	199,337
--	August 22, 1964	Milwaukee County	F1	2	400	--	--	1,993,698
5	September 3, 1964	City of Milwaukee	F2	--	100	--	--	1,993,698
6	August 11, 1969	Milwaukee County	F1	--	100	--	153	1,640,593
7	August 25, 1975	City of Milwaukee	F1	--	10	--	--	11,227
8	August 25, 1975	City of Milwaukee	F2	--	20	--	--	111,941
9	April 2, 1977	Milwaukee County	F2	1	33	--	--	99,393
10	August 4, 1977	City of Milwaukee	F1	--	--	--	--	--
11	August 4, 1980	City of Milwaukee	F2		20	--	--	730,645
--	July 20, 1981	City of Milwaukee	F1	1	20	--	--	66,262
12	August 17, 1985	City of Milwaukee	F1	2	50	--	--	--
13	May 24, 1989	City of Milwaukee	F0	--	23	--	--	485,519
--	August 30, 1993	Milwaukee County	N/A	--	--	--	--	--
14	March 8, 2000	City of Milwaukee	F1	2	75	--	16	6,433,371
--	July 2, 2000	Milwaukee County	F1	7	100	--	--	2,097,824
					Total	0	176	18,340,303

Note: N/A indicates data not available.

[a] *Dollar values are adjusted to year 2016 by using the average annual Consumer Price Index (CPI) values from the U.S. Department of Labor, Bureau of Labor Statistics.*

Source: National Climatic Data Center and SEWRPC

Figure 3.8
Damage Caused by the March 8, 2000 Tornado

Source: National Weather Service

hazardous winds. As of May 2017, there were five mobile home parks located in the City of Milwaukee. These parks had sites for a total of 655 mobile homes. These structures and their occupants may be particularly vulnerable to impacts from tornadoes.

In 2016, the total equalized assessed property value in the City of Milwaukee was estimated at over $25.1 billion.[71] About $20.7 billion of this total is comprised of buildings and other improvements. Based on the current average estimate of $310,853 in reported damages per year, it can be expected that approximately 0.0015 percent of the value of all property, including buildings and infrastructure in the City of Milwaukee, will be damaged from tornadoes each year. Due to the unpredictability of tornado events, all buildings, infrastructure, and critical facilities within the City are considered at risk. Based on availability, the 2016 assessed values of the identified critical facilities are provided in Appendix B.

Potential Future Changes in Tornado Conditions

Based upon historical data, the City of Milwaukee 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 among years in the number of events that occurred. While it would be expected that in some years the City will experience either fewer events or more events than the average number, the average annual number of events is not expected to change.

Changes in land use can have an impact on the potential for tornado and related hazards to occur. However, development within the City itself is approaching "buildout" conditions with new development expected to be limited, as documented in the adopted regional land use plan and summarized in Chapter 2, and indicate a continuing level of moderate risk of tornado damage and related losses in the City. Because of actions taken by the City, the County, and individuals, the current vulnerability to tornadoes and related hazards has decreased in recent years. Ongoing mitigation measures are described further in Chapter 5.

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 trends in tornados rated F1 or EF1 and higher over the period 1954 through 2013 found that the frequency of outbreaks of multiple tornadoes may be changing.[72] While the study found no change in the frequency at which tornadoes occur, it found a decrease in the number of days per year on which at least one tornado occurs. At the same time, it found an increase in the number of days per year on which multiple tornadoes occur. Increasing trends were found at several different thresholds for defining outbreaks of multiple tornadoes. Thus, the study found that the proportion of tornadoes that occur on

[71] *Wisconsin Department of Revenue.*

[72] *James B. Elsner, Svetoslava C. Elsner, and Thomas H. Jagger, "The Increasing Efficiency of Tornado Days in the United States,"* Climate Dynamics, *Volume 45, pages 651-659, 2015.*

"big tornado days" has increased. In addition, the study found that the spatial and temporal density of the tornadoes occurring has increased. The study concluded that the risk of "big tornado days" featuring clusters of densely packed tornadoes is increasing. This trend could potentially increase tornado-related damages.

3.6 VULNERABILITY ASSESSMENT FOR EXTREME TEMPERATURES

Extreme heat and cold are two of the most underrated, least understood, and deadly of all the natural hazard events that impact the City of Milwaukee. In contrast to the visible, destructive, and violent characteristics associated with floods and tornadoes, extreme high or low temperatures are "silent killers." Heat deaths occur quietly, without headline-making destruction. The Center for Disease Control and Prevention reports that on average, 688 people die each year nationwide from excessive heat, more than lightning, tornadoes, floods, and hurricanes combined.[73] Excessive heat has become the most deadly hazard in Wisconsin. According to the National Weather Service, between 1982 and 2015, 137 people have died in Wisconsin as a direct result of heat waves. During the same period excessive heat was identified as a contributing factor in 102 other deaths. This rate of mortality due to heat events during this period is over twice that of the next most deadly natural hazards, cold waves (65 deaths). Temperature data for two selected observation stations in the City of Milwaukee have been shown in Table 3.16 to indicate extreme high and low temperatures and the departure from average temperatures recorded in the period from 1990 through 2016. The average high and low extreme temperatures for these two stations are 95.1°F and -6.8°F for Milwaukee Mitchell International Airport and 97.8°F and -8.2°F for Mount Mary College during this period. Prolonged exposure to either of these temperatures could present a significant danger. It is worth noting that Lake Michigan may be exerting some effect on the average and the extreme cold temperature, but is not appreciably reducing the average extreme high temperature.

Heat and humidity together can inflict the most harm to human health. High humidity makes heat more dangerous because it slows the evaporation of perspiration, which is the body's natural cooling process. A measure of discomfort and the level of risk posed to people in high-risk groups is the Heat Index (HI) which is expressed in degrees Fahrenheit (°F) and equals a relative humidity (RH) adjustment added to the actual air temperature. For example, if the air temperature is 94°F and the RH is 55 percent, the HI would equal 106°F (see Table 3.17). Since HI values were devised for shady, light wind conditions, exposure to full sunshine can increase HI values by up to 15°F. The level of risk to people in high-risk groups associated with different levels of the HI is shown in Table 3.18.[74] The NWS initiates 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 related 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. During 2001 and 2002, there were 10 and 11 days, respectively, when weather conditions were forecast in southeastern Wisconsin which could have resulted in unhealthy levels of ozone (the main component of smog).

The following definitions/criteria are 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 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 48 hours in advance when Excessive Heat Warning conditions are expected.

- **Heat Advisory**—Issued six to 24 hours in advance of any 24-hour period in which daytime heat indices are expected to be 100° to 104°, or 95° to 99° for four or more consecutive days, and nighttime heat indices are greater than or equal to 75°. Advisories are issued for less serious conditions that cause significant inconvenience and, if caution is not exercised, could lead to situations that may threaten life.

[73] *U.S. Centers for Disease Control and Prevention, "Heat-Related Deaths—United States, 1999-2003,"* Morbidity and Mortality Weekly Reports, *Volume 55, July 28, 2008.*

[74] *High-risk groups include the very young, the old, and people with chronic health conditions.*

Table 3.16
Extreme and Departure from Average Temperature Characteristics Within the City of Milwaukee: 1990-2016

	Milwaukee Mitchell International Airport				Mount Mary College			
Year	High Temperature (°F)	Low Temperature (°F)	Average Annual Temperature (°F)	Departure from Average Temperature (°F)	High Temperature (°F)	Low Temperature (°F)	Average Annual Temperature (°F)	Departure from Average Temperature (°F)
1990	98	-7	49.9	3.8	98	-8	51.2	3.7
1991	97	-3	50.0	3.9	98	-6	50.6	3.1
1992	90	-5	47.5	1.4	93	-6	48.4	0.9
1993	95	-2	47.8	1.7	95	-5	48.3	0.1
1994	100	-21	49.4	3.3	100	-24	49.3	1.1
1995	103	-5	48.5	2.4	108	-6	49.1	0.8
1996	95	-26	46.0	-0.2	97	-25	46.8	-1.4
1997	92	-8	46.4	0.2	98	-10	48.2	-0.1
1998	95	-4	50.9	4.8	N/A	-5	N/A	N/A
1999	99	-15	48.3	3.1	104	-13	50.5	2.2
2000	89	-8	47.9	1.8	94	-8	48.9	0.7
2001	95	1	48.2	2.9	102	-6	50.5	2.3
2002	98	-6	49.2	1.7	103	-5	49.7	1.5
2003	96	-5	46.2	-0.1	98	-6	48.1	-0.1
2004	91	-10	47.7	0.2	94	-12	48.5	0.3
2005	97	-1	49.2	1.3	99	-3	49.5	1.3
2006	98	12	50.1	2.6	100	14	50.2	2.0
2007	94	-11	48.9	1.4	97	-14	49.3	1.1
2008	89	-6	47.0	-0.5	95	-8	46.8	-1.4
2009	94	-12	47.3	-0.3	95	-14	47.0	-1.2
2010	92	2	50.3	2.8	95	0	50.1	1.9
2011	98	-7	48.6	1.1	100	-9	48.5	0.3
2012	103	-1	51.9	4.4	105	-3	51.9	3.7
2013	95	-5	46.7	-0.8	96	-8	46.3	-1.9
2014	89	-14	45.0	-2.5	90	-15	44.7	-3.5
2015	93	-9	48.5	N/A	94	-10	48.4	-0.1
2016	94	-7	50.8	N/A	95	-7	52.3	3.8
Average	95.1	-6.8	48.5	1.6	97.8	-8.2	49.0	0.8

Note: N/A indicates data not available.

Source: National Oceanic and Atmospheric Administration and SEWRPC

- **Excessive Heat Warning**—Issued six to 24 hours in advance of any 24-hour period in which daytime heat indices are expected to exceed 105° for three or more hours, and nighttime heat indices are greater than or equal to 75°. In addition if Heat Advisory conditions are expected to persist for four or more days, an Excessive Heat Warning will be issued. Warnings are issued for weather conditions posing a threat to life.

During extended periods of very high temperatures, 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 symptom, 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 a 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.

Table 3.17
Heat Index Chart

	Relative Humidity (percent)												
	100	95	90	85	80	75	70	65	60	55	50	45	40
Temperature (°F)	**Heat Index (°F)**												
80	87.2	86.4	85.6	84.9	84.2	83.6	83.0	82.4	81.8	81.3	80.8	80.3	79.9
82	94.5	93.0	91.5	90.1	88.8	87.6	86.4	85.4	84.4	83.6	82.8	82.5	81.5
84	102.7	100.3	98.0	95.9	94.0	92.2	90.5	88.9	87.5	86.3	85.1	84.1	83.3
86	111.5	108.3	105.3	102.5	99.8	97.3	95.1	93.0	91.1	89.4	87.9	86.6	85.4
88	121.2	117.1	113.2	109.6	106.3	103.1	100.2	97.6	95.1	93.0	91.0	89.4	87.4
90	131.6	126.6	121.9	117.5	113.3	109.5	105.9	102.7	99.7	97.0	94.6	92.5	90.7
92	142.8	136.9	131.3	126.0	121.0	116.4	112.2	108.3	104.7	101.4	98.5	96.0	93.8
94	154.8	147.9	141.3	135.2	129.4	124.0	119.0	114.4	110.2	106.3	102.9	99.8	97.2
96	167.5	159.6	152.1	145.0	138.3	132.1	126.4	121.0	116.1	111.7	107.6	104.0	100.9
98	181.0	172.0	163.5	155.5	147.9	140.9	134.3	128.2	122.6	117.4	112.8	108.6	104.9
100	195.3	185.2	175.7	166.7	158.2	150.2	142.8	135.9	129.5	123.6	118.3	113.5	109.3
102	210.4	199.2	188.5	178.5	169.0	160.1	151.8	144.1	136.9	130.3	124.3	118.8	113.9
104	226.2	213.8	202.1	191.0	180.5	170.7	161.4	152.8	144.8	137.4	130.6	124.4	118.9
106	242.7	229.2	216.4	204.2	192.6	181.8	171.6	162.0	153.1	144.9	137.3	130.4	124.2
108	260.1	245.4	231.3	218.0	205.4	193.5	182.3	171.1	161.9	152.8	144.4	136.7	129.8
110	278.2	262.2	247.0	232.5	218.8	205.8	193.5	182.0	171.2	161.2	152.0	143.4	135.7

Source: National Weather Service

Table 3.18
Level of Risk for People in High Risk Groups Associated with the Heat Index

Heat Index (°F)	Category	Possible Heat Disorders for People 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

Extreme cold is also a deadly hazard. Exposure to extreme cold temperatures can 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 vehicle accidents and fatalities, fires due to dangerous use of heaters, and other winter weather fatalities are considered, the impact of severe cold periods become even greater.

Frostbite and hypothermia are two major health risks associated with severe cold. Frostbite is injury caused by freezing of the skin and underlying tissues. Frostbite causes a loss of feeling and a white or pale appearance in extremities. Mild frostbite, frostnip, does not cause permanent skin damage and can be treated with first-aid measures. More 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 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. Relative to temperature extremes, this occurs due to exposure to cold or frigid environments. As with frostbite, wind or wetness can contribute to producing hypothermia. Symptoms of mild hypothermia can include shivering, dizziness, hunger, nausea, fatigue, increased heart and respiration rates, lack of coordination, and difficulty speaking. As hypothermia worsens, shivering may end. 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, people using alcohol or other drugs, and people taking certain medications.

Wind chill is an index used to evaluate the risk posed by the combination of cold temperatures and wind. It is based on a combination of temperature and wind speed. Table 3.19 shows the wind chill table used by the National Weather Service. Wind chill is not the actual temperature, but rather a measure of how wind and cold feel on exposed skin. As the wind increases, heat is carried away from the body at an accelerated rate, driving down the body temperature. This combination can strongly affect the risks associated with exposure to the temperature. For example, a wind chill of -20°F will cause frostbite on exposed skin in just 30 minutes.

The National Weather Service issues wind chill advisories when wind chill temperatures are potentially hazardous and wind chill warnings when wind chill temperatures are life threatening. A wind chill advisory is issued when wind chill values will reach -5°F to -19°F, with wind speeds around 10 mph or more. A wind chill warning is issued when wind chill values will reach -20°F or colder, with wind speeds around 10 mph or more. In addition, a wind chill watch is issued when these conditions may be met 12 to 48 hours in the future.

During the period from 1982 through 2016, 65 people died in Wisconsin due to exposure to cold. When vehicle accidents and fatalities, fires due to dangerous use of heaters, and other winter weather fatalities are also considered, it increases the severity of severe cold periods. Exposure to extreme cold temperatures can cause hypothermia and frostbite; can lead to loss of fingers and toes; or cause permanent kidney, pancreas, and liver injury, and even death. A major winter storm can last for several days and be accompanied by high winds, freezing rain or sleet, heavy snowfall, and cold temperatures. Wind chill is not the actual temperature, but rather how wind and cold feel on exposed skin. As the wind increases, heat is carried away from the body at an accelerated rate, driving down the body temperature. A wind chill of -20°F will cause frostbite in just 30 minutes. Frostbite is damage to body tissue caused by extreme cold. Frostbite causes a loss of feeling and a white or pale appearance in extremities, such as fingers, toes, ear lobes, or the tip of the nose. If symptoms are detected seek immediate medical help. Hypothermia is a condition brought on when the body temperature drops to less than 95°F. Hypothermia may cause lasting kidney, liver, and pancreas problems or death. Warning signs include uncontrollable shivering, memory loss, disorientation, incoherence, slurred speech, drowsiness, and apparent exhaustion. Take the person's temperature. If below 95°F, get medical care immediately. Infants and elderly people are most susceptible. Fifty percent of all cold-related injuries are expected to occur in people over 60 years old, more than 75 percent will happen to men, and about 20 percent will occur in the home.

What constitutes extreme cold varies in different parts of the country. In the south, near freezing temperatures are considered extreme cold. Pipes may freeze and burst in homes that are poorly insulated or without heat. In the north, extreme cold means temperatures well below zero. Winter residents in the City of Milwaukee 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, watches.

Historical Extreme Temperature Problems

Historically, most of the all-time maximum daily temperatures in Wisconsin were recorded during the Dust Bowl years between 1934 and 1936. The City of Milwaukee reached a record high temperature of 105°F on July 24, 1934. The highest temperature ever recorded in Wisconsin was 114°F, which occurred on July 13, 1936, at the Wisconsin Dells. In the City of Milwaukee, beginning on July 12, 1995, the National Weather Service issued a heat advisory, the next day that advisory was upgraded to an excessive heat warning. Temperatures reached 104°F and the heat index peaked at 125°F. This was the very first time that the National Weather Service in Sullivan, Wisconsin, had issued a heat advisory and an excessive heat warning. There was a period of high temperatures in 1988, but that was a dry heat and the outcome was much different. This heat wave was unusual because high temperatures were combined with high humidity, resulting in a heat index, which peaked at 125°F. The "summer of 1995" severe heat wave affected most of Wisconsin and resulted in 154 fatalities, 82 direct and 72 indirect. In addition, approximately 400 people received medical treatment due to heat-related causes. Many of these deaths occurred in urbanized areas in southeastern Wisconsin, particularly in the City of Milwaukee. The 1995 summer heat wave holds the

Table 3.19
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

record as the number one weather-related killer in Wisconsin since it became a state in 1848. The July 1995 heat wave was a highly rare and, in some respects, unprecedented event in terms of both unusually high maximum and minimum temperatures and the accompanying high relative humidity.

On December 9, 1995, bitter-cold arctic air swept into Wisconsin on northwest winds of 20 to 40 mph. Temperatures dropped as much as 15°F in 15 minutes as the strong front moved through. Wind chill values ranged from -25°F to -50°F. In the City of Milwaukee, two people died directly from hypothermia, while hypothermia was a secondary cause indirectly related for one death in Dane County and one death in Kenosha County. Twelve cases of frostbite were also reported in the City of Milwaukee. An episode of extreme cold, which started in late January 1996, continued through the first four days of February across south-central and southeastern Wisconsin. Wind chills were in the -35°F to -60°F range many times during this event that resulted in four cold-weather hypothermia deaths. In addition, there were 15 reported cases of sustained frostbite in the City of Milwaukee and a low temperature of -23°F was recorded on February 3, 1996, in the City of Milwaukee.

Description of Recent Extreme Temperature Events

Extreme temperatures that affect the City of Milwaukee are not localized events, as they usually encompass the entire south-central and southeastern portions of the State and may continue for several days or weeks. Table 3.20 lists the extreme and record high and low temperature events in southeastern Wisconsin from 1994 through 2016, which have directly resulted in 125 fatalities and 246 injuries. Extreme heat was attributed as the cause of 104 reported fatalities and 220 reported injuries and extreme cold was attributed as the cause of 11 fatalities and 26 injuries.

Extreme Heat

In the spring and summer of 2002, several brief one day heat waves were recorded with heat indices over 100°F and as high as 110°F. Two deaths were directly related to these events. In the summer of 2001, three rounds of excessive heat in July and August affected most of southeastern Wisconsin. Heat index temperatures reached 110°F, six people died, and numerous people suffered from heat-related sicknesses in the City of Milwaukee.

Table 3.20
Extreme Temperature Events in the Region: 1994 To 2016

Beginning Date	Ending Date	Type	Fatalities	Injuries	Property Damages (dollars)
January 13, 1994	January 20, 1994	Extreme cold	0	0	--
June 14, 1994	June 23, 1994	Heat Wave	0	0	--
July 13, 1995	July 15, 1995	Excessive heat	85	0	--
October 12, 1995	October 12, 1995	Record warmth	0	0	--
November 7, 1995	November 7, 1995	Extreme cold	1	0	--
December 9, 1995	December 9, 1995	Extreme cold	2	0	--
January 30, 1996	January 30, 1996	Cold and wind chill	0	0	--
January 31, 1996	January 31, 1996	Cold and wind chill	0	7	--
February 1, 1996	February 4, 1996	Cold and wind chill	4	15	--
June 29, 1996	June 29, 1996	Heat	0	70	--
January 17, 1997	January 17, 1997	Cold and wind chill	0	3	--
July 16, 1997	July 16, 1997	Heat	1	0	--
October 3, 1997	October 8, 1997	Heat	0	0	--
October 12, 1997	October 12, 1997	Heat	0	0	--
November 30, 1997	November 30, 1997	Cold and wind chill	1	0	--
January 2, 1998	January 4, 1998	Heat	0	0	--
March 26, 1998	March 26, 1998	Heat	0	0	--
June 25, 1998	June 25, 1998	Heat	0	21	--
September 27, 1998	September 28, 1998	Heat	0	0	--
November 28, 1998	November 30, 1998	Heat	0	0	--
December 1, 1998	December 6, 1998	Heat	0	0	--
January 5, 1999	January 5, 1999	Cold and wind chill	0	0	--
February 11, 1999	February 11, 1999	Heat	0	0	--
July 4, 1999	July 5, 1999	Heat	0	0	--
July 23, 1999	July 24, 1999	Heat	0	0	--
July 29, 1999	July 31, 1999	Heat	4	0	--
January 2, 2000	January 2, 2000	Excessive heat	0	0	--
February 23, 2000	February 29, 2000	Excessive heat	0	0	--
March 4, 2000	March 8, 2000	Excessive heat	0	0	--
May 6, 2000	May 6, 2000	Excessive heat	0	0	--
July 21, 2001	July 22, 2001	Heat	2	0	--
August 6, 2001	August 9, 2001	Heat	2	0	--
April 15, 2002	April 18, 2002	Heat	1	0	--
June 20, 2002	June 20, 2002	Heat	1	0	--
June 22, 2002	June 25, 2002	Heat	1	0	--
June 30, 2002	June 30, 2002	Heat	0	0	--
July 1, 2002	July 3, 2002	Heat	0	0	--
July 8, 2002	July 8, 2002	Heat	0	0	--
July 21, 2002	July 21, 2002	Heat	0	0	--
July 26, 2002	July 26, 2002	Heat	0	0	--
July 24, 2005	July 24, 2005	Heat	0	0	--
December 18, 2005	December 19, 2005	Cold and wind chill	0	0	--
February 17, 2006	February 18, 2006	Cold and wind chill	0	0	--
February 18, 2006	February 19, 2006	Cold and wind chill	0	0	--
July 16, 2006	July 17, 2006	Heat	0	0	--
July 30, 2006	July 31, 2006	Heat	0	40	--
August 1, 2006	August 2, 2006	Heat	2	0	--
December 7, 2006	December 7, 2006	Cold and wind chill	1	0	--
February 3, 2007	February 6, 2007	Cold and wind chill	0	0	23,150
January 19, 2008	January 20, 2008	Cold and wind chill	1	0	--
January 30, 2008	January 30, 2008	Cold and wind chill	0	0	--
February 10, 2008	February 10, 2008	Extreme cold and wind chill	0	0	--

Table continued on next page.

Table 3.20 (Continued)

Beginning Date	Ending Date	Type	Fatalities	Injuries	Property Damages (dollars)
December 15, 2008	December 15, 2008	Cold and wind chill	0	0	--
December 21, 2008	December 22, 2008	Cold and wind chill	0	1	--
January 14, 2009	January 16, 2009	Cold and wind chill	0	0	--
January 21, 2011	January 21, 2011	Cold and wind chill	0	0	--
July 20, 2011	July 21, 2011	Heat	0	60	--
June 18, 2012	June 20, 2012	Heat	2	0	--
June 28, 2012	June 28, 2012	Heat	0	0	--
July 3, 2012	July 6, 2012	Excessive heat	2	0	--
July 16, 2012	July 17, 2012	Heat	0	0	--
July 23, 2012	July 23, 2012	Heat	0	0	--
July 25, 2012	July 25, 2012	Heat	0	0	--
January 21, 2013	January 22, 2013	Cold and wind chill	0	0	--
July 16, 2013	July 19, 2013	Excessive heat	0	0	--
August 30, 2013	August 30, 2013	Heat	0	0	--
January 3, 2014	January 3, 2014	Cold and wind chill	1	0	--
January 6, 2014	January 7, 2014	Extreme cold and wind chill	0	0	--
January 27, 2014	January 29, 2014	Cold and wind chill	1	0	--
February 5, 2014	February 5, 2014	Cold and wind chill	1	0	--
March 16, 2014	March 16, 2014	Cold and wind chill	1	0	--
December 3, 2014	December 3, 2014	Cold and wind chill	1	0	--
December 5, 2014	December 5, 2014	Cold and wind chill	1	0	--
January 1, 2015	January 1, 2015	Cold and wind chill	1	0	--
January 7, 2015	January 8, 2015	Cold and wind chill	0	0	--
January 9, 2015	January 10, 2015	Cold and wind chill	0	0	--
January 8, 2016	January 8, 2016	Cold and wind chill	1	0	--
January 17, 2016	January 17, 2016	Cold and wind chill	1	0	--
July 21, 2016	July 24, 2016	Heat	0	29	--
January 27, 2016	January 27, 2016	Heat	1	0	--
December 10, 2016	December 10, 2016	Cold and wind chill	1	0	--
December 14, 2016	December 15, 2016	Cold and wind chill	0	0	--
December 18, 2016	December 19, 2016	Cold and wind chill	1	0	--
		Total	125	246	23,150

Source: Milwaukee County Pre-Disaster Mitigation Plan, National Weather Service, and the National Climatic Data Center

During the last two weeks of July 1999, an oppressive heat wave enveloped the City of Milwaukee, peaking during the four days of July 28 through 31, 1999. Throughout these four days, high humidity and temperatures in the 90s and 100s produced heat index values from 110°F to as high as 125°F. The heat wave was directly and indirectly responsible for 20 deaths in Wisconsin, eight in the City of Milwaukee. During this time, there was record peak daily electric power demand in the Milwaukee area, and during that summer, there was a record set for the Midwest region for electrical demand.

A period of very hot and humid weather began on the evening of July 30, 2006 and continued into August 2, 2006. Overnight temperatures fell to only 70 to 75°F on July 30 and soared into the 95 to 100 degree range during the afternoon of July 31. With dew points in the low to mid 70s, heat index values dropped to about 75 degrees overnight on July 30 and peaked in the 105 to 110 degree range across south-central and southeastern Wisconsin during the afternoon of July 31. Temperatures and heat index values remained high until the passage of a cold front on the afternoon of August 2 ended the heat wave. This heat wave resulted in two heat-related deaths in Milwaukee County. In addition, an estimated 40 people in Milwaukee County were hospitalized due to heat-related symptoms.

A dome of hot and humid air over the southern and central Plains affected Wisconsin during the period of July 17, 2011 through July 21, 2011. Temperatures in the 90s accompanied by dewpoints in the 70s generated heat index values between 100°F to 110°F. Based on news reports, it is estimated that 60 people in Milwaukee sought treatment for heat-related problems. In addition, hundreds of others called a social

service agency seeking free air-conditioners. Milwaukee-area organizers and health officials took steps to address the safety of fair and festival-goers prior to and during this long-duration excessive heat event.

Beginning on June 16, 2012, gusty southwest winds brought a hot air-mass into southern Wisconsin that persisted until the afternoon of June 20. During this period, maximum daytime air temperatures reached the lower to middle 90s, resulting in heat index values of 95°F to 96°F. Heat index values during the evening and night remained in the 75°F to 80°F range. This heat wave resulted in two deaths from hyperthermia in the City of Milwaukee. The first was a 66-year-old woman found in her home's backyard. The second was a 60-year-old man found in his home.

Most heat-related deaths occur in cities. Large urban areas become "heat islands." Brick buildings, asphalt streets, and tar roofs store heat and radiate it 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 a 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 put some urban populations at greater risk. The elderly, disabled, and debilitated are especially susceptible to heat-related illness and death. During the 1995 nationwide heat wave, 67 percent of the fatalities occurred in the 60-year-old to 89year-old age group (see Table 3.21).

Extreme Cold

An arctic high-pressure ridge, fresh, deep snow cover, clear skies, and light winds allowed temperatures to plunge on January 5, 1999, to well below zero across south-central and southeastern Wisconsin. Several new low temperature records were set, -23°F at Janesville (Rock County) and -20°F in the City of Kenosha.

In the wake of a major winter storm on December 1, 2006, cold weather settled over southern Wisconsin, with daily temperature averages well below normal. December 7 was an unseasonably cold day in Milwaukee, with a high temperature of 17°F and a low temperature of 8°F. One death was attributed to this cold snap.

A cold weather event resulted in the death of a 64-year-old woman from hypothermia on December 3, 2014, in the City. The woman was homeless, and had been living in her vehicle at the time of her death. Temperatures were in the 20s in the early morning hours of this event, and were in the lower 30s when the woman was found.

Cold weather resulted in the death of a 58-year-old homeless man from hypothermia on January 1, 2015. The man was found deceased in an alcove near a liquor store, and the Milwaukee County Medical Examiner's office determined that intoxication significantly impacted his death. Temperatures ranged between 15°F and 30°F degrees throughout the day.

Vulnerability and Community Impact Assessment

Temperature extremes are primarily a public health concern. The poor and elderly are much more susceptible to temperature-related deaths and injury. Education, improved social awareness, and community outreach programs have likely helped to reduce the number of individuals killed or injured by extreme temperature events. Those at greatest risk are the very young, the very old, and the sick. Most deaths during a heat wave are the result of heat stroke. Large and highly urbanized cities can create an island of heat that can raise the area temperature 3°F to 5°F. Urban communities with substantial populations of elderly, disabled, and debilitated people could face a significant medical emergency during an extended period of excessive heat. Some residents in high crime areas, especially the elderly, may be afraid to open windows or travel to cooling shelters. As neighborhoods change, some older residents become isolated because of cultural, ethnic, and language differences.

In 2014, the Wisconsin Department of Health Services; Building Resilience Against Climate Effects (BRACE) program conducted a geo-spatial analysis of heat-related vulnerability in Milwaukee County.[75] This analysis used existing data related to population density, such as the number of people per square mile; health

[75] *Wisconsin Department of Health Services,* Milwaukee Heat Vulnerability Index, *P-00882A, October 2014.*

Table 3.21
1995 Nationwide Heat-Related Fatalities by Age and Gender

Age Group	Female	Male	Total	Percent of Total
0 to 9 Years Old	6	6	12	1
10 to 19 Years Old	0	2	2	<1
20 to 29 Years Old	2	3	5	<1
30 to 39 Years Old	7	27	34	3
40 to 49 Years Old	15	64	79	8
50 to 59 Years Old	22	73	95	9
60 to 69 Years Old	50	129	179	18
70 to 79 Years Old	131	122	253	25
80 to 89 Years Old	145	96	241	24
90 Years Old and Older	51	10	61	6
Unknown	6	54	60	6
Total	425	586	1,021	100
Percent	43	57	100	--

Source: National Weather Service

factors, such as the percentage of the population that visited a hospital emergency department for heat stress; demographic and socioeconomic factors, such as the percentages of young children or people over 85 years of age and the percentage of households in poverty; and natural and built environment factors, such as surface air temperature during a heat wave, land cover, and air quality; to create a heat vulnerability index (HVI) to identify areas of greatest risk for negative health impacts due to extreme heat. The HVI was calculated for each census block in the County. Based on the HVI, 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 HVI indicate relative levels of risk and do not indicate absolute risks.

Map 3.3 shows the HVI for census blocks in Milwaukee County. The largest areas of high and moderate high HVI values identified on the map are in the central portion of the City of Milwaukee. Areas of lower HVI values within the City occur along the Lake Michigan shoreline and in the southeastern portion of the City. It is important to note that major areas identified as having high and moderate high HVI values correspond to areas within the City that have concentrations of people living in poverty.[76]

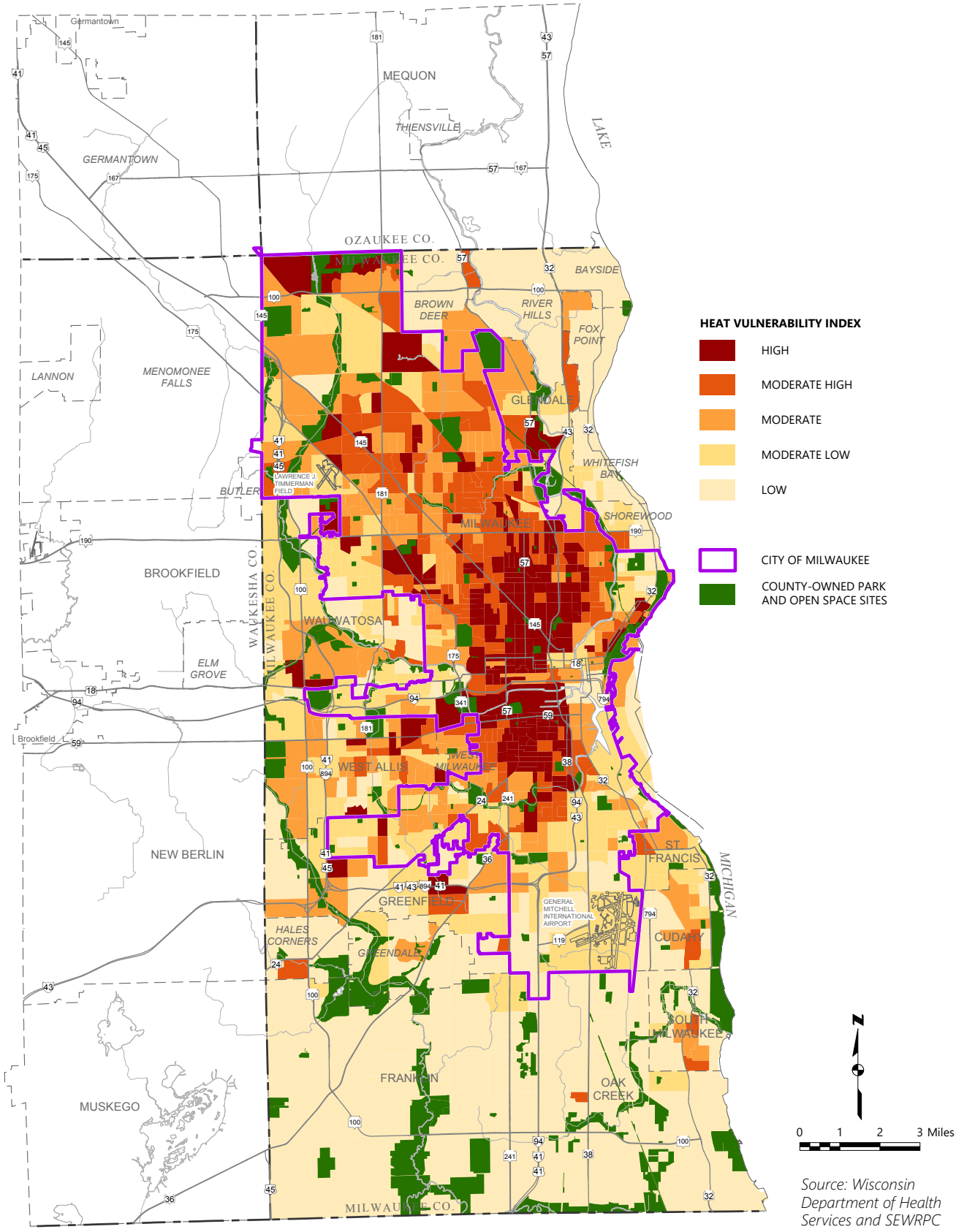
Extreme heat can lead to high demands for electricity related to operation of air conditioners and fans. This can result in blackouts and brownouts. Loss of water pressure can result from the opening of fire hydrants in urban areas. Stagnant atmospheric conditions that occur with heat waves are also favorable for trapping ozone and other pollutants in urban areas. Pets can suffer from prolonged exposure to excessive heat.

People who are homeless constitute one of the most vulnerable groups of people with regards to the hazardous impacts of cold weather. Non-profit organizations and religious institutions often provide temporary shelter for homeless people. When locations such as these are filled to capacity or are unavailable, homeless people often seek shelter in places not intended for human habitation, such as vehicles, city streets, and bridge underpasses. During winter months, these types of locations provide little to no protection from the hazardous conditions of intense, cold weather. In periods of extreme low temperatures, lodging in inadequately heated or uninsulated places can put occupants at high risk of experiencing serious health problems related to extended exposure to cold weather, such as hypothermia, frostbite, loss of fingers and toes, permanent damage to internal organs, and death.

The Milwaukee Continuum of Care conducted a Point-in-Time (PIT) count of homeless people in Milwaukee County on January 25, 2017. This survey counted 900 homeless people. Of these people, 765, or 85 percent, were being served by homeless shelters at the time they were counted. The remaining 135 people, or 15 percent, were not being served by shelters. Of the 900 total people counted, 98 people, or 11 percent of the total, were considered to be chronically homeless.

[76] *This can be shown by comparing Map 3.3 to Maps H.15 and H.25 in SEWRPC Planning Report No. 55,* VISION 2050: A Regional Land Use and Transportation Plan for Southeastern Wisconsin, *July 2017.*

Map 3.3
Milwaukee County Heat Vunerability Index: 2014



Source: Wisconsin Department of Health Services and SEWRPC

Although PIT counts provide valuable information regarding homelessness, the data from the counts do not report the absolute state of homelessness in surveyed communities. Numbers from PIT counts are considered underestimates because it is unlikely that all people experiencing homelessness in a certain area will be counted. While the counts are conducted at a time when homeless people are expected to enter shelters to escape cold weather conditions, not all homeless people enter shelters. Some homeless individuals and families seek habitation elsewhere. In particular, homeless youth can be under-represented in counts because shelters in many communities have a limited number of beds dedicated to young people. In addition, young people who are homeless tend to not reside in places that are inhabited by homeless adults. PIT counts also fail to include homeless people who are hospitalized or are incarcerated at the time of counting. Finally, people who are homeless are not always identifiable as homeless by sight, causing some people to be overlooked in the count process.

A review of the community assets described in Chapter 2 indicates the potential for extreme temperature hazard events to impact: 1) residents, especially the poor, elderly, and sick; 2) pets; 3) municipal water and electric utilities; and 4) natural surface and groundwater reserves. In addition, the Milwaukee County Pre-Disaster Mitigation Plan also found that extreme temperature hazards pose a risk to the population within Milwaukee County.[77] No specific cost data are estimated for temperature extreme events, because the nature of such events does not readily permit direct cost analysis.

Potential Future Changes in Extreme Temperature Conditions

Based upon historical data, the City of Milwaukee can expect to experience an average of 3.6 extreme temperature events per year. On average, there are 1.6 extreme cold events and 2.0 extreme heat events per year. It should be noted that the historical record shows considerable variation among years in the number of events that occurred. While it would be expected that in some years the City will experience fewer events or more events than the average number, the average annual number of events is not expected to change.

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 the City of Milwaukee are projected to increase by 6.0 to 5.5°F by year 2055. The number of days per year in which temperatures in southern Wisconsin exceed 90°F is expected to double from about 12 to about 25 by 2055. 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. Heat waves have direct impacts on human health, especially among sensitive populations such as young children and the elderly. In the absence of mitigative measures, the projected increase in the frequency, duration, and severity of heat waves will be likely to cause increases in fatalities and illnesses related to extreme heat.

By contrast, the frequency of extreme cold events may decrease by the middle of the century. The projected warming trends are expected to be greatest during the winter. Average winter temperatures in the City of Milwaukee are projected to increase by about 7.5°F. This may result in a reduction of some risks associated with extreme cold.

3.7 VULNERABILITY ASSESSMENT FOR LAKE MICHIGAN COASTAL HAZARDS

The Lake Michigan coast lying within the jurisdiction of the City of Milwaukee consists of about eight miles of shoreline. The land uses along the shoreline are documented in Chapter 2.

There are three types of Lake Michigan coastal hazards which potentially affect the City of Milwaukee, including:

- Erosion of coastal bluffs, beaches, and nearshore lakebeds
- Flooding from high lake levels and storm-induced surge (temporary water level changes)
- Damage to shoreline structures, such as residences, businesses, and public facilities, from storm waves, including wave runup

[77] *Milwaukee County Office of Emergency Management,* op. cit.

The focus of the vulnerability assessment is on the first type of hazard noted above, erosion of bluffs, beaches, and nearshore areas as that phenomenon is a documented hazard in Milwaukee County where bluff recession rates exceeding 12 feet per year have been reported.[78] However, there is only a short length of shoreline between Edgewood Avenue and the north end of the Linnwood Avenue water treatment plant where potential shoreline erosion is an issue. In this reach, the bluffs are considered moderately stable and the rate of erosion is less than one foot per year. The second hazard, flooding from high lake levels, is being considered, along with flooding in other areas of the City. With regard to the third hazard, storm wave damage, there are hazards in the County primarily in the City of Milwaukee in areas protected by sheet piling, breakwaters, and revetments. However, the design of these shore protection structures, most notably those protecting the City sewage treatment and water plants, and the marina facilities, have been designed using standards suitable for major public and private facilities. In addition, the structures are maintained as needed. Given these conditions, Lake Michigan coastal erosion is considered to be a relatively minor hazard in the City of Milwaukee even though there are areas within Milwaukee County where this hazard is more severe.

Coastal erosion can be influenced by a number of natural factors, including the orientation of the shoreline, currents, freeze-thaw cycles, and water levels in Lake Michigan. Water levels in the Lake and changes in these levels can also have a strong influence.

Water levels in Lake Michigan vary on a number of different time scales. Short-term variations result from the impacts of tides, wind, and barometric pressure. Tides are changes in water levels caused by the gravity of sun and moon. These occur twice daily on Lake Michigan. According to the National Oceanic and Atmospheric Administration, the largest tides on the Great Lakes are less than two inches in height. These variations are generally masked by fluctuations in water levels produced by other causes.

Annual variations occur with the changing seasons. Annual high water levels on Lake Michigan usually occur during the summer and low water levels usually occur during the winter. In the 30-year period between 1988 and 2017, the average difference between the summer high water levels and winter low water levels has been about one foot.[79] During the same period this difference has varied between about 0.4 and 2.2 feet. Long-term variations depend on climatic factors such as precipitation, the presence or absence of ice cover on the Lake during the winter, and evapotranspiration.

Historical Coastal Hazard Conditions

Coastal hazard problems have been most evident in the City of Milwaukee during high water periods. These have occurred in recent history on Lake Michigan in the early 1950s, the early 1970s, and the mid-1980s, with record high levels occurring in 1986, surpassing the previous record high level set in 1886. As of December 2017, Lake Michigan water levels were high. Between January 2013 and August 2017, monthly average water levels in the Lake rose over 4.5 feet. They have decreased by about 0.7 foot since then; however, this decrease most likely reflects normal seasonal variation. As of December 2017, Lake Michigan water levels were about 1.2 feet above the mean for the period 1918-2017.

Low water levels on Lake Michigan can also cause problems with shore protection structures, such as rotting of timber pilings, which are normally under water, being exposed to air, as well as significantly affecting shipping and boating and marina activity. As recently as 2011, lake levels were approximately 2.1 feet below the historical mean for the period 1918-2017, but approximately two-thirds of a foot above the historic record low levels set in 1964 and 1965. Lake Michigan low-water-level problems were discussed as an important topic during a March 2002 workshop.[80]

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[78] *SEWRPC Community Assistance Planning Report No. 163,* A Lake Michigan Coastal Erosion Management Study for Milwaukee County, Wisconsin*, October 1989; and SEWRPC Technical Report No. 36,* Lake Michigan Shoreline Recession and Bluff Stability in Southeastern Wisconsin: 1995*, December 1997*.

[79] *This is calculated from average monthly water levels obtained from the National Oceanic and Atmospheric Administration's Great Lakes Environmental Research Laboratory.*

[80] *University of Wisconsin-Sea Grant Institute and Bay Lake Regional Planning Commission,* Living with the Lakes Workshop*, at University of Wisconsin-Green Bay, March 22, 2002*.

A 1989 Lake Michigan coastal erosion management study, prepared for Milwaukee County with assistance from the Wisconsin Coastal Management Program, identified the extent of that erosion at 638 locations along the shoreline. The study identified erosion rates of less than one foot per year over the period 1963 to 1985.[81]

Description of Recent Coastal Hazard Conditions

As described in Chapter 2, a 1997 study was prepared by SEWRPC and others in cooperation with the Wisconsin Coastal Management Program to evaluate shoreline erosion and bluff stability conditions along the Lake Michigan shoreline in southeastern Wisconsin, including the City of Milwaukee.[82] That study found relatively stable bluff erosion rates of less than one foot per year over the period 1975 to 1995 in the area of concern in the City of Milwaukee. No building or infrastructure damage has been reported in association with bluff erosion.

In March 1987, 55 to 60 mile per hour northeast winds created 10-foot high waves that pounded the Lake Michigan shoreline. Significant shoreline and bluff erosion was reported all along the shore. Waves crashed over Lincoln Memorial Drive, leaving up to one foot of water standing in the road in some places. The MMSD Jones Island sewage treatment plant was closed due to flooding in tunnels below the plant.[83]

During a large rainfall event, a portion of a bluff along the Lake Michigan shoreline collapsed after soils became saturated with water.

Numerous improvements were made to the City of Milwaukee's lakefront as part of the creation of Lakeshore State Park and integration with Pier Wisconsin, Discovery World, and the Quadracci Pavilion 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 the island 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.[84]

Vulnerability and Community Impacts Assessment

A review of the Lake Michigan lakeshore erosion conditions within the City of Milwaukee indicates that there is a very limited potential community impact as a result of the potential loss of land improvements and infrastructure in selected areas due to lakeshore erosion. With proper surveillance, the need to prepare for major evacuations and other emergency actions are not a significant concern given the isolated nature and the limited severity of the problems. 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.[85]

Potential Future Changes in Coastal Hazard 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. Because of the current zoning procedures which are in place, this situation has not occurred.

As discussed in the sections above, Lake Michigan water levels have risen more than four feet since January 2013. 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, which are currently

[81] *SEWRPC Community Assistance Planning Report No. 163,* op. cit.

[82] *SEWRPC Technical Report No. 36,* op. cit.

[83] *Milwaukee Journal, "Storm Pounds Lakeshore," March 9, 1987.*

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

[85] *Milwaukee County Office of Emergency Management,* op. cit.

higher than average, are expected to fluctuate. Potential future fluctuations in Lake Michigan water levels could lead to erosion, 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. These fluctuations could also damage shoreline protection structures, especially where they are not adequately maintained or designed 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.[86] In addition, wind patterns over Lake Michigan have shifted. Prevailing winds during summer months shifted from coming from the southwest during the 1980s to coming from the east after 1990.[87] These climatic changes are expected to influence Lake levels, coastal erosion, flooding, and shoreline stability, sometimes in complex ways.

For example, Lake Michigan is likely to be impacted by trends that act both to increase and to decrease water levels. Increased precipitation[88] 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 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 is expected that the increases in evaporation will eventually be greater than the increases in precipitation. As a result, average water levels in Lake Michigan are expected to decrease by about 0.8 to 1.4 feet by the end of the 21st century. It should be noted that water levels in the Lake vary widely about their average, with high-water and low-water decades occurring. This variability is expected to continue. By the end of the century it is expected that highest and lowest water levels will be slightly lower than they have been over the past 100 years.

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, 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 are likely to lead to greater offshore wave development. This will 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 will 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

[86] *Desai, Austin, Bennington, and McKinnley, 2009,* op.cit.

[87] *James T. Waples and J. Val Klump, "Biophysical Effects of a Decadal Shift in Summer Wind Direction over the Laurentian Great Lakes,"* Geophysical Research Letters*, Volume 29, pages 43-1 through 43-4, 2009.*

[88] *Wisconsin Initiative on Climate Change Impacts, 2011,* op. cit. *The WICCI report indicates there is a 75 percent probability that average annual precipitation will increase under mid-century climate change conditions.*

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 slope failure.

3.8 VULNERABILITY ASSESSMENT FOR WINTER STORMS

Winter storms can vary in size and strength and include heavy snow storms, 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 harm, 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 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, between one and three inches per occurrence. Heavy snowfalls that produce at least eight to 10 inches of widespread accumulation occur, on average, only once per winter season across southern Wisconsin. In addition, a snowfall event of six to eight inches usually occurs once per winter. 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 the City of Milwaukee average 47.5 inches per season.

Historic Winter Storm Problems

True blizzards are not common in Wisconsin. However, when they do occur, they tend to affect the eastern counties near Lake Michigan. Due to less frictional drag over Lake Michigan, northwest wind storms can 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. Heavy snow and ice storms have been a part of nearly every winter in the City of Milwaukee history (see Milwaukee County Pre-Disaster Mitigation Plan).[89] As listed in Table 3.22, there have been 148 major winter storm events reported since January 1993. All of these storms contained some form of snow, sleet, freezing rain, or slippery road conditions. A heavy snowstorm may cause schools and businesses to close, delay or cancel airline flights, and create treacherous roadway travel conditions.

In March 1976 a disastrous ice storm occurred in the southern portion of the State. This storm was of such magnitude and caused such a significant amount of damage that a Presidential Disaster Declaration was obtained. This storm affected 22 counties, resulted in extensive power outages and caused over $50 million in damage. Near-blizzard conditions occurred in January 1979 when record snowfalls were recorded in many areas of the State and winds gusted to over 30 mph. Many people were isolated from assistance

[89] *Milwaukee County Office of Emergency Management,* op. cit.

Table 3.22
Winter Storm and Ice Storm Events in the City of Milwaukee: 1924-2016

Beginning Date	Ending Date	Affected Area	Event	Reported Damages		
				Fatalities	Injuries	Property Damages (dollars)[a]
February 1924	--	Milwaukee County	Blizzard	3	--	--
January 1947	--	Milwaukee County	Blizzard	0	--	--
April 1973	--	Milwaukee County	Blizzard	0	--	--
March 1976	--	Milwaukee County	Ice storm[b]	0	--	--
December 1978	January 1979	Milwaukee County	Snow emergency[b]	0	--	--
December 1987	--	City of Milwaukee	Blizzard	10	0	--
January 13, 1993	January 14, 1993	Statewide	Heavy snow	0	0	--
November 8, 1993	--	Milwaukee County	Heavy snow	0	0	--
November 28, 1993	--	City of Milwaukee	Heavy Snow	0	0	--
January 5, 1994	January 6, 1994	Central and southern Wisconsin	Heavy snow	0	0	--
January 26, 1994	January 28, 1994	All but far northwest Wisconsin	Heavy snow/Ice storm	0	0	--
February 7, 1994	February 9, 1994	Southern and eastern Wisconsin	Heavy snow	0	0	--
February 12, 1994	--	Southeast Wisconsin	Heavy snow	0	0	--
February 22, 1994	February 23, 1994	Southern Wisconsin	Heavy snow	0	0	--
February 25, 1994	--	Southern Wisconsin	Heavy snow	0	0	--
December 5, 1994	December 7, 1994	Southern Wisconsin	Heavy snow	0	0	--
January 19, 1995	January 20, 1995	Southeast Wisconsin	Heavy snow	0	0	--
November 26, 1995	November 27, 1995	Central and southern Wisconsin	Heavy snow	0	1	--
December 13, 1995	December 14, 1995	Southern Wisconsin	Glaze	0	0	--
January 5, 1996	January 6, 1996	Southeast Wisconsin	Heavy snow	0	0	--
January 16, 1996	January 16, 1996	Southeast and south-central Wisconsin	Winter weather	0	0	--
January 23, 1996	January 23, 1996	Southeast and south-central Wisconsin	Winter weather	0	0	--
January 29, 1996	January 29, 1996	Southeast and south-central Wisconsin	Blizzard	0	0	--
January 16, 1997	January 16, 1997	Southeast and south-central Wisconsin	Blizzard	0	0	--
January 8, 1998	January 9, 1998	Eastern Wisconsin	Winter storm	0	0	--
January 2, 1999	January 2, 1999	Southeast and south-central Wisconsin	Blizzard	0	5	2,881
March 9, 1999	March 9, 1999	Southeast and south-central Wisconsin	Winter storm	0	0	--
April 7, 2000	April 7, 2000	Southeast and south-central Wisconsin	Winter storm	0	0	--
December 11, 2000	December 12, 2000	Southeast Wisconsin	Heavy snow	0	0	--
December 18, 2000	December 19, 2000	Southeast and south-central Wisconsin	Heavy Snow	0	0	--
December 2000	January 2001	Milwaukee County	Snow emergency[b]	0	0	--
March 2, 2002	March 2, 2002	South-central and southeast Wisconsin	Heavy snow	0	0	--
February 3, 2003	February 3, 2003	Southeast and south-central Wisconsin	Winter weather	0	0	--
February 11, 2003	February 11, 2003	Southeast and south-central Wisconsin	Winter storm	0	0	--
March 4, 2003	March 5, 2003	Southeast Wisconsin	Heavy snow	0	0	--
April 4, 2003	April 4, 2003	Milwaukee County	Winter weather	0	0	--
April 7, 2003	April 7, 2003	Southern Wisconsin	Winter weather	0	0	--
January 4, 2004	January 5, 2004	Southeast and south-central Wisconsin	Winter weather	0	0	--
January 16, 2004	January 17, 2004	Southeast and south-central Wisconsin	Winter weather	0	0	--

Table continued on next page.

Table 3.22 (Continued)

Beginning Date	Ending Date	Affected Area	Event	Reported Damages		
				Fatalities	Injuries	Property Damages (dollars)[a]
January 26, 2004	January 27, 2004	Southeast Wisconsin	Heavy snow	0	0	--
February 8, 2004	February 9, 2004	Southeast and south-central Wisconsin	Winter weather	0	0	--
December 18, 2004	December 18, 2004	Milwaukee County	Winter weather	0	0	--
January 1, 2005	January 1, 2005	Southeast and south-central Wisconsin	Winter weather	0	0	--
January 6, 2005	January 6, 2005	Southeast and south-central Wisconsin	Winter storm	0	0	--
January 22, 2005	January 23, 2005	Milwaukee County	Winter storm	0	0	--
January 27, 2005	January 27, 2005	Milwaukee County	Heavy snow	0	0	--
February 16, 2006	February 16, 2006	Southeast and south-central Wisconsin	Winter storm	0	0	--
November 10, 2006	November 10, 2006	Southeast and south-central Wisconsin	Winter weather	0	0	--
December 1, 2006	December 1, 2006	Milwaukee County	Blizzard	0	0	--
January 12, 2007	January 12, 2007	Southeast and south-central Wisconsin	Winter weather	0	0	--
January 14, 2007	January 15, 2007	Southeast and south-central Wisconsin	Winter weather	0	0	--
January 21, 2007	January 21, 2007	Southeast and south-central Wisconsin	Winter weather	0	0	--
February 13, 2007	February 14, 2007	Milwaukee County	Winter weather	0	0	--
February 23, 2007	February 24, 2007	Southeast and south-central Wisconsin	Winter storm	0	0	--
February 24, 2007	February 25, 2007	Milwaukee County	Blizzard	0	0	86,813
February 25, 2007	February 25, 2007	Milwaukee County	Winter storm	0	0	--
March 2, 2007	March 2, 2007	Southeast and south-central Wisconsin	Winter weather	0	0	--
April 11, 2007	April 11, 2007	Southeast and south-central Wisconsin	Winter storm	0	0	11,575
November 21, 2007	November 21, 2007	Southeast and south-central Wisconsin	Winter weather	0	0	--
December 1, 2007	December 2, 2007	Southeast and south-central Wisconsin	Winter storm	0	0	--
December 11, 2007	December 11, 2007	Southeast and south-central Wisconsin	Ice storm	0	0	--
December 15, 2007	December 16, 2007	Southeast Wisconsin	Winter weather	0	0	--
December 28, 2007	December 28, 2007	Southeast and south-central Wisconsin	Winter weather	0	0	--
January 21, 2008	January 22, 2008	Southeast Wisconsin	Heavy snow	0	0	--
January 29, 2008	January 30, 2008	Southeast and south-central Wisconsin	Winter storm	0	0	--
January 31, 2008	January 31, 2008	Southeast Wisconsin	Winter storm	0	0	--
February 5, 2008	February 6, 2008	Southern Wisconsin	Winter storm[b]	0	0	--
February 9, 2008	February 10, 2008	Southeast and south-central Wisconsin	Winter weather	0	0	--
February 11, 2008	February 12, 2008	Southeast and south-central Wisconsin	Winter weather	0	0	--
February 17, 2008	February 17, 2008	Southeast Wisconsin	Winter weather	0	0	--
March 21, 2008	March 22, 2008	Southeast and south-central Wisconsin	Winter storm	0	0	--
November 24, 2008	November 24, 2008	Southeast and south-central Wisconsin	Winter weather	0	0	--
November 30, 2008	November 30, 2008	Southeast and south-central Wisconsin	Winter storm	0	0	--
December 1, 2008	December 1, 2008	Southeast and south-central Wisconsin	Winter storm	1	0	--
December 3, 2008	December 3, 2008	Southeast and south-central Wisconsin	Winter weather	0	0	--
December 16, 2008	December 17, 2008	Southeast and south-central Wisconsin	Winter weather	0	0	--
December 18, 2008	December 19, 2008	Southeast and south-central Wisconsin	Winter storm	0	0	--
December 21, 2008	December 21, 2008	Southeast and south-central Wisconsin	Winter storm	1	0	--
December 23, 2008	December 23, 2008	Southeast and south-central Wisconsin	Winter weather	0	0	--

Table continued on next page.

Table 3.22 (Continued)

Beginning Date	Ending Date	Affected Area	Event	Reported Damages		
				Fatalities	Injuries	Property Damages (dollars)[a]
December 24, 2008	December 24, 2008	Southeast and south-central Wisconsin	Winter weather	0	0	--
December 25, 2008	December 26, 2008	Southeast and south-central Wisconsin	Winter weather	0	0	--
January 3, 2009	January 4, 2009	Southeast and south-central Wisconsin	Winter weather	0	0	--
January 9, 2009	January 9, 2009	Southeast and south-central Wisconsin	Winter weather	0	0	--
January 12, 2009	January 13, 2009	Southeast and south-central Wisconsin	Winter weather	0	0	--
January 13, 2009	January 14, 2009	Southeast and south-central Wisconsin	Winter weather	0	0	--
February 21, 2009	February 21, 2009	Southeast and south-central Wisconsin	Winter storm	0	0	--
February 26, 2009	February 27, 2009	Southeast and south-central Wisconsin	Winter weather	0	0	--
March 2, 2009	March 2, 2009	Milwaukee County	Lake-effect snow	0	0	--
March 28, 2009	March 29, 2009	Milwaukee County	Winter storm	3	0	--
December 8, 2009	December 9, 2009	Southeast and south-central Wisconsin	Winter storm	0	0	--
December 23, 2009	December 24, 2009	Milwaukee County	Winter storm	0	0	--
January 7, 2010	January 8, 2010	Southeast and south-central Wisconsin	Winter storm	0	0	--
February 9, 2010	February 10, 2010	Southern Wisconsin	Winter storm	1	0	--
February 24, 2010	February 24, 2010	Milwaukee County	Winter weather	0	0	--
March 19, 2010	March 20, 2010	Southern Wisconsin	Winter weather	0	0	--
December 3, 2010	December 4, 2010	Southeast and south-central Wisconsin	Winter weather	0	0	--
December 9, 2010	December 10, 2010	Milwaukee County	Winter weather	0	1	5,504
December 12, 2010	December 12, 2010	Southeast Wisconsin	Winter weather	0	0	--
December 20, 2010	December 21, 2010	Southern Wisconsin	Winter weather	0	0	--
December 25, 2010	December 26, 2010	Milwaukee County	Winter weather	0	0	--
January 17, 2011	January 17, 2011	Southeast and south-central Wisconsin	Winter weather	0	0	--
February 1, 2011	February 2, 2011	Southern Wisconsin	Blizzard	3	2	10,670
February 6, 2011	February 6, 2011	Southeast and south-central Wisconsin	Winter weather	0	0	--
February 20, 2011	February 20, 2011	Southeast and south-central Wisconsin	Winter storm	0	0	--
February 21, 2011	February 22, 2011	Southeast and south-central Wisconsin	Winter weather	0	0	--
March 9, 2011	March 9, 2011	Southern Wisconsin	Winter weather	0	0	--
December 29, 2011	December 29, 2011	Southeast and south-central Wisconsin	Winter weather	0	0	--
January 12, 2012	January 13, 2012	Southeast and south-central Wisconsin	Winter weather	0	0	--
January 17, 2012	January 17, 2012	Southeast and south-central Wisconsin	Winter weather	0	0	--
February 23, 2012	February 24, 2012	Southern Wisconsin	Winter weather	0	0	--
March 2, 2012	March 2, 2012	Southeast and south-central Wisconsin	Winter storm	0	0	--
December 20, 2012	December 21, 2012	Southeast Wisconsin	Winter storm	0	0	--
January 27, 2013	January 27, 2013	Southern Wisconsin	Winter weather	0	0	--
January 30, 2013	January 30, 2013	Southeast and south-central Wisconsin	Winter weather	0	0	--
February 7, 2013	February 7, 2013	Southeast and south-central Wisconsin	Winter storm	0	0	--
February 22, 2013	February 22, 2013	Southeast and south-central Wisconsin	Winter weather	0	0	--
February 26, 2013	February 27, 2013	Southeast and south-central Wisconsin	Winter storm	0	0	--
March 5, 2013	March 5, 2013	Southeast Wisconsin	Winter weather	0	0	--
March 18, 2013	March 19, 2013	Southern Wisconsin	Winter weather	0	0	--

Table continued on next page.

Table 3.22 (Continued)

Beginning Date	Ending Date	Affected Area	Event	Reported Damages		
				Fatalities	Injuries	Property Damages (dollars)[a]
November 25, 2013	November 25, 2013	Milwaukee County	Winter weather	0	0	--
December 8, 2013	December 9, 2013	Southern Wisconsin	Winter weather	1	0	--
December 19, 2013	December 20, 2013	Southern Wisconsin	Winter weather	0	0	--
December 22, 2013	December 22, 2013	Southern Wisconsin	Winter storm	0	0	--
December 31, 2013	December 31, 2013	Southern and southeast Wisconsin	Winter weather	0	0	--
January 1, 2014	January 2, 2014	Southern and southeast Wisconsin	Winter weather	0	0	--
January 10, 2014	January 11, 2014	Southern Wisconsin	Winter weather	0	0	--
January 14, 2014	January 15, 2014	Southern Wisconsin	Winter weather	0	0	--
January 24, 2014	January 25, 2014	Milwaukee County	Winter weather	0	0	--
January 26, 2014	January 26, 2014	Southern Wisconsin	Winter weather	0	0	--
January 26, 2014	January 27, 2014	Southern Wisconsin	Winter weather	0	0	--
February 4, 2014	February 5, 2014	Southeast Wisconsin	Winter weather	0	0	--
February 13, 2014	February 13, 2014	Southern Wisconsin	Winter weather	0	0	--
February 17, 2014	February 17, 2014	Southeast and east-central Wisconsin	Winter storm	0	0	--
March 4, 2014	March 4, 2014	Southern Wisconsin	Winter weather	0	0	--
April 14, 2014	April 15, 2014	Southeast Wisconsin	Winter weather	0	0	--
November 22, 2014	November 22, 2014	Milwaukee County	Winter weather	0	0	--
November 28, 2014	November 28, 2014	Milwaukee County	Winter weather	0	0	--
December 18, 2014	December 18, 2014	Milwaukee County	Winter weather	0	0	--
January 8, 2015	January 8, 2015	Southern Wisconsin	Winter weather	0	0	--
February 1, 2015	February 2, 2015	Southern and eastern Wisconsin	Winter storm	3	0	--
February 25, 2015	February 26, 2015	Southern Wisconsin	Winter weather	0	0	--
March 3, 2015	March 3, 2015	Southern and southeast Wisconsin	Winter weather	0	0	--
November 20, 2015	November 21, 2015	Southern and southeast Wisconsin	Winter storm	0	0	--
December 28, 2015	December 29, 2015	Southern Wisconsin	Winter storm	2	0	5,063
February 8, 2016	February 8, 2016	Milwaukee County	Winter weather	0	0	--
February 29, 2016	February 29, 2016	Southern Wisconsin	Winter weather	0	0	--
March 1, 2016	March 1, 2016	Southern Wisconsin	Winter weather	0	0	--
March 24, 2016	March 24, 2016	Southern and central Wisconsin	Winter weather	0	0	--
April 2, 2016	April 2, 2016	Southern Wisconsin	Winter weather	0	0	--
April 8, 2016	April 8, 2016	Southeast and south-central Wisconsin	Winter weather	0	0	--
December 4, 2016	December 4, 2016	Southern Wisconsin	Winter weather	0	0	--
December 10, 2016	December 11, 2016	Southern Wisconsin	Winter storm	1	0	--
December 16, 2016	December 18, 2016	Southern Wisconsin	Winter storm	2	0	--
December 19, 2016	December 19, 2016	Milwaukee County	Winter weather	1	0	--
	Total	32		9		122,505

[a] *Dollar values are adjusted to year 2016 by using the average annual Consumer Price Index (CPI) values from the U.S. Department of Labor, Bureau of Labor Statistics.*

[b] *Federally Declared Presidential Emergency.*

Source: Milwaukee County Pre-Disaster Mitigation Plan and the National Climatic Data Center

and services as roads drifted shut and highway crews were unable to keep them open. Conditions were extremely hazardous in the City of Milwaukee where a Presidential Emergency Declaration was obtained to assist in snow removal operations. The winter of 1981-1982 recorded a storm event, with extremely cold temperatures, accompanied by high winds gusting to 50 mph. Wind chill factors reached 100 degrees below zero and severely affected the health and safety of those who ventured outdoors.

Description of Recent Winter Storm Events

Generally, the winter storm season in Wisconsin occurs between October and March. Severe winter weather has occurred, however, as early as September and as late as the latter half of April and into May in some locations in the State. The average annual duration of snow cover in the City of Milwaukee is approximately 85 days. As previously noted, since 1993, there have been 148 winter storms recorded in the City of Milwaukee, or about 3.1 per year.

Ice and sleet storms can occur at any time throughout the winter season from October to April. The majority of these storms occur in west-central to east-central Wisconsin, based on data from 1982-2008. In a typical winter season there are three to five light freezing rain events. A major ice storm occurs about once every other year somewhere in the State. 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 winter of 1998-1999 was considered mild. However, a heavy snowfall occurred January 1-3, 1999, and more than 10 inches fell in most southern counties with parts of Milwaukee, Racine, Kenosha, Ozaukee, Walworth, Washington, and Waukesha Counties receiving more than 18 inches of snow. A recent blizzard occurred December 2-4, 1990, depositing 10 or more inches of snow across the central and southern portions of the State. This excessive snowfall throughout such a large area of the State severely taxed capabilities to clear and remove snow.

December 2000 was one of the 10 coldest Decembers on record for most of the State. In addition, record or near record snow depths of 15 to 34 inches occurred in much of southern Wisconsin during December. The City of Milwaukee registered 49.5 inches in snowfall for the month of December alone and was included in a Presidential Emergency Declaration area.

Two heavy snowfalls occurred in the City of Milwaukee during January 2005. Over the period from January 4 through 6, 2005, low pressure in the southwestern United States pulled large amounts of moisture from the Gulf of Mexico and eastern Pacific Ocean over a stationary front located over Illinois, Iowa, and Missouri. Widespread heavy snow developed in northern Illinois and moved into southern Wisconsin, resulting in heavy snowfall in Milwaukee. Accumulations of snow were between eight and 10 inches in most of Milwaukee County, with a total of 12 inches reported at the University of Wisconsin-Milwaukee campus. Heavy snow also developed in southeastern Wisconsin on the evening of January 21, 2005, and persisted into January 22. Snowfall rates overnight were in the two to three inch per hour range at times. Total snow accumulations in Milwaukee County generally ranged from 12 to 16 inches. After the storm was over, lake effect snow produced an additional three to four inches of snow across the Region for a two-day total accumulation of 10 to 16 inches. In addition to heavy snow, winds began to strengthen to 20 to 30 miles per hour, with gusts up to 45 miles per hour, by the morning of January 22. This produced considerable blowing and drifting snow and blizzard conditions at times. Although hundreds of traffic accidents were reported, the storm swept through on a Friday night and road crews had an easier time clearing roadways on Saturday without the presence of rush hour traffic.

The 2007-2008 winter season in Wisconsin was "one-for-the-ages." Numerous winter storms, including a couple blizzards and four ice storms, pounded the southern half of the State. Winter snowfall totals of 70 to 122 inches across the southern counties established new all-time winter snowfall records at many locations. Most of Milwaukee County received in excess of 90 inches of snow during this winter, and much of the City of Milwaukee received over 110 inches. These totals were roughly 200 to 240 percent of normal. The worst storm of the winter occurred on February 5 and 6, 2008, southeast of a line from Dubuque, Iowa to Madison to Sheboygan where 12 to 21 inches of snow were deposited. Two-day snowfall totals in and near the City of Milwaukee ranged from about 13 inches at General Mitchell International Airport (GMIA) to over 17

inches at the City of West Allis. On February 6, snowfall at GMIA totaled 11.6 inches, breaking the old daily record of 8.3 inches set in 1974. Several roads in southeast Wisconsin were closed by the intense snowfalls and blowing snow. Milwaukee County was included in a Presidential Emergency Declaration. The City of Milwaukee received about $939,710 in Federal funds and about $156,618 in State funds for extraordinary expenses associated with clearing roads and emergency response efforts.

A clipper-type low pressure system passing to the southwest and south of Wisconsin resulted in widespread snow across southern Wisconsin on February 9 and 10, 2010. A second low that had moved northeastward from Texas merged with the clipper system over western Ohio and deepened. This resulted in increasing northeast winds, and with a favorable fetch down Lake Michigan, produced lake enhanced snow that boosted snow totals over eastern Wisconsin. Southeastern Wisconsin received widespread eight to 14 inches. The heaviest snow of 10 to 14 inches fell along and east of a line from northwest Sheboygan County near Elkhart Lake, through Hartford in Washington County, the City of Waukesha in Waukesha County, and Union Grove in western Racine County to Silver Lake in western Kenosha County. While the highest snow total from the storm was 15.0 inches near the Village of Belgium in Ozaukee County, slightly lower totals were reported near Milwaukee, with 13.4 inches falling in the City of West Allis in Milwaukee County. Over 250 traffic crashes, spin-outs and collisions were reported. One fatality related to the storm occurred in Milwaukee County, where a 73-year old man with a history of heart problems died shortly after shoveling snow.

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 31, 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 GMIA (Figure 3.9). Peak wind gusts of 60 miles per hour were reported at GMIA. 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 (IH 94) from the Illinois border north to Milwaukee, and IH 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 dangerous driving conditions. The storm, known as the Groundhog's Day blizzard, had several impacts. Most flights in and out of GMIA were canceled until later in the day 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. 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.

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.

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 29 in Milwaukee County. A golf dome was damaged by the weight of the heavy snow in Milwaukee County.

Vulnerability and Community Impact Assessment

Based on events reported from 1993 to December 2016, it is estimated that the City of Milwaukee experiences on average approximately 6.3 winter storm events each year. 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 the eighth most destructive natural hazard in Wisconsin. Snow and ice can cause traffic accidents, bring down telephone and power lines, 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.

Figure 3.9
Snow from the Groundhog's Day Blizzard of February 1-2, 2011

Source: National Weather Service

Ice storms and freezing rain are less common than snow, but produce road conditions that can make travel hazardous as shown in Table 3.23. 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.

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 citywide 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.[90]

In 2016, the total equalized assessed property value in the City of Milwaukee was estimated at over $25.1 billion.[91] About $20.7 billion of this total is comprised of buildings and other improvements. Due to the unpredictability of winter storm events, all buildings, infrastructure, and critical facilities within the City are considered at risk. Based on availability, the 2016 assessed values of the identified critical facilities are provided in Appendix B.

Potential Future Changes in Winter Storm Conditions

Based upon historical data, the City of Milwaukee can expect to experience an average of 6.3 winter storm events per year as documented by the National Climatic Data Center. It should be noted that the historical record shows considerable variation among years in the number of events that occurred. While it would be expected that in some years the City will experience fewer events or more events than the average number, the average annual number of events is not expected to change.

Changes over the 20th century and projections based on downscaled results from climate models indicate that there will likely be changes in winter storm conditions affecting the City of Milwaukee over the 21st century. It is projected that by 2055, the average amount of precipitation that the City receives during the winter will increase by about 0.5 to 1.0 inch, an increase of about 25 percent. 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.

[90] Ibid.

[91] *Wisconsin Department of Revenue.*

Table 3.23
Total Number of Accidents Among Weather and Road Conditions Reported Within the State of Wisconsin: 2013

Weather Conditions	Road Conditions							Total
	Dry	Wet	Snow/ Slush	Ice	Sand/Mud/ Dirt/Oil	Other	Unknown	
Clear	40,907	1,423	2,417	1,356	115	70	72	46,360
Cloudy	19,306	4,660	3,864	1,757	68	29	53	29,737
Snow	61	693	10,525	1,264	0	2	17	12,562
Rain	60	6,880	166	366	6	3	4	7,485
Sleet/Hail	4	153	502	947	1	1	2	1,610
Fog/Smog/Smoke	234	356	48	84	2	2	6	732
Blowing Sand/Dirt/Snow	3	12	361	248	1	1	0	626
Severe Crosswinds	28	12	14	20	0	1	0	75
Other	9	4	3	5	0	0	2	22
Unknown	202	38	99	25	5	2	18,673	19,044
Total	60,814	14,231	17,999	6,072	198	111	18,829	118,254

Source: Wisconsin Department of Transportation Bureau of Transportation Safety and SEWRPC

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.

3.9 VULNERABILITY ASSESSMENT FOR CONTAMINATION OR LOSS OF WATER SUPPLY

Water supply systems are among the most important infrastructure facilities affecting the economic development and environmental quality of the City of Milwaukee. Such systems directly affect the health and welfare of the resident and transient populations of an area, and the viability of commercial and industrial activities in an area. Accordingly, the availability of an ample supply of high-quality water for domestic, commercial, and industrial use and the protection and wise use of the available sources of supply were ranked high in priority votes by the City of Milwaukee Hazard Mitigation Steering Committee.

As noted in Chapter 2, approximately 94 million gallons per day (mgd) of Lake Michigan surface water are utilized as the source of supply by all water users in the City of Milwaukee. An ample supply of clean, wholesome water is essential to urban development. Indeed, without a reliable water supply, urban areas become unhealthy places in which to live and work, subject to epidemics of such waterborne diseases as cholera, dysentery, typhoid fever, and parasitic infections, such as *Cryptosporidium*. In addition to providing safe drinking water, a reliable water supply system is also essential in other ways to good sanitation in urban areas. An adequate and reliable water supply system is essential for bathing, laundering, and other forms of cleaning and washing, and provides the basis for the water carriage system of sanitary sewage conveyance essential to a high level of quality in urban life. An adequate and reliable water supply system is essential to good fire protection, and is also essential to all types of commercial and industrial development.

As noted above, the City of Milwaukee relies almost exclusively on surface water from Lake Michigan as its main water source. As a division of the Department of Public Works, Milwaukee Water Works operates two water treatment plants with the capability of processing 275 million gallons per day. The City's water

treatment plants have been upgraded over the past 25 years, including the installation of a state-of-the-art disinfection system. The plants are considered to be well maintained and have recently installed substantial plant security facilities and programs.

Water Supply Issues

Water Main Breaks

Breaks in water mains can interrupt water supply. Depending on the size and location of the main, the effects of a break can either be local or have a large effect on a portion of the distribution system. The Milwaukee Water Works reported experiencing an average of 537 water main breaks per year over the period from 2008 through 2017.

Because of the intense cold associated with a polar vortex, the Milwaukee Water Works experienced an exceptionally high number of breaks in water mains during the winter of 2013-2014. During the months of January through March 2014, the utility had 553 breaks. This is about 2.3 times the 10-year average for this three-month period.

Cross-Connections

Cross-connections are actual or potential connections between potable water supplies and a source of contamination. The most common form of cross-connection is a garden hose, which is easily connected to the public water supply system and can be used to apply a variety of potentially dangerous substances, including chemicals and fertilizer. Other common potential cross-connections include dishwashers, toilets, pressure washers, boilers, pools, and lawn sprinkler systems. Water normally flows in only one direction in a plumbing system; however, under certain conditions, such as backsiphonage or backpressure, water can flow backwards, contaminating potable water supplies within a building or within a water distribution system. Backsiphonage may occur due to a loss of pressure in a water utility distribution system. Such a pressure loss can occur due to a water main break, a repair to the distribution system, or a firefighting emergency. This can create a siphon in a plumbing system which can draw water out of a sink or bucket back into a building's water system and into the municipal system. Back pressure may be created when a source of pressure such as a boiler or a pump creates pressure greater than pressure supplied through the public water system. This may cause contaminated water to be pushed into a building's water system and into the municipal system. State plumbing codes require that approved backflow prevention methods be installed at every point of potable water connection and use.

Vulnerability and Community Impact Assessment

The potential for water supplies to be interrupted could be due to the following factors:

- Contamination of the Lake Michigan surface water source in the vicinity of the water supply intakes used
- Major facility malfunction or shutdown

In addition, water supplies could be locally interrupted due to water main breaks. The impact of such a break would depend upon the size and location of the affected water main. Local contamination could result from backflow due to cross-connections or release of lead from service lines. While contamination from an individual service line would most likely be restricted to the building or buildings served, the fact that a substantial portion of the service lines in the City are composed of lead suggests that this could have a large impact on drinking water quality experienced by residents of the City.

Lake Michigan has historically been a source of safe drinking water. However, no one can guarantee that an accident will not happen, and a mishap can have serious consequences. In 1993, the City of Milwaukee's public water supply became contaminated with *Cryptosporidium*, a parasite found in animal wastes. Nearly half of the 850,000 consumers were infected, 4,400 people were hospitalized, and at least 69 people died, making this the largest documented waterborne outbreak in U.S. history (Wisconsin Division of Health, 1996). Although the exact source of the *Cryptosporidium* that caused this outbreak is still uncertain, the total cost of the outbreak associated illness was estimated at about $37 million in medical costs and $77 million in productivity losses.[92] As previously noted, the City of Milwaukee has, over the past 15 years, upgraded its treatment and monitoring water quality systems that include the installation of a state-of-the-art disinfection equipment. This upgrading and related actions are considered to be a sound basis for mitigating potential water quality problems, and based on current and ongoing safety measures, the probability of future events is negligible.

Typically, water supply facilities have a history of safe operation with minimal malfunctions or shutdowns. The industry has been known for providing continuous service due to the use of high-quality and redundancy in

[92] *Phaedra S. Corso, Michael H. Kramer, Kathleen A. Blair, David G. Addiss, Jeffrey P. Davis, and Anne C. Haddix,* Cost of Illness in the 1992 Waterborne Cryptosporidium Outbreak, Milwaukee, Wisconsin*, Emerging Infectious Diseases, Volume 9, No. 4, April 2003. Costs and losses adjusted to 2010 dollars.*

equipment. However, the facilities are always subject to the potential for an unanticipated event which could interrupt services. During the last several years, water utilities, including the City of Milwaukee Water Works and related organizations, such as the American Water Works Association and the Wisconsin Department of Natural Resources, have increased efforts to evaluate vulnerability of water supply facilities to a wide range of hazards, including acts of terrorism. The focus of these efforts has been directed toward preparation of vulnerability assessments and emergency response and mitigation plans for each facility.

3.10 VULNERABILITY ASSESSMENT FOR HAZARDOUS MATERIALS INCIDENTS

This type of hazard occurs with the uncontrolled release or threatened release of hazardous materials or substances from a fixed site or during transport that may adversely impact public health and safety and/or the environment.

Understanding the potential health effects associated with exposure to a hazardous material contaminant can be complicated and involves determining who may be exposed, how they may be exposed, and how long the exposures may last. Individuals are also known to react differently to chemical exposures depending upon their age and health. In addition, different effects may occur depending on whether a chemical is ingested versus being inhaled and the duration of exposure. There are several ways in which chemicals may enter the human body and cause detrimental health effects as summarized below:

- Inhalation-breathing the chemical into the lungs
- Ingestion-swallowing contaminated food, water, or medication, or other chemicals
- Absorption-assimilation through direct contact with the skin, lungs, and eyes, or indirect contact with clothing or other contaminated items
- Injections-penetration through the skin, much less common than other modes of exposure, but can possibly occur due to an explosion or some other type of accident

In dealing with chemical contaminants, there are two types of exposure, namely, acute and chronic exposure. Acute exposure is defined as short-term, high-level exposure and the effects are usually immediate, whereas chronic exposure is defined as long-term, level exposure and the effects may take years to appear. Both are dangerous and have immediate and long-term health implications. General symptoms of toxic exposure can include, but are not limited to, dry and red skin upon contact, irritation of the eyes or lungs, headache, nausea, drowsiness, dizziness, insomnia, confusion, and tremors. Nonetheless, this report is only dealing with acute exposure.

In some instances, contamination can occur from legacy sources. As described in Chapter 2 of this report, there is one remediated Superfund site in the City of Milwaukee, the Moss-American site along the Little Menomonee River. The U.S. Environmental Protection Agency (USEPA) completed remediation activities at this site in 2009. Two additional sites in the City are being addressed through the Superfund: the Burnham Canal-Miller Compressing Company site and the Solvay Coke and Gas site. Neither are on the National Priorities List. Both of these sites are described in Chapter 2.

Fixed Facilities

Over the past several decades, the use of chemicals has increased in nearly every sector of the economy. As a result, hazardous materials are present in quantities of concern in business and industry, agriculture, universities, hospitals, utilities, and other facilities in the State. There are no areas of the State that are exempt from a possible hazardous material incident. Despite extensive precautions taken to ensure careful handling during manufacture, transport, storage, use, and disposal, accidents and inadvertent releases are bound to occur. The potential impacts of such releases include short and/or long-term health hazards to those exposed, explosions, fires, and environmental contamination. An incident may also necessitate short- or long-term evacuation, which disrupts the social and economic aspects of the affected area.

The Emergency Planning and Community Right-to-Know Act (EPCRA) of 1986 also known as SARA Title III, brings industry, government, and the general public together to address emergency preparedness for

accidental chemical releases. The EPCRA program requires communities to prepare for hazardous chemical releases through emergency planning. This plan provides essential information for emergency responders and creates a database of hazardous chemical storage information for the community. The community right-to-know aspect increases public awareness of chemical hazards in their community and allows the public and local governments to obtain information about these chemical hazards.

In Wisconsin, facilities that use, store, or produce chemicals at or above the threshold quantities are required to submit a Tier II Reporting Form to the State Emergency Response Board (SERB), Local Emergency Planning Committee (LEPC), and the local fire department.[93] This form is usually a one or two page document, depending on the number of chemicals being reported. Basic information asked for includes the facility name and address, emergency contact person and phone number, chemical names and quantities. The SERB sends the forms out by mid-January each year and they are due back by March 1st of that same year. Failure to receive a form does not absolve a facility from their reporting obligations. A facility can be a factory, school, gas station, community center, or hospital. Farm co-ops are exempt from reporting fertilizers and retailers are exempt from reporting goods packaged for resale. Although there are some exemptions, mainly for retailers, a facility that uses, stores, or produces hazardous chemicals may have to report the chemicals stored. However, it should also be noted that the Federal government no longer requires retail gas stations to report.

Under EPCRA, a hazardous material is defined as any chemical that is a physical hazard or health hazard for which the Occupational Safety and Health Administration (OSHA) requires a facility to maintain a Material Safety Data Sheet (MSDS). Under EPCRA there is no specific list of hazardous materials, but some of the most common hazardous chemicals include propane, kerosene, fuel oil, motor oil, and gasoline. If a facility stores 10,000 pounds or more of these products the owners are required to file a report. Under the law, there are two categories of regulated chemicals: hazardous substances and extremely hazardous substances (EHS). EHS chemicals are found on an Environmental Protection Agency list of approximately 366 substances. Common EHS chemicals include chlorine, sulfuric acid, anhydrous ammonia, and nitric acid. Unlike the more common hazardous substances, the minimum reporting quantities will vary depending on the chemical.

Transportation

The list of hazardous materials is extensive. However, the bulk of products being transported are petroleum products (gasoline, diesel fuel, jet fuel, fuel oil, asphalt, creosote, and propane), chemicals used for industrial or manufacturing processes (anhydrous ammonia, sulfuric acid, and chlorine) and waste products (industrial waste, food waste, medical waste, and animal waste). There are numerous other hazardous materials routinely transported in smaller quantities, such as pesticides, herbicides, and specialized industrial chemicals. The majority of releases are the result of transportation accidents. However, many minor releases are the result of illegal dumping of waste materials.

Demand for established and new chemical substances in all walks of life has resulted in extensive hazardous materials shipments within and through Wisconsin communities daily. The major overland modes of transportation are highways, railroads, and pipelines.

Highways

Trucks are the most common way of transporting hazardous materials, accounting for more than 90 percent of all hazardous materials shipments nationwide according to the U.S. Department of Transportation. Various fuels are the most common cargo that are classified as hazardous. Every roadway in Wisconsin is a potential route for hazardous material transport. IH 94 spans the eastern portion of the City of Milwaukee between the densely populated Milwaukee-Chicago corridor. Large tankers conducting inter- and intra-state transportation of hazardous materials and substances use this highway extensively.

[93] *Wisconsin Emergency Management, Emergency Planning and Community Right-to-Know Act Section, Planning Threshold: Facility has an extremely hazardous substance present at any one time in an amount equal or exceeding the chemical-specific threshold planning quantity (TPQ). Reporting Threshold: Facility has 10,000 pounds of a hazardous substance or either 500 pounds or the threshold planning quantity of an extremely hazardous substance present at any one time and is not exempt from reporting requirements.*

Rail

There are four railroad companies that operate in the City of Milwaukee, as shown on Map 2.6 in Chapter 2. Rail is used for the transport of hazardous materials because of large-load capabilities. Rail transport routes pass through the areas east of IH 94, the Menomonee River Valley, and other portions of the City.

It should be noted that the shipment of crude oil by rail has increased as domestic oil production has increased. The typical train carrying crude oil is over a mile long and consists of 100 or more cars. Each of these cars typically carry 30,000 gallons of crude oil. Much of the increased domestic crude oil production consists of Bakken crude oil. This oil comes from a rock formation located in the States of North Dakota and Montana and the Canadian Provinces of Manitoba and Saskatchewan. Derailments and incidents involving trains carrying crude oil may pose challenges for responding organizations. Such an incident could potentially involve the release and/or ignition of thousands of gallons crude oil. Crude oil is not a uniform substance and its physical and chemical properties can vary based upon where it was produced. Crude oil often contains flammable gases, whose presence can reduce the effectiveness of traditional firefighting techniques. Responses to crude oil incidents may require specialized outside resources that will take time to arrive to the site of the incident.

On May 1, 2015, the U.S. Department of Transportation issued rules related to enhanced tank car standards and operational controls for high-hazard flammable trains.[94] Key provisions include enhanced braking systems for trains considered high-hazard flammable trains (HHFT), enhanced design standards for new tank cars, retrofitting of existing tank cars, and operating speeds of HHFTs being limited to 50 mph in most areas and 40 mph in high-threat urban areas.

Pipeline

Natural gas service is provided for the entire City of Milwaukee by the We Energies-Gas Operations. We Energies is the primary distributor of natural gas. In the City of Milwaukee the main gas supply is primarily provided for by ANR Pipeline Company which owns main and branch gas pipelines in the City of Milwaukee and the surrounding area. In addition, the We Energies natural gas system is connected to other major gas pipelines outside of, but in the vicinity of, the City of Milwaukee.

It should be noted that natural gas service and selected other hazards could be vulnerable to events, such as earthquake or an act of terrorism. Such possibilities should be considered as facility and system redundancy is carried out.

An incident involving any one of the above modes of hazardous material transport could result in a local emergency, with the potential to affect large numbers of people. The potential effects include health hazards to those exposed to the hazardous materials, explosions, major fires, and environmental contamination. An incident may necessitate short- or long-term evacuation that would disrupt the affected area. Accidents on major transport arteries can disrupt or stop traffic for extended periods of time. In the State of Wisconsin there were 10,632 transportation-related hazardous material incidents reported over the period 1971 through 2014.[95] These incidents resulted in 11 deaths and 308 injuries. In about 75 percent of these incidents, there was no damage to property. Property damages in those incidents that had damages ranged up to about $6.9 million (2016 dollars). The total damages reported as resulting from these incidents were about $62.5 million and the average amount of reported damages per incident was about $5,880.

Port of Milwaukee

As described in Chapter 2, the Port of Milwaukee is a regional transportation and distribution center which handles a diverse mix of general cargos. Because of its cargo mix and current safety precautions and measures, it is generally considered to be at low risk in regard to potential hazardous materials or terrorism incidents. Nevertheless, the Port is an important facility which requires substantial consideration with regard to law enforcement, fire suppression, and rescue and emergency operations. The City of Milwaukee Police and Fire Departments and the U.S. Coast Guard are involved directly in providing protection services to the Port of Milwaukee. In addition, the Port of Milwaukee is subject to certain Federal regulations, including

[94] *49* Code of Federal Regulations*, Parts 171, 172, 173, 174, and 179.*

[95] *U.S. Department of Transportation Pipeline and Hazardous Material Safety Administration Incident Report Database, accessed on December 20, 2016.*

the Maritime Transportation Security Act, Public Law 107-295. In accordance with these regulations, and related guidelines, all major ports have developed an Area Maritime Security Plan and established an Area Maritime Security Committee. This plan and committee are intended to address security issues at the Port facilities. In addition, in 2017 the U.S. Coast Guard in cooperation with the U.S. Environmental Protection Agency updated their Area Contingency Plan for the Lake Michigan Shoreline.[96] This plan is a tool used to assist and coordinate a response to an oil or hazardous material spill or release into or near the Lake. Thus, the ongoing actions at the Port of Milwaukee related to security are considered to be a component of this hazard mitigation plan.

In September 2017, the City of Milwaukee amended its lease agreement with U.S. Oil, a fuel storage and distribution company that has storage facilities and conducts business at the Port of Milwaukee. The amended lease agreement prohibits the storage of crude oil or shipping of crude oil through the port. The lease does not prohibit storage or shipping of some other flammable substances. U.S. Oil began shipping ethanol through the Port of Milwaukee in spring 2018. The size of the first shipment was about 100,000 barrels. The company anticipates that it will make three to five ethanol shipments through the port per year.

Description of Recent Hazardous Materials Incident Events

Between 2014 and 2015, the City of Milwaukee averaged 90 hazardous material spills or releases per year. Almost all of these spills and releases were minor incidents. The majority of these incidents involved gasoline, diesel fuel, engine waste oil, mineral oil, or other petrochemical substances.

Over the period 1971 through 2016, 1,715 transportation-related hazardous materials incidents were reported in the City of Milwaukee.[97] Most were relatively minor. One of these incidents resulted in two deaths and another resulted in one death. Forty-five of these incidents resulted in a total of 114 injuries, although four of the incidents required hospitalization. Property damage was reported in 293 incidents, with the total damages reported being $3.06 million in 2016 dollars. While most of these incidents occurred on roadways, 34 occurred on railways and 70 were air travel-related.

A total of 35 pipeline incidents have been recorded in the City of Milwaukee during a 46-year period between 1971 through 2016.[98] These events and the resulting fatalities, injuries, and damages are listed in Table 3.24, based upon data published by the Federal Department of Transportation, Office of Pipeline Safety. As shown in Table 3.24, the long gap in events between 1992 and 2005 demonstrates that there is a very low probability of occurrence for these events within the City of Milwaukee. In total, these pipeline incidences have resulted in no deaths, 30 injuries, and more than $17 million in property damages within the City of Milwaukee. These data indicate that hazardous material incidents are relatively rare, but can cause considerable property damage and have a relatively low risk in terms of loss of human life or injury.

On January 23, 2012, an aviation jet fuel release occurred from a Shell Pipeline Company pipeline at General Mitchell International Airport. The first indication of this release was the presence of aviation fuel in a storm sewer near Wilson Park Creek. The cause of the release was the failure of a fuel pipeline located under a taxiway at the airport. As a result of this failure, aviation fuel entered a drainage ditch, the public storm sewer, and the Creek. While no fatalities or injuries were reported, an estimated 9,000 gallons of fuel were released. This caused damage to asphalt at the airport. The pipeline's owner spent an estimated $19.3 million on cleanup operations.

Vulnerability, Community Impact, and Multi-Jurisdictional Assessment

There are several factors that should be considered when attempting to identify the scope, magnitude and vulnerability in terms of transportation-related hazardous materials incidents within specific areas of the City of Milwaukee. One factor is the density of traffic and development. Certain pipeline sections, major highway segments, rail lines, or pipelines may handle more hazardous material traffic than others. Therefore, the northern and central portions of the City of Milwaukee are more vulnerable than the other

[96] *U.S. Coast Guard,* Sector Lake Michigan Area Contingency Plan, *February 15, 2017.*

[97] *U.S. Department of Transportation Pipeline and Hazardous Materials Safety Incident Report Database, accessed November 8, 2017.*

[98] Ibid.

Table 3.24
Natural Gas and Hazardous Liquid Pipeline Incidents in the City of Milwaukee: 1970-2016

Date	Pipeline Incident	Fatalities	Injuries	Property Damage (dollars)[a]
1971	Fuel oil	0	0	0
February 3, 1971	Natural gas	0	0	0
March 11, 1971	Natural gas	0	0	5,306
May 25, 1971	Natural gas	0	0	2,311
February 17, 1972	Natural gas	0	1	3,334
January 14, 1975	Natural gas	0	5	23,863
February 13, 1975	Natural gas	0	4	11,931
1977	Gasoline	0	0	338
March 23, 1977	Natural gas	0	0	1,473
September 30, 1977	Natural gas	0	0	8,423
December 18, 1977	Natural gas	0	0	2,104
January 19, 1978	Natural gas	0	1	1,169
November 21, 1978	Natural gas	0	0	3,895
November 25, 1980	Natural gas	0	0	2,339
1981	Gasoline	0	0	145
August 26, 1982	Natural gas	0	3	625
September 7, 1982	Natural gas	0	0	499
July 9, 1983	Natural gas	0	0	2,344
November 22, 1983	Natural gas	0	0	0
1984	Gasoline	0	0	0
March 19, 1984	Natural gas	0	0	0
May 21, 1984	Natural gas	0	0	7,730
May 21, 1984	Natural gas	0	0	12,141
August 9, 1984	Natural gas	0	2	220,856
April 24, 1988	Natural gas	0	12	2,966,405
October 15, 1990	Natural gas	0	0	181,958
February 15, 1991	Fuel oil	0	0	59,336
July 9, 1992	Natural gas	0	0	85,563
December 30, 2005	Natural gas	0	0	401,285
October 3, 2006	Gasoline	0	0	12,125
September 17, 2007	Natural gas	0	0	61,842
February 1, 2009	Natural gas	0	2	482,066
November 17, 2010	Jet Fuel	0	0	2,752
January 23, 2012	Jet Fuel	0	0	12,140,195
June 16, 2015	Petroleum product	0	0	354,410
	Total	0	30	17,058,763

[a] *Dollar values are adjusted to year 2016 by using the average annual Consumer Price Index (CPI) values from the U.S. Department of Labor, Bureau of Labor Statistics.*

Source: Federal Department of Transportation, Office of Pipeline Safety; and SEWRPC

areas, due to the presence of major highways, rail lines, and pipelines. The condition of the transport routes and seasonal weather effects should also be considered, as well as predominant wind patterns within the County. Developing communication between planning agencies and storage site and transportation system owner/operators can be beneficial in determining the possible risks associated with transporting hazardous materials into or through a particular community. Based on past events, it is likely that there would be averages of about 90 hazardous material releases or spills per year, about 38.1 transportation-related hazardous material incidents per year, and about 0.8 pipeline incidents per year. It should be noted that the historical record shows considerable variation among years in the number of events that occurred. While it would be expected that in some years the City will experience fewer events or more events than the average number, the average annual number of events is not expected to change. On average, these incidents have resulted in reported damages of about $447,000 per year. However, very few events have been responsible for a large percentage of the total damages. Thus, this average damage cost is considered to be a very approximate measure of potential damages. In 2016, the total equalized assessed property value in the City

of Milwaukee was estimated at over $25.1 billion. About $20.7 billion of this total assessment is comprised of buildings and other improvements. Based on the current average estimate of $447,000 in reported damages per year, it can be expected that less than 0.02 percent of the value of all property, including buildings and infrastructure in the City of Milwaukee, will be damaged from these events each year. Due to the unpredictability of hazardous material incidents all buildings, infrastructure, and critical facilities within the City are considered at risk. Based on availability, the 2016 assessed values of the identified critical facilities are provided in Appendix B.

Milwaukee County Emergency Management maintains records on all planning and reporting facilities within the City of Milwaukee and all reported incidents that have occurred at storage and transportation sites, and during acts of transport.

Potential Future Changes in Hazardous Materials Incident Conditions

Although significant hazardous materials incidents are not expected to change in the future, changes in land use can have an influence on the potential magnitude of any particular hazardous materials incidents that occurs. However, development within the City itself is approaching "buildout" conditions with new development expected to be limited, as documented in the adopted regional land use plan and summarized in Chapter 2, and indicate a small potential increased risk of potential exposure to hazardous materials incidents, damage, and related losses in the expanding urbanized areas within the County.

3.11 VULNERABILITY ASSESSMENT FOR MEDICAL/HEALTH RISKS

This type of hazard is a composite of both potential epidemics and the spread of disease from natural disasters or human-induced hazard-related events. The Center for Disease Control and Prevention (CDC) has developed a list of emerging infections priority issues which include; antimicrobial resistance, food and water safety, vectors and animal health, blood safety, infections that cause chronic diseases, opportunistic infections, maternal and child health, health of travelers and refugees, and vaccines. The potential for natural and human-induced hazardous incidents exists almost everywhere. While these incidents can be relatively infrequent, they are capable of endangering the health of the individuals involved and the emergency personnel directed to assist them.

Historical Public Health Emergencies

The "Spanish" influenza pandemic of 1918-1920 was a world-wide disaster. This virus infected an estimated 500 million people.[99] Estimates of the total number of deaths caused by this pandemic range between 50 million and 100 million.[100] About 675,000 people in the United States died from this disease outbreak. This strain of influenza was unusual in several ways. Influenza cases caused by this strain had a very rapid onset, and this virus was more virulent than typical influenza strains. In about 20 percent of cases, infection with this strain led to the development of pneumonia. While the fatalities caused by most strains of influenza occur among juvenile, elderly, or weakened patients, this strain predominantly killed healthy young adults. The pandemic struck the United States in three waves. The first erupted as a wave of mild influenza during late spring and early summer of 1918. The second wave struck as severe influenza during fall 1918 and the third wave struck during spring 1919. At least 103,000 Wisconsin residents developed "Spanish" influenza during the second wave of the outbreak and it caused about 8,460 deaths in the State. An estimated 1,295 deaths from this disease occurred in Milwaukee County—most of these in the City of Milwaukee. Based upon a recommendation from the U.S. Surgeon General, the Wisconsin State Health Officer ordered all public institutions in the State closed. This order included schools, churches, theaters, and other places of amusement and public gathering. Almost every local government in the State put this order into effect.[101]

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[99] *F. Burnet and E. Clark,* Influenza: A Survey of the Last 50 Years in the Light of Modern Work on the Virus of Epidemic Influenza, *MacMillan, 1942*.

[100] *Naill P.A.S. Johnson and Juergen Mueller, "Updating the Accounts: Global Mortality of the 1918-1920 'Spanish' Influenza Pandemic,"* Bulletin of the History of Medicine, *Volume 76, Pages 105-115, 2002*.

[101] *Steven Burg, "Wisconsin and the Great Spanish Flu Epidemic of 1918,"* Wisconsin Magazine of History, *Pages 37-56, Autumn, 2000*.

Two other world-wide influenza pandemics occurred during the twentieth century. The "Asian flu" pandemic of 1957-1958 was responsible for an estimated two million deaths world-wide and an estimated 69,800 deaths in the United States. The "Hong Kong flu" pandemic of 1968-1969 caused an estimated one million deaths world-wide and an estimated 34,000 deaths in the United States.

The Hong Kong flu pandemic struck the City of Milwaukee during the winter of 1968-1969. During the eight-week period between November 10, 1968 and January 11, 1969, an estimated 333,680 residents of the City, representing about 43 percent of the City's population, were clinically ill with influenza from this strain. Newspaper reports indicated that employers reported that high levels of absenteeism were associated with this epidemic. During December 1968, many schools were closed. Supplies of antibiotics and other drugs ran low, and the resources of the health, police, and fire departments were greatly strained. Hospital services were seriously reduced, and in some hospitals emergency care facilities were temporarily closed. The highest rates of infection were seen among working-age adults and older children. By contrast, preschool age children and adults over the age of 60 were less affected by this epidemic.[102]

Poliomyelitis is an infectious viral disease cause by the poliovirus. In most people, infection with poliovirus does not produce symptoms; however, in about 0.1 to 0.5 percent of cases infection results in muscle weakness that can cause paralysis. The weakness most often affects the legs, but may involve the muscles of the head and neck or the diaphragm. Poliovirus is transmitted from person to person through infected feces entering the mouth. Small, localized epidemics of paralytic poliomyelitis began to appear in the United States around 1900.[103] Outbreaks reached pandemic levels in the early twentieth century. Major outbreaks occurred in 1916, 1949, and 1952. The 1952 outbreak was the worst one reported in the United States. About 58,000 cases were reported in that year, resulting in 3,145 deaths and 21,269 people left with mild to disabling paralysis. Beginning in the 1950s, the widespread availability of vaccines for the poliovirus reduced the annual number of cases. Through the use of vaccines, poliomyelitis was eradicated from the Americas by 1994.

In 1993, there was an outbreak of cryptosporidiosis in Milwaukee related to contamination of the City's water supply that affected approximately 400,000 people. This incident was previously described in the section on contamination or loss of water supply.

Description of Recent Public Health Emergencies

In the year 2014 there were more than 12,700 reported incidents of infectious diseases within the City of Milwaukee as outlined in Table 3.25, based upon data published by the Wisconsin Department of Health Services' Office of Health Informatics. The majority of these diseases were sexually transmitted diseases which comprised almost 11,000 of the reported cases (see Table 3.25). These vital statistics also demonstrate that almost 90 percent of children in grades kindergarten through 12 have received all of the appropriate immunizations. Nonetheless, more than 11,000 children are noncompliant in terms of obtaining immunizations and pose a potential significant health risk within the City of Milwaukee. In addition, seasonal shortages of influenza vaccinations can also pose significant risk to both the elderly and young children within the City of Milwaukee

During the spring and summer of 2009, there was an outbreak of a novel type-A influenza virus (H1N1) in Wisconsin. Between April 15 and August 12, about 6,350 confirmed and probable cases were reported in the State. The majority of these cases occurred in the Southeastern Wisconsin Region, mostly in Milwaukee County. The number of reported cases peaked in mid-June and decreased to low levels by mid-July, although this may partially reflect changes in reporting by the Centers for Disease Control. As of August 12, 2009, 4,056 confirmed and probable cases had been reported in Milwaukee County, representing an infection rate of about 427 cases per 100,000 individuals. A second wave of H1N1 infection occurred during the fall 2009-winter 2010 influenza season. In early September, the Wisconsin State Division of Public Health reported that there were high levels of influenza-like illness in the Southeastern Wisconsin Region and lab reports indicated increased levels of

[102] *Frank F. Piraino, Edwin M. Brown, and Edward R. Krumbiegel, "Outbreak of Hong Kong Influenza in Milwaukee, Winter of 1968-1969,"* Public Health Reports, *Volume 85, 1970.*

[103] *Barry, Trevelyan, Matthew Smallman-Raynor, and Andrew D. Cliff, "The Spatial Dynamics of Poliomyelitis in the United States: From Epidemic Emergence to Vaccine-Induced Retreat, 1910-1971,"* Annals of the Association of American Geographers, *Volume 95, pages 269-293, 2005.*

H1N1.[104] This second wave peaked in early December 2009. By early January 2010, low levels of influenza-like illness were being reported in southeastern Wisconsin. Between September 1, 2009 and February 22, 2010, 1,077 hospitalizations for H1N1 had been reported in the State of Wisconsin, with 220 of these occurring in Milwaukee County. The combined number of deaths in Wisconsin attributed to H1N1 influenza in both waves was 56, with nine of these occurring in Milwaukee County.[105]

In 2011 and 2012, the United States experienced an outbreak of pertussis, which is also known as whooping cough. Pertussis is a bacterial disease of the respiratory tract that is transmitted through coughing by infected individuals. The symptoms and impacts are generally most severe in infants and young children. Wisconsin had the highest incidence of pertussis in the nation during this outbreak, with an incidence of 130.7 cases per 100,000 population. The outbreak began in July 2011. From July 1, 2011 through December 31, 2012, there were 5,322 confirmed cases and 2,132 probable cases reported in the State. While the highest number of cases occurred in southeastern Wisconsin, northern portions of the State had the largest percentage of their population affected. During the July 2011 through December 2012 outbreak, about 688 cases were reported in Milwaukee County.

In the year 2014, there were more than 4,200 deaths due to selected diseases within the City of Milwaukee, as shown in Table 3.26. The majority of these mortalities were due to heart- and cancer-related illnesses. Pneumonia and influenza accounted for 68 deaths and a calculated death rate of about 11 people per 100,000 population. Other infectious diseases and parasitic illnesses accounted for 116 deaths in the year 2014. Table 3.26 also demonstrates that 68 deaths in 2014 were associated with alcohol and drug abuse within the City, which is the same number as deaths related to pneumonia and influenza.

Table 3.25
Cases of Selected Infectious Diseases Reported in the City of Milwaukee: 2014

Disease	Number of Reported Cases
Babesiosis	0
Blastomycosis	9
Campylobacter Enteritis	64
Cryptosporidiosis	11
E. coli, Shiga Toxin-Producing (STEC)	10
Ehrlichiosis/Anaplasmosis	0
Giardiasis	57
Haemophilus Influenzae, Invasive	8
Hepatitis Type A	0
Hepatitis Type B	116
Hepatitis Type C	597
Influenza-Associated Hospitalization	470
Legionnaire's	24
Lyme	<5
Measles	0
N. meningitidis (Meningococcal disease)	<5
Meningitis, Other Bacterial	<5
Mumps	8
Pertussis	98
Salmonellosis	80
Shigellosis	188
Streptococcus Pneumonae, Invasive	53
Streptococcal Diseases, All Other	89
Tuberculosis	10
Sexually Transmitted Diseases	
Chlamydia Trachomatis	8,315
Gonorrhea	2,316
Syphilis	161
Immunizations[a]	
Compliant	98,418
Noncompliant	11,102
Percent Compliant	89.9

[a] *Children in grades K-12 by compliance*

Source: Wisconsin Department of Health Services, "Wisconsin Public Health Profile 2016: Milwaukee," accessed September 2017

Foodborne illness is a common and costly public health problem. An estimated one in six people in the United States gets sick from foodborne illness each year by consuming contaminated foods or beverages. There are more than 250 different disease causing pathogens that can contaminate foods. In addition to pathogens, poisonous chemicals and other harmful toxins can cause foodborne diseases when present in food. According to the CDC Foodborne Outbreak Online Database, there were 473 multi-state foodborne illness outbreaks that affected the State of Wisconsin during the period 1998 through 2014. These outbreaks caused almost 22,000 illnesses, 2,400 hospitalizations, and 71 deaths in the states affected. In 2014, the most recent year that data was available, 30 foodborne illness outbreaks were reported in the State of Wisconsin causing 594 illnesses, 79 hospitalizations, and 7 deaths. The most common pathogens that led to outbreaks in 2014 were Norovirus, *Salmonella enterica*, and *Escherichia coli*, typically originating from meats, fruits, or vegetables.

[104] *City of Milwaukee Health Department, "Novel Influenza A (H1N1) Situation Awareness Report No. 2," September 10, 2009.*

[105] *City of Milwaukee Health Department, "Novel Influenza A (H1N1) Situation Awareness Report No. 20," February 22, 2010.*

Vulnerability and Community Impact Assessment

The location of disease outbreaks is dictated by the proximity that residents have to infected people or to infected disease vectors.

The severity of a communicable disease outbreak can be evaluated from the perspective of the individual who has been infected or from the perspective of how many complications and deaths the disease causes in the population. Several factors can determine the severity of a disease outbreak. For example, the severity of a pandemic influenza outbreak can be influenced by:

- Properties of the virus: The inherent virulence and contagiousness of the virus influences the severity of a pandemic's impact. Pandemics can have a concentrated adverse impact within specific age groups. Concentrated illnesses and deaths in young, economically productive age groups may be more disruptive to societies and economies than when the very young or very old are most severely affected;

- Subsequent waves of virus spread: Cases of illness in a pandemic often occur in waves. These waves may last for six to twelve weeks and recur over a period of a year or longer. For example, the "Spanish" influenza pandemic occurred in three waves in the United States throughout 1918 and 1919. Following the initial wave, virus mutation and the emergence of more virulent strains can influence the severity of subsequent waves;

Table 3.26
Mortalities Due to Selected Diseases Reported in the City of Milwaukee: 2014

Disease	Number of Mortalities	Death Rates[a]
Heart Disease (total)	1,024	171.8
Ischemic heart disease	599	100.5
Cancer (total)	1,012	169.8
Trachea/Bronchus/Lung	265	44.5
Coleorectal	99	16.6
Female breast[b]	70	22.6
Cerebrovascular Disease	206	34.6
Lower Respiratory Disease	168	28.2
Pneumonia and Influenza	68	11.4
Accidents:	373	62.6
Motor Vehicle	64	10.7
Diabetes	111	18.6
Other Infectious and Parasitic Diseases	116	19.5
Suicide	56	9.4
Alcohol and Drug Abuse as Underlying Cause of Death		
Alcohol	60	10.1
Other Drugs	8	--
Tobacco Use	673	112.9

[a] *Death rates are per 100,000 people.*

[b] *Based on female deaths from breast cancer and female population.*

Source: Wisconsin Department of Health Service, "Wisconsin Public Health Profile 2016: Milwaukee," accessed September 2017

- Vulnerability of the population: In many communicable disease outbreaks, specific populations may be at greater risk than the general population. Examples of this include people with underlying health conditions or weakened immune systems and the very young or old. Nutritional factors also play a role and may influence the severity of a disease outbreak; and

- Community capacity to respond: The quality of the health services available to a community influences the impact of any pandemic. A virus that causes only mild symptoms in communities with strong health systems may be devastating to other communities where health systems are weaker. Vaccine shortages and problems with the distribution of medicines and vaccines can also impact the ability to respond to a disease outbreak.

In general, the frequencies of disease outbreaks are difficult to predict. This is due in part to the fact that communicable diseases differ from one another in their infectivity, virulence, and mode of transmission. For many diseases, these properties can be related to changes in the disease agent. For example, influenza pandemics have been related to genetic changes in the influenza virus.[106] While seasonal outbreaks of influenza occur annually, influenza pandemics are relatively rare events. A total of four influenza pandemics have occurred in the last 100 years, resulting in a rough average of one influenza pandemic every 25 years. The frequency of other diseases may be different from this. For example, cases of Lyme disease, a vector-borne disease, are detected in Milwaukee County almost every year.

[106] *Edwin D. Kilbourne, "Influenza Pandemics of the 20th Century,"* Emerging Infectious Diseases, *Volume 12, pages 9-14, 2006.*

The duration of individual disease outbreaks can be similarly difficult to predict. Based on the history of previous influenza pandemics, it is likely that a pandemic wave could last for about three to four months, with community outbreaks lasting about six to eight weeks. The duration of other diseases outbreaks may be different and can depend on the mode of transmission of the disease.

Different diseases also show different patterns of seasonality. While seasonal influenza viruses can be detected year-round in the United States, these viruses are most common during the fall and winter. The exact timing and duration of flu seasons can vary, but influenza activity often begins to increase in October. Most of the time flu activity peaks between December and February, although activity can last as late as May. Vector-borne pathogens, on the other hand, are most prevalent during the spring through fall when disease carrying agents such as mosquitoes and ticks are most active. Transmission of vector-borne diseases is likely to occur during these seasons. Foodborne pathogens, on the other hand, can occur throughout the year.

The economic impact of a communicable disease outbreak is likely to be dependent upon the particular disease and disease strain. For some diseases, the impacts could be major. A pandemic influenza event, for example, could have severe economic repercussions, with significant costs associated with hospitalization and care for those afflicted. Broader economic impacts associated with absenteeism and lost productivity and wages could also be expected.

While anyone can be affected by a communicable disease outbreak, some individuals may be at greater risk than others. Young people and the elderly can be more sensitive to or suffer greater impacts from some diseases than other members of the population. The Wisconsin Department of Health Services estimated that in 2013 about 30.5 percent of the City of Milwaukee's population was 19 years of age or younger and about 9.3 percent of the City's population was 65 years of age or older. Thus, about 40 percent of the City's population consists of members of these more sensitive age groups. People with some chronic medical conditions or who are immunosuppressed may also be more sensitive to some communicable diseases. Finally, for those diseases for which vaccines are available, people who are not immunized are at greater risk than those who are immunized. For some communicable diseases and segments of the population, the rates of immunization in the City of Milwaukee are high. The data in Table 3.25 indicates that the vast majority of school children in the City are compliant with the required immunizations. For other diseases for which vaccines are available, immunization rates in the City are likely to be much lower. Based on survey data, the CDC estimated that only about 44 percent of the people older than six months old in the State of Wisconsin received the seasonal influenza vaccine for the 2014-2015 influenza season.[107]

While a public health emergency will not directly impact critical facilities and infrastructure, it could severely impact local health care services. In addition, communicable diseases can often spread faster in locations where many people congregate such as schools, day care centers, and nursing homes.

Potential Future Changes in Public Health Emergency Conditions

Based upon historical national trends of infectious diseases, as well as the continuing threat of bio-terrorism, there is a potential for continued risk of communicable disease outbreaks to occur within the City of Milwaukee. For the five-year term of this plan, the probability of a communicable disease outbreak occurring is unknown. One reason for this is that numerous viruses, bacteria, protozoa, and fungi can cause communicable diseases. Each of these disease agents has its own specific characteristics, such as source, infectivity, and mode of transmission. In addition, for some disease agents such as pandemic influenza, changes in the property of the disease agent contribute to the development of major outbreaks.

As the twenty-first century proceeds, changes in climate may affect the incidence of communicable diseases in the City of Milwaukee in a number of ways.

Heavy rainfalls have been shown to be associated with outbreaks of waterborne diseases. This can happen through several pathways. Runoff resulting from heavy rains can become contaminated with animal wastes

[107] *U.S. Centers for Disease Control and Prevention, "Influenza Vaccination Coverage Estimates by State, HHS Region, and the United States, National Immunization Survey—Flu (NIS-Flu) and Behavioral Risk Factor Surveillance System (BRFSS), 2014-2015 Influenza Season: Wisconsin," www.cdc.gov/flu/fluvaxview/reportshtml/reporti1415/reportii/index.html, accessed January 19, 2016.*

from agricultural activities and/or human wastes from improperly maintained or failing septic systems or from decaying sewers or sewer laterals. This runoff can carry disease agents into surface waters. In addition as rain infiltrates into soil, it can carry contaminants into groundwater. Depending on the disease agents that are present in the wastes, this can lead to a variety of gastrointestinal and respiratory illnesses. The projected increase in the frequency of heavy rainfall events could lead to an increase in these sorts of disease outbreaks.

The projected increase in heavy rain events could also affect the likelihood of disease outbreaks resulting from the use of recreational waters. Increases in water temperatures resulting from climate change and runoff from intense storms may create environments that deposit and support pathogens on beaches. At the same time, the projected increases in air and water temperatures are likely to lengthen the period of the year that is suitable for water-based recreational activities such as swimming. A longer swimming season is likely to increase the amount of exposure to any waterborne pathogens that are present. Thus, between now and the middle of the twenty-first century, the projected change in climate could increase the incidence of waterborne diseases among recreational water users. This would be likely to lead to more frequent closures of Great Lakes and inland beaches in order to protect human health.

The projected changes in climate could also affect the risk posed by vector-borne diseases. The dynamics of many of these diseases are sensitive to fluctuations in climate. For example, outbreaks of West Nile virus to humans are associated with prolonged periods of hot, dry weather that are followed by a significant rain event.[108] Changes in temperature and moisture may also change the geographic ranges of animals that vector diseases. Wisconsin is currently not within the range of the mosquito *Aedes aegypti,* which is the vector for several disease-causing viruses, including the Zika virus and those that cause chikungunya, dengue fever, and yellow fever. This mosquito is a tropical species and exposure to temperatures below 32°F kill it. As a result, the distribution of this species is currently restricted to southern portions of the United States. The increases in winter temperatures that are projected to occur over the twenty-first century could allow this range of this mosquito to expand northward,[109] creating the potential for the transmission of the diseases that it carries to occur in areas, such as Wisconsin, where these diseases rarely occur today. While an effective vaccine exists for yellow fever, the current lack of available vaccines for chikungunya, dengue fever, and Zika suggests that there may be some potential for outbreaks to develop in Wisconsin later in the twenty-first century.

It should also be noted that changes in the ranges of disease vectors resulting from climate change could also reduce the risks posed by some vector-borne diseases. For example, preliminary results suggest that climate change may be causing the range of the deer tick that transmits Lyme disease to shift northward. This may result in the range of the tick moving out of Wisconsin and into Minnesota and Canada by the end of the twenty-first century.[110]

3.12 VULNERABILITY ASSESSMENT FOR TERRORISM

Terrorism can be defined as acts that are violent or dangerous to human life that violate Federal or state law and that appear intended to intimidate or coerce a civilian population; influence the policy of a government by intimidation or coercion; or affect the conduct of a government by mass destruction, assassination, or kidnapping.[111] The Federal Bureau of Investigation categorizes two types of terrorism in the United States: domestic terrorism that involves groups or individuals whose activities are directed at elements of our government or population without foreign direction; and international terrorism that involves groups or individuals who are foreign based and/or directed by countries or groups outside the United States, or whose activities transcend national boundaries. Additionally, some acts conducted by gangs, people involved in civil unrest, radical splinter groups or activists, and people involved in illegal drug trade could also be described as terrorism.

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[108] *Paul R. Epstein, "West Nile Virus and the Climate,"* Journal of Urban Health, *Volume 78, pages 367-371, 2001.*

[109] *César Caphinha, Jorge Rocha, and Carla A. Sousa, "Macroclimate Determines the Global Range Limit of* Aedes aegypti*,"* EcoHealth, *Volume 11, pages 420-428, 2014.*

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

[111] *Title 19 Section 2331 of the* United States Code.

An act of terrorism can take several forms, depending on the technological means available to the terrorist, the nature of the political issue motivating the act, and the points of weakness of the terrorism target. Based on guidelines provided by the U.S. Department of Homeland Security, terrorism refers to the use of Weapons of Mass Destruction (WMD), including biological, chemical, nuclear, and radiological weapons; arson, incendiary, explosive, and armed attacks; industrial sabotage and intentional hazardous materials releases; and "cyber-terrorism."[112] Several terrorist action possibilities are listed and briefly described below.

Terrorist Action Possibilities

Incendiary Devices and Arson

Most terrorist incidents in the United States have involved bombs or incendiary devices, including arson, detonated and undetonated explosive devices, tear gas, pipe and firebombs, and rocket attacks. Often the capacity existed for large-scale damage and/or mass casualties. An example of this would be the bombing of the Alfred Murrah Federal Building in Oklahoma City in April 1995. The type of materials and method of delivery utilized in the bombing of the Murrah Federal Building are readily accessible to a potential terrorist. Because of the ready availability of such materials, the potential for mass damage and casualties and experiences to date in the nation, it is anticipated that of the various types of Weapons of Mass Destruction (WMD) and explosive weapons have a high potential for use in the United States.

FEMA defines arson and incendiary attack as the initiation of fire or of explosion on or near a target either through direct contact or remotely by other means. Generally, the extent of damage can be determined by type or quantity of accelerant and the materials present at or near the target. Arson can further be defined as any willful or malicious burning or attempt to burn, with or without intent to defraud, a dwelling, public building, motor vehicle, or other property. Fires of suspicious or unknown origins are not classified as arson. Nationally, arson resulted in 310 civilian deaths and was responsible for $473 million in property losses in 2016.[113] The number of reported arsons in the City of Milwaukee rose in the 1990s as shown in Figure 3.10, as new techniques and equipment increased the identification of arson as the cause of suspicious fires. Over the period 2000 through 2009, the average number of arson fires in the City of Milwaukee was about 346 arson fires per year. Over the period 2010 through 2015, the average number of arson fires in the City was lower, about 288 per year. These fires resulted in an average of about $1.10 million in property damages per year.

Nationwide, an estimated 20,000 intentionally set structure fires occurred in 2016, a decrease of about 13 percent from 2015.[114] In 2015, 181 fires were caused by arson within the City of Milwaukee, resulting in over $1,955,000 in damages. As shown in Table 3.27, residential property accounted for the largest dollar loss due to arson, but only accounted for 48 of these fires. Arson loss for residential properties averaged $34,358 per fire. Damages to mobile property, such as vehicles, trailers, and boats, resulting from intentional set fires averaged $7,245 per fire. The majority of intentionally set fires in 2015 did not affect residential or mobile property, and damages resulting from these fires averaged about $800 per fire.

Airline Attack

After the events of September 11, 2001, questions were raised regarding the effectiveness of airport and airline security at the time. Since the September 11 attacks, security at airports and onboard airliners has been escalated. Specific changes include the oversight and supervision of passenger and baggage screening by the Transportation Security Administration, access to airplane boarding areas being restricted to passengers, restrictions being set on articles that can be taken onboard airliners, deployment of additional Federal air marshals on airliners, and improvements to cockpit security. Despite these efforts, it is possible that incidents may occur. Such incidents could include airplane bombing, sabotage or hijacking, airport bombings or shootings, or the tampering with air navigation and control systems, resulting in plane crashes or collisions.

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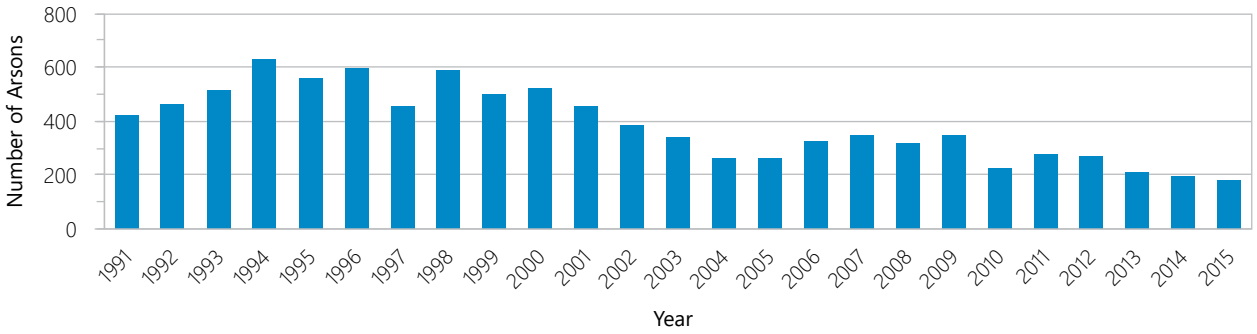
[112] *FEMA, State and Local Mitigation Planning How-to Guide, Integrating Manmade Hazards Into Mitigation Planning, Version 2.0, September 2003.*

[113] *Hilton J.G. Haynes, "Fire Loss in the United States During 2016," National Fire Protection Association, September 2017; available at www.nfpa.org/~/media/FD0144A044C84FC5BAF90C05C04890B7.ashx Accessed January 5, 2018.*

[114] Ibid.

Figure 3.10
Number of Arsons Reported in the City of Milwaukee: 1991-2015



Source: City of Milwaukee Public Safety Report and City of Milwaukee Fire Department

Table 3.27
Arson Fires and Reported Damages Within the City of Milwaukee: 2000-2015

Year	Total Number of Arson Fires	Reported Damages					
		Residential Arson Fires	Residential Arson Damages (in thousands of dollars)[a]	Mobile Property Arson Fires[b]	Mobile Property Arson Fire Damages (in thousands of dollars)a	Other Arson Fires[c]	Other Arson Damages (in thousands of dollars)[a]
2000	524	172	2,886.3	210	1,237.0	142	1,649.3
2001	453	143	1,885.5	232	1,481.4	78	538.7
2002	382	141	2,266.1	158	933.1	83	1,333.1
2003	341	97	654.5	172	589.0	72	392.6
2004	263	79	892.4	132	637.5	52	382.5
2005	257	51	739.9	41	369.9	165	986.4
2006	322	55	1,016.7	39	112.1	228	454.6
2007	347	50	1,380.3	47	135.3	250	102.6
2008	319	48	536.5	31	129.1	240	25.9
2009	348	25	766.9	42	69.1	281	18.4
2010	221	73	248.3	25	41.9	123	37.8
2011	273	114	1,110.9	26	40.8	133	298.2
2012	268	87	405.9	34	163.4	147	5.4
2013	207	52	236.6	30	166.4	125	36.4
2014	193	60	1,244.4	22	89.1	111	522.7
2015	181	48	1,649.2	31	224.6	102	81.3
Total	4,899	1,295	17,920.3	1,272	6,419.8	2,332	6,865.8

[a] *Dollar values are adjusted to year 2016 by using the Consumer Price Index (CPI) values from the U.S. Department of Labor, Bureau of Labor Statistics.*

[b] *Total includes vehicles, trailers, and boats.*

[c] *Total includes storage facilities and all other arson incidents. For 2005-2009, this was calculated by difference.*

Source: City of Milwaukee Public Safety Report, Milwaukee Fire Department

Weapons of Mass Destruction—Chemical/Biological/Nuclear/Radiological Attack

Terrorists can use chemical and biological agents or weapons to either extort or deliberately try to kill in order to further political goals. Toxins, or even some radiological materials, such as water-soluble plutonium chloride, could become a credible threat to municipal water supplies. An example of this would be the sarin gas attack on the Tokyo subway system that occurred in March 1995.

Hostage Taking

The taking of hostages can provide terrorist groups publicity for their political or social objectives, and allow negotiation for furtherance of their aims or result in events which are designed to invoke sympathy for their causes. The main goal of response agencies is to end the incident, with the absolute minimum loss of innocent lives. The common belief that most response agencies are willing to agree to any demand to prevent endangering the safety of hostages is not a true statement in all cases.

Infrastructure Attack

An individual or group of terrorists could coordinate an attack against utilities and other public services, such as the water supply, electric power generation and transmission, or telephone service. Another form of infrastructure attack is against computer resources, such as networks, databanks and software by infiltrating computer networks and altering, stealing or destroying programs and data. As society becomes more dependent on computers, this form of cyber-terrorism is a legitimate concern.

Response to Terrorism Incidents

The emergency management community in the United States must accept that national security and intelligence organizations may not always be successful in preventing terrorist incidents. It is up to State and local emergency management personnel and services to respond should these attacks occur. The ramifications of responding to a terrorist incident may not be the same as traditional large-scale emergencies. The safety of emergency service providers must be an early, primary consideration. The media will take an active interest in this type of incident. The public has high expectations for emergency managers and service providers in a terrorist situation and extraordinary efforts are demanded. Federal and State government agencies depend directly on local managers and emergency response personnel and their initial and follow-on actions during any terrorist incident.

Historical Terrorism Problems

Historically, the worst case of domestic terrorism in the City of Milwaukee to date occurred on November 24, 1917. A bomb suspected to have been planted by anarchists was discovered by children and brought to a police station in the Third Ward. It detonated in the police station, killing nine police officers.

In 1970, there was a series of five pipe bombings and fire bombings in the City of Milwaukee that were attributed to suspected leftist revolutionaries. Targets included two industrial research laboratories, a building containing Federal offices, a military reserve headquarters, and a fuel line at a petroleum terminal in the harbor. While some of these incidents caused property damage, there were no fatalities or injuries reported. There were also two attempted bombings in the City in 1979. In one incident, a bomb was placed in a telephone booth. No damages or casualties resulted from this incident. In the other incident, a bomb exploded outside of a parochial elementary school, injuring a police officer who was attempting to dismantle it. No property damage resulted from this incident.[115]

Description of Recent Terrorism Events

Since 2000, there has been one terrorism incident documented in the City of Milwaukee. In July 2000, a former Air National Guard pilot broke into the 128th Air Refueling Wing airbase at General Mitchell International Airport, placing a bomb, as well as scrawling graffiti calling for an end to U.S. intervention in Kosovo. The bomb failed to explode and the perpetrator was arrested. There were no injuries or fatalities, and only minor property damage was reported.[116] The National Consortium for the Study of Terrorism database includes two incidents of terrorism that occurred in the State of Wisconsin between 2009 and 2017.[117] On April 1, 2012, an assailant set fire to a Planned Parenthood clinic in the Town of Grand Chute in Outagamie County. There were no casualties. The clinic suffered minor damage to an examination room. On August 5, 2012, a member of a white supremacist group attacked a Sikh temple in the City of Oak Creek. The assailant killed six people and wounded four others before being shot by a responding police officer. The

[115] *National Consortium for the Study of Terrorism, Global Terrorism Database, www.start.umd.edu/gtd/, accessed January 5, 2018.*

[116] Ibid.

[117] Ibid.

assailant subsequently died from a self-inflicted gunshot wound. The National Consortium for the Study of Terrorism database lists 12 incidents of terrorism that occured in Wisconsin since 1989.

Vulnerability and Community Impact Assessment

The groups that have conducted terrorism, the issues that they are concerned with, and their objectives are widely varied. The groups and individuals responsible for or participating in terrorist incidents in Wisconsin between 1970 and 2017 have cited a variety of issues for their actions including antiwar activism, extreme left wing revolutionary activities, extreme right wing revolutionary activities, antiabortion activities, animal rights activities, and white supremacist activities. Because the objectives of these groups and individuals are so widely varied, there are numerous potential targets for terrorist activity. Any public facility, utility, element of infrastructure, or gathering place could be a potential target for terrorist activity. In addition, certain types of businesses and governmental institutions may be more prone to terrorist activities due to the specific nature of their business or size. For example, businesses such as banks, financial institutions, health care facilities, or businesses engaged in controversial activities are likely to be at risk. Local, State, and Federal government facilities; public schools; and colleges and universities are also potential terrorist targets.

A review of the community assets described in Chapter 2 indicate a limited potential for terrorism-related hazard impacts to: 1) a variety of residential, commercial, and other developed land uses; 2) roadway transportation system; 3) utilities; 4) critical community facilities; and 5) historic sites in the vicinity of the incident. It is safe to assume that any type of facility on which a terrorist attack could generate desired publicity or further terrorism objectives could be classified as a potential target for terrorist activity, including large-scale public events, such as a sporting or entertainment event. Based on past events, however, the probability of a terrorist attack occurring in the City of Milwaukee is assumed to be very low.

In 2016, the total equalized assessed property value in the City of Milwaukee was estimated at over $25.1 billion.[118] About $20.7 billion of this total is comprised of buildings and other improvements. Due to the unpredictability and lack of precedent concerning terrorism events in the City of Milwaukee, all buildings, infrastructure, and critical facilities within the City are considered at risk. Based on availability, the 2016 assessed values of the identified critical facilities are provided in Appendix B.

3.13 VULNERABILITY ASSESSMENT FOR MAJOR FIRE AND EMERGENCY MEDICAL INCIDENTS

Major structure fire or emergency medical incident is an important type of hazardous event that can potentially cause significant serious injuries, fatalities, and property damages. Local authorities and the City of Milwaukee Fire Department (MFD) maintain their own services to those affected by fire incidents, coordinate with various organizations which support emergency services, and have established lines of communication with neighboring fire departments, inclusive of areas outside of the City of Milwaukee. In addition, the City of Milwaukee Fire Department, like all emergency management programs, is required to conduct disaster preparedness exercises. Disaster exercises are valuable from a variety of standpoints, because they test emergency management plans and procedures, bring together people from various emergency response departments who must work together when disaster strikes, help break down barriers and foster communication between departments, allow simulation of emergency incidents, and provide valuable training.

The Milwaukee Fire Department houses 12 Emergency Medical Services (EMS) paramedic units located throughout the City (see Appendix B Table B.2). The Milwaukee Fire Department (MFD) has been a part of Milwaukee County's Emergency Medical System (EMS) since 1977. Milwaukee County provides each fire department in the County with medical oversight and training. The system allows paramedics from any participating fire department within the County to respond to emergencies in neighboring municipalities when needed. For example, MFD Med No. 15 routinely responds into St. Francis as their paramedic unit. Wauwatosa's Med 51 responds to emergencies in the "finger area" on the west side of Milwaukee. This is significant in the event of a major fire or emergency medical incident. This enables individual departments to supplement their own personnel, apparatus, and equipment with that from other departments in response to emergencies. Importantly, the agreement allows individual departments to access equipment, such as

[118] *Wisconsin Department of Revenue.*

tankers, aerial trucks, and extrication equipment, which they themselves do not possess and which they may only need infrequently.

The majority of EMS responses required Basic Life Support (BLS), which includes patient evaluation, monitoring of pulse, blood pressure, and breathing, bandaging wounds and splinting fractures, and the performance of Cardio-Pulmonary Resuscitation (CPR) and cardiac defibrillation. All Fire Department vehicles are equipped with defibrillators, a life-saving device used to control irregular heart activity. A Basic Life Support alarm usually results in the dispatch of a single BLS unit, which may be an engine, ladder truck, or fire squad staffed by Firefighter-Emergency Medical Technicians (EMTs). Almost all members of the Milwaukee Fire Department are trained as EMT, and many have received additional training to qualify them as Paramedics.

In addition to traditional fire-fighting and EMS functions, the Milwaukee Fire Department has several specially trained units which perform extra duties. The Dive Rescue Team and fireboat respond to water incidents. The Hazardous Materials Team responds to incidents involving the unintentional release of hazardous materials. The Heavy Urban Rescue Team (HURT) responds to building collapses, construction site incidents, confined space emergencies, and similar situations, including rescue of trapped firefighters. Special team responses, while infrequent, may require extensive Fire Department time on scene, as well as advance readiness in the form of specialized training and equipment. Table 3.28 indicates recent activity of each of these special teams.

Historical Major Fires and Emergency Medical Incidents

Historically, Milwaukee's greatest fire to date occurred in 1892 in what was known as the Irish 3rd Ward**.** The fire originated at what is now 232 North Water Street. More than 440 buildings throughout 16 city blocks were completely destroyed. Calculated in terms of an 1892 appraisal, the loss was in excess of $4.5 million or over $100 million in today's terms. Two firemen and five other people died, and more than 1,800 people were made homeless.

Description of Recent Major Fires and Emergency Medical Incidents

In 2015, the Milwaukee Fire Department responded to 13,999 fire, service, and rescue alarms and 70,504 Emergency Medical Service (EMS) calls. Table 3.28 illustrates the number of fire and emergency medical service responses between 2000 and 2015. Fire alarms include any dangerous situation which is not classified as medical, including gas leaks, oil spills, water leaks, electrical problems or malfunctioning appliances, extrications from vehicles involved in accidents, and a wide variety of other situations in addition to fires. Of the fire alarms in 2015, 1,039 were for residential and building fires in which structural damage and loss of contents totaled $25.5 million. Ten of these fires resulted in ten fatalities.

For a fire or hazard alarm, the minimum MFD response is a pumping engine and a ladder truck. More typically, the response would include three pumping engines, two ladder trucks, a fire squad, and two battalion chiefs. "Greater alarm" fires are incidents requiring additional equipment and personnel to respond. In 2009, 18 "greater alarms" or major incidents requiring additional equipment and personnel to respond occurred. No estimates are available on the loss or damage to property and value of contents resulting from these fires. Over the period 2000 through 2004, the last period for which data are available, annual damages to property and value of contents resulting from "greater alarm" incidents ranged between $2.2 million and $8.6 million with an annual average of $5.1 million.[119] In December 2003, a fire broke out on the 14th floor at 111 East Wisconsin Avenue (also known as the Bank One building) in downtown Milwaukee. It is believed that welding sparks from building renovation on the 17th floor traveled down a pipe shaft, igniting paper on the 14th floor. This fire caused more than $1.3 million in damage and injured three people. On December 6, 2006, a gas explosion related to a gas leak occurred at Falk Corporation in the Menomonee Valley. This explosion killed three people and injured 47. Debris from the explosion landed several blocks away. The incident was classified as a five-alarm fire.

On January 18, 2010, a four-alarm fire broke out at a building at the corner of E. North Avenue and Oakland Avenue. Over 150 firefighters responded to this blaze. The fire destroyed a restaurant, three other businesses, and 10 apartments. Damages resulting from the fire were estimated at $3.3 million.

[119] *Damages were adjusted to 2016 dollars using the Consumer Price Index.*

Table 3.28
Fire and Emergency Response Rates Within the City of Milwaukee: 2000-2015

Year	Emergency Medical Service Responses	EMS Response per 100,000 Persons	Number of Residential Building Fires	Fire Fatalities Rate per 100,000 Persons	Reported Damages			Special Team Responses		
					Fatalities	Total Property Damages (in millions of dollars)[a,b]	Residential Property Damages (in millions of dollars)[a]	DIVE	HURT	HAZMAT
2000	49,833	8,347.6	1,542	1.17	7 (in 5 fires)	25.2	16.5	29	13	24
2001	49,452	8,283.8	1,308	1.34	8 (in 7 fires)	29.8	16.1	24	18	24
2002	49,188	8,239.6	1,177	1.00	6 (in five fires)	28.0	15.1	56	83	209[c]
2003	48,593	8,139.9	1,612	1.70	10 (in 8 fires)	15.7	11.6	12	15	14
2004	54,028	9,050.3	--[d]	2.01	12 (in 9 fires)	21.7	16.2	22	7	17
2005	50,442	8,449.6	641	2.68	16 (in 9 fires)	19.7	12.5	29	9	20
2006	59,567	9,978.2	493	2.01	12 (in 9 fires	19.6	8.4	22	16	25
2007	48,890	8,110.7	583	2.32	14 (in 13 fires)	20.9	10.5	38	12	29
2008	55,898	9,273.3	343	1.00	6 (in 5 fires)	15.0	10.6	23	9	25
2009	53,047	8,886.0	305	1.16	7 (in 7 fires)	12.9	10.1	37	8	21
2010	54,927	9,234.0	958	0.50	4 (in 4 fires)	11.3	8.1	42	10	14
2011	56,085	9,417.7	1,166	1.68	11 (in 10 fires)	14.7	9.9	24	15	70
2012	59,587	10,005.5	1,151	1.34	8 (in 8 fires)	13.1	8.6	--[d]	11	--[d]
2013	60,499	10,142.3	1,074	0.34	2 (in two fires)	22.8	15.7	37	--[d]	--[d]
2014	62,766	10,531.3	1,107	1.68	10 (in 10 fires)	45.5	28.1	32	13	92
2015	70,504	11,833.8	1,039	1.68	10 (in 10 fires)	33.9	25.5	19	6	88
Total	883,306	--	14,499	--	142 (in 121 fires)	349.8	223.5	346	245	672

[a] *Dollar values are adjusted to year 2016 by using the average annual Consumer Price Index (CPI) values from the U.S. Department of Labor, Bureau of Labor Statistics.*

[b] *Includes buildings (residential and nonresidential), contents, vehicles, and other nonstructural fires.*

[c] *Total includes five responses outside of the City of Milwaukee.*

[d] *Data not available*

Source: City of Milwaukee Public Safety Report, Milwaukee Fire Department Annual Report, Milwaukee Fire Department

On June 20, 2012 a five-alarm fire occurred at a grocery store at N. 12th Street and W. Vliet Street. According to news reports, over 150 firefighters responded to this fire. The building was destroyed when its roof and three exterior walls collapsed. One firefighter sustained minor injuries fighting this blaze.

On July 17, 2012, a five-alarm fire broke out in a building housing and automobile repair shop, artist studios and galleries and apartments on E. Center Street. Over 100 firefighters responded. During the fire, portions of the 25,000-square foot building and roof collapsed. According to news reports, two firefighters were treated for heat exhaustion.

Vulnerability and Community Impact Assessment

Table 3.28 shows the number of fire deaths, fires and other hazard incidents, and medical responses, and the rate of fires per 1,000 people. EMS responses account for about three-quarters of Fire Department dispatches. Like fire alarms, the number of emergency medical alarms is usually highest in the summer. Fire and emergency medical incidents are not evenly distributed throughout the City. Densely populated areas may be more at risk for major fire and fire fatalities and injuries than more sparsely populated areas. Children and the elderly are most at risk for fatality or injury due to fire.

Generally, most fire injuries and fatalities occur in home and residential fires. In 2016, about 81 percent of all fire fatalities nationwide occurred in the home.[120] Figure 3.11 shows the number of fatal fires that occurred between 1990 and 2015 in the City of Milwaukee, and that the number of adults and children that have died in fires has significantly declined over this time period. In addition, fires caused by children playing with matches or other incendiary devices significantly declined during this time period as shown in Figure 3.12. In 1992, over 110 nonfatal fires were started by children playing with matches, lighters, or other heat sources. The Milwaukee Fire Department reported that in 2003, 38 nonfatal fires were caused by children playing with incendiary devices. In 2015, Milwaukee Fire Department reported that only 25 fires were caused by ignition related to matches, lighters, and similar incendiary devices. Similar declines were seen in fires started by careless smoking: in 1991, over 80 nonfatal fires were reported to have been caused by careless smoking. This number decreased to a low in 2005, with six fires caused by ignition related to smoking materials. While the number of fires caused by ignition related to smoking materials has increased slightly since then, it remains substantially lower than it was in the early 1990s.

Based on fire incidents reported between 2000 and 2015, it is likely that the City of Milwaukee will continue to average approximately 960 fires per year, and over the next few years, an estimated 7.6 fires could result in 8.9 fatalities each year.

In 2016, the total equalized assessed property value in the City of Milwaukee was estimated at over $25.1 billion.[121] Slightly over $20.7 billion of this total is comprised of buildings and other improvements. Based on data from 2000-2015, total property damages due to fire are approximately $21.9 million per year, or less than 0.1 percent of the total assessed property value in the City of Milwaukee. All buildings, infrastructure, and critical facilities within the City are considered at risk for fire. Based on availability, the 2016 assessed values of the identified critical facilities are provided in Appendix B.

Potential Future Changes in Major Fire and Emergency Response Conditions

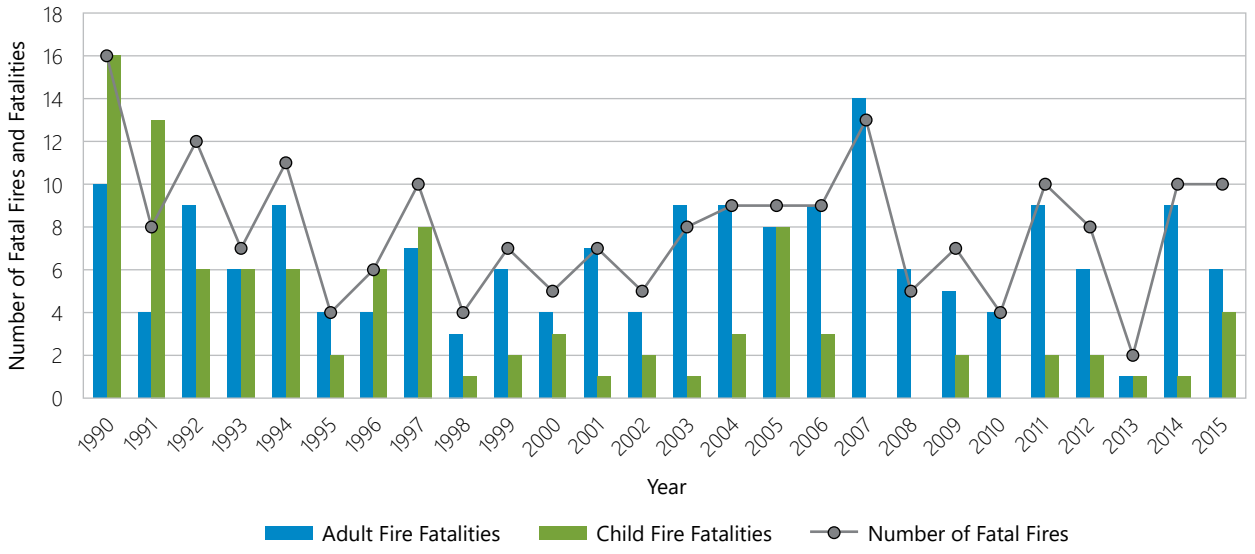
Several fire safety programs were implemented in the early 1990s and results indicate that the number of fatal fires and fatalities have decreased (further details of these programs are included in Chapter 5 of this report).[122] In 1991, the Milwaukee Fire Department instituted the FOCUS program (Firefighters Out Creating Urban Safety) to educate the public. In FOCUS, firefighters go door-to-door in targeted areas to install smoke detectors, explain their maintenance and replace batteries, provide fire safety tips, and answer questions. In 1992, Milwaukee Fire Education Center's Survive Alive House officially opened. Over 13,000 Milwaukee children visit each year to learn to survive in the event of an actual fire in the home. The house is available to public and private schools located in the City of Milwaukee. Child fatalities have greatly

[120] *Hylton J.G. Haynes, "Fire Loss in the United States during 2016,"* op. cit.

[121] *Wisconsin Department of Revenue.*

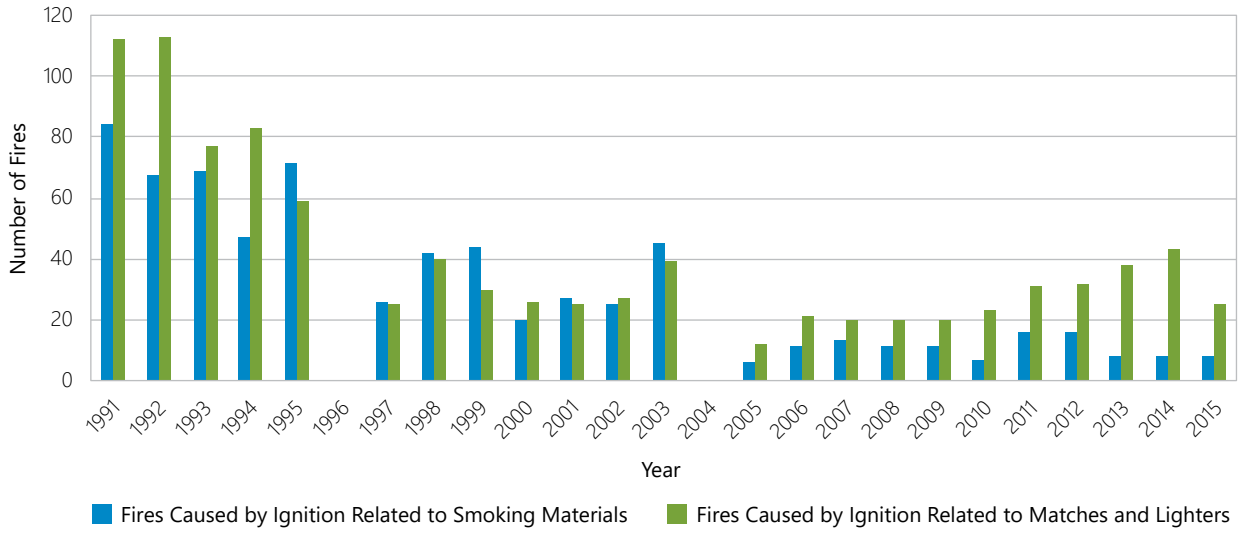
[122] *Milwaukee Fire Department community relations programs are described on the department website at city.milwaukee.gov/CommunityRelations.htm.*

Figure 3.11
Number of Fatal Fires and Fire Fatalities in the City of Milwaukee: 1990-2015



Source: City of Milwaukee Public Safety Report, City of Milwaukee Fire Department, and City of Milwaukee Police Department

Figure 3.12
Number of Fires in the City of Milwaukee Caused by Ignition Related to Smoking Material or Matches and Lighters: 1990-2015



Note: Data were not available for years 1996 and 2004.

Source: City of Milwaukee Public Safety Report, City of Milwaukee Fire Department, and City of Milwaukee Police Department

decreased since this program has been implemented. In 1997, the Fire Department also began providing fire inspection services for public buildings. The Fire Department also works with building managers to identify any potential fire hazards.

As the Milwaukee Fire Department continues to teach the public fire safety techniques and further outreach efforts to provide smoke detectors, the City of Milwaukee may continue to see decline in the number of fatalities and injuries associated with fires.

HAZARD MITIGATION GOALS AND OBJECTIVES 4

Planning may be defined as a rational process for formulating and meeting goals and objectives. Consequently, the formulation of 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 for use in consideration of alternative hazard mitigation strategies for the City of Milwaukee and in the selection of recommended strategies from among those alternatives.

It is important to note that Milwaukee County has completed a Pre-Disaster Mitigation Plan that includes specific goals and objectives that were developed through a series of public meetings and stakeholder interviews to assist County residents, local governments, and others in reducing risk and preventing loss from future hazard events.[123] The two goals stated in the Milwaukee County plan that are identified specifically for the City of Milwaukee, are to reduce the impacts from flooding and to enhance emergency response capabilities, both of which have been incorporated into the formulation of goals and objectives for this Plan as shown in Figure 4.1 (see Objective 4 and 6).

In formulating and setting forth goals and objectives, their differing natures and purposes must be kept in mind. In this regard, the definition of goals and objectives used herein is as promoted by the Federal Emergency Management Agency (FEMA). Goals are general guidelines that explain what a community desires to achieve. Based upon the selected goals, a community can then develop the specific objectives or standards needed to attain the goals. Objectives and standards more narrowly define strategies for meeting the selected goals and are more specific than goals.

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

The City of Milwaukee has prepared a comprehensive plan that will provide a basis for broad-based decision-making on land use-related issues by City officials and will increase the awareness of City planning goals and objectives by landowners, developers, and other private interests. That plan incorporates elements from other pertinent City, County, and Regional plans as appropriate. Components of that plan are listed in Table 1.1 in Chapter 1 of this report.

Milwaukee County has also prepared and adopted a park and open space plan[124] and the Regional Planning Commission has prepared and adopted a regional land use and transportation plan.[125] The City of Milwaukee has prepared a comprehensive outdoor recreation plan.[126] These plans provide guidance in preserving and developing recreational, land use, and other open space uses throughout the City. In addition, comprehensive

[123] *Milwaukee County Emergency Management,* Milwaukee County Wisconsin Pre-Disaster Mitigation Plan*, August 2004; Milwaukee County Emergency Management,* Milwaukee County Wisconsin Pre-Disaster Mitigation Plan*, June 2011; Milwaukee County Office of Emergency Management,* Milwaukee County Hazard Mitigation Plan*, draft, October 19, 2017.*

[124] *SEWRPC Planning Report No. 132,* A Park and Open Space Plan for Milwaukee County*, November 1991.*

[125] *SEWRPC Planning Report No. 55,* Vision 2050: A Regional Land Use and Transportation Plan for Southeastern Wisconsin*, July 2017.*

[126] *City of Milwaukee Department of City Development, Department of Public Works, and Environmental Collaboration Office,* City of Milwaukee Comprehensive Outdoor Recreation Plan 2016-2021*, September 2016.*

Figure 4.1
Objectives and Standards for the City of Milwaukee All Hazards Mitigation Plan

➤ **Objective 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.**

- **Standard 1.1:** Urban high-, medium-, and low-density residential uses should be located within planning units which are served with centralized public sanitary sewerage and water supply facilities and contain, within a reasonable walking distance, necessary supporting local service uses, such as neighborhood park, local commercial, and elementary school facilities, and should have reasonable access through the appropriate component of the transportation system to employment, commercial, cultural, and governmental centers, and secondary school and higher educational facilities; and should be provided with readily available fire and police protection and emergency medical services.

- **Standard 1.2:** Rural- and suburban-density residential uses should have reasonable access through the appropriate component of the transportation system to local service uses; employment, commercial, cultural, and governmental centers; and secondary school and higher educational facilities and should have reasonable access to fire and police protection and emergency medical services.

- **Standard 1.3:** Industrial uses should be located to have direct access to arterial street and highway facilities and reasonable access through an appropriate component of the transportation system to residential areas and to railway, seaport, and airport facilities, and should not be intermixed with commercial, residential, governmental, recreational, or institutional land uses; and should be provided with readily available fire and police protection and emergency medical services.

- **Standard 1.4:** Major commercial uses should be located in centers of concentrated activity on only one side of an arterial street and should be afforded direct access to the arterial street system; and should be provided with readily available fire and police protection and emergency medical services.

➤ **Objective 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.**

- **Standard 2.1:** Urban development should not be located in areas which would cause or be subject to flood damage.

- **Standard 2.2:** No structure or fill should be allowed to encroach upon and obstruct the flow of water in perennial stream channels.

- **Standard 2.3:** The types and distribution of land uses should be developed considering the potential impacts on flood flows, on surface water quality, and on groundwater quality and quantity.

- **Standard 2.4:** All remaining undeveloped lands within the designated primary environmental corridors in the City should be preserved in essentially natural, open uses.

- **Standard 2.5:** All remaining undeveloped lands within the designated secondary environmental corridors and isolated natural areas in the City should be considered for preservation as urban development proceeds and used as drainageways, floodwater storage areas, and parks.

- **Standard 2.6:** 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, the City may choose to preserve all wetlands.

Figure 4.1 (Continued)

➤ **Objective 3: The provision of facilities necessary to maintain a high quality of fire and police protection and emergency medical services throughout the City.**

- **Standard 3.1:** Because adequate fire and police protection and emergency medical services are essential to the protection of the public health and safety and of real property values, and is a public service which enhances the economic development potential of an area, fire and police stations and emergency medical equipment should be developed and distributed based upon the accepted standards for such services.

➤ **Objective 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.**

- **Standard 4.1:** In order to prevent significant property damage and safety hazards, the major components of the stormwater management system and the floodplain management system should be designed to accommodate runoff from a one-percent-annual probability storm event.

- **Standard 4.2:** In order to provide for an acceptable level of access to property and of traffic service, the minor components of the stormwater management system should be designed to accommodate a runoff from a 10-percent-annual-probability storm event in the combined sewer area of the City and a 20-percent-annual-probability storm event in the separate sewer area of the City.

- **Standard 4.3:** In order to provide for an acceptable level of access to property and of traffic service, the stormwater management system should be designed to provide two clear 10-foot lanes for moving traffic on existing arterial streets, and one clear 10-foot lane for moving traffic on existing collector and land access streets during storm events up to and including the 10-percent-annual-probability event in the combined sewer area of the City and a 20-percent-annual-probability event in the separate sewer area of the City.

- **Standard 4.4:** Flow of stormwater along and across the full pavement width of collector and land access streets shall be acceptable during storm events exceeding a 10-percent-annual-probability event in the combined sewer area of the City and a 20-percent-annual-probability event in the separate sewer area of the City when the streets are intended to constitute integral parts of the major stormwater drainage system.

- **Standard 4.5:** Plan components shall be designed to comply with the requirements of Chapter NR 116 of the Wisconsin Administrative Code.

- **Standard 4.6:** All new and replacement bridges and culverts over waterways shall be designed so as to accommodate, according to the categories listed below, the designated flood events without overtopping of the related roadway or railway track.

  a. Minor and collector streets used or intended to be used primarily for access to abutting properties: a 10-percent-annual-probability flood discharge.

  b. Arterial streets and highways, other than freeways and expressways, used or intended to be used primarily to carry heavy volumes of through traffic: a two-percent-annual-probability flood discharge.

  c. Freeways and expressways: a one-percent-annual-probability flood discharge.

  d. Railways: a one-percent-annual-probability flood discharge.

Figure 4.1 (Continued)

- **Standard 4.7:** All new and replacement bridges and culverts along waterways shall be designed so as not to inhibit fish passage in areas especially during low flow time periods which are supporting, or which are capable of supporting, valuable recreational sport and forage fish species.

- **Standard 4.8:** 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.

- **Standard 4.9:** In order to prevent property losses and health and safety hazards, the sanitary sewerage system and related stormwater and floodplain management systems should be designed to minimize basement backups through a) implementing the recommendations of the Milwaukee Metropolitan Sewerage District 2050 facilities plan and b) reducing problem sources of infiltration and inflow to the sanitary sewerage system.

➤ **Objective 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 real and personal property to shoreline erosion and bluff recession.**

- **Standard 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 study.[a]

➤ **Objective 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.**

[a] *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, *December 1997.*

Source: SEWRPC

watershed plans[127] have been developed for each of the major watershed areas which include areas in the City of Milwaukee. These plans included evaluation of alternatives and recommended flood mitigation plans developed on a comprehensive watershedwide basis. As park and open space planning, land use, and floodplain management planning is carried out in the City of Milwaukee and in the related watersheds, an integration and coordination of the goals and objectives has taken place. Park and open space and land use planning goals and objectives are integrated and coordinated with floodplain management planning. This is accomplished at the watershed level by developing comprehensive watershed plans which include floodplain management, land use, park and open space, and water quality planning in one integrated planning program. These watershed plans form a potential framework for subwatershed-level planning programs. As an example, the comprehensive watershed planning objectives, principles, and standards for the comprehensive plan for the Menomonee River watershed[128] include several specific objectives and supporting standards related to land use and park and open space use, as well as objectives and standards relating to flood control.

[127] *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. 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; SEWRPC Planning Report No. 32,* A Comprehensive Plan for the Kinnickinnic River Watershed*, December 1978; 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; and SEWRPC Community Assistance Planning Report No. 261,* Flood Mitigation Plan for the City of Milwaukee, Milwaukee County, Wisconsin*, October 2000.*

[128] *SEWRPC Planning Report No. 26,* op cit.

It is important to note that the flood control element of his hazard mitigation plan relies directly on the Milwaukee Metropolitan Sewerage District (MMSD) Watercourse Management Planning Program. That program includes a set of watercourse management plan objectives which are incorporated herein. The goals and objectives of the MMSD program are summarized as follows and are documented in the MMSD Phase 1 and Phase 2 watercourse management plans and subsequent documents.[129]

The overall goal of the MMSD watercourse management plan 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 100-year event
- 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.

4.2 HAZARD MITIGATION GOALS AND OBJECTIVES FOR THE CITY OF MILWAUKEE HAZARD MITIGATION PLAN

The following objectives have been established for the City of Milwaukee hazard mitigation planning program. The objectives have been established based, in part, upon goals previously established in watershed, park and open space, and land use planning programs. The fact that the objectives of this plan are drawn from and overlap with the goals of the other plans cited earlier in this chapter begins the integration of this plan into other planning mechanisms. At this point, this plan has not yet been further integrated into such planning mechanisms.

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.

[129] *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*, May 4, 2017; Milwaukee Metropolitan Sewerage District,* Menomonee River Phase 1 Watercourse System Management Plan*, August 2000; Milwaukee Metropolitan Sewerage District,* Menomonee River Phase 2 Watercourse Management Plan*, July 2002; Milwaukee Metropolitan Sewerage District,* Milwaukee River Watershed Phase 1 Watercourse System Management Plan*, August 2000;* Milwaukee Metropolitan Sewerage District, Lake Michigan Direct Drainage Area Phase 1 Watercourse System Management Plan*, August 2000;* Milwaukee Metropolitan Sewerage District, Oak Creek Phase 1 Watercourse Management Plan*, August 2000;* Milwaukee Metropolitan Sewerage District, Root River Phase 1 Watercourse Management Plan*, August 2000; and SEWRPC Memorandum Report No. 172,* A Watercourse System Plan for the Milwaukee River in Milwaukee County Upstream of the Milwaukee Harbor Estuary*, December 2010*.

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.

The population distribution by census block in the year 2010 shows maximum populations densities of more than 2,300 persons per census block, while most of the City of Milwaukee has population densities of 50 to 300 persons per census block, as shown on Map 2.2 in Chapter 2 of this report.

HAZARD MITIGATION STRATEGIES 5

Hazard mitigation planning may be defined as the systematic evaluation of the nature and vulnerability of hazards present, along with the development and implementation of sustained actions to reduce or eliminate long-term risks from hazards and their effects. Specific purposes of hazard mitigation include the elimination of loss of life, lessening of danger to human health and safety, minimization of monetary damage to private and public property, reduction in the cost of utilities and services, and minimization of disruption in community affairs. Hazard mitigation also involves the avoidance of intensification of existing and creation of new hazards.

The preparation of an all hazards mitigation plan for the City of Milwaukee involves the development and evaluation of alternative mitigation measures and plan elements, and the synthesis of the most effective elements into an integrated plan. Some of the mitigative measures described are ongoing or committed actions, which do not require the evaluation of alternative measures, but are proposed to be integrated into the mitigation plan as such. For other hazards, there may be only one or a number of integrated viable options. In these cases, alternatives are not presented and cost-effectiveness is not specifically addressed, but is implied by the nature of the mitigation measures. In other instances where there are viable alternatives, such alternatives are described and evaluated. However, flood mitigation alternatives were developed and summarized in the flood mitigation plan for the City of Milwaukee[130] and in several Milwaukee Metropolitan Sewerage District (MMSD) watercourse and flood management plans, therefore, only the recommended flood mitigation elements are presented in this report. This chapter describes the hazard mitigation measures considered to resolve the identified hazard problems within the City of Milwaukee.

The recommended hazard mitigation measures identified in the August 2017, Milwaukee County pre-disaster mitigation plan were also reviewed and incorporated herein as appropriate and applicable to the City of Milwaukee.

In preparing the updated plan, the City of Milwaukee Hazard Mitigation Local Planning Team reviewed and reevaluated the hazard mitigation goals, objectives, and supporting standards for the City (see Chapter 4 of this report). This review included consideration of whether the goals of the initial plan were still applicable and whether additional goals should be added. In addition, the Local Planning Team also reviewed and reevaluated hazard conditions within the City (see Chapter 3 of this report). This review included reevaluation of the identification of the hazards likely to affect the City, updating the data upon which the profiles of the extent and severity of hazard events which occurred in the City were based, reassessment of the vulnerability and risk associated with each type of hazard in light of the updated data, and reevaluation as warranted by the updated assessments of the potential for changes in hazard severity and risk under future conditions. This review and reevaluation of hazard mitigation goals and hazard conditions, along with consideration of changes in conditions in the City of Milwaukee since the initial plan was issued (see Chapter 2 of this report) and progress in implementing the initial plan, served as the basis for the Local Planning Team's review and reevaluation of measures to reduce vulnerability to hazards identified in the updated risk assessment and the Committee's selection of priority measures to address those hazards. The activities of the Local Planning Team are documented in Appendix A of this report.

Measures have been identified and evaluated for each of the hazards for which a vulnerability analysis was developed as set forth in Chapter 3.

[130] *SEWRPC Community Assistance Planning Report No. 261,* Flood Mitigation Plan for the City of Milwaukee*,* Milwaukee County, Wisconsin*, October 2000, revised April 2003.*

5.1 HAZARD MITIGATION PLAN COMPONENT FOR FLOODING AND ASSOCIATED STORMWATER DRAINAGE PROBLEMS

The flooding and related stormwater drainage problem mitigation plan for the City of Milwaukee consists of five elements: a floodplain and environmentally sensitive lands preservation element, a floodplain management element, a stormwater management element, a public information and education element, and a secondary plan element. Each element of the plan is an important component of the overall strategy for reducing flood risk and flood damage. Some aspects of the overall plan are already being implemented in the form of existing and ongoing activities being carried out by the City of Milwaukee and other local units of government that contribute toward realizing the flood mitigation goals and objectives.

City of Milwaukee Flooding Study Task Force

In response to the flooding, stormwater management, and basement backup problems that occurred during July 2010, the City formed a Flooding Study Task Force. The Task Force included representatives from the staffs of the City Engineering Department, the City Office of Environmental Collaboration, the WDNR Wastewater Section, MMSD, and the Southeastern Wisconsin Regional Planning Commission (SEWRPC), along with City Council members and a State Representative. The Task Force submitted a report and recommendations to the City of Milwaukee Common Council on June 11, 2011.[131] The report recommended that the City:

- Adopt the new rainfall frequency information released in 2012 by the National Oceanic and Atmospheric Administration titled NOAA Atlas 14;

- Work with MMSD, SEWRPC, and the Wisconsin Initiative on Climate Change Impacts to keep abreast of possible climate change trends and incorporate emerging climate models and rainfall frequency into sewer design criteria;

- Complete a Private Property Inflow and Infiltration Demonstration Project and evaluate the project's results to assess the effectiveness of the techniques used for cost-effectiveness and their ability to reduce future basement backups;

- Evaluate areas that have a history of surface flooding to identify measures that will improve appropriate stormwater flow paths and identify management measures to address deficiencies. Such measures should include green infrastructure elements that help control stormwater in identified problem areas;

- Collaborate with Milwaukee County to determine where existing parkland can be improved to provide stormwater benefit to areas with significant surface flooding;

- Work with MMSD to identify locations where the MMSD Metropolitan Interceptor System (MIS) could surcharge into a municipal sanitary sewer during a large storm, to establish critical elevations at connections to the MIS, and to pursue possible MIS and/or local system upgrades to minimize the occurrence of basement backups in such situations;

- Require that all new development and major redevelopment meet a stormwater retention standard of 1.2 inches and 1.0 inch, respectively;

- Develop policies to incorporate green infrastructure into development, re-development, and street construction efforts;

- Continue to engage in targeted separation of combined sewers in areas where timing and volume generate a high risk of inflow-induced backups and where limited utility connections and an accessible outlet allow for separation to be cost-effective;

- Consider future changes to the City's ordinances requiring the mandatory disconnection of foundation drains and the rehabilitation or replacement of faulty sewer laterals. Such changes

[131] *City of Milwaukee Flooding Study Task Force,* Report, *June 10, 2011.*

should be considered only as a part of a uniform policy requirement within the entire MMSD service area;

- Lobby for increased State assistance in flood mitigation projects;

- Evaluate the combined sewer area to establish targeted zones where mandatory downspout disconnections can be implemented;

- Work with MMSD and other partners to better educate the public on the causes and effects of sewer and flooding issues and the remedies at hand;

- Pursue funding from Federal, State, and MMSD sources to fund an effective flooding prevention program;

- Consider one hundred percent cost recovery for any work that involves the capping of foundation drains and installation of sump pump systems, including considering requiring property owners to pay for some or all of the cost of electrical upgrades to their property when such an upgrade is required for the installation of a sump pump;

- Consider a reasonable cost recovery subsidy for any sanitary sewer lateral work that is identified in need of lining or replacement;

- Not recommend or endorse any outside lateral insurance plan unless the plan is devised to cover the scope of work required to remedy identified inflow and infiltration issues; and

- Continue to allow the private installation of backup prevention devices, but not fund or subsidize any costs associated with such devices.

- As of 2019, some of the recommendations made in the Task Force's report have been implemented. One example includes completion of a Private Property Inflow and Infiltration Demonstration Project (see the section below on basement backup problems). Other recommendations reflect activities that are in progress or ongoing.

Floodplain and Environmentally Sensitive Lands Preservation Element

Floodplain management regulations and programs perform critical roles in assuring that flood mitigation efforts are properly implemented. As detailed in Chapter 2, the City of Milwaukee currently has several pertinent floodplain management regulations and programs in place, most notably in the form of zoning regulations and other ordinances, and environmentally sensitive area and open space preservation policies. A significant portion of the environmentally sensitive lands within the City of Milwaukee, including wetlands, woodlands, and floodplains, are under protective ownership and/or zoning.

Floodplain Zoning and Regulations

The City of Milwaukee floodplain zoning ordinance is intended to preserve the floodwater conveyance and storage capacity of floodplain areas and to prevent the location of new flood-damage-prone development in flood hazard areas. More information regarding this ordinance is set forth in Chapter 2 of this report. Implementation of this ordinance on an ongoing basis is an integral part of the City flood mitigation strategy. In this regard, the City will continue to work cooperatively with the Milwaukee County Land Information Council program,[132] MMSD, and the SEWRPC to incorporate references to updated floodplain mapping and studies which are currently being prepared, or have been prepared under an ongoing floodplain mapping program being conducted by SEWRPC for the Milwaukee County Land Information Council and MMSD. Those studies will ultimately be submitted to the Wisconsin Department of Natural Resources (WDNR) and Federal Emergency Management Agency (FEMA) for review and incorporation in the FEMA digital flood insurance rate maps (DFIRM) for Milwaukee County and the City floodplain zoning ordinance. Updating has

[132] *The Milwaukee County Land Information Council is the successor to the Milwaukee County Automated Mapping and Land Information (MCAMLIS) Steering Committee.*

been completed for the flood hazard areas associated with Lincoln Creek, the Milwaukee River, and some portions of the Menomonee River that are located in the City.

In the future it is anticipated that updated SEWRPC studies of the Kinnickinnic River, Lyons Park Creek, Wilson Park Creek, and the portions of Villa Mann Creek and Honey Creek within the City will be incorporated in the FEMA DFIRM and the City zoning ordinance. In 2014, a consultant to MMSD completed an updated hydrological model for the S. 43rd Street Ditch for the MCAMLIS Steering Committee and MMSD. In 2015, SEWRPC completed an updated hydraulic model for the S. 43rd Street Ditch for the MCAMLIS Steering Committee and MMSD. Completion of these models has resulted in an updated one-percent-annual-probability floodplain for this tributary. In 2016, a Conditional Letter of Map Revision (CLOMR) was approved by FEMA for the Menomonee River from North Avenue downstream to its mouth. The CLOMR included updated floodplain delineations for completed and proposed flood mitigation projects on the Menomonee River mainstem.

In addition, the MMSD has adopted a comprehensive stormwater rule, Chapter 13 of the MMSD rules, designed to minimize the potential for new development or redevelopment within or upstream of the City within the MMSD service area to increase flood risk. The rule, which took effect on January 1, 2002, and was amended on October 25, 2010, March 24, 2014, and December 19, 2016, requires the management of the volume and peak rate of stormwater flows from new development and redevelopment in an effort to avoid increases in downstream flooding. MMSD repealed and recreated Chapter 13 on March 25, 2019. The provisions of the revised chapter became effective on April 1, 2019. The District gave the municipalities it serves one year to revise their municipal codes to reflect the provisions of the revised chapter.

Environmentally Sensitive Area and Open Space Preservation Actions

As noted in Chapter 2 of this report, the preservation of environmental corridors and important natural features can assist in preventing increased flood flows and associated problems. These areas often include the most significant floodplains and wetlands within a given area. The preservation of wetlands is of particular importance because wetlands often afford natural filtration and floodwater storage. In addition, the intrusion of intensive urban land uses into environmentally sensitive areas may result in the creation of serious and costly problems, such as failing foundations for pavements and structures, wet basements, excessive operation of sump pumps, excessive clear-water infiltration into sanitary sewerage systems, and poor drainage. Destruction of ground cover may result in soil erosion, stream siltation, more rapid runoff, and increased flooding.

The regional land use plan includes provisions to preserve environmental corridors and isolated natural resource areas.[133] This regional plan forms the framework for ongoing local land use planning by the City of Milwaukee and Milwaukee County. Environmental corridors and floodplains are generally linear in nature and are often located along steam corridors within and upstream of the City of Milwaukee. Thus, any viable approach to planning for these lands and other environmentally sensitive areas located partly or wholly within the City of Milwaukee must encompass an area larger than the City alone. Such areas within the City of Milwaukee have been addressed through planning efforts undertaken by and for Milwaukee County. In 1991, the Milwaukee County Board of Supervisors adopted the Milwaukee County Park and Open Space Plan completed by SEWRPC.[134] Milwaukee County has primary responsibility for parks and related open space areas within the County, including within the City of Milwaukee.

Milwaukee County has taken an active role in preserving environmentally sensitive lands and currently owns approximately 15,400 acres of park, parkway, and open space land located in 160 sites. Of this, there are approximately 7,700 acres of park, parkway, and open space located in the City of Milwaukee. The current locations of major parks, primary and secondary environmental corridors, and isolated natural resource areas are shown on Map 5.1. 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.

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[133] *SEWRPC Planning Report No. 55,* Vision 2050: A Regional Land Use Plan for Southeastern Wisconsin, *July 2017.*

[134] *SEWRPC Community Assistance Planning Report No. 132,* A Park and Open Space Plan for Milwaukee County, *November 1991. This plan is currently being updated and revised.*

In 2001 the MMSD created the Greenseams program that contributes to the preservation of floodplains and environmentally sensitive areas. This program combines the conservation plan prepared by the MMSD with the "greenway connection plan" developed with assistance from SEWRPC. The conservation plan identified land parcels which are recommended to be protected for multiple purposes, including flood reduction potential and stormwater management benefits, as well as wildlife habitat, water quality, and recreational benefits. The conservation plan identified a number of sites for protection through public acquisition or conservation easements throughout the Menomonee River, Root River, and Oak Creek watersheds within the District.[135] The Greenseams program, which is managed by The Conservation Fund, has to date acquired 3,383 acres, including about 108 acres within the City of Milwaukee.

Floodplain Management Element

As noted in Chapter 4, identification, analysis, and recommendation of possible methods of mitigating flooding problems in the City have been the subject of various planning efforts. The most recent effort is currently being carried out by the MMSD under its watercourse system management planning program. This planning effort is intended to update and refine the 1990 MMSD watercourse system plan, which in turn was built upon the findings of the comprehensive watershed system plans prepared by SEWRPC for the five major watersheds that lie within the City. As with those earlier efforts, the current planning program uses the watershed as the basic geographic unit for planning. Thus, the floodplain management elements set forth below are also presented by watershed in summary form. Additional detail regarding the plan for each watershed is available in the referenced advanced planning reports prepared by various consultants for the MMSD.

Floodplain Management Plan for the Kinnickinnic River Watershed

The MMSD has recently completed an advanced planning effort of its watercourse system plan for the Kinnickinnic River watershed. This planning is documented in the Kinnickinnic River Watershed Flood Management Plan.[136] This plan includes recommendations for flood mitigation for the mainstem of the Kinnickinnic River, Wilson Park Creek, Lyons Park Creek, Villa Mann Creek, an unnamed tributary to Villa Mann Creek, and the S. 43rd Street Ditch.

Recommendations from this plan are shown in Table 5.1. As shown in the table, the estimated capital cost of implementing the floodplain management plan for the Kinnickinnic River watershed is about $283.1 million. The recommended improvements are described in the following subsections.

Recommended Improvements along the Mainstem of the Kinnickinnic River

The improvements along the mainstem of the Kinnickinnic River recommended in the Kinnickinnic River watershed flood management plan extend continuously for about 4.5 miles of channel from S. 6th Street to S. 43rd Street.

Improvements Between S. 6th Street and S. 27th Street

The recommended improvements for the section of the mainstem of the Kinnickinnic River between S. 6th Street and S. 27th Street consist of replacing the concrete channel lining with a more naturalized stream design, widening the stream corridor, acquiring and demolishing 83 structures between S. 6th Street and S. 16th Street to allow for the wider stream and replacing five vehicular and four pedestrian bridges. In addition to recommending the acquisition and removal of 83 structures required for the construction corridor, the plan recommends the acquisition and removal or floodproofing of seven flood-prone residential structures that are expected to remain in the floodplain after the recommended improvements are implemented. Acquisition or floodproofing for these seven structures would be performed on a voluntary basis at the option of the property owners.

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[135] *The Conservation Fund; Applied Ecological Services, Inc.; Heart Lake Conservation Associates; Velasco and Associates; and K. Singh and Associates,* Conservation Plan, Technical Report submitted to the Milwaukee Metropolitan Sewerage District, *October 31, 2001; SEWRPC Memorandum Report No. 152,* A Greenway Connection Plan for the Milwaukee Metropolitan Sewerage District, *December 2002.*

[136] *Milwaukee Metropolitan Sewerage District,* Kinnickinnic River Watershed Flood Management Plan: Final Report, *May 4, 2017.*

Table 5.1
Components and Costs of Floodplain Management Plan for the Kinnickinnic River Watershed

Plan Components	Estimated Capital Cost ($)[a]
Kinnickinnic River	
1. Channel and Floodplain Improvements	
a. Stabilize and enhance 500 feet of channel upstream of S. 43rd Street	1,158,000
b. Relocate and reconstruct 2,800 feet of channel through Jackson Park with relocated drop structure	6,482,000
c. Remove 4,350 feet of concrete lining and expand overbank storage between Jackson Park and S. 27th Street	7,168,000
d. Remove 10,900 feet of concrete lining, naturalize channel, and expand overbank storage from S. 27th Street to S. 6th Street	71,567,000
2. Bridge and Culvert Improvements	
a. S. 43rd Street – Increase capacity to 58-foot bridge span or equivalent flow area (from existing 22-foot bridge span)	1,477,000
b. Remove 700 feet of culvert that enclose waterway in Jackson Park	384,000
c. Kinnickinnic River Parkway bridge by S. 29th Street – increase capacity with expanded channel capacity and raised bridge deck	3,038,000
d. Remove abandoned railroad abutments by S. 16th Street	45,000
e. W. Cleveland Avenue – Increase channel capacity below existing bridge deck to provide an additional 230 square feet of hydraulic opening area	752,000
f. Pulaski Park pedestrian bridge – Increase span from existing 56 feet to 130 feet	984,000
g. S. 16th Street – Increase bridge span from existing 62 feet to 135 feet for a 90 percent increase in hydraulic opening or equivalent capacity	4,256,000
h. S. 15th Street pedestrian bridge – Increase span from existing 62 feet to 140 feet to accommodate the wider channel	693,000
i. S. 13th Street – Increase span from existing 62 feet to 122 feet for an 140 percent increase in hydraulic opening or equivalent capacity	3,657,000
j. S. 11th Street pedestrian bridge– Increase span from existing 62 feet to 145 feet to accommodate the wider channel	723,000
k. S. 9th Place – Increase bridge span from existing 62 feet to 132 feet for a 219 percent increase in hydraulic opening or equivalent capacity	3,279,000
l. Removal of S. 8th Street pedestrian bridge to accommodate the wider channel	45,000
3. Storage Facility	
a. Jackson Park storage improvements including lowered lagoon	22,739,000
4. Voluntary Floodproofing or Acquisitions	
a. Floodproof or acquire and remove three structures on W. Kinnickinnic River Parkway between W. Sumac Place and W. Montrose Avenue[b]	600,000
b. Floodproof or acquire and remove three structures between S. 31st Street and S. 33rd Street[b]	600,000
c. Floodproof or acquire and remove seven structures between S. 6th Street and S. 13th Street[b]	1,400,000
Kinnickinnic River Subtotal	161,047,000
Lyons Park Creek	
1. Channel and Floodplain Improvements	
a. Remove concrete lining removal and expand overbank storage for 650 feet between S. 57th Street and W. Lakefield Drive	1,134,000
b. Remove concrete lining and reconstruct channel for 2,200 feet between W. Bennett Avenue and W. Cleveland Avenue	3,968,000
c. Remove concrete lining and install grade control structures for 280 feet downstream of W. Cleveland Avenue	540,000
2. Bridge and Culvert Improvements	
a. S. 57th Street – Increase capacity from existing 9-foot by 5-foot culvert to 19-foot by 6-foot culvert or equivalent flow area	2,108,000
b. W. Oklahoma Avenue – add bypass culverts composed of 560 feet of twin 8-foot by 5-foot culverts and 150 feet of 12-foot by 6-foot culvert or equivalent flow area to existing 11-foot by 7-foot culvert	2,973,000
c. W. Stack Drive – Increase capacity to bridge span of 40 feet	1,913,000
d. W. Cleveland Avenue – Increase capacity of existing 10-foot by 6-foot culvert to two 10-foot by 8-foot culverts or equivalent flow area	2,189,000
Lyons Park Creek Subtotal	14,825,000

Table continued on next page.

Table 5.1 (Continued)

Plan Components	Estimated Capital Cost ($)[a]
Villa Mann Creek	
1. Channel and Floodplain Improvements	
a. Remove concrete lining and reconstruct channel for 2,640 feet from upstream of W. Bolivar Avenue to confluence with Wilson Park Creek	3,056,000
2. Bridge and Culvert Improvements	
a. Install 1,340 feet of 8-foot by 5-foot bypass culvert next to the existing 9.7-foot by 5-foot culvert on the Villa Mann Creek Tributary at S. 27th Street	2,518,000
Villa Mann Creek Subtotal	5,574,000
Wilson Park Creek	
1. Channel and Floodplain Improvements	
a. Remove concrete lining and reconstruct channel for 4,050 feet from railroad east of General Mitchell International Airport to W. Howell Avenue	6,874,000
b. Remove concrete lining and reconstruct channel for 4,700 feet from W. Layton Avenue to Canadian Pacific Railroad at IH-94	7,757,000
c. Remove concrete lining and reconstruct channel for 700 feet from Canadian Pacific Railroad to Wilson Park	952,000
d. Remove concrete lining and reconstruct channel for 4,320 feet from S. 20th Street to S. 27th Street	5,885,000
e. Remove concrete lining and reconstruct channel for 1,930 feet from W. Morgan Avenue to W. Euclid Avenue	11,966,000
2. Bridge and Culvert Improvements	
a. S. 5th Street – Increase capacity from existing two 12.6-foot by 10-foot culverts to three 14-foot by 10-foot culverts or equivalent flow area	855,000
b. S. 6th Street – Increase capacity from existing two 12.5-foot by 10-foot culvert by adding three 12.5-foot by 10-foot bypass culverts or equivalent flow area	1,492,000
c. W. Howard Avenue – Increase capacity of existing three 11-foot by 12-foot culverts to three 19-foot by 12-foot culverts or equivalent flow area	2,504,000
d. S. 27th Street to Morgan Tunnel – Increase capacity to three 11-foot by 16-foot culverts or equivalent flow area	18,120,000
e. W. Lakefield Drive – Increase capacity to three 13.4-foot by 11-foot culverts or equivalent flow area	3,227,000
3. Storage Facility	
a. Construct 190-acre-foot Central Wire and Steel storage basin	13,113,000
b. Wilson Park east storage – excavate and rework park area around existing lagoon to add 150 acre-feet of storage	13,082,000
c. Wilson Park west storage – construct 70-acre-foot storage basin	6,096,000
4. Voluntary Floodproofing or Acquisitions	
a. Floodproof or acquire and remove seven structures near S. 5th Street and W. Armour Avenue[b]	1,400,000
b. Floodproof or acquire and remove two structures near S. 20st Street and W. Howard Avenue[b]	400,000
Wilson Park Creek Subtotal	93,723,000
43rd Street Ditch	
1. Channel and Floodplain Improvements	
a. Remove 600 feet of concrete lining between W. Lincoln Avenue and Union Pacific Railroad	897,000
2. Bridge and Culvert Improvements	
a. S. 43rd Street – Increase capacity of existing 355 feet of double 11.5-foot by 7.6-foot pipe arch corrugated metal pipe culvert with two 16-foot by 7-foot concrete box culverts or equivalent flow capacity	4,038,000
b. Union Pacific Railroad – Increase capacity of 475 feet of double 10.5-foot diameter culverts with additional 10-foot diameter concrete culvert or equivalent flow capacity	3,013,000
43rd Street Ditch Subtotal	7,948,000
Total	283,117,000

Note: The plan components identified are the recommended alternative from MMSD's Kinnickinnic River Flood Management Plan.

[a] *Amounts are shown in 2017 dollars.*

[b] *Cost estimate assumes acquisition and deconstruction of structures.*

Source: Milwaukee Metropolitan Sewerage District and SEWRPC

Improvements Between S. 27th Street and the W. Kinnickinnic River Parkway

The recommended improvements for the mainstem of the Kinnickinnic River between S. 27th Street and the West Kinnickinnic River Parkway in Jackson Park consist of replacing the concrete channel lining and improvements to the West Kinnickinnic Parkway bridge that is located near S. 29th Street. In addition, the plan recommends the acquisition and removal or floodproofing of three flood-prone residential structures that are expected to remain in the floodplain following implementation of the recommended improvements. Acquisition and removal or floodproofing of these structures would be performed on a voluntary basis at the option of the property owners.

Improvements in and upstream of Jackson Park

The recommended improvements for the mainstem of the Kinnickinnic River in Jackson Park consist of lowering a portion of the park to provide flood storage to reduce flood risk to structures located on the Kinnickinnic River Mainstem, removing 700 feet of concrete lined channel, removing 700 feet of corrugated metal pipe culvert, and increasing the flow capacity under the S. 43rd Street Bridge. The recommended flood storage will also mitigate the increased flood flows from Lyons Park Creek and the S. 43rd Street Ditch as a result of the proposed conveyance recommendations to reduce flood risk in these tributary streams. The plan also recommends that additional improvements for the Kinnickinnic River mainstem reach between S. 43rd Street and S. 51st Street be evaluated during the preliminary engineering phase of design of improvements in the Jackson Park reach.

Recommended Improvements along Lyons Park Creek

The Kinnickinnic River watershed flood management plan concluded that flooding along Lyons Park Creek results from a number of hydraulic structures that are inadequately sized to convey the peak flow during a one-percent-annual-probability event. At these locations, stormwater runoff exits the channel and flows onto surrounding streets, resulting in flood damage to structures. While analysis of the subwatershed identified some storage opportunities, it showed that they were inadequate to provide any meaningful benefit. Because of this, the recommended improvements are primarily based on improving conveyance of water at four structures along Lyons Park Creek. Secondarily, these improvements also seek to create as much storage as possible within the confines of the existing channel corridor. The recommended improvements for Lyons Park Creek includes conveyance improvements to four structures, floodplain expansion within the confines of the existing stream corridor, and replacing 3,000 feet of concrete channel lining with a naturalized channel design including retaining walls to expand floodplain storage along the Creek from S. 57th Street to the confluence with the Kinnickinnic River.

Recommended Improvements along Villa Mann Creek and Villa Mann Creek Tributary

The Kinnickinnic River watershed flood management plan concluded that the primary cause of the structure flooding in the Villa Mann Creek subwatershed is an undersized 1,350-foot long enclosed section of the Villa Mann Creek Tributary which extends from South 27th Street to the confluence with the Villa Mann Creek mainstem.

To address the inadequate capacity, the plan recommends installing an 8-foot by 5-foot concrete box bypass culvert along the entire length of the enclosure. This bypass culvert would provide adequate capacity to reduce the risk to the structures in this subwatershed from the one-percent-annual-probability flood event. The plan also recommends removing the concrete lining from the channel between a point upstream of Bolivar Ave to the confluence with Wilson Park Creek and reconstructing the channel with a stone lined bottom that can incorporate riffles. It should be noted that the concrete lining removal of Villa Mann Creek is not necessary for flood protection benefits. Finally, the plan recommends connecting Villa Mann Creek with the Wilson Park west storage basin by means of an overflow weir structure at the downstream end of the Creek. This storage basin is discussed in the subsection describing recommended improvements to Wilson Park Creek.

Recommended Improvements along Wilson Park Creek

The Kinnickinnic River watershed flood management plan concluded that flooding along Wilson Park Creek results from several hydraulic structures that are inadequately sized to convey the peak flow for the one-percent-annual-probability flood event. At these locations, flow exits the channel onto surrounding streets, resulting in flood damage to structures.

The recommended improvements include the construction of three storage facilities, conveyance improvements to six culvert crossings, replacing 13,920 linear feet of concrete channel lining with a naturalized channel design, and making channel improvements to 1,800 feet of the Creek that is adjacent to the recommended Central Steel and Wire storage facility. In addition, the plan recommends the acquisition and removal or floodproofing of nine flood-prone residential structures that are expected to remain in the floodplain following implementation of the recommended improvements. Acquisition and removal or floodproofing of these structures would be performed on a voluntary basis at the option of the property owners.

The plan recommends installing one storage facility on the open land behind the Central Steel and Wire property and another in Wilson Park on the west side of S. 20th Street.[137] The plan recommends constructing a third storage facility in Wilson Park by excavating and reworking the park area around the existing lagoon. Conveyance improvements are recommended at the S. 5th Street, S. 6th Street, and W. Howard Avenue culverts; the S. 27th Street to W. Morgan Avenue tunnel; and at the culvert at the intersection of S. 30th Street and Lakefield Drive.

Recommended Improvements along the 43rd Street Ditch

The Kinnickinnic River watershed flood management plan recommends three improvements along the 43rd Street Ditch. The plan recommends replacing the existing 355-foot 11.5-foot by 7.6-foot pipe arch culverts at S. 43rd Street with two 16-foot by 7-foot concrete box culverts. This will increase flow capacity from a sag area along S. 43rd Street that has resulted in surrounding properties north of W. Lincoln Avenue experiencing flooding several times over the last decade. In addition, the plan recommends that a 480-foot section of 10-foot diameter concrete pipe bypass culvert be added to augment the existing twin culverts under the railroad yard at the downstream end of the waterway. Finally, the plan recommends that the concrete lining be removed and replaced with a stone lined channel for 600 feet between W. Lincoln Avenue and the railroad yard.

Floodplain Management Plan for the Menomonee River Watershed

The flood control plan for the Menomonee River watershed was developed through several planning efforts. These efforts include a stormwater drainage and flood control system plan for the streams for which the MMSD has jurisdiction, a stormwater drainage and flood control system plan for Grantosa Creek, and Phase 1 and 2 watercourse management plans for the Menomonee River. Although some of the plan elements are located outside of the City of Milwaukee, they are integral to the design and function of those elements that are located in the City. In particular, the floodplain lowering along Hart Park and the Milwaukee County Grounds detention basin serve to reduce downstream flood discharges in Milwaukee, thus, reducing the size of the required plan elements in that area. Due to the complexity of the flood control program recommended in these plans, implementation is being carried out over a number of years. Elements of this program that remain to be completed are summarized in Table 5.2. Elements that have been completed are summarized in Table 5.3.

The stormwater drainage and flood control system plan for Grantosa Creek recommended flood storage to eliminate overland flooding to buildings immediately south of W. Hampton Avenue in the City of Wauwatosa, and to reduce surcharging in the Grantosa Creek enclosure along N. 100th Street and W. Grantosa Avenue.[138] In 2001, the MMSD completed construction of a 58 acre-foot dry detention basin for Grantosa Creek at Timmerman Airport in the City of Milwaukee. As part of the second phase system planning for Grantosa Creek, field surveys were conducted along the lower Grantosa Creek area and along the channel enclosure. Those surveys indicated that no structures in the City of Milwaukee would be subject to flooding during a one-percent-annual-probability flood event.

[137] *The Wilson Park west storage basin is technically located on Villa Mann Creek, but has been designed to work as a part of the Wilson Park Creek recommended improvements.*

[138] *SEWRPC Memorandum Report No. 53,* A Stormwater Drainage and Flood Control System Plan for Grantosa Creek, *February 1992.*

Table 5.2
Components and Costs of Floodplain Management Plan Elements to be Completed for the Menomonee River Watershed

Plan Components	Estimated Capital Cost ($)[a]	Estimated Benefits for a One-Percent-Annual-Probability Flood Event ($)[a,b,c]
Menomonee River		
1. Floodproof two municipal structures in Hart Park and one structure in Jacobus Park in the City of Wauwatosa[d]	1,281,000	--
2. Acquisition and demolition of nine structures, floodplain lowering, and construction of 4,100 feet of berms or floodwalls in the western Milwaukee area[d]	41,209,000	--
Total	42,490,000	19,126,000

[a] *Amounts are shown in 2016 dollars.*

[b] *The estimated benefits are based upon the reduction in flood damages during a one-percent-annual-probability flood event for all elements of the Menomonee River plan. The damage estimates were developed by the Commission staff based upon structure values, flood stage, and depth of flooding data documented in the MMSD Phase I Watercourse Management Plan dated August 2000. The same information is included in the document, SEWRPC Community Assistance Planning Report No. 261,* Flood Mitigation Plan for the City of Milwaukee, Milwaukee County, Wisconsin, *dated April 2003.*

[c] *Benefits taken from MMSD Menomonee River Phase 1 system plan and reflects reduction of damages in both the Cities of Milwaukee and Wauwatosa.*

[d] *This mitigation measure is related but not essential to continued compliance with the requirements of the National Flood Insurance Program.*

Source: Milwaukee Metropolitan Sewerage District; Earth Tech, Inc.; and SEWRPC

The floodplain management measures recommended for the Little Menomonee River in the stormwater drainage and flood control system plan for MMSD[139] and subsequent planning efforts include the acquisition of one residential property. This property was acquired and demolished in 2011.

MMSD's Menomonee River Phase 1 Watercourse Management Plan called for a series of flood mitigation projects to be implemented along an 8.5-mile reach of the Menomonee River between the mouth of the River and W. North Avenue.[140] Additional Menomonee River projects were recommended in a second phase of planning by MMSD.[141] The projects recommended in these plans were designed to function as integrated, interdependent components of an overall system, with the design of some projects incorporating the flood reduction benefit of the upstream Milwaukee County Grounds flood management basin.

Several of the elements recommended in the Menomonee River Phase 1 and Phase 2 watercourse management plans have been completed. The MMSD had completed the property acquisition and construction of the earthen berm and floodwall in the Valley Park neighborhood. Also, the acquisition and removal of the 46 structures in the Hart Park area of the City of Wauwatosa has been completed. MMSD has completed lowering the floodplain and construction of about 6,500 feet of earthen berm in the Hart Park area of the City of Wauwatosa. The 966 acre-foot Milwaukee County Grounds detention basin in the City of Wauwatosa was completed and operational in 2011. The levee and floodwall at the Falk Corporation property was raised to prevent overtopping during a one-percent-annual-probability flood event. As of 2018, MMSD had completed two phases of the Western Milwaukee Flood Management Project. Phase 1 of the project consisted of a combination of structure removal, lowering the floodplain of the northern overbank, and construction of an approximately 750-foot earthen levee in the northern overbank located along the Menomonee River between river miles 4.66 and 4.84 in the City of Milwaukee. Phase 2A consisted of structure removal, floodplain lowering, and construction of an approximately 1,050-foot series of earthen

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

[140] *Milwaukee Metropolitan Sewerage District,* Menomonee River Phase 1 Watercourse Management Plan, *August 2000.*

[141] *Milwaukee Metropolitan Sewerage District,* Menomonee River Phase 2 Watercourse Management Plan, *July 2002.*

levees and reinforced concrete floodwalls in the northern overbank located along the Menomonee River between river miles 5.4 and 5.6 in the City of Milwaukee.

Two elements recommended in the Menomonee River Phase 1 and 2 watercourse management plans have yet to be implemented. These plans recommend floodproofing of two municipal structures in Hart Park and one in Jacobus Park in the City of Wauwatosa. In addition, Phase 2B of the Western Milwaukee Flood Management Project is currently being designed. It will include structure removal, floodplain lowering, and construction of an approximately 2,600-foot series of earthen levees and reinforced concrete floodwalls in the northern overbank located along the Menomonee River between river miles 4.86 and 5.4 in the City of Milwaukee.

To date, additional Menomonee River projects that were not in the cited plans have been completed. These include:

- The City of Milwaukee Menomonee Valley shops redevelopment project
- The City of Milwaukee Menomonee River north riverbank restoration project
- The City of Wauwatosa Hart Park athletic fields and bandshell project
- The Wisconsin Department of Transportation (WisDOT) replacement of the N. 70th Street bridge
- Phases 1 and 2 of the WisDOT Menomonee Valley passage project[142]

Table 5.3
Floodplain Management Projects Completed for the Menomonee River Watershed

Plan Components
Menomonee River
1. Acquire and demolish eight residential properties in the Valley Park neighborhood[a]
2. Construct 750-foot-long berm and 750-foot-long reinforced concrete floodwall along Valley Park neighborhood[a]
3. Acquire and demolish 80 structures in the Hart Park neighborhood[a]
4. Lower floodplain by one to two feet in the Hart Park area and western Milwaukee area[a]
5. Construct 6,500 feet of earthen berm in the Hart Park area[a]
6. Construct 966 acre-foot detention basin on Milwaukee County Grounds[a]
7. Remove or replace access bridge located upstream of Hawley Road
8. Raise the height of the existing floodwall and levee at the Falk property
Grantosa Creek
1. Construct 58 acre-foot detention basin at Timmerman Airport[a]
Little Menomonee River
1. Acquire and demolish one residential property[a]

[a] *This mitigation measure is related but not essential to continued compliance with the requirements of the National Flood Insurance Program.*

Source: Milwaukee Metropolitan Sewerage District; Earth Tech, Inc.; and SEWRPC

Full implementation of the floodplain management actions recommended for the subwatershed areas would eliminate structure flood damages in the City of Milwaukee due to direct overland flooding along the Menomonee River, Grantosa Creek, and the Little Menomonee River for floods up to, and including, the one-percent-annual-probability flood event under planned land use and channel conditions.

As shown in Table 5.2, the estimated capital cost of implementing the remaining components of the recommended floodplain management plan for the Menomonee River watershed that directly impact the City of Milwaukee are approximately $41.2 million. In addition to the specific mitigation measures recommended above, it is important to note that the City has completed a number of stormwater management projects as outlined in the stormwater management element subsection below.

Following a series of discussions with the WDNR and FEMA, it was agreed that the projects completed by MMSD and others, as well as several pending projects would be submitted to FEMA with a request for a Conditional Letter of Map Revision (CLOMR). The Cities of Milwaukee and Wauwatosa submitted the CLOMR request to FEMA in 2012. The CLOMR utilized updated hydrologic and hydraulic models prepared by SEWRPC as part of the program for updating flood hazard mapping in Milwaukee County for MCAMLIS and MMSD. These updated models reflected the floodplain conditions along this reach of the Menomonee River following completion of all of the planned Phase 1 and 2 projects. The CLOMR was approved by FEMA on April 21, 2016.

[142] *This project was conducted in partnership with the Menomonee Valley Partners, the WDNR, the City of Milwaukee, and the Urban Ecology Center.*

The modeling and floodplain mapping that were included in the CLOMR indicated that an additional 43 structures are located within the one-percent-probability flood hazard area at the downstream end of the River. These structures are located along the reach of the Menomonee River that extends between the crossing at S. 27th Street and the confluence with the Milwaukee River. MMSD is currently studying how to reduce floodplain impacts to structures in this area.

It is anticipated that completion of Phase 2B of the Western Milwaukee flood management project will require the City of Milwaukee to submit a revised CLOMR to FEMA.

Floodplain Management Plan for the Milwaukee River Watershed

Flood mitigation projects have been implemented by MMSD for Lincoln Creek and Southbranch Creek as set forth in Table 5.4. As of 2004, the plans for both streams had been fully implemented, which should eliminate structure flood damages due to direct overland flooding along Lincoln Creek and Southbranch Creek for floods up to, and including, the one-percent-annual-probability flood event under planned land use and existing channel conditions. Roadway flooding during such a flood event should also be eliminated. Of note is the fact that 211 of the repetitive-loss properties reported in Chapter 3 are located within the Lincoln Creek subwatershed, including three properties that met the FEMA high-priority criteria. The 2004 MMSD Lincoln Creek flood mitigation and stream rehabilitation project resulted in many of those repetitive loss structures being removed from the one-percent-probability floodplain. Also, of the 211 documented repetitive-loss properties in the Lincoln Creek subwatershed, seven have been acquired and demolished by FEMA.

MMSD removed Estabrook Dam during spring of 2018. As part of this project, the streambank immediately adjacent to the dam was restored. The dam removal resulted in a lowering of water levels upstream of the dam. This removed about 50 structures from the floodplain. It is anticipated that the floodplain map will need to be revised.

A watercourse system plan for the Milwaukee River in Milwaukee County was completed by SEWRPC.[143] The goal of the plan was to mitigate structures within the one-percent-annual-probability floodplain shown on the Milwaukee County effective Digital Flood Insurance Rate Maps. The recommended alternative for the City of Milwaukee was to floodproof three residential buildings in the one-percent-annual-probability floodplain. The floodproofing would be done voluntarily by the building owner, and MMSD would lead the effort and coordinate with the City of Milwaukee as appropriate. As shown in Table 5.5, the estimated capital cost of implementing the currently preferred floodplain management plan for the Milwaukee River watershed is $60,100.

Floodplain Management Plan for the Oak Creek Watershed

The MMSD is currently in the advanced planning stage of its watercourse system plan for the Oak Creek watershed. As such, final recommendations for flood mitigation are now being formulated for the two streams for which structural flood damages have been identified in the City of Milwaukee portion of the watershed. Information regarding the preliminary recommendations is set forth in Table 5.6.

As shown in Table 5.6, the preliminary recommendation pertaining to the City of Milwaukee portion of the North Branch of Oak Creek consists of floodproofing one nonresidential building at an estimated cost of $2,339,000. Implementing this recommendation would allow the avoidance of about $596,900 in damages for the one-percent-annual probability flood. To date, a second nonresidential building on the North Branch of Oak Creek was purchased and demolished by MMSD and a third nonresidential building was removed from the structure inventory due to its having minimal value.

The preliminary floodplain management recommendation for the Mitchell Field Drainage Ditch consists of constructing a floodwall and interior drainage facilities to protect three structures located at Milwaukee Mitchell International Airport. Costs associated this are shown in Table 5.6; however this recommendation is subject to change as MMSD and Milwaukee County investigate additional plan options. The affected area is slated by Milwaukee County for redevelopment and three structures in the floodplain will be addressed as part of these redevelopment plans. Determination of a final plan will be based upon coordination with all parties involved, including the MMSD, Milwaukee County, and the City of Milwaukee.

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

Full implementation of the preliminary floodplain management actions recommended for the subwatershed areas involved would eliminate structure flood damages due to direct overland flooding along the North Branch of Oak Creek and the Mitchell Field Drainage Ditch in the City of Milwaukee for floods up to, and including, the one-percent-annual-probability flood event under planned land use and channel conditions.

As shown in Table 5.6, the estimated capital cost of implementing the City of Milwaukee portion of the Oak Creek watershed floodplain management plan is about $4.16 million.

Stormwater Management Element

Because of the relationship between stormwater management and floodplain management, stormwater management actions are an important element of the flood mitigation plan. This element of the plan includes the status of stormwater management planning and stormwater ordinances and related regulations.

Stormwater-Related Planning

Stormwater drainage problems are known to exist throughout the urbanized portions of the City. The City has undertaken stormwater management planning programs or initial stormwater management system inventories as the first step in developing comprehensive stormwater management plans. The intense storm events of 2008 through 2010 caused significant surface flooding problems as the capacities of the minor and major local storm drainage systems were exceeded in some locations. The City of Milwaukee continues to identify specific locations where the major stormwater management system is inadequate to handle the runoff from storms with annual probabilities of occurrence of 1 percent or greater and prepare stormwater management plans to address those deficiencies.

The City of Milwaukee is part of the Menomonee River watershed-based municipal separate storm sewer (MS4) permit issued by the WDNR. As of 2019, the existing MS4 permit has expired and is being enforced through an extension of the previous permit. A new permit is currently being drafted and reviewed by the WDNR and participating communities. It is anticipated that the new permit will include a requirement that participating municipalities update their stormwater management plans. The City of Milwaukee expects that an update will require a three-year process.

Several planning efforts related to stormwater or recommending measures to address stormwater have been conducted by the City and other local and regional entities. These are briefly described in the following paragraphs. The stormwater management practices installed through the MMSD green infrastructure plan, the City's sustainability plan, and the City's Green Streets plan provide multiple benefits. In addition to providing reductions in the volume of stormwater runoff, these practices can help reduce urban heat island effects, improve water quality, and help the City adapt to climate change.

Table 5.4
Floodplain Management Projects Completed for the Milwaukee River Watershed

Plan Components
Lincoln Creek
1. Lower floodplain along 0.70-mile-long reach between N. Teutonia Avenue and a point downstream from W. Villard Avenue
2. Replace existing concrete lining with turf and add low-flow aquatic habitat along 0.60-mile-long reach between N. Teutonia Avenue and N. 32nd Street
3. Modify channel with selected floodplain lowering and add low-flow aquatic habitat along 2.34-mile-long reach between N. 32nd Street and N. 60th Street
4. Replace existing concrete lining with turf and add low-flow aquatic habitat along 1.56-mile-long reach between N. 60th Street and a point upstream from W. Silver Spring Drive[a]
5. Channel modification along 2.65-mile-long reach between a point upstream from W. Silver Spring Drive and the Union Pacific Railroad crossing located east of N. 60th Street
6. Construct 85 acre-foot detention basin north of W. Green Tree Road[a]
7. Construct 90 acre-foot detention basin at Havenwoods State Forest[a]
8. Create detention storage by lowering the north overbank north of W. Silver Spring Drive[a]
9. Replace, modify, or remove 13 bridges and culverts
Southbranch Creek
1. Construct 19 acre-foot detention basin south of W. Bradley Road[a]
2. Construct 17 acre-foot detention basin at Brown Deer Village Library[a]
3. Construct 11 acre-foot detention basin south of Dean Elementary School[a]
4. Construct 22 acre-foot detention basin along Churchill Lane between N. 48th and N. 51st Streets[a]
5. Modify channel along 1,300-foot-long reach between W. Bradley Road and a point about 560 feet downstream from N. 55th Street
6. Replace culvert under N. 51st Street with two 10-foot by seven-foot reinforced concrete box culverts
7. Replace existing culvert under N. 53rd/54th Street with open channel
8. Replace culvert under N. 55th Street with two 12-foot by six-foot reinforced concrete box culverts

[a] *This mitigation measure is related but not essential to continued compliance with the requirements of the National Flood Insurance Program.*

Source: CH2M Hill; Earth Tech, Inc.; and SEWRPC

Table 5.5
Components and Costs of Floodplain Management Plan for the Milwaukee River Watershed

Plan Components	Estimated Capital Cost ($)[a]	Estimated Benefits for a One-Percent-Annual-Probability Flood Event ($)[a,b]
Milwaukee River		
1. Floodproof three residential buildings[c]	60,100	60,100
Total	60,100	60,100

[a] *Amounts are shown in 2016 dollars.*

[b] *The estimated benefits are based upon the reduction in flood damages during a 1 percent probability flood event. The damage estimates were developed by the Commission staff based upon structure values, flood stage, and depth of flooding data documented in SEWRPC Memorandum Report No. 172,* A Watercourse System Plan for the Milwaukee River in Milwaukee County Upstream of the Milwaukee Harbor Estuary, *December 2010.*

[c] *This mitigation measure is related but not essential to continued compliance with the requirements of the National Flood Insurance Program.*

Source: Milwaukee Metropolitan Sewerage District; and SEWRPC

Table 5.6
Components and Costs of Floodplain Management Plan for the Oak Creek Watershed

Plan Components	Estimated Capital Cost ($)[a]	Estimated Benefits for a One-Percent-Annual-Probability Flood Event ($)[a]
North Branch of Oak Creek		
1. Floodproof one nonresidential building[b]		
North Branch of Oak Creek Subtotal	2,339,000[c]	596,900[c]
Mitchell Field Drainage Ditch		
1. Construct an 1,800-foot-long, seven-foot-high floodwall along south side of three Milwaukee Mitchell International Airport buildings and storm sewer for interior drainage[b]		
Mitchell Field Drainage Ditch Subtotal	1,816,300[d]	633,200[d]
Total	4,155,300	1,230,100

[a] *Amounts are shown in 2016 dollars.*

[b] *This mitigation measure is related but not essential to continued compliance with the requirements of the National Flood Insurance Program.*

[c] *The estimated benefits are based upon the reduction in flood damages during an 1 percent probability flood event. The capital costs and damage estimates were developed by the Commission staff based upon structure values and flood stage and depth of flooding data documented in the draft SEWRPC Staff Memorandum entitled "Oak Creek Updated Phase 1 Watercourse Management Plan–North Branch of Oak Creek above Canadian Pacific Railway Crossing," March 28, 2011 and updated in a SEH technical memorandum to MMSD entitled "Oak Creek Watershed Conceptual Floodproofing Designs MMSD Watercourse On-Services Project," June 22, 2018.*

[d] *The estimated capital cost was included in a Tetra Tech memorandum dated July 5, 2001 to MMSD regarding the Structure Floodproofing Analysis for MMIA Buildings from Tetra Tech. No benefit updates were included in the Tetra Tech memo. The estimated benefits are based upon the reduction in flood damages during a one percent-probability-flood event as developed by SEWRPC staff based upon structure values, flood stage, and depth of flooding data as documented in the MMSD Phase I Watercourse Management Plan dated August 2000.*

Source: Milwaukee Metropolitan Sewerage District, CDM, Tetra Tech, SEH, and SEWRPC

MMSD Green Infrastructure Plan

The MMSD has developed a green infrastructure plan for its planning area.[144] This planning area includes the entire City of Milwaukee. In developing this plan, the District undertook a detailed data analysis of the opportunities and constraints for implementing green infrastructure strategies. This analysis included extensive data collection, mapping, and quantification of the numbers of roads, buildings, and parking lots in the planning area that can be treated with green infrastructure.

[144] *Milwaukee Metropolitan Sewerage District,* Regional Green Infrastructure Plan*, June 2013.*

The objectives of the MMSD green infrastructure plan include capturing the first 0.5 inch of rainfall from impervious surfaces through green infrastructure, striving toward a rainwater harvest goal of capturing the first 0.25 gallon per square foot of area of rainfall for reuse, complementing MMSD's Private Property Infiltration and Inflow Program and Integrated Regional Stormwater Management Program, and helping municipalities and other entities prioritize green infrastructure actions. As part of its approach to meeting these objectives, the plan developed watershed-specific recommendations for the installation of green infrastructure over the plan implementation period of 2014 through 2035.

Since issuing its green infrastructure plan, MMSD has conducted additional planning related to implementation of green infrastructure in the Kinnickinnic River watershed. The Kinnickinnic River watershed flood management plan noted that implementation of green infrastructure in this watershed could provide environmental benefits related to the management of smaller-scale storms and associated flood events.[145] Following the release of the flood management plan, the District developed a green infrastructure plan specifically for the Kinnickinnic River watershed.[146] This plan refines and revises the recommendation of the MMSD green infrastructure plan for quantities, specifications, and placement of green infrastructure practices within the Kinnickinnic River watershed. In addition, it provides several tools intended to guide strategic implementation of green infrastructure practices in the watershed, including:

- A prioritization of sub-basins within the Kinnickinnic watershed for implementation of green infrastructure practices
- Identification of specific areas within each sub-basin where placement of infiltration-based green infrastructure practices would reduce the impacts from stormwater to structures
- Identification of areas within the watershed with the highest potential for implementation of green infrastructure practices due to the presence of:
    - Publicly-owned land
    - Parking lots with areas greater than two acres
    - Public rights-of-way
    - Flood management projects
    - Business improvement, neighborhood improvement, or tax incremental financing districts

<u>City of Milwaukee Sustainability Plan</u>

In 2013, the City of Milwaukee Office of Environmental Collaboration developed a sustainability plan.[147] One goal set forth in this plan is reducing the amount of stormwater runoff and clearwater entering the sewer system. The plan established several targets related to this goal, including establishing a baseline measure through assessing existing amounts of impervious surface and green infrastructure within the City, developing a green infrastructure policy plan for the City, and increasing the volume of stormwater runoff captured by green infrastructure by 10 percent annually. The plan also outlined elements that should be included in the recommended green infrastructure policy plan. Other recommendations of the sustainability plan that relate to stormwater management include recommendations that the City collaborate with Milwaukee County Parks and local land trusts to maximize the use of green space for stormwater management, replace and maintain City sewers, and work with private property owners to maintain private laterals.

The programs implementing the City's sustainability plan include the City's HOME GR/OWN program. While the main focus of this program is to repurpose foreclosed properties and vacant lots in order to increase the availability of healthy foods, it also provides opportunities for stormwater management through

[145] *Milwaukee Metropolitan Sewerage District, 2017,* op. cit.

[146] *Milwaukee Metropolitan Sewerage District,* Kinnickinnic River Watershed: Green Infrastructure Plan, *2018.*

[147] *City of Milwaukee,* ReFresh Milwaukee: City of Milwaukee Sustainability Plan: 2013-2023, *July 2013.*

the installation of green infrastructure and other stormwater best management practices. As indicated in the subsection below on recent actions, several HOME GR/OWN projects have included stormwater management features such as porous pavement, cisterns, rain gardens, and bioswales.

City of Milwaukee Baseline Green Infrastructure Inventory

In 2015, the City of Milwaukee conducted a baseline inventory of green infrastructure within the City.[148] The objectives of this inventory included:

- Determining the total amount of impervious area within the City
- Establishing the length of shoreline along rivers, streams, and Lake Michigan within the City
- Assessing the amount of shoreline within the City possessing properly maintained vegetative buffers
- Identifying, cataloging, and quantifying existing green infrastructure sites in the City and estimating the volume of water captured by these sites
- Identifying areas within the City that are prone to surface flooding, basement water infiltration, and/or basement backups due to topography
- Calculating the City's annual targets for stormwater runoff reductions through the implementation of green infrastructure practices

The findings of the inventory will be used to determine the highest priority locations in the City to implement green infrastructure practices and to support development of a City green infrastructure plan.

City of Milwaukee Green Infrastructure Plan

In October 2017, the Milwaukee Common Council directed the City's Environmental Collaboration Office (ECO) to develop a comprehensive green infrastructure plan for Milwaukee's combined sewer area. After extensive consultation with the MMSD, the City of Milwaukee Departments of Public Works and City Development, and community stakeholders, ECO proposed a green infrastructure plan framework.[149] This framework will serve to guide development of the City's green infrastructure plan. The framework was unanimously approved by the Common Council in September 2018. The green infrastructure plan is currently in development and is scheduled to be finalized in June 2019.

A companion Common Council resolution revise City ordinances to require green infrastructure on all large developments and redevelopments and explicitly outlines green infrastructure as a climate adaptation strategy in Chapter 120 of the City of Milwaukee Code of Ordinances.

City of Milwaukee Green Streets Stormwater Management Plan

The City of Milwaukee has developed a plan to reduce stormwater quantity and improve stormwater quality through implementation of green street stormwater strategies in conjunction with street and alley repaving or reconstruction projects.[150] The plan provides and evaluates a menu of strategies to manage stormwater runoff in street rights-of-way without sacrificing roadway function. This menu includes practices that can be installed in vegetated areas such as medians, street terraces, and adjacent open spaces and paved areas such as streets, alleys, and parking lanes. The strategies also include the use of trees as drainage components. Implementation of these strategies can be integrated into the design of street or alley repaving or reconstruction projects. The plan provides a mechanism for incorporating the installation of green street features into the City's standard process for planning and designing street and alley repaving and reconstruction projects. The City estimates that implementing such strategies during repaving and reconstruction projects can provide a cost savings of 20 to 40 percent over the cost of green street installation as a retrofit.

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[148] *City of Milwaukee,* Green Infrastructure Baseline Inventory, *April 2015*.

[149] *City of Milwaukee,* Framework for Green Infrastructure Plan, *September 2018*.

[150] *City of Milwaukee,* Green Street Stormwater Management Plan, *March 2013*.

City of Milwaukee BaseTern Feasibility Study

In 2014, the City of Milwaukee Office of Environmental Collaboration conducted a study to examine the feasibility of converting the basements of foreclosed homes in the City to combination stormwater management facilities and community gardens.[151] This study indicated that such a facility would have the potential to provide stormwater detention, groundwater recharge, and/or rainwater harvesting in support of the City's green infrastructure and flood mitigation programs. The study examined three alternatives for converting an existing basement into a stormwater storage facility: filling the basement with stone and covering it with topsoil, installing modular tanks within the basement and covering it with topsoil, and converting the existing first floor of the structure into a green roof. The study also examined four alternative combinations of conversion options and stormwater management function that would support using the facility for: rainwater harvesting, groundwater recharge, stormwater detention, or a multi-purpose option that would consist of some combination of the other three. The study concluded that conversion of the basement of an abandoned house into a stormwater management facility is technically and operationally feasible, but noted that the specific design and use would depend upon several factors that would need to be considered during preliminary engineering including the cost, the desired reduction in stormwater volume, and constraints and limitations related to the specific site.

Stormwater-Related City Regulations

The City, through Chapter 120 of the municipal code, seeks to 1) promote public health, safety, and general welfare; 2) establish procedures to control the adverse impacts associated with stormwater runoff; 3) assist in the attainment and maintenance of water quality standards; 4) reduce the effects of development and redevelopment on land and stream channel erosion; 5) minimize damage to public and private property; 6) reduce nonpoint source water pollution by minimizing impervious cover on development sites; 7) promote the co-benefits of visible green infrastructure, including reduction of urban heat island effects, benefits to human health, City beautification, and protection of coastal areas; and 8) help the City adapt to climate change and become more resilient to climate threats. The specific provisions involved are noted in Chapter II of the flood hazard mitigation plan for the City of Milwaukee.[152] The City has also enacted a construction site erosion control ordinance based on the State of Wisconsin model ordinance. As in the case of the floodplain and shoreland-wetland zoning provisions noted above, implementation of these ordinances on an ongoing basis is an integral part of the City's flood mitigation strategy and is to continue under this plan.

Stormwater-Related MMSD Regulations

The MMSD has adopted and is implementing a comprehensive rule designed to minimize the potential to increase flood risk due to development or redevelopment in the District's service area. The rule applies to the City of Milwaukee and the communities within the MMSD service area that lie upstream of the City in the tributary watershed areas. The Chapter 13 rule became effective on January 1, 2002 and was amended on October 25, 2010, March 24, 2014, and December 19, 2016. Chapter 13 requires the management of the volume and peak rate of stormwater flows from new development and redevelopment in such a way that peak flows in a watershed do not increase downstream flooding.

Recent Local Actions

The City has completed or participated in numerous stormwater management projects since the initial City hazard mitigation plan was issued in 2005. These are listed in Table 5.7.

Public Information and Education Element

Public information, education, and participation constitute an integral aspect of the City of Milwaukee's flood mitigation and related efforts. As discussed in Chapter 2 of the flood mitigation plan for the City of Milwaukee,[153] informational and educational efforts oriented toward resolving the flooding and related stormwater drainage and sanitary sewer backup problems in the City have been addressed primarily through the combined efforts of the City, the MMSD, and Milwaukee County. This element has been carried out under ongoing activities which are expected to be continued. These three subelements include MMSD

[151] *City of Milwaukee Office of Environmental Sustainability,* Vacant Basements for Stormwater Management Feasibility Study, *July 2, 2014*.

[152] *SEWRPC Community Assistance Planning Report No. 261,* op. cit.

[153] Ibid.

Table 5.7
Stormwater Management Projects Completed in the City of Milwaukee Since the Adoption of the Initial All Hazard Mitigation Plan in 2005

Year Completed	Project	Location	Project Description
2003-2007	Menomonee Valley Industrial Center and Community Park	Menomonee Valley	Development at this site created 60 acres of developable land and 40 acres of greenspace. The greenspace includes the stormwater treatment train which accepts water from the adjacent businesses for treatment before it flows into the Menomonee River.
2005	MSOE Pervious Pavement Parking Lot	N. Milwaukee Street between E. State Street and E. Juneau Avenue	Permeable pavement project
2005	Walnut Way	2240 N. 17th Street	Green roof, bioretention, and cistern project
2006	Canal Street Extension	Canal Street from S. 26th Street to Selig Drive	The project extended Canal Street from S. 26th Street west to Selig Drive. The extension includes a stormwater bio-retention pond at S. 26th Street and a stormwater treatment train at S. 35th Street. Both of these features manage stormwater from W. Canal Street.
2006	Josey Heights and Walnut Way Green Pavement-Phase 1	2024 N. 13th Street	Permeable pavement project
2006	Urban Ecology Center Riverside Parking Lot Project	1500 E. Park Place	Permeable pavement and bio-infiltration project
2007	Broadway Building Green Roof	809 N. Broadway	Green roof project
2007	Brown Street Academy Stormwater Park	N. 20th Street and W. Brown Street	Rain garden project
2007	Lincoln Center for the Arts Stormwater Learning Lab	820 E. Knapp Street	Permeable pavement and native landscaping project
2007	Milwaukee School of Engineering Grohmann Museum	1000 N. Broadway	Green roof project
2008	Bradford Beach End of Pipe Smart Sponge	2272 N. Lincoln Memorial Drive	Bioswale project
2008	Sandburg Hall Green Roof	University of Wisconsin-Milwaukee	Green roof project
2008	N. 27th Street Green Street Project	N. 27th Street from W. Capitol Drive to W. Roosevelt Avenue	Bio-infiltration project
2009	Fix Development LLC	255 W. Bruce Street	Green roof project
2009	Growing Power Rainwater Harvesting System	5500 W. Silver Spring Drive	Cistern project
2009	Miller Brewery Green Roof Project	4251 W. State Street	Green roof project
2009	Milwaukee County Zoo Rain Gardens and Rainwater Harvesting System	10001 W. Blue Mound Road	Permeable pavement, bioswale, and cistern project
2009	Pabst Boiler House Green Roof Project	1243 N. 10th Street	Green roof project
2009	United Community Center Parking Lot Project	1028 S. 9th Street	Green roof project
2010	W. Grange Avenue Green Street Project	W. Grange Avenue from S. 19th Street to S. 26th Street	Bio-infiltration project
2010	Hartung Quarry Regional Wet Detention Facility	W. Keefe Avenue, Wauwatosa	Wet detention facility
2010	Convent Hill Apartments (Housing Authority of the City of Milwaukee) Green Roof Project	455 E. Ogden Avenue	Green roof project
2010	Destiny High School Bioretention Facilities	N. 76th Street and W. Good Hope Road	Bio-retention project
2010	Hillside Family Resource Center (Housing Authority of the City of Milwaukee) Green Roof Project	1452 N. 7th Street	Green roof project
2010	Milwaukee Public Library Green Roof Project	814 W. Wisconsin Avenue	Green roof project

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Table 5.7 (Continued)

Year Completed	Project	Location	Project Description
2010	Olga Village Apartments (United Community Center/Housing Authority of the City of Milwaukee Green Roof Project	722 W. Washington Street	Green roof project
2010	Rockwell Automation Green Roof	1201 S. 2nd Street	Green roof project
2010	University of Wisconsin-Milwaukee Cambridge Commons Green Roof Project	2323 N. Cambridge Avenue	Green roof project
2010	University of Wisconsin-Milwaukee Power Plant Cistern Project	University of Wisconsin Milwaukee	Cistern project
2011	Aurora Sinai Medical Center Green Roof Project	945 N. 12th Street	Green Roof project
2011	Columbia St. Mary's Hospital Green Roof Project	2301 N. Lake Drive	Green roof project
2011	Golda Meir Library Green Roof Project	University of Wisconsin-Milwaukee	Green roof project
2011	Islamic Society of Milwaukee Green Roof Project	4707 S. 13th Street	Green roof project
2011	Southlawn Park Alley Project	S. 22nd Street, Union Pacific Railway right-of-way, W. Ohio Avenue, W. Morgan Avenue	Permeable paver project
2011	Southlawn Park Alley Project	S. 24th Street, Union Pacific Railway right-of-way, W. Verona Court, W. Morgan Avenue	Pervious concrete project
2011	S. 6th Street Green Street Project	S. 6th Street from W. Howard Avenue to W. Grange Avenue	Bio-infiltration project
2011	Milwaukee Public Museum Green Roof	800 W. Wells Street	Green roof project
2011	Mitchell Park Conservatory Green Roof	524 S. Layton Boulevard	Green roof project
2011	Silver City Townhouses	3501 N. 35th Street	Green roof project
2011	N. 85th and W. Auer Avenue Green Street Project	N. 85th Street and W. Auer Avenue	Bio-infiltration project
2012	Clock Shadow Building	138 W. Bruce Street	Green roof and rainwater harvesting project
2012	Dwell Bay View Green Roof Project	2440 S. Kinnickinnic Avenue	Green roof project
2012	Garden District Neighborhood Association Community Garden Space	5511 S. 6th Street	Permeable pavement, bio-infiltration, and cistern project
2012	J.F. Ahern Menomonee Valley Facility Project	3201 W. Canal Street	Green roof and rainwater harvesting project
2012	La Merenda	125 E. National Avenue	Bio-infiltration and cistern project
2012	Pabst Brewery Redevelopment	N. 10th Street and W. Juneau Avenue	Bio-infiltration, permeable pavement, and rainwater catchment project
2012	Tippecanoe Presbyterian Church Rooftop Pantry Garden	124 W. Saveland Avenue	Green roof project
2012	Urban Ecology Center-Menomonee Valley Green Roof Project	3700 W. Pierce Street	Green roof project
2012	W. Grange Avenue Green Street Project	W. Grange Avenue from S. 18th Street to S. Howell Avenue	Bio-infiltration project
2012	Wangard Partners 1910 On The Water Apartments Green Roof Project	1910 N. Water Street	Green roof project
2012	Westlawn Gardens (Housing Authority of the City of Milwaukee)	6331 W. Silver Spring Drive	Bio-infiltration project

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Table 5.7 (Continued)

Year Completed	Project	Location	Project Description
2012	Wisconsin Regional Training Partnership/Big Step (WRTP/Big Step)	3841 W. Wisconsin Avenue	Green roof project
2013	Braise Restaurant and Culinary School Green Roof Project	1101 S. 2nd Street	Green roof project
2013	W. Freshwater Way Green Street Project	W. Freshwater Way from S. 3rd Street to S. 6th Street	Bio-infiltration and permeable pavement project
2013	88.9 Radio Milwaukee Green Roof	220 E. Pittsburgh Avenue	Green roof project
2013	Havenwoods Economic Development Corporation Community Garden Project	N. 60th Street and W. Green Tree Road	Bio-infiltration project
2013	Lapham Park Apartments (Housing Authority of the City of Milwaukee)	1901 N. 6th Street	Green roof project
2013	North End Phase II	N. Water Street and E. Pleasant Street	Green roof project
2013	Water Accelerator, LLC Green Roof Project	247 W. Freshwater Way	Green Roof project
2013	Porous Sidewalk Project	N. 72nd Street from W. Locust Street to W. Burleigh Street	Porous sidewalk project
2013	Porous Sidewalk Project	N. Edison Street from E. Highland Avenue to E. Juneau Avenue	Porous sidewalk project
2014	N. Sherman Boulevard Green Street Project	N. Sherman Boulevard from W. Auer Avenue to W. Congress Street	Bio-infiltration project
2014	S. 27th Street Green Street Project	S. 27th Street from W. Howard Avenue to W. Oklahoma Avenue	Bio-infiltration project
2014	W. Hampton Avenue Green Street Project	W. Hampton Avenue from N. Green Bay Road to N. Teutonia Avenue	Bio-infiltration project
2014	N. 27th Street Green Street Project	N. 27th Street from W. Capitol Drive to W. Roosevelt Avenue	Redesign of bio-infiltration project
2014	E. Greenfield Avenue Green Street Project	E. Greenfield Avenue from Canadian and National Railway right-of-way to Kinnickinnic River	Bio-infiltration and permeable pavement project
2014	Ezekiel Gillespie Park HOME GR/OWN Project	W. Wright Street and N. 14th Street	Porous pavers, cistern, native landscaping, stormwater trees, and rain garden project
2014	Westlawn Gardens (Housing Authority of the City of Milwaukee	6331 W. Silver Spring Drive	Bio-infiltration project
2014	Green Alley Project	Alley bounded by W. Appleton Avenue, W. Congress Street, W. Hope Drive, W. Potomac Avenue, and N. 80th Street	Permeable pavement project
2014	Green Alley Project	Alley bounded by W. Center Street, W. Clarke Street, N. 55th Street, and N. 56th Street	Permeable pavement project
2014	Green Alley Project	Alley bounded by W. Center Street, W. Grant Street, W. Hadley Street, and N. Sherman Avenue	Permeable pavement project
2014	Green Alley Project	Alley bounded by W. Cleveland Avenue, W. Fremont Street, W. 63rd Street, and W. 67th Street	Permeable pavement project
2014	Green Alley Project	Alley bounded by W. Fernwood Avenue, S. Illinois Street, S. Indiana Avenue, and W. Oklahoma Avenue	Permeable pavement project
2014	Green Alley Project	Alley bounded by W. Grant Street, S. Lincoln Avenue, S. 20th Street, and S. 21st Street	Permeable pavement project

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Table 5.7 (Continued)

Year Completed	Project	Location	Project Description
2014	Porous Sidewalk Project	N. 39th Street from W. Concordia Avenue to W. Keefe Avenue	Porous sidewalk project
2014	Porous Sidewalk Project	N. Pinecrest Street from N. Story Parkway to N. 49th Street	Porous sidewalk project
2014	Porous Sidewalk Project	S. Griffin Avenue from E. Morgan Avenue to E. Holt Avenue	Porous sidewalk project
2014	Porous Sidewalk Project	S. 24th Street from W. Pierce Street to W. National Avenue	Porous sidewalk project
2015	All Peoples' Church Orchard HOME GR/OWN Project	W. Locust Street and N. 1st Street	Cistern, native landscaping, cistern and rain garden project
2015	Alverno College Green Project	Northeast of S. 43rd Street and W. Morgan Avenue	Green roof and bio-infiltration project
2015	Arlington Heights Park Rain Garden Project	3439 W. Pierce Street	Rain garden project
2015	Milwaukee Parkside School for the Arts Rain Garden	2969 S. Howell Avenue	Rain garden project
2015	Sunshine Park HOME GR/OWN Project	W. North Avenue and N. 14th Street	Rain garden project
2015	S. Howell Avenue Green Street Project	S. Howell Avenue from E. Layton Avenue to W. Howard Avenue	Bio-infiltration project
2015	E. Layton Avenue Green Street Project	E. Layton Avenue from S. Howell Avenue to IH-794	Bio-infiltration project
2015	Highland Community School Bio-infiltration Project	1706 W. Highland Avenue	Bio-infiltration project
2015	Green Alley Project	Alley bounded by W. Hadley Street, W. Locust Street, N. 81st Street, and N. 82nd Street	Green alley project
2015	Green Alley Project	Alley bounded by W. Hope Avenue, W. Marion Drive, N. 61st Street, and N. 62nd Street	Green alley project
2015	Green Alley Project	Alley bounded by W. Harrison Avenue, W. Windlake Avenue, and S. 20th Street	Green alley project
2015	Green Alley Project	Alley bounded by W. Harrison Avenue, W. Windlake Avenue, S. 18th Street, and S. 19th Street	Green alley project
2016	Marcus DeBack Playground Basketball Court	2461 N. 55th Street	Porous asphalt project
2016	Milwaukee Environmental Sciences School Stormwater Reuse Project	6600 W. Melvina Street	Cistern project
2016	Phillips Park Basketball Court	1800 N. 17th Street	Porous asphalt project
2016	N. Sherman Boulevard Green Street Project	N. Sherman Boulevard between W. North Avenue and S. Locust Street	Bio-infiltration project
2016	W. Fond du Lac Avenue Green Street Project	W. Fond du Lac Avenue between W. Capitol Drive and W. Hampton Avenue	Bio-infiltration project
2016	S. Kinnickinnic Avenue Green Street Project	S. Kinnickinnic Avenue between E. Morgan Avenue and E. Lincoln Avenue	Bio-infiltration project
2016	S. 5th Street Green Street Project	S. 5th Street between W. Scott Street and W. Virginia Street	Bio-infiltration project
2017	Adams Park HOME GR/OWN Project	N. 2nd Street and W. Vienna Avenue	Rain garden project
2017	Fondy Stormwater Park/Farmers Market HOME GR/OWN Project	N. 22nd Street and W. Fond du Lac Avenue	Bioswale and cistern project
2017	Green Alley Project	Alley bounded by W. Cleveland Avenue, W. Montana Street, S. 49th Street, and S. 50th Street	Permeable pavement project
2017	Green Alley Project	North-south leg of alley bounded by W. Greenfield Avenue, S. Layton Boulevard, W. Scott Street, and S. 28th Street	Permeable pavement project

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Table 5.7 (Continued)

Year Completed	Project	Location	Project Description
2017	Green Alley Project	East-west leg of alley bounded by W. Greenfield Avenue, S. Layton Boulevard, W. Scott Street, and S. 28th Street	Permeable pavement project
2017	Green Alley Project	North-south leg of alley bounded by W. Main Street, S. 61st Street, and S. 62nd Street	Permeable pavement project
2017	Green Alley Project	East-west leg of alley bounded by W. Main Street, S. 61st Street, and S. 62nd Street	Permeable pavement project
2017	Green Alley Project	Alley adjacent to N. 77th Street between W. Chambers Street and W. Locust Street	Permeable pavement project
2017	Green Alley Project	Alley bounded by W. Auer Avenue, W. Concordia Avenue, N. 87th Street, and N. 88th Street	Permeable pavement project
2017	Green Alley Project	North-south leg of alley bounded by W. Keefe Avenue, W. Medford Avenue, W. Roosevelt Drive, W. Scranton Place, and N. 45th Street	Permeable pavement project
2017	Green Alley Project	East-west leg of alley bounded by W. Keefe Avenue, W. Medford Avenue, W. Roosevelt Drive, W. Scranton Place, and N. 45th Street	Permeable pavement project
2017	Green Alley Project	North-south leg of alley bounded by W. Auer Avenue, W. Burleigh Street, N. 54th Street, and N. 55th Street	Permeable pavement project
2017	Milwaukee Public Museum Stormwater Collection Courtyard	800 W. Wells Street	Bio-infiltration, cistern, and permeable pavement project
2017	N. 91st Street/92nd Street Green Street Project	N. 91st Street and N. 92nd Street from W. Good Hope Road to W. Capitol Drive	Bio-infiltration project
2017	N 107th Street Green Street Project	N. 107th Street from W. Good Hope Road to W. Brown Deer Road	Bio-infiltration project
2017	Social Development Commission HOME GR/OWN Project	N. 17th Street and W. North Avenue	Bioswale installed at Social Development Commission parking lot. Funded by the Fund for Lake Michigan.
2017	South Shore Beach Parking Lot Project	2520 S. Shore Drive	Bio-infiltration project
2017	W. Highland Avenue Green Street Project	West Highland Avenue from N. 12th Street to N. 27th Street	Bio-infiltration project
2017	W. Roosevelt Avenue Green Street Project	W. Roosevelt Avenue from N. 27th Street to N. 30th Street	Bio-infiltration project
2017	W. Windlake Avenue Green Street Project	W. Windlake Avenue at S. 19th Street	Bio-infiltration project
2018	W. Oklahoma Avenue Green Street Project	W. Oklahoma Avenue from S. 49th Street to S. 60th Street	Bio-infiltration project
2018	W. Mill Road Green Street Project	W. Mill Road from N. 43rd Street to N. 91st Street	Bio-infiltration project
2018	W. Good Hope Road Green Street Project	W. Good Hope Road from N. 43rd Street to N. 91st Street	Bio-infiltration project
2018	S. Howell Avenue Green Street Project	S. Howell Avenue from W. Grange Avenue to W. Layton Avenue	Bio-infiltration project
2018	S. 76th Street Green Street Project	S. 76th Street from W. Honey Creek Drive to W. Waterford Avenue	Bio-infiltration project

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Table 5.7 (Continued)

Year Completed	Project	Location	Project Description
2018	Green Alley Project	Alley bounded by W. Fiebrantz Street, W. Hope Street, N. 99th Street, and N. 100th Street	Permeable pavement project
2018	Green Alley Project	Alley bounded by W. Keefe Avenue, W. Nash Street, N. 82nd Street, and N. 83rd Street	Permeable pavement project
2018	Green Alley Project	North-South leg of alley bounded by W. Fairmount Avenue, W. Villard Avenue, N. 51st Street, and N. 53rd Street	Permeable pavement project
2018	Green Alley Project	Alley bounded by W. Burleigh Street, W. Chambers Street, N. 90th Street, and N. 91st Street	Permeable pavement project

Source: City of Milwaukee Department of Public Works, City of Milwaukee Environmental Collaboration Office, Milwaukee Metropolitan Sewerage District, and SEWRPC

stakeholder groups and related public education activities and public participation programming and coordination associated with detailed stormwater and floodplain management plans.

MMSD Stakeholder Groups

The first subelement involves the creation and activity of MMSD stakeholder groups as described in Chapter II of the flood mitigation plan for the City of Milwaukee.[154] These groups have been formed by the MMSD on a watershedwide basis and include representatives of the City of Milwaukee and other concerned local units of government, including Milwaukee County, SEWRPC, and the WDNR, as well as other public and/or private agencies and organizations, such as environmental and neighborhood organizations and concerned private businesses. Stakeholder meetings allow the various parties involved to offer feedback to the MMSD regarding development of its stormwater and floodplain management plans. Stakeholder meetings have been held since 1998 and continue to be held throughout the planning process.

For example, development of the Kinnickinnic River watershed flood management plan involved stakeholders through an advisory committee, focus groups, and public meetings. These activities are described in the section on public participation activities.

Public Education Activities

The second subelement involves preparation and distribution of educational and self-help materials and provision of educational programs. Under this subelement of the flood mitigation plan, the MMSD has prepared and distributed various public informational and educational materials, including materials oriented toward local homeowners and local government agencies and designed to help them consider and potentially undertake actions to mitigate damage caused by stormwater flooding and sanitary sewer backups throughout the District, including the City of Milwaukee. In addition, the MMSD has established an internet site aimed at keeping interested parties up-to-date on its planning activities. The District has also undertaken an extensive public informational and educational program directed toward reducing infiltration and inflow into its sanitary and combined sewer systems. That program includes radio programming and public educational materials.

In addition to the MMSD efforts, the Milwaukee County Office of Emergency Management prepares and distributes a number of public educational materials and self-help booklets for local property owners. The materials set forth potential preventive measures that may be taken by homeowners to mitigate flood damages. The booklet also provides basic information about flood warnings, as well as National Flood Insurance Program (NFIP) and various Federal and State aid programs that may be available to flood victims. In addition to the booklet, a corresponding videotape is available through the Milwaukee County Federated Library System and Milwaukee County Office of Emergency Management.

Beginning in 2012, Root-Pike WIN and Sweet Water have been conducting the Respect Our Waters campaign, a multi-year marketing initiative to educate area residents on actions that they can take to reduce water pollution associated with stormwater runoff. This initiative includes a television advertising campaign using 30-second spots. These spots emphasize the importance of removing yard debris, cleaning up pet litter, using fertilizers and other yard chemicals responsibly, and preventing motor oil and other fluids from leaking from automobiles. This initiative also includes grassroots outreach, with Sweet Water and Root-Pike WIN being present at community events to educate residents. During these events, Sweet Water and Root-Pike WIN distribute pet waste bags, provide native plants for rain gardens, and conduct giveaways of rain barrels and Milorganite fertilizer. This initiative is funded by the Southeastern Wisconsin Watersheds Trust, Inc., in conjunction with over 50 municipalities, including the City of Milwaukee.

The City of Milwaukee provides information on flood and swift water awareness and flood clean up on its website. In addition, the City's Environmental Collaboration Office, in cooperation with the University of Wisconsin-Milwaukee, developed and distributes a handbook presenting guidelines for the collection and use of rainwater in the City.[155] This document is intended to provide property owners with direction on how to plan, install, and use a small-scale rainwater harvesting system.

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[154] Ibid.

[155] *City of Milwaukee Environmental Collaboration Office and University of Wisconsin-Milwaukee School of Freshwater Sciences,* Rainwater Collection Guidelines for Milwaukee Residents & Property Owners, *August 2017*.

State agencies also conduct public education activities regarding flooding. When flooding occurs, the University of Wisconsin-Extension distributes materials to the public on appropriate actions to take in response to flooding incidents. The Wisconsin Department of Health Services has prepared and distributes a flooding toolkit for citizens.[156] WEM also provides educational information regarding flooding on its ReadyWisconsin website.[157] Examples of outreach material are shown in Appendix C.

Public Participation Activities and Coordination with Other Agencies and Units of Government

The third subelement of this program involves direct public participation and coordination with other agencies during detailed stormwater and floodplain management plan development. As previously noted, the MMSD has formed stakeholder groups to help guide the planning process for each of the major watersheds within its jurisdiction. These groups allow local officials and neighborhood groups an opportunity to provide information regarding flooding and drainage problems, as well as comments regarding potential solutions for those problems. In some municipalities, the MMSD has also held community workshops to obtain input regarding possible solutions to flooding problems in the context of what area residents desire regarding their watercourse.

Toward further informing the public regarding flood mitigation, stormwater and floodplain management, and related issues, this hazard mitigation plan calls for concerned units and agencies of government, including the City of Milwaukee and MMSD, to involve members of the general public and to seek public input in the preparation and implementation of recommendations regarding such issues.

The development of the Kinnickinnic River watershed flood management plan by MMSD included considerable public involvement. At the beginning of plan development, the District established the Kinnickinnic River Watershed Advisory Committee (WAC) to oversee plan development. The Kinnickinnic River WAC consisted of approximately 60 representatives of Milwaukee County, municipalities, regulatory agencies, nongovernmental organizations, and other stakeholders. The WAC met four times in 2015 and 2016 to review progress on plan development and provide comments. As part of the planning process, MMSD partnered with the Milwaukee County Department of Parks, Recreation and Culture to develop updated park plans for County parks that could be potentially impacted by recommendations of the watershed flood management plan. As part of this joint planning effort, three park focus groups were held during 2015. The potential for flood storage within the parks was discussed at these meetings. Alternative flood management plans and park plans were presented at two public meetings in January 2016. Public comments from these meetings were incorporated into the recommended alternative flood management plan and park plans. The draft recommended flood management plan and the park plans were presented to the public at two meetings in October 2016. Public comments from these meetings were incorporated into the recommended alternative flood management plan and park plans.

MMSD has also established an advisory group for watershed management planning in the Menomonee River watershed.

Secondary Plan Element

In addition to the above noted measures, several secondary measures are also to be implemented. These secondary measures are described below.

National Flood Insurance Program and Floodplain Map Updating Efforts

The City of Milwaukee has been designated by FEMA as having flood hazard areas and has taken the steps needed to make its residents eligible to participate in the NFIP. As part of its Map Modernization program, FEMA incorporated the City of Milwaukee Flood Insurance Study (FIS) information into a countywide FIS that became effective on September 26, 2008. The City will continue to participate in the NFIP and, as necessary, will request that FEMA revise the FIS to reflect new flood hazard data. Furthermore, owners of property in flood-prone areas within the City should purchase flood insurance to provide some financial relief for losses sustained in floods that may occur before the implementation of any recommended flood

[156] *This can be accessed at: www.dhs.wisconsin.gov/flood/index.htm.*

[157] *readywisconsin.wi.gov/default.asp.*

control measures. Finally, as flood control measures are implemented, the City intends to work with MMSD and SEWRPC to submit revisions to the flood insurance study to FEMA.

In 1990 a cooperative agreement was executed between Milwaukee County and three local utility companies for the development and maintenance of a Milwaukee County Automated Land Information System (MCAMLIS).[158] Under that program, large-scale digital topographic mapping has been prepared for all of Milwaukee County, including the City of Milwaukee. The MCAMLIS Steering Committee has also requested that SEWRPC carry out a digital floodplain mapping program. That program is being conducted as a cooperative effort between SEWRPC and the MMSD. As part of that program, hydrologic and hydraulic analyses are being conducted to update flood flows and stages to reflect current channel conditions, as well as a uniform land use condition. The updated analyses and floodplain mapping reflect completed flood mitigation projects and other changed conditions, such as the removal of the North Avenue dam. The City of Milwaukee is currently in the process of coordinating the preparation, approval, and adoption of updated mapping for all streams as they are completed. Within the City of Milwaukee MCAMLIS mapping was incorporated into the 2008 FIS for the Milwaukee River mainstem, Lincoln Creek, North Branch Oak Creek, and the Mitchell Field Drainage Ditch.

MMSD is pursuing a floodplain map updating effort in the Kinnickinnic River watershed as the flood control projects discussed in previous sections are designed. The District is in the process of submitting these revisions to FEMA with requests for CLOMRs as required. In addition, it is anticipated that revisions for the floodplain of the Menomonee River and a request for a Letter of Map Revision (LOMR) will be submitted to FEMA upon completion of Phase 2B of the Western Milwaukee flood management project.

Upon completion of the floodplain studies for the remaining streams to be mapped under the MCAMLIS/ Milwaukee County Land Information Council program, the City will submit its proposed floodplain revisions and additions to the WDNR for approval and also request revision of the applicable flood insurance rate maps by the FEMA Federal Insurance Administration. Following WDNR and FEMA approval, the City will amend its floodplain zoning ordinance to reflect the updated one-percent-annual-probability water surface profiles.

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 and that the principal sources of flood hazard information be the most recent available studies for the watersheds and subwatersheds located partly or wholly within the City. 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 accord with Chapter 707, "Disclosures by Owners of Real Estate," of the *Wisconsin Statutes*.

Community Utility Policies and Emergency Programs

The policies of the governmental units and agencies responsible for the design, construction, operation, and maintenance of public utilities and facilities, such as water supply and sewerage facilities, drainageways, and streets and highways, are to carry out those functions in a manner fully consistent with the land use and floodplain regulation recommendations set forth or noted in this plan. Also, the City of Milwaukee and Milwaukee County will continue to implement existing emergency procedures and develop appropriate new emergency procedures as needed to provide residents of the City with timely information about floods in progress and to help them in taking appropriate action.

Stream Channel Maintenance

The City of Milwaukee will work cooperatively with the MMSD to continue and expand a program of regular stream channel maintenance. This program includes the periodic removal of sediment deposits, selected heavy vegetation, and debris from all watercourses within the City, including bridge openings and culverts.

[158] *In June 2016, the MCAMLIS Steering Committee was replaced by the Milwaukee County Land Information Council.*

Under a 1999 revision to its watercourse policy plan,[159] the MMSD would assume responsibility for carrying out channel maintenance duties for the streams under its jurisdiction, but only under certain conditions. Specifically, the MMSD would conduct channel clearing only for those instances where the deposition of sediment or debris would materially raise the elevation of the one-percent-annual-probability flood profile as established under its watercourse system plan such that additional insurable structures would be placed within the resulting floodplain. In no instance would the MMSD assume responsibility for the clearing of bridge and culvert openings. While the criteria used by the MMSD would address the most severe problems associated with channel obstructions, it does not address the potential for other problems that may arise, such as an increase in the incidence and severity of roadway flooding and the obstruction of storm sewer outlets. Those problems will need to be addressed by the City of Milwaukee. Therefore, the City will work with the MMSD in identifying those instances where channel maintenance would meet the MMSD criteria. The City will also develop its own program for providing channel maintenance where the MMSD jurisdiction is not in place.

Stormwater Management Facilities 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 vegetation channel linings, 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. The 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. The City of Milwaukee will carry out, or cause to carry out by others in the case of privately owned facilities, necessary stormwater management facility maintenance activities on a continuing basis to maximize the effectiveness of stormwater management facilities and measures, and to protect the capital investment in the facilities.

Basement Backup Problems

As described in Chapter 3, there are still areas where sanitary sewers backup into basements. In the case of the most severe problem areas, the cause and potential solutions to those basement backup problems are being investigated by the City of Milwaukee, the MMSD, and Veolia, which is a private firm under contract to the MMSD for operating the MMSD sewerage system. As part of the solution, the City of Milwaukee conducted a pilot project in the area where a large number of the 2004 basement backup problems occurred. In order to address ongoing inflow and infiltration (I/I) entering sanitary sewers and resulting in basement backups, the City of Milwaukee conducted pilot projects in 2011 and 2012 that examined I/I originating from private property sources.

The first pilot project was conducted in early 2011 and involved rehabilitating the plumbing in five city-owned homes in an area near W. Capitol Drive between N. 39th Street and N. 42nd Street. A major goal of this project was to identify the costs and challenges associated with lining sanitary sewer building laterals, disconnecting foundation drains from the sanitary sewer, installing sump pumps, and installing backflow preventers. The average per home cost to disconnect the existing foundation drain and rehabilitate the sanitary sewer lateral was approximately $14,200. In addition, the project demonstrated several challenges that are expected to be encountered in conducting large-scale projects of this type. These challenges include the potential need for an electrical service upgrade to provide dedicated service for a sump pump, locating areas in basements where a sump pump can be installed, and handling the sump discharge within the property.

From 2011 through 2013, MMSD and the City of Milwaukee completed the Cooper Park Sewer Lateral Demonstration Project. This project was intended to reduce the likelihood of sewage backups causing basement flooding in the Cooper Park neighborhood during heavy rainfalls. As part of this project, private

[159] *A policy for MMSD stormwater drainage and flood control was initially set forth in SEWRPC Community Assistance Planning Report No. 130,* A Stormwater Drainage and Flood Control Policy Plan for the Milwaukee Metropolitan Sewerage District*, March 1986. In 1998 the Milwaukee Metropolitan Sewerage Commission formed a Watercourse Policy Advisory Group to review and revise the District's policy plan. The recommendations of that committee were adopted by the Sewerage Commission in 1999.*

property owners allowed inspections and rehabilitation or repair of sewer laterals, and City contractors lined private sewer laterals at 432 homes. The City had previously lined the municipal sanitary sewers serving this area. In 2015, the City completed a related project in the Cooper Park neighborhood. Foundation drains were disconnected from sewers at 33 properties in a portion of the neighborhood. Flow monitoring was conducted as part of these projects, and the City reported reductions in peak flows in sewers during heavy rains of about 42 percent in the portion of the project area in which foundation drains were disconnected and 39 percent in the overall area.

From 2012 through 2014, MMSD and the City of Milwaukee completed the Clemens School Sewer Lateral Demonstration Project. This project was intended to reduce the likelihood of sewage backups, causing basement flooding in the area during heavy rainfalls. As part of this project, private property owners allowed inspection and rehabilitation or repair of sewer laterals, and City contractors lined private sewer laterals at 359 homes. The City had previously lined the municipal sanitary sewers serving the area. Flow monitoring was conducted as part of this project, and the City reported reductions in peak flows of about 38 percent in sewers in the neighborhood during heavy rains.

From 2016 through 2017, MMSD and the City of Milwaukee completed a pilot project in an area bounded by W. Layton Avenue to W. Edgerton Avenue from S. 20th Street to S. 27th Street. A major goal of this project was to reduce the amount of I/I in the sanitary sewer system, and reduce the likelihood of sewage backups sausing basement flooding in the area during heavy rains. As part of this project, private property owners allowed inspection and rehabilitation or repair of their sewer laterals. The City's contractor rehabilitated 354 private sewer laterals, using a trenchless cured-in-place pipe method. The City had previously lined the municipal sanitary sewers in this area, and flow monitoring equipment was installed in order to measure reduction in flow within the sanitary sewer system once the project was completed.

As of 2019, the City of Milwaukee is planning a pilot project in an area bounded by W. Harrison Avenue to W. Kinnickinnic River Parkway from S. 60th Street to S. 72nd Street. This project will include inspection and rehabilitation of sanitary sewer laterals, as well as disconnection of foundation drains from the sanitary sewer, and installation of sump pumps and backflow preventers. Major goals of this project are to reduce the amount of I/I in the sanitary sewer system and to reduce the likelihood of sewage backups causing flooding in the area during heavy rains. The city previously lined the municipal sanitary sewers serving this area, and flow monitoring equipment was installed in order to measure the reduction in flow within the sanitary sewer system once the project is completed.

Due to the continuing large number of basements flooded in the 2008-2010 events, the MMSD is currently pursuing a long term Private Property Infiltration and Inflow Reduction Program (PPII) in collaboration with the City of Milwaukee and the other 27 communities. The PPII effort is being conducted during the period 2010 to 2020. The allotment that the City receives through this program can be spent on any reasonable effort on private property to reduce infiltration and inflow. These efforts may include sewer and lateral investigation, lateral repair, and sump pump installation, among others. Each municipality will prioritize the private property infiltration and inflow reduction work within their jurisdiction. The percentage of the work paid for by the MMSD allotment versus private resident contributions will be decided by the City of Milwaukee. Projects that the City is pursuing through this program include inspecting and rehabilitating sanitary sewer laterals into buildings through trenchless cured-in-place technology and disconnecting foundation drains and installing sump pumps.

5.2 HAZARD MITIGATION PLAN COMPONENT FOR THUNDERSTORM, HIGH-WIND, HAIL, AND LIGHTNING HAZARDS

As described in Chapter 4, thunderstorms, high winds, hail, and lightning are natural hazard events of significant concern relative to the City of Milwaukee hazard mitigation plan. This section describes alternative and selected strategies to mitigate these types of hazards. As part of the updating process, these strategies were reviewed and reevaluated by the City of Milwaukee All Hazards Mitigation Plan Local Planning Team

in light of the updated hazard conditions and hazard mitigation goals documented in Chapters 3 and 4, respectively.

Identification of Alternative Mitigation Strategies

All thunderstorms and related hazard events are potentially dangerous and are the most common type of severe weather event compared to other natural hazards within the City of Milwaukee as discussed in Chapter 3. However, only about 10 percent of the thunderstorms and related hazard events that occur within the City of Milwaukee each year are classified as severe. Severe thunderstorm fronts can often be tracked, which generally provides ample warning for potentially affected areas to take preventative actions. In addition, when severe thunderstorms and related hazard events occur, they generally last for relatively short periods of time.

While it may not be possible to accurately identify specific areas where there is significant risk from thunderstorm and related hazard events, measures can be taken to reduce the potential damage caused by thunderstorm and related hazards wherever they may occur in the City. High-wind events associated with thunderstorms are very similar to tornadoes, except they are more common and usually less powerful than tornadoes. 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. During a hail storm personal safety is the first priority and persons should seek shelter and stop driving to avoid accidents. The aforementioned advance warning systems allow some actions to reduce hail damage to vehicles and some property, but little can be done to protect structures. Personal protection is paramount for lightning safety. Many people incur injuries or are killed due to misinformation and inappropriate behavior during thunderstorms. A few simple precautions can reduce many of the dangers posed by lightning. The individual is ultimately responsible for his/her personal safety and should take appropriate action when threatened by lightning. Through review by the City of Milwaukee All Hazards Mitigation Plan Local Planning Team, the following measures to reduce vulnerability to thunderstorms, high winds, hail, and lightning have been identified as viable for this update of the City of Milwaukee hazard mitigation plan.

- Review local building codes to determine if revisions are needed to improve the structures ability to withstand greater wind velocities and impacts from hail[160]
- Establish, update, and/or monitor public early warning systems and networks
- Trim and maintain the health of trees near vulnerable infrastructure, such as utility lines, essential facilities and roads, as well as near homes and businesses
- Bury and protect power and utility lines
- Enforce existing local ordinances, in terms of adequate grounding of newly constructed buildings
- Local fire suppression departments obtain and maintain equipment to help detect or mitigate lightning-related fires, such as thermal imaging devices
- Use surge protectors on critical electronic equipment
- Install 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, and computers
- Provide annual access to weather spotter training
- Maintain compliance with the National Incident Management System (NIMS) (see Federal and State Programs section)

[160] *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 the building code would be a viable mitigation measure, the City would need to pursue a change in the UDC at the State level.*

- Public Informational and Educational Programming

    - Increase public education and awareness of the potential severity of thunderstorms, including promoting public awareness of proven lightning safety guidelines to reduce the risk from lightning hazards and of the potential severity of hailstorms

    - Increase the coverage and use of National Oceanic and Atmospheric Administration (NOAA) weather radios

    - Promote inclusion of safety strategies for severe weather events in driver education classes and materials

    - Encourage residents to develop a Family Emergency Preparedness Plan which would include the preparation of a Disaster Supply Kit (Appendix D)

    - Produce and distribute emergency preparedness information related to thunderstorm hazards

    - Encourage the use and expansion of NOAA severe weather alert systems

Current Programs

Federal and State Programs

The National Weather Service (NWS) issues severe thunderstorm watches and warnings when there is a threat of severe weather conditions, including high winds, hail, lightning, and tornadoes. Several categories of warnings, watches, and advisories apply to thunderstorms and associated hazards. The NWS Milwaukee/Sullivan office will issue a severe thunderstorm warning when either a spotter reports a thunderstorm producing winds that equal or exceed 58 miles per hour (mph), hail of one inch or larger in diameter, or a severe thunderstorm is detected by Doppler radar. 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 high wind warning when sustained winds of 40 mph are expected to occur for an hour or more or 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 or wind gusts of 45 mph to 57 mph are expected to occur. The office also issues a variety of wind-related marine warnings for events in Lake Michigan.

Federal and State programs include thunderstorm awareness and education efforts. The NWS also has an extensive public information program to educate people about the dangers of thunderstorms and related hazards and assist in preventing related deaths and injuries. Wisconsin Emergency Management, in conjunction with the NWS and State and local government agencies, provides both preparedness information and severe weather information to the public. Preparedness 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 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.[161] Similarly, the Wisconsin Division of Emergency Management (WEM) has produced several educational resources regarding thunderstorms and related hazards including prerecorded radio public service announcements, scripts for radio public service announcements, fliers, and educational materials for children.[162] In addition, numerous other organizations, including the American Red Cross, provide public safety information regarding lightning.

The NWS recognizes the need for programs that assist communities in implementing procedures and plans that would reduce risk during a weather disaster. The NWS has developed StormReady, a voluntary program that assists communities with weather-related disaster planning and management. This program encourages communities to take a pro-active approach to develop local hazardous weather operations plans and public

[161] *Wisconsin Department of Health Services,* Wisconsin Severe Thunderstorm and Tornadoes Toolkit, *Publication P01037, June 2015.*

[162] *These can be accessed at Wisconsin Emergency Management's ReadyWisconsin Website located at: ready.wi.gov/Resources/Manager_Resources.asp.*

awareness for all types of severe weather threats. By participating in StormReady, local agencies can earn recognition for their communities by meeting criteria established by the NWS in partnership with Federal, State, and local emergency management professionals. The Milwaukee/Sullivan NWS Office promotes and administers the StormReady program that assists community or county emergency management agencies in Southeastern Wisconsin, including Milwaukee County.

In 2004, the Department of Homeland Security set forth the NIMS (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 the NIMS. The City of Milwaukee has complied with the implementation of NIMS.

Local Programs

The NWS sponsors several different weather-related information and education awareness campaigns throughout the year. During each awareness campaign, the Milwaukee/Sullivan NWS Office distributes information to the media and local emergency management agencies from the Wisconsin Office of Emergency Management. Most schools participate in the Tornado and Severe Weather Awareness Week activities. This event usually occurs in April. The Milwaukee/Sullivan NWS Office sponsors a NOAA Weather Awareness Day in May, and a Heat Awareness Day and a Lightning Awareness campaign in June. The Wisconsin Winter Awareness Week occurs in November each year.

The City of Milwaukee's website provides links to brochures and websites that are available for the public on severe weather safety.

The City of Milwaukee is currently covered by NOAA Weather Radio for severe thunderstorm and related hazard warnings. NOAA Weather Radio has a transmitter in the Town of Delafield, approximately 25 miles west of the City of Milwaukee. This transmitter operates at a frequency of 162.400 megahertz and covers much of southeastern Wisconsin and all of Milwaukee County. In addition, southern portions of the City are covered by a second NOAA Weather Radio transmitter located in Racine County which transmits at a frequency of 162.450 megahertz. Severe thunderstorm and related hazard warnings from NOAA Weather Radio are relayed to other media via the Federal Communication Commission's Emergency Alert System (EAS). The EAS allows officials to send emergency information targeted to specific geographical areas. The EAS sends alerts out to broadcast media, cable television providers, satellites, direct broadcast satellites, high definition television, and video dial tone. This system uses the same digital protocols as NOAA Weather Radio. Nationally, the NWS generates about 80 percent of EAS activations, primarily for short-duration weather warnings and watches. Federal, State, and local emergency personnel can also access this system to disseminate nonweather emergency messages through the NWS' HAZCollect system.

As described in Chapter 2, the Milwaukee County Office of Emergency Management has developed an emergency operations plan which sets forth an all-hazards action plan. In addition, many of the local municipal departments, such as the fire and police departments and the Milwaukee County Office of Emergency Management have developed emergency operations plans and/or programs that set forth procedures and actions to deal with a range of situations and events, including thunderstorms, high winds, hail, and lightning.

The Milwaukee County Office of the Sheriff operates and maintains a total of 57 outdoor warning sirens throughout Milwaukee County. The City of Milwaukee is covered by this warning system. The Milwaukee County Office of the Sheriff tests the system and makes upgrades as required. This system of sirens, however, is not designed to be heard inside closed buildings and the Milwaukee County Office of Emergency Management encourages supplemental use of weather alert radio systems for residents and businesses.

Evaluation of Alternatives and Identification of Mitigation Actions

Based upon review of the above, the refinement and expansion of current ongoing programs represents a major component of the planned mitigation action with regard to early warning systems. Milwaukee County has taken and continues to take steps to assess and correct weaknesses within the outdoor warning siren system.[163] In addition, informing the public of the significance of thunderstorm watches and warnings so that they take thunderstorm warnings and related hazards seriously and know where to seek shelter in emergency situations are important, ongoing components for minimizing the risks associated with these natural hazards. Community- and school-based informational programs should also continue to be conducted by the City of Milwaukee in partnership with Federal, State, County and other local authorities.

In addition, feasible mitigation actions include ordinance review and possible refinement, which may encourage use of appropriate building codes; provision of surge protection for sensitive electronic equipment; and other precautions that will limit possible future bodily injuries, deaths, or property damages due to severe weather events. The majority of these measures are currently in place, indicating an emphasis on informational programming and enforcement.

Thunderstorms and their related hazards can potentially cause damage to a variety of infrastructure, including, transmission lines, communication lines, transportation routes, buildings, or structures due to flooding or high winds. Hence, the City of Milwaukee and relevant businesses should coordinate hazard mitigation activities through a cooperative partnership in citywide disaster planning and response mechanisms. Such measures are already well underway through the coordinated emergency operations planning program involving Milwaukee County Emergency Management and coordinated local community emergency operations programs.

The Milwaukee County Office of Emergency Management maintains the Emergency Operations Plan (EOP) for Milwaukee County. Updated annually, the EOP provides overall guidance in response to major disasters throughout Milwaukee County, including the City of Milwaukee. This plan addresses direction and control, warning and communications, resource management, law enforcement, evacuation and shelter, human services, public works and engineering, public information and education, public health and emergency medical services, radiological protection, fire and rescue, and damage assessment and recovery. It also specifies procedures in the event of any incidents involving hazardous materials or terrorism, provides guidance for division standard operating procedures, and includes the countywide Master Notification List.

Priority Mitigation Measures

Based upon the foregoing evaluation, consideration of risk (see Natural and Other Hazard Risk Analysis included under a later section of this chapter), and review and action by the City of Milwaukee Hazard Mitigation Local Planning Team 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 City of Milwaukee hazards mitigation plan:

- Maintenance and expansion of early warning and communication systems that includes Emergency Alert System (EAS) capabilities and expanded use of emerging technologies. In this regard, the expanded use of the NOAA Weather Radio among residents is encouraged. This weather radio continuously broadcasts NWS forecasts, warnings and crucial weather information. NOAA Weather Radio also provides direct warning to the public for natural, man-made, or technological hazards, and is the primary trigger for activating the EAS on commercial radio, television, and cable systems;

- Promotion of educational and informational programming, especially related to the early warning network, NOAA Weather Radio and EAS broadcasts, and to individual actions to protect citizens, property, and businesses. Community Organizations Active in Disaster (COAD) may be able to provide assistance in these educational efforts;

[163] *Milwaukee County Sheriff's Department Emergency Management Bureau,* Pre-Disaster Mitigation Plan, *August 2004; Milwaukee County Sheriff's Department Emergency Management Bureau,* Milwaukee Pre-Disaster Mitigation Plan *(Draft)*, *June 2010*; *Milwaukee County Office of Emergency Management,* Milwaukee County Hazard Mitigation Plan, *October 2017*.

- Ongoing review and enforcement of building code ordinance requirements;
- Continue to maintain compliance with the NIMS;
- Consider installation of community safe rooms and hardening projects for community facilities;
- Work with businesses to explore the installation of community safe rooms and hardening projects against wind for businesses and manufactures;
- Provide annual access to weather spotting training; and
- Continued coordination of emergency operations and response plans among governmental units.

Because these measures are intended to be ongoing efforts, the Local Planning Team decided to retain them in the updated plan.

5.3 HAZARD MITIGATION PLAN COMPONENT FOR TORNADOES

As described in Chapter 3, tornadoes are natural hazard events of moderate concern relative to this update of the City of Milwaukee hazard mitigation plan. This section describes alternate and selected strategies to mitigate these types of hazards. As part of the updating process, these strategies were reviewed and reevaluated by the City of Milwaukee All Hazards Mitigation Plan Local Planning Team in light of the updated hazard conditions and hazard mitigation goals documented in Chapters 3 and 4, respectively.

Identification of Alternative Mitigation Strategies

All tornadoes are potentially dangerous hazards within the City of Milwaukee as discussed in Chapter 4. Tornadoes have been shown to impact the City of Milwaukee about once every 50 months (see Table 3.15 in Chapter 3) and these are most likely to be of EF1 magnitude or less. In addition, when tornadoes and related hazard events occur, they generally last for short periods of time and impact relatively small areas of the landscape.

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 tornados wherever they may occur in the City of Milwaukee. Based upon review by the City of Milwaukee All Hazards Mitigation Plan Local Planning Team, the following measures to reduce vulnerability to tornadoes have been identified as viable for this update of the City of Milwaukee hazard mitigation plan.

- Review local building codes to determine if revisions are needed to improve the structures ability to withstand greater wind velocities[164]
- Conduct an inventory and inspection of facilities to ensure the quality, quantity, and accessibility of adequate tornado shelters
- Ensure that mobile and manufactured housing is securely anchored
- Establish safe and appropriate locations for temporary debris disposal sites
- Establish, update, and/or monitor public early warning systems and networks
- Evaluate the need to retrofit existing or install new structures to ensure adequate shelters from tornadoes for public buildings, major industrial sites, and other large businesses or complexes, such as shopping malls, fairgrounds, and other vulnerable public areas
- Trim and maintain the health of trees near vulnerable infrastructure, such as utility lines, essential facilities and roads, as well as near homes and businesses
- Bury and protect power and utility lines

[164] Ibid.

- Continue to maintain compliance with the NIMS (see Federal and State Programs section below)
- Provide annual access to weather spotter training
- Public Informational and Educational Programming
    - Increase public education and awareness of the potential severity of tornadoes
    - Increase the coverage and use of NOAA Weather Radios and Emergency Alert System broadcast awareness
    - Promote inclusion of safety strategies for severe weather events in driver education classes and materials
    - Encourage residents to develop a Family Emergency Preparedness Plan which would include the preparation of a Disaster Supply Kit (Appendix D)
    - Produce and distribute emergency preparedness information related to tornado and thunderstorm hazards

Current Programs

Federal and State Programs

The NWS issues warnings, watches, and advisories when there is a threat of severe weather conditions. 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.

Federal and State programs include awareness and educational activities regarding tornadoes. These include public information programs conducted by the NWS, WEM, the Wisconsin Department of Health Services, and the American Red Cross. The NWS has also developed StormReady, a voluntary program that assists communities with weather-related disaster planning and management and the Federal Department of Homeland Security has set forth the NIMS to increase efficiency and effectiveness in incident management. These programs were previously described in the section of this chapter on thunderstorms.

Local Programs

The NWS sponsors several different weather-related awareness campaigns annually. During each awareness campaign, the Milwaukee/Sullivan NWS Office distributes information to the media and local emergency management agencies from the Wisconsin Emergency Management. Most schools participate in the Tornado and Severe Weather Awareness Week activities. This event usually occurs in April. The Milwaukee/Sullivan NWS Office sponsors a NOAA Weather Awareness Day in May, and a Heat Awareness Day and a Lightning Awareness campaign in June. The Wisconsin Winter Awareness Week occurs in November each year.

The City of Milwaukee's website provides links to brochures and websites that are available for the public on severe weather safety.

The Milwaukee County Office of Emergency Management has a number of brochures, booklets, and pamphlets available for the public on tornado safety and other general emergency management-related topics.

The City of Milwaukee is currently covered by NOAA Weather Radio for tornado and related hazard warnings. NOAA Weather Radio has a transmitter located in the Town of Delafield, located approximately 25 miles west of the City of Milwaukee. This transmitter operates at a frequency of 162.400 megahertz and covers much of southeastern Wisconsin, including all of Milwaukee County. In addition, southern portions of the City are covered by a second NOAA Weather Radio transmitter located in Racine County which transmits at a frequency of 162.450 megahertz. Severe thunderstorm and related hazard warnings from NOAA Weather Radio are relayed to other media via the Federal Communication Commission's Emergency Alert System

(EAS). The EAS allows officials to send emergency information targeted to specific geographical areas. The EAS sends alerts out to broadcast media, cable television providers, satellites, direct broadcast satellites, high definition television, and video dial tone. This system uses the same digital protocols as NOAA Weather Radio. Nationally, the NWS generates about 80 percent of EAS activations, primarily for short-duration weather warnings and watches. Federal, State, and local emergency personnel can also access this system to disseminated nonweather emergency messages through the NWS' HAZCollect system.

As described in Chapter 2, the Milwaukee County Office of Emergency Management has developed an emergency operations plan, which sets forth an all-hazards action plan. In addition, many of the local municipal departments, such as the fire and police departments and the Milwaukee County Office of the Sheriff, have developed emergency operations plans and/or programs that set forth procedures and actions to deal with a range of situations and events, including tornados. In addition, many local institutions, including Milwaukee Public Schools,[165] have developed emergency operations plans and programs to deal with tornado events.

As previously noted, the Milwaukee County Office of Emergency Management operates and maintains a total of 57 outdoor warning and communication sirens throughout Milwaukee County.

Evaluation of Alternatives and Identification of Mitigation Actions

Based upon review, the refinement and expansion of the current ongoing programs represents a major component of the planned mitigation action with regard to early warning systems. In the event of a tornado, the countywide early warning system will be sounded, warning people to seek shelter. The best shelters are specifically designed tornado shelters or safe rooms. Lacking such shelters, taking refuge in a basement near supporting walls or pillars, and away from windows, or, if there is no basement, taking shelter in smaller interior, windowless rooms, such as hallways or closets, can offer some protection and are the next best options. Cars, mobile homes, garages, and outbuildings are not safe shelters from tornadoes. 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 in emergency situations, are important, ongoing components for minimizing the risks associated with these natural hazards. Community- and school-based informational programs should also continue to be conducted by the City of Milwaukee in partnership with Federal, State and local authorities.

In addition, feasible mitigation actions include ordinance review and possible refinement, which may be applicable to encourage use of appropriate building codes; incorporation of wind resistant construction methods for the protection of buildings and infrastructure; and other precautions that will limit possible future bodily injuries, deaths, or property damages due to tornado and related hazard events.

Tornado events can potentially cause damage to a variety of infrastructure, including transmission lines, communication lines, transportation routes, and buildings or structures due to flooding or high winds. Hence, the City of Milwaukee, Milwaukee County, and relevant agencies and businesses are encouraged to coordinate hazard mitigation activities through a cooperative partnership in citywide disaster planning and response mechanisms. Such measures are already well underway through the coordinated emergency operations planning program involving the Milwaukee County Office of Emergency Management and coordinated local community emergency operations programs.

Priority Mitigation Measures

Based upon the foregoing evaluation, consideration of risk (see the Hazard Risk Analysis and Prioritization: 2018 section at the end of this chapter), and review and action by the City of Milwaukee Hazard Mitigation Local Planning Team (see Appendix A), the following mitigation measures related to tornado hazard events are included in the updated City of Milwaukee hazards mitigation plan:

- Continue developing effective means of warning at-risk populations, including installation and maintenance of early warning systems that incorporate EAS capabilities and expanded use of emergency technologies;

[165] *Milwaukee Public Schools,* Emergency Operations Plan, *August 2010.*

- Evaluate the need to retrofit existing or install new structures to ensure adequate shelters from tornadoes for public buildings, major industrial sites, and other large businesses or complexes, such as shopping malls, fairgrounds, and other vulnerable public areas;

- Promotion of educational and informational programming, especially related to the early warning network, including NOAA Weather Radio and EAS broadcasts, and to individual actions to protect citizens, property, and businesses. COAD may be able to provide assistance in these educational efforts;

- Ongoing review and enforcement of building code ordinance requirements;

- Continue to maintain compliance with the NIMS;

- Provide annual access to weather spotter training;

- Continued coordination of emergency response and operations plans among governmental units and first responders; and

- Promote and expand training through the Southeastern Wisconsin COAD program and encourage citizen involvement in the various components of that program and its affiliated programs (Community Emergency Response Teams (CERT), Fire Corps, Medical Reserve Corps, and Volunteers In Police Service).

Because these measures are intended to be ongoing efforts, the Local Planning Team decided to retain them in the updated plan.

5.4 HAZARD MITIGATION PLAN COMPONENT FOR EXTREME TEMPERATURES

As described in Chapter 3, extreme temperatures are natural hazard events of significant and high concern relative to the City of Milwaukee hazard mitigation plan. This section describes alternate and selected strategies to mitigate these types of hazards. As part of the updating process, these strategies were reviewed and reevaluated by the City of Milwaukee All Hazards Mitigation Plan Local Planning Team in light of the updated hazard conditions and hazard mitigation goals documented in Chapters 3 and 4, respectively.

Identification of Alternative Mitigation Strategies

Extreme temperature events pose a serious threat to the City of Milwaukee. Extreme heat and cold events combined are the number one most deadly natural hazard within the City of Milwaukee. Temperature extremes should be expected with each summer and winter season making this hazard the easiest to plan and prepare for. Extreme heat and cold events do not typically occur suddenly and are generally connected to a weather system that can be forecast days in advance. When temperature extreme events do occur, they commonly last for extended periods of time (days or weeks) and impact entire areas larger than the City of Milwaukee.

While it may not be possible to accurately identify specific areas where there is significant risk from extreme temperature, extreme heat will have the greatest impact in densely developed areas of the City. Demographically, the elderly, poor, and debilitated are most vulnerable to excessive heat and cold. Fatalities are usually related to age because excessive heat is stressful and can overwhelm those who are weakened because of age or illness. Measures can be taken to reduce the potential injuries and fatalities caused by temperature extremes wherever they may occur in the City. Based upon review by the City of Milwaukee All Hazards Mitigation Plan Local Planning Team, the following measures to reduce vulnerability to extreme temperature events have been identified as viable for this update of the City of Milwaukee hazard mitigation plan.

- Organize neighborhood outreach groups who look after vulnerable groups and individuals. Increase such outreach regarding the availability of shelters during extreme heat and cold events

- Provide special arrangements for payment of heating bills

- Increase coverage and use of NOAA Weather Radio and EAS broadcasts

- Conduct an inventory and inspection of facilities to ensure the quality, quantity, and accessibility of adequate heating and/or cooling centers in the community

- Encourage owners of heating and cooling shelters to extend their hours during extreme temperature events

- Continue to maintain compliance with the NIMS (see Federal and State Programs section below)

- Public Informational and Educational Programming

    - Increase public education and awareness of the potential severity of temperature extreme events
    - Produce and distribute emergency preparedness information related to temperature extremes

    - Produce and distribute emergency information related to the safe operation of generators, space heaters, fireplaces, and woodstoves

    - Promote and expand training through the Southeastern Wisconsin COAD program and encourage citizen involvement in the various components of that program and its affiliated programs (CERT, Fire Corps, Medical Reserve Corps, and Volunteers In Police Service)

Current Programs

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 extreme temperature conditions and associated hazards. The NWS Milwaukee/ Sullivan office will issue an excessive heat warning when daytime high temperatures of 105°F or higher and night-time temperatures of 75°F or higher are expected to occur over a 48-hour period or when high temperatures of 100°F or more are expected over four or more consecutive days. The office will issue a heat advisory when daytime high temperatures of 100°F or higher are expected or when daytime high temperatures are expected to be between 95°F and 99°F for four or more consecutive days. The office will issue a wind chill warning when wind chills of 35°F below zero or colder with winds of four or more mph are expected to occur for three or more hours. The office will issue a wind chill advisory when wind chills between 20°F below zero and 34°F below zero with winds of four or more mph are expected to occur for three or more hours.

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 are being tailored at major metropolitan centers based on research results that link unusual amounts of heat-related deaths to city-specific meteorological conditions. The alert procedures are as follows:

- Include Heat Index values in zone and city forecasts.

- Issue Special Weather Statements and/or Public Information Statements presenting a detailed discussion of 1) the extent of the hazard, including Heat Index values, 2) who is most at risk, and 3) safety rules for reducing the risk.

- Assist State and local health officials in preparing civil emergency messages prior to and during severe heat waves. Meteorological information from Special Weather Statements will be included, as well as medical information, advice, and names and telephone numbers of health officials.

- Release to the media and over the NOAA Weather Radio all of the above information.

State programs include awareness and education efforts. Wisconsin Emergency Management, in conjunction with the NWS and State and local government agencies, provide both preparedness information and severe weather information to the citizens of Wisconsin. Preparedness information is provided during several

severe weather awareness campaigns conducted during the year, each focusing on the prevalent weather hazard at that time. This includes two extreme temperature-related campaigns: a Heat Awareness Day in June, and Wisconsin Winter Awareness Week in November. The Wisconsin Department of Health Services 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.[166] Similarly, the Department has developed a winter weather toolkit to provide information about winter weather, including extreme cold.[167] Similarly, 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.[168] In addition, numerous other organizations, such as the American Red Cross, provide public safety information.

The NWS has also developed StormReady, a voluntary program that assists communities with weather-related disaster planning and management and the Federal Department of Homeland Security has set forth the NIMS to increase efficiency and effectiveness in incident management. These programs were previously described in the section of this chapter on thunderstorms. The City of Milwaukee has complied with the implementation of NIMS.

Local Programs

Led by the City of Milwaukee Health Department, the Milwaukee Metropolitan Area Heat Task Force 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 Office of Emergency Management 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. Together, the City of Milwaukee Health Department and the Milwaukee Heat Task Force collaborated on and instituted a plan for excessive heat conditions.[169] This plan outlines the roles and responsibilities of each participating group during excessive heat conditions. This plan was most recently updated in June 2018. This plan includes a list of public cooling sites that are identified to the public during extreme heat events as a place to cool down and essential recommendations and additional considerations for organizations offering to publicize their facilities as cooling centers.

As described in Chapter 2, the Milwaukee County Office of Emergency Management has developed an emergency operations plan, which sets forth an all-hazards action plan. In addition, many of the local municipal departments, such as the fire and police departments and Milwaukee County Office of the Sheriff, have developed emergency operations plans and/or programs that set forth procedures and actions to deal with a range of situations and events, including extreme temperature events.

Evaluation of Alternatives and Identification of Mitigation Actions

Based upon review of the above, the current ongoing informational and educational programs represent a major component of the planned mitigation action. The City of Milwaukee should promote basic strategies to reduce injuries and fatalities, hazard awareness, and community involvement. Temperature hazards are faced by the City of Milwaukee residents annually and the ability to make positive decisions concerning exposure limits will depend on safety awareness. Analysis of the vulnerability of humans, infrastructure, and economic production caused by extreme temperature events demonstrates that the provision of advanced weather forecasting systems, availability of adequate shelter from the heat and cold in public buildings, major industrial sites, and other large businesses or complexes, such as shopping malls, 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. The City of Milwaukee supports measures presently implemented by the NWS; Federal, State, and local health organizations; and the media preceding and during excessively hot weather. It is also important to continue to encourage concern for, and

[166] *Wisconsin Department of Health Services,* Wisconsin Extreme Heat Toolkit, *Publication 00632, March 2014.*

[167] *Wisconsin Department of Health Services,* Wisconsin Winter Weather Toolkit, *Publication 00652, April 2014.*

[168] *These can be accessed at Wisconsin Emergency Management's ReadyWisconsin website located at: ready.wi.gov/Resources/Manager_Resources.asp.*

[169] *City of Milwaukee Health Department and Milwaukee Metropolitan Area Heat Task Force,* "Excessive Heat Event Coordination Plan," *June 2018.*

awareness of, elderly neighbors. Community and school-based informational programs should continue to be conducted by the City of Milwaukee in partnership with Federal, State and local authorities.

Extreme temperature events are a public health concern and ultimately prevention should fall to the local authorities. These events affect individuals, typically the elderly, sick, and invalid, who cannot access shelter with decent heat or air conditioning. Continued coordinated effort involving the City of Milwaukee Health Department, the Milwaukee Heat Task Force, and local community emergency operations programs should be supported to identify and protect individuals vulnerable to temperature related hazards.

Priority Mitigation Measures

Based upon the foregoing evaluation, consideration of risk (see the Hazard Risk Analysis and Prioritization: 2018 section at the end of this chapter), and review and action by the City of Milwaukee Hazard Mitigation Local Planning Team (see Appendix A), the following mitigation measures related to extreme temperature events are included in the updated hazard mitigation plan for the City of Milwaukee:

- Organize neighborhood outreach groups who look after vulnerable groups and individuals;
- Increase outreach to vulnerable populations regarding availability of shelters during extreme heat and cold events;
- Continue support of the Milwaukee Heat Task Force;
- Encourage the provision of special arrangements for payment of heating bills;
- Identify and advertise a list of available heating and or cooling shelters in the immediate area;
- Encourage owners of heating and cooling shelter sites to extend their hours during extreme temperature events;
- Increase coverage and use of NOAA Weather Radio and EAS broadcasts;
- Promotion of educational and informational programming. COAD may be able to provide assistance in these educational efforts;
- Produce and distribute emergency information related to the safe operation of generators, space heaters, fire places; and wood stoves;
- Continue to maintain compliance with the NIMS; and
- Promote and expand training through the Southeastern Wisconsin COAD program and encourage citizen involvement in the various components of that program and its affiliated programs (CERT, Fire Corps, Medical Reserve Corps, and Volunteers In Police Service)

Because these measures are intended to be ongoing efforts, the Local Planning Team decided to retain them in the updated plan.

5.5 HAZARD MITIGATION PLAN COMPONENT FOR LAKE MICHIGAN COASTAL HAZARDS

As described in Chapter 3, Lake Michigan shoreline erosion and flooding are natural hazard events of low concern relative to the City of Milwaukee hazard mitigation plan. This section describes alternate and selected strategies to mitigate these types of hazards. As part of the updating process, these strategies were reviewed and reevaluated by the City of Milwaukee All Hazards Mitigation Plan Local Planning Team in light of the updated hazard conditions and hazard mitigation goals documented in Chapters 3 and 4, respectively.

Identification of Alternative Mitigation Strategies

As reported in Chapter 3, a number of studies and planning programs have been carried out relating to Lake Michigan coastal erosion and related hazards.[170] A review of those plans and materials developed under the State of Wisconsin Coastal Management Program indicates a range of alternative shoreline erosion control mitigation measures. The following measures to reduce the vulnerability to shoreline erosion and related hazards are considered as viable for incorporation into the City of Milwaukee hazard mitigation plan.

- Development and adoption of shoreland zoning ordinances incorporating bluff setback provisions. (Guidance on setback provisions is available from the Wisconsin Coastal Management Program);

- Construction and maintenance of shoreline protection structures and bluff stabilization measures where urban development commitments have been made dictating the need for structures. Effective shore protection requires a combination of bluff stabilization, surface water and subsurface water control, and bluff toe protection. Structural shore protection measures should be provided if it can be shown that such measures will effectively reduce shoreline erosion and not adversely affect adjacent sections of the shoreline to impair public rights in navigable waters; that there will be no significant reduction in public access, use, and enjoyment of the shoreline environment; and that any adverse impacts on fish and wildlife resources caused by the structure will be compensated for by providing fish and wildlife preservation measures;

- Continue ongoing programs to update and refine coastal hazard data; and

- Public informational and educational programming covering:

    - Information on shoreland erosion and related hazards to serve as a "fair warning" guide for, and a valuable service to, groups, such as realtor-brokers, shoreline property owners, developers, lending institutions, and prospective buyers.

    - Property owner guidance on proper shoreline and bluff management actions, such as vegetation and drainage practices.

    - Permitting and zoning: A number of educational materials have been developed through the cooperative efforts with the State Coastal Management Program.

Current Programs

Federal Programs

The U.S. Army Corps of Engineers is the primary Federal agency responsible for the regulation of structures and work related to surface waters. Initial Corps authority to regulate structures or work affecting navigable waters stems from the River and Harbor Act of 1899. Corps regulatory authority was expended with the passage of the Federal Water Pollution Control Act amendments in 1972. Section 404 of this act authorized the Corps to administer a permit program to regulate the deposition of dredged and fill materials into waters and related wetlands of the United States, as well as to regulate the construction of shore protection structures. The Corps also exercises some control over Lake Michigan levels through the use of water controls, such as locks and dams; however, the impacts of these controls are minimal compared to the impacts due to the effects of climate.

FEMA produced a Draft Great Lakes Coastal Guidelines Update, dated March 2009, which includes new methodology to determine flood hazard zones within the FEMA Region V coastal zone. Final guidelines were issued in March 2014.[171] Future steps will include pilot studies to evaluate the new methodologies at specific Great Lakes locations followed by a prioritization of coastal mapping needs within the FEMA

[170] *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, December 1997; and The H. John Heinz III Center for Science, Economics and the Environment, Evaluation of Erosion Hazards, April 2000.*

[171] *Federal Emergency Management Agency,* FEMA Great Lakes Coastal Guidelines, Appendix D.3 Update, *January 2014.*

Regions for future analyses. The ultimate goal of these efforts will be a remapping of the flood hazards along the Great Lakes coastal areas that would subsequently be reflected in revised Flood Insurance Studies.

The Great Lakes Coastal Flood Study (GLCFS) is a multi-year project led by FEMA to put a wide range of decision-making data in the hands of Great Lakes coastal communities, including more accurate and up-to-date Flood Insurance Rate Maps (FIRMs). These flood maps and related information will be tools that can help communities identify high-risk areas and guide land use planning and capital investments to mitigate future losses.

FEMA is conducting a coastal analysis and mapping study to produce updated DFIRMs of coastal counties around the Great Lakes. This study will update the coastal storm surge elevations for the shorelines. The resulting DFIRMs may have V zones in those shoreline areas that do not have bluffs. WDNR staff anticipate that preliminary digital flood insurance rate maps for the southern counties along Lake Michigan will be released in 2020.

State and Local Programs

Wisconsin's Shoreland Management Program is a partnership between State and local government that requires the adoption of County shoreland zoning ordinances to regulate development near navigable lakes and streams, in compliance with statewide minimum standards. These minimum statewide standards are set forth in Chapter NR 115, *Wisconsin Administrative Code*.

The Wisconsin Coastal Management Program (WCMP) 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 resource 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 WCMP is housed at the Wisconsin Department of Administration, Bureau of Housing and Intergovernmental Relations. The WCMP has constituted an interagency coastal hazards work group formed by staff from the WDNR, University of Wisconsin-Madison's Sea Grant Institute, State Cartographer's Office, and the Wisconsin Emergency Management Program as a forum to coordinate initiatives related to coastal management in the State.

In 2017, project team consisting of the WCMP, the University of Wisconsin Sea Grant Institute, the University of Wisconsin-Madison Department of Civil and Environmental Engineering, and SEWRPC began work on the Southeast Wisconsin Coastal Resilience Project. This project will provide resources and assistance to communities in Kenosha, Milwaukee, Ozaukee, and Racine Counties to plan and prepare for coastal hazards. The project team is evaluating and mapping shoreline recession rates through analysis of historical aerial photographs and assessing scenarios of potential shoreline recession under Lake level extremes and high-energy storm conditions. The project will also develop educational and outreach materials for best bluff management practices, bluff slope vegetation practices that can improve bluff stability, nature-based shoreline protection specifically for Great Lake shorelines, and resilient beach restorations practices that increase resistance to erosion. The project is funded through a Coastal Resilience Grant from the National Oceanic and Atmospheric Administration.

The WCMP created a web-based tool that allows users to examine photos from the late 1970's and compare them to corresponding photos from 2007 and 2008 to assess changes to the shoreline. GIS layers for shore structures, beach protection, and bluff conditions for each time frame allow for more detailed analysis of shoreline and bluff changes.

The University of Wisconsin Sea Grant is a statewide program of basic and applied research, education, and 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 the City of Milwaukee in dealing with Lake Michigan shoreline management issues.

The State of Wisconsin, through the WDNR, regulates shore protection-related activities under the provisions of Chapter 30 of the *Wisconsin Statutes*. State regulatory authority with respect to shore protection and erosion control projects is largely confined to projects initiated at or below the ordinary high water mark.

For example, Chapter 30 provides for the establishment of bulkhead lines by local units of government, which delineate an artificial shoreline and allow the deposit of materials or filling up to the bulkhead line if standards for the protection of fish, wildlife, and water quality are met. Under Chapter 30, the installation of riprap and shore protection structures on the bed and bank of the water, or the unbroken slope from the ordinary high water mark requires a WDNR permit.

Although the WDNR regulates shore protection-related activities throughout most of the Lake Michigan shoreline of the State, 93 percent of the immediate shoreline in Milwaukee County is regulated under lakebed grants made to the City of Milwaukee or to Milwaukee County between 1909 and 1973. The only two shoreline areas not regulated under lakebed grants are the 2,920-foot reach of shoreline within the City of Milwaukee just north of the City of Milwaukee Linnwood Avenue water treatment plant, and the 9,070-foot reach of shoreline along the Fox Point terrace near N. Beach Drive.

The lakebed grants made to the City of Milwaukee or to Milwaukee County govern submerged lands extending into Lake Michigan, and under the terms of the grants are to be held and used by the City or the County for navigation or harbor facilities, public parks, or highway purposes.

The City of Milwaukee, under Chapter 8 of the Code of Ordinances, requires that a City permit be obtained for the construction of dock improvements within the City lakebed grant areas. The State of Wisconsin does not regulate shore protection-related activities under Chapter 30 of the *Wisconsin Statutes* within the lakebed grant area.

Evaluation of Alternatives and Identification of Mitigation Actions

A review of the alternative measures noted above and the status of ongoing programs indicates that all of the measures noted above are considered to be appropriate for inclusion in the City of Milwaukee hazard mitigation plan. The measures noted have been developed, evaluated, and recommended in other studies and programs.

Priority Mitigation Measures

Based upon the foregoing evaluation, consideration of risk (see the Hazard Risk Analysis and Prioritization: 2018 section at the end of this chapter), and action by the City of Milwaukee Hazard Mitigation Local Planning Team (see Appendix A), the following mitigation measures related to Lake Michigan coastal hazards are included in the updated hazard mitigation plan for the City of Milwaukee:

- Continued enforcement and review of the City of Milwaukee shoreland regulations and policies relating to structural shoreline erosion protection
- Continued construction and maintenance of shoreline protection structures to protect urban development in selected areas of the City of Milwaukee
- Continue ongoing programs to update and refine coastal hazard data
- In cooperation with other programs, such as the WCMP, carry out public informational and educational programming on shoreline erosion hazards and proper property owner shoreline and bluff management actions

Because these measures are intended to be ongoing efforts, the Local Planning Team decided to retain them in the updated plan.

5.6 HAZARD MITIGATION PLAN COMPONENT FOR WINTER STORMS

As described in Chapter 3, winter storms are natural hazard events of moderate concern relative to the City of Milwaukee hazard mitigation plan. This section describes alternate and selected strategies to mitigate this type of hazard. As part of the updating process, these strategies were reviewed and reevaluated by the City of Milwaukee All Hazards Mitigation Plan Local Planning Team in light of the updated hazard conditions and hazard mitigation goals documented in Chapters 3 and 4, respectively.

Identification of Alternative Mitigation Strategies

As discussed in Chapter 3, winter storm events can pose a serious threat to the City of Milwaukee. Severe winter weather can include blizzards, freezing sleet, and dangerous combinations of temperatures and wind. Winter storms may last for days or weeks, completely shutting down businesses and government and isolating residents in their homes. Extreme cold temperature, often connected to winter storm events, is the number two leading natural hazard cause of deaths in the State. Additionally, unsuspected fatalities associated with winter storms include heart attacks while shoveling snow and fires caused by the 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 and cautionary 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 City of Milwaukee. High-wind, freezing rain, sleet and snow may be associated with a winter storm. In review by the City of Milwaukee All Hazards Mitigation Plan Local Planning Team, the following measures to reduce vulnerability to these dangers have been identified as viable for this update of the City of Milwaukee hazard mitigation plan.

- Ongoing review and enforcement of building code requirements
- Review the energy efficiency and winter readiness of critical facilities and housing in the community
- Work with utility companies to assess and improve, as needed, electric service systems reliability
- Consider burying utilities at critical and vulnerable junctions to avoid power loss due to downed lines
- Establish, update, and/or monitor public early warning systems and networks
- Trim and maintain the health of trees near vulnerable infrastructure, such as utility lines, essential facilities and roads, as well as near homes and businesses
- Promote planting windbreaks and installing snow fence to protect highways
- Continue to maintain compliance with the NIMS
- Public Informational and Educational Programming
    - Promote winter hazard awareness, including home and travel safety measures, such as avoiding travel during winter storms, and having a shovel, sand, warm clothing, food, and water, if automobile travel cannot be avoided, and installing a back-up heating system in at least one room in the home
    - Increase the coverage and use of NOAA Weather Radio and EAS broadcasts
    - Promote inclusion of safety strategies for severe weather events in driver education classes and materials
    - Encourage residents to develop a Family Emergency Preparedness Plan, including the preparation of a Disaster Supply Kit (Appendix D)
    - Produce and distribute emergency preparedness information related to winter storm hazards;
    - Produce and distribute emergency information related to the safe operation of generators, space heaters, fireplaces, and woodstoves
    - Promote and expand training through the Southeastern Wisconsin COAD program and encourage citizen involvement in the various components of that program and its affiliated programs (CERT, Fire Corps, Medical Reserve Corps, and Volunteers In Police Service)

Current Programs

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 winter weather conditions and associated hazards. The NWS 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 closes roads or 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 weather event

NWS forecasters also have discretion to issue winter storm warnings for events that may not officially reach the warning criteria, but are expected to have a significant impact on society. The office will issue a winter weather advisory if one or more of the following weather events are expected to occur over a period of 12 or fewer 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 weather event

The NWS office will issue a blizzard warning under conditions of sustained winds or frequent gusts of 35 mph or more and falling or blowing snow that reduces visibility to one-quarter mile or less for three or more hours. The office will issue an ice storm warning when ice accumulations of one-quarter inch or more are expected over a period of 12 or fewer hours and a freezing rain advisory when ice accumulations of less than one-quarter inch are expected over a period of 12 or fewer hours.

NWS bulletins are disseminated over a number of telecommunication channels including: the NOAA All Hazard Weather Radio, the NOAA All Hazard Weather Wire, NAWAS, the State law enforcement TIME system, and through an emergency e-mailing network. In addition, these bulletins are relayed to other local media via the Federal Communication Commission's Emergency Alert System (EAS) which rebroadcast the weather bulletins over public and private television and radio stations.

Federal and State programs include awareness and education activities. Wisconsin Emergency Management, in conjunction with the NWS, other State agencies, and local emergency management organizations, provides awareness and preparedness information to the public. This information is provided in three severe weather awareness campaigns conducted throughout the year, each focusing on the prevalent weather hazard at that time. In November of each year, Winter Awareness Week focuses on informing and educating people concerning the hazards presented by severe winter weather and information on preparedness for extreme weather conditions during winter. The Wisconsin Department of Health Services 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.[172] Similarly, the Wisconsin Division of Emergency Management 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.[173]

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[172] *Wisconsin Department of Health Services,* Wisconsin Winter Weather Toolkit, op. cit.

[173] *These can be accessed at Wisconsin Emergency Management's ReadyWisconsin website located at: ready.wi.gov/Resources/Manager_Resources.asp.*

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 NWS reports that 70 percent of winter storm fatalities occur in automobiles, therefore, listening to weather advisories and avoiding travel during winter storms would help prevent many fatalities.

Local Programs

One of the greatest concerns with winter storms is maintaining a safe and clear transportation network. Safety measures include plowing, salting, and sanding roads in order to improve both public and emergency response access during winter storms. The Wisconsin Department of Transportation (WisDOT) contracts with the Milwaukee County Highway Department and is responsible for plowing over 1,100 miles of Interstate, Federal, and State highways within Milwaukee County. The City of Milwaukee Department of Public Works is responsible for maintaining the 1,400 miles of secondary roads throughout the City.

Preventative community strategies include maintaining the health of urban trees to minimize damage from ice storms and promoting sound levels of home insulation. Older homes can be vulnerable to heat loss and any home is vulnerable to power loss, therefore, possession of an alternative heat and power source is a consideration in protecting against winter storm hazards.

As described in Chapter 2, the Milwaukee County Office of Emergency Management has developed an emergency operations plan, which sets forth an all-hazards action plan. In addition, many of the local municipal departments, such as the fire and police departments and Milwaukee County Office of the Sheriff, have developed emergency operations plans and/or programs that set forth procedures and actions to deal with a range of situations and events, including winter storms.

Evaluation of Alternatives and Identification of Mitigation Actions

Analysis of the vulnerability of humans, infrastructure, and economic production to winter storms and related hazard events demonstrates that the provision of 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 in emergency situations, are important, ongoing components to minimizing the risks associated with these natural hazards. The formation of 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 vulnerable population groups are protected during these events. Community and school based informational programs are currently being conducted by the City of Milwaukee and Milwaukee Public Schools in partnership with Federal, State and local authorities.

Winter storms and their related hazards can potentially impact all of the City of Milwaukee. 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 and ice. The City of Milwaukee, Milwaukee County, and relevant agencies and businesses are encouraged to coordinate hazard mitigation activities through local government participation in countywide disaster planning and response mechanisms. Such measures are already well underway through the coordinated emergency operations planning program involving the Milwaukee County Office of Emergency Management and coordinated local community emergency operations programs.

Priority Mitigation Measures

Based upon the foregoing evaluation, consideration of risk (see the Hazard Risk Analysis and Prioritization: 2018 section at the end of this chapter), and review and action by the City of Milwaukee Hazard Mitigation Plan Local Planning Team (see Appendix A), the following mitigation measures related to winter storm events are included in the updated hazard mitigation plan for the City of Milwaukee:

- Organize neighborhood outreach groups who look after vulnerable groups and individuals;
- Provide special arrangements for payment of heating bills;

- Identify and advertise a list of available heated shelters in the immediate area;
- Increase coverage and use of NOAA Weather Radio and EAS broadcasts;
- Promotion of educational and informational programming. Such programming should include promotion of safety strategies for driving in severe weather events in driver education classes and materials. COAD may be able to provide assistance in these educational efforts;
- Produce and distribute emergency preparedness information related to the safe operation of generators, space heaters, fireplaces, and wood stoves;
- Ongoing review and enforcement of building code ordinance requirements;
- Work with agencies, such as the American Red Cross, to establish a system to provide for short-term shelters and shelter operations during severe winter storm event situations;
- Continued coordination of emergency response plans among governmental units and first responders;
- Continue and refine State, County, and City road maintenance programs;
- Work with utilities to assess and improve, as needed, electrical service systems reliability;
- Continue to maintain compliance with the NIMS; and
- Promote and expand training through the Southeastern Wisconsin COAD program and encourage citizen involvement in the various components of that program and its affiliated programs (CERT, Fire Corps, Medical Reserve Corps, and Volunteers In Police Service).

Because these measures are intended to be ongoing efforts, the Local Planning Team decided to retain them in the updated plan.

5.7 HAZARD MITIGATION PLAN COMPONENT FOR CONTAMINATION AND LOSS OF WATER SUPPLY

As described in Chapter 3, contamination and loss of water supply are hazard events of moderate concern relative to the City of Milwaukee hazard mitigation plan. This section describes alternate and selected strategies to mitigate these types of hazards. As part of the updating process, these strategies were reviewed and reevaluated by the City of Milwaukee All Hazards Mitigation Plan Local Planning Team in light of the updated hazard conditions and hazard mitigation goals documented in Chapters 3 and 4, respectively.

Identification of Alternative Mitigation Strategies

The City of Milwaukee is richly endowed with the surface water resources of Lake Michigan, as noted in Chapter 3 of this report. However, these sources of freshwater are not unlimited and surface water resources are subject to contamination, as well as over-use. Contamination and loss of water supply events generally provide no warning, making it difficult for potentially affected areas to take preventative actions. In some cases, industries may be particularly vulnerable to loss of water supply, due to equipment and processing needs. In addition, fire protection is an important related issue. If contamination and loss of water supply events would occur, they could potentially last for extended periods of time, such as weeks or months, and likely would impact a specific water source such as a specific intake, treatment plant, or well. In review by the City of Milwaukee All Hazards Mitigation Plan Local Planning Team, the following measures to reduce vulnerability to water supply contamination events have been identified as viable for this update of the City of Milwaukee hazard mitigation plan.

- Promote development of a thorough drinking water supply risk and threat assessment that identifies potential vulnerabilities and targets for sabotage and terrorism attack

- Manage sewage sludge, chemicals, and hazardous materials effectively in areas that are susceptible to surface water contamination with emphasis on surface water related water quality management areas

- Develop a standard emergency operation plan for the public water supply system in order to plan procedures for mechanical failures, power outages, unsafe samples, and threats or acts of terrorism

- Maintenance and potential upgrading of water treatment capabilities, including disinfection equipment

- Maintain municipal water and sewer infrastructure at acceptable operating standards

- Continue to maintain compliance with the NIMS (see Federal and State Programs below)

- Public Informational and Educational Programming

    - Encourage residents to develop a Family Emergency Preparedness Plan, including the preparation of a Disaster Supply Kit (Appendix D)

    - Continue educational and outreach programs related to backflow prevention

    - Train operators and plant personnel in security awareness and reporting protocols

Current Programs

Federal and State Programs

There are various governmental agency programs to help address and fund surface water and groundwater contamination-related issues. The U.S. Environmental Protection Agency administers multiple programs designed to clean up the worst contaminated watersheds throughout the Great Lakes Region. The Milwaukee Harbor estuary and portions of the Milwaukee River, Lincoln Creek, the Menomonee River, and the Little Menomonee River are included in a designated area of concern from pollution and ongoing efforts are being made to mitigate surface water and sediment contamination within this area.

In 1991, the USEPA published a regulation known as the Lead and Copper Rule mandating that large water utilities begin corrosion control treatment to reduce lead and copper concentrations in the water provided to consumers. The rule has undergone various revisions since its formation. Municipal water utilities are also required to regularly test their water supply for lead and copper under Section NR 809.54(3) of the *Wisconsin Administrative Code*. Under this code, the action level is exceeded if the concentration in more than ten percent of tap water samples collected during any monitoring period is greater than 15 μg/l for lead and 1,300 μg/l for copper. That is, if the 90th percentile lead concentration is greater than 15 μg/l, or the 90th percentile copper concentration is greater than 1,300 μg/l, the utility is out of compliance with the State standards. If a utility fails to meet these standards, they are required to undertake additional action to control corrosion of pipes that are leading to the high lead or copper concentrations. The utility is also required to increase its monitoring program, and conduct public education and outreach regarding high lead or copper levels in the drinking water, including steps the consumer can take to protect their health.

In 2004, the Federal Department of Homeland Security has set forth the NIMS to increase efficiency and effectiveness in incident management. This program was previously described in the section of this chapter on thunderstorms.

The WDNR oversees several programs related to water supply contamination issues.

Relative to groundwater, the Department oversees several programs. One program is administered by the Department's Bureau for Remediation and Redevelopment (RR). This bureau oversees response actions at spills, hazardous substance release sites, abandoned containers, drycleaners, brownfields (including the Site Assessment Grant Program), "high priority" leaking underground storage tanks, closed wastewater and solid waste facilities, hazardous waste corrective action and generator closures, and sediment cleanup actions. It has primary responsibility for implementing and aiding cleanups under the Spill Law, the Environmental

Repair Law, Federal programs (Superfund, Hazardous Waste Corrective Action, Leaking Underground Storage Tanks (LUST), and Brownfields), the Land Recycling Law and State Brownfield Initiatives, the Drycleaner Environmental Response Fund, and at closed landfills. The RR program provides technical assistance, helps to clarify legal liability, provides financial assistance primarily to local governmental units, and provides technical project oversight of cleanup projects. Another program is the Well Compensation Program, which provides financial assistance through grant monies to remediate or seal contaminated private wells.

The Department also oversees the Source Water Assessment Program which was completed in May 2003, as required by the 1996 reauthorization of the Federal Safe Drinking Water Act (SDWA). The 1996 amendments to the SDWA require states to: 1) delineate assessment area boundaries from which public water systems receive supplies of drinking water, 2) inventory significant potential sources of contamination within those boundaries, 3) determine the susceptibility of the public water systems to those potential sources of contamination, and 4) provide the assessment results to the public. This required assessment was completed for the Milwaukee Waterworks.[174] The WDNR has also sent letters to all municipal water supply system operators recommending steps to be taken for system security purposes.

Local Programs

The City of Milwaukee water treatment plants have been upgraded within the past 10 years to include state-of-the-art disinfection systems. In addition, the plants are generally considered to be well maintained and have recently installed substantial security facilities and programs.

The City of Milwaukee operates two facilities where residents can recycle or safely dispose of a wide variety of items, many of which can contaminate water if disposed of improperly. These items include electronics, waste motor oil and other automotive fluids, and scrap metal. In addition, the MMSD has three year-around collection centers for the disposal of household hazardous waste and sponsors periodic mobile collection events for residents of Milwaukee County. The District also sponsors an annual event for unused prescription medication.

Section NR 810.15 of the *Wisconsin Administrative Code* requires that the water supplier for every municipal water system develop and implement a comprehensive cross-connection control program. The Milwaukee Water Works conducts public education related to prevent cross-connections both through its website and through brochures distributed to its customers.

Evaluation of Alternatives and Identification of Mitigation Actions

Based upon review of the above, the current ongoing programs represent the planned mitigation actions for water supply protection with regard to the continued provision of advanced protection and monitoring measures.

Priority Mitigation Measures

Based upon the foregoing evaluation, consideration of risk (see the Hazard Risk Analysis and Prioritization: 2018 section at the end of this chapter), and review and action by the City of Milwaukee All Hazard Mitigation Local Planning Team (see Appendix A), the mitigation measures recently taken and underway by the City of Milwaukee related to contamination or loss of water supply are considered adequate. These include:

- Promotion of educational and informational programming related to water safety issues. COAD may be able to provide assistance in these educational efforts;
- Continued maintenance, operation, and upgrading of the state-of-the-art treatment facilities;
- Continued maintenance, operation, and upgrading of water supply facility security programs and procedures. The WDNR correspondence on this element, including basic security measures to be considered can be found in Appendix E;
- Continued coordination of emergency response plans among governmental units and first responders;
- Continue to maintain compliance with the NIMS; and

[174] *Wisconsin Department of Natural Resources,* Source Water Assessment for Milwaukee Waterworks, *March 27, 2003*.

- Promote and expand training through the Southeastern Wisconsin COAD program and encourage citizen involvement in the various components of that program and its affiliated programs (CERT, Fire Corps, Medical Reserve Corps, and Volunteers In Police Service).

Because these measures are intended to be ongoing efforts, the Local Planning Team decided to retain them in the updated plan.

5.8 HAZARD MITIGATION PLAN COMPONENT FOR HAZARDOUS MATERIAL INCIDENTS

As described in Chapter 3, hazardous material incidents are human-induced hazard events of limited concern relative to the City of Milwaukee hazard mitigation plan. This section describes alternate and selected strategies to mitigate these types of hazards. As part of the updating process, these strategies were reviewed and reevaluated by the City of Milwaukee All Hazards Mitigation Plan Local Planning Team in light of the updated hazard conditions and hazard mitigation goals documented in Chapters 3 and 4, respectively.

Identification of Alternative Mitigation Strategies

As described in Chapter 2, a significant number of fixed facilities that store hazardous substances are located within the City of Milwaukee. In addition, a transportation system is in place to move hazardous materials throughout the City of Milwaukee. There have been a limited number of minor hazardous material incidents, all of which have been properly handled through local emergency response actions.

Hazardous materials are present in quantities of concern in business and industry, universities, hospitals, utilities, and other facilities in the City of Milwaukee. Despite extensive precautions taken to ensure careful handling during manufacture, transport, storage, use, and disposal, accidents and inadvertent releases may occur. In review by the City of Milwaukee All Hazards Mitigation Plan Local Planning Team, the following measures to reduce vulnerability to hazardous material incidents have been identified as viable for the updated City of Milwaukee hazard mitigation plan.

- Promote community and operator compliance with industry safety regulations and standards
- Promote control, enforcement, and cleanup of hazardous materials, including proper disposal of chemicals
- Promote development of site emergency plans for schools, factories, office buildings, shopping malls, hospitals, and other appropriate sites
- Promote proper design, construction, maintenance and inspections of hazardous material storage facilities, pipelines, and other related facilities
- Continue to maintain compliance with the NIMS (see Federal and State Programs section below)
- Continue participation in the Wisconsin Hazardous Materials Response System
- Public Informational and Educational Programming
    - Promote the current household hazardous waste management program
    - Promote public awareness of hazardous material dangers and personal protection actions for these dangers
    - Promote and expand training through the Southeastern Wisconsin COAD program and encourage citizen involvement in the various components of that program and its affiliated programs (CERT, Fire Corps, Medical Reserve Corps, and Volunteers In Police Service)

Current Programs

Federal and State Programs

In 2014, the U.S. Department of Transportation issued an Emergency Order requiring all railroads operating trains containing more than one million gallons of Bakken crude oil, or approximately 35 tank cars, in a particular state to provide the State Emergency Response Commission (SERC) notification regarding the expected transport of such cargo through the counties of that state. The notification must include estimated volumes of Bakken crude oil being transported, frequencies of anticipated train traffic, and the route that the crude oil will be transported. The railroad operators must also provide contact information for a responsible party from the railroad and assist the SERC in sharing the information with the appropriate emergency responders in appropriate communities. In addition, the Pipeline and Hazardous Materials Safety Administration (PHMSA) and Federal Railroad Administration (FRA), in coordination with Canada, issued a rule in 2015 that mandates enhanced standards for new tank cars and a retrofitting schedule for older tank cars carrying crude oil and ethanol. The rule also requires a new braking standard for certain trains and designates new operational protocols for trains transporting large volumes of flammable liquids, including routing requirements, speed restrictions, and information for local government agencies regarding the cargo.

The U.S. Coast Guard has developed an area contingency plan for the Lake Michigan shoreline. This plan is intended to coordinate the response to an oil or hazardous materials spill or release into or near the Lake. This plan was most recently undated in 2017.[175]

In accordance with The Emergency Planning and Community Right-to-Know Act (EPCRA) of 1986 and Chapter 166 of the *Wisconsin Statutes*, a Local Emergency Planning Committee (LEPC) has been established in Milwaukee County and in other counties in Wisconsin. Wisconsin Emergency Management has been charged with the duties of the State Emergency Response Commission and is the oversight organization for the EPCRA grant program, the emergency response system, and establishes training standards for the State and the LEPCs. In Wisconsin, the Federally mandated local planning districts have countywide jurisdiction, and the LEPCs develop emergency response plans and prepare for hazardous material emergencies within their individual counties. Each LEPC is required to coordinate its planning activities with local response agencies and local industries that handle extremely hazardous substances above threshold planning quantities (TPQs), and to develop emergency response plans for the transportation of hazardous materials through their communities. Additionally, facilities are required to make emergency release notification to the National Response Center, the State EPCRA program and LEPC whenever there is a release of an "extremely hazardous substance" or other hazardous substances listed under the Comprehensive Environmental Resources and Conservation Liability Act (CERCLA).

The National Pipeline Mapping System (NPMS) is a geographic information system (GIS) dataset of locations of hazardous liquid and gas transmission pipelines, breakout tanks, and liquefied natural gas plants. The system was created by the U.S. Department of Transportation, Pipeline and Hazardous Materials Safety Administration, and Office of Pipeline Safety in cooperation with other Federal and State government agencies and the pipeline safety industry. This dataset consists of geospatial data, attribute data, public contact information, and metadata pertaining to the interstate and intrastate hazardous liquid trunklines and hazardous liquid low-stress lines, as well as gas transmission pipelines, liquefied natural gas plants, and hazardous liquid breakout tanks within the legal authority of the Pipeline and Hazardous Materials Safety Administration.

To provide a high level of hazardous materials response capabilities to local communities, WEM contracts and manages 22 Regional Hazardous Materials Response Teams. The teams are divided into four Task Forces: Northeast Task Force, Northwest Task Force, Southeast Task Force, and the Southwest Task Force. These Task Forces are then divided into Type III, Type II, and Type I teams, all with complimentary capabilities and training requirements. In addition, there are county-based Type IV teams consisting of personnel drawn from local fire departments.

Type III teams are appropriately equipped and trained to handle all known industrial chemical hazards in liquid, aerosol, powder, and solid forms. They are not expected to be fully equipped to intervene and handle vapor or gas emergencies or incidents involving chemical, biological, radiological, nuclear, and

[175] *U.S. Coast Guard,* Sector Lake Michigan Area Contingency Plan, *February 15, 2017*.

explosive agents (CBRNE). Type II teams are equipped and trained to meet all Type III requirements and are appropriately equipped and trained to handle all unknown industrial chemical hazards in liquid, aerosol, powder, solids, and vapor or gas forms. They are generally not expected to be fully equipped to intervene and handle incidents involving CBRNE. Type I teams meet all Type III and Type II requirements and are also appropriately equipped and trained to handle and can function in all categories for all known and unknown CBRNE agents.

Milwaukee County is part of the Southeast Task Force. This task force includes Type III teams in Fond du Lac, Sheboygan, and Washington Counties, a Type II team in Racine County, and a Type I team in Milwaukee County.

The Wisconsin Hazardous Materials Response System may be activated for an incident involving a hazardous materials spill, leak, explosion, injury or the potential of immediate threat to life, the environment, or property. The Wisconsin Hazardous Materials Response system responds to the most serious spills and releases requiring the highest level of skin and respiratory protective gear. This includes all chemical, biological, or radiological emergencies.

Through public educational programs, emergency managers in Wisconsin counties are required to make the public aware of certain hazardous materials located at local facilities. Information about these facilities is shared with the public through the Milwaukee County Local Emergency Planning Committee (LEPC). The LEPC consists of representatives of a cross-section of individuals from Milwaukee County, including, but not limited to, elected officials, members of emergency response agencies, media representatives, community and environmental groups, and facility representatives from the community. Types of material, quantities stored, and their inherent dangers are discussed during quarterly LEPC meetings. Facilities having these hazardous materials are required to give this information to Wisconsin Emergency Management and to prepare written plans to respond to possible spills.

Federal and State programs also include awareness and education activities. The Wisconsin Department of Health Services has developed a chemical release tool kit to provide information to local governments, health departments, and citizens in Wisconsin about preparing for and responding to hazardous material incidents.[176]

In 2004, the Department of Homeland Security set forth the NIMS as a directive to increase efficiency and effectiveness in emergency incident management. The NIMS was previously described in the section on thunderstorms. The City of Milwaukee has complied with the implementation of NIMS.

Local Programs

The Milwaukee County Office of Emergency Management and the LEPC are responsible for developing, maintaining, and updating emergency response plans for facilities that use, receive, and store hazardous materials. This applies to both fixed facilities and vehicles used for transporting hazardous materials. Milwaukee County Office of Emergency Management and the LEPC are also responsible for receiving and maintaining files. The LEPC also maintains a countywide hazardous materials emergency response plan that contains information on protective actions, such as how to reach the facility coordinator in an emergency, evacuation, and in-place sheltering. The LEPC coordinates annual training exercises for emergency response agencies and other local government officials in the release of hazardous chemicals from both fixed facilities and vehicles.

The City of Milwaukee Fire Department Bureau of Special Operations maintains a hazardous materials response team (HAZMAT). This team is comprised of firefighters that have received specialized training and certification to respond to chemical-related emergencies. In the event of a Level A hazardous materials incident, the City of Milwaukee is served by one of eight regional hazardous material response teams: the Milwaukee Regional Hazardous Materials Response Team. This response team is comprised of members of the Milwaukee Fire Department, and includes members of the City of Milwaukee Fire Department's HAZMAT team. The Milwaukee Regional Hazardous Materials Response Team mitigates releases at fixed facilities, as well as transportation incidents in a five-county area that includes Milwaukee, Jefferson, Ozaukee,

[176] *Wisconsin Department of Health Services,* Wisconsin Chemical Release Toolkit, *Publication P00734, July 2014.*

Washington, and Waukesha Counties. A Level A release involves the most hazardous types of materials and requires the highest degree of protection for the emergency responder, including both respiratory and skin protection. Wisconsin Emergency Management develops policy and administers the programs that support regional emergency response teams.

As described in Chapter 2, the Milwaukee County Office of Emergency Management has developed an emergency operations plan, which sets forth an all-hazards action plan. In addition, many of the local municipal departments, such as the fire and police departments and the Milwaukee County Office of the Sheriff, have developed emergency operations plans and/or programs which set forth procedures and actions to deal with a range of situations and events, including hazardous materials incidents.

Evaluation of Alternatives and Identification of Mitigation Actions

Based upon review of the above, the current ongoing programs represent the major component of the planned mitigation action with regard to the continued compliance with safety regulation standards and enforcement and public informational and educational programming systems. Other potential mitigation actions include expansion of the current household hazardous waste management program.

Priority Mitigation Measures

Based upon the foregoing evaluation, consideration of risk (see the Hazard Risk Analysis and Prioritization: 2018 section at the end of this chapter), and review and action by the City of Milwaukee All Hazard Mitigation Local Planning Team (see Appendix A), the following mitigation measures, related to hazardous material incidents, which are largely a continuation of existing programs, are included in the updated City of Milwaukee hazards mitigation plan:

- Continued participation in the Wisconsin Hazardous Materials Response System;
- Promotion of educational and informational programming related to hazardous material safety, and to individual actions to protect citizens, property, and businesses. COAD may be able to provide assistance in these educational efforts;
- Promote community and operator compliance with industry safety regulations and standards;
- Promotion of ongoing enforcement of Federal, State, and City of Milwaukee regulatory standards;
- Support existing household waste management control programs;
- Continued support of training, equipment, planning, and preparedness of first responders;
- Continue to maintain compliance with the NIMS;
- Continued coordination of emergency response plans among governmental units, businesses and first responders; and
- Promote and expand training through the Southeastern Wisconsin COAD program and encourage citizen involvement in the various components of that program and its affiliated programs (CERT, Fire Corps, Medical Reserve Corps, and Volunteers in Police Service).

Because these measures are intended to be ongoing efforts, the Local Planning Team decided to retain them in the updated plan.

5.9 HAZARD MITIGATION PLAN COMPONENT FOR PUBLIC HEALTH EMERGENCIES

As described in Chapter 3, public health emergencies involving natural and human-induced hazard events are of moderate concern relative to the City of Milwaukee hazard mitigation plan. This section describes alternate and selected strategies to mitigate these types of hazards. As part of the updating process, these strategies were reviewed and reevaluated by the City of Milwaukee All Hazards Mitigation Plan Local Planning

Team in light of the updated hazard conditions and hazard mitigation goals documented in Chapters 3 and 4, respectively.

Identification of Alternative Mitigation Strategies

As described in Chapter 3, a range of public health emergencies from the individual level, through multi-casualty, to mass-casualty levels can occur throughout the City of Milwaukee. Within the City, the vast majority of the reported emergency medical incidents were associated with infectious diseases compared to any other natural or human-induced hazard events. The 2002 West Nile Virus situation is a good example of a potential health incident. In review by the City of Milwaukee All Hazards Mitigation Plan Local Planning Team, the following measures to reduce vulnerability to emergency medical incidents and related hazards have been identified as viable for the updated City of Milwaukee hazard mitigation plan.

- Continue to maintain the community public health system with adequate numbers of medical staff, sufficient disease monitoring and surveillance capabilities to adequately protect the population from small- and large-scale epidemics;
- Promote development of site emergency plans for schools, factories, office buildings, shopping malls, hospitals, and other appropriate sites;
- Continue to maintain compliance with the NIMS (see Federal and State Programs section below);
- Provide community support of clinics and school health services;
- Direct preventive actions toward specific medical situations as needed. For example, preventive actions considered for West Nile Virus include: mosquito abatement measures, such as catch basin cleaning or spraying and general spraying; standing water reduction actions; and individual actions, such as covering and use of repellents;
- Promote pollution control, enforcement, and cleanup, including proper disposal of chemicals and scrap materials;
- Improve ventilation techniques in areas or facilities prone to crowding, or areas that may involve exposure to contagion or noxious atmospheres;
- Promote demolition and clearance of vacant, condemned structures to prevent rodent infestations;
- Continue to maintain community water and sewer infrastructure at high operating standards;
- Develop and maintain plans for mass dispensing clinics for large-scale antibiotic or vaccine dispensing in the event of an infectious disease emergency; and
- Public Informational and Educational Programming
    - Promote public awareness of the causes, symptoms, and protective actions for disease outbreaks and other potential public health emergencies
    - Promote public awareness of radon dangers and personal protection actions for these dangers
    - Promote and expand training through the Southeastern Wisconsin COAD program and encourage citizen involvement in the various components of that program and its affiliated programs (CERT, Medical Reserve Corps, and Volunteers In Police Service)
    - Encourage residents to receive immunizations against communicable diseases, including annual flu shots
    - Promote preventive actions for specific medical situations, such as West Nile Virus actions involving reducing unprotected exposure to mosquitoes by the public

Current Programs

Federal and State Programs

The Department of Health and Human Services (HHS) is the United States government's principal agency for protecting the health of all Americans and providing essential human services, especially for those who are least able to help themselves. The Department's 11 operating divisions administer 115 programs, covering a wide spectrum of activities. These activities include:

- Medical and social science research
- Preventing the outbreak of infectious disease
- Immunization services
- Assuring food and drug safety
- Medicare (health insurance for elderly and disabled Americans) and Medicaid (health insurance for low-income people)
- Financial assistance and services for low-income families
- Improving maternal and infant health
- Head Start (pre-school education and services)
- Preventing child abuse and domestic violence
- Substance abuse treatment and prevention
- Services for older Americans, including home-delivered meals
- Comprehensive health services for Native Americans
- Medical preparedness for disease outbreak emergencies

HHS is the largest grant-making agency in the Federal government. The HHS Medicare program is the nation's largest health insurer, handling more than one billion claims per year.

HHS works closely with State, local and tribal governments, and many HHS-funded services are provided at the local level by State, city, or tribal agencies, or through private sector grantees. The Department's programs are administered by 11 HHS operating divisions, including eight agencies in the U.S. Public Health Service and three human services agencies. In addition to the services they deliver, the HHS programs provide for equitable treatment of beneficiaries nationwide, and they enable the collection of national health and other data.

The Centers for Disease Control and Prevention (CDC) is an agency of the Department of Health and Human Services and recognized as the lead Federal agency for protecting the health and safety of people both at home and abroad. The CDC provides credible information to enhance health decisions, and promotes health through strong partnerships. CDC serves as the national focus for developing and applying disease prevention and control, environmental health, and health promotion and education activities designed to improve the health of the people of the United States.

The CDC's mission is to promote health and quality of life by preventing and controlling disease, injury, and disability. CDC seeks to accomplish its mission by working with partners throughout the nation and world to monitor health, detect and investigate health problems, conduct research to enhance prevention, develop and advocate sound public health policies, implement prevention strategies, promote healthy behaviors, foster safe and healthy environments, and provide leadership and training. In addition, the CDC has developed and sustained many vital partnerships with public and private entities that improve service to the American people.

The Wisconsin Department of Health Services (WDHS)[177] works in partnership with local governments, health and human services agencies, private providers, and concerned and affected citizens to:

- Foster the availability and accessibility of care, treatment, and other assistance for persons most in need through careful planning of services and efficient distribution and use of resources.

- Promote individual, family, and community well-being and health through vigorous programs to reduce or prevent avoidable illness, disability, or dependency and their associated costs.

- Encourage local public and private initiatives and support for human service programs.

- Give priority to the interests and needs of vulnerable persons, including children and the elderly, those in need of long-term support, and families.

- Provide for public safety and protection through programs for adult criminal offenders who are mentally or emotionally impaired.

- Provide incentives and oversight so that public funds are put to effective use. Programs must be characterized by acceptable quality without unnecessary cost, accountability without needless paperwork, creativity and innovation without loss of purpose, and efficiency without jeopardizing access, equity, or availability.

- Carryout these responsibilities with the participation and advice of communities, providers, clients, and citizens in a way that respects the dignity and self-reliance of everyone involved.

The WDHS' mission is to protect and promote the health and safety of the people of Wisconsin. The Department's goals are to assure the health, safety, and well-being of Wisconsin citizens, while emphasizing prevention; make Wisconsin a national leader in reforming health care; improve the lives of Wisconsin seniors and people with disabilities; increase opportunities for children to grow up safe, healthy, and successful in strong families; and create a high-performing organization that is customer-focused and values their partners and employees.

The Wisconsin Department of Health Services has developed a planning guide on vector-borne diseases for public health and emergency response professionals.[178] This guide addresses several diseases spread by ticks and mosquitoes.

In addition to these aforementioned programs, there are a number of other related programs within the State of Wisconsin that include: Wisconsin Division of Public Health (WDPH), Wisconsin Hospital Association (WHA), Wisconsin Association of Local Health Departments and Boards (WALHDAB), Wisconsin Medical Society (WMS), University of Wisconsin and The Medical College of Wisconsin, Bureau of Local Public Health Practice and Emergency Management Services, Wisconsin Emergency Management (WEM), Wisconsin Primary Health Care Association (WPHCA), Rural Wisconsin Health Cooperative (RWHC), Wisconsin Office of Rural Health (WORH), and the Children's Hospital of Wisconsin Poison Center.

In 2004, the Department of Homeland Security set forth the NIMS as a directive to increase efficiency and effectiveness in emergency incident management. The NIMS was previously described in the section on thunderstorms. The City of Milwaukee has complied with the implementation of NIMS.

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[177] *As of July 1, 2008, the former Wisconsin Department of Health and Family Services became the Wisconsin Department of Health Services (WDHS) and the Wisconsin Department of Children and Families (WDCF) was created. The WDHS continues to provide the health-related programs that were the responsibility of the old department, while the WDCF provides programs that serve children and families, such as child welfare services, child support services, child care programs, and Wisconsin Works (W-2).*

[178] *Wisconsin Department of Health Services,* Vectorborne Disease Tookit, *Publication P-01109, October 2016.*

Local Programs

As described in Chapter 2, there are a total of 30 fire houses with 12 paramedic units and three fire department special teams, seven hospitals, and seven police stations distributed throughout the City of Milwaukee (see Appendix B for more details). In the event of a major public health emergency, these units along with the City of Milwaukee Health Department are the primary responders for the health and safety of the residents of the City of Milwaukee.

The City of Milwaukee Health Department's mission is to ensure that services are available to enhance the health of individuals and families, promote healthy neighborhoods, and safeguard the health of the Milwaukee community. Their goal is to ensure that the City of Milwaukee has the best personal and environmental health care, and population-based preventive services possible.

The City of Milwaukee Health Department is comprised of four multidisciplinary divisions: disease control and environmental health, family and community health, health laboratories, and consumer environmental health. These divisions assess public health needs, develop public policy on health related issues, and provide services to the public. The City of Milwaukee's Health Department fosters cooperation between public, private and nonprofit sectors of the health industry in order to accomplish public health-related goals. The Health Commissioner serves as the Department's medical and executive director and is the City's legal health officer. The Health Commissioner is assisted by the Health Operations Administrator, the Medical Director and Chief Medical Officer, and Directors of Public Health Research and Policy, Disease Control and Environmental Health, Family and Community Health Services, and Public Health Laboratories. In addition, the Department employs epidemiologists who track health and disease trends within the community.

The City of Milwaukee Health Department has developed a pandemic influenza preparedness plan.[179] This plan was developed to assist with surveillance, vaccine delivery, use of antiviral medications, health services, emergency services, and communications in the event of an influenza pandemic. Its goals are to minimize serious illness, loss of life, and infrastructure disruption among citizens of the City in the event of an influenza pandemic. The plan establishes protocols and policies for responding to all phases of such a pandemic.

The Milwaukee Health Department provides immunizations at its daily walk-in clinics. The Department can only provide vaccinations to children (18 years of age or younger) who meet one of the following criteria:

- The child is not covered by private medical insurance
- The child is enrolled in or eligible for Medicaid/BadgerCare
- The child is native American or Alaskan native

This program provides routine vaccinations for a variety of diseases. Vaccines provided through federal funding are free for those who are eligible. Children who are not eligible to receive federally funded vaccines from MHD must see their health care provider to receive vaccinations. The Department's walk-in clinics also provide influenza and pneumococcal vaccinations to uninsured adults for a fee.

As described in Chapter 2, the Milwaukee County Office of Emergency Management has developed an emergency operations plan, which sets forth an all-hazards action plan. In addition, many of the local municipal departments, such as the fire and police departments and Milwaukee County Office of the Sheriff, have developed emergency operations plans and/or programs that set forth procedures and actions to deal with a range of situations and events, including public health emergencies.

Evaluation of Alternatives and Identification of Mitigation Actions

Based upon review of the above, the current ongoing programs represent the major component of the planned mitigation action with regard to the continued prevention, control, and preparedness for medical emergency incidents, and public informational and educational programming systems.

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[179] *City of Milwaukee Health Department,* Pandemic Influenza Preparedness and Response Plan (Version IV), *August 6, 2007*.

Priority Mitigation Measures

Based upon the foregoing evaluation, consideration of risk (see the Hazard Risk Analysis and Prioritization: 2018 Section at the end of this chapter), and review and action by the City of Milwaukee All Hazard Mitigation Local Planning Team (see Appendix A), the following mitigation measures related to public health emergencies are included in the updated City of Milwaukee hazards mitigation plan:

- Promotion of educational and informational programming related to general public health and safety issues. In this regard, increasing awareness of specific public health issues is important. For example, topics, such as radon dangers and viable prevention efforts, and West Nile Virus prevention measures, should be specifically covered;

- Strengthen public health infrastructure to support surveillance, response, reporting, and research, and to implement prevention and control programs;

- Provide the public health work force with the knowledge and tools needed for the early detection and control of diseases and disease vectors;

- Continue to support and review policies for vacant structure demolition to minimize potential rodent infestation;

- Implement specific health issue mitigation and prevention strategies;

- Develop and maintain plans for mass dispensing clinics for large-scale antibiotic or vaccine dispensing in the event of an infectious disease emergency;

- Encourage residents to receive immunizations against communicable diseases;

- Ensure prompt implementation of prevention strategies and enhance communication of public health information about emerging diseases, their vectors, and control measures;

- Continue to maintain compliance with the NIMS; and

- Promote and expand training through the Southeastern Wisconsin COAD program and encourage citizen involvement in the various components of that program and its affiliated programs (CERT, Fire Corps, Medical Reserve Corps, and Volunteers In Police Service).

Because most of these measures are intended to be ongoing efforts, the Local Planning Team decided to retain them in the updated plan.

5.10 HAZARD MITIGATION PLAN COMPONENT FOR TERRORISM INCIDENTS

As described in Chapter 3, terrorism involving human-induced hazard events is of moderate concern relative to the City of Milwaukee hazard mitigation plan. This section describes alternate and selected strategies to mitigate these types of hazards. As part of the updating process, these strategies were reviewed and reevaluated by the City of Milwaukee All Hazards Mitigation Plan Local Planning Team in light of the updated hazard conditions and hazard mitigation goals documented in Chapters 3 and 4, respectively.

Identification of Alternative Mitigation Strategies

As described in Chapter 3, a range of terrorism incidents from the individual level, through multi-casualty, to mass-casualty levels have the potential to occur throughout the City of Milwaukee. The magnitude and scope of a terrorism incident is also dependent upon the technological means available to the terrorists, nature of the political issue motivating the act, and points of weakness of the terrorism target. In review by the City of Milwaukee All Hazards Mitigation Plan Local Planning Team, the following measures to reduce vulnerability to terrorism incidents and related hazards have been identified as viable for the updated City of Milwaukee hazard mitigation plan.

- Promote development of a thorough community risk and threat assessment that identifies potential vulnerabilities and targets for sabotage, terrorism, and/or weapons of mass destruction (WMD) attack

- Promote development of site emergency plans for schools, factories, office buildings, shopping malls, hospitals, and other appropriate sites

- Promote alertness, awareness, and monitoring of organizations and activities that may threaten the community

- Establish clear communication lines with the State of Wisconsin Department of Military Affairs, Wisconsin Emergency Management, as the means to access assistance from the Wisconsin National Guard

- Continue to participate in Federal programs, such as the Law Enforcement Terrorism Prevention Program

- Continue to maintain compliance with the NIMS (see Federal and State Programs section below)

- Provide legitimate channels of political and public expression

- Establish avenues of reporting (and potential rewards) for information preventing terrorist incidents and sabotage

- Promote consistent use of computer data back-up systems and anti-virus software

- Develop and promote workable population protection plans, such as evacuation and in-place sheltering plans, as appropriate

- Promote increased security measures at water supply facilities that could include increased security patrols, and/or increased monitoring for pathogens and chemical toxins

- Heighten security at public gatherings, special events, and critical community facilities and industries

- Public Informational and Educational Programming

    - Promote public awareness of terrorism-related dangers and personal protection actions for these dangers

    - Promote community awareness of designated shelters and accident warning systems

    - Promote greater awareness of, and provision for, mental health services in schools, workplaces, and institutional settings

    - Increased coverage and use of NOAA Weather Radio, which can provide notification to the community during any period of emergency, including enemy attack

    - Promote adequate training, equipment, planning, and preparedness for local law enforcement, fire and rescue departments, and other responders for a variety of terrorist/sabotage/WMD attacks

    - Promote and expand training through the Southeastern Wisconsin COAD program and encourage citizen involvement in the various components of that program and its affiliated programs (CERT, Medical Reserve Corps, and Volunteers In Police Service)

    - Promote development and testing of internal emergency plans and procedures by businesses and organizations

Current Programs

Federal and State Programs

At the Federal level, initiatives to combat terrorism are coordinated through the Department of Homeland Security (DHS), Since its establishment, DHS has been the lead Federal agency responsible for preparing for and responding to terrorist attacks, in addition to being the lead Federal agency for preparing for, responding to, and recovering from any accidental man-made or natural disasters. DHS also makes a variety of anti-terrorism resources available to local governments including information resources, training, and funding.

In 2004, the Department of Homeland Security set forth the NIMS as a directive to increase efficiency and effectiveness in emergency incident management. The NIMS was previously described in the section on thunderstorms. The City of Milwaukee has complied with the implementation of NIMS.

Wisconsin anti-terrorism efforts are coordinated by the Department of Military Affairs, Wisconsin Emergency Management in cooperation with various other Federal, State, and local agencies. A Wisconsin Interagency Working Group on Terrorism, which includes numerous State agencies and advisory members from Federal agencies, was initiated by the Governor in 1997. This group has been working with Wisconsin Emergency Management on Weapons of Mass Destruction and other terrorism related issues.

The response to terrorism is initially local, with response assistance from Federal and State agencies. Therefore, counties have been requested to add an Anti-Terrorism Response Appendix to their existing Emergency Operations Plan (EOP). This appendix was added to the Milwaukee County EOP, which is updated annually. Initially in 1999, 13 of the largest counties in Wisconsin and City of Milwaukee, were the focus of additional training, assessment and planning efforts, specifically including the development of the City of Milwaukee WMD plan and exercises to test the plans. These jurisdictions make up 61 percent of the population of Wisconsin.

In 1996, U.S. Congress passed the "Defense Against Weapons of Mass Destruction Act". Under this legislation, the Cities of Milwaukee and Madison were chosen to receive equipment and training from the United States Department of Defense and other Federal agencies to prepare for a WMD event.

During the year 2000, all counties were offered the opportunity to obtain funding to conduct WMD assessments and develop county emergency operations plans. The availability of funding allowed approximately 50 Wisconsin counties to receive training and begin to conduct WMD assessments as part of the Department of Justice's assessment program. These assessments continued into the fiscal year of 2001. Part of this overall assessment included the identification of potential targets, as well as threat and risk potentials within the City of Milwaukee and Milwaukee County. The assessments also included determinations of the current and needed capabilities of local response agencies with regard to WMD incidents. These assessments included a review of equipment, training and exercise needs. These county assessments, along with similar assessments being conducted at the State level, provided the information necessary for the development of a statewide WMD strategy to enhance response to potential WMD incidents.

Since the late 1990s, WMD training has been provided by the Wisconsin Technical College System through the National Fire Academy. The Wisconsin Technical College System received a FEMA funding grant to provide WMD training to first responders. This grant provides funding for the Emergency Response to Terrorism series of courses developed by the National Fire Academy. Wisconsin Emergency Management in partnership with the Wisconsin Technical College System has coordinated the delivery of these courses and the delivery of training courses to develop a cadre of instructors in the State. In addition, the Wisconsin Department of Health Services provides online training in response to WMD through the WI-Train training website.[180]

Another important State program is the availability of the Wisconsin National Guard, which can be accessed through the State of Wisconsin Department of Military Affairs, Wisconsin Emergency Management.

[180] *wi.train.org*.

Local Programs

As described in Chapter 2, there are a total of 30 fire houses with 12 paramedic units and three specialty teams, seven hospitals, and seven police stations distributed throughout the City of Milwaukee (see Appendix B for more details). In the event of a terrorism attack, these units are the primary responders for the health and safety of the residents of the City of Milwaukee.

The Milwaukee Police Department's Intelligence Fusion Center (IFC) was created in 2009 by combining several units from the Milwaukee Police Department, including the Crime Analysis Section and the Southeastern Wisconsin Threat Analysis Center (STAC). State and major urban area fusion centers serve as focal points within the state and local environment for the receipt, analysis, gathering, and sharing of threat-related information between the Federal government and state, local, and private sector partners. Located in states and major urban areas throughout the country, fusion centers are situated to empower front-line law enforcement, public safety, fire service, emergency response, public health, critical infrastructure and key resources protection, and private sector security personnel to understand local implications of national intelligence, enabling local officials to better protect their communities. Fusion centers provide interdisciplinary expertise and situational awareness to inform decision-making at all levels of government. They conduct analysis and facilitate information sharing while assisting law enforcement and homeland security agencies in preventing, protecting against, and responding to terrorism.

As also described in Chapter 2, the Milwaukee County Office of Emergency Management has developed an emergency operations plan, which sets forth an all-hazards action plan. In addition, many of the local municipal departments, such as the fire and police departments and the Milwaukee County Office of Emergency Management have developed emergency operations plans and/or programs that set forth procedures and actions to deal with a range of situations and events, including terrorist attacks. The City of Milwaukee All Hazards Mitigation Plan Local Planning Team intends that the City of Milwaukee all-hazards mitigation plan be consistent with and complement the procedures and actions set forth by these plans.

Evaluation of Alternatives and Identification of Mitigation Actions

Based upon review of the above, the current ongoing programs represent a major component of the planned mitigation action with regard to the continued prevention, control, and preparedness for terrorist incidents, and public informational and educational programming systems. Feasible mitigation actions include development of a thorough community risk and threat assessment that identifies potential vulnerabilities, heightening security at special events and critical community facilities, development of site emergency plans, and development of emergency water supply source protection measures which may be applicable at the municipality level.

Terrorism incidents could potentially impact the City of Milwaukee. These events can potentially cause multiple damages to a variety of infrastructure, including transmission lines, utilities, and transportation routes, as well as other critical community facilities in the vicinity of the incident. Hence, there is a need to coordinate hazard mitigation activities through the local government participation in city- and countywide disaster planning and response mechanisms. Such measures are already well underway through the coordinated emergency operations planning program involving the Milwaukee County Office of Emergency Management and coordinated local community emergency operations programs.

Priority Mitigation Measures

Based upon the foregoing evaluation, consideration of risk (see the Hazard Risk Analysis and Prioritization: 2018 Section at the end of this chapter), and action by the City of Milwaukee Hazard Mitigation Local Planning Team (see Appendix A), the following mitigation measures related to terrorism incidents are included in the City of Milwaukee hazards mitigation plan:

- Continue and expand educational and informational programming related to public health and safety issues due to terrorist incidents

- Continue to participate in Federal programs, such as the Law Enforcement Terrorism Prevention Program

- Consider the need to strengthen public health infrastructure to support surveillance, response, reporting and research, and to implement prevention and control programs from potential chemical and bio-terrorism attacks

- Continued support of training, equipment, planning, and preparedness for local law enforcement, fire and rescue departments, and other emergency management services

- Continued coordination of emergency response plans among Federal, State, and local governmental units, businesses, and emergency management services

- Continue to maintain compliance with the NIMS

- Promote and expand training through the Southeastern Wisconsin COAD program and encourage citizen involvement in the various components of that program and its affiliated programs (CERT, Medical Reserve Corps, and Volunteers In Police Service)

Because most of these measures are intended to be ongoing efforts, the Local Planning Team decided to retain them in the updated plan.

5.11 HAZARD MITIGATION PLAN COMPONENT FOR MAJOR FIRE AND EMERGENCY MEDICAL INCIDENTS

As described in Chapter 3, major fire and emergency medical incident hazard events are of high concern relative to the City of Milwaukee hazard mitigation plan. This section describes alternate and selected strategies to mitigate these types of hazards. As part of the updating process, these strategies were reviewed and reevaluated by the City of Milwaukee All Hazards Mitigation Plan Local Planning Team in light of the updated hazard conditions and hazard mitigation goals documented in Chapters 3 and 4, respectively.

Identification of Alternative Mitigation Strategies

As described in Chapter 3, a range of fire and emergency medical incidents from the individual level, through noncasualty, to mass-casualty levels have the potential to occur throughout the City of Milwaukee. The magnitude and scope of any event is dependent upon the area affected and the type of incident that occurs. Although the annual number of major structure fires in the City of Milwaukee appears to be declining due to educational efforts, the possibility of a major incident occurring continues to exist. The following measures to reduce vulnerability to major fire and emergency medical incidents have been identified as viable for the City of Milwaukee hazard mitigation plan.

- Promote development of site emergency and evacuation plans for schools, factories, office buildings, shopping malls, hospitals, and other appropriate sites

- Support community outreach and educational programs by the City of Milwaukee Fire Department

- Promote public programs that support alertness, awareness, and education in regards to fire safety

- Continue to maintain compliance with the NIMS (see Federal and State Programs section below)

- Promote consistent use of computer data back-up systems and anti-virus software

- Develop and promote workable population protection plans, such as evacuation plans, as appropriate

- Heighten security at public gatherings, special events, and critical community facilities and industries

- Public Informational and Educational Programming
    - Promote public awareness of terrorism-related dangers and personal protection actions for these dangers
    - Promote community awareness of designated shelters and accident warning systems
    - Increased coverage and use of NOAA Weather Radio, which can provide notification to the community during any period of emergency
    - Promote adequate training, equipment, planning, and preparedness for local law enforcement, fire and rescue departments, and other responders for a variety fire and emergency medical incidents
    - Promote and expand training through the Southeastern Wisconsin COAD program and encourage citizen involvement in the various components of that program and its affiliated programs (CERT, Medical Reserve Corps, and Volunteers In Police Service)
    - Promote development and testing of internal emergency plans and procedures by businesses and organizations

Current Programs

Federal and State Programs

At the Federal level, there are many programs that provide assistance and aid to fire departments. The United States Fire Administration (USFA), which is within the Department of Homeland Security and FEMA, sponsors the Assistance to Firefighter Grant (AFG) program. In Federal fiscal year 2016, this program dispersed over $307 million worth of assistance, vehicles, and EMS equipment to fire departments nationwide. As part of the AFG program, the Fire Prevention and Safety Grant specifically provides assistance for fire prevention and safety, and is focused on programs that mitigate fire-related injuries to high-risk populations. The Staffing for Adequate Fire and Emergency Response Grant program (SAFER) provides funding directly to fire departments and volunteer firefighter interest organizations in order to help them increase the number of trained, front line fire fighters available in their communities. The goal of SAFER is to enhance the ability of local fire departments to comply with staffing, response, and operational standards established by the National Fire Protection Association (NFPA) and the Federal Occupational Safety and Health Administration. In Federal fiscal year 2016, this program provided over $347 million to fire departments throughout the nation. The Department of Homeland Security also offers Emergency Management Performance Grants for All-Hazards Emergency and Terrorism preparedness. Within the Department of Homeland Security and FEMA, the Emergency Management Institute sponsors training programs, such as CERT and Disaster Field Training Operations (DTFO).

NFPA also offers various programs and awards of assistance, and is a resource for Federal firefighting data.

In 2004, the Department of Homeland Security set forth the NIMS as a directive to increase efficiency and effectiveness in emergency incident management. The NIMS was previously described in the section on thunderstorms. The City of Milwaukee has complied with the implementation of NIMS.

At the State level, Wisconsin Emergency Management (WEM) within the Department of Military Affairs coordinates with Federal, State, county and local agencies for emergency and disaster response. WEM provides training sessions for emergency managers, law enforcement, fire, EMS, public health, public works, local officials and volunteer organizations. WEM in partnership with the Wisconsin Technical College System has coordinated the delivery and training of courses aimed at firefighting and emergency response throughout the State of Wisconsin. Another important State program is the availability of the Wisconsin National Guard, which can also be accessed through the Wisconsin Department of Military Affairs. The Governor holds the authority to call the Wisconsin National Guard into action during local, county or statewide emergencies.

Local Programs

As described in Chapter 2, there are a total of 30 fire houses with 12 paramedic units and three specialty squads, seven hospitals, and seven police stations distributed throughout the City of Milwaukee (see Appendix B for more details). In the event of a major fire or emergency medical incident, these units are the primary responders for the health and safety of the residents of the City of Milwaukee.

As described in Chapter 2, the Milwaukee County Office of Emergency Management has developed an emergency operations plan, which sets forth an all-hazards action plan. In addition, many of the local municipal departments, such as the fire and police departments and Milwaukee County Office of the Sheriff, have developed emergency operations plans and/or programs that set forth procedures and actions to deal with a range of situations and events, including major fire and medical emergency incidents.

The Milwaukee Fire Department provides a wide range of educational opportunities to the citizens of Milwaukee. Firefighters meet with people of all ages to educate them on topics such as fire safety, emergency medical services, and evacuation planning and drills. The Department's Community Relations Section works with community members to schedule events based on their specific needs. Examples of training provided by Community Relations staff include the proper use of fire extinguishers, the proper way to perform evacuation drills, preparation for emergencies, and the importance of having at least one working smoke detector in each home. These programs are provided to businesses, apartment complexes, condominium associations, senior living centers, day cares, and through individual contact.

Since 1982, the Milwaukee Fire Education Center's Survive Alive House has provided training to elementary school students in fire safety and fire prevention techniques. Over 13,000 Milwaukee children visit the House each year to learn how to survive in the event of a home fire. The Survive Alive Program curriculum includes classroom instruction of fire safety, practical instruction from City firefighters on escaping a fire, and supplemental material reinforcing the lessons of the program. The program is available to public and private schools located in the City of Milwaukee. In addition, community-based organizations serving youth utilize the facility.

The Fire Department also uses social media sites such as Facebook and Twitter to spread fire safety messages to the public.

The City of Milwaukee's Smoke Alarm Hotline also provides and installs smoke detectors in qualifying residences.

Evaluation of Alternatives and Identification of Mitigation Actions

Based upon review of the above, the current ongoing programs represent a major component of the planned mitigation action with regard to the continued prevention, control, and preparedness for major fire and emergency medical incidents, and public informational and educational programming systems. Feasible mitigation actions include development of a thorough community risk and threat assessment that identifies potential vulnerabilities, heightening security at special events and critical community facilities, development of site emergency plans, and development of emergency water supply source protection measures that may be applicable at the municipal level.

Priority Mitigation Measures

Based upon the foregoing evaluation, consideration of risk (see the Hazard Risk Analysis included in the following section of this chapter), and review and action by the City of Milwaukee Hazard Mitigation Local Planning Team (see Appendix A), the following mitigation measures related to major fire and emergency medical incidents are included in the updated City of Milwaukee hazards mitigation plan:

- Continue educational and informational programming related to public health and safety issues due to major fire and emergency medical incidents
- Continue support of training, equipment, planning, and preparedness for local law enforcement, fire, and rescue departments, and other emergency management services
- Continue building safety inspection efforts

- Raze condemned buildings

- Consider the need to strengthen public health infrastructure to support surveillance, response, reporting and research, and to implement prevention and control programs from potential fire and major medical emergencies
- Continue maintenance and promote enhanced fire safety measures at critical facilities, and encourage widespread use of fire safety devices

- Continue to maintain compliance with the NIMS

- Continue/enhance coordination of emergency response plans among Federal, State, and local governmental units, businesses, and emergency management services

- Promote and expand training through the Southeastern Wisconsin COAD program and encourage citizen involvement in the various components of that program and its affiliated programs (CERT, Medical Reserve Corps, and Volunteers In Police Service)

Because most of these measures are intended to be ongoing efforts, the Local Planning Team decided to retain them in the updated plan.

5.12 HAZARD RISK ANALYSIS AND PRIORITIZATION: 2018

The major natural and other hazards that have been identified to potentially affect the City of Milwaukee have been compared and ranked by risk for implementation of the mitigation measures to assist in developing a mitigation plan. Additional description of natural and other hazards as well as the vulnerability assessment of the City of Milwaukee to these hazards have been identified and summarized in Chapter 3 of this report. These priority rankings were based upon the number of incidents per year, number of mortalities, number of injuries, and property damage inventories and analyses set forth in Chapter III of this report. Specifically, this prioritization is based upon the protection of human life and health and protection from property damages throughout the City of Milwaukee. Therefore, the major indicators of hazard severity used to rank the natural and other hazards in the City of Milwaukee are based upon the deaths and injuries versus economic losses resulting from such hazards and are summarized in Tables 5.7 and 5.8 respectively.

As identified in the vulnerability assessment of natural and other hazards to the City of Milwaukee in Chapter 3 of this report, 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, and time in terms of how long an event may last, such as winter storm events), size or scale, frequency of occurrence, population size potentially impacted, and amount of urban growth or development potentially impacted. This does not indicate that less densely populated areas are any more or less important than dense urban areas; however, it does indicate that the more dense 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 of this report, that many disaster events are compound in nature and not the result of a single event, such as increased flooding hazards and coastal erosion during a severe storm 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 the City of Milwaukee on a yearly basis (see Tables 5.7 and 5.8).

Ranking Severity of Natural and Other Hazards

Death and Injury

Using the data from the various sources summarized in the vulnerability assessment of Chapter 3 of this report, natural and other hazards of the City of Milwaukee were ranked first with respect to their severity in terms of the sum of the number of annual deaths and injuries they caused and then by frequency of occurrence of each type of hazard event as shown in Table 5.8.

The top nine from a combined total of 11 natural and other hazards based upon death and injury incidences, as shown in Table 5.8 in order of appearance, indicate that medical and health risks from infectious diseases, temperature extremes, major fire and emergency incidents, hazardous materials incidents, tornadoes,

Table 5.8
Priority Ranking of Natural and Other Hazards Affecting the City of Milwaukee Based upon Mortality and Injury

Order Based on Local Planning Team Perception[a]	Natural and Other Hazards	Period of Record	Number of Incidents per Year (average)	Average Number of Mortalities per Year	Average Number of Injuries per Year	Sum of Average Mortalities and Injuries per Year	Priority Ranking Based on Analysis
8	Medical/Health Risks (infectious diseases and parasites)	2005-2014	--	202.30	--	202.30	1
4	Temperature Extremes	1994-2016	3.61	5.43	10.70	16.13	2
5	Major Fire and Emergency Incidents	2000-2015	997 (fires) 55,207	8.90 (fires) --	-- --	8.90 --	3
3	Hazardous Materials Incidents	1971-2016	38.04[b]	0.06[b]	3.20[b]	3.26[b]	4
9	Tornadoes	1958-2016	0.24	0.00	2.98	2.98	5
2	Winter Storms	1987-2016	5.00	0.97	0.30	1.27	6
7	Thunderstorms, High Wind, Hail, and Lightning	1993-2016	12.00	0.13	0.36	0.49	7
1	Flooding	1996-2016	1.95	0.05	0.05	0.10	8
10	Coastal Erosion	1975-1995	Less than one foot per year	0.00	0.00	0.00	9
11	Contamination or Loss of Water Supply	1993-2016	<0.10	--[c]	--[c]	--[c]	--
6	Terrorism Incident	2000-2016	<0.10	--	--	--	--

[a] *These numbers reflect the ranked order of the hazards assigned by the City of Milwaukee Hazard Mitigation Local Planning Team. For more details see Hazard Identification section and Table 3.3 in Chapter 3 in this report.*

[b] *Refers to gas and liquid hazardous materials pipeline and transportation incidents within the City of Milwaukee 1971 to 2016.*

[c] *Information on mortalities and injuries is based on one event in 1993 related to a parasitic contamination of the water supply. According to the Wisconsin Division of Health, the estimated number of mortalities was about 69, and approximately 4,400 people were hospitalized. As the water treatment facilities have been upgraded to avoid such contamination, the number of mortalities and injuries are not being considered in the current ranking.*

Source: National Climatic Data Center; U.S. Department of Transportation, Office of Pipeline Safety; National Consortium for the Study of Terrorism; Wisconsin Department of Health Services; Milwaukee Fire Department; Milwaukee Police Department; City of Milwaukee Hazard Mitigation Local Planning Team; and SEWRPC

winter storms, thunderstorms and their related events, flooding, and coastal erosion are the most severe hazards in the City of Milwaukee. The vulnerability and community impact assessment in Chapter 3 of this report identified that all of the top three of these hazards were related to public health concerns, and the individuals at greatest risk are the very young, the very old, and disabled persons within the community.

Of the weather-related natural hazards, temperature extremes are the most costly in terms of the number of annual mortalities and injuries. Weather-related natural hazards comprise five of the top nine most costly hazards in terms of injuries and lost lives. These also include tornadoes, thunderstorms/high wind/hail/lightning, winter storms, and flooding, which pose a significant risk to public health and safety within the City of Milwaukee. The vulnerability and community impact assessment indicates that the entire County is at risk from these hazards, which are highly unpredictable in terms of exactly where they may occur and how powerful they might be.

Hazardous material incidents ranked fourth in priority, with these incidents averaging less than one fatality and slightly more than three injuries per year. This ranking is based upon hazardous material incidents involving pipelines and transportation accidents. It does not include fatalities and injuries caused by incidents involving hazardous material releases from fixed facilities, for which data were not available.

Although one incident of water supply contamination occurred in 1993 in which the Wisconsin Division of Health reported an associated 69 mortalities and an estimated 4,400 hospitalizations, major efforts have been undertaken to upgrade water treatment facilities among other measures to ensure the safety of the water supply. Thus, this type of hazard is not likely to reoccur.

The remaining two hazards, coastal erosion and terrorism, have not been recorded in recent history to be associated with human mortality or injury within the City of Milwaukee based upon known data.

A comparison of Table 5.8 and Table 5.9 illustrates significant differences in ranking hazards between human life and injury versus property damage comparisons within the City of Milwaukee (see Property Damage section below). Also, due to the importance of human life and health of individuals within the City of Milwaukee, and the high potential for a mass casualty event associated with these hazards, and that such incidents have been recorded elsewhere in the State of Wisconsin (see vulnerability assessment in Chapter 3 of this report), these hazards were incorporated into the final all-hazard mitigation plan and implementation strategies by the City of Milwaukee Hazard Mitigation Local Planning Team (see Appendix A of this report).

The priority rankings based upon death and injury in this update are similar to those presented in the previous update of the City of Milwaukee All Hazards Mitigation Plan. While the rank order of most of the hazards in terms of mortality and injuries has changed, the ranks of all but one hazard are within one position of their ranking in the previous update of the plan. In addition, the top three most costly hazards in terms of mortality and injuries in this update include all three of the hazards that were found to be among the most costly in the previous plan update.

Property Damage

Another way to assess the vulnerability of the City of Milwaukee to natural and other hazards is to examine the resultant property damages. Again, using the data from the various sources summarized in the vulnerability assessment of Chapter 3 of this report, natural and other hazards were ranked with respect to their severity in terms of the annual sum of property damages caused, and then by frequency of occurrence of each type of hazard event as shown in Table 5.9.

The top seven from a combined total of 11 natural and other hazards, as shown in Table 5.9 in order of appearance based upon total annual property damages, indicate that major fire/emergency incidents, flooding, thunderstorms/high wind/hail/lightning, hazardous materials incidents, tornadoes, winter storms, and temperature extremes are the most severe hazards to affect the City of Milwaukee. Among the top seven, major fire and emergency incidents was identified as the number one risk to property compared to any other hazards within the City of Milwaukee.

Flooding and thunderstorms/high wind/hail/lightning ranked as the second and third most costly hazards to cause property damage in the City of Milwaukee and, aside from major fires, these hazards inflict the

Table 5.9
Priority Ranking of Natural and Other Hazards Affecting the City of Milwaukee Based Upon Property Damage

Order Based on Local Planning Team Perception[a]	Natural and Other Hazards	Period of Record	Number of Incidents per Year (average)	Total Property Damage per Year (average)[b]	Priority Ranking Based on Analysis
5	Major Fire and Emergency Incidents	2000-2015	997 (fires)	21,862,500 (fires)	1
			55,207	--	
1	Flooding	1996-2016	1.95	13,835,935	2
7	Thunderstorms, High Wind, Hail, and Lightning	1993-2016	12.00	2,370,723	3
3	Hazardous Materials Incidents	1971-2016	38.04[c]	473,400	4
9	Tornadoes	1958-2016	0.24	310,853	5
2	Winter Storms	1987-2016	5.00	40,835	6
4	Temperature Extremes	1994-2016	3.61	1,007	7
10	Coastal Erosion	1975-1995	Less than one foot per year	--[d]	--
6	Terrorism Incident	2000-2016	<0.10	--[d]	--
11	Contamination or Loss of Water Supply	1993-2016	<0.10	--	--
8	Medical/Health Risks	2005-2014	--	--	--

[a] *These numbers reflect the ranked order of the hazards assigned by the City of Milwaukee Hazard Mitigation Local Planning Team. For more details see Hazard Identification section and Table 3.3 in Chapter 3 in this report.*

[b] *Dollar values are adjusted to year 2016 by using the average annual Consumer Price Index (CPI) values from the U.S. Department of Labor, Bureau of Labor Statistics.*

[c] *Refers to gas and liquid hazardous materials pipeline and transportation incidents within the City of Milwaukee 1971 to 2009.*

[d] *Data are not known.*

Source: National Climatic Data Center; U.S. Department of Transportation, Office of Pipeline Safety; National Consortium for the Study of Terrorism; Wisconsin Department of Health Services; Milwaukee Fire Department; Milwaukee Police Department; City of Milwaukee Hazard Mitigation Local Planning Team; and SEWRPC

greatest amount of property damage reported compared to the other severe weather-related damages. As summarized in the vulnerability and community impact assessment, flooding and their associated property damages are expected to decrease significantly in the future based on current steps being implemented to mitigate flood damages.

Five of the top seven most costly hazards to property damage within the City of Milwaukee are natural hazards; flooding, thunderstorms/high wind/hail/lightning, tornadoes, winter storms, and temperature extremes. Milwaukee County also determined that flooding, tornadoes, and winter storms pose a high risk to property.[181] The vulnerability and community impact assessment indicates that flooding hazard risks are associated with the major river systems within and adjacent to the City of Milwaukee; this includes the Kinnickinnic River, Menomonee River, Milwaukee River, and Oak Creek watersheds. The vulnerability and community impact assessment indicates that the entire County is at risk from thunderstorms/high wind/hail/lightning hazards, which are highly unpredictable in terms of storm location and magnitude. Tornadoes, winter storms, and temperature extremes rank as the fifth, sixth, and seventh most costly natural hazards in the City of Milwaukee. The vulnerability and community impact assessment indicates that the entire County is at risk from all three as locations and magnitudes of these events are unpredictable. In addition, the impacts of winter storm and extreme temperature events are often felt regionally, rather than in isolated locations.

The remaining four hazards, as shown in Table 5.9, have not been recorded to be associated with property damage within the City of Milwaukee based upon known data. These hazards include coastal erosion, terrorism, contamination or loss of water supply, and medical/health risk incidents. It is important to note that, although these hazards have not been recorded to cause property damage, two of these hazards, emergency medical health risk incidents and temperature extremes, are the highest ranking of the top nine hazards with respect to significant mortality and injury costs to the City of Milwaukee (see Table 5.8). For this reason, these hazards were incorporated into the final all-hazard mitigation plan and implementation strategies by the City of Milwaukee Hazard Mitigation Local Planning Team (see Appendix A).

The priority rankings based upon property damage in this update are similar to those presented in the previous update of the City of Milwaukee all hazard mitigation plan. While the rank order in terms of property damage of some of the hazards has changed, the ranks of all hazards are within one position of their rankings in the initial plan. In addition, the top six most costly hazards in terms of property damage in this update include all six hazards that were found to be among the most costly in the previous update of the hazard mitigation plan.

Ranking Summary

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 in the City of Milwaukee all hazard mitigation plan 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 preventive 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 and injuries they cause shifts the focus away from major and possibly avoidable disasters, such as floods. Weather hazards that have caused past Wisconsin disasters are probably the hazards that will cause future disasters. However, the types of natural hazards that result in fatalities remain a public health and safety concern, which is why these hazards were incorporated by the City of Milwaukee Hazard Mitigation Local Planning Team into the final updated all-hazard mitigation plan and implementation strategies, as summarized in this section of the plan.

[181] *Milwaukee County Sheriff's Department, Emergency Management Bureau,* op. cit.

5.13 SUMMARY

Based upon the foregoing evaluation for each of the natural and other hazards above, the priority mitigation measures identified to be included in the City of Milwaukee hazard mitigation plan are summarized in Table 5.10. Table 5.10 also includes a ranking evaluation of the mitigation measures identified in each hazard category based upon relative cost, direct benefits, and likely indirect benefits affected as summarized below.

There are several potential issues inherent in the prioritization or ranking of the mitigation measures, which were considered in development of the recommended ranking of priority mitigation measures summarized below. First, the City of Milwaukee hazard vulnerabilities as shown in Tables 5.7 and 5.8 are different for loss of life and injury versus property damages, which may affect prioritization of costs to be incurred. For the purposes of this plan, priority or emphasis was placed upon preventing loss of life and injury.

The costs of avoidance of a particular hazard may not be quantifiable, but the cost of occurrence of the hazard often is. For example, most hazards have been quantified by insurance underwriters in the issuance of property and life insurance policies. Conversely, the benefit of any particular mitigation measure may also not be quantifiable or realized. For example, continued coordination of emergency response and operation plans among governmental units and first responders will directly enhance preparedness and protection of the communities involved; however, this action may or may not ultimately result in reduced property damage, injuries, or death if the hazard does not occur. Similarly in the case of flood mitigation, upstream actions may result in downstream benefit even if the immediate benefits at the location where the mitigation measure was applied may be less than optimal, i.e. monetary costs are higher than the estimated benefit from such action.

Another potential issue is whether the hazard ranking reflects public health concerns for which mitigation is possible. For example, the vulnerability to hazards, such as extreme heat and lightning are very much a matter of personal exposure. Mitigation in the traditional sense (strengthening a structure or moving a structure away from the hazard, such as in flood mitigation) is of little use for these hazards. Neither extreme heat nor lightning are emergency management issues in terms of operations. Reducing the risk of mortality from lightning or temperature extremes requires public health information and hazard awareness so that individuals take precautions to limit their exposure to the hazard. While hazard awareness and public safety information are important for any type of hazard, it is especially important for hazards such as temperature extremes, lightning, tornadoes, and severe thunderstorms.

Ranking of Priority Mitigation Measures

The mitigation measures identified in each hazard category were further evaluated based upon relative cost, direct benefits, and likely indirect benefits and ranked accordingly as shown in Table 5.10. Consideration was given to the likelihood of occurrence of each type of hazard as set forth in the hazard prioritization analysis as shown in Tables 5.7 and 5.8, which is consistent with the project ranking and prioritization procedures in the Milwaukee County pre-disaster mitigation plan.[182] Greatest priority is recommended to be given to those mitigation measures that directly or indirectly resulted in minimized loss of life or injury.

Estimated Cost

Table 5.10 includes a summary of the estimated capital cost, average annual operation and maintenance cost, and estimated capital benefits, where possible, for each mitigation measure. It is important to note that the annual benefits and costs used in the benefit-cost analysis include only the direct benefits derived from the abatement of monetary flood damages, and the direct costs attendant to implementation of the floodplain management measures, including capital and operation and maintenance costs. Hence, environmental, recreational, or other intangible benefits and costs that cannot be readily quantified were not addressed or reflected in the final estimated capital costs or benefits as shown in Table 5.10 (see also Tables 5.1 to 5.6).

It is important to note that there were many mitigation measures, especially for hazards other than flooding and related stormwater drainage problems, where a direct monetary cost analysis was not possible to calculate. Therefore, mitigation measures were further prioritized based upon comparison of the relative cost of implementation, direct benefits, and indirect benefits (see Direct and Indirect Benefits section).

[182] Ibid.

Table 5.10
Cost Benefit Analysis Summary of Measures Included in the City of Milwaukee All-Hazards Mitigation Plan

Mitigation Measures	Cost of Implementation[a,b]				Benefits					
	Estimated Costs in Dollars (thousands)	Low	Medium	High	Estimated Benefits for a One-Percent Annual-Probability Flood Event[c] (thousands)	Enhanced Preparedness/ Protection	Reduce Property Damage	Reduced Injuries	Reduced Mortalities	Indirect Benefits[d]
Flooding and Related Stormwater Drainage Problems										
Floodplain and Environmentally Sensitive Land Preservation Element										
Floodplain zoning[e]	--[f]	X	--	--	--	X	X	X	X	5
Environmentally sensitive area and open space area preservation	--[f]	X	--	--	--	X	X	--	--	4
Floodplain Management Plan Element										
Kinnickinnic River Watershed[g]										
Kinnickinnic River[h]	161,047[i]	--	--	X	1,376[j]	X	X	--	--	3,4
Lyons Park Creek[h]	14,825[i]	--	--	X	198[j]	X	X	--	--	3,4
Villa Mann Creek[h]	5,574[i]	--	--	X	9[j]	X	X	--	--	3,4
Wilson Park Creek[h]	93,723[i]	--	--	X	325[j]	X	X	--	--	3,4
43rd Street Ditch[h]	7,948[i]	--	--	X	26[j]	X	X	--	--	3,4
Kinnickinnic River Watershed Total	283,117[i]	--	--	X	2,164[j]	X	X	--	--	
Menomonee River Watershed[k]										
Menomonee River[h]	42,490[l]	--	--	X	19,126[l]	X	X	X	X	3,4,5
Grantosa Creek	--[m]	--	--	--	--[m]	X	X	--	--	3
Little Menomonee River	--[m]	--	--	--	--[m]	X	X	X	X	--
Menomonee River Watershed Total	42,490	--	--	X	19,126[n]	--	--	--	--	
Milwaukee River Watershed[o]										
Milwaukee River	60	--	X	--	60	--	X	--	--	2,3
Lincoln Creek	--[m]	--	--	--	--[m]	X	X	--	--	3,4
Southbranch Creek	--[m]	--	--	--	--[m]	X	X	--	--	3
Oak Creek Watershed[p]										
North Branch of Oak Creek	2,339[q]	--	--	X	597[q]	X	X	--	--	3
Mitchell Field Drainage Ditch	1,816[q]	--	--	X	633[q]	X	X	--	--	5
Oak Creek Watershed Total	4,155[q]	--	--	X	1,230[q]	--	--	--	--	
Stormwater Management Plan Element										
Stormwater management plans[e]	--[f]	--	--	--	--	X	X	--	--	3,5
Stormwater-related regulations[e]	--[r]	--	--	--	--	X	X	--	--	3,5
Public Information and Education Element	--[s]	X	--	--	--	X	X	X	X	
Secondary Plan Element										
National Flood Insurance Program and Map Updating	--[f]	X	--	--	--	X	X	--	--	1,3

Table continued on next page.

Table 5.10 (Continued)

Mitigation Measures	Cost of Implementation[a,b]				Benefits					
	Estimated Costs in Dollars (thousands)	Low	Medium	High	Estimated Benefits for a One-Percent Annual-Probability Flood Event[c] (thousands)	Enhanced Preparedness/ Protection	Reduce Property Damage	Reduced Injuries	Reduced Mortalities	Indirect Benefits[d]
Flooding and Related Stormwater Drainage Problems (continued)										
Lending institution and real estate agent policies[e]	--[f]	X	--	--	--	X	X	--	--	3
Stormwater management facilities maintenance	--[f]	X	--	--	--	X	X	--	--	3
Community utility policies and emergency programs	--[f]	X	--	--	--	X	X	--	--	2,3,5
Basement backup problem resolution	--[t]	--	--	--	--	--	X	--	--	5
Stream channel maintenance	--[f]	X	--	--	--	X	X	--	--	3
Thunderstorm, High-Wind, Hail, and Lightning Hazards										
Maintenance and potential expansion of early warning and communication systems, with emphasis on NOAA Weather Radio, EAS broadcasts, and expanded use of emergency technologies	--[t]	--	X	--	--	X	--	--	--	1,5
Educational and informational programming, especially related to the early warning network, and to individual actions to protect citizens, property, and businesses	--[s]	X	--	--	--	X	--	--	--	1,5
Ongoing review and enforcement of building code ordinance and requirements	--[f]	X	--	--	--	X	X	X	X	5
Continue to maintain compliance with the National Incident Management System[h]	--[s]	X	--	--	--	X	--	--	--	1
Consider installation of community safe rooms and hardening projects for community facilities[h]	--[u]	--	X	--	--	X	--	X	X	5
Work with businesses to explore the installation of community safe rooms and hardening projects for businesses and manufacturers[h]	--[u]	X	--	--	--	X	--	X	X	5
Provide annual access to weather spotter training[h]	--[v]	X	--	--	--	X	--	--	--	1
Continued coordination of emergency operation and response plans among governmental units and first responders	--[f]	X	--	--	--	X	--	--	--	5

Table continued on next page.

Table 5.10 (Continued)

Mitigation Measures	Cost of Implementation[a,b]				Benefits					
	Estimated Costs in Dollars (thousands)	Low	Medium	High	Estimated Benefits for a One-Percent Annual-Probability Flood Event[c] (thousands)	Enhanced Preparedness/ Protection	Reduce Property Damage	Reduced Injuries	Reduced Mortalities	Indirect Benefits[d]
Tornadoes										
Maintenance and potential expansion of early warning and communication systems, with emphasis on NOAA Weather Radio, EAS broadcasts, and expanded use of emergency technologies	--[t]	--	X	--	--	X	--	--	--	1,5
Evaluate need to retrofit existing or install new structures to ensure adequate shelters from tornadoes for public buildings, major industrial sites and other large businesses or complexes such as shopping malls, fairgrounds, mobile home parks, and other vulnerable public areas	--[u]	--	X	--	--	X	X	X	X	5
Educational and informational programming, especially related to the early warning network, and to individual actions to protect citizens, property, and businesses	--[s]	X	--	--	--	X	--	--	--	1,5
Ongoing review and enforcement of building code ordinance and requirements	--[f]	X	--	--	--	X	X	X	X	5
Continue to maintain compliance with the National Incident Management System[h]	--[s]	X	--	--	--	X	--	--	--	1
Provide annual access to weather spotter training[h]	--[v]	X	--	--	--	X	--	--	--	1
Continued coordination of emergency operation and response plans among governmental units and first responders	--[f]	X	--	--	--	X	--	--	--	5
Promote and expand training through the Southeastern Wisconsin COAD program[h]	--[t]	--	X	--	--	X	X	X	X	1,2,3,5
Extreme Temperature Events										
Organize neighborhood outreach groups who look after vulnerable groups and individuals	--[t]	X	--	--	--	X	--	--	--	1,5
Increase outreach to vulnerable populations regarding availability of shelters during extreme heat and cold events[h]	--[t]	X	--	--	--	X	--	X	X	5
Continue support of the Milwaukee Heat Task Force[h]	--[f]	X	--	--	--	X	--	X	X	5

Table continued on next page.

Table 5.10 (Continued)

Mitigation Measures	Cost of Implementation[a,b]				Benefits					
	Estimated Costs in Dollars (thousands)	Low	Medium	High	Estimated Benefits for a One-Percent Annual-Probability Flood Event[c] (thousands)	Enhanced Preparedness/ Protection	Reduce Property Damage	Reduced Injuries	Reduced Mortalities	Indirect Benefits[d]
Extreme Temperature Events (continued)										
Encourage the provision of special arrangements for payment of heating bills	--[t]	X	--	--	--	X	--	--	--	5
Identify and advertise a list of available heating and or cooling shelters in the immediate area	--[f]	X	--	--	--	X	--	--	--	5
Encourage owners of heating and cooling shelter sites to extend their hours during extreme temperature eventsv	--[v]	X	--	--	--	X	--	X	X	5
Increase coverage and use of NOAA Weather Radio and EAS broadcasts	--[t]	--	X	--	--	X	--	X	X	1,5
Educational and informational programming	--[s]	X	--	--	--	X	--	--	--	1,5
Produce and distribute emergency information related to the safe operation of generators, space heaters, fire places, and wood stoves[h]	--[t]	X	--	--	--	--	X	X	X	3,5
Continue to maintain compliance with the National Incident Management System[h]	--[s]	X	--	--	--	X	--	--	--	1
Promote and expand training through the Southeastern Wisconsin COAD program[h]	--[t]	--	X	--	--	X	X	X	X	1,2,3,5
Lake Michigan Coastal Hazards										
Continued enforcement of City shoreland regulations and policies[f]	--[f]	X	--	--	--	X	X	X	X	5
Continued construction and maintenance of shoreline protection structures	--[v]	--	X	--	--	X	X	--	--	3
Continue ongoing programs to update and refine coastal hazard data[h]	--[f]	X	--	--	--	X	--	--	--	3
Public informational and educational programming	--[s]	X	--	--	--	X	--	--	--	5
Winter Storm Events										
Organize neighborhood outreach groups who look after vulnerable groups and individuals	--[t]	X	--	--	--	X	--	--	--	5
Encourage the provision of special arrangements for payment of heating bills	--[t]	X	--	--	--	X	--	--	--	5

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Table 5.10 (Continued)

Mitigation Measures	Cost of Implementation[a,b]				Benefits					
	Estimated Costs in Dollars (thousands)	Low	Medium	High	Estimated Benefits for a One-Percent Annual-Probability Flood Event[c] (thousands)	Enhanced Preparedness/ Protection	Reduce Property Damage	Reduced Injuries	Reduced Mortalities	Indirect Benefits[d]
Winter Storm Events (continued)										
Identify and advertise a list of available heated and cooling shelters in the immediate area	--[f]	X	--	--	--	X	--	--	--	5
Increase coverage and use of NOAA Weather Radio and EAS broadcasts	--[t]	--	X	--	--	X	--	X	X	1,5
Educational and informational programming	--[s]	X	--	--	--	X	--	--	--	1,5
Produce and distribute emergency preparedness information related to the safe operation of generators, space heaters, fire places and wood stoves[h]	--[t]	X	--	--	--	--	X	X	X	3,5
Ongoing review and enforcement of building code ordinance requirements	--[f]	X	--	--	--	X	X	X	X	5
Work with agencies to establish a system for short-term sheltering	--[t]	X	--	--	--	X	--	--	--	5
Continued coordination of emergency operation and response plans among governmental units and first responders	--[f]	X	--	--	--	X	--	--	--	5
Work with utilities to assess and improve electrical service reliability	--[f]	X	--	--	--	X	--	--	--	5
Continue and refine State, County, and local road maintenance programs	--[f]	X	--	--	--	X	--	--	--	5
Continue to maintain compliance with the National Incident Management System[h]	--[s]	X	--	--	--	X	--	--	--	1
Promote and expand training through the Southeastern Wisconsin COAD program	--[t]	--	X	--	--	X	X	X	X	1,2,3,5
Contamination or Loss of Water Supply										
Educational and informational programming related to water safety issues	--[t]	X	--	--	--	X	--	--	--	1,5
Continued maintenance, operation, and upgrading of the state-of-the-art treatment facilities	--[t]	--	--	X	--	X	--	--	X	5
Promote and expand training through the Southeastern Wisconsin COAD program[h]	--[t]	--	X	--	--	X	X	X	X	1,2,3,5
Continued maintenance, operation, and upgrading of water supply facility security facilities programs and procedures	--[t]	--	--	X	--	X	--	--	X	5

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Table 5.10 (Continued)

Mitigation Measures	Cost of Implementation[a,b]				Benefits					
	Estimated Costs in Dollars (thousands)	Low	Medium	High	Estimated Benefits for a One-Percent Annual-Probability Flood Event[c] (thousands)	Enhanced Preparedness/ Protection	Reduce Property Damage	Reduced Injuries	Reduced Mortalities	Indirect Benefits[d]
Contamination or Loss of Water Supply (continued)										
Continued coordination of emergency operation and response plans among governmental units and first responders	--[f]	X	--	--	--	X	--	--	--	5
Continue to maintain compliance with the National Incident Management System[h]	--[s]	X	--	--	--	X	--	--	--	1
Hazardous Material Events										
Continue participation in the Wisconsin Hazardous Materials Response System[h]	--[f]	X	--	--	--	X	--	--	--	5
Educational and informational programming related to hazardous material safety, and to individual actions to protect citizens, property, and businesses	--[s]	X	--	--	--	X	--	--	--	5
Promote community and operator compliance with industry safety regulations and standards	--[f]	X	--	--	--	X	X	X	X	5
Promotion of ongoing enforcement of Federal, State, and City regulatory standards	--[s]	X	--	--	--	X	X	X	X	5
Support existing household waste management control programs, which should include hazardous material disposal sites for public citizens	--[t]	X	--	--	--	X	--	--	--	5
Continue support of training, equipment, planning, and preparedness of first responders	--[t]	X	--	--	--	X	--	--	--	5
Continue to maintain compliance with the National Incident Management System[h]	--[s]	X	--	--	--	X	--	--	--	1,3,5
Continued coordination of emergency response plans among governmental units, businesses, and first responders	--[t]	X	--	--	--	X	--	--	--	5
Promote and expand training through the Southeastern Wisconsin COAD program[h]	--[t]	--	X	--	--	X	X	X	X	1,2,3,5

Table continued on next page.

Table 5.10 (Continued)

Mitigation Measures	Cost of Implementation[a,b]				Benefits					
	Estimated Costs in Dollars (thousands)	Low	Medium	High	Estimated Benefits for a One-Percent Annual-Probability Flood Event[c] (thousands)	Enhanced Preparedness/ Protection	Reduce Property Damage	Reduced Injuries	Reduced Mortalities	Indirect Benefits[d]
Public Health Emergencies										
Educational and informational programming related to public health and safety issues. Increase information and educational activities for specific health issues, such as West Nile Virus	--[s]	X	--	--	--	X	--	--	--	5
Strengthen public health infrastructure to support surveillance, response, reporting, and research, and to implement prevention and control programs	--[t]	--	X	--	--	X	--	--	--	5
Provide the public health workforce with the knowledge and tools needed for early detection and control of diseases and disease vectors	--[t]	--	X	--	--	X	--	--	--	5
Implement specific health issue-related mitigation strategies	--[t]	X	--	--	--	X	--	X	X	5
Develop and maintain plans for mass dispensing clinics for large-scale antibiotic or vaccine dispensing in the event of an infectious disease emergency[h]	--[t]	X	--	--	--	X	--	X	X	2,5
Encourage residents to receive immunizations against communicable diseases[h]	--[t]	X	--	--	--	X	--	X	--	2,5
Ensure prompt implementation of prevention strategies and enhance communication of public health information about emerging diseases, their vectors, and control measures	--[t]	X	--	--	--	X	--	--	--	5
Continue to maintain compliance with the National Incident Management System[h]	--[s]	X	--	--	--	X	--	--	--	1,3,5
Promote and expand training through the Southeastern Wisconsin COAD program[h]	--[t]	--	X	--	--	X	X	X	X	1,2,3,5
Terrorism Incidents										
Continue and expand educational and informational programming related to public health and safety issues due to terrorist incidents	--[s]	X	--	--	--	X	--	--	--	1,5
Continue to participate in Federal programs such as LETPP	--[v]	X	--	--	--	X	--	--	--	1

Table continued on next page.

Table 5.10 (Continued)

Mitigation Measures	Cost of Implementation[a,b]				Benefits					
	Estimated Costs in Dollars (thousands)	Low	Medium	High	Estimated Benefits for a One-Percent Annual-Probability Flood Event[c] (thousands)	Enhanced Preparedness/ Protection	Reduce Property Damage	Reduced Injuries	Reduced Mortalities	Indirect Benefits[d]
Terrorism Incidents (continued)										
Consider the need to strengthen public health infrastructure to support surveillance, response, reporting, and research, and to implement prevention and control programs from potential chemical and biological attacks	--[t]	--	X	--	--	X	--	--	--	5
Continue support for training, equipment, planning, and preparedness for local law enforcement, fire and rescue departments, and other emergency management services	--[t]	--	X	--	--	X	--	--	--	5
Continue coordination of emergency response plans among Federal, State, and local governmental units, businesses, and emergency management services	--[t]	X	--	--	--	X	--	--	--	5
Continue to maintain compliance with the National Incident Management System[h]	--[s]	X	--	--	--	X	--	--	--	1,3,5
Promote and expand training through the Southeastern Wisconsin COAD program[h]	--[t]	--	X	--	--	X	X	X	X	1,2,3,5
Major Fire and Emergency Medical Events										
Continue and expand educational and informational programming related to public health and safety issues due to fire and emergency medical incidents	--[s]	X	--	--	--	X	--	--	--	1,5
Continue support for training, equipment, planning, and preparedness for local law enforcement, fire and rescue departments, and other emergency management services	--[t]	X	--	--	--	X	--	--	--	5
Continue building safety inspection efforts	--[f]	--	--	X	--	X	X	X	X	1
Raze condemned buildings	--[f]	--	--	X	--	--	X	X	X	1
Consider the need to strengthen public health infrastructure to support surveillance, response, reporting, and research, and to implement prevention and control programs from potential fire and major medical emergencies	--[t]	--	X	--	--	X	X	X	X	1

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Table 5.10 (Continued)

Mitigation Measures	Cost of Implementation[a,b]				Benefits					
	Estimated Costs in Dollars (thousands)	Low	Medium	High	Estimated Benefits for a One-Percent Annual-Probability Flood Event[c] (thousands)	Enhanced Preparedness/ Protection	Reduce Property Damage	Reduced Injuries	Reduced Mortalities	Indirect Benefits[d]
Major Fire and Emergency Medical Events										
Continue maintenance and promote enhanced fire safety measures at critical facilities, and encourage widespread use of fire safety devices	--[t]	--	--	X	--	X	X	X	X	1
Continue to maintain compliance with the National Incident Management System[h]	--[s]	X	--	--	--	X	--	--	--	1,3,5
Continue/enhance coordination of emergency response plans among Federal, State, and local governmental units, businesses, and emergency management services	--[f]	X	--	--	--	X	--	--	--	3,5
Promote and expand training through the Southeastern Wisconsin COAD program[h]	--[t]	--	X	--	--	X	X	X	X	1,2,3,5

[a] *All costs and benefits expressed in 2016 dollars.*

[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 constraints*
- *New buildings (infrastructure)*
- *Capital programs*

[c] *Except where noted, the estimated benefits are based upon the reduction in flood damages during a one-percent-annual-probability flood event.*

Table continued on next page.

Table 5.10 (Continued)

[d] *Indirect benefits represent a continuum of potential benefits that may occur as a result of the implementation of specific management actions. For example, implementation of informational programming, while not directly saving lives, may ultimately result in people having the knowledge necessary to save lives and protect property. These intangible benefits cannot be readily quantified and range from increased awareness to reduced loss of life and property, and have been assessed using the following relative cumulative scale:*

1 = Increased awareness/preparedness
2 = Enhanced quality of life/social benefits
3 = Reduced property damage
4 = Increased environmental and recreational benefits/ecosystems services
5 = Reduced loss of life and injury with concomitant benefits for economic productivity

[e] *This mitigation measure is related but not essential to continued compliance with the requirements of the National Flood Insurance Program.*

[f] *Costs covered under ongoing activity.*

[g] *Mitigation measures in the Kinnickinnic River watershed related but not essential to continued compliance with the requirements of the National Flood Insurance Program are identified in Table 5.1.*

[h] *This recommendation was added to or substantially revised in this edition of the plan.*

[i] *For further details on estimated costs of recommended floodplain management measures, refer to Table 5.1.*

[j] *The estimated benefits represent reductions in estimated annual damages as given in the Kinnickinnic River Watershed Flood Management Plan. Refer to Table III-9 for flood damages that would be reduced through implementation of recommended measures.*

[k] *Mitigation measures in the Menomonee River watershed related but not essential to continued compliance with the requirements of the National Flood Insurance Program are identified in Tables 5.2 and 5.3.*

[l] *For further details on the benefit-cost analysis of floodplain mitigation alternatives, refer to Table 5.2.*

[m] *No cost or benefit given. This element has already been implemented.*

[n] *Benefits taken from MMSD Menomonee River Phase 1 system plan and reflects reduction of damages in both the Cities of Milwaukee and Wauwatosa.*

[o] *Mitigation measures in the Milwaukee River watershed related but not essential to continued compliance with the requirements of the National Flood Insurance Program are identified in Table 5.4 and 5.5.*

[p] *Mitigation measures in the Oak Creek watershed related but not essential to continued compliance with the requirements of the National Flood Insurance Program are identified in Table 5.6.*

[q] *For further details on estimated costs and benefits of recommended floodplain management measures, refer to Table 5.6.*

[r] *Cost of ordinance development is covered under ongoing projects. Cost of implementation is not determined.*

[s] *Portion of costs included in ongoing program and construction project implementation programs.*

[t] *Costs to be determined. Partially covered under ongoing programs.*

[u] *Costs are site specific and survey is needed for citywide estimate.*

[v] *Costs to be determined.*

Source: SEWRPC

Cost of Implementation

An estimated cost of implementation was developed in order to categorize the relative cost of each of the priority mitigation measures as shown in Table 5.10. The 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 including:

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

This cost categorization allows the mitigation measures to be prioritized with particular regard to cost effectiveness by comparing the estimated low, moderate, and high cost to the number of both direct and indirect benefits identified (see Direct and Indirect Benefits section).

Direct and Indirect Benefits

The benefits from implementation of a mitigation measure can be classified as direct, or measurable, and as indirect, or intangible. Direct benefits were defined in terms of enhanced preparedness/protection of individuals or communities, reduced property damage, reduced injuries and reduced mortalities. Although the exact numbers or amounts of such direct benefits are not known, these would be a direct result of implementation of a particular mitigation measure. In contrast, indirect benefits represent a continuum of potential benefits that may occur as a result of the implementation of specific management actions. For example, implementation of informational programming, while not directly saving lives, may ultimately result in people having the knowledge necessary to save lives and protect property. These intangible benefits cannot be readily quantified and range from increased awareness to reduced loss of life and property, and have been assessed using the following relative cumulative scale:

1 = Increased awareness/preparedness
2 = Enhanced quality of life/social benefits
3 = Reduced property damage
4 = Increased environmental and recreational benefits/ecosystems services
5 = Reduced loss of life and injury with concomitant benefits for economic productivity

PLAN ADOPTION, IMPLEMENTATION, MAINTENANCE, AND REVISION 6

This updated hazard mitigation plan is designed to attain, to the maximum extent practicable, the goals and objectives set forth in Chapter 4 of this report. In a practical sense, however, the plan is not complete until the steps to implement it, that is, to convert the plan into action policies and programs, have been specified. This chapter presents the plan implementation strategies envisioned and includes provisions and information on plan adoption, maintenance, and revision.

6.1 PLAN REFINEMENT, REVIEW, AND ADOPTION

As described in Chapter 1, the all-hazard mitigation planning program was initiated by the City of Milwaukee Department of Public Works in 2003 as part of its broader, ongoing program of flooding and other hazard mitigation conducted in cooperation with the Federal Emergency Management Agency (FEMA) and the Wisconsin Department of Military Affairs, Division of Emergency Management. The plan update set forth in this report was begun in 2016 and 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. During 2002, FEMA published new rules for hazard mitigation planning and the hazard mitigation grant program in response to the Disaster Mitigation Act of 2000. These rules address State and local mitigation planning and are important for the City of Milwaukee hazard mitigation program in three ways:

- The State of Wisconsin Department of Military Affairs, Division of Emergency Management 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; provides technical assistance and guidance for local all-hazards planning; and administers the Pre-Disaster Mitigation Program for FEMA.

- The rules outline State and local mitigation planning guidelines for accessing Hazard Mitigation Program funds. According to the rules, for disasters declared after November 1, 2004, local governments must have a FEMA-approved mitigation plan in order to receive grants from the Hazard Mitigation Grant Program (HMGP) and the Pre-Disaster Mitigation Program (PDM). This element is important because it requires local adoption of an all-hazards mitigation plan to remain eligible for certain future mitigation funds. This element can be achieved if the community formally adopts the City plan.

- The rules and related guidance set forth more specificity and detail on the hazard mitigation plan content.

Because of the 2002 rules noted above, the initial City of Milwaukee hazard mitigation plan was structured to meet the new guidance. The work was also coordinated with a Wisconsin Emergency Management statewide task force on hazard mitigation planning.

The City of Milwaukee all-hazards mitigation plan was prepared under the guidance of the City of Milwaukee Hazard Mitigation Steering Committee comprised of representatives and interested parties throughout the City, as well as County agency representatives. The committee met four times during the plan preparation period for the initial plan to provide input on the types of hazards to be considered, the appropriate mitigation strategies, and to review the draft report chapters with the report chapters then being refined to reflect the comments and recommendations of the Steering Committee. The Steering Committee was reconvened for this and the previous updating effort. The Steering Committee met three times during the preparation of the first update to provide input on the types of hazards to be considered, the appropriate mitigation strategies, and to review the draft report chapters with the report chapters then being refined

to reflect the comments and recommendations of the Steering Committee. For the second updating effort, the Steering Committee was renamed the City of Milwaukee Hazard Mitigation Plan Local Planning Team. During this updating effort, 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 draft report chapters, with the report chapters then being refined to reflect the comments and recommendations of the Local Planning Team (see Appendix A).

Following completion of the initial plan in draft form, a public informational meeting was held on April 21, 2005, to review the plan. Following plan finalization, the plan was presented for consideration and adoption to the City of Milwaukee Common Council. Formal adoption of the plan occurred on May 2, 2005.

With some additions, similar local adoption procedures were followed for the two updates of this plan. As draft chapters of the updated plan report were completed, copies were placed in downloadable format on the website of the Southeastern Wisconsin Regional Planning Commission (SEWRPC). Downloadable copies of agendas and summary notes from Local Planning Team meetings and presentations related to this plan updating effort were also available on this webpage. Members of the public could ask questions and submit comments on the draft plan update on the SEWRPC webpage as well. Following completion of updates to the community profiles and the risk and vulnerability sections of the plan and review of drafts of the corresponding chapters by the Local Planning Team, public informational meetings were held to review these sections of the plan with local officials, business and industry representatives, and citizens to solicit their input.

When the plan was completed in draft form, additional public informational meetings were held to review the plan and provide the public an opportunity to review and provide input on the updated plan. Following finalization of the updated plan, the plan update was presented to the City of Milwaukee Common Council for consideration and adoption.

An important first step in implementation of the all-hazards mitigation plan for the City of Milwaukee is its formal adoption by the City. Upon its formal adoption, the plan becomes an important guide to the making of hazard mitigation and related management decisions for the City and County. 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 municipal programs, such as land use control and public works development planning and programming.

The City of Milwaukee Department of Public Works and the Office of Emergency Management and Homeland Security will provide the means to ensure that actions identified in the all-hazards mitigation plan are incorporated into relevant ongoing municipal programs. The City of Milwaukee Department of City Development is responsible for administering land use plans, building codes, and other relevant planning activities within the City. After the City formally adopts the all hazards mitigation plan, the Department of Public Works will conduct periodic reviews of the City's policies in order to integrate the all hazards mitigation plan with such programs and policies.

6.2 PLAN IMPLEMENTATION STRATEGIES

The recommended hazard mitigation plan described in this report is designed to attain, to the maximum extent practicable, the goals and objectives set forth in Chapter 4 of this report. In a practical sense, however, the plan is not complete until the steps to implement it—that is, to convert the plan into action policies and programs—have been specified. Following formal adoption of the plan by the City of Milwaukee, 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 City and County officials and staff and various City, County, and community departments and other bodies. Close cooperation with the Wisconsin Department of Military Affairs, Division of Emergency Management, and FEMA is also essential.

A summary of the plan elements and selected implementation strategy information, including costs, designated management agencies, and schedules is included in Table 6.1.

It is recommended that the City incorporate the analyses performed and mitigation strategies recommended into other local planning efforts, such as those related to stormwater management, stream and river protections, land and water conservation, and comprehensive planning, where appropriate.

Table 6.1
City of Milwaukee All-Hazards Mitigation Plan Summary and Implementation Plan

Mitigation Measures	Cost of Implementation[a] (thousands)	Estimated Benefits for a One-Percent-Annual-Probability Flood Event[b] (thousands)	Managing Agency	Plan Implementation Schedule	Implementation Status Notes	Potential Funding Programs (see Appendix F)
Flooding and Related Stormwater Drainage Problems						
Floodplain and Environmentally Sensitive Land Preservation Element						
Floodplain zoning	--[c]	--	CMDCD	In place and ongoing	--[d]	1, 2, 5, 17, 45, 49, 51, 58
Environmentally sensitive area and open space area preservation	--[c]	--	CMDCD, MC, CO, MMSD with involvement of WDNR	In place and ongoing	--[e]	1, 2, 5, 21, 23, 24, 27, 39, 42, 43, 46, 47, 48, 49, 51, 59, 60, 61
Floodplain Management Plan Element[f]						
Kinnickinnic River Watershed						1, 2, 3, 5, 15, 16, 23, 25, 29, 33, 42, 47, 48
Kinnickinnic River[g]	161,047	1,376[h]	CMDPW, MMSD	Ongoing	Partially implemented	
Lyons Park Creek[g]	14,825	198[h]	CMDPW, MMSD	Ongoing	Partially implemented	
Villa Mann Creek[g]	5,574	9[h]	CMDPW, MMSD	Ongoing	Partially implemented	
Wilson Park Creek[g]	93,723	325[h]	CMDPW, MMSD, CMDCD	Ongoing	Partially implemented	
43rd Street Ditch[g]	7,948	26[h]		Ongoing	Partially Implemented	
Kinnickinnic River Watershed Total	283,117	2,164	--	--	--	--
Menomonee River Watershed						1, 2, 3, 5, 23, 29, 42, 51
Menomonee River[g]	42,490	19,126	CMDPW, MC, MMSD, LU	Ongoing	Partially implemented	
Grantosa Creek	--[i]	--[i]	CMDPW, MC, MMSD	2000	Implemented	
Little Menomonee River	--[i]	--[i]	CMDPW, MC, MMSD	2006	Implemented	
Menomonee River Watershed Total	42,490	19,126	--	--	--	--
Milwaukee River Watershed						1, 2, 16, 42
Milwaukee River	60	60	MMSD, CMDPW, CMDCD	Ongoing	Partially implemented	
Lincoln Creek	--[i]	--[i]	CMDPW, MC, MMSD	2002	Implemented	
Southbranch Creek	--[i]	--[i]	CMDPW, MC, MMSD, LU	2001	Implemented	
Milwaukee River Watershed Total	60	60	--	--	--	--
Oak Creek Watershed						1, 2, 3, 5, 15, 16, 23, 29, 42
North Branch of Oak Creek	2,339	597				
Mitchell Field Drainage Ditch	1,816	633	CMDPW, MC, MMSD	Ongoing	SEWRPC currently updating the watercourse management plan	
Oak Creek Watershed Total	4,155	1,230	--	--	--	--
Stormwater Management Plan Element					Currently being implemented	1, 2, 3, 5, 16, 21, 22, 23, 24, 39, 42, 43, 45, 46, 47, 48, 49, 50, 51, 52, 58
Stormwater management plans	--[c]	--	CMDPW, CMDCD, MMSD	Ongoing	Partially implemented	
Stormwater-related regulations	--[j]	--	CMDCD, MMSD	Ongoing	Implemented	

Table continued on next page.

Table 6.1 (Continued)

Mitigation Measures	Cost of Implementation[a] (thousands)	Estimated Benefits for a One-Percent-Annual-Probability Flood Event[b] (thousands)	Managing Agency	Plan Implementation Schedule	Implementation Status Notes	Potential Funding Programs (see Appendix F)
Flooding and Related Stormwater Drainage Problems (continued)						
Public Information and Education Element	--[k]	--	CMECO, MC, MMSD, RW, UWEX	Ongoing	Partially implemented	35, 49, 56
Secondary Plan Element						1, 2, 3, 5, 14, 16, 21, 23, 24, 25, 42, 45, 46, 47, 48, 49, 51
National Flood Insurance Program and Map Updating	--[c]	--	CMPDW, MC, MMSD, WDNR, FEMA, SEWRPC	Ongoing	Implemented	
Lending institution and real estate agent policies	--[c]	--	CMDCD,LI, RB	Ongoing	Partially implemented	
Stormwater management facilities maintenance	--[c]	--	CMDPW, MMSD	Ongoing	Partially implemented	
Community utility policies and emergency programs	--[c]	--	CMEM, MC	Ongoing	Partially implemented	
Stormwater management facilities maintenance	--[c]	--	CMDPW, MC	Ongoing	Partially implemented	
Stream channel maintenance	--[c]	--	CMDPW, MMSD	Ongoing	Partially implemented	
Basement backup problem resolution	--[l]	--	CMDPW, MMSD, VWM	Ongoing	Partially implemented	
Thunderstorm, High-Wind, Hail, and Lightning Hazards						
Maintenance and potential expansion of early warning and communication systems, with emphasis on NOAA Weather Radio, EAS broadcasts, and expanded use of emergency technologies	--[l]	--	CMEM, MC	Ongoing	Partially implemented	1, 4, 5, 9, 28, 32, 33, 55, 56
Educational and informational programming, especially related to the early warning network, and to individual actions to protect citizens, property, and businesses	--[k]	--	CMEM, MC, RW, UWEX	Ongoing	Partially implemented	
Ongoing review and enforcement of building code ordinance and requirements	--[c]	--	CMDCD, CMNS, WDSPS	Ongoing	Partially implemented	
Continue to maintain compliance with the National Incident Management System[g]	--[k]	--	CMEM, CMFD, CMPD, MC	Ongoing	Partially Implemented	
Consider installation of community safe rooms and hardening projects for community facilities[g]	--[m]	--	CMEM	Ongoing	Partially Implemented	
Work with businesses to explore the installation of community safe rooms and hardening projects for businesses and manufacturers[g]	--[m]	--	CMEM	Ongoing	Partially Implemented	

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Table 6.1 (Continued)

Mitigation Measures	Cost of Implementation[a] (thousands)	Estimated Benefits for a One-Percent-Annual-Probability Flood Event[b] (thousands)	Managing Agency	Plan Implementation Schedule	Implementation Status Notes	Potential Funding Programs (see Appendix F)
Thunderstorm, High-Wind, Hail, and Lightning Hazards (continued)						
Provide annual access to weather spotter training[g]	--[n]	--	CMEM, MC, NWS	Ongoing	Partially Implemented	1, 4, 5, 9, 28, 32, 33, 55, 56
Continued coordination of emergency operation and response plans among governmental units and first responders	--[c]	--	CMEM, CMFD, CMPD, MC	Ongoing	Partially implemented	
Tornadoes						
Maintenance and potential expansion of early warning and communication systems, with emphasis on NOAA Weather Radio, EAS broadcasts, and expanded use of emergency technologies	--[l]	--	CMEM, MC	Ongoing	Partially implemented	1, 4, 6, 28, 33, 53, 54, 56
Evaluate need to retrofit existing or install new structures to ensure adequate shelters from tornadoes for public buildings, major industrial sites and other large businesses or complexes such as shopping malls, fairgrounds, mobile home parks, and other vulnerable public areas	--[m]	--	CMEM, CMDPW, MC	Ongoing	Partially implemented	
Educational and informational programming, especially related to the early warning network, and to individual actions to protect citizens, property, and businesses	--[k]	--	CMEM, MC, RW, UWEX, WDHS	Ongoing	Partially implemented	
Ongoing review and enforcement of building code ordinance and requirements	--[c]	--	CMDCD, CMNS, WDSPS	Ongoing	Partially implemented	
Continue to maintain compliance with the National Incident Management System[g]	--[k]	--	CMEM, CMFD, CMPD, MC	Ongoing	Partially Implemented	
Provide annual access to weather spotter training[g]	--[n]	--	CMEM, MC, NWS	Ongoing	Partially Implemented	
Continued coordination of emergency operation and response plans among governmental units and first responders	--[c]	--	CMEM, CMFD, CMPD, MC	Ongoing	Partially implemented	
Promote and expand training through the Southeastern Wisconsin COAD program[g]	--[l]	--	CMEM, MC, COAD	Ongoing	Partially Implemented	

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Table 6.1 (Continued)

Mitigation Measures	Cost of Implementation[a] (thousands)	Estimated Benefits for a One-Percent-Annual-Probability Flood Event[b] (thousands)	Managing Agency	Plan Implementation Schedule	Implementation Status Notes	Potential Funding Programs (see Appendix F)
Extreme Temperature Events						
Organize neighborhood outreach groups who look after vulnerable groups and individuals	--[l]	--	CMEM, CMHD, MC	Ongoing	Partially implemented	1, 4, 6, 28, 32, 35, 56
Increase outreach to vulnerable populations regarding availability of shelters during extreme heat and cold events[g]	--[l]	--	CMHD	Ongoing	Partially implemented	
Continue support of the Milwaukee Heat Task Force[g]	--[c]	--	CMHD, CMDPW, MC	Ongoing	Partially implemented	
Encourage the provision of special arrangements for payment of heating bills	--[l]	--	MC, UC, WHEAP	Ongoing	Partially implemented	
Identify and advertise a list of available heating and or cooling shelters in the immediate area	--[c]	--	CMEM, CMHD, MC, UWEX	Ongoing	Partially implemented	
Encourage owners of heating and cooling shelter sites to extend their hours during extreme temperature events[g]	--[n]	--	CMHD	Ongoing	Partially implemented	
Educational and informational programming	--[k]	--	CMEM, CMHD, MC, RW, WDHS	Ongoing	Partially implemented	
Produce and distribute emergency information related to the safe operation of generators, space heaters, fire places, and wood stoves[g]	--[l]	--	CMEM, CMFD, CMHD, RW, UWEX	Ongoing	Partially implemented	
Continue to maintain compliance with the National Incident Management System[g]	--[k]	--	CMEM, CMFD, CMPD, MC	Ongoing	Partially Implemented	
Promote and expand training through the Southeastern Wisconsin COAD program[g]	--[l]	--	CMEM, MC, COAD	Ongoing	Partially Implemented	
Lake Michigan Coastal Hazards						
Continued enforcement of City shoreland regulations and policies	--[c]	--	MC	Ongoing	Implemented	15, 39, 57, 58, 60, 61
Continued construction and maintenance of shoreline protection structures	--[n]	--	CMDPW, MC, WDNR, SEWRPC	Ongoing	Partially Implemented	
Continue ongoing programs to update and refine coastal hazard data[g]	--[c]	--	CMDPW, MC, WDNR, SEWRPC, FEMA	Ongoing	Partially implemented	
Public informational and educational programming	--[k]	--	MMSD, CMEM, MC, UWEX	Ongoing	Partially implemented	

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Table 6.1 (Continued)

Mitigation Measures	Cost of Implementation[a] (thousands)	Estimated Benefits for a One-Percent-Annual-Probability Flood Event[b] (thousands)	Managing Agency	Plan Implementation Schedule	Implementation Status Notes	Potential Funding Programs (see Appendix F)
Winter Storm Events						
Organize neighborhood outreach groups who look after vulnerable groups and individuals	--[l]	--	CMEM, CMHD, MC	Ongoing	Partially implemented	1, 4, 8, 28, 32, 33, 53, 54, 55, 56
Encourage the provision of special arrangements for payment of heating bills	--[l]	--	MC, UC, WHEAP	Ongoing	Partially implemented	
Identify and advertise a list of available heated and cooling shelters in the immediate area	--[c]	--	CMEM, CMHD, MC, UWEX	Ongoing	Partially implemented	
Increase coverage and use of NOAA Weather Radio and EAS broadcasts	--[l]	--	CMEM, MC	Ongoing	Partially implemented	
Educational and informational programming	--[k]	--	CMEM, CMHD, MC, RW, UWEX	Ongoing	Partially implemented	
Produce and distribute emergency preparedness information related to the safe operation of generators, space heaters, fire places and wood stoves[g]	--[l]	--	CMEM, CMFD, CMHD, RW, UWEX	Ongoing	Partially implemented	
Ongoing review and enforcement of building code ordinance requirements	--[c]	--	CMDCD, CMNS, WDSPS	Ongoing	Partially implemented	
Work with agencies to establish a system for short-term sheltering	--[l]	--	CMEM, MC	Ongoing	Partially implemented	
Continued coordination of emergency operation and response plans among governmental units and first responders	--[c]	--	CMEM, CMFD, CMPD, MC	Ongoing	Partially implemented	
Work with utilities to assess and improve electrical service reliability	--[c]	--	CMEM, CMDPW, MC, PP, UC	Ongoing	Partially implemented	
Continue and refine State, County, and local road maintenance programs	--[c]	--	CMDPW, MC, WDOT	Ongoing	Partially implemented	
Continue to maintain compliance with the National Incident Management System[g]	--[k]	--	CMEM, CMFD, CMPD, MC	Ongoing	Partially Implemented	
Promote and expand training through the Southeastern Wisconsin COAD program[g]	--[k]	--	CMEM, MC, COAD	Ongoing	Partially Implemented	
Contamination or Loss of Water Supply						
Educational and informational programming related to water safety issues	--[k]	--	CMWW, MC, WDNR, UWEX	Ongoing	Partially implemented	4, 13, 30, 31, 35, 41, 42, 54, 55, 57, 58, 61, 62
Continued maintenance, operation, and upgrading of the state-of-the-art treatment water facilities	--[l]	--	CMWW	Ongoing	Partially implemented	

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Table 6.1 (Continued)

Mitigation Measures	Cost of Implementation[a] (thousands)	Estimated Benefits for a One-Percent-Annual-Probability Flood Event[b] (thousands)	Managing Agency	Plan Implementation Schedule	Implementation Status Notes	Potential Funding Programs (see Appendix F)
Contamination or Loss of Water Supply (continued)						
Promote and expand training through the Southeastern Wisconsin COAD program[g]	--[l]	--	CMEM, MC, COAD	Ongoing	Partially Implemented	4, 13, 30, 31, 35, 41, 42, 54, 55, 57, 58, 61, 62
Continued maintenance, operation, and upgrading of water supply facility security measures, programs, and procedures	--[l]	--	CMWW	Ongoing	Partially implemented	
Continued coordination of emergency operation and response plans among governmental units and first responders	--[c]	--	CMWW, CMEM, MC	Ongoing	Partially implemented	
Continue to maintain compliance with the National Incident Management System[g]	--[k]	--	CMEM, MC	Ongoing	Partially Implemented	
Hazardous Material Events						
Continue participation in the Wisconsin Hazardous Materials Response System[g]	--[c]	--	CMEM, CMFD	Ongoing	Implemented	1, 4, 7, 8, 11, 12, 34, 37, 40, 44, 54, 56
Educational and informational programming related to hazardous material safety, and to individual actions to protect citizens, property, and businesses	--[k]	--	CMEM, MC, RW, WDNR, WEM	Ongoing	Partially implemented	
Promote community and operator compliance with industry safety regulations and standards	--[c]	--	CMEM, MC, WEM, UWEX	Ongoing	Partially implemented	
Promotion of ongoing enforcement of Federal, State and City regulatory standards	--[k]	--	CMDCD, MC, WEM	Ongoing	Partially implemented	
Support existing household waste management control programs, which should include hazardous material disposal sites for public citizens	--[l]	--	CMDPW, CMHD, MC, MMSD, WDNR	Ongoing	Partially implemented	
Continued support of training, equipment, planning, and preparedness of first responders	--[l]	--	CMEM, CMFD, CMPD, MC, WEM	Ongoing	Partially implemented	
Continue to maintain compliance with the National Incident Management System[g]	--[k]	--	CMEM, CMFD. CMPD, MC	Ongoing	Partially Implemented	
Continued coordination of emergency response plans among governmental units, businesses, and first responders	--[l]	--	CMEM, CMFD, CMPD, MC, WEM	Ongoing	Partially implemented	
Promote and expand training through the Southeastern Wisconsin COAD program[g]	--[l]	--	CMEM, MC, COAD	Ongoing	Partially Implemented	

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Table 6.1 (Continued)

Mitigation Measures	Cost of Implementation[a] (thousands)	Estimated Benefits for a One-Percent-Annual-Probability Flood Event[b] (thousands)	Managing Agency	Plan Implementation Schedule	Implementation Status Notes	Potential Funding Programs (see Appendix F)
Public Health Emergencies						
Educational and informational programming related to public health and safety issues. Increase information and educational activities for specific health issues, such as West Nile Virus	--[k]	--	CMHD, MC, RW, WDHS	Ongoing	Partially implemented	40, 41, 54
Strengthen public health infrastructure to support surveillance, response, reporting, and research, and to implement prevention and control programs	--[l]	--	CMHD, MC, WDHS	Ongoing	Partially implemented	
Provide the public health work force with the knowledge and tools needed for early detection and control of diseases and disease vectors	--[l]	--	CMHD, MC, WDHS, PP	Ongoing	Partially implemented	
Implement specific health issue-related mitigation strategies	--[l]	--	CMHD, MC, WDHS	Ongoing	Partially implemented	
Develop and maintain plans for mass dispensing clinics for large-scale antibiotic or vaccine dispensing in the event of an infectious disease emergency[g]	--[c]	--	CMHD, WHDS	Ongoing	Partially implemented	
Encourage residents to receive immunizations against communicable diseases[g]	--[l]	--	CMHD, WHDS	Ongoing	Partially implemented	
Ensure prompt implementation of prevention strategies and enhance communication of public health information about emerging diseases, their vectors, and control measures	--[l]	--	CMHD, MC, WDHS, PP	Ongoing	Partially implemented	
Continue to maintain compliance with the National Incident Management System[g]	--[k]	--	CMEM, CMFD, CMHD, MC	Ongoing	Partially Implemented	
Promote and expand training through the Southeastern Wisconsin COAD program[g]	--[k]	--	CMEM, MC, COAD	Ongoing	Partially Implemented	
Terrorism Incidents						
Continue and expand educational and informational programming related to public health and safety issues due to terrorist incidents	--[k]	--	CMEM, MC, WEM, UWEX	Ongoing	Partially implemented	4, 6, 7, 8, 9, 10, 11, 12, 40, 41, 54
Continue to participate in Federal programs such as LETPP	--[n]	--	CMEM	Ongoing	Partially Implemented	

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Table 6.1 (Continued)

Mitigation Measures	Cost of Implementation[a] (thousands)	Estimated Benefits for a One-Percent-Annual-Probability Flood Event[b] (thousands)	Managing Agency	Plan Implementation Schedule	Implementation Status Notes	Potential Funding Programs (see Appendix F)
Terrorism Incidents (continued)						
Consider the need to strengthen public health infrastructure to support surveillance, response, reporting and research, and to implement prevention and control programs from potential chemical and biological attacks	--[l]	--	CMHD, MC, WEM, WDHS	Ongoing	Partially implemented	4, 6, 7, 8, 9, 10, 11, 12, 40, 41, 54
Continue support for training, equipment, planning, and preparedness for local law enforcement, fire and rescue departments and other emergency management services	--[l]	--	CMEM, CMFD, CMPD, MC, WEM,	Ongoing	Partially implemented	
Continue coordination of emergency response plans among Federal, State, and local governmental units, businesses and emergency management services	--[l]	--	CMEM, MC, WEM, UWEX	Ongoing	Partially implemented	
Continue to maintain compliance with the National Incident Management System[g]	--[k]	--	CMEM, CMFD, CMPD, MC	Ongoing	Partially Implemented	
Promote and expand training through the Southeastern Wisconsin COAD program[g]	--[l]	--	CMEM, MC, COAD	Ongoing	Partially Implemented	
Major Fire and Emergency Medical Events						
Continue and expand educational and informational programming related to public health and safety issues due to fire and emergency medical incidents	--[k]	--	CMFD, MC, RW, UWEX	Ongoing	Partially implemented	1, 4, 6, 7, 8, 9, 10, 11, 12, 36, 53, 54, 56
Continue support for training, equipment, planning, and preparedness for local law enforcement, fire and rescue departments and other emergency management services	--[l]	--	CMFD CMPD, MC, WEM	Ongoing	Partially implemented	
Continue building safety inspection efforts	--[c]	--	CMNS, CMFD	Ongoing	Implemented	
Raze condemned buildings	--[c]	--	CMNS	Ongoing	Implemented	
Consider the need to strengthen public health infrastructure to support surveillance, response, reporting and research, and to implement prevention and control programs from potential fire and major medical emergencies	--[l]	--	CMHD	Ongoing	Partially implemented	

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Table 6.1 (Continued)

Mitigation Measures	Cost of Implementation[a] (thousands)	Estimated Benefits for a One-Percent-Annual-Probability Flood Event[b] (thousands)	Managing Agency	Plan Implementation Schedule	Implementation Status Notes	Potential Funding Programs (see Appendix F)
Major Fire and Emergency Medical Events (continued)						
Continue maintenance and promote enhanced fire safety measures at critical facilities, and encourage widespread use of fire safety devices	--[c]	--	CMFD	Ongoing	Partially implemented	1, 4, 6, 7, 8, 9, 10, 11, 12, 36, 53, 54, 56
Continue to maintain compliance with the National Incident Management System[g]	--[k]	--	CMEM, CMFD, CMPD, MC	Ongoing	Partially Implemented	
Continue/enhance coordination of emergency response plans among Federal, State, and local governmental units, businesses, and emergency management services	--[c]	--	CMEM, WEM	Ongoing	Partially implemented	
Promote and expand training through the Southeastern Wisconsin COAD program[g]	--[l]	--	CMEM, MC, COAD	Ongoing	Partially Implemented	

Note: The following abbreviations are used for designated management agencies:

CMDCD = City of Milwaukee Department of City Development
CMDPW = City of Milwaukee Department of Public Works
CMECO = City of Milwaukee Environmental Collaboration Office
CMEM = City of Milwaukee Office of Emergency Management and Homeland Security
CMFD = City of Milwaukee Fire Department
CMHD = City of Milwaukee Health Department
CMNS = City of Milwaukee Department of Neighborhood Services
CMPD = City of Milwaukee Police Department
CMWW = City of Milwaukee Water Works
CO = Conservation Organizations
COAD = Coalition of Organizations Active in Disasters
LI = Lending Institutions
LU = General Purpose Local Units of Government
MC = Milwaukee County
MMSD = Milwaukee Metropolitan Sewerage District
NWS = National Weather Service
PP = Private Parties
RB = Real Estate Brokers
RW = Ready Wisconsin
SEWRPC = Southeastern Wisconsin Regional Planning Commission
UC = Utility Company
UWEX = University of Wisconsin-Extension
VWM = Veolia Water Milwaukee
WEM = Wisconsin Emergency Management
WDHS = Wisconsin Department of Health Services
WDNR = Wisconsin Department of Natural Resources
WDOT = Wisconsin Department of Transportation
WDSPS = Wisconsin Department of Safety and Professional Services
WHEAP = Wisconsin Home Energy Assistance Program

[a] *All costs expressed in 2016 dollars.*

[b] *All benefits are expressed in 2016 dollars. Except where noted, the estimated benefits are based upon the reduction of flood damages resulting from a one-percent-annual-probability flood event.*

[c] *Costs covered under ongoing activity.*

[d] *Plan implementation is largely complete in City of Milwaukee. Additional actions are needed within watershed.*

[e] *Plan implementation largely complete. Environmentally sensitive lands are all under County ownership. Additional actions are underway within watershed by MMSD.*

Table continued on next page.

Table 6.1 (Continued)

[f] *For further details on the benefit-cost analysis of floodplain mitigation alternatives in the Kinnickinnic River watershed, refer to Tables 3.9 and 5.1.*

[g] *The estimated benefits represent reductions in estimated annual flood damages as given in the Kinnickinnic River watershed flood management plan.*

[h] *No cost or benefit given. This element has already been implemented.*

[i] *Cost of ordinance development is covered under ongoing projects. Cost of implementation is not determined.*

[j] *Portion of costs included in ongoing program and construction project implementation programs.*

[k] *Costs to be determined. Partially covered under ongoing programs.*

[l] *Costs are site specific and survey is needed for citywide estimate.*

[m] *Costs to be determined.*

[n] *This recommendation was added to or substantially revised in this edition of the plan.*

Source: SEWRPC

6.3 HAZARD MITIGATION FUNDING SOURCES

Financing of the construction, operation, and maintenance of hazard mitigation measures may be accomplished through a number of means, including: the establishment of a stormwater utility; tax-incremental-financing (TIF) districts; local property taxes; reserve funds; general obligation bonds; private-developer contributions, including fees paid to be applied toward construction of regional stormwater management facilities in lieu of providing onsite facilities; State grants or loans; and certain Federal and State programs.

The identification of potential funding sources, including sources other than solely local-level sources, is an integral part of the implementation of a successful mitigation plan. The following description of funding sources includes those that appear to be potentially applicable for the City as of 2018. However, because funding programs and opportunities are constantly changing, the involved City and County government staffs have and will continue to become familiar with the potential funding sources and programs. Some of the programs described in this chapter may not be available under all envisioned conditions in the City 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 sources for implementing the flood mitigation plan recommended in this report (see also Appendices F and G).

Federal Emergency Management Agency Programs

The Federal Emergency Management Agency (FEMA) funds several programs that in the State of Wisconsin are administered through the Wisconsin Department of Military Affairs, Division of Emergency Management. These programs are described below. Examples of types of projects that can be eligible for funding under the Hazard Mitigation Grant Program, the Flood Mitigation Assistance Program, and the Pre-Disaster Mitigation Program are given in Table 6.2.

Hazard Mitigation Grant Program

The Hazard Mitigation Grant Program (HMGP) can provide up to 75 percent of the costs attendant to certain natural hazard mitigation programs. In the case of flood mitigation, projects can include the floodproofing or acquisition and relocation of floodprone properties, the elevation of structures in compliance with National Flood Insurance Program (NFIP) standards, and other flood control measures, including structural projects, where identified as cost-effective. To be eligible for mitigation activities with FEMA funding, structures must be insured under the NFIP. Under the HMGP, the balance of the costs is shared by the State of Wisconsin (12.5 percent) and the grantee (12.5 percent). Communities in Wisconsin can apply through the State for HMGP funds only after a Presidential disaster declaration is issued. HMGP funds must be applied for within 60 days of the declaration. The State, as HMGP grantee, is responsible for identifying and prioritizing projects. Eligible projects must be included as part of the grantee's all-hazard mitigation plan and must meet cost-benefit criteria established by FEMA. Although State and local units of government are eligible applicants, HMGP funds can be used on private property for eligible projects. The HMGP gives priority to properties identified by FEMA as repetitive-loss properties.

Flood Mitigation Assistance Program

The Flood Mitigation Assistance (FMA) program can provide up to 75 percent of the costs attendant to the acquisition, relocation, elevation, and floodproofing of structures in compliance with NFIP standards. Properties included in a project subapplication for FMA funding must be NFIP-insured at the time of the application submittal and prior to the period of availability or application start date. Flood insurance coverage must be maintained through completion of the mitigation activity and for the life of the structure. In addition to participating in the NFIP, eligible program applicants must meet cost-benefit criteria established by FEMA. Mitigation of repetitive-loss properties is given a high priority under this program. Increased cost of compliance (ICC) coverage under the NFIP may provide a funding source for bringing noncompliant structures into compliance after a flood loss.

Pre-Disaster Mitigation Program

FEMA's Pre-Disaster Mitigation Program (PDM) can potentially provide up to 75 percent of the costs attendant to pre-disaster mitigation planning and the implementation of cost-effective mitigation projects prior to a disaster event. Funding these plans and projects reduces overall risks to the population and

Table 6.2
Eligible Activities Under Federal Hazard Mitigation Grant Programs

Eligible Activity	Hazard Mitigation Grant Program	Flood Mitigation Assistance Program	Pre-Disaster Mitigation Program
Mitigation Projects	Y	Y	Y
Property Acquisition and Structure Demolition	Y	Y	Y
Property Acquisition and Structure Relocation	Y	Y	Y
Structure Elevation	Y	Y	Y
Mitigation Reconstruction	Y	Y	Y
Dry Floodproofing of Historic Residential Structures	Y	Y	Y
Dry Floodproofing of Non-residential Structures	Y	Y	Y
Generators	Y	--	Y
Localized Flood Risk Reduction Projects	Y	Y	Y
Non-localized Flood Risk Reduction Projects	Y	--	Y
Structural Retrofitting of Existing Buildings and Facilities	Y	Y	Y
Non-structural Retrofitting of Existing Buildings and Facilities	Y	Y	Y
Safe Room Construction	Y	--	Y
Wind Retrofit for One- and Two-Family Residences	Y	--	Y
Infrastructure Retrofit	Y	Y	Y
Soil Stabilization	Y	Y	Y
Wildfire Mitigation	Y	--	Y
Post-Disaster Code Enforcement	Y	--	--
Advance Assistance	Y	--	--
5 Percent Initiative Projects	Y	--	--
Miscellaneous/Other[a]	Y	Y	Y
Hazard Mitigation Planning	Y	Y	Y
Planning Related Activities	Y	--	--
Technical Assistance	--	Y	--
Management Cost	Y	Y	Y

[a] *Miscellaneous/Other indicates that any proposed action will be evaluated on its own merit against program requirements. Eligible projects may be approved provided funding is available.*

Source: Federal Emergency Management Agency

structures, while also reducing reliance on funding from actual disaster declarations. Examples of eligible projects include property acquisition, structure acquisition and demolition or relocation, structure elevation, safe room construction, dry floodproofing of nonresidential structures and historic residential structures, and minor localized flood reduction projects.

Public Assistance Program

FEMA's Public Assistance Program can provide some limited assistance with respect to structure elevation and relocation. For example, if entire portions of a community were to be relocated outside of a floodplain, this program can assist in rebuilding the necessary infrastructure in the new location. Funding under this program is provided for repair of infrastructure damaged during a flood that results in a Presidential disaster declaration. In making repairs to the infrastructure, cost-effective mitigation activities may be included. If a community determines that a badly damaged facility is not to be repaired, the estimated damage amount may be used to fund an alternate project. The Public Assistance Program may pay for mitigation measures under Section 406 of the Stafford Act. In addition, funding from the Public Assistance Program may be combined with funding from the HMGP, FMA, and/or PDM programs to implement mitigation measures on the same facility; however, they cannot be combined to pay for the same work.

National Training and Education Division

FEMA's National Training and Education Division provides over 100 training courses for state and local first responders.

U.S. Department of Housing and Urban Development
Community Development Block Grant Program

Community Development Block Grant (CDBG) programs, funded by the U.S. Department of Housing and Urban Development, are administered by the Wisconsin Departments of Administration and Commerce.

U.S. Small Business Administration Programs

The U.S. Small Business Administration (SBA) provides disaster loans to homeowners and businesses to repair or replace property damaged in a declared disaster. SBA loans are granted only for uninsured losses. Loans may be used to meet required building codes, such as the NFIP requirements. SBA may also provide loans for relocation out of special flood hazard areas when such relocations are required by local officials. While SBA's enabling legislation generally prohibits the agency from making disaster loans for voluntary relocations, there are exceptions that can be made, including relocations of homeowners, renters, and business owners out of special flood hazard areas when the community is participating in a buyout program. These loans would be limited to the amount necessary to repair or replace the damage at the disaster site. SBA loans may also be used to refinance existing mortgages. Up to 20 percent of the disaster loan can be used for mitigation measures.

U.S. Army Corps of Engineers

The Corps of Engineers programs are potential sources of funding for implementing the floodplain management recommendations of this plan. In order to be eligible for funding, the plan components must meet specific Corps economic feasibility and other criteria. The programs that may be applicable include the following:

- Section 22—Water resources planning assistance—(50 percent Federal, 50 percent local cost share).
- Section 205—Small flood control projects—Maximum $7.0 million per project (65 percent Federal, 35 percent local cost share).
- Section 208—Clearing debris and sediment from channels for flood prevention—Maximum $500,000 per project (65 percent Federal, 35 percent local cost share).
- Section 14—Emergency streambank and shoreline protection—Maximum $1.5 million per project (65 percent Federal, 35 percent local cost share).

U.S. Fire Administration

The U.S. Fire Administration (USFA) was established by the Federal Fire Prevention and Control Act of 1974, which called for the establishment of a National Fire Academy to advance the professional development of fire service personnel and of other persons engaged in fire prevention and control activities; a technology program of development, testing, and evaluation of equipment for use by the Nation's fire, rescue, and civil defense services; the operation of a National Fire Data Center for the selection, analysis, publication, and dissemination of information related to the prevention, occurrence, control, and results of fires of all types; and to take all necessary steps to educate the public and to overcome public indifference to fire and fire prevention. The USFA operates the National Fire Academy, which provides tuition-free training in firefighting, fire prevention, emergency medical services, and related areas to persons with substantial involvement in fire control and prevention, emergency medical services, fire-related emergency management activities, and related professions. The academy also has a program to provide travel stipends to students attending National Fire Academy courses.

The USFA also administers several grant programs that are designed to assist local fire departments and other organizations in protecting citizens and firefighters against the effects of fire and fire-related incidents. These programs include the Assistance to Firefighters Grant program, the Fire Protection and Safety Grant program, the Staffing for Adequate Fire and Emergency Response Grant program, and the Fire Management Assistance Grant program.

Assistance to Firefighters Grant Program

These grants provide direct assistance to fire departments for the purpose of protecting the health and safety of the public and firefighting personnel against fire and fire-related hazards. Funding is provided for programs that directly benefit fire departments or provide equipment to enhance safety. Emergency medical service units are eligible for assistance provided the unit falls organizationally under the auspices of a fire department as defined above. However, special operations teams, like DIVE or HURT, are ineligible for assistance under this grant, and limits and restrictions are set for specific equipment. Examples of eligible projects include firefighting and EMT training, purchase of firefighting and EMS equipment, and firefighter personal protective equipment. Cost-share matching requirements for this program are dependent upon the size of the population served by the fire department.

Fire Prevention and Safety Grant Program

This program provides grants to assist State, regional, national or local organization programs that address fire prevention and safety. The grant program is intended to support programs that reach high-risk groups, such as children, seniors and firefighters. Examples of eligible projects include public education programs, arson prevention programs, fire prevention-related training, fire prevention activities, and risk assessments. Cost-share matching requirements for this program are dependent upon the size of the population served by the fire department.

Staffing for Adequate Fire and Emergency Response (SAFER) Grant Program

The purpose of the SAFER program is to award grants directly to volunteer, combination, and career fire departments in order to assist the departments in increasing their cadre of firefighters. The program's goal is to enhance the grantees' ability to attain 24-hour staffing and assure that their communities have adequate protection from fire and fire-related hazards. The program provides funding to support the rehiring of laid off firefighters and for the hiring of new firefighters.

Fire Management Assistance Grant Program

The Fire Management Assistance Grant Program provides grants to States, Indian tribal governments, and local governments for the mitigation, management, and control of any fire burning on publicly (non-Federal) or privately owned forest or grassland that threatens such destruction as would constitute a major disaster.

National Institute of Environmental Health Sciences (NIEHS)
Hazardous Waste Worker Health and Safety Training

This program is sponsored by the National Institutes of Health, Department of Health and Human Services to provide assistance for Superfund Site worker training. This program assists organizations in the development of institutional competency to provide appropriate training and education to hazardous waste workers. It provides project grant support for the development and administration of model worker health and safety training programs consisting of classroom and practical health and safety training of workers and their supervisors, who are engaged in activities related to hazardous materials, hazardous waste generation, treatment, storage, disposal, removal, containment, transportation, or emergency response. Public or private-nonprofit entities are eligible for this program.

Wisconsin Emergency Management

Wisconsin Emergency Management (WEM) administers many of the Federally derived funding sources, directing assistance to local and county agencies. This includes assistance from the Hazard Mitigation Grant Program (HMGP). WEM also administers the Pre-Disaster Mitigation Program (PDM) which provides funding to local and county agencies to implement cost-effective hazard mitigation activities.

Wisconsin Department of Natural Resources

The Wisconsin Department of Natural Resources (WDNR) operates programs that may serve as potential funding sources for the City's flood mitigation efforts (see also Appendices F and G). These programs are described below.

Knowles-Nelson Stewardship Local Grant Assistance Programs

Local units of government are eligible to apply for funding through four stewardship grant programs and two related federal programs administered by the WDNR. The WDNR programs include the Aids for the Acquisition and Development of Local Parks, the Urban Green Space, the Urban Rivers, and the Acquisition of Development Rights programs. The WDNR also administers the Federal Land and Water Conservation Fund and Recreational Trails Act programs. These programs provide 50 percent matching grants to cities, villages, towns, counties, public inland lake protection and rehabilitation districts, and qualified nonprofit organizations. Eligible activities include acquisition of land; development and renovation projects for nature-based outdoor recreation; development, maintenance, and restoration of trails; river habitat restoration projects that serve public recreation or resource conservation purposes; and purchases of land for noncommercial gardening in urban areas. The annual application deadline is May 1.

Stormwater Management Program

The WDNR administers a Targeted Runoff Management (TRM) grant program provided for under Section 281.65(4c) of the *Wisconsin Statutes*. Local governmental units may be reimbursed up to 70 percent of eligible costs associated with installing Best Management Practices (BMPs) to reduce nonpoint source water pollution. Grant awards cannot exceed $150,000. Grants provided under this program may be used for projects to control nonpoint source pollution and may be available to partially support dual-purpose (quality and quantity) detention ponds, streambank protection projects, or other stormwater management facilities.

The WDNR also administers an Urban Nonpoint Source and Stormwater Grant Program provided for under Section 281.66 of the *Wisconsin Statutes*. Cities, towns, villages, and counties are eligible for grants under this program to improve urban water quality by limiting or ending sources of urban nonpoint source pollution. Funded projects are site-specific and targeted to address high priority problems in urban project areas. Two types of grants are available under this program: planning grants and construction grants. Construction grants are made for construction projects designed to control stormwater runoff rates, volumes, and discharge quality from nonpoint sources within existing urban development. Eligible project sponsors can be reimbursed up to 50 percent to construct BMPs. The maximum possible grant is $200,000 ($150,000 for construction activities and $50,000 for land acquisition or easements). A project must be located in an urban area to be eligible for BMP cost sharing. Eligible activities include construction of structural urban BMPs such as detention basins, wet basins, infiltration trenches, infiltration basins, or wetland basins; engineering design and construction services for BMP installation; land acquisition and easement purchase; storm sewers; and streambank and shoreland stabilization projects. Projects are selected for funding based on a competitive process.

Municipal Flood Control Grants

Under Chapter NR 199, "Municipal Flood Control Grants," of the *Wisconsin Administrative Code,* municipalities including cities, towns, and villages, as well as metropolitan sewerage districts, are eligible for cost-sharing grants from the State for projects such as acquisition and removal of structures; floodproofing and elevation of structures; riparian restoration projects; acquisition of vacant land or purchase of easements to provide additional flood storage or to facilitate natural or more efficient flood flows; construction of facilities for the collection, detention, retention, storage, and transmission of stormwater and groundwater for flood control and riparian restoration projects; and preparation of flood mapping projects. Municipalities and metropolitan sewerage districts are eligible for up to 70 percent State cost-share funding for eligible projects, and would have to provide at least a 30 percent local match. Applications are due on March 15 of even-numbered years.

Wisconsin Coastal Management Program

The Wisconsin Coastal Management Program administers an annual competitive grants program available for the 15 Wisconsin coastal counties. Under the category Coastal Resource and Community Planning, funds are available for projects that support natural hazard planning and development of ordinances.

Other Potential Funding Sources

A variety of other potential sources exist that may provide funds or technical assistance for implementation of elements of the recommended hazard mitigation plan. These are listed in Appendices F and G.

6.4 PLAN MONITORING AND REEVALUATION STRATEGIES

For a hazard mitigation plan to be successful it must not only be implemented, it must be monitored. Plan monitoring is best accomplished through a formal, periodic process designed to measure and assess progress in implementation, changing outside circumstances that may affect the plan and efforts to implement it, and the need for any changes to the plan and/or to how it is being implemented. The plan should also be reviewed following each hazard event occurrence to assess its continued viability and the need for revisions.

Plan Monitoring

To ensure successful monitoring of the hazard mitigation plan for the City of Milwaukee, the City intends to annually formally review the plan and the status of its implementation, as well as develop and recommend any necessary revisions of the plan to the Department of Public Works and other governmental departments involved, for consideration and possible adoption by those bodies. As needed, the City will call a meeting of the Hazard Mitigation Plan Local Planning Team. The revisions would be proposed, considered, and adopted in the form of a formal amendment to the hazard mitigation plan. This review process will be coordinated and conducted by the Department of Public Works, and will typically be in April of each year.

The Department of Public Works, with advice from the Local Planning Team, in its review process, will examine the plan and the efforts to implement it with respect to 1) whether any hazards affecting the City 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; and 6) whether applicable funding programs and levels have changed.

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 to respond to the major hazard experiences, circumstances, and consequences. In this regard, the post-disaster review effort will be coordinated with the emergency operations program administered by the City Office of Emergency Management in partnership with the local units of government. The experiences of the emergency operations may indicate a need for refined mitigation actions which would then be incorporated into the plan. Any plan updating found to be needed will be incorporated into the annual plan update noted above.

The meetings of the Local Planning Team will continue to be publicly noticed and salient decisions recorded in Public Works Department and City Emergency Management files and, where appropriate, on the City website and in press releases. Meetings of the Local Planning Team are considered public meetings under Wisconsin Law and are open to all interested parties.

Reevaluation Strategy

The components of the City of Milwaukee Hazard Mitigation Plan will be reviewed within the context of all hazards planning and programs developed for Milwaukee County and communities adjacent to the City of Milwaukee at five-year intervals. That review will consider the degree to which the actions recommended under such efforts would impact the City of Milwaukee Plan and any changes in the available hazard mitigation strategy state-of-the-art management methods and procedures. The plan components will be revised as necessary to reflect changing conditions and needs in accord with the appropriate review-revision procedures. This updated plan will then be submitted to the State Hazard Mitigation Officer.

Reevaluation, updating, and revision of this updated plan should be initiated approximately 24 months prior to expiration of this updated plan. For each five-year update, one or more public meetings will be scheduled prior to plan submittal and the public will be given an opportunity to provide feedback about the plan and any changes that may occur. Copies of the plan will be made available to the public through the Department of Public Works. If no changes to the plan are required, the State Hazard Mitigation Officer will be given a justification for this determination. Comments and recommendations offered by committee members, the public and the State Hazard Mitigation Officer will then be incorporated into the updated plan.

ACTIVITIES OF THE CITY OF MILWAUKEE ALL HAZARDS MITIGATION PLAN LOCAL PLANNING TEAM

APPENDIX A

Figure A-1

CITY OF MILWAUKEE ALL HAZARDS MITIGATION PLAN LOCAL PLANNING TEAM

Kurt Sprangers, Chair ..... Stormwater Manager, City of Milwaukee Department of Public Works
Joseph Boxhorn, Secretary ..... Principal Planner, Southeastern Wisconsin Regional Planning Commission
Nadia Vogt ..... Senior Project Manager, Milwaukee Metropolitan Sewerage District
Kristin Connelly ..... Principal Planner, City of Milwaukee Department of City Development
Evan Corbeil ..... HERC Coordinator, Southeastern Wisconsin Healthcare Emergency Readiness Coalition
Jeffrey Cross ..... Engineering Assistant, Southeastern Wisconsin Regional Planning Commission
Steven Fronk ..... Director, City of Milwaukee Office of Emergency Management and Homeland Security
Karen Dettmer ..... Coordination Manager, City of Milwaukee Department of Public Works
Kurt Drezek ..... Sergeant, City of Milwaukee Police Department
Patrick Elliot ..... Senior Project Manager, Milwaukee Metropolitan Sewerage District
Laura Herrick ..... Chief Environmental Engineer, Southeastern Wisconsin Regional Planning Commission
James H. Ley ..... Deputy Chief, City of Milwaukee Fire Department
Chris Miley ..... Coordinator, Milwaukee County Office of Emergency Management
Leah Redding ..... Emergency Management Coordinator, Milwaukee County Office of Emergency Management
Edward A. Richardson ..... Principal Planner, City of Milwaukee Department of City Development
Jose Rivera ..... Emergency Response Planning Coordinator, City of Milwaukee Health Department
Jose R. Rodriguez ..... Emergency Response Planning Coordinator, City of Milwaukee Health Department
Alex Roth ..... Disaster Program Manager, American Red Cross
Michael Schaefer ..... Water Security Manager, Milwaukee Water Works
Erick Shambarger ..... Director of Environmental Sustainability, City of Milwaukee Environmental Collaboration Office
Julie Schneider ..... Manager of Safety, Security and Risk Management, Milwaukee County Transit System
Carl Stenbol ..... Administrator, Milwaukee County Office of Emergency Management
Timothy Thur ..... Infrastructure Administration Manager, City of Milwaukee Department of Public Works

SUMMARY NOTES OF THE OCTOBER 5, 2016 MEETING OF THE CITY OF MILWAUKEE HAZARD MITIGATION PLAN LOCAL PLANNING TEAM

INTRODUCTION

The October 5, 2016 meeting of the City of Milwaukee Hazard Mitigation Plan Local Planning Team was convened at the Frank P. Zeidler Municipal Building at 1:00 p.m. The meeting was called to order by Kurt Sprangers, Stormwater Manager, City of Milwaukee Department of Public Works. Attendance was taken by circulating a sign-in sheet.

In attendance at the meeting were the following individuals:

Local Planning Team Members	
Kurt Sprangers, Chair	Stormwater Manager, City of Milwaukee Department of Public Works
Steve Fronk	Director, City of Milwaukee Office of Emergency Management and Homeland Security
Joseph E. Boxhorn, Secretary	Senior Planner, Southeastern Wisconsin Regional Planning Commission
Evan Corbeil	HERC Coordinator, Southeast Wisconsin Healthcare Emergency Readiness Coalition
Jeffrey Cross	Engineering Assistant, Southeastern Wisconsin Regional Planning Commission
Karen Dettmer	Coordination Manager, City of Milwaukee Department of Public Works
Kurt Drezek	Sergeant, City of Milwaukee Police Department
Patrick Elliott	Senior Project Manager, Milwaukee Metropolitan Sewerage District
Laura K. Herrick	Chief Environmental Engineer, Southeastern Wisconsin Regional Planning Commission
Jim Ley	Deputy Chief, City of Milwaukee Fire Department
Chris Miley	Coordinator, Milwaukee County Office of Emergency Management
Leah Redding	Coordinator, Milwaukee County Office of Emergency Management
Ed Richardson	Principal Planner, City of Milwaukee Department of City Development
Jose R. Rodriguez	Emergency Response Planning Coordinator, City of Milwaukee Health Department
Julie Schneider	Manager of Safety, Security and Risk Management, Milwaukee County Transit System
Erick Shambarger	Director of Environmental Sustainability, City of Milwaukee Environmental Collaboration Office
Carl Stenbol	Emergency Management Division Administrator, Milwaukee County Office of Emergency Management
Tim Thur	Infrastructure Administration Manager, City of Milwaukee Department of Public Works

Mr. Sprangers welcomed all attendees to the meeting. He noted that the City of Milwaukee hazard mitigation plan is required to be updated every five years, and that this would be the second update to the original plan. He informed the planning team that he anticipates that there will be four meetings of the team throughout the plan updating process. At Mr. Sprangers' request, the team members introduced themselves.

OVERVIEW OF HAZARD MITIGATION AND HAZARD MITIGATION PLAN UPDATING PROCESS

Mr. Sprangers introduced Joseph Boxhorn, Senior Planner, Southeastern Wisconsin Regional Planning Commission (SEWRPC). Mr. Boxhorn presented an overview of hazard mitigation and the hazard mitigation plan updating process.

[Secretary's Note: A copy of Mr. Boxhorn's presentation is attached herein as Exhibit A.]

BACKGROUND ON THE SECOND UPDATE OF THE CITY OF MILWAUKEE ALL HAZARD MITIGATION PLAN

Mr. Boxhorn presented background information on the initial hazard mitigation plan and the first update to the plan. He noted that the initial plan was completed in 2005 and the first plan update was completed in 2012. He stated he anticipates that the Local Planning Team will have four meetings during the plan updating process. He added that there will be two rounds of public meetings during the planning period. Mr. Boxhorn informed team members that they are not required to attend the public meetings, though they are welcome to participate.

Mr. Boxhorn stated that a project webpage has been created on the SEWRPC website. He indicated that draft chapters of the plan report, meeting materials, presentations, and summary notes from planning team meetings will be available on this page. He added that a comment screen is also available on this webpage through which members of the planning team and the public may submit questions or comments on the draft plan.

[Secretary's Note: As previously noted, Mr. Boxhorn's presentation is attached herein as Exhibit A. The SEWRPC webpage for hazard mitigation planning may be accessed at: http://www.sewrpc.org/HMP]

Mr. Shambarger asked whether any projects have been carried out since the completion of the first plan update. Mr. Boxhorn replied that the Milwaukee Fire Department (MFD) has conducted educational programs related to fire safety. He noted that these efforts would be documented in the new plan. Mr. Thur added that recent flood control efforts conducted by the Milwaukee Metropolitan Sewerage District (MMSD) have also implemented elements of the plan.

Ms. Dettmer asked whether the hazard mitigation plan will assist the City of Milwaukee in receiving funding from the U.S. Department of Housing and Urban Development (HUD). Mr. Thur replied that in the past the plan has helped the City to receive HUD funding.

Mr. Boxhorn stated that MMSD formally adopted the previous update of the plan. He added that he would like MMSD to adopt this current update, noting that by adopting the update the District would qualify for funding through Federal grant programs related to hazard mitigation.

Mr. Rodriguez asked if the plan would help the City to be eligible to receive hazard mitigation funding under Section 406 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (Stafford Act). Mr. Boxhorn replied that the approved mitigation plan would help to make the City of Milwaukee eligible to receive funding through the Hazard Mitigation Grant Program (HMGP), the Flood Mitigation Assistance (FMA) program, and the Pre-Disaster Mitigation (PDM) program.

[Secretary's Note: Section 406 of the Stafford Act provides disaster relief funding (public assistance) to state and local units of government in the event of a Presidential disaster declaration. Having an approved local hazard mitigation plan is not a requirement to receive funding under this program. In some instances, funding received through Section 406 may be used for hazard mitigation projects.]

Ms. Schneider asked if a particular project that the City seeks to pursue is not explicitly stated in the plan, would the Federal Emergency Management Agency (FEMA) find the pursuit of the project problematic. Mr. Boxhorn replied that FEMA would not find the pursuit of the project problematic as long as the project is related to one of the hazards addressed by the plan.

Ms. Dettmer inquired if the current plan addresses climate change. Mr. Boxhorn replied that the current plan does not address climate change, and that climate change would be added to the risk analysis section of the plan during the update process. Mr. Rodriguez stated that the City Health Department has been studying potential public

health effects of climate change. Mr. Boxhorn asked whether he could be provided materials related to these efforts.

[Secretary's Note: Subsequent to the meeting, Mr. Rodriguez provided SEWRPC staff two City of Milwaukee Health Department presentations related to climate change.]

Ms. Dettmer noted that addressing climate change in the plan could help the City of Milwaukee to receive grants from the Environmental Protection Agency. Mr. Shambarger indicated that he would like for the plan to extensively address climate change and flooding, as well as stormwater management.

HAZARD AND VULNERABILITY ASSESSMENT EXERCISE

Mr. Boxhorn stated that as part of the hazard and vulnerability analysis for the plan, it will be necessary to decide which hazards will be addressed by the plan. Mr. Boxhorn provided members of the Local Planning Team with a hazard and vulnerability assessment tool and instructions for completing the tool. He explained that the tool is a modified version of a tool developed by Kaiser Permanente for assessing the risks faced by healthcare facilities.

Mr. Boxhorn asked the members of the Local Planning Team to complete the hazard and vulnerability assessment (HVA) tool. He explained that the results of this exercise would be used to help determine which hazards are addressed by the hazard mitigation plan update. Local Planning Team members completed the HVA tool.

Mr. Stenbol and Mr. Corbeil informed team members that the City of Milwaukee also conducts a hazard vulnerability assessment from a health perspective, and that data stemming from the exercise is available. Mr. Boxhorn replied that SEWRPC would be interested in obtaining the results from the health assessment.

[Secretary's Note: SEWRPC staff will contact Mr. Stenbol to further discuss the health assessment and available data originating from the assessment.]

ADJOURNMENT

There being no further business, the meeting was adjourned by unanimous consent at 2:20 p.m.

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Exhibit A: Boxhorn presentation (Docs #232977)

HAZARD MITIGATION PLANNING

October 5, 2016

Joseph Boxhorn, Ph.D., Senior Planner
Southeastern Wisconsin Regional Planning Commission

DOCS #232977

What is Mitigation?

- "Mitigation is any sustained action taken to eliminate or reduce the long-term risk to human life and property from natural and technological hazards" – FEMA definition
- Constructive actions to reduce damages prior to the next disaster

Photo from Kenosha County

Photo from Soldiers Grove, WI

What is Mitigation?

- Mitigation is <u>not</u>
  - Emergency response
  - Crisis management
  - Disaster preparation and recovery
- Mitigation focuses on reducing the impacts of disasters when the occur

Mitigation Breaks the Disaster Cycle

Why Do We Mitigate?

- Disasters cost society too much
- State and federal aid insufficient
- Can prevent future damages
- Less impact and speed response and recovery process
- Mitigation happens at the local level

Why Do We Mitigate?

Nationwide Trends

- $80 Billion 2004-2011 (GAO) responding to disasters
- $6 Billion per year in flood damages
- Costs continue to rise
- People continue to build and live in high-risk areas

Why Do We Mitigate?

In Wisconsin

- $3 billion in disaster-related damages last 3 decades
- 12 Federal Disaster Declarations in the 90's compared to 6 in the 80's
- 2000, 2001, two in 2002, 2004, 2007, 2008, two in 2010, 2011, 2012, 2013, 2016
- 2 snow emergencies (2000 and 2008)

Value of Mitigation

In 2005, the National Institute of Building Sciences found that for every $1 spent on mitigation, $4 are saved in avoided future damages

Examples of Mitigation Measures
(mostly related to flooding)

Acquisition/Demolition

Communities acquire land, demolish structures, and keep the land in open space.

Images from Darlington, WI

Elevation

Elevation raises a structure out of the floodplain. Wisconsin has specific regulations to follow with elevation projects. See DNR for more information.

Images from Soldiers Grove, WI

Floodwall

Floodwalls can prevent water from inundating structures that cannot be elevated, relocated, or demolished.

Image from Darlington, WI

Community safe rooms built to FEMA-361 standards can withstand winds up to 250 MPH.

Image from Town of Dunn, WI

Detention ponds can store stormwater runoff, decreasing flash flooding in urban areas.

Image from MMSD Stormwater Detention Project (Wauwatosa, WI)

Stormwater Management

Stream restoration allows watersheds to better manage flooding.

Image from Thiensville, WI

River Warning Systems

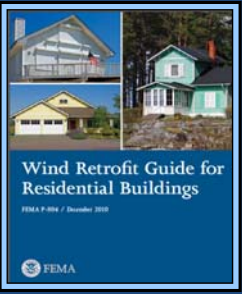
River warning systems installed on conservation dams to warn county officials about expected dam breaching.

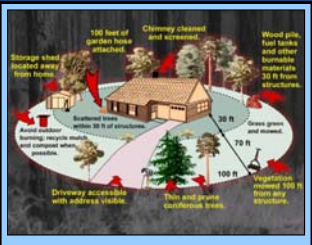
Images from Vernon County

Other Projects


NOAA Weather Radios


Mobile Home Tie-Downs




Proper Landscaping

- Raise appliances and utilities
- Install back-flow valves
- Retrofit for wind resistance
- Education and public awareness
- Insurance (flood and sewer backup)
- Land use planning

Benefits of Mitigation

- Enhance recreation and tourism
  - Parks
  - Trails
- Increase community pride and quality of live
- Save tax dollars

Darlington, WI


Chaseburg, WI

Hazard Mitigation Planning

Disaster Mitigation Act of 2000

- Established a national disaster mitigation program
- Communities must have an approved hazard mitigation plan to be eligible to receive Federal funds through:
  - Hazard Mitigation Grant Program (HMGP)
  - Pre-disaster Mitigation Program (PDM)
  - Flood Mitigation Assistance Program (FMA)
- Plans must be reviewed and updated every five years

Disaster Mitigation Act of 2000

Vision of the Disaster Mitigation Act of 2000

- Communities will have all hazards mitigation plans that identify and prioritize cost-effective mitigation measures that can be implemented prior to a disaster or quickly after a disaster
- Having a plan would speed up the recovery process

Plan Components

1. Documentation of the planning process
2. Description of study area
3. Analysis of hazard conditions
4. Hazard mitigation goals and objectives
5. Hazard mitigation strategies
6. Plan adoption, implementation, and maintenance

Plan Components

1. Documentation of the Planning Process
   - Chapter 1 and Appendix A
   - The City must adopt the plan in order to be covered
   - Public and adjacent communities must be given an opportunity to comment during the drafting stage

Plan Components

2. Description of Study Area – Chapter 2
   - Demographic
   - Surface waters
   - Transportation
   - Public facilities
     - Police facilities
     - Fire facilities
     - EMS facilities
   - Related regulations and programs
   - Land Use
   - Lake Michigan Shoreline
   - Flood hazard areas
   - Utility systems
   - Critical community facilities
   - Hazardous material use and storage
   - Emergency operation planning

Plan Components

3. Analysis of Hazard Conditions-Chapter 3
   - Vulnerability and risk analysis for each covered hazard
     - Historical and recent incidents
     - Vulnerabilities and community impacts
       - Human lives and property damages
     - Potential for future changes in hazard condition

Plan Components

4. Hazard Mitigation Goals-Chapter 4
   - Express what the plan is trying to achieve
   - Ties the plan to other active plans
     - City comprehensive plan
     - Watershed plans
     - Park and open space plans
   - Fairly general

Plan Components

5. Hazard Mitigation Strategies-Chapter 5
   - Develop a range of actions and projects to reduce the impacts of each hazard
     - Structural, nonstructural, educational
   - Prioritize actions for implementation
   - Identify responsible parties
   - Examine costs and benefits
   - Consider multi-jurisdictional aspects

Plan Components

6. Plan Adoption, Implementation, and Maintenance-Chapter 6
   - The City must formally adopt the plan
   - Detail available funding and technical assistance
   - Monitoring of plan implementation
   - Incorporation of the plan into existing planning mechanisms


Background on 2nd Plan Update

City of Milwaukee
All Hazards Mitigation Plan

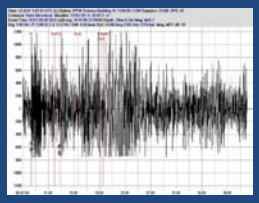
- Initial study conducted 2003-2005
  - Report published 2005
- First update conducted 2011-2012
  - Report published 2012

First Plan Update

- Reviewed and revised
  - Inventories
  - Goals
  - Vulnerability and risk analysis
  - Mitigation strategies
- Report published 2012

Natural Hazards Profiled in the Plan

(Required by FEMA)



Earthquake

Extreme Temperatures

Flooding and Stormwater Drainage Problems

Lake Michigan Coastal Hazards

Thunderstorms High Wind/Hail/Lightning

Tornado

Natural Hazards Profiled in the Plan

(Required by FEMA)

Winter Storms

Technological Hazards Profiled in the Plan

(Optional under FEMA rules)

Contamination/Loss of Water Supply

Public Health Emergencies

Major Fire or Emergency Medical Incident

Hazardous Material Incidents

Terrorism

Plan Components to Review and Revise

- Review implementation activities
- Update inventories of natural and built features
- Review and reevaluate identification of hazards
- Update and reevaluate risk analysis
- Review and revise mitigation goals
- Review and revise mitigation strategies
- Update plan implementation and maintenance
  - Update potential funding sources

Local Planning Team Role

- Weigh in on hazard identification
- Review the plan chapters
- Help us get needed information
  - Recent and historical problems with hazards ➔ Location, occurrence, damages
  - Recent projects, planned and contemplated projects, recent hazard-related outreach
  - Inventory data

Project Web Site

- http://www.sewrpc.org/HMP
  - Agendas and other meeting materials
  - Summary notes from meetings
  - Presentations
  - Draft chapters as they are completed
  - Comment screen
  - Other ways to send a comment
- Email to jboxhorn@sewrpc.org

SUMMARY NOTES OF THE SEPTEMBER 13, 2017 MEETING OF THE CITY OF MILWAUKEE HAZARD MITIGATION PLAN LOCAL PLANNING TEAM

INTRODUCTION

The September 13, 2017 meeting of the City of Milwaukee Hazard Mitigation Plan Local Planning Team was convened at the Frank P. Zeidler Municipal Building at 9:10 a.m. The meeting was called to order by Kurt Sprangers, Stormwater Manager, City of Milwaukee Department of Public Works. Attendance was taken by circulating a sign-in sheet.

In attendance at the meeting were the following individuals:

Local Planning Team Members	
Kurt Sprangers, Chair	Stormwater Manager, City of Milwaukee Department of Public Works
Steve Fronk	Director, City of Milwaukee Office of Emergency Management and Homeland Security
Joseph E. Boxhorn, Secretary	Senior Planner, Southeastern Wisconsin Regional Planning Commission
Nadia Bogue	Senior Project Manager, Milwaukee Metropolitan Sewerage District
Jeffrey Cross	Engineering Assistant, Southeastern Wisconsin Regional Planning Commission
Patrick Elliott	Senior Project Manager, Milwaukee Metropolitan Sewerage District
Jim Ley	Deputy Chief, City of Milwaukee Fire Department
Julia Orlowski	Engineer, Southeastern Wisconsin Regional Planning Commission
Ed Richardson	Principal Planner, City of Milwaukee Department of City Development
Alex Roth	American Red Cross
Erick Shambarger	Director of Environmental Sustainability, City of Milwaukee Environmental Collaboration Office

Mr. Sprangers welcomed all attendees to the meeting. He stated that this was the second meeting of the Local Planning Team for the second update to the original plan. He informed attendees that the purpose of the meeting was to review the first two chapters of the draft plan.

CONSIDERATION OF SUMMARY NOTES OF OCTOBER 5, 2016, LOCAL PLANNING TEAM MEETING

Mr. Sprangers introduced Joseph Boxhorn, Senior Planner, Southeastern Wisconsin Regional Planning Commission (SEWRPC). At Mr. Spranger's request, Mr. Boxhorn reviewed the summary notes from the October 5, 2016, meeting of the Local Planning Team. No questions or comments were offered on the summary notes. On a motion by Mr. Sprangers that was seconded by Mr. Richardson, the October 5, 2016, summary notes were approved.

CONSIDERATION OF CHAPTER I, "INTRODUCTION AND BACKGROUND," OF SEWRPC COMMUNITY ASSISTANCE PLANNING REPORT NO. 282 (3RD EDITION), *CITY OF MILWAUKEE ALL HAZARD MITIGATION PLAN UPDATE*

At Mr. Spranger's request, Mr. Boxhorn reviewed the preliminary draft of Chapter I of the plan report. Mr. Boxhorn indicated that he would display copies of the maps from Chapters I and II on the projection screen in the meeting room during discussion of these chapters.

[Secretary's Note: Mr. Boxhorn's presentation is attached herein as Exhibit A.]

Mr. Boxhorn stated that Chapter I does four things: 1) it sets forth the purpose and history of the plan, 2) it gives a brief description of the planning process, 3) it reviews implementation efforts over the last five years, and 4) it describes outreach efforts related to the plan. He noted that material in the draft chapters that is either new or revised has been highlighted blue in the text. He explained that this was done to assist readers in reviewing the chapter. He also noted that map and table numbers in the text were highlighted yellow for editing purposes only. He indicated that the highlighting will be removed prior to publication of the final report.

Mr. Richardson stated that he was unsure as to whether Mr. Boxhorn had obtained all of the information regarding the updates to the City of Milwaukee's Comprehensive Plan. He explained that the City had completed sub-neighborhood action plans to supplement the City's Comprehensive Plan. He noted that one of the plans will enter the legislative cycle in the weeks following the planning team meeting. Mr. Boxhorn replied that he will review the supplemental plans when they become available.

[Secretary's Note: The second bullet point in the first full paragraph on page 6 was revised to read as follows (text in bold is included here, and in similar subsequent Secretary's Notes, to indicate language changed or added onto the text. Text will not be bold in the report):

"Review of materials developed as part of the comprehensive planning process for the City of Milwaukee **(elements of the City's comprehensive plans are listed in Table I-1)**

Footnote number 4 was deleted and the subsequent footnotes were renumbered. Table I-1 was added to Chapter I. This table is included herein as Exhibit B."]

Mr. Shambarger commented that there was no discussion on climate change in the introduction of the report, and suggested that discussion on climate change be added. Mr. Boxhorn replied that climate change will be discussed as part of the risk analysis for individual hazards in Chapter III. He explained that the discussion of climate change in that chapter will include findings from downscaled climate projections presented in the report of the Wisconsin Initiative on Climate Change.

Ms. Bogue stated that the Milwaukee Metropolitan Sewerage District (MMSD) is developing a resilience plan for its service area. She noted that she expects this plan to be completed by about May 2018. She suggested that it would be desirable for this resilience plan to be consistent with the City's hazard mitigation plan. She noted that MMSD staff has been working with SEWRPC staff to obtain information that will serve as baseline data for both plans. Mr. Boxhorn responded that the Local Planning Team will first need to finalize the identification of hazards that will be addressed in the City's hazard mitigation plan before integrating information from other plans. Ms. Bogue stated that MMSD will narrow down which risks and vulnerabilities will be addressed in its resilience plan by November or December 2017. She added that the District will decide upon the most critical risks to be addressed by February 2018. Mr. Boxhorn asked how many risks will be addressed in the MMSD's resilience plan. Ms. Bogue replied that she anticipates that the plan will address four or five risks. She indicated that MMSD will work with local stakeholders and municipalities to receive public input on which risks to address.

[Secretary's Note: SEWRPC staff has been providing data to MMSD's contractor for development of the resilience plan.]

Mr. Richardson stated that the City of Milwaukee adopted the Wisconsin Department of Natural Resources' model floodplain ordinance. He added that it is Subchapter 11 in Chapter 295 of the City's Code of Ordinances.

[Secretary's Note: The first two sentences of the last paragraph on page 15 of Chapter II were revised to read as follows:

"The City of Milwaukee has enacted a floodplain **overlay** zoning ordinance. This ordinance **is Subchapter 11 of Chapter 295 of the City's Code of Ordinances. This ordinance reflects the City's adoption of the Wisconsin Department of Natural**

Resources' model ordinance for floodplain districts. It is intended largely to preserve floodwater conveyance and storage capacity of floodplain areas and to prevent the location of new flood-damage-prone development in flood hazard areas."]

Mr. Elliott stated that the MMSD completed a new flood management plan for the Kinnickinnic River Watershed in May- 2017. He noted that the plan calls for the removal of six miles of concrete lining from the Kinnickinnic River. Mr. Boxhorn asked whether information about the plan is available on the web. Mr. Elliott replied that he would forward information on the plan to Mr. Boxhorn.

[Secretary's Note: Mr. Elliott provided SEWRPC staff with a copy of the Kinnickinnic River Watershed Flood Management Plan. The following paragraph was added after the first full paragraph on page 8:

"In May 2017, MMSD completed a flood management plan for the Kinnickinnic River watershed.[5] This plan recommends specific channel and floodplain improvements, bridge and culvert improvements, construction of and improvement to flood storage facilities, and voluntary floodproofing or acquisition and demolition of structures in the floodplain at locations within the watershed along the Kinnickinnic River, Lyons Park Creek, Villa Mann Creek, Wilson Park Creek, and the 43rd Street Ditch. Specific details on elements of this plan are discussed in the section on flooding in Chapter V of this report.

[5]*Milwaukee Metropolitan Sewerage District*, Kinnickinnic River Watershed Flood Management Plan: Final Report, *May 4, 2017*."

Footnotes following this were renumbered.]

Mr. Elliott asked how the draft revised floodplain for the Kinnickinnic River fits into the hazard mitigation effort. Mr. Sprangers responded that a statement can be added to the plan indicating that the effort has continued but is still in a planning stage.

[Secretary's Note: The following paragraph was added before the second full paragraph on page 8:

"The Kinnickinnic River was remodeled as part of a Milwaukee County floodplain mapping project conducted by the Milwaukee County Automated Land Information System (MCAMLIS) Steering Committee, MMSD, and SEWRPC. The Wisconsin Department of Natural Resources (WDNR) has reviewed and tentatively approved the model and resulting floodplain delineation. MMSD is using this model as a basis of its watercourse planning effort for the watershed."]

Ms. Bogue asked whether FEMA is the primary audience of the City's hazard mitigation plan. Mr. Boxhorn replied that FEMA is the primary audience of the plan. He stated that one of the main purposes of developing and updating the plan is to ensure that the City of Milwaukee continues to receive funding for hazard mitigation efforts. Mr. Shambarger asked who serves as the applicant for the FEMA funding. Mr. Boxhorn replied that the City is the applicant. He added that the MMSD can also receive FEMA funding for projects in the City if it adopts the plan, noting that the District adopted the current version of the plan for just this reason. Mr. Fronk noted that the City Department of Public Works has acted as the applicant.

Ms. Bogue asked Mr. Boxhorn whether he knew how many people in the City of Milwaukee had downloaded the Ready Badger application since its launch. Mr. Boxhorn replied that he did not know how many people had downloaded the app. Ms. Bogue stated that it would be beneficial to know how many people downloaded the app to assess its effectiveness. Ms. Roth stated that the Ready Badger app receives hazard data and information from a FEMA app. She suggested that other emergency management apps be discussed in the plan. Mr. Boxhorn replied

that Chapter I mainly discusses the hazard mitigation efforts that have been implemented in the City since the first plan update. He stated that Chapter V will review current programs related to mitigation.

Mr. Shambarger suggested that a short, executive summary that highlights the main points of the plan be added to the report. Mr. Boxhorn replied that an executive summary can be added after the plan is completed.

Mr. Fronk asked whether the public informational meetings to review the updated plan had been scheduled. Mr. Boxhorn replied that the meetings had not yet been scheduled.

CONSIDERATION OF CHAPTER II, "BASIC STUDY AREA INVENTORY AND ANALYSIS," OF SEWRPC COMMUNITY ASSISTANCE PLANNING REPORT NO. 282 (3RD EDITION) *CITY OF MILWAUKEE ALL HAZARD MITIGATION PLAN UPDATE*

Mr. Boxhorn introduced Jeffrey Cross of the SEWRPC staff and asked him to review the preliminary draft of Chapter II of the plan report. Mr. Cross stated that Chapter II provides a basic study area inventory of the City of Milwaukee, and that it outlines the relevant geographic, demographic, and economic conditions of the study area.

In reference to the subsection on the City's population, Ms. Bogue asked whether there is a need to project future trends in population to study how changes in population growth can influence the severity of hazards. Mr. Cross replied that adding information on how population growth impacts hazard severity can be beneficial, and that doing so will be considered.

[Secretary's Note: Population and household projections for the City of Milwaukee for the year 2040 were obtained from the Wisconsin Department of Administration's Demographic Services Center and added to Tables II-1 and II-2. Revised tables are included herein as Exhibit C. As appropriate, discussion of the impacts of population growth on the severity of individual hazards will be added to the risk analysis in Chapter III.]

In reference to the section on Lake Michigan shoreline erosion hazard areas, Ms. Bogue stated that the National Oceanic and Atmospheric Administration (NOAA) provided the Wisconsin Coastal Management Program (WCMP) with a grant to perform a coastal resilience study in southeastern Wisconsin. She suggested that information on this study be added to the chapter. Mr. Fronk stated that most of the bluffs along the Lake Michigan shoreline in the City are stable.

[Secretary's Note: It is anticipated that the WCMP study will be completed and its findings will be available in 2020. For inventory purposes, this places the coastal resilience study beyond the completion date of this update of the hazard mitigation plan. A reference to this study will be included in the discussion of programs related to coastal hazards in Chapter V.]

Regarding the transportation system section, Mr. Shambarger stated that an edit should be made to the discussion on the Milwaukee Streetcar Network to reflect that construction on the Network had begun. Mr. Cross replied that the information on the Milwaukee Streetcar was added to the section before construction began.

[Secretary's Note: The second to last sentence of the last paragraph beginning on page 7 and continuing onto page 8 was revised to read:

"Construction of the streetcar network began in 2017."]

Mr. Sprangers stated that bus rapid transit services were also in the early stages of being implemented in the City.

[Secretary's Note: The following paragraph was added after the first partial paragraph on page 7:

"The MCTS and Milwaukee County are currently developing a nine-mile bus rapid transit (BRT) service connecting major employment, education, and recreation destinations through downtown Milwaukee, the City's near west side, Marquette University, Wauwatosa, and the Milwaukee Regional Medical Center. The County completed a feasibility study and identified a preliminary preferred route in 2016. As of 2017, the County has been performing initial engineering and has submitted an application to the Federal Transit Administration for funding. Assuming funding is approved, it is anticipated that construction would begin in 2019 and that BRT service would begin in 2021."]

Mr. Sprangers asked whether the plan includes information on the ferry services that are offered in the City. Mr. Cross replied that Chapter II briefly discusses the passenger ferry service that travels between the Port of Milwaukee and Muskegon, Michigan, daily during the spring, summer, and fall months.

Mr. Shambarger asked whether emergency personnel in the City have airlift capabilities, specifically for cases of flood incidences. Mr. Fronk replied that emergency personnel in the City do not have airlift capabilities, but that the City can access state resources through the Wisconsin Air National Guard when needed. Mr. Ley added that the City relies on the Wisconsin Division of Emergency Management for this. Mr. Elliott noted that the flash floods that occur in the City recede quickly.

In reference to the section on utility systems, Mr. Sprangers stated that a small, private water system is located west of Timmerman Field and south of Silver Spring Drive in City of Milwaukee. Mr. Ley noted that this system relies on groundwater. He added that some fire hydrants in this part of the City are connected to this system and that the Fire Department brings additional equipment into this part of the City when necessary to provide fire protection.

[Secretary's Note: The following paragraph was added after the second paragraph on page 9:

"A small portion of the City is served by a private, other-than-municipal community water system. This system is located in the northwestern part of the City west of Timmerman Airport. It utilizes groundwater from two wells as a source of supply. According to the most recent information available from the WDNR, it serves about 1,065 people through 342 service connections."]

Mr. Shambarger noted that while most of the City's gas supply is provided by We Energies, some is provided by Constellation Energy through We Energies' pipes.

[Secretary's Note: The first sentence of the first paragraph on page 10 was revised to read:

"Natural gas service is provided for **most of the** City of Milwaukee by We Energies-Gas Operations. **A portion of the City is supplied by Constellation Energy through We Energies' distribution system.**"]

Ms. Bogue stated that the Marquette University campus operates on steam power from We Energies. Mr. Shambarger added that all of downtown Milwaukee relies on steam power, and that its dependency on steam power may be worth discussing as a potential hazard in the plan. Mr. Boxhorn asked whether We Energies' Valley Power Plant is the source of downtown Milwaukee's steam power. Mr. Elliott replied that the Valley Plant is the source of downtown Milwaukee's steam power.

[Secretary's Note: The following paragraph was added after the second paragraph on page 10:

"We Energies also provides steam for heating and industrial processes to about 300 customers in an area of the City approximately between Mitchell Street north to W.

Vliet Street and from Lake Michigan west to 19th Street. The steam is cogenerated as part of electricity production at We Energies' Valley Power Plant."]

Regarding the section on public safety facilities and services, Mr. Ley stated that there will be numerous changes to fire station locations in the City due to the Milwaukee Fire Department's (MFD) new budget.

In reference to the section on critical facilities, Mr. Richardson asked what defines a critical community facility in relation to the hazard mitigation plan. Mr. Boxhorn replied that a critical facility is any facility that houses needed personnel or resources in times of disaster recovery. He stated that the planning team members should inform him of any other critical facilities that can be mapped in the plan. Mr. Richardson stated that the Department of Neighborhood Services building should be added to the list of critical facilities in the plan.

[Secretary's Note: The Department of Neighborhood Services office was added to the facilities shown on Map II-8 and listed in Table B-1.]

Mr. Fronk commented that the Information Technology Management Department's (ITMD) server building should be included on the list of critical facilities.

[Secretary's Note: In further discussions between City staff and SEWRPC staff it became apparent that the City's servers are housed in buildings that are already shown on Map II-8.]

Ms. Bogue asked whether public shelters are considered to be critical facilities in the plan. Mr. Boxhorn replied that shelters are not considered to be critical facilities, and that shelters are listed in a separate section.

Ms. Bogue stated that We Energies has a tiered system for restoring power, and that information on the system may help to identify other critical facilities in the City.

Mr. Ley stated that a few minor edits should be made to the text on the MFD's Type 1 Regional Response Hazardous Materials Team in the hazardous material storage and use section of the chapter. He stated that he will submit the suggested edits at a later date.

[Secretary's Note: As of December 13, 2017 no additional information has been received from Mr. Ley on this point.]

Mr. Elliott asked whether information on the MMSD's hazardous waste disposal program should be added to the plan. Mr. Boxhorn replied that this sort of program is inventoried in Chapter V in the review of existing programs and activities for each hazard. Mr. Richardson asked whether the City conducts an inventory of the facilities that handle hazardous materials. Mr. Ley replied that a list of the facilities that handle hazardous materials is available through Milwaukee County's Office of Emergency Management.

Ms. Bogue asked whether the Milwaukee Water Works is participating in the updating of the hazard mitigation plan. Mr. Boxhorn replied that they were invited to participate.

Regarding the section on historic sites, Mr. Richardson stated that the Milwaukee Historic Preservation Commission composes a list of historic sites that are located in the City. He noted that the list may provide more sites that can be added to the plan.

[Secretary's Note: A list of locally-designated historical sites was added to Appendix B as Table B-7. A copy of this table is attached herein as Exhibit D. The last sentence of the first paragraph on page 15 was revised to read:

"**The City of Milwaukee Historic Preservation Commission designates historic sites of local interest. Table B-7 in Appendix B lists these locally-designated historic sites.**"]

In reference to the section on regulations and programs related to hazard mitigation, Mr. Sprangers stated that the City adopted the state's model floodplain ordinance in 2013.

[Secretary's Note: The following sentence was added after the first sentence in the third paragraph on page 15:

"This ordinance was updated in 2013 through adoption of the State's model floodplain ordinance."]

Mr. Shambarger asked Mr. Sprangers about the status of the one-percent probability storm, noting that it is his understanding that it is based on data from the 1960s. Mr. Sprangers replied that hydrology has been updated, noting that the hydrology was adjusted for the remodeling of the Kinnickinnic River Watershed project. Mr. Elliott stated that the WDNR has asked that more recent flood events be included in the statistical analysis used for the Kinnickinnic River project.

In reference to the floodplain overlay zoning ordinance, Mr. Sprangers stated that the provision prohibiting development that would increase the regional flood height by 0.01 foot is no longer in the City's floodplain ordinance. He stated that he will provide information on the revisions to the ordinance at a later date.

[Secretary's Note: The last sentence in the second full paragraph on page 16 was revised to read:

"The ordinance prohibits floodplain development which **will** result in either the obstruction of flow or **in any** increase in the regional flood height due to floodplain storage lost."]

In reference to stormwater management regulations, Mr. Elliott stated that the rules in MMSD's Chapter 13 apply to the City of Milwaukee and other municipalities.

[Secretary's Note: The following paragraph was added after the second full paragraph on page 19:

"The MMSD has adopted and is implementing a comprehensive rule to minimize the potential to increase flood risk due to development or redevelopment in the District's service area. This rule, set forth in Chapter 13, "Surface Water and Stormwater," of MMSD"s rules, applies to the City of Milwaukee and the communities within the MMSD service area which lie upstream of the City in the tributary watershed areas. The Chapter 13 rule became effective on January 1, 2002 and was amended on October 25, 2010, March 24, 2014, and December 19, 2016. It requires the management of the volume and peak rate of stormwater flows from new development and redevelopment in such a way that peak flows in a watershed do not increase downstream flooding."]

Ms. Bogue stated that amendments to the Chapter 13 Rules are being considered and could be made in the near future.

Mr. Boxhorn asked Mr. Fronk whether the City of Milwaukee has a Comprehensive Emergency Management Plan (CEMP). Mr. Fronk replied that the City does have a CEMP, and that it is under revision. Mr. Boxhorn asked whether there is an anticipated date of completion for the revisions. Mr. Fronk replied that the revisions are expected to be completed by the spring of 2018.

Ms. Bogue asked when the hazard mitigation plan is expected to be completed. Mr. Boxhorn replied that the plan is expected to be completed by summer, 2018. Ms. Bogue asked how often the mitigation plan must be reapproved. Mr. Boxhorn replied that the plan must be updated and reapproved every five years following the date of adoption.

REVIEW OF RESULTS FROM THE HAZARD AND VULNERABILITY ASSESSMENT EXERCISE

At Mr. Spranger's request Mr. Boxhorn reviewed the results of the hazard and vulnerability assessment tool (HVA) which the Local Planning Team completed at its October 5, 2016, meeting. Mr. Boxhorn briefly explained how the data were analyzed. He noted that the 10 highest-ranked hazards identified by the tool were mostly related to severe storms or winter weather. He added that other notable hazards identified by the tool were related to automobile accidents and hazardous material incidents. He distributed a table summarizing the results of the HVA. He explained that this table contains preliminary data that will be included in Chapter III of the plan report.

[Secretary's Note: A copy of the handout is attached herein as Exhibit E.]

Ms. Bogue asked whether Mr. Boxhorn performed calculations to assess the risk posed by the hazards. Mr. Boxhorn replied that he did perform calculations to assess risk, and that he would discuss the calculations as he reviewed the results. Ms. Bogue asked how risk are calculated for potential supply chain related hazards, such as those that could impact the local water supply. Mr. Boxhorn replied that calculations in the preliminary risk analysis focused on damages that have been reported as a result of hazard incidents.

DISCUSSION OF HAZARDS TO BE ADDRESSED BY THE CITY OF MILWAUKEE ALL HAZARDS MITIGATION PLAN

Mr. Boxhorn stated that as part of the updating process for the hazard mitigation plan, it is important to review the set of hazards that the plan addresses. He explained that this review should make two determinations: 1) whether there are additional hazards that the plan should address and 2) whether current circumstances are such that there is no longer a need for the plan to profile some currently addressed hazards. He noted that factors to consider in making these determinations are the results from the HVA tool and the City's historical experience with hazards. Mr. Boxhorn noted that the handout he distributed also contains tables with preliminary data related to the City of Milwaukee's historical experience with several hazards. He added that these data will be refined as the risk analysis progresses.

Mr. Boxhorn reviewed the table containing preliminary estimates of hazard incidents and damages that affect the City of Milwaukee. He stated that the numbers shown are probably underestimates of actual damages since all damages were not reported. Mr. Fronk stated that the estimates for accidents involving the transportation of hazardous materials are less likely to be underreported in comparison to other hazard estimates.

Mr. Shambarger stated that earthquakes seemed to not be of high priority based on the HVA results. Mr. Boxhorn responded that he would recommend removing earthquakes from the plan.

Mr. Fronk stated that cyber security is a relevant topic, and that the planning team should consider addressing it in the plan. Mr. Boxhorn replied that cyber security hazards may be better addressed outside of the hazard mitigation plan. He noted that the City can take several measures to mitigate cyber-attacks, including insuring computers, training staff on cyber security practices, and conducting public outreach activities on cyber security.

Mr. Sprangers suggested that a paragraph be added to the text explaining why certain hazards are considered but not addressed in the plan. He stated that a brief explanation on why certain hazards are not addressed will help to assure readers that particular hazards of concern are not ignored. Mr. Shambarger suggested that text be added to the plan to explain why hazards related to automobile accidents are not addressed.

[Secretary's Note: A subsection will be added to Chapter III of the report discussing those hazards that were considered for inclusion in the plan but not addressed.]

Mr. Fronk inquired about the severity of Lake Michigan coastal hazards, and asked whether coastal hazards posed serious risks to the Lake Michigan shoreline. Mr. Boxhorn replied that risks related to Lake Michigan shoreline erosion and bluff failure do exist. He noted that there have been discussions regarding updating the 1995

SEWRPC Lake Michigan Erosion and Bluff Stability Analysis. Mr. Fronk stated that limited data exist on Lake Michigan coastal hazards. Mr. Boxhorn responded that he will seek out more information on Lake Michigan coastal hazards.

Mr. Shambarger stated that he would recommend removing earthquakes from the plan and adding civil unrest and cyber-attacks. Mr. Boxhorn asked planning team members whether there was a consensus on removing earthquakes from the plan. Mr. Sprangers asked what recommendations are made in the plan to address earthquake-related hazards. Mr. Boxhorn replied that the plan recommends enforcing structural maintenance requirements and expanding educational programs like the Community Emergency Response Team (CERT) program. Mr. Richardson stated that if earthquakes are removed from the plan, he would recommend replacing earthquakes with a hazard that FEMA will likely fund. The consensus of the Local Planning Team was to remove earthquakes from the hazards addressed by the plan.

[Secretary's Note: Earthquakes will be removed from the list of hazards addressed in the plan. The risk analysis and plan elements presented in Chapters III and V, respectively, of the second edition of the plan will be removed. The subsection added to Chapter III of the plan in the previous Secretary's note will include discussion of why the earthquake hazard was removed from the set of hazards addressed by the plan.]

Mr. Sprangers stated that the City of Milwaukee has experienced civil unrest in recent years, and that he was unsure as to whether civil unrest should be addressed in the plan. Mr. Boxhorn replied that he was unsure as to what mitigation measures can be recommended in the plan to address civil unrest. Mr. Richardson stated that hazards related to civil unrest may be of major concern to the City of Milwaukee's Common Council. After additional discussion, the consensus of the Local Planning Team was that civil unrest should not be included among the hazards addressed by the hazard mitigation plan. Mr. Sprangers suggested that an explanation be provided in the plan to explain why civil unrest and cyber-attacks are not addressed.

ADJOURNMENT

There being no further business, the meeting was adjourned by unanimous consent at 11:30 a.m.

REVISIONS TO CHAPTER II IN RESPONSE TO COMMENTS SUBMITTED THROUGH ELECTRONIC MAIL BY JAMES LEY, DEPUTY CHIEF, CITY OF MILWAUKEE FIRE DEPARTMENT

Following the September 13, 2017 meeting of the Local Planning Team, Mr. Ley submitted comments on the public safety facilities and services section of Chapter II through two electronic mail messages sent on October 3, 2017 and October 4, 2017.

[Secretary's Note: Copies of Mr. Ley's email messages are included herein as Exhibit F.]

In his October 3, 2017 email, Mr. Ley indicated that some fire stations are likely to close as a result of the City's budget. His email included a list of stations that are planned to continue operating under the budget.

[Secretary's Note: Map II-8 and Table B-2 in Appendix B were revised to reflect the list submitted by Mr. Ley. Copies of the revised map and table are included herein as Exhibit G.]

In his October 4, 2017 email, Mr. Ley suggested several revision to the subsection of Chapter II on fire suppression and rescues services that begins on page 11 and continues into page 13.

[Secretary's Note: The subsection "Fire Suppression and Rescue Services" beginning with the last paragraph on page 11 through the first partial paragraph on page 13 was revised to read:

"The City of Milwaukee maintains **30** fire **stations** which are divided geographically into five battalions. Within the fires houses are **30** engine companies, **eight** ladder companies, **two heavy rescue companies,** and 12 paramedic units. **The Milwaukee Fire Department 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, collapse, and trench rescue**, as well as in high and low angle rescue.**

The location of each of the fire stations within the City **of Milwaukee** are shown on Map II-8 and listed in Appendix B Table B-2. All firefighters are full-time employees.

The Milwaukee Fire Department (MFD) has **been a part of** Milwaukee County's Emergency Medical System (EMS) **since 1977.** Milwaukee County provides **each fire department in the County with** medical oversight **and training.** The system allows paramedics from any participating fire department within the County to respond to emergencies in neighboring municipalities when needed. For example, MFD Med No. 15 routinely responds into St. Francis as their paramedic unit**.** Wauwatosa's Med **51** responds to emergencies in the "finger area" on the west side of Milwaukee.

Since 1991, the Milwaukee Fire Department has had a service contract with the Village of West Milwaukee to provide full fire and emergency medical service to the Village.

Since 2006, the Milwaukee Fire Department has participated in the Mutual Aid Box Alarm System (MABAS). MABAS was originally formed in Illinois in the 1970s and eventually spread into Wisconsin. MABAS enables each member department to render assistance to and receive assistance from other departments without charge when incidents exceed local resources. MABAS Wisconsin currently covers 61 of Wisconsin's 72 counties. MABAS allows individual departments to access equipment such as water tenders, aerial trucks, and specialized equipment, which they themselves do not possess and which they may only need infrequently.

Since 2012, the Milwaukee Fire Department has participated in a "Shared Services" with many of its suburban neighbors. Shared services allows for the closest, most appropriate resources to be dispatched regardless of municipal borders. Member fire departments do not routinely respond into neighboring communities. Current members include the Milwaukee Fire Department, the Greenfield Fire Department, the North Shore Fire Department, the Oak Creek Fire Department, the St. Francis Fire Department, the Wauwatosa Fire Department, and the West Allis Fire Department."]

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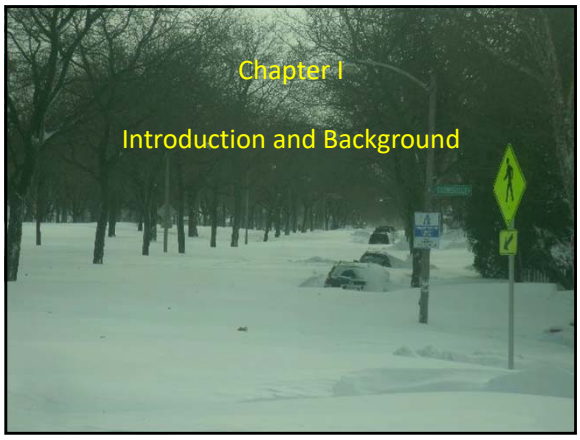
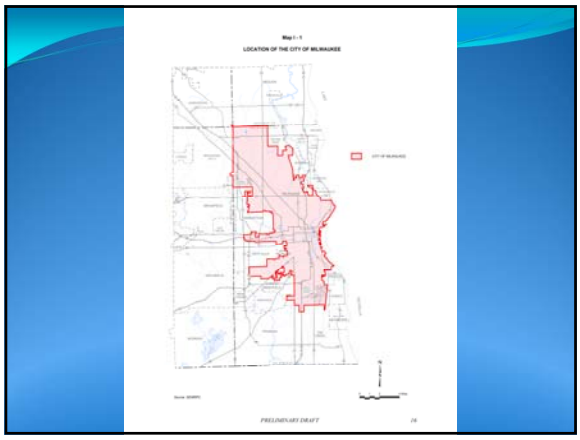
Exhibit A: Boxhorn presentation (Docs #238517)
Exhibit B: Table I-1 (Docs # 239983)
Exhibit C: Revised Tables II-1 and II-2 (from Docs #231766)
Exhibit D: Table B-7 from Appendix B (Docs #231802)
Exhibit E: Handout from meeting (Docs #238510)

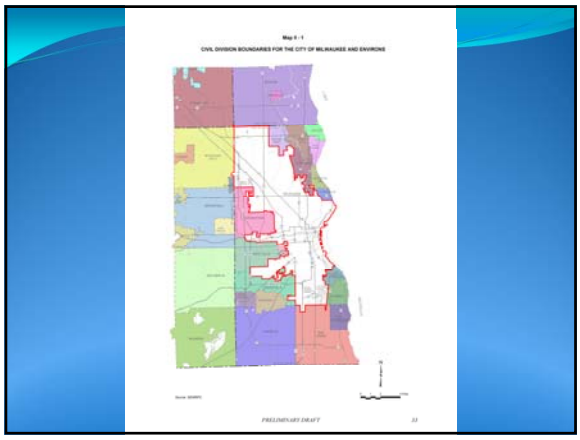
Exhibit F: October 3, 2017 and October 4, 2017 emails from James Ley (Docs #240123 & 240124 – include attachments as part of exhibit)
Exhibit G: Revised Map II-8 and Revised Table B-2 (Table B-2 from Docs #231802 and Joe will provide map)

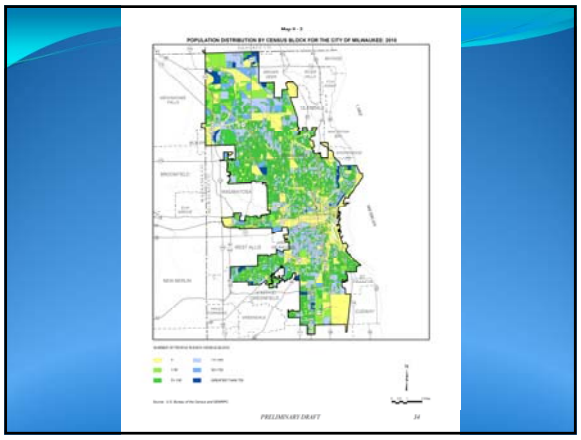


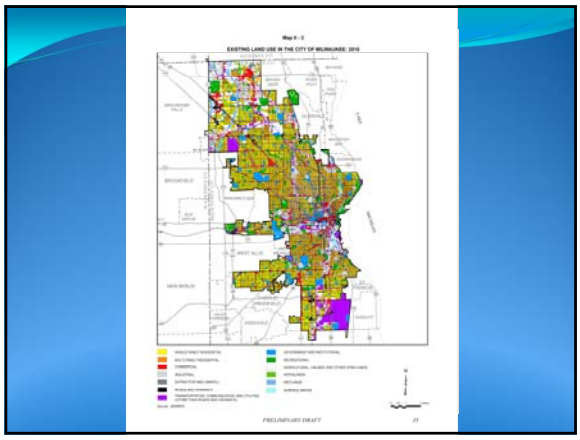
Chapter I Overview

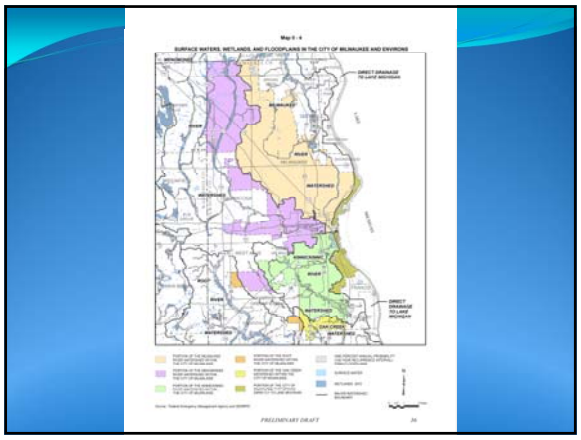
- Describes the scope and purpose of the plan update
- Briefly describes the planning process
- Describes implementation and outreach activities since completion of the last plan update

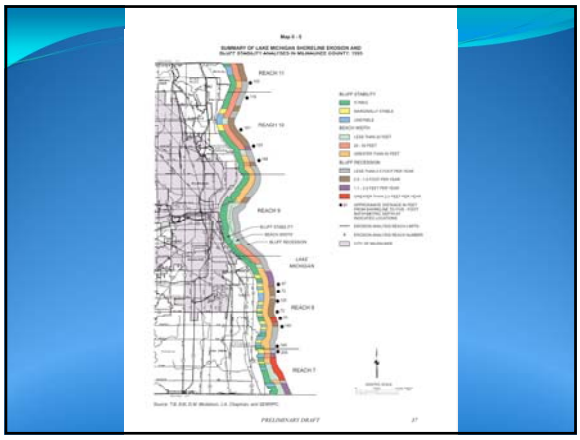


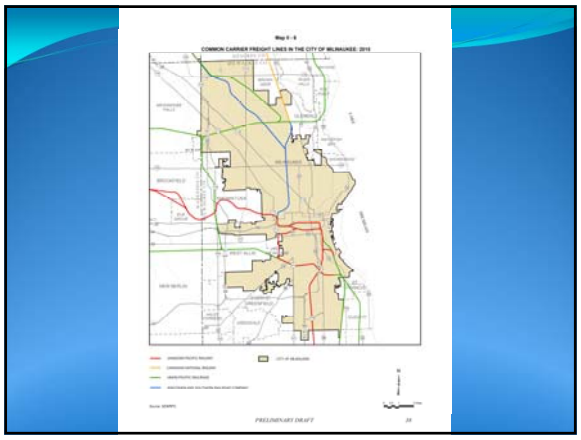


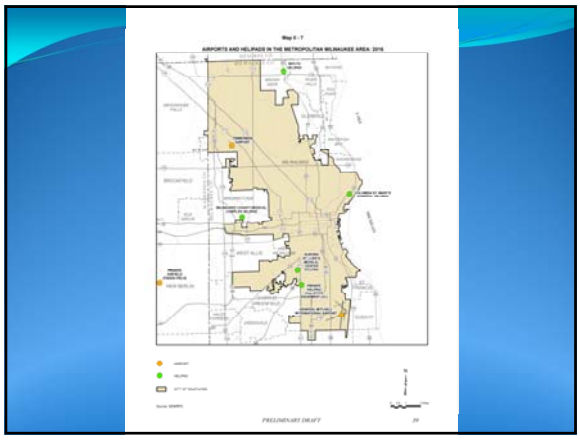


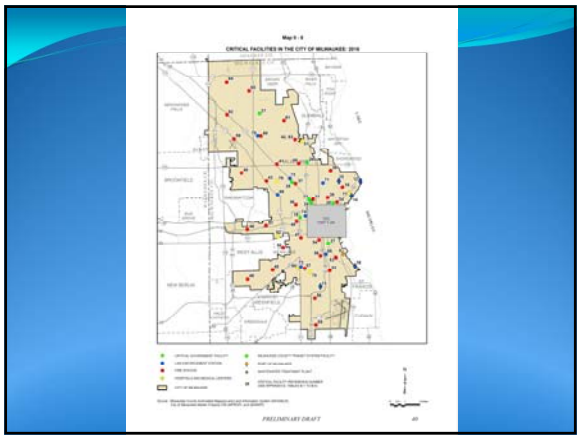


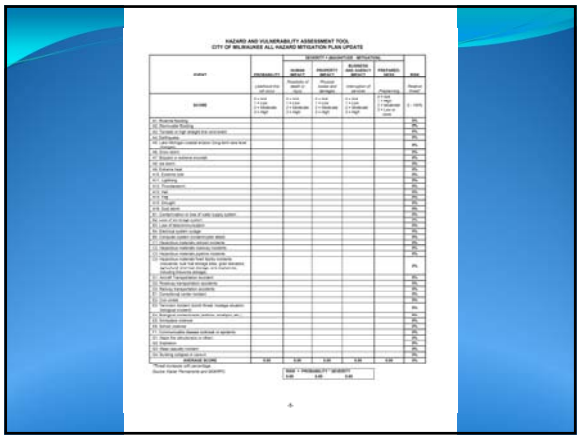












Hazard and Vulnerability Assessment Tool

1. Perceived risk determined by:

Risk = 100 x [(probability/3) x
(Human impact + Property impact + Business impact + Preparedness)/(4 x3)]

2. Percent risk (0 to 100 percent)
3. Relative measure → Higher percentage indicates greater perceived risk
4. Interquartile range is the range of the middle half of responses
5. Smaller interquartile range indicates greater agreement among team members → used to break ties

HVA Results – Top 10 Perceived Risks

1. Stormwater Flooding

2. Civil Unrest

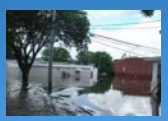
3. Cyberattack

4. Blizzard

5. Roadway Accident

HVA Results – Top 10 Perceived Risks

6. Winter Storm



7. Riverine Flooding

8. Workplace Violence

9. Ice Storm

10. Railroad Hazardous Material Incident

HVA Results – Other Notable Risks

Thunderstorm-related

18. Thunderstorm
19. Lightning
23. Hail
25. Tornado/High Wind

Hazard Material Incidents

15. Roadways
22. Fixed Facilities
36. Pipelines

HVA Results – Other Notable Risks

Temperature-related

11. Extreme cold
19. Extreme heat

17. Terrorism

20. Communicable disease outbreak

Fire-related

12. Major fire
14. Explosion

HVA Results – Bottom Ten Perceived Risks

30. Building collapse or cave-in
31. Aircraft transportation accidents
32. Railway transportation accidents
33. Contamination or loss of water supply
34. Loss of sewerage system
35. Correctional center incidents
36. Hazardous material pipeline incidents
37. Drought
38. Dust storm
39. Earthquake

Hazard Identification

- FEMA requires the plan to address natural hazards
  - Examples:
    - Drought, Flooding, Thunderstorms, Tornadoes
- The plan can also address human-induced or technological hazards
  - Examples
    - Hazardous Material Incidents, Transportation Accidents

Damage Totals

Hazard	Years	Incidents	Property Damages
Flooding	51	51	329,286,411
Hail	54	142	9,634,013
Lightning	22	27	2,762,413
Thunderstorms/High Wind	54	263	42,658,441
Tornadoes	59	17	18,340,303
Temperature Extremes	23	83	23,150
Winter Storms	44	153	122,505
Pipeline Hazardous Material Incidents	46	35	17,058,763
Transportation Hazardous Material Incidents	41	1,715	3,061,651
Terrorism	46	8	61,857
Automobile Accidents	15	221,360	4,042,163,900

Note: All damages are in 2016 dollars

Average Annual Damages

Hazard	Years	Incidents per year	Average Property Damages per year
Flooding	51	1.00	6,456,596
Hail	54	3.02	178,408
Lightning	22	1.23	125,564
Thunderstorms/High Wind	54	4.87	789,971
Tornadoes	59	0.29	310,853
Temperature Extremes	23	3.61	1,007
Winter Storms	44	3.48	2,784
Pipeline Hazardous Material Incidents	46	0.76	370,843
Transportation Hazardous Material Incidents	41	38.11	68,037
Terrorism	46	0.17	1,345
Automobile Accidents	15	14,757.33	269,477,593

Fatality and Injury Totals

Hazard	Years	Incidents	Fatalities	Injuries	Total
Flooding	51	51	1	1	2
Lightning	22	27	0	2	2
Temperature Extremes	23	83	122	246	368
Thunderstorms/High Wind	54	263	3	9	12
Contamination/Loss of Water Supply	27	1	69	403,000	403,069
Winter Storms	44	153	32	9	41
Communicable Diseases	10	23,036	?	?	23,036
Sexually-transmitted Diseases	10	100,084	?	?	100,084
Pipeline Hazardous Material Incidents	46	35	0	30	30
Transportation Hazardous Material Incidents	41	1,715	3	114	117
Terrorism	46	8	0	1	1
Automobile Accidents	15	221,360	582	108,187	108,769

Average Annual Fatalities and Injuries

Hazard	Years	Incidents per year	Fatalities year	Injuries per year	Total per year
Flooding	51	1.00	0.02	0.02	0.04
Lightning	22	1.23	0.00	0.09	0.09
Temperature Extremes	23	3.61	5.30	10.70	16.00
Thunderstorms/High Wind	54	4.87	0.06	0.17	0.23
Contamination/Loss of Water Supply	27	0.04	2.56	14,925.93	14,928.49
Winter Storms	44	3.48	0.68	0.20	0.88
Communicable Diseases	10	2,303.60	?	?	2,303.60
Sexually-transmitted Diseases	10	10,008.40	?	?	10,008.40
Pipeline Hazardous Material Incidents	46	0.76	0	0.65	0.65
Transportation Hazardous Material Incidents	41	38.11	0.07	2.53	2.60
Terrorism	46	0.17	0.00	0.02	0.02
Automobile Accidents	15	14,757.33	38.80	7,212.47	7,251.27

Hazard Identification

- Hazards with confirmed incidences, but no confirmed damage estimates
  - Earthquake, *Fog*
- Hazards no confirmed incidences
  - *Dust Storms, Landslides, Nuclear Power Plant Incidents,* Wild Fire
- Hazards without data on incidences or damages
  - *Correctional Center Incidents, Loss of Sewerage System, Power Outages, School Violence, Workplace Violence*

Hazards Currently Profiled in the Plan

Natural Hazards

1. Earthquake
2. Flooding
3. Lake Michigan Coastal Hazards
4. Temperature Extremes
5. Thunderstorms, Wind, Hail, Lightning
6. Tornado
7. Winter Storms

Technological Hazards

8. Contamination or Loss of Water Supply
9. Hazardous Material Incidents
10. Major Fire or Emergency Medical Incidents
11. Medical/Public Health Risk
12. Terrorism

Hazards Not Profiled by the Plan

Natural Hazards

1. Agricultural Pests
2. Dam Failure
3. Dust Storms
4. Land Subsidence
5. Landslide

Hazards Not Profiled by the Plan

Technological Hazards

7. Aviation Accidents
8. Civil Unrest
9. Communicable Disease Outbreak
10. Communication Outage
11. Correctional Center Incident
12. Dirty Bomb
13. Fuel Shortage
14. Landfill Incidents
15. Loss of Sewerage System
16. Nuclear Power Plant Incident
17. Power Plant Incident
18. School Violence
19. Waterway Transportation Accident
20. Workplace Violence


Project Web Site
http://www.sewrpc.org/HMP
Agendas and other meeting materials
Summary notes from meetings
Presentations
Draft chapters as they are completed
Comment screen
Other ways to send a comment
Email to jboxhorn@sewrpc.org

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Table I-1

CITY OF MILWAUKEE COMPREHENSIVE PLAN:
CITYWIDE POLICY PLAN, AREA PLANS, AND RELATED ACTION PLANS

Area	Plans	Adoption and Amendment Dates
Citywide	City of Milwaukee Department of City Development, *Milwaukee Comprehensive Plan: Citywide Policy Plan*, March 2010	Adopted on March 2, 2010
Downtown	City of Milwaukee Department of City Development, *Milwaukee Comprehensive Plan: Downtown—A Plan for the Area*, October 2010	Adopted on October 12, 2010
Fond du Lac and North	City of Milwaukee Department of City Development, *Milwaukee Comprehensive Plan: Fond du Lac and North—A Plan for the Area*, March, 2004	Adopted on March 19, 2004
Menomonee Valley	City of Milwaukee Department of City Development, *Milwaukee Comprehensive Plan: Menomonee Valley 2.0—A Plan for the Area*, June 2015	Adopted on June 2, 2015
Near North	City of Milwaukee Department of City Development, *Milwaukee Comprehensive Plan: Near North Side—A Plan for the Area*, December 2009	Adopted on December 22, 2009
Near South	City of Milwaukee Department of City Development, *Milwaukee Comprehensive Plan: Near South Side—A Plan for the Area*, May 2009, amended June 23, 2015 and March 1, 2016	Adopted on May 27, 2009; amended on June 23, 2015 and March 1, 2016
	City of Milwaukee Department of City Development, *Milwaukee Comprehensive Plan: Walker's Point Strategic Action Plan—A Plan for the Area*, June 2015	Adopted on June 23, 2015
	City of Milwaukee Department of City Development, Walker Square Neighborhood Association, *Milwaukee Comprehensive Plan: Walker Square Strategic Action Plan—A Part of the Near South Side Area Plan*, December 2015	Adopted on March 1, 2016
Near West	City of Milwaukee Department of City Development, *Milwaukee Comprehensive Plan: Near West Side—A Plan for the Area*, March 2004, amended March 3, 2009	Adopted on March 19, 2004 and amended on March 3, 2009
	City of Milwaukee Department of City Development, Near West Side Partners, *Milwaukee Comprehensive Plan: North 27th Street Corridor Strategy—A Part of the Near West Side Area Plan*, January 2018	Pending adoption
Northeast	City of Milwaukee Department of City Development, *Milwaukee Comprehensive Plan: Northeast Side—A Plan for the Area*, July 2009	Adopted on September 1, 2009
	City of Milwaukee Department of City Development, Riverworks Development Corporation, Riverworks Business Improvement Districts 25 and 36, *Milwaukee Comprehensive Plan: Riverworks Strategic Action Plan*, Summer 2012	Plan in final draft stage, pending adoption
Northwest	City of Milwaukee Department of City Development, *Milwaukee Comprehensive Plan: Northwest Side—A Plan for the Area*, December 2007, amended September 26, 2017	Adopted on February 5, 2008 and amended on September 26, 2017
	City of Milwaukee Department of City Development, Granville Business Improvement District, *Milwaukee Comprehensive Plan: Granville Strategic Action Plan and Land Use Study—A Part of the Northwest Side Area Plan*, October 2017	Adopted on September 26, 2017

Area	Plans	Adoption and Amendment Dates
Southeast	City of Milwaukee Department of City Development, *Milwaukee Comprehensive Plan: An Area Plan for the Southeast Side*, October 2008	Adopted on October 29, 2008
	City of Milwaukee Department of City Development, South 27th Street Business Improvement District, *Milwaukee Comprehensive Plan: South 27th Street Strategic Action Plan—A Part of the Southeast and Southwest Side Area Plans*, March 2017	Pending adoption
	City of Milwaukee Department of City Development, Aerotropolis Milwaukee, The Gateway to Milwaukee Improvement District, *Milwaukee Comprehensive Plan: Milwaukee Aerotropolis Development Plan Summary—A Part of the Southeast Side Area Plan*, August 2017	Pending adoption
Southwest	City of Milwaukee Department of City Development, *Milwaukee Comprehensive Plan: Southwest Side—A Plan for the Area*, December 2009	Adopted on December 22, 2009
	City of Milwaukee Department of City Development, South 27th Street Business Improvement District, *Milwaukee Comprehensive Plan: South 27th Street Strategic Action Plan—A Part of the Southeast and Southwest Side Area Plans*, March 2017	Pending adoption
Third Ward	City of Milwaukee Department of City Development, *Milwaukee Comprehensive Plan: The Third Ward—A Plan for the Neighborhood*, May 2005, amended July 12, 2006	Adopted on May 20, 2005 and amended on July 12, 2006
Washington Park	City of Milwaukee Department of City Development, *Milwaukee Comprehensive Plan: Washington Park—A Plan for the Area*, June 2006	Adopted on June 20, 2006
West	City of Milwaukee Department of City Development, *Milwaukee Comprehensive Plan: West Side—A Plan for the Area*, December 2009	Adopted on December 1, 2009

Source: City of Milwaukee Department of City Development and SEWRPC.

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Table II-1

HISTORICAL RESIDENT POPULATION LEVELS IN THE CITY OF MILWAUKEE: 1850-2010

Year	Population	Change from Preceding Census	
		Absolute	Percent
1850	20,061	- -	- -
1860	45,246	25,185	55.66
1870	71,440	26,194	36.67
1880	115,587	44,147	38.19
1890	204,468	88,881	43.47
1900	285,315	80,847	28.34
1910	373,857	88,542	23.68
1920	457,147	83,290	18.22
1930	578,249	121,102	20.94
1940	587,472	9,223	1.57
1950	637,392	49,920	7.83
1960	741,324	103,932	14.02
1970	717,099	-24,225	-3.38
1980	636,212	-80,887	-12.71
1990	628,088	-8,124	-1.29
2000	596,974	-31,114	-5.21
2010	594,833	-1,141	-0.36
2040[a]	627,400	32,567	5.47

[a]*2040 projection from Wisconsin Department of Administration Demographic Services Center.*

Source: U.S. Bureau of the Census, Wisconsin Department of Administration, and SEWRPC.

Table II-2

NUMBER OF HOUSEHOLDS IN THE CITY OF MILWAUKEE: 1970-2010

Year	Number of Households in the City of Milwaukee	Change from Preceding Census	
		Number	Percent
1970	236,981	- -	- -
1980	241,818	4,837	2.0
1990	240,540	-1,278	-0.5
2000	232,188	-8,352	-3.6
2010	230,221	-1,967	-0.8
2040[a]	258,467	28,246	12.27

[a] *2040 projection from Wisconsin Department of Administration Demographic Services Center.*

Source: U.S. Bureau of the Census, Wisconsin Department of Administration, and SEWRPC.

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Table B-7

LOCALLY-DESIGNATED HISTORIC SITES IN THE CITY OF MILWAUKEE: 2017

Site Name[a]	Address	Year Designated	Listed on National Register
47th Street Bungalow District	2500 block of N. 47th Street	2001	N
Abbot Row Building	1019 – 1043 E. Ogden Avenue	1983	Y
Adler, Emanuel D., House Building	1681 N. Prospect Avenue	2002	Y
All Saints' Episcopal Cathedral Historic District	804 – 828 E. Juneau Avenue	1984	Y
Allis, Charles, House Building (also known as Charles Allis Art Library)	1630 E. Royall Place	1982	Y
American System Built Homes Historic District	W. Burnham Street	1990	Y
Auer, Louis and Son Houses	2015, 2019, 2025, 2029 E. Kenwood Avenue	2007	N
Auer, Louis and Son Houses	2005, 2009 E. Kenwood Avenue	2008	N
Avalon Theater	2469-2483 S. Kinnickinnic Avenue	2004	N
Beth Israel Synagogue (also known as Greater Galilee Missionary Baptist Church)	2432 N. Teutonia Avenue	1989	Y
Bethel Evangelical Church	2392 S. Woodward Street	2002	N
Brady Street Historic District	E. Brady Street from N. Farwell Avenue to N. Van Buren Street	1990	Y
Brewers Hill Historic District	Roughly, Brown and Lloyd Streets and Garfield and North Avenues from 2nd Street to Hubbard Street	1985	Y
Brown Double House	1122-1124 N. Astor Street	2006	N
Bunaglow Style Firehouses	2901 N. 30th Street, 1615 W. Oklahoma Avenue, 407 N. Hawley Road	2001	N
Burhnam, J. L. Building	100-106 E. Seeboth Street	2004	N
Bzdawka Building	1112-1114 W. Lincoln Avenue	2017	N
Calvary Cemetery	South of W. Bluemound Road between N. Hawley Road and N. General Mitchell Boulevard	1987	N
Carr, Lester, House	2537 W. Kilbourn Avenue	1995	N
Cass-Wells Street Historic District	712, 718, and 724 E. Wells Street and 801, 809, 815, 819, and 823 N. Cass Street	1992	Y
Central Milwaukee Library	814 W. Wisconsin Avenue	1982	Y
Christ Polish Baptist Church	2009-2013 S. 19th Street	2007	N
City Hall	200 E. Wells Street	1982	Y
Coast Guard Station, Old	1600 N. Lincoln Memorial Drive	2003	Y
Cold Spring Park Historic District	W. McKinley Boulevard between N. 27th Street and N. 34th Street	1987	Y
Concordia Historic District	Roughly bounded by W. State Street, N. 27th Street, W. Kilbourn Avenue and N. 35th Street	1988, 2009	Y
Copeland Service Station	4924 W. Roosevelt Drive	1995	N
Crain/Claflin House	1773 N. Cambridge Avenue	2016	N
Diehnelt, Walter, House	4430 W. Roosevelt Drive	2001	N

Table B-7 (continued)

Site Name[a]	Address	Year Designated	Listed on National Register
Downer Avenue Commercial	2551-2651 N. Downer Avenue, 2604 N Hackett Avenue	2001	N
Eagles Club	2401 W. Wisconsin Avenue	1989	Y
East Side Commercial Historic District	Roughly bounded by E. Wells Street, N. Jefferson Street and N. Broadway, Michigan and E. Clybourn, and N. Water Streets	1987	Y
Ehler, C. Frederick, House	2576 N. 4th Street	1990	N
Epiphany Lutheran Church (also known as All People's Gathering Lutheran Church)	2600 N. 2nd Street	2000	N
Federal Building	515 – 519 E. Wisconsin Avenue	1982	Y
Fifteenth District School/McKinley School	2201 W. Vliet Street	2014	N
Fifteenth District School/McKinley School Playground	1255 N. 20th Street	2014	N
First German Methodist Church[b]	1037 W. Juneau Avenue	1985	N
First Unitarian Church	1009 E. Ogden Avenue	1991	Y
First Ward Triangle Historic District	Roughly Franklin Place, N. Prospect and E. Juneau Avenues, and E. Knapp Street	1983	Y
Fitzgerald, Robert Patrick, House	1119 N. Marshall Street	1990	N
Fourth Church of Christ, Scientist	3069 N. Downer Avenue, (also known as 2519 E. Kenwood Boulevard)	1996	N
Frattinger, Peter and Ida, House	807 N. 23rd Street	2017	N
Friedmann Row (also known as Patrician Row Condominiums)	1537, 1539, 1541, 1543 N. Cass Street and 731 E. Pleasant Street	1995	Y
Fundamental Bible Church[c]	2921-2927 W. State Street, 2925 W. State Street	1988	Y
Garden Homes Historic District	Roughly bounded by W. Ruby and N. Teutonia Avenues, N. 24th Place, W. Atkinson Avenue and N. 27th Street	2013	Y
Germania Building (also known as Brumder Building)	135 W. Wells Street	2014	Y
Gesu Church	1145 W. Wisconsin Avenue	1983	Y
Gipfel Union Brewery	423 -427 W. Juneau Avenue	1985	N
Goll, Frederick J., House	1550 N. Prospect Avenue	2002	N
Graham Row	1501, 1503, and 1507 N. Marshall Street	1982	Y
Grand Avenue Congregational Church (also known as Irish Cultual and Heritage Center)	2133 W. Wisconsin Avenue	1984	Y
Grant Boulevard Historic District	N. Grant Boulevard between W. Locust Street and W. Meinecke Avenue	1985	Y
Gustorf, Edmund, House	3138 N. Cambridge Avenue	1985	N
Haberer Saloon	3935-3937 W. Vliet Street	1986	N
Harnischfeger, Henry, House	3424 W. Wisconsin Avenue	1991	Y
Hausmann Building	1750 N. Martin Luther King, Jr. Drive	1986	N
Hide House, buildings 1 through 4	2625 S. Greeley Street	2009	N
Holy Rosary Roman Catholic Church	2003-2011 N. Oakland Avenue and 2038 N Bartlett Avenue	2000	N
Hrobsky/Berg Building	2722-2724 N. King Drive	2006	N

Table B-7 (continued)

Site Name[a]	Address	Year Designated	Listed on National Register
Hummel/Uihlein Building	2673-2679 N. Martin Luther King, Jr. Drive	2010	N
Immanuel Reformed Church (also known as Greater Mount Zion)[d]	2479 N. Sherman Boulevard	1995	N
Jefferson Hall	2617 W. Fond du Lac Avenue	1985	N
Jewett, Milo P., House	800 N. Marshall	1984	N
Kane, Sanford R., House (also known as Lakeshore Montessori School)	1841 N. Prospect Avenue	2003	Y
Kenwood Masonic Temple (formerly Italian Community Center)	2648 N. Hackett Avenue	1990	N
Kilbourn Avenue Bascule Bridge	Milwaukee River at Kilbourn Avenue	2006	N
Kilbourn/Reservoir Park	626 E. North Avenue, 701 E. Garfield Avenue	1999	N
Knowles, Jr., George, House	1879 Cambridge Avenue	2013	N
Koch, George, House (also known as Lion House)	3209 W. Highland Boulevard	1985	N
Koeffler, Charles, House	817-819 N. Marshall Street	1986	N
Konrad and Bauman Building	3225-3227 W. Lisbon Avenue	1998	N
Kren Building and Carriage Barn	2647-2649 N. 27th Street	2002	N
Kubbernuss, Frederick, House	222 E. Burleigh Street	2004	N
Kunzelmann, Albert, House	1635 S. 8th Street	1998	N
Koult, Anton, Saloon	322 W. State Street	1986	N
Lake Park[e]	2900 N. Lake Drive and 2800 E. Kenwood Boulevard	1983	Y
Leister, Isaac, House	11142 W. Bradley Road	1983	N
Lubavitch Chabad of Milwaukee (formerly Upham House)[f]	3109 N. Lake Drive	1984	N
Machek, Robert, House	1305 N. 19th Street	1986	Y
MacLaren, Mrs. Myron T, House (also known as University of Wisconsin-Milwaukee Alumni House)	3230 E. Kenwood Boulevard	1991	N
Manegold/Gramling House	1202 S. Layton Boulevard	2003	N
Mayer and Durner Buildings	2002-2006 N. Martin Luther King, Jr. Drive	1987	N
McIntosh, Charles, House (also known as Wisconsin Conservatory of Music)	1584 N. Prospect Avenue	1985	Y
Mier, Golda, School	1555 N. Martin Luther King, Jr. Drive	1988	N
Messmer, Henry, House	2302 N. Booth Street	1985	N
Miller Tavern/Catherine Foley Building (also known as Milwaukee Institute of Art and Design Student Union)	266-272 E. Erie Street	2015	N
Milwaukee Fire Department Firehouse Ladder Company No. 5	1945 N. Bartlett Avenue	2003	N
Milwaukee Protestant Home for the Aged	2449 N. Downer Avenue	1984	N
Milwaukee River Flushing Tunnel Station	1701 N. Lincoln Memorial Drive	1986	N
Murdock, Lafayette/Emily Groom House	1903 N. Cambridge Avenue	2013	N
Niezorawski, Francis (Frank) Duplex	1722-1724 N. Franklin Place	2008	N
North Lake Drive Historic District	North Lake Drive between E. Hartford Avenue and E. Park Place	1984	N
North Lake Drive Estates Historic District	Portions of North Lake Drive between E Edgewood Avenue and E. Hartford Avenue	1984, 1998	N

Table B-7 (continued)

Site Name[a]	Address	Year Designated	Listed on National Register
North Point North Historic District	Various	1983	Y
North Point South Historic District	Roughly bounded by North Avenue, Summit, Terrace, and Lafayette Streets	1983	Y
North Point Water Tower[g]	2588 N. Lake Drive	1982	Y
Northwestern National Insurance Company Building	526 E. Wisconsin Avenue	1987	N
Nunnemacher Estate/Wildenberg Hotel	2774 S. 27th Street	2014	N
Octagon House	2443 N. Gordon Place	1998	N
Old World Third Street Historic District	N. Old World 3rd Street, W. Highland Avenue, and W. State Street	1991	Y
Pabst Brewery Historic District	Roughly bounded by W. Highland Avenue, N 11th Street, W. Winnebago Street, and N. 9th Street	1985	Y
Pabst Brewing Company Hall (also known as Metropolitan Hall)	537-541 W. Clarke Street	2002	N
Pabst Mansion	2000 W. Wisconsin Avenue	1986	Y
Pabst Tavern	3431-3433 W. Vliet Street	1998	N
Pabst Theater	144 E. Wells Street	1982	Y
Paetzold, Lorenz, House	1942 S. Muskego Avenue	1986	N
Palmer, Henry L., Masonic Lodge No. 301/Love Tabernacle	2640-2650 N.1st Street	2012	N
Peck, George W., Row House	1620 – 1630 N. Farwell Avenue	2012	Y
Peck, James S., House	1105 W. Waverly Place	1988	N
Pettibone/White House	2051 W. Wisconsin Avenue	2015	N
Philipp, Emanuel, School	4310 N. 16th Street	1988	N
Pryor Avenue Iron Well	1710 E. Pryor Avenue	1987	N
Railroad Swing Bridge	Milwaukee River at Jefferson Street	2005	N
Richards, Daniel, House[h]	2863 N. 1st Street	2000	N
Saint Anthony's Church[i]	1711 S. 9th Street	1986	N
Saint Benedict the Moor Roman Catholic Church	1015 N. 9th Street	1998	N
Saint Casmir's Roman Catholic Church Complex Historic District	2604, 2618, 2626 N. Bremen Street, 904 E Clarke Street	1992	N
Saint Hedwig's Church[j]	1716 N. Humboldt Avenue	1990	N
Saint James Episcopal Church	833 W. Wisconsin Avenue	1991	Y
Saint John's Evangelical Lutheran Church	804 – 816 W. Vliet Street	1990	Y
Saint John the Evangelist Cathedral	812 N. Jackson Street	1992	Y
Saint Josaphat Basilica	601 W. Lincoln Avenue	1987	Y
Saint Marcus Parsonage/Mathis House	212 E. North Avenue	2010	N
Saint Mark's Episcopal Church[k]	2604 N. Hackett Avenue	2001	N
Saint Mary's Hospital	2320-2388 N. Lake Drive	2002	N
Saint Mary's Roman Catholic Church and Rectory	836-844 N. Broadway	1990	Y
Saint Stanislaus Church[l]	524 W. Mitchell Street	1986	N
Salem Evangelical Lutheran Church	6814 N. 107th Street	1992	N
Schlitz Tavern	2249 N Humboldt Avenue (also known as 1025 E. North Avenue)	2000	N
Schlitz Tavern/Coventry Inn	2501 W. Greenfield Avenue	2010	N

Table B-7 (continued)

Site Name[a]	Address	Year Designated	Listed on National Register
Schultz/Seeboth Duplex	839-841 N. 11th Street	2012	N
Schuster, George, House and Carriage Shed	3209 W. Wells Street	2007	Y
Second Church of Christ Scientist	2722 W. Highland Boulevard	1998	Y
Second Ward Savings Bank (also known as Milwaukee County Historical Society Building)	910 N. Old World Third Street	1983	N
Seventh Day Adventist Central Church[m]	2229 N. Terrace Avenue	1983	N
Sherman Boulevard Congregational Church (also known as Community Baptist Church)[d]	2249 N. Sherman Boulevard	1995	N
Sherman Boulevard Historic District	N. Sherman Boulevard between W. Fond du Lac Avenue and W. Lloyd Street	1995	N
Sherman Park Evangelical Lutheran Church[d]	2703 N. Sherman Boulevard	1995	N
Sieglaff, William, Duplex	1131 N. 13th Street	2002	N
Sievers, George A., House (also known as Green House)	3173 and 3179-3181 S. 31st Street	2009	N
Sixth Church of Christ, Scientist	1036 N. Van Buren Street	1983	Y
Smith, Lloyd R., House (also known as Villa Terrace)	2220 N. Terrace Avenue	1982	Y
South Second Street Historic District	200 block of South 2nd Street	2016	N
State Street Bascule Bridge	Milwaukee River at State Street	2004	N
Stehling, Charles, House	1840 N. 5th Street	1984	N
Stormowski, Edmund, Duplex	1874-1846 N. Warren Avenue	2002	N
Third Church of Christ, Scientist (also known as Schrager Auction Gallery)[d]	2195 N. Sherman Boulevard	1995	N
Tiefenthaler House	2425 W. McKinley Boulevard	2013	N
Town of Lake Water Tower and Municipal Building	4001 S. 6th Street	1990	N
Trinity Lutheran Church Complex	1046 N. 9th Street	2000	Y
Trinity Presbyterian Church[d]	3302 N. Sherman Boulevard	1995	N
Trowbridge Street School	1943 E. Trowbridge Street	1991	N
Turner Hall	1034 N. 4th Street	1986	Y
Turner, William J., House	743 N. 4th Street	2005	N
University Club of Milwaukee	924 E. Wells Street	2003	N
Villa Uhrig	1727 N. 34th Street	1997	N
Van Ells Drug Store	2652-2654 W. Fond du Lac Avenue	2001	N
Walker, Chastina, House	3130 W. Wells Street	1991	Y
Ward Yard Office for First Ward	1911 N. Humboldt Avenue	2001	N
Weinstock, Samuel, House	3402 W. St. Paul Avenue	2009	N
Whitehead, R. D., Monument	S. 16th Street, W. Bow Street, S. Pearl Street	1986	N
Whitnall House	1200-1204, 1208 E. Locust Street	1999	N
Zion Evangelical Lutheran Church (also known as Bethel Baptist Church)	2030 W. North Avenue	2000	N

[a]*Names are given as they are listed on the City of Milwaukee Historic Preservation Commission's list. For those sites on both the City's list and the National Register of Historic Places, the names that they are listed under may differ slightly.*

[b]*Part of Pabst Brewery Complex Historic District.*

[c]*Part of Concordia Historic District.*

[d]*Part of Sherman Boulevard Historic District.*

Table B-7 (continued)

[e]*Part of North Point North Historic District*

[f]*Part of North Lake Drive Historic District.*

[g]*Designated individually and as part of North Point South Historic District.*

[h]*Demolished by fire July 1, 2002.*

[i]*Part of Mitchell Street Historic District.*

[j]*Part of Brady Street Historic District.*

[k]*Part of Downer Avenue Historic District.*

[l]*Part of Mitchell Street Historic District.*

[m]*Part of North Point South Historic District.*

Source: City of Milwaukee Historic Preservation Commission

Table 1

PERCEIVED RISKS OF HAZARDS AS DETERMINED BY HAZARD AND VULNERABILITY ASSESSMENT TOOL: 2016

Event	Minimum (percent)[a]	Maximum (percent)[a]	Average (percent)[a]	Interquartile Range (percent)[b]	Rank
A2. Stormwater flooding	33.3	91.7	66.9	29.1	1
E2. Civil unrest	16.7	100.0	66.2	45.8	2
B5. Computer system incident/cyber attack	16.7	91.7	55.3	57.0	3
A7. Blizzard or extreme snowfall	27.8	83.3	55.3	26.4	4
D2. Roadway transportation accidents	27.8	75.0	53.5	26.4	5
A6. Snow storm	41.7	83.3	52.1	16.6	6
A1. Riverine flooding	19.4	91.7	51.7	31.3	7
E5. Workplace violence	19.4	75.0	51.4	27.8	8
A8. Ice storm	16.7	75.0	51.4	22.2	9
C1. Hazardous materials railroad incidents	19.4	100.0	50.2	27.7	10
A10. Extreme cold	33.3	75.0	50.2	19.4	11
G1. Major fire	22.2	83.3	49.5	30.6	12
E6. School violence	16.7	91.7	48.8	38.9	13
G2. Explosion	16.7	83.3	48.1	30.5	14
C2. Hazardous materials roadway incidents	16.7	83.3	45.8	29.1	15
A9. Extreme heat	27.8	66.7	45.8	25.0	16
E3. Terrorism incident	13.9	91.7	45.7	33.3	17
A12. Thunderstorm	8.3	75.0	43.8	33.3	18
A11. Lightning	25.0	75.0	43.5	12.5	19
F1. Communicable disease outbreak or epidemic	8.3	83.3	43.4	32.7	20
B4. Electrical system outage	19.4	66.7	39.1	32.0	21
C4. Hazardous materials fixed facility incidents	13.9	66.7	38.9	38.9	22
A13. Hail	5.6	66.7	38.4	15.3	23
E4. Biological contaminants (anthrax, smallpox, etc.)	8.3	83.3	38.0	31.3	24
A3. Tornado or high straight-line wind event	0.0	61.1	37.5	33.4	25
G3. Mass casualty incident	8.3	83.3	36.5	23.6	26
A14. Fog	8.3	50.0	35.4	12.5	27
A5. Lake Michigan coastal erosion	16.7	58.3	35.0	19.4	28
B3. Loss of telecommunication	11.1	75.0	32.5	20.9	29
G4. Building collapse or cave-in	13.9	55.6	32.4	13.9	30
D1. Aircraft transportation accidents	19.4	75.0	32.2	9.7	31
D3. Railway transportation accidents	11.1	75.0	31.9	18.1	32
B1. Contamination or loss of water supply	8.3	66.7	31.0	25.0	33
B2. Loss of sewerage system	5.6	61.1	29.4	13.9	34
E1. Correctional center incident	11.1	55.6	22.2	15.3	35
C3. Hazardous materials pipeline incidents	0.0	66.7	21.8	11.1	36
A15. Drought	0.0	38.9	17.6	13.9	37
A16. Dust storm	0.0	25.0	10.6	20.8	38
A4. Earthquake	0.0	33.3	9.0	22.2	39

[a]*Perceived threat increases with percentage.*

[b]*Interquartile range acts as a measure of agreement upon the perceived level of threat with a smaller interquartile range indicating stronger agreement and a larger interquartile range indicating weaker agreement.*

Source: SEWRPC.

Table 2

PRELIMINARY ESTIMATES OF HAZARD INCIDENTS AND DAMAGES AFFECTING CITY OF MILWAUKEE

Hazard[a]	Period	Incidents	Fatalities	Injuries	Property Damages (2016 dollars)
Natural Hazards					
Earthquake	**1956-2015**	**18**	**0**	**0**	**0**
Flood	**1966-2016**	**51**	**1**	**1**	**329,286,411**
Hail	**1963-2016**	**142**	**0**	**0**	**9,634,013**
Lake Michigan Coastal Hazards	**No Data**	**- -**	**- -**	**- -**	**- -**
Lightning	**1995-2016**	**27**	**0**	**2**	**2,762,413**
Temperature Extremes	**1994-2016**	**83**	**122**	**246**	**23,150**
Thunderstorms/High Winds	**1963-2016**	**263**	**3**	**9**	**42,658,441**
Tornadoes	**1958-2016**	**17**	**0**	**176**	**18,340,303**
Water Supply Loss or Contamination	**1990-2016**	**1**	**69**	**403,000**	**0**
Winter Storms	**1992-2016**	**153**	**32**	**9**	**122,505**
Wild Fires	**1994-2014**	**0**	**0**	**0**	**0**
Dam Failure	*1975-2016*	*0*	*0*	*0*	*0*
Drought	*1980-2016*	*17*	*0*	*0*	*0*
Dust Storms	*1959-2016*	*0*	*0*	*0*	*0*
Human-Induced Hazards					
Communicable Diseases	**2005-2014**	**23,036**	**- -**	**- -**	**- -**
Sexually-Transmitted Diseases	**2005-2014**	**100,084**	**- -**	**- -**	**- -**
Pipeline Hazmat Accidents	**1970-2015**	**35**	**0**	**30**	**17,058,763**
Terrorism	**1970-2015**	**8**	**0**	**1**	**61,857**
Transportation Hazmat Accidents	**1974-2014**	**1,715**	**3**	**114**	**3,061,651**
Automobile Accidents	*1999-2013*	*221,360*	*582*	*108,187*	*4,042,163,900*
Correctional Center Incident	*No Data*	*- -*	*- -*	*- -*	*- -*
Loss of Sewerage System	*No Data*	*- -*	*- -*	*- -*	*- -*
Nuclear Power Plant Incident	*2000-2016*	*0*	*0*	*0*	*0*
Waterway Transportations	*No Data*	*- -*	*- -*	*- -*	*- -*
Workplace Violence	*No Data*	*- -*	*- -*	*- -*	*- -*

[a]*Hazards in bold are currently profiled in the City of Milwaukee hazard mitigation plan. Hazards in italics are not currently profiled in the plan.*

Source: SEWRPC.

Table 3

ANNUAL INCIDENCE OF HAZARDS AND DAMAGES AFFECTING CITY OF MILWAUKEE

Hazard[a]	Years of Record	Incidents per Year	Fatalities per Year	Injuries per Year	Annual Property Damages (2016 dollars)
Natural Hazards					
Earthquake	**61**	**0.30**	**0.00**	**0.00**	**0**
Flood	**51**	**1.00**	**0.02**	**0.02**	**6,456,596**
Hail	**54**	**3.02**	**0.00**	**0.00**	**178,408**
Lake Michigan Coastal Hazards	**No Data**	**- -**	**- -**	**- -**	**- -**
Lightning	**22**	**1.23**	**0.00**	**0.09**	**125,564**
Temperature Extremes	**23**	**3.61**	**5.30**	**10.70**	**1,007**
Thunderstorms/High Winds	**54**	**4.87**	**0.06**	**0.17**	**789,971**
Tornadoes	**59**	**0.29**	**0.00**	**2.98**	**310,853**
Water Supply Loss or Contamination	**27**	**0.04**	**2.56**	**14,925.93**	**- -**
Winter Storms	**44**	**3.48**	**0.68**	**0.20**	**2,784**
Wild Fires	**11**	**0.00**	**0.00**	**0.00**	**0**
Dam Failure	*42*	*1.00*	*0.00*	*1.00*	*0*
Drought	*25*	*0.68*	*0.00*	*0.00*	*0*
Dust Storms	*58*	*0.00*	*0.00*	*0.00*	*0*
Human-Induced Hazards					
Communicable Diseases	**10**	**3,122.23**	**- -**	**- -**	**- -**
Sexually-Transmitted Diseases	**10**	**10,008.40**	**- -**	**- -**	**- -**
Pipeline Hazmat Accidents	**46**	**0.76**	**0.00**	**0.65**	**370,843**
Terrorism	**45**	**0.17**	**0.00**	**0.02**	**1,345**
Transportation Hazmat Accidents	**45**	**38.11**	**0.07**	**2.53**	**68,037**
Automobile Accidents	*15*	*14,757.33*	*38.80*	*7,212.47*	*269,477,593*
Correctional Center Incident	*No Data*	*- -*	*- -*	*- -*	*- -*
Loss of Sewerage System	*No Data*	*- -*	*- -*	*- -*	*- -*
Nuclear Power Plant Incident	*17*	*0.00*	*0.00*	*0.00*	*0*
Waterway Transportations	*No Data*	*- -*	*- -*	*- -*	*- -*
Workplace Violence	*No Data*	*- -*	*- -*	*- -*	*- -*

[a]*Hazards in bold are currently profiled in the City of Milwaukee hazard mitigation plan. Hazards in italics are not currently profiled in the plan.*

Source: SEWRPC.

Table 4

HAZARDS CURRENTLY PROFILED IN THE CITY OF MILWAUKEE HAZARD MITIGATION PLAN

Natural Hazards	Human-Induced Hazards
Earthquake	Contamination or Loss of Water Supply
Flooding	Hazardous Material Incidents
Lake Michigan Coastal Hazards	Major Fire and Emergency Incident
Temperature Extremes	Medical/Health Risk
Thunderstorms/High Winds (includes lightning and hail)	Terrorism
Tornadoes	
Winter Storms	

Source: SEWRPC.

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09/16/16

Boxhorn, Joseph E.

From: LEY, JAMES <JLEY@milwaukee.gov>
Sent: Tuesday, October 03, 2017 8:42 AM
To: Boxhorn, Joseph E.
Subject: Milwaukee County Hazard Mitigation Web Comment
Attachments: Mitigation plan Fire Station list.docx

Joe:
Attached is a list of fire stations (for 2018) to be included in Appendix B of the Mitigation plan. Our budget process is still ongoing and we may have an adjustment or two depending if the alderman find more money to save a fire station or company. I will be submitting some more updates relative to page 29 & 30.
Jim

James H. Ley
Deputy Chief
Milwaukee Fire Department
Special Operations Division
Phone: (414) 286-8943
Mobile: (414) 397-8195
Fax: (414) 286-8996

1st Battalion	Engine 1 (Tactical EMS team)	784 N. Broadway
	Engine 2, Truck 2	755 N. James Lovell St.
	Engine 18 (Incident Command Post), Battalion 1	3628 N. Holton St.
	Engine 21, Med 6	2050 N. Palmers St.
	Engine 27, Truck 5	2647 N. Bartlett Av.
	Engine 30, Med 7	2903 N. Teutonia Av.
2nd Battalion	Engine 13, Battalion 2	2901 N. 30th St.
	Engine 22, Med 3	8814 W. Lisbon Av.
	Engine 24, Rescue 2, HURT	4927 W. Fiebrantz Av.
	Engine 34, Med 13	6205 W. Burleigh St.
	Engine 36, Med 5	4060 N. 27th St.
	Engine 37	5335 N. Teutonia Av.
3rd Battalion	Engine 10, Med 18	5600 W. Oklahoma Av.
	Engine 26, Battalion 3	1140 S. 26th St.
	Engine 29	3529 S. 84th St.
	Engine 32, Truck 9	1551 N. 30th St.
	Engine 33, Truck 17, HAZMAT 1 & 2	4515 W. Burnham St.
	Engine 35, Med 14	100 N. 64th St.
4th Battalion	Engine 7, Battalion 4	3174 S. Chase St.
	Engine 11, Med 15	2526 S. KK Av.
	Engine 12, Rescue 1, Rescue 4 (HURT)	2130 W. Oklahoma Av.
	Engine 14, Truck 8	6074 S. 13th St.
	Engine 17, Med 17	4653 S. 13th St.
	Engine 23, Truck 1 (Dive Rescue)	1400 S. 9th St.
7th Battalion	Engine 4, Truck 3 (Community Paramedics)	9511 W. Appleton Av.
	Engine 8, Med 16	5585 N. 69th St.
	Engine 9, Med 4	4141 W. Mill Rd.
	Engine 16, Battalion 7	10320 W. Fond du Lac Av.
	Engine 38, Med 19	8463 N. Granville Rd.
	Engine 39, Truck 7	8025 W. Bradley Rd.

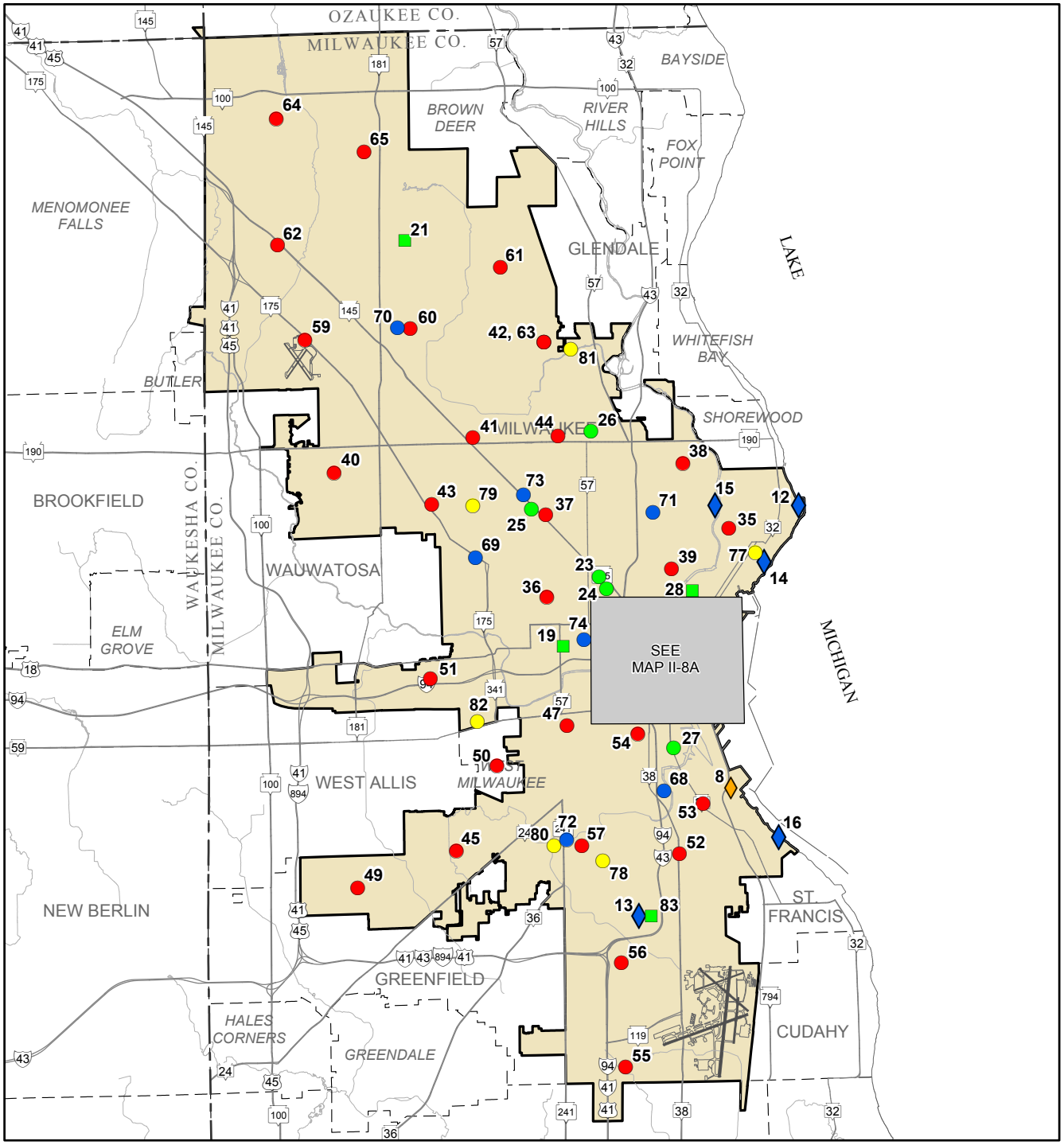
Boxhorn, Joseph E.

From: LEY, JAMES <JLEY@milwaukee.gov>
Sent: Wednesday, October 04, 2017 9:09 AM
To: Boxhorn, Joseph E.
Subject: Chapter 2 Fire Suppression & Rescue Services
Attachments: Chapter 2 Fire Suppression & Rescue Services.docx

Joe:
Attached is the Fire Suppression & Rescue Service update for Chapter 2
Jim

Map II - 8

CRITICAL FACILITIES IN THE CITY OF MILWAUKEE: 2016



- CRITICAL GOVERNMENT FACILITY
- LAW ENFORCEMENT STATION
- FIRE STATION
- HOSPITALS AND MEDICAL CENTERS
- CITY OF MILWAUKEE
- MILWAUKEE COUNTY TRANSIT SYSTEM FACILITY
- PORT OF MILWAUKEE
- WATER PURIFICATION PLANT OR PUMPING STATION
- WASTEWATER TREATMENT PLANT
- 29 — CRITICAL FACILITY REFERENCE NUMBER (SEE APPENDIX B, TABLES B-1 TO B-4)

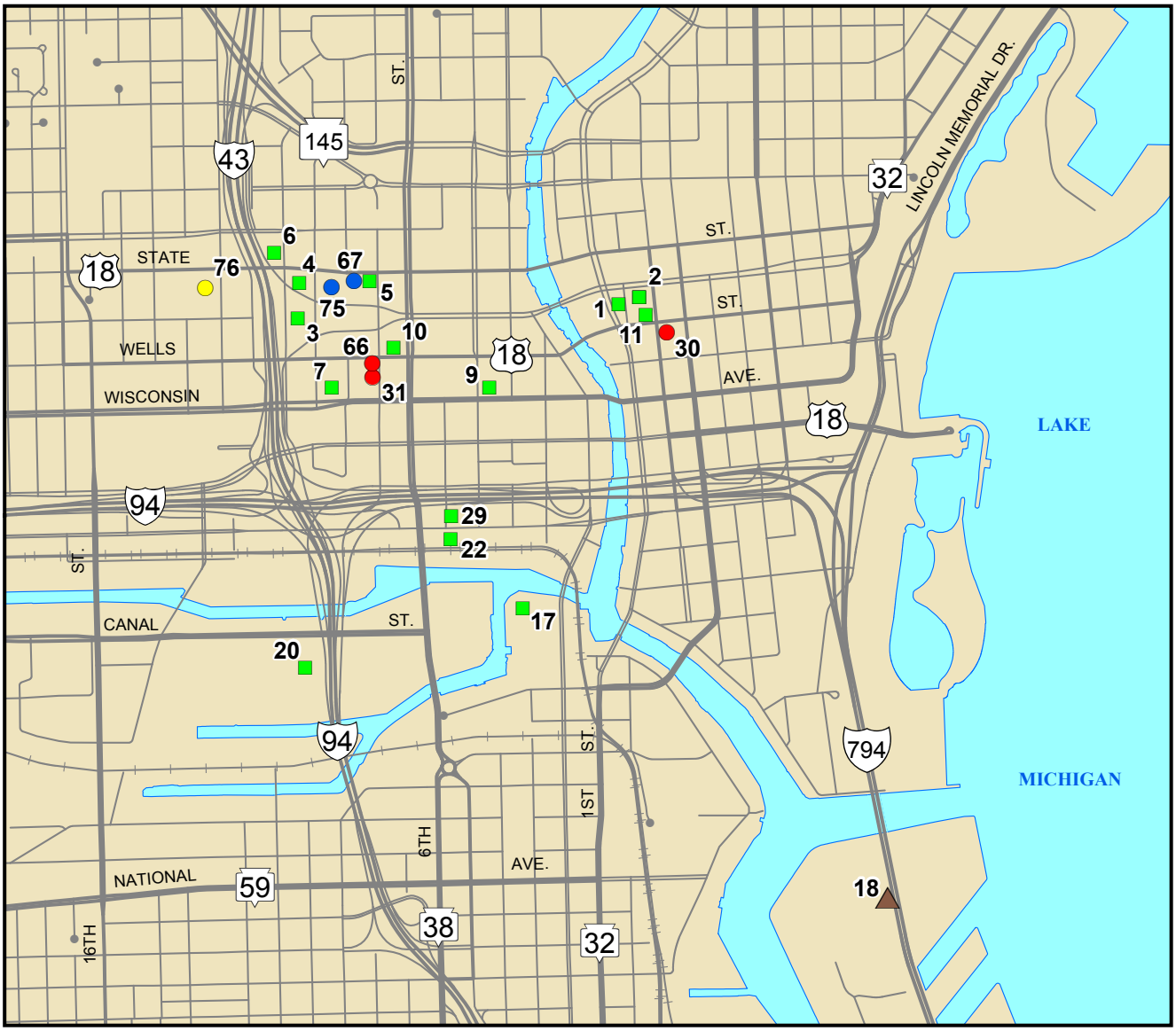
N

0 0.5 1 2 Miles

Source: Milwaukee County Automated Mapping and Land Information System (MCAMLIS), City of Milwaukee Master Property File (MPROP), and SEWRPC.

Map II - 8A

CRITICAL FACILITIES IN THE CITY OF MILWAUKEE: 2016



- CRITICAL GOVERNMENT FACILITY
- LAW ENFORCEMENT STATION
- FIRE STATION
- HOSPITALS AND MEDICAL CENTERS
- WASTEWATER TREATMENT PLANT

29 CRITICAL FACILITY REFERENCE NUMBER (SEE APPENDIX B, TABLES B-1 TO B-4)

N

GRAPHIC SCALE

0 1,000 2,000 Feet

Source: Milwaukee County Automated Mapping and Land Information System (MCAMLIS), City of Milwaukee Master Property File (MPROP), and SEWRPC.

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Table B-2

FIRE STATIONS IN THE CITY OF MILWAUKEE: 2018

Number on Map II-8	Battalions/Bureaus	Facility Name	2016 Assessed Value[a]	Address
30	1st Battalion	Engine #1,Tactical EMS Team	$211,700	784 N. Broadway Street
31		Engine #2, Truck #2	- -[b]	755 N. James Lovell Street
38		Engine #18, Incident Command Post, Battalion #1	237,000	3628 N. Holton Street
39		Engine #21, MED #6	35,700	2050 N. Palmer Street
35		Engine #27, Truck #5	42,900	2647 N. Bartlett Avenue
42		Engine #30, Med #7	- -[b]	2903 N. Teutonia Avenue
37	2nd Battalion	Engine #13, Battalion #2	159,000	2901 N. 30th Street
40		Engine #22, MED #3	389,500	8814 W. Lisbon Avenue
41		Engine #24, Rescue #2, HURT	326,000	4927 W. Fiebrantz Avenue
43		Engine #34, MED #13	264,000	6205 W. Burleigh Street
44		Engine #36, MED #5	17,460	4060 N. 27th Street
63		Engine #37	- -[b]	5335 N. Teutonia Avenue
45	3rd Battalion	Engine #10, MED # 18	388,000	5600 W. Oklahoma Avenue
47		Engine #26, Battalion #3	128,700	1140 S. 26th Street
49		Engine #29	23,300	3529 S. 84th Street
36		Engine #32, Truck #9	14,000	1551 N. 30th Street
50		Engine #33, Truck #17, HAZMAT #1 and #2t	- -[b]	4515 W. Burnham Street
51		Engine #35, MED #14	- -[b]	100 N. 64th Street
52	4th Battalion	Engine #7, Battalion #4	225,300	3174 S. Chase Avenue
53		Ladder #11, MED #15	84,000	2526 S. Kinnickinnic Avenue
57		Engine #12, Rescue #1, Rescue #4 (HURT)	122,900	2130 W. Oklahoma Avenue
55		Engine #14, Truck #8	284,500	6074 S. 13th Street
56		Engine #17, MED #17	287,000	4653 S. 13th Street
54		Engine #23, Truck #1 (Dive Rescue)	473,300	1400 S. 9th Street
59	7th Battalion	Engine #4, Truck #3 (Community Paramedics)	466,000	9511 W. Appleton Avenue
60		Engine #8, MED#16	712,000	5585 N. 69th Street
61		Engine #9, MED #4	520,800	4141 W. Mill Road
62		Engine #16, Battalion #7	571,400	10320 W. Fond du Lac Avenue
64		Engine #38, MED #19	280,000	8463 N. Granville Road
65		Engine #39, Truck #7	420,000	8025 W. Bradley Road
66	Administration	- -	1,300,930	711 W. Wells Street
66	Special Operations	Emergency Medical Services and Special Teams	1,300,930	711 W. Wells Street
- -	Fire and Police Commission	City Hall Room 706A	10,966,000	200 E. Wells Street

NOTE: The following abbreviations have been used:

DIVE = Dive Rescue Team
HURT = Heavy Urban Rescue Team
MED = Emergency Medical Services Unit
Hi-Vol = High Volume Unit
HAZMAT = Hazardous Materials Response Team

[a]*Current assessment value of improvements, based on 2016 Milwaukee Properties Master file (MPROP).*

[b]*Data not available.*

Source: City of Milwaukee Fire Department and SEWRPC.

SUMMARY NOTES OF THE JUNE 28, 2018 MEETING OF THE CITY OF MILWAUKEE HAZARD MITIGATION PLAN LOCAL PLANNING TEAM

INTRODUCTION

The June 28, 2018 meeting of the City of Milwaukee Hazard Mitigation Plan Local Planning Team was convened at the Frank P. Zeidler Municipal Building at 9:10 a.m. The meeting was called to order by Kurt Sprangers, Stormwater Manager, City of Milwaukee Department of Public Works. Attendance was taken by circulating a sign-in sheet.

In attendance at the meeting were the following individuals:

Local Planning Team Members

Kurt Sprangers, Chair	Stormwater Manager, City of Milwaukee Department of Public Works
Joseph E. Boxhorn, Secretary	Senior Planner, Southeastern Wisconsin Regional Planning Commission
Kristin Connelly	Principal Planner, City of Milwaukee Department of City Development
Jeffrey Cross	Engineering Assistant, Southeastern Wisconsin Regional Planning Commission
Laura Herrick	Chief Environmental Engineer, Southeastern Wisconsin Regional Planning Commission
Leah Redding	Emergency Management Coordinator, Milwaukee County Office of Emergency Management
Jose Rivera	Emergency Response Planning Coordinator, Milwaukee Health Department
Michael Schaefer	Water Security Manager, Milwaukee Water Works
Tim Thur	Infrastructure Administration Manager, City of Milwaukee Department of Public Works

Mr. Sprangers welcomed all attendees to the meeting. He stated that this was the third meeting of the Local Planning Team for the second update to the original plan. He informed attendees that the purpose of the meeting was to review Chapters III and IV of the draft plan.

CONSIDERATION OF SUMMARY NOTES OF SEPTEMEBER 13, 2017, LOCAL PLANNING TEAM MEETING

Mr. Sprangers introduced Joseph Boxhorn, Senior Planner, Southeastern Wisconsin Regional Planning Commission (SEWRPC). At Mr. Spranger's request, Mr. Boxhorn reviewed the summary notes from the September 17, 2017, meeting of the Local Planning Team. He stated that the summary notes documented updates that were made to Chapters I and II of the plan based upon discussion that occurred at the prior Team meeting.

Ms. Connelly noted that a Harbor District plan was added to the City of Milwaukee Comprehensive Plan, and that several of the neighborhood plans listed as pending adoption in Table I-1 of Chapter I were adopted by the City. Mr. Boxhorn replied that Table I-1 will be updated to include the changes that occurred to the comprehensive plan. No further comments were provided on the summary notes.

[Secretary's Note: Table I-1 of Chapter I was revised to include the Harbor District Water and Land Use Plan. This table was also revised to show the adoption by the City of the North 27th Street Corridor Strategy on January 29, 2017; the South 27th Street Strategic Action Plan on June 15, 2017; and the Aerotropolis Development Plan on November 7, 2017. A copy of the revised table is attached herein as Exhibit A.]

CONSIDERATION OF CHAPTER III, "ANALYSIS OF HAZARD CONDITIONS," OF SEWRPC COMMUNITY ASSISTANCE PLANNING REPORT NO. 282 (3RD EDITION), *CITY OF MILWAUKEE ALL HAZARD MITIGATION PLAN UPDATE*

At Mr. Spranger's request, Mr. Boxhorn reviewed the preliminary draft of Chapter III of the plan report. Mr. Boxhorn indicated that he would display copies of the maps from Chapter III on the projection screen in the meeting room during discussion of the chapter.

[Secretary's Note: A copy of Mr. Boxhorn's presentation is attached herein as Exhibit B.]

Mr. Boxhorn stated that Chapter III does three things: 1) it documents how the hazards that are addressed in the plan were identified, 2) it briefly describes how the risks and vulnerabilities associated with the hazards were assessed, and 3) it presents a profile of each hazard addressed by the plan. He noted that material in the draft chapters that is either new or revised has been highlighted blue in the text. He explained that this was done to assist readers in reviewing the chapter. He indicated that the highlighting will be removed prior to publication of the final report.

Mr. Boxhorn reviewed the section of the draft chapter on hazard identification. No questions or comments were offered on this section.

Mr. Boxhorn reviewed the section of the draft chapter on vulnerability assessment methods. In reference to the subsection on assessments of potential future changes in hazard conditions relative to climate change, Mr. Thur asked whether the projected increase in average temperatures in the City of Milwaukee will lead to an increase in average precipitation during winter months and what impact this might have on the potential for stormwater flooding in the City. Mr. Boxhorn replied that the projected increase in temperatures in the City will likely lead to more rain and freezing rain in winter months and less snow. He added that an increase in average precipitation will likely lead to an increase in the frequency and severity of flooding events that impact the City.

Mr. Boxhorn reviewed the section on flooding and associated stormwater drainage problems. Mr. Sprangers commented that the estimated number of structures in the floodplain appeared to be low. Mr. Thur concurred with Mr. Sprangers' comment. Mr. Boxhorn replied that most of the numbers came from the Milwaukee Metropolitan Sewerage District's (MMSD) recent Kinnickinnic River watershed flood management plan. Ms. Herrick asked whether a list is available that provides a more accurate number of structures in the floodplain. Mr. Sprangers replied that no such list is available. He suggested that the structures identified in the Milwaukee Harbor estuary study might be missing from the draft Chapter. Ms. Herrick replied that SEWPRC staff will review the estimate and make any necessary changes.

[Secretary's Note: SEWRPC staff reviewed the estimated numbers of structures in the floodplain in the City of Milwaukee. A breakdown of the revised count is attached herein as Exhibit C. Chapter III was revised accordingly.]

Mr. Boxhorn introduced Jeffrey Cross of the SEWRPC staff and asked him to review several sections of the draft chapter. Mr. Cross reviewed the section on thunderstorms and related hazards. Mr. Cross stated that a discussion of the vulnerability of mobile and manufactured homes to high winds from thunderstorms was added to this section. He explained that there are currently five mobile home parks located in the City and that installing community saferooms in such parks has be a recent priority for the Wisconsin Division of Emergency Management (WEM). Mr. Thur asked who is responsible for constructing such shelters. Mr. Boxhorn replied that the Federal Emergency Management Agency (FEMA) provides some funding, but the mobile home parks may provide the local match through setting aside land for the shelter. Mr. Thur asked whether the City Department of Community Development was interested in pursuing the installation of such shelters. Ms. Connelly replied that mobile home parks are currently a prohibited land use under the City's ordinances. She added that the City is seeking to phase out existing mobile home parks.

Mr. Cross reviewed the section of the draft chapter on tornadoes. No questions or comments were offered.

Mr. Cross reviewed the section of the draft chapter on extreme temperatures. He noted that more detailed discussion of extreme cold was added to the chapter. He added that the discussion of extreme heat includes a map showing a geographical analysis of vulnerability to extreme heat that was developed by the Wisconsin Department of Health Services. Mr. Rivera noted that he anticipates that a new map of heat vulnerability based upon additional data will become available next year. Mr. Boxhorn replied that this map will not be available soon enough to use for this update, but that it could be incorporated into the next edition of the hazard mitigation plan.

Mr. Cross reviewed the section of the draft chapter on Lake Michigan coastal hazards. Mr. Sprangers stated that FEMA is conducting studies of velocity zones along the Lake Michigan coast. Ms. Herrick responded that we are currently still awaiting the issuance of preliminary Lake Michigan maps from FEMA. Mr. Sprangers noted that these maps may have V zones showing areas subject to high velocity hazards from coastal flooding. He listed areas along Lincoln Memorial Drive and Jones Island as potential V zone locations. Ms. Herrick replied that she would check the status of this mapping effort.

[Secretary's Note: SEWRPC staff consulted staff from the Wisconsin Department of Natural Resources (WDNR) regarding the status of coastal flood hazard mapping for Wisconsin. WDNR staff anticipate that preliminary digital flood insurance rate maps for the southern counties along Lake Michigan will be released in 2020. In addition, WDNR staff indicated that they are currently working on the development of a model coastal flood-plain ordinance.]

Mr. Cross reviewed the section of the draft chapter on winter storms. No questions or comments were offered.

Mr. Boxhorn reviewed the section of the draft chapter on contamination or loss of water supply. He noted that discussion was added to this section on water main breaks, cross connections, and lead water service lines. He indicated that the hazard involving lead in drinking water would be better addressed in a separate planning effort from the City's hazard mitigation plan and suggested removing the related discussion from the draft chapter and adding a brief explanation as to why the hazard mitigation plan is not addressing it. Mr. Schaefer stated that the Water Works would support removing the issue of lead water service lines from the hazard mitigation plan. Mr. Boxhorn asked Local Planning Team members whether there was a consensus on removing the lead hazard from the plan. The consensus of the Local Planning Team was to remove the lead hazard from the plan.

[Secretary's Note: The last paragraph on page 67 and the first four paragraphs on page 68 were removed from the draft chapter. The following paragraph was added after the last paragraph on page 8:

"*Lead Water Service Lines*
One hazard addressed by this hazard mitigation plan is the contamination and/or loss of the City's water supply. Lead is one of several potential contaminants that could affect potable water in the City. Lead is a toxic metal that can cause health impacts that result in damage to peoples' nervous systems, kidneys, red blood cells, and reproductive systems. Children are especially sensitive to toxic effects of lead.

"Release of lead from lead water service lines and lead-containing plumbing fixtures and fittings constitute the major sources of lead in drinking water in the City. Most homes in the City that were built prior to 1951 have lead service lines. In addition, plumbing installed prior to 1986 may include fixtures, fittings, and solder containing lead. To reduce the release of lead from plumbing, the Milwaukee Water Works adds anticorrosion agents to municipal water supplies as part of its treatment process.

"People can be exposed to lead from sources other than drinking water. The greatest potential for human exposure to lead results from two of its former uses, as an additive to gasoline and a pigment in paints.

"The Milwaukee Water Works is currently conducting efforts related to addressing lead water services. In addition, the City of Milwaukee Health Department is conducting broader efforts related to lead poisoning within the City. The comprehensive approach required to address the sources and impacts of lead place this issue beyond the scope of what can be accomplished in a hazard mitigation plan. Because of this, the City of Milwaukee all hazard mitigation plan will not address lead in drinking water."]

Mr. Schaefer suggested revisions to several numbers shown in the vulnerability assessment for contamination or loss of water supply regarding water usage and water main breaks in the City of Milwaukee.

[Secretary's Note: The first sentence in the last paragraph on page 66 was revised to read (text in bold is included here, and in similar subsequent Secretary's Notes, to indicate language changed or added onto the text. Text will not be bold in the report):

"As noted in Chapter II, **approximately 94** million gallons per day (mgd) of Lake Michigan surface water are utilized as the source of supply by all water users in the City of Milwaukee."

The third sentence in the second full paragraph on page 67 was revised to read:

"The Milwaukee Water Works reported experiencing an average of **537** water main breaks per year over the period from 2008 through 2017."

The second sentence in the third full paragraph on page 67 was revised to read:

"During the months of January through March 2014, the utility had 553 breaks."]

Mr. Boxhorn reviewed the section of the draft chapter on hazardous material incidents. Mr. Sprangers commented that the Port of Milwaukee has begun transporting shipments of crude oil. Mr. Boxhorn replied that discussion of this would be added to the draft chapter.

[Secretary's Note: The following paragraph was added after the first partial paragraph on page 75:

"In September 2017, The City of Milwaukee amended its lease agreement with U.S. Oil, a fuel storage and distribution company that has storage facilities and conducts business at the Port of Milwaukee. The amended lease agreement prohibits the storage of crude oil or shipping of crude oil through the port. The lease does not prohibit storage or shipping of some other flammable substances. U.S. Oil began shipping ethanol through the Port of Milwaukee in spring 2018. The size of the first shipment was about 100,000 barrels. The company anticipates that it will make three to five ethanol shipments through the port per year."]

Mr. Boxhorn reviewed the section of the draft chapter on medical and health risks. No questions or comments were offered on this section.

Mr. Boxhorn reviewed the section of the draft chapter on terrorism. Mr. Rivera asked whether the plan will address cyberattacks. Mr. Boxhorn replied that the consensus of the Local Planning Team at a prior meeting was that the mitigation options available to local governments for addressing cyberattack were limited and consequently this plan will not address this hazard.

Mr. Boxhorn reviewed the section of the draft chapter on fire and emergency medical incidents. No questions or comments were offered on this section.

CONSIDERATION OF CHAPTER IV, "HAZARD MITIGATION GOALS AND OBJECTIVES," OF SEWRPC COMMUNITY ASSISTANCE PLANNING REPORT NO. 282 (3RD EDITION) *CITY OF MILWAUKEE ALL HAZARD MITIGATION PLAN UPDATE*

At Mr. Sprangers' request, Mr. Cross reviewed the preliminary draft of Chapter IV of the plan report. Mr. Cross stated that Chapter IV outlines the desired goals and objectives of the hazard mitigation plan. He indicated that no changes were made to the chapter other than to update and revised several references. No questions or comments were offered on this chapter.

DISCUSSION OF FUTURE PUBLIC MEETINGS

Mr. Boxhorn told the Local Planning Team that FEMA requires that at least two public meetings be held during the planning process to give the public an opportunity to comment on the plan. He indicated that this would be a good time to hold the first of these meetings. He explained that he anticipates that this meeting would cover the purpose and scope of the plan updating effort, review progress to date, and provide members of the public with an opportunity to ask questions and offer comments about the plan. He noted that members of the Local Planning Team are welcome to attend the meeting, but their attendance is not required.

Mr. Sprangers asked when the meeting should be held. Mr. Boxhorn replied that it should be held within the next month or so, but that he and Mr. Sprangers could discuss potential dates after the meeting.

[Secretary's Note: In consultation between City and SEWRPC staffs, it was decided to hold the public meeting on November 7, 2018.]

ADJOURNMENT

There being no further business, the meeting was adjourned by unanimous consent at 10:44 a.m.

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Exhibit A: Table I-1 from Docs # 239983
Exhibit B: Boxhorn presentation (Docs #242605)
Exhibit C: Revised structure count (Docs #243480)

Table I-1

CITY OF MILWAUKEE COMPREHENSIVE PLAN:
CITYWIDE POLICY PLAN, AREA PLANS, AND RELATED ACTION PLANS

Area	Plans	Adoption and Amendment Dates
Citywide	City of Milwaukee Department of City Development, *Milwaukee Comprehensive Plan: Citywide Policy Plan*, March 2010	Adopted on March 2, 2010
Downtown	City of Milwaukee Department of City Development, *Milwaukee Comprehensive Plan: Downtown—A Plan for the Area*, October 2010	Adopted on October 12, 2010
Fond du Lac and North	City of Milwaukee Department of City Development, *Milwaukee Comprehensive Plan: Fond du Lac and North—A Plan for the Area*, March, 2004	Adopted on March 19, 2004
Harbor District	City of Milwaukee Department of City Development, *Milwaukee Comprehensive Plan: Harbor District Water and Land Use Plan,* December 2017	Adopted on February 6, 2018
Menomonee Valley	City of Milwaukee Department of City Development, *Milwaukee Comprehensive Plan: Menomonee Valley 2.0—A Plan for the Area*, June 2015	Adopted on June 2, 2015
Near North	City of Milwaukee Department of City Development, *Milwaukee Comprehensive Plan: Near North Side—A Plan for the Area*, December 2009	Adopted on December 22, 2009
Near South	City of Milwaukee Department of City Development, *Milwaukee Comprehensive Plan: Near South Side—A Plan for the Area*, May 2009, amended June 23, 2015 and March 1, 2016	Adopted on May 27, 2009; amended on June 23, 2015 and March 1, 2016
	City of Milwaukee Department of City Development, *Milwaukee Comprehensive Plan: Walker's Point Strategic Action Plan—A Plan for the Area*, June 2015	Adopted on June 23, 2015
	City of Milwaukee Department of City Development, Walker Square Neighborhood Association, *Milwaukee Comprehensive Plan: Walker Square Strategic Action Plan—A Part of the Near South Side Area Plan*, December 2015	Adopted on March 1, 2016
Near West	City of Milwaukee Department of City Development, *Milwaukee Comprehensive Plan: Near West Side—A Plan for the Area*, March 2004, amended March 3, 2009	Adopted on March 19, 2004 and amended on March 3, 2009
	City of Milwaukee Department of City Development, Near West Side Partners, *Milwaukee Comprehensive Plan: North 27th Street Corridor Strategy—A Part of the Near West Side Area Plan*, January 2018	Adopted January 29, 2017
Northeast	City of Milwaukee Department of City Development, *Milwaukee Comprehensive Plan: Northeast Side—A Plan for the Area*, July 2009	Adopted on September 1, 2009
	City of Milwaukee Department of City Development, Riverworks Development Corporation, Riverworks Business Improvement Districts 25 and 36, *Milwaukee Comprehensive Plan: Riverworks Strategic Action Plan*, Summer 2012	Plan in final draft stage, pending adoption
Northwest	City of Milwaukee Department of City Development, *Milwaukee Comprehensive Plan: Northwest Side—A Plan for the Area*, December 2007, amended September 26, 2017	Adopted on February 5, 2008 and amended on September 26, 2017
	City of Milwaukee Department of City Development, Granville Business Improvement District, *Milwaukee Comprehensive Plan: Granville Strategic Action Plan and Land Use Study—A Part of the Northwest Side Area Plan*, October 2017	Adopted on September 26, 2017
Southeast	City of Milwaukee Department of City Development, *Milwaukee Comprehensive Plan: An Area Plan for the Southeast Side*, October 2008	Adopted on October 29, 2008

Area	Plans	Adoption and Amendment Dates
Southeast (continued)	City of Milwaukee Department of City Development, South 27th Street Business Improvement District, *Milwaukee Comprehensive Plan: South 27th Street Strategic Action Plan—A Part of the Southeast and Southwest Side Area Plans*, March 2017	Adopted on June 15, 2017
	City of Milwaukee Department of City Development, Aerotropolis Milwaukee, The Gateway to Milwaukee Improvement District*, Milwaukee Comprehensive Plan: Milwaukee Aerotropolis Development Plan Summary—A Part of the Southeast Side Area Plan*, August 2017	November 7, 2017
Southwest	City of Milwaukee Department of City Development, *Milwaukee Comprehensive Plan: Southwest Side—A Plan for the Area*, December 2009	Adopted on December 22, 2009
	City of Milwaukee Department of City Development, South 27th Street Business Improvement District, *Milwaukee Comprehensive Plan: South 27th Street Strategic Action Plan—A Part of the Southeast and Southwest Side Area Plans*, March 2017	Adopted on June 15, 2017
Third Ward	City of Milwaukee Department of City Development, *Milwaukee Comprehensive Plan: The Third Ward—A Plan for the Neighborhood*, May 2005, amended July 12, 2006	Adopted on May 20, 2005 and amended on July 12, 2006
Washington Park	City of Milwaukee Department of City Development, *Milwaukee Comprehensive Plan: Washington Park—A Plan for the Area*, June 2006	Adopted on June 20, 2006
West	City of Milwaukee Department of City Development, *Milwaukee Comprehensive Plan: West Side—A Plan for the Area*, December 2009	Adopted on December 1, 2009

Source: City of Milwaukee Department of City Development and SEWRPC.

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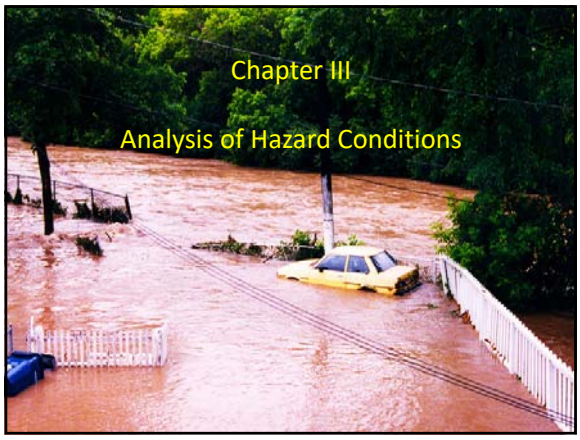


Chapter III Overview

- Documents the identification of the hazards that the plan addresses
  - This includes brief descriptions of hazards that are not addressed but were considered for inclusion during the planning process
- Describes how risks and vulnerabilities were assessed
- Gives a profile of each hazard addressed by the plan

Hazard Identification

Table III-8

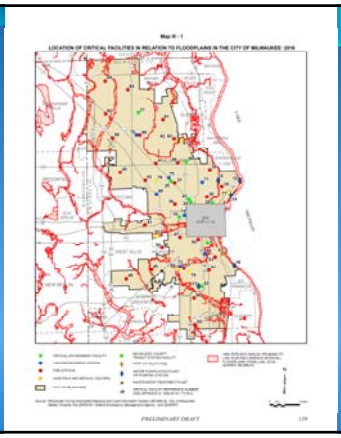
SUMMARY OF HAZARDS TO BE CONSIDERED IN THE CITY OF MILWAUKEE HAZARD MITIGATION PLAN

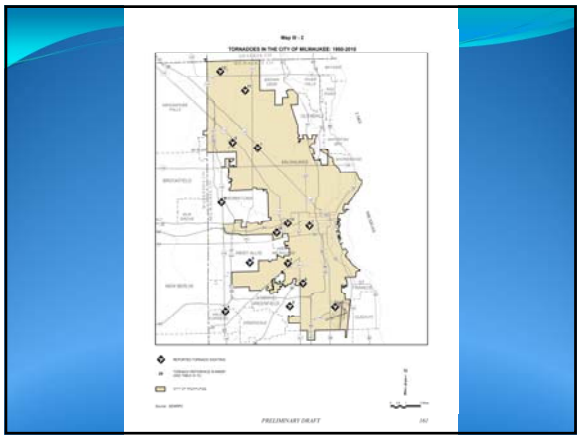
Hazard	Risk of Occurrence (high, medium, or low)	Warning Time (short, medium, or long)	Damage to Property (high, moderate, or low)	Threat to Life Safety (high, medium, or low)	Duration of Impact (long, moderate, or short)	Size of Affected Area (large, medium, or small)
Natural Hazards						
Flooding	High	Medium	High	Low	Moderate	Large
Thunderstorm, High Wind, Hail, Lightning	High	Short	High	High	Long	Large
Winter storms	Medium	Medium	Low	Medium	Moderate	Large
Tornadoes	Low	Short	High	Medium	Short	Small
Temperature Extremes	Medium	Long	Low	High	Long	Large
Coastal Erosion	Low	Long	Medium	Low	Long	Small
Other Hazards						
Contamination or Loss of Water Supply	Low	Short	Moderate	Medium	Moderate	Medium to large
Hazardous Materials Incident	High	Short	Low	Medium	Moderate	Small
Medical/Health Risks	Low	Short	Low	High	Moderate to long	Small to large
Terrorism Incident	Low	Short	Moderate to high	High	Short	Small to medium
Major Fire and Emergency Incident	Low	Short	Low	High	Moderate to long	Small to large

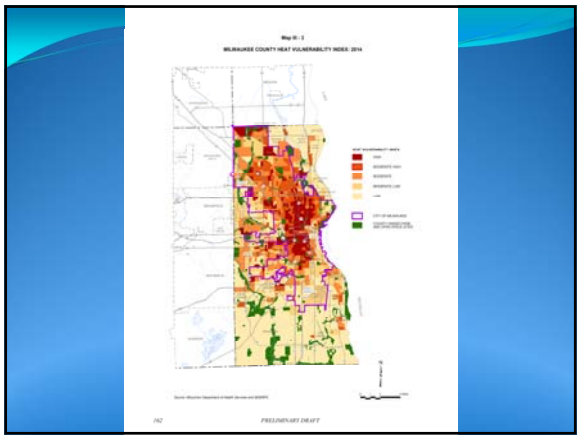
Source: City of Milwaukee Hazard Mitigation Local Planning Team and SEWRPC.

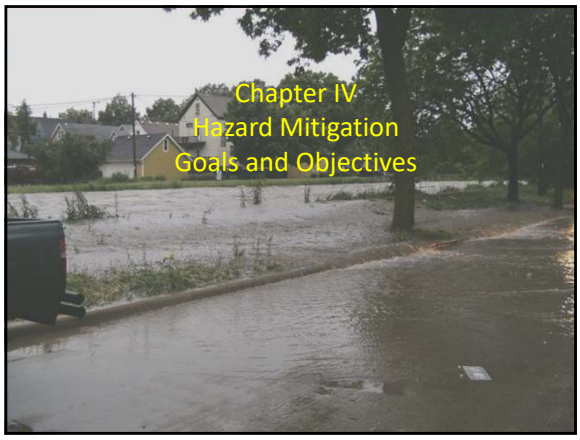
Hazard Profiles

- Most profiles follow a similar format
  - Definition and description of the hazard
  - Description of notable historical events that affected the City
  - Description of some notable recent events that affected the City
  - Assessment of vulnerabilities to the hazard and community impacts from the hazard
  - Description of potential future changes in impacts
  - Discussion of any differences among communities in risks









Hazard Mitigation Goals

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, and natural areas and critical species habitats.

Hazard Mitigation Goals

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.

Hazard Mitigation Goals

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 erosion.
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.

Public Meetings on Hazard Mitigation Plan

- Times and locations to be determined
- Review progress on the plan update to date
- Seek public input
  - Problem areas relative to hazards
  - Potential mitigation measures and projects
  - Comments on draft plan

Project Web Site

- http://www.sewrpc.org/HMP
  - Agendas and other meeting materials
  - Summary notes from meetings
  - Presentations
  - Draft chapters as they are completed
  - Comment screen
  - Other ways to send a comment
- Email to jboxhorn@sewrpc.org

City of Milwaukee Hazard Mitigation Plan (#243480.docx)

2018

Number of structures in the 100-year floodplain (City of Milwaukee only)

Watershed	Stream	100-yr Floodplain Source	Number of Structures in the Floodplain for City	Notes
Milwaukee (subtotal = 19)	Milwaukee River	FEMA	16	*13 downstream of former North Ave dam, 3 homes upstream of dam
	Lincoln Creek	FEMA	2	One at Custer & 60th, one at mouth
	Brown Deer Park Creek	MCAMLIS	0	
	Beaver Creek	FEMA (2017 LOMR)	1	
Menomonee River (subtotal = 52)	Menomonee River	CLOMR (North Ave to Mouth)	43	Note – CLOMR includes the Western Milwaukee Phase 2B levee which is a future condition, 4 at 45th St, *39 at mouth. {Note - An additional 43 structures are in current floodplain without WM Phase 2B project (map attached). With the hanging levee alternative in the WM Phase 2B project, 6 additional structures adjacent to Hwy 175 would remain in the floodplain. So add 43 to take WM P2B out, add 6 to update to latest proposed P2B design}
		MCAMLIS (upstream of North Ave	0	
	Woods Creek	MCAMLIS	1	
	Little Menomonee River	MCAMLIS	1	
	Honey Creek	MCAMLIS	7	
Oak Creek	Oak Creek	FEMA	6	2 on North Branch, 4 on GMIA
Kinnickinnic River	Kinnickinnic River and Tributaries	MCAMLIS	734	688 is MMSD count plus *46 at mouth
		TOTAL	811	

*Estuary counts all based on maps attached – which match source listed above for the three rivers LKH/RJP/JAM 6/29/18

SUMMARY NOTES OF THE NOVEMBER 7, 2018 PUBLIC MEETING FOR THE CITY OF MILWAUKEE HAZARD MITIGATION PLAN LOCAL PLANNING TEAM

INTRODUCTION

The November 7, 2018 public meeting for the City of Milwaukee Hazard Mitigation Plan was convened at the City of Milwaukee Department of Public Works Field Headquarters at 4:00 p.m. The meeting was called to order by Kurt Sprangers, Stormwater Manager, City of Milwaukee Department of Public Works. Attendance was taken by circulating a sign-in sheet.

In attendance at the meeting were the following individuals:

Members of the Public
None

Staff

Kurt Sprangers	Stormwater Manager, City of Milwaukee Department of Public Works
Joseph E. Boxhorn	Principal Planner, Southeastern Wisconsin Regional Planning Commission
Jeffrey Cross	Planner, Southeastern Wisconsin Regional Planning Commission

Mr. Sprangers welcomed all attendees to the meeting. He stated that this was the fourth meeting of the Local Planning Team for the second update to the original plan. He informed attendees that the purpose of the meeting was to review the draft plan. At Mr. Spranger's request, Mr. Boxhorn gave a presentation on the plan update (a copy of Mr. Boxhorn's presentation is attached herein as Exhibit A).

The meeting was adjourned at 5:00 p.m.

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Exhibit A: Docs # 242608, this can be six slides to the page

Agenda for Meeting

- Discuss purpose of plan
- Review the work completed to date
- Seek information
  - Problem areas related to hazards
  - Potential mitigation measures and projects
- Answer questions on the plan
- Take comments on plan

What is Hazard Mitigation?

- "Mitigation is any sustained action taken to eliminate or reduce the long-term risk to human life and property from natural and technological hazards"—FEMA
- Actions to reduce the damages that result when disasters occur

What is Hazard Mitigation?

- Mitigation is not:
  - Emergency response
  - Crisis management
  - Disaster preparation and recovery
- Mitigation focuses on reducing the impacts from hazard events when they occur

Why Do We Mitigate Hazards?

- Disasters are costly
- State and Federal assistance are insufficient
- We can prevent future damages
- Lesser impacts mean a quicker response and recovery process
- Can do this locally

City of Milwaukee All Hazard Mitigation Plan

- Sets forth strategies for mitigating impacts of several natural and technological hazards
- Establishes eligibility for hazard mitigation funding from the Federal Emergency Management Agency (FEMA)
  - FEMA requires that local hazard mitigation plans be updated and revised every five years

City of Milwaukee All Hazard Mitigation Plan

- Plan development and updating is overseen by a Local Planning Team
  - Team includes appointed officials, department and agency representatives, business representatives, knowledgeable citizens
  - Law enforcement and fire departments, public works department, planning department, health department, County emergency management department, and Milwaukee Metropolitan Sewerage District
- Staff include Department of Public Works, Office of Emergency Management and Homeland Security, and SEWRPC

Plan Components to Review and Revise

- Review implementation activities
- Update inventories of natural and built features
- Review and reevaluate identification of hazards
- Update and reevaluate risk and vulnerability analysis
- Review and revise hazard mitigation goals
- Review and revise hazard mitigation strategies
- Update plan adoption, implementation, and maintenance strategies
  - Update inventory of potential funding sources

Natural Hazards Profiled in the Plan

(Required by FEMA)

Flooding

Coastal Erosion

Extreme Temperatures

Thunderstorms High Wind/Hail/Lightning

Tornado

Winter Storms

Technological Hazards Profiled in the Plan

(Optional under FEMA rules)

Contamination/Loss of Water Supply

Hazardous Material Incidents

Major Fire or Emergency Incidents

Medical/Health Risks

Terrorism

Risk Analysis—Hazard Profiles

- Most profiles follow a similar format
  - Definition and description of the hazard
  - Description of notable historical events that affected the City
  - Description of some notable recent events that affected the City
  - Assessment of vulnerabilities to the hazard and community impacts from the hazard
  - Description of potential future changes in impacts

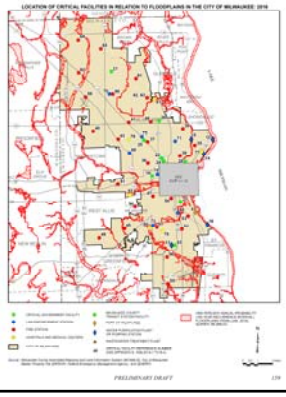
Average Annual Damages

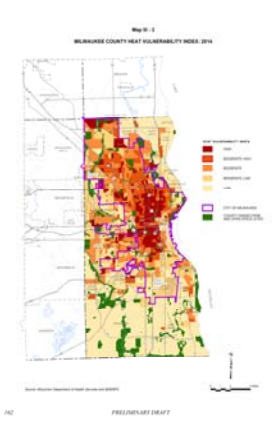
Hazard	Years	Incidents per year	Average Property Damages per year (dollars)
Flooding	51	1.00	6,456,596
Thunderstorms/High Wind	54	4.87	789,971
Pipeline Hazardous Material Incidents	46	0.76	370,843
Tornadoes	59	0.29	310,853
Hail	54	3.02	178,408
Lightning	22	1.23	125,564
Transportation Hazardous Material Incidents	41	38.11	68,037
Winter Storms	44	3.48	2,784
Terrorism	46	0.17	1,345
Temperature Extremes	23	3.61	1,007

Damages are expressed in 2016 dollars.

Average Annual Fatalities and Injuries

Hazard	Years	Incidents per year	Fatalities year	Injuries per year	Total per year
Contamination/Loss of Water Supply	27	0.04	2.56	14,925.93	14,928.49
Sexually-transmitted Diseases	10	10,008.40	?	?	10,008.40
Communicable Diseases	10	2,303.60	?	?	2,303.60
Temperature Extremes	23	3.61	5.30	10.70	16.00
Transportation Hazardous Material Incidents	41	38.11	0.07	2.53	2.60
Winter Storms	44	3.48	0.68	0.20	0.88
Pipeline Hazardous Material Incidents	46	0.76	0.00	0.65	0.65
Thunderstorms/High Wind	54	4.87	0.06	0.17	0.23
Lightning	22	1.23	0.00	0.09	0.09
Flooding	51	1.00	0.02	0.02	0.04
Terrorism	46	0.17	0.00	0.02	0.02





Hazard Mitigation Goals

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Hazard Mitigation Goals

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Hazard Mitigation Goals

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 erosion.
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Remaining Work

- Review, update, and revise recommended hazard mitigation measures
- Review, update, and revise plan adoption, implementation, and maintenance measures

Development of Hazard Mitigation Strategies

- Review existing alternative and recommended strategies
- Identify additional alternative strategies
  - Nonstructural, structural, public information and education
- Review current programs
  - Federal and State, local
- Evaluate existing and newly identified alternatives
- Examine multi-jurisdictional considerations
- Select a revised set of priority mitigation measures

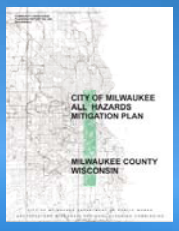
Implementation Strategies

- Update estimates of mitigation measure costs
- Summarize benefits of implementing mitigation measures
- Designate lead management agencies
- Update current implementation status
- Identify potential sources of funding and technical assistance

Plan Documentation

- The plan update will be documented in a SEWRPC Community Assistance Planning Report
- SEWRPC CAPR No. 282 (3rd edition), *City of Milwaukee All Hazard Mitigation Plan Update*
- The previous update is available on the SEWRPC website at:

  http://www.sewrpc.org/HMP



Approval and Adoption

- When a draft plan is complete
  - Host a second public meeting → Incorporate comments
  - Review by Wisconsin Division of Emergency Management → Incorporate comments
  - Review and approval by FEMA → Incorporate comments
  - The plan will need to be adopted by the Common Council


Project Web Site
http://www.sewrpc.org/HMP
Agendas and other meeting materials
Summary notes from meetings
Presentations
Draft chapters as they are completed
Comment screen
Other ways to send a comment
Email to jboxhorn@sewrpc.org

SUMMARY NOTES OF THE MAY 9, 2019 MEETING OF THE CITY OF MILWAUKEE HAZARD MITIGATION PLAN LOCAL PLANNING TEAM

INTRODUCTION

The May 9, 2019 meeting of the City of Milwaukee Hazard Mitigation Plan Local Planning Team was convened at the Frank P. Zeidler Municipal Building at 1:05 p.m. The meeting was called to order by Kurt Sprangers, Stormwater Manager, City of Milwaukee Department of Public Works. Attendance was taken by circulating a sign-in sheet.

In attendance at the meeting were the following individuals:

Local Planning Team Members

Kurt Sprangers, Chair	Stormwater Manager, City of Milwaukee Department of Public Works
Joseph E. Boxhorn, Secretary	Principal Planner, Southeastern Wisconsin Regional Planning Commission
Jeffrey Cross	Planner, Southeastern Wisconsin Regional Planning Commission
Laura Herrick	Chief Environmental Engineer, Southeastern Wisconsin Regional Planning Commission
Leah Redding	Emergency Management Coordinator, Milwaukee County Office of Emergency Management
Ed Richardson	Principal Planner, City of Milwaukee Department of Community Development
Michael Schaefer	Water Security Manager, Milwaukee Water Works
Julie Schneider	Director of Safety and Risk, Milwaukee County Transit System
Erick Shambarger	Director of Environmental Sustainability, City of Milwaukee Environmental Collaboration Office
Tim Thur	Infrastructure Administration Manager, City of Milwaukee Department of Public Works
Nadia Vogt	Senior Project Manager, Milwaukee Metropolitan Sewerage District

Mr. Sprangers welcomed all attendees to the meeting. He stated that this was the fourth meeting of the Local Planning Team for the second update to the original plan. He informed attendees that the purpose of the meeting was to review Chapters V and VI of the draft plan.

CONSIDERATION OF SUMMARY NOTES OF JUNE 28, 2019, LOCAL PLANNING TEAM MEETING

Mr. Sprangers introduced Joseph Boxhorn, Principal Planner, Southeastern Wisconsin Regional Planning Commission (SEWRPC). At Mr. Spranger's request, Mr. Boxhorn reviewed the summary notes from the June 28, 2018, meeting of the Local Planning Team. He asked whether the Team had any questions or comments on the summary notes. None were offered.

CONSIDERATION OF CHAPTER V, "HAZARD MITIGATION STRATEGIES," OF SEWRPC COMMUNITY ASSISTANCE PLANNING REPORT NO. 282 (3RD EDITION), *CITY OF MILWAUKEE ALL HAZARD MITIGATION PLAN UPDATE*

At Mr. Spranger's request, Mr. Boxhorn reviewed the preliminary draft of Chapter V of the plan report. Mr. Boxhorn indicated that he would display parts of the tables from Chapter V on the projection screen in the meeting room during discussion of the chapter.

[Secretary's Note: A copy of Mr. Boxhorn's presentation is attached herein as Exhibit A.]

Mr. Boxhorn stated that Chapter V does three things: 1) it presents alternative and recommended mitigation strategies for the hazards profiled in Chapter III, 2) it presents a comparison of relative risks associated with each hazard based on normalized impacts for use in prioritizing mitigation strategies for implementation, and 3) it presents estimates of costs and benefits of recommended measures, where such estimates are available. He noted that material in the draft chapters that is either new or revised has been highlighted blue in the text. He explained that this was done to assist readers in reviewing the chapter. He indicated that the highlighting will be removed prior to publication of the final report.

Mr. Boxhorn reviewed the section of the draft chapter on flooding and associated stormwater drainage problems. In reference to the subsection on the City of Milwaukee Flooding Study Task Force, Mr. Shambarger inquired about the status of the implementation of the recommendations made by the Task Force to the City. He suggested that discussion be added to the plan related to any progress made in implementing the recommendations. Mr. Boxhorn replied that the status of the implementation of the Task Force's recommendations will be assessed, and that any findings will be added to the report.

[Secretary's Note: The following paragraph was added after the last bullet point on page 4 of Chapter V:

"As of 2019, some of the recommendations made in the Task Force's report have been implemented. One example includes completion of a Private Property Inflow and Infiltration Demonstration Project (see the section below on basement backup problems). Other recommendations reflect activities that are in progress or ongoing."]

In reference to the discussion on the floodplain management plan for the Milwaukee River watershed, Mr. Sprangers noted that the removal of the Estabrook Dam was not discussed in the text. He asked that documentation of the Estabrook Dam removal be added to the recent actions for the Milwaukee River. Mr. Boxhorn replied that a paragraph documenting the removal of the Estabrook Park Dam will be added to this subsection.

[Secretary's Note: The following paragraph was added after the second paragraph on page 14 of Chapter V:

"MMSD removed Estabrook Dam during spring of 2018. As part of this project, the streambank immediately adjacent to the dam was restored. The dam removal resulted in a lowering of water levels upstream from the dam. This removed about 50 structures from the floodplain. As a result, it is anticipated that the floodplain map will need to be revised."]

In relation to the discussion on stormwater-related planning, Mr. Shambarger stated that the City of Milwaukee is developing a green infrastructure plan and that a framework document for the plan is available.

[Secretary's Note: The following section was added after the section on the City of Milwaukee Baseline Green Infrastructure Inventory on page 18:

"City of Milwaukee Green Infrastructure Plan

In October 2017, the Milwaukee Common Council directed the City's Environmental Collaboration Office (ECO) to develop a comprehensive green infrastructure plan for Milwaukee's Combined Sewer Area. After extensive consultation with the Milwaukee Metropolitan Sewerage District, Departments of Public Works and City Development, and community stakeholders, ECO proposed a Green Infrastructure Plan Framework.[18] This Framework will serve to guide development of the City's green infrastructure plan. The Framework was unanimously approved by the Common Council in September 2018. The Green Infrastructure Plan is currently in development and is scheduled to be finalized in June 2019.

"A companion Common Council resolution revised City ordinances to require green infrastructure on all large developments and redevelopments and explicitly outlines green infrastructure as a climate adaptation strategy in Chapter 120 of the City of Milwaukee Code of Ordinances.

[18]City of Milwaukee, Framework for Green Infrastructure Plan, September 2018."

The subsequent footnotes were renumbered.]

In regard to the discussion on stormwater-related City regulations, Mr. Shambarger noted that Chapter 120 of the City of Milwaukee's municipal code was revised. He added that this revision added additional purposes to the list of goals in the ordinance.

[Secretary's Note: The first sentence of the second paragraph on page 19 of Chapter V was revised to read (text in bold is included here, and in similar subsequent Secretary's Notes, to indicate language changed or added onto the text. Text will not be bold in the report):

"The City, through Chapter 120 of the municipal code, seek to 1) promote public health, safety, and general welfare; 2) establish procedures to control the adverse impacts associated with stormwater runoff; 3) assist in the attainment and maintenance of water quality standards; 4) reduce the effects of development and redevelopment on land and stream channel erosion; 5) minimize damage to public and private property; 6) reduce nonpoint source water pollution by minimizing impervious cover on development sites; **7) promote the co-benefits of visible green infrastructure, including reduction of urban heat island effects, benefits to human health, City beautification, and protection of coastal areas; and 8) help the City adapt to climate change and become more resilient to climate threats."**

The second sentence of the last paragraph on page 17 of Chapter II was revised to read:

"The stated purposes of that chapter include the following: 1) the promotion of the public health, safety, and general welfare; 2) the establishment of procedures to control the adverse impacts associated with stormwater runoff; 3) assistance in the attainment and maintenance of water quality standards; 4) reduction of the effects of development and redevelopment on land and stream channel erosion; 5) minimization of damage to public and private property; 6) reduction of nonpoint source water pollution by minimizing impervious cover on development sites; **7) promotion of the co-benefits of visible green infrastructure, including reduction of urban heat island effects, benefits to human health, City beautification, and protection of coastal areas; and 8) helping the City adapt to climate change and become more resilient to climate threats.**"]

Regarding the discussion on the City of Milwaukee BaseTern Feasibility Study, Mr. Shambarger asked that the references to the City of Milwaukee Office of Environmental Sustainability be changed to the read the City of Milwaukee Office of Environmental Collaboration to reflect the organization's current name.

[Secretary's Note: References to the City's "Office of Sustainability" were changed to the "Office of Environmental Collaboration" at the following locations in Chapter V:

The second sentence of the last paragraph on page 2, the first sentence of the first full paragraph on page 17, the first sentence of the first paragraph on page 19, and footnote 19.]

Concerning the discussion on the Milwaukee Metropolitan Sewerage District's (MMSD) stormwater-related regulations, Mr. Sprangers commented that MMSD updated its Chapter 13 Surface Water and Stormwater Rules (Rules). He stated that changes to the Rules were adopted in March 2019 and became effective April 1, 2019, and that the municipalities served by MMSD have been given one year to update their municipal codes to reflect the revisions.

[Secretary's Note: The following sentences were added to the end of the second full paragraph on page 5 of Chapter V:

"MMSD repealed and recreated Chapter 13 on March 25, 2019. The provisions of the revised chapter became effective on April 1, 2019. The District gave the municipalities it serves one year to revise their municipal codes to reflect the provisions of the revised chapter."]

In reference to the discussion on public participation activities and coordination with other agencies and units of government, Mr. Thur noted that there is an advisory group for the Menomonee River watershed. He asked that this advisory group be included in the discussion on public participation.

[Secretary's Note: The following paragraph was added after the first partial paragraph on page 23 of Chapter V:

"MMSD has also established an advisory group for watercourse management planning in the Menomonee River watershed."]

In relation to the discussion on public education activities, Ms. Redding noted that the Milwaukee County Office of Emergency Management (Office of Emergency Management) is no longer part of the Milwaukee County Sheriff's Department (Sheriff's Department). She asked that reference to the Sheriff's Department be removed from references to the Office of Emergency Management.

[Secretary's Note: References to the Milwaukee County Office of Emergency Management were changed throughout the draft text to reflect the Department's change in status.]

Mr. Sprangers noted that the City of Milwaukee's comprehensive stormwater management plan will need updating as a result of reissuance of the Menomonee River group permit.

[Secretary's Note: The following paragraph was added after the fifth full paragraph on page 15 of Chapter V:

"The City of Milwaukee is part of the Menomonee River watershed based municipal separate storm sewer (MS4) permit issued by the WDNR. As of 2019, the existing MS4 permit has expired and is being enforced through an extension of the previous permit. A new permit is currently being drafted and reviewed by the WDNR and participating communities. It is anticipated that the new permit will include a requirement that participating municipalities update their stormwater management plans. The City of Milwaukee expects that an update will require a three-year process."]

In relation to the discussion on basement backup problems, Mr. Thur stated that the City of Milwaukee has completed other inflow and infiltration (I/I) and lateral lining projects in addition to the Cooper Park Sewer Lateral Demonstration Project. He indicated that he would provide information on these projects.

[Secretary's Note: Messrs. Thur and Sprangers provided information on several I/I projects via email. Their email included additional information regarding the Cooper Park Sewer Lateral Demonstration Project.

The second full paragraph on page 26 of Chapter V was revised to read:

"From 2011 through **2012**, MMSD and the City of Milwaukee completed the Cooper Park Sewer Lateral Demonstration Project. The project was intended to reduce the likelihood of sewage backups causing basement flooding in the Cooper Park neighborhood during heavy rainfalls. As part of this project, private property owners allowed inspections and rehabilitation or repair of sewer laterals, and City contractors lined 446 private sewer laterals at homes. The City had previously lined the municipal sanitary sewers serving this area. **In 2015, the City completed a related project in the Cooper Park neighborhood. Foundation drains were disconnected from sewers at 33 properties in a portion of the neighborhood.** Flow monitoring was conducted as part of **these projects**, and the City reported reductions in peak flows **in sewers during heavy rains** of about **42 percent in the portion of the project area in which foundation drains were disconnected and 39 percent for the overall area.**"

The following paragraphs were added to Chapter V after the second full paragraph on page 26:

"From 2012 through 2014, MMSD and the City of Milwaukee completed the Clemens School Sewer Lateral Demonstration Project. This project was intended to reduce the likelihood of sewage backups causing basement flooding in the area during heavy rainfalls. As part of this project, private property owners allowed inspection and rehabilitation or repair of sewer laterals, and City contractors lined private sewer laterals at 359 homes. The City had previously lined the municipal sanitary sewers serving the area. Flow monitoring was conducted as part of this project, and the City reported reductions in peak flows of about 38 percent in sewers in the neighborhood during heavy rains.

From 2016 through 2017, MMSD and the City of Milwaukee completed a pilot project in an area bounded by W. Layton Avenue to W. Edgerton Avenue from S. 20th Street to S. 27th Street. A major goal of this project was to reduce the amount of I/I in the sanitary sewer system, and reduce the likelihood of sewage backups causing basement flooding in the area during heavy rainfalls. As part of this project, private property owners allowed inspections and rehabilitation or repair of their sewer laterals. The City contractor rehabilitated 354 private sewer laterals, using a trenchless cured-in-place pipe (CIPP) method. The City had previously lined the municipal sanitary sewers serving this area, and flow monitoring equipment was installed in order to measure the reduction in flow within the sanitary sewer system once the project is completed and sufficient data is collected post construction.

As of 2019, the City of Milwaukee is planning a pilot project in an area bounded by W. Harrison Avenue to W. Kinnickinnic River Parkway from S. 60th Street to S. 72nd Street. This project will include inspection and rehabilitation of sanitary sewer laterals, as well as disconnection of foundation drains from the sanitary sewer, and installation of sump pumps and backflow preventers. Major goals of this project are to reduce the amount of I/I in the sanitary sewer system and to reduce the likelihood of sewage backups causing basement flooding in the area during heavy rainfalls. The City previously lined the municipal sanitary sewers serving this area, and flow monitoring equipment was installed in order to measure the reduction in flow within the sanitary sewer system once the project is completed."]

Mr. Boxhorn reviewed the section of the draft chapter on thunderstorm, high-wind, hail, and lightning hazards. He noted that in this update of the plan, the discussion of mitigation measures for high winds, hail, and lightning has been consolidated into a single subsection. No questions or comments were offered on this section.

Mr. Boxhorn reviewed the section of the draft chapter on tornadoes. No questions or comments were offered on this section.

Mr. Boxhorn reviewed the section of the draft chapter on extreme temperatures. Mr. Sprangers indicated that he would ask staff from the City of Milwaukee Health Department to review this section and provide any relevant comments.

[Secretary's Note: Mr. Sprangers requested that Health Department staff provide comments on this section of Chapter V by May 24, 2019. As of May 29, 2019, no comments had been submitted.]

Mr. Boxhorn reviewed the section of the draft chapter on Lake Michigan coastal hazards. Ms. Vogt suggested adding findings from Southeast Wisconsin Coastal Resilience Project to the discussion. Ms. Herrick replied that findings from this project will not be available in time to add them to this plan.

[Secretary's Note: The following paragraph was added after the third paragraph on page 46 of Chapter V:

"In 2017, a project team consisting of the WCMP, the University of Wisconsin Sea Grant Institute, the University of Wisconsin-Madison Department of Civil and Environmental Engineering, and SEWRPC began work on the Southeast Wisconsin Coastal Resilience Project. This project will provide resources and assistance to communities in Kenosha, Milwaukee, Ozaukee, and Racine Counties to plan and prepare for coastal hazards. The project team is evaluating and mapping shoreline recession rates through analysis of historical aerial photographs and assessing scenarios of potential shoreline recession under Lake level extremes and high-energy storm conditions. The project will also develop educational and outreach materials for best bluff 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 is funded through a Coastal Resilience Grant from the National Oceanic and Atmospheric Administration."

The last sentence of the last paragraph on page 46 was deleted.]

Mr. Boxhorn reviewed the section of the draft chapter on winter storms. No questions or comments were offered on this section.

Mr. Boxhorn reviewed the section of the draft chapter on contamination and loss of water supply. No questions or comments were offered on this section.

Mr. Boxhorn reviewed the section of the draft chapter on hazardous material incidents. No questions or comments were offered on this section.

Mr. Boxhorn reviewed the section of the draft chapter on public health emergencies. Mr. Sprangers indicated that he would ask staff from the City of Milwaukee Health Department to review this section and provide any relevant comments.

[Secretary's Note: Mr. Sprangers requested that Health Department staff provide comments on this section of Chapter V by May 24, 2019. As of May 29, 2019, no comments had been submitted.]

Mr. Boxhorn reviewed the section of the draft chapter on terrorism incidents. In reference to the subsection on identification of alternative mitigation strategies, Ms. Schneider commented that the City of Milwaukee is no

longer eligible to participate in the Urban Area Security Initiative (UASI). Mr. Boxhorn replied that references to the City of Milwaukee's participation in the UASI will be removed from the plan.

[Secretary's Note: The fifth bullet point on page 71 of Chapter V was rewritten to read:

"Continue to participate in Federal programs, such as the Law Enforcement Terrorism Prevention Program."

The second bullet point on page 75 of Chapter V was rewritten to read:

"Continue to participate in Federal programs, such as the Law Enforcement Terrorism Prevention Program."

The second mitigation measure for terrorism listed in Table V-9 on page 115 of Chapter V was revised to read:

"Continue to participate in Federal programs such as LETPP"

The second mitigation measure for terrorism listed in Table VI-1 on page 20 of Chapter VI was revised to read:

"Continue to participate in Federal programs such as LETPP"

Reference to funding program No. 13 was removed from the funding sources for mitigation measures related to terrorism in Table VI-1 on page 20 of Chapter VI.

Program No. 13 was removed from Table F-1 on page 5 of Appendix F.

Contact information for the Urban Area Security Initiative grants was removed from page 16 of Appendix G.]

Mr. Boxhorn reviewed the section of the draft chapter on major fire and emergency medical incidents. No questions or comments were offered on this section. Mr. Sprangers indicated that he would ask staff from the Milwaukee Fire Department to review this section and provide any relevant comments.

[Secretary's Note: Mr. Sprangers requested that Fire Department staff provide comments on this section of Chapter V by May 24, 2019. As of May 29, 2019, no comments had been submitted.]

Mr. Boxhorn reviewed the section of the draft chapter on hazard risk analysis and prioritization. He discussed Tables V-7 and V-8 which present rankings of the hazards addressed in the plan based upon mortality and injury versus property damage, respectively. He added that these rankings were made to assist City staff in prioritizing mitigation measures for implementation. Ms. Vogt asked what method was used by Local Planning Team members to establish the perception rankings listed in the tables. Mr. Boxhorn replied that the Local Planning Team members completed a hazard and vulnerability assessment (HVA) tool at the beginning of the planning effort and that the perceived rankings shown in the tables were derived from their responses.

In reference to the section on terrorism incidents, Mr. Shambarger questioned why cyber security hazards are not addressed in the plan. Mr. Boxhorn replied that the Local Planning Team considered addressing cyber security threats in the plan, and ultimately concluded that hazards related to cyber security would be better addressed in a separate planning effort from the hazard mitigation plan.

CONSIDERATION OF CHAPTER VI, "PLAN ADOPTION, IMPLEMENTATION, MAINTENANCE, AND REVISION," OF SEWRPC COMMUNITY ASSISTANCE PLANNING REPORT NO. 282 (3RD EDITION) *CITY OF MILWAUKEE ALL HAZARD MITIGATION PLAN UPDATE*

At Mr. Boxhorn's request, Mr. Cross reviewed the preliminary draft of Chapter VI of the plan report. Mr. Cross stated that Chapter VI does four things: 1) it briefly discusses the process by which the plan is updated and adopted, 2) it presents plan implementation strategies, 3) it presents a list of potential funding sources for mitigation projects and activities, and 4) it discusses plan monitoring and reevaluation strategies.

Mr. Cross the reviewed the section of the draft chapter on plan refinement, review, and adoption. No questions or comments were offered on this section.

Mr. Cross reviewed the section of the draft chapter on plan implementation strategies. No questions or comments were offered on this section.

Mr. Cross reviewed the section of the draft chapter on hazard mitigation funding sources. No questions or comments were offered on this section.

Mr. Cross reviewed the section of the draft chapter on plan monitoring and reevaluation strategies. No questions or comments were offered on this section.

DISCUSSION OF UPCOMING PUBLIC MEETING

Mr. Boxhorn informed the Local Planning Team that FEMA requires that at least two public meetings be held during the planning process to give the public an opportunity to comment on the plan. With the first of these public meetings having taken place, Mr. Boxhorn stated that the second public meeting will be held on Thursday, May 23, 2019 at 4:00 pm at the City of Milwaukee Department of Public Works Field Headquarters. He explained that he anticipates that this meeting would cover the purpose and scope of the plan updating effort, review progress to date, and provide members of the public with an opportunity to ask questions and offer comments about the plan. He noted that members of the Local Planning Team are welcome to attend the meeting, but their attendance is not required. He indicated that comments on the draft plan update will be accepted through May 31, 2019.

ADJOURNMENT

There being no further business, the meeting was adjourned by unanimous consent at 2:30 p.m.

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LKH/JEB/JAC
05/10/19, 5/31/19, 06/04/19

Exhibit A: Docs # 248185, this can be six slides to the page

Chapter V Overview

- Presents alternative and recommended mitigation strategies for the hazards profiled in Chapter III
- Presents a comparison of relative risks associated with each hazard based on normalized impacts for use in prioritization
- Estimates costs and benefits of recommended measures

Mitigation Strategy Sections

- Most sections follow a similar format
  - Identification of alternative mitigation strategies
  - Review of current programs
    - Federal and State
    - Local
  - Evaluation of alternatives
  - Recommended priority mitigation measures

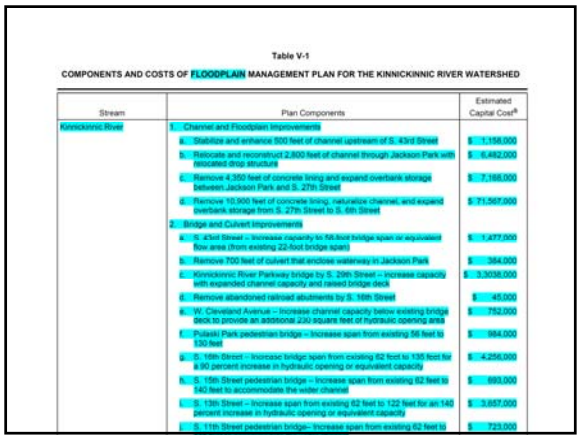


Table V-1

COMPONENTS AND COSTS OF FLOODPLAIN MANAGEMENT PLAN FOR THE KINNICKINNIC RIVER WATERSHED

Stream	Plan Components	Estimated Capital Cost[a]
Kinnickinnic River	1. Channel and Floodplain Improvements	
	a. Stabilize and enhance 500 feet of channel upstream of S. 43rd Street	$ 1,158,000
	b. Relocate and reconstruct 2,800 feet of channel through Jackson Park with associated drop structure	$ 6,482,000
	c. Remove 4,350 feet of concrete lining and expand overbank storage between Jackson Park and S. 27th Street	$ 7,168,000
	d. Remove 10,900 feet of concrete lining, naturalize channel, and expand overbank storage from S. 27th Street to S. 6th Street	$ 71,567,000
	2. Bridge and Culvert Improvements	
	a. S. 43rd Street – Increase capacity to 58-foot bridge span or equivalent flow area (from existing 22-foot bridge span)	$ 1,477,000
	b. Remove 700 feet of culvert that encloses waterway in Jackson Park	$ 364,000
	c. Kinnickinnic River Parkway bridge by S. 29th Street – increase capacity with expanded channel capacity and raised bridge deck	$ 3,3038,000
	d. Remove abandoned railroad abutments by S. 16th Street	$ 45,000
	e. W. Cleveland Avenue – Increase channel capacity below existing bridge deck to provide an additional 230 square feet of hydraulic opening area	$ 752,000
	f. Pulaski Park pedestrian bridge – Increase span from existing 56 feet to 130 feet	$ 984,000
	g. S. 16th Street – Increase bridge span from existing 62 feet to 135 feet for a 90 percent increase in hydraulic opening or equivalent capacity	$ 4,256,000
	h. S. 15th Street pedestrian bridge – Increase span from existing 62 feet to 140 feet to accommodate the wider channel	$ 693,000
	i. S. 13th Street – Increase span from existing 62 feet to 122 feet for an 148 percent increase in hydraulic opening or equivalent capacity	$ 3,857,000
	j. S. 11th Street pedestrian bridge– Increase span from existing 62 feet to	$ 723,000

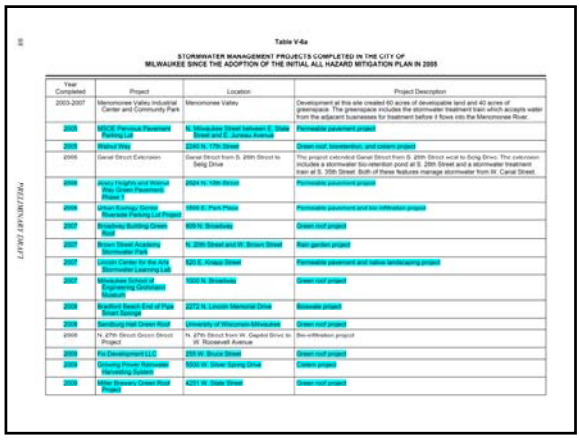


Table V-4a

STORMWATER MANAGEMENT PROJECTS COMPLETED IN THE CITY OF MILWAUKEE SINCE THE ADOPTION OF THE INITIAL ALL HAZARD MITIGATION PLAN IN 2005

Year Completed	Project	Location	Project Description
2003-2007	Menomonee Valley Industrial Center and Community Park	Menomonee Valley	Development at this site created 60 acres of developable land and 40 acres of greenspace. The greenspace includes the stormwater treatment train which accepts water from the adjacent businesses for treatment before it flows into the Menomonee River
2005	MSOE Peninsa Pavement Parking Lot	N. Milwaukee Street between E. State Street and E. Juneau Avenue	Permeable pavement project
2005	Walnut Way	2240 N. 17th Street	Green roof, bioretention, and cistern project
2006	Canal Street Extension	Canal Street from S. 25th Street to Selig Drive	The project extended Canal Street from S. 25th Street west to Selig Drive. The extension includes a stormwater bio-retention pond at S. 29th Street and a stormwater treatment train at S. 35th Street. Both of these features manage stormwater from W. Canal Street.
2006	Amity Heights and Walnut Way Green Pavement Phase 1	2024 N. 10th Street	Permeable pavement project
2006	Urban Ecology Center Riverside Parking Lot Project	1500 E. Park Place	Permeable pavement and bio-infiltration project
2007	Broadway Building Green Roof	609 N. Broadway	Green roof project
2007	Brown Street Academy Stormwater Park	N. 25th Street and W. Brown Street	Rain garden project
2007	Lincoln Center for the Arts Stormwater Learning Lab	520 E. Knapp Street	Permeable pavement and native landscaping project
2007	Milwaukee School of Engineering Grohspeil Museum	1000 N. Broadway	Green roof project
2008	Bradford Beach End of Pier Street Springs	2372 N. Lincoln Memorial Drive	Bioswale project
2008	Sandburg Hall Green Roof	University of Wisconsin Milwaukee	Green roof project
2008	N. 27th Street Green Street Project	N. 27th Street from W. Capitol Drive to W. Roosevelt Avenue	Bio-infiltration project
2009	Fe Development LLC	255 W. Bruce Street	Green roof project
2009	Growing Power Rainwater Harvesting System	5500 W. Silver Spring Drive	Cistern project
2009	Miller Brewery Green Roof Project	4251 W. State Street	Green roof project

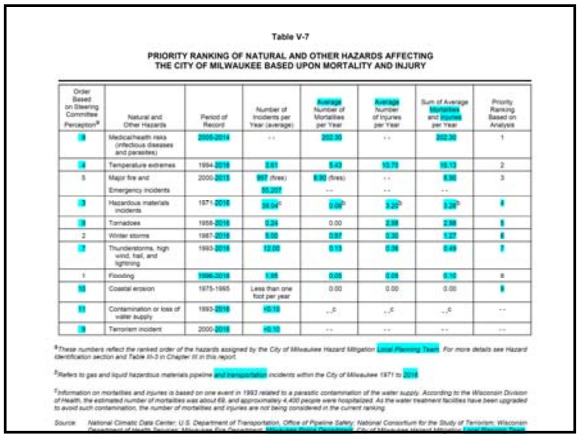


Table V-7
PRIORITY RANKING OF NATURAL AND OTHER HAZARDS AFFECTING THE CITY OF MILWAUKEE BASED UPON MORTALITY AND INJURY

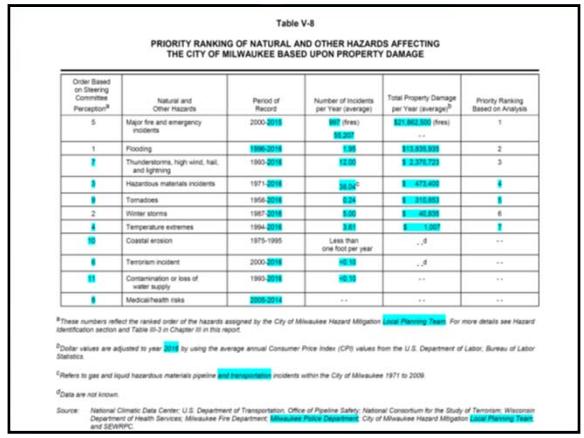


Table V-8
PRIORITY RANKING OF NATURAL AND OTHER HAZARDS AFFECTING THE CITY OF MILWAUKEE BASED UPON PROPERTY DAMAGE

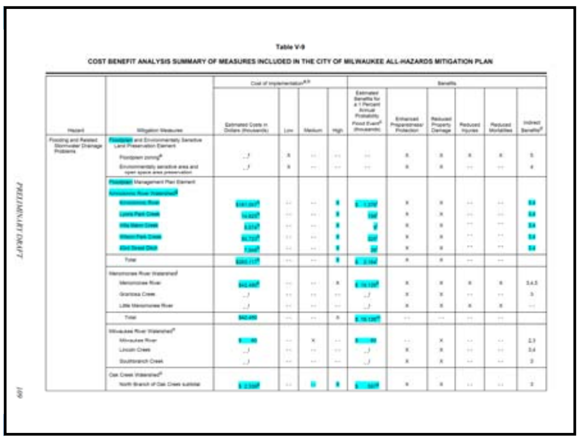
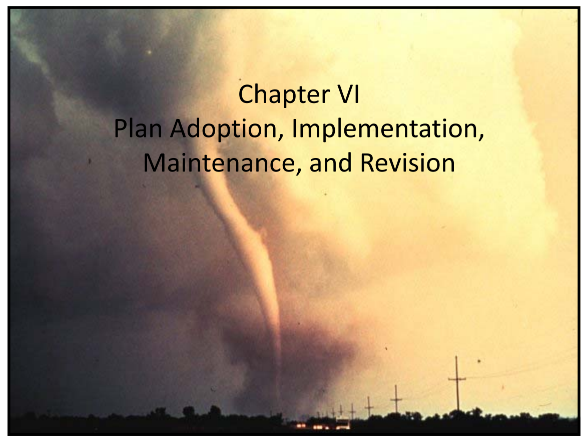
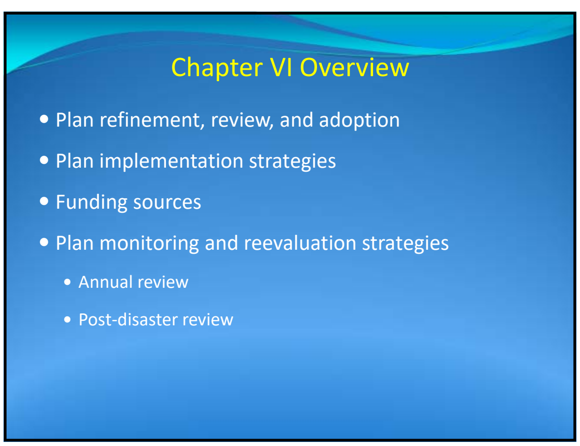


Table V-9
COST BENEFIT ANALYSIS SUMMARY OF MEASURES INCLUDED IN THE CITY OF MILWAUKEE ALL-HAZARDS MITIGATION PLAN


Chapter VI
Plan Adoption, Implementation,
Maintenance, and Revision


Chapter VI Overview
Plan refinement, review, and adoption
Plan implementation strategies
Funding sources
Plan monitoring and reevaluation strategies
Annual review
Post-disaster review

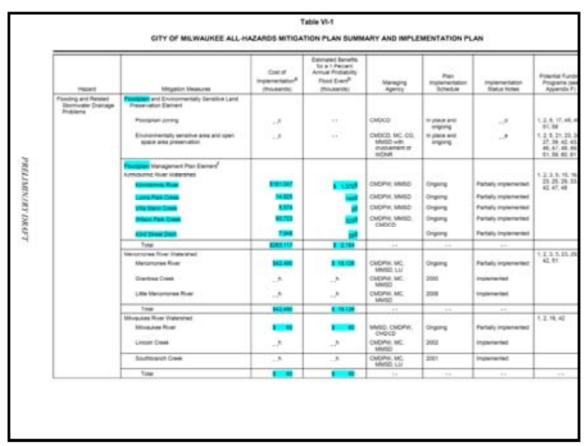


Table VI-1
CITY OF MILWAUKEE ALL-HAZARDS MITIGATION PLAN SUMMARY AND IMPLEMENTATION PLAN

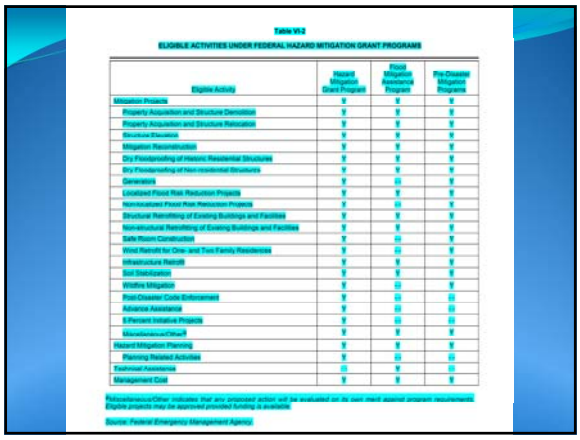


Table VI-2

ELIGIBLE ACTIVITIES UNDER FEDERAL HAZARD MITIGATION GRANT PROGRAMS

Eligible Activity	Hazard Mitigation Grant Program	Flood Mitigation Assistance Program	Pre-Disaster Mitigation Programs
Mitigation Projects	Y	Y	Y
Property Acquisition and Structure Demolition	Y	Y	Y
Property Acquisition and Structure Relocation	Y	Y	Y
Structure Elevation	Y	Y	Y
Mitigation Reconstruction	Y	Y	Y
Dry Floodproofing of Historic Residential Structures	Y	Y	Y
Dry Floodproofing of Non-residential Structures	Y	Y	Y
Generators	Y	[illegible]	Y
Localized Flood Risk Reduction Projects	Y	Y	Y
Nonlocalized Flood Risk Reduction Projects	Y	[illegible]	Y
Structural Retrofitting of Existing Buildings and Facilities	Y	Y	Y
Non-structural Retrofitting of Existing Buildings and Facilities	Y	Y	Y
Safe Room Construction	Y	[illegible]	Y
Wind Retrofit for One- and Two-Family Residences	Y	[illegible]	Y
Infrastructure Retrofit	Y	Y	Y
Soil Stabilization	Y	Y	Y
Wildfire Mitigation	Y	[illegible]	Y
Post-Disaster Code Enforcement	Y	[illegible]	[illegible]
Advance Assistance	Y	[illegible]	[illegible]
5-Percent Initiative Projects	Y	[illegible]	[illegible]
Miscellaneous/Other[a]	Y	Y	Y
Hazard Mitigation Planning	Y	Y	Y
Planning Related Activities	Y	[illegible]	[illegible]
Technical Assistance	[illegible]	Y	[illegible]
Management Cost	Y	Y	Y

[a]Miscellaneous/Other indicates that any proposed action will be evaluated on its own merit against program requirements. Eligible projects may be approved provided funding is available.

Source: Federal Emergency Management Agency

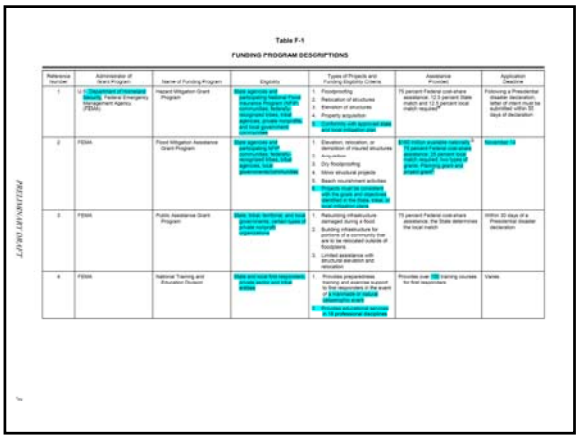
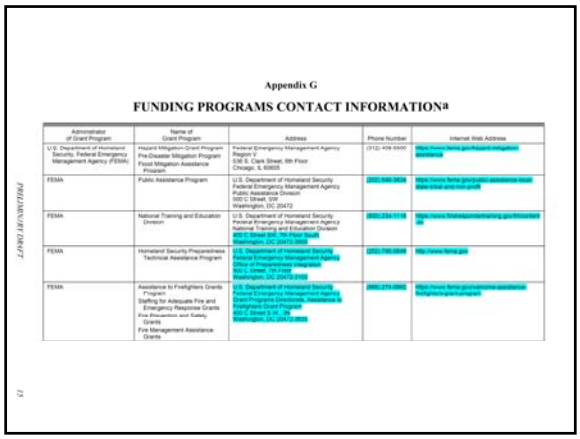


Table F-1

FUNDING PROGRAM DESCRIPTIONS

Reference Number	Administrator of Grant Program	Name of Funding Program	Eligibility	Types of Projects and Funding Eligibility Criteria	Assistance Provided	Application Deadline
1	U.S. Department of Homeland Security, Federal Emergency Management Agency (FEMA)	Hazard Mitigation Grant Program	State agencies and participating National Flood Insurance Program (NFIP) communities, federally recognized tribes, private nonprofit entities, and local governments/communities	1. Floodproofing 2. Relocation of structures 3. Elevation of structures 4. Property acquisition 5. Community-wide approved state and local hazard mitigation plan	75 percent Federal cost-share assistance; 12.5 percent State match and 12.5 percent local match required	Following a Presidential disaster declaration; letter of intent must be submitted within 30 days of declaration
2	FEMA	Flood Mitigation Assistance Grant Program	State agencies and participating NFIP communities, federally recognized tribes, local 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 Hazard M	$160 million available nationally; 75 percent Federal cost-share assistance; 25 percent local match required; two types of grant: Planning grant and project grant	November 29
3	FEMA	Public Assistance Grant Program	State, tribal, territorial, and local governments; certain types of private nonprofit organizations	1. Relocating infrastructure damaged during a flood 2. Building infrastructure for portions of a community that have been relocated outside of floodplains 3. Limited assistance with structure elevation and relocation	75 percent Federal cost-share assistance; the State determines the local match	Within 30 days of a Presidential disaster declaration
4	FEMA	National Training and Education Division	State and local first responders, public safety officials, and tribal leaders	1. Provides preparedness training for emergency support to first responders in the event of a catastrophic or natural catastrophic event 2. Provides educational services to 18 professional disciplines	Provides over 350 training courses for first responders	Varies

PREDECISIONAL DRAFT



Appendix G

FUNDING PROGRAMS CONTACT INFORMATION[a]

Administrator of Grant Program	Name of Grant Program	Address	Phone Number	Internet Web Address
U.S. Department of Homeland Security, Federal Emergency Management Agency (FEMA)	Hazard Mitigation Grant Program Pre-Disaster Mitigation Program Flood Mitigation Assistance Program	Federal Emergency Management Agency Region V 536 S. Clark Street, 6th Floor Chicago, IL 60605	(312) 408-5500	https://www.fema.gov/hazard-mitigation-assistance
FEMA	Public Assistance Program	U.S. Department of Homeland Security Federal Emergency Management Agency Public Assistance Division 500 C Street, SW Washington, DC 20472	(202) 646-3434	https://www.fema.gov/public-assistance-local-state-tribal-and-non-profit
FEMA	National Training and Education Division	U.S. Department of Homeland Security Federal Emergency Management Agency National Training and Education Division [illegible]	(800) 368-6498	https://www.firstrespondertraining.gov/frontdoor.do
FEMA	Homeland Security Preparedness Technical Assistance Program	U.S. Department of Homeland Security Federal Emergency Management Agency Office of Preparedness Integration 500 C Street, SW Room Washington, DC 20472-3100	(202) 786-9648	http://www.fema.gov
FEMA	Assistance to Firefighters Grants Program Staffing for Adequate Fire and Emergency Response Grants Fire Prevention and Safety Grants Fire Management Assistance Grants	U.S. Department of Homeland Security Federal Emergency Management Agency Grant Programs Directorate, Assistance to Firefighters Grant Program 500 C Street S.W., SC Washington, DC 20472-3100	(866) 274-0960	https://www.fema.gov/assistance-firefighters-grants-program

[a]Source: Federal Emergency Management Agency

PREDECISIONAL DRAFT

11

Public Meeting on Hazard Mitigation Plan

- May 23, 2019
  - 4:00 pm
  - City of Milwaukee Department of Public Works Field Headquarters – 3850 N. 35th Street
- Review the plan update
- Seek public input
  - Answer questions
  - Mitigation measures and projects
  - Comments on draft plan

Remaining Effort on Plan Update

- Public Meeting
- Review by the Wisconsin Division of Emergency Management
  - Any necessary revisions
- Review by the Federal Emergency Management Agency
  - Any necessary revisions
- Formal adoption by the Common Council

Project Web Site

- http://www.sewrpc.org/HMP
  - Agendas and other meeting materials
  - Summary notes from meetings
  - Presentations
  - Draft chapters
  - Comment screen
  - Other ways to send a comment
- Email to jboxhorn@sewrpc.org

SUMMARY NOTES OF THE MAY 23, 2019 PUBLIC MEETING FOR THE CITY OF MILWAUKEE HAZARD MITIGATION PLAN LOCAL PLANNING TEAM

INTRODUCTION

The May 23, 2019 public meeting for the City of Milwaukee Hazard Mitigation Plan was convened at the City of Milwaukee Department of Public Works Field Headquarters at 4:00 p.m. The meeting was called to order by Kurt Sprangers, Stormwater Manager, City of Milwaukee Department of Public Works. Attendance was taken by circulating a sign-in sheet.

In attendance at the meeting were the following individuals:

Members of the Public	
Andy Bochman	Resident, City of Milwaukee
Staff	
Kurt Sprangers	Stormwater Manager, City of Milwaukee Department of Public Works
Joseph E. Boxhorn	Principal Planner, Southeastern Wisconsin Regional Planning Commission
Jeffrey Cross	Planner, Southeastern Wisconsin Regional Planning Commission

Mr. Sprangers welcomed all attendees to the meeting. He stated that this was the fourth meeting of the Local Planning Team for the second update to the original plan. He informed attendees that the purpose of the meeting was to review the draft plan. At Mr. Spranger's request, Mr. Boxhorn gave a presentation on the plan update (a copy of Mr. Boxhorn's presentation is attached herein as Exhibit A).

Mr. Bochman inquired about the sources of funding for the technical hazards addressed in the plan. Mr. Boxhorn replied that projects and mitigation activities for technical hazards are not funded by the Federal Emergency Management Agency (FEMA), and that they are funded by other federal and state and programs.

In reference to Table V-7, Mr. Bochman asked whether the average number of mortalities per year due to fire emergencies is accurate. Mr. Boxhorn replied that the value listed in the table for average, annual fire deaths is based on the most current data from the Milwaukee Fire Department.

In relation to Map III-3, Mr. Bochman asked whether the City provides cooling shelters for at-risk citizens in instances of extreme temperature hazards. Mr. Boxhorn replied that the City of Milwaukee Health Department and the Milwaukee Metropolitan Area Heat Task Force have collaborated on a plan that includes a list of public cooling sites which are identified to the public during extreme heat events as places for relief from extreme high temperatures.

In reference to Map III-3, Mr. Bochman asked whether the heat vulnerability index (HVI) in Map III-3 reflects citizen's access to air conditioning. Mr. Boxhorn replied that the HVI strongly reflects a correlation between the effects of heat vulnerability and income.

In relation to the discussion on flood mitigation strategies, Mr. Bochman asked whether flooding hazards are becoming more severe in the City of Milwaukee. He also inquired about the methods used to access potential changes in the severity of flooding hazards. Mr. Sprangers replied that flooding hazards in the City are worsening over time and that rainfall data is used to access changes in severity. Mr. Boxhorn added that the City has continued mitigation efforts to reduce risks and damage related to flooding hazards.

In relation to cyber security hazards, Mr. Bochman asked why cyber security threats are not of the technical hazards addressed in the plan. He stated that mitigation efforts with regards to cyber security threats have become more significant in past years due to cities using more computer technology to operate public utilities such as water and energy resources. He noted that the City's Smart City Plan calls for automating many functions that are currently performed manually; however, this plan does not include a section on cyber security. He added that cyberattacks pose risks to critical infrastructure that could potentially result in a loss of services. Mr. Boxhorn replied that although cyber security threats exist in the City, not much can be done to mitigate cyber threats from the perspective of the hazard mitigation plan.

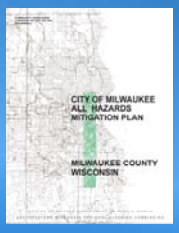
CAPR-282-3 SUMMARY NOTES C MILWAUKEE HMP PUBLIC MTG MAY 23 2019 (00248691).DOCX
500-1118
JEB/JAC
05/29/19, 5/31/19

Exhibit A: Docs # 248193

Plan Documentation

- The plan update will be documented in a SEWRPC Community Assistance Planning Report
- SEWRPC CAPR No. 282 (3rd edition), *City of Milwaukee All Hazard Mitigation Plan Update*
- When completed the update will be available on the SEWRPC website at:

  http://www.sewrpc.org/HMP



What is Hazard Mitigation?

- "Mitigation is any sustained action taken to eliminate or reduce the long-term risk to human life and property from natural and technological hazards"—FEMA
- Actions to reduce the damages that result when disasters occur

What is Hazard Mitigation?

- Mitigation is not:
  - Emergency response
  - Crisis management
  - Disaster preparation and recovery
- Mitigation focuses on reducing the impacts from hazard events when they occur

Why Do We Mitigate Hazards?

- Disasters are costly
- State and Federal assistance are insufficient
- We can prevent future damages
- Lesser impacts mean a quicker response and recovery process
- Can do this locally

City of Milwaukee All Hazard Mitigation Plan

- Sets forth strategies for mitigating impacts of several natural and technological/human induced hazards
- Establishes eligibility for hazard mitigation funding from the Federal Emergency Management Agency (FEMA)
  - FEMA requires that local hazard mitigation plans be updated and revised every five years
  - Hazard Mitigation Grant Program, Flood Mitigation Assistance Program, and the Pre-Disaster Mitigation Program

City of Milwaukee All Hazard Mitigation Plan

- Plan development and updating is overseen by a Local Planning Team
  - Team includes appointed officials, department and agency representatives, business representatives, knowledgeable citizens
  - Law enforcement and fire departments, public works department, planning department, health department, County emergency management department, and Milwaukee Metropolitan Sewerage District
- Staff include Department of Public Works, Office of Emergency Management and Homeland Security, and SEWRPC

Plan Components Reviewed and Revised

- Reviewed implementation activities
- Updated inventories of natural and built features
- Reviewed and reevaluated identification of hazards
- Updated and reevaluated risk and vulnerability analysis
- Reviewed and revised hazard mitigation goals
- Reviewed and revised hazard mitigation strategies
- Updated plan adoption, implementation, and maintenance strategies including funding source inventory

Natural Hazards Profiled in the Plan

(Required by FEMA)

Flooding

Coastal Erosion

Extreme Temperatures

Thunderstorms High Wind/Hail/Lightning

Tornado

Winter Storms

Technological Hazards Profiled in the Plan

(Optional under FEMA rules)

Contamination/Loss of Water Supply

Hazardous Material Incidents

Major Fire or Emergency Incidents

Medical/Health Risks

Terrorism

Risk Analysis—Hazard Profiles

- Most profiles follow a similar format
  - Definition and description of the hazard
  - Description of notable historical events that affected the City
  - Description of some notable recent events that affected the City
  - Assessment of vulnerabilities to the hazard and community impacts from the hazard
  - Description of potential future changes in impacts

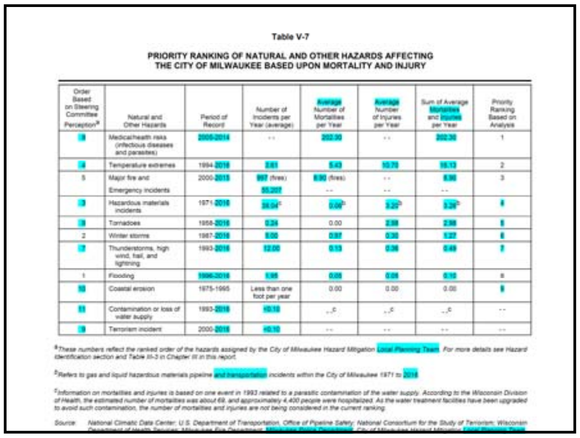


Table V-7

PRIORITY RANKING OF NATURAL AND OTHER HAZARDS AFFECTING THE CITY OF MILWAUKEE BASED UPON MORTALITY AND INJURY

Order Based on Steering Committee Perception[a]	Natural and Other Hazards	Period of Record	Number of Incidents per Year (average)	Average Number of Mortalities per Year	Average Number of Injuries per Year	Sum of Average Mortalities and Injuries per Year	Priority Ranking Based on Analysis
8	Medical/health risks (infectious diseases and parasites)	2005-2014	- -	202.30	- -	202.30	1
4	Temperature extremes	1994-2016	3.61	5.43	10.70	16.13	2
5	Major fire and	2000-2015	997 (fires)	8.90 (fires)	- -	8.90	3
	Emergency incidents		55,207	- -	- -	- -	
3	Hazardous materials incidents	1971-2016	38.04[c]	0.08[b]	3.20[b]	3.28[b]	4
9	Tornadoes	1958-2016	0.24	0.00	2.98	2.98	5
2	Winter storms	1987-2016	5.00	0.97	0.30	1.27	6
7	Thunderstorms, high wind, hail, and lightning	1993-2016	12.00	0.13	0.36	0.49	7
1	Flooding	1996-2016	1.95	0.05	0.05	0.10	8
10	Coastal erosion	1975-1995	Less than one foot per year	0.00	0.00	0.00	9
11	Contamination or loss of water supply	1993-2016	<0.10	- -[c]	- -[c]	- -[c]	- -
6	Terrorism incident	2000-2016	<0.10	- -	- -	- -	- -

[a]These numbers reflect the ranked order of the hazards assigned by the City of Milwaukee Hazard Mitigation Local Planning Team. For more details see Hazard Identification section and Table III-3 in Chapter III in this report.

[b]Refers to gas and liquid hazardous materials pipeline and transportation incidents within the City of Milwaukee 1971 to 2016.

[c]Information on mortalities and injuries is based on one event in 1993 related to a parasitic contamination of the water supply. According to the Wisconsin Division of Health, the estimated number of mortalities was about 69, and approximately 4,400 people were hospitalized. As the water treatment facilities have been upgraded to avoid such contamination, the number of mortalities and injuries are not being considered in the current ranking.

Source: National Climatic Data Center; U.S. Department of Transportation, Office of Pipeline Safety; National Consortium for the Study of Terrorism; Wisconsin Department of Health Services; Milwaukee Fire Department; Milwaukee Police Department; City of Milwaukee Hazard Mitigation Local Planning Team

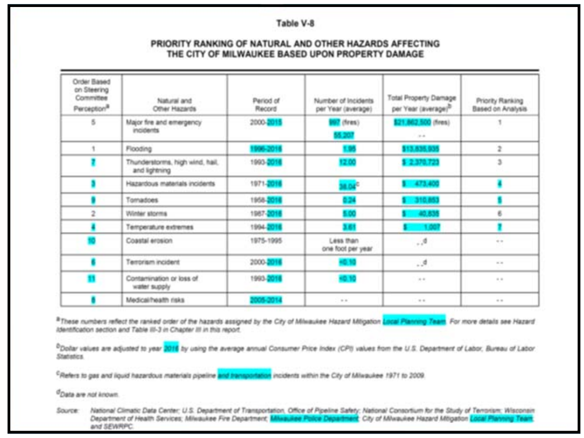


Table V-8

PRIORITY RANKING OF NATURAL AND OTHER HAZARDS AFFECTING THE CITY OF MILWAUKEE BASED UPON PROPERTY DAMAGE

Order Based on Steering Committee Perception[a]	Natural and Other Hazards	Period of Record	Number of Incidents per Year (average)	Total Property Damage per Year (average)[b]	Priority Ranking Based on Analysis
5	Major fire and emergency incidents	2000-2015	997 (fires) 55,207	$21,862,500 (fires) - -	1
1	Flooding	1996-2016	1.95	$13,835,935	2
7	Thunderstorms, high wind, hail, and lightning	1993-2016	12.00	$ 2,370,723	3
3	Hazardous materials incidents	1971-2016	38.04[c]	$ 473,400	4
9	Tornadoes	1958-2016	0.24	$ 310,853	5
2	Winter storms	1987-2016	5.00	$ 40,835	6
4	Temperature extremes	1994-2016	3.61	$ 1,007	7
10	Coastal erosion	1975-1995	Less than one foot per year	- -[d]	- -
6	Terrorism incident	2000-2016	<0.10	- -[d]	- -
11	Contamination or loss of water supply	1993-2016	<0.10	- -	- -
8	Medical/health risks	2005-2014	- -	- -	- -

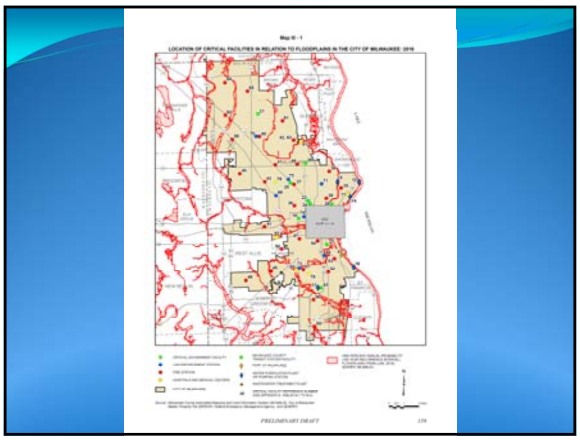
[a]These numbers reflect the ranked order of the hazards assigned by the City of Milwaukee Hazard Mitigation Local Planning Team. For more details see Hazard Identification section and Table III-3 in Chapter III in this report.

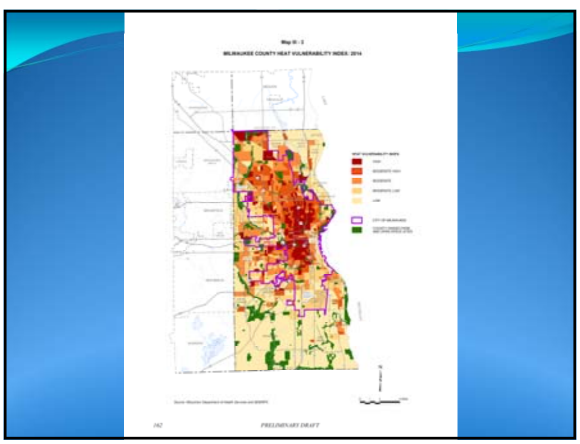
[b]Dollar values are adjusted to year 2016 by using the average annual Consumer Price Index (CPI) values from the U.S. Department of Labor, Bureau of Labor Statistics.

[c]Refers to gas and liquid hazardous materials pipeline and transportation incidents within the City of Milwaukee 1971 to 2009.

[d]Data are not known.

Source: National Climatic Data Center; U.S. Department of Transportation, Office of Pipeline Safety; National Consortium for the Study of Terrorism; Wisconsin Department of Health Services; Milwaukee Fire Department; Milwaukee Police Department; City of Milwaukee Hazard Mitigation Local Planning Team, and SEWRPC.





Flood Mitigation Strategies

Floodland and wetland zoning and zoning review

Preservation of open space and sensitive areas

Implementation of MMSD Watercourse and Flood Management Plans

- Channel and floodplain improvements
- Bridge and culvert improvements
- Voluntary acquisition, demolition, and removal or floodproofing of structures in the floodplain

Stormwater management planning and regulation

Stormwater management facility maintenance

Stream Channel Maintenance

National Flood Insurance Program (NFIP) map updating

Mitigation Strategies for Weather-related Hazards

Maintain early warning systems

- NOAA Weather Radio, EAS broadcasting, HAZCollect

Public information and education

Identify and advertise shelters

Review and enforcement of building code requirements

Continued coordination of local government emergency operations and response plan

Maintain compliance with National Incident Management System

Mitigation Strategies for Technological/Human-induced Hazards

Public information and education

- Driver safety, hazardous materials, public health, power outages

Continued support of training, equipping, planning, and preparedness for emergency responders

Implementation Strategies

- Updated estimates of mitigation measure costs
- Summarized benefits of implementing mitigation measures
- Designated lead management agencies
- Updated current implementation status
- Identified potential sources of funding and technical assistance

Approval and Adoption

- When a draft plan is complete
  - Review by Wisconsin Division of Emergency Management → Incorporate comments
  - Review and approval by FEMA → Incorporate comments
  - The plan will need to be adopted by the Common Council

Project Web Site

- http://www.sewrpc.org/HMP
  - Agendas and other meeting materials
  - Summary notes from meetings
  - Presentations
  - Draft chapters of the plan report
  - Comment screen
  - Other ways to send a comment
- Email to jboxhorn@sewrpc.org

CRITICAL COMMUNITY FACILITIES IN THE CITY OF MILWAUKEE

APPENDIX B

Table B.1
Critical Community Facilities for the City of Milwaukee: 2016

Number on Map 2.8	Facility Name	Address	Municipality	2016 Assessed Value ($)[a]
1	City Hall and the Office of the Mayor	200 E. Wells Street	Milwaukee	10,966,000
2	City Department of Public Works Municipal Building	841 N. Broadway Street, Room 501	Milwaukee	25,470,000
2	City of Milwaukee Health Department City Municipal Building	841 N. Broadway Street, 3rd Floor	Milwaukee	25,470,000
3	Milwaukee County Courthouse Office of the County Executive	901 N. 9th Street	Milwaukee	40,000,000
4	Milwaukee County Jail	949 N. 9th Street	Milwaukee	40,000,000
5	City of Milwaukee Municipal Court	951 N. James Lovell Street	Milwaukee	40,000,000
6	Milwaukee Secure Detention Facility-Wisconsin Department of Corrections	1015 N. 10th Street	Milwaukee	510,000
--	Milwaukee County Juvenile Detention Center	10201 W. Watertown Plank Road	Wauwatosa	--
7	Milwaukee Public Library-Central	814 W. Wisconsin Avenue	Milwaukee	12,388,000
8	Port of Milwaukee	2323 S. Lincoln Memorial Drive	Milwaukee	38,500,000
9	Henry S. Reuss Federal Plaza	310 W. Wisconsin Avenue	Milwaukee	28,314,000
10	Wisconsin State Office Building	819 N. 6th Street	Milwaukee	9,773,000
11	Milwaukee Water Works City Municipal Building	809 N. Broadway, Room 406	Milwaukee	8,757,000
12	Linnwood Avenue Station Water Purification Plant	3000 N. Lincoln Memorial Drive	Milwaukee	22,700,000
13	Howard Avenue Water Purification Plant	725 W. Howard Avenue	Milwaukee	33,186,000
14	North Point Pumping Station	2275 N. Lincoln Memorial Drive	Milwaukee	5,963,000
15	Riverside Pumping Station	1311 E. Chambers Street	Milwaukee	3,816,000
16	Texas Pumping Station	2900 E. Texas Avenue	Milwaukee	--
17	Milwaukee Metropolitan Sewerage District	260 W. Seeboth Street	Milwaukee	639,800
18	Jones Island Water Reclamation Facility-Veolia Water North America	700 E. Jones Street	Milwaukee	27,993,400
19	American Red Cross	2600 W. Wisconsin Avenue	Milwaukee	1,189,900
20	Valley Power Plant (We Energies)	1035 W. Canal Street	Milwaukee	33,759,000
21	Waste Management Transfer Station	6710 N. Industrial Road	Milwaukee	--
22	Milwaukee Intermodal Station	433 W. St. Paul Avenue	Milwaukee	3,087,000
23	MCTS Hillside Administration Facility	1942 N. 17th Street	Milwaukee	4,500,000
24	MCTS Hillside Fleet Maintenance Facility	1525 W. Vine Street	Milwaukee	9,203,700
25	MCTS Fond du Lac Bus Garage	3343 W. Fond du Lac Avenue	Milwaukee	6,780,000
26	MCTS Fiebrantz Bus Garage	1900 W. Fiebrantz Avenue	Milwaukee	840,000
27	MCTS Kinnickinnic Bus Garage	1710 S. Kinnickinnic Avenue	Milwaukee	3,424,400
28	Milwaukee Street Car Traction Power Station	1647 N. Cass Street	Milwaukee	--
29	Milwaukee Street Car Operations and Maintenance Facility	450 N. 5th Street	Milwaukee	--
83	City Department of Neighborhood Services	4001 S. 6th Street	Milwaukee	--
--	Waste Management-Metro Recycling & Disposal	10712 S. 124th Street	Franklin	--
--	Waste Management-Orchard Ridge Recycling & Disposal	W124 N9355 Boundary Road	Menomonee Falls	--
--	Veolia ES Emerald Park Landfill	W124 S10629 124th Street	Muskego	--
--	Oak Creek Power Plant (We Energies)	4801 E. Elm Road	Oak Creek	--
--	South Shore Wastewater Treatment Plant	8500 S. 5th Street	Oak Creek	--
--	Falk Landfill	13th Avenue North of Rawson	South Milwaukee	--
--	Milwaukee County Power Plant (We Energies)	9250 W. Watertown Plank Road	Wauwatosa	--

[a] *Current assessment value of improvements, based on 2016 Milwaukee Properties Master file (MPROP).*

Source: City of Milwaukee, Milwaukee County, Milwaukee Green Map, and SEWRPC

Table B.2
Fire Stations in the City of Milwaukee: 2018

Number on Map 2.8	Battalions/ Bureaus	Facility Name	2016 Assessed Value ($)[a]	Address
30	1st Battalion	Engine #1,Tactical EMS Team	211,700	784 N. Broadway Street
31		Engine #2, Truck #2	--[b]	755 N. James Lovell Street
38		Engine #18, Incident Command Post, Battalion #1	237,000	3628 N. Holton Street
39		Engine #21, MED #6	35,700	2050 N. Palmer Street
35		Engine #27, Truck #5	42,900	2647 N. Bartlett Avenue
42		Engine #30, Med #7	--[b]	2903 N. Teutonia Avenue
37	2nd Battalion	Engine #13, Battalion #2	159,000	2901 N. 30th Street
40		Engine #22, MED #3	389,500	8814 W. Lisbon Avenue
41		Engine #24, Rescue #2, HURT	326,000	4927 W. Fiebrantz Avenue
43		Engine #34, MED #13	264,000	6205 W. Burleigh Street
44		Engine #36, MED #5	17,460	4060 N. 27th Street
63		Engine #37	--[b]	5335 N. Teutonia Avenue
45	3rd Battalion	Engine #10, MED # 18	388,000	5600 W. Oklahoma Avenue
47		Engine #26, Battalion #3	128,700	1140 S. 26th Street
49		Engine #29	23,300	3529 S. 84th Street
36		Engine #32, Truck #9	14,000	1551 N. 30th Street
50		Engine #33, Truck #17, HAZMAT #1 and #2t	--[b]	4515 W. Burnham Street
51		Engine #35, MED #14	--[b]	100 N. 64th Street
52	4th Battalion	Engine #7, Battalion #4	225,300	3174 S. Chase Avenue
53		Ladder #11, MED #15	84,000	2526 S. Kinnickinnic Avenue
57		Engine #12, Rescue #1, Rescue #4 (HURT)	122,900	2130 W. Oklahoma Avenue
55		Engine #14, Truck #8	284,500	6074 S. 13th Street
56		Engine #17, MED #17	287,000	4653 S. 13th Street
54		Engine #23, Truck #1 (Dive Rescue)	473,300	1400 S. 9th Street
59	7th Battalion	Engine #4, Truck #3 (Community Paramedics)	466,000	9511 W. Appleton Avenue
60		Engine #8, MED#16	712,000	5585 N. 69th Street
61		Engine #9, MED #4	520,800	4141 W. Mill Road
62		Engine #16, Battalion #7	571,400	10320 W. Fond du Lac Avenue
64		Engine #38, MED #19	280,000	8463 N. Granville Road
65		Engine #39, Truck #7	420,000	8025 W. Bradley Road
66	Administration	--	1,300,930	711 W. Wells Street
66	Special Operations	Emergency Medical Services and Special Teams	1,300,930	711 W. Wells Street
--	Fire and Police Commission	City Hall, Room 706A	10,966,000	200 E. Wells Street

Note: The following abbreviations have been used:

DIVE = Dive Rescue Team
Hi-Vol = High Volume Unit
HURT = Heavy Urban Rescue Team
HAZMAT = Hazardous Materials Response Team
MED = Emergency Medical Services Unit

[a] *Current assessment value of improvements, based on 2016 Milwaukee Properties Master file (MPROP).*

[b] *Data not available.*

Source: City of Milwaukee Fire Department and SEWRPC

Table B.3
Law Enforcement Facilities in the City of Milwaukee: 2016

Number on Map 2.8	Facility Name	2016 Assessed Value ($)[a]	Address	Contact
67	Police District 1	10,114,000	749 W. State Street	Captain Eric Moore
68	Police District 2	587,600	245 W. Lincoln Avenue	Captain Heather Wurth
69	Police District 3	--[b]	2333 N. 49th Street	Captain Shunta Boston-Smith
70	Police District 4	557,300	6929 W. Silver Spring Drive	Captain Andra Williams
71	Police District 5	459,700	2920 N. 4th Street	Captain Edith L. Hudson
72	Police District 6	1,000,000	3006 S. 27th Street	Captain Diana Rowe
73	Police District 7	438,600	3626 W. Fond du Lac Avenue	Captain Boris Turcinovic
74	Police Substation, District 3	118,800	2100 W. Wells Street	--
75	Milwaukee County Sheriff's Department, Safety Building	15,076,000	821 W. State Street	Sheriff David Clarke, Jr.
--	Wisconsin State Patrol District 2 (WisDOT)	--	21115 E. Moreland Boulevard, Waukesha, WI 53186-2985	--

[a] *Current assessment value of improvements, based on 2016 Milwaukee Properties Master file (MPROP).*

Source: Milwaukee Police Department and the Milwaukee County Sheriff's Office

Table B.4
Critical Facilities: Hospitals and Major Clinics

Number on Map 2.9	Facility Name	Address	Municipality	2016 Assessed Value ($)[a]
76	Aurora Sinai Medical Center	945 N. 12th Street	Milwaukee	2,945,000
77	Columbia St. Mary's Hospital[b]	2301 N. Lake Drive	Milwaukee	50,560,000
78	Wheaton Franciscan Healthcare-St. Francis	3237 S. 16th Street	Milwaukee	43,500,000
79	Wheaton Franciscan Healthcare-St. Joseph	5000 W. Chambers Street	Milwaukee	470,000
80	Aurora St. Luke's Medical Center	2900 W. Oklahoma Avenue	Milwaukee	6,055,000
81	Wheaton Franciscan Healthcare-Family Care Center	2400 W. Villard Avenue	Milwaukee	452,400
82	Clement J. Zablocki Veterans Affairs Medical Center	5000 W. National Avenue	Milwaukee	46,377,000
--	Wheaton Franciscan Healthcare-Elmbrook Memorial Hospital	19333 W. North Avenue	Brookfield	--
--	Aurora St. Luke's South Shore Hospital	5900 S. Lake Drive	Cudahy	--
--	Orthopaedic Hospital of Wisconsin	475 W. River Woods Parkway	Glendale	--
--	Wisconsin Health Center	4448 W. Loomis Road	Greenfield	--
--	Community Memorial Hospital	W180 N8085 Town Hall Road	Menomonee Falls	--
--	Columbia St. Mary's Hospital Ozaukee	13111 N. Port Washington Road	Mequon	--
--	Children's Hospital of Wisconsin	8915 W. Connell Court	Wauwatosa	--
--	Froedtert Memorial Lutheran Hospital	9200 W. Wisconsin Avenue	Wauwatosa	--
--	Northwest Surgery Center	1233 N. Mayfair Road, Room #304	Wauwatosa	--
--	Surgicenter of Greater Milwaukee	3223 S. 103rd Street	Milwaukee	--
--	Wauwatosa Surgery Center	10900 W. Potter Road	Wauwatosa	--
--	Wheaton Franciscan-St Joseph's Outpatient Center	201 N. Mayfair Road	Wauwatosa	--
--	Aurora West Allis Medical Center	8901 W. Lincoln Avenue	West Allis	--

[a] *Current assessment value of improvements based on 2016 Milwaukee Properties Master file (MPROP).*

[b] *Sacred Heart Rehabilitation Institute is part of Columbia-St. Mary's Hospital campus.*

Source: Wisconsin Department of Health and Family Services and SEWRPC

Table B.5
Public, Private, Charter, Choice, and Partnership Schools in the City of Milwaukee: 2016

School Name	Address
Elementary Schools and K-8	
A.E. Burdick School	4348 S. Griffin Avenue
Academia de Lenguaje y Bella Artes	1712 S. 32nd Street
Academy of Accelerated Learning	3727 S. 78th Street
Albert Story School	3815 W. Kilbourn Avenue
Albert E. Kagel School	1210 W. Mineral Street
Alexander Mitchell Integrated Arts School	1728 S. 23rd Street
Allen-Field Elementary School	730 W. Lapham Boulevard
Anna F. Doerfler Elementary School	3014 W. Scott Street
Auer Avenue Elementary School	2319 W. Auer Avenue
Benjamin Franklin School	2308 W. Nash Street
Brown Street Academy Elementary School	2029 N. 20th Street
Browning Elementary School	5440 N. 64th Street
Bruce Elementary School	6453 N. 89th Street
Bruce-Guadalupe Elementary School	1028 S. 9th Street
Business and Economics Academy of Milwaukee	3620 N. 18th Street
Byron Kilbourn School	5354 N. 68th Street
Capitol West Academy	3939 N. 88th Street
Cass Street K-8 School	1647 N. Cass Street
Central City Cyberschool	4301 N. 44th Street
Clara Barton School	5700 W. Green Tree Road
Clarke Street Elementary School	2816 W. Clarke Street
Clement Avenue Elementary School	3666 S. Clement Avenue
Clement J. Zablocki School	1016 W. Oklahoma Avenue
Congress Elementary School	5225 W. Lincoln Creek Drive
Cooper Elementary School	5143 S. 21st Street
Craig Montessori Elementary School	7667 W. Congress Street
Daniels University Preparatory Academy	4834 N. Mother Daniels Way
Darrell Lynn Hines Academy	7151 N. 86th Street
Downtown Montessori Academy	2507 S. Graham Street
Dr. Benjamin Carson Academy of Science	4920 W. Capitol Drive
Dr. George Washington Carver Academy of Mathematics and Science	1900 N. 1st Street
Dr. Martin Luther King, Jr. Elementary School	3275 N. 3rd Street
Eighty-First Street Elementary School	2964 N. 81st Street
Elm Creative Arts Elementary School	900 W. Walnut Street
Engleburg Elementary School	5100 N. 91st Street
Escuela Vieau School	823 S. 4th Street
Fairview Elementary School	6500 W. Kinnickinnic River Parkway
Fernwood Montessori School	3239 S. Pennsylvania Avenue
Fifty-Third Street Elementary School	3618 N. 53rd Street
Forest Home Avenue Elementary School	1516 W. Forest Home Avenue
Frances Brock Starms Discovery Learning Center	2035 N. 25th Street
Frances Brock Starms Early Childhood Center	2616 W. Garfield Avenue
Franklin Pierce School	2765 N. Fratney Street
Frederick J. Gaenslen K-8 School	1250 E. Burleigh Street
Gilbert Stuart School	7001 N. 86th Street
Golda Meir School	1615 N. Dr. Martin Luther King Jr. Drive
Grantosa Drive Elementary School	4850 N. 82nd Street
Gwen T. Jackson Early Childhood and Elementary School	2121 W. Hadley Street
Greenfield Bilingual School	1711 S. 35th Street
H.W. Longfellow School	1021 S. 21st Street
Hamlin Garland School	3120 W. Green Avenue
Hampton Elementary School	5000 N. 53rd Street

Table continued on next page.

Table B.5 (Continued)

School Name	Address
Elementary Schools and K-8 (continued)	
Hartford Avenue K-8 School	2227 E. Hartford Avenue
Hawley Environmental School	5610 W. Wisconsin Avenue
Hayes Bilingual School	971 W. Windlake Avenue
Henry David Thoreau School	7878 N. 60th Street
Highland Community School	1706 W. Highland Avenue
Hi-Mount Community School	4921 W. Garfield Avenue
Hmong American Peace Academy	4601 N. 84th Street
Honey Creek Elementary School	6701 W. Eden Place
Hopkins Lloyd Community School	1503 W. Hopkins Street
Howard Avenue Montessori School	357 E. Howard Avenue
Humboldt Park Elementary School	3230 S. Adams Avenue
IDEAL K-8 School	1420 W. Goldcrest Avenue
James Whitcomb Riley School	2424 S. 4th Street
Jeremiah Curtin Leadership Academy	3450 S. 32nd Street
John Greenleaf Whittier Elementary School	4382 S. 3rd Street
Keefe Avenue Elementary School	1618 W. Keefe Avenue
La Causa Charter School	1643 S. 2nd Street
La Escuela Fratney	3255 N. Fratney Street
Lancaster Elementary School	4931 N. 68th Street
Lincoln Avenue Elementary School	1817 W. Lincoln Avenue
Lloyd Barbee Montessori School	4456 N. Teutonia Avenue
Louisa May Alcott School	3563 S. 97th Street
Lowell Elementary School	4360 S. 20th Street
Lowell P. Goodrich School	8251 N. Celina Street
Luther Burbank School	6035 W. Adler Street
MacDowell Montessori School	6415 W. Mount Vernon Avenue
Manitoba Elementary School	4040 W. Forest Home Avenue
Maple Tree Elementary School	6644 N. 107th Street
Marvin E. Pratt Elementary School	5131 N. Green Bay Avenue
Mary Mcleod Bethune Academy	1535 N. 35th Street
Maryland Avenue Montessori K-8 School	2418 N. Maryland Avenue
Milwaukee Academy of Chinese Language	2430 W. Wisconsin Avenue
Milwaukee College Preparatory School – 38th Street	2623 N. 38th Street
Milwaukee College Preparatory School – Lloyd Street	1228 W. Lloyd Street
Milwaukee Environmental Science Academy	6600 W. Melvina Street
Milwaukee French Immersion School	2360 N. 52nd Street
Milwaukee German Immersion School	3778 N. 82nd Street
Milwaukee Parkside School	2969 S. Howell Avenue
Milwaukee Scholars Charter School	7000 W. Florist Avenue
Milwaukee Sign Language School	7900 W. Acacia Street
Milwaukee Spanish Immersion School	2765 S. 55th Street
Morgandale Elementary School	3635 S. 17th Street
Nathaniel Hawthorne School	6945 N. 41st Street
Neeskara Elementary School	1601 N. Hawley Road
Next Door Charter School	2545 N. 29th Street
Ninety-Fifth Street Elementary School	3707 N. 94th Street
Oliver Wendell Holmes School	2463 N. Buffum Street
Parkview Elementary School	10825 W. Villard Avenue
Penfield Montessori Academy	2433 W. Cherry Street
Ralph H. Metcalfe School	3400 W. North Avenue
Ralph Waldo Emerson School	9025 W. Lawrence Avenue
Richard Kluge Elementary School	5760 N. 67th Street
River Trail Elementary School	12021 W. Florist Avenue
Robert M. LaFollette School	3239 N. 9th Street

Table continued on next page.

Table B.5 (Continued)

School Name	Address
Elementary Schools and K-8 (continued)	
Rocketship Southside Community Prep	3003 W. Cleveland Avenue
Rogers Street Academy	2430 W. Rogers Street
Samuel Clemens School	3600 W. Hope Avenue
School for Early Development and Achievement	2020 W. Wells Street
Seeds of Health Elementary School	2433 S. 15th Street
Siefert Elementary School	1547 N. 14th Street
Stellar Collegiate Charter School	1115 S. 7th Street
Thurston Woods Elementary School	5966 N. 35th Street
Townsend Street Elementary School	3360 N. Sherman Boulevard
Trowbridge Street Elementary School	1943 E. Trowbridge Street
U.S. Grant School	2920 W. Grant Street
Victory K-8 School for the Gifted and Talented and Italian Immersion	2222 W. Henry Avenue
Walt Whitman Elementary School	4200 S. 54th Street
Westside Academy I	1945 N. 31st Street
Westside Academy II	1940 N. 36th Street
William Cullen Bryant School	8718 W. Thurston Avenue
William T. Sherman Multicultural Arts School	5110 W. Locust Street
Woodlands School: Bluemound Road Campus	5510 W. Bluemound Road
Woodlands School: State Street Campus	3121 W. State Street
Middle Schools	
Audubon Technology and Communication Center Middle School	3300 S. 39th Street
Lad Lake Synergy School	2820 W. Grant Street
Lincoln Center of the Arts	820 E. Knapp Street
Milwaukee School of Languages	8400 W. Burleigh Street
Morse Middle School for the Gifted and Talented	6700 N. 80th Street
Roosevelt Creative Arts Middle School	800 W. Walnut Street
Rufus King International Middle School	121 E. Hadley Street
Southeastern Youth and Family School	4050 N. 34th Street
UCC Acosta Middle School	615 W. Washington Avenue
Wedgewood Park International School	6506 W. Warnimont Avenue
High Schools	
Alexander Hamilton High School	6215 W. Warnimont Avenue
Alliance School	850 W. Walnut Street
Assata High School	3517 W. Courtland Avenue
Audubon Technology and Communication High School	3300 S. 39th Street
Banner Preparatory High School	4610 W. State Street
Bay View High School	2751 S. Lenox Street
Carmen Schools of Science and Technology: South Campus	1712 S. 32nd Street
Carmen Schools of Science and Technology: Northwest Campus	5496 N 72nd Street
Casimir Pulaski High School	2500 W. Oklahoma Avenue
Community High School	6700 N. 80th Street
Grandview High School	615 W. Washington Street
Harold S. Vincent High School	7501 N. Granville Road
James E. Groppi High School	1312 N. 27th Street
James Madison Academic Campus	8135 W. Florist Avenue
Lynde and Harry Bradley Technology and Trade School	700 S. 4th Street
Milwaukee Collegiate Academy	4030 N. 29th Street
Milwaukee Community Cyber High School	131 S. 1st Street
Milwaukee County Youth Education Center	949 N. 9th Street
Milwaukee High School of the Arts (MHSA)	2300 W. Highland Avenue
Milwaukee Marshall High School	4141 N. 64th Street
New School for Community Service	609 N. 8th Street
North Division High School	1011 W. Center Street

Table continued on next page.

Table B.5 (Continued)

School Name	Address
High Schools (continued)	
NOVA Tech School	2433 W. Roosevelt Drive
Project Stay	609 N. 8th Street
Riverside University High School	1615 E. Locust Street
Ronald Wilson Reagan College Preparatory High School	4965 S. 20th Street
Rufus King International High School	1801 W. Olive Street
Shalom High School	1749 N. 16th Street
South Division High School	1515 W. Lapham Boulevard
Tenor High School	840 N. Jackson Street
Transition High School	2610 W. North Avenue
Veritas High School	3025 W. Oklahoma Avenue
Washington High School of Information Technology	2525 N. Sherman Boulevard
Combined Elementary/Secondary Schools	
Milwaukee Academy of Science	2000 W. Kilbourn Avenue
Milwaukee Excellence Charter School	4950 N. 24th Street
Milwaukee Math and Science Academy	110 W. Burleigh Street
Northwest Opportunities Vocational Academy (NOVA)	2320 W. Burleigh Street
Barack Obama School of Career and Technical Education	5075 N. Sherman Boulevard
Saint Charles Behavior Reassignment School	151 S. 84th Street
Universal Academy for the College Bound	3872 N. 8th Street
Wisconsin Conservatory of Lifelong Learning	1017 N. 12th Street
Other Schools	
A Promise of Hope Academy	5226 W. Hampton Avenue
Academy of Excellence	633 S. 12th Street
Acelero Learning: Capitol Center	7833 W. Capitol Drive
Atlas Preparatory Academy	1039 E. Russell Avenue
Atonement Lutheran School	4224 W. Ruby Avenue
Believers in Christ Christian Academy	4065 N. 25th Street
Believers Institute	3624 W. North Avenue
Blessed Sacrament Grade School	3126 S. 41st Street
Blessed Savior Catholic School	5140 N. 55th Street
Calvary Christian Academy	921 N. 49th Street
Carter's Christian Academy	5268 N. 35th Street
Catholic East Elementary School	2461 N. Murray Avenue
Ceria M. Travis Academy	4744 N. 39th Street
Christ-Saint Peter Lutheran School	2229 W. Greenfield Avenue
Christian Faith Academy of Higher Learning	2327 N. 52nd Street
Clara Mohammed School	317 W. Wright Street
Cross Trainers Academy	1530 W. Center Street
Destiny High School	7210 N. 76th Street
Divine Savior Holy Angels High School	4257 N. 100th Street
Early View Academy of Excellence	7132 W. Good Hope Road
Eastbrook Academy	5375 N. Green Bay Avenue
Garden Homes Lutheran School	2450 W. Roosevelt Drive
Granville Lutheran School	8242 N. Granville Road
Greater Holy Temple Christian Academy	5575 N. 76th Street
Hickman Academy Preparatory School	4200 N. 51st Boulevard
Holy Redeemer Christian Academy	3500 W. Mother Daniels Way
Holy Wisdom Academy	3344 S. 16th Street
Hope Christian High School	3215 N. Dr. Martin Luther King Jr. Drive
Hope Christian School: Caritas	8920 W. Brown Deer Road
Hope Christian School: Fidelis	4200 W. Douglas Avenue
Hope Christian School: Fortis	3601 N. Port Washington Avenue
Hope Christian School: Prima	2345 N. 25th Street
Hope Christian School: Semper	3040 W. Capitol Drive

Table continued on next page.

Table B.5 (Continued)

School Name	Address
Other Schools (continued)	
Institute of Technology and Academics	8940 N. 85th Street
Jo's Learning Academy	4827 W. North Avenue
King's Academy Christian School	7798 N. 60th Street
Loving Shepherd Lutheran School	3909 W. Clinton Avenue
Lutheran Special School and Education Services	9700 W. Grantosa Drive
Malaika Early Learning Center	125 W. Auer Avenue
Marquette University High School	3401 W. Wisconsin Avenue
Messmer Catholic Schools	742 W. Capitol Drive
Milwaukee Lutheran High School	9700 W. Grantosa Drive
Milwaukee Montessori School	345 N. 95th Street
Milwaukee Seventh Day Adventist School	10900 W. Mill Road
Mother of Good Counsel School	3001 N. 68th Street
Mount Lebanon Lutheran School	6100 W. Hampton Avenue
Mount Calvary Lutheran School	2862 N. 53rd Street
Mount Olive Lutheran School	5301 W. Washington Boulevard
Nativity Jesuit Middle School	1515 S. 29th Street
New Testament Christian Academy	10201 W. Bradley Road
Northwest Catholic School	7140 N. 41st street
Northwest Lutheran Grade School	4119 N. 81st Street
Notre Dame School of Milwaukee	1420 W. Scott Street
Our Lady Queen of Peace Catholic School	2733 W. Euclid Avenue
Pius XI Catholic High School	135 N. 76th Street
Prince of Peace School	1114 S. 25th Street
Right Step Inc.	8684 N. 76th Place
Risen Savior Evangelical Lutheran School	9550 W. Brown Deer Road
Saint Adalbert School	1913 W. Becher Street
Saint Anthony School	1747 S. 9th Street
Saint Catherine School	2647 N. 51st Street
Saint Charles Borromeo Parish School	3100 W. Parnell Avenue
Saint Coletta Day School of Milwaukee	1740 N. 55th Street
Saint Gregory the Great Parish School	3132 S. 63rd Street
Saint Joan Antida High School	1341 N. Cass Street
Saint John Kanty School	2840 S. 10th Street
Saint John's Lutheran School	4001 S. 68th Street
Saint Josaphat Parish School	801 W. Lincoln Avenue
Saint Joseph Academy	3027 S. 16th Street
Saint Lucas Lutheran School	648 E. Dover Street
Saint Marcus Lutheran School	2215 N. Palmer Street
Saint Margaret Mary Catholic School	3950 N. 92nd Street
Saint Martini Lutheran Grade School	1520 S. Cesar E. Chavez Drive
Saint Matthias Parish School	9300 W. Beloit Road
Saint Peter-Immanuel Lutheran School	7801 W. Acacia Street
Saint Philip's Lutheran School	3012 N. Holton Street
Saint Rafael the Archangel School	2251 S. 31st Street
Saint Roman Parish School	1810 W. Bolivar Avenue
Saint Rose Youth and Family Center	3801 N. 88th Street
Saint Sava Orthodox School	3201 S. 51st Street
Saint Sebastian Parish School	1747 N. 54th Street
Saint Thomas Aquinas Academy	341 E. Norwich Street
Saint Vincent Pallotti School	201 N. 76th Street
SaintA	8901 W. Capitol Drive
Salam School	4707 S. 13th Street
Salem Lutheran School	6844 N. 107th Street
Sharon Junior Academy	1369 W. Meinecke Avenue

Table continued on next page.

Table B.5 (Continued)

School Name	Address
Other Schools (continued)	
Sherman Park Lutheran School	2703 N. Sherman Boulevard
Shining Star Christian Schools	4050 N. 95th Street
Siloah Lutheran School	3721 N. 21st Street
Tamarack Waldorf School	1150 E. Brady Street
Texas Bufkin Christian Academy	827 N. 34th Street
TransCenter for Youth	1127 S. 35th Street
United to Serve Academy	2212 N. 12th Street
Wells Street Academy	2020 W. Wells Street
Wisconsin Institute for Torah Study	3288 N. Lake Drive
Wisconsin Lutheran High School	330 N. Glenview Avenue
Word of Life Lutheran School	3545 S. 23rd Street
Yeshiva Elementary School	5115 W. Keefe Avenue

Sources: Milwaukee Public Schools and the Wisconsin Department of Public Instruction

Table B.6
Historic Sites and Districts on the National Register of Historic Places, City of Milwaukee: 2016

Site Name	Address	Year Listed
27th and Wells Commercial Historic District	2632, 2711 W. Wells Street; 760, 801, 810, 820 N. 27th Street	2016
Abbot Row Building	1019 – 1043 E. Ogden Avenue	1983
Abresch, Charles, House Building	2126 W. Juneau Avenue	1986
Adler, Emanuel D., House Building	1681 N. Prospect Avenue	1991
All Saints' Episcopal Cathedral Complex Building	804 – 828 E. Juneau Avenue	1974
Allis, Charles, House Building (also known as Charles Allis Art Library)	1630 E. Royall Place	1975
American System Built Homes-Burnham Street District	W. Burnham Street	1985
Astor on the Lake Building. (also known as Hotel Astor)	924 E. Juneau Avenue	1984
Baasen House-German YMCA (also known as Wisconsin House Tavern)	1702 N. 4th Street	1984
Baumbach Building	302 N. Broadway Street	1983
Bay View Historic District (also known as Village of Bay View)	Roughly bounded by Lake Michigan, Meredith Street, Superior Street, Nock Street, Wentworth Avenue, Pryor Avenue, St. Clair Street, railroad tracks and Conway Street	1982
Bertelson Building	2101 – 2111 N. Prospect Avenue	1992
Blatz Brewery Complex	1001 – 1147 N. Broadway	1986
Blatz, Valentin, Brewing Company Office Building	1120 N. Broadway	1983
Bogk, Frederick C., House	2420 N. Terrace Avenue	1972
Brewers Hill Historic District (also known as Vine-Reservoir Historic District)[a]	Vine, Reservoir, Palmer, 1st, 2nd, and Brown Streets	1984
Brewers Hill Historic District (Boundary Increase)[a]	Roughly, Brown and Lloyd Streets and Garfield and North Avenues from 2nd Street to Hubbard Street	1995
Buemming, Herman W., House	1012 E. Pleasant Street	1990
Burnham, J. L., Block	907 – 911 W. National Avenue	1988
Calkins, Elias A., Doublehouse (also known as Meddaugh, B.A., House)	1612 – 1614 E. Kane Place	1990
Calvary Presbyterian Church	935 W. Wisconsin Avenue	1986
Carpenter, Michael, House (also known as Hope Parish House)	1115 35th Street	1986
Cass-Juneau Street Historic District (also known as All Saints' Episcopal Cathedral Complex)	Roughly bounded by E. Knapp and Marshall Streets, Juneau Avenue, and Van Buren Street	1988
Cass-Wells Street Historic District	712, 718, and 724 E. Wells Street and 801, 809, 815, 819, and 823 N. Cass Street	1986
Central Library (also known as Milwaukee Public Library and Museum)	814 W. Wisconsin Avenue	1974
Chief Lippert Fire Station (also known as Chemical Engine House No. 1)	642 W. North Avenue	1988
Christ Evangelical Lutheran Church	2235 W. Greenfield Avenue	1987
Clark Row House	2103 – 2109 W. Kilbourn Avenue	1989
Coast Guard Station, Old	1600 N. Lincoln Memorial Drive	1989
Commerce Street Power Plant	1338 N. Commerce Street	1999
Concordia Historic District	Roughly bounded by W. State Street, N. 27th Street, W. Kilbourn Avenue and N. 35th Street	1985
Congregation Beth Israel Synagogue (also known as Greater Galilee Missionary Baptist Church)	2432 N. Teutonia Avenue	1992
Cook, Thomas, House	853 N. 17th Street	1986
Dahinden, Edward J., House	3316 W. Wisconsin Avenue	1986
Desmond–Farnham–Hustis House	1535 N. Marshall Street	1990
Dover Street School and Social Center	619 E. Dover Street	2016
EMBA Shipwreck (Self-Unloading Barge)	5 miles east of North Point in Lake Michigan	2013
Eagles Club	2401 W. Wisconsin Avenue	1986
East Brady Street Historic District	E. Brady Street from N. Farwell Avenue to N. Van Buren Street	1990
East Oregon and South Barclay Industrial Historic District	300 S. Barclay Street; 139, 221 E. Oregon Street; and 214 E. Florida Street	2014

Table continued on next page.

Table B.6 (Continued)

Site Name	Address	Year Listed
East Side Commercial Historic District	Roughly bounded by E. Wells Street, N. Jefferson Street and N. Broadway, Michigan and E. Clybourn, and N. Water Streets	1986
East Village Historic District	Generally bounded by N. Humboldt Street, E. Brady Street, N. Warren Street, and the Milwaukee River	2004
Esbenshade, Abraham H., House	3119 W. Wells Street	1986
Excelsior Masonic Temple	2422 W. National Avenue	1988
Exton Apartments Building (also known as 1260 Apartments)	1260 N. Prospect Avenue	1997
Federal Building	515 – 519 E. Wisconsin Avenue	1973
Fiebing, Otto F., House	1302 N. Hawley Road	1985
First Church of Christ, Scientist (also known as Renaissance Place)	1443 – 1451 N. Prospect Avenue	1989
First Unitarian Church	1009 E. Ogden Avenue	1974
First Ward Triangle Historic District	Roughly Franklin Place, N. Prospect and E. Juneau Avenues, and E. Knapp Street	1987
Florida and Third Industrial Historic District	234 – 500 (even side) W. Florida Street; 222 W. Pittsburgh Avenue; 212, 222, 305, 331 S. 3rd Street; 400 S. 5th Street	2008
Forest Home Cemetery and Chapel	2405 W. Forest Home Avenue	1980
Foth, Christian, House	1209 – 1211 S. 7th Street	1988
Fourth Street School (also known as Golda Meir School)	333 W. Galena Street	1984
Friedmann Row (also known as Patrician Row Condominiums)	1537, 1539, 1541, 1543 N. Cass Street and 731 E. Pleasant Street	1996
Gallun Tannery Historic District	Holton and Water Streets	1984
Garden Homes Historic District	Roughly bounded by W. Ruby and N. Teutonia Avenues, N. 24th Place, W. Atkinson Avenue and N. 27th Street	1990
German-English Academy (also known as B Building, Milwaukee School of Engineering)	1020 N. Broadway	1977
Germania Building (also known as Brumder Building)	135 W. Wells Street	1983
Gesu Church	1145 W. Wisconsin Avenue	1986
Gimbels Parking Pavilion	555 N. Plankinton Avenue	2001
Goodwill Industries Building	2102 W. Pierce Street	2004
Graham Row	1501, 1503, and 1507 N. Marshall Street	1979
Grand Avenue Congregational Church	2133 W. Wisconsin Avenue	1986
Greene, Thomas A., Memorial Museum (also known as Greene Geological Museum; Greene Museum)	3367 N. Downer Avenue	1993
Harley-Davidson Motorcycle Factory Building	3700 W. Juneau Avenue (1147 N. 38th Street)	1994
Harnischfeger, Henry, House	3424 W. Wisconsin Avenue	1986
Highland Avenue Methodist Church (also known as Solomon Community Temple; First German Methodist Episcopal Church)	2024 W. Highland Avenue	1986
Highland Boulevard Historic District	W. Highland Boulevard roughly bounded by N. 33rd and N. 29th Streets	1985
Historic Third Ward District	Bounded by the Milwaukee River, Chicago & North Western Railway, and E. St. Paul and N. Jackson Streets	1984
Hoelz, Alfred M., House	3449 – 3451 N. Frederick Avenue	1985
Holy Trinity Roman Catholic Church (also known as Our Lady of Guadalupe Roman Catholic Church)	605 S. 4th Street	1972
Home Office, Northwestern Mutual Life Insurance Company (also known as North Broadway Building No. 611)	605 – 623 N. Broadway	1973
Howie, David W., House	3026 W. Wells Street	1986
Immanuel Presbyterian Church	1100 N. Astor Street	1974
Iron Block	205 E. Wisconsin Avenue	1974
Johnston Hall (also known as Johnston Hall-Marquette University)	1121 W. Wisconsin Avenue	1986
Joseph Schlitz Company Brewery Complex	219 W. Galena Street	1999
Kalvelage, Joseph B., House	2432 W. Kilbourn Avenue	1978

Table continued on next page.

Table B.6 (Continued)

Site Name	Address	Year Listed
Kane, Sanford R., House (also known as Lakeshore Montessori School)	1841 N. Prospect Avenue	1991
Kenwood Park-Prospect Hill Historic District	Roughly bounded by N. Hackett Avenue, E. Edgewood Avenue, N. Lake Drive and E. Newberry Avenue	2002
Ketter, Frederick, Warehouse	325 W. Vine Street	1984
Kilbourn Avenue Row House Historic District	Roughly bounded by N. 14th Street, W. Kilbourn Avenue, and N. 15th Street	1986
Kilbourn Masonic Temple	827 N. 11th Street	1986
Kinnickinnic River Parkway	Located between S. 72nd Street and S. 16th Street in Milwaukee and West Allis	2011
Knapp-Astor House (also known as Montgomery House)	930 E. Knapp Street and 1301 N. Astor Street	1980
Knickerbocker Hotel	1028 E. Juneau Avenue	1988
Lake Park	2900 N. Lake Drive and 2800 E. Kenwood Boulevard	1993
Light Vessel No. 57 (Shipwreck) (also known as Grays Reef Lightship; Mi402)	Lake Michigan	1991
Lindsay-Bostrom Building	133 W. Oregon Street	2002
Lohman Funeral Home and Livery Stable	804 W. Greenfield Avenue and 1325 S. 8th Street	1988
Machek, Robert, House	1305 N. 19th Street	1977
Mackie Building (also known as Chamber of Commerce)	225 E. Michigan Street	1973
Mansfield, George C., Company Building	1300 N. 4th Street	2016
Mayer Boot and Shoe Company Building	116 E. Walnut Street	1984
McIntosh-Goodrich Mansion (also known as Wisconsin Conservatory of Music)	1584 N. Prospect Avenue	2000
McKinley Boulevard Historic District	W. McKinley Boulevard between N. 34th and N. 27th Streets	1985
Milwaukee City Hall	200 E. Wells Street	1973
Milwaukee County Courthouse	901 N. 9th Street	1982
Milwaukee County Dispensary and Emergency Hospital	2430 W. Wisconsin Avenue	1985
Milwaukee County Historical Center (also known as Second Ward Savings Bank)	910 N. 3rd Street	1973
Milwaukee Fire Department High Pressure Pumping Station (also known as Kinnickinnic River Pumping Station)	2011 S. 1st Street	1981
Milwaukee Harbor Piers and Breakwaters	Milwaukee Harbor, Lake Michigan	1996
Milwaukee Hospital	2200 W. Kilbourn Avenue	2006
Milwaukee News Building and Milwaukee Abstract Association Building (also known as Law Offices of Shellow and Shellow)	222 E. Mason Street	1982
Milwaukee Normal School-Milwaukee Girls' Trade and Technical High School	1820 W. Wells Street	1986
Milwaukee Paper Box Company	1560 W. Pierce Street	2013
Milwaukee Pierhead Light	Milwaukee Harbor entry north pier, southeast corner of H.W. Maier Festival Park	2012
Milwaukee River Parkway	Located between Good Hope Road and W. Capitol Drive	2012
Milwaukee-Western Fuel Company Building (also known as North Western-Hanna Fuel Company Building; Electronic Data Systems)	2150 N. Prospect Avenue	1992
Milwaukee-Downer "Quad"	Northwest corner of Hartford and Downer Avenues	1974
Mitchell Building	207 E. Michigan Street	1973
Mitchell, Alexander, House (also known as Wisconsin Club)	900 W. Wisconsin Avenue	2012
New Coeln House	5905 S. Howell Avenue	1988
Newberry Boulevard Historic District	1802 – 3000 E. Newberry Boulevard	1994
North First Street Historic District	Roughly 1st and 2nd Streets between North and Center Streets	1984
North Grant Boulevard Historic District	2370 – 2879 N. Grant Boulevard	1995
North Point Lighthouse	Wahl Street at Terrace Avenue	1984

Table continued on next page.

Table B.6 (Continued)

Site Name	Address	Year Listed
North Point North Historic District	Various	2000
North Point South Historic District	Roughly bounded by North Avenue, Summit, Terrace, and Lafayette Streets	1979
North Point Water Tower	E. North Avenue between N. Lake Drive and N. Terrace Avenue	1973
North Sherman Boulevard Historic District	N. Sherman Boulevard roughly bounded by W. Keefe Avenue and W. Lisbon Avenue	2004
North Third Street Historic District	Roughly N. 3rd Street between N. 3rd Avenue and Vine Street	1984
Northwestern Branch, National Home for Disabled Volunteer Soldiers Historic District (also known as National Soldiers Home Historic District)	Roughly bounded by W. Bluemound Road, Mitchell Boulevard, IH 94 and the Veterans Affairs Medical Center	1994
Old St. Mary's Church	844 N. Broadway	1973
Old World Third Street Historic District	N. Old World 3rd Street, W. Highland Avenue, and W. State Street	1987
Oliver, Joseph B., House	1516 E. Brady Street	1990
Oneida Street Station (also known as East Wells Power Plant)	108 E. Wells and 816 N. Edison Streets	1984
Pabst Brewery Saloon (also known as Zion Rock Missionary Baptist Church)	1338 – 1340 W. Juneau Avenue	1986
Pabst Brewing Company Complex	Roughly bounded by W. Highland Avenue, N. 11th Street, W. Winnebago Street, and N. 9th Street	2003
Pabst Theater	144 E. Wells Street	1972
Pabst, Frederick, House	2000 W. Wisconsin Avenue	1975
Parking Lot Site (Site - #94000670) (also known as 47 Mi-397)	Prehistoric-Late Archaic site; address restricted	1994
Peck, George W., Row House	1620 – 1630 N. Farwell Avenue	2016
Peckham Junior High School	3245 N. 37th Street	2012
Pittsburgh Plate Glass Enamel Plant	201 E. Pittsburgh Avenue	2009
Plankinton, Elizabeth, House (also known as Knights of Columbus Building)	1492 W. Wisconsin Avenue	1980
Plankinton-Wells-Water Street Historic District	Roughly bounded by Wells, Bridge, N. Water, E. Mason, W. Wells, and N. 2nd Streets	1986
Pritzlaff, John, Hardware Company	305 – 333 N. Plankinton Avenue (odd), 143 and 155 East Street	2013
Prospect Avenue Apartment Buildings Historic District	N. Prospect Avenue area roughly between E. Kane Place and E. Windsor Street	1990
Prospect Avenue Mansions Historic District	1363 – 1551 N. Prospect Avenue	1990
Prospect Hill Historic District (also known as Gilman's Subdivision of Park of Lockwood's Addition)	2700 block of N. Hackett Avenue, N. Shepard Avenue, N. Summit Avenue and 2804-2806 E. Park Place	2005
Public School No. 27 (also known as Garfield Avenue School)	2215 N. 4th Street	1984
Public Service Building	231 W. Michigan Street	1998
Pythian Castle Lodge (also known as Crystal Palace)	1925 W. National Avenue	1988
Quarles, Charles, House	2531 N. Farwell Avenue	1979
Saint Francis of Assisi Historic District	Roughly bounded by N. 5th Street, W. Brown Street, N. 4th Street, and W. Reservoir Avenue	1984
Saint George Melkite Catholic Church	1617 W. State Street	1986
Saint James Court Apartments	831 W. Wisconsin Avenue	2008
Saint James Episcopal Church	833 W. Wisconsin Avenue	1979
Saint John de Nepomuc Rectory	4th and Court Streets	1984
Saint John's Evangelical Lutheran Church Complex	804 – 816 W. Vliet Street	1992
Saint John's Roman Catholic Cathedral	812 N. Jackson Street	1974
Saint Josaphat Basilica	601 W. Lincoln Avenue	1973
Saint Martini Evangelical Lutheran Church	1557 W. Orchard Street	1987
Saint Patrick's Roman Catholic Church	1105 S. 7th Street	1974
Saint Paul's Episcopal Church	904 E. Knapp Street	1974
Saint Peter's Evangelical Lutheran Church	1204, 1213, 1214, and 1215 S. 8th Street	1987
Saint Vincent's Infant Asylum	809 W. Greenfield Avenue	1987
Saints Peter and Paul Roman Catholic Church Complex	2474 and 2490 N. Cramer Street and 2479 and 2491 N. Murray Avenue	1991

Table continued on next page.

Table B.6 (Continued)

Site Name	Address	Year Listed
Salem Evangelical Church (also known as St. Michael's Ukrainian Catholic Church)	1025 and 1037 S. 11th Street	1987
Schlitz, Joseph, Brewing Company Historic District	Roughly, along W. Walnut, N. 2nd, and N. 3rd Streets	1984
Schlitz, Joseph, Brewing Company Saloon (also known as Three Brothers Bar and Restaurant)	2414 S. St. Clair Street	1977
Schlitz, Victor, House	2004 W. Highland Avenue	1986
Schoonmaker Reef (also known as Wauwatosa Reef; Schoonmaker Quarry; Raphu Station; Francey Reef)	North of West Street, between N. 66th Street and N. 64th Street extended	1997
Schuster, George, House and Carriage Shed	3209 W. Wells Street	1986
Second Church of Christ Scientist (also known as Saint Luke Emmanuel Baptist Church)	2722 W. Highland Boulevard	1986
Shorecrest Hotel	1962 N. Prospect Avenue	1984
Sivyer, Fred, House	761 N. 25th Street	1986
Sixth Church of Christ, Scientist (also known as First Church of Christ Scientist)	1036 N. Van Buren Street	1980
Smith, Lloyd R., House (also known as Villa Terrace Museum of Decorative Arts)	2220 N. Terrace Avenue	1974
Soldiers' Home Reef (also known as Rocky Point; National Military Asylum Reef; Veterans' Hill)	Northeast of junction of Wood Avenue and General Mitchell Boulevard, Clement J. Zablocki Veterans Affairs Medical Center grounds	1993
South Branch Library (also known as Southside Neighborhood Service Center)	931 W. Madison Street	1988
South First and Second Street Historic District	Roughly bounded by Menomonee River, Chicago & North Western Railway, Seeboth, S. 1st, Oregon, and S. 2nd Streets	1987
South Layton Boulevard Historic District	921 – 2264 S. Layton Boulevard	1996
Sovereign Apartments	1810 W. Wisconsin Avenue	1986
Spence, William G., House	1741 N. Farwell Avenue	1996
Spencerian Business College	2800 W. Wright Street	2008
Spring Grove Site	Address restricted prehistoric site	1979
Square D Company/Industrial Controller Division	710 S. 3rd Street	2014
State Bank of Wisconsin (also known as Bank of Milwaukee Block)	210 E. Michigan Street	1984
Steinmeyer, William, House	1716 – 1722 N. 5th Street	1984
Steinmeyer, William, House	1724 – 1730 N. 5th Street	1984
Tire Swing Site (also known as 47 Mi-395)	Address restricted prehistoric site	1994
Train Trestle Site (also known as 47 Mi-396)	Address restricted prehistoric site	1994
Trinity Evangelical Lutheran Church	1046 N. 9th Street	1979
Tripoli Temple	3000 W. Wisconsin Avenue	1986
Turner Hall	1034 N. 4th Street	1977
Walker's Point Historic District	Roughly bounded by the Freeway, Menomonee Canal, Scott, 2nd, and W. Virginia Streets	1978
Walker, Harry B., House	3130 W. Wells Street	1986
Ward Memorial Hall (also known as Building 41; Theater at Woods Veterans Administration)	5000 W. National Avenue	1984
West Side Commercial Historic District	Roughly, W. Wisconsin Avenue, N. 3rd Street, N. Plankinton Avenue, and N. 2nd Street	2000
West Washington-North Hi-Mount Boulevards Historic District	4701 – 5929 W. Washington Boulevard; 1720 – 2049 N. Hi-Mount Boulevard	1994
Wisconsin Consistory Building (also known as Scottish Rite Masonic Center)	790 N. Van Buren Street	1994
Wisconsin Leather Company Building	320 E. Clybourn Street	2005
Woman's Club of Wisconsin (also known as The Athenaeum)	813 E. Kilbourn Avenue	1982

[a] *The boundary of this historic district was increased to its present boundary in 1995.*

Source: National Register of Historic Places

Table B.7
Locally-Designated Historic Sites in the City of Milwaukee: 2017

Site Name[a]	Address	Year Designated	Listed on National Register
47th Street Bungalow District	2500 block of N. 47th Street	2001	N
Abbot Row Building	1019 – 1043 E. Ogden Avenue	1983	Y
Adler, Emanuel D., House Building	1681 N. Prospect Avenue	2002	Y
All Saints' Episcopal Cathedral Historic District	804 – 828 E. Juneau Avenue	1984	Y
Allis, Charles, House Building (also known as Charles Allis Art Library)	1630 E. Royall Place	1982	Y
American System Built Homes Historic District	W. Burnham Street	1990	Y
Auer, Louis and Son Houses	2015, 2019, 2025, 2029 E. Kenwood Avenue	2007	N
Auer, Louis and Son Houses	2005, 2009 E. Kenwood Avenue	2008	N
Avalon Theater	2469-2483 S. Kinnickinnic Avenue	2004	N
Beth Israel Synagogue (also known as Greater Galilee Missionary Baptist Church)	2432 N. Teutonia Avenue	1989	Y
Bethel Evangelical Church	2392 S. Woodward Street	2002	N
Brady Street Historic District	E. Brady Street from N. Farwell Avenue to N. Van Buren Street	1990	Y
Brewers Hill Historic District	Roughly, Brown and Lloyd Streets and Garfield and North Avenues from 2nd Street to Hubbard Street	1985	Y
Brown Double House	1122-1124 N. Astor Street	2006	N
Bunaglow Style Firehouses	2901 N. 30th Street, 1615 W. Oklahoma Avenue, 407 N. Hawley Road	2001	N
Burhnam, J. L. Building	100-106 E. Seeboth Street	2004	N
Bzdawka Building	1112-1114 W. Lincoln Avenue	2017	N
Calvary Cemetery	South of W. Bluemound Road between N. Hawley Road and N. General Mitchell Boulevard	1987	N
Carr, Lester, House	2537 W. Kilbourn Avenue	1995	N
Cass-Wells Street Historic District	712, 718, and 724 E. Wells Street and 801, 809, 815, 819, and 823 N. Cass Street	1992	Y
Central Milwaukee Library	814 W. Wisconsin Avenue	1982	Y
Christ Polish Baptist Church	2009-2013 S. 19th Street	2007	N
City Hall	200 E. Wells Street	1982	Y
Coast Guard Station, Old	1600 N. Lincoln Memorial Drive	2003	Y
Cold Spring Park Historic District	W. McKinley Boulevard between N. 27th Street and N. 34th Street	1987	Y
Concordia Historic District	Roughly bounded by W. State Street, N. 27th Street, W. Kilbourn Avenue and N. 35th Street	1988, 2009	Y
Copeland Service Station	4924 W. Roosevelt Drive	1995	N
Crain/Claflin House	1773 N. Cambridge Avenue	2016	N
Diehnelt, Walter, House	4430 W. Roosevelt Drive	2001	N
Downer Avenue Commercial	2551-2651 N. Downer Avenue, 2604 N Hackett Avenue	2001	N
Eagles Club	2401 W. Wisconsin Avenue	1989	Y
East Side Commercial Historic District	Roughly bounded by E. Wells Street, N. Jefferson Street and N. Broadway, Michigan and E. Clybourn, and N. Water Streets	1987	Y
Ehler, C. Frederick, House	2576 N. 4th Street	1990	N
Epiphany Lutheran Church (also known as All People's Gathering Lutheran Church)	2600 N. 2nd Street	2000	N
Federal Building	515 – 519 E. Wisconsin Avenue	1982	Y
Fifteenth District School/McKinley School	2201 W. Vliet Street	2014	N
Fifteenth District School/McKinley School Playground	1255 N. 20th Street	2014	N
First German Methodist Church[b]	1037 W. Juneau Avenue	1985	N
First Unitarian Church	1009 E. Ogden Avenue	1991	Y

Table continued on next page.

Table B.7 (Continued)

Site Name[a]	Address	Year Designated	Listed on National Register
First Ward Triangle Historic District	Roughly Franklin Place, N. Prospect and E. Juneau Avenues, and E. Knapp Street	1983	Y
Fitzgerald, Robert Patrick, House	1119 N. Marshall Street	1990	N
Fourth Church of Christ, Scientist	3069 N. Downer Avenue, (also known as 2519 E. Kenwood Boulevard)	1996	N
Frattinger, Peter and Ida, House	807 N. 23rd Street	2017	N
Friedmann Row (also known as Patrician Row Condominiums)	1537, 1539, 1541, 1543 N. Cass Street and 731 E. Pleasant Street	1995	Y
Fundamental Bible Church[c]	2921-2927 W. State Street, 2925 W. State Street	1988	Y
Garden Homes Historic District	Roughly bounded by W. Ruby and N. Teutonia Avenues, N. 24th Place, W. Atkinson Avenue and N. 27th Street	2013	Y
Germania Building (also known as Brumder Building)	135 W. Wells Street	2014	Y
Gesu Church	1145 W. Wisconsin Avenue	1983	Y
Gipfel Union Brewery	423 -427 W. Juneau Avenue	1985	N
Goll, Frederick J., House	1550 N. Prospect Avenue	2002	N
Graham Row	1501, 1503, and 1507 N. Marshall Street	1982	Y
Grand Avenue Congregational Church (also known as Irish Cultual and Heritage Center)	2133 W. Wisconsin Avenue	1984	Y
Grant Boulevard Historic District	N. Grant Boulevard between W. Locust Street and W. Meinecke Avenue	1985	Y
Gustorf, Edmund, House	3138 N. Cambridge Avenue	1985	N
Haberer Saloon	3935-3937 W. Vliet Street	1986	N
Harnischfeger, Henry, House	3424 W. Wisconsin Avenue	1991	Y
Hausmann Building	1750 N. Martin Luther King, Jr. Drive	1986	N
Hide House, buildings 1 through 4	2625 S. Greeley Street	2009	N
Holy Rosary Roman Catholic Church	2003-2011 N. Oakland Avenue and 2038 N Bartlett Avenue	2000	N
Hrobsky/Berg Building	2722-2724 N. King Drive	2006	N
Hummel/Uihlein Building	2673-2679 N. Martin Luther King, Jr. Drive	2010	N
Immanuel Reformed Church (also known as Greater Mount Zion)[d]	2479 N. Sherman Boulevard	1995	N
Jefferson Hall	2617 W. Fond du Lac Avenue	1985	N
Jewett, Milo P., House	800 N. Marshall	1984	N
Kane, Sanford R., House (also known as Lakeshore Montessori School)	1841 N. Prospect Avenue	2003	Y
Kenwood Masonic Temple (formerly Italian Community Center)	2648 N. Hackett Avenue	1990	N
Kilbourn Avenue Bascule Bridge	Milwaukee River at Kilbourn Avenue	2006	N
Kilbourn/Reservoir Park	626 E. North Avenue, 701 E. Garfield Avenue	1999	N
Knowles, Jr., George, House	1879 Cambridge Avenue	2013	N
Koch, George, House (also known as Lion House)	3209 W. Highland Boulevard	1985	N
Koeffler, Charles, House	817-819 N. Marshall Street	1986	N
Konrad and Bauman Building	3225-3227 W. Lisbon Avenue	1998	N
Kren Building and Carriage Barn	2647-2649 N. 27th Street	2002	N
Kubbernuss, Frederick, House	222 E. Burleigh Street	2004	N
Kunzelmann, Albert, House	1635 S. 8th Street	1998	N
Koult, Anton, Saloon	322 W. State Street	1986	N
Lake Park[e]	2900 N. Lake Drive and 2800 E. Kenwood Boulevard	1983	Y
Leister, Isaac, House	11142 W. Bradley Road	1983	N
Lubavitch Chabad of Milwaukee (formerly Upham House)[f]	3109 N. Lake Drive	1984	N
Machek, Robert, House	1305 N. 19th Street	1986	Y
MacLaren, Mrs. Myron T, House (also known as University of Wisconsin-Milwaukee Alumni House)	3230 E. Kenwood Boulevard	1991	N

Table continued on next page.

Table B.7 (Continued)

Site Name[a]	Address	Year Designated	Listed on National Register
Manegold/Gramling House	1202 S. Layton Boulevard	2003	N
Mayer and Durner Buildings	2002-2006 N. Martin Luther King, Jr. Drive	1987	N
McIntosh, Charles, House (also known as Wisconsin Conservatory of Music)	1584 N. Prospect Avenue	1985	Y
Mier, Golda, School	1555 N. Martin Luther King, Jr. Drive	1988	N
Messmer, Henry, House	2302 N. Booth Street	1985	N
Miller Tavern/Catherine Foley Building (also known as Milwaukee Institute of Art and Design Student Union)	266-272 E. Erie Street	2015	N
Milwaukee Fire Department Firehouse Ladder Company No. 5	1945 N. Bartlett Avenue	2003	N
Milwaukee Protestant Home for the Aged	2449 N. Downer Avenue	1984	N
Milwaukee River Flushing Tunnel Station	1701 N. Lincoln Memorial Drive	1986	N
Murdock, Lafayette/Emily Groom House	1903 N. Cambridge Avenue	2013	N
Niezorawski, Francis (Frank) Duplex	1722-1724 N. Franklin Place	2008	N
North Lake Drive Historic District	North Lake Drive between E. Hartford Avenue and E. Park Place	1984	N
North Lake Drive Estates Historic District	Portions of North Lake Drive between E Edgewood Avenue and E. Hartford Avenue	1984, 1998	N
North Point North Historic District	Various	1983	Y
North Point South Historic District	Roughly bounded by North Avenue, Summit, Terrace, and Lafayette Streets	1983	Y
North Point Water Tower[g]	2588 N. Lake Drive	1982	Y
Northwestern National Insurance Company Building	526 E. Wisconsin Avenue	1987	N
Nunnemacher Estate/Wildenberg Hotel	2774 S. 27th Street	2014	N
Octagon House	2443 N. Gordon Place	1998	N
Old World Third Street Historic District	N. Old World 3rd Street, W. Highland Avenue, and W. State Street	1991	Y
Pabst Brewery Historic District	Roughly bounded by W. Highland Avenue, N 11th Street, W. Winnebago Street, and N. 9th Street	1985	Y
Pabst Brewing Company Hall (also known as Metropolitan Hall)	537-541 W. Clarke Street	2002	N
Pabst Mansion	2000 W. Wisconsin Avenue	1986	Y
Pabst Tavern	3431-3433 W. Vliet Street	1998	N
Pabst Theater	144 E. Wells Street	1982	Y
Paetzold, Lorenz, House	1942 S. Muskego Avenue	1986	N
Palmer, Henry L., Masonic Lodge No. 301/ Love Tabernacle	2640-2650 N.1st Street	2012	N
Peck, George W., Row House	1620 – 1630 N. Farwell Avenue	2012	Y
Peck, James S., House	1105 W. Waverly Place	1988	N
Pettibone/White House	2051 W. Wisconsin Avenue	2015	N
Philipp, Emanuel, School	4310 N. 16th Street	1988	N
Pryor Avenue Iron Well	1710 E. Pryor Avenue	1987	N
Railroad Swing Bridge	Milwaukee River at Jefferson Street	2005	N
Richards, Daniel, House[h]	2863 N. 1st Street	2000	N
Saint Anthony's Church[i]	1711 S. 9th Street	1986	N
Saint Benedict the Moor Roman Catholic Church	1015 N. 9th Street	1998	N
Saint Casmir's Roman Catholic Church Complex Historic District	2604, 2618, 2626 N. Bremen Street, 904 E Clarke Street	1992	N
Saint Hedwig's Church[j]	1716 N. Humboldt Avenue	1990	N
Saint James Episcopal Church	833 W. Wisconsin Avenue	1991	Y
Saint John's Evangelical Lutheran Church	804 – 816 W. Vliet Street	1990	Y
Saint John the Evangelist Cathedral	812 N. Jackson Street	1992	Y
Saint Josaphat Basilica	601 W. Lincoln Avenue	1987	Y

Table continued on next page.

Table B.7 (Continued)

Site Name[a]	Address	Year Designated	Listed on National Register
Saint Marcus Parsonage/Mathis House	212 E. North Avenue	2010	N
Saint Mark's Episcopal Church[k]	2604 N. Hackett Avenue	2001	N
Saint Mary's Hospital	2320-2388 N. Lake Drive	2002	N
Saint Mary's Roman Catholic Church and Rectory	836-844 N. Broadway	1990	Y
Saint Stanislaus Church[l]	524 W. Mitchell Street	1986	N
Salem Evangelical Lutheran Church	6814 N. 107th Street	1992	N
Schlitz Tavern	2249 N Humboldt Avenue (also known as 1025 E. North Avenue)	2000	N
Schlitz Tavern/Coventry Inn	2501 W. Greenfield Avenue	2010	N
Schultz/Seeboth Duplex	839-841 N. 11th Street	2012	N
Schuster, George, House and Carriage Shed	3209 W. Wells Street	2007	Y
Second Church of Christ Scientist	2722 W. Highland Boulevard	1998	Y
Second Ward Savings Bank (also known as Milwaukee County Historical Society Building)	910 N. Old World Third Street	1983	N
Seventh Day Adventist Central Church[m]	2229 N. Terrace Avenue	1983	N
Sherman Boulevard Congregational Church (also known as Community Baptist Church)[d]	2249 N. Sherman Boulevard	1995	N
Sherman Boulevard Historic District	N. Sherman Boulevard between W. Fond du Lac Avenue and W. Lloyd Street	1995	N
Sherman Park Evangelical Lutheran Church[d]	2703 N. Sherman Boulevard	1995	N
Sieglaff, William, Duplex	1131 N. 13th Street	2002	N
Sievers, George A., House (also known as Green House)	3173 and 3179-3181 S. 31st Street	2009	N
Sixth Church of Christ, Scientist	1036 N. Van Buren Street	1983	Y
Smith, Lloyd R., House (also known as Villa Terrace)	2220 N. Terrace Avenue	1982	Y
South Second Street Historic District	200 block of South 2nd Street	2016	N
State Street Bascule Bridge	Milwaukee River at State Street	2004	N
Stehling, Charles, House	1840 N. 5th Street	1984	N
Stormowski, Edmund, Duplex	1874-1846 N. Warren Avenue	2002	N
Third Church of Christ, Scientist (also known as Schrager Auction Gallery)[d]	2195 N. Sherman Boulevard	1995	N
Tiefenthaler House	2425 W. McKinley Boulevard	2013	N
Town of Lake Water Tower and Municipal Building	4001 S. 6th Street	1990	N
Trinity Lutheran Church Complex	1046 N. 9th Street	2000	Y
Trinity Presbyterian Church[d]	3302 N. Sherman Boulevard	1995	N
Trowbridge Street School	1943 E. Trowbridge Street	1991	N
Turner Hall	1034 N. 4th Street	1986	Y
Turner, William J., House	743 N. 4th Street	2005	N
University Club of Milwaukee	924 E. Wells Street	2003	N
Villa Uhrig	1727 N. 34th Street	1997	N
Van Ells Drug Store	2652-2654 W. Fond du Lac Avenue	2001	N
Walker, Chastina, House	3130 W. Wells Street	1991	Y
Ward Yard Office for First Ward	1911 N. Humboldt Avenue	2001	N
Weinstock, Samuel, House	3402 W. St. Paul Avenue	2009	N
Whitehead, R. D., Monument	S. 16th Street, W. Bow Street, S. Pearl Street	1986	N
Whitnall House	1200-1204, 1208 E. Locust Street	1999	N
Zion Evangelical Lutheran Church (also known as Bethel Baptist Church)	2030 W. North Avenue	2000	N

[a] *Names are given as they are listed on the City of Milwaukee Historic Preservation Commission's list. For those sites on both the City's list and the National Register of Historic Places, the names that they are listed under may differ slightly.*

[b] *Part of Pabst Brewery Complex Historic District.*

[c] *Part of Concordia Historic District.*

[d] *Part of Sherman Boulevard Historic District.*

Table continued on next page.

Table B.7 (Continued)

[e] *Part of North Point North Historic District*

[f] *Part of North Lake Drive Historic District.*

[g] *Designated individually and as part of North Point South Historic District.*

[h] *Demolished by fire July 1, 2002.*

[i] *Part of Mitchell Street Historic District.*

[j] *Part of Brady Street Historic District.*

[k] *Part of Downer Avenue Historic District.*

[l] *Part of Mitchell Street Historic District.*

[m] *Part of North Point South Historic District.*

Source: City of Milwaukee Historic Preservation Commission

EXAMPLES OF OUTREACH MATERIAL PUBLISHED BY THE WISCONSIN DEPARTMENT OF HEALTH SERVICES AND THE WISCONSIN DIVISION OF EMERGENCY MANAGEMENT FOR INFORMATIONAL AND EDUCATIONAL EFFORTS DIRECTED TOWARD SOLVING LOCAL HOMEOWNERS' FLOODING PROBLEMS

APPENDIX C

Wisconsin Flood Toolkit

Wisconsin
Department of Health Services
Division of Public Health
Bureau of Environmental and Occupational Health
P-00631 (3/2014)

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Wisconsin
Department of Health Services
Division of Public Health
Bureau of Environmental and Occupational Health

Contents

Introduction

Purpose

The purpose of this flood toolkit is to provide information to local governments, health departments, and citizens in Wisconsin about preparing for and responding to flood events. The toolkit focuses on providing 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 and printed onto local government or health agency letterhead for distribution to residents affected by flood. Additional documents may be found in Appendix B, Additional Resources.

Background

Image Source: WICCI

Although Wisconsin does not have exceptionally steep terrain, mountain slopes, or low-lying coastlands, significant areas of the state are flooded every year. Flooding in Wisconsin is generally caused by the accumulation of excessive surface runoff in low-lying flat areas or the overflowing of rivers and lakes. Routine annual flooding poses a danger to human life and safety, causes significant damage to property and infrastructure, and negatively affects the state's economy. From 1990 to 2008, Wisconsin experienced eight flood-related fatalities[1] and countless injuries caused by responding to and recovering from flood events. Flooding in southwestern Wisconsin in 2008 was responsible for property damage, agricultural losses, and business losses with an estimated value of $764 million to $1 billion.[2] Based on these data, preparing for flood events remains a priority for Wisconsin governmental units, citizens, and businesses.

Climate Trends

Long-term trend analysis of Wisconsin's climate indicates that the state is becoming warmer and wetter. Climate data has provided evidence that parts of southern and western Wisconsin have had an increase in annual precipitation of 7 inches above the 1950-2006 average. After analyzing historical climate data from 1950 to 2006 and developing downscaled local climate models, University of Wisconsin climate scientists created potential climate projections based on the historical trends and scientifically validated models.[3] Several of the modeled outcomes suggest that flooding may become much more likely, and more intense, in coming years.

These projections suggest that Wisconsin emergency planners may be faced with more precipitation, coming in more frequent and intense storms, and more runoff, especially during the winter when soil may be frozen.[3]

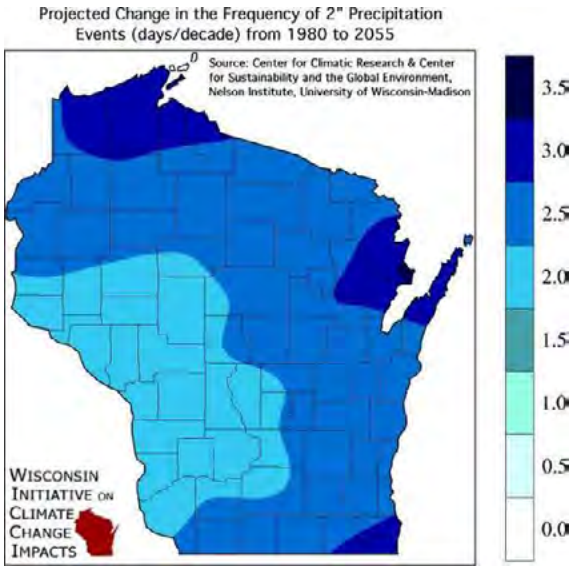


Image Source: WICCI

Health Impacts

These projections also suggest that Wisconsin may need to prepare for many more public health impacts due to flooding, including drowning, contaminated drinking water, damaged and dangerous property, and exposure to mold. Emergency planning must consider flooding needs, such as access to safe food and drinking water, safe use of electrical and heating appliances, and transportation out of flood zones.

Flood Response and Recovery Guidance

Under the Wisconsin "Home Rule" principle, flood preparedness and response are considered local activities. The local or county Emergency Management office, health agency, or police/fire first responders will be the lead agency during a flood event. However, when requested, state resources will be provided to assist and support the local response.

Image Source: Google

Definitions

Surface Water Flooding

Flooding due to increased flow volumes in river and stream beds reaching over their banks, increased flow volumes released from breached dams and impoundments, high volumes of overland flow (runoff), or increased recharge causing lake water levels to rise over their shorelines.

Groundwater Flooding

Flooding due to increased recharge causing the water table to rapidly rise, either forcing water to flood above the ground surface or forcing water by hydraulic pressure through cracks and crevices and into basements.

Septic System

A privately owned and operated home wastewater disposal system which includes: conventional septic tank/drain field systems, dry wells, holding tanks, mound systems, and alternative treatment systems.

Safe Water Supply

Drinking water is considered to be "safe" when it is determined to be free of coliform bacteria by a certified laboratory following approved standard methods. The accepted standard is "0" colony-forming units (cfu) of coliform bacteria per 100-ml of water or a "negative" result using a presence/absence sampling medium.

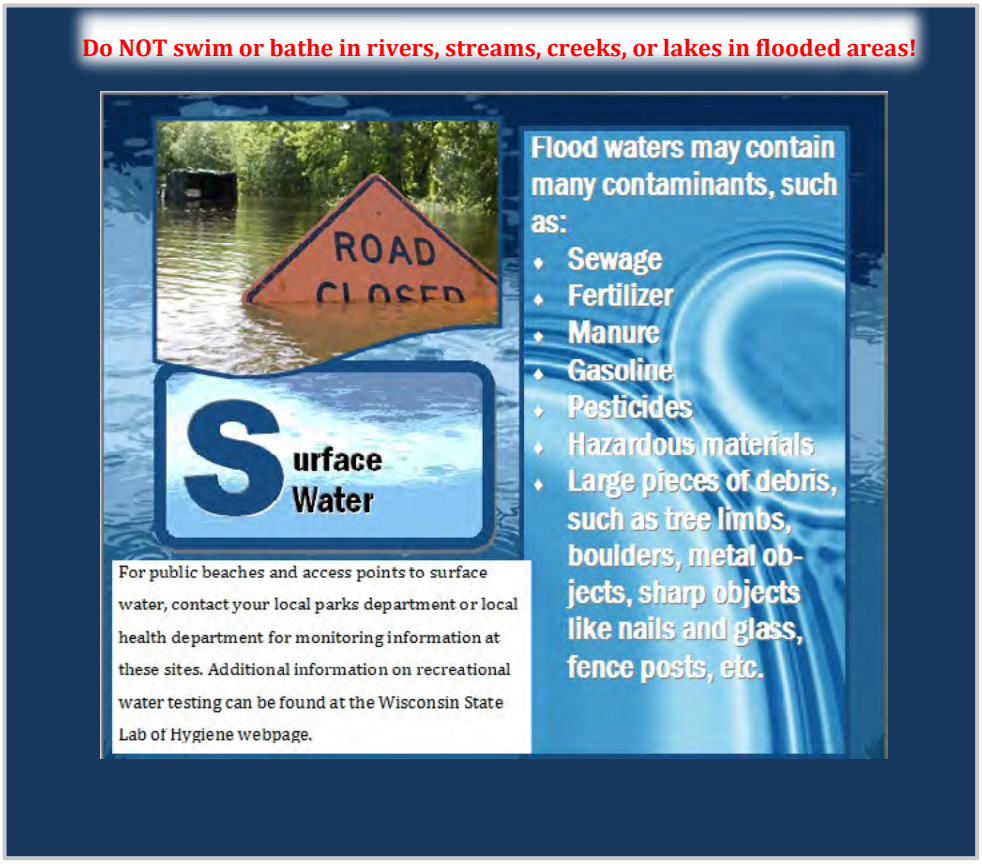
Flood/Flash Flood Watch

Flooding or flash flooding is possible in the flood watch area.

Flood/Flash Flood Warning

Flooding or flash flooding is already occurring or will occur soon in the warning area.

Guide 1: General Flood Information



Local Public Health Department Contact Information:

Water Testing Information: http://www.slh.wisc.edu/environmental/microbiology/

Drinking Water Issues

Be sure to check with your local health department regarding well testing kits, well disinfection information, or available flooding resources.

Municipal Water Users

- Turn on and run faucets for at least five minutes before using water for drinking or food preparation.
- If a "boil water" notice is issued, follow any directions given by the Wisconsin Department of Natural Resources, local water utility, or local health department.

Private Well Owners

- Private well owners whose well has been flooded should assume that flooded wells are contaminated.
- Do not drink or bathe in water from a private well that has been or is flooded.
- Wait until floodwaters have receded before sampling or disinfecting your well.
- To sample your water supply yourself, obtain a well water testing kit from your local public health department.
- If contamination is found, disinfect your well/water supply. See guide on Well Disinfection.
- Until the test results are known, follow these procedures to ensure safe drinking water:
  - Drink bottled water or water from a known, safe source.
  - If necessary, you can make water safe to drink by boiling it for five minutes.
- When in doubt, if the water is **CLOUDY, ODOROUS, COLORED - DO NOT DRINK THE WATER!**

Private sewage systems that are flooded are no longer reliable. Portable toilets or other facilities should be used.

Sewage may backflow from your septic or municipal system through floor drains, toilets, etc. Any affected areas, such as basements, must be cleaned and disinfected, as with a chlorine solution. Anything that cannot be cleaned should be thrown out.

Private Sewage Systems

For more information contact your local zoning office, code administrator, or sanitary inspection office.

Guide 2: Flood Preparedness

Secure your home:

- Contact your local health department to familiarize yourself with community emergency plans.
- Speak to your insurance company about flood coverage.
- List emergency numbers and contacts near phones.
- If you live in a flood zone, raise electrical components, furnace, and water heater above flood zone level.
- Install backflow valves for drains, toilets, and other sewer connections.
- Install sump pumps with backup power.

In case of a flood watch or warning:

- Gather emergency supplies (see next page).
- Stay informed – 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 water.** If water levels begin to rise, immediately seek 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 situation.
  - Collect important documents including ID cards, insurance cards, and medical records.
  - Map a safe evacuation route in advance.

In case of an ordered evacuation:

- Turn off the gas, electricity, and water.
- Disconnect appliances.
- Listen to evacuation orders and follow evacuation route.
  - Take emergency supplies, as outlined on the next page.
- Avoid flood zones and remain informed by listening to weather reports.

http://www.bt.cdc.gov/disasters/floods/readiness.asp
http://www.redcross.org/images/MEDIA_CustomProductCatalog/m4340128_Flood.pdf

ESSENTIAL MODERN SURVIVAL KIT

WATER
Potable water in suitable containers for immediate drink-ability, and a water filter for purifying after you run out of bottled water.

***Note: Have one gallon per person per day for at least three days.**

FOOD
High calorie foods such as high calorie energy bars or MRE (meals-ready-to-eat) are vital to maintain sufficient energy to keep going.

***Note: Pack at least a three-day supply of non-perishable food- and don't forget the manual can opener!**

EXTRA CLOTHING
Even if it's warm outside, if you get in trouble without extra clothes, hypothermia becomes a risk. Bring a stocking hat and rain jacket; and avoid cotton which is worthless when wet.

BODY WARMERS
Body warmers. Bring reflective "aluminized" space blanket or survival blanket to retain body heat, catalytic heater and bottled gas fuel.

SHELTER
Small tent, tarp with grommets, large plastic trash bag as poncho or expedient shelter roof.

SUNGLASSES
Good vision is essential. There are some great sunglasses out there that will enhance your vision, provide polarization for water or snow, and will prevent eye fatigue.

SANITATION
Toilet paper, hygiene products, soap, hand-towel and any other body care products you may need.

FIRST AID KIT
First aid kit. Keep at least the basics: band aids, sterile gauze, disinfectant, first aid manual, medical tape, medical scissors, disposable gloves, tweezers, cotton swabs and a thermometer.

EXTRA CASH
Extra cash will enable you to purchase the supplies you did not include and other necessary items. Although it may not be needed or deemed useless in the event of a major disaster, it is always good to keep some emergency cash on hand. A good amount to save is $50 for a disaster survival kit.

MEDICATIONS
Medications. There should be at least a seven-day supply of any prescription and non-prescription medications used by family members in your disaster survival kit.

MATCHES
'Strike Anywhere' matches, not the type that you must strike on the box. Store the matches in a water-tight case. Keeping a lighter and a fire starter in addition to matches are a good idea.

POCKET KNIFE
A multi-purpose tool with a knife is ideal.

MAP
Simply having a good map of the region you're in could get you out of trouble. Know how to read and navigate with maps.

COMPASS
A compass is ideal for establishing bearings while used in conjunction with a map. A GPS isn't so good for that.

FLASHLIGHT
And extra batteries. A LED flashlight, preferably a head-mounted style, is the best choice. Even though LED flashlight batteries last a considerable time, keep extras.

PERSONAL DOCS
Important personal documents like proof of address, insurance policies, birth certificates and passports should be stored together in an area with easy access in case of a natural disaster.

WEATHER RADIO
A small weather radio will keep you informed of the conditions outside and where to seek shelter or emergency personnel during and after a natural disaster.

CELL PHONE
And chargers. The towers may be down following a natural disaster, but emergency personnel will get them repaired fast for communication. Keep a cell phone with a wall and car charger handy.

SOURCES:

http://modernsurvivalblog.com/survival-kit/

http://www.idealhomegarden.com/home-improvement/disaster-survival-kit

http://en.wikipedia.org/wiki/Survival_kit

Guide 3: Disinfecting Your Well and Water System

DO NOT TURN ON THE PUMP!

☐ **Step 1:** Close the valves so you will bypass your water softener and any other water treatment equipment. A strong chlorine solution can damage this equipment. You should disinfect these devices separately following the manufacturer's instructions.

☐ **Step 2:** Calculate the amount of bleach needed for your well according to the following table:

Depth of Water	Diameter of Well					
	0.5 foot	1 foot	2 feet	3 feet	4 feet	5 feet
10 feet	1/2 cup	1-3/4 cups	7 cups	1 gal	1-3/4 gal	2-3/4 gal
20 feet	1 cup	3-1/2 cups	14 cups	2 gal	3-1/2 gal	5-1/2 gal
30 feet	1-1/2 cups	5-1/4 cups	1-1/4 gal	3 gal	5-1/4 gal	8-1/4 gal
40 feet	2 cups	7 cups	1-3/4 gal	4 gal	7 gal	11 gal
50 feet	2-1/2 cups	8-3/4 cups	2-1/4 gal	5 gal	8-3/4 gal	13-3/4 gal

Notes:

- Use only unscented household liquid chlorine bleach.
- Bleach concentrations can vary between 5% and 6%.
- Quantities given in this table are approximate and are rounded to the nearest practical measurement. Amounts given are calculated in accordance with reaching a chlorine concentration of 100 mg/L.

Key:

- gal: gallon
- 1 cup = 8 fluid ounces
- 1 gallon = 16 cups

http://www.cdc.gov/healthywater/emergency/safe_water/wells/disinfection_wells_bored.html

☐ **Step 3:** Using water from a known, safe source, add a volume of water – at least as great as the volume of water standing in the well – and the bleach into new, clean garbage cans or other comparable containers.

- When handling bleach, wear rubber hand and eye protection.

☐ **Step 4:** Turn off the power supply to the well, remove your well cap or seal, and note any issues with the well that may need repair.

- ☐ **Step 5:** Carefully pour the bleach solution down the well in one continuous pour.
- ☐ **Step 6:** Connect a new, clean hose to a nearby hose faucet and turn the electrical power back on.
- ☐ **Step 7:** Turn the water faucet on and recirculate the chlorinated solution through the hose and back to the well. Be sure you rinse the inside surface of the casing, all the way down to the bottom of the well.
- ☐ **Step 8:** Turn off the electrical power and drain both the pressure tank and the water heater. (Doing this will allow the water from these tanks to be totally replaced by the chlorinated solution.)
- ☐ **Step 9:** Turn the electrical power to the pump back on. Let the well water refill the pressure tank and water heater.
- ☐ **Step 10:** Turn on every water faucet, both inside and outside, until you can smell chlorine in each one.
- ☐ **Step 11:** Turn off every faucet, and allow the chlorine solution to remain in the well and plumbing system at least overnight, but preferably for 24 hours.
- ☐ **Step 12:** Flush the chlorine solution from the entire water system by using a hose connected to an outside faucet. Run the chlorinated water out of the system, but not into your septic system or into surface waters.
- ☐ **Step 13:** Keep running the water until you can no longer notice a smell of chlorine at any faucets.
- ☐ **Step 14:** Wait a few days, and then resample your well water to make sure it is bacteriologically safe to drink.

Guide 4: Re-entering Your Home

A home that is flooded might be contaminated with mold or sewage, which can cause health risks for your family. There might also be safety risks if your gas and electric service was interrupted. The following tips will help you avoid or reduce health and safety risks as you re-enter your home.

Avoid the Flood Zone

- Turn Around, Don't Drown®[6]: The Centers for Disease Control and Prevention (CDC) reports that **half of all flood-related drowning occurs when a vehicle is driven into floodwaters.** The next highest percentage is due to walking into or near flood waters.
- **Two feet of rushing water can carry away most vehicles, and six inches can knock over an adult.**
- Stay out of areas that are barricaded or closed.

Natural Gas Safety

- **If you notice a natural gas odor when entering your home, do NOT enter. Immediately call your local utility company or fire department.**
- Have your furnace or gas appliance inspected by a professional repair person, and then have them relight the appliance or furnace.
- While waiting for your furnace to be relighted, do NOT use other heating sources, such as gas space heaters, grills, or other appliances, that can give off dangerous fumes.
- **Carbon monoxide produced by gas appliances is dangerous and can be fatal.** If using a portable generator, keep it outside and far away from the building. Breathing the exhaust fumes from a portable generator could result in death in minutes.

Electrical Safety

- **Never turn power on or off while standing in water.**
- Have your electrical system inspected by an electrical contractor or building inspector.
- **Any electrical outlets that were submerged MUST be inspected for safety.**
- If you have electrical problems, call your local utility company.
- Electrical appliances that were exposed to water must be completely dry before use. Note: Electrical motors that were submerged probably will not work (e.g., refrigerator motor).
- If you use electric heaters, be careful to place them away from items that can burn. **Do not leave electric heaters unattended.**

Water Damage

Image Source: Google

Note: Damaged or wet flooring, carpeting, furniture, drywall, insulation, etc., should be removed and disposed of to prevent mold growth. In case of water damage, contact your local public health department for a list of plumbers and a flood brochure.

- Buildings that have been flooded should be inspected by a building inspector for structural damage before re-occupancy.
- If your basement is flooded, don't rush to pump it out. If you drain your basement too quickly, the pressure outside the walls will be greater than the pressure inside, which may cause the basement floor and walls to crack and collapse.
- Broken water pipes may have created puddles in your home. **Using electrical appliances while standing in water can cause electric shock or electrocution.**
- If you receive a cut or puncture wound while cleaning your home, tetanus shots are available through your local public health department.
- If you are on municipal water, run water faucets for at least five minutes before using water for drinking or food preparation. If a "boil water" notice is issued, follow any directions given by the Department of Natural Resources, the local utility company, or your local public health department.

Guide 5: What to do with Food after a Flood

Type of Food	Proper Action after Flood
Baby formula	Use only pre-prepared, canned baby formula that requires no added water.
Food not in waterproof containers	Discard if they have come into contact with floodwaters.
Canned foods	Discard if damaged. (Undamaged, commercially canned foods can be saved if you remove the can labels, wash cans, and disinfect with one cup bleach to five gallons of water. Re-label cans, including expiration date, with a marker.)
Screw caps, snap lids, crimped caps (soda pop bottles), twist caps, flip tops, and home-canned foods	Discard if they have come into contact with floodwaters.
Refrigerated or frozen food	Check food for spoilage by odor and appearance. Perishable foods left at room temperature for more than two hours should be thrown out. Frozen food that has thawed should be thrown out.

Guide 6: Cleaning and Sanitizing with Bleach after an Emergency

Cleaning and sanitizing your household after an emergency is important to help prevent the spread of illness and disease.

Using Cleaning and Sanitizing Products

1. Wash surfaces with soap and warm, clean water to remove dirt and debris.
2. Sanitize surfaces with a bleach solution (see below for instructions to make a bleach solution).

It is critical to read and follow the safety instructions on any product you use. Below are important safety guidelines when using sanitizing products:

- **WARNING: Never mix bleach with ammonia or any other cleaner**. This creates toxic gases that are dangerous and can cause serious injury. Ammonia is commonly found in window cleaners – *check the cleaner bottle to see if it contains ammonia*.
- Wear rubber boots, gloves, and eye protection.
- If using bleach mixtures indoors, open windows and doors to allow fresh air to enter.

Cleaning and Sanitizing with Bleach

Use regular unscented 5% household bleach and follow the instructions in the attached charts.

Recommendations for Cleaning and Sanitizing Various Surfaces with Bleach and Water

Area or Item to be Cleaned	*Amount of Bleach and Water to Mix*		*Cleaning Steps*
	Bleach Amount	Water Amount	
Clean and Sanitize Food Cans and Surfaces			
Food surfaces that may have touched floodwaters (Examples: countertops, cups and plates, flatware) **Note: Throw away wooden cutting boards, infant toys, baby bottle nipples, and pacifiers.**	1 teaspoon	1 gallon	1. Wash with soap and warm, clean water. 2. Rinse with clean water. 3. Dip or rinse in a sanitizing solution of 1 teaspoon of bleach per 1 gallon of clean water. 4. Allow to air-dry.
Food cans that are not bulging, open, or damaged	1 cup	5 gallons	1. Remove can labels. 2. Wash cans with soap and warm, clean water. 3. Dip cans in mixture of 1 cup of bleach per 5 gallons of water. 4. Allow to air-dry. 5. Re-label cans with permanent marker.

Clean and Sanitize Other Household Surfaces and Items			
Surfaces that do not soak up water and that may have touched floodwaters **(Examples: floors, stoves, sinks, certain toys, countertops, and tools)**	1 cup	5 gallons	1. Clean surface with soap and warm, clean water. 2. Rinse with clean water. 3. Sanitize using a mixture of 1 cup of bleach to 5 gallons of water. 4. Allow to air-dry.
Clean Mold Growth From Hard Surfaces			
Mold growth on hard surfaces **(Examples: floors, walls, windows, stoves, sinks, certain toys, countertops, flatware, plates, and tools)**	1 cup	1 gallon	1. Mix 1 cup of bleach in 1 gallon of water. 2. Wash surfaces with the bleach/water mixture. 3. If surfaces are rough, scrub them with a stiff brush. 4. Rinse surfaces with clean water. 5. Allow to air-dry.

Source: CDC

Guide 7: Mold Cleanup with Bleach

Before you clean

Fungi (molds) need a source of moisture, a source of organic matter, and proper temperature. After a flood event, the floodwaters will have soaked carpeting, furniture, building materials (drywall, wood studs, flooring, etc.), creating a suitable environment for mold growth. These materials must be removed or completely dried out to prevent mold from growing. Areas inside your home that have poor air movement and retain moisture are likely areas for future mold growth. Remove any sources of moisture, and repair damage that may contribute to moisture.

Image Source: Google

Image Source: FEMA

If I see mold in my home should it be tested?

Testing for mold is generally not necessary. If you can **see and smell it**, you have a mold problem. In flood situations, mold growth may begin on the back side of wet drywall, between building substrates, or under wet carpeting. It may not be visible, but you may notice a musty or moldy smell. Elimination of wet, flood-damaged building materials, furnishings, and personal items will be necessary to prevent mold problems. If ongoing mold problems occur, it is recommended that you have a thorough inspection to determine the cause of the mold growth. The Wisconsin Department of Health Services recommends that you hire a consultant specializing in building assessments to evaluate your entire house.

How can I clean up mold in my home?

Occasionally, mold can be found in the bathroom - on a windowsill, shower curtain, or wall. This mold can be wiped off the surface with a damp cloth and cleaning agent (e.g., window or bathroom cleaner). Preventing mold growth requires controlling the moisture source. This may be as simple as using a dehumidifier or fixing a simple leak. **For larger mold problems (about 10 square feet), follow the instructions on the next pages.**

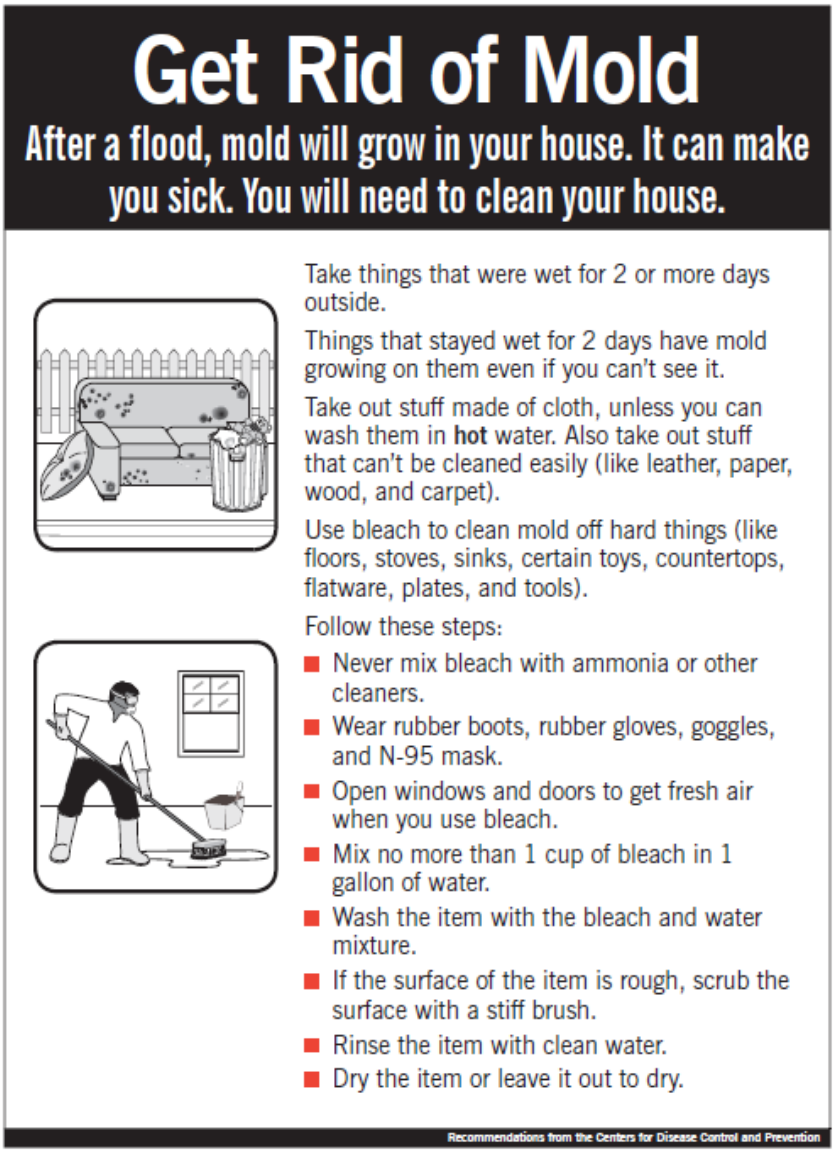


Image source: CDC

Step 1: **Preparation Phase** – What you need:

- Plastic sheets, at least 4 mm thick, to cover door openings, floors, and vents
- A breathing respirator that covers mouth and nose with HEPA cartridges
- Three spray bottles/plant misters
- Paper towels or disposable rags
- Heavy-duty plastic garbage bags
- General household cleaner (without ammonia)
- Regular household bleach (between 1% to 5% chlorine)
    - Note: Bleach is typically not necessary to clean up mold, unless a sewage release occurred. In that case, both mold and bacteria can be reduced by using a bleach solution as a final disinfecting rinse.
- Latex or rubber gloves and goggles
- A one-cup measuring container
- Three buckets that will hold at least one gallon of water each
- Commercial grade HEPA vacuum
    - Do not use a home vacuum since it is not designed for this type of work. Contact your local health department to find out where to rent a HEPA vacuum in your area.
- Dehumidifier
    - Do not use a fan since it can cause mold spores to be released.

Step 2: **Mixing Phase**

- **Spray bottle #1:** Mix general household cleaner and water in a bucket; then transfer to spray bottle (follow manufacturer's instructions).
- **Spray bottle #2:** Add 1 cup bleach to every gallon of tap water in a bucket; then transfer to spray bottle.
    - Note: Bleach is necessary when there has been a gray (laundry) or black (sewage) water release. Use precautionary measures, such as gloves and eyewear, when handling bleach.
- **Spray Bottle #3:** Clean, warm water for rinsing.

WARNING: Do not mix bleach with household cleaners that contain ammonia. If ammonia is mixed with bleach, a toxic gas can form, causing serious injury or death.

Step 3: **Application and Cleaning Phase**

- Prepare the work area:
    - Seal off the room from the rest of the house with the plastic and tape.
    - Keep children and animals out of the work area.
    - Do not eat, drink, use gum/tobacco, or smoke at any time during cleaning.
    - Use a dehumidifier prior to, during, and after the cleanup to keep areas dry and prevent mold from reoccurring.

CAUTION: The bleach solution is irritating and harmful to the skin, eyes, and clothing. Avoid direct

contact with the bleach by wearing rubber gloves, respirator, and goggles during the entire mixing and cleaning process.

- Removing the mold:
  - **Removing visible mold** – Spray with general household cleaner (spray bottle #1). Start from the top and work down, changing towels frequently. Discard towels in plastic bag. Rinse the same area with clean water on a damp towel or lightly spray with warm rinse water in a spray bottle (spray bottle #3) and wipe with a clean towel.
    - Repeat until all visible mold is gone.
  - **Removing mold and water** –Spray with bleach solution (spray bottle #2), wipe affected area of mold, and let set for 15 minutes. Rinse the area with a damp towel using clean, warm water or by lightly spraying with warm rinse water in a spray bottle (spray bottle #3) and wiping with a clean towel.

Step 4: **Cleaning up the Work Area**

- Once the surface is dry to the touch, use the HEPA vacuum to remove allergens. Place HEPA vacuum bag into a garbage bag. Tightly tie the garbage bag and dispose of it as you would your everyday household garbage.
- Flush wastewater down a toilet, utility sink, or floor drain.
- Change out of your cleaning clothes and wash them separately from your family's laundry.
- Wash hands and face.

- At this point, you can apply paint or other coating to the surface. You may wish to use a paint/coating that contains a fungicide to prevent future mold growth. Be sure to follow the manufacturer's instructions and recommendations when using any mold-resistant paint or paint additive. Remember, these are also pesticides and may have adverse health effects on some individuals.

- **Note on Use of Ozone Air Cleaners:**
  Do not use ozone air cleaners to kill mold. Ozone air cleaners generate ozone: a known respiratory irritant. The U.S. Environmental Protection Agency (EPA) does not recommend using ozone-generating air cleaners for treating indoor mold problems. If a contractor recommends the use of an ozone-generating air cleaner to treat mold problems in your home, please file a complaint with the Department of Agriculture, Trade, and Consumer Protection at 1-800-422-7128.

Guide 8: Suggested Talking Points about Floods

These talking points may be inserted into Message Maps for outreach broadcasts pre-flood, during the flood, and post-flood. See the example on the following page.

Pre-Flood Event Messages

- Prepare a family plan, and have emergency telephone numbers available.
- Assemble a disaster supply kit with enough food, water, and other supplies for at least 72 hours.
- Obtain a National Weather Service (NWS) Emergency Band Radio or portable radio. Have extra batteries.
- Follow the guidance provided in broadcasted flood warnings.

During the Flood Event Messages

- Follow broadcasted evacuation guidance.
- Stay out of floodwaters if possible. Floodwaters may contain bacterial contaminants, hazardous substances, and debris or sharp objects.
- Don't travel into or through floodwaters, if possible. Obey warning and road-closed signs.
- Don't attempt to save household possessions during the flood event. Wait until dangerous flood conditions have passed.

Post-Flood Event Messages

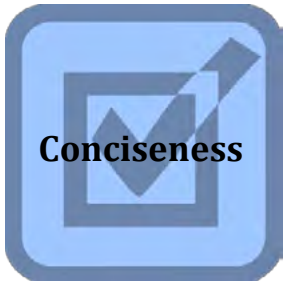
- Be sure the flood zone has been secured and hazardous conditions (e.g., downed power lines) have been eliminated.
- Before entering into any building, be sure the building has been inspected for structural integrity and that hazards (e.g., natural gas leaks) have been eliminated.
- Attempt to assess damage and losses, and estimate value of damage to provide a community-wide damage assessment.
- Attempt to begin cleanup assessment and identify options quickly to minimize water damage and environmental contamination issues.

Guide 9: Message Maps during a Flood Event

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 straightforward fashion.

General guidelines to follow when creating a message map include:

- 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.[4]
- Avoid unnecessary uses of the words no, not, never, nothing, and none.[5]



The following is a message map that could be used when addressing the general public regarding flood response and safety.

Main Message: "At this time, the City/County of_____ has experienced significant flooding. To help you and your loved ones stay safe during this event…"

Key Messages (3 key messages)	Supporting Information (3 items of supporting information for each key message)
Message 1: **Follow broadcasted evacuation guidance.**	**Supporting Information 1:** Listen to messages being broadcast by Emergency Management, your local news media, or your local governmental leaders regarding evacuation procedures.
	Supporting Information 2: Those living alone can be isolated and unaware of the dangers posed by flooding.
	Supporting Information 3: Check on your neighbors, friends, and relatives.
Message 2: **Stay out of flood waters, if at all possible.**	**Supporting Information 1:** Floodwaters may contain many contaminants, including bacteria, viruses, hazardous wastes, debris, and sharp objects.
	Supporting Information 2: Half of all flood-related drowning occurs when a vehicle is driven into floodwaters. Follow this advice: Turn Around, Don't Drown®.[5]
	Supporting Information 3: The next highest percentage of drowning is due to walking into or nearby floodwaters.
Message 3: **Don't attempt to save or salvage personal items during the flood.**	**Supporting Information 1:** Wait until flooding has receded before attempting to salvage belongings.
	Supporting Information 2: Don't attempt to enter the flood zone until authorities have declared the area safe.
	Supporting Information 3: Don't return to a flood-damaged home until it has been inspected for structural safety and hazards.

Appendix A: References

1 National Weather Service Weather Forecast Office, Milwaukee/Sullivan, WI. Floods and Flash Floods. (http://www.crh.noaa.gov/mkx/?n=flashfloodflyer)

2 National Weather Service. Hydrologic Information Center – Flood Loss Data. (http://www.nws.noaa.gov/hic/index.shtml)

3 Climate projections in this toolkit come from: Wisconsin's Changing Climate: Impacts and Adaptation. 2011. Wisconsin Initiative on Climate Change Impacts. Nelson Institute for Environmental Studies. UW-Madison and Wisconsin Department of Natural Resources, Madison, WI.

4 Covello VT. Message mapping. Accessed March 7, 2014 at: http://www.orau.gov/cdcynergy/erc/content/activeinformation/resources/Covello_message_mapping.pdf

5 National Weather Service. Turn Around Don't Drown®. (http://tadd.weather.gov/tadd-intro.shtml)

Appendix B: Additional Resources

Wisconsin Department of Health Services (DHS): Flood Hazards and Recovery

http://www.dhs.wisconsin.gov/flood/index.htm

DHS: West Nile Virus and Mosquito Bite Prevention

http://www.dhs.wisconsin.gov/communicable/ArboviralDiseases/WestNileVirus/Index.htm

Wisconsin Emergency Management, "Ready Wisconsin": Flooding

http://readywisconsin.wi.gov/flooding/default.asp

American Red Cross: Flood Safety

http://www.redcross.org/prepare/disaster/flood

American Red Cross: Flood Information in Other Languages

http://www.redcross.org/prepare/disaster-safety-library

American Red Cross: Flood Safety Checklist

http://www.redcross.org/images/MEDIA_CustomProductCatalog/m4340128_Flood.pdf

Federal Emergency Management Agency (FEMA)

http://www.fema.gov/

FEMA Spanish Language Portal

http://www.fema.gov/es/

Federal Centers for Disease Control and Prevention (CDC): Floods

http://emergency.cdc.gov/disasters/floods/

Federal Environmental Protection Agency (EPA): Flood Cleanup (Booklet)

http://www.epa.gov/iaq/flood/flood_booklet_en.pdf

Federal Environmental Protection Agency (EPA): Mold Guide

http://www.epa.gov/mold/pdfs/moldguide.pdf

Federal Environmental Protection Agency (EPA): National Stormwater Calculator

http://www.epa.gov/nrmrl/wswrd/wq/models/swc/

List of Wisconsin Local Public Health Departments

http://www.dhs.wisconsin.gov/localhealth/

List of Wisconsin Tribal Health Directors

http://www.dhs.wisconsin.gov/localhealth/

List of County Building, Code, and Zoning Officials

http://www.wccadm.com/staff_directory.htm

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://ready.wi.gov
Phone: 608-242-3232 Fax: 608-242-3247

HOMEOWNERS DISASTER PREPARATION INFORMATION

APPENDIX D

Are You READY WISCONSIN?

✓Get a Kit ✓Make a Plan ✓Be Informed

3-Day Emergency Supply Checklist

Get a Kit

When disaster strikes, immediate help may not be available. Every household should have an emergency kit with enough supplies to see you through three days following a natural disaster, health or manmade emergency.

Start out thinking about the basics of survival — fresh water, food, safety, warmth, sanitation and clean air.

For Everyone

- o Water (3 gallons per person for drinking and sanitation)
- o Non-perishable food
- o Manual can opener (if kit contains canned food)
- o Battery-powered NOAA Weather Radio and a commercial radio or hand crank radio
- o Flashlights and extra batteries
- o Sleeping bag or warm blanket for each person
- o First aid kit and emergency medical reference manual
- o Prescription medications and eyewear
- o Mess kits, paper cups, plates and plastic utensils, paper towels, moist towelettes, garbage bags and ties
- o Complete change of clothing, including a long-sleeved shirt, long pants, socks and sturdy shoes — add outdoor gear in winter
- o Cash in small denominations or traveler's checks and change
- o Copies of important family documents, such as insurance policies, identification and bank account records in a waterproof, portable container
- o Wrench or pliers to turn off utilities
- o Matches in a waterproof container
- o Household chlorine bleach and medicine dropper (When diluted nine parts water to one part bleach it can be used to disinfect)
- o Dust mask (to help filter contaminated air) and plastic sheeting/duct tape (to shelter where you are)
- o Local maps
- o Books, games, puzzles or other activities for children
- o Paper and pencil
- o Fire Extinguisher
- o Whistle to signal for help

For Pets

- o Identification tags on collars
- o Medications and veterinary immunization records
- o Food, drinking water, bowls, cat litter/pan and can opener
- o Sturdy leashes or carriers to transport pets safely (Carriers should be large enough for the pet to stand up, turn around and lie down)
- o Towels or blankets
- o Current photos of you with your pets
- o Feeding schedules, medical conditions, behavior problems, and the name and phone number of your veterinarian
- o Pet beds and toys

➢**More on back of page**

Wisconsin Emergency Management
http://readywisconsin.wi.gov
Phone: 608-242-3000

Are You READY WISCONSIN?
Get a Kit Make a Plan Be Informed

3-Day Emergency Supply Checklist

For Baby

- o Formula
- o Bottled water to mix with formula and to wash bottles
- o Bottles
- o Blankets (both emergency blankets and receiving blankets)
- o Diapers – keep the diaper size current
- o Disposable wipes
- o Copy of immunization records and other medical information
- o Bath towels and wash cloths
- o Burp cloths, bibs
- o Cotton swabs
- o Medications
- o Diaper rash ointment
- o Binkies and toys

Food Suggestions

- o Salt-free crackers, whole grain cereals, and canned foods with high liquid content.
- o Ready-to-eat canned meats, fruits and vegetables
- o Canned juices, milk, soup (if powdered, store extra water)
- o Staples--sugar, salt, pepper
- o High energy foods--peanut butter, jelly, crackers, granola bars, trail mix
- o Vitamins
- o Foods for infants, elderly persons or persons with special dietary needs
- o Comfort/stress foods--cookies, hard candy, sweetened cereals, lollipops, instant coffee, tea bags

Pack a can of Sterno if you want to heat your food. If you plan to use a barbecue grill, don't use it indoors.

First Aid Kit Suggestions

Consider taking a first aid class, through the American Red Cross.

Things you should have:

- o Two pairs of Latex, or other sterile gloves (if you are allergic to Latex).
- o Sterile dressings to stop bleeding.
- o Cleansing agent/soap and antibiotic towelettes to disinfect.
- o Antibiotic ointment to prevent infection.
- o Burn ointment to prevent infection.
- o Adhesive bandages in a variety of sizes.
- o Eye wash solution to flush the eyes or as general decontaminant.
- o Thermometer
- o Scissors
- o Tweezers
- o Tube of petroleum jelly or other lubricant
- o Aspirin or non-aspirin pain reliever
- o Anti-diarrhea medication
- o Antacid (for upset stomach)
- o Laxative
- o Cold medications

Wisconsin Emergency Management
http://readywisconsin.wi.gov
Phone: 608-242-3000

WISCONSIN DEPARTMENT OF NATURAL RESOURCES CORRESPONDENCE REGARDING STANDARD EMERGENCY OPERATION PLAN FOR WATER SUPPLY FACILITIES

APPENDIX E

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

Scott McCallum, Governor
Darrell Bazzell, Secretary

101 S. Webster St.
Box 7921
Madison, Wisconsin 53707-7921
Telephone 608-266-2621
FAX 608-267-3579
TTY 608-267-6897

October 8, 2001

Subject: Water System Security

Dear Water System Owner:

The events of September 11, 2001 will likely have profound affects on all our lives over the coming months and years. One effect that is already noticeable in the transportation industry is heightened security. The water supply industry, like the transportation industry, serves hundreds of millions of people every day. Therefore, as primary protectors of public health, we must be mindful of our responsibility to protect our customers and citizens against the potential of contaminated drinking water.

Toward that end, the Department would like to share with you some of our suggestions which may help keep your water system secure from external contamination, both intentional and accidental. Please keep in mind that the majority of these suggestions are either required by current State regulations or have been long recognized as sound operational security practices. We strongly urge you to implement as many of these suggestions as you find applicable and practicable in your individual situations.

The Department requests that every community water system perform a security analysis for their facilities. A standard emergency operation plan should be in place in event of mechanical failures, power outages, unsafe samples and threats or acts of terrorism.
Consider these basic security measures:

1. Cover all openings into reservoirs, treatment system vents and intakes with heavy hardware cloth, welded rods or other metal louvers resistant to removal. Code has always required these to be covered with fine mesh screen to exclude vermin. Now, these should also be designed to prevent intentional access. Frequent, regular inspections should be done of all vents in areas accessible to the public

2. Lock all pumphouses, reservoirs, booster stations and other remote facilities.

3. Restrict public access, especially by vehicles, to reservoir and pump house service roads. Be mindful of the possibility of large vehicles that could contain explosives and the proximity they can access. This can be accomplished with substantial locked gates, staggered concrete barriers, grading moats or by parking a large vehicle (snow plow, garbage truck).

4. Prohibit parking/stopping on public roadways adjacent to reservoirs, pump stations, treatment facilities within proximity where vehicle bomb explosions could impact facilities.

5. Request increased routine police patrols in sensitive areas and strict parking enforcement.

6. Operators should visit all facilities daily and maintain a log.

7. Install security lighting, motion detectors and TV cameras.

8. Maintain effective disinfection capability. Chorine, ozone and UV can be effective in destroying many biological agents. Acquire emergency disinfection equipment now if not already chlorinating.

9. Maintain a free chlorine residual at the ends of the distribution system of at least 0.2ppm. A free chlorine residual of 0.5 ppm could reasonably inactivate most biological agents likely to be used by terrorists.

10. Maintain chemical additives (fluoride, alum, lime) etc. under secure conditions that discourage tampering. Assure that containers delivered by suppliers are intact, secure and quality checked as feasible. Use only reliable sources and known contractors.

11. Develop a list of alternate, emergency water sources within the community such as industrial, commercial and private wells. Update inspection and testing programs for these wells pursuant to NR811.10. Develop plans with neighboring communities for mutual assistance to provide emergency water.

12. Train operators and plant personnel in security awareness. To prevent sabotage, think how would *you* attack your system? Then take measures to discourage or prevent such schemes from being effective.

13. Restrict access to water main maps and plans of all facilities. Seek legal counsel on open records requests to obtain facility plans. Contact consultants, contractors and regulators who have plans in their possession and require guarantees that access to their copies be secured. Access to water distribution maps is most sensitive.

14. Consider the reliability and security status of current and former personnel.

15. Post the chain of action for reporting threats or acts of terrorism: Call local law enforcement first. Local law enforcement authorities would in turn contact Wisconsin Emergency Management and the Federal Bureau of Investigation if it is determined that tampering has actually occurred at your water system. Second, call your local health department, the local health department will in turn call the Division of Health and Family Services Emergency Hotline at 1-608-258-0099. Have a plan for rapid public notification in place and practice it.

16. Join a security network such as Infragard, and/or contact American Waterworks Association to become part of their security information system by e-mailing: security@awwa.org. Consider hiring a professional consulting firm such as Sandia National Labs to develop a security plan. Visit the following websites on water system security: www.infragard.net , www.wi-infragard.com , www.awwa.org , www.awwa.org/waterweek/wwlast.htm , www.amwa.net/isac/

In addition to the preceding suggestions, the Department has been actively reviewing and revising our own emergency management plans and we have taken the initial steps to try to obtain additional formal training for our staff. We intend to highlight security as an issue in upcoming sanitary surveys and water system inspections and you can expect continued emphasis from our staff regarding water system emergency plans. Please remember that while the tragic events of September 11 may be the impetus for some of this emphasis, system security and emergency planning are essential for many types of natural

catastrophes. The tornado damage in the Village of Siren this year, comes to mind. Finally, please rest assured that as we get additional information and are able to offer it to you, we will do so.

While we have not yet established a formal organizational conduit for information requests, please direct any questions you might have regarding security or emergency planning to our Regional Drinking Water Experts through your assigned regional drinking water specialist or engineer. If information is needed beyond the expertise of our Regional Staff and Experts, they will forward requests to central office staff for answers or advice.

Thank you for doing your part to protect Wisconsin's drinking water.

Sincerely,

Jill D. Jonas, Director
Bureau of Drinking Water & Groundwater

cc: Regional DG Experts
Regional Water Leaders
Barb. Zellmer, AD/5
Susan Sylvester, AD/5
Bill Sonzogni, SLH
Lynda Knobeloch, DHFS, Division of Health
Dave Sheard, PSC

POTENTIAL FUNDING PROGRAMS TO IMPLEMENT PLAN RECOMMENDATIONS

APPENDIX F

Table F.1
Funding Program Descriptions

Reference Number	Administrator of Grant Program	Name of Funding Program	Eligibility	Types of Projects and Funding Eligibility Criteria	Assistance Provided	Application Deadline
1	U.S. Department of Homeland Security, Federal Emergency Management Agency (FEMA)	Hazard Mitigation Grant Program	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	75 percent Federal cost-share assistance; 12.5 percent State match and 12.5 percent local match required[a]	Following a Presidential disaster declaration; letter of intent must be submitted within 30 days of declaration
2	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	$160 million available nationally;[b] 75 percent Federal cost-share assistance; 25 percent local match required; two types of grants: Planning grant and project grant[c]	November 14
3	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	Within 30 days of a Presidential disaster declaration
4	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	Varies
5	FEMA	Pre-Disaster Mitigation Grant Program	State agencies and participating National Flood Insurance Program (NFIP) communities; local governments, U.S. Territories, and Federally-recognized tribes	1. Acquisition and relocation of structures in flood hazard areas 2. Floodproofing 3. Minor structural projects 4. Flood control projects for critical facilities 5. Plan preparation 6. Technical assistance 7. Applicants must have a FEMA-approved Mitigation Plan in order to qualify for project grants	$235,200,000 available nationwide;[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	January 31

Table continued on next page.

Table F.1 (Continued)

Reference Number	Administrator of Grant Program	Name of Funding Program	Eligibility	Types of Projects and Funding Eligibility Criteria	Assistance Provided	Application Deadline
6	FEMA	Homeland Security Preparedness Technical Assistance Program	State, local, and tribal governments	1. Activities that help achieve the National Preparedness Goal 2. Education and training on emerging homeland security issues	No statutory matching requirements. Amounts awarded vary based on the scope of the project	Contact headquarters or regional location
7	FEMA	Assistance to Firefighters Grant Program	City, Counties, 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	February 2
8	FEMA	Staffing for Adequate Fire and Emergency Response Grants (SAFER)	City, Counties, 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; Hiring of Firefighters Activity grant recipients are required to contribute non-federal funds subject to a Position Cost Limit and a Cost Share (see program guidance)	April 27
9	FEMA	Fire Prevention and Safety Grants (FP&S)	City, Counties, Village, Tribal, and Township Fire Departments; non-profit organizations, educational and public health institutions	1. Community risk reduction 2. Fire and arson investigation 3. Clinical Studies 4. Technology and product development 5. Code enforcement/awareness	Non-federal match equal to or greater than five percent of the grant awarded is required	March 16
10	FEMA	Fire Management Assistance Grants	States, Indian tribal governments, and local governments	Provides assistance for the mitigation, management, and control of any fire burning on publicly or privately owned forest or grassland that threatens such destruction as would constitute a major disaster	75 percent Federal cost-share assistance; 25 percent State and local match[d]	Rolling
11	U.S. Fire Administration	National Fire Academy	Persons with substantial involvement in fire prevention and control, emergency medical services, fire-related emergency management activities, or allied professions	Provides tuition-free training in firefighting, prevention, emergency medical services, and related areas	Provides tuition-free training in firefighting, prevention, emergency medical services, and related areas	June 15 for fall semester, December 15 for spring semester
12	U.S. Fire Administration	National Fire Academy Training Assistance Student Stipend Reimbursement Program	Persons who represent a career or volunteer fire department, rescue squad, or State or local government	Provides travel stipends for students attending National Fire Academy courses	Travel reimbursement	Rolling

Table continued on next page.

Table F.1 (Continued)

Reference Number	Administrator of Grant Program	Name of Funding Program	Eligibility	Types of Projects and Funding Eligibility Criteria	Assistance Provided	Application Deadline
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 floodflows 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	None
15	USACE	Emergency Streambank and Shore Protection Program	Local communities	1. 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 $5,000,000 for a given project; cost-share program with local match of 35 percent for design and construction required	--
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 $5,000,000 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	None
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	Ongoing
19	USACE	Flood Plain 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	Ongoing
20	U.S. Department of Agriculture, Farm Services Agency (FSA)	Conservation Reserve Program	Individual landowners in a 10- or 15-year contract	1. Riparian buffers 2. Trees 3. Windbreaks 4. Grassed waterways 5. Farmer must have owned or operated the land for at least 12 months prior to the previous program sign-up period.	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	Annually or ongoing

Table continued on next page.

Table F.1 (Continued)

Reference Number	Administrator of Grant Program	Name of Funding Program	Eligibility	Types of Projects and Funding Eligibility Criteria	Assistance Provided	Application Deadline
21	FSA	Conservation Reserve Enhancement Program	Individual landowners who have owned or operated land for at least 12 months prior to submitting an offer	1. Filter strips 2. Riparian buffers 3. Grassed waterways 4. Permanent grasses (only in specially designated grassland project areas) 5. Wetland development and restoration	50 percent Federal cost-share assistance; one-time signing incentive payment of $100 per acre for installing grass waterways, filter strips, and riparian buffers; one-time practice incentive payment equal to 40 percent of the eligible reimbursable cost to install grass waterways, filter strips, and riparian buffers; an annual rental payment; State of Wisconsin provides an incentive payment (equal to 20 percent of the eligible reimbursable cost of installing the approved practice), a one-time payment for land enrolled in the State's perpetual easement, and a one-time payment for land enrolled in the State's agreement program	Ongoing
22	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	After a designated State or presidential disaster declaration; sign-up periods vary by local FSA County Committee
23	U.S. Department of Agriculture (USDA), Natural Resources Conservation Service (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 4. 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	Ongoing
24	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 floodprone 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[e]	Variable

Table continued on next page.

Table F.1 (Continued)

Reference Number	Administrator of Grant Program	Name of Funding Program	Eligibility	Types of Projects and Funding Eligibility Criteria	Assistance Provided	Application Deadline
25	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	Variable
26	NRCS	Environmental Quality Incentives Program	Agricultural producers, owners of non-industrial private forestland, Indian Tribes, and those with an interest in the 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	Variable
27	U.S. Fish and Wildlife Service	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 grants request at no less than a 1-to-1 ratio; requests for small grants may not exceed $100,000	Standard grants due in February and July Small grants due in October
28	U.S. Department of Housing and Urban Development (HUD)	Community Development Block Grant Program	Local governments	1. Public Facilities Grants to fund tornado shelters and safe houses 2. Housing Grants to fund the rehabilitation of housing to meet current building codes 3. Funds continuous training course for the building code authority	No matching requirements. Amounts awarded vary based on assessed community needs	--
29	HUD and Wisconsin Department of Administration, Division of Energy, Housing, and Community Resources	Community Development Block Grant Program-Emergency Assistance Program	Local governments	1. Repair of public infrastructure 2. Housing rehabilitation to low-and moderate-income homeowners 3. Business assistance	75 percent Federal cost-share assistance; 25 percent local match required; maximum grant award equals $500,000	Application must be submitted within 90 days of a Presidential disaster declaration
30	HUD	Healthy Homes Technical Studies Grant Program	State, tribal, and local governments; non-profit organizations, for-profit firms, educational institutions	1. Improve methods for detecting and controlling key housing-related health and safety hazards and improve environmental sampling protocols 2. Evaluate efficacy and cost-effectiveness of interventions to address high-priority residential health and safety hazards	Approximately $6 million available nationally;[b] awards range from $300,000 to a maximum grant award of $1,000,000; No match is required, applicant leveraging contributions are encouraged	January 31
32	HUD	Home Investment Partnerships Program	Local Communities	Supports rental rehabilitation, home purchase for new homebuyers, weatherization related repairs, accessibility improvements and rental housing development	75 percent Federal cost-share assistance; 25 percent nonfederal match from participating jurisdictions	--

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Table F.1 (Continued)

Reference Number	Administrator of Grant Program	Name of Funding Program	Eligibility	Types of Projects and Funding Eligibility Criteria	Assistance Provided	Application Deadline
33	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	After a Presidential or U.S. Secretary of Agriculture disaster declaration
34	EPA	Pesticide Environmental Stewardship Grants	Companies and organizations that use pesticides, represent pesticide users, or implement or influence pest management practices of pesticide users (pesticide manufacturers and producers are not eligible)	1. Implementation of pollution control measures 2. Plan development which includes strategies to reduce pesticide risk	Approximately $500,000 available nationally;[b] locally grants are provided up to a maximum of $50,000	Ongoing
35	EPA	Environmental Education Grants Program	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	Check regional Request for Proposals (RFP) for deadline
36	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. Provides assistance for improvement and expansion of trauma and critical emergency medical services for children 2. Preferred programs provide assistance to populations with special needs (Native Americans, minorities, and the disabled)	No statutory matching requirements. Grants generally range from $130,000 to $3 million. Average grant awarded is $232,000 (2018). Amounts awarded vary based on the scope of the project	Rolling

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Table F.1 (Continued)

Reference Number	Administrator of Grant Program	Name of Funding Program	Eligibility	Types of Projects and Funding Eligibility Criteria	Assistance Provided	Application Deadline
37	U.S. Department of Health and Human Resources, National Institutes of Health	National Institute of Environmental Health Sciences (NIEHS) Hazardous Waste Worker Health and Safety Training	Public and private nonprofit organizations involved in hazardous waste removal, containment, or chemical emergency response	1. Assists organizations in the development of institutional competency to provide appropriate training and education to hazardous waste workers 2. Assists in development of model worker health and safety training programs consisting of classroom and practical health and safety training of workers in the treatment, storage, disposal, removal, containment, transportation or hazardous materials 3. Provides assistance for training and education emergency response in regards to a hazardous waste incident	No statutory matching requirements. Grants generally range from $26,960 to $2.7 million. Average grant awarded is $833,895 (2018)	Contact NIEHS headquarters for deadlines
38	U.S. Department Of Transportation (USDOT), Federal Highway Administration (FHWA)	Surface Transportation Block Grant Program	State and local units of government	Provides funding assistance for smaller-scale transportation projects and activities such as improvements to pedestrian and bicycle facilities and recreational trails; provides assistance for community improvements such as historic preservation and vegetation management, and environmental mitigation related to stormwater and habitat connectivity	80 percent Federal cost-share assistance; 20 percent local match is required	Contact State Transportation Enhancement Manager
39	Wisconsin Department of Administration	Wisconsin Coastal Management Grant Program	State and local units of government, nonprofit organizations, and tribal agencies	Enhancement and restoration of coastal resources within the state's coastal zone; eligible activities include wetland protection, nonpoint source pollution control, and historic preservation projects	Approximately $1.5 million is available biennially to all counties adjacent to Lakes Superior and Michigan	November 3
40	WDHS	Chemical Contamination Technical Assistance	Local Communities	Technical assistance can determine if an actual or potential public health threat is present and if hazard mitigation is warranted or desirable	Provide technical assistance and support	--
41	WDHS, Division of Public Health, Bureau of Communicable Diseases	Communicable or Infectious Diseases Technical Assistance	Local Communities	Technical assistance to determine if an actual or potential human threat is present	Provide technical assistance and support	--

Table continued on next page.

Table F.1 (Continued)

Reference Number	Administrator of Grant Program	Name of Funding Program	Eligibility	Types of Projects and Funding Eligibility Criteria	Assistance Provided	Application Deadline
42	Wisconsin Department of Natural Resources (WDNR)	Municipal Flood Control Grants Chapter NR 199 of the *Wisconsin Administrative Code*	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	March 16 (funding available every other year)
43	WDNR	Urban Green Space Program	Local units of government, tribal governments, lake protection and rehabilitation districts, and nonprofit conservation organizations	Land acquisition for greenway space in urban areas, protection of scenic or ecological features, and wildlife habitat improvement; local governments must have a WDNR accepted comprehensive outdoor recreation plan or master plan which has been approved by resolution by the local governing unit	50 percent State cost-sharing assistance; 50 percent local match is required	May 1
44	WDNR	Remediation and Redevelopment Program	Responsible Party	Oversees the investigation and cleanup of environmental contamination and the redevelopment of contaminated properties; consolidates state and federal cleanups into one program	Provide technical assistance and support	Department will take emergency action to remove or contain a spill at the expense of the responsible party
45	WDNR	Lake Management Planning Grant Program, Chapter NR 190 of the *Wisconsin Administrative Code*	Local units of government, lake districts, town sanitary districts, qualified school districts, and nonprofit conservation organizations	1. Gathering and analyzing water quality information 2. Land use planning within lake watersheds 3. Gathering and compiling demographic information pertinent to individual lakes 4. Developing lake management plans	Up to 67 percent State cost-share assistance for small-scale lake planning grants, not to exceed $3,000; 33 percent local match is required; up to 67 percent State cost-share assistance for large-scale lake planning grants, not to exceed $25,000; 33 percent local match is required; lakes are eligible for more than one grant, however, the total amount of State dollars cannot exceed $100,000; maximum grant award of $50,000 in any one year for each lake	December 10

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Table F.1 (Continued)

Reference Number	Administrator of Grant Program	Name of Funding Program	Eligibility	Types of Projects and Funding Eligibility Criteria	Assistance Provided	Application Deadline
46	WDNR	Lake Protection and Classification Grant Program, Chapter NR 191 of the *Wisconsin Administrative Code*	Local units of government, lake districts, and nonprofit conservation organizations	1. Land acquisition for easement establishment 2. Wetland restoration 3. Lake restoration projects 4. Other projects involving lake improvement	75 percent State cost-share which cannot exceed $200,000 for land/easement acquisition projects; cannot exceed $100,000 for wetland and shoreline habitat restoration projects; 25 percent local match is required	February 1 for Lake Protections grants; December 10 for Lake Classification grants
47	WDNR	Knowles-Nelson Stewardship Grant Program, Chapter NR 51 of the *Wisconsin Administrative Code*	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	May 1
48	WDNR	Urban Rivers Grant Program. Funding is through Chapter NR 51 of the *Wisconsin Administrative Code*	Local governments, tribal governments, and nonprofit conservation organizations	Land acquisition to preserve open areas in urban environments adjacent to streams and rivers	50 percent State cost-share assistance; 50 percent local match is required	May 1
49	WDNR	Urban Nonpoint Source and Stormwater Grants Program. Funding is through Chapter NR 155 of the *Wisconsin Administrative Code*	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	April 15
50	WDNR	Targeted Runoff Management Grants, Chapter NR 153 of the *Wisconsin Administrative Code*	Local units of government, tribal governments, regional planning commissions, and special purpose lake, sewerage and sanitary districts	1. Complying with nonpoint source performance standards 2. Improving 303(d) waters 3. Protecting outstanding water resources 4. Compliance with a notice of discharge for an animal feeding operation 5. Addressing a water quality concern of national or statewide importance, such as the Upper Mississippi River concerns	70 percent State cost-share assistance; 30 percent local match is required. Grant awards not to exceed $150,000 for small-scale TMDL and non-TDML projects	April 16
51	WDNR	River Protection Grant Program, Chapter NR 195 of the *Wisconsin Administrative Code*	Local units of government and nonprofit conservation organizations, qualified river management organizations	1. Activities designed to develop partnerships that protect river ecosystems 2. Educational projects 3. Activities associated with river management plan development 4. Land acquisition 5. Ordinance development 6. Installation of practices to control nonpoint source pollution	75 percent State cost-share assistance; 25 percent local match is required; Planning grants not to exceed $10,000, and Management grants not to exceed $50,000	Planning grants December 10; Management grants February 1

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Table F.1 (Continued)

Reference Number	Administrator of Grant Program	Name of Funding Program	Eligibility	Types of Projects and Funding Eligibility Criteria	Assistance Provided	Application Deadline
52	WDNR	Clean Water Fund Program	Local units of government, sanitary and utility districts, and federally recognized tribes	1. Compliance with nonpoint source performance standards 2. Stormwater management projects 3. Projects seeking water conservation, efficiency, and reuse 4. Construction or maintenance of water treatment facilities	Loans at 55 percent of market rate	Accepted year round for projects not seeking principal forgiveness or Hardship Program
53	Wisconsin Emergency Management	Hazard Mitigation Grant Program	State and local units of government, tribal governments, and eligible private, non-profit organizations	1. Mitigation Planning 2. Technical Assistance 3. Mitigation Projects	75 percent Federal cost-share assistance; 25 percent local match	Contact State Hazard Mitigation Officer
54	Wisconsin Emergency Management	Wisconsin Homeland Security Grant Program	State and local government units that must comply with HSPD-5	1. NIMS and ICS training courses 2. Funds purchase of equipment	Statewide $3,980,000 will be available	See Notice of Funding Opportunity for each grant for specific grant deadlines
55	Wisconsin Public Service Commission	Telecommunications, Water, Energy Divisions	Local Communities	Incorporate disaster resistance into Regulation development, land use practices and environmental impacts of public utilities	General Utility Assistance	--
56	University of Wisconsin Cooperative Extension	Extension Disaster Education Network	Local communities	Provides Community education and public information programs promoting hazard awareness and mitigation concepts	Education and Information provided through the University of Wisconsin System	--
57	Great Lakes Protection Fund	Great Lakes Protection Fund Grants Program	State and local units of government, nonprofit organizations, for-profit businesses, educational institutions, and individuals	1. To protect and restore the health of the Great Lakes 2. To promote the interdependence of healthy ecological and economic systems 3. To support innovative, creative, and venturesome ideas	Matching funds not required; past awards have ranged from $20,000 to $1.6 million; average award $460,000	Continuous applications process
58	Joyce Foundation	Joyce Foundation Grant Program	State and local units of government, nonprofit organizations and individuals, educational institutions	1. To protect and restore the health of the Great Lakes 2. To promote the interdependence of healthy ecological and economic systems 3. To support innovative, creative, and venturesome ideas 4. Developing improved regulatory approaches 5. Better understanding of the supply of and demand for Great Lakes 6. Creating transportation alternatives to reduce over reliance on automobiles	Finance the total cost of accepted projects	Grant proposals are considered at meetings of the Foundation's Board of Directors in April, July, and December

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Table F.1 (Continued)

Reference Number	Administrator of Grant Program	Name of Funding Program	Eligibility	Types of Projects and Funding Eligibility Criteria	Assistance Provided	Application Deadline
59	National Fish and Wildlife Foundation (NFWF)	Wal-Mart Stores, Inc. Acres for America Program	State and local units of government, nonprofit organizations, Indian Tribes, educational institutions	1. Acquisition of permanent easement for conservation of habitat	$3.5 million available nationally annually; minimum 1:1 match ratio required, higher local match preferred	Preproposals due April 13 Full proposals due June 29
60	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 5. Projects must have at least five contributing parties	$2,000,000 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	January 31
61	NFWF	Sustain Our Great Lakes Community Grant Program	State and local units of government, tribal governments, nonprofit organizations, educational institutions	1. Wetland restoration, enhancement, and protection projects 2. Tributary restoration, enhancement, and protection projects 3. Shoreline restoration, enhancement, and protection projects 4. Projects must be in the Great Lakes basin (current and historic)	Grant awards range from $25,000 to $1,500,000. No match is required; however, the ratio of matching funds offered is considered during review	April 24
62	WDNR	Safe Drinking Water Loan Program	Local units of government, sanitary and utility districts, and federally recognized tribes	Drinking water infrastructure projects	Loans at 55 percent of market share	June 30

[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] *The individual fire cost threshold for a State is the greater of $100,000 or 5 percent x $1.07 x state population. The cumulative fire cost threshold for a State is the greater of $500,000 or three times the 5 percent x $1.07 x State population. Both formulas are adjusted annually for inflation using the Consumer Price Index for All Urban Consumers published annually by the Department of Labor.*

[e] *In kind services are allowed as a part of the local cost-share assistance.*

Source: FEMA, Department of Homeland Security, U.S. Environmental Protection Agency, Wisconsin Department of Natural Resources, U.S. Department of Justice, Wisconsin Emergency Management, the State of Wisconsin and SEWRPC

APPENDIX G
FUNDING PROGRAM CONTACT INFORMATION

Table G.1
Funding Program Contact Information[a]

Administrator of Grant Program	Name of Grant Program	Address	Phone Number	Internet Web Address
U.S. Department of Homeland Security, Federal Emergency Management Agency (FEMA)	Hazard Mitigation Grant Program Pre-Disaster Mitigation Program Flood Mitigation Assistance Program	Federal Emergency Management Agency Region V 536 S. Clark Street, 6th Floor Chicago, IL 60605	(312) 408-5500	www.fema.gov/hazard-mitigation-assistance
FEMA	Public Assistance Program	U.S. Department of Homeland Security Federal Emergency Management Agency Public Assistance Division 500 C Street, SW Washington, DC 20472	(202) 646-3834	www.fema.gov/public-assistance-local-state-tribal-and-non-profit
FEMA	National Training and Education Division	U.S. Department of Homeland Security Federal Emergency Management Agency National Training and Education Division 400 C Street SW, 7th Floor South Washington, DC 20472-3600	(800) 234-1116	www.firstrespondertraining.gov/frt/content.do
FEMA	Homeland Security Preparedness Technical Assistance Program	U.S. Department of Homeland Security Federal Emergency Management Agency Office of Preparedness Integration 500 C Street, 7th Floor Washington, DC 20472-3100	(202) 786-0849	www.fema.gov
FEMA	Assistance to Firefighters Grants Program Staffing for Adequate Fire and Emergency Response Grants Fire Prevention and Safety Grants Fire Management Assistance Grants	U.S. Department of Homeland Security Federal Emergency Management Agency Grant Programs Directorate, Assistance to Firefighters Grant Program 400 C Street S.W., 3N Washington, DC 20472-3635	(866) 274-0960	www.fema.gov/welcome-assistance-firefighters-grant-program
U.S. Department of Homeland Security, Federal Emergency Management Agency, U.S. Fire Administration	National Fire Academy National Fire Academy Training Assistance Student Stipend Reimbursement Program	U.S. Fire Administration 16825 S. Seton Avenue Emmitsburg, MD 21727	(800) 238-3358	www.usfa.fema.gov/
U.S. Army Corps of Engineers (USACE)	Flood Risk Management Program Snagging and Clearing for Flood Risk Management Program Emergency Streambank and Shore Protection Program Water Resources Development and Flood Control Acts Small Hurricane and Storm Damage Reduction Program Flood Plain Management Services Program	U.S. Army Corps of Engineers Detroit District 477 Michigan Avenue Detroit, MI 48226	(313) 226-3387	www.lre.usace.army.mil/Missions/Planning/Technical-Planning-Assistance/

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Table G.1 (Continued)

Administrator of Grant Program	Name of Grant Program	Address	Phone Number	Internet Web Address
United States Department of Agriculture (USDA), Farm Services Agency	Conservation Reserve Program Conservation Reserve Enhancement Program Emergency Conservation Program	U.S. Department of Agriculture Farm Service Agency 8030 Excelsior Drive, Suite 100 Madison, WI 53717	(608) 662-4422	www.fsa.usda.gov
USDA, Natural Resources Conservation Service (NRCS)	Watershed Protection and Flood Prevention Program	Natural Resources Conservation Service 8030 Excelsior Drive Madison, WI 53717	(608) 662-4422	www.nrcs.usda.gov/wps/portal/nrcs/main/wi/programs/planning/wpfp/
NRCS	Emergency Watershed Protection Program - Floodplain Easement Option Emergency Watershed Protection Program - Recovery Assistance	U.S. Department of Agriculture Natural Resources Conservation Service 8030 Excelsior Drive, Suite 200 Madison, WI 53717	(608) 662-4422	www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/landscape/ewpp/
NRCS	Environmental Quality Incentives Program	U.S. Department of Agriculture Natural Resources Conservation Service 8030 Excelsior Drive, Suite 200 Madison, WI 53717	(608) 662-4422	www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/eqip/
U.S. Environmental Protection Agency (EPA)	Environmental Education Grants	U.S. Environmental Protection Agency, Region 5 Ralph Metcalfe Federal Building 77 West Jackson Boulevard Chicago, IL 60604-3590	(312) 353-2000	www.epa.gov/education/environmental-education-ee-grants
EPA	Pesticide Environmental Stewardship Grants	U.S. Environmental Protection Agency Office of Pesticide Programs 1200 Pennsylvania Avenue, NW Washington, DC 20460	(202) 564-4700	www.epa.gov/pesp/overview-pesticide-environmental-stewardship-program
U.S. Fish and Wildlife Service	North American Wetlands Conservation Grants Program	U.S. Fish and Wildlife Service Division of Bird Habitat Conservation 5275 Leesburg Pike Falls Church, VA 22041-3803	(703) 358-2017	www.fws.gov/birds/grants/north-american-wetland-conservation-act.php
U.S. Department of Health and Human Services (HHS), Health Resources and Services Administration	Emergency Medical Services for Children	U.S. Department of Health and Human Services Health Resources and Services Administration Parklawn Building 5600 Fishers Lane, Room 18N-54 Rockville, Maryland 20857	(301) 443-1527	www.hrsa.gov
HHS, National Institutes of Environmental Health Sciences	National Institute of Environmental Health Sciences Hazardous Waste Worker Health and Safety Training	National Institute of Environmental Health Sciences Worker Education and Training Program P.O. Box 12233 Research Triangle Park, NC 27709	(919) 541-3345	www.niehs.nih.gov/careers/hazmat/about_wetp/hwwt/index.cfm

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Table G.1 (Continued)

Administrator of Grant Program	Name of Grant Program	Address	Phone Number	Internet Web Address
U.S. Department of Housing and Urban Development (HUD)	Community Development Block Grant Program	U.S. Department of Housing and Urban Development 451 7th Street, SW Washington, DC 20410	(202) 708-1112	www.hud.gov/program_offices/comm_planning/communitydevelopment/programs
HUD	Healthy Homes Technical Studies Grant Program Healthy Homes Demonstration Grant Program	U.S. Department of Housing and Urban Development Room 8236 451 7th Street, SW Washington, DC 20410	(202) 402-7685	www.hud.gov/program_offices/healthy_homes/hhi
U.S. Small Business Administration	Disaster Loan Program	U.S. Small Business Administration Office of Disaster Assistance 409 3rd Street, S.W. Suite 6050 Washington, DC 20416	(202) 205-6734	disasterloan.sba.gov/ela/Information/Index
U.S. Department of Transportation, Federal Highway Administration	Surface Transportation Block Grant Program	Federal Highway Administration 1200 New Jersey Avenue, SE Washington, DC 20590	(202) 366-4000	www.fhwa.dot.gov/
Wisconsin Department of Administration (WDOA)	Wisconsin Coastal Management Program	Wisconsin Department of Administration 101 E. Wilson Street, 9th floor P.O. Box 8944 Madison, WI 53708-8944	(608) 267-7982	doa.wi.gov/Pages/LocalGovtsGrants/CoastalGrants.aspx
WDOA, Division of Energy, Housing and Community Resources	Community Development Block Grants	Wisconsin Department of Administration Division of Energy, Housing and Community Resources 101 E. Wilson Street Madison, WI 53707-7970	(608) 266-7531	doa.wi.gov/Pages/LocalGovtsGrants/CommunityDevelopmentPrograms.aspx
WDOA, Division of Energy, Housing and Community Resources	Home Investment Partnerships Program	Wisconsin Department of Administration Division of Energy, Housing and Community Resources 101 E. Wilson Street Madison, WI 53707-7970	(608) 267-6904	doa.wi.gov/Pages/LocalGovtsGrants/HOMEHHRMainPage.aspx
Wisconsin Department of Health Services (WDHS)	Chemical Contamination	Wisconsin Department of Health Services Division of Public Health Bureau of Environmental and Occupational Health 1 W. Wilson Street Madison, WI 53701	(608) 266-1120	www.dhs.wisconsin.gov/dph/beoh.htm
WDHS, Division of Public Health, Bureau of Communicable Diseases	Communicable and Infectious Diseases	Division of Public Health, Bureau of Communicable Diseases 1 W. Wilson Street Madison, WI 53701	(608) 267-9003	www.dhs.wisconsin.gov/dph/bcd.htm

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Table G.1 (Continued)

Administrator of Grant Program	Name of Grant Program	Address	Phone Number	Internet Web Address
Wisconsin Department of Natural Resources (WDNR)	Lake Management Planning Grant Program Lake Protection and Classification Grant Program River Protection Grant Program	Wisconsin Department of Natural Resources 2300 N. Dr. Martin Luther King Jr. Drive Milwaukee, WI 53212	(414) 263-8676	dnr.wi.gov/aid/surfacewater.html
WDNR	Municipal Flood Control Grants	Wisconsin Department of Natural Resources Community Financial Assistance-CF/2 P.O. Box 7921 Madison, WI 53707	(608) 267-7152	dnr.wi.gov/Aid/munfloodcontrol.html
WDNR	Knowles-Nelson Stewardship Grant Program Urban Green Space Program Urban Rivers Grant Program	Wisconsin Department of Natural Resources 2300 N. Dr. Martin Luther King Jr. Drive Milwaukee, WI 53212	(414) 263-8704	dnr.wi.gov/topic/Stewardship/grants/Contacts.html
WDNR	Clean Water Fund Program Safe Drinking Water Loan Program	Wisconsin Department of Natural Resources 2300 N. Dr. Martin Luther King Jr. Drive Milwaukee, WI 53212	(414) 303-1711	dnr.wi.gov/Aid/EIF.html
WDNR	Targeted Runoff Management Grants Urban Nonpoint Source and Storm Water Grants Program	Wisconsin Department of Natural Resources Bureau of Community Financial Assistance-CF/2 101 S. Webster Street PO Box 7921 Madison, WI 53707-7921	(608) 266-0156 (608) 267-9385	dnr.wi.gov/topic/Nonpoint/UrbanFinancialAssistance.html
WDNR	Remediation and Redevelopment Program	Wisconsin Department of Natural Resources 2300 N. Dr. Martin Luther King Jr. Drive Milwaukee, WI 53212	(608) 266-9263	dnr.wi.gov/topic/Brownfields/RRProgram.html
Wisconsin Emergency Management (WEM)	Hazardous Mitigation Section	Wisconsin Emergency Management 2400 Wright Street P.O. Box 7865 Madison WI 53707-7865	(608) 242-3000	dma.wi.gov/DMA/wem/grants/mitigation
WEM	Wisconsin Homeland Security Grant Program	Wisconsin Emergency Management 2400 Wright Street P.O. Box 7865 Madison WI 53707-7865	(608) 242-3000	dma.wi.gov/DMA/wem/grants/homeland-security
Wisconsin Public Service Commission	Public Utilities Assistance	Wisconsin Public Service Commission 4822 Madison Yards Way North Tower - 6th Floor Madison, Wisconsin 53705-9100	(608) 266-5481	psc.wi.gov/Pages/Home.aspx
University of Wisconsin – Extension	Extension Disaster Education Network	UW-Extension Building 432 N. Lake Street Madison, WI 53706	(608) 265-0568	www.uwex.edu/ces.uwex.edu

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Table G.1 (Continued)

Administrator of Grant Program	Name of Grant Program	Address	Phone Number	Internet Web Address
Great Lakes Protection Fund	Great Lakes Protection Fund Grants Program	Great Lakes Protection Fund 1560 Sherman Avenue, Suite 1370 Evanston, IL 60201	(847) 425-8150	glpf.org/
Joyce Foundation	Joyce Foundation Grant Program	The Joyce Foundation 321 N. Clark Street, Suite 1500 Chicago, IL 60654	(312) 782-2464	www.joycefdn.org/grants
National Fish and Wildlife Foundation (NFWF)	Five-Star and Urban Waters Restoration Program Wal-Mart Stores, Inc. Acres for America Program	National Fish and Wildlife Foundation 1133 15th Street, NW, Suite 1000 Washington, DC 20005	(202) 857-0166	www.nfwf.org/fivestar/Pages/home.aspx
NFWF	Sustain Our Great Lakes Program	National Fish and Wildlife Foundation 1133 15th Street, NW, Suite 1000 Washington, DC 20005	(202) 857-0166	www.nfwf.org/greatlakes/Pages/home.aspx

[a] *A complete listing of U.S. government assistance programs can be found at the Catalog of Federal Domestic Assistance web site:* www.cfda.gov.

Source: SEWRPC

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION STAFF

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