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# Table of Contents

<b>SECTION 1: Introduction .....</b>	<b>1</b>
Background .....	1
Purpose.....	2
Scope.....	3
Authority .....	3
<b>SECTION 2: Planning Process .....</b>	<b>4</b>
Overview of Hazard Mitigation Planning.....	4
History of Hazard Mitigation Planning Keweenaw County .....	5
Preparing the 2020 Plan .....	5
The Planning Team .....	7
Local Planning Team Meetings .....	9
Involving the Public .....	10
Involving Stakeholders .....	11
<b>SECTION 3: Community Profile .....</b>	<b>12</b>
Geography, Environment, and Land Use.....	12
Population and Demographics .....	17
Housing and Infrastructure .....	19
Employment and Industry .....	23
Police, Fire, and Emergency Services.....	24
Critical Facilities and Cultural Assets.....	26
Disaster Declarations .....	33
<b>SECTION 4: Hazard Identification .....</b>	<b>34</b>
<b>SECTION 5: Hazard Analysis.....</b>	<b>40</b>
Study Area .....	40
Natural Hazards: Weather Hazards.....	40
Extreme Temperatures .....	41
Fog .....	44
Hail.....	45
Ice and Sleet Storms.....	48
Lightning.....	49
Severe Winds .....	50
Snowstorms and Blizzards.....	54
Tornadoes.....	56
Hydrological Hazards .....	60
Dam Failures.....	61
Riverine and Urban Flooding.....	62
Shoreline Flooding and Erosion.....	65
Drought .....	67
Ecological Hazards .....	68
Wildfires .....	69
Invasive Species.....	72

Geological Hazards .....	77
Earthquakes .....	77
Subsidence (Ground Collapse) .....	78
Technological Hazards: Industrial Hazards .....	81
Scrap Tire Fire .....	82
Structural Fires .....	82
Hazardous Materials: Fixed Site Incident .....	84
Hazardous Materials: Transportation Accident .....	86
Petroleum and Natural Gas Incidents .....	87
Infrastructure Hazards .....	90
Infrastructure Failures and Secondary Technological Hazards .....	90
Transportation Accidents .....	92
Human-Related Hazards .....	94
Civil Disturbances .....	94
Public Health Emergencies .....	96
Sabotage and Terrorism .....	100
<b>SECTION 6: Risk Assessment .....</b>	<b>103</b>
Differential Vulnerability .....	103
Hazard Priority Risk Index and Ranking .....	108
PRI Results .....	111
<b>SECTION 7: Hazard Mitigation .....</b>	<b>115</b>
Overview of Mitigation Strategy Development .....	115
Review and Update of Mitigation Goals .....	117
Capability Assessment .....	117
Mitigating Hazards in Keweenaw County .....	120
Mitigation Resources .....	129
Updating the 2020 Keweenaw County Hazard Mitigation Plan .....	130
<b>SECTION 8: Action Plan .....</b>	<b>131</b>
Past Mitigation Accomplishments .....	131
<b>Appendix .....</b>	<b>141</b>
Appendix A: County Capability Snapshot	
Appendix B: Shoreline Erosion Maps for Houghton County	
Appendix C: Mitigation Funding and Resources	
Appendix D: County Letter to Commit Match	
Appendix E: Public Participation	
Appendix F: Meeting Materials	
Appendix G: State Document Review	
Appendix H: Plan Adoption	

## Table of Figures

Figure 2.1: Hazard Mitigation Planning Process .....	6
Figure 5.1: NOAA’s National Weather Heat Index Chart.....	42

## Table of Maps

Map 3.1: Keweenaw County Watersheds .....	14
Map 3.2: Land Use/Cover in Keweenaw County .....	16
Map 3.3: Local Units of Government in Keweenaw County .....	18
Map 3.4: Keweenaw County Transportation .....	21
Map 5.1: Hail Events in Keweenaw County, 1955-2019 .....	47
Map 5.2: Severe Wind Events in Keweenaw County, 1955-2018 .....	53
Map 5.3: Reported Tornadoes in Keweenaw County, 1950-2019.....	59
Map 5.4: Wildfire Hazard Potential in Keweenaw County .....	71
Map 5.5: Mine Locations by Type in Keweenaw County .....	80
Map 5.6: Pipeline in Keweenaw County .....	89

## Table of Tables

Table 2.1: Participating Local Units of Government and Representatives.....	8
Table 2.2: Keweenaw County Local Planning Team .....	8
Table 3.1: Municipal and Township Populations for Keweenaw County, 1960-2017.....	17
Table 3.2: Race and Ethnicity Percentages in Keweenaw County, 2017 .....	19
Table 3.3: Schools in Keweenaw County, 2019 .....	20
Table 3.4: Employment by Sector in Keweenaw County, 2016.....	24
Table 3.5: Fire Departments in Keweenaw County .....	25
Table 3.6: Siren Locations in Keweenaw County .....	26
Table 3.7: Critical Facilities in Keweenaw County .....	27
Table 3.8: Presidential Disaster Declarations for Keweenaw County, 1965-2018.....	33
Table 4.1: Descriptions of Identified Hazards .....	35
Table 5.1: Heat Index and Related Heat Disorders.....	42
Table 5.2: Cold Disorders Associated with Extreme Cold Temperatures .....	43
Table 5.3: Hail Size Reference .....	45
Table 5.4: Reported Hail Events by Size in Keweenaw County, 1955-2019 .....	46
Table 5.5: Reported Ice and Sleet Storms in Keweenaw County, 1955-2019.....	49
Table 5.6: Reported Severe Wind Events in Keweenaw County, 1955-2019 .....	51
Table 5.7: Snowstorms by Type in Keweenaw County, 1996-2019 .....	55
Table 5.8: Fujita Scale with Associated Damages.....	57

Table 5.9: Enhanced Fujita Scale with Associated Damages .....	57
Table 6.1: Differential Vulnerabilities by Jurisdiction in Keweenaw County.....	104
Table 6.2: State-Equalized Value for Keweenaw County, 2019 .....	105
Table 6.3: Hazard Extent in Keweenaw County.....	106
Table 6.4: Priority Risk Index Summary Table .....	110
Table 6.5: Summary of PRI Results for Keweenaw County .....	111
Table 6.6: Conclusions on Hazard Risk for Keweenaw County .....	113
Table 8.1: 2005 Hazard Mitigation Action Items .....	132
Table 8.2: 2013 Hazard Mitigation Action Items .....	132

## SECTION 1: Introduction

This section provides a general introduction to the Keweenaw County Hazard Mitigation Plan. It consists of the following four subsections:

- Background
- Purpose
- Scope
- Authority

### Background

Natural hazards, such as floods, severe winter storms, and wildfires are naturally occurring physical phenomena caused either by the rapid or slow onset of events which can have a negative effect on humans or the environment. Every year in the United States, natural hazards threaten lives and livelihoods and result in billions of dollars in damage.

Hazard mitigation is any action taken before, during, or after a disaster to eliminate or reduce the risk to human life and property from natural, technological or human-related hazards. This is accomplished through coordination of resources, programs, and authorities. When successful, mitigation will lessen the impacts to such a degree that future events will remain only incidents and not become disasters.

Mitigation is an essential part of the emergency management process. When a disaster strikes and a community responds, often the focus of repairs and reconstruction is to restore damaged property to pre-disaster conditions as quickly as possible. These efforts expedite a return to "normalcy," yet replication of pre-disaster conditions leaves the community vulnerable to the same hazards, resulting in a cycle of damage, reconstruction, and damage again. Hazard mitigation allows this cycle to be broken by ensuring that post-disaster repairs and reconstruction take place after damages are analyzed and that sounder, less vulnerable conditions are produced.

Mitigation planning allows a community to identify potential hazards, assess vulnerability/risk, and develop prioritized mitigation strategies to deal with those hazards long before an event occurs. The hazards and vulnerabilities are determined based on historical events, incidents in nearby communities, and scientific data and trends. Mitigation measures can be implemented systematically, based on assessed priorities, or, in the worst case, through repair and reconstruction after a hazard event occurs.

Keweenaw County is vulnerable to a wide range of natural, technological, and human-related hazards, including flooding, infrastructure failure, structural fires, winter storms, subsidence, and hazardous material spills due to transportation accidents. While the threat from hazardous events may never be fully eliminated, there is much that can be done to lessen their potential impact upon



#### **Hazard Mitigation:**

Any sustained action taken to reduce or eliminate the long-term risk to human life and property from hazards.

the community. The Keweenaw County Hazard Mitigation Plan (hereinafter referred to as “Hazard Mitigation Plan”) is the logical first step toward incorporating hazard mitigation principles and practices into the routine government activities and functions of Keweenaw County and its municipalities. At its most inner core, the Hazard Mitigation Plan recommends specific actions to combat forces of nature and protect its residents from losses to those hazards that pose the greatest risk. These mitigation actions go beyond simply recommending structural solutions to reduce existing vulnerabilities but also suggest local policies on community growth and development, incentives for natural resource protection, and public education activities are examples of other actions considered to reduce Keweenaw County’s future vulnerabilities to identified hazards. The Hazard Mitigation Plan is designed to be a living document, with implementation and evaluation procedures included to help achieve meaningful objectives and successful outcomes over time.

### **Disaster Mitigation Act of 2000 and the National Flood Insurance Reform Act of 2004**

To reduce national natural disaster losses, the U.S. Congress passed the Disaster Mitigation Act of 2000 (42 U.S. Code § 5165) to invoke new and revitalized approaches to mitigation planning. Section 322 of this Act emphasizes the need for state and local government to closely coordinate on mitigation planning activities and makes the development of a hazard mitigation plan a specific eligibility requirement for any local government applying for federal mitigation grant funds. These funds include the Hazard Mitigation Grant Program (HMGP), the Flood Mitigation Assistance (FMA) Program, and the Pre-Disaster Mitigation (PDM) Program, all of which are administered by the Federal Emergency Management Agency (FEMA) under the Department of Homeland Security.

This Hazard Mitigation Plan was prepared in coordination with FEMA, the Emergency Management and Homeland Security Division of the Michigan State Police, and the Keweenaw County Emergency Manager to ensure that it meets all applicable Disaster Mitigation Act planning requirements. The Local Mitigation Plan Review, found in Appendix G, provides a summary of FEMA’s current minimum standards of acceptability, and notes the location within the Hazard Mitigation Plan where each planning requirement is met.

## **Purpose**

The general purpose of this Hazard Mitigation Plan is to:

- Protect life and property by reducing the potential for future damages and economic losses that result from natural hazards
- Qualify for additional grant funding
- Speed recovery and redevelopment following future disaster events
- Demonstrate a firm local commitment to hazard mitigation principles
- Comply with federal and state legislative requirements for local hazard mitigation plans



## Scope

Beginning in March 2019, this plan was updated as required by the Emergency Management and Homeland Security Division of the Michigan State Police and FEMA. After review of FEMA's requirements for local hazard mitigation plan updates, the Local Planning Team (LPT) reviewed and analyzed each section of the plan and determined that each section needed to be updated to some degree to meet the requirements.

This plan will be updated and maintained to continually address those hazards determined to be of high and moderate risk through the detailed vulnerability assessment for Keweenaw County (see Section 6: *Risk Assessment*). Other hazards that post low or negligible risk will continue to be evaluated during future updates to the Plan, but they may not be fully addressed until they are determined to be of high or moderate risk to Keweenaw County.

The geographic scope (i.e. planning area) for the Hazard Mitigation Plan includes the entire area of Keweenaw County.

## Authority

Keweenaw County has adopted this Hazard Mitigation Plan in accordance with the authority and adoption powers granted to counties as defined by the State of Michigan (MI Const., Article VII § 2). This plan has also been adopted by Keweenaw County's participating municipal jurisdictions under the authority granted to cities, and villages as defined by the State of Michigan (MI Const. Article VII § 22 & 34). Copies of all local resolutions to adopt the Plan are compiled in *Appendix A*.

This plan was developed in accordance with current state and federal ruling and regulations governing local hazard mitigation plans. The document shall be monitored and updated on a five-year basis to maintain compliance with the following legislations:

- Section 322, Mitigation Planning, of the Robert T. Stafford Disaster Relief and Emergency Assistance Act, as enacted by Section 104 of the Disaster Mitigation Act of 2000 (P.L. 106-390) and by FEMA's Interim Final Rule published in the Federal Register on February 26, 2002, at 44 CFR Part 201.
- National Flood Insurance Act of 1968, as amended 42 U.S. Const 4001 et seq; and
- Michigan General Statutes: Emergency Management Act 390 of 1976

## **SECTION 2: Planning Process**

This section of the Hazard Mitigation Plan describes the mitigation planning process completed by Keweenaw County. It consists of the following nine subsections:

- Overview of Hazard Mitigation Planning
- History of Hazard Mitigation Planning Keweenaw County
- Preparing the 2020 Plan
- The Planning Team
- Local Planning Team Meetings
- Involving the Public
- Involving Stakeholders

### **Overview of Hazard Mitigation Planning**

Local hazard mitigation planning is a process of organizing community resources, developing the goals for hazard mitigation in the county, identifying and assessing local hazard risks, and determining how best to minimize/manage those risks. The process results in a hazard mitigation plan that identifies special mitigation actions that achieve both short- and long-term planning objectives for a community-based vision. Plan maintenance procedures are established for routine monitoring of implementation progress, as well as evaluation and enhancement of the plan itself. These procedures ensure that Keweenaw County's Plan remains a current, dynamic, and effective planning document over time.

Mitigation planning offers many benefits to the local community such as:

- Protect public safety and prevent loss of life and injury.
- Reduce harm to existing and future development.
- Maintain community continuity and strengthen the social connections that are essential for recovery.
- Prevent damage to the community's unique economic, cultural, and environmental assets.
- Minimize operational downtime and accelerate recovery of government, organizations, and businesses after a disaster.
- Reduce the costs of disaster response and recovery and the exposure for first responders.
- Help accomplish other community objectives, such as capital improvements, resource protection, open space preservation, green infrastructure installation, and economic resiliency.

Having a hazard mitigation plan will increase awareness of hazards, risk, and vulnerabilities; identify actions for risk reduction; focus resources on the greatest risks; and communicate priorities to state and federal offices.

## History of Hazard Mitigation Planning Keweenaw County

Keweenaw County's first formal hazard mitigation planning efforts started in 2005 with preparation of the County's first FEMA-approved Hazard Mitigation Plan. These efforts were in response to the Federal Disaster Mitigation Act of 2000, a new requirement at the time to obtain funds through FEMA. The initial plan was led by the mitigation planning team, formerly named *Keweenaw County Ad-hoc Committee* and organized by the *Keweenaw County Emergency Measures Office*. The committee included planning professionals from the Western U.P. Planning and Development Region (WUPPDR), the County Emergency Coordinator, engineering professionals, and representatives from the Keweenaw County Board of Commissioners and Road Commission. The final plan was adopted on April 13, 2005 by the Keweenaw County Board of Commissioners and the governing bodies of the supporting jurisdictions shortly after. FEMA approved the plan in Spring 2005, validating it until Spring 2010.

In 2012, Keweenaw County contracted with WUPPDR again to update the 2005 plan. This plan update began with a review of the 2005 plan and gathering new data and information from local sources, the State, and Michigan Technological University to update the hazard risks to municipalities within the County. The Ad-hoc Committee then met to identify new projects to address existing and newly identified hazards. A public meeting was held during the planning process on August 21, 2013. The final plan was adopted by Keweenaw County Board on October 16, 2013 and subsequently adopted by the participating jurisdictions.

## Preparing the 2020 Plan

Hazard mitigation plans are required to be updated every five years to remain eligible for certain State and Federal mitigation funding. In preparation of the 2020 Hazard Mitigation Plan update, Keweenaw County and WUPPDR determined the best approach would be for WUPPDR to apply to be a subrecipient of grant funding to assist the County to update its plan. WUPPDR followed the mitigation planning process recommended by FEMA (Local Mitigation Planning Handbook, March 2013) and recommendations by the Michigan State Police.

### 44 CFR Requirement

**201.6(c)(1):** The plan shall include documentation of the planning process used to develop the plan, including how it was prepared, who was involved in the process and how the public was involved.

This section of the Hazard Mitigation Plan provides a description of the process that was used to develop the 2020 plan update. For information about how previous versions of this plan were developed it will be necessary to review the previous versions of this plan.

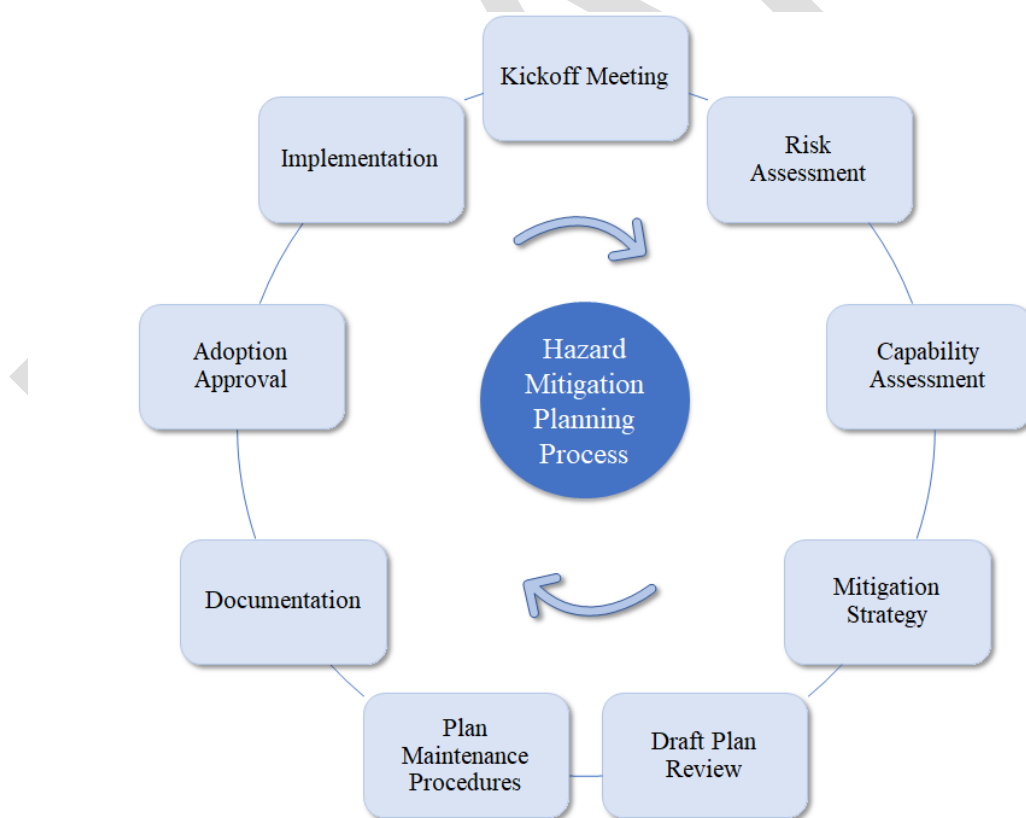
Plan update and review procedures were established in the previous versions of this plan and were used, in addition to the requirements discussed above, to prepare the 2020 update. These procedures provide the general guidelines for the updating and reviewing the plan on a five-year

basis. These procedures also state that the plan will be evaluated for effectiveness and appropriateness by addressing the following questions:

- A. Do Hazard Mitigation Plan goals and objectives continue to address current and expected conditions?
- B. Has the nature or magnitude of risks changed?
- C. Are current resources sufficient and appropriate for Hazard Mitigation Plan implementation?
- D. Are there any implementation problems that impede the action plan?
- E. What implementation outcomes have been completed?
- F. Have other agencies, organization, and jurisdictions participated as proposed in the previous plan?

These questions were considered and addressed by the local planning team. Each section of the updated plan was reviewed and updated with the identified results. The State of Michigan Hazard Mitigation Plans adopted in 2014 and 2019 were reviewed extensively to incorporate relevant material into the Keweenaw County Hazard Mitigation Plan update.

The planning process included several steps that were completed over the course of several months. These steps are illustrated in **Figure 2.1**.



**Figure 2.1:** Hazard Mitigation Planning Process

Each step of the planning process illustrated in **Figure 2.1** resulted in outcomes that make up the Plan. These work elements have been integrated into this document and are further explained here for introductory purposes.

The *Community Profile*, located in Section 3, provides a general overview of Keweenaw County and includes information on relevant topics such as geography, transportation, environment, population, demographics, housing, infrastructure, and land use. Specifics about declared disasters in the county can also be found.

The *Risk Assessment*, in Section 6, identifies, analyzes, and assesses overall risk from hazards in Keweenaw County. Hazards exclusive to individual jurisdictions in the Risk Assessment strive to identify unique vulnerabilities, as well as prioritize and rank county-wide hazards from high to low risk.

*Hazard Mitigation*, found in Section 7, determines the capability of a local jurisdiction to implement a comprehensive mitigation strategy and identify potential opportunities to establish or enhance mitigation policies, programs, or projects. Capabilities are detected by identifying existing strengths and weaknesses with ongoing government activities that have a direct impact on the community's vulnerability to hazards. This helps to identify what gaps or shortfalls need to be addressed and which positive mitigation measures already in place should continue to be supported. Coupled with the *Risk Assessment*, the *Capability Assessment* helps identify and target meaningful mitigation actions for incorporation in the Mitigation Strategy portion of the Hazard Mitigation Plan. Together, the *Community Profile*, *Risk Assessment*, and *Capability Assessment* help to determine the Hazard Mitigation Plan goals. A meaningful *Mitigation Strategy* based on accurate background information is developed, adopted, and implemented with these three components.

*Mitigation Strategies*, also found in Section 7, consist of a comprehensive strategy that looks to develop overarching goals addressing hazard mitigation, economic, environmental, and social factors. *Mitigation Action Plans*, in Section 8, were created for each jurisdiction, identifying specific plans for action to reduce or eliminate the impacts of natural hazards. Both sections make the plan comprehensive by identifying long-term and short-term goals that will influence day-to-day decision making and project implementation.

The plan's maintenance schedule is embedded in the action plan in Section 8 and describes in detail the procedures as a final action item for Keweenaw County to keep up to date with the Hazard Mitigation Plan.

## **The Planning Team**

To guide the development of this plan update, Keweenaw County's Emergency Management Coordinator convened a local planning team (LPT). While remaining consistent with the initial plan developed, it was important to reach out to more stakeholders to get a representative sample of critical facility staff, local officials, emergency personnel, and citizens. The LPT coordinated together on all aspects of the plan development process. Additional participation and input from

county residents and other identified stakeholders were sought through the distribution of surveys and the facilitation of a public meeting.

### **Jurisdictional Involvement**

All units of government in Keweenaw County have participated in the development of the 2020 Keweenaw County Hazard Mitigation Plan as required for pre-disaster federal mitigation funds under Section 104 of the Disaster Mitigation Act of 2000 (42 U.S. Const. 5165). These same jurisdictions also participated in the 2005, and 2012 Plan updates.

**Table 2.1:** Participating Local Units of Government and Representatives

<b>Jurisdiction</b>	<b>Name</b>	<b>Title</b>
Keweenaw County	Chris VanArsdale	Emergency Manager
Village of Ahmeek	Mike Maninga	Village Fire/Rescue
Allouez Township	Mark Aho	Township Supervisor
Eagle Harbor Township	Rich Probst	Township Supervisor
Grant Township	Ted Boost	Copper Harbor Fire
Houghton Township	Mel Jones	Township Supervisor
Sherman Township	Rob Middlemis-Brown	Township Supervisor

### **Keweenaw County Local Planning Team**

The participants listed in Table 2.2 represent the members of the Keweenaw County Local Planning Team who participated in the development of the Hazard Mitigation Plan. The planning process was led at the county level by the Keweenaw County Emergency Coordinator. WUPPDR provided a team of planners and a Geographic Information Systems coordinator to facilitate LPT meetings.

**Table 2.2:** Keweenaw County Local Planning Team

<b>Name</b>	<b>Agency/Jurisdiction</b>
Chris Van Arsdale	Keweenaw County Emergency Coordinator
Todd Fox	Superior Search and Rescue
Sandra Gayk	Keweenaw County
Virginia Schubert	9-1-1 Comm. E.H.
Michael Radigan	Eagle Harbor Fire Department
Rich Probst	Eagle Harbor Twp.
Dave Carlson	Eagle Harbor Twp.
Jim Vivian	Keweenaw County
Ann Gasparich	Keweenaw County
Liz Anderson	Keweenaw County
Kevin Rajala	Michigan State Police – Calumet Post

## **Local Planning Team Meetings**

The preparation of the Hazard Mitigation Plan required a series of meetings for facilitating discussion and initiating data collection efforts with local officials. The meetings also prompted continuous input and feedback from local officials throughout the drafting stages of the Hazard Mitigation Plan.

Below is a summary of the key meetings for the Local Planning Team. Copies of the agendas, sign-in sheets, and handout materials for all meetings can be found in Appendix F.

### **First Local Planning Team Meeting**

The first meeting of the Local Planning Team was held on May 30, 2019, during which the mitigation plan update process was presented. The intent of this meeting was to inform team members and guests about the planning process and requirements according to the law. The meeting also served to initiate the preliminary data collection efforts for the risk and capability assessment tasks associated with the plan's development.

### **Second Local Planning Team Meeting**

The second Local Planning Team meeting was held on November 5, 2019. The meeting began with a detailed presentation by WUPPDR on the findings of the risk assessment and public survey. By providing the county and municipal officials with a more thorough understanding of hazard risks in their communities, along with the survey results, the audience was prepared for the next step in the update process: to review the expired mitigation planning goals, and list specific mitigation actions designed to reduce future impacts of the identified hazards.

To summarize, the following general findings were presented and discussed at the second LPT meeting.

#### **Risk Assessment Findings:**

- The top 5 hazards in Keweenaw County based on the quantitative and qualitative prioritized risk assessment are: (1) Public Health Emergency, (2) Snowstorms and Blizzards, (3) Riverine and Urban Flooding, (4) Infrastructure Failures and Secondary Technological Hazards, and (5) Structural Fires.

#### **Capability Assessment Discussion**

- Keweenaw County, Grant Township, Houghton Township, and Sherman Township actively participate in the National Flood Insurance Program (NFIP).
- The whole of Keweenaw County and Eagle Harbor Township specifically has adopted and implement/enforce a comprehensive plan, building codes, and zoning ordinances.
- Local units of government in Keweenaw County have varying degrees of administrative and technical capability, with adequate staff resources to implement local government programs.



### Review of Existing Mitigation Plan Goals, Objectives, and Actions

The existing goals from the 2013 Keweenaw County Hazard Mitigation Plan were presented to the Local Planning Team during the second meeting. The committee agreed that these goals were still appropriate for what Keweenaw County means to accomplish. The goals are listed in Section 7 of this plan.

Prior to the second meeting, each municipality was asked to send updates on their current mitigation actions from 2013, and to develop any new actions that should be included in the plan. The group spent time brainstorming ideas and discussing these possible new actions.

### **Involving the Public**

Public participation is one of the fundamental components of Keweenaw County's community-based mitigation planning process. Individual citizen involvement provides the Local Planning Team with a greater understanding of local concerns and ensures a higher degree of mitigation success by developing community buy-in from those directly affected by the hazards in the region. Public awareness is a key part of the overall mitigation strategy aimed at making communities safer from the potentials risks that hazard effects.

For the 2020 plan update, public input was sought using multiple methods: (1) public and government/institutional surveys; (2) posting the draft on the WUPPDR website, and at government offices; and (3) a public meeting with opportunities for hearing public comments prior to adoption.

Keweenaw County encouraged more open and widespread public and stakeholder participation through the publication of newspaper advertisements, and a draft comment period. Local officials and institutions were also engaged to fill out a different survey to glean information about their respective organizations.

These media advertisements and survey tools provide local units of government, residents, businesses, academic organizations, and other private interests in Keweenaw County the opportunity to be involved and offer input throughout the planning process.

### **Summary of Public Participation Survey**

The 2019 Keweenaw County Hazard Mitigation Public Survey received 14 responses. All jurisdictions were represented except for Sherman Township and the Village of Ahmeek. A majority, 8 people, said they or someone in their household experienced a hazard in the last 5 years. The most listed hazard experienced were blizzards. Respondents were also asked whether they had taken actions to make their home or community more resistant to hazards. Over half of them said yes and explained what they had completed. Additional responses pertained to property located in a floodplain, flood frequency, flood insurance, and effective ways to receive hazard emergency information. A summary of the public survey results is available for review in Appendix E.



### **Summary of draft locations**

A list of locations where the draft plan was available is in Appendix E.

### **Summary of Public Meeting and Comments Received**

A summary of the public meeting and comments received are available for review in Appendix E.

## **Involving Stakeholders**

A range of stakeholders were invited and encouraged to participate in the Keweenaw County Hazard Mitigation Plan by joining the Local Planning Team meetings. The invitations were sent to the following individuals:

- Chris Van Arsdale, Houghton County Emergency Coordinator
- Ann Gasperich, Keweenaw County 911/Planning
- Brian McEachern, Negaunee Regional Communication Center
- Tonya Stefonich, Keweenaw County Sheriff's Office
- Del Rajala, Keweenaw County Board of Commissioners
- Dudley Martin, Keweenaw County 911
- Randal Danison, Michigan State Police
- Gary Bracco, Allouez Fire/First Responders
- Gerald Primeau, Mercy EMS
- Virginia Shubert, Eagle Harbor First Responders
- Mike Maninga, Ahmeek Fire/Rescue
- Curt Pennala, Keweenaw County Road Commission
- Gregg Patrick, Keweenaw County Road Commission
- Bill Labell, Keweenaw County Amateur Radio
- Rich Probst, Eagle Harbor Township
- Mark Aho, Allouez Township
- Rob Middlemis Brown, Sherman Township Fire/First Responders
- Kenneth Stigers, Grant Township
- Mike Radigan, Eagle Harbor Fire
- Ted Boost, Copper Harbor Fire
- Rick Olson, Lac La Belle Fire/First Responders

## SECTION 3: Community Profile

This section of the Plan provides a general overview of Keweenaw County. This information has been updated to reflect the community profile for the 2020 plan. It consists of the following seven subsections:

- Geography, Environment, and Land Use
- Population and Demographics
- Housing and Infrastructure
- Employment and Industry
- Police, Fire, and Emergency Services
- Critical Facilities
- Disaster Declarations

### Geography, Environment, and Land Use

Keweenaw County is in the northernmost portion of Michigan's Upper Peninsula, on the southern coast of Lake Superior, and covers an area of 365 square miles. The Keweenaw County line was established in 1861 when the mainland peninsula and Isle Royale were split off from Houghton County to the south by the Michigan Legislature. The entire county lies on the Keweenaw Peninsula - a 50-mile wide stretch of land that extends 75 miles out into the lake - as well as to the island archipelago Isle Royale National Park.

Keweenaw County's topography varies dramatically ranging from Lake Superior shore, marshes, and inland lakes to steep bedrock cliffs, rocky ridges and dissected moraines. The elevation varies in the County from a low of 600 feet on the shores of Lake Superior to upwards of 1200 to 1500 feet above sea level. This diverse landscape is the result of layers of ancient Precambrian rock being thrust upward to form the Keweenaw Fault and glaciations during the Pleistocene Epoch.

Isle Royale National Park consists of a large remote island with over 450 smaller islands covering 850 square miles in the northwest of Lake Superior. Like the mainland in forest species, Isle Royale hosts the Greenstone Ridge which contains part of the largest lava flow on Earth. The topography of the islands was shaped by glaciations 11,000 years ago. Isle Royale is a designated by UNESCO as an International Biosphere Reserve in 1980<sup>1</sup>.

Keweenaw County is surrounded on three sides by Lake Superior including 94 miles of shoreline. Ports along Lake Superior historically provided transportation routes but today serve as recreational outlets. Along the county shoreline are three State of Michigan marinas with services such as a boat launch and restrooms: Lac La Belle, Eagle Harbor, and Copper Harbor and a number of other launches that provide access to the lake. There are also several lighthouses located at Eagle Harbor, Copper Harbor, Gill Rock, Manitou Island, and Lac La Belle which provide navigational aids around the peninsula. Inland water features including lakes, rivers, and streams are an important asset of the County that provide both domestic and commercial sources of water and

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<sup>1</sup> <https://en.unesco.org/biosphere/eu-na>

facilitate many recreational activities. In total there are 10,158 acres of water, with around 374 water bodies in Keweenaw County including 11 lakes larger than 40 acres. The lakes in this county range from remote and undeveloped like Schlatter Lake to highly developed Lake Medora. Several large rivers and tributary streams dissect the landscape and have their mouths on Lake Superior, including Montreal in Grant Township; Eagle River in Houghton Township; Gratiot in Allouez Township; and the Tobacco, Big Betsy, and Little Betsy located in Sherman Township.

Keweenaw County is composed of seven watersheds ranging from 17 to 53 square miles named for rivers or creeks in the county. Watersheds include Montreal River, Little Gratiot River, Eagle River, Gratiot River, Tobacco River, Traverse River and Traprock River. Watersheds include Montreal River, Little Gratiot River, Eagle River, Gratiot River, Tobacco River, Traverse River and Traprock River; these smaller river watersheds are part of the Keweenaw Peninsula watershed, which flows into the Lake Superior (**Map 3.1**). Three of these smaller watersheds – Trap Rock, Tobacco, and Traverse – are shared with Houghton County to the south. Land use practices and decisions in one part of the County may affect water quality in downstream jurisdictions.

Keweenaw County has a typical humid continental climate that is heavily influenced by Lake Superior that surrounds it. The County enjoys cold dry winters and mild, warm summers. Average annual temperatures range between 15 degrees Fahrenheit in winter to 65 degrees in summer. Lake Superior has a moderating effect on the temperatures as the cool water moderates the temperature extremes. Another effect of the lakes is the formation of considerable cloudiness when cold air passes over the water in late fall and early winter. This effect causes considerable “lake effect” snowfall that provides an average of roughly 200 inches annually, with records over 300 inches. Annual precipitation averages 32.2 inches, of which 61 percent occurs from April-September. Heaviest precipitation is in August. Due to the moderate summer weather conditions and extreme winter snowfalls, the Keweenaw enjoys a wide range of season. These weather characteristics make the area an attractive place for summer cottages and recreation, and a destination for winter recreation activities such as snowmobiling and skiing. The growing season in Keweenaw County is roughly 145 days long.

Like Keweenaw County, Isle Royale experiences a moist continental climate. Isle Royale National Park operates from May-September, weather dependent. Due to its location in Lake Superior, the island experiences dense fog, high winds, and cooler summer months. The only transportation in and out of the island is by boat or seaplane, which makes weather conditions an important factor in visitation. Temperatures range from winter lows of -6.3 degrees Fahrenheit to summer highs of 75.9 degrees. Precipitation amount is like that of the Keweenaw Peninsula, with June-September having the highest rainfall averages.

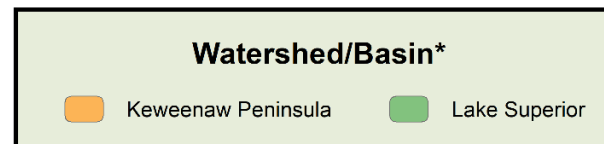
The bedrock geology of Keweenaw County is composed of five major stratigraphic units: the Portage Lake Volcanics, Copper Harbor Conglomerate, Jacobsville Sandstone, Nonesuch Formation, and Freda Sandstone.

**Map 3.1: Keweenaw County Watersheds**



## Watersheds Keweenaw County, Michigan

Boundary and watershed data were taken from Michigan's Open Data Portal; Created by WUPPDR July 2020



\*All watersheds drain to Lake Superior



Portage Lake Volcanics is the most prominent of these units, which forms the spine of the peninsula. Jacobsville Sandstone covers the southeast portions of the county, Freda Sandstone composes the southwest corner of Allouez Township, and Copper Harbor Conglomerate forms the northern shore of Keweenaw County<sup>2</sup>.

The Keweenaw Fault and Portage Lake Volcanics bedrock make up the rugged hills of the Copper Range which include Rocky Ridge, The Cliffs, Mt. Lookout, Mt. Horace Greeley, Mt. Bohemia, Mt. Houghton, Bear Bluff, West Bluff (Brockway Mountain), and East Bluff. The Range is characterized by bedrock escarpments on the southeast face with gentler slopes to the northwest. Within this bedrock, which is composed of basalt and andesite lava flows and interspersed with conglomerates, are cavities filled with copper. The native copper deposits are some of the largest in the world.

The landscape of Keweenaw County has been greatly influenced by glacial retreat, differential erosion, and deposition of materials. Keweenaw County enjoys a varying landscape of scenic and geologically intriguing cliffs, sandy beaches, cobblestone harbors, waterfalls, and sea stacks. Fossils of some of the earliest living plants, remnants of lava flows and some of the oldest rocks in North America can be found among the ancient bedrock.

Soils of Keweenaw County vary tremendously, with bedrock common in many areas. A detailed soil survey was completed in 2006 and 2014 that allowed for careful examination of lands within Keweenaw County<sup>3</sup>. This current soil survey is a tremendous tool for local government in determining the capacity of lands for development and to aid in land use decisions. This survey helps determine suitability for different types of development by describing important soil properties such as flood hazard, natural drainage, depth to bedrock, depth to seasonal water table, permeability, shrinking and swelling potential, bearing capacity, and content of silt, sand, and clay. Soil surveys also provide interpretations of limitation and suitability for foundations of structures, sanitary landfills, sewage lagoons and septic tank absorption fields, and more.

There are roughly 46 identified types of soil in Keweenaw County, which vary widely in natural drainage, depth, slope, and more characteristics. The steeper soils in the area are mostly well-drained and range from shallow to deep in areas over bedrock. The well-drained soils make up roughly one third of the county. The soils which are not well-drained are mostly level soils and are quite deep. The textures range from sand to loam in the Keweenaw. Due to this makeup, in unprotected areas this can result in erosion and sedimentation in lakes and streams.

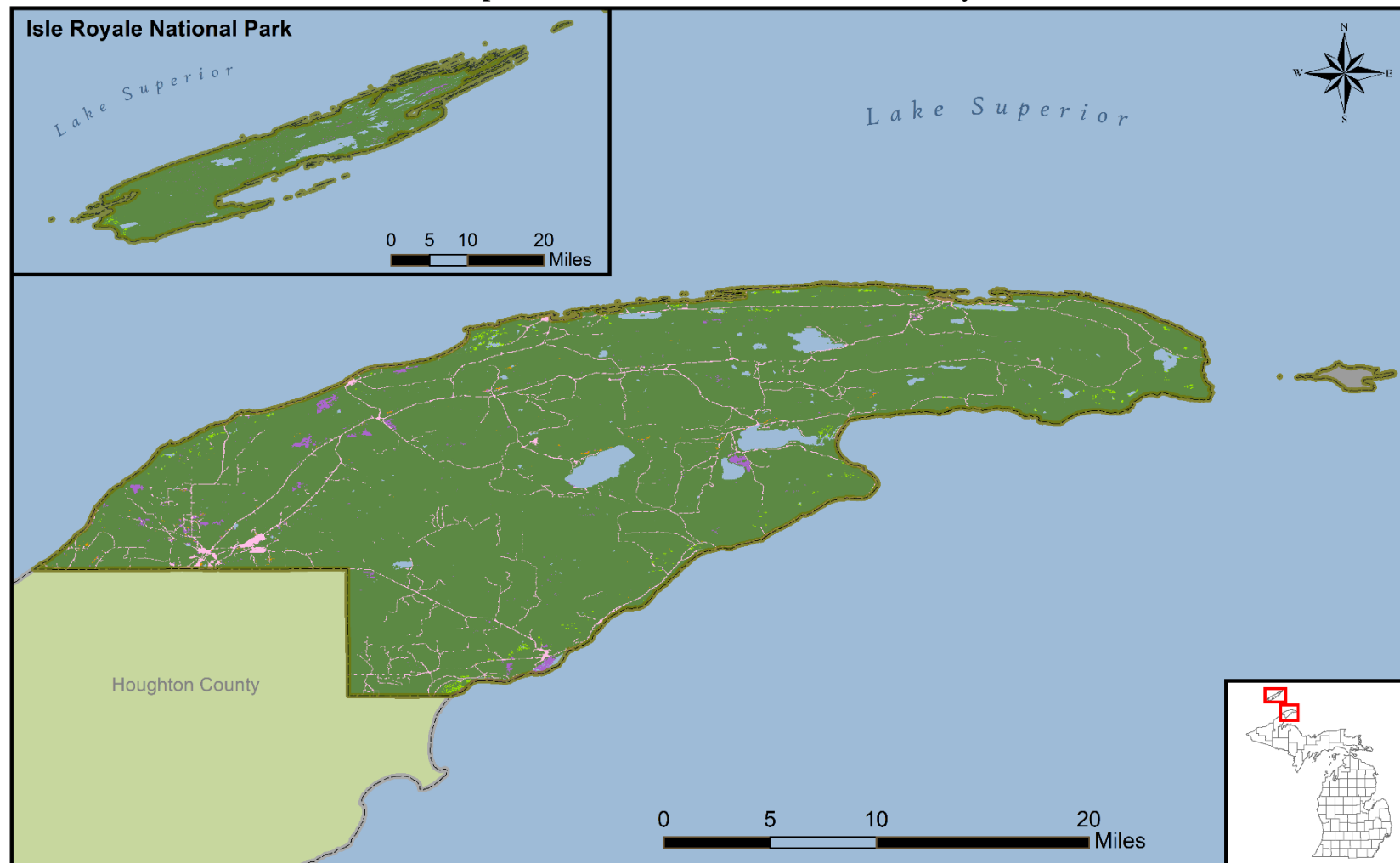
Keweenaw County's land use patterns are very closely tied to its natural resources including minerals, timber, water, wildlife, and shoreline (**Map 3.2**). Land use and development is directed by planning and/or zoning regulations set by Keweenaw County, as well as Eagle Harbor Township. Residential development is concentrated mainly in established communities in the northern and southern part of the county, with the largest numbers in Allouez and Grant Townships.

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<sup>2</sup> USGS Geological Units in Keweenaw County, <https://mrdata.usgs.gov/geology/state/fips-unit.php?code=f26083>

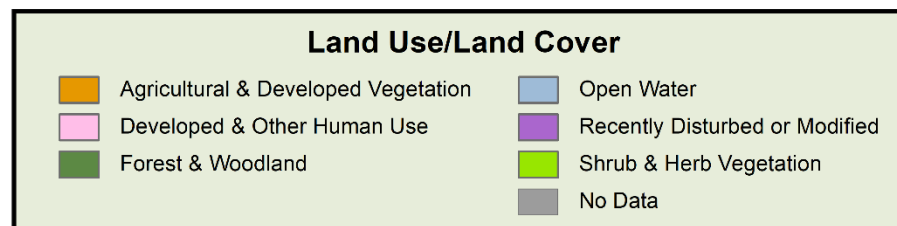
<sup>3</sup> NRCS Soil Survey, [https://www.nrcs.usda.gov/Internet/FSE\\_MANUSCRIPTS/michigan/MI605/0/maps/gsm.pdf](https://www.nrcs.usda.gov/Internet/FSE_MANUSCRIPTS/michigan/MI605/0/maps/gsm.pdf)

**Map 3.2: Land Use/Cover in Keweenaw County**



### Land Use/Land Cover Keweenaw County, Michigan

Boundary data was derived from Michigan's Open Data Portal; Land Use/Land Cover data downloaded from the USGS;  
Created by WUPPDR July 2020



Waterfronts can be dominated by residential development except for where there are environmental constraints which may be contradictory to the need or desire for development. Such factors include critical sand dunes, and high-risk erosion areas. The interior of the County is dominated by privately owned forestland (almost 165,000 acres) interspersed with few residential homes and hunting camps.

Corporate and governmental land ownership has a particularly strong influence and is dominated by two entities, the State of Michigan and GMO Threshold Timber Michigan, LLC. GMO owns an estimated 49% of the county, and the State owns about 13%, not including Isle Royale.

## Population and Demographics

Keweenaw County is comprised of five townships and one incorporated village (**Table 3.1; Map 3.3**). In addition, it has numerous unincorporated small communities where populations remain concentrated. These communities are remnants of much larger settlements founded during the copper mining era. The County's total 2017 population was 2,136.

Since the last hazard mitigation plan update, the county overall has seen a decrease in population. Allouez Township, Eagle Harbor Township, Sherman Township, and Ahmeek Village have seen a slight decrease in population, while Houghton and Grant Townships have seen an increase.

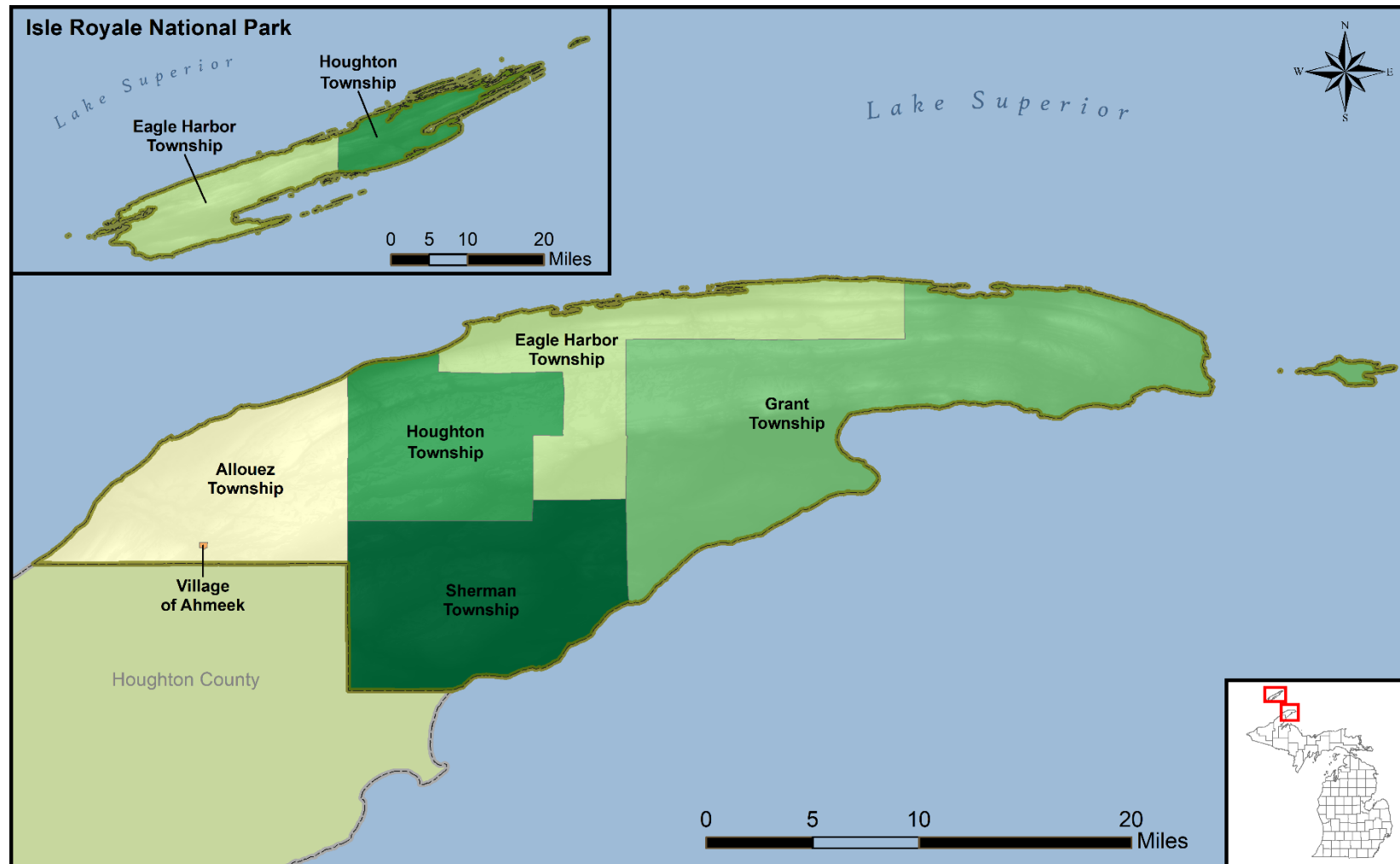
**Table 3.1:** Municipal and Township Populations for Keweenaw County, 1960-2017

Municipality	U.S. Census (Decennial)					American Community Survey (estimates)		
	1960	1990	2000	2010	1960-2010 Change	2010	2017	2010-2017 Change
Allouez Township	1,918	1422	1,584	1,571	-18%	1,560	1,480	-5.1%
Eagle Harbor Township	84	82	281	217	158%	261	260	-0.4%
Grant Township	71	104	172	219	208.5%	122	210	72.1%
Houghton Township	245	54	204	82	-66.5%	90	100	11.1%
Sherman Township	99	39	60	67	-32.3%	89	86	-3.4%
Ahmeek Village	265	148	157	146	-44.9%	181	128	-29.3%

Source: U.S. Census and ACS









**Map 3.3: Local Units of Government in Keweenaw County**



## Local Units of Government Keweenaw County, Michigan

Boundary data was derived from Michigan's Open Data Portal; DEM was derived from elevation data available through the USGS; Created by WUPPDR July 2020

<u>Village</u>		<u>Township</u>	
	Ahmeek		Allouez
	Eagle Harbor		Grant
			Houghton
			Sherman





According to the American Community Survey (ACS) for 2017, the median age for persons in Keweenaw County is 51.6 years. Nearly 24% of the county population is comprised of persons that are 65 years old and over. Poverty rates for persons within Keweenaw County are estimated at 14.5%. People identifying as white constitute 98.5% of Keweenaw County, followed by Black or African American and American Indian and Alaska Native equally at 0.1% each. **Table 3.2** displays the most recent estimates for demographic data on race distribution for Keweenaw County.

**Table 3.2:** Race and Ethnicity Percentages in Keweenaw County, 2017<sup>4</sup>

Race	People	Percent
White	2,123	98.5
Black	3	0.1
American Indian/Alaska Native	3	0.1
Asian	1	0.0
Pacific Islander	0	0
Other Race	1	0.0
Two or More Races	25	1.2
Total Latinx Population ( <i>ethnicity</i> )	15	0.7

## Housing and Infrastructure

In 2017, there were 2,483 housing units in Keweenaw County, a 3.6% increase from 2,397 in 2010. Of these, 1,013 are inhabited, 910 are owner occupied (89.8%) and 103 are renter occupied (10.2%). The average household size for the county is 2.12 persons. Median home values in Keweenaw County in 2017 were \$95,800 for owner-occupied units, a 17.1% increase from \$81,800 in 2010.

### Schools

Schools are some of the largest institutions in the county and could potentially see great impacts from the hazards discussed in this plan. Keweenaw County is within the Copper County Intermediate School District (ISD). **Table 3.3** shows the school districts, grade levels, number of students, and number of instructors at each of the schools that collaborate with Keweenaw County<sup>5</sup>. No institutions of higher education are located within the county.

<sup>4</sup> Data based on the 2013-2017 American Community Survey 5-year Estimates.

<sup>5</sup> MI School Data. Student Enrollment Counts and Staffing Information. [www.mischooldata.org/](http://www.mischooldata.org/)

**Table 3.3:** Schools in Keweenaw County, 2019

School District/School Name	Location	Grades	Students	Instructors
<b>Sherman Township Schools</b>				
Lake Linden-Hubbell Elementary School	Lake Linden	K-6	260	24
Lake Linden-Hubbell Jr./Sr. High School	Lake Linden	7-12	240	21
<b>Public Schools of Calumet, Laurium, and Keweenaw</b>				
Horizons Alternative School	Mohawk	9-12	54	6
CLK Elementary School	Calumet	K-5	668	33
Washington Middle School	Calumet	6-8	349	24
Calumet High School	Calumet	9-12	506	25
<b>Grant Township Schools</b>				
Copper Harbor School	Copper Harbor	K-8	5	1

### Historic and Archaeological Assets

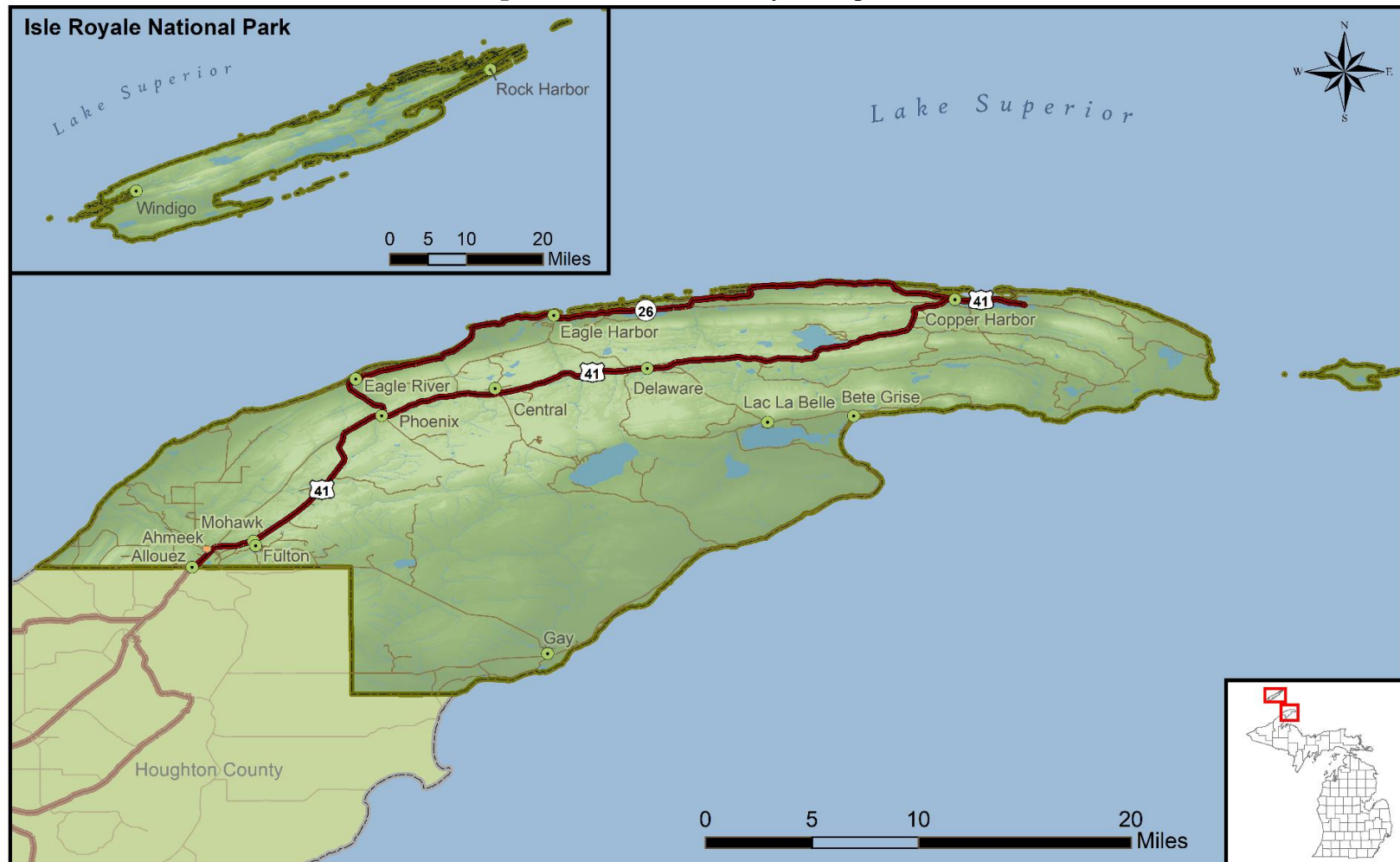
Among the existing towns and acres of forestland in the Keweenaw are numerous historic sites and remnants of once-thriving mining locations. These sites tell the story of the Copper Country's rich history and provide a variety of recreational and educational opportunities to residents and visitors alike. These sites also have economic development potential for the communities. A number of these sites have been recognized by the state and federal government, and others are promoted by the Keweenaw County Historical Society. 19 historic sites have been identified in Keweenaw County as State and/or National Historic Register Sites. At least seven historic sites in Keweenaw County are not currently State or National Registered sites. These historic sites will be delved into deeper detail under Critical Facilities.

### Public Works and Transportation

Keweenaw County has a Road Commission, based in Mohawk, that is responsible for maintaining county, state, and federal roads and highways. The Commission is responsible for county roadways and plows state and federal highways in winter. Most municipalities have public works agencies for maintenance and development of transportation and other infrastructure. Townships also have staff for maintenance of facilities and utilities. All such agencies are resources for implementation of related mitigation actions. Transportation networks are vital to Keweenaw County; not only for local transportation but for encouraging tourism as well as serving industries requiring transportation infrastructure for the shipment of goods.

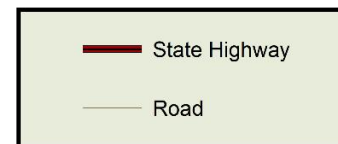
Transportations within Keweenaw County is dependent on public and private road systems (**Map 3.4**). State maintained paved highways in the county, some 60 miles, include Highway U.S. 41 and M-26. U.S. 41 is an interstate highway that begins just outside Copper Harbor and ends in the state of Florida. U.S. 41 extends through the center of the county until it swings north to connect with Copper Harbor. M-26 is a state highway located primarily along the north shore of the peninsula running from Copper Harbor to Eagle River, where it turns inland and joins U.S. 41 at Phoenix.

**Map 3.4: Keweenaw County Transportation**



## Transportation Keweenaw County, Michigan

Boundary data was derived from Michigan's Open Data Portal; DEM was derived from elevation data available through the USGS; Created by WUPPDR July 2020



A secondary road system is the county road network. This system is composed of 102 miles of county primary roads and 72 miles of local roads. The county primary roads connect points such as Mohawk-Fulton to Gay, Gay to Lac LaBelle, and Lac LaBelle to Delaware. The 72 miles of local roads provide access to coastline and inland lakes.

Much of Keweenaw County does not have public road access. These areas are traversed by a network of private roads. These include two types of roads in forest company land ownership: primary haul roads and secondary haul roads. This system of roads, estimated at over 1,000 miles, provides important access throughout much of Keweenaw County. The county also contains many miles of seasonal roads with a number being built and maintained by the U.S. Forest Service. Each incorporated community owns and maintains the local street networks within its limits. Highways in Keweenaw County are maintained by the Michigan Department of Transportation.

### **Portage Lake Lift Bridge**

Located to the south in Houghton County, the Portage Lake and Portage River provided a natural pathway across the Keweenaw Peninsula, dividing it almost in half. In the 1860s the current ship canal, referred to as the Portage Waterway, was completed connecting Lake Superior via Portage Lake on the east and to Lake Superior on the west. Completion of this canal made Keweenaw County an island, rather than a peninsula. In 1875 a bridge was built to connect Houghton and Hancock of Houghton County (located on opposite sides of Portage Lake).

This bridge now spans the waterway and has two levels for traffic. The upper level is for vehicular traffic and the lower level was originally used for trains. Trains no longer run in the Keweenaw, but snowmobiles use the lower level during the winter. The Portage Lake Lift Bridge is a vital link providing the only land entrance to the northern portion of Houghton County and to the entirety of Keweenaw County. A permanent committee has developed, and continues to review and update, a phased response plan to address short, medium, and long-term outages that may occur.

### **Rail**

Although rail service played a critical role in the development and economic growth of the Keweenaw Peninsula, most tracks that connected population centers, mines, and ports have been removed. Today these corridors serve as snowmobile, off-road vehicle, hiking, and biking trails.

### **Ports**

Keweenaw County hosts several sheltered harbors and recreational marinas. To the north, Isle Royale hosts the ports of Rock Harbor and Windigo, providing commercial ferry boat access as well as private docking and landing of seaplanes for tourism in the National Park.

### **Airports**

The closest airport to Keweenaw County is the Houghton County Memorial Airport (CMX) located four miles northeast of Hancock at an elevation of 1,095 feet. The airport, which lacks a control tower, is owned by Houghton County and operates year-round. This airport provides services for roughly 50,000-55,000 passengers each year. The airport maintains two paved runways, with the longest one, 13/31, extending 6501 feet. Only runway 13/31 is open November

1-April 15. Commercial air service nonstop to Chicago-O'Hare is provided by SkyWest Airlines (United Airlines). The airport also offers fuel, parking/hangars, airframe and power plant service, and flight instruction. Aircraft operations average 44 flights per day, with 37% local general aviation, 30% transient general aviation, 19% commercial, 13% air taxi, and less than 1% military. Seasonal air charter services to Isle Royale National Park are offered, and annually 3,000 charter, corporate, and transient aircraft make use of this airport. UPS and FedEx operate cargo shipments with more than 600,000 pounds of freight hauled annually. The next closest airfield is Prickett-Grooms Field Airport (6Y9), located in Baraga County one-mile northeast of Sidnaw at 1,372 feet. The 2,000-foot turf runway is rough and in poor condition, becoming soft when wet. The airport is closed November through April and when snow-covered since the runway is not plowed. The airport has no facilities and provides no services except free parking and camping on the field. It sees an average of 160 operations per year, all of which are transient general aviation.

### **Transit**

There is very limited commercial transit in Keweenaw County. Commercial transportation includes school bus service, occasional tour buses, once-weekly transit service to the community of Mohawk, and commercial boat service to Isle Royale.

The density of Keweenaw County is approximately 4 persons per square mile. Development and economic growth in the area significantly decreased from 1920-1970 but since 1990 has been on an upward trend.

### **Employment and Industry**

In 2017, the median household income for Keweenaw County was \$41,118 and median worker income was \$22,813. The state unemployment rate for 2017 was 4%, and for Keweenaw County the rate was 8.2%. 14.5% of people in Keweenaw County are reportedly below the federal poverty level.

Today, the largest industries in Keweenaw County are Educational Services, Health Care and Social Assistance, followed by Arts, Entertainment, Recreation, Accommodation and Food Services, and then followed by Retail Trade.

The county has also become a popular place for retirees and summer cottages. The growing tourism industry is built around the area's historical resources, interesting geology, and many recreational opportunities. Lake Superior, the numerous inland lakes and streams, abundant forests, the various trail systems, and an annual average of 200 inches of snow make the county a destination for summer and winter outdoor recreation enthusiasts alike. **Table 3.4** provides an overview of employment in Keweenaw County for 2016 by economic sector.

**Table 3.4:** Employment by Sector in Keweenaw County, 2016

Employment Sector	Percentage
Educational Services, Health Care, and Social Assistance	25.1
Arts, Entertainment, Recreation, Accommodation and Food Services	18.0
Retail Trade	12.3
Professional, Scientific, Management, Administrative and Waste Management services	8.2
Public Administration	8.2
Manufacturing	8.1
Finance and Insurance, Real Estate and Rental and Leasing	5.5
Construction	4.1
Other Services, Except Public Administration	3.6
Transportation and Warehousing and Utilities	3.4
Agriculture, Forestry, Fishing and Hunting, Mining	3.2
Wholesale Trade	0.2
Information	0.2

Source: ACS

## Police, Fire, and Emergency Services

Police, fire, and other emergency agencies are vital community resources not only for emergency response but for implementation of mitigation actions.

### Police

Keweenaw County is serviced by both state and local police. The Keweenaw County Sheriff's Department is in Eagle River and has several responsibilities. The office is responsible for maintaining the jail, addressing critical situations, serving the court, answering citizen complaints, investigating accident reports, and conducting road patrols around Keweenaw County's 540 square miles. They also conduct marine patrols with assistance from the MDNR. The County Sheriff's department is the only law enforcement agency located in the county itself. They currently employ five officers.

Michigan State Police District 8, which covers the entire Upper Peninsula, has headquarters in Marquette County. Eighth District Post 87 is located along U.S. 41 in Calumet and covers both Houghton and Keweenaw Counties.

### Fire

There are 6 separate volunteer fire departments that serve Keweenaw County, as shown in **Table 3.5**. Houghton Township contracts with Allouez Township for fire suppression. These are strictly fire departments except for Eagle Harbor, Allouez Township, Sherman Township, Copper Harbor, and Lac Labelle, which also provide Medical First Response. The Sheriff's Department also has First Response. First Response provides first aid until Emergency Medical Technicians arrive.



Firefighters are knowledgeable in several areas through mandatory training, including wildfire and structural fire containment and suppression, hazardous materials incidents, and safety.

**Table 3.5:** Fire Departments in Keweenaw County

Fire Department	Location	Service Area		Staff*
		Sq. Miles	Population	
Ahmeek Village VFD	Ahmeek	6	150	16
Allouez Township VFD	Mohawk	40	1,400	13
Copper Harbor VFD	Copper Harbor	2	120	2
Eagle Harbor Township FD/First Responders	Eagle Harbor	45	150	13
Lac La Belle VFD	Mohawk	64	400	15
Sherman Township VFD	Gay	80	86	8

*\*Staff includes paid and part-time staff and volunteers.*

## Medical

Aspirus Keweenaw Hospital located in Laurium (Houghton County) is the primary health care provider for residents and visitors in Keweenaw County. Aspirus Keweenaw offers surgery, radiology, physical therapy, pediatrics, respiratory therapy, intensive care, coronary care, labor and delivery, laboratory services, and outpatient specialty clinics. The center has 49 beds. They are a collaborator in the Upper Peninsula Health Care Network, which strives to create an integrated healthcare delivery system.

While Aspirus Keweenaw serves all age groups, its population base is largely geriatric, with diseases such as cancer, diabetes, heart disease, and stroke being common concerns as well as arthritis and osteoporosis. The closest tertiary care is through Marquette General Hospital, located over 100 miles away, which provides acute primary care services. To meet the needs of the community, Aspirus offers over 30 patient care services including nuclear medicine, respiratory care, physical therapy, surgery, and obstetrics.

Additional healthcare services are provided by healthcare professionals in the communities of Calumet/Laurium and Houghton/Hancock in Houghton County. Healthcare services available include physicians, surgeons, dentists, orthodontists, optometrists, podiatrists, and physical therapists.

Mercy Ambulance (a service of Marquette General Health System) covers most of Houghton County (except Duncan and Laird Townships) and all of Keweenaw County and helps when needed outside the area. Its advanced life support service employs 22 emergency medical technicians (EMTs) and paramedics — 11 full-time and 11 part-time. The agency operates six ambulances, one non-transporting response vehicle, and a snowmobile and rescue sled.

## Coast Guard

The U.S. Coast Guard patrols the area waterways from its station in Dollar Bay. The station is a small boat station with Aids to Navigation team. Its primary missions are search and rescue, law enforcement, and maintaining local Aids to Navigation (such as buoys, markers, and lighthouses). Their coverage includes the Keweenaw Waterway and Isle Royale.

## Office of Emergency Measures

The Keweenaw County Office of Emergency Measures located in the Houghton County courthouse promotes emergency and disaster education and awareness. The office serves as a dispatcher and ensures interagency coordination before, during, and after disasters or emergencies.

## Siren Coverage

Keweenaw County is serviced by three functional sirens in the County, all near population centers. The sirens are currently used for fire emergencies, not as public warning systems. **Table 3.6** shows the siren locations, range, and estimated population coverage.

**Table 3.6:** Siren Locations in Keweenaw County

VFD/Community	Siren	Remote Activation	Range (radius)(mi)	Est. Population Covered	Location
Allouez Township VFD	Yes	No	2.0	1,400	102 2 <sup>nd</sup> St., Mohawk
Ahmeek VFD	Yes	N/I	N/I	150	Township Hall
Eagle Harbor VFD	Yes	No	2.0	150	Fire Hall

## Critical Facilities and Cultural Assets

Even a slight chance of exposure to hazards, such as flooding, is too great a threat to the delivery of services offered by the maintenance and operation of a community's critical facilities. A critical facility provides services and functions essential to a community, especially during and after a disaster. Examples of critical facilities requiring special consideration include:

- Police stations, fire stations, critical vehicle and equipment storage facilities, and emergency operations centers needed for flood response activities before, during, and after a flood
- Medical facilities, including hospitals, nursing homes, blood banks, and health care facilities (including those storing vital medical records) likely to have occupants who may not be sufficiently mobile to avoid injury or death during a flood
- Schools and day care centers, especially if designated as shelters or evacuation centers
- Power generating stations and other public and private utility facilities vital to maintaining or restoring normal services to flooded areas before, during, and after a flood
- Drinking water and wastewater treatment plants



- Structures or facilities that produce, use, or store highly volatile, flammable, explosive, toxic, and/or water-reactive materials

For a critical facility to function, building systems and equipment must remain operational. Furthermore, it must be supplied with essential utilities (typically power, water, waste disposal, and communications, but occasionally natural gas and steam). The loss of municipal utilities has prevented some critical facilities from functioning during and immediately after major floods, and in some cases, loss of municipal water and waste disposal has prevented facilities from operating for weeks after an event.

In addition, this section has been modified to include cultural assets of importance to Keweenaw County. Tourism is a draw to Keweenaw County, and understanding and inventorying the important and visited locales of the Keweenaw provides a more thorough understanding of assets to the community. This section not only highlights tourism potential and important economic development projects for the future, but also shows the community's rich history, culture, and vitality.

**Table 3.7:** Critical Facilities in Keweenaw County

Facility Name	Location	Age	Est. Costs
<b>Emergency Services</b>			
Ahmeek Fire Department	Ahmeek		
Copper Harbor Fire Department	Copper Harbor		
Eagle Harbor Fire Department	Eagle Harbor		
Allouez Township Fire Department	Mohawk		
Lac La Belle VFD	Mohawk		
Sherman Township VFD	Gay		
Keweenaw County Sheriff's Department	Eagle River		
<b>Equipment Storage Facilities</b>			
<b>Medical Facilities</b>			
<b>Daycare Centers/Schools and Camps</b>			
Copper Harbor School	Copper Harbor		
Horizons Alternative High School	Mohawk		
Gitchee Gumees Bible Camp	Eagle River		
<b>Waste/Utility/Drinking Water/Wastewater Services</b>			
Wastewater Treatment	Copper Harbor		
Water Pumphouse	Eagle Harbor		
Water Treatment	Gay		
Eagle River Dam	Eagle River		
<b>Other Notable/Vulnerable Structures</b>			
Road Commission	Mohawk		
County Courthouse	Eagle River		

Keweenaw Mountain Lodge Complex	Copper Harbor		
Allouez Township Hall	Mohawk		
Keweenaw County Board of Commissioners	Mohawk		
Secretary of State Office	Mohawk		

### **Cultural Assets – Historic and Archaeological Sites**

As previously mentioned, amongst the existing communities and forestland in the Keweenaw are many historic sites and remnants of rich mining history. These sites tell the story of the Copper Country's rich history and provide a variety of recreational, educational, and economic opportunities to residents and visitors alike. According to the Keweenaw Historical Society, the following sites are listed as state and/or national historic places:

- Central Mine - in the summer of 1854, John Swanson, an agent for the Cliff Mine, discovered heavy masses of native copper in the bottom of an ancient pit. Located several miles from the Cliff Mine, the pit had apparently been dug by prehistoric Indian miners. On November 15, 1854, the Central Mining Company was organized. The mine produced large quantities of copper, and until the 1890s, when the Kearsarge lode was discovered 15 miles away, it was the largest and most profitable mine in the area. The town of Central soon grew up around the mine, and the population reached about 1,200 at its peak. By July of 1898, the ore had been depleted, the mine closed, and the town was soon abandoned. By 1905 the population had dropped to 100. State Registered Historic Site.



*Central Mine Historic District, August 15, 2009, photo by Andrew Jameson*

- Central Mine Historic District - an example of a former copper mining community, the district includes 20 of the original 130 structures. The Central Mine and the Central Mine Methodist Church are highlights of the district. State and National Registered Historic Site.

- Central Mine Methodist Church – the church was once the civic center of the mining company town. At its peak membership, the church numbered over 300. Designed after religious architecture in Cornwell, England, it was a sanctuary for homesick miners. Descendants continue to hold annual services at the location. State and National Registered Historic Site.



Official sign to Copper Harbor Cemetery, October 16, 2012, photo by Amanda Wais

- Copper Harbor Cemetery – One of the oldest cemeteries on the Keweenaw Peninsula, this is the final resting place of Copper Harbor's pioneer residents. The first burial was in 1853, and burials are still being conducted at the cemetery. State Registered Historic Site.
- Copper Harbor Lighthouse – Established in 1848, the Copper Harbor Light Station served as an entrance beacon to Copper Harbor. It includes a restored 1848 lightkeeper's dwelling, 1866 lighthouse, 1933 steel light tower and interpretive trails. The complex can be reached by boat. State Registered Historic Site.
- Eagle Harbor House – erected as one of the first four structures in Eagle Harbor, the Eagle Harbor House is the only one of these first structures that remains. Constructed on behalf of the Eagle Harbor Mining Company, probably to provide suitable housing for visiting officials, the building became a destination for summer travelers and visitors to the area.
- Eagle Harbor Light Station – In the mid-19th century when roads in the area were almost non-existent, the community of Eagle Harbor was a center for waterborne commerce, including incoming settlers and supplies and outgoing copper and logs. In 1851 the original lighthouse was commissioned to guide ships into and past the harbor. The original structure was replaced in 1871. In 1982 the Keweenaw County Historical Society became the 22nd "keeper of the light," and it now serves as an interpretive site along with three other museums and maritime museum. The Society became owner of the buildings and property in 1999. National Registered Site.
- Eagle Harbor Schoolhouse (Rathbone School) – This one-room school has had an unusual career since classes were dismissed in 1872. Justus H. Rathbone who began teaching there in 1860 conceived the idea in the building for the Knights of Pythias, a secret fraternal organization which he founded in Washington D.C. in 1864. The Pythians dedicated themselves to the principles of "friendship, charity, and benevolence." In 1982 the property



Eagle Harbor Light



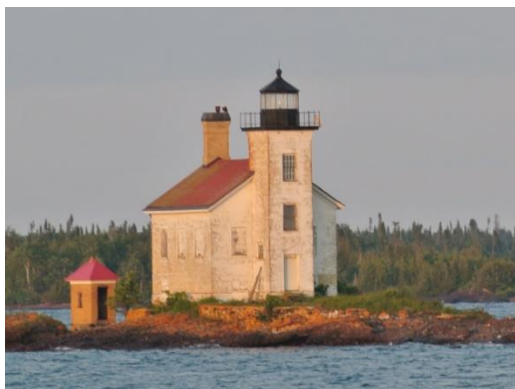
was deeded to the Keweenaw Historical Society who restored and converted it to an interpretive site. State and National Registered Historic Site.

- Eagle River Cemetery (Evergreen Cemetery) – One of the oldest cemeteries in the Keweenaw, already in use when the town of Eagle River was platted in 1855. State Registered Historic Site. Eagle River Historic District – This district contains structures that date mostly from the mid-19th to early 20th century and are associated with Eagle River's early growth as a mining port and seat of County government. Eagle River is one of the oldest Euro-American settlements in the Keweenaw Peninsula. Four somewhat distinct areas representative of the town's functions: buildings along East Main Street date to the 1840's and 50's and are typically simple structures (hotels, stores, saloons and residences); the areas along West Lane, developed after 1967, is primarily residential and non-uniform in appearance; the public and county square built in Georgian Revival Style; and an area with the remnants of early industrial enterprises. National Registered Historic Site.
- Eagle River Upper Bridge – Commonly known as the M-26 Bridge, the structure was erected in the heart of Eagle River in 1915 by the Wisconsin Bridge and Iron Company. The eighteen-foot-wide bridge consists of a 105-foot main span and two flanking spans 34 feet to the deck, for a total length of one hundred and thirty-nine feet. The bridge was converted for non-motorized traffic in 1990 when the adjacent timber bridge opened. State Registered Site.
- Fort Wilkins Historic Complex – This once-active U.S. Army post was built in 1844 (and abandoned two years later) to keep the peace in Michigan's booming Copper Country. Briefly regarrisoned in the 1860's, it now serves as a well-preserved example of mid-19th century army life on the northern frontier. The site is now part of the Fort Wilkins State Park and includes 19 restored buildings, costumed interpreters, copper mining sites, camping, and picnicking. State and National Registered Historic Site.



Eagle River Bridge (Source: [Richie Diesterheft](#))

- Gull Rock Light Station – located 0.5 miles west of Manitou Island in Grant Township, the station consists of an attached keeper's dwelling and light tower. Gull Rock was a threat to ships attempting to pass between the tip of the Keweenaw and Manitou Island and the station was put into service in 1867. National Registered Site.



Gull Rock Light Station (Source: [Otis-n](#))

- Holy Redeemer Church – Built in 1854, it is the oldest surviving church of the Roman Catholic diocese in northern Michigan. The bustling port of Eagle Harbor provided high attendance during the copper and shipping days of the 19th century. The church was renovated by diocese members and is now used for regular services during the summer months. State and National Registered Historic Site.
- Keweenaw County Courthouse Complex – The Keweenaw County Courthouse, sheriff's residence, jail, and carriage house are in Eagle River and continue to serve as the seat of County government. The courthouse was built in 1866. Prior to construction meetings were held at the Lake Superior Company's property, and the attic of a local residence was used as the jail. State Registered Historic Site.

- Keweenaw Mountain Lodge Complex – Located on 177 acres and consisting of a lodge/clubhouse and park grounds containing 23 cabins; tennis, shuffleboard and horseshoe courts; golf course and pro shop, the complex was built as part of the Federal Civil Works Administration. It opened in 1935 and features rustic log architecture appropriate to its wilderness setting. The project was significant as a planned effort to protect the environment while maximizing recreation possibilities. State and National Registered Site.



Keweenaw Mountain Lodge near Copper Harbor, MI  
(Source: [Andrew Jameson](#))

- Manitou Island Light Station – consisting of the oldest iron skeletal light tower on the Great Lakes (along with Whitefish Point), the station includes a two-story keeper's dwelling. Originally built in 1850 the structure was replaced with the iron tower in 1861. National Registered Historic Site.

- Sand Hills Light Station – Centered on a 47-acre wood site outside Eagle River, the station consists of five historic buildings, a breakwater and one contemporary pole barn. The light was the last traditionally attended light and is unique due to its functional design that has not been used at any other site on the Great Lakes or elsewhere in the United States. National Registered Historic Site.

Additionally, The Keweenaw County Historic Society has many more sites considered significant that display the Copper Country Heritage including:

- Phoenix Church – Built in 1858 to serve the Catholic residents of the community of Cliff, services continued until 1899 when it was dismantled and reassembled in Phoenix, where it was renamed 'The Church of Assumption.' The Society took over the property in 1985 and began extensive repair and restoration work. The church, now deconsecrated, is used for weddings and memorial services.
- Bammert Blacksmith Shop – Formed in 1882 at the Cliff, the building was moved in 1901 to its current location. The shop was reopened as an interpretive site in spring of 2000 displaying original blacksmith tools.
- Eagle Harbor Cemetery – also known as Pine Grove Cemetery and founded in 1859, indicates burials as early as 1850. Approximately 5 acres of property was given by the Eagle Harbor Mining Company to the Township of Eagle Harbor for the community cemetery.
- Mandan (Ghost Town) – Located off U.S. 41 south of Copper Harbor, this town had a population of 300 in 1910.
- Douglas Houghton Memorial – Located in Eagle River. This memorial recognizes the first State geologist. Houghton drowned in a boating accident off Eagle River.
- Mendota Lighthouse – This is a privately owned and operational, now-private residence; on Mendota Point at Bete Grise.



*Church of the Assumption (Phoenix Church) (Source: [Andrew Jameson](#))*

- *Estivant Pines* – Located outside Copper Harbor, this is the last stand of privately-owned virgin white pine in Michigan. The sanctuary features unique rock outcroppings, steep hillsides, and cliffs.
- *The Delaware Copper Mine* – One of the earliest copper mines in the area, having operated from 1847 until 1887, produced 8 million pounds of copper. Opened in 1977 and preserved as it was when it closed its doors in 1877, the Delaware Copper Mine Tour is one of the area's longest-established tourist attractions.



*White pines at Estivant Pines.*

Keweenaw County is also dotted with locations of prehistoric mining activities. To protect prehistoric archaeological sites and artifacts from exploitation, they are not specifically identified on this plan but should be recognized, researched, and considered when decisions are made within the County. Additionally, it should be noted that there are extensive trails, camping opportunities, and water-based tourist activity year-round that make Keweenaw county a popular attraction.

## Disaster Declarations

Since 1965, Keweenaw County has experienced a total of five presidential disaster declarations, shown in **Table 3.8**. three new disaster occurred since the completion of the 2013 plan. The county has also experienced additional emergencies and disasters that were not severe enough to require federal disaster relief through a presidential declaration.

**Table 3.8: Presidential Disaster Declarations for Keweenaw County, 1965-2020**

Event	Declaration Date	Declaration Number
Blizzards and Snowstorms	January 27, 1978	3057
Hurricane Katrina Evacuation*	September 7, 2005	3225
Flooding	June 18, 2013	4121
COVID-19	March 13, 2020	3455
COVID-19 Pandemic	March 27, 2020	4494

\*This declaration applied to all 83 counties in Michigan for Emergency Protective Measures only (to aid in direct relief efforts for Hurricane Katrina evacuees).

Source: Federal Emergency Management Agency



## SECTION 4: Hazard Identification

The United States and its communities are vulnerable to a wide array of hazards that threaten life and property. Upon review of the natural hazards suggested under FEMA planning guidance and the State of Michigan's Hazard Mitigation Plan, Keweenaw County has identified twenty-five (25) hazards that are addressed in this Plan. Following the State of Michigan's listed hazards, the 2020 Update features two new hazards (Fog and Invasive Species). The plan has also been reorganized so that the most closely related hazards are located near each other in the same section of the plan. The hazard analysis component of this plan now includes three major divisions that correspond to three major hazard classifications: Natural, Technological, and Human-Related Hazards. Each of these three major sections have been further organized so that readers and responders can more easily find information about hazards that are closely related. The three major hazard divisions and subsections addressed in this plan include:

- **Natural Hazards**

- **Weather Hazards**

- Extreme Temperatures
- Fog
- Hail
- Ice and Sleet Storms
- Lightning
- Severe Winds
- Snowstorms and Blizzards
- Tornadoes

- **Hydrologic Hazards**

- Flood Hazards
  - Dam Failure
  - Riverine and Urban Flooding
  - Shoreline Flooding and Erosion
- Drought

- **Ecological Hazards**

- Invasive Species
- Wildfires

- **Geologic Hazards**

- Earthquakes
- Subsidence (Ground Collapse)

- **Technological Hazards**

- **Industrial Hazards**

- Scrap Tire Fires
- Structural Fires
- Hazardous Materials: Fixed Site Incidents
- Hazardous Materials: Transportation Incidents

### 44 CFR Requirement

**201.6(c)(2)(i):** The risk assessment shall include a description of the type, location, and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.



- Petroleum and Natural Gas Incidents
- **Infrastructure Hazards**
  - Infrastructure Failure and Secondary Technological Hazards
  - Transportation Accidents
- **Human-Related Hazards**
  - Civil Disturbances
  - Public Health Emergencies
  - Sabotage and Terrorism

Some of these hazards are interrelated (i.e., snowstorms can consist of ice and sleet storms) and some consist of hazardous elements that are not listed separately (i.e., extreme hot temperatures can lead to drought conditions). It should be noted that some hazards, such as snowstorms and blizzards, may impact a large area yet cause little damage, while other hazards, such as a tornado, may impact a small area yet cause extensive damage. **Table 4.1** provides a brief description of the hazards listed above.

**Table 4.1:** Descriptions of Identified Hazards

Hazard	Description
<b>NATURAL HAZARDS</b>	
<b>WEATHER</b>	
<b>Extreme Temperatures</b>	Prolonged periods of very low or very high temperatures, often exacerbated by conditions such as high humidity with lack of rain or heavy snowfalls with high winds. Extreme cold is classified as any period of low temperatures or wind chill of -35°F or colder. Extreme heat is characterized by a combination of very high temperatures and humid conditions. Temperatures and the heat index values meet or exceed 90°F.
<b>Fog</b>	Condensed water vapor in cloudlike masses lying close to the ground and limiting visibility. Fog itself is not a hazard, but it is the interaction between humans and fog that can be a dangerous situation. However, freezing fog can cause direct harm by causing slickness on roadways and serious transportation accidents.
<b>Hail</b>	Hail is a type of precipitation that is formed when updrafts in thunderstorms carry raindrops upwards to parts of the atmosphere where temperatures are below freezing. The water freezes and can form ice pellets that can range from pea sized to as large as grapefruits.
<b>Ice and Sleet Storms</b>	Ice storms (freezing rain) are the result of cold rain that freezes upon contact with a cold surface and results in accumulation of at least 0.25” of ice on exposed surfaces. Sleet is small ice pellets that fall from the sky and bounce when hitting the ground or other surfaces.

<b>Lightning</b>	The random and unpredictable discharge of electrical energy resulting from the buildup of positive and negative charges within a thunderstorm. It creates a “bolt” when charge buildup is strong enough.
<b>Severe Winds</b>	Sustained non-tornadic, forceful winds of 58-mph or greater for any duration of time. Includes thunderstorm winds which can cause similar damage as high winds. Also known as straight line winds.
<b>Snowstorms and Blizzards</b>	A snowstorm is a period of rapid accumulating snow accompanied by high winds, low visibility, and cold temperatures. This includes lake-effect and heavy snowfall. It can also consist of a “wintry mix” of snow, sleet, ice, and freezing rain. Blizzards are the most dangerous of all winter storms. It combines low temperatures and heavy snow with winds of at least 35-mph. This reduces visibility to only a few yards.
<b>Tornadoes</b>	A tornado is a violently rotating column of air that extends from the base of a thunderstorm and has contact with the ground. It is hard to see unless it forms a condensation funnel made up of water droplets, dust, and debris. The funnel may have winds that range from 40 to 300-mph and interior air pressure that is 10 to 20 percent below that of the surrounding atmosphere.
<b>GEOLOGIC</b>	
<b>Earthquakes</b>	Shaking or trembling of the Earth’s crust caused by the breaking and shifting of rock beneath the surface. Also caused by an abrupt release of slowly accumulating strain resulting in ground shaking, surface faulting or ground failures.
<b>Subsidence (Ground Collapse)</b>	Ground settling or sudden sinking due to subsurface movement of earth materials. Depressions, cracks, and sinkholes in the ground surface that can threaten people and property. The greatest risk of subsidence in Michigan is associated with underground mining or improper stabilization of mine openings.
<b>HYDROLOGIC</b>	
<b>Dam Failure</b>	The collapse, breach, or other failure of a dam structure resulting in downstream flooding. Dam failure can result in severe property damage and loss of life.
<b>Riverine and Urban Flooding</b>	Overflowing of rivers, streams, drains, and lakes due to excessive rainfall, rapid snowmelt, or ice. Floodplains, the lands that are adjacent to rivers, streams, and lakes, are becoming more highly developed, increasing the potential for serious flooding. Urban flooding is due to the combination of excessive rainfall and/or snowmelt, saturated ground, and inadequate drainage. It usually involves low-lying areas

	that collect runoff waters even though they are not adjacent to drains or bodies of water.
<b>Shoreline Flooding and Erosion</b>	While shoreline flooding and erosion are natural processes along Lake Superior, during periods of high water, flooding and erosion are more frequent. Strong, onshore winds can also cause shoreline flooding and erosion due to vertical rise of water above normal level and increased wave action.
<b>Drought</b>	A drought occurs when there has been a prolonged period of well-below average precipitation. Common effects of drought include crop failure, water supply shortages, and fish/wildlife mortality. Drought conditions can be worsened by high temperature, winds, and low humidity.
<b>ECOLOGICAL</b>	
<b>Invasive Species</b>	A species that has been introduced by human action to a location where it did not previously occur natural. It can establish a breeding population in its new location without further intervention by humans and becomes a pest by threatening local biodiversity. It can also cause human health impacts, significant economic costs, and/or harmful ecological effects. Species can include animals, plants, and other organisms (e.g., microbes).
<b>Wildfires</b>	An uncontrolled fire in grass, brush, or forested areas.
<b>TECHNOLOGICAL HAZARDS</b>	
<b>INDUSTRIAL</b>	
<b>Scrap Tire Fires</b>	A large, uncontrolled fire that burns scrap tires that are being stored for recycling or reuse.
<b>Structural Fires</b>	Any instance of uncontrolled burning resulting in structural damage to residential, commercial, industrial, institutional, or other properties in developed areas.
<b>Hazardous Materials: Fixed Site Incidents</b>	An uncontrolled release of hazardous materials from a <b>stationary location</b> that can pose a risk to health, safety, property, and the environment. This is a particular risk for locations that store or have higher quantities of hazardous materials. This includes industrial businesses, agriculture, universities, and hospitals.
<b>Hazardous Materials: Transportation Incidents</b>	An uncontrolled release of hazardous materials during <b>transport</b> that can pose a risk to health, safety, property, or the environment. Hazardous materials are transported over highway, railway, seaway, airway, and pipeline systems.

<b>Petroleum and Natural Gas Incidents</b>	The uncontrolled release of petroleum, natural gas, or hydrogen sulfide, a poisonous by-product.
<b>INFRASTRUCTURE</b>	
<b>Infrastructure Failure and Secondary Technological Hazards</b>	Infrastructure failure is a failure of critical public or private transportation or utility infrastructure resulting in temporary loss of essential functions and/or services. This includes electric power, water, storm drainage, communications and transportation. If infrastructure failure results from a natural hazards event, it is termed a <b>secondary</b> or <b>cascading technological hazard</b> .
<b>Transportation Accidents</b>	A crash or accident involving air, land, or water-based commercial passenger carrier resulting in death or serious injuries.
<b>HUMAN-RELATED HAZARDS</b>	
<b>Civil Disturbances</b>	A public demonstration or gathering, or an uprising in a prison or other institution that results in some disruption of essential community function. Includes rioting, looting, arson, or other unlawful behavior. May be the result of labor disputes, controversial judicial proceedings, resource shortages, or perceived unjust injury or death of a person held in high regard.
<b>Public Health Emergencies</b>	A situation that presents a danger or negatively impacts the general health and wellbeing of the public. Examples include disease epidemics, water contamination, harmful exposure to chemical, radiological, or biological agents, or infestation of disease carrying insects or rodents. May also be considered a secondary event caused by other emergencies (e.g., floods).
<b>Sabotage and Terrorism</b>	An intentional, unlawful use of force or violence against persons or property to intimidate or coerce the government, civilian population, or any segment for political, social, or religious objectives.

**Data sources:**

Dillion, G.K. (2018). Wildfire Hazard Potential (WHP) for the conterminous United State (270-m GRID). USDA Forest Service, Fire Modeling Institute: <https://www.firelab.org/project/wildfire-hazard-potential>

Michigan GIS Open Data (map boundary data): <http://gis-michigan.opendata.arcgis.com/>

Michigan Hazard Mitigation Plan, Emergency Management and Homeland Security Division, Michigan Department of State Police: [www.michigan.gov/documents/msp/MHMP\\_480451\\_7.pdf](http://www.michigan.gov/documents/msp/MHMP_480451_7.pdf)

Mineral Resources Data System, USGS: <https://mrdata.usgs.gov/mrds/>

National Climatic Data Center (NCDC), National Oceanic and Atmospheric Administration (NOAA), U.S. Department of Commerce: [www.ncdc.noaa.gov](http://www.ncdc.noaa.gov)

National Centers for Environmental Information Storm Events Database, NOAA, U.S. Department of Commerce: [www.ncdc.noaa.gov/stormevents](http://www.ncdc.noaa.gov/stormevents)

National Geospatial Program, U.S. Geological Survey (DEM and Land Use/Land Cover data): <https://viewer.nationalmap.gov/basic>

National Mine Repository, Office of Surface Mining Reclamation and Enforcement, U.S. Department of Interior: <https://mmr.osmre.gov/>

National Pipeline Mapping System (NPMS) Public Viewer, Pipeline and Hazardous Materials Safety Administration: <https://pvnpm.phmsa.dot.gov/PublicViewer/>

National Weather Service (NWS), NOAA, U.S. Department of Commerce: [www.nws.noaa.gov](http://www.nws.noaa.gov)

NWS GIS Portal, NWS, NOAA, U.S. Department of Commerce: [www.weather.gov/gis](http://www.weather.gov/gis)

Storms Events Database, National Centers for Environmental Information (NCEI), NOAA, U.S. Department of Commerce: [www.ncdc.noaa.gov/stormevents](http://www.ncdc.noaa.gov/stormevents)

## SECTION 5: Hazard Analysis

This section of the Plan describes the hazards identified by Keweenaw County to pose a threat to people and the property located within the county and its participating jurisdictions. Further, an assessment of risk has been developed which includes hazard descriptions and background, climate change considerations, notable historical occurrences<sup>6</sup>, and the probability of occurrences for each hazard. Information has also been included regarding local jurisdictions or critical facilities where the hazard vulnerability is higher than that of the county. Readily available online information from reputable sources such as Federal and State agencies were also evaluated to supplement information from these key sources. Once the hazards have been analyzed, conclusions on hazard risk are presented. This includes the extent of each hazard as it pertains to Keweenaw County and the priority risk index which assigns a risk level to each hazard in the county. The hazards listed in Section 4 were identified and analyzed.

### Study Area

To a large extent, historical records are used to identify the level of risk within the planning area – with the methodological assumption that the data sources cited are reliable and accurate. This section also provides a series of maps that illustrate the location and spatial extent for those hazards within Keweenaw County and its participating jurisdictions that have a recognizable geographic boundary (i.e., hazards that are known to occur in certain areas of Keweenaw County, such as the 100- and 500-year floodplains, shoreline erosion areas, etc.). For those hazards not confined to a specific geographic area, such as thunderstorms and tornadoes, general information on the applicable intensity of these events across the entire planning area is provided.

### Natural Hazards: Weather Hazards

The following outline summarizes the significant weather hazards covered in this section:

1. Extreme Temperatures
2. Fog
3. Hail
4. Ice and Sleet Storms
5. Lightning
6. Severe Winds
7. Snowstorms and Blizzards
8. Tornadoes

Weather hazards are perhaps the single greatest natural hazard anywhere in the world due to climate change. Climate change is a significant variation in either the mean state of climate or in its variability, persisting for an extended period. Most authorities predict rising temperatures in all

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<sup>6</sup> Historical occurrences for hazards were sourced from NOAA's Storm Events Database, unless indicated otherwise.

areas, with warm temperatures coming from the equator and pushing various flora and fauna norther in the Northern Hemisphere. Along with these temperatures come overall changing weather patterns, causing events such as more frequent and severe winters that fluctuate towards either extreme, warm with light snowfall or cold with heavy snowfall.

In Keweenaw County, weather hazards already vary greatly by season and from year to year. In winter, Keweenaw County has a reputation for heavy and frequent snowfalls, especially throughout interior parts of the county. Residents are acclimated to severe winter weather. However, transportation is a hazard and is discouraged during severe winter weather events. Collapsing roofs are another of the primary winter hazards and are dependent on the age of buildings and building codes. When it is not winter, thunderstorms, hail, high winds, and extreme temperatures are more variable and less location dependent. Due to the variability and inability to control these types of storm events response plans are the best mitigation.

For the weather hazards and, particularly, in Keweenaw County, it may make sense to think in terms of two parts of the year: winter and non-winter. A general distinction can be made between the “winter weather risk season” and the “non-winter weather risk season.” The winter weather risk season is defined in terms of historically documented events involving extreme cold and significant snowstorms.

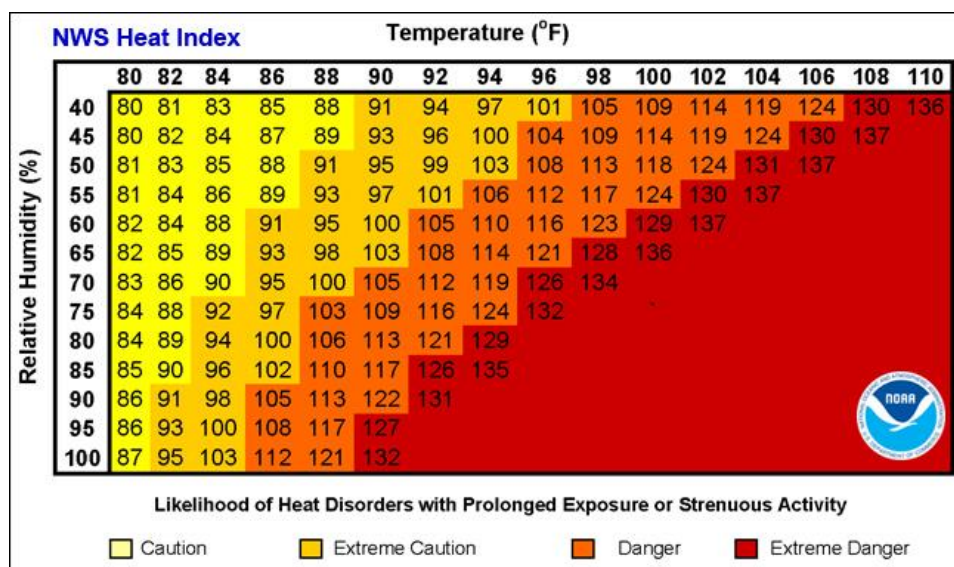
## Extreme Temperatures

### Hazard Description

Temperature extremes are broken down into two categories: extreme heat or extreme cold. In both instances there are extended periods of either abnormally low or high temperatures worsened by conditions such as high humidity with lack of rain or heavy snowfalls with high winds. Both extremes can last for weeks without any advance warning and in the middle of a seemingly normal weather pattern. Extreme heat and extreme cold can cause loss of life to vulnerable population (e.g., elderly, young children, impoverished individuals, and those in poor health), damage to infrastructure, and disruptions to schools and businesses.

Extreme heat or a “heat wave” occurs mainly during late May to early September in the Upper Peninsula and is marked by temperatures above 90°F. Individuals working outdoors, the elderly, and children need to be accounted for during oppressively hot conditions. Extreme hot temperatures also put a strain on the energy demands for an area, as air conditioning becomes a necessity for vulnerable populations. The National Weather Service devised the Heat Index as a mechanism to better inform the public of heat dangers, The Heat Index Chart (Error! Reference source not found.) uses air temperature and humidity to determine the heat index or apparent temperature. The major threats of extreme heat are heat exhaustion and heatstroke (a major medical emergency). **Table 5.1** shows the dangers associated with different heat index temperatures.



**Figure 5.1:** NOAA's National Weather Heat Index Chart**Table 5.1:** Heat Index and Related Heat Disorders

Heat Index (°F)	Possible Heat Disorders
80°F - 90°F	Possible fatigue with prolonged exposure and/or physical activity
90°F - 105°F	Heat exhaustion, heat cramps, and heat stroke possible with prolonged exposure and/or physical activity
105°F -130°F	Heat exhaustion and heat cramps likely; heat stroke possible with prolonged exposure and/or physical activity.
130°F or higher	Heat stroke exceedingly likely with continued exposure

Source: NOAA – National Weather Service

Extreme cold is primarily associated with the wintery months of late September through May in the Upper Peninsula and categorized by temperatures plunging near or below 0°F. Periods of extreme cold are risky for those in both rural and urban areas. An extreme cold event to the NWS can refer to a single day of extreme or record-breaking sub-zero temperatures. Extended or single day extreme cold temperatures can be hazardous to people and animals, and cause problems with buildings infrastructure and transportation. **Table 5.2** lists the threats associated with extreme cold, such as hypothermia, which is a medical emergency and is a concern for individuals living in inadequately insulated or heated apartments or rooms. Loss of life can occur with this situation. Damage to buildings and pipelines can also occur in bitter cold conditions, resulting in expensive repairs and potential days of business and school shutdowns.

**Table 5.2:** Cold Disorders Associated with Extreme Cold Temperatures

<b>Cold Hazard</b>	<b>Definition</b>
Wind Chill	Temperature based upon how wind and cold feel on exposed skin. As wind increases, it draws heat from the body, which drives down skin temperature and internal body temperature. Animals are also affected by wind chill.
Frostbite	Damage to body tissue when exposed to cold temperatures for a long period of time. A wind chill of -20°F will cause frostbite in 30 minutes. Frostbite is most susceptible to fingers, toes, ear lobes, and the tip of the nose. Signs of frostbite include loss of feeling and a white or pale appearance.
Hypothermia	A condition that occurs when body temperature falls below 95°F and, if not properly treated, can result in death. Warning signs include uncontrollable shivering, memory loss, disorientation, slurred speech, drowsiness, and exhaustion. Most commonly occurs in very cold temperatures, but it can also occur at cool temperatures (above 40°F) if an individual is not properly clothed.

### Climate Change Considerations

Certain indicators of climate change in Michigan and Keweenaw County have already been observed. In Michigan, new heat records outnumbered new cold records by 3 to 1 during the 1990s and 6 to 1 in the 2000s. Frequency of extreme heat events are expected to increase in the future. Although Michigan's winter season has been shortening, there have been lessened differences in temperature between polar and temperate regions (due to warming of the arctic and polar regions) can make it easier for a polar weather front to swing southward across the United States. Instances of persistently cold temperatures, ice storms, freezing rain, and heavy snowstorms are affecting the state with increasing rapidity.

### Historical Occurrences

Extreme temperatures typically cover a large area and cannot be confined to any geographic or political boundaries. All areas of Keweenaw County are subject to extreme temperatures. From 1996 to 2019, three extreme cold events were reported in the county (one in 2007; two in 2014). Nine wind chill events were also reported. The coldest temperature recorded was from January 27-28, 2014. Wind chill values fell between 35 to 45 degrees Fahrenheit below 0. Schools were closed during the same period due to the extreme cold. One heat event was reported on July 31, 2006. Temperatures in the 90s, combined with dewpoints in the low to mid-70s resulted in heat indices in the 100 to 105-degree Fahrenheit range on the afternoon of the 31<sup>st</sup>. For all events, Keweenaw County incurred no recorded damages.

### Occurrence Probability and County Vulnerability

The probability of an extreme temperature event is likely as it can occur anytime during the year. In the last ten years, there are been eight extreme cold/wind chill events in the county (two were extreme; six were wind chill) – a frequency of 0.8 events per year. While there is a likelihood that

these events will occur any given time during the year, severity is low countywide as resident behaviors are effective in limiting damage to life and property.

All Keweenaw County communities are vulnerable to both extreme heat and cold events. Vulnerability to extreme heat primarily impacts the elderly and persons with pre-existing health problems who live in housing with inadequate ventilation or cooling systems. Extreme heat can also increase the demand on electric utilities and may cause power outages to critical facilities. Critical facilities vulnerable to the extreme cold include sewage and water services, such as the Eagle Harbor Water Pumphouse and Gay Water Treatment Facility. If water mains were to freeze or break, these facilities would be unable to provide water to residents.

## **Fog**

### **Hazard Description**

Fog forms near the ground when water vapor condenses into tiny liquid 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 itself is not a hazard because it does not actually apply destructive forces, but the interaction between humans and fog can be a dangerous situation, sometimes resulting in disastrous consequences. However, freezing fog (a hazard that the National Weather Service does issue special statements for) can cause direct harm by causing slickness on roadways and thus leading to serious transportation accidents.

Fog has played a contributing role in several multi-vehicle accidents throughout Michigan over the past several years. It can be very dangerous because it reduces visibility. Although some forms of transport can penetrate fog using radar, road vehicles must travel slowly and use more lights. Localized fog is especially dangerous because it catches drivers by surprise.

### **Historical Occurrences**

Five dense fog events occurred in Keweenaw County from 1996-2019. There were no reported incidences of freezing fog. While no property damages or injuries were reported as a result from these events, the low visibility was attributed to longer commute times in the area. Fog is especially prevalent on the Lake Superior shoreline and is dependent on the right conditions.

### **Occurrence Probability and County Vulnerability**

While only five fog events were reported, only two were in the past 10 years (frequency of 0.2 events per year). However, fog is a common occurrence in Keweenaw County. It does typically dissipate by mid-morning. Fog and hazards associated with fog is assumed to uniformly impact the county. Only when fog and humans interact on transportation corridors, people and critical facilities become vulnerable to fog.

## Hail

### Hazard Description

Hail is produced by thunderstorms when strong updrafts among the clouds carry water droplets above the freezing level and cause the formation of ice pellets around some nucleus, such as a water crystal or a speck of dust. Frozen droplets gradually accumulate on the ice crystals until having developed enough weight and they fall in the form of a ball or irregularly shaped ice masses greater than 0.75 inches in diameter. Falling hailstones batter crops, home roofs, dent autos, and injure wildlife and people. Approximately \$1 billion in damages occur annually across the United States. In Michigan, there is usually at least one intense hailstorm per year that causes significant damages. Unfortunately, for many hailstorms, the total property damages go unreported.

As a product of strong thunderstorms, the size of hail is usually proportional to the intensity of the storm cell that generates it. As a thunderstorm 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. Whether in predictable locations or not, instances of hail can be very localized – to an area as small as a few city blocks.

Hail reported in Michigan range in size from a pea ( $\frac{1}{4}$ " diameter) to a golf ball ( $1\frac{3}{4}$ " diameter), but hailstones larger than baseball ( $2\frac{3}{4}$ " diameter) have occurred with the most severe thunderstorms. **Table 5.3** provides official classifications of hail magnitude as often used in weather reporting and event records.

**Table 5.3: Hail Size Reference**

Descriptive Size of Hail	Size in Diameter (inches)	Descriptive Size of Hail	Size in Diameter (inches)
Pea	$\frac{1}{4}$ "	Golf ball	$1\frac{3}{4}$ "
Marble or mothball	$\frac{1}{2}$ "	Hen's egg	2"
Penny or Dime	$\frac{3}{4}$ "	Tennis ball	$2\frac{1}{2}$ "
Nickel	0.9"	Baseball	$2\frac{3}{4}$ "
Quarter	1"	Teacup	3"
Half-dollar	$1\frac{1}{4}$ "	Softball	4"
Walnut/Ping-pong ball	$1\frac{1}{2}$ "		

### Climate Change Considerations

Climate change increases the occurrence of the more extreme and severe thunderstorms that often accompany hailstorms.<sup>7</sup> This means that, although North America may experience fewer

<sup>7</sup> Brimelow, J. C., Burrows, W. R., & Hanesiak, J. M. (2017). The changing hail threat over North America in response to anthropogenic climate change. *Nature Climate Change*, 7(7), 516-522.

rainstorms overall, the storms that do occur are those that are more likely to come with larger hailstones that can be dangerous and damaging to plants, animals, crops, and property.<sup>8</sup>

### Historical Occurrences

A hail event may occur anywhere throughout the county and is not confined to any geographic boundaries. Hail events are typically widespread because they often accompany thunderstorms. From 1955 to 2019, 7 hail events were recorded in Keweenaw County (**Table 5.4; Map 5.1**); 2 occurred in the last 10 years (2010-2019). The most significant hailstorm event in Keweenaw County occurred on June 14, 1994 in Copper Harbor where severe thunderstorms produced hail up to 2 inches. The hail damaged vehicle windshields and metal roof of a store. Thunderstorm winds blew down trees and power lines. Total estimated property damage was \$5,000. Other than this event, there were no damages recorded; hail damages were minor and incurred by individual property owners.

**Table 5.4:** Reported Hail Events by Size in Keweenaw County, 1955-2019

Hail Size Reported	Number of Events
¾"	3
0.9"	1
1"	2
1 ¼"	0
1 ½"	0
1 ¾"	0
2"	1
2 ½"	0
2 ¾"	0
<b>TOTAL</b>	<b>7</b>

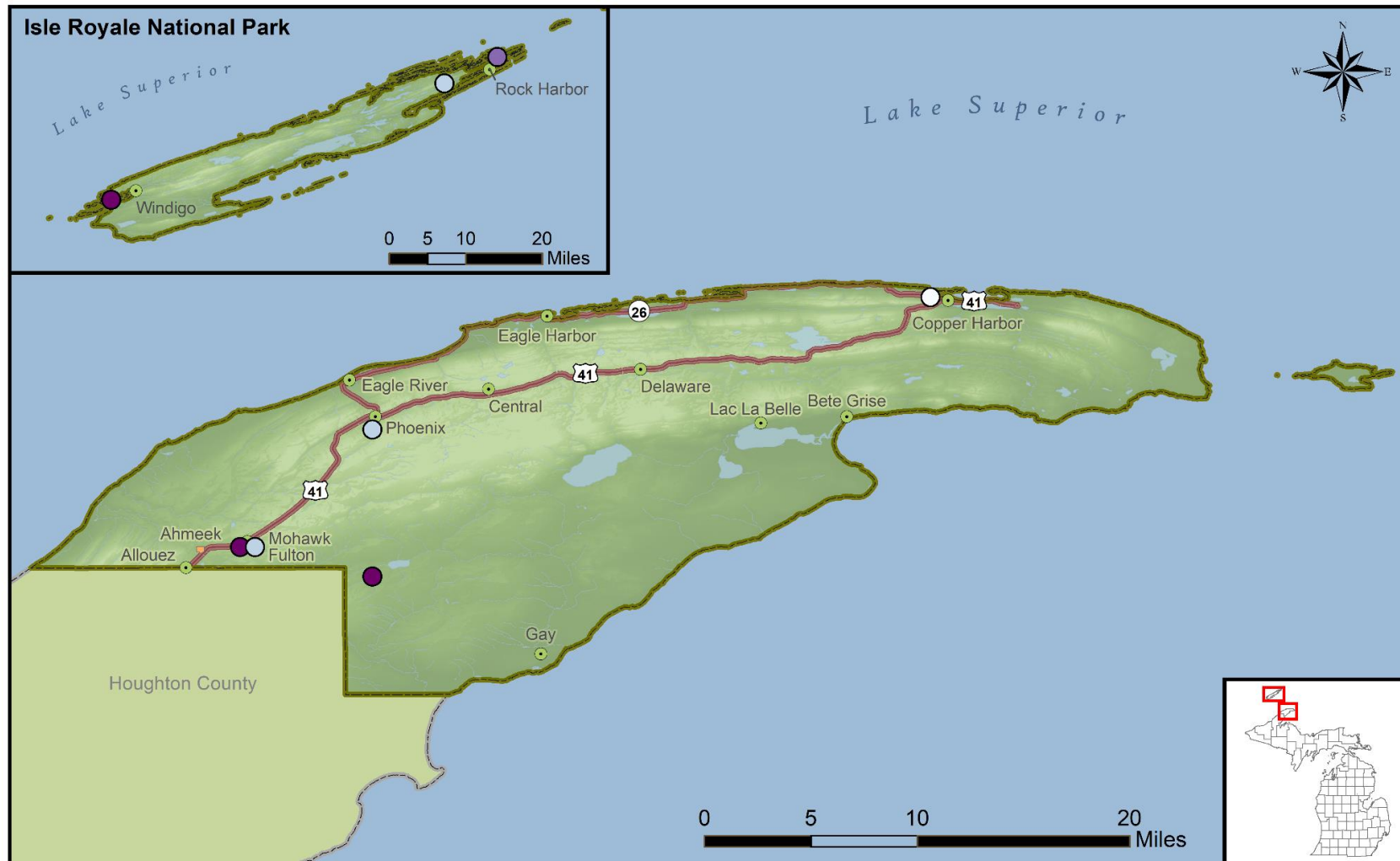
### Occurrence Probability and County Vulnerability

The frequency of a hail event within a year is approximately 0.2. Thus, probability of a hail event is low, and the severity of damages due to a hailstorm is low to moderate. There are no known areas in the county that have a higher risk from hail, but some communities may have structures that are more vulnerable to hail damage than others. Damage to vehicles, homes, and buildings, such as broken windows, dented roofs, and damaged siding, is frequently reported. Critical facilities in all Keweenaw County municipalities are vulnerable to receive similar damage from hail. However, hail should not negatively impact the services a facility provides.

<sup>8</sup> Botzen, W. J. W., Bouwer, L. M., & Van den Bergh, J. C. J. M. (2010). Climate change and hailstorm damage: Empirical evidence and implications for agriculture and insurance. *Resource and Energy Economics*, 32(3), 341-362.

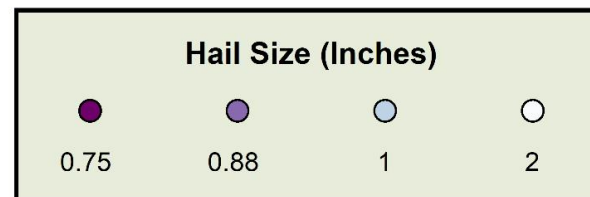


**Map 5.1: Hail Events in Keweenaw County, 1955-2019**



## Recorded Hail Events, 1955-2019 Keweenaw County, Michigan

Boundary data was derived from Michigan's Open Data Portal;  
DEM was derived from elevation data available through the USGS;  
Weather event data was downloaded from the National Weather Service  
Created by WUPPDR July 2020



## Ice and Sleet Storms

### Hazard Description

Severe winter weather hazards can include ice and sleet storms. Although these two types of winter storms have been combined for the purpose of this plan, ice and sleet storms are two different phenomena. Ice storms, also known as freezing rain, coat roads, trees, power lines, and buildings with thick, heavy, and slick surfaces. Ice storms are sometimes incorrectly referred to as sleet storms. Sleet is small frozen raindrops or ice pellets that bounce when hitting the ground or other objects. Sleet is less dangerous than ice storms as it does not stick to trees and wires but can still cause hazardous driving conditions if there is sleet of sufficient depth.

Ice storms are the result of cold rain that freezes on contact with a surface, coating the ground, trees, overhead wires, and other exposed objects with ice, sometimes causing extensive damage. When electric lines are downed due to ice, power may be out for several days. Massive traffic accidents and power outages from downed tree limbs and utility lines are common when an ice storm occurs. Often, ice storms are accompanied by snowfall, in which the ice is camouflaged and covered up by snow, creating treacherous transportation conditions. Both storms occur when the temperature is close to 32°F but are far more severe when the temperature is in the 20s.

### Climate Change Consideration

Climate change will likely cause an increase in the number of ice and sleet storm events. Average temperatures in and around the winter months are closer to the freezing point and at the temperature at which ice and sleet events typically occur. Instead of winter arriving and precipitation turning into snow, Michigan winters have involved many thawing episodes followed by refreezing which cause treacherous ice cover on frozen surfaces, weigh down cables and tree branches, and cause infrastructure failures. Even though Michigan winters have been shortening a bit over time,<sup>9</sup> winters remain hazardous because the increasing level of precipitation more often takes the form of a major snow event and provides more moisture for refreezing after the warmer thawing periods occur.

### Historical Occurrence

Ice storms usually have a regional effect and groups of counties are usually affected instead of just one county when they occur. In Keweenaw County, three ice storms were reported from 1955-2019. No sleet storms were recorded. **Table 5.5** lists all ice storms in the county, along with descriptions about the storm and any reported damages.

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<sup>9</sup> Andresen, J., S. Hilberg, K. Kunkel, 2012: Historical Climate and Climate Trends in the Midwestern USA. In: U.S. National Climate Assessment Midwest Technical Report. [http://glisa.msu.edu/docs/NCA/MTIT\\_Historical.pdf](http://glisa.msu.edu/docs/NCA/MTIT_Historical.pdf).



**Table 5.5:** Reported Ice and Sleet Storms in Keweenaw County, 1955-2019

Date	Type of Storm	Description and Location	Property Damages
04/04/1999	Ice Storm	Ice accumulations around a half inch thick around tree branches in Copper Harbor. This caused tree branches breaking and falling across power lines resulting in regional power outages. Police departments reported minor traffic accidents due to slick roads.	No reported damages.
12/30/2004	Ice Storm	Freezing rain resulting in about a quarter inch or more of ice on roadways. Numerous minor road accidents reported.	No reported damages
04/26/2017-04/27/2017	Ice Storm	The Keweenaw County Road Commission estimated between one-half inch to an inch of ice accumulation from freezing rain from the evening of the 26 <sup>th</sup> into the 27 <sup>th</sup> . The ice damaged trees and coated roads and power lines. Schools were closed April 27.	\$100,000

### Occurrence Probability and County Vulnerability

While ice and sleet storms do not appear to occur at a frequent rate, a storm is still likely to occur. Only one ice storm was reported in the past ten years – a frequency of 0.1 events per year. Severity is also variable, but generally low to moderate. However, the county’s vulnerability to such a storm is high, as little can be done to the impact of an ice and sleet storm, which primarily involve infrastructure and critical facility failures. Transportation and electric infrastructure are also vulnerable to ice storms, causing icy roadways or potential for power and communication outages. Additionally, icy weather conditions can slow emergency response travel and increase travel time for all commuters.

## Lightning

### Hazard Description

The discharge of electricity from a thunderstorm is called lightning. It is a random and unpredictable product of a thunderstorm’s energy. Lightning strikes when a thunderstorm’s electric potential (the difference between its positive and negative charges) becomes great enough to overcome the resistance of the surrounding air. In the United States, approximately 100,000 thunderstorms occur each year and each of those storms generates lightning. It is not uncommon for a single thunderstorm to produced hundreds or even thousands of lightning strikes.

Lightning is often perceived as a minor hazard, but it damages many structures and kills and injures more people in the United States each year, on average, than tornadoes and hurricanes. From 2005-

2014, Michigan ranked seventh in the nation in lightning fatalities<sup>10</sup>. Because it is virtually impossible to provide complete protection to individuals and structures from lightning, this hazard will continue to be a problem for Michigan's residents and communities. 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.

### **Historical Occurrence**

Based on the frequency of cloud-to-ground flash density map from 2008-2017<sup>11</sup>, Keweenaw County experiences approximately 0.75 to 3 strikes per square mile per year. However, no lightning events were reported in Keweenaw County between 1996-2019. Lightning of a lower level does occur, but these events usually do not have any recordable damage.

### **Occurrence Probability and County Vulnerability**

While no significant lightning events were reported in Keweenaw County, that does not mean that lightning strikes do not occur. Keweenaw County is in an area that has relatively low lightning strike density. However, it is likely that a future lightning event may occur, but the probability is low. Additionally, the likelihood of the lightning event causing damage to human life or property is negligible, but when a damaging event does occur its severity is extreme at the discharge site.

Most injuries or deaths due to lightning strikes occur on open fields and under trees. Keweenaw County parks, forests, and recreation areas contain most of these hazard-prone features and may contribute to or intensify the effects of lightning. Each municipality in the county has an equal vulnerability to lightning strikes as there is really no way to pinpoint exactly where, when, and to what extent lightning will cause damage. Critical facilities in the county are protected by lightning strikes through grounding and other protective measures. However, electrical substations, transformers, and power lines are still vulnerable to lightning strikes. A more specialized study will need to be done to determine what facilities in the county are a higher risk and might need greater protection.

## **Severe Winds**

### **Hazard Description**

weather systems and can be very damaging to communities. Severe winds with velocities over 58 mph may be confused with tornado occurrence. Locally, lesser events termed high winds and thunderstorm winds can cause similar damage as severe winds. Severe winds can cause damage to homes and businesses, power lines, trees, and agricultural crops. Large scale power failures, with

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<sup>10</sup> "Lightning Deaths the Last 10 years, Mapped," The Weather Channel, July 22, 2015, <https://weather.com/storms/severe/news/lightning-deaths-by-state-2005-2014>.

<sup>11</sup> Vaisala National Lightning Detection Network. <https://www.vaisala.com/en/products/data-subscriptions-and-reports/data-sets/nldn>

hundreds to thousands of customers affected, are common during straight-line wind events. Power outages can result in a need to shelter persons left without power for extended periods of time.

These wind events also have the potential to cause loss of life from breaking and falling trees, property damage, and flying debris, but tend not to cause as many deaths as tornadoes do. However, property damage from straight line winds can be more widespread than tornadoes, usually affecting multiple counties at a time. It is not rare to see severe wind events that produce wind-speeds of 60 and 70 miles per hour. Along the Great Lakes shoreline, high winds of lower magnitude occur regularly, as do hurricane-velocity gusts (over 74 miles per hour).

Microbursts are localized but powerful wind gusts that typically occur from a single storm. Microbursts result in what is often referred to as straight-line wind damage and usually result in damage like a brief, weak tornado. Derechos are usually large-scale storm systems that travel hundreds of miles and are many miles long. Damages from derechos can stretch statewide and often exceeds 250 miles in length. Derechos are most common in Michigan during the warmer half of the year. Wind speeds in derechos can exceed 100 mph at times. In the Upper Peninsula, a derecho can be expected once every four years.

### Historical Occurrence

Historically in Keweenaw County, windstorms are rarely a singular event. They usually accompany other severe weather – particularly thunderstorms and occasional blizzards. The strongest wind gust recorded in Keweenaw County from 1955-2019 was 84 knots or 96 miles per hour on August 17, 1984 during a thunderstorm. The windstorm causing the most property damage occurred November 9, 2005, when high winds of 65 knots or 75 miles per hour blew down a U.S. Coast Guard tower in the county. The antenna tower was damaged, with a total estimated replacement cost of \$150,000. Large trees were downed throughout the county.

From 1955-2019, 53 severe wind events were reported in Keweenaw County (**Map 5.2**). **Table 5.6** summarizes the total property and crop damages that these events caused. 24 of the total severe wind events caused some property damages.

**Table 5.6:** Reported Severe Wind Events in Keweenaw County, 1955-2019

Number of Events	Total Property Damage	Total Crop Damage	Injuries	Deaths
53	\$394,000	\$0.00	0	0

Other severe wind events that caused significant property damage in the last 10 years include:

- **August 16, 2010: Strong winds** of 52 mph downed trees onto power lines and one car, with reported damage estimates of \$10,000.
- **September 3, 2010: Severe high winds** moving 63 mph downed many trees throughout the county. Two campers in Copper Harbor sustained damage from downed trees. Property damage was estimated at \$10,000.

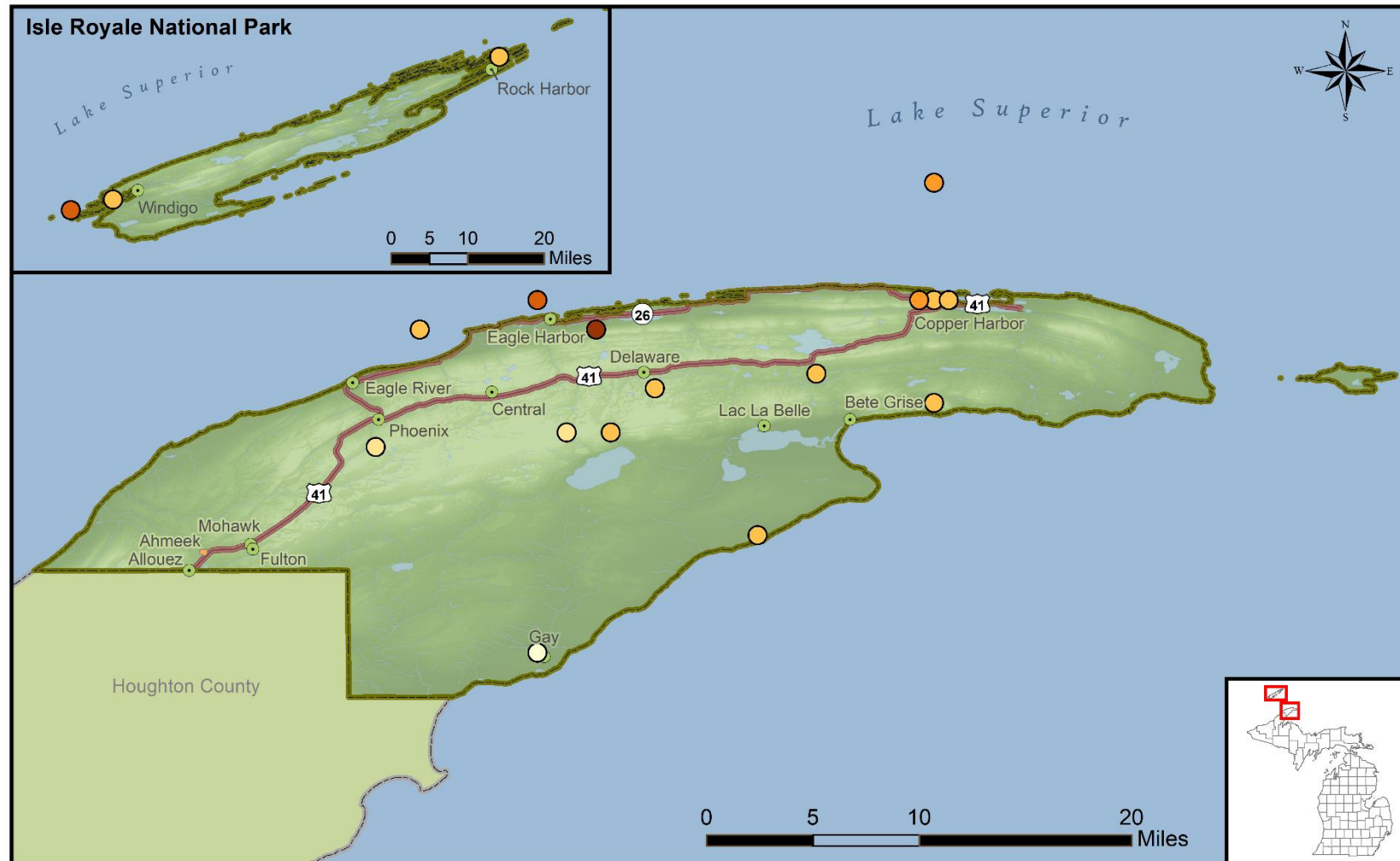
- September 29, 2011: **High winds** of 63 mph brought down large trees across roads and cut out power throughout the county. Power outage for 5 hours in Copper Harbor. Property damage estimated at \$5,000.
- August 14, 2012: Strong **high winds** of 57 mph caused power outages and downed trees. More than 1,000 UPPCO customers were without power in Copper Harbor and Mohawk. Estimated property damage of \$5,000.
- April 28, 2014: Severe **strong winds** of 44 mph reportedly pushed an eight-foot tall ice shove from Lake Superior, where camps near Gay and Rice Lake were damaged on the eastern side of the Keweenaw Peninsula. In total, reported property damage was \$25,000.
- December 24, 2015: Severe **strong winds** of 63 mph reported throughout Keweenaw County. Sporadic power outages resulted from downed trees and estimated \$5,000 in property damage.
- August 27, 2018: Thunderstorms with **high winds** of 69 mph downed trees up to 12 inches in diameter across the county and resulted in \$5,000 in property damage.
- July 15, 2019: **Thunderstorm winds** of 63 mph caused numerous trees to fall onto Lac La Belle Road. The road became impassible. Estimated property damage was \$3,000.
- October 21, 2019: **Strong winds** with gusts of up to 50 mph were reported throughout the county. UPPCO reported about 1,400 customers without power in Copper Harbor, Lac La Belle, and Bete Grise due to strong winds. Estimated property damaged was reported at \$10,000.

### Occurrence Probability and County Vulnerability

Most severe wind events in Keweenaw County are either classified as thunderstorm wind or high wind (sustained winds of 40 mph or greater for one hour or longer or gusts greater than 58 mph). In the past ten years, there were 53 severe wind events with 21 associated with thunderstorms and 28 high wind events – a frequency of 5.3 severe wind events per year, 2.1 thunderstorm wind events a year, and 2.8 high wind events per year. The probability of a future severe wind event is highly likely with individual events having a moderate severity throughout the county. Probability and severity are both highest along the Lake Superior shoreline.

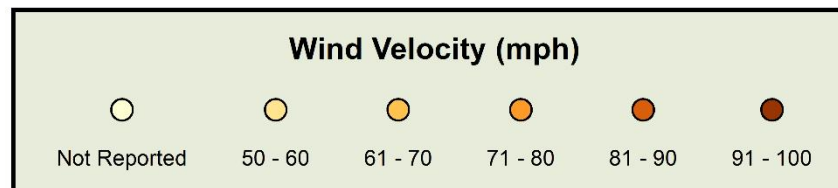
All Keweenaw County communities are vulnerable to severe wind events due to the proximity to the Lake Superior shoreline. Critical infrastructure, such as power and communication lines, are also vulnerable to damage from severe wind events. Fallen trees can damage these lines, causing electrical and communication outages. Additionally, trees on roadways can delay emergency response capabilities.

**Map 5.2: Severe Wind Events in Keweenaw County, 1955-2018**



### Recorded Wind Events, 1955-2018 Keweenaw County, Michigan

Boundary data was derived from Michigan's Open Data Portal; DEM was derived from elevation data available through the USGS; Weather event data was downloaded from the National Weather Service GIS Portal  
Created by WUPPDR July 2020





## Snowstorms and Blizzards

### Hazard Description

Snowstorms are a period of rapid snow accumulation that is usually accompanied with high winds and cold temperatures. This event can be very dangerous for a community over a period of days or weeks. Heavy snows can shut down towns and cities for several days if snow is persistent and cannot be cleared in a timely fashion. Rural areas may have inaccessible roads for some time but often have residents that are more equipped to independently deal with power outages and temporary isolation. Roof failures may occur as the weight of snow and area of snow can cause damage to homes and buildings.

Blizzards are the most dramatic of all snowstorms as it is characterized by low temperatures and strong winds of over 35 miles per hour. Most blizzard snow is in the form of fine, powdery particles that are wind-blown in such great quantities that, at times, visibility is reduced to only a few feet. Blizzards have the potential to result in property damage and loss of life. The cost of clearing snow can be enormous.

Some areas suffer greater flood risks because thick snow cover can rapidly melt off during rainstorms, causing rapid drainage of water towards populated communities and into drains and rivers. Partially melted snow and ice may cause blockages within these water channels, causing water to back up or divert sideways and over banks where they damage property and roadways.

As a result of being surrounded by the Great Lakes, Michigan experiences large differences in snowfall over relatively short geographic distances. The western Upper Peninsula experiences the most snowstorms and snowfall in Michigan each year. One reason for this is the “lake effect,” a process by which cold winter air moving across Lake Superior picks up moisture from the warmer lake waters, resulting in larger snowfall amounts. Due to weather patterns, severity of different types of snowstorms varies somewhat throughout the county. *Lake effect snow* is almost exclusively focused on areas close to Lake Superior. *System snow*, which includes heavy snow or snow associated with winter storm/weather, results from weather fronts moving across the country.

### Climate Change Considerations

The effect of climate change upon Michigan is expected to cause an increase in the amount of severe precipitation events. Even though the length of Michigan winters has been decreasing, the season remains intense and periods of deep freeze may become more likely as arctic and polar air masses occur more frequently during the winter season. During the winter months, the increase in precipitation means that snowfall events will tend on average to be more intense. More snowfall is likely to happen at a time and take the form of significant snowstorm events (e.g., eight or more inches, higher snowdrifts, transportation disruptions, canceled school sessions, etc.).

### Historical Occurrence

Residents of Keweenaw County are accustomed to major snow events, which occur regularly every winter. Average annual snowfall in the county for the past ten winters was 258.38 inches. The greatest amount of snow received was in the winter of 2013-2014; 340.5 inches was reported



by the county. The least amount of snow was in the winter for 2009-2010, where 169.3 inches was reported. While overall snow amounts greatly vary, heavy amounts of snow and snowstorms are an expected occurrence every winter in Keweenaw County.

From 1996-2019, 230 winter weather events (blizzard, heavy snow, lake effect snow, winter storm, and winter weather) were reported in Keweenaw County. Note that some winter weather events list freezing rain in addition to snow. **Table 5.7** summarizes the total number of snowstorm events and associated deaths or injuries. Of these storms, one event had reported property damages. On December 5, 2017, **winter storm** conditions from a strong low-pressure system generated lake effect snow and strong, gusty winds. About 9 inches of snow fell in 27 hours in Allouez. Gusts of 55 mph caused whiteout conditions and considerable drifting of snow of three to four feet. Multiple power outages reported. Estimated property damage was \$5,000.

**Table 5.7:** Snowstorms by Type in Keweenaw County, 1996-2019

Snowstorm Type	Number of Events	Total Property Damage	Injuries	Deaths
Blizzard	22	\$0.00	0	0
Heavy Snow	32	\$0.00	0	0
Lake Effect Snow	19	\$0.00	0	0
Winter Storm	69	\$5,000	0	0
Winter Weather	88	\$0.00	0	0
<b>TOTAL</b>	<b>230</b>	<b>\$5,000</b>	<b>0</b>	<b>0</b>

### Occurrence Probability and County Vulnerability

The probability of a snowstorm even in Keweenaw County is very high. From 2010-2019, there were 118 snowstorm and blizzard related events reported in the county – a frequency of 11.8 events per year. However, the vulnerability of the community is low due to the preparedness of residents and their properties. All communities in the county are vulnerable to lake effect snow and thus more snowfall than most parts of the western U.P.

Depending on type of snow (wet, heavy versus fine, powdery snow), snowstorms and blizzards may result in a variety of infrastructure problems. Snow accumulations on above-ground electrical lines often create power outages, which can vary from several hours to days. Dangerous driving conditions frequently occur during and shortly after severe snowstorms and blizzards. Some state and county roads experience drifting snow, which can result in greater vulnerability to accidents. When transportation is disrupted, schools close, emergency services are delayed, some businesses close, and some government services are delayed. Areas not near main transportation routes, such as M-26 and US-41, may experience impassable roads preventing emergency services from reaching residences in rural locations.

## Tornadoes

### Hazard Description

A tornado is an intense rotating column of wind extending from the base of a severe thunderstorm to the ground. Tornadoes are high-profile hazards that can cause catastrophic damage to either a limited or an extensive area. A strong tornado can level everything in its path. Tornadoes can have winds of more than 300 miles per hour and can have widths of over one mile.

The mean national annual death toll due to tornados is 87 persons. Death and injuries associated with tornadoes have declined since the 1950s, thanks to advances in severe weather forecasting, but tornadoes can still be deadly. Although tornado deaths have decreased, tornado damages have increased in recent years, since a larger part of the country's land area contains developments with each passing year. Property damage resulting from tornadoes totals hundreds of millions of dollars every year.

Note that winds are invisible until they pick up enough material that can allow their patterns to be seen and it is this carried material that provides a tornado with a visible form that is easy to recognize. Funnel clouds can be invisible except for the liquid, dust, and debris that they carry. Therefore, a tornado can be present but not yet discernable to nearby persons.

Tornado intensity is measured on the Fujita and Enhanced Fujita Scale, which examines the damage caused by a tornado on homes, commercial buildings, and other manufactured structures. Tornado magnitudes prior to 2005 were determined using the traditional version of the Fujita scale (**Table 5.8**). After 2005, the Enhanced Fujita Scale (**Table 5.9**) was utilized. The Enhanced Fujita Scale rates the intensity of a tornado based on damaged caused, not by its size. The size of the tornado is not necessarily an indication of its intensity.

Tornados in Michigan are most frequent in the spring and early summer when warm, moist air from the Gulf of Mexico collides with air from the polar regions to generate thunderstorms. These thunderstorms often produce the violently rotating columns of wind known as funnel clouds. Winds that converge from different directions, heights, or at different speeds are the source of the spinning pattern that gets concentrated as distinct funnels of wind. 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.

In Michigan, tornadoes occur more frequently in the southern half of the Lower Peninsula than any other area of the state. This area could be referred to as Michigan's "tornado alley." Since 1996, Michigan has averaged about 16 tornadoes per year.

**Table 5.8:** Fujita Scale with Associated Damages

F-Scale Number	Intensity	Wind Speed	Type of Damage
<b>F0</b>	Gale Tornado	40-72 MPH	Some damage to chimneys; branches break off trees; shallow-rooted trees blown over; damages to signs
<b>F1</b>	Moderate Tornado	73-112 MPH	Peels surface off roofs; mobile homes pushed off foundations or overturned; moving cars pushed off roadways
<b>F2</b>	Significant Tornado	113-157 MPH	Considerable damage. Roofs torn off homes; mobile homes demolished; large trees snapped or uprooted; light objects can turn into missiles.
<b>F3</b>	Severe Tornado	158-206 MPH	Roof and some walls torn off well-constructed homes; most trees uprooted
<b>F4</b>	Devastating Tornado	207-260 MPH	Well-constructed homes leveled; structures with weak foundations blown away; cars thrown; large objects can turn into missiles.
<b>F5</b>	Incredible Tornado	261-318 MPH	Strong frame house lifted off foundations and carried considerable distances; automobile sized missiles can fly over 100 meters; trees debarked; steel reinforced concrete structures damaged

Source: Storm Prediction Center

**Table 5.9:** Enhanced Fujita Scale with Associated Damages

EF-Scale Number	Intensity Phrase	3 Second Wind Gust	Type of Damage
<b>EF0</b>	Gale	65-85 MPH	Some damage to chimneys; branches break off trees; shallow-rooted trees blown over; damages to signs
<b>EF1</b>	Moderate	86-110 MPH	Peels surface off roofs; mobile homes pushed off foundations or overturned; moving cars pushed off roadways
<b>EF2</b>	Significant	111-135 MPH	Considerable damage. Roofs torn off homes; mobile homes demolished; large trees snapped or uprooted; light objects can turn into missiles.
<b>EF3</b>	Severe	136-165 MPH	Roof and some walls torn off well-constructed homes; most trees uprooted
<b>EF4</b>	Devastating	166-200 MPH	Well-constructed homes leveled; structures with weak foundations blown away; cars thrown; large objects can turn into missiles.
<b>EF5</b>	Incredible	Over 200 MPH	Strong frame house lifted off foundations and carried considerable distances; automobile sized missiles can fly over 100 meters; trees debarked; steel reinforced concrete structures damaged

Source: Storm Prediction Center

## **Climate Change Considerations**

According to NOAA, there is no known way to predict whether or how climate change is affecting thunderstorm and tornado frequency or severity. These types of weather events involve a different scale of phenomenon than climate change and the models of the latter have not yet been able to predict local trends in the former.

## **Historical Occurrences**

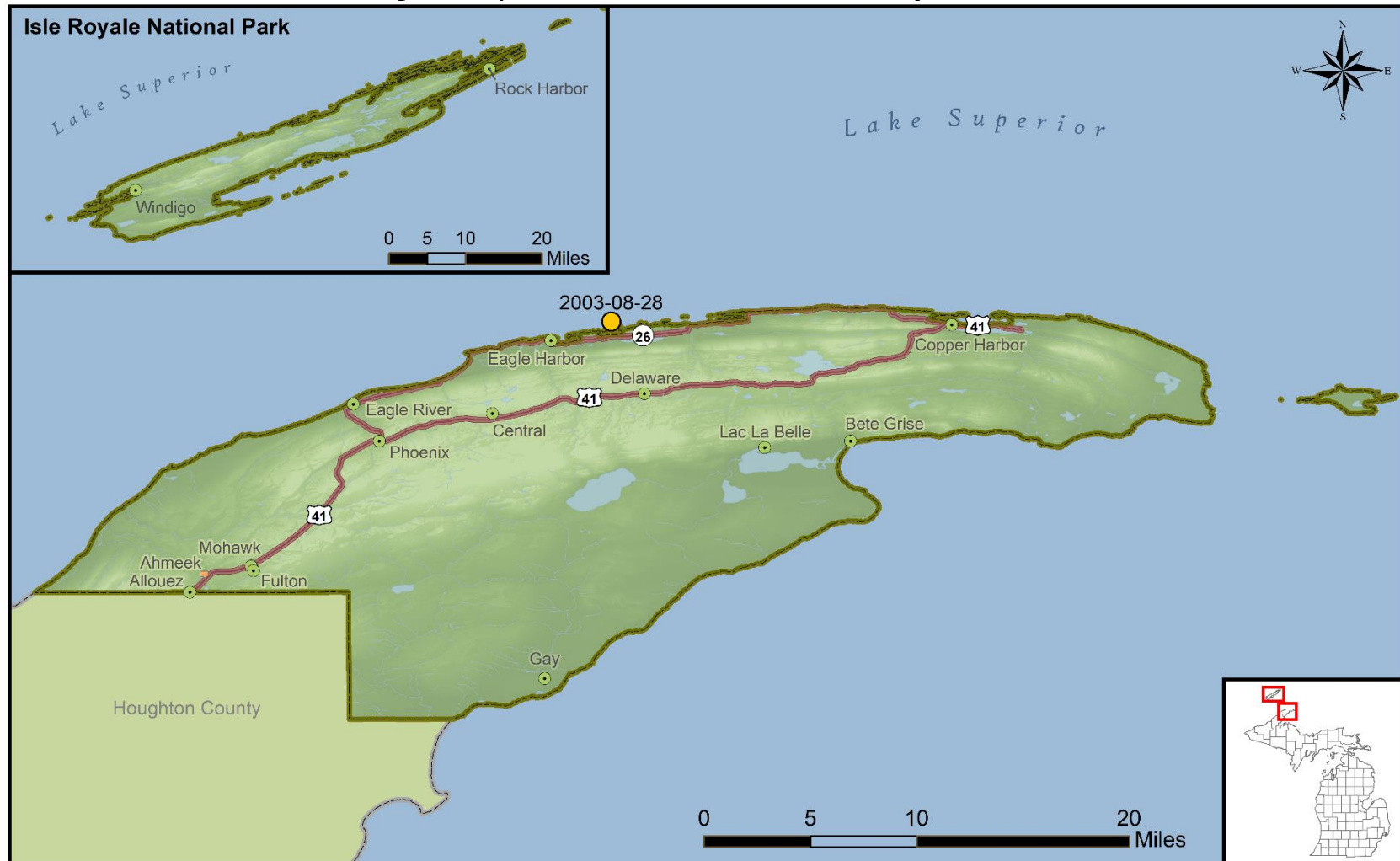
From 1950-2019, there have only been two tornadoes recorded in Keweenaw County. The tornadoes occurred on July 11, 1987 and August 28, 2003 and both were rated an F0. No specific details were reported about the path, but the 1987 tornado reportedly occurred southeast of the Village of Ahmeek, near the Keweenaw and Houghton County political border. It caused an estimated \$2,500 in property damages, but no details were provided.

Thunderstorms that originated from a low-pressure system produced a waterspout over Lake Superior near Eagle Harbor in August 2003 (**Map 5.3**). It moved onshore at Silver Island, knocked down a tree, then dissipated. No property damage was reported from this tornado.

## **Occurrence Probability and County Vulnerability**

In Keweenaw County, tornadoes occur with such infrequencies that the probability of such an event is very low. No tornadoes were reported within the last ten year. However, if an event were to occur, the vulnerability of the region to tornadoes is high due to their unpredictability and the lack of preparedness in the county. Tornadoes can hit anywhere in the region and forecasting where they may be located is difficult, making all critical facilities vulnerable to being impacted by a tornado. Emergency service response may be significantly delayed if tornadoes knock down trees, making main transportation routes impassible.

**Map 5.3: Reported Tornadoes in Keweenaw County, 1950-2019**



## Recorded Tornadoes, 1950-2019 Keweenaw County, Michigan

Boundary data was derived from Michigan's Open Data Portal; DEM was derived from elevation data available through the USGS; Tornado location data was downloaded from the National Weather Service GIS Portal; Created by WUPPDR July 2020

### Tornado Magnitude\*



**F-0**

\*Tornadoes are measured on the F-scale pre 2007 and the EF-scale after January 2007



## Hydrological Hazards

The following outline summarizes the significant hydrological hazards covered in this section:

1. Flood Hazards
  - a. Dam Failures
  - b. Riverine and Urban Flooding
  - c. Shoreline Flooding and Erosion
2. Drought

Michigan residents are largely impacted by flooding. The section, **Riverine and Urban Flooding**, focuses on inland areas, mapped floodplains, and urban areas. Not all flooding occurs within recognized floodplain areas or adjacent to rivers and lakes. In some cases, melting snow or other runoff waters pool in low-lying areas, damaging structures and obstructing roads and other infrastructure. In other cases, some type of breakdown in an area's pumping or drainage infrastructure may result in a damaging flood. **Urban flooding** typically occurs in well-developed urban or suburban areas. It tends to occur due to either a breakdown in infrastructure or inadequate planning and design standards on the part of builders, engineers, architects, and planners.

Many flood mitigation activities have taken place in recent decades, including separation of combined sewer systems, installation of backflow preventers in houses, and dredging, expansion, and re-design of drainage systems. Throughout the state, communities have learned lessons from previous flood occurrences and taken steps to mitigate flood impacts in the future. More importance is now placed on the preventative role in coordinating land development plans with existing knowledge of local floodplains, wetlands, sewer capacity, and upstream development and hydrology.

### Overlap with Other Sections of Hazard Analysis

Hydrological hazards stem from precipitation patterns, which are affected by the types of events described in **Weather Hazards** sections on thunderstorms, severe winter weather, and extreme temperatures. Thunderstorms, snowstorms, and ice/sleet storms produce precipitation that can cause or exacerbate flooding – either immediately or when frozen precipitation melts. Additionally, ice can build up and block critical parts of drainage-ways and cause flooding. During extreme temperatures, freeze events have caused flooding when pipes and water mains have broken, while heat waves may worsen the impact of drought.

**Technological Hazards** can inhibit smooth functioning or drainage on water supply infrastructure and may cause or worsen flooding or drought hazards. For example, sewer pumping and lift stations can go out of operation during a power failure and cause flooding to occur or a reduction in water supply.



## Dam Failures

### Hazard Descriptions

Dams are structures that stretch across a stream or other water body to control its flow or to convert the energy within the water into more convenient forms, such as electricity. The impounded waters may be used for agriculture, flood-control, artificial lakes, municipal water supplies, or for energy generation. Some dams have become obsolete and should be removed to restore the natural water flow through the area. Otherwise, neglected dams will eventually fail, and would then be likely to cause a flash flood downstream, through the sudden release of their impounded waters. Some dams are constructed by wildlife instead of humans but can pose similar risks.

Dam failure is the breach or collapse of an impoundment resulting in flooding downstream. Dam failure can result in loss of life and in extensive property or natural resource damage for miles downstream from the dam. Failure can occur not only during flood events which cause overflowing of the dam, but also due to poor operation, lack of maintenance, and vandalism. Most dam failures are considered catastrophic because they occur unexpectedly, with no time for evacuation. As of 2014, there has been approximately 287 dam failures in Michigan since 1888<sup>12</sup>.

Dams are officially classified into three categories of risk, based upon a wide array of potential impacts that can result from a dam's failure. The categories are as follow:

1. Low hazard potential dam: Failure or mis-operation results in no probable loss of human life and low economic and/or environmental losses. Losses are principally limited to the owner's property.
2. Significant hazard potential dam: Failure or mis-operation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or can impact other concerns.
3. High hazard potential dam: Failure or mis-operation will probably cause loss of human life.

### Historical Occurrence

There are 9 listed constructed dams in the county. Stream flow volumes are low for all in a typical year, and none of the dams are of sufficient size or in poor enough condition to pose a significant hazard. Keweenaw County has one small dam that impounds Eliza Creek creating Eliza Lake, located adjacent to the town of Eagle Harbor. There are also remains of a dam at Eagle River Falls on the site of the original Lake Superior Fuse Company. At Eagle River, the remains of the dam still span most of the 60-foot wide river and the dam extends the falls to a total height of well over 60 feet.



*Eagle River Falls*

<sup>12</sup> Michigan Department of Environmental Quality (MDEQ)

While neither have failed, it is worth mentioning that a failure of this dam could release contaminants such as copper that may have accumulated above the dam since the dam's construction in the 1950s.

Beaver dam failures are of concern. In 1971, a beaver dam located above M-26 on Jacob's Creek failed, washing out part of M-26 and a motel and restaurant in its path. Beaver dams have also been located near Keystone Bay Road and have flooded a section of the road. However, this area is not a main transportation thoroughway and is primarily used as a recreational route. Beaver dam failures on a small scale happen in Keweenaw County, and there is increasing concern about them although records of these events are limited.

### **Occurrence Probability and County Vulnerability**

Beaver dam failure presents an unknown and unpredictable risk and severity, as there are currently no existing maps of beaver dams or tracking of their locations

## **Riverine and Urban Flooding**

### **Hazard Description**

Riverine flooding is defined as a periodic occurrence of overflow of streams and rivers resulting in an inundation of the adjacent floodplain. While flooding of land adjacent to streams and rivers is a natural occurrence, floodplains typically are not left in the natural state. Development in and near floodplains have increased the potential for serious flooding because rainfall that used to soak into the ground or take several days to reach a river or stream via natural drainage now quickly runs off streets, parking lots, and rooftops, through man-made channels and pipes. This stormwater infrastructure may or may not be adequately maintained.

Riverine and urban floods are caused by prolonged, intense rainfall, snowmelt, ice jams, dam failures, or any combination of these factors. Bank overflows are natural and may occur on a regular basis on river systems that drain large geographic areas and many river basins. Floods on large river systems may extend several days. Many areas of Michigan are subject to riverine flooding.

Most riverine flooding occurs in early spring and is the result of excessive rainfall and/or the combination of rainfall and snowmelt. Ice jams are another cause of flooding in winter and early spring. Log jams can also cause streams and rivers to be clogged up and backed-up waters to overflow the stream's banks. Either ice jams or log jams can cause dangerous flash flooding to occur if the makeshift dam-effect caused by the ice or logs suddenly gives way. Severe thunderstorms may cause flooding during the summer or fall, although these are normally localized and have more impact on areas with smaller drainage areas.

Urban flooding may involve low-lying area that collect runoff waters even though they are not adjacent to drains or bodies of water. It is usually due to the combination of excessive rainfall and/or snowmelt, saturated ground, and inadequate drainage. With no place to go, the water will find the lowest elevations – areas that are not in a floodplain. This risk does vary with topography,

soil types, runoff rates, drainage basin size, drainage channel sizes, and impervious ground surfaces in each area. Other kinds of urban flooding stem from undersized or poorly designed sewer systems that cannot always process the amounts of precipitation and runoff that affects an area.

Both kinds of flooding can damage or destroy public and private property, disable utilities, make roads and bridges impassible, destroy crops and agricultural lands, cause disruptions 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 secondary dangers include potential disease outbreak, widespread animal death, broken sewer lines causing water supply pollution, downed power lines, broken gas lines, fires, and the release of hazardous materials.

### **Climate Change Considerations**

One of the Michigan trends connected with climate change is to experience increasing amounts of precipitation. This precipitation is considered more likely to take the form of acute and severe weather events. This includes larger proportions of snow precipitation occurring in snowstorm events and cause more extensive snow accumulation, which may add to the drainage burdens of the normal melting and rainfall patterns of the spring season. Both spring and summer flood risks are likely to worsen, as are ice jam related flood risks.

### **Historical Occurrence**

Several areas in Keweenaw County are susceptible to riverine and urban flooding. Riverbanks and many areas with inadequate culverts and ditches become overburdened, resulting in certain degrees of flooding and washouts. In the past, areas of Eagle Harbor along Eliza Creek and many areas with inadequate culverts (Garden City Creek and Jacobs Creek) have been overburdened, thus experiencing certain degrees of flooding and washouts. To address these risks, upgrading of storm sewers, ditch management and culverts are ongoing.

Keweenaw County has been affected by several minor and major floods, most due to heavy rainfall or significant snowmelt. From 1996-2019, four flooding events have occurred in the county. Details of these events, including one resulting in a disaster declaration, are listed below.

- May 11, 2003: Widespread flooding in the western U.P. resulted in multiple road washouts throughout the region including M-26 between Eagle Harbor and Eagle River in Keweenaw County. An estimated 3.3 inches of rain was measured to have fallen in Phoenix. No damages were reported in the county.
- June 23, 2005: A flash flood caused trail damage on the backcountry portion of Isle Royale National Park. Trails were washed out and other property damage occurred. There was evidence of high flows on surrounding streams.
- May 11, 2006: Heavy rain of 2 to 3 inches fell across portions of Keweenaw, Houghton and Baraga counties. The Keweenaw County Sheriff's Department reported a washout of US-41 at French Annie Creek just south of Copper Harbor. Estimated property damage was \$60,000.

- April 28-30, 2013: Rapid snowmelt caused minor to moderate flooding throughout the western U.P. In Keweenaw County, flooding was reported on M-26 between Eagle River and Copper Harbor and along Gay-Lac La Belle Road. Minor flooding continued into early May. Basement flooding was also reported in the county. On June 7, Governor Rick Snyder declared a state of disaster in the county where over \$72,000 of property damage occurred due to the flooding, mainly to the roadway infrastructure. On June 18, President Barack Obama declared that a major disaster occurred in the county, along with 15 other counties in Michigan.<sup>13</sup>

### **Flood Insurance in Keweenaw County**

In Keweenaw County, Grant, Houghton and Sherman Townships participate in the FEMA National Flood Insurance Program (NFIP).<sup>14</sup> The NFIP makes federally supported flood insurance available to homeowners, renters, and business owners in communities that adopt and enforce floodplain ordinances. Most other communities in Keweenaw County do not regularly experience severe flooding, particularly to the extent that participation in the NFIP would be considered necessary. Communities must choose to participate in the flood insurance program. NFIP puts a special focus on mediation of insured structures that have suffered more than one loss of at least \$1,000 within a rolling 10-year period since 1978; these are referred to as “repetitive loss properties.” There currently are no repetitive loss or severe repetitive loss structures in Keweenaw County.

Rates are determined based on a Flood Insurance Study and Flood Insurance Rate Map (FIRM), which FEMA develops during a flood hazard assessment. The FIRM is used by lenders to determine flood insurance requirements and by insurance agents to determine flood insurance premium rates for specific properties. The FIRM includes areas within the 100-year flood boundary, which are termed “Special Flood Hazard Areas” (SFHAs). A 100-year flood does not refer to a flood that occurs every 100 years but refers to a flood level with a one percent or greater chance of being equaled or exceeded in any given year. In Keweenaw County, Houghton Township have identified SFHAs. Both Grant and Sherman Township have registered to participate in the NFIP and have limited emergency coverage granted on October 27, 1997 and June 24, 2019, respectively.

### **Occurrence Probability and County Vulnerability**

From 2010 to 2019, one flood event was reported in Keweenaw County – a frequency of 0.1 events per year equating to a low probability of occurrence. Despite the low probability of occurrence, the flooding that occurred in 2013 was the costliest and resulted in state and federal disaster declarations. Riverine and urban flooding is a moderate risk in Keweenaw County because it can affect critical transportation infrastructure.

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<sup>13</sup> United States. Federal Emergency Management Agency. (2013, June 18). Michigan – Flooding: FEMA-4121-DR. [https://www.fema.gov/media-library-data/20130726-1923-25045-4160/dhs\\_ocfo\\_pda\\_report\\_fema\\_4121\\_dr\\_mi.pdf](https://www.fema.gov/media-library-data/20130726-1923-25045-4160/dhs_ocfo_pda_report_fema_4121_dr_mi.pdf)

<sup>14</sup> FEMA. Community Status Report Book – Communities Participating in the National Flood Program. <https://www.fema.gov/cis/MI.html>

While flooding can impact a variety of critical facilities and homes, identifying which specific facilities are most vulnerable to riverine and urban flooding is limited due to lack of available data. Critical facilities that are vulnerable to this kind of flooding include wastewater treatment facilities as well as septic and well systems. Any homes or business or industry facilities that rely on well or septic service may experience operational problems that force closure of the facility. If flood waters cover well heads, the well water is considered contaminated and no longer safe for human consumption. If grinder pumps in septic systems are inundated with water, the septic may overflow, causing additional human health issues.

## **Shoreline Flooding and Erosion**

### **Hazard Description**

Michigan has over 3,200 miles of coastline (the longest freshwater coastline in the world), and about 4.7 million persons live in the state's 41 shoreline counties, which includes Keweenaw County. Flooding and erosion along the Lake Superior shoreline are typically a result of high-water levels, storm surges, or high winds. These are natural processes that can occur at normal or even low water levels. However, during periods of high water, flooding and erosion are more frequent and serious, causing damage to homes, businesses, roads, water distribution and treatment facilities, and other structures in coastal communities. Seiches, which can drive lake water inland over large areas and may be caused by a storm surge, occur when windstorms and differences in atmospheric pressure temporarily tilt the surface of a lake up at one end. Water levels can rise to more than 10 feet. When the wind stops, lake water rebounds to the other side of the lake. This back and forth action, or oscillation, can occur for hours or even days.

Shoreline erosion hazards typically involve the loss of property as sand or soil is removed by water action and carried away over time. Erosion effects that are experienced along rivers may be included in this category of hazard.

Lake Superior levels have fluctuated since prehistoric times and accurate measurements of this change are available for the last 160 years. According to the U.S. Army Corp of Engineers, the peaks of this fluctuation have been higher during this century than they were in the past. Current lake levels are over a foot or a half of meter above the average annual (1918-2018) and continue to rise. The modern range of fluctuation between periods of high and low water is 1-meter. Long-term and seasonal variations in precipitation and evaporation rates primarily control lake levels and their fluctuations.

The land in the Great Lakes region is slowly recovering from the last glacial period when ice loaded and depressed the land surface. The land is rebounding from the weight of the former glaciers at different rates. The outlet channel to Lake Superior at Sault Ste. Marie is rising more rapidly than most other points along the U.S. shore, resulting in a tilting of the lake. The amount of inundation is greatest at Duluth, Minnesota where as much as 5.4 meters of inundation has occurred over the past 2,000 years. Maximum inundation over this period for the Michigan shore occurred near Ontonagon where as much as three meters is noted.

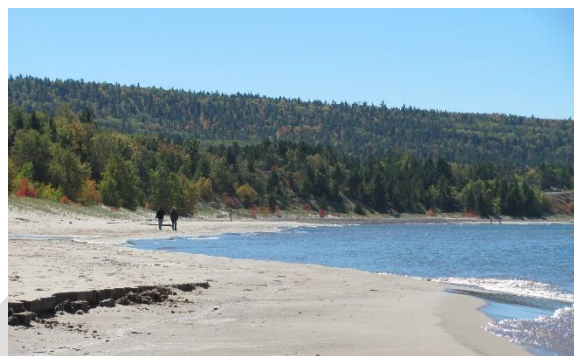


## **Climate Change Considerations**

Higher and lower water levels result from natural changes in climate in the region and will continue to occur. However, the impact from climate change on the magnitude and frequency of water-level change remains uncertain. Lake Superior water levels will continue to fluctuate, but the periods where it is either above or below average water levels may become prolonged.

## **Historical Occurrence**

Keweenaw County has two high-risk erosion areas identified by Michigan EGLE: Great Sand Bay in Houghton Township and Keystone Bay in Grant Township (Appendix B). These areas have mandatory and recommended setback regulations in place to mitigate losses due to erosion.



*Great Sand Bay*

From 1996-2019, two shoreline flooding events were reported in Keweenaw County on NOAA's Storm Events database. On September 10, 2014, east to northeast winds with gusts of up to or above 45 miles per hour resulted in high waves and significant erosion along the Lake Superior shoreline. Water covered a portion of M-26 highway in Eagle Harbor. An estimated \$2,000 in property damages were reported. High winds also caused extensive lakeshore flooding and erosion near Eagle Harbor on November 27, 2019. Northerly storm force winds over 55 mph produced waves as high as 15 to 20 feet over Lake Superior. Estimated property damage was \$100,000 in the county.

A seiche was reported on May 30, 2011 that developed after a dying thunderstorm complex moved over Lake Superior. The dying complex produced a low wake, which resulted in a seiche that caused lake water levels to fluctuate by two to four feet in minutes. Other U.P. counties, including Baraga, Marquette, Alger, and northern Houghton County, also experienced seiche conditions. No injuries or damages were reported in the county.

## **Occurrence Probability and County Vulnerability**

There have been three recent incidents of shoreline flooding in Keweenaw County in the past 10 years, thus the probability of occurrence is highly likely. Flooding and erosion may become even more frequent due to rising Lake Superior water levels. The county has approximately 95 miles of Lake Superior shoreline, present in every Keweenaw County township, all of which is potentially at risk from consistent low-severity flooding and erosion. However, erosion is an ongoing and unavoidable natural process – one that has exceedingly high probability, particularly in areas that are designated as high-risk areas. Mandatory setbacks that are required for shoreline development minimize the vulnerability of this hazard in Keweenaw County and keep flood risk low in structures.

Critical infrastructure, such as county roads and state highways, are vulnerability to this hazard particularly if they are near the Lake Superior shoreline. For example, M-26 in Eagle Harbor has



experienced repeated instances of flooding. Road closures can cause significant delays in emergency response and increased travel times for local commuters.

## **Drought**

### **Hazard Description**

Drought is a water shortage caused by unusual hydrologic conditions such as lack of rainfall and it generally lasts for an extended period, usually a season or more in length. Drought can be a normal part of an area's climate, including areas that have very high or low average rainfall. The level of precipitation or runoff associated with a drought is substantially below an area's norms. The severity of a drought depends not only on its location, duration, and geographical extent, but also on an area's water supply needs for human activities and vegetation.

Drought differs from other natural hazards in several ways. First, there is no exact beginning and end point that is obvious for a drought; the effects may accumulate slowly and linger even after the event is believed to be over. Second, the lack of clearly visible and universal standards to define a drought can make it difficult to confirm in a timely manner if a drought exists and its degree of severity. Third, drought impacts are often less obvious than other natural hazards. Fourth, most communities do not have any contingency plans in place for addressing drought. This lack of pre-planning can hinder support for drought mitigation capabilities.

The severe impacts from droughts on communities and regions include water shortages for human consumption, power generation, industrial and agricultural use, and recreation; drop in quantity and quality of agricultural crops; lower water quality in lakes, rivers, and other water bodies; increase in wildfires; decline in land values; increase in insect infestation, plant disease, and wind erosion, and; possible human impacts such as food shortages, extreme heat, fire, and other health-related problems such as diminished sewage flows and increased pollutant concentrations in surface waters.

Despite thousands of miles of rivers and streams and its surround Great Lakes, Michigan can still experience occasional drought conditions. Most common are agricultural droughts, with severe soil-moisture deficits, which have serious consequences for crop production, particularly when coupled with extreme summer temperatures. Also, various water bodies, both inland lakes and the Great Lakes, cyclically go through periods of low-water levels. Michigan has emerged from its latest such period and is now experiencing high water levels.

### **Climate Change Consideration**

While the effect of climate change on Michigan has involved an overall increase in precipitation and drought severity in the state has generally been decreasing, there will still be drought events and dryer seasonal phases, especially in areas that are locally more susceptible. Shorter duration seasonal droughts are expected to worsen during the warmer half of the year, even though overall annual averages of precipitation have increased. With enough planning and water infrastructure the climate change effects upon this hazard may be beneficial overall for a short period. However,

the threat and hazards from drought will not disappear and in the long-term is expected to greatly worsen.

### **Historical Occurrence**

Although Keweenaw County has not had a localized drought severe enough to be recorded, the United States Midwest has been significantly affected by drought in five years since 1981. These wide-ranging droughts have little long-term impact on wild flora and fauna, and since Houghton County has little cultivated land, drought does not significantly affect agriculture. Although stream and reservoir levels may drop, the county has not faced a critical power shortage resulting from interruption of hydroelectric generation (the power grid has a high degree of regional interconnectivity). The county does have some populated centers that are dependent on surface water for drinking water (Eagle Harbor, Copper Harbor, and Gay) and the rest rely on ground water, but temporary droughts have not diminished any water reserves to a notable extent. However, even a minor drought is one of the primary factors of wildfire potential and is a major hazard for that reason alone.

### **Occurrence Probability and County Vulnerability**

Countywide risk of other drought effects is minimal, with low probability of a recordable (moderately severe) drought but much higher incidence of less severe conditions. If a drought were to occur, all communities are vulnerable to drought effects, such as low water supplies in groundwater and drinking wells. Severe droughts can negatively affect drinking water supplies and impact critical facilities.

## **Ecological Hazards**

The following outline summarizes the significant ecological hazards covered in this section:

1. Wildfires
2. Invasive Species

These types of hazards deal with biological ecosystems and their effects on human economy and the built environment. The most well-known ecological hazard is wildfire, which occur naturally, but become dangerous when they threaten human that live in areas where the disaster event will periodically take place. Wildfires can cause damage and threats to human health and life. Ecological hazards must also be dealt with to maintain Michigan's environmental and recreational quality of life, as well as the important economic sectors that are closely connected with them (such as tourism, recreation, agriculture, and natural resource extraction).

## Wildfires

### Hazard Description

Forests cover approximately 55% (20.4 million acres) of Michigan's total land area and provide Michigan with the largest state-owned forest system in the U.S. Additionally, Michigan has the fifth largest quantity of timberland acreage, which includes 19.3 million acres of softwoods and hardwoods. While vast forest cover is a boon for industry and recreation, it also makes many areas of Michigan highly vulnerable to wildfires.

Michigan's landscape has significantly changed over the last several decades due to wildland development and thus potential danger from wildfires have become more severe. Increased development in and around rural areas has increased the possibility for loss of life and property from wildfires. Although most wildfires are small (a few acres), any one wildfire can burn out of control under the right conditions and multiply annual burned acreage. There are not enough fire suppression forces available in rural areas to protect every structure from a disastrous wildfire.

Most Michigan wildfires occur close to where people live and recreate. The most immediate dangers from wildfires are the potential injury or deaths of persons who live or recreate in the affected area and the destruction of homes, timber, and wildlife. Long-term effects included scorched and barren land, loss of wildlife habitat, soil erosion, landslides, water sedimentation, and loss of recreational opportunities.

According to the Michigan DNR, during 2019, the main cause (31%) of wildfires in the state is burning yard debris, such as grass clippings, leaves, and trash.<sup>15</sup> Most wildfires occur in the spring when days are dry and windy with abundant dead vegetation left after the snow melts. These conditions can spread a wildfire quickly because there is less moisture in the air and the wind carries burning debris to other areas. The dead vegetation makes for good wildfire fuel.<sup>16</sup>

### Climate Change Considerations

The average wildfire seasons has extended 78 days longer across the U.S., and large wildfires burn more than twice the area they did in 1970<sup>17</sup>. Changes in climate have led to hot, dry conditions that may increase fire activity. While there has been an overall increase in precipitation in Michigan, there will still be drought events and drier seasonal phases. Shorter duration seasonal droughts are expected to worsen in the warmer half of the year, which may affect wildfire



*A grass fire at the Little Gratiot River on Gay/Lac La Belle Road, April 30, 2020  
(Source: [Lac La Belle VFD/WLUC](#))*

<sup>15</sup> MDNR. 2019 fire program report. Forest Resources Division, Fire Management Section.

[https://www.michigan.gov/documents/dnr/2019\\_Fire\\_Report\\_web\\_optimized\\_693411\\_7.pdf](https://www.michigan.gov/documents/dnr/2019_Fire_Report_web_optimized_693411_7.pdf)

<sup>16</sup> MDNR, [https://www.michigan.gov/michiganprepares/0,4621,7-232-65025\\_65201---,00.html](https://www.michigan.gov/michiganprepares/0,4621,7-232-65025_65201---,00.html)

<sup>17</sup> Center for Climate and Energy Solutions. <https://www.c2es.org/content/wildfires-and-climate-change/>

occurrence. Development trends in Michigan seem to involve increases in wildfire risk over time, and annual cycles of summer drought have been projected by many climate analysts in the coming decades.

### **Historical Occurrence**

Over 90% of Keweenaw County is forest cover. This is an asset for both industry and recreation, but also leaves the county highly vulnerable to wildfires. From 1981 to 2018, the Michigan DNR reported 63 wildfires in the County on areas under MDNR jurisdiction, with an average of 1.7 fires per year. In that same time frame, 381.9 acres burned, with an average of 10.1 acres burned/year.<sup>18</sup> From 2007-2019, the Michigan DNR reported 11 wildfires in the county on areas under MDNR jurisdiction. A total of 51.6 acres were burned. Most wildfires in the county were ignited by lightning, but on occasion have been caused by campfires and debris burning.

The most recently reported wildfire was the Madison Gap Fire on May 23, 2015. A lightning strike started the fire and resulted in 5.7 burned acres. The largest wildfire was in 2008; the Noname fire burned 31.5 acres and was started by a campfire.<sup>19</sup>

### **Occurrence Probability and County Vulnerability**

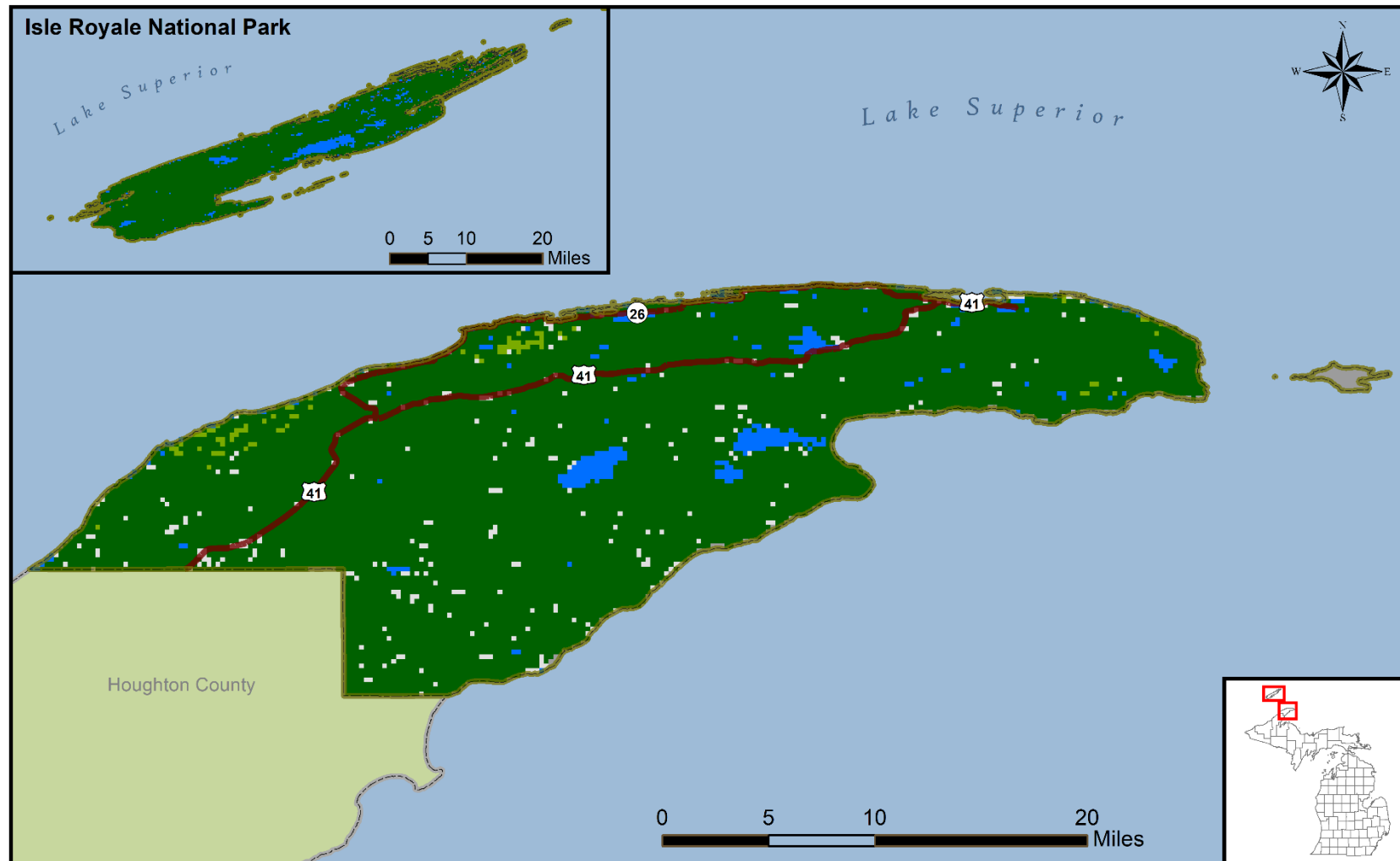
Keweenaw County has an ongoing risk of wildfires due to the tremendous amount of forest cover and increasing hazard due to urban infringement in rural areas. Although Keweenaw County is sparsely populated, development in rural areas can intensify overall damage from wildfires. Risk is relatively high in Keweenaw County due to human activities in the outdoors and the county's remoteness, which affects response time for emergency responders. All areas of the county have some vulnerability to wildfire, but extent varies greatly by location. Homes and other built infrastructure, such as roads and power lines, in rural townships are more vulnerable to wildfires due to their proximity to undeveloped areas.

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<sup>18</sup> State of Michigan Hazard Analysis: Natural Hazards, pg. 248.

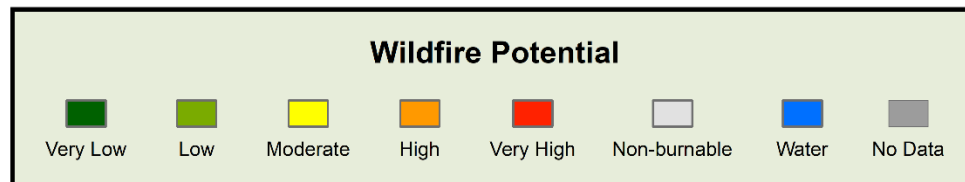
<sup>19</sup> MDNR. Wildland Fire Map. <http://www.mcgi.state.mi.us/wildfire/mcgi.html>

**Map 5.4: Wildfire Hazard Potential in Keweenaw County**



## Wildfire Hazard Potential Keweenaw County, Michigan

Boundary data was derived from Michigan's Open Data Portal; Hazard data was developed by the USDA and USFS; Created by WUPPDR July 2020



## **Invasive Species**

### **Hazard Description**

An invasive species is defined as a species that is 1) non-native to the local ecosystem and 2) whose introduction causes or is likely to cause economic or environmental harm, or harm to human health. Invasive species can be plant, animals, and other organisms (e.g., microbes). Human actions are typically the cause of invasive species' invasion; it is not a natural shift in a species distribution. Nationally, the current environmental, economic, and health costs associated with invasive species were estimated as exceeding the costs of all other natural disasters combined.

Invasive species can be transported into an ecosystem in many ways, such as on animals, vehicles, ships, commercial goods, produce, and clothing. Although some non-native species are used to prevent erosion, 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. "Invasive" or "nuisance" are used to describe such species.

A plant or animal that causes little damage to agriculture or natural ecosystems in one area may cause significant problems in another. Certain non-native 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 their new area. Hundreds of new species from other countries are introduced intentionally or accidentally to the U.S. each year. Transportation efficiencies make it possible for invasive species to travel around the globe in hours and make it possible for organisms to survive transportation from one continent to another. At least 200 well-known, high-impact, non-native species presently occur in the U.S.

As more adaptable and generalized species are introduced to environments already impacted by human activities, native species are often at a disadvantage to survive in what was previously a balanced ecosystem. While invasive species primarily cause environmental damage and degradation, there are situations in which serious threats to public health and well-being can occur due to animal disease or plant/animal infestation. Invasive species can also create serious public safety threats; some invasive insects can cause significant damage to trees (disease or death) and may lead to partial/total tree collapse.

Terrestrial species are likely to have more public awareness than aquatic ones. Although there have been well-publicized aquatic species of concern (e.g., zebra mussels, Asian carp), people tend to be more aware of the impacts of terrestrial species, unless their recreational or business activities are impacted by aquatic species.

### **Climate Change Considerations**

Due to the lengthening of Michigan's growing season, species that had been previously found only in warmer areas to the south have started to appear. While the definition of invasive species specifically refers to species introduced by humans, to distinguish these patterns from naturally occurring ones, species transported by human action can be more likely to survive as climatic changes occur.



## Historical Occurrence

Due to Keweenaw County's large amount of lakes, rivers and forest coverage, both terrestrial and aquatic species have been found throughout the County. There have been over 3,800 reported locations of invasive species, most of which are terrestrial invasive plants<sup>20</sup>. The following are some examples of reported invasive species that have been found or threaten the local ecosystem in Keweenaw County:

### Invasive Insects

**Emerald Ash Borer (*Agrilus planipennis*):** First discovered in southeastern Michigan near Detroit in 2002, this exotic beetle has killed hundreds of millions of ash trees throughout the U.S. Adult emerald ash borers (EAB) feed on ash foliage but cause little damage. The larvae feed on the inner bark of the ash trees, disrupting the tree's ability to transport water and nutrients. Many trees lose approximately 30 to 50 percent of their canopy in one year and the tree is often killed after 2-3 years of infestation. Most devastation has occurred in southeast Michigan, where about 20 million trees have been killed. EAB has been reported within Keweenaw County.<sup>21</sup>



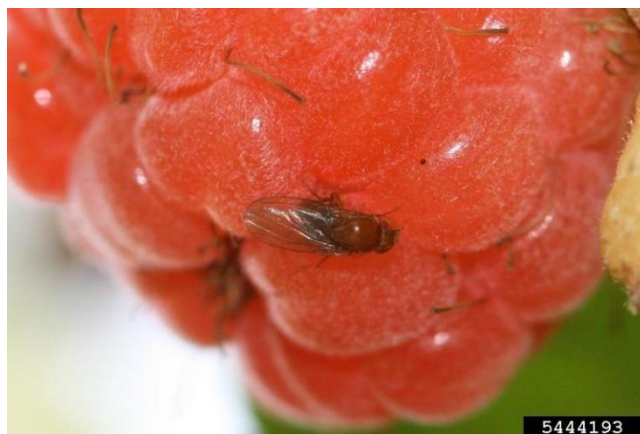
Emerald ash borer adult (a), larvae (b), and damage (c) to ash trees. (David Cappaert (a, b) and Troy Kimoto (c))

**Gypsy moth (*Lymantria dispar*):** Typically found on oak and aspen leaves, the Gypsy moth defoliates trees, leaving trees vulnerable to diseases and other pests. The damaged can lead to tree mortality. When there are large populations of gypsy moths, tree debris (e.g., branches and twigs) and frass (tree sawdust) may occur, disrupting outdoor recreation.

<sup>20</sup> Midwest Invasive Species Information Network. Data Map by State and County. [www.misin.msu.edu](http://www.misin.msu.edu)

<sup>21</sup> Emerald Ash Borer Story Map. [www.aphis.usda.gov/aphis/maps/plant-health/eab-storymap](http://www.aphis.usda.gov/aphis/maps/plant-health/eab-storymap)

Spotted Wing Drosophila (*Drosophila suzukii*): The Spotted Wing Drosophila (SWD) is a small vinegar fly with the potential to damage many fruit crops. It was first detected in Michigan in late September 2010. Unlike most other vinegar flies that require damaged fruit to attack, SWD causes damage when the female flies cut a slit and lay eggs in healthy fruit. This insect is a pest of most berry crops, cherries, grapes and other tree fruits, with a preference for softer-fleshed fruit. Given the propensity for this insect to spread and its potential to infest fruit, it is important to learn about monitoring and management of SWD to minimize the risk of larvae developing in fruit and affecting fruit marketability<sup>22</sup>.



Adult Female Spotted Wing Drosophila (Hannah Burrack, North Carolina State University)

### Invasive Plants

Wild parsnip (*Pastinaca sativa*): Wild parsnip has been found in Michigan since 1838 and was originally introduced to the U.S. as a food source. It is commonly found growing in open areas, fields, roadsides, and disturbed areas and can grow in a variety of soil types and moisture levels. Wild parsnip can spread through seeds carried by wind, water, and equipment. This kind of parsnip is also a human health hazard. The sap found in the stem, leaves, and flowers contain a chemical that increases skin sensitivity to sunlight and cause severe rashes or blisters. Wildlife and domesticated animals are also vulnerable.

Spotted knapweed (*Centaurea stoebe*): Spotted knapweed is commonly found on dry sandy soil in disturbed areas near roads and abandoned farms or in dry dunes or prairies. It was introduced into the U.S. in the 1890s from Eurasia and can outcompete native plants due to its ability to emit a



Eurasian watermilfoil (Chris Evans, University of Illinois)

chemical into the soil that is toxic to surrounding plants. While it is considered an invasive weed, it is also known for the honey that bees make from its nectar (Star Thistle Honey).

### Invasive Aquatic Plants

Eurasian watermilfoil (*Myriophyllum spicatum*): Eurasian watermilfoil (EWM) is an aquatic plant that was found in Michigan freshwater lakes during the 1960s. EWM has spread quickly throughout all U.P. counties.

<sup>22</sup> Rufus Isaacs, Noel Hahn, Bob Tritten, and Carlos Garcia. (2010) MSU Extension Bulletin E-3140. Spotted Wing Drosophila. Michigan State University <https://www.canr.msu.edu/ipm/uploads/files/E-3140.pdf>

Stem fragments, which can be attached to fishing lines or boats, can take root and form a new colony after being transported from one water body to another. It forms thick underwater vegetation mats that shade out native plants and impedes recreational activities, such as swimming, fishing, and boating. Prime EWM habitat includes lakes that have been disturbed by watershed runoff, shoreline construction, or stressed by pollution. If a lake has a healthy population of native aquatic plants, EWM has a hard time establishing itself in the lake.

Purple loosestrife (*Lythrum salicaria*): Purple loosestrife thrives in shorelines, roadsides, and wetlands. It is a perennial invasive plant and can spread quickly, replacing native vegetation which reduces food, shelter, and nesting sites for turtles, birds, frogs, and other wildlife. Seeds can germinate in water, but it prefers shorelines that are not always flooded. Purple loosestrife was first introduced to the U.S. in the 1800s from Europe as an ornamental plant and for bee keeping. It has since spread to every U.S. state.

### **Invasive Aquatic Species**



*Zebra mussel* (Photo: A; Randy Westbrook, Invasive Plant Control, Inc.) and *quagga mussel* (Photo: B; Amy Benson, USGS)

Dreissenid Mussels (including Zebra Mussels and Quagga Mussels); family *Dreissenidae*: Dreissenid mussels have been present in the Great Lakes since the late 1980s and were transported to the area via ballast waters from shipping barges. Both mussels can attach to hard surfaces, clogging water intake pipes and fouling other hard-shelled animals such as clams. Zebra mussels have significantly reduced plankton populations, as mussels filter large volumes of water for food, which can deplete food resources of larval and planktivorous fishes like smelt and alewife. This also results in an increase in water clarity and an increase in aquatic plants. Clear water is aesthetically pleasing, but the clarity indicates that there have been drastic changes at the base of the food web. While more attention has been given to the zebra mussels, quagga mussels have a large spatial extent in the Great Lakes as it can tolerate colder and deeper waters than zebra mussels.





Sea lamprey attached to a fish (Photo: A; U.S. Fish and Wildlife Service) and mouth (Photo: B; Angela Yu)

**Sea lamprey (*Petromyzon marinus*):** Sea lamprey were first discovered in the Great Lakes in the 1800s and its introduction into Lake Superior has caused serious decline in fish populations and an alteration of the ecosystem. The lamprey uses its suction cup like mouth to latch onto the skin of a fish and scrapes away tissue with its sharp probing tongue and hooked teeth. Secretions in the lamprey's mouth prevent the victim's blood from clotting and the lamprey sucks the blood from the fish. Victims typically die due to excessive blood loss or infection. The sea lamprey has played a significant role in the decline of Lake Superior lake trout, a key predator fish, which has allowed other invasive fish species, such as the alewife, to explode in population. Control efforts to mitigate the impacts of lamprey have been used, but it is still present in the Great Lakes.

### Occurrence Probability and County Vulnerability

The probability of future occurrence for invasive species for Keweenaw County is high and will rise due to the continual transport of goods and expanding global trade. This has created opportunities for many organisms to be transported to and establish themselves in new countries and regions. There are several invasive species that have yet to be found in Keweenaw County or surrounding area, but once established, they are hard to eradicate because most people will not notice their presence until the damage is already done.

The entire population is vulnerable to invasive species because the hazard primarily impacts the environment. The destruction that invasive species have on woodlands and water features ultimately impacts humans by diminishing the positive features that nature offers and diminishing our food supply. A widespread insect infestation, such as from the Emerald ash borer, can create serious public safety threats due to dead and dying trees being fire prone (due to their dry, brittle nature) or to partial/total collapse due to high winds or ice/snow accumulation. The falling trees or limbs can bring down power lines, cause damage to public and private structures, and cause injuries or death. Transportation infrastructure is also vulnerable to damage as tree debris can fall onto roadways and trails, blocking commuters, trail users, and emergency response vehicles.

## Geological Hazards

The following outline summarizes the significant geological hazards covered in this section:

1. Earthquakes
2. Subsidence (Ground Collapse)

Although some states recognize “landslides” as an additional hazard, Michigan’s geology and history tends to make it more prone to land subsidence instead. Michigan’s two main vulnerabilities to ground movement are therefore identified in the sections on earthquakes and subsidence hazards.

### Earthquakes

#### 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 tremors over a period of several days. Earthquakes usually occur without warning; however, scientists cannot yet predict exactly when or where an event 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 which show areas where an earthquake is more likely to occur.

Most areas of the country are subject to earthquakes, including parts of Michigan, and they occur thousands of times a year. Most earthquakes are minor tremors and results in little or no loss of life, property, or essential services. However, earthquakes are dangerous because they can cause severe and sudden loss and devastation without warning. Deaths and injuries are caused indirectly through the collapse of structures. Earthquakes are measured by their magnitude (amount of energy released at the epicenter) and intensity (measure of damage done at one location; essentially the same as “severity” as classified throughout this plan). The Richter Magnitude Scale is commonly used to determine earthquake magnitude, and the Modified Mercalli Intensity Scale is used for intensity. A 5.0 on the Richter Scale is a moderate event, while an 8.0 is a catastrophic event. The Mercalli Intensity Scale describes 12 increasing levels from imperceptible to catastrophic.

Michigan is not located in an area subject to major earthquake activities. Although there are faults in the bedrock of Michigan, they are now considered relatively stable. Earthquakes risks in Michigan are generally low, which means structures or utilities are not necessarily built to withstand even small seismic events. Due to low risk, Michigan may be more vulnerable to an earthquake because of poor preparation.

#### Historical Occurrence

No severely destructive earthquake has ever been documented in Michigan. However, several mildly damaging earthquakes have been felt since the late 1700s. Earthquake tremors have been felt in the Michigan Territory, with the earliest recorded in 1811. Up to nine tremors from the New Madrid Seismic Zone, which runs from Cairo, Illinois through New Madrid, Missouri to Marked

Tree, Arkansas, were reportedly felt in Detroit. Since then, there has been only questionable activity in the Upper Peninsula, occurring in the Keweenaw Peninsula in 1905, 1906, and 1908. While there were explosions and ground shaking felt as far away as Marquette, it is believed to have been from pillars collapsing in local mines.

### **Occurrence Probability and County Vulnerability**

There is a very low – nearly zero – probability of an earthquake occurring anywhere in Keweenaw County. However, because of the Keweenaw Fault, which runs up the spine of the peninsula and past minor incidents resulting from mining, the possibility of an earthquake cannot be completely ruled out. Due to the low probability of an earthquake, no critical facilities nor municipalities were considered vulnerable from earthquake impacts.

## **Subsidence (Ground Collapse)**

### **Hazard Description**

Subsidence is depressions, cracks, and sinkholes in the ground surface that can threaten people and property. When there is a collapse or lowering of a land surface, it can be caused by a variety of natural or human-induced activities. Natural subsidence occurs when the ground collapses into underground cavities due to the solution of limestone or other soluble materials, such as salt and gypsum, by groundwater. Overtime, the dissolution of rock into groundwater can create a void that may be subject to sudden and catastrophic collapse, causing a sinkhole. Human-induced subsidence is caused mainly by groundwater withdrawal, drainage of organic soils, and underground mining. In the U.S., these activities have caused more than 17,000 square miles of surface subsidence, with groundwater withdrawal as the primary culprit.

In Michigan, the greatest risk of subsidence is associated with underground mining. Mine subsidence is a geologic hazard that can occur with little or no warning. It occurs when the ground surface collapses into underground mine areas. Strain from geological movements, additional surface loading, and vibrations from truck traffic and other industrial machinery can cause the ground above and around old mines to sink and collapse. Industrial or residential developments that are near or above active or abandoned mines are threatened by subsidence due to their proximity to underground cavities. Mine subsidence can cause damage to buildings, disrupt underground utilities, and be a potential threat to human life.

The legacy of underground mining can be felt throughout the state. Many of the underground mining areas, whether active or abandoned, are vulnerable to subsidence in some form. Unfortunately, records of abandoned mines are often vague and sometimes non-existent; it is often difficult to determine exactly where the mines were located. Many areas throughout the state may have been developed over abandoned mines and may not be aware of it. While underground mining has fueled economic growth in many parts of the state, it has left a legacy or threat of subsidence. Old abandoned mines will eventually begin to collapse under their own weight or human neglect and oftentimes can swallow up whatever is built upon them.



## **Historical Occurrence**

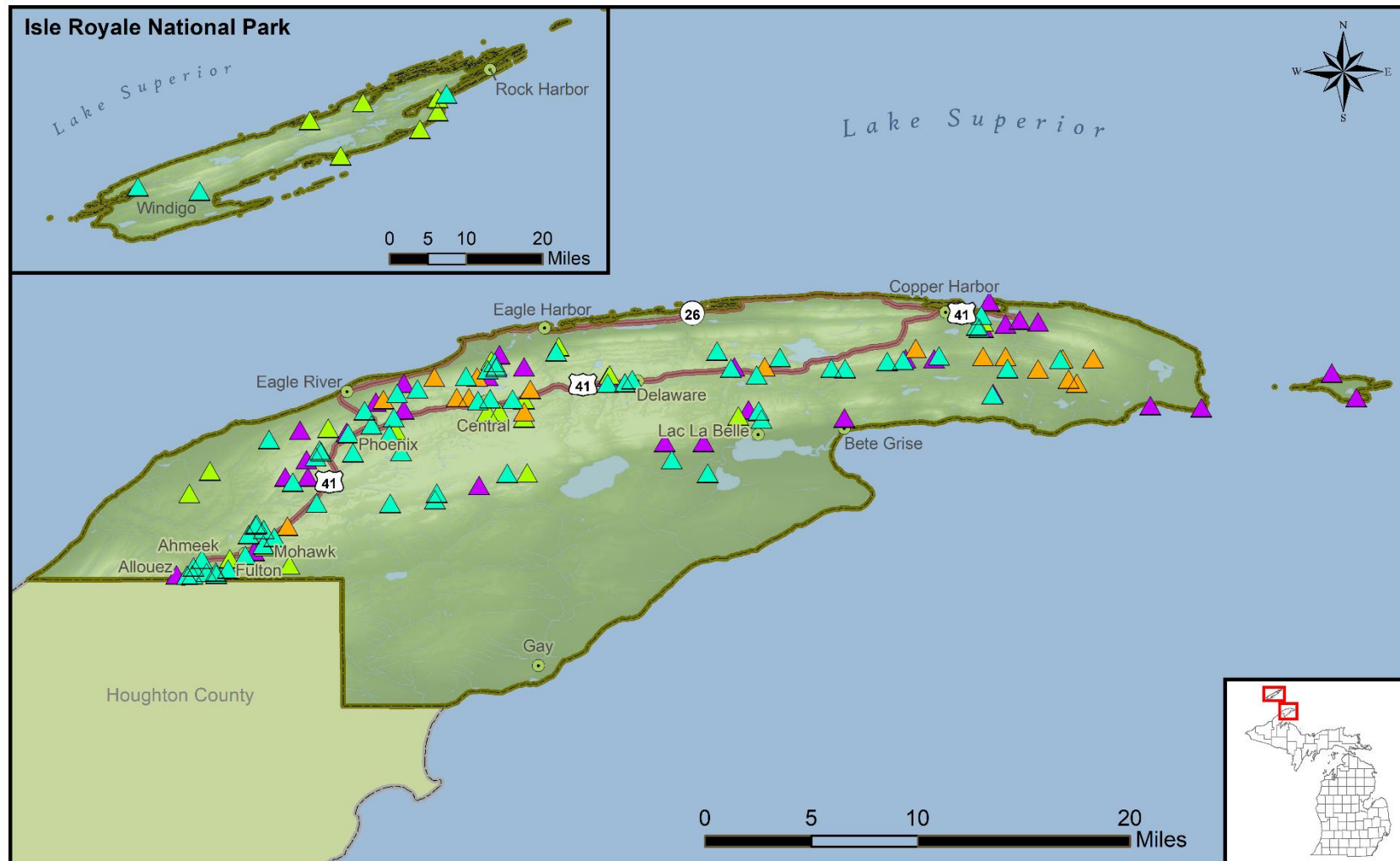
Michigan has a rich mining heritage and a wide variety of mineral resources, most notable of which are copper ore, iron ore, sand, gravel, coal, salt, oil, and gas. Underground mining has occurred on a significant scale throughout Michigan's history. Michigan's Lake Superior region has been home to significant copper mining operations since the mid-1800s. Mining activity ended in 1960s, when the last shipment of copper sent out.

There are over 800 underground mines in Michigan, with more than 2,300 shafts or other openings. Many mines were opened in the 1840s and even though many mine sites have been inspected by a county mine inspector, some are still unknown and/or unmarked. There are very limited records of the locations of shafts, and the extent of underground minds and proximity to surface to the surface may be unknown. This is also the case in Keweenaw County.

Keweenaw County has historically been a center for copper mining activities. Copper mines once existed along much of the Highway U.S. 41 corridor as far north as Delaware. Area mines included the Delaware, Central, Phoenix, Cliff, Mohawk, Ahmeek, and Allouez. A Michigan Abandoned Underground Mine Inventory was completed in late 1998. The inventory includes information on about 800 mine locations with nearly 2,000 openings to the surface throughout the state. Distribution of the reports was limited to the DNR and the County Mine Inspectors, or related agencies, for the counties containing the old mines. Distribution was limited to prevent the materials from becoming guides to potentially dangerous locations for adventurous people who may enter unsafe areas and be hurt or killed. Most mine shafts are on private land and pose a risk.

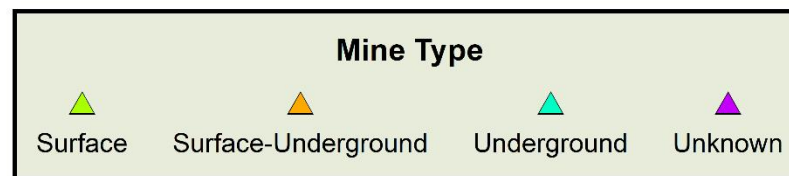
While Keweenaw County has not recorded a significant damaging subsidence event, smaller events in Eagle Harbor Cutoff Rd. and Copper City Rd. have occurred. In April 2001 in neighboring Houghton County, a 3-foot deep sinkhole developed presumably when the foundation of a church that once occupied the site collapsed. The Houghton County Mining Inspector has reported that numerous ground failures occur each year, often due to inadequate capping techniques. The comparable mining history and geology of Keweenaw County makes it vulnerable to a similar event.

**Map 5.5: Mine Locations by Type in Keweenaw County**



## Mine Locations Keweenaw County, Michigan

Boundary data was derived from Michigan's Open Data Portal; DEM was derived from elevation data available through the USGS; Mine location data was downloaded from the National Mine Repository and the U.S. Geological Survey; Created by WUPPDR July 2020



## **Occurrence Probability and County Vulnerability**

While smaller, single site/structure subsidence incidents have occurred in Keweenaw County, none have been deadly, most likely due to the county's low population density. However, these incidents will continue to occur in the future because of both known and unknown potential hazards. Areas adjacent to the historic copper mines are susceptible to future subsidence, and awareness is important to mitigate hazard impact. Areas in Keweenaw County that may be more likely to experience subsidence are along the U.S. 41 corridor from Allouez to Delaware where historical mining operations in the county were most prevalent. Probability is low based on known history but may be higher than expected since many failures likely go unreported each year. Severity is case- and site-specific and can range from low to extreme.

## **Technological Hazards: Industrial Hazards**

The following outlines the significant industrial hazards that are covered in this section:

1. Scrap Tire Fires
2. Structural Fires
3. Hazardous Materials: Fixed Site Incidents
4. Hazardous Materials: Transportation Incidents
5. Petroleum and Gas Pipeline Accidents

This section covers many related types of events that stem from breakdowns or weaknesses in the industry and the built environment. Unlike ordinary fires and wildfire events, scrap tire fires are a special case of industrial hazard as these types of fires involve toxic smoke and chemical residues that have more in common with hazardous material incidents. This is also the case for structural fires, as it considers various types of large fires that occur among important buildings or structures. This hazard analysis focuses on larger-scale fires that have greater potential to affect an entire community, either through a fire's magnitude or through the vital nature of the facilities or resources that it affects.

The other hazards listed, specifically dealing with hazardous materials, cover a wide array of extremely hazardous substances across diverse situations that typically involve industrial or warehousing operations. Fixed site incidents include a consideration of fire-related industrial accidents and explosions, even if these did not involve a hazardous substance. The emphasis is on events of a relatively large magnitude, particularly those that resulted in a community states of emergency, evacuations, impairment or loss of economically significant or critical facilities, or multiple casualties.

### **Overlap with Other Sections of Hazard Analysis**

Various types of structural, scrap tire, and industrial fires may be caused by other large-scale disaster events, such as lightning strikes which cause direct ignition of structure fires and the destruction caused by tornadoes could also lead to a fire. Additionally, wildfires have a clear potential to ignite structures and scrap tire piles. A structural fire involving a critical facility has

the potential to cause infrastructure failures, energy emergencies, flooding, wildfires, dam failures, and transportation accidents.

## **Scrap Tire Fire**

### **Hazard Description**

A scrap tire fire is a large uncontrollable fire that burns scrap tires being stored for recycling or reuse. Scrap tire fires are dangerous because they can require significant resources to control and extinguish, often beyond the capability of local fire departments. Furthermore, the extreme heat from the fire can convert a standard automobile tire into about two gallons of oily residue. This residue can leach into soil or runoff into surrounding waterways, creating an environmental hazard. Scrap tire fires may also require temporary evacuation of some residences and businesses and even close roadways.

Michigan generates approximately 10 million scrap tires each year. Whole tires are banned from disposal in Michigan landfills due to their associated problems. Stockpiled tires can be breeding grounds for mosquitoes and can be homes to snakes and other small mammals (rats, opossums, raccoons). Although responsible means of tire storage and disposal have become more common, tire dumps of the last 40 years still present environmental and safety hazards.

### **Historical Occurrence**

There are no licensed scrap tire facilities in Keweenaw County and no record of historical fires related to scrap tires. There are auto/tire shops that collect tires for a small fee in Houghton County, but the number of tires accepted is limited. Because of limited tire drop-off locations, this can lead to individuals improperly disposing scrap tires. Illegal dumping of tires has historically occurred off the top of Brockway Mountain. Illegal activity arises on private property as well due to the low population and large undeveloped acreage of private land.

### **Occurrence Probability and County Vulnerability**

There have been no known scrap fire tire incidents in Keweenaw County. Probability of future occurrences is low due to heavy regulation of scrap tire collection sites. However, the severity of the possible event is high as a small mistake on either a register or unregistered site can spark a severe fire – particularly where regulation is nonexistent. Because of low future probability, the associated vulnerability of a scrap tire fire is also low. Additionally, locations of non-compliant sites or potential dumping locations are not near critical facilities.

## **Structural Fires**

### **Hazard Description**

In terms of average annual loss of life and property, structure fires are by far the most common and significant hazard facing communities in Michigan and across the country. Structural fires

cause more property damage and loss of life than all types of natural disasters combined. These fires include any fire in or on a building or other structure, even if the structure itself was not damaged. Direct property losses due to fire exceed \$9 billion per year countrywide and much of that figure is the result of structural fires. In 2017, there were 13,523 structure fires statewide resulting in over \$415 million in losses and 104 deaths. Most deaths are due to structural fires in homes. In Michigan, residential fires account for 72.4% of all structural fires and cause nearly 82% of fire fatalities.

Structural fires can cause displacement and homelessness, in addition to serious injuries, death, and economic losses. Beyond the small-scale structural fires that only impact a single home or two, emergency management authorities are primarily focused on disaster level events involving multiple or major structures such as hotels, college residence halls, and major employers and community facilities (e.g., schools and hospitals). Structural fires occur more frequently than other Michigan hazards and often cause more deaths, injuries, and property damage.

### Historical Occurrence

Rural areas face similarly high risk of structure fires but for different reasons. Fire response, police, and ambulance response times are slower than in urban locales. Distance of these support services and more extensive firefighting capability (including modernized equipment with appropriate storage) exacerbates the severe nature of rural structure fires. In 2008, there were 14 fires in Keweenaw County which caused \$14,000 in damage. Of these fires, 14% were suspicious or determined to be arson.

Structural fires are of special concern in Keweenaw County because many of the buildings were built in the early 1900s or before. Many of these older homes, as well as numerous camps and cabins in the woods, are also heated by wood-burning stoves, placing them at additional risk. Homes also fall vacant and become dilapidated over time, decreasing maintenance and monitoring and increasing fire risk, which becomes an even greater problem with absentee property ownership.

On September 23, 2016, a house fire occurred in Fulton, near Mohawk (Allouez Township), and caused the deaths of two people. The direct cause of the fire was unknown but believed to have started near the wood stove in the basement of the residence.



*Fire fighters searching the interior of Fulton structure for hotspots following fire (Source: Graham Jaehnig, Daily Mining Gazette)*

### Occurrence Probability and County Vulnerability

Due to an older housing stock, compact development in downtown areas, and remote development, Keweenaw County is susceptible to fire. Probability is very high with potentially extreme severity throughout the County. Severity is highest in the cities and villages with large housing complexes.



The County has multiple fire departments with mutual aid agreements in place to respond to structural fires. Education and operational fire detectors can often mitigate the loss from this type of hazard. Frequency of fires is 14 per year based on 2008 occurrences. Property loss in 2008 was around \$14,000.

## Hazardous Materials: Fixed Site Incident

### Hazard Description

As new technologies have developed, hazardous materials are present in quantities of concern in business and industry, agriculture, universities, hospitals, utilities, and other facilities. Hazardous materials, if released, pose a potential risk to life, health, property, or the environment due to their chemical, physical, or biological nature. Examples of hazardous materials include corrosives, explosives, flammable materials, radioactive materials, poisons, oxidizers, and dangerous gases.

Hazardous materials are carefully regulated by the government to reduce risk, but accidental releases can occur during the manufacture, transport, storage, use, and disposal of the materials. Areas at highest risk are within a one- to five-mile radius of identified hazardous material sites. Many communities have detailed response plans in place to mitigate the harm to people, property, and the environment from hazardous materials.

### Historical Occurrences

There are no facilities within Keweenaw County with supplies of Extremely Hazardous Substances that require reporting under the Superfund Amendments and Reauthorization Act (SARA) Title III. Title III identifies what steps facilities, the State, and local communities must take to protect the public from hazardous materials accidents. Due to the County's large area of Lake Superior shoreline, water-related contamination is of concern and the extent of contamination from other incident locations is unknown.

Copper mining activities in the area from 1890s until 1969 produced mill tailings (called stamp sands) that contaminated sediments and shoreline in the Keweenaw. Stamp sands may be hazardous and contain trace amounts of heavy metals like arsenic. Former stamp mills dot the landscape of Keweenaw County, and were frequently constructed along water for processing. The Mohawk mine, for example, is known to contain significant arsenides. The Mohawk mine is the main source of the Gay Sands. The Wolverine mine also contributed mine tailings to Gay. Central Creek in Houghton Township is being rerouted to reduce copper content, and toward the west has conducted phase 1 and 2 of stamp sand remediation.



*Gay stamps sands and smokestack*



The stamp sands at Gay have drifted south to the Grand Traverse Harbor, covering nearly 1,400 acres of previously white sand shoreline and lake bottom. It also threatens to cover Buffalo Reef, a 2,200-acre reef in Lake Superior that is a spawning habitat for lake trout whitefish. The reef contributes approximately 30% of the lake trout harvested within 50 miles of the reef.<sup>23</sup> Currently, the stamp sands are being dredged from the reef to protect the spawning habitat and to prevent the sands from spreading further into the lake. If the stamp sands were not moved and the reef was not dredged, more than half of the fish spawning habitat would disappear. This would significantly threaten the local fisheries and associated outdoor recreation and commercial fishing industries that the spawning habitat supports.

Mount Horace Greeley Air Force Station in Eagle Harbor Township was home to the 665<sup>th</sup> Aircraft Control and Warning Squadron for four decades before being abandoned. Environmental contamination site assessments have been conducted to determine that remediation is necessary. Asbestos, lead-based paints, and remnants of oil spills are still present at the site. Groundwater at the site is also contaminated, which limits any types of new development from occurring near or at the site. While the site has long been abandoned, trespassers continue to visit the site and explore the dilapidated and weakened buildings. The Keweenaw County Sheriff has taken steps to prevent trespassing to eliminate the threat of injuries and further damage and vandalism to the site.<sup>24</sup>

In March 2018, the primary lagoon liner failed at the Copper Harbor Wastewater Treatment Plant, which handles flows from Copper Harbor and Fort Wilkins State Park. When the liner failed, sewage flowed out of the lagoon and partially intercepted by the underdrain system. Some sewage also flowed into Lake Superior. When this was discovered, the affluent was then diverted to the second lagoon. However, it was determined that since both liners were installed at the same time, the second lagoon liner was also at risk of failure. Improvements to the facility are planned.<sup>25</sup> In July 2019, the Western U.P Health department has maintained a precautionary beach closure for Lighthouse Overlook Beach in Copper Harbor due to questionable sewage discharge from one of the lagoons.

### **Occurrence Probability and County Vulnerability**

Chemicals that are being used in Keweenaw County are isolated and stored in relatively small quantities with no required reporting, so the probability of a major event (as opposed to long-term contamination) is low and severity also expected to be low. Vulnerability is somewhat high due to the possible presence of unknown stocks.

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<sup>23</sup> WLUC. (2019, November 6). "Task force designing alternatives for protecting Buffalo Reef." <https://www.uppermichigananssource.com/content/news/Task-force-designing-alternatives-for-protecting-Buffalo-Reef-564560041.html>

<sup>24</sup> Palarz, Anders. (2019, October 31). "The Calumet Air Force Station." Military History of the Upper Great Lakes. <https://ss.sites.mtu.edu/mhugl/2019/10/31/the-calumet-air-force-station/#:~:text=A%20hidden%20gem%20in%20the,along%20the%20northern%20US%20border.>

<sup>25</sup> MDEQ. (2018, February 4). Finding of No Significant Impact: Grant Township Wastewater Treatment Plan Improvements and Lagoon Liners. [https://www.michigan.gov/documents/deq/deq-dwmad-mfs-FNSI-EA-5674-01\\_643958\\_7.pdf](https://www.michigan.gov/documents/deq/deq-dwmad-mfs-FNSI-EA-5674-01_643958_7.pdf)

## **Hazardous Materials: Transportation Accident**

### **Hazard Description**

Due to the extensive use of chemicals in society, all modes of transportation – highway, rail, air, marine, and pipeline – are carrying thousands of hazardous materials shipments daily through local communities. A transportation accident involving any one of those hazardous material shipments could cause a local emergency affecting many people. Areas at greatest risk are those within one to five miles from major transportation routes.

Michigan has had numerous hazardous material transportation accidents that affected the immediate vicinity of an accident site or a small portion of the surrounding community. They are effectively dealt with by local and state emergency responders and hazardous material response teams. Large-scale or serious hazardous material transportation incidents that involve a widespread release of harmful material can adversely impact the life safety and/or health and well-being of those in the area surrounding the accident site. Statistics show that most hazardous material transportation incidents are the result of an accident or other human error. Rarely are they caused simply by mechanical failure.

Michigan has had few large-scale, serious hazardous material transportation incidents, but has had numerous small-scale material transportation incidents that required a response by local fire department and hazardous material teams, and many events also required evacuations and other protective actions.

### **Historical Occurrences**

U.S. 41 north to Copper Harbor is a major transportation corridor for Keweenaw County but is not a major transportation route for trucks. The types and amounts of hazardous materials transported on trucks traveling this route are often unknown. While there are State and Federal restrictions for the transport of hazardous materials, this information is not required to be passed on to the local units of government potentially affected by a transportation accident.

Keweenaw County has many miles of shoreline adjacent to major Great Lakes shipping routes. In October 2003, a Great Lakes freighter spilled fuel oil during an internal fuel transfer about 25 miles west of Eagle Harbor. About 1,300 gallons were lost with about 800 gallons of dime-sized tar balls washing up on shore about four miles south of the Portage Lake Canal north entry in Houghton County.

### **Occurrence Probability and County Vulnerability**

In Keweenaw County, the probability of a hazardous materials transportation accident is low based on history, but there is a considerable risk. Areas most susceptible and have a higher probability of experiencing an accident are corridors including US 41, M-26, and the immediate shorelines of Lake Superior. Damage estimates for the previous event are unavailable, but potential severity of an events could range from low to extreme.

Another potential risk to be considered is Isle Royale. As an unconnected part of the County, Isle Royale is at risk of fog-related transportation incidents occurring. Fuel barges pass through county lines regularly on Lake Superior, and wind and fog are the largest potential hazards near Isle Royale. The high vulnerability of Isle Royale is in part due to its remoteness.

## **Petroleum and Natural Gas Incidents**

### **Hazard Description**

Often overlooked as a hazard because most petroleum and natural gas infrastructure in the state is underground, these pipelines can pose a real threat to many Michigan communities. Petroleum and natural gas pipelines can leak or fracture, causing property damage, environmental contamination, injuries, and even loss of life. Most pipeline accidents that occur in Michigan are caused by third party damage to pipelines, 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. Michigan is the largest residential liquefied petroleum gas 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. Michigan also has the greatest underground natural gas storage capacity in the nation and supplies natural gas to neighboring states during high-demand winter months. The state has a highly developed and extensive gas and petroleum network, representing every sector of the two industries – from wells and production facilities, to cross-county transmission pipelines that bring the products to market, storage facilities, and finally to local distribution systems.

While petroleum and natural gas industries have historically had a fine safety record, and pipelines are the safest form of transportation for these products, the threat of fires, explosions, ruptures, and spills still exists. In addition to these hazards, there is a danger of hydrogen sulfide (H<sub>2</sub>S) release. 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.

### **Historical Occurrence**

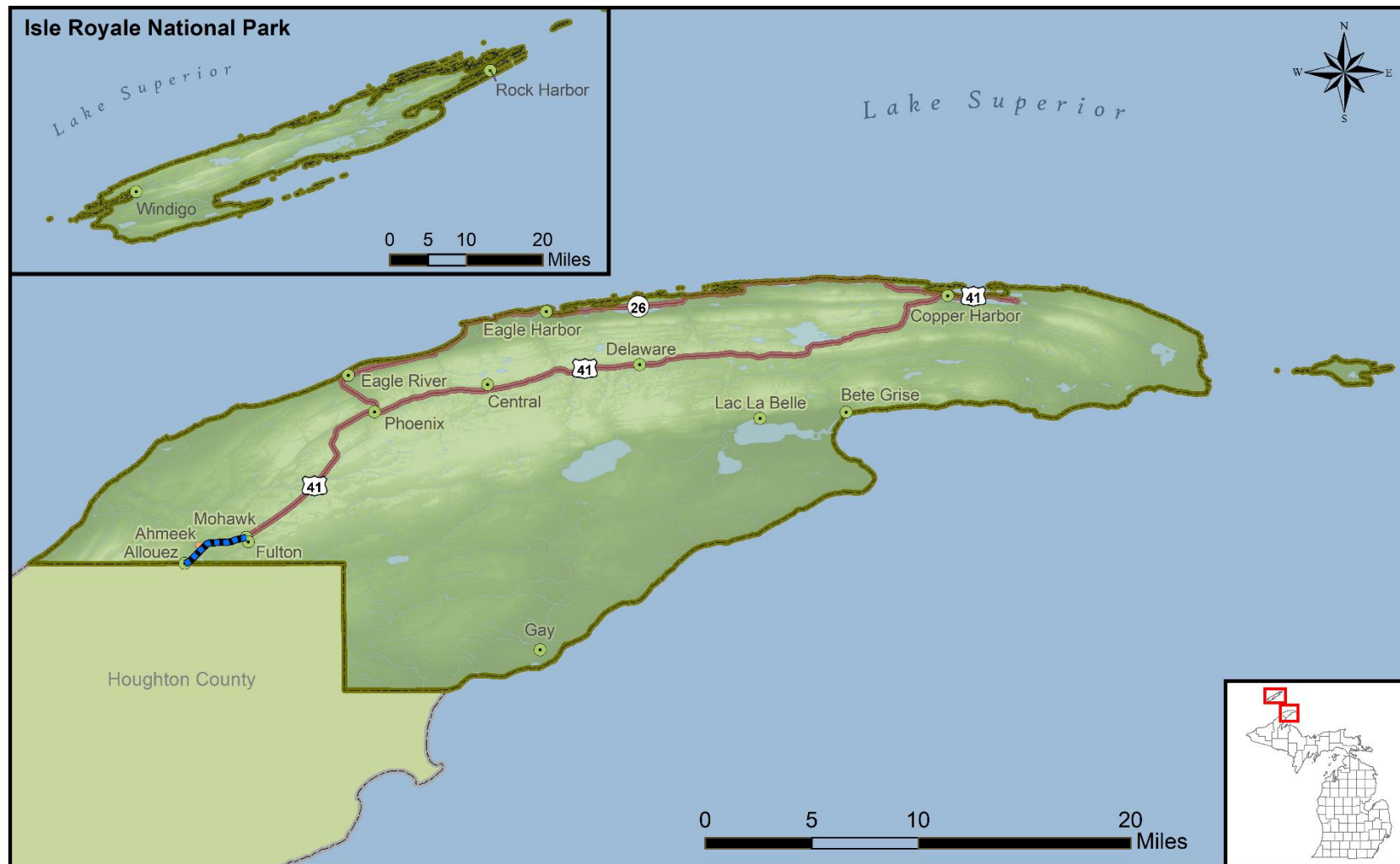
In Keweenaw County, Northern Natural Gas has a large natural gas pipeline that delivers natural gas to Mohawk. The jurisdictions served will be the Village of Ahmeek and greater Allouez Township (including the communities of Mohawk and Fulton). Propane tanks on individual properties are widespread throughout Keweenaw County. While there is a risk of a natural gas pipeline incident in the county due to aging transmission lines or sabotage, no historical occurrences have been recorded.

### **Occurrence Probability and County Vulnerability**

Probability of a propane incident is low throughout though possible where storage facilities exist. However, as none of these propane locations require reporting, the severity and vulnerability is unknown. The Village of Ahmeek and parts of Allouez Township (e.g., Mohawk and Fulton) have a higher vulnerability to a pipeline failure only due to their proximity to the pipeline.

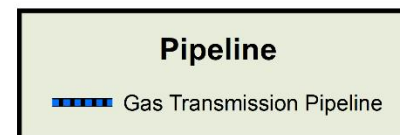
Though it is not uncommon for minor pipeline leaks to occur, the probability of a significant incident is low, and the same is true for petroleum events. Natural gas transmission lines present the greatest risk due to their remoteness, which may allow a leak to go undetected for an extended period. A single-tank petroleum explosion could happen on any site where one is located, but probability of either type of fuel event is otherwise very low in rural areas away from natural gas lines. Severity in most areas would be low to moderate. Consequences of a natural gas pipeline leak are mostly ecological or environmental, as pipelines are located underground and generally in sparsely developed areas, but evacuations are necessary for residents in the immediate surroundings due to the possibility of inhalation or an explosion.

**Map 5.6:** Pipeline in Keweenaw County



## Pipeline Keweenaw County, Michigan

Boundary data was derived from Michigan's Open Data Portal; DEM was derived from elevation data available through the USGS; Pipeline locations were estimated using the National Pipeline Mapping System (NPMS) Public Viewer; Created by WUPPDR July 2020



## Infrastructure Hazards

The following list summarizes the broad types of infrastructure problems covered in this section:

1. Infrastructure Failure and Secondary Technological Hazards
2. Transportation Accidents

Although various industrial hazards involve certain types of infrastructure (e.g., pipelines) and their breakdown, the section titled infrastructure failures and secondary technological hazards focuses on the interruptions in critical life-sustaining infrastructure, such as electricity and water supplies. For example, an electrical blackout affects all sectors of society including communications, commerce, government, education, health care, public safety, emergency services, food and water supply, and sanitation.

While technical systems become more efficient, they sometimes become more vulnerable to failures. Many industrial systems operate close to their full capacity and maximum efficiency during times when everything is functioning smoothly and predictably. When something in the operating environment breaks down, as in the case of a disaster or system failure, the system has issues operating outside relatively narrow parameters. The system then become more vulnerable to failure. System management can help, but it still has issues of its own, including lack of ways to overcome coordination problems, interdependencies, and lack of knowledge of system management flexibility.

The section on transportation accidents involves any of the major modes of transportation systems within the county.

## Infrastructure Failures and Secondary Technological Hazards

### 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 draining, communications, and transportation. When one or more of these utility systems fail due to disaster or other cause, it can have devastating consequences, even if it is over a short period of time. When infrastructure failures occur due to a natural hazard event, this is considered a secondary or cascading technological hazard. For example, during power outages, people can die in their homes during periods of extreme heat or cold if immediate mitigation actions are not taken. When water or wastewater treatment systems in a community are inoperable, serious public health issues can arise and actions must be taken immediately to prevent outbreaks of diseases. If storm drainage systems fail from damage or capacity overload, serious flooding can occur.

All these situations can lead to disastrous public health and safety consequences if immediate actions are not taken. It is the most vulnerable members of society (i.e., the elderly, children, impoverished individuals, and people in poor health) who are most heavily impacted by an



infrastructure failure. If the failure involves one or more system, whole communities and possibly entire regions can be severely impacted.

The risk of infrastructure failure grows each year, as physical and technological infrastructure becomes more complex and the interdependency between various facets of infrastructure (e.g., pipelines, telecommunications lines, and roads) become more intertwined. Additionally, more vulnerable and aging infrastructure (e.g., electrical components, bridges, roads, sewers, etc.) needs repair. Because of this, large-scale disruptions in various components of infrastructure are likely. Major disruptions could lead to widespread economic losses, limit security, and altered ways of life.

Many of the hazards considered in this plan could result in infrastructure failures and any resulting infrastructure failures are dangerous in Keweenaw County due to its harsh climate and remoteness. Keweenaw County is served by several systems, including power, water treatment, and phone, and loss of any or all these systems can have a detrimental impact on the functioning of the county. Failure of infrastructure or utilities includes anything from water treatment failure to power outages, which is the most common type of failure and produces a minor interruption of everyday life but has the potential to cause severe problems over a long period of time.

Although located in Houghton County, a malfunction of the Portage Lake Lift Bridge would have secondary impacts on Keweenaw County. This bridge is Keweenaw County's only link to the mainland of the Upper Peninsula; however, risk to human life is greatly mitigated by the presence of both area hospitals north of the bridge. In this regard Keweenaw County is at less risk than central Houghton County in the event of a medical emergency.

While power outages are usually of a short duration—up to a few hours—the implications of an extended outage could affect the health and safety of the community.

### **Historical Occurrences**

Electric service in Keweenaw County is provided by Upper Peninsula Power Company (UPPCO) and Ontonagon County Rural Electrification Association, and loss of power to the grid for the area can affect the entire region. Due to the rural nature of the county, trees can fall on power lines in remote locations causing a delay in restoration of service (REA). On Thanksgiving Day in 2019 (November 28), an all-day power outage occurred largely caused by trees falling on power lines following a snowstorm. Trimming trees adjacent to power lines is one way to decrease this risk. Water and wastewater systems, and phone services can also be affected by failure due to aging facilities. Creating redundant systems and outfitting them with generators lessens the impact of such failure. Frequency of power outages is estimated at two per year based on previous incidents.

Based on power outages as an indicator of likelihood of infrastructure failure, probability of infrastructure failure is high. From October 2019 through January 2020, approximately six power outages occurred; many were for longer than three hours. The impact of infrastructure failure is greatest in the Village and Township of Allouez, which has greatest access to public utility services, but otherwise the hazard is uniform countywide. With regard to the Portage Lake Lift Bridge in Houghton County, severity is dependent on the nature and degree of the failure, and

overall impact varies depending on the factor of interest (some aspects of life are affected more than others). Probability of bridge failure is low.

### **Occurrence Probability and County Vulnerability**

Probability of infrastructure failure is likely, based mainly on two or more power outages per year. Numerous factors contribute to the impact from infrastructure failure, including types of services affected, weather conditions, response capabilities, and time of day. Probability of future occurrences is similar countywide, but the severity from failures may be more pronounced in urban areas, where communities are more reliant on commuting and systems served by utilities. Necessary contingency planning is required and established through a group of emergency officials that continue to meet regularly at Mercy EMS in Houghton County.

All municipalities and critical facilities are vulnerable to infrastructure failures. Loss of electrical power, natural gas, or water treatment can cause an immediate threat to life, safety, and public health.

## **Transportation Accidents**

### **Hazard Description**

Transportation accidents can occur on land, air, or water. The one commonality all transportation accidents share is that they can result in mass casualties. Although automobile crashes tragically kill many hundreds of Michigan residents each year, this analysis focuses on the types of accidents that are large enough in scale to potentially cause an emergency of disaster-level situation. A major land transportation accident in Michigan has the potential to create a local emergency or to seriously strain or overwhelm local response and medical services. It can involve a commercial intercity passenger bus, a local public transit bus, or a school bus. Air transportation accidents can result in tremendous numbers of deaths and injuries, and major victim identification and crash scene management problems. Water transportation accidents that can involve marine passenger ferries, may require significant underwater rescue and recovery efforts that few local jurisdictions may be equipped or trained to handle. If any of these accidents were to occur in a rural community, an event can easily overwhelm the available resources in these areas.

Michigan has 19 airports with commercial passenger service<sup>26</sup>, 72 local bus transit systems serving 85 million passengers, 19 marine passenger ferry services and 3 intercity rail passenger corridors composed of 568 miles of track and serving 22 communities. Keweenaw County is serviced by occasional tour buses, once-weekly transit service to the community of Mohawk, and commercial boat service to Isle Royale. There are no airports or commercial rail service in the county. In the winter, snowmobiles are an additional form of transportation used by residents and visitors to the county.

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<sup>26</sup> Michigan Department of Transportation Aeronautics – Commercial Service Airports.  
[www.michigan.gov/aero/0,4533,7-352-79155\\_79156\\_79388---,00.html](http://www.michigan.gov/aero/0,4533,7-352-79155_79156_79388---,00.html)

## Historical Occurrence

While there have been minor transportation accidents within the county, there is no history of a large passenger transportation accident in Keweenaw County. In 2018, the Michigan State Police reported 73 car accidents in the county, resulting in one fatality (attributed to speed and alcohol) and 13 injuries.<sup>27</sup> Nearly half of all accidents (44% or 32 car accidents) were deer related.

Snowmobile accidents can also cause serious injuries and fatalities. On March 8, 2018, a 58-year-old Wisconsin man sustained fatal injuries after failing to negotiate a corner, leaving the trail, and losing control of the snowmobile. Speed or operator error typically are cited as causes for snowmobile accidents. The Keweenaw County Sheriff and DNR Conservation Officers monitor snowmobile trails and partner with local first responders and off-road rescue units to respond to any accidents or careless riding that may occur.

On July 28, 2015, the Isle Royale Queen IV ran aground on rock near Porter's Island north of Copper Harbor, off the coast of Hunter's Point Park, during an evening cruise.<sup>28</sup> No passengers were injured and were able to disembark the ship via Good Samaritans. The Queen did not suffer any damages and did not leak any fuel or oil. However, the boat was out of commission for a few days to further inspect the ship.



*Isle Royale Queen IV at dock (Source: [Chris Light](#))*

## Occurrence Probability and County Vulnerability

The probability of a large-scale transportation accident even in Keweenaw County is low, but if this type of accident were to occur, the severity would be high due to the remoteness of the county and emergency response times. US-41 and M-26 are the two main routes in the county and any accident that occurs may result in road closures and increased commuting times. In addition to roadways, off-road vehicle and snowmobile trails are also vulnerable to accidents. However, in the county, there is a low volume of commercial passenger traffic compared to the state average, meaning that any incident would likely be isolated and of a small scale and not impact a large number of people. Smaller scale transportation accidents, such as single vehicle or snowmobile accidents, have a high probability of occurrence due to the number of visitors to the county. Still, vulnerability to even a small, isolated event can be considered high as mitigating potential accident is difficult due to the unpredictability of an accident. Emergency response plans and awareness of hazardous intersections and roadways are ways to prepare for this type of hazard.

<sup>27</sup> MSP. (2018). 2018 Year End Traffic Crash Statistics. [https://www.michigan.gov/documents/msp/2018\\_Year-End\\_for\\_Web\\_653222\\_7.pdf](https://www.michigan.gov/documents/msp/2018_Year-End_for_Web_653222_7.pdf)

<sup>28</sup> "Isle Royale Queen IV runs aground." (2015, July 29). *The Daily Mining Gazette*. <https://www.mininggazette.com/news/local-news/2015/07/isle-royale-queen-iv-runs-aground/>

## Human-Related Hazards

The following list summarizes the significant human-related hazards covered in this section:

1. Civil Disturbances
2. Public Health Emergencies
3. Sabotage and Terrorism

The civil disturbance hazard now shifts farther beyond the emphasis on prisons that had been a part of its original concept in earlier planning documents. Prison disturbances are still considered a hazard, but these “disruptions” encompasses ongoing social, economic, political, and environmental issues in any society. Emergency management typically deals with recognized disasters and emergency events rather than social problems more broadly. Most civil disturbance events are rooted in other human circumstances. The most probable circumstances may involve reaction to other emergency or disaster events, if overwhelming to or poorly handled by responders or governmental agencies. There are few, if any, historical records of such incidences escalating to the point of a civil disturbance emergency in Michigan.

Public health emergencies have taken on new importance recently, with the rise in concern about global pandemic illnesses. Travel is so rapid and widespread that quickly detecting and containing outbreaks of serious, even lethal, contagious diseases has been considered necessary and given higher priority by numerous levels of government and their partnering agencies. Various natural and technological hazards have the potential to cause significant public health concerns. For example, weather hazards, such as extreme temperatures, flooding, and drought, can affect the quality of drinking water in an area and increase the risk of contagious illness and food contamination.

Terrorism is one of the potential causes of widespread threats to public health, as well as certain types of civil disturbance. In many cases, it may not be immediately clear if an incident was motivated by political causes, some other form of protest, criminal enterprises, or personal neurosis. It is recommended that human-related hazards be studied together since terrorism and civil disturbances can lead to public health emergencies and other hazards covered in this plan, such as infrastructure failures, transportation accidents, and hazardous materials incidents.

## Civil Disturbances

### Hazard Description

Civil disturbances, though rare, typically involve protests, hooliganism, riots, and insurrection. Places that may be subject to or impacted by these types of disturbances include government buildings, military bases, universities, businesses, nuclear power plants, and critical service facilities, such as police and fire stations.

Protest, including political protests and labor disputes, usually contain some level of formal organization or shared discontent. They are usually orderly, lawful, and peaceful. However, some

may become threatening, disruptive, and even deliberately malicious. When protests become malicious and there is destruction of property, interruption of services, interference with lawful behaviors, use of intimidation or civil rights violations, and threats/actual acts of violence, then it is considered a civil disturbance.

Another kind of civil disturbance is hooliganism, which is relatively unorganized and involves individual or collective acts of deviance inspired by the presence of crowds. Individuals take advantage of situations where there is anonymity and confusion, allowing them to behave in an unlawful or unusually expressive way that is normally considered publicly unacceptable. These individuals may be under the influence of illegal drugs and alcohol and may include criminals and persons with mental illnesses who may either be reacting with extreme hostility to the crowding, noise, and disorder. Common problems include destruction of property, assault and disorderly conduct, and criminal victimization.

Hooliganism and protests that become disorderly may result in riots. Riots may stem from motivations of protest but lacks organization. These events tend to involve violent gatherings of persons whose level of shared values and goals are not alike to allow their collective concerns or efforts to unite in a relatively organized manner.

Lastly, insurrection involves the deliberative collective effort to disrupt or replace the established authority of a government or its representatives by persons within a society or under its authority. Prison uprisings may fall into this category, but it can also be classified as a riot or protest.

### **Historical Occurrence**

There have been no recorded civil disturbance events in Keweenaw County in recent history. Historically, there have been large-scale strikes during the mining days, but in recent years the only disturbances have been small-scale peaceful protests to war.

### **Occurrence Probability and County Vulnerability**

The probability and risk of a civil disturbance event is very low throughout Keweenaw County. Despite a low possibility, there is still a risk of disturbances due to governmental institutions throughout the county. Critical governmental facilities that could be a target for this type of hazard include buildings in Mohawk (Allouez Township), Eagle Harbor (Houghton Township), and Copper Harbor (Grant Township). There is also a schoolhouse in Copper Harbor may be vulnerable to a civil disturbance as well.



## Public Health Emergencies

### **Hazard Description**

A public health emergency is the result of widespread and/or severe epidemic, contamination incident, or other situation that presents a danger to or otherwise negatively impacts the general health and well-being of the public. Public health emergencies include disease epidemics, food or water contamination, extended periods without adequate water and sewer services, and harmful exposure to chemical, radiological, or biological agents. The common characteristic of most public health emergencies is that they adversely impact, or have the potential to adversely impact, many people. An additional effect of public health emergencies is the number of “worried well,” individuals who think they are unwell, who can overwhelm the system by seeking treatment. The greatest emerging public health threat is the intentional release of a radiological, chemical, or biological agent with the potential to adversely impact many people.

Michigan has had several large-scale public health emergencies in recent history. There have been instances of infrastructure failure (widespread loss of water and sewer service in northern Michigan in 1994) and disease threats (foot-and-mouth disease and the West Nile encephalitis virus). Most recently, the novel Coronavirus diseases (COVID-19) global pandemic has infected over 103,000 Michigan residents and has resulted in 6,509 deaths (confirmed cases; as of September 2, 2020) since March 1, 2020. These numbers continue to increase due to the highly contagious character of COVID-19 and the continuing pandemic. No area in Michigan is immune to public health emergencies and areas with high population concentrations are more vulnerable to the threat. Additionally, more vulnerable members of society – elderly, children, impoverished individuals, and persons in poor health – are at higher risk than the general population.

The Western Upper Peninsula Health Department is responsible for addressing and trying to prevent public health emergencies within the county and Baraga, Gogebic, Keweenaw, and Ontonagon counties. It does so by distributing public information for both preparedness and notification, establishing a regional hotline in the event regular telephone system are overwhelmed. They also distribute and administer vaccines or countermeasures, if necessary. The Health Department also protects and treats emergency responders and has the sole power of quarantine should it become necessary. The Health Department also provides State mandated public health services, such as restaurant inspections, foodborne illness investigation, sewage and well inspections, beach monitoring, and mercury clean-ups.

### Exposure to Hazardous Materials

Exposure to hazardous materials can occur through accident, deliberate action, misuse of a product, or through natural means. Most common risks of exposure to materials are chemical in nature but can also be biological or radiological. Many materials are used in industry or in households. Household hazardous wastes come from everyday products that are used in the home, garden, or yard. Oil-based paints, antifreeze, household cleaners, and pesticides are a few examples. Household hazardous wastes are corrosive, toxic, flammable, or reactive. When hazardous waste is improperly disposed of, such as in the trash, down the sink, or into a storm



drain, it poses a threat to water quality, human health, and wildlife. Electronic waste that is improperly handled can pose human and environmental risk of exposure to lead and mercury. In addition to electronic waste, lead and mercury exposure may be due to legacy use of these heavy metals in household items such as paint, thermometers, dental fillings, and electric switches. Exposure to lead and mercury have long lasting negative health effects, such as memory loss, tremors, neuromuscular changes (e.g., weakness, atrophy), and lack of coordination of movements amongst other symptoms.

A natural exposure to a hazardous material is in the form of radon. Radon is a cancer-causing radioactive gas that moves up through soil and is trapped inside buildings. It cannot be smelled or seen and is the second leading cause of lung cancer in the U.S. Exposure to radon is possible in Keweenaw County. Testing kits are offered at no cost at the Western U.P. Health Department. If radon is detected above 4 picocuries per liter (pCi/L), follow-up testing and resistance techniques should be installed. Mitigation includes sealing cracks and venting gasses from the home.

### Individual Wells

Many Keweenaw County residents live in rural areas that are not serviced by public sewer and/or water. The contamination of individual wells and the failure of individual septic systems presents the potential for public health emergencies. Coliform bacteria, high nitrates, and arsenic in water wells are common public health risks. Coliform bacteria are associated with animal wastes, sewages, and surface water. Nitrates are a naturally occurring form of nitrogen found in soil and groundwater. High concentrations of nitrates in drinking water can be toxic to infants and young animals. Elevated nitrate concentrations in groundwater and wells are typically associated with excessive fertilizers, sewage disposal systems, farm runoff, municipal wastewater and sludge, and industrial wastes. Arsenic is also naturally occurring; exposure to high levels of arsenic poses serious health effects because it is a known human carcinogen.

### Public water and sewer facilities

Public water and sewer facilities are prone to public health emergencies such as broken or frozen lines that cause a loss in service, or system pressure loss that requires boil-water advisories due to potential water contamination. Any disruption in service is typically a secondary hazard because of a different hazard altogether. Extreme cold, subsidence, flooding, infrastructure failure, and sabotage are a few examples of what can cause a disruption in water or sewer service.

### Drug and Substance Abuse Epidemic

As defined by the CDC, an epidemic is “the occurrence of more cases of disease than expected in a given area or among a specific group of people over a particular period of time.”<sup>29</sup> While it is not an infectious disease outbreak, deaths due to drug overdoses are now greater than deaths due to car crashes in Michigan.<sup>30</sup> The state has the 14<sup>th</sup> highest overdose death rate in the country. In

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<sup>29</sup> Epidemic Disease Occurrence. Center for Disease Control and Prevention.

<https://www.cdc.gov/csels/dsepd/ss1978/lesson1/section11.html>

<sup>30</sup> “Opioid addiction: Michigan counties struggle to meet the need for treatment.” Michigan News – University of Michigan. <https://news.umich.edu/opioid-addiction-michigan-counties-struggle-to-meet-the-need-for-treatment/>

2017, there were 2,686 drug overdose deaths in Michigan and was 12.1% higher than drug overdose deaths in 2016<sup>31</sup>. Deaths due to synthetic opioids, such as fentanyl and tramadol, increased by 48.5% from 2016 to 2017. Most Michigan counties are underequipped to address the needs for people who have an opioid addiction and effects from this drug epidemic. This includes a lack of nearby drug treatment programs, medication-based treatment services, and transportation capability to get people who want help the necessary services they need.

### **Climate Change Consideration**

Climate change has the potential to affect human health by increasing the occurrence of vector-borne diseases such as malaria, Lyme disease, and West Nile virus. Warmer temperatures, shorter/milder winters, and earlier spring seasons can result in an increasingly hospitable environment for carriers of these diseases. Ticks and the bacterium that causes Lyme disease have higher survival rates in warmer, milder winters.

### **Historical Occurrence**

The most likely public health threat in Keweenaw County is influenza-type illnesses, which is the most common communicable disease, with an average mortality rate of 14.2 per 100,000 Western U.P. residents from 2015-2017<sup>32</sup>. Michigan's average mortality rate is 14.3. However, influenza, which can be widespread, rarely becomes a public health emergency.

There is potential in Keweenaw County, as in all areas, for a larger disease outbreak as an isolated event or secondary to flooding or another type of incident. Keweenaw County has vaccination rates below the state average, which increases the risk of diseases to the population (both vaccinated and not).<sup>33</sup> Even if number of disease cases within the county is low, this does not mean that the illness is not present in the community or that there is no risk of infection. If a virus, such as COVID-19, infects a large portion of the population in the county, it could overwhelm local medical facilities that are equipped to deal with this type of emergency. There are no medical or hospital facilities in the county. Portage Health and Aspirus Keweenaw hospitals, both in Houghton County, each have an infection isolation room and a 24-hour emergency department. Despite awareness and planning, shortages of supplies, hospital rooms, and medical professionals to respond to the COVID-19 pandemic and other future disease outbreaks can cause significant harm to the public.

Approximately a third of residents in Keweenaw County were reported as 65 years and older (33.4%) in the 2018 ACS 5-year estimate.<sup>34</sup> The county has nearly double the proportion of seniors that the state average (17.4%). The health needs of older residents are much different than those of a younger age, as seniors need medical care for chronic disease management, dementia care,

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<sup>31</sup> Drug Overdose Deaths in Michigan, 2016-2017. Michigan Department of Health and Human Services. [https://www.michigan.gov/documents/mdhhs/Drug\\_Overdose\\_Deaths\\_MI\\_2016-2017\\_649230\\_7.pdf](https://www.michigan.gov/documents/mdhhs/Drug_Overdose_Deaths_MI_2016-2017_649230_7.pdf)

<sup>32</sup> Michigan Department of Health and Human Services, Community Health Information. [www.mdch.state.mi.us/pha/osr/chi/IndexVer2.asp](http://www.mdch.state.mi.us/pha/osr/chi/IndexVer2.asp)

<sup>33</sup> Michigan Department of Health and Human Services, County Quarterly Immunization Report Card. (2020, June 30). [https://www.michigan.gov/documents/mdch/Keweenaw\\_447464\\_7.pdf](https://www.michigan.gov/documents/mdch/Keweenaw_447464_7.pdf)

<sup>34</sup> U.S. Census. Keweenaw County, Michigan. <https://data.census.gov/cedsci/profile?g=0500000US26083>

and quality assisted living options. As the community continues to get older, this has a significant impact and change on the needs for health care and elder services throughout the county. However, total population in Keweenaw County is relatively low and it is hypothesized that senior who do live in the county are healthier and are more socioeconomically able to move before their health deteriorates.<sup>35</sup>

Of increasing threat are opioid and meth-related issues. In the Upper Peninsula, babies are treated for neonatal abstinence syndrome (NAS) at a higher rate than anywhere else in Michigan— 29 per 1,000 births in 2016.<sup>36</sup> There are no NICU treatment centers in the county to deal with a rising concern of addicts and those seeking treatment. The Upper Peninsula Substance Enforcement Team (UPSET) is a multi-jurisdictional narcotics task force that serves all U.P. counties, and collaborates with local, state, and federal agencies to assist with local or state police in apprehension. They are the only federally trained and certified Clandestine Lab Team in the Upper Peninsula dealing with methamphetamine response. In 2016, UPSET West was formed to support an increased UPSET team, which targets the Western Upper Peninsula in increased narcotics enforcement. Since 2016, UPSET West detectives have made 48 felony arrests, but are fighting a growing meth supply as heroin supply decreases<sup>37</sup>. In Keweenaw County, there have been multiple arrests related to the sale, production, and distribution of narcotics that involve UPSET.

Isolated incidents of hazardous materials contamination may also pose a localized public health threat; however, there is no history of incidents in Keweenaw County. Another less urgent issue is that of dilapidated buildings, which are abundant in many jurisdictions in Keweenaw County. These structures are often associated with asbestos, a component of past insulation materials which has been found to cause health problems, and with other hazards.

### **Occurrence Probability and County Vulnerability**

Public health emergencies can arise from a wide range of causes and exhibit varying levels of severity. In Keweenaw County, the probability of a public health emergency is likely, as some health emergencies are currently occurring within the county and region (e.g., COVID-19 and opioid and meth-related health emergencies). The severity of a public health emergency, such as a disease pandemic, is unpredictable and could potentially be extreme as the population ages. A large magnitude pandemic could overload facilities that are inadequately equipped to deal with this type of emergency, such as long-term care facilities and rural medical centers.

All individuals are vulnerable to the hazards of a public health emergency, but vulnerable populations are at higher risk of succumbing to an illness. The remoteness of the county could also be problematic during a large-scale emergency. In Keweenaw County, the greatest susceptibility

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<sup>35</sup> WUPHD. (2018). Upper Peninsula Community Health Needs Assessment. <https://www.wupdhd.org/wp-content/uploads/2019/03/Upper-Peninsula-Community-Health-Needs-Assessment-2018-Second-Edition.pdf>

<sup>36</sup> Kovanis, G. (2018 May 30). The tiniest addicts: How U.P. babies became part of the opioid epidemic. *Detroit Free Press*. <https://www.freep.com/story/news/local/michigan/2018/05/03/opioid-epidemic-drug-addicted-babies/335398002/>

<sup>37</sup> UPSET West reducing heroin supply, meth use growing. (2019, February 14). Keweenaw Report <http://www.keweenawreport.com/featured/upset-west-reducing-heroin-supply-meth-use-growing/>

to most types of public health emergencies is any populated communities, such as Copper Harbor (Grant Township), Ahmeek Location (Allouez Township), and Eagle Harbor. Susceptibility is also high in recreational areas as there are high numbers of tourists that visit the county. However, events dealing with natural resource contamination would affect populated communities the most but could originate in rural outlying areas. Public health emergencies tend to be widespread rather than confined to a specific location.

Vulnerable locations include any public gathering areas, such as restaurants, stores, etc. Individual wells and septic systems and public water, sewer, and electric facilities are also vulnerable to public health emergencies. They may infect, transport, or have secondary impacts if not available or limited in service. Almost all local communities in Keweenaw County have at least one of these vulnerable critical facilities.

Public health emergencies have secondary impacts that may create further vulnerable situations that were otherwise not expected. For example, a pandemic or smaller disease outbreak, such as influenza, could result in large percentages of employees taking sick leave or mandated quarantine action (i.e. shelter-in-place mandates), removing workers from their place of employment and thus impacting productivity in the economy or in emergency response capacity. Any hazardous event that would have secondary public health implications would significantly disrupt or halt the normal business activities of an impacted community. However, these measures should be taken if it lessens or slows the impact of a public health emergency.

## **Sabotage and Terrorism**

### **Hazard Description**

Terrorism is the use of violence by individuals or groups to achieve political goals by creating fear, while sabotage is any kind of deliberate action, such as obstruction, disruption, or destruction, for political or military gain. Both can take many forms, including the following: bombings; assassinations; organized extortion; use of nuclear, chemical, and biological weapons; information warfare, such as hacking or release of classified information; ethnic, religious, and gender intimidation (hate crimes); advocacy for overthrowing local, state, or federal government, and; the disruption of legitimate scientific research or resource-related activities (eco-terrorism). 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.

Sabotage and terrorism are long-established strategies that are practiced by many groups in many nations. The U.S. is not only threatened by international terrorists or saboteurs, but also by home-grown domestic terrorist groups including racist, ecological, and extreme anti-abortion groups. Non-terrorist criminal activity may resemble terrorism or sabotage, but it lacks a political objective. These crimes are typically routine, individual crimes, but they may impact large portions of the population. Some of these attacks may require resources that are not available to local law

enforcement agencies. Non-terrorist criminal activities may include mass shootings, random sniper attacks, infrastructure sabotage, and cyberattacks.

1. **Nationalist terrorists** act in support of a culture or ethnic group. Typically, they are fighting on behalf of national populations that wish to have an independent government but are currently ruled by another country. They tend to direct their attacks against the “occupying power” but may also attack other nations that support their enemies. These terrorists claim to speak for their entire national group, but usually only represent a small minority of extremists.
2. **Religious extremist terrorists** are violent adherents of a specific religion. They tend to be especially committed because they believe their violent actions are supported by their deity. Religious terrorists see themselves fighting a battle of ultimate good against pure evil, in which any action is justified.
3. **Left wing terrorists** attempt to force society to change to match their goals and values. They tend to target the government, power institutions, and symbols of authority. Socialist and Communist terrorists of this type were a threat in the late 1960s and 1970s but have weakened in recent decades.
4. **Right wing terrorists** see themselves as fighting for traditional values against an invading group and/or against a tyrannical government. In the U.S., these terrorists are associated with anti-immigration, white supremacy, anti-government, and Christian Identity movements. Only the most extreme elements of these movements have become terrorist, but they have carried out a substantial portion of the recent attacks. Right wing groups tend to target members of hated ethnic or religious minorities, or government employees.
5. **Single-issue terrorists** are not committed to an all-encompassing belief system, but rather are intensely concerned with one cause. Common causes for these terrorists include animal-rights, environmentalism, and opposition to abortion. They tend to target property or individuals rather than attempting to cause massive casualties.

Because sabotage and terrorism objectives are so widely varied, the potential targets are also widely varied. Virtually any public facility, place of public assembly, or business engaged in controversial activities can be considered a potential target. Large computer systems operated by government agencies, financial institutions, large businesses, healthcare facilities, and universities are at risk.

### **Historical Occurrence**

While there have been acts of terrorism and sabotage within Michigan, there is no recorded history of these events occurring in Keweenaw County.

### **Occurrence Probability and County Vulnerability**

The probability of a sabotage and terrorism in Keweenaw County is very low since there are no significant high-risk targets in the county. However, this hazard should not be ignored as these incidents can happen at any level. It should be recognized that political, social, and religious

facilities could be a target. Most potential target facilities are in populated areas. Vulnerable critical facilities include, but are not limited to, water treatment plants, dams, and private wells. Earlier mentioned pipelines running through the county are another possible target. Other threatened locations are impossible to identify, especially since widely dispersed rural areas are increasingly perceived by both authorities and terrorists as vulnerable to the element of surprise. If an incident does occur, severity is impossible to predict.

DRAFT



## SECTION 6: Risk Assessment

The hazard profiles presented in the *Hazard Analysis* section were developed using best available data and result in what may be considered principally a qualitative assessment as recommended by FEMA in its “How-to” guidance document titled *Understanding Your Risks: Identifying Hazards and Estimating Losses* (FEMA Publication 386-2). It relies heavily on historical and anecdotal data, literature review, stakeholder input, and professional and experienced judgment regarding observed and/or anticipated hazard impacts. It also carefully considers the findings in other relevant plans, studies and technical reports.

This section will include the following components:

- Differential Vulnerability
- Hazard Extent
- Hazard Profiling Concept of Planning
- Hazard Risk Analysis Methodology
- Hazard Priority Risk Index and Ranking
- Hazard Summary

### Differential Vulnerability

Currently, there is no reliable way to accurately estimate costs associated with many hazards that affect Keweenaw County. Numerous variables can affect the vulnerability of the county to hazards, including climate, location, scale, and time of day. Time of year also affects vulnerability. The population in many jurisdictions varies by season, and response capabilities are often compromised in winter.

Although Keweenaw County is susceptible to many types of hazards, each jurisdiction varies in its level of vulnerability to certain hazards. Vulnerability to most fire hazards, weather hazards, flooding due to spring runoff, and all technological and societal hazards have been determined to be similar for all of Keweenaw County. Subsidence is of note because it can occur in most jurisdictions, but the most at-risk areas are in scattered locations. **Table 6.1** provides a summary of hazards within the County and notes especially high vulnerabilities for each jurisdiction. Countywide hazards and others that affect most but not all jurisdictions equally, such as subsidence and petroleum/natural gas incidents, are generally not noted for specific jurisdictions.

Technical expertise is necessary to estimate the costs of each potential hazard. The value of property in Keweenaw County and its communities can, at a minimum, provide an overview of property that can be affected by hazards. **Table 6.2** shows the State Equalized Value (SEV) of properties in Keweenaw County by location and class. Vulnerability estimates that are provided in this plan were based on a most likely scenario.

**Table 6.1:** Differential Vulnerabilities by Jurisdiction in Keweenaw County

Jurisdiction (Population)	Extreme Temperatures	Fog	Hail	Ice & Sleet Storms	Lightning	Severe Winds	Snowstorms and Blizzards	Tornadoes	Dam Failures	Riverine & Urban Flooding	Shoreline Flooding & Erosion	Drought	Wildfires	Invasive Species	Earthquakes	Subsidence	Scrap Tire Fires	Structural Fires	Hazardous Materials: Fixed Site Incidences	Hazardous Materials: Transportation Incidents	Petroleum & Natural Gas Incidents	Infrastructure Failures & Secondary Tech. Hazards	Transportation Accidents	Civil Disturbances	Public Health Emergencies	Sabotage & Terrorism
Keweenaw County (2,316)	X	X	X	X	X	X	X	X		X		X	X	X		X	X	X	X	X		X	X	X	X	X
Allouez Township (1,480)									X		X										X					
Eagle Harbor Township (260)									X		X															
Grant Township (210)											X															
Houghton Township (100)											X															
Sherman Township (86)											X															
Ahmeek Village (128)																					X					

**Table 6.2:** State-Equalized Value for Keweenaw County, 2019

**** REAL ****					Total Real	Personal	Total Real & Personal
Township	Commercial	Industrial	Residential	Timber Cutover			
Allouez Township	\$2,452,736	\$75,912	\$54,447,122	\$63,819	\$57,039,589	\$2,270,652	\$59,310,241
Eagle Harbor Township	\$1,113,473	\$0	\$67,829,329	\$0	\$68,942,802	\$727,187	\$69,669,989
Grant Township	\$8,775,664	\$0	\$58,453,379	\$2,679,738	\$69,908,781	\$1,194,324	\$71,103,105
Houghton Township	\$293,354	\$0	\$14,776,714	\$129,624	\$15,199,692	\$976,816	\$16,176,508
Sherman Township	\$231,473	\$0	\$8,666,039	\$21,720	\$8,919,232	\$145,964	\$9,065,196
<b>County Total Real and Personal</b>							<b>\$225,325,039</b>

Source: Michigan Department of Treasure Assessed & Equalized Valuation

## Hazard Extent

**Table 6.3** describes the extent of each hazard identified in Keweenaw County. The extent of a hazard is its severity or magnitude, as it relates to the county.

**Table 6.3: Hazard Extent in Keweenaw County**

Weather Hazards	
<b>Extreme Temperatures</b>	Extreme heat event extent is measured through the heat index, which is temperature in relation to the percentage of humidity.
<b>Fog</b>	The extent of fog is measured by area and number of roads and vehicles affected by a fog event, as fog itself is not hazardous.
<b>Hail</b>	Hail extent is defined by the size of the hail stone.
<b>Ice and Sleet Storms</b>	The extent of ice and sleet storms can be classified by meteorological measurements and by evaluating its societal impacts.
<b>Lightning</b>	The frequency of cloud-to-ground lightning flashes per square mile can be used as a method to measure extent.
<b>Severe Winds</b>	The extent of a severe wind event is measured by speed of wind recorded.
<b>Snowstorms and Blizzards</b>	The extent of winter storms can be measured by the amount of snowfall received (in inches).
<b>Tornadoes</b>	Tornado hazard extent is measured by historic tornadoes per county in Michigan provided by the NCEI and MSP, as well as the Fujita/Enhanced Fujita Scale (Tables 5.19 and 5.10).
Hydrological Hazards	
<b>Drought</b>	Drought extent is defined by the U.S. Drought Monitor classifications, which included abnormally dry, moderate drought, severe drought, extreme drought, and exceptional drought (in ascending order).
<b>Dam Failures</b>	Dam Failure extent is defined using the Michigan Department of Environment, Great Lakes, and Energy under Dam Safety criteria.
<b>Riverine and Urban Flooding</b>	Flood extent in Keweenaw County is measured by the duration and magnitude of an event.
<b>Shoreline Flooding and Erosion</b>	The extent of erosion can be defined by the rate (in feet) of erosion that occurs according to the Michigan Department of Environment, Great Lakes, and Energy – Coastal Management.
Ecological Hazards	
<b>Wildfires</b>	Extent of a wildfire is determined by the annual average of total acres burned.
<b>Invasive Species</b>	The extent of invasive species is largely dependent on the preferred habitat of the species as well as the species' ease of movement and establishment. Invasive species magnitude ranges from nuisance to widespread killer.

<b>Geological Hazards</b>	
<b>Earthquakes</b>	Earthquake extent can be measured the Modified Mercalli Intensity (MMI) scale and the distance of the epicenter from Keweenaw County. It was determined that this hazard does not threaten Keweenaw County.
<b>Subsidence (Ground Collapse)</b>	Subsidence is measured by total displacement material volume from the event, as well as monetary damages.
<b>Technological (Industrial) Hazards</b>	
<b>Scrap Tire Fires</b>	Extent is measured by the area affected, monetary damages incurred., as well as type of tire products involved.
<b>Structural Fires</b>	Structural fire hazard extent is measured in area affected, time required to extinguish the fire, and incurred monetary damages.
<b>Hazardous Materials: Fixed Site Incidents</b>	Measured by the spatial extent of the event and volume of material lost. Additionally, material type, wind speed and direction and terrain factors impact extent.
<b>Hazardous Materials: Transportation Accident</b>	Extent is measured by volume of material lost, as well as proximity to major transportation routes. Hazard extent is also influenced by material type, terrain and wind speed and direction.
<b>Petroleum and Natural Gas Incidents</b>	Extent is measured by the spatial extent of an incident, and volume of material lost
<b>Infrastructure Hazards</b>	
<b>Infrastructure Failures and Secondary Technological Hazards</b>	Hazard extent is measured by the type of failure and duration and what cascading effects are because of the hazard.
<b>Transportation Accidents</b>	Extent of a transportation accident can be measured by type of transportation involved and location of accident.
<b>Human Related Hazards</b>	
<b>Civil Disturbances</b>	Extent is measured by potential economic losses through damage to or disruption of operations of governmental facilities or other commercial businesses.
<b>Public Health Emergencies</b>	Public health emergency extent is measured by percentage of the population affected by the hazard. If the health emergency is a pandemic, the extent depends on how easily the illness is spread, mode of transmission, and amount of contact between infected and uninfected individuals.
<b>Sabotage and Terrorism</b>	Extent is measured by the area affected by the hazard, type of facility threatened, and the potential number of injuries or fatalities resulting from an event.

## Hazard Profiling Concept of Planning

The method used to rank the hazards, vulnerabilities and risks includes the following:

- A public survey that was released for 30 days online with paper copies being made available at the county clerk's office, public library, and the post office.
- A public comment period after the final draft was released and before plan adoption
- Government and institution survey released for added input into the plan
- Keweenaw County emergency manager reviewed the profile and ranked the overall risk for the county
- Members of the Local Planning Team reviewed and ranked the risks for their communities
- The risk profile was circulated among the staff at the Western U.P. Planning and Development Region for comment

A risk assessment identifies the characteristics and potential consequences of a disaster, how much the community could be affected by the disaster, and the impact on community assets.

## Hazard Priority Risk Index and Ranking

To draw some meaningful planning conclusions on hazard risk for Keweenaw County, the results of the hazard profiling process were used to generate countywide hazard classifications according to a "Priority Risk Index" (PRI). The purpose of the PRI, described further below, is to categorize and prioritize all potential hazards for Keweenaw County as high, moderate or low risk. Combined with the asset inventory and quantitative vulnerability assessment provided in the next section, the summary hazard classifications generated through the use of the PRI allows for the prioritization of those high hazard risks for mitigation planning purposes, and more specifically, the identification of hazard mitigation opportunities for Keweenaw County jurisdictions to consider as part of their proposed mitigation strategy.

The prioritization and categorization of identified hazards for Keweenaw County is based principally on the PRI, a tool used to measure the degree of risk for identified hazards in a planning area. The PRI is used to assist the Keweenaw County Local Planning Team (LPT) in gaining consensus on the determination of those hazards that pose the most significant threat to Keweenaw County based on a variety of factors. The PRI is not scientifically based but is rather meant to be utilized as an objective planning tool for classifying and prioritizing hazard risks in Keweenaw County based on standardized criteria. The application of the PRI results in numerical values that allow identified hazards to be ranked against one another (the higher the PRI value, the greater the hazard risk). PRI values are obtained by assigning varying degrees of risk to five categories for each hazard (probability, impact, spatial extent, warning time and duration). Each degree of risk has been assigned a value (1 to 4) and an agreed upon weighting factor, as summarized in **Table 6.4**.



To calculate the PRI value for a given hazard, the assigned risk value for each category is multiplied by the weighting factor. The sum of all five categories equals the final PRI value, as demonstrated in the example equation below:

$$\text{PRI VALUE} = [(\text{PROBABILITY} \times .30) + (\text{IMPACT} \times .30) + (\text{SPATIAL EXTENT} \times .20) + (\text{WARNING TIME} \times .10) + (\text{DURATION} \times .10)]$$

According to the weighting scheme, the highest possible PRI value is 4.0. Applying the weighting scheme to Keweenaw County, the highest score of 3.6 was given to Public Health Emergencies. Prior to being finalized, PRI values for each identified hazard were reviewed and accepted by the members of the LPT.

### **Key Definitions for Prioritized Risk Index Categories**

**Probability** – a guide to predict how often a random event will occur. Annual probabilities are expressed between 0.001 or less (low) up to 1 (high). An annual probability of 1 predicts that a natural hazard will occur at least once per year.

**Magnitude/Severity** – indicates the impact to a community through potential fatalities, injuries, property losses, and/or losses of services. The vulnerability assessment gives information that is helpful in making this determination for each community.

**Warning Time** – plays a factor in the ability to prepare for a potential disaster and to warn the public. The assumption is that more warning time allows for more emergency preparations and public information.

**Duration** – relates to the span of time local, state, and/or federal assistance will be necessary to prepare, respond, and recover from a potential disaster event.

**Table 6.4:** Priority Risk Index Summary Table

PRI Category	Degree of Risk			Assigned Weighting Factor
	Level	Criteria	Index Value	
<b>Probability</b>	Unlikely	Less than 1% annual probability	1	30%
	Possible	Between 1 and 10% annual probability	2	
	Likely	Between 10 and 100% annual probability	3	
	Highly Likely	100% annual probability	4	
<b>Impact</b>	Minor	Very few injuries, if any. Only minor property damage and minimal disruption on quality of life. Temporary shutdown of critical facilities	1	30%
	Limited	Minor injuries only. More than 10% of property in affected area damaged or destroyed. Complete shutdown of critical facilities for more than one day.	2	
	Critical	Multiple deaths/injuries possible. More than 25% of property in affected area damaged or destroyed. Complete shutdown of critical facilities for more than one week.	3	
	Catastrophic	High number of deaths/injuries possible. More than 50% of property in affected area damaged or destroyed. Complete shutdown of critical facilities for 30 days or more.	4	
<b>Spatial Extent</b>	Negligible	Less than 1% of area affected	1	20%
	Small	Between 1 and 10% of area affected	2	
	Moderate	Between 10 and 50% of area affected	3	
	Large	Between 50 and 100% of area affected	4	
<b>Warning Time</b>	More than 24 hours	Self-explanatory	1	10%
	12 to 24 hours	Self-explanatory	2	
	6 to 12 hours	Self-explanatory	3	
	Less than 6 hours	Self-explanatory	4	
<b>Duration</b>	Less than 6 hours	Self-explanatory	1	10%
	Less than 24 hours	Self-explanatory	2	
	Less than one week	Self-explanatory	3	
	More than one week	Self-explanatory	4	

## PRI Results

**Table 6.5** summarizes the degree of risk assigned to each category for all initially identified hazards based on the application of the PRI. Assigned risk levels were based on the detailed hazard profiles developed for this section, as well as input from the Local Planning Team (LPT). The results were then used in calculating PRI values and making final determinations for the risk assessment.

**Table 6.5:** Summary of PRI Results for Keweenaw County

Hazard	Category/Degree of Risk					
	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
<b>Weather Hazards</b>						
Extreme Temperatures	Highly Likely	Limited	Large	More than 24 hours	Less than one week	3.0
Fog	Highly Likely	Minor	Small	Less than 6 hours	Less than 6 hours	2.4
Hail	Highly Likely	Minor	Small	Less than 6 hours	Less than 6 hours	2.4
Ice and Sleet Storms	Likely	Minor	Large	12 to 24 hours	Less than 6 hours	2.3
Lightning	Highly Likely	Minor	Small	Less than 6 hours	Less than 6 hours	2.4
Severe Winds	Highly Likely	Limited	Small	Less than 6 hours	Less than 24 hours	2.8
Snowstorms and Blizzards	Highly Likely	Critical	Large	12 to 24 hours	Less than one week	3.4
Tornadoes	Unlikely	Critical	Negligible	Less than 6 hours	Less than 6 hours	1.9
<b>Hydrological Hazards</b>						
Dam Failures	Possible	Critical	Small	6 to 12 hours	Less than 24 hours	2.4
Riverine and Urban Flooding	Highly Likely	Critical	Moderate	6-12 hours	Less than one week	3.3
Shoreline Flooding and Erosion	Highly Likely	Limited	Small	Less than 6 hours	More than one week	3.0
Drought	Possible	Minor	Large	Less than 6 hours	More than one week	2.5
<b>Ecological Hazards</b>						
Wildfires	Likely	Limited	Small	12-24 hours	Less than 24 hours	2.3

Hazard	Category/Degree of Risk					
	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Invasive Species	Highly Likely	Limited	Large	More than 24 hours	More than one week	3.1
<b>Geological Hazards</b>						
Earthquakes	Unlikely	Critical	Small	Less than 6 hours	Less than 6 hours	1.9
Subsidence (Ground Collapse)	Highly Likely	Limited	Small	Less than 6 hours	Less than 6 hours	2.7
<b>Technological (Industrial) Hazards</b>						
Scrap Tire Fires	Unlikely	Minor	Small	Less than 6 hours	Less than 24 hours	1.6
Structural Fires	Highly Likely	Critical	Small	Less than 6 hours	Less than 24 hours	3.1
Hazardous Materials: Fixed Site Incidents	Likely	Minor	Small	12-24 hours	More than one week	2.2
Hazardous Materials: Transportation Accident	Possible	Limited	Small	Less than 6 hours	More than one week	2.8
Petroleum and Natural Gas Incidents	Possible	Limited	Moderate	Less than 6 hours	Less than one week	2.5
<b>Infrastructure Hazards</b>						
Infrastructure Failures and Secondary Technological Hazards	Likely	Critical	Moderate	Less than 6 hours	More than one week	3.2
Transportation Accidents	Highly Likely	Critical	Negligible	Less than 6 hours	Less than 6 hours	2.8
<b>Human Related Hazards</b>						
Civil Disturbances	Unlikely	Minor	Negligible	Less than 6 hours	Less than 24 hours	1.4
Public Health Emergencies	Highly Likely	Catastrophic	Moderate	12 to 24 hours	More than one week	3.6
Sabotage and Terrorism	Unlikely	Catastrophic	Negligible	Less than 6 hours	Less than one week	2.4

The conclusions drawn from the hazard profiling process for Keweenaw County, including the PRI results and input from the LPT, resulted in the classification of risk for each identified hazard according to three categories: High Risk, Moderate Risk and Low Risk (**Table 6.6**). For purposes of these classifications, risk is expressed in relative terms according to the estimated impact that a hazard will have on human life and property throughout all of Keweenaw County. A more quantitative analysis to estimate potential dollar losses for each hazard has been performed separately and is described in the Vulnerability Assessment section. It should be noted that although some hazards are classified below as posing low risk, their occurrence of varying or unprecedented magnitudes is still possible in some cases and their assigned classification will continue to be evaluated during future updates.

**Table 6.6:** Conclusions on Hazard Risk for Keweenaw County

<b>High Risk</b>	Public Health Emergencies Snowstorms and Blizzards Riverine and Urban Flooding Infrastructure Failures and Secondary Technological Hazards Structural Fires Invasive Species Extreme Temperatures Shoreline Flooding and Erosion
<b>Moderate Risk</b>	Transportation Accidents Severe Winds Subsidence (Ground Collapse) Petroleum and Natural Gas Incidents Drought Sabotage and Terrorism Dam Failures Hazardous Materials: Transportation Accident
<b>Low Risk</b>	Lightning Hail Fog Wildfires Ice and Sleet Storms Hazardous Materials: Fixed Site Incidents Earthquakes Tornadoes Scrap Tire Fires Civil Disturbance

## **Hazard Summary**

Although many of the hazards identified can and do occur throughout Keweenaw County, the highest priority hazards include:

- Public Health Emergencies
- Snowstorms and Blizzards
- Riverine and Urban Flooding
- Infrastructure Failures and Secondary Technological Hazards
- Structural Fires
- Invasive Species
- Extreme Temperatures
- Shoreline Flooding and Erosion

Hazard mitigation activities will focus on mitigating loss due to these priority hazards in Keweenaw County while also considering activities that may mitigate loss due to lower ranking hazards.



## SECTION 7: Hazard Mitigation

This section of the Hazard Mitigation Plan provides the blueprint which Keweenaw County and its municipal jurisdictions can follow to reduce potential exposure and losses identified as concerns in the *Risk Assessment* portion of this plan. The Local Planning Team and the Emergency Manager reviewed the risk assessment to identify and develop these actions. This section includes:

- Overview of Mitigation Strategy Development
- Review and Update of Mitigation Goals and Objectives
- Capability Assessment
- Mitigating Hazards in Keweenaw County
- Mitigation Resources
- Updating the 2020 Keweenaw County Hazard Mitigation Plan

### Overview of Mitigation Strategy Development

In formulating Keweenaw County's mitigation strategy, a wide range of activities were considered in order to help achieve the general countywide goals in addition to the specific hazard concerns of each participating jurisdiction (for more details on the specific activities discussed and considered by the Local Planning Team, please see the summary of the second LPT meeting in Section 3: Planning Process). In general, hazard mitigation actions are commonly broken into four different categories:

**Local Plans and Regulations (LPR)** – These actions include government authorities, policies or codes that influence the way land and buildings are being developed and built.

**Structure and Infrastructure Projects (SIP)** - These actions involve modifying existing structures and infrastructure to protect them from a hazard or remove them from a hazard area. This could apply to public or private structures as well as critical facilities and infrastructure. This type of action also involves projects to construct manufactured structures to reduce the impact of hazards.

**Natural Systems Protection (NRP)** – These are actions that minimize damage and losses and preserve or restore the functions of natural systems.

**Education and Awareness Programs (EAP)** – These are actions to inform and educate citizens, elected officials, and property owners about hazards and potential ways to mitigate them.

The intent of the hazard mitigation section is to provide Keweenaw County and its municipal jurisdictions with the goals that will serve as the guiding principles for future mitigation policy and project administration, along with a listing of proposed actions deemed necessary to meet those goals and reduce the impact of natural hazards. It is designed to be comprehensive and strategic in nature.

In being comprehensive, the development of the hazard mitigation strategy included a thorough review of all hazards and identifies far-reaching policies and projects intended to not only reduce

the future impacts of hazards, but also to assist the county and municipalities achieve compatible economic, environmental and social goals. In being strategic, the development of the strategy ensures that all policies and projects are linked to established priorities and assigned to specific departments or individuals responsible for their implementation with target completion deadlines. When necessary, funding sources are identified that can be used to assist in project implementation.

The first step in designing the mitigation strategy includes the identification of countywide mitigation goals. Mitigation goals represent broad statements that are achieved through the implementation of more specific, action-oriented objectives listed in each jurisdiction's mitigation Action Plan. These actions include both hazard mitigation policies (such as the regulation of land in known hazard areas through a local ordinance), and hazard mitigation projects that seek to address specifically targeted hazard risks (such as the acquisition and relocation of a repetitive loss structure).

The second step involves the identification, consideration and analysis of available mitigation measures to help achieve the identified mitigation goals. This is a long-term, continuous process sustained through the development and maintenance of this plan, beginning with the LPT during the first meeting. Alternative mitigation measures will continue to be considered as future mitigation opportunities become identified, as data and technology improve, as mitigation funding becomes available, and as this Hazard Mitigation Plan is maintained over time.

The third and last step in designing the hazard mitigation strategy is the creation of the local Mitigation Action Plans (MAPs), which are provided separately in Section 8: Action Plan. The MAPs represent an unambiguous plan for action and are the most essential outcome of the mitigation planning process. They include a prioritized listing of proposed hazard mitigation actions (policies and projects) for each of Keweenaw County's local jurisdictions along with accompanying information such as those agencies or individuals assigned responsibility for their implementation, potential funding sources and an estimated target date for completion. The MAPs provide those individuals or agencies responsible for implementing mitigation actions with a clear roadmap that also serves as an important tool for monitoring progress over time. The cohesive collection of actions listed in each jurisdiction's MAP also can serve as an easily understood menu of mitigation policies and projects for those local decision makers who want to quickly review their jurisdiction's respective element of the countywide Plan.

In preparing their own individual MAPs, each jurisdiction considered their overall hazard risk and capability to mitigate natural hazards as recorded through the risk and capability assessment process, in addition to meeting the adopted countywide mitigation goals and the unique needs of their community. Prioritizing mitigation actions for each jurisdiction was based on the following five (5) factors: (1) effect on overall risk to life and property; (2) ease of implementation; (3) political and community support; (4) a general economic cost/benefit review, and; (5) funding availability.

## Review and Update of Mitigation Goals

The goals of the Keweenaw County Hazard Mitigation Plan were crafted early in the planning process through a facilitated discussion and brainstorming session with the Local Planning Team (for more details, please see the summary of the second Local Planning Team meeting in Section 3: Planning Process). Each of the following goal statements represent a broad target for Keweenaw County and its jurisdictions to achieve through the implementation of their own MAPs. These goals were reviewed at the LPT Meeting (October 2019) and confirmed to still be valid with few changes for the 2020 Keweenaw County Hazard Mitigation Plan.

- Goal 1** Work to improve existing local government policies and codes to reduce the impacts of natural hazards.
- Goal 2** Design and implement specific mitigation measures to protect vulnerable public and private properties.
- Goal 3** Increase the protection and resilience of critical facilities and infrastructure from hazard threats through retrofit projects for existing facilities and innovative design standards for new facilities.
- Goal 4** Enhance public education programs to promote community awareness of hazards and hazard mitigation techniques available to reduce their impact.
- Goal 5** Improve stormwater management through enhanced local government programs, policies and practices.
- Goal 6** Enhance the county's evacuation and sheltering procedures through increased intergovernmental coordination between Keweenaw County, its municipalities, and the State of Michigan.
- Goal 7** Increase the County's emergency management capabilities through sustained system and technology improvements.
- Goal 8** Promote volunteer involvement in emergency preparedness and response through increased citizen awareness and training activities.

*Note:* A stated objective of the Disaster Mitigation Act of 2000 is to improve the coordination of risk reduction measures between state and local government authorities. Linking local and state mitigation planning goals is an important first step. It has been determined by the Keweenaw County Local Planning Team that the above goal statements are consistent with the State of Michigan's current mitigation planning goals as identified in the State Hazard Mitigation Plan promulgated by the Michigan Emergency Management and Homeland Security Division of the Michigan State Police.

## Capability Assessment

The purpose of conducting a capability assessment is to determine the ability of a local jurisdiction to implement a comprehensive mitigation strategy, and to identify potential opportunities for

establishing or enhancing specific mitigation policies, programs or projects. As in any planning process, it is important to try to establish which goals, objectives and/or actions are feasible, based on an understanding of the organizational capacity of those agencies or departments tasked with their implementation. A capability assessment helps to determine which mitigation actions are practical and likely to be implemented over time given a local government's planning and regulatory framework, level of administrative and technical support, amount of fiscal resources and current political climate.

A capability assessment has two primary components: an inventory of a local jurisdiction's relevant plans, ordinances or programs already in place; and an analysis of its capacity to carry them out. Careful examination of local capabilities will detect any existing gaps, shortfalls or weaknesses with ongoing government activities that could hinder proposed mitigation activities and possibly exacerbate community hazard vulnerability. A capability assessment also highlights the positive mitigation measures already in place or being implemented at the local government level, which should continue to be supported and enhanced if possible, through future mitigation efforts.

The capability assessment completed for Keweenaw County and its participating municipalities serves as a critical planning step and an integral part of the foundation for designing an effective multi-jurisdictional hazard mitigation strategy. Coupled with the Risk Assessment, the Capability Assessment helps identify and target meaningful mitigation actions for incorporation in the Hazard Mitigation Strategy portion of the Hazard Mitigation Plan. It not only helps establish the goals for Keweenaw County to pursue under this Hazard Mitigation Plan, but also ensures that those goals are realistically achievable under given local conditions.

### **Planning and Regulatory Capability**

Planning and regulatory capability is based on the implementation of plans, ordinances and programs that demonstrate a local jurisdiction's commitment to guiding and managing growth, development, and redevelopment in a responsible way while maintaining the general character of the community. It includes emergency response and mitigation planning, land use and transportation planning, zoning and building code enforcement, as well as protecting environmental, historical, and cultural resources. Some conflicts may arise, however these planning initiatives generally present significant opportunities to integrate mitigation principles into the local decision-making process.

**Table 7.1** below provides a summary of relevant local plans, ordinances and programs already in place or under development for Keweenaw County's participating local governments. A checkmark (✓) indicates that the given item is currently in place, or it is currently being developed for future implementation. Local governments will integrate, as appropriate the data, information, and hazard mitigation goals and actions from this plan into other planning mechanisms, such as those listed in Table 7.1.

**Table 7.1:** Relevant Plans, Ordinances, and Programs in Keweenaw County

Jurisdiction	Land Use Plan	Stormwater Management Plan	Master Plan	Asset Management Plan	Watershed Management Plan	Recreation Plan	Recreation and Natural Resource Conservation	Emergency Operations Plan	Disaster Recovery Plan	Capital Improvements Plan	Historic Preservation Plan	Zoning Ordinances	Building Code	National Flood Insurance Program
Allouez Township			✓						✓			✓	✓	
Eagle Harbor Township	✓		✓	✓		✓			✓	✓		✓	✓	
Grant township			✓			✓			✓			✓	✓	✓
Houghton Township			✓						✓			✓	✓	✓
Sherman Township			✓						✓			✓	✓	✓
Village of Ahmeek			✓						✓			✓	✓	
Keweenaw County	✓		✓	✓		✓		✓	✓	✓		✓	✓	✓

## Mitigating Hazards in Keweenaw County

The following is an overview of potential activities by category and general recommendations within each activity category for Keweenaw County. A more detailed list of activities, responsible parties, and estimated costs are mapped out in Section 8: Action Plan.

### Local Plans and Regulations

The purpose of these actions is to include government authorities, policies or codes that influence the way land and buildings are being developed and built. Several activities can be implemented at the local level, including:

- Building Codes
- Planning and Zoning
- Open Space Preservation
- National Flood Insurance Program

Building Codes: Building codes are an effective way to address many hazards identified in this plan. Through building code enforcement all new and improved buildings can be built or rehabilitated to withstand the impacts of certain hazards such as snow load, high winds, extreme temperatures and flooding.

In 1999 the State of Michigan amended the process of code adoption under the State Construction Code Act (Act 230). This Act now requires municipalities to administer and enforce the statewide codes, including the Michigan Building Code 2003, Michigan Plumbing Code 2003, Michigan Mechanical Code 2003, and Michigan Residential Building Code 2003, all developed by the International Code Council (ICC); and the National Electrical Code 2002, published by the National Fire Protection Association. The language does not permit local communities to modify the State codes. In Keweenaw County, the County itself is responsible for all electrical, mechanical, and plumbing code enforcement and for building code enforcement in all jurisdictions except Eagle Harbor Township, which maintain local control of building codes. Thorough inspection of property during and after construction ensures that builders are incorporating all the current standards and requirements in effect.

Planning and Zoning: Planning and zoning guides where development should occur based on suitability and compatibility, keeping development away from sensitive areas such as floodplains and wetlands and thereby protecting property from certain types of natural hazards. Master Plans are a primary way for a local unit of government to guide future development within their community. Through a planning process that reviews a community's background, current land use, and projected needs, guidance can be given to future development. Master Plans serve only as a guide and do not regulate land use.

Zoning regulations are the primary tool to implement comprehensive plans and control land use. By identifying different zones or districts a community can guide development within its boundaries. Zoning puts restrictions on use, lot size, setbacks, etc. but can be combined with more creative regulations such as a planned unit development option that allows more flexibility in the



development process. Zoning is enforced by the local unit of government and should be based on a comprehensive plan for the community. Keweenaw County adopted a new land use plan, “*Blue Print for Tomorrow*” in 2017 which includes an updated zoning for the county.



*Land conservation is another good tool for communities to use for reducing the risks of stormwater runoff and sewer overflows.*

Open Space Preservation: Open space preservation is a way to keep hazardous areas free from development and is especially effective in floodplain areas. Prohibiting new development in hazard-prone areas is the best way to mitigate future problems. An additional benefit to open space preservation is the maintenance of agricultural areas, green space/parks, and the installation of green infrastructure to mitigate stormwater runoff. While single-purpose gray stormwater infrastructure—conventional piped drainage and water treatment systems—is designed to move urban stormwater away from the built environment, green infrastructure reduces and

treats stormwater at its source while delivering environmental, social, and economic benefits. Comprehensive plans can help identify suitable areas to preserve through any number of means including acquisition, donation by developers, easement or regulated setbacks/buffers where development is restricted.

National Flood Insurance Program: The National Flood Insurance Program aims to reduce the impact of flooding on private and public structures. It does so by providing affordable insurance to property owners, renters and businesses and by encouraging communities to adopt and enforce floodplain management regulations. These efforts help mitigate the effects of flooding on new and improved structures.

### **Natural Systems Resource Protection**

Natural Systems Resource Protection mitigation activities are a way to enable land to function in a natural way. There are many benefits to naturally functioning watersheds, floodplains and wetlands, which can include:

- Reduction in runoff from rainwater and snowmelt
- Infiltration and velocity control during overland flow
- Filtering of excess nutrients, pollutants and sediments
- Floodwater storage
- Water quality improvement
- Groundwater recharge
- Habitat availability and regeneration
- Recreation and aesthetic qualities

Many natural areas have historically been affected by development and will be affected by development in the future, there are several ways to protect and restore the environment through hazard mitigation. Resource protection activities can include:

- Wetland protection
- Erosion and sedimentation control
- River restoration
- Best management practices
- Dumping regulations
- Urban forestry
- Farmland protection

Wetland Protection: Wetlands are a valuable resource that provides mitigation functions including storage of floodwaters and pollutant filtration, regulate overland flow, as well as habitat for fish, wildlife, and plants. As a result, wetlands are regulated in Michigan by Part 303, Wetland Protection, of the Natural Resources and Environmental Protection Act (Act 451 of 1995). EGLE administers the permit program. In Michigan, a permit is required to: deposit fill material in a wetland; dredge or remove soil or minerals from a wetland; construct, operate, or maintain any use or development in a wetland; or drain surface water from a wetland. Wetlands are specifically defined under the Act, and certain activities are exempted under the Act.

Local units of government can play a role in wetland protection and should serve as stewards over their water resources. Wetland protection measures can be implemented on a local level, and public education is a key to protecting this valuable resource.



*Bioswales are vegetated, or mulched channels that provide treatment and retention as they move stormwater from one place to another. Vegetated swales slow, infiltrate, and filter stormwater flows. As linear features, they are particularly well suited to being placed along streets and parking lots.*

Erosion and Sedimentation Control: Surface water can easily erode soil in large exposed areas including farmland, construction sites, and forested areas. In addition to exposed areas, erosion often occurs along stream banks and shorelines with high velocity currents and wave action. The erosion carries sediments and deposits them downstream where they can cause problems to storm sewers, culverts and ditches by reducing the capacity of the systems. Erosion also results in sediment in the water which reduces light and oxygen in the water. Heavy metals and other contaminants are the reason that sediment is identified as the number one nonpoint source pollutant for aquatic life.

Erosion and sedimentation can be controlled through phased construction, minimization of clearing, and stabilization of bare ground with vegetation, and other means. Sediment can be

captured onsite with traps and filters, and water velocity can be slowed by terraces, temporary cover, constructed wetlands, and impoundment.

Part 91, Soil Erosion and Sedimentation Control, of the Natural Resources and Environmental Protection Act (NREPA), PA 451 of 1994, as amended, regulates only earth change activity (primarily construction projects disturbing one or more acres of land or that which is within 500 feet of the water's edge of a lake or stream). Part 31, Water Resources Protection Act, of NREPA addresses most other sources of sediment. Locally, municipalities may adopt additional protection measures dependent on state laws via the NREPA or Planning and Zoning Enabling Acts.

River Restoration: History has proven that returning streams and adjacent land to a natural condition reduces erosion. The restoration of vegetation along stream banks protects the water by:

- Reducing the amount of sediment (and pollutants) entering the water
- Provides habitat for wildlife
- Slows the velocity of water, thus reducing flood damage and erosion
- Provides recreational opportunities and aesthetic value
- Reduces long-term maintenance costs

Best Management Practices: Non-point source pollutants including fertilizers, pesticides, animal wastes, chemicals, and sediment are washed away by storm water and distributed in storm sewers, ditches, and streams. The term “best management practices” (BMPs) refers to the design, construction and maintenance practices and criteria that minimize the impact of stormwater runoff.

Dumping Regulations: Dumping regulations attempt to regulate the disposal of solid matter that can end up in streams and wetlands. Solid waste can pollute water, obstruct water flow, and reduce the ability of the stream or wetland to clean storm water. The dumping of waste materials such as garbage is illegal, but the dumping of yard waste, such as leaves and branches, can also affect a watercourse. Waste can block culverts, creating earthen dams that can fail during heavy rain events. Public information should be a central focus of a dumping enforcement program.

Urban Forestry: Damage caused by wind, ice, and snowstorms is often due to their impact on trees. Downed trees and branches can upset power lines, damage buildings, and harm property under them. An urban forestry program can reduce the damage potential of trees through maintenance and monitoring. Through better tree selection, proper pruning and evaluation, communities can also mitigate damage caused by downed trees.

Farmland Protection: Farmland protection's purpose is to provide ways to keep prime, unique or important agricultural land intact. Farmland is being converted to nonagricultural uses at an alarming rate which results in residential development that needs more infrastructure, increased storm water runoff, and emergency services capacity. Farmland protection parallels open space protection in that it keeps the land open for future generations but also helps with storm water runoff, ecosystem maintenance, and scenic enhancement.

The Michigan Farmland and Open Space Preservation Act (PA 116) is a law that works to preserve farmland by offering incentives to farmers who are willing to participate. According to the

Michigan Department of Agriculture and Rural Development (MDARD), the law, which was passed in 1974, enables a farm landowner to enter into a development rights agreement with the state. The agreement is designed to ensure that the land remain in agricultural use for a minimum of 10 years. In return, the farm owner may be entitled to income tax benefits and exemption from special assessments on the land. Today, 3.3 million acres of land, or 9% of Michigan's total land area, is protected under this program<sup>38</sup>. In June 2019, MDARD issued a ruling opening farmland in the state preservation program to large-scale solar development, with several important caveats, including landowners not being able to claim tax credits under PA 116 until the panels are uninstalled<sup>39</sup>.

### **Emergency Services**

Local emergency services authorities, resources, and facilities throughout Keweenaw County are documented in Section 3 of this plan. Although all authorities are effective in conducting their internal and incident response activities, there is an opportunity to further educate the public about their operations – for example, through dissemination of hazard-related materials. Furthermore, several agencies lack necessary equipment to meet their responsibilities in areas of local government operations such as public works and planning. Inadequate funding sources will make this a continuing problem.

Emergency services provide protection for people both during and after a disaster. A thorough emergency services program addresses all hazards and involves all response departments and facilities. In Michigan, emergency services are supervised by the Michigan State Police Emergency Management and Homeland Security Division and coordinated through county emergency management offices. Several components pertain to emergency services, including:

- Threat Recognition
- Warning
- Response
- Critical Facilities Protection
- Post-Disaster Recovery and Mitigation

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<sup>38</sup> Farmland and Open Space Preservation Frequently Asked Questions. MDARD.

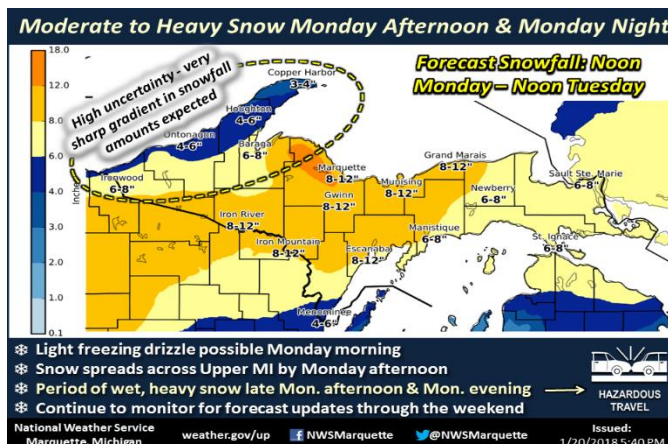
[https://www.michigan.gov/mdard/0,4610,7-125-1599\\_2558-10312--,00.html](https://www.michigan.gov/mdard/0,4610,7-125-1599_2558-10312--,00.html)

<sup>39</sup> Policy for Allowing Commercial Solar Panel Development on PA 116 Lands. MDARD.

[https://www.michigan.gov/documents/mdard/MDARD\\_Policy\\_on\\_Solar\\_Panel\\_and\\_PA116\\_Land\\_656927\\_7.pdf](https://www.michigan.gov/documents/mdard/MDARD_Policy_on_Solar_Panel_and_PA116_Land_656927_7.pdf)



**Threat Recognition:** The first step in responding to a hazard is being aware that there is potential for an event to occur. With a threat recognition system, adequate warnings can be disseminated, and other response actions can be undertaken. Flood threats can be evaluated by measuring rainfall, soil moisture, and stream flows upstream and then calculating flood levels for downstream locations. Discerning the time and height of a potential flood crest will allow more efficient evacuations. Some rivers have gauges that establish threat levels. Under threat conditions, the National Weather Service (NWS) may issue flash flood watches for affected areas. The NWS is the agency that predicts meteorological threats and can issue public warnings.



National Weather Service in Marquette issuing a heavy snowfall warning on January 20, 2018

**Warning:** After a threat is identified, the Office of Emergency Measures (OEM) notifies municipalities and other agencies that an event is possible or occurring. Early notification is key to distribute information to all affected parties. The NWS notifies the public using two levels: *Watch* and *Warning*. *Watch* refers to conditions that are right for flooding, thunderstorms, tornadoes or winter storms. *Warning* refers to a flood, tornado, etc. has started or has been observed. A more specific warning may be disseminated in a few ways, including:

- Warning sirens (outdoor and on public safety vehicles)
- Via commercial radio or TV (news and weather channels)
- NOAA Weather Radio (where available)
- Mass telephone notification
- Tone activated receivers in key facilities
- Door to door contact
- Mobile public address systems via text
- Internet/e-mail notification

All the systems have their limitations because they reach only certain audiences. TV and radio can provide information, but this method of notification is only effective if people have them on. NOAA radio will only reach those with access to a weather radio. Outdoor warnings can indicate to tune into another information source such as TV or radio, but this type of warning has limited reach and may not be heard by people indoors or in noisy environments. Door-to-door contact is time consuming but preferred when there is enough lead time for an incident. The best warning system is a redundant system that provides notification via numerous methods to reach as much of the population, as necessary.

The warning system should also include information as to the response action to take, such as staying indoors during a tornado warning or staying off roads in the event of a severe winter storm.

Response: Effective response, in combination with threat recognition and warnings, is another way for a community to mitigate hazard impact. A community typically coordinates an incident response through an emergency operations center (EOC) that assists the Incident Commander in the field with resources, expertise, etc. as part of the Emergency Action Plan (EAP). An EAP ensures that the community responds efficiently and appropriately to an incident. EAPs need to be regularly updated to keep names and contact information current.

Response activities may include a variety of agencies, offices, and measures such as closing streets and bridges, shutting off power to threatened areas, ordering an evacuation and opening evacuation centers, monitoring water levels, and implementing security measures.

Critical Facilities Protection: Critical facilities are the vital facilities that keep a community functioning as identified in Section 3. Critical facilities must be prepared to respond during an emergency. Most critical facilities will have their own response plan in place, and the facilities are also included in municipal emergency action plans. The best protections are early warning, response planning, and coordination in the event of an emergency.

Post-Disaster Recovery and Mitigation: Communities must be prepared for recovery and mitigation of future problems after an incident. While the primary focus is on recovery, it is also important to recognize mitigation methods to prevent the incident from reoccurring at the same magnitude. During recovery, several actions take place including patrolling, cleanup, providing services, monitoring impact, and regulating reconstruction. During this recovery time, mitigation activities can include undertaking public information efforts aimed at educating residents on how to protect themselves in the future, evaluating reconstruction methods including the addition of mitigation measures, and seeking funding for recovery efforts.

### **Structure and Infrastructure Projects**

Structure and infrastructure projects are intended to protect people and infrastructure from damage due to natural hazards. Such projects are typically used to manage and control flood waters. The complexity and cost of structural projects can vary greatly and are dependent on individual circumstances. Structural projects are undertaken where non-structural measures would not be effective. Structural projects may include:

- Reservoirs and Detention Areas
- Roadway and Crossing Improvements
- Levees/Floodwalls/Seawalls
- Drainage and Storm Water Improvements/Maintenance
- Channel improvements

Because of the construction costs, maintenance and impacts of structural projects, they are often undertaken and funded by larger agencies with coordination at the local level. Agencies including the Michigan Department of Natural Resources, U.S. Army Corps of Engineers, and the USDA Natural Resources Conservation Service are often involved in structural projects.



Reservoirs and Detention: Reservoirs are intended to protect development downstream by temporarily storing flood waters. The reservoirs hold water behind dams or in storage/detention basins until flood waters subside. The detained water is then released downstream at a rate the river or stream can accommodate. Reservoirs are built to address existing problems or may be built to handle increased runoff from new development.

Roadway and Road Crossings Improvements:

Flooding can often affect accessibility by inundating roadways, culverts, bridges, driveways, and other transportation infrastructure. There are several things that can be done to maintain access when alternative access is not available, including elevating the roadbed, enlarging culverts to increase channel capacity, or replacing culverts with bridges. A concern when undertaking these types of improvements is the impact to downstream locations from increased capacity of the water system when it is no longer constricted up stream.



*Upgraded culverts can mitigate flooding problems by increasing the flow capacity of streams as they pass under roadways.*

Levees, Floodwalls and Seawalls: One of the most popular flood control measures is the construction of an earth levee or concrete floodwall to protect property. The purpose of these structures is to keep a stream within its channel by providing higher "banks." Levees require extensive design to address large floods, erosion, river access and views, and cost of construction and maintenance. Seawalls are often used to protect from erosion due to storm surges along Lake Superior's edge. Seawalls are built along a property edge and are designed to protect a property from the storm surges. Along the Great Lakes they can be significantly impacted by ice movement during the winter months and often have difficulty resisting lake forces.

Drainage and Storm Water Improvements/Maintenance: Human-made ditches and storm sewers assist in guiding runoff where surface drainage is inadequate. These systems allow water to be conveyed quickly to other locations; thus, they are most appropriate where the receiving location has adequate capacity. Storm sewer improvements may include installing new sewers, enlarging pipes, and preventing back flows. Other improvements in combination with drainage enhancements may include wetland detention, vegetated trenches, and practices that reduce the quantity and velocity of runoff. It is also important to maintain storm water and drainage systems. This involves keeping channels, ditches, and culverts cleared of debris; maintaining overgrowth; and remediating stream bank erosion sites. Debris can be any number of things, from tree limbs and branches to illegally dumped trash. Maintenance of public drainage systems is the responsibility of government agencies. The city or township must perform routine maintenance on these drainage systems or they (or residents in the watershed) may petition the

County Drain Commission to establish a county drain which after approval by the County Board of Commissioners, then becomes the county's responsibility to maintain.

**Channel Improvements:** Channel improvements are another method of increasing the capacity of streams, thereby allowing more water to travel at a faster rate. Improvements can be made through dredging, "channelization," or diversion. Dredging increases the capacity of a stream by removing material at the bottom. Channelization refers to the straightening, widening, and/or deepening of a stream. Diversion is the practice of creating a new channel to send floodwaters to an alternative location.

### **Education and Awareness Programs**

Education and awareness programs are a mitigation strategy that has broad reaching impact across both the public and private sectors. Activities that provide local officials, property owners, renters, businesses, and other parties with information about how to protect themselves and others from potential hazards may have the greatest impact of all mitigation strategies. Information empowers people to protect their own property and lives.

There are many ways to get information out to the public affected by hazards through community outreach. Community outreach is informing the public through news media, community newsletters, direct mailings, presentations, displays, signs, the internet, brochures, technical assistance, and other outlets. Because methods are diverse, it is best to analyze each community to find out how people obtain information and use that knowledge to build an outreach plan. While in some communities a local newsletter is distributed, other communities may rely on a newspaper to get information.

While public information on hazards is important, it is also vital to provide people with methods to address the hazard. Outreach projects should include information on hazards, safety, health, and property protection measures at the local level. Community offices and libraries are good places to distribute printed information (books and pamphlets) and increasing internet use indicates web distribution is also an effective way to disseminate information. Information on a website can easily be linked to an infinite number of available resources.

Technical assistance can further assist people in protecting their property. Assistance can be in the form of hazard identification assistance or property protection assistance. Resources for technical assistance may include direction from building department staff or FEMA Flood Map clarification with assistance from community staff.

In Keweenaw County and its local jurisdictions, education is the key to hazard mitigation. By providing individual citizens with the information and tools necessary, much can be done to further mitigation efforts in Keweenaw County. An ongoing education program and availability of limited technical assistance could provide the public with the ability to protect themselves and their property.

## Mitigation Resources

There are two types of resources: existing institutional establishments, such as government agencies and continuing programs, and funding sources to undertake specific projects. The following list is intended to provide examples of funding sources for both current and future mitigation projects and should not be considered comprehensive. Potential new sources for mitigation funding should be added as identified. Project specific funding options are included in the respective Action Items identified in Section 8. The following mitigation funding and resources can be found with further detail in Appendix C.

Federal		
Economic Development Administration	U.S. Department of Agriculture	U.S. Department of Transportation
Federal Emergency Management Agency	U.S. Department of Energy	U.S. Small Business Administration
U.S. Army Corps of Engineers	U.S. Department of Health & Human Services	U.S. Department of Housing and Urban Development
U.S. Department of the Labor		
State		
Environment, Great Lakes, and Energy	Michigan Department of Natural Resources	Michigan Economic Development Corporation
Michigan Department of Transportation		
Other - Local		
Copper County Habitat for Humanity - Homeownership Program	Baraga-Houghton-Keweenaw Community Action Agency	Superior Watershed Partnership and Land Conservancy
Hancock Salvation Army	Habitat for Humanity Menominee River	Superior Health Foundation
Duck Lake Riparians' Association	Keweenaw Community Foundation	Portage Health Foundation
Keweenaw Land Trust	Keweenaw Economic Development Alliance	Western Upper Peninsula Planning & Development Region (WUPPDR)
Other - National		
Community Restoration and Resiliency	National Low-Income Housing Coalition	Rebuilding Together
Grants for Indigenous Peoples	Planning for Post Disaster Recovery	Volunteer Organizations Active in Disasters (VOAD)

## **Updating the 2020 Keweenaw County Hazard Mitigation Plan**

This section is intended to provide discussion on how communities will continue public participation in the plan maintenance process. It will also contain a description of plan monitoring, evaluating, and updating for keeping the plan current and updated within five years.

Throughout of the development of the 2020 Keweenaw County Hazard Mitigation Plan, the County has made a concerted effort to collect feedback from the public, local government, and agencies. Moving forward residents will continue to be notified of any plan updates and be invited to provide feedback through the incorporation of hazard mitigation into other planning documents.

The Hazard Mitigation Plan will be updated every five years to address changing priorities and remain eligible for FEMA mitigation funding programs. The Emergency Manager will convene a Local Planning Team representing local agencies and concerned parties to evaluate progress and update the plan in accordance with FEMA regulations. The committee will review the plan to determine the sections that need to be updated or modified based on changing conditions or alterations in State or Federal requirements. It is recommended that public participation will include surveys, charettes, and other community presentations at regularly scheduled meetings. Goals, objectives, and strategies will also be reviewed to determine whether they thoroughly address new or changing conditions.

The Emergency Manager will monitor and evaluate the plan implementation over time to assess the effectiveness of the plan at achieving its stated goals. They will work with Keweenaw County to update the plan within five years based on public feedback, the Local Planning Team and State Hazard Mitigation Officer recommendations. The public will also be notified of any plan updates (interim or within five years), and copies will be made available at all local government offices and online.

## SECTION 8: Action Plan

This section highlights the five-year action plan set out by the Local Planning Team for Keweenaw County to reduce the community's vulnerability and risk to local hazards based on their capability. The final step in the mitigation process is to build upon the general recommendations for mitigation activities suggested in Section 7 and identify specific action items for Keweenaw County and its communities. All the activities identified in this section are consistent with the following mitigation goals identified in Section 7:

- Goal 1** Protect lives and property within Keweenaw County from all known hazards while focusing on priority hazards.
- Goal 2** Identify feasible projects throughout the County that will help mitigate future problems.
- Goal 3** Be proactive in protecting public facilities and critical facilities through proper maintenance and upgrades.
- Goal 4** Educate citizens to encourage self-help and mitigation of hazards on private property.

Projects vary from structural measures to education and are prioritized based on impact to persistent, known hazards and potential resources available to complete the project. Although projects are prioritized on a countywide basis, this does not limit the county's or a local community's ability to pursue identified projects as funding becomes available. Several projects are ongoing action activities that will be accomplished as time and resources permit. Identified action items include a short description of the activity, the responsible agency or agencies, timeline, projected costs if available, and ways that Keweenaw County and its citizens will benefit.

Cost-benefit consideration, both financial and otherwise, is a major factor in the prioritization of action items. As a result, action priorities are not entirely consistent with the rankings in the Hazard Analysis section. In addition, a potential event that is anomalous within its hazard category may warrant action regardless of the rank of that general hazard type.

### Past Mitigation Accomplishments

**Tables 8.1 and 8.2** below summarize the status of the mitigation action items from the 2005 and 2013 Hazard Mitigation Plan.

**Table 8.1: 2005 Hazard Mitigation Action Items**

2005 Item	Status in 2013
Gay – Lac La Belle Road Erosion Stabilization	Not Completed
Eliza Lake / Dam / Creek Flood Mitigation Project	Not Completed
NOAA Weather Radio	Not Completed
Mine Shaft Safety	Ongoing
Improved Emergency Response, Equipment, and GIS System	Partially Completed and Ongoing
Portable Water Treatment System	Not Completed
Updated Shoreline Erosion Map and Identify Future Mitigation Activities	Not Completed
Public Information / Education Program	Ongoing
Review Plans and Development Regulations	Ongoing
Insurance	Ongoing
Adopt Hazard Mitigation Plan and Update Regularly	Ongoing

**Table 8.2: 2013 Hazard Mitigation Action Items**

2013 Item	Status
Gay – Lac La Belle Road Erosion Stabilization	Ongoing
Eliza Lake / Dam / Creek Flood Mitigation Project	Ongoing
Mine Shaft Safety	Ongoing
Drainage Improvements and Maintenance	Ongoing
Improved Emergency Response, Equipment, and GIS System	Ongoing
Portable Water Treatment System	Not Completed
Updated Shoreline Erosion Map and Identify Future Mitigation Activities	Completed
Public Information / Education Program	Ongoing
Review Plans and Development Regulations	Completed and ongoing
Insurance	Ongoing
Adopt Hazard Mitigation Plan and Update Regularly	Ongoing

Some action items are carried over from the 2013 Hazard Mitigation Plan. Several of these are ongoing activities that will continue indefinitely. Two projects have been completed – updating shoreline erosions maps and developing zoning regulations for Keweenaw County. The other items were and are dependent on funding that has not been available. No large-scale changes in land development have occurred in Keweenaw County since 2005. Most construction has been incremental within or adjacent to already-developed areas. Keweenaw County and Eagle Harbor have recently completed, are in progress of completing, or have explored, respectively, new Master Plans. None of these are expected to have a major effect on land use in the County. Note that the action item costs are estimated.



**Action Item 1: Disaster Recovery Plan**

The Federal Emergency Management Agency (FEMA) works to ensure that communities have the tools needed to make informed decisions to reduce risks and vulnerabilities and to effectively respond and recover. Effective pre-disaster planning is an important process that allows a comprehensive and integrated understanding of community objectives. Pre-disaster planning also connects community plans to guide post-disaster decisions and investments.

<i>Responsible Agency:</i>	Keweenaw County Emergency Manager, the local emergency planning team, and local units of government.
<i>Deadline:</i>	2021
<i>Cost:</i>	\$5,000
<i>Potential Funding Sources:</i>	Pre-Disaster Mitigation Grant Program (FEMA)
<i>Benefits:</i>	The ability of a community to successfully manage the recovery process begins with its efforts in pre-disaster preparedness, mitigation, and recovery capacity building. These efforts result in resilient communities with an improved ability to withstand, respond to and recover from disasters. Pre-disaster recovery planning promotes a process in which the whole community fully engages with and considers the needs and resources of all its members. The community will provide leadership in developing recovery priorities and activities that are realistic, well planned, and clearly communicated.

**Action Item 2: Gay – Lac La Belle Road Erosion Stabilization**

Gay-Lac La Belle Road in Grant and Sherman Townships has various locations, ranging from 20 to 100 feet long, along Oliver Bay and Bete Grise where the 23-mile roadway is threatened by shoreline erosion and rising water levels on Lake Superior. This project would stabilize the roadway with a reinforced concrete wall with drainage, riprap backfill and "geotextile" covering at seven locations. This project was included in the 2005/2013 Hazard Mitigation Plan but has lacked sufficient funding to complete.

<i>Responsible Agency:</i>	Keweenaw County Road Commission
<i>Deadline:</i>	2022
<i>Cost:</i>	\$600,000
<i>Potential Funding Sources:</i>	FEMA, MDOT, EGLE, EPA and Army Corps of Engineers
<i>Benefits:</i>	The project will protect Lac La Belle Road from shoreline erosion where relocation of the roadway is not feasible due to land ownership, wetlands, and other issues. Lac La Belle Road serves as a County primary providing access to much of Keweenaw County. Failure of the roadway due to erosion would result in up

to a 50-mile detour which not only inconveniences residents and travelers but substantially increases response time for Emergency Responders. Seven threatened locations along the Lac La Belle Road will be addressed through this mitigation project.

**Action Item 3: Eliza Lake/Dam/Creek Flood Mitigation Project**

Improve Eliza Lake and Dam in Eagle Harbor Township to adequately accommodate and control spring runoff. The Project would involve dredging Eliza Lake (Reservoir), modifying the dam to allow discharge of water under the dam and replacement of two culverts. This project has not been funded since the 2005/2013 plans but remains a high priority.

<i>Responsible Agency:</i>	Keweenaw County Emergency Manager
<i>Deadline:</i>	2023
<i>Cost:</i>	\$1 million
<i>Potential Funding Sources:</i>	FEMA, EGLE, DNR, and Army Corps of Engineers
<i>Benefits:</i>	The community of Eagle Harbor would benefit from the improvements that will provide for controlled, non-catastrophic release of runoff. Side benefits include an increase in water supply for local fire suppression and protection of the aquifer that feeds the Eagle Harbor wells. Modifications to the dam will also allow a cold-water discharge to Eliza Creek thus providing habitat for the endangered Coaster Brook Trout. This project was included in the 2005/2013 Hazard Mitigation Plans but has lacked sufficient funding to complete.

**Action Item 4: Mine Shaft and Stope Safety**

An ongoing program of mine safety that includes capping and other measures should be implemented. As funding is available, the County will prioritize and address hazardous shafts and stopes. Shafts should be closed off at their openings, whereas stopes should be identified and mitigated through internal supports and/or closure of overlying land. Mine shaft and stope safety were included in the 2005 and 2013 plans and is an ongoing process, but in this incarnation, the dollar amount needed for each cap has been significantly increased to allow for the full range of case-by-case projects. Cost of mitigation components is unknown and varies case by case.

<i>Responsible Agency:</i>	Keweenaw County Emergency Manager and Mine Inspector
<i>Deadline:</i>	Ongoing
<i>Cost:</i>	Up to \$75,000 for capping per shaft/opening. \$30,000 estimate for concrete and rebar needed to stabilize Central Mine.
<i>Potential Funding Sources:</i>	FEMA

*Benefits:* Action to address the numerous abandoned mines throughout the region is necessary to protect people and property. The long history of mining has led to a persistent problem with mine shaft openings, shafts that are reopening due to improper capping (with materials such as rotting logs and rusting cars), and unidentified stopes that needs to be addressed.

#### **Action Item 5: Mt. Horace Greeley Brownfield Remediation**

The former Calumet Air Force Station located on Mount Horace Greeley is classified as a Brownfield site. In 2017, the Air Force conducted tests for contaminated groundwater and confirmed the presence of asbestos, lead, and oil spills. The site is a hazard to the public, who continue to trespass on the site despite signage barring entrance.

*Responsible Agency:* Keweenaw County

*Deadline:* 2024

*Cost:* Unknown

*Potential Funding Sources:* FEMA, EGLE

*Benefits:* Remediation of the former Air Force Station would prevent future exposure of hazardous materials to the public.

#### **Action Item 6: Stamp Sand Removal at Buffalo Reef**

Buffalo Reef is a natural cobble feature in Lake Superior, located just off the eastern edge of the Keweenaw Peninsula in Keweenaw County. The reef has historically maintained an invaluable spawning habitat for lake trout and whitefish. These habitat features are threatened by migrating stamp sands, a mine waste product produced in the late 1800s. Modeling predicts that by 2025, 60 percent of Buffalo Reef no longer will be viable for lake trout and whitefish spawning, creating a huge threat to fisheries and the outdoor recreation and commercial fishing industries they support. The goal is to mitigate the damages to the reef by the stamp sand and complete restoration of the spawning site. Mitigation activities involve dredging and removal of the mine waste.

*Responsible Agency:* Keweenaw County, Keweenaw Bay Indian Community, Michigan Technological University, Michigan Department of Natural Resources, and Great Lake Indian Fish and Wildlife Commission

*Deadline:* 2025

*Cost:* Variable by remediation activity

*Potential Funding Sources:* EGLE, FEMA, DNR, and others

*Benefits:* Continued spawning for lake trout and whitefish (Michigan Tech estimates that 33% of all lake trout and whitefish in Lake Superior

spawn at Buffalo Reef). The mitigation also would benefit tribal and non-tribal commercial fishing industry and outdoor recreation.

#### **Action Item 7: Copper Falls Tower**

The observation tower at Copper Falls is in disrepair, however the public continues to use the tower at their own risk. Remove the observation tower from Copper Falls Park to prevent injury.

<i>Responsible Agency:</i>	Keweenaw County
<i>Deadline:</i>	2022
<i>Cost:</i>	Unknown
<i>Potential Funding Sources:</i>	DNR, County budget
<i>Benefits:</i>	Prevention of people being injured when they are recreating in Keweenaw County.

#### **Action Item 8: Grant Township Sewage Grinder Pump Replacement**

Copper Harbor is an unincorporated community of ~70 full-time residents whose sewage infrastructure is maintained by Grant Township. The sewage treatment lagoons are located .8 miles uphill from the center of the community, which means that the sewage is pumped from each house up to the system. Each residence and business have one (or several) grinder pump(s) on its property and pays for the electricity required to run them.

They were installed in 1993, which makes the original pumps nearly 27 years old. They are currently failing and, as they have failed over time, Grant Township has maintained the pumps, rebuilding them, and using replacement parts to help them limp along. The original manufacturer no longer makes replacement parts for pumps. Therefore, the grinder pumps must be upgraded.

If someone continues to use the toilets and sinks when a sewage grinder pump fails, sewage can back up into the house. It is a real possibility that the resident will not know it has failed if they are not paying close attention. The next-level of the problematic situation is that the sewage can also back up into the grinder-pump housing cans.

<i>Responsible Agency:</i>	Grant Township
<i>Deadline:</i>	2024
<i>Cost:</i>	\$800,000 - \$1,400,000
<i>Potential Funding Sources:</i>	FEMA
<i>Benefits:</i>	Upgrade of the grinder pump system prevents further environmental and public health issues by preventing municipal water contamination.

**Action Item 9: Drainage Improvements and Maintenance**

Drainage systems are insufficient to handle runoff in several areas throughout Keweenaw County. Ditches should be added, dredged, and culverts kept clear. Allouez Township, including the Village of Ahmeek, has identified problems largely due to buildup of vegetation and debris in drainage ditches. There is a need for a new drain box and culvert at 8th and Cliff Street and for dredging of the ditch between Central and Seneca Streets.

<i>Responsible Agency:</i>	Keweenaw County Road Commission and Township Public Works
<i>Deadline:</i>	2024
<i>Cost:</i>	Variable by project
<i>Potential Funding Sources:</i>	FEMA, and organization/ agency operating budgets
<i>Benefits:</i>	Inspection and maintenance of the existing drainage system will prevent flooding caused by plugged culverts, insufficient ditches and storm sewers. Problems will be alleviated in areas where materials are washed into waterways regularly during spring flood conditions. Studies and improvements in the highway corridors will address ongoing spring runoff problems.

**Action Item 10: Improved Emergency Response, Equipment, and GIS System**

Conduct ongoing reviews of response plans and programs to keep emergency contacts up to date, ensure critical facility information is current, and to identify/incorporate new and improved methods of warning and response. Enhance County GIS to incorporate all applicable data for hazard mitigation planning. Evaluation of shelter facilities, emergency response equipment, and training during the review process.

<i>Responsible Agency:</i>	Keweenaw County Office of Emergency Measures
<i>Deadline:</i>	Ongoing – incorporate into annual emergency plan revision process
<i>Cost:</i>	Variable
<i>Potential Funding Sources:</i>	General operating budget, FEMA, DHS State Homeland Security Grant Program, Firefighter Assistance Grants
<i>Benefits:</i>	Emergency plans that are up to date and incorporate all available methods of warning and response will be most effective in emergency situations thus mitigating loss from hazards. These plans serve as an effective tool in determining equipment needs on an annual basis while an integrated Geographic Information

System will provide a comprehensive inventory of County assets for hazard and emergency management.

**Action Item 11: Public Information/Education Program**

Public information is the key to mitigating many of the potential hazards in Keweenaw County. Several projects can help to educate the public on potential hazards and how to protect themselves from hazards. Recommended projects include preparing and gathering education materials on hazards affecting Keweenaw County and how people can help with mitigation. These materials should be organized and made available at government offices, schools and other easily accessible public facilities as well as on the internet. Topics to focus on include safe open burning, community hazard awareness, preparedness, resiliency, and invasive species.

<i>Responsible Agency:</i>	Keweenaw County Office of Emergency Measures, DNR, MSU Extension, Keweenaw Land Trust, and American Red Cross
<i>Deadline:</i>	Ongoing
<i>Cost:</i>	Unknown; staff time, cost of materials, and printing
<i>Potential Funding Sources:</i>	Organization/agency operating budgets, FEMA, DHS Homeland Security Grant Program, Michigan Invasive Species Grant Program, and other federal and state sources
<i>Benefits:</i>	Organizing locally applicable materials and making them available to the public ensures that the message is getting out. Through use of newspapers and the internet, the public is easily informed, and the message can be made consistent. This action item helps inform the public and assists people who want to learn more about property protection and how to reduce their risk.

**Action Item 12: Review Plans and Development Regulations**

Keweenaw County's Emergency Manager will work with the County Board and County Planning Commission to ensure hazard mitigation is included in ongoing county planning activities. During updates to County plans and regulations, the County will consider actions and recommendations that divert new development from identified hazards, include development standards that ensure adequate fire and emergency access, require buried utility lines, and promote open space requirements that protect properties from flooding.

As local land use plans, comprehensive plans, zoning, building codes, and other plans and regulations become due for revision, appropriate hazard mitigation provisions will be considered and incorporated.

<i>Responsible Agency:</i>	Keweenaw County Office of Emergency Measures, Keweenaw County Planning Commission, Municipalities
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<i>Deadline:</i>	Ongoing as plans and ordinances are reviewed
<i>Cost:</i>	Staff and commission time
<i>Potential Funding Sources:</i>	Organization / agency operating budgets
<i>Benefits:</i>	Citizens of Keweenaw County will benefit from plans that protect new development from known hazards and by awareness of methods of protecting their lands from known priority hazards.

**Action Item 13: Identify and Inventory Datasets for Quantitative Hazard Analysis**

Through the hazard mitigation planning process there were many data gaps identified including flood depth grids for rigorous hydrological modeling, structural and wildfire events, abandoned mine status, age and estimated value of all critical facilities, comprehensive asset inventory, dam inundation modeling, and updated flood erosion maps for current and rising lake levels.

<i>Responsible Agency:</i>	Keweenaw County Office of Emergency Measures and local municipalities; Department of Natural Resources; Local Volunteer Fire Departments
<i>Deadline:</i>	Ongoing
<i>Cost:</i>	Unknown
<i>Potential Funding Sources:</i>	FEMA Hazard Mitigation Grant Program, National Science Foundation
<i>Benefits:</i>	Comprehensive risk assessment including both qualitative and quantitative analysis.

**Action Item 14: Adopt Hazard Mitigation Plan and Update Regularly**

By adopting the Keweenaw County Hazard Mitigation Plan, the County and its municipalities recognize the need to incorporate hazard mitigation activities into everyday decisions at the County and local level. The plan will be reviewed annually by the Emergency Manager in coordination with the Emergency Operations Plan update to determine whether revisions are needed.

The Hazard Mitigation Plan will be updated every five years to address changing priorities and remain eligible for FEMA mitigation funding programs. The Emergency Manager will convene a Hazard Mitigation Committee representing local agencies and concerned parties to evaluate progress and update the plan in accordance with FEMA regulations. The Committee will review the plan to determine the sections that need to be updated or modified based on changing conditions or alterations in State or Federal requirements. Goals, objectives, and strategies will also be reviewed to determine whether they thoroughly address new or changing conditions.

The Emergency Manager will work with Keweenaw County to update the plan based on Hazard Mitigation Committee and State Hazard Mitigation Officer recommendations. The public will be notified of any plan updates, and copies will be made available at all local government offices and

online if feasible. The public will be provided with and notified of comment opportunities during all interim and five-year plan updates.

*Responsible Agency:* Emergency Manager

*Deadline:* FEMA and organization/agency operating budgets

*Cost:* Staff time

*Potential Funding Sources:* FEMA and organization / agency operating budgets

*Benefits:* The adoption of the Hazard Mitigation Plan commits Keweenaw County and its communities to working on mitigation efforts within its boundaries. Through implementation of mitigation strategies in the Plan, the County and municipalities will be actively working to prevent future problems within Keweenaw County.

## **Appendix**

Appendix A: County Capability Snapshot

Appendix B: Shoreline Erosion Maps for Keweenaw County

Appendix C: Mitigation Funding and Resources

Appendix D: County Letter to Commit Match

Appendix E: Public Participation

Appendix F: Meeting Materials

Appendix G: State Document Review

Appendix H: Plan Adoption