Bay County Hazard Mitigation Plan

July, 2010

Prepared for:

Auburn, City of
Bangor, Township of
Bay City
Beaver Township
Essexville, City of
Frankenlust, Township of
Fraser, Township of
Garfield, Township of
Gibson, Township of
Hampton, Township of
Kawkawlin, Township of
Merritt, Township of
Midland, City of
Monitor, Township of
Mount Forest, Township of
Pinconning, City of
Pinconning, Township of
Portsmouth, Township of
Williams, Township of

Prepared By:

Stantec

In Partnership With:

FEMA

EXECUTIVE SUMMARY

Natural hazards are an unavoidable part of daily life. Bay County and the jurisdictions within the county have experienced natural hazards, including but not limited to: droughts, earthquakes, extreme temperatures, flooding, hail, severe storms, severe winter storms, tornadoes, wildfires, and wind driven ice floes. There is little that citizens can do to control the forces of these events. The communities participating in this plan are subject to natural hazards that can impact the quality of life, and have the capability of destroying property, threatening lives, disrupting businesses and impacting infrastructure. Although it is not possible to control Mother Nature, it is possible to lessen the impact of natural hazards through comprehensive planning efforts. The Federal Emergency Management Agency (FEMA) defines hazard mitigation as "any sustained action taken to reduce or eliminate the long-term risk to human life and property from hazards". The purpose of this plan is to identify the risks associated with the hazards that threaten Bay County and identify ways to reduce these risks through mitigation activities for current structures and infrastructure and to lessen the impacts on future growth. These mitigation activities include structural projects, education and outreach efforts, capital improvement projects, etc. FEMA encourages the use of hazard mitigation to develop a complete document that can be modified and updated as needed. The goal of this document is to develop a framework for a living document that can be updated annually and after natural disasters and incorporated and referenced in other planning efforts. Additionally, this document contains the list of projects for the jurisdictions to implement in an effort to reduce natural hazard risks.

Disaster Mitigation Act of 2000

The United States Congress passed the Disaster Mitigation Act of 2000. This Act requires that state and local governments develop hazard mitigation plans in order to be eligible for pre- and post disaster funding from the federal government. This plan was developed in coordination with the Michigan State Police.

The Michigan State Hazard Mitigation Plan, 2008

This plan was developed with particular emphasis on the Michigan State Hazard Mitigation Plan (hereinafter referred to as the State Plan). The State Plan focused on two kinds of mitigation strategies; corrective and preventative. **Corrective mitigation** is focused on correcting past practices that have increased hazard vulnerability. **Preventative mitigation** prevents future problems from occurring in the first place through public education and outreach, informed decision-making and disaster resistant building/development practices. The original State Plan was completed in 2004. There have been two updates, one in 2006 and the latest in 2008. The 2008 update assessed only natural hazards. The 2008 update includes summaries of local vulnerabilities as documented in local hazard mitigation plans and development pressures. The

Michigan Hazard Analysis describes the State's vulnerability to 30 different types of natural, technological or human related hazards. These findings were incorporated into the Bay County Natural Hazard Plan to further define the risks for the communities.

TABLE OF CONTENTS

Table of Contents

Table of Contents

Table of Contents

TABLES **Page**

FIGURES **Page**

Table of Contents

1.0 PREREQUISITES

1.1 BAY COUNTY OVERVIEW

Bay County's rich history is directly related to its abundance of natural resources including forests, rivers, wildlife, and proximity to the Saginaw Bay. The Saginaw River flows through Bay City while the Kawkawlin River drains much of the central portion of the county. The Pinconning River and Saganing Creek drain the northern portion. The Saginaw Bay of Lake Huron lies to the east, giving the county its name. It is a place that has drawn humans to its bounty from the very beginning, including early Native Americans and later settlers.

Bay County was organized on April 29, 1857 from portions of the counties of Midland and Saginaw, and all of Arenac County. The founding townships were Williams and Hampton. Lower Saginaw was officially renamed Bay City on February 10, 1857. The village of Bay City was later incorporated as a City in 1865.

The county's greatest growth was during its pioneering history. The population swelled from 3,155 in 1860 to 56,412 thirty years later during the height of the lumbering era. Lumbering mills, shipbuilding yards, fishing and farming drew immigrants here from faraway places.

By the 1890s, with vast stands of Michigan timber depleted, the lumbering era came to an end in Bay County. The County then became home to several industries including shipbuilders. The Defoe Shipbuilding Company, which ceased operations on December 31, 1975, built destroyer escorts, guided missile destroyers, and patrol craft for the United States Navy.

Bay County is presently well known in Mid-Michigan for its numerous festivals and celebrations which take place during the summer months. Among them are the River Roar, the Independence Day Fireworks Festival, and the Pig Gig. Many of these events take place along one or more banks of the Saginaw River, often in Wenonah Park on the east bank or the larger Veterans Memorial Park on the west bank.

The Bay County economy is also impacted by tourism. With more than 36 miles of Saginaw Bay Shoreline, fifteen launch sites, nine public marinas, four private yacht clubs and 426 camp sites, the County is also a destination for avid campers, fishermen and boaters.

1.1.1 Geography and Climate

Location – Bay County is located in the east portion of Michigan's Lower Peninsula, approximately 100 miles north of Detroit. Bay County is part of the region commonly referred to as the Saginaw Valley and forms a portion of a metropolitan area including Midland and Saginaw Counties. Bay County comprises 1,634 km² (631 sq mi). 1,151 km² (444 sq mi) of it is land and 483 km² (187 sq mi) of it (29.59%) is water with a population of approximately 110,000 people (2000 Census Data).

Geology – The geological history of Bay County is consistent with the rest of Michigan. It is dominated by the influence of glacial action and ancient seas. Rock formations of gypsum, dolomite, sandstone, limestone and shale are covered with a variety of glacial deposits called drift to a depth of 450 feet. Throughout the county there are significant underground brine and salt deposits. During the 1800's, mining salt wells was a common practice in the County. Many of these were formerly tapped for industrial purposes. Currently, all mining operations have been phased out and all well sites have been closed.

Topography and Water Resources – The topographic character of Bay County is generally level as a result of glaciations some 15,000 years ago. Some manmade features such as highway overpasses and bridges have resulted in a change in topography.

The Saginaw, Kawkawlin, and Pinconning Rivers compose the natural waterways within Bay County. 36 miles of Saginaw Bay shoreline are situated inside of Bay County. Bay City is divided by the Saginaw River with a total of four drawbridges spanning the river.

Flooding is the primary concern in the community. The Saginaw Bay can also pose an increased risk of flooding. Serious flooding has been experienced in Bay City, and along the shoreline of the Saginaw Bay.

Vegetation – Bay County is a mix of open agricultural land, undeveloped land, and developed urban areas. Some areas of the county are low-lying and swampy. The vegetation and character of the landscape is greatly impacted by the Saginaw Bay, the Saginaw and Kawkawlin Rivers.

Climate – Bay County's climate is one of diversity and extremes, with hot and humid summer months and cold, snowy winters. The average January temperature is 20 degrees Fahrenheit and the average July temperature is 70 degrees Fahrenheit. Total annual precipitation averages 28 inches of rain. The average snowfall for the area is 39 inches. The prevailing winds are from the southwest. Storms generally come from the southwest in the spring and from the northwest during the summer months.

1.1.2 Land Use Patterns

Agricultural Land – There are over 191,400 acres of cropland in Bay County, representing over 50 percent of the land area. The primary agricultural use in Bay County is cropland, and in most cases, these lands have been designated as agricultural by local governmental units in their land use plans and zoning ordinances.

Residential Land – There are over 63,000 acres of residential development in Bay County. Bay City, and the townships contiguous with the City, represents approximately 50 percent of the residential land in Bay County.

Commercial Land – There are over 8,000 acres of commercial land in Bay County. The majority of commercial land is located in the City and townships contiguous with Bay City. Additional existing commercial land is located along Highway M-13, Highway M-25, around US-10 interchanges, and in the Pinconning and Kawkawlin areas.

Industrial Land – There are over 9,100 acres of industrial land in Bay County, with the majority of the industrial land in Bay City. Plans call for the industrial base to remain primarily within existing industrial areas. Growth has occurred within Monitor and Williams Townships. Further expansion in the Monitor and Williams Township area is projected.

Public Land – This consists of land holdings under public and quasi-public ownership, including institutional properties and lands in a natural condition. These encompass a state park and various county and other non-developed municipal holdings. The majority of the institutional acreage is located within Bay City. This includes Bay City Hall, Bay County Building, Bay County Courthouse and Jail, Bay Law Enforcement Center, Bay County Health Department, Bay County Civic Arena, libraries, and other facilities. The county is served by several senior citizen centers, community centers, schools, museums, fire stations, a hospital, ambulance stations, township halls, and a wide variety of city and county parks.

General Development Pattern – The availability of water and sewer services has greatly influenced the development pattern in Bay County. Most of the residential, retail, commercial and industrial growth has occurred within the City of Bay City and areas contiguous with the City in the surrounding townships. New condominium developments can be found in Downtown Bay City along the Saginaw River. An additional area of expanding development is along US-10 in Monitor and Williams Townships. Residential development can also be found in other areas of Bay County. New homes can be found in every township.

Housing Stock – Housing in Bay County consists of a variety of single family dwellings, duplexes, condominiums, townhouses, apartments and mobile home parks. Throughout Bay County, as of 2006, about 80 percent of the housing stock consisted of single family dwellings. The remainder of the housing stock was close to being equally divided between multi-family dwellings and mobile homes. The quality, value, and age of these structures are varied.

Public Infrastructure – The adequacy of public infrastructure is open for debate. Existing infrastructure in most cases is in fair to good condition.

Areas of Major Land Use Conflict – There are no major areas of land use conflict in Bay County.

Historic District – Bay City created the Bay City Downtown Historic District in 1985. This district contains a number of commercial locations and is located on the east side of Bay City in the downtown area. Bay City created Midland Street Commercial District in 1982. This district contains a number of commercial locations and is located on the west side of Bay City near the Saginaw River Waterfront. Bay City created the Center Avenue Neighborhood Residential District in 1982. This district contains a number of historic mansions built by lumber barons in the architectural style of the Late Victorian, Mid 19th Century Revival and Early 20th Century American Movements.

Major Mitigation Measures to Minimize Hazards – In Bay City and in many townships, land use controls for any development or redevelopment in the flood plain were incorporated into the building codes.

1.1.3 Transportation Network

Highways and Major Roads – Bay County is served by several major roadways. U.S. 10 crosses Bay County from Bay City to west edge of the County. It is the main route between Bay County and the City of Midland and it connects Bay County to U.S. 127 in central Michigan. State Highway M-25 runs east and west through eastern Bay County, connecting Bay County to the Northern Michigan thumb area. State Highway M-15 runs north and south in central and south eastern Bay County, connecting primarily with the Southern Michigan Thumb area. State Highway M-13 runs north and south through central Bay County connecting Bay County to the eastern side of the City of Saginaw, Saginaw County and Arenac County. State Highway M-84 runs north and south through central Bay County connecting Bay County to western side of the City of Saginaw and Saginaw County. Interstate I-75 runs north and south through central Bay County.

Airports – MBS International Airport is located ten miles southwest of Bay City in Saginaw County. This facility is operated jointly by the City of Midland, the City of Saginaw and Bay County. Also in Bay City is the municipally owned James Clements Airport, which is a general aviation facility.

Ports – Bay County has a customs port of entry located in the City of Bay City. The Saginaw River Lower Port Terminal Number 1 is located on Marquette Street (Port to Truman Parkway) and its connector length is 0.2 miles. The Saginaw River Lower Port Terminal Number 2 is located on Woodside Drive (Pine Street to Trumbell Street) and its connector length is 1.8 miles.

Rail Service – There are no passenger rail services in Bay County. The nearest passenger rail service is Amtrak, which is accessible in Flint or Lansing. The Huron Eastern Railway, Lake State Railway, and the Saginaw Bay Southern Railway companies provide rail service to Bay County.

Local Transit Services – The Bay Metro Transit Authority provides public transportation for Bay County Residents. Taxi service is also available in the Bay City area. The Bay Metro Transit Authority provides handicapped accessible transportation.

General Condition of Roads and Bridges – Improvements to roads and bridges in Bay County are ongoing by local and State Highway Department, the County Road Commission and local units of government. Even so, some roads are in poor condition. Bay City is divided by the Saginaw River. The river limits transportation east and west in Bay City. A series of four draw bridges connects Bay City. The Bay City bridges north to south are the Independence Bridge, Liberty Bridge, Veterans Memorial Bridge and the Lafayette Bridge. The two southern most bridges, the Lafayette Bridge and the Veterans Memorial Bridge, are MDOT owned bridges. Both the Independence Bridge and the Liberty Bridge are owned by the City of Bay City.

1.1.4 Population Characteristics

Current Population – The 2000 Census indicated that 110,157 people lived in Bay County.

Age/Racial Breakdown – In Bay County, 94.9% of residents are Caucasian, 1.3% are Black, 0.5% are Asian, 1.5% are multi-racial, 0.5% are Native American/Alaskan Native, 3.9% are Latino, and 1.2% are some other race. Most of the minority population resides in the City of Bay City. The median age for residents in Bay County is 38.4 years in 2000. In 2000, the percentage of residents in Bay County 65 years old and older was 14.7%.

Non-English Speaking Population – According to the 2000 US census, 5% of the Bay County population speaks a language other than English at home.

Seasonal Population Fluctuations – The population of Bay County does not vary significantly due to seasonal fluctuations. There are some seasonal/vacation homes along the Saginaw Bay Shoreline, but most of the homes on the Saginaw Bay are year-round residences; therefore, there is not a large influx of people in the summer. Several campgrounds operate in Bay County during the summer including the Bay City State Park and the County-owned Pinconning Park; however, they are not large enough to create a significant impact on the population. Also, as with other Michigan communities, a number of the retired citizens spend their winters in warmer US climates, but their departure does not cause a significant fluctuation.

1.1.5 Economic Characteristics

Major Employers - 2009 statistics are from Bay Future Inc., a private-public alliance of government, business and other organizations that support economic growth in our community.

Table 1.1 Bay County Employers

Company	Location	No. of Employees	Product
Bay Regional Medical Center	Bay City	1,947	Health Care
Dow Corning	Auburn	1,200	Silicone Products
Bay City Public Schools	Bay County	1,054	Education
Delta College	Bay City	930	Education
Michigan Sugar	Bay City	623	Sugar Processing
General Motors	Bay City	614	Automotive
Meijer Inc.	Bay City	586	Retail
Bay County	Bay City	533	Government
Consumers Energy	Essexville	516	Utility
S.C. Johnson	Bay City	444	Household Plastics

Unemployment – Consistent with the State of Michigan, Bay County has a high unemployment rate. The Michigan Department of Labor and Economic Growth recorded a 7.6% unemployment rate for Bay County in 2004. The unemployment rate for the State as of March 2010 was 14.1%, which was a 1.5% increase from the prior year.

Median Household Income - The median household income for Bay County estimated for 1999 in the 2000 Census was $38,646.

Poverty - In the 2000 Census, Bay County was shown to have 13.7% of the population living below the poverty level.

1.1.6 Key Community Facilities/Organizations

Community Services - Bay County residents are served in a variety of ways by county, city, village and township government. There are six law enforcement agencies, fifteen fire departments, and two emergency medical services that provide public safety services. Animal control and emergency management are also provided to residents by county government. Major services provided by Bay City to its residents include police and fire protection, electricity, garbage disposal, water and wastewater treatment facilities, and street maintenance. Areas of Bangor Township, Essexville, Pinconning Township, Auburn, Williams Township, Frankenlust Township, Monitor Township, Hampton Township, Portsmouth Township, Merritt Township and Kawkawlin Township also have water services available. Other county-wide services are provided through the Sheriff's Office, Road Commission, Public Health Department, Bay County Public Library System, Register of Deeds and County Clerk.

Utility Services - Natural gas and electric service for Bay County are provided by Consumers Energy. Electric service for Bay City is provided by the City. Cable television is provided by Charter Communications. Telephone service in Bay County is provided by a number of companies. Consumers Energy operates the coal fired Karn-Weadock power plant in Hampton Township.

Bay County and Bay City obtain water from Lake Huron. Both Bay City and Bay County have a sanitary sewage treatment system.

Non-Profit Organizations - There are a number of non-profit agencies in Bay County, most of which are located in Bay City. These agencies include but limited to: East Shoreline American Red Cross, United Way of Bay County, American Cancer Society, Big Brothers/Big Sisters, Voluntary Action Center, Salvation Army, Saint Vincent DePaul, and the Literacy Council, YMCA, YWCA, BASIS, The Boys and Girls Club, The Bay Area Women's Shelter, Cory Place (which provides youth crisis services), Do-All (which provides extended employment services to people with disabilities), Bay County Division on Aging, Mobile Meals of Bay County, Pinconning Area Emergency Food Pantry, and Mid-Michigan Community Action Agency.

Colleges and Universities - Located within Bay County are Delta and Davenport University; within easy driving distance of the County is Saginaw Valley State University in Saginaw County and Northwood University in Midland County.

Other Key Facilities - The Bay County area is known to have an abundance of cultural and recreational activities for a community of its size. Bay City, the Saginaw River and the Saginaw Bay and its coastline are the focal points for the area. Bay City hosts numerous summer events in the downtown Wenonah and Vets Park. The parks are located along East and West banks of the Saginaw River. Several marinas and public boat launches are also located on the Saginaw River and Saginaw Bay.

The Bay City State Park is a 2,200-acre natural area bounded by the Saginaw Bay. There are miles of hiking trails, naturalist programs and wildlife viewing areas.

Other important facilities are:

- Bay County Farmer's Market
- Bay County Community Center
- Bay County Golf Course
- State Theater
- Rail Trail
- Pinconning Park
- Bay County Fairgrounds

- Delta College Planetarium
- Infinity Skate Park
- Bay County Historical Museum
- Bay County Civic Arena
- Bay City Players
- Studio 23 Museum

1.1.7 Other Information

Major Events - Several major events take place in Bay County each year. These events bring more people, traffic, and congestion into the community for a limited period of time. The Bay City Fireworks Festival is the largest event in the County. The festival attracts visitors from all over the region. The population during the event swells to nearly 100,000 people.

- Auburn Corn Festival
- Bay County Fair
- Rock -n- Wheels Festival
- Hell Half Mile Film Festival
- Riverside Art Festival
- River Roar
- Linwood Pickle Festival
- Munger Potato Festival
- Pig Gig
- River of Time
- Pinconning Cheese Festival
- Saint Patrick's Day Race and Parade
- Tall Ships Celebration (occurs every 3-4 years)

1.2 ADOPTION BY THE LOCAL GOVERNING BODY

The Bay County Multi-Jurisdiction, Multi-Hazard Mitigation Plan, hereafter known as "the Plan" adheres to the guidelines outlined in *44 CFR, Section 201.6*, defining the requirements for Mitigation Planning and more specifically local mitigation planning.

As the Plan's Administrator, Bay County submitted the Plan to the Michigan State Police (MSA) and the Federal Emergency Management Agency (FEMA) Region V for review and comment. After the state and federal reviewers certified that the Plan was approved, Bay County adopted the plan and then forwarded the Plan to each participating jurisdiction for formal adoption. Signed copies of the executed orders for each jurisdiction are included in **Appendix A** of the Plan.

The following jurisdictions are represented by the Plan:

Table 1.2 Jurisdictions Represented by the Plan

Community	FEMA Community ID	Adoption Date	Zoning Ordinances	Master Plan	Meeting Attendance	Submit Documents	Mitigation Activities
City of Auburn	260886		X	X	X	X	X
Township of Bangor	260019		X	X	X	X	X
City of Bay City	260020		X	X	X	X	X
Bay County	260252		X	X	X	X	X
Township of Beaver	260357		X	X	X	X	X
City of Essexville	260021		X	X	X	X	X
Township of Frankenlust	260022		X	X	X	X	X
Township of Fraser	260657		X	X	X	X	X
Township of Garfield	260695		X	X	X	X	X
Township of Gibson	260684		X		X	X	X
Township of Hampton	260023		X	X	X	X	X
Township of Kawkawlin	260658		X	X	X	X	X
Township of Merritt	260024		X	X	X	X	X
Township of Monitor	260358		X	X	X	X	X
Township of Mount Forest	260887		X		X	X	X
City of Pinconning	260607		X	X	X	X	X

Table 1.2 Jurisdictions Represented by the Plan

Community	FEMA Community ID	Adoption Date	Zoning Ordinances	Master Plan	Meeting Attendance	Submit Documents	Mitigation Activities
Township of Pinconning	260025		X	X	X	X	X
Township of Portsmouth	260026		X	X	X	X	X
Township of Williams	260359		X		X	X	X

1.3 JURISDICTION PARTICIPATION

At the start of the planning process, a stakeholder meeting was held on December 9, 2009, which included representation from the 19 jurisdictions within Bay County. Representatives from the consultant hired to assist in the planning and authoring of the Plan explained the purpose of a Hazard Mitigation Plan and the requirements for inclusion in the Plan. The criteria were explained as follows:

a. Provide representation during the planning process.

b. Submit an inventory of plans, data, ordinances and codes, and reports relevant to hazard mitigation planning.

c. Review and complete the Bay County Multi-Hazard Mitigation Survey at http://gis01.stantec.com/baycounty/ .

d. Identify critical "at risk" structures and facilities.

e. Develop community-wide mitigation goals.

f. Submit a prioritized list of mitigation activities.

g. Review and comment on the draft plan.

h. Incorporate the Plan into existing planning efforts.

i. Formally adopt the Plan.

j. Participate in plan maintenance through yearly reviews and five year updates.

k. Plan participation.

2.0 PLANNING PROCESS

The Bay Countywide Hazard Mitigation Plan is developed as a multi-hazard, multi-jurisdictional plan for the communities within Bay County, Michigan. The Bay County Emergency Preparedness and Management Division Emergency Management Coordinator served as the Plan's administrator and is the primary point of contact for the Plan.

2.1 DESCRIPTION OF THE PLANNING PROCESS

The process used to develop the Plan was based upon FEMA's 386-8 Multi-Jurisdictional Planning document. Specifically, the planning process focused upon soliciting comprehensive feedback from stakeholders and the general public through meetings, open houses, interactive questionnaires, and document comment forms.

Phases of the planning effort were consistent with the original scope of work included in the Fiscal Year 2004 Hazard Mitigation Grant Program grant application and compliant with FEMA recommended approaches including:

a. Focusing toward including all jurisdictions within the County.

b. Forming a multi-tiered planning team with clearly defined roles and responsibilities.

c. Providing opportunities for neighboring communities, local and regional agencies involved in hazard mitigation activities, and agencies that have the authority to regulate development, as well as businesses, academia and other private and non-profit interests to be involved in the planning process.

d. Providing extensive public outreach and opportunities for involvement.

e. Reviewing and incorporating existing plans, studies, reports, and technical information, as appropriate.

f. Conducting thorough hazard profiling and comprehensive risk assessment.

g. Developing mitigation goals and actions prioritized for each community.

h. Providing opportunities for the public to comment on the Plan during the drafting stage and prior to plan approval.

i. Developing plan maintenance procedures that keep the Plan up to date.

2.2 THE PLANNING TEAM

The Bay County planning process was designed to maximize stakeholder involvement and participation to create a viable plan, complete with risk identification and risk mitigation strategies. Public involvement was an integral part of the development of the Plan and provides access to a broader cross section of county residents than the elected officials and interested professionals in the stakeholder group. The planning process, however, primarily relied on stakeholder involvement and participation guidance throughout all phases of the Plan. Two conference calls were held with the planning team, one on January 7, 2010 and one on March 31, 2010 to enhance communication, data collection efforts and stakeholder input.

A planning consultant was also contracted by Bay County to support the development of the plan and to perform analysis, mapping, and document support. Together, the Planning Team was represented by the following groups:

- Chief Elected Officials. Seven elected officials represented the following communities during meetings and/or conference calls: Bangor Township; Frankenlust Township; Frasier Township; Kawkawlin Township; Monitor Township; Williams Township; and Pinconning Township. More information regarding meeting attendance can be found in **Appendix B**.

- Planning Committee. Consisted of one person as the primary point of contact from each jurisdiction responsible for collecting data, reviewing plans/studies, facilitating public input, developing mitigation goals and actions for each of their jurisdictions, and helping in drafting the Plan. The Planning Committee will also be responsible for coordinating future plan maintenance including yearly reviews and five-year updates.

- Plan Consultant. Stantec Consulting Services Inc. (Stantec) and RJH Planning LLC were responsible for facilitating plan development, analysis, mapping, and document preparation support.

Table 1.2 contains a table that documents meeting participation..

2.3 PUBLIC INVOLVEMENT

The Bay County planning process was designed to maximize public participation. Public participation, for the purpose of the Plan, is defined as an opportunity for each jurisdiction and the citizens of that community to participate in the planning process. Opportunities for public participation were offered through multiple public stakeholder meetings and public informational meetings, a publicly available website, a multi-hazard questionnaire, and additional future plan maintenance opportunities. Meetings held on December 9, 2009, February 25, 2010, and May 13, 2010 were open to the public. In addition, representatives of neighboring counties and jurisdictions were solicited for their input into the planning process through press releases and legal notices. Documentation announcing the meetings and soliciting input from the public and stakeholders is available in **Appendix C**.

Opportunities for the public to participate were provided in the following ways:

a. Planning Team stakeholder meetings were open to the public.

b. Open public meeting was held to inform the public of the planning process and to request participation.

c. A Multi-Hazard questionnaire was placed online allowing the public to participate in the Plan and give their additional feedback for possible plan inclusion.

d. Draft plan text and supporting information were made available via the website for public input and review.

e. Public opportunities for review of the final plan.

The Planning Team worked together to incorporate relevant feedback from the public into all phases of plan development.

2.3.1 Public Meetings

Three public meetings were held during the development of the Plan, as shown in the table below. The meetings were publicized through letters to public officials, and a web link from the County's government homepage (**Appendix C**).

Table 2.1 Stakeholder Meetings Scheduled

Date	Purpose of Meeting	**Location**
December 9, 2009	Kickoff Meeting, Data collection	800 John F. Kennedy Drive Bay City, Michigan
February 25, 2010	Hazard Assessment and Mitigation Activities	800 John F. Kennedy Drive Bay City, Michigan
May 13, 2010	Mitigation Activity Implementation and Funding	800 John F. Kennedy Drive Bay City, Michigan

The Plan Kickoff Meeting held on December 9, 2009 included a presentation to inform plan stakeholders and the public about the hazard mitigation planning process and the benefits for each jurisdiction. The focus of the meeting was to introduce the planning process, request assistance from the public/private sector and citizens to compile hazard data for the plan, and encourage continued participation in the planning and implementation process. During this meeting, Mr. Chris Izworski Bay County Emergency Preparedness and Management Division Emergency Management Coordinator was identified as the Plan's primary point of contact for public input or questions and the primary contact between the County and the Plan's consultant, Stantec Consulting Services Inc and subconsultant RJH Planning, LLC. A conference call was held after the meeting to further assist the communities with data collection for the plan.

The Stakeholder Hazard Assessment and Mitigation Activities Meeting was held on February 25, 2010, and included a presentation sharing the results of the hazard identification surveys, hazard profiles, and hazard assessments. During this meeting, participants were encouraged to define mitigation goals and consider actions in a manner that weighted priority, funding, and mitigation methodology. A conference call was on March 30, 2010 to further assist the communities in developing their goals and mitigation activities.

The planning consultant and local plan administrator provided guidance throughout both meetings and shared ideas for maximizing stakeholder input. Presentations were made available to the public through the website that was developed as part of the planning process. They are provided in **Appendix D** of this Plan.

2.3.2 Multi-Media Outreach

The Planning Team worked with Stantec to develop and host a website for purposes of promoting planning meetings, hazard questionnaires, storing documents, facilitating Plan review and providing general plan information to the public and stakeholders. The site was accessible from the Bay County Emergency Preparedness and Management Division Emergency Management Director's homepage at www.baycounty-mi.gov/ESHS.

The site allowed users to upload, download, and access sections and supporting documents of the hazard plan. The result allowed the public to easily obtain and comment on the Plan during both draft stages and prior to Plan adoption. The site was also used to disseminate brochures, past presentations, promote FEMA mitigation project programs and link to the Michigan State Police and FEMA for additional support. The website proved to be very successful for reaching the community at-large, including those who were unable to attend the public or stakeholder meetings.

The stakeholders were also reached through letters and webinars. Letters were sent prior to meetings and webinars to set the agenda for the discussions. The webinars were held on January 7, 2010 and March 31, 2010. These webinars increased opportunities for communication and therefore an overall understanding of the plan. Plan participants were able to ask follow-up questions from prior meetings and to develop mitigation activities during the call on March 31, 2010. Attendees for the webinars can be found in **Appendix B**.

2.3.3 Public Hazards Questionnaire

The Stakeholders worked with their planning consultant to develop and approve a hazard questionnaire, which is in **Appendix D**. The purpose was to solicit additional feedback from the community in regard to perceived threats, vulnerabilities and general awareness of the risks associated with natural hazards. Questionnaires and brochures were disseminated to individual community municipal buildings and also made available upon the Hazard Mitigation Planning website www.baycounty-mi.gov/ESHS. Between promotions from the website, and the

Stakeholders, nine participants completed the survey. Questionnaire results are summarized in **Appendix E**.

2.3.4 Public Review of Draft Plan

The Planning Committee was given the opportunity to review a draft of the Plan prior to the final public meeting held on May 13, 2010. During this meeting, the Planning Committee provided feedback and had the opportunity to ask questions regarding the draft plan, plan maintenance and updates, and funding options for mitigation actions. The draft plan was assembled and provided to the public and the Stakeholders for review on May 21, 2010. The public and planning teams were given two weeks to provide comments. Electronic versions were made accessible from the Hazard Mitigation Plan website www. http://gis01.stantec.com/baycounty/. A press release was issued to encourage the public to access and comment on the plan. Comments received were then submitted to the planning consultant during the pre-approval plan review.

2.3.5 Final Plan Access

Following local adoption and FEMA approval of the Plan, the document will be made available to the public at the following locations:

a. The Plan will be accessible as follows:

    i. At local libraries;

    ii. The County Building; and

    iii. All municipalities will have a copy in their main administrative office.

    iv. Bay County Emergency Preparedness and Management Division Emergency Management website at www.baycounty-mi.gov/ESHS.

2.4 INCORPORATION OF EXISTING DOCUMENTS

Existing plans, studies, reports, and technical information were collected from agencies during the planning process and at meetings. The stakeholders reviewed and identified common problems, development policies, mitigation strategies, and other policies, plans, programs, and regulations. As part of this effort, the stakeholders coordinated with local agencies seeking local hazard data, existing plans, partnerships, common goals, projects, and commitment to an all natural hazards mitigation plan. This outreach included soliciting information from federal, state, and local resources.

The following are examples of the types of information used to identify natural hazards, vulnerable areas and assets, mitigation actions, and mitigation projects.

- GIS Data from Plan Participants.

- Zoning and Subdivision Ordinances. The Zoning Ordinances promote planned development and those submitted as part of the planning process are included with the CD in the back of this plan.

- Emergency Operations Plan (EOP). Bay County maintains an Emergency Action Guideline. The plan is a source for hazard identification and emergency operation procedures. Procedures include lists of roles and responsibilities of persons/departments in charge of dispatching support during a natural hazard, rules that are followed, evacuation routes, etc.

- Flood Insurance Rate Maps (FIRMs). The approved DFIRMS were used in the development of this plan for the vulnerability assessment for flooding.

- Michigan State Hazard Mitigation Plan. The state hazard mitigation plan was useful in providing information for each hazard (i.e. identifying hazards), vulnerability classes, and assessment methods.

- Land-Use Plans. Local land planning documents were summarized in **Appendix I** Land Development Trends.

- National Flood Insurance Program (NFIP). The County and several of the communities in the County are enrolled in the NFIP. The NFIP database contains information regarding the number and value of flood insurance policies in each jurisdiction, the value of any claims paid, and the number of repetitive loss structures in the communities.

If any plans, report, or studies were not included in the plan or if new documents are published, they may be added to the Plan during the next update.

3.0 RISK ASSESSMENT

The Risk Assessment portion of this Plan identifies, profiles, and assesses the natural hazards that are known to affect Bay County. The process incorporates describing each hazard and its effects, researching past events, documenting recorded damages, and assessing the probability and consequences of the event happening again.

The Risk Assessment is divided into the following sections so that a comprehensive analysis and review is completed for Bay County's vulnerabilities. The risk assessment sections provide a comprehensive overview.

- Identifying Hazards
- Profiling Hazard Events
- Assessing Vulnerability: Identifying Assets
- Assessing Vulnerability: Estimating Potential Losses
- Assessing Vulnerability: Analyzing Development Trends

Throughout the Risk Assessment, maps are used whenever possible to convey the spatial data and the locations of vulnerable areas. The maps also provided a GIS visual tool for analysis for the Planning Team. Data, maps, research, and guidance were developed using the best available data, including information from the approved State Plan.

In order to perform the Risk Assessment and the Vulnerability Assessment, the Planning Team and the Consultant reviewed data that was available through public databases, including Presidential Declarations and State Declarations to identify the hazards that impact Bay County.

3.1 IDENTIFYING HAZARDS

Natural hazards in the United States occur in many forms. They can be weather related such as flash floods, severe thunderstorms (hail, wind, and tornadoes), severe winter storms (snow, ice, and frigid temperatures), wind driven ice floes, and coastal storms (hurricanes, storm surges, and tsunamis). They can be geological hazards including volcanoes, earthquakes, and landslides. They can be climatologic including drought, excessive heat, and wildfires; or they can also be driven by topography and hydrology which affects riverine flooding from upstream rain or snow events. Understanding and identifying these hazards and their relationship to land, infrastructure, and population is the first step to achieving risk awareness.

Data sources utilized to determine which hazards to include or exclude within the Plan included: hazard data, reports, plans, flood ordinances, past hazard events, flood insurance claims, land use regulations for hazard data, local records of the emergency management offices, local newspapers, historical knowledge of Planning Team participants, local officials and community members, as well as GIS information from Michigan state sources.

The following **Tables 3.1** and **3.2** quantify and qualify the Presidential Declarations and Governors' Declarations for Events impacting Bay County were used as a means to profile the hazards and as part of the risk assessment.

Table 3.1 Presidential Declarations Affecting Bay County, Michigan (1953-2005)

Date	Type of Incident	Affected Area	Type of Declaration/Federal ID Numbers
09/07/05	Hurricane Evacuation	All 83 counties	Emergency (3225)
12/11-31/00	Blizzard & Snowstorm	39 counties: Allegan, Barry, Bay, Berrien, Branch, Calhoun, Cass, Clare, Clinton, Eaton, Genesee, Gladwin, Gratiot, Hillsdale, Huron, Ingham, Ionia, Isabella, Jackson, Kalamazoo, Kent, Lapeer, Livingston, Macomb, Mecosta, Midland, Montcalm, Muskegon, Oakland, Osceola, Ottawa, Saginaw, St. Clair, St. Joseph, Sanilac, Shiawassee, Tuscola, Van Buren, & Washtenaw Co.	Emergency (3160)
05/31/98	Thunderstorms & High Winds	13 counties: Bay, Clinton, Gratiot, Ionia, Kent, Mason, Montcalm, Muskegon, Newaygo, Oceana, Ottawa, Saginaw, & Shiawassee Co.	Major Disaster (1226)
06/21-7/1/96	Rainstorms, Flooding & Tornado	7 counties: Bay, Lapeer, Midland, Saginaw, Sanilac, St. Clair, & Tuscola Co.	Major Disaster (1128)
09/10-19/86	Flooding	30 counties: Allegan, Arenac, Bay, Clare, Clinton, Genesee, Gladwin, Gratiot, Huron, Ionia, Isabella, Kent, Lake, Lapeer, Macomb, Manistee, Mason, Mecosta, Midland, Montcalm, Muskegon, Newaygo, Oceana, Osceola, Ottawa, Saginaw, Sanilac, Shiawassee, Tuscola, & Van Buren Co.	Major Disaster (774)
01/26-27/78	Blizzard & Snowstorm	Statewide	Emergency (3057)

Table 3.1 Presidential Declarations Affecting Bay County, Michigan (1953-2005)

Date	Type of Incident	Affected Area	Type of Declaration/Federal ID Numbers
03/20/76 03/02-07/76	Ice Storm & Tornadoes	29 counties: Allegan, Bay, Clare, Clinton, Genesee, Gladwin, Gratiot, Ionia, Isabella, Jackson, Kent, Lapeer, Macomb, Mecosta, Midland, Montcalm, Muskegon, Newaygo, Oakland, Oceana, Osceola, Ottawa, Roscommon, Saginaw, St. Clair, Sanilac, Shiawassee, Tuscola, & Wayne Co.	Major Disaster (495)
04/12/1973	Severe Storms & Flooding	14 counties: Arenac, Bay, Berrien, Huron, Iosco, Macomb, Menominee, Monroe, Saginaw, Sanilac, St. Clair, Tuscola, Van Buren, & Wayne Co.	Major Disaster (371)
12/01/72	Severe Storms & Flooding	9 counties: Arenac, Bay, Berrien, Iosco, Macomb, Monroe, St. Clair, Tuscola, & Wayne Co.	Major Disaster (363)
04/11/1965	Tornadoes & Severe Storms	16 counties: Allegan, Barry, Bay, Branch, Clinton, Eaton, Gratiot, Hillsdale, Kalamazoo, Kent, Lenawee, Monroe, Montcalm, Ottawa, Shiawassee, & Washtenaw Co.	Major Disaster (190)

Sources: Michigan Hazard Mitigation Plan
FEMA Disaster History: http://www.fema.gov/news/disasters_state.fema?id=26

Table 3.2 Governors' Declarations Affecting Bay County, Michigan (1977-2010)

Date of Declaration	Type of Incident	Affected Area	Type of Declaration
09/04/05	Hurricane Evacuation	All 83 counties	Disaster
06/05/1998	Thunderstorms & High Winds	Bay, Clinton, Gratiot, Ionia, Kent, Mason, Mecosta, Montcalm, Muskegon, Newaygo, Oceana, Ottawa, Saginaw, & Shiawassee Co.; Village of Armada (Macomb Co.)	Disaster
06/26/96, 06/21/96	Rainstorms, Flooding & Tornado	Bay, Lapeer, Saginaw, Sanilac, St. Clair, & Tuscola Co.; City of Midland (Midland Co.)	Disaster
09/16/90	Ship Explosion & Fire	Bay Co.	Emergency
10/28/86 09/15/86 09/12/86	Flooding & Heavy Rain	Allegan, Arenac, Bay, Clare, Clinton, Genesee, Gladwin, Gratiot, Huron, Ionia, Isabella, Kent, Lake, Lapeer, Macomb, Manistee, Mason, Mecosta, Midland, Montcalm, Muskegon, Newaygo, Oceana, Osceola, Ottawa, Saginaw, Shiawassee, Tuscola, & Van Buren Co.	Disaster
04/13/1985	Great Lakes Flooding & Wave Action	Arenac, Bay, Macomb, Monroe, Saginaw, St. Clair, Tuscola, & Wayne Co.	Disaster

Sources: Michigan Hazard Mitigation Plan & Office of the Governor, Executive Orders: http://www.michigan.gov/gov/0,1607,7-168-21975---,00.html

Additional research used to identify hazards included interviews with knowledgeable officials and residents in the planning area, the use of FEMA and other web based databases and information sources that identify hazards by geographic locations, US Army Corps of Engineers flood data, Flood Insurance Rate Maps (FIRM), Flood Insurance Studies (FIS), GIS, and additional available historic data including information on past hazard events.

The State Plan considered the following natural hazards:

- Severe Winter Storms
- Ice and Sleet Storms
- Snow Storms
- Drought
- Earthquakes
- Extreme Temperatures
- Flooding
- Subsidence
- Tornados
- Lightning
- Hail
- Thunderstorms
- Severe Winds

- Wildfires
- Erosion

During the process of Hazard Identification, the Planning Team considered several natural hazards known to impact communities throughout the United States. Hazards considered included:

- Avalanche
- Coastal Storms
- Drought
- Earthquake
- Extreme Heat
- Flood
- Hailstorm
- Hurricane
- Mine Subsidence
- Severe Winter Storm
- Tornado
- Tsunami
- Volcano
- Wildfires
- Windstorm

The Planning Team carefully considered regional hazard data, past documented events, and other known sources of hazard information to identify the natural hazards most likely to affect Bay County. The hazards identified are:

- Drought
- Earthquake
- Extreme Heat
- Flooding
- Severe Storms
- Severe Winter Storms
- Tornadoes
- Hail
- Wildfires
- Wind Driven Ice Floes

3.2 NATURAL HAZARDS NOT IDENTIFIED WITHIN THE PLAN

Some natural hazards have little or no effect on Bay County and were not addressed in this Plan. They include avalanche and landslides, coastal storms and hurricanes, and volcanoes. While, these hazards were determined to present little to no threat within Bay County, they are not precluded from being incorporated into future updates of the Plan as new information is discovered.

The following hazards were excluded from the Plan:

Avalanche and Landslides. The topography and climate of the Bay County area are not conducive to the occurrence of avalanches or landslides. No historical events have been recorded in the Bay County area.

Coastal Storms and Hurricanes. The Bay County area is hundreds of miles from the nearest oceanic coast. The immediate effects of coastal storms (hurricanes, storm surge, and tsunamis) are not felt in the Bay County. The secondary effects, or remnants of hurricanes, may produce severe thunderstorms and flooding in the area and those hazards are addressed separately by the Plan.

Volcanoes. More than 50 volcanoes in the U.S. have erupted one or more times in the past 200 years. According to the USGS, the United States ranks third, behind Indonesia and Japan, in the number of historically active volcanoes (that is, those for which USGS has written accounts of eruptions). In addition, about 10 percent of the more than 1,500 volcanoes that have erupted in the past 10,000 years are located in the United States. Most of these volcanoes are found in the Aleutian Islands, the Alaska Peninsula, the Hawaiian Islands, and the Cascade Range of the Pacific Northwest; the remaining volcanoes are widely distributed in the western part of the Nation. A few U.S. volcanoes have produced some of the largest and most dangerous types of eruptions in this century, while several others have threatened to erupt.

Large explosive eruptions can endanger people and property hundreds of miles away and even affect global climate. Due to the location of Bay County, Michigan, volcanic activity as a hazard is judged to be minimal and will not be addressed in this Plan.

3.3 HAZARDS IDENTIFIED WITHIN THE PLAN

Hazards included within this Plan are:

- Drought
- Earthquake
- Extreme Temperatures
- Flooding
- Severe Storms/Winds
- Severe Winter Storms
- Tornadoes
- Hail
- Wildfires
- Wind Driven Ice Floes

3.4 INTRODUCTION TO PROFILING THE HAZARD

The following section is provided to describe each hazard, its associated causes and effects, and the historical occurrences of each of the hazards on Bay County and its jurisdictions.

These Hazard Profiles were created using the best available data from a variety of resources including, but not limited to, the National Climatic Data Center (NCDC), National Weather Service (NWS), FEMA Hazard Mapping website, local agencies and newspaper articles, and the approved Michigan State Hazard Mitigation Plan. As part of the profile, each hazard has a summary table like the table below, which defines each variable.

For the majority of the hazards identified in this plan, the entire County is at-risk equally, with the exceptions of different histories and vulnerabilities. In other words, a thunderstorm or earthquake is equally likely to impact a community without regard to geography. However, for floods, the impacted area is confined to the FEMA-mapped 100-year floodplain. The hazard assessments for flooding were then based on these geographical boundaries.

Table 3.3 Hazard Risk Factor Table Key

Period of Occurrence	The normal time of year when a hazard occurs.
Number of Events to Date	The number of past events over a period of time.
Annual Chance Probability	The number of past events divided by time of record. The Annual Chance Probability can be extrapolated to estimate the annual probability of future occurrences.
Warning Time	The amount of time available for shelter to be taken given the natural hazard event.
Potential Impacts	Impacts typically associated with a particular natural hazard
Injury or Death	The number of Injuries or deaths reported to the NCDC.
Potential Facility Shutdown	The timeframe that a facility could be out of service due to a natural hazard event.

3.4.1 Area Climate

The State of Michigan has a humid continental climate with two distinct regions. Humid continental means moist air masses prevail, which results in greater fluctuations in daily and seasonal temperatures. The southern and central parts of the Lower Peninsula have a warmer climate. The northern region has warm but shorter summers, and long cold winters. There are four distinct seasons. In the winter, lake effect snow can occur when dry air masses cross the Great Lakes. There are approximately 150 frost free days per year. The average annual temperature is 56 degrees Fahrenheit. During the winter, the average temperature is 24 degrees Fahrenheit and the summer average is 69 degrees Fahrenheit. Average rainfall is 27.9 inches of which 59% falls between April and September.

3.5 DROUGHT PROFILE

A drought is defined as the cumulative deficit of precipitation relative to what is normal for a region over an extended period of time. Unlike other natural hazards, a drought is a not a specific event but evolves as a prolonged dry spell. Droughts occur when a long period passes without substantial rainfall. A heat wave combined with a drought is a very dangerous situation.

3.5.1 Hazard Description

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

Drought differs from other natural hazards in several ways. First, a drought typically lacks an exact beginning and endpoint, whose effects may accumulate slowly and linger even after the event is generally considered being over. Second, the lack of a clear-cut definition of drought can make it difficult to confirm whether one actually exists, and if it does, its degree of severity. Third, drought impacts are often less obvious than other natural hazards, and they are typically spread over a much larger geographic area. Fourth, due primarily to the aforementioned reasons, most communities do not have in place any contingency plans for addressing drought. The lack of pre-planning can hinder support for drought mitigation capabilities that would otherwise effectively increase awareness and reduce drought impacts.

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

3.5.2 Types

Once a drought is recognized it can be classified within four different categories – meteorological, hydrologic, agricultural, and socioeconomic.

A **meteorological** drought is based on the degree of dryness, or the departure of actual precipitation from an expected average or normal amount based on monthly, seasonal, or annual time scales. A **hydrologic** drought involves the effects of precipitation shortfalls on stream flows or reservoir, lake, and groundwater levels. An **agricultural** drought concerns soil moisture deficiencies relative to the water demands of plant life, usually crops. A **socioeconomic** drought is when the effect of demands for water exceeds the supply, as a result of weather-related shortfalls.

The U.S. Drought Monitor uses classifications of severity, from the least intense category, D1, to the most intense, D4, with a D0 category used to designate a "drought watch" area in which long-term impacts such as low reservoir levels are probably present. The Drought Monitor summary map is available online, identifying general drought areas and labeling their intensity. While not the only way to characterize droughts, the U.S. Drought Monitor is convenient and their classification levels have recently been used in various reports and assessments of drought conditions. Short-term indicators are on the level of 1-3 months, while long-term indicators focus on a 6-60 month duration.

Table 3.4 Drought Severity Classification

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

Source: U.S. Drought Monitor: http://drought.unl.edu/dm/classify.htm

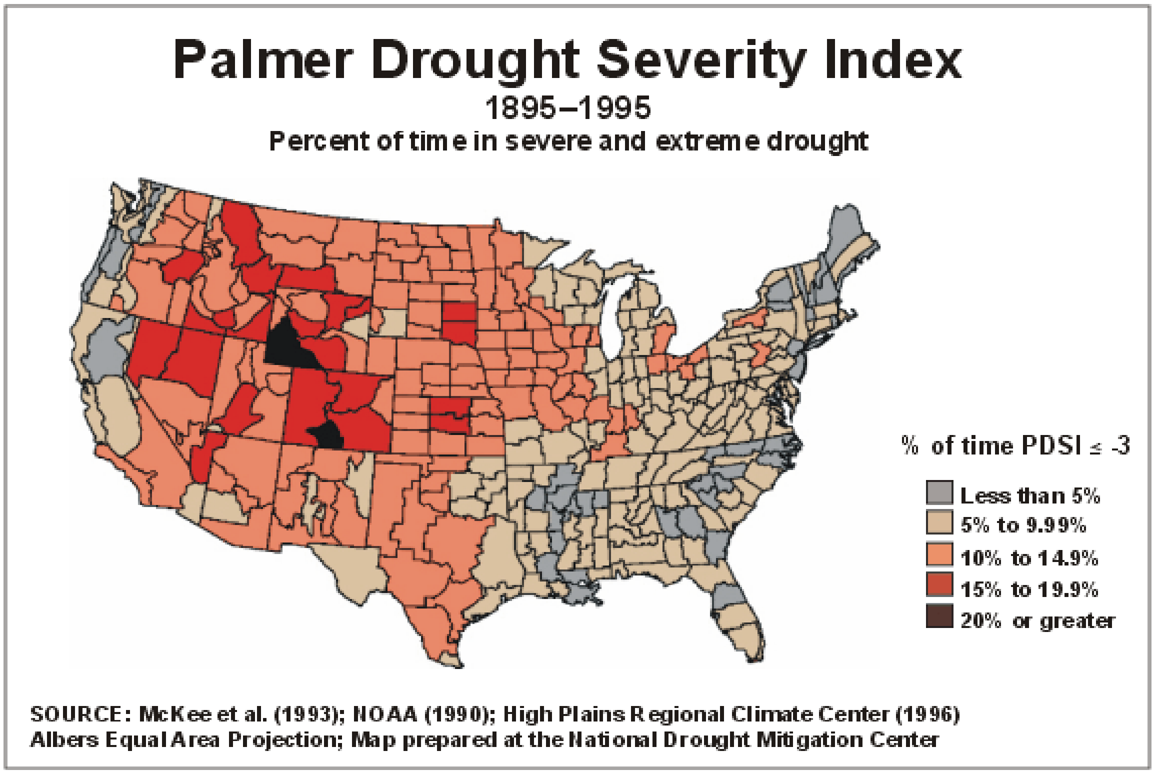


Figure 1 Palmer Drought Severity Index

3.5.3 History /Facts

In comparison to other natural hazards, drought differs in its potential to affect multiple communities and regions over longer periods of time. In addition to gathering historic information at the county-level, information was examined at the regional and state level to gather a more thorough understanding of the historical impacts of drought on Bay County, and how drought may affect Bay County in the future.

In the United States, drought conditions often exist in some region of the country, with some area likely to be experiencing drought conditions at a particular time. Significant droughts within the past century have included the following time periods and national regions:

Table 3.5 U.S. Droughts

Drought Years	U.S. Location(s) Primarily Affected
1924-1934	California
1930-1940	Midwest ("Dust Bowl" drought)
1942-1956	Southwest
1952-1956	Mid-continent and Southeast
1961-1967	Northeast
1976-1977	Great Plains, Upper Midwest, West
1980-1981	Central, Eastern
1987-1989	Central, Eastern
1987-1992	California, Upper Great Plains
1998-1999	Northeast, Mid-Atlantic
2000-2001	South-Central, Southeast, Michigan/Ohio
2002-2003	Western, Central Midwest, Eastern

Source: Michigan Hazard Mitigation Plan. Multi-Hazard Identification and Risk Assessment, FEMA, 1997; National Drought Mitigation Center; National Oceanic and Atmospheric Administration; MSNBC; USA Today

Despite the thousands of miles of rivers and streams in the state, Michigan has experienced occasional drought conditions. Most common are agricultural droughts, with severe soil-moisture deficits, that can have serious consequences for crop production, particularly when coupled with extreme summer temperatures.

Additionally, the water levels in various water bodies, both inland lakes and the Great Lakes themselves, cyclically go through period of low water levels. According to the Michigan State Hazard Mitigation Plan, Michigan has been in a period of low water levels for a number of years. Trends suggest that the pattern in Michigan will continue to be one of low water and lake levels, and even declared declarations of drought until the year 2011. In 2007, all 83 counties received drought disaster declarations from the U.S. Department of Agriculture because of drought related crop losses.

The table below lists significant regional droughts that have affected Michigan statewide:

Table 3.6 Significant Droughts Affecting Michigan

Date	Location
1930s	Midwest
1976-77	Great Plains; Upper Midwest (including Michigan); West
1987-89	Central U.S. (including Michigan); Eastern U.S.
1998-2003	Northeast; Mid-Atlantic; South-Central; Southeast; Michigan

Source: Michigan Hazard Mitigation Plan

Two drought hazard events were locally significant to Bay County, according to storm event records of the National Climatic Data Center:

July 1-31, 2001 - Counties affected: Bay, Genesee, Huron, Lapeer, Lenawee, Livingston, Macomb, Midland, Monroe, Oakland, Saginaw, Sanilac, Shiawassee, St. Clair, Tuscola, Washtenaw, Wayne. Estimated crop damage: $150 million.

An upper level high-pressure ridge dominated the weather pattern across southeast Michigan beginning late June and continuing through the month of July. This ridge prevented the development of widespread thunderstorms, and prevented rainfall from moving into the region from the west. While there were occasional isolated thunderstorms, much of the region suffered a pronounced dry spell. The lack of rainfall put a hardship on the area's water supply and measures were taken to curb usage (Source: NCDC Storm Event Database.)

September 1-30, 2002 – Counties affected: Bay, Genesee, Huron, Lapeer, Lenawee, Livingston, Macomb, Midland, Monroe, Oakland, Saginaw, Sanilac, Shiawassee, St. Clair, Tuscola, Washtenaw, Wayne. Severity/Magnitude: Unlisted.

The dry weather in September was especially severe from the northern suburbs of Detroit to the Tri Cities and thumb. Saginaw County, the closest reporting location to Bay County, recorded .39 inches of rainfall, making it the second driest September on record. Flint, Saginaw and Detroit metro airport received less than .05 inches of precipitation during the first half of the month. After an extremely hot and dry July and August, the weather of September 2002 only exasperated drought conditions. Several record highs were set throughout Michigan during the month of September. During the first half of the month, hundreds of communities across the area were under water restrictions. Hardest hit from the drought was the agricultural industry. September yields across most of the area were estimated at fewer than 50 percent and many counties across eastern Michigan were declared agricultural disaster areas (Source: NCDC Storm Event Database.)

3.5.4 Bay County Profile

The following table summarizes the hazard risks for drought.

Table 3.7 Bay County Drought Profile

Typical Impact Area	Regional-Statewide
Number of Events (1930-2010)	7
Past Damages (Regional):	$8,823,529
Annual Chance Probability Ratio	0.09
Period of Occurrence	Summer months or extended periods of no precipitation.
Warning Time	Weeks to Months
Potential Impacts	Activities that rely heavily on high water usage may be impacted significantly, including agriculture, tourism, wildlife protection, municipal water usage, commerce, recreation, electric power generation, and water quality deterioration. Droughts can lead to economic losses such as unemployment, decreased land values, and Agrobusiness losses. Minimal risk of damage or cracking to structural foundations, due to soil destabilization.

3.6 EARTHQUAKE PROFILE

An earthquake is a sudden, rapid shaking of the earth caused by the breaking and shifting of rock beneath the earth's surface. The forces of plate tectonics have shaped the earth as the huge plates that form the earth's surface move slowly over, under, and past each other. Sometimes the movement is gradual while at other times, the plates are locked together, unable to release the accumulating energy. When the accumulated energy grows strong enough, the plates break free, releasing the stored energy and producing seismic waves, generating an earthquake.

3.6.1 Hazard Description

Earthquakes result from crustal strain, volcanism, landslides, or the collapse of caverns. Ground motion, the movement of the earth's surface during earthquakes or explosions, is the catalyst for most of the damage during an earthquake. Ground motion, produced by waves generated by a sudden slip of a fault or sudden pressure at the explosive source, travels through the earth and along its surface and is amplified by soft soils overlying hard bedrock, referred to as ground motion amplification. Ground motion amplification can cause an excess amount of damage during an earthquake, even to sites very far from the epicenter.

Earthquakes can affect hundreds of thousands of square kilometers; cause damage to property measured in the tens of billions of dollars; result in loss of life and injury to hundreds of thousands of persons; and disrupt the social and economic functioning of the affected area. Ground shaking from earthquakes can collapse buildings and bridges, disrupt gas, electric, phone service, and sometimes trigger landslides, avalanches, flash floods, fires, disrupt transportation, cause hazardous materials spills and destructive ocean waves (tsunamis). During an earthquake, buildings with foundations resting on unconsolidated fill and other unstable soil, and trailers and homes not tied to their foundations are at risk because they can be shaken off their mountings. When an earthquake occurs in a populated area, it may cause deaths, injuries, and extensive property damage.

Most property damage and earthquake-related deaths are caused by the failure and collapse of structures due to ground shaking. Most casualties result from falling objects and debris. Disruption of communications systems, electric power lines, and gas, sewer and water mains can be expected. The level of damage depends upon the amplitude and duration of the shaking, which are directly related to the earthquake size, distance from the fault site, and regional geology. Other damaging earthquake effects include landslides, the down-slope movement of soil and rock (mountain regions and along hillsides), and liquefaction, in which ground soil loses the ability to resist shear and flows much like quick sand. In the case of liquefaction, anything relying on the substrata for support can shift, tilt, rupture, or collapse.

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. The energy of an earthquake is released in seismic waves. Earthquakes usually occur without warning. In some instances, advance warnings of unusual geophysical events may be issued.

However, scientists cannot yet predict exactly when or where an earthquake will occur. Earthquakes tend to strike repeatedly along fault lines, which are formed where large plates of the earth's crust below the surface constantly push and move against one another. Risk maps have been produced which show areas where an earthquake is more likely to occur. Earthquake monitoring is conducted by the U.S. Geological Survey, the National Oceanic and Atmospheric Administration, and universities throughout the country.

3.6.2 History/Facts

There have not been severely destructive earthquakes documented in Michigan. However, Michigan has experienced several mildly damaging earthquakes since the late 1700s. The exact number is difficult to determine, as scientific opinion on the matter varies. With most of these earthquakes, damage (if any) was limited to cracked plaster, broken dishes, damaged chimneys, and broken windows.

In recent years, attention has been focused on the New Madrid Seismic Zone. This zone extends from approximately Cairo, Illinois through New Madrid, Missouri to Marked Tree, Arkansas. During the winter of 1811-1812, a series of earthquakes shook the area. The three worst earthquakes destroyed the town of New Madrid, created a 17,000 acre lake in Northeastern Tennessee, caused ocean-like swells on the Mississippi River (which reportedly ran backwards), and rang church bells as far away as the eastern seaboard. Richter Scale estimates ranged from 8.0 to 8.8. The 1811-1812 earthquakes also included hundreds of aftershocks, some with magnitudes estimated to be between 6.5 and 7.6 on the Richter scale.

The New Madrid Seismic Zone is significant because scientists predict that a catastrophic earthquake (between 6.0 and 7.6 on the Richter Scale) will occur within the zone sometime during the next few decades. Michigan may be affected by such an earthquake. A repeat of the 1811-1812 earthquakes is unlikely in the near future. However, should it occur, it could result in damage, disruptions, casualties, and injuries on a scale never experienced from an earthquake in the history of the U.S. The immediate and long-term relief and recovery efforts could place a significant, prolonged burden on the regional and national economies.

3.6.3 Bay County Profile

Earthquakes are not considered a major threat to Bay County. Although there are fault lines in the bedrock of Michigan, they are now considered relatively stable. However, these fault lines are poorly mapped according to the U.S. Geological Survey. Michigan is in an area in which there is a low probability of earthquake occurrences, the area may be affected by distant earthquakes that occur in the New Madrid Seismic Zone and upstate New York. The New Madrid Seismic Zone poses the most significant threat. Based on recent scientific studies, portions of southern Michigan could be expected to receive minor damage from a New Madrid Seismic event. Although earthquakes have been recorded and felt in the Southern part of Michigan, the U.S. Geological survey does not have a record of an earthquake having affected Bay County in the past. During the completion of this report, on June 23, 2010, an earthquake originating from the Ontario-Quebec border that was measured at a 5.0 magnitude was felt by portions of Michigan, including Bay County. The June 23, 2010 earthquake was not included in the vulnerability assessment for this Plan. The following table summarizes the risk of an earthquake occurring in Bay County.

Table 3.8
Bay County Earthquake Profile

Typical Impact Area	Regional/Statewide
Number of Events (1811-2009)	No major earthquakes to date
Past Damages:	N/A
Annual Chance Probability Ratio	0
Period of Occurrence	Year-round
Warning Time	None
Potential Impacts	Impacts human life, health, and public safety. Utility damage and outages, infrastructure damage (transportation and communication systems), structural damage, fire, damaged or destroyed critical facilities, and hazardous material releases. Can cause severe transportation problems and make travel extremely dangerous. Aftershocks and secondary events could trigger landslides, releases of hazardous materials, and/or dam and levee failure and flooding.

3.7 EXTREME TEMPERATURES PROFILE

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

3.7.1 Hazard Description

Prolonged periods of extreme temperatures, whether extreme summer heat or extreme winter cold, can pose severe and often life-threatening problems for Bay County's citizens. Although they are different in terms of initiating conditions, the two hazards share a commonality in that they both primarily affect the most vulnerable segments of the population – the elderly, children, the poor, and those with compromised health. Due to their unique characteristics, extreme summer heat and extreme winter cold hazards will be discussed individually.

3.7.2 Extreme Summer Heat

Extreme summer weather is characterized by a combination of very high temperatures and humid conditions. When persisting over a long period of time, this phenomenon is commonly called a heat wave. The major threats of extreme summer heat are **heatstroke** (a major medical emergency), and **heat exhaustion**. **Heatstroke** often results in high body temperatures, and the victim may be delirious, stuporous, or comatose. Rapid cooling is critical to preventing permanent neurological damage or death. Heat exhaustion is a less severe condition than heatstroke, although it can still cause problems involving dizziness, weakness and fatigue. **Heat exhaustion** is often the result of fluid imbalance due to increased perspiration in response to the intense heat. Treatment generally consists of restoring fluids and staying indoors in a cooler environment until the body returns to normal. Other, less serious risks associated with extreme heat are often exercise-related and include heat syncope (a loss of consciousness by persons not acclimated to hot weather), and heat cramps (an imbalance of fluids that occurs when people unaccustomed to heat exercise outdoors).

How our bodies respond to heat is impacted by a combination of the air temperature and the relative humidity. Hydration and cooling needs are different for a 90°F day with 30% humidity versus a 90°F day with 90% humidity. The NWS has devised a measurement system known as the heat index (HI) to estimate the temperature a person is exposed to over a common temperature and humidity range. The NWS will initiate alert procedures when the HI is expected to exceed 105°- 110°F for at least two consecutive days. The chart below shows the HI that corresponds to the actual air temperature and relative humidity.

Because the combined effects of high temperatures and high humidity are more intense in urban centers, heatstroke and heat exhaustion are a greater problem in cities than in suburban or rural area. Nationwide, approximately 170 deaths a year are directly attributable to extreme heat. In Michigan, approximately 7% of weather-related fatalities (about 5 deaths per year) are attributed to extreme heat (according to the Michigan Department of Community Health and the National Weather Service). Extreme summer heat is also hazardous to livestock and agricultural crops, and it can cause water shortages, exacerbate fire hazards, and prompt excessive demands for energy. Roads, bridges, railroad tracks and other infrastructure are susceptible to damage from extreme heat (due to the effects of thermal expansion of the materials).

Air conditioning is probably the most effective measure for mitigating the effects of extreme summer heat on people. Unfortunately, many of those most vulnerable to this hazard do not live or work in air-conditioned environments, especially in major urban centers where the vulnerability is highest. The use of fans to move air may help some, but recent research indicates that increased air movement may actually exacerbate heat stress in many individuals.

Temperature (F) versus Relative Humidity (%)

°F	90%	80%	70%	60%	50%	40%
80	85	84	82	81	80	79
85	101	96	92	90	86	84
90	121	113	105	99	94	90
95		133	122	113	105	98
100			142	129	118	109
105				148	133	121
110						135

HI	Possible Heat Disorder:
80°F - 90°F	Fatigue possible with prolonged exposure and physical activity.
90°F - 105°F	Sunstroke, heat cramps and heat exhaustion possible.
105°F - 130°F	Sunstroke, heat cramps, and heat exhaustion likely, and heat stroke possible.
130°F or greater	**Heat stroke highly likely with continued exposure.**

Figure 2 Temperature versus Relative Humidity Scale
*http://www.crh.noaa.gov/pub/heat.htm
* Due to the nature of the heat index calculation, the values in the table have an error +/- 1.3 F.

3.7.2.1 Extreme Heat Historical Data

Bay County is susceptible to extreme heat. The Michigan Hazard Mitigation Plan and the National Climatic Data Center records show several notable events that have affected Bay County and the region/state.

July 1936 - Statewide. During the second week of July 1936, a terrible heat wave struck Michigan, and particularly Detroit, with temperatures exceeding 100 degrees for several days in a row. The temperature peaked at 112 degrees in Mio, setting a state record that still stands today. The extreme heat was an "equal opportunity" killer, causing many healthy adults to succumb to the heat at work or in the streets. Also, because most people relied on iceboxes to keep their food fresh, many heat-related deaths and illnesses occurred when the ice melted, causing the food to spoil. Statewide, 570 people died from heat-related causes, including 364 in Detroit. Nationally, the heat wave caused 5,000 deaths. Notice that these casualties disproportionately affected the large city of Detroit, and that Michigan was over-represented in terms of its population (11.4% of the national deaths were in Michigan) (Source: Michigan Hazard Mitigation Plan and National Climatic Data Center Storm Event Database).

July 4, 1999 - Southeast Michigan. Hot and extremely humid weather rolled into southeast Michigan for the Fourth of July holiday weekend. High temperatures climbed into the 90s across the area, with dew points well into the 70s. This resulted in triple-digit heat indices across southeast Michigan on both the 4th and 5th. The heat index exceeded 105 in and near Detroit. This resulted in numerous heat-related illnesses, as people overdid outdoor activities during the holiday weekend. Numerous hospitals in metro Detroit reported cases of heat stroke, heat exhaustion, dehydration, and severe sunburn. However, unlike many other parts of the country, no fatalities were reported. The NCDC recorded 52 injuries across southeast Michigan (Source: National Climatic Data Center Storm Event Database.)

June-August 2000 - Statewide. Severe drought and persistent heat over the South-Central and Southeastern U.S. caused an estimated 140 deaths nationwide. Large parts of the Southeast, Central Plains, and Rocky Mountains were especially hot, with some areas having more than 20 additional 90-degree days during July and August. Although days with 100-degree heat are fairly common in the Southwestern U.S. during the summer, the summer of 2000 was extreme by almost any standard. Records for consecutive number of days of 80-, 90-, or 100-degree days, as well as record maximums for individual days, were set at many locations from the Southeast to the intermountain West. Three elderly residents at a Detroit-area nursing home died and 5 more hospitalized due to heat-related stress (Source: Michigan Hazard Mitigation Plan.)

June – August 2001 - Midwest and Central Plains. Extreme heat and humidity in the Midwest and Central Plains during parts of June, July and August sent heat stress index readings soaring well above 100 degrees Fahrenheit on many days. Communities across the region were forced to open "cooling centers" and take other steps in an attempt to avoid heat-related deaths among vulnerable segments of the population. Despite those efforts, heat-related deaths occurred in many areas – and unfortunately Michigan was no exception. In mid-June, three elderly residents of a Detroit-area nursing home died and five more were hospitalized due to heat-related stress. (Note: the deaths prompted a bill within the Michigan Legislature to require all nursing homes in Michigan to have air condition in resident rooms and common areas) (Source: Michigan Hazard Mitigation Plan.)

August 6, 2001 - Southeast Michigan. A large high-pressure ridge settled across the Great Lakes region during the first week of August. With this ridge in place, high temperatures soared well into the 90s across southeast Michigan. Heat indices ranged from 105 to 110 degrees. The heat caused several people to seek emergency care for heat stroke and heat exhaustion. One fatality also occurred due to the heat when an Oak Park man was found suffering from severe heat exhaustion while locked in his care. Several hours later, he was pronounced dead at an area hospital. The hot weather only aggravated the dry conditions already in place across southeast Lower Michigan. This led to tremendous worries among area farmers that they may lose entire crops. Thousands of power outages also occurred throughout the region as demand surpassed supply. Several factory workers across the area were sent home from work to escape the extreme heat. Many of those who were not, however, threatened to walk off the job as a result of not having air conditioning in their factories. A total of 200 injuries were recorded during this heat wave (Source: National Climatic Data Center Storm Event Database.)

May 29, 2006 - Southeast Michigan. An early season heat wave, leading to an unusually hot Memorial Day, resulted in dozens of people suffering from heat related illnesses. Near record setting high temperatures, in the low to mid 90's, sent some people to the hospital. The official high temperatures from the day ranged from 88 to 93 degrees. Of the 52 cooperative observer reports received for the day, including at least one report from each of the 17 counties in southeast lower Michigan, 50 of them reported a high above 90. They ranged from 89 (along the lakeshore) to 98 (at Midland), and averaged out at 94 degrees. Most of the month of May, leading up to this weekend was well below normal. Combining this factor with temperatures at 20 to 30 degrees above the seasonal norms created very uncomfortable conditions. Conditions were further exacerbated by the combination of high humidity, light winds, and mostly clear skies. Nearly all the southeast lower Michigan reached 90 degrees by Noon EST… the only exceptions included those locations immediately adjacent to the lakes. Heat indices were in the mid 90's throughout most of the day. At least 27 people passed out in Roseville after the late morning Memorial Day Parade.

Most were treated on the scene for dehydration; however, eight were taken to the hospital and treated for heat related illnesses. According to local newspapers, at least 20 other people, from across the entire region, were admitted to area hospitals for heat illnesses (Source: National Climatic Data Center Storm Event Database.)

July 29, 2006 - Southern Lower Michigan. A 5-day stretch of maximum temperatures at or above 90 degrees began on Saturday, July 29th. A blanket of especially high heat and oppressive humidity settled over the area on Monday, July 31st, and remained relentless through Wednesday, August 2nd. Temperatures, on the 31st, soared above 90 by noon with heat indices over 100 degrees. Heat indices averaged between 105 and 110 degrees through the entire afternoon. Little relief was felt Monday evening with temperatures not dropping below 90 until 1900 EST. The major power companies in the area reported an all-time record customer demand for power from 1500 to 1600 EDT on the 31st. Very few heat related illnesses occurred during the event. Newspaper articles revealed an extremely high level of awareness and preparedness from the communities across southeast lower Michigan. A large number of cooling centers were made available to those in need as folks reportedly heeded the warnings and took extra precaution. Although area hospitals reported some increase due to heat related illnesses, most were mild and due to heat exhaustion and dehydration. Four cases of heatstroke were confirmed in Wayne and Macomb Counties, 2 on the 30th and 2 on the 31st. No heat related deaths were reported (Source: National Climatic Data Center Storm Event Database.)

3.7.3 Extreme Winter Cold Profile

Like heat waves, periods of prolonged, unusually cold weather can result in a significant number of temperature-related deaths. Each year in the United States, approximately 700 people die as a result of severe cold temperature-related causes. This is substantially higher than the average of 170 heat-related deaths each year. It should be noted that a significant number of cold-related deaths are not the direct result of "freezing" conditions. Rather, many deaths are the result of illnesses and diseases that are negatively impacted by severe cold weather, such as stroke, heart disease and pneumonia. It could be convincingly argued that, were it not for the extreme cold temperatures, death in many cases would not have occurred at the time it did from the illness or disease alone.

Hypothermia (the unintentional lowering of core body temperature), and **frostbite** (damage from tissue being frozen) are probably the two conditions most closely associated with cold temperature-related injury and death. Hypothermia is usually the result of over-exposure to the cold, and is generally thought to be clinically significant when core body temperature reaches 95 degrees or less. As body temperature drops, the victim may slip in and out of consciousness, and appear confused or disoriented. Treatment normally involves re-warming the victim, although there is some controversy in the medical community as to exactly how that should be done. Frostbite rarely results in death, but in extreme cases it can result in amputation of the affected body tissue.

Hypothermia usually occurs in one of two sets of circumstances. One situation involves hypothermia associated with prolonged exposure to cold while participating in outdoor sports such as skiing, hiking, or camping. Most victims of this form of hypothermia tend to be young, generally healthy individuals who may lack experience in dealing with extreme cold temperature. The second situation involves a particularly vulnerable person who is subjected to only a moderate, indoor cold stress. A common example would be that of an elderly person living in an inadequately heated home. In such circumstances, hypothermia may not occur until days or perhaps weeks after the cold stress begins.

The special vulnerability of elderly persons to hypothermia has become readily apparent. Over half of the approximately 700 persons who die each year due to cold exposure are 60 years of age or older, even though this age group only represents about 20% of the country's population. This remarkable statistic may be due, in part, to the fact that elderly persons appear to perceive cold less well than younger persons and may voluntarily set thermostats to relatively low temperatures. In addition, high energy costs and the relative poverty among some elderly people may discourage their setting thermostats high enough to maintain adequate warmth. Because many elderly people live alone and do not have regular visitors, the cold conditions may persist for several days or weeks, thus allowing hypothermia to set in.

Babies and very young children are also very vulnerable to hypothermia. In addition, statistics indicate that death due to cold is more frequent among males than females in virtually all age groups. Part of that may be explained by differences in risk factors, and part may be due to different rates of cold exposure between the sexes.

3.7.3.1 Extreme Cold Historical Data

Bay County is susceptible to extreme cold. The Michigan Hazard Mitigation Plan and the National Climatic Data Center records show several notable events that have affected Bay County and the region/state.

December 9, 1995 - Southern Lower Michigan. A cold wave resulted in three deaths by hypothermia in the city of Detroit during the period from the early morning on the 9th through the morning on the 10th. Two of the deaths occurred on the street, and the third occurred in a van. Low temperatures during that period ranged from three above zero at Detroit, to one above zero at Flint, to one below zero at WSFO White Lake. On the 9th, winds averaging 20 to 25 mph combined with afternoon temperatures in the single digits to produce wind chills of 30 to 35 below zero (Source: National Climatic Data Center Storm Event Database.)

February 1, 1996 - Southeast Michigan. The coldest weather of the winter season occurred across southeast Michigan during the first week of February. At Flint, the low temperature was zero or lower every day from January 31st through February 6th, reaching a low of -11 on the 3rd. At Detroit, the lowest temperature was -7, also on the 3rd. An elderly man died of hypothermia on the 2nd after wandering away from a nursing home in Detroit (Source: National Climatic Data Center Storm Event Database.)

January 17, 1997 - Southeast Michigan. The coldest weather of the winter occurred from the 17th through the 19th. During that period, lows reached as low as -6 at Detroit's metro airport, and -9 at Flint's Bishop airport and the National Weather Service forecast office at White Lake. One man died of hypothermia in Bay City. A few days earlier, on the 12th, another man died of hypothermia in Warren, when the temperature at metro airport fell to 2 above zero. Several other less severe cases of hypothermia were reported through mid-January (Source: National Climatic Data Center Storm Event Database.)

March 9, 1998 - Southeast Michigan. A Kawkawlin man passed out while walking home from a local tavern. A steady cold rain was falling, and the man died from hypothermia. Alcohol was likely a contributing factor (Source: National Climatic Data Center Storm Event Database.)

December 21, 2000 - Southeast Michigan. Temperatures remained in the single digits on the 22nd, with Detroit seeing a high of only 4 degrees, after a morning low of 3 below zero. Flint wasn't much better, recovering from a low of -5 to reach 8 degrees in the afternoon. Christmas morning dawned clear and frigid; with a morning low of 13 degrees below zero at Flint, setting an all-time mark for the month of December. The arctic weather caused pipe ruptures at many local facilities. The cold also hampered shipping interests. Ice formation was extremely rapid on the Great Lakes and the connecting waterways. Several freighters got stuck on ice on both the Detroit River and Lake St Clair, blocking the shipping channel and bringing dozens of ships to a halt. Icebreaker assistance was needed to free the freighters. Ferry service on the St Clair River between Michigan and Canada was also interrupted due to ice jams. Average temperatures for the month were 19.3 degrees in Detroit, 16.6 at Flint, and 17.2 in Saginaw (Source: National Climatic Data Center Storm Event Database.)

January 10, 2003 - Southeast Michigan. Temperatures averaged well below normal across the Great Lakes region for much of January. In fact, for a three-week period, the temperature never rose above freezing. Frozen pipes and water main breaks occurred in many areas of Detroit and its suburbs. The cities of Flint and Saginaw also had several reports of water main breaks. Several area schools had to cancel classes due to frozen pipes. Many area homeless shelters were filled to capacity and area hospitals reported dozens of cases of frostbite. Three deaths were also attributed to this cold spell (Source: National Climatic Data Center Storm Event Database.)

February 3, 2007 - Southern Lower Michigan. A bitter cold air mass blasted into the region on Saturday, February the 3rd and persisted through Tuesday, February the 6th. Temperatures through this period were 20 to 25 degrees below normal. Daytime temps struggled to reach 10 degrees while subzero temperatures occurred all 3 nights. Winds of 15 to 25 MPH gusted as high as 35 MPH at times. After factoring in the winds, apparent temperatures ranged from 15 below to 25 below through nearly the entire event. Almost every school district in Southeast Michigan canceled school on Monday and most did the same on Tuesday, citing conditions too dangerous for the kids either walking to school or waiting outside for the bus. Area hospitals reported numerous cases of patients suffering from cold related illnesses. Most of the cases involved frostbite. At least one fatality was blamed on the cold weather. Frozen pipes and water main breaks occurred throughout all of Southeast Michigan, leaving many residents and business owners out in the cold. Area homeless shelters were filled to capacity. There were also many cases of fire sprinkler lines freezing and breaking, leading to flooding. AAA Michigan reported over 20,000 vehicle service calls due to the cold air, the most in nearly 10 years. Total damages were roughly estimated at $425K, including electrical and mechanical damages to vehicles and property damages caused by flooding. Here are the official maximum and minimum temperatures observed at Detroit, Flint, and Saginaw, from the 4th through the 6th: Detroit: 8/-2 on the 4th, 12/-4 on the 5th, 12/-3 on the 6th. Flint: 4/-5 on the 4th, 9/-7 on the 5th, 11/-5 on the 6th. Saginaw: 5/-7 on the 4th, 10/-7 on the 5th, 10/-6 on the 6th (Source: National Climatic Data Center Storm Event Database.)

January 14-18, 2009 - Southern Lower Michigan. An arctic air mass become firmly established over the Great Lakes region on January 14th and persisted through the 18th. Temperatures fell below zero all four days, with wind chill values in the 5 to 30 below range during the majority of the time. Detroit's low temperatures for January 14-18th were as follows: -3, -3, -15, -11 (Source: National Climatic Data Center Storm Event Database.)

3.7.4 Bay County Profile

The following table summarizes the risk of extreme temperatures in Bay County.

Table 3.9 Bay County Extreme Temperature Profile

Typical Impact Area	Regional/Statewide
Number of Events (1936-2010)	19
Past Damages:	$500,000
Annual Chance Probability Ratio	Heat: 0-19 days at or above 90 degrees Fahrenheit Cold: 3-50 + days at or below 0 degrees Fahrenheit 0.26
Period of Occurrence	Year round
Warning Time	Days to weeks
Potential Impacts	Public health and safety, especially the elderly and homeless.

3.8 FLOODING

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

3.8.1 Hazard Description

A flood is a natural event for rivers and streams and is caused in a variety of ways. Floods can develop slowly or quickly, depending on several factors. Winter or spring rains, coupled with melting snows, can fill river basins too quickly. Torrential rains from decaying hurricanes or other tropical systems can also produce flooding. The excess water from snowmelt, rainfall, or storm surge accumulates and overflows onto the banks and adjacent floodplains.

A flood, as defined by the National Flood Insurance Program (NFIP), is a general and temporary condition of partial or complete inundation of two or more acres of normally dry land area, or of two or more properties from:

- Overflow of inland or tidal waters;
- Unusual and rapid accumulation or runoff of surface waters from any source;
- A mudflow;
- A collapse or subsidence of land along the shore of a lake or similar body of water as a result of erosion or undermining caused by waves or currents of water exceeding anticipated cyclical levels that result in a flood.

Floods are generally the result of excessive precipitation, and can be classified under two categories: flash floods, the product of heavy localized precipitation in a short time period over a given location; and general floods, caused by precipitation over a longer time period.

The severity of a flooding event is determined by a combination of stream and river basin topography and physiography, precipitation and weather patterns, recent soil moisture conditions and the degree of vegetative clearing. Flood currents also possess tremendous destructive power as lateral forces can demolish buildings and erosion can undermine bridge foundations and footings, leading to the collapse of structures.

Flash flooding events usually occur within minutes or hours of heavy amounts of rainfall, from a dam or levee failure, or from a sudden release of water held by an ice jam. General floods are usually longer-term events and may last for several days. The primary types of general flooding include riverine flooding, coastal flooding, and urban flooding.

Periodic flooding of lands adjacent to rivers, streams, and shorelines is a natural and inevitable occurrence that can be expected to take place based upon established recurrence intervals. The recurrence interval of a flood is defined as the average time interval, in years, expected between a flood event of a particular magnitude and an equal or larger flood. Flood magnitude increases with increasing recurrence interval. One way of expressing the flood frequency is the chance of occurrence in a given year, which is the percentage of the probability of flooding each year. For example, the 100-year flood has a 1% chance of occurring in any given year, rather than being that level of flooding which only occurs once a century. In other words, it is possible to have two 100- year floods in a five year span or to not have a 25-year flood for 30 years.

3.8.2 Summary of the Types of Flooding

Floods are the result of a multitude of naturally occurring and human-induced factors, but they all can be defined as the accumulation of too much water in too little time in a specific area. Types of floods include regional floods, river or riverine floods, flash floods, urban floods, ice-jam floods, storm-surge floods, and debris, landslide, and mudflow floods. The types of flooding are defined as follows:

- Regional Flooding can occur seasonally when winter or spring rains coupled with melting snow fill river basins with too much water too quickly. The ground may be frozen, reducing infiltration into the soil and thereby increasing runoff. Extended wet periods during any part of the year can create saturated soil conditions, after which any additional rain runs off into streams and rivers, until river capacities are exceeded. Regional floods are many times associated with slow-moving, low-pressure or frontal storm systems including decaying hurricanes or tropical storms.

- River or Riverine Flooding is a high flow or overflow of water from a river or similar body of water, occurring over a period of time too long to be considered a flash flood. Riverine flooding is a function of excessive precipitation levels and water runoff volumes within the watershed of a stream or river. 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 also a cause of flooding in winter and early spring.

- Great Lakes Shoreline Flooding, Erosion and Recession: The flooding, erosion and recession of shoreline areas caused by fluctuating Great Lakes water levels, storm surges, or winds.

- Flash Floods are quick-rising floods that usually occur as the result of heavy rains over a short period of time, often several hours or even less. Several factors can contribute to flash flooding. Among these are rainfall intensity, rainfall duration, surface conditions, and topography and slope of the receiving basin. Flash floods can occur within several seconds to several hours and with little warning. They can be deadly because they produce rapid rises in water levels and have devastating flow velocities. Most flash flooding is caused by slow-moving thunderstorms in a local area or by heavy rains associated with hurricanes and tropical storms. Although flash flooding occurs often along mountain streams, it is also common in urbanized areas where much of the ground is covered by impervious surfaces. Mountainous areas also are susceptible to flash floods, as steep topography may funnel runoff into a narrow canyon. Floodwaters accelerated by steep stream slopes can cause the flood-wave to move downstream too fast to allow escape, resulting in many deaths.

- Urban Flooding is possible when land is converted from fields or woodlands to roads and parking lots; thus, losing its ability to absorb rainfall. Urbanization of a watershed changes the hydrologic systems of the basin. Heavy rainfall collects and flows faster on impervious concrete and asphalt surfaces. The water moves from the clouds, to the ground, and into streams at a much faster rate in urban areas. The combination of excessive rainfall and/or snowmelt, saturated ground, and inadequate drainage contribute to urban flooding. With no place to go, the water will find the lowest elevations – areas that are often not in a floodplain. That type of flooding is becoming increasingly prevalent in Michigan, as development outstrips the ability of the drainage infrastructure to properly carry and disburse the water flow. Flooding also occurs due to combined storm and sanitary sewers that cannot handle the tremendous flow of water that often accompanies storm events. Typically, the result is water backing into basements, which damages mechanical systems and can create serious public health and safety concerns. Adding these elements to the hydrological systems can result in floodwaters that rise very rapidly and peak with violent force. During periods of urban flooding, streets can become swift moving rivers and basements can fill with water. Storm drains often back up with vegetative debris causing additional, localized flooding.

- Ice-Jam Flooding occurs on rivers that are totally or partially frozen. A rise in stream stage will break up a totally frozen river and create ice flows that can pile up on channel obstructions such as shallow riffles, log jams, or bridge piers. The jammed ice creates a dam across the channel over which the water and ice mixture continues to flow, allowing for more jamming to occur. Backwater upstream from the ice dam can rise rapidly and overflow the channel banks. Flooding moves downstream when the ice dam fails, and the water stored behind the dam is released. At this time the flood takes on the characteristics of a flash flood, with the added danger of ice floes that, when driven by the energy of the flood-wave, can inflict serious damage on structures. An added danger of being caught in an ice-jam flood is hypothermia, which can quickly kill. Ice-Jam Flooding and Wind Driven Ice Floes will be discussed in more detail later in this plan, because it was identified as a separate and distinct hazard for the community.

- Storm-surge flooding is water that is pushed up onto otherwise dry land by onshore winds. Friction between the water and the moving air creates drag. Depending upon the uninterrupted length of water (fetch) and the velocity of the wind, water can pile up to depths greater than 20 feet. Intense, low-pressure systems and hurricanes can create storm-surge flooding. The storm surge is unquestionably the most dangerous part of a hurricane as pounding waves create very hazardous flood currents.

- Debris, Landslide, and Mudflow Flooding is created by the accumulation of debris, mud, rocks, and/or logs in a channel, forming a temporary dam. Flooding occurs upstream as water becomes stored behind the temporary dam and then becomes a flash flood when the dam is breached and rapidly washes away. Landslides can create large waves on lakes or embayments and can be deadly.

3.8.3 Flood Impacts and History

Flooding is the most frequent and costly natural hazard in the U S. Property damage from flooding now totals over $1 billion each year in the U.S. More than $4 billion is spent on flood damage in the U.S. each year. During the 20th century, floods were the number one natural disaster in the U.S. in terms of number of lives lost and property damage, and floods are the number one weather-related killer. Flooding has caused the deaths of more than 10,000 people since 1900.

Flooding of land adjoining the normal course of a stream or river has been a natural occurrence since the beginning of recorded history. If these floodplain areas were left in their natural state, floods would not cause significant damage. Development has 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 a natural drainage basin now quickly runs off streets, parking lots, and rooftops, and through man-made channels and pipes.

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

3.8.4 Future Probability

For each river, engineers assign statistical probabilities for different sized floods. This is done to rate the size of the flood compared to other floods that have or may occur.

Common Flood-Related Terms

100-Year Floodplain: The area that has a 1% chance, on average, of flooding in any given year. (Also known as the Base Flood.)

500-Year Floodplain: The area that has a 0.2% chance, on average, of flooding in any given year.

Base Flood: Represents a compromise between minor floods and the greatest flood likely to occur in a given area. The elevation of water surface resulting from a flood that has a 1% chance of occurring in any given year. The base flood elevation is the basis for most flood related planning and mitigation activities.

Floodplain: The land area adjacent to a river, stream, lake, estuary, or other water body that is subject to flooding. This area, if left undisturbed, acts to store excess floodwater. The floodplain is made up of two sections: the floodway and the flood fringe.

Floodway: The NFIP floodway definition is “the channel of a river or other watercourse and adjacent land areas that must be reserved, in order to discharge the base flood without cumulatively increasing the water surface elevation more than one foot”. The floodway carries the bulk of the floodwater downstream and is usually the area where water velocities and forces are the greatest. NFIP regulations require that the floodway be kept open and free from development or other structures that would obstruct or divert flood flows onto other properties.

Flood Fringe: The flood fringe refers to the outer portions of the floodplain, beginning at the edge of the floodway and continuing outward.

For each waterway engineers assign statistical probabilities for different sized floods. This is done relative to the size of the flood compared to other floods that have occurred or may occur in the future.

The National Flood Insurance Program (NFIP) uses this same baseline flooding probability. This is referred to as the base flood, or the 100-year flood. FEMA describes the 100-year flood as "The flood elevation that has a one percent chance of being equaled or exceeded each year. Thus the 100-year flood could occur more than once in a relatively short period of time. The 100-year flood is used by the NFIP as the standard for floodplain management and to determine the need for flood insurance." (Source: www.fema.gov/plan/prevent/fhm/fq_fld03.shtm) The primary purpose of the NFIP is to provide flood insurance to properties located in floodplains, as delineated by Flood Insurance Rate Maps (FIRMs). The NFIP maintains records of the frequency and costs of insurance claims for each jurisdiction. The following table summarizes the number and value of policies and claims in Bay County and each of the incorporated jurisdictions.

Another level of risk that is used is the 500-year flood, or 0.2% chance of occurring in any given year. FEMA describes the 500 year flood as deeper than a 100-year flood and covering a greater area, but less likely to occur than a 100-year event. Given that this level of flooding is less likely to occur, it is the standard used for critical facility protection.

Table 3.10 Flood Probability

Time Periods	Flood Size			
	10-year	25-year	50-year	100-year
1 Year	10%	4%	2%	1%
10 Years	65%	34%	18%	10%
20 Years	88%	56%	33%	18%
30 Years	96%	71%	45%	26%
50 Years	99%	87%	64%	39%

Notice that during the course of a 30-year mortgage, a homeowner in a 100-year floodplain has a 26% chance of experiencing a 100-year flood and a 96% chance of experiencing a 10-year flooding event. While a 10-year flood is not as extensive as other floods, the odds of experiencing a 10-year event are nearly guaranteed during a typical 30-year mortgage.

Table 3.11 NFIP Policies and Claims in Bay County

Jurisdiction	Participating in NFIP	No. of Policies	Value of Policies	No. of Paid Losses	Value of Paid Losses	Existing Rep. Loss Structures	Repetitive Loss Payments
City of Auburn	Yes	1	$350,000.00	0	$0	0	$0
Township of Bangor	Yes	458	$53,974,900	121	$489,817.12	18	$193,278.14
City of Bay City	Yes	145	$17,813,700	51	$267,788.22	4	$33,659.15
Bay County	No	0	0	44	$179,195.40	0	$0
Township of Beaver	Yes	4	$587,100	0	$0	0	$0
City of Essexville	Yes	11	$2,790,100	2	$5,118.77	0	$0
Township of Frankenlust	Yes	33	$5,195,200	9	$28,011.51	0	$0
Township of Fraser	Yes	140	$15,672,500	0	$0	0	$0
Township of Garfield	No	0	0	0	$0	0	$0
Township of Gibson	No	0	0	0	$0	0	$0
Township of Hampton	Yes	90	$10,667,000	4	$20,385.94	1	$0
Township of Kawkawlin	Yes	159	$25,521,900	31	$153,192.08	9	$54,995.04
Township of Merritt	Yes	8	$820,100	0	$0	0	$0
Midland (In Neighboring Plan)	Yes	256	$41,701,100	66	$1,822,98.33	1	$831,907.16
Monitor	Yes	19	$2,825,600	5	$58,142.16	0	$0
Mount Forest	No	0	0	0	$0	0	$0
Pinconning, City	Yes	4	$426,200	2	$7,318.73	0	$0
Pinconning, Town	Yes	46	$5,085,400	8	$30,322.98	0	$6,153.00
Portsmouth	Yes	26	$2,704,900	6	$59,981.36	0	$0
Williams	Yes	9	$1,566,500	0	$0	0	$0

One of the primary concerns of the NFIP and FEMA are the repetitive loss structures and reoccurring payments. In general, these structures are located in the floodplain, and account approximately 1% of the insurance policies nationwide and 0.6 % in Bay County. However, the repetitive loss structures account for 30% of the annual NFIP claims nationally and 32% of the total claims within Bay County. Thus, minimizing, or ideally eliminating, repetitive loss structures is a primary goal of NFIP and FEMA.

The current data reflects that Bangor has 18 repetitive loss properties. The structure types are all residential with the exception of one non-residential retail commercial property. These are located on the shoreline and riverbank. In Hampton, there is one single-family residential property located on the shoreline that is a repetitive loss property. Kawkalin has nine single-family residential repetitive loss structures located on the shoreline. Bay City has four non-residential repetitive loss properties located on the river.

Flood prone areas are found throughout the state, as every lake, river, stream and open drain has a floodplain. The type of development that exists within the floodplain will determine whether or not flooding will cause damage. The Michigan Department of Environmental Quality estimates that about 6% of Michigan's land – roughly the size of the southeast Michigan counties of Wayne, Oakland, Macomb, Washtenaw, and Monroe combined – is flood-prone, including about 200,000 buildings. The southern half of the Lower Peninsula contains the areas with the most flood damage potential.

The primary flooding sources include the Great Lakes and connecting waters (Detroit River, St. Clair River, and St. Mary's River), thousands of miles of rivers and streams, and hundreds of inland lakes. Michigan is divided into 63 major watersheds, as shown in the map at the end of this section. All of these watersheds experience flooding, although the following watersheds have experienced the most extensive flooding problems or have significant damage potential: 1) Clinton River; 2) Ecorse River; 3) Grand River; 4) Huron River; 5) Kalamazoo River; 6) Muskegon River; 7) Saginaw River; 8) Rifle River; 9) River Raisin; 10) Rouge River; 11) St. Joseph River; and 12) Whitefish River. The flooding is not restricted to the main branches of these rivers.

3.8.5 Great Lakes Shoreline Flooding, Erosion and Recession

The flooding, erosion and recession of shoreline areas caused by fluctuating Great Lakes water levels, storm surges, or winds.

3.8.5.1 Hazard Description

Michigan has over 3,200 miles of coastline (the longest freshwater coastline in the world), and more than 4.9 million people live in the state's 41 shoreline counties. Wind, waves, water levels, and human activities constantly affect the communities along the shores. Shoreline flooding and erosion are natural processes, occurring at high, average, and even low Great.

Lakes water levels. However, during periods of high water, flooding and erosion are more obvious, causing serious damage to homes and businesses, roads, water and wastewater treatment facilities, and other structures in coastal communities. Low lake levels can also pose a hazard, as cargo ships are more prone to running aground and the shorelines may also become more polluted from lake bottom debris. Long-term and seasonal variations in precipitation and evaporation rates primarily control the Great Lakes water levels and their fluctuations.

The Great Lakes occupy an area of 95,000 square miles and drain an amount of land twice that size. They hold nearly one-fifth of the world's fresh surface water. Because the land draining into the Great Lakes is so vast, changes in the amount of water running into the lakes from precipitation within the basin has an enormous effect on water levels. Following long periods of above average yearly precipitation, there is an accompanying rise in water levels. This rise is not immediately evident because of the delay between the time precipitation falls within the drainage basin and the time that runoff waters enter the lakes. (The same holds true for below average yearly precipitation. The reduced flow of runoff water eventually results in lower Great Lakes water levels.)

Over one hundred years of record keeping have indicated no regular, absolutely predictable cycle of levels. The time between periods of high and low water levels can vary widely. Records indicate the maximum differences in levels have varied from nearly four feet on Lake Superior to over six and one-half feet on Lakes Michigan and Huron. Seasonal fluctuations caused by more water runoff can cause lake level fluctuations averaging about one foot on Lakes Superior, Michigan and Huron, and one and one-half feet on Lake Erie. Weather-related events can also cause fluctuations that can last from several hours to several days. For example, windstorms combined with differences in barometric pressure can temporarily tilt the surface of a lake up at one end as much as eight feet. This phenomenon is called a **storm surge** and can drive lake waters inland over large areas.

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

Generally, low-lying lands along the coastline are prone to shoreline flooding during both high and low lake water periods. The Michigan Department of Environmental Quality estimates that approximately 10% of Michigan's Great Lakes shoreline (30 counties encompassing greater than 45,000 acres) is flood prone.

3.8.5.2 Significant Periods of Shoreline Flooding and Erosion

In nearly every decade, high water levels on the Great Lakes have caused significant damage and impact to Michigan coastal communities.

The most recent high water period, in 1997-98, resulted in the Great Lakes being at or near record levels set in the mid- 1980s. In response to the threat of severe shoreline flooding and erosion, the U.S. Army Corps of Engineers (USACE), at the request of the Governor, implemented its Advance Measures Program to assist Michigan shoreline communities in their flood and erosion mitigation efforts. To date, over 20 Michigan jurisdictions have taken advantage of this program.

Prior to that, the record-high lake levels in 1985-86 culminated in a Governor's disaster declaration for 17 shoreline counties. The USACE implemented its Advanced Measures Program, and the State of Michigan implemented three unique shoreline flooding and erosion mitigation programs aimed at reducing future flood impacts on shoreline communities and homeowners.

During 1972-73, high water levels caused flooding in over 30 counties, resulting in more than $50 million in public and private damage. Thousands of people were forced to evacuate their homes. Similar high water level flooding occurred in the early 1950s and late 1960s, also resulting in millions of dollars worth of damage to shoreline communities.

3.8.5.3 Significant Periods of Great Lakes Recession

Just as damaging high water levels frequently occur in the Great Lakes, low water levels are also cyclical and can have severe economic impacts.

The low water levels in Lakes Michigan, Huron and Erie between1998-2004 resulted in the fastest decline in water levels in the Great Lakes in nearly a century and a half. Between the summer of 1997 and the spring of 2003, the middle Great Lakes - Michigan, Huron and Erie - each dropped by almost five feet.

A major contributor to low lake levels is a lack of snow pack runoff. The Lake Superior basin, which is the headwaters for the Great Lakes, is an important factor in lake levels. In the past, low snow pack in the Lake Superior basin has disrupted the other lakes' seasonal replenishment cycle, driving water levels down.

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

Under strict environmental laws, such dredged material has to be deposited in confined disposal facilities.

3.8.5.4 Impacts and History

From 1975-2005, Michigan experienced 10 flood disasters that resulted in both a Presidential Major Disaster Declaration and a Governor's Disaster Declaration, and nine that resulted solely in a Governor's Disaster Declaration. Combined, these flood disasters have caused hundreds of millions of dollars in damage to homes, businesses, personal property, and agriculture.

The following table represents flood disasters that resulted in **Presidential and Governor's Disaster Declarations** (opening up the full-range of Federal and state supplemental disaster assistance):

Table 3.12 Presidential and Governor's Declarations

Date	Location
May/June 2004	Southern Lower Michigan
April 2002	Western Upper Peninsula
September 2000	Wayne and Oakland Counties
July 1997	Wayne and Macomb Counties
June 1996	Thumb Area
September 1986	Central Lower Michigan
September 1985	East Central Michigan
March 1982	Berrien and Monroe Counties
September 1975	West Central / Central Lower Michigan
April 1975	Southern Lower Michigan

Source: Michigan Hazard Mitigation Plan

Following is a table of flood disasters that resulted in **Governor's Disaster Declarations only** (activating state supplemental and limited Federal disaster assistance):

Table 3.13 Governor's Disaster Declarations

Date	Location
May 2003	Marquette County
February 2001	Genesee County
April 1998	Alpena County
June 1997	West Michigan
May 1996	Berrien County
July 1994	Lapeer, Sanilac, and Tuscola Counties
April 1993	Shiawassee County
July 1992	Gogebic County
June 1989	Branch, St. Joseph, and Kalamazoo Counties

Source: Michigan Hazard Mitigation Plan

Based on data from the National Climatic Data Center Storm Event Database, the Michigan Hazard Mitigation Plan, and FEMA's database of Disaster Declarations (Presidential and Governor's), past flood hazard events have had a significant effect on Bay County. Below is a description for many of these events:

April 8-11, 1947 - Central and Eastern Lower Michigan. The flood of April 4-11, 1947 was caused by a combination of snow and rainfall that began in late March of that year. In early April, two frontal systems dumped several inches of rain in many localities across central and eastern Lower Michigan. The areas primarily affected by the April, 1947 flood included the Clinton, Detroit, Grand, Kalamazoo, Saginaw and St. Clair Rivers, and the River Rouge. The city of Flint was particularly hard hit, with damage totaling $4 million. Damage was also significant in Northville, where floodwaters filled basements and inundated first floors of numerous residences (Source: Michigan Hazard Mitigation Plan.)

December 1, 1972 - Bay County. Presidential Major Disaster Declaration due to severe storms and flooding. Counties affected: Arenac, Bay, Berrien, Iosco, Macomb, Monroe, St. Clair, Tuscola, & Wayne Co.

April 12, 1973 - Bay County. Presidential Major Disaster Declaration due to severe storms and flooding. Counties affected: Arenac, Bay, Berrien, Huron, Iosco, Macomb, Menominee, Monroe, Saginaw, Sanilac, St. Clair, Tuscola, Van Buren, & Wayne Co.

September 1, 1985 - East Central Michigan. Severe thunderstorms struck resulting in flooding in a six county area. As much as 7.45 inches of rain fell in Genesee County, which was hardest hit. The heavy rainfall caused flash flooding in many areas. Damage occurred primarily from overbank flooding on major rivers and streams. In addition, widespread flooding occurred in residential areas due to overburdened storm water drainage systems. Over 2,500 homes were damaged, many roads were washed out and bridges damaged, and extensive agricultural damage occurred. Total public and private damage was estimated at $63 million. A Presidential Major Disaster Declaration was granted for the six counties (Source: Michigan Hazard Mitigation Plan.)

September 11, 1986 - Bay County. It was on the morning of Sept. 11, 1986, that everyone woke up to massive flooding. The day before, heavy rains dumped as much as a foot of water in Bay County, leaving Bay City's South End and areas along the Kawkawlin River soaked. The rain nearly drowned places like Vassar. When Sept. 11 dawned, businesses, farms, and homes were under water (Source: Bay City Times Archives.) Bay County was of 30 counties in Michigan that were presidentially declared as a major disaster area due to flooding and received a Governor's Disaster Declaration.

Flooding of Hampton Township, Michigan in 1986

May 26, 1994 - 6 miles north of Bay City. A strong north to northeast wind of 15 to 25 mph with gusts of 40 to 45 mph caused water from the Saginaw Bay to back up into the Kawkawlin River. Minor flooding of the Kawkawlin River near the bay resulted, as water rose over the banks of the river and entered the yards of several residences. The high water washed away some lawn furniture and picnic tables from a few residences, and caused some docks along the river to float away (Source: National Climatic Data Center, Storm Event Database.)

June 1, 1996 - Thumb Area, Michigan. Intense thunderstorms produced heavy rainfall that caused widespread and severe flooding in east central Michigan (the Thumb area). Some areas received over five inches of rain in a four to five hour period, which quickly outstripped the ability of the public drainage and sewer systems to handle the massive amounts of water runoff. The result was widespread flash flooding that caused numerous road and bridge washouts, culvert failures, damage to drainage channels, and damage to over 2,700 homes and 40 businesses. These storms also spawned a tornado that struck the city of Frankenmuth in Saginaw County, destroying six homes and one business, and damaging another 108 homes and nine businesses. The total public and private damage exceeded $25 million, most of which was flood-related. A Presidential Major Disaster Declaration was granted for the seven counties most heavily impacted by the storms and flooding (Source: Michigan Hazard Mitigation Plan.)

June 21, 1996 - Bay County. A flash flood occurred in the Southern half of the count causing 1 fatality and $2,200,000 in property damage (Source: National Climatic Data Center Storm Event Database.) Bay County was of 7 counties that were presidentially declared as major disaster areas as a result of severe storm and flooding damage.

February 21, 1997 - Bay County. Countywide Flooding (Source: National Climatic Data Center Storm Event Database.)

April 9, 1998 - Lakeshore Countywide, Bay County. Strong northeast winds produced some problems near the lakeshores of Bay and Macomb Counties. From late morning through late afternoon, gusts off of Saginaw Bay along the Bay County shore reached near 50 mph. A large tree was downed onto a minivan, destroying it. Power lines were downed, causing 110 Consumers Power customers to lose power. These winds also produced lakeshore flooding in Bay County. The yards of about a dozen homes were flooded, as were many lakeshore parks. A mobile home park saw some minor flooding. Most of the problems were located in Bangor Township. However, significant beach erosion also took place near Pinconning. A portion of a county park parking lot was swallowed by Saginaw Bay. Some minor lakeshore flooding also took place along Lake St. Clair in Macomb County. Some lakeshore roads saw high water as 6-foot waves came crashing over seawalls (Source: National Climatic Data Center, Storm Event Database.)

March 7, 2004 - Bay County. Up to two inches of rain fell across the region on the morning of the 5th. This rainfall, coupled with snowmelt and a partially frozen ground lead to extensive flooding across Huron, Bay, and Midland counties. Law enforcement and trained weather spotters reported numerous road closures from ponding of water, as well as many streams, tributaries, and drainage ditches over their banks (Source: National Climatic Data Center, Storm Event Database.)

May 23, 2004 - Southeast Michigan. A stationary front over Iowa, Wisconsin, and Michigan over the weekend brought with it severe thunderstorms and heavy rains, which caused widespread flooding over Southeast Michigan. Much of the rainfall occurred in saturated areas that had experienced well-above average precipitation for the month of May. In fact, May 2004 will go down as the wettest May on record at Flint and Detroit. Over a 36 hour period 2 to 6 inches of rain fell across Southeast Michigan. A trained weather spotter in Armada reported the highest total, 5.8 inches. The following counties were declared a "state of disaster" due to the flooding and severe storms: Genesee, Livingston, Macomb, Oakland, Saginaw, Sanilac, St. Clair, Shiawassee, and Wayne. The Bay City State Recreation Area was forced to shut down for the first time in more than 15 years due to flooding. Over $100,000,000 of property damage was recorded in the region (Source: National Climatic Data Center Storm Event Database.)

June 10, 2005 - Mount Forest Township, Bay County. Numerous roads were washed out in Mount Forest Township (Source: National Climatic Data Center Storm Event Database.)

May 30, 2006 - Williams Township, Bay County. Strong thunderstorms dumped very heavy rain across Williams Township in the western part of Bay County. The Williams Township Supervisor reported that 3.7 inches of rain fell in parts of the township during the storm and much of that occurred in the first hour or so. A number of farm fields, even tiled ones, were overwhelmed by the large amount of rain. At least one farmer reported crop damage when his field washed out. Also, a number of homes in the Garfield Subdivision ended up with water in the basement. This event was localized and no roads or bridges were washed out in the area. Damages to crops were roughly estimated at $25K. Additional property damage was roughly estimated at $10K (Source: National Climatic Data Center Storm Event Database.)

July 22, 2008 - Bay City, Bay County. Heavy rain of 4 to 5 inches during the afternoon hours caused flash flooding across Bay City. At least a foot of standing water accumulated on Wilder Road. Several residents across Bay City also reported flooded basements. Recorded $50,000 in property damage (Source: National Climatic Data Center Storm Event Database.)

3.8.5.5 Bay County Profile

The following table summarizes the risk profile for flooding in Bay County.

Table 3.14 Bay County Profile For Flooding

Typical Impact Area	Regional/Statewide
Number of Events (1947-2010)	21
Past Damages:	$102,275,000
Annual Chance Probability Ratio	0.29
Period of Occurrence	Typically Spring, Summer, Fall
Warning Time	River flooding : 3 –5 days Flash flooding: minutes to hours Out-of-bank flooding : several hours/days
Potential Impacts	Impacts human life, health, and public safety. Utility damage and outages, infrastructure damage (transportation and communication systems), structural damage, fire, damaged or destroyed critical facilities, and hazardous material releases. Can lead to economic losses such as unemployment, decreased land values, and Agro-business losses. Floodwaters are a public safety issue due to contaminants and pollutants.

3.9 WIND DRIVEN ICE FLOES/ICE JAMS

An accumulation of ice in a river stream, or other flooding source that reduces that cross-sectional area available to carry the flow and increases the water-surface elevation.

3.9.1 Hazard Description

Ice Jams are a type of flooding hazard, designated by FEMA to be a "Special Flood Hazard". This type of hazard does not fit the national norm and is a hazard that was defined to be specific to Bay County due to the proximity to the Bay shoreline and lake effect winds. For purposes of this the plan wind driven ice floes were considered as a hazard similar to ice jams.

According to FEMA's "Special Hazards Supplement to the Community Rating System Coordinator's Manual" (Online Source Location: http://www.fema.gov/library/viewRecord.do?id=2431), when an ice jam occurs ice usually accumulates at a natural or human-made obstruction or a relatively sudden change in channel slope, alignment, or cross-section shape or depth. Ice jams are common in locations where the channel slope changes from relatively steep to mild, and where a tributary stream enters a large river. Ice jams often cause considerable increases in upstream water surface elevation, and the flooding often occurs quite rapidly after the jam forms.

In many northern regions, ice covers the rivers and lakes annually. The yearly freeze-up and break-up usually take place without major flooding. However, some communities face serious ice jam threats every year, while others experience ice-jam-induced flooding at random intervals. The former often have developed emergency plans to deal with ice jam problems, but the latter are often ill prepared to cope with a jam.

Because ice jam floods are less common and more poorly documented than open-water floods, it is more difficult to characterize these events compared to open-water flooding. In addition, because of the complex processes involved in the formation and progression of ice jams and the highly site-specific nature of these jams, these events are more difficult to predict than open-water flooding. The rates of water level rise can vary from feet per minute to feet per hour during ice jam flooding.

3.9.2 Types

There are generally two types of ice jams:

- Frazil ice freezes the river and forms a dam.
- When warm weather and rain break up frozen rivers or any time there is a rapid cycle of freezing and thawing, broken ice floats downriver until it is blocked by an obstruction such as a bridge or shallow area.

In both cases, an ice dam forms, blocking the channel and causing flooding upstream. Ice jams present three hazards:

- Sudden flooding of areas upstream from the jam, often on clear days with little or no warning.

Sudden flooding of areas downstream when an ice jam breaks. The impact is similar to a dam break and damages or destroys buildings and structures.

- Movement of ice chunks that can push over trees and crush buildings as demonstrated in the photo below.

Ice floes are a significant natural hazard to Bay County. In this photo, the movement of ice chucks over the shoreline near Brisette Beach Road threatens to damage this residence.

Ice jams tend to recur at the same locations on streams, and ice jam flood elevations have a recurrence interval just like clear water floods. Because freeze-up jams rely heavily on periods of intense cold that produce large quantities of frazil ice, they can be somewhat easier to predict than breakup jams, which are caused by a site-specific combination of complex physical processes. Evaluation of historical ice, meteorological, and hydrological records is necessary for developing a prediction method for either type of jam.

3.9.3 Facts

In a 1992 survey, the U.S. Army Corps of Engineers District and Division offices reported ice jam problems in 36 states, primarily in the northern tier of the United States. However, even mountainous regions as far south as New Mexico and Arizona experience river ice. Ice jams affect the major navigable inland waterways of the United States, including the Great Lakes. A study conducted in Maine, New Hampshire, and Vermont identified over 200 small towns and cities that reported ice jam flooding over a 10-year period. In March 1992 alone, 62 towns in New Hampshire and Vermont reported ice jam flooding problems after two rainfall episodes.

Ice jams in the United States cause approximately $125 million in damage annually, including an estimated $50 million in personal property damage and $25 million in operation and maintenance costs to navigation, flood control, and channel stabilization structures.

Bay County has suffered damage from ice jams in the past, most notably from the movement of ice chunks that have damaged trees and buildings. This hazard has been identified as **wind driven ice floes**. More specifically, wind driven ice floes are caused from wind blowing across the lake which causes the ice to move toward the land. According to interviews with residents, this has occurred approximately every forty years. Below is a description of a recent notable event that caused considerable damage in Bay County:

March 9, 2009 - Saginaw Bay, Bay County. Residents evacuated about 36 homes near the shore of Saginaw Bay (Bangor, Fraser, and Kawkawlin Townships) as wind driven ice floes crushed into houses, according to the police. Ice had entered as far as 12 feet inside some of the homes, according to troopers at the Michigan State Police post at Bay City. Troopers didn't report any injuries. Strong, persistent northeast winds caused the ice damage. National Weather Service meteorologists said winds came from the northeast – from 15 to 32 mph – for 11 consecutive hours, from 1 p.m. Sunday to midnight. The ice was moving about 20 feet every half hour (Source: Bay City Times Archives.)

3.9.4 Bay County Ice Floe Profile

The following table summarizes the data for the likelihood of an ice floe occurring in Bay County:

Table 3.15 Bay County Ice Floe Profile

Typical Impact Area	Bay front
Number of Events (1980-2010)	1
Past Damages:	N/A
Annual Chance Probability Ratio	N/A
Period of Occurrence	Spring: During thawing
Warning Time	Days
Potential Impacts	Impacts to property, utilities and human life.

3.10 SEVERE STORM

Severe storms are weather systems accompanied by strong winds, lightning, heavy rain, and possibly hail and tornadoes. The Bay County Planning Committee combined lighting, thunderstorm and severe winds into one category described as severe storm.

3.10.1 Hazard Description

A thunderstorm is formed from a combination of moisture, rapidly rising warm air and a force capable of lifting air such as a warm and cold front, a sea breeze or a mountain. All thunderstorms contain lightning and may occur singly, in clusters or in lines. Thus, it is possible for several thunderstorms to affect one location in the course of a few hours. Some of the most severe weather occurs when a single thunderstorm affects one location for an extended period time. The NWS considers a thunderstorm as severe if it develops ¾ inch hail or 50-knot (58 mph) winds.

Lightning is an electrical discharge that results from the buildup of positive and negative charges within a thunderstorm. When the buildup becomes strong enough, lightning appears as a "bolt". This flash of light usually occurs within the clouds or between the clouds and the ground. A bolt of lightning reaches a temperature approaching 50,000 degrees Fahrenheit in a split second. The rapid heating and cooling of air near the lightning causes thunder.

Additional types of severe storms include *straight line winds*. There are several terms that mean the same as straight-line winds and they are convective wind gusts, outflow and downbursts. Straight-line wind is wind that comes out of a thunderstorm. If these winds meet or exceed 58 miles per hours then the storm is classified as severe by the National Weather Service. These winds are produced by the downward momentum in the downdraft region of a thunderstorm. An environment conducive to strong straight-line wind is one in which the updrafts and thus downdrafts are strong, the air is dry in the middle troposphere and the storm has a fast forward motion.

3.10.2 Facts

Severe storms can occur at any time in Michigan, although they are most frequent during the warm spring and summer months from May through September. The potential thunderstorm threat is often measured by the number of "thunderstorm days" – defined as days in which thunderstorms are observed. Michigan is subject to 20-60 thunderstorm days per year. According to the National Weather Service (NWS) in White Lake, Michigan, the southern two tiers of counties of the Lower Peninsula (roughly the area south of Interstate 94) is subject to 40-60 thunderstorm days per year. The Lower Peninsula, in general, is subject to approximately 30-40 thunderstorm days per year, while the Upper Peninsula average is closer to 20-30 thunderstorm days per year.

3.10.3 Bay County History

Useful data for building the Bay County historical profile for severe storms was derived from the National Climatic Data Center's Storm Data website at http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvent~Storms. Other sources were utilized as well such as the Bay City Times, and the Michigan Hazard Mitigation Plan.

Listed below are descriptions of significant severe storm occurrences. Each involved damages and/or injuries as a result of lightning:

July 6, 1994 - 9 miles South West of Bay City. A few trees, large limbs, and power lines were downed by thunderstorm wind gusts in Bay City. Lightning struck two male golfers at the Twin Oaks Golf Course in Frankenlust Township, about nine miles southwest of Bay City. One of the men suffered severe burns on his right leg. In addition, a small child was hit by lightning in Bay City. At least one home caught fire as a result of a lightning strike. Three injuries were recorded (National Climatic Data Center Storm Event Database.)

June 21-July 1, 1996 - Bay County. Bay County was of 7 counties that were presidentially declared major disaster areas as a result of severe storm and flooding damage. Counties affected: Bay, Lapeer, Midland, Saginaw, Sanilac, St. Clair, & Tuscola Co (National Climatic Data Center Storm Event Database.)

May 31, 1998 - Bay County. Bay County was of 13 counties that were presidentially declared major disaster areas as a result of severe storm and high winds. Counties affected: Bay, Clinton, Gratiot, Ionia, Kent, Mason, Montcalm, Muskegon, Newaygo, Oceana, Ottawa, Saginaw, & Shiawassee Co. Bay County also received a Governor's Disaster Declaration (National Climatic Data Center Storm Event Database.)

August 29, 2004 - Bay City, City Hall. Damages: $41,000. Bay City Hall clock was struck by lightning shortly after 8 p.m. Saturday, lightning hit the tower, causing a surge that fried the clock and knocked out the city's computer and telephone system, causing about $41,000 in damage (Source: Bay City Times Archives.)

June 5, 2005 - Bay City. Lightning damaged a home on Stark Road off South Euclid Avenue. A potent storm system moved in from the upper Mississippi Valley on the 5th, placing southeast Michigan in the warm sector. Maximum temperatures climbed into the lower 90s, coupled with dew points near 70, lead to a very unstable air mass. High winds took down tree limbs and knocked out power to about 107,000 DTE Energy customers throughout Southeast Michigan (Source: National Climatic Data Center Storm Event Database.)

July 24, 2005 - 1 Mile East of Essexville. Damages: $50,000. Lightning struck a home in Hampton Township, which resulted in a fire. The fire extensively damaged the outside of the house and the second floor. An MCS developed over Wisconsin and progated into southeast Michigan during the morning of the 24th. The thunderstorm complex was moving at 50 mph, which helped produce severe thunderstorm wind gusts north of I-69 (National Climatic Data Center Storm Event Database.)

June 30, 2006 - Bangor Township, Bay County. Damages: $10,000. Lightning struck a tree, channeled through a dog run, and into a house on Wilder Rd in Bangor Township, destroying most of the electrical equipment in the home. Total damage was estimated at $10,000. There were numerous reports of large tree limbs and trees downed. Also, several hail reports were received, with the largest hail being reported as the size of quarters (National Climatic Data Center Storm Event Database.)

July 17, 2006 - Bay City, Bay County. In the Bay City area, about 200 Bay City Electric Department customers and 2,080 Bay City area Consumers Energy customers lost power overnight as a result of the high winds and lightning (Bay City Times Archives.)

October 3, 2006 - Bay County. Damages: $3,000. The lightning and rainstorms that blew through Bay County overnight left around 865 Consumers Energy customers without power today. The power went out for people in about 25 areas including 104 in Pinconning, 166 in Linwood, 118 in Bay City's northeast area and 219 in Bay City's northwest area, according to Consumers' spokesman Terry Dedoes. There also were about 130 in the Grayling area affected by the power outage. Lightning also struck a home causing $3,000 in damage (Bay City Times Archives.)

A summary of Severe Storm Events involving High Winds that have affected Bay County can be found in **Appendix G**.

The list below provides more detailed information regarding these severe storm hazard events:

December 1, 1972 - Bay County. Presidential Major Disaster Declaration due to severe storms and flooding. Counties affected: Arenac, Bay, Berrien, Iosco, Macomb, Monroe, St. Clair, Tuscola, & Wayne Co.

April 12, 1973 - Bay County. Presidential Major Disaster Declaration due to severe storms and flooding. Counties affected: Arenac, Bay, Berrien, Huron, Iosco, Macomb, Menominee, Monroe, Saginaw, Sanilac, St. Clair, Tuscola, Van Buren, & Wayne Co.

J**uly 6, 1994 - 9 miles South West of Bay City. 3 injuries**. A few trees, large limbs, and power lines were downed by thunderstorm wind gusts in Bay City. Lightning struck two male golfers at the Twin Oaks Golf Course about nine miles southwest of Bay City. One of the men suffered severe burns on his right leg. In addition, a small child was hit by lightning in Bay City. At least one home caught fire as a result of a lightning strike (National Climatic Data Center Storm Event Database.)

August 23, 1993 - Bay City, Bay County. A few large trees were blown down by gusty thunderstorm winds. A large oak tree was blown down, and strong thunderstorm winds took down all the power lines in the 900 block of South Otillia St. (National Climatic Data Center Storm Event Database.)

August 27, 1993 - Pinconning. Damages: $50,000. Power lines were knocked down by strong thunderstorm wind gusts (National Climatic Data Center Storm Event Database.)

June 28, 1994 - Bay City, Bay County. Strong thunderstorm wind gusts snapped off tree limbs which brought down power lines in Bay City (National Climatic Data Center Storm Event Database.)

July 6, 1994 - Bay City, Bay County. 2 injuries. A few trees, large limbs, and power lines were downed by thunderstorm wind gusts in Bay City. Lightning struck two male golfers at the Twin Oaks Golf Course about nine miles southwest of Bay City. One of the men suffered severe burns on his right leg. In addition, a small child was hit by lightning in Bay City. At least one home caught fire as a result of a lightning strike (National Climatic Data Center Storm Event Database.)

March 25, 1996 - Bay County. Damages: $65,000. A strong low pressure area tracked across northern Michigan during the morning on the 25th, with the cold front passing through southeast Michigan during the afternoon on the 25th. Strong winds associated with the front ripped the roof off of a car wash in Redford, ripped the roof off of a mobile home in Midland, uprooted a large tree and toppled it onto the roof of a house in Ferndale and shattered windows at a high-rise building in Detroit. In addition, downed power lines resulted in outages to about 10,000 Detroit Edison customers throughout southeast Michigan. The peak wind gust at Detroit's Metro Airport was 54 mph (National Climatic Data Center Storm Event Database.)

October 30, 1996 - Southeast Michigan. Damages: $90,000. An intense low pressure system tracked north of Lake Superior on the 30th, with its trailing cold front crossing southeast Michigan during the early morning hours. High winds associated with the front did widespread damage. Through the day, high winds downed trees and power lines, causing outages throughout southeast Michigan. Detroit Edison reported outages to 70,000 customers. Elsewhere, large trees blew over, crashing through the roofs of houses at Detroit Beach in Monroe County and in Ann Arbor (Washtenaw county) (National Climatic Data Center Storm Event Database.)

February 27, 1997 - Southeast Michigan. Damages: $20,000. Strong winds developed during the morning of the 27th in the wake of low pressure tracking off to the east. Peak winds reached 59 mph at Detroit's metro airport. Large trees were toppled in Monroe County, and scaffolding crashed down onto two parked cars in downtown Port Huron, in Saint Clair County. In Oakland County, 4,500 Detroit Edison customers reported power outages, as tree branches and power lines were knocked down by the winds (National Climatic Data Center Storm Event Database.)

April 6, 1997 - Southeast Michigan. 1 Injury. Damages: $1,200,000. A strong cold front tracked across southeast Michigan during the late afternoon on the 6th. Very strong west to southwest winds accompanied the frontal passage, and then continued through the night. Gusts to 70 mph were estimated in a few spots during the late afternoon. In Belleville, about 15 miles southwest of Detroit, a 34-pound four-year-old girl was blown several feet through the air, landing on the driveway by her house. She suffered a head wound that required stitches. Elsewhere, a five-story high metal frame for a building under construction in Ferndale was blown down, and two concrete walls under construction for an Ethan Allen furniture store were caved in at Sterling Heights. In the thumb area, a large barn collapsed near Deckerville, damaging several thousand dollars of farm equipment inside, and a large cable TV tower was toppled near Port Hope. The wind damaged trees and power lines throughout southeast Michigan, resulting in a power loss to 125,000 customers (National Climatic Data Center Storm Event Database.)

July 14, 1997 - Auburn, Bay County. An approaching cold front combined with a very warm unstable air mass to trigger severe thunderstorms during the afternoon on the 14th. There was very little property damage reported. Strong winds mainly resulted in downed trees and power lines. Golf ball-sized hail was reported at Newport, and nickel-sized hail was reported at Grosse Pointe Woods and at Fargo (National Climatic Data Center Storm Event Database.)

April 1, 1998 - Bay City, Bay County. A fast-moving line of showers with embedded thunderstorms crossed southeast lower Michigan in association with a cold front. A power pole was downed in Bay City. In Flint, power lines were downed, and the roof was blown off of a small outbuilding. Signs were blown down and a barn was destroyed in southwest Tuscola County. The wind gusted to near severe levels across much of southeast lower Michigan (National Climatic Data Center Storm Event Database.)

April 9, 1998 - Bay County. Damages: $4,000. Strong northeast winds produced some problems near the lakeshores of Bay and Macomb Counties. From late morning through late afternoon, gusts off of Saginaw Bay along the Bay County shore reached near 50 mph. A large tree was downed onto a minivan, destroying it. Power lines were downed, causing 110 Consumers Power customers to lose power. These winds also produced lakeshore flooding in Bay County. The yards of about a dozen homes were flooded, as were many lakeshore parks. A mobile home park saw some minor flooding. Most of the problems were located in Bangor Township. However, significant beach erosion also took place near Pinconning. A portion of a county park parking lot was swallowed by Saginaw Bay. Some lakeshore roads saw high water as 6-foot waves came crashing over seawalls (National Climatic Data Center Storm Event Database.)

May 29, 1998 - 5 miles south east of Bay City, Bay County. A weak cold front was oriented west to east across northern lower Michigan. A mesoscale convective system developed over the upper Mississippi Valley on the 28th, and stayed just south of the front as it crossed lower Michigan from west to east during the early morning hours of the 29th. Pockets of wind damage were associated with these storms in the Saginaw Valley and Thumb areas. Most of the wind damage was composed of downed trees and power lines. A spotter in nearby Akron estimated wind gusts of 80 mph. The only severe hail that morning came from a storm near the Tuscola-Sanilac county line. A National Weather Service employee estimated 70 mph winds near Marlette, with significant tree damage (National Climatic Data Center Storm Event Database.)

May 31, 1998 - Bay County. 1 death. Damages: $1,250,000. Wind speeds were extremely high aloft, with 65 mph winds located less than a half mile above ground level. Thunderstorms developed in the northern Plains during the afternoon of the 30th. The storms organized and accelerated as they headed east. The thunderstorms caused some of the most widespread wind damage events in state history. In Pinconning in Bay County, a woman was killed when a tree fell on her home as she slept. Most of the damage done to structures was caused by falling trees. Damage was widespread in Bay County. Bay City was especially hard hit, with many trees down and a gas main broken. The city clock tower had one of its faces torn off, and the drawbridge across the Saginaw River had all four gates snapped off. The Coast Guard Station in nearby Essexville recorded an 81 mph wind gust. Eleven thousand Bay City area residents were without power at the height of the storm. Crews were still cleaning up debris almost two months after the storms went through. Public damage alone was estimated at $610,000. President Clinton declared Bay County a Federal Disaster Area (National Climatic Data Center Storm Event Database.)

June 2, 1998 - Bay County. A cold front moved east across southeast Michigan early in the afternoon. West to northwest winds behind the cold front gusted as high as 40 mph. Some tree limbs and power lines, undoubtedly weakened by the severe weather two days previous, came down. Detroit Edison estimated that 40,000 customers lost power, and Consumers Energy reported that the gusty winds put the restoration of electrical service from the May 31st storms behind schedule (National Climatic Data Center Storm Event Database.)

July 14, 1998 - 1 mile north east of Bay City. Storms moved southeast from Northwest Wisconsin, crossing Lake Michigan by early afternoon. Abundant sunshine allowed the atmosphere to become very unstable in southeast Michigan, and the storms pulsed to severe levels as they crossed the Saginaw Valley during the afternoon and early evening hours. Quarter sized hail was reported in Midland and Saginaw Counties. A county sheriff reported 58 mph winds near Bay City. Along Corunna Road (M-21) in Flint Township, power lines were downed, and a construction trailer was moved off of its foundation. Training of thunderstorms produced some marginal flash flooding in and just west of the city of Saginaw. Up to three inches of rain fell in this area in less than two hours. Numerous underpasses and several city streets were flooded as a result (National Climatic Data Center Storm Event Database.)

November 10, 1998 - Southeast Michigan. Damages: $1,100,000. A very intense storm system moved north across the western Great Lakes on the 10th. Winds reached high wind criteria across southeast Michigan early in the afternoon of the 10th, associated with a cold front racing east across the state. A line of showers accompanied the front, locally enhancing wind speeds. High winds caused significant damage across the area. In the afternoon, the walls of a church under construction were destroyed in Troy. A warehouse in Flint was reroofed, and a second warehouse roof was damaged. Large tree limbs were downed in Saginaw. Wind speeds approaching 50 mph were measured at the Coast Guard Station in Port Huron. Damage was more widespread with the higher wind speeds that occurred at night. Trees, limbs, and power lines were downed across all of southeast Michigan. The falling trees and limbs caused damage to some homes and vehicles. The extended period of strong winds caused interesting phenomena on Saginaw Bay. Southwest gales occurred over the waters of Saginaw Bay for 12 to 18 hours, acting to push water out of the bay and into the main body of Lake Huron. Water levels in Saginaw Bay dropped dramatically as a result. Previous to the storm, the water level was running about 18 inches above chart datum. Any level lower than about 4 inches above chart datum begins to interfere with navigation on Saginaw Bay. At about 5 am on the 11th, the water level on Saginaw Bay bottomed out at an amazing 50 inches below chart datum - over 5 feet below the recent average! Most of Saginaw Bay is quite shallow, and the removal of over 5 feet of water exposed a huge portion of the bay bed; some estimate that up to half of the area of the bay briefly became dry land during the storm (National Climatic Data Center Storm Event Database.)

May 6, 1999 - Southeast Michigan. Damages: $92,000. A strong low pressure system drifted east across the upper Mississippi Valley during the day. Strong south winds ahead of the low brought warm, moist, and somewhat unstable air into Michigan. These winds were at times enhanced by scattered showers in the area, as well as by a strong cold front that pushed across southeast Michigan late in the afternoon. Sustained winds of 20 to 30 mph were common, with occasional gusts in excess of 40 mph. The gusts were sufficient to down trees in Blissfield, Adrian, Howell, Flint, and Bay City. The worst damage occurred in the northeast side of the city of Saginaw, where a furniture store was reroofed. One of the storms briefly produced a tornado that crossed from Lapeer into Tuscola County. The tornado moved across open farmland, and did no damage other that throwing some dirt around. However, the tornado was observed by numerous eyewitnesses (National Climatic Data Center Storm Event Database.)

July 24, 1999 - Bay City, Bay County. Damages: $90,000. An upper level disturbance crossed the Great Lakes region from northwest to southeast, igniting thunderstorms along its path. The thunderstorms evolved into a squall line as they moved across southeast Michigan. Instability was high on this warm and humid summer day, allowing many of the storms to become severe. Unlike the previous day, severe reports were almost evenly split between large hail and damaging wind. Most of the damaging wind gusts took down trees, tree limbs, utility poles, and power lines. However, the marine community felt the brunt of the severe thunderstorm winds in two separate incidents. A large number of sailboats were returning to the Bay City Yacht Club after a competition on Saginaw Bay, when the line of storms struck. As many as a dozen boats were capsized, with two sailboats demasted. The largest hail of the day, golf ball sized, was reported in Kawkawlin, Bay City, Zilwaukee, and Southfield. In Bay City, the large hail fell on the exposed mariners, causing welts and bruises to at least two (National Climatic Data Center Storm Event Database.)

May 9, 2000 - Kawkawlin, Bay County. Damages: $5,000. Thunderstorms erupted at night across lower Michigan; several became severe, producing damaging wind gusts. Most of the damage was in the form of trees, tree limbs, and power lines downed. The most substantial damage was in Washtenaw County. In Ann Arbor, falling trees crushed two cars. All told, over 40,000 people in southeast Michigan lost power at some point during the storms (National Climatic Data Center Storm Event Database.)

August 9, 2000 - Bay City, Bay County. Damages: $7,000. A tree was downed in Bay City, and large limbs were downed in Bay City and near Essexville. A spotter estimated 60 mph winds just east of Essexville (National Climatic Data Center Storm Event Database.)

June 9, 2001 - 6 Miles West of Pinconning. Damages: $2,000. A large tree was downed. Thunderstorms developed in northern lower Michigan along lake breeze boundaries. The storms moved southeast toward Saginaw Bay, producing wind damage in a couple of spots (National Climatic Data Center Storm Event Database.)

August 19, 2001 - 2 miles south of Bay City. Several large limbs blown down. An upper level low pressure system moved across the southern Great Lakes region. The cold air aloft with this low created enough instability to trigger scattered thunderstorms, most of which produced hail. A shower over the relatively warm waters of Lake Huron produced a waterspout, which moved onshore as a tornado (National Climatic Data Center Storm Event Database.)

September 7, 2001 - Bay City, Bay County. A cold front slowly approached the western Great Lakes region on Sep. 7th and 8th. Warm and unstable air ahead of this front, in combination with weak upper level disturbances, allowed thunderstorms to develop during the afternoon and evening hours both days. Most of the thunderstorms that developed over this three-day period produced severe wind gusts. The most common type of wind damage from these storms was trees being blown down or broken. Some of the storms also produced torrential rainfall. However, the rainfall did not last long enough to produce widespread or serious flooding (National Climatic Data Center Storm Event Database.)

November 25, 2001 - 2 miles north west of Linwood. Damages: $5,000. Law enforcement reported that part of a barn roof with wires on it was blown onto Anderson Road between Mackinaw and Fraser Roads. They also reported that a couple of trees had been blown down in the same area. During the afternoon and evening of the 24th, a deep low pressure system moved from the central plains into the western Great Lakes region. Ahead of this storm system, a strong cold front moved through southeast Michigan late in the evening of the 24th and early in the morning of the 25th. Gusty winds and scattered thunderstorms accompanied the passage of this frontal boundary. A few of the thunderstorms, in combination with the already gusty surface winds, produced damaging wind gusts (National Climatic Data Center Storm Event Database.)

February 1, 2002 - Southeast Michigan. 1 injury. Damages: $30,000. A low pressure system moved across southeast Michigan early in the morning on the 1st. Once the low moved east of the region it strengthened and created strong winds across the southern Great Lakes. Maximum wind gusts were around 45 miles an hour. The strong winds tore a seam in the Teflon-covered fabric of the dome on the Mulligan's Golf Center in Auburn Hills, which houses an indoor driving range and 18-hole miniature golf course. 40 golfers were inside at the time. One person sustained a minor ankle injury during the collapse (National Climatic Data Center Storm Event Database.)

March 9, 2002 - Southeast Michigan. 2 injuries. Damages: $780,000. A very strong cold front moved across southeast Michigan during the late afternoon hours of the 9th. A line of showers developed along the cold front. Very strong winds and brief heavy rain were associated with these showers. Behind the line of showers, powerful winds brought much colder air into the region. A low pressure system, which moved across the northern Great Lakes during the afternoon of the 9th, strengthened during the evening as it moved northeast of the region. This allowed the strong winds to continue into the early morning hours of the 10th. In addition to the winds, temperatures dropped from the 50s to the 20s by late evening. Wind gusts measured between 60 and 70 MPH affected southeast Michigan during the passage of the cold front. Hundreds of trees, power lines and utility poles were blown down across southeast Michigan. Falling trees caused damage to several homes throughout the region. High winds also tore roofing material and siding off of many homes and businesses. Falling trees and branches also struck a few cars. An estimated 180,000 homes and businesses across southeast Michigan lost power due many powers lines being blown down. In Bay County, the large statue and sign at the Big Boy restaurant on North Euclid Ave. toppled over onto the parking lot, causing damage to a pickup truck (National Climatic Data Center Storm Event Database.)

April 18, 2002 - 2 miles south west of Bay City. A trained weather spotter reported an estimated wind gust to 60 MPH at the intersection of I-75 and M84. A cold front moved across the Great Lakes region during the morning of the 19th. Thunderstorms moved into southeast Michigan ahead of the cold front shortly after midnight. A few of these storms produced damaging winds and large hail. The cold front broke a week-long period of record or near record high temperatures across the region (National Climatic Data Center Storm Event Database.)

August 13, 2002 - Essexville, Bay County. Trained spotters reported several large trees and power lines blown down in thunderstorm winds. An upper level disturbance moved into Lower Michigan and in combination with a humid and unstable air mass over the area, triggered numerous thunderstorms, mainly north of a Brighton to Bad Axe line. Some of the more widespread thunderstorms occurred across Tuscola County where thousands of people were left without power (National Climatic Data Center Storm Event Database.)

September 19, 2002 - 5 miles south west of Bay City. Damages: $25,000. Law enforcement reported that several large trees were blown down and that several garage doors were blown in due to thunderstorm winds. An upper air disturbance moved across Lower Michigan during the late afternoon and evening hours on the 19th. This disturbance combined with unseasonably warm and humid air across Lower Michigan to trigger widespread thunderstorms. These thunderstorms initially moved into the Saginaw Valley during the late afternoon hours. During the evening, another round of thunderstorms moved from south to north across the region. Some of these thunderstorms were severe with damaging wind gusts (National Climatic Data Center Storm Event Database.)

June 8, 2003 - Bay City, Bay County. Law enforcement reported a large tree blown down. A strong upper level low moved across southern Michigan during the early evening of the 8th. This system triggered numerous thunderstorms across the region, some of which produced damaging winds and large hail. Three tornadoes also occurred during the evening. Commemoration ceremonies to mark the 50th anniversary of the deadliest tornado in Michigan history (one of the top ten in U.S. history) was ongoing in Beecher, north of Flint in Genesee County. Ironically, a tornado struck the southern portion of Genesee County at the same time the commemoration ceremonies were underway (National Climatic Data Center Storm Event Database.)

June 28, 2003 - Bay City, Bay County. Damages: $1,000. Thunderstorm winds blew several trees down and knocked a porch wall down. A low pressure system moved through western and northern Lower Michigan on the 28th. Thunderstorms developed early in the day over Lake Michigan and continued to develop along a warm front which was draped across the Tri Cities and Thumb region during the early afternoon. The warm front moved north of the area, and was then followed by a cold front which pushed through Southeast Michigan during the early evening. Marginally severe winds and hail occurred with this system (National Climatic Data Center Storm Event Database.)

July 6, 2003 - Bay City, Bay County. Damages: $6,000. Several large trees were blown down. One tree fell onto the roof of a home. Another tree fell onto a parked van. A thunderstorm complex developed over southern WI and northern IL on the 6th. These storms moved into southeast Michigan during the evening hours. The environment was most unstable over the Saginaw valley and thumb regions. Thus, most of the severe wind events were north of I-69 (National Climatic Data Center Storm Event Database.)

November 12, 2003 - Southeast Michigan. Damages: $21,000,000. A strong low pressure system moved across the straits on the evening of the 12th, moving into Ontario overnight as it deepened to 974 mb. Strong cold advection and a tight pressure gradient over Lower Michigan produced wind gusts between 50 and 60 MPH across all of Southeast Michigan. In addition, there were even a few wind gusts reported between 60 and 88 mph. The highest wind gust was reported by a spotter in Dexter who recorded an 88 mph gust. An estimated 250,000 customers lost power in southeast Michigan, as widespread trees and power lines were blown down (National Climatic Data Center Storm Event Database.

April 19, 2004 - Southeast Michigan. 1 injury. A strong cold front moved through southeast Michigan during the early afternoon hours of the 19th, producing damaging wind gusts which brought down numerous trees and power lines throughout the region. The highest measured wind gust of 73 mph was reported by a trained weather spotter 2 miles southeast of Bad Ave. Trained weather spotters also estimated wind gusts over 60 mph in Roseville and Shelby Township. On the west side of Saginaw, a large tree fell onto a moving vehicle driven by a 19-year-old man. The man was driving north on South Mason Street just south of Adams Street. The driver suffered a fractured skull as a result of the impact of the 50-foot tree with a 3-foot-thick trunk. The tree snapped at its base due to the strong winds. Consumers Energy reported more than 3,600 customers losing power In the Tri-Cities region (National Climatic Data Center Storm Event Database.)

May 17, 2004 - Kawkawlin, Bay County. An upper level disturbance tracked northeast from Nebraska during the early morning hours of the 17th. As this disturbance encountered the deeper moisture plume that was established across the northern Ohio Valley region, thunderstorms initiated prior to midday, and then progressed northeastward into southeast Michigan. Numerous trees and power lines down. Part of the roof of the Fire Department was also blown off (National Climatic Data Center Storm Event Database.)

June 13, 2004 - Bay City, Bay County. A trained weather spotter reported large tree limbs down. The front that moved through our area on Wednesday June 9th maintained its identity and began to move north as a warm front during the afternoon of the 13th. The first cell of the day became a long-lived supercell. This storm moved through the Midland and Bay City areas, over the south end of Saginaw Bay, and into Huron County before moving out over the open waters of Lake Huron. Later in the afternoon and during the evening a nearly solid line of storms developed along a north-south surface trough over western lower Michigan. These storms developed bowing characteristics as they moved into southeast Michigan and generated some straight-line wind damage. The Midland Fire Department called out two extra crews to answer about 30 storm-related calls of downed wires, broken utility poles and fallen trees. At least two trees crashed into homes (National Climatic Data Center Storm Event Database.)

July 13, 2004 - 1 mile south of Linwood. A large tree was reported blown down on M-13. A cold front moved through southeast Michigan during the evening hours of the 13th, producing both hail and wind damage (National Climatic Data Center Storm Event Database.)

August 2, 2004 - 4 miles west of Bay City. Local law enforcement reported trees and power lines blown down. A cold front moved through southeast Michigan during the evening of the 2nd, producing both hail and wind damage (National Climatic Data Center Storm Event Database.)

August 29, 2004 - Bay City, City Hall. Damages: $41,000. Bay City Hall clock was struck by lightning shortly after 8 p.m. Saturday, lightning hit the tower, causing a surge that fried the clock and knocked out the city's computer and telephone system, causing about $41,000 in damage (National Climatic Data Center Storm Event Database.)

October 30, 2004 - Southeast Michigan. Damages: $3,500,000. A strong low pressure system tracked through Lake Superior during the 30th, with the associated cold front moving through southeast Michigan during the morning hours. Strong cold advection and a tight pressure gradient lead to high winds during the afternoon hours. Wind gusts of 60 mph lead to widespread power outages, downed trees and wires, along with some minor property damage throughout all of southeast Michigan. Utility companies reported power outages to 283,000 customers across lower Michigan, with at least half that total coming from southeast Michigan, where damage was estimated to be 3.5 million dollars. Here are some official winds gusts recorded across the region: Detroit Metro, 56 mph at 330 PM EST. Ann Arbor, 56 mph at 223 PM EST. Howell, 55 mph at 100 PM EST. NWS White Lake, 55 mph at 130 PM EST. Ypsilanti, 55 mph at 250 PM EST. Monroe, 54 mph at 115 PM EST. Detroit City, 52 mph at 307 PM EST. Flint, 51 mph at 100 PM EST. Unofficial wind gust reports from spotters indicated winds approaching 70 mph. There were no reported injuries with this event (National Climatic Data Center Storm Event Database.)

June 5, 2005 - Bay City, Bay County. Lightning damaged a home on Stark Road off South Euclid Avenue. A potent storm system moved in from the upper Mississippi Valley on the 5th, placing southeast Michigan in the warm sector. Maximum temperatures climbed into the lower 90s, coupled with dew points near 70, lead to a very unstable air mass. High winds took down tree limbs and knocked out power to about 107,000 DTE Energy customers throughout Southeast Michigan (National Climatic Data Center Storm Event Database.)

June 14, 2005 - 3 Miles East of Auburn. Local law enforcement reported power lines and a tree down. A strong cold front moved through southeast Michigan during the peak heating of the day. Severe weather was reported in every county along and north of M-59 (National Climatic Data Center Storm Event Database.)

June 30, 2005 - Bay City, Bay County. The National Weather Service received reports of a downed tree with an 8-inch diameter on West Saginaw Road between Three Mile Road and Delta Road, and siding that had been blown off a building and medium-sized trees down in the St. Paul Frankenlust Cemetery. Damage also was reported to private hangars at James Clements Airport in Bay City, and lightning sparked a house fire in Hampton Township. The storm knocked out power in several areas Consumers Energy this morning said there were 400 customers still without power in Bay County (National Climatic Data Center Storm Event Database.)

July 24, 2005 - 1 Mile East of Essexville. Damages: $50,000. Lightning struck a home in Hampton Township, which resulted in a fire. The fire extensively damaged the outside of the house and the second floor. An MCS developed over Wisconsin and progated into southeast Michigan during the morning of the 24th. The thunderstorm complex was moving at 50 mph, which helped produce severe thunderstorm wind gusts north of I-69 (National Climatic Data Center Storm Event Database.)

July 24, 2005 - Bay City, Bay County. Damages: $20,000. A thunderstorm wind gust snapped a tree in half. Four private hangers at James Clements Airport also sustained damage. An MCS developed over Wisconsin and progated into southeast Michigan during the morning of the 24th. The thunderstorm complex was moving at 50 mph, which helped produce severe thunderstorm wind gusts north of I-69 (National Climatic Data Center Storm Event Database.)

November 15, 2005 - Southeast Michigan. Damages: $7,200,000. Thunderstorms developed within the warm sector as the cold front approached from the west. Intense cloud to ground lightning was observed and one storm actually became severe in Monroe County, where a tree fell onto a road. The cold front pushed through during the evening, leading to another period of strong winds, occurring through the early morning hours. Southwest winds were sustained at 25 to 35 mph, gusting to around 50 mph, with the exception Huron County, where wind gusts estimated near 60 mph brought down trees along the lakeshore from Caseville to Grindstone City. Heavy rains also occurred across the region, and the combination of winds and rain led to property damage estimated at 7.2 million dollars. At 430 EST on the 16th, one man was killed (indirect) and another injured (indirect) in a vehicle collision caused by a tree that had fallen into the road (Grange Hall Road near Brandt Road in Groveland Township) due to the strong gusty winds (National Climatic Data Center Storm Event Database.)

March 13, 2006 - Southeast Michigan. 1 fatality, 2 injuries. A very deep low pressure system moved northeast across northern Lake Michigan early on the evening of the 13th. Damaging winds sustained from 30 to 40 MPH with frequent gusts over 50 MPH began during the late afternoon of the 13th and continued until 0300 EST on the 14th. The combination of the strong winds and a saturated ground led to large trees being uprooted across the entire area. Many homes and other structures received wind damage to the roofs and windows. The hardest hit areas extended along and north of the M59 corridor. A large Oak tree fell onto a moving Ford F-150 pick-up truck at 1436 EST on Sherwood Road in Brandon. The tree crushed the cab of the truck killing a 25 year old male passenger. Another passenger (female) and the driver (male) were seriously injured. Here are some of the highest wind gusts recorded at official weather stations across the region: Saginaw (Saginaw) 53 MPH NWS White Lake (Oakland) 52 MPH Adrian (Lenawee) 48 MPH Flint (Genesee) 47 MPH Detroit Metro (Wayne) 47 MPH Note: Estimates from spotters in combination with the amount of damage, suggested wind speeds approaching 60 MPH at times (National Climatic Data Center Storm Event Database.)

May 30, 2006 - Bangor Township, Bay County. Damages: $10,800. Lightning struck a tree, channeled through a dog run, and into a house on Wilder Rd in Bangor Township, destroying most of the electrical equipment in the home. Total damage was estimated at $10,000. There were numerous reports of large tree limbs and trees downed. Also, several hail reports were received, with the largest hail being reported as the size of quarters. 3 miles northwest of Auburn, a trained spotter reported that several 2 to 4 inch diameter tree limbs were blown down near Auburn by thunderstorm winds. (National Climatic Data Center Storm Event Database.)

July 17, 2006 - Bay City, Bay County. In the Bay City area, about 200 Bay City Electric Department customers and 2,080 Bay City area Consumers Energy customers lost power overnight as a result of the high winds and lightning (Bay City Times Archives.) Central dispatch reported trees blown down in Bay City (National Climatic Data Center Storm Event Database.)

October 3, 2006 - Bay County. Damages: $3,000. Lightning and rain storms blew through Bay County overnight leaving around 865 Consumers Energy customers without power. The power went out for people in about 25 areas including 104 in Pinconning, 166 in Linwood, 118 in Bay City's northeast area and 219 in Bay City's northwest area, according to Consumers' spokesman Terry Dedoes. There also were about 130 in the Grayling area affected by the power outage. Lightning also struck a home causing $3,000 in damage (Bay City Times Archives.)

October 4, 2006 - Kawkawlin, Bay County. A line of thunderstorms developed way out ahead of a cold front and dropped southeast into the Saginaw Valley and Thumb. This late season event occurred at night with intense lightning strikes and damaging wind gusts (National Climatic Data Center Storm Event Database.)

May 15, 2007 - 1 mile north of Essexville, Hampton Township. Damages: $1,502,000. The first major severe weather event of the season resulted in widespread reports of wind damage and large hail. Numerous reports of wind damage were received in a swath stretching from a Jackson/Adrian line, northeast to a Flint/Imlay City line. High winds toppled a coal stacker at the Karn-Weadock power plant in Hampton Township. The stacker was damaged the afternoon of May 15. A plant spokesman estimated wind gusts at 80 MPH. Total damages were estimated at roughly $1.5M (National Climatic Data Center Storm Event Database.)

June 27, 2007 - 6 miles south west of Bay City. Numerous waves of thunderstorms affected southeast Michigan during the afternoon and evening of June 27, 2007. Severe storms developed along and ahead of a cold front, which dropped south through a very warm and humid airmass. There were numerous reports of wind damage and hail. Saginaw County received two separate rounds of severe weather, producing hail to one-inch in diameter and a number of reports of trees and power poles blown down by winds. Flooding was also a concern, as some areas were repeatedly affected by complexes of storms. Northern Shiawassee County received the worst flooding, with National Weather Service radar estimating up to six inches of rainfall in just a few hours (National Climatic Data Center Storm Event Database.)

July 9, 2007 - 3 miles north east of Bentley. A cold front slowly crawled south through the lower peninsula of Michigan. Plenty of sunshine broke out over the Tri-Cities and sent temperatures to near 90 degrees. The atmosphere became unstable and the stage was set for severe thunderstorms to develop. Thunderstorms developed shortly after noon and were intense, but short-lived. The event only lasted a couple of hours and the last warning was canceled shortly after 1600 EST as the northernmost storms moved out over Lake Huron, and the southernmost storms weakened rather rapidly. Most of the events with this episode were marginally severe with one solid severe event in northern Bay County (National Climatic Data Center Storm Event Database.)

August 22, 2007 - 5 miles north west of Bay City. This late August event marked the beginning of a very active 3 day stretch of severe weather. A large complex of thunderstorms moved northeast across Lake Michigan during the afternoon and eventually swept through the Flint and Saginaw areas late in the evening of the 22nd. Despite the less than ideal late evening timing, the formidable thunderstorm winds led to numerous reports of trees down (National Climatic Data Center Storm Event Database.)

August 22, 2007 - 1 mile north east of Bay City. Damages: $8,000. Law enforcement reported large tree branches down at Lincoln Ave and 5th Street. There were also reports of numerous wires down and a couple of blown transformers across the Bay City area.

August 23, 2007 - Bay City, Bay County. This severe thunderstorm event was day two of a three consecutive day stretch of severe weather across Southeast Michigan. It also featured the first tornado of the season. The event began with a thunderstorm in Midland County that moved east across the Thumb. This storm prompted the issuance of several tornado warnings, but other than a few funnel cloud and large hail reports, there was only one report of damage. This occurred near Argyle in northwestern Sanilac County and based on funnel cloud reports/photographs, tree damage, and radar signatures, it was confirmed as an EF0 tornado. At the same time this was occurring, a very fast moving squall line with a history of producing damaging wind gusts was approaching the lower half of Southeast Lower Michigan. Although the squall line became less organized and slowed its forward progress dramatically, it still produced numerous reports of wind damage across the area (National Climatic Data Center Storm Event Database.)

June 6, 2008 - 2 miles north east of Duel. Damages: $2,000. A cold front moved through southeast Michigan during the early evening hours of June 6th. With temperature climbing into the lower 90s during the afternoon, the air mass became quite unstable, leading to numerous severe thunderstorms which produced damaging winds. The strongest thunderstorm winds occurred at Howell and Saginaw, where winds reached at least 70 mph. As such, Saginaw saw the greatest amount of damage and power outages, with 12,000 residents losing electricity (National Climatic Data Center Storm Event Database.)

June 15, 2008 - 1 mile south west of Bay City. Two rounds of thunderstorms affected southeast Michigan, one during the early afternoon hours, with the second round occurring during the evening hours associated with a cold front. Trees reported down at Marquette and Truman Parkway (National Climatic Data Center Storm Event Database.)

July 22, 2008 - 3 miles west of Crump. Damages: $8,000. An upper level disturbance triggered a few severe thunderstorms north of I-69. Trees and power lines reported down (National Climatic Data Center Storm Event Database.)

December 28, 2008 - Southeast Michigan. A rapidly deepening low pressure system tracked northeast from northern Lake Michigan, sending a strong cold front through southeast Michigan. Winds gusts of 50 to 65 mph behind the cold front lead to widespread tree branches and trees downed, along with extensive power outages, as more than 400,000 Michigan homes and businesses lost power. The majority of those customers who lost power were located in the Detroit Metro Area (National Climatic Data Center Storm Event Database.)

3.10.4 BAY COUNTY PROFILE

The following table summarizes the profile for Bay County for Severe Storms:

Table 3.16 Severe Storm Profile

Period of Occurrence 1960-2010	**Spring-Fall**
Number of Events	127
Past Damages:	$38,737,800
Annual Chance Probability Ratio	2.54
Warning Time	Minutes to hours
Potential Impacts	Utility damage and outages, infrastructure damage (transportation and communication systems), structural damage, fire, damaged or destroyed critical facilities, and hazardous material releases. Impacts human life, health, and public safety

3.11 HAIL STORMS

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

3.11.1 Hazard Description

Hail is a product of the strong thunderstorms that frequently move across the state. As one of these thunderstorms passes over, hail usually falls near the center of the storm, along with the heaviest rain. Sometimes, strong winds occurring at high altitudes in the thunderstorm can blow the hailstones away from the storm center, causing an unexpected hazard at places that otherwise might not appear threatened.

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

3.11.2 Facts

Hail is produced by thunderstorms when significant updrafts among the clouds allow for the formation of ice pellets that then fall with the heavy rains. Hail can be especially damaging to crops, home roofs, and automobiles. Approximately $1 billion in damages occurs annually across the United States. In Michigan, there is usually at least one intense hailstorm per year causing significant damages. Notably, in 2000, severe storms produced over $60 million in hail damage to property in and around Marquette. Unfortunately, for many hailstorms, the total damages to property go unreported.

The National Weather Service began recording hail activity in Michigan in 1967. Statistics since that time indicate that approximately 50% of the severe thunderstorms that produce hail have occurred during the months of June and July, and nearly 80% have occurred during the prime growing season of May through August. As a result, the damage to crops from hail is often extensive.

In Michigan, those areas of the state most prone to severe thunderstorms are also the area's most prone to large and damaging hail. Generally, severe thunderstorms that produce hail occur more frequently in the southern half of the Lower Peninsula than any other area of the state. Damaging hail has occurred in every part of Michigan, Bay County included.

3.11.3 Bay County History

Below are listed significant hail hazard occurrences from 1962 to 2008 derived from the National Climatic Data Center Storm Event Database:

June 18, 1962 - Bay County. Magnitude: 2.5 inches.

July 31, 1973 - Bay County. Magnitude: .75 inches

August 17, 1991 - 2 miles north of Bay City, Bay County. Magnitude: .75 inches.

April 26, 1994 - 5 miles west of Linwood, Bay County. Magnitude: .75 inches.

April 13, 1996 - Bay City, Bay County. Magnitude: .75 inches. Severe weather developed north of a stationary front on the 12th. The strongest storms moved across the far southern part of Michigan during the late afternoon on the 12th. The most damage was done in Lenawee County, where hailstones with diameters of up to 2.5 inches did widespread damage to windows, roofs and aluminum siding. Farther north, several reports of large hail and strong winds were received in the Saginaw/Midland area, where power outages affected over 2000 customers late in the afternoon.

May 8, 1997 - 5 miles southeast of Bay City. Magnitude: .88 inches. A strong low pressure system tracking across Lake Superior pushed a cold front across southeast Michigan late on the 8th. Scattered thunderstorms developed along the front, with the strongest storms affecting the Saginaw Valley. Hail with diameters of up to an inch was reported at several locations.

June 24, 1998 - 3 miles north west of Pinconning. Magnitude: 1.75 inches. Thunderstorms developed in a warm and humid air mass during the afternoon. The storms focused on a pair of east-west oriented boundaries: one stretched across central lower Michigan, while the second was a weak warm front moving north into the southern portion of the state. Thunderstorms near both boundaries became severe. Storms near the northern boundary were hail producers. Golf ball sized hail was reported by a spotter in Sanford, and also by the Michigan State Police northwest of Pinconning. Dime to quarter sized hail was reported at a number of other locations in Midland and Bay Counties.

September 26, 1998 - Bentley, Bay County. Magnitude: 1.75 inches. A number of severe thunderstorms developed in the early morning hours in northern and central lower Michigan. The southernmost severe storm produced golf ball sized hail in Bentley. This storm weakened as it moved east across Saginaw Bay, but was still potent enough to produce dime sized hail in Albert E Sleeper State Park.

May 17, 1999 - Kawkawlin, Bay County. Magnitude: .75 inches. An unusually warm day for mid-May in southeast Michigan, with temperatures near 90 degrees in many locations. The heat and humidity made the atmosphere very unstable, and allowed thunderstorms to develop in the afternoon. Several of the storms became severe during the late afternoon and evening hours. The first few severe storms of the day were in the Saginaw Bay area, and produced large hail. The largest hail (golf ball sized) fell in Port Hope. As thunderstorm activity gradually migrated south, large hail reports became less frequent. The largest hail in the southern part of the area was quarter sized near Saline. However, these southern storms produced stronger wind gusts. The highest measured wind gusts were 54 mph at the University of Michigan in Ann Arbor, and 51 mph at the airport in Owosso. However, winds were estimated much higher in some locations. The highest estimated gusts were near 90 mph just east of Deckerville. The most common effect of the severe wind gusts was to down trees and power lines. Power lines were downed across Interstate 94 near Dexter, closing the freeway for a short while. A few agricultural outbuildings were destroyed just northwest of Oakley, just south of Sandusky, and east of Deckerville. Windows were blown out of a Marlette home, while a home in Northville lost a number of shingles. In Ortonville, the roof was torn off a dugout at a ball field, and a home had a falling tree go through its roof. A tree was felled onto a Sandusky home, heavily damaging a porch; just south of town, a mobile home was shifted off its foundation. East of Deckerville near Lake Huron, a travel trailer was moved by the wind.

July 24, 1999 - Kawkawlin, Bay County. Magnitude: 1.75 inches. An upper level disturbance crossed the Great Lakes region from northwest to southeast, igniting thunderstorms along its path. The thunderstorms evolved into a squall line as they moved across southeast Michigan. Instability was high on this warm and humid summer day, allowing many of the storms to become severe. Most of the damaging wind gusts took down trees, tree limbs, utility poles, and power lines. However, the marine community felt the brunt of the severe thunderstorm winds in two separate incidents. A large number of sailboats were returning to the Bay City Yacht Club after a competition on Saginaw Bay, when the line of storms struck. As many as a dozen boats were capsized, with two sailboats demasted. On Lake St Clair, wind gusts capsized one sailboat, and caused a cabin cruiser to run aground. The largest hail of the day, golf ball sized, was reported in Kawkawlin, Bay City, Zilwaukee, and Southfield. In Bay City, the large hail fell on the exposed mariners, causing welts and bruises to at least two.

May 12, 2000 - Bay City, Bay County. Magnitude: .88 inches. A warm front moved north across lower Michigan on the 12th, ushering in another warm, muggy, unstable air mass. Thunderstorms developed northeast of Grand Rapids in the afternoon, and then moved east toward the Saginaw Valley and Thumb areas. One storm evolved into a classic supercell, producing baseball sized hail from just east of Bay City to near Sebewaing. The supercell continued east across Huron County, and produced the first tornado of the severe weather season a few miles north of White Rock. Many trees were downed near the Lake Huron shoreline, with some downed onto homes. A storage shed was blown into a neighbor's yard, a swimming pool was destroyed, and several canoes were damaged. Flash flooding resulted in the Pigeon/Elkton area. A trailer park in Elkton had to be evacuated as the Pinnebog River quickly rose out of its banks. Water rose as high as the electric meters on some of the mobile homes. High water lingered in the county through the night, with flooding along the Willow River in Bloomfield Township (Redman Road was closed for a time), and street flooding in Harbor Beach. Additional storms developed further south in the evening, and moved east across metro Detroit. These storms produced marginally severe hail, and sporadic wind damage in the form of downed trees and power lines.

June 29, 2000 - Linwood, Bay County. Magnitude: .75 inches. A potent upper level disturbance crossed lower Michigan, bringing with it very cold air aloft. The result was an unstable atmosphere, and a setup favorable for hail. Many storms developed in the afternoon and evening, with a number producing marginally severe hail. Hail as large as quarters fell in Yale; all the other reports were of dime-sized hail.

August 2, 2000 - 4 miles north west of Pinconning Magnitude: .75 inches. A weak cold front moved across southeast Michigan in the afternoon and evening, triggering the second batch of severe thunderstorms of the day. Like many of the other severe weather episodes of the summer, this one was composed of a large number of marginally severe events. The majority of these were hail, but a few damaging wind gusts occurred as well. Parts of the region were also vulnerable to flash flooding due to heavy rains during the past week; this flash flood potential was realized in the Ann Arbor area.

August 9, 2000 - Auburn, Bay County. Magnitude: .75 inches. A stationary front was located across central lower Michigan. A strong upper level disturbance ignited thunderstorms over northwest lower Michigan and northern

Lake Michigan in the early morning hours. These storms moved southeast, producing marginally severe hail and damaging winds in the Saginaw Valley and Thumb areas around sunrise.

June 17, 2002 - 7 miles west of Linwood, Bay County. Magnitude: .75 inches. An upper level disturbance interacting with cold air aloft caused numerous thunderstorms to develop across eastern Michigan during the afternoon and early evening on the 17th. Large hail was associated with many of these storms. Most of the strongest storms developed near Lakes Huron and Erie due to added convergence along Lake Breeze boundaries.

June 28, 2003 - Bay City, Bay County. Magnitude: .75 inches. A potent upper level disturbance crossed lower Michigan, bringing with it very cold air aloft. The result was an unstable atmosphere, and a setup favorable for hail. Many storms developed in the afternoon and evening, with a number producing.

June 13, 2004 - Kawkawlin, Bay County. Magnitude: 1.75 inches. A storm moved through the Midland and Bay City areas, over the south end of Saginaw Bay, and into Huron County before moving out over the open waters of Lake Huron. Later in the afternoon and during the evening a nearly solid line of storms developed along a north-south surface trough over western Lower Michigan. These storms developed bowing characteristics as they moved into southeast Michigan and generated some straight-line wind damage. The Midland Fire Department called out two extra crews to answer about 30 storm-related calls of downed wires, broken utility poles and fallen trees. At least two trees crashed into homes.

June 5, 2005 - 2 miles east of Essexville, Bay County. Magnitude: .75 inches. A potent storm system moved in from the upper Mississippi Valley on the 5th, placing southeast Michigan in the warm sector. Maximum temperatures climbed into the lower 90s, coupled with dew points near 70, lead to a very unstable air mass. High winds took down tree limbs and knocked out power to about 107,000 DTE Energy customers throughout Southeast Michigan.

June 5, 2005 - Bay City & Auburn, Bay County. Magnitude: 1.00 inch.

March 31, 2006 - Auburn, Bay County. Magnitude: .75 inches. An early season severe weather episode broke out in the form of mini-supercells. Most impressive mini-supercell went from northern Livingston County across southern Genesee and southern Lapeer counties. Several reports of funnel clouds, none of which touched down, were received when the supercells were at its peak. Most reports were hail up to 1 inch, and reports of hail that accumulated in spots. By the end of the event, most thunderstorm cells transitioned into line segments over far southeast/metro Detroit with wind damage.

May 30, 2006 - 3 miles north west of Auburn, Bay County. Magnitude: .88 inches. A lake breeze kicked off a pulse severe storm in Oakland County to start things rolling on Tuesday, May 30th. With a very unstable air mass in place, additional strong thunderstorms were able to develop on the outflow boundaries from previous storms. This led to severe thunderstorm development propagating as far north as Huron County. At the same time, another line of severe storms that had initially formed along a lake breeze off of Lake Michigan tracked across the Tri-Cities area. There were numerous reports of large tree limbs and trees downed. Also, several hail reports were received, with the largest hail being reported as the size of quarters.

October 4, 2006 - Essexville, Bay County. Magnitude: .75 inches. A potent storm system moved in from the upper Mississippi Valley placing southeast Michigan in the warm sector.

June 15, 2008 - 1 mile north east of Pinconning, Bay County. Magnitude: .88 inches.

3.11.4 Bay County Profile

The following table summarizes the profile for Bay County for hail storms.

Table 3.17 Profile for Hail Storms

Period of Occurrence (1960-2010)	Spring, Summer, and Fall
Number of Events	51
Past Damages:	$204,254
Annual Chance Probability Ratio	1.02
Warning Time	Minutes to hours
Potential Impacts	Large hailstorms can include minimal to severe property and crop damage and destruction.

3.12 TORNADO

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

3.12.1 Hazard Description

Tornadoes produce the violently rotating columns of wind known as funnel clouds. Most of a tornado's destructive force is exerted by the powerful winds that knock down walls and lift roofs from buildings in the storm's path. The violently rotating winds then carry debris aloft that can be blown through the air as dangerous missiles. 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. Tornadoes in Michigan are most frequent in the spring and early summer when warm, moist air from the Gulf of Mexico collides with cold air from the Polar Regions to generate severe thunderstorms.

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

3.12.2 Types

Tornado intensity is measured on the Fujita Scale, which examines the damage caused by a tornado on homes, commercial buildings, and other man-made structures. The Fujita Scale rates the intensity of a tornado based on damaged caused, not by its size. It is important to remember that the size of a tornado is not necessarily an indication of its intensity. Large tornadoes can be weak, and small tornadoes can be extremely strong, and vice versa. It is very difficult to judge the intensity and power of a tornado while it is occurring. Generally, that can only be done after the tornado has passed, using the Fujita Scale as the measuring stick. The Fujita Scale is presented in the following table.

Table 3.18 The Enhanced Fujita Scale of Tornado Intensity

F-Scale Number	Intensity Phrase	Wind Speed	Type of Damage Done
F0	Gale tornado	40-72 mph	Some damage to chimneys; breaks branches off trees; pushes over shallow-rooted trees; damages sign boards.
F1	Moderate tornado	73-112 mph	The lower limit is the beginning of hurricane wind speed; peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos pushed off the roads; attached garages may be destroyed.
F2	Significant tornado	113-157 mph	Considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars pushed over; large trees snapped or uprooted; light object missiles generated.
F3	Severe tornado	158-206 mph	Roof and some walls torn off well constructed houses; trains overturned; most trees in forest uprooted
F4	Devastating tornado	207-260 mph	Well-constructed houses leveled; structures with weak foundations blown off some distance; cars thrown and large missiles generated.
F5	Incredible tornado	261-318 mph	Strong frame houses lifted off foundations and carried considerable distances to disintegrate; automobile sized missiles fly through the air in excess of 100 meters; trees debarked; steel reinforced concrete structures badly damaged.
F6	Inconceivable tornado	319-379 mph	These winds are very unlikely. The small area of damage they might produce would probably not be recognizable along with the mess produced by F4 and F5 wind that would surround the F6 winds. Missiles, such as cars and refrigerators would do serious secondary damage that could not be directly identified as F6 damage. If this level is ever achieved, evidence for it might only be found in some manner of ground swirl pattern, for it may never be identifiable through engineering studies

(Source: The Tornado Project; Storm Data, National Climatic Data Center)

According to the National Weather Service (NWS), since 1950 the vast majority of tornadoes that occurred in United States (approximately 74%) were classified as weak tornadoes (F0 or F1 intensity). Approximately 24% were classified as strong tornadoes (F2 or F3 intensity), and only 3% were classified as violent tornadoes (F4 or F5 intensity). Unfortunately, those violent tornadoes, while few in number, caused about 65% of all tornado-related deaths nationally. Strong tornadoes accounted for another 33% of tornado-related deaths, while weak tornadoes caused only 1% of tornado-related deaths. If the data prior to 1950 is examined, the percentage of deaths attributable to violent tornadoes climbs drastically. That is largely due to the fact that tornado forecasting and awareness programs were not yet established. As a result, it was much more likely for death tolls from a single tornado to reach several hundred.

3.12.3 Facts

National Weather Service data indicates that Michigan has experienced 955 tornadoes and 239 related deaths during the period from 1950-May 2005, an average of 17 tornadoes and 4 tornado-related deaths per year. The greatest number of tornadoes per year during that period occurred in 1974 with 39 tornadoes. The least number occurred in 1959 with only 2 tornadoes. From 1950-March 2005, Michigan experienced 508 "tornado days" (defined as days in which tornadoes are observed), an average of 9 days per year.

In terms of intensity, Michigan's tornado experience since 1950 has essentially mirrored the national experience. Approximately 67% of all Michigan tornadoes have been weak tornadoes (F0 or F1 intensity); while 29% have been strong tornadoes (F2 or F3 intensity) and 4% have been classified as violent tornadoes (F4 or F5 intensity). However, those few violent tornadoes have been responsible for 88% of Michigan's tornado-related deaths. Strong tornadoes (F2 or F3 intensity) have accounted for approximately 11% of the deaths, while weak tornadoes (F0 or F1 intensity) have caused only 1% of all tornado-related deaths. Those patterns are fairly consistent with the national averages, although Michigan has had more strong and violent tornadoes (approximately 33% in Michigan vs. 27% nationally), and its death toll from violent tornadoes is slightly higher than the national average (67% in Michigan vs. 65% nationally). Michigan's higher than average death toll from violent tornadoes is largely due to the tragic storm events that occurred in Flint in 1953 and across southern Michigan in 1965.

3.12.4 Bay County History

According to the National Climatic Data Center Storm Event Database, Bay County has experienced 12 Tornado events dating back to 1957. Below is a table listing each event. For more details/descriptions on the events, refer to the descriptions following this table.

Table 3.19 Tornado Events Recorded in Bay County (1957-2010)

Date	Location	Magnitudes	Total Cost of Damage	Deaths/Injuries
June 22, 1957	Bay County	F2	$25,000	
April 11, 1965	Bay County	F2	$250,000	2 injuries
June 26, 1973	Bay County	F0		
June 26, 1973	Bay County	F0		
July 31, 1973	Bay County	F2	$25,000	
July 14, 1974	Bay County	F1		
March 20, 1976	Bay County			
June 20, 1979	Bay County	F0	$25,000	
July 17, 1982	Bay County	F0	$2,500	
June 12, 1984	Bay County	F3	$2,500,000	
October 24, 2001	10 Miles SE of Bay City	F1	$60,000	
August 4, 2003	1 mile S of Bay City	F0		
June 13, 2004	2 miles SW of Auburn	F0	$10,000	

Source: National Climatic Data Center Storm Event Database, http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvent~Storms

Below is a listing of tornado hazard events in more detail:

March 20, 1976 - Bay County. Presidential Major Disaster Declaration due to ice storm and tornado. Counties affected: Allegan, Bay, Clare, Clinton, Genesee, Gladwin, Gratiot, Ionia, Isabella, Jackson, Kent, Lapeer, Macomb, Mecosta, Midland, Montcalm, Muskegon, Newaygo, Oakland, Oceana, Osceola, Ottawa, Roscommon, Saginaw, St. Clair, Sanilac, Shiawassee, Tuscola, & Wayne Co.

October 24, 2001 - 10 Miles South East of Bay City. Magnitude: F1. Damages: $60,000. A tornado touched down 3.5 miles east of the town of Munger. The tornado struck a farmstead on Briggs Road. Property damage from the tornado included, complete destruction of a small barn and garage, a grain silo being lifted off its foundation, and minor damage to the siding and front porch of the main house. The tornado then moved northeast into Tuscola County. A strong cold front moved into the Great Lakes region during the early morning hours of the 25th. Ahead of this cold front, unseasonably warm air surged northward into the Great Lakes. Thunderstorms developed ahead of the cold front late in the afternoon of the 24th and continued into the evening. These thunderstorms extended from the Great Lakes all the way to the deep south. Strong winds just off the surface allowed some of the thunderstorms that developed across southern Michigan to become severe. Most of the severe storms caused damaging winds gusts associated with strait line microburst winds. However, increased low level directional shear via a surface warm front that extended across southeast Michigan allowed some of the thunderstorms to develop rotation, a few of which produced tornadoes. Three tornadoes were spawned from the thunderstorms. However, since two of the tornadoes crossed a county border, five tornadoes will officially be recorded with this event. This is considered an unusual event since tornadoes in late October in Southeast Michigan are extremely rare. Following the passage of the cold front early on the morning of the 25th, winds gusting as high as 45 MPH affected the region and dropped temperatures 20 to 30 degrees.

August 4, 2003 - 1 mile south of Bay City. Magnitude: F0. A cold air funnel briefly touched down on 25th street. The tornado moved a garage 2 feet and destroyed 2 sheds.

June 13, 2004 - 2 miles south west of Auburn. Magnitude: F0. Damages: $10,000. A weak tornado touched down near 11 mile and Salzburg Road, tracking east-northeast. The tornado lifted near 8 mile. Trees and power lines were blown down. A camper was also overturned. The front that moved through our area on Wednesday June 9th maintained its identity and began to move north as a warm front during the afternoon of the 13th. The first cell of the day became a long-lived supercell. This storm moved through the Midland and Bay City areas, over the south end of Saginaw Bay, and into Huron County before moving out over the open waters of Lake Huron. Later in the afternoon and during the evening a nearly solid line of storms developed along a north-south surface trough over western lower Michigan. These storms developed bowing characteristics as they moved into southeast Michigan and generated some straight-line wind damage. The Midland Fire Department called out two extra crews to answer about 30 storm-related calls of downed wires, broken utility poles and fallen trees. At least two trees crashed into homes.

3.12.5 Bay County Profile

The following table summarizes the risk for tornado hazard:

Table 3.20 Profile for Tornadoes

Period of Occurrence (1953 – 2010)	Year-round, primarily during March through August
Number of Events	20
Past Damages	$2,897,000
Annual Chance Probability Ratio	0.35
Warning Time	Minutes to hours. Over 80 % of all tornadoes strike between noon and midnight.
Potential Impacts	Utility damage and outages, infrastructure damage (transportation and communication systems), structural damage, and damaged or destroyed critical facilities. Impacts human life, health, and public safety.

3.13 WILDFIRE

An uncontrolled fire in grasslands, brushlands or forested areas.

3.13.1 Hazard Description

Forests cover approximately 49% (18.2 million acres) of Michigan's total land area. These vast forests provide Michigan with the largest state-owned forest system in the United States. In addition, Michigan has the fifth largest quantity of timberland acreage, with 4.2 million acres of softwoods and 13.1 million acres of hardwoods. That vast forest cover is a boon for both industry and recreation. However, it also makes many areas of Michigan highly vulnerable to wildfires.

Although Michigan's landscape has been shaped by wildfire, the nature and scope of the wildfire threat has changed. Michigan's landscape has changed substantially over the last several decades due to wildland development, and so the potential danger from wildfires has become more severe. Increased development in and around rural areas (more than a 60% increase in the number of rural homes since the 1980s) has increased the potential for loss of life and property from wildfires.

Contrary to popular belief, lightning strikes are **not** the primary cause of wildfires in Michigan. Today, only about 2% of all wildfires in Michigan are caused by lightning strikes; the rest are caused by human activity. Outdoor burning is the leading cause of wildfires in Michigan. Most Michigan wildfires occur close to where people live and recreate, which puts both people and property at risk. The immediate danger from wildfires is the destruction of property, timber, wildlife, and injury or loss of life to persons who live in the affected area or who are using recreational facilities in the area.

3.13.2 Types/Risks

FEMA (and others) have created fairly detailed methods for estimating wildfire risks. Wildfire risk estimations are primarily determined by weather, topography, and land cover (fuel) data. This process currently sorts all areas into three "fuel model" categories based on the types of vegetative land covers that could act as fuels in a wildfire event. Of the 449 square miles in bay County, 6.5% is urban, including roads and highways, 11.1% is water, and 18.0% is wetland, with 0.6% of the county indicated as bare ground. While some types of wetlands could be prone to wildfire due to vegetative characteristics, wetlands would be expected to not burn as fiercely as an upland area. Thus, 36.1% of the County is not prone to wildfires.

An additional 18.1% of the county is covered by cultivated crops, which would also be less prone to wildfires due to the limited quantity of fuel. As described below, FEMA includes pasture and grasslands, which accounts for 10.4% of the county, and scrub/shrub vegetative communities, which account for an additional 2.2% of the county, in the light fuel category. Thus, the amount of light fuel vegetation in Bay County is approximately 30.7%.

The remainder of the county (33.2%) is covered by various types of forest, including deciduous, evergreen, or mixed forests. The primary difference between the medium and heavy fuel categories in the FEMA definition is the ground cover within the forest. Forests that have not been heavily cut, leaving deadfall on the forest floor, would generally be categorized as medium fuel sources. However, the land cover dataset does not differentiate forests by the substory vegetation or groundcover, making a delineation between medium and heavy fuel categories impossible.

The land cover dataset utilized for this analysis was from the National Oceanic and Atmospheric Administration's Coastal Change Analysis Program. The dataset was derived from satellite imagery from 2005 and 2006. The map below shows the various land cover classes in Bay County.

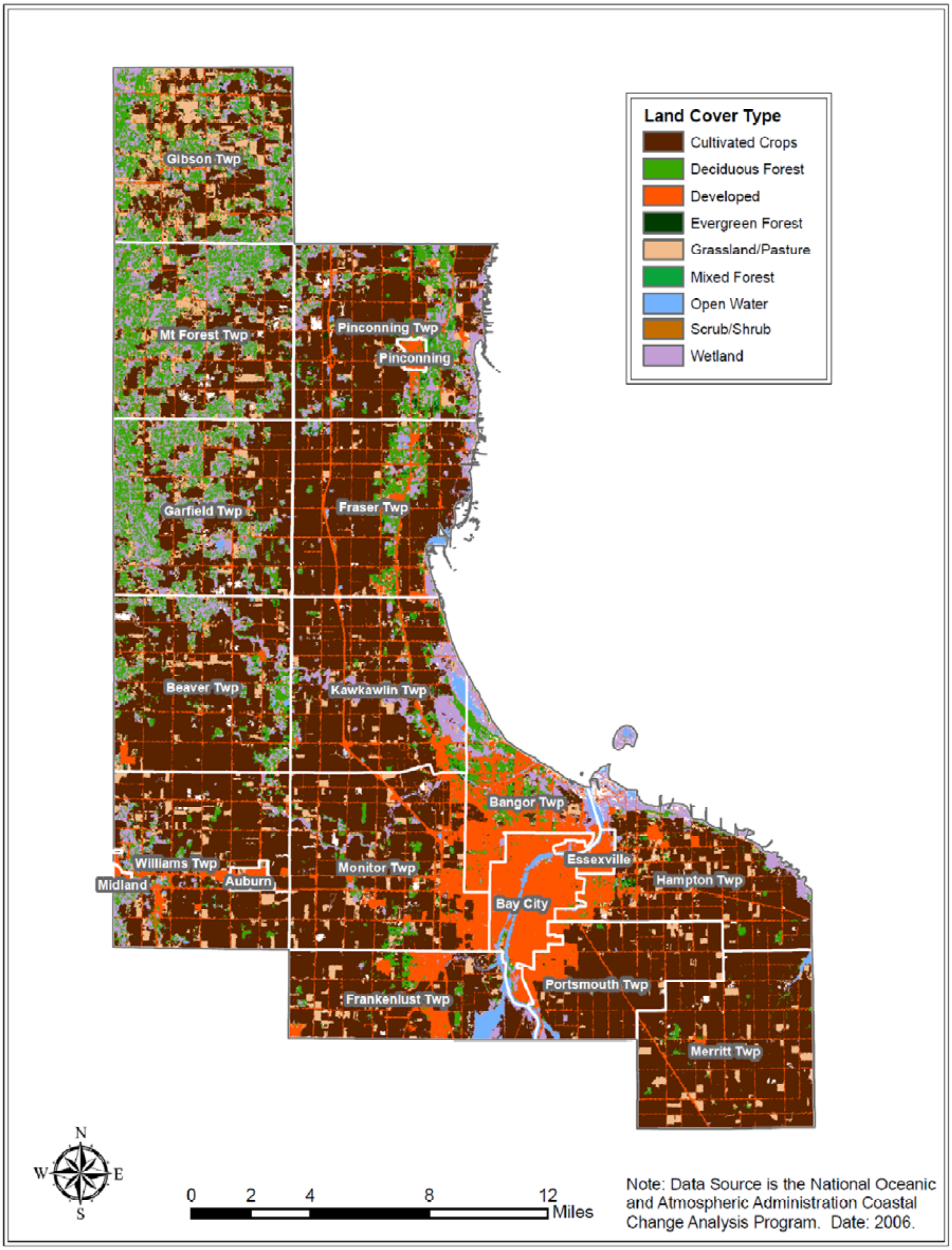


Figure 3 Bay County Land Cover Map

The following is a summary of the three fuel model categories described by FEMA:

3.13.2.1 Light Fuel Category

Covers any of the following general descriptions of vegetation in an area:

1. Predominantly marsh grasses and/or weeds.
2. Mosses, lichens, and low shrubs are the predominant ground fuels, but have no over story and/or occupy less than one-third of the site.
3. Grasses and/or forbs predominate. Any woody shrubs will occupy less than one-third of the site. An open over story of conifer and/or hardwood trees may be present.
4. Brush, shrubs, tree reproduction or dwarf tree species predominate, but this is only considered light fuel if the average height of woody plants is less than 6 feet, and they occupy less than one-third of the site.
5. Deciduous broadleaf tree species predominate and the area has not been thinned or partially cut (which would create a higher-risk fuel source called "slash").
6. Conifer species predominate, but the primary ground fuels are grasses and forbs. If the primary ground fuels are duff and litter, branch wood, and tree boles, then the area can only be considered "light fuel" if pine needles are 2 or more inches in length, the over story is not decadent, and there is only a nominal accumulation of debris.

3.13.2.2 Medium Fuel Category

Covers any of the following general descriptions of vegetation in an area:

1. Mosses, lichens, and low shrubs are the predominant ground fuels, and an over story of conifers occupies more than one-third of the site.
2. Grasses and/or forbs predominate, with woody shrubs occupying between one-third and two-thirds of the site.
3. Brush, shrubs, tree reproduction or dwarf tree species predominate, and woody plants are either greater than 6 feet in height, or cover more than one-third of the site.
4. Conifer species predominate, and the understory is dominated by lichens, mosses, low shrubs, woody shrubs, and/or reproduction. (If the primary ground fuels are duff and litter, branch wood, and tree boles, and pine 65 needles are less than 2 inches long, then the overstory must not be decadent, and there must be only a nominal accumulation of debris.)

3.13.2.3 Heavy Fuel Category

Covers any of the following general descriptions of vegetation in an area:

1. Deciduous broadleaf tree species predominate in an area that has been thinned or partially cut, leaving slash as the major fuel component.

2. Conifer species predominate, with duff and litter, branch wood, and tree boles as the primary ground fuels, and an over story that is overmature and decadent, with a heavy accumulation of dead tree debris.

3. Slash is the predominant fuel in the area. (Counts as heavy fuel at any level of loading, regardless of whether settling has been significant or slight, and whether foliage is attached or falling off.)

3.13.3 Bay County History

According to Michigan Hazard Mitigation Plan, the thumb area region has experienced 1 recorded wildfire event. Additionally, the Michigan Department of Natural Resources (MDNR) has recorded 36 wildfires in Bay County (MDNR jurisdiction only) from 1981-2005. To put the 36 wildfires events in perspective with the remainder of the state, MDNR recorded a total of 13,212 wildfire events in Michigan between 1983-2007 (Source: Michigan Hazard Mitigation Plan).

August-September 1881 - **Thumb Area**. **Damages: $2,000,000**. Several small fires in the Thumb came together to form a major conflagration. A massive area of fires moved through the Thumb counties, and six days later, stopped at Lake Huron. 282 were killed (Michigan Hazard Mitigation Plan).

3.13.4 Bay County Profile

The following table summarizes the profile for wildfires.

Table 3.21 Wildfire Profile

Period of Occurrence (1881-2010)	Late Summer Early Fall
Number of Events	1
Past Damages:	$2,000,000
Annual Chance Probability Ratio	0.01
Warning Time	None, unless related to drought. Humans, through negligence, accident, or intentional arson, have caused approximately 90% of all wildfires in the last decade.
Potential Impacts	Impacts human life, health, and public safety. Loss of wildlife habitat, increased soil erosion, and degraded water quality. Utility damage and outages, infrastructure damage (transportation and communication systems), structural damage, damaged or destroyed critical facilities, and hazardous material releases.

3.14 WINTER STORM

A period of rapid accumulation of snow/ice often accompanied by low temperatures, and low visibility, to result in hazardous conditions and/or property damage.

3.14.1 Hazard Description

Severe winter weather hazards include snowstorms, blizzards, extreme cold, and ice and sleet storms. As a northern state, Michigan is vulnerable to all of these winter hazards. Most of the severe winter weather events that occur in Michigan have their origin as Canadian and Arctic cold fronts that move across the state from the west or northwest, although some of the most significant winter storms have their origins from the southwest, in combination with Arctic air masses.

3.14.1.1 Ice Storm

Ice storms are sometimes incorrectly referred to as sleet storms. Sleet is small frozen rain drops (ice pellets) that bounce when hitting the ground or other objects. Sleet does not stick to trees and wires, but sleet in sufficient depth does cause hazardous driving conditions. Ice storms are the result of cold rain that freezes on contact with the surface, coating the ground, trees, buildings, overhead wires and other exposed objects with ice, sometimes causing extensive damage. When electric lines are downed, power may be out for several days, resulting in significant economic losses and the disruption of essential services in affected communities.

3.14.1.2 Snowstorm

As a result of being surrounded by the Great Lakes, Michigan experiences large differences in snowfall over relatively short geographic distances. The average annual snowfall accumulation in different areas ranges from 30 to 200 inches of snow. The highest accumulations are in the northern and western parts of the Upper Peninsula. In Lower Michigan, the highest snowfall accumulations occur near Lake Michigan and in the higher elevations of northern Lower Michigan.

Blizzards are the most dramatic and perilous of all snowstorms, characterized by low temperatures and strong winds (35+ miles per hour) bearing enormous amounts of snow. Most of the snow accompanying a blizzard 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. Just the cost of clearing the snow can be enormous.

3.14.2 Bay County History

January 27, 1967 - Bay County. The snowstorm turned out to be the worst of the entire 20th century. In fact, the whole state of Michigan was paralyzed by the Blizzard of '67. Everything was shut down from City Hall to schools, most stores and offices and factories. Nearly 2 feet of snow fell in the storm that lasted well into Friday with winds topping out at 50 mph. Besides city streets being clogged and impassable in places, county roads were completely gone, buried under 5- and 6-foot snow drifts, according to the Bay County Road Commission at the time (Source: Bay City Times Archives.)

March 20, 1976 - Bay County. Presidential Major Disaster Declaration due to ice storm and tornado. Counties affected: Allegan, Bay, Clare, Clinton, Genesee, Gladwin, Gratiot, Ionia, Isabella, Jackson, Kent, Lapeer, Macomb, Mecosta, Midland, Montcalm, Muskegon, Newaygo, Oakland, Oceana, Osceola, Ottawa, Roscommon, Saginaw, St. Clair, Sanilac, Shiawassee, Tuscola, & Wayne Co.

January 25, 1978 - Bay City, Bay County. The weather report indicated up to a foot of snow had been dumped on the area and another foot or more was falling. Winds of 35 mph created impassable drifts. Later, we learned that as many as 76 people died in the storm in the Midwest. Tens of thousands were without power (Source: Bay City Times Archives.) Statewide, Michigan was presidentially declared a major disaster area due to blizzard and snowstorm conditions.

January 12, 1993 – Regional. Damages: $50,000. 1 injury. Snow began across central Lower Michigan late in the evening of the 12th and quickly spread north across northern Lower Michigan during the early morning hours of the Wednesday the 13th. The combination of heavy snow, northeast winds of 15 to 25 mph and temperatures in the lower to mid 20s created near blizzard conditions at times most of Wednesday. The snow tapered to flurries by early evening hours of Wednesday with total snowfall ranging from six to twelve inches. The heaviest snow amounts were reported in central Lower Michigan with a foot at Saginaw and Alma. The heavy snow led to downed power, telephone and cable T.V lines across this area. Almost 20,000 people lost power from the heavy snow. Numerous traffic accidents occurred with one serious injury. Most of the schools were closed over central Lower Michigan due to the heavy snowfall (Source: National Climatic Data Center Storm Event Database.)

January 21, 1993 – Regional. Central and Eastern Upper Michigan Freezing rain began shortly after midnight on the 12th across far southwest Lower Michigan and spread across all of Lower Michigan by 7 am. The freezing rain spread across central and eastern Upper Michigan between 4 am and 9 am. Between 0.3 and 0.4 inches of ice accumulated on exposed surfaces across northwest Lower Michigan and Upper Michigan with lesser amounts of ice across southern and far eastern Lower Michigan. The ice caused treacherous road conditions across northern Lower Michigan and Upper Michigan resulting in numerous traffic accidents. Virtually all schools and universities were closed on the 21st over central and eastern Upper and northern Lower Michigan (Source: National Climatic Data Center Storm Event Database.)

April 1, 1993 – Regional. Damages: $50,000. This storm brought a wintry mix to Lower Michigan on April 1st and 2nd. Rain began across most of lower Michigan during the evening hours of March 31st with only flurries reported across northeastern Lower Michigan. Rain changed to freezing rain across central Lower Michigan from Bay City, Saginaw and Midland to Lansing, and Flint after midnight on the 1st. The maximum snowfall from this storm was 8 inches in the city of Pontiac. The combination of wind gusts to 40 mph and ice accumulations of up to 0.25 inches caused numerous power outages in central lower Michigan in the Tri-city area of Bay City, Midland and Saginaw. Up to 57,000 customers were without power. Numerous schools also were closed across these areas due to the icy road conditions (Source: National Climatic Data Center Storm Event Database.)

January 29, 1994 – Regional. Damages: $5,000,000. Snow developed over southwest Lower Michigan just after Midnight on the 27th. Snowfalls of six to eight inches were common over the north half of Lower Michigan. As for ice accumulations over Lower Michigan during the freezing rain, around a quarter inch accumulated over the south third of lower Michigan, from 0.50 to 0.80 inches accumulated over central and northeast Lower Michigan and one to three tenths of an inch accumulated over northwest sections of Lower Michigan. This resulted in numerous outages. Detroit Edison reported 50,000 people affected by power outages. Consumers Power County reported 2,000 customers without power. Most of the power loss problems were over the southeastern part of Michigan even though this was not the area of heaviest ice accumulation or of the strongest winds. Most of the power loss occurred on Thursday, January 27th, during the ice accumulation phase of the storm. More than 150 schools canceled classes across the state. Hope College, in Holland (near Grand Rapids), called off classes and many of Grand Rapids area malls were closed on Friday, the 28th. The Kent County Airport, which services the Grand Rapids area, was closed for five hours on the morning of the 27th (Thursday), due to icy runways. Over the southeast part of Lower Michigan, in the Detroit area, there were tales of man-eating potholes. The potholes were so big and so numerous that dozens of cars were stranded along Interstate 75 in the Detroit area after becoming disabled from hitting the potholes, and as a result, blocking the Interstate. Two students were killed Thursday evening, in the Midland area of east-central Michigan, when their cars crashed into to each other. Across the rest of Michigan, there were numerous reports of cars skidding off the road and minor fender-bender type accidents (Source: National Climatic Data Center Storm Event Database.)

December 6, 1994 - Southern Lower Michigan. Heavy snow fell across the southern half of lower Michigan from the evening on the 6th through the morning of the 7th. The snow fell as low pressure tracked from north Texas northeast across northern Ohio. The snow began in southwest lower Michigan during the afternoon on the 6th, and then quickly spread northeast to cover all of southern lower Michigan by early evening. Accumulations of 6 to 11 inches occurred in a band from near Holland and Muskegon in western lower Michigan, east through Grand Rapids, Battle Creek, Lansing, Flint, and the Detroit Metropolitan area. Snow amounts of 2 to 4 inches occurred over extreme southern lower Michigan, where some of the precipitation fell as freezing rain. Numerous traffic accidents were reported across the area, along with scattered power outages (Source: National Climatic Data Center Storm Event Database.)

January 20, 1995 - Northwest Upper Michigan. Heavy snow fell across large areas of southern lower Michigan and across portions of upper Michigan as low pressure tracked northeast across the Ohio Valley on the 19th and 20th, then became nearly stationary near Lake Ontario from the 21st through the 24th. Accumulations ranged from 6 to 12 inches across most of the southern half of lower Michigan during the period, while local accumulations of up to 20 inches occurred near Lake Superior in northern upper Michigan. Travel disruptions across southern lower Michigan were not as severe as what would normally be expected with such large snow amounts, since much of the snow fell during the weekend, and the snow fell over a several day period. Still, many serious traffic accidents were reported, along with scattered power outages (Source: National Climatic Data Center Storm Event Database.)

February 25, 1995 - Southern Lower Michigan. Heavy snow developed to the north of a slow-moving cold front across portions of southern lower Michigan on the 25th. The heaviest snow fell in a band from near Muskegon southeast to near Detroit during the period from late afternoon on the 25th through the early morning hours of the 26th. Accumulations of three to six inches were common in that area. Numerous traffic accidents were reported during the evening on the 25th, as temperatures fell quickly below freezing once the snow began, causing sudden icing on roadways (Source: National Climatic Data Center Storm Event Database.)

February 27, 1995 - Southern Lower Michigan. Freezing rain developed across southern lower Michigan late on the 26th, then continued through the morning hours on the 27th, as low pressure tracked northeast from the mid-Mississippi Valley toward southern Michigan. Several hours of sleet preceded the freezing rain in many places. Ice accumulations of one-quarter inch were common throughout southern Michigan by late morning on the 27th. Numerous traffic accidents were reported, and most schools were closed. Despite the heavy icing, only widely scattered power outages occurred, since the storm was accompanied by very little wind (Source: National Climatic Data Center Storm Event Database.)

March 6, 1995 – Regional. Freezing rain occurred across much of southern Michigan during the early morning on the 6th, but the heaviest accumulation of ice occurred early on the 7th, when many areas reported accumulations of one-quarter inch. Most schools were closed for at least one day, and many schools were closed on both the 6th and the 7th. A brief thaw occurred across the far south during the afternoon on the 7th, followed by a sharp temperature drop and a light accumulation of snow, making roads extremely hazardous once again during the evening on the 7th. Scattered power outages occurred, but the outages were not as widespread as what might have occurred had the storm been accompanied by strong winds. Many serious traffic accidents were reported throughout the state, with several fatalities (Source: National Climatic Data Center Storm Event Database.)

March 6, 1995 – Regional. Heavy snow fell across the Upper Peninsula and across the northwest part of the Lower Peninsula, with most of that area receiving from 6 to 10 inches of snow from the afternoon on the 6th through the morning of the 8th. Localized accumulations as high as 17 inches occurred near Marquette in north-central Upper Michigan (Source: National Climatic Data Center Storm Event Database.)

December 13, 1995 - Southeast Michigan. Low pressure tracked from the central Plains on the 13th northeast to near Lake Huron by the afternoon on the 14th. Snow developed across southeast Michigan late in the afternoon on the 13th, and then quickly changed to freezing rain and sleet during the evening. The precipitation ended as light rain during the early morning on the 14th. Snow accumulations were generally two inches or less, but 1/4 inch ice accumulations occurred in many places. At least 230 school districts throughout southern Michigan cancelled school on the 14th, as roads became icy and hazardous. Scattered power outages were also reported (Source: National Climatic Data Center Storm Event Database.)

December 28, 1995 - East Central Michigan. A powerful low pressure system tracked from Missouri northeast across extreme southeast lower Michigan on the 27th and early on the 28th. The rain/snow line developed about midway between Saginaw and Flint during the afternoon on the 27th, and remained nearly stationary until late evening. As a result, heavy snow fell across the Saginaw area, while less than an inch of snow was observed at Flint, just 40 miles to the south. The heaviest accumulation in southeast Michigan occurred at the tri-cities airport near Saginaw, where 11 inches was reported. Even within the snow area, accumulations were quite variable, with most places reporting four to eight inches in a band from Saginaw through Huron County. The snow resulted in numerous car accidents and several school closings (Source: National Climatic Data Center Storm Event Database.)

January 9, 1997 - Southeast Michigan. Low pressure tracked northeast from the Ohio valley across extreme southeast Michigan on the 9th. The result was snow across all of southeast Michigan, with the heaviest amounts falling from the Flint area north through the upper thumb and Saginaw valley. Some accumulations on the 9th included 10 inches at the Tri Cities airport near Saginaw, 8.5 inches at Cass City, 8 inches in Vassar and Owosso and 7 inches at Flint's Bishop Airport. Farther south across the Detroit Metropolitan area accumulations ranged from 2 to 6 inches. Unusually heavy lake effect snow followed the storm on the 10th, bringing an additional 1 to 4 inches of snow to most areas. Numerous auto accidents and school closings were reported (Source: National Climatic Data Center Storm Event Database.)

March 13, 1997 - Southeast Michigan. Damages: $19,000,000. Low pressure tracked from the central Plains northeast across southeast lower Michigan late on the 13th through the 14th. The storm brought widespread precipitation to southeast Michigan from late on the 13th through midday on the 14th. North of Detroit, nearly all of the precipitation fell in the form of freezing rain, with small amounts of snow and sleet noted in a few spots. From Detroit and Ann Arbor south to the state-line, the freezing rain changed to rain, but not before heavy ice accumulations occurred. Total precipitation amounts ranged from 1.5 to nearly 2.5 inches from Detroit and Ann Arbor south to the Ohio state-line. From the northern suburbs of Detroit north to Flint and Port Huron, amounts ranged from 0.8 to 1.5 inches. North of that area, amounts ranged from 0.40 to 0.80 inches. In the Detroit Metropolitan area, the ice storm resulted in power outages to over 425,000 homes and businesses; the 3rd largest outage in history, and the worst ever for an ice storm. Several thousand residents were without power for as long as 4 days. In addition to power lines, falling trees damaged dozens of cars and houses throughout the area. Most schools were closed, and there were numerous auto accidents (Source: National Climatic Data Center Storm Event Database.)

October 26, 1997 – Regional. Low pressure tracked northeast across Ohio late on the 26th through early morning on the 27th. Rain changed to snow over the Saginaw Valley and Flint area during the evening on the 26th, and snow continued until around daybreak on the 27th. Accumulations were mostly from 3 to 6 inches, with a maximum of 6 inches reported at Saint Charles, in Saginaw County. The combination of the heavy wet snow, and the fact that many trees had not yet lost their leaves, resulted in widespread tree damage and downed power lines. Around 40000 homes lost power on the 27th. Measurable snow fell as far south as the northern suburbs of Detroit (Source: National Climatic Data Center Storm Event Database.)

January 7, 1998 - Southern Lower Michigan. Low pressure moved from Mississippi on the afternoon of the 7th, to Ohio by the evening of the 8th. This low spread a mixture of freezing rain, sleet and snow across parts of southeast lower Michigan including the Flint, Saginaw and Thumb regions. The heaviest of the freezing rain fell in the Saginaw area where it caused power outages to 200 customers and some flight delays at Tri Cities International Airport (Source: National Climatic Data Center Storm Event Database.)

March 9, 1998 - Southeast Michigan. A strong low pressure system moved northeast from the southern Plains, reaching the lower Ohio Valley on the evening of the 8th, then crossing Ohio and Lake Erie into Ontario on the 9th. This system brought a multitude of weather events to southeast Michigan. Over two inches of rain fell on parts of far southeast Michigan on the night of the 8th into the morning of the 9th. Some of the higher rainfall totals were 2.16 inches in Morenci and 2.1 inches in Allen Park. The rain caused some minor urban flooding in Wayne County, where a few streets were flooded. In Allen Park, 14 homes experienced some flooding. Four to six inches of snow fell in Bay County on the 9th. The highest snowfall total, six inches, was recorded seven miles west of Linwood, near the community of Crump. Strong north winds occurred during the storm's closest approach on the 9th. A few trees were downed along the Tuscola County shoreline, seven miles northwest of Akron, as these winds came off of Saginaw Bay. Later in the morning, the wind downed power lines in Flint, Burton, Davison, Otisville, and Swartz Creek (Source: National Climatic Data Center Storm Event Database.)

January 3, 1999 Southeast Michigan - Damages: $50,000. Snow developed from south to north across southeast Michigan during the daylight hours of the 2nd. A combination of snow, blowing snow, and wind produced blizzard conditions across the metro Detroit area in the early afternoon. The winds subsided slightly as the snow intensified, but near-blizzard conditions were the rule into the overnight hours. With temperatures in the teens across most of the area, the snow was very fluffy and dry - which is unusual for Michigan heavy snow events. An exception occurred late in the evening of the 2nd, as a surge of warmer air struggled into extreme southeast Michigan. Temperatures rose to around freezing for a few hours, and some freezing rain occurred in Monroe County. Thundersnow at the leading edge of warm air surge added to snowfall totals in the far southeast. Cold air returned to this corner of the state soon after midnight. Snowfall amounts by county: Bay County: 11" in Essexville; 9" in Linwood and Bay City (Source: National Climatic Data Center Storm Event Database.)

January 12, 1999 - Southeast Michigan. Damages: $1,800,000. 3 injuries. A stationary front lay just south of Michigan on the afternoon of the 12th. A strong upper level disturbance moved toward the Great Lakes, causing snow to develop north of the front. In southeast Michigan, snowfall amounts were heavy near and north of Interstate 69. The heaviest snow occurred along the Lake Huron shoreline, as northeast winds at the surface allowed the snowfall to be enhanced by moisture off the lake. Snowfall amounts by county: Bay County: 8" in Essexville; 6" in Bay City (Source: National Climatic Data Center Storm Event Database.)

February 13, 2000. Southeast Michigan. A warm front was oriented west to east in the Ohio Valley during the 13th. Moist air moved north over the front into lower Michigan. A passing upper level disturbance acted on the available moisture, producing a narrow band of heavy snow in central lower Michigan. The highest snowfall amounts came from Huron County; 8 inches fell in Sebewaing and just east of Bad Axe. Seven inches of snow fell in Linwood, while 6 inches fell in Caro, Vassar, Kawkawlin, Edenville, Port Hope, and Sandusky (Source: National Climatic Data Center Storm Event Database.)

February 13, 2000. Southeast Michigan. Damages: $25,000. A strong upper level disturbance helped develop a low pressure system in the central Ohio Valley on the 13th. The low moved quickly off to the northeast that night. This system brought another round of snow to the central and southern Great Lakes. The heaviest snow was near the Ohio border, with 6.5 inches of snow in Monroe and Adrian. Most of the rest of the area picked up 3 to 6 inches. The accumulated snow caused a golf dome in Burton to burst while it was being deflated (Source: National Climatic Data Center Storm Event Database.)

October 8, 2000 - Southeast Michigan. An unusual early October cold blast brought one of the earliest snowfalls on record to southeast Michigan. Wet snowflakes fell in Flint on both the 7th and 8th, while snow was observed at Detroit Metro Airport on the 8th only. For Detroit, this was the third earliest snowfall on record, going back 130 years (the earliest was October 1st, 1974). While the snow only fell in trace amounts in the major metropolitan areas, more substantial snow was observed in the Thumb area. One to two inches of slushy snow contributed to auto accidents in Huron County (Source: National Climatic Data Center Storm Event Database.)

December 11, 2000 - South-Central and Southeast Michigan. Damages: $1,100,000. 1 injury. A powerful storm system moved east just south of Michigan, dumping heavy snow and blizzard-like conditions across all of the area, with some freezing rain and sleet near the Ohio border. Presidential Emergency Declarations were made for all counties in southeast Michigan except Wayne, Lenawee, and Monroe. Specific snowfall amounts and impacts of the storm, by county: Bay: 7" in Essexville; 8" near Linwood; 8 to 10" in Bay City with lightning. (Source: National Climatic Data Center Storm Event Database.) Bay County was of 39 counties that were presidentially declared emergency areas as a result of blizzard and snowstorm conditions.

December 17, 2000 - Southeast Michigan. Damages: $560,000. As the low moved to the east, arctic air returned to the Great Lakes, changing precipitation back to snow. A strong upper level disturbance enhanced snowfall during the early morning hours of the 17th. Snowfall amounts were as high as 7 inches in Wheeler, Akron, Fairgrove Township (Tuscola County), Corunna, Bay City, Saginaw, and Flint. In the Tri-Cities area, high winds combined with the snow to drift many roads shut, and to snap off snow-covered tree limbs. About 7000 homes lost power. A low pressure system would drop 2 to 4 inches of snow on the night of the 18th into the morning of the 19th. A lake effect snow event would produce isolated reports of heavy snow in the Thumb just before the New Year (Source: National Climatic Data Center Storm Event Database.)

February 7, 2001 - South-Central and Southeast Michigan. Low pressure in the plains pushed a warm front north across the Ohio Valley. Precipitation broke out north of the warm front, in the form of a wintry mix. Near Saginaw Bay, much of this mix took the form of freezing rain. In general, minimal glaze formed on ground surfaces. Instead, ice accumulations were generally confined to power lines, tree branches, and overpasses. The ice accumulations, about a quarter to a half-inch, did not persist long, as temperatures warmed and changed the freezing rain to rain. As a result, the ice caused little damage (Source: National Climatic Data Center Storm Event Database.)

January 30, 2002 - South-Central and Southeast Michigan. The prolonged period of winter weather across southeast Michigan from January 30th to February 1st was the result of a series of low pressure systems that developed in Texas and moved northeastward along an arctic frontal boundary. During the morning of the 30th, the arctic front extended from central Texas to the southern Ohio River valley. A narrow band of heavy snow, associated with the frontal boundary, fell along the 1-94 corridor from Ann Arbor to Detroit from the morning of the 30th through the early evening hours. The heaviest freezing rain fell along and south of a line from Ann Arbor to Detroit, with precipitation being mostly in the form of snow to the north. Precipitation gradually tapered to light freezing rain and freezing drizzle late in the morning of the 31st across all of southeast Michigan as the low moved east of the state. Freezing rain redeveloped during the evening of the 31st across all of southeast Michigan, and again was heaviest along and south of a Detroit to Ann Arbor line. After the snow had changed over to freezing rain, one quarter to one half of an inch of ice had accumulated onto trees and power lines by the evening of the 31st. Southeast Michigan, mainly north of I-96, saw the heaviest precipitation fall in the form of snow. Snowfall amounts ranged from 5 to 9 inches across this area, with as much as 10 to 11 inches reported around Flint, Owosso, and Lapeer. Most of the damage from this prolonged winter storm occurred in Washtenaw, Wayne, Lenawee, and Monroe counties due to the higher accumulations of ice. The weight of the snow and ice on trees caused hundreds of tree limbs to break and even uprooted a few large trees. This did damage to dozens of homes and automobiles. At least 5 fatal traffic accidents occurred across southeast Michigan during the two days of winter weather. Falling tree branches and the weight of the ice downed hundreds of power lines and left an estimated 290 thousand residents and businesses without power, some of which had to wait several days for power to be restored. Most of the power outages occurred in the metro Detroit area, as well as across Washtenaw, Lenawee, and Monroe counties. (Source: National Climatic Data Center Storm Event Database.)

March 2, 2002 - Central Lower Michigan. A storm system developed across the southern plains and mid Mississippi River valley and moved northeast across central Michigan. Snowfall developed during the morning of the 2nd. The snowfall changed over to rain late in the morning in locations south of a Bad Axe to Owosso line. North of this line, the precipitation remained in the form of snow well into the evening. A band of heavy snow affected locations from southwest Lower Michigan across central Michigan and into the tri cities region. By late in the evening of the 2nd, snowfall had totaled 12 inches across much of Midland County. Snowfall amounts in Bay county ranged from 8 to 10 inches, while in Saginaw county, amounts ranged from 6 to 9 inches, with the higher amounts reported in the northwestern part of the county (Source: National Climatic Data Center Storm Event Database.)

December 18, 2002 - Central Lower Michigan. Freezing Rain affected the Central Lower are of Michigan. The heaviest precipitation occurred across Midland and northern Bay counties, where ice accumulations of around one quarter of an inch were reported, mainly on the roads. Saginaw and Tuscola counties reported around a tenth of an inch of ice accumulations. Across the rest of eastern Michigan, many secondary roadways and overpasses were coated with a thin glazing of ice. Dozens of traffic accidents were reported due to the icy roads during morning rush hour on the 18th. Most of the accidents were reported in the Saginaw Valley. The ice also led to many school closings across Midland, Bay, Saginaw, Tuscola, and Washtenaw Counties (Source: National Climatic Data Center Storm Event Database.)

April 3, 2003 - Central Lower Michigan. Damages: $161,100,000. 3 injuries Ice accumulations led to considerable tree damage and widespread power outages across the entire area. Locations hardest hit, with around an inch of ice reported on the trees, were across northern Oakland County, northern Macomb County, and throughout Lapeer, St Clair, Sanilac and Huron counties. In these areas, the tree damage was so severe that dozens of roads were blocked by trees and damage occurred to hundreds of homes, businesses and automobiles as tree limbs, or in many cases large trees themselves, were brought to the ground under the weight of the ice. It was estimated that 450,000 homes and businesses lost power during the storm. In fact nearly 50,000 people were without power for up to a week as persistent cold temperatures keep the heavy ice on the trees for 4 days after the storm. Crews came from four different states to help local utility companies restore power and remove hundreds of broken tree branches away from power lines. There were several direct and indirect injuries and fatalities. In Bay County, a 59-year old man died when his car slid into a ditch filled with water (indirect). (Source: National Climatic Data Center Storm Event Database.)

December 24, 2003 - Central and Southern Lower Michigan. An upper level low closed off over the state on Christmas Eve and continued to slowly track east overnight. This produced snowfall accumulations of two to four inches across the Tri-Cities and western Thumb region by Christmas morning. A warm conveyor belt from the northwest Atlantic Ocean then wrapped in behind this low toward Northern Lower Michigan late in the afternoon on Christmas Day. This snow band then progressed south during the evening into the Tri-Cities and Thumb, producing an additional three to five inches. Total snowfall accumulations for this 30 hour event were 5 to 9 inches (Source: National Climatic Data Center Storm Event Database.)

January 14, 2004 - Southern Lower Michigan. An Alberta Clipper tracked from Minnesota on January 14th, across southern Lake Michigan to near Toledo, then east to the eastern Seaboard on January 15th. While this system tracked across southern Lake Michigan, a persistent moderate to heavy snow band occurred along and north of M-59. Twelve hour snowfall with this system was generally between 6 and 11 inches across much of southeast Michigan, with the heaviest snow falling between M-59 and I-69. These high snowfall amounts are unusual for an Alberta Clipper, as these systems generally produce much less snow. This event lingered into the morning of the 15th as a Lake effect contribution off of Lake Huron helped Port Huron and Saint Clair record the highest total snowfall of 12 inches. Bay City, Bay County recorded 7 inches of snow accumulation (Source: National Climatic Data Center Storm Event Database.)

January 26, 2004 - Southeast Michigan. A strong storm system lifted from the southern Plains and moved through southeast Michigan on Tuesday January 27th. Areas of snow developed across the region Monday evening. The snow was mixed with sleet, especially from M59 south. An inch or two of snow was reported in scattered locations from M59 north. This precipitation was replaced by widespread freezing drizzle overnight, with an 1/8 of an inch of ice reported in some locations from I-69 South. Freezing rain and sleet crossed the Michigan border shortly after 6 am

EST. This precipitation changed to all snow during the morning, with accumulations of 1 to 2 inches per hour common, with even a couple reports of thunder. A dry slot moved into Southeast Michigan during the afternoon hours, before snow picked up again late in the day and continued into the early morning hours of Wednesday. By the time the snow ended Wednesday morning, total snowfall accumulations ranged from 5 to 10 inches. Linwood (Bay county) recorded 8 inches of snow accumulation (Source: National Climatic Data Center Storm Event Database.)

February 23, 2004 - Central Lower Michigan. A storm system slowly dropping southeast from Minnesota into lower Michigan on the 23rd deposited significant snow over the northern Tri-Cities region. Snowfall accumulations across Bay and Midland counties ranged from 5 to 7 inches, with the highest amount reported in Hope (Midland county) (Source: National Climatic Data Center Storm Event Database.)

November 25, 2004 - Southeast Michigan. A potent storm system lifted out of the Southern Plains and moved through the Central and Eastern Great Lakes region on Thanksgiving Eve. This storm produced the first widespread snowfall of the season over southeast Michigan. Although this system had a lot of moisture to work with, temperatures were just marginally cold enough to produce snow. In fact, the precipitation did start out as rain before turning over to snow. Snowfall rates exceeded an inch per hour for a period, as thundersnow was reported. Due to the convective nature of the wet snow, snowfall accumulations varied significantly within and across the counties, generally ranging from 2 to 8 inches. Gusty northeast winds of 30 to 40 mph further aggravated the situation, causing scattered power outages, and reducing visibilities to a quarter of a mile or less at times. Hundreds of car accidents occurred, which left three people dead, and many more injured. Auburn (Bay County) received 6.4 inches. (Source: National Climatic Data Center Storm Event Database.)

January 6, 2005 - Central Lower Michigan. A low pressure system tracked from west Texas on Tuesday the 4th through Missouri and into central Lake Erie by Thursday afternoon on the 6th. Four to Seven inches of snow fell across the Tri-Cities region (Source: National Climatic Data Center Storm Event Database.)

January 22, 2005 - Southeast Michigan. A deepening clipper type system tracked through the Ohio Valley. A big swath of snow fell across southeast Michigan roughly in a band centered from Brighton to Detroit. Snowfall amounts within the band were mostly in the 10 to 13 inch range, with lesser amounts to the north and south. Essexville (Bay) received 6.0 inches of snow (Source: National Climatic Data Center Storm Event Database.)

February 14, 2005 - Central Lower Michigan. This was a marginal icing event that affected the Tri-Cities and Northern Thumb region. Temperatures hovered just below freezing during the early evening hours of the 14th as precipitation quickly advanced northeastward. Continued overrunning of precipitation and persistent cold low level easterly flow allowed for ice accumulations between a quarter of an inch and half an inch (Source: National Climatic Data Center Storm Event Database.)

February 20, 2005 - Central and Southern Lower Michigan. A weak area of low pressure tracked along the southern Michigan border during the 20th. Four to Eight inches of snow fell across much of southeast Michigan. Localized higher amounts where reported across the Tri-Cities region, with as much as a foot of snow reported in Midland. Auburn (Bay County) received 7.8 inches of snow (National Climatic Data Center Storm Event Database.)

March 1, 2005 - Southeast Michigan. Low pressure slowly tracked across the southern Michigan border on February 28th into March 1st. Most locations across southeast Michigan received 4 to 7 inches in a 24 hour period. Lake Enhancement off of Lake Huron on March 1st allowed Bay, Midland, and Huron Counties to check in with around 8 inches of snow (Source: National Climatic Data Center Storm Event Database.)

April 23, 2005 - Central and Southern Lower Michigan. A powerful spring storm tracked across the Ohio Valley on Friday the 22nd, and into the Eastern Great Lakes on the 23rd. The storm then deepened as it slowly backed west toward Lake Huron on the 24th. This intense area of low pressure dumped heavy snow along and north of M-59, as well as producing frequent wind gusts to 30 mph. Final snowfall accumulations were generally in the 6 to 12 inch range, with slightly higher accumulations over the higher terrain along and just south of I-69. The combination of heavy wet snow and strong winds lead to numerous reports of trees and tree limbs down, which resulted in power outages. Bay City (Bay County) received 5.0 inches of snow accumulation (Source: National Climatic Data Center Storm Event Database.)

January 21, 2006 - Southeast Michigan. A fast moving storm system moved out of the Texas Panhandle on Friday and moved northeast across the Detroit metro area early on the 21st. Heavy snow accumulated 6 to 7 inches north of a line from northern Shiawassee County to Northern Sanilac County. The snow began at 2000 EST on the 20th and reached 6 inches by 0500 EST on the 21st. The heaviest snowfall occurred during the early morning hours of the 21st during which time snowfall rates equaled one inch per hour. By 0800 EST, the snow had ended. Locations just south of this area received a mixture of precipitation including rain, freezing rain, sleet, and snow. Pinconning (Bay County) received 7.1 inches of accumulation (Source: National Climatic Data Center Storm Event Database.)

February 16, 2006 - Central Lower Michigan. Damages: $1,000,000. A significant ice storm hit the Tri Cities as warm air aloft surged north ahead of a warm front. The front made it as far north as Flint before stalling out. North of the front, surface temperatures remained below freezing. Three rounds of thunder freezing rain, some of which had hail up to 1/2 inch in diameter, pelted the Tri Cities on the afternoon of Thursday February 16. The ice began to accumulate right around noon and continued all afternoon and evening. The first round of thunderstorms occurred just prior to 1500 EST, followed by another round the following hour. The 3rd and final round struck between 1900 and 2000 EST and hit the hardest. The ASOS at MBS recorded an amazing 91 hundredths of an inch of precipitation during the entire duration of the frozen precipitation. Scores of trees and power lines were brought down under the weight of the ice. The heaviest icing occurred across Midland and Bay counties where widespread ice accumulations 1/2 to 1 inch caused significant damage which resulted in power outages for much of the region. The coldest air of the season settled into the area on the 17th. The thermometer plummeted to 0 degrees by sunrise on the 18th. Frigid temperatures, well below normal, continued through the weekend. Many remained without power for days. In response, Red Cross and public schools in the area opened temporary warming shelters to accommodate those without power. Insurance companies estimated the total damage across the three County regions at $1M (Source: National Climatic Data Center Storm Event Database.)

February 16, 2006 - Mid-Michigan. A winter storm with a thunderous twist cut power to more than 100,000 mid-Michigan homes Thursday night, and some may not see the juice restored until Sunday. The outages stretched from Clare to the Saginaw Bay and up to the Tawas area, where 4,000 utility customers were without electricity. In Bay County, about 8,100 utility customers were without electricity this morning. The Bay City area received up to 1.5 inches of precipitation in the past 24 hours, which included about an inch of snow, said Steven Freitag, meteorologist with the National Weather Service in White Lake (Bay City Times Archives.)

March 2, 2006 - Central Lower Michigan. A winter storm system tracked out of the Northern Plains on the 1st and crossed over the Ohio Valley on the morning of the 2nd. A relatively narrow band of 8 to 10 inches of snow fell across the Tri Cities and thumb region with up to a foot of snow across northern Tuscola County. Moderate to heavy snow began around 2 AM EST and continued into the afternoon hours before finally tapering off. There was a sharp gradient to the snow accumulations. Bay City (Bay County) received 11.0 inches of snow (Source: National Climatic Data Center Storm Event Database.)

January 14, 2007 - Southeast Michigan. Damages: $100,000. By 0200 EST on the 15th, spotters were reporting 3/10 of an inch of ice on vegetative and elevated surfaces across the county. Several trees were downed across the area due to the extra weight of the ice. Up to 2 inches of snow fell on top of the ice around sunrise across the northern sections of the county. Total property damages were roughly estimated at $100,000. Over 150,000 customers were without power at one time during the ice storm. Many were without power for 2 days, and some for over 3 days. Several senior homes lost power and 200 residents had to be evacuated from one of them. Most of the damage and associated power outages occurred between M59 and I94. Along and just north of the I-69 corridor, a mixture of freezing rain, sleet, and snow fell, where reports confirmed up to 5 inches of snow and one tenth of an inch of ice. Mostly all snow fell across the Tri-Cities and Thumb, where 4 to 6 inches of snow accumulated across portions of these areas. (Source: National Climatic Data Center Storm Event Database.)

March 1, 2007 - Central and Eastern Lower Michigan. The winter storm event started before sunrise on March 1st, when a mixture of snow, sleet, and freezing rain fell along and south of the I69 corridor. North of the corridor, the precipitation started as all snow and accumulated up to 4 inches before changing over to freezing rain by late afternoon. Temperatures remained just below freezing throughout the evening, when several bands of very heavy precipitation led to significant icing across portions of Midland County, Bay County, and the Thumb. Areas hardest hit, with widespread ice accumulations around an inch, were across northern Tuscola County, northern Sanilac County, and throughout Huron County, especially in communities along the shoreline in the tip of the Thumb. Most of the damage occurred when strong winds gusted up to 50 MPH and brought down widespread trees and snapped power poles in half for miles. Hundreds of traffic accidents were reported during the storm. Most traffic related injuries were minor, but about a half dozen people were critically injured and at least one death was blamed on the storm (indirect). The total monetary value attributed to this storm was estimated at around $1.5M, with nearly all of this in Huron County alone. There were a few reports from trained spotters of 3 inches of snow and a quarter inch of ice in Bay County (Source: National Climatic Data Center Storm Event Database.)

April 4, 2007 - Central and Eastern Lower Michigan. A very cold air mass blasted into the region, leading to intense lake effect snow squalls from Saginaw to Flint and east into Lapeer County. The squalls were narrow but intense bands that dumped up to 4 inches of snow in some areas with only trace amounts in other areas. The snow was also accompanied by wind gusts up to 40 MPH which created brief periods of near whiteout conditions. The snow squalls caused numerous accidents and multiple spinouts beginning early Wednesday evening, April 4th. The accidents continued through the night and into Thursday morning, April 5th. There were 43 weather related accidents reported in Saginaw County, at least 14 in Bay County, 46 in Lapeer County, and numerous accidents and spinouts in Genesee County. Several roads were closed, including a stretch of Interstate 75 near Birch Run after a large number of vehicles crashed on both lanes of the icy expressway. A 19 year old male was killed after an oncoming vehicle lost control on an icy road in Lapeer County (indirect). At least 2 people were critically injured in other accidents (indirect) (Source: National Climatic Data Center Storm Event Database.)

December 1, 2007 - Southern Lower Michigan. A low pressure system developed over Colorado and tracked through the Central Plains and eventually over Southeast Lower Michigan. With temperatures in the low 20s, the precipitation on the evening of the 1st began as all snow. Portions of the Tri-Cities and Thumb region received up to 7 inches of snow, with generally only one to three inches elsewhere because of a late evening transition to sleet and freezing rain. A total of 7 inches of snow fell in a 6 hour period in Bay County. Most locations throughout the rest of Southeast Lower Michigan had between one and two tenths of an inch of ice accumulation. Locations around Saginaw had the most ice accumulation, with numerous spotters reporting a quarter inch of ice. Numerous accidents were reported across the area (Source: National Climatic Data Center Storm Event Database.)

December 11, 2007 - South-Central and Southeast Michigan. A low pressure system with a plentiful supply of moisture moved from the Central Plains through the Great Lakes on Tuesday, the 11th. This system caused a combination of light snow and freezing rain over the area. Generally light amounts of mixed precipitation fell with best snowfall amounts of 2 to 4 inches over parts of the Tri Cities and Thumb Region. Icing amounts ranged from a trace to two tenths of an inch, leading to numerous accidents across all of Southeast Lower Michigan. (Source: National Climatic Data Center Storm Event Database.)

December 16, 2007 - South-Central and Southeast Michigan. A deepening storm center moved northeast toward the lower Great Lakes on Sunday (16th) and brought widespread heavy amounts of snow. Widespread snow, heavy at times, moved into the region during the early morning hours and persisted throughout much of the day. Snowfall ranged from generally 6 to 10 inches throughout much of Southeast Lower Michigan. Strong gusty winds of 35 to 45 mph created 1 to 3 foot drifts with near blizzard conditions across much of Southeast Lower Michigan. Blizzard conditions were reported across the eastern Thumb Region from late Sunday morning through much of the afternoon, mainly along M-25 near the Lake Huron shoreline. In Bay County, trained spotters reported 8.5 inches in 12 hours. Numerous accidents were reported during the storm and schools were closed on Monday (Source: National Climatic Data Center Storm Event Database.)

December 23, 2007 - Bay County. Winds gusting more than 50 mph uprooted trees Sunday and knocked out power to thousands of people across Michigan before a snowstorm moved into the western part of the state. According to Bay City area police agencies, winds left traffic lights out at the intersection of Youngs Ditch and Tuscola roads and at Euclid Avenue and Wilder Road. A utility pole fell down across the road near the U.S. Post Office on Woodside Avenue, while other crews dealt with a low hanging wire at Michigan Avenue and 32nd Street, police said (Bay City Times Archives.)

December 28, 2007 - South-Central and Southeast Michigan. This storm affected the Saginaw Valley. A band of moderate to heavy snow moved quickly over Southeast Lower Michigan on December 28th. Conditions deteriorated rapidly as the snow intensified during the afternoon. The snow fell at a rate of an inch per hour and persisted before diminishing during the evening (Source: National Climatic Data Center Storm Event Database.)

December 30, 2007 - Bay County. A snowstorm and thin ice aren't enough to keep anglers from fishing on Saginaw Bay. At least six fishermen were rescued Friday afternoon from two ice floes, both off Fish Point, in blowing snow and near white-out conditions, according to U.S. Coast Guard officials and Cy Thomas, a Unionville marina owner who assisted. A private boat, manned by Thomas and neighbor Jim Wurm, helped ferry three men ashore in an airboat, Thomas said (Bay City Times Archives.)

January 21, 2008 - Central Lower Michigan. A low pressure system tracked across central Lower Michigan, with the highest snow occurring near the surface low track over the Tri-Cities region. Here are some of the higher snowfall reports: Bay City, 8.0 inches. Essexville, 7.0 inches. Midland, 6.0 inches. Oil City, 6.0 inches. Huron, 6.0 inches. Saginaw, 6.0 inches (Source: National Climatic Data Center Storm Event Database.)

February 6, 2008 - Southeast Michigan. A cold front moved through Southeast Michigan. A secondary low then developed along the trailing front, with the center passing just south of the area. This allowed heavy precipitation to spread north into southeast Michigan, with predominantly snow along and north of M-59. Widespread heavy snowfall of 8 to 12 inches occurred along and north of I-69, with the heaviest snow, 16 to 18 inches occurring over Saginaw County, making this storm the biggest since the Blizzard of 1978. Strong northeast winds off of Saginaw Bay also lead to near blizzard conditions. Road Crews in Saginaw County could not keep up with the snow, which fell at a rate of 2-4 inches per hour. Two to three foot snow drifts left at least 50 cars stranded. Snowfall amounts tapered off south of I-69, as sleet mixed in, cutting down accumulations quickly, with less than 3 inches across Wayne County and points south. Here are some of the higher snowfall reports received from each county: Burt (Saginaw) 16.0 inches. Birch Run (Saginaw) 16.0 inches. Bay City (Bay County) received 10.5 inches of snow accumulation. (Source: National Climatic Data Center Storm Event Database.)

December 1, 2008 - Bay County. Wet, heavy snow knocked out power in Bay County and across Michigan today. The Bay City area saw 3-5 inches of snow on Sunday night, said David Cook, a meteorologist with the National Weather Service (Bay City Times Archives.)

December 9, 2008 - Southeast Michigan. A low pressure system tracked through southeast Michigan, delivering 5 to 9 inches of snow north of I-69, with amounts quickly tapering off farther south as precipitation type was mostly rain. Auburn (Bay County) received 8 inches of snow (Source: National Climatic Data Center Storm Event Database.)

December 19, 2008 - Southern Lower Michigan. A strong upper wave tracked through southern Lower Michigan, with the associated surface low track through northern Ohio. This track helped lock in the cold air in place, resulting in a general 6 to 12 inch snowfall across southeast Michigan, which fell in a ten hour period (Source: National Climatic Data Center Storm Event Database.)

January 17, 2009 - Southeast Michigan. Snow overspread southeast Michigan around 10 AM Saturday January 17th and continued into Saturday night. Twenty-One hour snowfall totals averaged 4 to 7 inches along and north of I-94 with a few isolated 8 inch reports north of I-69. A low pressure system tracking from Wisconsin eastward across Mid Michigan was responsible for the snow. Out ahead of the system Saturday afternoon, southerly winds gusting 25-30 mph caused blowing and drifting snow. This in combination with temperatures hovering in the lower teens, caused roadways to remain snow covered and slippery. Here are some of the higher snowfall totals reported: Auburn (Bay) 8.0 inches. Pontiac (Oakland) 7.2 inches. Fairgrove (Tuscola) 8.0 inches (Source: National Climatic Data Center Storm Event Database.)

December 9, 2009 - Bay County. The Bay City area received about 5 inches of snow Wednesday. On Wednesday morning, 4,585 power outages were reported in Bay County and 2,695 outages in Arenac County (Bay City Times Archives.)

February 11, 2010 - Bay County. More than a half-foot of snow fell over Bay County, resulting in numerous accidents and school closings and claiming the lives of a Kalamazoo woman and Mount Pleasant man (Bay City Times Archives.)

3.14.3 Bay County Profile

The following table summarizes the probability of a winter storm in Bay County.

Table 3.22 Winter Storm Profile

Period of Occurrence (1967-2010):	43
Number of Events:	70
Past Damages:	$39,194,615
Annual Chance Probability Ratio:	1.63
Warning Time:	Days for snow Minutes to hours for ice
Potential Impacts:	Infrastructure damage (transportation and communication systems), structural damage, and damaged or destroyed critical facilities Can cause severe transportation problems and make travel extremely dangerous. Power outages, which results in loss of electrical power and potentially loss of heat, and human life. Extreme cold temperatures may lead to frozen water mains and pipes, damaged car engines, and prolonged exposure to cold resulting in frostbite.

4.0 ASSESSING VULNERABILITY

This hazard vulnerability section uses "best available data" from national, state, and local data sets. These estimates should be used to understand relative risk and potential losses from hazards. Uncertainties are inherent in any vulnerability assessment and loss estimation methodology, arising in part from a still-developing scientific knowledge concerning natural hazards and their effects on the built environment. Uncertainties also result from approximations and simplifications that are necessary for a comprehensive analysis (such as incomplete inventories, demographics, or economic parameters). The Bay County planning team using the best available data and methods determined the vulnerability of Bay County for a variety of natural hazards.

Important definitions to understand for this vulnerability assessment model:

- *Hazard Identification*: A hazard is considered to be anything which either threatens the residents of a community or the things that they value.
- *Exposure*: The community's assets: people, property, critical facilities and infrastructure potentially exposed to a hazard.
- *Risk*: Risk equals the hazard probability based on occurrences and or your probability based on geographic hazard layers.
- *Vulnerability*: Defines what part of the "exposure" is at "risk" to each "hazard".

4.1 VULNERABILITY ASSESSMENT METHODOLOGY

There are many different methodologies to determine hazard vulnerability. The Bay County planning team spent many hours of research and conducted test runs to develop a county specific methodology. The final model relies heavily on GIS software and provides the user several layers of information that can be used as developed in this report or individually for varying informational and planning needs.

In order to facilitate data collection and analysis, a planning area or an area of measure must be identified. Typically, county boundaries or some form of census boundaries (tracts, blocks) are used. However, in Bay County this methodology did not complement the boundaries of the individual jurisdictions. After researching specific and relevant planning areas, the team used the county's township boundaries (18 jurisdictions see following map). This method is logical for the multi-jurisdictional plan and provided Bay County an area specific vulnerability assessment for previously defined and established units of government. The jurisdictional boundaries were used to organize the data inputs and normalize the data providing the baseline for our multi-jurisdictional risk assessment. This approach supported developing a vulnerability score for each jurisdiction and for each hazard. Thereby, allowing local jurisdiction decision makers to concentrate mitigation actions on their specific jurisdictional areas. The following figure demonstrates the jurisdictions in Bay County.

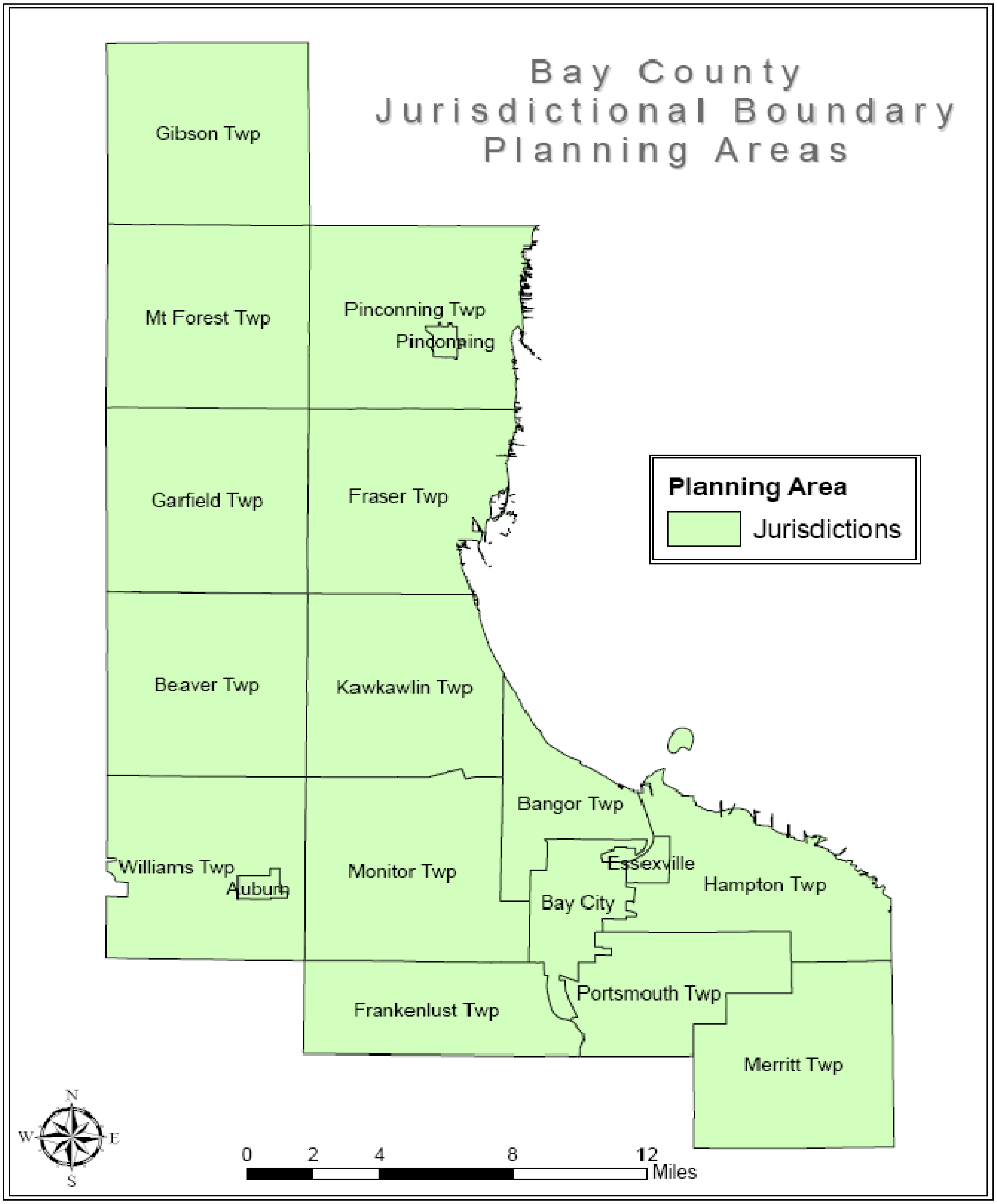


Figure 4 Bay County Jurisdictional Boundary

4.1.1 Model

The risk assessment model used for Bay County was based upon the University of Louisville's Center for Hazard Research and Policy Development FEMA accepted methodology that has been previously used for other state, local and university hazard mitigation plans.

Hazard Vulnerability Score = Exposure Score X Risk Score

When measuring vulnerability, the planning team measured the exposure of each jurisdiction to risk for each natural hazard. The **Exposure Score** provides the information needed to complete a Vulnerability Assessment on any type of hazard. The Bay County exposure score consisted of four different variables called ranks. In the Local Mitigation Plan Crosswalk, FEMA asks "*Does the new or updated plan describe vulnerability in terms of the types and numbers of **existing buildings, infrastructure**, and **critical facilities** locate in the identified hazard areas?*" The Bay County Exposure Score is the baseline variable in understanding FEMA's above mentioned question.

4.1.1.1 Exposure Score

Exposure Score = Population Rank + Property Value Rank + Critical Facility Rank + Infrastructure Rank

Definitions of Variables

1. *Population Rank*

Variable	***Source***
Population by Jurisdiction	*Bay County GIS Department*

<u>*Population Rank*</u> *was derived for each jurisdiction based on Census 2000 Population Density Data. Given the variation of the jurisdictional areas, density was used to normalize the data.*

2. *Property Rank*

Variable	***Source***
Property Numbers by Jurisdiction	*Bay County GIS Department*

<u>*Property Value Rank*</u> *was derived for each jurisdiction based on Census 2000 Housing Units Density data creation. Given the variation of the jurisdictional areas, a Property Density calculation was performed and used to normalize the data.*

3. Critical Facility Rank

Variable	***Source***
Critical Facilities per Jurisdiction	*Bay County GIS Department*

<u>Critical Facilities Rank</u> was derived for each jurisdiction based on a count of the total number of critical facilities located within each jurisdiction.

Critical Facilities identified were populated from several GIS layers depicting the geographic locations of the following variables for each jurisdiction: government buildings, police stations, fire stations, schools, hospitals, HAZ-MAT facilities and airports.

4. Infrastructure Rank

Variable	***Source***
Infrastructure Facilities per Jurisdiction	*Bay County GIS Department*

Infrastructure Rank was derived for each jurisdiction based on a count of the total number of infrastructure facilities and infrastructure lines located within each jurisdiction.

Infrastructure Facilities/Lines identified were populated from several GIS layers depicting the geographic locations of the following variables within each jurisdiction: ***total number*** *of towers, water plants, wells, flood pump stations, oil and gas wells and bridges;* ***number of miles*** *of waterlines, pipeline, sewer lines, major utility lines, rail and roads. An* ***Infrastructure Point Rank*** *and an* ***Infrastructure Line Rank*** *was created. These two ranks were combined to create the overall* ***Infrastructure Rank****.*

Each "Rank" (Population Rank, Property Rank, Critical Facility Rank and Infrastructure Rank) was calculated and then ranked 0 – 3 (0 N/A, 1 Low, 2 Medium, 3 High) using the Natural Breaks (Jenks) method provided in ArcGIS as a classification choice. The Natural Breaks classification model creates classes that are based on natural groupings inherent in the data by picking the class breaks, that best groups similar values, and maximizes the differences between classes.

Each variable was calculated as previously described and the ranks were added to produce an Exposure Score, **one of the variables used to equate the Hazard Vulnerability Score**. It is important to note that each one of the exposure variables can be used individually to show important information or combined in different formulas to produce different results. This Vulnerability Assessment Model was developed to be flexible and encompassing.

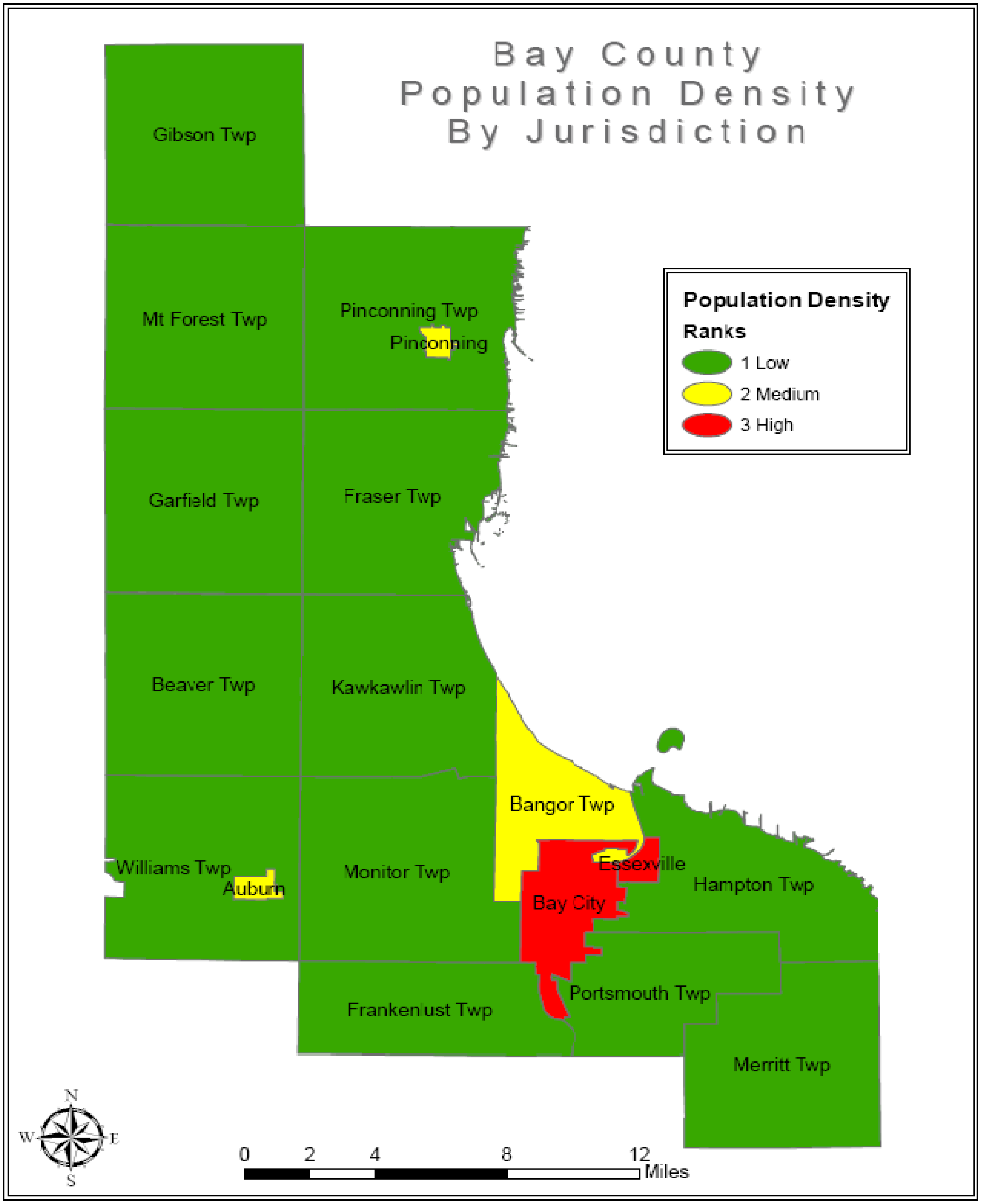


Figure 5 Population Rank Map

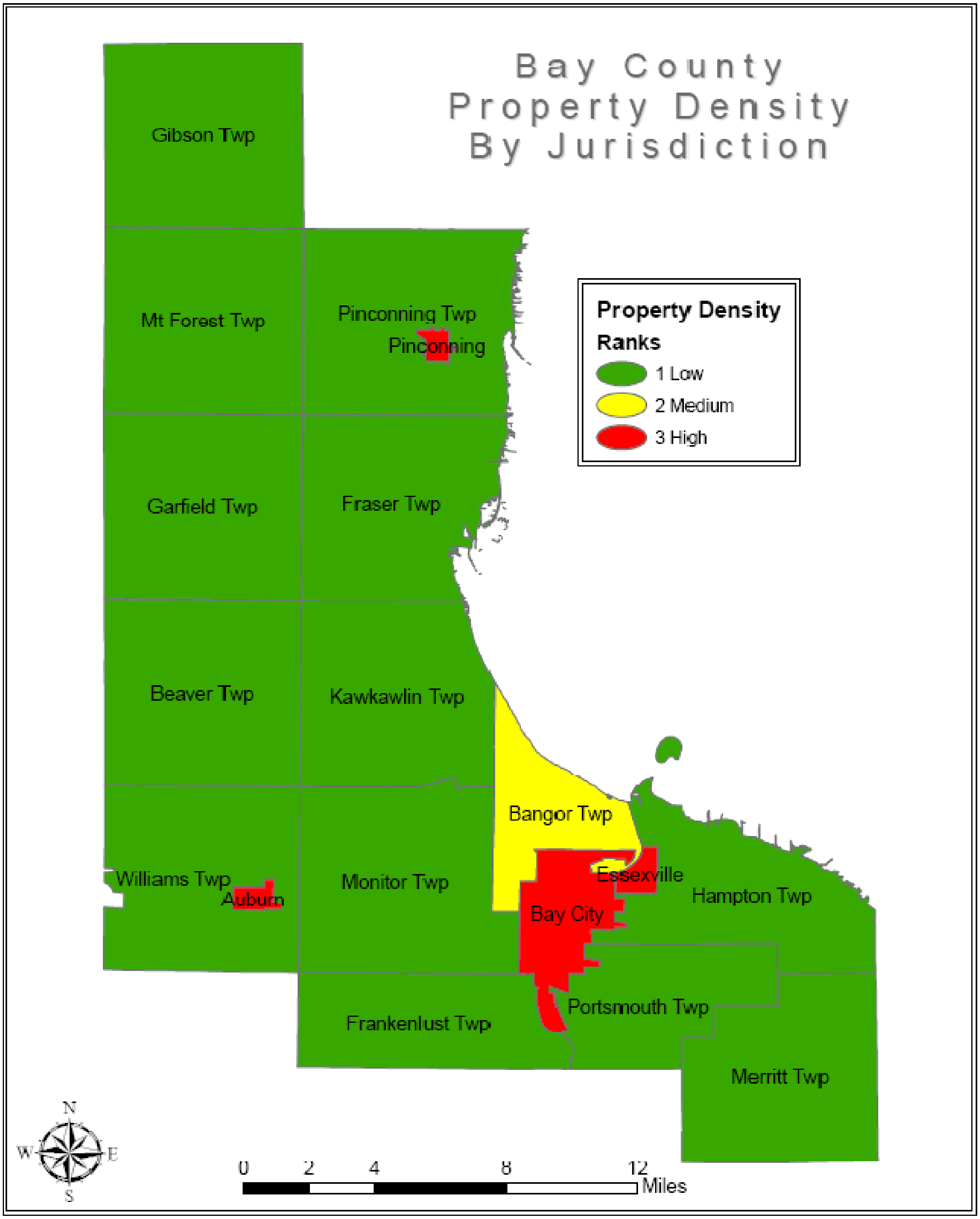


Figure 6 Property Rank Map

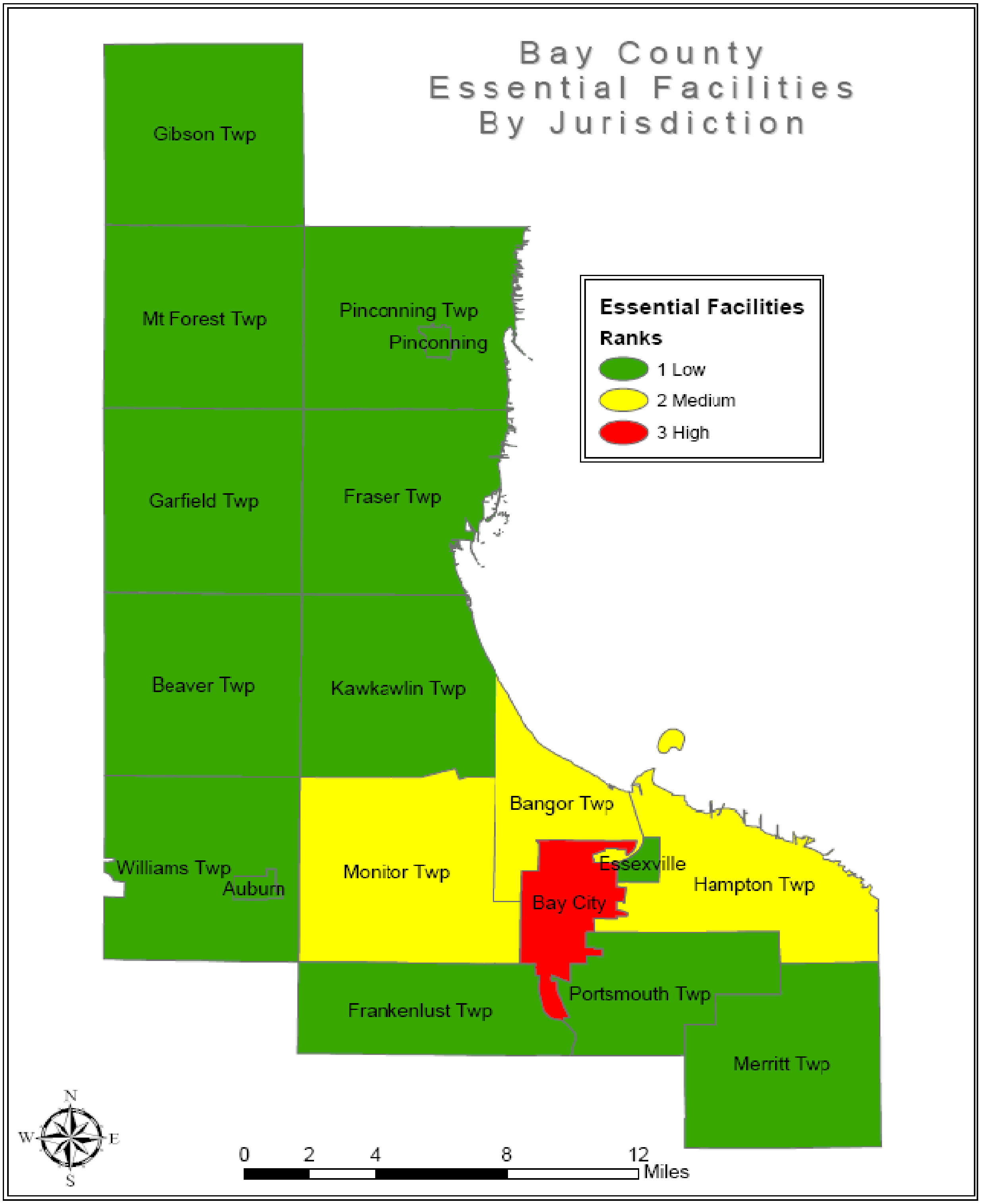


Figure 7 Critical Facility Rank Map

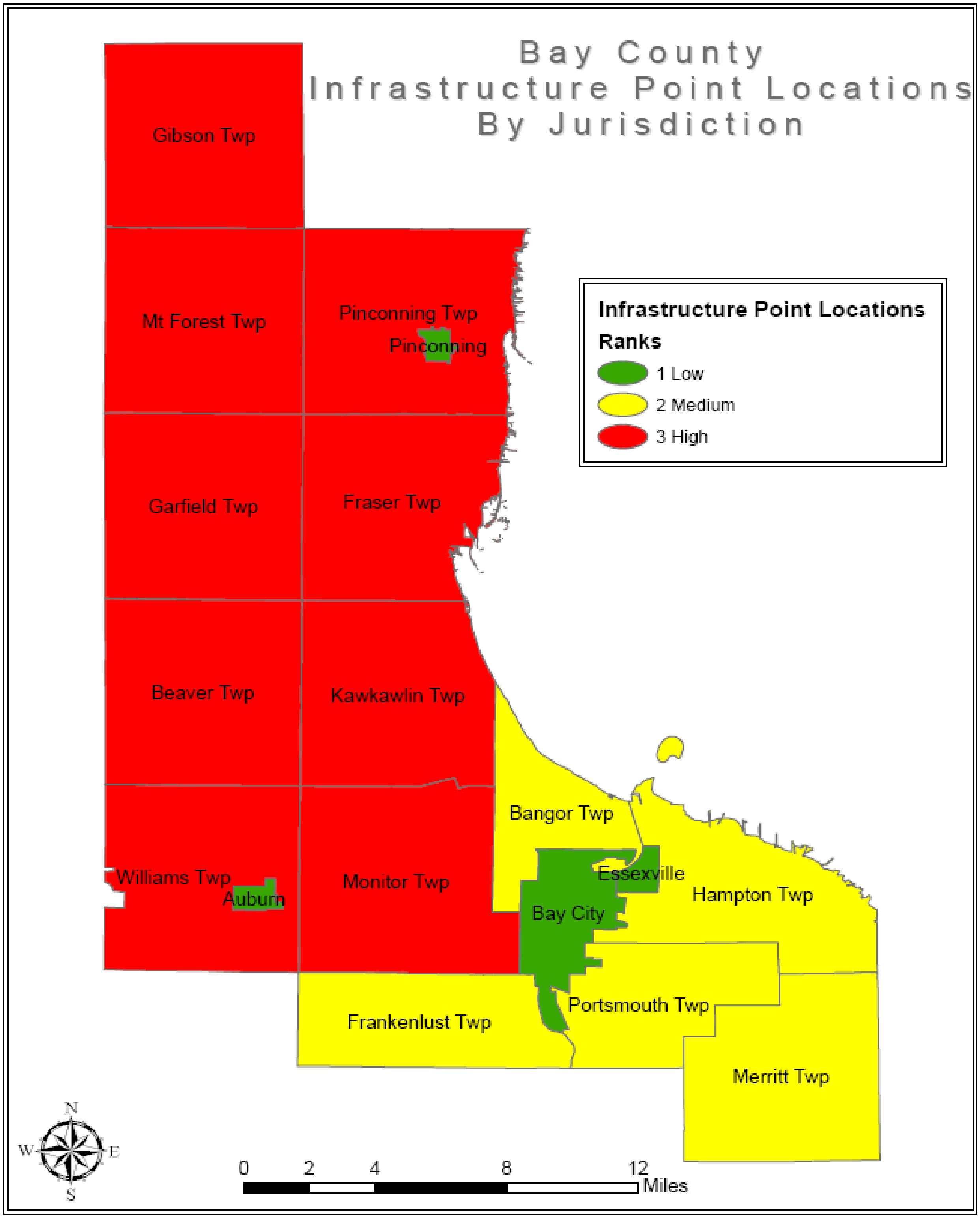


Figure 8 Infrastructure Point Rank Map

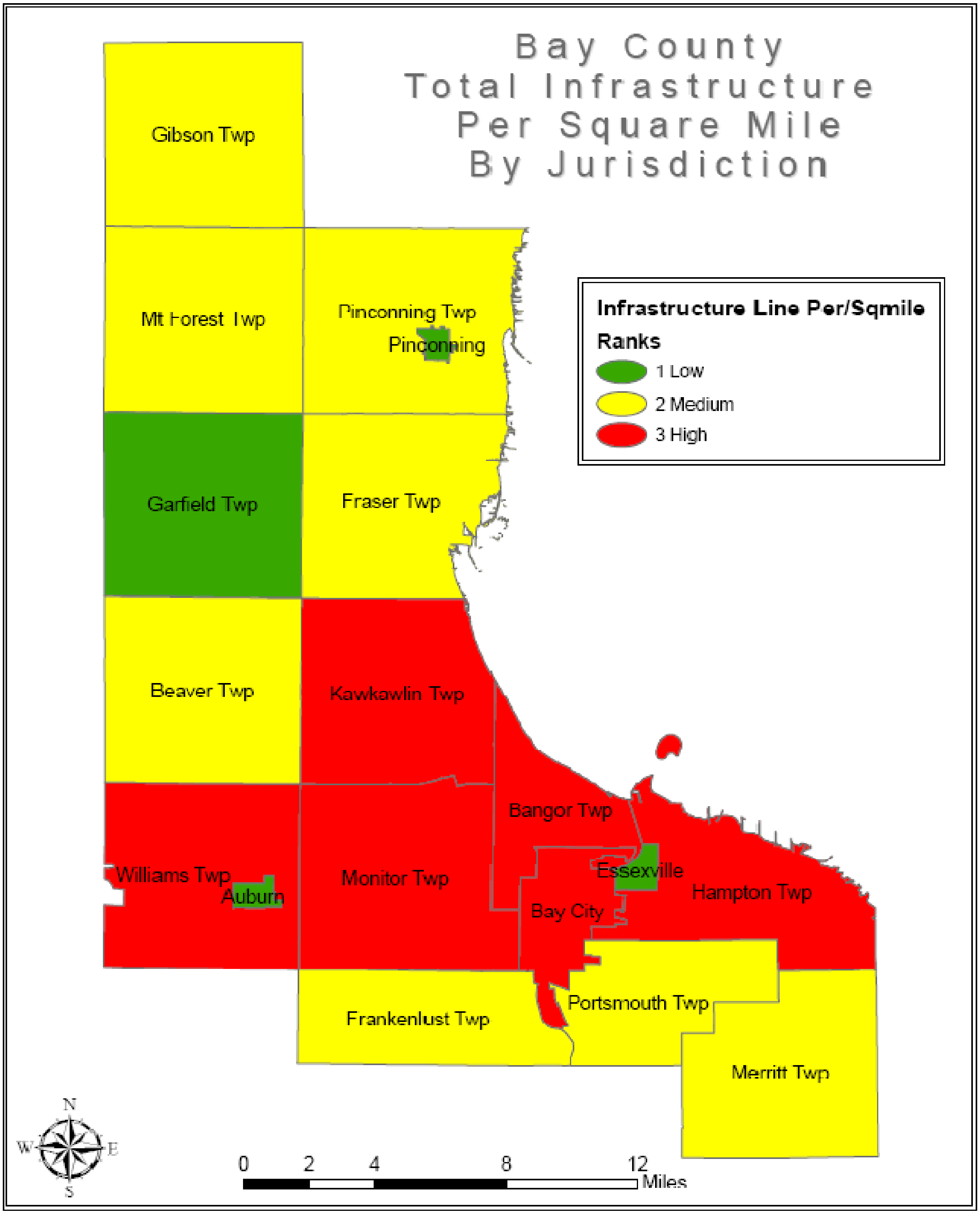


Figure 9 Infrastructure Line Rank Map

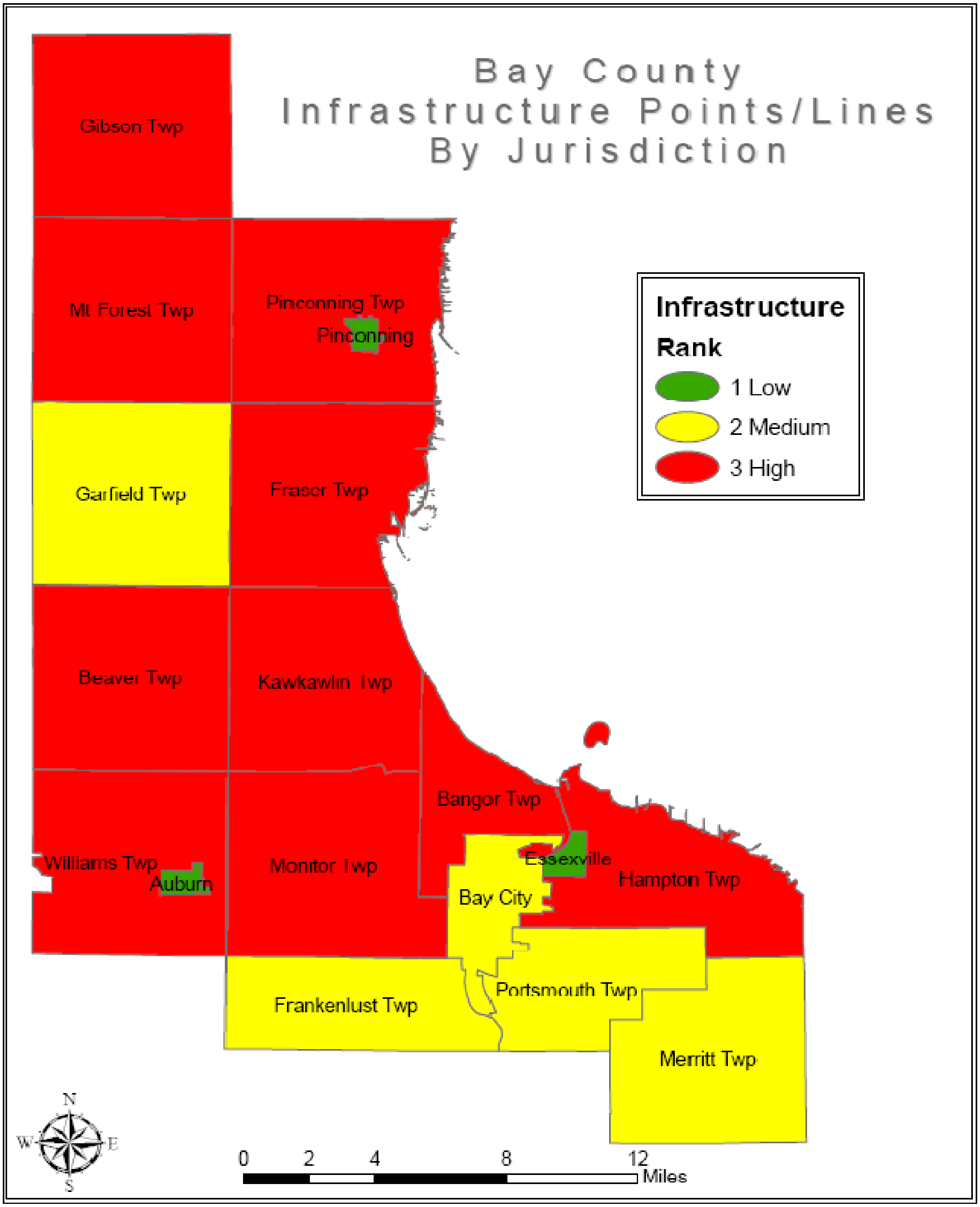


Figure 10 Infrastructure Rank Map

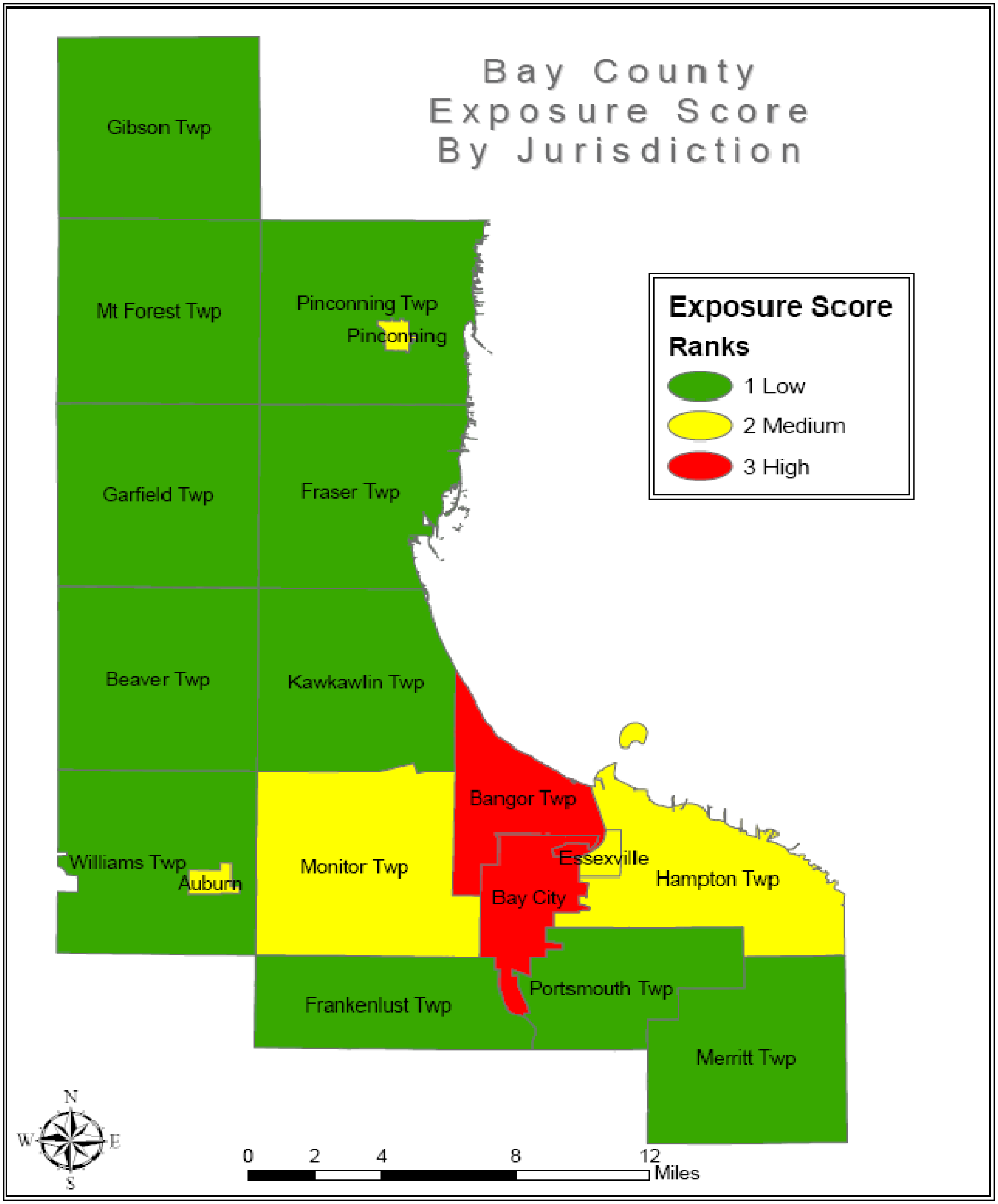


Figure 11 Exposure Score Map

4.1.1.2 Risk Score

The second piece of the *Hazard Vulnerability Score* is the calculation of the ***Risk Score***.

Risk Score = Occurrence Rank and/or Area Effected Rank

When measuring vulnerability, the planning team measured the effects of natural hazards on each Bay County jurisdiction. The risk score assigns a hazard variable to the hazard vulnerability score. The Planning Team decided the risk score would be composed of one of the following variables: occurrence rank and/or area effected rank. These two variables were chosen because of the differences in information recorded for natural hazards. Some hazards have boundaries for analysis, such as flooding, while total numbers of occurrences are best used to analyze risk of those hazards occurring anytime or anyplace, such as severe storms.

The *occurrence rank* was derived from various sources. However, the most useful occurrence data was created through local stakeholders' identification of specific hazard occurrence locations. This data can be used to identify specific locations that need to be mitigated and thus become a mitigation action in Bay County's ***Mitigation Strategies***. Other occurrence data points were located for each jurisdiction using data derived from NOAA's geo-located NOAA/NWS SVRGIS database. This database geo-references NCDC data where there is sufficient information. It is important to note that while it is possible to capture occurrence data for drought, extreme temperatures and severe winter storms at the county level; this data does not provide sufficient data to perform a multi-jurisdictional level analysis. For these three hazards, the exposure score drives the vulnerability assessment. The following hazards received an occurrence rank: flood, hail, severe storm, tornado and wind driven ice floes.

The *area effected rank* illustrates each jurisdiction's vulnerability based on the percent of the area affected by each hazard. This type of data provides certainty of where problem areas are located, thus providing geographically informed decisions on where to mitigate in the future. The area effected boundary files were acquired and developed from different data sources discussed in greater detail later in this report. The following hazards received an area affected rank: Flood and Wildfire.

It is also important to note that there is no historical record of Bay County having an earthquake or being vulnerable to one. However due to the extreme and unpredictable nature of earthquakes the planning team decided to keep earthquakes as a hazard (identified and profiled) but at this time there is no data to compile a risk assessment for earthquakes.

The *hazard vulnerability score* displays the jurisdictional location of each hazard, displays the extent (low, medium, high) and displays past occurrences where data permits.

Once the risk scores were determined and ranked ***0 – 3 (0 N/A, 1 Low, 2 Medium, 3 High)*** for each hazard, the equation was defined to produce a hazard vulnerability score, per hazard, for each jurisdiction.

The following pages will display each individual *hazard vulnerability score* along with a description of how each score was calculated.

4.1.1.3 Flood Vulnerability Score = Exposure Score X Flood Risk Score

Flood Risk Score was derived from the 2010 Digital Flood Insurance Rate Map (DFIRM) floodplain data to create a percent of area effected by jurisdiction (**Area Effected Rank**). Also added was locational data provided by citizens (**Occurrence Rank**). The risk score ranks were aggregated and ranked ***0 – 3 (0 N/A, 1 Low, 2 Medium, 3 High)*** for each of the 18 jurisdictions. The flood risk score was then multiplied by the exposure score to create the flood vulnerability score for each jurisdictions based on identifying at risk flood areas that have high exposure.

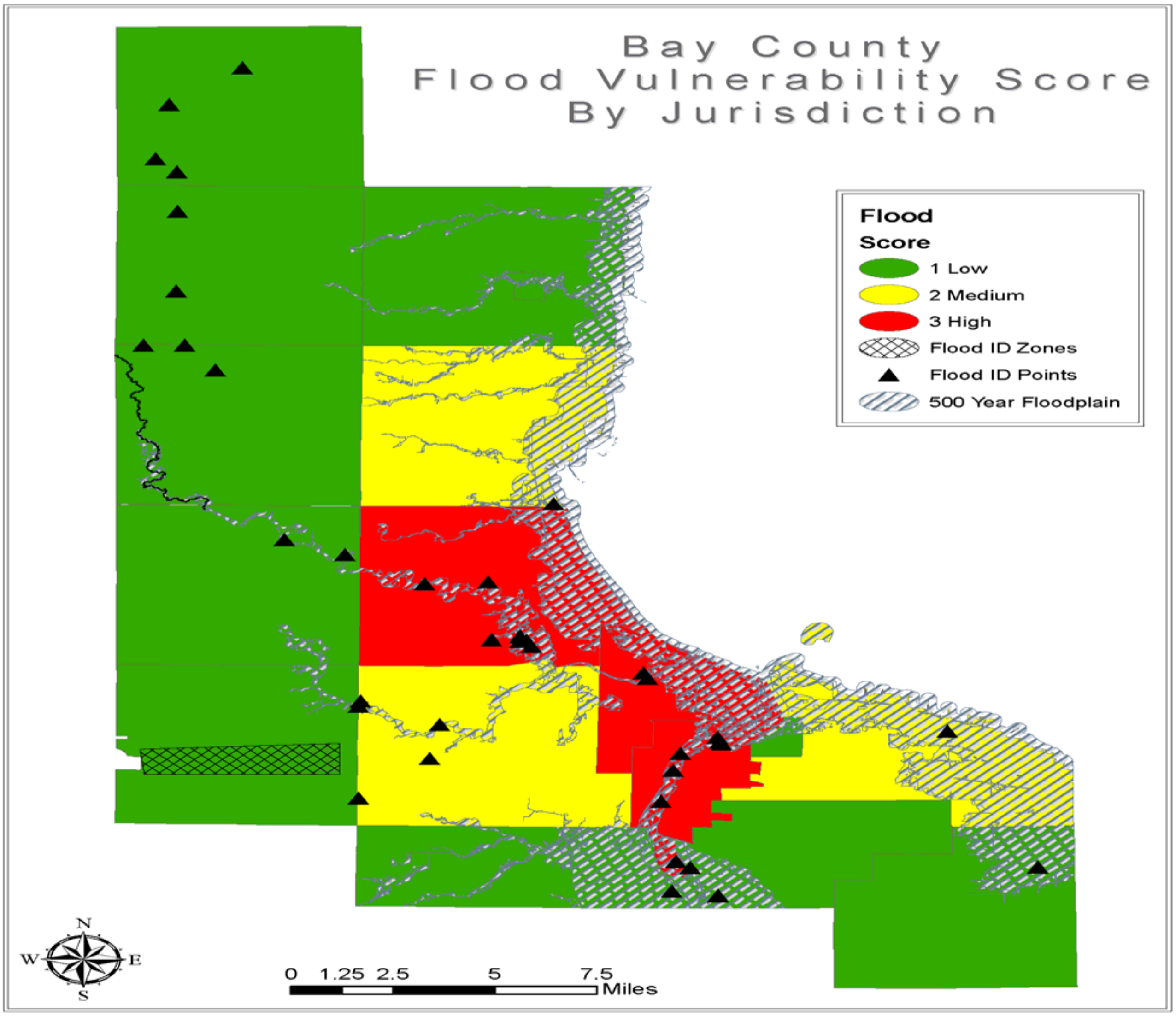


Figure 12 Flood Vulnerability Score

4.1.1.4 Hail Vulnerability Score = Exposure Score X Hail Risk Score

Hail Risk Score was derived from NOAA/NWS SVRGIS database for hail events. This data set geo-locates hail occurrences across the country. An **Occurrence Rank** was built based on the number of events per jurisdiction which created the **Hail Risk Score** which was ranked ***0 – 3 (0 N/A, 1 Low, 2 Medium, 3 High)***. The risk score was then multiplied by the exposure score to create the hail vulnerability score for each jurisdictions based on identifying at risk hail areas that have high exposure.

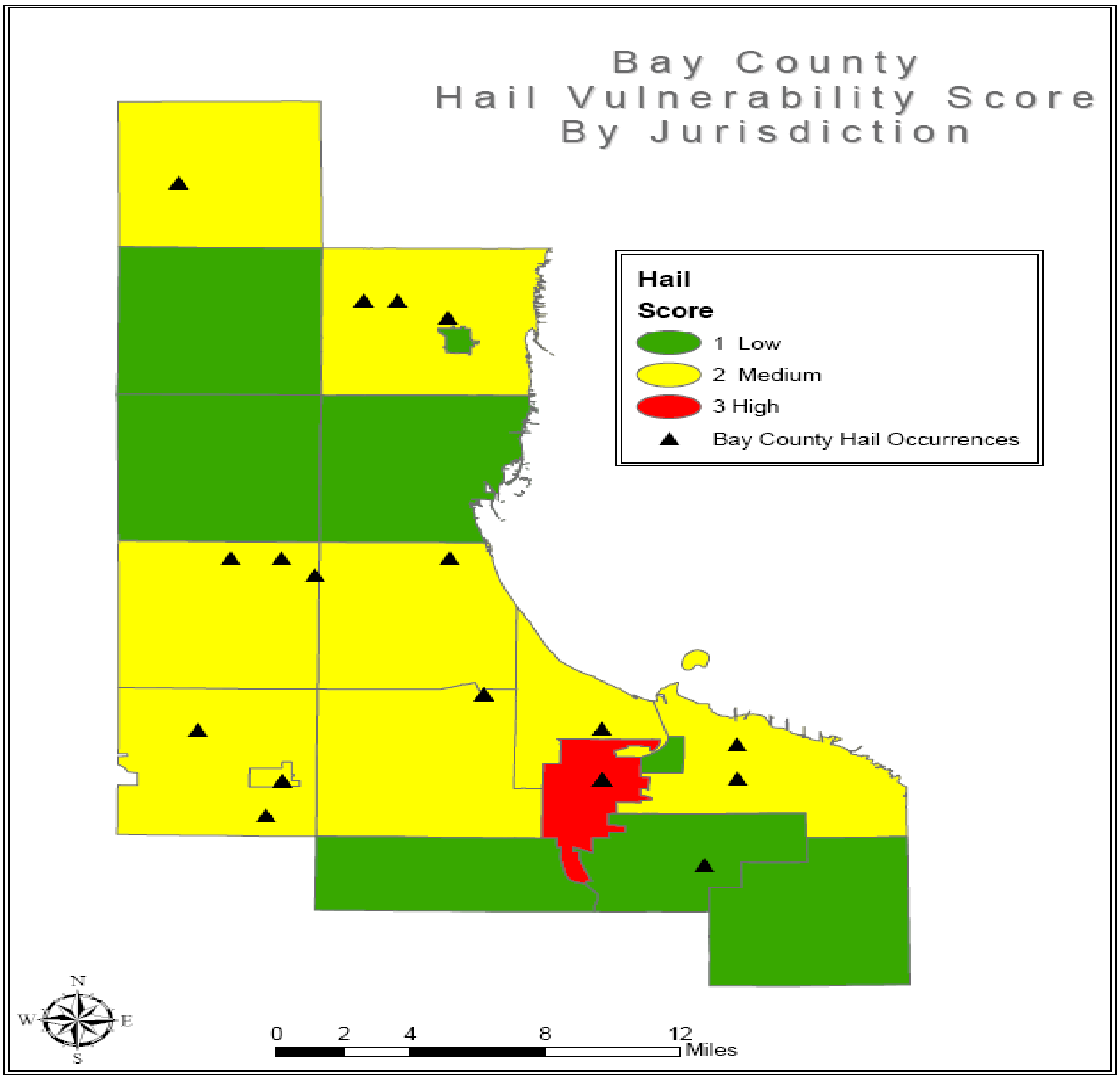


Figure 13 Hail Vulnerability Score

4.1.1.5 Severe Storm Vulnerability Score = Exposure Score X Severe Storm Risk Score

Severe Storm Risk Score was derived from NOAA/NWS SVRGIS database for severe storm events. This data set geo-locates severe storm occurrences across the country. An **Occurrence Rank** was built based on the number of events per jurisdiction which created the **Severe Storm Risk Score** which was ranked ***0 – 3 (0 N/A, 1 Low, 2 Medium, 3 High)***. The risk score was then multiplied by the exposure score to create the severe storm vulnerability score for each jurisdiction based on identifying at risk severe storm areas that have high exposure.

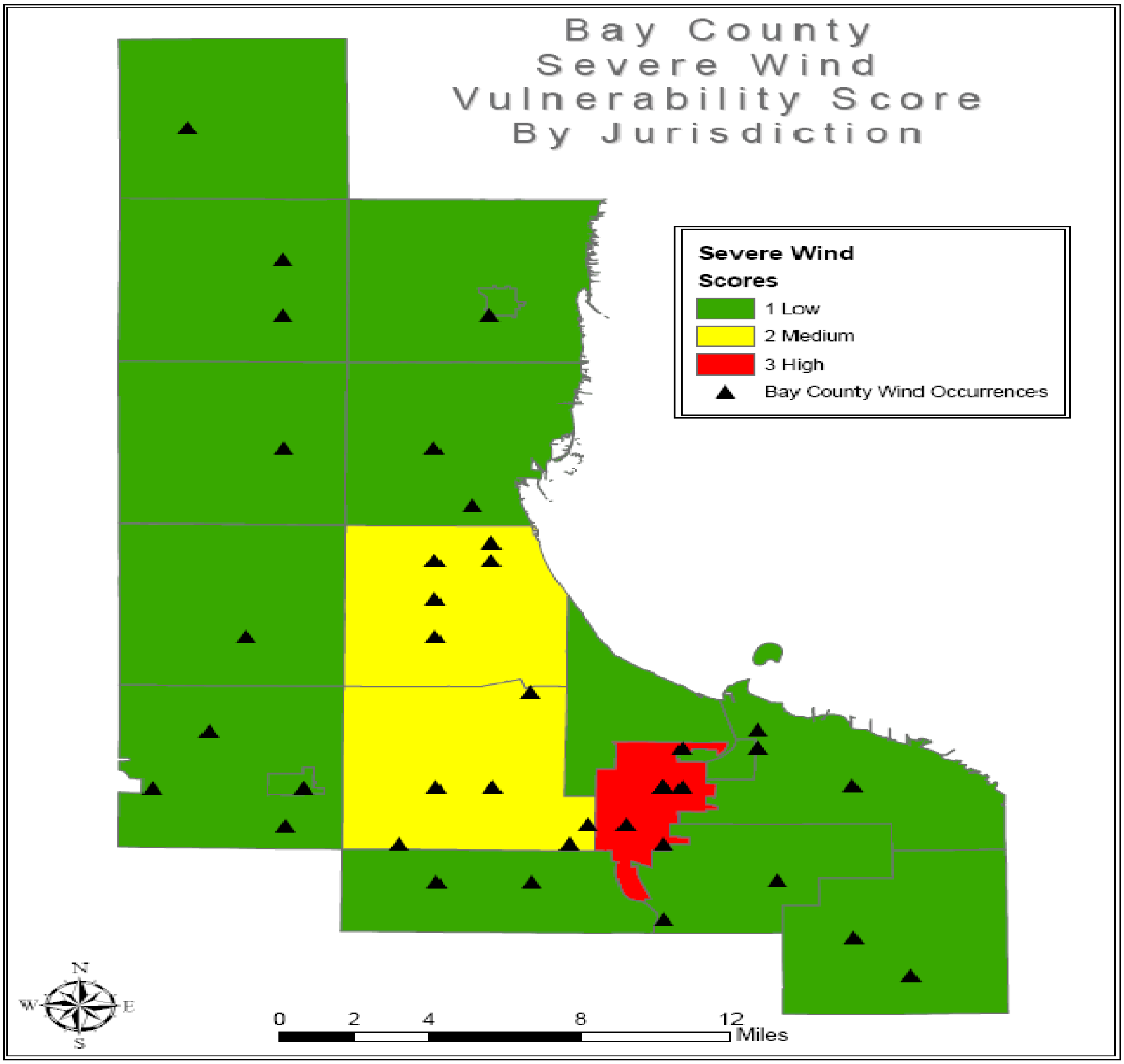


Figure 14 Severe Wind Vulnerability Score

4.1.1.6 Tornado Vulnerability Score = Exposure Score X Tornado Risk Score

Tornado Risk Score was derived from NOAA/NWS SVRGIS database for Tornado events. This data set geo-locates Tornado occurrences across the country. An **Occurrence Rank** was built based on the number of events per jurisdiction which created the **Tornado Risk Score** which was ranked ***0 – 3 (0 N/A, 1 Low, 2 Medium, 3 High)***. The risk score was then multiplied by the exposure score to create the Tornado Vulnerability Score for each jurisdictions based on identifying at risk tornado areas that have high exposure.

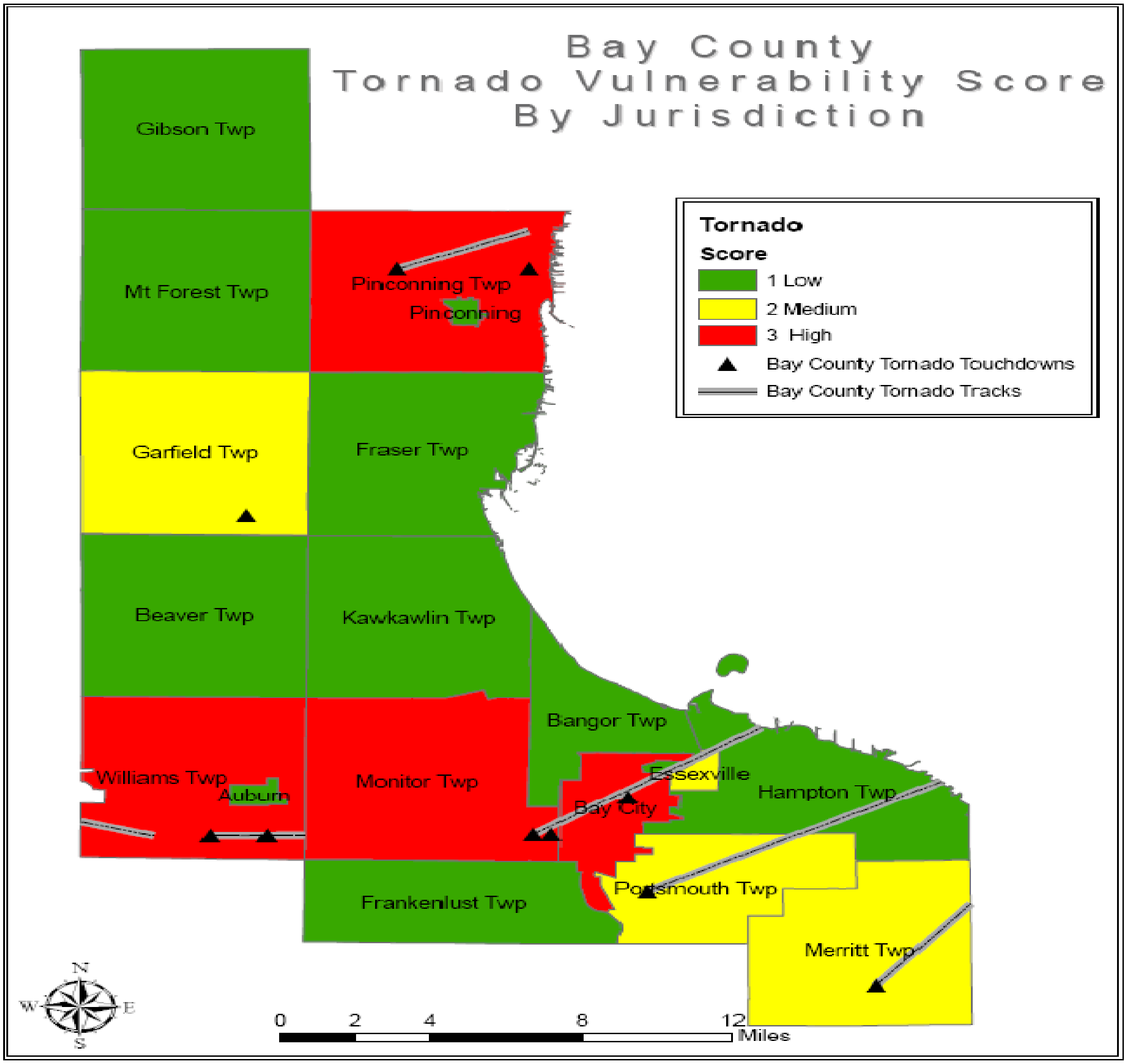


Figure 15 Tornado Vulnerability Score

4.1.1.7 Wildfire Vulnerability Score = Exposure Score X Wildfire Risk Score

Wildfire Risk Score was derived from USGS Landfire Forest Cover database. An **Area Effected Rank** was built based on the percent of forest cover per jurisdiction. This data created the **Wildfire Risk Score** which was multiplied with the exposure score to produce the wildfire vulnerability score.

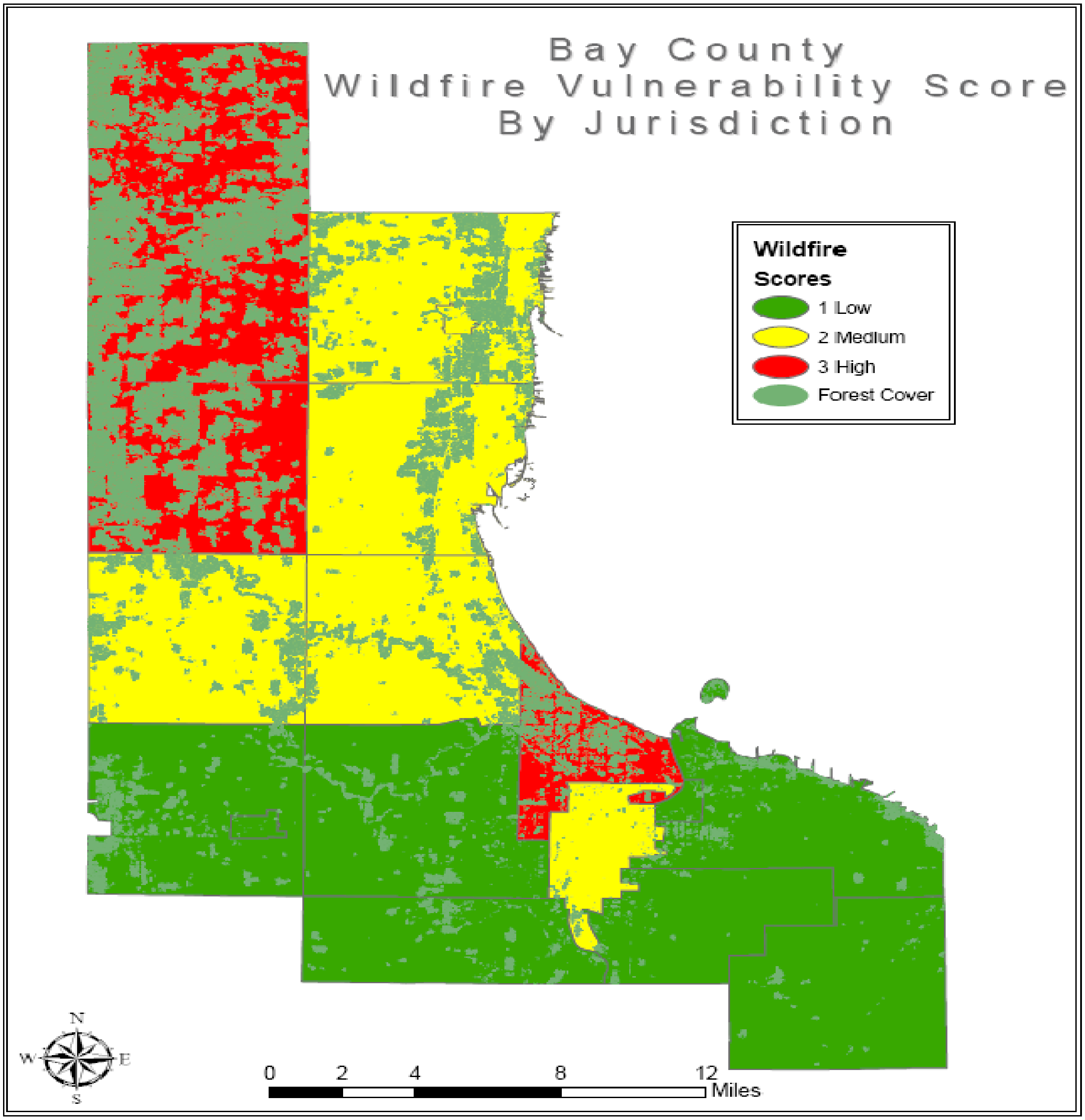


Figure 16 Wildfire Vulnerability Score

4.1.1.8 Wind Driven Ice Floes Vulnerability Score = Exposure Score X Wind Driven Ice Floes Risk Score

The **Wind Driven Ice Floes Risk Score** was derived from local hazard identification. Fraser Township, Kawkawlin Township and Bangor Township were identified as areas that have been impacted by wind driven ice floes. An Area Effected rank was built based on the hazard areas located for each jurisdiction. This methodology differed from the other hazards, since only the jurisdictions identified as having past occurrences by the stakeholders were deemed vulnerable to wind driven ice floes.

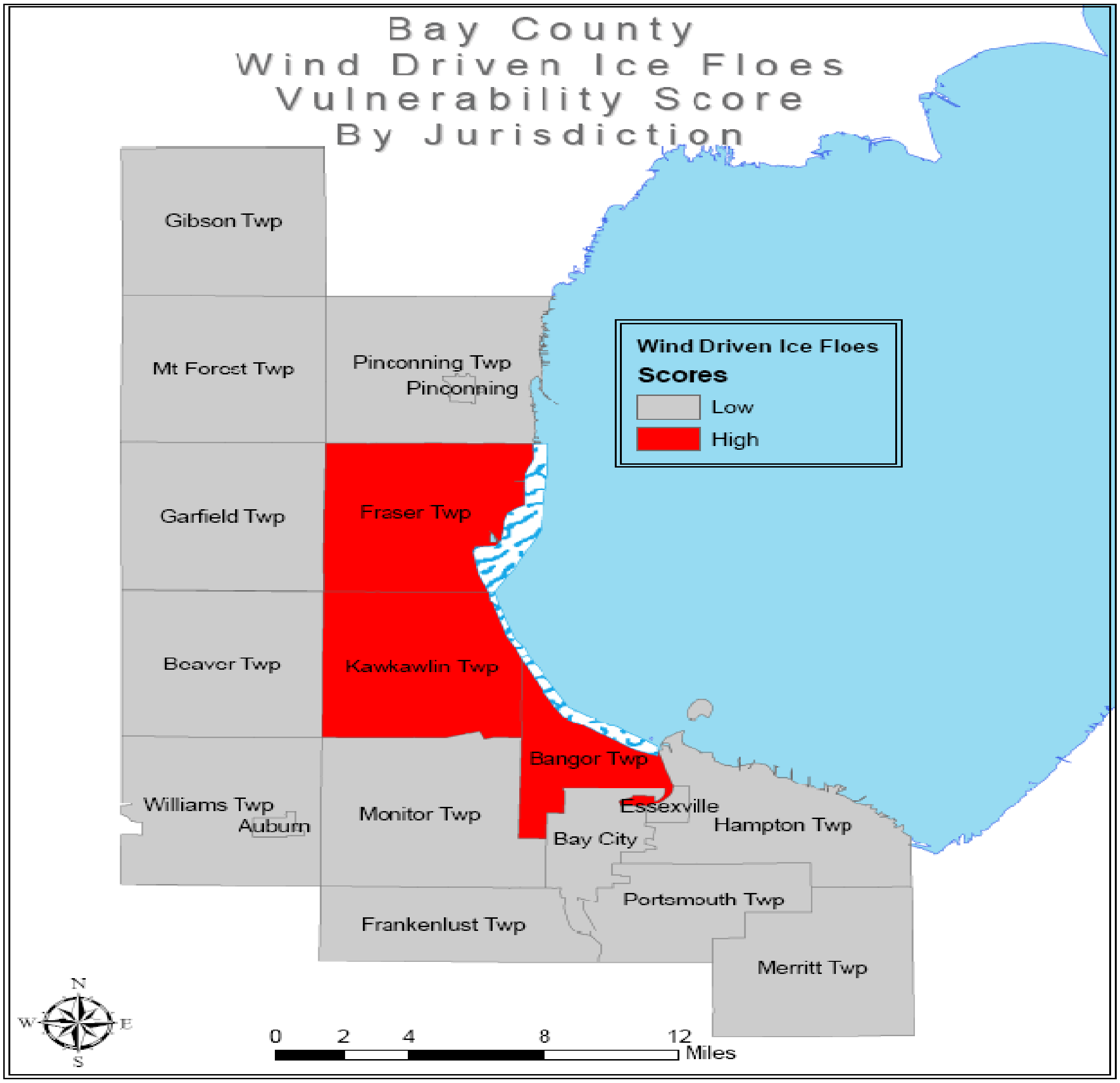


Figure 17 Wind Drive Ice Floes Vulnerability

4.1.1.9 Drought, Extreme Temperatures, and Winter Storm Vulnerability Score

As mentioned above there is county-wide occurrence data for drought, extreme heat and winter storms. However, this data is not geo-located within the county. Therefore, each jurisdiction has an equal vulnerability to each hazard. The following map depicts highly vulnerable jurisdictions for each of the above mentioned hazards based on exposure.

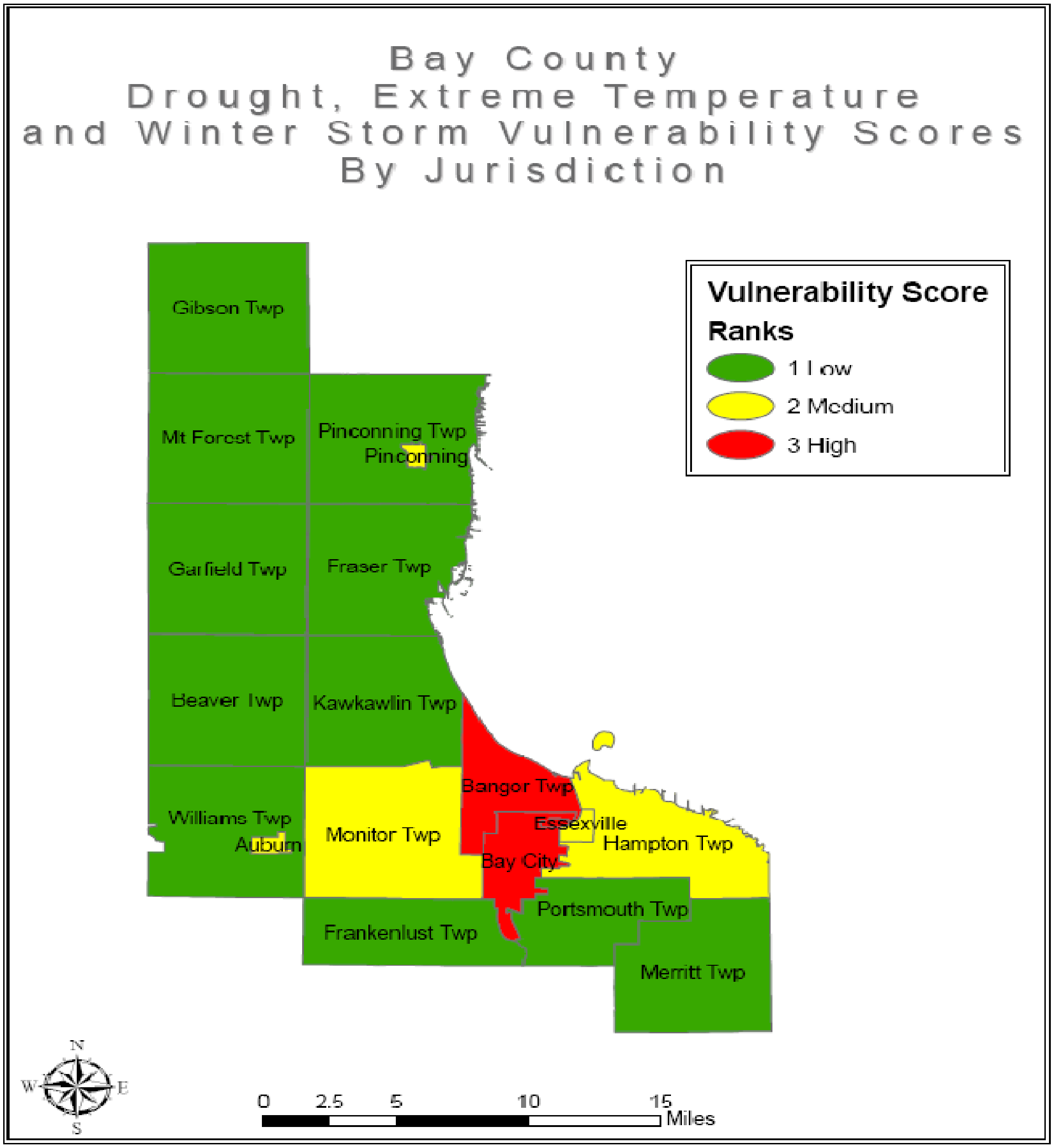


Figure 18 Drought, Extreme Temperatures, and Winter Storm Vulnerability Score

4.1.2 Loss Estimates

The *Hazard Vulnerability Score* provides detail on regarding the overall vulnerability for each jurisdiction, another component of the Risk Assessment is to estimate loss for each jurisdiction. The Planning Team developed a way to capture the Average Annualized Risk for each hazard. This methodology calculated the probability of an event occurring for each hazard and calculated the average consequences each hazard event caused. Next, an Average Annualized Risk (Loss) was calculated by multiplying the probability by the average consequences. The data used to compile this information is comprised of NCDC, Sheldus and local sources. This data is intended to provide a loss estimation model based on actual occurrences and consequences data. The hazards have also been ranked based on their Average Annualized Risk (**See Table 4.1 Average Annual Risk: By Hazard).**

The model provides Bay County with the loss estimation data for each hazard. However, this model does not provide estimation data for each jurisdiction. The Planning Team developed a model to capture a Geographic Weighted Distribution of each event for each jurisdiction. This is accomplished by comparing the relative area that each jurisdiction occupies in respect to the entire county. For example Bay City occupies 2.53% of the county's geographic area. Once the jurisdiction's area was calculated, a Geographic Weighted Distribution calculation was achieved by taking the Average Annualized Risk data by dividing the percent of the area each jurisdiction represents. Thus, providing a loss estimation model for each jurisdiction and hazard based on a geographical distributed annualized loss estimate (**See Table 4.2 Geographic Weighted Distribution Average Annual Risk: By Jurisdiction).**

Table 4.1
Average Annual Risk Table: By Hazard

Hazard Type	Dates	Range	Frequency	Total Losses	Probability	Avg. Consequences	Avg. Annual Risk	Rank
Drought	1930-2010	80	7	$8,823,529	0.09	$1,260,504	$110,294.11	4
Earthquake	1811-2009	425	0	$0	0.00	$0	$0.00	10
Extreme Temperature	1936-2010	74	19	$500,000	0.26	$26,316	$6,756.76	7
Flooding	1947-2010	73	21	$102,275,000	0.29	$4,870,238	$1,401,027.40	1
Hail	1960-2010	50	51	$204,254	1.02	$4,005	$4,085.08	8
Severe Storm	1960-2010	50	127	$38,737,800	2.54	$305,022	$774,756.00	3
Winter Storm	1967-2010	43	70	$39,194,615	1.63	$559,923	$911,502.67	2
Tornado	1953-2010	57	20	$2,897,500	0.35	$144,875	$50,833.33	5
Wildfire	1881-2010	129	1	$2,000,000	0.01	$2,000,000	$15,503.88	6
Wind Driven Ice Floes	2009	1	1	$0	0.00	$0	$0.00	9

Table 4.2
Geographic Weighted Distribution Average Annual Risk Table: By Jurisdiction

Jurisdiction	Jurisdiction % Area	Drought Avg. Ann Risk	Geographic Weighted Distribution	Extreme Temperature Avg. Ann Risk	Geographic Weighted Distribution	Flooding Avg. Ann Risk	Geographic Weighted Distribution	Hail Avg. Ann Risk	Geographic Weighted Distribution	Severe Storm Avg. Ann Risk	Geographic Weighted Distribution	Winter Storm Avg. Ann Risk	Geographic Weighted Distribution	Tornado Avg. Ann Risk	Geographic Weighted Distribution	Wildfire Avg. Ann Risk	Geographic Weighted Distribution
Auburn	0.24	$110,294	$265	$6,757	$16	$1,401,027	$3,362	$4,085	$10	$774,756	$1,859	$911,503	$2,188	$50,833	$122	$15,504	$37
Bangor Twp	3.32	$110,294	$3,662	$6,757	$224	$1,401,027	$46,514	$4,085	$136	$774,756	$25,722	$911,503	$30,262	$50,833	$1,688	$15,504	$515
Bay City	2.53	$110,294	$2,790	$6,757	$171	$1,401,027	$35,446	$4,085	$103	$774,756	$19,601	$911,503	$23,061	$50,833	$1,286	$15,504	$392
Beaver Twp	7.88	$110,294	$8,691	$6,757	$532	$1,401,027	$110,401	$4,085	$322	$774,756	$61,051	$911,503	$71,826	$50,833	$4,006	$15,504	$1,222
Essexville	0.31	$110,294	$342	$6,757	$21	$1,401,027	$4,343	$4,085	$13	$774,756	$2,402	$911,503	$2,826	$50,833	$158	$15,504	$48
Frankenlust Twp	5.13	$110,294	$5,658	$6,757	$347	$1,401,027	$71,873	$4,085	$210	$774,756	$39,745	$911,503	$46,760	$50,833	$2,608	$15,504	$795
Fraser Twp	7.32	$110,294	$8,074	$6,757	$495	$1,401,027	$102,555	$4,085	$299	$774,756	$56,712	$911,503	$66,722	$50,833	$3,721	$15,504	$1,135
Garfield Twp	7.95	$110,294	$8,768	$6,757	$537	$1,401,027	$111,382	$4,085	$325	$774,756	$61,593	$911,503	$72,464	$50,833	$4,041	$15,504	$1,233
Gibson Twp	7.93	$110,294	$8,746	$6,757	$536	$1,401,027	$111,101	$4,085	$324	$774,756	$61,438	$911,503	$72,282	$50,833	$4,031	$15,504	$1,229
Hampton Twp	6.27	$110,294	$6,915	$6,757	$424	$1,401,027	$87,844	$4,085	$256	$774,756	$48,577	$911,503	$57,151	$50,833	$3,187	$15,504	$972
Kawkawlin Twp	7.45	$110,294	$8,217	$6,757	$503	$1,401,027	$104,377	$4,085	$304	$774,756	$57,719	$911,503	$67,907	$50,833	$3,787	$15,504	$1,155
Merritt Twp	7.05	$110,294	$7,776	$6,757	$476	$1,401,027	$98,772	$4,085	$288	$774,756	$54,620	$911,503	$64,261	$50,833	$3,584	$15,504	$1,093
Monitor Twp	8.24	$110,294	$9,088	$6,757	$557	$1,401,027	$115,445	$4,085	$337	$774,756	$63,840	$911,503	$75,108	$50,833	$4,189	$15,504	$1,278
Mt Forest Twp	8.00	$110,294	$8,824	$6,757	$541	$1,401,027	$112,082	$4,085	$327	$774,756	$61,980	$911,503	$72,920	$50,833	$4,067	$15,504	$1,240
Pinconning	0.19	$110,294	$210	$6,757	$13	$1,401,027	$2,662	$4,085	$8	$774,756	$1,472	$911,503	$1,732	$50,833	$97	$15,504	$29
Pinconning Twp	8.20	$110,294	$9,044	$6,757	$554	$1,401,027	$114,884	$4,085	$335	$774,756	$63,530	$911,503	$74,743	$50,833	$4,168	$15,504	$1,271
Portsmouth Twp	4.50	$110,294	$4,963	$6,757	$304	$1,401,027	$63,046	$4,085	$184	$774,756	$34,864	$911,503	$41,018	$50,833	$2,288	$15,504	$698
Williams Twp	7.50	$110,294	$8,272	$6,757	$507	$1,401,027	$105,077	$4,085	$306	$774,756	$58,107	$911,503	$68,363	$50,833	$3,813	$15,504	$1,163

The above data provides a loss estimation for all hazards except for wildfire and wind driven ice floes. Currently there is not enough data to create a loss estimate for these hazards. However, this is an area that will be assigned as a mitigation action for the next iteration of the plan.

Another method to capture loss estimations is to use the Hazard boundary of a specific hazard overlaid onto property data. The Planning Team identified only one hazard, flooding, that this method could be used. Bay County recently received their new Digital Flood Insurance Rate Maps (DFIRMS). The DFIRM was used to show areas where potential losses could occur based on the geographic locations of the flood boundary overlaid onto the parcel data provided by the Bay County GIS department and the Bay City GIS department. Using the new DFIRM layer (500 and 100 year boundaries) as the hazard boundary, the planning team was able to determine how many parcels were vulnerable to flooding and thus could be assumed to be lost during a county wide flooding event. The following map and table display the data captured in this loss estimation model.

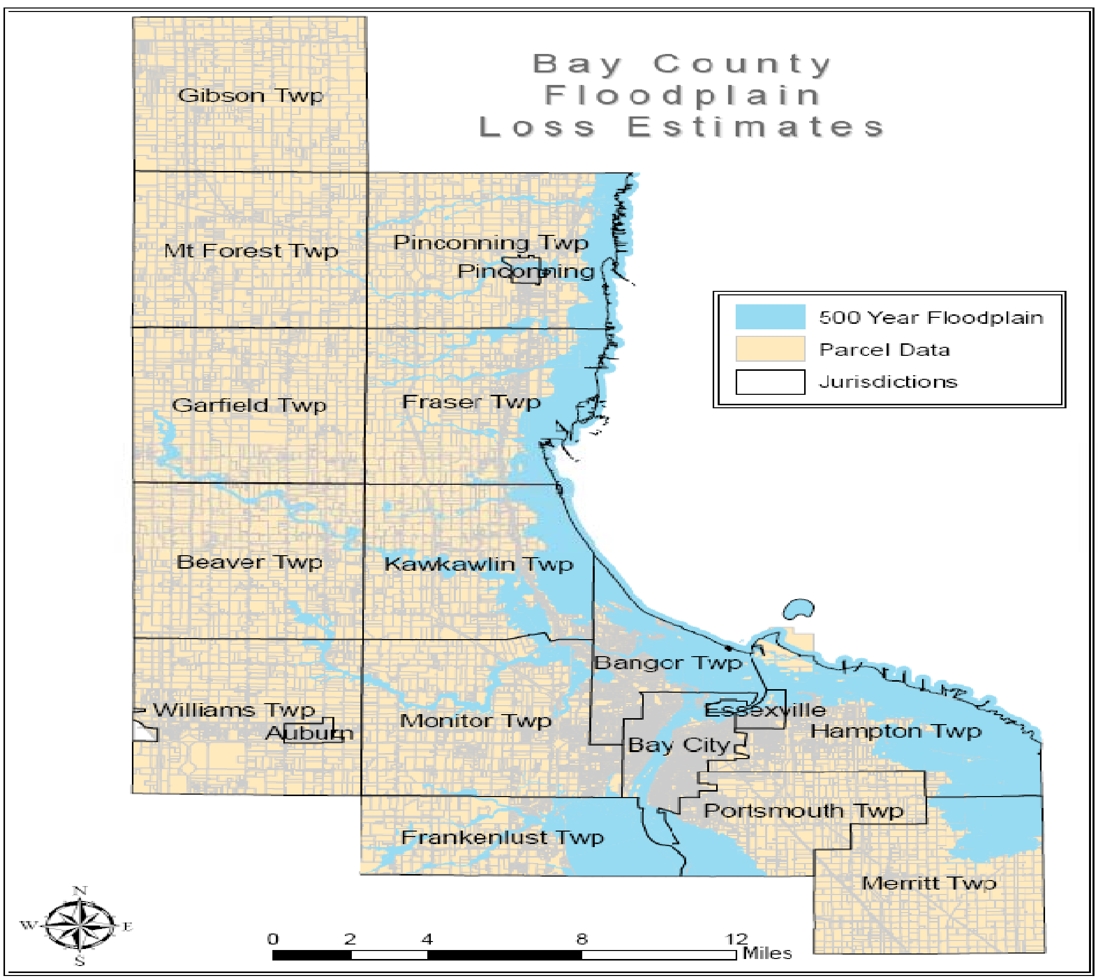


Figure 19 Floodplain Loss Estimates

The following table depicts the total number of parcels that were intersected with the DFIRM flood hazard boundary. This is a geographic based loss estimation model where the **Average Annualized Risk** loss estimation model is based on past consequences and occurrences. Both models produce insightful data for local decision makers.

Table 4.3
Average Annualized Risk for Flooding

Jurisdiction	Number of Parcels	Potential Dollar Loss
Bay County	8832	$783,174,712.00

5.0 MITIGATION STRATEGY

The Mitigation Strategy portion of this plan uses the results of the hazard identification and vulnerability assessment to identify local risk reduction goals and actions. The process incorporated participation and coordination among the Planning Team to develop goals and actions that were specific, measurable, achievable, relevant and time or schedule dependent.

The mitigation strategies developed within the Plan provide a blueprint for reducing the potential losses identified in the risk assessments and does not conflict with existing authorities, policies, programs and resources.

5.1 DEFINITION OF MITIGATION

Mitigation is defined as “sustained action that reduces or eliminates long-term risk to people and property from hazards and their effects.” Mitigation is the ongoing effort at the federal, state, local and individual levels to decrease the impact of disasters upon families, homes, the jurisdiction and the economy. Mitigation also includes making existing and future development in hazard prone areas safer. A jurisdiction can steer growth to areas with fewer risks through non-structural measures such as avoiding construction in flood-prone areas. Preventing damages or loss to lives or property is the essence of mitigation. Incorporating mitigation into decisions relating to a jurisdiction’s growth can result in a safer, more resilient jurisdiction, and one that is more attractive to families and businesses.

5.2 LOCAL HAZARD MITIGATION GOALS

The Mitigation Strategies were developed through Stakeholder work sessions, individual conversations, and meetings at the local level. The Stakeholders worked together to develop and complete a series of community mitigation worksheets. These worksheets encouraged communities to work with local resources to develop mitigation goals, activities, priorities, and capabilities. A sample of the worksheet each community completed is located in **Appendix J**.

During the February 25, 2010 stakeholder meeting, attendees reviewed the hazard profiles and results of the vulnerability assessments. The concept of risk mitigation activities was introduced and examples were discussed together, and then each community separated to develop individualized plans. The principal goals for the mitigation activities are those formulated by FEMA; namely:

1. Reduce risks through regulations, such as building codes, planning ordinances, or floodplain regulations.
2. Reduce exposure to hazards through building or parcel specific activities, such as flood proofing or property acquisition.

3. Reduce impacts through response and recovery activities implemented during and after a disaster.
4. Minimize impacts through projects, such as detention basins or tornado shelters.
5. Assist residents to prepare for risks and implement protective measures for themselves and their property.

Meeting participants were also given the opportunity to create additional goals if they so desired.

A conference call with the participating jurisdictions and the planning consultant was later held, on March 31, 2010 to follow-up regarding any questions related to the mitigation activities. As a result of the public meeting and conference call, the group ultimately developed several mitigation activities to reduce or avoid long-term vulnerabilities for hazards within each jurisdiction. These activities are provided in **Appendix H**.

5.3 IDENTIFICATION AND ANALYSIS OF MITIGATION ACTIVITIES

The Planning Team worked together and individually throughout the planning process to identify, evaluate and analyze a comprehensive range of specific mitigation actions. These actions were based on the evaluation of the risk assessment and in coordination with the mitigation goals that were formed by each jurisdiction.

5.3.1 Mitigation Activities by Type

The group focused upon various types of activities that could be performed to reduce the risk of natural hazards throughout their communities. These activities were categorized as follows:

a. Prevention. (PA) Prevention activities are designed to keep current problems from getting worse and to eliminate the possibility of future problems. Prevention activities reduce a jurisdiction's vulnerability to hazard events. This type of activity is especially effective in hazard prone areas where development has not occurred. Prevention activity examples include the following:

    1) Planning and Zoning
    2) Floodplain regulations
    3) Local ordinances

b. Property Protection. (PP) Property protection activities are designed to adapt existing structures to withstand natural hazards or to remove structures away from hazard prone areas. Property protection activity examples include the following:

    1) Acquisition
    2) Relocation
    3) Foundation elevation
    4) Insurance – flood and homeowner's
    5) Retrofitting (includes activities such as wind proofing, flood proofing, and seismic design standards)

c. Emergency Services. (ES) Emergency services minimize the impact that a natural hazard has on the residents of a jurisdiction. Usually, actions are taken by emergency response services immediately before, during, or in response to a hazard event. Emergency service activity examples include the following:

1) Warning systems
2) Evacuation planning and management
3) Sandbagging for flood protection

d. Structural Projects. (SP) Structural projects lessen the impact of a natural hazard by changing the natural progression of the hazard. These types of projects are usually designed by engineers. Structural projects include the following:

1) Storm sewers
2) Floodwalls
3) Highway projects
4) Tornado shelters

e. Public Information and Awareness. (PI) Public information and awareness activities are used to educate the residents of a jurisdiction about the potential hazards that affect their area, hazard prone areas, and mitigation strategies they can take part in to protect themselves and their property. Public information and awareness activity examples include the following:

1) Public speaking events
2) Outreach projects
3) Availability of hazard maps
4) School programs
5) Library materials

5.4 IMPLEMENTATION OF MITIGATION ACTIVITIES

Each jurisdiction's Plan Stakeholder worked with community resources to develop mitigation activities based upon local vulnerabilities and capabilities. These actions were identified and prioritized using a prioritization scheme, generalized benefit/cost approach, and funding identification strategy. For each action developed, an action administrator or authority was defined along with an estimated timeframe for completing the activity.

The hazard mitigation actions developed were prioritized based upon the capacity of an action to eliminate or reduce risk, the category of activity performed, the generalized benefit to cost of each activity, and its potential for funding.

5.4.1 Activity Prioritization

The Planning Team prioritized each activity based upon its ability to eliminate or reduce risk associated with mitigation goal. The following table was used to categorize each activity's priority as listed within **Appendices H and I**.

Table 5.1 Activity Prioritization

Priority	Description
A-Very High	Projects or activities that permanently eliminate damages, or deaths and injuries in the community from any hazard.
B-High	Projects or activities that reduce the probability of damages, deaths, and injuries in the community from any hazard.
C-Medium	Projects or activities that educate the public on the subjects of hazard mitigation, hazard research, and disaster preparedness.
D-Low	Projects or activities that warn the public of the approach of a natural hazard threat across the community.

5.4.2 Activity Benefit-Cost Review

The Stakeholders also considered the return on investment for each activity. Both the benefits and the costs were examined on a qualitative basis (i.e. High, Medium, and Low). The three categories were divided based on the estimated value of the benefits derived or the cost of developing the action or project. If the costs or benefits were expected to be less than $100,000, the category was low. If the costs or benefits were expected to surpass $100,000 but be less than $500,000, the category was medium. If the costs or benefits were expected to exceed $500,000, the category was high. The result produced a generalized approach for assessing relative benefits to cost. The Planning Team agreed that more detailed benefit cost analysis would be performed as necessary prior to the implementation of each activity. In cases of activities identified for funding through FEMA mitigation programs, the group recognized that FEMA approved benefit-cost analysis would be required.

5.4.3 Activity Funding and Implementation

The Stakeholders considered and identified the funding resources that may be available for each activity. At this stage, no specific plans were developed to fund projects, but probable sources of funding were identified. In general, the identified source of funding corresponded to the implementing agency. As part of the activity development process, each activity defined by a given jurisdiction was recommended to identify a lead agency or personnel responsible for implementing the activity.

Most sources of public funding will require a detailed cost-benefit analysis of the proposed mitigation activities, as well as an analysis of potential alternatives. Development of mitigation actions should also include a STAPLE (E) analysis. STAPLE (E) is an acronym standing for Social, Technical, Administrative, Political, Legal, Environmental, and Economic. Each of these criteria should be reviewed to determine the usefulness and potential for implementation. Difficulties in any of the seven criteria could potentially derail a mitigation action because of unforeseen opposition or ramifications.

5.5 LOCAL MITIGATION STRATEGY AND CAPABILITIES ASSESSMENT

This plan includes specific actions for each jurisdiction in Bay County. These actions are based on goals developed to address the risks identified throughout the region. It is the intent of each jurisdiction to implement these actions using practices that are cost-effective, environmentally sound, and technically feasible.

Following the Plan's adoption, the Stakeholders will continue to work with the Bay County government, the Bay County Emergency Management Coordinator, departments and other regional organizations to implement mitigation strategies on a regional basis where feasible. While the commitment to implementing this strategy is strong, the potential for success is directly linked to each jurisdiction's capability.

The purpose of the capability assessment is to identify the potential hazard mitigation opportunities available to each jurisdiction that may already exist as part of each jurisdiction's daily operations (e.g. code enforcement, operations, maintenance, etc).

This assessment will highlight the positive measures already in place in the jurisdiction as well as identify weaknesses that could increase vulnerability in a jurisdiction. The capability assessment serves as the foundation for an effective hazard mitigation strategy. By establishing goals and objectives for jurisdictions to pursue under the Plan, it ensures that the goals and objectives that are decided upon are realistically attainable given local resources.

5.5.1 Local Mitigation Practices

The following defines local practices already in place throughout the county's jurisdictions that encourage or promote mitigation activities. These practices reside within existing polices, ordinances, programs, and other planning efforts. The practices will continue to be reviewed and where appropriate the practices along with the Plan will be integrated for consistent hazard mitigation practices.

<u>Mitigation Management Policies.</u> The Emergency Action Guideline for Bay County provides for an integrated countywide emergency preparedness and response plan, utilizing public, nonprofit, and private resources. Bay County maintains an emergency operations plan. The plan includes roles and responsibilities of persons/departments in charge of dispatching help during a natural hazard, rules that are followed, evacuation procedures dispersed by the transportation officer to be followed, etc. Likewise, the communities that participate in the NFIP will continue to be compliant.

<u>Existing Plans.</u> In general, the County's policies encourage cooperation and coordination within its jurisdictional agencies, as well as cooperation, including mutual aid compacts, between neighboring counties and municipalities within the region. The Emergency Action Guidline provides for an integrated countywide emergency preparedness and response plan, utilizing public, nonprofit, and private resources.

Mitigation Programs. The main mitigation programs are the county's floodplain management regulations and participation in and administration of the National Flood Insurance Program. Additional programs include:

5.5.2 Funding Opportunities

There are several sources of funding for both pre- and post-disaster hazard mitigation policies and projects. While all mitigation techniques will save money by avoiding different types of losses, the implementation of mitigation efforts can be costly and well beyond the local jurisdiction or county's capacity to fund the mitigation activity. There are existing federal and state funding programs that can be utilized for funding assistance. The following is a list of some sources of funding presently available. This list is not comprehensive, as new programs can be developed or existing programs can be eliminated or modified over time.

a. Federal Sources:

1) *Pre-disaster Mitigation Program: Federal Emergency Management Agency (FEMA)*: Through the Disaster Mitigation Act of 2000, Congress approved the creation of a national program to provide a funding mechanism that is not dependent on a Presidential disaster declaration. The Pre-Disaster Mitigation (PDM) Program provides funding to states and communities for cost-effective hazard mitigation activities that complement a comprehensive mitigation program, as well as reduce injuries, loss of life, and damage and destruction of property.

2) *Emergency Management Performance Grant*: *Federal Emergency Management Agency (FEMA):* The Emergency Management Performance Grant (EMPG) encourages the development of comprehensive emergency management at the State and local level in order to improve emergency management planning, preparedness, mitigation, response, and recovery capabilities. Funding is provided to the State, which can be used to educate people and protect lives and structures from natural and technological hazards.

3) *Public Assistance Grant Program: Federal Emergency Management Agency (FEMA):* The Public Assistance (PA) Grant Program provides supplemental assistance to states, local governments, and certain private non-profit organizations to alleviate sufferings and hardship resulting from major disasters or emergencies declared by the President. These grants allow State and local government to respond to disasters, recover from their impact, and mitigate impact from future disasters.

4) *Flood Mitigation Assistance Program*: *Federal Emergency Management Agency (FEMA):* FEMA's Flood Mitigation Assistance Program (FMA) provides funding to assist states and communities in implementing measures to reduce or eliminate the long-term risk of flood damage to buildings, manufactured homes, and other structures insurable under the National

Flood Insurance Program (NFIP). FMA was created as part of the National Flood Insurance Reform Act of 1994 (42 U.S.C. 4101) with the goal of reducing or eliminating claims under the NFIP. FMA is a pre-disaster grant program, and is made available to states on an annual basis. This funding is exclusively available for mitigation planning and implementation of mitigation measures.

The community must be a participant in NFIP and the project must be cost effective, beneficial to the NFIP fund, and technically feasible. The project must conform to the minimum standards of the NFIP Floodplain Management Regulations, the applicant's Flood Mitigation Plan, and all applicable laws and regulations.

5) *Hazard Mitigation Grant Program: Federal Emergency Management Agency (FEMA):* The Hazard Mitigation Grant Program (HMGP) was created in November 1988 through Section 404 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act. The HMGP assists states and local communities in implementing long-term mitigation measures following a Presidential disaster declaration.

   A project must conform to the State's Hazard Mitigation Plan, provide a beneficial impact on the disaster area, meet environmental requirements, solve a problem independently, and be cost-effective.

6) *Community Development Block Grants: US Department of Housing and Urban Development*: The Community Development Block Grant (CDBG) program provides grants to local governments for community and economic development projects that primarily benefit low- and moderate-income people. The CDBG program also provides grants for post-disaster hazard mitigation and recovery following a Presidential disaster declaration. To be eligible for a CDBG, a community must have a population less than 50,000 (200,000 for counties) and be located within a Presidential disaster declaration area.

7) *Sustainable Development Assistance: Department of Energy*: A Sustainable Development Assistance team works with communities to help them define and implement sustainable development strategies as part of their comprehensive community planning efforts. The team provides technical assistance to disaster-affected communities as they plan for long-term recovery by introducing a wide array of environmental technologies and sustainable redevelopment planning practices.

8) *Emergency Watershed Protection: Department of Agriculture*: Natural Resources Conservation Service *(NRCS)*: The Emergency Watershed Protection Program (EWP) provides financial assistance to sponsors and individuals in implementing emergency measures to relieve imminent hazards to life and property created by a disaster. Activities include providing financial and technical assistance to remove debris from streams, protect destabilized

stream banks, and purchase floodplain easements. The program is designed for the implementation of recovery measures. It is not necessary for a national emergency to be declared to be eligible for assistance.

9) *Emergency Relief Program (Transportation Infrastructure): Department of Transportation, Federal Highway Administration*: The Emergency Relief (ER) Program provides assistance for repair of Federal-aid roads. This funding is allocated to rebuild transportation facilities that are damaged extensively, causing a "disastrous impact" on transportation services. States must request ER funding in order to initiate this assistance program.

10) *United States Army Corps of Engineers*: Congress delegates to the United States Army Corps of Engineers (USACE) the authority and appropriations for projects through the Water Resources and Development Act (WRDA). Projects eligible for funding include the following: disaster response, water supply, shore protection, navigation, facilities design & construction, installation support, hydropower, recreation, flood damage reduction, environmental infrastructure, ecosystem restoration, master planning, regulatory projects, and the rehabilitation of flood control structures.

6.0 PLAN MAINTENANCE

Plan Maintenance is the process in which the Plan will be monitored, evaluated, and updated within a five-year cycle. When updated, the plan will be reviewed, revised, and resubmitted to the Michigan State Police, Emergency Management and Homeland Security Division within five years of the plan for approval by FEMA Region V. As appropriate, the plan will also be evaluated after a disaster, or after unexpected changes in land use or demographics in or near hazard areas. The Planning Committee also will be kept apprised of a change in federal regulations, programs and policies, such as a change in the allocation of FEMA's funding for mitigation grant programs. These evaluations will be addressed in the annual progress report for the plan and may affect the Action Plan for Mitigation goals and activities.

6.1 MONITORING, EVALUATING, AND UPDATING THE PLAN

<u>Monitoring</u>. The Community Stakeholders will continue to monitor the status and track the progress of the plan elements on an annual basis. The Community Stakeholders will oversee the progress made on the implementation of the identified actions and update the plan as needed to reflect changing conditions. Representatives will also meet annually to evaluate plan progress and recommend updates. The Bay County Emergency Management Coordinator will facilitate the annual meetings.

<u>Evaluating.</u> Evaluation of the plan will not only include checking the implementation status of mitigation actions, but also assessing their degree of effectiveness and assessing whether other natural hazards need to be addressed and added to the plan (man-made hazards). This will be accomplished by reviewing the benefits (or avoided losses) of the mitigation activities that were in place within each jurisdiction and county. These will be compared to the goals the Plan has set to achieve. The team will also evaluate whether mitigation actions need to be discontinued or modified in light of new developments or changes within the community. Public comment on the plan and achievement of goals and objectives will also be solicited annually during the evaluation by the committee. The process will be documented by the Stakeholders and submitted to the Bay County Emergency Management Coordinator for review who will then update the Bay County website with any review updates.

<u>Updating</u>. As required by part 201.6(c)(4)(i) of the Local Hazard Mitigation Plan Review Crosswalk, this plan will be updated within 5 years of the date of the Federal Emergency Management Agency's (FEMA) approval of the plan. The plan may be updated earlier, at the discretion of the Planning Team and its jurisdictions. Also, the Stakeholder's ability to update the mitigation process by adding new data and incorporating it into the mitigation plan, will allow for the efficient use of available resources, staff, and programs. Any changes in the Plan will be documented and appended in a section titled "Amendments". The Action Plan will be maintained as an appendix so it can remain a living document. The participants will meet annually to discuss the plan and document data collected including hazard events, completed

mitigation activities, new mitigation activities, and FEMA grant application efforts. The information will be used for the 5 year update. The Bay County Emergency Management Coordinator will coordinate the annual meeting and keep records of the participants and information received.

6.2 IMPLEMENTATION THROUGH EXISTING PROGRAMS

The identified action projects address reducing the effects of hazards on new buildings and infrastructure as well as existing buildings and infrastructure. Activities also incorporate mitigation activities into other planning mechanisms and recommends mitigation projects that can be integrated into Master Plans, Flood Mitigation Plans, Stormwater Master Plans, Capital Improvement Plans, Land Use Plans, Emergency Management Plans, Zoning Ordinances, Building Codes, and Post-Disaster Mitigation Policies and Procedures where appropriate. In addition, projects will be implemented through existing or ongoing programs.

6.3 CONTINUED PUBLIC PARTICIPATION

In order to have continued public support of the mitigation process, it is important that the public be involved not only in the preparation of the initial plan, but also in any modifications or updates to the plan. To ensure that public support is maintained, the following actions may be taken by the Community Stakeholder or Bay County Emergency Management Coordinator:

- Updates to the plan.
- Develop informational mailings to be distributed to the public about mitigation efforts in the County and updates made to the plan.
- Develop mitigation flyers or mailings that contain mitigation activities and actions that promote reducing damages and risks of natural hazards.
- Develop a survey and communicate with stakeholders following a Presidential, Emergency, or State Declaration to solicit public input about current or possible future mitigation activities, and place it on the County website.
- Invited the public for annual meetings.
- Hold a public meeting prior to plan update/re-adoption every five (5) years, to allow for public comment on the plan.

7.0 RESOURCES

ACS Demographic and Housing Estimates: 2006-2008. Bay County, MI. Data Set: 2006-2008 American Community Survey. Survey: American Community Survey. U.S. Census Bureau. Source: http://factfinder.census.gov/servlet/ADPTable?_bm=y&-geo_id=05000US26017&-qr_name=ACS_2008_3YR_G00_DP3YR5&-ds_name=ACS_2008_3YR_G00_&-_lang=en&-redoLog=false&-_sse=on

Bay City Master Plan. Prepared by McKenna Associates, Inc. and Carlisle/Wortman Associates. Northville, MI. Adopted: September 20, 2000. Amended on August 10, 2005.

Bay City Official Zoning Map. Adopted: October 20, 2003.

Bay City Zoning Ordinance. Adopted: October 23, 2003.

Bay County Website. Source: http://www.baycounty-mi.gov

Bay County Profile. Michigan State University Extension and Community Development Area of Expertise Team. Bay City, MI. November 27, 2006. Source: http://www.baycounty-mi.gov/Docs/MSUE/BayCountyProfile.pdf

Beaver Township General Development Plan. Prepared by: Williams & Works. Grand Rapids, MI. Adopted: October 1978.

Beaver Township Zoning Ordinance. Effective Date: May 31, 1979. Amended: October 1, 2002

Building Permit Estimates. Bay County. U.S. Bureau of the Census. Source: http://censtats.census.gov/cgi-bin/bldgprmt/bldgsel.pl

Charter Township of Bangor Master Plan. Prepared by: McKenna Associates, Inc. Northville, MI. Final Draft: January 2002.

Charter Township of Bangor Zoning Ordinance. Adopted: 2000.

City of Auburn Master Plan. Adopted February 21, 1994.

City of Auburn Zoning Ordinance. Adopted: November 2, 2005.

City of Auburn Zoning Map. Prepared by: Spicer Group. Saginaw, MI. Last Revisions: November 23, 2009.

City of Essexville Community Master Plan. Prepared By: Beckett and Reader, Inc./BRI, Inc. Plan Date: December 1996.

City of Essexville Zoning Ordinance. Adopted: May 10, 1983. Effective Date: May 24, 1983. Amended: July 2004.

City of Pinconning Downtown Redevelopment Plan. Prepared By: Gove Associates, Inc. Kalamazoo, MI. Plan Date: June 1995.

City of Pinconning Zoning Ordinance. Effective Date: December 18, 2000.

Frankenlust Township Master Plan. Prepared with assistance of: McKenna Associates, Inc. Farmington Hills, MI. Adopted: 1997.

Frankenlust Township Sign Ordinance.

Frankenlust Zoning Ordinance. Ordinance Number 29. Prepared: October 13, 1998.

Frankenlust Township Master Plan. Prepared with assistance of Spicer Group, Inc. Adopted: January 2005.

Garfield Township Master Plan. Prepared By: Wade-Trim, Inc. Bay City, MI. Adopted: August 28, 1997.

Garfield Township Zoning Ordinance. Adopted: March 10, 1985.

Gibson Township Zoning Ordinance. Adopted December 11, 1979. Revised: June 10, 1996.

Hampton Charter Township Comprehensive Plan Update. Plan Date: March 7, 2001.

Hampton Charter Township Comprehensive Plan. Plan Date: 1989.

Hampton Charter Township Zoning Ordinance. Last Amended: April 11, 2002.

Kawkawlin Township Master Plan. Prepared with assistance of: Wade-Trim, Inc. Bay City, MI. Adopted: June 27, 2002.

Kawkawlin Township Zoning Ordinance. Effective Date: December 23, 2002.

Kawkawlin Zoning Map. Effective Date: January 9, 2003.

Merritt Township Master Plan. Prepared By: Crescent Consulting, Inc. and Cindy Winland, AICP, PCP. Midland, MI. Plan Date: November 13, 2007.

Merritt Township Land Use Plan. Prepared By: IMPACT: Improved Planning Action Community Planners. Plan Date: September 1977.

Merritt Township Zoning Ordinance. Adopted: April 16, 1980. Revised: October 8, 1991 and October 13, 1992.

Monitor Charter Township Master Plan Update. Prepared with the assistance of: McKenna Associates, Inc. Northville, MI. Plan Date: 2005.

Monitor Charter Township Zoning Map. January 2000.

Mount Forest Township Zoning Ordinance. Effective Date: August 10, 2000.

Official State of Michigan Website. U.S. Census Bureau, Estimates of Subcounty Population for 2000-2007, released July 10, 2008. These estimates were prepared through the Federal-State Cooperative for Population Estimates. Table prepared by the Library of Michigan. Online: http://www.michigan.gov/som/0,1607,7-192-29938_54272-222658--,00.html

Pinconning Township Comprehensive Plan. Prepared By: Comprehensive Planning Services. Rogers City, MI. Adopted: 1978. Amended: 1997.

Pinconning Township Zoning Ordinance. Ordinance Date: September 11, 2001.

Selected Housing Characteristics: 2006-2008. Bay County, MI. Data Set: 2006-2008 American Community Survey. Survey: American Community Survey. U.S. Census Bureau. Source: Source: http://factfinder.census.gov/servlet/ACSSAFFFacts?_event=Search&geo_id=&_geoContext=&_street=&_county=Bay+County&_cityTown=Bay+County&_state=04000US26&_zip=&_lang=en&_sse=on&pctxt=fph&pgsl=010

Selected Economic Characteristics: 2006-2008. Bay County, MI. Data Set: 2006-2008 American Community Survey. Survey: American Community Survey. U.S. Census Bureau. Source: http://factfinder.census.gov/servlet/ADPTable?_bm=y&-geo_id=05000US26017&-qr_name=ACS_2008_3YR_G00_DP3YR3&-ds_name=ACS_2008_3YR_G00_&-_lang=en&-redoLog=false&-_sse=on

Township of Pinconning Land Division Ordinance. Adopted: March 31, 1997. Effective Date: April 30, 1997.

Williams Township Zoning Ordinance. Effective Date: June 13, 1977. Revised and Adopted: October 26, 2004.

References – Hazard Profile

Bay City Times Archives. (9/2004-03/2010). Source: http://nl.newsbank.com/nl-search/we/Archives/?p_action=keyword&p_product=NewsLibrary&p_theme=newslibrary2&d_sources=location&d_place=Michigan&p_nbid=

Drought Severity Classification. U.S. Drought Monitor. Source: http://drought.unl.edu/dm/classify.htm

FEMA Presidential Disaster Declarations. Michigan State Hazard Mitigation Plan. Source: http://www.fema.gov/femaNews/disasterSearch.do

Michigan State Hazard Mitigation Plan. Prepared by: Emergency Management and Homeland Security Division, Michigan Department of State Police, and The Michigan Citizen-Community Emergency Response Coordinating Council. Adopted: 2004. Updated: 2006 and 2008.

National Climatic Data Center Storm Event Database. National Climatic Data Center. Source: http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvent~Storms

"Special Hazards Supplement to the Community Rating System Coordinator's Manual". FEMA. Source: http://www.fema.gov/library/viewRecord.do?id=2431

Temperature versus Relative Humidity Scale. Source: http://www.crh.noaa.gov/pub/heat.htm

The Enhanced Fujita Scale of Tornado Intensity. The Tornado Project; Storm Data. National Climatic Data Center. Source: http://www.tornadoproject.com/

US Geological Survey. Source: http://www.usgs.gov/

Kentucky State Hazard Mitigation Plan. Prepared by: Kentucky Emergency Management and the University of Louisville Center for Hazards Research and Policy Development. Adopted: 2004. Updated 2007, 2008 and 2010.

Appendix A

Adoption Resolutions

Sample **Hazard Mitigation Plan Adoption Resolution**

(Resolution No. __)

Whereas **(insert community name)**, Michigan has experienced risks that may damage commercial, residential and public properties, displace citizens and businesses, close streets and impair infrastructure, and present general public health and safety concerns; and

Whereas the community of (**insert name**) has prepared a *Hazard Mitigation Plan* that outlines the community's options to reduce damages and impacts from natural and technological hazards; and

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

Now, therefore, be it resolved that:

The *Hazard Mitigation Plan* is hereby adopted as an official plan of the **(insert community name)**.

A hazard mitigation planning group is hereby established as a permanent community advisory body. The **(insert name of position)** shall designate its members, subject to the approval of **(insert community governing body)**. They shall serve one-year terms. The group's duties shall be as designated in the *Hazard Mitigation Plan*.

The **(insert name of position)** is charged with supervising the implementation of the Plan's recommendations within the funding limitations as provided by the (insert community governing body) or other sources.

The **(insert name of position)** shall give priority attention to the following action items recommended by the *Hazard Mitigation Plan*:

__________________________ (Recommendation _______, page ___)
__________________________ (Recommendation _______, page ___)
__________________________ (Recommendation _______, page ___)
__________________________ (Recommendation _______, page ___)

The **(insert name of position)** shall convene the hazard mitigation planning group quarterly. The planning group shall monitor implementation of the plan and shall submit a written progress report to **(insert community governing body)** in accordance with the following format:

- A review of the original plan.
- A review of any disasters or emergencies that occurred during the previous calendar year.
- A review of the actions taken, including what was accomplished during the previous year.
- A discussion of any implementation problems.
- Recommendations for new projects or revised action items. Such recommendations shall be subject to approval by this (insert community governing body).

Passed this ____ day of (date).

NOTE: AN OFFICIAL SIGNED COPY OF A RESOLUTION OF ADOPTION <u>MUST</u> BE SUBMITTED TO THE MICHIGAN STATE POLICE EMERGENCY MANAGEMENT AND HOMELAND SECURITY DIVISION (to comply with the requirements of the Disaster Mitigation Act of 2000).

Optional elements and language in this example may be removed or changed.

Appendix B

Sing-In Sheets and Attendance Tables

core group 4-5:15

Hazard Mitigation Plan Stakeholder Kick-off Meeting
Wednesday, December 9, 2009
Bay City, Michigan

Name	Community	Title	Phone Number	Email
DAVID ENGELHARDT	BAY COUNTY	GIS COORDINATOR	989-895-4064	engelhardtd@baycounty.net
Randy VanDenBoom	Hampton Twp	Fire Chief	989-893-7791	Hamptonfirechief@chartermi.net
RICK DONAHUE	BANGOR TWP	FIRE CHIEF	989-684-8504	rickdonahue@bangortownship.org
Ryan Manz	Bay County	Director/American Red Cross	989-892-1541	manzr@redcross-esc.org
ROBERT HILL	BAY COUNTY	ENV. HEALTH BCHD	989/895-4006	hillr@baycounty.net

Hazard Mitigation Plan Stakeholder Kick-off Meeting
Wednesday, December 9, 2009
Bay City, Michigan

Name	Community	Title	Phone Number	Email
Dirk Westbury	Bay County	GIS Tech.	895-4245	westburyd@baycounty.net
Bill Deaton	Bay County	Equalization	895 4081	DeatonW@baycounty.NET
Rick Donahue	Bangor Twp	Fire Chief	684-8504	
Randy Stefaniak	Portsmouth Twp	Fire Chief	529-8737	PTFD1800@GMail.com
Dennis Volk	Beaver Twp	Fire Chief	662-4390	
Paul E. Smith	Garfield Twp	Fire Chief	879-2042	
John M. Gaydos	Bay City	Engineering Manager	894-8181	JGAYDOS@BAYCITYMI.ORG
Tony Rytlewski	Bay City	Streets Manager	894-8317	trytlewski@baycitymi.org
Dave Engelhardt	Bay County	GIS Coord	895-4064	engelhardtd@baycounty.net
Darwin Baranski	City of Bay City	Parks Mgr.	989.894.8813	dbaranski@baycitymi.org
Ryan Manz	Bay County	Director of Disaster & Military Services Red Cross	989-892-1541	manzr@redcross-esc.org
Chris Izworski	Bay County	Emergency Mgt Cwr	895 4112	izworskic@baycounty.net
Mike Anderson K. Dunnaway J. Human	Stantec			

Bay County Hazard Mitigation 12-9-2009
~~Core~~ Team Meeting
SIGN-IN SHEET

Please Print:

Name	Title	Agency	Address	Phone	Email
Melissa Maillette	EP&M Div. Manager	Bay Co. Health Dept.	1200 Washington Ave. Bay City, MI 48708	895-2032	maillettem@baycounty.net
Greg Michalek	Fire chief	Bay City Fire	1101 Center Ave Bay City	894-8601	GMichalek@BayCity.org
ROBERT HILL	SR. SAN	B CHD	1200 WASHINGTON BAY CITY	895-4006	hillr@baycounty.net

Community	Name
Bangor Twp	David DeGrow
Bangor Twp	Mark Norton
Bangor Twp	Rick Donahue
Bangor Twp	Terry Watson
Bay City	Amy L. DeHaan-Legge
Bay City	Greg Mickalek
Bay City	Jim Bedell
Bay City	Jim Bedell
Bay City	Mark Newvine
Bay City	Robert Belleman
Bay County	Dirk Westbury
Bay County	Joe Rivet
Bay County	Tom Hickner
Bay County	Mike Gray
Bay County	Laura Ogar
Bay County	Bob Hill
Bay County	Melissa Maillette
Bay County	Bill Deaton
Bay County	Barb MacGregor
Bay County	Joel Straz
Bay County	Dave Engelhardt
Beaver Twp	A.J. Neumann
Beaver Twp	Dennis Volk
Beaver Twp	Ronald Robbins
Beaver Twp	Ronald Robbins
City of Auburn	Eric E. Larsen
City of Auburn	JoElla Krantz
City of Auburn	Les Houck
City of Auburn	Michael Snyder
City of Auburn	Mike Synder
City of Pinconning	Allan Thompson
City of Pinconning	David Ramsay
City of Pinconning	Richard Byrne
City of Pinconning	Robert Hall
Essexville	Alan Hugo
Essexville	Dale J. Majerczyk
Essexville	Russell Tanner
Essexville	Timothy Weiler
Frankenlust Twp	Karl Verity
Frankenlust Twp	Richard Sabias
Frankenlust Twp	Ronald Campbell
Fraser Twp	Al Thompson
Fraser Twp	Dave Ramsay
Fraser Twp	George Augustyniak
Fraser Twp	Tom Fouchea
Garfield Twp	Alan Tompson
Garfield Twp	James Dubay
Garfield Twp	Leroy Day
Garfield Twp	Paul Smith
Gibson Twp	Al Thompson
Gibson Twp	Art Rivard

Gibson Twp	Dan Chapman
Gibson Twp	Todd McLincha
Hampton Twp	Alan Hugo
Hampton Twp	Randy VanDenBoom
Hampton Twp	Terry Spegel
Kawkawlin Twp	Dennis Bragiel
Kawkawlin Twp	Jim Burke
Kawkawlin Twp	Richard Sabias
Monitor Twp	Gary Brandt
Monitor Twp	John Kramer
Monitor Twp	Margaret Ford
Monitor Twp	Richard Sabias
Mt. Forest Twp	Al Thompson
Mt. Forest Twp	Christy Fedak
Mt. Forest Twp	George Schwerin
Mt. Forest Twp	Michael Haranda
Munger Twp	David Schabel
Munger Twp	Howard Meyer
Munger Twp	James Peplinski
Pinconning Twp	Al Thompson
Pinconning Twp	Mark Harnden
Pinconning Twp	Sharon Stalsberg
Portsmouth Twp	James Peplinski
Portsmouth Twp	Les Houck
Portsmouth Twp	Paul Wasek
Portsmouth Twp	Randy Stefaniak
Portsmouth Twp	Robert Klemish
Portsmouth Twp	Robert Pawlak

Title	Address
Bangor Twp Building Inspector	180 State Park Drive
Bangor Twp Planning Commission	180 State Park Drive
Bangor Twp Fire Chief	180 State Park Drive
Bangor Twp Supervisor	180 State Park Drive
Bay City Bay City Assessor	301 Washington Avenue
Bay City Fire Chief	1401 Center Avenue
Bay City Planner/Zoning Administrator	301 Washington Avenue
Bay City Building Inspector	301 Washington Avenue
Bay City Safety officer	1401 Center Avenue
Bay City Manager	301 Washington Avenue
Bay County GIS	515 Center Avenue Suite 505
Bay County Drain Commissioner	515 Center Avenue Suite 601
Bay County County Executive	515 Center Avenue Suite 401
Bay County Assistant County Executive for Recreatio	515 Center Avenue Suite 403
Bay County Enviormental Affairs / Community Devel	515 Center Avenue Suite 501
Bay County BCHD - Enviormental Health	1212 Washington Ave.
Bay County Emergency Preparedness & Management	1200 Washington Ave.
Bay County Equalization	515 Center Avenue Suite 602
Bay County Health Dept - Health Director/Officer	1200 Washington Ave.
Bay County Health Dept - Public Health Clinical Servi	1200 Washington Ave.
Bay County GIS	515 Center Avenue Suite 505
Beaver Twp Building Inspector	1235 Ivy Leaf Court
Beaver Twp Fire Chief/Assessor	939 West River Road
Beaver Twp Supervisor/ Zoning Adminstrator	1850 Garfield Road
Beaver Twp Supervisor/ Zoning Administrator	849 West River Road
City of Auburn Mayor	311 W. Elm Street
City of Auburn Manager/Zoning Administrator	113 East Elm Street
City of Auburn Building Inspector	1080 W Midland Road
Auburn Williams Fire Chief	250 Sycamore
Auburn WilliamsFire Chief	1090 West Midland Road
City of Pinconning Building Inspector	413 5. Mable
Pinconning Fraser Fire Chief	P.O. Box 201
Pinconning City Manager/Zoning Administrator	208 Manitou Street PO Box 628
City of Pinconning Mayor	208 Manitou Street PO Box 628
EssexvilleBuilding Inspector	1107 Woodside Avenue
Essexville Manager/Zoning Administrator	315 Scheurmann Street
Essexville Mayor	1411 Borton Avenue
Essexville Chief of Public Safety	1107 Woodside Avenue
Frankenlust Twp Fire Chief	2401 Delta Road
Frankenlust Twp Building Inspector	2401 Delta Road
Frankenlust Twp Supervisor	2401 Delta Road
Fraser Twp Building Inspector	1751 Cody Estey Road
Pinconning Fraser Fire Chief	1751 Cody Estey Road
Fraser Supervisor	1474 North Mackinaw Road
Fraser Zoning Administrator	1474 North Mackinaw Road
Garfield Twp Building Inspector	1751 Cody Estey Road
Garfield Twp Supervisor	1138 West Erickson
Garfield Twp Zoning Administrator	1155 North Carter Road
Garfield Twp Fire Chief	801 North Eight Mile road
Gibson Twp Building Administrator	PO Box 58
Gibson Twp Zoning Administrator	944 Saganing Road

Gibson Twp Fire Chief	8292 Standish Road
Gibson Twp Supervisor	2991 Brown Road
Hampton Twp Building Inspector	1200 Morningstar
Hampton Twp Fire Chief	949 N. Wagner Rd
Hampton Twp Supervisor	801 West Center Avenue
Kawkawlin Twp Supervisor	1836 East Parish Road
Kawkawlin Twp Fire Chief	1836 East Parish Road
Kawkawlin Twp Building Inspector / Zoning	1836 East Parish Road
Monitor Twp Supervisor	2483 East Midland Road
Monitor Twp Fire Chief	2483 East Midland Road
Monitor Twp Assessor	2483 East Midland Road
Monitor Twp Building DepartmentChief Building Offic	2483 East Midland Road
Mt. Forest Twp Building Administrator	1751 East Cody Estey Road
Mt. Forest Twp Zoning Administrator	1705 West Cody Estey Road
Mt. Forest Twp Fire Chief	1678 West Mount Forest Road
Mt. Forest Twp Supervisor	1705 West Cody Estey Road
Munger Twp Supervisor	1601 Knight Road
Munger Twp Fire Chief	1224 South Finn Road
Munger Twp Zoning Administrator / Building Inspect	34 Stanley Drive
Pinconning Twp Building Administrator	P.O. Box 58
Pinconning Twp Zoning Administrator	P.O. Box 58
Pinconning Twp Supervisor	PO Box 58
Portsmouth Twp Zoning Administrator/Building Inspe	34 Stanley Drive
Portsmouth Twp Building Inspector	1080 W. Midland Road
Portsmouth Twp Supervisor	1080 W. Midland Road
Portsmouth Twp Fire Cheif	2507 25th Street
Portsmouth Twp Zoning Administrator	1080 W. Midland Road
Portsmouth Twp Supervisor	1711 West Cass Avenue Road

City	State	Zip Code	Phone
Bay City	MI	48706	(989) 684-5427
Bay City	MI	48706	(989) 684-8931
Bay City	MI	48706	(989) 684-8504
Bay City	MI	48706	(989) 684-8931
Bay City	MI	48708	(989) 894-8123
Bay City	MI	48708	(989) 892-8601
Bay City	MI	48708	(989) 894-8173
Bay City	MI	48708	(989) 894-8166
Bay City	MI	48708	(989) 893-6512
Bay City	MI	48708	(989) 894-8246
Bay City	MI	48708	(989) 895-4245
Bay City	MI	48708	(989) 895-4290
Bay City	MI	48708	(989) 895-4130
Bay City	MI	48708	(989) 895-4132
Bay City	MI	48708	(989)-895-4135
Bay City	MI	48708	(989) 895-4006
Bay City	MI	48708	(989) 895-2032
Bay City	MI	48708	(989) 895-4075
Bay City	MI	48708	(989) 895-6181
Bay City	MI	48708	(989) 895-6151
Bay City	MI	48708	(989) 895-4064
Essexville	MI	48732	(989) 714-9150
Auburn	MI	48611	(989) 662-4390
Auburn	MI	48611	(989) 662-4996
Auburn	MI	48611	(989) 662-2656
Auburn	MI	48611	(989) 662-2208
Auburn	MI	48611	(989) 662-6761
Auburn	MI	48611	(989) 662-4408
Auburn	MI	48611	(989) 662-2566
Auburn	MI	48611	(989) 662-2699
Pinconning	MI	48650	(989) 879-3012
Pinconning	MI	48650	(989) 879-3821
Pinconning	MI	48650	(989) 879-4845
Pinconning	MI	48650	(989) 879-3800
Essexville	MI	48732	(989) 893-0772
Essexville	MI	48732	(989) 893-0772
Essexville	MI	48732	(989) 893-8664
Essexville	MI	48732	
Bay City	MI	48706	
Bay City	MI	48706	
Bay City	MI	48706	
Pinconning	MI	48650	(989) 879-3012
Pinconning	MI	48650	
Linwood	MI	48634	
Linwood	MI	48634	(989) 697-3158
Linwood	MI	48634	(989) 879-3012
Linwood	MI	48634	
Linwood	MI	48634	(989) 879-2234
Linwood	MI	48634	(989) 879-2042
Pinconning	MI	48650	(989) 879-3012
Bentley	MI	48613	(989) 846-6697

Bentley	MI	48613	
Bentley	MI	48613	(989) 846-9773
Essexville	MI	48732	(989) 894-4224
Essexville	MI	48732	(989) 893-7791
Essexville	MI	48732	(989) 893-7541
KawKawlin	MI	48631	(989) 686-8710
KawKawlin	MI	48631	(989) 686-1120
KawKawlin	MI	48631	(989) 686-8710
Bay City	MI	48706	(989) 684-7203
Bay City	MI	48706	(989) 684-6320
Bay City	MI	48706	(989) 684-7203
Bay City	MI	48706	(989) 684-7203
Pinconning	MI	48650	(989) 879-3012
Pinconning	MI	48650	(989) 879-7575
Pinconning	MI	48650	(989) 879-3637
Pinconning	MI	48650	(989) 879-7575
Munger	MI	48747	(989) 659-2136
Munger	MI	48747	(989) 659-2178
Bay City	MI	48708	(989) 894-4023
Pinconning	MI	48650	(989) 879-3012
Pinconning	MI	48650	(989) 879-4018
Pinconning	MI	48650	(989) 879-4018
Bay City	MI	48708	(989) 894-4023
Auburn	MI	48611	(989) 662-4408
Auburn	MI	48611	(989) 662-4408
Bay City	MI	48708	(989) 894-0002
Auburn	MI	48611	(989) 662-4408
Bay City	MI	48708	(989) 892-7221

All sessions in GMT -06:00, Central Standard Time (Chicago)
Session detail for 'Bay County Hazard Planning Kickoff Review'

Participant	Name	NameEmail	Community
1	Donald Jeske Jr.	pffd1520@yahoo.com	Pinconning Twp
2	Gary A. Brandt		Monitor Twp
3	Dennis Bragiel	dennisbragiel@yahoo.com	Kawkawlin Twp
4	Ronald Campbell	rwc_supervisor@frankenlust.com	Frankenlust Twp
5	Daniel J. Hansford	dpwsupt@essexville.org	Essexville
6	George L. Augustyniak	frasersupervisor@att.net	Fraser Twp
7	Mike Snyder (Auburn-Williams FD)	mike.snyder@dowcorning.com	Auburn Williams Fire
8	Tim Weiler	dirpublicsafety@essexville.org	Essexville
9	Jo Ella Krantz	jkrantz@auburnmi.org	City of Auburn
10	Mike Anderson	mike.anderson@stantec.com	Stantec
11	Rick DeCaire	rick.decaire@dowcorning.com	Auburn Williams Fire
12	Richard Byrne	redhorse2121@yahoo.com	City of Pinconning
13	Bill Deaton	deatonw@baycounty.net	Bay County
14	Chris Izworski	izworskic@baycounty.net	Bay County
15	Paul Wasek	pwasek@williamstwp.com	Williams Twp
16	Amy L. DeHaan-Legge	adehaan-legge@baycitymi.org	City of Bay City
17	Art Rivard		Gibson Twp
18	John Kramer		Monitor Twp

Date	Start time	End time	Duration
1/7/2010	12:57 PM	2:05 PM	69 mins
1/7/2010	1:06 PM	2:03 PM	58 mins
1/7/2010	12:55 PM	2:04 PM	69 mins
1/7/2010	12:58 PM	1:06 PM	8 mins
1/7/2010	1:21 PM	1:39 PM	44 mins
1/7/2010	1:23 PM	2:06 PM	43 mins
1/7/2010	12:59 PM	2:08 PM	69 mins
1/7/2010	12:52 PM	2:08 PM	77 mins
1/7/2010	12:53 PM	2:08 PM	75 mins
1/7/2010	12:43 PM	2:08 PM	86 mins
1/7/2010	1:00 PM	1:22 PM	63 mins
1/7/2010	1:01 PM	2:08 PM	67 mins
1/7/2010	12:55 PM	2:03 PM	69 mins
1/7/2010	12:48 PM	2:04 PM	76 mins
1/7/2010	1:36 PM	2:08 PM	33 mins
1/7/2010	12:44 PM	2:05 PM	81 mins
1/7/2010			
1/7/2010			

Hazard Mitigation Plan Public Meeting
Thursday, 13, 2010
4:00 pm
800 JOHN F. KENNEDY DRIVE
BAY CITY, MICHIGAN

Name	Community	Title	Phone Number	Email
DAVE SWINSON	HAMPTON	DEPT SUPR.	893-7541	dswinson@chartermi.net
LeRoy Day	Garfield	Zoning Adm.	879-2552	
GEORGE L. AUGUSTYNIAK	FRASER	SUPERVISOR	697-3820	frasersupervisor@att.net
GARY A. BRANDT	MONITOR TWP	SUPERVISOR	684-7203	monitorsupervisor@charterinternet.com
RICHARD BYRNE	CITY OF PINCONNING	CITY MGR	615-8585	REDHORSE2121@YAHOO.COM
Dennis Bragiel	Kawkawlin	Supervisor	686-8770	dennisbragiel@yahoo.com
Randy Stefaniak	Portsmouth	Fire Chief	529-8737	PTFD180@Gmail.com
Greg Michalek	BAY City	fire chief	892-8601	gmichalek@Baycitymi.org
JOHN R. KROMER	Monitor TWP. F.D.	FIRE CHIEF	989-684-6320	MONITORCHIEF@CHARTERINTERNET.COM
DAVE ENGELHARDT	BAY COUNTY GIS	GIS COORD	895-4064	
Chris Izworski	Bay Co EMC	EMC	895-4112	Izworskic@baycounty...
Joy Brooks	DNRE	District Floodplain Engineer	894-6226	brooksj@michigan.gov
Ryan Manz	Bay County Red Cross	Director of Disaster & Military Services	989-892-1541	manzr@redcross-esc.org

Hazard Mitigation Plan Public Meeting
Thursday, 13, 2010
4:00 pm
800 JOHN F. KENNEDY DRIVE
BAY CITY, MICHIGAN

Name	Community	Title	Phone Number	Email
DARWIN BARANSKI	City of Bay City	PARKS MANAGER	989.894.8313	dbaranski@baycitymi.org
PAUL WASEK	Williams Twp.	Supervisor	989-662-4241	supervisor@williamstwp.com
Bill Deaton	Bay County	Appraiser	989 895 4081	deatonw@baycounty.net
ELWIN APPOLD	FRANKENLUST TWP	CLERK	989-686-5300	AJAPPR@CHARTERMI.NET
Tony Rytlewski	City of Bay City	streets Manager	989-894-8317	trytlewski@baycitymi.org
Robert Pawlak	Portsmouth Twp	Supervisor	989-233-7320	bopav@aol.com ~~pawlakb@~~
RICK DONAHUE	BANGOR TWP	FIRE CHIEF	989-684-8504	rickdonahue@bangortownship.org

BAY COUNTY HAZARD MITIGATION PLAN KICK-OFF MEETING

THURSDAY, FEBRUARY 25, 2010
4:00 PM
800 JOHN F. KENNEDY DRIVE
BAY CITY, MICHIGAN

1. Introductions

2. Hazard Mitigation Plan Elements
   a. Risk Assessment
   b. Mitigation Strategies
   c. Plan Adoption

3. Share Survey Results

4. Risk Assessment Results

5. Mitigation Goals

6. Develop Mitigation Actions
   - New Structures / Infrastructure
   - Existing Structures / Infrastructure

7. Prioritizing Mitigation Actions

8. Plan Maintenance Responsibilities

9. Review Schedule

CONTACT INFORMATION:

Chris Izworski
Emergency Management Coordinator
Bay County Emergency Preparedness and Management Division
1200 Washington Ave.
Bay City, MI 48708
(989) 895-4112 *Office*
(989) 895-4014 *Fax*
izworskic@baycounty.net
www.baycounty-mi.gov/ESHS

2hrs
4-6

Hazard Mitigation Plan Public Meeting
Thursday, February 25, 2010
4:00 pm
800 JOHN F. KENNEDY DRIVE
BAY CITY, MICHIGAN

Name	Community	Title	Phone Number	Email
Randy VanDenBoom	Hampton twp	Fire Chief	989-893-7791	Hamptonfirechief@chartermi.net
Greg Michalek	Bay City Fire	Fire chief	(989) 892-8601	gmichalek@baycitymi.org

Hazard Mitigation Plan Public Meeting
Thursday, February 25, 2010
4:00 pm
800 JOHN F. KENNEDY DRIVE
BAY CITY, MICHIGAN

Name	Community	Title	Phone Number	Email
ALVIN APPOD	FRANKENLUST TWP	CLERK	686-5300	AJAPR@CHARTERMI.NET
John Gaydos	BAY CITY	ENGINEERING MANAGER	894-8181	JGAYDOS@BAYCITYMI.ORG
CLARENCE W. BILL PELTON	GARFIELD TWP	Sec PLANNING CO. Fire Fighter.	697 5181	Clarence W. Pelton @CHARTER.COM
LeRoy Day	GARfield Twp	Zoning Adm	989-879-2234	
Dennis Bragiel	Kawkawlin Twp	Supervisor	989 686 8710	dennisbragiel@yahoo.com
Dan Chapman	Gibson Twp	Fire Chief	989 846-4777	dkchapmanma@yahoo.com
RANDY STEFANIAK	Portsmouth Twp	Fire Chief	989-892-0642	PTFD1800@GMAIL.COM
GEORGE L. AUGUSTYNIAK	FRASER TWP	SUPERVISOR	697-3820	fraser supervisor @ATT.NET
JOE KRANTZ	City of Auburn	City MGR	989-662-6761	jkrantz@auburnmi.org
[illegible]	Williams Twp	[illegible]	662 4408	---
ROBERT HILL	BAY CO	CHIEF SAN	895-4019	hillr@baycounty.net
ROBIN DEMING	STATE OF MI/MSP	SENIOR EQA 12	894 6258	DEMINGR@MICHIGAN.GOV
DENNIS VOLK	BEAVER TWP	FIRE CHIEF	662-4984	

Hazard Mitigation Plan Public Meeting
Thursday, February 25, 2010
4:00 pm
800 JOHN F. KENNEDY DRIVE
BAY CITY, MICHIGAN

Name	Community	Title	Phone Number	Email
Sharon Szalsberg	Pinconning Twp.	Supervisor	989-879-[illegible]	sgralsberg@[illegible].net
DARWIN BARANSKI	City of Bay City	Parks Manager	989.894.8313	dbaranski@baycitymi.org

Hazard Mitigation Plan Public Meeting
Thursday, February 25, 2010
4:00 pm
800 JOHN F. KENNEDY DRIVE
BAY CITY, MICHIGAN

Name	Community	Title	Phone Number	Email
DAVE ENGELHARDT	BAY COUNTY	GIS COORDINATOR	895-4064	engelhardtd@baycounty.net
Tim Weiler	Essexville	Director of Public Safety	892-2541	dirpublicsafety@essexville.or
Tony Rytlewski	City of Bay City	Street Supr	894-8317	trytlewski@baycitymi.org
Ryan Manz	Bay County	Director of Disaster & Military Services	892-1541	manzr@redcross-esc.org

Appendix C

Meeting Announcements and Information Requests

Order Confirmation

Ad Order Number 0003529455

THE BAY CITY TIMES

Customer	Payor Customer		
Account: 1000089485	*Account:* 1000089485	*PO Number*	waiting on
BAY COUNTY ACCTS PAYABLE CLAS	BAY COUNTY ACCTS PAYABLE CLASS	*Ordered By*	
515 CENTER, SUITE 404	515 CENTER, SUITE 404	*Sales Rep.*	kott
BAY CITY MI 48708-0000 USA	BAY CITY MI 48708-0000 USA	*Order Taker*	kott
(989) 895-4280	(989) 895-4280	*Order Source*	
(989) 895-4040	(989) 895-4040	*Special Pricing*	None

FAX
corteze@baycounty.net

Tear Sheets	0	*Net Amount*	$160.23
Proofs	0	*Tax Amount*	$0.00
Affidavits	1	*Total Amount*	$160.23
Blind Box		*Payment Method*	
Promo Type		*Payment Amount*	$0.00
Materials	B-Affidavit(1.0 X $5.00)	*Amount Due*	$160.23

Ad Number	0003529455-01	*Ad Type*	D-CLS Liner
		Ad Size	1.0 X 84 Li
Pick Up #		*Ad Attributes*	
		Ad Released	No
External Ad #		*Color*	<NONE>
		Production Method	AdBooker
		Production Notes	
Invoice Text:			

Product	B-Bay City Times::	*Placement/Class*	B-Announcements - Announcem
# Inserts	1	*POS/Sub-Class*	Legal Notices B-135
Run Dates	12/6/2009		
Sort Text	NOTICEOFPUBLICMEETINGBAYCOUNTYWILLHOLDAPUBLICMEETINGONDECEMBER9 TH2009AT600PMAT800JOHNFKENNEDYDRIVEBAYCITYMICHIGANTODISCUSSTHEMUL		
Run Schedule Invoice Text:	NOTICE OF PUBLIC MEETING Bay County will hold a public meeting		
Product	B-Internet::	*Placement/Class*	B-Announcements - Announcem
# Inserts	1	*POS/Sub-Class*	Legal Notices B-135
Run Dates	12/6/2009		
Sort Text	NOTICEOFPUBLICMEETINGBAYCOUNTYWILLHOLDAP		
Run Schedule Invoice Text:	NOTICE OF PUBLIC MEETING Bay County wil		

Ad Content Proof

NOTICE OF PUBLIC MEETING

Bay County will hold a public meeting on December 9th, 2009, at 6:00 pm at 800 John F. Kennedy Drive Bay City, Michigan to discuss the multi-jurisdictional natural hazard mitigation plan recently awarded by Federal Emergency Management Agency (FEMA) Pre-Disaster Mitigation (PDM). Through the "Bay County Multi-Jurisdictional Natural Hazard Mitigation Plan", your risk-prone assets will be better identified, prioritized, and ultimately managed. After this plan has been drafted and ultimately approved by the participating jurisdictions and FEMA, the participating communities will be eligible for FEMA Mitigation Grant Programs which can fund up to 75% of cost-effective mitigation projects.

For Additional Information, Please Contact:Christopher Izworski, Emergency management CoordinatorBay County Health Department – Emergency Preparedness and Management Division1200 Washington AvenueBay City, Michigan 48708Office: 989-895-4112 Fax: 989-895-4014 izworskic@baycounty.net

1The County of Bay will provide necessary and reasonable auxiliary aids and services such as signers for the hearing impaired and audio tapes of printed materials to individuals with disabilities upon 10 days notice to the County of Bay. Individuals with disabilities requiring auxiliary aids or services should contact the County of Bay by writing or calling:

Michael Gray,
ADA Coordinator
Office of The Bay County Executive
515 Center Avenue
Bay City, MI 48708
(989)895-4130
(989)895-4049 TDD

Thomas L. Hickner
Bay County Executive

BAY COUNTY
Health Department
Creating A Healthy Environment For The Community

Barbara MacGregor, RN, BSN
Health Director

Chris Izworski
Emergency Management Coordinator

1200 Washington Avenue
Bay City, Michigan 48708
(989) 895-4112
FAX (989) 895-4014
TDD (989) 895-4049

February 2, 2010

Dear _____:

I want to again express my thanks for your assistance with the Bay County Multi-Jurisdictional, Multi-Hazard Mitigation Plan. The next stakeholder meeting for the Plan will be held **Thursday, February 25, 2010 at 4:00 p.m. at the Bay County Community Center**, 800 John F. Kennedy Drive. This meeting will be open to the public.

As you may recall, risk is estimated as the probability and consequences of an event. As part of the risk analysis, we combined the data submitted by Bay County communities with other sources to estimate the consequences of each hazard impacting participating jurisdictions. The risk and vulnerability assessment process developed a description of the natural hazards that have occurred within each community. The hazards that are being assessed as part of this Plan are: droughts, earthquakes, extreme temperatures, floods, hail, severe winter storms, ice and sleet storms, wind-driven ice flows, severe storms, tornadoes, wildfires and thunderstorms.

During this next meeting we will discuss the results of the risk analysis and possible mitigation strategies to minimize your exposure to the identified hazards. These strategies will ultimately serve as the action plan to reduce or avoid long-term vulnerabilities to the hazards identified throughout Bay County. The strategies will consist of specific actions and projects that reduce the effects of each hazard with particular emphasis on buildings and infrastructure. These and other recommended activities will be organized into the five general categories:

- **Preventative Activities** that keep problems from becoming exacerbated through regulations including building codes, development of hazardous areas, and local planning or capital improvement projects.

- **Property Protection Activities** that are building or parcel specific such as flood proofing, acquisition, or retrofitting.

- **Emergency Services** measures implemented during a disaster to minimize associated impacts.

- **Structural Projects** that control flooding, drainage, and other hazards.

- **Public Information Initiatives** that educate residents to local hazards and the protective measures they can perform to better protect themselves and their property.

If there is any additional information you would like included in the plan that has not yet been submitted, please mail them to my address below or you may include them on the ftp site at http://gis01.stantec.com/baycounty/. Should you have any questions, please feel free to contact me.

Sincerely,

Chris Izworski
Emergency Management Coordinator, Bay County
Emergency Preparedness and Management Division
1200 Washington Ave.
Bay City, MI 48708
Office: (989) 895-4112
Fax: (989) 895-4014
izworskic@baycounty.net
www.baycounty-mi.gov/ESHS

CC: Melissa Maillette
Barb MacGregor
Michael Gray
Tom Hickner

BAY COUNTY
(989) 895-4051 • FAX (989) 892-3744
911 Central Dispatch
1228 Washington Ave., Bay City MI 48708
Leonard Norman
Director

Thomas L. Hickner
Bay County Executive

Chris Izworski
Emergency Management Coordinator
989-895-4112

To: **Area Media Outlets**

From: Chris Izworski
Emergency Management Coordinator
(989) 895-4112

Date: May 18, 2010

Subject: **Draft of the Bay County Natural Hazard Mitigation Plan is Available On-Line for Review**

Bay County Michigan and the following cities and townships Auburn, Bangor, Bay, Beaver, Essexville, Frankenlust, Fraser, Garfield, Gibson, Hampton, Kawkawlin, Merritt, Monitor, Mount Forest, City of Pinconning, Pinconning Township, Portsmouth, and Williams held the final meeting for the Bay County Natural Hazard Plan at 4:00 pm on May 13, 2010 at 800 John F. Kennedy Drive Bay City, Michigan. The meeting was open to the public. The purpose of this plan is to identify and assess the hazards that may impact the citizens of Bay County and the cities and townships within the County. The draft plan was reviewed and federal and state funding opportunities were discussed.

The public will have the opportunity to review and comment the draft plan. For more information, please contact Chris Izworski at (989) 895-4112. The public can also visit the website at http: //gis01.stantec.com/baycounty/ to view the draft plan.

The Draft Plan will be made available on the website. Hard copies of the plans will also be made available throughout the County. The locations will be identified on the website. Comments will can be emailed to Chris Izworski at IzworskiC@baycounty.net and can be submitted until June 1, 2010.

For Additional Information, Please Contact:
Christopher Izworski, Plan Coordinator
Bay County Health Department
1200 Washington Avenue
Bay City, Michigan 48708
Office: 989-895-4112
Fax: 989-895-4014

XXX

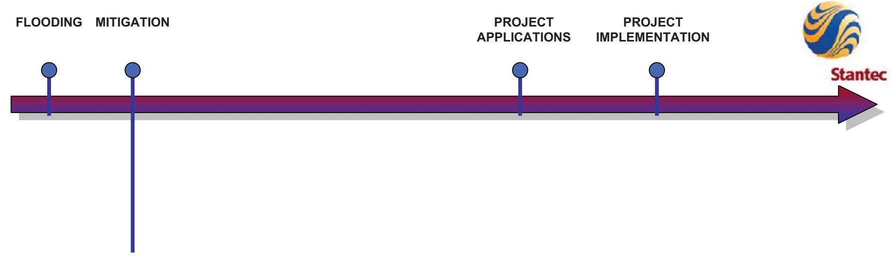
Appendix D

Presentations and Education Materials

Stantec

FEMA

Hazard Mitigation Plan Kick-off Meetings
Wednesday,
December 9, 2009



Stantec

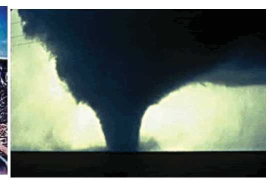
DEVELOP
HAZ-PLAN

Stantec

Project Goal?

Create a Local Multi-Hazard Mitigation Plan to:

- Protect lives, property, economic viability and quality of life,
- Become more disaster-resistant,
- Compliment existing efforts,
- Organize future mitigation efforts.

DEVELOP
HAZ-PLAN

Stantec

PLANNING
PROCESS

RISK
ASSESSMENT

MITIGATION
STRATEGIES

PLAN
MAINTENANCE

Coordination Meetings

Website and Community Promotion

Public and Stakeholder Involvement



DEVELOP
HAZ-PLAN

Stantec

Why Are You Here?

You are the Core Group (Planning Team)

- Awareness of the process,
- Information gathering,
- Utilize your expertise,
- Provide documents and data,
- Perform draft plan reviews, and
- Offer feedback.

Primary Points of Contact

- Key representatives,
- Coordination roles, etc.
- Emergency Management & Homeland Security Division, Michigan State Police,
- FEMA Region V.

DEVELOP
HAZ-PLAN

Stantec

PLANNING PROCESS

1. Discuss Natural Hazards
2. Define Critical Facilities
3. Discuss Timeline
4. Hand Out Press Release
5. Establish Remaining Meetings
6. Identify Relevant Documents
7. Organize and Schedule Interviews

PUBLIC INVOLVMENT

1. Present Plan Process
2. Confirm Schedules
3. Discuss Prioritized Hazards

DEVELOP HAZ-PLAN

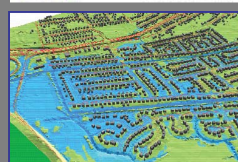
PLANNING PROCESS | RISK ASSESSMENT | MITIGATION STRATEGIES | PLAN MAINTENANCE

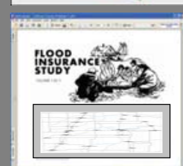
Identify Regional Hazards

Review History of Occurrences

Assess Vulnerabilities Based On:

- Population
- Critical Facilities
- Value of Assets (Infrastructure/Bldgs.)

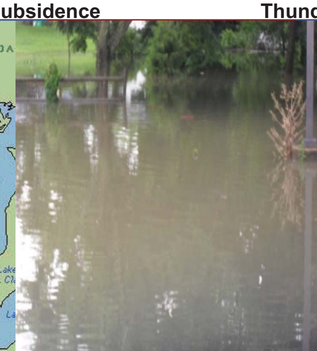




Types of Hazards

Natural Hazards Identified by the State of Michigan:

Severe Winter Storms	**Earthquakes**	**Tornadoes**	**Wildfires**
Ice and Sleet Storms	**Extreme Temperatures**	**Lightening**	**Erosion**
Snow storms	**Flooding**	**Hail**	
Drought	**Subsidence**	**Thunderstorms**	



Types of Hazards

Natural Hazards Identified by Bay County:

Severe Winter Storms	**Earthquakes**	**Tornadoes**
Ice and Sleet Storms	**Extreme Temperatures**	**Hail**
Snow Storms	**Flooding**	**Drought**
Wind Driven Ice Flows	**Wildfires**	**Severe Storms**

DEVELOP HAZ-PLAN

RISK ASSESSMENT

1. Data Gathering
2. Existing Plan Check-List
3. Existing Regulations
4. Local Mapping – GIS Base Data
5. Critical Facilities
6. Property Value Information
7. GAP Analysis and Data Augmentation
8. Discuss Assessment Techniques
9. Determine Vulnerability
10. Coordination

PUBLIC INVOLVEMENT

1. Awareness

Bay County National Floodplain Insurance Program Information

Community	Flood Policies	Past Claims Number / Total	Repetitive Loss Buildings
Auburn	1	0 / $0	0
Bangor	458	121 / $489,817.12	17
Bay City	145	51 / $267,788.22	4
Bay County	0	44 / $179,195.40	0
Beaver	4	0 / $0	0
Essexville	11	2 / $5,118.77	0
Frankenlust	33	9 / $28,011.51	0
Fraser	140	0 / $0	0
Garfield (Not Participating)	0	0 / $0	0
Gibson (Not Participating)	0	0 / $0	0
Hampton	90	4 / $20,385.94	0
Kawkawlin	159	31 / $153,192.08	6
Merritt	8	0 / $0	0
Midland	256	66 / $1,822,918.33	1
Monitor	19	5 / $58,142.16	0
Mount Forest (Not Participating)	0	0 / $0	0
Pinconning City	4	2 / $7,318.73	0
Pinconning Township	46	8 / $30,322.98	0
Portsmouth	26	6 / $59,981.36	0
Williams	9	0 / $0	0

Stantec

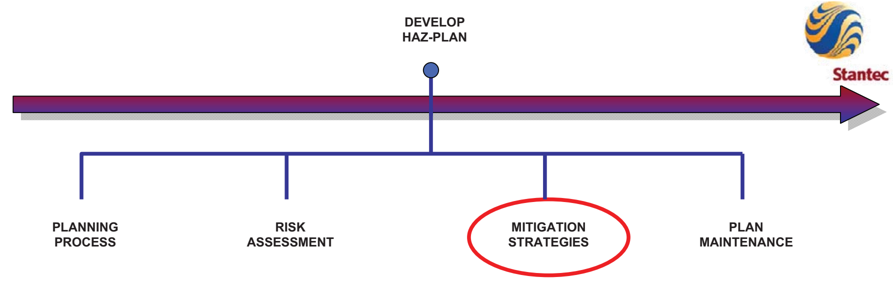
Presidential Disasters Declared for Bay County (1998 Dollars)

Event Type	Year	Damages
Tornados and Severe Weather	1965	$8,053,300
Severe Storms and Flooding	1972	$2,127,463
Severe Storms and Flooding	1973	$7,094,487
Severe Storms and Tornados	1976	$32,454,198
Severe Storms and Flooding	1985	$10,840,498
Severe Storms and Flooding	1986	$52,292,876
Severe Storms and Flooding	1996	$28,140,949
Severe Storms	1998	$45,591,012

Stantec

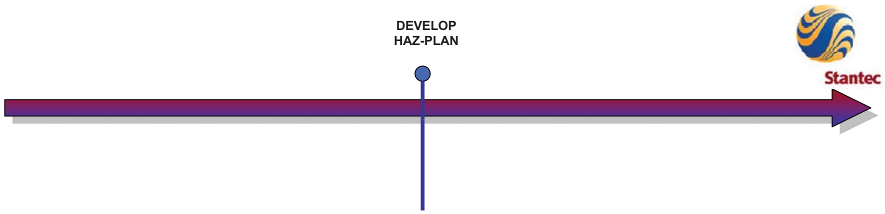
Reported Storm Events
NCDC (1950-2009)

Event Type	Number of Events	Deaths	Injuries	Damages
Droughts	2	0	0	$150,000,000
Floods	8	1	0	$102,250,000
Hail	27	0	2	$0
Snow/Ice/Severe Winter Weather	59	8	577	$500,000
Thunderstorms/ High Wind	115	2	22	$1,444,000
Tornados	12	0	4	$2,898,000



Developing S M A R T goals and activities.

Specific
Measurable
Attainable
Relevant
Time-Phased



MITIGATION STRATEGIES

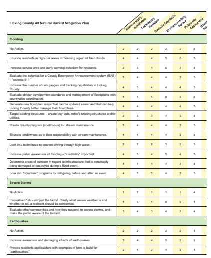
1. Develop Goals and Actions
2. Develop Alternatives, Costs
3. Create Evaluation Criteria
4. Prioritization Matrix

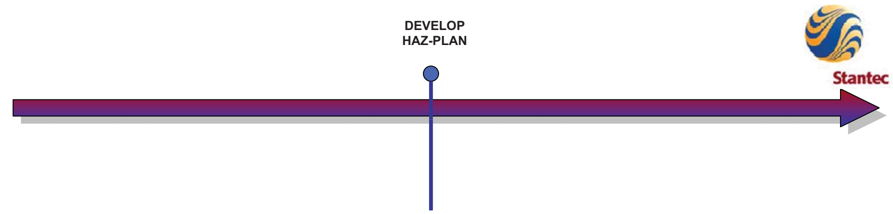
PLAN MAINTENANCE

1. Capability Assessment
2. Incorporation into Existing Planning
3. Plan Revisions and Five-Year Updates
4. Public Involvement and Outreach

PUBLIC PORTION

1. Awareness
2. Feedback





REVIEW, APPROVAL, ADOPTION

1. Draft Review
2. Incorporate Comments
3. Submit
4. Incorporate Comments
5. Finalize and Submit
6. Adoption by Local Municipalities Upon FEMA Approval

PUBLIC INVOLVMENT

1. Awareness
2. Draft Review

DEVELOP
HAZ-PLAN

Stantec

PLANNING PROCESS

RISK ASSESSMENT

MITIGATION STRATEGIES

PLAN MAINTENANCE

Annual Meetings

Five-Year Plan Update

Assess Risks

Identify Mitigation Projects

HMGP HAZARD MITIGATION GRANT PROGRAM

PDM PRE-DISASTER MITIGATION

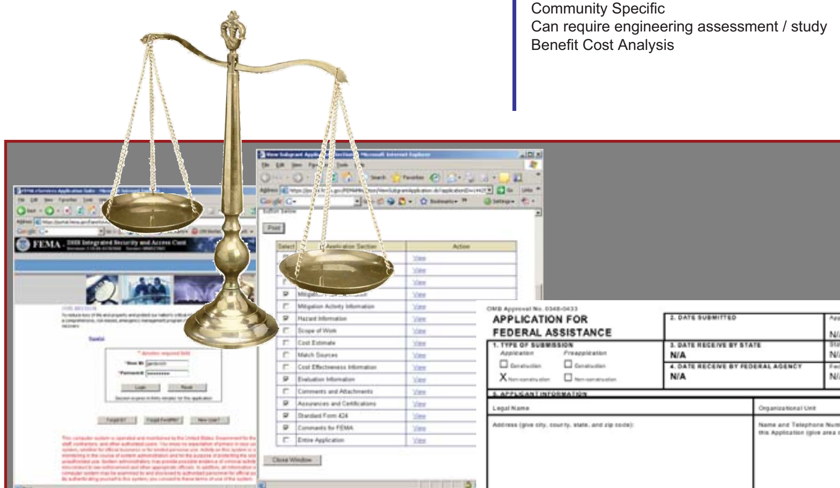
FMA FLOOD MITIGATION ASSISTANCE

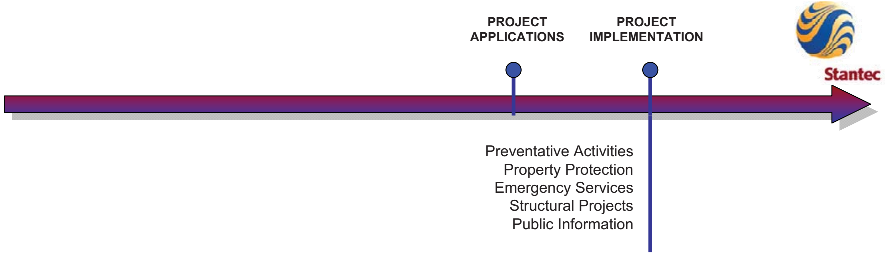
DEVELOP
HAZ-PLAN

PROJECT
APPLICATIONS

Stantec

Community Specific
Can require engineering assessment / study
Benefit Cost Analysis





Each Jurisdiction must participate in the Planning Process through…

- Representation during planning meetings
- Submit inventory of plans, data, and reports relevant to hazard mitigation planning
  - GIS datasets
  - Capitol Improvement Plans
  - Growth Management Plans
  - Floodplain Management Plans
  - Zoning Ordinances
  - Elevation Certificates
- Update website by adding Mitigation Plan link
- Identify critical 'at risk' structures and facilities
- Submit a targeted list of mitigation actions
- Review and comment on draft plan
- Incorporate plan in existing planning efforts
- Formally adopt final plan
- Participate in plan maintenance

Next steps…

1. Fill out the survey
2. Schedule future meetings
3. Submit hazard information

Stantec

What Is A Multi-Jurisdictional Natural Hazard Mitigation Plan?

A multi-jurisdictional natural hazard mitigation plan is a plan jointly prepared by more than one jurisdiction. The plan identifies and assesses areas at risk to natural hazards including flooding, severe storms, drought, snow, earthquakes and tornados. The plan also develops the recommended mitigation activities to reduce the associated risks.

FEMA

Why Conduct A Multi-Jurisdictional Natural Hazard Mitigation Plan?

Local jurisdictions have the option of preparing a multi-jurisdictional hazard mitigation plan under the Disaster Mitigation Act of 2000 (DMA 2000).

Benefits of this process include:

- Enables comprehensive approaches to mitigation of hazards that affect multiple jurisdictions
- Allows economies of scale by leveraging individual capabilities and sharing costs and resources
- Avoids duplication of efforts
- Imposes an external discipline on the process

Bay County Multi-Jurisdictional Natural Hazard Mitigation Plan

Hazard Mitigation Plan Public Meeting (everyone is welcome)

December 9th, 2009
6:00 pm
800 John F. Kennedy Drive
Bay City, Michigan

For more information please contact:
Chris Izworski
989-895-4112

Or visit: http://www.baycounty-mi.gov/ESHS/HazardMitigationPlan.aspx

Your Presence is Requested

Please give back to your community by participating in the development of the Bay County Multi-Jurisdictional Natural Hazard Mitigation Plan.

This plan will help to identify areas prone to natural hazards, including flooding, and develop the actions necessary to mitigate these risks in the future. Your participation will help local officials and planners to better identify and rank areas throughout the County that are subject to higher risk and therefore in need of prioritized risk reduction.

Mitigation Alternatives

The natural hazard mitigation plan is a major step toward recognizing risks throughout the County. It is also a requirement to qualify for federal hazard mitigation funding. These funds may be used to offset costs for projects intended to reduce local exposure to loss of life or damage of property. Examples of projects that can quality for federal funding include:

- Acquisition of property for willing sellers
- Flood proofing structures
- Elevation of flood prone structures
- Implementation of vegetative management programs
- Minor flood control / capital improvement projects
- Building construction, tornado shelters, etc.
- Burying of overhead utility lines

Mitigation Strategies

Mitigation Goals

- Goals to reduce or avoid hazard impacts for each jurisdictions will be developed.

Mitigation Actions:

- Specific mitigation actions will be recommended based on risk assessments and local participation.

Mitigation Prioritization:

- Each recommended mitigation action will be prioritized based on a variety of factors including social impact, administrative capabilities, and environmental impact.

Bay County Multi-Jurisdictional Natural Hazard Mitigation Plan Survey

MULTI-HAZARD MITIGATION INFORMATION

1. Please indicate where you live in Bay County:

- ☐ City of Auburn
- ☐ Township of Bangor
- ☐ Bay City
- ☐ Township of Beaver
- ☐ City of Essexville
- ☐ Township of Frankenlust
- ☐ Township of Fraser
- ☐ Township of Garfield
- ☐ Township of Gibson
- ☐ Township of Hampton
- ☐ Township of Kawkawlin
- ☐ Township of Merritt
- ☐ City of Midland
- ☐ Township of Monitor
- ☐ Township of Mount Forest
- ☐ City of Pinconning
- ☐ Town of Pinconning
- ☐ Township of Portsmouth
- ☐ Township of Williams
- ☐ Other:________________

2. In the past 10 years, have you or has someone in your household experienced a natural disaster *within Bay County* such as: severe storms, floods, winter storms, extreme heat, tornadoes, drought, earthquakes, or other natural disaster?

- ☐ Yes
- ☐ No

2a. If yes to question #2, which of the following types of natural hazard events have you or someone in your household experienced? (Please check all that apply) *If you answered no to question #2, please move on to question #3.*

- ☐ Severe Weather damage in excess of $500
- ☐ Floods
- ☐ Winter Storms
- ☐ Extreme Heat
- ☐ Tornadoes
- ☐ Drought
- ☐ Earthquakes
- ☐ Other (Please specify)________________________

3. Do you consider yourself prepared for the probable impacts from natural hazard events that may occur within your community and/or the greater Bay County?

- ☐ Yes
- ☐ No

3a. If yes to question #3, where did you learn about being prepared for a disaster? (Please check all that apply) * *If you answered no to question #3, please move on to question #4*

- ☐ Emergency preparedness information from a government source (i.e. Federal, State, or Local emergency management)
- ☐ Personal experience; have experienced one or more natural hazard events
- ☐ Locally provided news or other media information
- ☐ Schools and other educational institutions
- ☐ Meetings or trainings offered by volunteer organizations (Red Cross, etc)
- ☐ Other (please specify) _______________________________

3b. Please rank how prepared you feel that you and your household are for the probable impacts of natural hazard events likely to occur within Bay County. Rank on a scale of 1 to 5, with 5 representing the most prepared.

- ☐ 1 Not at all prepared
- ☐ 2 Somewhat prepared
- ☐ 3 Adequately prepared
- ☐ 4 Well prepared
- ☐ 5 Very well prepared

3c. What steps, if any, have you or someone in your household taken to prepare for a natural disaster? (Check all that apply)
Have stored or stocked up on:

- ☐ Food
- ☐ Water
- ☐ Flashlight (s)
- ☐ Batteries
- ☐ Battery-powered radio
- ☐ Medical supplies (First Aid Kit)
- ☐ Fire extinguisher
- ☐ Smoke detector on each level of the house
- ☐ Prepared a disaster supply kit
- ☐ Received First Aid/ CPR training
- ☐ Made a fire escape plan
- ☐ Discussed utility shutoffs
- ☐ Other (please specify) ____________________

4. How concerned are you about the following natural hazards impacting your community and or/ the greater Bay County area (*Please check the corresponding number for each hazard)*

Natural Hazard	Not Concerned	Somewhat Concerned	Concerned	Very Concerned	Extremely Concerned
Severe Storm (wind, lightening)	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
Flood	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
Winter Storms	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
Extreme Heat	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
Tornados	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
Drought	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
Earthquakes	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
Other Please specify: ____________	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

5. What is the most effective way for you to receive information about how to make your household and home safer from natural disasters? (*Please check all that apply*)

Newspapers:
- ☐ Newspaper stories
- ☐ Newspaper ads

Television:
- ☐ Television news
- ☐ Television ads

Radio:
- ☐ Radio news
- ☐ Radio ads

Other Methods:
- ☐ Schools
- ☐ Books
- ☐ Mail

- ☐ Fire Department/Rescue
- ☐ Internet
- ☐ Fact sheet/Brochure
- ☐ Chamber of Commerce
- ☐ Public workshops/Meetings
- ☐ Magazine
- ☐ University or research institution
- ☐ Other (*please explain*): ____________________

6. To the best of your knowledge, is your property located in a designated floodplain?
- ☐ Yes
- ☐ No
- ☐ Not sure

6a. To the best of your knowledge, is your property located in close proximity (<1 mile) to an earthquake fault line?
- ☐ Yes
- ☐ No
- ☐ Not sure

7. Do you have flood insurance?
- ☐ Yes
- ☐ No

8. Do you have earthquake insurance?
- ☐ Yes
- ☐ No

9. How vulnerable to damage is your infrastructure to:

Natural Hazard	Severely Vulnerable	Moderately Vulnerable	Minimally Vulnerable	Don't Know
Severe Storm (wind, lightening)	☐ 3	☐ 2	☐ 1	☐ 0
Flood	☐ 3	☐ 2	☐ 1	☐ 0
Winter Storms	☐ 3	☐ 2	☐ 1	☐ 0
Extreme Heat	☐ 3	☐ 2	☐ 1	☐ 0
Tornados	☐ 3	☐ 2	☐ 1	☐ 0
Drought	☐ 3	☐ 2	☐ 1	☐ 0
Earthquakes	☐ 3	☐ 2	☐ 1	☐ 0
Other *Please specify*: ____________	☐ 3	☐ 2	☐ 1	☐ 0

9a.) How vulnerable to damage are the critical facilities (i.e. police stations, fire stations, emergency operation centers, etc) within your jurisdiction to:

Natural Hazard	Severely Vulnerable	Moderately Vulnerable	Minimally Vulnerable	Don't Know
Severe Storm (wind, lightening)	☐ 3	☐ 2	☐ 1	☐ 0
Flood	☐ 3	☐ 2	☐ 1	☐ 0
Winter Storms	☐ 3	☐ 2	☐ 1	☐ 0
Extreme Heat	☐ 3	☐ 2	☐ 1	☐ 0
Tornados	☐ 3	☐ 2	☐ 1	☐ 0
Drought	☐ 3	☐ 2	☐ 1	☐ 0
Earthquakes	☐ 3	☐ 2	☐ 1	☐ 0
Other *Please specify*: ______________	☐ 3	☐ 2	☐ 1	☐ 0

NATURAL HAZARD MITIGATION

10. Did you consider the impact that the possible occurrence of a natural disaster would have on your home before you purchased/moved in to your home?
- ☐ Yes
- ☐ No

11. Was the presence of a natural hazard risk zone (i.e. flood zone, fault zone, etc) disclosed to you by a Real Estate agent, Seller, or Landlord before you purchased/moved into your home?
- ☐ Yes
- ☐ No

12. Would the disclosure of this type of information influence your decision to purchase/move into a home?
- ☐ Yes
- ☐ No

13. Would you be willing to spend money on your current home to modify/retrofit it from the impacts of future possible natural disasters within Bay County? (Examples of retrofitting are: Elevating a flood prone home, bolting a foundation for seismic impacts, or improving home exteriors to withstand higher winds)
- ☐ Yes
- ☐ No
- ☐ Maybe

(*If you answered No, please skip to question #15)*

14. How much money would you be willing to spend to better protect your home from the impacts of natural disasters?
- ☐ $5,000 and above
- ☐ $2,500 to $4,999
- ☐ $1,000 to $2,499
- ☐ $500 to $999
- ☐ $100 to $499
- ☐ Less than $100
- ☐ Nothing
- ☐ Don't know
- ☐ Other (please specify) ____________________

15. Which of the following **incentives** would help to encourage you to spend money to retrofit your home from the possible impacts of natural disasters (*Please check all that apply)*
- ☐ Low interest rate loan
- ☐ Insurance premium discount
- ☐ Mortgage discount
- ☐ Property tax break or incentive
- ☐ Grant funding that requires a "Cost-Share"
- ☐ None
- ☐ Other (please specify)____________________________________

16. If your property were located in a designated high hazard area, or had received repetitive damages from a natural event, would you consider a buyout or relocation offered by a public agency?
- ☐ Yes
- ☐ No

GENERAL HOUSEHOLD INFORMATION

17. Please indicate your age range:
- ☐ 18 to 29
- ☐ 30 to 39
- ☐ 40 to 49
- ☐ 50 to 59
- ☐ 60 or over

18. Gender:
- ☐ Male
- ☐ Female

19. Please indicate your highest level of education:
- ☐ Grade school/no schooling
- ☐ Some high school
- ☐ High school graduate/GED
- ☐ Some College/Trade school
- ☐ College Degree
- ☐ Post Graduate degree
- ☐ Other ___________________________

20. How long have you lived in Bay County?
- ☐ Less than 1 year
- ☐ 1 to 4 years
- ☐ 5 to 9 years
- ☐ 10 to 19 years
- ☐ 20 or more years

21. Do you have access to the Internet?
- ☐ Yes
- ☐ No

22. Do you own or rent your home?
- ☐ Own
- ☐ Rent

23. Do you own/rent a:
- ☐ Single-family home
- ☐ Duplex
- ☐ Apartment (3-4 units in structure)
- ☐ Apartment (5 or more units in structure)
- ☐ Condominium/townhouse
- ☐ Manufactured home
- ☐ Other ____________________

24. **Other Comments:**

____
____
____
____
____

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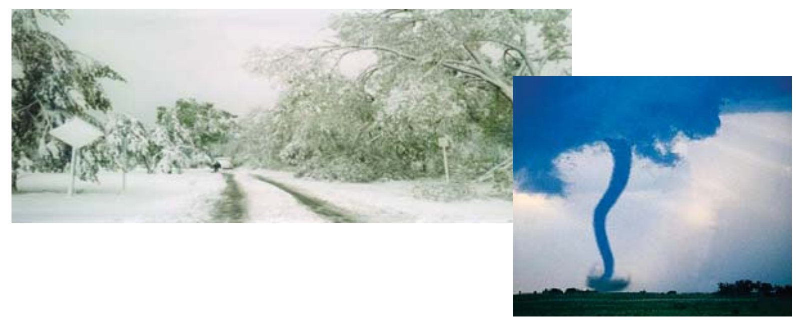
Hazard Mitigation Plan Final Meeting Thursday, May 13, 2010

FEMA



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Project Overview

1. Planning Process,
   - Meetings, stakeholder input, data gathering
2. Risk Assessment (Hazard Identification and Vulnerability),
   - Analyze past occurrences, probabilities, document and map.
3. Multiple Hazard Mitigation Strategy,
   - Determine strategies to reduce risk (preventative, protection, projects, education, etc)
4. Hazard Mitigation Plan Maintenance Process
   - Periodic plan monitoring, evaluating and update. Annual reviews. 5-yr updates.
5. Hazard Mitigation Plan Review, Approval and Adoption
   - Committee, advisory group, public review and council adoption.

RISK ASSESSMENT

1. Data Gathering
2. Existing Plan Check-List
3. Existing Regulations
4. Local Mapping – GIS Base Data
5. Critical Facilities/Essential Facilities
6. GAP Analysis and Data Augmentation
7. Discuss Assessment Techniques
8. Determine Vulnerability
9. State Coordination

PUBLIC PORTION

1. Awareness

FEMA's Crosswalk

Risk Assessment

- Identify Hazards
- Profile Hazards
  - Location, Extent, Previous Occurrences and Probability
- Assessing Vulnerability
  - Summary of each jurisdictions vulnerability to each hazard
- Assessing Vulnerability: Identifying Structures
  - Identifying buildings, infrastructure and essential facilities
- Assessing Vulnerability: Estimating Potential Losses

Hazards Identified and Profiled

DROUGHT
EARTHQUAKE
EXTREME HEAT
FLOODING
HAIL
SEVERE STORMS
SEVERE WINTER STORMS
TORNADOS
WILDFIRE
WIND DRIVEN ICE FLOES

Researched:
National Climatic Data Center
National Weather Service
FEMA Map Service Center
Data Submitted by Residents
Local Newspapers
State Hazard Mitigation Plan
State Agencies

Hazard Identification and Hazard Ranking R = (P x C) (County Wide)

Hazard Type	Dates	Range	Frequency	Total Losses	Probability	Avg. Consequences	Avg. Annual Risk	Rank
Drought	1930-2010	80	7	$8,823,529	0.09	$1,260,504	$110,294.11	4
Earthquake	1584-2009	425	0	$0	0.00	$0	$0.00	10
Extreme Temperature	1936-2010	74	19	$500,000	0.26	$26,316	$6,756.76	7
Flooding	1947-2010	73	21	$102,275,000	0.29	$4,870,238	$1,401,027.40	1
Hail	1960-2010	50	51	$204,254	1.02	$4,005	$4,085.08	8
Severe Storm	1960-2010	50	127	$38,737,800	2.54	$305,022	$774,756.00	3
Winter Storm	1967-2010	43	70	$39,194,615	1.63	$559,923	$911,502.67	2
Tornado	1953-2010	57	20	$2,897,500	0.35	$144,875	$50,833.33	5
Wildfire	1881-2010	129	1	$2,000,000	0.01	$2,000,000	$15,503.88	6
Wind Driven Ice Floes	2009	1	1	$0	0.00	$0	$0.00	9

Key Definitions: for Your Vulnerability Assessment Model

Hazard Identification: A hazard is considered to be anything which either threatens the residents of a community or the things that they value.
Exposure: Your communities assets: People, Property, Essential Facilities and Infrastructure potentially exposed to a hazard.
Risk: Risk equals your hazard probability based on occurrences and or your probability based on geographic hazard layers.
Vulnerability: Defines what part of your "exposure" is at "risk" to each "hazard"

Vulnerability Assessment

Geographic Information Systems (GIS)

GIS provides the integration vehicle for the following:

Mapping (Identifying)

Modeling (Vulnerability Score)

Database management (Hazards and Multiple Variables)

Information analysis (Model Sampling and Flexibility)

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Vulnerability Assessment Model:

FEMA Headquarters praised
FEMA Region IV praised
Used for State, Local, and University Plans

The RJH Planning Vulnerability methodology was designed to be flexible and rely on GIS production.

RJH derived a methodology to achieve a "Vulnerability Score" which is the foundation in your vulnerability assessment.

Vulnerability Score = Exposure Score x Risk Score

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Vulnerability Assessment Model: How it works

1. **We need an area for measure/planning area**

   - County, Jurisdiction, Census Tract, Census Block Group
   - Jurisdiction Boundaries

Provides:
Better hazard scenario assumptions
Better dollar allocation
Better local policy decisions
Better visuals
Better for locals

Bay County Vulnerability Assessment

Hazard Vulnerability Score = Exposure Score x Risk Score

Variable creation

Exposure Score = Population Rank + Property Value Rank+ Critical Facility Rank + Infrastructure Rank

1. Population Rank was derived for each jurisdiction based on population density of each jurisdiction.
2. Property Rank was derived for each jurisdiction based on property density of each jurisdiction.
3. Essential Facilities Rank was derived for each jurisdiction based on a count of the total number of government buildings, police stations, fire stations, schools, hospitals, Haz-MAT facilities and airports.
4. Infrastructure Rank was derived for each jurisdiction based on a count of the total number of towers, water plants, wells, flood pump stations, oil and gas wells and bridges; number of miles of waterlines, pipeline, sewer lines, major utility lines, rail and roads.

Breakdown of each Exposure Variable

Exposure Score = Population Rank + Property Rank + Essential Facility Rank + Infrastructure Rank

1. Population Rank was populated from census 2000 Population Density data

- *Data received from Bay County Department of Environmental Affairs & Community Development (GIS Department)*
- *Each "Rank" (Population Rank, Essential Facilities Rank etc.) will be calculated and then ranked 0 – 3 (0 N/A, 1 Low, 2 Medium, 3 High) using the Natural Breaks (Jenks) method provided in ArcGIS as a classification choice.*
- *Note this will be the case for all the rankings*

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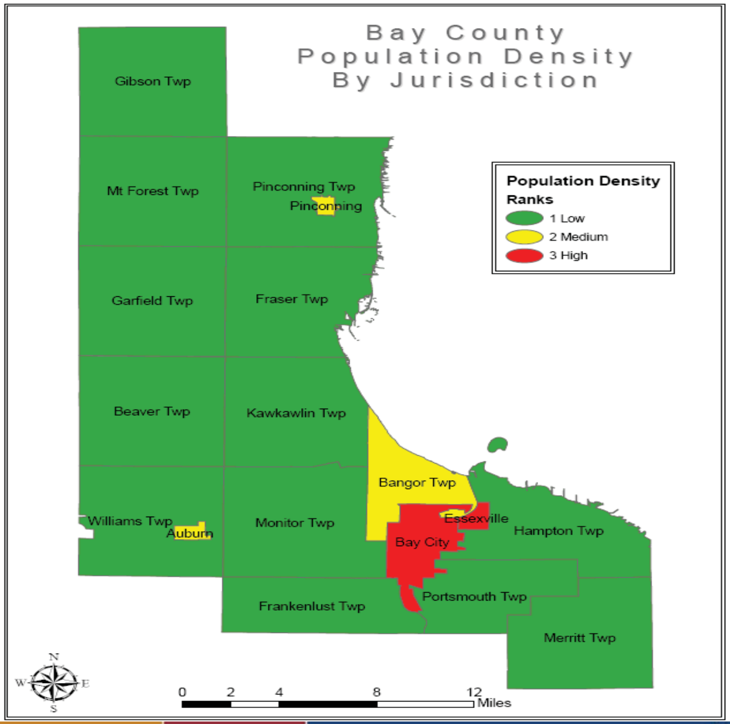

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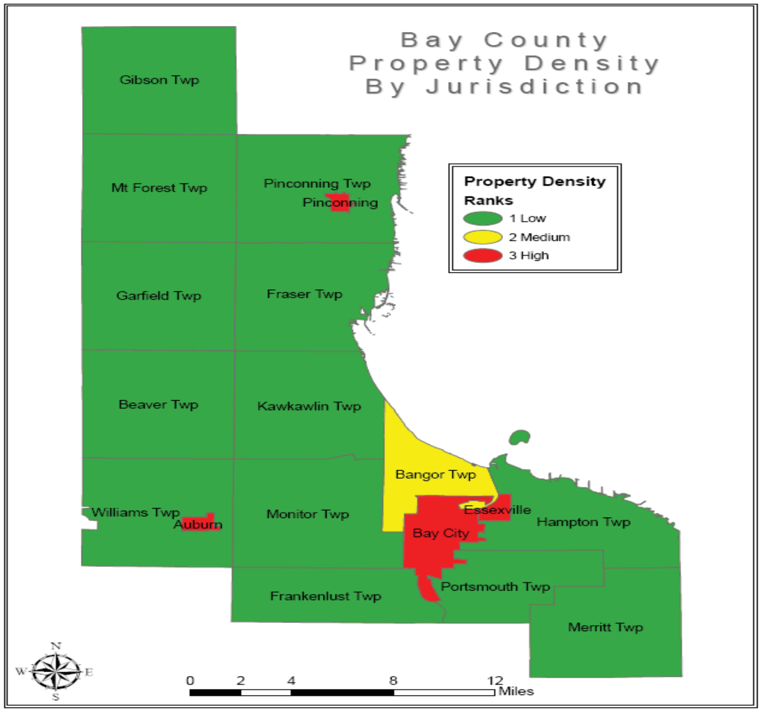
Breakdown of each Exposure Variable

Exposure Score = Population Rank + *Property Rank* *+ Essential Facility Rank + Infrastructure Rank*

1. <u>Property Rank</u> was populated from a census 2000 Housing Units density creation.

- *Data received from Bay County Department of Environmental Affairs & Community Development (GIS Department)*



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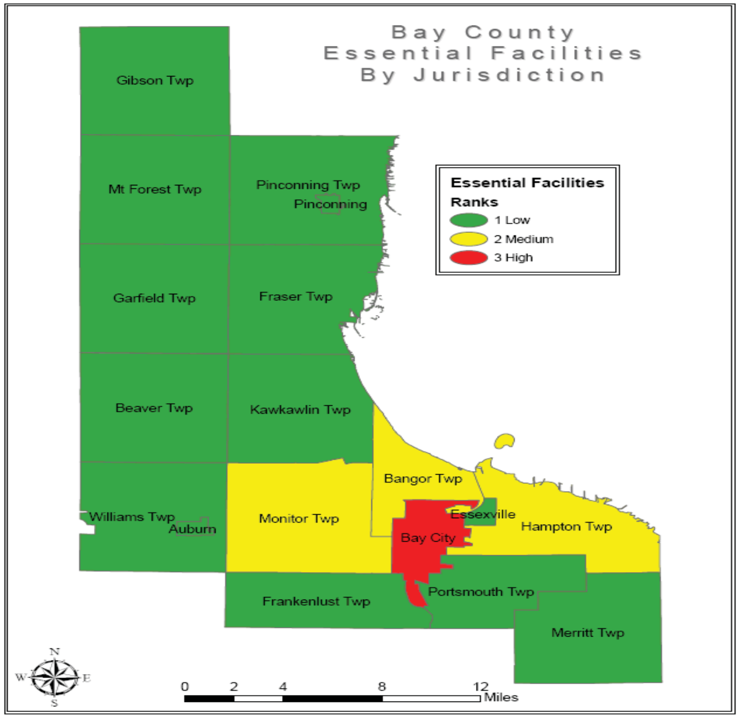
Breakdown of each Exposure Variable

Exposure Score = Population Rank + Property Rank + Essential Facility Rank + Infrastructure Rank

1. Essential Facilities Rank was populated from several GIS layers depicting the geographic locations of the following variables for each jurisdiction: government buildings, police stations, fire stations, schools, hospitals, Haz-MAT facilities and airports.

- *Data received from Bay County Department of Environmental Affairs & Community Development (GIS Department)*



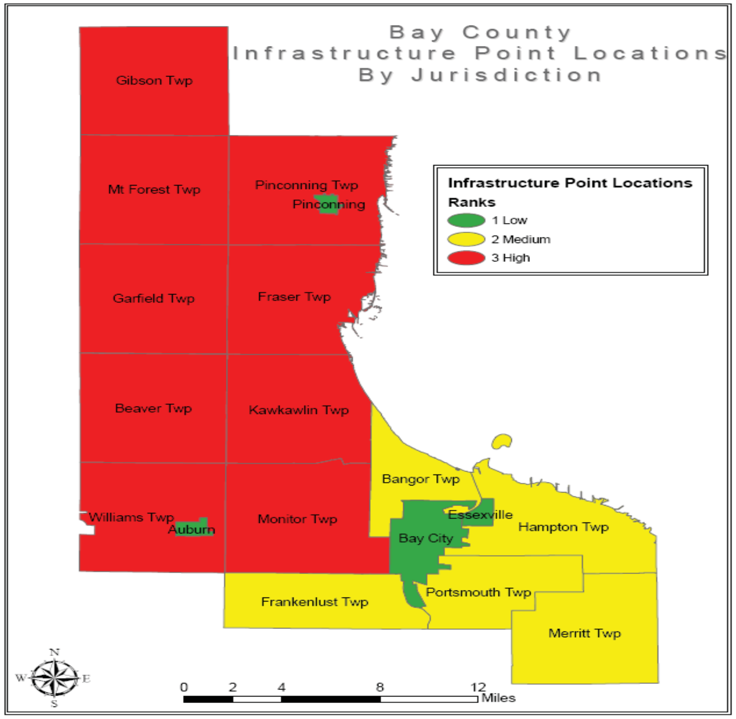
Breakdown of each Exposure Variable

Exposure Score = Population Rank + Property Rank + Essential Facility Rank + Infrastructure Rank

1. Infrastructure Rank was populated from several GIS layers depicting the geographic locations of the following variables with in each jurisdiction: **total number** of towers, water plants, wells, flood pump stations, oil and gas wells and bridges; **number of miles** of waterlines, pipeline, sewer lines, major utility lines, rail and roads

- We created a Infrastructure Point Rank and a Infrastructure Line Rank

- *Data received from Bay County Department of Environmental Affairs & Community Development (GIS Department)*



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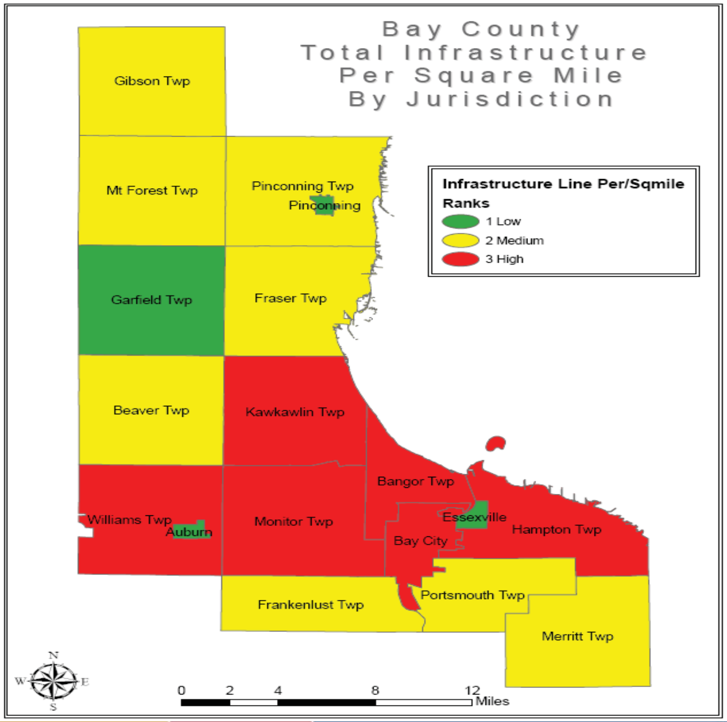
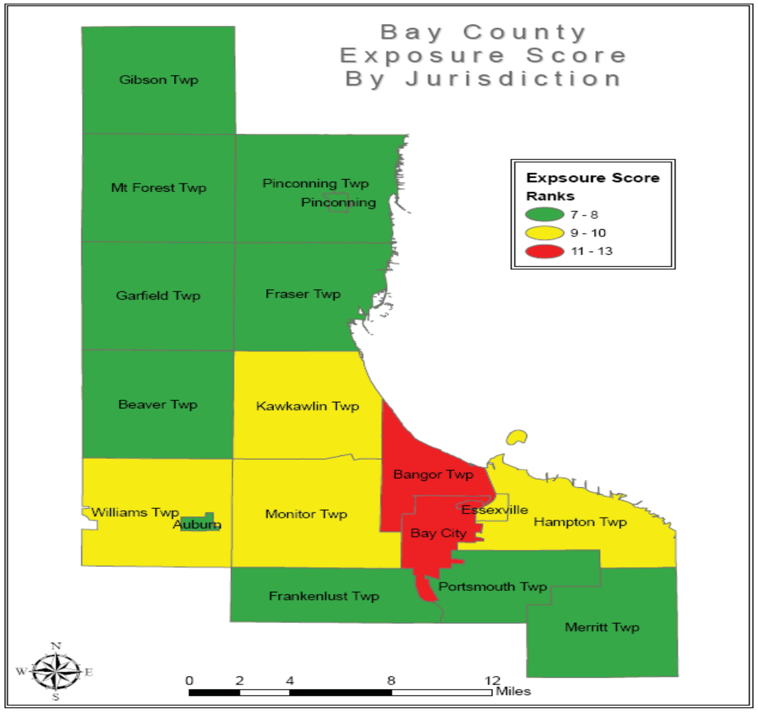

Bay County
Total Infrastructure
Per Square Mile
By Jurisdiction
Infrastructure Line Per/Sqmile
Ranks
1 Low
2 Medium
3 High
Gibson Twp
Mt Forest Twp
Pinconning Twp
Pinconning
Garfield Twp
Fraser Twp
Beaver Twp
Kawkawlin Twp
Bangor Twp
Williams Twp
Auburn
Monitor Twp
Essexville
Hampton Twp
Bay City
Frankenlust Twp
Portsmouth Twp
Merritt Twp
0 2 4 8 12
Miles


Bay County
Exposure Score
By Jurisdiction
Expsoure Score
Ranks
7 - 8
9 - 10
11 - 13
Gibson Twp
Mt Forest Twp
Pinconning Twp
Pinconning
Garfield Twp
Fraser Twp
Beaver Twp
Kawkawlin Twp
Bangor Twp
Williams Twp
Auburn
Monitor Twp
Essexville
Hampton Twp
Bay City
Frankenlust Twp
Portsmouth Twp
Merritt Twp
0 2 4 8 12
Miles

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Vulnerability Assessment Model

- *The "Exposure Score" is the meat and potatoes of any Vulnerability model.*
- *Provides information needed to complete a risk assessment on any type of hazard.*
- *FEMA asks us to assess our jurisdictions (Population & Property), Infrastructure, Essential Facilities and Government Owned Facilities.*

Regardless of hazards you need to know what is at risk!!

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Vulnerability Assessment Model: How it works

Variable creation

Risk Score = Occurrence Rank and/or Area affected rank

•Occurrence Rank is based on total number of occurrences for each jurisdiction
•Area effected takes a percent of the jurisdictions total area affected by the hazard
•Some hazards have both

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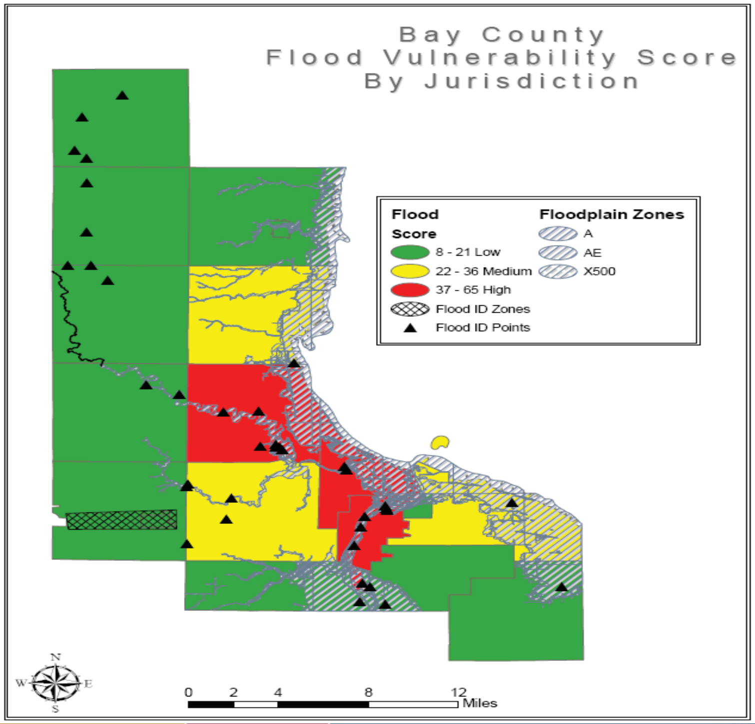
Breakdown of each Hazard Vulnerability Score

Hazard Vulnerability Score = Exposure Score x Risk Score

Risk Score = Occurrence Rank and/or Area effected rank

1. Flood Vulnerability Score was derived from 1996 Q3 FEMA Floodplain data to create a percent of area effected by jurisdiction (area effected rank). Also added was locational data provided by Bay County citizens (occurrence rank).

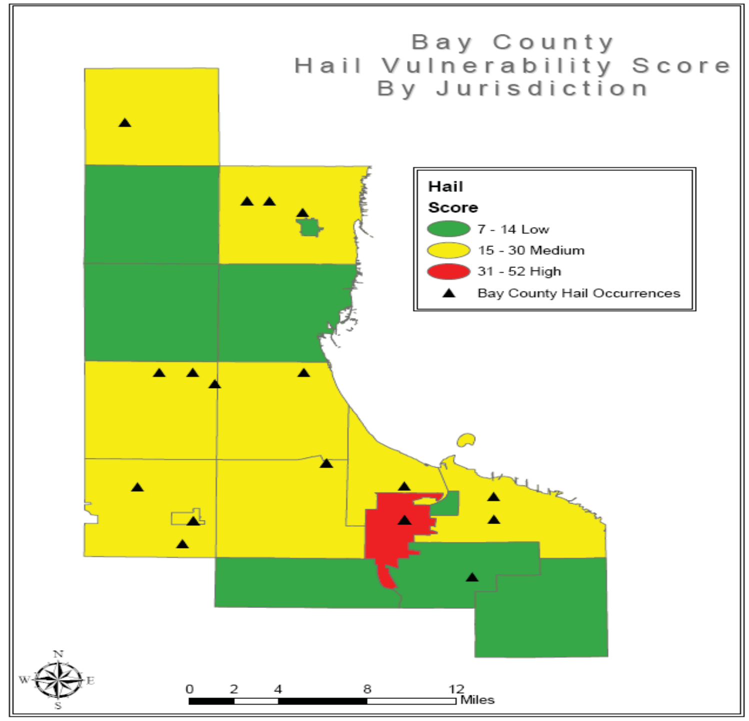
- *Data received from Bay County Department of Environmental Affairs & Community Development (GIS Department) and local citizens.*
- *Each "Rank" (Occurrence Rank and Area Effected Rank) will be calculated and then ranked 0 – 3 (0 N/A, 1 Low, 2 Medium, 3 High) using the Natural Breaks (Jenks) method provided in ArcGIS as a classification choice.*
- *Note this will be the case for all the rankings*



Breakdown of each Hazard Vulnerability Score

Risk Score = Occurrence Rank and/or Area effected rank

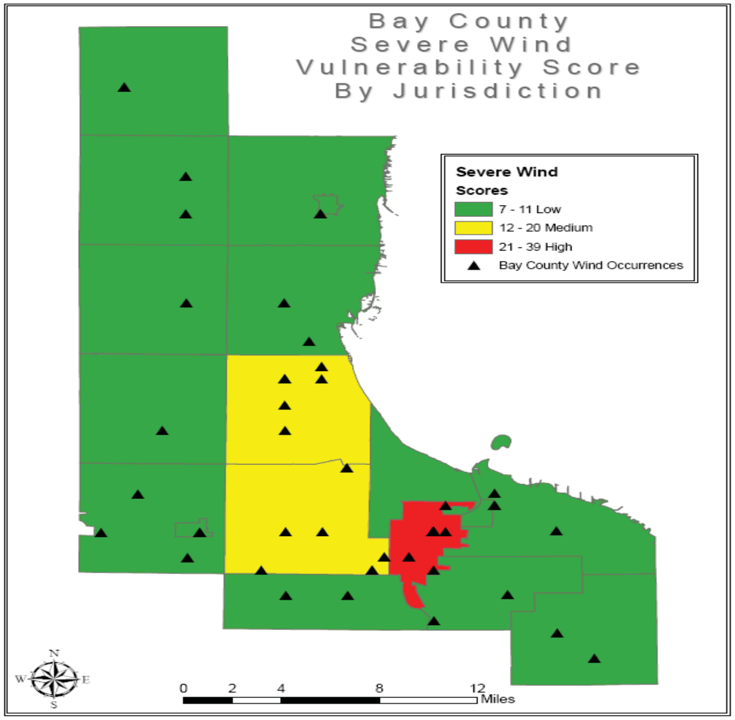
1. Hail Vulnerability Score was derived from NOAA/NWS SVRGIS database for Hail events. An occurrence rank was built based on the number of events per jurisdiction.



Breakdown of each Hazard Vulnerability Score

Risk Score = Occurrence Rank and/or Area effected rank

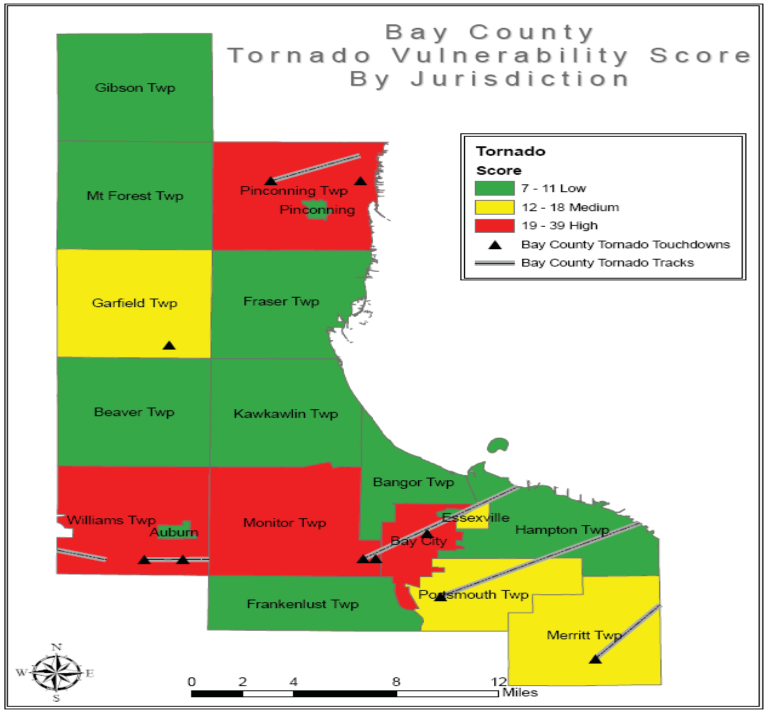
1. Severe Storm Vulnerability Score was derived from NOAA/NWS SVRGIS database for Severe Storm related events. An occurrence rank was built based on the number of events per jurisdiction.



Breakdown of each Hazard Vulnerability Score

Risk Score = Occurrence Rank and/or Area effected rank

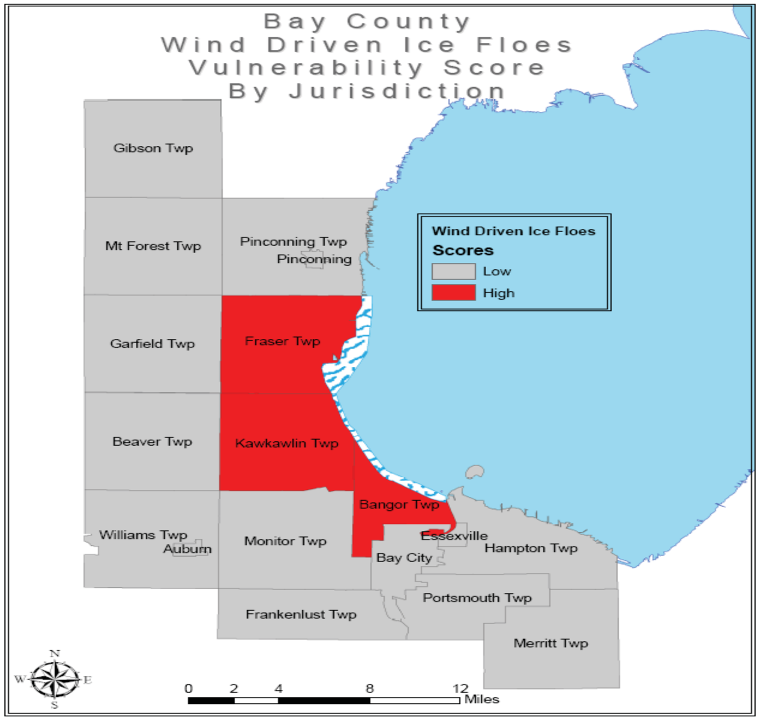
1. Tornado Vulnerability Score was derived from NOAA/NWS SVRGIS database for Tornado events. An occurrence rank was built based on the number of events per jurisdiction.



Breakdown of each Hazard Vulnerability Score

Risk Score = Occurrence Rank and/or Area effected rank

1. Wind Driven Ice Floes Score was derived from local hazard identification. An area effected rank was built based on the hazard areas located per jurisdiction.



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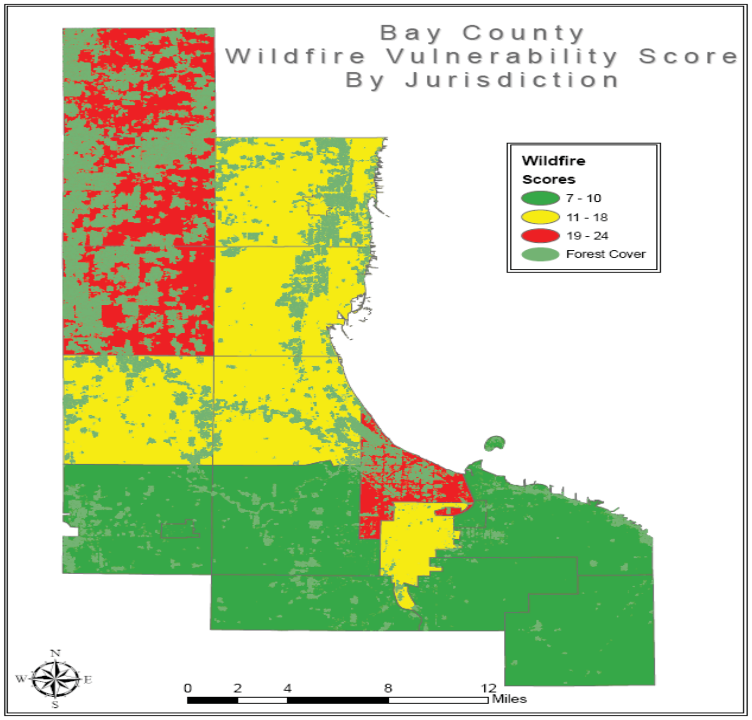
Breakdown of each Hazard Vulnerability Score

Risk Score = Occurrence Rank and/or Area effected rank

1. Wildfire Vulnerability Score was derived from USGS Landfire Forest Cover database. An area effected rank was built based on the percent of forest cover per jurisdiction.



Risk Score = Occurrence Rank and/or Area effected rank

1. Drought, Extreme Temperature and Severe Winter Storms do not currently have geographic data that can be assigned by jurisdiction. So each one of these hazards will be depicted showing the exposure map as the highest Vulnerable areas.

- Note we do know how many occurrences have occurred over the entire county but not pinpointed.

- There is no historical record of this area having an earthquake or being vulnerable to one. The extreme and unpredictable nature of Earthquakes have convinced us to keep earthquakes as a hazard but at this time we have no data for a Risk Assessment on Earthquakes.

The ***Risk Assessment*** provides your community the framework
to build your mitigation strategy on.

•There are several ways to complete a risk assessment and several
ways to use the data.

•One of the most important Risk Assessment factors derived in
Bay County was the locational hazard data points identified by the local community members.

•This data can be used to identify specific locations that need to
be mitigated and thus become a mitigation action in your ***Mitigation Strategy***.

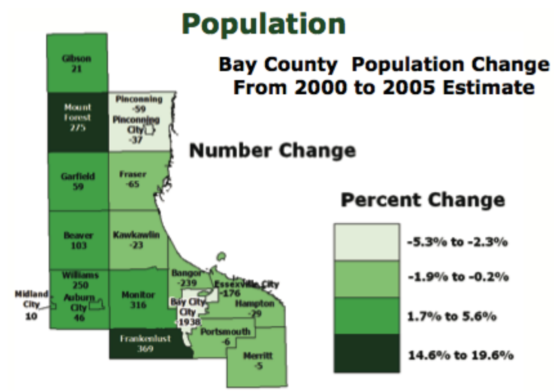
Estimating Potential Losses R = (P x C) x D (Geographic Weight)

NAME	Jurisdiction % Area	Drought Avg. Ann Risk	Geographic Weighted Distribution	Extreme Temperature Avg. Ann Risk	Geographic Weighted Distribution	Flooding Avg. Ann Risk	Geographic Weighted Distribution	Hail Avg. Ann Risk	Geographic Weighted Distribution	Severe Storm Avg. Ann Risk	Geographic Weighted Distribution	Winter Storm Avg. Ann Risk	Geographic Weighted Distribution	Tornado Avg. Ann Risk	Geographic Weighted Distribution	Wildfire Avg. Ann Risk	Geographic Weighted Distribution
Auburn	0.24	$110,294	$265	$6,757	$16	$1,401,027	$3,362	$4,085	$10	$774,756	$1,859	$911,503	$2,188	$50,833	$122	$15,504	$37
Bangor Twp	3.32	$110,294	$3,662	$6,757	$224	$1,401,027	$46,514	$4,085	$136	$774,756	$25,722	$911,503	$30,262	$50,833	$1,688	$15,504	$515
Bay City	2.53	$110,294	$2,790	$6,757	$171	$1,401,027	$35,446	$4,085	$103	$774,756	$19,601	$911,503	$23,061	$50,833	$1,286	$15,504	$392
Beaver Twp	7.88	$110,294	$8,691	$6,757	$532	$1,401,027	$110,401	$4,085	$322	$774,756	$61,051	$911,503	$71,826	$50,833	$4,006	$15,504	$1,222
Essexville	0.31	$110,294	$342	$6,757	$21	$1,401,027	$4,343	$4,085	$13	$774,756	$2,402	$911,503	$2,826	$50,833	$158	$15,504	$48
Frankenlust Twp	5.13	$110,294	$5,658	$6,757	$347	$1,401,027	$71,873	$4,085	$210	$774,756	$39,745	$911,503	$46,760	$50,833	$2,608	$15,504	$795
Fraser Twp	7.32	$110,294	$8,074	$6,757	$495	$1,401,027	$102,555	$4,085	$299	$774,756	$56,712	$911,503	$66,722	$50,833	$3,721	$15,504	$1,135
Garfield Twp	7.95	$110,294	$8,768	$6,757	$537	$1,401,027	$111,382	$4,085	$325	$774,756	$61,593	$911,503	$72,464	$50,833	$4,041	$15,504	$1,233
Gibson Twp	7.93	$110,294	$8,746	$6,757	$536	$1,401,027	$111,101	$4,085	$324	$774,756	$61,438	$911,503	$72,282	$50,833	$4,031	$15,504	$1,229
Hampton Twp	6.27	$110,294	$6,915	$6,757	$424	$1,401,027	$87,844	$4,085	$256	$774,756	$48,577	$911,503	$57,151	$50,833	$3,187	$15,504	$972
Kawkawlin Twp	7.45	$110,294	$8,217	$6,757	$503	$1,401,027	$104,377	$4,085	$304	$774,756	$57,719	$911,503	$67,907	$50,833	$3,787	$15,504	$1,155
Merritt Twp	7.05	$110,294	$7,776	$6,757	$476	$1,401,027	$98,772	$4,085	$288	$774,756	$54,620	$911,503	$64,261	$50,833	$3,584	$15,504	$1,093
Monitor Twp	8.24	$110,294	$9,088	$6,757	$557	$1,401,027	$115,445	$4,085	$337	$774,756	$63,840	$911,503	$75,108	$50,833	$4,189	$15,504	$1,278
Mt Forest Twp	8.00	$110,294	$8,824	$6,757	$541	$1,401,027	$112,082	$4,085	$327	$774,756	$61,980	$911,503	$72,920	$50,833	$4,067	$15,504	$1,240
Pinconning	0.19	$110,294	$210	$6,757	$13	$1,401,027	$2,662	$4,085	$8	$774,756	$1,472	$911,503	$1,732	$50,833	$97	$15,504	$29
Pinconning Twp	8.20	$110,294	$9,044	$6,757	$554	$1,401,027	$114,884	$4,085	$335	$774,756	$63,530	$911,503	$74,743	$50,833	$4,168	$15,504	$1,271
Portsmouth Twp	4.50	$110,294	$4,963	$6,757	$304	$1,401,027	$63,046	$4,085	$184	$774,756	$34,864	$911,503	$41,018	$50,833	$2,288	$15,504	$698
Williams Twp	7.50	$110,294	$8,272	$6,757	$507	$1,401,027	$105,077	$4,085	$306	$774,756	$58,107	$911,503	$68,363	$50,833	$3,813	$15,504	$1,163

Development Trends

Important uses of data:

- Land uses
- Zoning
- Ordinances
- Comprehensive Planning



Develop Mitigation Actions

Specific actions that are measurable and promote goals.

Consider new proposed actions.

Mitigation Goals:
1.**Preventative Activities**. Reduce risks through regulations including building codes, development outside of hazardous areas, and local planning or capital improvement projects.
2.**Property Protection**. Reduce exposure to hazards through building or parcel specific activities such as flood proofing, structure acquisition, or retrofitting.
3.**Emergency Services.** Reduce impacts through response and recovery activities that are implemented during a disaster.
4.**Structural Projects.** Minimize impacts through projects, such as detention basins, tornado shelters, tornado sirens, etc.
5.**Public Information.** Assist residents to prepare for risks and protective measures to better protect themselves and their property.

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Submitted Mitigation Actions

- Siren Warning System for Severe Weather
- Construction of Shelters
- Vegetation Management
- Construction of Sea Walls
- Public Education Regarding Emergency Operations
- Drainage Improvements
- Educational Programs Regarding Flooding and Severe Weather
- Maintain Drainage Ditches
- Install Emergency Generators
- Retrofitting Sanitary Sewer System
- Dredging and Cleaning Kawkawlin River
- Bury Power Lines
- Promote Awareness of Crop Insurance
- Promote Awareness of NFIP Countywide
- Repair pumps at flood gate locations
- Purchase Structures in 100 Year Flood Plain

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Activity Prioritization

Priority	Description
A-Very High	Projects or activities that permanently eliminate damages or deaths and injuries in the community from any hazard.
B-High	Projects or activities that reduce the probability of damages, deaths, and injuries in the community from any hazard.
C-Medium	Projects or activities that educate the public on the subjects of hazard mitigation, hazard research, and disaster preparedness.
D-Low	Projects or activities that warn the public to the approach of a natural hazard threat across the community.

Approval and Adoption Process

- Submittal to State for review and comments
  - Incorporate comments, as necessary
- State recommends approval by FEMA and forwards the plan to FEMA Region V
- FEMA review and comment
  - Incorporate comments, as necessary
- FEMA conditionally accepts plan, pending community adoption
- Each community adopts a resolution recognizing the plan and incorporating it into future planning efforts

Plan Maintenance Responsibilities

1. Schedule for Monitoring Plan
   - Planning committee meets annually

2. Plan is Updated Every 5 Years
   - Planning committee coordinates
   - Contractor supported
   - FEMA funded

FEMA Mitigation Activity Funding Programs

Eligible Activities	HMGP	PDM	FMA	RFC	SRL
1. Mitigation Projects	√	√	√	√	√
Property Acquisition and Structure Demolition	√	√	√	√	√
Property Acquisition and Structure Relocation	√	√	√	√	√
Structure Elevation	√	√	√	√	√
Mitigation Reconstruction					√
Dry Floodproofing of Historic Residential Structures	√	√	√	√	√
Dry Floodproofing of Non-residential Structures	√	√	√	√	
Minor Localized Flood Reduction Projects	√	√	√	√	√
Structural Retrofitting of Existing Buildings	√	√			
Non-structural Retrofitting of Existing Buildings and Facilities	√	√			
Safe Room Construction	√	√			
Infrastructure Retrofit	√	√			
Soil Stabilization	√	√			
Wildfire Mitigation	√	√			
Post-Disaster Code Enforcement	√				
5% Initiative Projects	√				
2. Hazard Mitigation Planning	√	√	√		
3. Management Costs	√	√	√	√	√

STATE AGENCY MITIGATION FUNDING PROGRAMS (2007)

Funding Source	Drought	Earthquake	Extreme Temperatures	Wildfire	Dam Failure	Riverine Flooding	Great Lakes Shoreline Flooding and Erosion	Subsidence	Hail	Lightning	Severe Wind	Tornadoes	Ice and Sleet Storms	Snowstorms	FINANCIAL ASSISTANCE	TECHNICAL ASSISTANCE
MICHIGAN DEPARTMENT OF AGRICULTURE																
Conservation Reserve Enhancement Program						X					X				X	X
Intercounty Drain Program (available to drain commissioners only)					X	X										X
MICHIGAN DEPT OF ENVIRONMENTAL QUALITY																
Coastal Management Program							X								X	X
Michigan Great Lakes Protection Fund							X								X	
State Revolving Fund (Loan)						X									X	
Wetland Program Development (also see 66.461 in CFDA)						X	X								X	
MICHIGAN DEPARTMENT OF NATURAL RESOURCES																
Land & Water Conservation Fund (Re-opens 2001; see 15.916 CFDA)						X	X								X	
Michigan Habitat Improvement Fund Project Grants						X									X	
Michigan Natural Resources Trust Fund				X		X									X	
Michigan Volunteer Fire Assistance				X											X	
Recreational Trails Program Grants						X	X								X	
Community Forestry Program											X	X	X		X	X
MICHIGAN DEPARTMENT OF STATE POLICE																
									X	X	X	X	X	X	X	
Flood Mitigation Assistance (also see 97.029 in CFDA)						X	X								X	
Hazard Mitigation Grant Program (also see 97.039 in CFDA)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Disaster Housing Assistance To Individuals And Households In Presidential Declared Disaster Areas (also		X		X		X	X	X			X	X			X	
Presidential Declared Disaster Assistance - Disaster Housing Operations For Individuals And Households (also see 97.049 in CFDA)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Presidential Declared Disaster Assistance To Individuals And Households - Other Needs (also see 97.050 in CFDA)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Disaster Grants-Public Assistance (Presidentially Declared Disasters) (also see 97.036 in CFDA)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Pre-Disaster Mitigation (also see 97.047 in CFDA)			X	X		X	X				X	X			X	
Severe Loss Repetitive Program (also see 97.110 in CFDA)						X	X								X	
Repetitive Flood Claims (also see 97.092 in CFDA)						X	X								X	
MICHIGAN DEPARTMENT OF TRANSPORTATION																
Transportation Economic Development Fund						X	X								X	
MICHIGAN ECONOMIC DEVELOPMENT CORP																
Community Development Block Grant Program (also see 14.218,14.219, 14.228 in CFDA)						X	X								X	
Urban Land Assembly						X	X								X	
MICHIGAN STATE HOUSING DEVELOPMENT AUTHORITY																
CDBG Housing Resource Fund (inc HOME) (also see 14.239 in CFDA)						X	X		X		X	X			X	
Home/Property Improvement Loans						X	X		X		X	X			X	
MICHIGAN DEPARTMENT OF TREASURY																
Michigan Municipal Bond Authority-Local Government Loan Program	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Michigan Municipal Bond Authority-State Aid Note Program	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	

Hazard Mitigation Grant Program

- Purpose:
  - Cost effective and long-term mitigation measures following a **major disaster declaration (funding competitive within State)**
- Requirements:
  - Must be in good standing with NFIP.
  - Have an approved all-hazard mitigation plan.
- The amount of funding is based on a percentage of the total disaster costs and varies from disaster to disaster.
- A project does not have to be in a declared county to be eligible for HMGP funding. Projects must be environmentally sound, cost-effective, solve a problem and prevent future disaster damages.
- Projects can protect public or private property.
- Cost share: 75% Federal, 25% Local

Pre-Disaster Mitigation Program

- Purpose:
  - Implement cost-effective hazard mitigation activities that complement a comprehensive mitigation program.
  - This program is nationally competitive.
- Requirements:
  - Must have an approved all hazards plan
  - Must participate in NFIP and have Special Flood Hazard Area (Flood Hazard Boundary Map (FHBM) or Flood Insurance Rate Map (FIRM) has been issued.
  - Must not be suspended or on probation from the NFIP.
- Funding can be awarded for the development of all-hazards mitigation plan or for cost effective hazard mitigation project.
- Cost share: 75% Federal, 25% Local

Flood Mitigation Assistance Program

- Purpose:
  - Implementation of Flood Mitigation Projects
  - This program is nationally competitive.
- Requirements:
  - Must belong to the National Flood Insurance Program (NFIP)
- Typically these grants are used for acquisition and demolition of repetitively flooded structures.
  - A repetitive loss property is any insured structure that has two or more flood insurance claims of at least $1,000 each.
- Cost share: 75% Federal, 25% Local

Repetitive Flood Claims Program

- Purpose:
  - Reduce or eliminate the long-term risk of flooding damage to repetitive loss structures insured under the NFIP.
  - The program is nationally competitive.
- Requirements:
  - Property has received one or more NFIP payment.
  - Property must be NFIP-insured and must maintain insurance through completion of the activity.
- Cost share: 100% Federal
  - Applicant must explain why the local match is unavailable.

Severe Repetitive Loss Program

- Purpose:
  - Reduce or eliminate the long-term risk of flooding damage to severe repetitive loss (SRL) structures insured under the NFIP.
- Requirements:
  - Property is residential and is insured under the NFIP and has either:
    - At least four NFIP claims (building and contents) over $5,000 each, with the cumulative amount greater than $20,000; or
    - At least two separate claims payments (building payments only), with the cumulative amount exceeding the market value of the building.
- SRL payments will assist in the conversion of the property to open space, the elevation of the property above the BFE, and dry floodproofing for historic structures.
- Cost share: 90% Federal, 10% Local

Other State Agency Funding Opportunities

Community Development Block Grants

Administration:
•Michigan State Housing Development Authority
•Michigan Economic Development Corporation
•Housing and Urban Development

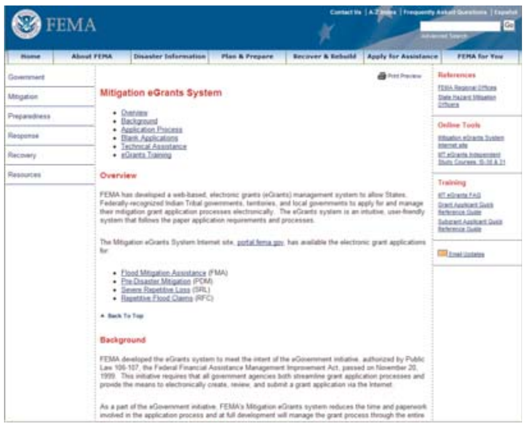
Funding:
•Approximately $36 million in annual funding
•Approximately 150 projects funded

Other Federal Funding Opportunities

Economic Development Administration

Programs:
Public Works and Economic Development
Economic Adjustment and Assistance Program
Community Trade Adjustment Assistance
Planning Program
Trade Adjustment Assistance for Firm Program
Local Technical Assistance

FEMA Grant Application Website



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Home | About FEMA | Disaster Information | Plan & Prepare | Recover & Rebuild | Apply for Assistance | FEMA for You

Government
Mitigation
Preparedness
Response
Recovery
Resources

Print Preview

Mitigation eGrants System

- Overview
- Background
- Application Process
- Blank Applications
- Technical Assistance
- eGrants Training

Overview

FEMA has developed a web-based, electronic grants (eGrants) management system to allow States, Federally-recognized Indian Tribal governments, territories, and local governments to apply for and manage their mitigation grant application processes electronically. The eGrants system is an intuitive, user-friendly system that follows the paper application requirements and processes.

The Mitigation eGrants System Internet site, portal.fema.gov, has available the electronic grant applications for:

- Flood Mitigation Assistance (FMA)
- Pre-Disaster Mitigation (PDM)
- Severe Repetitive Loss (SRL)
- Repetitive Flood Claims (RFC)

Back To Top

Background

FEMA developed the eGrants system to meet the intent of the eGovernment initiative, authorized by Public Law 106-107, the Federal Financial Assistance Management Improvement Act, passed on November 20, 1999. This initiative requires that all government agencies both streamline grant application processes and provide the means to electronically create, review, and submit a grant application via the Internet.

As a part of the eGovernment initiative, FEMA's Mitigation eGrants system reduces the time and paperwork involved in the application process and at full development will manage the grant process through the entire

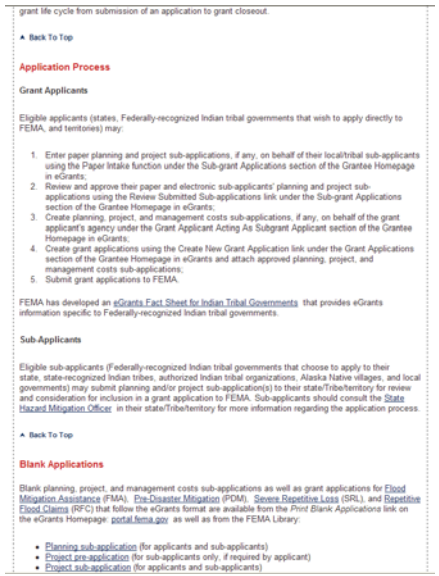
References
FEMA Regional Offices
State Hazard Mitigation Officers

Online Tools
Mitigation eGrants System Internet site
IS eGrants Independent Study Courses: IS-30 & 31

Training
IS eGrants FAQ
Grant Applicant Quick Reference Guide
Subgrant Applicant Quick Reference Guide

Email Updates

http://www.fema.gov/government/grant/egrants.shtm



grant life cycle from submission of an application to grant closeout.

Back To Top

Application Process

Grant Applicants

Eligible applicants (states, Federally-recognized Indian tribal governments that wish to apply directly to FEMA, and territories) may:

1. Enter paper planning and project sub-applications, if any, on behalf of their local/tribal sub-applicants using the Paper Intake function under the Sub-grant Applications section of the Grantee Homepage in eGrants;
2. Review and approve their paper and electronic sub-applicants' planning and project sub-applications using the Review Submitted Sub-applications link under the Sub-grant Applications section of the Grantee Homepage in eGrants;
3. Create planning, project, and management costs sub-applications, if any, on behalf of the grant applicant's agency under the Grant Applicant Acting As Subgrant Applicant section of the Grantee Homepage in eGrants;
4. Create grant applications using the Create New Grant Application link under the Grant Applications section of the Grantee Homepage in eGrants and attach approved planning, project, and management costs sub-applications;
5. Submit grant applications to FEMA.

FEMA has developed an eGrants Fact Sheet for Indian Tribal Governments that provides eGrants information specific to Federally-recognized Indian tribal governments.

Sub-Applicants

Eligible sub-applicants (Federally-recognized Indian tribal governments that choose to apply to their state, state-recognized Indian tribes, authorized Indian tribal organizations, Alaska Native villages, and local governments) may submit planning and/or project sub-application(s) to their state/Tribe/territory for review and consideration for inclusion in a grant application to FEMA. Sub-applicants should consult the State Hazard Mitigation Officer in their state/Tribe/territory for more information regarding the application process.

Back To Top

Blank Applications

Blank planning, project, and management costs sub-applications as well as grant applications for Flood Mitigation Assistance (FMA), Pre-Disaster Mitigation (PDM), Severe Repetitive Loss (SRL), and Repetitive Flood Claims (RFC) that follow the eGrants format are available from the *Print Blank Applications* link on the eGrants Homepage: portal.fema.gov as well as from the FEMA Library:

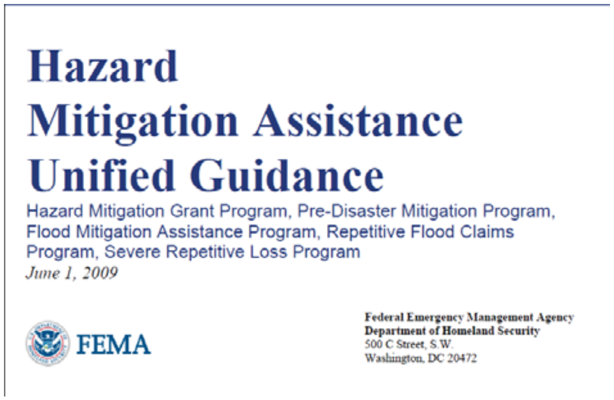
- Planning sub-application (for applicants and sub-applicants)
- Project pre-application (for sub-applicants only, if required by applicant)
- Project sub-application (for applicants and sub-applicants)

Benefit-Cost Analysis

Benefit-Cost Analysis (BCA) is the method by which the future benefits of a mitigation project are determined and compared to its cost. The end result is a Benefit-Cost Ratio (BCR), which is derived from a project's total net benefits divided by its total cost. The BCR is a numerical expression of the cost-effectiveness of a project. BCRs of 1.0 or greater have more future benefits than costs, and are therefore considered cost-effective. **FEMA can only fund cost-effective mitigation projects.**

The BCA Toolkit is available through FEMA's toll-free Benefit-Cost Analysis Technical Assistance Helpline: 1-866-222-3580 or e-mail: bchelpline@dhs.gov.

FEMA Documentation



Hazard Mitigation Assistance Unified Guidance

Hazard Mitigation Grant Program, Pre-Disaster Mitigation Program, Flood Mitigation Assistance Program, Repetitive Flood Claims Program, Severe Repetitive Loss Program

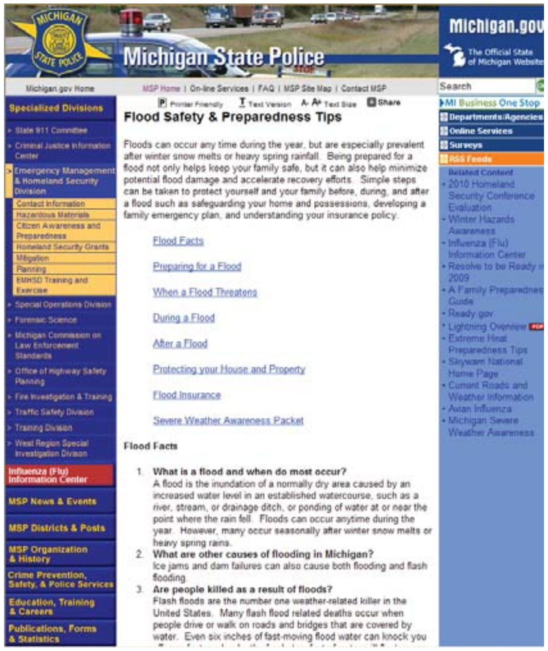
June 1, 2009

FEMA

Federal Emergency Management Agency
Department of Homeland Security
500 C Street, S.W.
Washington, DC 20472

http://www.fema.gov/library/

Michigan State Police Website



http://www.michigan.gov/msp/0,1607,7-123-1593_3507-210959--,00.html

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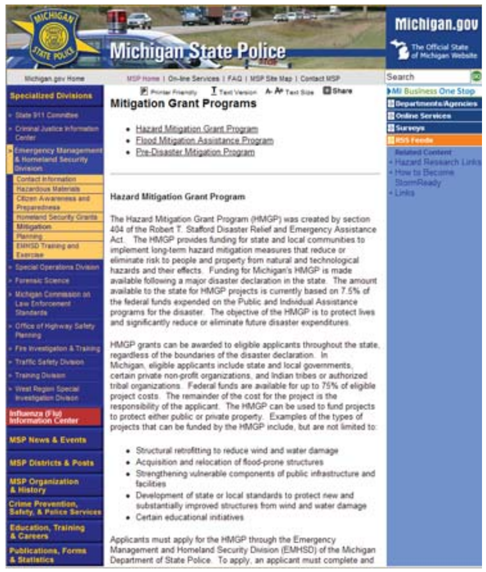
Mitigation Grant Programs



Mitigation Grant Programs

- Hazard Mitigation Grant Program
- Flood Mitigation Assistance Program
- Pre-Disaster Mitigation Program

Hazard Mitigation Grant Program

The Hazard Mitigation Grant Program (HMGP) was created by section 404 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act. The HMGP provides funding for state and local communities to implement long-term hazard mitigation measures that reduce or eliminate risk to people and property from natural and technological hazards and their effects. Funding for Michigan's HMGP is made available following a major disaster declaration in the state. The amount available to the state for HMGP projects is currently based on 7.5% of the federal funds expended on the Public and Individual Assistance programs for the disaster. The objective of the HMGP is to protect lives and significantly reduce or eliminate future disaster expenditures.

HMGP grants can be awarded to eligible applicants throughout the state, regardless of the boundaries of the disaster declaration. In Michigan, eligible applicants include state and local governments, certain private non-profit organizations, and Indian tribes or authorized tribal organizations. Federal funds are available for up to 75% of eligible project costs. The remainder of the cost for the project is the responsibility of the applicant. The HMGP can be used to fund projects to protect either public or private property. Examples of the types of projects that can be funded by the HMGP include, but are not limited to:

- Structural retrofitting to reduce wind and water damage
- Acquisition and relocation of flood-prone structures
- Strengthening vulnerable components of public infrastructure and facilities
- Development of state or local standards to protect new and substantially improved structures from wind and water damage
- Certain educational initiatives

Applicants must apply for the HMGP through the Emergency Management and Homeland Security Division (EMHSD) of the Michigan Department of State Police. To apply, an applicant must complete and

http://www.michigan.gov/msp/0,1607,7-123-1593_3507_8950-15282--,00.html

Michigan State Police Professionals

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Hazard Mitigation Plan
Thursday, February 25, 2010

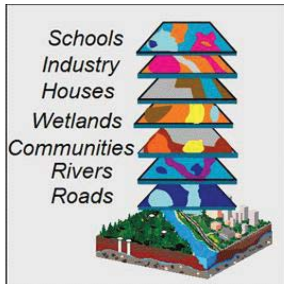
FEMA

Project Overview

1. Planning Process,
   - Meetings, stakeholder input, data gathering
2. Risk Assessment (Hazard Identification and Vulnerability),
   - Analyze past occurrences, probabilities, document and map.
3. Multiple Hazard Mitigation Strategy,
   - Determine strategies to reduce risk (preventative, protection, projects, education, etc)
4. Hazard Mitigation Plan Maintenance Process
   - Periodic plan monitoring, evaluating and update. Annual reviews. 5-yr updates.
5. Hazard Mitigation Plan Review, Approval and Adoption
   - Committee, advisory group, public review and council adoption.

Today's Activities

1. Share Survey Results
2. Hazard Profile Results
3. Risk Assessment
4. Mitigation Goals
5. Develop Mitigation Actions
   - New Structures / Infrastructure
   - Existing Structures / Infrastructure
6. Prioritizing Mitigation Actions
7. Plan Maintenance Responsibilities
8. Review Schedule



Why Are You Here?

You are the Planning Team.

- Awareness of the process,
- Information gathering,
- Utilize your expertise, and
- Local jurisdiction representation,

Planning Team Objectives:

- Provide documents
- Offer feedback
- Perform reviews
- Obtain official committee recognition,
- Understand plan process and maintenance,
- Contribute to mitigation goals,
- Update plan every 5-years.

Survey Results

- •67% experienced a natural disaster within past ten years
- •71% experienced winter storms
- •14% experienced floods
- •14% experienced extreme heat

RISK ASSESSMENT

1. Data Gathering
2. Existing Plan Check-List
3. Existing Regulations
4. Local Mapping – GIS Base Data
5. Critical Facilities/Essential Facilities
6. GAP Analysis and Data Augmentation
7. Discuss Assessment Techniques
8. Determine Vulnerability
9. State Coordination

PUBLIC PORTION

1. Awareness

FEMA's Crosswalk

Risk Assessment

- Identify Hazards
- Profile Hazards
  - Location, Extent, Previous Occurrences and Probability
- Assessing Vulnerability
  - Summary of each jurisdictions vulnerability to each hazard
- Assessing Vulnerability: Identifying Structures
  - Identifying buildings, infrastructure and essential facilities
- Assessing Vulnerability: Estimating Potential Lossess

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Hazards Identified and Profiled

DROUGHT
EARTHQUAKE
EXTREME HEAT
FLOODING
HAIL
SEVERE STORMS
SEVERE WINTER STORMS
TORNADOS
WILDFIRE
WIND DRIVEN ICE FLOES

Researched:
National Climatic Data Center
National Weather Service
FEMA Map Service Center
Data Submitted by Residents
Local Newspapers
State Hazard Mitigation Plan
State Agencies

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Hazard Identification and Hazard Ranking R = (P x C) (County Wide)

Hazard Type	Dates	Range	Frequency	Total Losses	Probability	Avg. Consequences	Avg. Annual Risk	Rank
Drought	1930-2010	80	7	$8,823,529	0.09	$110,294	$9,650.73	5
Earthquake	1584-2009	425	0	$0	0.00	$0	$0.00	10
Extreme Temperature	1936-2010	74	19	$500,000	0.26	$6,757	$1,734.84	6
Flooding	1947-2010	63	21	$102,275,000	0.33	$1,623,413	$541,137.57	3
Hail	1962-2010	48	26	$0	0.54	$0	$0	8
Severe Storm	1960-2010	50	127	$38,737,800	2.54	$774,756	$1,967,880.24	1
Severe Winter Storm	1967-2010	43	70	$39,194,615	1.63	$911,503	$1,483,841.56	2
Tornado	1953-2010	57	20	$2,897,500	0.35	$50,833	$17,836.26	4
Wildfire	1881-2010	129	1	$2,000,000	0.008	$15,503	$124.02	7
Wind Driven Ice Floes	1946-2009	63	5	$0	0.08	$0	$0	9

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Key Definitions: for Your Vulnerability Assessment Model

Hazard Identification: A hazard is considered to be anything which either threatens the residents of a community or the things that they value.

Exposure: Your communities assets: People, Property, Essential Facilities and Infrastructure potentially exposed to a hazard.

Risk: Risk equals your hazard probability based on occurrences and or your probability based on geographic hazard layers.

Vulnerability: Defines what part of your “exposure” is at “risk” to each “hazard”

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Vulnerability Assessment

Geographic Information Systems (GIS)

GIS provides the integration vehicle for the following:

Mapping (Identifying)

Modeling (Vulnerability Score)

Database management (Hazards and Multiple Variables)

Information analysis (Model Sampling and Flexibility)

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Vulnerability Assessment Model:

FEMA Headquarters praised
FEMA Region IV praised
Used for State, Local, and University Plans

The RJH Planning Vulnerability methodology was designed to be flexible and rely on GIS production.

RJH derived a methodology to achieve a "Vulnerability Score" which is the foundation in your vulnerability assessment.

Vulnerability Score = Exposure Score x Risk Score

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Vulnerability Assessment Model: How it works

We need an area for measure/planning area:

- County, Jurisdiction, Census Tract, Census Block Group
- Jurisdiction Boundaries

Provides:
Better hazard scenario assumptions
Better dollar allocation
Better local policy decisions
Better visuals
Better for locals

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Bay County Vulnerability Assessment

Hazard Vulnerability Score = Exposure Score x Risk Score

Variable creation

Exposure Score = Population Rank + Property Value Rank+ Critical Facility Rank + Infrastructure Rank

1. Population Rank was derived for each jurisdiction based on population density of each jurisdiction.
2. Property Rank was derived for each jurisdiction based on property density of each jurisdiction.
3. Essential Facilities Rank was derived for each jurisdiction based on a count of the total number of government buildings, police stations, fire stations, schools, hospitals, Haz-MAT facilities and airports.
4. Infrastructure Rank was derived for each jurisdiction based on a count of the total number of towers, water plants, wells, flood pump stations, oil and gas wells and bridges; number of miles of waterlines, pipeline, sewer lines, major utility lines, rail and roads.

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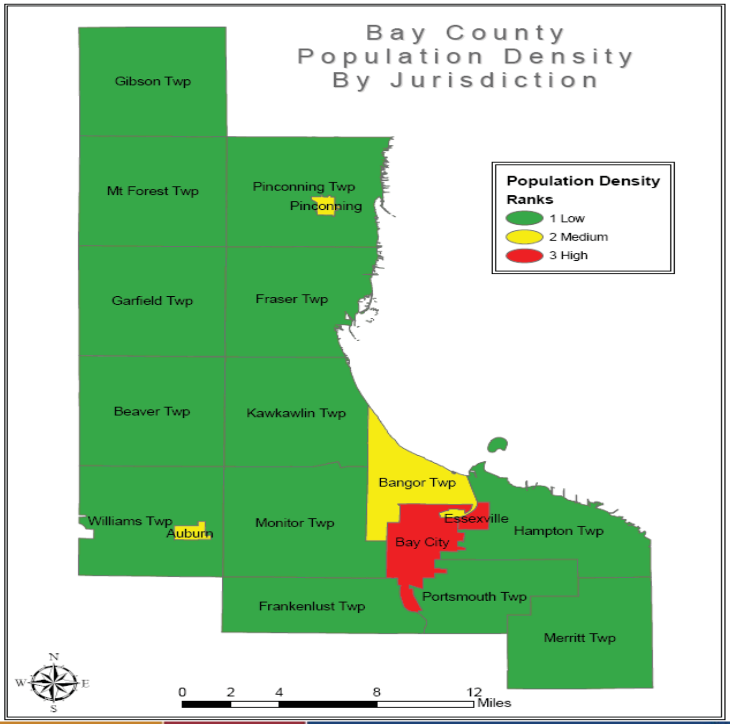
Breakdown of each Exposure Variable

Exposure Score = Population Rank + Property Rank + Essential Facility Rank + Infrastructure Rank

1. Population Rank was populated from census 2000 Population Density data

- *Data received from Bay County Department of Environmental Affairs & Community Development (GIS Department)*
- *Each "Rank" (Population Rank, Essential Facilities Rank etc.) will be calculated and then ranked 0 – 3 (0 N/A, 1 Low, 2 Medium, 3 High) using the Natural Breaks (Jenks) method provided in ArcGIS as a classification choice.*
- *Note this will be the case for all the rankings*

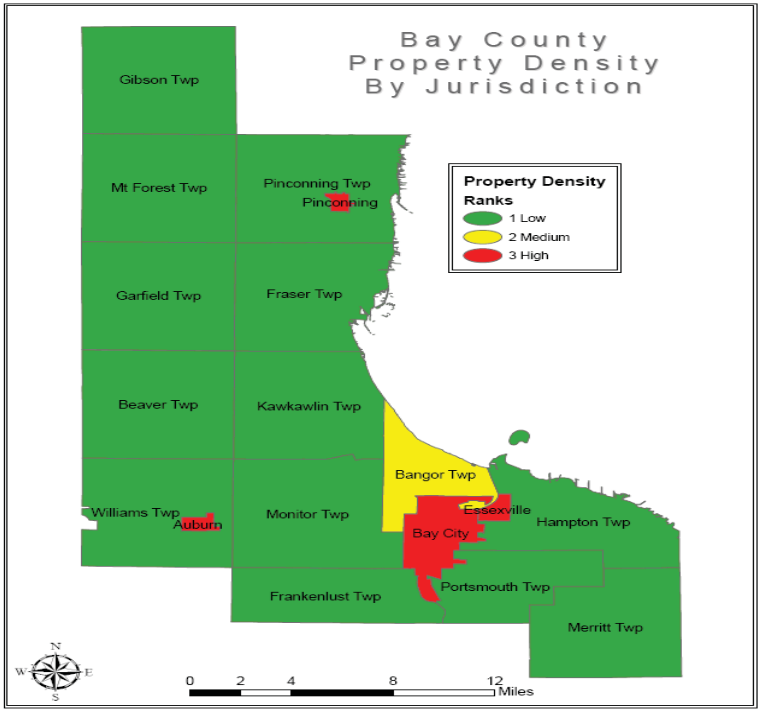


Breakdown of each Exposure Variable

Exposure Score = Population Rank + Property Rank + Essential Facility Rank + Infrastructure Rank

1. <u>Property Rank</u> was populated from a census 2000 Housing Units density creation.

- *Data received from Bay County Department of Environmental Affairs & Community Development (GIS Department)*



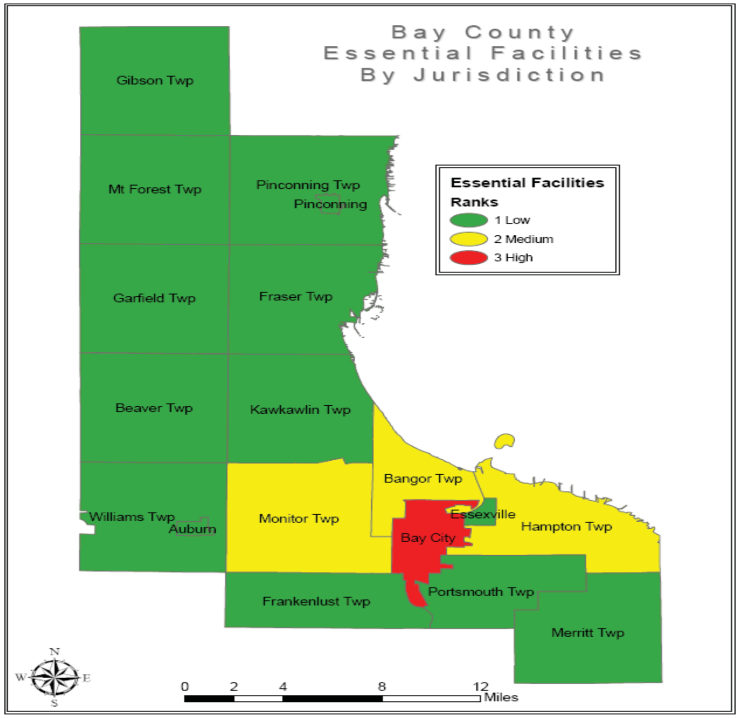
Stantec

Breakdown of each Exposure Variable

Exposure Score = Population Rank + Property Rank + Essential Facility Rank + Infrastructure Rank

1. Essential Facilities Rank was populated from several GIS layers depicting the geographic locations of the following variables for each jurisdiction: government buildings, police stations, fire stations, schools, hospitals, Haz-MAT facilities and airports.

- *Data received from Bay County Department of Environmental Affairs & Community Development (GIS Department)*



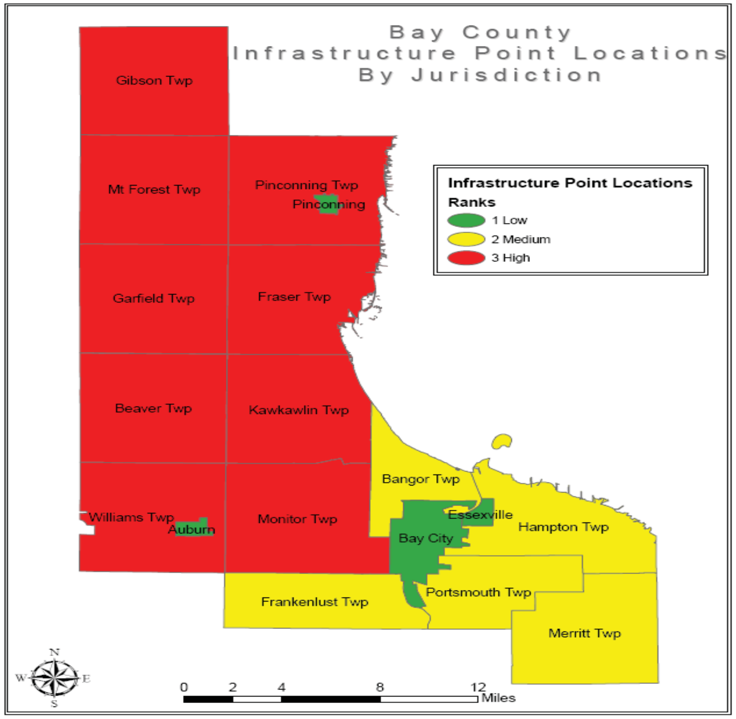
Breakdown of each Exposure Variable

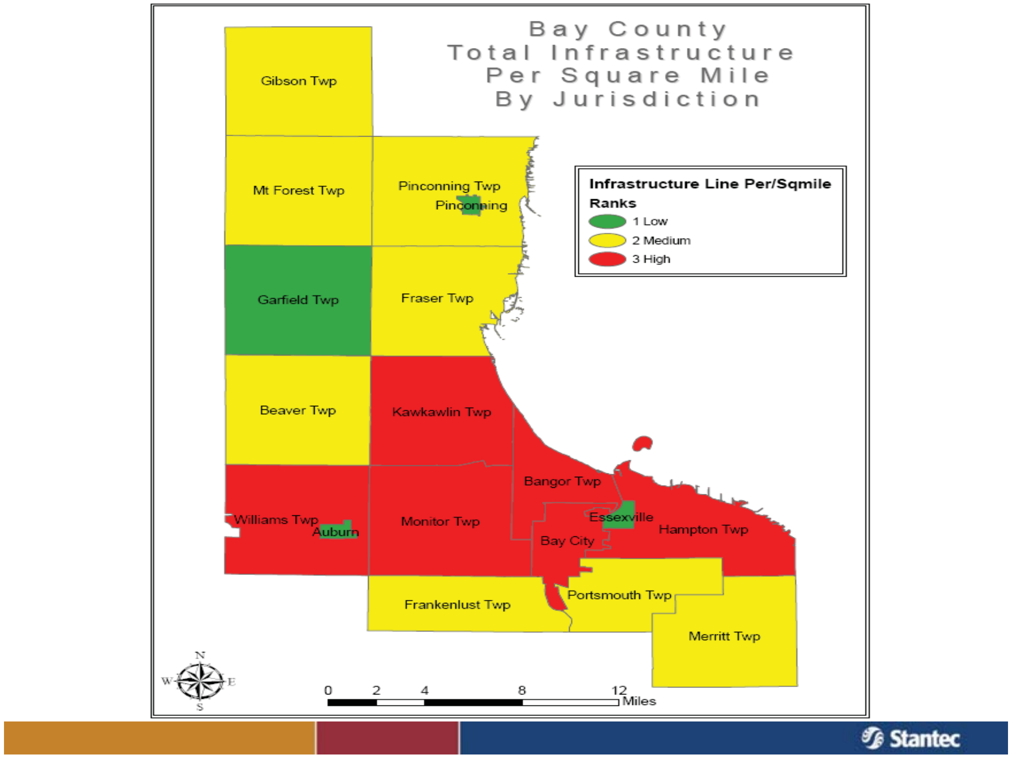
Exposure Score = Population Rank + Property Rank + Essential Facility Rank + Infrastructure Rank

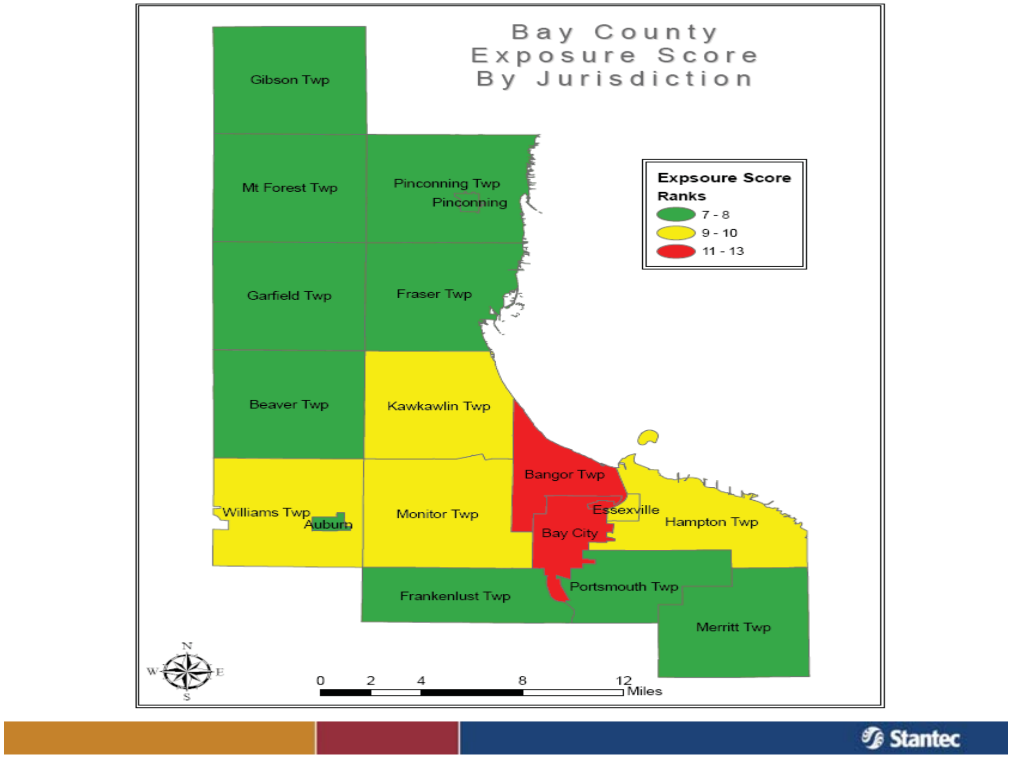
1. Infrastructure Rank was populated from several GIS layers depicting the geographic locations of the following variables with in each jurisdiction: **total number** of towers, water plants, wells, flood pump stations, oil and gas wells and bridges; **number of miles** of waterlines, pipeline, sewer lines, major utility lines, rail and roads

- We created a Infrastructure Point Rank and a Infrastructure Line Rank

- *Data received from Bay County Department of Environmental Affairs & Community Development (GIS Department)*




Bay County
Total Infrastructure
Per Square Mile
By Jurisdiction
Infrastructure Line Per/Sqmile
Ranks
1 Low
2 Medium
3 High
Gibson Twp
Mt Forest Twp
Pinconning Twp
Pinconning
Garfield Twp
Fraser Twp
Beaver Twp
Kawkawlin Twp
Bangor Twp
Williams Twp
Auburn
Monitor Twp
Essexville
Hampton Twp
Bay City
Frankenlust Twp
Portsmouth Twp
Merritt Twp
0 2 4 8 12
Miles
Stantec


Bay County
Exposure Score
By Jurisdiction
Expsoure Score
Ranks
7 - 8
9 - 10
11 - 13
Gibson Twp
Mt Forest Twp
Pinconning Twp
Pinconning
Garfield Twp
Fraser Twp
Beaver Twp
Kawkawlin Twp
Bangor Twp
Williams Twp
Auburn
Monitor Twp
Essexville
Hampton Twp
Bay City
Portsmouth Twp
Frankenlust Twp
Merritt Twp
0 2 4 8 12
Miles
Stantec

Vulnerability Assessment Model

- *The "Exposure Score" is the meat and potatoes of any Vulnerability model.*
- *Provides information needed to complete a risk assessment on any type of hazard.*
- *FEMA asks us to assess our jurisdictions (Population & Property), infrastructure, Essential Facilities and Government Owned Facilities.*

Regardless of hazards you need to know what is at risk!!

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Vulnerability Assessment Model: How it works

Variable creation

Risk Score = Occurrence Rank and/or Area effected rank

•Occurrence Rank is based on total number of occurrences for each jurisdiction
•Area effected takes a percent of the jurisdictions total area affected by the hazard
•Some hazards have both

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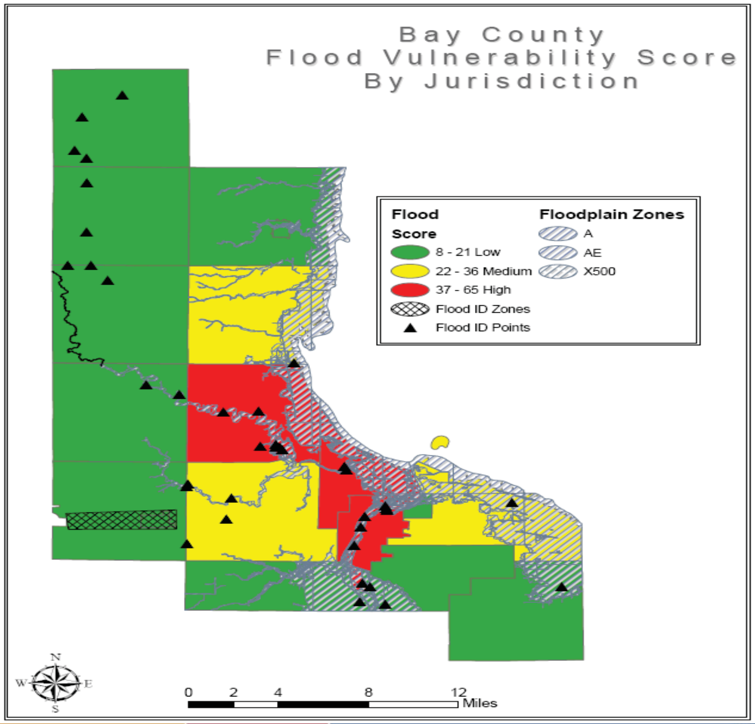
Breakdown of each Hazard Vulnerability Score

Hazard Vulnerability Score = Exposure Score x Risk Score

Risk Score = Occurrence Rank and/or Area effected rank

1. Flood Vulnerability Score was derived from 1996 Q3 FEMA Floodplain data to create a percent of area effected by jurisdiction (area effected rank). Also added was locational data provided by Bay County citizens (occurrence rank).

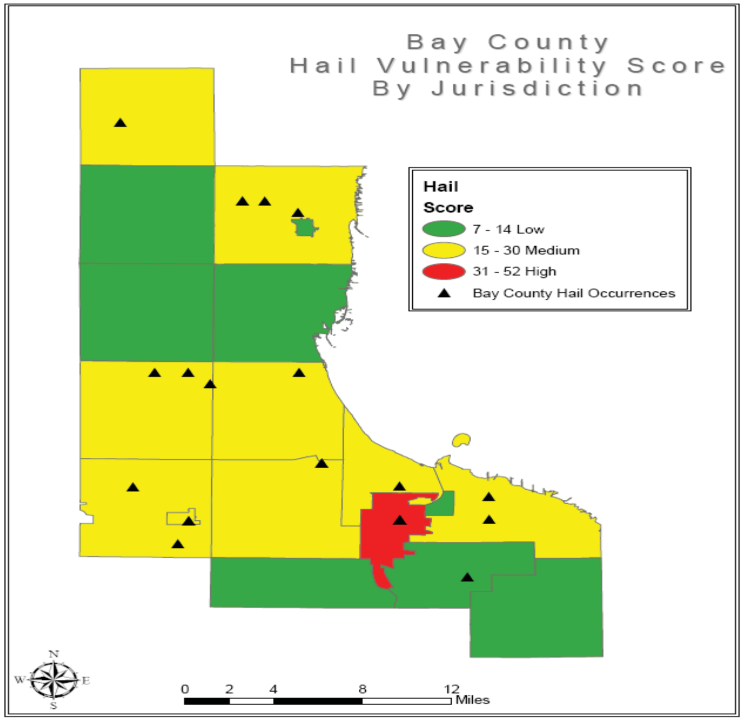
- *Data received from Bay County Department of Environmental Affairs & Community Development (GIS Department) and local citizens.*
- *Each "Rank" (Occurrence Rank and Area Effected Rank) will be calculated and then ranked 0 – 3 (0 N/A, 1 Low, 2 Medium, 3 High) using the Natural Breaks (Jenks) method provided in ArcGIS as a classification choice.*
- *Note this will be the case for all the rankings*



Breakdown of each Hazard Vulnerability Score

Risk Score = Occurrence Rank and/or Area effected rank

1. <u>Hail Vulnerability Score</u> was derived from NOAA/NWS SVRGIS database for Hail events. An occurrence rank was built based on the number of events per jurisdiction.



Breakdown of each Hazard Vulnerability Score

Risk Score = Occurrence Rank and/or Area effected rank

1. Severe Storm Vulnerability Score was derived from NOAA/NWS SVRGIS database for Severe Storm related events. An occurrence rank was built based on the number of events per jurisdiction.

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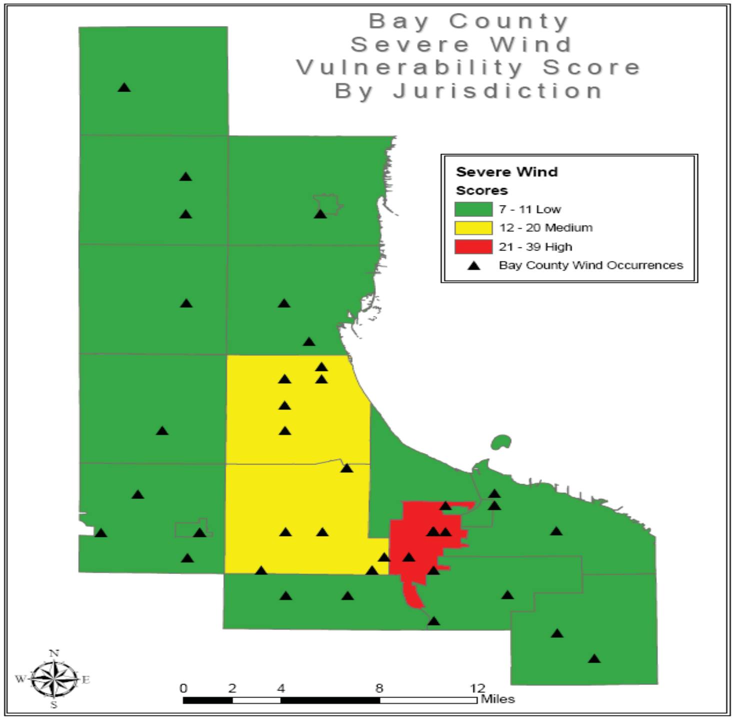

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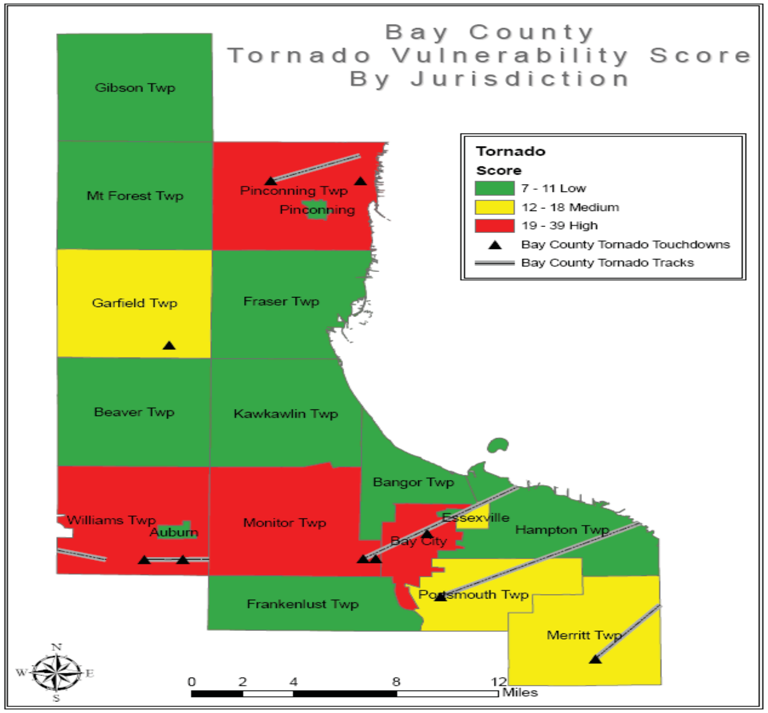
Breakdown of each Hazard Vulnerability Score

Risk Score = Occurrence Rank and/or Area effected rank

1. Tornado Vulnerability Score was derived from NOAA/NWS SVRGIS database for Tornado events. An occurrence rank was built based on the number of events per jurisdiction.



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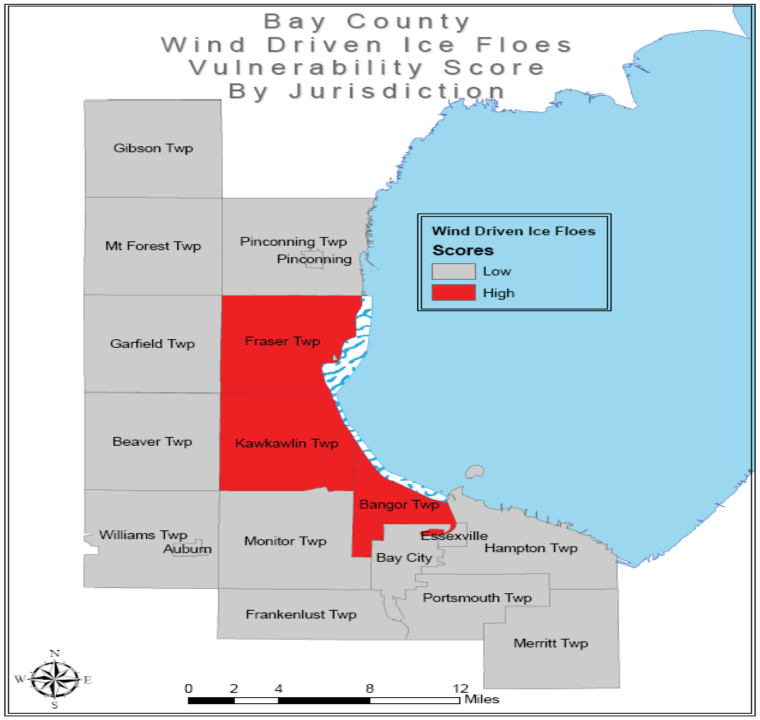
Breakdown of each Hazard Vulnerability Score

Risk Score = Occurrence Rank and/or Area effected rank

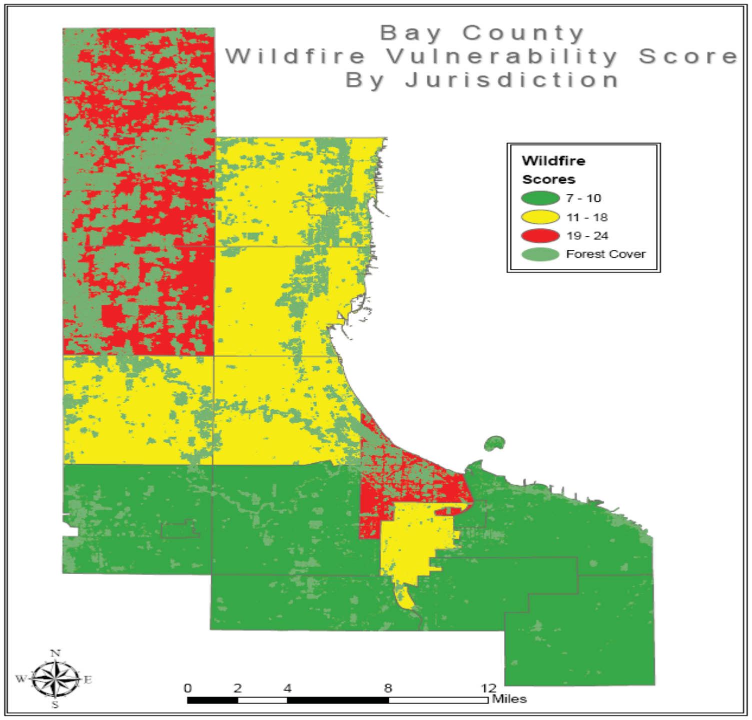
1. Wind Driven Ice Floes Score was derived from local hazard identification. An area effected rank was built based on the hazard areas located per jurisdiction.



Breakdown of each Hazard Vulnerability Score

Risk Score = Occurrence Rank and/or Area effected rank

1. Wildfire Vulnerability Score was derived from USGS Landfire Forest Cover database. An area effected rank was built based on the percent of forest cover per jurisdiction.



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Breakdown of each Hazard Vulnerability Score

Risk Score = Occurrence Rank and/or Area effected rank

1. Drought, Extreme Temperature and Severe Winter Storms do not currently have geographic data that can be assigned by jurisdiction. So each one of these hazards will be depicted showing the exposure map as the highest Vulnerable areas.

- Note we do know how many occurrences have occurred over the entire county but not pinpointed.
- There is no historical record of this area having an earthquake or being vulnerable to one. The extreme and unpredictable nature of Earthquakes have convinved us to keep earthquakes as a hazard but at this time we have no data for a Risk Assessment on Earthquakes.

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The ***Risk Assessment*** provides your community the framework to build your mitigation strategy.

•There are several ways to complete a risk assessment and several ways to use the data.

•One of the most important Risk Assessment factors derived in Bay County was the locational hazard data points identified by the local community members.

•This data can be used to identify specific locations that need to be mitigated and thus become a mitigation action in your ***Mitigation Strategy***.

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Develop Mitigation Actions

Specific actions that are measurable and promote goals.

Consider existing actions previously developed. Site plan or ordinance.

Consider new proposed actions.

Mitigation Goals:

1.**Preventative Activities**. Reduce risks through regulations including building codes, development outside of hazardous areas, and local planning or capital improvement projects.
2.**Property Protection**. Reduce exposure to hazards through building or parcel specific activities such as flood proofing, structure acquisition, or retrofitting.
3.**Emergency Services.** Reduce impacts through response and recovery activities that are implemented during a disaster.
4.**Structural Projects.** Minimize impacts through projects, such as detention basins, tornado shelters, tornado sirens, etc.
5.**Public Information.** Assist residents to prepare for risks and protective measures to better protect themselves and their property.

Worksheet

1. **Preventative Activities**. Reduce risks through regulations including building codes, development outside of hazardous areas, and local planning or capital improvement projects.
2. **Property Protection**. Reduce exposure to hazards through building or parcel specific activities such as flood proofing, structure acquisition, or retrofitting.
3. **Emergency Services.** Reduce impacts through response and recovery activities that are implemented during a disaster.
4. **Structural Projects.** Minimize impacts through projects, such as detention basins, tornado shelters, tornado sirens, etc.
5. **Public Information.** Assist residents to prepare for risks and protective measures to better protect themselves and their property.

Item Number	Goal Number	Mitigation Action	Responsible Agency & Contact Person	Funding Source	Implementation Timeline	Estimated Benefits†	Estimated Costs†
Example	*2*	*Purchase homes in the 100 year floodplain and convert the space to a park or greenspace to reduce flood impacts.*	*County Planning Department Director*	*HMGP& General Funds*	*5 years*	*Medium*	*Medium*
1.							

Grant Funding Opportunities/Project Examples

- Elevating flood-prone homes or businesses;
- Acquiring (and either demolishing or relocating) flood-prone homes from willing owners and returning the property to open space;
- Retrofitting buildings to minimize damage from high winds, flooding, earthquakes, and other hazards; and
- Implementing minor flood control projects to protect critical facilities.

Plan Maintenance Responsibilities

1. Schedule for Monitoring Plan
   - Planning committee meets annually.
2. Plan is Updated Every 5 Years
   - Planning committee coordinates
   - Contractor supported
   - FEMA funded.

Appendix E

Questionnaire Results

Bay County Multi-Hazard Questionnaire

Edit

Default Report | + Add Report

Response Summary

Total Started Survey: 9
Total Completed Survey: 9 (100%)

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PAGE: NATURAL HAZARD INFORMATION

1. 1. Please indicate where you live in Bay County: Create Chart Download

	Response Percent	Response Count
City of Auburn	0.0%	0
Township of Bangor	11.1%	1
City of Bay City	44.4%	4
Township of Beaver	11.1%	1
City of Essexville	0.0%	0
Township of Frankenlust	0.0%	0
Township of Fraser	0.0%	0
Township of Garfield	11.1%	1
Township of Gibson	0.0%	0
Township of Hampton	11.1%	1
Township of Kawkawlin	0.0%	0
Township of Merritt	0.0%	0
City of Midland	0.0%	0
Township of Monitor	0.0%	0
Township of Mount Forest	0.0%	0
City of Pinconning	0.0%	0
Town of Pinconning	0.0%	0
Township of Portsmouth	11.1%	1
Township of Williams	0.0%	0
Other (please specify)	0.0%	0
	answered question	9
	skipped question	0

2. 2. In the past 10 years, have you or someone in your household experienced a natural disaster within Bay County such as: severe storms, floods, winter storms, extreme Create Chart Download heat, tornadoes, drought, earthquakes, or other natural disaster?

	Response Percent	Response Count
Yes	66.7%	6
No	33.3%	3
answered question		9
skipped question		0

3. 2a. If yes to question #2, Which of the following types of natural hazard events have you or someone in your household experienced? (Please check all that apply) If you answered no to question #2, please move on to question #3. Create Chart Download

	Response Percent	Response Count
Severe Weather damage in excess of $500	28.6%	2
Floods	14.3%	1
Winter Storms	71.4%	5
Extreme Heat	14.3%	1
Tornadoes	0.0%	0
Drought	0.0%	0
Earthquakes	0.0%	0
Show replies Other (please specify)	14.3%	1
answered question		7
skipped question		2

4. 3. Do you consider yourself prepared for the probable impacts from natural hazard events that may occur within your community and/or the greater Bay County? Create Chart Download

	Response Percent	Response Count
Yes	66.7%	6
No	33.3%	3
answered question		9
skipped question		0

5. 3a. If yes to question #3, Where did you learn about being prepared for a disaster? (Please check all that apply) * If you answered no to question #3, please move on to question #4 Create Chart Download

	Response Percent	Response Count
Emergency preparedness information from a government source (i.e. Federal, State, or Local emergency management)	66.7%	4
Personal experience. Have experienced one or more natural hazard events	50.0%	3
Locally provided news or other media information	16.7%	1

		Response Percent	Response Count
Schools and other educational institutions		0.0%	0
Meetings or trainings offered by volunteer organizations (Red Cross, etc)		33.3%	2
Other (please specify)		0.0%	0
		answered question	6
		skipped question	3

6. 3b. Please check, on a scale of 1 to 5, how prepared you feel and your household are for the probable impacts of natural hazard events likely to occur within Bay County. Create Chart Download

		Response Percent	Response Count
1 Not at all prepared		0.0%	0
2 Somewhat prepared		33.3%	2
3 Adequately prepared		16.7%	1
4 Well prepared		50.0%	3
5 Very well prepared		0.0%	0
		answered question	6
		skipped question	3

7. 3c. What steps, if any, have you or someone in your household taken to prepare for a natural disaster? (Check all that apply) Create Chart Download

		Response Percent	Response Count
Food		66.7%	4
Water		66.7%	4
Flashlight(s)		100.0%	6
Batteries		66.7%	4
Battery-powered radio		50.0%	3
Medical supplies (First Aid Kit)		66.7%	4
Fire extinguisher		100.0%	6
Smoke detector on each level of the house		100.0%	6
Prepared a disaster supply kit		16.7%	1
Received First Aid/ CPR training		66.7%	4
Made a fire escape plan		83.3%	5
Discussed utility shutoffs		50.0%	3
Other (please specify)		0.0%	0
		answered question	6
		skipped question	3

8. 4. How concerned are you about the following natural hazards impacting your community and or/ the greater Bay County area? Create Chart Download

	Not Concerned	Somewhat Concerned	Concerned	Very Concerned	Extremely Concerned	Response Count
Severe Storm (wind, lightning)	0.0% (0)	0.0% (0)	11.1% (1)	**77.8% (7)**	11.1% (1)	9
Flood	0.0% (0)	11.1% (1)	22.2% (2)	**33.3% (3)**	**33.3% (3)**	9
Winter Storms	0.0% (0)	0.0% (0)	33.3% (3)	**55.6% (5)**	11.1% (1)	9
Extreme Heat	**44.4% (4)**	22.2% (2)	11.1% (1)	22.2% (2)	0.0% (0)	9
Tornadoes	0.0% (0)	11.1% (1)	**44.4% (4)**	33.3% (3)	11.1% (1)	9
Drought	**77.8% (7)**	11.1% (1)	0.0% (0)	11.1% (1)	0.0% (0)	9
Earthquakes	**88.9% (8)**	11.1% (1)	0.0% (0)	0.0% (0)	0.0% (0)	9
					Other (please specify)	0
					answered question	**9**
					skipped question	**0**

9. 5. What are the most effective ways for you to receive information about how to make your household and home safer from natural disasters? (Please check all that apply) Create Chart Download

	Response Percent	Response Count
Newspapers	55.6%	5
Television	88.9%	8
Radio	44.4%	4
Schools	11.1%	1
Books	0.0%	0
Mail	11.1%	1
Fire Department/Rescue	44.4%	4
Internet	77.8%	7
Fact sheet/Brochure	11.1%	1
Chamber of Commerce	0.0%	0
Public workshops/Meetings	33.3%	3
Magazine	0.0%	0
University or research institution	11.1%	1
Other (please specify)	0.0%	0
answered question		**9**
skipped question		**0**

10. 6. To the best of your knowledge, is your property located in a designated floodplain? Create Chart Download

	Response Percent	Response Count
Yes	11.1%	1
No	66.7%	6

	Response Percent	Response Count
Not Sure	22.2%	2
	answered question	9
	skipped question	0

11. 6a. To the best of your knowledge, is your property located in close proximity (<1 mile) to an earthquake fault line? Create Chart Download

	Response Percent	Response Count
Yes	0.0%	0
No	66.7%	6
Not Sure	33.3%	3
	answered question	9
	skipped question	0

12. 7. Do you have flood insurance? Create Chart Download

	Response Percent	Response Count
Yes	11.1%	1
No	88.9%	8
	answered question	9
	skipped question	0

13. 8. Do you have earthquake insurance? Create Chart Download

	Response Percent	Response Count
Yes	0.0%	0
No	100.0%	9
	answered question	9
	skipped question	0

14. 9. How vulnerable to damage is your infrastructure to: Create Chart Download

	Severely Vulnerable	Moderately Vulnerable	Minimally Vulnerable	Don't Know	Response Count
Severe Storm(wind/lightning)	11.1% (1)	77.8% (7)	11.1% (1)	0.0% (0)	9
Flood	33.3% (3)	33.3% (3)	33.3% (3)	0.0% (0)	9
Winter Storms	22.2% (2)	66.7% (6)	11.1% (1)	0.0% (0)	9
Extreme Heat	0.0% (0)	12.5% (1)	87.5% (7)	0.0% (0)	8
Tornadoes	33.3% (3)	33.3% (3)	22.2% (2)	11.1% (1)	9
Drought	0.0% (0)	12.5% (1)	50.0% (4)	37.5% (3)	8
Earthquakes	0.0% (0)	12.5% (1)	62.5% (5)	25.0% (2)	8
				Other (please specify)	0
				answered question	9
				skipped question	0

15. 9a.) How vulnerable to damage are the critical facilities (i.e. police stations, fire stations, emergency operation centers, etc) within your jurisdiction to: Create Chart Download

	Severely Vulnerable	Moderately Vulnerable	Minimally Vulnerable	Don't Know	Response Count
Severe Storm(wind/lightning)	0.0% (0)	55.6% (5)	33.3% (3)	11.1% (1)	9
Flood	22.2% (2)	22.2% (2)	44.4% (4)	11.1% (1)	9
Winter Storms	11.1% (1)	66.7% (6)	11.1% (1)	11.1% (1)	9
Extreme Heat	0.0% (0)	0.0% (0)	75.0% (6)	25.0% (2)	8
Tornadoes	11.1% (1)	33.3% (3)	44.4% (4)	11.1% (1)	9
Drought	0.0% (0)	0.0% (0)	77.8% (7)	22.2% (2)	9
Earthquakes	0.0% (0)	0.0% (0)	62.5% (5)	37.5% (3)	8
				Other (please specify)	0
				answered question	**9**
				skipped question	**0**

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PAGE: NATURAL HAZARD MITIGATION

1. 10. Did you consider the impact that the possible occurrence of a natural disaster would have on your home before you purchased or moved in? Create Chart Download

	Response Percent	Response Count
Yes	44.4%	4
No	55.6%	5
answered question		**9**
skipped question		**0**

2. 11. Was the presence of a natural hazard risk zone (i.e. flood zone, fault zone, etc) disclosed to you by a Real Estate agent, Seller, or Landlord before you purchased/moved into your home? Create Chart Download

	Response Percent	Response Count
Yes	44.4%	4
No	55.6%	5
answered question		**9**
skipped question		**0**

3. 12. Would the disclosure of this type of information influence your decision to purchase/move into a home? Create Chart Download

	Response Percent	Response Count
Yes	100.0%	9
No	0.0%	0
answered question		**9**

skipped question	0

4. 13. Would you be willing to spend money to modify/retrofit your current home from the impacts of future natural disasters within Bay County? (Examples of retrofitting are: Elevating a flood prone home, bolting a foundation for seismic impacts, or improving home exteriors to withstand higher winds) (If you answered No, please skip to #15) Create Chart Download

	Response Percent	Response Count
Yes	55.6%	5
No	11.1%	1
Maybe	33.3%	3
answered question		9
skipped question		0

5. 14. How much money would you be willing to spend to better protect your home from the impacts of natural disasters? Create Chart Download

	Response Percent	Response Count
$5,000 and above	0.0%	0
$2,500 to $4,999	22.2%	2
$1,000 to $2,499	0.0%	0
$500 to $999	22.2%	2
$100 to $499	0.0%	0
Less than $100	0.0%	0
Nothing	11.1%	1
Don't know	44.4%	4
Other (please specify)	0.0%	0
answered question		9
skipped question		0

6. 15. Which of the following incentives would help to encourage you to spend money to retrofit your home from the possible impacts of natural disasters (Please check all that apply) Create Chart Download

	Response Percent	Response Count
Low interest rate loan	55.6%	5
Insurance premium discount	33.3%	3
Mortgage discount	11.1%	1
Property tax break or incentive	55.6%	5
Grant funding that requires a "Cost-Share"	66.7%	6
None	11.1%	1
Other (please specify)	0.0%	0
answered question		9
skipped question		0

7. 16. If your property were located in a designated high hazard area or had received repetitive damages from a natural event, would you consider a buyout or relocation offered by a public agency? Create Chart Download

	Response Percent	Response Count
Yes	100.0%	9
No	0.0%	0
answered question		9
skipped question		0

Show this Page Only

PAGE: GENERAL HOUSEHOLD INFORMATION

1. 17. Please indicate your age range: Create Chart Download

	Response Percent	Response Count
18 to 29	0.0%	0
30 to 39	11.1%	1
40 to 49	0.0%	0
50 to 59	66.7%	6
60 or over	22.2%	2
answered question		9
skipped question		0

2. 18. Gender: Create Chart Download

	Response Percent	Response Count
Male	100.0%	9
Female	0.0%	0
answered question		9
skipped question		0

3. 19. Please indicate your highest level of education: Create Chart Download

	Response Percent	Response Count
Grade school/no schooling	0.0%	0
Some high school	0.0%	0
High school graduate/GED	22.2%	2
Some College/Trade school	44.4%	4
College Degree	22.2%	2
Post Graduate degree	11.1%	1
Other (please specify)	0.0%	0

answered question	9
skipped question	0

4. 20. How long have you lived in Bay County? Create Chart Download

	Response Percent	Response Count
Less than 1 year	0.0%	0
1 to 4 years	11.1%	1
5 to 9 years	0.0%	0
10 to 19 years	22.2%	2
20 or more years	66.7%	6
answered question		9
skipped question		0

5. 21. Do you have access to the Internet? Create Chart Download

	Response Percent	Response Count
Yes	100.0%	9
No	0.0%	0
answered question		9
skipped question		0

6. 22. Do you own or rent your home? Create Chart Download

	Response Percent	Response Count
Own	88.9%	8
Rent	11.1%	1
answered question		9
skipped question		0

7. 23. Do you own/rent a: Create Chart Download

	Response Percent	Response Count
Single-family home	88.9%	8
Duplex	11.1%	1
Apartment (3-4 units in structure)	0.0%	0
Apartment (5 or more units in structure)	0.0%	0
Condominium/townhouse	0.0%	0
Manufactured home	0.0%	0
Other (please specify)	0.0%	0
answered question		9
skipped question		0

8. 24. Other Comments:

	Response Count
	0
answered question	0
skipped question	9

Appendix F

Natural Hazard Declarations

DOC >NOAA >NESDIS >NCDC Search Field: Search NCDC

Query Results

254 event(s) were reported in **Bay County, Michigan** between **01/01/1950** and **03/31/2010 (High Wind limited to speed greater than 0 knots)**.

*Click on **Location or County** to display Details.*

Mag: Magnitude
Dth: Deaths
Inj: Injuries
PrD: Property Damage
CrD: Crop Damage

Michigan

Location or County	Date	Time	Type	Mag	Dth	Inj	PrD	CrD
1 BAY	06/22/1957	1800	Tornado	F2	0	0	25K	0
2 BAY	09/01/1960	1400	Tstm Wind	85 kts.	0	0	0	0
3 BAY	06/18/1962	1630	Hail	2.50 in.	0	0	0	0
4 BAY	10/10/1962	1800	Tstm Wind	0 kts.	0	0	0	0
5 BAY	04/11/1965	1950	Tornado	F2	0	2	250K	0
6 BAY	04/20/1966	2015	Tstm Wind	0 kts.	0	0	0	0
7 BAY	07/12/1966	1050	Tstm Wind	0 kts.	0	0	0	0
8 BAY	06/13/1967	1530	Tstm Wind	50 kts.	0	0	0	0
9 BAY	04/23/1968	1430	Tstm Wind	0 kts.	0	0	0	0
10 BAY	06/12/1969	1630	Tstm Wind	0 kts.	0	0	0	0
11 BAY	06/12/1969	1640	Tstm Wind	0 kts.	0	0	0	0
12 BAY	06/26/1973	1200	Tornado	F0	0	0	0K	0

13 BAY	06/26/1973	1225	Tornado	F0	0	0	0K	0
14 BAY	07/31/1973	0520	Hail	0.75 in.	0	0	0	0
15 BAY	07/31/1973	0520	Tornado	F2	0	0	25K	0
16 BAY	05/14/1974	2145	Tstm Wind	0 kts.	0	0	0	0
17 BAY	07/14/1974	1300	Tornado	F1	0	0	0K	0
18 BAY	04/18/1975	1900	Tstm Wind	0 kts.	0	0	0	0
19 BAY	07/10/1975	0900	Tstm Wind	0 kts.	0	0	0	0
20 BAY	06/20/1979	1150	Tornado	F0	0	0	25K	0
21 BAY	07/17/1982	1230	Tornado	F0	0	0	3K	0
22 BAY	08/03/1982	1645	Tstm Wind	0 kts.	0	0	0	0
23 BAY	08/03/1982	1705	Tstm Wind	0 kts.	0	0	0	0
24 BAY	07/21/1983	1100	Tstm Wind	0 kts.	0	0	0	0
25 BAY	06/12/1984	1720	Tornado	F3	0	2	2.5M	0
26 BAY	06/12/1984	1805	Tstm Wind	0 kts.	0	0	0	0
27 BAY	09/08/1985	0130	Tstm Wind	0 kts.	0	0	0	0
28 BAY	07/20/1987	1707	Tstm Wind	55 kts.	0	0	0	0
29 BAY	08/03/1988	1450	Tstm Wind	0 kts.	0	0	0	0
30 BAY	08/14/1988	1600	Tstm Wind	0 kts.	0	0	0	0
31 BAY	05/25/1989	0115	Tstm Wind	0 kts.	0	0	0	0
32 BAY	09/14/1990	1030	Tstm Wind	0 kts.	0	0	0	0
33 BAY	03/27/1991	2000	Tstm Wind	0 kts.	0	0	0	0
34 BAY	05/13/1991	1230	Tstm Wind	0 kts.	0	0	0	0

35 BAY	05/29/1991	1800	Tstm Wind	0 kts.	0	0	0	0
36 BAY	07/07/1991	1825	Tstm Wind	0 kts.	0	0	0	0
37 BAY	08/17/1991	1300	Hail	0.75 in.	0	0	0	0
38 BAY	06/17/1992	1625	Tstm Wind	0 kts.	0	0	0	0
39 BAY	06/17/1992	1630	Tstm Wind	0 kts.	0	5	0	0
40 MIZ004>006 - 013>017 - 022 - 023 - 025 - 026 - 032>034 - 037>051 - 058>068	01/12/1993	2300	Heavy Snow	N/A	0	0	50K	0
41 MIZ001>073 - 080>083	01/21/1993	0000	Ice Storm	N/A	0	0	0	0
42 MIZ011 - 012 - 018>039 - 042>048 - 062>068	04/01/1993	0000	Heavy Snow	N/A	0	0	50K	0
43 Bay City	08/23/1993	2304	Thunderstorm Winds	0 kts.	0	0	0	0
44 Pinconning	08/27/1993	1925	Thunderstorm Wind	0 kts.	0	0	50K	0
45 Part Of Upper And All	01/27/1994	0000	Heavy Snow/freezing Rain	N/A	0	0	5.0M	0
46 Bay City	04/26/1994	2145	Hail	0.75 in.	0	0	0	0
47 Bay City	04/26/1994	2200	Funnel Cloud	N/A	0	0	0	0
48 Bay City	05/26/1994	0810	Flood/flash Flood	N/A	0	0	0	0
49 Bay City	06/28/1994	1433	Thunderstorm Winds	0 kts.	0	0	0	0
50 Munger	06/28/1994	1445	Thunderstorm Winds	0 kts.	0	0	0	0
51 Bentley	07/06/1994	1738	Funnel Cloud	N/A	0	0	0	0

52 Bay City	07/06/1994	1840	Lightning	N/A	0	3	0	0
53 Bay City	07/06/1994	1840	Thunderstorm Winds	0 kts.	0	0	0	0
54 MIZ001>083	11/18/1994	1200	High Winds	62 kts.	0	0	1.0M	0
55 Southern Lower	12/06/1994	1800	Heavy Snow	N/A	0	0	0	0
56 MIZ001>009 - 016>080	01/01/1995	0000	Heavy Lake Snow	N/A	0	0	0	0
57 Lower Michigan	01/11/1995	1800	Dense Fog	N/A	0	0	0	0
58 Northwest Upper	01/20/1995	0000	Heavy Snow	N/A	0	0	0	0
59 MIZ001>008 - 016>078	02/03/1995	1800	Heavy Lake Snow	N/A	0	0	0	0
60 MIZ001>003 - 006>008 - 016>078	02/11/1995	0000	Heavy Lake Snow	N/A	0	0	0	0
61 Southern Lower	02/25/1995	1500	Heavy Snow	N/A	0	0	0	0
62 Southern Lower	02/27/1995	0100	Ice Storm	N/A	0	0	0	0
63 MIZ001>050	03/06/1995	0000	Heavy Snow	N/A	0	0	0	0
64 MIZ040>083	03/06/1995	0000	Ice Storm	N/A	0	0	0	0
65 Countywide	08/13/1995	1400	Thunderstorm Winds	0 kts.	0	0	0	0
66 Countywide	08/13/1995	1445	Thunderstorm Winds	0 kts.	0	0	0	0
67 East Central Lower	11/27/1995	0400	Heavy Snow	N/A	0	0	0	0
68 All Of S.e. Lower	12/09/1995	0400	Cold Wave	N/A	3	0	0	0
69 All Of S.e. Lower	12/13/1995	1800	Ice Storm	N/A	0	0	0	0
70	02/01/1996	12:00 AM	Extreme Cold	N/A	1	0	0	0

MIZ047>049 - 053>055 - 060>063 - 068>070 - 075>076 - 082>083								
71 MIZ047>049 - 053>055 - 060>063 - 068>070 - 075>076 - 082>083	03/25/1996	12:00 PM	High Wind	50 kts.	0	0	65K	0K
72 Linwood	04/12/1996	06:12 PM	Hail	0.75 in.	0	0	0	0
73 Bay City	04/13/1996	12:30 AM	Hail	0.75 in.	0	0	0	0
74 Bay City	06/21/1996	09:50 PM	Tstm Wind	75 kts.	0	0	400K	0
75 Srn 1/2 Of Co.	06/21/1996	10:00 PM	Flash Flood	N/A	1	0	2.2M	0
76 Pinconning	08/07/1996	04:34 PM	Tstm Wind	50 kts.	0	0	0	0
77 Bentley	08/22/1996	05:10 PM	Tstm Wind	50 kts.	0	0	0	0
78 MIZ047>049 - 053>055 - 060>063 - 068>070 - 075>076 - 082>083	10/30/1996	12:00 AM	High Wind	60 kts.	0	0	90K	0
79 MIZ047>049 - 053>055 - 060 - 062	01/09/1997	08:00 AM	Heavy Snow	N/A	0	0	0	0
80 MIZ047>049 - 053>055 - 060>063 - 068>070 - 075>076 - 082>083	01/17/1997	12:00 AM	Extreme Cold	N/A	2	0	0	0
81 Countywide	02/21/1997	12:00 PM	Flash Flood	N/A	0	0	0	0

82 MIZ047>049 - 053>055 - 060>063 - 068>070 - 075>076 - 082>083	02/27/1997	08:00 AM	High Wind	55 kts.	0	0	20K	0
83 MIZ047>049 - 053>055 - 060>063 - 068>070 - 075>076 - 082>083	03/13/1997	09:00 PM	Ice Storm	N/A	0	0	19.0M	0
84 MIZ047>049 - 053>055 - 060>063 - 068>070 - 075>076 - 082>083	04/06/1997	03:00 PM	High Wind	70 kts.	0	1	1.2M	0
85 Bay City	05/08/1997	09:15 PM	Hail	0.88 in.	0	0	0	0
86 Bay City	07/02/1997	03:13 PM	Tstm Wind	60 kts.	0	0	0	0
87 Auburn	07/14/1997	06:51 PM	Tstm Wind	50 kts.	0	0	0	0
88 Bay City	07/14/1997	06:57 PM	Tstm Wind	60 kts.	0	0	1K	0
89 MIZ047>049 - 053>054 - 060>062 - 068	10/26/1997	10:00 PM	Heavy Snow	N/A	0	0	0	0
90 MIZ047>048 - 053	01/07/1998	08:00 PM	Ice Storm	N/A	0	0	0	0
91 MIZ048	03/09/1998	04:00 AM	Extreme Cold	N/A	1	0	0	0
92 MIZ048	03/09/1998	09:00 AM	Heavy Snow	N/A	0	0	0	0
93 Bay City	04/01/1998	02:00 PM	Tstm Wind	52 kts.	0	0	0	0
94 MIZ048	04/09/1998	09:00 AM	High Wind	45 kts.	0	0	4K	0

95 MIZ048 - 070	04/09/1998	09:00 AM	Flood	N/A	0	0	0	0
96 Bay City	05/29/1998	02:37 AM	Tstm Wind	52 kts.	0	0	0	0
97 Auburn	05/31/1998	05:05 AM	Tstm Wind	70 kts.	0	0	200K	0
98 Linwood	05/31/1998	05:12 AM	Tstm Wind	70 kts.	1	0	100K	0
99 Bentley	05/31/1998	05:20 AM	Tstm Wind	65 kts.	0	0	50K	0
100 Bay City	05/31/1998	05:27 AM	Tstm Wind	70 kts.	0	0	1.0M	0
101 MIZ047>049 - 053>055 - 060>063 - 068>069 - 075	06/02/1998	01:00 PM	High Wind	35 kts.	0	0	0	0
102 Pinconning	06/24/1998	04:30 PM	Hail	1.75 in.	0	0	0	0
103 Bay City	07/14/1998	05:10 PM	Tstm Wind	51 kts.	0	0	0	0
104 Bentley	09/26/1998	06:20 AM	Hail	1.75 in.	0	0	0	0
105 MIZ047>049 - 053>055 - 060>063 - 068>070 - 075>076 - 082>083	11/10/1998	12:00 PM	High Wind	61 kts.	0	0	1.1M	0
106 MIZ047>049 - 053>055 - 060>063 - 068>070 - 075>076 - 082>083	01/02/1999	09:00 AM	Heavy Snow	N/A	0	0	50K	0
107 MIZ047>049 - 053>055 - 060>063	01/12/1999	04:00 PM	Heavy Snow	N/A	0	0	0	0
108	01/12/1999	05:00 PM	Snow	N/A	0	3	1.8M	0

MIZ047>049 - 053>055 - 060>063 - 068>070 - 075>076 - 082>083								
109 MIZ047>049 - 053>055 - 060>063 - 068>070 - 075>076 - 082>083	02/11/1999	12:00 PM	Record Warmth	N/A	0	0	0	0
110 MIZ048 - 053 - 061 - 063 - 068 - 082	05/06/1999	12:00 PM	Wind	N/A	0	0	92K	0
111 Kawkawlin	05/17/1999	03:10 PM	Hail	0.75 in.	0	0	0	0
112 MIZ047>049 - 053>055 - 060>063 - 068>070 - 075>076 - 082>083	07/04/1999	11:00 AM	Excessive Heat	N/A	0	52	0	0
113 Kawkawlin	07/24/1999	01:55 PM	Hail	1.75 in.	0	0	0	0
114 Bay City	07/24/1999	02:19 PM	Hail	1.75 in.	0	2	0	0
115 Bay City	07/24/1999	02:19 PM	Tstm Wind	55 kts.	0	0	90K	0
116 MIZ047>049 - 054>055	02/13/2000	06:00 AM	Heavy Snow	N/A	0	0	0	0
117 MIZ047>049 - 053>055 - 060>063 - 068>070 - 075>076 - 082>083	03/08/2000	12:00 PM	Record Warmth	N/A	0	0	0	0
118 Kawkawlin	05/09/2000	12:15 AM	Tstm Wind	52 kts.	0	0	5K	0
119 Bay City	05/12/2000	04:30 PM	Hail	0.88	0	0	0	0

				in.				
120 Bay City	05/12/2000	05:10 PM	Hail	2.75 in.	0	0	0	0
121 Linwood	06/29/2000	02:30 PM	Hail	0.75 in.	0	0	0	0
122 Pinconning	08/02/2000	02:30 PM	Hail	0.75 in.	0	0	0	0
123 Bay City	08/09/2000	03:35 PM	Tstm Wind	52 kts.	0	0	7K	0
124 Auburn	08/09/2000	05:50 AM	Hail	0.75 in.	0	0	0	0
125 MIZ047>049 - 053>055 - 060>063 - 068>070 - 075>076 - 082>083	10/07/2000	01:00 AM	Snow	N/A	0	0	0	0
126 MIZ047>048 - 053	10/25/2000	03:00 AM	Fog	N/A	0	0	0	0
127 MIZ047>049 - 053>055 - 060>062 - 068>069	12/11/2000	12:00 PM	Heavy Snow	N/A	0	1	1.1M	0
128 MIZ047>049 - 053>055 - 060>063 - 068>070 - 075>076	12/13/2000	03:00 PM	Snow	N/A	0	0	25K	0
129 MIZ047>048 - 053>054 - 060>061	12/17/2000	01:00 AM	Heavy Snow	N/A	0	0	560K	0
130 MIZ047>049 - 053>055 - 060>063 - 068>070 - 075>076 - 082>083	12/21/2000	06:00 PM	Extreme Cold	N/A	0	0	475K	0

131 MIZ048>049 - 053>054	02/07/2001	11:00 PM	Ice Storm	N/A	0	0	0	0
132 Pinconning	06/09/2001	06:25 PM	Tstm Wind	50 kts.	0	0	2K	0
133 MIZ047>049 - 053>055 - 060>063 - 068>070 - 075>076 - 082>083	07/01/2001	12:00 AM	Drought	N/A	0	0	0	150.0M
134 Bay City	07/01/2001	12:30 PM	Dust Devel	N/A	0	0	0	0
135 MIZ047>049 - 053>055 - 060>063 - 068>070 - 075>076 - 082>083	08/06/2001	12:00 PM	Excessive Heat	N/A	1	200	0	0
136 Bay City	08/19/2001	11:10 AM	Tstm Wind	50 kts.	0	0	0	0
137 Bay City	09/07/2001	05:55 PM	Tstm Wind	55 kts.	0	0	0	0
138 Bay City	10/24/2001	07:42 PM	Tornado	F1	0	0	60K	0
139 Linwood	11/25/2001	12:00 AM	Tstm Wind	55 kts.	0	0	5K	0
140 MIZ047>049 - 053>055 - 060>063 - 068>070 - 075>076	01/30/2002	08:00 AM	Winter Storm	N/A	0	0	0	0
141 MIZ047>049 - 053>055 - 060>063 - 068>070 - 075>076 - 082>083	02/01/2002	09:00 AM	High Wind	40 kts.	0	1	30K	0
142 MIZ047>048 - 053	03/02/2002	06:00 AM	Winter Storm	N/A	0	0	0	0

143 MIZ047>049 - 053>055 - 060>063 - 068>070 - 075>076 - 082>083	03/09/2002	03:00 PM	High Wind	61 kts.	0	2	780K	0
144 Bay City	04/18/2002	11:25 PM	Tstm Wind	52 kts.	0	0	0	0
145 Linwood	06/17/2002	04:38 PM	Hail	0.75 in.	0	0	0	0
146 Essexville	08/13/2002	02:55 PM	Tstm Wind	50 kts.	0	0	0	0
147 MIZ047>049 - 053>055 - 060>063 - 068>070 - 075>076 - 082>083	09/01/2002	12:00 AM	Drought	N/A	0	0	0	0
148 Bay City	09/19/2002	04:00 PM	Tstm Wind	52 kts.	0	0	25K	0
149 Essexville	09/19/2002	04:05 PM	Tstm Wind	54 kts.	0	0	0	0
150 Willard	09/19/2002	04:05 PM	Tstm Wind	50 kts.	0	0	0	0
151 MIZ047>048	12/18/2002	01:00 AM	Ice Storm	N/A	0	0	0	0
152 MIZ047>049 - 053>055 - 060>063 - 068>070 - 075>076 - 082>083	01/10/2003	08:00 AM	Extreme Cold/wind Chill	N/A	0	0	0	0
153 MIZ047>049 - 053>055 - 060>063 - 068>070	04/03/2003	10:00 PM	Ice Storm	N/A	1	2	161.1M	0
154 Bay City	06/08/2003	04:30 PM	Tstm Wind	50 kts.	0	0	0	0
155 Bay City	06/28/2003	03:36 PM	Hail	0.75	0	0	0	0

				in.				
156 Bay City	06/28/2003	03:36 PM	Tstm Wind	55 kts.	0	0	1K	0
157 Bay City	07/06/2003	08:35 PM	Tstm Wind	56 kts.	0	0	6K	0
158 Bay City	08/04/2003	05:45 PM	Tornado	F0	0	0	0	0
159 MIZ047>049 - 053>055 - 060>063 - 068>070 - 075>076 - 082>083	11/12/2003	05:00 PM	High Wind	76 kts.	0	0	21.0M	0
160 MIZ047>049 - 053>054	12/24/2003	05:00 PM	Heavy Snow	N/A	0	0	0	0
161 MIZ047>048 - 053>054 - 060>063 - 068>070	01/14/2004	06:00 AM	Heavy Snow	N/A	0	0	0	0
162 MIZ047>049 - 053>055 - 060>062 - 068>069 - 075	01/26/2004	07:00 PM	Winter Storm	N/A	0	0	0	0
163 MIZ047>048	02/23/2004	03:00 AM	Heavy Snow	N/A	0	0	0	0
164 MIZ047>049	03/05/2004	11:15 AM	Flood	N/A	0	0	0	0
165 MIZ047>049 - 053>055 - 068>070 - 075	04/19/2004	10:45 AM	High Wind	63 kts.	0	1	0	0
166 Kawkawlin	05/17/2004	03:35 PM	Tstm Wind	55 kts.	0	0	0	0
167 MIZ047>048 - 053>055 - 060>063 - 068>070 - 075>076 - 082>083	05/23/2004	03:00 AM	Flood	N/A	0	0	100.0M	0

168 Auburn	06/13/2004	02:50 PM	Tornado	F0	0	0	10K	0
169 Kawkawlin	06/13/2004	03:04 PM	Hail	1.75 in.	0	0	0	0
170 Bay City	06/13/2004	05:30 PM	Tstm Wind	52 kts.	0	0	0	0
171 Linwood	07/13/2004	08:08 PM	Tstm Wind	52 kts.	0	0	0	0
172 Bay City	08/02/2004	04:30 PM	Tstm Wind	54 kts.	0	0	0	0
173 MIZ047>049 - 053>055 - 060>063 - 068>070 - 075>076 - 082>083	10/30/2004	11:30 AM	High Wind	54 kts.	0	0	3.5M	0
174 MIZ047>048 - 053>054 - 060>062 - 068	11/24/2004	04:00 PM	Winter Storm	N/A	0	0	0	0
175 MIZ047>048 - 053	01/06/2005	04:00 AM	Heavy Snow	N/A	0	0	0	0
176 MIZ048 - 053 - 060>062 - 068>070 - 075>076 - 082>083	01/22/2005	03:00 AM	Winter Storm	N/A	0	0	0	0
177 MIZ047>049 - 053>055	02/14/2005	06:00 PM	Ice Storm	N/A	0	0	0	0
178 MIZ047>049 - 053>055 - 061>063 - 069>070 - 076	02/20/2005	12:00 AM	Heavy Snow	N/A	0	0	0	0
179 MIZ047>049	03/01/2005	12:00 AM	Heavy Snow	N/A	0	0	0	0
180 MIZ047>048 - 053>055 - 060>063 - 069>070	04/23/2005	04:00 PM	Winter Storm	N/A	0	0	0	0

181 Essexville	06/05/2005	01:45 PM	Hail	0.75 in.	0	0	0	0
182 Bay City	06/05/2005	02:50 PM	Hail	1.00 in.	0	0	0	0
183 Bay City	06/05/2005	02:50 PM	Tstm Wind	56 kts.	0	0	0	0
184 Auburn	06/05/2005	03:29 PM	Tstm Wind	61 kts.	0	0	0	0
185 Bay City	06/05/2005	03:30 PM	Tstm Wind	55 kts.	0	0	0	0
186 Bay City	06/05/2005	03:30 PM	Tstm Wind	70 kts.	0	0	40K	0
187 Auburn	06/05/2005	03:35 PM	Tstm Wind	58 kts.	0	0	0	0
188 Bay City	06/05/2005	03:35 PM	Lightning	N/A	0	0	0	0
189 Bay City	06/05/2005	03:35 PM	Lightning	N/A	0	0	0	0
190 Auburn	06/05/2005	05:25 PM	Hail	1.00 in.	0	0	0	0
191 Mt Forest	06/10/2005	05:30 PM	Flash Flood	N/A	0	0	0	0
192 Auburn	06/14/2005	03:05 PM	Tstm Wind	54 kts.	0	0	0	0
193 Essexville	07/24/2005	08:00 AM	Lightning	N/A	0	0	50K	0
194 Auburn	07/24/2005	08:05 AM	Tstm Wind	54 kts.	0	0	0	0
195 Bay City	07/24/2005	08:15 AM	Tstm Wind	54 kts.	0	0	0	0
196 Bay City	07/24/2005	08:15 AM	Tstm Wind	55 kts.	0	0	20K	0
197 MIZ047>048 - 053>055 - 060>063 - 068>070 - 075>076 - 082>083	11/15/2005	09:00 PM	Strong Wind	48 kts.	0	0	7.2M	0
198 MIZ047>049 - 053>054	01/21/2006	05:00 AM	Heavy Snow	N/A	0	0	0	0
199 MIZ047>048 -	02/16/2006	04:00 PM	Ice Storm	N/A	0	0	1.0M	0

053									
200 MIZ047>049 - 053>055	03/02/2006	08:00 AM	Winter Storm	N/A	0	0	0	0	
201 MIZ047>049 - 053 - 061>063 - 068>070 - 076 - 082	03/13/2006	02:00 PM	High Wind	52 kts.	1	2	0	0	
202 Auburn	03/31/2006	05:10 PM	Hail	0.75 in.	0	0	0	0	
203 MIZ047>049 - 053>055 - 060>063 - 068>070 - 075>076 - 082>083	05/29/2006	12:00 PM	Heat	N/A	0	75	0	0	
204 Willard	05/30/2006	04:00 PM	Heavy Rain	N/A	0	0	10K	25K	
205 Auburn	05/30/2006	05:40 PM	Hail	0.88 in.	0	0	0	0	
206 Auburn	05/30/2006	05:40 PM	Tstm Wind	50 kts.	0	0	1K	0	
207 Bangor Township	05/30/2006	06:00 PM	Lightning	N/A	0	0	10K	0	
208 Bay City	07/17/2006	06:00 PM	Tstm Wind	55 kts.	0	0	0	0	
209 MIZ047>049 - 053>055 - 060>063 - 068>070 - 075>076 - 082>083	07/29/2006	12:00 PM	Heat	N/A	0	25	0	0	
210 MIZ047>049 - 053>055 - 060>063 - 068>070 - 075>076 - 082>083	08/01/2006	12:00 AM	Heat	N/A	0	215	0	0	
211 Kawkawlin	10/04/2006	01:45 AM	Thunderstorm Wind	52 kts.	0	0	0K	0K	

212 Essexville	10/04/2006	01:52 AM	Hail	0.75 in.	0	0	0K	0K
213 Bay City	10/04/2006	07:15 AM	Lightning	N/A	0	0	3K	0K
214 MIZ047>049 - 053 - 063 - 070	01/14/2007	23:00 PM	Heavy Snow	N/A	0	0	0K	0K
215 MIZ047>049 - 053 - 063 - 070	01/14/2007	23:00 PM	Ice Storm	N/A	0	0	100K	0K
216 MIZ047>049 - 053 - 063 - 070	01/14/2007	23:00 PM	Winter Weather	N/A	0	0	0K	0K
217 MIZ047>049 - 053>055 - 060>063 - 068>070 - 075>076 - 082	02/03/2007	16:00 PM	Cold/wind Chill	N/A	0	10	25K	0K
218 MIZ047 - 048	03/01/2007	05:00 AM	Winter Storm	N/A	0	0	0K	0K
219 MIZ048 - 061 - 062	04/04/2007	16:00 PM	Winter Weather	N/A	0	0	0K	0K
220 Bay City	05/15/2007	14:38 PM	Thunderstorm Wind	52 kts.	0	0	2K	0K
221 Bay City	05/15/2007	14:40 PM	Thunderstorm Wind	56 kts.	0	0	0K	0K
222 Essexville	05/15/2007	14:43 PM	Thunderstorm Wind	70 kts.	0	0	1.5M	0K
223 Bay City	06/27/2007	14:32 PM	Thunderstorm Wind	54 kts.	0	0	0K	0K
224 Bentley	07/09/2007	15:00 PM	Thunderstorm Wind	58 kts.	0	0	0K	0K
225 Bay City	08/22/2007	22:15 PM	Thunderstorm Wind	54 kts.	0	0	0K	0K
226 Bay City	08/22/2007	22:25 PM	Thunderstorm Wind	53 kts.	0	0	8K	0K
227 Bay City	08/22/2007	22:40 PM	Thunderstorm Wind	54 kts.	0	0	0K	0K
228 Bay City	08/23/2007	16:41 PM	Thunderstorm Wind	56 kts.	0	0	0K	0K

229 Bay City	08/23/2007	16:41 PM	Thunderstorm Wind	56 kts.	0	0	0K	0K
230 MIZ047 - 048	12/01/2007	20:00 PM	Winter Storm	N/A	0	0	0K	0K
231 MIZ047 - 048	12/01/2007	20:00 PM	Winter Weather	N/A	0	0	0K	0K
232 MIZ047>049 - 053>055 - 060>063 - 068>070 - 075>076 - 082	12/11/2007	09:00 AM	Winter Weather	N/A	0	0	0K	0K
233 MIZ047>049 - 053>055 - 060>063 - 068>070 - 075>076 - 082	12/16/2007	00:00 AM	Blizzard	N/A	0	0	0K	0K
234 MIZ047>049 - 053>055 - 060>063 - 068>070 - 075>076 - 082	12/16/2007	00:00 AM	Winter Storm	N/A	0	0	0K	0K
235 MIZ047 - 048	12/28/2007	14:00 PM	Heavy Snow	N/A	0	0	0K	0K
236 MIZ047 - 048	01/21/2008	21:00 PM	Heavy Snow	N/A	0	0	0K	0K
237 MIZ047>049 - 053>055 - 060>063 - 068>070 - 075	02/06/2008	11:00 AM	Winter Storm	N/A	0	0	0K	0K
238 Duel	06/06/2008	16:18 PM	Thunderstorm Wind	54 kts.	0	0	2K	0K
239 Kawkawlin	06/15/2008	20:50 PM	Thunderstorm Wind	54 kts.	0	0	0K	0K
240 Pinconning	06/15/2008	21:10 PM	Hail	0.88 in.	0	0	0K	0K
241 Kawkawlin	06/15/2008	21:25 PM	Thunderstorm Wind	52 kts.	0	0	0K	0K
242 Aplin	06/15/2008	21:35 PM	Thunderstorm	52	0	0	5K	0K

Beach			Wind	kts.				
243 Bangor Township	06/15/2008	21:35 PM	Thunderstorm Wind	53 kts.	0	0	0K	0K
244 Bay City	06/15/2008	21:40 PM	Thunderstorm Wind	56 kts.	0	0	0K	0K
245 Crump	07/22/2008	15:05 PM	Thunderstorm Wind	52 kts.	0	0	5K	0K
246 Kawkawlin	07/22/2008	15:30 PM	Flash Flood	N/A	0	0	50K	0K
247 Kawkawlin	07/22/2008	15:35 PM	Thunderstorm Wind	52 kts.	0	0	3K	0K
248 MIZ047>049 - 053	12/09/2008	00:00 AM	Winter Storm	N/A	0	0	0K	0K
249 MIZ047>049 - 053>055 - 060>063 - 068>070 - 075>076 - 082	12/19/2008	04:00 AM	Winter Storm	N/A	0	0	0K	0K
250 MIZ047>049 - 053>055 - 060>063 - 068>070 - 075>076 - 082	12/28/2008	04:00 AM	High Wind	56 kts.	0	0	0K	0K
251 MIZ047>049 - 053>055 - 060>063 - 068>070 - 075>076 - 082	01/14/2009	20:00 PM	Extreme Cold/wind Chill	N/A	0	0	0K	0K
252 MIZ048 - 054 - 069	01/17/2009	10:00 AM	Winter Storm	N/A	0	0	0K	0K
253 MIZ047 - 048	12/08/2009	21:00 PM	Heavy Snow	N/A	0	0	0K	0K
254 MIZ048 - 053>055 - 060>063 - 068>070 - 075>076 - 082	02/09/2010	16:00 PM	Heavy Snow	N/A	0	0	0K	0K
				TOTALS:	12	604	335.154M	150.025M

Appendix G

Risk Assessment Tables

NAME	MCD Pop. 2000	Pop. Density	Pop. Density Rank	House Units	Prop. Density	Prop. Density Rank	# Govt. Blgs.	# Police	# Fire Stations	Schools	Hospital / Clinics	HAZMAT	Airport	Total Ess. Facilities	EF Rank	Towers	Water Plants	Wells	Flood Wtr Pumps	Oil / Gas Wells	Bridges	# of Infra. Points	Infra. Point Rank	Wtr Line	Pipe Line	Sewer Line	Fiber Line	Maj Util Line	RR Line	Road Line	Tot # of Line	Infra. Line Rank	InfraRK	Exp Score	WFRskRk
Auburn	2011	1895	2	867	817	3	2	1	0	4	0	0	0	7	1	0	0	1	1	0	4	6	1	13769	85010	36386	24682	0	46498	119633	325978	1	1	7	0
Bangor Twp	15547	1044	2	6563	441	2	7	1	2	7	6	6	0	29	2	2	2	8	11	101	4	128	2	117268	286932	369672	51860	75581	2805	612098	2E+06	3	3	9	0
Bay City	36817	3242	3	16259	1432	3	20	1	4	20	8	9	1	63	3	7	1	4	0	1	19	32	1	22431	216821	52273	43909	17419	1436	1E+06	1E+06	3	2	11	0
Beaver Twp	2806	79	1	998	28	1	1	0	1	2	0	2	0	6	1	3	0	409	0	38	14	464	3	58194	0	0	0	64956	0	491540	614690	2	3	6	0
Essexville	3766	2708	3	1530	1100	3	2	1	1	5	0	0	0	9	1	1	1	0	1	0	0	3	1	702	52262	9723	43909	0	4238	114551	225385	1	1	8	0
Frankenlust Twp	2530	110	1	1203	52	1	2	1	1	2	0	3	0	9	1	8	0	132	1	2	20	163	2	52868	127217	100932	0	78911	19344	456817	836089	2	2	5	0
Fraser Twp	3375	103	1	1374	42	1	3	0	1	0	0	4	0	8	1	4	1	412	0	46	26	489	3	36958	145730	8064	88872	78832	47165	668707	1E+06	2	3	6	0
Garfield Twp	1775	50	1	627	18	1	1	0	1	0	0	0	0	2	1	1	0	398	0	25	3	427	3	0	0	0	0	49586	0	372416	422002	1	2	5	0
Gibson Twp	1245	35	1	431	12	1	1	0	1	0	0	1	0	3	1	3	0	266	0	83	1	353	3	0	150842	0	0	95654	0	398574	645070	2	3	6	0
Hampton Twp	9902	352	1	4341	154	1	2	1	1	5	4	5	0	18	2	5	1	6	12	77	2	103	2	134079	110012	196257	43909	309294	486	590131	1E+06	3	3	7	0
Kawkawlin Twp	5104	153	1	2021	60	1	2	0	1	4	0	6	0	13	1	8	0	283	2	168	28	489	3	139430	229341	61532	88872	67183	10457	660096	1E+06	3	3	6	0
Merritt Twp	1510	48	1	554	18	1	3	0	1	0	0	9	0	13	1	3	0	84	0	12	10	109	2	41487	97303	0	0	148865	22520	571218	881393	2	2	5	0
Monitor Twp	10037	272	1	4111	111	1	5	0	1	5	2	8	0	21	2	3	2	128	1	137	62	333	3	135287	317385	239905	170284	177109	10457	978378	2E+06	3	3	7	0
Mt Forest Twp	1405	39	1	550	15	1	1	0	1	1	0	0	0	3	1	2	0	326	0	31	6	365	3	0	163439	0	0	95654	0	461861	720954	2	3	6	0
Pinconning	1386	1610	2	645	749	3	2	1	1	5	3	1	0	13	1	2	1	0	0	0	2	5	1	15498	0	0	5052	0	13443	68293	102286	1	1	7	0
Pinconning Twp	2608	71	1	1055	29	1	1	0	0	1	0	1	1	4	1	4	0	341	0	119	31	495	3	22414	175199	0	114820	67535	12710	629063	1E+06	2	3	6	0
Portsmouth Twp	3619	179	1	1484	73	1	1	0	1	0	0	8	0	10	1	1	0	104	1	2	2	110	2	70198	196923	7858	0	233546	16137	473384	998046	2	2	5	0
Williams Twp	4492	133	1	1703	51	1	1	0	1	2	0	3	0	7	1	4	0	282	0	104	26	416	3	103783	190390	102838	24682	155185	46498	680013	1E+06	3	3	6	0

Name	# Govt. Blgs.	# Police	# Fire Stations	# Schools	# Hospital/Clinics	# HAZMAT	# Airport	Total Ess. Facilities	Ess. Facilities Rank
Auburn	2	1	0	4	0	0	0	7	1
Bangor Twp	7	1	2	7	6	6	0	29	2
Bay City	20	1	4	20	8	9	1	63	3
Beaver Twp	1	0	1	2	0	2	0	6	1
Essexville	2	1	1	5	0	0	0	9	1
Frankenlust Twp	2	1	1	2	0	3	0	9	1
Fraser Twp	3	0	1	0	0	4	0	8	1
Garfield Twp	1	0	1	0	0	0	0	2	1
Gibson Twp	1	0	1	0	0	1	0	3	1
Hampton Twp	2	1	1	5	4	5	0	18	2
Kawkawlin Twp	2	0	1	4	0	6	0	13	1
Merritt Twp	3	0	1	0	0	9	0	13	1
Monitor Twp	5	0	1	5	2	8	0	21	2
Mt Forest Twp	1	0	1	1	0	0	0	3	1
Pinconning	2	1	1	5	3	1	0	13	1
Pinconning Twp	1	0	0	1	0	1	1	4	1
Portsmouth Twp	1	0	1	0	0	8	0	10	1
Williams Twp	1	0	1	2	0	3	0	7	1

Name	Pop. Density Rank	Prop. Density Rank	Ess. Facility Rank	Infra. Rank	Exposure Score
Auburn	2	3	1	1	7
Bangor Twp	2	2	2	3	9
Bay City	3	3	3	2	11
Beaver Twp	1	1	1	3	6
Essexville	3	3	1	1	8
Frankenlust Twp	1	1	1	2	5
Fraser Twp	1	1	1	3	6
Garfield Twp	1	1	1	2	5
Gibson Twp	1	1	1	3	6
Hampton Twp	1	1	2	3	7
Kawkawlin Twp	1	1	1	3	6
Merritt Twp	1	1	1	2	5
Monitor Twp	1	1	2	3	7
Mt Forest Twp	1	1	1	3	6
Pinconning	2	3	1	1	7
Pinconning Twp	1	1	1	3	6
Portsmouth Twp	1	1	1	2	5
Williams Twp	1	1	1	3	6

Name	Towers	Water Plants	Wells	Flood Wtr. Pumps	Oil/Gas Wells	Bridges	# of Infra. Points	Infra. Point Rank	Water Line	Pipe Line	Sewer Line	Fiber Line	Major Utility Line	RR Line	Road Line
Auburn	0	0	1	1	0	4	6	1	13769	85010	36386	24682	0	46498	119633
Bangor Twp	2	2	8	11	101	4	128	2	117268	286932	369672	51860	75581	2805	612098
Bay City	7	1	4	0	1	19	32	1	22431	216821	52273	43909	17419	1436	1113544
Beaver Twp	3	0	409	0	38	14	464	3	58194	0	0	0	64956	0	491540
Essexville	1	1	0	1	0	0	3	1	702	52262	9723	43909	0	4238	114551
Frankenlust Twp	8	0	132	1	2	20	163	2	52868	127217	100932	0	78911	19344	456817
Fraser Twp	4	1	412	0	46	26	489	3	36958	145730	8064	88872	78832	47165	668707
Garfield Twp	1	0	398	0	25	3	427	3	0	0	0	0	49586	0	372416
Gibson Twp	3	0	266	0	83	1	353	3	0	150842	0	0	95654	0	398574
Hampton Twp	5	1	6	12	77	2	103	2	134079	110012	196257	43909	309294	486	590131
Kawkawlin Twp	8	0	283	2	168	28	489	3	139430	229341	61532	88872	67183	10457	660096
Merritt Twp	3	0	84	0	12	10	109	2	41487	97303	0	0	148865	22520	571218
Monitor Twp	3	2	128	1	137	62	333	3	135287	317385	239905	170284	177109	10457	978378
Mt Forest Twp	2	0	326	0	31	6	365	3	0	163439	0	0	95654	0	461861
Pinconning	2	1	0	0	0	2	5	1	15498	0	0	5052	0	13443	68293
Pinconning Twp	4	0	341	0	119	31	495	3	22414	175199	0	114820	67535	12710	629063
Portsmouth Twp	1	0	104	1	2	2	110	2	70198	196923	7858	0	233546	16137	473384
Williams Twp	4	0	282	0	104	26	416	3	103783	190390	102838	24682	155185	46498	680013

Total # of Line (Miles)	Infra. Line Rank	Infra. Rank
325978	1	1
1516216	3	3
1467833	3	2
614690	2	3
225385	1	1
836089	2	2
1074328	2	3
422002	1	2
645070	2	3
1384168	3	3
1256911	3	3
881393	2	2
2028805	3	3
720954	2	3
102286	1	1
1021741	2	3
998046	2	2
1303389	3	3

Name	MCD Pop. 2000	Pop. Density	Pop. Density Rank
Auburn	2011	1895	2
Bangor Twp	15547	1044	2
Bay City	36817	3242	3
Beaver Twp	2806	79	1
Essexville	3766	2708	3
Frankenlust Twp	2530	110	1
Fraser Twp	3375	103	1
Garfield Twp	1775	50	1
Gibson Twp	1245	35	1
Hampton Twp	9902	352	1
Kawkawlin Twp	5104	153	1
Merritt Twp	1510	48	1
Monitor Twp	10037	272	1
Mt Forest Twp	1405	39	1
Pinconning	1386	1610	2
Pinconning Twp	2608	71	1
Portsmouth Twp	3619	179	1
Williams Twp	4492	133	1

Name	House Units	Prop. Density	Prop. Density Rank
Auburn	867	817	3
Bangor Twp	6563	441	2
Bay City	16259	1432	3
Beaver Twp	998	28	1
Essexville	1530	1100	3
Frankenlust Twp	1203	52	1
Fraser Twp	1374	42	1
Garfield Twp	627	18	1
Gibson Twp	431	12	1
Hampton Twp	4341	154	1
Kawkawlin Twp	2021	60	1
Merritt Twp	554	18	1
Monitor Twp	4111	111	1
Mt Forest Twp	550	15	1
Pinconning	645	749	3
Pinconning Twp	1055	29	1
Portsmouth Twp	1484	73	1
Williams Twp	1703	51	1

Average Annual Risk Table: By Hazard

Hazard Type	Dates	Range	Frequency	Total Losses	Probability	Avg. Consequences	Avg. Annual Risk	Rank
Drought	1930-2010	80	7	$8,823,529	0.09	$1,260,504	$110,294.11	4
Earthquake	1584-2009	425	0	$0	0.00	$0	$0.00	10
Extreme Temperature	1936-2010	74	19	$500,000	0.26	$26,316	$6,756.76	7
Flooding	1947-2010	73	21	$102,275,000	0.29	$4,870,238	$1,401,027.40	1
Hail	1960-2010	50	51	$204,254	1.02	$4,005	$4,085.08	8
Severe Storm	1960-2010	50	127	$38,737,800	2.54	$305,022	$774,756.00	3
Winter Storm	1967-2010	43	70	$39,194,615	1.63	$559,923	$911,502.67	2
Tornado	1953-2010	57	20	$2,897,500	0.35	$144,875	$50,833.33	5
Wildfire	1881-2010	129	1	$2,000,000	0.01	$2,000,000	$15,503.88	6
Wind Driven Ice Floes	2009	1	1	$0	0.00	$0	$0.00	9

Geographic Weighted Distribution Average Annual Risk Table: By Jurisdiction

Jurisdiction	Jurisdiction % Area	Drought Avg. Ann Risk	Geographic Weighted Distribution	Extreme Temperature Avg. Ann Risk	Geographic Weighted Distribution	Flooding Avg. Ann Risk	Geographic Weighted Distribution	Hail Avg. Ann Risk	Geographic Weighted Distribution	Severe Storm Avg. Ann Risk	Geographic Weighted Distribution	Winter Storm Avg. Ann Risk	Geographic Weighted Distribution	Tornado Avg. Ann Risk	Geographic Weighted Distribution	Wildfire Avg. Ann Risk	Geographic Weighted Distribution
Auburn	0.24	$110,294	$265	$6,757	$16	$1,401,027	$3,362	$4,085	$10	$774,756	$1,859	$911,503	$2,188	$50,833	$122	$15,504	$37
Bangor Twp	3.32	$110,294	$3,662	$6,757	$224	$1,401,027	$46,514	$4,085	$136	$774,756	$25,722	$911,503	$30,262	$50,833	$1,688	$15,504	$515
Bay City	2.53	$110,294	$2,790	$6,757	$171	$1,401,027	$35,446	$4,085	$103	$774,756	$19,601	$911,503	$23,061	$50,833	$1,286	$15,504	$392
Beaver Twp	7.88	$110,294	$8,691	$6,757	$532	$1,401,027	$110,401	$4,085	$322	$774,756	$61,051	$911,503	$71,826	$50,833	$4,006	$15,504	$1,222
Essexville	0.31	$110,294	$342	$6,757	$21	$1,401,027	$4,343	$4,085	$13	$774,756	$2,402	$911,503	$2,826	$50,833	$158	$15,504	$48
Frankenlust Twp	5.13	$110,294	$5,658	$6,757	$347	$1,401,027	$71,873	$4,085	$210	$774,756	$39,745	$911,503	$46,760	$50,833	$2,608	$15,504	$795
Fraser Twp	7.32	$110,294	$8,074	$6,757	$495	$1,401,027	$102,555	$4,085	$299	$774,756	$56,712	$911,503	$66,722	$50,833	$3,721	$15,504	$1,135
Garfield Twp	7.95	$110,294	$8,768	$6,757	$537	$1,401,027	$111,382	$4,085	$325	$774,756	$61,593	$911,503	$72,464	$50,833	$4,041	$15,504	$1,233
Gibson Twp	7.93	$110,294	$8,746	$6,757	$536	$1,401,027	$111,101	$4,085	$324	$774,756	$61,438	$911,503	$72,282	$50,833	$4,031	$15,504	$1,229
Hampton Twp	6.27	$110,294	$6,915	$6,757	$424	$1,401,027	$87,844	$4,085	$256	$774,756	$48,577	$911,503	$57,151	$50,833	$3,187	$15,504	$972
Kawkawlin Twp	7.45	$110,294	$8,217	$6,757	$503	$1,401,027	$104,377	$4,085	$304	$774,756	$57,719	$911,503	$67,907	$50,833	$3,787	$15,504	$1,155
Merritt Twp	7.05	$110,294	$7,776	$6,757	$476	$1,401,027	$98,772	$4,085	$288	$774,756	$54,620	$911,503	$64,261	$50,833	$3,584	$15,504	$1,093
Monitor Twp	8.24	$110,294	$9,088	$6,757	$557	$1,401,027	$115,445	$4,085	$337	$774,756	$63,840	$911,503	$75,108	$50,833	$4,189	$15,504	$1,278
Mt Forest Twp	8.00	$110,294	$8,824	$6,757	$541	$1,401,027	$112,082	$4,085	$327	$774,756	$61,980	$911,503	$72,920	$50,833	$4,067	$15,504	$1,240
Pinconning	0.19	$110,294	$210	$6,757	$13	$1,401,027	$2,662	$4,085	$8	$774,756	$1,472	$911,503	$1,732	$50,833	$97	$15,504	$29
Pinconning Twp	8.20	$110,294	$9,044	$6,757	$554	$1,401,027	$114,884	$4,085	$335	$774,756	$63,530	$911,503	$74,743	$50,833	$4,168	$15,504	$1,271
Portsmouth Twp	4.50	$110,294	$4,963	$6,757	$304	$1,401,027	$63,046	$4,085	$184	$774,756	$34,864	$911,503	$41,018	$50,833	$2,288	$15,504	$698
Williams Twp	7.50	$110,294	$8,272	$6,757	$507	$1,401,027	$105,077	$4,085	$306	$774,756	$58,107	$911,503	$68,363	$50,833	$3,813	$15,504	$1,163

Severe Storm Events

Date	Location	Magnitude (mph)	Total Cost of Damage	Deaths/ Injuries	Description	Source
September 1, 1960	Bay County	85				NCDC
October 10, 1962	Bay County					NCDC
April 20, 1966	Bay County					NCDC
July 12, 1966	Bay County					NCDC
June 13, 1967	Bay County	50				NCDC
April 23, 1968	Bay County					NCDC
June 12, 1969	Bay County					NCDC
December 1, 1972	Bay County				Description Below	MHMP
April 12, 1973	Bay County				Description Below	MHMP
May 14, 1974	Bay County					NCDC
April 18, 1975	Bay County					NCDC
July 10, 1975	Bay County					NCDC
August 3, 1982	Bay County					NCDC
July 21, 1983	Bay County					NCDC
June 12, 1984	Bay County					NCDC
September 8, 1985	Bay County					NCDC
July 20, 1987	Bay County	55				NCDC
August 3, 1988	Bay County					NCDC
August 14, 1988	Bay County					NCDC
May 25, 1989	Bay County					NCDC
September 14, 1990	Bay County					NCDC
March 27, 1991	Bay County					NCDC
May 13, 1991	Bay County					NCDC
May 29, 1991	Bay County					NCDC
July 7, 1991	Bay County					NCDC
June 17, 1992	Bay County			5 injuries		NCDC
August 23, 1993	Bay City, Bay County				Description Below	NCDC
August 27, 1993	Pinconning		$50,000		Description Below	NCDC
June 28, 1994	Bay City, Bay County				Description Below	NCDC
July 6, 1994	Bay City, Bay County				Description Below	NCDC
July 13-15, 1995	Statewide					MHMP
August 13, 1995	Bay County					NCDC
March 25, 1996	Bay County	50	$65,000		Description Below	NCDC
June 21, 1996	4 Miles SW of Bay City	75	$400,000			NCDC
August 7, 1996	Pinconning	50				NCDC
August 22, 1996	Bentley, Bay County	50				NCDC
October 30, 1996	SE Michigan	60	$90,000		Description Below	NCDC
February 27, 1997	SE Michigan	55	$20,000		Description	NCDC

Date	Location	Magnitude (mph)	Total Cost of Damage	Deaths/ Injuries	Description	Source
					Below	
April 6, 1997	SE Michigan	70	$1,200,000	1 injury	Description Below	NCDC
July 2, 1997	10 Miles SE of Bay City	60				NCDC
July 14, 1997	Auburn, Bay County	50			Description Below	NCDC
April 1, 1998	Bay City, Bay County	52			Description Below	NCDC
April 9, 1998	Bay County	45	$4,000		Description Below	NCDC
May 29, 1998	5 miles SE of Bay City, Bay County	52			Description Below	NCDC
May 31, 1998	3 miles N of Auburn, Bay County	70	$200,000		Description Below	NCDC
May 31, 1998	Bentley, Bay County	65	$1,050,000		Description Below	NCDC
June 2, 1998	Bay County	35			Description Below	NCDC
July 14, 1998	1 mile NE of Bay City	51			Description Below	NCDC
November 10, 1998	SE Michigan	61	$1,100,000		Description Below	NCDC
May 6, 1999	SE Michigan		$92,000		Description Below	NCDC
July 24, 1999	Bay City, Bay County	55	$90,000		Description Below	NCDC
May 9, 2000	Kawkawlin, Bay County	52	$5,000		Description Below	NCDC
August 9, 2000	Bay City, Bay County	52	$7,000		Description Below	NCDC
June 9, 2001	6 Miles W of Pinconning	50	$2,000		Description Below	NCDC
August 19, 2001	2 Miles S of Bay City	50			Description Below	NCDC
September 7, 2001	Bay City, Bay County	55			Description Below	NCDC
November 25, 2001	2 miles NW of Linwood	55	$5,000		Description Below	NCDC
February 1, 2002	SE Michigan	40	$30,000	1 injury	Description Below	NCDC
March 9, 2002	SE Michigan	61	$780,000	2 injuries	Description Below	NCDC
April 18, 2002	2 Miles SW of Bay City	52			Description Below	NCDC
August 13, 2002	Essexville, Bay County	50			Description Below	NCDC

Date	Location	Magnitude (mph)	Total Cost of Damage	Deaths/ Injuries	Description	Source
September 19, 2002	5 Miles SW of Bay City	52	$25,000		Description Below	NCDC
January 10, 2003	SE Michigan				Description Below	NCDC
June 8, 2003	Bay City, Bay County	50			Description Below	NCDC
June 28, 2003	Bay City, Bay County	55	$1,000		Description Below	NCDC
July 6, 2003	Bay City, Bay County	56	$6,000		Description Below	NCDC
November 12, 2003	SE Michigan	76	$21,000,000		Description Below	NCDC
April 19, 2004	SE Michigan	63		1 injury	Description Below	NCDC
May 17, 2004	Kawkawlin, Bay County	55			Description Below	NCDC
June 13, 2004	Bay City, Bay County	52			Description Below	NCDC
July 13, 2004	1 Mile S of Linwood	52			Description Below	NCDC
August 2, 2004	4 Miles W of Bay City	54			Description Below	NCDC
October 30, 2004	SE Michigan	54	$3,500,000		Description Below	NCDC
June 5, 2005	Bay City, Bay County	56			Description Below	NCDC
June 14, 2005	3 Miles E of Auburn	54			Description Below	NCDC
June 30, 2005	Bay City, Bay County				Description Below	Bay City Times Archives
July 24, 2005	Bay City, Bay County	55	$20,000		Description Below	NCDC
November 15, 2005	SE Michigan	48	$7,200,000		Description Below	NCDC
March 13, 2006	SE Michigan	52		1 fatality, 2 injuries	Description Below	NCDC
May 30, 2006	3 Miles NW of Auburn	50	$800		Description Below	NCDC
July 17, 2006	Bay City, Bay County	55			Description Below	NCDC
October 4, 2006	Kawkawlin, Bay County	52			Description Below	NCDC
February 3, 2007	SE Michigan		$25,000		Description Below	NCDC
May 15, 2007	Bay City, Bay County	52	$2,000		Description Below	NCDC
May 15, 2007	1 Mile N of Essexville	70	$1,500,000		Description Below	NCDC

Date	Location	Magnitude (mph)	Total Cost of Damage	Deaths/ Injuries	Description	Source
June 27, 2007	6 Miles SW of Bay City	54			Description Below	NCDC
July 9, 2007	3 Miles NE of Bentley	58			Description Below	NCDC
August 22, 2007	1 Mile NE of Bay City	53	$8,000		Description Below	NCDC
August 23, 2007	Bay City, Bay County	56			Description Below	NCDC
June 6, 2008	2 Miles NE of Duel	54	$2,000		Description Below	NCDC
June 15, 2008	1 Mile SW of Bay City	56			Description Below	NCDC
July 22, 2008	3 Miles W of Crump	52	$8,000		Description Below	NCDC
December 28, 2008	SE Michigan	56			Description Below	NCDC
January 14, 2009	SE Michigan				Description Below	NCDC

Appendix H

Mitigation Activities

JURISDICTIONAL MITIGATION ACTIVITIES

Mitigation goals and actions for each community are summarized in the following tables. Actions identified by each community will be reviewed annually for purposes of tracking progress and or revising implementation approaches.

The following table lists mitigation actions for each jurisdiction. These actions would mitigate the associated hazard and support the corresponding goals of the community. Below are descriptions and definitions of each category within the following tables.

- **Item Number:** Most of the actions identified correspond to a specific area, thus this number corresponds to the numbers on each jurisdiction's map.
- **Hazard:** The primary hazard(s) addressed by each mitigation activity.
- **Type of Activity or Project:** This category is a description of the identified project.
- **Responsible Agency:** The lead implementer or contact is the person, department, or agency responsible for each action listed.
- **Implementation Timeline:** The proposed schedule or time frame for completion of each action or project.
- **Funding Source:** Potential funding source of the identified action item.
- **Priority:** The priority rankings for each activity.
- **Activity Categorization:** The type of goal which the project was designed to achieve.

    1. **Preventative Activities**. Reduce risks through regulations including building codes, development outside of hazardous areas, and local planning or capital improvement projects.
    2. **Property Protection**. Reduce exposure to hazards through building or parcel specific activities such as flood proofing, structure acquisition, or retrofitting.
    3. **Emergency Services.** Reduce impacts through response and recovery activities that are implemented during a disaster.
    4. **Structural Projects.** Minimize impacts through projects, such as detention basins, tornado shelters, tornado sirens, etc.
    5. **Public Information.** Assist residents to prepare for risks and protective measures to better protect themselves and their property.

- **Benefit-Cost:** A qualitative description of the expected benefits and costs of implementation of the project. The benefits and costs were defined as described in Section 5.

Table I-1. City of Auburn Action Plan

ITEM NUMBER	HAZARD	TYPE OF ACTIVITY OR PROJECT	RESPONSIBLE AGENCY	IMPLEMENTATION TIMELINE	FUNDING SOURCE	PRIORITY	ACTIVITY CATEGORIZATION	BENEFIT/ COST
1	All Hazards	Expand Emergency Siren System County-wide	Central Dispatch / Emergency Mgt/ Local Jurisdiction	5 years	Hazard Mitigation Grant Program	Low	Emergency Services	Medium-High/Medium
2	Flooding	Drainage Structure, Improvements and Maintenance	Bay County Drainage Commission	5 Years	General Fung	High	Property Protection	High/High

Table I-2. Township of Bangor Action Plan

ITEM NUMBER	HAZARD	TYPE OF ACTIVITY OR PROJECT	RESPONSIBLE AGENCY	IMPLEMENTATION TIMELINE	FUNDING SOURCE	PRIORITY	ACTIVITY CATEGORIZATION	BENEFIT/ COST
1	Flooding	Dredging of Kawkawlin River to move flood waters from area during major rain events	Bangor Twp Supervisor	ASAP	Hazard Mitigation Grant Program	High	Property Protection	High/High
2	Flooding	Increasing the drainage of the Kawkawlin River where drainage is inadequate or non-existent	Bangor Twp Supervisor	5 yrs	Hazard Mitigation Grant Program	High	Property Protection	Medium/Medium
3	Flooding	Installing pump stations near the Kawkawlin river to allow more water to get to the river faster	Bangor Twp Supervisor	5 yrs	Hazard Mitigation Grant Program	High	Structural Projects	Medium/Medium
4	Flooding	Improver road grades in areas that water is not allowed to drain properly into the drains	Bangor Twp Supervisor	7 yrs	Hazard Mitigation Grant Program	High	Structural Projects	Medium/Medium
5	All Hazards	Expand Emergency Siren System County-wide	Central Dispatch / Emergency Mgt/ Local Jurisdiction	5 years	Hazard Mitigation Grant Program	Low	Emergency Services	Medium-High/Medium
6	Wild Fires	Develop an evacuation route for Killarney Beach Rd residents and create a 30+ ft. green space West of Killarney Beach Road that will act as a fire break.	Bangor Twp Supervisor	1 year	Hazard Mitigation Grant Program	High	Structural Projects	High/Medium

Table I-3. City of Bay City Action Plan

ITEM NUMBER	HAZARD	TYPE OF ACTIVITY OR PROJECT	RESPONSIBLE AGENCY	IMPLEMENTATION TIMELINE	FUNDING SOURCE	PRIORITY	ACTIVITY CATEGORIZATION	BENEFIT/ COST
1	Flood	James Clements Flood Protection Dike stabilization and improvement Ditch drainage and pump station improvements	City of Bay City	5 Years	FAA/MDOT	Medium	Structural Projects	High/High
2	All Hazards	Purchase and install emergency warning sirens	City of Bay City	3 Years	FEMA	Low	Structural Projects	High/Medium
3	Severe Weather, Winds, Tornados, Severe Winter Weather	Tree management	City of Bay City	5-7 Years	Hazard Mitigation Grant Program and Other	High	Property Protection	High/Medium
4	Flooding	Liberty and Independence Bridges Erosion Protection	City of Bay City	3 Years	FHWA/MDOT/ Local	Very High	Property Protection	High/High

Table I-5. Township of Beaver Action Plan

ITEM NUMBER	HAZARD	TYPE OF ACTIVITY OR PROJECT	RESPONSIBLE AGENCY	IMPLEMENTATION TIMELINE	FUNDING SOURCE	PRIORITY	ACTIVITY CATEGORIZATION	BENEFIT/ COST
1	High Winds	Bury Power Lines	County Planning ITC	5 Years	To Be Determined	High	Property Protection	High/Medium
2	Flooding	Monitoring Gages	Central Dispatch / Emergency Mgt/ Local Jurisdiction	5 Years	Local Funding	High	Property Protection	Medium/Medium
3	All Hazards	Expand Emergency Siren System County-wide	Central Dispatch / Emergency Mgt/ Local Jurisdiction	5 years	Hazard Mitigation Grant Program	High	Emergency Services	Medium-High/Medium

Table I-6. City of Essexville Action Plan

ITEM NUMBER	HAZARD	TYPE OF ACTIVITY OR PROJECT	RESPONSIBLE AGENCY	IMPLEMENTATION TIMELINE	FUNDING SOURCE	PRIORITY	ACTIVITY CATEGORIZATION	BENEFIT/ COST
1	Flooding	Establish sea wall along the Saginaw River	DPW	5 Years	Grants	High	Structural Projects	Medium/High
2	Severe Weather, Winds, Tornados, Severe Winter Weather	Bury utility lines	DPW	15 Years	Grants	High	Structural Projects	High/High
3	Severe Weather, Winds, Tornados, Severe Winter Weather	Tree management: Remove dead trees, trim trees, and plant new trees	DPW	5 Years	Grants	High	Emergency Services	High/Medium
	All Hazards	Expand Emergency Siren System County-wide	Central Dispatch / Emergency Mgt/ Local Jurisdiction	5 years	Hazard Mitigation Grant Program	High	Emergency Services	Medium-High/Medium

Table I-7. Township of Frankenlust Action Plan

ITEM NUMBER	HAZARD	TYPE OF ACTIVITY OR PROJECT	RESPONSIBLE AGENCY	IMPLEMENTATION TIMELINE	FUNDING SOURCE	PRIORITY	ACTIVITY CATEGORIZATION	BENEFIT/ COST
1	Flooding	Remove contaminants from river dredging site spoils return to AG.	Local Jurisdiction	10 years	Hazard Mitigation Grant Program	Low	Preventative Activities	High/High
2	All Hazards	Shelters for 2 schools in Township	Local Jurisdiction	5 years	Hazard Mitigation Grant Program	Medium	Structural Projects	High/Medium
3	Flooding	Purchase homes in the 100 year floodplain and convert the space to a park or green space to reduce flood impacts.	Local Jurisdiction	10 years	Hazard Mitigation Grant Program	High	Property Protection	High/High
	All Hazards	Expand Emergency Siren System County-wide	Central Dispatch / Emergency Mgt/ Local Jurisdiction	5 years	Hazard Mitigation Grant Program	High	Emergency Services	Medium-High/Medium

Table I-8. Township of Fraser Action Plan

ITEM NUMBER	HAZARD	TYPE OF ACTIVITY OR PROJECT	RESPONSIBLE AGENCY	IMPLEMENTATION TIMELINE	FUNDING SOURCE	PRIORITY	ACTIVITY CATEGORIZATION	BENEFIT/ COST
1	Wind Driven Floes	Build barrier or purchase homes along Saginaw Bay	Supervisor Fraser Township	10 Years	Hazard Mitigation Grant Programs and General Funds	Medium	Property Protection	Low/High
2	Flooding	Clean Tebo Drain and enlarge Lake State Railroad Bridge	Supervisor Fraser Township	5 Years	Hazard Mitigation Grant Programs and General Funds	High	Property Protection	Low/Medium
3	All Hazards	Expand Emergency Siren System County-wide	Central Dispatch / Emergency Mgt/ Local Jurisdiction	5 years	Hazard Mitigation Grant Program	High	Emergency Services	Medium-High/Medium
4	Flooding	Vegetation removal of invasive species impacting drainage	County Planning	5 Years	Hazard Mitigation Grant Programs and General Funds	High	Other	Medium/Medium

Table I-10. Township of Garfield Action Plan

ITEM NUMBER	HAZARD	TYPE OF ACTIVITY OR PROJECT	RESPONSIBLE AGENCY	IMPLEMENTATION TIMELINE	FUNDING SOURCE	PRIORITY	ACTIVITY CATEGORIZATION	BENEFIT/ COST
1	Flooding	Dredge River/Flood Walls	Drainage Commission	5 Years	Bay County Drain Commission	Medium	Structural Projects	Medium
2	High Winds	Bury Power Lines	ITC	To Be Determined	Consumers	High	Structural	Medium
3	All Hazards	Expand Emergency Siren System County-wide	Central Dispatch / Emergency Mgt/ Local Jurisdiction	5 years	Hazard Mitigation Grant Program	Low	Emergency Services	Medium-High/Medium

Table I-11. Township of Gibson Action Plan

ITEM NUMBER	HAZARD	TYPE OF ACTIVITY OR PROJECT	RESPONSIBLE AGENCY	IMPLEMENTATION TIMELINE	FUNDING SOURCE	PRIORITY	ACTIVITY CATEGORIZATION	BENEFIT/ COST
1	Wildfire	Present Firewise Program to public to educate them on ways to protect their property from wildfire	Fire Department	2 Years	Fire Department Budget	High	Public Information	Medium/Low
2	Hail	Promote awareness of crop insurance programs and encourage participation	County Extension Service	1 Year	County Extension Budget	High	Public Information	Medium/Low
3	Severe Storm Winter Storm Tornado	Purchase back-up generator, folding cots, blankets, food and medical supplies to facilitate Township Hall as an Emergency Shelter	Fire Department Township Board	5 Years	Grant Funding	High	Emergency Services	Medium/Low
4	All Hazards	Expand Emergency Siren System County-wide	Central Dispatch / Emergency Mgt/ Local Jurisdiction	5 years	Hazard Mitigation Grant Program	High	Emergency Services	Medium-High/Medium

Table I-13. Township of Hampton Action Plan

ITEM NUMBER	HAZARD	TYPE OF ACTIVITY OR PROJECT	RESPONSIBLE AGENCY	IMPLEMENTATION TIMELINE	FUNDING SOURCE	PRIORITY	ACTIVITY CATEGORIZATION	BENEFIT/ COST
1	Flooding	Repair pumps at flood gate locations	Twp. DPW Director	1 Year	Hazard Mitigation Grant program	High	Property Protection	Low/Low
2	Flooding	Increase height of dike to remove twp. 1% Flood plain	Hampton Township Supervisor	2 Years	Hazard Mitigation grant program	High	Property Protection	Medium/Medium
3	Severe storms	Cleaning of drainage Ditches	Hampton Township Supervisor	5 Years	Hazard mitigation grant program	Very High	Property Protection	High/High
4	All Hazards	Install emergency warning sirens In heavy populated areas of the twp.	Hampton Township Supervisor	1 Year	Hazard Mitigation grant program	Low	Preventative Activities	High/Low
5	Tornados	Install emergency generator at Twp. Hall emergency shelter	Hampton Township Supervisor	1 Year	Hazard Mitigation grant program	High	Emergency Services	Medium/Low
6	Severe storms	Retrofitting sanitary sewer system to remove storm water	Hampton Township Supervisor	5 Years	Hazard Mitigation grant program	Very High	Property Protection	High/High
7	Tornados	Build tornado shelters At both Manufacture Mobile Home community and twp. RV campground	Hampton Township Supervisor	1 Year	Hazard Mitigation grant program	Very High	Preventative Activities	High/Low
8	Flood	Education of public for flood warnings	Hampton Twp Fire	5 Years	General Funds	High	Public Information	Medium/Medium

Table I-14. Township Kawkawlin Action Plan

ITEM NUMBER	HAZARD	TYPE OF ACTIVITY OR PROJECT	RESPONSIBLE AGENCY	IMPLEMENTATION TIMELINE	FUNDING SOURCE	PRIORITY	ACTIVITY CATEGORIZATION	BENEFIT/ COST
1	Ice Floes	Break walls and other structure in the Bay	Township Planning Commission	5 yrs	Hazard Mitigation Grant Program & General Funds	High	Structural Projects	Medium/Medium
2	Severe Storms	Purchase tornado sirens and build tornado shelters	Township Board	5 yrs	Hazard Mitigation Grant Program & General Funds	Medium	Structural Projects	High/Medium
3	Flooding	Dredging and cleaning out Kawkawlin River	Township Board	10 yrs	Hazard Mitigation Grant Program & General Funds	Very High	Structural Projects	High/High
4	Severe Storms	Purchase back-up generator, folding cots, blankets, food and medical supplies to facilitate Township Hall as an Emergency Shelter	Township Board	5 yrs	Hazard Mitigation Grant Program & General Funds	Medium	Structural Projects	Medium/Medium
5	Natural Disaster	Publish information on Website	Township Board	1 yr	Hazard Mitigation Grant Program & General Funds	Medium	Public Information	Medium/Low
6	All Hazards	Expand Emergency Siren System County-wide	Central Dispatch / Emergency Mgt/ Local Jurisdiction	5 years	Hazard Mitigation Grant Program	Low	Emergency Services	Medium-High/Medium
7	Wild Fires	Develop an evacuation route for Brissette Beach and Linwood Beach Rd residents and create a 30+ ft. green space West of Brissette Beach and Linwood Beach Roads that will act as a fire break.	Township Board	1 year	Hazard Mitigation Grant Program	High	Structural Projects	High/Medium

Table I-12. Township of Merritt Action Plan

ITEM NUMBER	HAZARD	TYPE OF ACTIVITY OR PROJECT	RESPONSIBLE AGENCY	IMPLEMENTATION TIMELINE	FUNDING SOURCE	PRIORITY	ACTIVITY CATEGORIZATION	BENEFIT/ COST
1	All Hazards	Expand Emergency Siren System County-wide	Central Dispatch / Emergency Mgt/ Local Jurisdiction	5 years	Hazard Mitigation Grant Program	High	Emergency Services	Medium-High/Medium

Table I-14. Township of Monitor Action Plan

ITEM NUMBER	HAZARD	TYPE OF ACTIVITY OR PROJECT	RESPONSIBLE AGENCY	IMPLEMENTATION TIMELINE	FUNDING SOURCE	PRIORITY	ACTIVITY CATEGORIZATION	BENEFIT/ COST
1	Flooding	Funding for drainage structure to minimize road flooding	Bay Co. Drain Commission	5 Years	Hazard Mitigation Grant	Very High	Property Protection	Medium/High
2	All Hazards	Build Tornado Shelters in our trailer parks	Monitor Township Board	5 Years	Hazard Mitigation Grant	Very High	Structural Project	Medium/Medium
3	All Hazards	Install Warning Systems in Township	County Planning Commission	5 Years	Hazard Mitigation Grant	Medium	Structural Project	Medium/Medium
4	All Hazards	Educational Programs to assist public with Flooding and Severe weather warnings	Monitor Township Board	3 Years	Hazard Mitigation Grant	Medium	Public Information	Medium/Medium

Table I-15. Township of Mount Forest Action Plan

ITEM NUMBER	HAZARD	TYPE OF ACTIVITY OR PROJECT	RESPONSIBLE AGENCY	IMPLEMENTATION TIMELINE	FUNDING SOURCE	PRIORITY	ACTIVITY CATEGORIZATION	BENEFIT/ COST
1	All Hazards	Expand Emergency Siren System County-wide	Central Dispatch / Emergency Mgt/ Local Jurisdiction	5 years	Hazard Mitigation Grant Program	High	Emergency Services	Medium-High/Medium

Table I-16. City of Pinconning Action Plan

ITEM NUMBER	HAZARD	TYPE OF ACTIVITY OR PROJECT	RESPONSIBLE AGENCY	IMPLEMENTATION TIMELINE	FUNDING SOURCE	PRIORITY	ACTIVITY CATEGORIZATION	BENEFIT/ COST
1	All Hazards	Expand Emergency Siren System County-wide	Central Dispatch / Emergency Mgt/ Local Jurisdiction	5 years	Hazard Mitigation Grant Program	High	Emergency Services	Medium-High/Medium
2	All Hazards	Tree Management, Remove dead trees, trim trees and plant new trees	City of Pinconning	5-7 years	Hazard Mitigation Grant Program	Medium	Property Protection	High-Medium

Table I-17. Township of Pinconning Action Plan

ITEM NUMBER	HAZARD	TYPE OF ACTIVITY OR PROJECT	RESPONSIBLE AGENCY	IMPLEMENTATION TIMELINE	FUNDING SOURCE	PRIORITY	ACTIVITY CATEGORIZATION	BENEFIT/ COST
1	Wind Driven Ice Floes	Erect sea walls and barriers to reduce ice floes along the Saginaw Bay	Township Office	5 Years	FEMA	High	Structural Projects/Property Protection	High/High
2	All Hazards	Warning system for storms and Emergency Operations Plan	Township Board	5 Years	FEMA	High	Property Protection/Emergency Activities	High/High
3	All Hazards	Educate the public on likely Hazards in our community	Township Board	1 Year	FEMA	High	Public Information	High/High
4	Flooding	Improve drainage via the County Drain system to the bay	Township Board	1 Year	County Drains Township	High	Structural Projects/Property Protections	High/High
5	Flooding	Control vegetation on shoreline of the Saginaw Bay	Township Board	As needed	DNR	High	Preventative	Low/Low

Table I-18. Township of Portsmouth Action Plan

ITEM NUMBER	HAZARD	TYPE OF ACTIVITY OR PROJECT	RESPONSIBLE AGENCY	IMPLEMENTATION TIMELINE	FUNDING SOURCE	PRIORITY	ACTIVITY CATEGORIZATION	BENEFIT/ COST
1	Flooding	Reinforce dikes along southern end of township	Central Dispatch / Emergency Mgt/ Local Jurisdiction	1-3 Years	Hazard Mitigation Grant Program	High	Structural Projects	Medium/Medium
2	All Hazards	Expand Emergency Siren System County-wide	Central Dispatch / Emergency Mgt/ Local Jurisdiction	5 years	Hazard Mitigation Grant Program	Low	Emergency Services	Medium-High/Medium
3	All Hazards	Shelter for Riverview Trailer Park	Central Dispatch / Emergency Mgt/ Local Jurisdiction	1-3 Years	Hazard Mitigation Grant Program	High	Structural Projects	Medium/Medium

Table I-19. Township of Williams Action Plan

ITEM NUMBER	HAZARD	TYPE OF ACTIVITY OR PROJECT	RESPONSIBLE AGENCY	IMPLEMENTATION TIMELINE	FUNDING SOURCE	PRIORITY	ACTIVITY CATEGORIZATION	BENEFIT/ COST
1	All Hazards	Siren System for Severe Weather	Planning Departments	3 Years	Hazard Mitigation Grant Program and General Funds	Very High-High	Structural Projects	Medium/Medium
2	Tornado	Install Community Shelters in Schools and Manufactured Housing Complexes	Planning Departments	6 Years	Hazard Mitigation Grant Program and General Funds	High-Medium	Structural Projects	Medium/Medium
3	Severe Storms/Severe Winter Storms/Tornados	Tree trimming near power lines	Planning Departments	5 Years	Hazard Mitigation Grant Program and General Funds	Very High-High	Emergency Projects	Medium/Medium
4	All Hazards	Email/Text/Phone call Emergency Notification System	Bay County Emergency Management	2 Years	Hazard Mitigation Grant Program and General Funds	Medium	Structural Projects	Medium/Medium
5	All Hazards	Expansion of fire ambulance sub-station so that it can be used as a severe weather stations	Fire Department	3 Years	Hazard Mitigation Grant Program and General Funds	Very High-High	Structural Projects	Medium/Medium

Table I-20. Bay County

ITEM NUMBER	HAZARD	TYPE OF ACTIVITY OR PROJECT	RESPONSIBLE AGENCY	IMPLEMENTATION TIMELINE	FUNDING SOURCE	PRIORITY	ACTIVITY CATEGORIZATION	BENEFIT/ COST
1	All Hazards	Siren System for Severe Weather	Bay County Emergency Management	5 Years	Grant Funding	Medium	Structural Projects	Medium/Medium
2	All Hazards	Continued Education Regarding Hazard Mitigation	Bay County Emergency Management	Ongoing	Local	Medium	Preventative	Medium/Medium
3	All Hazards	Tree Trimming Near Infrastructure	Bay County Emergency Management	Ongoing	Local	Medium	Preventative Projects	Medium/Medium

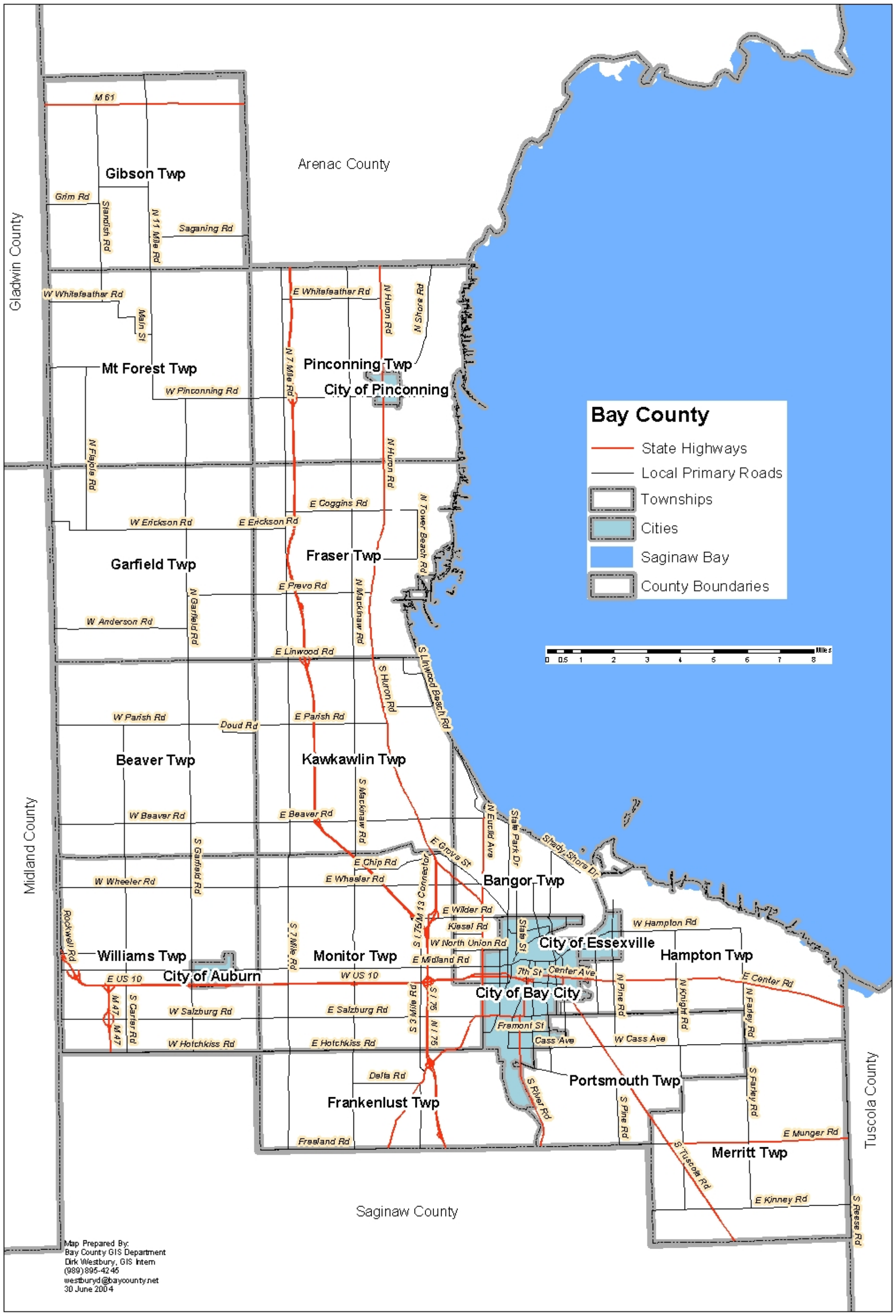
Table I-21. All Jurisdictions

ITEM NUMBER	HAZARD	TYPE OF ACTIVITY OR PROJECT	RESPONSIBLE AGENCY	IMPLEMENTATION TIMELINE	FUNDING SOURCE	PRIORITY	ACTIVITY CATEGORIZATION	BENEFIT/ COST
1	Flooding	Participating jurisdictions in NFIP-Continued compliance with NFIP	Local Floodplain Manager	Ongoing	Local	High	Preventative Projects	High/Low
2	Flooding	Adopt and continue to implement floodplain ordinances	Local Floodplain Manager	Ongoing	Local	High	Preventative Projects	High/Low
3	Flooding	Educate the public regarding the benefits of the NFIP	Local Floodplain Manager	Ongoing	Local	High	Preventative Projects	High/Low
4	All Hazards	Updating local plans, codes and ordinances consistent with hazard mitigation goals and to reduce impact of hazards on new and existing development	Local Governments	Ongoing	Local	High	Preventative	High/Low

Appendix I

Development Trends

Bay County Map: Townships and Cities



Source: Bay County Website. http://www.baycounty-mi.gov

Community Profile

The Hazard Mitigation Plan describes the physical and social factors that shape Bay County, and that may affect the County's vulnerability to natural hazards. The following profile was developed by using the best available information derived primarily from the U.S. Census, Bay County staff, and each component jurisdiction.

Below is a snapshot of Bay County facts in comparison to Michigan. This snapshot was obtained from the Bay County Profile, created by Michigan State University Extension and Community Development Area of Expertise Term from 2006.

Table 1
Bay County Demographics

Quick Facts	Bay County	Michigan
Land Area 2000 (square miles)	444	56,804
Population	109,029	10,120,860
Housing Units, 2004	47,617	4,433,482
Households, 2000	43,930	3,785,661
Median Household Income, 2003	$39,151	$46,291
Retail Sales, 2002 ($1000)	1,280,626	109,350,139
Median Age, 2000	38.4	35.5

Source: http://www.baycounty-mi.gov/Docs/MSUE/BayCountyProfile.pdf

Social Factors

Political Jurisdictions and Planning Areas

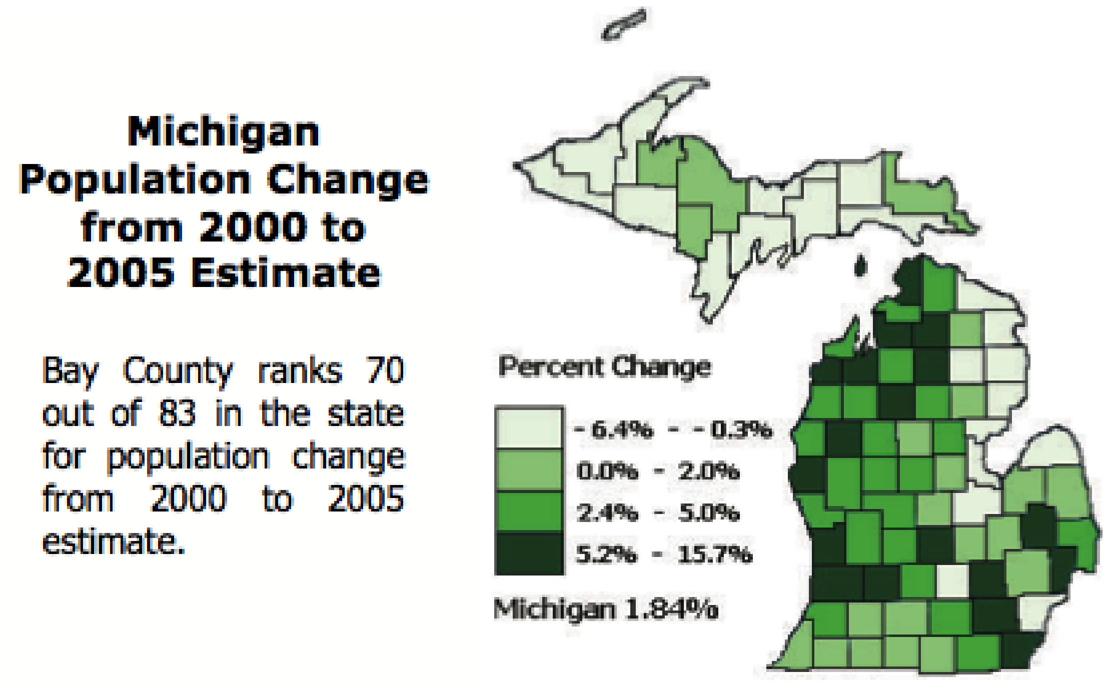
Bay County contains 18 units of local government: fourteen townships and four cities. Each of these jurisdictions has local decision-making authority for governmental functions such as land use planning, zoning, building codes, and other areas that can have a major bearing on hazard mitigation efforts.

The following descriptions of social and economic characteristics have been created by utilizing the best available and accessible sources, such as the U.S. Census Bureau, the Department of Labor Statistics, and the Bay County website and staff.

Population Characteristics

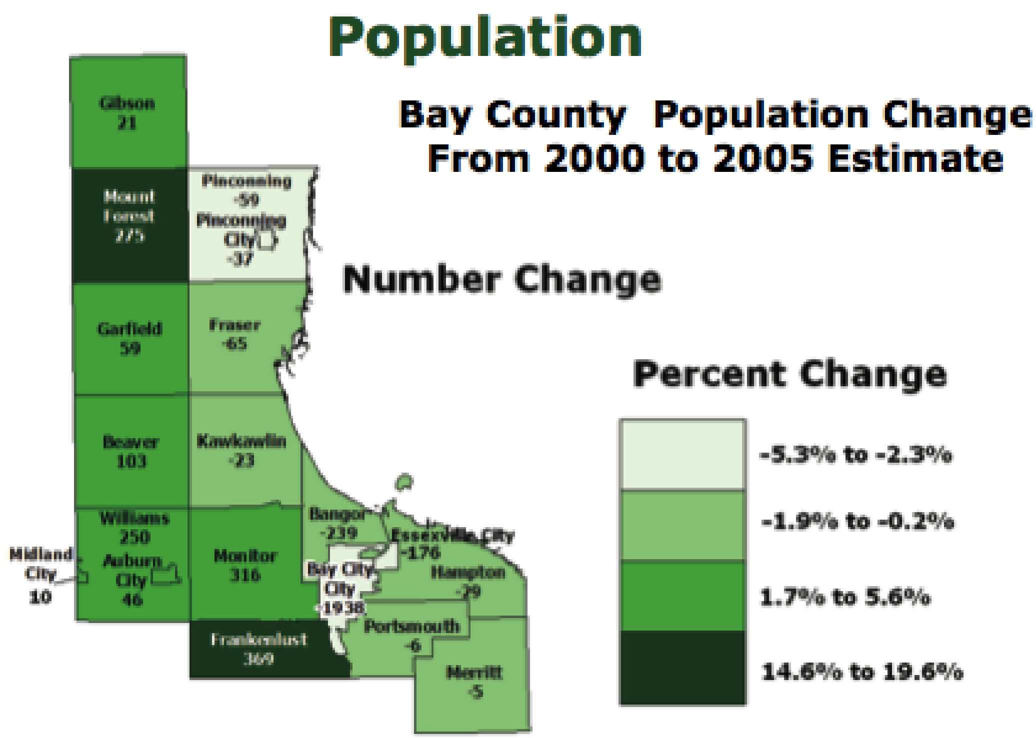
The 2009 population estimate for Bay County is 107,424, a -2.5% change since 2000. The table and maps below indicate population trend estimates for periods of time during the past decade. The period between 2000 through 2005 Bay County ranked 73 out of 83 in Michigan for population changes.

Figure 1
Michigan Population Change



The below map from 2000 to 2005 U.S. Census estimates indicates that population growth occurred primarily in the western and southwestern townships of the county.

Figure 2
Bay County Population Change



The timeframe between 2000 and 2007 the communities that experienced substantial population growth in Bay County were as follows: Frankenlust Township (+19.8%), and Mt. Forest Township (+25%). The notable declines occurred in the City of Bay City (-7.6%), the City of Essexville (-6.9%), and the City of Pinconning (-4.9%).

Table 2
Michigan Cities and Townships Estimated Population Change

Estimated Population of Michigan Cities and Townships by County, 2000-2007					
	April 1, 2000				
Area Name	Census	Estimates Base	2000 Estimate	2007 Estimate	Change 04/00-7/07
Bay County	110,157	110,157	110,094	107,517	-2.4%
Auburn City	2,011	2,011	2,008	2,033	+1.1%
Bangor Charter Township	15,547	15,547	15,532	15,017	-3.4%
Bay City	36,817	36,817	36,726	34,026	-7.6%
Beaver Township	2,806	2,806	2,811	2,923	+4.2%
Essexville City	3,766	3,766	3,757	3,508	-6.9%
Frankenlust Township	2,530	2,530	2,544	3,030	+19.8%
Fraser Township	3,375	3,375	3,372	3,253	-3.6%
Garfield Township	1,775	1,775	1,777	1,860	+4.8%
Gibson Township	1,245	1,245	1,247	1,236	-0.7%
Hampton Charter Township	9,902	9,902	9,901	9,726	-1.8%
Kawkawlin Township	5,104	5,104	5,102	5,003	-2.0%
Merritt Township	1,510	1,510	1,510	1,491	-1.3%
Midland City	222	222	224	225	+1.4%
Monitor Charter Township	10,037	10,037	10,052	10,327	+2.9%
Mount Forest Township	1,405	1,405	1,418	1,756	+25.0%
Pinconning City	1,386	1,386	1,384	1,318	-4.9%
Pinconning Township	2,608	2,608	2,607	2,505	-3.9%
Portsmouth Charter Township	3,619	3,619	3,622	3,541	-2.2%
Williams Charter Township	4,492	4,492	4,500	4,739	+5.5%

Source: http://www.michigan.gov/som/0,1607,7-192-29938_54272-222658--,00.html

Countywide Age Distribution (1990-2005)

The 2005 Census estimates shows that the highest populated age groups in Bay County are 40-44 (7.6%), 45-49 (8.2%), and 50-54 (7.6%). The median age in Bay County has risen from 28.7 years in 1990 to 38.4 years in 2000. This rise is generally in alignment with Michigan (28.8 to 35.5) and the United States (30.0 to 35.3) of which saw similar rises.

Racial Diversity

The table below demonstrates the population diversity of Bay County.

Table 3
Bay County Population Estimates

Population by Race and Hispanic or Latino Origin	1990	2000	2004 estimate
White	107,747	106,238	105,490
Black	1,242	1,442	1,489
Asian or Pacific Islander	428	556	548
American Indian or Alaskan Native	726	632	623
Two or more races	1,580	1,289	1,330
Total	111,723	110,157	109,480
Hispanic or Latino (of an race)	3,494	4,308	4,475

Income

The tables below demonstrate income data for Bay County. The per capita income was $19,698 in 1999, approximately $31,925 when inflated to 2009.

Table 4
Bay County Income Estimates

Median household income, 2008	$45,704
Per capita money income, 1999	$19,698
Persons below poverty level, percent, 2008	12.8%

Source: U.S. Census Quickfacts, http://quickfacts.census.gov

Housing

The table below reflects some of the housing data for Bay County. The median value of $84,900 for owner-occupied housing units would be worth $104,730 in 2009 dollars.

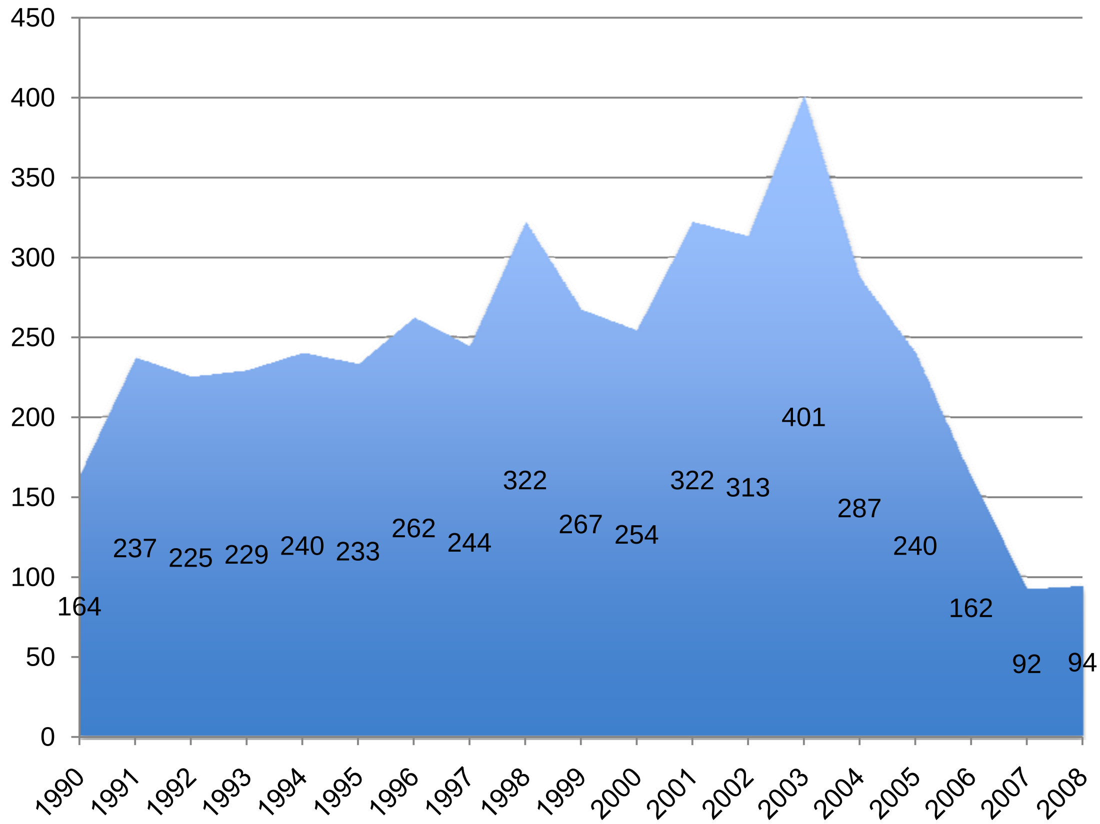
Table 5
Bay County Housing Demographics

Housing units, 2008	48,189
Homeownership rate, 2000	79.3%
Housing units in multi-unit structures, percent, 2000	15.8%
Median value of owner-occupied housing units, 2000	$84,900

Source: U.S. Census Quickfacts, http://quickfacts.census.gov

The following graph shows the building permit numbers for new privately-owned residential buildings. Most notable has been the significant decreased in permit numbers in the past 5 years +/-.

Figure 3
Bay County EmployersAnnual New Privately-Owned Residential Building Permits, Bay County, Michigan. Source: U.S. Census Bureau



Employment

The largest sectors of employment in Bay County in 2000 were educational, health and social services, manufacturing, and retail trade. Jobs in health service areas such as ambulatory health care, and nursing and residential care facilities are forecasted to increase significantly, as well as employment in the administrative and support services sector. The chart below contains data for employment by industry on forecasted regional employment increases from 2002 to 2012.

Figure 4
Employment by Industry in Bay County

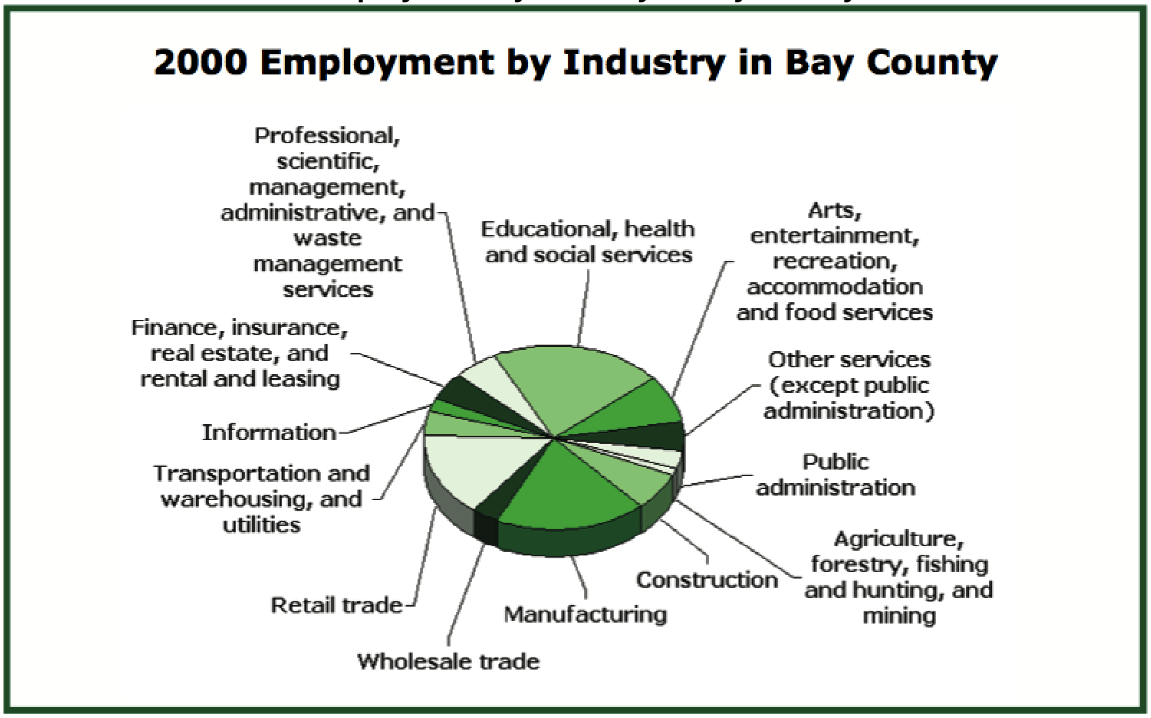


Table 6

Regional Forecast for Bay, Midland and Saginaw Counties

Regional Employment Forecast for Bay Midland and Saginaw Counties	*# of Employees 2002*	*# of Employees Forecasted for 2012*	*Growth Rate*
Total, Wage and Salary Employment	*176,480*	*191,370*	*8.4%*
Administrative and Support Services	*9,070*	*12,600*	*38.9%*
Food Services and Drinking Places	*13,510*	*14,810*	*9.6%*
Educational Services	*16,460*	*17,750*	*7.8%*
Ambulatory Health Care Services	*6,820*	*8,070*	*18.3%*
Nursing and Residential Care Facilities	*3,670*	*4,530*	*23.6%*
Hospitals	*10,230*	*11,020*	*7.7%*
Membership Associations and Organizations	*4,660*	*5,330*	*14.5%*
Professional, Scientific and Tech Services	*6,120*	*6,760*	*10.5%*

Physical Factors

Land Use & Development Trends

Part of the process for the development Bay County Hazard Mitigation Plan has been to consider the effects of recent trends in development, population, and interferences about development pressures that are likely to be associated with observed trends.

The following sections examine in more detail the current and existing land use maps/plans, as well as observed development trends, with the best available information from select townships and cities. This information provides a snapshot into how each jurisdiction has taken action toward controlling population and development pressures.

Land Use and Zoning

Zoning is an important aspect of land use planning which is important to the mitigation of natural hazards. Zoning is the development of a community into districts for the purpose of regulating the use of land and buildings, their height and bulk, the proportion of the lot that may be covered by them and the density of the development. Zoning is enacted under the police power of the State for the purpose of promoting health, safety and general welfare.

Many of the townships and cities of Bay County have been active in establishing a land use zoning code and ordinance to define the way their communities develop. This holds great importance to the area of hazard mitigation planning, as the physical manner in which land develops can have a great impact on the ability for communities to mitigate the effects and damages from natural hazards.

CITY OF AUBURN

The current local zoning ordinance for the City of Auburn, adopted in 2005, established classes of districts for the purpose of regulating and restricting the locations to where development occurs. The City of Auburn is a participant in the National Flood Insurance Program (NFIP). As of November 2009 there was one policy in force with $350,000. There are no repetitive loss properties. The flood map currently being used is from June 18, 1996; however a new study is currently underway.

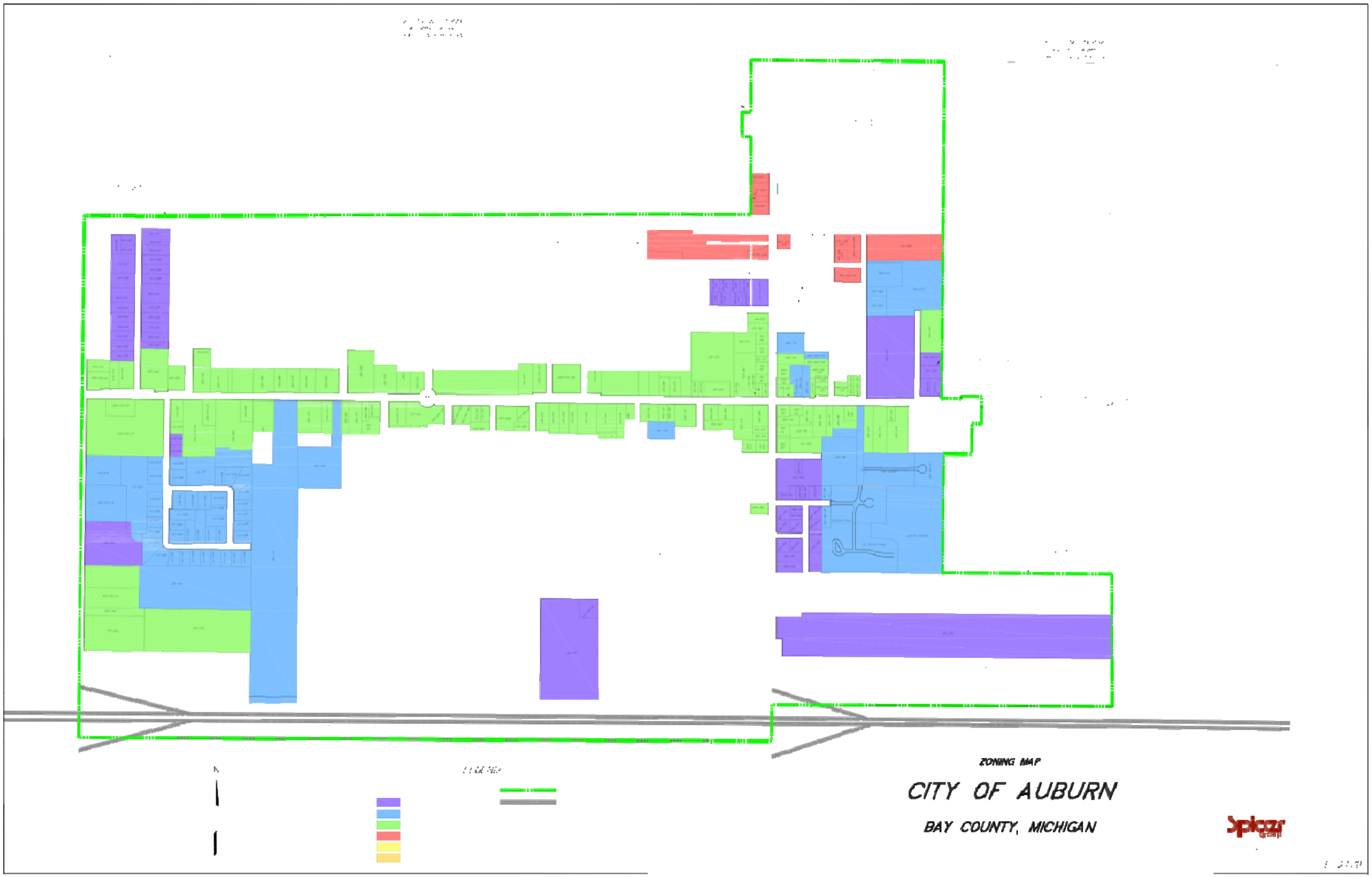
The City of Auburn is bordered by U.S. 10 along the south and the Michigan Central Railroad to the north. According the master plan, the City's development has relied on maintenance and enhancements to the City's transportation system.

Land Use & Development Trends

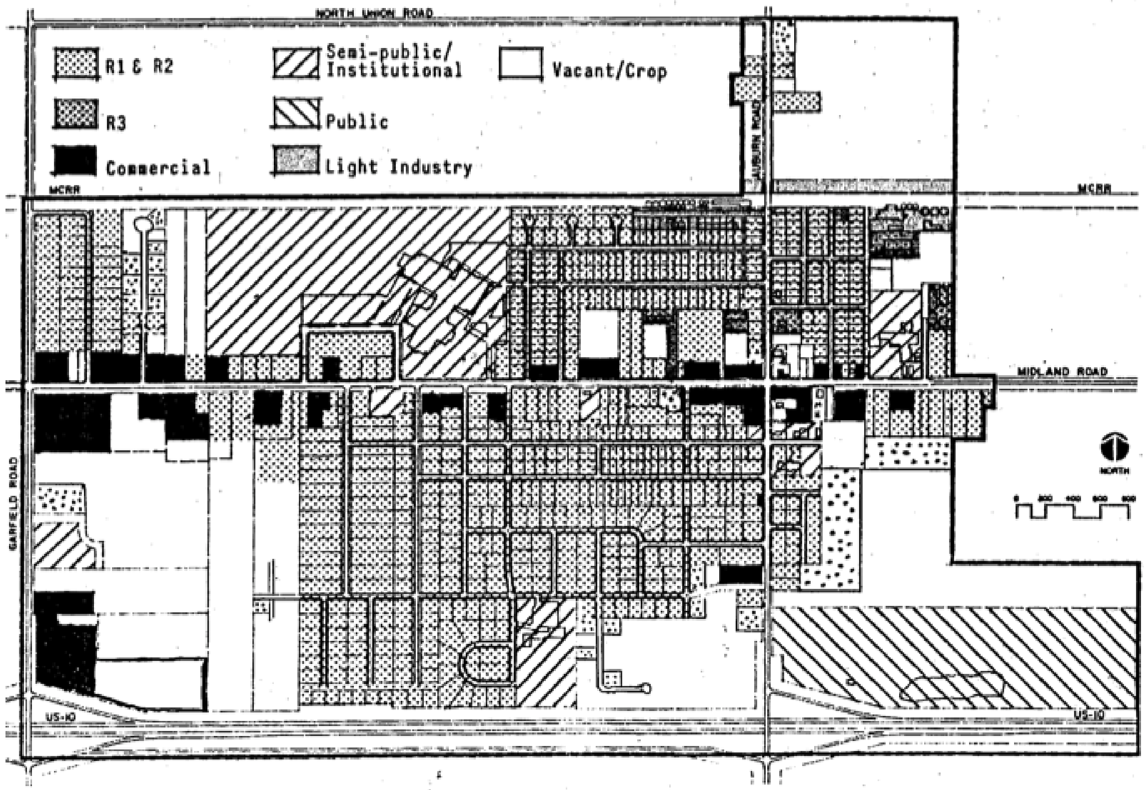
The initial ordinance pertaining to land use regulation was adopted in 1957. The following page contains the most recent Zoning map for the City of Auburn. Following the zoning map is a land use map dated 1994. This map indicates where development was concentrated at that time.

The most recent land use map for the City of Auburn shows that commercial development has primarily occurred along a major thoroughfare, Midland Road, while residential and planned unit developments are located off the thoroughfare primarily in grid-like patterns.

There is a Master Plan that became effective February 21, 1994. The City of Auburn is currently in the process of updating its Master Plan, which will be a useful tool in identifying land use development trends particularly significant to natural hazard mitigation.


ZONING MAP
CITY OF AUBURN
BAY COUNTY, MICHIGAN

Current Land Use Map (1994)



Source: Auburn City Master Plan, Adopted: 1994.

BANGOR TOWNSHIP

Bangor Township is located in northeastern Bay County, Michigan. The Township borders Bay City, Essexville, and Monitor Township to the south, the Saginaw Bay to the north, Essexville and Hampton Township to the east, and Monitor Township and Kawkawlin Township to the west. The area is approximately 15 square miles with over 13 miles of lake and river shoreline within the Township.

The Township of Bangor is a participant in the NFIP. There are approximately 458 flood insurance policies in place totaling $53,974,900. There are 121 paid losses totaling $489,817.12. There are approximately seventeen repetitive loss buildings in Bangor.

The current local zoning ordinance for Bangor Township, adopted in 2000, established classes of districts for the purpose of regulating and designating areas of development.

The Master Plan for the community was completed in 2002. Between 1990 and 2000 the Township had a 3% decline in population. According to the 2002 Master Plan, the number of building permits issued decreased from 1996 to 2000. The economic conditions documented for the Township in the 2002 Master Plan were favorable. The median household income was $33,608; $5,668 more than the County and $2,588 more than the state. Likewise, there was a growth in property value between 1995 and 2000. During this time, the State Equalized Value demonstrated a growth in property value. This data does not include information from the current recession. According to the 2000 Census 80.8% of all occupied housing units were owner occupied.

A land use survey was conducted in Bangor in February 2001. The survey included field data, aerial photographs, and local information. Nine categories were developed to classify the land uses throughout the Township including: Agriculture, Single Family Residential, Multiple Family, Mobile Home Park, Commercial, Office, Industrial, Public/Semi-Public, and Vacant. Bangor is primarily a residential community. Agriculture is not as prominent as it used to be due to increased development pressure. There are two major commercial corridors within the Township, the Euclid Road corridor and Wilder Road east to Patterson Road. Offices are located primarily in these commercial corridors. Industrial uses are randomly located around the community. The Township contains four mobile home parks that were constructed during the 1960’s and 1970’s. There is a great deal of vacant/undeveloped land that is available for future development and open space preservations.

The Township has the following adjacent waters: Saginaw River, Kawkalin River and Saginaw Bay. Stormwater in the community is drained over land by a network of drains and natural streams and rivers. Clean Water Act laws and flood control measures have impacted the management of stormwater. Detention and retention ponds are a consideration for new development.

Land Use & Development Trends

From 1989 to 2001, agricultural/vacant land use has dropped significantly (-21.8%) due to an increase in overall development. This increase in development has occurred in all other land use categories, most significantly in industrial uses (+4%) and single-family residential (+7%).

The chart below indicates the percentage change (+/-) in land use percentage/concentration compared to the total acreage.

Table 6
Bangor Land Use Trends (1989-2001)

	1989		2001	
Land Use Categories	**Acres**	**Percent of Total**	**Acres**	**Percent of Total**
Agriculture/Vacant	4,328.00	49.4	2,334	27.6
Residential				
Single Family	2,126.00	24.3	2,638	31.3
Mobile Homes	55.1	0.62	86	1
Multi-Family	105	1.2	92	1
Commercial	359.3	4.1	490	5.8
Office	17.6	0.2	48	0.57
Industrial	527.9	6.1	850	10.1
Public/Semi-public	1,234.40	14.1	1,339	15.9
Total	**8,753**	**100**	**8,436***	**100**

Source: Charter Township of Bangor Master Plan

** Total includes right-of-way (559 acres).*

Source: Charter Township of Bangor Master Plan, 1990; McKenna Associates, Inc., 2001

Based on this analysis of the population and housing data and other considerations, the following are expected to affect residential development (Source: Bangor Township Master Plan).

- Regional Development Patterns

  The extent of new development that Bangor will see is dependent on the growth of the region and movement patterns. The Township and its attractive features such as its close proximity to Bay City, waterfront location, commercial corridors, and accessibility to regional highways, will continue to be a draw for development. However, it is a good assumption that Bangor will probably receive little or no growth at all if Bay County or Saginaw County do not expand.

- Public Services

  Development in Bangor is also dependant on the amount and extent of public services within the Township. Any large-scale development will continue to be limited to the areas where utilities are provided. Thus new development should be concentrated into areas that are currently serviced by or anticipated to be serviced by public utilities in the near future.

- Housing Affordability and Range

  The median housing value and rent of Bangor will remain a factor in the type or extent of growth that the Township will receive. It is important that a wide range of housing values and type are provided that will allow a mixed population.

- Schools

  Growth is also dependent on the traits of the local school system. The location, quality, and size of the school can affect whether people move in or stay in Bangor Township.

The table below summarizes the Future Land Use designations identified in the Charter Township of Bangor Master Plan.

Table 7
Future Land Use Designation for Bangor

Category	Acres	Percent
Recreation - Open Space	1,155	13.1%
Estate Residential	85	0.96%
Medium Density Single Family	336	3.8%
Urban Density Single Family	4,581	52.0%
High Density Single Family	81	0.92%
Low Density Multiple Family	210	2.38%
Medium Density Multiple Family	256	2.9%
High Density Multiple Family	11	0.12%
Local Commercial	58	0.66%
General Commercial	539	6.1%
Office	142	1.6%
Light Industrial	649	7.38%
General Industrial	619	7.1%
Special Environmental Study Area	76	0.9%
Total	**8,798***	**100%**

- *Does not include waterways or right-of-ways*
- *This table is from the 2002 Master Plan*

CITY OF BAY CITY

The City of Bay City is located in the eastern central portion of Bay County, bordering the Saginaw Bay.

During the 2000 Census there were 36,817 people and in 2008 the population was estimated to be at 33,874. The area of Bay City is 11.3 square miles with 10.4 square miles of land and 0.9 square miles of water. The City is divided by the Saginaw River. There are four bridges that cross the Saginaw River. The median income for a household in the City was $30,425 during the 2000 census. The City is a participant in the NFIP. As of November 2009 there were 145 policies in force totaling $17,813,700.00. The City has four repetitive loss properties.

The current local zoning ordinance for Bay City, adopted in 2003, established classes of districts for the purpose of regulating and restricting the locations where development occurs.

Land Use & Development Trends

According to the Bay City Master Plan, Single-family and two-family residential land use has increased by 26 acres, or 1.2%, since 1964. This is true for multiple-family as well, increasing from 26 to 135 acres from 1964 to 1998. Commercial uses occupied only 182 acres in 1964, whereas today about twice as much acreage is used for commercial. Much of this commercial growth has occurred along Wilder Road. Industrial land use acreage has increased from 566 acres to 836 acres. The amount of institutional land use within the City has increased to 769 acres.

The City has seen a substantial increase in park and open space lands since 1964. Today, 227 acres are (dedicated) used for parks and open space, compared with only 144 acres in 1964. Vacant land use has decreased from 880 acres to 423 acres.

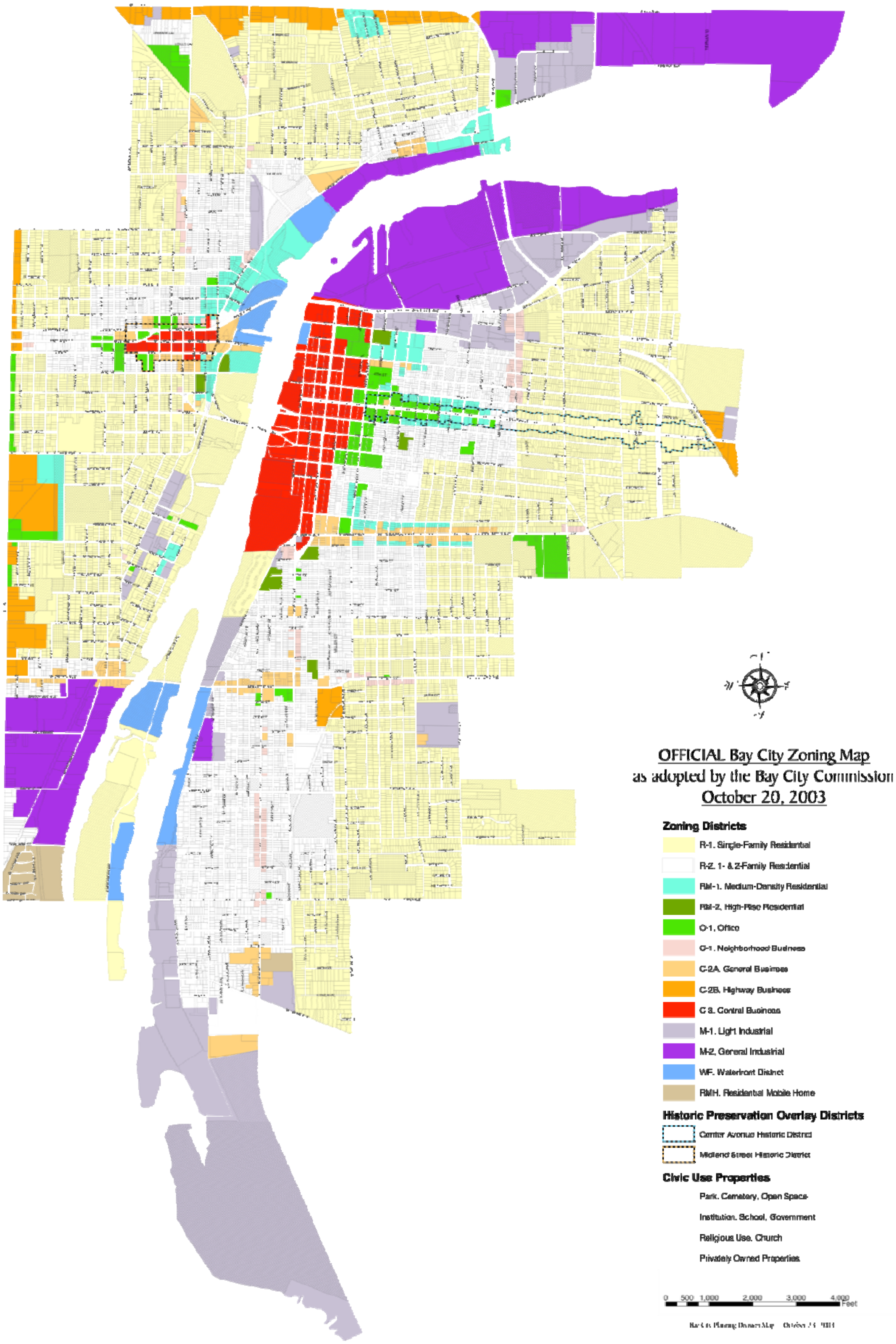
Table 8
Land Use Parcel Count and Total Acreage (1964-1998)

Existing Land Use	1998 Parcel Count	Total Acreage (% of Total) 1998	1964
Single Family Residential	11,151	2,001 (28.1%)	2,112 (32.5%) (single + two family)
Two Family Residential	912	137 (1.9%)	
Multiple Family Residential	563	135 (1.9%)	26 (0.4%)
Commercial	632	301 (4.2%)	182 (2.8%) (includes CBD and office)
Office	25	12 (0.16%)	
Central Business District	273	101 (1.4%)	
Mixed Use	45	7(0.10%)	
Light Industrial	69	71 (1.0%)	566 (8.7%) (light and heavy)
Heavy Industrial	218	765 (10.8%)	---
Institutional	113	769 (10.8%)	241 (3.7%)
Parks and Open Space	106	227 (3.2%)	144 (2.2 %)
Vacant	593	423 (5.9%)	880 (13.5%)
Manufactured Home Park	2	27 (0.39%)	---
Roads and Railroad Rights-of- Way	---	1,483 (20.8%)	1,490 (22.9%)
River		637 (9.0%)	600 (9.2%)
TOTALS	**15,102**	**7,119 acres**	**6,503 acres**

Source: Bay City Master Plan

The 1964 Master Plan was the source for the land use data. Approximately 448 acres have been annexed into the City since 1964. The following zoning map for Bay City provides an indication as to where land use and zoning designations will be concentrated as development occurs.

Figure 9
Bay City Zoning Map



BEAVER TOWNSHIP

Beaver Township is located in the west central portion of Bay County in the farmlands of the Bay Valley. Beaver Township is located 15 miles northwest of Bay City and is primarily an agricultural community. Many branches of the Kawkawlin River traverse the township.

Beaver Township's population during the 2000 census was 2,806 and is included in the Bay City Metropolitan Statistical Area. The median household income for the community was $51,546. Beaver sits on the north branch of the Kawkawlin River. The Township is 35.4 square miles and is comprised totally of land. Beaver Township is a participating in the NFIP. As of November 2009, there were four policies in place, totaling $587,100.00. There are no repetitive loss buildings in the Township.

The Beaver Township Planning Commission commissioned the Beaver Township General Development Plan. The Plan was adopted in October 1978. The Plan included the following: existing land use; housing information; population growth and characteristics; economic base; physical features; generalized soils; agricultural land; transportation; utilities; community facilities; community attitudes; goals and objectives for future planning; planning dimensions; general development plan; and plan implementation.

The current zoning ordinance for Beaver Township was enacted in 1979 and was amended in 2002. The ordinance established classes of districts for the purpose of regulating and restricting the locations where development occurs.

Land Use & Development Trends

Land use patterns in Beaver Township are quite similar to the 1970's, the time at which the development/master plan was written. According to the township administrator, Beaver Township was and still is a community dominated by agricultural and residential uses.

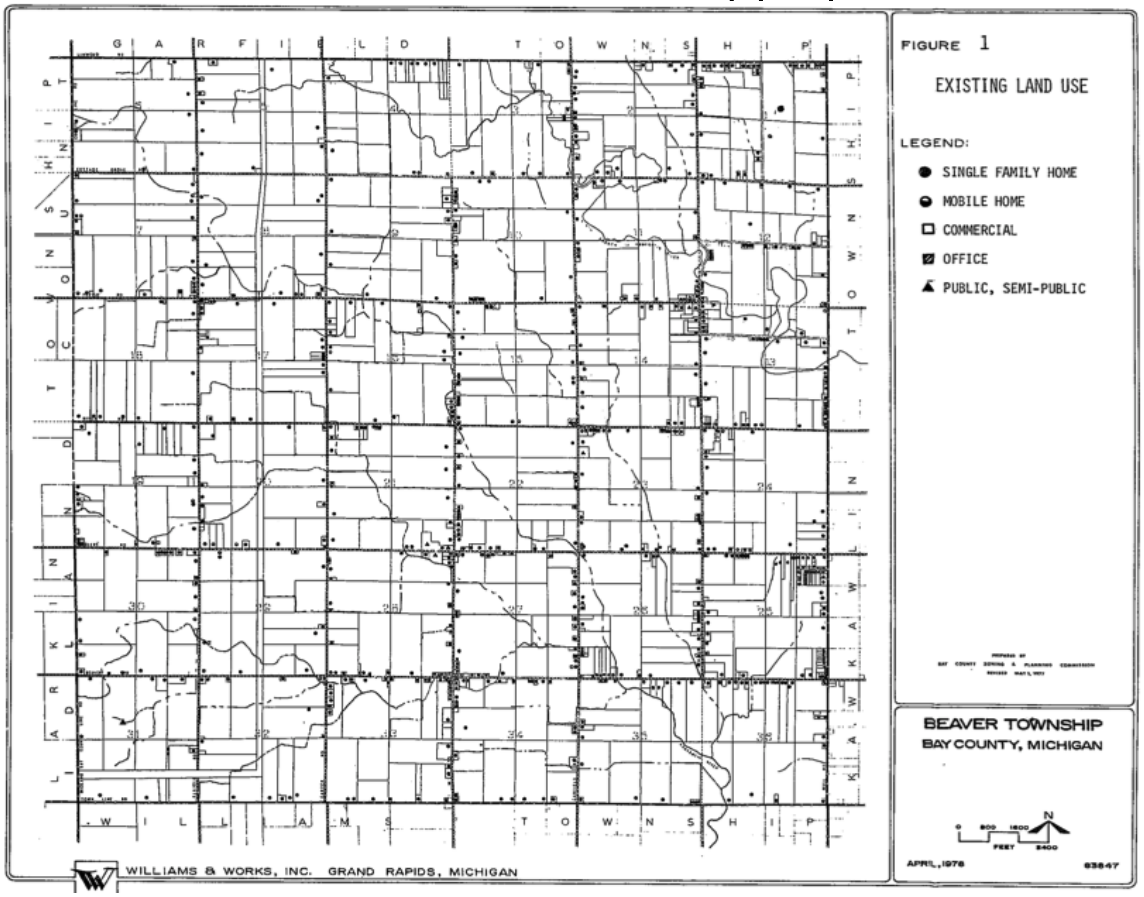
The map below was used for the Beaver Township General Development Plan (1976). This map graphically portrays the settlement patterns as they existed in Beaver Township. From this map, it is readily noted that the bulk of the Township was given over to agricultural lands and open space. The majority of development was scattered along the section line roads. Only one exception is noted; in the area of Seilders and Eight Mile Roads, a concentration of mobile homes existed at a density not normally found in the township.

In 1976, there were 860 total structures in Beaver Township; 823 (92.9%) residential, 25 (2.9%) commercial, 11 public/semi-public (1.3%), and 1 office (0.1%).

At this time and most likely at present, nonresidential uses were largely concentrated in the unincorporated communities of Beaver, Dual and Willard. These commercial uses consisted of a hardware store, drug store, and gas station type. Since there weren't any major shopping centers in the Township at the time, the small service centers were geared to supply the basic needs of area residents.

Figure 9

Land Use in Beaver Township (1976)



Source: Beaver Township General Development Plan (1976)

Population trends can also indicate development pressures over time. Beaver Township's population has increased from 2,806 in 2000 to 2,923 in 2007, a 4.2% increase.

CITY OF ESSEXVILLE

The City of Essexville is located in the south central portion of Bay County, just north of Bay City.

During the 2000 census, there were 3,766 people in Essexville. Essexville is part of the Bay City Metropolitan Statistical Area. The median income for a household in the City was $ 43,750. The total area of the community is 1.4 square miles with 1.2 square miles of land and 0.2 square miles of water. The City is a participant in the NFIP. As of November 2009 there were eleven policies in force totaling $2,790,100.00. There are no repetitive loss buildings in the community.

The City is located in an economically active and enriched metropolitan area and one of the more highly industrialized portions of the Great Lakes basin. Functionally the City's economic base consists of Woodside Avenue Business District and waterfront related bulk industries along the Saginaw River.

The current zoning map within the City of Essexville shows the nature that development can currently take. This is illustrated on the accompanying “Existing Zoning” map. The Essexville zoning ordinances integrates some unique designations regarding land use, specifically Development District (D1) category.

Land zoned Development (D1) is basically land that has been set aside with no particular zoning designation. This designation is used until an appropriate development is filed for and approved by the City. At that time the zoning designation will be changed to reflect the use.

Land Use & Development Trends

According to the Essexville Community Master Plan, population forecasts indicate that the City of Essexville will continue to decline slightly in population. This decline is not related to out-migration of population rather it is associated with a national trend of declining household size. Because Essexville is a built-out community with minimal vacant residential area for new development, the community will be impacted by this national lifestyle trend. In 1970 the number of persons per household in the City of Essexville was 3.31. In 1980 and 1990 this ratio declined to 2.84 and 2.69, respectively. Between 1970 and 1990 there was a population decline of 18% measured against an insignificant increase in the numbers of households.

The Community Master Plan included data that demonstrated distribution of housing built by year. The majority of residential development occurred prior to 1939 through 1969. The following table shows the amount of land in each of the seven general land use categories that exist within Essexville:

Table 9
Existing Land Uses in Essexville

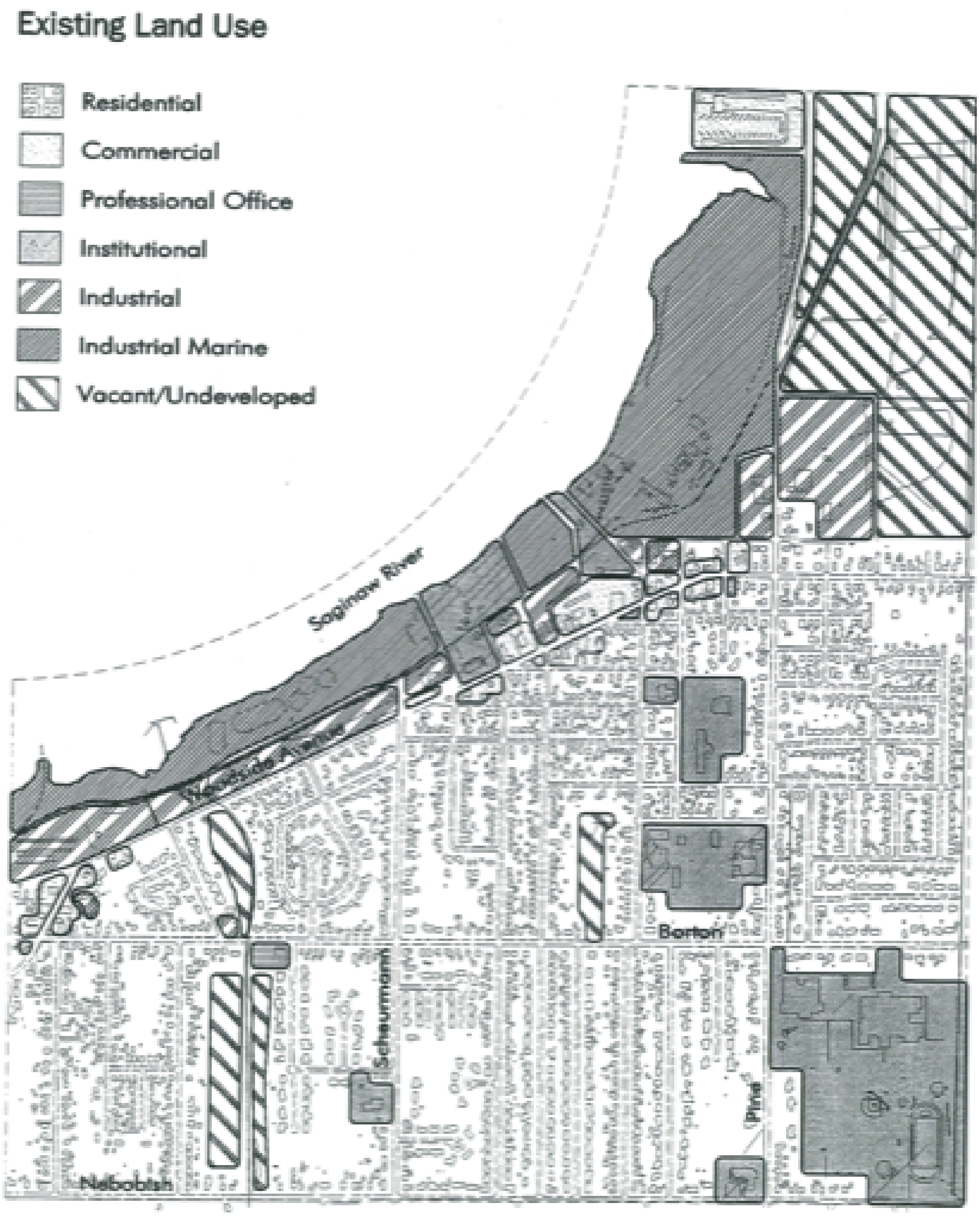
Land Use Type	Acres	Percent of Total
Single Family Residential	496	55%
Commercial	24	3%
Professional Office	1	-
Institutional/Government	81	9%
Industrial	40	4%
Industrial/Marine	88	10%
Vacant	90	10%
River within City Limits	78	9%
Total	**898**	**100%**

Source: Essexville Community Master Plan (Updated: 2007)

The most predominate land use in Essexville is in Single Family Residential, making up fifty-five (55%) percent of the land within the City. Only three (3%) percent of the total land area of Essexville, or approximately 25 acres, is devoted to commercial and office uses. This is an extremely small percentage of the total land area in Essexville and indicates a lack of land available for new commercial development.

The below map entitled "Existing Land Use" breaks up the city into general land use categories:

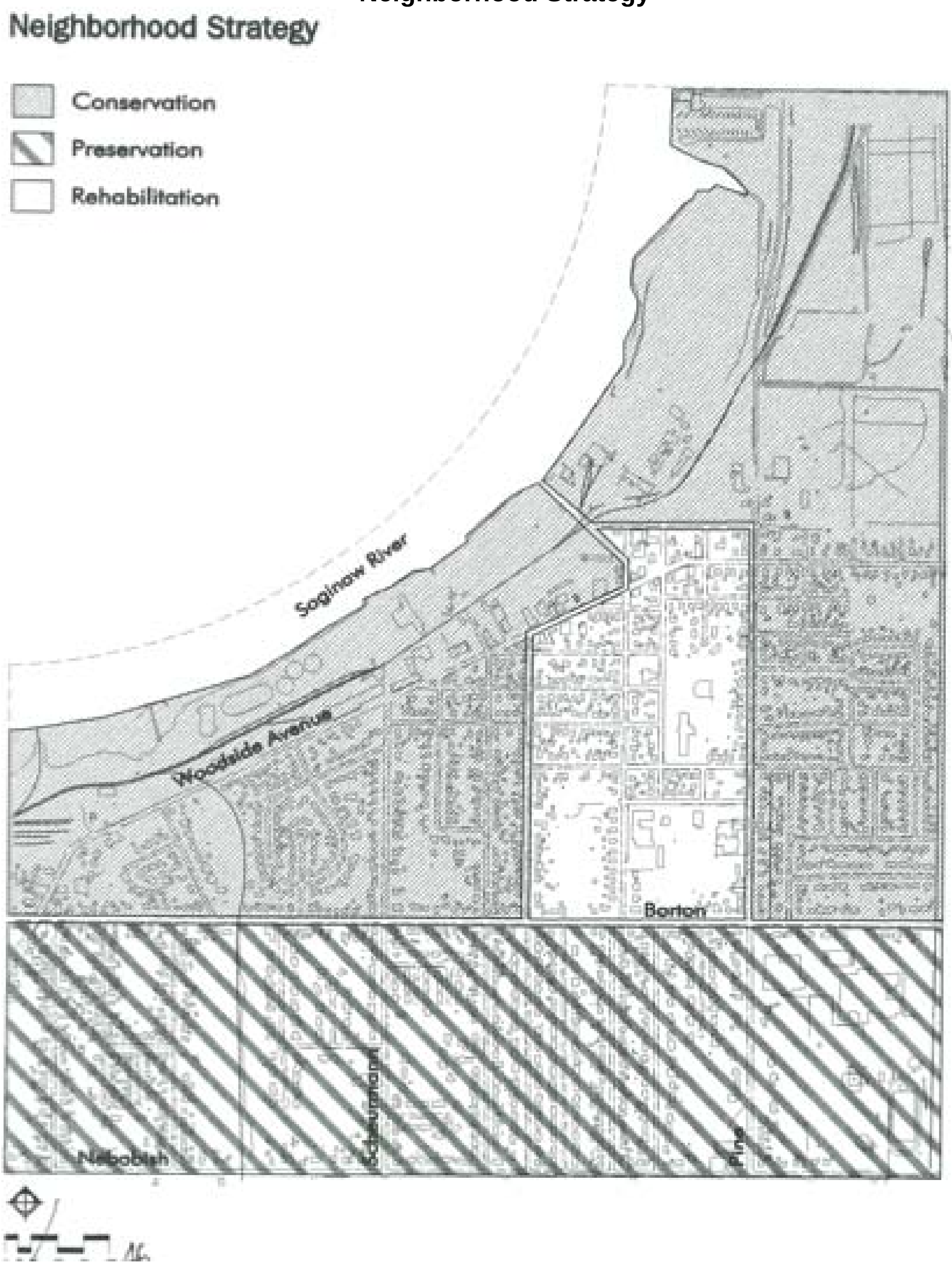
Figure 10
Existing Land Use



Source: Essexville Community Master Plan (Updated: 2007)

As a result of the Community Master Plan, the City of Essexville has focused their attention toward future development trends and how a neighborhood strategy can help maintain and rehabilitate housing stock that already exists in the community. The below map demonstrates the neighborhood's strategy for different residential area of the City of Essexville.

Figure 11
Neighborhood Strategy

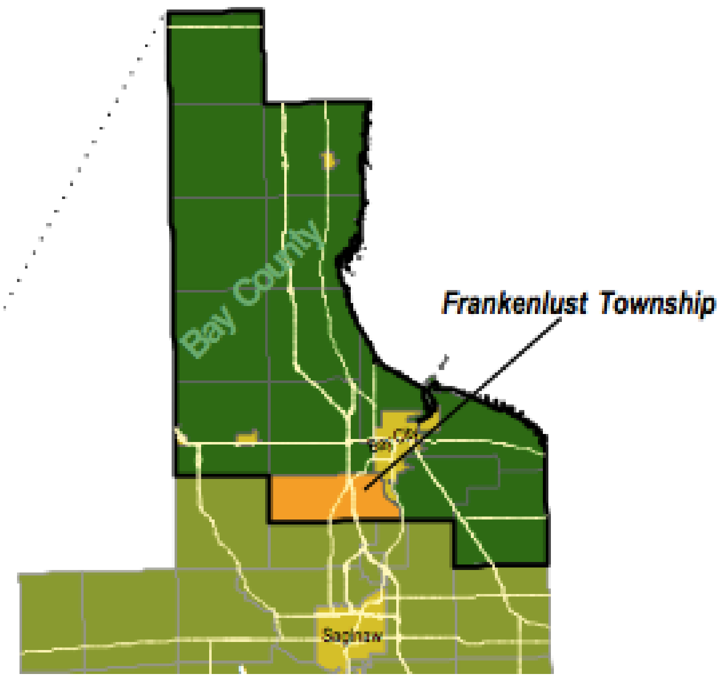


FRANKENLUST TOWNSHIP

Frankenlust Township is located in southern Bay County just southwest of Bay City and approximately 10 miles north of Saginaw. It is bordered by Monitor Township to the north, Portsmouth Township to the east, Saginaw County's Kochville and Zilwaukee Townships to the south of Tittabawassee Township to the west.

During the 2000 Census, the township had 3,375 residents. The median age was 39. The median income for a household was $41,581. The total area of the Township is 38.2 square miles with 32.3 square miles of land and 5.9 square miles of water. Frankenlust is a participant in the NFIP. As of November 2009, there were thirty three policies in force totaling $5,195,200.00. There are no repetitive loss properties.

Figure 12
Frankenlust Township



Source: Frankenlust Township Master Plan

The current local zoning ordinance for Frankenlust Township, effective in 1998, established classes of districts for the purpose of regulating and restricting the locations where development occurs. This ordinance coupled with the Frankenlust Township Master Plan (2005) has helped shape land use and development.

<u>Land Use & Development Trends</u>

Frankenlust Township has experienced a high increase in residential development over the past 30 years. Based on housing construction data, Frankenlust Township has grown at a much faster rate than either Bay City or the County overall between 1970 and 1990. Frankenlust Township experienced a growth in housing units between 1970 and 1980 that almost doubled the units in its housing stock. There was actually a net loss in housing units in the City during the same time, while the County grew at a more moderate rate of 18.6 percent. Of course, the difference in growth patterns are due primarily to the simple fact that the City is considerably built out while the Township is currently experiencing development demands as a bedroom community.

Today Frankenlust Township relies on its agricultural roots, but it is also known as home to Delta Community College and three golf courses. Housing has grown tremendously during the past 30 years and it is now mostly a bedroom community for residents who work in Bay City, Saginaw, and Midland.

The Frankenlust Master Plan was adopted in 1997. The plan includes the following information: demographic analysis; resident survey; housing information; economic analysis; public infrastructure; existing land use analysis; goals and objectives; and future land use planning.

According to the Frankenlust Township Master Plan (1997/2005), the land use is divided into six classifications: Agricultural, Residential, Single & Multi-Family, Commercial, Mixed Use, Industrial, Public-Institutional, Wooded/Vacant, Open Space, and Wetlands.

The following chart details the acreage of existing land use and percentage in Frankenlust Township. Following the Land Use chart is a map derived from the Frankenlust Township Master Plan that shows a spatial representation of land use.

Table 10
Existing Land Uses in Frankenlust Township

Type	Acreage	Percent
Agricultural	9,764.71	70.5%
Residential	816.54	5.9%
Commercial	74.34	0.5%
Mixed Use	137.63	1%
Industrial	1.79	.01%
Public Institutional	697.87	5%
Wooded Vacant	.64	.004%
Open Space	481.15	3.5%
Wetlands	1,871.30	13.5
Total	**13,846**	**100%**

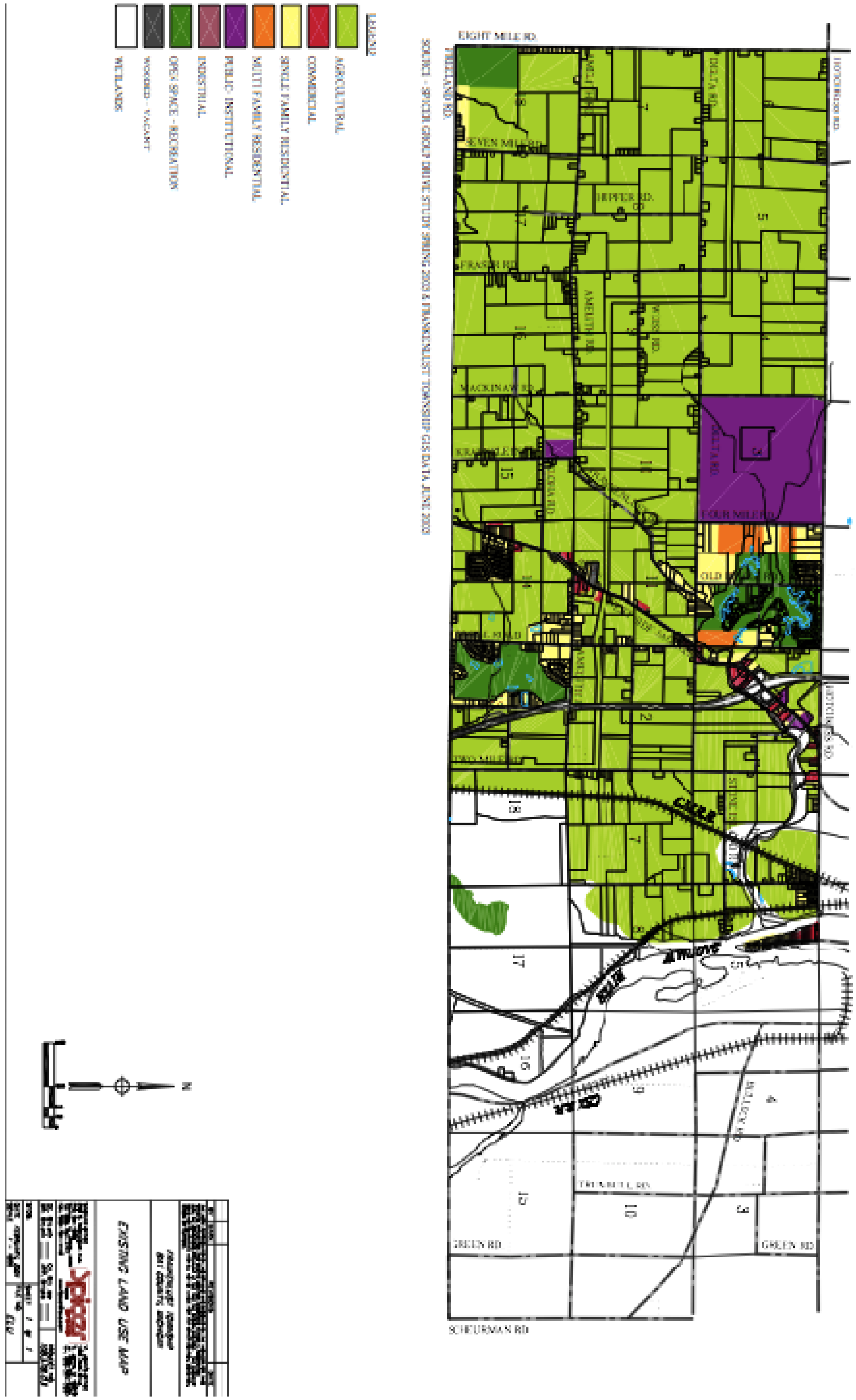
Source: 2003 Driving Survey, Frankenlust Master Plan 1997, reprinted in Frankenlust Township Master Plan 2003

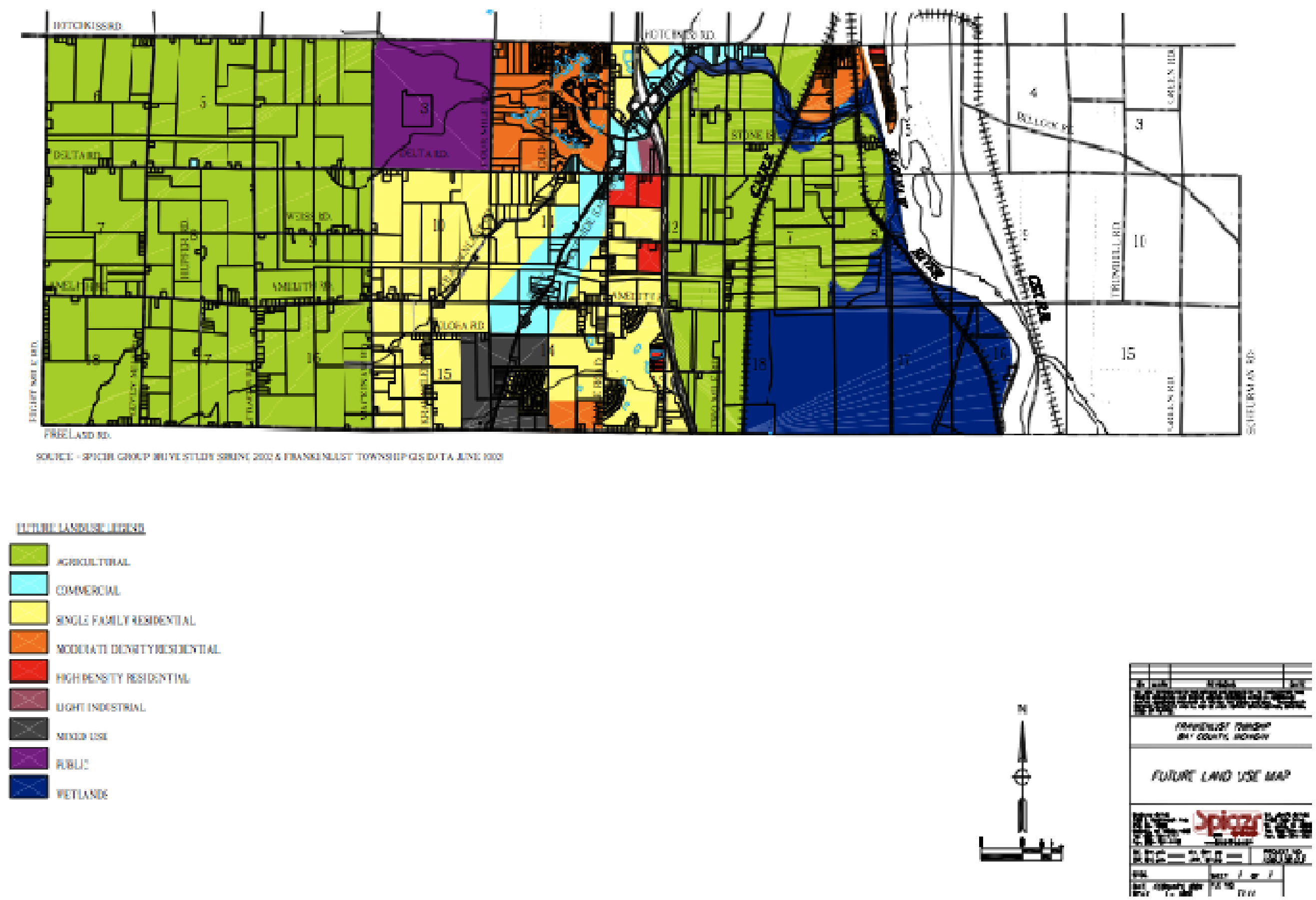
Source: Frankenlust Township Master Plan (2005)

Following the existing land use map is a map of the Township containing future land use categories to show where the Township intends to shape development and land use in the future.

For more information related to land use development and trends, see the "Frankenlust Township Master Plan" which is located on the Frankenlust Township website at: www.frankenlust.com

Figure 13
Frankenlust Township Existing Land Uses




HOTCHKISS RD.
DELTA RD.
WEISS RD.
AMELITH RD.
FREELAND RD.
SOURCE - SPICER GROUP DRIVE STUDY SPRING 2002 & FRANKENLUST TOWNSHIP GIS DATA JUNE 2002
FUTURE LANDUSE LEGEND
AGRICULTURAL
COMMERCIAL
SINGLE FAMILY RESIDENTIAL
MODERATE DENSITY RESIDENTIAL
HIGH DENSITY RESIDENTIAL
LIGHT INDUSTRIAL
MIXED USE
PUBLIC
WETLANDS
N
FUTURE LAND USE MAP

FRASER TOWNSHIP

Fraser Township was organized in 1875, becoming the tenth township of Bay County. When Fraser was organized it stretched from the shores of the Saginaw Bay to the west county line bordering Midland County. It was the second largest township in the Bay County.

Fraser was a source of timber during the lumbering era in Bay County. The Michigan Central and Detroit & Mackinac railroads traversed the township with stations at Lengsville, Michie and Linwood. Farming became the primary source of subsistence when the land was depleted of most of its trees and lumbering close operations in the area.

Historical population:

- 1880: 301 residents
- 1894: 1,444 residents
- 1900: 1,900 residents
- 2000: 3,375 residents

During the 2000 Census, the township had 3,375 residents. The median age was 39. The median income for a household was $41,581. The total area of the Township is 38.2 square miles with 32.3 square miles of land and 5.9 square miles of water. The Township is a member of the NFIP. As of November 2009 there were 140 policies in place totaling $15,672,500.00. Fraser is a participant in the Community Rating System, a voluntary program available through FEMA, which provides discounts on policies. There are no repetitive loss properties.

Population trends can be notable to determining residential, commercial, and industrial increases/decreases over time. As you can see in the chart below, Fraser Township's population decreased from 3,372 in 2000 to 3,253 in 2007, a -3.6% change.

Table
Fraser Population Change

Estimated Population of Michigan Cities and Townships by County, 2000-2007					
	April 1, 2000				
Area Name	**Census**	**Estimates Base**	**2000 Estimate**	**2007 Estimate**	**Change 04/00-7/07**
Fraser Township	3,375	3,375	3,372	3,253	-3.6%

Source: *http://www.michigan.gov/som/0,1607,7-192-29938_54272-222658--,00.html*

Residential growth and development in Fraser Township reached its peak in the 1970's with 377 units constructed. This growth has increased a small amount since the 1980's (119) to the 1990's (194).

Table
Fraser Housing Units Cosntructed

Housing Units Constructed in Fraser Township (pre-1939 to 2000)	
1999 to March 2000	25
1995 to 1998	74
1990 to 1994	95
1980 to 1989	119
1970 to 1979	377
1960 to 1969	214
1950 to 1959	175
1940 to 1949	131
1939 or earlier	163

Source: http://www.city-data.com/township/Fraser-Bay-MI.html

The stated purpose of the Fraser Township Master Plan plan is to provide a guide for the development of the land within the Township. The plan following table reflects existing land uses.

Table Existing Land Uses for Fraser Township

Land Use	**Acres**	**Percent of Total**
Agriculture	10,286	50.0
Single-Family	1,378	6.7
Multiple Family	2	-
Office	3	-
Convenience Commercial	5	-
Comparison Commercial	24	0.1
General Commercial	36	0.2
Industrial	66	0.3
Public-Semi Public	433	2.1
MDNR Land	974	4.7
Right of Way	1,100	5.5
Vacant	6,240	30.4
Total Land Use	20,542	100.0

GARFIELD TOWNSHIP

Garfield Township is located in the east central portion of Bay County. The total area for the community is 35.7 square miles; none of this area is water. The population in the Township was 1,775 as of the 2000 Census. The median income for a household in the township was $44,044. The median age was 37 years. As of November 2009, Garfield is not a participant in the NFIP. There are no repetitive loss properties in the Township.

The Garfield Master Plan (1997-2020) was adopted in 1997. The Plan includes the following information: existing land use analysis; natural features assessment; socioeconomic profile; community goals and objectives; future land use plan; and plan implementation resources.

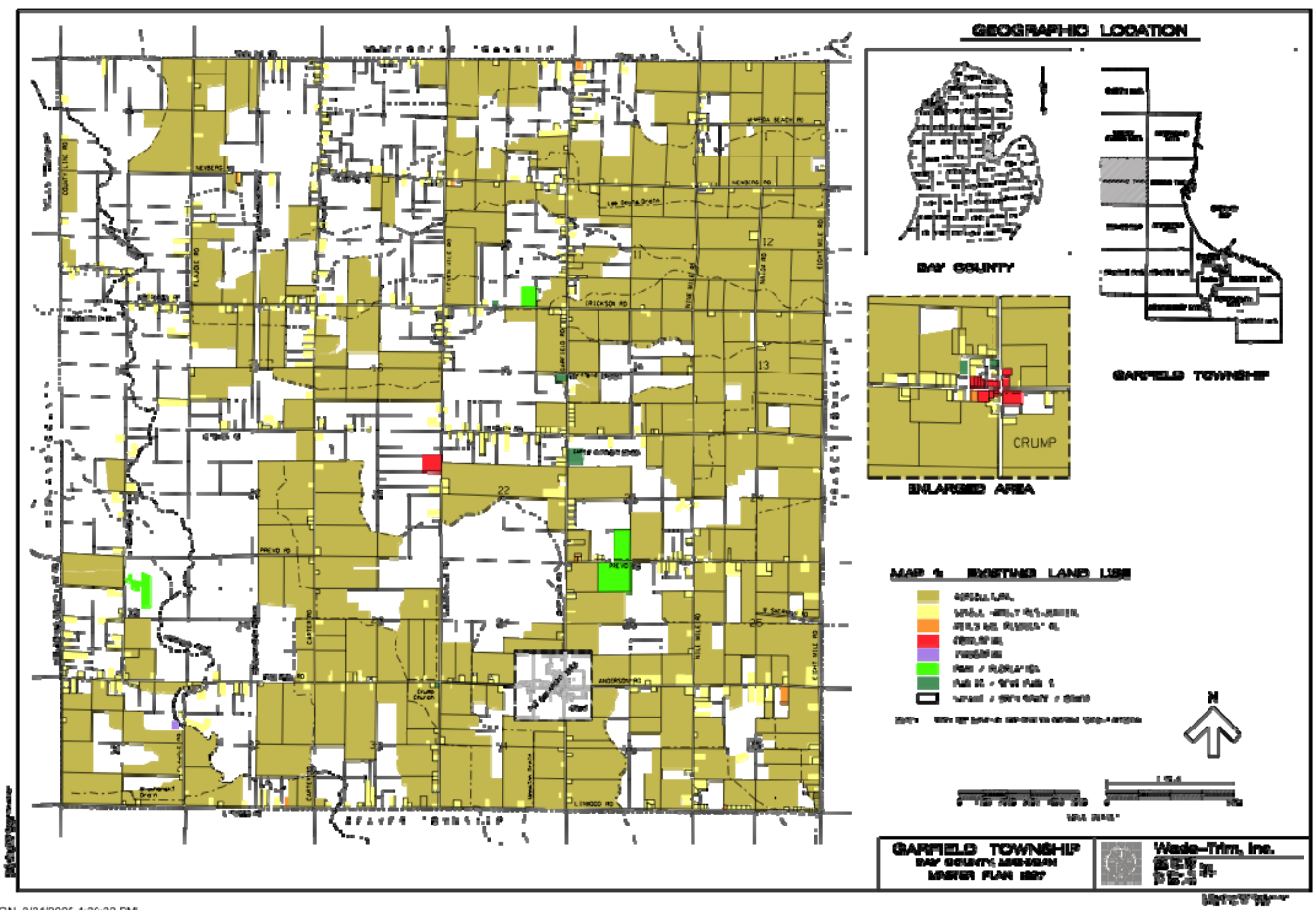
The current local zoning ordinance for Garfield Township, effective in 1985, established classes of districts for the purpose of regulating and restricting the locations where development occurs. This ordinance coupled with the Garfield Township Master Plan (1997) has helped shape land use and development in Garfield Township.

<u>Land Use & Development Trends</u>

The Garfield Township Master Plan (1997) considered land use and development trends as seven land use classifications were proposed for Garfield Township: Agricultural/Rural, Single-family residential, Commercial, Light Industrial, Public/Semi-Public, Park/Recreation, and Conservation.

The map below, entitled, Existing Land Use, Illustrates how the land in the Township is being used. The image that is revealed after the "jigsaw" pieces are assembled is essentially a simple organization of land uses that resemble a rural mid-western farming community. Crump serves as the central commercial center and focal point for the Township. The vast majority of residences are located along section line roads throughout the entire Township. No medium to high density developments exist in the Township, thus preserving its rural character.

Figure
Garfield Existing Land Use



LANDUSE.DGN 8/31/2005 4:30:33 PM

Source: Garfiled Township Master Plan (1997)

The Township largely consists of agricultural and undeveloped land. Combined, they comprise over 96 percent of Township's total area. The chart below provides Existing Land Use Acreage from the 1997 Garfield Township Master Plan.

Table
Existing Land Uses for Garfield Township

Land Use	Acres	Percent of Total
Agricultural	10,245.91	44.85
Single Family Residential	697.55	3.05
Mixed Use	6.12	0.03
Commercial	60.52	0.26
Industrial	1.25	0.01
Park/Recreation	12.45	0.05
Public/Semi-Public	14.66	0.06
Vacant/Open Space/Other	11,806.41	51.68
Total	22,844.87	100.0

Source: Land Use Survey by Wade Trim, March 1997.

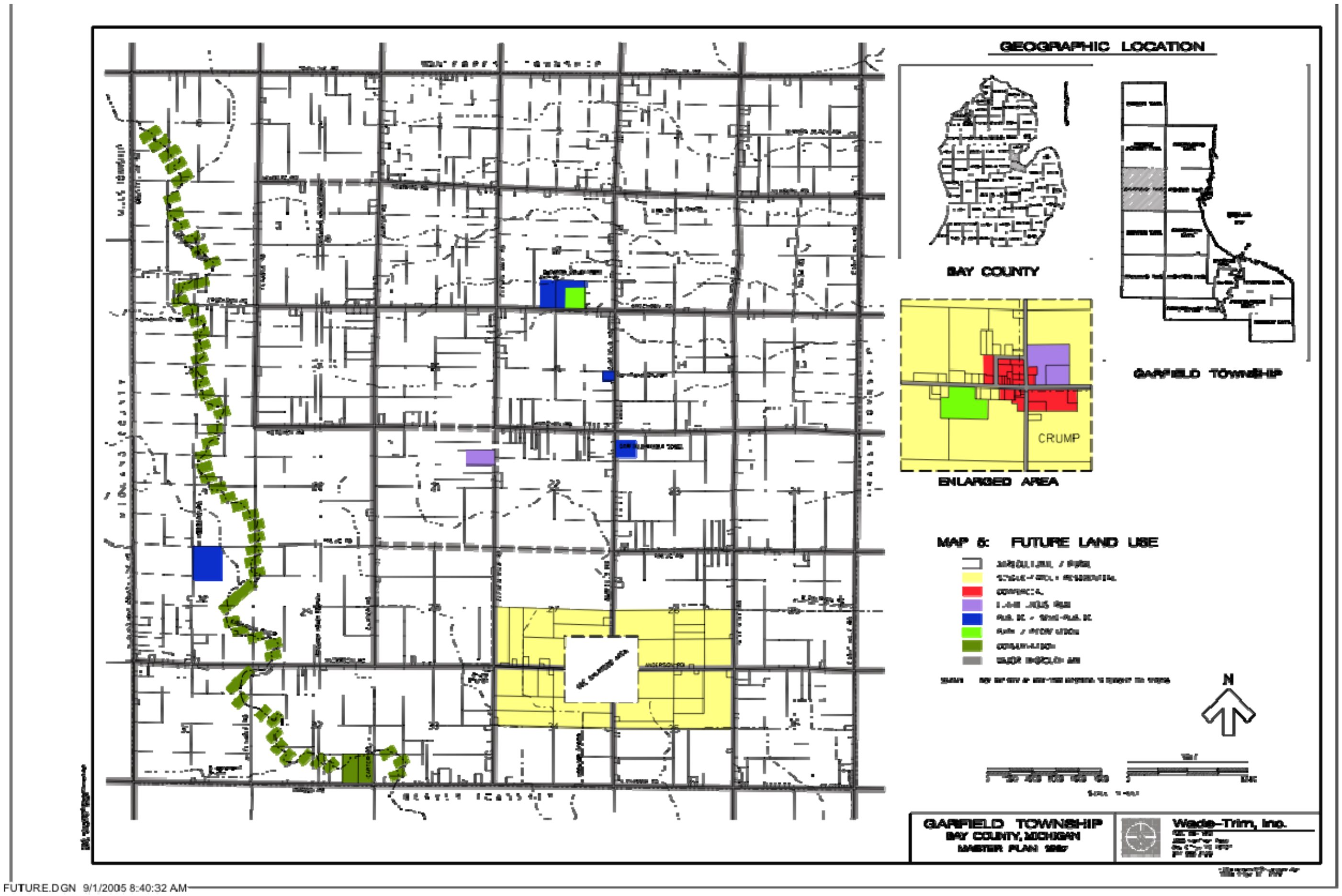
The following chart and map demonstrates the future land uses for the Township.

Table
Future Land Uses for Garfield Township

Land Use Category	**Acreage**	**Percent of Total**
Agricultural/Rural	19,353	84.7%
Single-Family Residential	1,680	7.4%
Commercial	101	0.4%
Light Industrial	154	0.7%
Public/Semi-Public	91	0.4%
Park/Recreation	75	0.3%
Conservation	1,391	6.1%
Total	22,845	100.0%

Source: Garfield Township Master Plan 1997

Figure
Garfield Future Land Use Map



GIBSON TOWNSHIP

Gibson Township was organized on April 1, 1888, becoming the thirteenth township of Bay County. Created from the western half of Pinconning Township, consisting of township 18 north or range 3 east. Branches of Pine and Saganing rivers traverse the township in an east-west direction. The township shares a border with Arenac County to its north and Gladwin to its west.

The results from the 2000 census indicate that there were 1,245 people, 398 households, and 312 families in the Township. The median income for a household in the Township was $35,978. The total area in the community is 35.7 square miles, all of which are land. The town is located three miles west of I-75. As of November 2009, Gibson was participating in the NFIP. There are no repetitive loss buildings in the Township.

Land Use & Development Trends

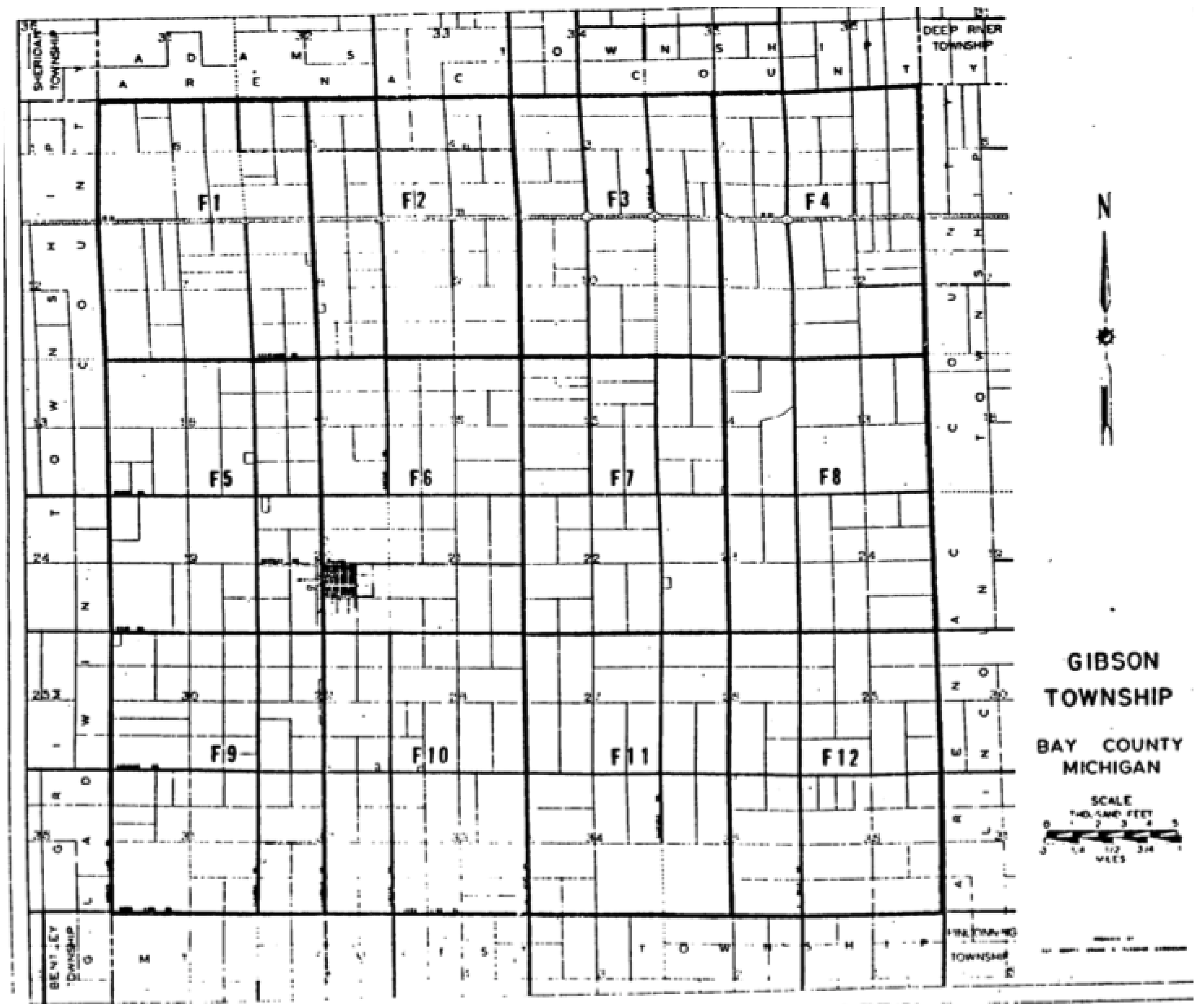
With limited information on Gibson Township's development trends, historical population information can provide a general snapshot into how residential development has been influenced overtime:

1894: 494 residents
1900: 761 residents
2000: 1,245 residents

The 2007 estimated population of Gibson Township was 1,236 residents, a -0.7% decrease from the year 2000.

The map below shows Gibson Township. The areas marked as F1-F4, located along M-61, are designated as commercial/light industrial land. Other residential development is located in the unincorporated area of Bentley. This map is derived from Gibson Township's local zoning ordinance and may reflect anticipated land use and development patterns as a result of zoning designations.

Figure
Gibson Township Land Use Designations



HAMPTON TOWNSHIP

Hampton Township is located in the southeastern portion of Bay County along the Saginaw Bay. The population in the township as of the 2000 census was 9,902. The area is included in the Bay City Statistical Metropolitan Area. The median income for a household was $34,579. The total area of the township is 32.5 square miles; 27.1 square miles are land and 5.5 square miles are water. Hampton is a participant in the NFIP. As of November 2009, there were 90 policies in place with $10,667,000.00 of insurance in force. There are no repetitive loss buildings.

The Hampton Charter Township Planning Commission adopted a Comprehensive Plan Update in 2001. The update reviewed the land designated as R-3 High-Density Residential Use. The original master plan was adopted in the late 1980s.

Land Use & Development Trends

There has been a strong planning presence in Hampton Township since the mid 1960's. Both the Comprehensive Plan, Zoning Map, and Zoning Ordinance have evolved over a long period of time. The first zoning ordinance was adopted in the 1940's. The first public water system was constructed in the Township in 1960 and served the extreme west portion of the Township. At that time there were approximately 1000 single-family homes and one small mobile home park located within the Township. The population of the Township at the time was approximately 5,500 persons.

During the next few years, 300 new single family homes were constructed within the Township and the population had increased to 6,868 persons by 1970. As a result of the amount of growth that was taking place, the Township updated the Comprehensive Plan in 1970. By this time, much of the commercial land along Center Road, west of Pine Street, had been developed and the plan proposed the area along Center Road between Wagner and Burns roads for long range commercial development.

During the 1970's, the population of the Township increased by 3,550 persons and approximately 2,100 dwelling units were constructed between 1970 and 1980.

Table
Hampton Township 1970-1980 Residential Development

Type	Number	Percent
Single Family Homes	600	28.6
Multiple Family Homes	1,200	57.1
Mobile Homes	300	14.3
Total	2,100	100.0

Source: Hampton Township Comprehensive Plan Update (2001)

During the 1980's relatively little development took place within the Township. The increased population resulting from development during the 1970's was beneficial to business owners during the 1980's by providing many additional customers and increasing the Township tax base.

Between 1990 – 1999, 257 new single family homes were constructed for an average of 26 new homes per year. A number of new businesses were also constructed with the largest being the Meijer store at the northwest corner of Pine Street and Youngs Ditch Road. Few multiple family units were constructed and they primarily consisted of condominiums at Ironwood Estates located along Hampton Road and the assisted living units located at the southeast corner of Pine Street and Ridge Road. The following table reflects the housing types in Hampton in 2007.

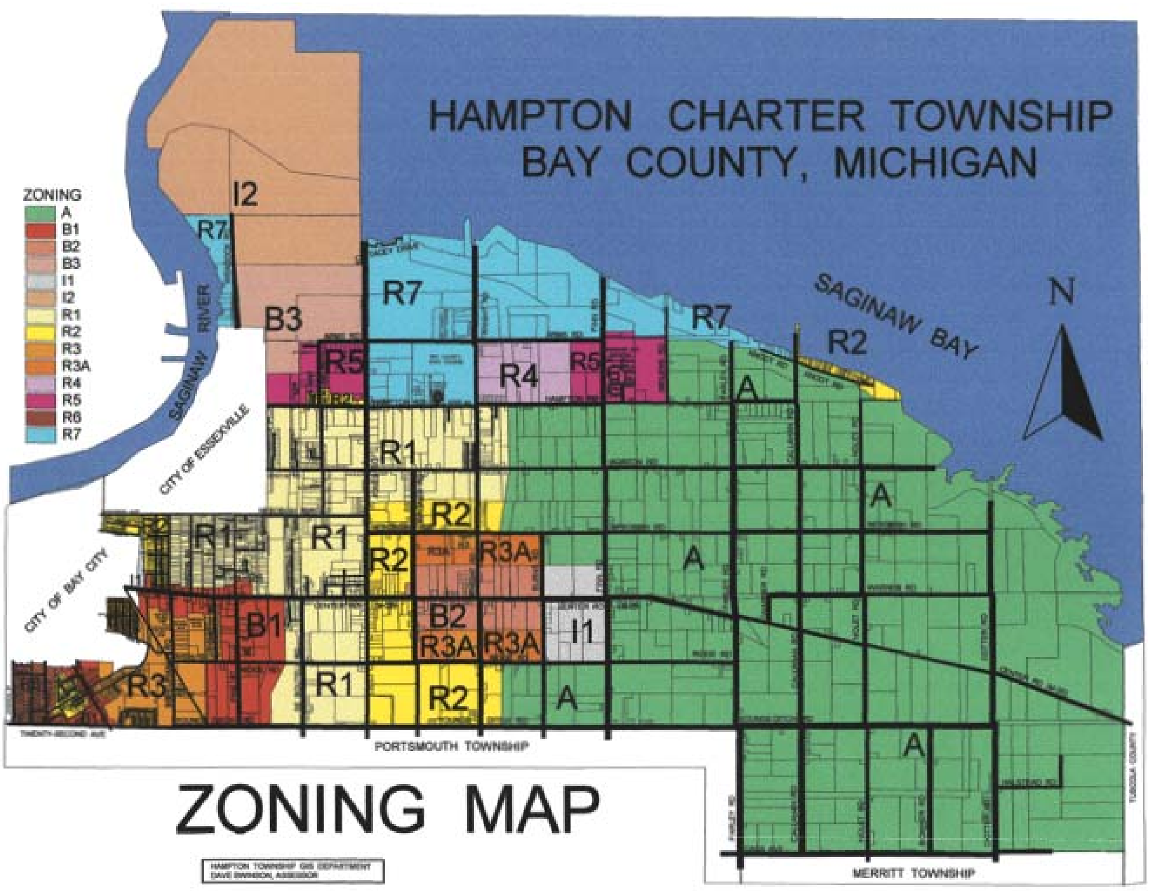
Table
Housing Types in Hampton Township

Type	Number of Dwelling Units	Percent
Single Family Home	2,404	56.2
Duplexes	26	0.6
Multiple Family Units	1,422	33.3
Mobile Homes in Parks	421	9.9
Total	4,273	100.0

Source: Hampton Township Comprehensive Plan Update (2001)

The map below demonstrates the zoning designations for Hampton Township which have shaped the current and will shape future land use patterns:

Figure
Hampton Township Zoning Designations



KAWKAWLIN TOWNSHIP

Kawkawlin Township is located in central Bay County with a two and a half mile shoreline along the Saginaw Bay. The township is located approximately eight miles northwest of the City of Bay City, and is linked to the City in terms of public services, employment, recreation, and entertainment. Four Townships border Kawkawlin, including Fraser to the north, Beaver to the west, Monitor to the south, and Bangor to the east.

During the 2000 census there were 5,104 people in the township. The median income for a household in the township was $43,951. The total are is 41.5 square miles; 32.7 miles is land and 8.8 square miles is water. Kawkawlin is a participant in the NFIP. There were 159 policies in force for a total of $25,521,900 of insurance in force in November 2009. The township has six repetitive loss buildings.

Kawkawlin adopted a Master Plan in 2002. The components of the Plan included the following: input from the public; community history; population; economy; housing; natural resources; existing land uses; public services and facilities; community goals and objectives; future land use plan; and plan implementation.

Land Use & Development Trends

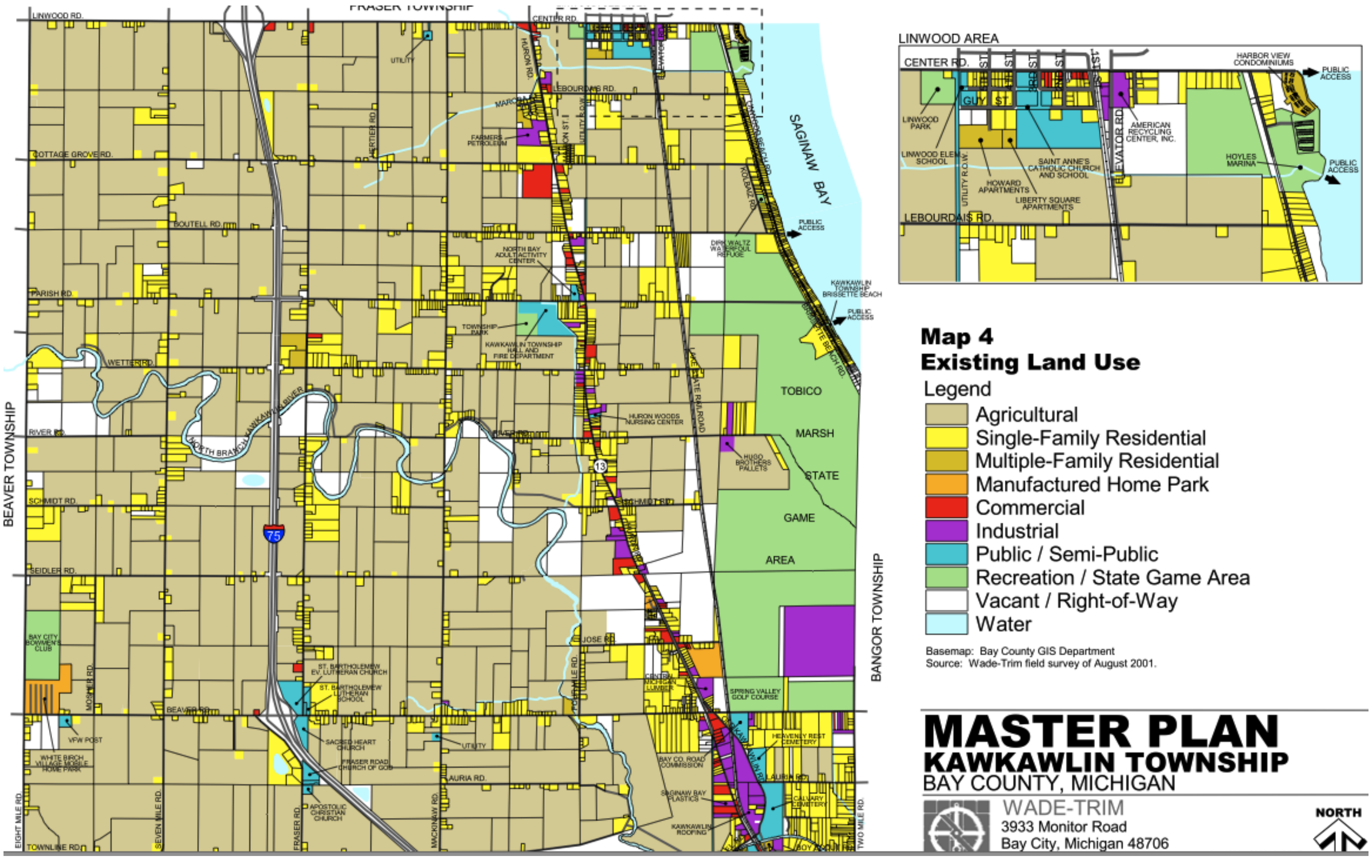
According to the Kawkawlin Township Master Plan, the development patterns in the Township have historically been characterized by agricultural uses and low-density residential development. With a focus on maintaining the same character, the Future Land Use Plan designates the largest percentage of the Township as Agricultural/Rural Residential (53.0%). The purpose of this district is to promote agricultural activities, preserve environmentally significant forested and open space lands, and discourage inappropriate development.

The existing land uses found in Kawkawlin Township follow a typical rural and agricultural land use development pattern. Agricultural lands are primarily found in the less developed western two-thirds of the Township. More concentrated single-family and cottage type residential developments are found in the eastern one-third of the Township. Scattered low-density single-family residential uses have developed throughout the Township along the section line roads. Higher intensity residential, commercial, and industrial uses are located along or near the Township's state highways.

Even though Kawkawlin Township has a fair amount and variety of land uses, its citizens depend on other communities such as Bay City and Saginaw to provide them with many of their everyday needs including employment.

The below map provides information on the existing land use in Kawkawlin Township. Of the 21, 502 total acres of land in the Township, the highest percentage (60.0%) is agricultural. The second largest land use category is vacant/right-of-way, comprising of 3,958 acres or 19.1% of the Township. Single-family residential lands comprise 10.7% of the Township.

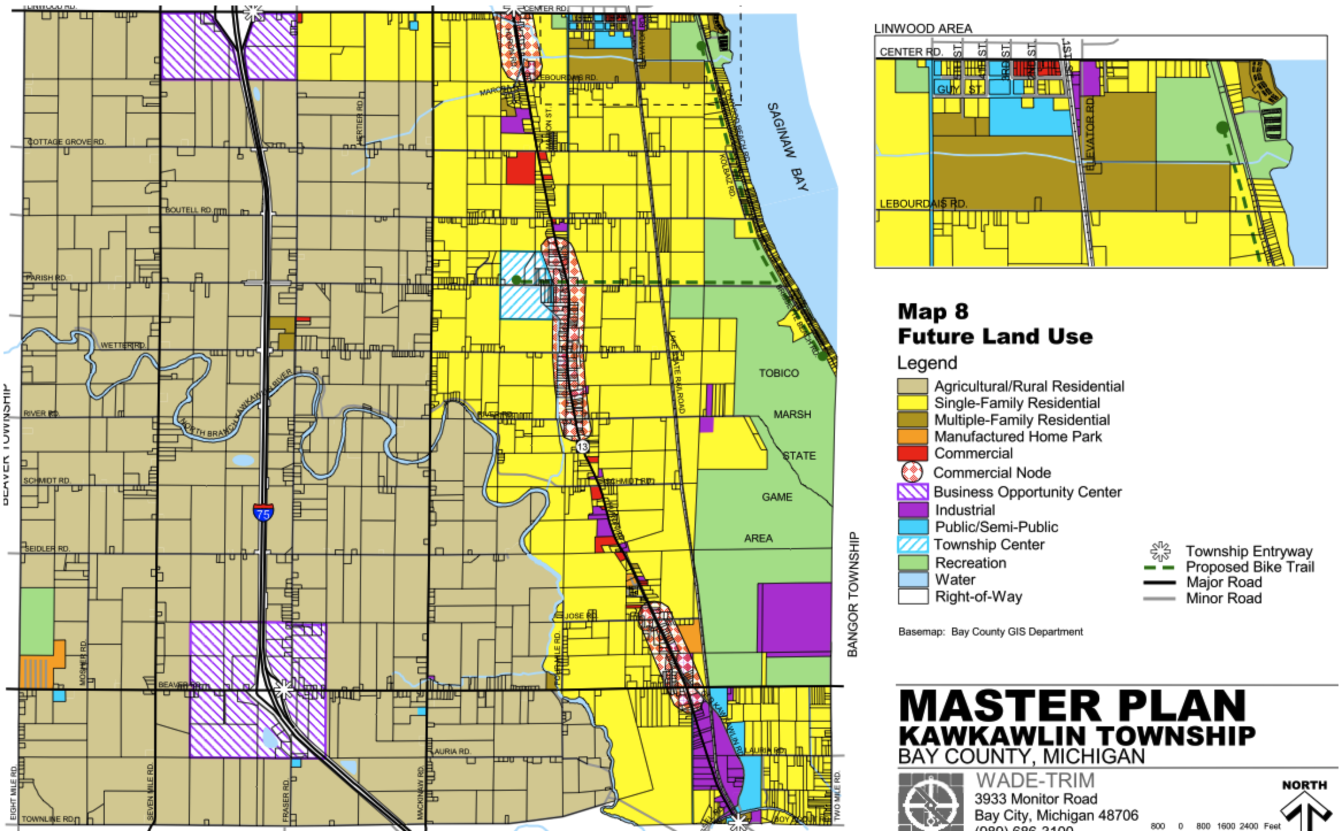
Figure
Kawkawlin Township Existing Land Uses



Another significant recommendation of the Future Land Use Plan is to designate the eastern one-third of the Township as single-family residential. The purpose of this district is to enhance the existing single-family residences, encourage new single-family development, and to promote orderly growth resulting in cost-effective expansion of Township services.

The Future Land Use Map located below shows areas anticipating future growth in Kawkawlin Township:

Figure
Kawkawlin Future Land Uses



MERRITT TOWNSHIP

Merritt Township is located in the southeast corner of Bay County. Merritt Township is unique in that its shape is slightly different than most townships, which are typically six miles square and contain a total of 36 square miles of land. Merritt Township is 31.7 square miles of land due to a “stair-stepped” division of its northwest corner, which borders Portsmouth Township.

During the 2000 census there were 1,510 people. This township is included in the Bay City Metropolitan Statistical Area. The median income for a household was $44,861. Merritt is a participant in the NFIP. As of November 2009, there were eight policies in force with a total of $820,100.00 of insurance. There are no repetitive loss buildings.

The Merritt Planning Commission initiated a master plan that was completed in November 2007. The Master Plan contained the following topics: population, housing, employment and income characteristics; natural features within the community; existing land uses; community input data; goals; future land use; the purchase of development rights program (preservation strategies to preserve farmland and agricultural land, the basis for selection of agricultural and farmland in the designation preservation area); and plan implementation.

Land Use & Development Trends

Agricultural is the predominate land use in Merritt Township, accounting for over 98.56% of all land. The feature of the township gives agricultural land use concerns featured status in decision making. Wooded and vacant comprise mere 0.49% of the total land use in the township and is most concentrated near streams and major drainage areas. The table below shows the existing land use percentages for Merritt Township.

Table
Merritt Township Land Uses

Land Use Percentages, Merritt Township	
Agricultural Land	98.56%
Wooded/Vacant	0.49%
Industrial	0.09%
Residential	0.59%
Recreational/Public	0.15%
Commercial	0.12%

Source: Merritt Township Master Plan (2007)

Figure
Merritt Township Future Land Use Map

MONITOR TOWNSHIP

Monitor Township is in south-central Bay County, Michigan. Bay County is situated at the head of Saginaw Bay in Lake Huron. The Township borders Bay City and Bangor Township to the east, Kawkawlin Township to the north, Williams Township to the west, and Frankenlust Township to the south. The northwest corner of the Township is approximately 3.5 miles from Saginaw Bay to the northeast. Lansing lies about 90 miles southwest, and Detroit is about 120 miles southeast.

Monitor Township covers more than 36 square miles of land. I-75/US-23, US-10, M-84 and M-13 traverse the Township, making Monitor easily accessible to Bay City, Midland, Saginaw and other area communities. In the past, Monitor's pastoral agricultural character and proximity to metropolitan areas made it a desirable bedroom community.

The Township is located in South Central Bay County. It is located at the head of Saginaw Bay in Lake Huron. Monitor covers more 36 square miles of land. The population in Monitor as of the 2000 Census was 10,037. Between 1980 and 2000, the percentage change was -1.0%. Between 1990 and 2000, the community actually saw an increase in population +5.5%. Between 2001 and 2004, the community saw an increase in new dwellings and new population. The median age of residents was 43.3 years old in 2000. Monitor is a participant in the NFIP. As of November 2009 there were 19 policies in force totaling $2,825,600.00 of insurance. The Township has no repetitive loss buildings.

The Township of Monitor Master Plan was completed in 2005. Like this document, the Master Plan planning function is a continuous process that does not conclude with the adoption of this plan. It was recommended that the Master Plan be updated every three to five years. The Plan contains information regarding the natural features, social characteristics within the community, economic analysis, housing analysis, culture and leisure activities, public infrastructure, existing land use, community visions and actions, future land use plans, and plan implementation.

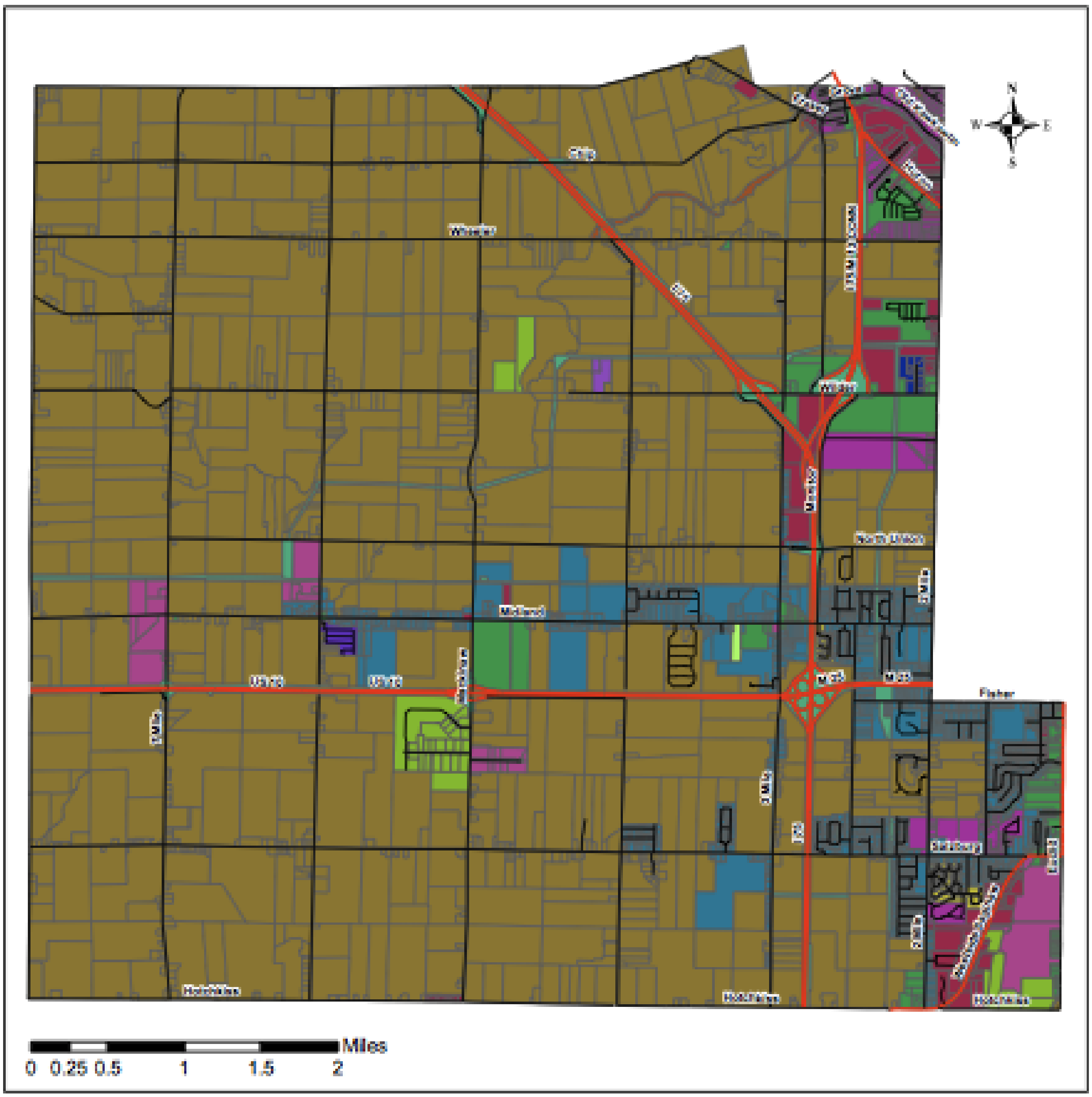
Land Use & Development Trends

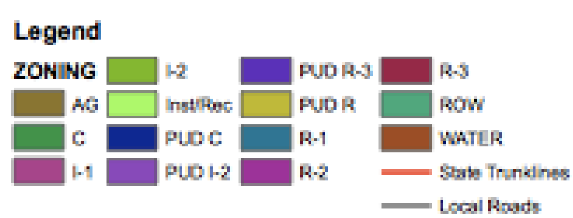
The map below shows the existing land use zoning categorization for Monitor Township. Eight land use categories were established to define the various land uses found throughout the Township. These categories include Mobile Home Park, Private Recreation, Public, Industrial, Commercial, Multiple Family, Single Family, and Agricultural/Open Space. The Existing Land Use Map shows where these land uses are found.

Monitor Township's land use is characterized by human features including residential outgrowth from Bay City, I-75/US-23, US-10. It is also characterized by natural features such as the Kawkawlin River and the wetlands of Squaconning Creek. These features will continue to significantly influence land utilization in the Township. Though there is not a great deal of population growth predicted for the Township, growth in the form of land development should be plentiful. This growth will depend on existing land features and public utilities that must be provided by the Township and other public entities.

Figure
Monitor Township Land Use Designations

Monitor Twp. Zoning
as of Jan. 2000





Please Contact Monitor Twp.
for Most recent zoning map.

MOUNT FOREST TOWNSHIP

Mount Forest is located in the northwestern portion of Bay County. The population in the township during the 2000 census was 1,405 and is included in the Bay City Metropolitan Statistical Area. The median income for a household in the community during the 2000 census was $38,125. The total area of the community is 36.0 square miles. All of which are land. Mount Forest does not participate in the NFIP. There are no repetitive loss buildings.

Land Use & Development Trends

An important tool for shaping land use and development is through land use planning and the establishment of a zoning ordinance. Mt. Forest Township has established a zoning ordinance, as effective in the 2000, to help guide growth within the Township.

The below table indicates that population in Mt. Forest Township was estimated to increase substantially from 2000 to 2007 by +25%. With limited information on specific land use trends, population change can provide a general indication of what type of growth is occurring. With the population increasing within the township, it may be that residential growth is and has been occurring over the years.

Table
Estimated Population of Mount Forest Township, 2000-2007

Estimated Population of Michigan Cities and Townships by County, 2000-2007					
	April 1, 2000				
Area Name	**Census**	**Estimates Base**	**2000 Estimate**	**2007 Estimate**	**Change 04/00-7/07**
Mount Forest Township	1,405	1,405	1,418	1,756	+25.0%

Source: http://www.michigan.gov/som/0,1607,7-192-29938_54272-222658--,00.html

CITY OF PINCONNING

The City of Pinconning, located in northern Bay County, has historically been a center of commerce for surrounding townships. Pinconning was originally platted in 1872 as a 100 acre settlement. The settlement became incorporated as a village in 1887 and ultimately as a city in 1931 when it adopted a municipal charter. At that time, Pinconning's population had grown to almost a thousand residents. The early economy of the area was based upon lumbering, which subsequently declined around the turn of the century. Between then and the 1930s, when manufacturing came into its own, the City was primarily a trading center and retail center for farmers in outlying areas.

During the 2000 census there were 1,386 people. The median income for a household was $27,188. General industrial areas are located in the central and south central portion of the City. There are two commercial areas the Central Business District which is bounded by Warren Street on the east, Fourth Street on the south, Manitou Street on the west and the properties bordering Second Street on the north. The second area of the commercial development is located on both sides of Mabel Street between the southern and northern City limits.

The total area for the City is 0.9 square miles, all of which is land. The majority of the land is residential. The City is a participant in the NFIP. As of November 2009, there were four policies in place, totaling $426,200 in insurance. The City has no repetitive loss buildings. The City of Pinconning Downtown Redevelopment Plan was completed in June 1995. There are several components to this Plan, including the following: Area Description, Market Analysis, Consumers Activities and Attitudes, Merchant Activities and Attitudes, Goals and Objectives, Recommended Retail Mix, Downtown Development Design, Administration Marketing Plan, and Implementation Program.

Land Use & Development Trends

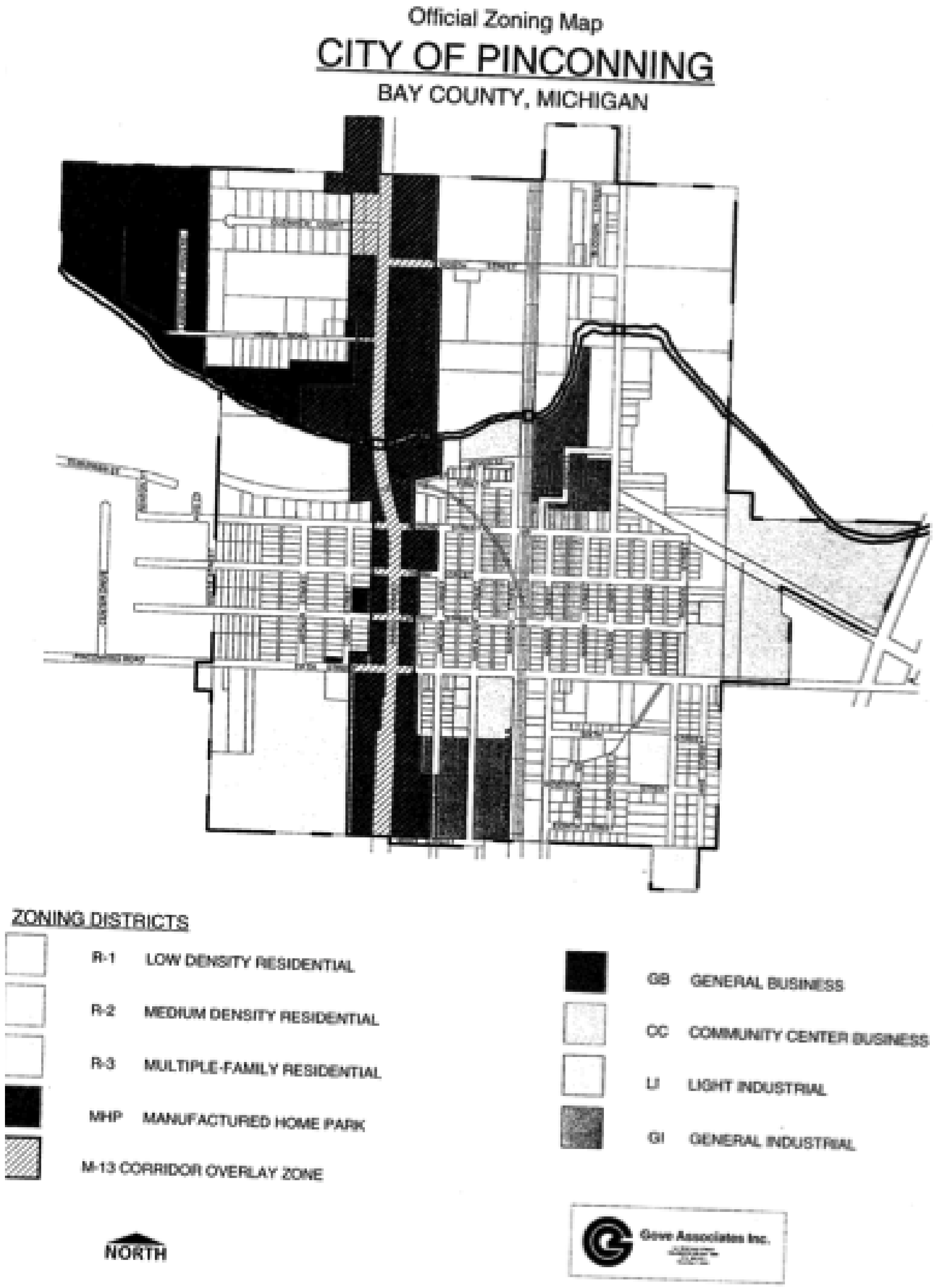
In 1995, the City of Pinconning developed a downtown redevelopment plan that inventoried current land use distribution and made recommendations for future land use in the City. The following table provides a snapshot of current land use trends dated to the 1980's. The subsequent map, derived from the City of Pinconning Zoning Ordinance (2000), provides a snapshot of City of Pinconning, its boundaries, and how it intends to grow and develop in the future.

Table
City of Pinconning Land Use Trends

Land Use	Acres	Percent of Total
Residential	104.1	18.4
Commercial	37.7	6.6
Industrial	25.9	4.6
Streets/Railroad	105.3	18.5
School, Parks, etc.	72.8	12.9
Undeveloped Land	220.7	39.0
Total	**566.5**	**100.0**

Source: Pinconning City Master Plan (1995)

Figure
City of Pinconning Zoning Map



Source: City of Pinconning Zoning Ordinance (2000)

PINCONNING TOWNSHIP

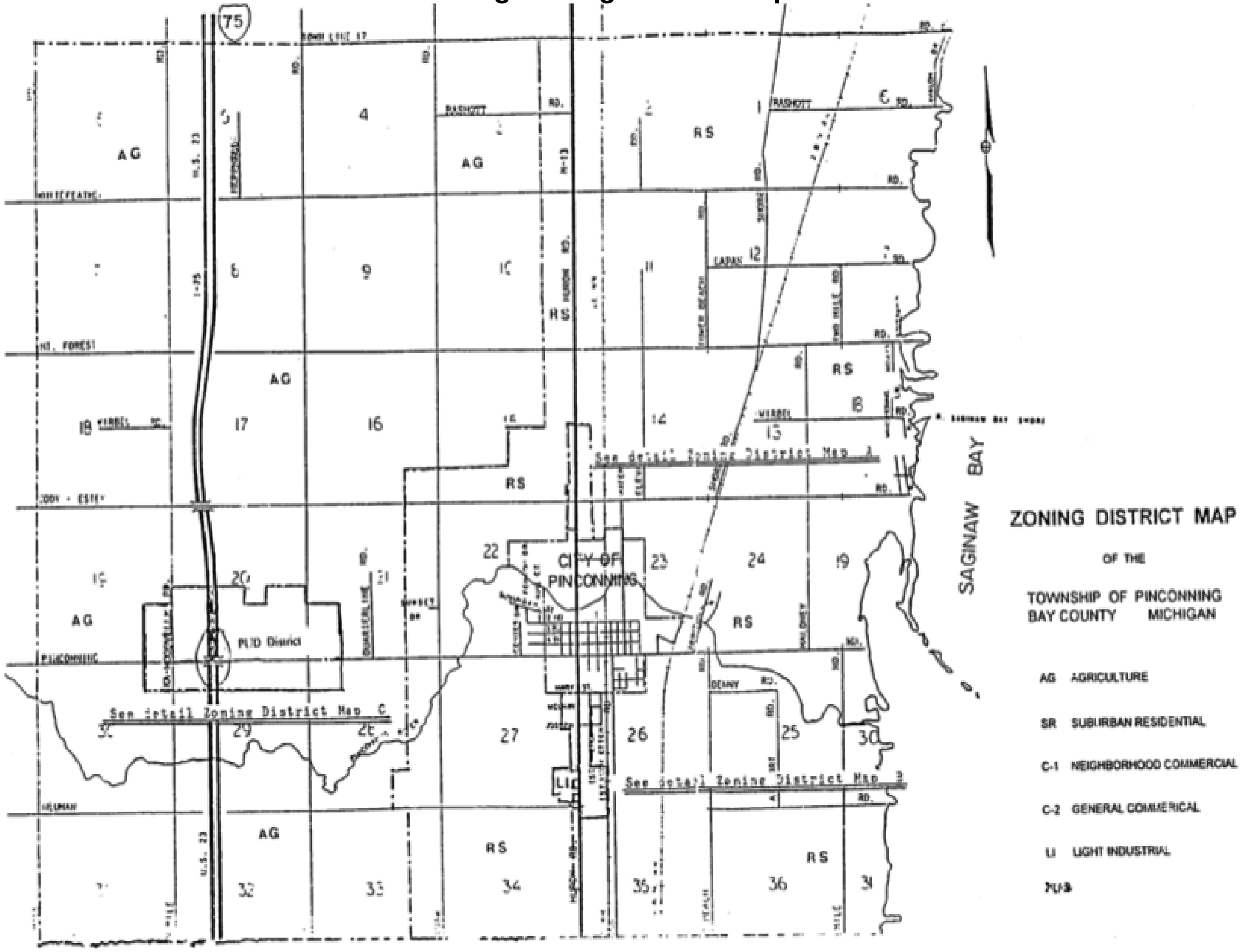
Pinconning Township is located in the northeastern portion of Bay County with Mount Forest Township to the west, Fraser Township to the south, Saginaw Bay to the east, and Arenac County to the north. Pinconning Township is the second largest township in Bay County.

The population in the Township was 2,608 during the 2000 census and is included in the Bay City Metropolitan Statistical Area. The median income for a household was $43,021. The City of Pinconning is surrounded by the Township but is administratively separate. The Township is 41.9 square miles; 36.6 square miles are land and 5.3 square miles are water. The Township is a participant in the NFIP. As of November 2009, there were 46 policies in force, with $5,085,400.00 of insurance. There is one repetitive loss building. The Pinconning Township Comprehensive Plan was completed in 1978 and amended in 1997. The Plan and Zoning Ordinances were later updated during the 1990's.

Land Use & Development Trends

In response to development pressures, Pinconning Township has developed a Zoning Ordinance, and a Comprehensive Plan to help shape the way development will occur in the Township. The below map provides a snapshot of how the development trends will occur based upon the zoning designations for the Township. For more information regarding land use and development trends, see the Pinconning Township Zoning Ordinance and Master Plan.

Figure
Pinconning Zoning District Map



Source: Pinconning Township Zoning Ordinance (2001)

PORTSMOUTH

The Township of Portsmouth is located in the southeastern portion of Bay County. As of the 2000 U.S. Census, there were 3,619 people and 1,408 households in the township. The median income for a household was $45,500. The median age for a resident was 41 years. The total area of the community is 20.1 square miles, with 20.0 miles being land. The Township is a participant in the NFIP. As of November 2009, there were 26 policies in force with $2,704,900.00 of insurance. There are no repetitive loss buildings.

Land Use & Development Trends

With limited land use and development information on the Township, population data can provide an indication of whether a strong development pressure is present. According to the Population Estimation Map, Portsmouth Township's population was estimated to decrease by -2.2% from 2000 to 2007.

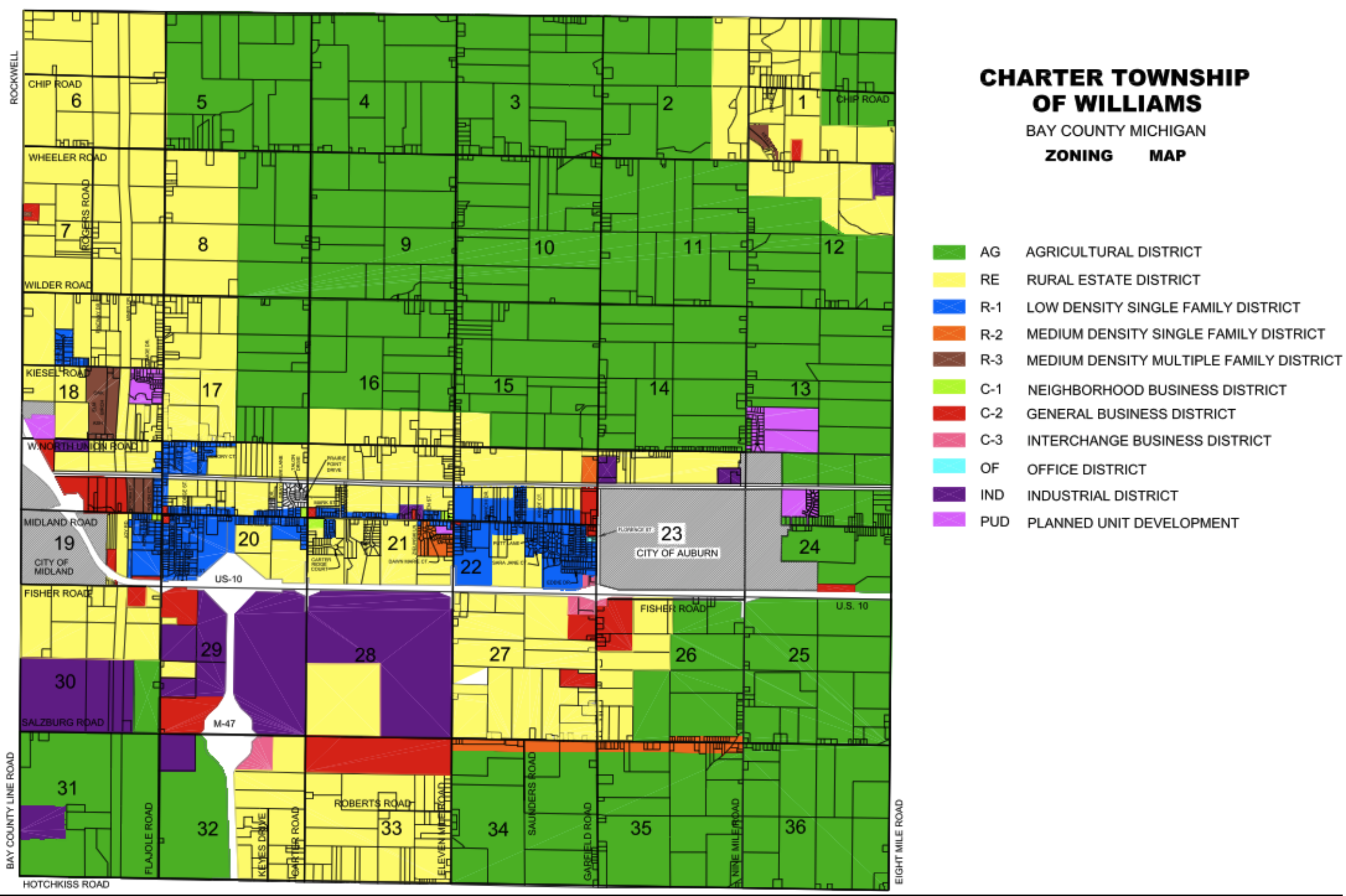
WILLIAMS TOWNSHIP

Williams Township is located in the southwestern corner of Bay County. In recent years, from 2000-2007, the population of Williams Township was estimated to grow from 4,492 to 4,739 (+5.5%). Williams Township is 33.6 square miles with 33.5 square miles being land. During the 2000 Census, there were 4,492 people. The median income for a household in the community was $54,766. Williams is a participant in the NFIP. As of November 2009 there were 9 policies in place totaling $1,566,500.00 of insurance. The Township has no repetitive loss buildings.

Land Use & Development Trends

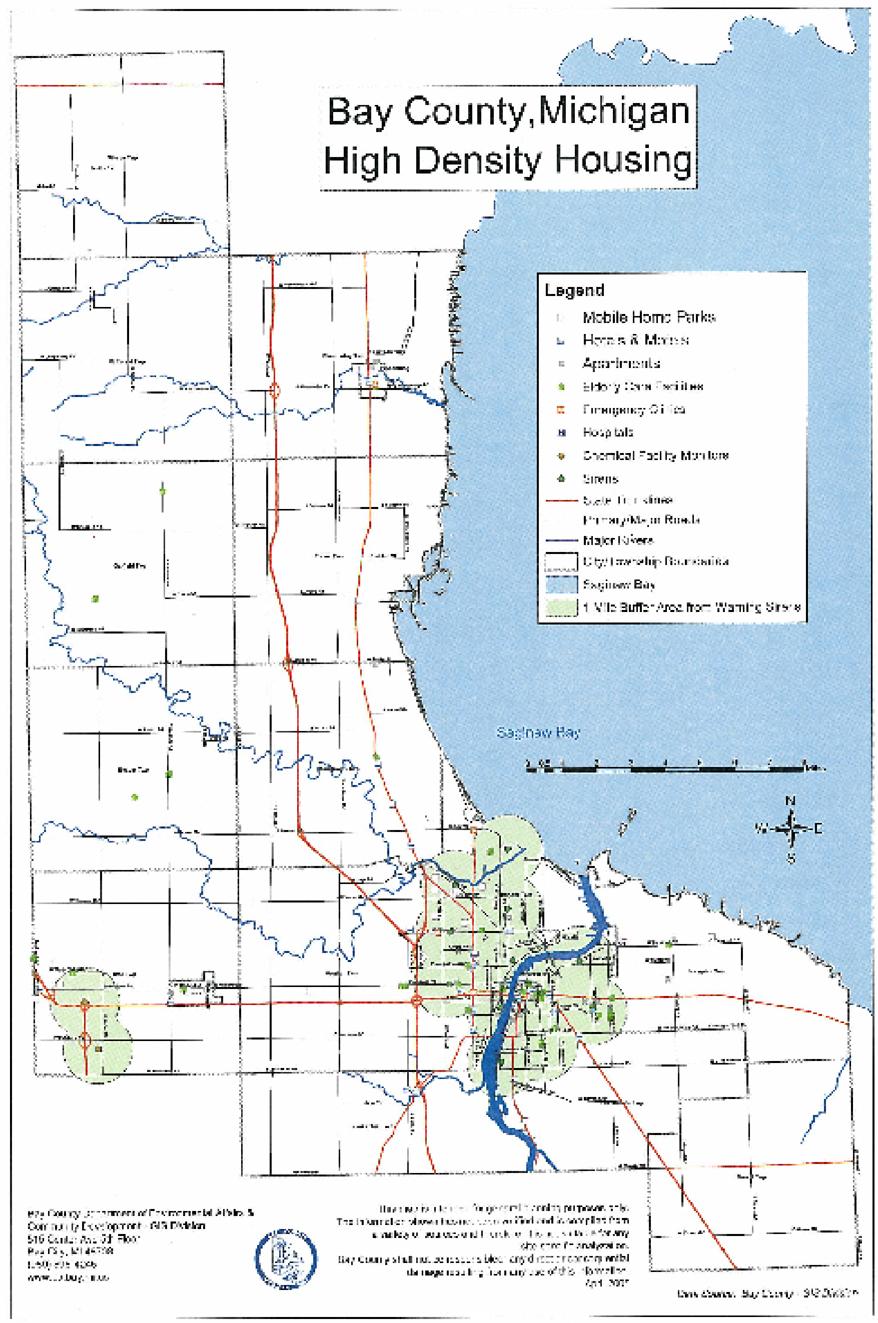
In response to development pressures, Williams Township has developed a Zoning Ordinance to help shape the way development will occur in the Township. The below map provides a snapshot of how the development trends will occur based upon the zoning designations for the Township.

Figure
Williams Township Zoning Map



Source: Williams Township (2010)

Figure
Map of Warning Sirens Locations



The above map shows the locations of the warning sirens and the one mile buffer surrounding them. Increasing the warning system is a consistent mitigation action for the communities participating in the plan.

Conclusion

It is important to understand the development trends of each community within Bay County when contemplating affective mitigation planning activities. This overview describes each jurisdictions growth and or decline. It is also important to note which jurisdictions have zoning and land use planning enacted in their jurisdictions. These functions of government will help promote the activities of hazard mitigation throughout a community. It is also important that the data created in the hazard mitigation plan be used in the future to develop more refined land use and zoning ordinances. Bay county is aware of the correlation between the data created in the mitigation plan and the positive effects it can have on the development trends throughout the community. Future development in Bay County will consider the hazard information created in the hazard mitigation plan in order to keep lives and property safe from natural hazards.

Appendix J

Mitigation Activities Worksheet

Community Name: ________________________ **Contact Name**: ________________________ **Contact Phone No.**: ____________

Mitigation Goals:

1. **Preventative Activities**. Reduce risks through regulations including building codes, development outside of hazardous areas, and local planning or capital improvement projects.
2. **Property Protection**. Reduce exposure to hazards through building or parcel specific activities such as flood proofing, structure acquisition, or retrofitting.
3. **Emergency Services.** Reduce impacts through response and recovery activities that are implemented during a disaster.
4. **Structural Projects.** Minimize impacts through projects, such as detention basins, tornado shelters, tornado sirens, etc.
5. **Public Information.** Assist residents to prepare for risks and protective measures to better protect themselves and their property.
6. **Other**. ________________________
7. **Other**.________________________

Item Number	Goal Number	Mitigation Action	Responsible Agency & Contact Person	Funding Source	Implementation Timeline	Estimated Benefits†	Estimated Costs†
Example	*2*	*Purchase homes in the 100 year floodplain and convert the space to a park or greenspace to reduce flood impacts.*	*County Planning Department - Bob Jones, Director*	*Hazard Mitigation Grant Program & General Funds*	*5 years*	*Medium*	*Medium*
1.							
2.							
3.							
4.							
5.							
6.							

† **Benefits and Costs estimates should be based on these categories:**

Less than $100,000 = Low
$100,000 - $500,000 = Medium
More than $500,000 = High

Appendix K

Plan Amendments