Hazard Mitigation Plan
for
Muskegon County
and
Constituent Local Governments

Updated in 2015
Adopted by Muskegon County
July 14, 2015

WEST MICHIGAN SHORELINE
REGIONAL DEVELOPMENT COMMISSION

WEST MICHIGAN SHORELINE
REGIONAL DEVELOPMENT COMMISSION
(WMSRDC)

The WMSRDC is a federal and state designated regional planning and development agency serving 120 local governments in Lake, Mason, Muskegon, Newaygo, and Oceana counties.

The mission of WMSRDC is to promote and foster regional development in West Michigan through cooperation amongst local governments.

WMSRDC
WEST MICHIGAN SHORELINE
REGIONAL DEVELOPMENT COMMISSION

Project Staff:

Stephen Carlson, Senior Planner
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Prepared by WMSRDC in conjunction with Muskegon County Emergency Services and the Muskegon County Local Emergency Planning Committee

TABLE OF CONTENTS

Letter of Transmittal from Chief Elected Official

(Date)

(Organization)
(Name)
(Title)
(Street Address)
(City), MI (Zip Code)

Dear Mr./ Ms.:

Attached is the Muskegon County Hazard Mitigation Plan. This plan has been developed in conjunction with involved agencies, the state of Michigan, affected businesses, and interested members of the public. The plan provides the process for evaluation of land use and development in the county from a hazard mitigation perspective, which will protect lives and property in the community.

It is my expectation that all future development decisions in Muskegon County will consider hazard vulnerability reduction as a standard business practice and that such considerations will be incorporated into land use plans and zoning ordinances, as appropriate. The intent of the hazard mitigation plan is not to limit development, but to ensure that all development avoids the possibility of damage from natural and technological hazards to the extent practicable.

Questions and concerns related to content and use of this plan should be directed to Dan Stout, Director of Muskegon County Emergency Services, at (231) 724-6341.

Sincerely,

Terry J. Sabo, Chairman

Muskegon County Board of Commissioners

Muskegon County Board of Commissioners

HAZARD MITIGATION PLAN ADOPTION RESOLUTION
#2015-267

WHEREAS, Muskegon County, Michigan, has experienced repetitive disasters that have damaged commercial, residential and public properties, displaced citizens and businesses, closed streets and bridges dividing the community both physically and emotionally, and presented general public health and safety concerns; and

WHEREAS, the community has prepared a Hazard Mitigation Plan that outlines the community's options to reduce overall damage and impact from natural and technological hazards; and

WHEREAS, the Hazard Mitigation Plan has been reviewed by community residents, business owners and federal, state and local agencies, and has been revised to reflect their concerns; and

NOW, THERFORE, BE IT RESOLVED THAT:

1) The Hazard Mitigation Plan is hereby adopted as an official plan of the County of Muskegon.
2) The Muskegon County Local Emergency Planning Commission (LEPC) is hereby established as a permanent community advisory body whose members are subject to the approval of the Michigan State Police.
3) The Muskegon County Emergency Services Director, Assistant Director or designee is charged with supervising the implementation of the Plan's recommendations within the funding limitations as provide by the County of Muskegon or other sources.
4) The Muskegon County Emergency Services Director, Assistant Director or designee shall give priority attention to Potential Hazard Mitigation Actions recommended by the Hazard Mitigation Plan.
5) The Muskegon County Emergency Services Director shall convene the LEPC quarterly. The LEPC shall monitor implementation of the Plan and shall submit a written progress report to Muskegon County in accordance with the following format:
    a) A review of the original Plan.
    b) A review of any disasters or emergencies that occurred during the previous calendar year.
    c) A review of the actions taken including what was accomplished during the previous year.
    d) A discussion of any implementation problems.
    e) Recommendations for new projects or revised action items. Such recommendations shall be subject to approval by the Muskegon County Board of Commissioners.

The Muskegon County Board of Commissioners, at its July 14, 2015, meeting recommended approval by Kenneth Mahoney, support by Rillastine Wilkins, the aforementioned resolution.

Terry J. Sabo, Chairman
Muskegon County Board of Commissioners

HAZARD MITIGATION PLAN

Part A
PURPOSE AND PLANNING PROCESS

Purpose

The Muskegon County Hazard Mitigation Plan was created to protect the health, safety, and economic interests of residents by reducing the impacts of natural and technological hazards through hazard mitigation planning, awareness, and implementation. Hazard mitigation is any action taken to permanently eliminate or reduce the long-term risk to human life and property from natural and technological hazards. It is an essential element of emergency management along with preparedness, response and recovery.

This plan serves as the foundation for hazard mitigation activities within the county. Implementation of the plan's recommendations will reduce injuries, loss of life, and destruction of property due to natural and technological hazards. The plan provides a path toward continuous, proactive reduction of vulnerability to the most frequent hazards that result in repetitive and often severe social, economic and physical damage. The ideal end-state is total integration of hazard mitigation activities, programs, capabilities and actions into normal, day-to-day governmental functions and management practices.

Some of the mitigation activities recommended in this document are inexpensive to carry out while others require funding. The Federal Emergency Management Agency's (FEMA's) Pre-Disaster Mitigation (PDM) program and Hazard Mitigation Grant Program (HMGP) can assist with funding for many activities. Authorized under Section 404 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act, the HMGP is administered by FEMA and provides grants to states and local governments to implement long-term hazard mitigation measures after a major disaster declaration. The purpose of the program is to reduce the loss of life and property due to natural disasters and to enable mitigation measures to be implemented during the immediate recovery from a disaster.

However, communities must have participated in the development of this plan and adopt it to be eligible to apply. Section 104 of the Disaster Mitigation Act of 2000 (42 USC 5165) states that after November 1, 2003 (later changed to November 1, 2004), local governments applying for pre- and post- disaster mitigation funds must have approved local mitigation plans. Pursuant to these requirements, which are spelled out in 44 CFR (Code of Federal Regulations) Part 201, the Muskegon County Hazard Mitigation Plan was adopted by Muskegon County in 2006 and fully approved by FEMA in 2006. Further, all 27 jurisdictions within Muskegon County (7 cities, 4 villages and 16 townships) were successful in adopting the county's multi-jurisdictional hazard mitigation plan at the local level.

In addition, mitigation planning regulations state that "a local jurisdiction must review and revise its plan to reflect changes in development, progress in local mitigation efforts, and changes in priorities, and resubmit it for approval within 5 years in order to continue to be eligible for mitigation project grant funding." Thus in 2010, efforts began to perform the mandated five-year update, resulting in this document.

Planning Process

The Muskegon County Hazard Mitigation Plan examines a wide array of hazards and mitigation activities on a multi-jurisdictional level (county, city, village, and township). Emphasis is placed on hazards, both natural and human-induced, that have had significant impacts on the county in the past. Because this is a multi-jurisdictional plan, the very first action of the planning process was to request a Letter of Participation from each local unit of government within Muskegon County. Montague Township was the only municipality out of

27 local units that did not submit a letter of participation. Community participation is discussed later in this chapter.

The planning process followed in the update of the Muskegon County Hazard Mitigation Plan consists of the following steps:

- Public and stakeholder involvement;
- Establishment of an Advisory Team;
- Identification of hazards, risks and vulnerabilities;
- Identification and definition of goals and objectives;
- Identification of alternatives for solving problems;
- Selection of evaluation criteria to prioritize alternatives;
- Selection of potential hazard mitigation actions;
- Preparation of a draft plan;
- Preparation of the final plan;
- Implementation of the plan; and
- Monitoring and periodic revision of the plan.

Planning Approach

The Muskegon County Hazard Mitigation was developed by the West Michigan Shoreline Regional Development Commission (WMSRDC) under the guidance of the Muskegon County Local Emergency Planning Committee, the Muskegon County Hazard Mitigation Advisory Team, and Muskegon County Emergency Services.

WMSRDC is a federal and state designated regional planning and development agency serving 120 local governments in Lake, Mason, Muskegon, Newaygo, and Oceana counties. WMSRDC is also the planning agency for the metropolitan transportation planning (MPO) program for Muskegon and Northern Ottawa counties, and is responsible for the management and administration of the homeland security program for the counties of Clare, Ionia, Isabella, Kent, Lake, Mason, Mecosta, Montcalm, Muskegon, Newaygo, Oceana, Osceola, and Ottawa.

As of January 2014, the LEPC comprised of 17 voting members from the following categories: broadcast media, local elected official, education, emergency services, fire fighting service, first aid organization, hospitals, law enforcement, local public health, owners/operators (industry), print media, and transportation. By law, the Michigan Emergency Planning and Community Right-to-Know Commission designates emergency planning districts. Title III of the Superfund Amendment and Reauthorization Act of 1986 (SARA Title III) requires that the following groups be represented on the LEPC:

- Elected state and local officials;
- Law enforcement;
- Civil defense;
- Fire-fighting;
- First aid and health;
- Local environmental;
- Hospital;
- Transportation personnel;
- Broadcast and print media;
- Community groups; and
- Owners/operators of facilities subject to the reporting requirement of SARA Title III.

Additionally, the Michigan Emergency Planning Commission recommends that representatives from the following sectors also be appointed to the LEPC:

- Organized labor;
- Education; and
- Agriculture.

The Advisory Team was assembled by the Muskegon County Emergency Services Director to aid the process of reviewing and updating the Muskegon County Hazard Mitigation Plan. All LEPC members were invited to join the team, which was eventually comprised of thirteen individuals representing Muskegon County Emergency Services, Muskegon County Administration, Muskegon County Health Department, Muskegon County Information Services, Muskegon County Road Commission, Muskegon County Sheriff Department, Muskegon County HazMat Team, Norton Shores Police Department, Norton Shores Fire Department, Blue Lake Fire Department, ProMed Ambulance Service, Muskegon Area RACES, and Mercy General Health Care Partners. This body was established and utilized at the beginning stages of the update process; however, as the Update evolved, the full LEPC emerged as the primary advisory body to the Plan Update.

Appendix E includes the following plan documentation: LEPC appointees (as of January 2014); Advisory Team members; attendance lists from LEPC meetings and other public meetings where hazard mitigation was discussed during the Update Process; resources utilized during the formation of this Plan and Update; and public notices and hazard mitigation articles published in WMSRDC newsletters.

Outreach, Input and Participation

Muskegon County Emergency Services and the LEPC provided ongoing guidance and assistance in the plan development. Meetings where the LEPC specifically discussed hazard mitigation are listed in Appendix E. In addition, valuable input was obtained through a survey sent to 220 individuals in March 2012. LEPC members received the survey, as well as representatives of agencies and departments listed below. The survey was also made available to the public on the WMSRDC website during the drafting stage of the planning process.

- County commissioners
- Local planning commissioners
- Local zoning officials
- City mayors, village presidents, and township supervisors
- Fire chiefs and law enforcement
- Public works directors
- School superintendents
- Muskegon Area Intermediate School District
- College presidents
- Chambers of commerce and economic development organizations
- Public utilities
- Muskegon County Administration
- Muskegon County Road Commission
- Muskegon County Drain Commission
- Muskegon County Equalization
- Muskegon County Department of Human Services
- Public Health Muskegon County
- Muskegon County Wastewater Management System
- Muskegon County Airport
- Muskegon Area Transit System
- Senior Resources

- Promed Ambulance (EMS)
- Community Mental Health Services of Muskegon County
- American Red Cross – Lakeshore & West Shore Chapter
- Mercy Health Muskegon
- Muskegon Central Dispatch
- Muskegon County MSU Extension
- Muskegon Conservation District
- Michigan DNR Forest Resources
- Michigan DNR State Parks
- Huron-Manistee National Forest Fire Management

The survey, developed with assistance of the Michigan State Police Emergency Management Division, was distributed early in the planning process and served a number of functions. First, the broad distribution of the survey to local, county, and regional agencies, organizations, and stakeholders was intended to raise awareness throughout the community of hazard mitigation planning, as well as to encourage local input and participation. Second, the survey included a list of historical hazard events, as reported in the original Muskegon County Hazard Mitigation Plan. This offered an opportunity for recipients to not only identify past and potential hazards in their community, but also allowed them to verify the accuracy of the Plan's previous edition. Third, the survey provided a prioritized list of hazards identified in the Muskegon County Hazard Mitigation Plan, and asked recipients to rank those hazards according to their own priorities. Although feedback obtained from this section was inherently subjective, it was useful for gauging community opinion and was taken into consideration when the hazard rating and rankings were revisited during this Plan Update.

The survey incited responses from a wide range of local and regional entities; including Muskegon County Emergency Services; cities of Montague, Muskegon Heights, and Norton Shores; townships of Casnovia, Egelston, and White River; Holton, Muskegon Township, and Norton Shores fire departments; Muskegon Township and Whitehall police departments; Montague Public Schools; Muskegon Community College; Michigan DNR; Mercy Health Muskegon; ESCO; and Bayer CropScience. Survey feedback was used to help identify hazards, establish goals and objectives, recommend activities and prioritize actions. Although the survey produced a meager 7.3% response rate, it was successful in increasing awareness of hazard mitigation throughout Muskegon County. Explanations for the low response rate include the survey length, as well as the possibility that some recipients simply agreed with the survey content and chose not to respond. A copy of the survey, cover letter, and summary of responses can be found in Appendix D.

Attempts to obtain input from county stakeholders via email and mail were utilized at other stages of the Planning Process as well. In April 2012, the chief elected official and in some cases the professional manager of each local jurisdiction received a copy of its community profile section for review and comment. In November 2013, these individuals were asked to review the Action Agenda and comment on any hazard mitigation progress that had been made since the plan was approved in 2006. All of these efforts provided information about hazard mitigation and invited individuals to participate in the Plan Update.

The following chart shows the hazard mitigation participation status of each local jurisdiction in Muskegon County. Participation is based on whether or not a representative from a jurisdiction (1) attended a hazard mitigation meeting, (2) responded to a request for information, or (3) contributed to the plan in any other way during the planning process.

Muskegon County Hazard Mitigation Plan
Jurisdiction Participation

Jurisdiction	Adopted 2006 Muskegon Co HazMit Plan*	2006 HazMit Plan Participant	2011 Letter to Participate	HazMit Plan Update Participant	Participant Status
Muskegon County	✓	✓	✓	✓	Continuing
Blue Lake Twp	✓	✓	✓		
Casnovia Village	✓		✓	✓	**New Participant**
Casnovia Twp	✓		✓	✓	**New Participant**
Cedar Creek Twp	✓		✓		
Dalton Twp	✓	✓	✓	✓	Continuing
Egelston Twp	✓	✓	✓	✓	Continuing
Fruitland Twp	✓	✓	✓	✓	Continuing
Fruitport Village	✓		✓	✓	**New Participant**
Fruitport Twp	✓		✓		
Holton Twp	✓	✓	✓	✓	Continuing
Laketon Twp	✓		✓	✓	**New Participant**
Lakewood Club Village	✓		✓		
Montague City	✓		✓	✓	**New Participant**
Montague Twp	✓				Non-Participant
Moorland Twp	✓		✓	✓	**New Participant**
Muskegon City	✓		✓		
Muskegon Twp	✓	✓	✓	✓	Continuing
Muskegon Heights City	✓		✓	✓	**New Participant**
North Muskegon City	✓	✓	✓	✓	Continuing
Norton Shores City	✓	✓	✓	✓	Continuing
Ravenna Village	✓		✓		
Ravenna Twp	✓		✓		
Roosevelt Park City	✓	✓	✓		
Sullivan Twp	✓		✓	✓	**New Participant**
Whitehall City	✓	✓	✓	✓	Continuing
Whitehall Twp	✓	✓	✓	✓	Continuing
White River Twp	✓		✓	✓	**New Participant**

** Approved by FEMA in 2006*

Neighboring counties were notified of the plan through a communication sent to their Emergency Manager on October 15, 2013. All were asked to identify any concerns of hazards in their county that may impact Muskegon County, and vice versa. Muskegon County is bounded by Newaygo and Oceana counties to the north; Ottawa County to the south; and Kent County to the east. All were given the option of reviewing drafts of this document.

Public Engagement

The Muskegon County LEPC hosted a public meeting to discuss hazard mitigation at the beginning of the planning process at its April 10, 2012 meeting. The meeting was noticed in the Muskegon Chronicle, discussed in the WMSRDC electronic newsletter, and announced in the March 2012 survey mailing. The meeting featured a presentation about the hazard mitigation planning process, and the public was invited to comment upon and discuss the survey that was distributed and made available on the WMSRDC website.

A second public meeting was held during the drafting stage of the planning process. This meeting was hosted by the LEPC at its quarterly meeting on February 10, 2015. The meeting was noticed in the Muskegon Chronicle; announced on the WMSRDC website; and invitations were mailed and emailed to the LEPC members, all local elected officials in Muskegon County, and Muskegon County Commisioners. These communications invited recipients to review the Hazard Identification, Risk Assessment, and Goals & Objectives sections, which were posted on the WMSRDC website prior to the public meeting. Invitees were offered an opportunity to comment on the drafted sections by attending the public meeting or by submitting comments, in writing to WMSRDC staff prior to the meeting. The meeting also featured a work session, whereas a proposed set of hazard mitigation action items were reviewed, discussed, and prioritized utilizing interactive polling technology.

Hazard mitigation was featured several times in the WMSRDC's bi-monthly print newsletter. Hazard mitigation was also featured in WMSRDC Updates, an electronic newsletter emailed, at a minimum, bi-monthly (opposite the printed newsletter). Not only were the newsletters distributed to all constituents in Lake, Mason, Muskegon, Newaygo and Oceana counties, but they also reached a majority of the county's neighboring communities. These communications were also presented on the WMSRDC's website. Lastly, the WMSRDC website, www.wmsrdc.org, offered an opportunity for the public to become familiar with hazard mitigation and participate in the plan development. This website provided general information about hazard mitigation; offered access to the latest approved edition of the county's Hazard Mitigation Plan; and provided access to surveys and draft sections for public review.

WMSRDC staff discussed hazard mitigation at the "Water, Woods, & Wetlands" regional forum on October 23, 2013 in Muskegon, Michigan. The hazard mitigation session addressed the potential for coordination between hazard mitigation and a variety of environmental initiatives. Examples of successful mitigation projects in Michigan highlighted many common interests, such as culvert improvements, flood control, and stream bank stabilization. Attendees of the forum included representatives from international, regional, and local environmental groups; federal agencies including USGS, USFWS, and NOAA; Michigan agencies MDEQ Office of Great Lakes, MDEQ Coastal Zone Management, MDEQ Non-Point Source, and MDNR; non-profit organizations; and private engineering and consulting firms. The forum also drew attendance from local watershed groups, local government officials, and residents.

Process for Approval and Adoption

At the conclusion of the planning process, Muskegon County Emergency Services is to submit the Draft Plan prepared by the WMSRDC to the Federal Emergency Management Agency (FEMA) and the Michigan State Police, Emergency Management and Homeland Security Division (MSP-EMHSD) to verify that the requirements of a hazard mitigation plan have been met. Subsequent to these approvals, the LEPC (and by extension the Advisory Team) then reviews any comments, approves any necessary adjustments to the Draft Plan, and submits the Final Draft of the Hazard Mitigation Plan Update to the County Board of Commissioners for consideration. Following County Board approval, the plan is then sent to local governments for public hearings and adoption, as desired, to qualify them for pre- and post- disaster hazard mitigation assistance. Documentation of all local adoptions should be returned to the county Emergency Manager for notification to MSP-EMHSD and FEMA.

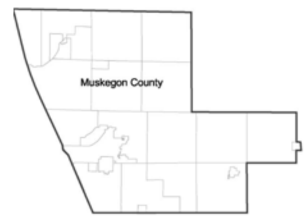
Part B

COMMUNITY PROFILE DESCRIPTIONS RELATED TO HAZARD RISK

(See Appendix A for additional detail)

1.0 COUNTY PROFILE SUMMARY

1.01 Muskegon County



Muskegon County is located in the western portion of Michigan's Lower Peninsula along Lake Michigan's shoreline. It is bordered by Oceana County to the north, Newaygo County to the northeast, Ottawa County to the south, Kent County to the southeast and Lake Michigan to the west. The county has an area of 504 square miles, or approximately 322,560 acres, 27 miles of Lake Michigan waterfront, 20 inland lakes, and more than 400 miles of river. The 2010 U.S. Census counted 172,188 persons, 65,778 households, and 45,366 families. The U.S. Census for the year 2000 counted 170,200 persons, 63,330 households, and 44,267 families. From 2000 to 2010, the population grew about 1.17%. The population is projected to increase by .58% in 2015 to 173,191. For the 65,788 households counted in 2010, the median income was $40,670. The county has a population density of 344.9 persons per square mile and there were 73,561 housing units at an average density of 147.3 housing units per square mile. In terms of race, the 2010 Census states that Muskegon County consists of 82.6% White, 15.9% Black or African American, 1.9% American Indian, .9% Asian, .1% Pacific Islander, 1.8% some other race, and 2.8% from two or more races. 4.8% of the population is Hispanic or Latino.

1.02 History and Development

The earliest recorded history of the Muskegon area reflects that it was inhabited by the Ottawa and Pottawatomi tribes. Perhaps the best remembered of the Indian inhabitants of this area was Ottawa Indian Chief Pendalouan. The name "Muskegon" is derived from the Ottawa Indian term "Masquigon" meaning "marshy river" or "swamp". The "Masquigon" river is identified on French maps as early as the late 17th century, suggesting that French explorers and fur traders had reached western Michigan by that time. The first known Frenchmen in the area were Father Jacques Marquette, who traveled through the area in 1675 on his way to St. Ignace, and a party of French soldiers under LaSalle's lieutenant, Henry de Tonty, who passed through in 1679. If the French established trading posts in the area, their locations are not known. The earliest known resident of the county was a fur trader and trapper named Edward Fitzgerald, who settled in the area in 1748. Between 1810 and 1820, several French Canadian fur traders established posts around Muskegon Lake.

Muskegon County was organized in 1837 from portions of Ottawa (3/4) and Oceana (1/4) Counties. At the time of its incorporation in 1859, Muskegon County had six townships (Muskegon, Norton, Ravenna, White River, Dalton, and Oceana.). The development of the area, with vast numbers of white pines, coincided with its timbering activities during the turn-of-the-century lumber boom. When the lumber industry reached its peak in the 1880's, there were over 47 sawmills on Muskegon Lake's 12 square mile body of water and another 16 on White Lake in northern Muskegon County, establishing Muskegon as the "Lumber Queen of the Midwest."

Following the lumber era, at the end of the nineteenth century, Muskegon County directed its economic growth to industry; including paper and cement manufacturing, production of chemicals, engines, and bowling equipment. The County also experienced a mini oil boom in the late 1920's when oil was accidentally discovered in the search for salt. Today the county is a major metropolitan center and a major producer of agricultural products (wheat, corn, dairy and livestock). The beaches of Lake Michigan and the inland fishing and water sport opportunities make tourism a major part of the economy. The Lake Michigan shoreline is accessible at eleven dune-filled public parks.

The county is also home to a number of state parks, a state game area, and Manistee National Forest. It has over 151,000 acres of forest, of which over 12,000 acres are national forest and over 8,000 acres are dedicated as state game and wildlife areas. The county's outdoor recreation opportunities are year-round with mild summers for water-based recreation, camping, and hiking. The winter brings approximately 80 inches of snow on average for winter outdoor recreation such as snowmobiling, sledding, skating, hockey, and ice fishing. There are also a variety of man-made recreational and tourism destinations that make Muskegon County attractive to visitors including a number of events and festivals.

1.03 <u>Climate</u>

Muskegon has a quasi-marine or continental climate. Because the county borders Lake Michigan and prevailing winds are westerly, much of the time air reaching the county has passed over a large amount of water, making for a quasi-marine climate. When the wind changes, however, and is coming from the east or southeast, the air moves over a large amount of land and the climate becomes continental. Because of the prevailing westerly winds, the influence of the lake is strong. Winters are milder, summers are cooler, and snowfall is greater than they would be if the lake were not there.

The influence of Lake Michigan on temperature is shown by the higher maximum and minimum temperatures in January at Muskegon as compared to those at Grand Rapids in Kent County. Grand Rapids is used for comparison because there is no weather station in the eastern part of Muskegon County and because climate at Grand Rapids is considered representative of the eastern part of Muskegon. The highest temperature ever recorded, according to the Michigan State Climatologist's Office, at Muskegon was 98 degrees in June 1995 and the lowest was -14 degrees in November 1950. At Grand Rapids, the highest temperature of record was 102 degrees in June 1953 and the lowest was -22 degrees in January 1951. Also, temperatures in April and May are lower at Muskegon. The latest freezing temperature ever recorded at Muskegon was on May 20 and at Grand Rapids was on May 27. In fall, the average date of the first 32 degree temperature is October 19 at Muskegon and October 6 at Grand Rapids.

The influence of Lake Michigan on precipitation is shown by the higher precipitation measurements. Average total precipitation per year is 33.42 inches in Muskegon and 38.18 in Grand Rapids. The average number of days with snow cover per year is 80 in Muskegon and 74 in Grand Rapids. Average annual snowfall in Muskegon County is about 91.94 inches, as compared to about 74.40 inches in Grand Rapids.

1.04 <u>Agriculture</u>

Agriculture began in Muskegon County in about 1845 by the early lumberjacks. As the land was cleared, farms were established but many of them were soon abandoned because the soils were sandy. Growing food for home use was the main concern of the first farmers. Agriculture was stimulated by the influx of settlers and by the building of roads and railroads. Farms increased in number and by 1870 there was a surplus of crops that could be sold outside the county.

According to the 2007 Census of Agriculture, 79,663 acres or about 25% of land in the county was farmland, up 8% from the 2002 Census when 73,918 acres was used as farmland. 72.99% or 58,146.02 acres of farmland was cropland (includes five components: cropland harvested, crop failure, cultivated summer fallow, cropland used only for pasture, and idle cropland), 13.47% or 10,730.61 acres was woodland, and 13.55% or 10,794.34 acres was used for other uses (wetlands, rural residential land, or land generally of low value for agricultural purposes). Of the 58,146.02 acres used for cropland, 43,994 acres were used for corn for grain, forage (land used for all hay and haylange, grass silage, and greenchop), corn for silage, soybeans for beans, and wheat for grain. These crops are considered the top crops in terms of acres of farmland used. Milk and dairy products; fruits, tree nuts, and berries; vegetables, melons, potatoes, and sweet potatoes; and grains, oilseeds, dry beans, and dry peas are also important parts of the agriculture in the county.

1.05 <u>Industry and Transportation</u>

Manufacturing is important and varied in Muskegon County, employing about 25.2% of the civilian workforce or about 17,360 people according to 2007-2011 American Community Survey Estimates. The port of Muskegon, located on Muskegon Lake, is the gateway of the western part of Michigan to the St. Lawrence Seaway and world trade. As such, it is the greatest economic asset of the area. Other major industries in terms of employees and number of establishments are healthcare and social assistance; retail trade; accommodation and food services; and administrative and support and waste management and remediation services.

Muskegon County is well served by a series of freeways, state highways, major roads and local roads. The County's primary link to other metropolitan areas in southern Michigan is by Interstate 96, which terminates as it enters the City of Norton Shores and changes to BR-31 (Seaway Drive). Other regional access routes are provided by US-31, which is the primary north-south road for communities along the coast of Lake Michigan; a small section of M-37, which runs north-south through Casnovia Township; and M-46 (Apple Avenue), which is a state highway providing access to townships and communities to the east. M-120, which begins in the City of Muskegon and terminates in Hesperia on the Oceana and Newaygo county line at M-20, provides access to the northeast section of Muskegon County. Other roads include B-15, B-23, B-31, B-35, B-72, and B-86. A total of 693 miles of roads are maintained by the Muskegon County Road Commission, 374 of which are primary roads. There are 513 miles of local roads within the jurisdictions of the cities and villages of Muskegon County.

Important road bridges in the county include: U.S. 31, Business Route U.S. 31, and B-86 (Fruitvale Road) over the White River; U.S. 31, M-120, and B-31 (Maple Island Road) over the Muskegon River; and Henry Street and Lake Harbor Road over Mona Lake. Major railroad bridges are found crossing the Muskegon River in the City of Muskegon, and above Seaway Drive in Muskegon Heights and Norton Shores.

Muskegon County is serviced by Michigan Shore and Marquette Rail short-line railroads, both of which are owned by Genesee & Wyoming, Inc. There are freight services available from Muskegon, Muskegon Heights and Norton Shores. Lake Express offers ferry service between Muskegon and Milwaukee. Muskegon County Airport serves the air transportation needs of the County and occupies 1,200 acres in Norton Shores. Airport services include commercial passenger (SkyWest operating as United Airlines) service to Chicago, freight service, and general aviation activity.

1.06 Physiography

The physiography of Muskegon County is mostly a result of the Wisconsin, or latest, glacial period. The glacial ice that once covered the state melted about 8 to 12 thousand years ago. As this ice melted, a covering of raw soil materials was left on the surface of the county. This glacial deposit ranges from about 150 feet to more than 400 feet in thickness.

The present surface of the county ranges form nearly level to rolling and hilly. Along the shore of Lake Michigan is a belt of strongly rolling sand dunes. These dunes are post-glacial in origin but are now generally stationary. After vegetation covers these dunes, a soil profile begins to develop. For several miles inland, smaller dunes are scattered throughout the poorly drained areas of the lake plain.

A wide plain with little relief lies east of the dunes. Rolling to hilly areas are toward the eastern side of the county and in the extreme northwestern part. Parts of the central plain are somewhat broken by stream channels and lake basins. Post-glacial sand dunes dominate the area. Most of the county ranges from 600 to about 800 feet above sea level but a small area in Casnovia Township is more than 800 feet above sea level.

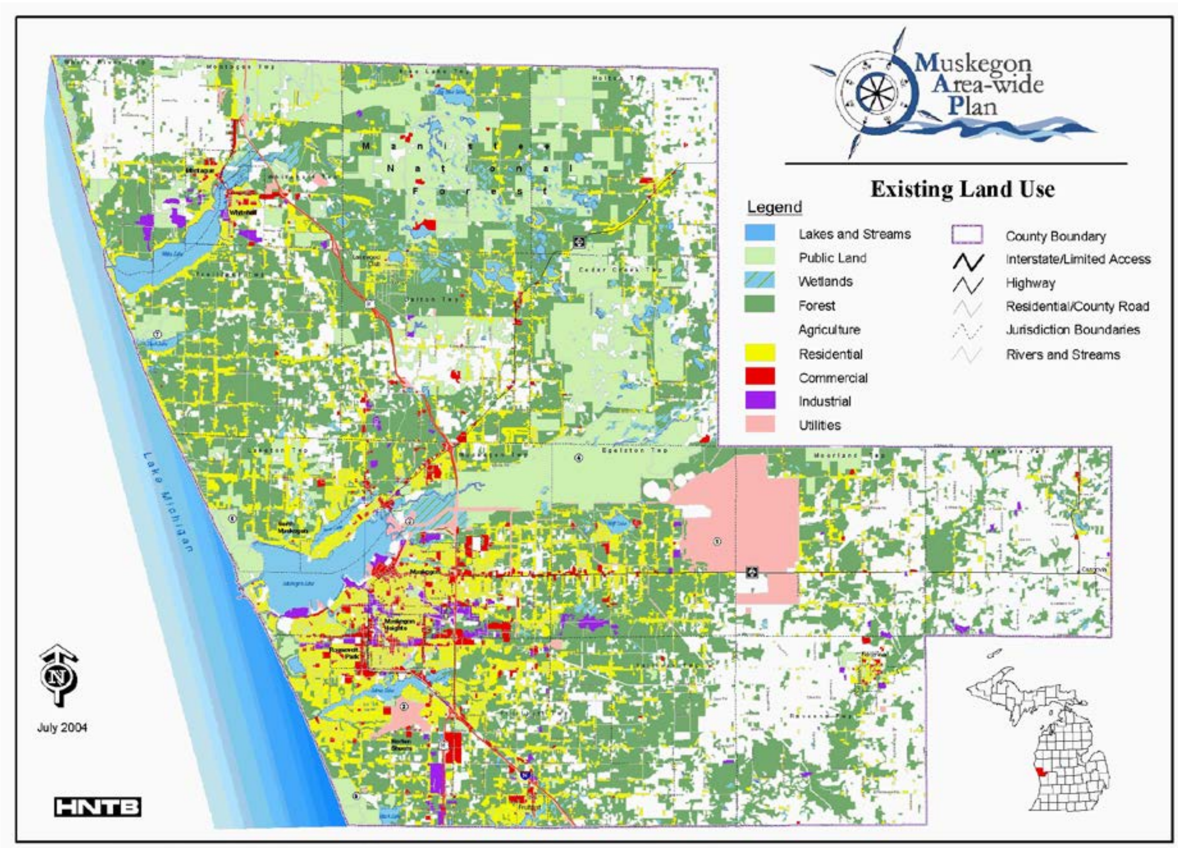
The central plain of Muskegon County is a part of the bed of glacial Lake Chicago. The deposits in this lake bed are sandy, underlain by clayey deposits in many areas. Another broad, gently undulating lake plain is in the northeastern part of the county. This plain is mainly in Holton Township, but it extends into the western part of Newaygo County. The soil material of this lake plain is finer textured than that of the plain in the central part of the county.

The principal morainic areas of the county are: most of Casnovia Township; a smaller area north of the valley of the Muskegon River; and an area that begins at a point north of Whitehall and extends for several miles south and east of that town.

1.07 Lakes and Rivers

The five primary water systems that drain Muskegon County include Grand River, Lake Michigan, Mona Lake/Black Creek, Muskegon Lake/River, and White Lake/River. Crockery Creek and Spring Lake/Norris Creek, both tributaries of the Grand River, drain the southeastern and southern parts of the county. The Mona Lake basin, including Little Black and Black creeks, drains much of the southern half of the county. The Muskegon River bisects the county and empties into Muskegon Lake, an inlet of Lake Michigan. Its main tributary within the county is Cedar Creek, which drains large portions of Cedar Creek and Holton townships. The White River drains much of the northern portion of the county and empties into White Lake, another Lake Michigan inlet. In addition, much of the western area of the county drains directly into Lake Michigan, including the Lake Michigan Shoreline, Duck Lake/Creek, Flower Creek, and Little Black Lake.

The abundant water in the numerous lakes and streams is one of the greatest assets in Muskegon County. The three major lakes, inlets of Lake Michigan, are Muskegon Lake, Mona Lake, and White Lake. Many other lakes, mostly north of the Muskegon River, provide areas for homes, recreation, youth camps, and other recreational facilities. A 1962 inventory lists 262 lakes and ponds in the county covering 11,453 acres.



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-"Soil Survey - Muskegon County, Michigan", Soil Conservation Service, United States Department of Agriculture, October, 1968.

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- American Fact Finder, 2011 County Business Patterns, Muskegon County

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Part B Continued

COMMUNITY PROFILE DESCRIPTIONS RELATED TO HAZARD RISK

(See appendix A for additional detail)

2.0 CITY PROFILE SUMMARIES

2.01 Montague City

Montague City sits to the north of White Lake and to the northwest of the City of Whitehall. It lies in the northern portion of Muskegon County and is situated on a hill overlooking White River and its sister city, Whitehall. Settlement of the area began in 1855 when Nat Sargent built the first house. The town was officially incorporated into a village in 1883 and a city in 1935. It was named after William Ferry Montague, who was one of the town fathers.

The 2010 population of the city was 2,361 with an estimated peak seasonal population of 2,577. 865 residents commuted to work and 494 were school-aged. The city had 1,182 total housing units, of which 1,006 were occupied and 176 were vacant. 92 of the vacant homes were for seasonal, recreational or occasional use. Important critical facilities of the city include the Montague Police and Fire departments, Montague Maintenance Garage, Montague Area High School and Middle School, St. James Lutheran Church, Montague City Hall, and Muskegon Area District Library Montague Branch. Major infrastructure includes U.S. 31 Business Route and the U.S. 31 Business Route bridge over the White River. Hayes Lemmerz International is the largest employer in Montague with over 600 employees, followed by Montague Area Public Schools with 137. White Lake is the most prominent geographic feature of the city.

2.02 Muskegon City

The City of Muskegon is located on the shores of Lake Michigan and along side Muskegon Lake, which connects Muskegon River to Lake Michigan. It lies to the south of the city of North Muskegon, and to the north of Muskegon Heights, Roosevelt Park, and Norton Shores. French explorers named the city in the late 1600's from the Indian word Masquigon meaning "marshy river." The first recorded settlers were Louis Baddaeu and Joseph Troutier, who opened up trading posts in 1834 and 1835. The lumber boom of the 1860's was good to the town, giving it village status in 1861. City status was obtained in 1869.

In 2010, the city had a total population of 38,401 and an estimated seasonal peak population of 38,818. 11,835 residents commuted to work and 7,617 were school-aged. There were a total of 16,105 housing units in the city, 2,138 of those units were vacant and 13,967 were occupied. Of the vacant homes, 175 are for seasonal, recreational or occasional use. Critical facilities in the city include the City of Muskegon Police Department, the Muskegon County Sheriff Department, the Marquette, Robinson, and Terrace stations of the Muskegon Fire Department, two public works yards, a pumping station, seventeen community shelters, eight community medical facilities, and five other critical facilities. There are many major employers in the city, the top three of which are Mercy General Health Partners, the County of Muskegon, and Muskegon Public Schools.

Critical infrastructure consists of four major roads, Michigan Shore railroad, four bridges, two power stations, a water filtration plant, a water and sewer maintenance facility, two transit systems, a coast guard station, and an army reserve center. Major geographic features of the city include the Lake Michigan shoreline and beach, coastal sand dunes, Muskegon Lake, and Muskegon River. There are also 4-6 small lakes and ponds, 4-6 small creeks, and dense residential, industrial, and commercial areas.

2.03 <u>Muskegon Heights City</u>

The City of Muskegon Heights is a southeastern suburb of the Muskegon urban area, incorporated in 1903. It is surrounded by the cities of Norton Shores and Muskegon and lies in the southwestern portion of Muskegon County. Its origin goes back to 1890 when local business leaders were looking to stimulate the economy after the lumber boom ended. They formed the Muskegon Improvement Company and purchased 1,000 acres. The land was then sold in lots by lottery and the proceeds were used to underwrite new businesses. The successful improvement project, and proximity to the City of Muskegon, precipitated a station spot for the Chicago and Western Michigan Railroad Company in 1902.

The city had a 2010 population of 10,856 with a peak summer population of 10,877. 2,649 commuted to work and 2,720 residents are school-aged. There were 4,842 total housing units, 846 of those were vacant, while 8 of the vacant housing units are for seasonal, recreational or occasional use. Important critical facilities of the city include the Muskegon Heights Police and Fire departments, Muskegon Heights City Hall, a Muskegon Area District Library Muskegon Heights Branch, and Muskegon County Family Independence Agency (FIA). No major employers were identified within the city. Major infrastructure includes Muskegon Heights Water and Sewer, Muskegon Area Transit System, U.S. 31 Business Route, Michigan Shore railroad. Major geographic features within the city include dense residential and industrial areas and 1-2 small lakes and ponds along with 1-2 small creeks.

2.04 <u>North Muskegon City</u>

North Muskegon is located just inland from Lake Michigan, to the north of Muskegon City and Muskegon Lake and to the south of Bear Lake. It lies in the southwestern portion of Muskegon County. Like most of the cities and villages in the area, the lumber boom was responsible for the formation of the city. It was originally named Reedsville after the first settler, Archibald Reed, but was later re-named North Muskegon in 1881 when it was deemed a village. City stature came in 1891.

The 2010 census population was 3,786 with a peak seasonal population of 3,899. 1,580 commuted and 727 residents were school-aged. The city had a total of 1,834 housing units, 213 of which were vacant. Of those 213, 49 were for seasonal, recreational or occasional use. Critical Facilities include the city's Police and Fire Departments, the Department of Public Works, City Hall, and Muskegon Area District Library Walker Branch. No major employers were identified within the city. Infrastructure in the city includes Michigan Highway M-120, Michigan Shore railroad, and a power transmission line. Major geographic features consist of Muskegon Lake, Bear Lake, Muskegon River, and dense residential and light commercial areas.

2.05 Norton Shores City

Norton Shores is located just to the south of Muskegon around Mona Lake, which has access to Lake Michigan. The city, which was once Norton Township and before that Nortonville during the lumber boom, sits in the southwest portion of Muskegon County and is bordered by Ottawa County to the south, Lake Michigan to the west and Fruitport Township to the east. It was named after Colonel S. Norton who built a sawmill and settled in the area around 1846. It was chartered as a City in 1967.

Norton Shores had a 2010 total population of 23,994 and a peak seasonal population of 24,596. 10,477 commuted and 4,561 residents were school-aged. The total number of housing units in the city was 10,939, of which 962 were vacant. Of those 962 vacant, 252 were for seasonal, recreational or occasional use. Critical facilities include the city's Police Department, two fire stations, a public works yard, a community medical facility, City Hall, and Muskegon Area District Library Norton Shores Branch. Major employers include Meijer Inc. and Knoll, each employing over 400 people. Major infrastructure in the city includes two highways, Michigan Shore railroad, two prominent bridges over Mona Lake, the Muskegon Heights water filtration plant, a dam at Black Lake, Muskegon County Airport, and the United States Coast Guard Air Facility. Lake Michigan's shoreline and costal sand dunes are major geographic features in the area. Others include Mona Lake, 10-12 other small lakes and ponds, 8-10 creeks, and dense residential and moderate commercial areas.

2.06 Roosevelt Park City

Roosevelt Park, a one square mile suburb community, was formed in 1946 and named after President Franklin D.Roosevelt. It was one of the many residential suburbs in the nation that were formed shortly after WWII. It is surrounded by the cities of Muskegon and Norton Shores.

The total population in 2010 was 3,831, with a peak seasonal population of 3,853. 1,584 commuted and 764 residents were school-aged. The total number of housing units in the city was 1,925, of which 194 were vacant. Of those 194 vacant, 10 are for seasonal, recreational or occasional use. Critical facilities in Roosevelt Park include the city's Police Department and City Hall. The city's two major employers are CWC Castings Division of Textron Inc. and Michigan Spring & Stamping. Critical infrastructure consists of the Michigan Shore railroad. Major geographic features include dense residential and moderate commercial areas.

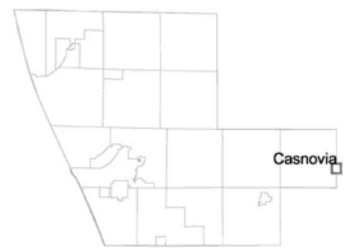
2.07 Whitehall City

The city of Whitehall is located in northern Muskegon County just southeast of the city of Montague. It is bordered by Whitehall Township to the east and Fruitland Township to the south. The city is named for its location at the edge of White Lake. The recorded history for Whitehall began around 1859 when Charles Mears, a lumber tycoon, and Giles B. Slocum platted the land. Originally named Mears, the area benefited from its strategic location for floating and distributing lumber. It grew into a village in 1867 and then into a city in 1942.

Whitehall's total population in 2010 was 2,706, with a seasonal peak population of 2,790. 1,190 commuted and 522 residents were school-aged. Whitehall had 1,288 total housing units, 135 of the total housing units were vacant and, of those vacant, 38 were for seasonal, recreational or occasional use. Critical facilities in the city include police and fire departments, four community medical facilities, City Hall, and the White Lake Community Library. Major employers include Howmet Corporation and Hilite International. Vital or critical infrastructure includes US-31 Business Route, US-31 Business Route bridge over White River, City of Whitehall Water and Sewer, and Mill Pond Dam. Major geographic features in the area include White Lake, 6-8 small lakes and ponds, 6-8 small creeks, and dense residential and light commercial areas.

3.0 VILLAGE COMMUNITY PROFILES

3.01 Casnovia Village



Casnovia Village is located in the eastern most portion of Muskegon County in Casnovia Township. Half of the village is in Kent County (Tyrone Township). The settlement was founded by tavern keeper Lot Fulkerson in 1850 and became a village in 1875. The name Casnovia means "new home" and comes from the Latin root words of casa meaning "home" and nova meaning "new". The village of Casnovia had a 2010 total population of 319, with a peak seasonal population of the same amount. 184 commuted to work and 63 residents were school-aged. There were 131 total housing units, 10 of which were vacant, and none used for seasonal recreational or occasional use. The village's only critical facility is the village hall and there are no major employers or critical infrastructure. There are 1-2 small creeks.

3.02 Fruitport Village

The Village of Fruitport is located on the southern border of Fruitport Township in the extreme southern portion of Muskegon County. It is at the end of the north branch of Spring Lake and is bordered by Ottawa County to the south. The town was originally founded by Edward Craw in 1868 and named Crawville. The town was incorporated into a village in 1891. The current name comes from the fact that it is a port and that the area is fertile fruit growing land. The total population in 2010 for the village was 1,093, and the peak seasonal population was 1,110. 464 commuted and 211 residents were school-aged. There were 476 total housing units, 36 of which were vacant. Of those vacant, 7 were for seasonal, recreational, or occasional use. The village DPW building and Muskegon Area District Library Fruitport Branch are the only two critical facilities and there is no major infrastructure. Major geographic features include Spring Lake and 2-4 small creeks.

3.03 Lakewood Club Village

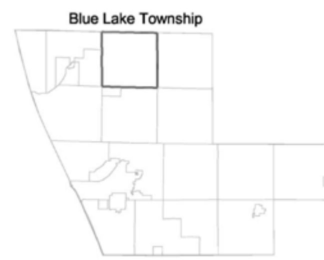
Lakewood Club is located in the northwest portion of Dalton Township in the northern tier of Muskegon County. The Village originated in 1812 as a resort association founded by the Mayo brothers. It was popular enough by 1914 that a seasonal post office was set up. The post office became permanent in the 1940's when the area became residential. Official village status came in 1967. In 2010, the total population was 1,291, with a peak seasonal population of 1,339. 646 commuted and 303 residents were school-aged. The village is home to 507 total housing units, 49 of which are vacant. Of those that are vacant, 17 are for seasonal, recreational or occasional use. The lone critical facility is the village hall and the power transmission line is the only critical infrastructure. Major geographic features include moderately dense residential usage and Fox Lake.

3.04 Ravenna Village

Ravenna village is located in Ravenna Township in the southeastern portion of Muskegon County. Like many other towns in the area, Ravenna was settled when the first sawmill was built (1844). In spite of the fact that E.B. Bostwick built it, the town was named after the Ohio home town of the surveyor who platted the land in 1882. Ravenna was incorporated into a village in 1922. The total population in 2010 was 1,219, with a peak seasonal population of 1,222. 478 commuted and 292 residents were school-aged. There were 476 total housing units, of which 22 are vacant. Of the 22 vacant, 1 is for seasonal, recreational or occasional use. There is neither a police precinct nor a fire station in the Village of Ravenna and the only critical facilities are the village hall and Muskegon Area District Library Ravenna Branch. B-35 is the only major road and also the only identified critical infrastructure in the village. The major geographic feature in the village is Crockery Creek.

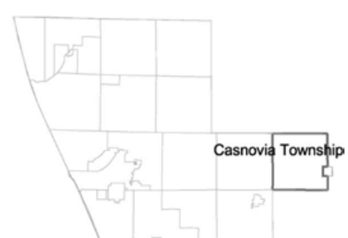
4.0 TOWNSHIP COMMUNITY PROFILES

4.01 Blue Lake Township



Blue Lake Township is located in the northern portion of Muskegon County. It is bordered by Dalton Township to the south, Oceana County to the north, Whitehall and Montague townships to the west, and Holton Township to the east. The first supervisor of the township was Austin P. Ware who settled in the area in 1864. The township was incorporated in 1865, and is named after Big Blue Lake which is its largest lake. The total population in 2010 for the township was 2,399, with a seasonal peak population of 2,716. 1,045 commuted and 615 residents were school-aged. There were 975 total housing units, 153 of which were vacant. Of those vacant housing units, 109 were for seasonal, recreational or occasional use. The township has no police precinct but does have its two fire stations and a township hall. Critical facilities in the township include county roads B-23and B-86, two dams, and a natural gas pipeline. Scattered rural housing, dense forest, Big Blue Lake, Wolverine Lake, White River, 50-60 small lakes and ponds, and 20-25 small creeks are among the major geographic features in the township.

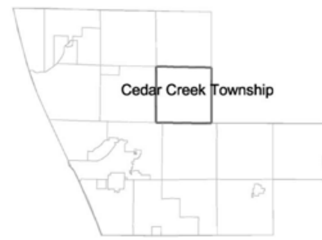
4.02 Casnovia Township



Casnovia is Muskegon County's eastern-most township and is bordered by Newaygo County to the north, Ottawa County to the south and east, and Moorland Township (Muskegon County) to the west. Settlers are believed to have arrived as early as 1848 but the township was not organized until 1852. The first township meeting was held April 4, 1853. According to the 2010 census, the population was 2,805 including the Village of

Casnovia and had a peak seasonal population of 2,843. 1,322 commuted and 692 residents were school-aged. The township has 1,022 total housing units, 78 of which are vacant. Of those 78 vacant housing units, 13 are for seasonal, recreational or occasional use. The township fire department and the township hall are the only critical facilities identified. Critical infrastructure includes two state highways (M-46 and M-37), one county road (B-35), and a power transmission line. Major geographic features in the township consist of scattered rural housing and moderate residential areas, moderate forest, moderate farmland, Half Moon Lake, 14-16 small lakes and ponds, and 20-25 small creeks.

4.03 Cedar Creek Township



Cedar Creek Township lies on the eastern side of Muskegon County and is bordered by Newaygo County to the east, Holton Township to the north, Dalton Township to the west, and Egleston Township to the south. It was incorporated in 1861. According to the 2010 census, the total population was 3,186, with a peak seasonal population of 3,403. 1,572 commuted to work and 652 residents were school-aged. There were 1,409 total housing units, 202 of which were vacant. Of those 202 vacant, 83 are for seasonal, recreational or occasional use. Critical facilities in the township include the DNR Muskegon Field Office and the township hall. State highway M-120 runs through the township, along with county-designated B-31 and Michigan Shore railroad. There is also a power transmission line and a natural gas pipeline. Major geographic features include scattered rural housing, dense forest, Muskegon River, Hornungs Duck Lake, 26-30 small lakes and ponds, and 12-16 small creeks.

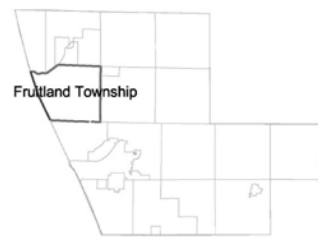
4.04 Dalton Township

Dalton Township, incorporated in 1859, is located in the northern portion of Muskegon County and is bordered by Blue Lake Township to the North, Muskegon Township to the south, Cedar Creek Township to the east, and Fruitland Township to the west. The total population in 2010 including Lakewood Club Village was 9,300, with a peak seasonal population of 9,714. 4,149 commuted and 2,094 were school-aged. There were 3,748 total housing units, of which 380 were vacant. Of those vacant 150 are for seasonal, recreational or occasional use. Critical facilities in the township include the fire department, a public works yard, the township hall, Muskegon Area District Library Dalton Branch, and Muskegon County Road Commission. Traversing the township are US-31, M-120, B-23, Michigan Shore railroad, a power transmission line, and a natural gas pipeline. Midget Private Airport is also among the township's critical infrastructure. Major geographic features include scattered housing, moderate residential areas, moderate forests, Twin Lakes, 24-26 small lakes and ponds, and 8-10 small creeks.

4.05 Egelston Township

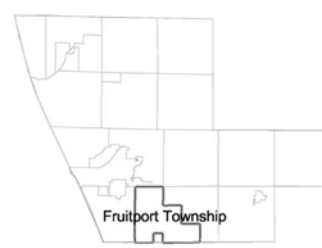
Egelston Township sits in the southern tier of Muskegon County and is bordered by five townships; Cedar Creek and Bridgeton (Newaygo County) to the north, Sullivan to the south, Moorland to the east, and Muskegon to the west. It was incorporated in 1859. The 2010 census population was 9,909, with a peak seasonal population of 10,010. 4,028 commuted and 2,272 residents were school-aged. The township had 3,882 total housing units, of which 262 are vacant. Of those vacant, 37 are for seasonal, recreational or occasional use. Over ¼ of the housing supply is comprised of mobile homes. Critical facilities include the police and fire departments, the township hall, Muskegon Area District Library Egelston Branch, and Muskegon County Road Commission. Infrastructure in the township includes M-46 and B-31, Muskegon County Wastewater Management-Metro Site, Egleston Township Sewer and Maintenance, a power transmission line, a natural gas pipeline, and Muskegon Wastewater Lagoon Dam. Dense forests, sewage lagoons, Wolf Lake, Muskegon River, 5-7 small lakes and ponds, and 8-10 small creeks are among Egelston Township's major geographic features.

4.06 <u>Fruitland Township</u>



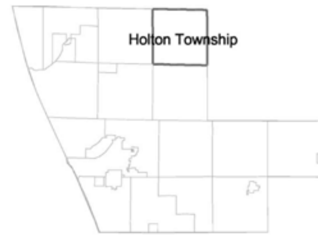
Fruitland Township, the county's largest township by size, partially contains Michigan's Adventure Amusement Park on its east side and abuts Lake Michigan on its west side. It is bounded by White Lake, Whitehall City and Whitehall Township to the north, Laketon Township to the south, and Lakewood Club Village and Dalton Township to the east. The earliest recorded history indicates that a French Canadian trader, Joseph LaFramboise, established a trading post at the mouth of Duck Lake in 1790-1800. The township was officially organized by the Muskegon County Board of Supervisors in 1869 and was named for its successful culture of fruits of all kinds. According to the 2010 Census, there was a total population of 5,543, with a peak seasonal population of 6,554. 2,209 commuted and 1,179 residents were school-aged. The township had 2,592 total housing units, 495 of which were vacant. Of those vacant, 383 are for seasonal, recreational or occasional use. The township hall is the only critical facility in the township. Critical infrastructure includes US-31 and a power transmission line. Scattered housing and moderate residential areas, moderate forests, the Lake Michigan Shoreline, White Lake, Duck Lake, 10-12 small lakes and ponds, and 8-10 small creeks make up the major geographical features of the township.

4.07 <u>Fruitport Charter Township</u>



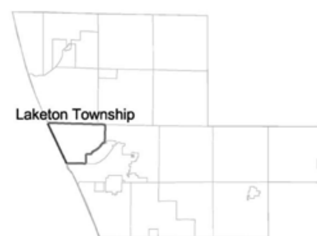
Fruitport Charter Township is located in the southern portion of Muskegon County and is bordered by Sullivan Township to the east, Muskegon City and Muskegon Township to the north, Ottawa County to the south, and the City of Norton Shores to the west. The first settler arrived in 1836, but it wasn't until 1867 that the area separated from Norton Township and then incorporated as a township in 1868. In 2010, the township, including Fruitport Village, had a total population of 13,598, with a peak seasonal population of 13,733. 6,249 commuted and 2,938 residents were school-aged. The total number of housing units was 5,389, 286 of which are vacant. Of those vacant, 51 are or seasonal, recreational or occasional use. The township has its own police and fire departments. The township hall is also a critical facility in the township. Critical infrastructure includes I-96, US-31, B-72, B-31, and the Fruitport Township water and sewer departments along with a natural gas pipeline. Scattered housing and moderate residential areas, moderate forests, Spring Lake, 8-10 small lakes and ponds, and 10-12 small creeks make up the major geographic features in Fruitport Township.

4.08 Holton Township



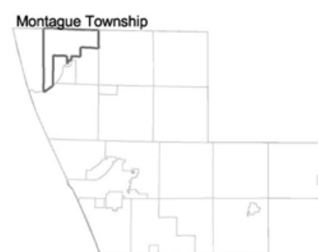
Holton Township is located in the northeastern corner of Muskegon County. It is bordered by Oceana County to the north, Dalton Township to the south, Newaygo County to the east, and Blue Lake Township to the west. Originally an Indian Reservation, it was organized into a township in 1871. In the year 2010, the total population was 2,515, with a peak seasonal population of 2,646. 961 commuted and 541 residents were school-aged. There were 1,050 total housing units, 134 of which were vacant. Of those vacant, 48 were for seasonal, recreational or occasional use. About ¼ of the housing supply was comprised of mobile homes. The fire department, township hall, and Muskegon Area District Library Holton Branch make up the important or critical facilities in the township. M-120, B-86, B-31, Michigan Shore railroad, and a power transmission line are all listed as vital or critical infrastructure. Major geographic features in the township include scattered rural housing with moderate residential areas, dense forest, Deer Lake, 14-16 small lakes and ponds, and 10-12 small creeks.

4.09 Laketon Township



Laketon Township is located along the shores of Lake Michigan and is bordered by Fruitland Township to the north, Muskegon and North Muskegon to the south, and Muskegon Township to the east. The township, organized in 1865, has a 2010 census population of 7,563, with a peak seasonal population of 7,773. There are 3,178 total housing units, 256 of which are vacant. Of those 256, 81 are used for seasonal, recreational or occasional use. The township has three community shelters and a township hall listed as critical facilities but has no vital or critical infrastructure. Major geographic features consist of scattered housing and moderate residential areas, moderate forest, Lake Michigan shoreline, coastal sand dunes, Muskegon Lake, Bear Lake, 8-10 small lakes and ponds, and 6-8 small creeks.

4.10 Montague Township



Montague Township is located in the northwest portion of Muskegon County and was incorporated in 1874. It is bordered by Oceana County to the north; White Lake, Whitehall Township, and the cities of Whitehall and Montague to the south; Blue Lake Township to the east; and White River Township to the west. The 2010 census recorded 1,600 as the total population, with a peak seasonal population of 1,683. There are 684 total housing units, 66 of which are vacant. Of those vacant, 32 are for seasonal, recreational or occasional use. The only identified important or critical facility is the township hall. Vital or critical infrastructure includes US-31, US-31 Business Route, Old US-31, B-15, and B-86. Other critical infrastructure consists of a power transmission line, Ottiger Airport, and a natural gas pipeline. Scattered rural housing and moderate residential areas, moderate forest and farmland, White Lake, White River, 6-8 small lakes and ponds, and 14-16 small creeks are all major geographic features in the township.

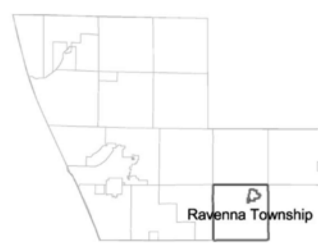
4.11 Moorland Township

Moorland Township sits in the southeast portion of Muskegon County. It is bordered by Ravenna Township to the south, Casnovia Township to the east, and Egelston Township to the west, and Newaygo County to the north. Settlers arrived in the area as early as 1857 and the township was organized in 1860 when the first officers were elected. According to the 2010 census, the total population was 1,575, with a peak seasonal population of 1,583. The township has 618 total housing units, of which 44 are vacant. Of those 44 vacant, 3 are for seasonal, recreational or occasional use. The fire department and the township hall are the two identified critical facilities in Moorland Township. Vital infrastructure includes roads M-46, B-35, Muskegon County Solid Waste Management, a power transmission line, and a natural gas pipeline. Major geographic features in the area include scattered rural housing, moderate forest, moderate farmland, a sewage Lagoon, 3-5 small lakes and ponds, and 10-12 small creeks.

4.12 Muskegon Charter Township

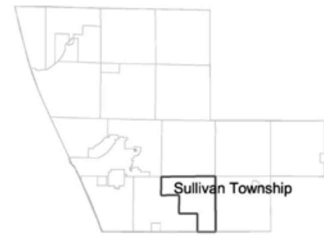
Muskegon Charter Township is located near the center of Muskegon County. It is bordered by Dalton and Cedar Creek townships to the north; the cities of Muskegon and North Muskegon and Laketon Township to the west; Fruitport Township to the south; and Egelston Township to the east. In 1837, Muskegon Township was organized as a subdivision of Ottawa County. One of the earliest settlers, Henry Pennoyer, was elected as the first Township Supervisor in 1838. In 2010, Muskegon Township's total population was 17,840 with a peak seasonal population of 17,886. There are 7,191 total housing units, of which 384 are vacant. Of those 384 vacant, 18 are for seasonal, recreational or occasional use. Muskegon Township has one police precinct, two fire stations, and one public works yard. It also has eight community shelters, a community medical facility, a township hall, and the Muskegon Area District Library Muskegon Township Branch. Among its vital or critical infrastructure are US-31, M-120, M-46, Michigan Shore railroad, two bridges along US-31, a power transmission line, and Northside Airport. Major geographic features include scattered housing and moderate residential areas, moderate forest areas, Muskegon River, 4-6 small lakes and ponds, and 8-10 small creeks.

4.13 Ravenna Township



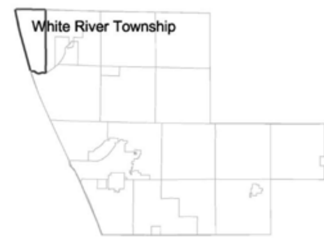
Ravenna Township lies in the southeastern-most portion of Muskegon County. It is bordered by Moorland Township to the north, Ottawa County to the south and east, and Sullivan Township to the west. E.B Bostwick was the first to locate land in the township in 1844. The township was organized in 1849 when the first town meeting was held. The 2010 census population is 2,905, including the Village, with a peak seasonal population of 2,927. There are 1,100 total housing units in the township, 62 of which are vacant. Of those vacant, 8 are for seasonal, recreational or occasional use. Important or critical facilities include the fire station, one community shelter, and the township hall. Roads B-72, B-35, and a power transmission line are the listed vital or critical infrastructure in the township. Major geographic features in the area are scattered rural housing, moderate forest, moderate farmland, Crockery Creek, 1-3 small lakes and ponds, and 14-16 small creeks.

4.14 Sullivan Township



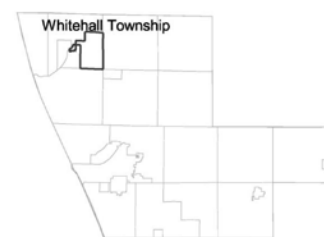
Sullivan Township is located in the southern portion of Muskegon County and was incorporated in 1891. It is bordered by Ottawa County to the south, Egelston Township to the north, Ravenna Township to the east, and Fruitport Township to the west. The 2010 census gives a total population of 2,441, with a peak seasonal population of 2,454. There are 978 total housing units in the township, of which 46 are vacant. Of those vacant, only one is for seasonal, recreational or occasional use. The township hall is the only listed critical facility in the township. Critical infrastructure includes roads B-72, B-31, and a power transmission line. Major geographic features in the area include scattered rural housing, moderate forest area, 4-6 small lakes and ponds, and 6-8 small creeks.

4.15 White River Township

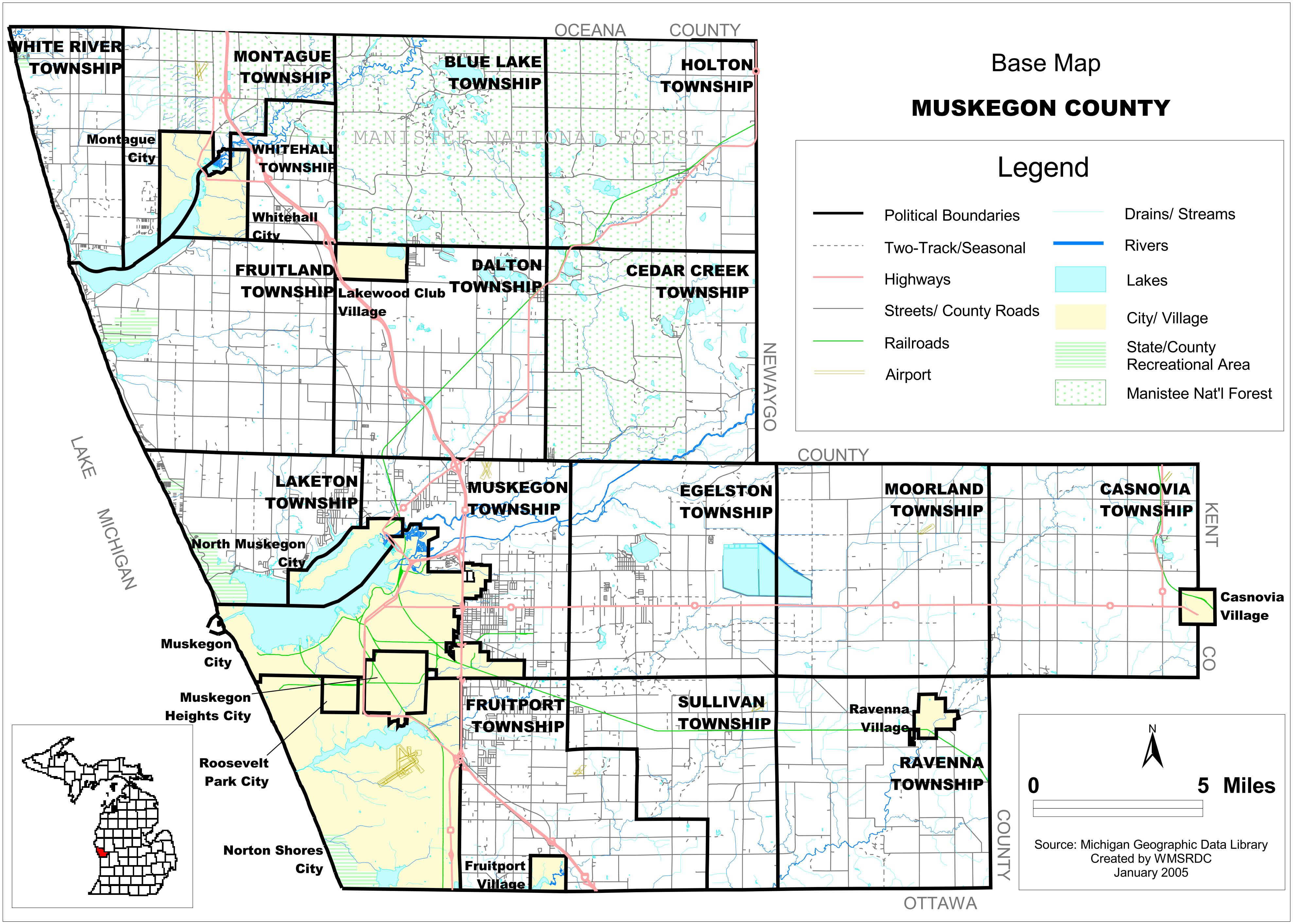


White River Township is located in the northwestern corner of Muskegon County. Lake Michigan borders it to the west, Oceana County to the north, White Lake to the south, and Montague Township to the east. It is difficult to get an accurate history of the township because all records were burned in 1859 to make a fresh start, one free of debt, but the date of incorporation (1848) is known. The 2010 census shows a total population for White River Township of 1,335, with a peak seasonal population of 2,195. There are 907 total housing units, of which 383 are vacant. Of those vacant, 340 are for seasonal, recreational or occasional use. Critical facilities in the township include one community medical facility and the township hall. Vital infrastructure includes county road B-15, and a power transmission line. Major geographic features consist of scattered rural housing, moderate forests, moderate farmland, the Lake Michigan shoreline, White Lake, 6-8 small lakes and ponds, and 10-12 small creeks.

4.16 Whitehall Township

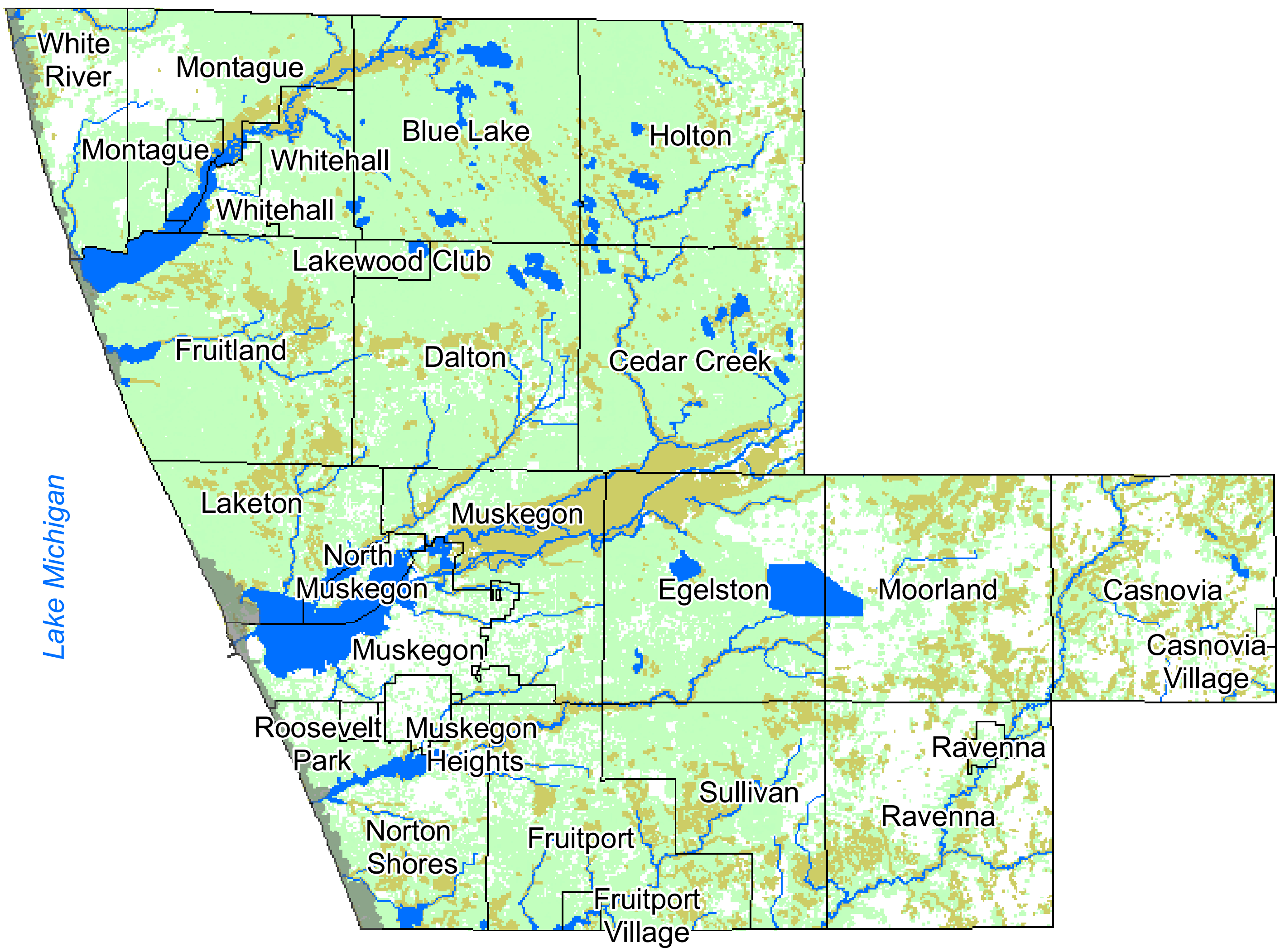


Whitehall Township is located in the northwest portion of Muskegon County and is bordered by the City of Whitehall to the west, Montague Township to the north, Fruitland Township to the south, and Blue Lake Township to the east. It was formed in 1874 when Oceana Township was split into two separate townships: Montague to the north and Whitehall to the south. According to the 2010 census, Whitehall Township's total population was 1,739, with a peak seasonal population of 1,787. There are 723 total housing units in the township, 50 of those are vacant. Of those 50 vacant, 19 are for seasonal, recreational or occasional use. Over ¼ of the housing supply is comprised of mobile homes. Critical facilities include the township hall and Muskegon County Road Commission Garage. Highway U.S. 31, its bridge over White River, a power transmission line, and the Silver Creek Pond Dam are among vital or critical infrastructure. Major geographic features in the township include scattered housing and moderate residential areas, moderate forests, White River, 4-6 small lakes and ponds, and 2-4 small creeks.



Base Map
MUSKEGON COUNTY
Legend
Political Boundaries
Two-Track/Seasonal
Highways
Streets/ County Roads
Railroads
Airport
Drains/ Streams
Rivers
Lakes
City/ Village
State/County Recreational Area
Manistee Nat'l Forest
OCEANA COUNTY
NEWAYGO COUNTY
KENT CO
OTTAWA COUNTY
LAKE MICHIGAN
MANISTEE NATIONAL FOREST
WHITE RIVER TOWNSHIP
MONTAGUE TOWNSHIP
BLUE LAKE TOWNSHIP
HOLTON TOWNSHIP
Montague City
WHITEHALL TOWNSHIP
Whitehall City
FRUITLAND TOWNSHIP
Lakewood Club Village
DALTON TOWNSHIP
CEDAR CREEK TOWNSHIP
LAKETON TOWNSHIP
MUSKEGON TOWNSHIP
EGELSTON TOWNSHIP
MOORLAND TOWNSHIP
CASNOVIA TOWNSHIP
Casnovia Village
North Muskegon City
Muskegon City
Muskegon Heights City
Roosevelt Park City
Norton Shores City
FRUITPORT TOWNSHIP
Fruitport Village
SULLIVAN TOWNSHIP
Ravenna Village
RAVENNA TOWNSHIP
N
0
5 Miles
Source: Michigan Geographic Data Library
Created by WMSRDC
January 2005

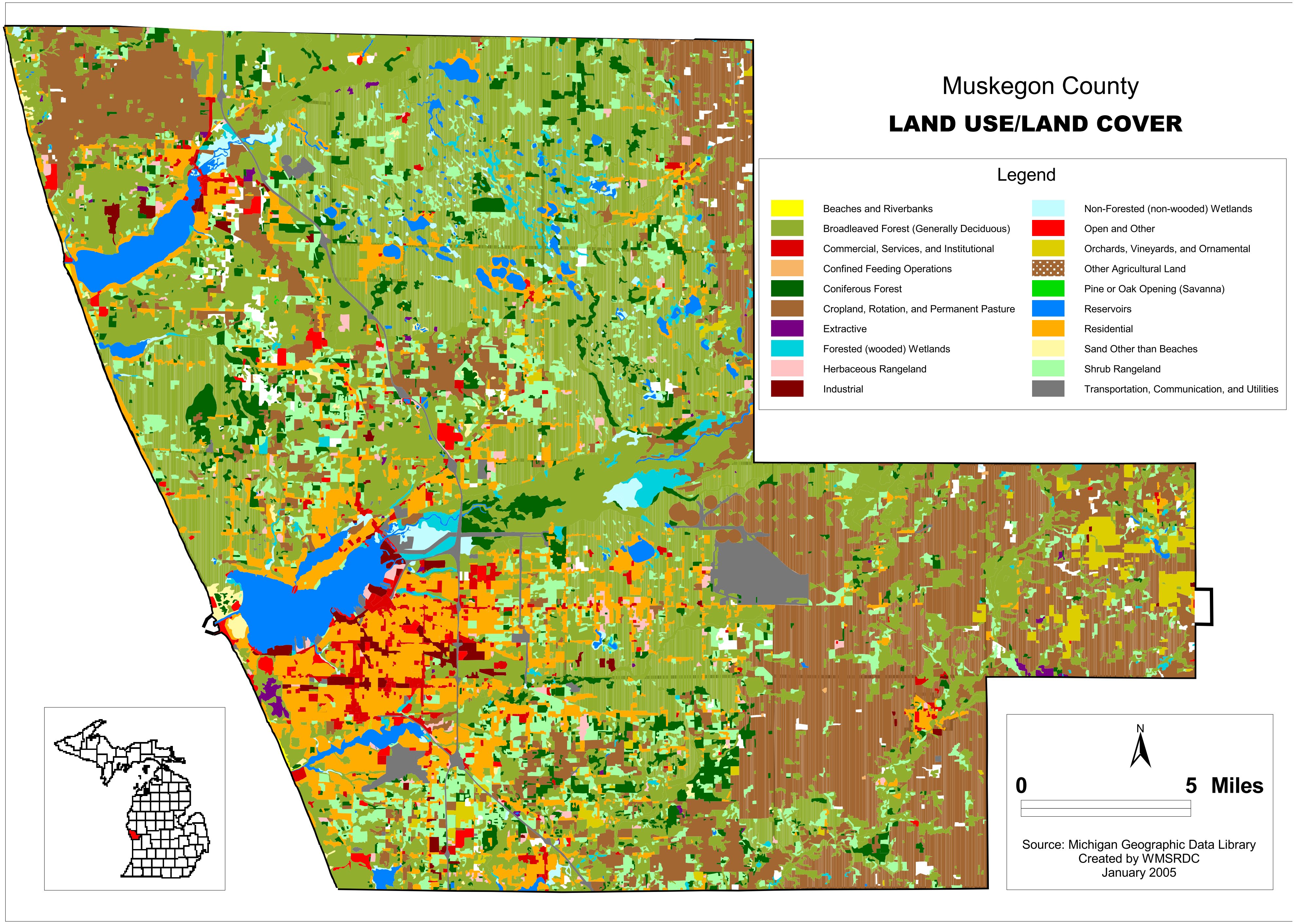
MUSKEGON COUNTY
Natural Features



Forests
Wetlands
Critical Dunes
Water Feature

WMSRDC
WEST MICHIGAN SHORELINE
REGIONAL DEVELOPMENT COMMISSION

Sources: MDNR, MCGI, NWI
Created June 13th, 2013


Muskegon County
LAND USE/LAND COVER
Legend
Beaches and Riverbanks
Broadleaved Forest (Generally Deciduous)
Commercial, Services, and Institutional
Confined Feeding Operations
Coniferous Forest
Cropland, Rotation, and Permanent Pasture
Extractive
Forested (wooded) Wetlands
Herbaceous Rangeland
Industrial
Non-Forested (non-wooded) Wetlands
Open and Other
Orchards, Vineyards, and Ornamental
Other Agricultural Land
Pine or Oak Opening (Savanna)
Reservoirs
Residential
Sand Other than Beaches
Shrub Rangeland
Transportation, Communication, and Utilities
N
0
5 Miles
Source: Michigan Geographic Data Library
Created by WMSRDC
January 2005

Part C
IDENTIFICATION OF COMMUNITY HAZARDS

(See Appendix B for the Hazard Identification Profile for each local governmental unit in the county)

Although FEMA requires that only natural hazards be addressed in the Hazard Mitigation Plan (44CFR Part 201), the Michigan Department of State Police (MSP) recommends that plans also look at technological and human-related hazards. MSP believes that it is important to discuss **all** known hazards that **could** impact the area, even those that pose no known threat, and to document the analyses on all hazards. Such documentation assures that risks from all hazards were considered and none were overlooked in the hazard analysis.

For hazards that are not considered significant, it is recommended that statements be included to explain why they are not. For example, a nuclear plant located over 50 miles away may not pose a threat to the area. Thus, if Muskegon County is located over 100 miles away from a nuclear power plant, it is sufficient analysis to state the fact. Further analysis is not required.

The Michigan Hazard Mitigation Plan, 2011 edition (MHMP), produced by the Michigan State Police, Emergency Management and Homeland Security Division (MSP-EMHSD), considers a wide range of potential hazards in the state. The table below reveals the classification of those hazards as presented in the statewide plan.

NATURAL HAZARDS	TECHNOLOGICAL HAZARDS	HUMAN-RELATED HAZARDS
Weather Hazards: ▪ Thunderstorms, including Hail & Lightning ▪ Severe Winter Weather, including Ice, Sleet, & Snow ▪ Severe Winds ▪ Tornadoes ▪ Extreme Temperatures ▪ Fog Hydrological Hazards: ▪ Riverine/Urban Flooding ▪ Great Lakes Shoreline Hazards ▪ Dam Failures ▪ Drought Ecological Hazards: ▪ Wildfire ▪ Invasive Species Geological Hazards: ▪ Earthquakes ▪ Subsidence ▪ Celestial Impact	Industrial Hazards: ▪ Structural Fires ▪ Scrap Tire Fires ▪ HAZMAT – Fixed Site ▪ HAZMAT – Transportation ▪ Nuclear Power Plant Emergencies ▪ Petroleum & Natural Gas Pipeline Accidents ▪ Oil & Natural Gas Well Accidents Infrastructure Problems: ▪ Infrastructure Failures ▪ Energy Emergencies ▪ Transportation Accidents, including Air, Rail, Highway & Marine	▪ Catastrophic Incidents (National Emergencies) ▪ Civil Disturbances ▪ Nuclear Attack ▪ Public Health Emergencies ▪ Terrorism and Similar Criminal Activities

The list above represents a significant expansion and reorganization of potential hazards contained within the MHMP. The hazards addressed in this plan have therefore been expanded and reorganized to remain consistent with the MHMP. Hazard descriptions within this chapter draw heavily upon the wealth of information and data contained within the MHMP. The MHMP can be consulted for information additional to that which is included in this document, especially with regard to hazard analyses conducted at the state-level, as opposed to the county and local levels.

Analysis of each individual natural, technological, and human-related hazard is included in the remainder of this chapter. The analyses are organized alphabetically, and draw heavily on historical records, especially those of the National Climatic Data Center (NCDC), a division of the National Oceanic and Atmospheric Administration (NOAA). NCDC receives information from the National Weather Service (NWS) and maintains records of tornadoes from 1950, of thunderstorm winds and hail since 1955 and of all storms (including lightning) since 1993. Storm Data are categorized by County or by NWS Forecast Zone. Smaller (areal coverage) events are collected by County for Tornado, Thunderstorm Winds, Flash Floods and Hail events. Larger scale events are collected by NWS Forecast Zone for Heat, Cold, Drought, Flood, Tropical, and Winter Weather events. Muskegon County is situated in the Southwest Lower Michigan Forecast Area of the NWS, headquartered in Grand Rapids, MI.

A few words of caution: Severe weather observations are strongly population-dependent. The likelihood of a report being made is proportional to population density. Therefore it is likely that many severe weather events in less-populated areas have gone unreported to the NCDC Storm Events Database. This may understate the actual frequency of a particular hazard in a particular area. On the other hand, the observations that are made will tend to come from areas of human development which may be more likely to benefit from hazard mitigation actions.

Preceding the individual analyses is a summary of notable natural hazard events in the county, including Declarations of Major Disasters and Emergencies by the President, as well as Declarations of Disasters by the Governor. A major disaster is defined as “any natural catastrophe (including any hurricane, tornado, storm, high water, wind driven water, tidal wave, tsunami, earthquake, volcanic eruption, landslide, mudslide, snowstorm, or drought), regardless of cause, any fire, flood, or explosion, in any part of the U.S. which in the determination of the President causes damage of sufficient severity and magnitude to warrant major disaster assistance under this Act to supplement the efforts and available resources of states, local governments, and disaster relief organizations in alleviating the damage, loss, hardship, or suffering caused thereby.” An emergency is defined as “any occasion or instance for which, in the determination of the President, federal assistance is needed to supplement state and local efforts and capabilities to save lives and to protect property and public health and safety, or to lessen or avert the threat of a catastrophe in any part of the U.S.”

Significant Updates

While the general format of this chapter has remained the same, a number of significant updates have been made. Five new hazards have been introduced to the plan, increasing the total number of hazards addressed within to 31. These additional hazards include Celestial Impacts, Fog, Invasive Species, Energy Emergencies, and Catastrophic Incidents.

Further, a number of hazards have been renamed or reorganized. For example, “Flooding: Shoreline” is now considered “Great Lakes Shoreline Hazards” and “Snow/Ice/Storms” is now “Winter Weather.” “Land Subsidence” is now simply “Subsidence,” and has been classified under Natural Hazards, rather than Technological Hazards. Lastly, “Weapons of Mass Destruction/Terrorism Incidents” has been revised to “Terrorism and Similar Criminal Activities.”

Where appropriate, other updates within this chapter include: revisions to hazard descriptions; inclusion of recent hazard events, or additional events identified by research; and adjustments to “Frequency of Occurrence.”

Historically Significant Natural Hazard Events

Drought:
- Droughts lasting eight or more months (12): 1895-96, 1899-1900, 1901-02, 1909-11, 1925-26, 1930-31, 1956-57, 1962-63, 1971-72, 1976-77, and 2002-03.

Extreme Temperatures:
- July 1936: Heat wave. 570 deaths statewide, 7 in Muskegon.
- Summer 1988: 39 days in Michigan with temperatures over 90 degrees Fahrenheit.
- March 2012: Record warmth. Early growing season led to $209.8m crop losses in Michigan.

Floods (riverine, urban):
- August 20 - September 6, 1975: Flooding. Declaration of Major Disaster by President.
- February 21, 1986: Great lakes flooding and wave action. Declaration of disaster by Governor.
- September 10-19, 1986: Flood. Declaration of Major Disaster by President.
- May 18-20, 2000: Flood. $100k property damage, $50k crop damage in Muskegon County.
- May 15-16, 2001: Flood. $500k property and $200k crop damage, southwestern Lower MI.
- May 20-24, 2004: Flood. Declaration of Major Disaster by President.
- April 16- May 14, 2013; Flood. Declaration of Major Disaster by President.

Great Lakes Shoreline:
- 1986: Record high water level on Lake Michigan.
- 2013: Record low water level on Lake Michigan.

Severe Winds & Thunderstorm Hazards (winds, tornadoes, hail, lightning):
- May 13, 1956: 4 inch hail. Fruitport Township.
- September 4, 1965: Tornado (F2). $25k property damage, Sullivan Township.
- April 16, 1967: Tornado (F1). $3k property damage, Whitehall.
- August 20-Sept 6, 1975: Rainstorms, high winds. Declaration of major disaster by President.
- July 20, 1994: Lightning. Killed a dog and caused $50k property damage, Muskegon County.
- April 6, 1997: High wind. $5m property damage across southwest Lower Michigan.
- May 29, 1998: Severe thunderstorm winds. $1m property damage, Muskegon County.
- May 31, 1998: Severe thunderstorm winds. Declarations disaster by Governor and major disaster by President. $2.5m in public damage costs.
- August 22, 2000: Severe thunderstorm winds. $150k property damage, Muskegon County.
- October 30, 2004: High wind. $1.15m property damage across southwest Lower Michigan.
- May 20-24, 2004: Severe storms. Declaration of major disaster by President.
- August 9, 2009: Severe thunderstorm winds. $2m property damage, Muskegon County.
- November 17, 2013: Tornado. $50 k property damage, Casnovia Township.

Severe Winter Weather (ice, sleet, snow storms):
- March 2-7, 1976: Ice storms. Declaration of major disaster by President.
- January 26-31, 1977: Blizzard, snowstorm. Declaration of emergency by President.
- January 26-27, 1978: Blizzard, snowstorm. Declaration of statewide emergency by President.
- January 12-21, 1994: Heavy lake effect snow. $500k property damage across western Lower Michigan.
- January 27, 1994: Heavy snow and freezing rain. $5m property damage across region.
- October 26, 1997: Heavy snow. $1.2m property damage across southwestern Lower Michigan.
- January 2-15, 1999: Blizzard, snowstorm. Declaration of emergency by President.
- December 11-31, 2000: Blizzard, snowstorm. Declaration of emergency by President.
- April 3, 2003: Ice storm. $4.9m property damage throughout West Michigan.
- February 16, 2006: Ice storm. $1m property damage across Lower Michigan.

Wildfires:
- October 1871: Wildfires. 1.2m acres burned, 200 fatalities, Lower Peninsula.
- May-September, 1891: Uncontrollable wildfires across Michigan during the drought of 1891.

1.0 NATURAL HAZARDS

1.01 CELESTIAL IMPACT

An impact or threatened impact from a meteorite, asteroid, comet, satellite, space vehicle, space debris, solar storm, or similar phenomena that may cause physical damages or other disruptions.

Summary: Historically, celestial impact has not received consideration as a potential hazard in Muskegon County. However, this hazard is discussed by the Michigan Hazard Mitigation Plan and is summarized in this plan to increase awareness among emergency responders, public safety officials, and community leaders. The following hazard description is only a portion of the information contained within the state plan, which can be referenced for additional information.

The most likely effect of celestial impacts in Muskegon County appears to be "space weather" generated by the sun. This is considered relevant to Muskegon County primarily for its potential to disrupt complex modern communication systems (i.e. satellites, television, radio, GPS, power supply networks), as well as the extensive human and technological infrastructure that rely upon those communication and utility networks. Physical collision of an object on the Earth's surface, although potentially devastating or even catastrophic, is considered to be significantly less likely.

Hazard Description: The celestial impact hazard primarily concerns the effects of large forces (from objects or energy) upon the Earth or its atmosphere. Most such forces are extraterrestrial in origin—meteors (which burn up in the atmosphere) or meteorites (which impact physically upon the ground) that were originally asteroids or comets from elsewhere in the solar system. Even in cases where no meteorite actually strikes the ground, the explosive energies from the meteor's impact upon the many layers of atmosphere can create an intense heat and blast area, along with very strong winds, and can release more energy than even the largest nuclear bombs. Massive or fast moving bodies that impact upon either the ground, the oceans, or the atmosphere can cause widespread destruction and disruption of both human and natural systems, including secondary hazards such as earthquakes, volcanoes, tsunamis, and severe winds.

Although it has been estimated that a major impact from a physical body upon the Earth occurs approximately once per century, recent discoveries (and the fact that human activities continue to expand across the Earth's surface) have increased concern over this hazard. Celestial objects are more likely to strike a body of water rather than land because, according to the United States Geological Survey (USGS), approximately 70% of the Earth's surface is water. This should not underscore the potential effects an ocean strike can have upon land, such as widely damaging tsunamis and seismic activity.

Much more common than physical collisions is the flare-up of energy and charged particles that are emitted and ejected by the Sun towards the Earth. Solar flares and storms (also known as "space weather") are highly relevant for their potential impacts and possible disruption of these complex modern communication systems—satellites, television, radio, GPS, power supply networks, and the extensive human and technological infrastructure that relies upon those communication and utility networks. The space weather hazard is far more likely to cause disruptive effects, economic impacts, and risks to human life in the near term. The effects of space weather have already had strong impacts upon Michigan within the normal historical timeframe typical for this type of plan.

The following discussion of asteroids, comets, and space weather is provided primarily to be "on the safe side" so that readers and emergency managers can be well-informed in the event that a very serious incident does occur, or threatens to occur.

<u>Asteroids</u>: Most asteroids are located in the main asteroid belt and have well-defined orbits there between 200 and 310 million miles from the Sun, but thousands of asteroids also exist in other

parts of the solar system. There are groups of "Trojan" asteroids that share an orbit with Jupiter, for example, located 60 degrees both ahead of and behind that planet itself while going around the Sun. Asteroids that have paths which cross over Earth's orbit are classified as Near-Earth Objects (NEOs), and are called Apollo asteroids. Two other types of NEOs are Amor asteroids, which approach the Earth's orbit from positions outside of it, and Aten asteroids, which approach the Earth's orbit from the direction of the Sun. As of January 2009, there were 6,021 NEOs identified, of which 1,026 were classified as posing the possibility of threat (having the potential to come within 466,000 miles of the Earth's orbit). The typical asteroid would impact upon the Earth at an angle of 45 degrees and a speed of 10 miles per second.

Comets: More than 99% of all meteorites come from asteroids, but some comet impacts have also been confirmed (9 are known, constituting less than 0.03% of all meteorites). The main difference between comets and asteroids is that comets tend to have elliptical orbits that carry them out beyond the "nebular frost line" (located in the main asteroid belt, about 250 million miles from the Sun) and thus their composition includes a substantial amount of icy and frozen matter. Comets usually lose about 0.1% of this matter each time they pass by the sun, due to the effects of warming and the pressure of solar radiation, and this matter trails behind them in their long "tails," which include charged particles (with associated magnetic fields) and can stretch across many tens of millions of miles of space. Where such tails cross the Earth's orbit, this matter (typically small and harmless to us) generates sometimes spectacular "meteor showers" as it periodically burns up in the Earth's atmosphere at regular times during the year. After a certain number of orbits, however, the comet simply breaks apart. Even if less dense than the average asteroid, a comet's heavy nucleus can be sizeable (from several hundred meters to over 40km in diameter), and a comet impact upon the Earth would typically occur at a speed of 31 miles per second—about three times as fast as the average asteroid, with a proportionally larger momentum of destructive energy if the amount of mass is the same. (It is worth noting here that the maximum impact upon the Earth for any object orbiting the Sun would be no more than 44.5 miles per second.)

Comets are classifiable by their orbital period, with long period comets taking more than 200 years to travel around the Sun, and short period comets taking less than that. The short period comets are further subdivided into Halley-type comets with orbital periods between 30 and 200 years, and Jupiter-type comets with orbital periods of less than 30 years. Long period comets originate in the farthest reaches of the Solar System (the Oort Cloud) and approach the Sun and Earth from any direction, while short period comets originate from the "Kuiper Belt" that exists beyond Neptune and is approximately in the same plane as all of the major planets.

A physical impact by a celestial object that is either sufficiently massive or fast-moving can cause effects comparable to any number of other hazards described in this plan. For example, it could compare to a nuclear blast in terms of the amount of energy released in the form of pressure (shock) waves and thermal effects (heat/fire). Additionally, major earthquake activity would be felt in areas that normally wouldn't have had to worry about such effects. An impact into any major water body (including the Great Lakes) can cause tsunamis and significant shoreline flooding, and severe winds could also result in extensive physical damages many miles (or hundreds of miles) from the main impact site. Depending upon the mass and velocity of the meteorite, the effects on the public may range from barely noticeable to complete destruction in a given area.

If advance notice of an approaching meteor, asteroid, or comet is available, then widespread alerts may be distributed, similar to when the explosive breakup of the Space Shuttle Columbia in 2003 prompted warnings and alerts across the southwestern U.S. due to the possible effects of falling debris. In this case, debris needed special handling for both investigation purposes and out of concern of exposure to hazardous substances. The threat of a celestial impact could be much more dangerous and far-reaching. One clear example of the potential damage was seen in the impact of the comet Shoemaker-Levy 9 on the planet Jupiter, in 1994, which resulted in blasts that were estimated as the equivalent of ten million megatons of explosives. In comparison, the 1979 Mount St. Helens eruption was roughly 5 megatons, and the 1885 Krakatoa eruption in Indonesia was about 100 megatons. Following the Shoemaker-Levy comet impact, Congress authorized new research to analyze this type of celestial impact hazard.

Space Weather: The Sun does not "burn" in the sense that we usually experience that common heat-generating process on Earth, but rather emits huge amounts of energy from the continuous processes of nuclear fusion that take place in the Sun's core. The gravitational pressures of the Sun's enormous mass, pulling toward itself, are thus generally offset by outward pressures from the fusion processes that take place at its core. Enormous amounts of energy are radiated from the Sun, including the spectrum of electromagnetic waves up through gamma wave frequencies. These include infrared (heat) radiation, ultraviolet, all colors of visible light, x-rays, microwaves, and radio waves. The intensity of these forms of radiation varies, and gamma waves are normally only emitted during solar flare events (to be explained shortly). It should also be understood that in the midst of all these solar interactions of matter and energy are powerful magnetic forces, which also affect the distribution of heat energy in and around the Sun and sometimes cause cooler areas, called sunspots, to form for a while, readily visible even with crude forms of observational equipment. (Although an observer should never look directly at the Sun, a pinprick of solar light projected onto a surface provides one basic means of seeing a Solar image). The relatively low temperatures of sunspot areas, however, are coupled with a rise in energy above the Sun's surface. Solar prominences are arches of plasma that soar above the Sun's surface, in a pattern that is itself shaped by the powerful magnetic fields present. In some cases, these magnetic fields have become too twisted to maintain such forces within these ordinary patterns, and a solar flare is generated, which releases a huge amount of energy from the Sun. Normally, a solar wind exists in the form of milder pressures exerted by emitted photons, ions, and other particles that flow outward from the Sun until they are eventually halted (beyond the orbit of Neptune, at an area called the heliopause) by the pressure of interstellar gases. Within the realm of the Sun's planets, however, the solar wind is an ongoing feature of the space environment, constantly sending energy and charged particles outward.

Space weather is a term that denotes the impacts of the Sun's activity upon the bodies within this sphere inside the heliopause, including our own Earth. As with the weather on Earth, there are some clear patterns that are exhibited by space weather. More turbulent space weather is produced during times when more sunspots are present (called a solar maximum), and space weather is calm during times when sunspots are rare and small (or not even seen to be present at all, called a solar minimum). A sunspot cycle exists, in which sunspot activity regularly shifts between a minimum and maximum level. As with our Earthly seasons, however, it cannot be known in advance exactly how turbulent or calm things will be at a given moment during the sunspot cycle—only that calmer periods regularly give way to more turbulent periods. As to the regularity of the sunspot cycle itself, although it has been found that the average amount of time between a solar minimum and a solar maximum is about 11 years, the actual length varies quite a bit within each cycle. The interval is sometimes as long as 15 years and sometimes as short as 7 years. In addition, it has been observed that long periods can occur with little or no sunspot activity. The "Maunder minimum," which occurred between the years 1645 and 1715, is the primary example of such long-term variation from the normal cycle, but it is not yet known what caused it, or when it might recur. The Earth's atmosphere serves as a shield for us against many types of particles and radiation zipping across space, and Earth also has a magnetosphere that similarly provides protection against most of the charged particles traveling through space. There are some weak spots in the Earth's magnetic field, however, that exist near its two magnetic poles and allow many ions to penetrate, where they collide with atoms in the Earth's upper atmosphere and glow to produce the beautiful auroras in the skies of the arctic regions of the north and south. In addition, the Earth is surrounded by "belts" of charged particles (called Van Allen belts) which are hazardous to spacecraft and astronauts. These are known and predictable conditions of calm space weather, however, and the actual hazard is the turbulence that is generated by large solar flares, causing problems with radio communications, damage to satellites, and even disruptions in power delivery networks on the Earth. As of early 2011, sunspot cycle number 24 proceeded from a solar minimum that was reached in December 2008, and was projected to transition to a solar maximum by the middle of 2013.

Another type of solar disturbance is a coronal mass ejection (CME), in which built-up pressures cause the sudden release of gases and magnetic fields at tremendous speeds, with impacts that reach far across interplanetary space. Like solar flares, CME events are a source of geomagnetic storms on Earth (usually 1 to 4 days after the solar event), and occur more frequently during periods with more sunspots. An additional effect of space weather involves increased exposure to ionizing radiation, especially to those in aircraft at high altitudes and along polar flight paths. Extra costs in fuel and delays are imposed upon airlines during periods of harmful space weather.

Space weather may result in the disruption of transportation and communication systems, and in some cases may result in fatal transportation accidents, economic losses, and widespread power supply interruptions. A catastrophic physical impact event would require extensive use of mutual aid and state/federal disaster and emergency assistance, with the likelihood that all normal response resources would be disabled within the area of impact, and would need to be replaced by resources from adjacent local areas, or even from beyond the state. In addition, an extremely large impact, even if not in Michigan, could cause a National Emergency situation to arise, which Michigan may have to help to respond to and recover from (please refer to the chapter on National Emergencies).

Historically Significant and Related Events: The Michigan Hazard Mitigation Plan includes an extensive list of historical celestial impacts and solar weather events. A variety of these are included below as examples of potential effects of this hazard.

March 19, 1996 – International

A celestial “close call” involved asteroid 1996 JA1 (large enough to cause catastrophic damage), which came within 280,000 miles—nearly as close as the Moon.

Feb 1, 2003 – National

The Space Shuttle Columbia broke apart violently when returning from a mission, causing a widespread alert about the potential for falling debris across the southwestern United States. More than 2,000 debris impact sites were eventually reported, but fortunately these were predominantly in sparsely populated areas. NASA issued warnings that the shuttle debris could contain hazardous materials and that it should remain untouched (and instead reported to authorities upon discovery).

March 26, 2003 – “Park Forest event” in Suburban Chicago, Illinois

Hundreds of meteorites fell across residential areas in the suburbs of Chicago. This event was highly unusual, having been described as “the most densely populated region to be hit by a meteorite shower in modern times.” Coincidentally, the area of impact was in the midst of numerous highly-trained experts associated with the University of Chicago and other scientific institutions. The original meteoroid was calculated to have been between 1 and 7 thousand kilograms (possibly more) before it broke apart in the atmosphere. About 30 kilograms of meteorite fragments were recovered, with the largest weighing 5.26kg. Numerous holes were punched through windows, roofs, and ceilings in homes, and also a fire station. One roof hole was caused by a meteorite that weighed only 545 grams. There were about 18 documented fragments of about that size or larger across a couple of square miles of neighborhoods.

December 2005 – International

A geomagnetic storm caused the disruption of satellite-to-ground communications and GPS (Global Positioning System) navigational signals. Although this disruption only lasted about 10 minutes, it threatened the safety of commercial air flights and marine traffic during that time.

September 20, 2007 – Southern Peru

After a loud explosion was heard, residents of an isolated village found a large crater measuring 41 feet in diameter near Lake Titicaca and filled with water. A 1.5 magnitude earthquake was detected in the area.

The unusual aspect of this incident is that many villagers subsequently reported symptoms such as headaches and nausea. It has been proposed that the impact of a meteorite, along with the heat that was generated, caused the release of toxic fumes from the ground.

Frequency of Occurrence: It is likely that the next major celestial physical impact will occur somewhere in the world other than Michigan, and that Michigan's role as part of the United States would at most involve the provision of support to the impacted areas. If a major impact happens to occur in North America, state-level mutual aid may result, and possibly even the intake of evacuees, as had taken place during the Katrina and Rita hurricane disasters of 2005.

The space weather hazard, by contrast, is likely to cause one or more serious infrastructure failures in the near future, due to the extent of our reliance on complicated electronic and satellite systems that are vulnerable to disruption. In addition to power failures and phone communication breakdowns, it is also quite possible for the disruption of radio and navigational systems to cause risks for air and marine traffic. Even if cautious transportation providers are diligent about maintaining safety during such events, considerable economic impacts and delays can result from the electronic breakdowns caused by solar geomagnetic storm events.

1.02 DROUGHT

A water shortage caused by a deficiency of rainfall, generally lasting for an extended period of time.

Summary: Muskegon County is located adjacent to the world's fifth largest body of fresh water, yet is still vulnerable to drought. Droughts experienced in Michigan can cause significant economic losses and increase the likelihood of brush and forest fires. The gradual and unpredictable onset and recession of a drought, combined with the relative impacts it may have from location to location, complicate mitigation efforts for this hazard.

Hazard Description: Drought is the consequence of a natural reduction in the amount of precipitation expected over an extended period of time, usually a season or more in length. Drought is a normal part of the climate of Michigan and of virtually every climate around the world – including areas with high and low average rainfall. In low rainfall areas, drought differs from normal arid conditions in that the extent of aridity exceeds even that which is unusual for the climate. The severity of a drought depends not only on its location, duration, and geographical extent, but also on the area's water supply needs for human activities and vegetation. This local variation of drought standards makes the hazard difficult to define a drought and assess when and where one is likely to occur.

Drought differs from other natural hazards in several ways. First, droughts lack an exact beginning and ending, as effects may accumulate slowly and linger long after the event is generally considered over. Second, the lack of a clear-cut definition of drought can make it difficult to confirm whether one actually exists, and/or its degree of severity. Third, drought impacts are often less obvious than other natural hazards, and are typically spread over a larger geographic area. Fourth, due primarily to the aforementioned reasons, most communities do not have a drought contingency plan in place. This lack of preparation can hinder support for drought mitigation capabilities that would otherwise effectively increase awareness and reduce drought impacts.

Some of the potential drought impacts on communities and regions include: 1) water shortages for human consumption, industrial, business and agricultural uses, power generation, recreation and navigation; 2) a decrease in quantity and quality of agricultural crops; 3) decline of water quality in lakes, streams and other natural bodies of water; 4) malnourishment of wildlife and livestock; 5) increase in wildfires and wildfire-related losses to timber, homes, and other property; 6) decline in tourism in areas dependent on water-related activities; 7) decline in land values due to physical damage from the drought conditions and/or decreased economic or functional use of the property; 8) reduced tax revenue due to income losses in agriculture, retail, tourism and other economic sectors; 9) increases in insect infestations, plant disease, and wind erosion; and 10) possible loss of human life due to food shortages, extreme heat, fire, and other health-related problems such as diminished sewage flows and increased pollutant concentrations in surface water.

Although it is difficult to determine when a drought is actually occurring, once a drought is recognized it can be classified within four categories: meteorological, hydrologic, agricultural, and socioeconomic. A *meteorological* drought is based on the degree of dryness, or the departure of actual precipitation from an expected average or normal amount based on monthly, seasonal, or annual periods. These droughts are generally short-lived. A *hydrologic* drought involves the effects of precipitation shortfalls on stream flows and reservoir, lake, and groundwater levels. Human activity, such as land use or dam construction, may exacerbate naturally occurring drought conditions. Onset and recovery of hydrologic droughts typically lag behind the other types of drought. An *agricultural* drought concerns soil moisture deficiencies relative to the water demands of plant life, usually crops. A *socioeconomic* drought is when the effective demand for water exceeds the supply, as a result of weather-related shortfalls.

The U.S. Drought Monitor uses four classifications of severity, from the least intense category (D1) to the most intense (D4), with an additional category (D0) used to designate a "drought watch" area in which long-term impacts such as low reservoir levels are probably present. The Drought Monitor summary map is available online, identifying general drought area and labeling their intensity. While not the only way to characterize droughts, the U.S. Drought Monitor is a standardized and convenient representation of drought conditions which is widely referenced in various reports and assessments. The Drought Monitor is available at the website http://droughtmonitor.unl.edu/.

Another useful index for monitoring drought conditions is the Palmer Drought Severity Index, which was developed in the 1960's. The U.S. Drought Monitor and the Palmer Index are compared in the following table along with other drought indices.

Drought Classification Categories

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

Source: Michigan Hazard Mitigation Plan, 2011

Historically Significant and Related Events: To aid the tracking and analysis of drought conditions in the state, the Michigan Hazard Mitigation Plan 2011 edition divided the state into ten climate divisions and analyzed historical data from the National Climatic Data Center (NCDC) dating back to 1895. Muskegon County is grouped with Lake, Mason, Newaygo, and Oceana counties in west-central Lower Michigan. The statewide plan lists the following 12 drought events recorded within this division lasting eight months or greater: 1895-1896 (15 months), 1899-1900 (11 months), 1901-1902 (10 months), 1909-1911 (24 months), 1925-1926 (11 months), 1930-1931 (18 months), 1956-1957 (8 months), 1962-1963 (9 months), 1971-1972 (12 months), 1976-1977 (13 months), and 2002-2003 (12 months). The most extreme of these droughts was in January 1931, when the Palmer Drought Severity Index hit a record low of -7.20.

In addition, the Michigan plan identified the percentages of years and months exhibiting a degree of drought in Muskegon County's climate division. The minimum qualification for drought in this analysis is a Palmer Index of -2.0, which is considered a moderate drought on the U.S. Drought Monitor (category D1).

Percentage of Drought Months and Years, 1895 to 2010

Lake, Mason, Muskegon, Newaygo, and Oceana Counties

	No Drought	Palmer ≤ -2.0	Palmer ≤ -3.0	Palmer ≤ -4.0	Palmer ≤ -5.0	Palmer ≤ -6.0	Palmer ≤ -7.0
Drought Years	43%	57%	29%	12%	2%	2%	1%
Drought Months	77.9%	22.1%	8.2%	2.5%	0.7%	0.4%	0.1%

Source: Michigan Hazard Mitigation Plan, 2011

In August 2012, the United States Department of Agriculture (USDA) issued a Secretarial Designation for all 83 counties in the State of Michigan as primary natural disaster areas for drought and excessive heat conditions which began in March 2012. The counties designated by USDA as natural disaster or contiguous disaster areas means that qualified farm operators are eligible for low interest emergency (EM) loans from USDA's Farm Service Agency (FSA), provided eligibility requirements are met.

Frequency of Occurrence: A review of historic drought events reveals that Muskegon County is certain to occasionally experience drought. Mild droughts are common, while severe droughts are less frequent and generally of shorter duration. A severe drought in Muskegon County may significantly lower the water table and pose multiple threats as described in the preceding Hazard Description. Low water levels could possibly hinder water-based recreation and tourism, negatively affect agriculture, increase risk of wildfire, and also affect the drinking water supply.

According to NCDC records, Muskegon County has experienced drought conditions of eight months or greater 12 times in the 116-year period from 1895 to 2010. Of those events, 11 occurred over three separate spans of 21 years or less: 1895-1911 (4 events, 16 years), 1925-1931 (2 events, 6 years), and 1956-1977 (5 events, 21 years). The outlying event occurred in 2002-2003. Overall, historical trends suggest there is an approximate 10 percent chance of experiencing lengthy drought conditions in any given year.

Drought conditions of shorter duration are more common than lengthy events, as 57 percent of the years from 1895 to 2010 attained a Palmer Index rating of at least -2.0. This statistic however, may overstate the prevalence and effects of drought in Muskegon County because it fails to address their duration and severity. A more precise indication of drought frequency is revealed in the percentage of months experiencing drought from 1895 to 2010, which is 22.1 percent.

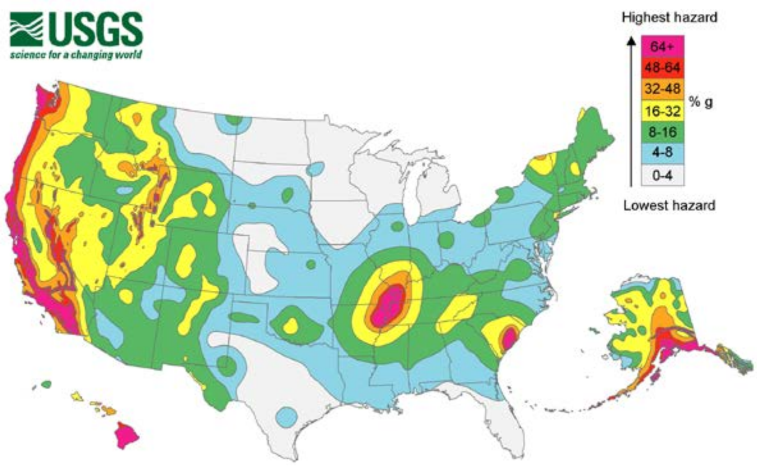
1.03 EARTHQUAKE

A shaking or trembling of the crust of the earth caused by the breaking and shifting of rock beneath the surface.

Summary: The earthquake hazard is low for Muskegon County. The United States Geological Survey predicts a 2% probability of an earthquake occurring in the next 50 years of a magnitude capable of a peak acceleration of 4% g (gravity). This might cause damage and possible collapse of buildings constructed before 1940.

Hazard Description: Earthquakes range in intensity from slight tremors to great shocks. They may last from a few seconds to several minutes, or come as a series of tremor over a period of several days. Earthquakes, whose energy is released through a series of seismic waves, usually occur without warning. In some instances, advanced warnings of unusual geologic events may be issued. However, it is not yet possible to forecast or predict where an earthquake will occur. Earthquakes tend to strike repeatedly along faults, which are formed where tectonic forces in the earth's crust cause the movement of rock bodies against each other. Risk maps have been produced, such as the map shown below, which show areas earthquakes are more likely to occur. Earthquake monitoring is conducted by the U.S. Geological Survey, the National Oceanic and Atmospheric Administration, and universities throughout the country.

USGS National Seismic Hazard Map



Source: http://earthquake.usgs.gov/hazards/products/

Actual movement of the ground in an earthquake is seldom the direct cause of injury or death. Most casualties result from falling objects and debris. Disruption of communications systems, electric power lines, and gas, sewer and water mains can be expected. Water supplies can become contaminated by seepage around water mains. Damage to roadways and other transportation systems may create food and other resource shortages if transportation is interrupted. In addition, earthquakes may trigger other emergency situations such as fires and hazardous material spills, thereby compounding the difficulties of an emergency situation.

Historically Significant and Related Events: Research for this document found no records of earthquake damage in Muskegon County. The nearest significant tremors have historically been no closer than the lower third of the state. However, tremors have been sensible in Muskegon, such as in 1925 and 1947. Records from the Lakeshore Museum in Muskegon show that "tremors (were) felt in Muskegon County from earthquake centered in California" in 1925. Then on August 9, 1947 a 4.6 magnitude earthquake shook southern Michigan. According to the USGS, it is the largest earthquake to occur in Michigan. More recently, a magnitude 5.8 earthquake in central Virginia on August 23, 2011 was felt well into the Midwestern states. At least weak shaking was widely reported across the southern half of Lower Michigan.

The New Madrid Seismic Zone is the most likely source of seismic activity to affect the area. It is located in the vicinity of the Mississippi River in Missouri, Tennessee, and Arkansas, poses a minimal threat to Muskegon County. Notable historic earthquakes emanating from this area occurred in 1811, 1812 and 1895, with intensities ranging from to 6.6 about 8.0 on the Richter Scale. These earthquakes sent vibrations across the eastern United States, including southern Lower Michigan.

Frequency of Occurrence: According to U.S. Geological Survey maps, Muskegon County lies north of the area of impact that would be expected to result from a maximum intensity earthquake anywhere along the New Madrid Seismic Zone. Earthquakes are not considered a significant hazard in Muskegon County.

1.04 EXTREME TEMPERATURES

Prolonged periods of very high or very low temperatures, often accompanied by other extreme meteorological conditions.

Summary: Muskegon County enjoys a relatively stable and comfortable climate year-round, thanks to the moderating influence of nearby Lake Michigan. Even so, significant temperature extremes are realized every year. From 1981 to 2010, the Weather Service Office at the Muskegon County Airport in Norton Shores annually averaged 2.4 days with a high temperature of 90 degrees or more and 3 days with a minimum temperature of 0 degrees or less.

High humidity in summer and high winds in winter exacerbate the effects of temperature extremes and increase the risk of harm on human health and property, while prolonged periods of extreme temperatures can pose life-threatening problems for residents. Public education about extreme temperature hazards, early notification of impending extremes, and the availability of cooling and warming shelters are all beneficial actions in mitigating the impacts of these hazards upon people. Although quite different from each other in terms of conditions and impacts, the two hazards share a commonality in that they both pose particular problems for the most vulnerable segments of society: the elderly, children, impoverished persons, and persons in poor health. Extreme temperatures can also negatively impact livestock, crops, wildlife, and infrastructure.

Hazard Description: Temperature extremes are broken down into two categories: extreme heat and extreme cold. Both extremes can last for weeks, affect large expanses, and occur without any advance warning and in the middle of a seemingly normal weather pattern. Additionally, both extreme heat and extreme cold can cause loss of life to vulnerable populations, sporadic damage to infrastructure, and disruptions to schools and businesses. About 900 annual deaths nationwide have been attributed to extreme temperatures (mostly from extreme cold, which claims about 700 deaths). Each type of extreme temperature is addressed separately in the following discussion.

<u>Extreme heat</u> occurs primarily in the summer months of June, July, and August and is marked by temperatures over 90 degrees Fahrenheit. When these conditions persist over a prolonged period of time, it is known as a heat wave. Heat can be lethal by taxing the human body beyond its abilities to maintain homeostasis. Conditions characterized by a combination of very high temperature and high humidity can result in several dangerous and potentially life-threatening health conditions including heat cramps, heat exhaustion, and heatstroke.

- *Heat cramps* are muscular pains that are caused by an imbalance of fluids in the body because of dehydration from heavy sweating. These cramps usually involve the legs or abdominal muscles.
- *Heat exhaustion* is often the result of exercise or heavy work in a hot place. Physical exertion causes a person to lose fluids through heavy sweating. Blood flow to the skin increases, causing blood flow to vital organs to decrease, leading to a mild form of shock. Symptoms include

dizziness, weakness, and fatigue. Heat exhaustion can usually be treated by drinking fluids and staying in a cool place until the body temperature and fluids return to normal.

- *Heatstroke* is a life threatening condition that results when a person's temperature control system, which produces sweating to cool the body, stops working. When this happens, the body's temperature can rise so high that brain damage and death may be possible.

In general, fatigue sets in (80 to 90 degrees), followed by heat exhaustion (90 to 105 degrees), then sunstroke or heatstroke (106 to 130 degrees). Urban areas are especially prone to high heat, with impervious surfaces reflecting sunlight, air pollutants trapping heat, and lessened air circulation in densely developed areas. Individuals in urban and rural areas who are young, elderly, impoverished, in poor health, or isolated are at additional risk to extreme heat due to poor access to air conditioning or having physical limitations.

The "Heat Index" table indicates an estimation of how warm temperatures might actually feel to the human body when combined with a given humidity. It should be noted that conditions for each individual will vary with the duration and type of weather, activity, exposure, personal health, extent of acclamation, and the type of clothing worn. Also, actual indoor conditions may vary, trapping heat and/or humidity in some locations and making them potentially more dangerous.

Heat Index

Relative Humidity	Actual Temperature (degrees Fahrenheit) 90	92	94	96	98	100	102	104	106	108
40%	91	94	97	101	105	109	114	119	129	130
45%	92	96	100	104	109	114	119	124	130	137
50%	95	99	103	108	113	118	124	131	137	144
55%	97	101	106	112	117	124	130	137	145	
60%	100	105	110	116	123	129	137	145		
65%	103	108	114	121	128	136	144			
70%	106	112	119	126	134	143				
75%	109	116	124	132	141					
80%	113	121	129	138						
85%	117	126	135	145						
90%	122	131	141							
95%	127	137								

Source: Michigan Hazard Mitigation Plan, 2011

Prolonged extreme heat can also have an economic impact on society, through (1) lost work, (2) increased electricity usage, leading to brown-outs or black-outs, (3) drought, (4) increased stress on farm crops, streams and lakes, (5) increased stress on farm animals, pets, and wildlife, and (6) increased stress on infrastructure and on commercial and residential buildings. The table below reveals heat statistics recorded at the Muskegon County Airport between 1981 and 2010.

Extreme Heat in Muskegon 1981-2010

	May	June	July	Aug.	Sept.	Annual
Avg. number of days with 90° F or greater	0	0.6	1	0.6	0.1	2.4
Annual chance at least 1 day of 90° F or greater	0%	37%	47%	23%	0.7%	63%

Source: Michigan State Climatologist's Office

Extreme cold is primarily associated with the wintery months of November through April and categorized by temperatures plunging near or below 0 degrees Fahrenheit. Periods of extreme cold are risky for those in both urban and rural areas. Frostbite and hypothermia are common in rural areas where people are trapped outdoors and do not adjust properly to the temperatures. Even indoors, hypothermia is a concern for individuals living in inadequately heated dwellings. Loss of life can occur with either of these situations. Damage to buildings and infrastructure can also occur in bitter cold conditions, resulting in expensive repairs and days of business and school shutdowns. Strong winds accompanying the cold temperatures work to intensify their effects. Like extreme heat, exposure to extreme cold can create significant health problems. Most cold-related deaths are not the direct result of freezing, but rather the result of pre-existing illness and diseases that are exacerbated by the extreme temperatures. These illnesses may include stroke, heart disease, and/or pneumonia. Health conditions directly resulting from exposure to extreme cold include:

- *Frostbite* is the freezing or partial freezing of some part of the body, usually occurring in the extremities such as toes, fingers, ears, or nose. Frostbite rarely results in death, but does damage the tissue that has been frozen, and in extreme cases may require amputation. A loss of feeling and a white or pale appearance in body parts are symptoms of frostbite.
- *Hypothermia* is a condition brought on when the body's temperature drops significantly due to exposure to cold. Hypothermia becomes serious when the body's internal temperature goes below 95 degrees Fahrenheit. When the body falls below 90 degrees, normal shivering reactions stop and emergency treatment is necessary. Symptoms of hypothermia include uncontrollable shivering (when body temperature is above 90 degrees), slowed speech, memory lapses, frequent stumbling, drowsiness, and exhaustion. If left untreated or treated improperly, hypothermia can lead to death. Unlike frostbite, hypothermia can occur in a person who is exposed to only moderately cold temperatures (even when indoors)—typically over a prolonged period of time. Infants, the elderly, and persons with conditions that do not allow their bodies to heat normally are most susceptible to this form of hypothermia.

Wind chill temperatures reflect the effects of winds and cold, based on the rate of heat loss from exposed skin. Wind chill does not affect inanimate objects such as car radiators or exposed water pipes because they do not cool below the actual air temperature. As extreme cold and winds cool the skin, frostbite can occur as the body tissue begins to freeze. Hypothermia occurs when a person cools to an abnormally low body temperature (below 95 degrees). Similar to extreme heat, individuals who are young, elderly, impoverished, in poor health, or isolated in a rural location are at additional risk to extreme cold due to poor access to heating or having physical limitations.

The "Wind Chill" table indicates an estimation of how cold temperatures might actually feel to the human body when combined with a given wind speed. Actual conditions for each individual will vary with the duration and type of weather, activity, exposure, personal health, extent of acclamation, and the type of clothing worn.

Wind Chill

Wind Speed (mph)	Actual Temperature (degrees Fahrenheit)									
	40	30	20	10	0	-10	-20	-30	-40	-50
5	36	25	13	1	-11	-22	-34	-46	-57	-69
10	34	21	9	-4	-16	-28	-41	-53	-66	-78
15	32	19	6	-7	-19	-32	-45	-58	-71	-83
20	30	17	4	-9	-22	-35	-48	-61	-74	-88
25	29	16	3	-11	-24	-37	-51	-64	-78	-91
30	28	15	1	-12	-26	-39	-53	-67	-80	-94
35	28	14	0	-14	-27	-41	-55	-69	-82	-96
40	27	13	-1	-15	-29	-43	-57	-71	-84	-98
45	26	12	-2	-16	-30	-44	-58	-72	-86	-100
50	26	12	-3	-17	-31	-45	-60	-74	-88	-102
55	25	11	-3	-18	-32	-46	-61	-75	-89	-104
60	25	10	-4	-19	-33	-48	-62	-76	-91	-105

Source: Michigan Hazard Mitigation Plan, 2011

The economic impacts of extreme cold include (1) lost work, (2) increased use of utilities, (3) increased stress to farm animals, pets and wildlife, (4) damage to infrastructure, particularly roadways and water systems, and (5) disrupted transportation. Unusually cold temperatures during the growing season, even if not normally defined as "extreme" under other circumstances, can harm or destroy agricultural crops, drastically reducing crop yields and thus causing economic hardship for farmers and farming communities. Severe, extended below-freezing temperature situations are defined as when the air temperature or wind factor temperature stays below 20 degrees Fahrenheit for 12 hours or more. These conditions pose the greatest risk when partnered with another hazard such as severe winter weather, transportation accidents, and infrastructure failure. The table below reveals cold statistics recorded at the Muskegon County Airport between 1981 and 2010.

Extreme Cold in Muskegon
1981-2010

	Dec.	Jan.	Feb.	Mar.	Annual
Avg. number of days with 0° F or less	0.3	1.5	0.9	0.3	3
Annual chance at least 1 day of 0° F or less	20%	60%	40%	20%	73%

Source: Michigan State Climatologist's Office

Historically Significant and Related Events: While Muskegon County is certainly susceptible to prolonged periods of hot, humid weather in the summer and extreme cold during the winter, their impacts are somewhat mitigated due to the county's proximity to Lake Michigan. This geographic relation leads to moderated temperature extremes throughout the year. According to the National Weather Service (NWS), the all-time record high temperature is 99 degrees (1913, 1964, 2012), while the all-time low temperature is -30 degrees (1899). From 1981 through 2010, there was an annual average of 2 days with temperatures 90 degrees or above, and 3 days with temperatures 0 degrees or below in Muskegon.

The National Climatic Data Center (NCDC) has documentation of two cold events for Muskegon County since January 1994. The record cold of January 13-20, 1994 warranted a Presidential Declaration of Major Disaster (Underground Freeze) for counties primarily in the Upper Peninsula. Although Muskegon was not included in the declaration, it was mentioned in the NCDC list of 32 counties suffering a combined $50 million in property damages and frozen water and sewer lines from the event. The second event, which took place on December 9th and 10th in 1995, affected the entire state and caused 3 fatalities in the city of Detroit.

The Michigan Hazard Mitigation Plan also lists a number of significant heat waves affecting Michigan. For example, extreme heat during the summer of 1936 caused 570 deaths statewide, including seven in Muskegon. In the summer of 1988, the central and eastern regions of the U.S. experienced drought and heat wave conditions that caused an estimated 5,000 to 10,000 deaths (depending on one's definition of "heat-related" death). In that year, a Michigan state record was set for consecutive days of 90 degrees or more, 39 days. The previous record of 36 days was set during the "Dust Bowl" era in 1934. Undoubtedly these events had some degree of impact on Muskegon County; however specific accounts were not identified.

While not extreme in terms of annual temperatures, anomalous temperatures were realized across the Great Lakes region, including Muskegon County, for a significant duration in March 2012. The following is summary of the event taken from the "March 2012 Climate Summary for Southwest Lower Michigan" by the National Weather Service in Grand Rapids, MI. Muskegon County resides within the forecast area of this NWS Forecast Office.

> "*March 2012 was a historically warm March, setting records at the primary climate sites. Average temperatures ranged from 45 degrees to over 50 degrees, which is 13 to 16 degrees*

above normal across Southwest Lower Michigan and most of the Great Lakes region. Grand Rapids, Lansing and Muskegon all set or equaled the all-time March high temperature records on the 20th. This happened again on the 21st. The new record highs for March are 87 degrees in Grand Rapids, 86 degrees in Lansing and 82 degrees in Muskegon. Temperatures were most extreme from the 11th through the 25th. There were only about ten days during the month with values near or just below normal."

"The daily temperatures were well above normal nearly continuously from the 6th through the 28th. From the 14th through the 23rd temperatures were more than 20 degrees above normal every day. That is the all-time record for any month for days in a row with temperatures 20 degrees or more above normal. There have only been 2 years on record with more than 10 days at 20 degrees above normal, 1894 and 1990, both of those years had 11 days for the entire year."

The March warmth was a major contributing factor to the spring of 2012 becoming the most extreme season of any kind in U.S. history to date. This historically significant event triggered an early growing season across much of the U.S. In Michigan, this put sensitive crops and agriculture at a significant risk of exposure to freezing temperatures following the warm spell. At the time this description was written, the crop loss was estimated to be $209.8 million in Michigan, while the total estimated economic impact of the crop loss was $502.9 million.

Frequency of Occurrence: Extreme or anomalous temperatures are inevitable in Muskegon County and are possible any given day of the year. Long stretches of these conditions are certainly less likely than short duration events. While extreme temperatures should be expected to occur every winter and summer, recent records indicate that Muskegon County is likely to experience more days of severe cold than severe heat.

In the 30-year period from 1981 to 2010, the temperature at the Muskegon County Airport reached a high temperature of 90 degrees or more at least once per year 63% of the time, with an overall average of 2.4 days per year. A minimum temperature of 0 degrees or less was observed at least once per year 73% of the time, with an overall average of 3 days per year.

1.05 FLOODING: RIVERINE/URBAN

The overflowing of rivers, streams, drains and lakes due to excessive rainfall, rapid snowmelt or ice.

Summary: Annual flood losses amount to several billion dollars per year nationwide, along with over 140 fatalities on average. In Michigan, as well as across the nation, the leading cause for disaster declarations by the Governor or the President is flooding.

Muskegon County has a number of rivers and streams whose flows occasionally exceed their banks, and there are many developed areas that are at risk of flooding. Twelve communities in the county participate in the National Flood Insurance Program (NFIP), and four repetitive loss properties have been identified. In addition, Muskegon County has watercourses that are prized for their natural scenery, historic value, and outstanding recreational attributes such as paddling and fishing. Major flooding and flash flooding may damage theses systems, endanger individuals, and negatively impact local businesses.

Hazard Description: Flooding of lands adjacent to the normal course of a stream, river, drain, lake, or reservoir has been a natural occurrence throughout recorded history. If these floodplain areas were left in their natural state, floods would not cause significant damage. In addition, developments near waterways increase the potential for serious flooding by increasing runoff rates and decreasing opportunities for natural infiltration. Impervious surfaces such as streets, parking lots and rooftops, and man-made channels and pipes, increase rainfall runoff that would otherwise soak into the ground, or take several days to reach a river or stream via a natural drainage basin (also known as a watershed). Developments within a floodplain are not only at a risk for significant damage, but they may also impede the carrying capacity of the drainage area, increasing flood levels and putting additional development at risk.

Floods can damage or destroy public and private property, disable utilities, make roads and bridges impassable, destroy crops and agricultural lands, cause disruption to emergency services, and result in fatalities. People may be stranded in their homes for several days without power or heat, or they may be unable to reach their homes at all. Long-term collateral dangers include the outbreak of disease, widespread animal death, broken sewer lines causing water supply pollution, downed power lines, broken gas lines, fire, release of hazardous materials, dam failure, and environmental damage to natural ecosystems.

Most riverine flooding occurs in the early spring as the result of excessive rainfall and/ or the combination of rainfall and snowmelt. Ice jams (in winter and early spring), log jams, and any other type of debris jam can also lead to flooding. These blockages can cause flash flooding if the jam suddenly gives way. Severe thunderstorms are another common cause flooding, and are most likely during the spring, summer, or fall. These instances are normally localized events and have more impact on watercourses with smaller drainage areas.

It is widely known that controlling floodplain development is the key to reducing flood-related damages. Although there are state and local programs to regulate new development and substantial improvements in flood-prone areas, the opportunity to mitigate flood hazards ultimately rests with local governments since they control the regulation or direction of land development. Proper land use management and strict enforcement of building codes can make communities safer from flood hazards and help reduce the high cost of flood losses.

The Federal Emergency Management Agency's National Flood Insurance Program (NFIP) is designed to identify and map floodplains, to provide flood insurance to flood-prone locations, and also to encourage flood protection activities. Through the NFIP Community Rating System (CRS), communities involved in the program are awarded points based on the various flood protection activities they are engaged in. These points are then applied to a rating system used to grant insurance premium reductions based on the number of points attained by each community. There are no communities in Muskegon County currently participating in the CRS.

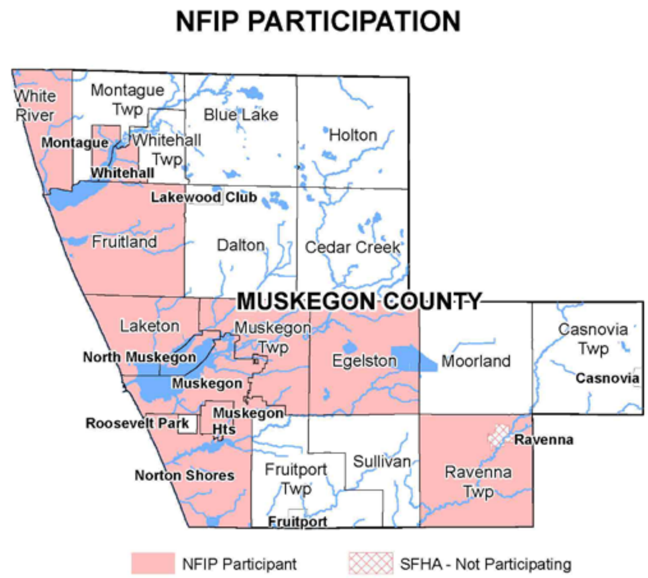
One goal of the NFIP is to reduce the number of "repetitive loss properties." This is any property receiving two or more flood insurance claim payments for at least $1,000 within any 10-year period since 1978. Repetitive loss properties are a high priority because they account for approximately 33% of the total NFIP claim payments. As of October 2013, there had been four repetitive losses in the County; two in Norton Shores and two in Laketon Township.

NFIP Insurance Policies
- As of November 30, 2014 -

Community	Total Premium	Number of Policies	Policy Coverage	Since 1978	
				# of Claims	*Claims Paid*
Egelston Twp	$6,426	6	$631,000	2	$18,496
Fruitland Twp	$12,095	15	$2,571,800	3	$12,880
Laketon Twp	$5,452	5	$823,000	7	$33,629
Montague City	$3,452	4	$876,000	7	$78,853
Muskegon Hts City	$3,492	3	$1,008,000	2	$0
Muskegon City	$32,864	22	$4,628,700	27	$39,733
Muskegon Twp	$2,782	5	$746,400	3	$40,449
North Muskegon City	$13,910	55	$13,332,500	3	$0
Norton Shores City	$24,889	45	$6,006,300	24	$94,165
Ravenna Twp	$746	2	$420,000	1	$14,091
White River Twp	$2,660	5	$1,146,000	9	$16,801
Whitehall City	$1,382	3	$610,200	2	$387
Muskegon Co. Total	**$110,150**	**170**	**$32,799,900**	**90**	**$349,484**

Source: *Federal Emergency Management Agency*
http://www.fema.gov/policy-claim-statistics-flood-insurance/policy-claim-statistics-flood-insurance/policy-claim-13

There are currently twelve communities in Muskegon County participating in the NFIP: cities of Montague, Muskegon, Muskegon Heights, North Muskegon, Norton Shores and Whitehall; and townships of Egelston, Fruitland, Laketon, Muskegon, Ravenna, and White River. Flood Insurance Rate Maps (FIRM) have been produced for all of these communities. In addition, the Village of Ravenna participated in the program in the past, but does not at this time. The map to the right shows all NFIP-participant communities.



NFIP participation as of January 30, 2015

Flooding may not always be attributable to the overflowing of a natural water feature. Rather it may result from a combination of excessive rainfall and/or snowmelt, saturated or frozen ground, and inadequate drainage. Flooding may also occur from a combined sewer system if it becomes overloaded by an excessive amount of water in a short time span, such as during a heavy thunderstorm. These additional sources of flooding typically result in flooded basements and ponding of water over roads or other low-lying areas because surface water of any kind will always gravitate to the lowest elevation. Flooding in such locations may lead to significant property damage, infrastructure failure, crop loss, and/or public health and safety concerns, even if it occurs outside a floodplain. In rural areas of Muskegon County, sources of flooding other than rivers and streams are mitigated somewhat by natural vegetation. Even so, roads, bridges, and culverts in Muskegon County are susceptible to erosion and failure from flash flooding produced by torrential rainfall.

Flooding is a hazard whose risks are routinely underestimated by the public, who may be inclined to attempt to walk or drive through shallow waters, or to allow their children and pets to play in the water as if it were part of a beach or swimming pool. Public education is vital so that there is widespread knowledge of the contaminants and germs that floodwaters may contain, and a greater awareness of the risks that floodwaters pose to drivers and pedestrians. Drivers need to know that roads and bridges are often weakened and degraded by flood impacts, and that the road they assume is still there under shallow waters may no longer be intact. Less than a foot of flowing water can cause travelers to end up in a ditch or sinkhole where it may be impossible to escape a submerged vehicle under the pressure exerted by flowing water. Pedestrians should be informed that floodwaters tend to conceal open manholes and dangerous debris, such as rusty nails and metal, or live electrical wires.

Flooding is generally part of a natural cycle that has many important and beneficial functions for the environment. Flooding raises the water table in wetlands, maintains biodiversity, and replenishes soil nutrients. Additionally, high water tables allow fish and vegetation to recolonize and may also help to control some invasive species. Flooding, however, becomes a problem in the built environment. Impervious surfaces cause increased runoff, which may carry pollutants into natural water resources. Increased runoff also promotes erosion, which can lead to road washouts and increased sediment in surface water features. Finally, drainage systems and city sewers can become overwhelmed, causing raw sewage to enter basements, spread onto roadways, and infiltrate groundwater supplies. Residential septic systems can also be flooded, which may cause a release of household waste and chemicals into the environment.

The potential effects of flooding on recreational and ecological values of water features must also be considered. In Muskegon County, the White River is a Michigan Natural River and is currently under consideration for the National Wild and Scenic River System. The Muskegon River is currently under consideration for inclusion into the Michigan Natural River system. Increased erosion and sedimentation near water bodies in the county may harm the ecology of water features, destroying habitat for fish and wildlife. A sudden inundation of rainfall runoff, perhaps enhanced by impervious surfaces, may also pose serious dangers to persons recreating in and near waterways.

Historically Significant and Related Events: Since 1975, Muskegon County has had four Declarations of Major Disaster by the President due to flooding: September 1975, September 1986, June 2004, and April-June 2013. In addition, a significant flood in February 1986 garnered the county a Declaration of Disaster by the Governor, but not the President. The two most recent of these events are noted in the NCDC Storm Events database. The 2004 event led the Muskegon River at Newaygo (upstream of Muskegon County) to its 6th highest crest in history at 12.49 feet (flood stage is 11 feet). In addition, Muskegon experienced urban flooding. The City of Roosevelt Park reported 2-3 dozen homes with flooded basements, due to an elevated water table from the wettest May in history, and a need to improve the storm water drain to Ruddiman Creek. This flood caused $1 million of property damage and $2 thousand of crop damage in Muskegon County, and was perhaps the worst flood since 1986. The 2013 event flooded hundreds of homes in Michigan, closed over 300 roads, and caused about $5 million in property damage in Muskegon County.

In all, the NCDC lists eleven flooding episodes between 1993 and 2013, six of which caused damage. One of these occurred on May 15-16, 2001, when numerous rounds of thunderstorms dropped heavy rain on Lower Michigan, causing over $500 thousand in property damage and over $200 million in crop damage across Muskegon County.

Frequency of Occurrence: At the very least, minor flooding is likely to naturally occur every year in Muskegon County. There are floodplains identified in all twelve municipalities in Muskegon County currently participating in the National Flood Insurance Program. By definition, these areas have at least a 1% chance per year of flooding. Refer to the Hazard/Risk Profile maps in Appendix B for approximate delineations of floodplain areas in the county. In addition, the severity and frequency of flooding are likely to increase when Lake Michigan is at or near record levels, as it was in 1986. The levels of the Great Lakes are cyclic, but impossible to predict at this point.

Recent history shows that Muskegon County experienced a major flooding at a rate of about once every seven years. Five such events (September 1975, February 1986, September 1986, May 2004, and April-May 2013) occurred in 39 years from 1975 through 2013. It is likely that less-significant floods will occur at the rate of about once every two years. There are eleven flood or flash flood events documented by NCDC in 21 years from 1993 through 2013.

1.06 FOG

Condensed water vapor in cloud-like masses close to the ground and limiting visibility.

Summary: Historically, fog has not been considered as a significant hazard in Muskegon County. However, this hazard is addressed by the Michigan Hazard Mitigation Plan, and is therefore discussed in this plan.

The NCDC does include fog and freezing fog events in its Storm Events Database; however documentation for these events is not as extensive and standardized as it is for other natural hazards, such as thunderstorms and winter weather.

Hazard Description: Fog forms near the ground when water vapor condenses into tiny liquid water droplets that remain suspended in the air. Many different processes can lead to the formation of fog, but the main factor is saturated air. Two ways that air can become saturated are by cooling it to its dew point temperature or by evaporating moisture into it to increase its water vapor content. Fog is often hazardous when visibility is reduced to 1/4 mile or less. The interaction between humans and fog can be a dangerous situation, sometimes resulting in disastrous consequences. The National Weather Service issues dense fog advisories when fog reduces visibility to 1/8 mile or less over a widespread area. For marine environments, dense fog advisories are issued for widespread or localized fog reducing visibilities to regionally or locally defined limitations not to exceed 1 nautical mile. Freezing fog (a hazard for which the National Weather Service issues special statements) can cause harm by causing slickness on roadways and thus leading to serious transportation accidents.

In considering severe and high-impact meteorological events, attention can easily become focused on the more dramatic storms. Tornadoes and hurricanes for example, are readily recognized by the general public and the meteorological community alike for their devastating consequences. Fog, on the other hand, does not lend itself as readily to this categorization. Yet, in terms of cost and casualties, fog has consistently impacted society. In particular, the transportation sector is vulnerable to fog, with sometimes deadly consequences. Fog has played a contributing role in several multi-vehicle accidents over the past several years. While statistics suggest that highway accidents and fatalities have generally decreased in recent history, that trend is not evident with respect to accidents and fatalities caused by fog.

Fog may be widespread or localized, and can be very dangerous because it reduces visibility. Although some forms of transport can penetrate fog using radar, road vehicles have to travel slowly and use more lights. Localized fog is especially dangerous, as drivers can be caught by surprise. Fog is particularly hazardous at airports, where some attempts have been made to develop methods to aid fog dispersal, such as using heating or spraying salt particles. These methods have seen some success at temperatures below freezing.

The primary risks from fog involve the dangers of traveling under conditions of limited visibility. Although some modes of transportation such as aircraft are well-regulated, other modes, including simple pedestrian travel, may involve risks that have not been properly accounted for by those who are focused merely on reaching their destination as quickly as possible. The most substantial impacts have recently involved drivers whose bad habits (primarily that of not maintaining safe speeds and following distances) proved to be simply unsustainable under conditions of reduced visibility, resulting in severe crashes and subsequent roadway obstruction. In some circumstances, these conditions of reduced visibility can arise very quickly, although careless drivers, in their desire for fast travel conditions, may erroneously try to ignore the risks from reduced visibilities, in the hope that the condition will suddenly correct itself before any harm is caused. Fog may also increase the threat of hazardous materials (HAZMAT) transportation accidents. That hazard is addressed as a separate hazard in this document.

In addition to creating potentially hazardous automotive and air transportation conditions, fog may cause increased risks to outdoor recreation activities, such as boating, off-roading, and snowmobiling. These outdoor activities are common in Muskegon County.

Historically Significant and Related Events: There is one fog event listed in the NCDC for Muskegon County, which took place in January 1995. Dense fog blanketed much of Lower Michigan during the period from the evening on the 11th through the morning on the 13th. The fog caused numerous traffic accidents, which resulted in four fatalities. School openings were delayed in parts of southwest Michigan as visibilities dropped to near zero. Low visibilities caused most of the flights at Detroit's metro airport to be cancelled, delayed or diverted on the 12th. Approximately 75 flights were also delayed or cancelled at Kent County International Airport in Grand Rapids.

Another, more recent fog event in the nearby county of Manistee demonstrates the potential threat of fog to outdoor recreational activities. On May 22, 2010, dense fog inhibited visibility in the area, and a fishing boat struck a pier at the entrance to Manistee Harbor. It subsequently took on water and submerged, requiring the rescue of seven persons from the water. The accident led to one indirect fatality, two injuries requiring treatment at a Manistee hospital, and four minor injuries that were treated on-site.

Frequency of Occurrence: According to the Michigan Hazard Mitigation Plan, one major fog event is estimated to occur in Michigan approximately every two years. Property damage can be significant for vehicles, although real property and structures are usually unaffected.

Although Muskegon County was included in one dense fog event reported to the NCDC, there is insufficient fog data from which to derive a frequency of occurrence. Fog is possible at any time of the year; and especially during the winter and spring seasons when relatively warm and moist air is most likely to encounter a melting snowpack from recent snowfall.

1.07 GREAT LAKES SHORELINE HAZARDS

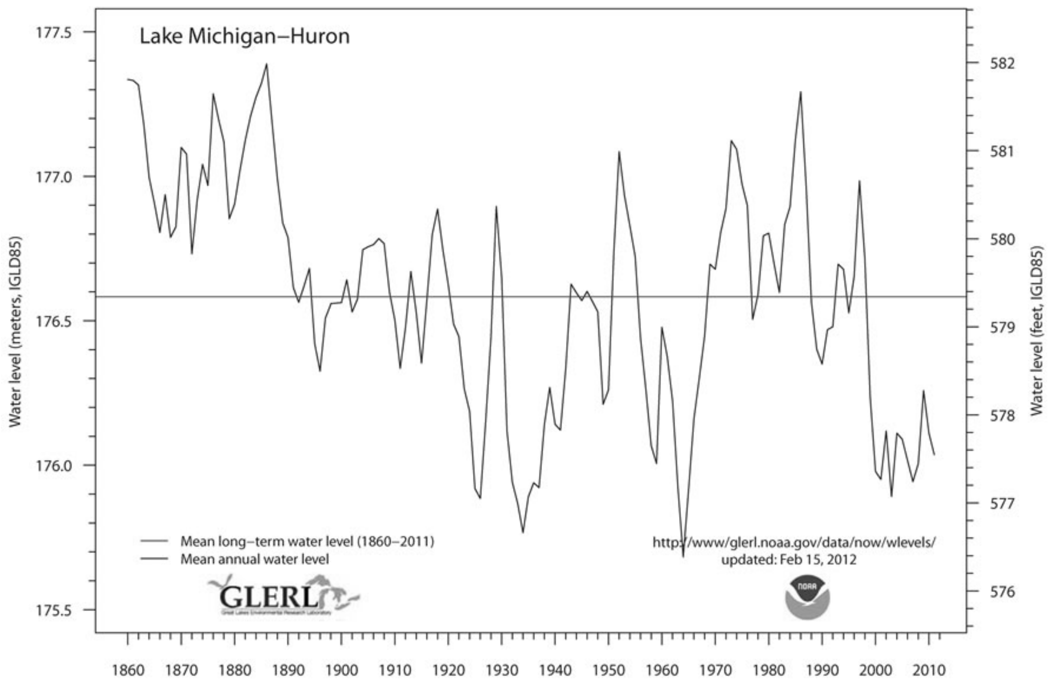
High or low water levels that cause flooding or erosion, and other threatening shoreline conditions, including storm surges, rip currents, and shoreline recession.

Summary: Shoreline flooding and erosion are natural processes that occur constantly, regardless of water levels. However, during periods of high water, the effects of flooding and erosion are more evident, causing serious damage to homes and businesses, roads, water and wastewater treatment facilities, and other structures in coastal communities. Low water levels can also present hazards, such as shallow shipping and recreation channels or increased exposure of polluted lake-bottom debris. Other shoreline hazards include severe winds, seiches, and rip currents. These conditions can be life-threatening for boaters and swimmers, and are often exacerbated by the presence of structures such as breakwalls, piers, and river mouths.

With about 31 miles of Lake Michigan coastline, Muskegon County is at risk from Great Lakes shoreline hazards. Approximately 7,000 citizens reside within census blocks that are within a half-mile of the Lake Michigan shoreline. There are approximately 4,100 housing units within the same area. Communities that border Lake Michigan include the cities of Muskegon and Norton Shores, and the townships of Fruitland, Laketon, and White River. Each community has a number of popular public access points for recreation on Lake Michigan. In addition, Muskegon County has one deep water commercial harbor at Muskegon Lake, and recreational harbors at Mona Lake and White Lake. There are breakwalls that shield the Muskegon Lake Channel, while the White Lake Channel has north and south piers that extend into Lake Michigan.

Hazard Description: The Great Lakes occupy an area of 95,000 square miles and drain an amount of land twice that size. They hold nearly one-fifth of the world's fresh surface water. Because the Great Lakes' watershed is so vast, seasonal changes in precipitation within the basin have a direct effect on water levels. However, this relationship is not immediately evident because of the delay between the time precipitation falls within the drainage basin and the time that runoff waters enter the lakes.

Long-term and seasonal variations in precipitation and evaporation rates primarily determine the fluctuation of water levels on the Great Lakes. Over one hundred years of record keeping have not indicated a simple, easily-predictable cycle of water levels on the Great Lakes. Geologic research has indicated quasi-periodic cycles of 33 years and 160 years for lake level fluctuations; e.g. Baedke and Thompson's article in the Journal of Great Lakes Research, v.26 p. 416-426, 2000. The time between periods of high and low water levels can vary widely.



In addition to natural causes of water level fluctuation, there are four man-made factors that can also affect water levels to some degree: (1) diversion of water for power generation, municipal water supply and navigation; (2) regulation of water levels via dams and other control structures; (3) dredging of connecting waterways for navigation purposes; and (4) covering land surfaces with impervious materials that cause storm runoff to be delivered to water bodies more quickly than the pre-development runoff rates. Although these man-made factors do impact water levels, natural factors such as precipitation, evaporation, and wind have a far greater overall impact. The vast majority of shoreline flooding and erosion that occurs along the Great Lakes is caused by natural factors. However, it should be remembered that it is humans who place themselves in harm's way by building structures in dynamic coastal areas. If that did not occur, the natural processes of flooding and erosion would not be viewed as problems.

Under Part 323, Shorelands Protection and Management, the Michigan Department of Environmental Quality (MDEQ) has determined communities with high-risk erosion areas. A high-risk erosion area is defined by the MDEQ as an area where erosion studies have indicated that the erosion hazard line is receding at an average of one foot or more per year over a minimum 15-year period. The erosion can be caused from one or several factors, including high water levels, storms, wind, ground water seepage, surface water runoff, and frost. The high risk erosion area regulations require a setback distance to protect new structures from erosion for a period of 30 to 60 years, depending on the size, number of living units, and type of constructions. All five shoreline communities of Muskegon County contain one or more sections of high-risk erosion areas. These areas can be viewed on the Hazard/Risk maps found within Appendix B. In addition, the MDEQ also designated flood risk areas along Michigan's shoreline, meaning that they have floodplain-like areas with a 1% annual chance of a designated flood level being exceeded. Most of Muskegon County's coastline has received this designation. In general, low-lying lands along the coastline are prone to shoreline flooding during both high and low lake water periods. For more information about flooding, see section "1.05 Flooding: Riverine/Urban."

The intent of these and other applicable building restrictions is to minimize the extent and magnitude of shoreline flooding and serious erosion problems along the Great Lakes shoreline. Although shoreline flooding and erosion is inevitable, severe damage can be avoided if prudent shoreland management practices are followed and adequate emergency procedures are implemented. Coordination of federal, state and local shoreland management and emergency preparedness efforts is vital to keeping shoreline areas as safe and undamaged as possible. The recession of the Great Lakes water levels is also inevitable, but there is not much, other than dredging, that can be done to combat the negative effects. That is why it is important for all those involved in water transportation to be prepared for all types of water fluctuations.

Much of Muskegon County's character is defined by Lake Michigan, as well as inland water features. The beaches provide numerous recreational opportunities and are considered prime real estate. Unfortunately, the inherent hazards of coastal areas are not always apparent. Development activities along the shoreline significantly alter the natural ebb and flow of coastal dynamics. Development of coastal areas threatens to exacerbate the shoreline flooding and erosion problem. As more people and structures are put in harm's way, the problem of shoreline flooding and erosion will continue to grow in frequency and significance.

The MDEQ administers programs aimed at balancing the impact of shoreline flooding and erosion with the development pressures facing the Great Lakes shoreline by implementing non-structural approaches, such as construction setbacks and lowest floor elevation requirements. These types of approaches do not interfere with the natural processes of erosion and flooding, but instead take what is known about the coastal hazard and develop construction standards to prevent the premature collision between homes and nature.

The MDEQ has the responsibility of administering the permitting programs that implement the coastal construction standards. However, under Part 323, local governments have the authority to take over the permitting programs for high-risk erosion and flood risk areas. In the area of floodplain management, permitting responsibility is handled at the local level due to the overlap of regulations found in Part 323, the NFIP, and the building codes. However, few communities have shown an interest in adding the regulatory responsibility of the erosion program to their already busy building and zoning departments. As with many regulatory programs that address private property development rights, the potential for conflict in these areas is high. This is especially true in the realm of expensive shoreline real estate where a view of the water can outweigh the threat of future flood or erosion damage. Political pressure can also come into play in some situations. Compliance with these regulations has best been achieved through cooperation between the State and local governments. Public understanding and support of these programs can be increased by improved communication with property owners regarding natural shoreline hazards.

While high water levels generally increase the risk of flooding and erosion, low water levels can cause significant economic impacts as well. Among those most affected by the low water levels are the shipping companies that operate massive, 1,000-foot-long iron ore and coal carriers on the Great Lakes. Low water levels can force these cargo ships to lighten their loads by as much as 6,000 tons to reduce their drafts and avoid running aground in channels and ports. Also, ferry services that transport people to and from islands may be forced to shut down because of low water depths. Significant drops in water levels can also result in an increase in demand for dredging projects, which can be very expensive. In addition to the high cost of the dredging itself, homeowners and marina operators are faced with the cost of safely disposing of sediments that have been contaminated with heavy metals, pesticides, diesel fuel and other toxic substances. Under strict environmental laws, such dredged material must be deposited in confined disposal facilities.

Aside from precipitation rates and human influences, weather-related events can also cause water level fluctuations lasting from several hours to several days. For example, windstorms combined with differences in barometric pressure can temporarily tilt the surface of a lake up at one end as much as eight feet. This phenomenon, known as storm surge, can drive lake waters inland over large areas. After the storm surge, an oscillation phenomenon called a seiche (pronounced sigh-shh or saysh) is likely to take place. As the water level retreats on one shore, it then shifts back to the opposite side of the lake, but with less intensity. This oscillation is repeated until the body of water becomes calm again and water levels return to normal. Seiches can produce dangerous shoreline conditions called rip currents.

A rip current is a strong flow of water returning seaward from the shore. When wind and waves push water towards the shore, the previous backwash is often pushed sideways. This water streams along the shoreline until it finds an exit back to the sea. The resulting rip current is usually narrow and located between sandbars, under piers, or along jetties. The current is strongest at the surface, and can dampen incoming waves, leading to the illusion of a particularly calm area. Rip currents cause approximately 100 deaths annually in the United States, more than all other natural hazards except excessive heat.

From 2002 through 2012, Lake Michigan has the highest number of rip current-related fatalities and rescues of all the Great Lakes, with 77 fatalities and at least 230 rescues. The majority of these incidents occurred along the eastern and southern shoreline. There are numerous factors, but the primary explanation is that the prevailing wind direction is westerly, or onshore, across the eastern shore of Lake Michigan, making it more prone to rip current development. Secondly, there are a higher number of recreational locations on the Michigan side of the lake; therefore more people are at risk. Rip currents occur less frequently on the western side of Lake Michigan. The main type of rip current on Lake Michigan is the structural rip current, where the longshore current interacts with a pier or breakwall extending out into the lake, such as the piers at White Lake. The typical weather pattern for the development of these rip currents is any that involves onshore flow or flow parallel to the shore, which enhances the longshore current. This typically manifests itself as an approaching or exiting cold front, where onshore winds are either southwesterly (ahead of the front) or northwesterly (behind the front). Lastly, seiches can cause uneven distributions of water in the nearshore environment, leading to rip current development.

In May 2012, the National Weather Service began testing a new warning product, called a Beach Hazards Statement, in certain areas of the United States. Muskegon County is located within one of those areas. This warning informs beach goers and local authorities about a multitude of hazards in a single statement and provides safety information on these hazards. Some examples of the types of hazards (but not limited to) which may be included in the Beach Hazards Statement are…dangerous currents in the surf zone or unusual surf/wave/water conditions. In coordination with other agencies (as needed), the product may also inform users of various types of environmental hazards such as chemical spills, harmful algal blooms, and other unusual hazards.

For swimmers experiencing a rip current, the most important action is to conserve one's strength so as to stay afloat (rather than expending one's strength in an over-desperate struggle to "fight the current"). Once out of the rip current's pull, head back to shore at a pace that is appropriate to one's strength. In some circumstances, a swimmer may have been observed by beach lifeguards while being pulled by the current, and in such a case, if waves and weather are not too severe to allow a rescue, a swimmer may simply need to stay afloat until the lifeguards can bring aid.

Another Great Lakes hazard is the potential effect of severe winds and waves upon boating activities. Although some discussion of marine accidents can be found in the Transportation Accidents section of this chapter, it must be noted here that severe winds tend to be felt more strongly on open waters (winds from an approaching storm front often strike in advance of the storm itself, by 5 minutes or even more). Waterspouts (which are like a tornado involving contact with water instead of land) are another occurrence posing a great threat to marine traffic and recreation.

Historically Significant and Related Events: According to the Michigan Hazard Mitigation Plan, there have been 10 major periods of flooding/erosion on the Great Lakes since 1918. Extremely high water level peaks occurred in 1929, 1952, 1973, 1986, and 1997. During one of these periods in 1972-1973, high water levels caused shoreline flooding in over 30 Michigan counties that border the Great Lakes, resulting in an excess of $50 million in public and private damage. Thousands of people were forced to evacuate their homes. Similar high water level flooding occurred in the early 1950s and late 1960s, also resulting in millions of dollars in damage to shoreline communities. The record high water levels in 1986, when Muskegon County was granted a Presidential Disaster Declaration for Riverine and Shoreline Flooding, caused severe erosion that required the relocation of homes (particularly in Norton Shores) away from Lake Michigan. The high water in 1985-1968 led to a Governor's disaster declaration for 17 shoreline counties, which included Muskegon County. In 1997-1998, high Great Lakes water levels occurred again, approaching the record levels set in the 1980's.

Low water levels are also cyclical and can have severe economic impacts in the form of dredging and sediment disposal costs and marine transportation hazards. Extreme low water levels occurred in 1926, 1934, 1964, and 2003. The low water levels in lakes Michigan, Huron and Erie between 1998 and 2004 were the fastest decline in water levels in the Great Lakes in nearly a century and a half. Between the summer of 1997 and the spring of 2003, the lakes Michigan, Huron, and Erie each dropped by almost five feet. In December 2012, the water level on Lake Michigan was the lowest ever recorded for that month. The following January, a new all-time recorded low level was achieved, eclipsing the previous record low established in March 1964. Low levels such as these have a propensity to disrupt marine activity in the Muskegon harbor. A number of ships have run aground in recent years, such as the 1,000-foot freighter, *Indiana Harbor,* which was stuck in the harbor entrance in August 2007 and again in October 2010.

In addition, there have been two notable seiche events in Lake Michigan adjacent to Muskegon County. According to an article in Hope College's Joint Archives Quarterly, on July 13, 1938, a seiche caused a massive storm surge that stretched from Holland to Pentwater. Waves triggered by the seiche drowned three people at Holland State Park. It also caused "freak high waves" that drowned a swimmer in Muskegon and another man canoeing in Lake Michigan near Pentwater. The second seiche occurred on May 31, 1998. NCDC information states the following. "The tug boat Stephen M. Asher sunk in White Lake Channel, just north of Wabaningo between Lake Michigan and White Lake, at approximately 5:15 a.m. EDT due to a seiche created by the derecho moving across Lake Michigan. The crew reported a storm surge swept through the channel into White Lake as the derecho moved onshore. As the storm passed, the water rushed back out of White Lake through the channel, reaching the top of the channel walls. The tug boat, floating against a barge, rolled on its side and sank. No crew members were injured. The company which owns the tug boat estimated repairs would cost $20,000."

According to the Great Lakes Current Incident Database (National Weather Service, Marquette, MI) there were 77 rip current fatalities and 230 rescues (307 incidents) on Lake Michigan from 2002 through 2012. Incidents along Muskegon County's Lake Michigan shoreline have contributed to these totals; such as the two drownings (separate incidents) that occurred in 2010 near the Water Filtration Plant at Pere Marquette Beach.

Frequency of Occurrence: Though water levels on the Great Lakes are known to be cyclical, the timing, extent, and duration of high and low periods can only be estimated. According to the

Michigan Hazard Mitigation Plan, about 10 major periods of flooding/erosion have occurred on the Great Lakes since 1918, or approximately once per decade.

In the 11-year period 2002-2012, there was an annual average of seven fatalities and 21 rescues (28 total incidents) on the shores of Lake Michigan related to rip currents. Most of these incidents occurred on the southern and eastern shores of Lake Michigan due in part to prevailing onshore or longshore winds. Drownings and rescues are expected to happen each year in Muskegon County; however the number of incidents cannot be estimated.

1.08 HAIL

Conditions where atmospheric water particles from thunderstorms form into rounded or irregular lumps of ice that fall to the earth.

Summary: Hail is a hazard that often coincides with thunderstorms, and may occur simultaneously with other hazards such as lightning, severe winds, tornadoes, and heavy rains. Muskegon County experiences between 34 and 38 thunderstorms annually, many of which produce hail. There are numerous records of large hail up to grapefruit-sized (4”) hail in the county documented by the National Climatic Data Center. In addition, approximately $425,000 in property damage and $250,000 in crop damage has been attributed to hail events from 2000 through 2012.

The impacts of hail in Muskegon County can vary greatly, depending on location. In rural areas of the county, crops and livestock may be most-impacted; property damage is more likely in developed areas; and harm to people is possible in areas of outdoor recreation and activity. It is incumbent upon public safety officials and county residents to monitor forecasts from the National Weather Service, and to heed severe thunderstorm watches and warnings to minimize the effects on people and property.

Hazard Description: Hail is a product of the strong thunderstorms that frequently move across the Midwest. As one of these thunderstorms passes over, hail usually falls near the center of the storm, along with the heaviest rain. Sometimes, strong winds occurring at high altitudes in the thunderstorm can blow the hailstones away from the storm center, causing an unexpected hazard at places that otherwise might not appear threatened. Downdrafts produced by thunderstorms may also accelerate the descent of hail, thereby increasing the potential for damages.

Most hailstones range in size from a pea (¼ inch) to a golf ball (1¾ inches), but hailstones larger than softballs have occurred with the most severe thunderstorms. Hail is formed when strong updrafts within the storm carry water droplets above the freezing level, where they remain suspended and continue to grow larger until their weight can no longer be supported by the winds. They finally fall to the ground, battering crops, denting autos, and injuring wildlife and people. Large hail is a characteristic of severe thunderstorms, and it may precede the occurrence of a tornado.

Hail Size Chart

Diameter	Description
1/4"	Pea
1/2”	Plain M&M
3/4”	Penny
7/8”	Nickel
1” (severe)	Quarter
1¼”	Half Dollar
1½”	Ping Pong Ball
1¾”	Golf Ball
2”	Lime
2½”	Tennis Ball
2¾”	Baseball
3”	Teacup
4”	Grapefruit
4½”	Softball
4¾” – 5”	Compact Disk

Source: National Weather Service

The National Weather Service (NWS) issues severe thunderstorm watches for areas when the meteorological conditions are conducive to the development of severe thunderstorms. People in the watch area are instructed to stay tuned to National Oceanic and Atmospheric Administration (NOAA) weather radio and local radio or television stations for weather updates, and watch for developing storms. Once radar or a trained Skywarn spotter detects the existence of a severe thunderstorm, the NWS will issue a severe thunderstorm warning. The warning will identify where the storm is located, the direction in which it is moving, and the time frame during which the storm is expected to be in the area. Persons in the warning area are instructed to seek shelter immediately.

The State and local government agencies are warned via the Law Enforcement Information Network (LEIN), NOAA weather radio, and the Emergency Managers Weather Information Network (EMWIN). Public warning is provided through the Emergency Alert System (EAS). The NWS stations in Michigan transmit information directly to radio and television stations, which in turn pass the warning on to the public. The NWS also provides detailed warning information on the Internet at www.weather.gov, where an interactive map can be used.

Severe thunderstorm forecasts by the NWS usually give sufficient warning time to allow residents to take appropriate action to reduce the effects of hail damage on vehicles and some property. However, little can be done to prevent damage to agriculture, natural vegetation, and wildlife. In addition, hail can damage some fruit and vegetable plants, rendering them unsuitable for human consumption, and leading to an increased risk of bacteria that can kill healthy trees and nearby wildlife. Hail can also potentially exacerbate flooding and flash flooding through increased soil erosion, as well as jamming or reduced effectiveness of drainage paths, culverts, and grates.

In 2009, the NWS increased the definition of severe hail from ¾ inch to 1 inch in central and western U.S. states, including Michigan. This was implemented nationwide on January 5, 2010.

Historically Significant and Related Events: Muskegon County is no stranger to hailstorms. The NCDC lists 56 hail events since 1955, 23 of which were severe (1 inch diameter or greater). Hail events were observed in the months of January through October, with 83% of the severe events occurring in the months of April through July. It is important to note that numerous hail reports may be documented in a single day. With that in mind, there were 43 days with at least one hail report, 19 of which were severe.

Between 2000 and 2013, there were 37 total hail reports spread across 25 days. Ten of these reports included severe hail on seven separate days. Damages attributed to hail (both sub-severe and severe) during this period were noted on 17 different days, totaling $425,000 to property and $250,000 to crops.

Hail 1.5" or Greater
Muskegon County
1955 - 2012

Date	Location	Size
5-13-56	Fruitport Township	4.00 in.
6-17-78	n/a	2.00 in.
6-25-78	n/a	1.75 in.
10-03-79	n/a	1.75 in.
7-04-90	n/a	1.75 in.
4-11-01	Fruitport	1.75 in.
8-03-03	Muskegon Township	1.75 in.
7-02-08	Dalton Township	1.50 in.
6-21-11	Muskegon	2.00 in.

Source: National Climatic Data Center

A notable severe hail episode was observed on April 11, 2001, when several rounds of severe thunderstorms swept across the area. Hail reports in Muskegon County included 1.75 inch hail in Fruitport, and 0.75 inch hail in Holton and Twin Lake. Countywide damage attributed to hail totaled $70,000 to property and $45,000 to crops. This instance shows that hail need not be "severe" to cause damage to property and crops. This severe weather outbreak also produced flash flooding and a weak tornado in Muskegon County, demonstrating how hail typically occurs in concert with other thunderstorm-related hazards.

Frequency of Occurrence: With between 34 and 38 thunderstorm days per year, it is highly likely that Muskegon County will experience multiple sub-severe hail events annually. In most cases, these events will cause little or no damage. In the 59 years encompassing 1955 though 2013, the NCDC has documented 19 days where severe hail (one inch or larger) was observed. This data suggests that the county will experience a severe hail event once every three years. However, as population has increased and reporting techniques have improved, this estimate may understate the actual frequency. More recent records spanning 14 years from 2000 through 2013 show severe hail was observed on seven different days. Therefore based on recent trends, Muskegon County could expect to average a day with at least one severe hail report once every two years. Hail is possible in any month of the year, however severe hail is most likely to occur in the months of April, May, June, and July.

1.09 INVASIVE SPECIES

A species that has been introduced by human action to a location where it did not previously occur naturally, becomes capable of establishing a breeding population in the new location without further intervention by humans, and becomes a pest by threatening the local biodiversity and causing human health impacts, significant economic costs, and/or ecological effects.

Summary: Historically, invasive species has not been considered as a significant hazard in Muskegon County. However, this hazard is discussed by the Michigan Hazard Mitigation Plan and is summarized in this plan to increase awareness among emergency responders, public safety officials, and community leaders. The following hazard description is only a portion of the information contained within the state plan, which can be referenced for additional information.

Muskegon County boasts a wide variety of land uses and land cover, and is therefore susceptible to a wide range of exotic species. Invasive aquatic species also pose a threat to water features in the county. In addition, Muskegon County welcomes a significant number of visitors each year, thereby increasing the opportunities for accidental importation of non-native species.

Hazard Description: An invasive species is defined as a species that is (1) non-native (alien) to the ecosystem under consideration and (2) whose introduction causes or is likely to cause economic or environmental harm, or harm to human health. Invasive species can be plants, animals, and other organisms (e.g., microbes). Human actions are the primary consideration here as a means of invasive species' introduction (thus distinguishing the situation from natural shifts in the distribution of species). Nationally, the current environmental, economic, and health costs of invasive species were estimated as exceeding the costs of all other natural disasters combined.

Invasive species can be transported in many ways, such as on animals, vehicles, ships, commercial goods, produce, and clothing. Although non-native (exotic) species are the foundation of U.S. agriculture, and also are used to prevent erosion, to provide fishing and hunting opportunities, and as ornamental plants and pets, occasionally a non-native organism flourishes too well and causes unwanted economic, ecological, or human health impacts. The terms "invasive" or "nuisance" are used to describe such species. New environments may affect rates of reproduction, susceptibility to disease, and other features that affect a species' success. Consequently, a plant or animal that causes little damage to agriculture or natural ecosystems in one area may cause significant problems in another. Certain nonnative species are very successful in their new habitats because they out-compete native plants or animals and have no natural controls (predators, diseases, etc.) in the new area. At least 200 well-known, high-impact, non-native species presently occur in the United States. They range from the European gypsy moth and emerald ash borer to crabgrass, dandelions, and German cockroaches, annually costing well over a billion dollars to control. Some even pose human health risks. Others, like the zebra mussel, threaten widespread disruption of ecosystems and the displacement or loss of native plants and animals.

Hundreds of new species from other countries are introduced intentionally or accidentally into the United States each year. These invasive species may arrive in a variety of ways. Transportation efficiencies that make it possible to travel around the globe in hours rather than weeks enable organisms to survive transportation from one continent to another.

As more adaptable and generalized species are introduced to environments already impacted adversely by human activities, native species are often at a disadvantage to survive in what was previously a balanced ecosystem. There are many examples of decreased biodiversity in such areas. One of the primary threats to biodiversity is the spread of humanity into what were once isolated areas, with land clearing and habitation putting significant pressure on local species. Agriculture, livestock, and fishing can also introduce changes to local populations of indigenous species and may result in a previously innocuous native species becoming a pest, due to a reduction of natural predators. This threat intensifies the need for scientists, managers, and stakeholders to cooperate to build better systems to prevent invasion, improve early detection of invaders, track established invaders, and to coordinate containment, control, and effective habitat restoration.

Although invasive species, in most cases, primarily cause environmental damage and degradation, there are situations in which serious threats to public health, safety, and well-being can occur due to animal disease or plant/animal infestations. For example, certain diseases could wipe out large segments of an animal population, creating a potentially serious public health emergency and the need to properly (and rapidly) dispose of the dead animal carcasses.

Similarly, a widespread insect infestation, such as that of the Emerald Ash Borer, can create serious public safety threats (especially in densely populated urban areas) due to dead and dying trees being fire prone (because of their dry, brittle nature) or to partial/total collapse due to high winds or ice/snow accumulation. The falling trees or limbs can also bring down power lines, cause damage to public and private structures, and cause injuries or even death.

County and local officials should cooperate closely with state agencies that actively monitor and manage invasive threats, such as the U.S. Forest Service, U.S. Fish and Wildlife Service, Michigan Department of Natural Resources, and the Michigan State Police, Emergency Management Division.

Historically Significant and Related Events: There are hundreds of known invasive species in Michigan and the Great Lakes. There are hundreds of potential threats as well. The effects of these invaders are often a mere nuisance; however, cases exist where effects are costly and damaging. The discussion below provides a small sample of the overall invasive species threat.

Though not a significant issue in Muskegon County, the Emerald Ash Borer has caused extensive damage to trees in parts of Michigan. Weakened trees have often (1) collapsed and caused property damage, or (2) required removal, at considerable expense. A disaster declaration request was sent to FEMA, but the request was not accepted by that agency, leaving state and local budgets, residents, and insurance companies to try to cover the considerable expenses and efforts involved in dealing with the problem.

Sea lampreys are an aquatic invader that is a constant threat to the rivers and streams in Michigan, including Muskegon County. According to the Great Lakes Science Center (GLSC), “the sea lamprey is one of the few aquatic invasive species that is being successfully controlled.” Numerous techniques have been attempted in Michigan, including screen weirs, electric screens, and chemicals. Two rivers in Muskegon County, the Muskegon and the White, are regularly treated with lampricides every three to five years.

The character of Muskegon County is closely tied to, and influenced by, the presence of Lake Michigan. The Great Lakes provide a potential conduit for the transportation of exotic and invasive species from other regions in North America and world-wide. Listed in the following table are examples of invasive species in the Great Lakes, according to the Great Lakes Information Network.

Invasive Species in the Great Lakes Region

Current Invaders	
Crustaceans:	Rusty Crayfish, Spiny Water Flea
Fish:	Round Goby, Tubenose Goby, Rudd, Ruffe, Sea Lamprey, White Perch
Mollusks:	Quagga Mussel, Zebra Mussel
Plants:	Curly-leaf Pondweed, Eurasian Waterfoil, Phragmites, Purple Loosestrife
Viruses:	Viral Hemorrhagic Septicemia Virus (VHSv)
Potential Invaders	
Fish:	Asian Carp

Source: Great Lakes Information Network,
http://www.great-lakes.net/envt/flora-fauna/invasive/invasive.html

According to the Muskegon Conservation District (MCD), invasive plant species, such as garlic mustard, phragmites, Japanese honeysuckle, spotted knapweed, and oriental bittersweet, are non-native species that spread aggressively, choking out native species and degrading natural areas. Each summer MCD staff and volunteers spend countless hours combating the spread of invasive species in Muskegon County.

Frequency of Occurrence: The effects of invasive species are inherently unpredictable. Insufficient data exists regarding significant impacts of invasive species in Muskegon County. However, it should be recognized that invasive and exotic species are a constant threat, primarily to the environment and the economy.

1.10 LIGHTNING

Discharge of electricity from within a thunderstorm.

Summary: Lightning is a hazard produced by thunderstorms, and may occur simultaneously with other hazards such as hail, severe winds, tornadoes, and heavy rains. Muskegon County experiences between 34 and 38 thunderstorms annually, all of which produce lightning.

It is virtually impossible to provide complete protection to individuals and structures from lightning, therefore this hazard will continue to be a risk for Muskegon County's residents. However, lightning deaths, injuries, and property damage can be reduced through a combination of public education, human vigilance, technology, proper building safety provisions, and simple common sense. It is incumbent upon public safety officials and county residents to monitor forecasts from the National Weather Service, and to heed severe thunderstorm watches and warnings to minimize the effects on the population.

Hazard Description: Lightning is a random and unpredictable product of a thunderstorm's tremendous energy which produces an intense electrical field like a giant battery, with the positive charge concentrated at one end and the opposite charge concentrated at the other. Lightning strikes when a thunderstorm's electrical potential (the difference between its positive and negative charges) becomes great enough to overcome the resistance of the surrounding air. Bridging that difference, lightning can jump from cloud to cloud, cloud to ground, ground to cloud, or even from the cloud to the air surrounding the thunderstorm. Lightning strikes can generate current levels of 30,000 to 40,000 amperes, with air temperatures often superheated to higher than 50,000 degrees Fahrenheit (hotter than the surface of the sun) and speeds approaching one-third the speed of light.

Globally, about 2,000 thunderstorms are occurring at any given time, producing approximately 100 lightning strikes to earth each second. In the United States, approximately 100,000 thunderstorms occur each year, and every one of those storms generates lightning. It is not uncommon for a single thunderstorm to produce hundreds or even thousands of lightning strikes. However, to the majority of the general public, lightning is perceived as a minor hazard. That perception lingers despite the fact that lightning damages many structures and kills and injures more people in the United States per year, on average, than tornadoes or hurricanes. Many lightning deaths and injuries could be avoided if people would have more respect for the threat lightning presents to their safety.

Lightning deaths are usually caused by the electrical force shocking the heart into cardiac arrest or throwing the heartbeat out of its usual rhythm. Lightning can also cut off breathing by paralyzing the chest muscles or damaging the respiratory center in the brain stem. It takes only about one-hundredth of an ampere of electric current to stop the human heartbeat or send it into ventricular fibrillation. Lightning can also cause severe skin burns that can lead to death if complications from infection set in.

As an indicator of the circumstances involving lightning fatalities, injuries and damage in the U. S., consider the following statistics compiled by the National Oceanic and Atmospheric Administration (NOAA) and the National Lightning Safety Institute (NLSI) for the period of 1959-1994:

Location of Lightning Strikes
· 40% at unspecified locations
· 27% in open fields and recreation areas (not including golf courses)
· 14% to someone under a tree (not including golf courses)
· 8% water-related (boating, fishing, swimming, etc.)
· 5% golf-related (on golf course or under tree on golf course)
· 3% related to heavy equipment and machinery
· 2.4% telephone-related
· 0.7% radio, transmitter and antenna-related

Gender of Victims
· 84% male; 16% female

Months of Most Strikes
· July (30%); August (22%); June (21%)

Most Likely Time Period of Reported Strikes
· 2:00 PM – 6:00 PM

Number of Victims
· One victim (91%); two or more victims (9%)

The NLSI has estimated that 85% of lightning victims are children and young men (ages 10-35) engaged in recreation or work-related activities. Approximately 20% of lightning strike victims die, and 70% of survivors suffer serious long-term after-effects such as memory and attention deficits, sleep disturbance, fatigue, dizziness, and numbness.

In terms of property losses from lightning, statistics vary widely according to source. The Insurance Information Institute (a national clearinghouse of insurance industry information) estimates that lightning damage amounts to nearly 5% of all paid insurance claims, with residential claims alone exceeding $1 billion. Information from insurance companies shows one homeowner's damage claim for every 57 lightning strikes. The NLSI has estimated that lightning causes more than 26,000 fires annually, with damage to property exceeding $5-6 billion. Electric utility companies across the country estimate as much as $1 billion per year in damaged equipment and lost revenue from lightning. The Federal Aviation Administration (FAA) reports approximately $2 billion per year in airline industry operating costs and passenger delays from lightning. Because lightning-related damage information is compiled by so many different sources, using widely varying collection methods and criteria, it is difficult to determine a collective damage figure for the U.S. from lightning. However, annual lightning-related property damages are conservatively estimated at several billion dollars per year, and those losses are expected to continue to grow as the prevalent use of computers and other lightning-sensitive electronic components continues.

Because it is virtually impossible to provide complete protection to individuals and structures from lightning, it will continue to be a problem for Michigan's residents. However, lightning deaths, injuries, and property damage can be reduced through a combination of public education, human vigilance, technology, proper building safety provisions, and simple common sense.

The National Weather Service (NWS) issues severe thunderstorm watches for areas when the meteorological conditions are conducive to the development of severe thunderstorms. People in the watch area are instructed to stay tuned to National Oceanic and Atmospheric Administration (NOAA) weather radio and local radio or television stations for weather updates, and watch for developing storms. Once radar or a trained Skywarn spotter detects the existence of a severe thunderstorm, the NWS will issue a severe thunderstorm warning. The warning will identify where the storm is located, the direction in which it is moving, and the time frame during which the storm is expected to be in the area. Persons in the warning area are instructed to seek shelter immediately.

The State and local government agencies are warned via the Law Enforcement Information Network (LEIN), NOAA weather radio, and the Emergency Managers Weather Information Network (EMWIN). Public warning is provided through the Emergency Alert System (EAS). The NWS stations in Michigan transmit information directly to radio and television stations, which in turn pass the warning on to the public. The NWS also provides detailed warning information on the Internet at www.weather.gov, where an interactive map can be used.

Severe thunderstorm forecasts by the NWS usually give sufficient warning time to allow residents to take appropriate action to reduce the risks of lightning. Large outdoor gatherings (e.g., sporting events, concerts, campgrounds, fairs, festivals, etc.) are particularly vulnerable to lightning strikes that could result in many deaths and injuries. This vulnerability underscores the importance of developing site-specific emergency procedures for these types of events, with particular emphasis on adequate early detection, monitoring, and warning of approaching thunderstorms. Early detection, monitoring, and warning of lightning hazards, combined with prudent protective actions, can greatly reduce the likelihood of lightning injuries and deaths. In addition, close coordination between event organizers, local emergency management officials, and response agencies (i.e., police, fire, emergency medical care) can help prevent unnecessary (and often tragic) delays and mistakes in rendering care should a lightning incident occur.

In addition to the significant risks to individuals, lightning may also damage buildings, electrical and communications infrastructure, and trees, as well as spark wildfires. In fact, lightning is the most common natural cause of wildfire.

Historically Significant and Related Events: NCDC has record of three lightning events in Muskegon County between 1994 and 1998. A July 20, 1994 event killed a dog and caused $50,000 in property damage; a July 4, 1995 event caused $10,000 in property damage; and a July 21, 1998 event caused $40,000 in property damage and a power outage for 7,500 people. Damages from the latter event were attributed to lightning strikes in Egelston and Muskegon townships.

In addition, a cursory search for lightning-related damages revealed possible property damage and/or structural fire reported by local media in three consecutive years (2010, 2011, and 2012). Perhaps the most damaging of these events was the lightning strike at a radio station in the City of Muskegon. The strike knocked the station off-air, damaged equipment, and triggered a small fire.

Statewide statistics derived from NCDC data that lend additional historical credence to the risk of lightning in Muskegon County. The tables below detail lightning-related injuries and deaths in Michigan from 1959 to 2005.

Lightning-Related Deaths in Michigan
- 1959-July 2005 -

Lightning Deaths: 101		
Number of Deaths	Location	Percent of Total
29	Open fields, ball fields	29%
26	Under trees, not golf	26%
11	Boats / water-related	11%
10	Golf course	10%
4	Near tractors / heavy equipment	4%
2	At telephone	2%
19	Other location / unknown	19%

Source: Storm Data, National Climatic Data Center

Lightning-Related Injuries in Michigan
- 1959-July 2005 -

Lightning Injuries: 711		
Number of Injuries	Location	Percent of Total
243	Open fields, ball fields	34%
104	Under trees, not golf	15%
35	Golf course	5%
26	Boats / water-related	4%
19	At telephone	3%
20	Near tractors / heavy equipment	3%
264	Other location / unknown	37%

Source: Storm Data, National Climatic Data Center

Frequency of Occurrence: Based on the sample of events identified above, it is reasonable to state that Muskegon County (especially developed areas) is likely to experience lightning-related damage every year. Lightning is possible in any month; however it is most likely to occur in the spring, summer, and early fall months. Unfortunately, these are also the peak seasons for many popular outdoor activities in Muskegon County. Statistics show that individuals engaged in outdoor activities are generally at a higher risk from lightning during a thunderstorm. Muskegon County typically experiences between 34 and 38 thunderstorm days per year according to the Michigan State Police (see Thunderstorm Hazards map in Appendix C), all of which produce lightning.

1.11 SEVERE WINDS

Non-tornadic winds of 58 miles per hour or greater.

Summary: Severe winds are a fairly common occurrence in Muskegon County. Although possible any time throughout the year, severe winds are most likely to occur in association with severe thunderstorms during the summer. Strong weather systems, generally in the fall, can also produce damaging winds. Though these high wind events may not reach a magnitude of 58 mph (severe wind criteria), they are often characterized by sustained strong winds, with occasionally severe gusts, affecting large areas for hours or even days.

Severe winds are the most common thunderstorm hazard to cause damage in Muskegon County and may occur simultaneously with other hazards such as lightning, hail, tornadoes, and heavy rains. Muskegon County annually experiences between 34 and 38 thunderstorms which produce some or all of these hazards.

Advanced warning and weather monitoring are effective ways to mitigate the effects of severe winds. Therefore, it is incumbent upon public safety officials and county residents to monitor forecasts from the National Weather Service, and to heed severe thunderstorm and high wind watches and warnings to minimize the effects on people and property.

Hazard Description: Severe winds spawned by thunderstorms or other storm events have had devastating effects on Michigan, including 118 deaths, nearly 700 injuries, and hundreds of millions of dollars in damage to public and private property and agricultural crops since 1970. Severe wind events are characterized by wind velocities of 58 miles per hour or greater, with gusts sometimes exceeding 74 miles per hour (hurricane velocity), but do not include tornadoes.

Severe winds, including those produced by thunderstorms and high wind events produced by strong weather systems, can be very damaging to communities. Severe winds have the potential to cause loss of life from property damage and flying debris, but do not produce as many deaths as tornadoes. However, the property damage from severe wind events can be just as extreme as that of a tornado, since the damage can be widespread rather than isolated.

According to NOAA's National Severe Storms Laboratory, damage from severe thunderstorm winds account for half of all severe weather reports in the lower 48 states and is more common than damage from tornadoes. Wind speeds can reach up to 100 miles per hour and can produce a damage path extending for hundreds of miles. These winds are often called "straight-line" winds to differentiate the damage they cause from tornado damage. The following narrative describes a number of different processes that can produce strong thunderstorm winds.

Types of damaging winds

- *Straight-line winds* – a term used to define any thunderstorm wind that is not associated with rotation, and is used mainly to differentiate from tornadic winds.
- *Downdrafts* – A small-scale column of air that rapidly sinks toward the ground. A downburst is a result of a strong downdraft.
- *Downbursts* – A strong downdraft with horizontal dimensions larger than 4 km (2.5 mi) resulting in an outward burst or damaging winds on or near the ground. (Imagine the way water comes out of a faucet and hits the bottom of the sink.) Downburst winds may begin as a microburst and spread out over a wider area, sometimes producing damage similar to a strong tornado. Although usually associated with thunderstorms, downbursts can occur with showers too weak to produce thunder.
- *Microbursts* – A small concentrated downburst that produces an outward burst of damaging winds at the surface. Microbursts are generally small (less than 4km across) and short-lived, lasting only 5-10 minutes, with maximum wind speeds up to 168 mph. There are two kinds of microbursts: wet and dry. A wet microburst is accompanied by heavy precipitation at the surface. Dry microbursts, common in places like the high plains and the intermountain west, occur with little or no precipitation reaching the ground.
- *Gust front* – A gust front is the leading edge of rain-cooled air that clashes with warmer thunderstorm inflow. Gust fronts are characterized by a wind shift, temperature drop, and gusty winds out ahead of a thunderstorm. Sometimes the winds push up air above them, forming a shelf cloud or detached roll cloud.
- *Derecho* – A derecho is a widespread thunderstorm wind event caused when new thunderstorms form along the leading edge of an outflow boundary (a surface boundary formed by the horizontal spreading of thunderstorm-cooled air). The thunderstorms feed on this boundary and continue to reproduce themselves. Derechos typically occur in the summer months when complexes of thunderstorms form over the plains and northern plains states. Usually these thunderstorms produce heavy rain and severe wind reports as they rumble across several states during the night. The word "derecho" is of Spanish origin and means "straight ahead." They are particularly dangerous because the damaging winds can last a long time and can cover such a large area.
- *Bow Echo* – A radar echo which is linear but bent outward in a bow shape. Damaging straight-line winds often occur near the "crest" or center of a bow echo. Bow echoes can be over 300km in length, last for several hours, and produce extensive swaths of wind damage at the ground.

The National Weather Service (NWS) issues severe thunderstorm watches for areas when the meteorological conditions are conducive to the development of severe thunderstorms. People in the watch area are instructed to stay tuned to National Oceanic and Atmospheric Administration (NOAA) weather radio and local radio or television stations for weather updates, and watch for developing storms. Once radar or a trained Skywarn spotter detects the existence of a severe thunderstorm, the NWS will issue a severe thunderstorm warning. The warning will identify where the storm is located, the direction in which it is moving, and the time frame during which the storm is expected to be in the area. Persons in the warning area are instructed to seek shelter immediately.

The State and local government agencies are warned via the Law Enforcement Information Network (LEIN), NOAA weather radio, and the Emergency Managers Weather Information Network (EMWIN). Public warning is provided through the Emergency Alert System (EAS). The NWS stations in Michigan transmit information directly to radio and television stations, which in turn pass the warning on to the public. The NWS also provides detailed warning information on the Internet at www.weather.gov, where an interactive map can be used. Muskegon County also contracts with First Call Network to provide an Emergency Notification System (ENS) to its residents. This system delivers a message to listed phone numbers (and unlisted numbers upon request) in the event of an emergency at a rate of 212 calls per minute. The system can be activated by Muskegon Central Dispatch at the request of the fire department or police department. Citizens may also request to receive calls in the event of severe weather in the area.

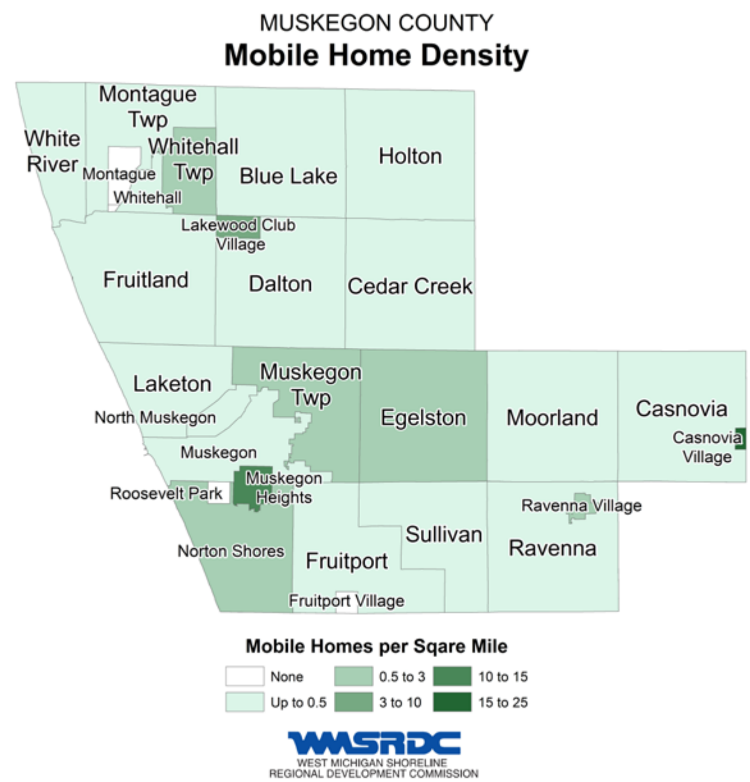
Severe thunderstorm and high wind forecasts by the NWS usually give sufficient warning time to allow residents to take appropriate action to reduce the effects of wind damage on people and some property. A particular concern with severe winds is the presence of buildings without basements, which may be overturned or damaged by strong winds. Such buildings include mobile and manufactured homes, seasonal homes, workplaces, remote hunting lodges, campgrounds, etc. According to the 2007-2011 American Community Survey 5-year Estimates, mobile homes make up 6.6% of Muskegon's housing. This type of housing may either be concentrated in mobile home parks or scattered (generally in rural areas). According to FEMA's Building Performance Assistance Team, newer manufactured housing anchored to permanent foundations performs better than older manufactured housing in windstorms. Such mitigation measures must be taken well prior to issuance of a severe thunderstorm watch or warning.

In addition to property damage to buildings (especially unsecured and less sturdy structures such as storage sheds, outbuildings, etc.), there is a risk for infrastructure damage from downed power lines due to falling limbs and trees. Downed power lines also carry the risk of electrocution to people and animals. Large scale power failures, with hundreds of thousands of customers affected, are common during straight-line wind events.

Mobile Homes in Muskegon County

Community	# Mobile Homes	% of Homes in Municipality
Muskegon County *	4,865	6.6
Montague City	0	0.0
Muskegon City	108	0.6
Muskegon Heights City	133	2.6
North Muskegon City	8	0.5
Norton Shores City	**906**	8.7
Roosevelt Park City	0	0.0
Whitehall City	6	0.5
Casnovia Village	6	3.8
Fruitport Village	0	0.0
Lakewood Club Village	39	7.9
Ravenna Village	3	0.6
Blue Lake Township	37	3.7
Casnovia Township	143	14.8
Cedar Creek Township	256	**17.7**
Dalton Township	340	9.2
Egelston Township	**1,149**	**28.4**
Fruitland Township	21	0.8
Fruitport Charter Township	270	5.0
Holton Township	257	**23.6**
Laketon Township	25	0.8
Montague Township	91	12.7
Moorland Township	58	10.1
Muskegon Charter Township	**827**	11.8
Ravenna Township	32	3.0
Sullivan Township	51	5.3
White River Township	23	2.6
Whitehall Township	124	17.2

** total of city and townships only; village totals already included within township totals*
Source: American Community Survey 2007-2011 5-year Estimates



Map prepared by WMSRDC, March 19, 2013
Source: 2007-2077 American Community Survey 5-Year Estimates

The Federal Emergency Management Agency (FEMA) has produced a wind zone classification map for the United States that divides the country into four winds zones and identifies areas that are susceptible to hurricanes and special wind regions (see map in Appendix C). The zones range from I – IV, with the highest potential winds in Zone IV. According to the map, Muskegon County is located within zone IV; meaning winds are capable of reaching speeds of up to 250 miles per hour. Wind speeds of this magnitude are possible in extreme tornadoes.

Historically Significant and Related Events: The county has been repeatedly buffeted with strong winds, as documented by lists of disasters and damages compiled by the MSPEMD and NCDC. There have been two federal major disaster declarations for Muskegon County due to high winds on August 20-September 6, 1975, and May 31, 1998.

Two of the most damaging storms in Muskegon's recent history are described in the following narrative. They essentially occurred back-to-back, on May 29 and 31, 1998. The NCDC provides the following description of the May 29, 1998 storm:

> *"Widespread wind damage occurred in the Muskegon metropolitan area; including the cities of Muskegon, North Muskegon, Muskegon Heights, and Norton Shores and the townships of Laketon, Muskegon, and Fruitport; in the early morning of May 29, 1998. Many large trees, utility poles, and power lines were downed by sustained 60-80 mph winds (estimated) over a 10-15 minute period. Overall, an estimated 900 power lines were downed in the Muskegon area, leaving approximately 54,000 homes and businesses without power and affecting approximately a third of all Muskegon County residents. An estimated 27,000 people were still without power as of late the next day. Most structural damage to homes and businesses was caused by fallen trees and utility poles. An estimated 500 homes and 30 businesses sustained minor to moderate damage. Despite widespread damage, estimated at $1 million, no injuries were reported."*

Just as the county was recovering from this event, it was hit by another, stronger storm. A review of National Weather Service Doppler Radar indicates that "the widespread and severe damage, which occurred with the fast-moving line of thunderstorms during the early morning hours of May 31st, was caused primarily by strong straight-line winds (60-90 mph) and isolated wet microburst winds (120-130 mph)." This particular derecho formed in South Dakota on the evening of May 30 and raced across Minnesota, Iowa and Wisconsin, before striking the Lower Peninsula around 4:30 a.m. An in-depth analysis of this derecho can be found at http://www.spc.noaa.gov/misc/AbtDerechos/casepages/may30-311998page.htm.

The storm prompted a federal major disaster declaration for "winds from thunderstorms." According to the MSPEMD Damage and Injury Assessment Report, Muskegon sustained $2,458,958 in public damage costs from this storm. An estimated 42 homes were destroyed, 1,805 homes were damaged, 5 businesses were destroyed, 73 businesses were damaged, and two people were injured. Total public and private costs were estimated at $24,205,908 according to FEMA and local media reports, with total statewide costs at $166 million, four deaths and 146 minor injuries.

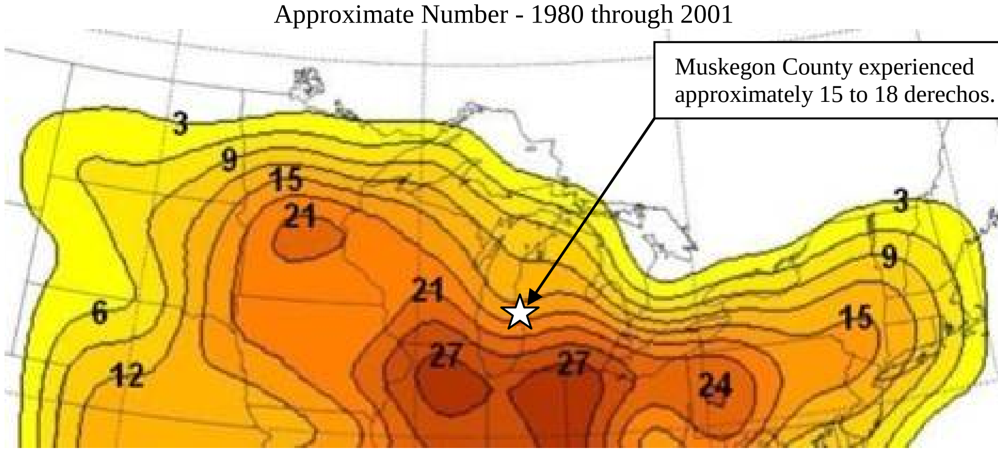
Approximately 50% of Whitehall was left without water service and 50,000 customers were left without power in Muskegon County. The Muskegon Chronicle reported five large transmission towers were toppled northeast of the City of Muskegon. These towers were designed to withstand 90 mph wind with gusts to 100 mph. Consumers Energy reported the derecho event was the most destructive weather event in its history, with over 600,000 of its customers without power. North Muskegon went 7-9 days without power. (See Section 2.06 for more information on Infrastructure Failures).

Numerous roads were closed to allow for tree and debris removal, causing road commission employees to work 12 hour days for several months to repair them. (It took a year, according to the Road Commission, for total clean-up.) The Muskegon Chronicle also reported severe crop damage to fruit trees, estimated at $5 million, in the southeast part of the county. Severe tree damage was reported in Muskegon State Park, Hoffmaster State Park, and Duck Lake State Park; all of which border Lake Michigan.

In addition to the disastrous storms, NCDC has documented a significant number of less destructive wind events. The NCDC has documented 101 days with strong wind incidents in Muskegon County between 1955 and 2013; 92 from thunderstorm wind reports and 10 from high wind reports (there was one day in 2013 when both thunderstorm winds and strong non-thunderstorm winds were observed). About half of the thunderstorm days occurred in the months of June and July, while about half of the high wind events occurred in the months of October and November. Notable wind damages among these events include: $50,000 from thunderstorm wind damage in Norton Shores on April 18, 1994; $50,000 of damage in Dalton Township from the May 8, 2000 storm; $150,000 of property damage in Muskegon County (including a flipped airplane in Norton Shores) from the August 22, 2000 storm; $100,000 of property damage across southern Muskegon County (especially the Village of Fruitport) from the August 9, 2009 storm; and $50,000 of property damage from the September 21, 2010 storm.

"Moderate and High Intensity" Derechos

Approximate Number - 1980 through 2001



Source: NOAA webpage- http://www.spc.noaa.gov/misc/AbtDerechos/climatologypage.htm

Muskegon County has also experienced numerous wind events associated with strong weather systems. Ten "high wind" events listed by the NCDC have involved Muskegon County from 1993 and through 2013. One of these events happened on October 30, 2004, when widespread high winds swept across Lower Michigan. Wind gusts between 58 and 60 miles per hour caused approximately $1.15 million in property damages in southwest Michigan, and cut off power to approximately 100,000 people statewide. On November 17, 2013, a very strong low pressure system brought a round of severe thunderstorms during the afternoon hours followed by very strong winds in the 60 to 70 mph range in Muskegon County and caused numerous power outages.

Frequency of Occurrence: Muskegon County is subjected to between 34 and 38 thunderstorms per year according to the Michigan Hazard Mitigation Plan. Since most thunderstorms produce some straight-line winds as a result of outflow generated by the thunderstorm downdraft, anyone living in Muskegon County is at risk of experiencing this phenomenon. Locations along the immediate Lake Michigan shoreline are particularly at risk of experiencing the strongest winds approaching from western directions.

Long-term data from 1955 through 2013 suggests that Muskegon County averages 1.7 severe wind days every year (101 event days in 59 years). However, perhaps due to improved quality and consistency of storm documentation, data from the recent past suggests that the county will experience wind events more frequently. The current NCDC Storm Events Database shows 42 days with a wind event from 2000 through 2013, a rate of 3.2 event days per year.

According to the NOAA Storm Prediction Center's webpage titled "About Derechos," Muskegon County is situated in a zone that typically experiences one derecho every two years.

1.12 SUBSIDENCE

The lowering or collapse of the land surface caused by natural or human-induced activities that erode or remove sub-surface support.

Summary: Overall, subsidence is not considered a significant threat in Muskegon County. In Michigan, the primary cause of subsidence is underground mining. Mining for minerals such as coal and copper is not a part of Muskegon County's past. However, the county does have a history of oil and gas well exploration thanks to an "oil boom" in the 1920's. Some abandoned wells, borings and their accompanying pits could be prone to subsidence over time.

Because residents in rural areas of the county use groundwater for potable water and for agriculture, excessive groundwater withdrawal might be considered a subsidence threat to the county. In urban and developed environments, broken water and sewer pipes and the improper discharge of rainwater are other possible causes of water-related subsidence in Muskegon County.

Hazard Description: Natural subsidence occurs when the ground collapses into underground cavities produced by the dissolution of limestone or other soluble materials by groundwater. Human-induced subsidence is caused principally by groundwater withdrawal, drainage of organic soils, and underground mining. In the United States, these activities have caused nearly 17,000 square miles of surface subsidence, with groundwater withdrawal (10,000 square miles of subsidence) being the primary culprit. In addition, approximately 18% of the United States' land surface is underlain by cavernous limestone, gypsum, salt, or marble, making the surface of these areas susceptible to collapse into sinkholes. Generally, subsidence poses a greater risk to property than to life. Nationally, the average annual damage from all types of subsidence is conservatively estimated to be at least $125 million. The National Research Council estimates of annual damage from various types of subsidence are outlined in the table below:

Land Subsidence: Estimated Annual National Damage

Type of Subsidence	Annual Damage ($)
Drainage of organic soils	40,000,000
Underground fluid withdrawal	35,000,000
Underground mining	30,000,000
Natural compaction	10,000,000
Sinkholes	10,000,000
Hydrocompaction (collapsible soils)	N/A
TOTAL:	**$125,000,000**

Source: National Research Council, Multi-Hazard Identification and Risk Assessment, FEMA

In Michigan, the primary cause of subsidence is underground mining. Although mine subsidence is not as significant a hazard in Michigan as in other parts of the country, many areas in Michigan are potentially vulnerable to mine subsidence hazards. Mine subsidence is a geologic hazard that occurs when the ground surface collapses into underground mined areas. It can strike with little or no warning and can result in very costly damage to buildings and disruption of underground utilities. In extreme cases, mine subsidence can literally swallow whole buildings or sections of ground into sinkholes, endangering anyone that may be present at that site. Mine subsidence may take years to manifest. Examples of collapses occurring 100 years after mines were abandoned have been documented in several areas of the country. Records of abandoned mines are often sketchy and sometimes non-existent. Therefore, it is often difficult to determine exactly where the mines were located. Many areas of Michigan may have developed over abandoned mines and may not even be aware of it. Oftentimes, the one way a community or home/business owner becomes aware of a potential hazard is when subsidence actually occurs and damage or destruction results.

Compaction of soils in some aquifer systems can accompany excessive ground-water pumping and cause subsidence. Excessive pumping of such aquifer systems has resulted in permanent subsidence and related ground failures. In some systems, when large amounts of water are pumped, the subsoil compacts, thus reducing in size and number the open pore spaces in the soil that previously held water. This can result in a permanent reduction in the total storage capacity of the aquifer system. More than 80% of the identified subsidence in the United States is a consequence of human impact on subsurface water. Three distinct processes account for most of the water-related subsidence: compaction of aquifer systems, drainage and subsequent oxidation of organic soils, and dissolution and collapse of susceptible rocks.

- *Mining Groundwater* - Groundwater in the pore spaces of an aquifer supports some of the weight of the overlying materials. When groundwater is depressurized or even removed from aquifers, where the materials are very compressible and pore pressures can be high, compaction may occur. This subsidence may be partially recoverable if pressures rebound, but much of it is not. Thus the aquifer is permanently reduced in capacity, and the surface of the ground may also subside.

- *Drainage of Organic Soils* - Land subsidence may occur when soils rich in organic carbon are drained for agriculture or other purposes. The most important cause of this subsidence is microbial decomposition, which, under drained conditions, readily converts organic carbon to carbon-dioxide gas and water. Compaction, desiccation, erosion by wind and water, and prescribed or accidental burning can also be significant factors.

- *Collapsing Cavities* - This type of subsidence is commonly triggered by ground-water-level declines caused by pumping and by enhanced percolation of groundwater. Collapse features tend to be associated with specific rock types, such as evaporites (salt, gypsum, and anhydrite) and carbonates (limestone and dolomite). These rocks are susceptible to dissolution in water and the formation of cavities. Salt and gypsum are much more soluble than limestone, the rock type most often associated with catastrophic sinkhole formation. Evaporite rocks underlie about 35 to 40% of the United States, though in many areas they are buried at great depths. Collapse sinkholes may develop over a period of hours and cause extensive damage.

In the past there has been pressure for the Great Lakes states to export bulk quantities of water to various locations in the United States. If plans to withdraw large amounts of water from the Great Lakes ever took place, it may have a major affect on the level of the groundwater tables in Michigan, which may make subsidence a more common occurrence.

There is no history of coal or copper mining in Muskegon County. However, there has been a great deal of oil and gas well exploration as a result of oil discovered in the 1920's. Though only a few wells are still in operation, thousands of exploratory wells were drilled and subsequently abandoned across the county. In addition, many of these wells were insufficiently capped by today's standards, creating the potential for surface water and groundwater to infiltrate the borings. A 2010 report titled "Preliminary Assessment of Lower Muskegon River Watershed Oil Field" identified potential concerns associated with abandoned wells in the county, stating "the presence of old pits or borings presents risks for cave-in, unstable soil conditions (e.g. sinkholes) and falling hazards."

Muskegon County has an extensive network of infrastructure, including water, wastewater, and stormwater pipes and culverts. Failure of any of these has the potential to cause erosion-related subsidence hazards. Currently, broken water pipes and the improper discharge of rainwater are the most common causes of water-related subsidence in Michigan. It primarily occurs when water from the leak washes out the fine particles beneath the foundation causing voids that result in collapse or subsidence. Refer to section 2.07 - Infrastructure Failure for more information about Muskegon County infrastructure.

Historically Significant and Related Events: There are no documented incidences of significant subsidence in Muskegon County, and subsidence is not currently considered a serious threat. However, risks in Muskegon County warrant a cursory analysis of subsidence as a potential hazard. Such risks include excessive groundwater withdrawal (especially during periods of low water levels); the presence of hundreds of abandoned oil, gas, and brine wells; and subsidence related to stormwater or infrastructure failure.

Frequency of Occurrence: Lack of documented subsidence events in Muskegon County prohibits the prediction of its frequency.

1.13 TORNADOES

An intense rotating column of wind that extends from the base of a severe thunderstorm to the ground.

Summary: Although just seven tornadoes have been observed in Muskegon County between 1950 and 2012, tornadoes occur in Michigan every year with grim regularity. The Federal Emergency Management Agency (FEMA) has produced a wind zone classification map for the United States that divides the country into four winds zones (see map in Appendix C). The zones range from I to IV, with IV having the highest potential winds. According to the map, Muskegon County is located within zone IV; meaning winds are capable of reaching speeds of up to 250 miles per hour. Wind speeds of this magnitude are possible in extreme tornadoes.

Tornado damages can range from minor to devastating. Deaths and property loss are frequent by-products of these events. Improved public education in tornado safety, through community efforts and media coverage, has increased the public's awareness of potential hazards from tornadoes and their response to those hazards. The current average lead-times for tornado warnings by the

National Weather Service is 13 minutes. Local TV stations can also provide advanced warning with Doppler radar. Education and early awareness need to be continually improved to mitigate tornado hazards. Injuries can also occur during rescue and clean-up efforts after a tornado strikes.

Hazard Description: Tornadoes in Michigan are most frequent in the spring and early summer when warm, moist air from the Gulf of Mexico collides with cold air from the polar regions to generate severe thunderstorms. These thunderstorms often produce the violently rotating columns of wind known as funnel clouds. Michigan lies at the northeastern edge of the nation's primary tornado belt, which extends from Texas and Oklahoma through Missouri, Illinois, Indiana, and Ohio. Most of a tornado's destructive force is exerted by the powerful winds that knock down walls and lift roofs from buildings in the storm's path. The violently rotating winds then carry debris aloft that can be blown through the air as dangerous missiles.

A tornado may have winds up to 300+ miles per hour and an interior air pressure that is 10-20% below that of the surrounding atmosphere. The typical length of a tornado path is approximately 16 miles, but tracks much longer than that – even up to 200 miles – have been reported. Tornado path widths are generally less than one-quarter mile wide. Typically, tornadoes last only a few minutes on the ground, and can result in tremendous damage and devastation. Historically, tornadoes have resulted in tremendous loss of life, with the mean national annual death toll being around 87 persons. Property damage from tornadoes is in the hundreds of millions of dollars every year.

Enhanced Fujita (EF) Scale of Tornado Intensity

EF Rating	Wind Speeds	Expected Damage
EF-0	65-85 mph	'Minor' damage: shingles blown off or parts of a roof peeled off, damage to gutters/siding, branches broken off trees, shallow rooted trees toppled.
EF-1	86-110 mph	'Moderate' damage: more significant roof damage, windows broken, exterior doors damaged or lost, mobile homes overturned or badly damaged.
EF-2	111-135 mph	'Considerable' damage: roofs torn off well constructed homes, homes shifted off their foundation, mobile homes completely destroyed, large trees snapped or uprooted, cars can be tossed.
EF-3	136-165 mph	'Severe' damage: entire stories of well constructed homes destroyed, significant damage done to large buildings, homes with weak foundations can be blown away, trees begin to lose their bark.
EF-4	166-200 mph	'Extreme' damage: Well constructed homes are leveled, cars are thrown significant distances, top story exterior walls of masonry buildings would likely collapse.
EF-5	> 200 mph	'Massive/incredible' damage: Well constructed homes are swept away, steel-reinforced concrete structures are critically damaged, high-rise buildings sustain severe structural damage, trees are usually completely debarked, stripped of branches and snapped.

Source: NOAA, National Weather Service

Tornado intensity is measured on the Enhanced Fujita Scale, which examines the damage caused by a tornado on homes, commercial buildings, other man-made structures, and trees. The scale rates the intensity of a tornado based on damaged caused, not by its size. It is important to remember that the size of a tornado is not necessarily an indication of its intensity. Large tornadoes can be weak, and small tornadoes can be extremely strong, and vice versa. It is very difficult to judge the intensity and power of a tornado while it is occurring. Generally, that can only be done after the tornado has passed, using the Enhanced Fujita Scale as the measuring stick. The Enhanced Fujita Scale is a set of wind estimates (not measurements) based on damage. It uses three-second gusts estimated at the point of damage based on a judgment of eight levels of damage to 28 different indicators.

Although tornadoes cannot be predicted, prevented or contained, their potential impacts on Michigan's citizens and communities can certainly be reduced. In general, improved surveillance and warning systems implemented by the National Weather Service and emergency management agencies, coupled with extensive public education campaigns, have been very effective in keeping the death toll down in recent years. However, this is not to say that a major death toll could not occur again if a strong tornado should strike a highly populated area. History has clearly shown that tornadoes must always be treated with the utmost respect and caution. Other initiatives, such as structural bracing, urban forestry practices, manufactured home anchoring, and strengthening electrical system components, can help to reduce public and private property damage. Regardless of any amount of preparation, ample warning is the best way to save lives in the event of a tornado.

There is a concern for mobile and manufactured homes just as there is for mobile homes undergoing severe winds. Every community in Muskegon County is susceptible to tornados and should have an availability of secure shelter areas for those who live in mobile homes, or at temporary and seasonal locations. This need is backed by the fact that there are 4,865 mobile homes in the county according to the 2007-2011 ACS 5-Year Estimates. The jurisdictions with the highest number of mobile homes include Egelston Township (1,149), the City of Norton Shores (906), and Muskegon Charter Township (827). From another perspective, mobile homes make up over 17% of the housing stock in four jurisdictions: Egelston Township (28.4%), Holton Township (23.6%), Cedar Creek Township (17.7%), and Whitehall Township (17.2%).

Historically Significant and Related Events: According to NCDC storm data, there have been seven tornadoes in Muskegon County since 1950. Only two were rated as stronger than "F0" and had property damages associated with them. Sullivan Township suffered $25,000 of property damage from a 1965 "F2" tornado. Whitehall sustained $2,500 of property damage from its April 16, 1967 "F1" tornado. The county was included, along with 28 others, in the March 2-7, 1976 Declaration of Major Disaster by the President due to tornadoes and an ice storm. Since NCDC does show record of any tornadoes in the county around this date, it is probable that Muskegon County was included in the declaration because of the ice storm.

The surrounding counties of Kent, Newaygo, Oceana, and Ottawa have seen 68 tornadoes (75 including Muskegon) over the same 63-year period. Therefore the total number of observed tornadoes in Muskegon County, as it relates to the county's overall tornado risk, is misleading.

Tornado Touchdowns by Month
- 1950 through 2012 -

Muskegon County and Adjacent Counties*									
Month	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.
Tornadoes	4	16	12	11	9	9	13	0	1
Percentage	5.3%	21.3%	16%	14.7%	12%	12%	17.3%	0.0%	1.3%

**Includes Kent, Muskegon, Newaygo, Oceana, and Ottawa counties*
Source: Storm Data, National Climatic Data Center

Frequency of Occurrence: In 63 years from 1950 through 2012, there have been seven tornadoes in Muskegon County documented by the NCDC. However, since Muskegon County and its adjacent counties have seen 75 tornadoes over that span, the actual chance of tornado activity in the area is somewhat greater. Records since 1950 show that an average of just over one tornado per year is observed in or near Muskegon County. With more than half of the observed tornadoes occurring between March and June, observations in this area reflect the statewide tendency of tornadoes to be most common in the spring and early summer. April has the greatest frequency of tornadoes around Muskegon County, claiming 21.3 percent of all tornado touchdowns in the area.

1.14 WILDFIRE

An uncontrolled fire in grass lands, brush lands, or forested areas.

Summary: Most Michigan wildfires occur close to where people live and recreate, which puts people, property, and the environment at risk. Development within and around forested areas often increases the potential for loss of life and property from wildfires, since most fires are caused by human activities, such as outdoor burning.

According to the Muskegon Conservation District, forest covers approximately half of Muskegon County's land area, and is the county's most predominant land cover. The vast forest cover is a boon for both industry and recreation. However, it also makes many areas of the county potentially vulnerable to wildfires; particularly in portions of the Manistee National Forest and in the county's many camping areas. A majority of the forest land is in private ownership, and is often intermixed publicly-owned lands in the county. There are also wooded areas of higher risk where fairly steep slopes exist (see the topographic maps in Appendix B), such as along the Lake Michigan shoreline.

Hazard Description: Wildfires are a normal ecological phenomenon and serve long-term functions for vegetation and the natural environment. Wildfires can burn excessive brush, maintain large savannah-like openings, and restore wetlands by forcing out unwanted brush and vegetation. The natural function of fires within the environment can be considered a renewal or "cleansing process" as long as the fire is not too severe.

The negative impacts and immediate danger from wildfires are destruction of timber, property, wildlife, and injury or loss of life to persons who live in the affected area or who are using recreational facilities in the area. A wildland-urban interface (WUI) occurs where nature meets development. People and development residing within these areas are at greater risk from wildfires. Long-term and corollary effects of wildfire may include:

- Increased erosion and flooding, due to the disappearance of vegetation that would otherwise protect soils and slow surface runoff of water;
- Smoke (low visibilities and reduced air quality), closed roadways, and infrastructure impacts that may interfere with ordinary life, an area's economy, and planned tourism-based events; and
- Structural fires, particularly near areas of outdoor recreation and along wildlife-urban interfaces.

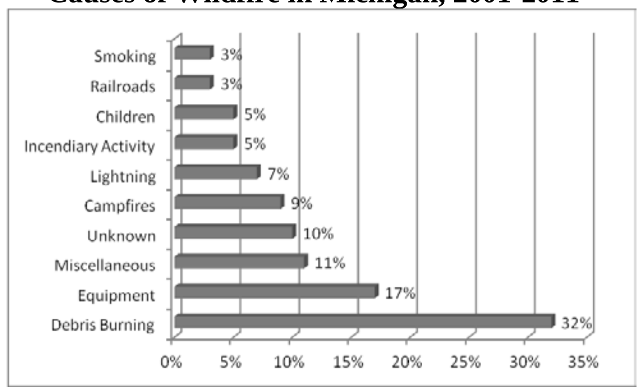
The threat of wildfire may be elevated in times of drought, high heat, and/or low humidity. Unfortunately these conditions often correspond to peak seasons of outdoor activity and recreation. Therefore, wildfires are often induced by human activity, rather than as a part of natural processes. Other factors that may increase the risk or severity of wildfire include: mild winters with abnormally low precipitation, allowing brush and other wildfire fuels to dry out; and severe wind storms that knock down trees, increasing the availability of fuel for wildfires.

An additional caveat of the wildfire hazard is the slight potential for it to be used maliciously due to the low cost and limited technical expertise required, the potential for causing large-scale damage, and the low risk of apprehension. This aspect of wildfire may be related to the "Terrorism and Similar Criminal Activities" hazard which is discussed in section 3.05.

Historically Significant and Related Events: Contrary to popular belief, lightning strikes are not the primary cause of wildfires in Michigan. Between 2001 and 2010, only about 7% of all wildfires in Michigan were caused by lightning strikes, while most other causes were attributed to human activity. Outdoor debris burning is the leading cause of wildfires in Michigan in recent years, comprising nearly one-third of the total. Most Michigan wildfires occur close to where people live and recreate, placing both people and property at risk.

Wildfires occur annually in Muskegon County, and have had significant effects on the area. The first recorded catastrophic fire in Michigan occurred in October of 1871 after a prolonged drought over much of the Great Lakes region in the preceding summer months. Logging waste and debris, dried from the drought, greatly contributed to the spread of the fire. A similar series of wildfires burned in the spring and summer months of 1891. These fires played a role in dismantling Michigan's logging industry, and subsequently weakening Muskegon's economy.

Causes of Wildfire in Michigan, 2001-2011



Source: Michigan Hazard Mitigation Plan, 2011

Wildfire incidents have continued to occur in Muskegon County and nearby areas of the state since the late 1800's despite advances in firefighting technology and methodology. These advances have drastically reduced the number of acres burned per year and have helped prevent major wildfires such as those of 1871 and 1891. Firebreaks installed in sections of the forests may help manage and contain any future wildfires. Spotters and planes are alert for signs of wildfire, and response to sighted fires has been very good, with many trained fire fighters prepared to respond. Nearly 8 percent of Muskegon County's land area is owned by state or federal entities according to Muskegon County Blueways and Greenways Plan written by WMSRDC in 2010. Therefore, the county has state and federal assistance for wildfire response in and around those areas.

In June 2012, a lightning-induced wildfire in Luce County in the Upper Peninsula (known as the Duck Lake fire) proved that wildfires are still a significant threat in Michigan. It burned over 21,000 acres and destroyed 136 structures including 47 homes and cabins, one hotel and one store. It was the third largest wildfire in Michigan history. A total of 300 personnel served on the Duck Lake Fire from agencies including Michigan State Police, Luce County Sheriff's Department, Red Cross, Luce County Emergency Management, Wisconsin DNR, American Red Cross, and Salvation Army.

While Muskegon County has not experienced a wildfire of that magnitude in recent memory, smaller scale wildfires happen numerous times each year. An example of a human-caused wildfire happened in White River Township in April 2008. An 11-year-old boy playing with a magnifying glass started a fire which swept through 10 acres of dune grass along Lake Michigan. There were no injuries, and the only property damaged may have been some boardwalks leading to the Lake Michigan beach. The incident required the efforts of two-dozen firefighters from the Montague Fire District, White Lake Fire Authority, and Grant Township in Oceana County.

There were a total of 235 wildfires **reported** by the MDNR in Muskegon County that burned 2,089 acres between 1981 and 2000. However, between 1981 and 2010, the number of reported wildfires under MDNR jurisdiction increased to 251, with a total of 2,676 acres burned. Over this 30-year period, the county annually averaged about 8 wildfires and nearly 89 burned acres per year. Since many minor wildfires over Muskegon's landscape may go unreported to the MDNR, these statistics likely underscore the actual amounts.

Frequency of Occurrence: Recent trends, such as above average temperatures, low water levels, below average precipitation (both rain and snow), and the occasional addition of fuel to the forests from the fallen trees by wind storms all help to ensure that wildfires will occur annually. It is difficult, however, to determine their frequency due to unpredictable weather patterns and human activity. In addition, wildfire statistics for Muskegon County are difficult to pin down because the United States Forest Service, Michigan Department of Natural Resources, and local fire departments all respond to wildfires in the area.

Statistics show that over 90 percent of wildfires are human-induced in Michigan. Muskegon County has many developed areas that abut and/or intermix with forested settings. There are also numerous opportunities for outdoor recreation (especially in warmer months conducive to both recreation and wildfire) which increase the concentration of people in the county, as well as the number of people interacting with nature. Therefore, wildfires are almost certain to occur numerous times each year within Muskegon County. The severity of each occurrence will depend greatly upon the time of year, climatological conditions, geographic location of the fire, as well as the response efforts and capabilities of federal, state, and local fire suppression resources.

1.15 WINTER STORMS

Severe winter weather hazards include snowstorms, blizzards, and ice and sleet storms.

Summary: Severe winter hazards include snowstorms, blizzards, sleet, and ice storms. Extreme cold is another winter hazard that is addressed in the Extreme Temperatures section. Winter-like storms are possible from late October through April in Muskegon County; however they are most likely from mid November through early April. As a northern state, Michigan is vulnerable to all of these hazards as the result of arctic air interaction with any number of meteorological factors. It is not unusual for an area to experience any combination of these hazards in a given winter storm, thereby enhancing their effects. In addition, Muskegon County is susceptible to significant lake effect snow accumulations due to its close proximity to Lake Michigan. Annual costs of snow plowing, snow removal, vehicle damage from snow and ice-related accidents, and damage from ice storms have a significant economic impact on the county.

Hazard Description: Winter storms typically cover large areas, leading to millions of dollars worth of estimated damage. Snowstorms involve the rapid precipitation and accumulation of snow, often accompanied by high winds, cold temperatures, and low visibility. Blizzards are the most dramatic and perilous of all snowstorms, characterized by low temperatures and strong winds (35+ miles per hour) bearing profuse amounts of snow. Snow accompanying a blizzard is wind-blown in such great quantities that visibility can be reduced to only a few feet, and snow drifts many feet deep can develop. Blizzards have the potential to result in property damage and loss of life. Just the cost of clearing the snow can be debilitating to a community.

Ice storms, also known as freezing rain, are the result of cold rain that freezes on contact with the surface, coating the ground, trees, buildings, overhead wires and other exposed objects with ice, sometimes causing extensive damage. Massive traffic accidents and power outages from downed tree limbs and utility lines are common when an ice storm occurs. Ice storms usually have a regional effect whereas groups of counties are affected instead of just one county or community. Often times, ice storms are accompanied by snowfall, which camouflages accumulated ice and creates treacherous transportation conditions. Sleet storms, which involve small pellets of ice accumulating on surfaces, are less dangerous than ice storms, but can still prove hazardous to transportation and electrical systems. Both ice and sleet storms occur when the temperature is close to 32°F, but are far more severe with temperatures in the 20s.

The western half of the Lower Peninsula experiences heavy snowfall and a significant number of snowstorms. One reason for this is the "lake effect," a process by which cold winter air moving across Lakes Michigan and Superior picks up moisture from the warmer lake waters, resulting in greater snowfall amounts in the western part of the state.

All winter hazards exist in Muskegon County and may be exacerbated in rural areas of the county. People may be snowed in for days before all of the roads can be cleared, potentially causing problems for special populations who have immediate needs. The County Road Commission is alert to trees that may be downed across roads in forested areas, and has equipment that can deal with such problems. Efforts taken by the County Road Commission and local municipalities, such as salting, de-icing and plowing, help maintain safe road conditions in order to reduce hazardous impacts of winter weather. However, rural areas may be subjected to longer durations of impacts on transportation routes; depending on the road clearing strategies employed by the county road commission. The greatest concern with winter hazards seems to be the potential impacts upon transportation, electrical, and/or water and sewer infrastructure. When electric lines are downed, households may be without power for several days, resulting in significant economic loss and disruption of essential services in affected communities.

By observing winter storm watches and warnings, adequate preparation can usually be made to reduce the impact of snowstorms on Michigan communities. Providing for the mass care and sheltering of residents left without heat or electricity, and mobilizing sufficient resources to clear blocked roads, are the primary challenges facing community officials. Severe winter weather has a propensity to affect Muskegon County. It should therefore plan and prepare for winter emergencies; including the identification of mass care facilities and necessary resources such as cots, blankets, food supplies and generators, as well as snow clearance and removal equipment and services. In addition, communities should develop debris management procedures (to include the identification of multiple debris storage, processing and disposal sites) so that the tree and other storm-related debris can be handled in the most expedient, efficient, and environmentally safe manner possible.

Historically Significant and Related Events: Muskegon County has been granted four Presidential Declarations of Emergency due to blizzards and snowstorms, including January 26-31, 1977; January 26-27, 1978; January 2-15, 1999; and December 11-31, 2000. In addition, there was a Presidential Declaration of Major Disaster for an ice storm on March 20, 1976.

The blizzard of March 9, 1998 caused $100 million of property damage across the region. Snowfall was heavy and was reported at rates around and slightly over 1 inch per hour. Northerly winds increased to sustained speeds of 25 to 35 miles per hour during the morning hours and wind gusts of 45-60 miles per hour were reported along the counties bordering Lake Michigan. Downed trees and power lines cut power to some residents. The ice storm of April 3-5, 2003 affected 17 counties, caused a total of $4.9 million in property damage, and brought down thousands of trees and limbs and hundreds of power lines.

Severe Winter Events
- 2000 through 2012 -

	Nov.	Dec.	Jan.	Feb.	Mar.	Apr
# of Events	1	22	21	12	7	2
Percentage	1.5%	33.8%	32.3%	18.5%	10.8%	3.1%

Source: Storm Data, National Climatic Data Center

The NCDC lists 65 severe winter weather events in the 13 years from 2000 through 2012 in Muskegon County. These events occurred in the months of November through April, with 66 percent of them striking in December and January. During this period there were five blizzards, and freezing rain accumulation of at least one-tenth of an inch was noted five times as well.

Frequency of Occurrence: There is little doubt that winter hazards will occur a number of times every year in Muskegon County. A graphic within the Michigan Hazard Mitigation Plan (included in Appendix C) shows that the county annually receives anywhere from 70 inches of snow over the eastern reaches of the county, to over 100 inches near the Lake Michigan shoreline. In addition, the "Annual Snowfall" table gives statistics for two weather stations in Muskegon County for the 30-year period from 1981 to 2010. All accumulating snow at these stations occurred between the months of October through April. December and January are the snowiest months, combining to receive over half of the annual snowfall.

Annual Snowfall
- 1981 through 2010 -

	Montague	**Norton Shores** *Muskegon Airport*
Mean	74.55"	91.94"
30-year Low	39.2" (2001)	33.5 (2001)
30-year High	150.2" (1985)	171.9" (2008)
# years over 100"	4	10

Source: Michigan State Climatologist's Office

In the last 50 years, Muskegon County has been affected by five major storms resulting in Presidential Declarations; or once every 10 years. Less powerful, yet still significant, storms should impact the county numerous times a year. Based on 65 severe winter weather reports collected by the NCDC from 2000 through 2012, Muskegon County should expect approximately five episodes of notable severe winter weather every year. Though winter-like storms can happen from October through April, the most likely time for severe winter weather appears to be during the months of December and January. Significant ice/ freezing rain events are less frequent, occurring once every two to three years. Blizzards have also appeared, on average, once every two to three years.

2.0 TECHNOLOGICAL HAZARDS

2.01 DAM FAILURE

The uncontrolled release of impounded water resulting in downstream flooding.

Summary: Dams can fail as a result of both natural and human influences. Either case may result in downstream flooding with the potential to harm people, property, and the environment. The relatively sudden increase of downstream flow can have a similar effect as a flash flood; and impacts may also be incurred upstream, as well as downstream from a failed dam.

Because dam failures are a byproduct of the intentional impoundment of water (thus not occurring naturally), this hazard is considered a technological hazard in this plan, rather than a natural hazard. Although the risks and threats associated with dam failures are similar to those of flooding and flash flooding, mitigation actions are primarily focused on proper maintenance and regular monitoring of dams prior to failure, as well as monitoring development within the hydraulic shadow of a dam.

There are six dams in Muskegon County listed in the U.S. Army Corps of Engineers, National Inventory of Dams (NID). These dams range from low to high hazard potential.

Hazard Description: A dam failure can result in loss of life and extensive property or natural resource damage within many miles downstream from the dam, with no regard for jurisdictional boundaries. Dam failures occur not only during times of excessive precipitation, which may cause overtopping of a dam, but also as a result of poor operation, vandalism, and/or lack of maintenance and repair. Dam failures can be catastrophic if they occur unexpectedly, allowing little or no time for evacuation.

Dams may serve any number of functions, such as recreation, scenery, and the production of hydroelectricity. They can create reservoirs that are desirable locations for humans to live and recreate, and if lost, can have negative impacts on the local economy. The loss of a reservoir may reduce the value of residential properties, and eliminate recreational uses such as boating, swimming, and fishing. An emptied reservoir may also lead to public health issues if people come into contact with newly exposed sediment that is polluted. A suddenly emptied reservoir may also be a breeding ground for insects and disease.

Dams in Michigan are regulated by Part 315 of The Natural Resources and Environmental Protection Act, 1994 PA 451, as amended. Part 315, Dam Safety provides for the inspection of dams. This statute requires the MDEQ to rate each dam as either "high," "significant," or "low" hazard potential, according to the potential downstream impact if the dam were to fail (not according to the physical condition of the dam). The MDEQ has identified and rated over 2,400 dams. Dams over 6 feet in height that create an impoundment with a surface area of 5 acres or more are regulated by this statute. Dam owners are required to maintain an Emergency Action Plan (EAP) for "high" and "significant" hazard potential dams. Owners are also required to coordinate with local emergency management officials to assure consistency with the local emergency operations plan (EOP).

A report from the American Society of Civil Engineers, Michigan Section released in 2009 discusses some serious threats associated with dams in Michigan. For example, over 90% of Michigan's 2,581 dams will reach or exceed their design life by 2020; many dams are abandoned, no longer serve any useful purpose, and pose safety hazards to downstream residents. Limited, if any, funding is currently available in Michigan to help dam owners repair, rehabilitate, or remove aging dams. In addition, with the exception of 110 hydropower dams, only a few dams in Michigan (mostly lake level control structures) produce any income or have a mechanism for funding needed maintenance or repairs. Owners of dams that do not generate revenue generally do not set aside funds for their eventual repair, rehabilitation or removal; and often cannot afford to properly care for their dams. This combined with a lack of State or other public-funding mechanisms to assist dam owners causes inadequate or crumbling dams to go unattended, posing significant safety hazards to downstream residents and local and regional economies.

Muskegon County has six dams that are identified in the National Inventory of Dams (NID), which classifies dams as high, significant, or low hazard potential. See Appendix C for more information on the hazard potential class definitions. Of the Muskegon County dams, one is rated high, two are rated significant, and three are rated low. The high hazard potential dam is located in Egelston Township. The two dams rated significant hazard potential are in Blue Lake Township. The three low hazard potential dams are located in the City of Norton Shores, City of Whitehall, and Whitehall Township.

The county is also somewhat vulnerable to dam failures occurring in neighboring communities. The Croton and Hardy Dams are located upstream from Muskegon County on the Muskegon River and the Hesperia Pond Dam is located upstream from Whitehall and Montague on the White River. Fortunately, both rivers have wide "river flats" as they enter Muskegon County. Some flooding along these rivers could result from a failure of any of these dams. Any sudden rush of water would have the potential to cause significant erosion along the riverbanks and may threaten the stability of road-river crossings such as Maple Island Road, US-31, Business Route US-31, and the Veterans Memorial Causeway along the Muskegon River; and Fruitvale Road, US-31, and Business Route US-31 along the White River. The 1.5-mile stretch of US-31 across the Muskegon River marsh was constructed atop a levee, essentially bisecting the marsh. This structure may help to slow the downstream progression of floodwater from dam failures in Newaygo County. However, failure of this earthen structure may complicate matters around Muskegon Lake, especially if US-31 is washed away.

Historically Significant and Related Events: The MDEQ has documented approximately 287 dam failures in Michigan since 1888. Since 1970, at least four of these failures have been in Muskegon County but the specific dates, reasons, and locations for the failures are not available. It is assumed that one was the Silver Creek Dam failure in 1986.

Though upstream dam failures have not directly caused damage in Muskegon County, failures have occurred. For example, White River dams in Hesperia (Oceana County) and White Cloud (Newaygo County) failed during floods in 1975 and 1986. The City of White Cloud breached the northern side of the earthen dike in 1975 to save the dam. The earthen portion of the Hesperia Dam was also washed out or intentionally breached during this flood. Both dams were rebuilt. In 1986 both the City of White Cloud and Village of Hesperia cut channels through the earthen embankments to save the dam structures.

Frequency of Occurrence: Muskegon County is somewhat vulnerable to dam failures since dams do exist in the county and do age. Dam failures in the past have not been memorable but might have occurred during the 1986 flooding event. If all failures occurred then, there would have been only one event in 43 years.

According to the MSP-EMHSD, there is no correlation between hazard potential and the number of documented failures in Michigan. Dams in Muskegon County are believed to be in good shape and are monitored constantly (one dam in Blue Lake Township has been repaired within recent years). However future failures in the county are expected. With four known failures between 1970 and 2012, the county averaged up to one failure every ten years. However, since records of dam failures are incomplete, this estimated frequency might be inaccurate. It is possible that some or all of the recorded dam failures were the direct or indirect result of one weather event (floods of 1986).

It is therefore possible that there will be approximately one weather event every 43 years severe enough to cause dam failures.

2.02 ENERGY EMERGENCIES

An actual or potential shortage of gasoline, electrical power, natural gas, fuel oil, or propane of sufficient magnitude and duration to potentially threaten public health and safety, and/or economic and social stability.

Summary: Historically, energy emergencies have not been considered as a significant hazard in Muskegon County. However, this hazard is discussed by the Michigan Hazard Mitigation Plan and is summarized in this plan to increase awareness among emergency responders, public safety officials, and community leaders. The following hazard description is only a portion of the information contained within the state plan, which can be referenced for additional information.

Energy supplies in Muskegon County are largely at the mercy of events beyond the county's borders, as well as greater regional and national trends. This hazard is addressed in order to raise awareness of this vulnerability and highlight the fact that Muskegon County's energy needs are closely connected to statewide and national issues. For more detailed information about this potential hazard, please refer to the Michigan Hazard Mitigation Plan.

Hazard Description: An adequate energy supply is critical to Michigan's (and the nation's) economic and social well-being. The American economy and lifestyle are dependent on an uninterrupted, reliable, and relatively inexpensive supply of energy that includes gasoline to fuel our vehicles, and electricity, natural gas, fuel oil and propane to operate our homes, businesses and public buildings. Energy emergencies became a serious national issue in the 1970s when two major "energy crises" exposed America's increasing vulnerability to long term energy disruptions. Americans have always dealt with short term energy disruptions caused by severe weather damage (i.e., downed power lines and poles), broken natural gas and fuel pipelines, and shortages caused by the inability of the energy market to adequately respond to consumer demand and meet needed production levels. However, the Oil Embargo of 1973-74, the natural gas shortage of 1976-77, the 1979 major price increases in oil resulting from the Iranian Revolution, the Gulf War in 1991 (after Iraq invaded Kuwait and destroyed many of its oil fields) and the aftermath of the September 11, 2001 terrorist attacks in the U.S. forced the country to recognize its vulnerability to energy disruptions. That vulnerability was again exposed during the Great Blackout of 2003 when about 50 million electric customers in the northeast United States lost power due to a power grid malfunction. The oil price increases during 2007 and 2008 pushed American gasoline prices to over $4 a gallon and caused major economic and energy related issues as well.

There are three types of energy emergencies. The first and most frequent type of energy emergency involves physical damages to energy production or distribution facilities, caused by severe storms, tornadoes, floods, earthquakes, or sabotage. Michigan has experienced a number of these short-term energy disruptions in recent history, mostly due to high winds associated with severe thunderstorms or damage caused by ice storms. While there have been only a few incidents of sabotaged energy systems in this country, networks supporting terrorist activity exist throughout the world and the possibility of more frequent incidents in the United States is always present. This category of energy emergency also covers short-term disruptions caused by human error, accidents or equipment failure, such as the power outages that occurred in Detroit in December 1998 and the Summer of 2000, the Wolverine Pipeline Company pipeline rupture in Jackson County in June 2000, the Mackinac Island power failure in July 2000, and the Great Blackout of 2003 that affected over 50 million energy customers. (Refer to the Infrastructure Failures, Severe Winds, and Ice/Sleet Storms sections of this document for additional information on short-term energy emergencies caused by weather, accidents, and equipment failure.)

The second type of energy emergency involves a sharp, sudden escalation in energy prices, usually resulting from a curtailment of oil supplies. Michigan experienced this type of energy emergency in the mid and late 1970s due to events in the world oil market, and in 1991 following Iraq's invasion of Kuwait. The winter of 2000/2001 saw a sharp spike in natural gas costs due to reduced availability. However, many Michigan customers were unaffected, due to a price freeze on Michigan's major gas utilities. When oil reserves in Louisiana were blocked during Hurricane Katrina (August 2005), the effects were felt in Michigan and the Governor issued a State of Energy Emergency due to a gasoline shortage. Since 2001, energy costs for the average U.S. household have more than doubled, and sharply escalating gasoline prices have again strained the budgets of lower and middle class families. The summer of 2008 had the highest oil prices on record, following a dramatic rise in prices from 2007 to 2008. Gasoline prices peaked at more than $4 per gallon. This contributed to the economic downturn beginning in 2007, as well as a move toward more fuel-efficient vehicles.

The third type of energy emergency is a sudden surge in energy demand caused by a national security emergency involving mobilization of U.S. defense forces. National defense, in a time of crisis, will demand an increase in energy. Although the regulated natural gas and electric utilities have approved state and federal priority allocation systems that are in place, regulatory changes to introduce competition into natural gas and electric markets have not fully addressed how such shortages might be managed once these markets are fully opened.

Historically Significant and Related Events: Listed below are a few examples of energy emergencies that have affected Muskegon County residents.

January 1918 – Muskegon: Fuel Shortages

Serious coal and fuel shortages combined with a major blizzard forced city-wide curfew in the City of Muskegon to conserve resources.

December 2000 – State of Michigan: Propane Supply Problems

Going into the winter of 2000 - 2001, propane supplies were very tight and inventories were low. In the Midwest, propane inventories in mid-October 2000 were 44% below levels of one year earlier. In December 2000, the state experienced record cold weather. Heating degree-days showed temperatures were 27 degrees colder than normal, the second coldest December on record and the snowiest on record. The propane industry found it increasingly difficult to maintain deliveries in light of the high levels of demand. In response to industry requests and in view of the heavy snows and very cold weather, the Chair of the Michigan Public Service Commission, in consultation with the Emergency Management and Homeland Security Division of the Michigan State Police, requested a 10-day waiver of limits on driver hour restrictions from the Regional Administrator of the Federal Motor Carrier Safety Administration. Waivers were granted for Michigan (and also Indiana, at their request). The extremely tight supply coupled with additional demand to use propane as a substitute for natural gas (which also had a sharp run up in prices) caused residential propane prices to reach a record high in Michigan of $1.76 per gallon in January 2001 before declining to $1.00 per gallon by the end of the heating season. A significant warming trend in January allowed the industry time to replace seriously depleted supplies. Had this not occurred, the situation could have become much more serious.

February 2003 – Western Lower Peninsula

A break in a major transmission line caused a 60-mile electrical blackout that stretched over parts of six counties. The break cut electricity to tens of thousands of customers in the counties of Montcalm, Mecosta, Oceana, Newaygo, Muskegon, and northern Kent. The customers included hospitals, retirement homes, and schools. The power outage apparently started in the Croton-Hardy Dam area in Newaygo County. The power line that was cut normally supplies electricity to about 70 substations in the affected counties.

August 2005 – State of Michigan: Petroleum Product Supply Problems

On August 31, 2005, Governor Granholm issued three executive orders to address energy-related issues in Michigan caused by Hurricane Katrina. The massive hurricane blocked off oil refineries stationed in Louisiana and affected the supply in Michigan. Executive Order 2005-16 declared a State of Energy

Emergency in accordance with 1982 PA 191. Executive Order 2005-17 temporarily waived regulations relating to motor carriers and drivers transporting gasoline, diesel fuel, and jet fuel. Executive Order 2005-18 provided for a temporary suspension of rules for gasoline vapor pressure. The State of Energy Emergency was in effect until November 29, 2005.

2007-2008 – United States: Oil Price Increases

Crude oil prices reached an all-time high in Michigan in July-September 2008. During 2003, the price rose above $30 a barrel in the peak summer months, and reached $60 a barrel by August 2005 nationally. The dramatic rise in oil prices began in March of 2007 with a steady increase that included little break during the 2007-2008 winter's traditional low point. March of 2008 started the very large increase in oil prices, starting at just over $80 a barrel, eclipsing $100 a barrel in May 2008, and finally peaking at $147 a barrel in July 2008. Following the July 2008 peak, oil prices then took a dramatic dive, and by November 2008 returned to just under $40 a barrel, the lowest level since March 2005. The increase in prices led to gasoline prices of over $4 a gallon during the summer of 2008. Commentators attributed these price increases to many factors, including reports from the United States Department of Energy and others, such as the decline in petroleum reserves, concern about high demand for oil, Middle East tension, and oil price speculation. Also, an unusual number of fires and other outages among U.S. refineries in the summer of 2007 disrupted supplies. A reduction in routine refinery maintenance was made necessary by the need to operate near full capacity to make up for a loss in refinery capacity from the 2005 Atlantic hurricane season; and deferred maintenance on refineries that escaped hurricane damage led to an increase in fires and accidents in 2007. Hurricane Ike in 2008 played a role in the price spike. Also, rising demand from U.S. consumers stretched refinery capacity to the limit and made the whole system more vulnerable to disruptions.

Frequency of Occurrence: Localized interruptions of electrical service are undoubtedly the most likely type of energy emergency in the county (see section 2.07 Infrastructure Failures for more information regarding power outages). However, the short list of energy emergencies presented above demonstrates that Muskegon County residents are exposed to other types of energy emergencies as well.

2.03 FIRE: SCRAP TIRES

A large and uncontrolled fire that burns scrap tires being stored for recycling/re-use.

Summary: Scrap tire fires produce a slew of complications, including toxic smoke and groundwater contamination, and require significant resources to extinguish. In addition, scrap tire piles pose a threat to public health by providing shelter and breeding grounds for mosquitoes and small animals.

In 2001, there were an estimated 112,000 scrap tires in Muskegon. However today, there are only a few small concentrations remaining thanks to annual scrap tire cleanup grants awarded by the MDEQ. Even so, the threat remains for concentrations to redevelop, and careful steps should be taken to ensure proper disposal of scrap tires.

Hazard Description: With the disposal of an estimated 290 million vehicle tires annually in the United States, management of scrap tires has become a major economic and environmental issue. Michigan generates approximately 10 million scrap tires each year. Although responsible means of storage and disposal have become more common, tire dumps of the last forty years still present environmental and safety hazards. In November 2009, the State of Michigan identified a total of over 990,400 tires (those that pose the greatest fire danger) in outdoor stockpiles scattered around the state. Since the MDEQ Michigan Scrap Tire Program began in 1991, the total amount of Michigan's scrap tire stockpile has gone from 31 million to about 3,400,000. The department estimated that most of the remaining tires could be disposed of before the program's ending date in December 2012.

Issues pertaining to the management of scrap tire disposal sites are difficult and diverse. Whole tires are difficult to landfill because they tend to float to the surface. Whole tires are banned from disposal in Michigan landfills due to their associated problems. Scrap tires are breeding grounds for mosquitoes, which can reproduce at thousands of times their natural rate in a scrap tire disposal site. These mosquitoes can carry and transmit life-threatening diseases. Stockpiles also are home to snakes and small mammals such as rats, opossums, skunks, and raccoons. Stockpiled tires are often soiled with mud, dirt, or other foreign materials that limit potential markets and increase processing costs. From an emergency management perspective, the most serious problem that scrap tire disposal sites pose is that they can be a tremendous fire hazard if not properly designed and managed.

Tire disposal sites can be serious fire hazards due to the sheer number of tires typically present at a site. This large quantity of "fuel," coupled with the fact that the shape of a tire allows air to flow into the interior of a large tire pile, renders standard fire fighting practices nearly useless. Flowing burning oil released by the tires spreads the fire to adjacent areas. Some scrap tire fires have burned for months, creating acrid smoke and an oily residue that can leach into the soil, creating long-term environmental problems.

Deep stockpiles of compacted tire shreds can undergo a progressive series of exothermic reactions that increase pile temperatures and generate combustible gases. Surface symptoms of this phenomenon can be subtle, such as a slight sulfur odor, vapor steaming from isolated sections of the pile surface, or a slight oil sheen on adjacent standing water after rainfall. Due to the potential for auto-ignition, surface fires can ignite on a shredded tire stockpile, especially as shreds are removed from the area near the hot zone. Gases and shreds are then exposed to air and may ignite.

Scrap tire fires differ from conventional fires in several respects: 1) even relatively small scrap tire fires can require significant resources to control and extinguish; 2) the costs of fire management are often far beyond that which local government can absorb; 3) the environmental consequences of a major tire fire are significant; and 4) as alluded to earlier, the extreme heat converts a standard passenger vehicle tire into about two gallons of oily residue, which can leach into the soil or drain into streams.

Current technologies are sufficient to address the reuse of newly generated scrap tires, but some waste tires still migrate to the least expensive disposal method, which usually means they end up in legal and illegal scrap tire disposal sites. Lightning strikes, equipment overheating or sparks, unattended burning of debris/refuse, and arson are the leading causes of tire fires. Fires are also sometimes started by site operators or local residents in the wake of publicity over clean-up activities. This publicity can include enforcement proceedings or initial abatement activities, suggesting that a landowner may be acting out of frustration or attempting to avoid costs associated with tire abatement.

Much work still needs to be done to mitigate the impacts of scrap tire fires. Incident management planning, recognition of the hazardous material potential of fires at scrap tire sites, and improving and enhancing disposal site selection and design processes are all critical pre-incident preparedness factors that must be addressed by government and the private sector. In light of the potential consequences of scrap tire fires, prevention must become a primary goal in the treatment of scrap tire disposal sites. The Rubber Manufacturers Association maintains a website that contains extensive information regarding scrap tires that may be useful to local officials. This website can be accessed at: http://www.rma.org/scrap_tires/.

In Muskegon County, it is doubtful that a fire involving scrap tires would in itself cause a severe emergency or disaster. Rather, scrap tires are more likely to add problems to an already existing fire. Although there were an estimated 112,000 scrap tires in Muskegon County in 2001, most have been removed since then. In 2012, the Michigan Department of Environmental Quality estimated 4,400 total scrap tires at three "Registration Non-Compliant" sites in Muskegon County. Six scrap tire cleanup grants totaling $19,951 were awarded in Muskegon County in Fiscal Year 2012 to dispose the passenger tire equivalent (PTE) of 15,930 tires. It is possible that other, undocumented concentrations exist within the county.

To prevent the scrap tire fire hazard, as well as threats to public health from scrap tire piles, mitigation measures must involve the prevention of indiscriminate scrap tire dumping and include proper disposal, recycling, and reuse practices. Various "junk days," such as the Spring and Fall Dumpster Days in the City of Muskegon, are held at various places throughout the county to encourage the disposal of garbage, such as scrap tires. This type of service helps to control mass accumulations of scrap tires within the county. Though Muskegon County does not have a registered outdoor scrap tire collection site, numerous tire retailers and municipal transfer stations accept tires for a small fee.

Historically Significant and Related Events: Although research for this document was unable to reveal a history of scrap tire fires in Muskegon County, the possibility of one cannot be ignored. Because automobiles are the primary mode of transportation in Muskegon County, there is a constant potential for accumulation of discarded tires. Therefore this hazard should be monitored as a potential threat to public health and safety.

In 2012, there were an estimated 4,400 scrap tires in Muskegon County, though it is likely most have been or will be cleaned up thanks to grants awarded in fiscal year 2012.

The nearby counties of Mecosta and Osceola have experienced the following significant scrap tire fires in the recent past:

April 16, 1997 – Osceola County

The worst tire fire ever in Michigan occurred in Osceola County. The salvage yard where the blaze started contained over 6 million tires. All of the fire departments in a five county area were contacted. Residents within a three-mile radius were evacuated. The fire was extinguished in about two and one-half days by digging a trench around the perimeter of the fire to prevent its spread, and capping the fire with sand. In all, 478 firefighters from 34 different departments fought the blaze. The final cost of putting the fire out came to approximately $300,000. Over 1.5 million tires, two buildings and some trailers were lost in the fire.

February 24, 2000 – Mecosta County

A fire broke out at a tire recycling plant located in Hinton Township in Mecosta County. The fire had started in a pole barn that contained approximately 50,000 shredded tires. Nearby structures that also contained scrap tires were in danger of catching fire as well. Approximately 150 fire personnel from 13 local fire departments fought the blaze. Eventually, sand was brought in by a local contracting firm to smother the flames. Investigators determined that the apparent cause of the fire was a machine that had caught fire earlier and had not been adequately extinguished. The fire had then spread from the machine to the tires.

Frequency of Occurrence: Although there is no record of a serious scrap tire fire in Muskegon County, the possibility of one cannot be entirely discounted as a threat in the future. It is doubtful that a fire involving scrap tires would in itself cause a severe emergency or disaster, therefore scrap tire fires are not considered a significant hazard in Muskegon County.

2.04 FIRE: STRUCTURAL

A fire, of any origin, that ignites one or more structures, causing loss of life and/or property.

Summary: Every 23 seconds, a fire department responds to a fire somewhere in the nation. A structural fire occurs at the rate of one every 65 seconds, and in particular a residential fire occurs every 85 seconds. In 2011, structure fires represented 34.9% of all fires across the United States.

In terms of average annual loss of life and property, structural fires – often referred to as the "universal hazard" because they occur in virtually every community – are by far the most common hazard facing most communities in Michigan and across the country. In Muskegon County, developed areas have a greater risk of experiencing widespread structural fires than rural areas. In addition, the county's stock of historical structures increases the threat of conflagration, especially in downtown areas. Historic buildings increase this risk because they often do not meet today's fire protection standards.

Hazard Description: Structural fires are most threatening when they occur in densely developed or urban environments, where there is a potential for a single fire to become a conflagration. According to the National Fire Protection Association (NFPA), in 2011, there were 2,640 civilian deaths and 15,635 civilian injuries as a result of structural fire in the United States. There were 21 fatalities in 2011 where firefighters became ill or injured while on the scene of a structure fire. There were an estimated 484,500 structural fires in 2011, while direct property damage due to fires was estimated at $9.7 billion.

The 2011 statistics continue a declining trend in fires, casualties, and injuries over the past few decades. For example, from 1977 to 1979, the nation averaged 1,065,500 structural fires, 6,275 civilian deaths, 25,382 civilian injuries, and property damages of about $14.8 billion (when adjusted for inflation).

Unfortunately, although the United States has made great strides in lessening deaths and injuries caused by other types of disasters, structural fires are a worse problem in this country than in many other industrialized countries (even those with a more densely-developed population pattern). The United States Centers for Disease Control (CDC) figures indicate that fire-associated mortality rates in the United States are approximately 2-3 times greater than those in many other developed countries. According to the Federal Emergency Management Agency's National Fire Data Center, residential fires represent 78% of all structural fires and cause 80% of all fire fatalities. Approximately 83% of those fatalities occur in single-family homes and duplexes. Perhaps the most tragic statistic of all is that over 40% of residential fires and 60% of residential fatalities occur in homes with no smoke alarms. (Studies have repeatedly shown that a working smoke alarm dramatically increases a person's chance of surviving a fire.)

Michigan's fire experience generally mirrors the national fire situation. According to statistics compiled by the Fire Marshal Division of the Michigan Department of Energy, Labor and Economic Growth for 2003, nearly 19,000 structural fires occurred in Michigan, resulting in 161 deaths and 624 injuries. The dollar loss for all fires was estimated at over $230 million. The Fire Marshal Division estimated that a structural fire occurred in Michigan about every 28 minutes in 2003. The U.S. Fire Administration reports that Michigan's fire death rate was 15.4 persons per million in 2007 and 16.4 per million in 2009. In 2009, Michigan ranked 11th among states in the nation, and was well above the national average of 11.0 deaths per million population.

Structural fires are especially likely to happen in the winter when wood stoves and sub-standard heating implements are most often used. Rural homes are more likely to use wood stoves, fireplaces and liquid propane heating equipment, and they may also have a greater exposure to wildfire threats during warm seasons. A special concern for many rural homes is the fact that emergency personnel cannot adequately respond to emergencies due to complications such as: 1) home addresses that are not visible from main roads; 2) driveways, two-tracks, or dirt roads that are too narrow for large vehicles to enter, turn around, or pass other vehicles; or 3) driveways that are "gated." These complications may be more common within coastal dune areas along Lake Michigan and in densely wooded areas.

Another concern is the potential for large structural fires in the "core" of the county's old commercial districts. Aging wooden framed multi-story commercial buildings with common walls, substandard electrical systems and remodeled 2nd and 3rd floors, done with little or no regard for fire code, present a fire chief with his worst nightmare, especially if the higher stories are tenant occupied. Mobile home fires also present a significant threat to life. There are many mobile home concentrations scattered throughout the county. See the "Severe Winds" hazard section for mobile home statistics in Muskegon County.

Historically Significant and Related Events: Structural fires are a common occurrence in Muskegon County. Statistics from the Michigan State Police, Fire Marshal Division estimated that the county's fire incident rate was 3.8 fires per 1,000 in population in 1998, about average for Michigan counties. If this rate held true for the 2010 county population (172,188), Muskegon would have experienced approximately 654 fire incidents in that year. This estimate includes all types of fire incidents and it is not known how many of these fires would be structural.

In 2003, Michigan fire departments reported 43,509 fires to the National Fire Incident Reporting System (NFIRS), with 18,759 of them (43%) involving "structures." The remaining fires are listed as "outside/other" (15,285) or "mobile properties" (9,475). Therefore, in Michigan in 2003, there was a fire of any origin once every 12 minutes and 7 seconds, and one structural fire every 28 minutes and 6 seconds. These fires resulted in 161 civilian deaths, 624 civilian injuries, and 514 fire service on-duty injuries. There were 895 fires in Muskegon County in 2003 which caused property and contents losses of $3,167,705. Based on the proportion of structural fires to all types of fire in Michigan, it is likely that around 385 (43%) of the reported fires involved structures.

Devastating fires affected the City of Muskegon in 1871, 1874, 1891, and 1946. The fires of 1871 and 1874 prompted the establishment of a fire department in the city. The costliest fire in the City's, and perhaps the County's, history was the Hardy's Department Store Fire on February 22, 1946. The blaze destroyed a block of Western Avenue businesses causing $1.5 million in losses. When adjusted for inflation, it caused nearly $17 million in damage. The Pine Street Fire in 1891 was the city's second-most destructive fire, destroying 250 buildings across 17 city blocks and 80 acres in the City of Muskegon. Numerous other significant fires afflicted business in districts Muskegon County, such as those in Fruitport and Ravenna in 1900.

More recently, the 162-year-old Michillinda Lodge in Fruitland Township burned down in December 2012. The apparent cause was attributed to a space heater in one of the historic facility's 52 rooms. The fire prompted a collaborative effort to fight the fire that included all fire departments in the county except for Muskegon's. An estimated minimum of 65 firefighters were at the scene. Fire officials from the adjacent counties of Newaygo, Oceana, and Ottawa were called in to cover the county during the response.

Frequency of Occurrence: There will certainly be structural fires each year in Muskegon County. Fortunately most of these fires will be confined to a single site and widespread damages will be limited. Based on the 2003 and 2010 fire estimates discussed above (estimated 385-654 fires per year), Muskegon County should expect an average of one to two fires of any kind per day. The actual number of fires experienced in the county can vary greatly from season to season, and year to year.

2.05 **HAZARDOUS MATERIAL INCIDENTS: FIXED SITE** (including industrial accidents)

An uncontrolled release of hazardous materials from a fixed site capable of posing a risk to life, health, safety, property or the environment.

Summary: The potential release of hazardous materials exists wherever that material may be located. Hazardous materials are chemical substances which, if released or misused, can pose a threat to people, property, or the environment. These chemicals are used in industry, agriculture, medicine, research, and consumer goods. As many as 500,000 products pose physical or health hazards and can be defined as "hazardous chemicals." Each year, over 1,000 new synthetic chemicals are introduced.

As of 2013, there were 51 SARA Title III sites in Muskegon County (known to store potentially dangerous amounts of hazardous materials); two-thirds of which were located within the cities of Muskegon, Muskegon Heights, and Norton Shores. Most of these sites host industrial activity. According to the 2007-2011 American Community Survey, manufacturing is the largest employment sector in Muskegon County, accounting for 25.2 percent of the county's jobs.

Also included in this section are industrial accidents, defined as a fire, explosion, or other severe accident (especially if it involves hazardous materials) at an industrial facility that results in serious property damage, injury, or loss of life.

Hazard Description: Over the past few decades, new technologies have developed at a stunning pace. As a result, hazardous materials are present in quantities of concern in business and industry, agriculture, universities, hospitals, utilities, and other facilities in our communities. Hazardous materials are materials or substances which, because of their chemical, physical, or biological nature, pose a potential risk to life, health, property, or the environment if they are released. Examples of hazardous materials include corrosives, explosives, flammable materials, radioactive materials, poisons, oxidizers, and dangerous gases. Hazardous materials are highly regulated by federal and state agencies to reduce risk to the general public and the environment. A facility is subject to SARA Title III provisions if extremely hazardous substances, as determined by the US Environmental Protection Agency (EPA), are present at the Facility in quantities at or above the minimum threshold quantities established in Section 302 of the Act.

Industrial accidents differ from hazardous material incidents in the scope and magnitude of offsite impacts. Whereas hazardous material incidents typically involve an uncontrolled release of material into the surrounding community and environment that may require evacuations or in-place sheltering of the affected population, the impacts from industrial accidents are often confined to the site or facility itself, with minimal physical outside impacts. Nonetheless, industrial accidents, such as fires, explosions, and excessive exposure to hazardous materials, may cause injury or loss of life to workers at the facility, and significant property damage. Industrial accidents may result in severe economic disruption to the facility and surrounding community, as well as significant long-term impacts on the families of the workers injured or killed.

Despite precautions taken to ensure careful handling during the manufacture, transport, storage, use, and disposal of these materials, accidents do occur. Often, these incidents can cause severe harm to people or the environment if proper action is not immediately taken. Most incidents are the result of human error. Occasionally, incidents can be attributed to natural causes, such as a flood that washes away barrels of chemicals stored at a site. However, those situations are the exception rather than the rule.

As of 2013, there were 51 sites in Muskegon County designated as a SARA Title III, Section "302 Site." Should there be any future site designations, law requires each site to have an emergency plan on file with the Local Emergency Planning Committee (LEPC), fire department, and at the facility. The LEPC's are responsible for developing emergency response plans for communities that have facilities in their jurisdiction that are subject to SARA Title III Emergency Planning Requirements. The LEPC is the primary mechanism through which local SARA Title III planning, training and exercising activities are implemented. Despite such extensive guidelines, the possibility of human error in complying with these plans means that a hazard would still exist in the event that a location in the county becomes designated as a "302 Site." When a "302 Site" is located near other developments, compliance with LEPC planning is especially important.

Historically Significant and Related Events: Muskegon County has experienced several hazardous materials incidents and industrial accidents over the years. Below is a timeline including some of the significant events:

- 1920 – Explosion and fire at Brunswick, Balke, Collender Co. claims seven lives.
- 1935 – Fire at Naph-Sol Refinery occurs when processing chemicals explode.
- 1990 – Release of phosphorus oxychloride caused 1,000 to be evacuated in Egelston Twp.
- 1999 – Release of hydrogen sulfide caused one fatality, one injury, $411,000 in property damage and the evacuation of 11 employees in Whitehall.
- 2000 – Foundry explosion in Egelston Township injured ten people.
- 2001 – Explosion in Norton Shores set two homes and a business on fire.
- 2003 – Explosion caused a fatality in Egelston Township.
- 2012 – Explosion in Norton Shores, spraying molten metal and setting fire to the facility.

Muskegon County is fortunate to have excellent coordination and cooperation between fire departments, as well as an award-winning HAZMAT team to deal with any situations that require its assistance. Four members of the 18 member team took top honors in the inaugural "HAZMAT Team Challenge," hosted by the MSPEMD's Hazardous Materials Training Center in 2004. The members demonstrated knowledge regarding fire-fighting, law enforcement, and chemical analysis.

Frequency of Occurrence: Thanks in part to the industrial history in Muskegon County, releases of hazardous materials and industrial explosions have been unfortunately regular occurrences. With 51 SARA Title III Sites in Muskegon County, the possibility of an illicit or accidental release is a distinct possibility. And, although the number of manufacturing jobs in the county has declined in the recent past, numerous operations continue to thrive.

Research for this hazard uncovered eight incidents involving hazardous materials or industrial explosions over a 93-year period, an average of once every 12 years. This rate likely underscores the actual frequency because the true number of incidents over this period is likely to be greater.

2.06 HAZARDOUS MATERIAL INCIDENTS: TRANSPORTATION

An uncontrolled release of hazardous materials during transport, capable of posing a risk to life, health, safety, property or the environment.

Summary: The transportation of hazardous materials along highways, roads, and rails is a common occurrence, both passing through and directly to sites within Muskegon County. As of 2012, there were 51 SARA Title III sites in Muskegon County (see discussion in 2.05 Hazardous Material Incidents: Fixed Site); most of which host industrial activities in urban settings. Hazardous materials may also be transported to rural areas of the county for agricultural purposes.

Hazard Description: As a result of the extensive use of chemicals in our society, all modes of transportation - highway, rail, air, marine, and pipeline - are transporting hazardous materials on a daily basis through local communities. A transportation accident involving any one of those hazardous material shipments could cause a local emergency with the potential to affect many people. Smaller incidents, while problematic for the affected community, are fairly common in Michigan, and are effectively dealt with by local and state emergency responders and hazardous material response teams. Larger incidents, however, pose a whole new set of problems and concerns for the affected community. Large-scale or serious hazardous material transportation incidents that involve a widespread release of harmful material (or have the potential for such a release) can adversely impact the life safety and/or health and well-being of those in the area surrounding the accident site, as well as those who come in contact with the spill or airborne plume. In addition, damage to property and the environment can be severe as well. Statistics show that nearly every hazardous material transportation incident is the result of an accident or other human error. Incidents are rarely caused solely by mechanical failure of the carrying vessel.

There have been many minor petroleum and hazardous materials spills throughout the years on highway systems in Michigan. Muskegon County contains two major divided highways, US-31 and I-96, and several state roads that are heavily used. These routes are heavily congested in the summer months and often icy or impassable in the winter.

The Muskegon County Airport provides a variety of local transportation services. The county also lies beneath the "fly-over" zone for aircraft plying their way back and forth between the "air hubs" of Minneapolis, Grand Rapids, Detroit and New York. At times, there may be anywhere from 12-18 aircraft flying above the county. Also, The Michigan Shore Railroad, operated by Genesee and Wyoming, Inc., makes regular runs to industrial sites in the Muskegon urban area. The rail connects to Fremont to the northeast, and to Grand Haven and other points to the south.

Freight ships and barges use Muskegon's deepwater port for receiving raw materials and shipping products. Bordering the Great Lakes and containing a commercial port, one of the most dangerous hazardous material transportation scenarios that could occur in the county would be a spill or release of oil, petroleum, or other harmful material from a marine cargo vessel. Such an incident, if it involved a large quantity of material, could cause environmental damage of unprecedented proportions. Fortunately, the Great Lakes states, working in partnership with oil and petroleum companies and other industries, have taken significant steps to ensure that a spill of significant magnitude is not likely to occur on the Great Lakes. Low water levels may increase the possibility of a ship running aground and releasing harmful amounts of contaminants into the environment.

Historically Significant and Related Events: Although there is no record of a major hazardous materials incident occurring on Muskegon County transportation routes, there have been minor incidents. In 1982, a freight train derailment caused a spill of chlorine and caustic acid, after which 600 Fruitport Township residents were evacuated. Then on December 6, 1985 a gasoline tanker overturned on M120 near Brickyard Road and dumped about 2,200 gallons into the ditch.

Frequency of Occurrence: There has only been one serious transportation accident involving hazardous materials documented in Muskegon County in last 30 years. Less serious accidents are estimated as occurring once or more a year in the 2000 Muskegon County Hazard Analysis. A serious hazardous materials incident may occur on a county roadway, railway, airway, or waterway.

2.07 INFRASTRUCTURE FAILURES

The failure of critical public or private utility infrastructure resulting in a temporary loss of essential functions and/or services.

Summary: As reported in a 2009 study by the National Academy of Sciences, an electrical blackout "has the potential to affect virtually all sectors of society: communications, transportation, banking and finance, commerce, manufacturing, energy, government, education, health care, public safety, emergency services, the food and water supply, and sanitation."

Power loss is the most common form of infrastructure failure in Muskegon County, often occurring as a result of natural hazards. Isolated residences in rural areas may be exceptionally vulnerable to extended power loss events, especially during the winter months. Muskegon also has an extensive network of roads and municipal water and wastewater infrastructure.

Hazard Description: Michigan's citizens are dependent on public and private utility infrastructure to provide essential life supporting services such as electric power, heating and air conditioning, water, sewage disposal and treatment, storm drainage, communications, and transportation. When one or more of these independent, yet interrelated, systems fail due to disaster or other cause - even for a short period of time - it can have devastating consequences. For example, when power is lost during periods of extreme heat or cold, people can literally die in their homes if immediate action is not taken. When the water or wastewater treatment systems in a community are inoperable, serious public health problems may arise and require immediate attention in order to prevent outbreaks of disease. When storm drainage systems fail due to damage or an overload of capacity, serious flooding can occur. These are just some examples of the types of infrastructure failures that can occur, and all of these situations can lead to disastrous public health and safety consequences if immediate mitigation actions are not taken.

Typically, special populations such as the elderly, children, impoverished, and people in poor health are the most impacted by infrastructure failures and must receive special consideration when failures occur. If the failure involves more than one infrastructure system, or is large enough in scope and magnitude, whole communities and possibly even regions can be severely impacted.

Although Michigan has in place many codes and standards that govern the design, construction, and operation of public and private utility infrastructure, these codes and standards are often inadequate to protect the infrastructure from disaster-related damage. In many cases, the codes and standards call for the minimum level of structural integrity and operational performance recommended in accepted engineering practice, when a higher level would result in less disaster damage. Obviously, a balance must be reached between structural integrity, operational reliability, and short- and long-term costs associated with upgrading facility codes and standards.

Though it is possible to design and operate facilities that are virtually "disaster-proof," in many cases it is not economically feasible. Extensive increases in integrity and reliability can result in prohibitive increases in cost. It is often too expensive to upgrade infrastructure codes and standards much beyond their current levels. However, in those cases where recurring, severe damage and system down-time occur due to natural or technological hazard events, it makes sense to explore the possibility of enhancing infrastructure design, construction, and operational codes and standards.

As Michigan's public and private utility infrastructure systems continue to age, infrastructure disasters will undoubtedly become more common. Because many of these systems were developed decades ago, the costs of repairing and replacing aging sections and/or components have greatly increased. As a result, many communities cannot afford to do the maintenance work necessary to keep the system in ideal operational mode. Increasing demands on the systems also lead to increased deterioration and in many cases pipes have far exceeded their useful service life. This creates a situation of increasing risk for infrastructure-related disasters, either as a primary event, or as a secondary event to floods, windstorms, snow and ice storms, or other natural or technological hazards. When those disasters do occur, they cause great inconvenience to the affected population and they can also create subsequent public health and safety concerns.

There are just over 1,101 miles of designated state, county, and city paved and unpaved roads in Muskegon County (Muskegon County Road Commission, 2010). According to the Michigan Asset Management Council, the condition of 10,000 miles of Michigan's federal aid eligible roads went from either “good” or “fair” to “poor” between 2004 and 2007. According to the US Census Bureau, Michigan has been ranked in the bottom ten of all states for over 40 years in its level of funding. After a decade of stagnant revenues in road funding, the Michigan Department of Transportation (MDOT) showed an additional 15 percent decline in funding between 2008 and 2011. Another challenge for Michigan’s roads and bridges is the annual winter freeze-and-thaw cycle that causes a continual breakdown of road and bridge surfaces. According to the July 2008 report by the Citizens Advisory Committee on Transportation Funding, Michigan’s roads and bridges will require an estimated annual investment of $6.1 billion, which is nearly two times the current funding level, for basic improvements to its road and bridge system.

A May 2012 report by the West Michigan Shoreline Regional Development Commission identified 74 “priority” culverts out of the over 1,800 culverts in Muskegon County. The report, entitled *Finding Common Ground: Linking Transportation and Watershed Partner Priorities – Road/Stream Crossings in Muskegon County*, gathered and compared road/stream crossing priorities of the Muskegon County Road Commission, Muskegon County Drain Commission, Muskegon Lake Watershed Partnership, and the White River Watershed Partnership. A map from this report can be found in Appendix C of this document.

Drinking water supplies in Muskegon County come from two basic sources: groundwater and surface water. The two largest public water supplies (Muskegon Heights and the City of Muskegon) originate from Lake Michigan. Each plant has multiple units to provide for reliability of operation. Neither plant has experienced a substantial failure that would result in a prolonged plant shut down. Additionally, both plants have undertaken extensive upgrades since 2000. As of 2010, they serve a combined total of 41,407 households in Muskegon County. The City of Muskegon Water Filtration Plant served 21,575 households in the City of Muskegon, Muskegon Township, North Muskegon, Roosevelt Park and Muskegon County. The Muskegon Heights system served 19,832 households in the City of Muskegon Heights, Norton Shores, Fruitport Village, and Fruitport Township.

About one-third of water users in Muskegon County depend on either private well or municipal well drinking water systems that utilize groundwater. The vast majority of these users are households. Three municipal systems in the county treat groundwater for public water supplies in the communities of Ravenna, Whitehall, and Montague. The Ravenna system serves households in the Village of Ravenna, and Ravenna Township. The Whitehall and Montague systems, under the White Lake Water Authority, serve households in the City of Whitehall, City of Montague, Whitehall Township, and Montague Township. These two systems are interconnected and serve as backups for one another. As of 2010, the groundwater systems in the County served the following:

- Ravenna System: Serves 550 households, including commercial and industrial users.
- Whitehall System: Serves 1,078 households, with 341 commercial and industrial users.
- Montague System: Serves 1,076 households, including commercial and industrial users.

The Muskegon County Wastewater Management System (MCWMS) collects and transmits the wastewater to the MCWMS facility via a network of county-owned and operated gravity sewer, pump stations, and force mains. The 11,000-acre site is permitted to receive 43 million gallons per day and consists of a complete mix aeration basin, aerated settling basin, 5 billion gallon storage lagoons, and 5,000-acre slow-rate irrigation system. The treated effluent and intercepted groundwater is gathered through underdrains and drainage ditches running throughout the site and discharged to the Muskegon River. MCWMS is the only permitted wastewater facility in the County other than a small lagoon in Ravenna. MCWMS serves 15 municipalities and permits 177 industries. The cities include Montague, Muskegon, Muskegon Heights, North Muskegon, Norton Shores, Roosevelt Park, and Whitehall. The townships include Cedar Creek, Dalton, Egelston, Fruitport, Laketon, Montague, Muskegon, and Whitehall. Each municipal and industrial user owns and operates its own wastewater collection system which connects to the county system.

Historically Significant and Related Events: Infrastructure failures are common in Muskegon County, with power loss affecting the greatest portion of the population. The NCDC Storm Events Database mentions downed power lines or power outages 45 times for Muskegon County between 1993 and 2012; all of which were either caused by thunderstorms (55.6%), winter weather (26.7%), or high wind events (17.8%). Some recent and notable power outages that affected Muskegon County to some degree are listed below.

Notable Power Outages Affecting Muskegon County, 1993-2012

Date	Event	Number of Outages	Area Affected
January 12,1993	Heavy Snow	Almost 20,000	Lower Michigan
August 8, 1993	Thunderstorms	4,400	Muskegon and Oceana counties
January 27,1994	Ice Storm	Over 50,000	Lower Michigan
March 14, 1997	Ice Storm	250,000	Michigan
April 6-7, 1997	Windstorm	180,000-200,000	Michigan
September 29, 1997	Windstorm	35,000	Southern Lower Michigan
October 26, 1997	Heavy Snow	333,000	Michigan
March 9, 1998	Blizzard	1,900	Lake, Clare, Oceana, and Muskegon counties
May 29, 1998	Thunderstorms	54,000	Muskegon County
May 31, 1998	Thunderstorms	50,000	Muskegon County
June 18, 1998	Thunderstorms	13,400	Southern Lower Michigan
July 21, 1998	Thunderstorms	7,500	Muskegon County
November 10, 1998	Windstorm	167,000	Southern Lower Michigan
April 3, 2003	Ice Storm	Hundreds of thousands	Southwest Lower Michigan
October 30, 2004	Windstorm	100,000	Michigan
December 28, 2008	Windstorm	Hundreds of thousands	Michigan
August 9, 2009	Thunderstorms	Village of Fruitport	Southern Muskegon County

Source: NCDC Storm Events Database, Local Reports

The May 29 and 31, 1998 thunderstorms may have combined to cause the greatest power loss in Muskegon County recent history. The storm on May 29th left 54,000 customers (1/3 of the county) without service due to thunderstorm winds and 900 downed power lines. The following day, 27,000 customers were still without power. The storm on May 31st left 50,000 customers without service and toppled five transmission towers designed to withstand sustained 90 mph winds and gusts to 110 mph. Notably, half of Whitehall was without water on May 31, 1998, and the City of North Muskegon was without power for seven to nine days.

Muskegon County has a relatively clean history of municipal water service. Exceptions include the afore-mentioned outage in 1998, and two disruptions in the City of Muskegon Heights. In January 2005, the city experienced a couple days without water service when a water main was severed. Then in November 2012, a broken water main triggered a "Boil Water Advisory" as a precaution against harmful bacteria that may have entered the system. The advisory lasted nearly two days.

Public sewer systems in Muskegon County have failed with catastrophic consequences. In March 2007, a 66-inch sewer main failed in Muskegon Township, flooding and contaminating a residential neighborhood. The event forced 40 home evacuations and damaged eight houses, three of which were eventually condemned. Local media reported that the same line has experienced five catastrophic failures since 1982. The Muskegon County Wastewater System had to be temporarily shut down, causing 25 million gallons of raw sewage to pour into lakes and streams. Estimated damages totaled over $1 million, and the county was fined $40,000 by the MDEQ for the sewage spilled into the environment. More recently in July 2011, a County Wastewater pipe along Colby Road in Whitehall Township sprung a leak, resulting in 2,000 gallons of leaked sewage.

In the rural areas of the county, infrastructure failures other than power failures seldom cause widespread problems. Most residents rely on site-based sewage, water and heating facilities rather than those provided by urban utility providers. They have been known to fail, as they did in January 1994 during a prolonged period of severe cold weather that caused ground frost to increase well beyond normal depths and affecting many site-based sewage systems. In addition, extremely low water levels and drought conditions may cause some water wells to go dry.

Transportation infrastructure in Muskegon County is also susceptible to failure or interruption. There are numerous examples within the NCDC Storm Data documenting road closures, most of which were the result of severe winter weather. Excessive rains and flash flooding also have a propensity to render roads impassable; or even washout roads completely. The most memorable recent road washout occurred January 30, 2013 in White River Township along Hancock Road. The combination of rain and melting snow overwhelmed a culvert, causing Hancock road to collapse. Two men narrowly escaped significant harm as their car plunged into the void.

Frequency of Occurrence: Natural hazards, especially thunderstorms, windstorms and winter weather, are the primary cause of infrastructure failure in Muskegon County in the form of power outages and sewage spills. Since these hazards are expected to affect the county a numerous times per year, infrastructure failures are possible virtually anywhere in the county in any given season.

NCDC Storm Data lists 45 instances of downed power lines or outages for Muskegon County in the 20-year period between 1993 and 2012. At this rate, Muskegon County experienced two to three incidents per year. Of the total number of events, 17 were locally or regionally significant events, occurring once every one to two years on average. Isolated or localized power failures can be resolved in a matter of hours, while widespread events may take days to fully recover.

In the 12-year period from 2000-2011, there were 47 sewer system overflows, or about four per year, according to the Michigan Department of Environmental Quality. Between 1998 and 2012, there have been two documented cases of wide-spread municipal water system failure (Whitehall 1998, Muskegon Heights 2005), putting the average around once every seven to eight years.

2.08 NUCLEAR POWER PLANT EMERGENCIES

An actual or potential release of radioactive material at a commercial nuclear power plant or other nuclear facility, in sufficient quantity to constitute a threat to the health and safety of the off-site population.

Summary: The nearest nuclear power plant is more than 50 miles away from Muskegon County, well beyond the facility's Emergency Planning Zone. Nuclear power plant emergencies are therefore not considered a significant threat to Muskegon County.

Hazard Description: Though the construction and operation of nuclear power plants are closely monitored and regulated by the Nuclear Regulatory Commission (NRC), accidents at these plants are considered a possibility and appropriate on-site and off-site emergency planning is conducted. An accident could result in the release of potentially dangerous levels of radioactive materials into the environment that could affect the health and safety of the public living near the nuclear power plant. A nuclear power plant accident might involve both a release of air borne radioactive materials and radioactive contamination of the environment around the plant. The degree and area of environmental contamination could vary greatly depending on the type and amount of radioactivity and weather conditions. Response to a nuclear power plant accident requires specialized personnel who have been trained to handle radioactive materials safely, who have specialized equipment to detect and monitor radiation, and who are trained in personal radiation exposure control.

The nearest nuclear facility is the Palisades located in Van Buren County. The facility is just over

50 miles south of Muskegon County, and is not considered to be a threat to Muskegon County. Even if a major plume cloud were to be released from that facility, most radioactive materials would probably have dispersed into relatively harmless quantities over the long distance between the county and that site. A more likely scenario is one where a disaster at the Palisades facility puts significant stress on the medical resources in Muskegon County. Muskegon lies just outside of the facility's secondary emergency planning zone, and would therefore be an important place for victims to receive medical attention. The county may also expect to see an influx of people seeking refuge from the disaster. Lastly, there may be long-term ancillary impacts on Lake Michigan that may affect Muskegon County.

History: Muskegon County has never experienced damage from a nuclear power facility.

Frequency of Occurrence: Nuclear power plant accidents are not considered a significant threat in Muskegon County.

2.09 OIL AND NATURAL GAS WELL ACCIDENTS

An uncontrolled release of oil or natural gas, or the poisonous by-product hydrogen sulfide, from production wells.

Summary: There are a number complications and hazards that may be associated with oil and gas wells, highlighted by the potential for uncontrolled releases of hydrogen sulfide. Muskegon County has one oil field (Laketon) and a sizable number of wells (1,090). Abandoned and insufficiently capped wells are known to exist in the county as well.

Hazard Description: Oil and natural gas are produced from fields scattered across 63 counties in the Lower Peninsula. From 1927 to January 2009, there have been 56,525 oil and natural gas wells drilled in Michigan, of which roughly half have produced oil and gas. To date, Michigan wells have produced over 1.4 billion barrels of crude oil and 6 trillion cubic feet of gas.

The petroleum and natural gas industry is highly regulated and has a fine safety record, but the threat of accidental releases, fires and explosions still exists. In addition to these hazards, many of Michigan's oil and gas wells contain extremely poisonous hydrogen sulfide (H2S) gas. Hydrogen sulfide is a naturally occurring gas mixed with natural gas or dissolved in the oil or brine and released upon exposure to atmospheric conditions. Over 1,300 wells in Michigan have been identified as having H2S levels exceeding 300 parts per million (ppm).

As the following table indicates, at concentrations of 700 ppm, one breath of hydrogen sulfide can be deadly. Although hydrogen sulfide can be detected by a "rotten egg" odor in concentrations from .03 ppm to 150 ppm, larger concentrations paralyze a person's olfactory nerves so that odor is no longer an indicator of the hazard. Within humans, small concentrations can cause coughing, nausea, severe headaches, irritation of mucous membranes, vertigo, and loss of consciousness. Hydrogen sulfide forms explosive mixtures with air at temperatures of 500 degrees Fahrenheit or above, and is dangerously reactive with powerful oxidizing materials. Hydrogen sulfide can also cause the failure of high-strength steels and other metals. This requires that all company and government responders be familiar not only with emergency procedures for the well site, but also with the kinds of materials that are safe for use in sour gas well response.

Physiological Response to H_2S

10 ppm	Beginning eye irritation
50-100 ppm	Slight conjunctivitis and respiratory tract irritation after 1 hour exposure
100 ppm	Coughing, eye irritation, loss of sense of smell after 2-15 minutes. Altered respiration, eye pains and drowsiness after 15-30 minutes followed by throat irritation after 1 hour. Several hours of exposure results in gradual increase in severity of symptoms and death may occur within the next 48 hours.
200-300 ppm	Marked conjunctivitis and respiratory tract irritation after 1 hour of exposure.
500-700 ppm	Loss of consciousness and possibly death in 30 minutes to 1 hour.
700-1000 ppm	Rapid unconsciousness, cessation of respiration and death.
1000-2000 ppm	Unconsciousness at once, with early cessation of respiration and death in a few minutes. Death may occur even if the individual is removed to fresh air at once.

Source: American National Standards Institute, Standard: 237.2-1972

An unplugged abandoned well, also known as an orphan well, can be a hazard to the health and safety of the surrounding people and environment. There are many situations where an unplugged well can become dangerous. For example, a rusted-out casing in a gas well can let natural gas flow underground and accumulate in the basement of a nearby building, possibly causing an explosion. Occasionally, gas leaking from an old well can contaminate a nearby water well. An old well might also be a conduit for salt brine from deeper formations to pollute fresh groundwater, or to discharge at the surface. In some cases, oil leaks from abandoned wells, polluting soil and water.

According to the Michigan DEQ, Office of Oil, Gas and Minerals in October 2012, there are 1,090 total oil and gas wells in Muskegon County. While a vast majority of these wells are inactive, abandoned or capped, 17 of them were “active” or “producing.” Fifteen wells are known to have detectable levels of hydrogen sulfide in the following Muskegon County townships: Blue Lake (1), Egelston (1), Laketon (3), Muskegon (8), and White River (2). It is important to note that any type of oil or gas well, even one that has been capped, is capable of leaking dangerous levels of hydrogen sulfide.

In the 1920’s, Muskegon County experienced an oil boom resulting from the discovery of crude oil. Though oil production has nearly ceased since the 1970’s, the oil rush left behind thousands of wells and exploratory borings about the county. As of 2012, there are 15 wells producing oil or natural gas in the county, and 490 wells that are no longer productive where plugging has been approved but not yet completed.

Along with wells that have produced or are producing, there are dry holes – areas where drilling was unsuccessful. There are 514 dry holes on record where plugging has been permitted but plugging needs to occur. Of all unproductive and dry hole wells, only 13 have been subject to proper sealing procedures to prevent aquifer contamination. It has been reported to cost nearly a million dollars to properly plug one abandoned or out of use well.

A cursory analysis of well locations in Muskegon County shows that some may be located fairly close to major roads, homes, or developed areas, such as neighborhoods in Laketon Township. This in itself is not cause for undue alarm, but the locations merit increased precautions and awareness. Continued monitoring and investigation should ensure that these wells do not pose any threat to any nearby developments. Field investigation may determine that these wells and processing plants are far enough from other developments that the risks of harmful incidents are minimal. The Michigan Department of Environmental Quality has information on all permitted wells in the state.

A report released in October 2010 entitled “Preliminary Assessment of Lower Muskegon River Watershed Oil Field” focuses on perhaps the greatest concentration of wells in Muskegon County. The report was prepared by Westshore Consulting, and funded by the Community Foundation for Muskegon County and Laketon Township. The “Conclusions & Recommendations” of that report are given below to increase awareness of these wells and the risks they present:

> "A total of 621 borings were identified and mapped in an especially dense area in Laketon and Muskegon townships, and the Cities of Muskegon and North Muskegon. Borings included oil and gas wells, dry holes, brine disposal wells, and those of unknown type. These borings coincided with residential, institutional, commercial, rural, wetland and open water land uses and landscapes.
>
> Potential risks to human health and the environment associated with these borings and related facilities include soil, groundwater and surface water contamination, drinking water contamination, ecological, fish and wildlife impacts, indoor vapors, cave-in and falling hazards, and hurdles to economic development and job creation.
>
> The vast majority of these borings have never been investigated and the actual risks to human health and the environment are unknown. When borings have been investigated as a result of drinking water well permitting, private investments or other reasons, cases of both minimal risk and unacceptably high risk have been identified. While most borings likely present a limited concern, the potential remains for high risks to exist and be unknown to the community.
>
> The Work Group concludes that the status quo is not acceptable. A way to address these concerns needs to be found. While not wanting to cause undue alarm, there is a clear need to investigate and pursue sound management of these old borings. Resources need to be found to locate in the field, inspect, and otherwise investigate these borings and associated facilities as necessary to determine the actual risks they pose. Where individual borings and facilities are found to present real risks to human health and the environment, sound management, clean-up and other steps to terminate or contain and reduce these risks to acceptable levels need to be implemented.
>
> In general terms, the Work Group recommends:
>
> - The community should be educated about the nature of these old oil and gas borings and associated facilities, and the human health and environmental risks they pose. By improving our understanding, we will be better able to help address these issues as individuals and as a community. Support for a more holistic, comprehensive approach will likely result from increased comprehension.
> - Programmatic tools and resources should be identified to assist a response to these risks by private individuals, and facilitate the development of a more comprehensive, community-wide effort.
> - Existing government and community programs, resources, ordinances and policies should be evaluated with respect to these old borings, and improved and tailored to help address the associated risks. The Work Group strongly urges local agencies and governing bodies to look for ways to address this issue by reviewing their land use planning, zoning and permitting, construction and inspection, public health and emergency response programs.
> - The old petroleum borings and facilities should be investigated and the attendant risks defined. Funding should be allocated to locate and field investigate these borings and their surroundings to determine if unacceptably high risks to human health and the environment are present.
> - Where specific borings and facilities are found to present a real risk, the resources must be dedicated to soundly manage and reduce the risk to an acceptable level. The full tool kit of environmental management techniques should be considered as necessary to stop or prevent human health risks or environmental damage."

An additional concern in Muskegon County is the fact that as many as 32 (in 2005) different organizations and individuals own the wells. As a general rule, most gas companies prefer to respond to incidents involving their wells themselves; and in the vast majority of cases that is what happens. Because gas companies often have controlled burns, and deal with wells on a daily basis, it is impossible to ascertain how many incidents have actually occurred in Muskegon County. However, there is still the possibility that an emergency response agency could find itself in the situation of responding to an incident at a well. Responders must understand the dangers associated with H_2S and must have a working knowledge of the wells that are in their areas of responsibility. In rare cases, gases may be released in a way that affects adjacent areas.

Historically Significant and Related Events: There are no identified oil or gas well incidents in Muskegon County. However, the nearby county of Mecosta experienced a gas well explosion in December of 2006 which resulted in the evacuation of several nearby residents. The issue was later resolved, with no additional threat to public safety.

At least one orphan well in Muskegon County is known to be actively leaking crude oil into a tributary of Bear Lake in Laketon Township. The MDEQ has installed booms to contain and absorb the leak. The full effects of the leak are unknown; however local residents have reported smelling oil in their household water. In another area of Laketon Township, homes in the vicinity of Green Creek Road have suffered severe contamination of their water from abandoned oil wells. It was such a concern that the State of Michigan recently paid $3.9 million to extend municipal water service to 150 houses.

Frequency of Occurrence: Because Muskegon County has a moderate number of oil and gas wells, the occurrence of a significant accident is a possibility. Although there has been some seepage of oil into the environment causing groundwater contamination, there is no basis for predicting the frequency of a separate oil or gas well accident in Muskegon County. It is possible that the county will continue to experience effects of oil and gas wells, especially as former and orphan wells continue to age.

2.10 PIPELINE ACCIDENTS

An uncontrolled release of petroleum or natural gas, or the poisonous by-product hydrogen sulfide, from a pipeline.

Summary: Pipeline accidents are a real and constant threat to countless communities across the country. There are major petroleum and natural gas pipelines in Muskegon County, as well as numerous distribution lines throughout. Seventy-nine percent of Muskegon County households rely on utility natural gas as their primary heating fuel.

Hazard Description: Though often overlooked, petroleum and natural gas pipelines pose a real threat in many Michigan communities. Petroleum and natural gas pipelines can leak or erupt and cause property damage, environmental contamination, injuries, and even loss of life. The vast majority of pipeline accidents that occur in Michigan are caused by third-party damage to the pipeline, often due to construction or some other activity that involves trenching or digging operations. Many structures are located right next to pipelines and thus may be at-risk. Pipelines can also cross through rivers, streams, and wetlands, thus posing the possibility of extensive environmental damage in the event of a major failure.

Michigan is both a major consumer and producer of natural gas and petroleum products. According to the federal Energy Information Administration, Michigan's consumption of petroleum products, particularly liquefied petroleum gases (LPG) is high; Michigan is the largest residential LPG market in the nation, due mostly to high residential and commercial propane consumption. The state has a single petroleum refinery but a large network of product pipelines. More than 78% of the overall home heating market uses natural gas as its primary fuel. With over one-tenth of U.S. capacity, Michigan has the greatest underground natural gas storage capacity in the nation and supplies natural gas to neighboring states during high-demand winter months. Driven largely by the residential sector, Michigan's natural gas consumption is high. Nearly four-fifths of Michigan households use natural gas as their primary energy source for home heating.

The State Energy Data System (SEDS) released data in August 2009 that describes energy consumption by source and total consumption per capita. Michigan ranks 13th in the nation in production of natural gas with 264.9 billion cubic feet and 7th in consumption at 847.8 billion cubic feet. These figures underscore the fact that vast quantities of petroleum and natural gas are extracted from, transported through, and stored in the state, making many areas vulnerable to petroleum and natural gas emergencies. Michigan's gas and petroleum networks are highly developed and extensive, representing every sector of the two industries – from wells and production facilities, to cross-country transmission pipelines that bring the products to market, to storage facilities, and finally to local distribution systems. Pipeline users have response and recovery systems in place for all the pipelines under their control, and continually monitor the status of pipelines in the county, state, and throughout the country.

While it is true that the petroleum and natural gas industries have historically had a fine safety record, and that pipelines are by far the safest form of transportation for these products, the threat of fires, explosions, ruptures, and spills nevertheless exists. In addition to these hazards, there is the danger of hydrogen sulfide (H_2S) release. These dangers (fully explained in section "2.08: Oil and Gas Well Accidents") can be found around oil and gas wells, pipeline terminals, storage facilities, and transportation facilities where the gas or oil has high sulfur content. Hydrogen sulfide is not only an extremely poisonous gas, but is also explosive when mixed with air at temperatures of 500 degrees Fahrenheit or above.

Muskegon County has major pipelines actively transmitting gasoline and natural gas through the area. Marathon Petroleum Company operates 15 miles of 10-inch gasoline pipeline that runs from the southern border of the county to its distribution terminal on Holton Road in Muskegon Township. MichCon, a subsidiary of DTE Energy, operates 38.5 miles of high-pressure natural gas transmission pipelines. This total does not include smaller gathering or distribution pipelines, such as lines that deliver natural gas to homes and businesses. Much of the distribution pipeline system in the Muskegon metropolitan area is aging and will require significant investments to avoid serious leaks and/or explosions. MichCon natural gas service is available in every municipality in Muskegon County.

Historically Significant and Related Events: Major natural gas explosions in recent years have highlighted the danger of aging natural gas pipelines. In 2011, a large crack in an 83-year-old, cast-iron gas main caused a gas explosion in Allentown, Pa. The incident killed five and damaged nearly 50 homes. More recently on February 27, 2013, a natural gas explosion rocked a neighborhood in Royal Oak, Michigan as a Consumers Energy work crew replaced pipelines dating to 1929. The incident killed a man, leveled his house, and damaged 30 other homes nearby.

In Muskegon County, there are two identified natural gas pipeline accidents in Muskegon County in the last 20 years or more. In the early 1990's, a pipeline in Ravenna froze and burst allowing gas to escape into the surrounding shed. When it was drawn over the pilot, an explosion occurred that damaged the person opening the door and his truck. Later on August 28, 2007 a house exploded in Egelston Township after a contractor accidentally struck a natural gas line. Fortunately, no one was inside the home when the incident occurred. The explosion also caused damage to a neighbor's house. There have also been significant incidents in neighboring counties in recent years. The following records provide examples of events that are possible in Muskegon County.

June 23, 1999 – Lake County

A broken gas main near the intersection of M-37 and US-10 in Pleasant Plains Township prompted the evacuation of nearby residents, including senior and low-income housing complexes.

October 21, 2000 – Newaygo County

A propane explosion in the unincorporated community of Woodland Park demolished a summer home, killing four members of a family shortly after they arrived for a weekend visit. Two other family members survived the blast, which may have originated in the basement of the home.

In addition to natural gas pipelines, petroleum pipelines carry the potential for serious accidents. On July 26, 2010, Enbridge Energy Partners LLP reported a 30-inch pipeline ruptured near Marshall, Michigan. The release, estimated at 819,000 gallons, entered Talmadge Creek and flowed into the Kalamazoo River, a Lake Michigan tributary. Heavy rains subsequently caused the river to overtop existing dams and carried oil 35 miles downstream on the Kalamazoo River. The incident remains the costliest pipeline spill in U.S. history.

There is one significant gasoline pipeline accident known to have occurred in Muskegon County. On February 22, 1986, an 8-inch, high pressure Marathon Oil line ruptured north of Sherman Boulevard near Estes Street in the City of Muskegon. The event caused thousands of gallons of gasoline spilled into a Ruddiman Creek tributary, a number of minor house explosions and at least one fire, and dozens of area residents to evacuate. Later as workers searched for the leak, a sewer line was ruptured causing raw sewage to spill into the tributary as well. This pipeline is no longer in use. There may have been one other significant petroleum pipeline accident near the intersection of Airline Road and Getty Street in the City of Norton Shores. At one time this site was on the Environmental Protection Agency's National Priorities List (NPL), under the title "Marathon Pipeline Leak." However, this site is no longer on the NPL, and no further information was gathered about the incident.

Frequency of Occurrence: Past pipeline accidents; in Muskegon, nearby counties, and across the country; have demonstrated how similar accidents may affect Muskegon County in the future. With two minor natural gas pipeline incidents and one significant petroleum pipeline accident identified in Muskegon County, the frequency of this hazard is nearly impossible to determine. However, if aging pipelines are not maintained or replaced, the risk of a leak, spill, or explosion is certain to persist.

2.11 TRANSPORTATION ACCIDENTS

A crash or accident involving an air, land or water-based commercial passenger carrier.

Summary: Minor transportation accidents along the county's road network are frequent and inevitable; especially during inclement weather and along roads that are in disrepair. The primary emphasis of this hazard description, however, is placed upon commercial and larger-scale modes of transportation.

Possible accidents involving commercial passenger transportation in Muskegon County include air transport, marine transport, and buses including public transportation, school buses, tour buses, shuttles, and Greyhound. Natural weather hazards, as well as high traffic volumes, occasionally increase the risk of accident involving any of these modes of transportation.

Hazard Description: Communities vulnerable to transportation accidents would contain an airport offering commercial passenger service, railroad tracks on which commercial rail service is provided, commercial inter-city passenger bus or local transit bus service, school bus service and/or commercial marine passenger service. A serious accident involving any of modes of passenger transportation could result in a mass casualty incident requiring immediate life-saving community response. When responding to any of these types of transportation accidents, emergency personnel may be confronted with a number of problems, such as: 1) suppressing fires; 2) rescuing and providing emergency first aid for survivors; 3) establishing mortuary facilities for victims; 4) detecting the presence of explosive or radioactive materials; and 5) providing crash site security, crowd and traffic control, and protection of evidence. In addition, a marine transportation accident could require a water rescue operation, possibly under dangerous conditions on Lake Michigan. There are concerns that a major transportation accident could cause many injuries or deaths and might occupy all area responders.

A land transportation accident in Michigan could involve a commercial intercity passenger bus, a local public transit bus, a school bus, or an intercity passenger train. These modes of land transportation have a good safety record, however accidents do occur. Nationally, an average of about six persons die each year in charter and commuter bus crashes, and 11 school children die in school bus accidents. About 8,500 children are injured each year in school bus crashes. Typically, bus accidents are caused when buses slip off the roadway in inclement weather, or collide with another vehicle. Intercity passenger train accidents usually involve a collision with a vehicle attempting to cross the railroad tracks before the train arrives at the crossing. Unless the train accident results in a major derailment, serious injuries are usually kept to a minimum. Bus accidents, on the other hand, can be quite serious; especially if the bus has tipped over. Major land transportation accidents are more likely to occur in areas of heavy traffic, industrial activity, decrepit roads, and during periods of inclement weather.

Buses are the primary mode of commercial passenger transportation on land in Muskegon County, as there is no passenger rail service. Long distance bus travel service is provided by Greyhound during the work week and on Saturday. The bus depot is located in the City of Muskegon. The county's bus system, the Muskegon Area Transit System (MATS), operates buses on nine fixed routes throughout the workday and in the evening mainly within on the metropolitan area which includes the cities of Muskegon, Muskegon Heights, North Muskegon, Norton Shores, Roosevelt Park, and the townships of Fruitport and Muskegon. The system also features demand-response services throughout the county with its GoBus program, which utilizes lift-equipped vans to serve persons over the age of 60 and persons with disabilities. In addition, two trolley routes are in operation during the summer months between the Memorial Day and Labor Day weekends. One route connects Pere Marquette Park at Lake Michigan with downtown Muskegon. The other route is dedicated solely to destinations within the downtown Muskegon area. Together, the trolley and bus system carried 739,283 passengers in 2011 (MDOT, 2013). In 2014, MATS began running rural routes to Holton, Ravenna, Montague, and Whitehall areas.

In addition to the MATS, a number of additional bus services operate in Muskegon County as well. Pioneer Resources also has a fleet of buses and vans providing transportation, including charters, for the physically challenged and seniors. School districts provide bus transportation service during the school year. School buses travel routes throughout the county, often along rural routes that are easily impacted by inclement weather. Walmart offers a fixed route bus service, with stops at apartment complexes in the area, to and from stores in Fruitport Township and Roosevelt Park. The service is available during mid-day on Monday, Tuesday, and Thursday through Saturday. Finally, charter and tour buses frequently travel to and through the county and especially downtown Muskegon.

Statistics from the National Transportation Safety Board (NTSB) and the airline industry show that over 75% of airplane crashes and accidents occur during the takeoff or landing phases of a flight. As a result, developed areas that are adjacent to major airports, and along airport flight paths, are particularly vulnerable to this hazard. Accordingly, the probability of a crash or accident increases as the number of landings and takeoffs increase. The challenge for jurisdictions with a passenger air carrier airport is to develop adequate procedures to handle a mass casualty incident that could result from an airplane crash or accident.

Muskegon County contains one major airport (an air carrier airport), which serviced over 36,080 passengers in 2012. This was an increase of 27 percent from the year before. It is located in the City of Norton Shores, occupies 1,200 acres, and has daily flights to Chicago through United Airlines. There are also monthly charters on Sun Country Airlines to Laughlin, Nevada.

In 2004, high-speed ferry service was initiated by Lake Express between Muskegon and Milwaukee. The ferry is capable of holding 46 cars and arrives/departs three times a day in the summer and two times a day in the spring and fall. It does not operate in the winter or early spring. In addition, small-scale fishing charters are available out of Muskegon Lake and White Lake.

Historically Significant and Related Events: On January 21, 2002, one person was killed and nearly two dozen high school students were injured when a school bus collided with two cars. About 22 persons were taken to area hospitals with injuries. The accident occurred at Holton Road and Brickyard Road in Holton Township.

There have been numerous shipwrecks near the Muskegon harbor due to strong storms and weather systems. On October 28, 1919, huge waves crashed the wooden side-wheel steamer, City of Muskegon, into the south pier. About 30 passengers and crew members died in the accident. On November 30, 1934, the 315-foot Henry Cort was sent into the north breakwater by a strong gust of wind. A small Coast Guard vessel responded and subsequently capsized, killing one Coast Guardsman.

Frequency of Occurrence: Even though there are just a few documented incidences of major transportation accidents in Muskegon County, the possibility of a land, air, or marine transportation accident can't be overlooked.

Minor traffic accidents are a common occurrence, and take place daily in Muskegon County. Periods of heavy traffic are most likely around holidays, especially during warm weather seasons. Inclement weather is possible any time during the year; however treacherous traveling conditions are most common during the winter months. Other types of transportation accidents are possible, but not common in the county. There is no historical data for predicting accidents with commercial carriers within the county.

3.0 HUMAN RELATED HAZARDS

3.01 CATASTROPHIC INCIDENTS (National Emergencies)

A large-scale event that has severe effects upon large numbers of persons, across a wide area, and immediately overwhelms State, tribal, and local response capabilities. Such incidents are likely to require coordination activities from many states, including Michigan, even if the event took place in a distant location.

Summary: Many of the hazards addressed in this chapter may achieve "catastrophe" status. Inclusion of catastrophic incidents as a stand-alone hazard is intended to highlight the extraordinary circumstances that such events produce, with the hope that it will assist planners and analysis in further developing mutual aid arrangements at all levels, to accommodate a wider variety of needs, and to suggest some possible repercussions that may not have previously been considered in existing planning and exercise scenarios.

Hazard Description: Within the past decade, the nation has been affected by disastrous events that have caused various states, including Michigan, to undertake significant actions to respond to, assist, or help accommodate the impact of events that took place well outside of their borders. Mutual aid agreements are in place between states to provide one another with supplemental resources and capabilities that are needed to help respond to and recover from a disastrous event. It is also possible that certain types of events outside of U.S. territory may require coordinated response as well.

The National Response Framework (aka Federal Response Plan) involves a recognition of, and reaction to, events of national significance. This was observed during the terrorist events of September 11, 2001—along with the federal government, all states went into a mode of heightened alert and exchanged various information and resources in a coordinated manner. More recently, Hurricanes Katrina and Rita caused such disruption in the southern states that nation-wide assistance and coordination was needed. Not only were resources deployed to the disaster areas themselves, but distant states such as Michigan also needed to accommodate large numbers of evacuees who were temporarily displaced from their homes, jobs, businesses, and even families. Some evacuees even chose to permanently change their residence to new homes in other communities across the U.S.

In some disaster scenarios, although the State of Michigan may experience some direct impacts, it may turn out that much greater effects in other states or nations (e.g. Canada) may require extensive additional actions to be taken by Michigan government and personnel. In recognition of these extra tasks, a Catastrophic Incident hazard is now identified, in addition to the many hazards that are known to potentially have a direct impact within Michigan.

FEMA has (in its Catastrophic Incident Annex of November 2008) defined the nature of the catastrophic disaster situation. It "will result in large numbers of casualties and/or displaced persons, possibly in the tens to hundreds of thousands… The nature and scope of a catastrophic incident will immediately overwhelm State, tribal, and local response capabilities and require immediate Federal support… A catastrophic incident will have significant international dimensions, including impacts on the health and welfare of border community populations, cross-border trade, transit, law enforcement coordination, and others."

Special aspects that may be part of catastrophic incidents include the possibility of occurrence without warning, the occurrence of multiple incidents over a wide-ranging area (or even without any clearly defined incident site), may involve large-scale evacuations (whether organized or self-directed), may cause widespread homelessness and displacement (either temporary or permanent), may overwhelm existing health-care systems, and may produce severe environmental impacts that exceed governmental abilities to achieve a timely recovery.

There are a great many possible situations that can result in nationwide activation of mutual aid and other response and recovery mechanisms, so it is not intended that this section will provide an exhaustive list of everything that may happen. Below are a number of situations that may arise and be considered to be a catastrophic incident.

- Major Hazardous Materials Incidents
- Energy Emergencies and "Great Blackouts"
- A "Supervolcano" Event
- Major Terrorist Attack
- Major Earthquakes
- Celestial Impact
- Hurricanes
- Tsunami Events
- Pandemics or other Public Health Emergencies

A catastrophic incident may require the coordination of emergency responders (and associated personnel) between states, and even from across the nation or between nations (e.g. Canada, or its Ontario province). The most direct impact of a national emergency upon responders would be dealing with the logistics of interstate mutual aid (or even its international equivalents). In an event such as the 9-11-2001 terrorist events, or the 2005 Hurricane events, numerous response personnel may have to juggle their time, resources, and efforts involving activities that assist other states or jurisdictions with disaster response and recovery, while simultaneously ensuring that their own jurisdictions' preparedness and response needs are also met. An additional potential impact may arise from events that occur in one's home jurisdiction after various aid has been granted to some other area—various staff, equipment, expertise, and funds may suddenly be needed "back at home" in the midst of complicated and important response or recovery operations abroad. Extra complexity would also be entailed in the tracking of expenses and the paperwork involved in reimbursement procedures, which might ordinarily be used on activities that are of clearer importance to the home jurisdiction's own emergency needs.

Another effect of national emergencies is the potential need to deal with evacuees coming from affected areas, who would need food, shelter, and other types of assistance under conditions of displacement and even duress. Such evacuees would tend to have numerous financial and material needs, since the emergency event may have caused severe material hardships for them (or at least temporarily denied them access to their homes and wealth). In addition, various disaster and emergency events tend to cause emotional, social, and psychological hardships, as well as material and economic ones, since various trauma may have been experienced during the emergency events (including the loss of family and friends), and the uncertainties and stresses of relocations, job loss, etc. would often require a social and psychological support structure to be sought (and often provided by the host community) in order to restore a degree of security to the evacuees conditions and lifestyle. As a part of long-term recovery, such evacuees would ideally be able to restore their lifestyles to some sort of normalcy, perhaps even including successful relocation back to their original homes and the resumption of their previous circumstances.

Historically Significant and Related Events: There have been a number of catastrophic events to affect the United States in the recent past. Some of these events are listed below. Their precise effects upon Muskegon County are unknown.

- Major warfare, such as World War II – Some effects of WW II on Muskegon County included 48-hour minimum work weeks, rationing of certain food and goods, and 274 county men killed in battle.

- Great Blackouts, such as those of 1965 and 2003
- Anticipated or threatened infrastructure breakdowns (such as "Y2K")
- Major terrorist incidents or threats, such as 9/11 and the subsequent anthrax events
- Hurricanes, such as Katrina and Rita in 2005 (with many displaced evacuees) – A gubernatorial disaster declaration and a presidential emergency declaration were issued in Michigan in September 2005 for hurricane evacuation. These declarations made certain types of financial assistance available to communities providing assistance to hurricane evacuees.

Frequency of Occurrence: National emergencies are bound to occur from time to time, and could break out at any time of the year. However, the frequency of a catastrophic event having a significant impact on Muskegon County cannot be estimated.

3.02 CIVIL DISTURBANCES

Collective behavior that results in a significant level of lawbreaking, perceived threat to public order, or disruption of essential functions and quality of life.

Summary: Only one major civil disturbance is known to have happened in Muskegon County within the last 100 years. Although future incidents are certainly possible, civil disturbance is not considered to be a significant hazard at this time.

Hazard Description: Civil disturbances can be classified within the following four types: (1) act or demonstration of protest, (2) hooliganism, (3) riot, or (4) insurrection. Most of these share similarities with each other, and the classifications presented here are not absolute and mutually exclusive.

Types of civil disturbance

- *Protest* – Usually contains some level of formal organization or shared discontent that allows goal oriented activities to be collectively pursued. This includes political protests and labor disputes.
- *Hooliganism* – relatively unorganized and involves individual or collective acts of deviance inspired by the presence of crowds, in which the means (and responsibility) for ordinary levels of social control are perceived to have slackened or broken down. Examples include disorder following a sporting event or college parties.
- *Riot*– may stem from motivations of protest, but lacks the organization of formal protests. Although legitimate and peaceful protests may spontaneously form when people gather publicly for a mutually shared cause, riots tend to involve violent gatherings of persons whose level of shared values and goals is not sufficiently similar to allow their collective concerns or efforts to coalesce in a relatively organized manner.
- *Insurrection* – involves a deliberate collective effort to disrupt or replace an established authority or its representatives, by persons within a society or under its authority. An insurrection has the deliberate goal of either replacing established authorities or power structure with anarchy or a smaller-scale set of recognized criminal, ethnic, or other group networks and power structures.

Although destructive civil disturbances are rare, the potential is always there for an incident to occur. It is possible that risks for future disturbances may be exacerbated today by the ability of modern mass media (television, radio, the Internet, and various wireless communication devices) to instantly relay information (factual or not), in real time, to large numbers of people. That coverage may help to spread awareness of protests, discontent, riots, disorderly "parties," or other incidents to other areas or interested groups and persons, potentially exacerbating an already difficult situation. For example, media coverage of certain events has, in the past, spurred uprisings inside prisons. Real-time media coverage of unfolding events is a fact of modern life that is inescapable.

As a result, law enforcement officials must be skilled in monitoring all forms of media coverage to anticipate public and perpetrator actions and event progression.

It is always a good idea for important community facilities and functions, such as schools and festival areas, to be aware of individuals or organizations that may create a disturbance. It is also important for correctional facilities to plan for disruptions. Good labor-industrial relations are helpful in preventing incidents of labor unrest, but incidents of such unrest may be possible at some point in the future.

As explained in the "History and Development" section of the county profile (Part B), Muskegon directed its economic growth to industry at the end of the 19th century following the lumber era. According to the 2007-2011 American Community Survey 5-Year Estimates, the county has a civilian labor force of 81,738 people. Manufacturing jobs make up 25.2 percent of the employed civilian labor force.

Muskegon County is home to three state correctional facilities, all within the same compound, and a county jail. The Muskegon Correctional Facility, a Security Level-2 facility, opened in 1974 and has a capacity of 1,306 males. The West Shoreline Correctional Facility, a Security Level-1 facility, opened in 1987 and can house up to 960 males. The Earnest C. Brooks Correctional Facility, which opened in 1989, has security levels 1, 2, and 4 and can hold up to 1,224 males. The West Shoreline and Earnest Brooks facilities share services and staff between the two. These facilities are managed under disaster management plans, have on-site health care, and have not experienced civil disturbances.

The county has an annual county-wide fair, several festivals, several theaters and museums, an amusement park, and many campgrounds. Although large groups gather at these places and events, they generally are not groups that cause disturbances. Most of the controversial political issues that could generate violent protest do not originate from the local or county level government.

Historically Significant and Related Events: One significant riot is known to have occurred in Muskegon's past. On August 5, 1919, street car riders revolted against a rate increase from six cents to seven cents. The rioters destroyed 13 street cars and $100,000 to $125,000 (approximately $1.3 to $1.5 million today) in damage. The street car service of the City of Muskegon was interrupted and suspended awaiting the repair of the property of the traction company for a period of two weeks.

In 1930, a bomb exploded in the empty Regent Theater in downtown Muskegon during a union dispute. No serious labor-industrial disputes have occurred Muskegon County since then; however there have been sporadic and non-violent strike incidences. In 1976, the Muskegon Area Labor Management Committee (MALMC) was established with the mission of developing and strengthening good labor-management relationships by providing educational and interactive opportunities outside the collective bargaining agreement.

Frequency of Occurrence: Only one significant civil disturbance is known to have afflicted Muskegon County. However, that incident occurred in a bygone era, prohibiting the prediction of future occurrences.

Although there have been no documented civil disturbances in recent history, the chance of a civil disturbance cannot be entirely discounted. Any disturbance would likely be restricted to a single site.

3.03 NUCLEAR ATTACK

A hostile act taken against the United States which involved nuclear weapons and results in destruction of property and/or loss of life.

Summary: The possibility of a nuclear attack is a serious and grim consideration. The effects of such an occurrence on United States' soil would have a wide range of social, economical, political, and environmental impacts well beyond the immediate location of detonation.

Hazard Description: Nuclear weapons are explosive devices that manipulate atoms to release enormous amounts of energy. Compared to normal chemical explosives such as TNT or gunpowder, nuclear weapons are far more powerful and create harmful effects not seen with conventional bombs. A single nuclear weapon is able to devastate an area several miles across and inflict thousands of casualties. Although nuclear attack is an unlikely threat, the severe damage that would be caused by even one weapon requires the danger to be taken seriously.

World events in recent years have greatly changed the nature of the nuclear attack threat against the United States. In the last half of the 20th Century, this threat has primarily been associated with the Cold War between the United States and the Soviet Union. Although the Cold War has ended, there remains a threat of nuclear attack. A greater number of nations have developed nuclear weapons and there is also the possibility that terrorists could obtain a nuclear weapon for use against the United States.

A nearby strike with a one-megaton bomb would have a clear impact on those within Muskegon County. Sheltering would be required during the initial explosion, and if detonation occurred on the ground, a sheltering/evacuation plan would have to be followed to protect residents from the effects of fallout. Electronic equipment and communications would be damaged by the electromagnetic pulse created by such a blast, which may include a breakdown in transportation, fire and EMS systems if their computerized equipment and vehicular ignition systems fail to operate as a result. Finally, although Muskegon County may lack "attractive" nuclear attack targets, consideration must be given to the county's ability to facilitate and/or accommodate mass evacuations from other areas in Michigan and perhaps around the country.

Historically Significant and Related Events: There have been no incidences involving nuclear weapons in Muskegon County.

Frequency of Occurrence: Although unlikely, the significant threats associated with this hazard seem to offset its low probability and therefore merit consideration when planning for the protection of large numbers of people, necessary agricultural processes, and the community's "lifeline" services.

3.04 PUBLIC HEALTH EMERGENCIES

A widespread and/or severe epidemic, incident of contamination, or other situation that presents a danger to or otherwise negatively impacts the general health and well being of the public.

Summary: The public health emergencies category includes a wide range of potential causes, from naturally occurring epidemics; to failure of infrastructure; to malicious releases of harmful agents. Such events pose threats to individuals' health and well-being of the population, as well as the economy and delivery of services. A widespread public health emergency may strain Muskegon County's medical facilities, and require the assistance of resources from outside the county.

Hazard Description: Public health emergencies can take many forms such as: disease epidemics, large-scale incidents of food or water contamination, extended periods without adequate water and sewer services, exposure to chemical, radiological or biological agents, and large-scale infestations of disease-carrying insects or rodents. Public health emergencies can occur as primary events, or they may be secondary events to another disaster such as a flood, tornado, power outage, or hazardous material incident. The common characteristic of most public health emergencies is that they adversely impact, or have the potential to adversely impact, a large number of people. Public health emergencies can be statewide, regional, or localized in scope and magnitude.

Michigan has had several large-scale public health emergencies in recent history, but fortunately nothing that caused widespread severe injury or death. The 1973 PBB contamination incident is unprecedented in U.S. history, but the long-term implications of contamination on that level so far appear minimal. Similarly, the northern Michigan water and sewer infrastructure disaster of 1994 is also unprecedented in scope, magnitude, and public health and safety implications for the affected communities. These events, though unusual, have heightened awareness of the broad nature of threats that can result in a public health emergency. Such emergencies no longer simply involve the spread of disease, but rather can arise out of a variety of situations and circumstances.

In 2001, Michigan health officials were introduced to the emerging health threats posed by foot-and-mouth disease and the West Nile encephalitis virus. Foot-and-mouth disease is a highly contagious disease that only affects animals. A widespread disease outbreak among animal populations, such as the foot-and-mouth outbreak that occurred in the United Kingdom in 2001, could have significant public health implications for humans due to the potentially large numbers of dead animal carcasses that would have to be disposed of to prevent subsequent disease outbreaks. According to the Michigan Department of Agriculture and Rural Development, foot-and-mouth disease rarely infects humans and the disease is not considered a public health problem.

The West Nile encephalitis virus, which arrived in Michigan in August 2001, presents an equally challenging scenario for public health officials. Transmitted to humans by the bite of an infected mosquito, the West Nile virus is commonly found in Africa, West and Central Asia, and the Middle East. Health officials do not know how the virus was introduced to the United States. However, in 1999 and 2000, it caused an outbreak of human encephalitis in and around New York City that created a national stir and raised fears across the country that it would cause a full-blown public health emergency. The virus eventually spread to Michigan in 2001, peaking in 2002 with 644 probable cases, including 51 deaths. The disease is now considered endemic to Michigan.

The Muskegon County Health Profile 2012 produced by Public Health Muskegon County contains a section regarding the spread of vector-borne and zoonotic disease (passed from animals or insects to humans). The document states that the threat of such disease has been on the rise in human populations throughout the world. According to scientific estimates, as many as 75 percent of all emerging infectious diseases are zoonotic and/or vector-borne, meaning the disease is passed from animals or insects to humans. Of 1,400 different microbes that cause disease in humans, nearly 60 percent can be linked to animals (MDEQ). While, historically, Michigan has only been threatened by a small number of vector-borne diseases, the number is growing due to increasing globalization, genetic changes in organisms, and the threat of biological weapons of destruction. For further information on some of the known threats in Michigan (Bovine Tuberculosis, Rabies, West Nile virus, Lyme Disease, Bed Bugs, and Eastern Equine Encephalitis virus), the Muskegon County Health Profile can be viewed at the Health Department's website (www.muskegonhealth.net).

Michigan is fortunate to have an excellent public health system that constantly monitors the threats that could lead to a widespread or significant public health emergency. However, even the best monitoring and surveillance programs cannot always prevent such incidents from occurring. When they do occur, Michigan's public health agencies have shown the ability to effectively muster the resources necessary to identify and isolate the problem, and mitigate its effects on the population. In addition, if the problem is such that a multi-agency and jurisdictional response is required, the emergency management system in Michigan can be utilized to enhance coordination and effectiveness of the response and recovery effort.

Although no area is completely immune to public health emergencies, areas with high population concentrations will always be more vulnerable. In addition, densely populated areas will tend to have more vulnerable members of society who are more at risk than the general population, such as the elderly, children, impoverished individuals, and persons in poor health. This not only applies to dense urban areas; it also applies to resident camps and nursing homes.

The primary types of public health impacts involve the threat or presence of disease, contamination, or sanitation problems. Disease epidemics or pandemics have the potential to cause widespread debilitation or loss of life, associated medical expenditures, and decreases in productivity and quality of life. Contamination can at least temporarily lower property values, as well. Sanitation problems require effort and expense to resolve. Contamination and sanitation issues increase the probability and variety of diseases that may affect the population. Facilities may be shut down, as a means of preventing disease transmission or of containing contamination, and thus cause a loss of the services being provided to the public (by schools, for example). The Public Health Muskegon County continually monitors health threats and enforces strict regulations for septic systems in resort and summer-surge population areas.

Muskegon County is host to a number of medical facilities that serve the regional population. If a large health emergency occurs, especially during "surge" population seasons, medical resources may become overwhelmed and unable to deal with any additional needs. Generally speaking, as traditional medical services become increasingly difficult to access (or if their quality declines due to overwork or understaffing) then increasing numbers may turn to less responsible and effective alternative means of treatment (or may forego treatment entirely). Close cooperation with medical resources from outside the county may be needed. Even a public health emergency on a local scale would have potential to strain existing medical resources, and interrupt businesses and services.

Historically Significant and Related Events: According to the Public Health Muskegon County, the leading causes of death are non-communicable diseases such as heart disease and cancer. Like the rest of the United States and the world, Muskegon County has had serious outbreaks of diseases like smallpox, measles, mumps, and influenza. It has been many years since the county has had to deal with diseases like polio, which gripped the country in the '50's. If a health epidemic of large proportions were to occur in the area, responders may have serious staffing problems. Listed below are some of the notable public health events in Muskegon County history:

- 1913 – Diphtheria Epidemic.
- 1916 – Small pox and scarlet fever force closures of schools and businesses.
- 1918 – Influenza epidemic closes theaters, dance halls, and churches.
- 1937 – Children under 18 banned from theaters and schools close from fear of polio outbreak.
- 1941 – Influenza epidemic cuts school attendance by 60%.
- 2009 – H1N1 influenza pandemic causes school absences spike in the fall. Two county residents die from complications.
- 2013 – North Muskegon Schools close for two days due to widespread influenza.

Since 2001, there have been five human cases of West Nile virus in Muskegon County: one in 2002; three in 2006; and one in 2012. None of the cases have ended in death. In 2012, Michigan experienced the worst season of human West Nile virus since 2002 with 201 cases and 15 deaths.

The County has experienced many instances of power outages that could have created unhealthy conditions, as documented in Section 2.06. Fortunately, none have caused widespread health problems. A new concern is the return of wild animals to populated areas. In recent years, there have been sightings of coyote, bobcat, cougar, and a bear around the peripheries of the Muskegon metropolitan area.

Frequency of Occurrence: This is a difficult hazard to assess because there are many undefined factors; such as the unexpected development of new diseases such as influenza outbreaks, and the threat of an intentional release of a radiological, chemical or biological agent intended to adversely impact a large number of people.

Each year brings a unique and relatively unpredictable strain of the flu to county residents. It has been over 50 years since an incidence such as polio has threatened residents. The 2000 Muskegon County Hazard Analysis estimates public health emergencies as occurring every twenty-five years. The Health Department continually monitors health threats and has recommended increasing surveillance activities to prevent the spread of vector-born and zoonotic disease.

3.05 TERRORISM AND SIMILAR CRIMINAL ACTIVITIES

Terrorism: "…activities that involve violent… or life-threatening acts… that are a violation of the criminal laws of the United States or of any State and… appear to be intended (i) to intimidate or coerce a civilian population; (ii) to influence the policy of a government by intimidation or coercion; or (iii) to affect the conduct of a government by mass destruction, assassination, or kidnapping" Federal criminal code. 18 U.S.C. §2331

Summary: Terrorism is the use of violence by individuals or groups to achieve political goals by creating fear. The political motives of terrorism distinguish it from ordinary crime. Terrorism is carried out for a cause; not for financial gain, personal revenge, or a desire for fame.

Hazard Description: Terrorism is a long-established strategy that is practiced by many groups in many nations. The United States is threatened not only by international terrorists such as Al Qaeda, but also by home-grown domestic terrorist groups including racist, ecological, anti-abortion, and anti-government terrorists.

A wide range of techniques can be used by terrorists, including bombings, shootings, arson, and hijacking. Regardless of the specific tactics used, terrorists seek the greatest possible media exposure. The goal of terrorists is to frighten as many people as possible, not necessarily to cause the greatest damage possible. Media coverage allows terrorists to affect a much larger population than those who are directly attacked.

Non-terrorist criminal activity may resemble terrorism, but lacks a political objective. Emergency management is typically not concerned with routine, individual crimes, but does need to prepare for crimes that impact large portions of the population. Such attacks may require resources not available to local law enforcement agencies. Crimes of this sort include mass shootings, random sniper attacks, sabotage of infrastructure, and cyber-attacks. The types of criminal attacks considered in this section are those that resemble terrorism or that may cause widespread immediate disruption to society.

In today's world, sabotage/terrorism can take on many forms, although civilian bombings, assassination and extortion are probably the methods with which we are most familiar. Cyber-attacks appear to be an increasingly eminent threat. Internationally, such acts have become commonplace as various religious, ethnic, and nationalistic groups have attempted to alter and dictate political and social agendas, seek revenge for perceived past wrongdoing, or intentionally disrupt the political, social and economic infrastructure of individual businesses, units of government, or nations. The Middle East and European continent, in particular, have been hard hit by acts of sabotage and terrorism over the past several decades. Parts of Asia and South America have also experienced a high level of activity.

Unfortunately, with advances in transportation and technology, sabotage/terrorism has now crossed the oceans into the United States. Equally alarming is the rapid increase in the scope and magnitude of sabotage/terrorism methods and threats, which now include: 1) nuclear, chemical and biological weapons; 2) information warfare; 3) ethnic/religious/gender intimidation (hate crimes); 4) state and local militia groups that advocate the overthrow of the U.S. government; 5) eco-extremism designed to destroy or disrupt specific research or resource-related activities; and 6) widespread and organized narcotics (and other contraband) smuggling and distribution organizations. Just as the methods and potential instigators have increased, so too have the potential targets of sabotage/terrorism.

As recent events across the country have shown, virtually any public facility, segment of infrastructure, or place of public assembly can be considered a target of sabotage. In addition, certain types of businesses engaged in controversial activities are also potential targets. With the advent of the information age and growth in the number of computer "hackers", computer systems (especially those of government agencies, large businesses, financial institutions, health care facilities, and colleges/universities) are potential targets as well. One of the primary common denominators of most saboteurs is their general desire for organizational recognition, but not necessarily individual recognition. They often seek publicity for their "cause" or specific agenda, but they go to great lengths to avoid individual detection by law enforcement agencies. The exception to this might be individuals and organizations involved in narcotics or other contraband smuggling and distribution, which seek to keep their clandestine operations out of public and law enforcement scrutiny. Another commonality is that innocent people are always the ones that suffer the most in these senseless and cowardly criminal acts.

Historically Significant and Related Events: In the past, manufacturers in the county have had significant ties to the production of parts and vehicles for military and defense. As a result, Muskegon may have been considered a potential target for an attack. Though much of this activity has steadily declined in the end of World War II, a few of these manufacturers remain in business to this day.

Although Muskegon County has never experienced a significant act of terrorism or major criminal incident, recent high profile national events have increased concern among local officials for this hazard. Examples of such events have included: 1) school and workplace violence; 2) cyber terrorism; 3) sabotage/arson; and 4) domestic/international terrorism.

Frequency of Occurrence: Although it might appear Muskegon County is an unlikely target for terrorism, it cannot be totally discounted. A more detailed study may be performed by Muskegon County Emergency Services to ascertain whether the county's preparedness matches the estimated risk from terrorism and large-scale criminal activities. Consequently, this hazard is not addressed beyond the cursory level in this document.

Part D
HAZARD RISK & VULNERABILITY ASSESSMENT

The primary goal of the Risk & Vulnerability Assessment is to utilize information regarding the previous occurrences, locations and extent of hazards to gain some idea of how often they might arise, where they might occur, and how much harm they might do in the future. When hazards affect the entire county, it is important to consider potential impacts they might have on different parts of the county, especially areas that may have a harder time preparing for and responding to an event (for instance, severe snowstorms and blizzards could close roads throughout the county but the most remote and least traveled roads are plowed last, leaving their residents snowed in for days). It is also important to consider "worst-case scenarios," wherein one hazard causes others (such as severe winds causing infrastructure failures causing public health concerns), and to assess the limits of response capabilities (for example, a public health emergency may temporarily overwhelm medical service capabilities).

The simplest technique to assess risk and vulnerability is to: (1) compare the community profile map with hazard maps for the same area and (2) determine areas where hazards overlap with the locations of people, structures, and infrastructure. Areas where hazards might overlap with development are examined more closely to estimate what kinds of damages might occur during an emergency event. Maps throughout this document can be used to help facilitate this process. County-level maps at the end of this section show critical facilities/infrastructure and hazards, respectively. Other county-level maps are included in Part B for Natural Features and Land Cover. Appendix A contains municipal-level USGS Topographic maps which provide some information about locations of man-made structures. Appendix B includes municipal-level Hazard Risk maps which show critical facilities/infrastructure and mappable hazards. Altogether, the maps in this document are useful for conducting cursory hazard risk and vulnerability assessments. However, a detailed assessment would likely require additional means of investigation because some maps may lack a requisite level of accuracy and/or currency.

Another technique, which is more effective when hazards tend to be area-wide rather than location specific, is to rate and rank hazards in each community according to a standard set of variables. Such rankings will help to prioritize mitigation efforts according to the severity of a given hazard's risks in a given community. A quantitative assessment helps to measure the potential threats of each hazard; however, there is no need to reach perfect accuracy with these measurements. They are mainly used to compare hazards with each other, to prioritize them and determine the ones to which the community is most vulnerable.

The previous edition of this plan employed a "weighted average" technique of assessing and prioritizing hazards to quantify and compare the different hazards facing each community. While this is an effective technique for comparing hazards against each other, some individuals found it to be too subjective and rather complicated. Therefore, an alternative methodology was sought for this plan update. The first step involved a review of numerous hazard assessment techniques employed by other FEMA-approved hazard mitigation plans. A unique system was then devised, reviewed by MSP-EMHSD, and finally reviewed and accepted by the Muskegon County LEPC.

The revised rating and ranking methodology used in this plan factors the probability of each hazard's occurrence, as well as its likely impact on people, impact on property, and impact on the economy of the community. These four *hazard metrics* are each rated on a scale of 0 to 3, according to a unique set of benchmarks, for each hazard in each municipality in the county. Ratings were influenced by 1) hazard identification and analysis (Part C of this document); 2) ratings assigned in the previous edition of this plan; 3) input obtained through the survey questionnaire (described in Part A); and 4) input from the Muskegon County LEPC and the Advisory Team. Listed below is the schedule of metrics and benchmarks used to rate hazards in this plan.

Hazard Assessment Rating Benchmarks		
Hazard Metric	Benchmark	Rating
Probability of Occurrence	Unlikely Occurrence	0
	Not likely within 50+ years	1
	Likely within 50 years	2
	Likely within 10 years	3
Population Impact	No one affected	0
	<10% of population	1
	10-50% of population	2
	50-100% of population	3
Property Impact	No effects	0
	Isolated location	1
	Multiple locations	2
	Widespread	3
Economic Impact	No effects	0
	Mere Inconvenience	1
	Slight disruption of Services and Commerce	2
	Extended disruption of Services and Commerce	3

Once rated, each hazard is then ranked. However, each metric has a unique degree of influence upon a community's overall risk and vulnerability to a given hazard. To help account for the varying importance of each metric, unique values (or weights) are applied. The three "impact" metrics receive such weights: *population impact* gets a weight of 3; *property impact* gets a weight of 2; and *economic impact* gets a weight of 1. A higher number shows greater importance. These weighting factors are consistent with those typically used for measuring the benefits of hazard mitigation actions; which helps to develop a more compelling comparison of hazards as they relate to the selection of potential mitigation actions. *Probability of occurrence* is assumed to be the most significant component, one which magnifies the potential impacts of a hazard. To quantify this relationship, the sum of the *weighted impacts* is multiplied by the hazard's probability of occurrence.

Hazard Vulnerability Ranking Formulas
Weighted Impacts = (Population Impact x 3) + (Property Impact x 2) + (Economic Impact x 1)
Hazard Vulnerability Score = Probability of Occurrence x Weighted Impacts

The result is a standardized list of *hazard vulnerability* scores; a tool with which to rank the hazards facing a community. It can be used to 1) establish priority, 2) provide a way to build consensus about these priorities, and 3) explain decisions that have been made from these priorities. It fulfills the requirements of a Vulnerability Assessment.

The Hazard Assessment Ratings and Hazard Vulnerability Rankings for Muskegon County are revealed in the following. Ratings and rankings for individual municipalities in the county have been placed in Appendix B – Hazard Identification and Analyses.

MUSKEGON COUNTY
Hazard Assessment Ratings

Natural Hazards	Probability of Occurrence	Population Impact	Property Impact	Economic Impact
1.01 Celestial Impacts	1	2	0	2
1.02 Drought	2	2	2	2
1.03 Earthquake	0	-	-	-
1.04 Extreme Temperatures	3	2	1	1
1.05 Flooding: Riverine/Urban	3	1	2	2
1.06 Fog	3	1	0	2
1.07 Great Lakes Shoreline	3	1	2	1
1.08 Hail	3	1	1	1
1.09 Invasive Species	2	1	1	2
1.10 Lightning	3	1	2	1
1.11 Severe Winds	3	2	2	2
1.12 Subsidence	1	1	1	1
1.13 Tornadoes	2	1	2	2
1.14 Wildfire	3	1	2	1
1.15 Winter Storms	3	3	2	2
Technological Hazards				
2.01 Dam Failure	2	1	2	2
2.02 Energy Emergencies	2	2	0	2
2.03 Fire – Scrap Tires	1	1	1	1
2.04 Fire – Structural	3	1	2	3
2.05 HAZMAT – Fixed Site	3	1	1	2
2.06 HAZMAT – Transportation	3	1	1	1
2.07 Infrastructure Failures	3	2	1	2
2.08 Nuclear Power Emergencies	0	-	-	-
2.09 Oil/Natural Gas Well Accidents	2	1	1	1
2.10 Pipeline Accidents	2	1	2	2
2.11 Transportation Accidents	2	1	1	2
Human-Related Hazards				
3.01 Catastrophic Incidents (National Emergencies)	1	3	3	3
3.02 Civil Disturbances	2	1	1	1
3.03 Nuclear Attack	0	-	-	-
3.04 Public Health Emergencies	2	2	0	3
3.05 Terrorism & Similar Criminal Acts	1	1	1	1

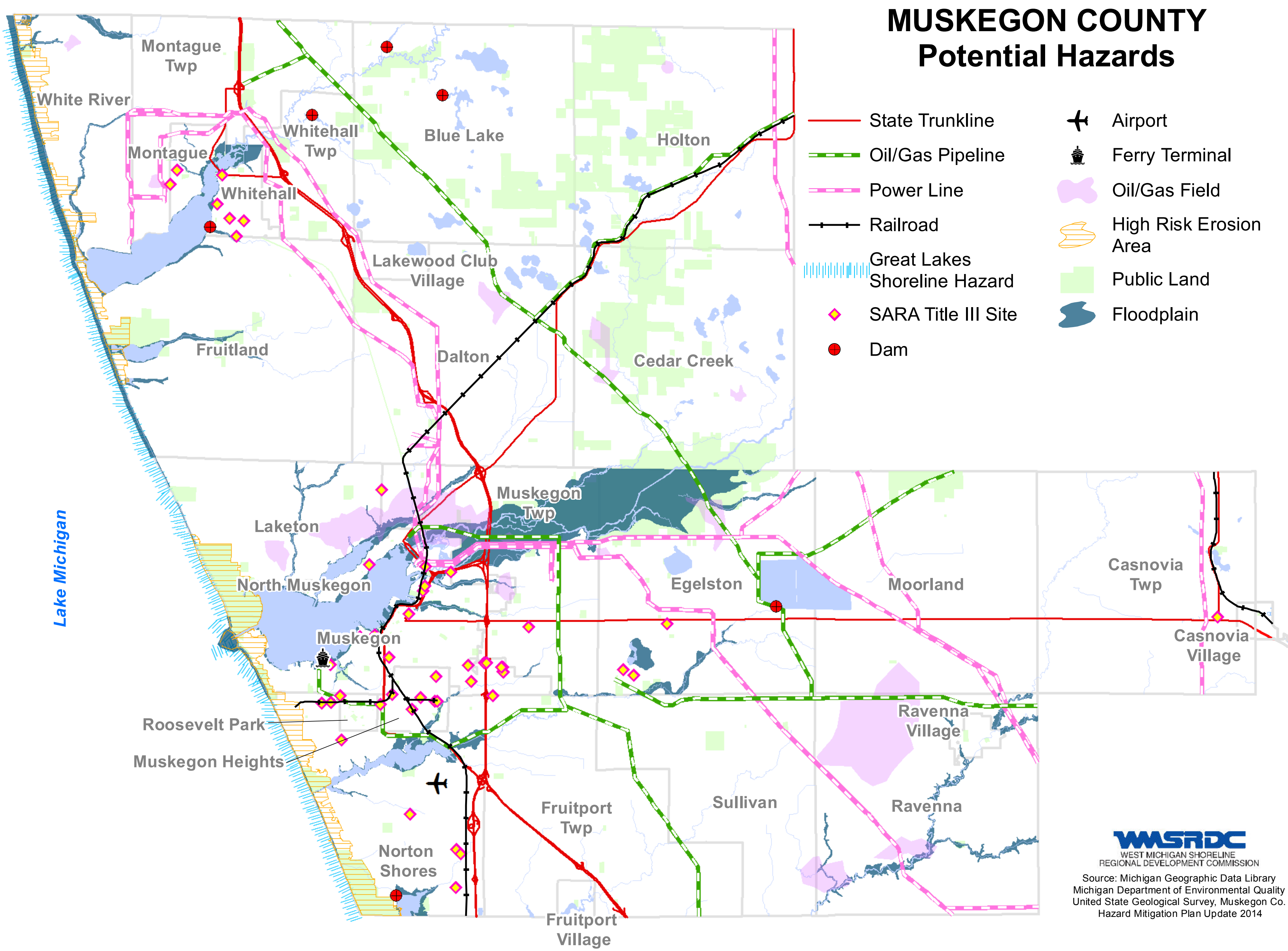
MUSKEGON COUNTY
Hazard Vulnerability Rankings

Rank	Hazard	Probability of Occurrence	x	Sum of Weighted Impacts	=	Hazard Vulnerability Ranking
1	Winter Storms	3		15		45
2	Severe Winds	3		12		36
3	Fire – Structural	3		10		30
3	Infrastructure Failures	3		10		30
5	Extreme Temperatures	3		9		27
5	Flooding: Riverine/Urban	3		9		27
7	Drought	2		12		24
7	Great Lakes Shoreline	3		8		24
7	Lightning	3		8		24
7	Wildfire	3		8		24
11	HAZMAT – Fixed Site	3		7		21
12	Catastrophic Incidents	1		18		18
12	Dam Failure	2		9		18
12	Hail	3		6		18
12	HAZMAT – Transportation	3		6		18
12	Pipeline Accidents	2		9		18
12	Public Health Emergencies	2		9		18
12	Tornadoes	2		9		18
19	Energy Emergencies	2		8		16
20	Fog	3		5		15
21	Invasive Species	2		7		14
21	Transportation Accidents	2		7		14
23	Civil Disturbances	2		6		12
23	Oil/Natural Gas Well Accidents	2		6		12
25	Celestial Impacts	1		8		8
26	Fire – Scrap Tires	1		6		6
26	Subsidence	1		6		6
26	Terrorism & Similar Criminal Acts	1		6		6
n/a	Earthquake	0		-		-
n/a	Nuclear Attack	0		-		-
n/a	Nuclear Power Emergencies	0		-		-

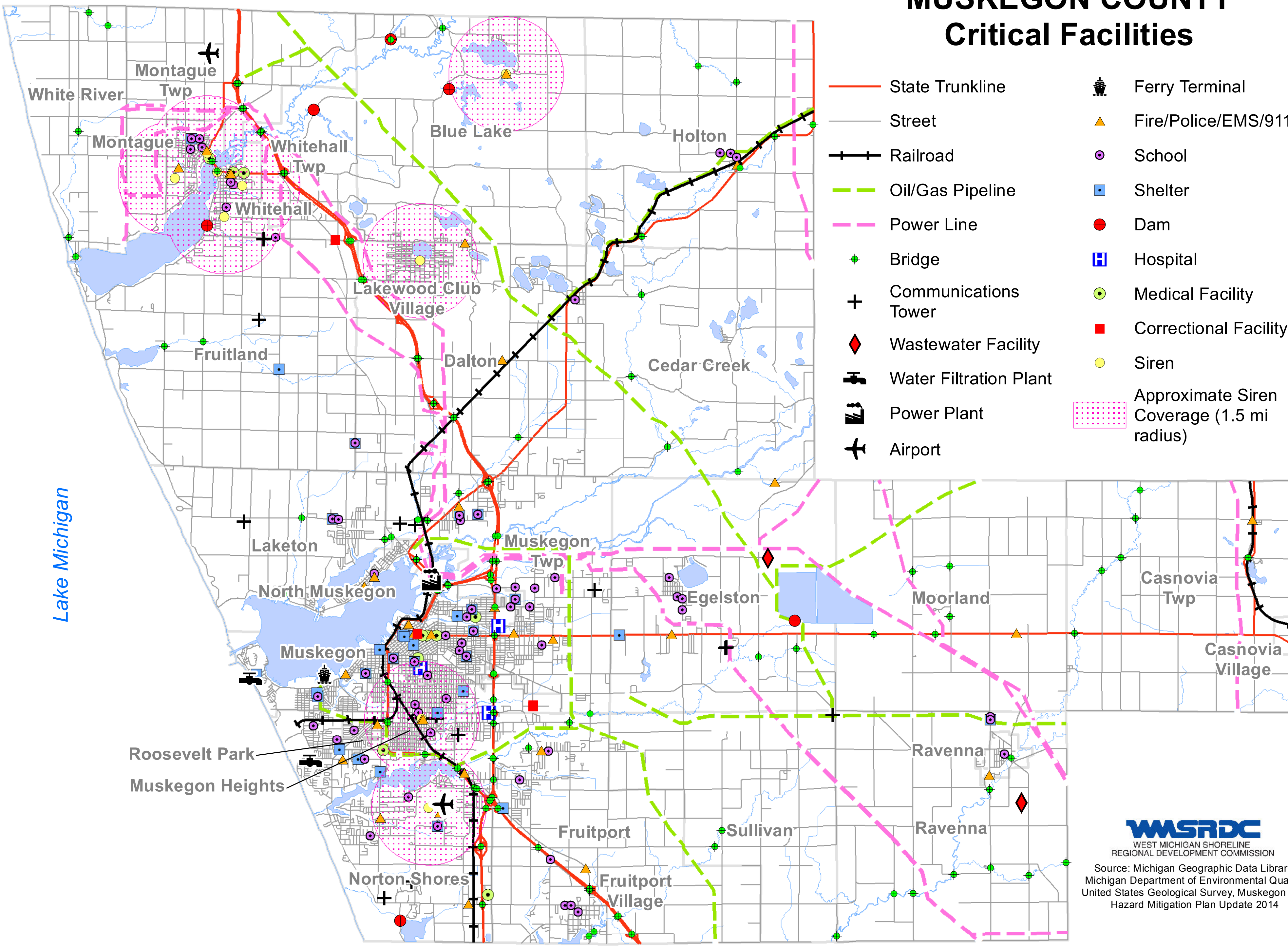
The revised rating and ranking system produced results similar to the 2006 Muskegon County Hazard Mitigation Plan, helping to validate the results. The county's top five hazards remain the same, with only *Extreme Temperatures* falling two spots to #5. The largest change in ranking for any hazard was the promotion of *Great Lake Shoreline* (formerly known as *Flooding: Shoreline*) from #17 to #7. This dramatic increase in priority is partly because the scope of the hazard analysis was broadened to include additional aspects, such as "rip currents" and the impacts of low water levels on the Great Lakes.

The individual community level hazard rankings, which can be found in Appendix B, are similar to the county rankings. For all communities, *Winter Storms* is the #1 hazard; while the next four priority hazards are *Severe Winds, Fire – Structural, Infrastructure Failures,* and *Extreme Temperatures*, though not necessarily in that order. Beyond the top hazards, some variations in hazard ranking and priorities occur depending on the community. For example, *Fire - Structural* is more of a concern in a developed community than a rural area. Likewise *Drought* may be more of a concern to a predominately agricultural community than a commercialized area.

2014 Rank	Hazard	2006 Rank	Change
1	Winter Storms	1	*- no change -*
2	Severe Winds	2	*- no change -*
3	Fire – Structural	t3	*- no change -*
3	Infrastructure Failures	5	**↑2**
5	Extreme Temperatures	t3	**↓2**
5	Flooding: Riverine/Urban	10	**↑5**
7	Drought	8	**↑1**
7	Great Lakes Shoreline	17	**↑10**
7	Lightning	11	**↑4**
7	Wildfire	7	*- no change -*
11	HAZMAT – Fixed Site	6	**↓5**
12	Catastrophic Incidents	-	**new hazard**
12	Dam Failure	9	**↓3**
12	Hail	13	**↑1**
12	HAZMAT – Transportation	14	**↑2**
12	Pipeline Accidents	16	**↑4**
12	Public Health Emergencies	12	*- no change -*
12	Tornadoes	18	**↑6**
19	Energy Emergencies	-	**new hazard**
20	Fog	-	**new hazard**
21	Invasive Species	-	**new hazard**
21	Transportation Accidents	15	**↓6**
23	Civil Disturbances	20	**↓3**
23	Oil/Natural Gas Well Accidents	19	**↓4**
25	Celestial Impacts	-	**new hazard**
26	Fire – Scrap Tires	*not ranked*	**-**
26	Subsidence	21	**↓5**
26	Terrorism & Similar Criminal Acts	*not ranked*	**-**
not ranked	Earthquake	*not ranked*	**-**
not ranked	Nuclear Attack	*not ranked*	**-**
not ranked	Nuclear Power Emergencies	*not ranked*	**-**


MUSKEGON COUNTY
Potential Hazards
State Trunkline
Oil/Gas Pipeline
Power Line
Railroad
Great Lakes Shoreline Hazard
SARA Title III Site
Dam
Airport
Ferry Terminal
Oil/Gas Field
High Risk Erosion Area
Public Land
Floodplain
Lake Michigan
Montague Twp
White River
Montague
Whitehall Twp
Whitehall
Blue Lake
Holton
Lakewood Club Village
Fruitland
Dalton
Cedar Creek
Muskegon Twp
Laketon
North Muskegon
Egelston
Moorland
Casnovia Twp
Casnovia Village
Muskegon
Roosevelt Park
Muskegon Heights
Ravenna Village
Fruitport Twp
Sullivan
Ravenna
Norton Shores
Fruitport Village
WMSRDC
WEST MICHIGAN SHORELINE REGIONAL DEVELOPMENT COMMISSION
Source: Michigan Geographic Data Library
Michigan Department of Environmental Quality
United State Geological Survey, Muskegon Co.
Hazard Mitigation Plan Update 2014

MUSKEGON COUNTY
Critical Facilities



WMSRDC
WEST MICHIGAN SHORELINE REGIONAL DEVELOPMENT COMMISSION

Source: Michigan Geographic Data Library
Michigan Department of Environmental Quality
United States Geological Survey, Muskegon Co.
Hazard Mitigation Plan Update 2014

Part E
HAZARD MITIGATION GOALS AND OBJECTIVES

Goals are general guidelines that explain what the county wants to achieve. They are usually long-term and represent global visions such as “protect public health and safety.” Objectives define strategies or implementation steps to attain the identified goals. Objectives are more specific and measurable than goals, making them more likely to have a defined completion date.

The development of clear goals and objectives helps clarify problems, issues, and opportunities in hazard mitigation, as well as other areas. An important feature of developing them is raising community awareness of the relationship between community development practices and the level of hazard vulnerability and risk. Also, raising citizen awareness can help gain support for ongoing mitigation planning efforts.

The following goals and objectives were established for hazard mitigation efforts in Muskegon County. They are based on the county’s hazard analyses and input from LEPC members, government officials, government departments, planning and zoning officials, emergency responders, schools, correctional facilities, the public, and other interested entities.

For the updated edition of this plan, the goals and objectives from the 2006 edition were reviewed and then discussed at the November 12, 2013 Muskegon County LEPC meeting. It was determined that the goals and objectives remain valid, and therefore no significant changes or additions were proposed. The two foremost factors contributing to this conclusion were that: 1) conditions within the county have remained generally the same; and 2) the revamped risk assessment findings were comparable to the 2006 risk assessment.

OVERALL HAZARD MITIGATION GOAL:
Reduce or eliminate the long-term risk to human life and property from the full range of disasters.

GOAL 1. Promote growth in a sustainable, hazard-free manner.

Objective 1.1. Incorporate hazard provisions in building code standards, ordinances, and procedures.
Objective 1.2. Incorporate hazard mitigation into land use and capital improvement planning and development activities.
Objective 1.3. Incorporate hazard mitigation into existing land use regulation mechanisms to ensure that development will not put people in danger or increase threats to existing properties.
Objective 1.4. Research, recommend, adopt and enforce programs, plans, and ordinances that protect natural resources so that they can, in turn, provide hazard protection.

GOAL 2. Protect existing and new properties.

Objective 2.1. Use the most cost-effective approaches to keep hazards away from existing buildings and facilities.
Objective 2.2. Use the most cost-effective approaches to protect existing buildings and sites from hazards.
Objective 2.3. Maximize insurance coverage to provide financial protection against hazard events.
Objective 2.4. Maximize the resources for investment in hazard mitigation, including the use of outside sources of funding.

GOAL 3. Protect public health and safety.

Objective 3.1. Assure that threat recognition (watches) and warning systems are adequate and appropriate and that they utilize the latest technology.
Objective 3.2. Protect infrastructure and services.
Objective 3.3. Build and support local capacity, commitment and partnerships to continuously become less vulnerable to hazards.
Objective 3.4. Enlist support of committed volunteers to safeguard the community before, during, and after a disaster.

GOAL 4. Increase public understanding, support, and participation in hazard mitigation.

Objective 4.1. Heighten public awareness of the full range of existing natural and man-made hazards and actions they can take to prevent or reduce the risk to life or property.
Objective 4.2. Encourage local communities, agencies, organizations and businesses to participate in the hazard mitigation process.
Objective 4.3. Encourage cooperation and communication between planning and emergency management officials.

In order for these goals and objectives to succeed, they must be integrated into and compatible with other community goals. They must also be divided into manageable components, or actions, that can be accomplished and they must be prioritized so local officials can better focus their attention on developing alternatives.

The following sections guide and encourage concrete actions to be taken. Parts F and G contain alternatives that can be utilized by the county to accomplish hazard mitigation. Also included in Part F is information about the known employment of those alternatives within Muskegon County. Part H explains how the recommended action items are selected from the list of potential actions; and Part I reveals the recommended action agenda for plan implementation.

Part F
Hazard Mitigation Alternatives

The identification of risks and vulnerabilities, paired with established goals and objectives, should lead planners directly to a consideration of various mitigation alternatives that might be applied to improve the safety and security of residents, property, the environment, the economy, and quality of life. A mitigation alternative is not the same as a project or specific action that will definitely be implemented. Rather, an alternative is one in a set of potential actions or strategies that will be evaluated and compared.

It is important to recognize that "hazard mitigation" is often presented as something entirely distinct from "preparedness, response, and recovery," (known together as the four phases of emergency management). However, state planners in Michigan prefer to not place clear limits or distinctions around the mitigation alternatives, since all phases of emergency management share the same ultimate goals of protecting life and property, etc. Many of the mitigation alternatives discussed in this section may seem to include other aspects of emergency management.

There is a multitude of alternatives for mitigating hazards, which can be organized into the five basic strategies summarized in the table below.

Basic Hazard Mitigation Strategies

Mitigation Strategy	Description	Examples of Measures	Advantages / Limitations
MODIFYING THE HAZARD	Modifying the hazard itself (which involves removing or eliminating the hazard), reducing its size or amount, or controlling the rate of release of the hazard. In the right circumstances, this strategy can be successful but it is often difficult to do.	• Cloud seeding to modify precipitation • Slope planting to prevent erosion or collapse • Stream modification or widening to divert or improve water flow • Dredging to deepen water channel or body to improve water flow and capacity	• Can be cost-effective in many situations • Application is limited and therefore may not be as effective as other strategies • Does not always reduce or eliminate damage on a wide scale • Some hazards simply cannot be modified
SEGREGATING THE HAZARD	Attempts to "keep the hazard away from people." Primarily for flood hazards but also has applicability to other hazards. Measures are designed to redirect the impacts of a hazard away from people and development	• Dams • Dikes / Levees • Floodwalls • Flood drainage channels • Debris basins • Designated routes for hazardous transport • Buffer zones around hazard sites • Defensible space around development • Safe rooms (indoor shelter space) to protect building occupants from harm	• Can be effective for some hazard situations • Some measures can be expensive • Some measures may cause or exacerbate environmental problems • May protect one community but cause problems for adjacent communities • Economically marginal for many situations and locations
PREVENTING OR LIMITING DEVELOPMENT	Preventing or limiting development in locations where people and development would be at risk. This strategy is based on "keeping the people away from the hazard" and includes a variety of land use planning and development regulation tools. Attempts to reduce or eliminate community hazard vulnerability through wise and prudent land use and development decision-making.	• Comprehensive planning • Zoning ordinances • Building codes • Subdivision regulations • Floodplain management ordinances and other special area, use and design regulations • Capital improvements planning • Disclosure laws • Acquisition and relocation of hazard prone properties	• Can be highly effective in promoting safe, sustainable development • Widespread application (i.e., statewide, regional, local) • Proactive – seeks to prevent or reduce future vulnerabilities • Reduces future incident response / recovery costs • Administrative tools have minimal associated costs • May in some cases reduce future tax revenue if development does not occur
ALTERING DESIGN OR CONSTRUCTION	Altering the design or construction of development to make it less vulnerable (more resilient) to disaster damage. This strategy allows hazards to interact with human systems that have been designed and planned to withstand potentially destructive impacts. This strategy allows development in hazard prone areas, but requires that the development meet stringent disaster resistant performance criteria.	• Elevating flood-prone structures • Wet / dry flood proofing to improve flood damage resistance • Defensible space (vegetation buffer zones) in urban / wildland intermix areas • Wind bracing to improve wind damage resistance • Insulating water and sewer lines to prevent ground freeze damage	• Balances the dual needs of enhancing a community's economic base while at the same time reducing community hazard vulnerability • Can result in safe, sustainable development if done properly • Reduces future incident response / recovery costs • Allows for maximum land use potential • Resilient structures "rebound" better from incident impacts
EARLY WARNING AND PUBLIC EDUCATION	Seeks to ensure that the public is aware of the hazards it faces, and that proper warning and communication systems and practices are in place to save lives and protect property.	• Community hazard identification / analysis • Early warning systems (indoor and outdoor) • Tailored public awareness / education campaigns regarding hazards, warning systems and protective actions • Warning devices in congregate facilities • Special needs population warning systems	• Universal strategy – should be applied in all communities • Typically the last line of defense against serious disaster related injury, loss of life and property damage • Recognizes that some hazards cannot be prevented and therefore must be dealt with using proper safety precautions • Enhances community awareness of and support for emergency management efforts

Source: MSP/EMHSD Pub. 106a, Michigan Hazard Mitigation Success Stories, 2011

The remainder of this chapter considers a variety of mitigation alternatives for the county's top hazards. They are presented in one or more of the following groups: Preventative Measures, Corrective Measures, Resource Protection, Emergency Services, and Public Education and Awareness. Much of the following narrative was either borrowed from, or supplemented by information compiled in the Michigan Hazard Mitigation Plan.

For the 2014 edition of this plan, descriptions of mitigation alternatives were reviewed and updated as needed. How alternatives are being utilized within Muskegon County (community capabilities) were also reviewed and updated. Other updates to this chapter include a revised description of basic mitigation strategies (see table on previous page), and the inclusion of common mitigation funding sources.

1. Preventive Measures.

Preventive mitigation is desirable because it seeks to prevent future problems from occurring. Wise land use planning and building design, small-scale retrofitting, and early warning and public education fall under this category. Doing it right the first time is almost always preferable to going back and trying to correct recurring problems at a later date. Preventive mitigation is generally easier to implement than other types of mitigation because the administrative mechanisms that guide the land development process – planning and plan review, zoning, capital improvements programming, building codes and standards, etc. – are available to every local community and only require adoption and consistent application to be highly effective in reducing or eliminating hazard vulnerability. Prevention is also generally more flexible and cost-effective and can significantly reduce or eliminate future hazard vulnerability. Preventive mitigation can help ensure that, at the very least, responsible agencies do not contribute to the increasing severity of the problem through unwise decision-making.

Preventive measures protect new construction from hazards and assure that future development does not increase the potential for losses. They are particularly important where there is an abundance of undeveloped land, such as in Muskegon County. Planning, zoning, and code-enforcement officials usually administer preventive measures.

A. Building Codes. Building codes are designed to ensure that a structure will be constructed in such a manner as to be safe for occupancy and use. These codes also regulate health and sanitation requirements for water, ventilation, plumbing, electricity, mechanical equipment, and air conditioning, and contain minimum construction standards for natural hazard resistance. Building codes, used in concert with other available land use / development guidance measures, can be effective in reducing or eliminating damage caused by many natural hazards such as high winds, wildfire, and flooding. In communities where comprehensive planning is not done or not done properly, the building code may essentially be the only land use regulatory measure available.

Building codes provide one of the best methods of addressing the hazards in this plan, and are a prime measure to protect new construction from damage caused by natural hazards. Many times, minimum building code requirements make the difference between a structure that suffers minimal or no damage and one that suffers major damage or is a total loss. Hazard protection standards for all new and improved or repaired buildings can be incorporated into the local building code. Such standards may include:

- Making sure roofing systems will handle high winds and expected snow/ice/sleet/hail loads;
- Making sure windows, doors and siding can handle high winds;
- Providing special standards for tying the roof, walls and foundation together (crossbracing and anchoring walls to foundations, and roof rafters to walls) to resist the effects of wind;
- Requiring new buildings to have tornado "safe rooms";
- Making sure electrical systems are grounded and fire walls and sprinklers are installed in attached structures;
- Including insulation standards that ensure protection from extreme heat and cold;
- Securing the "envelope" of a structure, to reduce water-related damage; and
- Mandating overhead sewers for all new basements to prevent sewer backup.

Building codes; primarily the Michigan Residential Code, the Michigan Plumbing Code, the Michigan Mechanical Code, the Michigan Building Code for commercial construction, and the National Electric Code; are adopted and enforced locally in Muskegon County. These codes provide the basis for good building safety programs, especially protection from fire and electrical hazards. They can be complemented by rehabilitation codes, such as the 2003 Michigan Rehabilitation Code for Existing Buildings. They are constantly being evaluated and updated to reflect new information and recommended practices.

Pursuant to 1972 PA 230, adopted November 5, 1974 and amended by 1999 PA 245, all communities in Michigan are subject to the State Construction Code, which establishes general minimum construction standards for buildings and structures in all Michigan municipalities. The State Construction Code is a compilation of the International Residential Code, the International Building Code, the International Mechanical Code, the International Plumbing Code published by the International Code Council, the National Electrical Code published by the National Fire Prevention Association, and the Michigan Uniform Energy Code with amendments, additions, or deletions as the Michigan Department of Energy, Labor and Economic Growth determines appropriate. The Code became effective statewide on July 31, 2001. The State Construction Code provides for statewide uniformity of application and implementation of rules governing the construction, use, and occupancy of buildings and structures.

FEMA, the Insurance Institute for Business and Home Safety (IBHS), and Insurance Services Office (ISO) are three national organizations that conduct evaluations, and then suggest revisions for insufficient or inappropriate codes. For example, FEMA often utilizes a Building Performance Assistance Team (BPAT) to assess tornado damages to code-conforming structures. If building performance is deemed inadequate, the BPAT may then recommend revisions to the codes to protect structures from future hazard damage.

The IBHS is a non-profit insurance industry research center that is dedicated to maintaining specific building code standards to reduce deaths, injuries, property damage, economic losses and human suffering caused by natural disasters such as wildfire, tornadoes, freezing weather, and hail. Its "FORTIFIED for Safer Living" program is one component of the IBHS suite of "FORTIFIED" programs dedicated to improving the quality of residential and light commercial buildings. The "Safer Living" section specifies construction, design, and landscaping guidelines to increase a new home's resistance to disaster from the ground up. A bevy of FORTIFIED resources for governments, business owners, and homeowners are available on the IBHS website, www.http://www.disastersafety.org/fortified/.

The ISO administers the Building Code Effectiveness Grading Schedule (BCEGS), a program designed to foster better building code enforcement and thereby reduce natural hazard damage. Local building departments are "graded" on their building codes and how those codes are enforced, with special emphasis on mitigation of losses from natural hazards. Communities with good codes and code enforcement programs in place will receive a better grade than those communities that don't, and property owners in the higher-graded communities will be rewarded with homeowners' insurance premium credits. ISO began implementing the program in states with high exposure to wind (hurricane) hazards, then moved to states with high seismic exposure, and then continued through the rest of the country. Code enforcement is done by local jurisdictions in Muskegon County, including inspections during construction to ensure that builders understand code requirements and are following them.

The BCEGS was developed after determining that much of the construction failure resulting from natural disasters was due, in large part, to construction not built to comply with codes. The insurance industry's experience has shown that communities with effective codes and code enforcement have a more favorable (lower) insurance loss experience because they have less disaster-related damage to structures. BCEGS is modeled after a similar and long-standing ISO fire-grading program, which assesses local fire departments and water supplies. It is similar to and acknowledged by the Community Rating System (CRS) of the National Flood Insurance Program (NFIP), which awards CRS credit according to BCEGS rating. The BCEGS and CRS operate under the assumption that communities with well-enforced, up-to-date codes will experience fewer damages. Homeowners within the participating communities can therefore receive lower insurance rates. This often provides communities with enough incentive to rigorously enforce their building codes.

Over 1,100 Michigan communities have received a BCEGS rating. Fire chiefs, chief building officials, and community chief administrative officials may request a single copy of the BCEGS free of charge. If a community has not yet received a BCEGS grading, or if the community has recently made improvements in its building code enforcement services, it may be eligible for a BCEGS survey.

B. Standards for Manufactured Homes. Manufactured or “mobile” homes are usually not regulated by local building codes since they are built in out-of-state factories and then shipped to sites. However, they must comply with the U.S. Department of Housing and Urban Development’s National Manufactured Home Construction and Safety Standards (effective June 15, 1976) and meet local standards for on-site installation, both in terms of location and technique. The greatest mitigation concern with manufactured housing is protection from wind damage, which is best achieved through appropriate installation. FEMA’s Building Performance Assistance Team (BPAT) found that newer manufactured housing, designed to better transmit wind up-lift and overturning forces to the foundation, performed better when anchored to permanent foundations. Unfortunately, they also found that building officials were often unaware of manufacturer’s installation guidelines with respect to permanent foundations.

The Michigan Manufactured Housing Commission Act of 1987 (PA 96, as amended) and its implementing Administrative Rules provide regulation on the placement of manufactured homes and establishes construction criteria. Manufactured homes are prohibited from being placed within a floodway, as determined by the Department of Environmental Quality. In addition, manufactured homes sited within a floodplain must install an approved anchoring system to prevent the home from being moved from the site by floodwaters (or by high wind), and be elevated above the 100-year elevation. These provisions are highly effective when properly carried out and enforced.

Recent figures show that mobile homes account for about 6.6% of the housing stock in Muskegon County.

C. Planning, Zoning, and Capital Improvements. While building codes provide guidance on *how* to build in hazardous areas, planning and zoning activities direct development *away* from these areas, especially floodplains and wetlands. They do this by designating land uses that are compatible to the natural conditions of the land, such as open space or recreation in a flood plain, or by simply allowing developers more flexibility in arranging structures on a parcel of land through the planned development approach.

The purpose of a comprehensive plan is to establish an orderly, convenient, efficient and enjoyable environment in a community, and to improve the quality of life for all its citizens. A comprehensive plan provides for future development or improvement of the land use pattern and public service program of the community. In Michigan, planning commissions are required to prepare and adopt a comprehensive plan if the community is enforcing a zoning ordinance. (The zoning ordinance must be based on an adopted comprehensive plan to be legally defensible and enforceable.) This may be the most significant responsibility of the planning commission. Once adopted (by the planning commission and/or the community’s legislative body), the comprehensive plan serves as the foundation document for the preparation and subsequent implementation of other land use / development measures such as the zoning ordinance, capital improvements planning, subdivision regulations, and special area use or design regulations. All of these other measures can be used to implement hazard mitigation measures, so the importance of the comprehensive plan in relation to mitigation cannot be understated.

The Muskegon Area-wide Plan (MAP), a comprehensive plan for Muskegon County, was updated in 2013. According to the MAP, all 27 local units of government in Muskegon County have an active Land Use/Master Plan and Zoning Ordinance in place as allowed by Michigan Law. Therefore, the

MAP can serve as a coordinating influence throughout the county. It was developed with considerable public and governmental input and recommends a "Smart Growth" approach to future development within the county, wherein consideration is given not only to natural resources but also to the availability of existing services. One of the MAP "Visions" is to "encourage and promote land use and growth patterns that sustain and improve quality of life in Muskegon County, while maintaining a strong sense of place, community, and responsibility."

A zoning ordinance is probably the most effective measure a community has for guiding and regulating development and the land use pattern, and it can be very effective in mitigating hazard risk and vulnerability. The zoning ordinance provides a mechanism for implementing the policy decisions articulated in the comprehensive plan concerning the desired locations of various land uses and public facilities. The zoning ordinance is based on the comprehensive plan and therefore is developed and adopted after the comprehensive plan has been formally adopted by the community. One major difference between the two mechanisms is the timeframe upon which they are based. Generally, the comprehensive plan is designed to guide development for the next 20-30 years, whereas the zoning ordinance will typically be adopted on the basis of a 7-10 year land use development need projection.

A zoning ordinance typically addresses three areas: 1) the use of land and structures and the height and bulk of structures; 2) the density of population and intensity of land and structural use; and 3) the provision for space around structures (i.e., requirements for side yards, rear yards, open space, building setback lines, etc.).

Some zoning ordinances may specifically address potential hazards to life and property, although there is no requirement to do this. The ordinance itself consists of a map or maps delineating the zoning districts in the community where various land uses will be allowed, and an accompanying set of administrative procedures, standards and methods for enforcing the zoning regulations. Zoning districts typically include various types of industrial, commercial, residential, agricultural, and public facility uses. Specific zoning districts are tailored to the particular needs of the community. For example, communities that have a significant amount of lakefront properties may have a special zoning district for residential development around lakes.

Through zoning, communities can also prohibit development in some areas; such as in flood plains, along shorelines or in the hydraulic shadow of dams (where flooding would occur if a dam failed). Zoning ordinances usually set minimum lot sizes for each zoning district but communities can allow flexibility in lot sizes and location so that developers can avoid hazardous areas. One way to encourage such flexibility is to use the planned unit development (PUD) approach, which allows the developer to easily incorporate flood hazard mitigation measures into the project. Open space and/or floodplain preservation can be accommodated with site design standards and adjusted land use densities. Granting larger minimum lot sizes, i.e., four or five acres, for areas next to water courses allows streams to run near lot lines, and gives developers flexibility to build on higher ground while still including floodplains in backyards.

A Capital Improvements Plan (CIP) is the mechanism through which a community identifies, prioritizes, and establishes financing methods for needed public improvements such as new or improved public buildings, roads, bridges, treatment plants, water and sewer infrastructure, etc. Under Michigan law, planning commissions are required to annually prepare and adopt a CIP and recommend it to the legislative body for their use in considering public works projects. Generally, public improvements included in the CIP are those that require a substantial expenditure of public funds. (Each jurisdiction must decide what constitutes a substantial expenditure.) The CIP can be an effective implementing mechanism for the community's comprehensive plan and zoning ordinance because it dictates the nature and timing of public facility expenditures. Normally, the CIP is established for a six-year period. The first year of the CIP becomes the year's capital budget and is the basis for making appropriations for capital improvements. As a result, the annually approved items are the highest priority public improvements to be built in planned areas.

From a hazard mitigation perspective, the CIP, if coordinated with the community's comprehensive plan and zoning ordinance, can be an effective mechanism for creating a desirable, less vulnerable land use and development pattern. Planning commissions, because they create and adopt each of the three mechanisms, are instrumental in ensuring that public investment is done in such a way that it helps reduce or eliminate the community's risk and vulnerability to hazards. Capital expenditures may include acquisition of open space within hazardous areas; extension of public services into hazardous areas; installing or improving storm sewers and drainage ditches, culverts and spillways; increasing the depth of water lines; retrofitting existing public structures to withstand hazards; tree management; water detention and retention basins, debris detention basins, debris removal, bridge construction and modification, etc.

D. Subdivision Regulations. Subdivision regulations are the legally established standards of design and construction for dividing a land parcel into smaller ones for the purpose of selling or leasing the property**.** The Land Division Act (1967 PA 288, as amended by 1996 PA 591, 1997 PA 87, and 2004 PA 524) governs the subdivision of land in Michigan. The Act requires that the land being subdivided be suitable for building sites and public improvements, that there be adequate drainage and proper ingress and egress to lots, and that reviews be conducted at the local, county and state levels to ensure that the land being subdivided is suitable for development. The Act also requires conformance with all local planning codes. From a hazard mitigation standpoint, that point is important because it gives the local planning commission the authority to approve subdivision development in accordance with the local comprehensive plan and regulatory standards.

In terms of process, the subdivision of land has three major phases. The first involves a preliminary review of the engineering aspects of the project – roads, drainage, utilities, and other necessary services, by local and county reviewing agencies. The second phase involves a review of the proposal by the Michigan Department of Environmental Quality, the Michigan Department of Transportation, and the Michigan Department of Energy, Labor and Economic Growth to ensure compliance with state standards regarding location and engineering. At the end of this phase, the developer can obtain tentative approval from the local governing body of the jurisdiction in which the project is located. The final phase involves preparation of the final plat or map of the subdivision. Local and state reviewing agencies again review the final design to ensure compliance with local and state standards. Once approved, the plat is registered with the county register of deeds.

Subdivision regulations can be an effective tool in reducing risk and vulnerability to certain hazards, such as flooding and wildfires, if mitigation factors are incorporated into the subdivision process through mechanisms such as local planning codes. For example, a community may allow a subdivision to be placed in a heavily wooded area susceptible to wildfire if proper engineering measures are taken regarding lot size and ingress and egress, thereby providing a basic level of protection to developed home sites and the residents occupying those home sites.

From a flood hazards viewpoint, proposed subdivisions are typically reviewed by the County Drain Commissioner for proper drainage. The Michigan Department of Environmental Quality / Land and Water Management Division reviews subdivisions for floodplain impacts. (Refer to the Riverine Flooding chapter of the Michigan Hazard Analysis section in the MHMP for specific MDEQ provisions that directly address flood mitigation.)

Like any regulation, the Land Division Act can be effective if it is enforced and coordinated with other land use / development mechanisms in an effort to reduce overall community risk and vulnerability to hazards.

The subdivision rules relating to flooding are implemented through a review process and use of restrictive deed covenants. However, the restrictive deed covenants that are filed under the Act are only effective if the local building official is aware of and enforces the restrictions. Continuing education for the local building officials is essential for effective implementation of the Act.

The rules currently allow the construction of basements below the 100-year flood elevation, but these basements must be flood proofed, or it must be demonstrated by an engineering analysis that the basement will not be adversely impacted by hydrostatic pressures exerted by floodwaters. The developer must also obtain a letter of map revision (LOMR) from FEMA, certifying that the property has been filled above the 100-year flood elevation and the soil has been properly compacted. The LOMR officially removes the property from the 100-year floodplain.

The design standards for a flood proofed basement are fairly involved. Unless the building official is aware of the restrictive deed covenants and the design standards, and is enforcing these requirements, there is considerable potential for flood damage to basements even in subdivisions platted under the current act. Thus, as noted earlier, continuing education is essential.

Other examples of hazard protection standards that may be addressed through subdivision regulation may include:

- Identification of all hazardous areas;
- Road standards that allow passage of fire fighting equipment and snow plows and are no more than one foot below flood elevation;
- Buried power or phone lines; and
- Minimum water pressures adequate for fire fighting.

E. Open Space Preservation. The best approach to preventing damage to new developments is to limit, prevent, or remove development within flood plains and other hazard areas. Open space can be maintained in agricultural use or can serve as parks, greenway corridors, and golf courses. Capital improvement plans and comprehensive land use plans can identify areas to be preserved through any or all of the following means:

- Acquisition;
- Dedication by developers;
- Dedicating or purchasing an easement to keep the land open; or
- Specifying setbacks or buffer zones where development is not allowed.

Additional examples of special area, use and design regulations include:

- Local floodplain management ordinances;
- Coastal zone management regulations;
- Watershed management regulations;
- Special infrastructure design standards and regulations;
- Drainage regulations;
- Housing regulations;
- Wetland protection regulations;
- Natural rivers protection regulations;
- Farmland and open space protection regulations;
- Endangered species / habitat regulations; and
- Historic preservation regulations (among many others).

These regulations (most of which are administered by a state or federal agency in cooperation with local officials) are designed to regulate a certain aspect of the natural or built environment to ensure protection of the public health, safety and welfare, or some significant or unique natural feature. Not surprisingly, most of the regulations have goals that are remarkably similar to those of hazard mitigation. They provide valuable mechanisms for achieving mitigation objectives. These regulations are discussed in greater detail in the following sections of this plan.

To be effective, the provisions of these special regulations must be fully integrated into the comprehensive planning process at the local level. Major provisions of pertinent regulations must be included or addressed in the comprehensive plan and primary implementing mechanisms such as the zoning ordinance, capital improvements plan, etc. The Muskegon Area-wide Plan (2013) helps set the table for open space preservation in the county. A major vision of the document is to "Protect and preserve natural resources and continually improve the quality of air, water, and land resources found in Muskegon County."

Two programs administered by the State of Michigan provide good examples of special area / use measures that, while originally designed to accomplish something else, also contribute to a reduction in a community's risk and vulnerability to hazards (flooding and wildfires in these two instances):

Natural Rivers Program
This program, administered by the Michigan Department of Environmental Quality, seeks to establish a system of outstanding rivers in Michigan and to preserve, protect and enhance their wildlife, fisheries, scenic, historical, recreational and other values. Through the natural rivers designation process, a natural river district is established and a zoning ordinance is adopted. Within the natural river district, permits are required for building construction, land alteration, platting of lots, cutting of vegetation, and bridge construction. Not all of the zoning ordinances on the natural rivers have the same requirements, although they all have building setback requirements and vegetative strip requirements.

Although not specifically designed to reduce flood losses, the program nonetheless has flood hazard mitigation benefits by requiring building to be constructed away from the river and out of the floodplain. The program is very effective when administered as intended. Like any regulatory program, if the administrator and the variance board are aware of the requirements of the program and their duties, it is very effective.

Muskegon County contains one river currently included in the Michigan Natural Rivers Program (White River), and one river that is under consideration for inclusion into the Natural Rivers Program (Muskegon River).

Farmland and Open Space Preservation Program
This program, administered by the Michigan Department of Agriculture and Rural Development, has the primary goal of preserving unique and beneficial open space. It does this by transferring development rights and acquiring easements. There are two categories of land eligible. The first category makes up historic, riverfront, and shoreland areas. The second category includes land that conserves natural or scenic resources, enhances recreational opportunities, promotes the conservation of soils, wetlands and beaches, or preserves historic sites and idle farmland.

The largest component of the program provides landowners with an opportunity to get a break on their property taxes for designating parcels of land that will remain undeveloped. Thus, this mechanism could be used to reduce risk and vulnerability to wildfires by preventing development in heavily forested areas. It could also reduce vulnerability to flooding by preventing development along rivers and in floodplains. However, the program does have a drawback in that the agreements are not in perpetuity and may be relinquished under certain circumstances. The land can be removed from the program under certain circumstances, with the payment of a penalty. Over the short-term, the program is very effective at slowing the development of the special open spaces. It does not, however, necessarily eliminate future development on the parcels and therefore should not be considered an effective long-term mitigation tool. However, there is also a Purchase of Development Rights program, which does purchase development rights in perpetuity. In addition, landowners may donate development rights to the State and to local conservation programs.

F. Stormwater Management. New construction in a floodplain increases the amount of development exposed to damage and can aggravate flooding on neighboring properties. Development outside a floodplain can also contribute to flooding problems since stormwater runoff is increased when natural ground cover is replaced by development. Land use and land cover changes anywhere within a watershed can increase water runoff and/or inhibit natural water infiltration, increasing the frequency and/or severity of flooding downstream within that watershed. Development in a watershed that drains to a river can aggravate downstream flooding, overload the community's drainage system, cause erosion, and impair water quality. Stormwater management encompasses two approaches to protecting new construction from damage by surface water:

- Regulating development in the floodplain to ensure that it will be protected from flooding and that it won't divert floodwaters onto other properties; and
- Regulating all development to ensure that the post-development peak runoff will not be greater than under pre-development conditions.

The National Flood Insurance Program (NFIP) and the Michigan Department of Natural Resources (MDNR) set minimum requirements for regulating development in identified floodplains. All new buildings must be protected from base elevations or 100-year floodplains and no development may cause an increase in flood heights or velocities. There are currently twelve communities in Muskegon County participating in the NFIP: cities of Montague, Muskegon, Muskegon Heights, North Muskegon, Norton Shores and Whitehall; and townships of Egelston, Fruitland, Laketon, Muskegon, Ravenna, and White River. Flood Insurance Rate Maps (FIRM) have been produced for all of these communities. In addition, the Village of Ravenna participated in the program in the past, but does not at this time.

There is currently no state law that regulates stormwater runoff quantity. Any regulation that exists is done at the local/county level. The MDEQ has prepared a stormwater management best management practices guidebook to assist local governments in their stormwater management efforts.

The Michigan Drain Code (1956), administered by county drain commissioners, contains regulations regarding set-backs from the established drain channels to assure proper carrying capacity of the drains. The code officially "establishes laws relating to the laying out of drainage districts, the consolidation of drainage districts, the construction and maintenance of drains, sewers, pumping equipment, bridges, culverts, fords, and the structures and the mechanical devices to properly purify the flow of drains." It also "gives authority to provide for flood control projects, to provide for water management, water management districts and sub-districts, and for flood control and drainage projects within the districts."

Stormwater runoff regulations supplement other efforts to regulate development by requiring developers to build retention or detention basins to minimize the increases in the runoff rate caused by impervious surfaces and new drainage systems. In general, each development must not let stormwater leave at a rate higher than it did under pre-development conditions.

Stormwater ordinances set requirements for managing runoff from new developments and may require storage facilities based on the size of the development and capacity. The ordinance and proper site planning reduce runoff and the impact of the development on the surrounding area. Examples include:

- Promoting the use of native vegetation within the runoff storage basins;
- Requiring buffers along streams, lakes, wetlands, etc.;
- Requiring retention or infiltration of the initial runoff; and
- Requiring existing depressional storage (areas not designated as floodplains) to be compensated for at a 1:1 ratio.

Stormwater ordinances may also provide for the development of watershed plans. Watershed plans examine the unique characteristics of each watershed and may adopt more or less stringent requirements. The ordinances can also provide for a fee, in lieu of site runoff storage, in the event a watershed plan recommends the use of a larger central basin.

2. Corrective Measures.

Corrective mitigation can be expensive, resource intensive, time consuming, and sometimes only marginally effective. Structural protection measures, hazard modification, and large-scale retrofitting fall under this category. Attempting to go back and fix something that is problematic is almost always more difficult than doing it right the first time. However, when dealing with hazard prone property (i.e., structures in a floodway, floodplain or other hazard area), it is often necessary to go back and try to correct the problem in order to protect the affected community and individual property owners from future harm.

When structures and communities are located in hazardous areas, corrective measures are directed at working with current conditions. They are emphasized for areas that suffer recurring or particularly severe disaster damages and impacts or that offer unique mitigation opportunities that can be addressed with existing resources. Examples of the more common corrective measures include:

Modifications. Modifications to a site and/or to a structure. Examples include landscape grading, or retrofitting existing structures to be damage resistant (i.e. floodproofing existing buildings, adding structural braces to buildings to improve earthquake or wind resistance, etc.).

Relocation. Permanent evacuation of hazard-prone areas through movement of existing hazard-prone development and population to safer areas. The two common approaches to relocation are physical removal of buildings to a safer area with future use of the vacated area limited to permanent open space, and replacing existing land uses with others that are less vulnerable to the hazard.

Acquisition. Public acquisition and management of lands that are vulnerable to damage from local hazards. Following acquisition, land uses more appropriate to the degree of risk may be chosen. Public acquisition has been achieved by: a) purchase at full market value; b) purchase at less than full market value through such methods as foreclosure of tax delinquent property, bargain sales, purchase and lease back, etc.; c) donation, through reserved real estate, donation by will, donation and lease back; d) leases; and e) easements.

Modification measures are normally implemented by property owners and include actions to modify the site to keep the hazard from reaching the building; to modify the building/site, or retrofit it, so that it can withstand the impacts of the hazard; and to insure the property to provide financial relief after damage occurs. Relocation and acquisition measures can be implemented by property owners and/or governments through technical and financial assistance.

A. Site Modification (Keeping the Hazard Away). Natural hazards generally do not damage vacant areas but instead threaten people and improved property. In some cases, properties can be modified so the hazard does not reach the damage-prone improvements.

For example, a home may survive a wildfire because a “defensible space” was created and maintained between it and adjacent wild lands. This “defensible space” is similar in concept to that of “firebreaks,” wherein brush and other fuel are cleared away in areas of state and national forests. A clearing around homes for at least 30 feet on all sides will discourage wildfires from spreading directly to them. Proper maintenance of adjacent property (short grass, thinned trees, removal of low-hanging branches, selection of fire-resistant vegetation, etc.) is also helpful in keeping wildfires away. Restricting campfires to controlled areas, away from homes, and requiring burn permits lowers risks to occupied properties. Homes should also be set back from slopes (which allow fires to spread faster than on flat terrain). The need for local homeowners to “fireproof” their properties is probably the county’s primary wildfire vulnerability.

Four common methods used to “keep flooding away” include:

- Erect a barrier between the building and the source of flooding;
- Move the building out of the floodprone area;

- Elevate the building above the flood level; and
- Demolish the building.

A flood protection barrier can be built of dirt or soil (berm or levee), or concrete or steel (floodwall). Careful design is needed so as not to create flooding or drainage problems on neighboring properties. Depending on the porosity of the ground, if floodwaters stay up for more than an hour or two, the design must account for leaks, seepage of water underneath, and rainwater that falls inside the perimeter. This is usually done with a sump and/or drain to collect the internal groundwater and surface water, and a pump and pipe to remove the internal drainage over the barrier. Barriers can only be built so high and can therefore be overtopped by floods higher than expected. Berms can settle over time, and are susceptible to erosion from rain and floodwaters if not properly sloped, covered with grass, and maintained, lowering their protection level. Floodwalls can crack, weaken, and lose their watertight seals. Therefore, barriers need careful design and maintenance and should be insured in case of failure.

The surest and safest way to protect a building from flooding is to move it to higher ground. Almost any building can be moved but the cost climbs for heavier structures, such as those with exterior brick and stone walls, and for large or irregularly shaped buildings. In areas subject to flash flooding, deep waters, or other high hazard, relocation is often the only safe approach. Relocation is also preferred for large lots that include buildable areas outside the floodplain or where the owner has a new flood-free lot (or portion of the existing lot) available.

Raising a building above the flood level can be almost as effective as moving it out of the floodplain. Water flows under the building, causing little or no damage to the structure or its contents. Raising a building above the flood level is cheaper than moving it and can be less disruptive to a neighborhood. Elevation has proven to be an acceptable and reasonable means of complying with floodplain regulations that require new, substantially improved, and substantially damaged buildings to be elevated above the base flood elevation. On the other hand, elevating a building will change its appearance. If the required amount of elevation is low, the result is similar to putting a building on a 2' or 3' high crawlspace. If the building is raised 4', 6', or more, owners are often concerned about its appearance and may decline to implement an elevation project. Another problem with this approach is with basements. Only the first floor and higher are elevated. The basement remains as the foundation. All utilities are elevated and the basement is filled in to protect the walls from water pressure. The owner loses the use of the basement, which may deter him or her from trying this approach. A third problem with elevation is that it may expose the structure to greater impacts from other hazards. If not braced and anchored properly, an elevated building may have less resistance to the shaking of an earthquake and the pressures of high winds. A fourth problem is that access can be lost when floodwaters overtop local roads, driveways, and culverts or ditches. If this happens frequently and alternate access is not available, roadways might have to be elevated and crossing points improved.

Some buildings, especially heavily damaged or repetitively flooded ones (such as those in the floodways, the most dangerous portions of the floodplains that naturally carry the majority of fast moving waters), are not worth the expense to protect them from future damage (floodways have many code requirements for repair, expansion or replacement of structures). It is cheaper to demolish them and either replace them with new, flood-protected structures, or relocate the occupants to a safer site. In general, demolition projects are undertaken by a government agency so the cost is not borne by the property owner. The land may then be converted to public use, such as a park. Acquisition, followed by demolition, is most appropriate for buildings that are difficult to move (such as larger, slab foundation, or masonry structures) and for dilapidated structures that are not worth protecting. One problem sometimes resulting from an acquisition and demolition project is a "checkerboard" pattern in which non-adjacent properties are acquired. This can occur when some owners, especially those who have and prefer a waterfront location, prove reluctant to relocate.

B. Building or Site Modification (Retrofitting). An alternative to modifying the site to keep the hazard away is to modify or "retrofit" the site or building to minimize or even prevent damage. There are a variety of techniques to do this. This section looks at the measures that can be implemented to protect existing buildings from damage by wildfires, structural fires, floods, sewer backup, tornadoes, high winds, winter storms, hail, and extreme temperatures.

Modifications to prevent damages from wildfires not only include the creation of a "defensible space" but also a number of other very effective actions such as the use of fire-resistant siding and roofing materials, as well as functional shutters and heavy fire-resistant drapes. Homeowners can sweep clean their roofs, decks and eaves to prevent blowing embers from igniting twigs and leaves. They can move woodpiles and combustibles away from buildings, enclose eaves and any openings under structures that would allow blown embers in, and clean up yard and house waste and flammable oils and spills, which are generally in garages and driveways. Homeowners can also keep private roads and driveways accessible to vehicles and fire equipment. Driveways should be relatively straight and flat, with at least some open spaces to turn, bridges that can support emergency vehicles, and clearance wide and high enough for two-way traffic and emergency vehicle access. This is especially true in areas where space is limited by the local topography. In addition, spare keys to gates around property should be provided to the local fire department, addresses should be clearly visible from the main road, and homeowners can make sure that adequate water supply is available for fire-fighters (small pond, cistern, well, swimming pool, garden hoses, etc.).

The National Fire Protection Association administers the Firewise Communities Program, which encourages local solutions for safety by involving homeowners in taking individual responsibility for preparing their homes from the risk of wildfire. Firewise is a key component of Fire Adapted Communities – a collaborative approach that connects all those who play a role in wildfire education, planning and action with comprehensive resources to help reduce risk. The program is co-sponsored by the USDA Forest Service, the US Department of the Interior, and the National Association of State Foresters.

The Firewise Communities/USA Recognition Program is a process that empowers neighbors to work together in reducing their wildfire risk. Communities may pursue this using a five-step process to develop an action plan that guides their residential risk reduction activities, while engaging and encouraging their neighbors to become active participants:

- Obtain a wildfire risk assessment as a written document from your state forestry agency or fire department.
- Form a board or committee, and create an action plan based on the assessment.
- Conduct a "Firewise Day" event.
- Invest a minimum of $2 per capita in local Firewise actions for the year.
- Submit an application to your state Firewise liaison.

Modifications to prevent damages from structural fires include: the safe installation and maintenance of electrical outlets and wiring; the installation of firewalls; and provision of equipment needed to inhibit fire dangers (such as sprinkler systems, smoke alarms, and fire extinguishers). In urban areas, the denser pattern of development may allow a fire in one structure to spread to one or more other structures. Appropriate firewall use in connected units or downtown commercial/pedestrian strips can help to protect property against the spread of fire. Older attached structures especially should be checked for safety and code compliance. Any special facility such as a nursing home, day care center, or health clinic should ensure that it has a workable fire plan and is equipped with the equipment needed to inhibit fire dangers, such as sprinkler systems, functioning smoke alarms, and usable fire extinguishers. In rural areas, proper education on and maintenance of non-utility heat sources will help allay this hazard. The National Fire Protection Association has information available for homeowners on how to prevent fires. Proper cleaning of chimneys, fire places and wood stoves, keeping objects away from heating sources to prevent malfunction or ignition, and proper installation and fueling of heaters are all important. Space heaters should be at least three feet from objects.

Flood retrofitting measures include dry floodproofing where all areas below the flood protection level are made watertight. Walls are coated with waterproofing compounds or plastic sheeting. Openings (doors, windows, and vents) are closed, either permanently, or with removable shields or sandbags. Sump pumps are used to remove any water that enters. Dry floodproofing of new and existing non-residential buildings in the regulatory floodplain is permitted under state, FEMA and local regulations. Dry floodproofing existing residential buildings in the floodplain is also permitted as long as the building is not substantially damaged or being substantially improved. Dry floodproofing is also a viable option for homes located outside the regulatory floodplain.

The alternative to dry floodproofing is wet floodproofing, where water is let in and everything that could be damaged by a flood is removed or elevated above the flood level. Structural components below the flood level are replaced with materials that are not subject to water damage. For example, concrete block walls are used instead of wooden studs and gypsum wallboard. The furnace, water heater, and laundry facilities are permanently relocated to a higher floor or raised on blocks or platforms where the flooding is not deep. Simply moving furniture and electrical appliances out of a basement can prevent a great deal of damage.

A third flood protection modification addresses flooding caused by overloaded sanitary or combined sewers. Four approaches may be used to protect a structure against sewer backup: floor drain plugs, floor drain stand-pipes, overhead sewers, and backflow protection valves. The first two devices keep water from discharging out of the lowest opening into the building, the floor drain, and are inexpensive. However, if water becomes deep enough in the sewer system, it can flow out of the next lowest opening, such as a toilet or tub, or it can overwhelm a drain plug by hydrostatic pressure and flow into the building through the floor drain. The other two measures, overhead sewers and backflow protection valves keep water in the sewer line during a backup. They are more secure but more expensive.

Other considerations for the minimization of flooding damages include: stronger anchoring requirements for propane tanks and hazardous materials in the floodplain/floodway; assurance of proper location, cleaning and maintenance of septic tanks; and back-up power for sump pumps. Critical facilities should have written flood response and recovery plans to identify the equipment and materials necessary to protect them. Cost-sharing programs, such as rebates, to encourage low cost (under $10,000) property protection measures on private property (surface and sub-surface drainage, sewer back-up protections, berms and regrading, sewer back-up protection, furnace and water heater relocations, lightning rods, etc.) should be considered.

Tornado and severe wind retrofitting measures include constructing underground shelters or “safe rooms” in residences and constructing shelter areas for those who live in mobile homes or temporary, seasonal locations. Another retrofitting approach for tornadoes and high winds is to secure the roof, walls, and foundation with adequate fasteners or tie downs and cross-bracing. These devices help hold the building together when the combination of high wind and barometric pressure differences work to pull the building apart. A third tornado and high wind protection modification is to strengthen garage doors, windows (with laminated glass panes) and other large openings. If winds break the building’s “envelope,” the pressures on the structure are greatly increased. Trailers and mobile homes can be secured to foundations, functional wind shutters can be installed over windows, and yard items can be secured or brought inside to avoid damage. Inter-locking shingles on roofs can offer much additional protection against wind and hail damage. Workplaces, remote hunting lodges, campgrounds, fairgrounds, mobile homes, and other such facilities may still have vulnerabilities for proper warning and shelter. It is important to provide inhabitants with safe and accessible sheltering options before, during and after severe weather events.

Retrofitting approaches to protect buildings from the effects of thunderstorms include storm shutters, lightning rods, and strengthening connections and tie-downs (similar to tornado retrofitting). Roofs could be replaced with materials less susceptible to damage by hail, such as modified asphalt or formed steel shingles. Loose materials and yard and patio items should also be secured so that they can’t blow away.

Burying utility lines is a retrofitting measure that addresses the impacts of severe winds, tornadoes, and winter storms. Installing or incorporating backup power supplies minimizes the effects of power losses caused by downed lines. Surge suppressors protect delicate appliances from lightning damage. "Retrofitting" trees that hang over power lines, as discussed later in the discussion on Urban Forestry, is yet another option.

Winter storm retrofitting measures include improving insulation on older buildings and relocating water lines from outside walls to interior spaces. Windows can be sealed or covered with an extra layer of glass (storm windows) or plastic sheeting. Roofs can be retrofitted to shed heavy loads of snow and prevent ice dams that form when snow melts. Water and sewer lines can be buried below the frost line or insulated to protect against ground freeze. Roads can be protected from blowing snow by the installation of snow fences beside them, especially along highways and in residential developments with limited access. These fences can be "living" fences (lines of trees).

Air conditioning is probably the most effective measure for mitigating the effects of extreme summer heat on people. Unfortunately, those most vulnerable to heat often do not live or work in air-conditioned environments. The use of fans to move air may help some, but recent research indicates that increased air movement may actually exacerbate heat stress in many individuals. However, air circulation is important and is limited for those unwilling to open windows because of security concerns. In these instances, inexpensive safety latches can be installed to allow windows to be opened far enough for air to circulate, while at the same time preventing them from being completely opened from the outside.

C. Insurance. Technically speaking, insurance does not mitigate damage caused by a natural hazard. However, it does help the owner repair, rebuild and (hopefully) afford to incorporate some of the other mitigation measures in the process.

A standard homeowner's insurance policy will cover a property for the hazards of tornado, wind, hail, and winter storms. Separate endorsements are usually needed for damages from sump pump failure, sewer back-up, and earth movement and can be added to a homeowner's insurance policy. Each company has different amounts of coverage, exclusions, deductibles, arrangements, and costs. Most exclude damage from surface flooding and owners must purchase such coverage through the National Flood Insurance Program, which is available if they live in communities participating in the program. Banks and mortgage companies require flood insurance when loans are for purchase or repair of properties located in flood plains if the loans are federally insured. Agricultural insurance is available to protect growers from crop loss in the event of a drought.

Critical facilities should be inventoried and proper insurance coverage should be reviewed (both types and amount, including deductibles and policy limits) and assured. Larger local governments can self-insure and absorb the cost of damage to one facility, but if many properties are exposed to damage, self-insurance can be a major drain on the treasury. Communities cannot expect federal disaster assistance to make up the difference. Under Section 406(d) of the Stafford Act "if an eligible insurable facility damaged by flooding is located in a [mapped floodplain] … and the facility is not covered (or is underinsured) by flood insurance on the date of such flooding, FEMA is required to reduce Federal disaster assistance by the *maximum* amount of insurance proceeds that would have been received had the buildings and contents been fully covered under a National Flood Insurance Program (NFIP) standard flood insurance policy". Generally, the maximum amount of proceeds for a non-residential property is $500,000. In other words, the law expects public agencies to be fully insured as a condition of receiving federal disaster assistance.

D. Technical and Financial Assistance. Property protection measures are usually considered the responsibility of the property owner. However, there are various roles the county or a municipality can play in encouraging and supporting implementation of these measures.

One of the first duties of a local government is to protect its own facilities. Critical facilities should be a high priority for retrofitting projects and insurance coverage. Often public agencies discover after the disaster that their "all-hazard" insurance policies did not cover the property for the type of damage incurred. Flood insurance is even more important as a mitigation measure because of the Stafford Act provisions discussed above.

Providing basic information to property owners is an important action that can be taken to support property protection measures. Another step is to help pay for a retrofitting project. Financial assistance can range from full funding of a project to helping residents find money from other programs. Some communities assume responsibility for sewer backups, street flooding, and other problems that arise from an inadequate public sewer or public drainage system. Less expensive community programs include low-interest loans, forgivable (after a certain period of occupancy) loans and rebates. These approaches don't always fully fund the project but they either cost the community less or increase the owner's commitment to the retrofitting project. In addition, communities can assist residents with referrals to home repair programs and heating assistance programs.

The community can be the focal point of a project, such as floodplain property acquisition. Most funding programs require a local public agency to sponsor the project. The county or a municipality could process the funding application, work with the owners, and/or provide some or the entire local share. In some cases, the local government would be the ultimate owner of the property, but in other cases a public agency could assume ownership and maintenance responsibilities. The West Michigan Land Conservancy is an organization that can help by purchasing and holding certain lands until a government agency or other party can take possession.

Mandates are considered a last resort if information, funding, and incentives aren't enough to cause protective actions. Examples of retrofitting mandates are the requirements that downspouts be disconnected from sanitary sewer lines or that buildings in flood plains be elevated or brought up to current flood protection codes if "substantial" repair costs equal or exceed 50% of the value of the original building. Another possible mandate is to require less expensive hazard protection steps as a condition of a home improvement project. If a person were to apply for a permit for electrical work, the community could require that the service box be moved above the base flood elevation or that separate ground fault interrupter circuits be installed in the basement. An extreme mandate would be to "Fill your Basement with Water." For example, if the mandate is issued in an NFIP community during flood conditions under FEMA procedures, FEMA funds would later be made available to assist with repairs. However, those repairs would be less expensive since filling the basement would equalize pressure from saturated soils on building walls with water tight, near water tight, or pumped out basements. It would also facilitate clean-up because there is clean water instead of silt and sewage-laden muddy water in the structure.

Repetitive Loss properties deserve special attention because they are more prone to damage by natural hazards than other properties and protecting such buildings is a priority with FEMA and MSP-EMHSD mitigation funding programs. As of October 2013, there had been four repetitive losses in Muskegon County; two in Norton Shores and two in Laketon Township. Appropriate property protection measures are based on studies of flood and building conditions. General guidelines, which are not site specific, are as follows.

- Buildings in high hazard areas (in the floodway or where the 100-year flood is two or more feet over the first floor) or in less than good condition should be acquired and demolished.
- Buildings with basements and split level foundations in high hazard areas should be acquired and demolished. They are too difficult to elevate and the hydrostatic pressures on the walls from deeper flooding make them too risky to protect in place.
- Buildings subject to shallow flooding from local drainage should be protected through area-wide flood control or sewer improvement projects.
- Buildings in good condition on crawlspaces should be elevated or relocated.
- Buildings in good condition on slab, basement or split level foundations subject to shallow flooding (less than 2 feet) can be protected by barriers and dry floodproofing.

The most common sources for hazard mitigation assistance are listed in the table below. Unfortunately, some are only available after a disaster, not before, when damage could be prevented. Following past disaster declarations, FEMA, the Michigan State Police, Emergency Management and Homeland Security Division (MSP-EMHSD), and the Michigan Department of Natural Resources have provided advice on how to qualify and apply for these funds. A detailed listing of potential federal and state funding sources for hazard-specific measures is included in Appendix F.

Common Hazard Mitigation Sources

Program	Eligibility	Eligible Activities	Program Type / Cost Share
HAZARD MITIGATION GRANT PROGRAM (HMGP) HMGP grants are provided to implement long-term hazard mitigation measures after a major disaster declaration. The purpose of the HMGP is to reduce the loss of life and property due to natural disasters and to enable mitigation measures to be implemented during the immediate recovery from a disaster.	Eligible Subapplicants: · State agencies · Tribal governments · Local governments · Private nonprofit orgs	· Property acquisition / structure demolition or relocation · Structure elevation · Dry floodproofing of historic residential structures · Dry floodproofing of non-residential structures · Minor localized flood reduction projects · Structural / non-structural retrofitting · Safe room construction · Infrastructure retrofitting · Soil stabilization · Wildfire mitigation · Post-disaster code enforcement · Hazard mitigation planning	Disaster Based (Stafford Act Major Disaster Declaration Required) 75% Federal 25% Non-Federal
PRE-DISASTER MITIGATION PROGRAM (PDMP) PDMP funds are provided for hazard mitigation planning and the implementation of mitigation projects prior to a disaster. Funding these plans and projects reduces overall risks to the population and structures from future hazard events, while also reducing reliance on federal funding from future major disaster declarations.	Eligible Subapplicants: · State agencies · Tribal governments · Local governments · Universities	· Property acquisition / structure demolition or relocation · Structure elevation · Dry floodproofing of historic residential structures · Dry floodproofing of non-residential structures · Minor localized flood reduction projects · Structural / non-structural retrofitting · Safe room construction · Infrastructure retrofitting · Soil stabilization · Wildfire mitigation · Hazard mitigation planning	Annual Appropriation 75% Federal 25% Non-Federal 90% Federal 10% Non-Federal if subgrantee is a small impoverished community
FLOOD MITIGATION ASSISTANCE PROGRAM (FMAP) FMAP funds are provided to implement measures that reduce or eliminate the long term risk of flood damage to buildings, manufactured homes, and other structures insured under the National Flood Insurance Program (NFIP). The goal of the FMAP is to reduce or eliminate claims under the NFIP.	Eligible Subapplicants: · State agencies · Tribal governments · Local governments	· Property acquisition / structure demolition or relocation · Structure elevation · Dry floodproofing of historic residential structures · Dry floodproofing of non-residential structures · Minor localized flood reduction projects · Hazard mitigation planning	Annual Appropriation 75% Federal 25% Non-Federal
REPETITIVE FLOOD CLAIMS PROGRAM (RFCP) RFCP funds are provided to reduce flood damages to insured properties that have had one or more claims under the NFIP and that will result in the greatest savings to the National Flood Insurance Fund (NFIF) in the shortest period of time. (Note: RFCP funds are only available to sub- applicants who cannot meet the cost share requirements of the FMAP.)	Eligible Subapplicants: · State agencies · Tribal governments · Local governments	· Property acquisition / structure demolition or relocation · Structure elevation · Dry floodproofing of historic residential structures · Dry floodproofing of non-residential structures · Minor localized flood reduction projects	Annual Appropriation 100% Federal
SEVERE REPETITIVE LOSS PROGRAM (SRLP) SRLP funds are provided to reduce or eliminate the long-term risk of flood damage to severe repetitive loss (SRL) structures insured under the NFIP, and that will result in the greatest amount of savings to the NFIF in the shortest period of time.	Eligible Subapplicants: · State agencies · Tribal governments · Local governments	· Property acquisition / structure demolition or relocation · Structure elevation · Mitigation reconstruction · Dry floodproofing of historic residential structures · Minor localized flood reduction projects	Annual Appropriation 75% Federal 25% Non-Federal
*States, Territories and Indian Tribal Governments are eligible HMA applicants. Interested and eligible subapplicants must apply to the applicant for HMA funding consideration. Individuals and businesses are not eligible to apply for HMA funds; however, an eligible subapplicant may apply for funding to mitigate private structures.			

Source: MSP/EMHSD Pub. 106a, Michigan Hazard Mitigation Success Stories, 2011

The City of Montague received $262,500 of HMGP funds in late 2003, which it matched with $87,500, to acquire and demolish a vacant structure in a floodplain. Both PDM and FMAP funds were made available in Muskegon County as a result of the Presidential Declaration of Disaster for the May 20-24, 2004 flooding event. After a Declaration of Disaster was denied by both the President and the Governor for the winter 2005 flooding event, caused by ice jams and high waters on area rivers, the Small Business Administration made funds available to assist with property losses and home repairs in Muskegon County and three other counties.

3. Resource Protection.

Resource protection activities are generally aimed at preserving (or in some cases restoring) natural areas as development occurs so that these areas can, in turn, provide hazard protection. For instance, watersheds, floodplains, and wetlands can reduce run-off from rainwater and snow melt in pervious areas; reduce overland flood flow and store floodwaters; remove and filter excess nutrients, pollutants and sediments; absorb flood energy and reduce flood scour; and recharge groundwater.

These natural benefits can be preserved though regulatory steps for protecting natural areas or natural functions. General regulatory programs are discussed in the section on Preventive Measures. This section covers resource protection programs and standards, including the following:

- Wetland protection;
- Erosion and sedimentation control;
- River restoration;
- Best management practices;
- Dumping regulations;
- Urban forestry;
- Farmland protection;
- Sand dune protection and management; and
- Shorelands protection and management.

A. Wetland Protection. Wetlands are often found in floodplains and depressional areas of a watershed. Many wetlands receive and store floodwaters, thus slowing and reducing downstream flows. They also serve as natural filters, helping to improve water quality. Wetlands that are part of the waters of the United States are regulated by the U.S. Army Corps of Engineers and the U.S. Environmental Protection Agency under Section 404 of the Clean Water Act. Proposed development in these wetlands requires a “404” permit, which can’t be issued until plans are reviewed and approved by several agencies including the Corps and the U.S. Fish and Wildlife Service. Small projects that meet certain criteria, as well as projects that are not in the Corps’ wetlands, may proceed under nationwide permits instead of under individual permits and are regulated by local authorities (i.e. the Michigan Department of Environmental Quality). In either case, the impact of the development must be mitigated.

Wetland mitigation, as defined in each issued permit, can include creation, restoration, enhancement or preservation of wetlands on the site or elsewhere – even in another watershed. It should be noted that, when a wetland is mitigated at another site, there are drawbacks to consider. First, it takes many years for a new wetland to approach the same quality as an existing one. Second, a new wetland in a different location (especially if it’s in a different watershed) will not have the same flood damage reduction benefits as the original one did. Some developers and government agencies mitigate by buying into wetland banks, which are large wetlands created for the purpose of mitigation. The bank accepts money to reimburse the owner for setting the land aside from development.

B. Soil Erosion and Sedimentation Control. Farmlands and construction sites typically contain large areas of exposed soil. Surface water runoff can erode soil from these sites, sending sediment into downstream waterways. Erosion also occurs along streambanks and shorelines as water flow and wave action wash away the soil. Suspended sediment tends to settle out where flowing water slows down and can clog storm sewers, drain tiles, culverts and ditches and can reduce the transport and storage capacity of water channels. When they are constricted and flooding cannot deposit sediment in the bottomlands, even more is left in the channels. The result is either clogged streams or increased dredging or “channelization” (straightening, deepening, or widening the channel) costs.

There are two principal strategies to address these problems: minimize erosion and control sedimentation. Techniques to minimize erosion include phased construction, minimal land clearing, and stabilizing bare ground and slopes as soon as possible with vegetation and other soil stabilizing practices (geo-textile fabrics, rip-rap boulders, etc.). Techniques to control sedimentation include: silt fences, sediment traps and vegetated filter strips. Runoff can be slowed down by terraces, contour strip farming, no-till farm practices, hay or straw bales, constructed wetlands, and impoundments (e.g., sediment basins and farm ponds) to reduce the volume of topsoil eroded from the site.

Erosion and sedimentation control regulations, which are usually oriented toward construction sites, mandate that these types of practices be incorporated into construction plans. They also require applicants for permits to submit erosion and sediment control plans for construction projects. Michigan's Soil Erosion and Sedimentation Control (Part 91) ordinance requires permits for projects or activities (not crop production) involving earth changes that disturb one or more acres of land or are located within 500 feet of a lake or stream. Enforcement of the ordinance can be handled by a designated county department, with assistance from the Conservation District, or a municipality. In Muskegon County, the county enforcing agency is the Muskegon County Department of Public Works, while municipal enforcing agencies are the cities of Muskegon Heights, Montague and Whitehall. Municipalities have the opportunity to adopt and enforce more stringent regulations, as long as they don't conflict with the state ordinance and have state approval.

C. River Restoration. Approaches such as "stream conservation," "bioengineering," and "riparian corridor restoration" aim to return streams, streambanks and adjacent lands to more natural conditions. "Ecological restoration" aims to restore native indigenous plants and animals to an area. Native plantings along banks; such as willow cuttings, wetland plants, and/or rolls of landscape material covered with natural fabric that decomposes after plants take root; resist erosion. Studies have shown that, after establishing appropriate vegetation on banks, long-term maintenance costs are lower than for maintenance of concrete banks or conventional landscape (e.g., mowing turf grass). These approaches are not required but are recommended by economics.

Another restoration option is to improve culverts. Restoring the natural flow of a watercourse through culvert improvements and streambank treatments around the culvert can have numerous benefits that may appeal to a variety of governmental and environmental groups. Potential benefits include: water quality improvement; coldwater tributary protection / restoration; fish habitat improvement; and decreased risk of culvert failure which may lead to flooding and washouts.

There are numerous watershed groups that include Muskegon County within their borders, including: Duck Creek Watershed Partnership, Lower Grand River Organization of Watersheds, Mona Lake Watershed Council, Muskegon Lake Watershed Partnership, Muskegon River Watershed Assembly, White Lake Public Advisory Council, and White River Watershed Partnership.

D. Best Management Practices. *Point source* pollutants are discharged from pipes (such as the outfall of a municipal wastewater treatment plant) and are regulated by the U.S. EPA and the Michigan Department of Environmental Quality. *Non-point source* pollutants come from non-specific locations and are harder to regulate. Examples of non-point source pollutants are lawn fertilizers, pesticides, and other farm chemicals, animal wastes, oils from street surfaces and industrial areas, and sediment from agriculture, construction, mining and forestry. The term "best management practices" (BMP's) refers to design, construction and maintenance practices and criteria that minimize the impact of stormwater runoff, prevent erosion, protect natural resources and capture non-point source pollutants (including sediment). They can prevent increases in downstream flooding by attenuating runoff and enhancing infiltration of stormwater. They also minimize water quality degradation, maintain natural base flows, and provide multiple uses of drainage and storage facilities.

E. Dumping Regulations. BMP's usually address pollutants that are liquids or are suspended in water while dumping regulations address solid matter, such as shopping carts, appliances, and landscape waste that can be accidentally or intentionally thrown into channels or wetlands. Such materials may not pollute the water, but they can obstruct even low flows and reduce the channels' and wetlands' ability to convey or clean stormwater. Nuisance ordinances can prohibit dumping garbage or other "objectionable waste" on public or private property. Waterway dumping regulations can prohibit "non-objectionable" waste (grass clippings or tree branches) which can kill ground cover or cause obstructions in channels. These regulations can be enforced with penalties but programs should have public information components since property owners might not be aware of the impact of their actions (i.e. re-grading their yards, discarding leaves or branches in a watercourse, etc.). Voluntary compliance by property owners and annual "clean-up" programs by local communities can be quite effective.

F. Urban Forestry. The major damage caused by wind and snow/ice/sleet storms is to trees. Downed trees and branches break utility lines and damage buildings, parked vehicles, and anything else under them. An urban forestry program, developed by a municipality, can reduce the damage potential of trees by addressing proper tree care prior to a storm and recommend actions for managing trees before, during, and after a storm. Urban foresters or arborists can select hardier trees that better withstand high wind and ice accumulation and trees that are shorter than utility lines for use in power and telephone line rights-of-way. They can review damaged trees to determine if they should be pruned or removed.

A properly written and enforced urban forestry plan can lessen the frequency of fallen trees and limbs caused by wind and ice build-up, reduce liability, assist in assuring that utility lines are not damaged, and provide guidance on repairs and pruning after a storm. Such a plan helps a community qualify to be a "Tree City USA." "Tree City USA" is a program sponsored by The National Arbor Day Foundation, in cooperation with the USDA Forest Service and the National Association of State Foresters, to ensure that every qualifying community has a viable tree management plan and program. It provides direction, technical assistance, public attention, and national recognition for urban and community forestry programs. The cities of Montague, Muskegon, and Whitehall have all achieved "Tree City USA" endorsements.

In addition, utility companies are heavily involved in tree management. A recent Consumers Energy brochure states that; since the company is responsible for providing safe, reliable electricity; employees (and companies hired to help) "are sent out on a planned, rotating schedule to clear trees and bushes from electric rights-of-way." Following guidelines from the American National Standards Institute (ANSI) and working under required permits, Consumers Energy promises the following actions.

- Trees next to distribution lines, which carry electricity from pole to pole, will be trimmed a safe, clear distance from lines.
- The safety of employees and the public, particularly children, may require removal of a tree. A tree may have to be removed because it is dead, dying, damaged, or subject to falling because of wind or a shallow root system-making it a safety and power outage threat. Some fast-growing trees can be a continuing hazard and may have to be removed.
- Trimming methods are aimed at helping the tree heal, decreasing future trimming needs, and directing future growth away from electric lines.

The need for these activities is eliminated when utility lines are buried. Burying the lines is recommended when they are being upgraded or installed for new developments.

G. Farmland Protection. The purpose of farmland protection is to provide planning and zoning mechanisms for preserving prime, unique, or important agricultural land from conversion to non-agricultural uses. Farm owners feel forced to sell their land to residential or commercial developers if it is taxed based on the value of the property, if developed, instead of farmed and the increased taxation can't be afforded. The ensuing development brings more buildings, roads, and other infrastructure that can create additional stormwater runoff and emergency management difficulties. To offset this situation, the Farmland Protection Program in the U.S. Department of Agriculture's 2002 Farm Bill (Part 519) allows for funds to go to states, tribes, local governments, and non-profit organizations to help purchase easements on agricultural land to protect against the development of the land. Eligible lands include cropland, range land, grass land, pasture land, and forestland that are part of an agricultural operation. Certain lands with historical or archaeological resources are also included. The hazard mitigation benefits of farmland protection are similar to those of open space preservation.

In addition to protecting farmland, efforts can be made to protect crops. These efforts can include the support of agricultural programs that promote soil health, preserve soil moisture, and monitor soil moisture levels to help minimize loss of crops and topsoil during drought conditions. They can also include recommendations for water supply infrastructure that is not vulnerable to drought and planting crops tolerant of low moisture levels. Drought ordinances can prioritize or control water use during drought conditions. Drought mitigation plans can be developed which include:

- Collection and analysis of drought-related information;
- Criteria for declaring drought emergencies and triggering various mitigation and response activities;
- Information flow between and within levels of government;
- Definition of the duties and responsibilities of all agencies with respect to drought;
- A current inventory of state and federal programs used in assessing and responding to drought emergencies;
- Identification of drought-prone areas and vulnerable economic sectors, individuals, or environments;
- Identification of mitigation actions to address vulnerabilities and reduce drought impacts; a mechanism to ensure timely and accurate assessment of drought's impacts on agriculture, industry, municipalities, wildlife, tourism and recreation, health, and other areas;
- Public information methods; and
- A strategy to remove obstacles to the equitable allocation of water during shortages and establish requirements or provide incentives to encourage water conservation.

H. Sand Dune and Shorelands Protection and Management. According to MDEQ, Michigan's sand dunes are a resource of global significance since they are the largest assemblage of fresh water dunes in the world. The Michigan Legislature has found that critical dune areas of this state are "unique, irreplaceable, and fragile resources that provide significant recreational, economic, scientific, geological, scenic, botanical, educational, agricultural, and ecological benefits to the people of this state and to people from other states and countries who visit this resource."

Construction in these areas is carefully controlled. In addition to the required local building permits, MDEQ permits are required for all proposed new uses in designated areas of Muskegon County, as contained in its "Atlas of Critical Dune Areas" (www.michigan.gov/deq under "sand dunes"). There are designated areas in the City of Muskegon, the City of Norton Shores, Fruitland Township, Laketon Township and White River Township.

In addition, Michigan's Shorelands Protection and Management legislation determines if a high-risk erosion area shall be regulated to prevent property loss or if suitable methods of protection shall be installed to prevent property loss. A permit is required for the erection, installation, or moving of a permanent structure on a parcel of land where any portion is a designated high risk erosion area. Examples include homes, porches, septic systems, additions, substantial improvements of existing structures, and out buildings. With the exception of Alcona, Charlevoix, Macomb, Monroe, and Wayne Counties, all coastal counties in Michigan have some designated high risk erosion areas.

This careful control of development can assist in the prevention of hazards such as increased wildfire risk (caused by the residential/wildlands intermix) and increased erosion potential. It can also assist in assuring fire-fighting access to development.

4. Emergency Services.

Emergency service measures protect people during and after a disaster. A good emergency management program addresses all hazards and involves all departments. At the state level, programs are coordinated by the Michigan State Police, Emergency Management and Homeland Security Division (MSP-EMHSD); while at the county level, programs are coordinated through Muskegon County Emergency Services. These measures can be divided into four stages:

- Threat Recognition (Watch);
- Warning;
- Response; and
- Post-Disaster Recovery and Mitigation.

A. Threat Recognition (Watch). The first step in responding to a snowstorm, windstorm, tornado, flood, or other natural hazard is to know when weather conditions are such that an event could occur and issuing a "watch." Proper and timely threat recognition systems allow for adequate warnings to be disseminated. Systems are described below for flooding, tornadoes and thunderstorms, and winter storms.

A flood threat recognition system predicts the time and height of the flood crest. This can be done by measuring rainfall, soil moisture, and stream flows upstream of the community and calculating the subsequent flood levels. On smaller rivers, local rainfall and river gauges are needed. The National Weather Service has a system through which it installs and monitors water level gauges at selected locations on the Muskegon River and the White River. In the absence of gauges, local personnel and/or volunteers monitor rainfall and stream conditions. While specific flood crests and times are not predicted, advance notice of potential local or flash flooding is provided.

On larger rivers, measuring and calculating is done by the National Weather Service (NWS), which is in the U.S. Department of Commerce's National Oceanic and Atmospheric Administration (NOAA), with support from cooperating state and local partners. Forecasts are made through the Advanced Hydrologic Prediction Service (AHPS), which utilizes river gauges for information. In Muskegon County, gauges are located on Bear Creek near North Muskegon, and on the White River near Whitehall. There is also a gauge on the Muskegon River upstream of Muskegon County. In addition, Muskegon County is on the phone tree and attends semi-annual meetings for Croton Dam on the Muskegon River.

Flood threat predictions are broadcasted on the NOAA Weather Wire and Weather Radio, the official source for weather information, to those who have equipment to receive it (state police, 911 and dispatch centers, municipalities, and critical facilities). Weather radios can be tone-activated through the Emergency Alert Radio System (EARS). Predictions are also transmitted through social media, and by television, radio, and cable television through the Emergency Alert System (EAS), previously known as the Emergency Broadcast System.

The National Weather Service (NWS) is the prime agency for detecting meteorological threats, such as tornadoes and thunderstorms, and uses transmitters located in West Olive in Ottawa County to the south and Hesperia in Oceana County to the north for service in Muskegon County. Severe weather warnings are transmitted through the NOAA Weather Radio System and, subsequently, through the Michigan State Police's Law Enforcement Information Network (LEIN). The network includes law enforcement agencies and emergency service providers such as "911" who then issue their own warnings. However, NWS coverage is done on a large scale and only considers if conditions are appropriate for formation of a tornado or thunderstorm. More site-specific and timely recognition is provided by sending out NWS trained spotters to watch and report on the weather when the NWS issues a watch or warning. Training for spotters is provided annually, usually in the spring, by Muskegon County Emergency Services and NWS.

The NWS is also the prime agency for predicting winter storms. Severe snow storms can often be forecasted days in advance of the expected event, which allows time for warning and preparation. The NWS can also forecast ice storms, issue dense fog advisories, and give notice when conditions are conducive for rip currents in Lake Michigan.

In summation, Muskegon County receives threat recognition information from NOAA weather radios or from the Michigan State Police who monitor the NOAA Weather Wire. The NWS also activates public notice through EAS when the hazard impacts a large area. The Michigan State Police disseminate weather threats through the LEIN system to 911 and other dispatch centers around the state. Police and fire stations, schools and other public facilities may also receive alerts from 911. When conditions are appropriate, Muskegon County Emergency Services and NWS use their formal organization of storm spotters.

B. Warning. When the NWS determines that a flood, tornado, thunderstorm, winter storm or other hazard has been observed or is coming, a warning is issued to take immediate action and the systems described above are again utilized to notify police, 911 and dispatch centers, municipalities, the public, and staff of other agencies and critical facilities. Early warning allows for a greater number of people to implement protection measures.

More specific warnings may be issued by communities and are included on the following list, which contains methods already discussed, as well as common and cutting edge methods.

- NOAA All Hazards Radio;
- The Weather Channel;
- Commercial or public radio or TV stations;
- Cable TV emergency news inserts;
- Tone activated receivers in key facilities;
- Outdoor warning sirens and fire department call-in sirens;
- Sirens on public safety vehicles;
- Mobile public address systems;
- E-mail notifications;
- Broadcast faxes;
- Pocket paging services for the hearing impaired;
- AT&T language line for those who speak a different language;
- Automated telephone notification services;
- Telephone trees/mass telephone notification;
- Mobile device text messages and apps;
- Social media outlets; and
- Door-to-door contact.

Warning systems need to be evaluated, updated to include new technologies, and expanded to include warnings to people with "special needs" continually and should include warnings for slow onset, as well as fast onset hazards. Different warning systems are required for different hazards, some of which are location-specific and some of which are area-wide. In addition, any confusion over warnings needs to be eliminated. The public is often confused by fire station alarms and doesn't know if the alarm indicates a hazard or is just calling in fire fighters.

Multiple or redundant systems are most effective. If people do not hear one warning, they may still get the message from another. Also more effective are warnings that provide public information about the hazard and what to do. However, each method has advantages and disadvantages that are partially described below.

- Radio and television, when turned on, provide useful information.
- NOAA Weather Radio, where available, can provide short messages of any impending weather hazard or emergency and advise people to turn on their radios or televisions, or to access the internet.

- Outdoor warning sirens can quickly reach many people, particularly those who are outside, and trigger them to turn on a radio or television or to access the internet to find out what hazard is coming. They do not reach people in tightly insulated buildings or those surrounded by loud noise, such as in a factory, during a thunderstorm, or near an air conditioning unit.
- Automated telephone notification services are also fast, but can be expensive and do not work when phone lines are down or for unlisted numbers and calling screener services.
- Going door-to-door and conducting manual "telephone trees" can be effective but require a longer lead time.
- Social media alerts require individuals to be active on those networks and require access to the internet.
- Mobile device alerts are only effective if there is adequate cell phone service, and when devices are turned on.

Muskegon County does not own or maintain any type of outdoor warning system (sirens). Municipal fire stations are responsible for the installation and operation of fire department sirens which could also be used as warning sirens. Sirens in Muskegon County are located in Blue Lake Township, Lakewood Club Village, Norton Shores (Muskegon County Airport; air crash only), Montague, Muskegon Heights, and Whitehall.

In areas not serviced by outdoor sirens, the most effective means of warning are radio, television, and cable systems (EAS), the EARS tone alert radios, social media, NOAA Weather Radios, and messages send directly to mobile devices. Muskegon County currently utilizes the "First Call Telephone Notification System", which is capable of simultaneously sending from 200 to over 1,000 messages per minute anywhere in the county, depending on the capabilities of the telephone exchange. These messages can inform residents of emergencies in their areas and can recommend actions. The system is payed for by Muskegon County, Muskegon Central Dispatch, Norton Shores, and Muskegon Township.

The NWS established the "StormReady" program to help local governments improve the timeliness and effectiveness of hazardous weather-related warnings for the public. A community must satisfy a set of guidelines to receive "StormReady" recognition. The guidelines are organized into six categories:

- Communications;
- NWS Information Reception;
- Hydrometeorological Monitoring;
- Local Warning Dissemination;
- Community Preparedness; and
- Administrative.

Certain requirements for each guideline may vary depending on the population of the community. More information on the program is available at http://www.stormready.noaa.gov/index.html. The cities of Montague and Whitehall are StormReady communities.

NWS also established the Turn Around Don't Drown (TADD) campaign "to warn people of the hazards of walking or driving a vehicle through flood waters." One activity is to warn motorists of the dangers of flooded roads, particularly when there are barricades, since it is impossible to tell the depth of the water or the condition of the road under the water. Barricades are very definite warnings and should never be ignored. An additional and inexpensive warning technique is the use of PVC markers on roads prone to flooding which show the depth at which motorists should not attempt passage.

C. Response. The protection of life and property is the foremost task of emergency responders. A community should respond to hazards with threat recognition, warnings and actions that can prevent or reduce damage and injuries. Typical actions and responding parties in a flooding event include the following:

- Activating the emergency operations center (emergency management);
- Closing streets or bridges (police or public works);
- Shutting off power to threatened areas (utility company);
- Passing out sand and sandbags (public works);
- Ordering an evacuation (governor, upon local recommendation);
- Holding children at school/releasing children from school (school district);
- Opening evacuation shelters (Red Cross);
- Activating volunteers to check on/assist vulnerable populations;
- Monitoring water levels (engineering); and
- Security and other protection measures (police).

Additional activities for different types of events include: advertising heating and cooling shelters when extreme temperatures occur; having volunteers check on those needing assistance when there are infrastructure failures; sending vulnerable folks (in parks, campgrounds, mobile home parks, shopping malls, and large public or private buildings) to tornado shelters when high winds are predicted

An emergency action plan ensures that all bases are covered and that response activities are appropriate for the expected threat. These plans can be developed for municipalities, critical facilities, SARA sites, businesses, etc. and should include coordination with all of the agencies, offices, first responders and service providers that are given various responsibilities. They should consider the possibility of “mutual aid” and utilize volunteer groups such as Radio Amateur Civil Emergency Services (RACES) and Muskegon County Amateur Radio Emergency Services (ARES). Emergency response plans should be updated annually to keep contact names and telephone numbers current and to make sure that supplies and equipment that will be needed are still available. They should be critiqued and revised after disasters and exercises to take advantage of the lessons learned and changing conditions.

The Muskegon County Emergency Action Guidelines (EAG) document, updated in 2013, is designed to present a common platform for coordination of major response activities for all types of natural and technological hazards. It establishes the Incident Command System that assigns responsibilities during a disaster, such as communications, evacuation and public health. Implementation of the plan relies on the combined effort of Muskegon County departments and local communities. The EAG is augmented with annexes (including terrorism), standard operating procedures and other guidance documents that cover the details of various aspects of emergency response, such as communications, evacuation, sheltering, damage assessment, and severe weather.

The Incident Command System is required for Muskegon County’s participation in the Michigan Emergency Management Assistance Compact (MEMAC), an initiative of the Michigan State Police, Emergency Management and Homeland Security Division (MSP/EMHSD). MEMAC creates an organized process and structure spelled out in advance for jurisdictions large and small across the state to render or receive assistance in times of crisis. It addresses problematic issues concerning workmen's compensation insurance, expense reimbursement and liability coverage before assistance is needed and requested. Designed to be flexible, MEMAC is also intended to supplement rather than replace existing, local mutual aid agreements already in place to handle "routine" public safety services among neighboring jurisdictions and fire departments. It is important to note that the implementation of MEMAC helps to facilitate the receipt of state or federal disaster funds through the Public Assistance Program.

Planning is best done with adequate data. One of the best tools in a flooding event is a flood stage forecast map that shows what areas would be under water at various flood stages. Emergency management staff can identify the number of properties flooded, which roads will be under water, which critical facilities will be affected, etc. With this information, an advanced plan can be prepared that shows problem sites and determines what resources will be needed to respond to the predicted flood level.

A Geographic Information System (GIS) allows for this type of analysis as it works with digitized layers of geographic data. For instance, the locations of buildings can be overlaid with areas of concern for development (topography, infrastructure, land use, zoning, fire service areas, etc.) and areas of concern for flooding (floodplains, hydraulic shadows of dams, etc.). GIS can model the effects of different levels of flooding and be used for hydrologic monitoring and modeling of the effects of removing/raising bridges over rivers to remove constriction to the flow of floodwater.

Protecting critical facilities during a disaster is the responsibility of the facility owner or operator. Some critical facilities have their own emergency response plans. Michigan law requires hospitals, nursing homes, and other public health facilities to develop such plans. Many facilities would benefit from early warning, response planning, and coordination with community response efforts. If critical facilities are not prepared for an emergency and are damaged, workers and resources may be unnecessarily drawn away from other disaster response efforts. If they are adequately prepared by the owner or operator, the community's emergency response efforts will be better supported.

D. Recovery and Mitigation. After a disaster, communities should undertake activities to protect public health and safety, facilitate recovery, and help prepare people and property for the next disaster. Throughout the recovery phase, everyone wants to get “back to normal.” However, “normal” can’t mean the way things were before the disaster or there would again be the same exposure to future disasters. Here are some examples of potential recovery actions:

- Patrolling evacuated areas to prevent looting (police).
- Providing safe drinking water (public works).
- Monitoring for diseases (health department).
- Vaccinating residents for tetanus (health department).
- Clearing streets (road commission).
- Cleaning up debris and garbage (road commission).
- Providing referrals to recovery vendors for post-disaster goods and services (emergency services).
- Regulating reconstruction to ensure that it meets all code requirements (building inspectors).

Requiring permits for building repairs and conducting inspections are vital activities to ensure that damaged structures are safe for people to re-enter and repair. There is a special requirement to do this in identified floodplains, regardless of the type of disaster or cause of damage. The National Flood Insurance Program (NFIP) directs local officials to enforce the substantial damage regulations. These rules require that if the cost to repair a building in the mapped floodplain equals or exceeds 50% of the building’s market value, the building must be retrofitted to meet the standards of a new building in the floodplain. In most cases, this means that a substantially damaged building must be elevated above the base flood elevation. This requirement can be very difficult for understaffed and overworked offices after a disaster. If these activities are not carried out properly, not only does the community miss a tremendous opportunity to redevelop or clear out a hazardous area, it may be violating its obligations under the NFIP.

A chance is also available to assess the strength of buildings; the effectiveness of emergency action plans for communities, critical facilities, and businesses; and the readiness of responders. Should efforts be deemed inadequate, improvements can be recommended such as revisions to building codes, increased training for responders, and improvements to existing plans or creation of sample plans.

Reviews of emergency response plans and programs should focus on whether all involved communities had coordinators and liaisons, if all information was provided (flood plain map, critical facilities, etc.), if there were post-disaster procedures for public information, and if adequate warnings were provided. Model business disaster plans can include details on response such as evacuation plans; data protections, security, and recovery; property security; drills; and first-aid training and CPR. They could also include post-disaster mitigation actions such as facilities management; damage assessment; relocation of both services and people; insurance; contractors; list of resources for public and private assistance; and evaluate, test, and update plans.

Reviews of building strengths should be similar to FEMA's, wherein a Building Performance Assessment Team (BPAT) may recommend revisions after a disaster. Other considerations for revisions could include the following.

- Did fire fighters have adequate detection and firefighting equipment?
- Did critical facilities have necessary back-up generators?
- Did electrical distribution systems have built-in redundancies to limit the impact of failures?
- Did the Road Commission have the equipment and personnel to be able to clear the roads?
- Was there a place to store personal property?
- Were there detention areas for debris disposal (snow, ice, branches, power/phone lines, etc.)?
- Were critical facilities protected with lightning rods and surge protection devices?
- Was the Health Department able to monitor threats and take the necessary steps to prevent or limit the scope and magnitude of threats?
- Were emergency responders sufficiently trained and able to communicate?

An assessment of damages is necessary and can be provided by state and federal officials, as is the case in flooding events, or by local emergency responders and emergency staff. In Muskegon County, local damage assessments are handled jointly by the Accounting and Equalization departments. Assessments can be facilitated by GIS which could detail damages, identify mitigation projects, establish environmental baselines, and monitor changes in land use. FEMA offers courses, free of charge, to emergency staff for evaluation training.

In addition to identifying the amount of damage, communities can acquire substantially or repeatedly damaged properties from willing sellers, plan for long-term mitigation activities, and apply for post-disaster mitigation funds.

5. Public Education and Awareness.

Public education and awareness programs are necessary to periodically inform the public (property owners, renters, businesses and local officials) about the county's hazards, the measures necessary to minimize potential damage and injury, and what actions are being taken. This information is primarily intended to precipitate appropriate actions.

Information can be disseminated through the media (newspapers, newsletters, websites, television, radio, etc.) and at public forums and civic meetings. It can be distributed through schools and made available in public buildings or shopping areas. Brochures can be available at libraries and government offices, including building inspection offices. Special populations can be reached through direct mailings, workshops, and seminars. Signage along hazardous areas can also be effective.

A. Distribution of Existing Information. There is a great deal of information regarding hazards and hazard mitigation available to communities and the public on the national level. Both FEMA and American Red Cross present information on the Internet and in documents and brochures. The National Weather Service makes information available through its "StormReady" program and "Turn Around Don't Drown" campaign, to name just a few.

Insurance companies and non-profit programs have been heavily involved in identifying and responding to hazards. The Institute for Business and Home Safety (IBHS) gives detailed information on how to increase a home, business, or new construction's resistance to disaster through its suite of FORTIFIED programs. The National Fire Protection Association (NFPA) provides information about co-existing with wildfire along with mitigation information through its Firewise Communities program. The NFPA also has information available for homeowners on how to prevent fires. The National Arbor Day Federation provides direction on tree management.

Unfortunately, this information doesn't always reach the intended target audience; whether that audience is communities, the general public, or specific populations. Local efforts can be made to select pertinent information and get it out to places and people where it is needed (such as information on wildfire hazards to campers). Programs and web sites can be publicized. Brochures can be stockpiled and distributed. This information can be very helpful, although it is not specific to the community.

B. Distribution of Local Information. In addition to the national-level information discussed above, there is an abundance of information available locally to educate and warn the public of hazards. The Muskegon County Health Department publishes an annual Community Profile, available on its website, describing health threats in the county and efforts to protect residents. Local newspapers and television stations frequently update the public on hazards. Muskegon County Emergency Services is an excellent source of information on a variety of topics as varied as the location of shelters or financial assistance in hazard response and mitigation. Local building inspectors can provide advice regarding protection measures, property compliance, and required building permits.

Mitigation efforts the county takes to protect its residents, including the creation and adoption of this plan to qualify itself (and local communities which participate in the planning process and adopt the plan) for federal disaster funding and the use of the First Call Telephone Notification System, can be publicized. The general public, or eligible target groups, can be notified when financial resources for hazard response and mitigation become available.

C. Technical Assistance. Communities often have information that can assist homeowners. If they have FEMA's Flood Insurance Rate Maps and Flood Insurance Studies available, they can provide information to residents and can assist them in submitting requests for map amendments and revisions (Letter of Map Revision, or LOMR) when a building is not in the flood plain but a part of the property is. Lenders will notify applicants for federally insured loans if the involved property is in the flood plain and require flood insurance as a condition of the loan.

Local building inspectors can provide advice regarding protection measures, property compliance and required building permits.

Emergency Services can recommend that residents develop Family Emergency Plans, including the preparation of Disaster Supply Kits, identification of emergency telephone numbers, and the preparation of pre-planned escape routes. The county can assist local communities through the provision of local information regarding hazards, risks and protections. For example, a GIS system could lay out the location of homes in floodplains so that mitigation measures can be considered. It can also assist communities in the development of the plans identified in this document by researching and providing model plans to them.

Part G
POTENTIAL HAZARD MITIGATION ACTIONS

The previous chapter identified a multitude of alternatives for addressing hazard concerns; some of which may not be economically feasible or appropriate for a county with limited financial and professional resources, such as Muskegon. In addition, many of Muskegon County's top hazards are natural and weather-related and cannot be easily mitigated. Nothing can be done to eliminate severe winds or snow/ice/sleet storms or to alter their frequency, intensity or spatial distribution across the landscape. Mitigation actions associated with natural hazards must focus on limiting the impacts on the populations or structures that are being affected. For instance, power failures caused by severe winds and snow/sleet/ice storms can be reduced by several mitigation activities and the impacts on residents and properties from the power failures can be alleviated.

The potential actions presented in this section were selected because they may potentially help to save lives and protect communities and important agencies, rather than because they are considered pure "mitigation actions" distinct from other types of emergency management actions. However, in the final selection of strategies for any hazard mitigation plan, care should be taken to ensure the inclusion of at least some strategies that are clearly hazard mitigation. That is, a true hazard mitigation strategy is an effort to prevent hazard impacts, or to take advance, proactive steps toward the long-term reduction of the impacts of hazards on a community. If some of these take place during the response or recovery phases of a disaster, or happen to also increase an agency's preparedness, the existence of such overlap is primarily of academic interest so long as the community's safety is being served. On occasion, specific criteria for hazard mitigation must be met to satisfy the requirements of a given grant. Thus it is useful to be aware of both the distinctions and the overlap between hazard mitigation and other types of emergency management activities.

Identification of a possible mitigation measure does not necessarily mean that it can or even should be implemented. Implementation (and the desirability) of a mitigation measure is highly dependent on a number of factors – environmental, social, economic and political. Just because a measure may reduce or eliminate the effects of a hazard does not necessarily mean that it should be implemented. There may be extenuating factors or circumstances that could (or even should) preclude its implementation. Those decisions will be made in the local and state political arenas and in the land use / land development decision-making processes. Typically, mitigation measures will be implemented if they are able to balance environmental, social, economic and political factors, and are cost-effective. It does not make sense to implement a measure that will not be supported by state and/or local officials and the citizenry, or that cannot be economically justified. Although implementability cannot (and should not) always be the final litmus test for a potential mitigation measure, it certainly should be considered when identifying and developing measures. In general, those mitigation opportunities that could not pass this basic litmus test have been excluded from this plan.

The following potential actions are presented according to the county's hazard mitigation goals and objectives identified in Part E. For each goal, there are several objectives; and under each objective, there are several action items. These potential action items are "snapshots" of some of the alternatives discussed in the previous chapter. The highest priority action items are selected from this set and discussed further in "Part I - Plan Implementation."

For the updated edition of this plan, many of the potential action items remain the same, though minor revisions were made to improve the readability of the action items. A few action items were added and a few were removed according to the preference of the Advisory Team / LEPC. Care was taken to ensure that there are numerous potential action items presented to address each of the county's top priority hazards.

Goal 1. Promote growth in a sustainable, hazard-free manner.

Objective 1.1. Incorporate hazard provisions in building code standards, ordinances, and procedures.

Action Item 1. Review local building codes to determine if revisions are needed to improve structural ability to withstand greater wind velocities, snow weight, ice, and hail; to provide better protection against structural fires and flooding; and to provide better protection from extreme temperatures.

Action Item 2. Contact Insurance Services Office (ISO) to request a copy of the community's Building Code Effectiveness Grading Scale (BCEGS), and work to improve the BCEGS rating through improvements to building codes and enforcement.

Action Item 3. Utilize the Institute for Business and Home Safety (IBHS) guidelines provided through the "FORTIFIED" programs to guard new and existing structures against hazards (such as structural fire, wildfire, tornadoes, and freezing weather), and consider incorporating them into existing codes.

Action Item 4. Review code requirements for the installation of mobile homes and manufactured homes to assure protection against severe winds and tornadoes.

Action Item 5. Assess the need to strengthen anchoring requirements for propane tanks and hazardous materials in the floodplain/floodway.

Action Item 6. Assure proper location, installation, cleaning and maintenance of septic systems, particularly in the floodplain/floodway and around lakes.

Objective 1.2. Incorporate hazard mitigation into land use and capital improvement planning and development activities.

Action Item 7. Incorporate mitigation provisions into comprehensive plans and land use plans; such as identification of acceptable land uses and densities based on consideration of flood-prone areas, soil types, topography, and etc.

Action Item 8. Incorporate the Muskegon Area-wide Plan's "Smart Growth" principles (supporting the link between resource protection and development and a collaborative approach for infrastructure and services) into comprehensive plans and land use plans.

Action Item 9. Integrate hazard mitigation into the capital improvement planning process so that public infrastructure does not lead to development in hazard areas and so that possible set-asides for planned and engineered structural projects (berms, levees, floodwalls, detention and retention ponds, debris storage areas, culvert replacement, etc.) are considered.

Objective 1.3. Incorporate hazard mitigation into existing land use regulation mechanisms to ensure that development will not put people in danger or increase threats to existing properties.

Action Item 10. Incorporate hazard mitigation provisions and recommendations into local zoning ordinances and resolutions as they restrict or direct development; with consideration given to dams, floodplains, soil type and topography; and as they allow flexibility in lot sizes and locations, such as in Planned Unit Developments (PUD).

Action Item 11. Enforce the existing Michigan Drain Code requirement for "set-back" from the drain channel, thereby assuring proper carrying capacity of the drain.

Action Item 12. Enforce Michigan's Part 91, Soil Erosion and Sedimentation Control, of the Natural Resources and Environmental Protection Act, regarding earth changes affecting an acre or more or within 500' of a lake or stream, and consider adopting and enforcing more stringent local regulations.

Action Item 13. Enforce Michigan's Land Division Act as it furthers the orderly layout and use of land, provides for proper ingress and egress to lots and parcels, controls residential building development within floodplain areas, provides for reserving easements for utilities, and governs internal drainage.

Action Item 14. Enforce Michigan's Sand Dune and Shorelands Protection and Management Programs that control development in high-risk erosion areas and protect dunes.

Action Item 15. Consider regulation of development in the hydraulic shadows of dams (where flooding would occur if there was a severe dam failure).

Objective 1.4. Research, recommend, adopt and enforce other plans and ordinances that protect natural resources so that they can, in turn, provide hazard protection.

Action Item 16. Develop a Stormwater Management Plan to identify best management practices (BMP's), and to assess the efficacy of local stormwater ordinances and rules.

Action Item 17. Develop, adopt, and enforce a Nuisance Ordinance to prevent dumping "objectionable" solid matter into channels and wetlands and Waterway Dumping Regulations to prevent dumping "non-objectionable" waste.

Action Item 18. Develop and enact a Community Forestry Program to reduce the damage potential of trees by addressing proper tree care prior to a storm (pruning, maintenance, removal, and replacement) by communities and property owners and by managing trees before, during, and after a storm. This is a standard for qualification as a "Tree City USA" community.

Action Item 19. Develop policies or ordinances aimed at mitigating the impacts of drought conditions, such as: the promotion of planting crops tolerant of low moisture levels; partner with programs that promote soil health and monitor and preserve soil moisture; and prioritize or control water use during drought conditions.

Goal 2. Protect existing and new properties.

Objective 2.1. Use the most cost-effective approaches to keep hazards away from existing buildings and facilities.

Action Item 20. Assess the capacity of storm water systems to handle both storm waters and high water tables and make necessary improvements and expansions to assure the protection of property and infrastructure.

Action Item 21. Raise or relocate buildings above the 100-year flood level, and/or acquire properties in flood and high-risk erosion areas for demolition and re-use of the land as open space.

Action Item 22. Identify structural projects to channel water away from people and property (e.g. berms, dikes, levees, or floodwalls), or to improve drainage capabilities (e.g. culvert improvements, bridge modifications, spillways, relief drains, or floodgates).

Action Item 23. Identify environmental restoration projects to lessen the impacts of flooding and improve water quality and wildlife habitat, such as erosion control techniques (streambank modification), dredging / clearance of sediment and debris from drainage channels, and protection / restoration of wetlands and natural water retention areas.

Action Item 24. Employ "Firewise" principles of proper grounds maintenance, equipment storage, vegetation clearance, and other techniques.

Action Item 25. Create firebreaks, wherein brush and other fuel is cleared away, in wildland areas.

Action Item 26. Identify and prioritize fuel reduction projects, especially for developments in wildland-urban interface (WUI) areas.

Action Item 27. Adopt and enforce local ordinances that require burn permits and restrict campfires and outdoor burning.

Action Item 28. Enforce Michigan P.A. 102 of 2012 which prohibits the open burning of household trash that contains plastic, rubber, foam, chemically treated wood, textiles, electronics, chemicals, or hazardous materials.

Objective 2.2. Use the most cost-effective approaches to protect existing buildings and sites from hazards.

Action Item 29. Encourage property owners and public facility operators to increase their property's resilience and resistance to hazards.

Action Item 30. Adopt and enforce the Michigan Rehabilitation Code to hold repaired buildings to higher standards for protection against natural hazards, similar to the standards for newly constructed buildings.

Action Item 31. Utilize mandates for upgrading homes, such as requiring upgraded electrical work for substantial rehabilitation of existing properties, or for issuing "Fill Your Basement With Water" orders.

Action Item 32. Review the energy efficiency, winter readiness, and electrical protection of critical facilities and government buildings in the community and consider replacing aged facilities and equipment.

Action Item 33. Install lightning protection devices on the community's communications infrastructure and appropriate public facilities; and lightning grade surge protection devices on critical electronic components used by government, public service, and public safety facilities.

Objective 2.3. Maximize insurance coverage to provide financial protection against hazard events.

Action Item 34. Assure insurance coverage on properties and obtain additional insurance coverage as appropriate (sump pump failure, sewer back-up, wildfire, dam failure, etc.).

Action Item 35. Encourage and assist municipalities that are at risk to flooding, or that have been exposed to flooding in the past, to join the National Flood Insurance Program (NFIP) so that residents can obtain flood insurance.

Action Item 36. Encourage municipalities to join the NFIP's Community Rating System (CRS), implement the CRS minimum standards, and implement additional flood loss reduction activities to reduce the cost of NFIP flood insurance.

Action Item 37. Inventory critical facilities and assure proper insurance coverage, both type and amount, including deductibles and policy limits. Evaluate self-insurance coverage in light of its expense and NFIP policies.

Objective 2.4. Maximize the resources for investment in hazard mitigation, including the use of outside sources of funding.

Action Item 38. Utilize federal programs; such as but not limited to FEMA's Pre-Disaster Mitigation Program, Flood Mitigation Assistance Program, and Hazard Mitigation Grant Program; to address community needs for hazard mitigation.

Action Item 39. Utilize, and assist those with special needs to utilize, available programs for assistance with home repairs, weatherization, and heating costs to address hazards for persons and properties.

Action Item 40. Facilitate donations for heating assistance through cooperation with local utility providers and local charitable organizations to assure that all residents have heat during the winter, regardless of their ability to pay.

Action Item 41. Establish a cost sharing program to encourage low cost (under $10,000) property protection measures against natural hazards on private property, such as rebates offered through a "flood-proofing" program for instances when acquisition and/or relocation is not required.

Action Item 42. Establish a voluntary floodway property acquisition and land re-use program, with corresponding changes in zoning, and purchase/transfer of development rights for properties.

Action Item 43. Tap into state and federal funding and technical assistance for dam/spillway repairs.

Action Item 44. Investigate the availability of resources and need for creating firebreaks and the availability of resources for acquiring land as necessary to achieve continuity of needed firebreak areas.

Goal 3. Protect public health and safety.

Objective 3.1. Assure that threat recognition (watches) and warning systems are adequate and appropriate and that they utilize the latest technology.

Action Item 45. Regularly evaluate the effectiveness of the public warning system including the threat detection process, management system, communications links, and methods of dissemination.

Action Item 46. Implement improvements to the warning system as deemed necessary for improving coverage and effectiveness.

Action Item 47. Maintain a description of the public warning process and coordinate actions in a section of the Emergency Action Guidelines (EAG).

Action Item 48. Maintain the "First Call" telephone emergency notification system to assure immediate warnings to Muskegon County residents or target groups of pending and existing hazards and actions they can take to protect themselves.

Action Item 49. Increase the coverage and use of NOAA All-Hazards radios and weather alert systems (Emergency Alert Radio System, etc.) to people and communities in need.

Action Item 50. Encourage the MDNR, U. S. Geological Survey, National Weather Service, and U. S. Army Corps of Engineers to continue to operate and monitor stream gauging stations and groundwater monitoring wells and consider whether the exposure to flooding on smaller rivers and streams warrants additional Advanced Hydrologic Prediction Services (AHPS) or local rain and stream gauging and flood threat recognition systems.

Action Item 51. Maintain adequate monitoring and surveillance capabilities by the County Health Department to monitor public health threats and take the necessary steps to prevent or limit the scope and magnitude of threats.

Action Item 52. Utilize the NWS "Turn Around Don't Drown" system to warn motorists and pedestrians not to enter or cross flooded areas, and install PVC markers alongside roads to illustrate dangerous water levels.

Objective 3.2. Protect infrastructure and services.

Action Item 53. Encourage electrical utilities to place power lines underground wherever possible, but especially when upgrading lines or running power to new developments.

Action Item 54. Recommend design of the electrical distribution system with built-in redundancies such that isolated failures do not lead to wide scale outages; recommend consideration of back-up generators powered with wind, sun, gasoline, or natural gas; and assess and improve electric service system reliability as needed.

Action Item 55. Install back-up generators, as needed for short-term relief from power failures, at critical facilities such as sewage pump stations, hospitals and medical centers, nursing home facilities, schools, shelters and government facilities.

Action Item 56. Bury water/sewer lines below the frost line or insulate and maintain lines to protect against ground freeze.

Action Item 57. Establish safe and appropriate locations for temporary debris disposal sites.

Action Item 58. Assure the county has adequate equipment (road barriers, sand bags, portable lighting, snow plows, etc.) to respond to widespread weather events.

Action Item 59. Refine state, county, and local road and bridge maintenance / vegetation management programs to maintain visibilities, provide for living snow fences, reduce erosion, slow stormwater runoff, and so as not to undermine the structural integrity of transportation infrastructure.

Objective 3.3. Build and support local capacity, commitment and partnerships to continuously become less vulnerable to hazards.

Action Item 60. Adopt this Hazard Mitigation Plan by official resolution to assure both consideration of natural hazards and eligibility for funding through the Pre-Disaster Mitigation Program, Flood Mitigation Assistance Program, and Hazard Mitigation Grant Program.

Action Item 61. Explore funding options for a Hazard Mitigation Coordinator position, either on a county or regional level, to facilitate the actions contained in this plan.

Action Item 62. Develop and review coordinated response plans and programs across service providers, agencies and local governments, and assure both mutual aid and the ability to communicate during emergencies.

Action Item 63. Share vital public safety services and resources more effectively and efficiently through county participation in MEMAC, which helps facilitate the receipt of state or federal disaster funds through the Public Assistance Program.

Action Item 64. Refer emergency responders and emergency staff to FEMA and MSP/EMHSD training for conducting Damage Assessments and determining "Substantial Damage" for an efficient and accurate assessment of building damages.

Action Item 65. Design and plan for water supply infrastructure systems that include a consideration of, and are more resistant to, drought events.

Action Item 66. Obtain extra fire-fighting and rescue equipment, including specialized equipment for limited access areas (such as the Lake Michigan shoreline), thermal imaging devices, and special equipment for water and ice rescues.

Action Item 67. Construct concrete storm / tornado safe rooms in homes, public buildings, major industrial sites, shopping malls, and other large complexes; and shelter areas in parks, campgrounds, fairgrounds, mobile home parks, and other vulnerable public areas.

Action Item 68. Coordinate with the Conservation District, local watershed councils, and lake associations to maintain healthy, free-flowing watercourses with minimal erosion and sedimentation, and to restore / preserve wetlands.

Action Item 69. Coordinate with fire departments to promote "Firewise" program recommendations and strategies to property owners, especially those within wildland/urban interface and limited access areas.

Action Item 70. Meet the criteria to become a NWS-approved "Storm Ready" community.

Objective 3.4. Enlist support of committed volunteers to safeguard the community before, during, and after a disaster.

Action Item 71. Utilize volunteer communication networks by amateur radio operators (RACES and Muskegon County ARES) to facilitate communication during emergencies when phone lines may be inoperable.

Action Item 72. Designate amateur radio operators to relay information on "immediately dangerous" weather situations and storm damage reports to the NWS, Central Dispatch, and/or Muskegon County Emergency Services.

Action Item 73. Create a volunteer outreach program, whereby a network of amateur radio operators and others regularly check on the needs and conditions of elderly, disabled, homebound, and other special-needs groups during and after severe weather conditions; deliver goods / assistance to them; and / or disseminate information about emergency shelters.

Action Item 74. Utilize NWS-trained weather spotters to watch for developing storms, take flood water measurements, and monitor stream conditions.

Action Item 75. Conduct an annual "clean-up" program when trash, limbs, barrels, shopping carts and other potential blockages are removed from drainage culverts, channels and adjacent lands.

Goal 4. Increase public understanding, support, and participation in hazard mitigation.

Objective 4.1. Heighten public awareness of the full range of existing natural and man-made hazards and actions they can take to prevent or reduce the risk to life or property from them.

Action Item 76. Obtain and distribute available information on hazards and cost-effective mitigation actions individuals can implement (for example, Firewise pamphlets), and post-disaster repair and cleanup guidance.

Action Item 77. Produce and distribute local emergency preparedness and safety information to the general public and/or targeted groups (seasonal populations, floodplain residents, developers and builders, farm owners and operators, decision makers, Spanish speaking, etc.). Include local resources for information such as fire stations, local radio stations, shelters, and utilities.

Action Item 78. Produce and distribute information on mitigation measures the county is taking/will take, as identified in this hazard mitigation plan, to local units of government and encourage them to participate in the plan and take mitigation actions.

Action Item 79. Promote educational and informational programming through the media, especially related to the early warning network and individual actions that can be taken to protect citizens, properties, and businesses. For example, inform the general public about the First Call telephone emergency notification system and encourage citizens and visitors to register unlisted phone numbers.

Action Item 80. Provide local schools with information for the classroom regarding severe weather hazards and how families can prepare for and respond to them.

Action Item 81. Incorporate safety strategies for severe weather events in driver education classes and materials.

Action Item 82. Encourage residents to develop a Family Emergency Preparedness Plan; including the preparation of a Disaster Supply Kit, the posting of emergency telephone numbers, and pre-planned escape routes.

Action Item 83. Promote public awareness on fire hazards such as recreational fires (especially in resort/vacation home areas), smoking, fireworks, campfires, wood stoves, and outdoor burning; and support safe disposal of yard and house waste rather than open burning.

Action Item 84. Research availability of local and Michigan-based recovery "vendors" for post-disaster goods and services to support disaster recovery efforts.

Action Item 85. Identify and advertise available heated and cooled shelters to the elderly and other special populations who may be at risk during extreme temperature events and power outages.

Action Item 86. Provide local units of government and builders with information and guidance on methods of protecting new construction from wind damage. Encourage builders and contractors to design wind resistance into the construction of new homes and major home renovation projects.

Action Item 87. Through coordination with the County Health Department, increase public awareness of the causes, symptoms and protective actions for disease outbreaks and other potential public health emergencies.

Objective 4.2. Encourage local communities, agencies, organizations and businesses to participate in the hazard mitigation process.

Action Item 88. Participate in programs such as NFIP, CRS, Firewise, Tree City USA, StormReady, etc. and respond to concerns regarding program requirements and obstacles to participation.

Action Item 89. Develop model hazard mitigation and contingency plans and regulations (such as stormwater ordinance, nuisance ordinance, waterway dumping regulations, community forestry program, drought plan and ordinance, etc.) and provide them to interested communities.

Action Item 90. Develop model business and critical facility disaster plans that include details on disaster response (evacuation plans; data protection, security, and recovery; property security; drills; first-aid training and CPR; and post disaster mitigation actions), facilities management, damage assessment, relocation of both services and people, insurance, contractors, list of resources for assistance, and evaluation, testing, and updating plans. Inform business owners about available disaster-recovery training programs.

Action Item 91. Notify communities of hazard mitigation funds, as they become available, and assist them in applying for funds.

Action Item 92. Encourage meetings between utility providers and local Public Works and Road Commission departments to determine the resources and funding required to mitigate recurring infrastructure failures.

Action Item 93. Support agricultural programs that promote soil health, preserve soil moisture, and monitor soil moisture levels to help to minimize loss of crops and topsoil during drought conditions and promote educational programming relating to water conservation, especially in irrigation and farming, during periods of drought.

Objective 4.3. Encourage cooperation and communication between planning and emergency management officials.

Action Item 94. Assist the LEPC in its activities relating to the development and review of SARA Title III Section 302 site emergency plans, including assistance in updating SARA site plans, and in the appointment of qualified members to the committee.

Action Item 95. Assist the LEPC in its activities related to developing and continually revising Emergency Action Guidelines detailing the response requirements of emergency responders (emergency management, damage assessment, communications, medical services, fire services, public health services, human services, law enforcement, public works, and public information).

Action Item 96. Strengthen the role of hazard mitigation in the land development process, incorporating goals, objectives, and action items into land use plans, comprehensive plans, and zoning ordinances.

Action Item 97. Utilize the County Geographic Information System (GIS) capabilities to support pre-disaster planning (such as the creation of flood stage forecast maps, and maps showing the locations of secluded, gated, and seasonal homes), disaster response activities, and post-disaster recovery activities.

Action Item 98. Coordinate with American Red Cross to ensure the county-wide availability of designated and accessible emergency shelters and assure facilities are inspected, certified, and have back-up power.

Part H
EVALUATION CRITERIA TO SELECT AND PRIORITIZE ACTION ITEMS

The selection of appropriate evaluation criteria is intended to ensure that the recommended implementation action items reflect the values, policies, and desires of the community; and to communicate to governing officials which measures are the most meritorious and desirable.

Local input and planning principles were used to select action items for implementation from the list of potential actions presented in Part G. Common mitigation criteria helped guide the selection process, and included evaluation of each action item's *economic justifiability, technical feasibility, social equitability*, and *environmental soundness*. If, for example, relocation of a structure is proposed, the following conditions must be met in order to satisfy the criteria:

- The cost of relocation must be less than the cost of the repetitive repairs that would be necessary (along with other costs from displacement, loss of services, etc.) if there were no relocation.
- The structures must be able to be moved from their present location to a suitable site.
- The relocation must be acceptable to those who are to participate.
- The relocation must be affordable to all it affects, and not discriminate against those who are unable to bear the cost of either moving the structure, or finding comparable housing.
- In the case of a public facility, such as a fire station, the relocation should not result in an inequitable distribution of fire protection services.
- The relocation project must meet appropriate environmental regulations, and not cause any adverse effects.

Additional considerations used in selecting action items for implementation included: 1) ensuring an appropriate number of mitigation actions be selected to address each of the county's top-priority hazards; and 2) ensuring that an appropriate number of measures be selected to accomplish each of the four hazard mitigation goals established by this plan. Bonus consideration was given to action items that also addressed the goals of other community planning initiatives, and action items that provide clear and obvious solutions for hazard mitigation.

The next chapter presents a schedule of recommended action items for implementation. For each measure, the plan identifies basic details needed in order for it to be accomplished, including who will take the action and when it will be taken. Possible sources of technical or financial assistance, as previously discussed in Part F - Identification of Alternatives for Solving Problems, are matched to the actions as well.

In some cases, a local government may be able to implement an action, while the county can only make recommendations. Therefore applicability of each action item is assigned to the appropriate governments in a table on the last page. As a result, objectives will work on multiple scales and can be overseen by several governments. The benefits of combining all of the objectives into one plan include: the ability to recognize contradictions in policy more easily; the ability to cooperate in shared objectives; the ability to eliminate or reduce redundancy in efforts; and the fact that local governments will have a local-level plan for adoption and implementation, qualifying those governments for hazard mitigation funding.

Part I
PLAN IMPLEMENTATION

The previous edition of this hazard mitigation plan (2006) included 18 action items that were recommended for implementation and then assigned to the appropriate jurisdictions within Muskegon County. This chapter contains a review of the 2006 Action Agenda, as well as a revised Action Agenda for this updated edition.

Review of Hazard Mitigation Progress

To identify any mitigation progress that had been made on the 2006 Action Agenda, discussions were held with county officials and the LEPC / Advisory Team. A questionnaire was also sent to Muskegon County Emergency Services, LEPC / Advisory Team, and the chief elected official of each city, village and township that had adopted the 2006 plan. The questionnaire listed the 2006 Action Agenda, along with a place for the respondent to identify whether each item on the agenda was *Complete*, *Ongoing or In-Progress*, *Action Pending*, or *Incomplete* within his or her jurisdiction. If a particular action item was incomplete, the respondent was encouraged to explain why. This review process revealed the following:

1) At least some progress has been made on most of the action items.
2) Many inherited items on the Action Agenda remained priorities as of the time this plan was updated.
3) 2006 action items #20 (urban stormwater systems), #32 (CRS), #46 (stream gauges), #56 (hazard mitigation coordinator), and #82 (community assistance) are no longer considered priority action items and will not be included on the revised Action Agenda.

Six out of the 28 local units of government in Muskegon County responded to the questionnaire. In addition, six LEPC / Advisory Team members took part in the exercise, including Muskegon County Emergency Services, American Red Cross, Mercy Health Muskegon, ESCO Company, Professional Med Team, and Bayer Cropscience. Even though only about 20% of Muskegon County municipalities responded to the questionnaire, at least some progress was reported for 15 out of the 18 items on the Action Agenda. The results of the questionnaire exercise are compiled into the two tables following this narrative. The "Status Report" table summarizes the status of items on the 2006 Action Agenda, and reports any additional comments or information gleaned from the questionnaire. The "Progress by Jurisdiction" table shows the known degree of progress that has been made towards the 2006 Action Agenda, by jurisdiction, in Muskegon County.

2006 Action Agenda
STATUS REPORT

2006 Hazard Mitigation Plan Action Items	Status in 2014				Comments
	Complete	Ongoing or In-Progress	Pending	Incomplete or Unknown	
#2. Encourage participation in ISO's Building Code Effectiveness Grading Schedule (BCEGS), as recognized by FEMA for the Community Rating System of the National Flood Insurance Program.	X				**Norton Shores City –** Building Division participates in the BCEGS each 5-year cycle. The city's last evaluation was on 1/12/2011. **Mercy Health Muskegon –** Participates in many programs associated with hospital accreditation.
#7. Incorporate mitigation provisions into comprehensive plans and land use plans, especially as they address open space preservation and development restrictions (particularly in floodplains).	X	X	X		**Norton Shores City –** 2001 Conservation Design Ordinance; 2000 Comprehensive Plan (updated in 2008 and 2014). **Mercy Health Muskegon –**Mitigation strategies include opportunities to improve the wetlands near our Mercy campus, optimizing the use of the adjacent open land around all of our facility locations; and as we build, to consider the environment and ways to minimize the impact to it.

#9. Integrate hazard mitigation into the capital improvement planning process so that public infrastructure does not lead to development in hazard areas and so that possible set-asides for planned and engineered structural projects (berms, levees, floodwalls, detention and retention ponds, debris storage areas, etc.) are considered.		X			**Norton Shores City –** Detention / retention ponds are typically used on new developments for stormwater management. **Dalton Twp** – Lack of resources.
#10. Incorporate hazard mitigation provisions and recommendations into local zoning ordinances as they restrict or direct development; with consideration given to flood plains, soil type, and topography; and as they allow flexibility in lot sizes and locations, such as in PUDs.	X	X			**Norton Shores City –** 2011 Low Impact Design Ordinance.
#20. Assess the capacity of urban storm water sewer systems to handle both storm waters and high water tables and make necessary improvements and expansions to assure property protection.		X			**Norton Shores City –** Storm systems are sized when installed and reviewed if / when additional development has an impact on a particular sewer.
#25. Maximize the participation of property owners in protecting their properties from natural hazards.		X			**Norton Shores City –** Building Division enforces the MI Residential Code 2009 for the wind shear & 60 lb ground snow loads, among all other current code requirements. **Mercy Health Muskegon –** Considers hazard threats with all building projects.
#31. Encourage municipalities to join the National Flood Insurance Program (NFIP) so that residents can obtain flood insurance.				X	
#32. Encourage municipalities to join the NFIP's Community Rating System (CRS), implement the CRS minimum standards, and implement additional flood loss reduction activities (such as the adoption of this plan) to reduce the cost of NFIP flood insurance.				X	
#34. Utilize federal programs; such as but not limited to FEMA's Pre-Disaster Mitigation Program, Flood Mitigation Assistance Program, and Hazard Mitigation Grant Program; to address community needs for hazard mitigation.	X	X			
#44. Maintain the "First Call Telephone Notification System" to assure immediate warnings to Muskegon County residents or target groups of pending and existing hazards and actions they can take to protect themselves.		X			**Mercy Health Muskegon –** Strongly supports this system, and also has an internal system to notify employees of significant events.
#46. Encourage the MDNR, U. S. Geological Survey, National Weather Service, and U. S. Army Corps of Engineers to continue to operate and monitor stream gauging stations and groundwater monitoring wells and consider whether the exposure to flooding on smaller rivers and streams warrants additional Advanced Hydrologic Prediction Services (AHPS) or local rain and stream gauging and flood threat recognition systems.		X			
#51. Install back-up generators, as needed for short-term relief from power failures, at critical facilities such as sewage pump stations, road commissions, hospitals and medical centers, nursing home facilities, schools and shelters.	X				**Norton Shores City –** One sewage lift station has a permenant fixed generator; the remaining lift stations are maintained with portable generators. **Mercy Health Muskegon –** Hospitals and other facilities have generators in place and are tested monthly. **Professional Med Team** – Incorporating of backup power to new building locations.
#54. Continue and refine State, County, and local road and bridge maintenance programs (including vegetation management), assure that road commissions have adequate equipment (including road barriers, sand bags, portable lighting, etc.) to respond to widespread weather events, and promote snow fences beside highways and other roads to decrease snow on roads (focusing on residential developments with limited road access).	X				

#55. Adopt this Hazard Mitigation Plan by official resolution to assure both consideration of natural hazards and eligibility for FEMA funding through the Pre-Disaster Mitigation Program and Hazard Mitigation Grant Program.	X				All Muskegon County jurisdictions adopted the 2006 Muskegon County Hazard Mitigation Plan
#56. Explore funding options for a Hazard Mitigation Coordinator position, either on a county or regional level, to facilitate the actions contained in this plan.				X	**Montague City** – Lack of resources.
#70. Distribute already produced information on hazards and cost-effective mitigation actions individuals can implement to county residents and/or targeted groups most at risk to experience significant impacts due to natural hazards.		X			**Sullivan Twp**– Lack of resources. **Whitehall Twp**– Don't know of any such materials. **Red Cross –** Distributes materials and trains individuals, families, businesses, and schools to be prepared for a variety of disasters.
#71. Produce and distribute local emergency preparedness and safety information concerning all natural hazards to the general public and/or targeted groups.		X			**Dalton Twp**– Lack of resources. **Whitehall Twp**– Lack of resources. **Bayer Cropscience –** Holds quarterly community advisory panel meeting to communicate with the local community. **Mercy Health Muskegon –** Several preparedness items are discussed at employee orientation, and there is ongoing education via newsletters, conferences, etc. **Red Cross –** Distributes materials and trains individuals, families, businesses, and schools to be prepared for a variety of disasters.
#82. Assist local communities in participating in programs mentioned in Objectives 1.1,1.4, and 2.3 (NFIP, CRS, Firewise, Tree City USA, BCEGS, Fortified, Storm Ready, TADD, etc.) and assess and respond to concerns regarding program requirements and obstacles to participation.	X	X			**Sullivan Twp**– Lack of resources. **Professional Med Team –** Would like to be involved in a drowning prevention program.

2006 Action Agenda

PROGRESS BY JURISDICTION

Governmental Unit	2 B.C.E.G.S.	7 COMP/LAND-USE PLAN	9 CAPITAL IMPROVEMENT	10 ZONING ORDINANCES	20 STORMWATER	25 OWNER PARTICIPATION	31 N.F.I.P.	32 C.R.S.	34 FEDERAL PROGRAMS	44 FIRST CALL	46 STREAM GAUGES	51 GENERATORS	54 ROAD MAINTENANCE	55 H.M.P. APPROVAL	56 MITIGATION COORDINATOR	70 HAZARD AWARENESS	71 PREPAREDNESS INFORMATION	82 COMMUNITY ASSISTANCE
Muskegon County	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●
Montague City	●	●	●	●				●	●			●	●	●				
Muskegon Heights City	●	●	●	●	●			●	●			●		●				
Muskegon City	●	●	●	●	●			●	●			●	●	●				
North Muskegon City	●	●	●	●	●			●	●			●	●	●				
Norton Shores City	●	●	●	●	●			●	●			●	●	●				
Roosevelt Park City	●	●	●	●	●				●			●		●				
Whitehall City	●	●	●	●	●			●	●			●	●	●				
Casnovia Vil.	●	●	●	●			●	●	●					●				
Fruitport Vil.	●	●	●	●			●	●	●			●		●				
Lakewood Club Vil.	●	●	●	●			●	●	●					●				
Ravenna Vil.	●	●	●	●			●	●	●			●		●				
Blue Lake Twp.	●	●	●	●			●	●	●					●				
Casnovia Twp.	●	●	●	●			●	●	●					●				
Cedar Creek Twp.	●	●	●	●			●	●	●					●				
Dalton Twp.	●	●	●	●			●	●	●			●	●	●				
Egelston Twp.	●	●	●	●				●	●			●		●				
Fruitland Twp.	●	●	●	●				●	●			●		●				
Fruitport Twp.	●	●	●	●			●	●	●			●		●				
Holton Twp.	●	●	●	●			●	●	●			●		●				
Laketon Twp.	●	●	●	●				●	●			●		●				
Montague Twp.	●	●	●	●			●	●	●					●				
Moorland Twp.	●	●	●	●			●	●	●					●				
Muskegon Twp.	●	●	●	●	●			●	●			●	●	●				
Ravenna Twp.	●	●	●	●				●	●			●		●				
Sullivan Twp.	●	●	●	●			●	●	●					●				
White River Twp.	●	●	●	●				●	●					●				
Whitehall Twp.	●	●	●	●			●	●	●					●				

● *Action Item applicable to municipal jurisdiction*

Complete

Ongoing or In Progress

Action Pending

Revised Action Agenda

The action items highlighted in this section were selected from the list of potential hazard mitigation actions presented in Part G and are presented below as the Action Agenda for 2015-2019. The selection process was guided by criteria described in Part H. All items on this revised Action Agenda are considered to be of the highest priority. Implementation of these action items may be appropriate on the county level and / or the local level. The "List of Hazard Mitigation Actions Applicable to Governmental Units" at the end of the chapter assigns action items to appropriate jurisdictions within Muskegon County. Each action item includes the following information to help facilitate implementation:

Priority Level

All identified action items are considered priorities within this Hazard Mitigation Plan. In order to help structure implementation of the Plan, a further prioritization of high, medium, or low is assigned to each measure. This is intended to convey a sense of importance relative to the other action items from a countywide perspective.

Timeframe

Generally identifies when an action item might begin. Where appropriate, prerequisite activities are discussed.

Applicable Governmental Unit(s) / Responsible Person (s)

Identifies key players for initiating and implementing each action. Often the work will be shared by a number of individuals and agencies.

Potential Technical / Financial Assistance

Identifies common sources of technical and financial assistance. In many cases, identified parties will provide referrals to currently available or specialized assistance and / or guidance. Detail provided is not intended to be exhaustive because opportunities for assistance may come and go; such as following a disaster declaration. **A detailed listing of potential federal and state funding sources for hazard-specific measures is included in Appendix F.**

Comments

Additional details or helpful information about the action item. This feature was added for the revised edition of this plan.

Action Item 2. Contact Insurance Services Office (ISO) to request a copy of the community's Building Code Effectiveness Grading Scale (BCEGS), and work to improve the BCEGS rating through improvements to building codes and enforcement.

Priority Level: Low

Timeframe: 2015-2016.

Applicable Governmental Unit(s)/Responsible Person(s):
Local units of government.

Potential Technical/Financial Assistance Sources:
Local resources.

Comments:
A free copy of the community's BCEGS report is available upon the request of a community's chief elected official or building official. This information can be used to identify deficiencies in existing building codes and enforcement. Addressing those deficiencies can enhance the resiliency of new and rehabilitated structures.

It is known that the City of Norton Shores already engages in this action item, and the potential exists for other municipalities to do so as well.

Action Item 7. Incorporate mitigation provisions into comprehensive plans and land use plans; such as identification of acceptable land uses and densities based on consideration of flood-prone areas, soil types, topography, and etc.

Priority Level: Low

Timeframe: To be completed when land use plans are written or updated.

Applicable Governmental Unit(s)/Responsible Person(s):
Local units of government; Muskegon County (Muskegon Area Wide Plan).

Potential Technical/Financial Assistance Sources:
Local resources.

Comments:
Land use planning helps provide rationale for local rules and policies, so it is important to integrate principals of hazard mitigation into this process. Following adoption of this plan, local units of government and the county will be encouraged to consider the contents of this hazard mitigation plan when writing or updating local plans. State law in Michigan requires that master plans must be reviewed, and updated if necessary, every five years.

Action Item 9. Integrate hazard mitigation into the capital improvement planning process so that public infrastructure does not lead to development in hazard areas and so that possible set-asides for planned and engineered structural projects (berms, levees, floodwalls, detention and retention ponds, debris storage areas, culvert replacement, etc.) are considered.

Priority Level: High

Timeframe: To be completed during planning for capital improvements.

Applicable Governmental Unit(s)/Responsible Person(s):
Local units of government; Muskegon County (e.g. Road Commission, Public Works, Drain Commission, etc.).

Potential Technical/Financial Assistance Sources:
Local resources.

Comments:
Local adoption of this plan (Action Item #60) is the first step towards completing this measure. Muskegon County Emergency Services (MCES) will then promote the utilization of this plan to local governments and county departments to help coordinate hazard mitigation activities across county departments and local governments.

One benefit of integrating hazard mitigation into capital improvements planning will be that the community will have shovel-ready mitigation projects when hazard mitigation funds become available. When the time comes to implement the projects, MSP-Emergency Management and Homeland Security Division (MSP-EMHSD) and Hazard Mitigation Grant Program (HMGP) are two potential sources of technical and/or financial assistance.

Action Item 10. Incorporate hazard mitigation provisions and recommendations into local zoning ordinances and resolutions as they restrict or direct development; with consideration given to dams, floodplains, soil type and topography; and as they allow flexibility in lot sizes and locations, such as in Planned Unit Developments (PUD).

Priority Level: Medium

Timeframe: To be completed when zoning ordinances are written or updated.

Applicable Governmental Unit(s)/Responsible Person(s):
Local zoning officials.

Potential Technical/Financial Assistance Sources:
Local resources.

Comments:
Following adoption of this plan, local units of government will be encouraged to consider the contents of this plan when writing or updating local ordinances. Resources such as the IBHS suite of FORTIFIED programs can provide additional guidance for increasing the resistance of new and existing structures to hazards.

Action Item 22. Identify structural projects to channel water away from people and property (e.g. berms, dikes, levees, or floodwalls), or to improve drainage capabilities (e.g. culvert improvements, bridge modifications, spillways, relief drains, or floodgates).

Priority Level: Low

Timeframe: 2016-2017.

Applicable Governmental Unit(s)/Responsible Person(s):
Muskegon County Emergency Management (MCEM); Muskegon County Road Commission; Muskegon County Drain Commission.

Potential Technical/Financial Assistance Sources:
MSP-Emergency Management and Homeland Security Division (MSP-EMHSD); Hazard Mitigation Grant Program (HMGP).

Comments:
This plan identifies Flooding as one of the top hazard in Muskegon County. Structural projects should be considered to protect existing structures and infrastructure from this hazard. This action item is new for the 2015 Action Agenda.

Action Item 29. Encourage property owners and public facility operators to increase their property's resilience and resistance to hazards.

Priority Level: Low

Timeframe: Ongoing.

Applicable Governmental Unit(s)/Responsible Person(s):
Local elected officials; Local zoning officials; Local inspectors.

Potential Technical/Financial Assistance Sources:
MCES; MSP-EMHSD.

Comments:
Hazard mitigation concepts and strategies will be incorporated into the day-to-day activities of elected officials, zoning officials, and building inspectors; especially those activities that involve interaction with local land owners and facility operators. Local officials should refer to the Hazard Mitigation Alternatives chapter for information about potential mitigation strategies. Examples include promotion of Firewise principles for property maintenance, and proper anchoring of objects located within floodplain areas.

Action Item 35. Encourage and assist municipalities that are at risk to flooding, or that have been exposed to flooding in the past, to join the National Flood Insurance Program (NFIP) so that residents can obtain flood insurance.

Priority Level: Medium

Timeframe: Following adoption of this plan.

Applicable Governmental Unit(s)/Responsible Person(s):

MCES; Municipalities that currently do not participate in the NFIP: City of Roosevelt Park; villages of Casnovia, Fruitport, Lakewood Club and Ravenna; and townships of Blue Lake, Casnovia, Cedar Creek, Dalton, Fruitport, Holton, Montague, Moorland, Sullivan, and Whitehall.

Potential Technical/Financial Assistance Sources:
MSP-EMHSD; MDEQ NFIP Coordinator.

Comments:
All municipalities are eligible to participate in the program, so long as the minimum requirements are met. NFIP flood insurance can only be acquired in communities that participate in the program.

Action Item 38. Utilize federal programs; such as but not limited to FEMA's Pre-Disaster Mitigation Program, Flood Mitigation Assistance Program, and Hazard Mitigation Grant Program; to address community needs for hazard mitigation.

Priority Level: High

Timeframe: As funding becomes available, and especially following a disaster declaration.

Applicable Governmental Unit(s)/Responsible Person(s):
MCES; Local units of government that participate in the development and then adopt this plan.

Potential Technical/Financial Assistance Sources:
Federal Emergency Management Agency (FEMA); MSP-EMHSD.

Comments:
HMGP funding opportunities are made available following a disaster declaration. Annual funding opportunities may be made available through the PDM and FMA programs, which are nationally competitive. Refer to Appendix F for lists of potential state and federal sources of hazard mitigation funding.

Action Item 45. Regularly evaluate the effectiveness of the public warning system including the threat detection process, management system, communications links, and methods of dissemination.

Priority Level: High

Timeframe: Annually.

Applicable Governmental Unit(s)/Responsible Person(s):
MCES; Muskegon Central Dispatch.

Potential Technical/Financial Assistance Sources:
Local resources.

Comments:
Protecting public health and safety is one of the four main goals of this plan. Maintaining an effective and reliable public warning system is one of the best ways to accomplish that goal. Evaluation should consider warning for slow onset, as well as short onset hazards, new technologies, public views of the warning system and the effect this has on response to warnings (especially confusion about fire station sirens), disseminating warnings to people with "special needs", redundancies, and effective methods of risk communication. This action item is new for the 2015 Action Agenda.

Action Item 48. Maintain the "First Call" telephone emergency notification system to assure immediate warnings to Muskegon County residents or target groups of pending and existing hazards and actions they can take to protect themselves.

Priority Level: High

Timeframe: Ongoing.

Applicable Governmental Unit(s)/Responsible Person(s):
MCES; City of Norton Shores; Muskegon Township; Muskegon Central Dispatch.

Potential Technical/Financial Assistance Sources:
Local resources.

Comments:
This action item supports ongoing efforts to inform and protect the public. It may be beneficial to engage in public outreach to encourage residents to register cell phone numbers to receive emergency notifications. There is strong community support for an emergency notification system such as this. As new technologies emerge, First Call may be replaced in time.

Action Item 55. Install back-up generators, as needed for short-term relief from power failures, at critical facilities such as sewage pump stations, hospitals and medical centers, nursing home facilities, schools, shelters and government facilities.

Priority Level: Medium

Timeframe: Ongoing; as funds become available.

Applicable Governmental Unit(s)/Responsible Person(s):
MCES; Critical facility managers.

Potential Technical/Financial Assistance Sources:
MSP-EMHSD; Local resources.

Comments:
Though many facilities in Muskegon County currently have generators, the some remain in need of backup power. MCES may consider developing an inventory of the critical facilities that have back-up power or that are in need of back-up power. The County may also consider working with generator owners in the community to identify portable generators that might be available for public use during an emergency.

Action Item 59. Refine state, county, and local road and bridge maintenance / vegetation management programs to maintain visibilities, provide for living snow fences, reduce erosion, slow stormwater runoff, and so as not to undermine the structural integrity of transportation infrastructure.

Priority Level: Medium

Timeframe: Ongoing.

Applicable Governmental Unit(s)/Responsible Person(s):
MCES; Muskegon County Road Commission.

Potential Technical/Financial Assistance Sources:
MDOT; Muskegon Conservation District; Muskegon County Drain Commission.

Comments:
MCES should work through the Muskegon LEPC to identify opportunities to incorporate hazard mitigation provisions into management programs to protect new and existing infrastructure and enhance public safety.

Action Item 60. Adopt this Hazard Mitigation Plan by official resolution to assure both consideration of natural hazards and eligibility for funding through the Pre-Disaster Mitigation Program, Flood Mitigation Assistance Program, and Hazard Mitigation Grant Program.

Priority Level: High

Timeframe: Immediately following FEMA conditional approval of this plan.

Applicable Governmental Unit(s)/Responsible Person(s):
Muskegon County; Local units of government.

Potential Technical/Financial Assistance Sources:
West Michigan Shoreline Regional Development Commission (WMSRDC).

Comments:
Muskegon County Emergency Services, with assistance from WMSRDC, will facilitate local adoptions of this plan immediately following FEMA approval.

Action Item 69. Coordinate with fire departments to promote “Firewise” program recommendations and strategies to property owners, especially those within wildland/urban interface and limited access areas.

Priority Level: Medium

Timeframe: 2016.

Applicable Governmental Unit(s)/Responsible Person(s):
MCES; Local fire departments.

Potential Technical/Financial Assistance Sources:
MSU Extension.

Comments:
Muskegon County might consider developing a Community Wildfire Protection Plan, which would help identify high-risk areas that can be targeted for Firewise strategies and help qualify the county for funding to mitigate wildfire. This action item is new for the 2015 Action Agenda.

Action Item 76. Obtain and distribute available information on hazards and cost-effective mitigation actions individuals can implement (for example, Firewise pamphlets), and post-disaster repair and cleanup guidance.

Priority Level: Medium

Timeframe: Seasonally.

Applicable Governmental Unit(s)/Responsible Person(s):
MCES; Local units of government.

Potential Technical/Financial Assistance Sources:
MSP-EMHSD; FEMA; MSU Extension; NFIP; Red Cross; Salvation Army.

Comments:
Mitigation and disaster recovery information may be distributed via social media, public meetings, newsletters, etc. MCES will consider distributing such information in the days and weeks ahead of a given season; e.g. the distribution of fire safety information in the early spring.

Action Item 77. Produce and distribute local emergency preparedness and safety information to the general public and/or targeted groups (seasonal populations, floodplain residents, developers and builders, farm owners and operators, decision makers, Spanish speaking, etc.). Include local resources for information such as fire stations, local radio stations, shelters, and utilities.

Priority Level: High

Timeframe: Ongoing.

Applicable Governmental Unit(s)/Responsible Person(s):
MCES; Muskegon County Departments.

Potential Technical/Financial Assistance Sources:
HMGP; HSGP; MSP-EMHSD; Utilities.

Comments:
Many county departments are constantly implementing this action item. It is included here to support efforts that are currently in effect, and to encourage MCES to distribute pertinent information through 211, social media, public meetings, etc.

Action Item 91. Notify communities of hazard mitigation funds, as they become available, and assist them in applying for funds.

Priority Level: Medium

Timeframe: As hazard mitigation funding becomes available.

Applicable Governmental Unit(s)/Responsible Person(s):
MCES.

Potential Technical/Financial Assistance Sources:
MSP-EMHSD.

Comments:
MCES would be a resource to help facilitate awareness of state and federal funding opportunities for hazard mitigation. This action item is new for the 2015 Action Agenda.

Action Item 98. Coordinate with American Red Cross to ensure the county-wide availability of designated and accessible emergency shelters and assure facilities are inspected, certified, and have back-up power.

Priority Level: High

Timeframe: Annually.

Applicable Governmental Unit(s)/Responsible Person(s):
MCES; Communities identified in this plan as not having a community shelter designated by the American Red Cross: Cities of North Muskegon, Roosevelt Park, and Whitehall; Villages of Casnovia, Fruitport, Lakewood Club, and Ravenna; and Townships of Blue Lake, Casnovia, Cedar Creek, Holton, Montague, Moorland, Sullivan, White River, and Whitehall.

Potential Technical/Financial Assistance Sources:
American Red Cross.

Comments:
Determinations must be made as to which communities listed above are in need of a community shelter.

Action Agenda 2015-2019

List of Hazard Mitigation Actions Applicable to Governmental Units

Action Item	BCEGS	COMPREHENSIVE PLANNING	CAPITAL IMPROVEMENTS	ZONING ORDINANCES	STRUCTURAL PROJECTS	OWNER MITIGATION	NFIP	FEDERAL PROGRAMS	WARNING SYSTEM	MAINTAIN "FIRST CALL"	GENERATORS	ROAD MAINTENANCE	PLAN ADOPTION	PROMOTE FIREWISE	HAZARD AND MITIGATION INFO.	PREPAREDNESS AND SAFETY INFORMATION	FUNDING NOTIFICATIONS	EMERGENCY SHELTERS
Action Item #	2	7	9	10	22	29	35	38	45	48	55	59	60	69	76	77	91	98
Muskegon County	•	•	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•
Montague City	•	•	•	•		•		*Applicable to any local government that adopts this Hazard Management Plan*			•		•	•	•			
Muskegon Hts. City	•	•	•	•		•					•		•	•	•			
Muskegon City	•	•	•	•		•					•		•	•	•			
N. Muskegon City	•	•	•	•		•					•		•	•	•			
Norton Shores City	•	•	•	•		•				•	•		•	•	•			
Roosevelt Park City	•	•	•	•		•	•				•		•		•			
Whitehall City	•	•	•	•		•					•		•	•	•			
Casnovia Vil.	•	•	•	•		•	•				•		•		•			
Fruitport Vil.	•	•	•	•		•	•				•		•		•			
Lakewood Club Vil.	•	•	•	•		•	•				•		•		•			
Ravenna Vil.	•	•	•	•		•	•				•		•		•			
Blue Lake Twp.	•	•	•	•		•	•				•		•	•	•			
Casnovia Twp.	•	•	•	•		•	•				•		•	•	•			
Cedar Creek Twp.	•	•	•	•		•	•				•		•		•			
Dalton Twp.	•	•	•	•		•	•				•		•	•	•			
Egelston Twp.	•	•	•	•		•					•		•	•	•			
Fruitland Twp.	•	•	•	•		•					•		•		•			
Fruitport Twp.	•	•	•	•		•	•				•		•	•	•			
Holton Twp.	•	•	•	•		•	•				•		•	•	•			
Laketon Twp.	•	•	•	•		•					•		•		•			
Montague Twp.	•	•	•	•		•	•				•		•		•			
Moorland Twp.	•	•	•	•		•	•				•		•	•	•			
Muskegon Twp.	•	•	•	•		•				•	•		•	•	•			
Ravenna Twp.	•	•	•	•		•					•		•	•	•			
Sullivan Twp.	•	•	•	•		•	•				•		•		•			
White River Twp.	•	•	•	•		•					•		•		•			
Whitehall Twp.	•	•	•	•		•	•				•		•		•			

Part J

PLAN MONITORING, REVISIONS, AND INCORPORATION

Communities and plans are both dynamic entities. Communities grow and change over time. In order to be effective, plans must also grow and evolve to avoid becoming void and obsolete. Planning doesn't stop once the plan is initiated. The plan must be evaluated and updated periodically to ensure the success of the hazard mitigation program.

This section describes a monitoring system that will help in the annual Hazard Mitigation Plan evaluation and periodic update. A monitoring system also helps keep the plan running on schedule even when there are other jobs or duties to perform. Local officials wear different hats and are responsible for multiple assignments. Few have the luxury of focusing on one assignment, task or plan. Because the local community is often involved in administering numerous other programs, it is important to develop a monitoring system (e.g. project work schedule) to help remind each participant of their part in carrying out the plan, as well as when associated tasks should be completed.

Ideally, the system for plan maintenance (monitoring, evaluating, and updating the plan) would be the responsibility of a locally funded Hazard Mitigation Coordinator, with support from Muskegon County Emergency Services and the LEPC. Unfortunately, planning for such a position appears unrealistic at this time. Maintenance of this plan would therefore need to fit into existing schedule and workloads of the Emergency Services Director with assistance from the LEPC.

Monitoring

The Muskegon County Emergency Services Director would be responsible for monitoring the implementation of the Hazard Mitigation Plan at the end of each calendar year, as work schedules allow. Such monitoring would include noting the following events throughout the year: occurrence of hazards, adoption of the plan by local governments, applications for hazard mitigation funds, grant awards, and project implementation. In addition to county staff and LEPC knowledge, sources of this information would be obtained from comments submitted to the Emergency Services office or to the West Michigan Shoreline Regional Development Commission (WMSRDC). It would also be obtained from declarations of disasters and emergencies by the president and the governor and updates on NOAA and NCDC websites.

Evaluating

The Emergency Management Director would prepare and present a brief annual progress report for the LEPC at its first meeting of the year. This report would include recommendations to achieve goals and objectives of the plan, or explain the need to change them in light of new issues and circumstances. The following outline should be used to guide preparation of the report:

- A review of the goals and objectives of the plan;
- A review of disasters or emergencies that occurred during the year;
- A review of what elements or objectives of the plan were accomplished the previous year;
- A discussion of why any objectives were not reached or why implementation is behind schedule; and
- Recommendations for new projects/action items (with updated information on responsible persons, time schedules and sources of assistance) or revised objectives.

After LEPC review, the report could be submitted to the County Board of Commissioners at the direction of the LEPC. The report could also be made available to local governments and the public through the county's website, and / or the WMSRDC website. In the event that workloads prohibit the preparation of an annual report, a more streamlined version (perhaps verbal) would be presented by the Emergency Management Director to the LEPC and County Board of Commissioners.

Updating

The county would comply with the FEMA requirement that the plan be reviewed every five years and updated if necessary. This work would be done by the Emergency Management Director, with assistance from the LEPC. Projects that were completed over that time would be replaced with new ones. Priorities would be re-assessed. Development patterns would be analyzed to see if they have rendered the previous hazard analysis out-of-date. Lastly, those hazard mitigation goals, priorities and information contained in the most current edition of the Michigan Hazard Mitigation Plan would also be heavily considered during the five-year update.

The mandatory five-year review and update of the community mitigation plan is necessary because of ever-changing circumstances. Risks may change, areas may have increased or decreased risks and vulnerabilities, and therefore goals and priorities might have to be altered. There may even be new hazards that appear in that time. Evaluations of the plan should also assess how well the plan is working and if there are problems (financial, legal, coordination, etc.) with implementing the action items in the document.

While adjustments would be made throughout the process as new issues emerge and evolve, this method would ensure that the county remains on course in implementing the program.

Continued Public Involvement

In addition to the mandatory update and evaluation of the plan, there must be a process by which public involvement can continue to occur as the hazard mitigation plan is updated. Copies of the plan will be available in the Emergency Services office and at the WMSRDC. It will also be presented on the WMSRDC website, www.wmsrdc.org. The website offers an on-going opportunity to input into the plan, its implementation, and its update. All comments received by the WMSRDC will be forwarded to the Emergency Management Director who will receive all other forms of correspondence. The Emergency Services Department will also be listed as a contact point. The Emergency Services phone number is included in the Letter of Transmittal at the beginning of this document.

During the update of the plan, all methods previously used for assuring public involvement will again be considered: surveys, contacts with neighboring counties, LEPC meetings, public hearings, etc.

Incorporation into Existing Planning Mechanisms

The County's transmittal of the Hazard Mitigation Plan to local governments requests that they incorporate the document into local land use plans and zoning ordinances, as appropriate. Most communities in Muskegon County have adopted land use plans and regularly update them. According to Public Act 33 of 2008, municipal jurisdictions must notify neighboring jurisdictions, the county, the region, and any registered public utility, railroad, or other governmental entities of the municipality's intention to amend, revise, or create a totally new plan. By law, each of these entities has the opportunity to comment on local land use plans, and is encouraged to do so in order to promote more coordinated land use planning.

Appendix A:
COMMUNITY PROFILES

MUSKEGON COUNTY

1.	**major geographic features:**	- 344.9 persons per square mile - 147.3 housing units per square mile - 27 miles of Lake Michigan shoreline, Muskegon Lake, White Lake, Mona Lake - White River, Muskegon River - Manistee National Forest - Hart-Montague Bicycle Trail - Musketawa Trail
2.	**Population Concentrations**	
a.	**group homes:**	- Agape Home at Blueberry Fields, 4747 E. Mount Garfield Rd, Fruitport, MI (capacity 18) - Airline Road Home, 4752 Airline Rd, Muskegon, MI (capacity 6) - Amanda CLF, 4021 Amanda St, Muskegon, MI (capacity 6) - Annette Street Home, 2475 Annette Ave, Muskegon, MI (capacity 6) - Baker Haven Home, 2145 Baker St, Muskegon Heights, MI (capacity 6) - Benston Road Home, 7468 Whitehall Rd, Whitehall, MI (capacity 6) - Big Bear AFC Home, 1690 Sanford St, Muskegon, MI (capacity 6) - Bracey Home, 1345 Marquette Ave, Muskegon, MI (capacity 1) - Brandel AFC, 1559 S. Sheridan, Muskegon, MI (capacity 5) - Broadway Home, 2315 E. Broadway Ave, Muskegon, MI (capacity 6) - Brookmere Home, 3086 Creekview Ln, Muskegon, MI (capacity 6) - Brooks CLF, 599 S. Brooks Rd, Muskegon, MI (capacity 6) - Bush Creek Family Manor, 1126 Allice St, Whitehall, MI (capacity 3) - Bush Creek Manor, 1023 Alice St, Whitehall, MI (capacity 6) - C.M.L. Homes, 2424 Peck St, Muskegon Heights, MI (capacity 4) - Cedar Creek Personal Care 2, 8842 cedar Creek Dr, Holton, MI (capacity 12) - Cedar Creek Personal Care Home I, 8840 Cedar Creek Dr, Muskegon, MI (capacity 12) - Chestnut Fields Retirement Community, 5425 Chestnut Dr, Muskegon, MI (capacity 20) - Christian Care Senior Community, 1530 McLaughlin Ave, Muskegon, MI (capacity 105) - Clark AFC Home, 909 Ducey Ave, Muskegon, MI (capacity 5) - Clouds of Joy AFC, 2216 Baker St, Muskegon Heights, MI (capacity 5) - Country Style AFC, 6427 Blackmer Rd, Ravenna, MI (capacity 2) - Crockery Creek Elder Care, 12291 Crockery Creek, Ravenna, MI (capacity 6) - Crystal Lake Home, 7875 Whitehall Rd North, Whitehall, MI (capacity 6) - Dayspring Assisted Living Residence, 572 Lake Forest Ln, Muskegon, MI (capacity 48) - Donna’s View, 2140 Jefferson, Muskegon Heights, MI (capacity 6) - Ducey CLF, 1271 Ducey Ave, Muskegon, MI (capacity 6) - E and L AFC, 1924 Maryland Blvd, Muskegon, MI (capacity 6) - East Side Manor, 1439 East St, Muskegon, MI (capacity 4) - FA-HO-LO Family, 1585 S. Wolf Lake Rd, Muskegon, MI (capacity 8) - Families Manor, 2330 Riverwood Dr, Twin Lake, MI (capacity 6) - Friendly Haven, 7665 E. Ryerson Rd, Holton, MI (capacity 4) - Gibson Garfield East, 4791 Mount Garfield Rd, Fruitport, MI (capacity 12) - Glenside Manor AFC, 2479 Hadden St, Muskegon, MI (capacity 6) - Golden Years Personal Care Home, 6274 MacCarthur Rd, Muskegon, MI (capacity 12) - Hansen Safe, 1635 Hansen St, North Muskegon, MI (capacity 4) - Hume Home of Muskegon, 1244 W. Southern Ave, Muskegon, MI (capacity 34) - Indian Bay Residence, 8770 Indian Bay Rd, Montague, MI (capacity 10) - J.B.C. Home, 2508 McIlwraith St, Muskegon Heights, MI (capacity 6) - Jefferson House AFC, 1311 Jefferson St, Muskegon, MI (capacity 6) - Joseph’s House, 866 Forest Park Rd, Muskegon, MI (capacity 6)

		- Kelly's Kare AFC, 7888 Whitehall Rd, Whitehall, MI (capacity 6) - Kenneth L. Brinks Residence, 155 E. Apple Ave (capacity 16) - Krzykwa AFC, 305 E. Colby, Whitehall, MI (capacity 4) - Lakeside Manor, 2314 Harrison Ave, Muskegon, MI (capacity 6) - Lakeview, 403 S. Mears Ave, Whitehall, MI (capacity 12) - Lawrence Home, 1228 Lawrence Ave, Muskegon, MI (capacity 6) - Light House Retreat, 1357 Terrace, Muskegon, MI (capacity 5) - Lightfoot House, 381 Houston Ave, Muskegon, MI (capacity 16) - Lilac Street Home, 1901 Lilac St, Muskegon, MI (capacity 6) - Little Bear AFC Home, 1698 Sanford St, Muskegon, MI (capacity 6) - Luthern Social Services, 1635 Hansen - Marcoux Home, 1465 Marcoux Ave, Muskegon, MI (capacity 6) - Mary's House, 862 Forest Park Rd, Muskegon, MI (capacity 6) - Mcintyre Home, 2760 Mararebacah Ln, Muskegon, MI (capacity 3) - Morning Glory AFC, 2325 Peck St, Muskegon Heights, MI (capacity 6) - Morris Manor, 23 Strong Ave, Muskegon, MI (capacity 6) - Morton Terrace AFC, 3929 Hess St, Muskegon, MI (capacity 12) - Muskegon Adult Foster Care Home, 309 E. Hackley Ave, Muskegon Heights, MI (capacity 12) - MZ DZ, 501 S Sheridan Ave, Muskegon, MI (capacity 4) - Northcrest Assisted Living Center, 2650 Ruddiman St, North Muskegon, MI (capacity 86) - Northridge, 788 Marquette Ave, Muskegon, MI (capacity 7) - Oak Creek Home, 137 W. Holton Road, Whitehall, MI (capacity 6) - Oxford Circle, 3293 Orshal Rd, Whitehall, MI (capacity 4) - Palmer Adult Foster Care Home, 1916 Continental St, Muskegon, MI (capacity 4) - Park Place Personal Care, 1383 Park St, Muskegon, MI (capacity 6) - Parkside Home, 1443 Quarterline Rd, Muskegon, MI (capacity 7) - Patti's Place, 2255 Pillon Rd, Twin Lake, MI (capacity 4) - Paul's Place AFC, 3475 E Tyler, Twin Lake, MI (capacity 6) - Pauley AFC, 480 Apple Ave, Muskegon, MI (capacity 6) - Pinewood Retirement Home, 3234 Nestrom, Whitehall, MI (capacity 6) - Pioneer House, 1390 Brusse Ave, Muskegon, MI (capacity 12) - Plan B Adult Foster Care, Muskegon, MI (capacity 6) - Priority AFC, 6832 Post Rd, Montague, MI (capacity 3) - Rescued Dreams, 2812 Sixth St, Muskegon Heights, MI (capacity 6) - River St Home, 620 E River St, Whitehall, MI (capacity 6) - Riverwood, 2743 S Riverwood, Twin Lake, MI (capacity 6) - Ruddiman Home, 224 Ruddiman, North Muskegon, MI (capacity 6) - Sanctuary at the Oaks #1, 1740 Village Dr 1st Floor, Muskegon, MI (capacity 20) - Sanctuary at the Oaks #2, 1740 Village Dr 2nd Floor, Muskegon, MI (capacity 20) - Seminole Shores Assisted Living Cntr, 850 Seminole Rd, Muskegon, MI (capacity 129) - Shaffer House AFC, 171 Dennis St, Fruitport, MI (capacity 6) - Sheridan AFC, 4144 Sheridan Dr, Muskegon, MI (capacity 6) - Skyline Home, 3297 Orshal Rd, Whitehall, MI (capacity 4) - Slocum Street Home, 817 Slocum St, Whitehall, MI (capacity 6) - Sophia Street Home, 814 Sophia St, Whitehall, MI (capacity 3) - Spring Street Manor AFC, 121 W Spring St, Whitehall, MI (capacity 5) - Stacy's AFC, 2648 Ninth Street, Muskegon Heights, MI (capacity 5) - Sternberg Road Home, 897 W Sternberg Rd, Muskegon, MI (capacity 6) - Terra Nova, 2745 W White Lake Dr, Whitehall, MI (capacity 3) - Terrace Manor, 1148 Terrace St, Muskegon, MI (capacity 12) - The Agape Home, 4445 S Brooks Rd, Muskegon, MI (capacity 20) - The Cove, 1776 Vulcan St, Muskegon, MI (capacity 80) - Virginia's House, 391 Whispering Oaks Dr, Muskegon, MI (capacity 5) - Walker House AFC, 125 Delaware, Muskegon, MI (capacity 15)

		- Walker Road Home, 6646 Walker Rd, Fruitport, MI (capacity 6) - West Fruitport Home, 2289 W. Fruitport Road, Spring Lake, MI (capacity 6) - White Lake Assisted Living, 6827 Whitehall Rd, Whitehall, MI (capacity 38) - Winicki AFC, 2646 LeBouef St, Norton Shores, MI (capacity 6) - Wood Ridge, 1231 Horton Rd, North Muskegon, MI (capacity 3)
b.	**large apartment buildings:**	- Amazon Apartments, 550 W Western Ave, Muskegon, MI (129 units) - Barclay Senior Village, 2081 Barclay St, Muskegon, MI (70 units) - Barclay Townhouses, 2081 Barclay St, Muskegon, MI (54 units) - Barclay Village, 2081 Barclay St, Muskegon, MI (92 units) - Bayview Tower, 864 Spring St, Muskegon, MI (200 senior units) - Bear Creek Apts., 91 E Giles Rd, Muskegon, MI (38 units) - Beverly Hills Apartments, 415 Mitzi St, North Muskegon, MI (138 units) - Blue Lake Residences LP, 7190 Progress Dr, Twin Lake, MI (68 units) - Brittany Hills Apartments, 1269 Witham Apt G, North Muskegon, MI - Catalina Shores, 5970 Avalon Dr, Muskegon, MI (88 units) - Channel View Apartments, 8050 Cook St, Montague, MI (56 units) - Chesapeake Landing Apartments, 2690 Chesapeake Dr, Muskegon, MI (88 units) - Christian Manor, 1480 McLauglin Ave, Muskegon, MI (42 units) - Columbia Court, 65 E. Columbia Ave, Muskegon Heights, MI (89 units) - Countryside Manor, 3199 S Slocum Rd, Ravenna, MI (11 senior units) - Creekside, 3796 S Ravenna Rd, Ravenna, MI (32 units) - East Park Manor, 615 E. Hovey Ave, Muskegon Heights, MI (200 units) - East Side Court, 615 E. Hovey Ave, Muskegon Heights, MI (50 units) - Eastwood Village Apartments, 2243 E. Apple Ave, Muskegon, MI (69 units) - Harbour Pointe Apartments, 8673 Ferry St, Montague, MI (34 units) - Hartford Terrace, 1080 Terrace St, Muskegon, MI (160 units) - Hidden Cove Apartments, 3975 Grand Haven Rd, Norton Shores, MI (54 units) - Jefferson Towers, 1077 Jefferson St, Muskegon, MI (156 senior units) - Lake Forest Apartments, 581 Lake Forest Ln, Norton Shores, MI (252 units) - M.A. Houston Towers, 3020 Peck St, Muskegon Heights, MI (52 senior units) - Mona Shores Apartments, 3711 Henry St, Muskegon, MI (36 units) - Muskegon Townhoueses, 919 Marquette Ave, Muskegon, MI (213 units) - Nelson Place, 350 Houston Ave, Muskegon, MI (101 units) - Roosevelt Park Apartments, 3224 Maple Grove, Muskegon, MI (48 units) - Park Terrace, 1290 W Hackley Ave, Muskegon, MI (150 units) - Park Woods Apts, 924 Shonat St, Muskegon, MI (100 senior units) - Pine Grove Manor, 1764 E. Apple Ave, Muskegon, MI (172 senior units) - Quail Meadow, 725 Meadow Ln, Muskegon, MI (120 units) - Renaissance Place Apartments, 570 W. Clay Ave, Muskegon, MI (24 senior units) - Royale Glen Townhomes, 1085 Royale Glen Dr, Muskegon, MI (78 units) - Shoreline Landing, 959 Flette St, Norton Shores, MI (210 units) - Shawl Apartments, 225 S Hall St, Whitehall, MI (40 units) - Shawl II, Senior Housing of Montague, 8363 Cook St, Montague, MI (25 units) - The Reserve at Norton Shores, 1523 Norton Shores Ln, Norton Shores, MI (150 units) - The Hamptons of Norton Shores, 909 Hamptons Ct, Muskegon, MI (104 units) - The Shores of Roosevelt Park, 3050 Maple Grove Rd, Muskegon, MI (302 units) - The Village at Park Terrace, 1350 W. Hackley Ave, Muskegon, MI (122 senior units) - Tiffany Woods Apartments, 3298 Roosevelt Rd, Muskegon, MI (302 units) - Trinity Village I, 2250 Valley St, Muskegon, MI (30 units) - Trinity Village II, 2250 Valley St, Muskegon, MI (30 units) - Trinity Manor, 347 Shonat St, Muskegon, MI (45 senior units) - Village at Jackson Hill, 557 McClaren Ave, Muskegon, MI (50 units) - Wells Villa, 2818 Woodcliffe Dr, Muskegon, MI (104 units) - West Shore Apartments, 1201 E. Colby Rd, Whitehall, MI (48 units) - Whitehall Apartments, 1123 E Colby St, Whitehall, MI (48 units)

c.	**schools:**	- Baker College, 1903 Marquette Ave (4,467 students, 500 full & part-time employees)
		- Cavalry Christian School, 5873 Kendra Rd (200 students, 30 staff)
		- Fruitport Community Schools
		  - Fruitport Community High School, 357 N 6^{th} Ave (894 students)
		  - Fruitport Middle School, 3113 Pontaluna (703 students)
		  - Beach Elementary, 2741 Heights Ravenna (390 students)
		  - Edgewood Elementary, 3255 Pontaluna Rd (558 students)
		  - Shettler Elementary, 2187 Shettler Rd (396 students)
		- Holton Public Schools
		  - Holton High School, 6477 Syers Rd (265 students, 28 staff)
		  - Holton Middle School, 6245 Syers Rd (211 students, 15 staff)
		  - Holton Elementary, 6500 4^{th} St (389 students, 45 staff)
		- Mona Shores Public Schools (2005 estimates)
		  - Mona Shores High School, 1121 Seminole Rd (1,315 students, 72 staff)
		  - Mona Shores Middle School, 1700 Woodside Rd (884 students, 47 staff)
		  - Cambell Elementary, 1355 Greenwhich Rd (380 students, 26 staff)
		  - Churchill Elementary, 961 Porter Rd (360 students, 20 staff)
		  - Lincoln Park Elementary, 2951 Leon St (445 students, 24 staff)
		  - Ross Park Elementary, 121 Randall Rd (395 students, 28 staff)
		- Montague Public Schools
		  - Montague Area High School, 4900 Stanton Blvd (373 students, 40 staff)
		  - R.R. Oehrli Elementary, 4859 Knudsen St (604 students, 60 staff)
		  - Nellie B Chisholm Middle School, 4700 Stanton Blvd (345 students, 38 staff)
		  - Montague Area Childhood Center, 5161 Dicey St (175 students, 24 staff)
		- Muskegon Area Intermediate School District (MAISD)
		  - Wesley School, 915 Wesley Ave (200 students, 100 staff)
		  - Career Tech Center, 200 Harvey St (700 students, 45 staff)
		- Muskegon Catholic High School & Middle School, 1145 W Laketon Ave (459 students, 40 staff)
		- Muskegon Christian Elementary School, 1220 Eastgate St (233 students, 35 staff)
		- Muskegon Community College, 221 S Quarterline Rd (5,067 students, 544 full & part-time employees)
		- Muskegon Heights Public School Academy System
		  - Muskegon Heights High School, 2441 Sanford St (300 estimated students)
		  - Muskegon Heights Middle School, 55 E Sherman St (300 estimated students)
		  - Edgewood Elementary School, 3028 Howden St (300 estimated students)
		  - M.L. King Jr Elementary School, 600 E Barney Ave (300 estimated students)
		- Muskegon Public Schools
		  - Muskegon High School, 80 W Southern Ave (1000 students, 114 staff)
		  - Muskegon Middle School, 1150 Amity Ave (618 students, 64 staff)
		  - Lakeside Elementary, 2312 Denmark St (594 students, 67 staff)
		  - Marquette Elementary, 480 Bennett St (584 students, 84 staff)
		  - Moon Elementary, 1826 Hoyt (393 students, 49 staff)
		  - Nelson Elementary School, 550 W Grand Ave (529 students, 82 staff)
		  - Oakview Elementary, 1420 Madison St (539 students, 61 staff)
		  - Muskegon Community Education, 571 Apple Ave (97 students, 32 staff)
		- North Muskegon Public Schools
		  - North Muskegon High School, 1600 Mills Ave (276 students, 23 staff)
		  - North Muskegon Middle School, 1600 Mills Ave (223 students, 23 staff)
		  - North Muskegon Elementary, 1600 Mills Ave (498 students, 29 staff)
		- Oakridge Public Schools
		  - Oakridge High School, 5493 Hall Rd (493 students, 51 staff)
		  - Oakridge Middle School, 251 S Wolf Lake Rd (296 students, 36 staff)
		  - Oakridge Upper Elementary, 481 S Wolf Lake Rd (471 students, 42 staff)
		  - Oakridge Lower Elementary, 5290 Bryn Mawr Pl (660 students, 61 staff)

		- Oakridge Alternative Education (56 students, 7 staff) - Orchard View Schools - Orchard View High School, 16 N Quarterline Rd (657 students, 58 staff) - Orchard View Middle School, 35 S Sheridan Rd (560 students, 53 staff) - Orchard View Elementary, 2310 Marquette (747 students, 45 staff) - Orchard View Early Elementary, 2820 MacArthur Rd (422 students, 57 staff) - Ravenna Public Schools - Ravenna High School, 2700 S Ravenna Rd (342 students, 23 staff) - Ravenna Middle School, 2766 S Ravenna Rd (345 students, 26 staff) - Beechnau Elementary School, 12322 Stafford St (390 students, 41 staff) - Reeths-Puffer Schools - Reeths-Puffer High School, 1545 N Roberts Rd (1,178 students, 92 staff) - Reeths-Puffer Middle School, 1911 W Giles Rd (645 students, 46 staff) - Reeths-Puffer Elementary, 874 E Giles Rd (487 students, 39 staff) - Central Elementary, 1807 W Giles Rd (413 students, 38 staff) - McMillan Elementary, 2885 Hyde Park Rd (200 students, 26 staff) - Pennsylvania Elementary School, 2500 Pennsylvania (38 students, 2 staff) - Twin Lake Elementary, 3175 5th St (269 students, 25 staff) - Reeths-Puffer Intermediate School, 1500 N Getty Rd (577 students, 46 staff) - Three Oaks Academy, 1212 Kingsley St (325 students, 35 staff) - Timberland Charter Academy, 2574 McLaughlin Ave (500 students, 54 staff) - Western Michigan Christan High School, 455 E Ellis Rd (330 students, 48 staff) - Whitehall District Schools - Whitehall High School, 3100 White Lake Drive (640 students, 50 staff) - Whitehall Middle School, 401 S Elizabeth St (455 students, 40 staff) - Ealy Elementary, 425 E Sophia St (455 students, 40 staff) - Shoreline Elementary, 205 Market St (500 students, 50 staff)
d.	**childcare facilities:**	**Refer to individual city, village and township profiles**
e.	**large office buildings:**	- Comerica Building, 801 W Norton - Michael E. Kobza Hall of Justice, 990 Terrace St. - Park Row Mall Tower, 950 W. Norton - Terrace Plaza, 316 Morris Ave.
f.	**other:** (such as stadiums, concert halls, amusement parks, fairgrounds, correctional facilities, nursing homes, other special populations or large crowd assembly areas)	**Refer to individual city, village and township profiles**
g.	**major employers:**	- Mercy Health Partners (3,657 employees) - Alcoa Howmet, 1 Misco Drive, Whitehall, MI (2,060 employees) - County of Muskegon, 990 Terrace St, Muskegon, MI (1,028 employees) - Muskegon Public Schools, 349 Terrace St, Muskegon, MI (941 employees) - Meijer (866 employees) - Target Stores, 5057 Harvey, Norton Shores, MI (125 employees) - ADAC Automotovie, 2050 Port City Blvd, Muskegon, MI (750 employees) - G.E. Aviation, 2034 Latimer Dr, Muskegon, MI (553 employees) - G.E. Aviation, 6060 Norton Center Dr, Norton Shores, MI (322 employees) - Port City Group, 1985 E Laketon Ave, Muskegon, MI (493 employees) - Knoll, 2800 Estes St, Norton Shores, MI (403 employees) - L-3 Combat Propulsion Systems, 76 S Getty St, Muskegon, MI (380 employees) - Eagle Alloy, 5142 Evanston Ave, Muskegon, MI (361 employees) - SAF Holland, 1950 Industrial Blvd, Muskegon, MI (330 employees) - Kautex-CWC Textron, 1085 W Sherman Blvd, Muskegon, MI (280 employees) - Diversified Machine Inc, 5353 Wilcox St, Montague, MI (270 employees)

		- Hines Corporation, 1218 E Pontaluna Rd, Norton Shores, MI (270 employees) - Hilite International, 2001 Peach St, Whitehall, MI (250 employees) - Structural Concepts, 888 E Porter Rd, Norton Shores, MI (245 employees) - Metal Technologies, 3800 Adams Rd, Ravenna, MI (220 employees) - Muskegon Community College, 221 S Quarterline Rd, Muskegon, MI (211 employees) - Sun Chemical, 5025 Evanston Ave, Muskegon, MI (182 employees) - Brunswick, 525 W Laketon Ave, Muskegon, MI (175 employees) - Kaydon, 2860 McCraken St, Norton Shores, MI (175 employees) - Cannon Muskegon, 2875 Lincoln St, Norton Shores, MI (170 employees) - Coles, 1188 Lakeshore Dr, Muskegon, MI (147 employees) - Baker College, 1903 Marquette Ave, Muskegon, MI (143 employees) - ACEMCO, 7297 Enterprise Dr, Spring Lake, MI (125 employees) - TGW Ermanco, 5566 Grand Haven Rd, Muskegon, MI (124 employees) - Mastertage International, 9751 U.S. 31 Business, Montague, MI (120 employees) - Michigan Spring & Stamping, 2700 Wickham St, Muskegon, MI (115 employees) - Michigan's Adventure, 4750 Whitehall Rd, Muskegon, MI
3.	**Population Shifts**	
a.	**daily:**	- 67,269 commute to work with an average commuting time of 20.8 minutes - 36,376 school-aged children
b.	**seasonal:**	- 73,561 total housing units: 65,616 occupied/7,945 vacant - Of the vacant, 2,004 (25.2%) are for seasonal, recreational, or occasional use
4.	**Important or Critical Public and Private Facilities**	
a.	**police precincts:**	- Montague Police Department, 5085 Wilcox St - City of Muskegon Police Department, 980 Jefferson St - Muskegon Central Dispatch, 770 Terrace St - Muskegon County Sheriff Department, 25 W Walton Ave - Muskegon Heights Police Department, 2715 Baker St - North Muskegon Police Department, 1114 Ruddiman Dr - Norton Shores Police Department, 4814 Henry St - Roosevelt Park Police Department, 900 Oak Ridge Rd - Whitehall Police Department, 405 E Colby St - Egelston Township Police Department, 5380 E Apple Ave - Muskegon Township Police Department, 1990 E Apple Ave
b.	**fire stations:**	- Montague Fire Department, 8660 Water St - Muskegon Fire Department, 770 Terrace St - Marquette Station (Muskegon FD), 1477 Marquette Ave - Robinson Station (Muskegon FD), 1836 Robinson St - Muskegon Heights Fire Department, 2715 Baker St - North Muskegon Fire Department, 1102 Ruddiman Dr - Norton Shores Fire Station #1, 1577 Seminole Rd - Norton Shore Fire Station #2, 3920 Airline Rd - Norton Shores Fire Station #3, 1100 E Pontaluna - Whitehall Fire Department- White Lake Fire Authority, 115 S Baldwin St - Blue Lake Township Fire Department, 1491 Owasippe Rd - Blue Lake Fire Department #2, 796 White Lake Dr - Casnovia Township Fire Department, 17569 Bailey Rd - DNR Muskegon Field Office, 7550 E Messinger Rd - Dalton Township Fire Department, 1650 E Riley Thompson Rd - Egelston Township Fire Deparment, 5380 E Apple Ave - Fruitport Township Fire Department (2 stations), 3368 Black Creek Rd., 5815 Airline Rd

		- Holton Fire Department, 6590 Holton-Whitehall Rd - Moorland Township Fire Department, 12416 E Apple Ave - Muskegon Township Fire Department, 1117 S Walker Rd - Muskegon Township Fire Department #2, 1699 N Getty St - Ravenna Area Fire Department, 3763 Blackmer Rd
c.	**public works yards:**	- Dalton Maintenance, 1618 E. Riley Thompson - Department of Public Works, 990 Terrace St. (Muskegon) - Department of Public Works, 2113 Lake Ave.(North Muskegon) - Montague Maintenance Garage, 4976 Bowen St. - Muskegon Public Works and Utility Department, 1350 E. Keating Ave. - Muskegon Township Highway Department, 103 S. Quarterline - Norton Shores Public Works Garage, 85 E. Mount Garfield Rd.
d.	**pumping stations:**	- Seven stations across county
e.	**community shelters:**	- American Red Cross, 313 W. Webster, Muskegon, MI - Bethesda Baptist Church, 575 Getty, Muskegon, MI - Bluffton Elementary School, 1875 Waterworks Rd, Muskegon, MI - Bunker Middle School, 2312 Denmark St, Muskegon, MI - Central United Methodist Church, 1011 2nd St, Muskegon, MI - Christ Temple Apostolic Church, 412 E Sherman Blvd, Muskegon, MI - Dr. Martin Luther Lutheran Church, 1860 E Hile Rd, Muskegon, MI - Fellowship Reformed Church, 4200 E Apple Ave, Muskegon, MI - First Congregational Church, 1201 Jefferson St, Muskegon, MI - Forest Park Covenant Church, 3815 Henry St, Muskegon, MI - Fruitland Evangelical Covenant Church, 4283 Weber Rd, Whitehall, MI - Greater Muskegon Catholic High School, 1145 E Laketon Ave, Muskegon, MI - Holy Trinity Church of God in Christ, 2140 Valley St, Muskegon, MI - Lakeside Baptist Church, 2250 Denmark, Muskegon, MI - Marquette Elementary School, 480 Bennett St, Muskegon, MI - McMillan Elementary, 2885 Hyde Park Rd, Muskegon, MI - Montague High School, 4900 Stanton Blvd, Montague, MI - Muskegon Community College, 221 S Quarterline Rd, Muskegon, MI - Muskegon High School, 80 W Southern Ave, Muskegon, MI - Nelson School, 550 W Grand Ave, Muskegon, MI - Oakview School, 1420 Madison St, Muskegon, MI - Ravenna SR High School, 2766 S Ravenna Rd, Ravenna, MI - Reeths-Puffer High School, 1545 N Roberts, Muskegon, MI - Reeths-Puffer Intermediate School, 1500 N Getty St, Muskegon, MI - Reeths-Puffer Middle School, 1911 W Giles Rd, Muskegon, MI - Steele Middle School, 1150 Amity Ave, Muskegon, MI - St Gregory's Episcopal, 1200 Seminole Rd, Muskegon, MI - St Luke's Lutheran Church, 1655 W. Norton Ave, Muskegon, MI - St Paul's Episcopal Church, 1006 Third St, Muskegon, MI - Torrent House, 315 W Webster Ave, Muskegon, MI - Western Michigan Christian High School, 455 Ellis Rd, Muskegon, MI - YMCA, 900 W Western, Muskegon, MI
f.	**medical facilities, hospitals:**	- Accessible Health Center Urgent, 4478 Dowling St - Mercy Health Partners Hackley Campus, 1700 Clinton St (186 beds) - Mercy General Health Partners, 1500 E Sherman Blvd, 1700 Oak Ave (196 beds) - Community Mental Health of Muskegon County -New mental health center, 376 Apple Ave - Kenneth L. Brinks Residence, 155 E Apple Ave - Lifeskills, 97 E Apple Ave - Club Interaction, 1470 Peck St

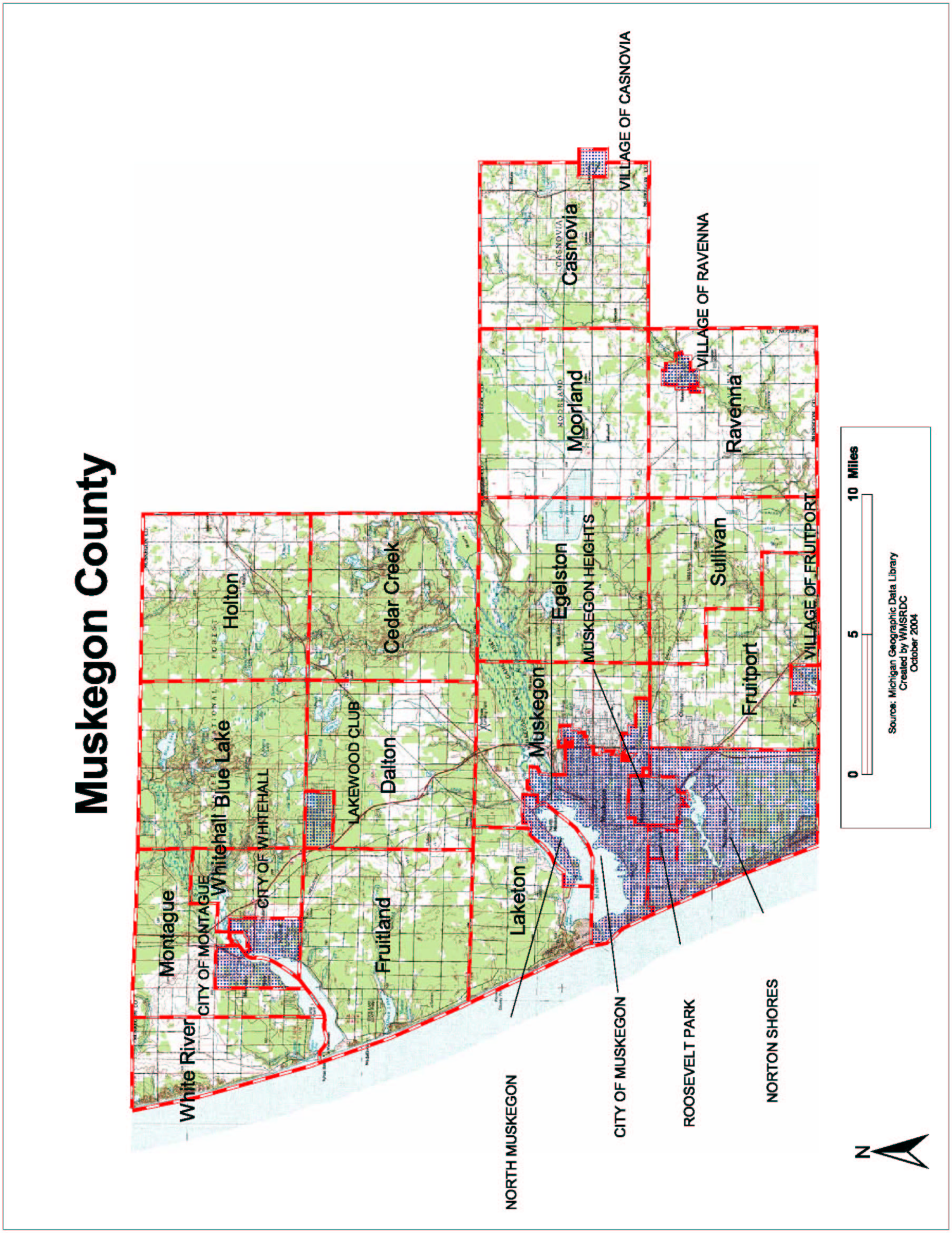
		- Wesley/Roberts Center, 1175 Wesley Ave - Norton Redi-Med, 747 W Norton Ave - Mercy Health Partners – Lakes Village, 6401 Prairie St - Lakeshore Medical Associates PC, 905 E Colby St - Community Mental Health of Muskegon County Whithall Adult Activity Center, 511 E Colby St - Pro Med Ambulance, 965 Fork St - White Lake Ambulance Authority, 119 S Baldwin St
g.	**historic sites:**	**Refer to individual city, village and township profiles**
h.	**other:** (i.e., government buildings, record center, major construction companies, warehouses, demolition companies, heavy equipment rental, emergency equipment and vehicle storage)	**Refer to individual city, village and township profiles**
5.	**Vital or Critical Infrastructure**	
a.	**roads, railroads, and bridges:**	- I-96 - US-31 - State Highways: M-37, M-46, M-120 - County Roads: B-15, B-23, B-31, B-35, B-72, B-86 - Michigan Shore Railroad - Bridges: US-31 over White River; US-31 over Muskegon River; M-120 over Muskegon River; Railroad over Muskegon River; Henry St. over Mona Lake; Lake Harbor Rd. over Mona Lake
b.	**dams, power stations, water treatment plants, sanitary lift stations, etc.**	- Cleveland Lake Dam (Cleveland Creek), Brown's Pond Dam (Sand Creek), Little Black Lake Dam, Mill Pond Dam (Mill Pond Creek), Muskegon Wastewater Lagoon Dam (Black and Mosquito Creeks), Silver Creek Pond Dam (Silver Creek) - Power Transmission Line (Casnovia Twp, Cedar Creek Twp, City of Montague, City of Muskegon, City of North Muskegon, Dalton Twp, Egelston Twp, Fruitland Twp, Holton Twp, Montague Twp, Moorland Twp, Muskegon Twp, Ravenna Twp, Sullivan Twp, Village of Lakewood Club, White River Twp, Whitehall Twp) - B.C. Cobb Gas & Coal Generating Plant, 101 SR-120 - City of Muskegon Water and Sewer Maintenance, 1350 E. Keating Ave. - City of Muskegon Water Filtration Plant, 1900 Beach St. - City of Muskegon Heights Water Filtration, 2323 Seminole Rd. - City of Whitehall Water and Sewer - Egelston Township Sewer and Maintenance, 5360 E. Apple Ave. - Fruitport Township Water Department, 6543 Airline Rd - Fruitport Township Sewer Department, 2810 E. Mt. Garfield - Muskegon County Solid Waste Management, 9366 E. Apple Ave. - Muskegon County Wastewater Management - Metro Site, 8301 White Rd. - Muskegon Heights Water and Sewer - Sixteen Sanitary Lift Stations in the county
c.	**other** (i.e. airports, pipelines, bus terminals, train stations, military bases, marine passenger ferry services)	- Natural Gas Pipelines (Blue Lake Twp, Cedar Creek Twp, Dalton Twp, Egelston Twp, Holton Twp, Sullivan Twp, Montague Twp, Moorland Twp, Whitehall Twp) - Oil Pipeline (City of Muskegon, City of Muskegon Heights, City of North Muskegon, City of Norton Shores, City of Roosevelt Park, Fruitport Township, Sullivan Township - Greyhound Bus Terminal, 351 Morris Ave. - Landing Strip, Jensen Rd. and Cloverville Rd. - Midget Private Airport, 4821 Cady Rd.

		- Muskegon Area Transit System Terminal, 2624 Morris Ave - Muskegon County Airport, 99 Sinclair Dr. - Northside Airport, 2151 River Rd. - Ottiger Airport, 10770 Sikkenga Rd. - United States Coast Guard Air Facility, 689 Airport Rd. - United States Coast Guard Station, 1555 Beach St. - United States Army Reserve Center, 1430 Parslow Dr.

6.	**Socio-Economic Profile of Sector**		
a.	**total population (night):**		172,188
b.	**peak population (seasonal):**		177,258
c.	**percent over 65:**		13.6
d.	**percent under 18:**		24.8
e.	**percent that are homeowners:**		75.1
f.	**percent below poverty level:**		14.5
g.	**percent with disability or mobility limitation:**		22.3
h.	**estimated property insurance coverage:** **(Real and Personal Equalized Valuations)**	Agricultural: Commercial: Industrial: Residential: Utility (Personal): Total:	$115,088,300 $752,802,200 $238,909,000 $3,182,341,250 $457,344,700 $4,746,485,450
i.	**flood insurance coverage:**	Total Losses since 01/01/78: Total Payments since 01/01/78: Policies In-Force: Total Insurance In-Force:	90 $349,483 170 33,303,000
j.	**location of floodplains:**	**Refer to individual city, village and township profiles**	

7.	**Emergency Warning System Coverage**	
a.	**siren locations and/or description of warning system:**	- Webster Well, 8660 Water St, Montague - Scharmer Water Tower, 8195 Scharmer Dr, Montague - Muskegon Heights Fire Department, 2715 Baker St, Muskegon Heights - Muskegon County Airport, 115 Sinclair Dr - Siren in 400 Block of S Warner St, Whitehall - Siren at Benston & S Division St, Whitehall - Siren in 200 Block of E Colby St, Whitehall - Siren at Kenwood & Auburn Rd, Lakewood Club - Siren at 1491 Owasippe Rd, Blue Lake
b.	**percent of population covered by warning sirens or system:**	- One mile radius

(Note: Map showing warning siren locations and approximate system coverage is contained in Part D.)


Muskegon County
White River
Montague
CITY OF MONTAGUE
Whitehall
CITY OF WHITEHALL
Blue Lake
Holton
Cedar Creek
Dalton
LAKEWOOD CLUB
Fruitland
Laketon
Muskegon
Egelston
MUSKEGON HEIGHTS
Moorland
Casnovia
VILLAGE OF CASNOVIA
VILLAGE OF RAVENNA
Ravenna
Sullivan
Fruitport
VILLAGE OF FRUITPORT
NORTH MUSKEGON
CITY OF MUSKEGON
ROOSEVELT PARK
NORTON SHORES
0
5
10 Miles
Source: Michigan Geographic Data Library
Created by WMSRDC
October 2004
N

CITY OF MONTAGUE

1.	**major geographic features:**	- 922.3 persons per square mile - 461.7 housing units per square mile - Moderate dense residential area, light commercial - White Lake - 2 to 4 small creeks - Hart-Montague Bicycle Trail
2.	**Population Concentrations**	
a.	**group homes:**	- None Identified
b.	**large apartment buildings:**	- Channel View Apartments, 8050 Cook St (54 family units) - Harbour Pointe, 8673 Ferry St (34 elderly units) - Senior Housing Association of White Lake II, 8363 Cook (25 elderly units)
c.	**schools:**	- Montague Area High School, 4900 Stanton Blvd (373 students, 40 staff) - Nellie B. Chisholm Middle School (Montague Area Schools), 4700 Stanton Blvd (345 students, 38 staff) - R. R. Oehrli Elementary (Montague Area Schools), 4859 Knudsen St (604 students, 24 staff)
d.	**childcare facilities:**	- Janet Hams, 8543 Old Channel Trail (capacity 12) - Good Shepherd Preschool, St. James Church, 8945 Stebbins Rd (capacity 24) - Montague Kid's Stop, 4859 Knudsen (capacity 50) - Montague Area Childhood Center, 9151 Dicey (capacity 82)
e.	**large office buildings:**	- See 4.h.
f.	**other:** (such as stadiums, concert halls, amusement parks, fairgrounds, correctional facilities, nursing homes, other special populations or large crowd assembly areas)	- Montague High School Football Stadium, 4900 Stanton Blvd - Ellenwood Landing Marina, 8560 Ellenwood Dr. (187 seasonal and 20 transient slips) - Harbor Hill Landing, 8166 Old Channel Trail (18 seasonal slips) - Maple Beach Yacht Club, 4770 Goodrich St (66 slips) - Little Harbor Yacht Club, 4650 Goodrich St (84 seasonal slips) - Trailway Campground, 4540 Dowling St (55 sites) - Montague City Museum, Church St and Meade St (summer weekends) - Montague Mountain Inn, 9075 Water St (7 rooms) - Weathervane Inn, 4527 Dowling St (23 rooms) - Montague Farmers Market, Water & Church St (Saturdays-May, then every Wendsday & Saturday – Labor Day) - Montague 4th of July Parade & Fireworks - White Lake Community Music Shell, Launch Ramp Rd (summer concerts)
g.	**major employers:**	- Diversified Machine Inc, 5353 Wilcox St (270 employees)
3.	**Population Shifts**	
a.	**daily:**	- 865 commute with an average commuting time of 21.3 minutes - 494 school-aged children
b.	**seasonal:**	- 1,182 total housing units: 1,006 occupied/176 vacant - Of the vacant, 92 (52.3%) are seasonal recreational or occasional use

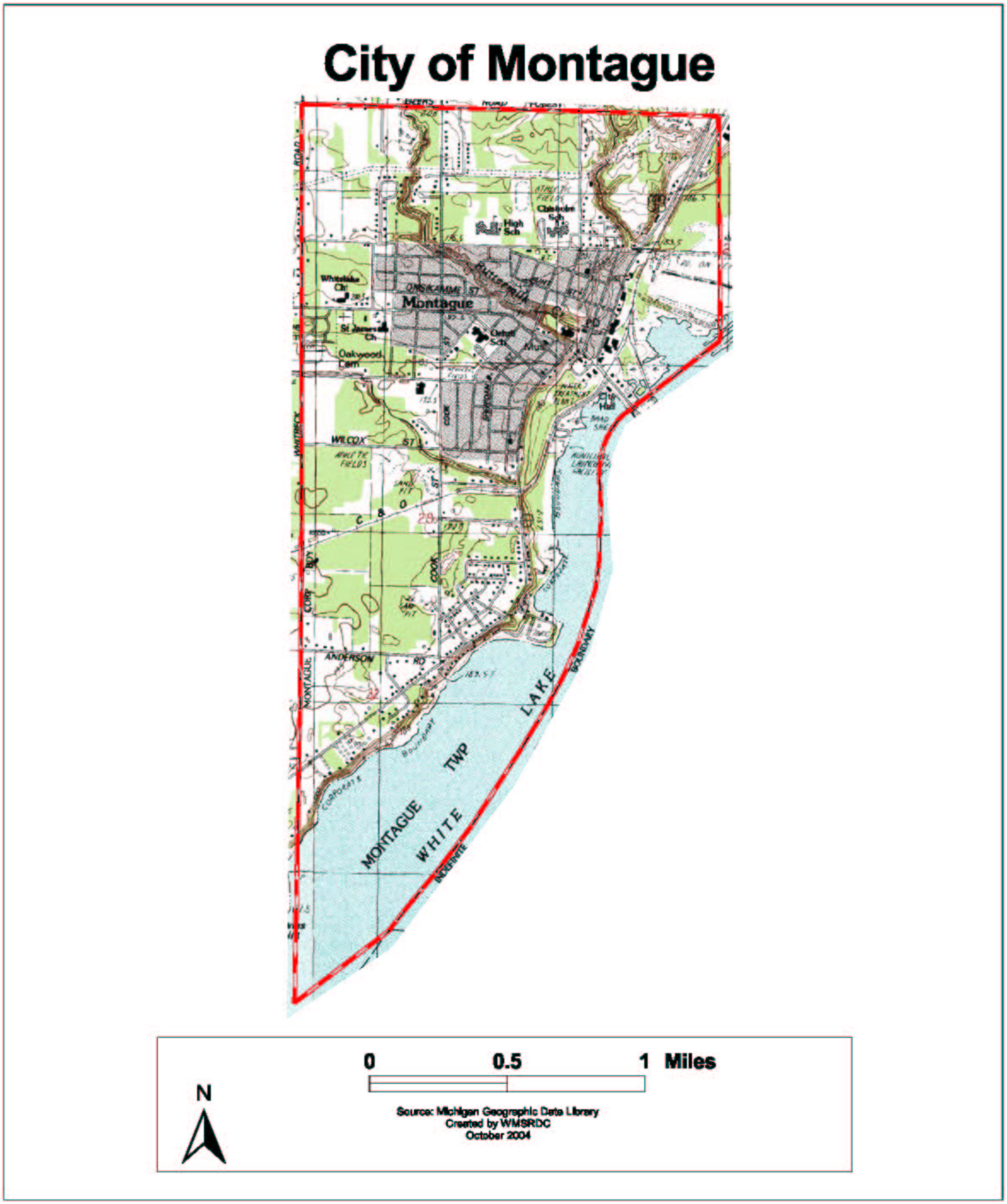
4.	Important or Critical Public and Private Facilities
a.	**police precincts:**	- Montague Police Department, 8778 Ferry St.
b.	**fire stations:**	- Montague Fire Department, 5085 Wilcox St.
c.	**public works yards:**	- Montague Maintenance Garage, 4976 Bowen St.
d.	**pumping stations:**	- Two
e.	**community shelters:**	- Montague Area High School, 4900 Stanton Blvd
f.	**community medical facilities, hospitals:**	- Accessible Health Center Urgent, 4478 Dowling St
g.	**historic sites:**	- None Identified
h.	**other:** (i.e., government buildings, record center, major construction companies, warehouses, demolition companies, heavy equipment rental, emergency equipment and vehicle storage)	- Montague City Hall, 8778 Ferry St. - Montague Branch – Muskegon County Library, 8778 Ferry St.

5.	Vital or Critical Infrastructure	
a.	**roads, railroads, and bridges:**	- US-31 Business Route - US-31 Business Route bridge over White River
b.	**dams, power stations, water treatment plants, sanitary lift stations, etc.**	- Power Transmission Line - Sanitary Lift Stations: Two
c.	**other** (i.e. airports, pipelines, bus terminals, train stations, military bases, marine passenger ferry services)	- None Identified

6.	Socio-Economic Profile of Sector	
a.	**total population (night):**	2,361
b.	**peak population (seasonal):**	2,577
c.	**percent over 65:**	16.1
d.	**percent under 18:**	25.2
e.	**percent of homeowners:**	70.2
f.	**percent below poverty level:**	9.4
g.	**percent with disability or mobility limitation:**	19
h.	**estimated property insurance coverage:** **(Real and Personal Equalized Valuations)** Agricultural: Commercial: Industrial: Residential: Utility (Personal): Total:	$0 $9,337,600 $5,211,100 $56,800,600 $17,791,200 $89,140,500
i.	**flood insurance coverage:** Total Losses since 01/01/78: Total Payments since 01/01/78: Policies In-Force: Total Insurance In-Force:	7 $78,853 4 $$876,000
j.	**location of floodplains:**	- White Lake shoreline, White River, Koon Creek, and Buttermilk Creek

7.	Emergency Warning System Coverage	
a.	**siren locations and/or description of warning system:**	- Webster Well, 8660 Water St - Scharmer Water Tower, 8195 Scharmer Dr
b.	**percent of population covered by warning sirens or system:**	- One mile radius
(Note: Map showing warning siren location and system coverage is contained in Part D.)		

Land Use and Natural Features Map (USGS Quad.)



CITY OF MUSKEGON

1.	**major geographic features:**	- 2,702.4 persons per square mile - 1,133.4 housing units per square mile - Dense residential, industrial and commercial areas - Lake Michigan shoreline and beach - Coastal sand dunes - Muskegon Lake - Muskegon River - 4 to 6 small lakes and ponds, 4 to 6 small creeks
2.	**Population Concentrations**	
a.	**group homes:**	- Big Bear AFC Home, 1690 Sanford St (capacity 6) - Bracey Home, 1345 Marquette Ave (capacity 1) - Chestnut Fields Retirement Community, 5425 Chestnut Dr (capacity 20) - Clark AFC Home, 909 Ducey Ave (capacity 5) - Ducey CLF, 1271 Ducey Ave (capacity 6) - Glenside Manor AFC, 2479 Hadden St (capacity 6) - Hume Home of Muskegon, 1244 W Southern Ave (capacity 34) - Jefferson House AFC, 1311 Jefferson St (capacity 6) - Kenneth L. Brinks Residence, 155 E. Apple Ave (capacity 16) - Lakeside Manor, 2314 Harrison Ave (capacity 6) - Lawrence Home, 1228 Lawrence Ave (capacity 6) - Light House Retreat, 1357 Terrace (capacity 5) - Lightfoot House, 381 Houston Ave (capacity 16) - Little Bear AFC Home, 1698 Sanford St (capacity 6) - Marcoux Home, 1465 Marcoux Ave (capacity 6) - Morris Manor, 23 Strong Ave (capacity 6) - Northridge, 788 Marquette Ave (capacity 7) - Palmer Adult Foster Care Home, 1916 Continental St (capacity 4) - Park Place Personal Care, 1383 Park St (capacity 6) - Pauley AFC, 480 Apple Ave (capacity 6) - Sanctuary at the Oaks #1, 1740 Village Dr 1st Floor (capacity 20) - Sanctuary at the Oaks #2, 1740 Village Dr 2nd Floor (capacity 20) - Terrace Manor, 1148 Terrace St (capacity 12) - The Cove, 1776 Vulcan St (capacity 80) - Walker House AFC, 125 Delaware (capacity 15)
b.	**large apartment buildings:**	- Nelson Place, 350 Houston Ave (101 units) - Trinity Village II, 2250 Valley St (30 units) - Trinity Village I, 2250 Valley St (30 units) - Jefferson Towers, 1077 Jefferson St (156 senior units) - Amazon Apartments, 550 W Western Ave (129 units) - Renaissance Place Apartments, 570 W Clay Ave (24 senior units) - Muskegon Townhouses, 919 Marquette Ave (213 units) - Bayview Tower, 864 Spring St (200 units) - Royale Glen Townhomes, 1085 Royale Glen Dr (78 units) - The Village at Park Terrace, 1290 W Hackley Ave (122 senior units) - Park Terrace, 1290 W Hackley Ave (150 units) - Village at Jackson Hill, 557 McClaren Ave (50 units) - Barclay Village, 2081 Barclay St (92 units) - Trinity Manor, 347 Shonat St (45 senior units) - Trinity Manor, 347 Shonat St (46 units)

		- Hartford Terrace, 1080 Terrace St (160 units) - Barclay Townhouses, 2081 Barclay St (54 units) - Barclay Senior Village, 2081 Barclay St (70 senior units)

c.	**schools:**	- Baker College, 1903 Marquette Ave (4,467 students, 500 employees)
		- Head Start of Muskegon/Oceana, 1017 Wesley
		- Muskegon Catholic High School & Middle School, 1145 W. Laketon Ave (459 students, 40 staff)
		- Muskegon Christian Elementary, 1220 Eastgate St (233 students, 35 staff)
		- Muskegon Community College, 221 S Quarterline Rd (5,067 students, 544 employees)
		- Muskegon Public Schools
		  - Muskegon High School, 80 W Southern Ave (1000 students, 114 staff)
		  - Muskegon Middle School, 1150 Amity Ave (618 students, 64 staff)
		  - Glenside Elementary, 1213 W Hackley Ave
		  - Lakeside Elementary, 2312 Denmark St (594 students, 67 staff)
		  - Marquette Elementary, 480 Bennett St (584 students, 84 staff)
		  - Moon Elementary, 1826 Hoyt (393 students, 49 staff)
		  - Nelson Elementary School, 550 W Grand Ave (529 students, 82 staff)
		  - Oakview Elementary, 1420 Madison St (539 students, 61 staff)
		  - Muskegon Community Education, 571 Apple Ave (97 students, 32 staff)
		- Three Oaks Academy, 1212 Kingsley St (325 students, 35 staff)
		- Wesley School (MAISD), 915 Wesley Ave (200 students, 100 staff)
		- Career Tech Center (MAISD), 200 Harvey St (700 students, 45 staff)

d.	**childcare facilities:**	- Cynthia Niemeyer, 1535 5th St (capacity 12) - Tiny Toes Childcare, 2396 Blodgett St (capacity 12) - Sally Ann Truss, 213 Broadmoor St (capacity 12) - Elva Walker, 1536 Park St (capacity 12) - Redha Karla Ali, 1688 Elwood St (capacity 12) - Rebecca Sue Smith, 1367 Flower (capacity 12) - B's Big Adventure Daycare, 549 Marlane St (capacity 12) - Tamara Warren, 1322 Francis (capacity 12) - Terri Carter, 1916 Hoyt (capacity 12) - Corky's Day Care, 832 Orchard Ave (capacity 12) - Solutions Unlimited- TOO, 1753 Madison (capacity 30) - Helping Hands Learning Center A, 1198 Spring St (capacity 35) - Muskegon Catholic Preschool- Small Blessings, 1145 W Laketon (capacity 46) - Muskegon Pub Sch P K Marquette, 480 Bennett St (capacity 47) - Bright Beginnings Preschool and Day Care, 1220 Eastgate St (capacity 75) - Advanced Beginnings C.O.G.I.C. Learning Center, 2140 Valley St (capacity 96) - Muskegon Pub Sch Pre K Nelson, 550 W Grand Ave (capacity 100) - Muskegon Middle School, 1150 Amity Ave (capacity 100) - Muskegon Pub Sch Pre K Oakview, 1420 Madison St (capacity 100) - Glenside Head Start & Kid's World Learning Center, 1213 W Hackley Ave (capacity 248)
e.	**large office buildings:**	- Terrace Plaza, 316 Morris Ave - Michael E. Kobza Hall of Justice, 990 Terrace St - See 4.h.
f.	**other:** (such as stadiums, concert halls, amusement parks, fairgrounds, correctional facilities, nursing homes, other special populations or large crowd assembly areas)	- L.C. Walker Arena, 955 4th St (6,000 capacity) - Frauenthal Theater, 425 W. Western Ave (1,800 capacity) - Beardsley Theater, 425 W. Western Ave (170 capacity) - Heritage Landing, (Coast West Music Festival- July 1-6; Unity Christian Music Festival – August; Michigan Irish Music Festival - September) Shoreline Dr. - Bike Time, Western Ave, Mid-July - McGraft Park Amphitheater, Wickham and Glen Ave

		- Muskegon High School Football Stadium, 80 W. Southern Ave - Muskegon County Museum, 430 W. Clay Ave - Muskegon Museum of Art, 296 W. Webster Ave - Milwaukee Clipper Museum, Lakeshore & McCracken - Lake Express Car Ferry (Milwaukee-Muskegon), Lakeshore Drive at Great Lakes Marina (46 cars, 250 passengers) - Port City Princess, Hartshorn Marina (150 passengers) - USS Silversides Submarine Museum, 1346 Bluff St - Muskegon County Jail, 25 W. Walton Ave. (370 capacity, 46 officers) - Muskegon Correctional Facility, 2400 S. Sheridan (1,306 capacity, 304 staff) - Earnest C. Brooks Correctional Facility, 2500 S. Sheridan Rd (1,224 capacity, 508 staff) - West Shoreline Correctional Facility, 2500 S. Sheridan Rd (960 capacity, shares staff with Brooks Facility) - Christian Care Nursing Center, 1275 Kenneth St (49 beds) - Deboer Nursing Home, 1684 Vulcan St. (90 beds) - Heartland Health Care Center - Knollview, 1061 W. Hackley Ave (107 beds) - McAuley Place A Mercy Living Center, 1380 E. Sherman Blvd (98 beds) - University Park - A Mercy Living Center, 570 Harvey St (99 beds) - Muskegon Country Club, 2801 Lakeshore Dr (18 holes) - University Park Golf Course, 2100 Marquette Ave (9 holes) - Balcom Marina, 2964 Lakeshore Dr (72 seasonal and 6 transient slips) - Bluffton Bay Marina, 3040 Lakeshore Dr (100 slips) - Great Lakes Marina, 1920 Lakeshore Dr (250 seasonal and 20 transient slips) - Harbor Towne Marina, 3429 Fulton Ave (242 seasonal and 20 transient slips) - Hartshorn Municipal Marina, 920 W. Western Ave (146 seasonal and 43 transient slips) - Lakeshore Yacht Harbour, 1200 Lakeshore Dr (63 seasonal slips) - Muskegon Yacht Club, 3198 Edgewater (70 slips) - Pigeon Key Marina, 3545 Marina View Pt - Terrace Point Marina, 722 Terrace Point (112 seasonal and 14 transient slips) - Torresen Marine, 3126 Lakeshore Dr (150 seasonal and 10 transient slips) - Holiday Inn, 939 3rd St. (200 rooms) - Shoreline Inn & Suites, 750 Terrace Point Rd(140 rooms) - Fisherman's Landing, 538 Western Ave (39 campsites) - Dunes Mobile Home Park, 2481 W Sherman Blvd
g.	**major employers:**	- Mercy Health Partners - County of Muskegon, 990 Terrace St (1,028 employees) - Muskegon Public Schools, 349 W Webster Ave (941 employees) - ADAC Automotive, 2050 Port City Blvd (750 employees) - G.E. Aviation, 2034 Latimer Drive (553 employees) - Port City Group, 1985 E Laketon (493 employees) - SAF Holland, 1950 Industrial Blvd (330 employees) - Brunswick, 525 W Laketon Ave (175 employees) - Coles, 1188 Lakeshore Dr (147 employees) - Baker College, 1903 Marquette Ave (143 employees)
3.	**Population Shifts**	
a.	**daily:**	- 11,835 commute with an average commuting time of 18.3 minutes - 7,617 school-aged children
b.	**seasonal:**	- 16,105 total housing units: 13,967 occupied/2,138 vacant - Of the vacant, 175 (8.2%) are for seasonal recreational or occasional use

4.	Important or Critical Public and Private Facilities	
a.	**police precincts:**	- City of Muskegon Police Department, 980 Jefferson St. - Muskegon Central Dispatch, 770 Terrace St. - Muskegon County Sheriff Department, 25 W. Walton Ave.
b.	**fire stations:**	- Muskegon Fire Department, 770 Terrace St. - Marquette Station (Muskegon FD), 1477 Marquette Ave. - Robinson Station (Muskegon FD), 1836 Robinson St.
c.	**public works yards:**	- Department of Public Works, 990 Terrace St. - Muskegon Public Works and Utility Department, 1350 E. Keating Ave.
d.	**pumping stations:**	- One
e.	**community shelters:**	- American Red Cross, 313 W Webster - Bethesda Baptist Church, 575 Getty - Bluffton Elementary School, 1875 Waterworks Rd - Bunker Middle School, 2312 Denmark St - Central United Methodist Church, 1011 2nd St - Greater Muskegon Catholic High School, 1145 E Laketon Ave - Holy Trinity Church of God in Christ, 2140 Valley St - Lakeside Baptist Church, 2250 Denmark - Marquette Elementary School, 480 Bennett St - Muskegon Community College, 221 S Quarterline Rd - Muskegon High School, 80 W Southern Ave - Nelson School, 550 W Grand Ave - Oakview School, 1420 Madison St - Steele Middle School, 1150 Amity Ave - St Paul's Episcopal Church, 1006 Third St - Torrent House, 315 W Webster Ave - YMCA, 900 W Western

f.	**community medical facilities, hospitals:**	- Mercy Health Partners Hackley Campus, 1700 Clinton St. (186 beds)
		- Mercy General Health Partners, 1500 E Sherman, 1700 Oak (196 beds)
		- Community Mental Health of Muskegon County
		  - New mental health center, 376 E. Apple Ave.
		  - Kenneth L. Brinks Residence, 155 E. Apple Ave.
		  - Lifeskills, 97 E. Apple Ave.
		  - Club Interaction, 1470 Peck St.
		  - Wesley/Roberts Center, 1175 Wesley Ave.
		- Pro Med Ambulance, 965 Fork St.

g.	**historic sites:**	- Amazon Hoisery Mill, 530-550 W Western Ave - Bluffton Actors Colony Commemorative Designation, Water Works St - Central United Methodist Church, 1011 Second St - Duquette-Carlson Market, 585 Clay - Evergreen Cemetery, Bounded by Grand, Wood, Pine, and Irvin - Ferris Business College Informational Deisignation, 141 Hartford - Hackley Public Library, 316 W Webster Ave - Hackley, Charles H, House, 484 W Webster Ave - Hackley-Holt House, 523 W Clay Ave - Hartshorn Curtain Roller Company, 1150 W Western Ave - Hovey, Horatio N., House, 318 Houston Ave - Hume House, 472 W Webster Ave - Indian Cemetery, Morris Ave between 1st & 2nd St - Michigan Theater Building, 407 W Western Ave - Muskegon Central Fire Station, 75 Walton Ave - Muskegon Historic District, Bounded by Clay, Muskegon, 2nd, and 6th St - Muskegon Woman's Club, 280 Webster Ave

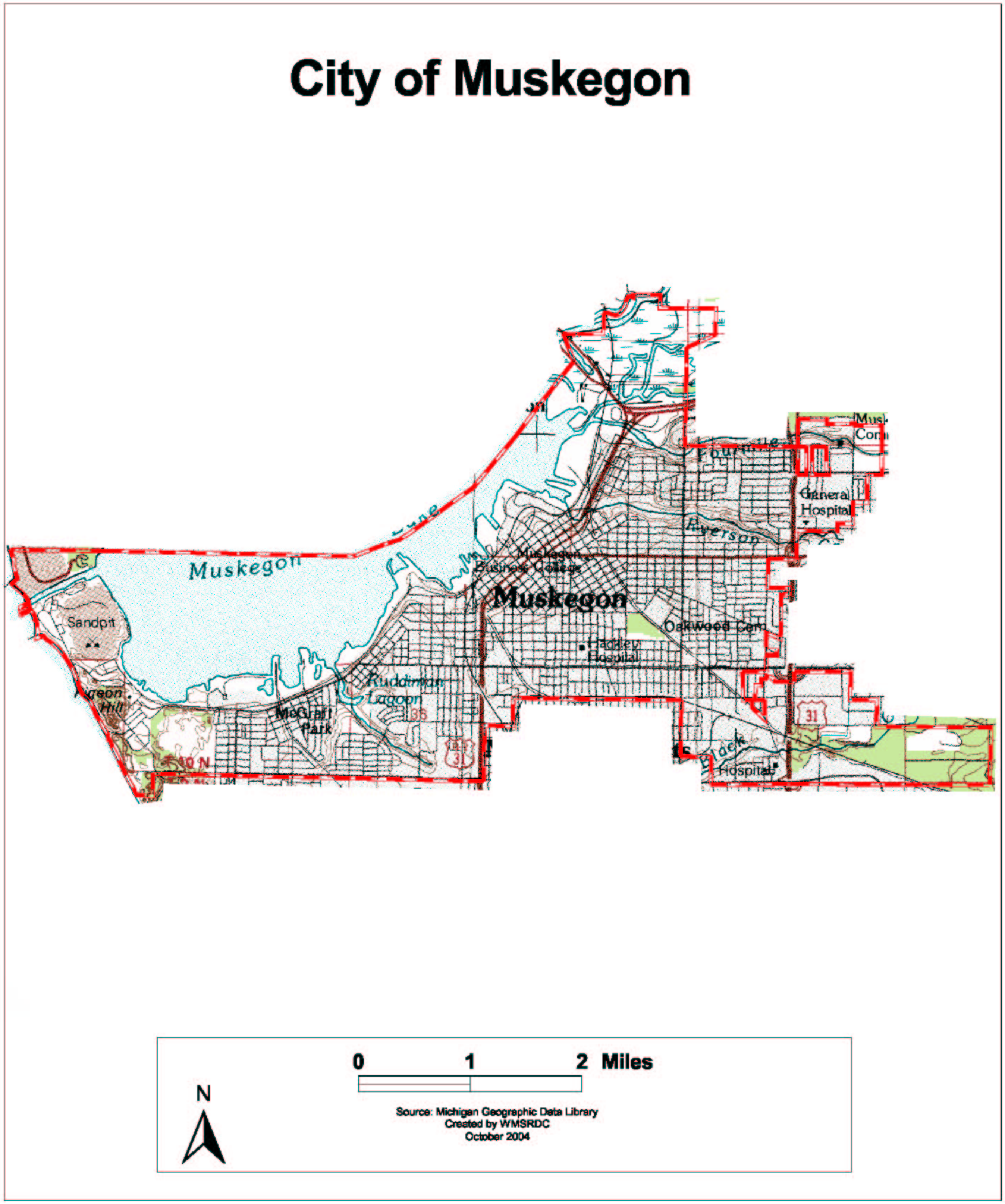
		- Muskegon YMCA 297 W Clay Ave - Pinchtown Informational Designation, corner of Laketon & Lakeshore - Muskegon Log Booming Company Informational Site, Richards Park - S.S. Milwaukee Clipper, Grand Trunk Carferry Dock - Torrent House, 315 W Webster - Union Depot, 610 W Western Ave - USS Silversides, Muskegon Channel- Fulton & Bluff St
h.	**other:** (i.e., government buildings, record center, major construction companies, warehouses, demolition companies, heavy equipment rental, emergency equipment and vehicle storage)	- Muskegon City Hall, 933 Terrace St. - Blind and Physically Handicapped Library, 97 E. Apple Ave. - Hackley Public Library, 316 W. Webster Ave. - Muskegon County Emergency Services, 131 E. Apple Ave. - County of Muskegon Community Corrections, 131 E Apple Ave

5.	**Vital or Critical Infrastructure**	
a.	**roads, railroads, and bridges:**	- US-31 - US-31 Business Route - M-46 - B-72 - Michigan Shore Railroad - Michigan Shore Railroad Bridge over Muskegon River North Branch - Michigan Shore Railroad Bridge over Muskegon River South Branch - M-120 bridge over Muskegon River - Lakeshore Drive bridge over Ruddiman Creek
b.	**dams, power stations, water treatment plants, sanitary lift stations, etc.**	- B.C. Cobb Gas & Coal Generating Plant, 101 SR-120 - Water Filtration Plant, 1900 Beach St. - City of Muskegon Water and Sewer Maintenance, 1350 E. Keating Ave. - Sanitary Lift Stations: Three - Power Transmission Line
c.	**other** (i.e. airports, pipelines, bus terminals, train stations, military bases, marine passenger ferry services)	- Greyhound Bus Terminal, 351 Morris Ave. - Muskegon Area Transit System, 2624 Morris Ave - Oil Pipeline - United States Coast Guard Station, 1555 Beach St. - United States Army Reserve Center, 1430 Parslow Dr.

6.	**Socio-Economic Profile of Sector**		
a.	**total population (night):**		38,401
b.	**peak population (seasonal):**		38,818
c.	**percent over 65:**		11.6
d.	**percent under 18:**		23.3
e.	**percent that are homeowners:**		52.5
f.	**percent below poverty level:**		27.8
g.	**percent with disability or mobility limitation:**		28.1
h.	**estimated property insurance coverage:** **(Real and Personal Equalized Valuations)**	Agricultural: Commercial: Industrial: Residential: Utility (Personal): Total:	$0 $143,167,500 $111,320,300 $327,218,300 $103,850,900 $685,557,000

i.	**flood insurance coverage:**	Total Losses since 01/01/78: Total Payments since 01/01/78: Policies In-Force: Total Insurance In-Force:	27 $39,733 22 $4,628,700
j.	**location of floodplains:**	- Lake Michigan shoreline, Muskegon Lake shoreline, Muskegon River, Ryerson Creek, Ruddiman Lagoon, and Four Mile Creek	
7.	**Emergency Warning System Coverage**		
a.	**siren locations and/or description of warning system:**	- None Identified	
b.	**percent of population covered by warning sirens or system:**	N/A	

Land Use and Natural Features Map (USGS Quad.)



CITY OF MUSKEGON HEIGHTS

1.	**major geographic features:**	- 3,403.1 persons per square mile - 1,517.9 housing units per square mile - Dense residential and industrial areas - 1 to 2 small lakes and ponds, 1 to 2 small creeks
2.	**Population Concentrations**	
a.	**group homes:**	- Baker Haven Home, 2145 Annette Ave (capacity 6) - C.M.L. Homes, 2424 Peck St (capacity 4) - Clouds of Joy AFC, 909 Ducey Ave (capacity 5) - Donna's View, 2140 Jefferson (capacity 6) - Morning Glory AFC, 2325 Peck (capacity 6) - Muskegon Adult Foster Care Home, 309 E Hackley Ave (capacity 12) - Rescued Dreams, 2812 Sixth St (capacity 6) - Stacy's AFC, 2648 Ninth Street (capacity 5)
b.	**large apartment buildings:**	- Wells Villa, 2818 Woodcliffe Dr (104 units) - M.A. Houston Towers, 3020 Peck St (52 senior units) - East Park Manor, 615 E Hovey Ave (200 units) - Columbia Court, 65 E Columbia Ave (89 units) - East Side Court, 615 E Hovey Ave (50 units)
c.	**schools:**	- Muskegon Heights High School, 2441 Sanford St (300 (est) students) - Muskegon Heights Middle School, 55 E Sherman (300 (est) students) - Edgewood Elementary School, 3028 Howden St (300 (est) students) - M.L. King Jr Elementary School, 600 E Barney Ave (300 (est) students)
d.	**childcare facilities:**	- Bobbie Hampton, 3028 Leahy (capacity 12) -Thomas Denise Lavette, 2913 Leahy (capacity 12) - Right Start Learning Center, 2325 Lemuel (capacity 30) - Caring Hands Day Care Center, 440 Sherman Blvd (capacity 30) - Bed Buggs Child Development Center, 2244 Peck St (capacity 45) - Dr. Martin Luther King Jr Elementary, 600 E Barney St (capacity 245) - Little Hands Learning Center, 3355 Merriam St (capacity 60)
e.	**large office buildings:**	- See 4.h.
f.	**other:** (such as stadiums, concert halls, amusement parks, fairgrounds, correctional facilities, nursing homes, other special populations or large crowd assembly areas)	- Muskegon Heights High School Football Stadium, 2427 Jefferson St. - Muskegon Heights Festival, Rowan Park- June 13-15 - Cornerhouse Motor Inn, 3350 Glade St. (23 rooms) - Heights Motel, 3300 Hoyt St. - Red Roof Inn & Suites, 150 Seaway Dr. (129 rooms) - Mona Lake Mobile Home Park, 3527 Hoyt Street
g.	**major employers:**	- Muskegon Heights Public School Academy System
3.	**Population Shifts**	
a.	**daily:**	- 2,649 commute with an average commuting time of 16.8 minutes - 2,720 school-aged children
b.	**seasonal:**	- 4,842 total housing units: 3,996 occupied/846 vacant - Of the vacant, 8 (1.0%) are for seasonal recreational or occasional use

4.	Important or Critical Public and Private Facilities	
a.	**police precincts:**	- Muskegon Heights Police Department, 2715 Baker St.
b.	**fire stations:**	- Muskegon Heights Fire Department, 2715 Baker St.
c.	**public works yards:**	- None Identified
d.	**pumping stations:**	- None Identified
e.	**community shelters:**	- Christ Temple Apostolic Church, 412 E Sherman Blvd
f.	**community medical facilities, hospitals:**	- None Identified
g.	**historic sites:**	- None Identified
h.	**other:** (i.e., government buildings, record center, major construction companies, warehouses, demolition companies, heavy equipment rental, emergency equipment and vehicle storage)	- Muskegon Heights City Hall, 2724 Peck St. - Muskegon Heights Library, 2808 Sanford St. - Muskegon County FIA, 2700 Baker St.

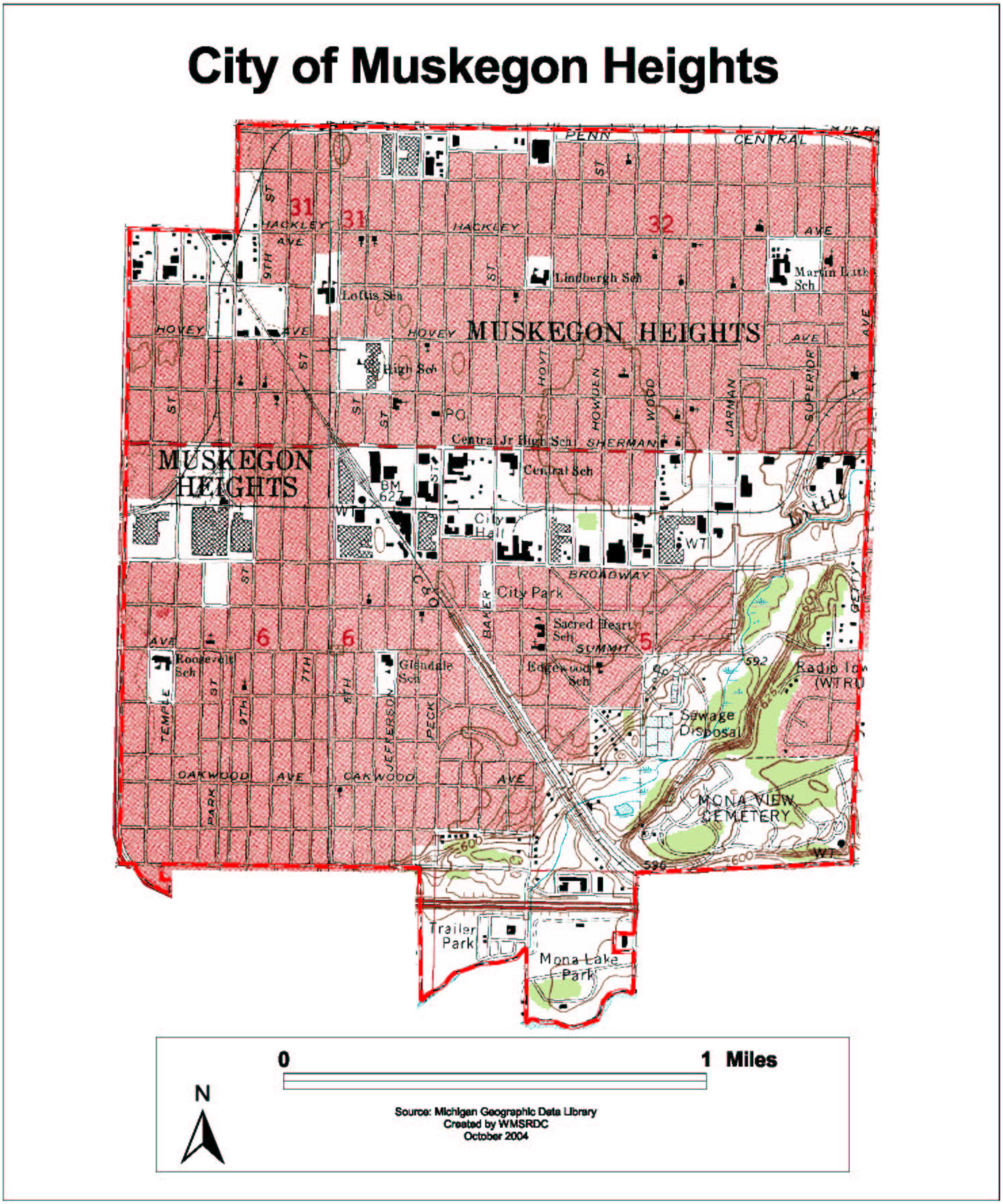
5.	Vital or Critical Infrastructure	
a.	**roads, railroads, and bridges:**	- US-31 Business Route - Michigan Shore Railroad
b.	**dams, power stations, water treatment plants, sanitary lift stations, etc.**	- Muskegon Heights Water and Sewer - Sanitary Lift Stations: Four
c.	**other** (i.e. airports, pipelines, bus terminals, train stations, military bases, marine passenger ferry services)	- Muskegon Area Transit System, 2624 6th St. - Oil Pipeline

6.	Socio-Economic Profile of Sector		
a.	**total population (night):**		10,856
b.	**peak population (seasonal):**		10,877
c.	**percent over 65:**		9.6
d.	**percent under 18:**		32.3
e.	**percent that are homeowners:**		51.1
f.	**percent below poverty level:**		42
g.	**percent with disability or mobility limitation:**		32.1
h.	**estimated property insurance coverage:** **(Real and Personal Equalized Valuations)**	Agricultural: Commercial: Industrial: Residential: Utility (Personal): Total:	$0 $23,053,400 $111,320,300 $327,218,300 $21,659,900 $483,251,900
i.	**flood insurance coverage:**	Total Losses since 01/01/78: Total Payments since 01/01/78: Policies In-Force: Total Insurance In-Force:	2 N/A 3 $1,008,000
j.	**location of floodplains:**	- Mona Lake shoreline, Black Creek	

7.	Emergency Warning System Coverage	
a.	**siren locations and/or description of warning system:**	- Siren at Muskegon Heights Fire Department, 2715 Baker St
b.	**percent of population covered by warning sirens or system:**	- One mile radius

(Note: Map showing warning siren location and system coverage is contained in Part D.)

Land Use and Natural Features Map (USGS Quad.)



CITY OF NORTH MUSKEGON

1.	**major geographic features:**	- 2,151.1 persons per square mile - 1,042 housing units per square mile - Dense residential, light commercial areas - Muskegon Lake - Bear Lake - Muskegon River
2.	**Population Concentrations**	
a.	**group homes:**	- Northcrest Assisted Living Center, 2650 Ruddiman Dr. (capacity 86) - Ruddiman Home, 224 Ruddiman (capacity 6)
b.	**large apartment buildings:**	- Beverly Hills Apartments, 415 Mitzi St. (60 units)
c.	**schools:**	- North Muskegon High School, 1600 Mills (276 students, 23 staff) - North Muskegon Middle School, 1600 Mills (223 students, 23 staff) - North Muskegon Elementary, 1600 Mills (498 students, 29 staff)
d.	**childcare facilities:**	- Dawn Dick, 606 W Sunset (capacity 12) - Laurie LeMieux, 922 Central Ave (capacity 12) - Susan Lloyd, 419 Oaknoll Dr (capacity 12) - Little Norse Daycare, 2108 Ruddiman Ave (capacity 12) - North Muskegon Lighthouse Learning Center, 1600 Mills (capacity 51) - Maple Tree Inc, 1825 Ruddiman Dr (capacity 75)
e.	**large office buildings:**	- See 4.h.
f.	**other:** (such as stadiums, concert halls, amusement parks, fairgrounds, correctional facilities, nursing homes, other special populations or large crowd assembly areas)	- North Muskegon High School Football Stadium, 511 Eimer Ave. - Hillcrest Nursing Centre, 695 Mitzi St. (62 beds) - Pointe Marine,350 Cihak Rd. (124 seasonal and 6 transient slips) - Causeway Motel, 440 Whitehall Rd.
g.	**major employers:**	- None Identified
3.	**Population Shifts**	
a.	**daily:**	- 1,580 commute with an average commuting time of 19.7 minutes - 727 school-aged children
b.	**seasonal:**	- 1,834 total housing units: 1,621 occupied/213 vacant - Of the vacant, 49 (21.2%) are for seasonal recreational or occasional use
4.	**Important or Critical Public and Private Facilities**	
a.	**police precincts:**	- North Muskegon Police Department, 1114 Ruddiman Dr.
b.	**fire stations:**	- North Muskegon Fire Department, 1102 Ruddiman Dr.
c.	**public works yards:**	- Department of Public Works, 2113 Lake Ave.
d.	**pumping stations:**	- None Identified
e.	**community shelters:**	- None Identified
f.	**community medical facilities, hospitals:**	- None Identified
g.	**historic sites:**	- Jean Baptiste Recollect Trading Post Informational Site, SE Corner of Ruddiman and Bear Lake Rd

h.	**other:** (i.e., government buildings, record center, major construction companies, warehouses, demolition companies, heavy equipment rental, emergency equipment and vehicle storage)	- North Muskegon City Hall, 1502 Ruddiman Dr. - Walker Memorial Library, 1522 Ruddiman Dr. - Erickson's, 2217 Lake Ave.

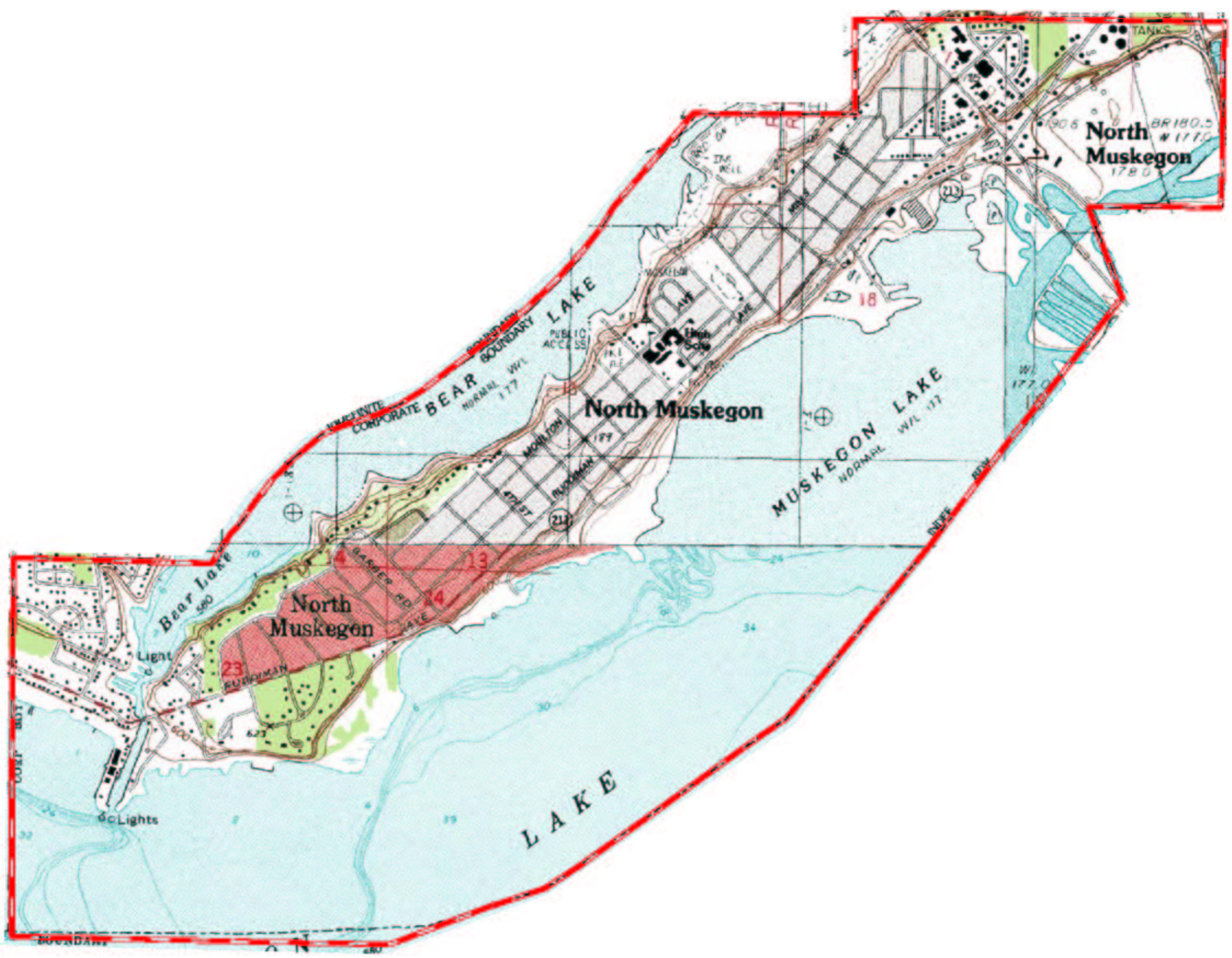
5.	**Vital or Critical Infrastructure**	
a.	**roads, railroads, and bridges:**	- M-120 - Michigan Shore Railroad - Whitham Rd. bridge over Bear Lake
b.	**dams, power stations, water treatment plants, sanitary lift stations, etc.**	- Power Transmission Line - Sanitary Lift Stations: One
c.	**other** (i.e. airports, pipelines, bus terminals, train stations, military bases, marine passenger ferry services)	- Oil Pipeline and Storage Tanks

6.	**Socio-Economic Profile of Sector**		
a.	**total population (night):**		3,786
b.	**peak population (seasonal):**		3,899
c.	**percent over 65:**		20.6
d.	**percent under 18:**		22.7
e.	**percent that are homeowners:**		76.1
f.	**percent below poverty level:**		7.9
g.	**percent with disability or mobility limitation:**		15.1
h.	**estimated property insurance coverage:** **(Real and Personal Equalized Valuations)**	Agricultural: Commercial: Industrial: Residential: Utility (Personal): Total:	$0 $14,912,200 $1,275,900 $124,361,300 $5,655,900 $146,205,300
i.	**flood insurance coverage:**	Total Losses since 01/01/78: Total Payments since 01/01/78: Policies In-Force: Total Insurance In-Force:	3 N/A 55 $13,266,000
j.	**location of floodplains:**	- Muskegon Lake shoreline, Bear Lake shoreline, and Muskegon River	

7.	**Emergency Warning System Coverage**	
a.	**siren locations and/or description of warning system:**	- None Identified
b.	**percent of population covered by warning sirens or system:**	N/A

Land Use and Natural Features Map (USGS Quad.)

City of North Muskegon



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Source: Michigan Geographic Data Library
Created by WMSRDC
October 2004

CITY OF NORTON SHORES

1.	**major geographic features:**	- 1,032.4 persons per square mile - 470.7 housing units per square mile - Dense residential, moderate commercial areas - Lake Michigan shoreline and beach - Coastal sand dunes - Mona Lake, Black Lake - 10 to 12 small lakes and ponds, 8 to 10 small creeks
2.	**Population Concentrations**	
a.	**group homes:**	- Dayspring Assisted Living Residece, 572 Lake Forest Ln (capacity 48) - E and L AFC, 1924 Maryland Blvd (capacity 6) - Joseph's House, 866 Forest Park Rd (capacity 6) - Mary's House, 862 Forest Park Rd (capacity 6) - Morton Terrace AFC, 3929 Hess St (capacity 12) - Seminole Shores Assisted Living Center, 850 Seminole (capacity 129) - Sternberg Road Home, 897 W Sternberg Rd (capacity 6) - Winicki AFC, 2646 LeBouef St (capacity 6)
b.	**large apartment buildings:**	- Lake Forest Apartments, 581 Lake Forest Ln (252 units) - Hidden Cove Apartments, 3975 Grand Haven Rd (54 units) - Mona Shores Apartments, 3711 Henry St (36 units) - The Reserve at Norton Shores, 1523 Norton Shores Ln (150 units) - Shoreline Landing, 959 Flette St (210 units) - The Hamptons of Norton Shores, 909 Hamptons Ct (104 units)
c.	**schools:**	- Mona Shores High School, 1121 Seminole Rd (1,315 students, 72 staff(2005 est)) - Mona Shores Middle School, 1700 Woodside Rd (884 students, 47 staff (2005 est)) - Churchill Elementary (Mona Shores Schools), 961 Porter Rd (360 students, 20 staff (2005 est)) - Lincoln Park Elementary (Mona Shores Schools), 2951 Leon St (445 students, 24 staff (2005 est)) - Ross Park Elementary (Mona Shores Schools), 121 Randall Rd (395 students, 28 staff (2005 est)) - Western Michigan Christian High School, 455 E. Ellis Rd (330 students, 48 staff) - Mona Shores Preschool, 3374 McCracken St - St. Mark Lutheran Preschool, 4475 Henry St
d.	**childcare facilities:**	- Melissa Bush, 5155 Gay St (capacity 12) - Raquel Szymanski, 963 Donna Ave (capacity 12) - Jumpstart Child Care Center, 2417 Sherman Blvd (capacity 30) - Diana Thieu Vachirasudlekha, 547 Aue Rd (capacity 12) - Cuddly Cubs Child Care, 830 E Sternberg Rd (capacity 12) - Janet Stefanich, 2943 Austin (capacity 12) - Sunshine Day Care, 4556 Grand Haven Rd (capacity 23) - Mona Shores and Lincoln Park Childcare, 2951 Leon St (capacity 35) - Ross Park Head Start and GSRP, 121 Randall Rd (capacity 38) - Mona Shores and Churchill Childcare, 961 Porter Rd (capacity 50) - Michigan Dunes Montessori Inc, 5248 Henry St (capacity 100) - Mona Shores/ Ross Park Child Care, 121 Randall Rd (capacity 200)

e.	**large office buildings:**	- Comerica Building, 801 W Norton
f.	**other:** (such as stadiums, concert halls, amusement parks, fairgrounds, correctional facilities, nursing homes, other special populations or large crowd assembly areas)	- Maranatha Bible and Missionary Conference, 4759 Lake Harbor Rd. - Mona Shores High School Football Field, 1121 Seminole Rd. - Shoreline Soccer Club, 6875 Norton Pines Drive (up to 6,000 spectators per week) - Mona Shores Performing Arts Center, 1121 Seminole Rd. (850 capacity) - Cinema Carousel Theatre, 4289 Grand Haven Rd. (2,500 capacity) - Plaza 1 & 2 Theatre, 3450 Henry St. - Getty-4 Drive In Theater, 920 Summit (capacity 1,200 cars, closed winters) - Muskegon Elk's Campground, 5447 Lake Harbor Rd. - P.J. Hoffmaster State Park, 6585 Lake Harbor Rd. (293 campsites) - Oak Ridge Golf Course, 513 Pontaluna Rd. (18 holes) - Alpine Motel, 4262 Airline Rd. (18 rooms) - Baymont Inn, 4677 S. Harvey St. (61 rooms) - Bel-Aire Motel, 4240 Airline Rd. (18 rooms) - Fairfield Inn, 5214 Martin Rd. (100 rooms) - Hampton Inn, 1401 E. Ellis Rd. (81 rooms) - Motel Haven, 4344 Airline Rd. - Seaway Motel, 631 W. Norton Ave. (29 rooms) - Chateau Norton Shores Mobile Home Community, 3223 Bailey Ave - Hillcrest Mobile Home Park, 3290 Getty Street - Nomad Trailer Park, 2701 Huizenga - The Oaks Mobile Home Park, 3240 Getty - Pontaluna Shores Mobile Home Park, 1281 Pontaluna Rd - Dunes Mobile Home Park, Sherman Blvd
g.	**major employers:**	- Meijers Inc., 700 W. Norton Ave. (550 employees) - Knoll, 2800 Estes St (403 employees) - Hines Corporation, 1218 E Pontaluna Rd (270 employees) - Structural Concepts, 888 E Porter Rd (245 employees) - Kaydon, 2860 McCraken St (175 employees) - Cannon Muskegon, 2875 Lincoln St (170 employees) - ACEMCO, 7297 Enterprise Dr (125 employees) - TGW Ermanco, 5566 Grand Haven Rd (124 employees) - GE Aviation, 6060 Norton Center Dr (322 employees) - Target Stores, 5057 Harvey St (125 employees)

3.	**Population Shifts**	
a.	**daily:**	- 10,477 commute with an average commuting time of 18.0 minutes - 4,561 school-aged children
b.	**seasonal:**	- 10,939 total housing units: 9,977 occupied/962 vacant - Of the vacant, 252 (26.2%) are for seasonal recreational or occasional use

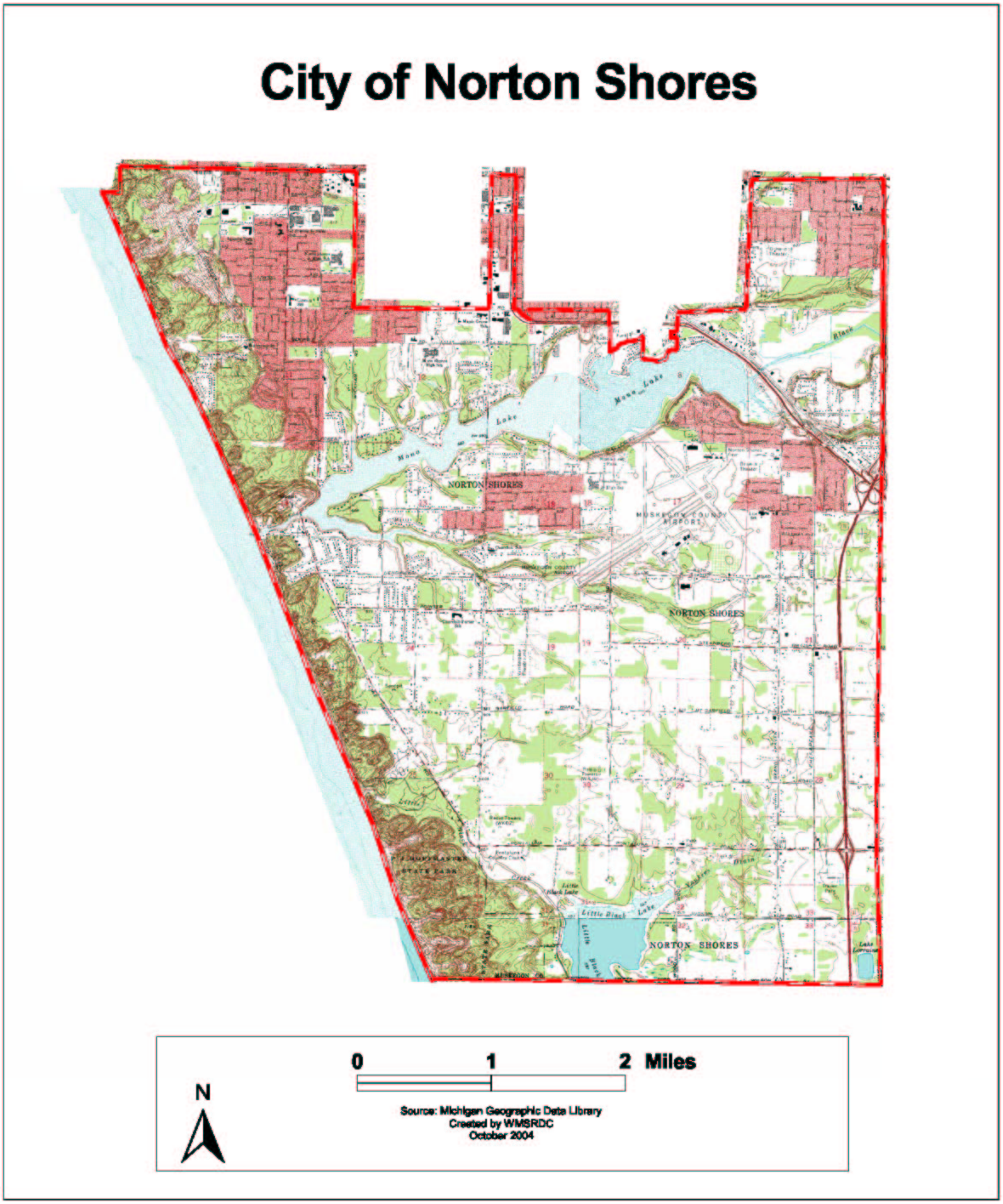
4.	**Important or Critical Public and Private Facilities**	
a.	**police precincts:**	- Norton Shores Police Department, 4814 Henry St.
b.	**fire stations:**	- Norton Shores Fire Station #1, 1577 Seminole Rd. - Norton Shores Fire Station #2, 3920 Airline Rd. - Norton Shores Fire Station #3, 1100 E. Pontaluna
c.	**public works yards:**	- Norton Shores Public Works Garage, 85 E. Mount Garfield Rd.
d.	**pumping stations:**	- One

e.	**community shelters:**	- Forest Park Covenant Church, 3815 Henry St - St Gregory's Episcopal, 1200 Seminole Rd - St Luke's Lutheran Church, 1655 W Norton Ave - Western Michigan Christian High School, 455 Ellis Rd
f.	**community medical facilities, hospitals:**	- Norton Redi-Med, 747 W. Norton Ave - Mercy Health Partners – Lakes Village, 6401 Prairie St
g.	**historic sites:**	- None Identified
h.	**other:** (i.e., government buildings, record center, major construction companies, warehouses, demolition companies, heavy equipment rental, emergency equipment and vehicle storage)	- Norton Shores City Hall, 4814 Henry St. - Norton Shores Library, 705 Seminole Rd. - Norton Shores Department of Public Works, Mt Garfield Rd
5.	**Vital or Critical Infrastructure**	
a.	**roads, railroads, and bridges:**	- US-31 - US-31 Business Route - Michigan Shore Railroad - Henry St. Bridge over Mona Lake, ¼ mile south of Seminole Rd. - Lake Harbor Rd Bridge over Mona Lake - Black Lake Rd Bridge
b.	**dams, power stations, water treatment plants, sanitary lift stations, etc.**	- City of Muskegon Heights Water Filtration, 2323 Seminole Rd. - Sanitary Lift Stations: One - Little Black Lake Dam
c.	**other** (i.e. airports, pipelines, bus terminals, train stations, military bases, marine passenger ferry services)	- Muskegon County Airport, 99 Sinclair Dr. - Oil Pipeline - United States Coast Guard Air Facility, 689 Airport Rd.

6.	**Socio-Economic Profile of Sector**		
a.	**total population (night):**		23,994
b.	**peak population (seasonal):**		24,596
c.	**percent over 65:**		17.8
d.	**percent under 18:**		22
e.	**percent that are homeowners:**		81.6
f.	**percent below poverty level:**		4.9
g.	**percent with disability or mobility limitation:**		20.1
h.	**estimated property insurance coverage:** **(Real and Personal Equalized Valuations)**	Agricultural: Commercial: Industrial: Residential: Utility (Personal): Total:	$0 $182,917,500 $49,049,600 $576,927,100 $72,165,800 $881,060,000
i.	**flood insurance coverage:**	Total Losses since 01/01/78: Total Payments since 01/01/78: Policies In-Force: Total Insurance In-Force:	24 $94,165 45 $6,006,300
j.	**location of floodplains:**	Black Lake, Mona Lake, and Black Creek	

7.	Emergency Warning System Coverage	
a.	**siren locations and/or description of warning system:**	- Siren at Muskegon County Airport, 115 Sinclair Dr. (air crash only)
b.	**percent of population covered by warning sirens or system:**	- One mile radius
(Note: Map showing warning siren location and system coverage is contained in Part D.)		

Land Use and Natural Features Map (USGS Quad.)



CITY OF ROOSEVELT PARK

1.	**major geographic features:**	- 3,719.4 persons per square mile - 1,868.9 housing units per square mile - Dense residential, moderate commercial areas
2.	**Population Concentrations**	
a.	**group homes:**	- None Identified
b.	**large apartment buildings:**	- The Shores of Roosevelt Park, 3050 Maple Grove Rd. (302 units) - Roosevelt Park Apartments, 3224 Maple Grove Rd. (48 units) - Tiffany Woods Apartments, 3298 Roosevelt Rd. (302 units)
c.	**schools:**	- Campbell Elementary (Mona Shores Schools), 1355 Greenwhich Rd. (380 students, 26 staff (2005 est))
d.	**childcare facilities:**	- Mona Shores and Campbell Child Care, 1355 Greenwich Rd (capacity 30) - West Shore Lutheran, 3225 Roosevelt Rd (capacity 114)
e.	**large office buildings:**	- Park Row Mall Tower, 950 W. Norton
f.	**other:** (such as stadiums, concert halls, amusement parks, fairgrounds, correctional facilities, nursing homes, other special populations or large crowd assembly areas)	- Roosevelt Park Nursing Centre, 1300 W. Broadway Ave. (69 beds) - The Nursing Home Group, 1380 W. Broadway Ave. - A Victory Inn & Suites, 2967 Henry St. (111 rooms) - Roosevelt Park Days, Roosevelt Park- August 24
g.	**major employers:**	- CWC Castings Division of Textron Inc., 1085 W. Sherman Blvd. (280 employees) - Michigan Spring & Stamping, 2700 Wickham St (115 employees)
3.	**Population Shifts**	
a.	**daily:**	- 1,584 commute with an average commuting time of 15.2 minutes - 764 school-aged children
b.	**seasonal:**	- 1,925 total housing units: 1,731 occupied/194 vacant - Of the vacant, 10 (5.2%) are for seasonal recreational or occasional use
4.	**Important or Critical Public and Private Facilities**	
a.	**police precincts:**	- Roosevelt Park Police Dept, 900 Oak Ridge Rd.
b.	**fire stations:**	- None Identified
c.	**public works yards:**	- None Identified
d.	**pumping stations:**	- None Identified
e.	**community shelters:**	- None Identified
f.	**community medical facilities, hospitals:**	- None Identified
g.	**historic sites:**	- None Identified
h.	**other:** (i.e., government buildings, record center, major construction companies, warehouses, demolition companies, heavy equipment rental, emergency equipment and vehicle storage)	- City of Roosevelt Park, 900 Oak Ridge Rd.

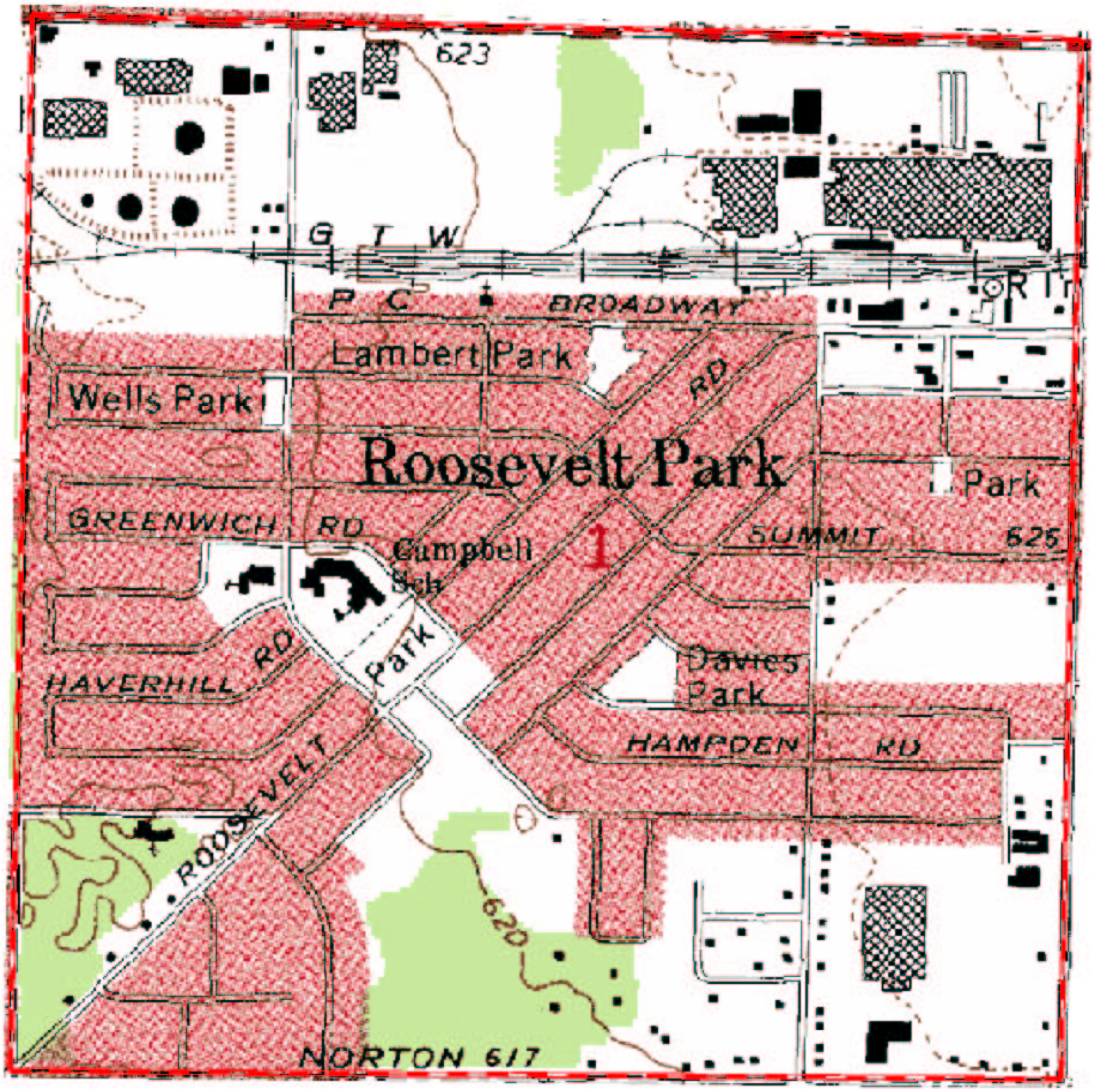
5.	**Vital or Critical Infrastructure**	
a.	**roads, railroads, and bridges:**	- Michigan Shore Railroad
b.	**dams, power stations, water treatment plants, sanitary lift stations, etc.**	- None Identified
c.	**other** (i.e. airports, pipelines, bus terminals, train stations, military bases, marine passenger ferry services)	- Oil Pipeline

6.	**Socio-Economic Profile of Sector**		
a.	**total population (night):**		3,831
b.	**peak population (seasonal):**		3,853
c.	**percent over 65:**		17.2
d.	**percent under 18:**		23.8
e.	**percent that are homeowners:**		63.7
f.	**percent below poverty level:**		11.3
g.	**percent with disability or mobility limitation:**		19.4
h.	**estimated property insurance coverage:** **(Real and Personal Equalized Valuations)**	Agricultural: Commercial: Industrial: Residential: Utility (Personal): Total:	$0 $39,958,900 $3,223,700 $53,644,300 $13,344,500 $110,171,400
i.	**flood insurance coverage:**	Total Losses since 01/01/78: Total Payments since 01/01/78: Policies In-Force: Total Insurance In-Force:	*Not participating in the NFIP*
j.	**location of floodplains:**	N/A	

7.	**Emergency Warning System Coverage**	
a.	**siren locations and/or description of warning system:**	- None Identified
b.	**percent of population covered by warning sirens or system:**	N/A

Land Use and Natural Features Map (USGS Quad.)

City of Roosevelt Park



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Source: Michigan Geographic Data Library
Created by WMSRDC
October 2004

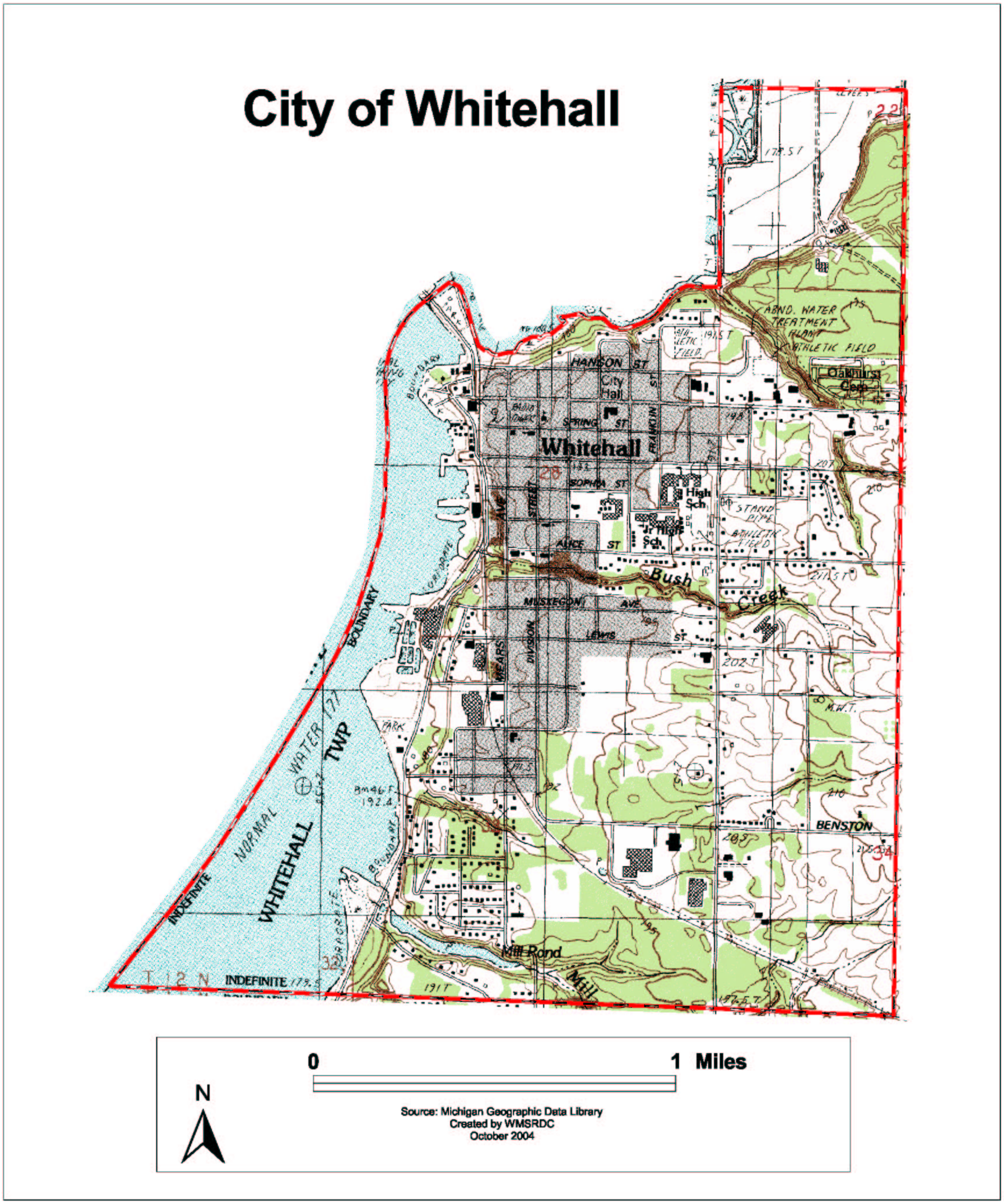
CITY OF WHITEHALL

1.	**major geographic features:**	- 867.3 persons per square mile - 412.8 housing units per square mile - Dense residential and light commercial areas - White Lake - 6 to 8 small lakes and ponds, 6 to 8 small creeks
2.	**Population Concentrations**	
a.	**group homes:**	- Krzykwa AFC, 305 E. Colby (capacity 4) - Lakeview, 403 S Mears Ave (capacity 12) - River St Home, 620 E River St (capacity 6) - Slocum Street Home, 817 Slocum St (capacity 6) - Sophia Street Home, 814 Sophia St (capacity 3) - Spring Street Manor AFC, 121 W Spring St (capacity 5)
b.	**large apartment buildings:**	- West Shore Apartments, 1201 E Colby Rd (48 units) - Whitehall Apartments, 1123 E Colby St (48 units) - Shawl Apartments, 225 S Hall St (40 units)
c.	**schools:**	- Whitehall High School, 3100 White Lake Drive (640 students, 50 staff) - Whitehall Middle School, 401 S. Elizabeth St. (455 students, 40 staff) - Ealy Elementary (Whitehall Schools), 425 E. Sophia St. (455 students, 40 staff) - Shoreline Elementary (Whitehall Schools), 205 Market St. (500 students, 50 staff)
d.	**childcare facilities:**	- Special Blessings Daycare, 916 S Livingston St (capacity 12) - Venema Jennifer Lyne, 106 Tulgeywood (capacity 12) - Happy Apples Child Development Center, 115 W Lewis St (capacity 23) - Buttons and Bows Preschool, W L Congregational, 1809 S Mears Ave (capacity 24) - Bright Futures ELC, 2860 Albers Dr (capacity 48) - Kid's Stop-Ealy Elementary, 425 Sophia St (capacity 60) - Shoreline Elementary, 205 Market (capacity 90) - WLACE- Community Services Bldg, 541 E Slocum (capacity 110)
e.	**office buildings:**	- See 4.h.
f.	**other:** (such as stadiums, concert halls, amusement parks, fairgrounds, correctional facilities, nursing homes, other special populations or large crowd assembly areas)	- Howmet Theater, 304 S. Mears (400 capacity) - Whitehall Sr. High School Football Stadium, 541 E. Slocum St. - Heartland Health Care Center - Whitehall, 918 E. Lewis St. (125 beds) - Whitehall Family Education Center, 1101 S. Mears Ave. (26 capacity) - Whitehall Learning Center, 117 S. Division St. (32 capacity) - Crosswinds Marina, 302 Lake St. (96 seasonal and 10 transient slips) - White Bay Marina, 220 Lake St. (89 seasonal and 5 transient slips) - White Lake Municipal Marina, 100 N Lake St. (50 seasonal and 35 transient slips) - Whitehall Landing, 410 Lake St. (180 seasonal and 35 transient slips) - Lake Land Motel, 1002 E. Colby St. (12 rooms) - Maple Tree Inn, 323 S. Mears Ave. - White Lake Motel, 305 E. Colby St. (20 rooms)
g.	**major employers:**	- Alcoa Howmet, 1 Misco Dr (2,060 employees) - Hilite International, 2001 Peach St (250 employees)

3.	**Population Shifts**	
a.	**daily:**	- 1,190 commute with an average commuting time of 16.4 minutes - 522 school-aged children
b.	**seasonal:**	- 1,288 total housing units: 1,153 occupied/135 vacant - Of the vacant, 38 (28.1%) are for seasonal recreational or occasional use
4.	**Important or Critical Public and Private Facilities**	
a.	**police precincts:**	- Whitehall Police Department, 405 E. Colby St.
b.	**fire stations:**	-Whitehall Fire Department- White Lake Fire Authority (includes Fruitland and Whitehall townships) 115 S Baldwin St
c.	**public works yards:**	- None Identified
d.	**pumping stations:**	- Three
e.	**community shelters:**	- None Identified
f.	**community medical facilities, hospitals:**	- Lakeshore Medical Associates PC, 905 E. Colby St. - Community Mental Health of Muskegon County - Whitehall Adult Activity Center, 511 E. Colby St. - White Lake Ambulance Authority, 119 S Baldwin St.
g.	**historic sites:**	- Swedish Evangelical Lutheran Church of Whitehall, 1101 S Mears Ave - Thompson, Ruth, Commemorative Designation, 405 E Colby St
h.	**other:** (i.e., government buildings, record center, major construction companies, warehouses, demolition companies, heavy equipment rental, emergency equipment and vehicle storage)	- City of Whitehall, 405 E. Colby St. - White Lake Community Library, 3900 W. White Lake Dr.
5.	**Vital or Critical Infrastructure**	
a.	**roads, railroads, and bridges:**	- US-31 Business Route - US-31 Business Route bridge over White River
b.	**dams, power stations, water treatment plants, sanitary lift stations, etc:**	- City of Whitehall Water and Sewer - Sanitary Lift Stations: Five - Mill Pond Dam (Mill Pond Creek)
c.	**other** (i.e. airports, pipelines, bus terminals, train stations, military bases, marine passenger ferry services)	- None Identified
6.	**Socio-Economic Profile of Sector**	
a.	**total population (night):**	2,706
b.	**peak population (seasonal):**	2,790
c.	**percent over 65:**	20.8
d.	**percent under 18:**	22.7
e.	**percent that are homeowners:**	64.6
f.	**percent below poverty level:**	10.5
g.	**percent with disability or mobility limitation:**	20.7

h.	**estimated property insurance coverage:** **(Real and Personal Equalized Valuations)**	Agricultural: Commercial: Industrial: Residential: Utility (Personal): Total:	$0 $17,405,300 $654,400 $42,417,200 $45,811,700 $106,288,600
i.	**flood insurance coverage:**	Total Losses since 01/01/78: Total Payments since 01/01/78: Policies In-Force: Total Insurance In-Force:	2 $387 3 $610,200
j.	**location of floodplains:**	- White Lake, Mill Pond, and White River & tributaries	
7.	**Emergency Warning System Coverage**		
a.	**siren locations and/or description of warning system:**	- Siren in 400 Block of S Warner St - Siren at Benston & S Division St - Siren in 200 Block of E Colby St	
b.	**percent of population covered by warning sirens or system:**	- One mile radius	
(Note: Map showing warning siren location and system coverage is contained in Part D.)			

Land Use and Natural Features Map (USGS Quad.)



VILLAGE OF CASNOVIA

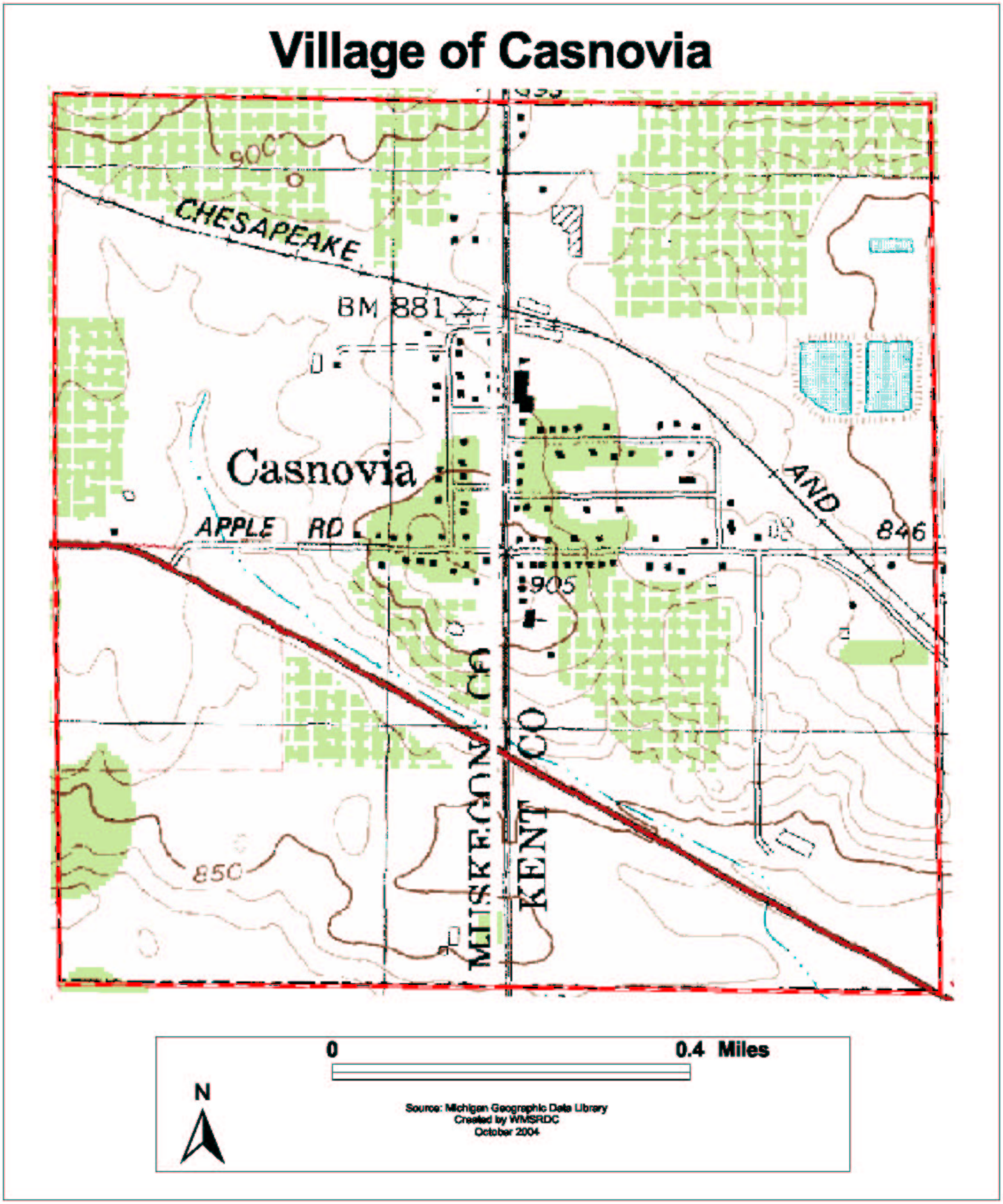
1.	**major geographic features:**	- 295.4 persons per square mile - 121.3 housing units per square mile - 1 to 2 small creeks
2.	**Population Concentrations**	
a.	**group homes:**	- None Identified
b.	**large apartment buildings:**	- None Identified
c.	**schools:**	- None Identifed
d.	**childcare facilities:**	- None Identified
e.	**large office buildings:**	- See 4.h.
f.	**other:** (such as stadiums, concert halls, amusement parks, fairgrounds, correctional facilities, nursing homes, other special populations or large crowd assembly areas)	- None Identified
g.	**major employers:**	- None Identified
3.	**Population Shifts** *(also included in Casnovia Township)*	
a.	**daily:**	- 184 commute with an average commuting time of 27.6 minutes - 63 school-aged children
b.	**seasonal:**	- 131 total housing units: 121 occupied/10 vacant; of the 10 vacant, 0 are for seasonal recreational or occasional use
4.	**Important or Critical Public and Private Facilities**	
a.	**police precincts:**	- None Identified
b.	**fire stations:**	- None Identified
c.	**public works yards:**	- None Identified
d.	**pumping stations:**	- None Identified
e.	**community shelters:**	- None Identified
f.	**community medical facilities, hospitals:**	- None Identified
g.	**historic sites:**	- Whipple's Castle, 389 North Main
h.	**other:** (i.e., government buildings, record center, major construction companies, warehouses, demolition companies, heavy equipment rental, emergency equipment and vehicle storage)	- Village of Casnovia, 141 N. Main St.
5.	**Vital or Critical Infrastructure**	
a.	**roads, railroads, and bridges:**	- M-37/M-46 (junction) - Marquette Rail Railroad
b.	**dams, power stations, water treatment plants, sanitary lift stations, etc.**	- None Identified

c.	**other** (i.e. airports, pipelines, bus terminals, train stations, military bases, marine passenger ferry services)	- None Identified

6.	**Socio-Economic Profile of Sector**		
a.	**total population (night):**	*(also included in Casnovia Township)*	319
b.	**peak population (seasonal):**	*(also included in Casnovia Township)*	319
c.	**percent over 65:**		12.9
d.	**percent under 18:**		77.7
e.	**percent that are homeowners:**		82.6
f.	**percent below poverty level:**		10.4
g.	**percent with disability or mobility limitation:**		17.6
h.	**estimated property insurance coverage:** **(Real Equalized Valuations)**	Agricultural: Commercial: Industrial: Residential: Total:	N/A N/A N/A N/A N/A
i.	**flood insurance coverage:**	Total Losses since 01/01/78: Total Payments since 01/01/78: Policies In-Force: Total Insurance In-Force:	*Not participating in the NFIP*
j.	**location of floodplains:**	N/A	

7.	**Emergency Warning System Coverage**	
a.	**siren locations and/or description of warning system:**	- None Identified
b.	**percent of population covered by warning sirens or system:**	N/A

Land Use and Natural Features Map (USGS Quad.)



VILLAGE OF FRUITPORT

1.	**major geographic features:**	- 1,201.1 persons per square mile - 523.1 housing units per square mile - Spring Lake - 2 to 4 small creeks

2.	**Population Concentrations**	
a.	**group homes:**	- Shaffer House AFC, 171 Dennis St (capacity 6)
b.	**large apartment buildings:**	- None Identified
c.	**schools:**	- Fruitport Community High School, 357 N. 6th Ave (894 students) - Edgewood Elementary, 3255 Pontaluna Rd. (558 students)
d.	**childcare facilities:**	- None Identified
e.	**large office buildings:**	- See 4.h.
f.	**other:** (such as stadiums, concert halls, amusement parks, fairgrounds, correctional facilities, nursing homes, other special populations or large crowd assembly areas)	- Fruitport Community High School Football Stadium, 357 N. 6th Ave. - Fruitport Old Fashion Days- May 22-27
g.	**major employers:**	- None Identified

3.	**Population Shifts** *(also included in Fruitport Township)*	
a.	**daily:**	- 464 commute with an average commuting time of 18.3 minutes - 211 school-aged children
b.	**Seasonal:**	- 476 total housing units: 440 occupied/36 vacant - Of the vacant, 7 (19.4%) are for seasonal recreational or occasional use

4.	**Important or Critical Public and Private Facilities**	
a.	**police precincts:**	- None Identified
b.	**fire stations:**	- None Identified
c.	**public works yards:**	- None Identified
d.	**pumping stations:**	- None Identified
e.	**community shelters:**	- None Identified
f.	**community medical facilities, hospitals:**	- None Identified
g.	**historic sites:**	- None Identified
h.	**other:** (i.e., government buildings, record center, major construction companies, warehouses, demolition companies, heavy equipment rental, emergency equipment and vehicle storage)	- Village of Fruitport, 45 N. 2rd Ave. - Fruitport District Library, 47 Park St.

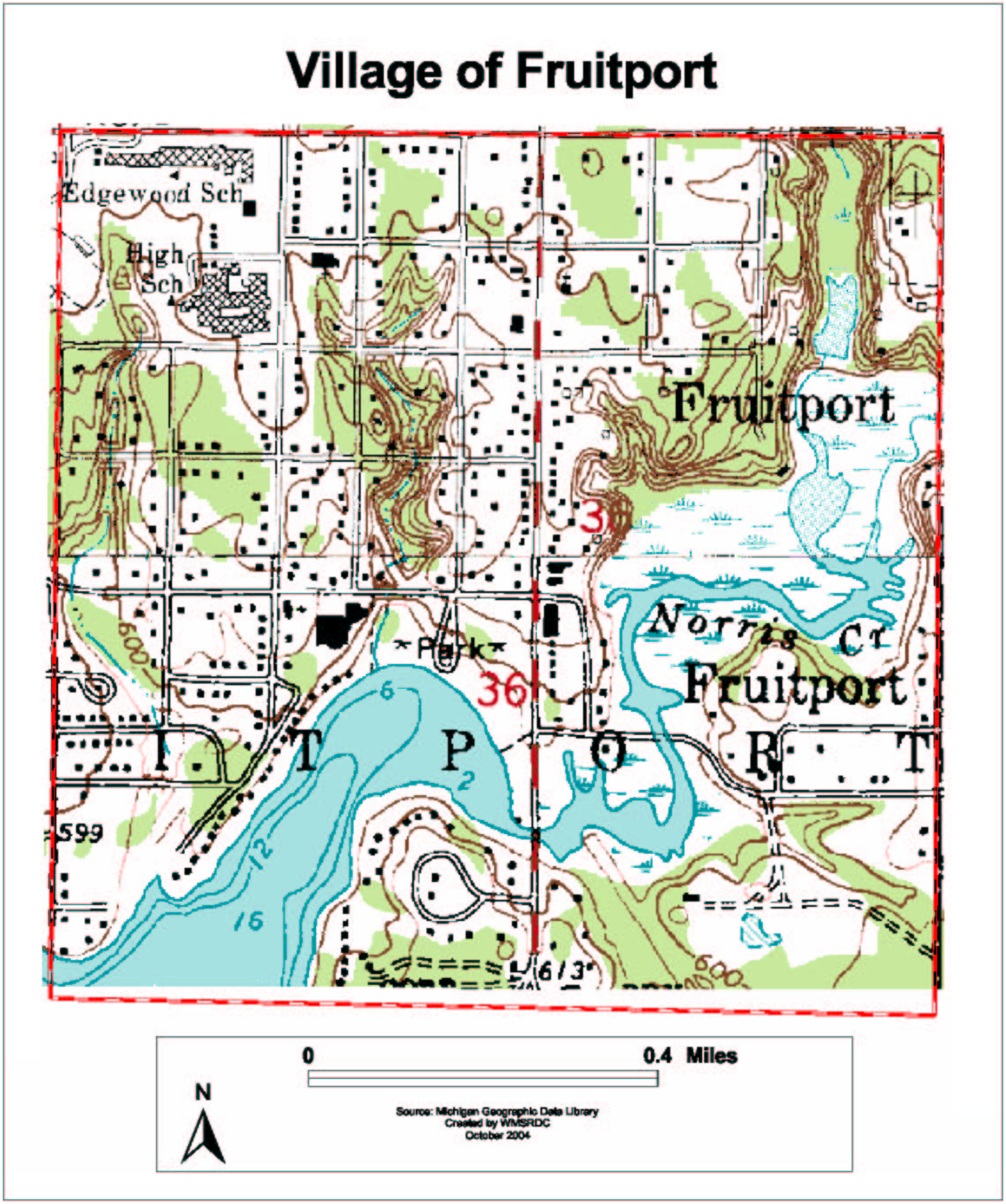
5.	**Vital or Critical Infrastructure**	
a.	**roads, railroads, and bridges:**	- 3rd Ave Bridge & Bridge St (Norris Creek)
b.	**dams, power stations, water treatment plants, sanitary lift stations, etc.**	- None Identified

c.	**other** (i.e. airports, pipelines, bus terminals, train stations, military bases, marine passenger ferry services)	- None Identified

6.	**Socio-Economic Profile of Sector**		
a.	**total population (night):**	*(also included in Fruitport Township)*	1,093
b.	**peak population (seasonal):**	*(also included in Fruitport Township)*	1,110
c.	**percent over 65:**		16.3
d.	**percent under 18:**		22.5
e.	**percent that are homeowners:**		82.6
f.	**percent below poverty level:**		5.9
g.	**percent with disability or mobility limitation:**		17.5
h.	**estimated property insurance coverage:** **(Real Equalized Valuations)**	Agricultural: Commercial: Industrial: Residential: Total:	N/A N/A N/A N/A N/A
i.	**flood insurance coverage:**	Total Losses since 01/01/78: Total Payments since 01/01/78: Policies In-Force: Total Insurance In-Force:	*Not participating in the NFIP*
j.	**location of floodplains:**	N/A	

7.	**Emergency Warning System Coverage**	
a.	**siren locations and/or description of warning system:**	- None Identified
b.	**percent of population covered by warning sirens or system:**	N/A

Land Use and Natural Features Map (USGS Quad.)



VILLAGE OF LAKEWOOD CLUB

1.	**major geographic features:**	- 675.9 persons per square mile - 265.4 housing units per square mile - Fox Lake

2.	**Population Concentrations**	
a.	**group homes:**	- None Identified
b.	**large apartment buildings:**	- None Identified
c.	**schools:**	- None Identified
d.	**childcare facilities:**	- Jaime Bishop, 645 W Englewood (capacity 12) - Vicki Esch, 6581 Automobile Rd (capacity 12) - Shelly Carnes, 6689 Automobile Rd (capacity 12) - Kuddly Kidz Daycare, 444 W Madison Ave (capacity 12)
e.	**large office buildings:**	- See 4.h.
f.	**other:** (such as stadiums, concert halls, amusement parks, fairgrounds, correctional facilities, nursing homes, other special populations or large crowd assembly areas)	- None Identified
g.	**major employers:**	- None Identified

3.	**Population Shifts** *(also included in Dalton Township)*	
a.	**daily:**	- 646 commute with an average commuting time of 21.6 minutes - 303 school-aged children
b.	**seasonal:**	- 507 total housing units: 458 occupied/49 vacant - Of the vacant, 17 (34.7%) are for seasonal recreational or occasional use

4.	**Important or Critical Public and Private Facilities**	
a.	**police precincts:**	- None Identified
b.	**fire stations:**	- None Identified
c.	**public works yards:**	- None Identified
d.	**pumping stations:**	- None Identified
e.	**community shelters:**	- None Identified
f.	**community medical facilities, hospitals:**	- None Identified
g.	**historic sites:**	- None Identified
h.	**other:** (i.e., government buildings, record center, major construction companies, warehouses, demolition companies, heavy equipment rental, emergency equipment and vehicle storage)	- Village of Lakewood Club, 6681 Automobile Rd.

5.	**Vital or Critical Infrastructure**	
a.	**roads, railroads, and bridges:**	- None Identified

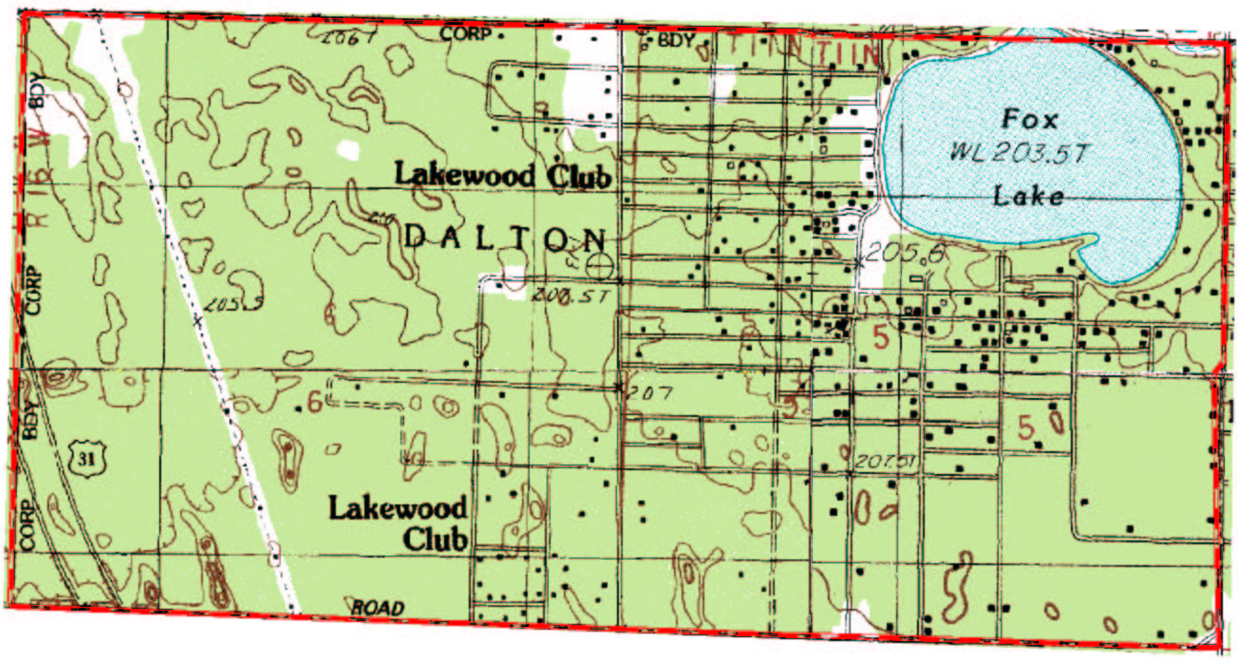
b.	**dams, power stations, water treatment plants, sanitary lift stations, etc.**	- Power Transmission Line
c.	**other** (i.e. airports, pipelines, bus terminals, train stations, military bases, marine passenger ferry services)	- None Identified

6.	**Socio-Economic Profile of Sector**		
a.	**total population (night):**	*(also included in Dalton Township)*	1,291
b.	**peak population (seasonal):**	*(also included in Dalton Township)*	1,339
c.	**percent over 65:**		5.7
d.	**percent under 18:**		30.4
e.	**percent that are homeowners:**		93.4
f.	**percent below poverty level:**		12.1
g.	**percent with disability or mobility limitation:**		22.5
h.	**estimated property insurance coverage:** **(Real Equalized Valuations)**	Agricultural: Commercial: Industrial: Residential: Total:	N/A N/A N/A N/A N/A
i.	**flood insurance coverage:**	Total Losses since 01/01/78: Total Payments since 01/01/78: Policies In-Force: Total Insurance In-Force:	*Not participating in the NFIP*
j.	**location of floodplains:**	N/A	

7.	**Emergency Warning System Coverage**	
a.	**siren locations and/or description of warning system:**	- Siren at Kenwood & Auburn Rd
b.	**percent of population covered by warning sirens or system:**	N/A

Land Use and Natural Features Map (USGS Quad.)

Village of Lakewood Club



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Source: Michigan Geographic Data Library
Created by WMSRDC
October 2004

VILLAGE OF RAVENNA

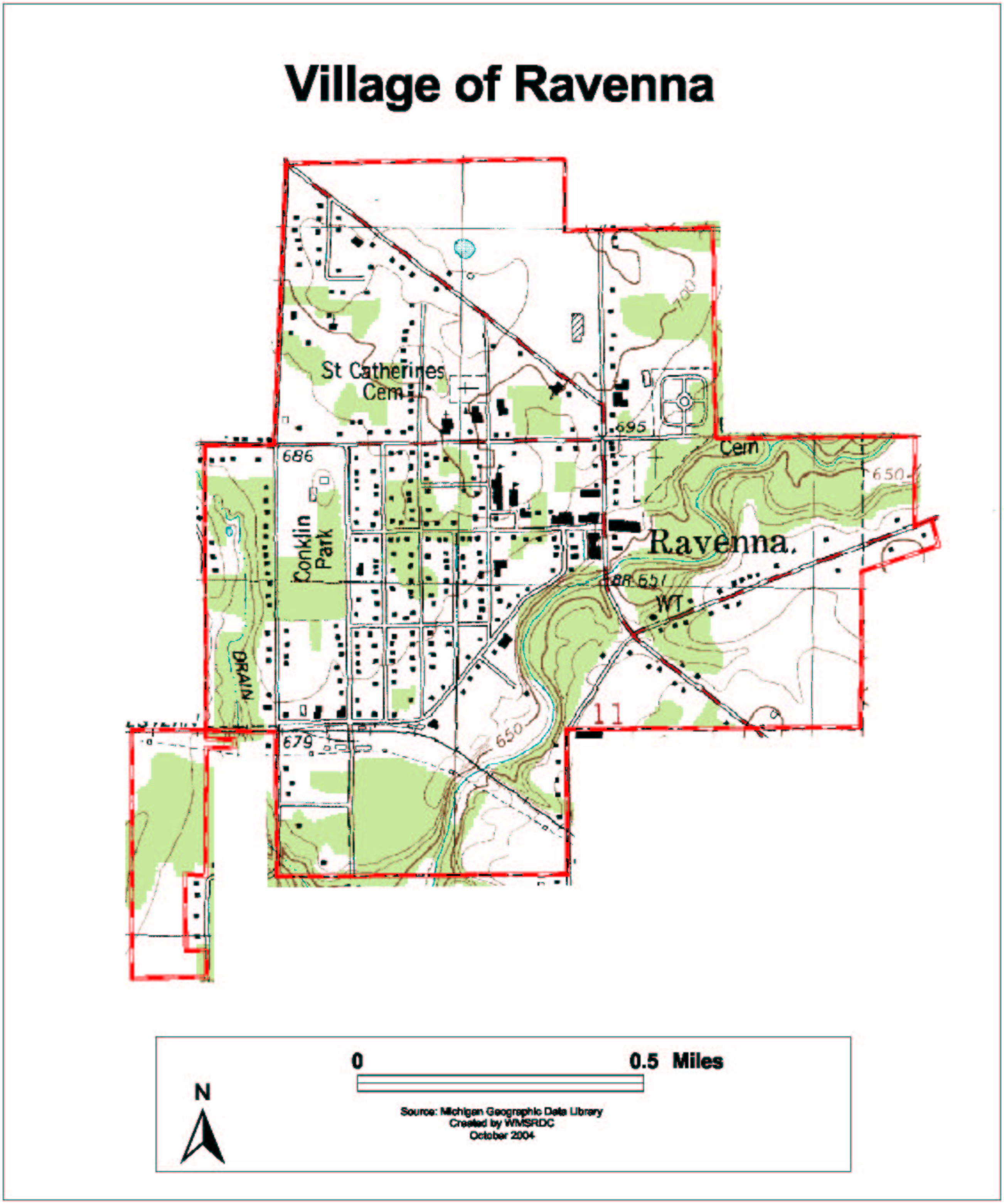
1.	**major geographic features:**	- 1,007.4 persons per square mile - 393.4 housing units per square mile - 2 to 4 small creeks
2.	**Population Concentrations**	
a.	**group homes:**	- Crockery Creek Elder Care, 12291 Crockery Creek (capacity 6)
b.	**large apartment buildings:**	- Creekside Apartments, 3796 S Ravenna Rd (31 family units) - Countryside Manor, Slocum Rd (12 elderly units)
c.	**schools:** **(Contacted Jeanie on 3/12/13)**	- Beechnau Elementary School (Ravenna Public Schools), 12322 Stafford St. (390 students, 41 teachers)
d.	**childcare facilities:**	- Ages and Stages Child Care, 12335 Stafford St (capacity 52) - Beechnau Preschool, 12322 Stafford St (capacity 42) - Ravenna Head Start, 12322 Stafford St (capacity 20) - St Catherine Preschool, 3376 Thomas St (capacity 18) - Tracy Porter, 3601 Thomas St (capacity 12)
e.	**large office buildings:**	- See 4.h.
f.	**other:** (such as stadiums, concert halls, amusement parks, fairgrounds, correctional facilities, nursing homes, other special populations or large crowd assembly areas)	- None Identified
g.	**major employers:**	- None Identified
3.	**Population Shifts** *(also included in Ravenna Township)*	
a.	**daily:**	- 478 commute with an average commuting time of 26.0 minutes - 292 school-aged children
b.	**seasonal:**	- 476 total housing units: 454 occupied/22 vacant - Of the vacant, 1 (4.5%) is for seasonal recreational or occasional use
4.	**Important or Critical Public and Private Facilities**	
a.	**police precincts:**	- None Identified
b.	**fire stations:**	- None Identified
c.	**public works yards:**	- None Identified
d.	**pumping stations:**	- None Identified
e.	**community shelters:**	- None Identified
f.	**community medical facilities, hospitals:**	- None Identified
g.	**historic sites:**	- None Identified
h.	**other:** (i.e., government buildings, record center, major construction companies, warehouses, demolition companies, heavy equipment rental, emergency equipment and vehicle storage)	- Village of Ravenna, 12090 Crockery Creek Dr. - Muskegon County Library - Ravenna Branch, 12278 Stafford St.

5.	Vital or Critical Infrastructure	
a.	**roads, railroads, and bridges:**	- B-35
b.	**dams, power stations, water treatment plants, sanitary lift stations, etc.**	- None Identified
c.	**other** (i.e. airports, pipelines, bus terminals, train stations, military bases, marine passenger ferry services)	- None Identified

6.	Socio-Economic Profile of Sector		
a.	**total population (night):**	*(also included in Ravenna Township)*	1,219
b.	**peak population (seasonal):**	*(also included in Ravenna Township)*	1,222
c.	**percent over 65:**		13.5
d.	**percent under 18:**		29
e.	**percent that are homeowners:**		78.9
f.	**percent below poverty level:**		3.6
g.	**percent with disability or mobility limitation:**		13.9
h.	**estimated property insurance coverage:** **(Real Equalized Valuations)**	Agricultural: Commercial: Industrial: Residential: Total:	N/A N/A N/A N/A N/A
i.	**flood insurance coverage:**	Total Losses since 01/01/78: Total Payments since 01/01/78: Policies In-Force: Total Insurance In-Force:	*Not participating in the NFIP*
j.	**location of floodplains:**	- Flood hazard areas along Crockery Creek and tributiaries	

7.	Emergency Warning System Coverage	
a.	**siren locations and/or description of warning system:**	- None Identified
b.	**percent of population covered by warning sirens or system:**	N/A

Land Use and Natural Features Map (USGS Quad.)



BLUE LAKE TOWNSHIP

1.	**major geographic features:**	- 69.7 persons per square mile - 28.3 housing units per square mile - Scattered rural housing - Densely forested (Manistee National Forest) - Big Blue Lake - Wolverine Lake - White River - 50 to 60 small lakes and ponds, 20 to 25 small creeks

2.	**Population Concentrations**	
a.	**group homes:**	- Oak Creek Home, 137 W Holton Road (capacity 6)
b.	**large apartment buildings:**	- Blue Lake Residences LP, 7190 Progress Dr. (68 family units)
c.	**schools:**	- None Identified
d.	**childcare facility:**	- None Identified
e.	**large office buildings:**	- See 4.h.
f.	**other:** (such as stadiums, concert halls, amusement parks, fairgrounds, correctional facilities, nursing homes, other special populations or large crowd assembly areas)	- Blue Lake County Park, 10701 Nichols Rd. (25 campsites) - Happy Mohawk Canoe Livery, 735 Fruitvale Rd. - Oak Knoll Family Campground, 1522 E. Fruitvale Rd. (60 campsites) - White River Campground, 735 W. Fruitvale Rd. (227 campsites) - Blue Lake Fine Arts Camp, 300 E. Crystal Lake Rd. - Boy Scouts of America - Camp Gerber Ranger, 1733 Owasippe Rd. - Camp Pendalouan, 1243 E. Fruitvale Rd. - Owasippe Scout Reservation, 9900 Russell Rd. - Pioneer Trails, 1421 E Fruitvale (camp)
g.	**major employers:**	- None Identified

3.	**Population Shifts**	
a.	**daily:**	- 1,045 commute with an average commuting time of 28.1 minutes - 615 school-aged children
b.	**seasonal:**	- 975 total housing units: 822 occupied/153 vacant - Of the vacant, 109 (71.2%) are for seasonal recreational or occasional use

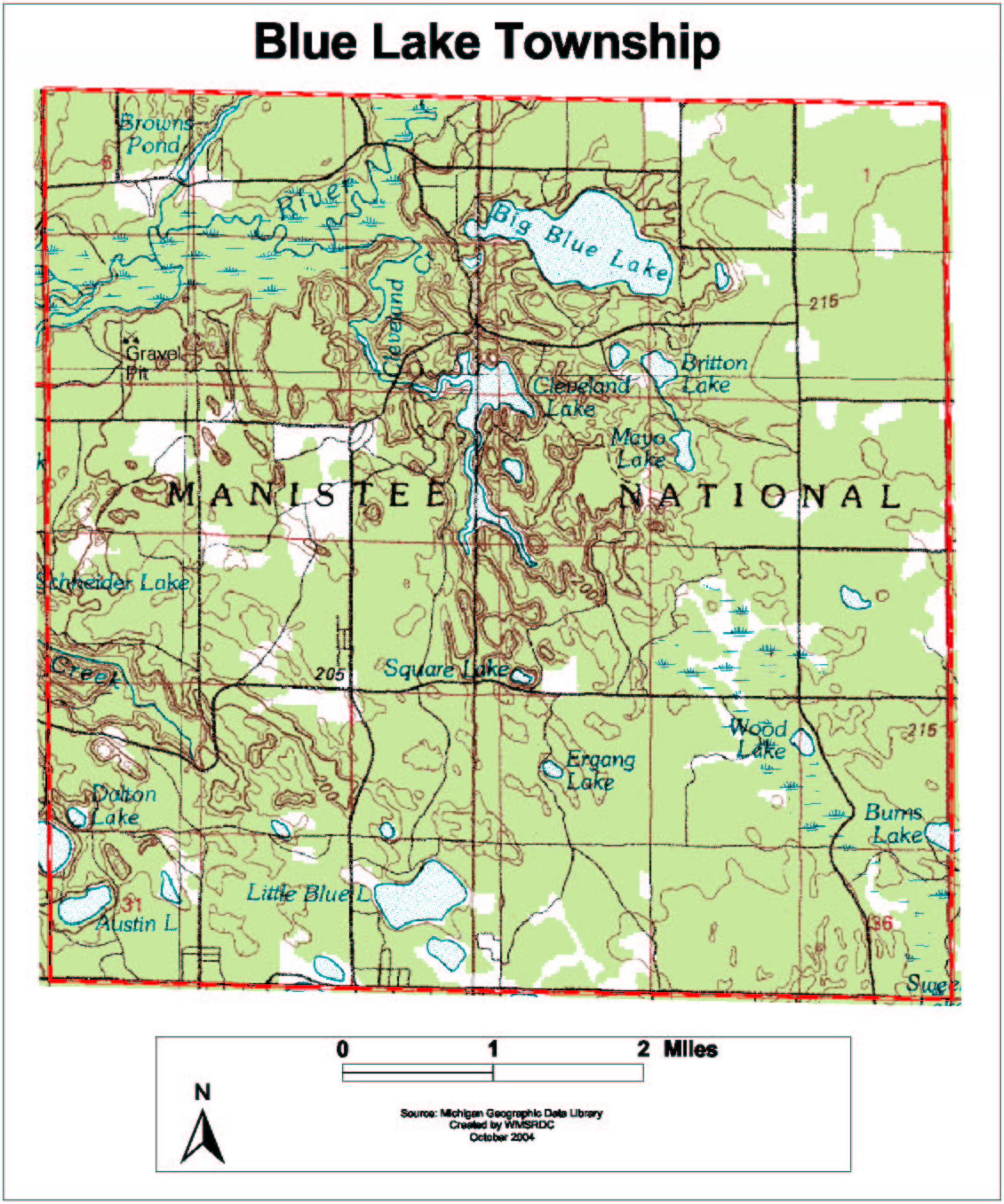
4.	**Important or Critical Public and Private Facilities**	
a.	**police precincts:**	- None Identified
b.	**fire stations:**	- Blue Lake Township Fire Dept, 1491 Owasippe Rd. - Blue Lake Township Fire Dept, 796 White Lake Dr.
c.	**public works yards:**	- None Identified
d.	**pumping stations:**	- None Identified
e.	**community shelters:**	- None Identified
f.	**medical facilities, hospitals:**	- None Identified

g.	**historic sites:**	- None Identified
h.	**other:** (i.e., government buildings, record center, major construction companies, warehouses, demolition companies, heavy equipment rental, emergency equipment and vehicle storage)	- Blue Lake Township Hall, 1491 Owasippe Rd.
5.	**Vital or Critical Infrastructure**	
a.	**roads, railroads, and bridges:**	- B-23, B-86
b.	**dams, power stations, water treatment plants, sanitary lift stations, etc.**	- Cleveland Lake Dam (Cleveland Creek) - Brown's Pond Dam (Sand Creek) - Power Transmission Line
c.	**other** (i.e. airports, pipelines, bus terminals, train stations, military bases, marine passenger ferry services)	- Natural Gas Pipeline

6.	**Socio-Economic Profile of Sector**		
a.	**total population (night):**		2,399
b.	**peak population (seasonal):**		2,716
c.	**percent over 65:**		8.8
d.	**percent under 18:**		29.7
e.	**percent that are homeowners:**		85.2
f.	**percent below poverty level:**		16.6
g.	**percent with disability or mobility limitation:**		22.4
h.	**estimated property insurance coverage:** **(Real and Personal Equalized Valuations)**	Agricultural: Commercial: Industrial: Residential: Utility (Personal): Total:	$0 $927,200 $0 $66,357,100 $2,280,500 $69,564,800
i.	**flood insurance coverage:**	Total Losses since 01/01/78: Total Payments since 01/01/78: Policies In-Force: Total Insurance In-Force:	*Not participating in the NFIP*
j.	**location of floodplains:**	N/A	

7.	**Emergency Warning System Coverage**	
a.	**siren locations and/or description of warning system:**	- Siren at 1491 Owasippe Rd
b.	**percent of population covered by warning sirens or system:**	- One mile radius
(Note: Map showing warning siren location and system coverage is contained in Part D.)		

Land Use and Natural Features Map (USGS Quad.)



CASNOVIA TOWNSHIP

1.	**major geographic features:**	- 78.6 persons per square mile - 28.6 housing units per square mile - Scattered rural housing and moderate residential areas - Moderately forested, moderate farmland - Half Moon Lake - 14 to 16 small lakes and ponds, 20 to 25 small creeks
2.	**Population Concentrations**	
a.	**group homes:**	- None Identified
b.	**large apartment buildings:**	- None Identified
c.	**schools:**	- None Identified
d.	**childcare facilities:**	- Julie Klinger, 17950 Apple (capacity 12)
e.	**large office buildings:**	- See 4.h.
f.	**other:** (such as stadiums, concert halls, amusement parks, fairgrounds, correctional facilities, nursing homes, other special populations or large crowd assembly areas)	- The Redneck Kountry Club RV Campground
g.	**major employers:**	- None Identified
3.	**Population Shifts** *(numbers include Village of Casnovia)*	
a.	**daily:**	- 1,322 commute with an average commuting time of 30.4 minutes - 692 school-aged children
b.	**seasonal:**	- 1,022 total housing units: 944 occupied/78 vacant - Of the vacant, 13 (16.7%) are for seasonal recreational or occasional use
4.	**Important or Critical Public and Private Facilities**	
a.	**police precincts:**	- None Identified
b.	**fire stations:**	- Casnovia Township Fire Department, 17569 Bailey Rd.
c.	**public works yards:**	- None Identified
d.	**pumping stations:**	- None Identified
e.	**community shelters:**	- None Identified
f.	**community medical facilities, hospitals:**	- None Identified
g.	**historic sites:**	- None Identified
h.	**other:** (i.e., government buildings, record center, major construction companies, warehouses, demolition companies, heavy equipment rental, emergency equipment and vehicle storage)	- Casnovia Township Hall, 245 Canada Rd.

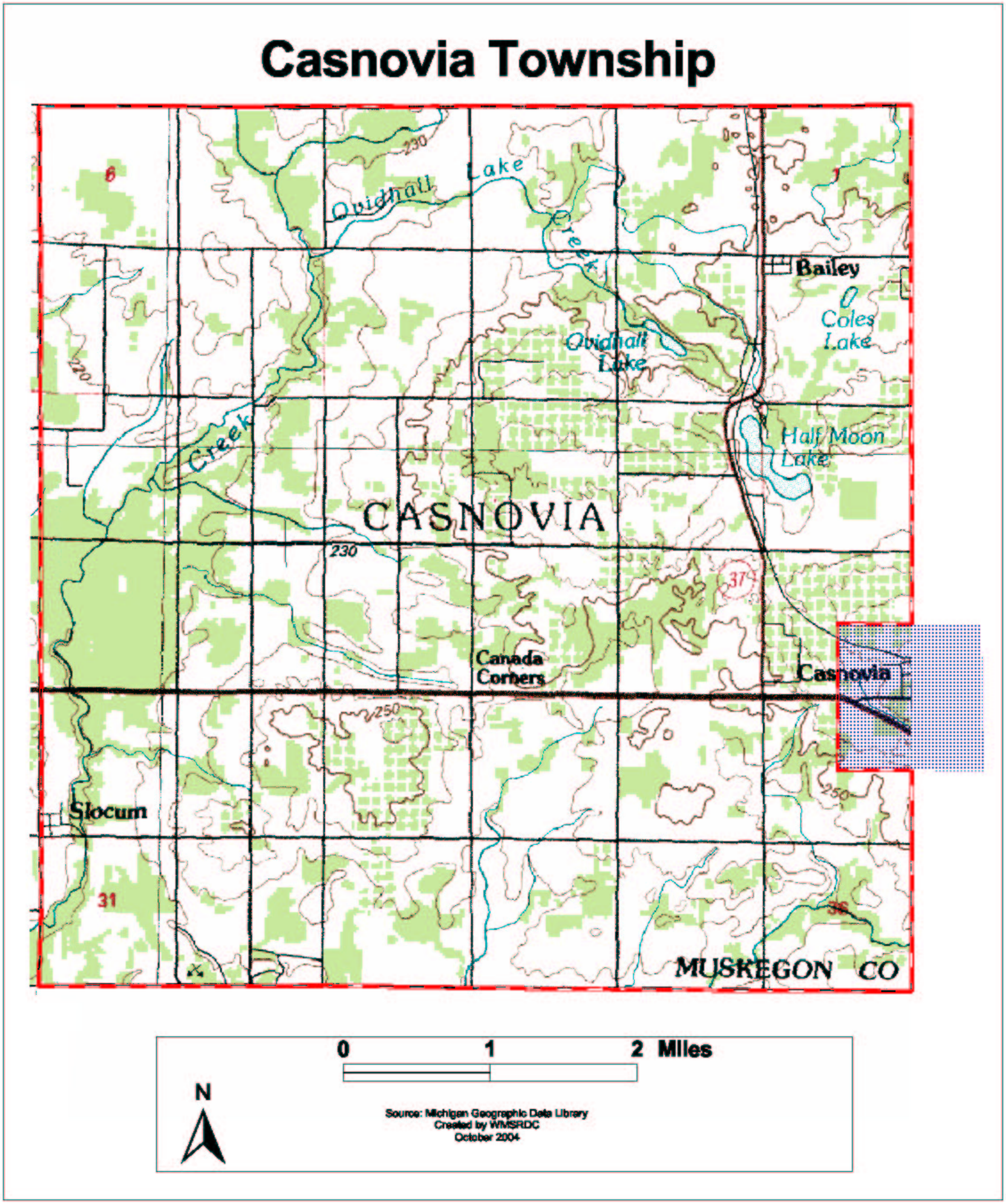
5.	Vital or Critical Infrastructure	
a.	**roads, railroads, and bridges:**	- M-46, M-37 - B-35 - Marquette Rail Railroad
b.	**dams, power stations, water treatment plants, sanitary lift stations, etc.**	- Power Transmission Line - Great Lakes Co-op
c.	**other** (i.e. airports, pipelines, bus terminals, train stations, military bases, marine passenger ferry services)	- None Identified

6.	Socio-Economic Profile of Sector		
a.	**total population (night):**	*(numbers include Village of Casnovia)*	2,805
b.	**peak population (seasonal):**	*(numbers include Village of Casnovia)*	2,843
c.	**percent over 65:**		9.9
d.	**percent under 18:**		29.2
e.	**percent that are homeowners:**		87.3
f.	**percent below poverty level:**		7.1
g.	**percent with disability or mobility limitation:**		17.2
h.	**estimated property insurance coverage:** **(Real and Personal Equalized Valuations)**	Agricultural: Commercial: Industrial: Residential: Utility (Personal): Total:	$29,586,300 $2,259,700 $970,000 $43,802,900 $3,295,700 $79,914,600
i.	**flood insurance coverage:**	Total Losses since 01/01/78: Total Payments since 01/01/78: Policies In-Force: Total Insurance In-Force:	*Not participating in the NFIP*
j.	**location of floodplains:**	N/A	

7.	Emergency Warning System Coverage	
a.	**siren locations and/or description of warning system:**	- None Identified
b.	**percent of population covered by warning sirens or system:**	N/A

(Note: Map showing warning siren location and system coverage is contained in Part D.)

Land Use and Natural Features Map (USGS Quad.)



CEDAR CREEK TOWNSHIP

1.	**major geographic features:**	- 90.5 persons per square mile - 40 housing units per square mile - Densely forested (Manistee National Forest and Muskegon State Game Area in southern portion) - Muskegon River - Hornungs Duck Lake - 26 to 30 small lakes and ponds, 12 to 16 small creeks

2.	**Population Concentrations**	
a.	**group homes:**	- Friendly Haven, 7665 E Ryerson Rd (capacity 4) - Paul's Place AFC, 3475 E Tyler (capacity 6)
b.	**large apartment buildings:**	- Cedar Creek Apartments, 2226 Dalson Rd. (32 family units)
c.	**schools:**	- None
d.	**childcare facilities:**	- Darlene Potter, 4298 E River Rd (capacity 12) - Wooly Lambs Education and Daycare (capacity 45)
e.	**large office buildings:**	- See 4.h.
f.	**other:** (such as stadiums, concert halls, amusement parks, fairgrounds, correctional facilities, nursing homes, other special populations or large crowd assembly areas)	- Wooly Lambs Education and Daycare, 3529 E. Tyler Rd. (45 capacity) - YMCA Camp Pinewood, 4230 Obenauf Rd. - Stonegate Golf Club, 4100 Sweeter Rd.
g.	**major employers:**	- None Identified

3.	**Population Shifts**	
a.	**daily:**	- 1,572 commute with an average commuting time of 26.8 minutes - 652 school-aged children
b.	**seasonal:**	- 1,409 total housing units: 1,207 occupied/202 vacant - Of the vacant, 83 (41.1%) are for seasonal recreational or occasional use

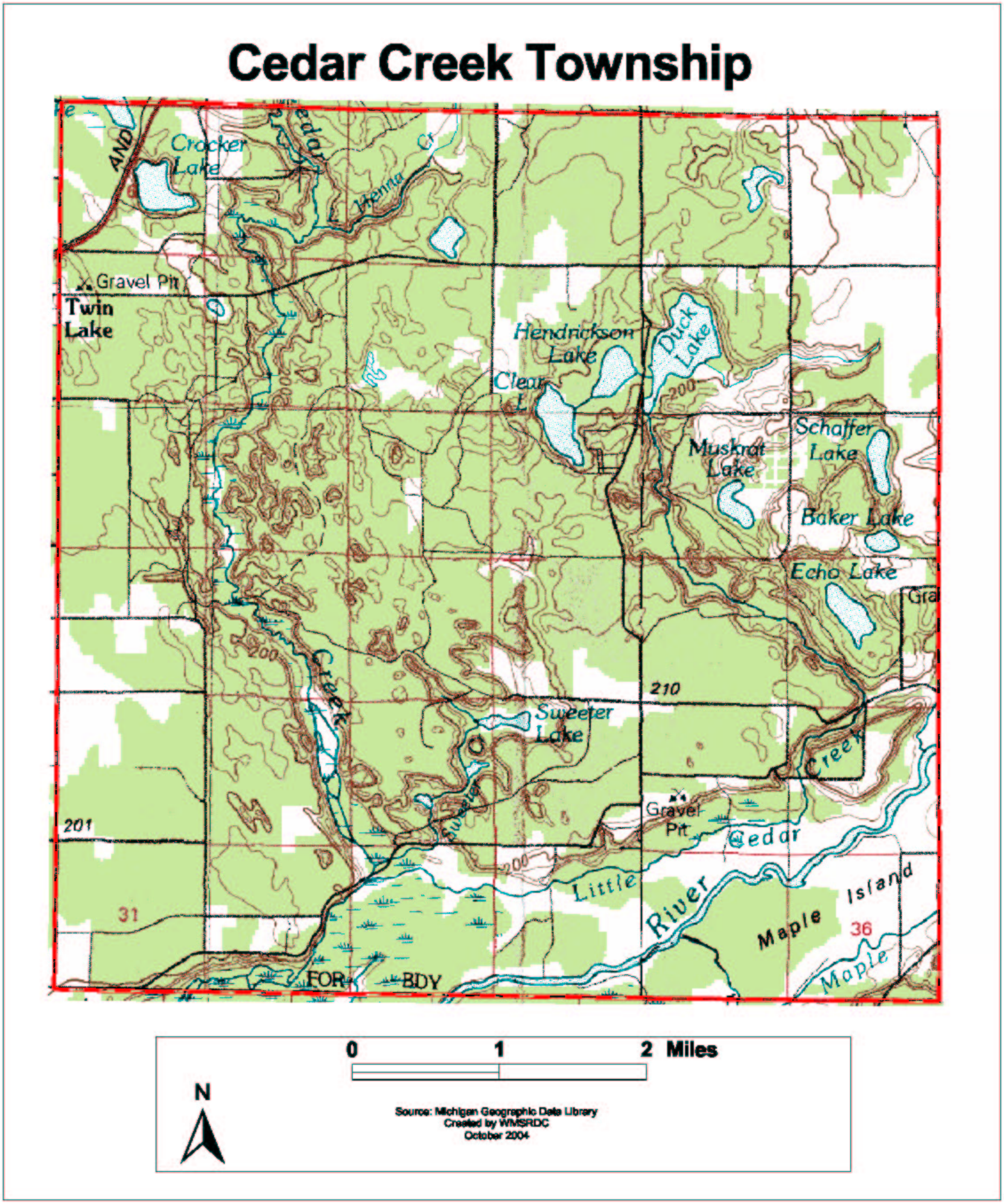
4.	**Important or Critical Public and Private Facilities**	
a.	**police precincts:**	- None Identified
b.	**fire stations:**	- DNR Muskegon Field Office, 7550 E Messinger Rd
c.	**public works yards:**	- None Identified
d.	**pumping stations:**	- None Identified
e.	**community shelters:**	- None Identified
f.	**community medical facilities, hospitals:**	- None Identified
g.	**historic sites:**	- None Identified
h.	**other:** (i.e., government buildings, record center, major construction companies, warehouses, demolition companies, heavy equipment rental, emergency equipment and vehicle storage)	- Cedar Creek Township Hall, 6556 Sweeter Rd. - Michigan State Government Department of Natural Resources, 7600 Messinger Rd.

5.	**Vital or Critical Infrastructure**	
a.	**roads, railroads, and bridges:**	- M-120 - B-31 - Michigan Shore Railroad
b.	**dams, power stations, water treatment plants, sanitary lift stations, etc.**	- Power Transmission Line
c.	**other** (i.e. airports, pipelines, bus terminals, train stations, military bases, marine passenger ferry services)	- Natural Gas Pipeline

6.	**Socio-Economic Profile of Sector**		
a.	**total population (night):**		3,186
b.	**peak population (seasonal):**		3,403
c.	**percent over 65:**		12.1
d.	**percent under 18:**		24.3
e.	**percent that are homeowners:**		89.5
f.	**percent below poverty level:**		15.1
g.	**percent with disability or mobility limitation:**		25.8
h.	**estimated property insurance coverage:** **(Real and Personal Equalized Valuations)**	Agricultural: Commercial: Industrial: Residential: Utility (Personal): Total:	$4,601,900 $5,014,200 $0 $58,510,400 $2,334,600 $70,461,100
i.	**flood insurance coverage:**	Total Losses since 01/01/78: Total Payments since 01/01/78: Policies In-Force: Total Insurance In-Force:	*Not participating in the NFIP*
j.	**location of floodplains:**	N/A	

7.	**Emergency Warning System Coverage**	
a.	**siren locations and/or description of warning system:**	- None Identified
b.	**percent of population covered by warning sirens or system:**	N/A

Land Use and Natural Features Map (USGS Quad.)



DALTON TOWNSHIP

1.	**major geographic features:**	- 260.5 persons per square mile - 105 housing units per square mile - Moderate residential areas - Moderately forested - Twin Lakes - 7 small lakes and ponds, 3 small creeks

2.	**Population Concentrations**	
a.	**group homes:**	- Families Manor, 2330 Riverwood Dr (capacity 6) - Patti's Place, 2255 Pillon Rd (capacity 4) - Riverwood, 2743 S Riverwood (capacity 6)
b.	**large apartment buildings:**	- None Identified
c.	**schools:**	- Twin Lake Elementary (Reeths-Puffer Schools), 3175 5th St. (269 students, 25 staff)
d.	**childcare facilities:**	- Tricia Slatton, 862 Agard Rd (capacity 12) - Marjorie Mura, 508 E Riley Thompson Rd (capacity 12) - Erin Wilks, 5019 Automobile Rd (capacity 12) - Leah Nummerdor, 2331 Beattie Rd (capacity 12) - Julie Grinwis & Connie Grinwis, 3118 N Riverwood Dr (capacity 12) - Kimberly Kay Stanhope, 2536 Cove Rd (capacity 12) - Reeths Puffer-Twin Lake Head Start & Kids Stop, 3175 Fifth St (capacity 45) - The Hop Inc Your Neighborhood Child Care Center, 2495 Holton Rd (capacity 59)
e.	**large office buildings:**	- See 4.h.
f.	**other:** (such as stadiums, concert halls, amusement parks, fairgrounds, correctional facilities, nursing homes, other special populations or large crowd assembly areas)	- Thunderbird Raceway, 350 W Riley Thompson Rd - Lake Sch-Nepp-A-Ho Campground, 390 E. Tyler Rd. (100 campsites) - Muskegon KOA, 3500 Strand Rd. (96 campsites) - Camp Lor-Ray, 5281 Russell Rd - Twin Lake County Park, 6231 Main St. - Chase Hammond Golf Course, 2454 Putnam Rd. (18 holes)
g.	**major employers:**	- Michigan's Adventure, 4750 Whitehall Rd

3.	**Population Shifts** *(numbers include Village of Lakewood Club)*	
a.	**daily:**	- 4,149 commute with an average commuting time of 22.8 minutes - 2,094 school-aged children
b.	**seasonal:**	- 3,748 total housing units: 3,368 occupied/380 vacant - Of thevacant, 150 (39.5%) are for seasonal recreational or occasional use

4.	**Important or Critical Public and Private Facilities**	
a.	**police precincts:**	- None Identified
b.	**fire stations:**	- Dalton Township Fire Department, 1650 E. Riley Thompson
c.	**public works yards:**	- Dalton Maintenance, 1618 E. Riley Thompson

d.	**pumping stations:**	- None Identified
e.	**community shelters:**	- Twin Lake Elementary, 3175 Fifth St - Fifth Reformed Church, 1800 E River Rd
f.	**community medical facilities, hospitals:**	- None Identified
g.	**historic sites:**	- None Identified
h.	**other:** (i.e., government buildings, record center, major construction companies, warehouses, demolition companies, heavy equipment rental, emergency equipment and vehicle storage)	- Dalton Township Hall, 1616 E. Riley Thompson Rd. - Dalton Township Library, 3175 5th St. - Muskegon County Road Commission, 5333 Holton Rd

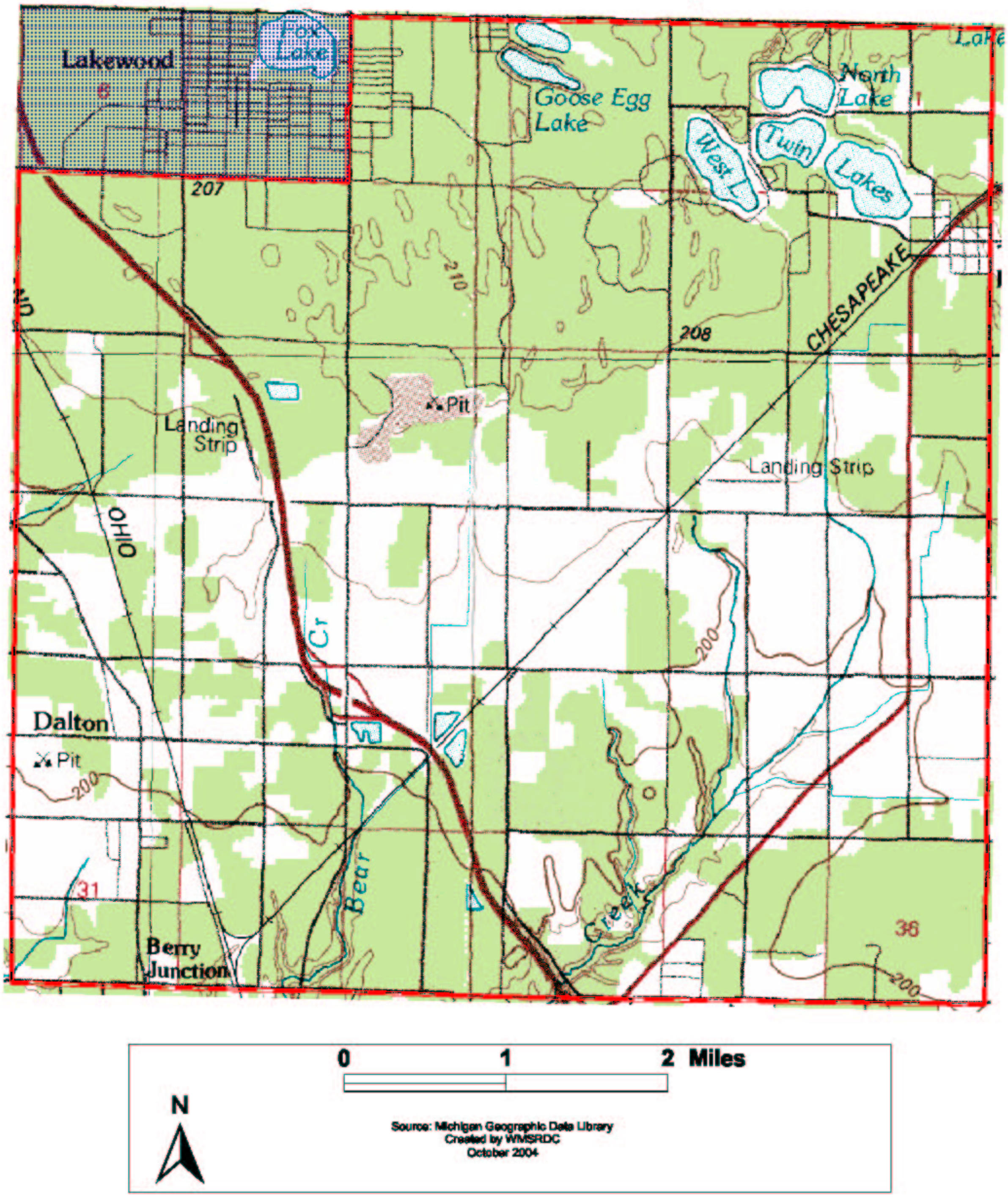
5.	**Vital or Critical Infrastructure**	
a.	**roads, railroads, and bridges:**	- US-31 - M-120 - B-23 - Michigan Shore Railroad
b.	**dams, power stations, water treatment plants, sanitary lift stations, etc.**	- Power Transmission Line
c.	**other** (i.e. airports, pipelines, bus terminals, train stations, military bases, marine passenger ferry services)	- Midget Private Airport, 4821 Cady Rd. - Natural Gas Pipeline

6.	**Socio-Economic Profile of Sector**		
a.	**total population (night):**	*(numbers include Village of Lakewood Club)*	9,300
b.	**peak population (seasonal):**	*(numbers include Village of Lakewood Club)*	9,714
c.	**percent over 65:**		9.7
d.	**percent under 18:**		27.5
e.	**percent that are homeowners:**		90.5
f.	**percent below poverty level:**		7.7
g.	**percent with disability or mobility limitation:**		20.9
h.	**estimated property insurance coverage:** **(Real and Personal Equalized Valuations)**	Agricultural: Commercial: Industrial: Residential: Utility (Personal): Total:	$0 $19,222,600 $1,431,100 $187,248,900 $16,867,800 $224,770,400
i.	**flood insurance coverage:**	Total Losses since 01/01/78: Total Payments since 01/01/78: Policies In-Force: Total Insurance In-Force:	*Not participating in the NFIP*
j.	**location of floodplains:**	N/A	

7.	**Emergency Warning System Coverage**	
a.	**siren locations and/or description of warning system:**	- None Identified
b.	**percent of population covered by warning sirens or system:**	N/A

Land Use and Natural Features Map (USGS Quad.)

Dalton Township



EGELSTON TOWNSHIP

1.	**major geographic features:**	- 283.1 persons per square mile - 110.9 housing units per square mile - Densely forested (Muskegon State Game Area in northern half) - Muskegon County Water Management Sewage Lagoons - Wolf Lake and Muskegon River - 5 to 7 small lakes and ponds, 8 to 10 small creeks

2.	**Population Concentrations**	
a.	**group homes:**	- None Identified
b.	**large apartment buildings:**	- None Identified
c.	**schools:**	- Oakridge High School, 5493 Hall Rd. (493 students, 51 staff) - Oakridge Middle School, 251 S. Wolf Lake Rd. (296 students, 36 staff) - Oakridge Upper Elem., 481 S. Wolf Lake Rd. (471 students, 42 staff) - Oakridge Lower Elem., 5290 Bryn Mawr Pl. (660 students, 61 staff) - Oakridge Alternative Education, (56 students, 7 staff)
d.	**childcare facilities:**	- Creative Child Preschool, 4200 Apple Ave (capacity 20) - Dawn Lewis, 1167 Ellison Rd (capacity 12) - Grandma Shirley's DayCare, 4410 E Laketon Ave (capacity 12) - Little Ones, 4775 E Apple Ave (capacity 16) - Oakridge Lower Elementary, 120 N Park St (capacity 140) - Sanda Kay Morence, 4260 White Rd (capacity 12)
e.	**large office buildings:**	- See 4.h.
f.	**other:** (such as stadiums, concert halls, amusement parks, fairgrounds, correctional facilities, nursing homes, other special populations or large crowd assembly areas)	- Oakridge High School Football Stadium, 5493 Hall Rd. - Gonyons Child Care Center, 622 Chatterson Rd. (18 capacity) - Wolf Lake Resort & Campground, 5451 Harding Ave. - Apple Carr Village I Mobile Home Community, 516 Courtland Ln - Apple Carr Village II Mobile Home Community, 516 Courtland Ln - Apple Carr Village III Mobile Home Community, 516 Courtland Ln - Egelcraft Mobile Home Park, 4065 South Ironwood - Eglecraft Mobile Home Park, 4158 Sawgrass Trail Lot 281 - Maple Island Estates Mobile Home Community, 7321 White Road Lot 74 - Egelston-Wolf Lake Festival, Flickema Park- July 12-13
g.	**major employers:**	- Eagle Alloy, 5142 Evanston Ave (361 employees) - Sun Chemical, 5025 Evanston Ave (182 employees)

3.	**Population Shifts**	
a.	**daily:**	- 4,028 commute with an average commuting time of 23.2 minutes - 2,272 school-aged children
b.	**seasonal:**	- 3,882 total housing units: 3,620 occupied/262 vacant - Of thevacant, 37 (14.1%) are for seasonal recreational or occasional use

4.	**Important or Critical Public and Private Facilities**	
a.	**police precincts:**	- Egelston Township Police Department, 5380 E. Apple Ave.

b.	**fire stations:**	- Egelston Township Fire Department, 5380 E. Apple Ave.
c.	**public works yards:**	- None Identified
d.	**pumping stations:**	- Muskegon County Waste Management, Metro Site, 8301 White Rd.
e.	**community shelters:**	- Oakridge Middle School, 251 S Wolf Lake Rd
f.	**community medical facilities, hospitals:**	- None Identified
g.	**historic sites:**	- None Identified
h.	**other:** (i.e., government buildings, record center, major construction companies, warehouses, demolition companies, heavy equipment rental, emergency equipment and vehicle storage)	- Egelston Township Hall, 5428 E. Apple Ave. - Egelston Township Library, 5428 E. Apple Ave. - Muskegon County Road Commission, 7700 E. Apple Ave.

5.	**Vital or Critical Infrastructure**	
a.	**roads, railroads, and bridges:**	- M-46 - B-31
b.	**dams, power stations, water treatment plants, sanitary lift stations, etc.**	- Muskegon County Wastewater Management - Metro Site, 8301 White Rd. - Egelston Township Sewer and Maintenance, 5360 E. Apple Ave. - Sanitary Lift Stations: One - Power Transmission Line - Muskegon Wastewater Lagoon Dam (Black and Mosquito Creeks)
c.	**other** (i.e. airports, pipelines, bus terminals, train stations, military bases, marine passenger ferry services)	- Natural Gas Pipeline

6.	**Socio-Economic Profile of Sector**		
a.	**total population (night):**		9,909
b.	**peak population (seasonal):**		10,010
c.	**percent over 65:**		1,165
d.	**percent under 18:**		26.7
e.	**percent that are homeowners:**		88.4
f.	**percent below poverty level:**		10.8
g.	**percent with disability or mobility limitation:**		20.7
h.	**estimated property insurance coverage:** **(Real and Personal Equalized Valuations)**	Agricultural: Commercial: Industrial: Residential: Utility (Personal): Total:	$0 $20,194,500 $11,561,400 $139,401,200 $23,242,100 $194,399,200
i.	**flood insurance coverage:**	Total Losses since 01/01/78: Total Payments since 01/01/78: Policies In-Force: Total Insurance In-Force:	2 $18,496 6 $631,000
j.	**location of floodplains:**	- Black Creek, Carr Lake area, Mosquito Creek, Maple River, and Muskegon River & tributaries	

7.	Emergency Warning System Coverage	
a.	**siren locations and/or description of warning system:**	- None Identified
b.	**percent of population covered by warning sirens or system:**	N/A
(Note: Map showing warning siren location and system coverage is contained in Part D.)		

Land Use and Natural Features Map (USGS Quad.)

Egelston Township

FRUITLAND TOWNSHIP

1.	**major geographic features:**	- 151.9 persons per square mile - 71 housing units per square mile - Moderately forested - Lake Michigan shoreline and beach - Coastal sand dunes - White Lake - Duck Lake - 10 to 12 small lakes and ponds, 8 to 10 small creeks
2.	**Population Concentrations**	
a.	**group homes:**	- Oxford Circle, 3293 Orshal Rd (capacity 4) - Pinewood Retirement Home, 3234 Nestrom (capacity 6) - Skyline Home, 3297 Orshal Rd (capacity 4) - Terra Nova, 2745 W White Lake Dr (capacity 3) - White Lake Assisted Living, 6827 Whitehall Rd (capacity 38)
b.	**large apartment buildings:**	- None Identified
c.	**schools:**	- McMillan Elementary (Reeths-Puffer Schools), 2885 Hyde Park Rd. (200 students, 26 staff)
d.	**childcare facilities:**	- Cookie's Kids Daycare, 1936 W Bard Rd (capacity 12) - Raquel Heylmun, 3135 White Lake Dr (capacity 12) - Reeths Puffer McMillan Elementary, 2885 Hyde Park Rd (capacity 58) - Robin Carpenter, 5187 Duck Lake Rd (capacity 12)
e.	**large office buildings:**	- See 4.h.
f.	**other:** (such as stadiums, concert halls, amusement parks, fairgrounds, correctional facilities, nursing homes, other special populations or large crowd assembly areas)	- Michigan's Adventure Amusement Park, 4750 Whitehall Rd. - South Shore Marina, 6806 S. Shore Dr. (boat rentals) - Bent Pine Golf Club, 2480 Duck Lake Rd. (18 holes) - Lincoln Golf Club, 4907 Whitehall Rd. (18 holes) - White Lake Golf Club, 6777 S. Shore Dr. (18 holes) - Duck Lake State Park, 5849 W. Michillinda Rd. - Lakeside Inn Resort, 5700 N. Scenic Dr. (35 units, 3 apartments, 1 cottage)
g.	**major employers:**	- None Identified
3.	**Population Shifts**	
a.	**daily:**	- 2,209 commute with an average commuting time of 25.3 minutes - 1,179 school-aged children
b.	**seasonal:**	- 2,592 total housing units: 2,097 occupied/495 vacant - Of the vacant, 383 (77.4%) are for seasonal recreational or occasional use
4.	**Important or Critical Public and Private Facilities**	
a.	**police precincts:**	- None Identified
b.	**fire stations:**	- (covered by White Lake Fire Authority)
c.	**public works yards:**	- None Identified
d.	**pumping stations:**	- None Identified

e.	**community shelters:**	- Duck Creek Learning Center, 4600 Gibson Rd. - Fruitland Evangelical Covenant, 4283 N. Weber Rd. - McMillan Elementary, 2885 Hyde Park Rd.
f.	**community medical facilities, hospitals:**	- None Identified
g.	**historic sites:**	- Fruitland District No. 6 School, 6227 South Shore Rd
h.	**other:** (i.e., government buildings, record center, major construction companies, warehouses, demolition companies, heavy equipment rental, emergency equipment and vehicle storage)	- Fruitland Township Hall, 4545 Nestrom Rd.

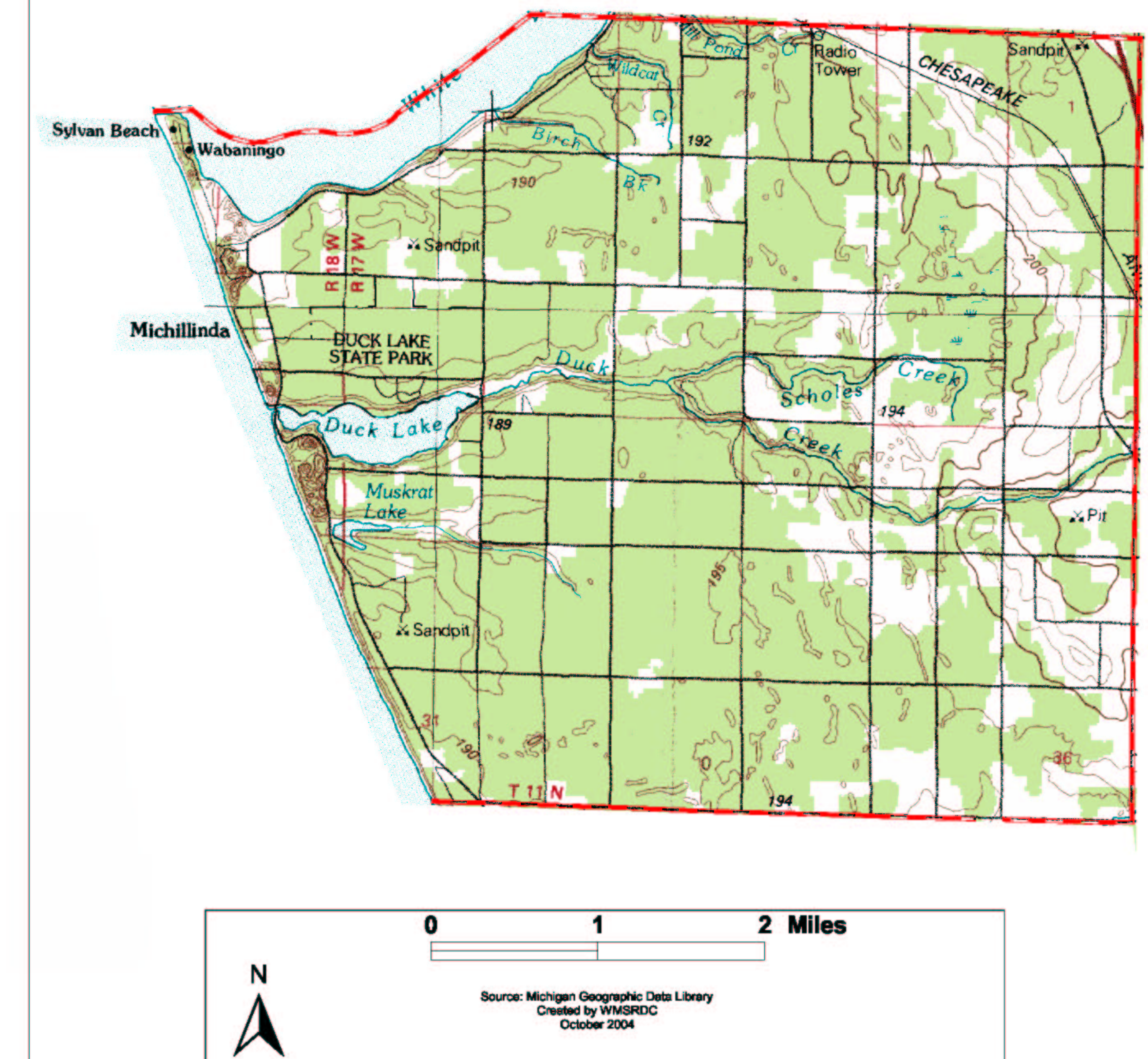
5.	**Vital or Critical Infrastructure**	
a.	**roads, railroads, and bridges:**	- US-31
b.	**dams, power stations, water treatment plants, sanitary lift stations, etc.**	- Power Transmission Line
c.	**other** (i.e. airports, pipelines, bus terminals, train stations, military bases, marine passenger ferry services)	- None Identified

6.	**Socio-Economic Profile of Sector**		
a.	**total population (night):**		5,543
b.	**peak population (seasonal):**		6,554
c.	**percent over 65:**		9.7
d.	**percent under 18:**		29.0
e.	**percent that are homeowners:**		89
f.	**percent below poverty level:**		9.3
g.	**percent with disability or mobility limitation:**		17
h.	**estimated property insurance coverage:** **(Real and Personal Equalized Valuations)**	Agricultural: Commercial: Industrial: Residential: Utility (Personal): Total:	$2,458,100 $10,582,400 $0 $260,538,500 $10,027,600 $283,606,600
i.	**flood insurance coverage:**	Total Losses since 01/01/78: Total Payments since 01/01/78: Policies In-Force: Total Insurance In-Force:	3 $12,880 15 $2,571,800
j.	**location of floodplains:**	- Lake Michigan shoreline, White Lake shoreline, Duck Lake shoreline, Muskrat Lake shoreline and tributaries	

7.	**Emergency Warning System Coverage**	
a.	**siren locations and/or description of warning system:**	- None Identified
b.	**percent of population covered by warning sirens or system:**	N/A

Land Use and Natural Features Map (USGS Quad.)

Fruitland Township



FRUITPORT CHARTER TOWNSHIP

1.	**major geographic features:**	- 453.3 persons per square mile - 179.6 housing units per square mile - Moderately forested - Spring Lake - 8 to 10 small lakes and ponds, 10 to 12 small creeks
2.	**Population Concentrations**	
a.	**group homes:**	- Agape Home at Blueberry Fields, 4747 E Mount Garfield Rd (capacity 18) - Airline Road Home, 4752 Airline Rd (Capacity 6) - Amanda CLF, 4021 Amanda St (capacity 6) - Broadway Home, 2315 E Broadway (capacity 6) - Brookmere Home, 3086 Creekview Ln (capacity 6) - Plan B Adult Foster Care, 2171 Monte Ave (capacity 6) - Sheridan AFC, 4144 Sheridan Dr (capacity 6) - The Agape Home, 4445 S Brooks Rd (capacity 20)
b.	**large apartment buildings:**	- Catalina Shores, 5970 Avalon (88 units)
c.	**schools:**	- Fruitport Middle School, 3113 Pontaluna (703 students) - Beach Elementary, 2741 Heights Ravenna (390 students) - Shettler Elementary, 2187 Shettler Rd. (396 students) - Cavalry Christian School, 5873 Kendra Rd. - Eagle’s Nest Preschool, 5873 Kendra Rd. - Broadway Baptist School, 2892 Oak Lane
d.	**childcare facilities:**	- Sandra A Liphard, 2756 E Sternberg Rd (capacity 12) - Shannon L Donley, 6701 Beech Creek Dr (capacity 12) - Marla Punches, 3180 S Dangl Rd (capacity 12) - CJS Playhouse, 4445 S Virginia Dr (capacity 12) - Janet Boyer, 3648 W Fuller Dr (capacity 12) - Cathy Chandler, 3278 Hts Ravenna Rd (capacity 12) - Robin Liphard, 1816 Pontaluna Rd (capacity 12) - Grace Lutheran Preschool, 2651 Shettler Rd (capacity 18) - Eagle’s Nest Preschool, 5873 Kendra Rd (capacity 25) - Shettler Elementary School, 2187 E Shettler Rd (capacity 45) - Fruitport Early Childhood Center, 3113 E Pontaluna Rd (capacity 90) - Edgewood Elementary School, 3255 E Pontaluna Rd (capacity 122)
e.	**large office buildings:**	- See 4.h.
f.	**other:** (such as stadiums, concert halls, amusement parks, fairgrounds, correctional facilities, nursing homes, other special populations or large crowd assembly areas)	- Lakeshore Sports Center (2 ice rinks, 1 indoor soccer field), 4470 Airline Rd. - Fruitport Golf Club, 6330 S. Harvey St. (18 holes) - West Wind Golf Course, 2540 E. Hile Rd. (two, 18 hole courses) - The Lakes Mall, 5600 S. Harvey St. - Comfort Inn, 1675 E. Sherman Blvd. (117 rooms) - El Royal Motel, 4610 Airline Rd. (31 rooms) - Clover Estates Mobile Home Park, 3239 Clover Parkway - Hidden Oaks Mobile Home Community, 14787 Apple Rd - Muskegon County Fairgrounds, 6621 Heights Ravenna Rd

g.	**major employers:**	- Mercy Health Partners-Lakes Village, 6401 Prairie St - Meijer-Fruitport, 5326 S Harvey St - Lakes Mall, 5600 S Harvey St

3.	**Population Shifts** *(numbers include Village of Fruitport)*	
a.	**daily:**	- 6,249 commute with an average commuting time of 20 minutes - 2,938 school-aged children
b.	**seasonal:**	- 5,389 total housing units: 5,103 occupied/286 vacant - Of the vacant, 51 (17.8%) are for seasonal recreational or occasional use

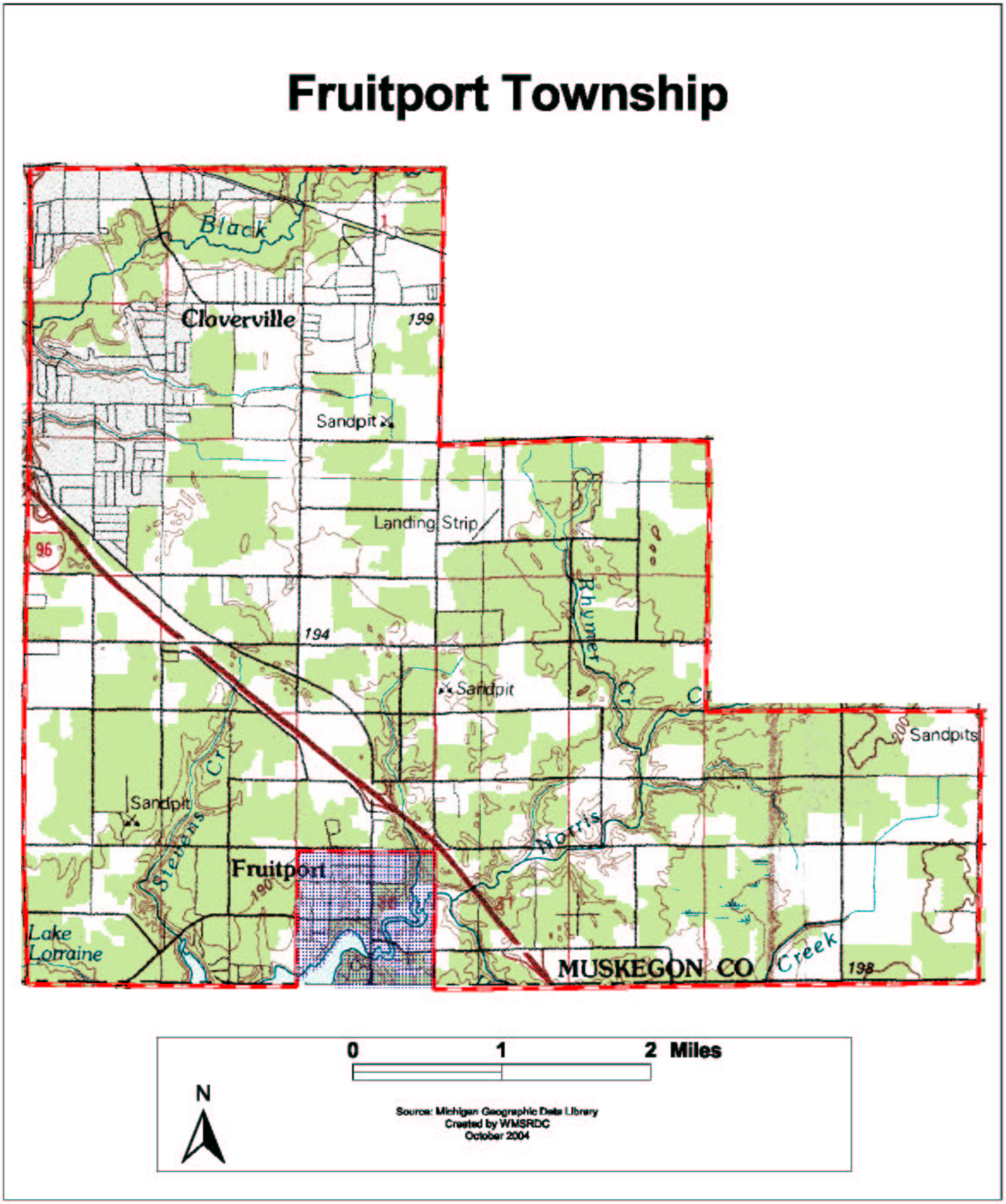
4.	**Important or Critical Public and Private Facilities**	
a.	**police precincts:**	- None Identified
b.	**fire stations:**	- Fruitport Township Fire Department #1, 5815 Airline Rd. - Fruitport Township Fire Department #2, 3368 Black Creek Rd.
c.	**public works yards:**	- None Identified
d.	**pumping stations:**	- None Identified
e.	**community shelters:**	- Fruitport Middle School, 3113 Pontaluna Rd.
f.	**community medical facilities, hospitals:**	- None Identified
g.	**historic sites:**	- None Identified
h.	**other:** (i.e., government buildings, record center, major construction companies, warehouses, demolition companies, heavy equipment rental, emergency equipment and vehicle storage)	- Fruitport Township Hall, 5865 Airline Rd.

5.	**Vital or Critical Infrastructure**	
a.	**roads, railroads, and bridges:**	- I-96 - US-31 - B-72, B-31
b.	**dams, power stations, water treatment plants, sanitary lift stations, etc.**	- Fruitport Township Water Dept, 6543 Airline Rd - Fruitport Township Sewer Dept, 2810 E. Mt. Garfield
c.	**other** (i.e. airports, pipelines, bus terminals, train stations, military bases, marine passenger ferry services)	- Oil Pipeline - Landing Strip, Jenson Rd. and Cloverville Rd.

6.	**Socio-Economic Profile of Sector**		
a.	**total population (night):**	*(numbers include Village of Fruitport)*	13,598
b.	**peak population (seasonal):**	*(numbers include Village of Fruitport)*	13,733
c.	**percent over 65:**		13.6
d.	**percent under 18:**		24.7
e.	**percent that are homeowners:**		89.1
f.	**percent below poverty level:**		6.5
g.	**percent with disability or mobility limitation:**		15

h.	**estimated property insurance coverage:** **(Real and Personal Equalized Valuations)**	Agricultural: Commercial: Industrial: Residential: Utility (Personal): Total:	$5,305,800 $126,164,000 $4,453,700 $321,631,400 $29,661,100 $487,216,000
i.	**flood insurance coverage:**	Total Losses since 01/01/78: Total Payments since 01/01/78: Policies In-Force: Total Insurance In-Force:	*Not participating in the NFIP*
j.	**location of floodplains:**	N/A	
7.	**Emergency Warning System Coverage**		
a.	**siren locations and/or description of warning system:**	- None	
b.	**percent of population covered by warning sirens or system:**	N/A	

Land Use and Natural Features Map (USGS Quad.)



HOLTON TOWNSHIP

1.	**major geographic features:**	- 71.4 persons per square mile - 29.8 housing units per square mile - Densely forested (Manistee National Forest) - Deer Lake - 14 to 16 small lakes and ponds, 10 to 12 small creeks
2.	**Population Concentrations**	
a.	**group homes:**	- Cedar Creek Personal Care 2, 8842 Cedar Creek (capacity 12) - Cedar Creek Personal Care Home I, 8840 Cedar Creek (capacity 12)
b.	**large apartment buildings:**	- None Identified
c.	**schools:**	- Holton High School, 6477 Syers Rd. (265 students, 28 staff) - Holton Middle School, 6245 Syers Rd. (211 students, 15 staff) - Holton Elementary, 6500 4th St. (389 students, 45 staff)
d.	**childcare facilities:**	- Catherine Jo VanTreese, 8130 Brunswick Rd (capacity 12) - Jerrica Warner, 5985 Brunswick Rd (capacity 12) - Holton Head Start, Box 159 Fourth St (capacity 19) - Holton Preschool, 8894 Holton-Duck Lake Rd (capacity 32)
e.	**large office buildings:**	- See 4.h.
f.	**other:** (such as stadiums, concert halls, amusement parks, fairgrounds, correctional facilities, nursing homes, other special populations or large crowd assembly areas)	- Holton High School Football Stadium, 6477 Syers Rd. - Pine Island Estates Mobile Home Community, 3545 Pinewood Tr. - West Pine Island Estates Mobile Home Community, 3534 Pinewood
g.	**major employers:**	- None Identified
3.	**Population Shifts**	
a.	**daily:**	- 961 commute with an average commuting time of 25.5 minutes - 541 school-aged children
b.	**seasonal:**	- 1,050 total housing units: 916 occupied/134 vacant - Of the vacant, 48 (35.8%) are for seasonal recreational or occasional use
4.	**Important or Critical Public and Private Facilities**	
a.	**police precincts:**	- None Identified
b.	**fire stations:**	- Holton Fire Department, 6590 Holton-Whitehall Rd.
c.	**public works yards:**	- None Identified
d.	**pumping stations:**	- None Identified
e.	**community shelters:**	- None Identified
f.	**community medical facilities, hospitals:**	- None Identified
g.	**historic sites:**	- None Identified
h.	**other:** (i.e., government buildings, record center, major construction companies, warehouses, demolition companies, heavy equipment rental, emergency equipment and vehicle storage)	- Holton Township Hall, 6511 Holton Whitehall Rd. - Muskegon County Library - Holton Branch, 8667 Main St.

5.	**Vital or Critical Infrastructure**		
a.	**roads, railroads, and bridges:**	- M-120 - B-86, B-31 - Michigan Shore Railroad	
b.	**dams, power stations, water treatment plants, sanitary lift stations, etc.**	- Power Transmission Line	
c.	**other** (i.e. airports, pipelines, bus terminals, train stations, military bases, marine passenger ferry services)	- Natural Gas Pipeline	
6.	**Socio-Economic Profile of Sector**		
a.	**total population (night):**	2,515	
b.	**peak population (seasonal):**	2,646	
c.	**percent over 65:**	12.8	
d.	**percent under 18:**	24	
e.	**percent that are homeowners:**	84.4	
f.	**percent below poverty level:**	12.2	
g.	**percent with disability or mobility limitation:**	26.5	
h.	**estimated property insurance coverage:** **(Real and Personal Equalized Valuations)**	Agricultural: Commercial: Industrial: Residential: Utility (Personal): Total:	$11,891,100 $3,350,100 $0 $42,052,900 $3,414,000 $60,708,100
i.	**flood insurance coverage:**	Total Losses since 01/01/78: Total Payments since 01/01/78: Policies In-Force: Total Insurance In-Force:	*Not participating in the NFIP*
j.	**location of floodplains:**	N/A	
7.	**Emergency Warning System Coverage**		
a.	**siren locations and/or description of warning system:**	- None Identified	
b.	**percent of population covered by warning sirens or system:**	N/A	

Land Use and Natural Features Map (USGS Quad.)

LAKETON TOWNSHIP

1.	**major geographic features:**	- 437.2 persons per square mile - 183.7 housing units per square mile - Moderately forested - Lake Michigan shoreline and beach - Coastal sand dunes - Muskegon Lake - Bear Lake - 8 to 10 small lakes and ponds, 6 to 8 small creeks
2.	**Population Concentrations**	
a.	**group homes:**	- Hansen Safe, 1635 Hansen St (capacity 4) - Wood Ridge, 1231 Horton Rd (capacity 3) - Luthern Social Services, 1635 Hansen
b.	**large apartment buildings:**	- Brittany Hills Apartments, 2565 Memorial Drive
c.	**schools:**	- Reeths-Puffer Middle School, 1911 W. Giles (645 students, 46 staff) - Central Elementary, 1807 W. Giles (413 students, 38 staff) - Pennsylvania Elementary School, 2500 Pennsylvania (38 students, 2 staff)
d.	**childcare facilities:**	- Carolyn Jean Zietlow, 1491 Hansen St (capacity 12) - Jodi Bowen, 4234 W Giles Rd (capacity 12) - Hayley Gouine, 3696 Kern Rd (capacity 12) - Danielle Santose, 1186 N Robinhood Dr (capacity 12) - Central Elementary, 1807 W Giles Rd (capacity 44)
e.	**large office buildings:**	- See 4.h.
f.	**other:** (such as stadiums, concert halls, amusement parks, fairgrounds, correctional facilities, nursing homes, other special populations or large crowd assembly areas)	- Muskegon State Park, 3560 Memorial Dr. (247 campsites) - Muskegon Winter Sports Complex, Muskegon State Park - Pioneer County Park, 1563 N. Scenic Dr. (240 campsites) - Snug Harbor Motel, 3492 Memorial Dr. - Pines Motel, 1507 Whitehall Rd. - Bear's Den Motel, 2165 Whitehall Rd. - Maple Ridge School (one room schoolhouse), 1659 N. Buys Rd.
g.	**major employers:**	- None Identified
3.	**Population Shifts**	
a.	**daily:**	- 3,488 commute with an average commuting time of 22 minutes - 1,652 school-aged children
b.	**seasonal:**	- 3,178 total housing units: 2,922 occupied/256 vacant - Of the vacant, 81 (31.6%) are for seasonal recreational or occasional use
4.	**Important or Critical Public and Private Facilities**	
a.	**police precincts:**	- None Identified
b.	**fire stations:**	- None Identified
c.	**public works yards:**	- None Identified
d.	**pumping stations:**	- None Identified

e.	**community shelters:**	- Reeths-Puffer Middle School, 1911 W. Giles Rd.
f.	**community medical facilities, hospitals:**	- None Identified
g.	**historic sites:**	- None Identified
h.	**other:** (i.e., government buildings, record center, major construction companies, warehouses, demolition companies, heavy equipment rental, emergency equipment and vehicle storage)	- Laketon Township Hall, 2735 W. Giles Rd.

5. Vital or Critical Infrastructure

a.	**roads, railroads, and bridges:**	- None Identified
b.	**dams, power stations, water treatment plants, sanitary lift stations, etc.**	- None Identified
c.	**other** (i.e. airports, pipelines, bus terminals, train stations, military bases, marine passenger ferry services)	- None Identified

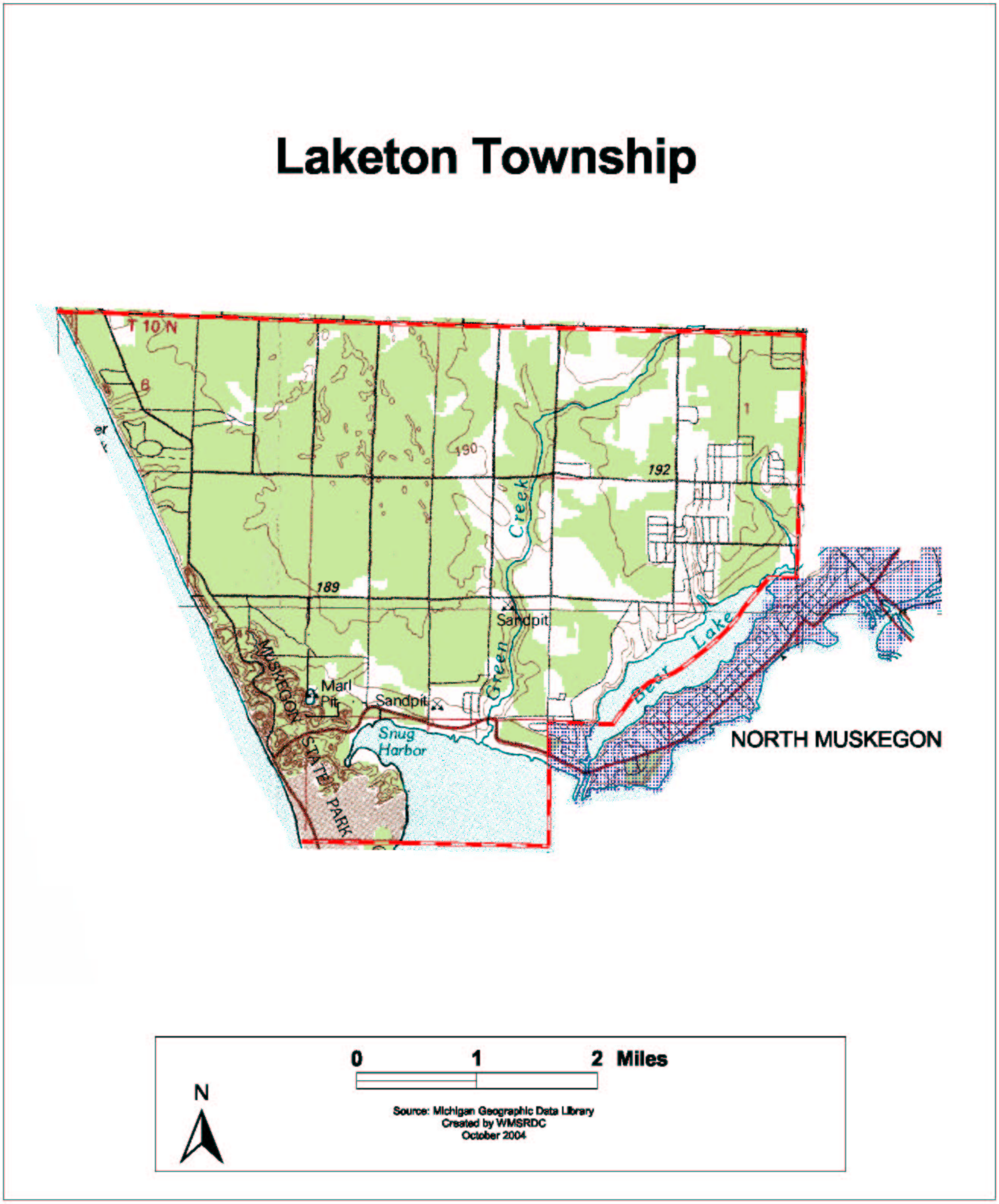
6. Socio-Economic Profile of Sector

a.	**total population (night):**		7,563
b.	**peak population (seasonal):**		7,773
c.	**percent over 65:**		14.8
d.	**percent under 18:**		23.9
e.	**percent that are homeowners:**		90.4
f.	**percent below poverty level:**		4.6
g.	**percent with disability or mobility limitation:**		18.4
h.	**estimated property insurance coverage:** **(Real and Personal Equalized Valuations)**	Agricultural: Commercial: Industrial: Residential: Utility (Personal): Total:	\$0 \$5,112,000 \$0 \$218,315,800 \$5,461,800 \$228,889,600
i.	**flood insurance coverage:**	Total Losses since 01/01/78: Total Payments since 01/01/78: Policies In-Force: Total Insurance In-Force:	7 \$33,629 5 \$823,000
j.	**location of floodplains:**	- Lake Michigan shoreline, Muskegon Lake shoreline, Bear Lake shoreline, and Green Creek & tributaries	

7. Emergency Warning System Coverage

a.	**siren locations and/or description of warning system:**	- None Identified
b.	**percent of population covered by warning sirens or system:**	N/A

Land Use and Natural Features Map (USGS Quad.)



Montague Township

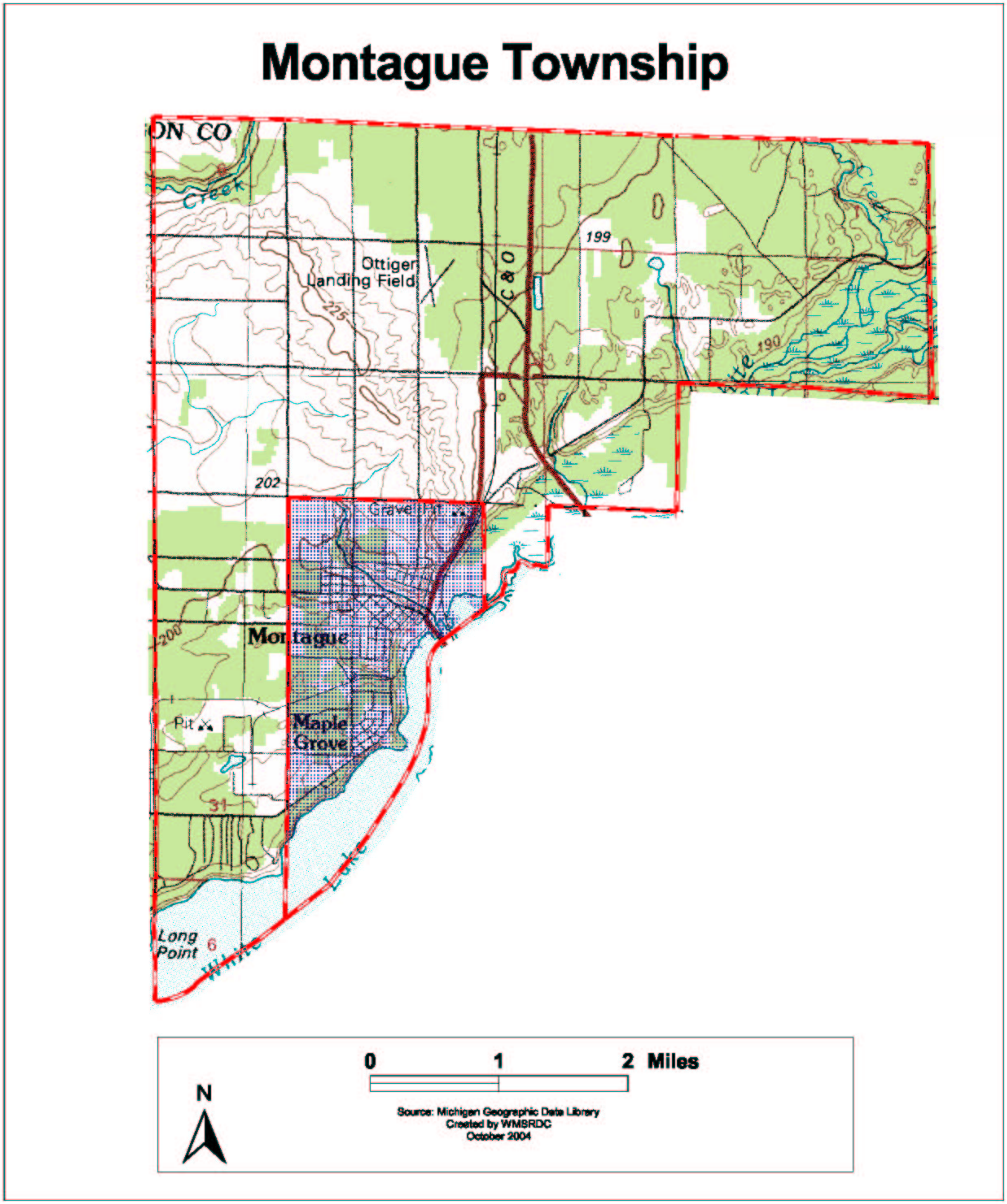
1.	**major geographic features:**	- 84.7 persons per square mile - 36.2 housing units per square mile - Moderately forested, moderate farmland - White Lake - White River - 6 to 8 small lakes and ponds, 14 to 16 small creeks - Hart-Montague Bicycle Trail
2.	**Population Concentrations**	
a.	**group homes:**	- None Identified
b.	**large apartment buildings:**	- None Identified
c.	**schools:**	- None Identified
d.	**childcare facilities:**	- None Identified
e.	**large office buildings:**	- See 4.h.
f.	**other:** (such as stadiums, concert halls, amusement parks, fairgrounds, correctional facilities, nursing homes, other special populations or large crowd assembly areas)	- Montgomery Inn, 10233 Old Highway 31
g.	**major employers:**	- Mastertag International, 9751 U.S. 31 Business (120 employees)
3.	**Population Shifts**	
a.	**daily:**	- 799 commute with an average commuting time of 24.3 minutes - 336 school-aged children
b.	**seasonal:**	- 684 total housing units: 618 occupied/66 vacant - Of the vacant, 32 (48.5%) are for seasonal recreational or occasional use
4.	**Important or Critical Public and Private Facilities**	
a.	**police precincts:**	- None Identified
b.	**fire stations:**	- None Identified
c.	**public works yards:**	- None Identified
d.	**pumping stations:**	- None Identified
e.	**community shelters:**	- None Identified
f.	**community medical facilities, hospitals:**	- None Identified
g.	**historic sites:**	- None Identified
h.	**other:** (i.e., government buildings, record center, major construction companies, warehouses, demolition companies, heavy equipment rental, emergency equipment and vehicle storage)	- Montague Township Hall, 8915 Whitbeck Rd.

5.	**Vital or Critical Infrastructure**	
a.	**roads, railroads, and bridges:**	- US-31 - US-31 Business Route - Old US-31 - B-15, B-86
b.	**dams, power stations, water treatment plants, sanitary lift stations, etc.**	- Power Transmission Line
c.	**other** (i.e. airports, pipelines, bus terminals, train stations, military bases, marine passenger ferry services)	- Ottiger Airport, 10770 Sikkenga Rd. - Natural Gas Pipeline

6.	**Socio-Economic Profile of Sector**		
a.	**total population (night):**		1,600
b.	**peak population (seasonal):**		1,712
c.	**percent over 65:**		15.4
d.	**percent under 18:**		23.4
e.	**percent that are homeowners:**		89.2
f.	**percent below poverty level:**		11.3
g.	**percent with disability or mobility limitation:**		17.9
h.	**estimated property insurance coverage:** **(Real and Personal Equalized Valuations)**	Agricultural: Commercial: Industrial: Residential: Utility (Personal): Total:	$8,234,200 $3,886,700 $962,400 $44,094,900 $6,222,500 $63,400,700
i.	**flood insurance coverage:**	Total Losses since 01/01/78: Total Payments since 01/01/78: Policies In-Force: Total Insurance In-Force:	*Not participating in the NFIP*
j.	**location of floodplains:**	N/A	

7.	**Emergency Warning System Coverage**	
a.	**siren locations and/or description of warning system:**	- None Identified
b.	**percent of population covered by warning sirens or system:**	N/A

Land Use and Natural Features Map (USGS Quad.)



MOORLAND TOWNSHIP

1.	**major geographic features:**	- 43.3 persons per square mile - 17 housing units per square mile - Moderately forested, moderate farmland - Sewage Lagoon (Muskegon County Wastewater Management System) - 3 to 5 small lakes and ponds, 10 to 12 small creeks
2.	**Population Concentrations**	
a.	**group homes:**	- None Identified
b.	**large apartment buildings:**	- None Identified
c.	**schools:**	- None Identified
d.	**childcare facilities:**	- None Identified
e.	**large office buildings:**	- See 4.h.
f.	**other:** (such as stadiums, concert halls, amusement parks, fairgrounds, correctional facilities, nursing homes, other special populations or large crowd assembly areas)	- Moss Ridge Golf Club, 13545 Apple Ave. (18 holes)
g.	**major employers:**	- None Identified
3.	**Population Shifts**	
a.	**daily:**	- 658 commute with an average commuting time of 30.1 minutes - 327 school-aged children
b.	**seasonal:**	- 618 total housing units: 574 occupied/44 vacant - Of the vacant, 3 (6.8%) are for seasonal recreational or occasional use
4.	**Important or Critical Public and Private Facilities**	
a.	**police precincts:**	- None Identified
b.	**fire stations:**	- Moorland Township Fire Department, 12416 E. Apple Ave.
c.	**public works yards:**	- None Identified
d.	**pumping stations:**	- None Identified
e.	**community shelters:**	- None Identified
f.	**community medical facilities, hospitals:**	- None Identified
g.	**historic sites:**	- None Identified
h.	**other:** (i.e., government buildings, record center, major construction companies, warehouses, demolition companies, heavy equipment rental, emergency equipment and vehicle storage)	- Moorland Township Hall, 12416 E. Apple Ave.
5.	**Vital or Critical Infrastructure**	
a.	**roads, railroads, and bridges:**	- M-46 - B-35

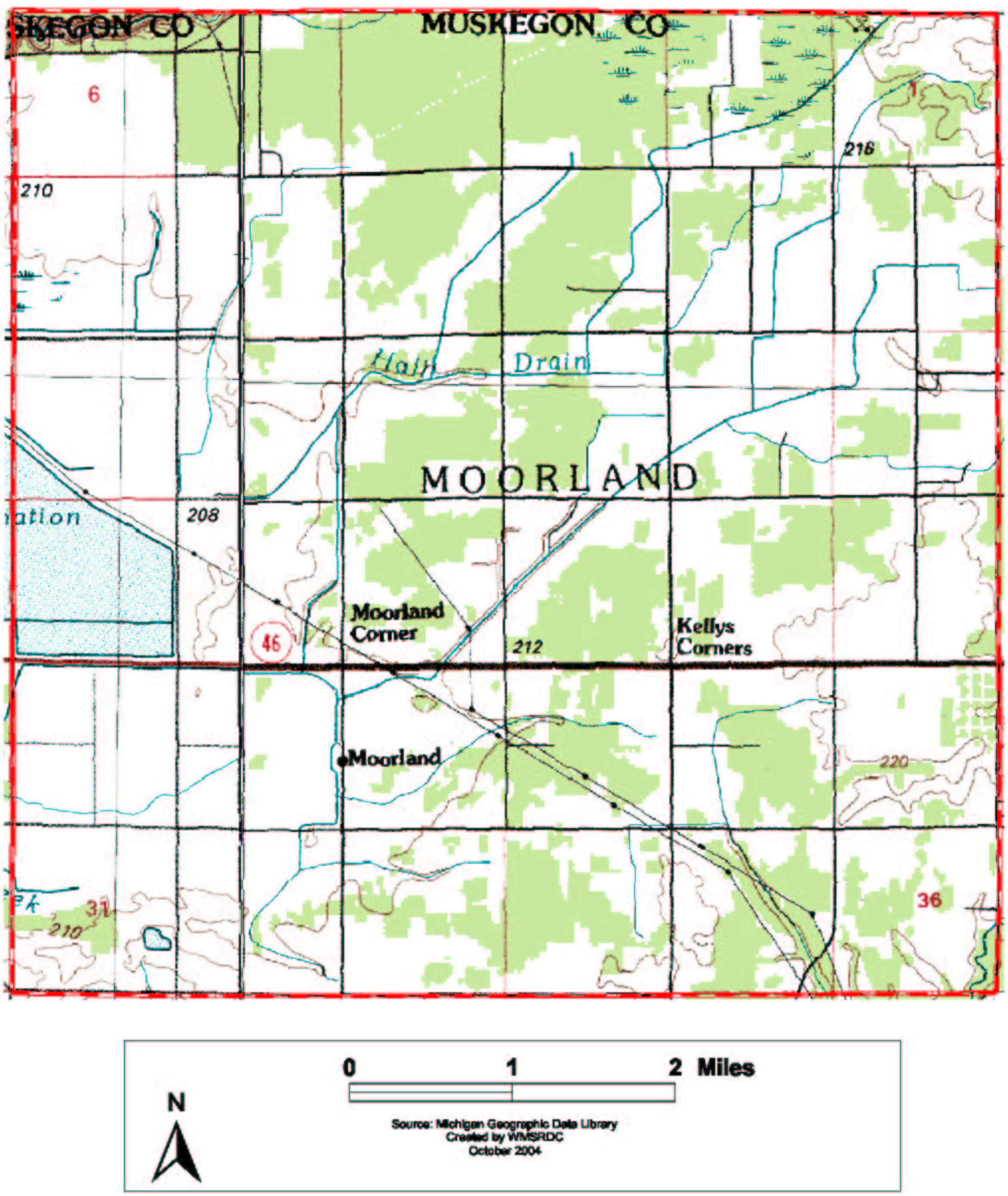
b.	**dams, power stations, water treatment plants, sanitary lift stations, etc.**	- Muskegon County Solid Waste Management, 9366 E. Apple Ave. - Power Transmission Line
c.	**other** (i.e. airports, pipelines, bus terminals, train stations, military bases, marine passenger ferry services)	- Natural Gas Pipeline

6.	**Socio-Economic Profile of Sector**		
a.	**total population (night):**		1,575
b.	**peak population (seasonal):**		1,583
c.	**percent over 65:**		11.7
d.	**percent under 18:**		24.4
e.	**percent that are homeowners:**		89.5
f.	**percent below poverty level:**		9.9
g.	**percent with disability or mobility limitation:**		21.2
h.	**estimated property insurance coverage:** **(Real and Personal Equalized Valuations)**	Agricultural: Commercial: Industrial: Residential: Utility (Personal): Total:	$11,105,100 $1,709,800 $725,900 $30,298,100 $2,340,900 $46,179,800
i.	**flood insurance coverage:**	Total Losses since 01/01/78: Total Payments since 01/01/78: Policies In-Force: Total Insurance In-Force:	*Not participating in the NFIP*
j.	**location of floodplains:**	N/A	

7.	**Emergency Warning System Coverage**	
a.	**siren locations and/or description of warning system:**	- None Identified
b.	**percent of population covered by warning sirens or system:**	N/A

Land Use and Natural Features Map (USGS Quad.)

Moorland Township



MUSKEGON CHARTER TOWNSHIP

1.	**major geographic features:**	- 749.6 persons per square mile - 302.1 housing units per square miles - Moderately forested (Muskegon State Game Area) - Muskegon River - 4 to 6 small lakes and ponds, 8 to 10 small creeks
2.	**Population Concentrations**	
a.	**group homes:**	- Annette Street Home, 2475 Annette Ave (capacity 6) - Brandel AFC, 1559 S Sheridan (capacity 5) - Christian Care Senior Community, 1530 McLaughlin Ave (capacity 105) - East Side Manor, 1439 East St (capacity 4) - Lilac Street Home, 1901 Lilac St (capacity 6) - MZ DZ, 501 S Sheridan Ave (capacity 4) - Parkside Home, 1443 Quarterline Rd (capacity 7) - Pioneer House, 1390 Brusse Ave (capacity 12)
b.	**large apartment buildings:**	- Arbor Crossings Apartments, 834 S. Sheridan Rd. (108 family units) - Bear Creek Apts., 91 E Giles Rd. (38 units) - Chesapeake Landing Apartments, 2690 Chesapeake Dr (88 units) - Christian Manor, 1480 McLaughlin Ave (42 units) - Creekwood Estates, 2000 Creekwood Dr. (96 family units) - Eastwood Village Apartments, 2243 E. Apple Ave. (69 units) - Park Woods Apartments, 924 Shonat St. (70 elderly, 30 family units) - Pine Grove Manor, 1764 E. Apple Ave. (172 elderly units) - Pioneer House, 1390 Brusse Ave. (12 elderly units) - Quail Meadow Apartments, 725 Meadow Ct. (120 family units)
c.	**schools:**	- Reeths-Puffer High School, 1545 N. Roberts (1,178 students, 92 staff) - Reeths-Puffer Intermediate School, 1500 N. Getty (577 students, 46 staff) - Reeths-Puffer Elementary, 874 E. Giles Rd. (487 students, 39 staff) - Orchard View High School, 16 N Quarterline (657 students, 58 staff) - Orchard View Middle School, 35 S. Sheridan Rd. (560 students, 53 staff) - Orchard View Elementary, 2310 Marquette (747 students, 45 staff) - Orchard View Early Elementary, 2820 MacArthur (422 students, 57 staff) - Timberland Charter Academy, 2574 McLaughlin (500 students, 54 staff)
d.	**childcare facilities:**	- Marcy Lynn Skidmore, 2811 MacArthur Rd (capacity 12) - Cynthia Goforth-Trevino, 121 S Brooks Rd (capacity 12) - Winter Sun Schoolhouse, Suite F, 1500 Whitehall Rd (capacity 72) - Beatrice Louise Siuda, 2270 Vine Ave (capacity 12) - Robin Wilson, 1026 Wesley Ave (capacity 12) - Michelle Macomber, 1856 Sheridan Dr (capacity 12) - Alaina Kay Skidmore, 107 S Walker Rd (capacity 12) - Audra Macomber, 3232 Macarthur (capacity 12) - Angel Hernandez, 1920 Barbara St (capacity 12) - Barbara Lynn Slater, 516 Harold St (capacity 12) - Cheryl Taylor, 1863 Kregel Ave (capacity 12) - Lori J McKinstry, 3760 Hall Rd (capacity 12) - Michelle Beeckman, 1721 Roberts Rd (capacity 12) - Kelly Perez, 2600 Becker Rd (capacity 12) - Rebecca Walker, 2068 Rambling Oak Dr (capacity 12) - Little Learners Preschool Inc, First Lutheran Church, 1206 Whitehall Rd

		(capacity 18) - Reeths-Puffer Elementary (RPE), 874 E Giles (capacity 36) - Orchard View Community Care, Bldg A-101, 834 Sheridan (capacity 43) - Cardinal Elementary, 2310 Marquette (capacity 100) - Orchard View Early Elementary, 2820 MacArthur Rd (capacity 123) - Orchard View Community Ed Center, 1074 Shonat (capacity 137)
e.	**large office buildings:**	- See 4.h.
f.	**other:** (such as stadiums, concert halls, amusement parks, fairgrounds, correctional facilities, nursing homes, other special populations or large crowd assembly areas)	- Kalamazoo Probation Enhancement, 985 Barney - Sheridan Christian Care, 2053 S. Sheridan - Reeths-Puffer High School Football Stadium, 1545 N. Roberts Rd. - Orchard View High School Football Stadium, 2310 Marquette Ave. - Softball World, 878 S. Mill Iron Rd - Eagle Island Golf Club, 800 S. Mill Iron Rd. (9 holes) - Northside Motel, 1145 Whitehall Rd. - Arlington Estates Mobile Home Community, 2222 Marlette - Arlington Estates North Mobile Home Community, 3785 Evanston Ave - Park Meadows Mobile Home Community, 210 East Giles
g.	**major employers:**	- Meijer- North Muskegon, 1800 Holton Rd - L-3 Combat Propulsion Systems, 76 S Getty St (380 employees)

3.	**Population Shifts**	
a.	**daily:**	- 6,992 commute with an average commuting time of 19.3 minutes - 3,888 school-aged children
b.	**seasonal:**	- 7,191 total housing units: 6,807 occupied/384 vacant - Of the vacant, 18 (4.7%) are for seasonal recreational or occasional use

4.	**Important or Critical Public and Private Facilities**	
a.	**police precincts:**	- Muskegon Township Police Department, 1990 E. Apple Ave.
b.	**fire stations:**	- Muskegon Township Fire Department, 1117 S. Walker Rd. - Muskegon Township Fire Department #2, 1699 N. Getty St.
c.	**public works yards:**	- Muskegon Township Highway Department, 103 S. Quarterline
d.	**pumping stations:**	- None Identified
e.	**community shelters:**	- Reeths-Puffer High School, 1545 N. Roberts Rd. - Reeths-Puffer Intermediate, 1500 N. Roberts Rd.
f.	**community medical facilities, hospitals:**	- Brookhaven Medical Care Facility, 1890 E. Apple Ave. (218 beds)
g.	**historic sites:**	- None Identified
h.	**other:** (i.e., government buildings, record center, major construction companies, warehouses, demolition companies, heavy equipment rental, emergency equipment and vehicle storage)	- Muskegon Township Hall, 1990 E. Apple Ave.

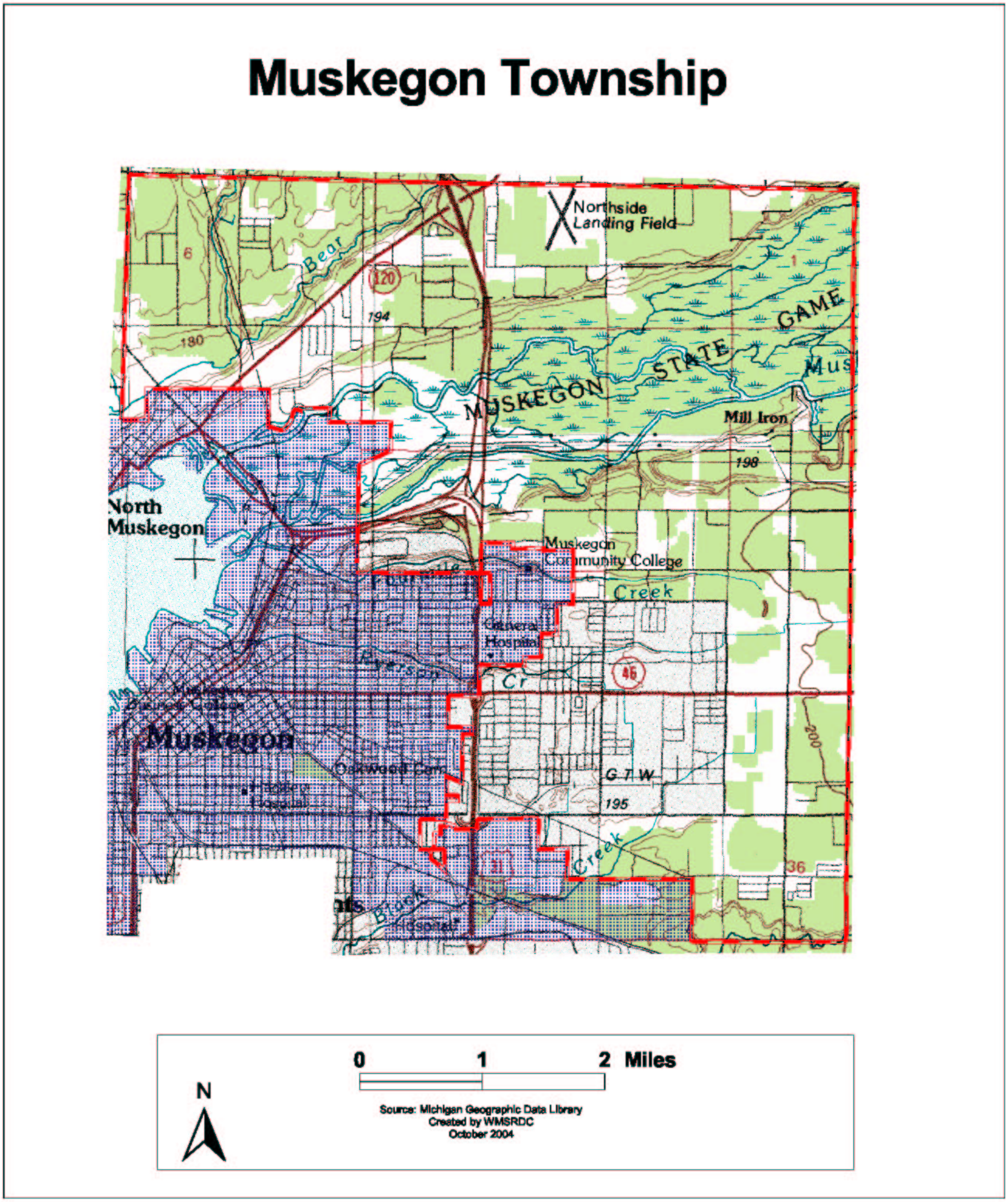
5.	**Vital or Critical Infrastructure**	
a.	**roads, railroads, and bridges:**	- US-31 - M-120 - M-46 - Michigan Shore Railroad - US-31 bridge over Muskegon River North & South Branches

b.	**dams, power stations, water treatment plants, sanitary lift stations, etc.**	- Sanitary Lift Stations: 785 Whitehall, 3200 MacArthur, 2943 Becker, 1990 Apple, 1527 DeBaker, 1940 Northside - Power Transmission Line
c.	**other** (i.e. airports, pipelines, bus terminals, train stations, military bases, marine passenger ferry services)	- Northside Airport, 2151 River Rd. - Oil Pipeline

6.	**Socio-Economic Profile of Sector**		
a.	**total population (night):**		17,840
b.	**peak population (seasonal):**		17,886
c.	**percent over 65:**		14.2
d.	**percent under 18:**		26.3
e.	**percent that are homeowners:**		78.8
f.	**percent below poverty level:**		16.7
g.	**percent with disability or mobility limitation:**		22
h.	**estimated property insurance coverage:** **(Real and Personal Equalized Valuations)**	Agricultural: Commercial: Industrial: Residential: Utility (Personal): Total:	$0 $90,389,600 $17,474,600 $225,900,900 $51,445,700 $385,210,800
i.	**flood insurance coverage:**	Total Losses since 01/01/78: Total Payments since 01/01/78: Policies In-Force: Total Insurance In-Force:	3 $40,449 5 $746,400
j.	**location of floodplains:**	- Black Creek, Little Black Creek, Four Mile Creek, Bear Creek, and Muskegon River & tributaries	

7.	**Emergency Warning System Coverage**	
a.	**siren locations and/or description of warning system:**	- None Identified
b.	**percent of population covered by warning sirens or system:**	N/A

Land Use and Natural Features Map (USGS Quad.)



RAVENNA TOWNSHIP

1.	**major geographic features:**	- 80 persons per square mile - 35.4 housing units per square mile - Moderately forested, moderate farmland - Crockery Creek - 1 to 3 small lakes and ponds, 14 to 16 small creeks

2.	**Population Concentrations**	
a.	**group homes:**	- Country Style AFC, 6427 Blackmer Rd (capacity 2)
b.	**large apartment buildings:**	- None Identified
c.	**schools:**	- Ravenna High School, 2700 S. Ravenna Rd. (342 students, 23 staff) - Ravenna Middle School, 2766 S. Ravenna Rd. (345 students, 26 staff)
d.	**childcare centers:**	- None Identified
e.	**large office buildings:**	- See 4.h.
f.	**other:** (such as stadiums, concert halls, amusement parks, fairgrounds, correctional facilities, nursing homes, other special populations or large crowd assembly areas)	- Ravenna High School Football Stadium, 2700 S. Ravenna Rd. - Ravenna Golf Course, 11566 Heights Ravenna Rd. (18 holes)
g.	**major employers:**	- Metal Technologies- Ravenna Ductile Iron, 3800 Adams Rd (220 employees)

3.	**Population Shifts** *(numbers include Village of Ravenna)*	
a.	**daily:**	- 1,286 commute with an average commuting time of 25.1 minutes - 695 school-aged children
b.	**seasonal:**	- 1,100 total housing units: 1,038 occupied/62 vacant - Of the vacant, 8 (12.9%) are for seasonal recreational or occasional use

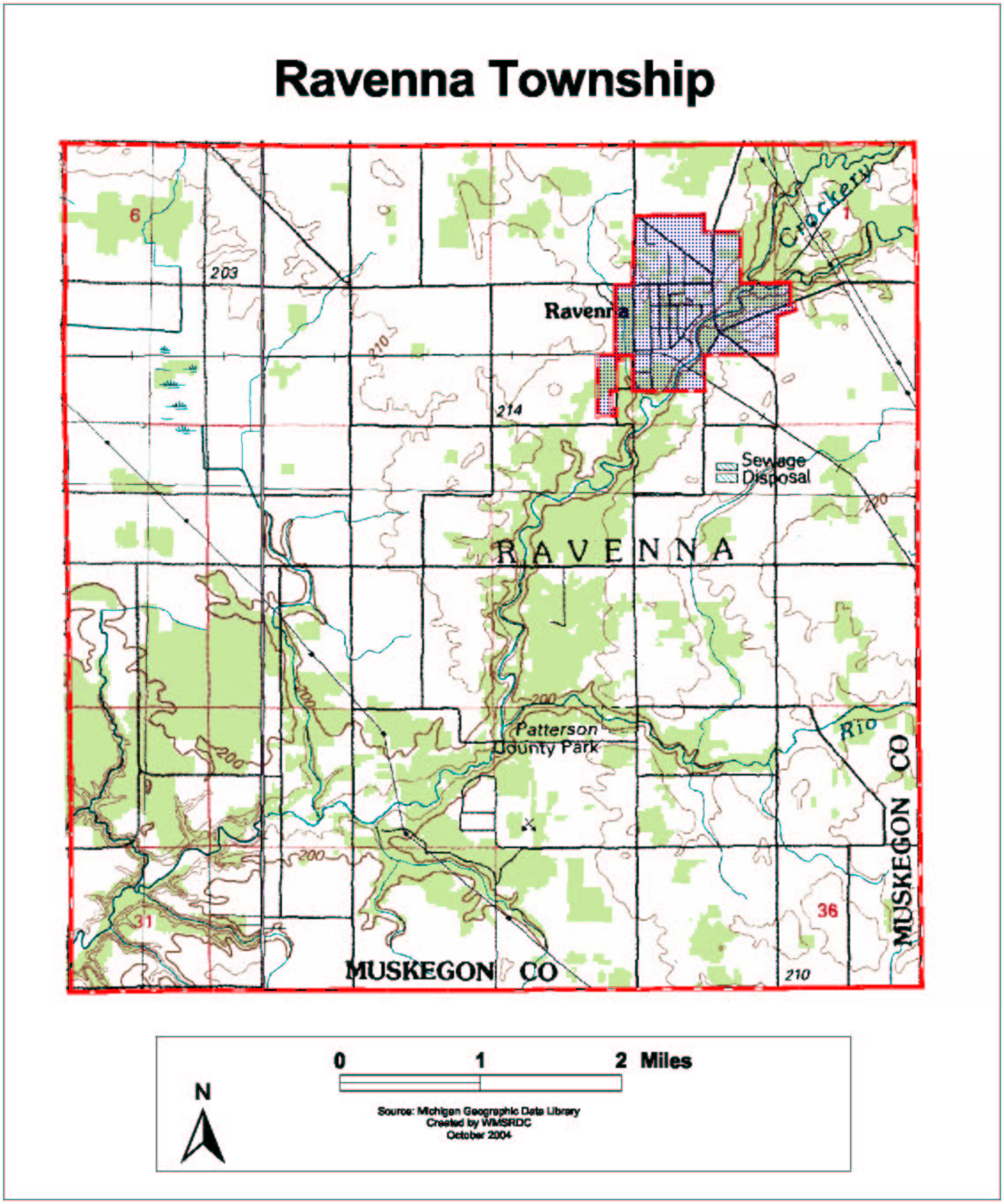
4.	**Important or Critical Public and Private Facilities**	
a.	**police precincts:**	- None Identified
b.	**fire stations:**	- Ravenna Area Fire Department, 3763 Blackmer Rd.
c.	**public works yards:**	- None Identified
d.	**pumping stations:**	- None Identified
e.	**community shelters:**	- Ravenna Jr/Sr High School, 2766 S Ravenna Rd
f.	**community medical facilities, hospitals:**	- None Identified
g.	**historic sites:**	- None Identified
h.	**other:** (i.e., government buildings, record center, major construction companies, warehouses, demolition companies, heavy equipment rental, emergency equipment and vehicle storage)	- Ravenna Township Hall, 3770 Blackmer Rd.

5.	**Vital or Critical Infrastructure**	
a.	**roads, railroads, and bridges:**	- B-72, B-35
b.	**dams, power stations, water treatment plants, sanitary lift stations, etc.**	- Power Transmission Line
c.	**other** (i.e. airports, pipelines, bus terminals, train stations, military bases, marine passenger ferry services)	- Natural Gas Pipeline

6.	**Socio-Economic Profile of Sector**		
a.	**total population (night):**	*(numbers include Village of Ravenna)*	2,905
b.	**peak population (seasonal):**	*(numbers include Village of Ravenna)*	2,927
c.	**percent over 65:**		12.8
d.	**percent under 18:**		28.3
e.	**percent that are homeowners:**		84.5
f.	**percent below poverty level:**		3.5
g.	**percent with disability or mobility limitation:**		16.2
h.	**estimated property insurance coverage:** **(Real and Personal Equalized Valuations)**	Agricultural: Commercial: Industrial: Residential: Utility (Personal): Total:	$28,851,800 $4,903,500 $2,252,100 $51,020,000 $10,136,500 $97,163,900
i.	**flood insurance coverage:**	Total Losses since 01/01/78: Total Payments since 01/01/78: Policies In-Force: Total Insurance In-Force:	1 $14,091 2 $420,000
j.	**location of floodplains:**	- Crockery Creek, Rio Grande Creek, North Branch Smith Drain, and Tidioute Drain	

7.	**Emergency Warning System Coverage**	
a.	**siren locations and/or description of warning system:**	- None Identified
b.	**percent of population covered by warning sirens or system:**	N/A

Land Use and Natural Features Map (USGS Quad.)

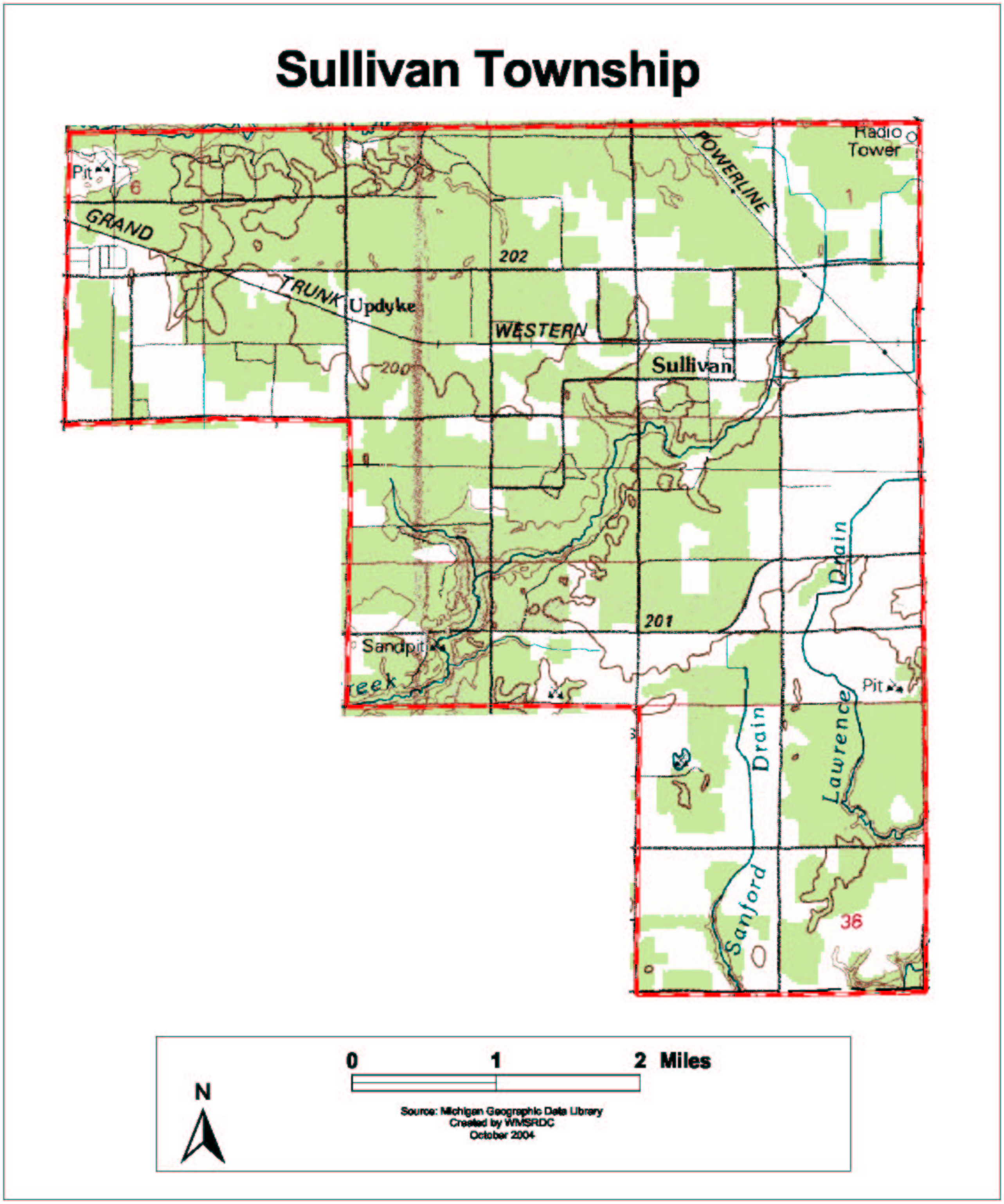


SULLIVAN TOWNSHIP

1.	**major geographic features:**	- 101.3 persons per square mile - 40.6 housing units per square mile - Moderately forested - 4 to 6 small lakes and ponds, 6 to 8 small creeks
2.	**Population Concentrations**	
a.	**group homes:**	- None Identified
b.	**large apartment buildings:**	- None Identified
c.	**schools:**	- None Identified
d.	**childcare facilities:**	- Vickie Alsteens, 5054 Heights-Ravenna Rd (capacity 12)
e.	**large office buildings:**	- See 4.h.
f.	**other:** (such as stadiums, concert halls, amusement parks, fairgrounds, correctional facilities, nursing homes, other special populations or large crowd assembly areas)	- Muskegon County Fairgrounds, 6621 Heights Ravenna Rd. (Early July)
g.	**major employers:**	- None Identified
3.	**Population Shifts**	
a.	**daily:**	- 1,114 commute with an average commuting time of 22.7 minutes - 499 school-aged children
b.	**seasonal:**	- 978 total housing units: 932 occupied/46 vacant - Of the vacant, 5 (10.9%) are for seasonal recreational or occasional use
4.	**Important or Critical Public and Private Facilities**	
a.	**police precincts:**	- None Identified
b.	**fire stations:**	- None Identified
c.	**public works yards:**	- None Identified
d.	**pumping stations:**	- None Identified
e.	**community shelters:**	- None Identified
f.	**community medical facilities, hospitals:**	- None Identified
g.	**historic sites:**	- None Identified
h.	**other:** (i.e., government buildings, record center, major construction companies, warehouses, demolition companies, heavy equipment rental, emergency equipment and vehicle storage)	- Sullivan Township Hall, 8138 Heights Ravenna Rd.
5.	**Vital or Critical Infrastructure**	
a.	**roads, railroads, and bridges:**	- B-72, B-31
b.	**dams, power stations, water treatment plants, sanitary lift stations, etc.**	- Power Transmission Line
c.	**other** (i.e. airports, pipelines, bus terminals, train stations, military bases, marine passenger ferry services)	- Natural Gas Pipeline - Oil Pipeline

6.	**Socio-Economic Profile of Sector**		
a.	**total population (night):**		2,441
b.	**peak population (seasonal):**		2,454
c.	**percent over 65:**		14.1
d.	**percent under 18:**		22.5
e.	**percent that are homeowners:**		93.2
f.	**percent below poverty level:**		6.4
g.	**percent with disability or mobility limitation:**		24.2
h.	**estimated property insurance coverage:** **(Real and Personal Equalized Valuations)**	Agricultural: Commercial: Industrial: Residential: Utility (Personal): Total:	$5,311,800 $1,051,500 $0 $58,702,400 $2,085,000 $67,150,700
i.	**flood insurance coverage:**	Total Losses since 01/01/78: Total Payments since 01/01/78: Policies In-Force: Total Insurance In-Force:	*Not participating in the NFIP*
j.	**location of floodplains:**	N/A	
7.	**Emergency Warning System Coverage**		
a.	**siren locations and/or description of warning system:**	- None Identified	
b.	**percent of population covered by warning sirens or system:**	N/A	

Land Use and Natural Features Map (USGS Quad.)



WHITE RIVER TOWNSHIP

1.	**major geographic features:**	- 84 persons per square mile - 57 housing units per square mile - Moderately forested, moderate farmland - Lake Michigan shoreline and beach - Coastal sand dunes - White Lake - 6 to 8 small lakes and ponds, 10 to 12 small creeks
2.	**Population Concentrations**	
a.	**group homes:**	- Indian Bay Residence, 8770 Indian Bay Rd (capacity 10) - Priority AFC, 6832 Post Rd (capacity 3)
b.	**large apartment buildings:**	- None Identified
c.	**schools:**	- None Identified
d.	**childcare facilities:**	- None Identified
e.	**large office buildings:**	- See 4.h.
f.	**other:** (such as stadiums, concert halls, amusement parks, fairgrounds, correctional facilities, nursing homes, other special populations or large crowd assembly areas)	- Meinert County Park/Pines Campground, 8390 Meinert Park Rd. (67 campsites) - Old Channel Trail Golf Course, 8242 Old Channel Trail (27 holes)
g.	**major employers:**	- None Identified
3.	**Population Shifts**	
a.	**daily:**	- 650 commute with an average commuting time of 28.8 minutes - 246 school-aged children
b.	**seasonal:**	- 907 total housing units: 524 occupied/383 vacant - Of the vacant, 340 (88.8%) are for seasonal recreational or occasional use
4.	**Important or Critical Public and Private Facilities**	
a.	**police precincts:**	- None Identified
b.	**fire stations:**	- None Identified
c.	**public works yards:**	- None Identified
d.	**pumping stations:**	- None Identified
e.	**community shelters:**	- None Identified
f.	**community medical facilities, hospitals:**	- Community Mental Health of Muskegon County – Indian Bay Residence, 8770 Indian Bay Rd.
g.	**historic sites:**	- Mouth Cemetery, 6666 Sunset Lane
h.	**other:** (i.e., government buildings, record center, major construction companies, warehouses, demolition companies, heavy equipment rental, emergency equipment and vehicle storage)	- White River Township Hall, 7386 Post Rd.

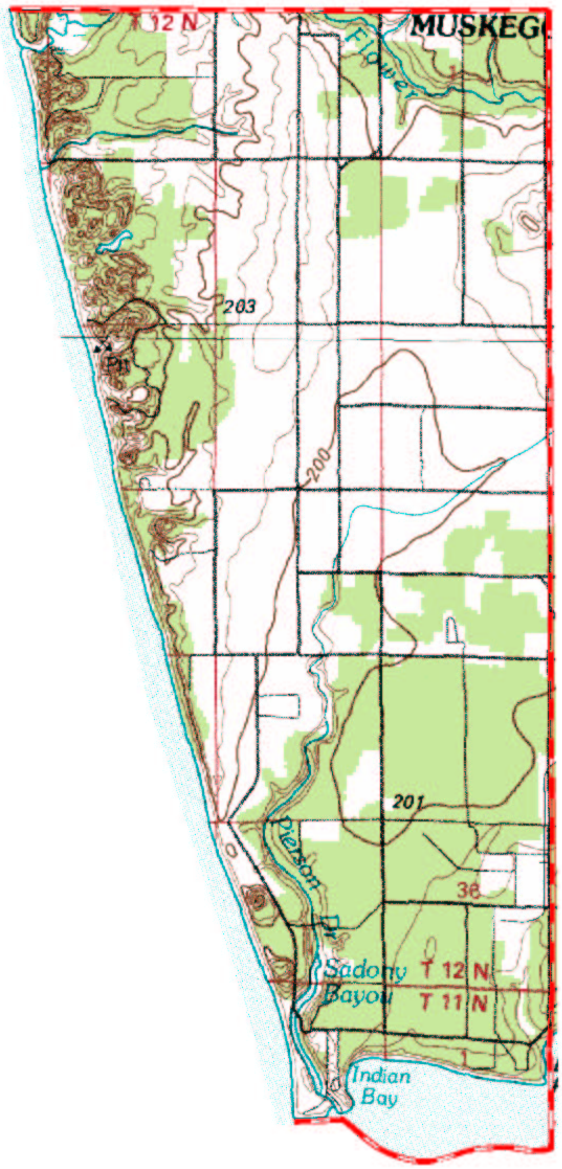
5.	**Vital or Critical Infrastructure**	
a.	**roads, railroads, and bridges:**	- B-15
b.	**dams, power stations, water treatment plants, sanitary lift stations, etc.**	- Power Transmission Line
c.	**other** (i.e. airports, pipelines, bus terminals, train stations, military bases, marine passenger ferry services)	- None Identified

6.	**Socio-Economic Profile of Sector**		
a.	**total population (night):**		1,335
b.	**peak population (seasonal):**		2,195
c.	**percent over 65:**		21
d.	**percent under 18:**		21.3
e.	**percent that are homeowners:**		95.4
f.	**percent below poverty level:**		3.8
g.	**percent with disability or mobility limitation:**		16.3
h.	**estimated property insurance coverage:** **(Real and Personal Equalized Valuations)**	Agricultural: Commercial: Industrial: Residential: Utility (Personal): Total:	$7,742,200 $5,450,800 $2,477,800 $129,954,850 $1,328,200 $146,953,850
i.	**flood insurance coverage:**	Total Losses since 01/01/78: Total Payments since 01/01/78: Policies In-Force: Total Insurance In-Force:	9 $16,801 5 $1,146,000
j.	**location of floodplains:**	- Lake Michigan shoreline, White Lake shoreline, Sadony Bayou, Pierson Drain, Flower Creek, Little Flower Creek	

7.	**Emergency Warning System Coverage**	
a.	**siren locations and/or description of warning system:**	- None Identified
b.	**percent of population covered by warning sirens or system:**	N/A

Land Use and Natural Features Map (USGS Quad.)

White River Township



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Source: Michigan Geographic Data Library
Created by WMSRDC
October 2004

WHITEHALL TOWNSHIP

1.	**major geographic features:**	- 185 persons per square mile - 76.9 housing units per square mile - Moderately forested - White River - 4 to 6 small lakes and ponds, 2 to 4 small creeks

2.	**Population Concentrations**	
a.	**group homes:**	- Benston Road Home, 7468 Whitehall Rd (capacity 6) - Bush Creek Family Manor, 1126 Allice St (capacity 3) - Bush Creek Manor, 1023 Alice St (capacity 6) - Crystal Lake Home, 7875 Whitehall Rd North (capacity 6) - Kelly's Kare AFC, 7888 Whitehall Rd (capacity 6)
b.	**large apartment buildings:**	- None Identified
c.	**schools:**	- None Identified
d.	**childcare facilities:**	- None Identified
e.	**large office buildings:**	- See 4.h.
f.	**other:** (such as stadiums, concert halls, amusement parks, fairgrounds, correctional facilities, nursing homes, other special populations or large crowd assembly areas)	- North Star Cinema, 8171 Whitehall Rd. (350 capacity) - Hickory Knoll Golf Courses, 3065 Alice St. (four, 9 hole courses) - Muskegon County Juvenile Detention Center, 1830 W. White Lake Dr. - Ramada Inn, 2865 Holton Whitehall Rd. (66 rooms) - Super 8 Motel, 3080 Colby Rd. (54 rooms) - Best Western Inn & Suites, 2822 N. Durham Rd. (68 rooms) - Crystal Downs Mobile Village, 2701 Crystal Lake Rd - Edgewood Trailer Park, 7415 Whitehall
g.	**major employers:**	- Sunset Waste Services, 3278 E Colby (100 employees)

3.	**Population Shifts**	
a.	**daily:**	- 801 commute with an average commuting time of 21.9 minutes - 345 school-aged children
b.	**seasonal:**	- 723 total housing units: 673 occupied/50 vacant - Of the vacant, 19 (38%) are for seasonal recreational or occasional use

4.	**Important or Critical Public and Private Facilities**	
a.	**police precincts:**	- None Identified
b.	**fire stations:**	- None Identified
c.	**public works yards:**	- None Identified
d.	**pumping stations:**	- One
e.	**community shelters:**	- None Identified
f.	**community medical facilities, hospitals:**	- None Identified
g.	**historic sites:**	- None Identified

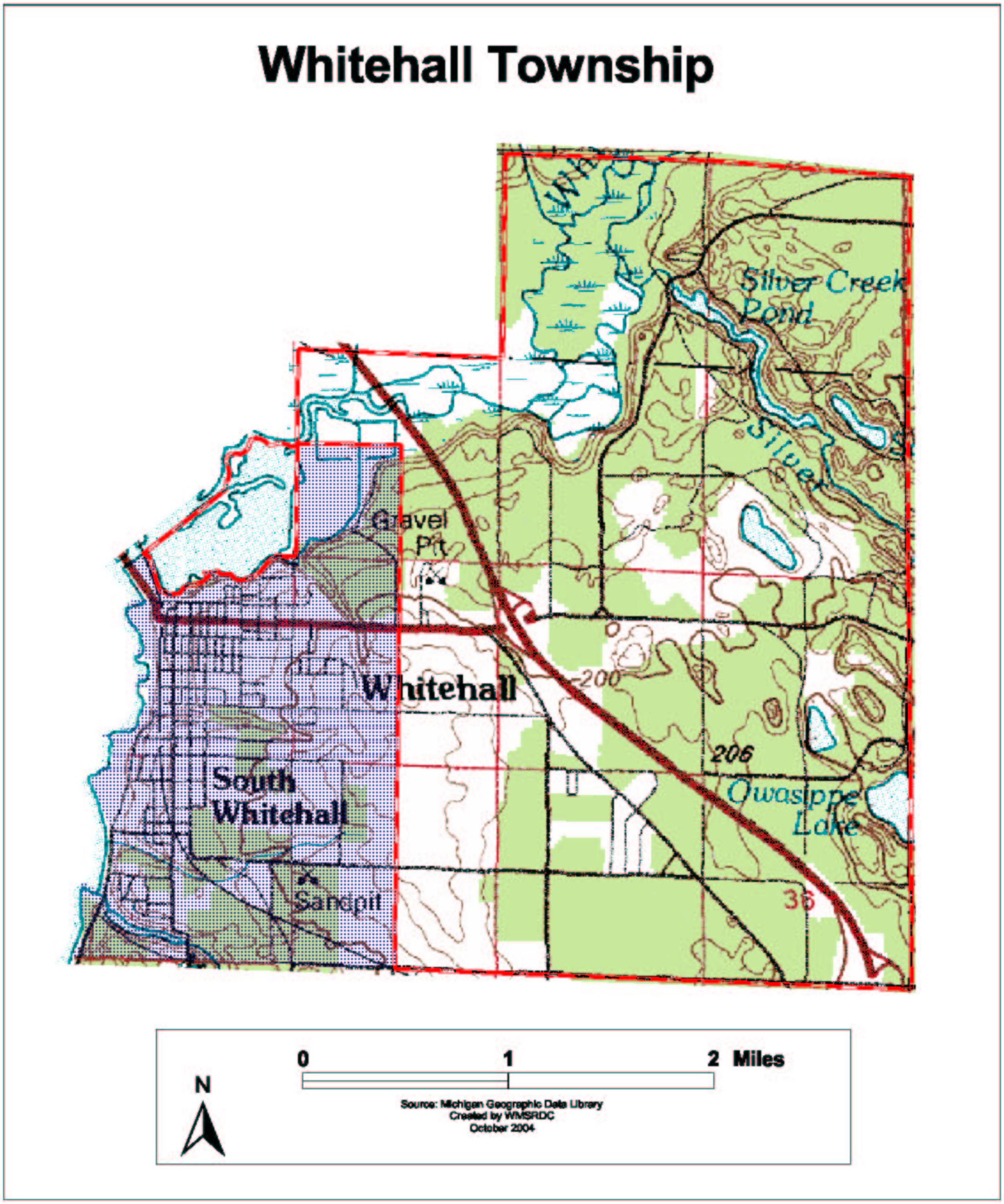
h.	**other:** (i.e., government buildings, record center, major construction companies, warehouses, demolition companies, heavy equipment rental, emergency equipment and vehicle storage)	- Whitehall Township Hall, 7644 Durham Rd. - Muskegon County Road Commission Garage, 7050 Whitehall Rd. - White Lake Excavating, 2571 Holton-Whitehall Rd

5.	**Vital or Critical Infrastructure**	
a.	**roads, railroads, and bridges:**	- US-31 - US-31 bridge over White River
b.	**dams, power stations, water treatment plants, sanitary lift stations, etc.**	- Power Transmission Line - Silver Creek Pond Dam (Silver Creek)
c.	**other** (i.e. airports, pipelines, bus terminals, train stations, military bases, marine passenger ferry services)	- Natural Gas Pipeline

6.	**Socio-Economic Profile of Sector**		
a.	**total population (night):**		1,739
b.	**peak population (seasonal):**		1,787
c.	**percent over 65:**		14.2
d.	**percent under 18:**		23
e.	**percent that are homeowners:**		91.2
f.	**percent below poverty level:**		4.3
g.	**percent with disability or mobility limitation:**		15.6
h.	**estimated property insurance coverage:** **(Real and Personal Equalized Valuations)**	Agricultural: Commercial: Industrial: Residential: Utility (Personal): Total:	$0 $17,405,300 $654,400 $42,417,200 $6,920,800 $67,397,700
i.	**flood insurance coverage:**	Total Losses since 01/01/78: Total Payments since 01/01/78: Policies In-Force: Total Insurance In-Force:	*Not participating in the NFIP*
j.	**location of floodplains:**	N/A	

7.	**Emergency Warning System Coverage**	
a.	**siren locations and/or description of warning system:**	- None Identified
b.	**percent of population covered by warning sirens or system:**	N/A

Land Use and Natural Features Map (USGS Quad.)



Appendix B:
HAZARD IDENTIFICATIONS AND ANALYSES

Hazard Identification Profile
Muskegon County

1. NATURAL HAZARDS

1.01 Celestial Impacts: - None Identified.

1.02 Drought:

- 12 recorded drought events in the area (including Lake, Mason, Muskegon, Newaygo, and Oceana counties) lasting eight months or greater: 1895-1896, 1899-1900, 1901-1902, 1909-1911, 1925-1926, 1930-1931, 1956-1957, 1962-1963, 1971-1972, 1976-1977, and 2002-2003.
- Summer 1871: Prolonged drought over much of the Great Lakes region.
- May-September, 1891: Drought devastated Michigan's lumber industry.

1.03 Earthquake: - None Identified.

1.04 Extreme Temperatures:

- July 1936: Heatwave. 570 deaths statewide, 7 in Muskegon.
- Summer, 1988: 39 days with temperatures over 90 degrees, statewide.
- January 13-20, 1994: Record cold. $50m property damage across Michigan.
- December 9-10, 1995: Coldwave across Lower Michigan.
- March 2012: Record warm temperatures triggered early growing season. $209.8m crop damage across Michigan.

1.05 Flooding - Riverine/ Urban:

- August 20 - September 6, 1975: Flooding. Declaration of major disaster by President.
- February 21, 1986: Great lakes flooding and wave action. Declaration of disaster by Governor.
- September 10-19, 1986: Flooding. Declaration of major disaster by President.
- September, 1986: Flooding & heavy rain. Declaration of disaster by Governor.
- May 18-20, 2000: Flood. $100k property damage, $50k crop damage in Muskegon County.
- February 9-10, 2001: Flooding. $100k property damage across West Michigan.
- February 24-28, 2001: Flooding. $190k property damage across West Michigan.
- May 15-16, 2001: Flooding. $500k property damage, $200k crop damage across southwestern Lower Michigan.
- May 20-24, 2004: Flooding. Declaration of major disaster by President.
- April 17-23, 2013: Flooding. Declaration of major disaster by President. $5m property damage, Muskegon County.

1.06 Fog:

- January 11-13, 1995: Dense Fog. 4 traffic accident fatalities, school closures, and flight delays across Lower Michigan.

1.07 Great Lakes Shoreline Hazards:

- Extreme high water levels in the Great Lakes: 1929, 1952, 1973, 1986, and 1997.
- Extreme low water levels in the Great Lakes: 1926, 1934, 1964, 2003, and 2013.
- Rip current incidents on Lake Michigan, 2002-2012: 77 fatalities, 230 rescues.
- June 1986: Record high water level on Lake Michigan.
- July 13, 1938: Seiche/storm surge on Lake Michigan. 3 drowned in Holland, 1 in Muskegon, and 1 near Pentwater.
- May 31, 1998: Tugboat capsized during seiche in White Lake Channel. Estimated $20,000 damage to tugboat.
- 2013: Record low water level on Lake Michigan.

1.08 Hail:

- Days with severe hail reported (1" or greater) recorded in Muskegon County, 2000-2012: 7
- May 13, 1956: 4 inch hail. Fruitport Township.
- May 12, 2000: 1 inch hail. $50k property damage, Holton Township.
- April 11, 2001: 1.75 inch hail. $50k property damage, $25k crop damage, Village of Fruitport.
- May 15, 2001: 0.75-1.00 inch hail. $95k property damage, $95k crop damage across Muskegon County.
- August 3, 2003: 1.75 inch hail in Muskegon Twp, $55k property damage and $25k crop damage from hail countywide.
- July 2, 2008: 2.00 inch hail, City of Muskegon.

1.09 Invasive Species: - Invasive species exist in Muskegon County; No significant events identified.

1.10 Lightning:

- July 20, 1994: Lightning killed a dog and caused $50k property damage, Muskegon County.
- July 4, 1995: Lightning struck a boat in the Muskegon Lake Channel. $10k property damage.
- July 21, 1998: Lightning. $40k property damage from lightning induced structural fires, Egelston and Muskegon twps.
- July 1, 2011: Lightning struck a radio station in Muskegon Heights. Estimated $10k property damage.

1.11 Severe Winds:

- August 20 - September 6, 1975: Rainstorms, high winds. Declaration of major disaster by President.
- April 18, 1994: Severe thunderstorm winds. $50k property damage, Norton Shores.
- November 18, 1994: High wind. $1m property damage statewide.
- April 6, 1997: High wind. $5m property damage across southwest Lower Michigan.
- May 29, 1998: Severe thunderstorm winds. 54,000 homes and businesses without power; estimated 500 homes and 30 businesses sustained minor to moderate damage. $1m property damage, Muskegon County.
- May 31, 1998: Thunderstorms & high winds. Declarations of disaster by Governor and major disaster by President. $2,458,958 in public damage costs, 42 homes destroyed, 1,805 homes damaged, 5 businesses destroyed, and 73 businesses damaged. Total public and private costs have been estimated at $24,205,908.
- May 8, 2000: Severe thunderstorm winds. $50k property damage, Dalton Township.

- June 1, 2000: Severe thunderstorm winds. $40k property damage, City of Muskegon.
- August 22, 2000: Severe thunderstorm winds. $150k property damage, Muskegon County.
- March 9, 2002: High wind. $485k property damage across southwest Lower Michigan.
- October 30, 2004: High wind. $1.15m property damage across southwest Lower Michigan.
- May 20-24, 2004: Severe storms. Declaration of major disaster by President.
- August 9, 2009: Severe thunderstorm winds. $2m property damage, Muskegon County.
- September 21, 2010: Severe thunderstorm winds. $50k property damage, Fruitland Township.
- November 17, 2013: Severe thunderstorm winds. $200k property damage, Muskegon County.

1.12 Subsidence: - None Identified.

1.13 Tornadoes:

- Number of tornadoes in Muskegon County, 1950-2012: 7.
- September 4, 1965: Tornado (F2). $25k property damage, Sullivan Township.
- April 16, 1967: Tornado (F1). $2.5k property damage, Whitehall.
- November 17, 2013: Tornado (EF0). $50k property damage, Casnovia Township.

1.14 Wildfire:

- October 1871: Wildfires. 1.2m acres burned, 200 fatalities, Michigan's Lower Peninsula.
- May-September, 1891: Uncontrollable wildfires across Michigan during the drought of 1891.
- 1981-2010: Approximately 8 wildfires and 89 acres burned per year on county lands under MDNR jurisdiction (251 total wildfires, 2,676.0 total acres burned).

1.15 Winter Storms:

- March 2-7, 1976: Ice storms. Declaration of major disaster by President.
- January 26-31, 1977: Blizzard, snowstorm. Declaration of emergency by President.
- January 26-27, 1978: Blizzard, snowstorm. Declaration of statewide emergency by President.
- January 12, 1993: Heavy snow. $50k property damage, northern Lower Michigan.
- January 12-21, 1994: Heavy lake effect snow. $500k property damage across western Lower Michigan.
- January 27, 1994: Heavy snow and freezing rain. $5m property damage across region.
- October 26, 1997: Heavy snow. $1.2m property damage across southwestern Lower Michigan.
- March 9, 1998: Winter storm. $100k property damage across region.
- January 2-15, 1999: Blizzard, snowstorm. Declaration of emergency by President.
- December 11-31, 2000: Blizzard, snowstorm. Declaration of emergency by President.
- April 3, 2003: Ice storm. $4.9m property damage throughout West Michigan.
- February 16, 2006: Ice storm. $1m property damage across Lower Michigan.

2. TECHNOLOGICAL HAZARDS

2.01 Dam Failure:

- Four documented failures in Muskegon County, unidentified locations.

2.02 Energy Emergencies:

- January 1918: Coal and fuel shortages during a blizzard. Curfew to conserve resources, City of Muskegon.
- February 2003: A break in a major transmission line caused an electrical blackout over parts of Montcalm, Oceana, Newaygo, Muskegon, and Kent counties.

2.03 Fire - Scrap Tire:

- Approximate scrap tire inventory in Muskegon County in 2012: 4,400.

2.04 Fire - Structural:

- County fire rate per 1,000 population in 1998: 3.8.
- Major fires in the City of Muskegon: 1871, 1874, 1891, and 1946.
- 1900: Major business district fires in Fruitport and Ravenna.
- June 30, 2009: Apartment complex destroyed (all 10 units), causing 5 injuries in the City of Muskegon.
- December 2012: Fire destroys Michillinda Lodge in Fruitland Township.
- February 9, 2013: 12 apartment units destroyed and 12 units damaged in Norton Shores.

2.05 Hazard Material Incidents - Fixed Site (including industrial accidents):

- SARA Title III Sites in Muskegon County in 2012: 51.
- 1920: Explosion and fire at Brunswick, Balke, Collender Co. claims seven lives, City of Muskegon.
- 1935: Fire at Naph-Sol Refinery occurs when processing chemicals explode, Muskegon Township.
- April 22, 1990: Release of phosphorus oxychloride. 1,000 people evacuated, Egelston Township.
- June 4, 1999: Release of hydrogen sulfide. 1 fatality, 1 other injured, 11 employees evacuated, and $411,000 property damage, City of Whitehall.
- April 12, 2000: Explosion and flash fire at chemical plant, 10 people injured, Egelston Township.
- May 21, 2001: Foundry explosion, 2 homes and 1 business set on fire, 1 injury, Norton Shores.
- September 13, 2003: Barrel explosion at foundry, 1 fatality, Egelston Township.
- April 10, 2010: Chemical reaction Calcium Silicon Barium. Localized evacuation of surrounding business, Norton Shores.
- January 30, 2012: Explosion at foundry sprays molten metal and sets fire to the facility, Norton Shores.

2.06 Hazard Material Incidents - Transportation:

- March 15, 1982: Freight train derailment caused a spill of chlorine and caustic acid. 600 evacuated, Fruitport Township.
- December 6, 1985: Gasoline tanker overturned on M120 near Brickyard and dumped about 2,200 gallons into the ditch, Holton Township.

2.07 Infrastructure Failure:

- Number of NCDC records with mention of downed power lines or power outages in Muskegon County, 1993-2012: 45
- Number of sanitary sewer overflows in Muskegon County, 2000-2011: 47.
- August 8, 1993: 4,400 without power (thunderstorm winds), Muskegon and Oceana counties
- March 9, 1998: 1,900 power outages (blizzard conditions), Lake, Clare, Oceana and Muskegon counties.
- May 29-30, 1998: 54,000 without power; 27,000 on second day (thunderstorm winds), Muskegon County.
- May 31, 1998: 50,000 without power (thunderstorm winds), Muskegon County.
- May 31, 1998: Half of Whitehall City without water service (thunderstorm winds).
- June 18, 1998: Most of Montague without power (thunderstorm winds and lightning), Montague City and Montague Twp.
- July 21, 1998: 7,500 without power (thunderstorm winds and lightning), Muskegon County.
- January 2005: City of Muskegon Heights without water service (broken water main).
- March 2007: Sewer main failure causes 40 home evacuations, damage to 5 homes, and condemnation of 3 homes, Muskegon Township. Estimated total damages over $1m.
- January 2008: Henry Stree Bridge NE approach washout – heavy rains, plugged sewer, Norton Shores.
- August 9, 2009: Village of Fruitport and much of southern Muskegon County without power (thunderstorm winds).

2.08 Nuclear Power Plant Emergencies: - None Identified.

2.09 Oil and Natural Gas Well Accidents:

- Oil and gas wells in Muskegon County in 2012: 1,090.
- 15 wells with known detectable levels of hydrogen sulfide.
- Orphan well in Laketon Township slowly leaking crude oil into tributary of Bear Lake.

2.10 Pipeline Accidents:

- February 22, 1986: Gasoline pipeline rupture in the City of Muskegon. Thousands of gallons of gasoline spilled into a Ruddiman Creek tributary, causing minor house explosions, at least one fire, and dozens of area residents to evacuate.
- August 28, 2007: A house exploded after a contractor accidentally struck a natural gas line in Egelston Township.

2.11 Transportation Accidents:

- October 28, 1919: Huge waves crashed the wooden side-wheel steamer, *City of Muskegon*, into the Muskegon Channel's south pier. About 30 passengers and crew members died in the accident.
- November 30, 1034: A strong gust of wind sent the 315-foot *Henry Cort* into the north breakwater of the Muskegon Channel. The entire crew was rescued, however a small Coast Guard vessel responding to the accident capsized, killing one Coast Guardsman.
- January 21, 2002: School bus accident at Holton Rd and Brickyard Rd in Holton Township. One person killed and about 22 persons taken to area hospitals with injuries.

3. HUMAN -RELATED HAZARDS

3.01 Catastrophic Incidents (National Emergencies):

- 1939-1945: World War II. In Muskegon, 48-hour minimum work weeks, rationing of certain food and goods, and 274 county men killed in battle.
- 2005: Hurricanes Katrina and Rita. Declarations of Gubernatorial Disaster and Presidential Emergency were issued in Michigan in September 2005 for hurricane evacuation.

3.02 Civil Disturbances:

- August 5, 1919: Street Car Riots. Riders revolted against a rate increase from six cents to seven cents and destroyed 13 street cars, causing $100,000 to $125,000 (approximately $1.3 to $1.5 million today) in property damage.

3.03 Nuclear Attack: - None Identified.

3.04 Public Health Emergencies:

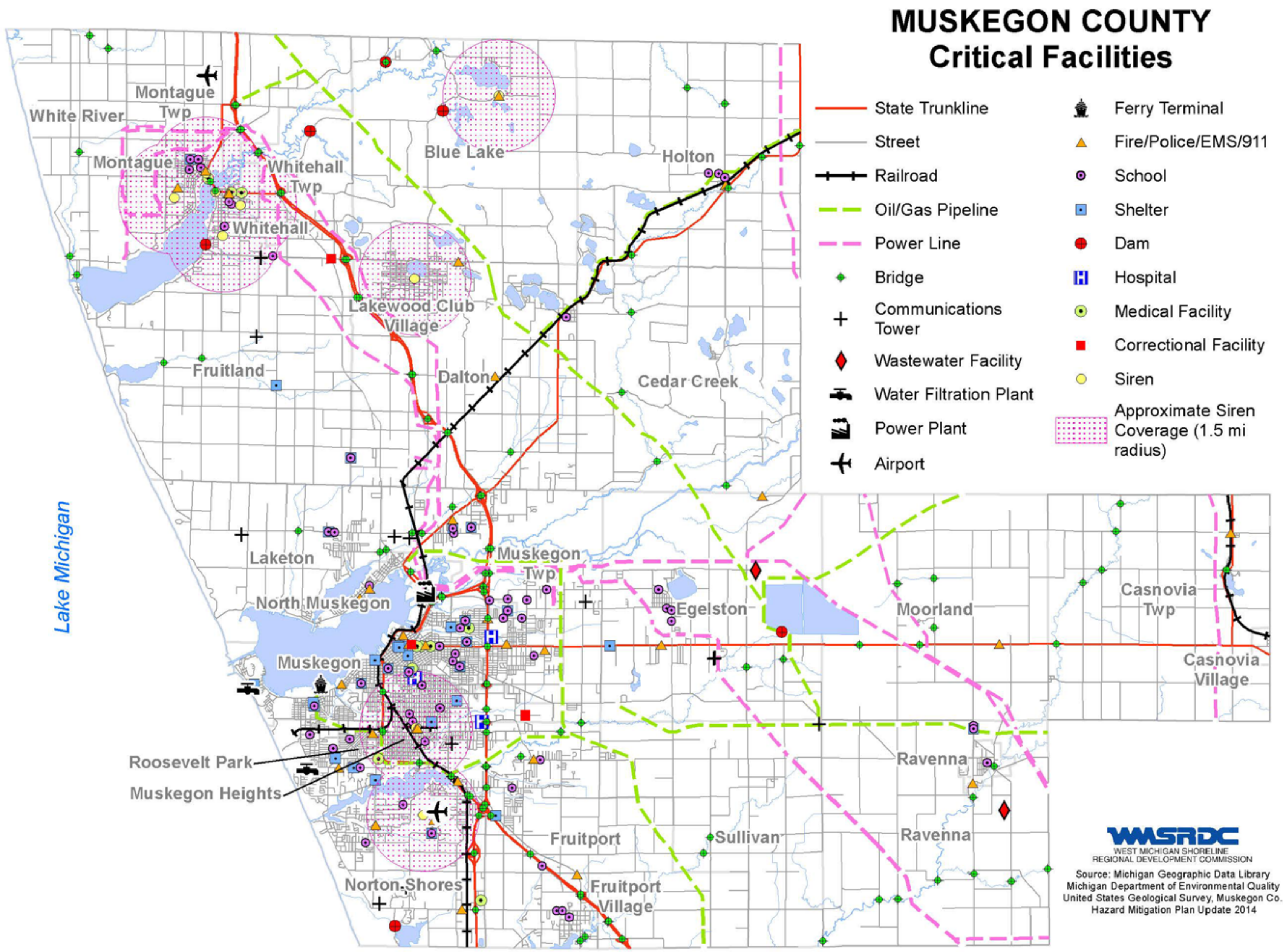
- 1913: Diphtheria Epidemic.
- 1916: Small pox and scarlet fever force closures of schools and businesses.
- 1918: Influenza epidemic closes theaters, dance halls, and churches.
- 1937: Children under 18 banned from theaters and schools close from fear of polio outbreak.
- 1941: Influenza epidemic cuts school attendance by 60%.
- 2009: H1N1 influenza pandemic causes school absences spike in the fall. Two county residents die from complications.
- 2013: North Muskegon Schools close for two days due to widespread influenza.

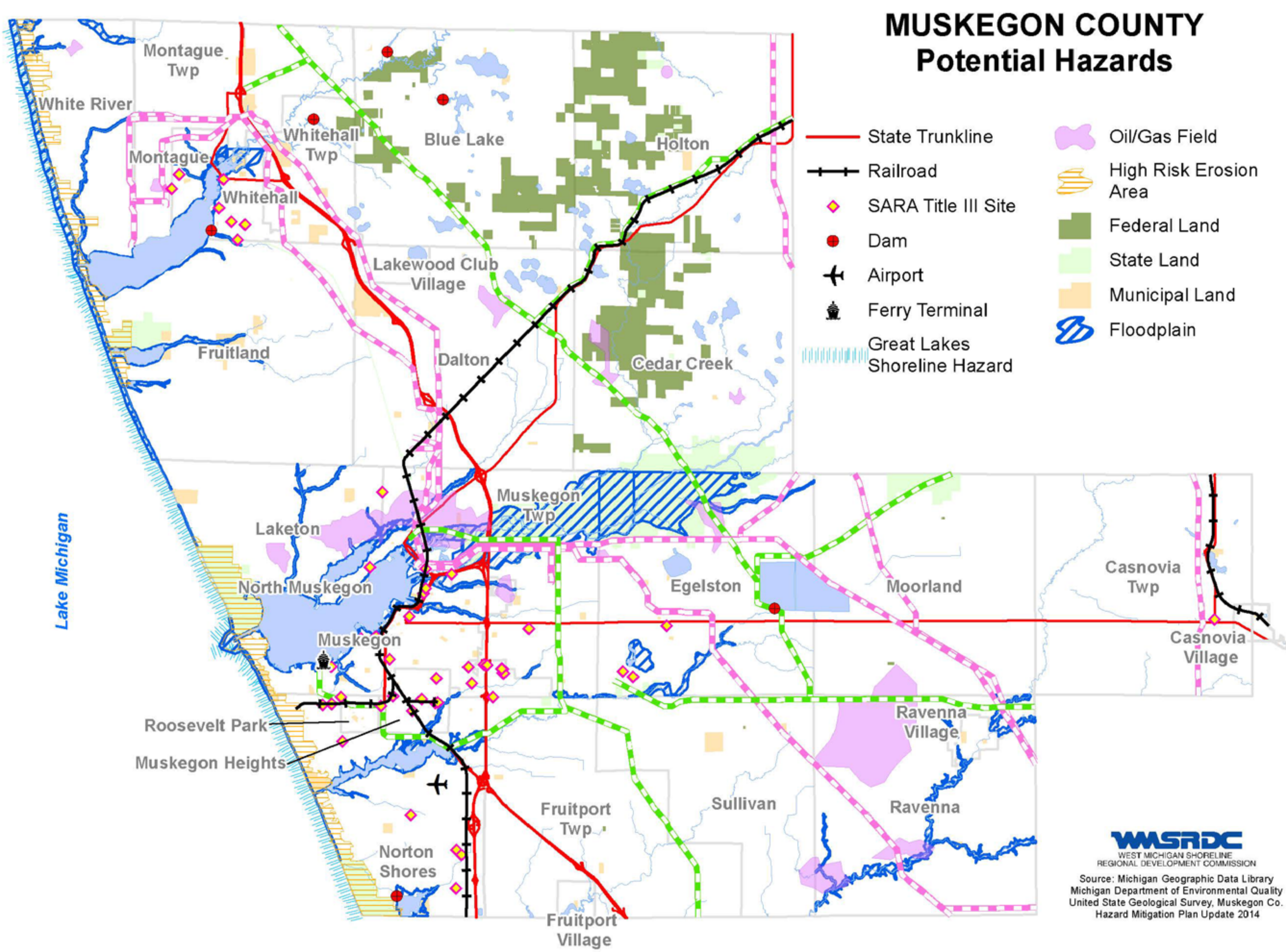
3.05 Terrorism and Similar Criminal Activities: - None Identified.

	Muskegon County Hazard Rating	Probability of Occurrence	Impact on People	Impact on Property	Impact on Economy	Impacts Total	Hazard Score
1.01	Celestial Impacts	1	2	0	2	8	8
1.02	Drought	2	2	2	3	13	26
1.03	Earthquake	0	-	-	-	-	-
1.04	Extreme Temperatures	3	2	1	2	10	30
1.05	Flooding: Riverine/Urban	3	1	2	1	8	24
1.06	Fog	3	1	0	1	4	12
1.07	Great Lakes Shoreline	3	1	2	1	8	24
1.08	Hail	3	1	1	1	6	18
1.09	Invasive Species	2	1	1	2	7	14
1.10	Lightning	3	1	2	1	8	24
1.11	Severe Winds	3	2	2	2	12	36
1.12	Subsidence	1	1	1	1	6	6
1.13	Tornadoes	2	1	2	2	9	18
1.14	Wildfire	3	2	2	1	11	33
1.15	Winter Storms	3	3	2	2	15	45
2.01	Dam failure	2	1	2	3	10	20
2.02	Energy Emergencies	2	2	0	2	8	16
2.03	Fire – Scrap Tires	1	1	1	1	6	6
2.04	Fire – Structural	3	1	2	2	9	27
2.05	HAZMAT – Fixed Site	2	1	1	2	7	14
2.06	HAZMAT – Transportation	2	1	1	2	7	14
2.07	Infrastructure Failures	3	2	1	2	10	30
2.08	Nuclear Power Emergencies	0	-	-	-	-	-
2.09	Oil/Natural Gas Well Accidents	2	1	1	1	6	12
2.10	Pipeline Accidents	2	1	1	2	7	14
2.11	Transportation Accidents	2	1	1	2	7	14
3.01	Catastrophic Incidents	1	3	3	3	18	18
3.02	Civil Disturbances	1	1	1	1	6	6
3.03	Nuclear Attack	0	-	-	-	-	-
3.04	Public Health Emergencies	2	2	0	3	9	18
3.05	Terrorism & Similar Criminal Acts	1	1	1	1	6	6

Muskegon County Hazard Ranking

		Probability of Occurrence	X Impacts Total	= Hazard Score
1	Winter Storms	3	15	45
2	Severe Winds	3	12	36
3	Fire – Structural	3	10	30
3	Infrastructure Failures	3	10	30
5	Extreme Temperatures	3	9	27
5	Flooding: Riverine/Urban	3	9	27
7	Drought	2	12	24
7	Great Lakes Shoreline	3	8	24
7	Lightning	3	8	24
7	Wildfire	3	8	24
11	HAZMAT – Fixed Site	3	7	21
12	Catastrophic Incidents	1	18	18
12	Dam Failure	2	9	18
12	Hail	3	6	18
12	HAZMAT – Transportation	3	6	18
12	Pipeline Accidents	2	9	18
12	Public Health Emergencies	2	9	18
12	Tornadoes	2	9	18
19	Energy Emergencies	2	8	16
20	Fog	3	5	15
21	Invasive Species	2	7	14
21	Transportation Accidents	2	7	14
23	Civil Disturbances	2	6	12
23	Oil/Natural Gas Well Accidents	2	6	12
25	Celestial Impacts	1	8	8
26	Fire – Scrap Tires	1	6	6
26	Subsidence	1	6	6
26	Terrorism & Similar Criminal Acts	1	6	6
	Earthquake	0	-	-
	Nuclear Attack	0	-	-
	Nuclear Power Emergencies	0	-	-


MUSKEGON COUNTY
Critical Facilities
State Trunkline
Street
Railroad
Oil/Gas Pipeline
Power Line
Bridge
Communications Tower
Wastewater Facility
Water Filtration Plant
Power Plant
Airport
Ferry Terminal
Fire/Police/EMS/911
School
Shelter
Dam
Hospital
Medical Facility
Correctional Facility
Siren
Approximate Siren Coverage (1.5 mi radius)
Lake Michigan
White River
Montague Twp
Montague
Whitehall Twp
Whitehall
Blue Lake
Holton
Lakewood Club Village
Fruitland
Dalton
Cedar Creek
Laketon
North Muskegon
Muskegon Twp
Muskegon
Egelston
Moorland
Casnovia Twp
Casnovia Village
Roosevelt Park
Muskegon Heights
Fruitport
Sullivan
Ravenna
Ravenna
Norton Shores
Fruitport Village
WMSRDC
WEST MICHIGAN SHORELINE REGIONAL DEVELOPMENT COMMISSION
Source: Michigan Geographic Data Library
Michigan Department of Environmental Quality
United States Geological Survey, Muskegon Co.
Hazard Mitigation Plan Update 2014


MUSKEGON COUNTY
Potential Hazards
State Trunkline
Railroad
SARA Title III Site
Dam
Airport
Ferry Terminal
Great Lakes Shoreline Hazard
Oil/Gas Field
High Risk Erosion Area
Federal Land
State Land
Municipal Land
Floodplain
Lake Michigan
Montague Twp
White River
Montague
Whitehall
Whitehall Twp
Blue Lake
Holton
Lakewood Club Village
Fruitland
Dalton
Cedar Creek
Laketon
Muskegon Twp
North Muskegon
Muskegon
Egelston
Moorland
Casnovia Twp
Casnovia Village
Ravenna Village
Roosevelt Park
Muskegon Heights
Norton Shores
Fruitport Twp
Sullivan
Ravenna
Fruitport Village
WMSRDC
WEST MICHIGAN SHORELINE REGIONAL DEVELOPMENT COMMISSION
Source: Michigan Geographic Data Library
Michigan Department of Environmental Quality
United State Geological Survey, Muskegon Co.
Hazard Mitigation Plan Update 2014

Hazard Identification Profile
City of Montague

1. NATURAL HAZARDS

1.01 Celestial Impacts: - None Identified.

1.02 Drought:
- 12 recorded drought events in the area (including Lake, Mason, Muskegon, Newaygo, and Oceana counties) lasting eight months or greater: 1895-1896, 1899-1900, 1901-1902, 1909-1911, 1925-1926, 1930-1931, 1956-1957, 1962-1963, 1971-1972, 1976-1977, and 2002-2003.
- Summer 1871: Prolonged drought over much of the Great Lakes region.
- May-September, 1891: Drought devastated Michigan's lumber industry.
- 2013: Record low Lake Michigan water levels.

1.03 Earthquake: - None Identified.

1.04 Extreme Temperatures:
- July 1936: Heatwave. 570 deaths statewide, 7 in Muskegon.
- Summer, 1988: 39 days with temperatures over 90 degrees, statewide.
- January 13-20, 1994: Record cold. $50m property damage across Michigan.
- December 9-10, 1995: Coldwave across Lower Michigan.
- March 2012: Record warm temperatures triggered early growing season. $209.8m crop damage across Michigan.

1.05 Flooding - Riverine/ Urban:
- August 20 - September 6, 1975: Flooding. Declaration of major disaster by President.
- February 21, 1986: Great lakes flooding and wave action. Declaration of disaster by Governor.
- September 10-19, 1986: Flooding. Declaration of major disaster by President.
- September, 1986: Flooding & heavy rain. Declaration of disaster by Governor.
- May 18-20, 2000: Flood. $100k property damage, $50k crop damage in Muskegon County.
- February 9-10, 2001: Flooding. $100k property damage across West Michigan.
- February 24-28, 2001: Flooding. $190k property damage across West Michigan.
- May 15-16, 2001: Flooding. $500k property damage, $200k crop damage across southwestern Lower Michigan.
- May 20-24, 2004: Flooding. Declaration of major disaster by President.
- April 17-23, 2013: Flooding. Declaration of major disaster by President. $5m property damage, Muskegon County.

1.06 Fog:
- January 11-13, 1995: Dense Fog. 4 traffic accident fatalities, school closures, and flight delays across Lower Michigan.

1.07 Great Lakes Shoreline Hazards: - None Identified.

1.08 Hail:
- Days with severe hail reported (1" or greater) recorded in Muskegon County, 2000-2012: 7
- May 15, 2001: 0.75-1.00 inch hail. $95k property damage, $95k crop damage across Muskegon County.
- August 3, 2003: 1.75 inch hail in Muskegon Twp, $55k property damage and $25k crop damage from hail countywide.

1.09 Invasive Species: - Invasive species exist in Muskegon County; No significant events identified.

1.10 Lightning:
- July 20, 1994: Lightning killed a dog and caused $50k property damage, Muskegon County.

1.11 Severe Winds:
- August 20 - September 6, 1975: Rainstorms, high winds. Declaration of major disaster by President.
- November 18, 1994: High wind. $1m property damage statewide.
- April 6, 1997: High wind. $5m property damage across southwest Lower Michigan.
- May 29, 1998: Severe thunderstorm winds. 54,000 homes and businesses without power ; estimated 500 homes and 30 businesses sustained minor to moderate damage. $1m property damage, Muskegon County.
- May 31, 1998: Thunderstorms & high winds. Declarations of disaster by Governor and major disaster by President. $2,458,958 in public damage costs, 42 homes destroyed, 1,805 homes damaged, 5 businesses destroyed, and 73 businesses damaged. Total public and private costs have been estimated at $24,205,908.
- August 22, 2000: Severe thunderstorm winds. $150k property damage, Muskegon County.
- March 9, 2002: High wind. $485k property damage across southwest Lower Michigan.
- October 30, 2004: High wind. $1.15m property damage across southwest Lower Michigan.
- May 20-24, 2004: Severe storms. Declaration of major disaster by President.
- August 9, 2009: Severe thunderstorm winds. $2m property damage, Muskegon County.
- November 17, 2013: Severe thunderstorm winds. $200k property damage, Muskegon County.

1.12 Subsidence: - None Identified.

1.13 Tornadoes:
- Number of tornadoes in Muskegon County, 1950-2012: 7.

1.14 Wildfire:
- October 1871: Wildfires. 1.2m acres burned, 200 fatalities, Michigan's Lower Peninsula.
- May-September, 1891: Uncontrollable wildfires across Michigan during the drought of 1891.
- 1981-2010: Approximately 8 wildfires and 89 acres burned per year on county lands under MDNR jurisdiction (251 total wildfires, 2,676.0 total acres burned).

1.15 Winter Storms:

- March 2-7, 1976: Ice storms. Declaration of major disaster by President.
- January 26-31, 1977: Blizzard, snowstorm. Declaration of emergency by President.
- January 26-27, 1978: Blizzard, snowstorm. Declaration of statewide emergency by President.
- January 12, 1993: Heavy snow. $50k property damage, northern Lower Michigan.
- January 12-21, 1994: Heavy lake effect snow. $500k property damage across western Lower Michigan.
- January 27, 1994: Heavy snow and freezing rain. $5m property damage across region.
- October 26, 1997: Heavy snow. $1.2m property damage across southwestern Lower Michigan.
- March 9, 1998: Winter storm. $100k property damage across region.
- January 2-15, 1999: Blizzard, snowstorm. Declaration of emergency by President.
- December 11-31, 2000: Blizzard, snowstorm. Declaration of emergency by President.
- April 3, 2003: Ice storm. $4.9m property damage throughout West Michigan.
- February 16, 2006: Ice storm. $1m property damage across Lower Michigan.

2. TECHNOLOGICAL HAZARDS

2.01 Dam Failure:

- Four documented failures in Muskegon County, unidentified locations.

2.02 Energy Emergencies:

- February 2003: A break in a major transmission line caused an electrical blackout over parts of Montcalm, Oceana, Newaygo, Muskegon, and Kent counties.

2.03 Fire - Scrap Tire:

- Approximate scrap tire inventory in Muskegon County in 2012: 4,400.

2.04 Fire - Structural:

- County fire rate per 1,000 population in 1998: 3.8.

2.05 Hazard Material Incidents - Fixed Site (including industrial accidents):

- SARA Title III Sites in Muskegon County in 2012: 51.

2.06 Hazard Material Incidents - Transportation: - None Identified.

2.07 Infrastructure Failure:

- Number of NCDC records with mention of downed power lines or power outages in Muskegon County, 1993-2012: 45
- Number of sanitary sewer overflows in Muskegon County, 2000-2011: 47.
- August 8, 1993: 4,400 without power (thunderstorm winds), Muskegon and Oceana counties
- March 9, 1998: 1,900 power outages (blizzard conditions), Lake, Clare, Oceana and Muskegon counties.
- May 29-30, 1998: 54,000 without power; 27,000 on second day (thunderstorm winds), Muskegon County.
- May 31, 1998: 50,000 without power (thunderstorm winds), Muskegon County.
- ***June 18, 1998: Most of Montague without power (thunderstorm winds and lightning), Montague City and Montague Twp.***
- July 21, 1998: 7,500 without power (thunderstorm winds and lightning), Muskegon County.

2.08 Nuclear Power Plant Emergencies: - None Identified.

2.09 Oil and Natural Gas Well Accidents:

- Oil and gas wells in Muskegon County in 2012: 1,090.

2.10 Pipeline Accidents: - None Identified.

2.11 Transportation Accidents: - None Identified.

3. HUMAN -RELATED HAZARDS

3.01 Catastrophic Incidents (National Emergencies):

- 1939-1945: World War II. In Muskegon, 48-hour minimum work weeks, rationing of certain food and goods, and 274 county men killed in battle.
- 2005: Hurricanes Katrina and Rita. Declarations of Gubernatorial Disaster and Presidential Emergency were issued in Michigan in September 2005 for hurricane evacuation.

3.02 Civil Disturbances: - None Identified.

3.03 Nuclear Attack: - None Identified.

3.04 Public Health Emergencies:

- 1913: Diphtheria Epidemic.
- 1916: Small pox and scarlet fever force closures of schools and businesses.
- 1918: Influenza epidemic closes theaters, dance halls, and churches.
- 1937: Children under 18 banned from theaters and schools close from fear of polio outbreak.
- 1941: Influenza epidemic cuts school attendance by 60%.
- 2009: H1N1 influenza pandemic causes school absences spike in the fall. Two county residents die from complications.

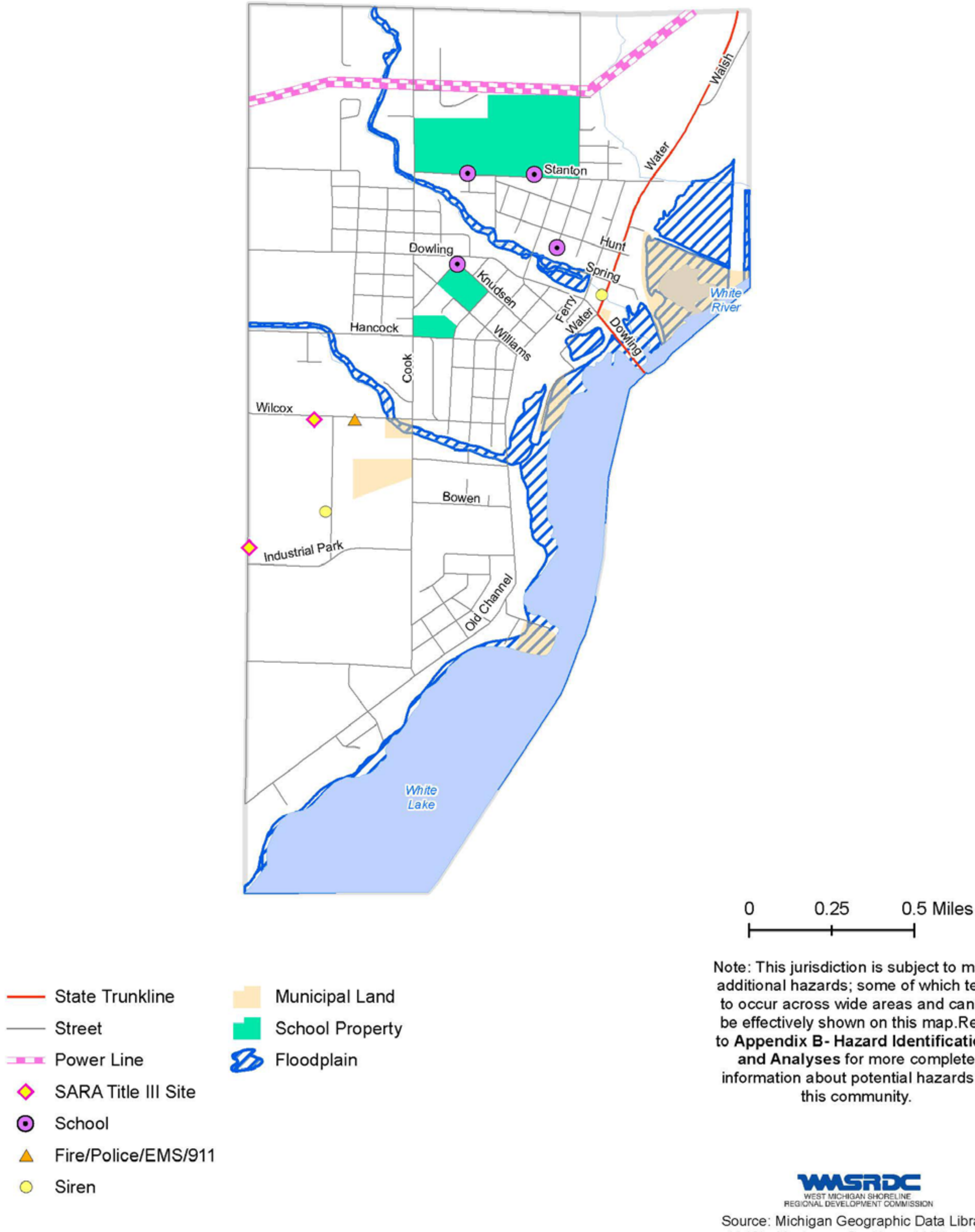
3.05 Terrorism and Similar Criminal Activities: - None Identified.

	City of Montague Hazard Rating	Probability of Occurrence	Impact on People	Impact on Property	Impact on Economy	Impacts Total	Hazard Score
1.01	Celestial Impacts	1	2	0	2	8	8
1.02	Drought	2	2	1	2	10	20
1.03	Earthquake	0	-	-	-	-	-
1.04	Extreme Temperatures	3	2	1	1	9	27
1.05	Flooding: Riverine/Urban	3	1	2	2	9	27
1.06	Fog	3	1	0	1	4	12
1.07	Great Lakes Shoreline	0	-	-	-	-	-
1.08	Hail	2	2	1	1	9	18
1.09	Invasive Species	2	1	1	1	6	12
1.10	Lightning	3	1	2	1	8	24
1.11	Severe Winds	3	2	2	2	12	36
1.12	Subsidence	1	1	1	1	6	6
1.13	Tornadoes	1	3	2	2	15	15
1.14	Wildfire	2	2	2	2	12	24
1.15	Winter Storms	3	3	2	2	15	45
2.01	Dam failure	2	1	2	1	8	16
2.02	Energy Emergencies	2	2	0	2	8	16
2.03	Fire – Scrap Tires	0	-	-	-	-	-
2.04	Fire – Structural	3	1	2	3	10	30
2.05	HAZMAT – Fixed Site	1	1	1	1	6	6
2.06	HAZMAT – Transportation	3	1	1	1	6	18
2.07	Infrastructure Failures	3	2	1	2	10	30
2.08	Nuclear Power Emergencies	0	-	-	-	-	-
2.09	Oil/Natural Gas Well Accidents	1	1	1	1	6	6
2.10	Pipeline Accidents	0	-	-	-	-	-
2.11	Transportation Accidents	2	1	1	1	6	12
3.01	Catastrophic Incidents	1	3	3	3	18	18
3.02	Civil Disturbances	1	1	1	1	6	6
3.03	Nuclear Attack	0	-	-	-	-	-
3.04	Public Health Emergencies	2	2	0	3	9	18
3.05	Terrorism & Similar Criminal Acts	1	1	1	1	6	6

City of Montague Hazard Ranking

		Probability of Occurrence	X Impacts Total	= Hazard Score
1	Winter Storms	3	15	45
2	Severe Winds	3	12	36
3	Fire – Structural	3	10	30
3	Infrastructure Failures	3	10	30
5	Extreme Temperatures	3	9	27
5	Flooding: Riverine/Urban	3	9	27
7	Lightning	3	8	24
7	Wildfire	2	12	24
9	Drought	2	10	20
10	Catastrophic Incidents	1	18	18
10	Hail	2	9	18
10	HAZMAT – Transportation	3	6	18
10	Public Health Emergencies	2	9	18
12	Dam Failure	2	8	16
12	Energy Emergencies	2	8	16
14	Fog	3	5	15
14	Tornadoes	1	15	15
16	Invasive Species	2	7	14
17	Transportation Accidents	2	6	12
18	Celestial Impacts	1	8	8
19	Civil Disturbances	1	6	6
19	HAZMAT – Fixed Site	1	6	6
19	Oil/Natural Gas Well Accidents	1	6	6
19	Subsidence	1	6	6
19	Terrorism & Similar Criminal Acts	1	6	6
	Earthquake	0	-	-
	Fire – Scrap Tires	0	-	-
	Great Lakes Shoreline	0	-	-
	Nuclear Attack	0	-	-
	Nuclear Power Emergencies	0	-	-
	Pipeline Accidents	0	-	-

CITY OF MONTAGUE
Critical Facilities and Potential Hazards



Note: This jurisdiction is subject to many additional hazards; some of which tend to occur across wide areas and cannot be effectively shown on this map.Refer to **Appendix B- Hazard Identifications and Analyses** for more complete information about potential hazards in this community.

WMSRDC
WEST MICHIGAN SHORELINE REGIONAL DEVELOPMENT COMMISSION

Source: Michigan Geographic Data Library V 12b, Muskegon Co. Hazard Mitigation Plan Update 2014

City of Muskegon

1. NATURAL HAZARDS

1.01 Celestial Impacts: - None Identified.

1.02 Drought:

- 12 recorded drought events in the area (including Lake, Mason, Muskegon, Newaygo, and Oceana counties) lasting eight months or greater: 1895-1896, 1899-1900, 1901-1902, 1909-1911, 1925-1926, 1930-1931, 1956-1957, 1962-1963, 1971-1972, 1976-1977, and 2002-2003.
- Summer 1871: Prolonged drought over much of the Great Lakes region.
- May-September, 1891: Drought devastated Michigan's lumber industry.

1.03 Earthquake: - None Identified.

1.04 Extreme Temperatures:

- ***July 1936: Heatwave. 570 deaths statewide, 7 in Muskegon.***
- Summer, 1988: 39 days with temperatures over 90 degrees, statewide.
- January 13-20, 1994: Record cold. $50m property damage across Michigan.
- December 9-10, 1995: Coldwave across Lower Michigan.
- March 2012: Record warm temperatures triggered early growing season. $209.8m crop damage across Michigan.

1.05 Flooding - Riverine/ Urban:

- August 20 - September 6, 1975: Flooding. Declaration of major disaster by President.
- February 21, 1986: Great lakes flooding and wave action. Declaration of disaster by Governor.
- September 10-19, 1986: Flooding. Declaration of major disaster by President.
- September, 1986: Flooding & heavy rain. Declaration of disaster by Governor.
- May 18-20, 2000: Flood. $100k property damage, $50k crop damage in Muskegon County.
- February 9-10, 2001: Flooding. $100k property damage across West Michigan.
- February 24-28, 2001: Flooding. $190k property damage across West Michigan.
- May 15-16, 2001: Flooding. $500k property damage, $200k crop damage across southwestern Lower Michigan.
- May 20-24, 2004: Flooding. Declaration of major disaster by President.
- April 17-23, 2013: Flooding. Declaration of major disaster by President. $5m property damage, Muskegon County.

1.06 Fog:

- January 11-13, 1995: Dense Fog. 4 traffic accident fatalities, school closures, and flight delays across Lower Michigan.

1.07 Great Lakes Shoreline Hazards:

- Extreme high water levels in the Great Lakes: 1929, 1952, 1973, 1986, and 1997.
- Extreme low water levels in the Great Lakes: 1926, 1934, 1964, 2003, and 2013.
- Rip current incidents on Lake Michigan, 2002-2012: 77 fatalities, 230 rescues.
- June 1986: Record high water level on Lake Michigan.
- ***July 13, 1938: Seiche/storm surge on Lake Michigan. 3 drowned in Holland, 1 in Muskegon, and 1 near Pentwater.***
- 2013: Record low water level on Lake Michigan.

1.08 Hail:

- Days with severe hail reported (1" or greater) recorded in Muskegon County, 2000-2012: 7
- May 15, 2001: 0.75-1.00 inch hail. $95k property damage, $95k crop damage across Muskegon County.
- August 3, 2003: 1.75 inch hail in Muskegon Twp, $55k property damage and $25k crop damage from hail countywide.
- ***July 2, 2008: 2.00 inch hail, City of Muskegon.***

1.09 Invasive Species: - Invasive species exist in Muskegon County; No significant events identified.

1.10 Lightning:

- July 20, 1994: Lightning killed a dog and caused $50k property damage, Muskegon County.
- ***July 4, 1995: Lightning struck a boat in the Muskegon Lake Channel. $10k property damage.***

1.11 Severe Winds:

- August 20 - September 6, 1975: Rainstorms, high winds. Declaration of major disaster by President.
- November 18, 1994: High wind. $1m property damage statewide.
- April 6, 1997: High wind. $5m property damage across southwest Lower Michigan.
- May 29, 1998: Severe thunderstorm winds. 54,000 homes and businesses without power; estimated 500 homes and 30 businesses sustained minor to moderate damage. $1m property damage, Muskegon County.
- May 31, 1998: Thunderstorms & high winds. Declarations of disaster by Governor and major disaster by President. $2,458,958 in public damage costs, 42 homes destroyed, 1,805 homes damaged, 5 businesses destroyed, and 73 businesses damaged. Total public and private costs have been estimated at $24,205,908.
- ***June 1, 2000: Severe thunderstorm winds. $40k property damage, City of Muskegon.***
- August 22, 2000: Severe thunderstorm winds. $150k property damage, Muskegon County.
- March 9, 2002: High wind. $485k property damage across southwest Lower Michigan.
- October 30, 2004: High wind. $1.15m property damage across southwest Lower Michigan.
- May 20-24, 2004: Severe storms. Declaration of major disaster by President.
- August 9, 2009: Severe thunderstorm winds. $2m property damage, Muskegon County.
- November 17, 2013: Severe thunderstorm winds. $200k property damage, Muskegon County.

1.12 Subsidence: - None Identified.

1.13 Tornadoes:

- Number of tornadoes in Muskegon County, 1950-2012: 7.

1.14 Wildfire:

- October 1871: Wildfires. 1.2m acres burned, 200 fatalities, Michigan's Lower Peninsula.
- May-September, 1891: Uncontrollable wildfires across Michigan during the drought of 1891.
- 1981-2010: Approximately 8 wildfires and 89 acres burned per year on county lands under MDNR jurisdiction (251 total wildfires, 2,676.0 total acres burned).

1.15 Winter Storms:

- March 2-7, 1976: Ice storms. Declaration of major disaster by President.
- January 26-31, 1977: Blizzard, snowstorm. Declaration of emergency by President.
- January 26-27, 1978: Blizzard, snowstorm. Declaration of statewide emergency by President.
- January 12, 1993: Heavy snow. $50k property damage, northern Lower Michigan.
- January 12-21, 1994: Heavy lake effect snow. $500k property damage across western Lower Michigan.
- January 27, 1994: Heavy snow and freezing rain. $5m property damage across region.
- October 26, 1997: Heavy snow. $1.2m property damage across southwestern Lower Michigan.
- March 9, 1998: Winter storm. $100k property damage across region.
- January 2-15, 1999: Blizzard, snowstorm. Declaration of emergency by President.
- December 11-31, 2000: Blizzard, snowstorm. Declaration of emergency by President.
- April 3, 2003: Ice storm. $4.9m property damage throughout West Michigan.
- February 16, 2006: Ice storm. $1m property damage across Lower Michigan.

2. TECHNOLOGICAL HAZARDS

2.01 Dam Failure:

- Four documented failures in Muskegon County, unidentified locations.

2.02 Energy Emergencies:

- ***January 1918: Coal and fuel shortages during a blizzard. Curfew to conserve resources, City of Muskegon.***
- February 2003: A break in a major transmission line caused an electrical blackout over parts of Montcalm, Oceana, Newaygo, Muskegon, and Kent counties.

2.03 Fire - Scrap Tire:

- Approximate scrap tire inventory in Muskegon County in 2012: 4,400.

2.04 Fire - Structural:

- County fire rate per 1,000 population in 1998: 3.8.
- ***Major fires in the City of Muskegon: 1871, 1874, 1891, and 1946.***
- ***June 30, 2009: Apartment complex destroyed (all 10 units), causing 5 injuries in the City of Muskegon.***

2.05 Hazard Material Incidents - Fixed Site (including industrial accidents):

- SARA Title III Sites in Muskegon County in 2012: 51.
- ***1920: Explosion and fire at Brunswick, Balke, Collender Co. claims seven lives, City of Muskegon.***

2.06 Hazard Material Incidents - Transportation: - None Identified.

2.07 Infrastructure Failure:

- Number of NCDC records with mention of downed power lines or power outages in Muskegon County, 1993-2012: 45
- Number of sanitary sewer overflows in Muskegon County, 2000-2011: 47.
- August 8, 1993: 4,400 without power (thunderstorm winds), Muskegon and Oceana counties
- March 9, 1998: 1,900 power outages (blizzard conditions), Lake, Clare, Oceana and Muskegon counties.
- May 29-30, 1998: 54,000 without power; 27,000 on second day (thunderstorm winds), Muskegon County.
- May 31, 1998: 50,000 without power (thunderstorm winds), Muskegon County.
- July 21, 1998: 7,500 without power (thunderstorm winds and lightning), Muskegon County.

2.08 Nuclear Power Plant Emergencies: - None Identified.

2.09 Oil and Natural Gas Well Accidents:

- Oil and gas wells in Muskegon County in 2012: 1,090.

2.10 Pipeline Accidents:

- ***February 22, 1986: Gasoline pipeline rupture in the City of Muskegon. Thousands of gallons of gasoline spilled into a Ruddiman Creek tributary, causing minor house explosions, at least one fire, and dozens of area residents to evacuate.***

2.11 Transportation Accidents:

- ***October 28, 1919: Huge waves crashed the wooden side-wheel steamer, City of Muskegon, into the Muskegon Channel's south pier. 15 passengers and 7 crew members died in the accident.***
- ***November 30, 1034: A strong gust of wind sent the 315-foot Henry Cort into the north breakwater of the Muskegon Channel. The entire crew was rescued, however a small Coast Guard vessel responding to the accident capsized, killing one Coast Guardsman.***

3. HUMAN -RELATED HAZARDS

3.01 Catastrophic Incidents (National Emergencies):

- 1939-1945: World War II. In Muskegon, 48-hour minimum work weeks, rationing of certain food and goods, and 274 county men killed in battle.
- 2005: Hurricanes Katrina and Rita. Declarations of Gubernatorial Disaster and Presidential Emergency were issued in Michigan in September 2005 for hurricane evacuation.

3.02 Civil Disturbances:

- ***August 5, 1919: Street Car Riots. Riders revolted against a rate increase from 6 cents to 7 cents and destroyed 13 street cars, causing $100,000 to $125,000 (approximately $1.3 to $1.5 million today) in property damage.***

3.03 Nuclear Attack: - None Identified.

3.04 Public Health Emergencies:

- 1913: Diphtheria Epidemic.
- 1916: Small pox and scarlet fever force closures of schools and businesses.
- 1918: Influenza epidemic closes theaters, dance halls, and churches.
- 1937: Children under 18 banned from theaters and schools close from fear of polio outbreak.
- 1941: Influenza epidemic cuts school attendance by 60%.
- 2009: H1N1 influenza pandemic causes school absences spike in the fall. Two county residents die from complications.

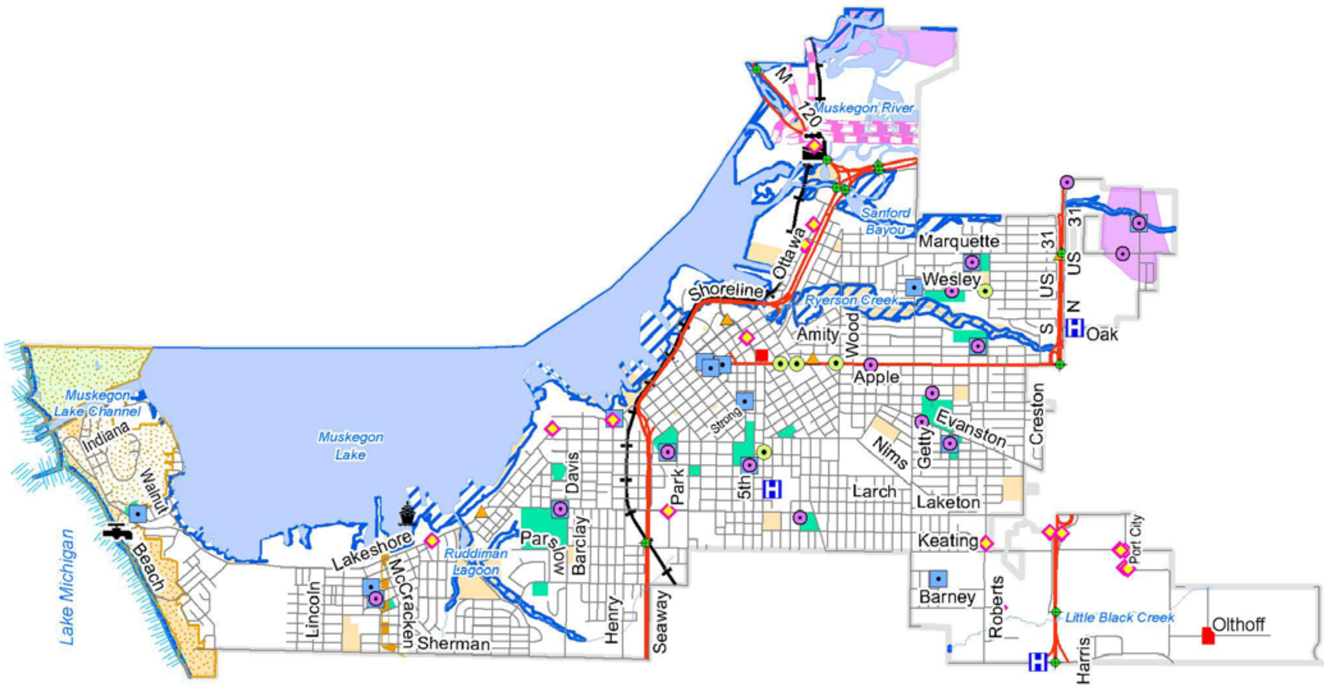
3.05 Terrorism and Similar Criminal Activities: - None Identified.

	City of Muskegon Hazard Rating	Probability of Occurrence	Impact on People	Impact on Property	Impact on Economy	Impacts Total	Hazard Score
1.01	Celestial Impacts	1	2	0	2	8	8
1.02	Drought	2	2	1	2	10	20
1.03	Earthquake	0	-	-	-	-	-
1.04	Extreme Temperatures	3	2	1	1	9	27
1.05	Flooding: Riverine/Urban	3	1	2	2	9	27
1.06	Fog	3	1	0	2	5	15
1.07	Great Lakes Shoreline	3	1	2	1	8	24
1.08	Hail	2	2	1	1	9	18
1.09	Invasive Species	2	1	1	1	6	12
1.10	Lightning	3	1	2	1	8	24
1.11	Severe Winds	3	2	2	2	12	36
1.12	Subsidence	1	1	1	1	6	6
1.13	Tornadoes	1	3	2	2	15	15
1.14	Wildfire	2	1	2	2	9	18
1.15	Winter Storms	3	3	2	2	15	45
2.01	Dam failure	2	1	2	1	8	16
2.02	Energy Emergencies	2	2	0	2	8	16
2.03	Fire – Scrap Tires	1	1	1	1	6	6
2.04	Fire – Structural	3	1	2	3	10	30
2.05	HAZMAT – Fixed Site	3	1	1	2	7	21
2.06	HAZMAT – Transportation	3	1	1	1	6	18
2.07	Infrastructure Failures	3	2	1	2	10	30
2.08	Nuclear Power Emergencies	0	-	-	-	-	-
2.09	Oil/Natural Gas Well Accidents	2	1	1	1	6	12
2.10	Pipeline Accidents	1	1	1	2	7	7
2.11	Transportation Accidents	2	1	1	2	7	14
3.01	Catastrophic Incidents	1	3	3	3	18	18
3.02	Civil Disturbances	2	1	1	1	6	12
3.03	Nuclear Attack	0	-	-	-	-	-
3.04	Public Health Emergencies	2	2	0	3	9	18
3.05	Terrorism & Similar Criminal Acts	1	1	1	1	6	6

City of Muskegon Hazard Ranking

		Probability of Occurrence X	Impacts Total =	Hazard Score
1	Winter Storms	3	15	45
2	Severe Winds	3	12	36
3	Fire – Structural	3	10	30
3	Infrastructure Failures	3	10	30
5	Extreme Temperatures	3	9	27
5	Flooding: Riverine/Urban	3	9	27
7	Great Lakes Shoreline	3	8	24
7	Lightning	3	8	24
9	HAZMAT – Fixed Site	3	7	21
10	Drought	2	10	20
11	Catastrophic Incidents	1	18	18
11	Hail	2	9	18
11	HAZMAT – Transportation	3	6	18
11	Public Health Emergencies	2	9	18
11	Wildfire	2	9	18
16	Dam Failure	2	8	16
16	Energy Emergencies	2	8	16
18	Fog	3	5	15
18	Tornadoes	1	15	15
20	Transportation Accidents	2	7	14
21	Civil Disturbances	2	6	12
21	Invasive Species	2	6	12
21	Oil/Natural Gas Well Accidents	2	6	12
24	Celestial Impacts	1	8	8
25	Pipeline Accidents	1	7	7
26	Fire – Scrap Tires	1	6	6
26	Subsidence	1	6	6
26	Terrorism & Similar Criminal Acts	1	6	6
	Earthquake	0	-	-
	Nuclear Power Emergencies	0	-	-
	Nuclear Attack	0	-	-

CITY OF MUSKEGON
Critical Facilities and Potential Hazards



- State Trunkline
- Street
- Railroad
- Oil Pipeline
- Power Line
- Great Lakes Shoreline Hazard
- SARA Title III Site
- Bridge
- Power Plant
- Water Filtration Plant
- Ferry Terminal
- Fire/Police/EMS/ 911
- Hospital
- Medical Facility
- School
- Shelter
- Correctional Facility
- State Land
- Municipal Land
- School Property
- High Risk Erosion Area
- Oil/Gas Field
- Floodplain

0 0.45 0.9 1.8 Miles

Note: This jurisdiction is subject to many additional hazards; some of which tend to occur across wide areas and cannot be effectively shown on this map.Refer to **Appendix B- Hazard Identifications and Analyses** for more complete information about potential hazards in this community.

WMSRDC
WEST MICHIGAN SHORELINE REGIONAL DEVELOPMENT COMMISSION

Source: Michigan Geographic Data Library V 12b, Muskegon Co. Hazard Mitigation Plan Update 2014

Hazard Identification Profile
City of Muskegon Heights

1. NATURAL HAZARDS

1.01 Celestial Impacts: - None Identified.

1.02 Drought:

- 12 recorded drought events in the area (including Lake, Mason, Muskegon, Newaygo, and Oceana counties) lasting eight months or greater: 1895-1896, 1899-1900, 1901-1902, 1909-1911, 1925-1926, 1930-1931, 1956-1957, 1962-1963, 1971-1972, 1976-1977, and 2002-2003.
- Summer 1871: Prolonged drought over much of the Great Lakes region.
- May-September, 1891: Drought devastated Michigan's lumber industry.
- 2013: Record low Lake Michigan water levels.

1.03 Earthquake: - None Identified.

1.04 Extreme Temperatures:

- July 1936: Heatwave. 570 deaths statewide, 7 in Muskegon.
- Summer, 1988: 39 days with temperatures over 90 degrees, statewide.
- January 13-20, 1994: Record cold. $50m property damage across Michigan.
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1.05 Flooding - Riverine/ Urban:

- August 20 - September 6, 1975: Flooding. Declaration of major disaster by President.
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- May 18-20, 2000: Flood. $100k property damage, $50k crop damage in Muskegon County.
- February 9-10, 2001: Flooding. $100k property damage across West Michigan.
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- May 20-24, 2004: Flooding. Declaration of major disaster by President.
- April 17-23, 2013: Flooding. Declaration of major disaster by President. $5m property damage, Muskegon County.

1.06 Fog:

- January 11-13, 1995: Dense Fog. 4 traffic accident fatalities, school closures, and flight delays across Lower Michigan.

1.07 Great Lakes Shoreline Hazards: - None Identified.

1.08 Hail:

- Days with severe hail reported (1" or greater) recorded in Muskegon County, 2000-2012: 7
- May 15, 2001: 0.75-1.00 inch hail. $95k property damage, $95k crop damage across Muskegon County.
- August 3, 2003: 1.75 inch hail in Muskegon Twp, $55k property damage and $25k crop damage from hail countywide.

1.09 Invasive Species: - Invasive species exist in Muskegon County; No significant events identified.

1.10 Lightning:

- July 20, 1994: Lightning killed a dog and caused $50k property damage, Muskegon County.
- ***July 1, 2011: Lightning struck a radio station in Muskegon Heights. Estimated $10k property damage.***

1.11 Severe Winds:

- August 20 - September 6, 1975: Rainstorms, high winds. Declaration of major disaster by President.
- November 18, 1994: High wind. $1m property damage statewide.
- April 6, 1997: High wind. $5m property damage across southwest Lower Michigan.
- May 29, 1998: Severe thunderstorm winds. 54,000 homes and businesses without power; estimated 500 homes and 30 businesses sustained minor to moderate damage. $1m property damage, Muskegon County.
- May 31, 1998: Thunderstorms & high winds. Declarations of disaster by Governor and major disaster by President. $2,458,958 in public damage costs, 42 homes destroyed, 1,805 homes damaged, 5 businesses destroyed, and 73 businesses damaged. Total public and private costs have been estimated at $24,205,908.
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- October 30, 2004: High wind. $1.15m property damage across southwest Lower Michigan.
- May 20-24, 2004: Severe storms. Declaration of major disaster by President.
- August 9, 2009: Severe thunderstorm winds. $2m property damage, Muskegon County.
- November 17, 2013: Severe thunderstorm winds. $200k property damage, Muskegon County.

1.12 Subsidence: - None Identified.

1.13 Tornadoes:

- Number of tornadoes in Muskegon County, 1950-2012: 7.

1.14 Wildfire:

- October 1871: Wildfires. 1.2m acres burned, 200 fatalities, Michigan's Lower Peninsula.
- May-September, 1891: Uncontrollable wildfires across Michigan during the drought of 1891.

- 1981-2010: Approximately 8 wildfires and 89 acres burned per year on county lands under MDNR jurisdiction (251 total wildfires, 2,676.0 total acres burned).

1.15 Winter Storms:

- March 2-7, 1976: Ice storms. Declaration of major disaster by President.
- January 26-31, 1977: Blizzard, snowstorm. Declaration of emergency by President.
- January 26-27, 1978: Blizzard, snowstorm. Declaration of statewide emergency by President.
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- October 26, 1997: Heavy snow. $1.2m property damage across southwestern Lower Michigan.
- March 9, 1998: Winter storm. $100k property damage across region.
- January 2-15, 1999: Blizzard, snowstorm. Declaration of emergency by President.
- December 11-31, 2000: Blizzard, snowstorm. Declaration of emergency by President.
- April 3, 2003: Ice storm. $4.9m property damage throughout West Michigan.
- February 16, 2006: Ice storm. $1m property damage across Lower Michigan.

2. TECHNOLOGICAL HAZARDS

2.01 Dam Failure:

- Four documented failures in Muskegon County, unidentified locations.

2.02 Energy Emergencies:

- February 2003: A break in a major transmission line caused an electrical blackout over parts of Montcalm, Oceana, Newaygo, Muskegon, and Kent counties.

2.03 Fire - Scrap Tire:

- Approximate scrap tire inventory in Muskegon County in 2012: 4,400.

2.04 Fire - Structural:

- County fire rate per 1,000 population in 1998: 3.8.

2.05 Hazard Material Incidents - Fixed Site (including industrial accidents):

- SARA Title III Sites in Muskegon County in 2012: 51.

2.06 Hazard Material Incidents - Transportation: - None identified.

2.07 Infrastructure Failure:

- Number of NCDC records with mention of downed power lines or power outages in Muskegon County, 1993-2012: 45
- Number of sanitary sewer overflows in Muskegon County, 2000-2011: 47.
- August 8, 1993: 4,400 without power (thunderstorm winds), Muskegon and Oceana counties
- March 9, 1998: 1,900 power outages (blizzard conditions), Lake, Clare, Oceana and Muskegon counties.
- May 29-30, 1998: 54,000 without power; 27,000 on second day (thunderstorm winds), Muskegon County.
- May 31, 1998: 50,000 without power (thunderstorm winds), Muskegon County.
- July 21, 1998: 7,500 without power (thunderstorm winds and lightning), Muskegon County.
- ***January 2005: City of Muskegon Heights without water service (broken water main).***

2.08 Nuclear Power Plant Emergencies: - None Identified.

2.09 Oil and Natural Gas Well Accidents:

- Oil and gas wells in Muskegon County in 2012: 1,090.

2.10 Pipeline Accidents: - None identified.

2.11 Transportation Accidents: - None Identified.

3. HUMAN -RELATED HAZARDS

3.01 Catastrophic Incidents (National Emergencies):

- 1939-1945: World War II. In Muskegon, 48-hour minimum work weeks, rationing of certain food and goods, and 274 county men killed in battle.
- 2005: Hurricanes Katrina and Rita. Declarations of Gubernatorial Disaster and Presidential Emergency were issued in Michigan in September 2005 for hurricane evacuation.

3.02 Civil Disturbances: - None identified.

3.03 Nuclear Attack: - None Identified.

3.04 Public Health Emergencies:

- 1913: Diphtheria Epidemic.
- 1916: Small pox and scarlet fever force closures of schools and businesses.
- 1918: Influenza epidemic closes theaters, dance halls, and churches.
- 1937: Children under 18 banned from theaters and schools close from fear of polio outbreak.
- 1941: Influenza epidemic cuts school attendance by 60%.
- 2009: H1N1 influenza pandemic causes school absences spike in the fall. Two county residents die from complications.

3.05 Terrorism and Similar Criminal Activities: - None Identified.

	City of Muskegon Heights Hazard Rating	Probability of Occurrence	Impact on People	Impact on Property	Impact on Economy	Impacts Total	Hazard Score
1.01	Celestial Impacts	1	2	0	2	8	8
1.02	Drought	2	2	1	2	10	20
1.03	Earthquake	0	-	-	-	-	-
1.04	Extreme Temperatures	3	2	1	1	9	27
1.05	Flooding: Riverine/Urban	3	1	2	2	9	27
1.06	Fog	2	1	0	1	4	8
1.07	Great Lakes Shoreline	0	-	-	-	-	-
1.08	Hail	2	2	1	1	9	18
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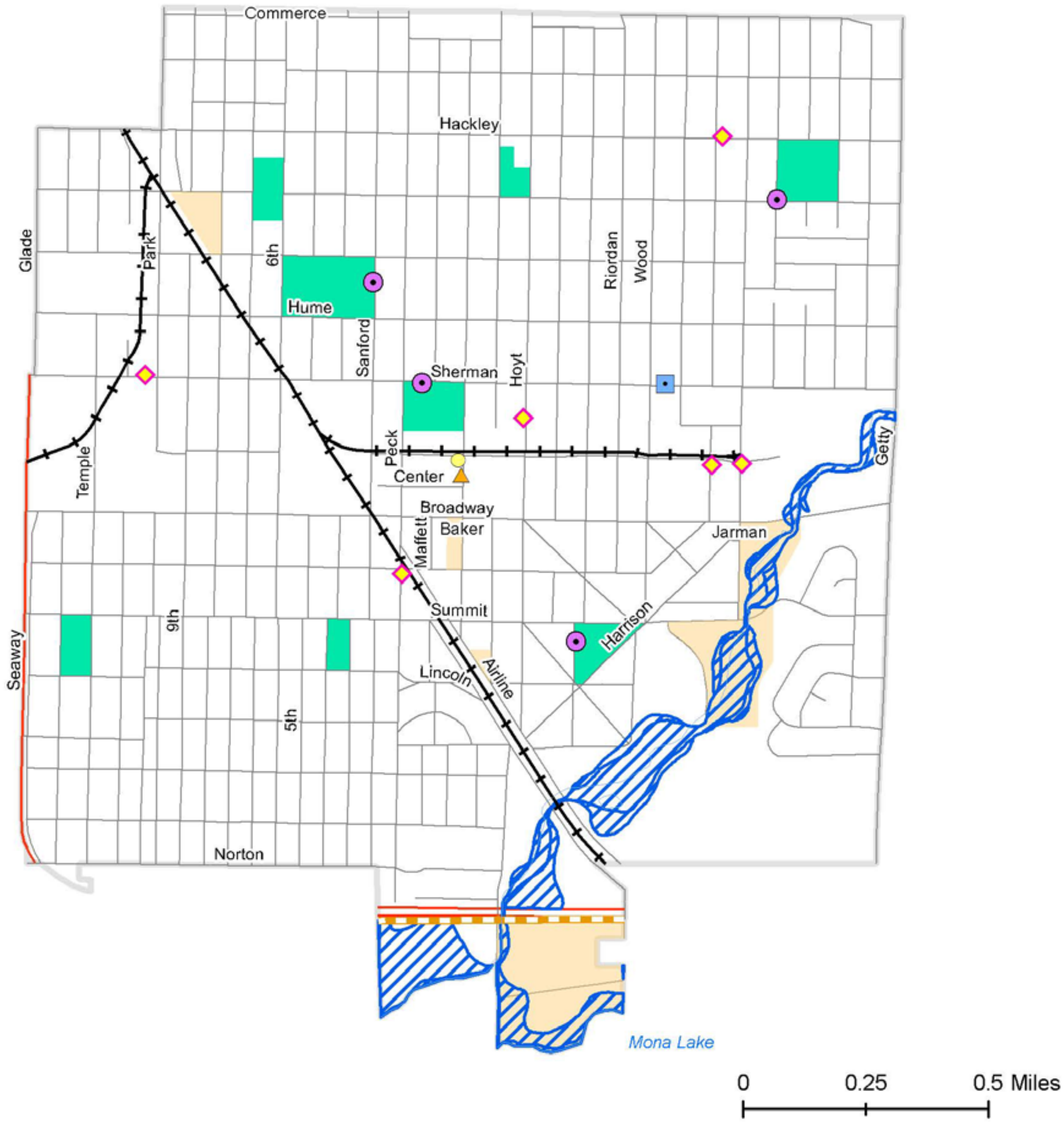
1.11	Severe Winds	3	2	2	2	12	36
1.12	Subsidence	1	1	1	1	6	6
1.13	Tornadoes	1	3	2	2	15	15
1.14	Wildfire	2	1	2	1	8	16
1.15	Winter Storms	3	3	2	2	15	45
2.01	Dam failure	0	-	-	-	-	-
2.02	Energy Emergencies	2	2	0	2	8	16
2.03	Fire – Scrap Tires	0	-	-	-	-	-
2.04	Fire – Structural	3	1	2	3	10	30
2.05	HAZMAT – Fixed Site	3	1	1	2	7	21
2.06	HAZMAT – Transportation	3	1	1	1	6	18
2.07	Infrastructure Failures	3	2	1	2	10	30
2.08	Nuclear Power Emergencies	0	-	-	-	-	-
2.09	Oil/Natural Gas Well Accidents	0	-	-	-	-	-
2.10	Pipeline Accidents	1	1	1	2	7	7
2.11	Transportation Accidents	2	1	1	2	7	14
3.01	Catastrophic Incidents	1	3	3	3	18	18
3.02	Civil Disturbances	1	1	1	1	6	6
3.03	Nuclear Attack	0	-	-	-	-	-
3.04	Public Health Emergencies	2	2	0	3	9	18
3.05	Terrorism & Similar Criminal Acts	1	1	1	1	6	6

City of Muskegon Heights Hazard Ranking

		Probability of Occurrence X	Impacts Total =	Hazard Score
1	Winter Storms	3	15	45
2	Severe Winds	3	12	36
3	Fire – Structural	3	10	30
3	Infrastructure Failures	3	10	30
5	Extreme Temperatures	3	9	27
5	Flooding: Riverine/Urban	3	9	27
7	Lightning	3	8	24
8	HAZMAT – Fixed Site	3	7	21
9	Drought	2	10	20
10	Catastrophic Incidents	1	18	18
10	Hail	2	9	18
10	HAZMAT – Transportation	3	6	18
10	Public Health Emergencies	2	9	18
14	Energy Emergencies	2	8	16
14	Wildfire	2	8	16
16	Tornadoes	1	15	15
17	Transportation Accidents	2	7	14
18	Invasive Species	2	6	12
19	Celestial Impacts	1	8	8
19	Fog	2	4	8
21	Pipeline Accidents	1	7	7
22	Civil Disturbances	1	6	6
22	Subsidence	1	6	6
22	Terrorism & Similar Criminal Acts	1	6	6
	Dam Failure	0	-	-
	Earthquake	0	-	-
	Fire – Scrap Tires	0	-	-
	Great Lakes Shoreline	0	-	-
	Nuclear Attack	0	-	-
	Nuclear Power Emergencies	0	-	-
	Oil/Natural Gas Well Accidents	0	-	-

CITY OF MUSKEGON HEIGHTS
Critical Facilities and Potential Hazards



- State Trunkline
- Street
- Railroad
- Oil Pipeline
- SARA Title III Site
- School
- Shelter
- Fire/Police/EMS/911
- Siren
- Municipal Land
- School Property
- Floodplain

Note: This jurisdiction is subject to many additional hazards; some of which tend to occur across wide areas and cannot be effectively shown on this map.Refer to **Appendix B- Hazard Identifications and Analyses** for more complete information about potential hazards in this community.

WMSRDC
WEST MICHIGAN SHORELINE REGIONAL DEVELOPMENT COMMISSION

Source: Michigan Geographic Data Library V 12b, Muskegon Co. Hazard Mitigation Plan Update 2014

Hazard Identification Profile
City of North Muskegon

1. NATURAL HAZARDS

1.01 Celestial Impacts: - None Identified.

1.02 Drought:
- 12 recorded drought events in the area (including Lake, Mason, Muskegon, Newaygo, and Oceana counties) lasting eight months or greater: 1895-1896, 1899-1900, 1901-1902, 1909-1911, 1925-1926, 1930-1931, 1956-1957, 1962-1963, 1971-1972, 1976-1977, and 2002-2003.
- Summer 1871: Prolonged drought over much of the Great Lakes region.
- May-September, 1891: Drought devastated Michigan's lumber industry.
- 2013: Record low Lake Michigan water levels.

1.03 Earthquake: - None Identified.

1.04 Extreme Temperatures:
- July 1936: Heatwave. 570 deaths statewide, 7 in Muskegon.
- Summer, 1988: 39 days with temperatures over 90 degrees, statewide.
- January 13-20, 1994: Record cold. $50m property damage across Michigan.
- December 9-10, 1995: Coldwave across Lower Michigan.
- March 2012: Record warm temperatures triggered early growing season. $209.8m crop damage across Michigan.

1.05 Flooding - Riverine/ Urban:
- August 20 - September 6, 1975: Flooding. Declaration of major disaster by President.
- February 21, 1986: Great lakes flooding and wave action. Declaration of disaster by Governor.
- September 10-19, 1986: Flooding. Declaration of major disaster by President.
- September, 1986: Flooding & heavy rain. Declaration of disaster by Governor.
- May 18-20, 2000: Flood. $100k property damage, $50k crop damage in Muskegon County.
- February 9-10, 2001: Flooding. $100k property damage across West Michigan.
- February 24-28, 2001: Flooding. $190k property damage across West Michigan.
- May 15-16, 2001: Flooding. $500k property damage, $200k crop damage across southwestern Lower Michigan.
- May 20-24, 2004: Flooding. Declaration of major disaster by President.
- April 17-23, 2013: Flooding. Declaration of major disaster by President. $5m property damage, Muskegon County.

1.06 Fog:
- January 11-13, 1995: Dense Fog. 4 traffic accident fatalities, school closures, and flight delays across Lower Michigan.

1.07 Great Lakes Shoreline Hazards: - None Identified

1.08 Hail:
- Days with severe hail reported (1" or greater) recorded in Muskegon County, 2000-2012: 7
- May 15, 2001: 0.75-1.00 inch hail. $95k property damage, $95k crop damage across Muskegon County.
- August 3, 2003: 1.75 inch hail in Muskegon Twp, $55k property damage and $25k crop damage from hail countywide.

1.09 Invasive Species: - Invasive species exist in Muskegon County; No significant events identified.

1.10 Lightning:
- July 20, 1994: Lightning killed a dog and caused $50k property damage, Muskegon County.
- July 1, 2011: Lightning struck a radio station in Muskegon Heights. Estimated $10k property damage.

1.11 Severe Winds:
- August 20 - September 6, 1975: Rainstorms, high winds. Declaration of major disaster by President.
- November 18, 1994: High wind. $1m property damage statewide.
- April 6, 1997: High wind. $5m property damage across southwest Lower Michigan.
- May 29, 1998: Severe thunderstorm winds. 54,000 homes and businesses without power; estimated 500 homes and 30 businesses sustained minor to moderate damage. $1m property damage, Muskegon County.
- May 31, 1998: Thunderstorms & high winds. Declarations of disaster by Governor and major disaster by President. $2,458,958 in public damage costs, 42 homes destroyed, 1,805 homes damaged, 5 businesses destroyed, and 73 businesses damaged. Total public and private costs have been estimated at $24,205,908.
- August 22, 2000: Severe thunderstorm winds. $150k property damage, Muskegon County.
- March 9, 2002: High wind. $485k property damage across southwest Lower Michigan.
- October 30, 2004: High wind. $1.15m property damage across southwest Lower Michigan.
- May 20-24, 2004: Severe storms. Declaration of major disaster by President.
- August 9, 2009: Severe thunderstorm winds. $2m property damage, Muskegon County.
- November 17, 2013: Severe thunderstorm winds. $200k property damage, Muskegon County.

1.12 Subsidence: - None Identified.

1.13 Tornadoes:
- Number of tornadoes in Muskegon County, 1950-2012: 7.

1.14 Wildfire:
- October 1871: Wildfires. 1.2m acres burned, 200 fatalities, Michigan's Lower Peninsula.
- May-September, 1891: Uncontrollable wildfires across Michigan during the drought of 1891.

- 1981-2010: Approximately 8 wildfires and 89 acres burned per year on county lands under MDNR jurisdiction (251 total wildfires, 2,676.0 total acres burned).

1.15 Winter Storms:

- March 2-7, 1976: Ice storms. Declaration of major disaster by President.
- January 26-31, 1977: Blizzard, snowstorm. Declaration of emergency by President.
- January 26-27, 1978: Blizzard, snowstorm. Declaration of statewide emergency by President.
- January 12, 1993: Heavy snow. $50k property damage, northern Lower Michigan.
- January 12-21, 1994: Heavy lake effect snow. $500k property damage across western Lower Michigan.
- January 27, 1994: Heavy snow and freezing rain. $5m property damage across region.
- October 26, 1997: Heavy snow. $1.2m property damage across southwestern Lower Michigan.
- March 9, 1998: Winter storm. $100k property damage across region.
- January 2-15, 1999: Blizzard, snowstorm. Declaration of emergency by President.
- December 11-31, 2000: Blizzard, snowstorm. Declaration of emergency by President.
- April 3, 2003: Ice storm. $4.9m property damage throughout West Michigan.
- February 16, 2006: Ice storm. $1m property damage across Lower Michigan.

2. TECHNOLOGICAL HAZARDS

2.01 Dam Failure:

- Four documented failures in Muskegon County, unidentified locations.

2.02 Energy Emergencies:

- February 2003: A break in a major transmission line caused an electrical blackout over parts of Montcalm, Oceana, Newaygo, Muskegon, and Kent counties.

2.03 Fire - Scrap Tire:

- Approximate scrap tire inventory in Muskegon County in 2012: 4,400.

2.04 Fire - Structural:

- County fire rate per 1,000 population in 1998: 3.8.

2.05 Hazard Material Incidents - Fixed Site (including industrial accidents):

- SARA Title III Sites in Muskegon County in 2012: 51.

2.06 Hazard Material Incidents - Transportation: - None Identified.

2.07 Infrastructure Failure:

- Number of NCDC records with mention of downed power lines or power outages in Muskegon County, 1993-2012: 45
- Number of sanitary sewer overflows in Muskegon County, 2000-2011: 47.
- August 8, 1993: 4,400 without power (thunderstorm winds), Muskegon and Oceana counties
- March 9, 1998: 1,900 power outages (blizzard conditions), Lake, Clare, Oceana and Muskegon counties.
- May 29-30, 1998: 54,000 without power; 27,000 on second day (thunderstorm winds), Muskegon County.
- May 31, 1998: 50,000 without power (thunderstorm winds), Muskegon County.
- July 21, 1998: 7,500 without power (thunderstorm winds and lightning), Muskegon County.

2.08 Nuclear Power Plant Emergencies: - None Identified.

2.09 Oil and Natural Gas Well Accidents:

- Oil and gas wells in Muskegon County in 2012: 1,090.

2.10 Pipeline Accidents: - None Identified.

2.11 Transportation Accidents: - None Identified.

3. HUMAN -RELATED HAZARDS

3.01 Catastrophic Incidents (National Emergencies):

- 1939-1945: World War II. In Muskegon, 48-hour minimum work weeks, rationing of certain food and goods, and 274 county men killed in battle.
- 2005: Hurricanes Katrina and Rita. Declarations of Gubernatorial Disaster and Presidential Emergency were issued in Michigan in September 2005 for hurricane evacuation.

3.02 Civil Disturbances: - None Identified.

3.03 Nuclear Attack: - None Identified.

3.04 Public Health Emergencies:

- 1913: Diphtheria Epidemic.
- 1916: Small pox and scarlet fever force closures of schools and businesses.
- 1918: Influenza epidemic closes theaters, dance halls, and churches.
- 1937: Children under 18 banned from theaters and schools close from fear of polio outbreak.
- 1941: Influenza epidemic cuts school attendance by 60%.
- 2009: H1N1 influenza pandemic causes school absences spike in the fall. Two county residents die from complications.
- ***2013: North Muskegon Schools close for two days due to widespread influenza.***

3.05 Terrorism and Similar Criminal Activities: - None Identified.

	City of North Muskegon Hazard Rating	Probability of Occurrence	Impact on People	Impact on Property	Impact on Economy	Impacts Total	Hazard Score
1.01	Celestial Impacts	1	2	0	2	8	8
1.02	Drought	2	2	1	2	10	20
1.03	Earthquake	0	-	-	-	-	-
1.04	Extreme Temperatures	3	2	1	1	9	27
1.05	Flooding: Riverine/Urban	3	1	2	2	9	27
1.06	Fog	3	1	0	1	4	12
1.07	Great Lakes Shoreline	3	1	2	1	8	24
1.08	Hail	0	-	-	-	-	-
1.09	Invasive Species	2	1	1	1	6	12
1.10	Lightning	3	1	2	1	8	24
1.11	Severe Winds	3	2	2	2	12	36
1.12	Subsidence	1	1	1	1	6	6
1.13	Tornadoes	1	3	2	2	15	15
1.14	Wildfire	2	1	2	1	8	16
1.15	Winter Storms	3	3	2	2	15	45
2.01	Dam failure	2	1	1	1	6	12
2.02	Energy Emergencies	2	2	0	2	8	16
2.03	Fire – Scrap Tires	0	-	-	-	-	-
2.04	Fire – Structural	3	1	2	3	10	30
2.05	HAZMAT – Fixed Site	3	1	1	2	7	21
2.06	HAZMAT – Transportation	3	1	1	1	6	18
2.07	Infrastructure Failures	3	2	1	2	10	30
2.08	Nuclear Power Emergencies	0	-	-	-	-	-
2.09	Oil/Natural Gas Well Accidents	1	2	1	1	9	9
2.10	Pipeline Accidents	0	-	-	-	-	-
2.11	Transportation Accidents	2	1	1	1	6	12
3.01	Catastrophic Incidents	1	3	3	3	18	18
3.02	Civil Disturbances	1	1	1	1	6	6
3.03	Nuclear Attack	0	-	-	-	-	-
3.04	Public Health Emergencies	2	2	0	3	9	18
3.05	Terrorism & Similar Criminal Acts	1	1	1	1	6	6

City of North Muskegon Hazard Ranking

Rank	Hazard	Probability of Occurrence	X Impacts Total	= Hazard Score
1	Winter Storms	3	15	45
2	Severe Winds	3	12	36
3	Fire – Structural	3	10	30
3	Infrastructure Failures	3	10	30
5	Extreme Temperatures	3	9	27
5	Flooding: Riverine/Urban	3	9	27
7	Great Lakes Shoreline	3	8	24
7	Lightning	3	8	24
9	HAZMAT – Fixed Site	3	7	21
10	Drought	2	10	20
11	Catastrophic Incidents	1	18	18
11	HAZMAT – Transportation	3	6	18
11	Public Health Emergencies	2	9	18
14	Energy Emergencies	2	8	16
14	Wildfire	2	8	16
16	Tornadoes	1	15	15
17	Dam Failure	2	6	12
17	Fog	3	4	12
17	Invasive Species	2	6	12
17	Transportation Accidents	2	6	12
21	Oil/Natural Gas Well Accidents	1	9	9
22	Celestial Impacts	1	8	8
23	Civil Disturbances	1	6	6
23	Subsidence	1	6	6
23	Terrorism & Similar Criminal Acts	1	6	6
	Earthquake	0	-	-
	Fire – Scrap Tires	0	-	-
	Hail	0	-	-
	Nuclear Attack	0	-	-
	Nuclear Power Emergencies	0	-	-
	Pipeline Accidents	0	-	-

CITY OF NORTH MUSKEGON
Critical Facilities and Potential Hazards

State Trunkline

Street

SARA Title III Site

School

Fire/Police/EMS/911

Municipal Land

School Property

Floodplain

Note: This jurisdiction is subject to many additional hazards; some of which tend to occur across wide areas and cannot be effectively shown on this map.Refer to **Appendix B- Hazard Identifications and Analyses** for more complete information about potential hazards in this community.

WMSRDC
WEST MICHIGAN SHORELINE REGIONAL DEVELOPMENT COMMISSION

Source: Michigan Geographic Data Library V 12b, Muskegon Co. Hazard Mitigation Plan Update 2014

Hazard Identification Profile
City of Norton Shores

1. NATURAL HAZARDS

1.01 Celestial Impacts: - None Identified.

1.02 Drought:
- 12 recorded drought events in the area (including Lake, Mason, Muskegon, Newaygo, and Oceana counties) lasting eight months or greater: 1895-1896, 1899-1900, 1901-1902, 1909-1911, 1925-1926, 1930-1931, 1956-1957, 1962-1963, 1971-1972, 1976-1977, and 2002-2003.
- Summer 1871: Prolonged drought over much of the Great Lakes region.
- May-September, 1891: Drought devastated Michigan's lumber industry.

1.03 Earthquake: - None Identified.

1.04 Extreme Temperatures:
- July 1936: Heatwave. 570 deaths statewide, 7 in Muskegon.
- Summer, 1988: 39 days with temperatures over 90 degrees, statewide.
- January 13-20, 1994: Record cold. $50m property damage across Michigan.
- December 9-10, 1995: Coldwave across Lower Michigan.
- March 2012: Record warm temperatures triggered early growing season. $209.8m crop damage across Michigan.

1.05 Flooding - Riverine/ Urban:
- August 20 - September 6, 1975: Flooding. Declaration of major disaster by President.
- February 21, 1986: Great lakes flooding and wave action. Declaration of disaster by Governor.
- September 10-19, 1986: Flooding. Declaration of major disaster by President.
- September, 1986: Flooding & heavy rain. Declaration of disaster by Governor.
- May 18-20, 2000: Flood. $100k property damage, $50k crop damage in Muskegon County.
- February 9-10, 2001: Flooding. $100k property damage across West Michigan.
- February 24-28, 2001: Flooding. $190k property damage across West Michigan.
- May 15-16, 2001: Flooding. $500k property damage, $200k crop damage across southwestern Lower Michigan.
- May 20-24, 2004: Flooding. Declaration of major disaster by President.
- April 17-23, 2013: Flooding. Declaration of major disaster by President. $5m property damage, Muskegon County.

1.06 Fog: - January 11-13, 1995: Dense Fog. 4 traffic accident fatalities, school closures, and flight delays, Lower Michigan.

1.07 Great Lakes Shoreline Hazards:
- Extreme high water levels in the Great Lakes: 1929, 1952, 1973, 1986, and 1997.
- Extreme low water levels in the Great Lakes: 1926, 1934, 1964, 2003, and 2013.
- Rip current incidents on Lake Michigan, 2002-2012: 77 fatalities, 230 rescues.
- June 1986: Record high water level on Lake Michigan.
- 2013: Record low water level on Lake Michigan.

1.08 Hail:
- Days with severe hail reported (1" or greater) recorded in Muskegon County, 2000-2012: 7
- May 15, 2001: 0.75-1.00 inch hail. $95k property damage, $95k crop damage across Muskegon County.
- August 3, 2003: 1.75 inch hail in Muskegon Twp, $55k property damage and $25k crop damage from hail countywide.

1.09 Invasive Species: - Invasive species exist in Muskegon County; No significant events identified.

1.10 Lightning: - July 20, 1994: Lightning killed a dog and caused $50k property damage, Muskegon County.

1.11 Severe Winds:
- August 20 - September 6, 1975: Rainstorms, high winds. Declaration of major disaster by President.
- ***April 18, 1994: Severe thunderstorm winds. $50k property damage, Norton Shores.***
- November 18, 1994: High wind. $1m property damage statewide.
- April 6, 1997: High wind. $5m property damage across southwest Lower Michigan.
- May 29, 1998: Severe thunderstorm winds. 54,000 homes and businesses without power; estimated 500 homes and 30 businesses sustained minor to moderate damage. $1m property damage, Muskegon County.
- May 31, 1998: Thunderstorms & high winds. Declarations of disaster by Governor and major disaster by President. $2,458,958 in public damage costs, 42 homes destroyed, 1,805 homes damaged, 5 businesses destroyed, and 73 businesses damaged. Total public and private costs have been estimated at $24,205,908.
- August 22, 2000: Severe thunderstorm winds. $150k property damage, Muskegon County.
- March 9, 2002: High wind. $485k property damage across southwest Lower Michigan.
- October 30, 2004: High wind. $1.15m property damage across southwest Lower Michigan.
- May 20-24, 2004: Severe storms. Declaration of major disaster by President.
- August 9, 2009: Severe thunderstorm winds. $2m property damage, Muskegon County.
- November 17, 2013: Severe thunderstorm winds. $200k property damage, Muskegon County.

1.12 Subsidence: - None Identified.

1.13 Tornadoes: - Number of tornadoes in Muskegon County, 1950-2012: 7.

1.14 Wildfire:
- October 1871: Wildfires. 1.2m acres burned, 200 fatalities, Michigan's Lower Peninsula.
- May-September, 1891: Uncontrollable wildfires across Michigan during the drought of 1891.
- 1981-2010: Approximately 8 wildfires and 89 acres burned per year on county lands under MDNR jurisdiction (251 total wildfires, 2,676.0 total acres burned).

1.15 Winter Storms:

- March 2-7, 1976: Ice storms. Declaration of major disaster by President.
- January 26-31, 1977: Blizzard, snowstorm. Declaration of emergency by President.
- January 26-27, 1978: Blizzard, snowstorm. Declaration of statewide emergency by President.
- January 12, 1993: Heavy snow. $50k property damage, northern Lower Michigan.
- January 12-21, 1994: Heavy lake effect snow. $500k property damage across western Lower Michigan.
- January 27, 1994: Heavy snow and freezing rain. $5m property damage across region.
- October 26, 1997: Heavy snow. $1.2m property damage across southwestern Lower Michigan.
- March 9, 1998: Winter storm. $100k property damage across region.
- January 2-15, 1999: Blizzard, snowstorm. Declaration of emergency by President.
- December 11-31, 2000: Blizzard, snowstorm. Declaration of emergency by President.
- April 3, 2003: Ice storm. $4.9m property damage throughout West Michigan.
- February 16, 2006: Ice storm. $1m property damage across Lower Michigan.

2. TECHNOLOGICAL HAZARDS

2.01 Dam Failure:

- Four documented failures in Muskegon County, unidentified locations.

2.02 Energy Emergencies:

- February 2003: A break in a major transmission line caused an electrical blackout over parts of Montcalm, Oceana, Newaygo, Muskegon, and Kent counties.

2.03 Fire - Scrap Tire:

- Approximate scrap tire inventory in Muskegon County in 2012: 4,400.

2.04 Fire - Structural:

- County fire rate per 1,000 population in 1998: 3.8.
- ***February 9, 2013: 12 apartment units destroyed and 12 units damaged in Norton Shores.***

2.05 Hazard Material Incidents - Fixed Site (including industrial accidents):

- SARA Title III Sites in Muskegon County in 2012: 51.
- ***May 21, 2001: Foundry explosion, 2 homes and 1 business set on fire, 1 injury, Norton Shores.***
- ***April 10, 2010: Chemical reaction Calcium Silicon Barium. Eevacuation of surrounding business, Norton Shores.***
- ***January 30, 2012: Explosion at foundry sprays molten metal and sets fire to the facility, Norton Shores.***

2.06 Hazard Material Incidents - Transportation: - None Identified.

2.07 Infrastructure Failure:

- Number of NCDC with mention of downed power lines or power outages in Muskegon County, 1993-2012: 45
- Number of sanitary sewer overflows in Muskegon County, 2000-2011: 47.
- August 8, 1993: 4,400 without power (thunderstorm winds), Muskegon and Oceana counties
- March 9, 1998: 1,900 power outages (blizzard conditions), Lake, Clare, Oceana and Muskegon counties.
- May 29-30, 1998: 54,000 without power; 27,000 on second day (thunderstorm winds), Muskegon County.
- May 31, 1998: 50,000 without power (thunderstorm winds), Muskegon County.
- July 21, 1998: 7,500 without power (thunderstorm winds and lightning), Muskegon County.
- ***January 2008: Henry Stree Bridge NE approach washout – heavy rains, plugged sewer, Norton Shores.***
- August 9, 2009: Village of Fruitport and much of southern Muskegon County without power (thunderstorm winds).

2.08 Nuclear Power Plant Emergencies: - None Identified.

2.09 Oil and Natural Gas Well Accidents:

- Oil and gas wells in Muskegon County in 2012: 1,090.

2.10 Pipeline Accidents: - None Identified.

2.11 Transportation Accidents: - None Identified.

3. HUMAN -RELATED HAZARDS

3.01 Catastrophic Incidents (National Emergencies):

- 1939-1945: World War II. In Muskegon, 48-hour minimum work weeks, rationing of certain food and goods, and 274 county men killed in battle.
- 2005: Hurricanes Katrina and Rita. Declarations of Gubernatorial Disaster and Presidential Emergency were issued in Michigan in September 2005 for hurricane evacuation.

3.02 Civil Disturbances: - None Identified.

3.03 Nuclear Attack: - None Identified.

3.04 Public Health Emergencies:

- 1913: Diphtheria Epidemic.
- 1916: Small pox and scarlet fever force closures of schools and businesses.
- 1918: Influenza epidemic closes theaters, dance halls, and churches.
- 1937: Children under 18 banned from theaters and schools close from fear of polio outbreak.
- 1941: Influenza epidemic cuts school attendance by 60%.
- 2009: H1N1 influenza pandemic causes school absences spike in the fall. Two county residents die from complications.

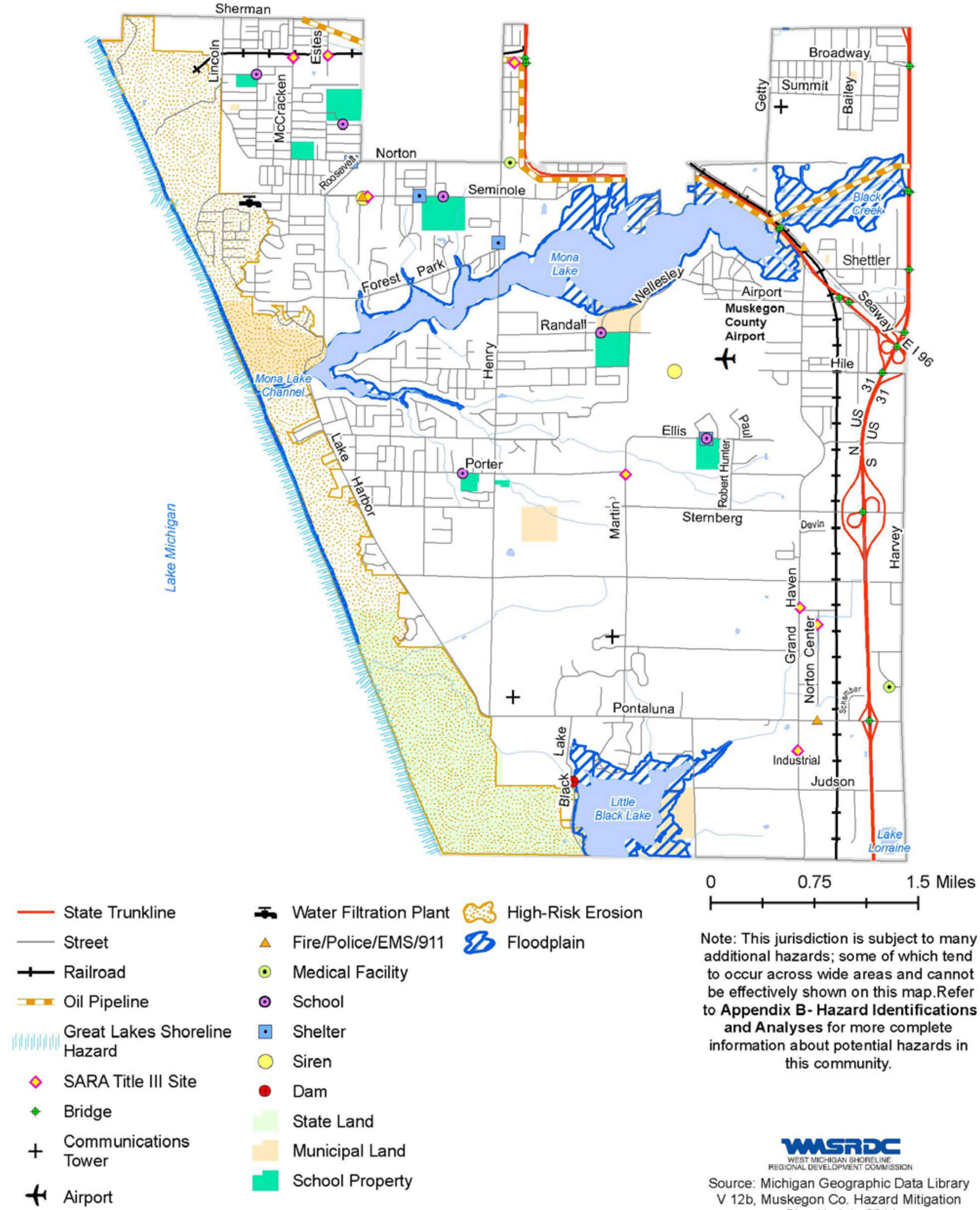
3.05 Terrorism and Similar Criminal Activities: - None Identified.

City of Norton Shores Hazard Rating		Probability of Occurrence	Impact on People	Impact on Property	Impact on Economy	Impacts Total	Hazard Score
1.01	Celestial Impacts	1	2	0	2	8	8
1.02	Drought	2	2	1	2	10	20
1.03	Earthquake	0	-	-	-	-	-
1.04	Extreme Temperatures	3	2	1	1	9	27
1.05	Flooding: Riverine/Urban	3	1	2	2	9	27
1.06	Fog	3	1	0	1	4	12
1.07	Great Lakes Shoreline	3	1	2	1	8	24
1.08	Hail	2	2	1	1	9	18
1.09	Invasive Species	2	1	1	1	6	12
1.10	Lightning	3	1	2	1	8	24
1.11	Severe Winds	3	2	2	2	12	36
1.12	Subsidence	1	1	1	1	6	6
1.13	Tornadoes	1	3	2	2	15	15
1.14	Wildfire	3	1	2	1	8	24
1.15	Winter Storms	3	3	2	2	15	45
2.01	Dam failure	1	1	1	1	6	6
2.02	Energy Emergencies	2	2	0	2	8	16
2.03	Fire – Scrap Tires	1	1	1	1	6	6
2.04	Fire – Structural	3	1	2	3	10	30
2.05	HAZMAT – Fixed Site	3	1	1	2	7	21
2.06	HAZMAT – Transportation	3	1	1	1	6	18
2.07	Infrastructure Failures	3	2	1	2	10	30
2.08	Nuclear Power Emergencies	0	-	-	-	-	-
2.09	Oil/Natural Gas Well Accidents	1	1	1	1	6	6
2.10	Pipeline Accidents	0	-	-	-	-	-
2.11	Transportation Accidents	2	1	1	2	7	14
3.01	Catastrophic Incidents	1	3	3	3	18	18
3.02	Civil Disturbances	1	1	1	1	6	6
3.03	Nuclear Attack	0	-	-	-	-	-
3.04	Public Health Emergencies	2	2	0	3	9	18
3.05	Terrorism & Similar Criminal Acts	1	1	1	1	6	6

City of Norton Shores Hazard Ranking

Rank	Hazard	Probability of Occurrence	X Impacts Total	= Hazard Score
1	Winter Storms	3	15	45
2	Severe Winds	3	12	36
3	Fire – Structural	3	10	30
3	Infrastructure Failures	3	10	30
5	Extreme Temperatures	3	9	27
5	Flooding: Riverine/Urban	3	9	27
7	Great Lakes Shoreline	3	8	24
7	Lightning	3	8	24
7	Wildfire	3	8	24
10	HAZMAT – Fixed Site	3	7	21
11	Drought	2	10	20
12	Catastrophic Incidents	1	18	18
12	Hail	2	9	18
12	HAZMAT – Transportation	3	6	18
12	Public Health Emergencies	2	9	18
16	Energy Emergencies	2	8	16
17	Tornadoes	1	15	15
18	Transportation Accidents	2	7	14
19	Fog	3	4	12
19	Invasive Species	2	6	12
21	Celestial Impacts	1	8	8
22	Civil Disturbances	1	6	6
22	Dam Failure	1	6	6
22	Fire – Scrap Tires	1	6	6
22	Oil/Natural Gas Well Accidents	1	6	6
22	Subsidence	1	6	6
22	Terrorism & Similar Criminal Acts	1	6	6
	Earthquake	0	-	-
	Nuclear Power Emergencies	0	-	-
	Nuclear Attack	0	-	-
	Pipeline Accidents	0	-	-

CITY OF NORTON SHORES
Critical Facilities and Potential Hazards



Note: This jurisdiction is subject to many additional hazards; some of which tend to occur across wide areas and cannot be effectively shown on this map.Refer to **Appendix B- Hazard Identifications and Analyses** for more complete information about potential hazards in this community.

WMSRDC
WEST MICHIGAN SHORELINE REGIONAL DEVELOPMENT COMMISSION

Source: Michigan Geographic Data Library V 12b, Muskegon Co. Hazard Mitigation Plan Update 2014

Hazard Identification Profile
City of Roosevelt Park

1. NATURAL HAZARDS

1.01 Celestial Impacts: - None Identified.

1.02 Drought:

- 12 recorded drought events in the area (including Lake, Mason, Muskegon, Newaygo, and Oceana counties) lasting eight months or greater: 1895-1896, 1899-1900, 1901-1902, 1909-1911, 1925-1926, 1930-1931, 1956-1957, 1962-1963, 1971-1972, 1976-1977, and 2002-2003.
- Summer 1871: Prolonged drought over much of the Great Lakes region.
- May-September, 1891: Drought devastated Michigan's lumber industry.
- 2013: Record low Lake Michigan water levels.

1.03 Earthquake: - None Identified.

1.04 Extreme Temperatures:

- July 1936: Heatwave. 570 deaths statewide, 7 in Muskegon.
- Summer, 1988: 39 days with temperatures over 90 degrees, statewide.
- January 13-20, 1994: Record cold. $50m property damage across Michigan.
- December 9-10, 1995: Coldwave across Lower Michigan.
- March 2012: Record warm temperatures triggered early growing season. $209.8m crop damage across Michigan.

1.05 Flooding - Riverine/ Urban:

- August 20 - September 6, 1975: Flooding. Declaration of major disaster by President.
- February 21, 1986: Great lakes flooding and wave action. Declaration of disaster by Governor.
- September 10-19, 1986: Flooding. Declaration of major disaster by President.
- September, 1986: Flooding & heavy rain. Declaration of disaster by Governor.
- May 18-20, 2000: Flood. $100k property damage, $50k crop damage in Muskegon County.
- February 9-10, 2001: Flooding. $100k property damage across West Michigan.
- February 24-28, 2001: Flooding. $190k property damage across West Michigan.
- May 15-16, 2001: Flooding. $500k property damage, $200k crop damage across southwestern Lower Michigan.
- May 20-24, 2004: Flooding. Declaration of major disaster by President.
- April 17-23, 2013: Flooding. Declaration of major disaster by President. $5m property damage, Muskegon County.

1.06 Fog:

- January 11-13, 1995: Dense Fog. 4 traffic accident fatalities, school closures, and flight delays across Lower Michigan.

1.07 Great Lakes Shoreline Hazards: - None Identified.

1.08 Hail:

- Days with severe hail reported (1" or greater) recorded in Muskegon County, 2000-2012: 7
- May 15, 2001: 0.75-1.00 inch hail. $95k property damage, $95k crop damage across Muskegon County.
- August 3, 2003: 1.75 inch hail in Muskegon Twp, $55k property damage and $25k crop damage from hail countywide.

1.09 Invasive Species: - Invasive species exist in Muskegon County; No significant events identified.

1.10 Lightning:

- July 20, 1994: Lightning killed a dog and caused $50k property damage, Muskegon County.

1.11 Severe Winds:

- August 20 - September 6, 1975: Rainstorms, high winds. Declaration of major disaster by President.
- November 18, 1994: High wind. $1m property damage statewide.
- April 6, 1997: High wind. $5m property damage across southwest Lower Michigan.
- May 29, 1998: Severe thunderstorm winds. 54,000 homes and businesses without power; estimated 500 homes and 30 businesses sustained minor to moderate damage. $1m property damage, Muskegon County.
- May 31, 1998: Thunderstorms & high winds. Declarations of disaster by Governor and major disaster by President. $2,458,958 in public damage costs, 42 homes destroyed, 1,805 homes damaged, 5 businesses destroyed, and 73 businesses damaged. Total public and private costs have been estimated at $24,205,908.
- August 22, 2000: Severe thunderstorm winds. $150k property damage, Muskegon County.
- March 9, 2002: High wind. $485k property damage across southwest Lower Michigan.
- October 30, 2004: High wind. $1.15m property damage across southwest Lower Michigan.
- May 20-24, 2004: Severe storms. Declaration of major disaster by President.
- August 9, 2009: Severe thunderstorm winds. $2m property damage, Muskegon County.
- November 17, 2013: Severe thunderstorm winds. $200k property damage, Muskegon County.

1.12 Subsidence: - None Identified.

1.13 Tornadoes:

- Number of tornadoes in Muskegon County, 1950-2012: 7.

1.14 Wildfire:

- October 1871: Wildfires. 1.2m acres burned, 200 fatalities, Michigan's Lower Peninsula.
- May-September, 1891: Uncontrollable wildfires across Michigan during the drought of 1891.
- 1981-2010: Approximately 8 wildfires and 89 acres burned per year on county lands under MDNR jurisdiction (251 total wildfires, 2,676.0 total acres burned).

1.15 Winter Storms:

- March 2-7, 1976: Ice storms. Declaration of major disaster by President.
- January 26-31, 1977: Blizzard, snowstorm. Declaration of emergency by President.
- January 26-27, 1978: Blizzard, snowstorm. Declaration of statewide emergency by President.
- January 12, 1993: Heavy snow. $50k property damage, northern Lower Michigan.
- January 12-21, 1994: Heavy lake effect snow. $500k property damage across western Lower Michigan.
- January 27, 1994: Heavy snow and freezing rain. $5m property damage across region.
- October 26, 1997: Heavy snow. $1.2m property damage across southwestern Lower Michigan.
- March 9, 1998: Winter storm. $100k property damage across region.
- January 2-15, 1999: Blizzard, snowstorm. Declaration of emergency by President.
- December 11-31, 2000: Blizzard, snowstorm. Declaration of emergency by President.
- April 3, 2003: Ice storm. $4.9m property damage throughout West Michigan.
- February 16, 2006: Ice storm. $1m property damage across Lower Michigan.

2. TECHNOLOGICAL HAZARDS

2.01 Dam Failure:

- Four documented failures in Muskegon County, unidentified locations.

2.02 Energy Emergencies:

- February 2003: A break in a major transmission line caused an electrical blackout over parts of Montcalm, Oceana, Newaygo, Muskegon, and Kent counties.

2.03 Fire - Scrap Tire:

- Approximate scrap tire inventory in Muskegon County in 2012: 4,400.

2.04 Fire - Structural:

- County fire rate per 1,000 population in 1998: 3.8.

2.05 Hazard Material Incidents - Fixed Site (including industrial accidents):

- SARA Title III Sites in Muskegon County in 2012: 51.

2.06 Hazard Material Incidents - Transportation: - None Identified.

2.07 Infrastructure Failure:

- Number of NCDC with mention of downed power lines or power outages in Muskegon County, 1993-2012: 45
- Number of sanitary sewer overflows in Muskegon County, 2000-2011: 47.
- August 8, 1993: 4,400 without power (thunderstorm winds), Muskegon and Oceana counties
- March 9, 1998: 1,900 power outages (blizzard conditions), Lake, Clare, Oceana and Muskegon counties.
- May 29-30, 1998: 54,000 without power; 27,000 on second day (thunderstorm winds), Muskegon County.
- May 31, 1998: 50,000 without power (thunderstorm winds), Muskegon County.
- July 21, 1998: 7,500 without power (thunderstorm winds and lightning), Muskegon County.

2.08 Nuclear Power Plant Emergencies: - None Identified.

2.09 Oil and Natural Gas Well Accidents:

- Oil and gas wells in Muskegon County in 2012: 1,090.

2.10 Pipeline Accidents: - None Identified.

2.11 Transportation Accidents: - None Identified.

3. HUMAN -RELATED HAZARDS

3.01 Catastrophic Incidents (National Emergencies):

- 1939-1945: World War II. In Muskegon, 48-hour minimum work weeks, rationing of certain food and goods, and 274 county men killed in battle.
- 2005: Hurricanes Katrina and Rita. Declarations of Gubernatorial Disaster and Presidential Emergency were issued in Michigan in September 2005 for hurricane evacuation.

3.02 Civil Disturbances: - None Identified.

3.03 Nuclear Attack: - None Identified.

3.04 Public Health Emergencies:

- 1913: Diphtheria Epidemic.
- 1916: Small pox and scarlet fever force closures of schools and businesses.
- 1918: Influenza epidemic closes theaters, dance halls, and churches.
- 1937: Children under 18 banned from theaters and schools close from fear of polio outbreak.
- 1941: Influenza epidemic cuts school attendance by 60%.
- 2009: H1N1 influenza pandemic causes school absences spike in the fall. Two county residents die from complications.

3.05 Terrorism and Similar Criminal Activities: - None Identified.

City of Roosevelt Park Hazard Rating

		Probability of Occurrence	Impact on People	Impact on Property	Impact on Economy	Impacts Total	Hazard Score
1.01	Celestial Impacts	1	2	0	2	8	8
1.02	Drought	2	2	1	2	10	20
1.03	Earthquake	0	-	-	-	-	-
1.04	Extreme Temperatures	3	2	1	1	9	27
1.05	Flooding: Riverine/Urban	2	1	1	1	6	12
1.06	Fog	2	1	0	1	4	8
1.07	Great Lakes Shoreline	3	1	2	1	8	24
1.08	Hail	2	2	1	1	9	18
1.09	Invasive Species	2	1	1	1	6	12
1.10	Lightning	3	1	2	1	8	24
1.11	Severe Winds	3	2	2	2	12	36
1.12	Subsidence	1	1	1	1	6	6
1.13	Tornadoes	1	3	2	2	15	15
1.14	Wildfire	1	2	2	1	11	11
1.15	Winter Storms	3	3	2	2	15	45
2.01	Dam failure	0	-	-	-	-	-
2.02	Energy Emergencies	2	2	0	2	8	16
2.03	Fire – Scrap Tires	0	-	-	-	-	-
2.04	Fire – Structural	3	1	2	3	10	30
2.05	HAZMAT – Fixed Site	2	1	1	1	6	12
2.06	HAZMAT – Transportation	2	1	1	1	6	12
2.07	Infrastructure Failures	3	2	1	2	10	30
2.08	Nuclear Power Emergencies	0	-	-	-	-	-
2.09	Oil/Natural Gas Well Accidents	0	-	-	-	-	-
2.10	Pipeline Accidents	1	1	1	2	7	7
2.11	Transportation Accidents	2	1	1	1	6	12
3.01	Catastrophic Incidents	1	3	3	3	18	18
3.02	Civil Disturbances	1	1	1	1	6	6
3.03	Nuclear Attack	0	-	-	-	-	-
3.04	Public Health Emergencies	2	2	0	3	9	18
3.05	Terrorism & Similar Criminal Acts	1	1	1	1	6	6

City of Roosevelt Park Hazard Ranking

Rank	Hazard	Probability of Occurrence	X Impacts Total	= Hazard Score
1	Winter Storms	3	15	45
2	Severe Winds	3	12	36
3	Fire – Structural	3	10	30
3	Infrastructure Failures	3	10	30
5	Extreme Temperatures	3	9	27
6	Great Lakes Shoreline	3	8	24
6	Lightning	3	8	24
8	Drought	2	10	20
9	Catastrophic Incidents	1	18	18
9	Hail	2	9	18
19	Public Health Emergencies	2	9	18
12	Energy Emergencies	2	8	16
13	Tornadoes	1	15	15
14	Flooding: Riverine/Urban	2	6	12
14	HAZMAT – Fixed Site	2	6	12
14	HAZMAT – Transportation	2	6	12
14	Invasive Species	2	6	12
14	Transportation Accidents	2	6	12
19	Wildfire	1	11	11
20	Celestial Impacts	1	8	8
20	Fog	2	4	8
22	Pipeline Accidents	1	7	7
23	Civil Disturbances	1	6	6
23	Subsidence	1	6	6
23	Terrorism & Similar Criminal Acts	1	6	6
	Dam Failure	0	-	-
	Earthquake	0	-	-
	Fire – Scrap Tires	0	-	-
	Nuclear Attack	0	-	-
	Nuclear Power Emergencies	0	-	-
	Oil/Natural Gas Well Accidents	0	-	-

CITY OF ROOSEVELT PARK
Critical Facilities and Potential Hazards

0 0.125 0.25 Miles

- Street
- Railroad
- Oil Pipeline
- SARA Title III Site
- School
- Municipal Land
- School Property

Note: This jurisdiction is subject to many additional hazards; some of which tend to occur across wide areas and cannot be effectively shown on this map.Refer to **Appendix B- Hazard Identifications and Analyses** for more complete information about potential hazards in this community.

WMSRDC
WEST MICHIGAN SHORELINE REGIONAL DEVELOPMENT COMMISSION

Source: Michigan Geographic Data Library V 12b, Muskegon Co. Hazard Mitigation Plan Update 2014

Hazard Identification Profile
City of Whitehall

1. NATURAL HAZARDS

1.01 Celestial Impacts: - None Identified.

1.02 Drought:
- 12 recorded drought events in the area (including Lake, Mason, Muskegon, Newaygo, and Oceana counties) lasting eight months or greater: 1895-1896, 1899-1900, 1901-1902, 1909-1911, 1925-1926, 1930-1931, 1956-1957, 1962-1963, 1971-1972, 1976-1977, and 2002-2003.
- Summer 1871: Prolonged drought over much of the Great Lakes region.
- May-September, 1891: Drought devastated Michigan's lumber industry.
- 2013: Record low water level on Lake Michigan.

1.03 Earthquake: - None Identified.

1.04 Extreme Temperatures:
- July 1936: Heatwave. 570 deaths statewide, 7 in Muskegon.
- Summer, 1988: 39 days with temperatures over 90 degrees, statewide.
- January 13-20, 1994: Record cold. $50m property damage across Michigan.
- December 9-10, 1995: Coldwave across Lower Michigan.
- March 2012: Record warm temperatures triggered early growing season. $209.8m crop damage across Michigan.

1.05 Flooding - Riverine/ Urban:
- August 20 - September 6, 1975: Flooding. Declaration of major disaster by President.
- February 21, 1986: Great lakes flooding and wave action. Declaration of disaster by Governor.
- September 10-19, 1986: Flooding. Declaration of major disaster by President.
- September, 1986: Flooding & heavy rain. Declaration of disaster by Governor.
- May 18-20, 2000: Flood. $100k property damage, $50k crop damage in Muskegon County.
- February 9-10, 2001: Flooding. $100k property damage across West Michigan.
- February 24-28, 2001: Flooding. $190k property damage across West Michigan.
- May 15-16, 2001: Flooding. $500k property damage, $200k crop damage across southwestern Lower Michigan.
- May 20-24, 2004: Flooding. Declaration of major disaster by President.
- April 17-23, 2013: Flooding. Declaration of major disaster by President. $5m property damage, Muskegon County.

1.06 Fog:
- January 11-13, 1995: Dense Fog. 4 traffic accident fatalities, school closures, and flight delays across Lower Michigan.

1.07 Great Lakes Shoreline Hazards: None Identified

1.08 Hail:
- Days with severe hail reported (1" or greater) recorded in Muskegon County, 2000-2012: 7
- August 3, 2003: 1.75 inch hail in Muskegon Twp, $55k property damage and $25k crop damage from hail countywide.

1.09 Invasive Species: - Invasive species exist in Muskegon County; No significant events identified.

1.10 Lightning:
- July 20, 1994: Lightning killed a dog and caused $50k property damage, Muskegon County.

1.11 Severe Winds:
- August 20 - September 6, 1975: Rainstorms, high winds. Declaration of major disaster by President.
- November 18, 1994: High wind. $1m property damage statewide.
- April 6, 1997: High wind. $5m property damage across southwest Lower Michigan.
- May 29, 1998: Severe thunderstorm winds. 54,000 homes and businesses without power; estimated 500 homes and 30 businesses sustained minor to moderate damage. $1m property damage, Muskegon County.
- May 31, 1998: Thunderstorms & high winds. Declarations of disaster by Governor and major disaster by President. $2,458,958 in public damage costs, 42 homes destroyed, 1,805 homes damaged, 5 businesses destroyed, and 73 businesses damaged. Total public and private costs have been estimated at $24,205,908.
- August 22, 2000: Severe thunderstorm winds. $150k property damage, Muskegon County.
- March 9, 2002: High wind. $485k property damage across southwest Lower Michigan.
- October 30, 2004: High wind. $1.15m property damage across southwest Lower Michigan.
- May 20-24, 2004: Severe storms. Declaration of major disaster by President.
- August 9, 2009: Severe thunderstorm winds. $2m property damage, Muskegon County.
- November 17, 2013: Severe thunderstorm winds. $200k property damage, Muskegon County.

1.12 Subsidence: - None Identified.

1.13 Tornadoes:
- Number of tornadoes in Muskegon County, 1950-2012: 7.
- ***April 16, 1967: Tornado (F1). $2.5k property damage, Whitehall.***

1.14 Wildfire:
- October 1871: Wildfires. 1.2m acres burned, 200 fatalities, Michigan's Lower Peninsula.
- May-September, 1891: Uncontrollable wildfires across Michigan during the drought of 1891.
- 1981-2010: Approximately 8 wildfires and 89 acres burned per year on county lands under MDNR jurisdiction (251 total wildfires, 2,676.0 total acres burned).

1.15 Winter Storms:

- March 2-7, 1976: Ice storms. Declaration of major disaster by President.
- January 26-31, 1977: Blizzard, snowstorm. Declaration of emergency by President.
- January 26-27, 1978: Blizzard, snowstorm. Declaration of statewide emergency by President.
- January 12, 1993: Heavy snow. $50k property damage, northern Lower Michigan.
- January 12-21, 1994: Heavy lake effect snow. $500k property damage across western Lower Michigan.
- January 27, 1994: Heavy snow and freezing rain. $5m property damage across region.
- October 26, 1997: Heavy snow. $1.2m property damage across southwestern Lower Michigan.
- March 9, 1998: Winter storm. $100k property damage across region.
- January 2-15, 1999: Blizzard, snowstorm. Declaration of emergency by President.
- December 11-31, 2000: Blizzard, snowstorm. Declaration of emergency by President.
- April 3, 2003: Ice storm. $4.9m property damage throughout West Michigan.
- February 16, 2006: Ice storm. $1m property damage across Lower Michigan.

2. TECHNOLOGICAL HAZARDS

2.01 Dam Failure:

- Four documented failures in Muskegon County, unidentified locations.

2.02 Energy Emergencies:

- February 2003: A break in a major transmission line caused an electrical blackout over parts of Montcalm, Oceana, Newaygo, Muskegon, and Kent counties.

2.03 Fire - Scrap Tire:

- Approximate scrap tire inventory in Muskegon County in 2012: 4,400.

2.04 Fire - Structural:

- County fire rate per 1,000 population in 1998: 3.8.

2.05 Hazard Material Incidents - Fixed Site (including industrial accidents):

- SARA Title III Sites in Muskegon County in 2012: 51.
- ***June 4, 1999: Release of hydrogen sulfide. 1 fatality, 1 other injured, 11 employees evacuated, and $411,000 property damage, City of Whitehall.***

2.06 Hazard Material Incidents - Transportation: - None Identified.

2.07 Infrastructure Failure:

- Number of NCDC records with mention of downed power lines or power outages in Muskegon County, 1993-2012: 45
- Number of sanitary sewer overflows in Muskegon County, 2000-2011: 47.
- August 8, 1993: 4,400 without power (thunderstorm winds), Muskegon and Oceana counties
- March 9, 1998: 1,900 power outages (blizzard conditions), Lake, Clare, Oceana and Muskegon counties.
- May 29-30, 1998: 54,000 without power; 27,000 on second day (thunderstorm winds), Muskegon County.
- May 31, 1998: 50,000 without power (thunderstorm winds), Muskegon County.
- ***May 31, 1998: Half of Whitehall City without water service (thunderstorm winds).***
- July 21, 1998: 7,500 without power (thunderstorm winds and lightning), Muskegon County.

2.08 Nuclear Power Plant Emergencies: - None Identified.

2.09 Oil and Natural Gas Well Accidents:

- Oil and gas wells in Muskegon County in 2012: 1,090.

2.10 Pipeline Accidents: - None Identified.

2.11 Transportation Accidents: - None Identified.

3. HUMAN -RELATED HAZARDS

3.01 Catastrophic Incidents (National Emergencies):

- 1939-1945: World War II. In Muskegon, 48-hour minimum work weeks, rationing of certain food and goods, and 274 county men killed in battle.
- 2005: Hurricanes Katrina and Rita. Declarations of Gubernatorial Disaster and Presidential Emergency were issued in Michigan in September 2005 for hurricane evacuation.

3.02 Civil Disturbances: - None Identified.

3.03 Nuclear Attack: - None Identified.

3.04 Public Health Emergencies:

- 1913: Diphtheria Epidemic.
- 1916: Small pox and scarlet fever force closures of schools and businesses.
- 1918: Influenza epidemic closes theaters, dance halls, and churches.
- 1937: Children under 18 banned from theaters and schools close from fear of polio outbreak.
- 1941: Influenza epidemic cuts school attendance by 60%.
- 2009: H1N1 influenza pandemic causes school absences spike in the fall. Two county residents die from complications.

3.05 Terrorism and Similar Criminal Activities: - None Identified.

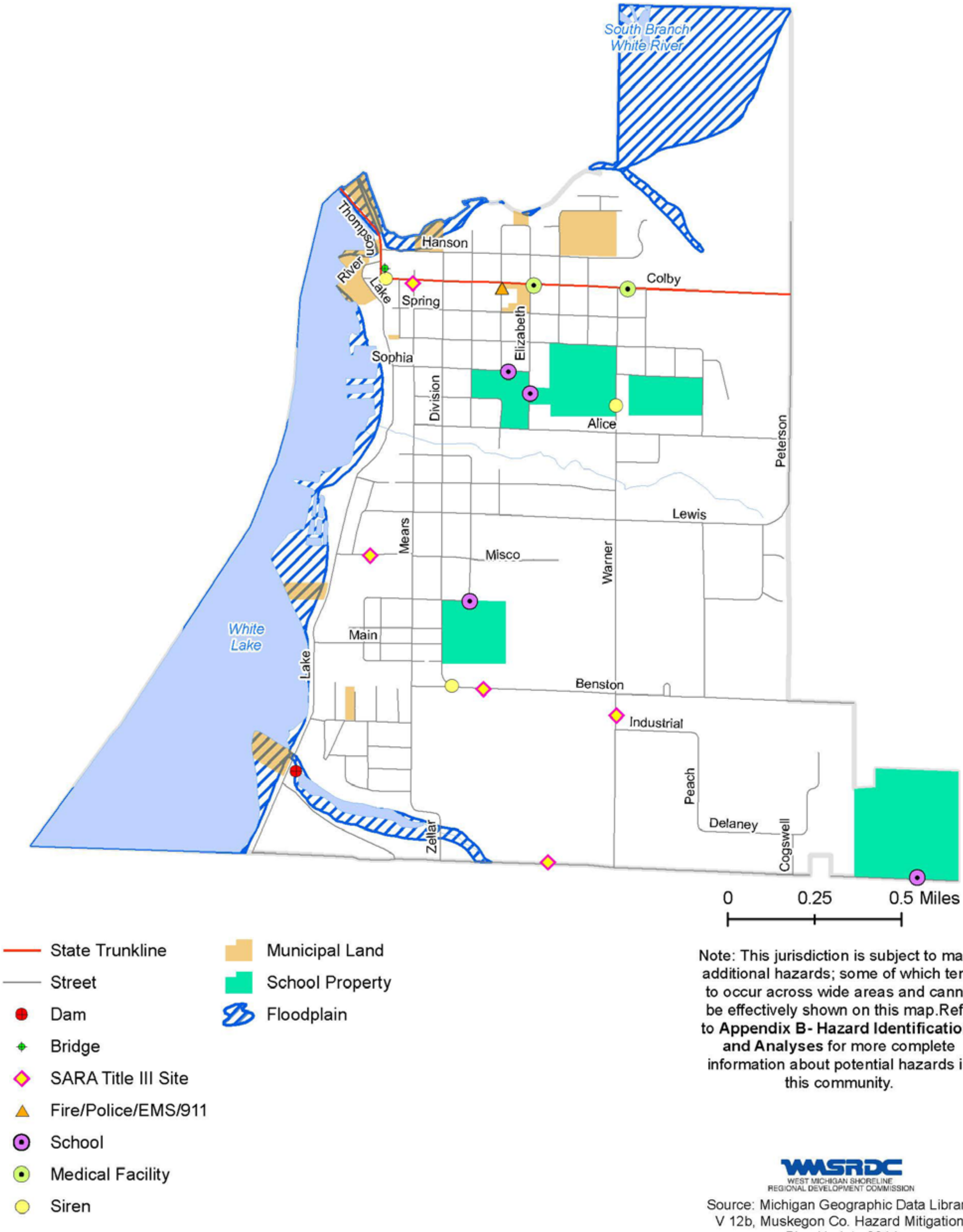
	City of Whitehall Hazard Rating	Probability of Occurrence	Impact on People	Impact on Property	Impact on Economy	Impacts Total	Hazard Score
1.01	Celestial Impacts	1	2	0	2	8	8
1.02	Drought	2	2	1	2	10	20
1.03	Earthquake	0	-	-	-	-	-
1.04	Extreme Temperatures	3	2	1	1	9	27
1.05	Flooding: Riverine/Urban	3	1	2	2	9	27
1.06	Fog	3	1	0	1	4	12
1.07	Great Lakes Shoreline	0	-	-	-	-	-
1.08	Hail	2	2	1	1	9	18
1.09	Invasive Species	2	1	1	1	6	12
1.10	Lightning	3	1	2	1	8	24
1.11	Severe Winds	3	2	2	2	12	36
1.12	Subsidence	1	1	1	1	6	6
1.13	Tornadoes	1	3	2	2	15	15
1.14	Wildfire	2	1	2	1	8	16
1.15	Winter Storms	3	3	2	2	15	45
2.01	Dam failure	2	1	2	1	8	16
2.02	Energy Emergencies	2	2	0	2	8	16
2.03	Fire – Scrap Tires	0	-	-	-	-	-
2.04	Fire – Structural	3	1	2	3	10	30
2.05	HAZMAT – Fixed Site	3	1	1	2	7	21
2.06	HAZMAT – Transportation	3	1	1	1	6	18
2.07	Infrastructure Failures	3	2	1	2	10	30
2.08	Nuclear Power Emergencies	0	-	-	-	-	-
2.09	Oil/Natural Gas Well Accidents	1	1	1	1	6	6
2.10	Pipeline Accidents	0	-	-	-	-	-
2.11	Transportation Accidents	2	1	1	1	6	12
3.01	Catastrophic Incidents	1	3	3	3	18	18
3.02	Civil Disturbances	1	1	1	1	6	6
3.03	Nuclear Attack	0	-	-	-	-	-
3.04	Public Health Emergencies	2	2	0	3	9	18
3.05	Terrorism & Similar Criminal Acts	1	1	1	1	6	6

City of Whitehall Hazard Ranking

Probability of Occurrence X Impacts Total = Hazard Score

		Probability of Occurrence	Impacts Total	Hazard Score
1	Winter Storms	3	15	45
2	Severe Winds	3	12	36
3	Fire – Structural	3	10	30
3	Infrastructure Failures	3	10	30
5	Extreme Temperatures	3	9	27
5	Flooding: Riverine/Urban	3	9	27
7	Lightning	3	8	24
8	HAZMAT – Fixed Site	3	7	21
9	Drought	2	10	20
10	Catastrophic Incidents	1	18	18
10	Hail	2	9	18
10	HAZMAT – Transportation	3	6	18
10	Public Health Emergencies	2	9	18
14	Dam Failure	2	8	16
14	Energy Emergencies	2	8	16
14	Wildfire	2	8	16
17	Tornadoes	1	15	15
18	Fog	3	4	12
18	Invasive Species	2	6	12
18	Transportation Accidents	2	6	12
21	Celestial Impacts	1	8	8
22	Civil Disturbances	1	6	6
22	Oil/Natural Gas Well Accidents	1	6	6
22	Subsidence	1	6	6
22	Terrorism & Similar Criminal Acts	1	6	6
	Earthquake	0	-	-
	Fire – Scrap Tires	0	-	-
	Great Lakes Shoreline	0	-	-
	Nuclear Attack	0	-	-
	Nuclear Power Emergencies	0	-	-
	Pipeline Accidents	0	-	-

CITY OF WHITEHALL
Critical Facilities and Potential Hazards



Note: This jurisdiction is subject to many additional hazards; some of which tend to occur across wide areas and cannot be effectively shown on this map.Refer to **Appendix B- Hazard Identifications and Analyses** for more complete information about potential hazards in this community.

WMSRDC
WEST MICHIGAN SHORELINE REGIONAL DEVELOPMENT COMMISSION

Source: Michigan Geographic Data Library V 12b, Muskegon Co. Hazard Mitigation Plan Update 2014

Hazard Identification Profile
Village of Casnovia

1. NATURAL HAZARDS

1.01 Celestial Impacts: - None Identified.

1.02 Drought:

- 12 recorded drought events in the area (including Lake, Mason, Muskegon, Newaygo, and Oceana counties) lasting eight months or greater: 1895-1896, 1899-1900, 1901-1902, 1909-1911, 1925-1926, 1930-1931, 1956-1957, 1962-1963, 1971-1972, 1976-1977, and 2002-2003.
- Summer 1871: Prolonged drought over much of the Great Lakes region.
- May-September, 1891: Drought devastated Michigan's lumber industry.
- 2013: Record low Lake Michigan water levels.

1.03 Earthquake: - None Identified.

1.04 Extreme Temperatures:

- July 1936: Heatwave. 570 deaths statewide, 7 in Muskegon.
- Summer, 1988: 39 days with temperatures over 90 degrees, statewide.
- January 13-20, 1994: Record cold. $50m property damage across Michigan.
- December 9-10, 1995: Coldwave across Lower Michigan.
- March 2012: Record warm temperatures triggered early growing season. $209.8m crop damage across Michigan.

1.05 Flooding - Riverine/ Urban:

- August 20 - September 6, 1975: Flooding. Declaration of major disaster by President.
- February 21, 1986: Great lakes flooding and wave action. Declaration of disaster by Governor.
- September 10-19, 1986: Flooding. Declaration of major disaster by President.
- September, 1986: Flooding & heavy rain. Declaration of disaster by Governor.
- May 18-20, 2000: Flood. $100k property damage, $50k crop damage in Muskegon County.
- February 9-10, 2001: Flooding. $100k property damage across West Michigan.
- February 24-28, 2001: Flooding. $190k property damage across West Michigan.
- May 15-16, 2001: Flooding. $500k property damage, $200k crop damage across southwestern Lower Michigan.
- May 20-24, 2004: Flooding. Declaration of major disaster by President.
- April 17-23, 2013: Flooding. Declaration of major disaster by President. $5m property damage, Muskegon County.

1.06 Fog:

- January 11-13, 1995: Dense Fog. 4 traffic accident fatalities, school closures, and flight delays across Lower Michigan.

1.07 Great Lakes Shoreline Hazards: - None Identified.

1.08 Hail:

- Days with severe hail reported (1" or greater) recorded in Muskegon County, 2000-2012: 7
- May 15, 2001: 0.75-1.00 inch hail. $95k property damage, $95k crop damage across Muskegon County.
- August 3, 2003: 1.75 inch hail in Muskegon Twp, $55k property damage and $25k crop damage from hail countywide.

1.09 Invasive Species: - Invasive species exist in Muskegon County; No significant events identified.

1.10 Lightning:

- July 20, 1994: Lightning killed a dog and caused $50k property damage, Muskegon County.

1.11 Severe Winds:

- August 20 - September 6, 1975: Rainstorms, high winds. Declaration of major disaster by President.
- November 18, 1994: High wind. $1m property damage statewide.
- April 6, 1997: High wind. $5m property damage across southwest Lower Michigan.
- May 29, 1998: Severe thunderstorm winds. 54,000 homes and businesses without power; estimated 500 homes and 30 businesses sustained minor to moderate damage. $1m property damage, Muskegon County.
- May 31, 1998: Thunderstorms & high winds. Declarations of disaster by Governor and major disaster by President. $2,458,958 in public damage costs, 42 homes destroyed, 1,805 homes damaged, 5 businesses destroyed, and 73 businesses damaged. Total public and private costs have been estimated at $24,205,908.
- August 22, 2000: Severe thunderstorm winds. $150k property damage, Muskegon County.
- March 9, 2002: High wind. $485k property damage across southwest Lower Michigan.
- October 30, 2004: High wind. $1.15m property damage across southwest Lower Michigan.
- May 20-24, 2004: Severe storms. Declaration of major disaster by President.
- August 9, 2009: Severe thunderstorm winds. $2m property damage, Muskegon County.
- November 17, 2013: Severe thunderstorm winds. $200k property damage, Muskegon County.

1.12 Subsidence: - None Identified.

1.13 Tornadoes:

- Number of tornadoes in Muskegon County, 1950-2012: 7.

1.14 Wildfire:

- October 1871: Wildfires. 1.2m acres burned, 200 fatalities, Michigan's Lower Peninsula.
- May-September, 1891: Uncontrollable wildfires across Michigan during the drought of 1891.
- 1981-2010: Approximately 8 wildfires and 89 acres burned per year on county lands under MDNR jurisdiction (251 total wildfires, 2,676.0 total acres burned).

1.15 Winter Storms:

- March 2-7, 1976: Ice storms. Declaration of major disaster by President.
- January 26-31, 1977: Blizzard, snowstorm. Declaration of emergency by President.
- January 26-27, 1978: Blizzard, snowstorm. Declaration of statewide emergency by President.
- January 12, 1993: Heavy snow. $50k property damage, northern Lower Michigan.
- January 12-21, 1994: Heavy lake effect snow. $500k property damage across western Lower Michigan.
- January 27, 1994: Heavy snow and freezing rain. $5m property damage across region.
- October 26, 1997: Heavy snow. $1.2m property damage across southwestern Lower Michigan.
- March 9, 1998: Winter storm. $100k property damage across region.
- January 2-15, 1999: Blizzard, snowstorm. Declaration of emergency by President.
- December 11-31, 2000: Blizzard, snowstorm. Declaration of emergency by President.
- April 3, 2003: Ice storm. $4.9m property damage throughout West Michigan.
- February 16, 2006: Ice storm. $1m property damage across Lower Michigan.

2. TECHNOLOGICAL HAZARDS

2.01 Dam Failure:

- Four documented failures in Muskegon County, unidentified locations.

2.02 Energy Emergencies:

- February 2003: A break in a major transmission line caused an electrical blackout over parts of Montcalm, Oceana, Newaygo, Muskegon, and Kent counties.

2.03 Fire - Scrap Tire:

- Approximate scrap tire inventory in Muskegon County in 2012: 4,400.

2.04 Fire - Structural:

- County fire rate per 1,000 population in 1998: 3.8.

2.05 Hazard Material Incidents - Fixed Site (including industrial accidents):

- SARA Title III Sites in Muskegon County in 2012: 51.

2.06 Hazard Material Incidents - Transportation: - None Identified.

2.07 Infrastructure Failure:

- Number of NCDC with mention of downed power lines or power outages in Muskegon County, 1993-2012: 45
- Number of sanitary sewer overflows in Muskegon County, 2000-2011: 47.
- August 8, 1993: 4,400 without power (thunderstorm winds), Muskegon and Oceana counties
- March 9, 1998: 1,900 power outages (blizzard conditions), Lake, Clare, Oceana and Muskegon counties.
- May 29-30, 1998: 54,000 without power; 27,000 on second day (thunderstorm winds), Muskegon County.
- May 31, 1998: 50,000 without power (thunderstorm winds), Muskegon County.
- July 21, 1998: 7,500 without power (thunderstorm winds and lightning), Muskegon County.

2.08 Nuclear Power Plant Emergencies: - None Identified.

2.09 Oil and Natural Gas Well Accidents:

- Oil and gas wells in Muskegon County in 2012: 1,090.

2.10 Pipeline Accidents: - None Identified.

2.11 Transportation Accidents: - None Identified.

3. HUMAN -RELATED HAZARDS

3.01 Catastrophic Incidents (National Emergencies):

- 1939-1945: World War II. In Muskegon, 48-hour minimum work weeks, rationing of certain food and goods, and 274 county men killed in battle.
- 2005: Hurricanes Katrina and Rita. Declarations of Gubernatorial Disaster and Presidential Emergency were issued in Michigan in September 2005 for hurricane evacuation.

3.02 Civil Disturbances: - None Identified.

3.03 Nuclear Attack: - None Identified.

3.04 Public Health Emergencies:

- 1913: Diphtheria Epidemic.
- 1916: Small pox and scarlet fever force closures of schools and businesses.
- 1918: Influenza epidemic closes theaters, dance halls, and churches.
- 1937: Children under 18 banned from theaters and schools close from fear of polio outbreak.
- 1941: Influenza epidemic cuts school attendance by 60%.
- 2009: H1N1 influenza pandemic causes school absences spike in the fall. Two county residents die from complications.

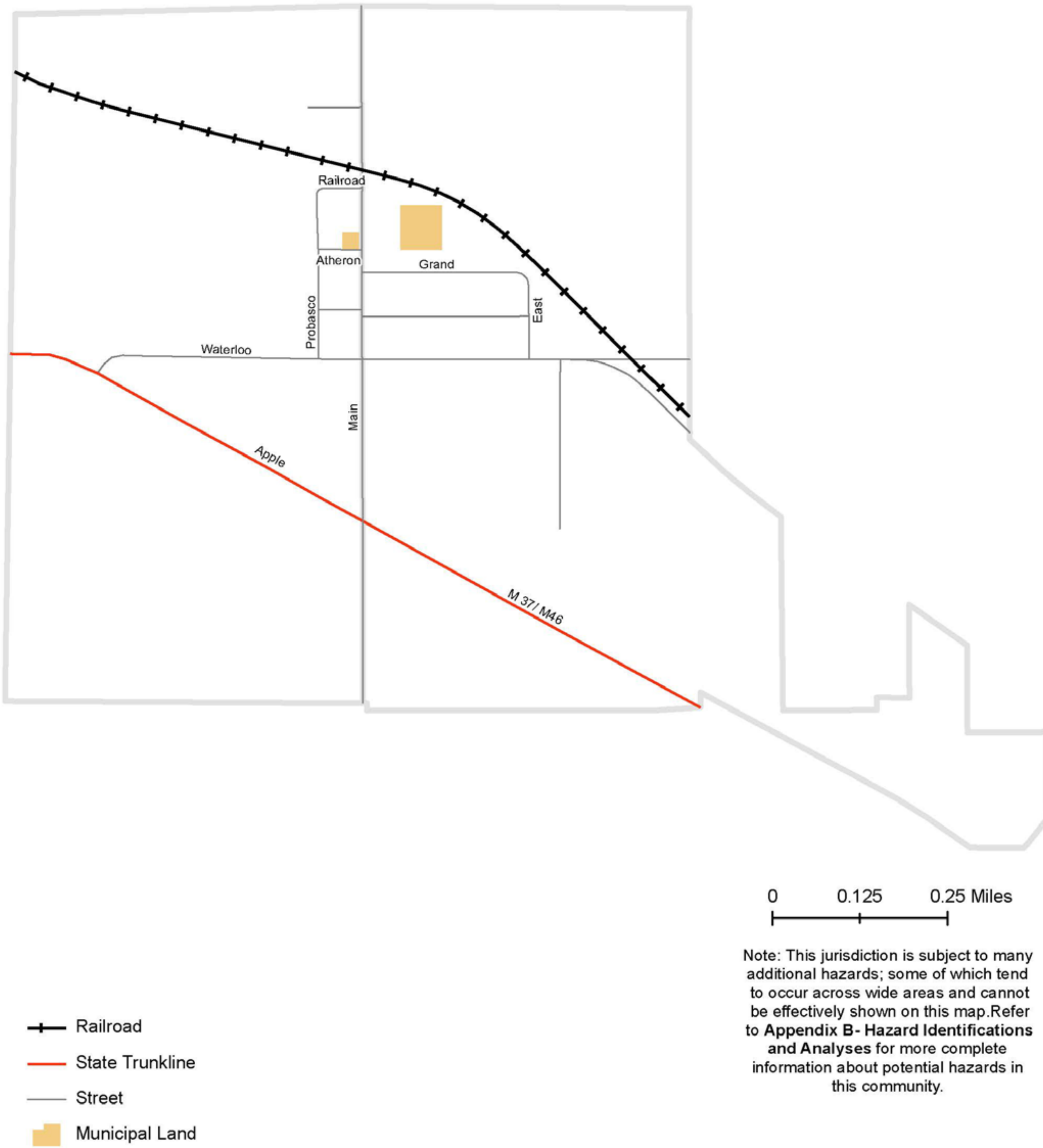
3.05 Terrorism and Similar Criminal Activities: - None Identified.

	Village of Casnovia Hazard Rating	Probability of Occurrence	Impact on People	Impact on Property	Impact on Economy	Impacts Total	Hazard Score
1.01	Celestial Impacts	1	2	0	2	8	8
1.02	Drought	2	2	1	2	10	20
1.03	Earthquake	0	-	-	-	-	-
1.04	Extreme Temperatures	3	2	1	1	9	27
1.05	Flooding: Riverine/Urban	2	1	1	1	6	12
1.06	Fog	2	1	0	1	4	8
1.07	Great Lakes Shoreline	0	-	-	-	-	-
1.08	Hail	2	2	1	1	9	18
1.09	Invasive Species	2	1	1	1	6	12
1.10	Lightning	3	1	2	1	8	24
1.11	Severe Winds	3	2	2	2	12	36
1.12	Subsidence	1	1	1	1	6	6
1.13	Tornadoes	1	3	2	2	15	15
1.14	Wildfire	2	2	2	1	11	22
1.15	Winter Storms	3	3	2	2	15	45
2.01	Dam failure	0	-	-	-	-	-
2.02	Energy Emergencies	2	2	0	2	8	16
2.03	Fire – Scrap Tires	0	-	-	-	-	-
2.04	Fire – Structural	3	1	2	3	10	30
2.05	HAZMAT – Fixed Site	0	-	-	-	-	-
2.06	HAZMAT – Transportation	3	1	1	1	6	18
2.07	Infrastructure Failures	3	2	1	2	10	30
2.08	Nuclear Power Emergencies	0	-	-	-	-	-
2.09	Oil/Natural Gas Well Accidents	0	-	-	-	-	-
2.10	Pipeline Accidents	0	-	-	-	-	-
2.11	Transportation Accidents	2	1	1	2	7	14
3.01	Catastrophic Incidents	1	3	3	3	18	18
3.02	Civil Disturbances	1	1	1	1	6	6
3.03	Nuclear Attack	0	-	-	-	-	-
3.04	Public Health Emergencies	2	2	0	3	9	18
3.05	Terrorism & Similar Criminal Acts	1	1	1	1	6	6

Village of Casnovia Hazard Ranking

Rank	Hazard	Probability of Occurrence	X Impacts Total	= Hazard Score
1	Winter Storms	3	15	45
2	Severe Winds	3	12	36
3	Fire – Structural	3	10	30
3	Infrastructure Failures	3	10	30
5	Extreme Temperatures	3	9	27
6	Lightning	3	8	24
7	Wildfire	2	11	22
8	Drought	2	10	20
9	Catastrophic Incidents	1	18	18
9	Hail	2	9	18
9	HAZMAT – Transportation	3	6	18
9	Public Health Emergencies	2	9	18
13	Energy Emergencies	2	8	16
14	Tornadoes	1	15	15
15	Transportation Accidents	2	7	14
16	Flooding: Riverine/Urban	2	6	12
16	Invasive Species	2	6	12
18	Celestial Impacts	1	8	8
18	Fog	2	4	8
20	Civil Disturbances	1	6	6
20	Subsidence	1	6	6
20	Terrorism & Similar Criminal Acts	1	6	6
	Dam Failure	0	-	-
	Earthquake	0	-	-
	Fire – Scrap Tires	0	-	-
	Great Lakes Shoreline	0	-	-
	HAZMAT – Fixed Site	0	-	-
	Nuclear Attack	0	-	-
	Nuclear Power Emergencies	0	-	-
	Oil/Natural Gas Well Accidents	0	-	-
	Pipeline Accidents	0	-	-

VILLAGE OF CASNOVIA
Critical Facilities and Potential Hazards



Note: This jurisdiction is subject to many additional hazards; some of which tend to occur across wide areas and cannot be effectively shown on this map. Refer to **Appendix B- Hazard Identifications and Analyses** for more complete information about potential hazards in this community.

WMSRDC
WEST MICHIGAN SHORELINE REGIONAL DEVELOPMENT COMMISSION

Source: Michigan Geographic Data Library V 12b, Muskegon Co. Hazard Mitigation Update 2014

Hazard Identification Profile
Village of Fruitport

1. NATURAL HAZARDS

1.01 Celestial Impacts: - None Identified.

1.02 Drought:

- 12 recorded drought events in the area (including Lake, Mason, Muskegon, Newaygo, and Oceana counties) lasting eight months or greater: 1895-1896, 1899-1900, 1901-1902, 1909-1911, 1925-1926, 1930-1931, 1956-1957, 1962-1963, 1971-1972, 1976-1977, and 2002-2003.
- Summer 1871: Prolonged drought over much of the Great Lakes region.
- May-September, 1891: Drought devastated Michigan's lumber industry.
- 2013: Record low water level on Lake Michigan.

1.03 Earthquake: - None Identified.

1.04 Extreme Temperatures:

- July 1936: Heatwave. 570 deaths statewide, 7 in Muskegon.
- Summer, 1988: 39 days with temperatures over 90 degrees, statewide.
- January 13-20, 1994: Record cold. $50m property damage across Michigan.
- December 9-10, 1995: Coldwave across Lower Michigan.
- March 2012: Record warm temperatures triggered early growing season. $209.8m crop damage across Michigan.

1.05 Flooding - Riverine/ Urban:

- August 20 - September 6, 1975: Flooding. Declaration of major disaster by President.
- February 21, 1986: Great lakes flooding and wave action. Declaration of disaster by Governor.
- September 10-19, 1986: Flooding. Declaration of major disaster by President.
- September, 1986: Flooding & heavy rain. Declaration of disaster by Governor.
- May 18-20, 2000: Flood. $100k property damage, $50k crop damage in Muskegon County.
- February 9-10, 2001: Flooding. $100k property damage across West Michigan.
- February 24-28, 2001: Flooding. $190k property damage across West Michigan.
- May 15-16, 2001: Flooding. $500k property damage, $200k crop damage across southwestern Lower Michigan.
- May 20-24, 2004: Flooding. Declaration of major disaster by President.
- April 17-23, 2013: Flooding. Declaration of major disaster by President. $5m property damage, Muskegon County.

1.06 Fog:

- January 11-13, 1995: Dense Fog. 4 traffic accident fatalities, school closures, and flight delays across Lower Michigan.

1.07 Great Lakes Shoreline Hazards: - None Identified.

1.08 Hail:

- Days with severe hail reported (1" or greater) recorded in Muskegon County, 2000-2012: 7
- ***April 11, 2001: 1.75 inch hail. $50k property damage, $25k crop damage, Village of Fruitport.***
- May 15, 2001: 0.75-1.00 inch hail. $95k property damage, $95k crop damage across Muskegon County.
- August 3, 2003: 1.75 inch hail in Muskegon Twp, $55k property damage and $25k crop damage from hail countywide.

1.09 Invasive Species: - Invasive species exist in Muskegon County; No significant events identified.

1.10 Lightning: - July 20, 1994: Lightning killed a dog and caused $50k property damage, Muskegon County.

1.11 Severe Winds:

- August 20 - September 6, 1975: Rainstorms, high winds. Declaration of major disaster by President.
- November 18, 1994: High wind. $1m property damage statewide.
- April 6, 1997: High wind. $5m property damage across southwest Lower Michigan.
- May 29, 1998: Severe thunderstorm winds. 54,000 homes and businesses without power; estimated 500 homes and 30 businesses sustained minor to moderate damage. $1m property damage, Muskegon County.
- May 31, 1998: Thunderstorms & high winds. Declarations of disaster by Governor and major disaster by President. $2,458,958 in public damage costs, 42 homes destroyed, 1,805 homes damaged, 5 businesses destroyed, and 73 businesses damaged. Total public and private costs have been estimated at $24,205,908.
- August 22, 2000: Severe thunderstorm winds. $150k property damage, Muskegon County.
- March 9, 2002: High wind. $485k property damage across southwest Lower Michigan.
- October 30, 2004: High wind. $1.15m property damage across southwest Lower Michigan.
- May 20-24, 2004: Severe storms. Declaration of major disaster by President.
- August 9, 2009: Severe thunderstorm winds. $2m property damage, Muskegon County.
- November 17, 2013: Severe thunderstorm winds. $200k property damage, Muskegon County.

1.12 Subsidence: - None Identified.

1.13 Tornadoes:

- Number of tornadoes in Muskegon County, 1950-2012: 7.

1.14 Wildfire:

- October 1871: Wildfires. 1.2m acres burned, 200 fatalities, Michigan's Lower Peninsula.
- May-September, 1891: Uncontrollable wildfires across Michigan during the drought of 1891.
- 1981-2010: Approximately 8 wildfires and 89 acres burned per year on county lands under MDNR jurisdiction (251 total wildfires, 2,676.0 total acres burned).

1.15 Winter Storms:

- March 2-7, 1976: Ice storms. Declaration of major disaster by President.
- January 26-31, 1977: Blizzard, snowstorm. Declaration of emergency by President.
- January 26-27, 1978: Blizzard, snowstorm. Declaration of statewide emergency by President.
- January 12, 1993: Heavy snow. $50k property damage, northern Lower Michigan.
- January 12-21, 1994: Heavy lake effect snow. $500k property damage across western Lower Michigan.
- January 27, 1994: Heavy snow and freezing rain. $5m property damage across region.
- October 26, 1997: Heavy snow. $1.2m property damage across southwestern Lower Michigan.
- March 9, 1998: Winter storm. $100k property damage across region.
- January 2-15, 1999: Blizzard, snowstorm. Declaration of emergency by President.
- December 11-31, 2000: Blizzard, snowstorm. Declaration of emergency by President.
- April 3, 2003: Ice storm. $4.9m property damage throughout West Michigan.
- February 16, 2006: Ice storm. $1m property damage across Lower Michigan.

2. TECHNOLOGICAL HAZARDS

2.01 Dam Failure:

- Four documented failures in Muskegon County, unidentified locations.

2.02 Energy Emergencies:

- February 2003: A break in a major transmission line caused an electrical blackout over parts of Montcalm, Oceana, Newaygo, Muskegon, and Kent counties.

2.03 Fire - Scrap Tire:

- Approximate scrap tire inventory in Muskegon County in 2012: 4,400.

2.04 Fire - Structural:

- County fire rate per 1,000 population in 1998: 3.8.
- ***1900: Major business district fires in Fruitport and Ravenna.***

2.05 Hazard Material Incidents - Fixed Site (including industrial accidents):

- SARA Title III Sites in Muskegon County in 2012: 51.

2.06 Hazard Material Incidents - Transportation: - None Identified.

2.07 Infrastructure Failure:

- Number of NCDC records with mention of downed power lines or power outages in Muskegon County, 1993-2012: 45
- Number of sanitary sewer overflows in Muskegon County, 2000-2011: 47.
- August 8, 1993: 4,400 without power (thunderstorm winds), Muskegon and Oceana counties
- March 9, 1998: 1,900 power outages (blizzard conditions), Lake, Clare, Oceana and Muskegon counties.
- May 29-30, 1998: 54,000 without power; 27,000 on second day (thunderstorm winds), Muskegon County.
- May 31, 1998: 50,000 without power (thunderstorm winds), Muskegon County.
- July 21, 1998: 7,500 without power (thunderstorm winds and lightning), Muskegon County.
- ***August 9, 2009: Village of Fruitport and much of southern Muskegon County without power (t-storm winds).***

2.08 Nuclear Power Plant Emergencies: - None Identified.

2.09 Oil and Natural Gas Well Accidents:

- Oil and gas wells in Muskegon County in 2012: 1,090.

2.10 Pipeline Accidents: - None Identified.

2.11 Transportation Accidents: - None Identified.

3. HUMAN -RELATED HAZARDS

3.01 Catastrophic Incidents (National Emergencies):

- 1939-1945: World War II. In Muskegon, 48-hour minimum work weeks, rationing of certain food and goods, and 274 county men killed in battle.
- 2005: Hurricanes Katrina and Rita. Declarations of Gubernatorial Disaster and Presidential Emergency were issued in Michigan in September 2005 for hurricane evacuation.

3.02 Civil Disturbances: - None Identified.

3.03 Nuclear Attack: - None Identified.

3.04 Public Health Emergencies:

- 1913: Diphtheria Epidemic.
- 1916: Small pox and scarlet fever force closures of schools and businesses.
- 1918: Influenza epidemic closes theaters, dance halls, and churches.
- 1937: Children under 18 banned from theaters and schools close from fear of polio outbreak.
- 1941: Influenza epidemic cuts school attendance by 60%.
- 2009: H1N1 influenza pandemic causes school absences spike in the fall. Two county residents die from complications.

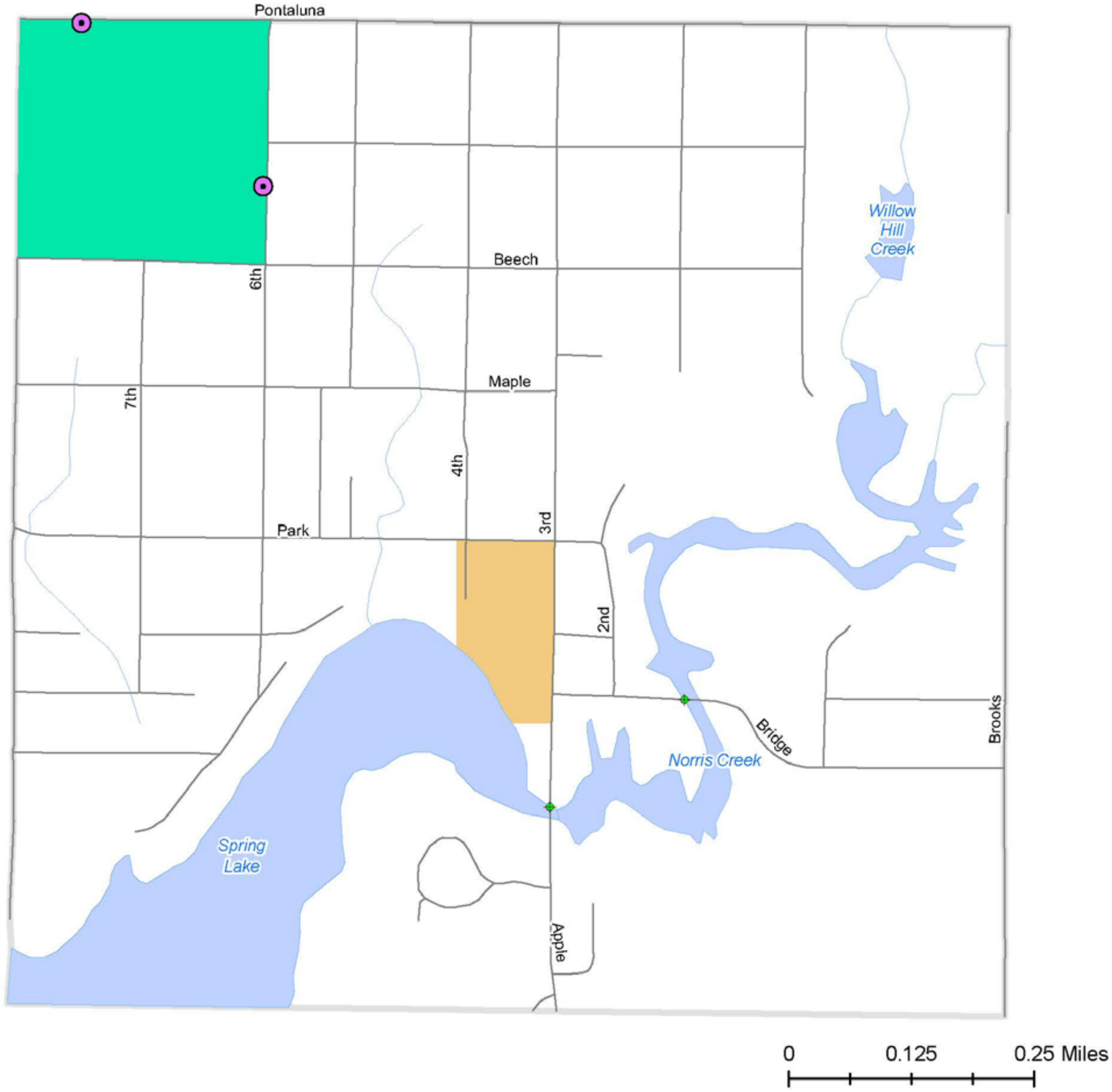
3.05 Terrorism and Similar Criminal Activities: - None Identified.

	Village of Fruitport Hazard Rating	Probability of Occurrence	Impact on People	Impact on Property	Impact on Economy	Impacts Total	Hazard Score
1.01	Celestial Impacts	1	2	0	2	8	8
1.02	Drought	2	2	1	2	10	20
1.03	Earthquake	0	-	-	-	-	-
1.04	Extreme Temperatures	3	2	1	1	9	27
1.05	Flooding: Riverine/Urban	2	1	2	1	8	16
1.06	Fog	2	1	0	1	4	8
1.07	Great Lakes Shoreline	0	-	-	-	-	-
1.08	Hail	2	2	1	1	9	18
1.09	Invasive Species	2	1	1	1	6	12
1.10	Lightning	3	1	2	1	8	24
1.11	Severe Winds	3	2	2	2	12	36
1.12	Subsidence	1	1	1	1	6	6
1.13	Tornadoes	1	3	2	2	15	15
1.14	Wildfire	2	2	2	1	11	22
1.15	Winter Storms	3	3	2	2	15	45
2.01	Dam failure	0	-	-	-	-	-
2.02	Energy Emergencies	2	2	0	2	8	16
2.03	Fire – Scrap Tires	1	1	1	1	6	6
2.04	Fire – Structural	3	1	2	3	10	30
2.05	HAZMAT – Fixed Site	0	-	-	-	-	-
2.06	HAZMAT – Transportation	2	1	1	1	6	12
2.07	Infrastructure Failures	3	2	1	2	10	30
2.08	Nuclear Power Emergencies	0	-	-	-	-	-
2.09	Oil/Natural Gas Well Accidents	1	1	1	1	6	6
2.10	Pipeline Accidents	0	-	-	-	-	-
2.11	Transportation Accidents	2	1	1	1	6	12
3.01	Catastrophic Incidents	1	3	3	3	18	18
3.02	Civil Disturbances	1	1	1	1	6	6
3.03	Nuclear Attack	0	-	-	-	-	-
3.04	Public Health Emergencies	2	2	0	3	9	18
3.05	Terrorism & Similar Criminal Acts	1	1	1	1	6	6

Village of Fruitport Hazard Ranking

		Probability of Occurrence X	Impacts Total =	Hazard Score
1	Winter Storms	3	15	45
2	Severe Winds	3	12	36
3	Fire – Structural	3	10	30
4	Infrastructure Failures	3	10	30
4	Extreme Temperatures	3	9	27
6	Lightning	3	8	24
7	Wildfire	2	11	22
8	Drought	2	10	20
8	Catastrophic Incidents	1	18	18
8	Hail	2	9	18
11	Public Health Emergencies	2	9	18
12	Energy Emergencies	2	8	16
12	Flooding: Riverine/Urban	2	8	16
12	Tornadoes	1	15	15
12	HAZMAT – Transportation	2	6	12
16	Invasive Species	2	6	12
17	Transportation Accidents	2	6	12
17	Celestial Impacts	1	8	8
17	Fog	2	4	8
17	Civil Disturbances	1	6	6
17	Fire – Scrap Tires	1	6	6
22	Oil/Natural Gas Well Accidents	1	6	6
22	Subsidence	1	6	6
24	Terrorism & Similar Criminal Acts	1	6	6
25	Dam Failure	0	-	-
25	Earthquake	0	-	-
25	Great Lakes Shoreline	0	-	-
25	HAZMAT – Fixed Site	0	-	-
	Nuclear Attack	0	-	-
	Nuclear Power Emergencies	0	-	-
	Pipeline Accidents	0	-	-

VILLAGE OF FRUITPORT
Critical Facilities and Potential Hazards



- Street
- Bridge
- School
- Municipal Land
- School Property

Note: This jurisdiction is subject to many additional hazards; some of which tend to occur across wide areas and cannot be effectively shown on this map.Refer to **Appendix B- Hazard Identifications and Analyses** for more complete information about potential hazards in this community.

WEST MICHIGAN SHORELINE REGIONAL DEVELOPMENT COMMISSION

Source: Michigan Geographic Data Library V 12b, Muskegon Co. Hazard Mitigation Plan Update 2014

Hazard Identification Profile
Village of Lakewood Club

1. NATURAL HAZARDS

1.01 Celestial Impacts: - None Identified.

1.02 Drought:
- 12 recorded drought events in the area (including Lake, Mason, Muskegon, Newaygo, and Oceana counties) lasting eight months or greater: 1895-1896, 1899-1900, 1901-1902, 1909-1911, 1925-1926, 1930-1931, 1956-1957, 1962-1963, 1971-1972, 1976-1977, and 2002-2003.
- Summer 1871: Prolonged drought over much of the Great Lakes region.
- May-September, 1891: Drought devastated Michigan's lumber industry.
- 2013: Record low Lake Michigan water levels.

1.03 Earthquake: - None Identified.

1.04 Extreme Temperatures:
- July 1936: Heatwave. 570 deaths statewide, 7 in Muskegon.
- Summer, 1988: 39 days with temperatures over 90 degrees, statewide.
- January 13-20, 1994: Record cold. $50m property damage across Michigan.
- December 9-10, 1995: Coldwave across Lower Michigan.
- March 2012: Record warm temperatures triggered early growing season. $209.8m crop damage across Michigan.

1.05 Flooding - Riverine/ Urban:
- August 20 - September 6, 1975: Flooding. Declaration of major disaster by President.
- February 21, 1986: Great lakes flooding and wave action. Declaration of disaster by Governor.
- September 10-19, 1986: Flooding. Declaration of major disaster by President.
- September, 1986: Flooding & heavy rain. Declaration of disaster by Governor.
- May 18-20, 2000: Flood. $100k property damage, $50k crop damage in Muskegon County.
- February 9-10, 2001: Flooding. $100k property damage across West Michigan.
- February 24-28, 2001: Flooding. $190k property damage across West Michigan.
- May 15-16, 2001: Flooding. $500k property damage, $200k crop damage across southwestern Lower Michigan.
- May 20-24, 2004: Flooding. Declaration of major disaster by President.
- April 17-23, 2013: Flooding. Declaration of major disaster by President. $5m property damage, Muskegon County.

1.06 Fog:
- January 11-13, 1995: Dense Fog. 4 traffic accident fatalities, school closures, and flight delays across Lower Michigan.

1.07 Great Lakes Shoreline Hazards: - None Identified.

1.08 Hail:
- Days with severe hail reported (1" or greater) recorded in Muskegon County, 2000-2012: 7
- May 15, 2001: 0.75-1.00 inch hail. $95k property damage, $95k crop damage across Muskegon County.
- August 3, 2003: 1.75 inch hail in Muskegon Twp, $55k property damage and $25k crop damage from hail countywide.

1.09 Invasive Species: - Invasive species exist in Muskegon County; No significant events identified.

1.10 Lightning:
- July 20, 1994: Lightning killed a dog and caused $50k property damage, Muskegon County.

1.11 Severe Winds:
- August 20 - September 6, 1975: Rainstorms, high winds. Declaration of major disaster by President.
- November 18, 1994: High wind. $1m property damage statewide.
- April 6, 1997: High wind. $5m property damage across southwest Lower Michigan.
- May 29, 1998: Severe thunderstorm winds. 54,000 homes and businesses without power; estimated 500 homes and 30 businesses sustained minor to moderate damage. $1m property damage, Muskegon County.
- May 31, 1998: Thunderstorms & high winds. Declarations of disaster by Governor and major disaster by President. $2,458,958 in public damage costs, 42 homes destroyed, 1,805 homes damaged, 5 businesses destroyed, and 73 businesses damaged. Total public and private costs have been estimated at $24,205,908.
- August 22, 2000: Severe thunderstorm winds. $150k property damage, Muskegon County.
- March 9, 2002: High wind. $485k property damage across southwest Lower Michigan.
- October 30, 2004: High wind. $1.15m property damage across southwest Lower Michigan.
- May 20-24, 2004: Severe storms. Declaration of major disaster by President.
- August 9, 2009: Severe thunderstorm winds. $2m property damage, Muskegon County.
- November 17, 2013: Severe thunderstorm winds. $200k property damage, Muskegon County.

1.12 Subsidence: - None Identified.

1.13 Tornadoes:
- Number of tornadoes in Muskegon County, 1950-2012: 7.

1.14 Wildfire:
- October 1871: Wildfires. 1.2m acres burned, 200 fatalities, Michigan's Lower Peninsula.
- May-September, 1891: Uncontrollable wildfires across Michigan during the drought of 1891.
- 1981-2010: Approximately 8 wildfires and 89 acres burned per year on county lands under MDNR jurisdiction (251 total wildfires, 2,676.0 total acres burned).

1.15 Winter Storms:

- March 2-7, 1976: Ice storms. Declaration of major disaster by President.
- January 26-31, 1977: Blizzard, snowstorm. Declaration of emergency by President.
- January 26-27, 1978: Blizzard, snowstorm. Declaration of statewide emergency by President.
- January 12, 1993: Heavy snow. $50k property damage, northern Lower Michigan.
- January 12-21, 1994: Heavy lake effect snow. $500k property damage across western Lower Michigan.
- January 27, 1994: Heavy snow and freezing rain. $5m property damage across region.
- October 26, 1997: Heavy snow. $1.2m property damage across southwestern Lower Michigan.
- March 9, 1998: Winter storm. $100k property damage across region.
- January 2-15, 1999: Blizzard, snowstorm. Declaration of emergency by President.
- December 11-31, 2000: Blizzard, snowstorm. Declaration of emergency by President.
- April 3, 2003: Ice storm. $4.9m property damage throughout West Michigan.
- February 16, 2006: Ice storm. $1m property damage across Lower Michigan.

2. TECHNOLOGICAL HAZARDS

2.01 Dam Failure:

- Four documented failures in Muskegon County, unidentified locations.

2.02 Energy Emergencies:

- February 2003: A break in a major transmission line caused an electrical blackout over parts of Montcalm, Oceana, Newaygo, Muskegon, and Kent counties.

2.03 Fire - Scrap Tire:

- Approximate scrap tire inventory in Muskegon County in 2012: 4,400.

2.04 Fire - Structural:

- County fire rate per 1,000 population in 1998: 3.8.

2.05 Hazard Material Incidents - Fixed Site (including industrial accidents):

- SARA Title III Sites in Muskegon County in 2012: 51.

2.06 Hazard Material Incidents - Transportation: - None Identified.

2.07 Infrastructure Failure:

- Number of NCDC with mention of downed power lines or power outages in Muskegon County, 1993-2012: 45
- Number of sanitary sewer overflows in Muskegon County, 2000-2011: 47.
- August 8, 1993: 4,400 without power (thunderstorm winds), Muskegon and Oceana counties
- March 9, 1998: 1,900 power outages (blizzard conditions), Lake, Clare, Oceana and Muskegon counties.
- May 29-30, 1998: 54,000 without power; 27,000 on second day (thunderstorm winds), Muskegon County.
- May 31, 1998: 50,000 without power (thunderstorm winds), Muskegon County.
- July 21, 1998: 7,500 without power (thunderstorm winds and lightning), Muskegon County.

2.08 Nuclear Power Plant Emergencies: - None Identified.

2.09 Oil and Natural Gas Well Accidents:

- Oil and gas wells in Muskegon County in 2012: 1,090.

2.10 Pipeline Accidents: - None Identified.

2.11 Transportation Accidents: - None Identified.

3. HUMAN -RELATED HAZARDS

3.01 Catastrophic Incidents (National Emergencies):

- 1939-1945: World War II. In Muskegon, 48-hour minimum work weeks, rationing of certain food and goods, and 274 county men killed in battle.
- 2005: Hurricanes Katrina and Rita. Declarations of Gubernatorial Disaster and Presidential Emergency were issued in Michigan in September 2005 for hurricane evacuation.

3.02 Civil Disturbances: - None Identified.

3.03 Nuclear Attack: - None Identified.

3.04 Public Health Emergencies:

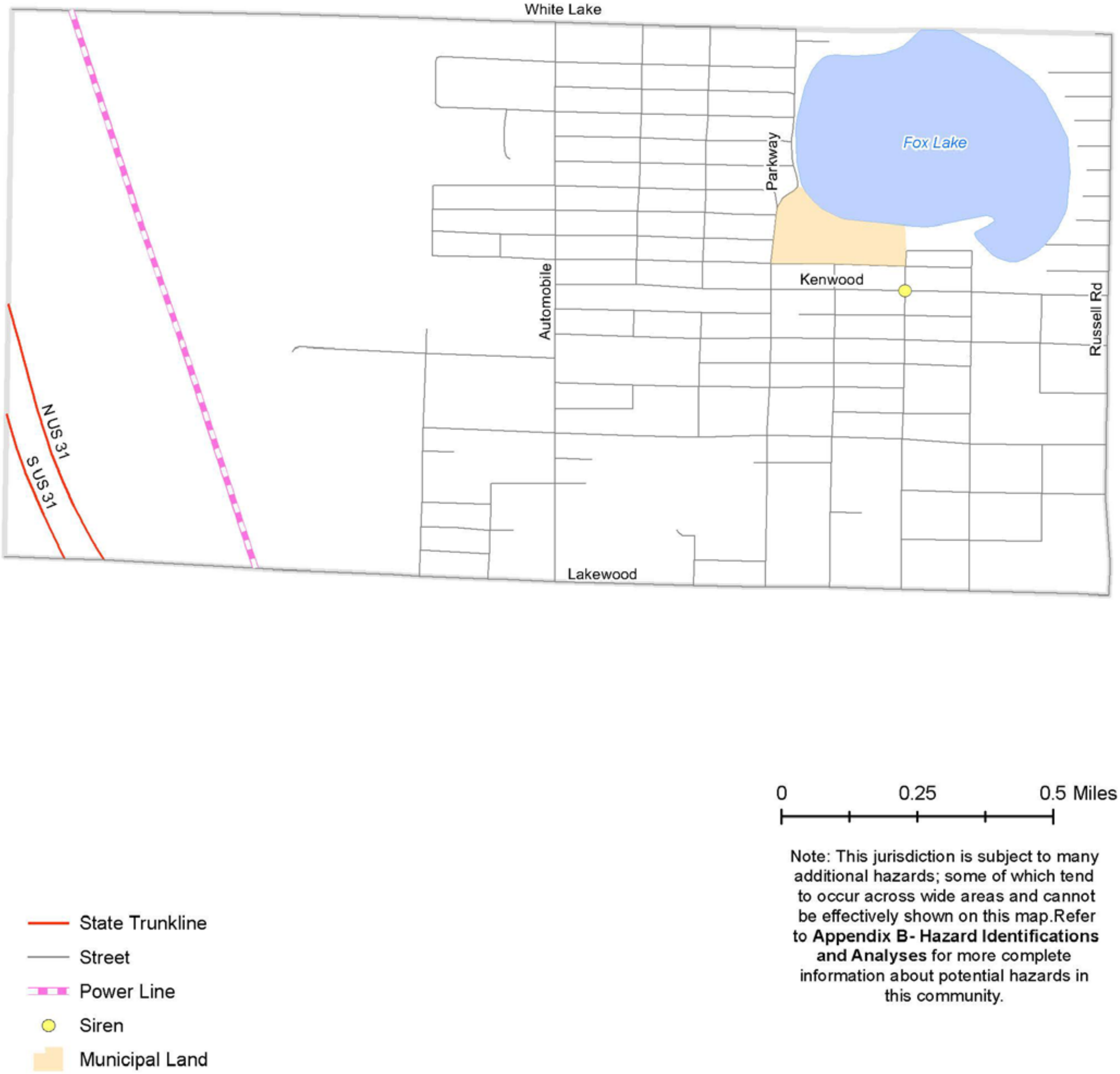
- 1913: Diphtheria Epidemic.
- 1916: Small pox and scarlet fever force closures of schools and businesses.
- 1918: Influenza epidemic closes theaters, dance halls, and churches.
- 1937: Children under 18 banned from theaters and schools close from fear of polio outbreak.
- 1941: Influenza epidemic cuts school attendance by 60%.
- 2009: H1N1 influenza pandemic causes school absences spike in the fall. Two county residents die from complications.

3.05 Terrorism and Similar Criminal Activities: - None Identified.

	Village of Lakewood Club Hazard Rating	Probability of Occurrence	Impact on People	Impact on Property	Impact on Economy	Impacts Total	Hazard Score
1.01	Celestial Impacts	1	2	0	2	8	8
1.02	Drought	2	2	1	2	10	20
1.03	Earthquake	0	-	-	-	-	-
1.04	Extreme Temperatures	3	2	1	1	9	27
1.05	Flooding: Riverine/Urban	2	1	1	1	6	12
1.06	Fog	2	1	0	1	4	8
1.07	Great Lakes Shoreline	0	-	-	-	-	-
1.08	Hail	2	2	1	1	9	18
1.09	Invasive Species	2	1	1	1	6	12
1.10	Lightning	3	1	2	1	8	24
1.11	Severe Winds	3	2	2	2	12	36
1.12	Subsidence	1	1	1	1	6	6
1.13	Tornadoes	1	3	2	2	15	15
1.14	Wildfire	3	1	2	1	8	24
1.15	Winter Storms	3	3	2	2	15	45
2.01	Dam failure	0	-	-	-	-	-
2.02	Energy Emergencies	2	2	0	2	8	16
2.03	Fire – Scrap Tires	1	1	1	1	6	6
2.04	Fire – Structural	3	1	2	3	10	30
2.05	HAZMAT – Fixed Site	0	-	-	-	-	-
2.06	HAZMAT – Transportation	3	1	1	1	6	18
2.07	Infrastructure Failures	3	2	1	2	10	30
2.08	Nuclear Power Emergencies	0	-	-	-	-	-
2.09	Oil/Natural Gas Well Accidents	0	-	-	-	-	-
2.10	Pipeline Accidents	0	-	-	-	-	-
2.11	Transportation Accidents	2	1	1	2	7	14
3.01	Catastrophic Incidents	1	3	3	3	18	18
3.02	Civil Disturbances	1	1	1	1	6	6
3.03	Nuclear Attack	0	-	-	-	-	-
3.04	Public Health Emergencies	2	2	0	3	9	18
3.05	Terrorism & Similar Criminal Acts	1	1	1	1	6	6

	Village of Lakewood Club Hazard Ranking	Probability of Occurrence	X Impacts Total	= Hazard Score
1	Winter Storms	3	15	45
2	Severe Winds	3	12	36
3	Fire – Structural	3	10	30
3	Infrastructure Failures	3	10	30
5	Extreme Temperatures	3	9	27
6	Lightning	3	8	24
6	Wildfire	3	8	24
8	Drought	2	10	20
9	Catastrophic Incidents	1	18	18
9	Hail	2	9	18
9	HAZMAT – Transportation	3	6	18
9	Public Health Emergencies	2	9	18
13	Energy Emergencies	2	8	16
14	Tornadoes	1	15	15
15	Transportation Accidents	2	7	14
16	Flooding: Riverine/Urban	2	6	12
16	Invasive Species	2	6	12
18	Celestial Impacts	1	8	8
18	Fog	2	4	8
20	Civil Disturbances	1	6	6
20	Fire – Scrap Tires	1	6	6
20	Subsidence	1	6	6
20	Terrorism & Similar Criminal Acts	1	6	6
	Dam Failure	0	-	-
	Earthquake	0	-	-
	Great Lakes Shoreline	0	-	-
	HAZMAT – Fixed Site	0	-	-
	Nuclear Attack	0	-	-
	Nuclear Power Emergencies	0	-	-
	Oil/Natural Gas Well Accidents	0	-	-
	Pipeline Accidents	0	-	-

VILLAGE OF LAKEWOOD CLUB
Critical Facilities and Hazard Potential



Note: This jurisdiction is subject to many additional hazards; some of which tend to occur across wide areas and cannot be effectively shown on this map.Refer to **Appendix B- Hazard Identifications and Analyses** for more complete information about potential hazards in this community.

WMSRDC
WEST MICHIGAN SHORELINE REGIONAL DEVELOPMENT COMMISSION

Source: Michigan Geographic Data Library V 12b, Muskegon Co. Hazard Mitigation Plan Update 2014

Hazard Identification Profile
Village of Ravenna

1. NATURAL HAZARDS

1.01 Celestial Impacts: - None Identified.

1.02 Drought:

- 12 recorded drought events in the area (including Lake, Mason, Muskegon, Newaygo, and Oceana counties) lasting eight months or greater: 1895-1896, 1899-1900, 1901-1902, 1909-1911, 1925-1926, 1930-1931, 1956-1957, 1962-1963, 1971-1972, 1976-1977, and 2002-2003.
- Summer 1871: Prolonged drought over much of the Great Lakes region.
- May-September, 1891: Drought devastated Michigan's lumber industry.
- 2013: Record low Lake Michigan water levels.

1.03 Earthquake: - None Identified.

1.04 Extreme Temperatures:

- July 1936: Heatwave. 570 deaths statewide, 7 in Muskegon.
- Summer, 1988: 39 days with temperatures over 90 degrees, statewide.
- January 13-20, 1994: Record cold. $50m property damage across Michigan.
- December 9-10, 1995: Coldwave across Lower Michigan.
- March 2012: Record warm temperatures triggered early growing season. $209.8m crop damage across Michigan.
- 2013: Record low water level on Lake Michigan.

1.05 Flooding - Riverine/ Urban:

- August 20 - September 6, 1975: Flooding. Declaration of major disaster by President.
- February 21, 1986: Great lakes flooding and wave action. Declaration of disaster by Governor.
- September 10-19, 1986: Flooding. Declaration of major disaster by President.
- September, 1986: Flooding & heavy rain. Declaration of disaster by Governor.
- May 18-20, 2000: Flood. $100k property damage, $50k crop damage in Muskegon County.
- February 9-10, 2001: Flooding. $100k property damage across West Michigan.
- February 24-28, 2001: Flooding. $190k property damage across West Michigan.
- May 15-16, 2001: Flooding. $500k property damage, $200k crop damage across southwestern Lower Michigan.
- May 20-24, 2004: Flooding. Declaration of major disaster by President.
- April 17-23, 2013: Flooding. Declaration of major disaster by President. $5m property damage, Muskegon County.

1.06 Fog:

- January 11-13, 1995: Dense Fog. 4 traffic accident fatalities, school closures, and flight delays across Lower Michigan.

1.07 Great Lakes Shoreline Hazards: - None Identified.

1.08 Hail:

- Days with severe hail reported (1" or greater) recorded in Muskegon County, 2000-2012: 7
- May 15, 2001: 0.75-1.00 inch hail. $95k property damage, $95k crop damage across Muskegon County.
- August 3, 2003: 1.75 inch hail in Muskegon Twp, $55k property damage and $25k crop damage from hail countywide.

1.09 Invasive Species: - Invasive species exist in Muskegon County; No significant events identified.

1.10 Lightning: - July 20, 1994: Lightning killed a dog and caused $50k property damage, Muskegon County.

1.11 Severe Winds:

- August 20 - September 6, 1975: Rainstorms, high winds. Declaration of major disaster by President.
- November 18, 1994: High wind. $1m property damage statewide.
- April 6, 1997: High wind. $5m property damage across southwest Lower Michigan.
- May 29, 1998: Severe thunderstorm winds. 54,000 homes and businesses without power; estimated 500 homes and 30 businesses sustained minor to moderate damage. $1m property damage, Muskegon County.
- May 31, 1998: Thunderstorms & high winds. Declarations of disaster by Governor and major disaster by President. $2,458,958 in public damage costs, 42 homes destroyed, 1,805 homes damaged, 5 businesses destroyed, and 73 businesses damaged. Total public and private costs have been estimated at $24,205,908.
- August 22, 2000: Severe thunderstorm winds. $150k property damage, Muskegon County.
- March 9, 2002: High wind. $485k property damage across southwest Lower Michigan.
- October 30, 2004: High wind. $1.15m property damage across southwest Lower Michigan.
- May 20-24, 2004: Severe storms. Declaration of major disaster by President.
- August 9, 2009: Severe thunderstorm winds. $2m property damage, Muskegon County.
- November 17, 2013: Severe thunderstorm winds. $200k property damage, Muskegon County.

1.12 Subsidence: - None Identified.

1.13 Tornadoes: - Number of tornadoes in Muskegon County, 1950-2012: 7.

1.14 Wildfire:

- October 1871: Wildfires. 1.2m acres burned, 200 fatalities, Michigan's Lower Peninsula.
- May-September, 1891: Uncontrollable wildfires across Michigan during the drought of 1891.
- 1981-2010: Approximately 8 wildfires and 89 acres burned per year on county lands under MDNR jurisdiction (251 total wildfires, 2,676.0 total acres burned).

1.15 Winter Storms:

- March 2-7, 1976: Ice storms. Declaration of major disaster by President.
- January 26-31, 1977: Blizzard, snowstorm. Declaration of emergency by President.
- January 26-27, 1978: Blizzard, snowstorm. Declaration of statewide emergency by President.
- January 12, 1993: Heavy snow. $50k property damage, northern Lower Michigan.
- January 12-21, 1994: Heavy lake effect snow. $500k property damage across western Lower Michigan.
- January 27, 1994: Heavy snow and freezing rain. $5m property damage across region.
- October 26, 1997: Heavy snow. $1.2m property damage across southwestern Lower Michigan.
- March 9, 1998: Winter storm. $100k property damage across region.
- January 2-15, 1999: Blizzard, snowstorm. Declaration of emergency by President.
- December 11-31, 2000: Blizzard, snowstorm. Declaration of emergency by President.
- April 3, 2003: Ice storm. $4.9m property damage throughout West Michigan.
- February 16, 2006: Ice storm. $1m property damage across Lower Michigan.

2. TECHNOLOGICAL HAZARDS

2.01 Dam Failure:

- Four documented failures in Muskegon County, unidentified locations.

2.02 Energy Emergencies:

- February 2003: A break in a major transmission line caused an electrical blackout over parts of Montcalm, Oceana, Newaygo, Muskegon, and Kent counties.

2.03 Fire - Scrap Tire:

- Approximate scrap tire inventory in Muskegon County in 2012: 4,400.

2.04 Fire - Structural:

- County fire rate per 1,000 population in 1998: 3.8.
- ***1900: Major business district fires in Fruitport and Ravenna.***

2.05 Hazard Material Incidents - Fixed Site (including industrial accidents):

- SARA Title III Sites in Muskegon County in 2012: 51.

2.06 Hazard Material Incidents - Transportation: - None Identified.

2.07 Infrastructure Failure:

- Number of NCDC records with mention of downed power lines or power outages in Muskegon County, 1993-2012: 45
- Number of sanitary sewer overflows in Muskegon County, 2000-2011: 47.
- August 8, 1993: 4,400 without power (thunderstorm winds), Muskegon and Oceana counties
- March 9, 1998: 1,900 power outages (blizzard conditions), Lake, Clare, Oceana and Muskegon counties.
- May 29-30, 1998: 54,000 without power; 27,000 on second day (thunderstorm winds), Muskegon County.
- May 31, 1998: 50,000 without power (thunderstorm winds), Muskegon County.
- July 21, 1998: 7,500 without power (thunderstorm winds and lightning), Muskegon County.
- August 9, 2009: Village of Fruitport and much of southern Muskegon County without power (thunderstorm winds).

2.08 Nuclear Power Plant Emergencies: - None Identified.

2.09 Oil and Natural Gas Well Accidents:

- Oil and gas wells in Muskegon County in 2012: 1,090.

2.10 Pipeline Accidents: - None Identified.

2.11 Transportation Accidents: - None Identified.

3. HUMAN -RELATED HAZARDS

3.01 Catastrophic Incidents (National Emergencies):

- 1939-1945: World War II. In Muskegon, 48-hour minimum work weeks, rationing of certain food and goods, and 274 county men killed in battle.
- 2005: Hurricanes Katrina and Rita. Declarations of Gubernatorial Disaster and Presidential Emergency were issued in Michigan in September 2005 for hurricane evacuation.

3.02 Civil Disturbances: - None Identified.

3.03 Nuclear Attack: - None Identified.

3.04 Public Health Emergencies:

- 1913: Diphtheria Epidemic.
- 1916: Small pox and scarlet fever force closures of schools and businesses.
- 1918: Influenza epidemic closes theaters, dance halls, and churches.
- 1937: Children under 18 banned from theaters and schools close from fear of polio outbreak.
- 1941: Influenza epidemic cuts school attendance by 60%.
- 2009: H1N1 influenza pandemic causes school absences spike in the fall. Two county residents die from complications.

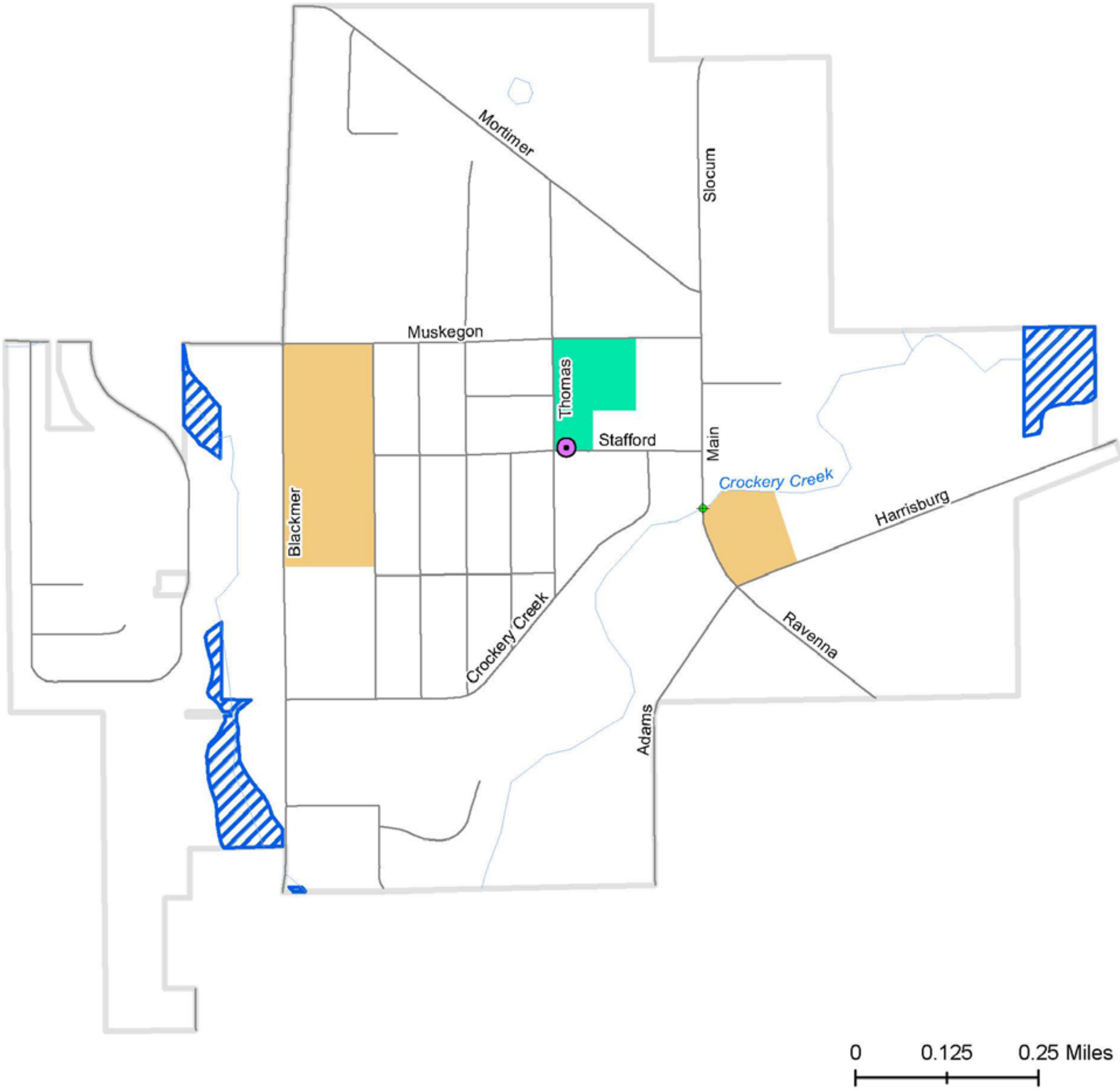
3.05 Terrorism and Similar Criminal Activities: - None Identified.

	Village of Ravenna Hazard Rating	Probability of Occurrence	Impact on People	Impact on Property	Impact on Economy	Impacts Total	Hazard Score
1.01	Celestial Impacts	1	2	0	2	8	8
1.02	Drought	2	2	1	2	10	20
1.03	Earthquake	0	-	-	-	-	-
1.04	Extreme Temperatures	3	2	1	1	9	27
1.05	Flooding: Riverine/Urban	3	1	2	1	8	24
1.06	Fog	2	1	0	1	4	8
1.07	Great Lakes Shoreline	0	-	-	-	-	-
1.08	Hail	2	2	1	1	9	18
1.09	Invasive Species	2	1	1	1	6	12
1.10	Lightning	3	1	2	1	8	24
1.11	Severe Winds	3	2	2	2	12	36
1.12	Subsidence	1	1	1	1	6	6
1.13	Tornadoes	1	3	2	2	15	15
1.14	Wildfire	2	1	2	1	8	16
1.15	Winter Storms	3	3	2	2	15	45
2.01	Dam failure	0	-	-	-	-	-
2.02	Energy Emergencies	2	2	0	2	8	16
2.03	Fire – Scrap Tires	1	1	1	1	6	6
2.04	Fire – Structural	3	1	2	3	10	30
2.05	HAZMAT – Fixed Site	1	1	1	1	6	6
2.06	HAZMAT – Transportation	2	1	1	1	6	12
2.07	Infrastructure Failures	3	2	1	2	10	30
2.08	Nuclear Power Emergencies	0	-	-	-	-	-
2.09	Oil/Natural Gas Well Accidents	0	-	-	-	-	-
2.10	Pipeline Accidents	0	-	-	-	-	-
2.11	Transportation Accidents	2	1	1	1	6	12
3.01	Catastrophic Incidents	1	3	3	3	18	18
3.02	Civil Disturbances	1	1	1	1	6	6
3.03	Nuclear Attack	0	-	-	-	-	-
3.04	Public Health Emergencies	2	2	0	3	9	18
3.05	Terrorism & Similar Criminal Acts	1	1	1	1	6	6

Village of Ravenna Hazard Ranking

		Probability of Occurrence	X Impacts Total	= Hazard Score
1	Winter Storms	3	15	45
2	Severe Winds	3	12	36
3	Fire – Structural	3	10	30
3	Infrastructure Failures	3	10	30
5	Extreme Temperatures	3	9	27
6	Flooding: Riverine/Urban	3	8	24
6	Lightning	3	8	24
8	Drought	2	10	20
9	Catastrophic Incidents	1	18	18
9	Hail	2	9	18
9	Public Health Emergencies	2	9	18
12	Energy Emergencies	2	8	16
12	Wildfire	2	8	16
14	Tornadoes	1	15	15
15	HAZMAT – Transportation	2	6	12
15	Invasive Species	2	6	12
15	Transportation Accidents	2	6	12
18	Celestial Impacts	1	8	8
18	Fog	2	4	8
20	Civil Disturbances	1	6	6
20	Fire – Scrap Tires	1	6	6
20	HAZMAT – Fixed Site	1	6	6
20	Subsidence	1	6	6
20	Terrorism & Similar Criminal Acts	1	6	6
	Dam Failure	0	-	-
	Earthquake	0	-	-
	Great Lakes Shoreline	0	-	-
	Nuclear Attack	0	-	-
	Nuclear Power Emergencies	0	-	-
	Oil/Natural Gas Well Accidents	0	-	-
	Pipeline Accidents	0	-	-

VILLAGE OF RAVENNA
Critical Facilities and Potential Hazards



Note: This jurisdiction is subject to many additional hazards; some of which tend to occur across wide areas and cannot be effectively shown on this map.Refer to **Appendix B- Hazard Identifications and Analyses** for more complete information about potential hazards in this community.

- Street
- Bridge
- School
- Municipal Land
- School Property
- Floodplain

WMSRDC
WEST MICHIGAN SHORELINE REGIONAL DEVELOPMENT COMMISSION

Source: Michigan Geographic Data Library V 12b, Muskegon Co. Hazard Mitigation Plan Update 2014

Hazard Identification Profile
Blue Lake Township

1. NATURAL HAZARDS

1.01 Celestial Impacts: - None Identified.

1.02 Drought:

- 12 recorded drought events in the area (including Lake, Mason, Muskegon, Newaygo, and Oceana counties) lasting eight months or greater: 1895-1896, 1899-1900, 1901-1902, 1909-1911, 1925-1926, 1930-1931, 1956-1957, 1962-1963, 1971-1972, 1976-1977, and 2002-2003.
- Summer 1871: Prolonged drought over much of the Great Lakes region.
- May-September, 1891: Drought devastated Michigan's lumber industry.
- 2013: Record low Lake Michigan water levels.

1.03 Earthquake: - None Identified.

1.04 Extreme Temperatures:

- July 1936: Heatwave. 570 deaths statewide, 7 in Muskegon.
- Summer, 1988: 39 days with temperatures over 90 degrees, statewide.
- January 13-20, 1994: Record cold. $50m property damage across Michigan.
- December 9-10, 1995: Coldwave across Lower Michigan.
- March 2012: Record warm temperatures triggered early growing season. $209.8m crop damage across Michigan.

1.05 Flooding - Riverine/ Urban:

- August 20 - September 6, 1975: Flooding. Declaration of major disaster by President.
- February 21, 1986: Great lakes flooding and wave action. Declaration of disaster by Governor.
- September 10-19, 1986: Flooding. Declaration of major disaster by President.
- September, 1986: Flooding & heavy rain. Declaration of disaster by Governor.
- May 18-20, 2000: Flood. $100k property damage, $50k crop damage in Muskegon County.
- February 9-10, 2001: Flooding. $100k property damage across West Michigan.
- February 24-28, 2001: Flooding. $190k property damage across West Michigan.
- May 15-16, 2001: Flooding. $500k property damage, $200k crop damage across southwestern Lower Michigan.
- May 20-24, 2004: Flooding. Declaration of major disaster by President.
- April 17-23, 2013: Flooding. Declaration of major disaster by President. $5m property damage, Muskegon County.

1.06 Fog:

- January 11-13, 1995: Dense Fog. 4 traffic accident fatalities, school closures, and flight delays across Lower Michigan.

1.07 Great Lakes Shoreline Hazards: - None Identified.

1.08 Hail:

- Days with severe hail reported (1" or greater) recorded in Muskegon County, 2000-2012: 7
- May 15, 2001: 0.75-1.00 inch hail. $95k property damage, $95k crop damage across Muskegon County.
- August 3, 2003: 1.75 inch hail in Muskegon Twp, $55k property damage and $25k crop damage from hail countywide.

1.09 Invasive Species: - Invasive species exist in Muskegon County; No significant events identified.

1.10 Lightning:

- July 20, 1994: Lightning killed a dog and caused $50k property damage, Muskegon County.

1.11 Severe Winds:

- August 20 - September 6, 1975: Rainstorms, high winds. Declaration of major disaster by President.
- November 18, 1994: High wind. $1m property damage statewide.
- April 6, 1997: High wind. $5m property damage across southwest Lower Michigan.
- May 29, 1998: Severe thunderstorm winds. 54,000 homes and businesses without power; estimated 500 homes and 30 businesses sustained minor to moderate damage. $1m property damage, Muskegon County.
- May 31, 1998: Thunderstorms & high winds. Declarations of disaster by Governor and major disaster by President. $2,458,958 in public damage costs, 42 homes destroyed, 1,805 homes damaged, 5 businesses destroyed, and 73 businesses damaged. Total public and private costs have been estimated at $24,205,908.
- August 22, 2000: Severe thunderstorm winds. $150k property damage, Muskegon County.
- March 9, 2002: High wind. $485k property damage across southwest Lower Michigan.
- October 30, 2004: High wind. $1.15m property damage across southwest Lower Michigan.
- May 20-24, 2004: Severe storms. Declaration of major disaster by President.
- August 9, 2009: Severe thunderstorm winds. $2m property damage, Muskegon County.
- November 17, 2013: Severe thunderstorm winds. $200k property damage, Muskegon County.

1.12 Subsidence: - None Identified.

1.13 Tornadoes:

- Number of tornadoes in Muskegon County, 1950-2012: 7.

1.14 Wildfire:

- October 1871: Wildfires. 1.2m acres burned, 200 fatalities, Michigan's Lower Peninsula.
- May-September, 1891: Uncontrollable wildfires across Michigan during the drought of 1891.
- 1981-2010: Approximately 8 wildfires and 89 acres burned per year on county lands under MDNR jurisdiction (251 total wildfires, 2,676.0 total acres burned).

1.15 Winter Storms:

- March 2-7, 1976: Ice storms. Declaration of major disaster by President.
- January 26-31, 1977: Blizzard, snowstorm. Declaration of emergency by President.
- January 26-27, 1978: Blizzard, snowstorm. Declaration of statewide emergency by President.
- January 12, 1993: Heavy snow. $50k property damage, northern Lower Michigan.
- January 12-21, 1994: Heavy lake effect snow. $500k property damage across western Lower Michigan.
- January 27, 1994: Heavy snow and freezing rain. $5m property damage across region.
- October 26, 1997: Heavy snow. $1.2m property damage across southwestern Lower Michigan.
- March 9, 1998: Winter storm. $100k property damage across region.
- January 2-15, 1999: Blizzard, snowstorm. Declaration of emergency by President.
- December 11-31, 2000: Blizzard, snowstorm. Declaration of emergency by President.
- April 3, 2003: Ice storm. $4.9m property damage throughout West Michigan.
- February 16, 2006: Ice storm. $1m property damage across Lower Michigan.

2. TECHNOLOGICAL HAZARDS

2.01 Dam Failure:

- Four documented failures in Muskegon County, unidentified locations.

2.02 Energy Emergencies:

- February 2003: A break in a major transmission line caused an electrical blackout over parts of Montcalm, Oceana, Newaygo, Muskegon, and Kent counties.

2.03 Fire - Scrap Tire:

- Approximate scrap tire inventory in Muskegon County in 2012: 4,400.

2.04 Fire - Structural:

- County fire rate per 1,000 population in 1998: 3.8.

2.05 Hazard Material Incidents - Fixed Site (including industrial accidents):

- SARA Title III Sites in Muskegon County in 2012: 51.

2.06 Hazard Material Incidents - Transportation: - None Identified.

2.07 Infrastructure Failure:

- Number of NCDC with mention of downed power lines or power outages in Muskegon County, 1993-2012: 45
- Number of sanitary sewer overflows in Muskegon County, 2000-2011: 47.
- August 8, 1993: 4,400 without power (thunderstorm winds), Muskegon and Oceana counties
- March 9, 1998: 1,900 power outages (blizzard conditions), Lake, Clare, Oceana and Muskegon counties.
- May 29-30, 1998: 54,000 without power; 27,000 on second day (thunderstorm winds), Muskegon County.
- May 31, 1998: 50,000 without power (thunderstorm winds), Muskegon County.
- July 21, 1998: 7,500 without power (thunderstorm winds and lightning), Muskegon County.

2.08 Nuclear Power Plant Emergencies: - None Identified.

2.09 Oil and Natural Gas Well Accidents:

- Oil and gas wells in Muskegon County in 2012: 1,090.
- ***1 well with known detectable levels of hydrogen sulfide in Blue Lake Township.***

2.10 Pipeline Accidents: - None Identified.

2.11 Transportation Accidents: - None Identified.

3. HUMAN -RELATED HAZARDS

3.01 Catastrophic Incidents (National Emergencies):

- 1939-1945: World War II. In Muskegon, 48-hour minimum work weeks, rationing of certain food and goods, and 274 county men killed in battle.
- 2005: Hurricanes Katrina and Rita. Declarations of Gubernatorial Disaster and Presidential Emergency were issued in Michigan in September 2005 for hurricane evacuation.

3.02 Civil Disturbances: - None Identified.

3.03 Nuclear Attack: - None Identified.

3.04 Public Health Emergencies:

- 1913: Diphtheria Epidemic.
- 1916: Small pox and scarlet fever force closures of schools and businesses.
- 1918: Influenza epidemic closes theaters, dance halls, and churches.
- 1937: Children under 18 banned from theaters and schools close from fear of polio outbreak.
- 1941: Influenza epidemic cuts school attendance by 60%.
- 2009: H1N1 influenza pandemic causes school absences spike in the fall. Two county residents die from complications.

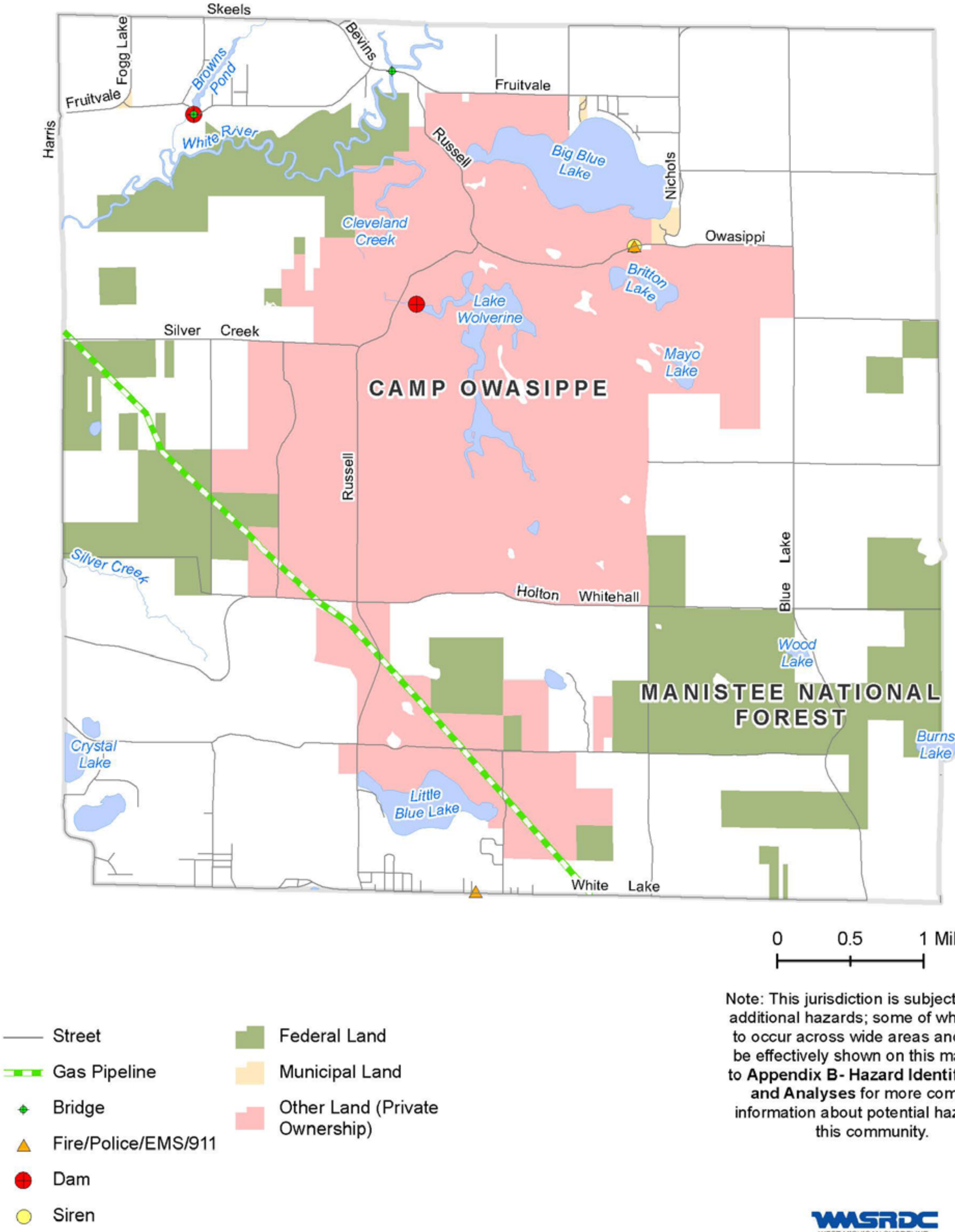
3.05 Terrorism and Similar Criminal Activities: - None Identified.

	Blue Lake Township Hazard Rating	Probability of Occurrence	Impact on People	Impact on Property	Impact on Economy	Impacts Total	Hazard Score
1.01	Celestial Impacts	1	2	0	2	8	8
1.02	Drought	2	2	1	2	10	20
1.03	Earthquake	0	-	-	-	-	-
1.04	Extreme Temperatures	3	2	1	1	9	27
1.05	Flooding: Riverine/Urban	3	1	1	1	6	18
1.06	Fog	2	1	0	1	4	8
1.07	Great Lakes Shoreline	0	-	-	-	-	-
1.08	Hail	2	2	1	1	9	18
1.09	Invasive Species	2	1	1	1	6	12
1.10	Lightning	3	1	2	1	8	24
1.11	Severe Winds	3	2	2	2	12	36
1.12	Subsidence	1	1	1	1	6	6
1.13	Tornadoes	1	2	2	2	12	12
1.14	Wildfire	3	1	2	2	9	27
1.15	Winter Storms	3	3	2	2	15	45
2.01	Dam failure	2	1	2	2	9	18
2.02	Energy Emergencies	2	2	0	2	8	16
2.03	Fire – Scrap Tires	1	1	1	1	6	6
2.04	Fire – Structural	3	1	2	3	10	30
2.05	HAZMAT – Fixed Site	0	-	-	-	-	-
2.06	HAZMAT – Transportation	2	1	1	1	6	12
2.07	Infrastructure Failures	3	2	1	2	10	30
2.08	Nuclear Power Emergencies	0	-	-	-	-	-
2.09	Oil/Natural Gas Well Accidents	2	1	1	1	6	12
2.10	Pipeline Accidents	1	1	1	2	7	7
2.11	Transportation Accidents	2	1	1	1	6	12
3.01	Catastrophic Incidents	1	3	3	3	18	18
3.02	Civil Disturbances	1	1	1	1	6	6
3.03	Nuclear Attack	0	-	-	-	-	-
3.04	Public Health Emergencies	2	2	0	3	9	18
3.05	Terrorism & Similar Criminal Acts	1	1	1	1	6	6

Blue Lake Township Hazard Ranking

Rank	Hazard	Probability of Occurrence	X Impacts Total	= Hazard Score
1	Winter Storms	3	15	45
2	Severe Winds	3	12	36
3	Fire – Structural	3	10	30
3	Infrastructure Failures	3	10	30
5	Extreme Temperatures	3	9	27
5	Wildfire	3	9	27
7	Lightning	3	8	24
8	Drought	2	10	20
9	Catastrophic Incidents	1	18	18
9	Dam Failure	2	9	18
9	Flooding: Riverine/Urban	3	6	18
9	Hail	2	9	18
9	Public Health Emergencies	2	9	18
14	Energy Emergencies	2	8	16
15	HAZMAT – Transportation	2	6	12
15	Invasive Species	2	6	12
15	Oil/Natural Gas Well Accidents	2	6	12
15	Tornadoes	1	12	12
15	Transportation Accidents	2	6	12
20	Celestial Impacts	1	8	8
20	Fog	2	4	8
22	Pipeline Accidents	1	7	7
23	Civil Disturbances	1	6	6
23	Fire – Scrap Tires	1	6	6
23	Subsidence	1	6	6
23	Terrorism & Similar Criminal Acts	1	6	6
	Earthquake	0	-	-
	Great Lakes Shoreline	0	-	-
	HAZMAT – Fixed Site	0	-	-
	Nuclear Power Emergencies	0	-	-
	Nuclear Attack	0	-	-

BLUE LAKE TOWNSHIP
Critical Facilities and Potential Hazards



Note: This jurisdiction is subject to many additional hazards; some of which tend to occur across wide areas and cannot be effectively shown on this map.Refer to **Appendix B- Hazard Identifications and Analyses** for more complete information about potential hazards in this community.

WMSRDC
WEST MICHIGAN SHORELINE REGIONAL DEVELOPMENT COMMISSION

Source: Michigan Geographic Data Library V 12b, Muskegon Co. Hazard Mitigation Plan Update 2014

Hazard Identification Profile
Casnovia Township

1. NATURAL HAZARDS

1.01 Celestial Impacts: - None Identified.

1.02 Drought:

- 12 recorded drought events in the area (including Lake, Mason, Muskegon, Newaygo, and Oceana counties) lasting eight months or greater: 1895-1896, 1899-1900, 1901-1902, 1909-1911, 1925-1926, 1930-1931, 1956-1957, 1962-1963, 1971-1972, 1976-1977, and 2002-2003.
- Summer 1871: Prolonged drought over much of the Great Lakes region.
- May-September, 1891: Drought devastated Michigan's lumber industry.
- 2013: Record low Lake Michigan water levels.

1.03 Earthquake: - None Identified.

1.04 Extreme Temperatures:

- July 1936: Heatwave. 570 deaths statewide, 7 in Muskegon.
- Summer, 1988: 39 days with temperatures over 90 degrees, statewide.
- January 13-20, 1994: Record cold. $50m property damage across Michigan.
- December 9-10, 1995: Coldwave across Lower Michigan.
- March 2012: Record warm temperatures triggered early growing season. $209.8m crop damage across Michigan.

1.05 Flooding - Riverine/ Urban:

- August 20 - September 6, 1975: Flooding. Declaration of major disaster by President.
- February 21, 1986: Great lakes flooding and wave action. Declaration of disaster by Governor.
- September 10-19, 1986: Flooding. Declaration of major disaster by President.
- September, 1986: Flooding & heavy rain. Declaration of disaster by Governor.
- May 18-20, 2000: Flood. $100k property damage, $50k crop damage in Muskegon County.
- February 9-10, 2001: Flooding. $100k property damage across West Michigan.
- February 24-28, 2001: Flooding. $190k property damage across West Michigan.
- May 15-16, 2001: Flooding. $500k property damage, $200k crop damage across southwestern Lower Michigan.
- May 20-24, 2004: Flooding. Declaration of major disaster by President.
- April 17-23, 2013: Flooding. Declaration of major disaster by President. $5m property damage, Muskegon County.

1.06 Fog:

- January 11-13, 1995: Dense Fog. 4 traffic accident fatalities, school closures, and flight delays across Lower Michigan.

1.07 Great Lakes Shoreline Hazards: - None Identified.

1.08 Hail:

- Days with severe hail reported (1" or greater) recorded in Muskegon County, 2000-2012: 7
- May 15, 2001: 0.75-1.00 inch hail. $95k property damage, $95k crop damage across Muskegon County.
- August 3, 2003: 1.75 inch hail in Muskegon Twp, $55k property damage and $25k crop damage from hail countywide.

1.09 Invasive Species: - Invasive species exist in Muskegon County; No significant events identified.

1.10 Lightning: - July 20, 1994: Lightning killed a dog and caused $50k property damage, Muskegon County.

1.11 Severe Winds:

- August 20 - September 6, 1975: Rainstorms, high winds. Declaration of major disaster by President.
- November 18, 1994: High wind. $1m property damage statewide.
- April 6, 1997: High wind. $5m property damage across southwest Lower Michigan.
- May 29, 1998: Severe thunderstorm winds. 54,000 homes and businesses without power; estimated 500 homes and 30 businesses sustained minor to moderate damage. $1m property damage, Muskegon County.
- May 31, 1998: Thunderstorms & high winds. Declarations of disaster by Governor and major disaster by President. $2,458,958 in public damage costs, 42 homes destroyed, 1,805 homes damaged, 5 businesses destroyed, and 73 businesses damaged. Total public and private costs have been estimated at $24,205,908.
- August 22, 2000: Severe thunderstorm winds. $150k property damage, Muskegon County.
- March 9, 2002: High wind. $485k property damage across southwest Lower Michigan.
- October 30, 2004: High wind. $1.15m property damage across southwest Lower Michigan.
- May 20-24, 2004: Severe storms. Declaration of major disaster by President.
- August 9, 2009: Severe thunderstorm winds. $2m property damage, Muskegon County.
- November 17, 2013: Severe thunderstorm winds. $200k property damage, Muskegon County.

1.12 Subsidence: - None Identified.

1.13 Tornadoes:

- Number of tornadoes in Muskegon County, 1950-2012: 7.
- ***November 17, 2013: Tornado (EF0). $50k property damage, Casnovia Township.***

1.14 Wildfire:

- October 1871: Wildfires. 1.2m acres burned, 200 fatalities, Michigan's Lower Peninsula.
- May-September, 1891: Uncontrollable wildfires across Michigan during the drought of 1891.
- 1981-2010: Approximately 8 wildfires and 89 acres burned per year on county lands under MDNR jurisdiction (251 total wildfires, 2,676.0 total acres burned).

1.15 Winter Storms:

- March 2-7, 1976: Ice storms. Declaration of major disaster by President.
- January 26-31, 1977: Blizzard, snowstorm. Declaration of emergency by President.
- January 26-27, 1978: Blizzard, snowstorm. Declaration of statewide emergency by President.
- January 12, 1993: Heavy snow. $50k property damage, northern Lower Michigan.
- January 12-21, 1994: Heavy lake effect snow. $500k property damage across western Lower Michigan.
- January 27, 1994: Heavy snow and freezing rain. $5m property damage across region.
- October 26, 1997: Heavy snow. $1.2m property damage across southwestern Lower Michigan.
- March 9, 1998: Winter storm. $100k property damage across region.
- January 2-15, 1999: Blizzard, snowstorm. Declaration of emergency by President.
- December 11-31, 2000: Blizzard, snowstorm. Declaration of emergency by President.
- April 3, 2003: Ice storm. $4.9m property damage throughout West Michigan.
- February 16, 2006: Ice storm. $1m property damage across Lower Michigan.

2. TECHNOLOGICAL HAZARDS

2.01 Dam Failure:

- Four documented failures in Muskegon County, unidentified locations.

2.02 Energy Emergencies:

- February 2003: A break in a major transmission line caused an electrical blackout over parts of Montcalm, Oceana, Newaygo, Muskegon, and Kent counties.

2.03 Fire - Scrap Tire:

- Approximate scrap tire inventory in Muskegon County in 2012: 4,400.

2.04 Fire - Structural:

- County fire rate per 1,000 population in 1998: 3.8.

2.05 Hazard Material Incidents - Fixed Site (including industrial accidents):

- SARA Title III Sites in Muskegon County in 2012: 51.

2.06 Hazard Material Incidents - Transportation: - None Identified.

2.07 Infrastructure Failure:

- Number of NCDC with mention of downed power lines or power outages in Muskegon County, 1993-2012: 45
- Number of sanitary sewer overflows in Muskegon County, 2000-2011: 47.
- August 8, 1993: 4,400 without power (thunderstorm winds), Muskegon and Oceana counties
- March 9, 1998: 1,900 power outages (blizzard conditions), Lake, Clare, Oceana and Muskegon counties.
- May 29-30, 1998: 54,000 without power; 27,000 on second day (thunderstorm winds), Muskegon County.
- May 31, 1998: 50,000 without power (thunderstorm winds), Muskegon County.
- July 21, 1998: 7,500 without power (thunderstorm winds and lightning), Muskegon County.

2.08 Nuclear Power Plant Emergencies: - None Identified.

2.09 Oil and Natural Gas Well Accidents:

- Oil and gas wells in Muskegon County in 2012: 1,090.

2.10 Pipeline Accidents: - None Identified.

2.11 Transportation Accidents: - None Identified.

3. HUMAN -RELATED HAZARDS

3.01 Catastrophic Incidents (National Emergencies):

- 1939-1945: World War II. In Muskegon, 48-hour minimum work weeks, rationing of certain food and goods, and 274 county men killed in battle.
- 2005: Hurricanes Katrina and Rita. Declarations of Gubernatorial Disaster and Presidential Emergency were issued in Michigan in September 2005 for hurricane evacuation.

3.02 Civil Disturbances: - None Identified.

3.03 Nuclear Attack: - None Identified.

3.04 Public Health Emergencies:

- 1913: Diphtheria Epidemic.
- 1916: Small pox and scarlet fever force closures of schools and businesses.
- 1918: Influenza epidemic closes theaters, dance halls, and churches.
- 1937: Children under 18 banned from theaters and schools close from fear of polio outbreak.
- 1941: Influenza epidemic cuts school attendance by 60%.
- 2009: H1N1 influenza pandemic causes school absences spike in the fall. Two county residents die from complications.

3.05 Terrorism and Similar Criminal Activities: - None Identified.

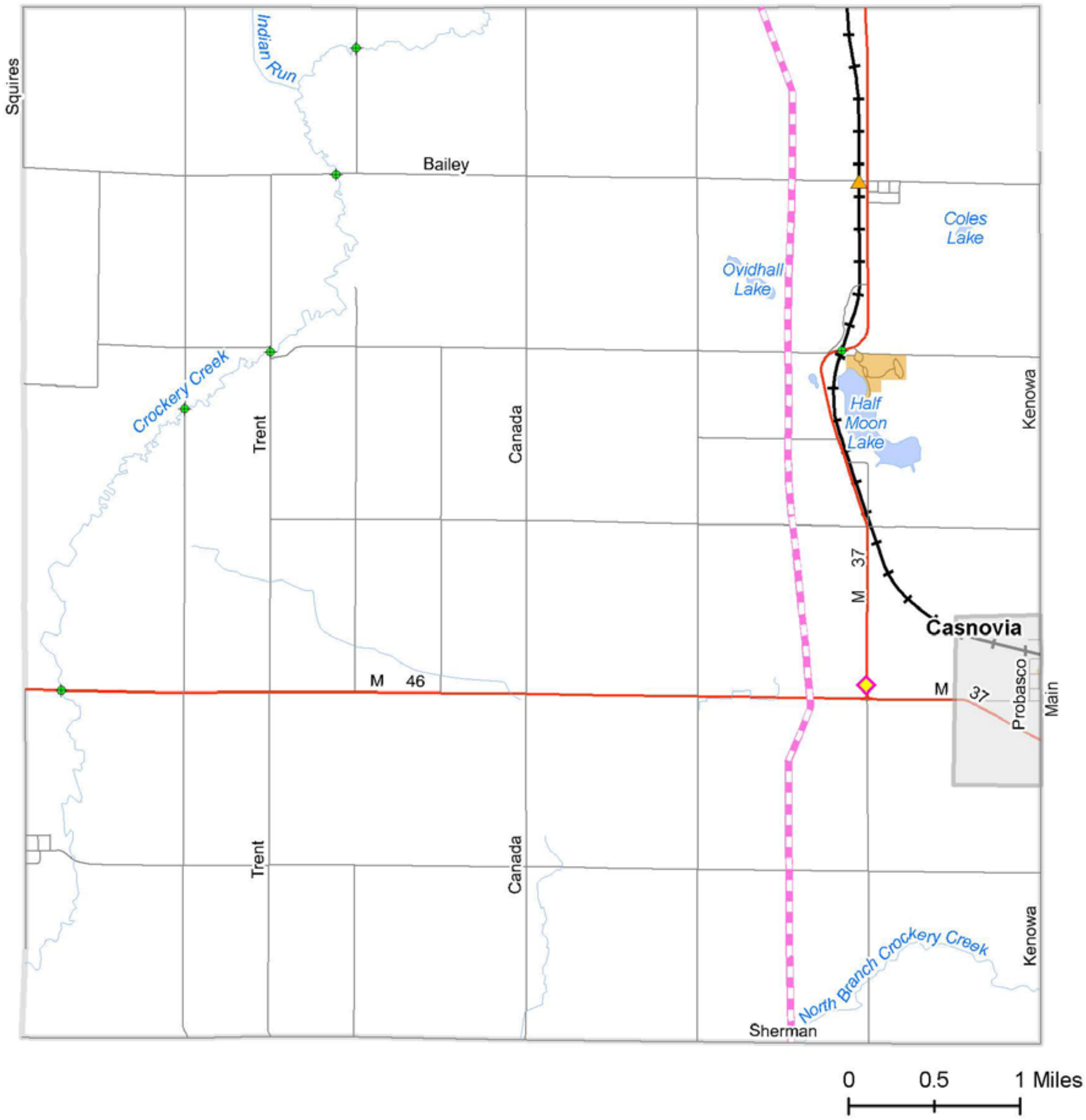
	Casnovia Township Hazard Rating	Probability of Occurrence	Impact on People	Impact on Property	Impact on Economy	Impacts Total	Hazard Score
1.01	Celestial Impacts	1	2	0	2	8	8
1.02	Drought	2	2	2	2	12	24
1.03	Earthquake	0	-	-	-	-	-
1.04	Extreme Temperatures	3	2	1	2	10	30
1.05	Flooding: Riverine/Urban	2	1	1	1	6	12
1.06	Fog	2	1	0	1	4	8
1.07	Great Lakes Shoreline	0	-	-	-	-	-
1.08	Hail	2	2	1	1	9	18
1.09	Invasive Species	2	1	1	2	7	14
1.10	Lightning	3	1	2	1	8	24
1.11	Severe Winds	3	2	2	2	12	36
1.12	Subsidence	1	1	1	1	6	6
1.13	Tornadoes	1	2	2	2	12	12
1.14	Wildfire	2	1	2	1	8	16
1.15	Winter Storms	3	3	2	2	15	45
2.01	Dam failure	0	-	-	-	-	-
2.02	Energy Emergencies	2	2	0	2	8	16
2.03	Fire – Scrap Tires	1	1	1	1	6	6
2.04	Fire – Structural	3	1	2	2	9	27
2.05	HAZMAT – Fixed Site	2	1	1	2	7	14
2.06	HAZMAT – Transportation	3	1	1	1	6	18
2.07	Infrastructure Failures	3	2	1	2	10	30
2.08	Nuclear Power Emergencies	0	-	-	-	-	-
2.09	Oil/Natural Gas Well Accidents	2	1	1	1	6	12
2.10	Pipeline Accidents	0	-	-	-	-	-
2.11	Transportation Accidents	2	1	1	2	7	14
3.01	Catastrophic Incidents	1	3	3	3	18	18
3.02	Civil Disturbances	1	1	1	1	6	6
3.03	Nuclear Attack	0	-	-	-	-	-
3.04	Public Health Emergencies	2	2	0	3	9	18
3.05	Terrorism & Similar Criminal Acts	1	1	1	1	6	6

Casnovia Township Hazard Ranking

Probability of Occurrence X Impacts Total = Hazard Score

		Probability of Occurrence	Impacts Total	Hazard Score
1	Winter Storms	3	15	45
2	Severe Winds	3	12	36
3	Extreme Temperatures	3	10	30
3	Infrastructure Failures	3	10	30
5	Fire – Structural	3	9	27
6	Drought	2	12	24
6	Lightning	3	8	24
8	Catastrophic Incidents	1	18	18
8	Hail	2	9	18
8	HAZMAT – Transportation	3	6	18
8	Public Health Emergencies	2	9	18
12	Energy Emergencies	2	8	16
12	Wildfire	2	8	16
14	HAZMAT – Fixed Site	2	7	14
14	Invasive Species	2	7	14
14	Transportation Accidents	2	7	14
17	Flooding: Riverine/Urban	2	6	12
17	Oil/Natural Gas Well Accidents	2	6	12
17	Tornadoes	1	12	12
20	Celestial Impacts	1	8	8
20	Fog	2	4	8
22	Civil Disturbances	1	6	6
22	Fire – Scrap Tires	1	6	6
22	Subsidence	1	6	6
22	Terrorism & Similar Criminal Acts	1	6	6
	Earthquake	0	-	-
	Great Lakes Shoreline	0	-	-
	Dam Failure	0	-	-
	Nuclear Power Emergencies	0	-	-
	Nuclear Attack	0	-	-
	Pipeline Accidents	0	-	-

CASNOVIA TOWNSHIP
Critical Facilities and Potential Hazards



- State Trunkline
- Street
- Railroad
- SARA Title III Site
- Power Line
- Bridge
- Fire/Police/EMS/911
- Municipal Land

Note: This jurisdiction is subject to many additional hazards; some of which tend to occur across wide areas and cannot be effectively shown on this map.Refer to **Appendix B- Hazard Identifications and Analyses** for more complete information about potential hazards in this community.

WMSRDC
WEST MICHIGAN SHORELINE REGIONAL DEVELOPMENT COMMISSION

Source: Michigan Geographic Data Library V 12b, Muskegon Co. Hazard Mitigation Plan Update 2014

Hazard Identification Profile
Cedar Creek Township

1. NATURAL HAZARDS

1.01 Celestial Impacts: - None Identified.

1.02 Drought:

- 12 recorded drought events in the area (including Lake, Mason, Muskegon, Newaygo, and Oceana counties) lasting eight months or greater: 1895-1896, 1899-1900, 1901-1902, 1909-1911, 1925-1926, 1930-1931, 1956-1957, 1962-1963, 1971-1972, 1976-1977, and 2002-2003.
- Summer 1871: Prolonged drought over much of the Great Lakes region.
- May-September, 1891: Drought devastated Michigan's lumber industry.
- 2013: Record low Lake Michigan water levels.

1.03 Earthquake: - None Identified.

1.04 Extreme Temperatures:

- July 1936: Heatwave. 570 deaths statewide, 7 in Muskegon.
- Summer, 1988: 39 days with temperatures over 90 degrees, statewide.
- January 13-20, 1994: Record cold. $50m property damage across Michigan.
- December 9-10, 1995: Coldwave across Lower Michigan.
- March 2012: Record warm temperatures triggered early growing season. $209.8m crop damage across Michigan.

1.05 Flooding - Riverine/ Urban:

- August 20 - September 6, 1975: Flooding. Declaration of major disaster by President.
- February 21, 1986: Great lakes flooding and wave action. Declaration of disaster by Governor.
- September 10-19, 1986: Flooding. Declaration of major disaster by President.
- September, 1986: Flooding & heavy rain. Declaration of disaster by Governor.
- May 18-20, 2000: Flood. $100k property damage, $50k crop damage in Muskegon County.
- February 9-10, 2001: Flooding. $100k property damage across West Michigan.
- February 24-28, 2001: Flooding. $190k property damage across West Michigan.
- May 15-16, 2001: Flooding. $500k property damage, $200k crop damage across southwestern Lower Michigan.
- May 20-24, 2004: Flooding. Declaration of major disaster by President.
- April 17-23, 2013: Flooding. Declaration of major disaster by President. $5m property damage, Muskegon County.

1.06 Fog:

- January 11-13, 1995: Dense Fog. 4 traffic accident fatalities, school closures, and flight delays across Lower Michigan.

1.07 Great Lakes Shoreline Hazards: - None Identified.

1.08 Hail:

- Days with severe hail reported (1" or greater) recorded in Muskegon County, 2000-2012: 7
- May 15, 2001: 0.75-1.00 inch hail. $95k property damage, $95k crop damage across Muskegon County.
- August 3, 2003: 1.75 inch hail in Muskegon Twp, $55k property damage and $25k crop damage from hail countywide.

1.09 Invasive Species: - Invasive species exist in Muskegon County; No significant events identified.

1.10 Lightning:

- July 20, 1994: Lightning killed a dog and caused $50k property damage, Muskegon County.

1.11 Severe Winds:

- August 20 - September 6, 1975: Rainstorms, high winds. Declaration of major disaster by President.
- November 18, 1994: High wind. $1m property damage statewide.
- April 6, 1997: High wind. $5m property damage across southwest Lower Michigan.
- May 29, 1998: Severe thunderstorm winds. 54,000 homes and businesses without power; estimated 500 homes and 30 businesses sustained minor to moderate damage. $1m property damage, Muskegon County.
- May 31, 1998: Thunderstorms & high winds. Declarations of disaster by Governor and major disaster by President. $2,458,958 in public damage costs, 42 homes destroyed, 1,805 homes damaged, 5 businesses destroyed, and 73 businesses damaged. Total public and private costs have been estimated at $24,205,908.
- August 22, 2000: Severe thunderstorm winds. $150k property damage, Muskegon County.
- March 9, 2002: High wind. $485k property damage across southwest Lower Michigan.
- October 30, 2004: High wind. $1.15m property damage across southwest Lower Michigan.
- May 20-24, 2004: Severe storms. Declaration of major disaster by President.
- August 9, 2009: Severe thunderstorm winds. $2m property damage, Muskegon County.
- November 17, 2013: Severe thunderstorm winds. $200k property damage, Muskegon County.

1.12 Subsidence: - None Identified.

1.13 Tornadoes:

- Number of tornadoes in Muskegon County, 1950-2012: 7.

1.14 Wildfire:

- October 1871: Wildfires. 1.2m acres burned, 200 fatalities, Michigan's Lower Peninsula.
- May-September, 1891: Uncontrollable wildfires across Michigan during the drought of 1891.
- 1981-2010: Approximately 8 wildfires and 89 acres burned per year on county lands under MDNR jurisdiction (251 total wildfires, 2,676.0 total acres burned).

1.15 Winter Storms:

- March 2-7, 1976: Ice storms. Declaration of major disaster by President.
- January 26-31, 1977: Blizzard, snowstorm. Declaration of emergency by President.
- January 26-27, 1978: Blizzard, snowstorm. Declaration of statewide emergency by President.
- January 12, 1993: Heavy snow. $50k property damage, northern Lower Michigan.
- January 12-21, 1994: Heavy lake effect snow. $500k property damage across western Lower Michigan.
- January 27, 1994: Heavy snow and freezing rain. $5m property damage across region.
- October 26, 1997: Heavy snow. $1.2m property damage across southwestern Lower Michigan.
- March 9, 1998: Winter storm. $100k property damage across region.
- January 2-15, 1999: Blizzard, snowstorm. Declaration of emergency by President.
- December 11-31, 2000: Blizzard, snowstorm. Declaration of emergency by President.
- April 3, 2003: Ice storm. $4.9m property damage throughout West Michigan.
- February 16, 2006: Ice storm. $1m property damage across Lower Michigan.

2. TECHNOLOGICAL HAZARDS

2.01 Dam Failure:

- Four documented failures in Muskegon County, unidentified locations.

2.02 Energy Emergencies:

- February 2003: A break in a major transmission line caused an electrical blackout over parts of Montcalm, Oceana, Newaygo, Muskegon, and Kent counties.

2.03 Fire - Scrap Tire:

- Approximate scrap tire inventory in Muskegon County in 2012: 4,400.

2.04 Fire - Structural:

- County fire rate per 1,000 population in 1998: 3.8.

2.05 Hazard Material Incidents - Fixed Site (including industrial accidents):

- SARA Title III Sites in Muskegon County in 2012: 51.

2.06 Hazard Material Incidents - Transportation: - None Identified.

2.07 Infrastructure Failure:

- Number of NCDC with mention of downed power lines or power outages in Muskegon County, 1993-2012: 45
- Number of sanitary sewer overflows in Muskegon County, 2000-2011: 47.
- August 8, 1993: 4,400 without power (thunderstorm winds), Muskegon and Oceana counties
- March 9, 1998: 1,900 power outages (blizzard conditions), Lake, Clare, Oceana and Muskegon counties.
- May 29-30, 1998: 54,000 without power; 27,000 on second day (thunderstorm winds), Muskegon County.
- May 31, 1998: 50,000 without power (thunderstorm winds), Muskegon County.
- July 21, 1998: 7,500 without power (thunderstorm winds and lightning), Muskegon County.

2.08 Nuclear Power Plant Emergencies: - None Identified.

2.09 Oil and Natural Gas Well Accidents:

- Oil and gas wells in Muskegon County in 2012: 1,090.

2.10 Pipeline Accidents: - None Identified.

2.11 Transportation Accidents: - None Identified.

3. HUMAN -RELATED HAZARDS

3.01 Catastrophic Incidents (National Emergencies):

- 1939-1945: World War II. In Muskegon, 48-hour minimum work weeks, rationing of certain food and goods, and 274 county men killed in battle.
- 2005: Hurricanes Katrina and Rita. Declarations of Gubernatorial Disaster and Presidential Emergency were issued in Michigan in September 2005 for hurricane evacuation.

3.02 Civil Disturbances: - None Identified.

3.03 Nuclear Attack: - None Identified.

3.04 Public Health Emergencies:

- 1913: Diphtheria Epidemic.
- 1916: Small pox and scarlet fever force closures of schools and businesses.
- 1918: Influenza epidemic closes theaters, dance halls, and churches.
- 1937: Children under 18 banned from theaters and schools close from fear of polio outbreak.
- 1941: Influenza epidemic cuts school attendance by 60%.
- 2009: H1N1 influenza pandemic causes school absences spike in the fall. Two county residents die from complications.

3.05 Terrorism and Similar Criminal Activities: - None Identified.

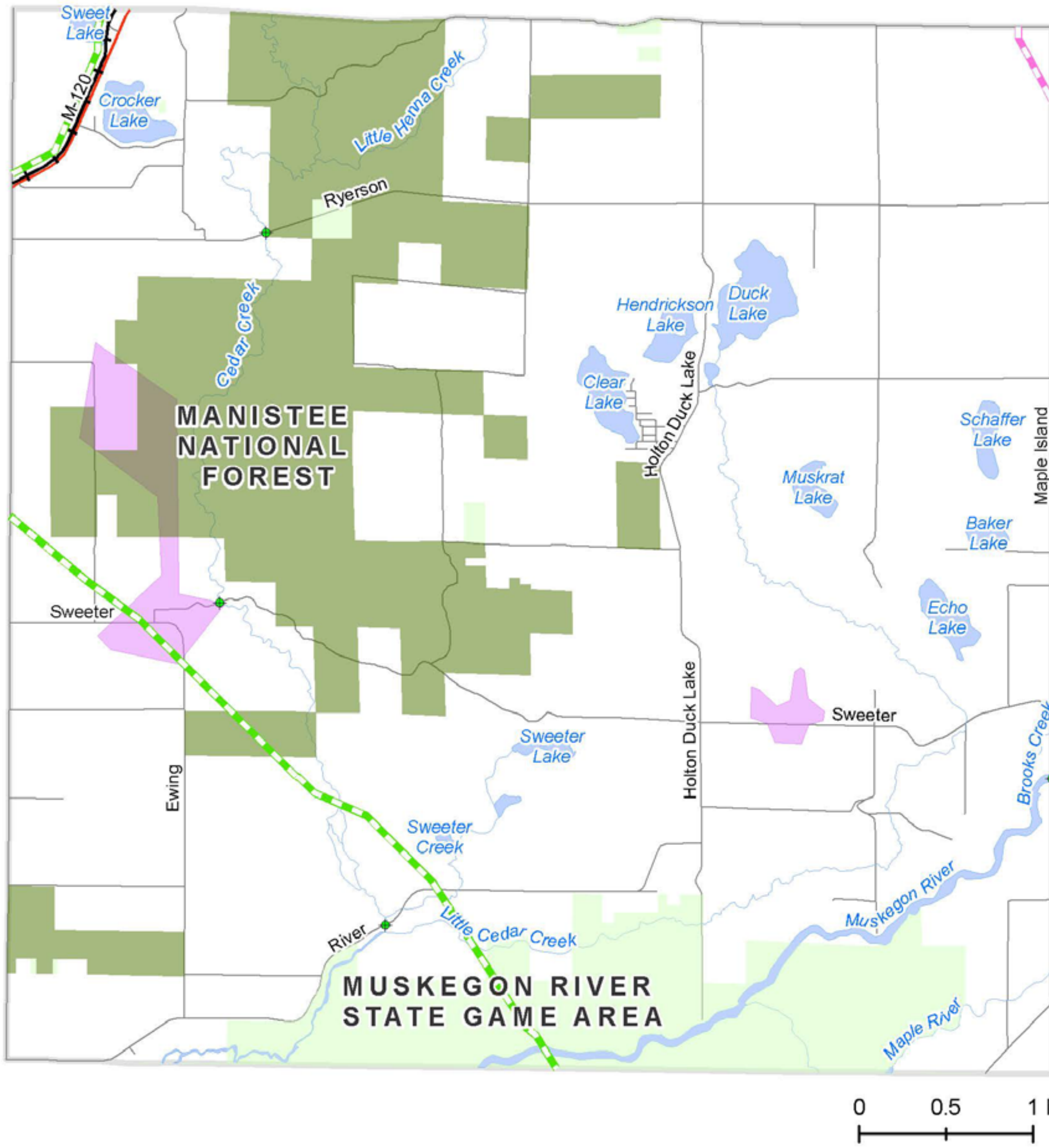
	Cedar Creek Township Hazard Rating	Probability of Occurrence	Impact on People	Impact on Property	Impact on Economy	Impacts Total	Hazard Score
1.01	Celestial Impacts	1	2	0	2	8	8
1.02	Drought	2	2	1	2	10	20
1.03	Earthquake	0	-	-	-	-	-
1.04	Extreme Temperatures	3	2	1	1	9	27
1.05	Flooding: Riverine/Urban	3	1	1	1	6	18
1.06	Fog	2	1	0	1	4	8
1.07	Great Lakes Shoreline	0	-	-	-	-	-
1.08	Hail	3	1	1	1	6	18
1.09	Invasive Species	2	1	1	1	6	12
1.10	Lightning	3	1	2	1	8	24
1.11	Severe Winds	3	2	2	2	12	36
1.12	Subsidence	1	1	1	1	6	6
1.13	Tornadoes	1	2	2	2	12	12
1.14	Wildfire	3	1	2	1	8	24
1.15	Winter Storms	3	3	2	2	15	45
2.01	Dam failure	2	1	2	1	8	16
2.02	Energy Emergencies	2	2	0	2	8	16
2.03	Fire – Scrap Tires	1	1	1	1	6	6
2.04	Fire – Structural	3	1	2	2	9	27
2.05	HAZMAT – Fixed Site	1	1	1	1	6	6
2.06	HAZMAT – Transportation	3	1	1	1	6	18
2.07	Infrastructure Failures	3	2	1	2	10	30
2.08	Nuclear Power Emergencies	0	-	-	-	-	-
2.09	Oil/Natural Gas Well Accidents	2	1	1	1	6	12
2.10	Pipeline Accidents	1	1	1	2	7	7
2.11	Transportation Accidents	2	1	1	1	6	12
3.01	Catastrophic Incidents	1	3	3	3	18	18
3.02	Civil Disturbances	1	1	1	1	6	6
3.03	Nuclear Attack	0	-	-	-	-	-
3.04	Public Health Emergencies	2	2	0	3	9	18
3.05	Terrorism & Similar Criminal Acts	1	1	1	1	6	6

Cedar Creek Township Hazard Ranking

Probability of Occurrence X Impacts Total = Hazard Score

		Probability of Occurrence	Impacts Total	Hazard Score
1	Winter Storms	3	15	45
2	Severe Winds	3	12	36
3	Infrastructure Failures	3	10	30
4	Extreme Temperatures	3	9	27
4	Fire – Structural	3	9	27
6	Lightning	3	8	24
6	Wildfire	3	8	24
8	Drought	2	10	20
9	Catastrophic Incidents	1	18	18
9	Flooding: Riverine/Urban	3	6	18
9	Hail	3	6	18
9	HAZMAT – Transportation	3	6	18
9	Public Health Emergencies	2	9	18
14	Dam Failure	2	8	16
14	Energy Emergencies	2	8	16
16	Invasive Species	2	6	12
16	Oil/Natural Gas Well Accidents	2	6	12
16	Tornadoes	1	12	12
16	Transportation Accidents	2	6	12
20	Celestial Impacts	1	8	8
20	Fog	2	4	8
22	Pipeline Accidents	1	7	7
23	Civil Disturbances	1	6	6
23	Fire – Scrap Tires	1	6	6
23	HAZMAT – Fixed Site	1	6	6
23	Subsidence	1	6	6
23	Terrorism & Similar Criminal Acts	1	6	6
	Earthquake	0	-	-
	Great Lakes Shoreline	0	-	-
	Nuclear Power Emergencies	0	-	-
	Nuclear Attack	0	-	-

CEDAR CREEK TOWNSHIP
Critical Facilities and Potential Hazards



- State Trunkline
- Street
- Railroad
- Power Line
- Gas Pipeline
- Bridge
- Federal Land
- State Land
- Oil/Gas Field

Note: This jurisdiction is subject to many additional hazards; some of which tend to occur across wide areas and cannot be effectively shown on this map.Refer to **Appendix B- Hazard Identifications and Analyses** for more complete information about potential hazards in this community.

WMSRDC
WEST MICHIGAN SHORELINE REGIONAL DEVELOPMENT COMMISSION

Source: Michigan Geographic Data Library V 12b, Muskegon Co. Hazard Mitigation Plan Update 2014

Hazard Identification Profile
Dalton Township

1. NATURAL HAZARDS

1.01 Celestial Impacts: - None Identified.

1.02 Drought:
- 12 recorded drought events in the area (including Lake, Mason, Muskegon, Newaygo, and Oceana counties) lasting eight months or greater: 1895-1896, 1899-1900, 1901-1902, 1909-1911, 1925-1926, 1930-1931, 1956-1957, 1962-1963, 1971-1972, 1976-1977, and 2002-2003.
- Summer 1871: Prolonged drought over much of the Great Lakes region.
- May-September, 1891: Drought devastated Michigan's lumber industry.
- 2013: Record low water level on Lake Michigan.

1.03 Earthquake: - None Identified.

1.04 Extreme Temperatures:
- July 1936: Heatwave. 570 deaths statewide, 7 in Muskegon.
- Summer, 1988: 39 days with temperatures over 90 degrees, statewide.
- January 13-20, 1994: Record cold. $50m property damage across Michigan.
- December 9-10, 1995: Coldwave across Lower Michigan.
- March 2012: Record warm temperatures triggered early growing season. $209.8m crop damage across Michigan.

1.05 Flooding - Riverine/ Urban:
- August 20 - September 6, 1975: Flooding. Declaration of major disaster by President.
- February 21, 1986: Great lakes flooding and wave action. Declaration of disaster by Governor.
- September 10-19, 1986: Flooding. Declaration of major disaster by President.
- September, 1986: Flooding & heavy rain. Declaration of disaster by Governor.
- May 18-20, 2000: Flood. $100k property damage, $50k crop damage in Muskegon County.
- February 9-10, 2001: Flooding. $100k property damage across West Michigan.
- February 24-28, 2001: Flooding. $190k property damage across West Michigan.
- May 15-16, 2001: Flooding. $500k property damage, $200k crop damage across southwestern Lower Michigan.
- May 20-24, 2004: Flooding. Declaration of major disaster by President.
- April 17-23, 2013: Flooding. Declaration of major disaster by President. $5m property damage, Muskegon County.

1.06 Fog:
- January 11-13, 1995: Dense Fog. 4 traffic accident fatalities, school closures, and flight delays across Lower Michigan.

1.07 Great Lakes Shoreline Hazards: - None Identified.

1.08 Hail:
- Days with severe hail reported (1" or greater) recorded in Muskegon County, 2000-2012: 7
- May 15, 2001: 0.75-1.00 inch hail. $95k property damage, $95k crop damage across Muskegon County.
- August 3, 2003: 1.75 inch hail in Muskegon Twp, $55k property damage and $25k crop damage from hail countywide.

1.09 Invasive Species: - Invasive species exist in Muskegon County; No significant events identified.

1.10 Lightning: - July 20, 1994: Lightning killed a dog and caused $50k property damage, Muskegon County.

1.11 Severe Winds:
- August 20 - September 6, 1975: Rainstorms, high winds. Declaration of major disaster by President.
- November 18, 1994: High wind. $1m property damage statewide.
- April 6, 1997: High wind. $5m property damage across southwest Lower Michigan.
- May 29, 1998: Severe thunderstorm winds. 54,000 homes and businesses without power; estimated 500 homes and 30 businesses sustained minor to moderate damage. $1m property damage, Muskegon County.
- May 31, 1998: Thunderstorms & high winds. Declarations of disaster by Governor and major disaster by President. $2,458,958 in public damage costs, 42 homes destroyed, 1,805 homes damaged, 5 businesses destroyed, and 73 businesses damaged. Total public and private costs have been estimated at $24,205,908.
- ***May 8, 2000: Severe thunderstorm winds. $50k property damage, Dalton Township.***
- August 22, 2000: Severe thunderstorm winds. $150k property damage, Muskegon County.
- March 9, 2002: High wind. $485k property damage across southwest Lower Michigan.
- October 30, 2004: High wind. $1.15m property damage across southwest Lower Michigan.
- May 20-24, 2004: Severe storms. Declaration of major disaster by President.
- August 9, 2009: Severe thunderstorm winds. $2m property damage, Muskegon County.
- November 17, 2013: Severe thunderstorm winds. $200k property damage, Muskegon County.

1.12 Subsidence: - None Identified.

1.13 Tornadoes:
- Number of tornadoes in Muskegon County, 1950-2012: 7.

1.14 Wildfire:
- October 1871: Wildfires. 1.2m acres burned, 200 fatalities, Michigan's Lower Peninsula.
- May-September, 1891: Uncontrollable wildfires across Michigan during the drought of 1891.
- 1981-2010: Approximately 8 wildfires and 89 acres burned per year on county lands under MDNR jurisdiction (251 total wildfires, 2,676.0 total acres burned).

1.15 Winter Storms:

- March 2-7, 1976: Ice storms. Declaration of major disaster by President.
- January 26-31, 1977: Blizzard, snowstorm. Declaration of emergency by President.
- January 26-27, 1978: Blizzard, snowstorm. Declaration of statewide emergency by President.
- January 12, 1993: Heavy snow. $50k property damage, northern Lower Michigan.
- January 12-21, 1994: Heavy lake effect snow. $500k property damage across western Lower Michigan.
- January 27, 1994: Heavy snow and freezing rain. $5m property damage across region.
- October 26, 1997: Heavy snow. $1.2m property damage across southwestern Lower Michigan.
- March 9, 1998: Winter storm. $100k property damage across region.
- January 2-15, 1999: Blizzard, snowstorm. Declaration of emergency by President.
- December 11-31, 2000: Blizzard, snowstorm. Declaration of emergency by President.
- April 3, 2003: Ice storm. $4.9m property damage throughout West Michigan.
- February 16, 2006: Ice storm. $1m property damage across Lower Michigan.

2. TECHNOLOGICAL HAZARDS

2.01 Dam Failure:

- Four documented failures in Muskegon County, unidentified locations.

2.02 Energy Emergencies:

- February 2003: A break in a major transmission line caused an electrical blackout over parts of Montcalm, Oceana, Newaygo, Muskegon, and Kent counties.

2.03 Fire - Scrap Tire:

- Approximate scrap tire inventory in Muskegon County in 2012: 4,400.

2.04 Fire - Structural:

- County fire rate per 1,000 population in 1998: 3.8.

2.05 Hazard Material Incidents - Fixed Site (including industrial accidents):

- SARA Title III Sites in Muskegon County in 2012: 51.

2.06 Hazard Material Incidents - Transportation: - None Identified.

2.07 Infrastructure Failure:

- Number of NCDC records with mention of downed power lines or power outages in Muskegon County, 1993-2012: 45
- Number of sanitary sewer overflows in Muskegon County, 2000-2011: 47.
- August 8, 1993: 4,400 without power (thunderstorm winds), Muskegon and Oceana counties
- March 9, 1998: 1,900 power outages (blizzard conditions), Lake, Clare, Oceana and Muskegon counties.
- May 29-30, 1998: 54,000 without power; 27,000 on second day (thunderstorm winds), Muskegon County.
- May 31, 1998: 50,000 without power (thunderstorm winds), Muskegon County.
- July 21, 1998: 7,500 without power (thunderstorm winds and lightning), Muskegon County.

2.08 Nuclear Power Plant Emergencies: - None Identified.

2.09 Oil and Natural Gas Well Accidents:

- Oil and gas wells in Muskegon County in 2012: 1,090.

2.10 Pipeline Accidents: - None Identified.

2.11 Transportation Accidents: - None Identified.

3. HUMAN -RELATED HAZARDS

3.01 Catastrophic Incidents (National Emergencies):

- 1939-1945: World War II. In Muskegon, 48-hour minimum work weeks, rationing of certain food and goods, and 274 county men killed in battle.
- 2005: Hurricanes Katrina and Rita. Declarations of Gubernatorial Disaster and Presidential Emergency were issued in Michigan in September 2005 for hurricane evacuation.

3.02 Civil Disturbances: - None Identified.

3.03 Nuclear Attack: - None Identified.

3.04 Public Health Emergencies:

- 1913: Diphtheria Epidemic.
- 1916: Small pox and scarlet fever force closures of schools and businesses.
- 1918: Influenza epidemic closes theaters, dance halls, and churches.
- 1937: Children under 18 banned from theaters and schools close from fear of polio outbreak.
- 1941: Influenza epidemic cuts school attendance by 60%.
- 2009: H1N1 influenza pandemic causes school absences spike in the fall. Two county residents die from complications.

3.05 Terrorism and Similar Criminal Activities: - None Identified.

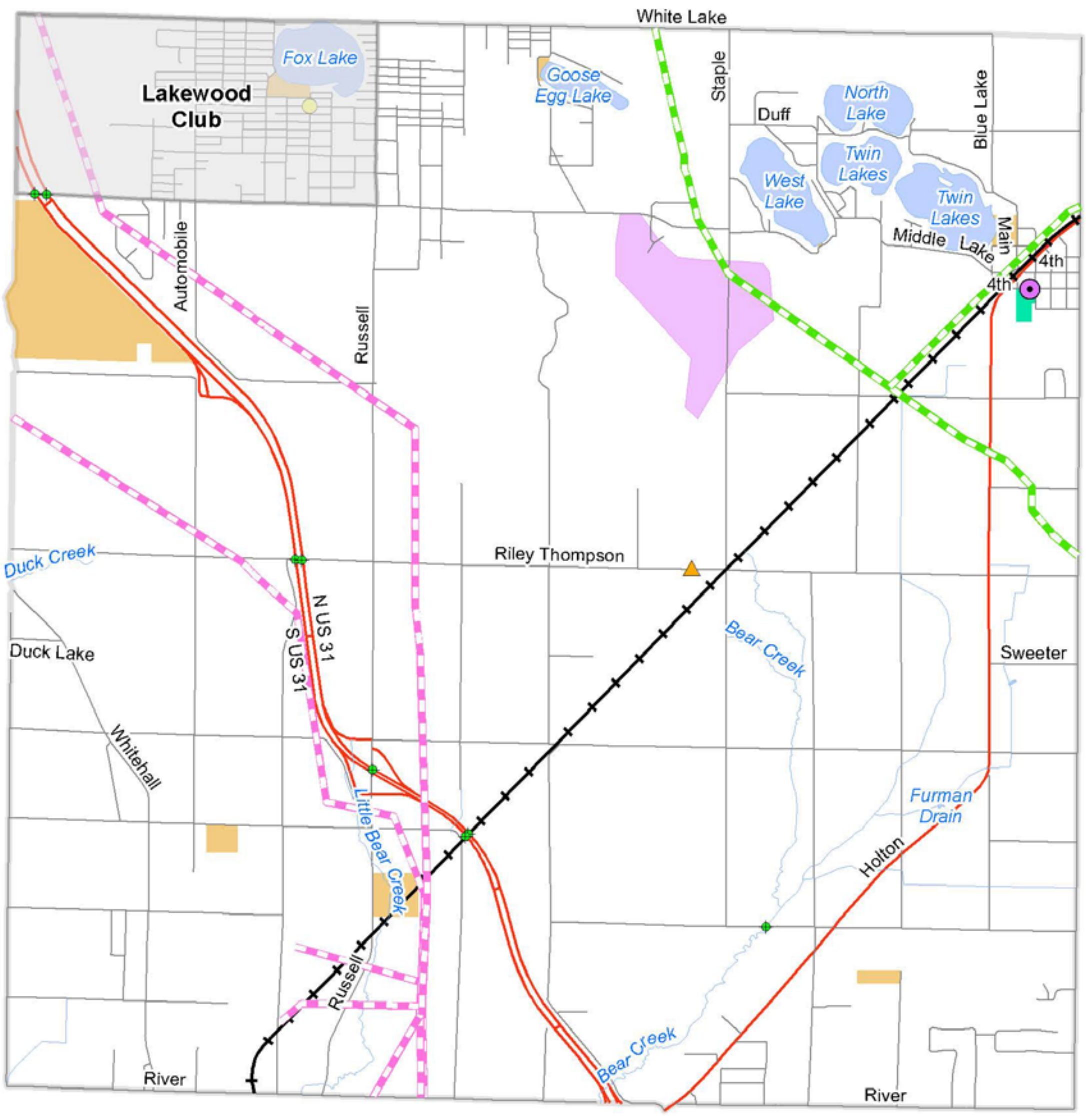
	Dalton Township Hazard Rating	Probability of Occurrence	Impact on People	Impact on Property	Impact on Economy	Impacts Total	Hazard Score
1.01	Celestial Impacts	1	2	0	2	8	8
1.02	Drought	2	2	1	2	10	20
1.03	Earthquake	0	-	-	-	-	-
1.04	Extreme Temperatures	3	2	1	1	9	27
1.05	Flooding: Riverine/Urban	2	1	2	1	8	16
1.06	Fog	2	1	0	1	4	8
1.07	Great Lakes Shoreline	0	-	-	-	-	-
1.08	Hail	2	2	1	1	9	18
1.09	Invasive Species	2	1	1	1	6	12
1.10	Lightning	3	1	2	1	8	24
1.11	Severe Winds	3	2	2	2	12	36
1.12	Subsidence	1	1	1	1	6	6
1.13	Tornadoes	1	2	2	2	12	12
1.14	Wildfire	3	1	2	1	8	24
1.15	Winter Storms	3	3	2	2	15	45
2.01	Dam failure	0	-	-	-	-	-
2.02	Energy Emergencies	2	2	0	2	8	16
2.03	Fire – Scrap Tires	1	1	1	1	6	6
2.04	Fire – Structural	3	1	2	3	10	30
2.05	HAZMAT – Fixed Site	1	1	1	1	6	6
2.06	HAZMAT – Transportation	3	1	1	1	6	18
2.07	Infrastructure Failures	3	2	1	2	10	30
2.08	Nuclear Power Emergencies	0	-	-	-	-	-
2.09	Oil/Natural Gas Well Accidents	2	1	1	1	6	12
2.10	Pipeline Accidents	1	1	1	2	7	7
2.11	Transportation Accidents	2	1	1	2	7	14
3.01	Catastrophic Incidents	1	3	3	3	18	18
3.02	Civil Disturbances	1	1	1	1	6	6
3.03	Nuclear Attack	0	-	-	-	-	-
3.04	Public Health Emergencies	2	2	0	3	9	18
3.05	Terrorism & Similar Criminal Acts	1	1	1	1	6	6

Dalton Township Hazard Ranking

Probability of Occurrence X Impacts Total = Hazard Score

		Probability of Occurrence	Impacts Total	Hazard Score
1	Winter Storms	3	15	45
2	Severe Winds	3	12	36
3	Fire – Structural	3	10	30
3	Infrastructure Failures	3	10	30
5	Extreme Temperatures	3	9	27
6	Lightning	3	8	24
6	Wildfire	3	8	24
8	Drought	2	10	20
9	Catastrophic Incidents	1	18	18
9	Hail	2	9	18
9	HAZMAT – Transportation	3	6	18
9	Public Health Emergencies	2	9	18
13	Energy Emergencies	2	8	16
13	Flooding: Riverine/Urban	2	8	16
15	Transportation Accidents	2	7	14
16	Invasive Species	2	6	12
16	Oil/Natural Gas Well Accidents	2	6	12
16	Tornadoes	1	12	12
19	Celestial Impacts	1	8	8
19	Fog	2	4	8
21	Pipeline Accidents	1	7	7
22	Civil Disturbances	1	6	6
22	Fire – Scrap Tires	1	6	6
22	HAZMAT – Fixed Site	1	6	6
22	Subsidence	1	6	6
22	Terrorism & Similar Criminal Acts	1	6	6
	Dam Failure	0	-	-
	Earthquake	0	-	-
	Great Lakes Shoreline	0	-	-
	Nuclear Attack	0	-	-
	Nuclear Power Emergencies	0	-	-

DALTON TOWNSHIP
Critical Facilities and Potential Hazards



- State Trunkline
- Street
- Railroad
- Gas Pipeline
- Power Line
- Bridge
- Siren
- Municipal Land
- School Property
- Oil/Gas Field

Note: This jurisdiction is subject to many additional hazards; some of which tend to occur across wide areas and cannot be effectively shown on this map.Refer to **Appendix B- Hazard Identifications and Analyses** for more complete information about potential hazards in this community.

WMSRDC
WEST MICHIGAN SHORELINE REGIONAL DEVELOPMENT COMMISSION

Source: Michigan Geographic Data Library V 12b, Muskegon Co. Hazard Mitigation Plan Update 2014

Hazard Identification Profile
Egelston Township

1. NATURAL HAZARDS

1.01 Celestial Impacts: - None Identified.

1.02 Drought:

- 12 recorded drought events in the area (including Lake, Mason, Muskegon, Newaygo, and Oceana counties) lasting eight months or greater: 1895-1896, 1899-1900, 1901-1902, 1909-1911, 1925-1926, 1930-1931, 1956-1957, 1962-1963, 1971-1972, 1976-1977, and 2002-2003.
- Summer 1871: Prolonged drought over much of the Great Lakes region.
- May-September, 1891: Drought devastated Michigan's lumber industry.
- 2013: Record low water level on Lake Michigan.

1.03 Earthquake: - None Identified.

1.04 Extreme Temperatures:

- July 1936: Heatwave. 570 deaths statewide, 7 in Muskegon.
- Summer, 1988: 39 days with temperatures over 90 degrees, statewide.
- January 13-20, 1994: Record cold. $50m property damage across Michigan.
- December 9-10, 1995: Coldwave across Lower Michigan.
- March 2012: Record warm temperatures triggered early growing season. $209.8m crop damage across Michigan.

1.05 Flooding - Riverine/ Urban:

- August 20 - September 6, 1975: Flooding. Declaration of major disaster by President.
- February 21, 1986: Great lakes flooding and wave action. Declaration of disaster by Governor.
- September 10-19, 1986: Flooding. Declaration of major disaster by President.
- September, 1986: Flooding & heavy rain. Declaration of disaster by Governor.
- May 18-20, 2000: Flood. $100k property damage, $50k crop damage in Muskegon County.
- February 9-10, 2001: Flooding. $100k property damage across West Michigan.
- February 24-28, 2001: Flooding. $190k property damage across West Michigan.
- May 15-16, 2001: Flooding. $500k property damage, $200k crop damage across southwestern Lower Michigan.
- May 20-24, 2004: Flooding. Declaration of major disaster by President.
- April 17-23, 2013: Flooding. Declaration of major disaster by President. $5m property damage, Muskegon County.

1.06 Fog: - January 11-13, 1995: Dense Fog. 4 traffic accident fatalities, school closures, and flight delays, Lower Michigan.

1.07 Great Lakes Shoreline Hazards: - None Identified.

1.08 Hail:

- Days with severe hail reported (1" or greater) recorded in Muskegon County, 2000-2012: 7
- May 15, 2001: 0.75-1.00 inch hail. $95k property damage, $95k crop damage across Muskegon County.
- August 3, 2003: 1.75 inch hail in Muskegon Twp, $55k property damage and $25k crop damage from hail countywide.

1.09 Invasive Species: - Invasive species exist in Muskegon County; No significant events identified.

1.10 Lightning:

- July 20, 1994: Lightning killed a dog and caused $50k property damage, Muskegon County.
- ***July 21, 1998: Lightning. $40k property damage from lightning induced structural fires, Egelston and Muskegon townships.***

1.11 Severe Winds:

- August 20 - September 6, 1975: Rainstorms, high winds. Declaration of major disaster by President.
- November 18, 1994: High wind. $1m property damage statewide.
- April 6, 1997: High wind. $5m property damage across southwest Lower Michigan.
- May 29, 1998: Severe thunderstorm winds. 54,000 homes and businesses without power; estimated 500 homes and 30 businesses sustained minor to moderate damage. $1m property damage, Muskegon County.
- May 31, 1998: Thunderstorms & high winds. Declarations of disaster by Governor and major disaster by President. $2,458,958 in public damage costs, 42 homes destroyed, 1,805 homes damaged, 5 businesses destroyed, and 73 businesses damaged. Total public and private costs have been estimated at $24,205,908.
- August 22, 2000: Severe thunderstorm winds. $150k property damage, Muskegon County.
- March 9, 2002: High wind. $485k property damage across southwest Lower Michigan.
- October 30, 2004: High wind. $1.15m property damage across southwest Lower Michigan.
- May 20-24, 2004: Severe storms. Declaration of major disaster by President.
- August 9, 2009: Severe thunderstorm winds. $2m property damage, Muskegon County.
- November 17, 2013: Severe thunderstorm winds. $200k property damage, Muskegon County.

1.12 Subsidence: - None Identified.

1.13 Tornadoes: - Number of tornadoes in Muskegon County, 1950-2012: 7.

1.14 Wildfire:

- October 1871: Wildfires. 1.2m acres burned, 200 fatalities, Michigan's Lower Peninsula.
- May-September, 1891: Uncontrollable wildfires across Michigan during the drought of 1891.
- 1981-2010: Approximately 8 wildfires and 89 acres burned per year on county lands under MDNR jurisdiction (251 total wildfires, 2,676.0 total acres burned).

1.15 Winter Storms:

- March 2-7, 1976: Ice storms. Declaration of major disaster by President.
- January 26-31, 1977: Blizzard, snowstorm. Declaration of emergency by President.
- January 26-27, 1978: Blizzard, snowstorm. Declaration of statewide emergency by President.
- January 12, 1993: Heavy snow. $50k property damage, northern Lower Michigan.
- January 12-21, 1994: Heavy lake effect snow. $500k property damage across western Lower Michigan.
- January 27, 1994: Heavy snow and freezing rain. $5m property damage across region.
- October 26, 1997: Heavy snow. $1.2m property damage across southwestern Lower Michigan.
- March 9, 1998: Winter storm. $100k property damage across region.
- January 2-15, 1999: Blizzard, snowstorm. Declaration of emergency by President.
- December 11-31, 2000: Blizzard, snowstorm. Declaration of emergency by President.
- April 3, 2003: Ice storm. $4.9m property damage throughout West Michigan.
- February 16, 2006: Ice storm. $1m property damage across Lower Michigan.

2. TECHNOLOGICAL HAZARDS

2.01 Dam Failure:

- Four documented failures in Muskegon County, unidentified locations.

2.02 Energy Emergencies:

- February 2003: A break in a major transmission line caused an electrical blackout over parts of Montcalm, Oceana, Newaygo, Muskegon, and Kent counties.

2.03 Fire - Scrap Tire:

- Approximate scrap tire inventory in Muskegon County in 2012: 4,400.

2.04 Fire - Structural:

- County fire rate per 1,000 population in 1998: 3.8.

2.05 Hazard Material Incidents - Fixed Site (including industrial accidents):

- SARA Title III Sites in Muskegon County in 2012: 51.
- ***April 22, 1990: Release of phosphorus oxychloride, 1,000 people evacuated, Egelston Township.***
- ***April 12, 2000: Explosion and flash fire at chemical plant, 10 people injured, Egelston Township.***
- ***September 13, 2003: Barrel explosion at foundry, 1 fatality, Egelston Township.***

2.06 Hazard Material Incidents - Transportation: - None Identified.

2.07 Infrastructure Failure:

- Number of NCDC records with mention of downed power lines or power outages in Muskegon County, 1993-2012: 45
- Number of sanitary sewer overflows in Muskegon County, 2000-2011: 47.
- August 8, 1993: 4,400 without power (thunderstorm winds), Muskegon and Oceana counties
- March 9, 1998: 1,900 power outages (blizzard conditions), Lake, Clare, Oceana and Muskegon counties.
- May 29-30, 1998: 54,000 without power; 27,000 on second day (thunderstorm winds), Muskegon County.
- May 31, 1998: 50,000 without power (thunderstorm winds), Muskegon County.
- July 21, 1998: 7,500 without power (thunderstorm winds and lightning), Muskegon County.

2.08 Nuclear Power Plant Emergencies: - None Identified.

2.09 Oil and Natural Gas Well Accidents:

- Oil and gas wells in Muskegon County in 2012: 1,090.
- ***1 well with known detectable levels of hydrogen sulfide in Egelston Township.***

2.10 Pipeline Accidents:

- ***August 28, 2007: A house exploded after a contractor accidentally struck a natural gas line in Egelston Twp.***

2.11 Transportation Accidents: - None Identified.

3. HUMAN -RELATED HAZARDS

3.01 Catastrophic Incidents (National Emergencies):

- 1939-1945: World War II. In Muskegon, 48-hour minimum work weeks, rationing of certain food and goods, and 274 county men killed in battle.
- 2005: Hurricanes Katrina and Rita. Declarations of Gubernatorial Disaster and Presidential Emergency were issued in Michigan in September 2005 for hurricane evacuation.

3.02 Civil Disturbances: - None Identified.

3.03 Nuclear Attack: - None Identified.

3.04 Public Health Emergencies:

- 1913: Diphtheria Epidemic.
- 1916: Small pox and scarlet fever force closures of schools and businesses.
- 1918: Influenza epidemic closes theaters, dance halls, and churches.
- 1937: Children under 18 banned from theaters and schools close from fear of polio outbreak.
- 1941: Influenza epidemic cuts school attendance by 60%.
- 2009: H1N1 influenza pandemic causes school absences spike in the fall. Two county residents die from complications.

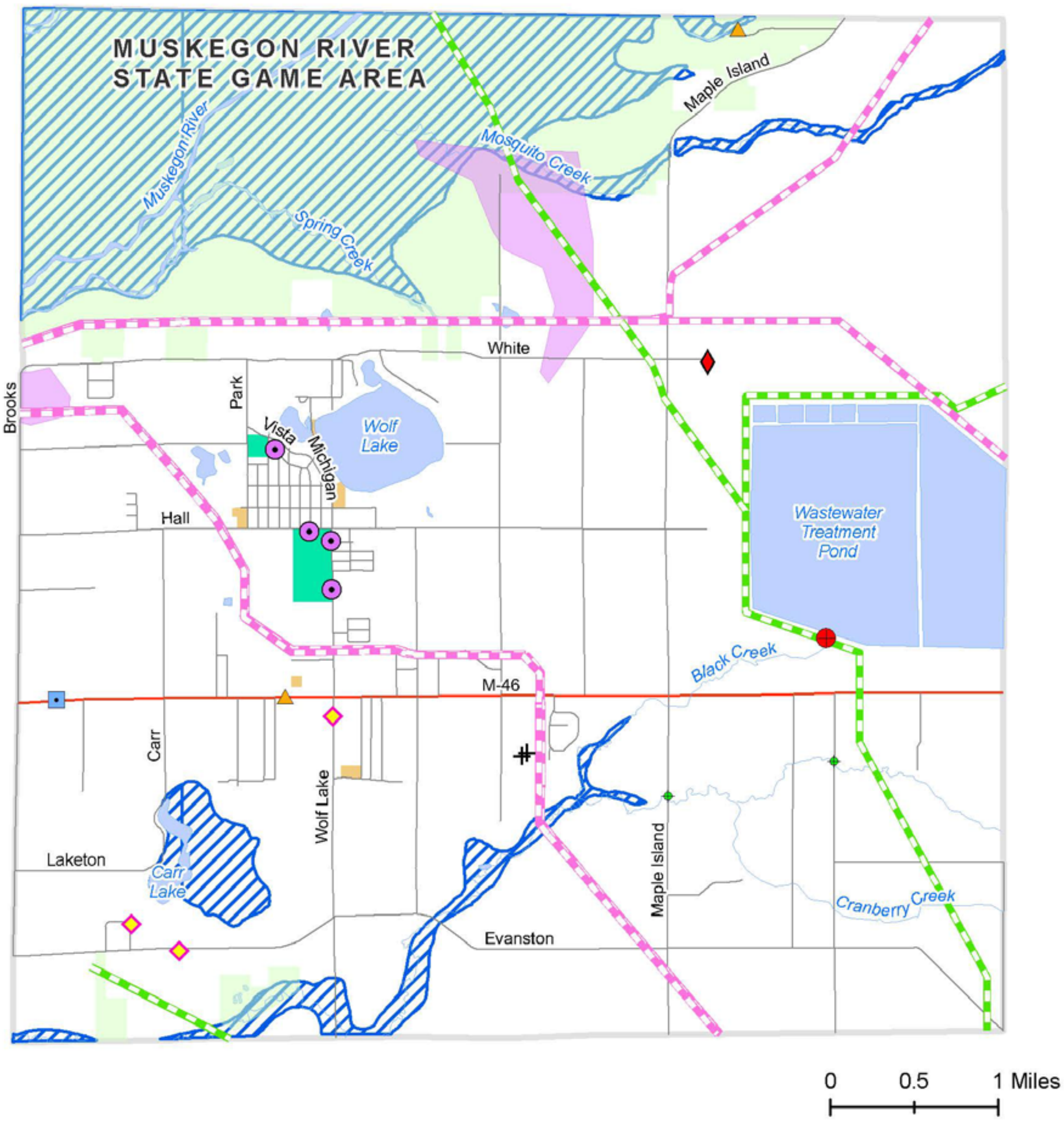
3.05 Terrorism and Similar Criminal Activities: - None Identified.

	Egelston Township Hazard Rating	Probability of Occurrence	Impact on People	Impact on Property	Impact on Economy	Impacts Total	Hazard Score
1.01	Celestial Impacts	1	2	0	2	8	8
1.02	Drought	2	2	1	2	10	20
1.03	Earthquake	0	-	-	-	-	-
1.04	Extreme Temperatures	3	2	1	1	9	27
1.05	Flooding: Riverine/Urban	3	1	2	2	9	27
1.06	Fog	2	1	0	1	4	8
1.07	Great Lakes Shoreline	0	-	-	-	-	-
1.08	Hail	2	2	1	1	9	18
1.09	Invasive Species	2	1	1	1	6	12
1.10	Lightning	3	1	2	1	8	24
1.11	Severe Winds	3	2	2	2	12	36
1.12	Subsidence	1	1	1	1	6	6
1.13	Tornadoes	1	2	2	2	12	12
1.14	Wildfire	3	1	2	1	8	24
1.15	Winter Storms	3	3	2	2	15	45
2.01	Dam failure	2	1	1	2	7	14
2.02	Energy Emergencies	2	2	0	2	8	16
2.03	Fire – Scrap Tires	1	1	1	1	6	6
2.04	Fire – Structural	3	1	2	3	10	30
2.05	HAZMAT – Fixed Site	3	1	1	2	7	21
2.06	HAZMAT – Transportation	3	1	1	1	6	18
2.07	Infrastructure Failures	3	2	1	2	10	30
2.08	Nuclear Power Emergencies	0	-	-	-	-	-
2.09	Oil/Natural Gas Well Accidents	2	1	1	1	6	12
2.10	Pipeline Accidents	1	1	1	2	7	7
2.11	Transportation Accidents	2	1	1	2	7	14
3.01	Catastrophic Incidents	1	3	3	3	18	18
3.02	Civil Disturbances	1	1	1	1	6	6
3.03	Nuclear Attack	0	-	-	-	-	-
3.04	Public Health Emergencies	2	2	0	3	9	18
3.05	Terrorism & Similar Criminal Acts	1	1	1	1	6	6

Egelston Township Hazard Ranking

		Probability of Occurrence	X Impacts Total	= Hazard Score
1	Winter Storms	3	15	45
2	Severe Winds	3	12	36
3	Fire – Structural	3	10	30
3	Infrastructure Failures	3	10	30
5	Extreme Temperatures	3	9	27
5	Flooding: Riverine/Urban	3	9	27
7	Lightning	3	8	24
7	Wildfire	3	8	24
9	HAZMAT – Fixed Site	3	7	21
10	Drought	2	10	20
11	Catastrophic Incidents	1	18	18
11	Hail	2	9	18
11	HAZMAT – Transportation	3	6	18
11	Public Health Emergencies	2	9	18
15	Energy Emergencies	2	8	16
16	Dam Failure	2	7	14
16	Transportation Accidents	2	7	14
18	Invasive Species	2	6	12
18	Oil/Natural Gas Well Accidents	2	6	12
18	Tornadoes	1	12	12
21	Celestial Impacts	1	8	8
21	Fog	2	4	8
23	Pipeline Accidents	1	7	7
24	Civil Disturbances	1	6	6
24	Fire – Scrap Tires	1	6	6
24	Subsidence	1	6	6
24	Terrorism & Similar Criminal Acts	1	6	6
	Earthquake	0	-	-
	Great Lakes Shoreline	0	-	-
	Nuclear Power Emergencies	0	-	-
	Nuclear Attack	0	-	-

EGELSTON TOWNSHIP
Critical Facilities and Potential Hazards



- State Trunkline
- Street
- Gas Pipeline
- Power Line
- SARA Title III Site
- Bridge
- Communications Tower
- Wastewater Treatment
- Fire/Police/EMS/911
- School
- Shelter
- Dam
- State Land
- Municipal Land
- School Property
- Oil/Gas Field
- Floodplain

Note: This jurisdiction is subject to many additional hazards; some of which tend to occur across wide areas and cannot be effectively shown on this map.Refer to **Appendix B- Hazard Identifications and Analyses** for more complete information about potential hazards in this community.

WMSRDC
WEST MICHIGAN SHORELINE REGIONAL DEVELOPMENT COMMISSION

Source: Michigan Geographic Data Library V 12b, Muskegon Co. Hazard Mitigation Plan Update 2014

Hazard Identification Profile
Fruitland Township

1. NATURAL HAZARDS

1.01 Celestial Impacts: - None Identified.

1.02 Drought:

- 12 recorded drought events in the area (including Lake, Mason, Muskegon, Newaygo, and Oceana counties) lasting eight months or greater: 1895-1896, 1899-1900, 1901-1902, 1909-1911, 1925-1926, 1930-1931, 1956-1957, 1962-1963, 1971-1972, 1976-1977, and 2002-2003.
- Summer 1871: Prolonged drought over much of the Great Lakes region.
- May-September, 1891: Drought devastated Michigan's lumber industry.

1.03 Earthquake: - None Identified.

1.04 Extreme Temperatures:

- July 1936: Heatwave. 570 deaths statewide, 7 in Muskegon.
- Summer, 1988: 39 days with temperatures over 90 degrees, statewide.
- January 13-20, 1994: Record cold. $50m property damage across Michigan.
- December 9-10, 1995: Coldwave across Lower Michigan.
- March 2012: Record warm temperatures triggered early growing season. $209.8m crop damage across Michigan.

1.05 Flooding - Riverine/ Urban:

- August 20 - September 6, 1975: Flooding. Declaration of major disaster by President.
- February 21, 1986: Great lakes flooding and wave action. Declaration of disaster by Governor.
- September 10-19, 1986: Flooding. Declaration of major disaster by President.
- September, 1986: Flooding & heavy rain. Declaration of disaster by Governor.
- May 18-20, 2000: Flood. $100k property damage, $50k crop damage in Muskegon County.
- February 9-10, 2001: Flooding. $100k property damage across West Michigan.
- February 24-28, 2001: Flooding. $190k property damage across West Michigan.
- May 15-16, 2001: Flooding. $500k property damage, $200k crop damage across southwestern Lower Michigan.
- May 20-24, 2004: Flooding. Declaration of major disaster by President.
- April 17-23, 2013: Flooding. Declaration of major disaster by President. $5m property damage, Muskegon County.

1.06 Fog: - January 11-13, 1995: Dense Fog. 4 traffic accident fatalities, school closures, and flight delays, Lower Michigan.

1.07 Great Lakes Shoreline Hazards:

- Extreme high water levels in the Great Lakes: 1929, 1952, 1973, 1986, and 1997.
- Extreme low water levels in the Great Lakes: 1926, 1934, 1964, 2003, and 2013.
- Rip current incidents on Lake Michigan, 2002-2012: 77 fatalities, 230 rescues.
- June 1986: Record high water level on Lake Michigan.
- ***May 31, 1998: Tugboat capsized during seiche in White Lake Channel. Estimated $20,000 damage to tugboat.***
- 2013: Record low water level on Lake Michigan.

1.08 Hail:

- Days with severe hail reported (1" or greater) recorded in Muskegon County, 2000-2012: 7
- May 15, 2001: 0.75-1.00 inch hail. $95k property damage, $95k crop damage across Muskegon County.
- August 3, 2003: 1.75 inch hail in Muskegon Twp, $55k property damage and $25k crop damage from hail countywide.

1.09 Invasive Species: - Invasive species exist in Muskegon County; No significant events identified.

1.10 Lightning: - July 20, 1994: Lightning killed a dog and caused $50k property damage, Muskegon County.

1.11 Severe Winds:

- August 20 - September 6, 1975: Rainstorms, high winds. Declaration of major disaster by President.
- November 18, 1994: High wind. $1m property damage statewide.
- April 6, 1997: High wind. $5m property damage across southwest Lower Michigan.
- May 29, 1998: Severe thunderstorm winds. 54,000 homes and businesses without power; estimated 500 homes and 30 businesses sustained minor to moderate damage. $1m property damage, Muskegon County.
- May 31, 1998: Thunderstorms & high winds. Declarations of disaster by Governor and major disaster by President. $2,458,958 in public damage costs, 42 homes destroyed, 1,805 homes damaged, 5 businesses destroyed, and 73 businesses damaged. Total public and private costs have been estimated at $24,205,908.
- August 22, 2000: Severe thunderstorm winds. $150k property damage, Muskegon County.
- March 9, 2002: High wind. $485k property damage across southwest Lower Michigan.
- October 30, 2004: High wind. $1.15m property damage across southwest Lower Michigan.
- May 20-24, 2004: Severe storms. Declaration of major disaster by President.
- August 9, 2009: Severe thunderstorm winds. $2m property damage, Muskegon County.
- ***September 21, 2010: Severe thunderstorm winds. $50k property damage, Fruitland Township.***
- November 17, 2013: Severe thunderstorm winds. $200k property damage, Muskegon County.

1.12 Subsidence: - None Identified.

1.13 Tornadoes: - Number of tornadoes in Muskegon County, 1950-2012: 7.

1.14 Wildfire:

- October 1871: Wildfires. 1.2m acres burned, 200 fatalities, Michigan's Lower Peninsula.
- May-September, 1891: Uncontrollable wildfires across Michigan during the drought of 1891.

- 1981-2010: Approximately 8 wildfires and 89 acres burned per year on county lands under MDNR jurisdiction (251 total wildfires, 2,676.0 total acres burned).

1.15 Winter Storms:

- March 2-7, 1976: Ice storms. Declaration of major disaster by President.
- January 26-31, 1977: Blizzard, snowstorm. Declaration of emergency by President.
- January 26-27, 1978: Blizzard, snowstorm. Declaration of statewide emergency by President.
- January 12, 1993: Heavy snow. $50k property damage, northern Lower Michigan.
- January 12-21, 1994: Heavy lake effect snow. $500k property damage across western Lower Michigan.
- January 27, 1994: Heavy snow and freezing rain. $5m property damage across region.
- October 26, 1997: Heavy snow. $1.2m property damage across southwestern Lower Michigan.
- March 9, 1998: Winter storm. $100k property damage across region.
- January 2-15, 1999: Blizzard, snowstorm. Declaration of emergency by President.
- December 11-31, 2000: Blizzard, snowstorm. Declaration of emergency by President.
- April 3, 2003: Ice storm. $4.9m property damage throughout West Michigan.
- February 16, 2006: Ice storm. $1m property damage across Lower Michigan.

2. TECHNOLOGICAL HAZARDS

2.01 Dam Failure:

- Four documented failures in Muskegon County, unidentified locations.

2.02 Energy Emergencies:

- February 2003: A break in a major transmission line caused an electrical blackout over parts of Montcalm, Oceana, Newaygo, Muskegon, and Kent counties.

2.03 Fire - Scrap Tire:

- Approximate scrap tire inventory in Muskegon County in 2012: 4,400.

2.04 Fire - Structural:

- County fire rate per 1,000 population in 1998: 3.8.
- ***December 2012: Fire destroys Michillinda Lodge in Fruitland Township.***

2.05 Hazard Material Incidents - Fixed Site (including industrial accidents):

- SARA Title III Sites in Muskegon County in 2012: 51.

2.06 Hazard Material Incidents - Transportation: - None Identified.

2.07 Infrastructure Failure:

- Number of NCDC records with mention of downed power lines or power outages in Muskegon County, 1993-2012: 45
- Number of sanitary sewer overflows in Muskegon County, 2000-2011: 47.
- August 8, 1993: 4,400 without power (thunderstorm winds), Muskegon and Oceana counties
- March 9, 1998: 1,900 power outages (blizzard conditions), Lake, Clare, Oceana and Muskegon counties.
- May 29-30, 1998: 54,000 without power; 27,000 on second day (thunderstorm winds), Muskegon County.
- May 31, 1998: 50,000 without power (thunderstorm winds), Muskegon County.
- July 21, 1998: 7,500 without power (thunderstorm winds and lightning), Muskegon County.

2.08 Nuclear Power Plant Emergencies: - None Identified.

2.09 Oil and Natural Gas Well Accidents:

- Oil and gas wells in Muskegon County in 2012: 1,090.

2.10 Pipeline Accidents: - None Identified.

2.11 Transportation Accidents: - None Identified.

3. HUMAN -RELATED HAZARDS

3.01 Catastrophic Incidents (National Emergencies):

- 1939-1945: World War II. In Muskegon, 48-hour minimum work weeks, rationing of certain food and goods, and 274 county men killed in battle.
- 2005: Hurricanes Katrina and Rita. Declarations of Gubernatorial Disaster and Presidential Emergency were issued in Michigan in September 2005 for hurricane evacuation.

3.02 Civil Disturbances: - None Identified.

3.03 Nuclear Attack: - None Identified.

3.04 Public Health Emergencies:

- 1913: Diphtheria Epidemic.
- 1916: Small pox and scarlet fever force closures of schools and businesses.
- 1918: Influenza epidemic closes theaters, dance halls, and churches.
- 1937: Children under 18 banned from theaters and schools close from fear of polio outbreak.
- 1941: Influenza epidemic cuts school attendance by 60%.
- 2009: H1N1 influenza pandemic causes school absences spike in the fall. Two county residents die from complications.

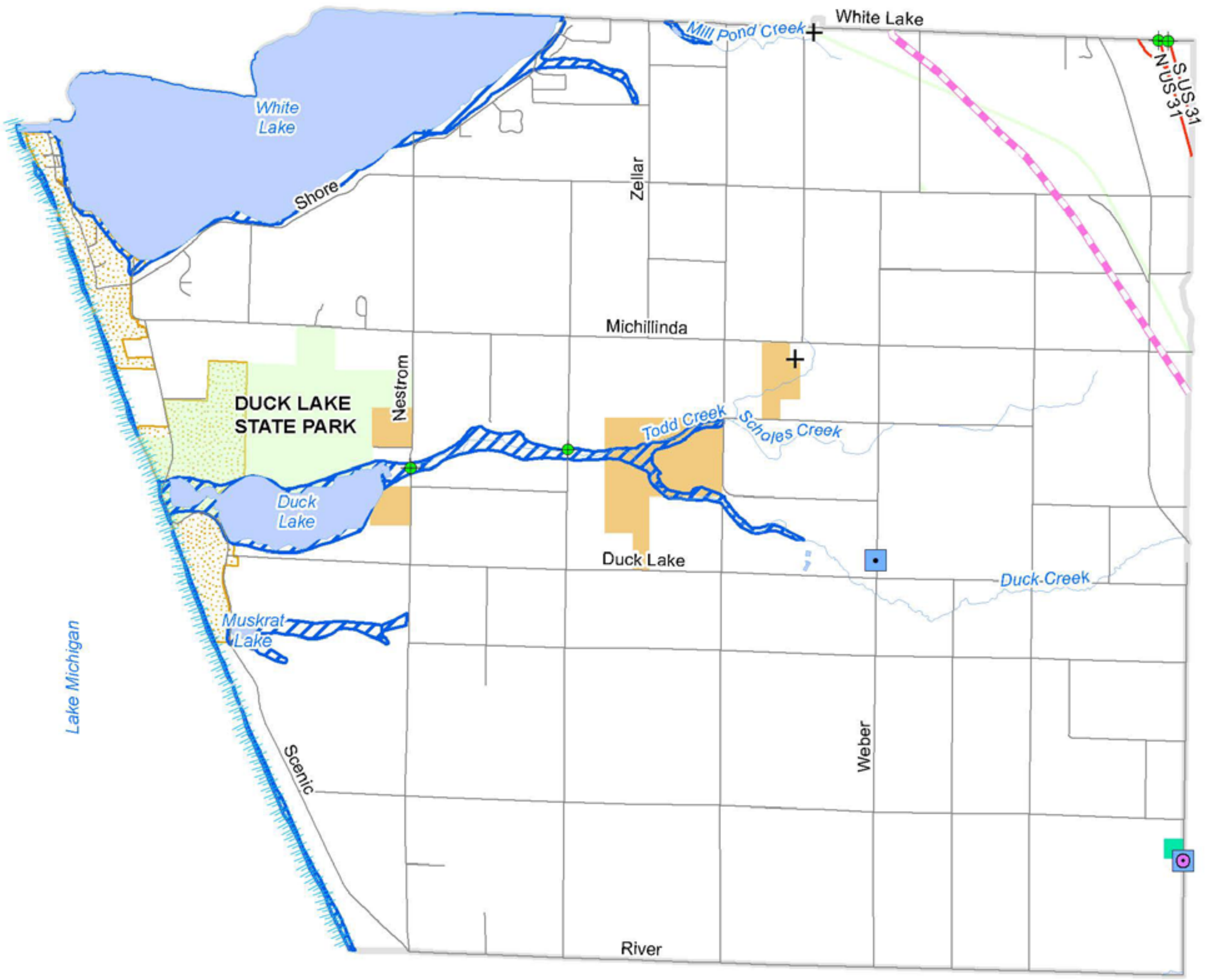
3.05 Terrorism and Similar Criminal Activities: - None Identified.

	Fruitland Township Hazard Rating	Probability of Occurrence	Impact on People	Impact on Property	Impact on Economy	Impacts Total	Hazard Score
1.01	Celestial Impacts	1	2	0	2	8	8
1.02	Drought	2	2	1	2	10	20
1.03	Earthquake	0	-	-	-	-	-
1.04	Extreme Temperatures	3	2	1	1	9	27
1.05	Flooding: Riverine/Urban	2	1	2	2	9	18
1.06	Fog	3	1	0	1	4	12
1.07	Great Lakes Shoreline	3	1	2	1	8	24
1.08	Hail	2	2	1	1	9	18
1.09	Invasive Species	2	1	1	1	6	12
1.10	Lightning	3	1	2	1	8	24
1.11	Severe Winds	3	2	2	2	12	36
1.12	Subsidence	1	1	1	1	6	6
1.13	Tornadoes	1	2	2	2	12	12
1.14	Wildfire	3	1	2	1	8	24
1.15	Winter Storms	3	3	2	2	15	45
2.01	Dam failure	1	1	1	1	6	6
2.02	Energy Emergencies	2	2	0	2	8	16
2.03	Fire – Scrap Tires	1	1	1	1	6	6
2.04	Fire – Structural	3	1	2	3	10	30
2.05	HAZMAT – Fixed Site	0	-	-	-	-	-
2.06	HAZMAT – Transportation	2	1	1	1	6	12
2.07	Infrastructure Failures	3	2	1	2	10	30
2.08	Nuclear Power Emergencies	0	-	-	-	-	-
2.09	Oil/Natural Gas Well Accidents	1	1	1	1	6	6
2.10	Pipeline Accidents	0	-	-	-	-	-
2.11	Transportation Accidents	2	1	1	1	6	12
3.01	Catastrophic Incidents	1	3	3	3	18	18
3.02	Civil Disturbances	1	1	1	1	6	6
3.03	Nuclear Attack	0	-	-	-	-	-
3.04	Public Health Emergencies	2	2	0	3	9	18
3.05	Terrorism & Similar Criminal Acts	1	1	1	1	6	6

Fruitland Township Hazard Ranking

		Probability of Occurrence	X Impacts Total	= Hazard Score
1	Winter Storms	3	15	45
2	Severe Winds	3	12	36
3	Fire – Structural	3	10	30
3	Infrastructure Failures	3	10	30
5	Extreme Temperatures	3	9	27
6	Great Lakes Shoreline	3	8	24
6	Lightning	3	8	24
6	Wildfire	3	8	24
9	Drought	2	10	20
10	Catastrophic Incidents	1	18	18
10	Flooding: Riverine/Urban	2	9	18
10	Hail	2	9	18
10	Public Health Emergencies	2	9	18
14	Energy Emergencies	2	8	16
15	Fog	3	4	12
15	HAZMAT – Transportation	2	6	12
15	Invasive Species	2	6	12
15	Tornadoes	1	12	12
15	Transportation Accidents	2	6	12
20	Celestial Impacts	1	8	8
21	Civil Disturbances	1	6	6
21	Dam Failure	1	6	6
21	Fire – Scrap Tires	1	6	6
21	Oil/Natural Gas Well Accidents	1	6	6
21	Subsidence	1	6	6
21	Terrorism & Similar Criminal Acts	1	6	6
	Earthquake	0	-	-
	HAZMAT – Fixed Site	0	-	-
	Nuclear Power Emergencies	0	-	-
	Nuclear Attack	0	-	-
	Pipeline Accidents	0	-	-

FRUITLAND TOWNSHIP
Critical Facilities and Potential Hazards



0 0.5 1 Miles

- State Trunkline
- Street
- Power Line
- Great Lakes Shoreline Hazard
- Bridge
- Communications Tower
- School
- Shelter
- State Land
- Municipal Land
- School Property
- High Risk Erosion Area
- Floodplain

Note: This jurisdiction is subject to many additional hazards; some of which tend to occur across wide areas and cannot be effectively shown on this map.Refer to **Appendix B- Hazard Identifications and Analyses** for more complete information about potential hazards in this community.

WMSRDC
WEST MICHIGAN SHORELINE REGIONAL DEVELOPMENT COMMISSION

Source: Michigan Geographic Data Library V 12b, Muskegon Co. Hazard Mitigation Plan Update 2014

Hazard Identification Profile
Fruitport Charter Township

1. NATURAL HAZARDS

1.01 Celestial Impacts: - None Identified.

1.02 Drought:

- 12 recorded drought events in the area (including Lake, Mason, Muskegon, Newaygo, and Oceana counties) lasting eight months or greater: 1895-1896, 1899-1900, 1901-1902, 1909-1911, 1925-1926, 1930-1931, 1956-1957, 1962-1963, 1971-1972, 1976-1977, and 2002-2003.
- Summer 1871: Prolonged drought over much of the Great Lakes region.
- May-September, 1891: Drought devastated Michigan's lumber industry.
- 2013: Record low water level on Lake Michigan.

1.03 Earthquake: - None Identified.

1.04 Extreme Temperatures:

- July 1936: Heatwave. 570 deaths statewide, 7 in Muskegon.
- Summer, 1988: 39 days with temperatures over 90 degrees, statewide.
- January 13-20, 1994: Record cold. $50m property damage across Michigan.
- December 9-10, 1995: Coldwave across Lower Michigan.
- March 2012: Record warm temperatures triggered early growing season. $209.8m crop damage across Michigan.

1.05 Flooding - Riverine/ Urban:

- August 20 - September 6, 1975: Flooding. Declaration of major disaster by President.
- February 21, 1986: Great lakes flooding and wave action. Declaration of disaster by Governor.
- September 10-19, 1986: Flooding. Declaration of major disaster by President.
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- May 18-20, 2000: Flood. $100k property damage, $50k crop damage in Muskegon County.
- February 9-10, 2001: Flooding. $100k property damage across West Michigan.
- February 24-28, 2001: Flooding. $190k property damage across West Michigan.
- May 15-16, 2001: Flooding. $500k property damage, $200k crop damage across southwestern Lower Michigan.
- May 20-24, 2004: Flooding. Declaration of major disaster by President.
- April 17-23, 2013: Flooding. Declaration of major disaster by President. $5m property damage, Muskegon County.

1.06 Fog:

- January 11-13, 1995: Dense Fog. 4 traffic accident fatalities, school closures, and flight delays across Lower Michigan.

1.07 Great Lakes Shoreline Hazards: - None Identified.

1.08 Hail:

- Days with severe hail reported (1" or greater) recorded in Muskegon County, 2000-2012: 7
- ***May 13, 1956: 4 inch hail. Fruitport Township.***
- ***April 11, 2001: 1.75 inch hail. $50k property damage, $25k crop damage, Village of Fruitport.***
- May 15, 2001: 0.75-1.00 inch hail. $95k property damage, $95k crop damage across Muskegon County.
- August 3, 2003: 1.75 inch hail in Muskegon Twp, $55k property damage and $25k crop damage from hail countywide.

1.09 Invasive Species: - Invasive species exist in Muskegon County; No significant events identified.

1.10 Lightning: - July 20, 1994: Lightning killed a dog and caused $50k property damage, Muskegon County.

1.11 Severe Winds:

- August 20 - September 6, 1975: Rainstorms, high winds. Declaration of major disaster by President.
- November 18, 1994: High wind. $1m property damage statewide.
- April 6, 1997: High wind. $5m property damage across southwest Lower Michigan.
- May 29, 1998: Severe thunderstorm winds. 54,000 homes and businesses without power; estimated 500 homes and 30 businesses sustained minor to moderate damage. $1m property damage, Muskegon County.
- May 31, 1998: Thunderstorms & high winds. Declarations of disaster by Governor and major disaster by President. $2,458,958 in public damage costs, 42 homes destroyed, 1,805 homes damaged, 5 businesses destroyed, and 73 businesses damaged. Total public and private costs have been estimated at $24,205,908.
- August 22, 2000: Severe thunderstorm winds. $150k property damage, Muskegon County.
- March 9, 2002: High wind. $485k property damage across southwest Lower Michigan.
- October 30, 2004: High wind. $1.15m property damage across southwest Lower Michigan.
- May 20-24, 2004: Severe storms. Declaration of major disaster by President.
- August 9, 2009: Severe thunderstorm winds. $2m property damage, Muskegon County.
- November 17, 2013: Severe thunderstorm winds. $200k property damage, Muskegon County.

1.12 Subsidence: - None Identified.

1.13 Tornadoes: - Number of tornadoes in Muskegon County, 1950-2012: 7.

1.14 Wildfire:

- October 1871: Wildfires. 1.2m acres burned, 200 fatalities, Michigan's Lower Peninsula.
- May-September, 1891: Uncontrollable wildfires across Michigan during the drought of 1891.
- 1981-2010: Approximately 8 wildfires and 89 acres burned per year on county lands under MDNR jurisdiction (251 total wildfires, 2,676.0 total acres burned).

1.15 Winter Storms:

- March 2-7, 1976: Ice storms. Declaration of major disaster by President.
- January 26-31, 1977: Blizzard, snowstorm. Declaration of emergency by President.
- January 26-27, 1978: Blizzard, snowstorm. Declaration of statewide emergency by President.
- January 12, 1993: Heavy snow. $50k property damage, northern Lower Michigan.
- January 12-21, 1994: Heavy lake effect snow. $500k property damage across western Lower Michigan.
- January 27, 1994: Heavy snow and freezing rain. $5m property damage across region.
- October 26, 1997: Heavy snow. $1.2m property damage across southwestern Lower Michigan.
- March 9, 1998: Winter storm. $100k property damage across region.
- January 2-15, 1999: Blizzard, snowstorm. Declaration of emergency by President.
- December 11-31, 2000: Blizzard, snowstorm. Declaration of emergency by President.
- April 3, 2003: Ice storm. $4.9m property damage throughout West Michigan.
- February 16, 2006: Ice storm. $1m property damage across Lower Michigan.

2. <u>TECHNOLOGICAL HAZARDS</u>

2.01 Dam Failure:

- Four documented failures in Muskegon County, unidentified locations.

2.02 Energy Emergencies:

- February 2003: A break in a major transmission line caused an electrical blackout over parts of Montcalm, Oceana, Newaygo, Muskegon, and Kent counties.

2.03 Fire - Scrap Tire:

- Approximate scrap tire inventory in Muskegon County in 2012: 4,400.

2.04 Fire - Structural:

- County fire rate per 1,000 population in 1998: 3.8.
- ***1900: Major business district fires in Fruitport and Ravenna.***

2.05 Hazard Material Incidents - Fixed Site (including industrial accidents):

- SARA Title III Sites in Muskegon County in 2012: 51.

2.06 Hazard Material Incidents - Transportation:

- ***March 15, 1982: Freight train derailment caused a spill of chlorine and caustic acid. 600 evacuated, Fruitport Twp.***

2.07 Infrastructure Failure:

- Number of NCDC records with mention of downed power lines or power outages in Muskegon County, 1993-2012: 45
- Number of sanitary sewer overflows in Muskegon County, 2000-2011: 47.
- August 8, 1993: 4,400 without power (thunderstorm winds), Muskegon and Oceana counties
- March 9, 1998: 1,900 power outages (blizzard conditions), Lake, Clare, Oceana and Muskegon counties.
- May 29-30, 1998: 54,000 without power; 27,000 on second day (thunderstorm winds), Muskegon County.
- May 31, 1998: 50,000 without power (thunderstorm winds), Muskegon County.
- July 21, 1998: 7,500 without power (thunderstorm winds and lightning), Muskegon County.
- ***August 9, 2009: Village of Fruitport and much of southern Muskegon County without power (t-storm winds).***

2.08 Nuclear Power Plant Emergencies: - None Identified.

2.09 Oil and Natural Gas Well Accidents:

- Oil and gas wells in Muskegon County in 2012: 1,090.

2.10 Pipeline Accidents: - None Identified.

2.11 Transportation Accidents: - None Identified.

3. <u>HUMAN -RELATED HAZARDS</u>

3.01 Catastrophic Incidents (National Emergencies):

- 1939-1945: World War II. In Muskegon, 48-hour minimum work weeks, rationing of certain food and goods, and 274 county men killed in battle.
- 2005: Hurricanes Katrina and Rita. Declarations of Gubernatorial Disaster and Presidential Emergency were issued in Michigan in September 2005 for hurricane evacuation.

3.02 Civil Disturbances: - None Identified.

3.03 Nuclear Attack: - None Identified.

3.04 Public Health Emergencies:

- 1913: Diphtheria Epidemic.
- 1916: Small pox and scarlet fever force closures of schools and businesses.
- 1918: Influenza epidemic closes theaters, dance halls, and churches.
- 1937: Children under 18 banned from theaters and schools close from fear of polio outbreak.
- 1941: Influenza epidemic cuts school attendance by 60%.
- 2009: H1N1 influenza pandemic causes school absences spike in the fall. Two county residents die from complications.

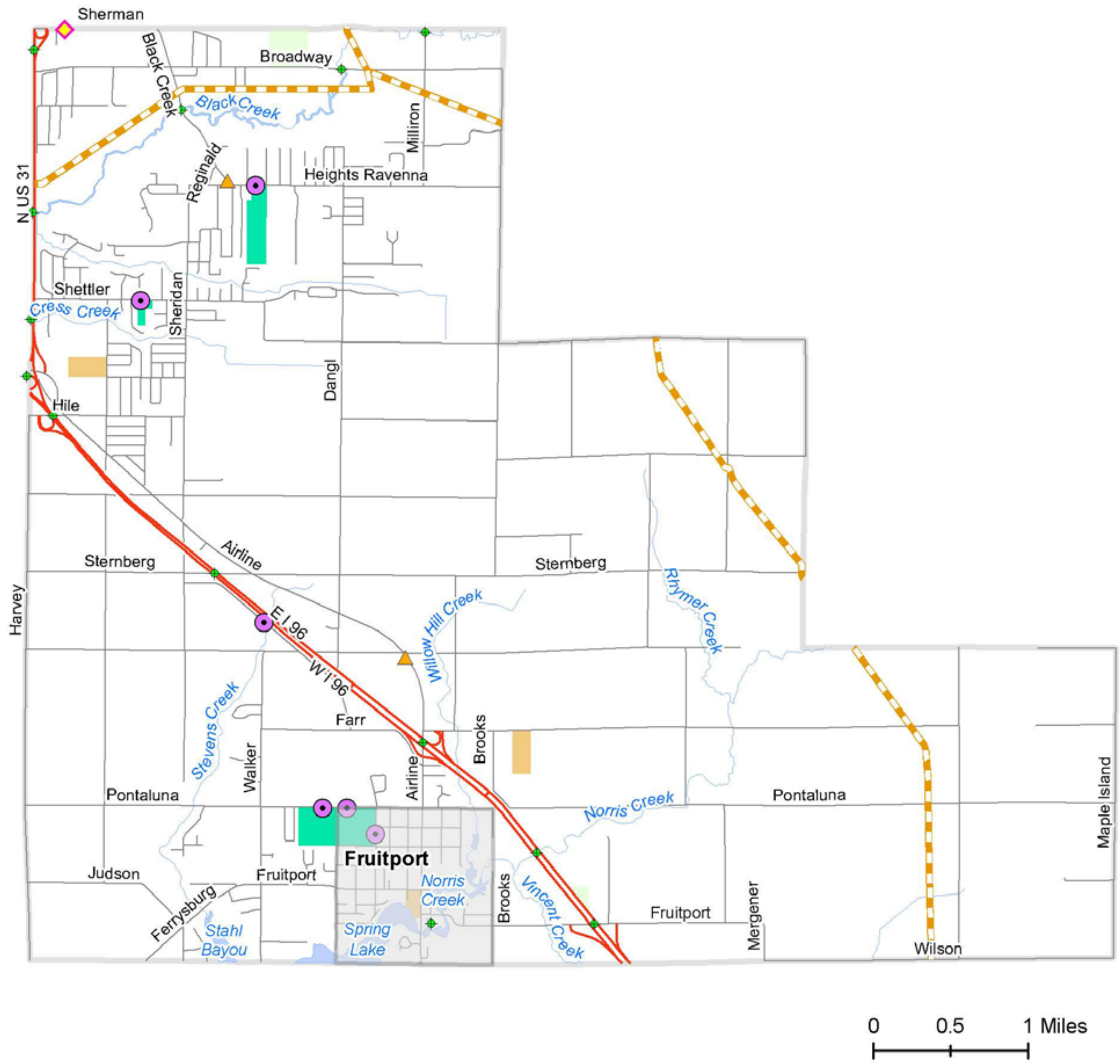
3.05 Terrorism and Similar Criminal Activities: - None Identified.

	Fruitport Charter Township Hazard Rating	Probability of Occurrence	Impact on People	Impact on Property	Impact on Economy	Impacts Total	Hazard Score
1.01	Celestial Impacts	1	2	0	2	8	8
1.02	Drought	2	2	2	2	12	24
1.03	Earthquake	0	-	-	-	-	-
1.04	Extreme Temperatures	3	2	1	1	9	27
1.05	Flooding: Riverine/Urban	2	1	2	2	9	18
1.06	Fog	2	1	0	1	4	8
1.07	Great Lakes Shoreline	0	-	-	-	-	-
1.08	Hail	2	2	1	1	9	18
1.09	Invasive Species	2	1	1	1	6	12
1.10	Lightning	3	1	2	1	8	24
1.11	Severe Winds	3	2	2	2	12	36
1.12	Subsidence	1	1	1	1	6	6
1.13	Tornadoes	1	2	2	2	12	12
1.14	Wildfire	3	1	2	1	8	24
1.15	Winter Storms	3	3	2	2	15	45
2.01	Dam failure	0	-	-	-	-	-
2.02	Energy Emergencies	2	2	0	2	8	16
2.03	Fire – Scrap Tires	1	1	1	1	6	6
2.04	Fire – Structural	3	1	2	3	10	30
2.05	HAZMAT – Fixed Site	1	1	1	1	6	6
2.06	HAZMAT – Transportation	3	1	1	1	6	18
2.07	Infrastructure Failures	3	2	1	2	10	30
2.08	Nuclear Power Emergencies	0	-	-	-	-	-
2.09	Oil/Natural Gas Well Accidents	1	1	1	1	6	6
2.10	Pipeline Accidents	1	1	2	2	9	9
2.11	Transportation Accidents	2	1	1	2	7	14
3.01	Catastrophic Incidents	1	3	3	3	18	18
3.02	Civil Disturbances	1	1	1	1	6	6
3.03	Nuclear Attack	0	-	-	-	-	-
3.04	Public Health Emergencies	2	2	0	3	9	18
3.05	Terrorism & Similar Criminal Acts	1	1	1	1	6	6

Fruitport Charter Township Hazard Ranking

		Probability of Occurrence	X Impacts Total	= Hazard Score
1	Winter Storms	3	15	45
2	Severe Winds	3	12	36
3	Fire – Structural	3	10	30
3	Infrastructure Failures	3	10	30
5	Extreme Temperatures	3	9	27
6	Drought	2	12	24
6	Lightning	3	8	24
6	Wildfire	3	8	24
9	Catastrophic Incidents	1	18	18
9	Flooding: Riverine/Urban	2	9	18
9	Hail	2	9	18
9	HAZMAT – Transportation	3	6	18
9	Public Health Emergencies	2	9	18
14	Energy Emergencies	2	8	16
15	Transportation Accidents	2	7	14
16	Invasive Species	2	6	12
16	Tornadoes	1	12	12
18	Pipeline Accidents	1	9	9
19	Celestial Impacts	1	8	8
19	Fog	2	4	8
20	Civil Disturbances	1	6	6
20	Fire – Scrap Tires	1	6	6
20	HAZMAT – Fixed Site	1	6	6
20	Oil/Natural Gas Well Accidents	1	6	6
20	Subsidence	1	6	6
20	Terrorism & Similar Criminal Acts	1	6	6
	Dam Failure	0	-	-
	Earthquake	0	-	-
	Great Lakes Shoreline	0	-	-
	Nuclear Attack	0	-	-
	Nuclear Power Emergencies	0	-	-

FRUITPORT TOWNSHIP
Critical Facilities and Potential Hazards



- State Trunkline
- Street
- SARA Title III Site
- Oil Pipeline
- Bridge
- Fire/Police/EMS/911
- School
- State Land
- Municipal Land
- School Property

Note: This jurisdiction is subject to many additional hazards; some of which tend to occur across wide areas and cannot be effectively shown on this map.Refer to **Appendix B- Hazard Identifications and Analyses** for more complete information about potential hazards in this community.

WMSRDC
WEST MICHIGAN SHORELINE REGIONAL DEVELOPMENT COMMISSION

Source: Michigan Geographic Data Library V 12b, Muskegon Co. Hazard Mitigation Update 2014

Hazard Identification Profile
Holton Township

1. NATURAL HAZARDS

1.01 Celestial Impacts: - None Identified.

1.02 Drought:

- 12 recorded drought events in the area (including Lake, Mason, Muskegon, Newaygo, and Oceana counties) lasting eight months or greater: 1895-1896, 1899-1900, 1901-1902, 1909-1911, 1925-1926, 1930-1931, 1956-1957, 1962-1963, 1971-1972, 1976-1977, and 2002-2003.
- Summer 1871: Prolonged drought over much of the Great Lakes region.
- May-September, 1891: Drought devastated Michigan's lumber industry.
- 2013: Record low water level on Lake Michigan.

1.03 Earthquake: - None Identified.

1.04 Extreme Temperatures:

- July 1936: Heatwave. 570 deaths statewide, 7 in Muskegon.
- Summer, 1988: 39 days with temperatures over 90 degrees, statewide.
- January 13-20, 1994: Record cold. $50m property damage across Michigan.
- December 9-10, 1995: Coldwave across Lower Michigan.
- March 2012: Record warm temperatures triggered early growing season. $209.8m crop damage across Michigan.

1.05 Flooding - Riverine/ Urban:

- August 20 - September 6, 1975: Flooding. Declaration of major disaster by President.
- February 21, 1986: Great lakes flooding and wave action. Declaration of disaster by Governor.
- September 10-19, 1986: Flooding. Declaration of major disaster by President.
- September, 1986: Flooding & heavy rain. Declaration of disaster by Governor.
- May 18-20, 2000: Flood. $100k property damage, $50k crop damage in Muskegon County.
- February 9-10, 2001: Flooding. $100k property damage across West Michigan.
- February 24-28, 2001: Flooding. $190k property damage across West Michigan.
- May 15-16, 2001: Flooding. $500k property damage, $200k crop damage across southwestern Lower Michigan.
- May 20-24, 2004: Flooding. Declaration of major disaster by President.
- April 17-23, 2013: Flooding. Declaration of major disaster by President. $5m property damage, Muskegon County.

1.06 Fog:

- January 11-13, 1995: Dense Fog. 4 traffic accident fatalities, school closures, and flight delays across Lower Michigan.

1.07 Great Lakes Shoreline Hazards: - None Identified.

1.08 Hail:

- Days with severe hail reported (1" or greater) recorded in Muskegon County, 2000-2012: 7
- ***May 12, 2000: 1 inch hail. $50k property damage, Holton Township.***
- May 15, 2001: 0.75-1.00 inch hail. $95k property damage, $95k crop damage across Muskegon County.
- August 3, 2003: 1.75 inch hail in Muskegon Twp, $55k property damage and $25k crop damage from hail countywide.

1.09 Invasive Species: - Invasive species exist in Muskegon County; No significant events identified.

1.10 Lightning: - July 20, 1994: Lightning killed a dog and caused $50k property damage, Muskegon County.

1.11 Severe Winds:

- August 20 - September 6, 1975: Rainstorms, high winds. Declaration of major disaster by President.
- November 18, 1994: High wind. $1m property damage statewide.
- April 6, 1997: High wind. $5m property damage across southwest Lower Michigan.
- May 29, 1998: Severe thunderstorm winds. 54,000 homes and businesses without power; estimated 500 homes and 30 businesses sustained minor to moderate damage. $1m property damage, Muskegon County.
- May 31, 1998: Thunderstorms & high winds. Declarations of disaster by Governor and major disaster by President. $2,458,958 in public damage costs, 42 homes destroyed, 1,805 homes damaged, 5 businesses destroyed, and 73 businesses damaged. Total public and private costs have been estimated at $24,205,908.
- August 22, 2000: Severe thunderstorm winds. $150k property damage, Muskegon County.
- March 9, 2002: High wind. $485k property damage across southwest Lower Michigan.
- October 30, 2004: High wind. $1.15m property damage across southwest Lower Michigan.
- May 20-24, 2004: Severe storms. Declaration of major disaster by President.
- August 9, 2009: Severe thunderstorm winds. $2m property damage, Muskegon County.
- November 17, 2013: Severe thunderstorm winds. $200k property damage, Muskegon County.

1.12 Subsidence: - None Identified.

1.13 Tornadoes:

- Number of tornadoes in Muskegon County, 1950-2012: 7.

1.14 Wildfire:

- October 1871: Wildfires. 1.2m acres burned, 200 fatalities, Michigan's Lower Peninsula.
- May-September, 1891: Uncontrollable wildfires across Michigan during the drought of 1891.
- 1981-2010: Approximately 8 wildfires and 89 acres burned per year on county lands under MDNR jurisdiction (251 total wildfires, 2,676.0 total acres burned).

1.15 Winter Storms:

- March 2-7, 1976: Ice storms. Declaration of major disaster by President.
- January 26-31, 1977: Blizzard, snowstorm. Declaration of emergency by President.
- January 26-27, 1978: Blizzard, snowstorm. Declaration of statewide emergency by President.
- January 12, 1993: Heavy snow. $50k property damage, northern Lower Michigan.
- January 12-21, 1994: Heavy lake effect snow. $500k property damage across western Lower Michigan.
- January 27, 1994: Heavy snow and freezing rain. $5m property damage across region.
- October 26, 1997: Heavy snow. $1.2m property damage across southwestern Lower Michigan.
- March 9, 1998: Winter storm. $100k property damage across region.
- January 2-15, 1999: Blizzard, snowstorm. Declaration of emergency by President.
- December 11-31, 2000: Blizzard, snowstorm. Declaration of emergency by President.
- April 3, 2003: Ice storm. $4.9m property damage throughout West Michigan.
- February 16, 2006: Ice storm. $1m property damage across Lower Michigan.

2. TECHNOLOGICAL HAZARDS

2.01 Dam Failure:

- Four documented failures in Muskegon County, unidentified locations.

2.02 Energy Emergencies:

- February 2003: A break in a major transmission line caused an electrical blackout over parts of Montcalm, Oceana, Newaygo, Muskegon, and Kent counties.

2.03 Fire - Scrap Tire:

- Approximate scrap tire inventory in Muskegon County in 2012: 4,400.

2.04 Fire - Structural:

- County fire rate per 1,000 population in 1998: 3.8.

2.05 Hazard Material Incidents - Fixed Site (including industrial accidents):

- SARA Title III Sites in Muskegon County in 2012: 51.

2.06 Hazard Material Incidents - Transportation:

- ***December 6, 1985: Gasoline tanker overturned on M120 near Brickyard and dumped about 2,200 gallons into the ditch, Holton Township.***

2.07 Infrastructure Failure:

- Number of NCDC records with mention of downed power lines or power outages in Muskegon County, 1993-2012: 45
- Number of sanitary sewer overflows in Muskegon County, 2000-2011: 47.
- August 8, 1993: 4,400 without power (thunderstorm winds), Muskegon and Oceana counties
- March 9, 1998: 1,900 power outages (blizzard conditions), Lake, Clare, Oceana and Muskegon counties.
- May 29-30, 1998: 54,000 without power; 27,000 on second day (thunderstorm winds), Muskegon County.
- May 31, 1998: 50,000 without power (thunderstorm winds), Muskegon County.
- July 21, 1998: 7,500 without power (thunderstorm winds and lightning), Muskegon County.

2.08 Nuclear Power Plant Emergencies: - None Identified.

2.09 Oil and Natural Gas Well Accidents:

- Oil and gas wells in Muskegon County in 2012: 1,090.

2.10 Pipeline Accidents: - None Identified.

2.11 Transportation Accidents:

- ***January 21, 2002: School bus accident at Holton Rd and Brickyard Rd in Holton Township. One person killed and about 22 persons taken to area hospitals with injuries.***

3. HUMAN -RELATED HAZARDS

3.01 Catastrophic Incidents (National Emergencies):

- 1939-1945: World War II. In Muskegon, 48-hour minimum work weeks, rationing of certain food and goods, and 274 county men killed in battle.
- 2005: Hurricanes Katrina and Rita. Declarations of Gubernatorial Disaster and Presidential Emergency were issued in Michigan in September 2005 for hurricane evacuation.

3.02 Civil Disturbances: - None Identified.

3.03 Nuclear Attack: - None Identified.

3.04 Public Health Emergencies:

- 1913: Diphtheria Epidemic.
- 1916: Small pox and scarlet fever force closures of schools and businesses.
- 1918: Influenza epidemic closes theaters, dance halls, and churches.
- 1937: Children under 18 banned from theaters and schools close from fear of polio outbreak.
- 1941: Influenza epidemic cuts school attendance by 60%.
- 2009: H1N1 influenza pandemic causes school absences spike in the fall. Two county residents die from complications.

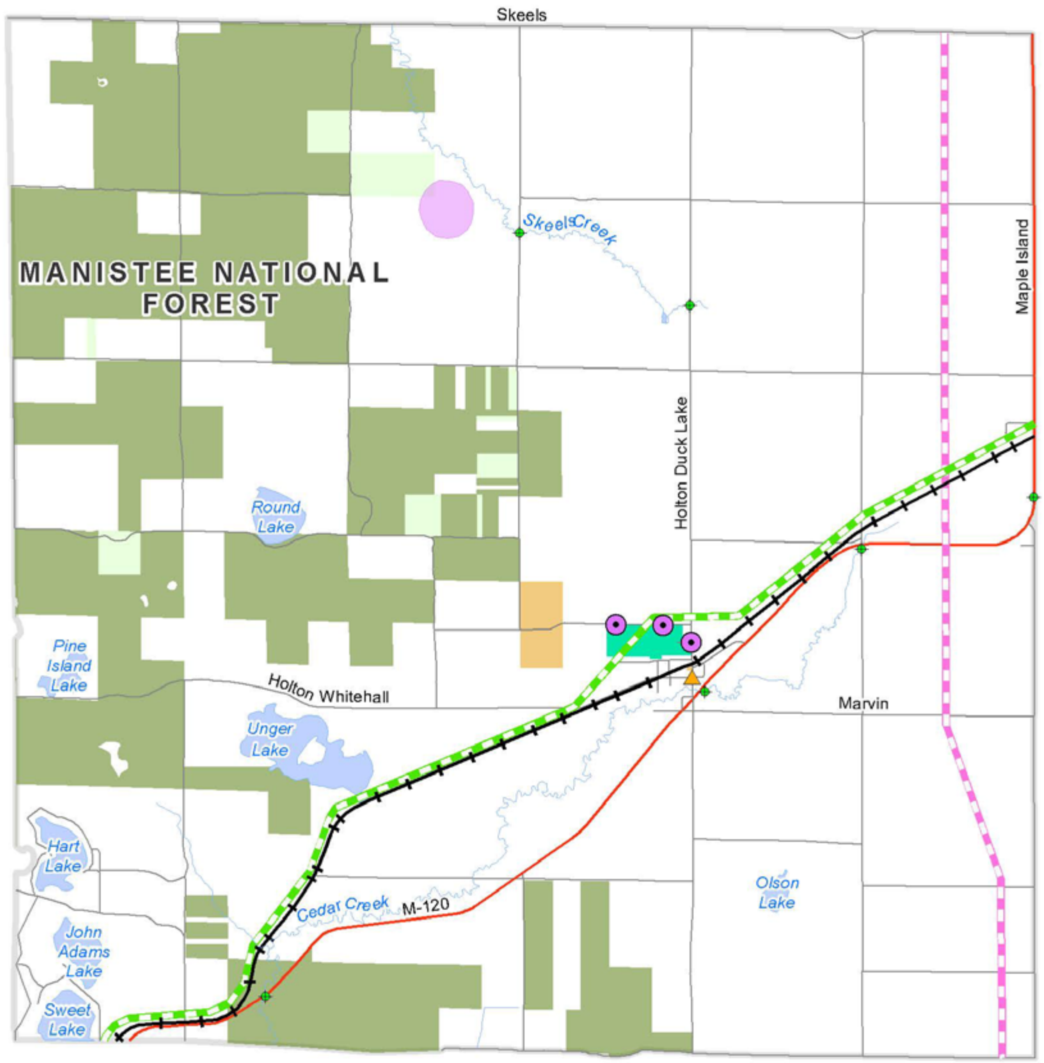
3.05 Terrorism and Similar Criminal Activities: - None Identified.

	Holton Township Hazard Rating	Probability of Occurrence	Impact on People	Impact on Property	Impact on Economy	Impacts Total	Hazard Score
1.01	Celestial Impacts	1	2	0	2	8	8
1.02	Drought	2	2	2	2	12	24
1.03	Earthquake	0	-	-	-	-	-
1.04	Extreme Temperatures	3	2	1	2	10	30
1.05	Flooding: Riverine/Urban	2	1	1	1	6	12
1.06	Fog	2	1	0	1	4	8
1.07	Great Lakes Shoreline	0	-	-	-	-	-
1.08	Hail	2	2	1	1	9	18
1.09	Invasive Species	2	1	1	2	7	14
1.10	Lightning	3	1	2	1	8	24
1.11	Severe Winds	3	2	2	2	12	36
1.12	Subsidence	1	1	1	1	6	6
1.13	Tornadoes	1	2	2	2	12	12
1.14	Wildfire	3	1	2	1	8	24
1.15	Winter Storms	3	3	2	2	15	45
2.01	Dam failure	0	-	-	-	-	-
2.02	Energy Emergencies	2	2	0	2	8	16
2.03	Fire – Scrap Tires	1	1	1	1	6	6
2.04	Fire – Structural	3	1	2	2	9	27
2.05	HAZMAT – Fixed Site	2	1	1	1	6	12
2.06	HAZMAT – Transportation	2	1	1	1	6	12
2.07	Infrastructure Failures	3	2	1	2	10	30
2.08	Nuclear Power Emergencies	0	-	-	-	-	-
2.09	Oil/Natural Gas Well Accidents	2	1	1	1	6	12
2.10	Pipeline Accidents	0	-	-	-	-	-
2.11	Transportation Accidents	2	1	1	2	7	14
3.01	Catastrophic Incidents	1	3	3	3	18	18
3.02	Civil Disturbances	1	1	1	1	6	6
3.03	Nuclear Attack	0	-	-	-	-	-
3.04	Public Health Emergencies	2	2	0	3	9	18
3.05	Terrorism & Similar Criminal Acts	1	1	1	1	6	6

Holton Township Hazard Ranking

		Probability of Occurrence	X Impacts Total	= Hazard Score
1	Winter Storms	3	15	45
2	Severe Winds	3	12	36
3	Extreme Temperatures	3	10	30
3	Infrastructure Failures	3	10	30
5	Fire – Structural	3	9	27
6	Drought	2	12	24
6	Lightning	3	8	24
6	Wildfire	3	8	24
9	Catastrophic Incidents	1	18	18
9	Hail	2	9	18
9	Public Health Emergencies	2	9	18
12	Energy Emergencies	2	8	16
13	Invasive Species	2	7	14
13	Transportation Accidents	2	7	14
15	Flooding: Riverine/Urban	2	6	12
15	HAZMAT – Fixed Site	2	6	12
15	HAZMAT – Transportation	2	6	12
15	Oil/Natural Gas Well Accidents	2	6	12
15	Tornadoes	1	12	12
20	Celestial Impacts	1	8	8
20	Fog	2	4	8
22	Civil Disturbances	1	6	6
22	Fire – Scrap Tires	1	6	6
22	Subsidence	1	6	6
22	Terrorism & Similar Criminal Acts	1	6	6
	Dam Failure	0	-	-
	Earthquake	0	-	-
	Great Lakes Shoreline	0	-	-
	Nuclear Attack	0	-	-
	Nuclear Power Emergencies	0	-	-
	Pipeline Accidents	0	-	-

HOLTON TOWNSHIP
Critical Facilities and Potential Hazards



- State Trunkline
- Street
- Railroad
- Gas Pipeline
- Power Line
- Bridge
- Fire/Police/EMS/911
- School
- Federal Land
- State Land
- Municipal Land
- School Property
- Oil/Gas Field

Note: This jurisdiction is subject to many additional hazards; some of which tend to occur across wide areas and cannot be effectively shown on this map.Refer to **Appendix B- Hazard Identifications and Analyses** for more complete information about potential hazards in this community.

WMSRDC
WEST MICHIGAN SHORELINE REGIONAL DEVELOPMENT COMMISSION

Source: Michigan Geographic Data Library V 12b, Muskegon Co. Hazard Mitigation Plan Update 2014

Hazard Identification Profile
Laketon Township

1. NATURAL HAZARDS

1.01 Celestial Impacts: - None Identified.

1.02 Drought:
- 12 recorded drought events in the area (including Lake, Mason, Muskegon, Newaygo, and Oceana counties) lasting eight months or greater: 1895-1896, 1899-1900, 1901-1902, 1909-1911, 1925-1926, 1930-1931, 1956-1957, 1962-1963, 1971-1972, 1976-1977, and 2002-2003.
- Summer 1871: Prolonged drought over much of the Great Lakes region.
- May-September, 1891: Drought devastated Michigan's lumber industry.

1.03 Earthquake: - None Identified.

1.04 Extreme Temperatures:
- July 1936: Heatwave. 570 deaths statewide, 7 in Muskegon.
- Summer, 1988: 39 days with temperatures over 90 degrees, statewide.
- January 13-20, 1994: Record cold. $50m property damage across Michigan.
- December 9-10, 1995: Coldwave across Lower Michigan.
- March 2012: Record warm temperatures triggered early growing season. $209.8m crop damage across Michigan.

1.05 Flooding - Riverine/ Urban:
- August 20 - September 6, 1975: Flooding. Declaration of major disaster by President.
- February 21, 1986: Great lakes flooding and wave action. Declaration of disaster by Governor.
- September 10-19, 1986: Flooding. Declaration of major disaster by President.
- September, 1986: Flooding & heavy rain. Declaration of disaster by Governor.
- May 18-20, 2000: Flood. $100k property damage, $50k crop damage in Muskegon County.
- February 9-10, 2001: Flooding. $100k property damage across West Michigan.
- February 24-28, 2001: Flooding. $190k property damage across West Michigan.
- May 15-16, 2001: Flooding. $500k property damage, $200k crop damage across southwestern Lower Michigan.
- May 20-24, 2004: Flooding. Declaration of major disaster by President.
- April 17-23, 2013: Flooding. Declaration of major disaster by President. $5m property damage, Muskegon County.

1.06 Fog: - January 11-13, 1995: Dense Fog. 4 traffic accident fatalities, school closures, and flight delays, Lower Michigan.

1.07 Great Lakes Shoreline Hazards:
- Extreme high water levels in the Great Lakes: 1929, 1952, 1973, 1986, and 1997.
- Extreme low water levels in the Great Lakes: 1926, 1934, 1964, 2003, and 2013.
- Rip current incidents on Lake Michigan, 2002-2012: 77 fatalities, 230 rescues.
- June 1986: Record high water level on Lake Michigan.
- 2013: Record low water level on Lake Michigan.

1.08 Hail:
- Days with severe hail reported (1" or greater) recorded in Muskegon County, 2000-2012: 7
- May 15, 2001: 0.75-1.00 inch hail. $95k property damage, $95k crop damage across Muskegon County.
- August 3, 2003: 1.75 inch hail in Muskegon Twp, $55k property damage and $25k crop damage from hail countywide.

1.09 Invasive Species: - Invasive species exist in Muskegon County; No significant events identified.

1.10 Lightning:
- July 20, 1994: Lightning killed a dog and caused $50k property damage, Muskegon County.
- ***July 4, 1995: Lightning struck a boat in the Muskegon Lake Channel. $10k property damage.***

1.11 Severe Winds:
- August 20 - September 6, 1975: Rainstorms, high winds. Declaration of major disaster by President.
- November 18, 1994: High wind. $1m property damage statewide.
- April 6, 1997: High wind. $5m property damage across southwest Lower Michigan.
- May 29, 1998: Severe thunderstorm winds. 54,000 homes and businesses without power; estimated 500 homes and 30 businesses sustained minor to moderate damage. $1m property damage, Muskegon County.
- May 31, 1998: Thunderstorms & high winds. Declarations of disaster by Governor and major disaster by President. $2,458,958 in public damage costs, 42 homes destroyed, 1,805 homes damaged, 5 businesses destroyed, and 73 businesses damaged. Total public and private costs have been estimated at $24,205,908.
- August 22, 2000: Severe thunderstorm winds. $150k property damage, Muskegon County.
- March 9, 2002: High wind. $485k property damage across southwest Lower Michigan.
- October 30, 2004: High wind. $1.15m property damage across southwest Lower Michigan.
- May 20-24, 2004: Severe storms. Declaration of major disaster by President.
- August 9, 2009: Severe thunderstorm winds. $2m property damage, Muskegon County.
- November 17, 2013: Severe thunderstorm winds. $200k property damage, Muskegon County.

1.12 Subsidence: - None Identified.

1.13 Tornadoes: - Number of tornadoes in Muskegon County, 1950-2012: 7.

1.14 Wildfire:
- October 1871: Wildfires. 1.2m acres burned, 200 fatalities, Michigan's Lower Peninsula.
- May-September, 1891: Uncontrollable wildfires across Michigan during the drought of 1891.

- 1981-2010: Approximately 8 wildfires and 89 acres burned per year on county lands under MDNR jurisdiction (251 total wildfires, 2,676.0 total acres burned).

1.15 Winter Storms:

- March 2-7, 1976: Ice storms. Declaration of major disaster by President.
- January 26-31, 1977: Blizzard, snowstorm. Declaration of emergency by President.
- January 26-27, 1978: Blizzard, snowstorm. Declaration of statewide emergency by President.
- January 12, 1993: Heavy snow. $50k property damage, northern Lower Michigan.
- January 12-21, 1994: Heavy lake effect snow. $500k property damage across western Lower Michigan.
- January 27, 1994: Heavy snow and freezing rain. $5m property damage across region.
- October 26, 1997: Heavy snow. $1.2m property damage across southwestern Lower Michigan.
- March 9, 1998: Winter storm. $100k property damage across region.
- January 2-15, 1999: Blizzard, snowstorm. Declaration of emergency by President.
- December 11-31, 2000: Blizzard, snowstorm. Declaration of emergency by President.
- April 3, 2003: Ice storm. $4.9m property damage throughout West Michigan.
- February 16, 2006: Ice storm. $1m property damage across Lower Michigan.

2. TECHNOLOGICAL HAZARDS

2.01 Dam Failure:

- Four documented failures in Muskegon County, unidentified locations.

2.02 Energy Emergencies:

- February 2003: A break in a major transmission line caused an electrical blackout over parts of Montcalm, Oceana, Newaygo, Muskegon, and Kent counties.

2.03 Fire - Scrap Tire:

- Approximate scrap tire inventory in Muskegon County in 2012: 4,400.

2.04 Fire - Structural:

- County fire rate per 1,000 population in 1998: 3.8.

2.05 Hazard Material Incidents - Fixed Site (including industrial accidents):

- SARA Title III Sites in Muskegon County in 2012: 51.

2.06 Hazard Material Incidents - Transportation: - None Identified.

2.07 Infrastructure Failure:

- Number of NCDC records with mention of downed power lines or power outages in Muskegon County, 1993-2012: 45
- Number of sanitary sewer overflows in Muskegon County, 2000-2011: 47.
- August 8, 1993: 4,400 without power (thunderstorm winds), Muskegon and Oceana counties
- March 9, 1998: 1,900 power outages (blizzard conditions), Lake, Clare, Oceana and Muskegon counties.
- May 29-30, 1998: 54,000 without power; 27,000 on second day (thunderstorm winds), Muskegon County.
- May 31, 1998: 50,000 without power (thunderstorm winds), Muskegon County.
- May 31, 1998: Half of Whitehall City without water service (thunderstorm winds).
- June 18, 1998: Most of Montague without power (thunderstorm winds and lightning), Montague City and Montague Twp.
- July 21, 1998: 7,500 without power (thunderstorm winds and lightning), Muskegon County.

2.08 Nuclear Power Plant Emergencies: - None Identified.

2.09 Oil and Natural Gas Well Accidents:

- Oil and gas wells in Muskegon County in 2012: 1,090.
- ***3 wells with known detectable levels of hydrogen sulfide in Laketon Township.***
- ***Orphan well in Laketon Township slowly leaking crude oil into tributary of Bear Lake.***

2.10 Pipeline Accidents: - None Identified.

2.11 Transportation Accidents: - None Identified.

3. HUMAN -RELATED HAZARDS

3.01 Catastrophic Incidents (National Emergencies):

- 1939-1945: World War II. In Muskegon, 48-hour minimum work weeks, rationing of certain food and goods, and 274 county men killed in battle.
- 2005: Hurricanes Katrina and Rita. Declarations of Gubernatorial Disaster and Presidential Emergency were issued in Michigan in September 2005 for hurricane evacuation.

3.02 Civil Disturbances: - None Identified.

3.03 Nuclear Attack: - None Identified.

3.04 Public Health Emergencies:

- 1913: Diphtheria Epidemic.
- 1916: Small pox and scarlet fever force closures of schools and businesses.
- 1918: Influenza epidemic closes theaters, dance halls, and churches.
- 1937: Children under 18 banned from theaters and schools close from fear of polio outbreak.
- 1941: Influenza epidemic cuts school attendance by 60%.
- 2009: H1N1 influenza pandemic causes school absences spike in the fall. Two county residents die from complications.

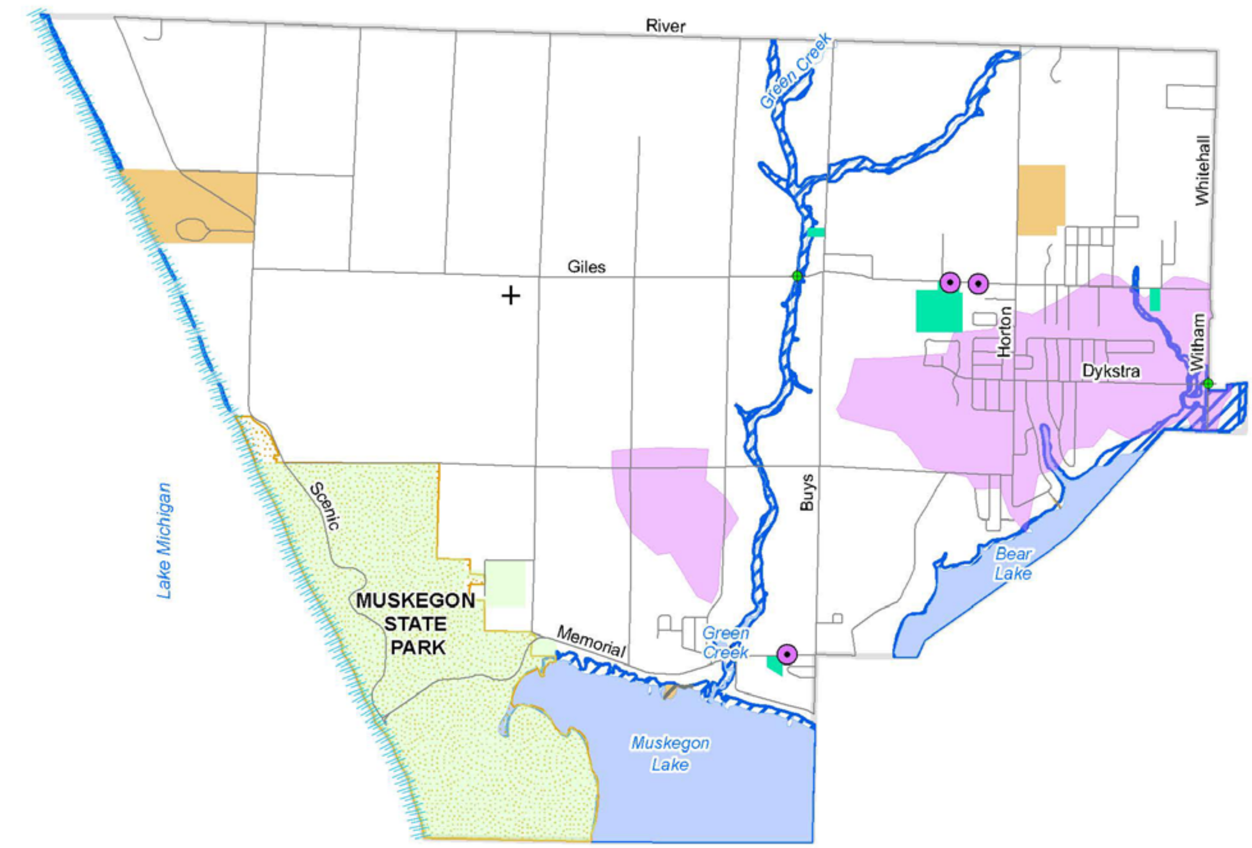
3.05 Terrorism and Similar Criminal Activities: - None Identified.

	Laketon Township Hazard Rating	Probability of Occurrence	Impact on People	Impact on Property	Impact on Economy	Impacts Total	Hazard Score
1.01	Celestial Impacts	1	2	0	2	8	8
1.02	Drought	2	2	1	2	10	20
1.03	Earthquake	0	-	-	-	-	-
1.04	Extreme Temperatures	3	2	1	1	9	27
1.05	Flooding: Riverine/Urban	3	1	2	2	9	27
1.06	Fog	3	1	0	1	4	12
1.07	Great Lakes Shoreline	3	1	2	1	8	24
1.08	Hail	2	2	1	1	9	18
1.09	Invasive Species	2	1	1	1	6	12
1.10	Lightning	3	1	2	1	8	24
1.11	Severe Winds	3	2	2	2	12	36
1.12	Subsidence	1	1	1	1	6	6
1.13	Tornadoes	1	2	2	2	12	12
1.14	Wildfire	3	1	2	1	8	24
1.15	Winter Storms	3	3	2	2	15	45
2.01	Dam failure	1	1	1	1	6	6
2.02	Energy Emergencies	2	2	0	2	8	16
2.03	Fire – Scrap Tires	1	1	1	1	6	6
2.04	Fire – Structural	3	1	2	3	10	30
2.05	HAZMAT – Fixed Site	0	-	-	-	-	-
2.06	HAZMAT – Transportation	1	1	1	1	6	6
2.07	Infrastructure Failures	3	2	1	2	10	30
2.08	Nuclear Power Emergencies	0	-	-	-	-	-
2.09	Oil/Natural Gas Well Accidents	2	1	2	1	8	16
2.10	Pipeline Accidents	0	-	-	-	-	-
2.11	Transportation Accidents	2	1	1	1	6	12
3.01	Catastrophic Incidents	1	3	3	3	18	18
3.02	Civil Disturbances	1	1	1	1	6	6
3.03	Nuclear Attack	0	-	-	-	-	-
3.04	Public Health Emergencies	2	2	0	3	9	18
3.05	Terrorism & Similar Criminal Acts	1	1	1	1	6	6

Laketon Township Hazard Ranking

		Probability of Occurrence X	Impacts Total =	Hazard Score
1	Winter Storms	3	15	45
2	Severe Winds	3	12	36
3	Fire – Structural	3	10	30
3	Infrastructure Failures	3	10	30
5	Extreme Temperatures	3	9	27
5	Flooding: Riverine/Urban	3	9	27
7	Great Lakes Shoreline	3	8	24
7	Lightning	3	8	24
7	Wildfire	3	8	24
10	Drought	2	10	20
11	Catastrophic Incidents	1	18	18
11	Hail	2	9	18
11	Public Health Emergencies	2	9	18
14	Energy Emergencies	2	8	16
14	Oil/Natural Gas Well Accidents	2	8	16
16	Fog	3	4	12
16	Invasive Species	2	6	12
16	Tornadoes	1	12	12
16	Transportation Accidents	2	6	12
20	Celestial Impacts	1	8	8
21	Civil Disturbances	1	6	6
21	Dam Failure	1	6	6
21	Fire – Scrap Tires	1	6	6
21	HAZMAT – Transportation	1	6	6
21	Subsidence	1	6	6
21	Terrorism & Similar Criminal Acts	1	6	6
	Earthquake	0	-	-
	HAZMAT – Fixed Site	0	-	-
	Nuclear Attack	0	-	-
	Nuclear Power Emergencies	0	-	-
	Pipeline Accidents	0	-	-

LAKETON TOWNSHIP
Critical Facilities and Potential Hazards



0 0.5 1 Miles

Note: This jurisdiction is subject to many additional hazards; some of which tend to occur across wide areas and cannot be effectively shown on this map.Refer to **Appendix B- Hazard Identifications and Analyses** for more complete information about potential hazards in this community.

- Street
- Great Lakes Shoreline Hazard
- Bridge
- Communications Tower
- State Land
- Municipal Land
- School Property
- High-Risk Erosion Area
- Oil/Gas Field
- Floodplain

WMSRDC
WEST MICHIGAN SHORELINE REGIONAL DEVELOPMENT COMMISSION

Source: Michigan Geographic Data Library V 12b, Muskegon Co. Hazard Mitigation Plan Update 2014

Hazard Identification Profile
Montague Township

1. NATURAL HAZARDS

1.01 Celestial Impacts: - None Identified.

1.02 Drought:
- 12 recorded drought events in the area (including Lake, Mason, Muskegon, Newaygo, and Oceana counties) lasting eight months or greater: 1895-1896, 1899-1900, 1901-1902, 1909-1911, 1925-1926, 1930-1931, 1956-1957, 1962-1963, 1971-1972, 1976-1977, and 2002-2003.
- Summer 1871: Prolonged drought over much of the Great Lakes region.
- May-September, 1891: Drought devastated Michigan's lumber industry.
- 2013: Record low water level on Lake Michigan.

1.03 Earthquake: - None Identified.

1.04 Extreme Temperatures:
- July 1936: Heatwave. 570 deaths statewide, 7 in Muskegon.
- Summer, 1988: 39 days with temperatures over 90 degrees, statewide.
- January 13-20, 1994: Record cold. $50m property damage across Michigan.
- December 9-10, 1995: Coldwave across Lower Michigan.
- March 2012: Record warm temperatures triggered early growing season. $209.8m crop damage across Michigan.

1.05 Flooding - Riverine/ Urban:
- August 20 - September 6, 1975: Flooding. Declaration of major disaster by President.
- February 21, 1986: Great lakes flooding and wave action. Declaration of disaster by Governor.
- September 10-19, 1986: Flooding. Declaration of major disaster by President.
- September, 1986: Flooding & heavy rain. Declaration of disaster by Governor.
- May 18-20, 2000: Flood. $100k property damage, $50k crop damage in Muskegon County.
- February 9-10, 2001: Flooding. $100k property damage across West Michigan.
- February 24-28, 2001: Flooding. $190k property damage across West Michigan.
- May 15-16, 2001: Flooding. $500k property damage, $200k crop damage across southwestern Lower Michigan.
- May 20-24, 2004: Flooding. Declaration of major disaster by President.
- April 17-23, 2013: Flooding. Declaration of major disaster by President. $5m property damage, Muskegon County.

1.06 Fog:
- January 11-13, 1995: Dense Fog. 4 traffic accident fatalities, school closures, and flight delays across Lower Michigan.

1.07 Great Lakes Shoreline Hazards: - None Identified.

1.08 Hail:
- Days with severe hail reported (1" or greater) recorded in Muskegon County, 2000-2012: 7
- May 15, 2001: 0.75-1.00 inch hail. $95k property damage, $95k crop damage across Muskegon County.
- August 3, 2003: 1.75 inch hail in Muskegon Twp, $55k property damage and $25k crop damage from hail countywide.

1.09 Invasive Species: - Invasive species exist in Muskegon County; No significant events identified.

1.10 Lightning:
- July 20, 1994: Lightning killed a dog and caused $50k property damage, Muskegon County.

1.11 Severe Winds:
- August 20 - September 6, 1975: Rainstorms, high winds. Declaration of major disaster by President.
- November 18, 1994: High wind. $1m property damage statewide.
- April 6, 1997: High wind. $5m property damage across southwest Lower Michigan.
- May 29, 1998: Severe thunderstorm winds. 54,000 homes and businesses without power; estimated 500 homes and 30 businesses sustained minor to moderate damage. $1m property damage, Muskegon County.
- May 31, 1998: Thunderstorms & high winds. Declarations of disaster by Governor and major disaster by President. $2,458,958 in public damage costs, 42 homes destroyed, 1,805 homes damaged, 5 businesses destroyed, and 73 businesses damaged. Total public and private costs have been estimated at $24,205,908.
- August 22, 2000: Severe thunderstorm winds. $150k property damage, Muskegon County.
- March 9, 2002: High wind. $485k property damage across southwest Lower Michigan.
- October 30, 2004: High wind. $1.15m property damage across southwest Lower Michigan.
- May 20-24, 2004: Severe storms. Declaration of major disaster by President.
- August 9, 2009: Severe thunderstorm winds. $2m property damage, Muskegon County.
- November 17, 2013: Severe thunderstorm winds. $200k property damage, Muskegon County.

1.12 Subsidence: - None Identified.

1.13 Tornadoes:
- Number of tornadoes in Muskegon County, 1950-2012: 7.

1.14 Wildfire:
- October 1871: Wildfires. 1.2m acres burned, 200 fatalities, Michigan's Lower Peninsula.
- May-September, 1891: Uncontrollable wildfires across Michigan during the drought of 1891.
- 1981-2010: Approximately 8 wildfires and 89 acres burned per year on county lands under MDNR jurisdiction (251 total wildfires, 2,676.0 total acres burned).

1.15 Winter Storms:

- March 2-7, 1976: Ice storms. Declaration of major disaster by President.
- January 26-31, 1977: Blizzard, snowstorm. Declaration of emergency by President.
- January 26-27, 1978: Blizzard, snowstorm. Declaration of statewide emergency by President.
- January 12, 1993: Heavy snow. $50k property damage, northern Lower Michigan.
- January 12-21, 1994: Heavy lake effect snow. $500k property damage across western Lower Michigan.
- January 27, 1994: Heavy snow and freezing rain. $5m property damage across region.
- October 26, 1997: Heavy snow. $1.2m property damage across southwestern Lower Michigan.
- March 9, 1998: Winter storm. $100k property damage across region.
- January 2-15, 1999: Blizzard, snowstorm. Declaration of emergency by President.
- December 11-31, 2000: Blizzard, snowstorm. Declaration of emergency by President.
- April 3, 2003: Ice storm. $4.9m property damage throughout West Michigan.
- February 16, 2006: Ice storm. $1m property damage across Lower Michigan.

2. TECHNOLOGICAL HAZARDS

2.01 Dam Failure:

- Four documented failures in Muskegon County, unidentified locations.

2.02 Energy Emergencies:

- February 2003: A break in a major transmission line caused an electrical blackout over parts of Montcalm, Oceana, Newaygo, Muskegon, and Kent counties.

2.03 Fire - Scrap Tire:

- Approximate scrap tire inventory in Muskegon County in 2012: 4,400.

2.04 Fire - Structural:

- County fire rate per 1,000 population in 1998: 3.8.

2.05 Hazard Material Incidents - Fixed Site (including industrial accidents):

- SARA Title III Sites in Muskegon County in 2012: 51.

2.06 Hazard Material Incidents - Transportation: - None Identified.

2.07 Infrastructure Failure:

- Number of NCDC records with mention of downed power lines or power outages in Muskegon County, 1993-2012: 45
- Number of sanitary sewer overflows in Muskegon County, 2000-2011: 47.
- August 8, 1993: 4,400 without power (thunderstorm winds), Muskegon and Oceana counties
- March 9, 1998: 1,900 power outages (blizzard conditions), Lake, Clare, Oceana and Muskegon counties.
- May 29-30, 1998: 54,000 without power; 27,000 on second day (thunderstorm winds), Muskegon County.
- May 31, 1998: 50,000 without power (thunderstorm winds), Muskegon County.
- ***June 18, 1998: Most of Montague without power (thunderstorm winds and lightning), Montague City and Montague Township.***
- July 21, 1998: 7,500 without power (thunderstorm winds and lightning), Muskegon County.

2.08 Nuclear Power Plant Emergencies: - None Identified.

2.09 Oil and Natural Gas Well Accidents:

- Oil and gas wells in Muskegon County in 2012: 1,090.

2.10 Pipeline Accidents: - None Identified.

2.11 Transportation Accidents: - None Identified.

3. HUMAN -RELATED HAZARDS

3.01 Catastrophic Incidents (National Emergencies):

- 1939-1945: World War II. In Muskegon, 48-hour minimum work weeks, rationing of certain food and goods, and 274 county men killed in battle.
- 2005: Hurricanes Katrina and Rita. Declarations of Gubernatorial Disaster and Presidential Emergency were issued in Michigan in September 2005 for hurricane evacuation.

3.02 Civil Disturbances: - None Identified.

3.03 Nuclear Attack: - None Identified.

3.04 Public Health Emergencies:

- 1913: Diphtheria Epidemic.
- 1916: Small pox and scarlet fever force closures of schools and businesses.
- 1918: Influenza epidemic closes theaters, dance halls, and churches.
- 1937: Children under 18 banned from theaters and schools close from fear of polio outbreak.
- 1941: Influenza epidemic cuts school attendance by 60%.
- 2009: H1N1 influenza pandemic causes school absences spike in the fall. Two county residents die from complications.

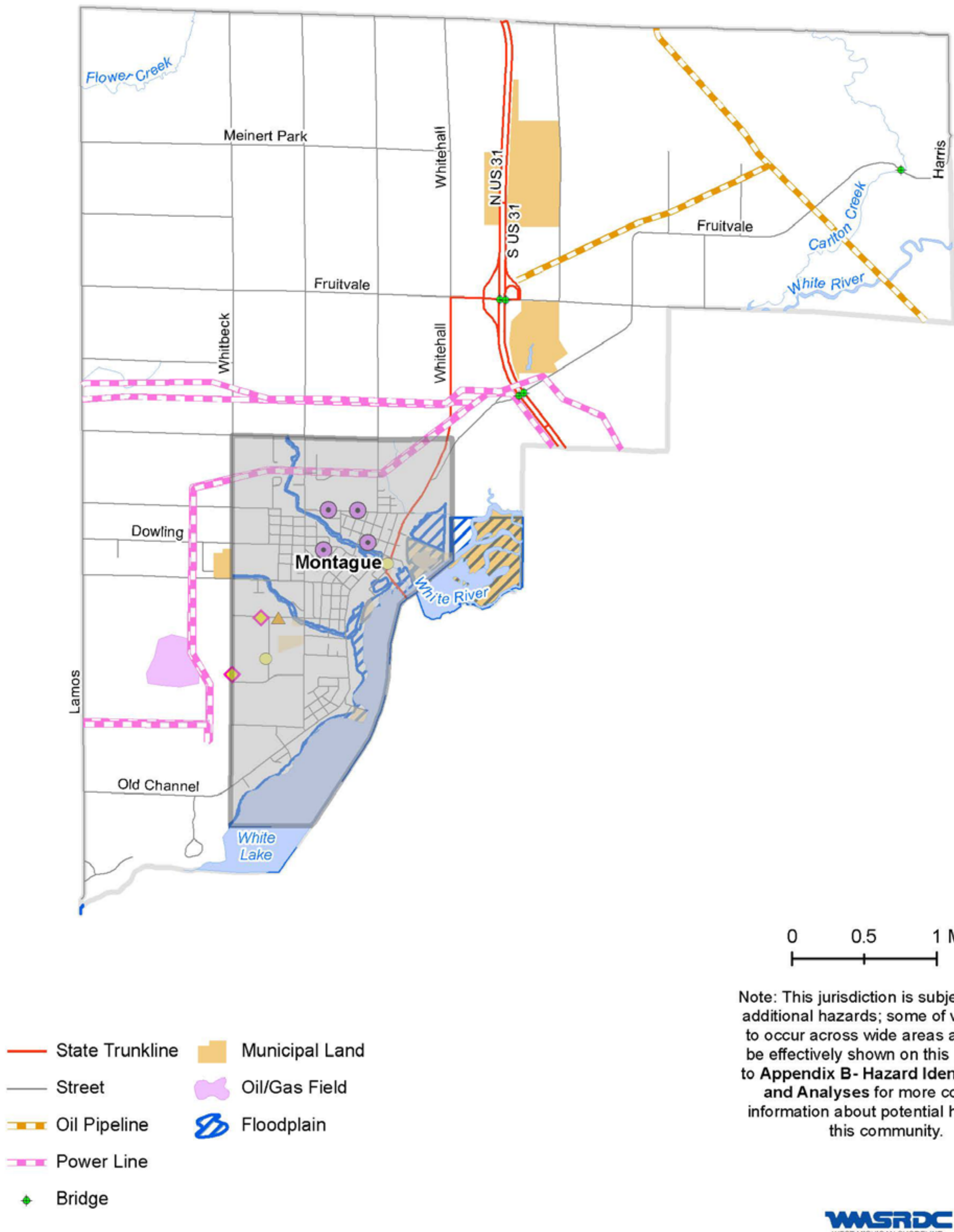
3.05 Terrorism and Similar Criminal Activities: - None Identified.

	Montague Township Hazard Rating	Probability of Occurrence	Impact on People	Impact on Property	Impact on Economy	Impacts Total	Hazard Score
1.01	Celestial Impacts	1	2	0	2	8	8
1.02	Drought	2	2	2	2	12	24
1.03	Earthquake	0	-	-	-	-	-
1.04	Extreme Temperatures	3	2	1	1	9	27
1.05	Flooding: Riverine/Urban	2	1	2	2	9	18
1.06	Fog	3	1	0	1	4	12
1.07	Great Lakes Shoreline	0	-	-	-	-	-
1.08	Hail	2	2	1	1	9	18
1.09	Invasive Species	2	1	1	2	7	14
1.10	Lightning	3	1	2	1	8	24
1.11	Severe Winds	3	2	2	2	12	36
1.12	Subsidence	1	1	1	1	6	6
1.13	Tornadoes	1	2	2	2	12	12
1.14	Wildfire	3	1	2	1	8	24
1.15	Winter Storms	3	3	2	2	15	45
2.01	Dam failure	1	1	1	1	6	6
2.02	Energy Emergencies	2	2	0	2	8	16
2.03	Fire – Scrap Tires	1	1	1	1	6	6
2.04	Fire – Structural	3	1	2	2	9	27
2.05	HAZMAT – Fixed Site	1	1	1	1	6	6
2.06	HAZMAT – Transportation	3	1	1	1	6	18
2.07	Infrastructure Failures	3	2	1	2	10	30
2.08	Nuclear Power Emergencies	0	-	-	-	-	-
2.09	Oil/Natural Gas Well Accidents	2	1	1	1	6	12
2.10	Pipeline Accidents	1	1	1	2	7	7
2.11	Transportation Accidents	2	1	1	2	7	14
3.01	Catastrophic Incidents	1	3	3	3	18	18
3.02	Civil Disturbances	1	1	1	1	6	6
3.03	Nuclear Attack	0	-	-	-	-	-
3.04	Public Health Emergencies	2	2	0	3	9	18
3.05	Terrorism & Similar Criminal Acts	1	1	1	1	6	6

Montague Township Hazard Ranking

		Probability of Occurrence	X Impacts Total	= Hazard Score
1	Winter Storms	3	15	45
2	Severe Winds	3	12	36
3	Infrastructure Failures	3	10	30
4	Extreme Temperatures	3	9	27
4	Fire – Structural	3	9	27
6	Drought	2	12	24
6	Lightning	3	8	24
6	Wildfire	3	8	24
9	Catastrophic Incidents	1	18	18
9	Flooding: Riverine/Urban	2	9	18
9	Hail	2	9	18
9	HAZMAT – Transportation	3	6	18
9	Public Health Emergencies	2	9	18
14	Energy Emergencies	2	8	16
15	Invasive Species	2	7	14
15	Transportation Accidents	2	7	14
17	Fog	3	4	12
17	Oil/Natural Gas Well Accidents	2	6	12
17	Tornadoes	1	12	12
20	Celestial Impacts	1	8	8
21	Pipeline Accidents	1	7	7
22	Civil Disturbances	1	6	6
22	Dam Failure	1	6	6
22	Fire – Scrap Tires	1	6	6
22	HAZMAT – Fixed Site	1	6	6
22	Subsidence	1	6	6
22	Terrorism & Similar Criminal Acts	1	6	6
	Earthquake	0	-	-
	Great Lakes Shoreline	0	-	-
	Nuclear Attack	0	-	-
	Nuclear Power Emergencies	0	-	-

MONTAGUE TOWNSHIP
Critical Facilities and Potential Hazards



Note: This jurisdiction is subject to many additional hazards; some of which tend to occur across wide areas and cannot be effectively shown on this map.Refer to **Appendix B- Hazard Identifications and Analyses** for more complete information about potential hazards in this community.

WMSRDC
WEST MICHIGAN SHORELINE REGIONAL DEVELOPMENT COMMISSION

Source: Michigan Geographic Data Library V 12b, Muskegon Co. Hazard Mitigation Plan Update 2014

Hazard Identification Profile
Moorland Township

1. NATURAL HAZARDS

1.01 Celestial Impacts: - None Identified.

1.02 Drought:
- 12 recorded drought events in the area (including Lake, Mason, Muskegon, Newaygo, and Oceana counties) lasting eight months or greater: 1895-1896, 1899-1900, 1901-1902, 1909-1911, 1925-1926, 1930-1931, 1956-1957, 1962-1963, 1971-1972, 1976-1977, and 2002-2003.
- Summer 1871: Prolonged drought over much of the Great Lakes region.
- May-September, 1891: Drought devastated Michigan's lumber industry.
- 2013: Record low Lake Michigan water levels.

1.03 Earthquake: - None Identified.

1.04 Extreme Temperatures:
- July 1936: Heatwave. 570 deaths statewide, 7 in Muskegon.
- Summer, 1988: 39 days with temperatures over 90 degrees, statewide.
- January 13-20, 1994: Record cold. $50m property damage across Michigan.
- December 9-10, 1995: Coldwave across Lower Michigan.
- March 2012: Record warm temperatures triggered early growing season. $209.8m crop damage across Michigan.

1.05 Flooding - Riverine/ Urban:
- August 20 - September 6, 1975: Flooding. Declaration of major disaster by President.
- February 21, 1986: Great lakes flooding and wave action. Declaration of disaster by Governor.
- September 10-19, 1986: Flooding. Declaration of major disaster by President.
- September, 1986: Flooding & heavy rain. Declaration of disaster by Governor.
- May 18-20, 2000: Flood. $100k property damage, $50k crop damage in Muskegon County.
- February 9-10, 2001: Flooding. $100k property damage across West Michigan.
- February 24-28, 2001: Flooding. $190k property damage across West Michigan.
- May 15-16, 2001: Flooding. $500k property damage, $200k crop damage across southwestern Lower Michigan.
- May 20-24, 2004: Flooding. Declaration of major disaster by President.
- April 17-23, 2013: Flooding. Declaration of major disaster by President. $5m property damage, Muskegon County.

1.06 Fog:
- January 11-13, 1995: Dense Fog. 4 traffic accident fatalities, school closures, and flight delays across Lower Michigan.

1.07 Great Lakes Shoreline Hazards: - None Identified.

1.08 Hail:
- Days with severe hail reported (1" or greater) recorded in Muskegon County, 2000-2012: 7
- May 15, 2001: 0.75-1.00 inch hail. $95k property damage, $95k crop damage across Muskegon County.
- August 3, 2003: 1.75 inch hail in Muskegon Twp, $55k property damage and $25k crop damage from hail countywide.

1.09 Invasive Species: - Invasive species exist in Muskegon County; No significant events identified.

1.10 Lightning:
- July 20, 1994: Lightning killed a dog and caused $50k property damage, Muskegon County.

1.11 Severe Winds:
- August 20 - September 6, 1975: Rainstorms, high winds. Declaration of major disaster by President.
- November 18, 1994: High wind. $1m property damage statewide.
- April 6, 1997: High wind. $5m property damage across southwest Lower Michigan.
- May 29, 1998: Severe thunderstorm winds. 54,000 homes and businesses without power; estimated 500 homes and 30 businesses sustained minor to moderate damage. $1m property damage, Muskegon County.
- May 31, 1998: Thunderstorms & high winds. Declarations of disaster by Governor and major disaster by President. $2,458,958 in public damage costs, 42 homes destroyed, 1,805 homes damaged, 5 businesses destroyed, and 73 businesses damaged. Total public and private costs have been estimated at $24,205,908.
- August 22, 2000: Severe thunderstorm winds. $150k property damage, Muskegon County.
- March 9, 2002: High wind. $485k property damage across southwest Lower Michigan.
- October 30, 2004: High wind. $1.15m property damage across southwest Lower Michigan.
- May 20-24, 2004: Severe storms. Declaration of major disaster by President.
- August 9, 2009: Severe thunderstorm winds. $2m property damage, Muskegon County.
- November 17, 2013: Severe thunderstorm winds. $200k property damage, Muskegon County.

1.12 Subsidence: - None Identified.

1.13 Tornadoes:
- Number of tornadoes in Muskegon County, 1950-2012: 7.

1.14 Wildfire:
- October 1871: Wildfires. 1.2m acres burned, 200 fatalities, Michigan's Lower Peninsula.
- May-September, 1891: Uncontrollable wildfires across Michigan during the drought of 1891.
- 1981-2010: Approximately 8 wildfires and 89 acres burned per year on county lands under MDNR jurisdiction (251 total wildfires, 2,676.0 total acres burned).

1.15 Winter Storms:

- March 2-7, 1976: Ice storms. Declaration of major disaster by President.
- January 26-31, 1977: Blizzard, snowstorm. Declaration of emergency by President.
- January 26-27, 1978: Blizzard, snowstorm. Declaration of statewide emergency by President.
- January 12, 1993: Heavy snow. $50k property damage, northern Lower Michigan.
- January 12-21, 1994: Heavy lake effect snow. $500k property damage across western Lower Michigan.
- January 27, 1994: Heavy snow and freezing rain. $5m property damage across region.
- October 26, 1997: Heavy snow. $1.2m property damage across southwestern Lower Michigan.
- March 9, 1998: Winter storm. $100k property damage across region.
- January 2-15, 1999: Blizzard, snowstorm. Declaration of emergency by President.
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- April 3, 2003: Ice storm. $4.9m property damage throughout West Michigan.
- February 16, 2006: Ice storm. $1m property damage across Lower Michigan.

2. TECHNOLOGICAL HAZARDS

2.01 Dam Failure:

- Four documented failures in Muskegon County, unidentified locations.

2.02 Energy Emergencies:

- February 2003: A break in a major transmission line caused an electrical blackout over parts of Montcalm, Oceana, Newaygo, Muskegon, and Kent counties.

2.03 Fire - Scrap Tire:

- Approximate scrap tire inventory in Muskegon County in 2012: 4,400.

2.04 Fire - Structural:

- County fire rate per 1,000 population in 1998: 3.8.

2.05 Hazard Material Incidents - Fixed Site (including industrial accidents):

- SARA Title III Sites in Muskegon County in 2012: 51.

2.06 Hazard Material Incidents - Transportation: - None Identified.

2.07 Infrastructure Failure:

- Number of NCDC with mention of downed power lines or power outages in Muskegon County, 1993-2012: 45
- Number of sanitary sewer overflows in Muskegon County, 2000-2011: 47.
- August 8, 1993: 4,400 without power (thunderstorm winds), Muskegon and Oceana counties
- March 9, 1998: 1,900 power outages (blizzard conditions), Lake, Clare, Oceana and Muskegon counties.
- May 29-30, 1998: 54,000 without power; 27,000 on second day (thunderstorm winds), Muskegon County.
- May 31, 1998: 50,000 without power (thunderstorm winds), Muskegon County.
- July 21, 1998: 7,500 without power (thunderstorm winds and lightning), Muskegon County.

2.08 Nuclear Power Plant Emergencies: - None Identified.

2.09 Oil and Natural Gas Well Accidents:

- Oil and gas wells in Muskegon County in 2012: 1,090.

2.10 Pipeline Accidents: - None Identified.

2.11 Transportation Accidents: - None Identified.

3. HUMAN -RELATED HAZARDS

3.01 Catastrophic Incidents (National Emergencies):

- 1939-1945: World War II. In Muskegon, 48-hour minimum work weeks, rationing of certain food and goods, and 274 county men killed in battle.
- 2005: Hurricanes Katrina and Rita. Declarations of Gubernatorial Disaster and Presidential Emergency were issued in Michigan in September 2005 for hurricane evacuation.

3.02 Civil Disturbances: - None Identified.

3.03 Nuclear Attack: - None Identified.

3.04 Public Health Emergencies:

- 1913: Diphtheria Epidemic.
- 1916: Small pox and scarlet fever force closures of schools and businesses.
- 1918: Influenza epidemic closes theaters, dance halls, and churches.
- 1937: Children under 18 banned from theaters and schools close from fear of polio outbreak.
- 1941: Influenza epidemic cuts school attendance by 60%.
- 2009: H1N1 influenza pandemic causes school absences spike in the fall. Two county residents die from complications.

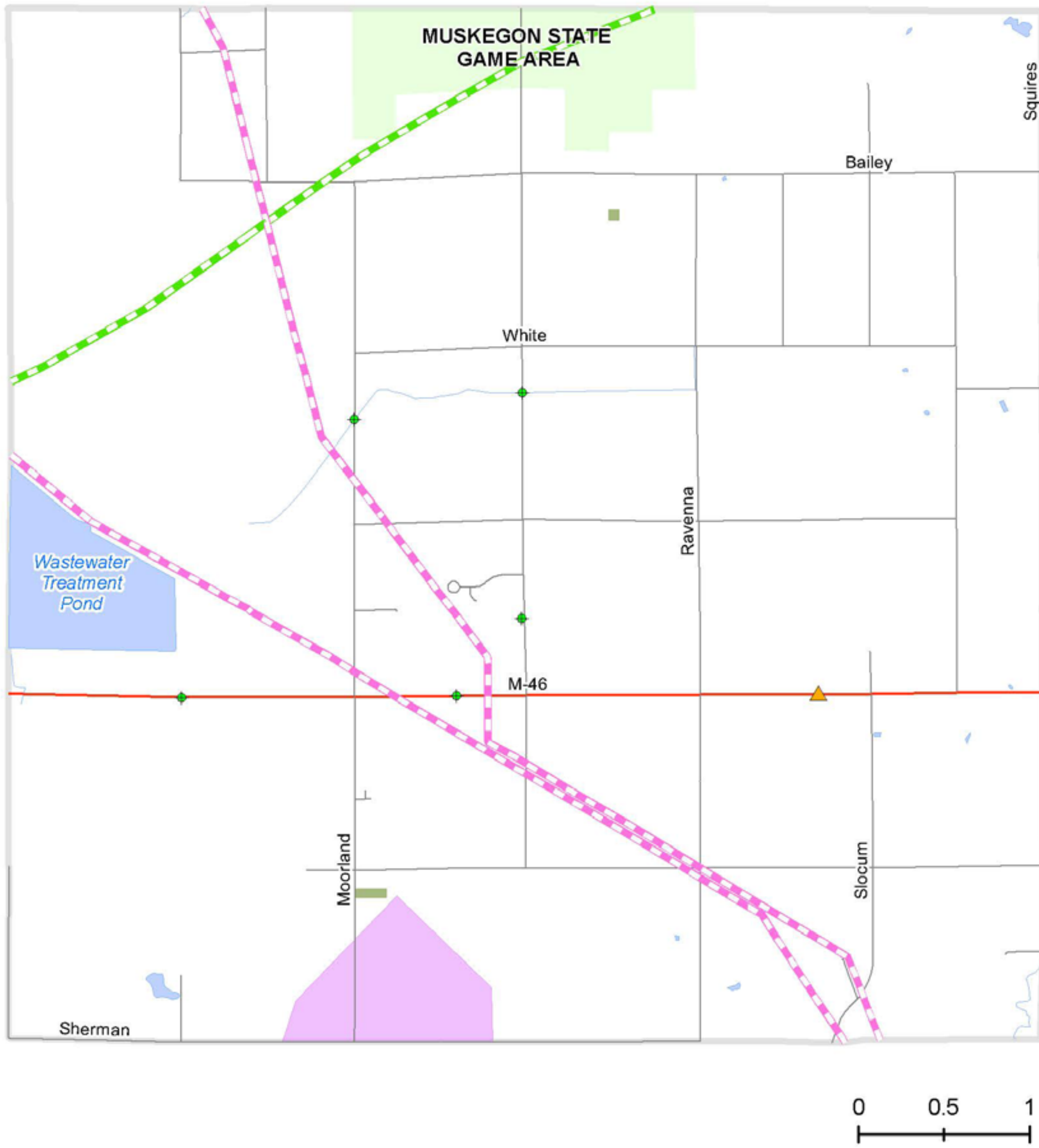
3.05 Terrorism and Similar Criminal Activities: - None Identified.

	Moorland Township Hazard Rating	Probability of Occurrence	Impact on People	Impact on Property	Impact on Economy	Impacts Total	Hazard Score
1.01	Celestial Impacts	1	2	0	2	8	8
1.02	Drought	2	2	2	2	12	24
1.03	Earthquake	0	-	-	-	-	-
1.04	Extreme Temperatures	3	2	1	1	9	27
1.05	Flooding: Riverine/Urban	2	1	1	1	6	12
1.06	Fog	2	1	0	1	4	8
1.07	Great Lakes Shoreline	0	-	-	-	-	-
1.08	Hail	2	2	1	1	9	18
1.09	Invasive Species	2	1	1	2	7	14
1.10	Lightning	3	1	2	1	8	24
1.11	Severe Winds	3	2	2	2	12	36
1.12	Subsidence	1	1	1	1	6	6
1.13	Tornadoes	1	2	2	2	12	12
1.14	Wildfire	3	1	2	1	8	24
1.15	Winter Storms	3	3	2	2	15	45
2.01	Dam failure	0	-	-	-	-	-
2.02	Energy Emergencies	2	2	0	2	8	16
2.03	Fire – Scrap Tires	1	1	1	1	6	6
2.04	Fire – Structural	3	1	2	2	9	27
2.05	HAZMAT – Fixed Site	1	1	1	1	6	6
2.06	HAZMAT – Transportation	3	1	1	1	6	18
2.07	Infrastructure Failures	3	2	1	2	10	30
2.08	Nuclear Power Emergencies	0	-	-	-	-	-
2.09	Oil/Natural Gas Well Accidents	2	1	1	1	6	12
2.10	Pipeline Accidents	1	1	1	2	7	7
2.11	Transportation Accidents	2	1	1	2	7	14
3.01	Catastrophic Incidents	1	3	3	3	18	18
3.02	Civil Disturbances	1	1	1	1	6	6
3.03	Nuclear Attack	0	-	-	-	-	-
3.04	Public Health Emergencies	2	2	0	3	9	18
3.05	Terrorism & Similar Criminal Acts	1	1	1	1	6	6

Moorland Township Hazard Ranking

		Probability of Occurrence	X Impacts Total	= Hazard Score
1	Winter Storms	3	15	45
2	Severe Winds	3	12	36
3	Infrastructure Failures	3	10	30
4	Extreme Temperatures	3	9	27
4	Fire – Structural	3	9	27
6	Drought	2	12	24
6	Lightning	3	8	24
6	Wildfire	3	8	24
9	Catastrophic Incidents	1	18	18
9	Hail	2	9	18
9	HAZMAT – Transportation	3	6	18
9	Public Health Emergencies	2	9	18
13	Energy Emergencies	2	8	16
14	Invasive Species	2	7	14
14	Transportation Accidents	2	7	14
16	Flooding: Riverine/Urban	2	6	12
16	Oil/Natural Gas Well Accidents	2	6	12
16	Tornadoes	1	12	12
19	Celestial Impacts	1	8	8
19	Fog	2	4	8
21	Pipeline Accidents	1	7	7
22	Civil Disturbances	1	6	6
22	Fire – Scrap Tires	1	6	6
22	HAZMAT – Fixed Site	1	6	6
22	Subsidence	1	6	6
22	Terrorism & Similar Criminal Acts	1	6	6
	Dam Failure	0	-	-
	Earthquake	0	-	-
	Great Lakes Shoreline	0	-	-
	Nuclear Attack	0	-	-
	Nuclear Power Emergencies	0	-	-

MOORLAND TOWNSHIP
Critical Facilities and Potential Hazards



- State Trunkline
- Street
- Gas Pipeline
- Power Line
- Bridge
- Fire/Police/EMS/911
- Federal Land
- State Land
- Oil/Gas Fields

Note: This jurisdiction is subject to many additional hazards; some of which tend to occur across wide areas and cannot be effectively shown on this map.Refer to **Appendix B- Hazard Identifications and Analyses** for more complete information about potential hazards in this community.

WMSRDC
WEST MICHIGAN SHORELINE REGIONAL DEVELOPMENT COMMISSION

Source: Michigan Geographic Data Library V 12b, Muskegon Co. Hazard Mitigation Plan Update 2014

Hazard Identification Profile
Muskegon Charter Township

1. NATURAL HAZARDS

1.01 Celestial Impacts: - None Identified.

1.02 Drought:

- 12 recorded drought events in the area (including Lake, Mason, Muskegon, Newaygo, and Oceana counties) lasting eight months or greater: 1895-1896, 1899-1900, 1901-1902, 1909-1911, 1925-1926, 1930-1931, 1956-1957, 1962-1963, 1971-1972, 1976-1977, and 2002-2003.
- Summer 1871: Prolonged drought over much of the Great Lakes region.
- May-September, 1891: Drought devastated Michigan's lumber industry.
- 2013: Record low water level on Lake Michigan.

1.03 Earthquake: - None Identified.

1.04 Extreme Temperatures:

- July 1936: Heatwave. 570 deaths statewide, 7 in Muskegon.
- Summer, 1988: 39 days with temperatures over 90 degrees, statewide.
- January 13-20, 1994: Record cold. $50m property damage across Michigan.
- December 9-10, 1995: Coldwave across Lower Michigan.
- March 2012: Record warm temperatures triggered early growing season. $209.8m crop damage across Michigan.

1.05 Flooding - Riverine/ Urban:

- August 20 - September 6, 1975: Flooding. Declaration of major disaster by President.
- February 21, 1986: Great lakes flooding and wave action. Declaration of disaster by Governor.
- September 10-19, 1986: Flooding. Declaration of major disaster by President.
- September, 1986: Flooding & heavy rain. Declaration of disaster by Governor.
- May 18-20, 2000: Flood. $100k property damage, $50k crop damage in Muskegon County.
- February 9-10, 2001: Flooding. $100k property damage across West Michigan.
- February 24-28, 2001: Flooding. $190k property damage across West Michigan.
- May 15-16, 2001: Flooding. $500k property damage, $200k crop damage across southwestern Lower Michigan.
- May 20-24, 2004: Flooding. Declaration of major disaster by President.
- April 17-23, 2013: Flooding. Declaration of major disaster by President. $5m property damage, Muskegon County.

1.06 Fog:

- January 11-13, 1995: Dense Fog. 4 traffic accident fatalities, school closures, and flight delays across Lower Michigan.

1.07 Great Lakes Shoreline Hazards: - None Identified.

1.08 Hail:

- Days with severe hail reported (1" or greater) recorded in Muskegon County, 2000-2012: 7
- May 15, 2001: 0.75-1.00 inch hail. $95k property damage, $95k crop damage across Muskegon County.
- ***August 3, 2003: 1.75 inch hail in Muskegon Twp***, $55k property damage and $25k crop damage from hail countywide.

1.09 Invasive Species: - Invasive species exist in Muskegon County; No significant events identified.

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1.12 Subsidence: - None Identified.

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- Number of tornadoes in Muskegon County, 1950-2012: 7.

1.14 Wildfire:

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- December 11-31, 2000: Blizzard, snowstorm. Declaration of emergency by President.
- April 3, 2003: Ice storm. $4.9m property damage throughout West Michigan.
- February 16, 2006: Ice storm. $1m property damage across Lower Michigan.

2. TECHNOLOGICAL HAZARDS

2.01 Dam Failure:

- Four documented failures in Muskegon County, unidentified locations.

2.02 Energy Emergencies:

- February 2003: A break in a major transmission line caused an electrical blackout over parts of Montcalm, Oceana, Newaygo, Muskegon, and Kent counties.

2.03 Fire - Scrap Tire:

- Approximate scrap tire inventory in Muskegon County in 2012: 4,400.

2.04 Fire - Structural:

- County fire rate per 1,000 population in 1998: 3.8.

2.05 Hazard Material Incidents - Fixed Site (including industrial accidents):

- SARA Title III Sites in Muskegon County in 2012: 51.
- ***1935: Fire at Naph-Sol Refinery occurs when processing chemicals explode, Muskegon Township.***

2.06 Hazard Material Incidents - Transportation: - None Identified.

2.07 Infrastructure Failure:

- Number of NCDC records with mention of downed power lines or power outages in Muskegon County, 1993-2012: 45
- Number of sanitary sewer overflows in Muskegon County, 2000-2011: 47.
- August 8, 1993: 4,400 without power (thunderstorm winds), Muskegon and Oceana counties
- March 9, 1998: 1,900 power outages (blizzard conditions), Lake, Clare, Oceana and Muskegon counties.
- May 29-30, 1998: 54,000 without power; 27,000 on second day (thunderstorm winds), Muskegon County.
- May 31, 1998: 50,000 without power (thunderstorm winds), Muskegon County.
- July 21, 1998: 7,500 without power (thunderstorm winds and lightning), Muskegon County.
- ***March 2007: Sewer main failure causes 40 home evacuations, damage to 5 homes, and condemnation of 3 homes, Muskegon Township. Estimated total damages over $1m.***

2.08 Nuclear Power Plant Emergencies: - None Identified.

2.09 Oil and Natural Gas Well Accidents:

- Oil and gas wells in Muskegon County in 2012: 1,090.
- ***8 wells with known detectable levels of hydrogen sulfide in Muskegon Township.***

2.10 Pipeline Accidents: - None Identified.

2.11 Transportation Accidents: - None Identified.

3. HUMAN -RELATED HAZARDS

3.01 Catastrophic Incidents (National Emergencies):

- 1939-1945: World War II. In Muskegon, 48-hour minimum work weeks, rationing of certain food and goods, and 274 county men killed in battle.
- 2005: Hurricanes Katrina and Rita. Declarations of Gubernatorial Disaster and Presidential Emergency were issued in Michigan in September 2005 for hurricane evacuation.

3.02 Civil Disturbances: - None Identified.

3.03 Nuclear Attack: - None Identified.

3.04 Public Health Emergencies:

- 1913: Diphtheria Epidemic.
- 1916: Small pox and scarlet fever force closures of schools and businesses.
- 1918: Influenza epidemic closes theaters, dance halls, and churches.
- 1937: Children under 18 banned from theaters and schools close from fear of polio outbreak.
- 1941: Influenza epidemic cuts school attendance by 60%.
- 2009: H1N1 influenza pandemic causes school absences spike in the fall. Two county residents die from complications.

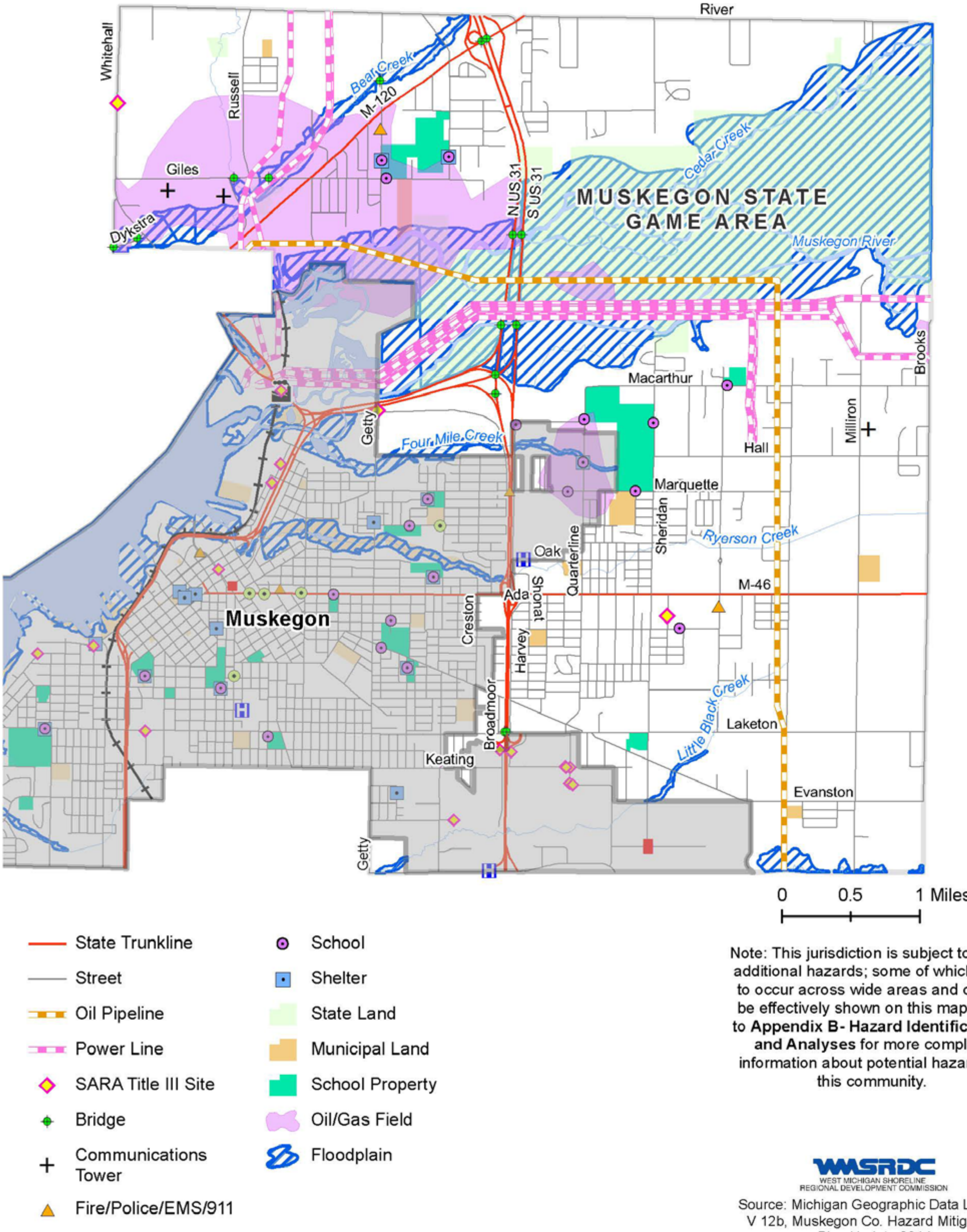
3.05 Terrorism and Similar Criminal Activities: - None Identified.

	Muskegon Charter Township Hazard Rating	Probability of Occurrence	Impact on People	Impact on Property	Impact on Economy	Impacts Total	Hazard Score
1.01	Celestial Impacts	1	2	0	2	8	8
1.02	Drought	2	2	1	2	10	20
1.03	Earthquake	0	-	-	-	-	-
1.04	Extreme Temperatures	3	2	1	1	9	27
1.05	Flooding: Riverine/Urban	3	1	2	2	9	27
1.06	Fog	2	1	0	1	4	8
1.07	Great Lakes Shoreline	0	-	-	-	-	-
1.08	Hail	2	2	1	1	9	18
1.09	Invasive Species	2	1	1	1	6	12
1.10	Lightning	3	1	2	1	8	24
1.11	Severe Winds	3	2	2	2	12	36
1.12	Subsidence	1	1	1	1	6	6
1.13	Tornadoes	1	2	2	2	12	12
1.14	Wildfire	2	1	2	1	8	16
1.15	Winter Storms	3	3	2	2	15	45
2.01	Dam failure	2	1	2	1	8	16
2.02	Energy Emergencies	2	2	0	2	8	16
2.03	Fire – Scrap Tires	1	1	1	1	6	6
2.04	Fire – Structural	3	1	2	3	10	30
2.05	HAZMAT – Fixed Site	3	1	1	2	7	21
2.06	HAZMAT – Transportation	3	1	1	1	6	18
2.07	Infrastructure Failures	3	2	1	2	10	30
2.08	Nuclear Power Emergencies	0	-	-	-	-	-
2.09	Oil/Natural Gas Well Accidents	2	1	2	1	8	16
2.10	Pipeline Accidents	1	1	2	2	9	9
2.11	Transportation Accidents	2	1	1	2	7	14
3.01	Catastrophic Incidents	1	3	3	3	18	18
3.02	Civil Disturbances	1	1	1	1	6	6
3.03	Nuclear Attack	0	-	-	-	-	-
3.04	Public Health Emergencies	2	2	0	3	9	18
3.05	Terrorism & Similar Criminal Acts	1	1	1	1	6	6

Muskegon Charter Township Hazard Ranking

Rank	Hazard	Probability of Occurrence	X Impacts Total	= Hazard Score
1	Winter Storms	3	15	45
2	Severe Winds	3	12	36
3	Fire – Structural	3	10	30
3	Infrastructure Failures	3	10	30
5	Extreme Temperatures	3	9	27
5	Flooding: Riverine/Urban	3	9	27
7	Lightning	3	8	24
8	HAZMAT – Fixed Site	3	7	21
9	Drought	2	10	20
10	Catastrophic Incidents	1	18	18
10	Hail	2	9	18
10	HAZMAT – Transportation	3	6	18
10	Public Health Emergencies	2	9	18
14	Dam Failure	2	8	16
14	Energy Emergencies	2	8	16
14	Oil/Natural Gas Well Accidents	2	8	16
14	Wildfire	2	8	16
18	Transportation Accidents	2	7	14
19	Invasive Species	2	6	12
19	Tornadoes	1	12	12
21	Pipeline Accidents	1	9	9
22	Celestial Impacts	1	8	8
22	Fog	2	4	8
24	Civil Disturbances	1	6	6
24	Fire – Scrap Tires	1	6	6
24	Subsidence	1	6	6
24	Terrorism & Similar Criminal Acts	1	6	6
	Earthquake	0	-	-
	Great Lakes Shoreline	0	-	-
	Nuclear Attack	0	-	-
	Nuclear Power Emergencies	0	-	-

MUSKEGON TOWNSHIP
Critical Facilities and Potential Hazards



Note: This jurisdiction is subject to many additional hazards; some of which tend to occur across wide areas and cannot be effectively shown on this map.Refer to **Appendix B- Hazard Identifications and Analyses** for more complete information about potential hazards in this community.

WMSRDC
WEST MICHIGAN SHORELINE REGIONAL DEVELOPMENT COMMISSION

Source: Michigan Geographic Data Library V 12b, Muskegon Co. Hazard Mitigation Plan Update 2014

Hazard Identification Profile
Ravenna Township

1. NATURAL HAZARDS

1.01 Celestial Impacts: - None Identified.

1.02 Drought:

- 12 recorded drought events in the area (including Lake, Mason, Muskegon, Newaygo, and Oceana counties) lasting eight months or greater: 1895-1896, 1899-1900, 1901-1902, 1909-1911, 1925-1926, 1930-1931, 1956-1957, 1962-1963, 1971-1972, 1976-1977, and 2002-2003.
- Summer 1871: Prolonged drought over much of the Great Lakes region.
- May-September, 1891: Drought devastated Michigan's lumber industry.
- 2013: Record low water level on Lake Michigan.

1.03 Earthquake: - None Identified.

1.04 Extreme Temperatures:

- July 1936: Heatwave. 570 deaths statewide, 7 in Muskegon.
- Summer, 1988: 39 days with temperatures over 90 degrees, statewide.
- January 13-20, 1994: Record cold. $50m property damage across Michigan.
- December 9-10, 1995: Coldwave across Lower Michigan.
- March 2012: Record warm temperatures triggered early growing season. $209.8m crop damage across Michigan.

1.05 Flooding - Riverine/ Urban:

- August 20 - September 6, 1975: Flooding. Declaration of major disaster by President.
- February 21, 1986: Great lakes flooding and wave action. Declaration of disaster by Governor.
- September 10-19, 1986: Flooding. Declaration of major disaster by President.
- September, 1986: Flooding & heavy rain. Declaration of disaster by Governor.
- May 18-20, 2000: Flood. $100k property damage, $50k crop damage in Muskegon County.
- February 9-10, 2001: Flooding. $100k property damage across West Michigan.
- February 24-28, 2001: Flooding. $190k property damage across West Michigan.
- May 15-16, 2001: Flooding. $500k property damage, $200k crop damage across southwestern Lower Michigan.
- May 20-24, 2004: Flooding. Declaration of major disaster by President.
- April 17-23, 2013: Flooding. Declaration of major disaster by President. $5m property damage, Muskegon County.

1.06 Fog:

- January 11-13, 1995: Dense Fog. 4 traffic accident fatalities, school closures, and flight delays across Lower Michigan.

1.07 Great Lakes Shoreline Hazards: - None Identified.

1.08 Hail:

- Days with severe hail reported (1" or greater) recorded in Muskegon County, 2000-2012: 7
- May 15, 2001: 0.75-1.00 inch hail. $95k property damage, $95k crop damage across Muskegon County.
- August 3, 2003: 1.75 inch hail in Muskegon Twp, $55k property damage and $25k crop damage from hail countywide.

1.09 Invasive Species: - Invasive species exist in Muskegon County; No significant events identified.

1.10 Lightning:

- July 20, 1994: Lightning killed a dog and caused $50k property damage, Muskegon County.

1.11 Severe Winds:

- August 20 - September 6, 1975: Rainstorms, high winds. Declaration of major disaster by President.
- November 18, 1994: High wind. $1m property damage statewide.
- April 6, 1997: High wind. $5m property damage across southwest Lower Michigan.
- May 29, 1998: Severe thunderstorm winds. 54,000 homes and businesses without power; estimated 500 homes and 30 businesses sustained minor to moderate damage. $1m property damage, Muskegon County.
- May 31, 1998: Thunderstorms & high winds. Declarations of disaster by Governor and major disaster by President. $2,458,958 in public damage costs, 42 homes destroyed, 1,805 homes damaged, 5 businesses destroyed, and 73 businesses damaged. Total public and private costs have been estimated at $24,205,908.
- August 22, 2000: Severe thunderstorm winds. $150k property damage, Muskegon County.
- March 9, 2002: High wind. $485k property damage across southwest Lower Michigan.
- October 30, 2004: High wind. $1.15m property damage across southwest Lower Michigan.
- May 20-24, 2004: Severe storms. Declaration of major disaster by President.
- August 9, 2009: Severe thunderstorm winds. $2m property damage, Muskegon County.
- November 17, 2013: Severe thunderstorm winds. $200k property damage, Muskegon County.

1.12 Subsidence: - None Identified.

1.13 Tornadoes:

- Number of tornadoes in Muskegon County, 1950-2012: 7.

1.14 Wildfire:

- October 1871: Wildfires. 1.2m acres burned, 200 fatalities, Michigan's Lower Peninsula.
- May-September, 1891: Uncontrollable wildfires across Michigan during the drought of 1891.
- 1981-2010: Approximately 8 wildfires and 89 acres burned per year on county lands under MDNR jurisdiction (251 total wildfires, 2,676.0 total acres burned).

1.15 Winter Storms:

- March 2-7, 1976: Ice storms. Declaration of major disaster by President.
- January 26-31, 1977: Blizzard, snowstorm. Declaration of emergency by President.
- January 26-27, 1978: Blizzard, snowstorm. Declaration of statewide emergency by President.
- January 12, 1993: Heavy snow. $50k property damage, northern Lower Michigan.
- January 12-21, 1994: Heavy lake effect snow. $500k property damage across western Lower Michigan.
- January 27, 1994: Heavy snow and freezing rain. $5m property damage across region.
- October 26, 1997: Heavy snow. $1.2m property damage across southwestern Lower Michigan.
- March 9, 1998: Winter storm. $100k property damage across region.
- January 2-15, 1999: Blizzard, snowstorm. Declaration of emergency by President.
- December 11-31, 2000: Blizzard, snowstorm. Declaration of emergency by President.
- April 3, 2003: Ice storm. $4.9m property damage throughout West Michigan.
- February 16, 2006: Ice storm. $1m property damage across Lower Michigan.

2. <u>TECHNOLOGICAL HAZARDS</u>

2.01 Dam Failure:

- Four documented failures in Muskegon County, unidentified locations.

2.02 Energy Emergencies:

- February 2003: A break in a major transmission line caused an electrical blackout over parts of Montcalm, Oceana, Newaygo, Muskegon, and Kent counties.

2.03 Fire - Scrap Tire:

- Approximate scrap tire inventory in Muskegon County in 2012: 4,400.

2.04 Fire - Structural:

- County fire rate per 1,000 population in 1998: 3.8.
- ***1900: Major business district fires in Fruitport and Ravenna.***

2.05 Hazard Material Incidents - Fixed Site (including industrial accidents):

- SARA Title III Sites in Muskegon County in 2012: 51.

2.06 Hazard Material Incidents - Transportation: - None Identified.

2.07 Infrastructure Failure:

- Number of NCDC records with mention of downed power lines or power outages in Muskegon County, 1993-2012: 45
- Number of sanitary sewer overflows in Muskegon County, 2000-2011: 47.
- August 8, 1993: 4,400 without power (thunderstorm winds), Muskegon and Oceana counties
- March 9, 1998: 1,900 power outages (blizzard conditions), Lake, Clare, Oceana and Muskegon counties.
- May 29-30, 1998: 54,000 without power; 27,000 on second day (thunderstorm winds), Muskegon County.
- May 31, 1998: 50,000 without power (thunderstorm winds), Muskegon County.
- July 21, 1998: 7,500 without power (thunderstorm winds and lightning), Muskegon County.
- August 9, 2009: Village of Fruitport and much of southern Muskegon County without power (thunderstorm winds).

2.08 Nuclear Power Plant Emergencies: - None Identified.

2.09 Oil and Natural Gas Well Accidents:

- Oil and gas wells in Muskegon County in 2012: 1,090.

2.10 Pipeline Accidents: - None Identified.

2.11 Transportation Accidents: - None Identified.

3. <u>HUMAN -RELATED HAZARDS</u>

3.01 Catastrophic Incidents (National Emergencies):

- 1939-1945: World War II. In Muskegon, 48-hour minimum work weeks, rationing of certain food and goods, and 274 county men killed in battle.
- 2005: Hurricanes Katrina and Rita. Declarations of Gubernatorial Disaster and Presidential Emergency were issued in Michigan in September 2005 for hurricane evacuation.

3.02 Civil Disturbances: - None Identified.

3.03 Nuclear Attack: - None Identified.

3.04 Public Health Emergencies:

- 1913: Diphtheria Epidemic.
- 1916: Small pox and scarlet fever force closures of schools and businesses.
- 1918: Influenza epidemic closes theaters, dance halls, and churches.
- 1937: Children under 18 banned from theaters and schools close from fear of polio outbreak.
- 1941: Influenza epidemic cuts school attendance by 60%.
- 2009: H1N1 influenza pandemic causes school absences spike in the fall. Two county residents die from complications.

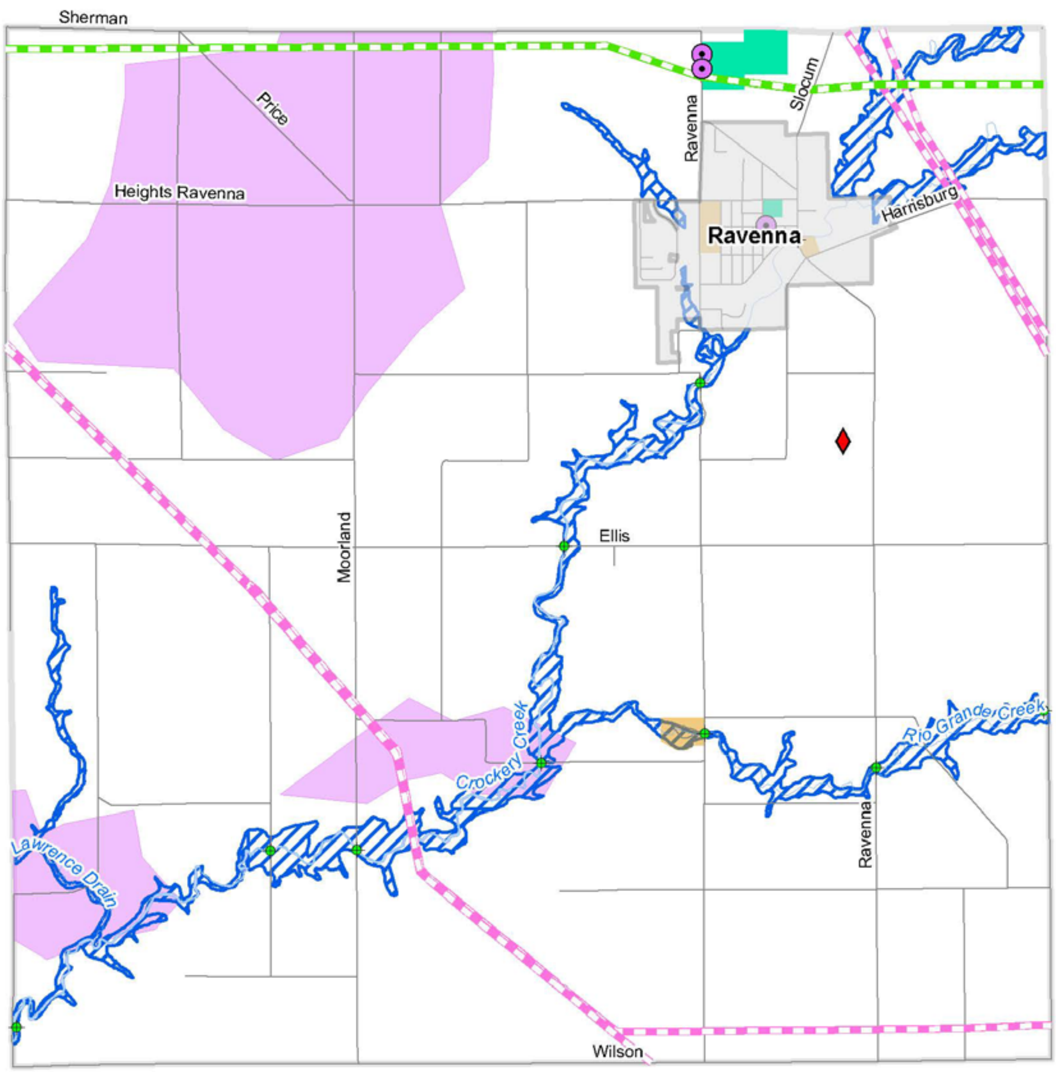
3.05 Terrorism and Similar Criminal Activities: - None Identified.

	Ravenna Township Hazard Rating	Probability of Occurrence	Impact on People	Impact on Property	Impact on Economy	Impacts Total	Hazard Score
1.01	Celestial Impacts	1	2	0	2	8	8
1.02	Drought	2	2	2	2	12	24
1.03	Earthquake	0	-	-	-	-	-
1.04	Extreme Temperatures	3	2	1	1	9	27
1.05	Flooding: Riverine/Urban	3	1	2	2	9	27
1.06	Fog	2	1	0	1	4	8
1.07	Great Lakes Shoreline	0	-	-	-	-	-
1.08	Hail	2	2	1	1	9	18
1.09	Invasive Species	2	1	1	2	7	14
1.10	Lightning	3	1	2	1	8	24
1.11	Severe Winds	3	2	2	2	12	36
1.12	Subsidence	1	1	1	1	6	6
1.13	Tornadoes	1	2	2	2	12	12
1.14	Wildfire	3	1	2	1	8	24
1.15	Winter Storms	3	3	2	2	15	45
2.01	Dam failure	0	-	-	-	-	-
2.02	Energy Emergencies	2	2	0	2	8	16
2.03	Fire – Scrap Tires	1	1	1	1	6	6
2.04	Fire – Structural	3	1	2	2	9	27
2.05	HAZMAT – Fixed Site	2	1	1	1	6	12
2.06	HAZMAT – Transportation	3	1	1	1	6	18
2.07	Infrastructure Failures	3	2	1	2	10	30
2.08	Nuclear Power Emergencies	0	-	-	-	-	-
2.09	Oil/Natural Gas Well Accidents	2	1	1	1	6	12
2.10	Pipeline Accidents	1	1	1	2	7	7
2.11	Transportation Accidents	2	1	1	1	6	12
3.01	Catastrophic Incidents	1	3	3	3	18	18
3.02	Civil Disturbances	1	1	1	1	6	6
3.03	Nuclear Attack	0	-	-	-	-	-
3.04	Public Health Emergencies	2	2	0	3	9	18
3.05	Terrorism & Similar Criminal Acts	1	1	1	1	6	6

Ravenna Township Hazard Ranking

Rank	Hazard	Probability of Occurrence	X Impacts Total	= Hazard Score
1	Winter Storms	3	15	45
2	Severe Winds	3	12	36
3	Infrastructure Failures	3	10	30
4	Extreme Temperatures	3	9	27
4	Fire – Structural	3	9	27
4	Flooding: Riverine/Urban	3	9	27
7	Drought	2	12	24
7	Lightning	3	8	24
7	Wildfire	3	8	24
10	Catastrophic Incidents	1	18	18
10	Hail	2	9	18
10	HAZMAT – Transportation	3	6	18
10	Public Health Emergencies	2	9	18
14	Energy Emergencies	2	8	16
15	Invasive Species	2	7	14
16	HAZMAT – Fixed Site	2	6	12
16	Oil/Natural Gas Well Accidents	2	6	12
16	Tornadoes	1	12	12
16	Transportation Accidents	2	6	12
20	Celestial Impacts	1	8	8
20	Fog	2	4	8
22	Pipeline Accidents	1	7	7
23	Civil Disturbances	1	6	6
23	Fire – Scrap Tires	1	6	6
23	Subsidence	1	6	6
23	Terrorism & Similar Criminal Acts	1	6	6
	Earthquake	0	-	-
	Great Lakes Shoreline	0	-	-
	Dam Failure	0	-	-
	Nuclear Power Emergencies	0	-	-
	Nuclear Attack	0	-	-

RAVENNA TOWNSHIP
Critical Facilities and Potential Hazards



0 0.5 1 Miles

Note: This jurisdiction is subject to many additional hazards; some of which tend to occur across wide areas and cannot be effectively shown on this map.Refer to **Appendix B- Hazard Identifications and Analyses** for more complete information about potential hazards in this community.

- Street
- Gas Pipeline
- Power Line
- Bridge
- Wastewater Treatment
- School
- State Land
- Municipal Land
- School Property
- Oil/Gas Field
- Floodplain

WMSRDC
WEST MICHIGAN SHORELINE REGIONAL DEVELOPMENT COMMISSION

Source: Michigan Geographic Data Library V 12b, Muskegon Co. Hazard Mitigation Plan Update 2014

Hazard Identification Profile
Sullivan Township

1. NATURAL HAZARDS

1.01 Celestial Impacts: - None Identified.

1.02 Drought:

- 12 recorded drought events in the area (including Lake, Mason, Muskegon, Newaygo, and Oceana counties) lasting eight months or greater: 1895-1896, 1899-1900, 1901-1902, 1909-1911, 1925-1926, 1930-1931, 1956-1957, 1962-1963, 1971-1972, 1976-1977, and 2002-2003.
- Summer 1871: Prolonged drought over much of the Great Lakes region.
- May-September, 1891: Drought devastated Michigan’s lumber industry.
- 2013: Record low water level on Lake Michigan.

1.03 Earthquake: - None Identified.

1.04 Extreme Temperatures:

- July 1936: Heatwave. 570 deaths statewide, 7 in Muskegon.
- Summer, 1988: 39 days with temperatures over 90 degrees, statewide.
- January 13-20, 1994: Record cold. $50m property damage across Michigan.
- December 9-10, 1995: Coldwave across Lower Michigan.
- March 2012: Record warm temperatures triggered early growing season. $209.8m crop damage across Michigan.

1.05 Flooding - Riverine/ Urban:

- August 20 - September 6, 1975: Flooding. Declaration of major disaster by President.
- February 21, 1986: Great lakes flooding and wave action. Declaration of disaster by Governor.
- September 10-19, 1986: Flooding. Declaration of major disaster by President.
- September, 1986: Flooding & heavy rain. Declaration of disaster by Governor.
- May 18-20, 2000: Flood. $100k property damage, $50k crop damage in Muskegon County.
- February 9-10, 2001: Flooding. $100k property damage across West Michigan.
- February 24-28, 2001: Flooding. $190k property damage across West Michigan.
- May 15-16, 2001: Flooding. $500k property damage, $200k crop damage across southwestern Lower Michigan.
- May 20-24, 2004: Flooding. Declaration of major disaster by President.
- April 17-23, 2013: Flooding. Declaration of major disaster by President. $5m property damage, Muskegon County.

1.06 Fog: - January 11-13, 1995: Dense Fog. 4 traffic accident fatalities, school closures, and flight delays, Lower Michigan.

1.07 Great Lakes Shoreline Hazards: - None Identified.

1.08 Hail:

- Days with severe hail reported (1” or greater) recorded in Muskegon County, 2000-2012: 7
- May 15, 2001: 0.75-1.00 inch hail. $95k property damage, $95k crop damage across Muskegon County.
- August 3, 2003: 1.75 inch hail in Muskegon Twp, $55k property damage and $25k crop damage from hail countywide.

1.09 Invasive Species: - Invasive species exist in Muskegon County; No significant events identified.

1.10 Lightning:

- July 20, 1994: Lightning killed a dog and caused $50k property damage, Muskegon County.

1.11 Severe Winds:

- August 20 - September 6, 1975: Rainstorms, high winds. Declaration of major disaster by President.
- November 18, 1994: High wind. $1m property damage statewide.
- April 6, 1997: High wind. $5m property damage across southwest Lower Michigan.
- May 29, 1998: Severe thunderstorm winds. 54,000 homes and businesses without power; estimated 500 homes and 30 businesses sustained minor to moderate damage. $1m property damage, Muskegon County.
- May 31, 1998: Thunderstorms & high winds. Declarations of disaster by Governor and major disaster by President. $2,458,958 in public damage costs, 42 homes destroyed, 1,805 homes damaged, 5 businesses destroyed, and 73 businesses damaged. Total public and private costs have been estimated at $24,205,908.
- August 22, 2000: Severe thunderstorm winds. $150k property damage, Muskegon County.
- March 9, 2002: High wind. $485k property damage across southwest Lower Michigan.
- October 30, 2004: High wind. $1.15m property damage across southwest Lower Michigan.
- May 20-24, 2004: Severe storms. Declaration of major disaster by President.
- August 9, 2009: Severe thunderstorm winds. $2m property damage, Muskegon County.
- November 17, 2013: Severe thunderstorm winds. $200k property damage, Muskegon County.

1.12 Subsidence: - None Identified.

1.13 Tornadoes:

- Number of tornadoes in Muskegon County, 1950-2012: 7.
- ***September 4, 1965: Tornado (F2). $25k property damage, Sullivan Township.***

1.14 Wildfire:

- October 1871: Wildfires. 1.2m acres burned, 200 fatalities, Michigan’s Lower Peninsula.
- May-September, 1891: Uncontrollable wildfires across Michigan during the drought of 1891.
- 1981-2010: Approximately 8 wildfires and 89 acres burned per year on county lands under MDNR jurisdiction (251 total wildfires, 2,676.0 total acres burned).

1.15 Winter Storms:
- March 2-7, 1976: Ice storms. Declaration of major disaster by President.
- January 26-31, 1977: Blizzard, snowstorm. Declaration of emergency by President.
- January 26-27, 1978: Blizzard, snowstorm. Declaration of statewide emergency by President.
- January 12, 1993: Heavy snow. $50k property damage, northern Lower Michigan.
- January 12-21, 1994: Heavy lake effect snow. $500k property damage across western Lower Michigan.
- January 27, 1994: Heavy snow and freezing rain. $5m property damage across region.
- October 26, 1997: Heavy snow. $1.2m property damage across southwestern Lower Michigan.
- March 9, 1998: Winter storm. $100k property damage across region.
- January 2-15, 1999: Blizzard, snowstorm. Declaration of emergency by President.
- December 11-31, 2000: Blizzard, snowstorm. Declaration of emergency by President.
- April 3, 2003: Ice storm. $4.9m property damage throughout West Michigan.
- February 16, 2006: Ice storm. $1m property damage across Lower Michigan.

2. TECHNOLOGICAL HAZARDS

2.01 Dam Failure:
- Four documented failures in Muskegon County, unidentified locations.

2.02 Energy Emergencies:
- February 2003: A break in a major transmission line caused an electrical blackout over parts of Montcalm, Oceana, Newaygo, Muskegon, and Kent counties.

2.03 Fire - Scrap Tire:
- Approximate scrap tire inventory in Muskegon County in 2012: 4,400.

2.04 Fire - Structural:
- County fire rate per 1,000 population in 1998: 3.8.

2.05 Hazard Material Incidents - Fixed Site (including industrial accidents):
- SARA Title III Sites in Muskegon County in 2012: 51.

2.06 Hazard Material Incidents - Transportation: - None Identified.

2.07 Infrastructure Failure:
- Number of NCDC records with mention of downed power lines or power outages in Muskegon County, 1993-2012: 45
- Number of sanitary sewer overflows in Muskegon County, 2000-2011: 47.
- August 8, 1993: 4,400 without power (thunderstorm winds), Muskegon and Oceana counties
- March 9, 1998: 1,900 power outages (blizzard conditions), Lake, Clare, Oceana and Muskegon counties.
- May 29-30, 1998: 54,000 without power; 27,000 on second day (thunderstorm winds), Muskegon County.
- May 31, 1998: 50,000 without power (thunderstorm winds), Muskegon County.
- July 21, 1998: 7,500 without power (thunderstorm winds and lightning), Muskegon County.
- August 9, 2009: Village of Fruitport and much of southern Muskegon County without power (thunderstorm winds).

2.08 Nuclear Power Plant Emergencies: - None Identified.

2.09 Oil and Natural Gas Well Accidents:
- Oil and gas wells in Muskegon County in 2012: 1,090.

2.10 Pipeline Accidents: - None Identified.

2.11 Transportation Accidents: - None Identified.

3. HUMAN -RELATED HAZARDS

3.01 Catastrophic Incidents (National Emergencies):
- 1939-1945: World War II. In Muskegon, 48-hour minimum work weeks, rationing of certain food and goods, and 274 county men killed in battle.
- 2005: Hurricanes Katrina and Rita. Declarations of Gubernatorial Disaster and Presidential Emergency were issued in Michigan in September 2005 for hurricane evacuation.

3.02 Civil Disturbances: - None Identified.

3.03 Nuclear Attack: - None Identified.

3.04 Public Health Emergencies:
- 1913: Diphtheria Epidemic.
- 1916: Small pox and scarlet fever force closures of schools and businesses.
- 1918: Influenza epidemic closes theaters, dance halls, and churches.
- 1937: Children under 18 banned from theaters and schools close from fear of polio outbreak.
- 1941: Influenza epidemic cuts school attendance by 60%.
- 2009: H1N1 influenza pandemic causes school absences spike in the fall. Two county residents die from complications.

3.05 Terrorism and Similar Criminal Activities: - None Identified.

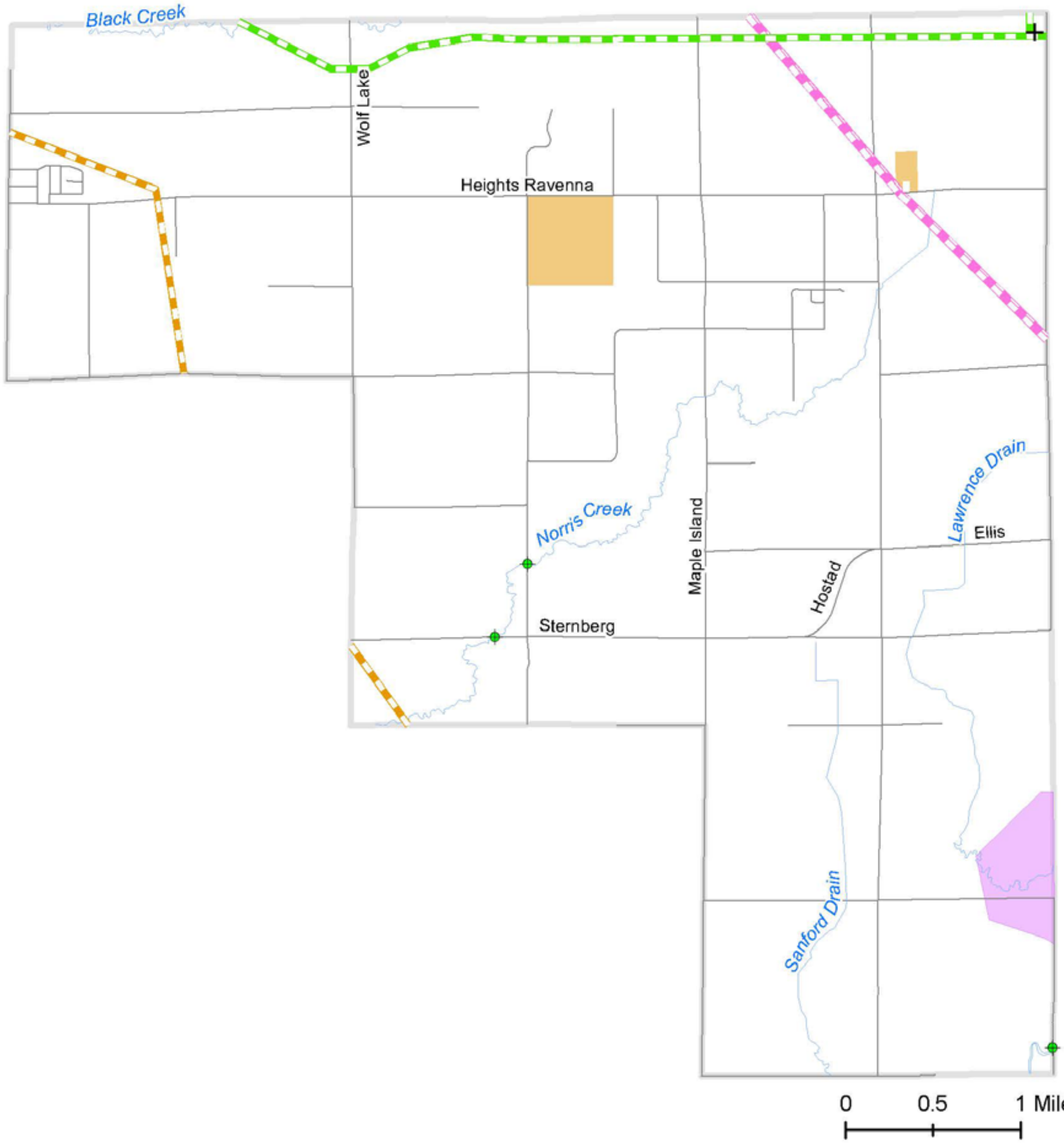
	Sullivan Township Hazard Rating	Probability of Occurrence	Impact on People	Impact on Property	Impact on Economy	Impacts Total	Hazard Score
1.01	Celestial Impacts	1	2	0	2	8	8
1.02	Drought	2	2	2	2	12	24
1.03	Earthquake	0	-	-	-	-	-
1.04	Extreme Temperatures	3	2	1	1	9	27
1.05	Flooding: Riverine/Urban	2	1	2	1	8	16
1.06	Fog	2	1	0	1	4	8
1.07	Great Lakes Shoreline	0	-	-	-	-	-
1.08	Hail	2	2	1	1	9	18
1.09	Invasive Species	2	1	1	2	7	14
1.10	Lightning	3	1	2	1	8	24
1.11	Severe Winds	3	2	2	2	12	36
1.12	Subsidence	1	1	1	1	6	6
1.13	Tornadoes	1	2	2	2	12	12
1.14	Wildfire	3	1	2	1	8	24
1.15	Winter Storms	3	3	2	2	15	45
2.01	Dam failure	0	-	-	-	-	-
2.02	Energy Emergencies	2	2	0	2	8	16
2.03	Fire – Scrap Tires	1	1	1	1	6	6
2.04	Fire – Structural	3	1	2	2	9	27
2.05	HAZMAT – Fixed Site	1	1	1	1	6	6
2.06	HAZMAT – Transportation	2	1	1	1	6	12
2.07	Infrastructure Failures	3	2	1	2	10	30
2.08	Nuclear Power Emergencies	0	-	-	-	-	-
2.09	Oil/Natural Gas Well Accidents	2	1	1	1	6	12
2.10	Pipeline Accidents	1	1	2	2	9	9
2.11	Transportation Accidents	2	1	1	1	6	12
3.01	Catastrophic Incidents	1	3	3	3	18	18
3.02	Civil Disturbances	1	1	1	1	6	6
3.03	Nuclear Attack	0	-	-	-	-	-
3.04	Public Health Emergencies	2	2	0	3	9	18
3.05	Terrorism & Similar Criminal Acts	1	1	1	1	6	6

Sullivan Township Hazard Ranking

Probability of Occurrence X Impacts Total = Hazard Score

1	Winter Storms	3	15	45
2	Severe Winds	3	12	36
3	Infrastructure Failures	3	10	30
4	Extreme Temperatures	3	9	27
4	Fire – Structural	3	9	27
6	Drought	2	12	24
6	Lightning	3	8	24
6	Wildfire	3	8	24
9	Catastrophic Incidents	1	18	18
9	Hail	2	9	18
9	Public Health Emergencies	2	9	18
12	Energy Emergencies	2	8	16
12	Flooding: Riverine/Urban	2	8	16
14	Invasive Species	2	7	14
15	HAZMAT – Transportation	2	6	12
15	Oil/Natural Gas Well Accidents	2	6	12
15	Tornadoes	1	12	12
15	Transportation Accidents	2	6	12
19	Pipeline Accidents	1	9	9
20	Celestial Impacts	1	8	8
20	Fog	2	4	8
22	Civil Disturbances	1	6	6
22	Fire – Scrap Tires	1	6	6
22	HAZMAT – Fixed Site	1	6	6
22	Subsidence	1	6	6
22	Terrorism & Similar Criminal Acts	1	6	6
	Dam Failure	0	-	-
	Earthquake	0	-	-
	Great Lakes Shoreline	0	-	-
	Nuclear Attack	0	-	-
	Nuclear Power Emergencies	0	-	-

SULLIVAN TOWNSHIP
Critical Facilities and Potential Hazards



Street
Oil Pipeline
Gas Pipeline
Power Line
Bridge
Communications Tower
Municipal Land
Oil/Gas Field

Note: This jurisdiction is subject to many additional hazards; some of which tend to occur across wide areas and cannot be effectively shown on this map.Refer to **Appendix B- Hazard Identifications and Analyses** for more complete information about potential hazards in this community.

WMSRDC
WEST MICHIGAN SHORELINE REGIONAL DEVELOPMENT COMMISSION

Source: Michigan Geographic Data Library V 12b, Muskegon Co. Hazard Mitigation Plan Update 2014

Hazard Identification Profile
White River Township

1. NATURAL HAZARDS

1.01 Celestial Impacts: - None Identified.

1.02 Drought:

- 12 recorded drought events in the area (including Lake, Mason, Muskegon, Newaygo, and Oceana counties) lasting eight months or greater: 1895-1896, 1899-1900, 1901-1902, 1909-1911, 1925-1926, 1930-1931, 1956-1957, 1962-1963, 1971-1972, 1976-1977, and 2002-2003.
- Summer 1871: Prolonged drought over much of the Great Lakes region.
- May-September, 1891: Drought devastated Michigan's lumber industry.

1.03 Earthquake: - None Identified.

1.04 Extreme Temperatures:

- July 1936: Heatwave. 570 deaths statewide, 7 in Muskegon.
- Summer, 1988: 39 days with temperatures over 90 degrees, statewide.
- January 13-20, 1994: Record cold. $50m property damage across Michigan.
- December 9-10, 1995: Coldwave across Lower Michigan.
- March 2012: Record warm temperatures triggered early growing season. $209.8m crop damage across Michigan.

1.05 Flooding - Riverine/ Urban:

- August 20 - September 6, 1975: Flooding. Declaration of major disaster by President.
- February 21, 1986: Great lakes flooding and wave action. Declaration of disaster by Governor.
- September 10-19, 1986: Flooding. Declaration of major disaster by President.
- September, 1986: Flooding & heavy rain. Declaration of disaster by Governor.
- May 18-20, 2000: Flood. $100k property damage, $50k crop damage in Muskegon County.
- February 9-10, 2001: Flooding. $100k property damage across West Michigan.
- February 24-28, 2001: Flooding. $190k property damage across West Michigan.
- May 15-16, 2001: Flooding. $500k property damage, $200k crop damage across southwestern Lower Michigan.
- May 20-24, 2004: Flooding. Declaration of major disaster by President.
- April 17-23, 2013: Flooding. Declaration of major disaster by President. $5m property damage, Muskegon County.

1.06 Fog:

- January 11-13, 1995: Dense Fog. 4 traffic accident fatalities, school closures, and flight delays across Lower Michigan.

1.07 Great Lakes Shoreline Hazards:

- Extreme high water levels in the Great Lakes: 1929, 1952, 1973, 1986, and 1997.
- Extreme low water levels in the Great Lakes: 1926, 1934, 1964, 2003, and 2013.
- Rip current incidents on Lake Michigan, 2002-2012: 77 fatalities, 230 rescues.
- June 1986: Record high water level on Lake Michigan.
- ***May 31, 1998: Tugboat capsized during seiche in White Lake Channel. Estimated $20,000 damage to tugboat.***
- 2013: Record low water level on Lake Michigan.

1.08 Hail:

- Days with severe hail reported (1" or greater) recorded in Muskegon County, 2000-2012: 7
- May 15, 2001: 0.75-1.00 inch hail. $95k property damage, $95k crop damage across Muskegon County.
- August 3, 2003: 1.75 inch hail in Muskegon Twp, $55k property damage and $25k crop damage from hail countywide.

1.09 Invasive Species: - Invasive species exist in Muskegon County; No significant events identified.

1.10 Lightning:

- July 20, 1994: Lightning killed a dog and caused $50k property damage, Muskegon County.

1.11 Severe Winds:

- August 20 - September 6, 1975: Rainstorms, high winds. Declaration of major disaster by President.
- November 18, 1994: High wind. $1m property damage statewide.
- April 6, 1997: High wind. $5m property damage across southwest Lower Michigan.
- May 29, 1998: Severe thunderstorm winds. 54,000 homes and businesses without power; estimated 500 homes and 30 businesses sustained minor to moderate damage. $1m property damage, Muskegon County.
- May 31, 1998: Thunderstorms & high winds. Declarations of disaster by Governor and major disaster by President. $2,458,958 in public damage costs, 42 homes destroyed, 1,805 homes damaged, 5 businesses destroyed, and 73 businesses damaged. Total public and private costs have been estimated at $24,205,908.
- August 22, 2000: Severe thunderstorm winds. $150k property damage, Muskegon County.
- March 9, 2002: High wind. $485k property damage across southwest Lower Michigan.
- October 30, 2004: High wind. $1.15m property damage across southwest Lower Michigan.
- May 20-24, 2004: Severe storms. Declaration of major disaster by President.
- August 9, 2009: Severe thunderstorm winds. $2m property damage, Muskegon County.
- November 17, 2013: Severe thunderstorm winds. $200k property damage, Muskegon County.

1.12 Subsidence: - None Identified.

1.13 Tornadoes:

- Number of tornadoes in Muskegon County, 1950-2012: 7.

1.14 Wildfire:

- October 1871: Wildfires. 1.2m acres burned, 200 fatalities, Michigan's Lower Peninsula.
- May-September, 1891: Uncontrollable wildfires across Michigan during the drought of 1891.
- 1981-2010: Approximately 8 wildfires and 89 acres burned per year on county lands under MDNR jurisdiction (251 total wildfires, 2,676.0 total acres burned).

1.15 Winter Storms:

- March 2-7, 1976: Ice storms. Declaration of major disaster by President.
- January 26-31, 1977: Blizzard, snowstorm. Declaration of emergency by President.
- January 26-27, 1978: Blizzard, snowstorm. Declaration of statewide emergency by President.
- January 12, 1993: Heavy snow. $50k property damage, northern Lower Michigan.
- January 12-21, 1994: Heavy lake effect snow. $500k property damage across western Lower Michigan.
- January 27, 1994: Heavy snow and freezing rain. $5m property damage across region.
- October 26, 1997: Heavy snow. $1.2m property damage across southwestern Lower Michigan.
- March 9, 1998: Winter storm. $100k property damage across region.
- January 2-15, 1999: Blizzard, snowstorm. Declaration of emergency by President.
- December 11-31, 2000: Blizzard, snowstorm. Declaration of emergency by President.
- April 3, 2003: Ice storm. $4.9m property damage throughout West Michigan.
- February 16, 2006: Ice storm. $1m property damage across Lower Michigan.

2. TECHNOLOGICAL HAZARDS

2.01 Dam Failure:

- Four documented failures in Muskegon County, unidentified locations.

2.02 Energy Emergencies:

- February 2003: A break in a major transmission line caused an electrical blackout over parts of Montcalm, Oceana, Newaygo, Muskegon, and Kent counties.

2.03 Fire - Scrap Tire: - Approximate scrap tire inventory in Muskegon County in 2012: 4,400.

2.04 Fire - Structural: - County fire rate per 1,000 population in 1998: 3.8.

2.05 Hazard Material Incidents - Fixed Site (including industrial accidents):

- SARA Title III Sites in Muskegon County in 2012: 51.

2.06 Hazard Material Incidents - Transportation: - None Identified.

2.07 Infrastructure Failure:

- Number of NCDC records with mention of downed power lines or power outages in Muskegon County, 1993-2012: 45
- Number of sanitary sewer overflows in Muskegon County, 2000-2011: 47.
- August 8, 1993: 4,400 without power (thunderstorm winds), Muskegon and Oceana counties
- March 9, 1998: 1,900 power outages (blizzard conditions), Lake, Clare, Oceana and Muskegon counties.
- May 29-30, 1998: 54,000 without power; 27,000 on second day (thunderstorm winds), Muskegon County.
- May 31, 1998: 50,000 without power (thunderstorm winds), Muskegon County.
- July 21, 1998: 7,500 without power (thunderstorm winds and lightning), Muskegon County.

2.08 Nuclear Power Plant Emergencies: - None Identified.

2.09 Oil and Natural Gas Well Accidents:

- Oil and gas wells in Muskegon County in 2012: 1,090.
- ***2 wells with known detectable levels of hydrogen sulfide in White River Township.***

2.10 Pipeline Accidents: - None Identified.

2.11 Transportation Accidents: - None Identified.

3. HUMAN -RELATED HAZARDS

3.01 Catastrophic Incidents (National Emergencies):

- 1939-1945: World War II. In Muskegon, 48-hour minimum work weeks, rationing of certain food and goods, and 274 county men killed in battle.
- 2005: Hurricanes Katrina and Rita. Declarations of Gubernatorial Disaster and Presidential Emergency were issued in Michigan in September 2005 for hurricane evacuation.

3.02 Civil Disturbances: - None Identified.

3.03 Nuclear Attack: - None Identified.

3.04 Public Health Emergencies:

- 1913: Diphtheria Epidemic.
- 1916: Small pox and scarlet fever force closures of schools and businesses.
- 1918: Influenza epidemic closes theaters, dance halls, and churches.
- 1937: Children under 18 banned from theaters and schools close from fear of polio outbreak.
- 1941: Influenza epidemic cuts school attendance by 60%.
- 2009: H1N1 influenza pandemic causes school absences spike in the fall. Two county residents die from complications.

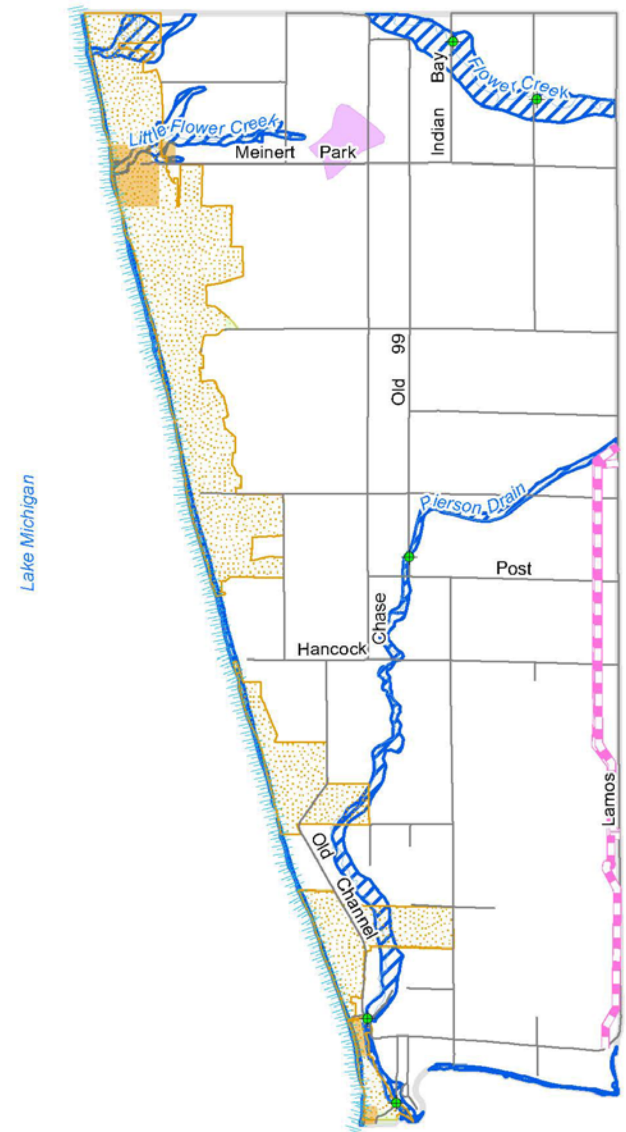
3.05 Terrorism and Similar Criminal Activities: - None Identified.

	White River Township Hazard Rating	Probability of Occurrence	Impact on People	Impact on Property	Impact on Economy	Impacts Total	Hazard Score
1.01	Celestial Impacts	1	2	0	2	8	8
1.02	Drought	2	2	2	2	12	24
1.03	Earthquake	0	-	-	-	-	-
1.04	Extreme Temperatures	3	2	1	1	9	27
1.05	Flooding: Riverine/Urban	3	1	2	2	9	27
1.06	Fog	3	1	0	1	4	12
1.07	Great Lakes Shoreline	3	1	2	1	8	24
1.08	Hail	2	2	1	1	9	18
1.09	Invasive Species	2	1	1	2	7	14
1.10	Lightning	3	1	2	1	8	24
1.11	Severe Winds	3	2	2	2	12	36
1.12	Subsidence	1	1	1	1	6	6
1.13	Tornadoes	1	2	2	2	12	12
1.14	Wildfire	3	1	2	1	8	24
1.15	Winter Storms	3	3	2	2	15	45
2.01	Dam failure	1	1	1	1	6	6
2.02	Energy Emergencies	2	2	0	2	8	16
2.03	Fire – Scrap Tires	1	1	1	1	6	6
2.04	Fire – Structural	3	1	2	2	9	27
2.05	HAZMAT – Fixed Site	1	1	1	1	6	6
2.06	HAZMAT – Transportation	2	1	1	1	6	12
2.07	Infrastructure Failures	3	2	1	2	10	30
2.08	Nuclear Power Emergencies	0	-	-	-	-	-
2.09	Oil/Natural Gas Well Accidents	2	1	1	1	6	12
2.10	Pipeline Accidents	0	-	-	-	-	-
2.11	Transportation Accidents	2	1	1	1	6	12
3.01	Catastrophic Incidents	1	3	3	3	18	18
3.02	Civil Disturbances	1	1	1	1	6	6
3.03	Nuclear Attack	0	-	-	-	-	-
3.04	Public Health Emergencies	2	2	0	3	9	18
3.05	Terrorism & Similar Criminal Acts	1	1	1	1	6	6

White River Township Hazard Ranking

		Probability of Occurrence X	Impacts Total =	Hazard Score
1	Winter Storms	3	15	45
2	Severe Winds	3	12	36
3	Infrastructure Failures	3	10	30
4	Extreme Temperatures	3	9	27
4	Fire – Structural	3	9	27
4	Flooding: Riverine/Urban	3	9	27
7	Drought	2	12	24
7	Great Lakes Shoreline	3	8	24
7	Lightning	3	8	24
7	Wildfire	3	8	24
11	Catastrophic Incidents	1	18	18
11	Hail	2	9	18
11	Public Health Emergencies	2	9	18
14	Energy Emergencies	2	8	16
15	Invasive Species	2	7	14
16	Fog	3	4	12
16	HAZMAT – Transportation	2	6	12
16	Oil/Natural Gas Well Accidents	2	6	12
16	Tornadoes	1	12	12
16	Transportation Accidents	2	6	12
21	Celestial Impacts	1	8	8
22	Civil Disturbances	1	6	6
22	Dam Failure	1	6	6
22	Fire – Scrap Tires	1	6	6
22	HAZMAT – Fixed Site	1	6	6
22	Subsidence	1	6	6
22	Terrorism & Similar Criminal Acts	1	6	6
	Earthquake	0	-	-
	Nuclear Attack	0	-	-
	Nuclear Power Emergencies	0	-	-
	Pipeline Accidents	0	-	-

WHITE RIVER TOWNSHIP
Critical Facilities and Potential Hazards



0 0.5 1 Miles

Street

Great Lakes Shoreline Hazard

Bridge

Power Line

State Land

Municipal Land

High-Risk Erosion Area

Oil/Gas Field

Floodplain

Note: This jurisdiction is subject to many additional hazards; some of which tend to occur across wide areas and cannot be effectively shown on this map. Refer to **Appendix B- Hazard Identifications and Analyses** for more complete information about potential hazards in this community.

WMSRDC
WEST MICHIGAN SHORELINE REGIONAL DEVELOPMENT COMMISSION

Source: Michigan Geographic Data Library V 12b, Muskegon Co. Hazard Mitigation Plan Update 2014

Hazard Identification Profile
Whitehall Township

1. NATURAL HAZARDS

1.01 Celestial Impacts: - None Identified.

1.02 Drought:
- 12 recorded drought events in the area (including Lake, Mason, Muskegon, Newaygo, and Oceana counties) lasting eight months or greater: 1895-1896, 1899-1900, 1901-1902, 1909-1911, 1925-1926, 1930-1931, 1956-1957, 1962-1963, 1971-1972, 1976-1977, and 2002-2003.
- Summer 1871: Prolonged drought over much of the Great Lakes region.
- May-September, 1891: Drought devastated Michigan's lumber industry.
- 2013: Record low water level on Lake Michigan.

1.03 Earthquake: - None Identified.

1.04 Extreme Temperatures:
- July 1936: Heatwave. 570 deaths statewide, 7 in Muskegon.
- Summer, 1988: 39 days with temperatures over 90 degrees, statewide.
- January 13-20, 1994: Record cold. $50m property damage across Michigan.
- December 9-10, 1995: Coldwave across Lower Michigan.
- March 2012: Record warm temperatures triggered early growing season. $209.8m crop damage across Michigan.

1.05 Flooding - Riverine/ Urban:
- August 20 - September 6, 1975: Flooding. Declaration of major disaster by President.
- February 21, 1986: Great lakes flooding and wave action. Declaration of disaster by Governor.
- September 10-19, 1986: Flooding. Declaration of major disaster by President.
- September, 1986: Flooding & heavy rain. Declaration of disaster by Governor.
- May 18-20, 2000: Flood. $100k property damage, $50k crop damage in Muskegon County.
- February 9-10, 2001: Flooding. $100k property damage across West Michigan.
- February 24-28, 2001: Flooding. $190k property damage across West Michigan.
- May 15-16, 2001: Flooding. $500k property damage, $200k crop damage across southwestern Lower Michigan.
- May 20-24, 2004: Flooding. Declaration of major disaster by President.
- April 17-23, 2013: Flooding. Declaration of major disaster by President. $5m property damage, Muskegon County.

1.06 Fog:
- January 11-13, 1995: Dense Fog. 4 traffic accident fatalities, school closures, and flight delays across Lower Michigan.

1.07 Great Lakes Shoreline Hazards: - None Identified.

1.08 Hail:
- Days with severe hail reported (1" or greater) recorded in Muskegon County, 2000-2012: 7
- May 15, 2001: 0.75-1.00 inch hail. $95k property damage, $95k crop damage across Muskegon County.
- August 3, 2003: 1.75 inch hail in Muskegon Twp, $55k property damage and $25k crop damage from hail countywide.

1.09 Invasive Species: - Invasive species exist in Muskegon County; No significant events identified.

1.10 Lightning:
- July 20, 1994: Lightning killed a dog and caused $50k property damage, Muskegon County.

1.11 Severe Winds:
- August 20 - September 6, 1975: Rainstorms, high winds. Declaration of major disaster by President.
- November 18, 1994: High wind. $1m property damage statewide.
- April 6, 1997: High wind. $5m property damage across southwest Lower Michigan.
- May 29, 1998: Severe thunderstorm winds. 54,000 homes and businesses without power; estimated 500 homes and 30 businesses sustained minor to moderate damage. $1m property damage, Muskegon County.
- May 31, 1998: Thunderstorms & high winds. Declarations of disaster by Governor and major disaster by President. $2,458,958 in public damage costs, 42 homes destroyed, 1,805 homes damaged, 5 businesses destroyed, and 73 businesses damaged. Total public and private costs have been estimated at $24,205,908.
- August 22, 2000: Severe thunderstorm winds. $150k property damage, Muskegon County.
- March 9, 2002: High wind. $485k property damage across southwest Lower Michigan.
- October 30, 2004: High wind. $1.15m property damage across southwest Lower Michigan.
- May 20-24, 2004: Severe storms. Declaration of major disaster by President.
- August 9, 2009: Severe thunderstorm winds. $2m property damage, Muskegon County.
- November 17, 2013: Severe thunderstorm winds. $200k property damage, Muskegon County.

1.12 Subsidence: - None Identified.

1.13 Tornadoes:
- Number of tornadoes in Muskegon County, 1950-2012: 7.

1.14 Wildfire:
- October 1871: Wildfires. 1.2m acres burned, 200 fatalities, Michigan's Lower Peninsula.
- May-September, 1891: Uncontrollable wildfires across Michigan during the drought of 1891.
- 1981-2010: Approximately 8 wildfires and 89 acres burned per year on county lands under MDNR jurisdiction (251 total wildfires, 2,676.0 total acres burned).

1.15 Winter Storms:

- March 2-7, 1976: Ice storms. Declaration of major disaster by President.
- January 26-31, 1977: Blizzard, snowstorm. Declaration of emergency by President.
- January 26-27, 1978: Blizzard, snowstorm. Declaration of statewide emergency by President.
- January 12, 1993: Heavy snow. $50k property damage, northern Lower Michigan.
- January 12-21, 1994: Heavy lake effect snow. $500k property damage across western Lower Michigan.
- January 27, 1994: Heavy snow and freezing rain. $5m property damage across region.
- October 26, 1997: Heavy snow. $1.2m property damage across southwestern Lower Michigan.
- March 9, 1998: Winter storm. $100k property damage across region.
- January 2-15, 1999: Blizzard, snowstorm. Declaration of emergency by President.
- December 11-31, 2000: Blizzard, snowstorm. Declaration of emergency by President.
- April 3, 2003: Ice storm. $4.9m property damage throughout West Michigan.
- February 16, 2006: Ice storm. $1m property damage across Lower Michigan.

2. TECHNOLOGICAL HAZARDS

2.01 Dam Failure:

- Four documented failures in Muskegon County, unidentified locations.

2.02 Energy Emergencies:

- February 2003: A break in a major transmission line caused an electrical blackout over parts of Montcalm, Oceana, Newaygo, Muskegon, and Kent counties.

2.03 Fire - Scrap Tire:

- Approximate scrap tire inventory in Muskegon County in 2012: 4,400.

2.04 Fire - Structural:

- County fire rate per 1,000 population in 1998: 3.8.

2.05 Hazard Material Incidents - Fixed Site (including industrial accidents):

- SARA Title III Sites in Muskegon County in 2012: 51.

2.06 Hazard Material Incidents - Transportation: - None Identified.

2.07 Infrastructure Failure:

- Number of NCDC records with mention of downed power lines or power outages in Muskegon County, 1993-2012: 45
- Number of sanitary sewer overflows in Muskegon County, 2000-2011: 47.
- August 8, 1993: 4,400 without power (thunderstorm winds), Muskegon and Oceana counties
- March 9, 1998: 1,900 power outages (blizzard conditions), Lake, Clare, Oceana and Muskegon counties.
- May 29-30, 1998: 54,000 without power; 27,000 on second day (thunderstorm winds), Muskegon County.
- May 31, 1998: 50,000 without power (thunderstorm winds), Muskegon County.
- July 21, 1998: 7,500 without power (thunderstorm winds and lightning), Muskegon County.

2.08 Nuclear Power Plant Emergencies: - None Identified.

2.09 Oil and Natural Gas Well Accidents:

- Oil and gas wells in Muskegon County in 2012: 1,090.

2.10 Pipeline Accidents: - None Identified.

2.11 Transportation Accidents: - None Identified.

3. HUMAN -RELATED HAZARDS

3.01 Catastrophic Incidents (National Emergencies):

- 1939-1945: World War II. In Muskegon, 48-hour minimum work weeks, rationing of certain food and goods, and 274 county men killed in battle.
- 2005: Hurricanes Katrina and Rita. Declarations of Gubernatorial Disaster and Presidential Emergency were issued in Michigan in September 2005 for hurricane evacuation.

3.02 Civil Disturbances: - None Identified.

3.03 Nuclear Attack: - None Identified.

3.04 Public Health Emergencies:

- 1913: Diphtheria Epidemic.
- 1916: Small pox and scarlet fever force closures of schools and businesses.
- 1918: Influenza epidemic closes theaters, dance halls, and churches.
- 1937: Children under 18 banned from theaters and schools close from fear of polio outbreak.
- 1941: Influenza epidemic cuts school attendance by 60%.
- 2009: H1N1 influenza pandemic causes school absences spike in the fall. Two county residents die from complications.

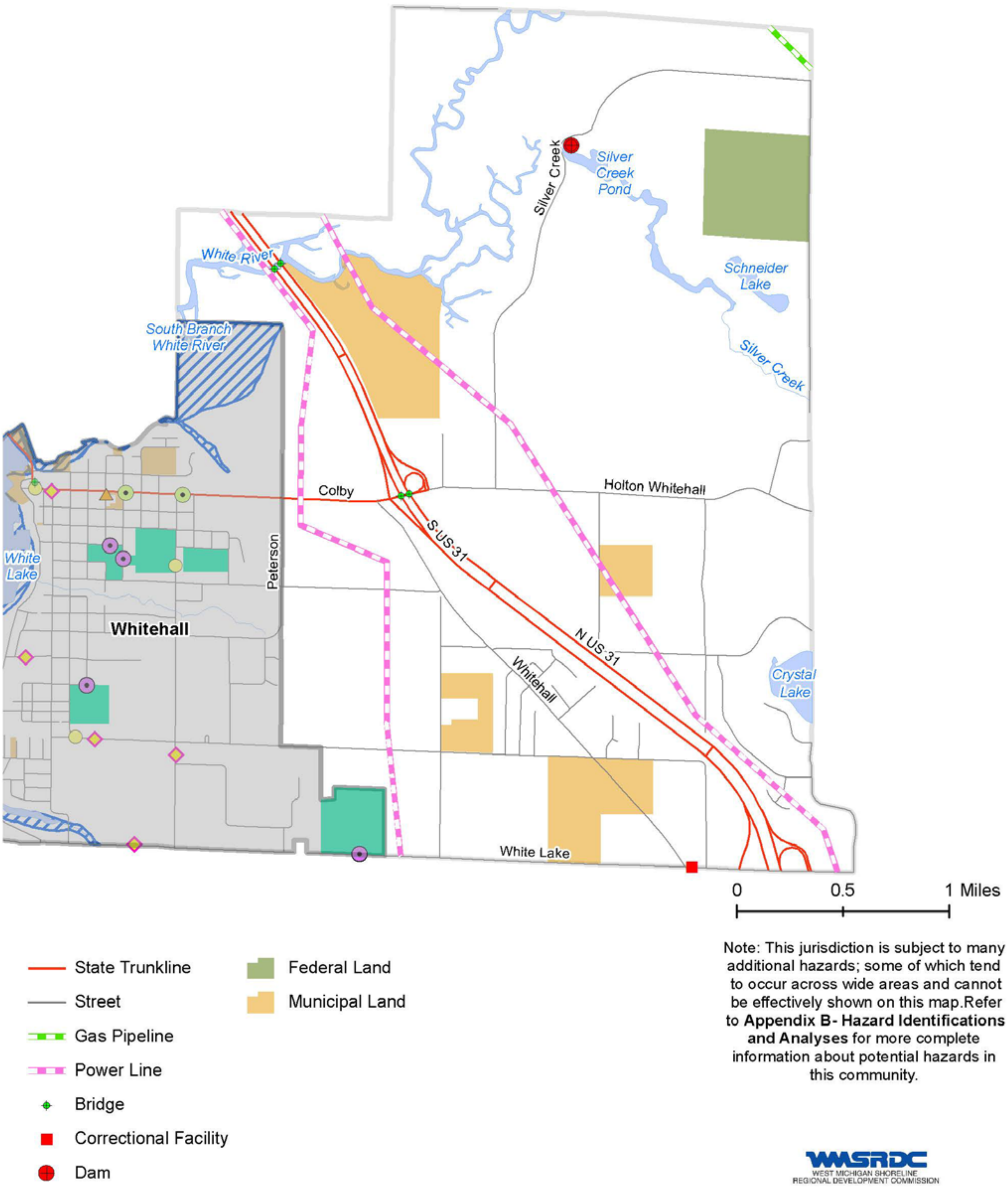
3.05 Terrorism and Similar Criminal Activities: - None Identified.

	Whitehall Township Hazard Rating	Probability of Occurrence	Impact on People	Impact on Property	Impact on Economy	Impacts Total	Hazard Score
1.01	Celestial Impacts	1	2	0	2	8	8
1.02	Drought	2	2	1	2	10	20
1.03	Earthquake	0	-	-	-	-	-
1.04	Extreme Temperatures	3	2	1	1	9	27
1.05	Flooding: Riverine/Urban	2	1	1	2	7	14
1.06	Fog	2	1	0	1	4	8
1.07	Great Lakes Shoreline	0	-	-	-	-	-
1.08	Hail	2	2	1	1	9	18
1.09	Invasive Species	2	1	1	1	6	12
1.10	Lightning	3	1	2	1	8	24
1.11	Severe Winds	3	2	2	2	12	36
1.12	Subsidence	1	1	1	1	6	6
1.13	Tornadoes	1	2	2	2	12	12
1.14	Wildfire	3	1	2	1	8	24
1.15	Winter Storms	3	3	2	2	15	45
2.01	Dam failure	2	1	1	1	6	12
2.02	Energy Emergencies	2	2	0	2	8	16
2.03	Fire – Scrap Tires	1	1	1	1	6	6
2.04	Fire – Structural	3	1	2	3	10	30
2.05	HAZMAT – Fixed Site	2	1	1	1	6	12
2.06	HAZMAT – Transportation	2	1	1	1	6	12
2.07	Infrastructure Failures	3	2	1	2	10	30
2.08	Nuclear Power Emergencies	0	-	-	-	-	-
2.09	Oil/Natural Gas Well Accidents	1	1	1	1	6	6
2.10	Pipeline Accidents	1	1	1	2	7	7
2.11	Transportation Accidents	2	1	1	2	7	14
3.01	Catastrophic Incidents	1	3	3	3	18	18
3.02	Civil Disturbances	1	1	1	1	6	6
3.03	Nuclear Attack	0	-	-	-	-	-
3.04	Public Health Emergencies	2	2	0	3	9	18
3.05	Terrorism & Similar Criminal Acts	1	1	1	1	6	6

Whitehall Township Hazard Ranking

		Probability of Occurrence X	Impacts Total =	Hazard Score
1	Winter Storms	3	15	45
2	Severe Winds	3	12	36
3	Fire – Structural	3	10	30
3	Infrastructure Failures	3	10	30
5	Extreme Temperatures	3	9	27
6	Lightning	3	8	24
6	Wildfire	3	8	24
8	Drought	2	10	20
9	Catastrophic Incidents	1	18	18
9	Hail	2	9	18
9	Public Health Emergencies	2	9	18
12	Energy Emergencies	2	8	16
13	Flooding: Riverine/Urban	2	7	14
13	Transportation Accidents	2	7	14
15	Dam Failure	2	6	12
15	HAZMAT – Fixed Site	2	6	12
15	HAZMAT – Transportation	2	6	12
15	Invasive Species	2	6	12
15	Tornadoes	1	12	12
20	Celestial Impacts	1	8	8
20	Fog	2	4	8
22	Pipeline Accidents	1	7	7
23	Civil Disturbances	1	6	6
23	Fire – Scrap Tires	1	6	6
23	Oil/Natural Gas Well Accidents	1	6	6
23	Subsidence	1	6	6
23	Terrorism & Similar Criminal Acts	1	6	6
	Earthquake	0	-	-
	Great Lakes Shoreline	0	-	-
	Nuclear Attack	0	-	-
	Nuclear Power Emergencies	0	-	-

WHITEHALL TOWNSHIP
Critical Facilities and Potential Hazards



Note: This jurisdiction is subject to many additional hazards; some of which tend to occur across wide areas and cannot be effectively shown on this map.Refer to **Appendix B- Hazard Identifications and Analyses** for more complete information about potential hazards in this community.

WMSRDC
WEST MICHIGAN SHORELINE REGIONAL DEVELOPMENT COMMISSION

Source: Michigan Geographic Data Library V 12b, Muskegon Co. Hazard Mitigation Plan Update 2014

Appendix C:
HAZARD IDENTIFICATION DATA AND MAPS

National Climatic Data Center: Storm Events

(230 events were reported in Muskegon County, Michigan between 01/01/1950 and 06/30/2004)

LOCATION	DATE	TYPE	MAGNITUDE	DEATHS	INJURIES	DAMAGE ($)	
						Property	Crop
1 MUSKEGON	5/13/56	Tornado	F?	0	0	0K	0
2 MUSKEGON	5/13/56	Hail	4.00 in.	0	0	0	0
3 MUSKEGON	5/13/56	Tornado	F?	0	0	0K	0
4 MUSKEGON	6/26/56	Tstm Wind	60 kts.	0	0	0	0
5 MUSKEGON	6/26/56	Tstm Wind	60 kts.	0	0	0	0
6 MUSKEGON	4/25/57	Hail	1.00 in.	0	0	0	0
7 MUSKEGON	7/22/60	Hail	0.75 in.	0	0	0	0
8 MUSKEGON	7/29/60	Tstm Wind	67 kts.	0	0	0	0
9 MUSKEGON	9/30/61	Tstm Wind	0 kts.	0	0	0	0
10 MUSKEGON	3/19/63	Hail	1.00 in.	0	0	0	0
11 MUSKEGON	6/8/63	Tstm Wind	0 kts.	0	0	0	0
12 MUSKEGON	8/11/64	Tstm Wind	0 kts.	0	0	0	0
13 MUSKEGON	8/22/64	Tstm Wind	0 kts.	0	0	0	0
14 MUSKEGON	9/4/65	Tornado	F2	0	0	25K	0
15 MUSKEGON	1/24/67	Tstm Wind	53 kts.	0	0	0	0
16 MUSKEGON	4/16/67	Tornado	F1	0	0	3K	0
17 MUSKEGON	4/21/67	Tornado	F0	0	0	0K	0
18 MUSKEGON	6/29/68	Tstm Wind	0 kts.	0	0	0	0
19 MUSKEGON	5/31/69	Tstm Wind	0 kts.	0	0	0	0
20 MUSKEGON	4/30/70	Tstm Wind	55 kts.	0	0	0	0
21 MUSKEGON	6/6/71	Tstm Wind	50 kts.	0	0	0	0
22 MUSKEGON	5/14/72	Hail	0.75 in.	0	0	0	0
23 MUSKEGON	8/17/73	Tstm Wind	0 kts.	0	0	0	0
24 MUSKEGON	6/13/75	Tstm Wind	0 kts.	0	0	0	0
25 MUSKEGON	6/17/78	Hail	2.00 in.	0	0	0	0
26 MUSKEGON	6/25/78	Hail	1.75 in.	0	0	0	0
27 MUSKEGON	10/3/79	Hail	1.75 in.	0	0	0	0
28 MUSKEGON	4/8/80	Hail	1.00 in.	0	0	0	0
29 MUSKEGON	7/15/80	Tstm Wind	60 kts.	0	0	0	0
30 MUSKEGON	8/19/80	Tstm Wind	0 kts.	0	0	0	0
31 MUSKEGON	8/19/80	Tstm Wind	65 kts.	0	0	0	0
32 MUSKEGON	3/31/81	Hail	1.00 in.	0	0	0	0
33 MUSKEGON	4/16/82	Hail	1.00 in.	0	0	0	0
34 MUSKEGON	8/3/82	Tstm Wind	0 kts.	0	0	0	0
35 MUSKEGON	10/20/82	Tstm Wind	0 kts.	0	0	0	0
36 MUSKEGON	12/5/82	Tstm Wind	0 kts.	0	0	0	0
37 MUSKEGON	7/21/83	Tstm Wind	51 kts.	0	0	0	0
38 MUSKEGON	7/28/83	Tstm Wind	0 kts.	0	0	0	0
39 MUSKEGON	8/21/83	Tstm Wind	0 kts.	0	0	0	0
40 MUSKEGON	8/21/83	Tstm Wind	0 kts.	0	0	0	0
41 MUSKEGON	7/10/84	Tstm Wind	0 kts.	0	0	0	0
42 MUSKEGON	7/10/84	Tstm Wind	0 kts.	0	0	0	0
43 MUSKEGON	8/30/84	Tstm Wind	0 kts.	0	0	0	0
44 MUSKEGON	6/11/86	Hail	1.00 in.	0	0	0	0
45 MUSKEGON	7/15/86	Tstm Wind	0 kts.	0	0	0	0
46 MUSKEGON	7/15/86	Tstm Wind	0 kts.	0	0	0	0
47 MUSKEGON	9/10/86	Tstm Wind	0 kts.	0	0	0	0
48 MUSKEGON	7/20/87	Tstm Wind	0 kts.	0	0	0	0
49 MUSKEGON	4/5/88	Tstm Wind	53 kts.	0	0	0	0
50 MUSKEGON	8/17/88	Tstm Wind	55 kts.	0	0	0	0

51 MUSKEGON	5/25/89	Tstm Wind	0 kts.	0	0	0	0
52 MUSKEGON	7/2/89	Tstm Wind	50 kts.	0	0	0	0
53 MUSKEGON	8/4/89	Tstm Wind	0 kts.	0	0	0	0
54 MUSKEGON	7/4/90	Hail	0.75 in.	0	0	0	0
55 MUSKEGON	7/4/90	Hail	1.00 in.	0	0	0	0
56 MUSKEGON	7/4/90	Hail	1.75 in.	0	0	0	0
57 MUSKEGON	10/17/90	Tstm Wind	0 kts.	0	0	0	0
58 MUSKEGON	3/27/91	Tstm Wind	61 kts.	0	0	0	0
59 MUSKEGON	3/27/91	Hail	0.75 in	0	0	0	0
60 MUSKEGON	6/14/91	Tstm Wind	0 kts.	0	0	0	0
61 MUSKEGON	7/3/91	Tstm Wind	0 kts.	0	0	0	0
62 MUSKEGON	7/7/91	Tstm Wind	0 kts.	0	0	0	0
63 MUSKEGON	9/9/91	Tstm Wind	0 kts.	0	0	0	0
64 MUSKEGON	6/17/92	Tstm Wind	0 kts.	0	0	0	0
65 MUSKEGON	6/17/92	Tstm Wind	0 kts.	0	0	0	0
66 MIZ004	1/12/93	Heavy Snow	N/A	0	0	50K	0
67 MIZ001	1/21/93	Ice Storm	N/A	0	0	0	0
68 NW MI	1/28/93	Heavy Lake Snow	N/A	0	0	0	0
69 MIZ001	2/22/93	Lake Effect Snow	N/A	0	0	0	0
70 Norton Shores	8/30/93	Flood/flash Flood	N/A	0	0	0	0
71 UP and W MI	12/20/93	Heavy Snow	N/A	0	0	0	0
72 MIZ001	12/23/93	Heavy Snow	N/A	0	0	0	0
73 UP and W MI	12/25/93	Heavy Snow	N/A	0	0	0	0
74 UP and W MI	12/29/93	Heavy Snow	N/A	0	0	0	0
75 UP MI	1/12/94	Heavy Lake Snow	N/A	0	0	500K	0
76 Miz000	1/13/94	Record Cold	N/A	0	0	50.0M	0
77 Countywide	1/27/94	Hvy Snow/Frz Rain	N/A	0	0	5.0M	0
78 W Lower MI	2/2/94	Heavy Snow	N/A	0	0	0	0
79 S Lower MI	2/7/94	Snow	N/A	0	0	0	0
80 C UP, N MI	2/22/94	Heavy Snow	N/A	0	0	0	0
81 S Lower MI	2/25/94	Heavy Snow	N/A	0	0	0	0
82 MUSKEGON	4/18/94	Tstm Winds	N/A	0	0	50K	0
83 Fruitport	4/26/94	Tstm Winds	N/A	0	0	5K	0
84 Muskegon	4/26/94	Hail	0.75 in.	0	0	0	0
85 Montague	7/4/94	Tstm Winds	N/A	0	0	0	0
86 Montague	7/20/94	Tstm Winds	N/A	0	0	5K	0
87 MUSKEGON	7/20/94	Lightning	N/A	0	0	50K	0
88 Statewide	11/18/94	High Wind	up to 62 kts.	0	0	1M	0
89 S Lower MI	12/6/94	Heavy Snow	N/A	0	0	0	0
90 S Lower MI	1/1/95	Heavy Lake Snow	N/A	0	0	0	0
91 Lower MI	1/11/95	Dense Fog	N/A	0	0	0	0
92 Statewide	1/20/95	Heavy Snow	N/A	0	0	0	0
93 MIZ001	2/3/95	Heavy Lake Snow	N/A	0	0	0	0
94 MIZ006	2/7/95	Heavy Lake Snow	N/A	0	0	0	0
95 MIZ001	2/11/95	Heavy Lake Snow	N/A	0	0	0	0
96 S Lower MI	2/25/95	Heavy Snow	N/A	0	0	0	0
97 S Lower MI	2/27/95	Ice Storm	N/A	0	0	0	0
98 S Lower MI	3/6/95	Ice Storm	N/A	0	0	0	0
99 Statewide	3/6/95	Heavy Snow	N/A	0	0	0	0
100 Norton Shores	4/18/95	Tstm Winds	N/A	0	0	0	0
101 Muskegon	4/18/95	Tstm Winds	N/A	0	0	3K	0
102 Montague	4/18/95	Tstm Winds	N/A	0	0	0	0
103 Holton	4/18/95	Tstm Winds	N/A	0	0	0	0
104 Muskegon	7/4/95	Lightning	N/A	0	0	10K	0
105 Montague	8/13/95	Tstm Winds	50 kts	0	0	0	0

106 Whitehall	9/16/95	Tstm Winds	N/A	0	0	0	0
107 W Lower MI	11/27/95	Heavy Snow	N/A	0	0	0	0
108 SE Lower MI	12/9/95	Cold Wave	N/A	3	0	0	0
109 SE Lower MI	12/13/95	Ice Storm	N/A	0	0	0	0
110 Lakewood Club	2/26/96	Hail	0.75 in.	0	0	0	0
111 MIZ050	3/1/96	Heavy Snow	N/A	0	0	0	0
112 Montague	4/12/96	Hail	1.00 in.	0	0	0	0
113 MIZ037	11/10/96	Heavy Snow	N/A	0	0	0	0
114 MIZ050	12/18/96	Heavy Snow	N/A	0	0	0	0
115 MIZ037	12/25/96	Heavy Snow	N/A	0	0	0	0
116 MIZ043	1/10/97	Heavy Snow	N/A	0	0	0	0
117 MIZ039	1/15/97	Heavy Snow	N/A	0	0	0	0
118 MIZ037	2/21/97	Flood	N/A	0	0	0	0
119 Montague	2/21/97	Flash Flood	N/A	0	0	0	0
120 MIZ050	3/14/97	Ice Storm	N/A	0	0	0	0
121 MIZ050	4/6/97	High Wind	61 kts.	0	0	5.0M	0
122 Montague	6/24/97	Tstm Wind	0 kts.	0	0	3K	0
123 Fruitport	9/17/97	Tstm Wind	0 kts.	0	0	5K	0
124 MIZ050	9/29/97	High Wind	42 kts.	0	0	0	0
125 MIZ039	10/26/97	Heavy Snow	N/A	0	0	1.2M	0
126 MIZ037	11/11/97	Lake Effect Snow	N/A	0	0	0	0
127 MIZ037	12/4/97	Lake Effect Snow	N/A	0	0	0	0
128 MIZ050	12/10/97	Winter Storm	N/A	0	0	0	0
129 MIZ043	12/24/97	Winter Storm	N/A	0	0	0	0
130 MIZ037	12/30/97	Lake Effect Snow	N/A	0	0	0	0
131 MIZ037	1/7/98	Winter Storm	N/A	0	0	0	0
132 MIZ040	1/14/98	Heavy Snow	N/A	0	0	0	0
133 MIZ037	1/22/98	Winter Storm	N/A	0	0	0	0
134 MIZ037	3/9/98	Blizzard	N/A	0	0	0	0
135 MIZ037	3/13/98	Heavy Snow	N/A	0	0	0	0
136 Fruitport	5/29/98	Tstm Wind	0 kts.	0	0	20K	0
137 N Muskegon	5/29/98	Tstm Wind	65 kts.	0	0	0	0
138 Muskegon	5/29/98	Tstm Wind	0 kts.	0	0	1.0M	0
139 Muskegon Co.	5/31/98	Tstm Wind	54 kts.	0	2	24.2M	5.0M
140 Wabaningo	5/31/98	Seiche	N/A	0	0	20K	0
141 Montague	6/18/98	Tstm Wind	0 kts.	0	0	5K	0
142 Muskegon	6/18/98	Tstm Wind	0 kts.	0	0	2.5K	0
143 Muskegon	6/27/98	Tstm Wind	52 kts.	0	0	2.5K	0
144 Muskegon	7/21/98	Tstm Wind	52 kts.	0	0	0	0
145 Muskegon	7/21/98	Lightning	N/A	0	0	40K	0
146 Muskegon	8/4/98	Flash Flood	N/A	0	0	0	0
147 Roosevelt Pk	11/10/98	Waterspout/Tornado	F0	0	0	0	0
148 MIZ037	11/10/98	High Wind	87 kts.	1	0	0	0
149 MIZ037	12/21/98	Lake Effect Snow	N/A	0	0	0	0
150 MIZ037	12/29/98	Lake Effect Snow	N/A	0	0	0	0
151 MIZ037	1/2/99	Blizzard	N/A	0	0	0	0
152 W. Lower MI	1/3/99	Heavy Snow	N/A	0	0	0	0
153 Lower MI	1/4/99	Snow	N/A	0	0	0	0
154 MIZ037	1/5/99	Lake Effect Snow	N/A	0	0	0	0
155 MIZ037	1/8/99	Lake Effect Snow	N/A	0	0	0	0
156 MIZ037	1/10/99	Winter Storm	N/A	0	0	0	0
157 W. Lower MI	1/11/99	Winter Storm	N/A	0	0	0	0
158 MIZ037	2/5/99	Freezing Rain	N/A	0	0	0	0
159 MIZ043	2/12/99	Lake Effect Snow	N/A	0	0	0	0
160 MIZ037	3/4/99	Snow	N/A	0	0	0	0

161 MIZ037	3/8/99	Snow	N/A	0	0	0	0
162 Muskegon	6/6/99	Tstm Wind	0 kts.	0	0	5K	0
163 Ravenna	7/9/99	Tstm Wind	53 kts.	0	0	10K	0
164 MIZ037	1/3/00	Winter Storm	N/A	0	0	0	0
165 W. Lower MI	1/12/00	Winter Storm	N/A	0	0	0	0
166 MIZ037	1/19/00	Winter Storm	N/A	0	0	0	0
167 MIZ037	4/7/00	Winter Storm	N/A	0	0	0	0
168 Muskegon	5/8/00	Tstm Wind	53 kts.	0	0	50K	0
169 Twin Lake	5/12/00	Hail	1.00 in.	0	0	50K	0
170 Countywide	5/18/00	Flood	N/A	0	0	100K	50K
171 Muskegon	6/1/00	Tstm Wind	53 kts.	0	0	40K	0
172 Muskegon	8/22/00	Tstm Wind	70 kts.	0	0	150K	0
173 Ravenna	8/22/00	Tstm Wind	53 kts.	0	0	25K	0
174 MIZ037	11/19/00	Winter Storm	N/A	0	0	0	0
175 MIZ037	12/11/00	Winter Storm	N/A	0	0	0	0
176 MIZ037	12/20/00	Heavy Snow	N/A	0	0	0	0
177 W. Lower MI	12/21/00	Heavy Snow	N/A	0	0	0	0
178 Countywide	2/9/01	Flood	N/A	0	0	100K	0
179 MIZ043	2/24/01	Flood	N/A	0	0	190K	0
180 MIZ050	3/5/01	Heavy Snow	N/A	0	0	0	0
181 W. Lower MI	3/24/01	Heavy Snow	N/A	0	0	0	0
182 Holton	4/11/01	Hail	0.75 in.	0	0	10K	10K
183 Fruitport	4/11/01	Hail	1.75 in.	0	0	50K	25K
184 Twin Lake	4/11/01	Flash Flood	N/A	0	0	10K	10K
185 Cloverville	4/11/01	Tornado	F0	0	0	0K	0
186 Twin Lake	4/11/01	Hail	0.75 in.	0	0	10K	10K
187 Muskegon	5/15/01	Tstm Wind	53 kts.	0	0	25K	0
188 Muskegon	5/15/01	Flash Flood	N/A	0	0	500K	200K
189 Countywide	5/15/01	Hail	1.00 in.	0	0	35K	35K
190 Whitehall	5/15/01	Hail	1.00 in.	0	0	25K	25K
191 Countywide	5/15/01	Flood	N/A	0	0	25K	25K
192 Countywide	5/15/01	Hail	1.00 in.	0	0	50K	50K
193 Countywide	5/15/01	Hail	0.75 in	0	0	20K	20K
194 Countywide	5/15/01	Tstm Wind	51 kts.	0	0	10K	0
195 Countywide	5/16/01	Flash Flood	N/A	0	0	25K	25K
196 Countywide	5/16/01	Flood	N/A	0	0	25K	25K
197 Norton Shrs	6/11/01	Hail	0.75 in.	0	0	10K	10K
198 Muskegon	9/7/01	Hail	0.75 in.	0	0	15K	0
199 Ravenna	10/24/01	Tstm Wind	53 kts.	0	0	15K	0
200 MIZ037	12/23/01	Winter Storm	N/A	0	0	0	0
201 MIZ050	12/25/01	Winter Storm	N/A	0	0	0	0
202 W. Lower MI	12/28/01	Winter Storm	N/A	0	0	0	0
203 MIZ044	1/30/02	Winter Storm	N/A	0	0	0	0
204 MIZ037	3/2/02	Winter Storm	N/A	0	0	0	0
205 MIZ037	3/9/02	High Wind	62 kts.	0	0	485K	0
206 Montague	4/18/02	Hail	0.88 in.	0	0	10K	5K
207 Norton Shrs	8/21/02	Tstm Wind	53 kts.	0	2	10K	0
208 Montague	10/4/02	Tstm Wind	53 kts.	0	0	10K	0
209 Roosevelt Pk	10/6/02	Tstm Wind	60 kts.	0	0	20K	0
210 MIZ037	2/11/03	Heavy Snow	N/A	0	0	0	0
211 MIZ037	3/4/03	Heavy Snow	N/A	0	0	0	0
212 Whitehall	3/28/03	Tstm Wind	52 kts.	0	0	5K	0
213 MIZ037	4/3/03	Ice Storm	N/A	0	0	4.9M	0
214 Dalton	7/4/03	Tstm Wind	53 kts.	0	0	15K	5K
215 Muskegon	7/21/03	Hail	0.75 in.	0	0	25K	10K

216 Whitehall	8/3/03	Hail	0.75 in.	0	0	10K	5K
217 Muskegon Twp	8/3/03	Hail	1.75 in.	0	0	25K	10K
218 Fruitport	8/3/03	Hail	0.75 in.	0	0	10K	5K
219 Muskegon	8/3/03	Hail	0.75 in.	0	0	10K	5K
220 MIZ050	1/6/04	Blizzard	N/A	0	0	0	0
221 MIZ037	1/27/04	Winter Storm	N/A	0	0	0	0
222 M Heights	3/1/04	Hail	0.75 in.	0	0	5K	0
223 Lakewood Club	5/10/04	Hail	0.75 in.	0	0	15K	15K
224 Cloverville	5/21/04	Tstm Wind	53 kts.	0	0	30K	10K
225 MIZ037	5/21/04	Flood	N/A	0	0	25.0M	4.6M
226 Muskegon	6/9/04	Tstm Wind	53 kts.	0	0	5K	0
227 Twin Lake	6/9/04	Tstm Wind	53 kts.	0	0	5K	0
228 Muskegon	6/23/04	Hail	0.75 in.	0	0	10K	10K
229 Muskegon	6/23/04	Hail	0.75 in.	0	0	10K	10K
230 Muskegon	6/24/04	Tstm Wind	53 kts.	0	0	10K	0
			TOTALS:	4	4	126.713M	10.21M

*The Storm Events Database contains data from the following sources:
All Weather Events from 1993 - 1995, as entered into Storm Data. (Except 6/93 - 7/93, which is missing) (NO Latitude/Longitude)
All Weather Events from 1996 - Current, as entered into Storm Data. (Including Latitude/Longitude)
Plus additional data from the Storm Prediction Center; Including

Tornadoes 1950-1992
Thunderstorm Winds 1955-1992
Hail 1955-1992

National Climatic Data Center: Storm Events

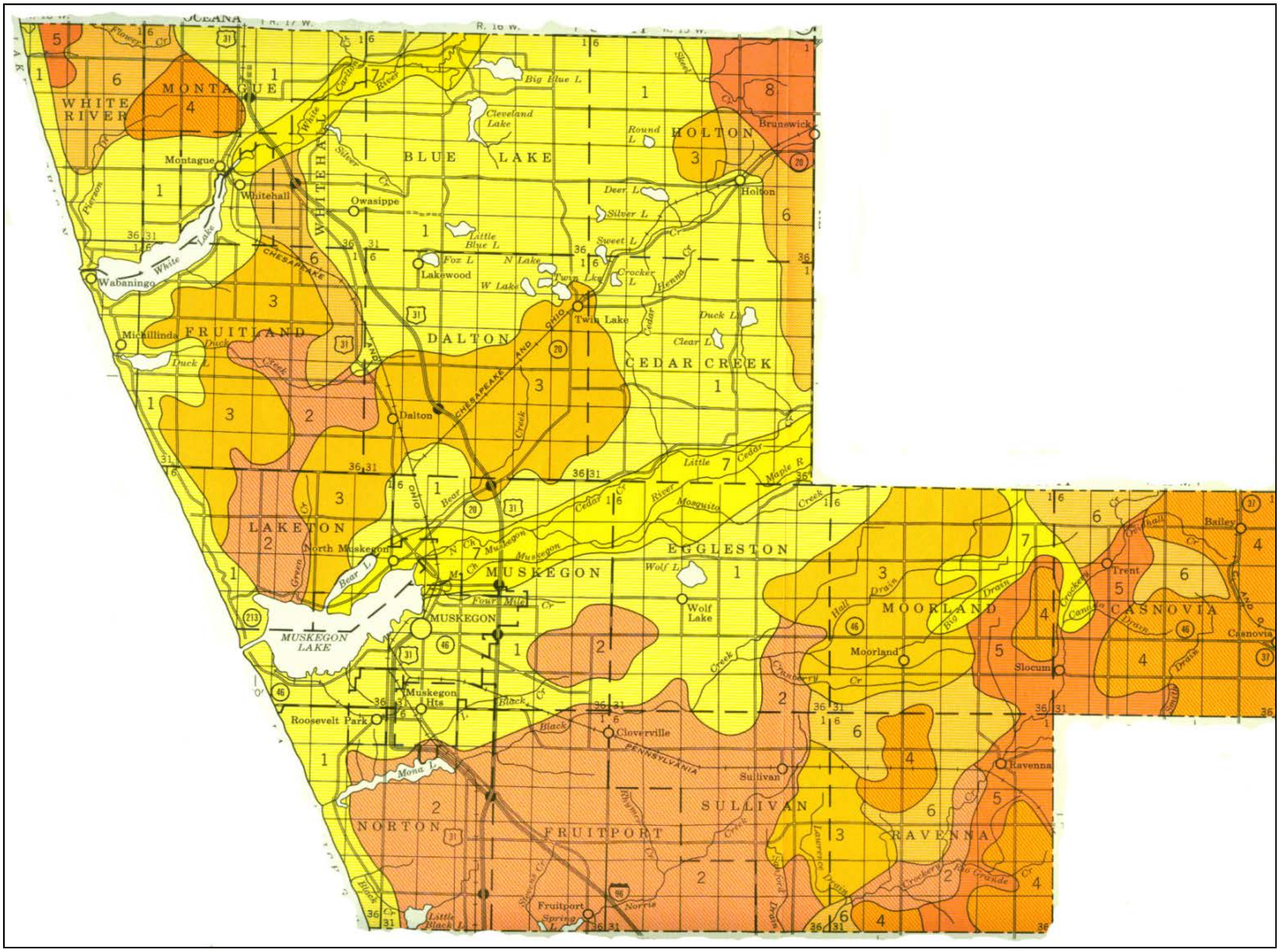
07/01/2004 through 03/31/2014 ♦ 111 events reported for Muskegon County

Location or Zone (zone indicates multiple counties)	Date	Duration	Type	Magnitude	Death	Injury	Damage ($)		Notes
							property	crop	
Dalton Township	7/13/04	<1 day	Thunderstorm Wind	61 mph	0	0	10k	0	8 trees downed 2 miles SE of Lakewood Club
Blue Lake Township	8/2/04	<1 day	Hail	.75”	0	0	5k	5k	
Whitehall	8/27/04	<1 day	Thunderstorm Wind	61 mph	0	0	25k	0	Tree downed onto mobile home, and numerous tree limbs and power line downed
Muskegon (zone)	10/30/04	1 day	High Wind	58-60 mph	0	0	1.15m	0	Scattered downed trees and power lines; 100,000 without power statewide
Muskegon (zone)	12/20/04	1 day	Heavy Snow	6-8” snow	0	0	0	0	
Muskegon (zone)	1/18/05	1 day	Heavy Snow	8-11” snow	0	0	0	0	
Muskegon (zone)	1/21/05	1 day	Heavy Snow	10-12” snow	0	0	0	0	
Muskegon (zone)	2/20/05	1 day	Heavy Snow	6-12” snow	0	0	0	0	
Muskegon	3/30/05	<1 day	Hail	.75”	0	0	10k	0	
Fruitport	7/25/05	<1 day	Thunderstorm Wind	61 mph	0	0	30k	0	Downed trees, limbs, and power lines across area
Norton Shores	9/22/05	<1 day	Hail	.75”	0	0	5k	5k	
Muskegon (zone)	1/20/06	1 day	Heavy Snow	8-11” snow	0	0	0	0	
Whitehall	4/14/06	<1 day	Hail	.75”	0	0	5k	5k	
Whitehall	7/17/06	<1 day	Thunderstorm Wind	61 mph	0	0	15k	0	
Montague	7/17/06	<1 day	Thunderstorm Wind	61 mph	0	0	15k	0	Several large trees blown down in Montague
Holton Township	9/6/06	<1 day	Hail	.88”	0	0	10k	5k	
Norton Shores	10/4/06	<1 day	Thunderstorm Wind	60 mph	0	0	25k	10k	
Muskegon (zone)	12/1/06	1 day	Heavy Snow	6-7” snow	0	0	0	0	
Muskegon (zone)	12/4/06	1 day	Lake Effect Snow	6-8” snow	0	0	0	0	
Muskegon (zone)	12/6/06	1 day	Lake Effect Snow	6-9” snow	0	0	0	0	
Muskegon (zone)	1/14/07	1 day	Winter Storm	6” snow	0	0	0	0	
Muskegon (zone)	1/29/07	1 day	Lake Effect Snow	14” snow	0	0	0	0	
Muskegon (zone)	2/2/07	2 days	Blizzard	up to 12” snow	0	0	0	0	Heavy snow with wind gusts to 40 mph caused road closures, power outages, and car accidents
Norton Shores	6/3/07	<1 day	Thunderstorm Wind	60 mph	0	0	20k	0	Trees and power lines downed in Norton Shores
Fruitport Township	6/3/07	<1 day	Thunderstorm Wind	60 mph	0	0	10k	0	Trees and limbs downed in Cloverville
Ravenna Township	7/25/07	<1 day	Thunderstorm Wind	58 mph	0	0	10k	0	Trees downed on Squires Rd. 2 mi. SE of Ravenna
Fruitland Township	7/26/07	<1 day	Hail	1.00”	0	0	10k	0	2 mi. SW of Lakewood Club in Fruitland Township
Norton Shores	7/26/07	<1 day	Hail	.75”	0	0	10k	5k	Enough hail to cover a car at the MKG airport
Muskegon County	8/22/07	<1 day	Thunderstorm Wind	63 mph	0	0	25k	0	Trees downed on houses in Fruitland and Dalton Twps; wind measured in Muskegon and Nrtn Shrs
Muskegon County	10/18/07	<1 day	Thunderstorm Wind	60 mph	0	0	45k	0	Trees downed countywide with scattered power outages
Muskegon (zone)	12/1/07	1 day	Winter Storm	N/A	0	0	0	0	
Muskegon (zone)	12/15/07	1 day	Heavy Snow	4-6”	0	0	0	0	
Muskegon	12/23/07	<1 day	Thunderstorm Wind	gusts 50-70mph	0	0	0	0	Widespread power outages and wind damage across central and southern Lower MI
Muskegon (zone)	12/28/07	1 day	Heavy Snow	6-8” snow	0	0	0	0	
Muskegon County	1/7/08	<1 day	Heavy Rain	N/A	0	0	0	0	Street flooding at the intersection of Getty and Sherman estimated at 8” deep
Norton Shores	1/7/08	<1 day	Hail	.75”	0	0	0	0	
Muskegon (zone)	1/10/08	1 day	Winter Storm	N/A	0	0	0	0	
Muskegon (zone)	1/21/08	1 day	Winter Storm	7-10” snow	0	0	0	0	

Muskegon (zone)	1/29/08	1 day	Winter Storm	4-7” snow	0	0	0	0	Blizzard to near blizzard conditions
Muskegon (zone)	2/6/08	1 day	Winter Storm	9-11” snow	0	0	0	0	Near blizzard conditions
Muskegon (zone)	2/10/08	1 day	Blizzard	<4” snow	0	0	0	0	
Muskegon (zone)	2/18/08	2 days	Lake Effect Snow	10-15” snow	0	0	0	0	
Muskegon (zone)	3/21/08	1 day	Winter Storm	7” snow	0	0	0	0	7” snow measured at MKG airport set a record for March 21
Norton Shores	6/8/08	<1 day	Thunderstorm Wind	60 mph	0	0	0	0	
Muskegon	6/13/08	<1 day	Thunderstorm Wind	60 mph	0	0	0	0	
Fruitland Township	6/28/08	<1 day	Thunderstorm Wind	58 mph	0	1	0	0	A 16” diameter branch fell on a truck resulting in minor injuries
Muskegon	6/28/08	<1 day	Thunderstorm Wind	58 mph	0	0	0	0	Tree blown onto a home
Whitehall	7/2/08	<1 day	Hail	.88”	0	0	0	0	Hail reported in downtown Whitehall
Norton Shores	7/2/08	<1 day	Hail	1.00”	0	0	0	0	Reported 1 mi S of MKG airport
Dalton Township	7/2/08	<1 day	Hail	1.50”	0	0	0	0	
Muskegon	7/2/08	<1 day	Hail	1.00”	0	0	0	0	Spotted 1 mi E of Muskegon Lake
Muskegon	7/2/08	<1 day	Thunderstorm Wind	60 mph	0	0	0	0	
Muskegon Heights	7/16/08	<1 day	Thunderstorm Wind	60 mph	0	0	0	0	2 trees blown down
Fruitport Township	10/26/08	<1 day	Hail	.75”	0	0	0	0	Hail reported in Cloverville
Muskegon (zone)	12/6/08	1 day	Winter Storm	6-10” snow	0	0	0	0	
Muskegon (zone)	12/8/08	1 day	Winter Storm	5-10” snow	0	0	0	0	Sleet and freezing rain were also reported
Muskegon (zone)	12/19/08	1 day	Winter Storm	8-12” snow	0	0	0	0	
Muskegon (zone)	12/20/08	2 days	Blizzard	8-12” snow	0	0	0	0	Snow with 40-45 mph gusts caused several stretches of highway to be shut down in SW MI
Muskegon (zone)	12/23/08	2 days	Winter Storm	6-10” snow	0	0	0	0	
Muskegon (zone)	12/28/08	1 day	High Wind	61 mph	0	0	0	0	Trees and power lines blown down; hundreds of thousands lost power statewide
Muskegon (zone)	1/17/09	1 day	Winter Storm	up to 15” snow	0	0	0	0	
Muskegon (zone)	2/21/09	1 day	Winter Storm	8” snow	0	0	0	0	
Fruitport	8/9/09	<1 day	Thunderstorm Wind	75 mph	0	0	100k	0	100’s of trees down, ~12 homes damaged, and entire Village of Fruitport without power
Muskegon County	8/9/09	<1 day	Thunderstorm Wind	61 mph	0	0	2m	0	Extensive damage across southern Muskegon Co, especially the Village of Fruitport
Muskegon County	10/06/09	1 day	High Wind	61 mph	0	0	0	0	Nearly 7,000 in Muskegon County lost power
Muskegon (zone)	12/3/09	1 day	Winter Storm	up to 7” snow	0	0	0	0	
Muskegon (zone)	12/7/09	1 day	Lake Effect Snow	5-7” snow	0	0	0	0	
Muskegon (zone)	12/9/09	2 days	Winter Storm	4-8” snow	0	0	0	0	Snow and 40 mph wind created near blizzard conditions
Muskegon (zone)	12/24/09	1 day	Winter Weather	.1-.25” ice	0	0	0	0	
Muskegon (zone)	12/26/09	1 day	Lake Effect Snow	up to 8” snow	0	0	0	0	
Muskegon (zone)	1/1/10	2 days	Lake Effect Snow	12-17” snow	0	0	0	0	
Muskegon (zone)	2/9/10	1 day	Heavy Snow	4-9” snow	0	0	0	0	
Muskegon (zone)	2/23/10	1 day	Lake Effect Snow	up to 9” snow	0	0	0	0	
Muskegon County	9/21/10	<1day	Thunderstorm Wind	76 mph	0	0	50k	0	Spotty tree damage and some power outages
Muskegon (zone)	10/27/10	<1day	High Wind	61 mph	0	0	0	0	
Muskegon (zone)	12/6/10	2 days	Lake Effect Snow	6-10” snow	0	0	0	0	
Muskegon (zone)	1/3/11	1 day	Winter Weather	4.9” snow	0	0	0	0	
Muskegon (zone)	1/6/11	3 days	Winter Weather	8-10” snow	0	0	0	0	
Muskegon (zone)	1/22/11	1 day	Lake Effect Snow	10.7” snow	0	0	0	0	
Muskegon (zone)	2/1/11	1 day	Blizzard	14” snow	0	0	0	0	Snow with gusts to 4 mph

Muskegon (zone)	2/20/11	1 day	Winter Storm	8-12” snow	0	0	0	0	
Muskegon (zone)	3/4/11	1 day	Winter Weather	.1” ice	0	0	0	0	
Muskegon (zone)	3/22/11	1 day	Winter Weather	.1-.25” ice	0	0	0	0	
Dalton Township	6/8/11	<1 day	Thunderstorm Wind	60 mph	0	0	0	0	Downed tree branches in Twin Lake
Muskegon	6/21/11	<1 day	Hail	2.00”	0	0	0	0	
Dalton Township	6/21/11	<1 day	Thunderstorm Wind	70 mph	0	0	0	0	Several branches downed and damages to a pontoon boat and a garage roof
Dalton Township	7/11/11	<1 day	Hail	.75”	0	0	0	0	
Muskegon County	7/11/11	<1 day	Thunderstorm Wind	66 mph	0	0	0	0	Gust measured at the White Lake Lighthouse; trees downed at Apple Ave and US-31 and near Twin Lk
Muskegon County	9/3/11	<1 day	Thunderstorm Wind	60 mph	0	0	0	0	Numerous trees and power lines downed across Muskegon County
Muskegon (zone)	1/1/12	2 days	Lake Effect Snow	6” snow	0	0	0	0	
Muskegon (zone)	1/12/12	2 days	Winter Storm	8-12” snow	0	0	0	0	
Muskegon (zone)	2/23/12	1 day	Heavy Snow	6” snow	0	0	0	0	
Dalton Township	5/3/12	<1 day	Hail	.75”	0	0	0	0	Hail and trees downed in Twin Lake
Blue Lake Township	5/15/12	<1 day	Thunderstorm Wind	63 mph	0	0	.2k	0	Multiple trees downed 4 mi N of Twin Lake
Muskegon County	5/28/12	<1 day	Thunderstorm Wind	52 mph	0	0	.25k	0	Trees downed in Fruitland and Blue Lake Townships
Cedar Creek Township	7/30/12	<1 day	Thunderstorm Wind	60 mph	0	0	10k	0	Trees and power lines downed
Norton Shores	7/31/12	<1 day	Hail	.75”	0	0	0	0	Observed at Hoffmaster State Park
Muskegon (zone)	1/19/13	5 days	Lake-effect Snow	12-16” snow, 65 mph	0	0	0	0	Up to 10 inches of this fell in a twelve hour period on January 21
Muskegon (zone)	2/01/13	1 day	Lake-effect Snow	up to 12” snow	0	0	0	0	Moderate travel impacts and some power outages were reported.
Muskegon (zone)	2/07/13	1 day	Heavy Snow	12-14” snow	0	0	0	0	Snowfall rates reached up to two inches per hour at times
Muskegon (zone)	2/15/13	2 days	Winter Weather	up to 7” snow	0	0	0	0	
Muskegon (zone)	2/19/13	2 days	Winter Weather	8-12” snow	0	0	0	0	
Muskegon County	4/17/13	6 days	Flood		0	0	5m	0	State and Federal Disaster Declarations
Blue Lake Township	6/17/13	<1 day	Thunderstorm Wind	60 mph	0	0	10k	0	Trees downed
Muskegon County	11/17/13	<1 day	Thunderstorm Wind	62 mph	0	0	200k	0	Several reports of downed trees and power lines across Muskegon county
Casnovia Township	11/17/13	<1 day	Tornado	EF0	0	0	50k	0	
Muskegon (zone)	11/17/13	<1 day	High Wind	70 mph	0	0	75k	0	Numerous power outages in Muskegon county
Muskegon (zone)	12/23/13	1 day	Heavy Snow	12-18” snow	0	0	0	0	
Muskegon (zone)	1/22/14	<1 day	Heavy Snow	8-11” snow	0	0	0	0	
Muskegon (zone)	1/26/14	1day	Heavy Snow	6” snow	0	0	0	0	Wind chill readings fell to around 15 to 20 below zero overnight
Muskegon (zone)	2/17/14	<1 day	Heavy Snow	6-7” snow	0	0	0	0	

GENERAL SOILS MAP



1	Rubicon-Croswell-Deer Park association: Nearly level to steep, well drained and moderately well drained, sandy soils on outwash plains, beach ridges, and dunes
2	Rubicon-Au Gres-Roscommon association: Gently sloping, well-drained and poorly drained, sandy soils on outwash plains and uplands
3	Au Gres-Roscommon-Granby association: Nearly level and slightly depressional, poorly drained, sandy soils on outwash plains, uplands, and lake plains
4	Nester-Ubly-Sims association: Gently sloping to hilly, well drained, moderately well drained, and poorly drained, loamy soils on lake plains and uplands
5	Belding-Allendale-Rubicon loamy substratum-Montcalm association: Nearly level and gently sloping, poorly drained and well-drained, loamy and sandy soils on lake plains
6	Montcalm-Nester-Belding-Kawkawlin association: Gently sloping to rolling, somewhat poorly drained and well-drained, sandy and loamy soils on lake plains, outwash plains, and glaciated uplands
7	Carlisle-Tawas association: Nearly level and depressional, poorly drained peats and mucks
8	Selkirk-Kent-Kawkawlin association: Nearly level and gently sloping, poorly drained, moderately well drained, and well drained, loamy soils on lake plains

Source: USDA/Mich.Dept.Agr.(issued Oct., 1968)

MUSKEGON COUNTY DAMS

The National Inventory of Dams (NID) identifies six dams within Muskegon County. The NID consists of dams meeting at least one of the following criteria:

1) High hazard classification - loss of one human life is likely if the dam fails;
2) Significant hazard classification - possible loss of human life and likely significant property or environmental destruction;
3) Equal or exceed 25 feet in height and exceed 15 acre-feet in storage;
4) Equal or exceed 50 acre-feet storage and exceed 6 feet in height.

Dam hazard potential classes are defined as:

LOW HAZARD POTENTIAL

Dams assigned the low hazard potential classification are those where failure or misoperation results in no probable loss of human life and low economic and/or environmental losses. Losses are principally limited to the owner's property.

SIGNIFICANT HAZARD POTENTIAL

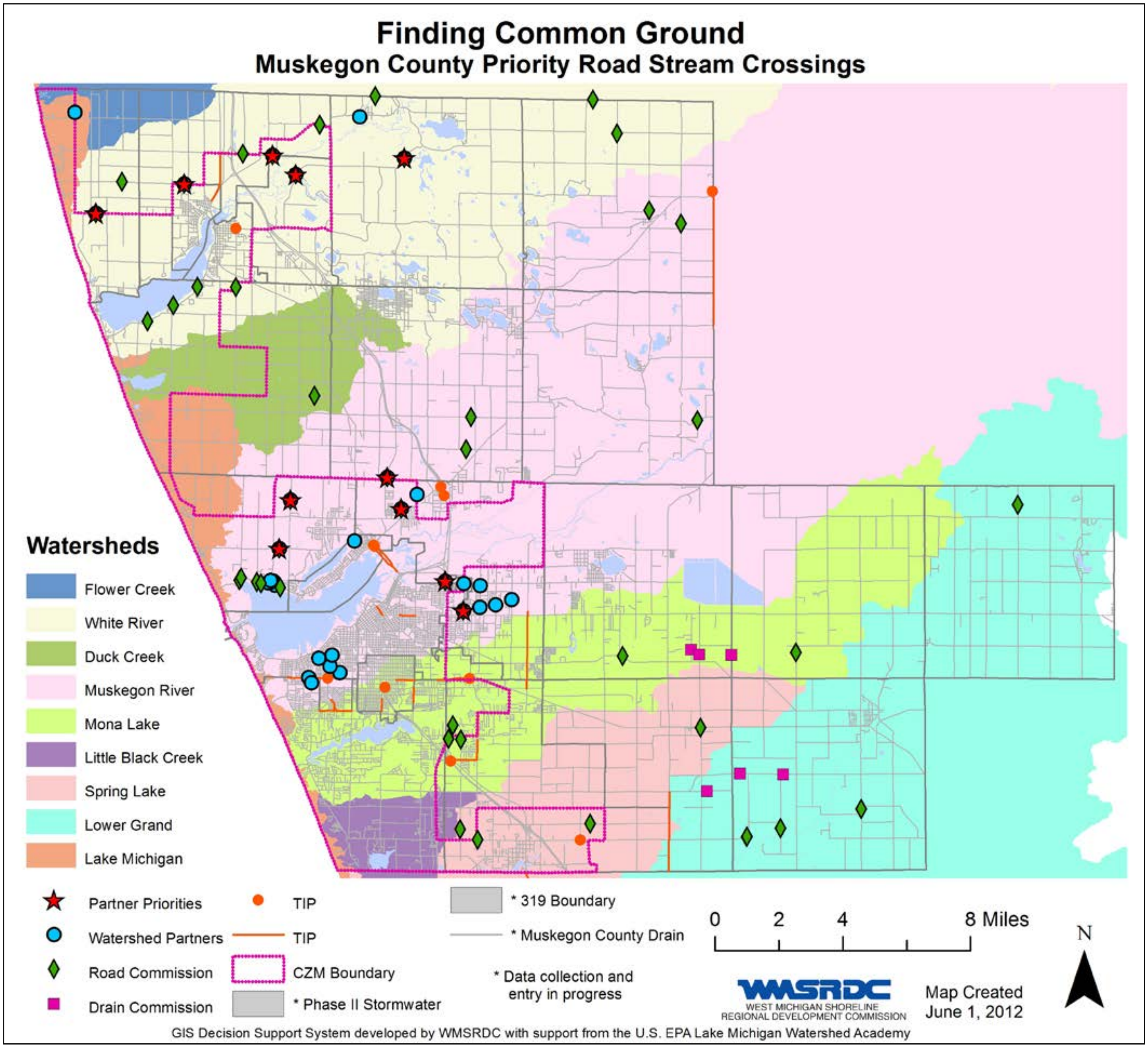
Dams assigned the significant hazard potential classification are those dams where failure or misoperation results in no probable loss of human life but can cause economic loss, environment damage, disruption of lifeline facilities, or impact other concerns. Significant hazard potential classification dams are often located in predominantly rural or agricultural areas but could be located in areas with population and significant infrastructure.

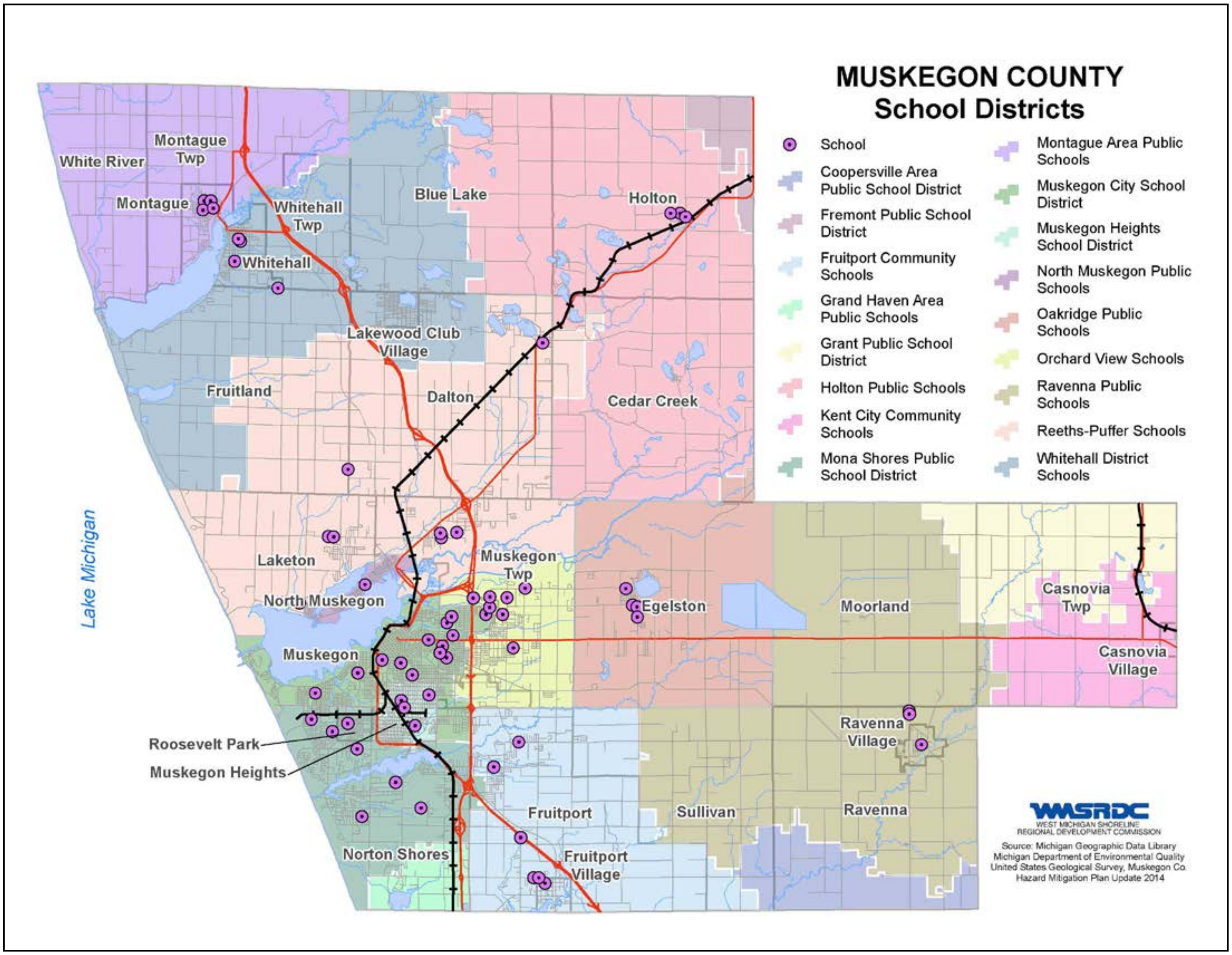
HIGH HAZARD POTENTIAL

Dams assigned the high hazard potential classification are those where failure or misoperation will probably cause loss of human life.

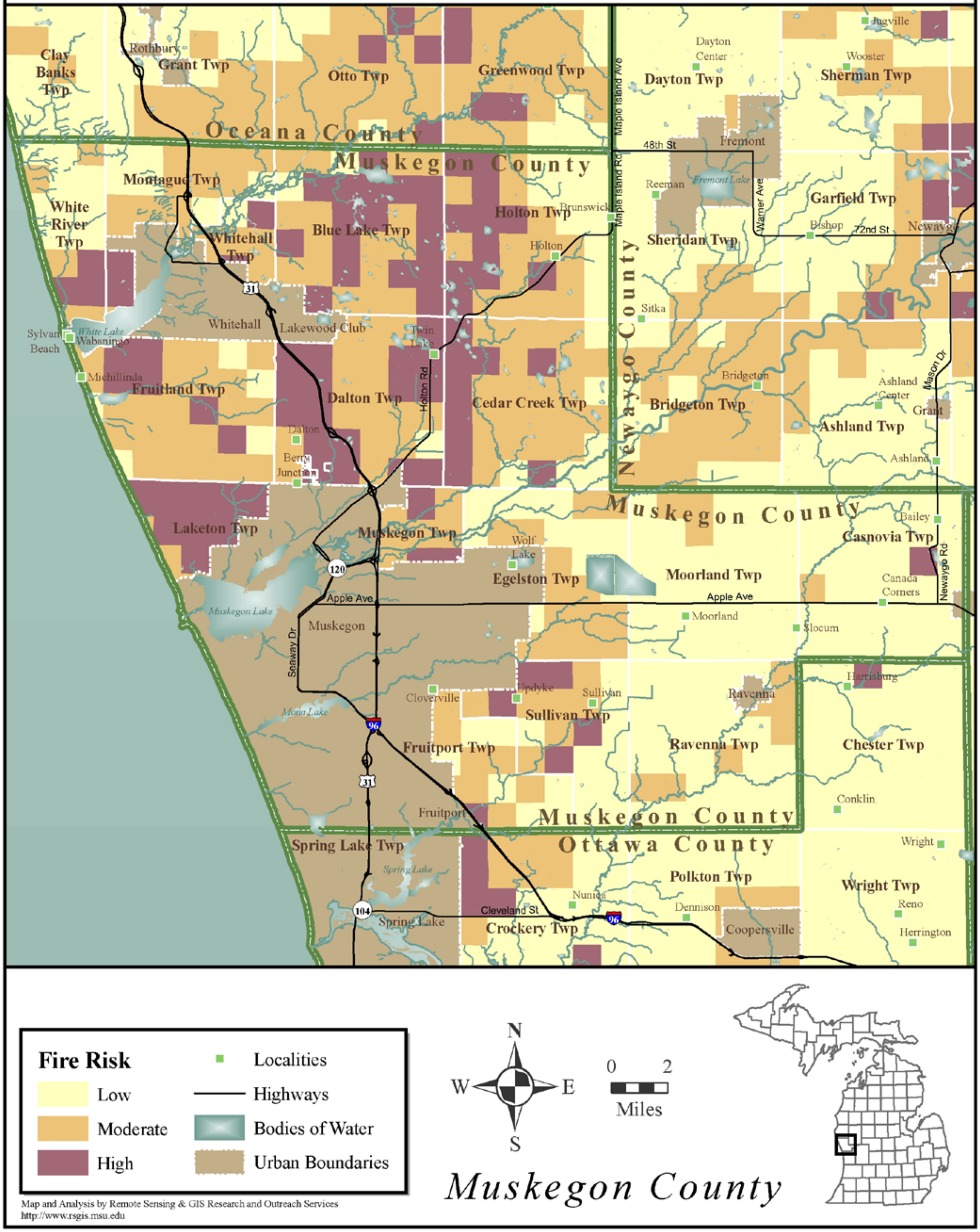
NAME	LOCATION	HAZARD POTENTIAL
Little Black Lake Dam	City of Norton Shores	LOW
Silver Creek Pond Dam	Whitehall Township	
Mill Pond Dam	City of Whitehall	
Browns Pond Dam	Blue Lake Township	SIGNIFICANT
Cleveland Lake Dam	Blue Lake Township	
Muskegon Wastewater Lagoons	Egelston Township	HIGH

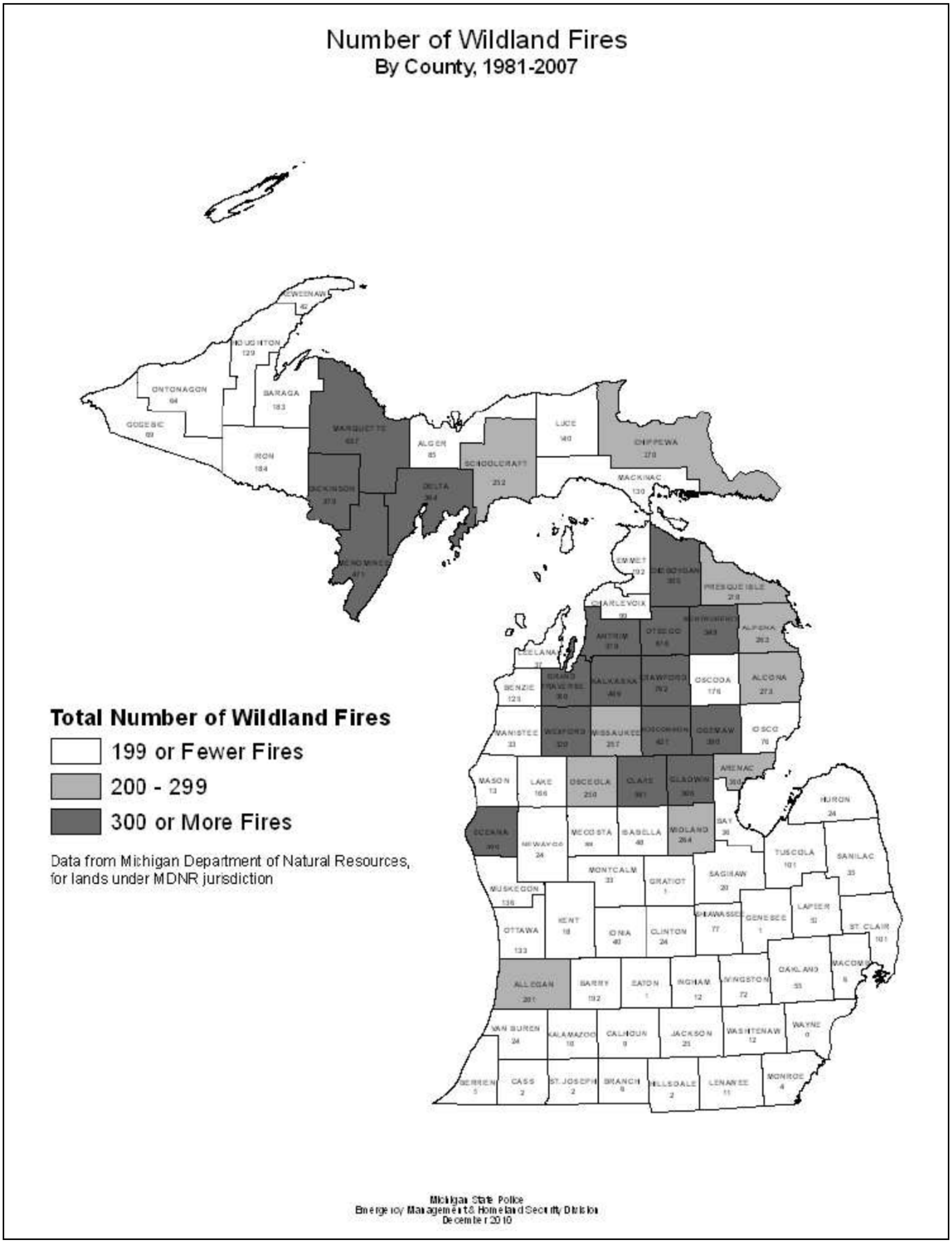
Source: National Inventory of Dams, US Army Corps of Engineers; July 19, 2013


Finding Common Ground
Muskegon County Priority Road Stream Crossings
Watersheds
Flower Creek
White River
Duck Creek
Muskegon River
Mona Lake
Little Black Creek
Spring Lake
Lower Grand
Lake Michigan
Partner Priorities
Watershed Partners
Road Commission
Drain Commission
TIP
TIP
CZM Boundary
* Phase II Stormwater
* 319 Boundary
* Muskegon County Drain
* Data collection and entry in progress
0 2 4 8 Miles
N
WMSRDC
WEST MICHIGAN SHORELINE REGIONAL DEVELOPMENT COMMISSION
Map Created June 1, 2012
GIS Decision Support System developed by WMSRDC with support from the U.S. EPA Lake Michigan Watershed Academy


MUSKEGON COUNTY
School Districts
School
Coopersville Area Public School District
Fremont Public School District
Fruitport Community Schools
Grand Haven Area Public Schools
Grant Public School District
Holton Public Schools
Kent City Community Schools
Mona Shores Public School District
Montague Area Public Schools
Muskegon City School District
Muskegon Heights School District
North Muskegon Public Schools
Oakridge Public Schools
Orchard View Schools
Ravenna Public Schools
Reeths-Puffer Schools
Whitehall District Schools
White River
Montague Twp
Montague
Whitehall Twp
Whitehall
Blue Lake
Holton
Lakewood Club Village
Fruitland
Dalton
Cedar Creek
Lake Michigan
Laketon
North Muskegon
Muskegon Twp
Egelston
Moorland
Casnovia Twp
Casnovia Village
Muskegon
Roosevelt Park
Muskegon Heights
Ravenna Village
Fruitport
Sullivan
Ravenna
Norton Shores
Fruitport Village
WMSRDC
WEST MICHIGAN SHORELINE
REGIONAL DEVELOPMENT COMMISSION
Source: Michigan Geographic Data Library
Michigan Department of Environmental Quality
United States Geological Survey, Muskegon Co.
Hazard Mitigation Plan Update 2014

Fire Management - Communities at Risk





Number of Wildland Fires
By County, 1981-2007
Total Number of Wildland Fires
199 or Fewer Fires
200 - 299
300 or More Fires
Data from Michigan Department of Natural Resources, for lands under MDNR jurisdiction
Michigan State Police
Emergency Management & Homeland Security Division
December 2010

Number of Wildfires and Acres Burned, by County: 1981-2010 (MDNR jurisdiction only)

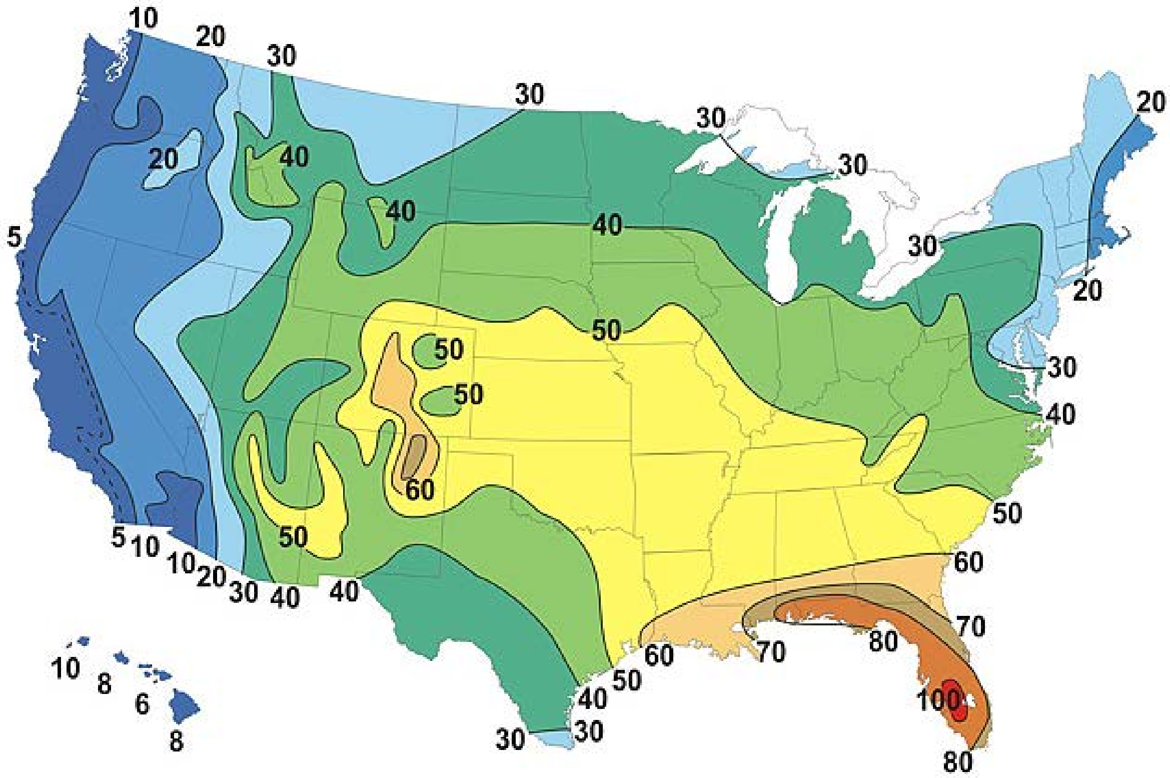
County	Number of Wildfires	Number of Wildfires/Year* (over 30 year period)	Number of Acres Burned	Number of Acres Burned/Year* (over 30 year period)
Alcona	119	4	843.8	28
Alger	41	1	123.0	4
Allegan	72	2	312.0	10
Alpena	156	5	267.2	9
Antrim	194	6	194.1	6
Arenac	127	4	418.8	14
Baraga	57	2	1897.6	63
Barry	99	3	447.3	15
Bay	16	1	142.2	5
Benzie	169	6	279.3	9
Berrien	8	0	24.4	1
Branch	6	0	19.3	1
Calhoun	9	0	41.2	1
Cass	3	0	27.0	1
Charlevoix	151	5	492.3	16
Cheboygan	737	25	1424.0	47
Chippewa	391	13	5108.2	170
Clare	822	27	2385.6	80
Clinton	27	1	138.9	5
Crawford	1142	38	25861.5	862
Delta	551	18	3213.8	107
Dickinson	506	17	2411.0	80
Eaton	3	0	0.3	0
Emmet	317	11	543.5	18
Genesee	1	0	0.1	0
Gladwin	484	16	1938.9	65
Gogebic	116	4	245.4	8
Grand Traverse	386	13	1296.9	43
Gratiot	2	0	40.0	1
Hillsdale	2	0	23.0	1
Houghton	181	6	1200.1	40
Huron	29	1	725.5	24
Ingham	14	0	474.7	16
Ionia	33	1	728.4	24
Iosco	112	4	1630.3	54
Iron	279	9	1953.9	65
Isabella	101	3	931.8	31
Jackson	35	1	520.5	17
Kalamazoo	14	0	74.3	2
Kalkaska	559	19	2953.4	98
Kent	20	1	125.9	4
Keweenaw	59	2	375.6	13
Lake	315	11	1283.5	43
Lapeer	60	2	533.8	18
Leelanau	56	2	212.0	7
Lenawee	16	1	224.2	7
Livingston	79	3	651.4	22
Luce	207	7	18679.9	623
Mackinac	197	7	1610.6	54
Macomb	7	0	15.4	1
Manistee	49	2	1041.6	35
Marquette	835	28	16087.6	536
Mason	32	1	154.6	5
Mecosta	169	6	844.9	28
Menominee	646	22	2353.4	78
Midland	412	14	1414.9	47
Missaukee	344	11	1772.0	59
Monroe	5	0	233.3	8
Montcalm	33	1	567.6	19
Montmorency	555	19	1271.5	42
Muskegon	251	8	2675.7	89
Newaygo	47	2	404.2	13
Oakland	54	2	368.5	12
Oceana	346	12	1766.0	59
Ogemaw	563	19	8296.1	277
Ontonagon	94	3	1438.1	48
Osceola	405	14	1085.2	36
Oscoda	268	9	8765.3	292
Otsego	970	32	1924.9	64
Ottawa	145	5	469.9	16
Presque Isle	330	11	838.4	28
Roscommon	613	20	4551.9	152
Saginaw	20	1	474.7	16
Sanilac	44	1	427.3	14
Schoolcraft	344	11	3210.5	107
Shiawassee	80	3	576.7	19
St. Clair	110	4	1642.8	55
St. Joseph	3	0	7.7	0
Tuscola	121	4	930.9	31
Van Buren	27	1	249.2	8
Washtenaw	17	1	217.5	7
Wayne	2	0	42.2	1
Wexford	428	14	1057.4	35
Total DNR fire events	17449	582	152228.3	5074

*rounded to nearest whole number

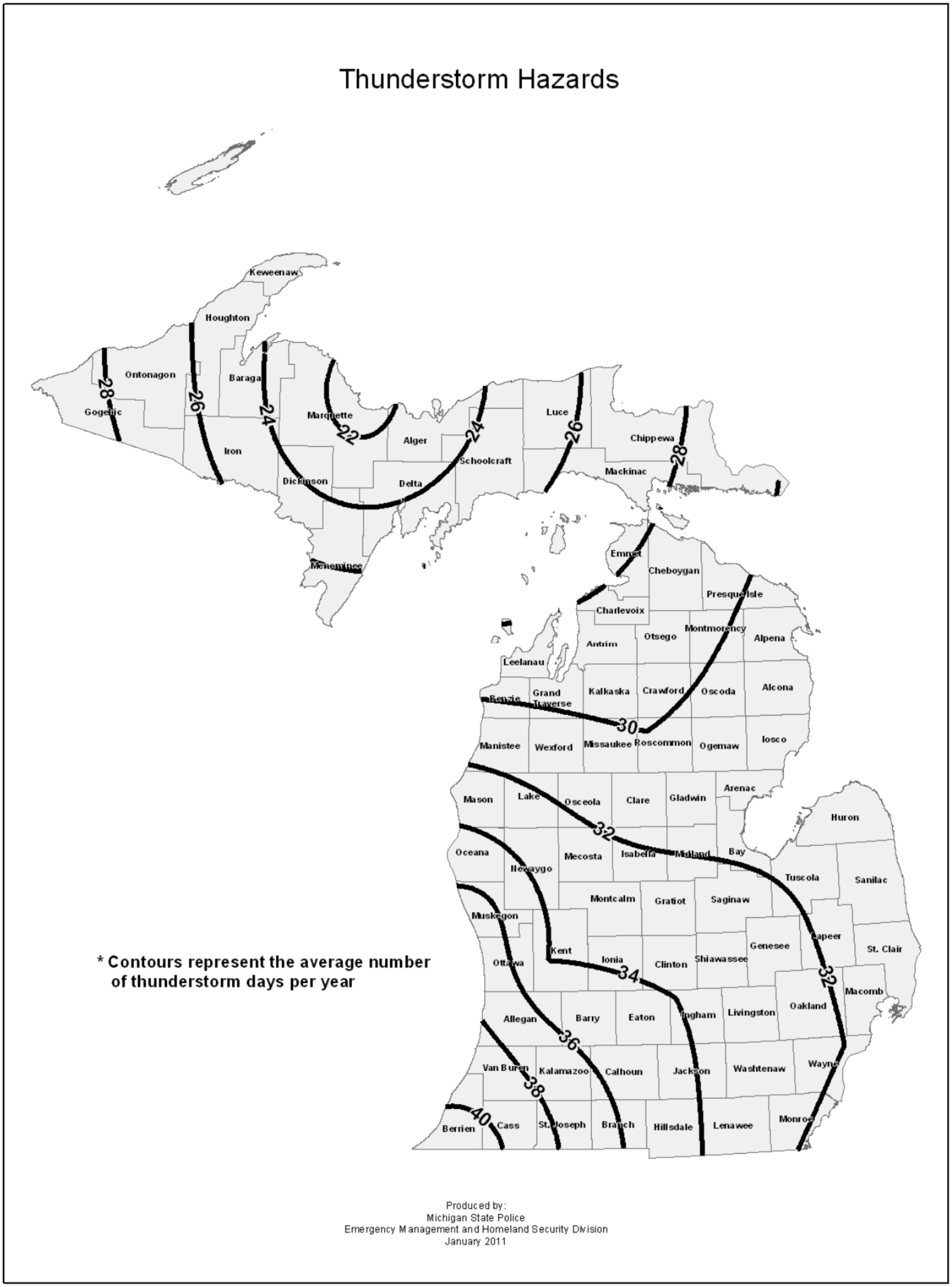
Source: Michigan Department of Natural Resources—Forest Management Division

Source: Michigan Hazard Mitigation Plan, 2011

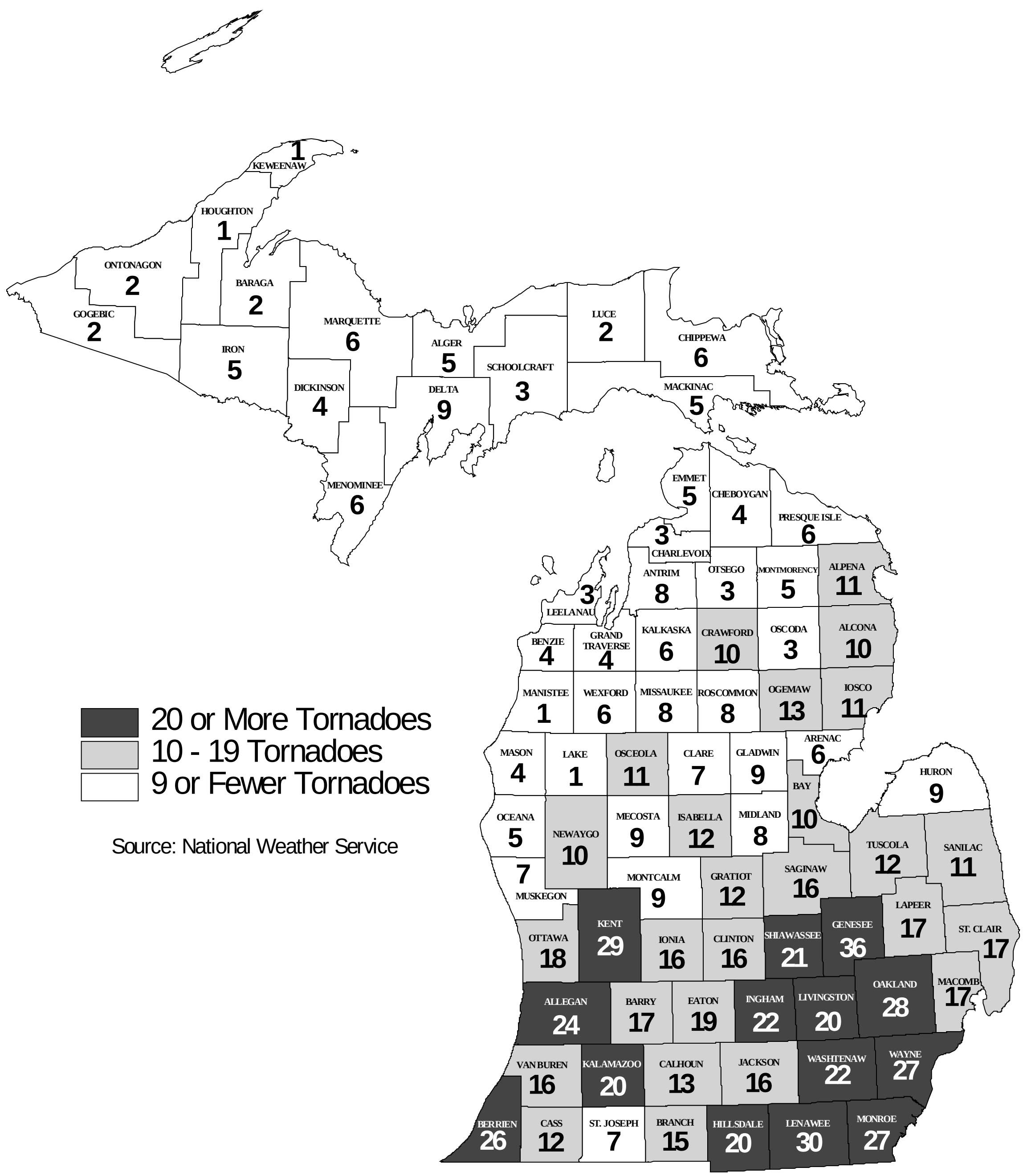
Average Annual Thunderstorm Days



Source: NOAA National Weather Service

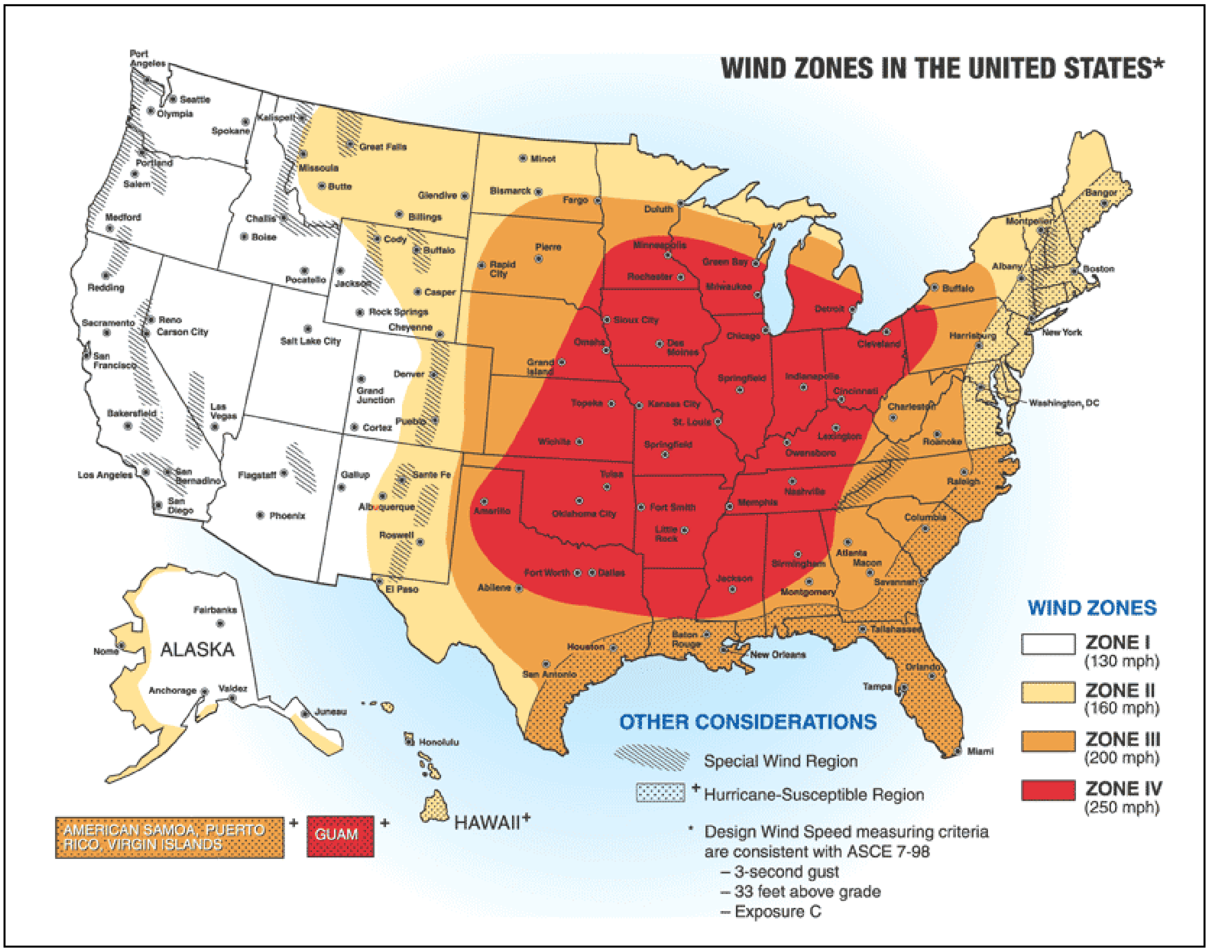

Thunderstorm Hazards
* Contours represent the average number of thunderstorm days per year
Keweenaw
Houghton
Ontonagon
Baraga
Gogebic
Iron
Marquette
Alger
Luce
Chippewa
Schoolcraft
Mackinac
Dickinson
Delta
Menominee
Emmet
Cheboygan
Presque Isle
Charlevoix
Otsego
Montmorency
Alpena
Antrim
Leelanau
Benzie
Grand Traverse
Kalkaska
Crawford
Oscoda
Alcona
Manistee
Wexford
Missaukee
Roscommon
Ogemaw
Iosco
Arenac
Mason
Lake
Osceola
Clare
Gladwin
Huron
Oceana
Newaygo
Mecosta
Isabella
Midland
Bay
Tuscola
Sanilac
Montcalm
Gratiot
Saginaw
Muskegon
Lapeer
St. Clair
Genesee
Kent
Ionia
Clinton
Shiawassee
Ottawa
Macomb
Allegan
Barry
Eaton
Ingham
Livingston
Oakland
Van Buren
Kalamazoo
Calhoun
Jackson
Washtenaw
Wayne
Berrien
Cass
St. Joseph
Branch
Hillsdale
Lenawee
Monroe
22
24
26
28
30
32
34
36
38
40
Produced by:
Michigan State Police
Emergency Management and Homeland Security Division
January 2011

Number of Tornadoes in Michigan by County, 1950-2001

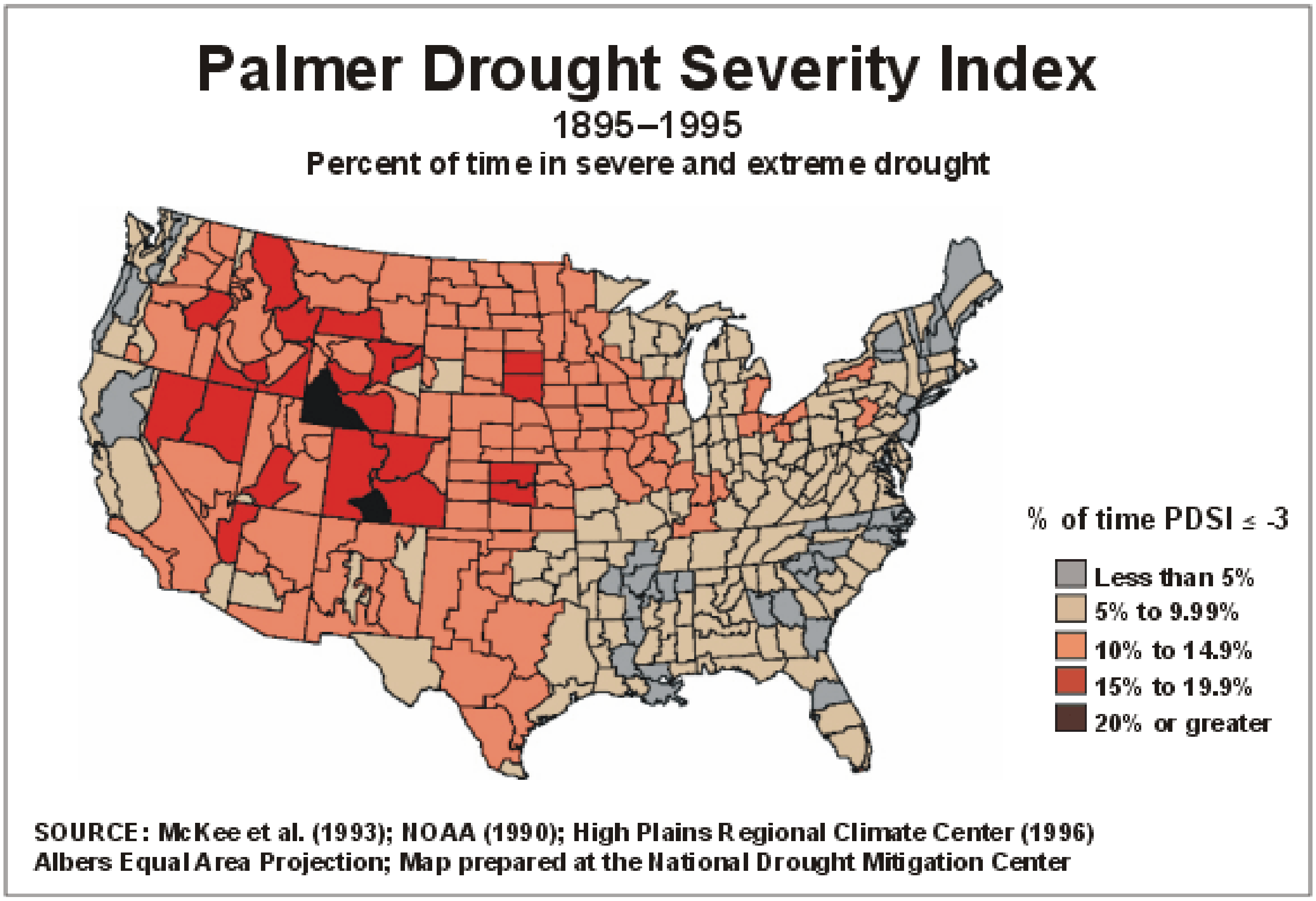


Source: National Weather Service

Produced by:
Michigan State Police
Emergency Management Division
12 December 2001

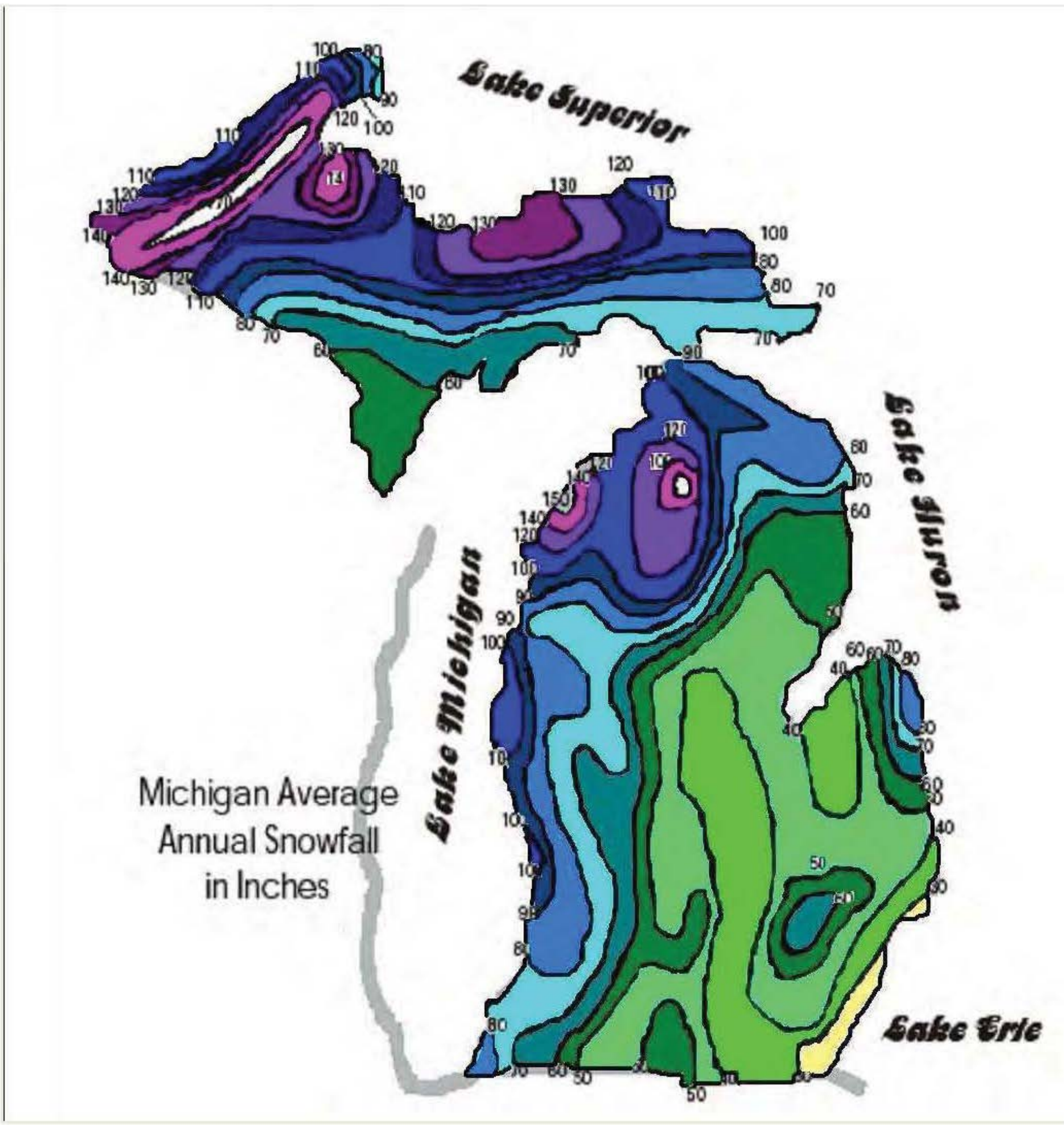


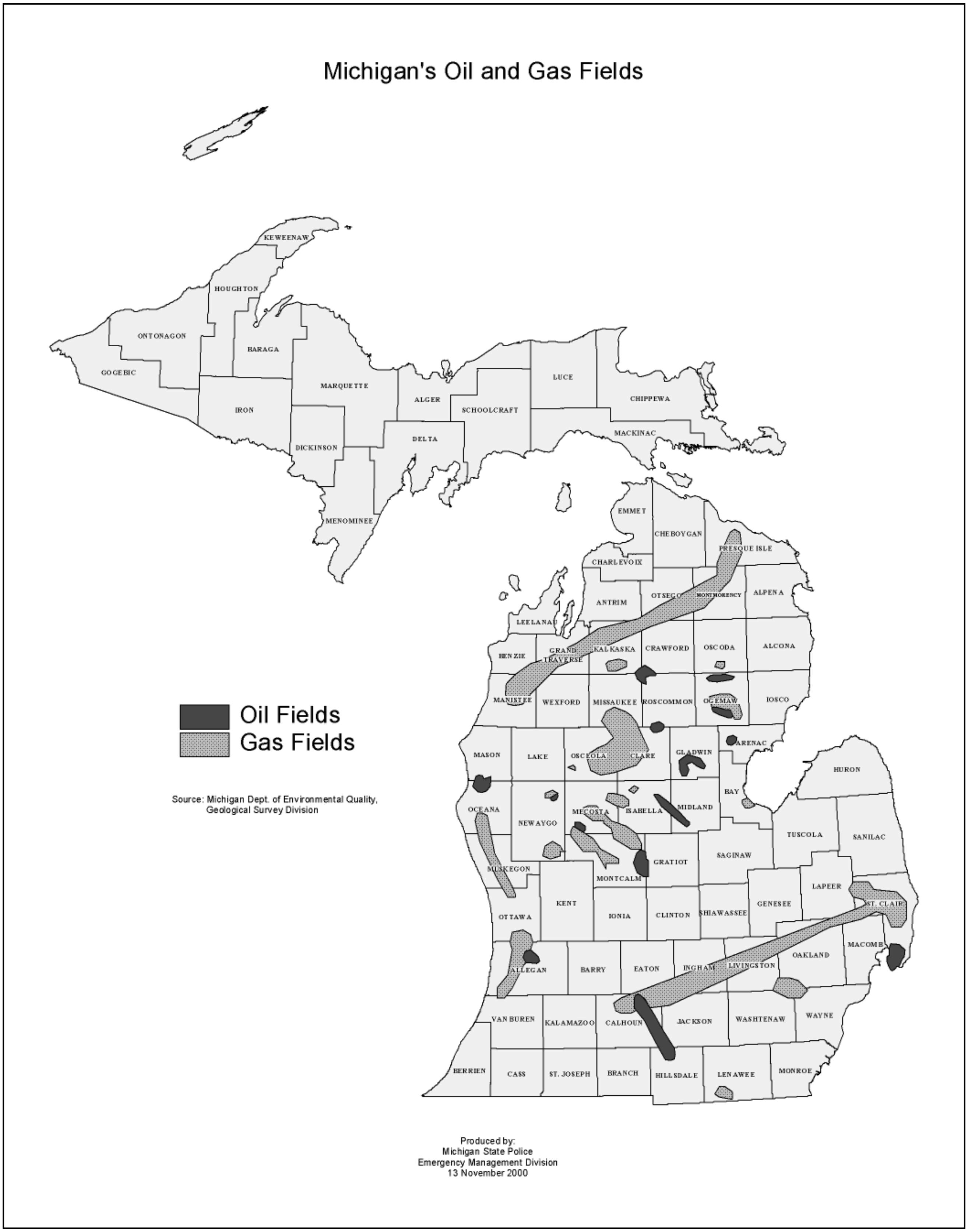
Source: Federal Emergency Management Agency


Palmer Drought Severity Index
1895–1995
Percent of time in severe and extreme drought
% of time PDSI ≤ -3
Less than 5%
5% to 9.99%
10% to 14.9%
15% to 19.9%
20% or greater
SOURCE: McKee et al. (1993); NOAA (1990); High Plains Regional Climate Center (1996)
Albers Equal Area Projection; Map prepared at the National Drought Mitigation Center

Michigan Average Annual Snowfall

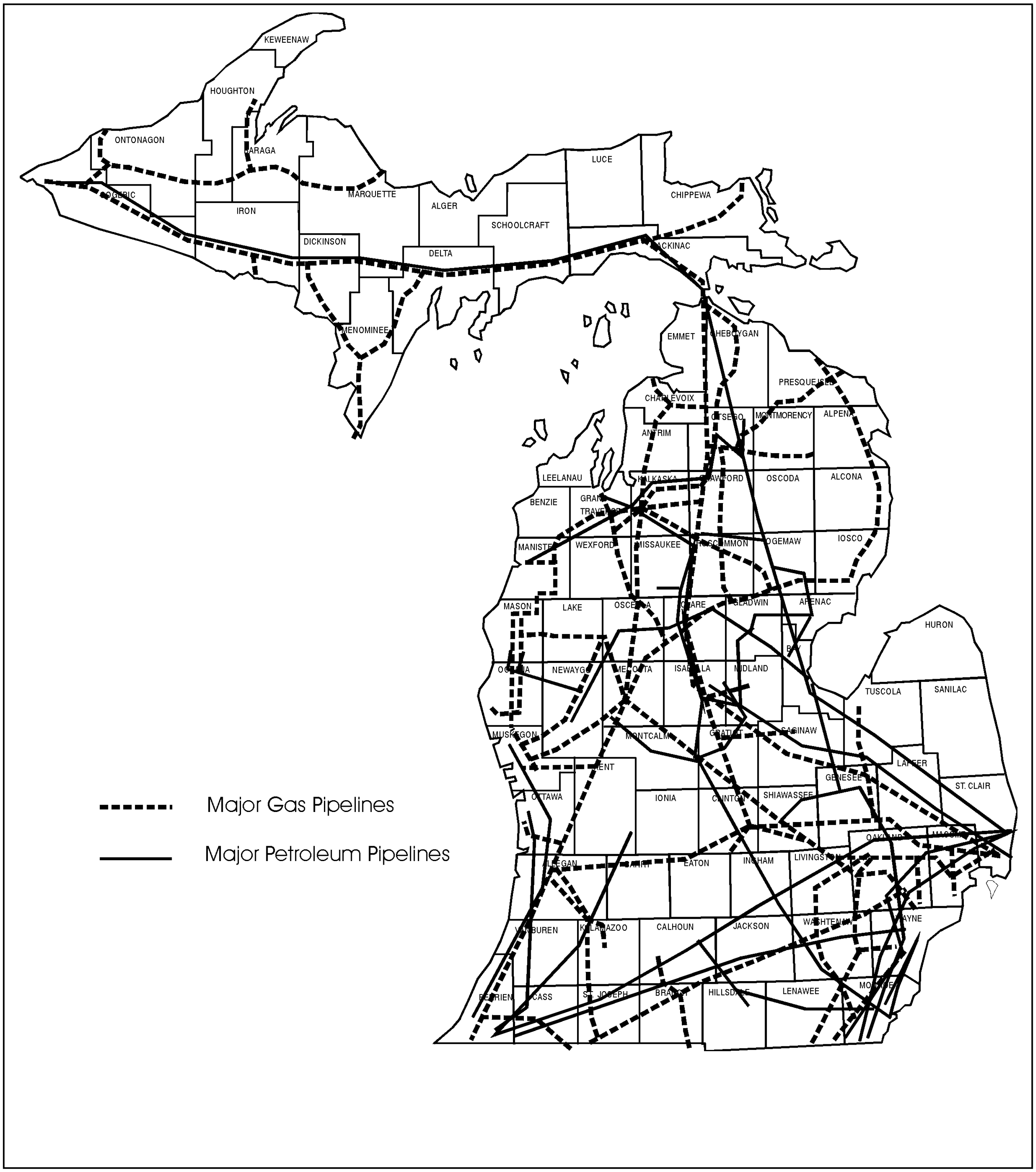
Source: Michigan Committee for Severe Weather Awareness



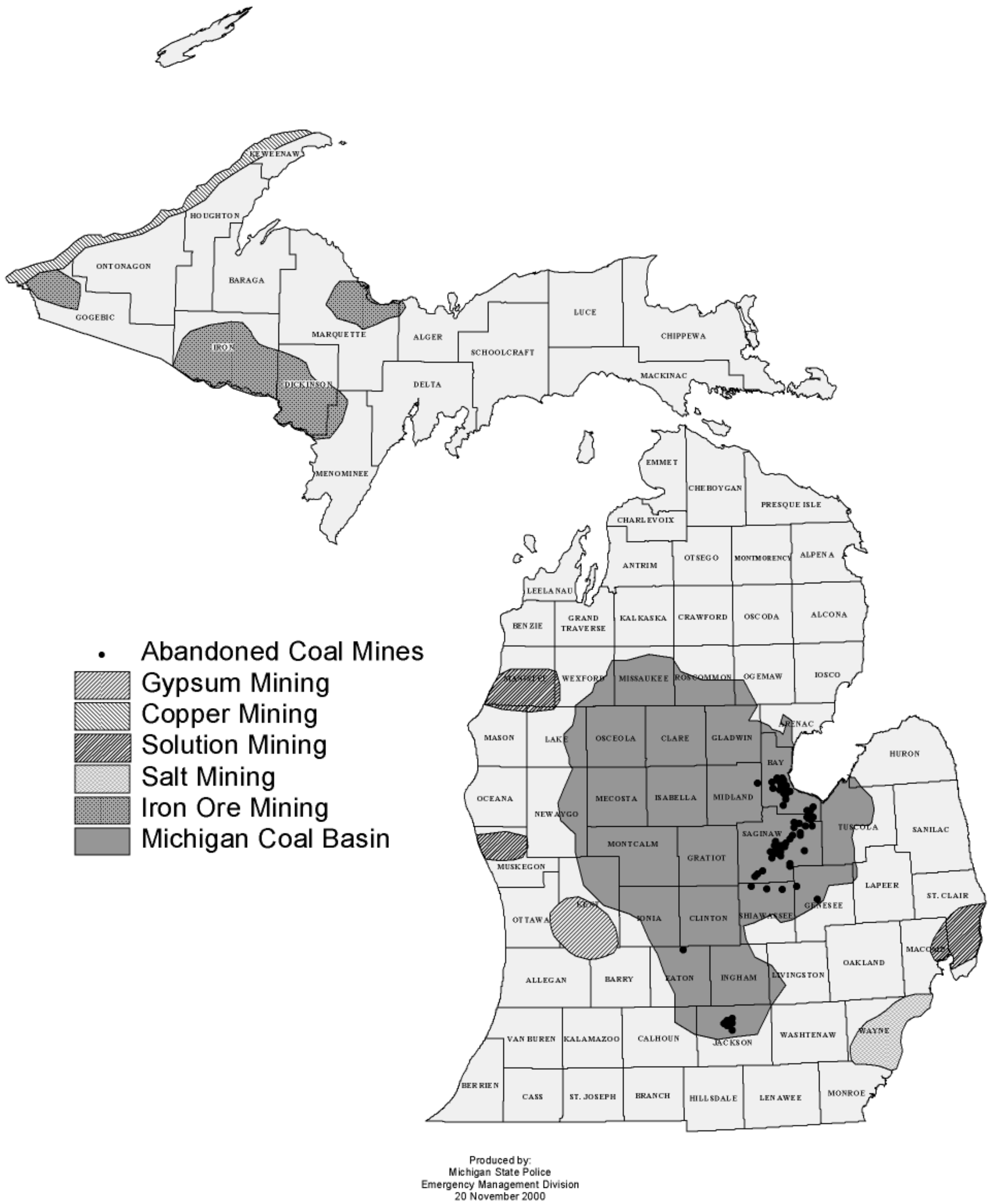

Michigan's Oil and Gas Fields
Oil Fields
Gas Fields
Source: Michigan Dept. of Environmental Quality,
Geological Survey Division
Produced by:
Michigan State Police
Emergency Management Division
13 November 2000
KEWEENAW
HOUGHTON
ONTONAGON
BARAGA
GOGEBIC
MARQUETTE
IRON
ALGER
SCHOOLCRAFT
LUCE
CHIPPEWA
DICKINSON
DELTA
MACKINAC
MENOMINEE
EMMET
CHEBOYGAN
PRESQUE ISLE
CHARLEVOIX
ANTRIM
OTSEGO
MONTMORENCY
ALPENA
LEELANAU
BENZIE
GRAND TRAVERSE
KALKASKA
CRAWFORD
OSCODA
ALCONA
MANISTEE
WEXFORD
MISSAUKEE
ROSCOMMON
OGEMAW
IOSCO
MASON
LAKE
OSCEOLA
CLARE
GLADWIN
ARENAC
HURON
BAY
OCEANA
NEWAYGO
MECOSTA
ISABELLA
MIDLAND
TUSCOLA
SANILAC
SAGINAW
MUSKEGON
MONTCALM
GRATIOT
LAPEER
KENT
ST. CLAIR
OTTAWA
IONIA
CLINTON
SHIAWASSEE
GENESEE
MACOMB
OAKLAND
ALLEGAN
BARRY
EATON
INGHAM
LIVINGSTON
VAN BUREN
KALAMAZOO
CALHOUN
JACKSON
WASHTENAW
WAYNE
BERRIEN
CASS
ST. JOSEPH
BRANCH
HILLSDALE
LENAWEE
MONROE

Major Petroleum and Natural Gas Pipelines in Michigan

Source: Michigan Public Service Commission; pipeline company maps



Potential Subsidence Hazards



Appendix D:
HAZARD MITIGATION PLAN UPDATE SURVEY

February 21, 2012

Dear Interested Person,

The West Michigan Shoreline Regional Development Commission (WMSRDC) is seeking information about various hazards that might eventually affect people, property, or the environment in the area of Muskegon County.

The WMSRDC is beginning the research that is necessary to help fulfill federal requirements for updating a hazard mitigation plan, and thereby maintain the Muskegon County Hazard Mitigation Plan. Communities that wish to apply for funding for hazard mitigation projects from the Hazard Mitigation Grant Program are required (by the Federal Emergency Management Agency) to create, or participate in the creation of, an approved local hazard mitigation plan satisfying the requirements of the Disaster Mitigation Act of 2000 and 44 CFR 201.6. If your community intends to adopt the hazard mitigation plan once updated, you are strongly encouraged to participate in this survey.

Please take a moment to consider the enclosed questionnaire, and note any conditions which may bring harm to people or property, or interfere significantly with business or community infrastructure. If you need more room to respond, feel free to use additional sheets of paper. Completed surveys are requested by Friday, April 6, 2012.

A public hearing is scheduled for Tuesday, April 10, 2012 to discuss the hazard mitigation project and receive comments and concerns from the public with regards to potential hazards to the community. The hearing will take place during the Muskegon County LEPC meeting at 10:30 A.M. at the Norton Shores City Hall.

Additional copies of the survey can be obtained at www.wmsrdc.org in the Special Projects section. If you have any questions about the questionnaire or the hazard mitigation project, please contact Stephen Carlson at (231) 722-7878 extension 11, or at scarlson@wmsrdc.org.

Respectfully,

Stephen Carlson
Associate Planner

MUSKEGON COUNTY

Hazard Mitigation Plan Update Survey

PART 1 - Hazard Identification

Provided below is documentation of historical hazard events in Muskegon County, according to the Hazard Mitigation Plan for Muskegon County prepared in 2005.

Please take a moment to review these events and provide additions, changes, and updates to this information.

Thunderstorm Hazards (severe winds, tornadoes, hail, lightning, heavy rain):

- May 13, 1956: 4 inch hail. Fruitport Township.
- September 4, 1965: Tornado (F2). $25k property damage, Sullivan Township.
- April 16, 1967: Tornado (F1). $3k property damage, Whitehall.
- August 20 - September 6, 1975: Rainstorms, high winds. Declaration of major disaster by President.
- March 2-7, 1976: Tornadoes. Declaration of major disaster by President, 29 counties.
- April 18, 1994: Severe thunderstorm winds. $50k property damage, Norton Shores.
- July 20, 1994: Lightning. $50k property damage, Muskegon County.
- May 31, 1998: Thunderstorms & high winds. Declaration of major disaster by President.
- June 3-5, 1998: Thunderstorms & high winds. Declaration of disaster by Governor.
- July 21, 1998: Lightning. $40k property damage from lightning induced house fires, Egelston and Muskegon Twps.
- May 8, 2000: Severe thunderstorm winds. $50k property damage, Dalton Township.
- May 12, 2000: 1 inch hail. $50k property damage, Holton Township.
- June 1, 2000: Severe thunderstorm winds. $40k property damage, City of Muskegon.
- August 22, 2000: Severe thunderstorm winds. $150k property damage, Muskegon County.
- April 11, 2001: 1.75 inch hail. $50k property damage, $25k crop damage, Village of Fruitport.
- October 6, 2002: Severe thunderstorm winds. $20k property damage, Roosevelt Park.
- May 20-24, 2004: Severe storms. Declaration of major disaster by President.

Severe Winter Weather (ice, sleet, snow storms):

- March 20, 1976: Ice storms. Declaration of major disaster by President.
- January 26-31, 1977: Blizzard, snowstorm. Declaration of emergency by President.
- January 26-27, 1978: Blizzard, snowstorm. Declaration of statewide emergency by President.
- January 12, 1993: Heavy snow. $50k property damage, northern Lower Michigan.
- January 12-21, 1994: Heavy lake effect snow. $500k property damage across western Lower Michigan.
- January 27, 1994: Heavy snow and freezing rain. $5m property damage across region.
- October 26, 1997: Heavy snow. $1.2m property damage across southwestern Lower Michigan.
- March 9, 1998: Winter storm. $100k property damage across region.
- January 2-15, 1999: Blizzard, snowstorm. Declaration of emergency by President.
- December 11-30, 2000: Blizzard, snowstorm. Declaration of emergency by President.
- April 3, 2003: Ice storm. $4.9m property damage throughout West Michigan.

Floods (shoreline, riverine, urban):

- August 20 - September 6, 1975: Flooding. Declaration of major disaster by President.
- February 21, 1986: Great lakes flooding and wave action. Declaration of disaster by Governor.
- September 10-19, 1986: Flooding. Declaration of major disaster by President.
- October 28, 1986: Flooding & heavy rain. Declaration of disaster by Governor.
- August 30, 1993: Flash flood, Norton Shores.
- May 18-20, 2000: Flood. $100k property damage, $50k crop damage in Muskegon County.
- February 10, 2001: Flooding. $100k property damage across western Michigan.
- May 15-16, 2001: Flooding. $500k property damage, $200k crop damage across southwestern Lower MI.
- May 20-24, 2004: Flooding. Declaration of major disaster by President.

Extreme Temperatures:

- July 1936: Heat wave. 570 deaths statewide, 364 in Detroit.
- Summer, 1988: 39 days with temperatures over 90 degrees.
- January 20, 1994: Record cold. $50m property damage across Michigan.

Drought:

- Summer 1871: Prolonged drought over much of the Great Lakes regions.
- May-September, 1891: Drought devastated Michigan's lumber industry.
- Statewide: 1930-1937, 1960-1967, 1976-1980, and 1986-1989.
- Lower Peninsula: 1939-1942 (crop damage).
- 1964: Record "low" water levels.

Wildfires:

- October 1871: Wildfires across Lower Peninsula, 200 fatalities and 1.2 million acres burned.
- May-September, 1891: Uncontrollable wildfires across Michigan during the summer drought.
- Approximately 12 wildfires and 104 acres burned per year in county on lands under MDNR Jurisdiction from 1981 to 2000.

Structural and Scrap Tire Fires (including explosions, industrial accidents):

- County fire rate per 1,000 population in 1998: 3.8.
- Scrap tire inventory at disposal sites for the county in 2001: 112,000.
- April 12, 2000: Explosion and flash fire at chemical plant, 10 people injured, Egelston Township.
- May 21, 2001: Foundry explosion, 2 homes and 1 business set on fire, 1 injury, Norton Shores.
- September 13, 2003: Barrel explosion at foundry, 1 fatality, Egelston Township.

Dam Failures:

- Four documented failures in Muskegon County, unidentified locations.

Infrastructure Failure (storm/sanitary sewers, water, electrical, and communications systems):

- January 20, 1994: Frozen sewer/water lines. Record cold.
- April 6-7, 1997: 180,000-200,000 customers statewide without power, 70,000 on second day. High wind.
- March 9, 1998: 1,900 power outages, Muskegon County. Blizzard conditions.
- May 29-30, 1998: 54,000 Muskegon County customers without power, 27,000 on second day. Tstorm winds.
- May 31, 1998: 50,000 in Muskegon County without power, over 600,000 statewide. Tstorms and high winds.
- May 31, 1998: Half of Whitehall City without water service. Thunderstorms and high winds.
- June 18, 1998: Most residents without power, City of Montague and Montague Twp. T-storm winds and lightning.
- July 21, 1998: 7,500 without power, Muskegon County. Thunderstorm lightning.
- April 3, 2003: Hundreds of thousands without power, Lower Michigan. Ice storm.
- January 2005: City of Muskegon Heights without water service. Broken water main.

Oil and Gas Well/Pipeline Accidents:

- Oil and gas wells in the county: 1,072.

Hazard Material Incidents (fixed site and transportation related, nuclear material):

- SARA Title III sites in the county: 18.
- March 15, 1982: Freight train derailment caused a spill of chlorine and caustic acid. 600 evacuated, Fruitport Twp.
- April 22, 1990: Release of phosphorus oxychloride. 1,000 people evacuated, Egelston Township.
- June 4, 1999: Release of hydrogen sulfide. 1 fatality, 1 other injured, 11 employees evacuated, and $411,000 property damage, City of Whitehall.

Other Hazards Events:

- Earthquake
- Land Subsidence
- Transportation Accidents
- Public Health Emergencies
- Civil Disturbances (riots, prison uprisings, etc.)
- Nuclear Attack/Civil Defense Emergency
- Weapons of Mass Destruction/Terrorism/Sabotage
- Any other vulnerability

Comments:

(see next page)

PART 2 – Hazard Ranking

Provided below is a prioritized list of hazards in Muskegon County, according to the Hazard Mitigation Plan for Muskegon County. Priorities were determined through a ranking system that scored the impact of each hazard in the following areas: Likelihood of Occurrence; Percent of Population Affected; Potential for Causing Casualties; Potential for Negative Effects; Corollary Effects; and Public Awareness of Hazard.

Please take a moment to consider these hazards and prioritize them, with #1 being the most important.

Priority	Hazard	Score (out of 10 possible points)	Your Priority
1st	Snow/Ice/Sleet Storms	7.75	
2nd	Severe Winds	6.45	
3rd	Extreme Temperatures	6.30	
4th	Fire Hazards: Structural	6.30	
5th	Infrastructure Failures	6.20	
6th	HAZMAT: Fixed Site	5.05	
7th	Fire Hazards: Wildfire	4.85	
8th	Drought	4.85	
9th	Dam Failures	4.60	
10th	Flooding: Riverine/Urban	4.40	
11th	Lightning/Heavy Rain	4.30	
12th	Public Health Emergencies	4.10	
13th	Hail	4.05	
14th	HAZMAT: Transportation	3.85	
15th	Transportation Accident	3.80	
16th	Pipeline Accident	3.70	
17th	Flooding: Shoreline	3.50	
18th	Tornadoes	3.30	
19th	Oil/Gas Well Accident	2.30	
20th	Civil Disturbances	1.75	
21st	Land Subsidence	1	
-	Earthquakes	-	
-	Fire Hazards: Scrap Tires	-	
-	Nuclear: Civil Defense	-	
-	Nuclear: Power Plant	-	
-	WMD/Terrorism Incident	-	

PART 3 – Contact Information

Name | ______________________ Date | ____________

Organization | ______________________ Title | ____________

Email | ______________________

Please remit survey to:	WMSRDC attention: Stephen Carlson PO Box 387 Muskegon, MI 49443-0387	OR	email: scarlson@wmsrdc.org fax: 231-722-9362

Summary of Survey Results

Part 1 – Hazard Identification

Comments

- Consider adding industrial fires in Muskegon Heights (mid 90's) and recent fire at Cannon Muskegon
- Labor Day Weekend, September 2011: tree fall, electrical loss, and small forest fire caused by severe winds and heavy rains.
- May31, 1998 thunderstorms left Holton area without power for 5 days. Holton Fire Department supplied water to families and farmers in Holton and Cedar Creek townships.
- December 6, 1985: gasoline tanker overturned on M120 near brickyard and dumped about 2,200 gallons into the ditch.
- December 23, 2007: severe winds in Norton Shores caused $30,000 property damage.
- January 30, 2012: Foundry furnace explosion in Norton Shores.
- January 2008: Henry Stree Bridge NE approach washout – heavy rains, plugged sewer.
- April 10, 2010: Chemical reaction Calcium Silicon Barium. Localized evacuation of surrounding business, Norton Shores.

Part 2 – Hazard Ranking

Hazard Mitigation Plan	Hazard	Casnovia Township	White River Twp	Muskegon Heights	Montague City	Norton Shores	Egelston Township	Montague Public Schools	Muskegon Community College	Norton Shores FD	Whitehall Police	Muskegon Twp Police	Holton Fire Dept	MDNR	Mercy Health Partners	ESCO	Bayer/Muskegon Twp FD	SUBTOTAL	AVERAGE	Average - Ranked	Hazard Mitigation Plan
1	Snow/Ice/Sleet Storms	3	2	1	2	1	1	1	2	1	1	1	1	5	1	1	1	25	1.6	1	1
2	Severe Winds	1	3	3	1	2	2	3	1	2	2	2	2	1	2	2	2	31	1.9	2	2
3	Extreme Temperatures	9	11	10	12	7	3		8	3	11	4	9	15	3	3	3	111	7.4	5	3
4	Fire Hazards: Structural	5	7	11	5	4	4		6	4	7	3	6	6	4	4	4	80	5.3	3	4
5	Infrastructure Failure	6	9	2	3	5	5		13	5	9	5	8	4	5	5	5	89	5.9	4	5
6	HAZMAT: Fixed Site	10		4	4	6	6		9	6	4	6	15	13	6	16	6	111	7.9	7	6
7	Fire Hazards: Wildfire	7		22	13	14	7		4	7	10	9	3	2	7	10	7	122	8.7	8	7
8	Drought	11	10	12	15	19	8		12	8	16	10	11		8	11	15	166	11.9	14	8
9	Dam Failures	17		23	9	17	9		11	9	14	11	10		9	12	14	165	12.7	15	9
10	Flooding: Riverine/Urban	16	8	18	10	16	10		16	10	6	7	12	12	10	7	16	174	11.6	13	10
11	Lightning/Heavy Rain	2	4	13	6	8	11		3	11	12	8	7	3	11	6	11	116	7.7	6	11
12	Public Health Emergencies	8	5	19	8	13	12	2	9	12	13	12	14		12	9	12	160	10.7	9	12
13	Hail	12	6	5	16	9	13		7	13	15	13	13	7	13	8	13	163	10.9	10	13
14	HAZMAT: Transportation	13		14	7	10	14		15	14	3	14	4	14	14	15	9	160	11.4	12	14
15	Transportation Accident	14		6	11	3	15		17	15	8	15	5	11	15	14	8	157	11.2	11	15
16	Pipeline Accident	15		15	14	12	16		18	16	18	16	17		16	17	10	200	15.4	17	16
17	Flooding: Shoreline	18		7	20	20	17		21	17	17	17	18	8	17	18	17	232	16.6	18	17
18	Tornadoes	4		8	19	15	18		5	18	10	18	16	10	18	13	22	194	13.9	16	18
19	Oil/Gas Well Accident	19	1	20	18	22	19		14	19	19	19	19	9	19	20	19	256	17.1	19	19
20	Civil Disturbances	20		16	17	11	20		19	20	20	20	21		20	19	20	243	18.7	22	20
21	Land Subsidence	21		24	21	23	21		20	21	21	21	20		21	21	21	276	21.2	24	21
	Earthquakes			21		24											16	61	20.3	23	-
	Fire Hazards:Scrap Tires			9		21											23	53	17.7	20	-
	Nuclear: Civil Defense			25		25											24	74	24.7	25	-
	Nuclear: Power Plant			26		26											25	77	25.7	26	-
	WMD/Terrorism Incident			17		18											18	53	17.7	21	-

Survey Results Observations

1. Snow/Ice/Sleet Storms and Severe Winds are the highest priorities overall.
2. Extreme Temperatures are a lower priority than Structural Fire and Infrastructure Failure.
3. Lightning/Heavy Rain is a much higher priority than previously ranked.
4. Public Health Emergencies, Hail, and Transportation Accidents are higher priorities than Riverine/Urban Flooding, Drought, and Dam Failure.
5. Tornadoes are a higher priority than Pipeline Accidents and Shoreline Flooding.

Comments

- Structural Fires is too high because it is limited in scope and affects few.
- Wilfire should be higher because it has potential to affect a larger area.
- HAZMAT Fixed Site and HAZMAT Transportation should be closer together because they are similar.
- Civil Disturbance is ranked too low.

Appendix E:
ACKNOWLEDGMENTS & DOCUMENTATION

Muskegon County LEPC
MEMBERSHIP ROSTER
January 2014

Category	Voting Member	Alternate
Agriculture		
At Large		
At Large	Tim Lipan	
At Large	David McCastle	Shawn Grabinski
At Large	Bob McCann	Rich Pospisil
At Large	Mike Terry	
At Large		
Broadcast Media	Gordon Burnham	
Elected State Official		
Elected Local Official	Ken Mahoney	Marvin Engle
Education	Ron Ruel	
Emergency Services	Dan Stout, Secretary	
Fire Fighting Service	Steve Lague, Vice	Bob Smith, Egelston Twp
First Aid Organization	Tom Schmiedeknecht	Jerry Evans MD
Hospitals	Leon Conklin	Jim Roberge
Law Enforcement	Dean Roesler	Greg Throne
Local Environmental		
Local Public Health	Rob Olmstead	
Organized Labor		
Owners/Operators	David Ernvall	Bob Brenton
Owners/Operators	Bruce Katje, Chair	
Print Media	Peg West	Paula Holmes-Greeley
Transportation	Kolin Convertini	Melissa Baker

Muskegon County Hazard Mitigation Plan Update
2011 ADVISORY COMMITTEE

Urban Fire Service	David Purchase, Norton Shores Fire Dept	David.Purchase@mcd911.net
Rural Fire Service	Larry Radke, Blue Lake Fire Department	lrrskr@gmail.com
Municipal Law Enforcement	Dan Shaw, Norton Shores Police Department	nspddrs1@mcd911.net
County Law Enforcement	Dean Roesler, Muskegon County Sheriff Dept	dean.roesler@muskegonsheriff.com
Emergency Management	Daniel A. Stout, Muskegon Co Emergency Services	Daniel.stout@muskegonsheriff.com
Emergency Medical Service	James Bartholomew, Professional Ambulance Service	jbartholomew@promed.org
HazMat	Steve Lague, Muskegon County Hazmat Team	slague@cityofnorthmuskegon.com
Public Works	Kenneth Hulka, Muskegon County Road Commission	KHulka@MuskegonCountyRoads.org
Public Safety Communications	James Duram, Muskegon Area R.A.C.E.S.	jimk8cop@afo.net
Governmental Administrative	Bonnie Hammersley, Muskegon County Administrator	hammersleybo@co.muskegon.mi.us
Local Public Health	Ken Krause, Muskegon County Health Department	krauske@co.muskegon.mi.us
Healthcare	Leon Conklin, Mercy-General Health Care Partners	conklinl@trinity-health.org
Private Security	N/A	
Cyber Security	Heath Kaplan, Muskegon Co Information Services	kaplanhe@co.muskegon.mi.us

MEETINGS

Public meetings attended by WMSRDC staff for the purpose of updating the Muskegon County Hazard Mitigation Plan, including attendance lists and synopses of pertinent comments and discussion that took place during the meeting.

February 14, 2012: Muskegon County LEPC Meeting

Attendees:

Robert Smith, Egelston Twp
Dan Stout, Muskegon County Emergency Services
Leon Conklin, Mercy Health Partners
Vicki Webster, Public Health Muskegon County
Roger Squires, Whitehall PD
Mike Zimmerman, Michigan Volunteer Defense Force
Rhona Colbert, Citizens Corps
Stephen Carlson, WMSRDC
Ken Hulka, Muskegon County Road Commission
Steve Lague, N Muskegon FD/HAZMAT
Bill Gray, American Red Cross
Greg Throne, MDOC
Bruce Katje, ESCO Company, LLC
Tim Lipan, American Red Cross
Alice Meldrum, American Red Cross
Thomas VanBruggen, Muskegon County Equalization/GIS

Synopsis:

Introduction of Hazard Mitigation planning and a presentation of the anticipated planning process. Also discussed establishment of the Hazard Mitigation Advisory Team.

April 10, 2012: Muskegon County LEPC Meeting and Hazard Mitigation Public Hearing

Attendees:

Robert Smith, Egelston Fire
Steven Lague, Hazmat, North Muskegon Fire
Frank Towsley, R.A.C.E.S.
John Borgerding Jr, Muskegon Chronicle
Stephen Carlson, WMSRDC
Mike Zimmerman, MI Volunteer Defense Force
Dan Stout, Muskegon County Sheriff/Emergency Services
Dennis Harris, R.A.C.E.S.
Leon Conklin, Mercy Health Partners
Tom Schmedeknecht, Promed
Bruce Katje, ESCO
Kolin Convertini, Webb Chemical
Jim Duram, Whitehall PD/R.A.C.E.S.
Bob McCann, Bayer Crop Science
Rich Pospisil, Bayer Crop Science
Mark Timmer, Muskegon County Road Commission
Dave Less, Dalton Twp Planning Committee
Tim Lipan, American Red Cross

Synopsis:

Public meeting to discuss hazard mitigation at the beginning of the planning process. It was noticed in the Muskegon Chronicle, discussed in the WMSRDC electronic newsletter, and announced in the February 2012 survey mailing. The meeting featured a presentation about the hazard mitigation planning process, and the public was invited to comment upon and discuss the survey that was distributed to 220 community individuals, and made available on the WMSRDC website.

February 12, 2013: Muskegon County LEPC Meeting

Attendees:

Dan Stout-Muskegon County
Rhona Colbert-Citizens Corps
Roger Squiers-Whitehall Police Department
Mike Wolffis-Valley City Environmental & Muskegon HAZMAT
Jim Duram-Muskegon R.A.C.E.S.
Leon Conklin-Mercy Health Partners
Tom Schmiedeknecht-Pro Med
Denny Harriss-Muskegon R.A.C.E.S.
Greg Throne-MDOC
Steven Lague-Muskegon HAZMAT
Bruce Katje-ESCO
Peg West-MLive/The Muskegon Chronicle
Sidney Shaw-Sun Chemical
Mike Zimmerman-Michigan VDF
Rob Olmstead-Public Health-Muskegon County
Ted Sietsema-Public health-Muskegon County
Bob Gagon-Norton Shores Fire Department
Tim Lipan-American Red Cross
Stephen Carlson- WMSRDC

Synopsis:

Discussion of progress made on plan update. 5 new hazards added to the plan: Fog, Celestial Impacts, Invasive Species, Energy Emergencies, and Catastrophic Incidents. New threats, or changes in perceived threats since early 2000's include Wildfire Terrorism and Cyber Terrorism.

March 27, 2013: FEMA Resilience Meeting

Attendees:

WMSRDC staff
A small number of local governments from Muskegon County
Muskegon County Emergency Services
STARR (consultants)

Synopsis:

Brief discussion of HAZUS-MH; potentially sensitive information (dams, pipelines, etc); Cyber Terrorism; and Wildfire Terrorism. One local mitigation success story identified in Muskegon County: City of Montague Buyout/Acquitition of a building located within floodplain in July 2007. High risk considerations include "pinchpoints" (culverts) and old agricultural dams. 2012 Michigan building codes contain FEMA minimum requirements. New FEMA flood maps anticipated to be effective in 2014. Potential sources of funding include FEMA (HMGP, PDM, FMA, RFC, SRL), USACE, USEPA, USDA, HUD, BLM,USGS. Meeting concluded with a map activity.

May 14, 2013: Muskegon County LEPC Meeting

Attendees:

Dan Stout, Muskegon County
Stephen Carlson, WMSRDC
Bob Brenton, Honeywell
Mike Zimmerman, MI Volunteer Defense Force
Jim Bartholomew, Muskegon County
Steven Lague, Muskegon County HAZMAT
Rhona Colbert, Citizens Corp
Bruce Katje, ESCO Co, LLC
Tim Lipan, American Red Cross
Jim Duram, Muskegon County RACES
Rob Olmstead, Public Health Muskegon County
Ted Sietsema, Public Health Muskegon County
Renee Gavin, Muskegon County Intern
Sidney Shaw, Sun Chemical
Roger Squiers, Whitehall PD

Synopsis:

Discussion of progress made on plan update. Discussion of recent flood which led to local and state declarations of emergency. FEMA was in the area to assess damages to determine possible federal declarations. Red Cross was working in all counties affected by the flooding. Shelters were set up for approximately five days and meals were provided. Door-to-door assessments were conducted. The worked with the Salvation Army and also provided clean up kits.

August 13, 2013: Muskegon County LEPC Meeting

Attendees:

Bruce Katje, ESCO Co, LLC, Chairperson
Stephen Carlson, WMSRDC
Susan Mayette, Sun Chemical
Karen Strait, MCECS
Rich (Doc) Strait, MCECS
Mike Zimmerman, Michigan Volunteer Defense Force
Dan Stout, Muskegon County Emergency Services
Dennis Harris, RACES
Max Bjorkman, Public Health Muskegon County
Rob Olmstead, Public Health Muskegon County
James Duram, RACES, Whitehall Police Department
Kevin Green, Public Health Muskegon County
Steven Lague, Hazmat
Leon Conklin, Mercy Health Muskegon
Renee Gavin, Muskegon County Emergency Services
Rhona Colbert, Citizen Corps

Synopsis:

Discussed the revamped Hazard Vulnerability Rankings for Muskegon County. A map showing the concentration of facilities and infrastructure was also handed out. Dan Stout suggested the location of a correctional facility in Whitehall Township was inaccurate. Leon Conklin suggested splitting the “medical facilities” category into two; hospital and medical office. He also suggested keeping a hospital point for Mercy General Hospital. Muskegon County is the first patient care zone for a Palisades power plant emergency. Road Commission is looking at submitting an HMGP project under funds recently made available.

October 23, 2013: Water, Woods & Wetlands Regional Forum

Attendees:

ALISA	GONZALES-PENNINGTON	DEQ CZM	OFFICE OF GREAT LAKES-CZM
GARY	WILSON	Great Lks environmental	CHICAGO COMMENTATOR, GREAT LAKES ECHO
MATTHEW	CHILD	International JC	IJC - GREAT LAKES REGIONAL OFFICE
ANNA	KORNOELJE	Kzoo environmental	KALAMAZOO NATURE CENTER
STEPHANIE	SWART	MDEQ	MDEQ OFFICE OF THE GREAT LAKES
ROBERT	SWEET	MDEQ	MDEQ NON POINT SOURCE PROGRAM
JON	ALLAN	MDEQ	DIRECTOR, MICHIGAN OFFICE OF THE GREAT LAKES
SUZANNE	DIXON	MDNR	LEAGUE OF WOMEN VOTERS-DIRECTOR-DNR
SHAUN	HOWARD	MI environmental	NATURE CONSERVANCY IN MICHIGAN
JEAN	WEIRICH	MI environmental	WILDFLOWER ASSOCIATION OF MICHIGAN
STEPHANIE	BARRETT	Mkg Co. elected	MUSKEGON COUNTY INTERIM DRAIN COMMISSION
SUSIE	HUGHES	Mkg Co. elected	MUSKEGON COUNTY COMMISSIONER
LUPE	ALVIAR	Mkg Co. Veterans	MUSKEGON COUNTY VETERANS BOARD
KIM	ARTER	Mkg local elected	LAKETON TOWNSHIP SUPERVISOR
LEA	MARKOWSKI	Mkg local official	CITY OF MUSKEGON COMMISSIONER
DAVID	SHEEHY	Mkg local official	LAKETON TOWNSHIP ZONING ADMINISTRATOR
RON	BROWN	Mkg Non-Profit	MUSKEGON ENVIRONMENTAL RESEARCH & EDUCATION SOCIETY
DARLENE	DEHUDY	Mkg resident	MUSKEGON COUNTY RESIDENT
TOM	MATYCH	Mkg resident	MUSKEGON COUNTY RESIDENT
BILLIE	HOLMES	MLWP	JACKSON HILL NEIGHBORHOOD ASSOC. & MLWP
CATHERINE	SWIATEK	MLWP	MUSKEGON LAKE WATERSHED PARTNERSHIP
THERESA	BERNHARDT	MLWP	MUSKEGON LAKE WATERSHED PARTNERSHIP
WAYNE	GROESBECK	MLWP	MUSKEGON LAKE WATERSHED PARTNERSHIP & MRWA
NANCY	BURMEISTER	MRWA	MUSKEGON RIVER WATERSHED ASSEMBLY
GARY	NOBLE	MRWA	MUSKEGON RIVER WATERSHED ASSEMBLY
DENNIS	DONAHUE	NOAA	NOAA GLERL LAKE MICHIGAN FIELD STATION
TERRY	HEATLIE	NOAA	NOAA FISHERIES
JOEL	DARLING	Non-Profit	DARLING CETACEANS
LISA	DUTCHER	Oceana Co. RC	RSX CONSULTANT - OCEANA COUNTY ROAD COMMISSION
TOM	BOOM	Private Business	BARR ENGINEERING
ERIC	JOHNSON	Private Business	WEST SHORE CONSULTANTS
BOB	KRENN	Private Business	TIMBER BRIDGES
KELLY	RICE	Private Business	CARDNO JF NEW
CHRIS	WARREN	Private Business	BARR ENGINEERING COMPANY
ELAINE	ISELY	Regional environmental	WEST MICHIGAN ENVIRONMENTAL ACTION COUNCIL
JENNIFER	MCKAY	Regional environmental	TIP OF THE MITT WATERSHED COUNCIL
CAROLYN	ULSTAD	Regional environmental	MACATAWA AREA COORDINATING COUNCIL
RICK	WESTERHOF	USFWS	US FISH & WILDLIFE SERVICE
CHARLES	BYERS	USGS	US GEOLOGICAL SURVEY
JOE	DURIS	USGS	USGS - MICHIGAN WATER SCIENCE CENTER
RYAN	OSTER	USGS	USGS MICHIGAN WATER SCIENCE CENTER
DENNIS	MARVIN	utilities	CMS ENERGY
TANYA	CABALA	Wh. Lk. PAC	WHITE LAKE PUBLIC ADVISORY COUNCIL
GREG	MUND	Wh. Lk. PAC	WHITE LAKE PUBLIC ADVISORY COUNCIL
THOMAS	TISUE	Wh. Lk. PAC	WHITE LAKE PUBLIC ADVISORY COUNCIL
TOM	HAMILTON	Wh. R. WP	WHITE RIVER WATERSHED PARTNERSHIP
STEPHEN	CARLSON	WMSRDC	WMSRDC SENIOR PLANNER
JOSHUA	CROFF	WMSRDC	WMSRDC PLANNER
SANDEEP	DEY	WMSRDC	WMSRDC EXECUTIVE DIRECTOR
KATHY	EVANS	WMSRDC	WMSRDC ENVIRONMENTAL PROGRAM MANAGER
JOEL	FITZPATRICK	WMSRDC	WMSRDC TRANSPORTATION PLANNER
AMY	HAACK	WMSRDC	WMSRDC
ERIN	KUHN	WMSRDC	WMSRDC ECONOMIC DEVELOPMENT PROGRAM MGR
BRIAN	MULNIX	WMSRDC	WMSRDC TRANSPORTATION PROGRAM MGR
MARY	SEEGER	WMSRDC	WMSRDC
RUTH	OLSEN		
VIRGINIA	O'TOOLE		

Synopsis:

WMSRDC staff discussed hazard mitigation at the "Water, Woods, & Wetlands" regional forum on October 23, 2013 in Muskegon, Michigan. The hazard mitigation session addressed the potential for coordination between hazard mitigation and a variety of environmental initiatives. Examples of successful mitigation projects in Michigan highlighted many common interests, such as culvert improvements, flood control, and stream bank stabilization.

November 12, 2013: Muskegon County LEPC Meeting

Attendees:

Bruce Katje, ESCO Company, LLC
Dennis Harriss, RACES
Jim Duram, RACES
Dan Stout, Emergency Services
Sidney Shaw, Sun Chemical
Tom Schmiedeknecht, Pro Med
Christopher Dean, Muskegon Heights FD
Stephen Carlson, WMSRDC
Josh Croff, WMSRDC

Synopsis:

The committee was asked to review and discuss the Muskegon County Hazard Mitigation Plan Goals & Objectives. The Goals & Objectives were distributed to the LEPC members prior to the meeting. No comments or objections were received. A general discussion of hazard mitigation followed

February 11, 2014: Muskegon County LEPC Meeting

Attendees:

Dan Stout, Muskegon County Sheriff Dept/Emergency Services
Rich Pospisil, Bayer Crop Science
Margaret Pibuldhanapatana
Robert Brenton, Honeywell
Susan Mayette, Sun Chemical
Bruce Katje, Esco
Kevin Green, Public Health Muskegon County
Christopher Dean, Muskegon Hts FD
Terry Zahniser, Muskegon County Equalization
Tom Finneer, Webb Chemical
Mike Zimmerman, Michigan Volunteer Defense Force
Roger Squiers, Whitehall PD
Stephen Carlson, WMSRDC
Dean Roesler, Muskegon County Sheriff

Synopsis:

WMSRDC staff gave a brief report on the progress of the plan update and offered the LEPC members an opportunity to ask questions. No comments from the committee.

November 4, 2014: Muskegon County LEPC Meeting

Attendees:

Dan Stout II, Muskegon County Emergency Services
Rhona Colbert, Citizen Corps
Dan Stout, Muskegon County Sheriff Dept.
Susan Mayette, Sun Chemical
Ted Karnitz, Norton Shores Fire Department
Bruce Katje, ESCO Company LLC
Stephen Carlson, WMSRDC
Rob Olmstead, Public Health Muskegon County
Rich Pospisil, Bayer Crop Science
Tom Finkler, Webb Chemical
Jeff Lewis, Muskegon Public Safety
Chris Dean, Muskegon Hts Fire Department
Roger Squiers, Whitehall Police Department
Dean Roesler, Muskegon County Sheriff Department
Leon Conklin, Mercy Health
Ken Hulka, Muskegon County Road Commission

Synopsis:

WMSRDC staff gave a brief report on the progress of the plan update and identification of action items. Project grant period ends July 31, 2015. Next meeting will feature a public meeting and an interactive action item prioritization activity

February 10, 2015: Muskegon County LEPC Meeting and Hazard Mitigation Public Meeting

Attendees:

Dan Stout II, Muskegon County Emergency Services
Dan Stout, Muskegon County Sheriff Dept.
Jim Durham, Muskegon County RACES
Rob Olmstead, Public Health Muskegon County
Ken Causie, Muskegon County Emergency Services
Chris Dean, Muskegon Hts Fire Department
Margaret Pibuldhanapatana, Honeywell
Bruce Katje, ESCO Company LLC
Rich Pospisil, Bayer Crop Science
Penny Serensen, Bayer Crop Science
Roger Squiers, Whitehall Police Department
Stephen Carlson, WMSRDC
Thomas VanBruggen, Muskegon County GIS
John Gale, Norton Shores Police Department
Terry Sabo, Muskegon County Board Admin
Susue Hughes, Muskegon County Commissioner
Jeff Lewis, Muskegon Public Safety
Leon Conklin, Mercy Health

Synopsis:

This meeting was noticed in the Muskegon Chronicle, announced on the WMSRDC website, and invitations were mailed and emailed to all local elected officials in Muskegon County. These communications invited recipients to review the Hazard Analysis and Goals & Objectives sections, which were posted on the WMSRDC website prior to the public meeting. Invitees were offered an opportunity to comment on the drafted sections by attending the public meeting or by submitting written comments to WMSRDC staff prior to the meeting. No comments were received from the public during the public meeting. The LEPC meeting also featured a work session, whereas a proposed set of hazard mitigation action items were reviewed, discussed, and prioritized utilizing interactive polling technology. A number of useful comments were received during the work session:

- Regarding Action Item 48 (First Call): It would be useful to encourage public to register cell phone numbers.
- Regarding Action Item 55 (Generators): Portable generators will become increasingly necessary, especially for home health care purposes. The county may consider establishing a system whereby available/extra generators in the community (owned by public, private, and/or business) can be registered in an inventory and made available during a public emergency or disaster.
- Regarding Action Item 59 (Road Maintenance): The Muskegon County Drain Commissioner should be listed under the "potential technical/financial assistance" heading.

RESOURCES

Many resources, documents, and websites were researched and referenced during the development of this plan. The following were most helpful during this process:

Muskegon Area-wide Plan (updated 2013)

Finding Common Ground: Linking Transportation and Watershed Partner Priorities – Road/Stream Crossings in Muskegon County (May 2012)

Preliminary Assessment of Lower Muskegon River Watershed Oil Field (October 2010)

Muskegon County Hazard Analysis (9/00)

Muskegon County Emergency Action Guidelines

Muskegon County Health Profile of the Muskegon County Health Department (2012)

Michigan Hazard Analysis (July 2012)

Michigan Hazard Mitigation Plan (updated March 2011)

Michigan Department of Agriculture Food and Agricultural Systems Profiles (2009)

Pipeline Emergency Response Planning Information (2011)

Hazard Mitigation Plan for Kent and Ottawa Counties (revised 2012)

United States 2010 Census

Flood Insurance Rate Maps from the National Flood Insurance Program

USGS topographic maps

Plat maps

USDA Soil Survey-Muskegon County, Michigan (1968)

Web sites referenced include, but are not limited to:

- National Climatic Data Center: http://www.ncdc.noaa.gov/
- FEMA www.fema.gov
- Michigan Geographic Data Library: www.mcgi.state.mi.us/mgdl/
- Local media
    - Muskegon Chronicle / MLIVE: www.mlive.com

ARTICLES & PUBLIC NOTICES

Articles and public notices published during the Muskegon County Hazard Mitigation Plan Update planning process.

June / July 2011 – WMSRDC print newsletter

Expected Hazard Mitigation Plan Updates

Hazard mitigation is sustained action taken to reduce or eliminate long-term risk to people and their property from hazards. Mitigation Plans form the foundation for a community's long-term strategy to reduce disaster losses and break the cycle of disaster damage, reconstruction, and repeated damage.

Five years ago, WMSRDC authored Hazard Mitigation Plans for the counties of Lake, Mason, Muskegon, Newaygo, and Oceana. All five plans attained Federal Emergency Management Agency (FEMA) approval, helping the counties become eligible for certain types of non-emergency disaster assistance, including funding for mitigation projects.

These plans are now in need of a formal update to maintain this condition for mitigation funding eligibility. The Commission recently partnered with Oceana County to apply for a FEMA Hazard Mitigation Planning Grant to update existing Hazard Mitigation plans for the five counties.

This two-year project is expected to commence in August 2011. WMSRDC will coordinate with each county's Emergency Manager to assemble an advisory committee, identify local hazards, and educate local communities and citizens about local hazards and how to mitigate their effects. This planning process is as important as the plan itself, because it creates a framework for risk-based decision-making to reduce damages to lives, property, and the economy from future disasters.

For more information, check out the Hazard Mitigation Planning section at wmsrdc.org under "Special Projects." You may also contact Stephen Carlson, Associate Planner, at (231) 722-7878 extension 11 or scarlson@wmsrdc.org.

Novemer 8, 2011 – WMSRDC e-newsletter

WMSRDC Initiates Updates of Hazard Mitigation Plans

Five years ago, WMSRDC authored Hazard Mitigation Plans for the counties of Lake, Mason, Muskegon, Newaygo, and Oceana. All five plans attained Federal Emergency Management Agency (FEMA) approval, helping the counties become eligible for certain types of non-emergency disaster assistance, including funding for mitigation projects. WMSRDC is now in the process of updating the plans to maintain this condition for mitigation funding eligibility. As a part of the planning process, WMSRDC will coordinate with each county's emergency manager to identify local hazards and educate local communities and citizens about local hazards and how to mitigate their effects. This two-year project is expected conclude in October 2013.

December 2011 / January/February 2012 – WMSRDC print newsletter

Spotlight on… Hazard Mitigation Planning

In October of 2011, Oceana County with assistance from the WMSRDC secured a Federal Emergency Management Agency (FEMA) Pre-Disaster Mitigation Planning Grant for the update of Hazard Mitigation Plans for the five counties of Lake, Mason, Muskegon, Newaygo and Oceana. WMSRDC will be responsible for performing these FEMA-required five-year updates over a two-year period.

The primary objective of hazard mitigation is to reduce or eliminate long-term risk to people and property. These plans are helpful in identifying a community's risks, prioritizing those risks, and identifying actions to mitigate those risks. The plans, once approved by FEMA, also help communities qualify for certain types of non-emergency disaster assistance, including funding for mitigation projects.

Community and stakeholder involvement in the preparation of a hazard mitigation plan is essential to the planning process and has a direct influence on a plan's effectiveness. Therefore, Advisory Teams have been established in each county to help guide the update of the plans. Each team is lead by their county's Emergency Manager, and includes representatives from an array of sectors involved with emergency planning.

The first major task in the update planning process is to invite participation from the public. In the month of February WMSRDC will distribute a hazard mitigation survey questionnaire to a wide range of organizations such as local officials and agencies, public utilities, and emergency responders via mail and e-mail. This survey will also be available to the public on the WMSRDC website under Special Projects. In March and April, WMSRDC will organize a public meeting in each county to discuss the hazard mitigation project, and to receive public comments and concerns associated with hazard mitigation.

For more information regarding the Hazard Mitigation project or to receive a survey, visit www.wmsrc.org, or contact Stephen Carlson, Associate Planner at (231) 722-7878 extension 11 or at scarlson@wmsrdc.org.

February 26, 2012 – Muskegon Chronicle

NOTICE OF PUBLIC HEARING REGARDING HAZARD MITIGATION

The West Michigan Shoreline Regional Development Commission (WMSRDC), in cooperation with Muskegon County, has begun the process of updating the Muskegon County Hazard Mitigation Plan. Public input is requested regarding natural and man-made hazards that pose a threat to people and property in Muskegon County. A public hearing to discuss Hazard Mitigation and receive input from the community will take place at 10:30 AM on April 10, 2012 at the Norton Shores City Hall located at 4814 Henry Street, Muskegon, MI, 49441. Information about the Muskegon County Hazard Mitigation Plan Update is available at www.wmsrdc.org. Please direct any questions to Mr. Stephen Carlson, Associate Planner, at (231) 722-7878, extension 11 or at scarlson@wmsrdc.org.

March 2012 – WMSRDC e-newsletter

Participate in Hazard Mitigation Planning in Your Community Through Surveys and Public Hearings

WMSRDC recently distributed over 700 hazard mitigation questionnaires to community leaders and stakeholders via mail and e-mail. This survey is an important component of the process to update the Hazard Mitigation plans for Lake, Mason, Muskegon, Newaygo, and Oceana counties. It is intended to encourage respondents to provide valuable input from a local perspective, as well as increase awareness of the hazard mitigation update process which is underway. The surveys are open to the public, and can be viewed and downloaded here..

This spring, WMSRDC and partners will hold hazard mitigation public hearings in each of the five counties. Hazard mitigation will be discussed and opportunities will be provided for attendees to comment on natural and man-made threats to their community. Dates, times, and locations of the public hearings are listed below. For more information, please contact Stephen Carlson, associate planner at (231) 722-7878 ext. 11 or scarlson@wmsrdc.org.

Public Hearings

- Lake County, March 8, 11:00 AM, Lake County Courthouse
- Mason County, May 15, 4:00 PM, Mason County Sheriff's Office
- Muskegon County, April 10, 10:30 AM, Norton Shores City Hall
- Newaygo County, March 20, 2:00 PM, Newaygo County Emergency Operations Center
- Oceana County, March 27. 12:00, Oceana County Courthouse

March / April 2012 – WMSRDC print newsletter

Hazard Mitigation Update

Efforts are in full-swing to update the Hazard Mitigation Plans for the counties of Lake, Mason, Muskegon, Newaygo, and Oceana. In February and March, surveys were mailed or emailed to over 700 individuals throughout the five counties in order to gather information, as well as increase awareness of hazard mitigation planning.

In addition, research is underway to identify natural and manmade hazards. Once the research is complete, hazards will be ranked prioritized for each county and strategies will be identified to prevent or lessen future damages to people, structures, and property from disasters. The public is invited to participate throughout the project, which on schedule to conclude in the fall of 2013.

For more information or to partake in the Hazard Mitigation Survey, visit the Hazard Mitigation Planning page at www.WMSRDC.org, or contact Stephen Carlson, Associate Planner, at (231) 722-7878 extension 11 or at scarlson@wmsrdc.org.

December 2012 Annual Report – WMSRDC print newsletter

Spotlight on Hazard Mitigation

In 2011, Oceana County with the assistance of WMSRDC received a $225,000 Pre-Disaster Mitigation (PDM) grant from the Federal Emergency Management Agency (FEMA) to update the hazard mitigation plans for Lake, Mason, Muskegon, Newaygo and Oceana counties. Each county, as well as WMSRDC, combined to contribute local match for the grant. In 2012, WMSRDC made great progress towards accomplishing the updates, a process which is expected to span two years.

Hazard mitigation aims to reduce or eliminate long-term risk to people and property from hazards. Mitigation plans (like the ones prepared by WMSRDC) form the foundation for a community's long-term strategy to reduce disaster losses and break the cycle of disaster damage, reconstruction, and repeated damage. In addition, the plans help communities qualify for certain Hazard Mitigation Assistance (HMA) funding for pre-disaster and post-disaster mitigation. The relocation or demolition of a structure located within a floodplain is example of a mitigation project.

Community and stakeholder involvement in the preparation of a hazard mitigation plan is essential to the planning process and has a direct influence on a plan's effectiveness. Once a plan is completed, it must be approved by FEMA and then adopted locally. The goals, objectives, and action items should then be incorporated into the community's planning for such things as capital improvements, transportation, and future land use.

Hazards addressed in WMSRDC's hazard mitigation plans are organized into three areas and include, but are not limited to, the following hazards:

- Natural Hazards such as thunderstorms, flooding, winter weather, wildfires, etc;
- Technological Hazards such as structural fires, infrastructure failures, and transportation accidents; and
- Human-Related Hazards such as public health emergencies, civil disturbances, and terrorism.

June 2013 – WMSRDC e-newsletter

Hazard Mitigation Planning Update

WMSRDC is continuing the process of updating Hazard Mitigation Plans for Lake, Mason, Muskegon, Newaygo, and Oceana counties. The first phase of the project is nearly complete for all five plans. This has included extensive research of demographics, critical facilities, infrastructure, and so forth; as well as the identification of potential hazards and documentation of historical hazardous events. A survey was also mailed and/or emailed to over seven hundred individuals and agencies within the five-county region. The survey is still available and open to the public at www.wmsrdc.org on the Hazard Mitigation page. The next step for the Hazard Mitigation Plan updates will be to prioritize the identified hazards with a ranking system that takes into account each hazard's frequency and propensity to impact people, property, and the economy.

August / September 2013 – WMSRDC print newsletter

Hazard Mitigation Update

WMSRDC continues working to update the Hazard Mitigation plans for the counties of Lake, Mason, Muskegon, Newaygo, and Oceana. Each plan includes analysis of 31 natural, technological, and human-related hazards. The latest milestone of this effort was the revision of the method used to rate and rank these hazards. The new system assesses four metrics for each hazard. These metrics include:

- Probability of Occurrence;
- Impact on the Population;
- Impact on Property; and
- Impact on the Economy.

A weighting system is then applied to help rank the hazards in order of importance. "Probability of Occurrence" and "Impact on the Population" are the two most important factors in this ranking system.

The resulting list of hazards will be used in the next phase of the planning process to help identify hazard mitigation priorities and to select feasible mitigation projects for each county.

For more information about Hazard Mitigation, please contact Stephen Carlson, Senior Planner, at (231) 722-7878 ext. 11 or at scarlson@wmsrdc.org.

February / March 2014 – WMSRDC print newsletter

Hazard Mitigation Update

Hazard mitigation is a relatively unknown concept. Yet upon closer inspection, one realizes that hazard mitigation is virtually everywhere. It encompasses any action taken to eliminate or reduce damages and losses to property and life. Seemingly endless policies and practices are already in place with that goal in mind.

Having a Federal Emergency Management Agency (FEMA)-approved hazard mitigation plan helps a community qualify for certain types of hazard mitigation assistance. Projects in Michigan that have received such assistance include acquisition of flood-prone properties, stream bank stabilization, and culvert replacements.

WMSRDC continues working to update the Hazard Mitigation plans for the counties of Lake, Mason, Muskegon, Newaygo, and Oceana. Once the updates are complete, financial and/or technical help might be available to further hazard mitigation in those areas. The plan updates are on track to be complete in second half of 2014.

For more information about Hazard Mitigation, please contact Stephen Carlson, Senior Planner, at (231) 722-7878 ext. 11 or at scarlson@wmsrdc.org.

April / May 2014 – WMSRDC print newsletter

Hazard Mitigation

WMSRDC continues to make progress toward updating the Hazard Mitigation plans for Lake, Mason, Muskegon, Newaygo, and Oceana counties. The project is funded through a grant awarded to Oceana County by the Michigan State Police – Emergency Management and Homeland Security Division. Oceana County is the fiduciary for the grant, while WMSRDC is responsible for fulfilling the grant obligations.

The project is scheduled to end July 31, 2014, however a one-year extension has been requested to accommodate the potentially lengthy approval and adoption process. Each county's hazard mitigation plan must be reviewed by MSP, approved by FEMA, and locally adopted. The plans are "multi-jurisdictional," meaning that each municipality in addition to the county may adopt the plan to become eligible for certain types of hazard mitigation funds.

February 3, 2015 – Muskegon Chronicle

STATE OF MICHIGAN)
County of Muskegon ss Dejà McHerron

Being duly sworn deposes and say he/she is Principal Clerk of

THE MUSKEGON CHRONICLE
DAILY EDITION

a newspaper published and circulated in the County of Muskegon and otherwise qualified according to Supreme Court Rule; and that the annexed notice, taken from said paper, has been duly published in said paper on the following day(days)

February 3 A.D. 20 15

Sworn to and subscribed before me this 3 day of February 20 15

Marietta Foley

MARIETTA FOLEY
Notary Public, State of Michigan
County of Kent
My Commission Expires: December 23, 2016

HAZARD MITIGATION PUBLIC MEETING

Public input is requested for the Muskegon County Hazard Mitigation Plan, which is being developed by Muskegon County Emergency Services with assistance from the West Michigan Shoreline Regional Development Commission (WMSRDC). The "Hazard Analysis" and "Goals & Objectives" of the plan are currently available for public review at www.wmsrdc.org/hazardmitigation. The public will have an opportunity to comment on these sections at 10:30 AM on February 10, 2015 at the Whitehall City Hall, 405 East Colby Street, Whitehall, MI. Written comments may be emailed to scarlson@wmsrdc.org prior to the meeting. Please direct any questions to Mr. Stephen Carlson, Senior Planner, at (231) 722-7878.

FEB 10 2015

Appendix F:
Potential Hazard Mitigation Funding Sources

Source: Michigan Hazard Mitigation Plan (Updated March 2011)

STATE AGENCY MITIGATION FUNDING PROGRAMS

Funding Sources for Hazard-Specific Measures	Drought	Earthquake	Extreme Temperatures	Wildfire	Dam Failure	Riverine Flooding	Great Lakes Shoreline Flooding	Subsidence	Hail	Lightning	Severe Wind	Tornadoes	Ice and Sleet Storms	Snowstorms	FINANCIAL ASSISTANCE	TECHNICAL ASSISTANCE
MICHIGAN DEPARTMENT OF AGRICULTURE																
Conservation Reserve Enhancement Program						X					X				X	X
Intercounty Drain Program (available to drain commissioners only)					X	X										X
MICHIGAN DEPT. OF ENVIRONMENTAL QUALITY																
Coastal Management Program							X								X	X
Michigan Great Lakes Protection Fund							X								X	
State Revolving Fund (Loan)						X									X	
Wetland Program Development (also see 66.461 in CFDA)						X	X								X	
MICHIGAN DEPT. OF NATURAL RESOURCES																
Land & Water Conservation Fund						X	X								X	
Michigan Habitat Improvement Fund Project Grants						X									X	
Michigan Natural Resources Trust Fund				X		X									X	
Michigan Volunteer Fire Assistance				X											X	
Recreational Trails Program Grants						X	X								X	
Community Forestry Program											X	X	X		X	X
MICHIGAN DEPARTMENT OF STATE POLICE																
Emergency Management Performance Grants (also see 97.042 in CFDA)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Flood Mitigation Assistance (also see 97.029 in CFDA)						X	X								X	
Hazard Mitigation Grant Program (also see 97.039 in CFDA)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Federal Disaster Assistance to Individuals and Households in Presidential Declared Disaster Areas (also see 97.048 in CFDA)		X		X		X	X	X			X	X			X	
Presidential Declared Disaster Assistance - Disaster Housing Operations For Individuals And Households (also see 97.049 in CFDA)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Presidential Declared Disaster Assistance To Individuals And Households - Other Needs (also see 97.050 in CFDA)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Disaster Grants-Public Assistance (Presidentially Declared Disasters) (also see 97.036 in CFDA)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Pre-Disaster Mitigation (also see 97.047 in CFDA)			X	X		X	X				X	X			X	
Severe Loss Repetitive Program (also see 97.110 in CFDA)						X	X								X	
Repetitive Flood Claims (also see 97.092 in CFDA)						X	X								X	
MICHIGAN DEPARTMENT OF TRANSPORTATION																
Transportation Economic Development Fund						X	X								X	
MICHIGAN ECONOMIC DEVELOPMENT CORP																
Community Development Block Grant Program (also see 14.218,14.219, 14.228 in CFDA)						X	X								X	
Urban Land Assembly						X	X								X	
MICHIGAN STATE HOUSING DEVELOPMENT AUTHORITY																
CDBG Housing Resource Fund (Inc HOME) (also see 14.239 in CFDA)						X	X		X		X	X			X	
Home/Property Improvement Loans						X	X		X		X	X			X	
MICHIGAN DEPARTMENT OF TREASURY																
Michigan Finance Authority-Local Gov't Loan Program	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Michigan Finance Authority-State Aid Note	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	

FEDERAL HAZARD MITIGATION FUNDING SOURCES

Funding Sources for Hazard-Specific Measures	Drought	Earthquake	Temperatures	Wildfire	Dam Failure	Riverine Flooding	Shoreline Flooding and Erosion	Subsidence	Hail	Lightning	Severe Wind	Tornados Ice and Sleet	Storms	Snowstorms	FINANCIAL ASSISTANCE	TECHNICAL ASSISTANCE
10.054 Emergency Conservation Program	X					X					X	X			X	
10.069 Conservation Reserve Program						X					X	X			X	X
10.072 Wetlands Reserve Program						X	X								X	X
10.202 Cooperative Forestry Research				X							X	X			X	
10.410 Very Low to Moderate Income Housing Loans			X	X		X	X	X	X	X	X	X			X	
10.411 Rural Housing Site Loans and Self Help Housing and Development Loans						X	X								X	
10.417 Very Low Income Housing Repair Loans/Grants			X	X		X	X	X	X	X	X	X			X	
10.445 Direct Housing Natural Disaster (Very Low/Low Income Loans)				X		X	X		X	X	X	X			X	
10.652 Forestry Research						X	X				X	X			X	
10.664 Cooperative Forestry Assistance				X											X	
10.760 Water & Waste Disposal Sys. for Rural Comm.						X	X								X	
10.763 Emergency Community Water Assistance Grants	X					X	X								X	
10.766 Community Facilities Loans & Grants	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
10.768 Business and Industry Loans	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
10.770 Water/Waste Disposal Loans/Grants						X	X								X	
10.773 Rural Business Opportunity Grants						X	X								X	
10.850 Rural Electrification Loans and Loan Guarntees										X	X	X	X	X	X	
10.901 Resource Conservation and Development	X	X	X	X		X	X									X
10.902 Soil and Water Conservation	X	X	X	X		X	X									X
10.904 Watershed Protection and Flood Prevention					X	X	X								X	X
10.913 Farm and Ranch Land Protection Program						X	X								X	
10.914 Wildlife Habitat Incentive Program						X	X								X	
11.300 Investments for Public Works and Economic Development Facilities					X	X	X								X	
11.303 Economic Development Technical Assistance						X	X								X	X
11.307 Economic Adjustment Assistance					X	X	X				X	X			X	
11.419 Coastal Zone Mgmt. Administration Awards							X									X
11.462 Hydrologic Research	X				X	X	X								X	
11.463 Habitat Conservation							X								X	
11.477 Fisheries Disaster Relief	X			X	X	X	X								X	
11.478 Center for Coastal Ocean Research_Coastal Ocean Program							X								X	
11.550 Public Telecommunication Facilities-Planning & Construction												X			X	
12.101 Beach Erosion Control Projects							X								X	
12.102 Emergency Rehabilitation of Flood Control Works or Federally Authorized Coastal Protection Works					X	X	X								X	
12.103 Emergency Operations Flood Response & Post-Flood Response					X	X	X								X	
12.104 Flood Plain Management Services					X	X	X									X
12.105 Protection of Essential Highways, Highway Bridge Approaches, and Public Works					X	X	X								X	
12.106 Flood Control Projects					X	X	X								X	
12.108 Snagging and Clearing for Flood Control					X	X	X								X	
12.109 Protection, Clearing and Straightening Channels						X	X								X	
12.111 Emergency Advance Measures for Flood Protection					X	X	X								X	
14.218 Community Development Block Grants/Entitlement Grants	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
14.228 Community Development Block Grants-State's Program	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	

FEDERAL HAZARD MITIGATION FUNDING SOURCES (CONT.)

Funding Sources for Hazard-Specific Measures	Drought	Earthquake	Temperatures	Wildfire	Dam Failure	Riverine Flooding	Shoreline Flooding and Erosion	Subsidence	Hail	Lightning	Severe Wind	Tornadoes Ice and Sleet	Storms	Snowstorms	FINANCIAL ASSISTANCE	TECHNICAL ASSISTANCE
14.218 Community Development Block Grants/Entitlement Grants	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
14.219 Community Development Block Grants -Small Cities Program	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
14.228 Community Development Block Grants-State's Program	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
14.239 HOME Investment Partnerships Program						X	X		X	X	X	X			X	
14.246 Community Development Block Grant/Brownfileds Economic Development Initiative						X	X				X	X			X	
14.250 Rural Housing and Economic Development	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
14.511 Community Outreach Partnership Center Program	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
15.623 North American Wetlands Conservation Fund						X	X								X	
15.904 Historic Preservation Fund Grants-In-Aid						X	X	X	X	X	X	X	X	X		X
15.916 Outdoor Recreation-Acquisition, Development and Planning (Land and Water Conservation Fund Grants)						X	X								X	
15.918 Disposal of Federal Surplus Real Property for Parks, Recreation, and Historic Monuments						X	X									
15.921 Rivers, Trails, and Conservation Assistance						X	X									X
47.041 Engineering Grants	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
59.008 Disaster Assistance Loans		X		X		X	X	X	X	X	X	X	X	X	X	
66.461 Regional Wetlands Program Development Grants						X	X								X	
66.469 Great Lakes Program							X								X	
81.042 Weatherization Assistance for Low-Income Persons			X												X	
97.018 National Fire Academy Training Assistance				X												X
97.022 Flood Insurance						X	X									X
97.023 Community Assistance Program - State Support Services Element (NFIP)						X	X									X
97.024 Emergency Food and Shelter National Board Program	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
97.026 Emergency Management Institute-Training Assistance	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X
97.028 Emergency Management Institute-Resident Education Program	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X
97.029 Flood Mitigation Assistance						X	X								X	
97.030 Community Disaster Loans	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
97.031 Cora Brown Fund	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
97.036 Disaster Grants - Public Assistance (Presidentially Declared Disasters)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
97.037 Disaster Housing Program	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
97.039 Hazard Mitigation Grant Program	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
97.041 National Dam Safety Program					X											X
97.042 Emergency Management Performance Grants	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
97.044 Assistance to Firefighters Grant				X											X	
97.045 Cooperating Techincal Partners						X	X								X	
97.046 Fire Management Assistance Grant				X											X	
97.047 Pre-Disaster Mitigation		X		X		X	X	X			X	X			X	
97.048 Disaster Housing Assistance to Individuals and Households in Presidential Declared Disaster Areas	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
97.049 Presidential Declared Disaster Assistance - Disaster Housing Operations for Individuals and Housholds	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
97.050 Presidential Declared Disaster Assistance to Individual and Households - Other Needs	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
97.092 Repetitive Flood Claims						X	X								X	
97.110 Severe Repetitive Loss Program						X	X								X	

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