Tuscola County

Hazard Analysis and Mitigation Plan

September 22, 2015 draft

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Preface

Hazard mitigation is any action taken before, during or after a disaster to permanently eliminate or reduce the long-term risk to human life and property from natural, technological, and human-related hazards. It is an essential element of emergency management, along with preparedness, response and recovery. There is a cyclical relationship between the four phases of emergency management. A community prepares for a disaster and then responds when it occurs. Following the response, there is a transition into the recovery process, during which mitigation measures are evaluated and adopted. This, in turn, involves the preparedness posture of the community for the next incident. When successful, mitigation will lessen the impacts to such a degree that succeeding incidents will remain incidents and not become disasters.

Hazard mitigation strives to reduce the impact of hazards on people and property through the coordination of resources, programs, and authorities so that, at the very least, communities do not contribute to the increasing severity of the problem by allowing repairs and reconstruction to be completed in such a way as to simply restore damaged property as quickly as possible to pre-disaster conditions. While such efforts may expedite a return to “normalcy,” replication of pre-disaster conditions that could be changed results in a cycle of damage, reconstruction and damage again.

Hazard mitigation is needed to ensure that such cycles are broken, that post-disaster repairs and reconstruction take place after damages are analyzed and that sounder, less vulnerable conditions are produced. Through a combination of regulatory, administrative and engineering approaches, losses can be limited by reducing susceptibility to damage. Hazard mitigation provides the mechanism by which communities and individuals can break the damage-reconstruction cycle.

Recognizing the importance of reducing community vulnerability to natural and technological hazards, Tuscola County is actively addressing the issue through the development and subsequent implementation of this plan. The many benefits to be realized through this effort – protection of the public health and safety, preservation of essential services, prevention of property damage, and preservation of the local economic base, to mention just a few – will help ensure that Tuscola County remains a vibrant, safe and enjoyable place to live and work.

Introduction

Purpose:

The Tuscola County Hazard Mitigation Plan (hereafter referred to as the "Plan") was created to protect the health, safety and economic interests of residents by reducing the impact of natural and technological hazards through hazard mitigation, planning, awareness, and implementation. Hazard mitigation is any action taken to permanently eliminate or reduce long term risk to human life and property from natural and technological hazards. It is an essential element of emergency management along with preparedness, response and recovery. This plan serves as the foundation for hazard mitigation activities within the community. Implementation of the plan's recommendations will reduce injuries, loss of life and destruction of property due to natural and technological hazards. The plan provides a path toward continuous, proactive reduction of vulnerability to the most frequent hazards that result in repetitive and often severe social, economic and physical damage. The ideal end-state is total integration of hazard mitigation activities, programs, capabilities and actions into normal day-to-day governmental functions and management practices.

Planning Process:

The Tuscola County Hazard Mitigation Plan examines multi-hazard mitigation activities and opportunities. Emphasis is placed on hazards that have had significant impact on the community in the past. The planning process followed in the development of the Tuscola County Hazard Mitigation Plan consisted of the following steps:

1. Identification of the hazards and risks
2. Identification and definition of goals and objectives
3. Identification of alternatives for solving problems
4. Selection of evaluation criteria
5. Selection of alternatives considered feasible as mitigation strategies
6. Implementation strategies

The initial effort toward these steps was completed during the first meeting of the Hazard Mitigation Planning team held on July 8, 2015. The meeting was led by the Tuscola County Emergency Management Director, Steve Anderson, and included all members of the planning team. This team meets monthly to review and take action on emergency management issues.

On July 12, 2015 a second meeting was held at the Tuscola County Skills center to accommodate a larger groups of people representing all the jurisdictions and the public in the county. All police chiefs, fire chiefs, township supervisors, village managers, township and village clerks, an economic development representative, the county planning commission chair, the county Board of Commissioners chair, the drain commissioner, 911 staff and the

undersheriff were invited as well as neighboring communities. Six people attended this meeting, representing two municipalities and emergency providers in Tuscola County.

Those that attended represented the following communities and agencies:

- City of Vassar Fire Department
- City of Vassar Police Department
- City of Vassar Council
- Juniata Township
- Village of Fairgrove
- Vassar Township
- Tuscola County Emergency Management

At this meeting the group reviewed hazards as written in the draft plan. Following this the group reviewed a hazard-ranking rubric (Appendix A) that was supplied to each person present at the meeting. The results of this ranking were later tabulated and included in the overall hazard rankings of the plan. This overall hazard ranking also took in to account historical data and calculations of historical probabilities of hazards based on data obtained from various agencies. Weights were assigned to each hazard based on the public input received at this first meeting and each hazard's historical likelihood and impact and a final ranking of the hazards was arrived at (for a summary of this ranking, see Table 22). Finally, the group reviewed goals and objectives (step 2) for hazard mitigation planning, although this was more seriously undertaken at the following meeting.

All of the individual communities in Tuscola County participated in the Plan drafting either by participating in the meetings or by direct communication with the Emergency Management program. Some communities elected to opt out of participation in the update of the Plan but all communities are expected to formally adopt the Plan upon completion and FEMA approval. During the Plan writing process specific concerns were discussed by jurisdiction and hazards were identified with proposed mitigation projects for most jurisdictions.

The City of Vassar's current flood mitigation plan is the most prominent of these and is included in this Plan by reference in the flood section. The City of Vassar's flood mitigation plan is an existing plan and is included here since it was used as a partial basis for this plan. The City of Vassar adopted this plan on September 21, 1998 and has not updated it locally.

A second meeting was held on August 12, 2015 to continue with steps 2, 3 and 4. There were 20 people at this meeting, some of whom had attended the previous meeting. Attendees represented county agencies, local government, and concerned county citizens. The meeting began with a review of the results of the hazard ranking undertaken at the previous meeting. Given the very low attendance, this process was repeated to include more representatives from different geographic areas of the county. Attendees represented the following jurisdictions:

- Almer Township
- Caro police department
- City of Caro

- Village of Kingston
- City of Vassar
- Elmwood Township fire department
- LEPC -2
- Mayville police department
- Millington Township
- Richville Fire Department
- Star of the West Milling Co.
- Tuscola County ACRES/RACES
- Tuscola County Drain Office
- Tuscola County Sheriff - 2
- Tuscola Township
- Unionville fire department
- Vassar Township
- Village of Gagetown
- Village of Mayville – 2

Community members were given the opportunity to express how accurate they felt the hazard rankings were, which at this point had been arrived at through the combined consideration of historical incidences and severities of various hazards as well as the community's assessment, of what represented the actual hazard threat to the county. Community members included both invitees that participated as part of the Hazard Planning Team and the general public, who learned of the meeting through the newspaper, at their Township Hall or from any number of other places and meetings where the Hazard Mitigation Plan writing process was discussed.

After these suggestions were noted, meeting participants moved on to discuss hazard mitigation goals, objectives and strategies. A number of sample goals and objectives were provided in order to give participants a general idea of the kind of language and purposes involved, and what followed was a discussion of the community's goals, and objectives to meet those goals.

Using the priorities and goals established at these two meetings as a foundation, the Hazard Mitigation Planning team went on to develop specific solutions (steps 5. and 6.) for the County's top hazards and prepared a complete first draft of the plan.

A third meeting of the Hazard Mitigation Planning Team was held on _____, 2015 to review the plan as a whole prior to soliciting additional public input. _____ people, representing the core of the Planning Team, attended. The purpose and outcome of this meeting was a consensus on a final draft of the plan that now included specific solutions, proposed partners for projects and estimates of cost. The general public did not attend this meeting, although they were invited. The following municipalities were represented at this meeting:

- Dayton Township
- Kingston police department
- Fremont Township
- Cass City police department

- Village of Kingston
- Caro police department
- Caro fire department
- Columbia Township
- Millington fire department
- Millington Township
- Tuscola Township
- Juniata Township
- Akron Village
- Tuscola County Road Commission
- Tuscola County Health Department

After preparation of the first draft of the plan, the Tuscola County staff, consultants and the Michigan State Police Hazard Mitigation representative met to discuss necessary revisions to the plan. These changes were incorporated into the second draft of the plan.

Following the submission of the first draft of the plan to the state, the public was given an opportunity to review the completed draft and submit any comments or concerns to the Emergency Management Director and county officials. The open comment period lasted roughly three months.

Public participation has been encouraged though individual mailings and telephone calls to jurisdictions and establishment of a mailing list throughout the Plan writing process for interested people and agencies. Individual invitations were sent out and broad advertising campaigns were undertaken in the local paper, the Chamber of Commerce's web site, the County's web site and intra county communications. People specifically notified represented business interests, academia, neighboring communities, neighborhood groups and other interested parties. All meetings were open to the public.

During the process several key points regarding hazard mitigation that are unique to Tuscola County were raised and addressed: The ethanol plant in Caro requires specific preparedness actions, flooding severity and nature varies widely between the shoreline, rural and City of Vassar areas, and there are multiple gas wells, chemical transmission lines and other relatively unseen hazards that are being addressed in the plan.

Chapter 1: Hazards and Risks in Tuscola

COMMUNITY PROFILE

The following summary provides a brief overview of the key characteristics of Tuscola County. This information will assist in understanding potential hazard risks and vulnerable areas, and will help in determining feasible mitigation strategies.

History

Today's Tuscola County lies on land that was originally inhabited by Ojibwa Native Americans who arrived in the presumably uninhabited area around the 14th century.

The first European settlers in the area arrived from New York. In 1835, Ebenezer Davis, with his wife and eleven children, founded the first settlement in what is today Tuscola County. Around 1850, Tuscola began to flourish with the introduction of the logging industry. In 1864, the county sent 40 million feet of logs down the Cass River to be processed as far away as the Saginaw Bay.

History would prove that this prosperity could not last forever. The great forest fires of 1871 and 1881 effectively ended logging in Tuscola County. With these apparent disasters, however, came great opportunity. Tuscola's land was left cleared of trees and its soil was fertilized by ash, positioning it to become a prosperous farming community. Government incentives to grow sugar beets, originally introduced to the area by German settlers, ensured the crop's importance in Tuscola's agriculture that remains today.

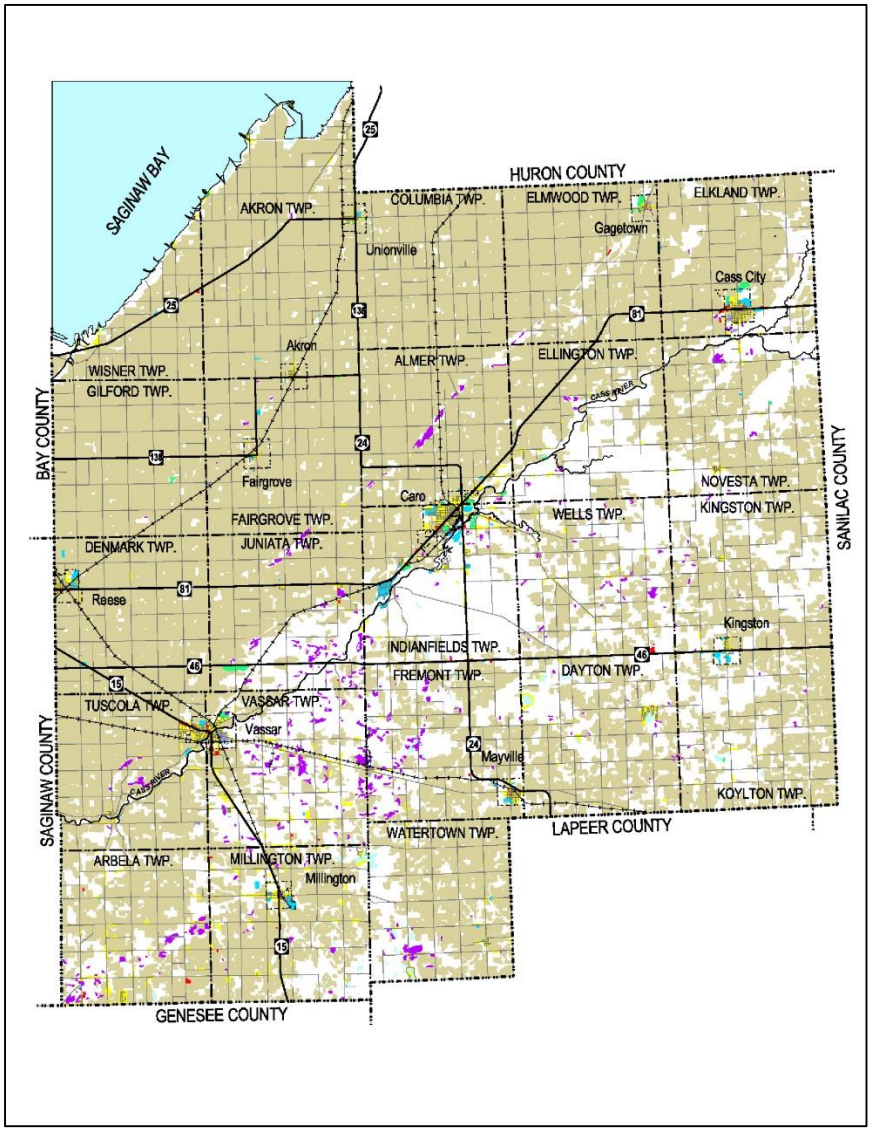
In addition to sugar beets, corn is an important agricultural product to the county. Originally grown for food, in 2001 construction began on an ethanol plant in Caro to process corn into ethanol fuel. Corn growers throughout the state supported the effort with coordination from Michigan State University and today the Caro ethanol plant buys grain from farmers throughout the county and employs many people in Tuscola County.

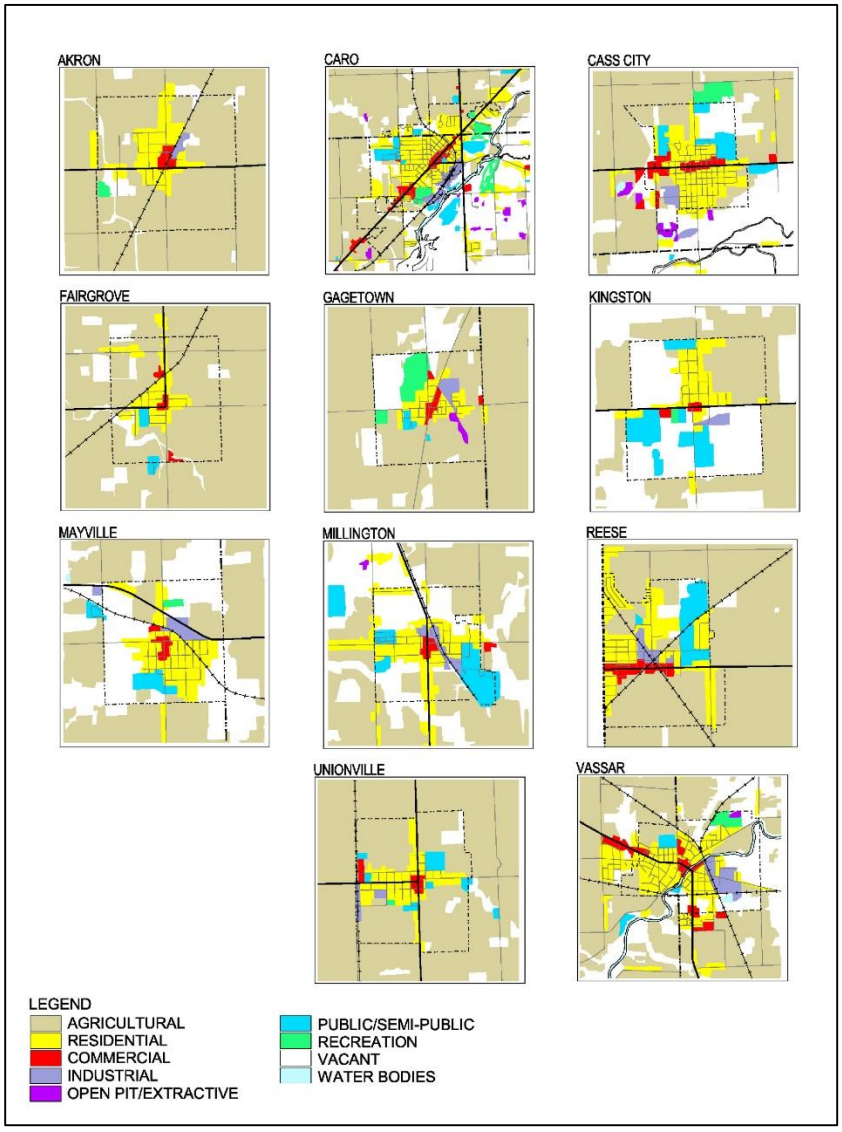
Tuscola County is divided into the townships of Akron, Almer, Arbela, Columbia, Dayton, Denmark, Elkland, Ellington, Elmwood, Fairgrove, Fremont, Gilford, Indianfields, Juniata, Kingston, Koylton, Millington, Novesta, Tuscola, Vassar, Watertown, Wells and Wisner. It contains the Cities of Caro and Vassar and also the villages of Akron, Cass City, Fairgrove, Gagetown, Kingston, Mayville, Millington, Reese and Unionville.

Existing and Future Land Use –

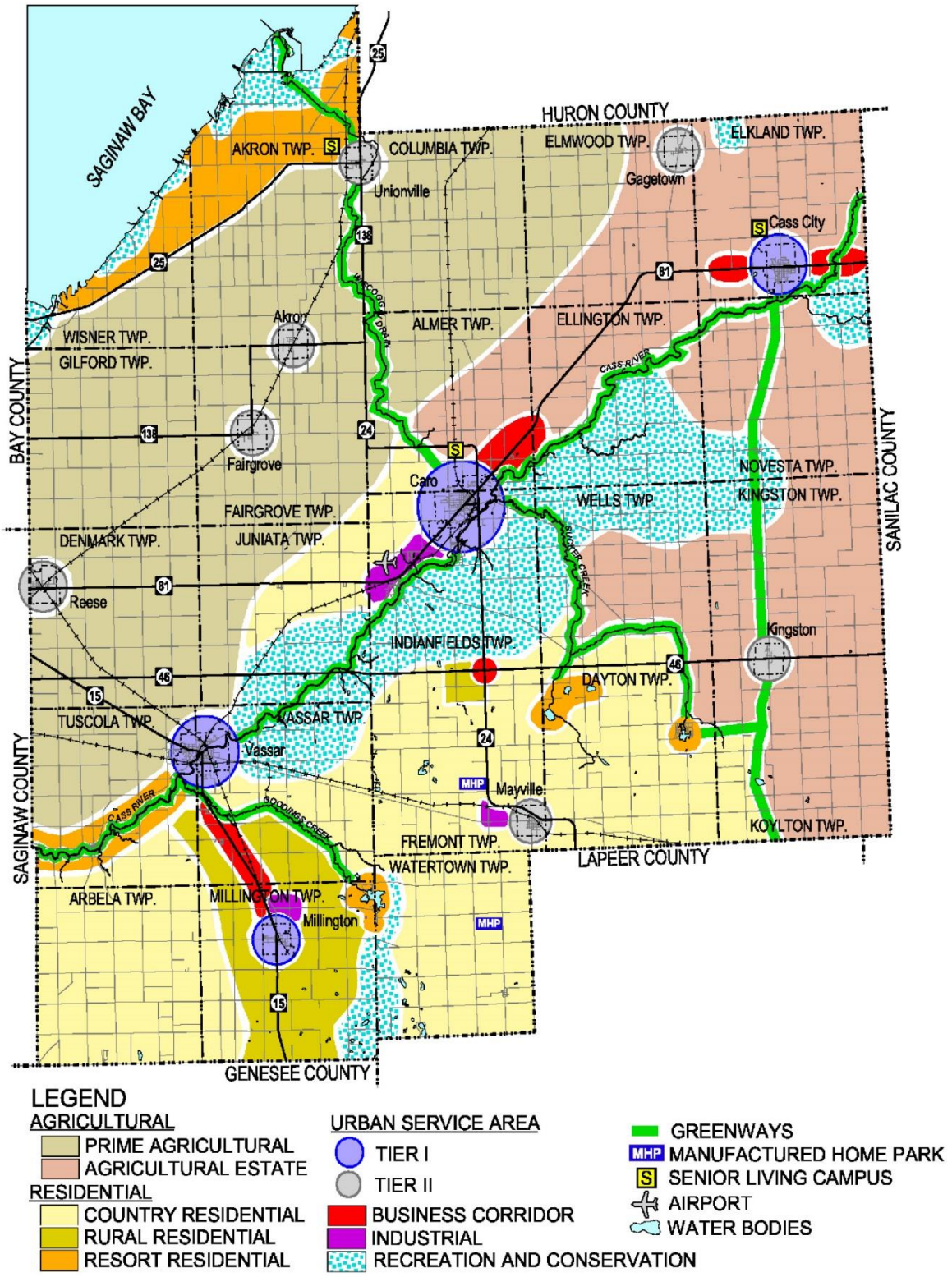
Land use planning is a key factor to consider when planning for an emergency. Guiding development to appropriate locations and prohibiting development in locations where predictable or obvious hazards may impact structures or people is one of the most important ways to mitigate hazards. The following five maps, reproduced from the Tuscola County Master Plan of 2013, show general existing land use using land coverage data, a general Development Plan and a composite Future Land Use Plan for the county, where information is available.

Map 1 Land Use Map

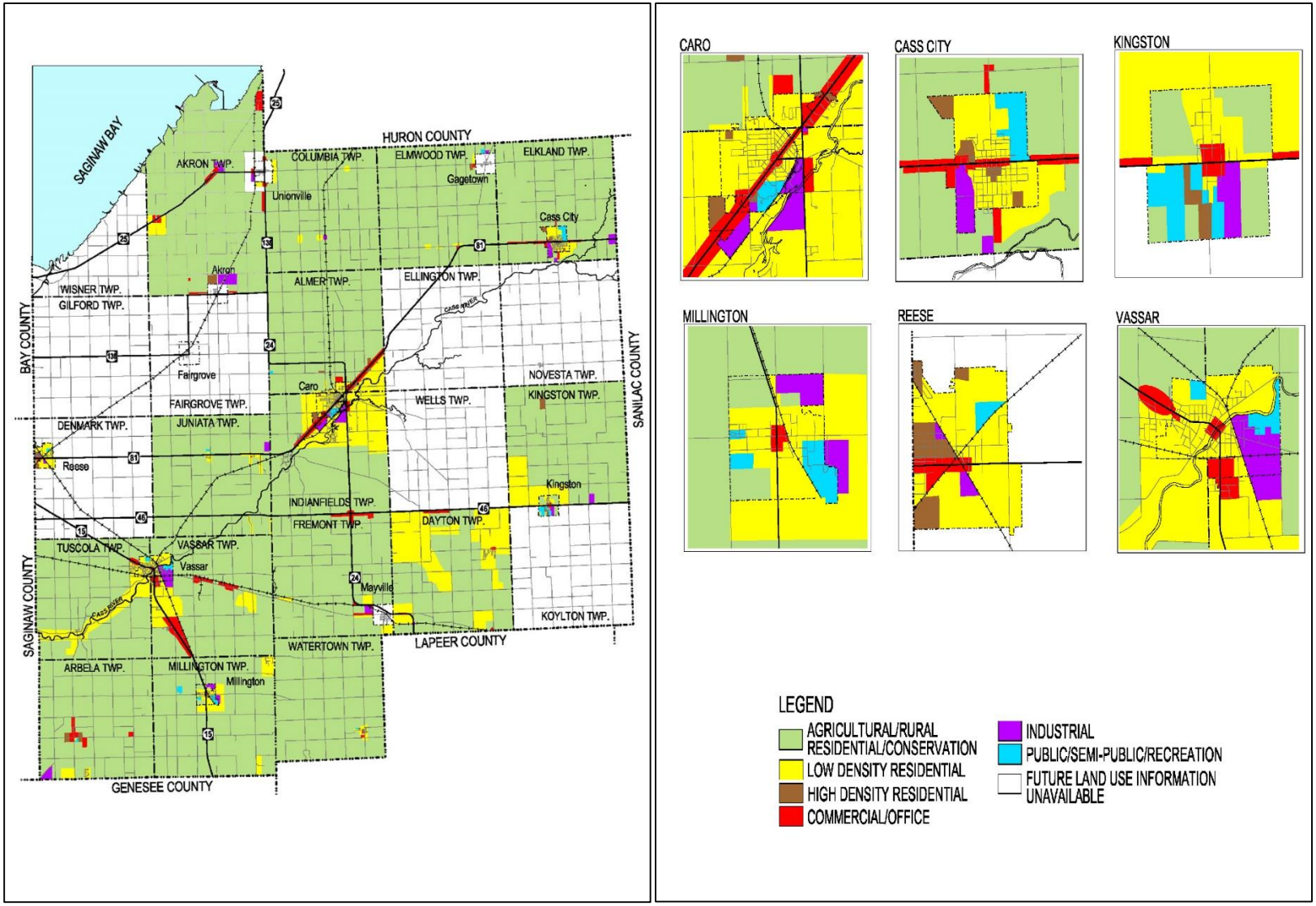




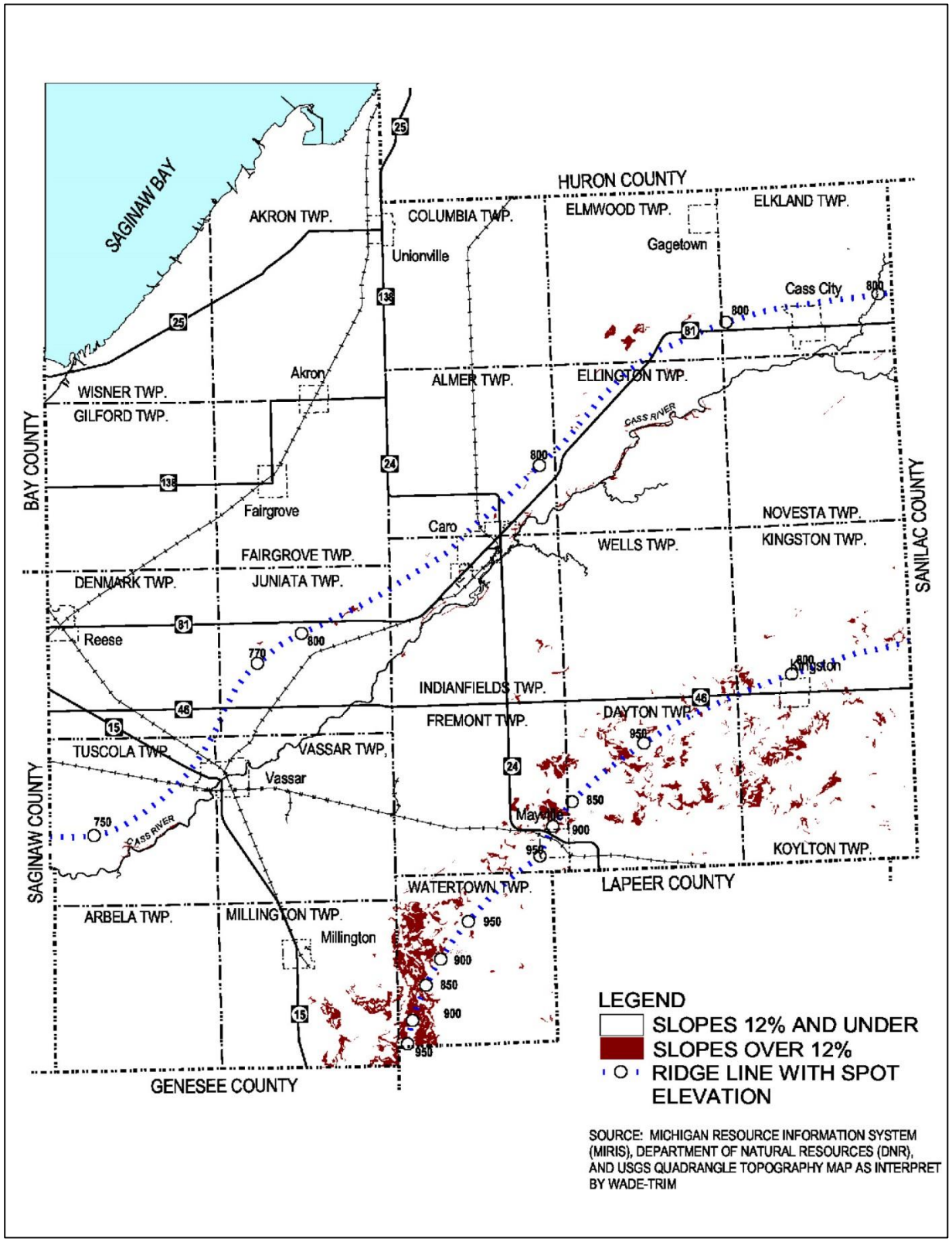
Map 2 General Development Plan Map



Map 3 Future Land Use Composite Map



Map 4 Topographical Map



Climate

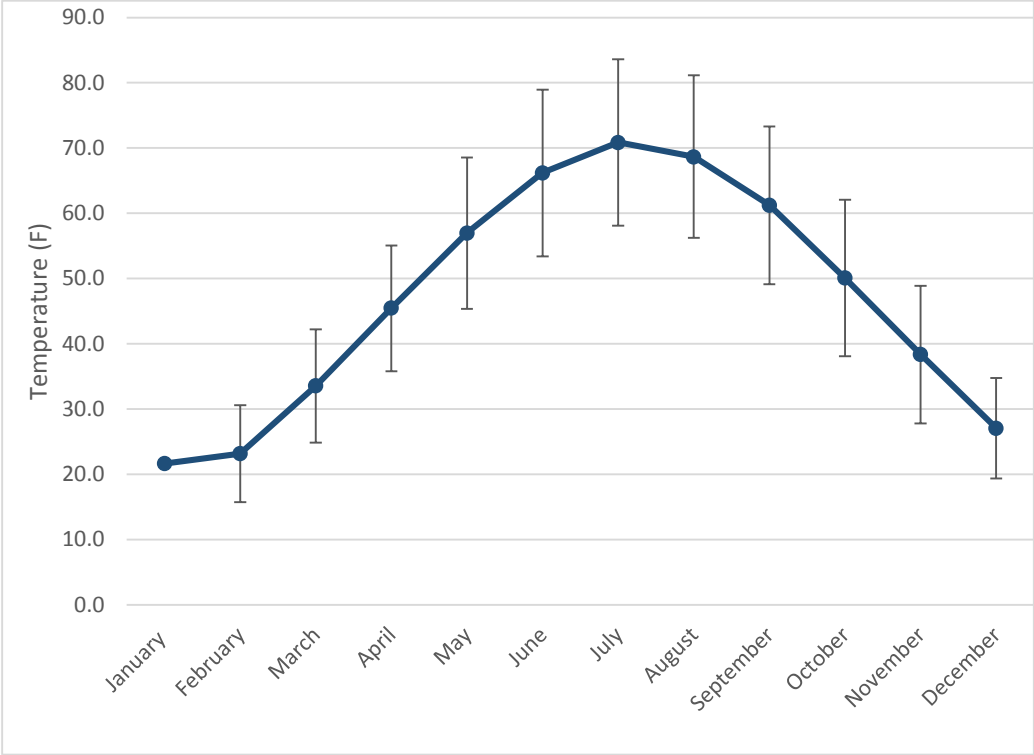
Tuscola County exhibits a climate typical of its region, shown in Table 1 below.

Table 1: Climate

Month	Avg. High	Avg. Low	Mean	Avg. Precipitation
Jan	29.1 ºF	14.2 ºF	21.7 ºF	1.93 In.
Feb	31.8 ºF	14.5 ºF	23.2 ºF	1.42 In.
Mar	43.2 ºF	23.8 ºF	33.6 ºF	2.23 In.
Apr	57.1 ºF	33.9 ºF	45.5 ºF	3.04 In.
May	69.7 ºF	44.2 ºF	57.0 ºF	3.25 In.
Jun	78.9 ºF	53.4 ºF	66.2 ºF	3.33 In.
Jul	83.3 ºF	58.4 ºF	70.9 ºF	3.14 In.
Aug	80.7 ºF	56.6 ºF	68.7 ºF	3.00 In.
Sep	73.2 ºF	49.2 ºF	61.2 ºF	3.64 In.
Oct	60.6 ºF	39.5 ºF	50.1 ºF	2.62 In.
Nov	46.0 ºF	30.7 ºF	38.4 ºF	2.61 In.
Dec	33.7 ºF	20.4 ºF	27.1 ºF	2.14 In.

(Source: NCDC TD 9641 Clim 81 1971-2015 Normals)

Figure 1: Average Temperatures of Tuscola County (1971-2015)



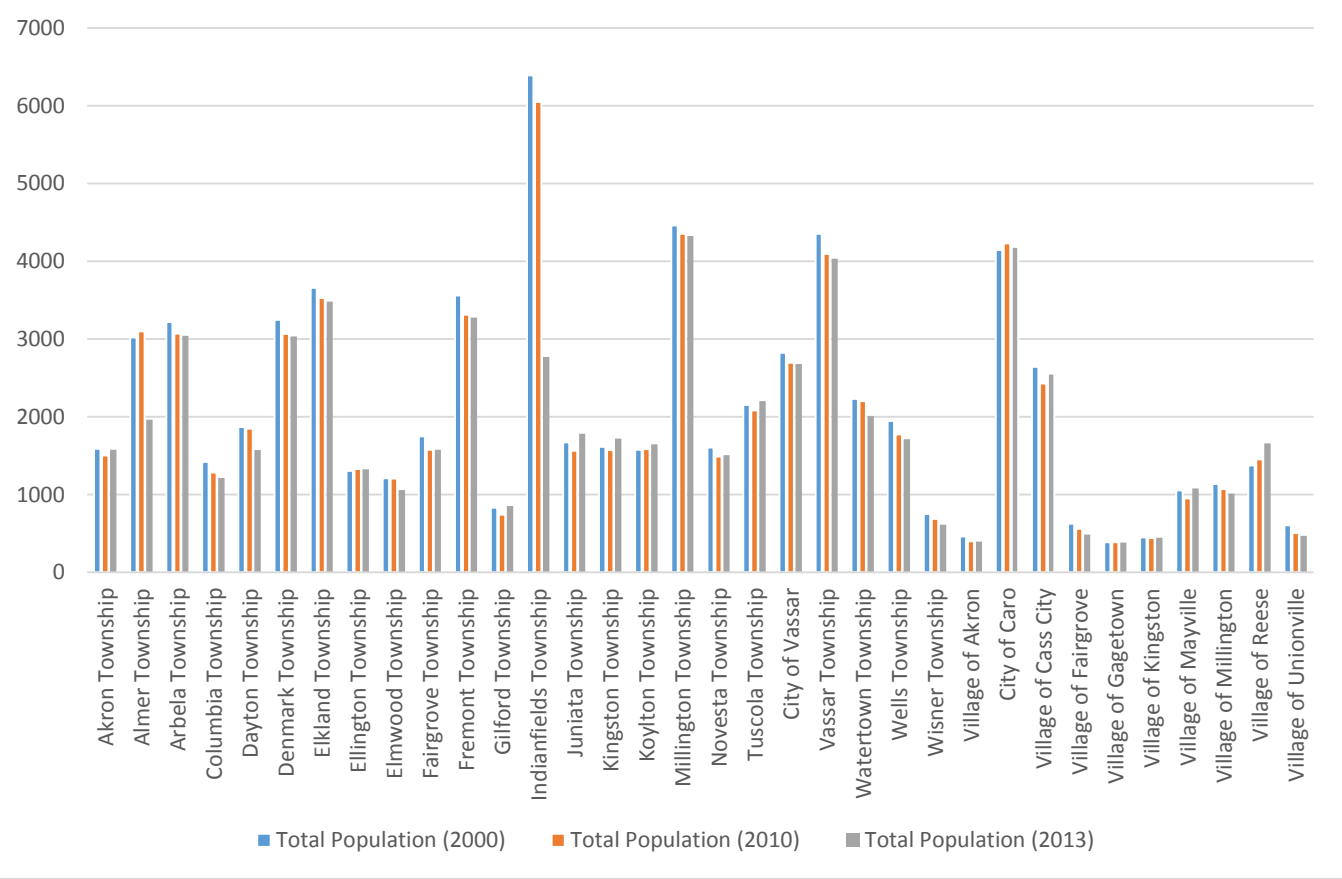
Source: NCDC TD 9641 Clim 81 1971-2015 Normals

Population and Housing Characteristics

The following demographics for Tuscola County have been compiled from the 2000 and 2010 U.S. censuses, as well as from the 2013 American Community Survey.

Population

Figure 2 Population Trends in Tuscola County



Source: U.S. Census, 2010 Population and Housing

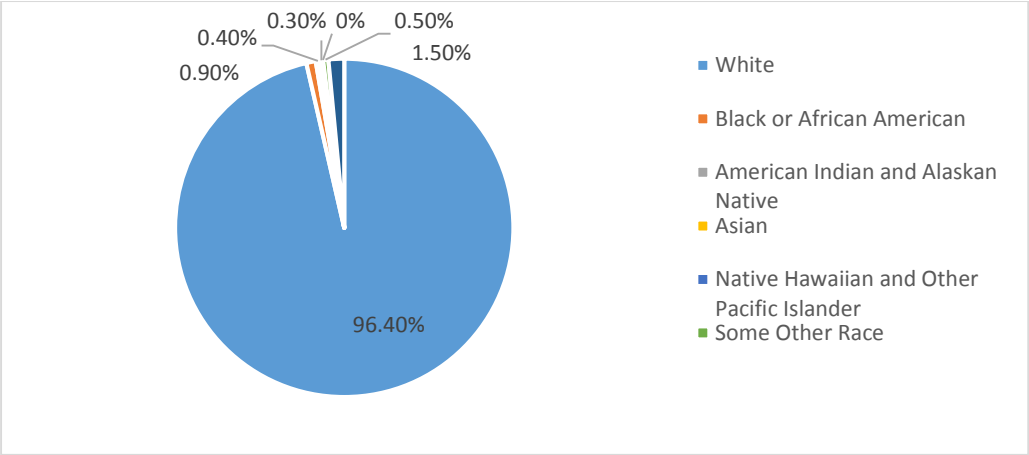
The total population of Tuscola County in 2013 was 55,172, a 5.3% decrease from 2000.

Most municipalities within Tuscola exhibit population decrease with the exceptions of Ellington Township, Gilford Township, Juniata Township, Kingston Township, Koylton Township, Tuscola Township, the City of Caro, Village of Mayville, and the Village of Reese.

Since 2000, Juniata Township and Kingston Township have had the largest increase in population (7%), while the Indianfields Township has had the largest decrease in population (57%). The large decrease in population in Indianfields Township is due to the Village of Caro becoming a City. Village populations are included in Township figures but City's, as home rule jurisdictions, are not, resulting in a net decrease of the City area from the Township's figures.

Ethnic Breakdown

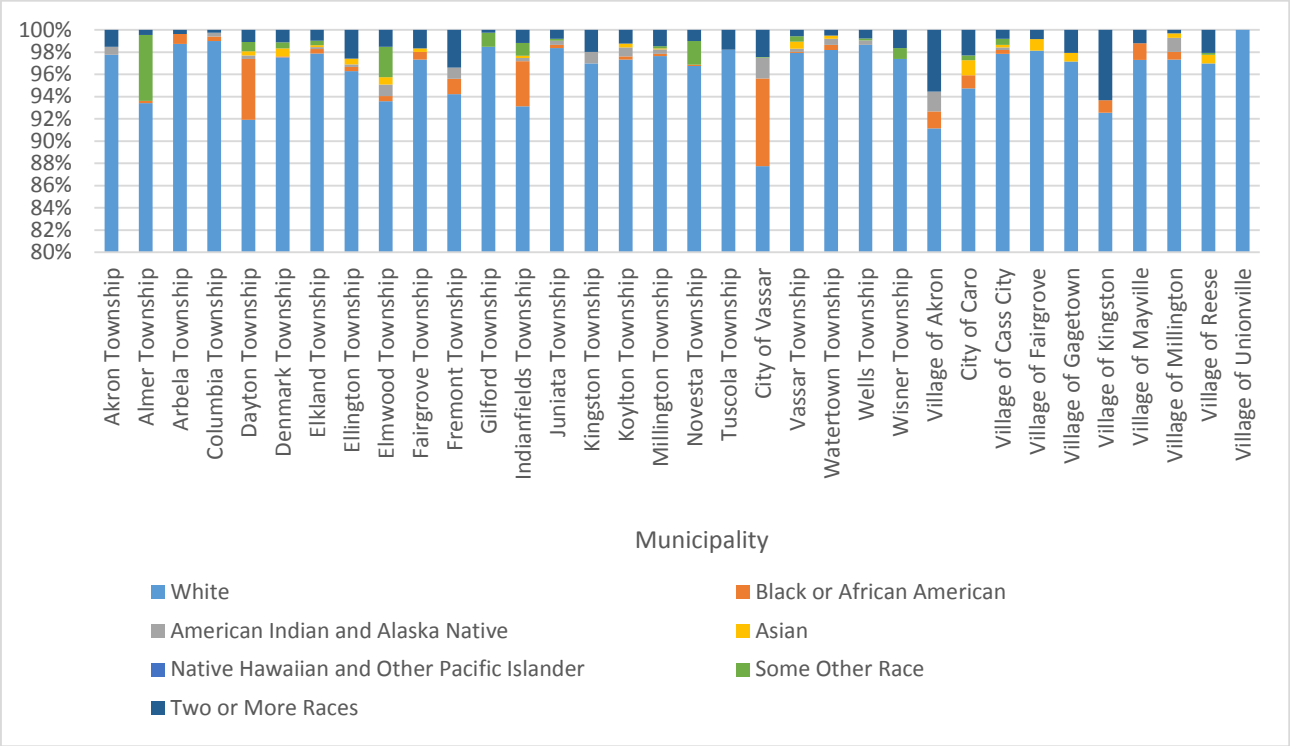
Figure 3: Ethnic Breakdown for all of Tuscola County



Source: U.S. Census, 2010 Population and Housing

Tuscola County has a majority white population; total minority populations equal less than 4% of the county's inhabitants. The municipal breakdown of these statistics, however, reveals that racial and ethnic diversity varies between municipalities, although the white majority usually remains around 95%.

Figure 4 Ethnic Breakdown for Tuscola County Municipalities



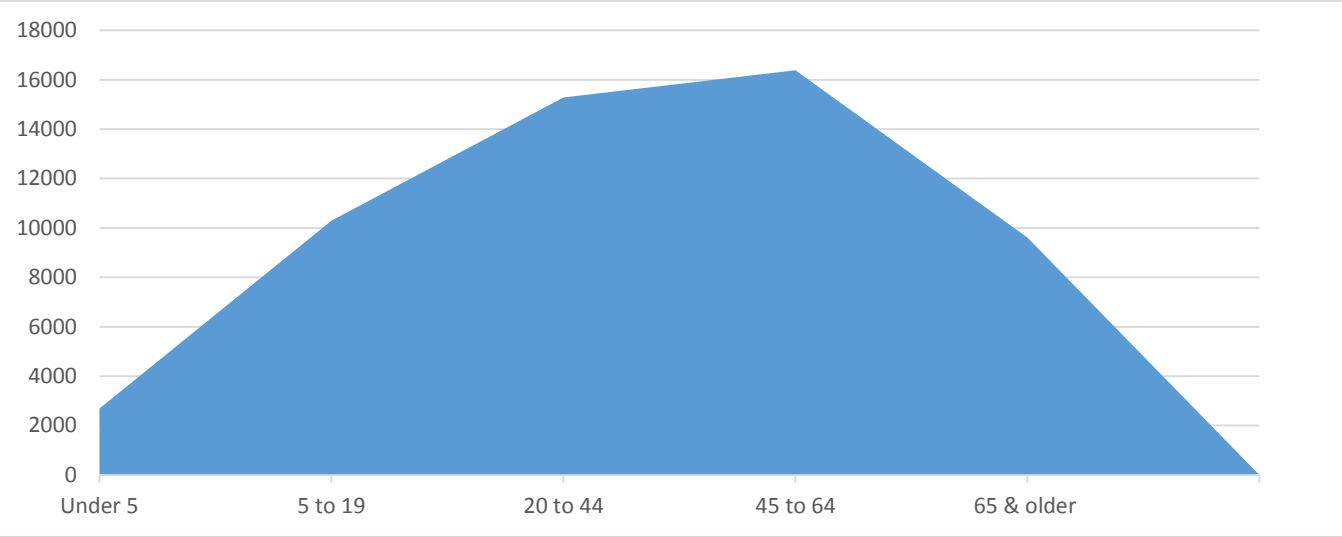
Source: U.S. Census, 2010 Population and Housing

Age Breakdown

Tuscola County exhibits a somewhat bell-shaped age curve. The biggest age group in Tuscola in 2013 was the Midlife age range (ages 45 to 64) at 30.2% of the population, followed closely by the Family Forming category (ages 20 to 44) at 28.2%, together accounting for over half of the population. Twenty-four percent of Tuscola County's current population is under the age of 20.

Seniors 65 and older currently represent about 17.7% of Tuscola County's total population, up from 12.8% in 2000. This reflects the national statistic that seniors have become a more statistically significant group.

Figure 5 Age Distribution for Tuscola County



Source: U.S. Census, 2010 Population and Housing

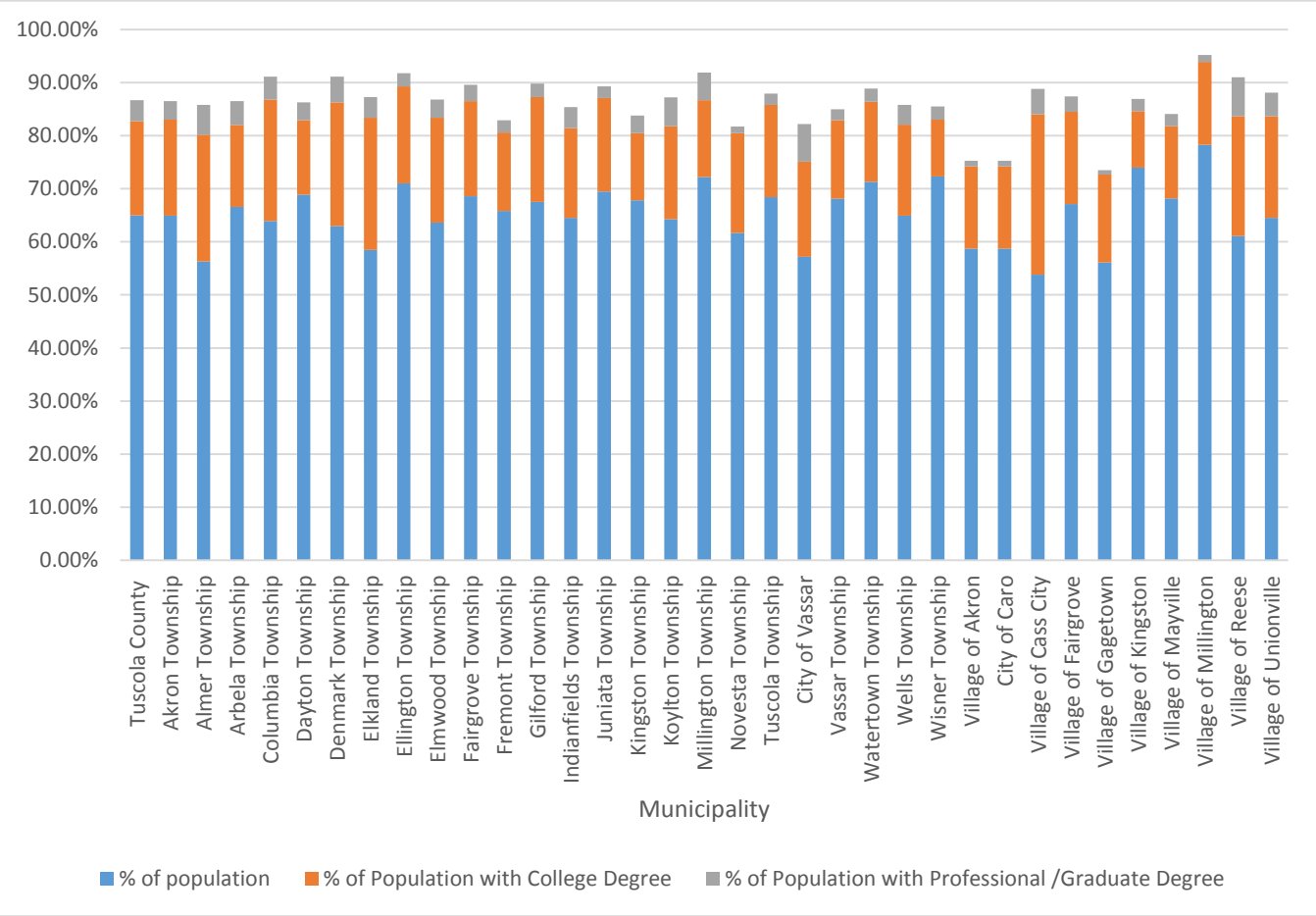
Educational Attainment

Educational achievement rates vary from municipality to municipality within Tuscola County. In some areas over 70% of the population aged 25 and older are high school graduates, while in others nearly 90% are high school graduates.

Levels of higher education are also disparate: The Village of Reese, exhibits the highest percentage of graduate or professional degrees at 7.1%, while other municipalities have much lower rates.

Of the municipalities in Tuscola County, the Village of Millington has the highest level of adults with a high school diploma, around 78%. This falls short of the State of Michigan's high school diploma rate, which is 83.4%.

Figure 6 Educational Attainment in Tuscola County by Municipality



Source: U.S. Census, 2010 Population and Housing

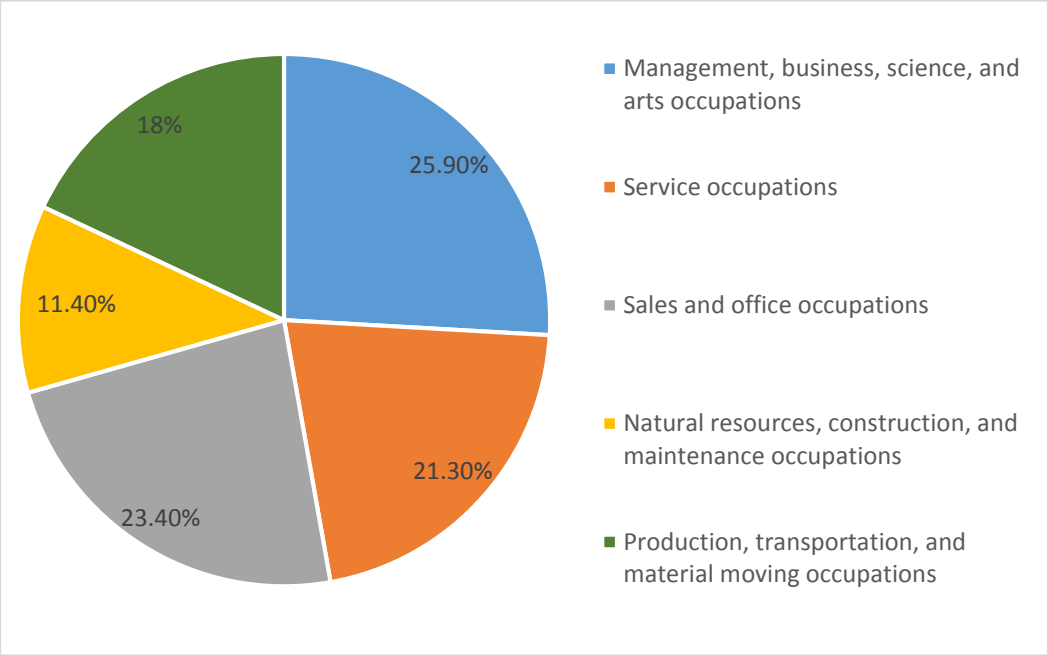
Employment Characteristics

The largest percentage of workers in Tuscola County are employed in management, business, science, and arts occupations (25.9%). Natural resources, construction, and maintenance occupations account for the smallest portion of the employed in Tuscola County at 11.4%

The largest single employer in Tuscola County is the Caro Regional Center, an inpatient mental health treatment facility located in Caro.

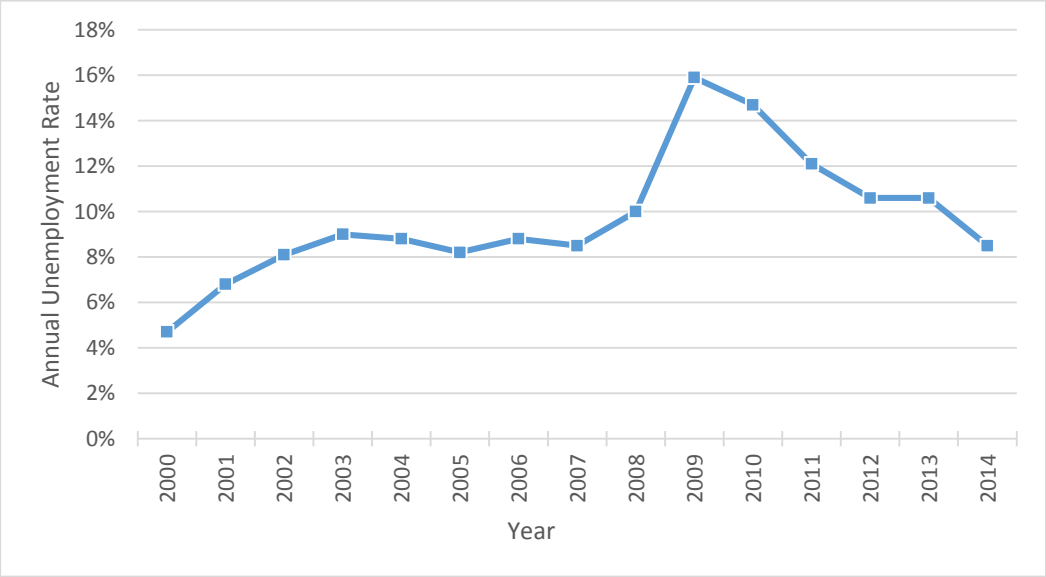
The overall unemployment rate in 2014 was 9%. This is a decrease from 2010 of 6%, but an increase from 2000 of 4%. Since 2009, the unemployment rate in Tuscola County has been steadily decreasing.

Figure 7 Occupations in Tuscola County



Source: U.S. Census, 2010 Population and Housing

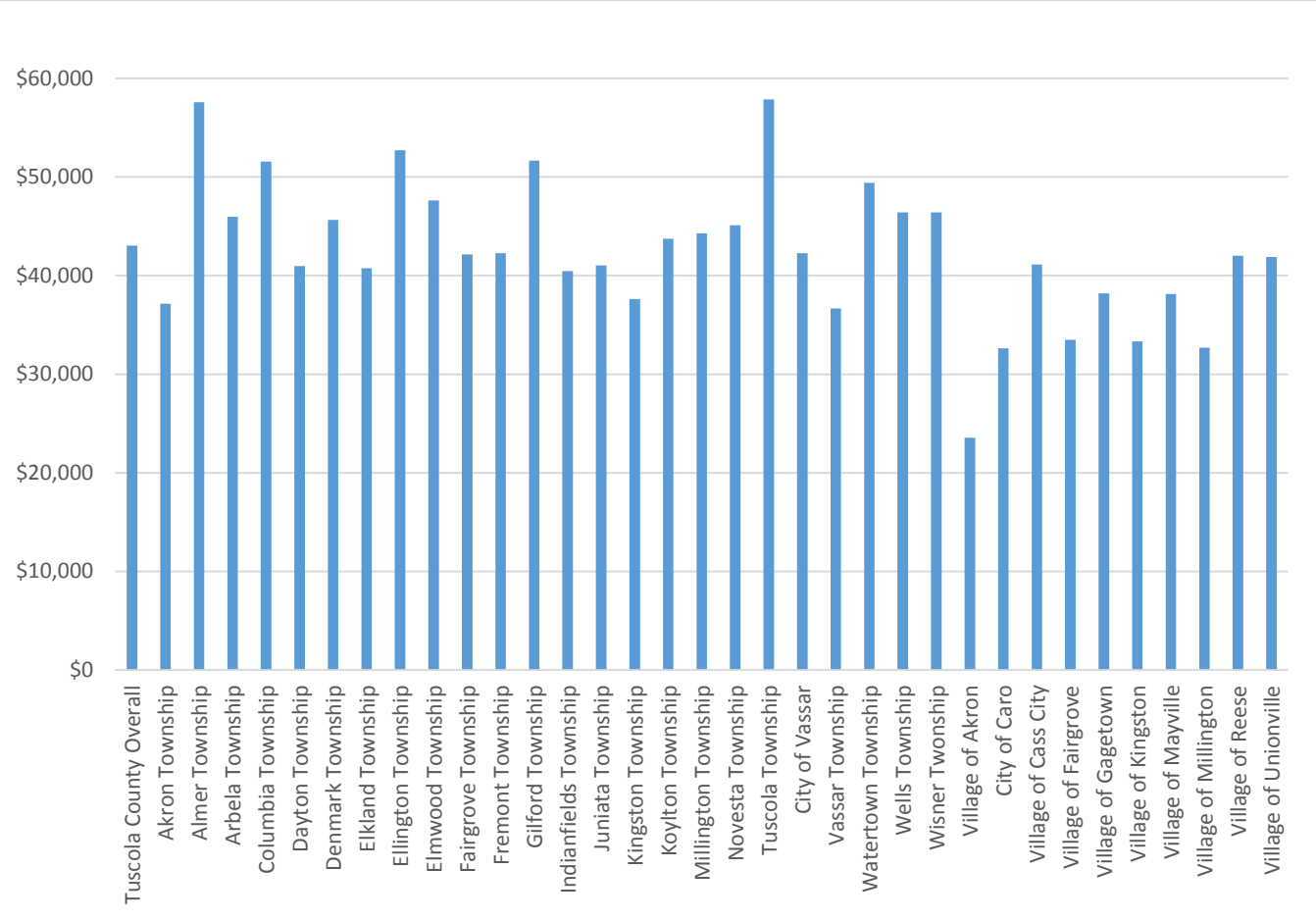
Figure 8 Unemployment Rates in Tuscola County from 2000-2014



Source: U.S. Census, 2010 Population and Housing

Income

Figure 9 Median Household Income Tuscola County



Source: U.S. Census, 2010 Population and Housing

Median household incomes for Tuscola County range from $23,571 per year to $57,865 per year. The median household income for all of Tuscola County was $43,039 in 2013, slightly below the State of Michigan average of $48,273.

Households

The U.S. census defines a household as:

> "All the people who occupy a housing unit. A house, an apartment or other group of rooms, or a single room, is regarded as a housing unit when it is occupied or intended for occupancy as separate living quarters; that is, when the occupants do not live and eat with any other persons in the structure and there is direct access from the outside or through a common hall."

Table 2 describes trends for households within Tuscola County.

Table 2 Households in Tuscola County

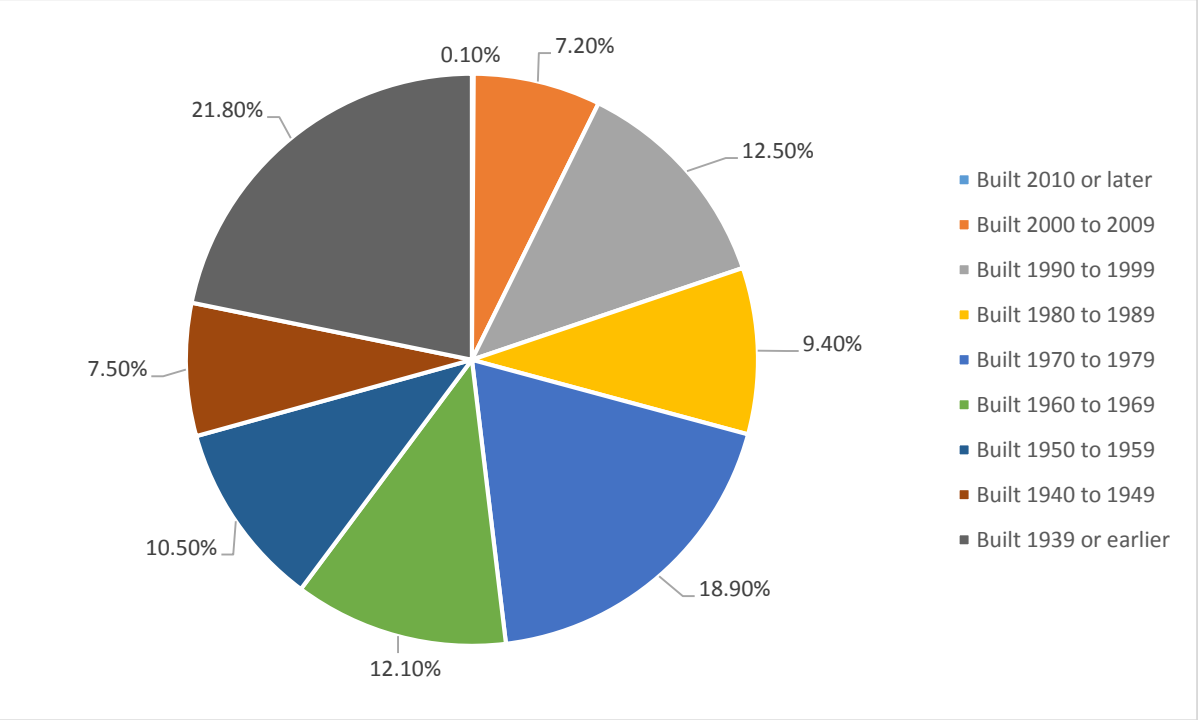
	Number of Households				Average Household Size			
Municipalities	**2000**	**2010**	**2013**	**% Change 2000 to 2013**	**2000**	**2010**	**2013**	**% Change from 2000 to 2013**
Tuscola County	**21454**	**21590**	**21211**	**-1.15%**	**2.65**	**2.52**	**2.55**	**-3.92%**
Akron Township	602	583	603	0.17%	2.58	2.55	2.61	1.15%
Almer Township	1112	1223	784	-41.84%	2.54	2.3	2.39	-6.28%
Arbela Township	1134	1138	1123	-0.98%	2.84	2.69	2.7	-5.19%
Columbia Township	528	514	487	-8.42%	2.66	2.5	2.46	-8.13%
Dayton Township	679	711	639	-6.26%	2.73	2.57	2.44	-11.89%
Denmark Township	1265	1262	1350	6.30%	2.56	2.43	2.24	-14.29%
Elkland Township	1471	1426	1413	-4.10%	2.41	2.39	2.39	-0.84%
Ellington Township	480	505	478	-0.42%	2.7	2.6	2.75	1.82%
Elmwood Township	470	477	396	-18.69%	2.57	2.52	2.66	3.38%
Fairgrove Township	653	631	596	-9.56%	2.6	2.47	2.58	-0.78%
Fremont Township	1266	1270	1309	3.28%	2.78	2.57	2.46	-13.01%
Gilford Township	317	302	308	-2.92%	2.62	2.45	2.77	5.42%
Indianfields Township	2505	2388	1126	-122.47%	2.39	2.34	2.19	-9.13%
Juniata Township	608	643	664	8.43%	2.75	2.44	2.69	-2.23%
Kingston Township	578	580	588	1.70%	2.79	2.71	2.93	4.78%
Koylton Township	559	581	582	3.95%	2.82	2.73	2.83	0.35%
Millington Township	1609	1661	1564	-2.88%	2.75	2.62	2.76	0.36%
Novesta Township	568	564	570	0.35%	2.82	2.64	2.64	-6.82%
Tuscola Township	793	814	813	2.46%	2.71	2.56	2.71	0.00%
Vassar Township	1532	1541	1446	-5.95%	2.84	2.65	2.78	-2.16%
Watertown Township	796	819	713	-11.64%	2.8	2.69	2.67	-4.87%
Wells Township	621	656	601	-3.33%	2.79	2.7	2.84	1.76%
Wisner Township	309	300	281	-9.96%	2.42	2.3	2.19	-10.50%
City of Caro	1738	1777	1785	2.63%	2.21	2.22	2.19	-0.91%
City of Vassar	991	1001	952	-4.10%	2.55	2.47	2.61	2.30%
Village of Akron	173	160	172	-0.58%	2.64	2.48	2.2	-20.00%
Village of Cass City	1100	1024	1032	-6.59%	2.31	2.26	2.37	2.53%
Village of Fairgrove	238	225	203	-17.24%	2.58	2.48	2.34	-10.26%
Village of Gagetown	154	150	131	-17.56%	2.52	2.59	2.94	14.29%
Village of Kingston	169	163	156	-8.33%	2.66	2.7	2.85	6.67%
Village of Mayville	402	369	380	-5.79%	2.62	2.43	2.71	3.32%
Village of Millington	446	420	408	-9.31%	2.51	2.55	2.46	-2.03%
Village of Reese	591	635	756	21.83%	2.33	2.29	2.2	-5.91%
Village of Unionville	231	218	212	-8.96%	2.62	2.33	2.23	-17.49%

Source: U.S. Census, 2010 Population and Housing

In Tuscola County from 2000 to 2013, the number of households decreased by 1.76%, and the size of these households decreased by 1.19%, indicating that the rate of increase of household formation was outpacing population growth in Tuscola County as is demonstrated in much of the nation.

Age and Value of Housing

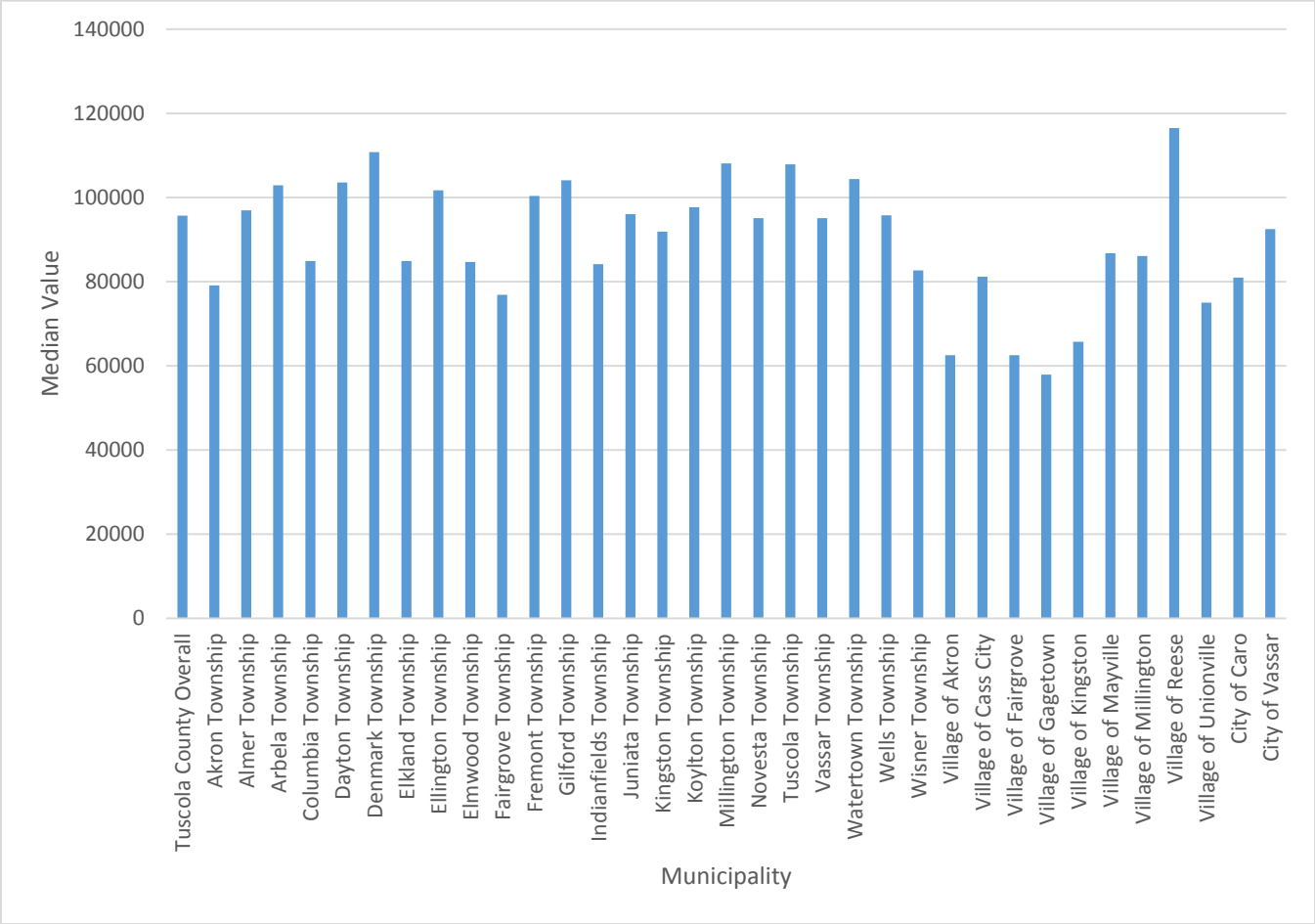
Figure 10 Age of Housing Stock in Tuscola County



Source: U.S. Census, 2010 Population and Housing

Housing in Tuscola County is relatively old; 39.8% of houses county-wide were built prior to 1959. Conversely, with a few exceptions, housing built after 2000 represents only 7.3% of the total housing stock of Tuscola County's municipalities.

Figure 11 Median Values of Housing in Tuscola County



Source: U.S. Census, 2010 Population and Housing

Transportation Characteristics

Interstates

I-75, which runs north and south, is located within ten miles of Tuscola County. I-75 makes the major cities of Michigan and the Midwest more easily accessible to the residents of Tuscola County.

State Highways

Six State highways run through Tuscola County, including M-15, M-24, M-25, M-46, M-81, and M-138. All six provide direct access to locations throughout the State of Michigan. M-15 and M-25 go to Bay City, M-46 and M-81 to Saginaw, M-15 to Flint, and M-15 and M-24 to Detroit.

Transit

Public transportation is not available countywide. It is available, however, in Almer and Indianfields townships, the City of Caro, with limited service in Cass City, Mayville, and Vassar. It is provided by the Caro Thumbody Express, which operates eight handicap-accessible buses. It provides transportation to senior citizens, children, the handicapped, and the general public,

many of whom rely on it in their daily activities. The buses operate within the county and also provide trips to Saginaw two days a week.

Rail

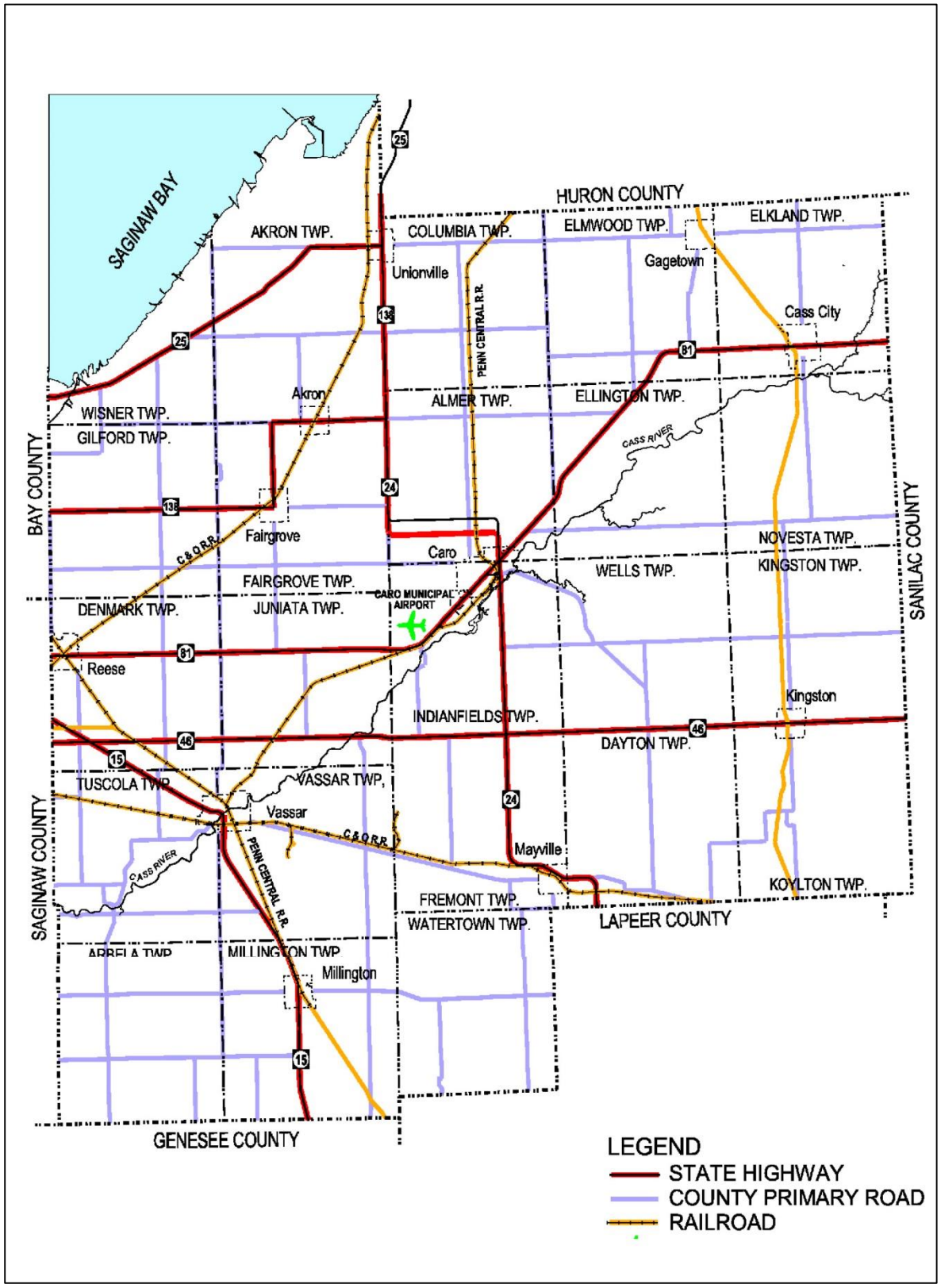
Three lines provide Tuscola County with rail service. The Huron and Eastern Railway have a line that begins in the county in Reese and heads northeast through Fairgrove and Akron before turning north through Unionville and out of the county. Huron and Eastern also has a line between Reese and the City of Vassar and a line heading northeast out of Vassar that passes through Caro before heading north again.

Air

Tuscola County has access to three airports. Most directly, it is serviced by the Tuscola Area Airport, located three miles outside of Caro, but MBS International Airport in Freeland and Bishop International Airport in Flint are both within an hour's drive.

(Source: Tuscola County General Development Plan, 2013)

Map 5 Tuscola County Road Map



Community Services and Facilities

Public services in Tuscola County play an essential role providing public goods that aid in public and private development. Because these services are typically managed by local government, they vary greatly between Tuscola's townships, villages, and cities. These public services could prove to be among the most important systems in responding to disasters, so in order to more completely understand the likely impact of disasters on the county it is important to understand the public services and resources available to each part of the county.

Sanitary Sewer System – update with new maps

The sanitary sewer system is an excellent example of the often disparate provision of services in Tuscola County. The villages and cities provide this service to all of their residents and the unincorporated area of Richville Township. In the other townships, residents must rely on their own means of sewer waste disposal, usually private septic tanks.

Water System

Public water systems also vary in availability, with access in every village and city, except Fairgrove, while on the township level available in Indianfields Township, the most populous township and parts of Wisner, Akron, Denmark, and Gilford Townships. Where public water systems are not available, the residents must access water primarily through private wells.

There has been some concern about arsenic levels in groundwater in Southeastern Michigan, but the results of a U.S. Geological Survey study conducted in Tuscola reveal that arsenic levels are quite low. The following table (Table 3) shows the results of that study.

Storm Water Drainage

Storm drainage also follows the typical pattern of village/city-township disparity. Every village and city in Tuscola County has a local storm water drainage system. Flooding is a key hazard in Tuscola County, so these systems may prove essential. Tuscola County has 554 established drains, including 75 inter-county drains that are under the jurisdiction of the drain commissioner. There are 1,259 linear miles of drain that drain about 827 square miles. Tuscola County is near several watersheds, including Lake Huron, Flint, Saginaw, Cass, and Pigeon-Wiscoggin. In 2003, the county received a federal grant to build a new drainage system in the city of Vassar, a site of acute flooding.

The "Moore drain" will divert water from the Cass River to prevent downtown flooding in Vassar. This project began in March, 1998 and was completed in September, 1998, along with another major drain project, the Sebewaing drain.

Other more recent upgrades to sewer and water systems have occurred in the City of Caro and the Village of Millington. Denmark Township also received USDA grants and loans to install a sanitary sewer system.

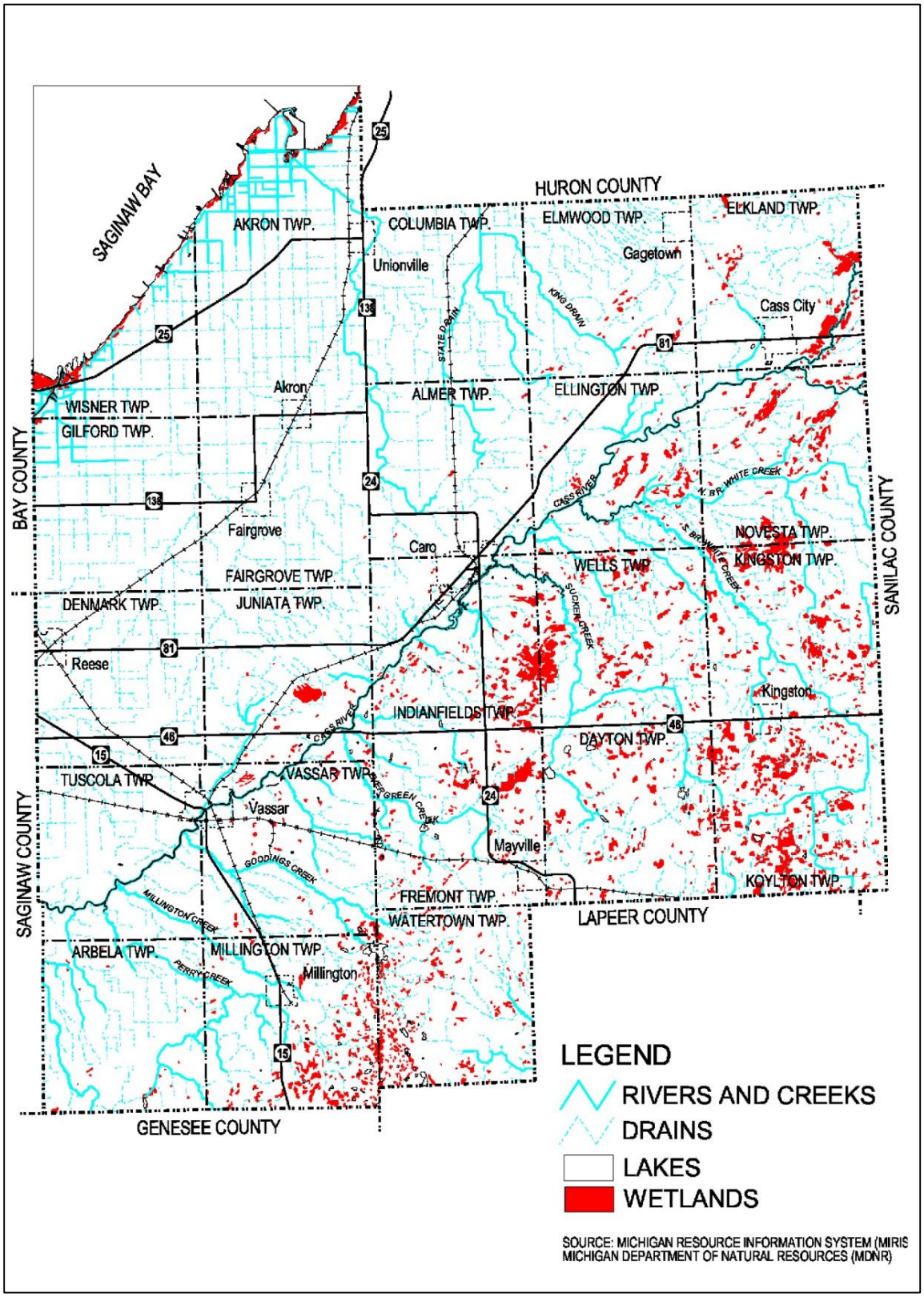
(*Sources: General Plan; EPA; tuscolacounty.org; 2003, 2008, and 2009 Comprehensive Financial Reports*)

Table 3: Arsenic Levels in Tuscola Groundwater

Township	Number of Wells	Median Arsenic Concentration (µg/L)	Percent < 5 µg/L (%)	Percent > 50 µg/L (%)
Akron	6	0.0	100.0	0.0
Almer	4	0.5	100.0	0.0
Arbela	5	0.0	60.0	0.0
Columbia	1	0.0	100.0	0.0
Dayton	4	10.4	50.0	0.0
Denmark	1	17.0	0.0	0.0
Elkland	6	19.5	16.7	0.0
Elmwood	2	16.7	0.0	0.0
Fairgrove	4	0.0	75.0	0.0
Fremont	8	11.8	37.5	0.0
Gilford	1	0.0	100.0	0.0
Indianfields	4	6.0	50.0	0.0
Juniata	3	1.0	66.7	0.0
Kingston	2	7.2	50.0	0.0
Koylton	8	9.3	37.5	0.0
Millington	5	6.0	20.0	0.0
Novesta	2	14.4	0.0	0.0
Tuscola	5	0.0	100.0	0.0
Vassar	4	0.0	75.0	0.0
Watertown	3	0.0	66.7	0.0
Total	78	3.2	57.7	0.0

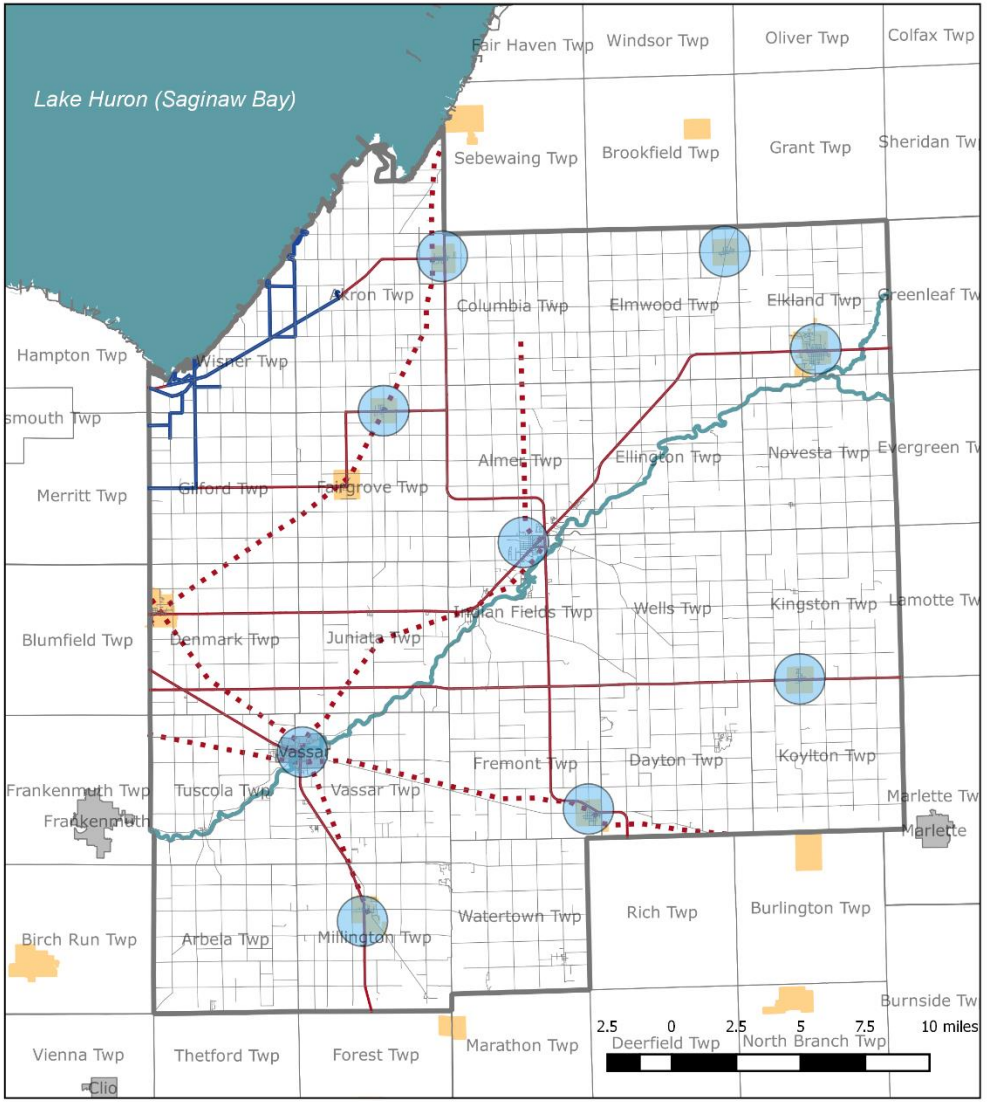
Source: US Geological Survey

Map 6 Hydrology Base Map



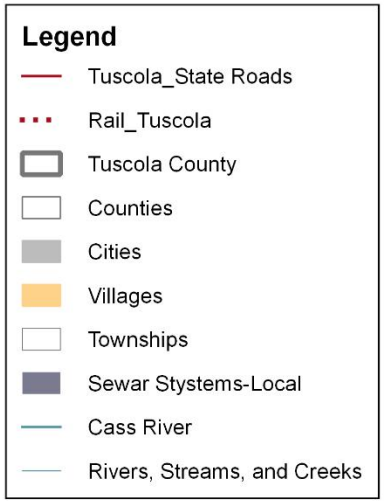
Map 7 Water System map

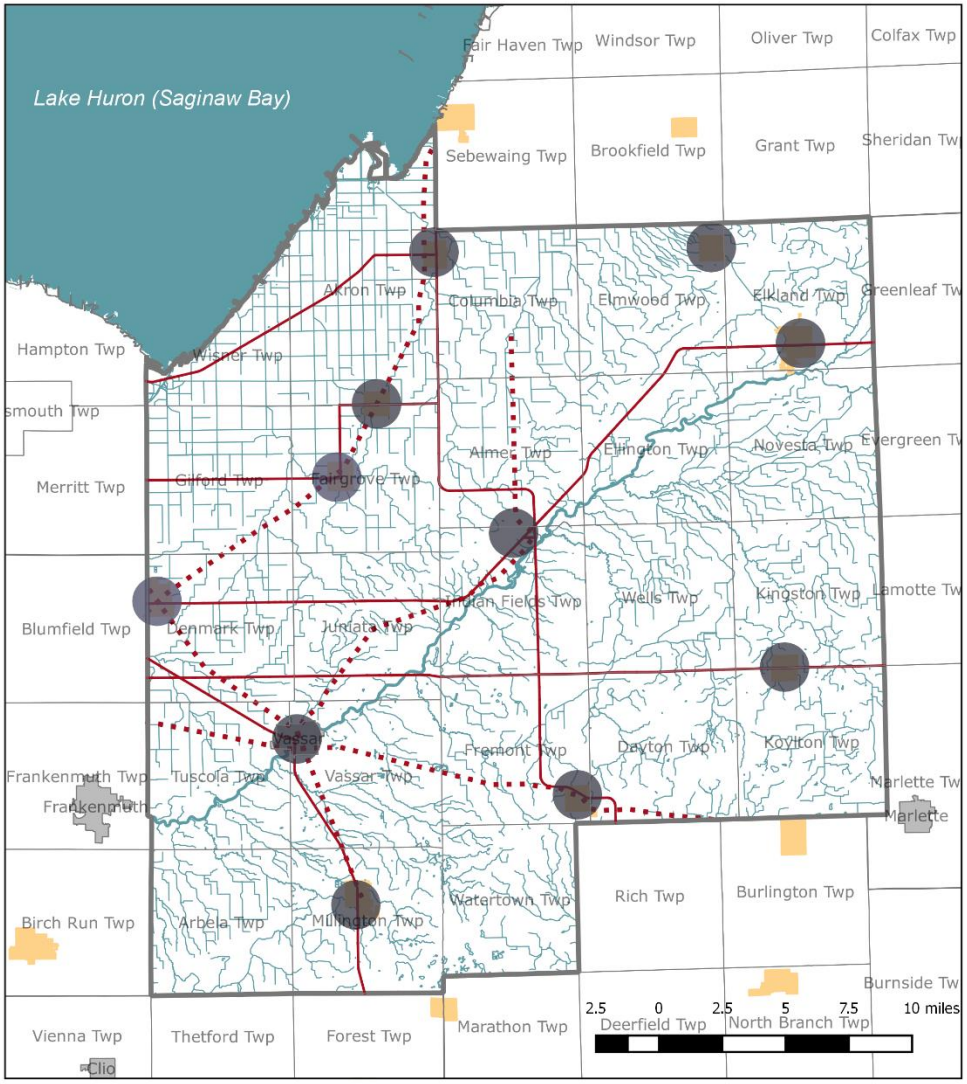
Tuscola County Water System Map



Map 8 Sewer System Map

Tuscola County Water System Map





Public Safety

Law Enforcement:

Sheriff's Office

Countywide law enforcement is provided by the Tuscola County Sheriff's Office, headquartered at 420 Court Street in Caro. The Sheriff's Office road patrol division handles criminal complaints and enforcement of traffic laws in the County.

State Police

The Michigan State Police have a post in Tuscola County, located at 1485 Cleaver Rd. in Caro.

Police Departments

In addition to the County Sheriff, some municipalities maintain police departments for further law enforcement capability. The Cities of Caro and Vassar, the Villages of Akron, Cass City, Gagetown, Kingston, Mayville, Millington, Reese, and Unionville all have their own police departments.

Fire Departments

Thirteen fire departments serve Tuscola County, providing fire and other emergency services. Their locations are found in Table 4 below.

Table 4: Fire Departments

Name	Address
Akron Columbia Wisner Fire Dept.	6554 Merry St, Unionville, MI 48767
Akron Fire Dept.	4380 Beach St, Akron, MI 48701
Caro Fire Dept.	317 S. State Street, Caro, MI 48723
Elkland Twp Fire Dept.	6691 Church St, Cass City, MI 48726
Fairgrove Fire Dept.	5005 Center St, Fairgrove, MI 48733
Gagetown/Elmwood Fire Dept.	6437 South St, Gagetown, MI 48735
Kingston Fire Dept.	3655 Ross St, Kingston, MI 48741
Mayville Fire Dept.	6044 Trend St, Mayville, MI 48744
Millington/Arbela Fire Dept.	8571State St, Millington, MI 48746
Reese Fire Dept.	1955 Gugino Md, Reese, MI 48757
Richville Fire Dept.	9941 W Saginaw St, Richville, MI 48758
Vassar Fire Dept.	131 S Sheridan St, Vassar, MI 48768
Watertown Twp Fire Dept.	9405 Foster St, Fostoria, MI 48435

Map 9 Police and Fire Map

Tuscola County Police and Fire Department Map

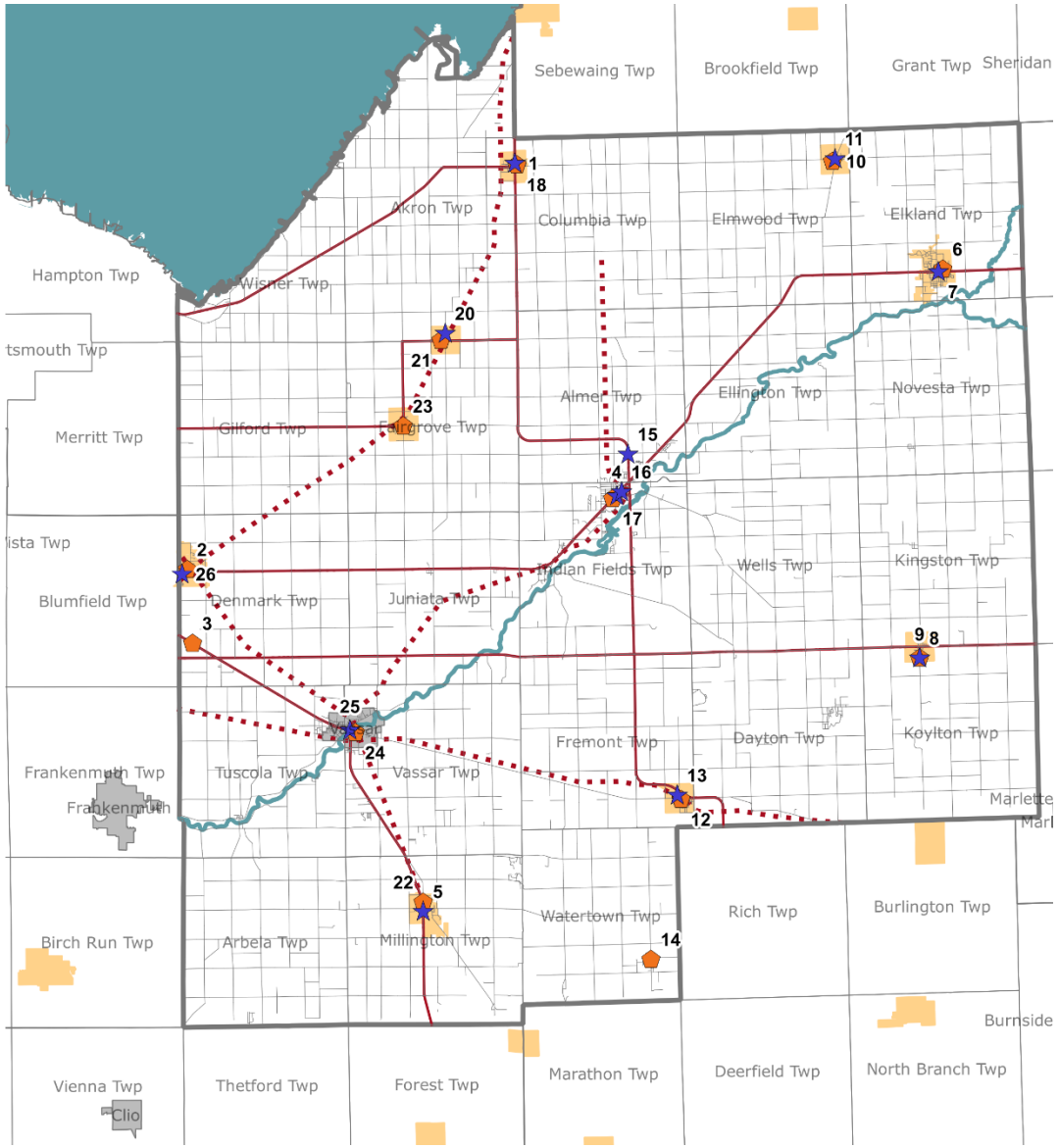
Legend

- Tuscola_County
- Townships
- Cities
- State Roads
- Contry Roads
- Railroads

Police and Fire Departments

- Fire Dept
- Police Dept

ID	Name
1	Unionville PD
2	Reese Fire Dept.
3	Richville Fire Dept.
4	Caro PD
5	Millington PD
6	Elkland Twp Fire Dept.
7	Cass City PD
8	Kingston PD
9	Kingston Fire Dept.
10	Gagetown/Elmwood Fire Dept.
11	Gagetown PD
12	Mayville Fire Dept.
13	Mayville PD
14	Watertown Twp Fire Dept.
15	MI State Police
16	Tuscola County Sheriff
17	Caro Fire Dept.
18	Akron Columbia Wisner Fire Dept.
19	Unionville PD
20	Akron PD
21	Akron Fire Dept.
22	Millington/Arbela Fire Dept.
23	Fairgrove Fire Dept.
24	Vassar Fire Dept.
25	Vassar PD
26	Reese PD



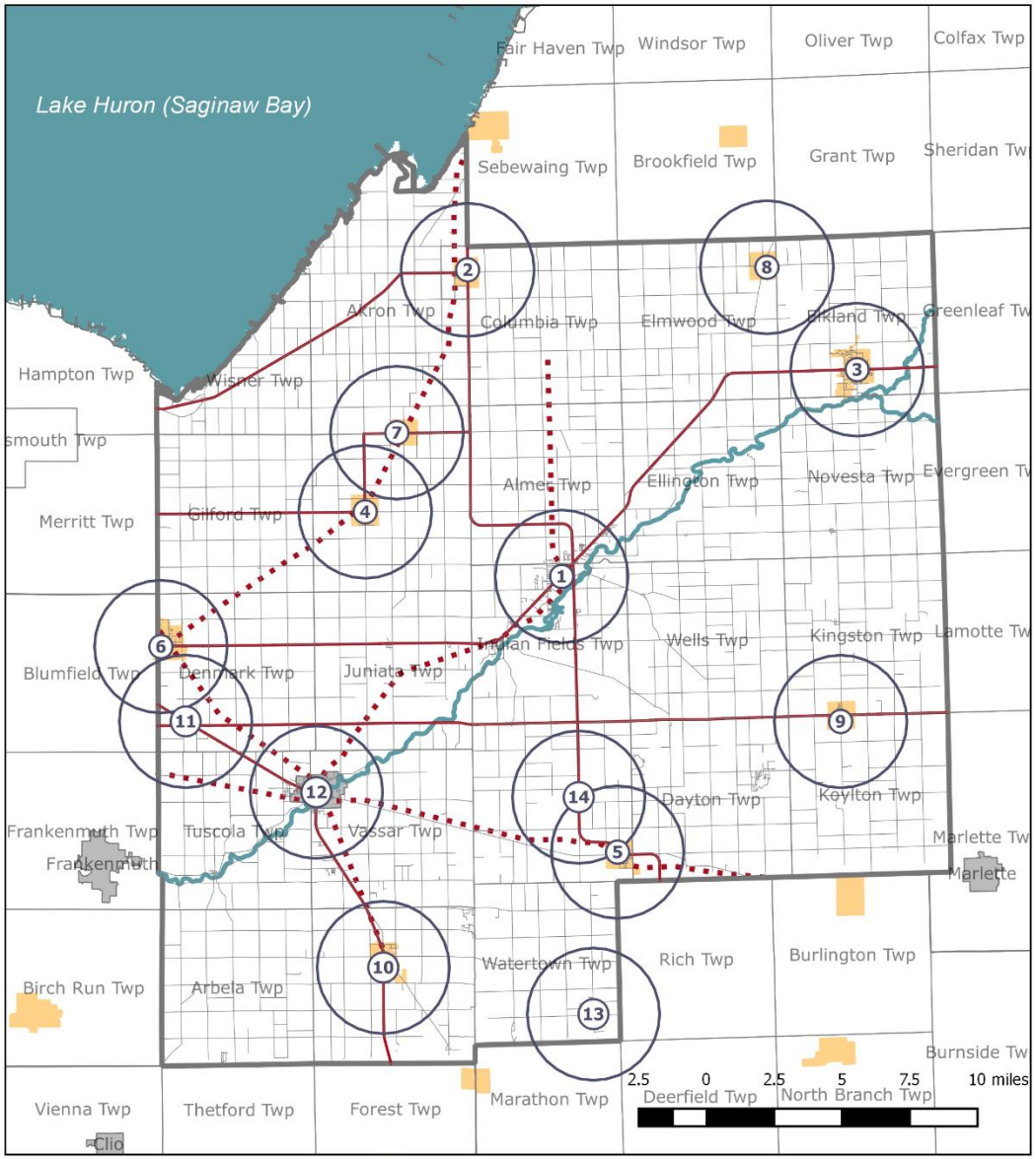
Map 10 Emergency Siren Coverage Map

Tuscola County Emergency Siren Coverage Map

Legend

- Local Roads
- Railroads
- State Roads
- Townships
- Counties
- Tuscola County
- Cities
- Villages
- Emergency Siren Buffers (2.5 mi Radius)
- Emergency Sirens

ID	Name
1	Caro FD
2	Unionville FD
3	Cass City FD
4	Fairgrove FD
5	Mayville FD
6	Reese FD
7	Akron FD
8	Gagetown/Elmwood FD
9	Kingston FD
10	Millington FD
11	Richville FD
12	Vassar FD
13	Watertown Twp FD
14	Fremont Township



Emergency Management

The Tuscola County Office of Emergency Management is a division of the Tuscola County Sheriff's Office and serves as the disaster services coordination office and Homeland Security representative for Tuscola County. As part of the Office of Emergency Management, there is an Emergency Operations Center located in the City of Caro with alternate locations throughout the county.

The Office of Emergency Management is responsible for continually monitoring and updating the County's Emergency Action Guidelines, as well as many other disaster related activities. Some of those activities involve the following four functions:

- **Mitigation**: Which is to eliminate, reduce or prevent long-term risk to human life and property from natural and man-made hazards.

- **Emergency Preparedness**: Advance emergency planning that develops operational capabilities and facilitates an effective response in the event of an emergency.

- **Emergency Response**: The actions taken immediately before, during or directly after an emergency with the primary goal of saving lives, minimizing damage to property and to enhance the effectiveness of the recovery.

- **Recovery**: the short-term activity to return vital life support systems to minimum operating standards and long term activity designed to return life to normal or improved levels.

Source: Emergency Management Director, 2015

Government Facilities

County Courthouse

The county seat of Tuscola is Caro, home to the Tuscola County Courthouse. This beautiful art-deco edifice was completed in 1932 and replaced the previous brick courthouse. The courthouse, located at 440 N. State Street in Caro, is home to Tuscola's Circuit, Probate, and District Courts.

Correctional Facilities

Tuscola County has no major correctional facilities within its boundaries.

Mental Health Facilities

The Caro Center, located in Caro, is a nationally accredited mental health facility that houses just under two hundred patients. Of these patients, a few less than half are forensic patients, acquitted of crimes for reason of insanity or having been found mentally incompetent to stand trial.

Education

Public Schools

A total of 8,772 students are enrolled in public schools in Tuscola County. The school districts and their enrollment levels for the 2014-2015 academic year are shown in Table 5.

Table 5: School Districts

School District	Enrollment
Tuscola Intermediate School District	8,772
Akron-Fairgrove Schools	285
Caro Community Schools	1,786
Cass City Public Schools	1,048
Kingston Community Schools	634
Mayville Community Schools	668
Millington Community Schools	1,266
Reese Public Schools	820
Tuscola ISD – District created from ISD	474
Unionville-Sebewaing Area Schools	736
Vassar Public Schools	1,372

(Source: mischooldata.org)

Private Schools

Tuscola County also offers a range of non-public religious schools. They include Christ the King Lutheran Schools in Sebewaing and Unionville, Deford Christian Academy in Deford, Juniata Christian School in Vassar, St. Luke's Lutheran School in Vassar, St. Michael's Lutheran School in Richville, St. Paul Lutheran School in Millington, and Trinity Lutheran School in Reese.
(Source: http://www.yellowpages.com & http://www.privateschoolreview.com/Michigan/Tuscola-county)

Higher Education

Higher education within Tuscola County can be sought at Baker College. Students with an interest in cosmetology can attend Howard's Beauty Academy in Caro.
(*Source: Tuscola County General Development Plan*)

Community Events

Tuscola County offers many recreational opportunities, festivals and events for its residents and visitors. 29,476 acres of Tuscola County's public lands are dedicated to recreation. Tuscola County has just 20.1 miles of Great Lakes shoreline. A detailed list of area recreation and special events is available on the Thumb Area Tourism Council website. http://www.thumbtourism.org/busdetail.php?id=0000001748

Caro Pumpkin Festival

Probably the most anticipated community event of the year, the Caro Pumpkin festival was first celebrated in 1981 and occurs every October. The festival lasts four days and has attracted as many as 50,000 visitors in the past. Activities take place all over the City of Caro and have in the past included three on three basketball tournaments, pie-eating contests, and a 5k run/fitness walk. The festival, which revolves around pumpkins, is fun for the whole family and culminates on the fourth day with the Grand Parade, which has attracted such dignitaries as Ronald McDonald, Laurel and Hardy, and Miss Michigan.
(*Source: www.carovillage.net*)

HAZARD RISK ASSESSMENT

HAZARD IDENTIFICATION

This step in the hazard planning process involves identifying potential hazards for Tuscola County. These hazards have been organized into three categories that will be referenced throughout the document. The categories are: Natural Hazards, Technological Hazards, and Human-Related Hazards.

NATURAL HAZARDS

These hazards are generally limited to those that would occur naturally because of Earth's geology or meteorological conditions. With the exception of flooding, all natural disasters impact the entire county and each jurisdiction. The NOAA National Climatic Data Center maintains records of these events. Using their records, historical damages and frequencies of natural hazards can be determined. Table 6 summarizes the historical effect of natural hazards on Tuscola County as presented in the 2010 Hazard Mitigation Plan. Table 7 shows additional events that have occurred since the end of 2010 until May 31, 2015, In addition to the number of events during these time periods, the probability of occurrence each day is calculated.

Table 6: Natural Hazards in Tuscola County, 1/1/1981 – 12/31/2010

Natural Hazard	Number of Occurrences since 1/1/1981	Days from 1/1/1981 to 1/1/2011	Historical Probability of Occurrence per day	Total Deaths	Total Injuries	Total Property and Crop Damage
Thunderstorms	131	10957	1.196%	0	0	$436,000
Hail	67	10957	0.611%	0	0	$500,000
Snowstorms	56	10957	0.511%	0	4	$8,535,000
Severe Wind	22	10957	0.201%	1	5	$40,085,000
Flooding	17	10957	0.155%	0	0	$117,720,000
Tornadoes	12	10957	0.110%	0	1	$1,835,000

Ice/Sleet Storms	8	10957	0.073%	1	2	$180,100,000
Cold Wave/Extreme Cold	7	10957	0.064%	6	10	$500,000
Heat Wave/Extreme Heat	7	10957	0.064%	1	567	$0
Drought	2	10957	0.018%	0	0	$150,000,000
Lightning	2	10957	0.018%	0	0	$350,000
Wildfires	0	10957	0.000%	0	0	$0
Shoreline Flooding	0	10957	0.000%	0	0	$0
Earthquakes	0	10957	0.000%	0	0	$0

Source: NOAA National Climate Data Center

Table 7: Natural Hazards in Tuscola County, 1/1/2011 – 5/31/2015

Natural Hazard	Number of Occurrences since 1/1/2011	Days from 1/1/2011 to 5/31/2015	Probability of Occurrence per Day	Total Deaths	Total Injuries	Total Property and Crop Damage
Thunderstorms	24	1612	1.489%	0	0	27,500
Hail	5	1612	0.310%	0	0	0
Heavy Snow	2	1612	0.124%	0	0	0
Blizzard	1	1612	0.062%	0	0	0
Severe Wind	4	1612	0.002%	0	0	2,007,000
Flood	2	1612	0.124%	0	0	250,000
Tornadoes	0	1612	0.000%	0	0	0
Ice Storm	1	1612	0.062%	0	0	3,000,000
Frost/Freeze	1	1612	0.062%	0	0	1,300,000
Cold/Wind Chill	2	1612	0.124%	0	0	0
Extreme Cold/Wind Chill	3	1612	0.186%	0	0	0
Heat	3	1612	0.186%	0	0	0
Excessive Heat	1	1612	0.062%	0	0	0
Drought	0	1612	0.000%	0	0	0
Lightning	0	1612	0.000%	0	0	0
Wildfire	1	1612	0.062%	0	0	0
Shoreline Flooding	0	1612	0.000%	0	0	0
Earthquakes	0	1612	0.000%	0	0	0

Source: NOAA National Climate Data Center

Weather Hazards

Extreme Temperatures

Description: Temperature extremes are broken down into two categories: extreme heat and extreme cold. Both extremes can last for weeks, without any advance warning and in the middle

of a seemingly normal weather pattern. Additionally, both extreme heat and extreme cold can cause loss of life to vulnerable populations, damage to infrastructure, and disruptions to schools and businesses.

Extreme cold is primarily associated with the wintery months of November through March and categorized by temperatures plunging near or below 0°F. Extreme heat occurs mainly during the summer months of June, July, and August and is marked by temperatures above 90°F.

Prolonged periods of extreme temperatures, whether extreme summer heat or extreme winter cold, can pose severe and life-threatening problems for Michigan's citizens. Although they differ in their initiating conditions, the two hazards share a commonality in that they both tend to have a special impact on the most vulnerable segments of the population—the elderly, young children and infants, impoverished individuals, and persons who are in poor health. Due to their different characteristics, extreme summer heat and extreme winter cold hazards will mostly be discussed separately in this section. For both types of temperature extremes, however, a longer hot or cold spell makes the temperature effects much more severe on vulnerable populations—a longer duration tends to produce more severe effects.

Analysis: Prolonged periods of extreme heat can have devastating effects upon human life. In the past 4.5 years, Tuscola County has experienced 3 heat events and 1 day of excessive heat. Over the previous 30 years, Tuscola County had experienced only seven days of extreme heat, but in that small period there was one death and five hundred and sixty-seven injuries resulting from the weather. Nothing can be done to control the outdoor temperature, but adequate preparation by health authorities to treat heatstroke and heat exhaustion could help mitigate this problem. The locations of emergency shelters can be seen on Map 15 (page 80). There is a heating and cooling center at the LeeRoy Clark Center, 435 Green Street, Caro, MI. Extreme heat has not proven to be a major or recurring threat in Tuscola, so it may be that authorities are sufficiently prepared and extreme heat preparation need not be a priority.

Extreme cold can be as dangerous as extreme heat, and is more common in Tuscola County. Since the start of 2011, there have been 2 cold days and 3 extreme cold days. In the previous 30 years, there have been seven days when the temperatures have been classified as extremely cold. Over the last 4 and a half years, extreme cold has not been responsible for any deaths or property damage, however, over the previous 30 year time period, extreme cold has been responsible for six deaths and five hundred thousand dollars in property damage. Because of the high costs in life and dollars, county officials should carefully consider plans to cope with extreme cold. *(Source: 2010 Tuscola Hazard Mitigation Plan and NCDC Storm Events)*

Jurisdictions impacted: Extreme temperatures impact all jurisdictions in the county equally.

Thunderstorms

Description: Severe thunderstorms are weather systems accompanied by strong winds (at least 56mph), lightning, heavy rain (that could cause flash flooding), hail (at least ¾" diameter), or tornadoes. Severe thunderstorms 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. Various areas in Michigan are subject to an average of at least 20 thunderstorm days per year, and up to just over 40 days per year in the state's southwestern corner. The Lower Peninsula, in general, is subject to approximately 28-40 thunderstorm days per year, while the Upper Peninsula average is closer to 20-30 thunderstorm days per year.

Thunderstorms form when a shallow layer of warm, moist air is overrun by a deeper layer of cool, dry air. Cumulonimbus clouds, frequently called "thunderheads," are formed in these conditions. These clouds are often enormous (up to six miles or more across and 40,000 to 50,000 feet high) and may contain tremendous amounts of water and energy. That energy is often released in the form of high winds, excessive rains, lightning, and possibly hail and tornadoes.

Thunderstorms are typically short-lived (often lasting no more than 30-40 minutes) and fast moving (30-50 miles per hour). Strong frontal systems, however, may spawn one squall line after another, composed of many individual thunderstorm cells. Severe thunderstorms may also cause severe flood problems because of the torrential rains that they may bring to an area. Thunderstorms sometimes move very slowly, and can thus dump a tremendous amount of precipitation onto a location. Flooding can result, including flash floods, "urban flooding," and riverine flooding. Please refer to the hydrological hazard section for more information about these hazards. Large complexes of thunderstorms, called mesoscale convection systems (MCS), may operate as a larger-scale weather system and persist for several hours or more.

Analysis: Thunderstorms are very common in Tuscola County as well as throughout Michigan. Since the start of 2011, Tuscola County has experienced twenty-four thunderstorms but experienced zero deaths, zero injuries, and only $27,500 in property damage. That is an average cost of only $1,146 per storm, and most of the storms caused no recorded damage.

Severe thunderstorms have been occurring with slightly greater frequency then in previous years. In the 30 years prior to the previous Hazard Mitigation Plan, thunderstorms occurred with an average frequency of 4.4 per year. Since 2011, this number has increased slightly to about 5.43 thunderstorms per year. Whether it is because of adequate preparation or the low severity of storm events, thunderstorms do not pose a significant threat to Tuscola County. (*Source: NCDC Storm Events*)

Jurisdictions Impacted: The threat of thunderstorms cannot be targeted accurately so for purposes of mitigation planning all jurisdictions are impacted equally.

Hail

Description: Hail is produced by thunderstorms when strong updrafts among the clouds carry water droplets above the freezing level and cause the formation of ice pellets around some nucleus (such as a water crystal or speck of dust). These can remain suspended in the winds and can continue to grow larger until their weight is no longer supportable and they fall to earth, possibly accompanied by heavy rains. Falling hailstones batter crops, dent autos, and injure

wildlife and people. Large hail is a characteristic of severe thunderstorms, and it may precede the occurrence of a tornado.

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 that causes significant damages. Unfortunately, for many hailstorms, the total damages to property go unreported.

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

Analysis: Hail has been recorded in Tuscola County five times since 2011 and seventy-two times since 1981. In that time, it caused no deaths or injuries and only $500,000 in property damage. In the last 4 and a half years, hail events have decreased in frequency down from 2.2 times per year in the previous 30 years to 1.13 times per year. Hail will likely continue to in Tuscola County but is not considered a significant hazard. *(Source: NCDC Storm Events)*

Jurisdictions Impacted: The threat of hail cannot be targeted accurately so for purposes of mitigation planning all jurisdictions are impacted equally.

Lightning

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

Analysis: Authorities call lightning a hidden threat because although unanticipated, it kills more people than tornadoes and hurricanes each year. That being said, lightning does not appear to be a serious threat to Tuscola County. In thirty years, there have been only two recorded lightning strikes in the county (lightning is only recorded when it causes damage). These strikes did not kill anyone and caused property damage worth $350,000 with no new events occurring since 2006. As long as Tuscola County fire and medical response teams remain prepared, lightning will continue to be a minor threat. (*Source: NCDC Storm Events*)

Jurisdictions Impacted: The location of lighting cannot be targeted accurately so for purposes of mitigation planning all jurisdictions are impacted equally.

Severe Weather

Snowstorms

Description: 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, as some areas of Baraga and Houghton Counties receive over 200 inches of snow per year. In Lower Michigan, the highest snowfall accumulations occur near Lake Michigan and in the higher elevations of northern Lower Michigan. Areas in the northwest portion of the Lower Peninsula average greater than 120 inches of snow annually. On the low end of snowfall totals, areas in the east central and southeastern portions of the state receive less than 50 inches of snow per year. Communities in West Michigan typically receive 60-100 inches of snow.

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.

Snowstorms can be very dangerous for a community over a period of days or weeks. Heavy snows can shut down towns and cities for several days if snow is persistent and cannot be cleared in a timely fashion. Pre-planning for snow storage areas will be helpful. Roof failures may occur as the weight of the snow and area of snow cause damage to homes and buildings. Motorists and passengers in cars can be stranded in rural areas and die of exposure because of inadequate preparation for conditions.

Extreme snows are most likely in the Upper Peninsula and the northern sections of Lower Michigan. Areas in the northwest portion of the Lower Peninsula average greater than 120 inches of snow annually. The snow is more extreme in the Upper Peninsula, as some areas of Baraga and Houghton Counties receive over 200 inches of snow per year. On the low end of snowfall totals, areas in the east central and southeastern portions of the state receive less than 50 inches of snow per year. Communities in West Michigan typically receive 60-100 inches of snow. A map appears on the next page.

Urban areas can be especially susceptible to outages and problems with snow removal, due to their complexity and limited space for snow clearance and storage. Rural areas may have inaccessible roads for some time but often have residents that are more equipped to independently handling power outages and temporary isolation. Information about snow cover and types, which may be useful either for an analysis of the snowstorm hazard, or in an analysis of snowmelt-related flood risks, may be found at http://www.nohrsc.nws.gov.

Analysis: Snowstorms hit Tuscola County somewhat frequently, with fifty-six appearing in the thirty years before the last hazard mitigation plan. This approximate 1.9 snowstorms per year has decreased in recent years with only two heavy snow events and one blizzard recorded since

2011 equating to about 0.68 events each year. Michigan governments and residents tend to expect this kind of weather in the winter and are usually prepared for it. Despite the frequency of these storms, only four injuries and no deaths have occurred in the 35 years examined. Snowstorms have, however, been responsible for $8,535,000 in property damage over this same time period. *(Source: 2010 Tuscola Hazard Mitigation Plan and NCDC Storm Events)*

Jurisdictions impacted: Snowstorms impact all jurisdictions in the county equally.

Ice and Sleet Storms

Description: Although these two types of winter storms have been combined in this subsection, ice storms and sleet storms are two different phenomena. Ice storms, also known as freezing rain, coat roads, trees, power lines, and buildings with thick, heavy, and slick surfaces. Ice storms are sometimes incorrectly referred to as sleet storms. Sleet is small frozen rain drops (ice pellets) that bounce when hitting the ground or other objects. Sleet storms, which involve small pellets of ice accumulating on surfaces, are less dangerous than ice storms, but still cause potential harm to transportation and electrical systems. 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 a 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. Massive traffic accidents and power outages from downed tree limbs and utility lines are common when an ice storm occurs.

Ice storms usually have a regional effect and may influence all corners of Michigan. Groups of counties are usually affected instead of just one county. Often, ice storms are accompanied by snowfall, in which the ice is camouflaged and covered up by snow, creating treacherous transportation conditions. Both storms occur when the temperature is close to 32°F, but are far more severe when the temperature is in the 20s. The southern parts of the state have annual winter temperatures closer to 32°F, so the prevalence for ice and sleet storms seems more likely there than in the northern areas of the state. Events tend to be more severe when they occur as temperatures lower into the 20s.

Analysis: Ice and sleet storms are acutely dangerous. Despite the low frequency of such storms, just one since 2011 and eight in the thirty years preceding 2011, the costs of individual storms can be huge. This history of storms means that Tuscola County can expect a severe ice and sleet storm about once every four years. The one ice storm in the last 4 and a half years happened in December of 2013 and caused $3 million in damage. In the eight storms in the thirty years preceding, one person died and two people were injured. Damage to property totaled $180,100,000, with one storm alone responsible for $161,000,000 in damage, largely due to the collapse of heavily laden trees and power lines. Even though they are rare, ice storms cause severe damage when they do occur. (*Source: NCDC Storm Events*)

Jurisdictions impacted: Snow and ice storms can have a localized impact, however, for purposes of mitigation planning all jurisdictions are impacted equally in the county.

Table 8: Snow and Ice Storms affecting Tuscola County

Date	Location	Type	Deaths*	Injuries*	Damage*
2/22/1993	Thumb Region	Lake Effect Snow	0	0	0
12/17/1998	Thumb Region	Heavy Snow	0	0	0
1/12/2000	Thumb Region	Heavy Snow	0	0	0
10/7/2000	Thumb Region	Snow	0	0	0
12/11/2000	Thumb Region	Heavy Snow	0	1	1.1m
12/12/2000	Thumb Region	Blizzard	0	0	0
12/24/2003	Western Thumb	Heavy Snow	0	0	0
1/22/2005	Northern Thumb	Blizzard	0	0	0
2/14/2005	Northern Thumb	Ice Storm	0	0	0
1/21/2006	Western Thumb	Heavy Snow	0	0	0
2/5/2006	Thumb Region	Winter Storm	0	0	0
3/2/2006	Thumb Region	Winter Storm	0	0	0
2/25/2007	Thumb Region	Winter Weather	0	0	0
3/1/2007	Thumb Region	Winter Storm	0	0	0
3/1/2007	Thumb Region	Winter Weather	0	0	0
2/3/2008	Western Thumb	Heavy Snow	0	0	0
		Totals	0	1	1.1 million
*Deaths, Injuries, and Damage may have occurred outside Tuscola County for events affecting multiple counties					

(Source: NCDC Storm Events)

Severe Wind

Description: Severe winds, or straight-line winds, sometimes occur during severe thunderstorms and other weather systems, and can be very damaging to communities. Often, when straight-line winds occur, the presence of the forceful winds, with velocities over 58 mph, may be confused with a tornado occurrence. Severe winds have the potential to cause loss of life from breaking and falling trees, property damage, and flying debris, but tend not to cause as many deaths as tornadoes do. However, the property damage from straight line winds can be more widespread than a tornado, usually affecting multiple counties at a time. In addition to property damage to buildings (especially less sturdy structures such as storage sheds, outbuildings, etc.), there is a risk for infrastructure damage from downed power lines due to falling limbs and trees. Large scale power failures, with hundreds of thousands of customers affected, are common during straight-line wind events.

Analysis: In thirty-five years, Tuscola's twenty-six cases of severe wind have resulted in one death, five injuries, and about $42,092,000 in property damage. Since the start of 2011, there have been four such events, resulting in $2,007,000 in damages. These figures translate to an average of .74 severe wind events per year over the last 35 years with .91 severe wind events happening per year since the last hazard mitigation plan. In light of these figures, it is clear that severe wind poses a significant threat of property loss to the county. Strong winds in Tuscola typically blow from the southwest to the northeast. Wind speeds can be predicted and measured

accurately by the National Weather Service, but with little forewarning, so adequate preparation is crucial for preparing for this hazard.

Jurisdictions Impacted: All jurisdictions are similarly impacted by severe winds. Severe winds can impact the entire county and have been ranked according to previous damages from high winds in these communities.

Table 9: Severe Winds in Tuscola County since January 1, 2000

DATE	TYPE	Wind Speed (knots)	Damage*	Injuries*
10/16/2001	High Wind	40	$0	0
2/1/2002	High Wind	40	$0	0
3/9/2002	High Wind	61	$10,000	0
11/12/2003	High Wind	52	$800,000	0
3/5/2004	High Wind	50	$0	0
4/19/2004	High Wind	52	$0	0
10/30/2004	High Wind	54	$200,000	0
11/6/2005	High Wind	52	$0	0
11/15/2005	Strong Wind	48	$450,000	0
4/16/2007	Strong Wind	43	$20,000	0
12/23/2007	High Wind	50	$35,000	0
1/30/2008	High Wind	50	$0	0
12/28/2008	High Wind	56	$250,000	0
9/7/2010	Strong Wind	39	$5,000	0
10/27/2010	High Wind	52	$5,000	0
10/15/2011	Strong Wind	39	$2,000	0
10/19/2011	High Wind	52	$5,000	0
1/19/2013	High Wind	53	$1,000,000	0
11/17/2013	High Wind	50	$1,000,000	0
		Totals	$3,782,00	0
*Injuries and damage may not have occurred totally in Tuscola County in cases of storms affecting multiple counties.				

Source: NOAA National Climate Data Center

Tornadoes

Description: Tornadoes are rapidly rotating columns of air that form most often in some severe thunderstorms during Michigan's warm months. Tornadoes are high-profile hazards that can cause catastrophic damage to either a limited or an extensive area. A tornado can have winds in excess of 300 miles per hour and can have widths over one mile. The deaths and injuries associated with tornadoes have declined since the 1950s, thanks to advances in severe weather forecasting and technology improvements, but tornadoes can still be deadly killers. Although

tornado deaths have decreased, tornado damages have increased in recent years, since a larger part of the country's land area contains developments with each passing year.

There can be wide sections of a community completely destroyed by one or more tornadoes. Neighborhoods can be reduced to piles of splintered trees and homes, and a junkyard of twisted metal objects. A strong tornado can level everything in its path. Communities need to be prepared for the possibility of having many residents without homes, areas with no power or phone lines, a series of burst pipes, and a gigantic amount of wooden and metallic debris to clean up (in patterns that are both scattered and concentrated).

It should be kept in mind that winds are invisible until they pick up a sufficient amount of material that can allows their patterns to be seen, and it is this carried material that provides a tornado with a visible form that is easy to recognize. Funnel clouds can be invisible except for the liquid, dust, and debris that they carry. Therefore, a tornado can be present but not yet discernable to nearby persons. This is one reason why tornado warnings need to be taken seriously. A tornado's initial presence might only be directly observed by its effects upon things at ground level, with the main funnel cloud visibly forming only after enough material has been swept up from the ground. Many persons have placed themselves at risk by not realizing that tornadoes do not always appear in their classic, fully visible form. That classic darkly visible form is merely the one that is most easily discernable in photographs, and is therefore the form that is most widely recognized from such photographs and video. Moreover, tornadoes often reach beyond existing visible funnels (and multiple tornadoes can form simultaneously).

Analysis: Tornadoes have touched down in Tuscola County fairly frequently, twelve in the last thirty five years, but have caused surprisingly little damage. The most recent tornado occurred in June of 2015. The estimated frequency of tornadoes is once every three years. Only one person has been injured by tornadoes and the property damage resulting from all twelve storms was about $1,850,000. High winds have proven to be a more significant risk for the county. The common occurrence of tornadoes means that more powerful and damaging ones are likely to occur in the future. The preparations necessary to mitigate tornado damage are the same as those that will decrease risk from high winds, so the county would do well to implement such measures. (*Source: NCDC Storm Events*)

Jurisdictions Impacted: The threat of tornadoes cannot be targeted accurately so for purposes of mitigation planning all jurisdictions are impacted equally.

Fog

Description: Fog forms near the ground when water vapor condenses into tiny liquid water droplets that remain suspended in the air. Many different processes can lead to the formation of fog, but the main factor is saturated air. Two ways that air can become saturated are by cooling it to its dew point temperature or by evaporating moisture into it to increase its water vapor content. Although most fog, by itself, is not a hazard because it does not actually apply destructive forces, the interaction between humans and fog can be a dangerous situation, sometimes resulting in disastrous consequences. It must be noted, however, that freezing fog (a hazard for which the National Weather Service does issue special statements) can cause

direct harm by causing slickness on roadways and thus leading to serious transportation accidents

Analysis: Fog can be very dangerous because it reduces visibility. Fog is a particular hazard for road vehicles which have to travel slowly and use more lights. Localized fog is especially dangerous, as drivers can be caught by surprise. Fog can be particularly hazardous at airports, where some attempts have been made to develop methods (such as using heating or spraying salt particles) to aid fog dispersal. These methods have seen some success at temperatures below freezing but fog remains a safety concern statewide. In the state of Michigan, one major fog event is estimated to occur every two years. According to the most recent State Hazard Mitigation Plan, 0.6 fog events occur per county in the Lower Peninsula. No fog event was reported for Tuscola County from January 1996 to October 2013; however, Tuscola County should be prepared for fog events in the future. *(Source: 2014 Michigan Hazard Mitigation Plan)*.

Jurisdictions Impacted: All Jurisdictions are impacted equally by the risk of fog. The most substantial impacts involve motor vehicles and the risk of crashes and roadway obstructions as a result of low visibility. While fog can be dangerous for drivers, it does not pose a significant risk to Tuscola County at large.

Hydrological Hazards

Riverine Flooding/Erosion

Description: The overflowing of rivers, streams, drains and lakes due to excess rainfall, rapid snowmelt or ice. 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. Some developments have also encroached into flood plain areas and thus impeded the carrying capacity of the drainage area.

Analysis: Flooding is typically considered to be one of Tuscola County's main hazards. The flood maps indicate areas in the county where there is a 1% chance of flooding in a year. Since the most recent hazard mitigation plan, there have been two days of flooding resulting in an estimated $250,000 in property damage. In the previous thirty years, Tuscola County experienced seventeen days of flooding, and though that number seems infrequent, those days accounted for $117,720,000 in property and crop damage. Much of this was the result of major flooding in May of 2004 in all of Southeastern Michigan. *(Source: 2010 Tuscola Hazard Mitigation Plan and NCDC Storm Events)*

Previously, the problem of flooding in Tuscola County has been compounded by the lack of accurate floodplain maps for much of the county. However, presently, up-to-date Flood Insurance Rate maps are available for a majority of the county and the entire county has a Flood Hazard Layer in FEMA's GIS system. (https://www.fema.gov/national-flood-hazard-layer-nfhl) as well as the County's GIS system. http://www.tuscolacounty.org/gis/ The availability of this flood data now allows planners to identify problem areas in a more accurate manner than was

previously possible. Flood maps allow the county to take more comprehensive measures against the repetitive losses caused by riverine flooding. Flood Insurance Rate maps are also available online from FEMA at http://msc.fema.gov/

Storm drainage programs such as the Sebewaing and Moore drains will help to alleviate the flooding problem. Beyond this overbank flooding, Caro has experienced sewer overflow in the past as a result of other flood events.

Jurisdictions impacted: As noted above, flooding in Tuscola County is primarily known to impact communities that include rivers and drains. The primary jurisdictions impacted, based on past flood damages are:

- Almer Township
- Arbela Township
- City of Caro
- Fremont Township
- Gilford Township
- Indianfields Township
- Juniata Township
- Millington Township
- Village of Millington
- Novesta Township
- Tuscola Township
- Vassar Township
- City of Vassar

Tuscola County experienced a major (100 year) flooding event in 1986 along the Cass River. One of the communities most profoundly affected by this flood was the City of Vassar. In response to the extensive damages resulting from this flood, Vassar created a Flood Mitigation Assistance Plan and adopted it officially on September 21, 1998. The City of Vassar's Flood Mitigation Assistance Plan is available at the Vassar City Hall, 287 E. Huron Ave., Vassar, MI and on line at

Change in Risk from 2008 Plan: Since 2008 all flood maps have been updated to reflect flooding based on watersheds as the jurisdiction instead of municipality. These revised flood maps area available on the Tuscola County GIS website**.** http://www.tuscolacounty.org/gis/ The City of Vassar should update their flood plan to reflect new maps and recent drain construction.

Shoreline Flooding/Erosion

Description: Michigan has over 3,200 miles of coastline (the longest freshwater coastline in the world), and about 4.7 million persons live in the state's 41 shoreline counties. Wind, waves, water levels, and human activities constantly affect the communities along the shores of the Great Lakes. 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.)

Analysis: Although Tuscola County has about twenty miles of Great Lakes shoreline, government records show no shoreline flooding events since 1950. This does not mean that shoreline flooding will not be a potential hazard along this shoreline in the future. Although it should not be as high a priority as some of the more persistent hazards, it may eventually require attention. The regional flood maps indicate where there is a 1% chance of flooding in any one year in a number of shoreline areas. (Source: 2010 Tuscola Hazard Mitigation Plan and NCDC Storm Events)

Jurisdictions impacted: Wisner and Akron Townships both border the Saginaw Bay of Lake Huron. The FEMA-issued Flood Insurance Rate Maps for both jurisdictions are included below. These maps are also available online from FEMA at http://msc.fema.gov or at http://www.tuscolacounty.org/gis/

Impaired Waters

Dam Failure

Description: A dam failure can result in loss of life, and in extensive property or natural resource damage for miles downstream from the dam. Dam failures occur not only during flood events, which may cause overtopping of a dam, but also as a result of poor operation, lack of maintenance and repair, and vandalism. Such failures can be catastrophic because they occur unexpectedly, with no time for evacuation. The Michigan Department of Environmental Quality (MDEQ) has documented approximately 287 dam failures in Michigan since 1888.

Information on dams with low hazard potential may be available from the National Inventory of Dams. As of 2012, 136 of the dams in Michigan were classified as "high hazard" (meaning there was at least some development downstream, in the dam's "hydraulic shadow"), down from the count of 161 from just a few years before. Development should be discouraged in areas that would increase the risks from potential dam failures. Effects from dam failures can be more

severe than those from riverine flooding, due to the possibility of the extra effects of flash flooding and wave action from a catastrophic dam failure.

Analysis: The Department of Environmental Quality reports 14 dams for Tuscola County. Of these, eight are used exclusively for lake level control or wetland control. Many of the dams are located in or around Caro or Vassar. The Caro Dam is nonoperational.

- Caro Dam
- Murphy Lake Level Control
- Peter's Dam
- Shay Lake Level Control
- North Graede Marsh Dam
- South Graede Marsh Dam
- Fish Point Pond C Dam
- Fish Point Pond B Dam
- Old Muskrat Farm Dam
- Odessa Lakes Dam #1
- Odessa Lakes Dam #2
- Odessa Lakes Dam #3
- Odessa Lakes Dam #4
- Camp Pine Acres Dam

None of the dams in Tuscola County are required to have emergency action plans and none are considered a "high hazard potential" by the Michigan DEQ. However, the American Society of Civil Engineers states that "more than 90% of Michigan's nearly 2,600 dams will reach or exceed their design life by 2020." *(Source: American Society of Civil Engineers, 2013 Report Card for America's Infrastructure. http://www.infrastructurereportcard.org/grades/)*

In the event of flooding, which is a rather common occurrence in the county, these dams pose a risk of failure. Failure of the Odessa Lakes Dams on the Cass River could be particularly traumatic to the City of Vassar. Inactive dams also pose a threat; an out of use dam near Caro that still holds water could also break, inundating the surrounding area. In cases of both active and inactive dams, proper dam maintenance and monitoring is the key to avoiding major hazards. (*Source: Michigan DEQ*)

Jurisdictions Impacted: See hydrology base map (Map 6) for the locations of major dams. The following jurisdictions all contain major dams:

- Village of Cass City
- Indianfields Township
- City of Vassar
- Vassar Township

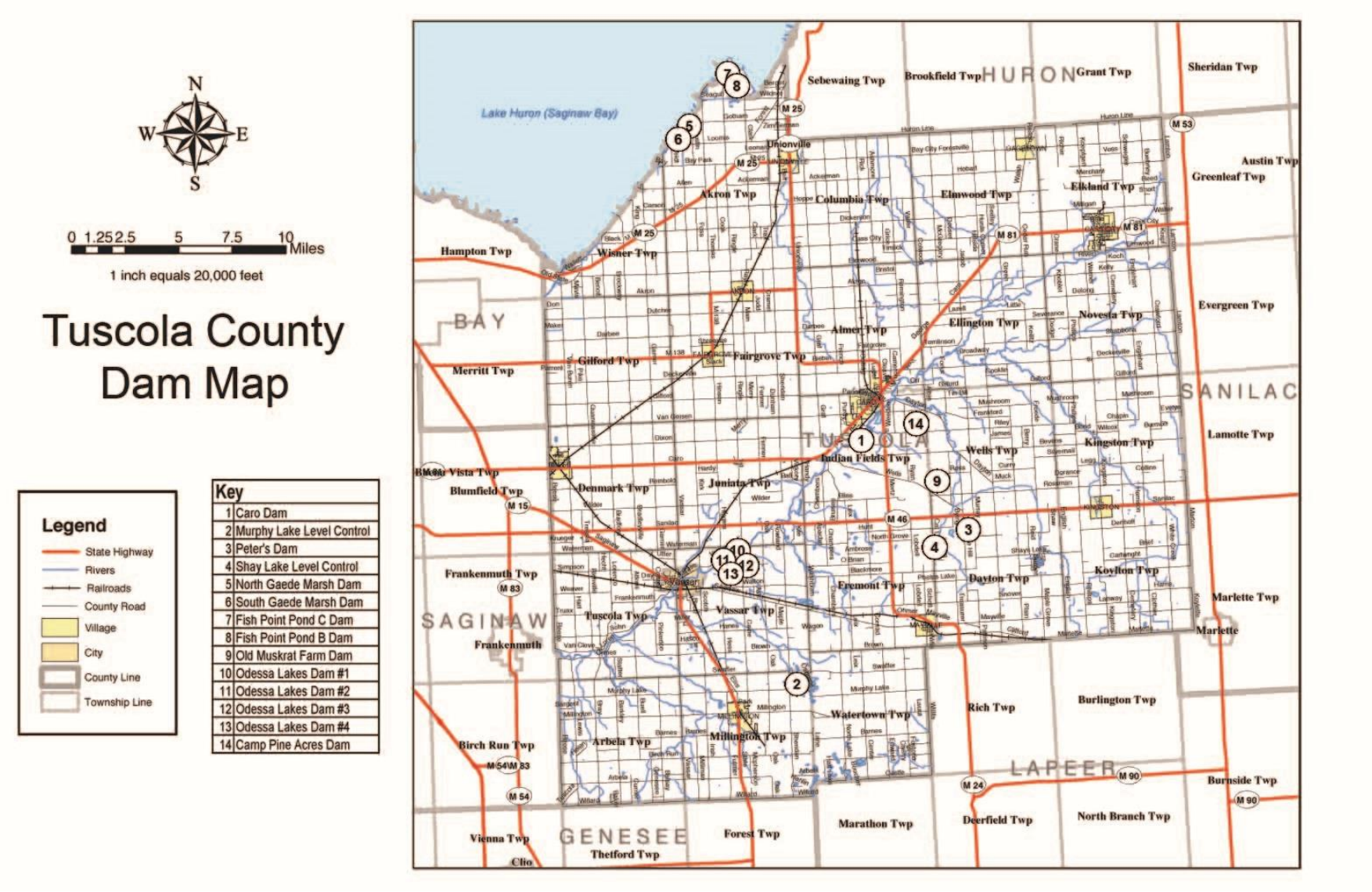
Change in Risk from 2008 Plan: In 2013, the City of Vassar removed the Vassar Dam, after receiving a $40,300 grant from the Michigan Department of Natural Resources. The dam was a timber crib structure with a concrete cap, approximately 200 feet in length. The dam was in a

state of ruin due to a collapsed portion in the center. The dam served no economic purpose and was a public safety hazard.

In June 2014, the local paper noted low water levels in the Cass River due to the failure of a control gate at the Caro dam, which is privately owned. The control gate failed in April 2014 at the 109-year old dam, causing water levels to slowly drop. The owner has not yet fixed the control gate. There are on-going discussions within the Michigan Department of Natural Resources and the Michigan Department of Environmental Quality regarading whether the Caro dam should be repaired or removed altogether.

In the near term, the risk of dam failure remains unchanged. However, as the American Society of Civil Engineers has noted and as citizens of Tuscola County have recently experienced, the dam infrastructure in the county is aging and failing. Without funds to repair or remove obsolete and failing dams and water control structures, it is reasonable to believe that the risk of dam failure will increase with each passing year.

Map 11 Dam Map



Drought

Description: Drought is the consequence of a natural reduction in the amount of precipitation received over an extended period of time, usually a season or more in length. Drought is a normal part of the climate of Michigan and of virtually 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. This 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, in the lack of an exact beginning and endpoint for a drought, whose effects may accumulate slowly and linger even after the event is generally thought of as 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. This lack of pre-planning can hinder support for drought mitigation capabilities that would otherwise effectively increase awareness and reduce drought impacts.

Analysis: The importance of agriculture to Tuscola makes drought damage particularly significant. Indeed, the county has experienced just two droughts in the last thirty five years, each lasting about thirty days, but experienced $150,000,000 in crop damage. Based on this history, serious drought happens about once every 15 years. This is an extremely significant economic loss for the county. Methods for mitigating drought damage involve the stockpiling of water in reservoirs and establishing means for distribution of that water, including pipelines and irrigation systems. Although the county might consider such measures in the future and because drought does not pose a significant risk to human lives in the county at this time, and mitigation measures are prohibitively expensive, especially in light of the benefits they provide, drought has not been considered a high priority risk for the county and is not given further consideration. (*Source: NCDC Storm Events*)

Jurisdictions Impacted: Drought could impact all jurisdictions equally but is considered a risk of low significance in that the frequency of occurrence is low.

Ecological Hazards

Wildfires

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.

Analysis: While in the late 1800s wildfires were the key to transforming Tuscola's economy from one based on logging to agriculture, since 1981 there has been one reported wildfire in 2012. This wildfire burned approximately 335 acres of state land in just six hours along Saginaw Bay but did not result in the loss of any structures or land. Substantial areas of State Forests within the county, particularly in Wisner and Juniata townships continue to present a hazard in the future as temperatures continue to rise. (*Source: NCDC Storm Events*)

Jurisdictions Impacted: Only one wildfire has occurred in Tuscola County in the last 35 years. While increasing temperatures coupled with dry conditions could increase the chances of wildfire on forested lands, the threat of future wildfires cannot be targeted accurately. Therefore, for the purposes of mitigation planning, all jurisdictions are impacted equally.

Invasive Species

Description: An invasive species is defined as a species that is (1) non-native (alien) to the ecosystem under consideration and (2) whose introduction causes or is likely to cause economic or environmental harm, or harm to human health. Invasive species can be plants, animals, and other organisms (e.g., microbes). Human actions are the primary consideration here as a means of invasive species' introduction (thus distinguishing the situation from natural shifts in the distribution of species). Nationally, the current environmental, economic, and health costs of invasive species were estimated as exceeding the costs of all other natural disasters combined. Invasive species can be transported in many ways, such as on animals, vehicles, ships, commercial goods, produce, and clothing. Although non-native species are the foundation of U.S. agriculture, and also are used to prevent erosion, to provide fishing and hunting opportunities, and as ornamental plants and pets, occasionally a non-native organism flourishes too well and causes unwanted economic, ecological, or human health impacts. The terms "invasive" or "nuisance" are used to describe such species. New environments may affect rates of reproduction, susceptibility to disease, and other features that affect a species' success. Consequently, a plant or animal that causes little damage to agriculture or natural ecosystems in one area may cause significant problems in another. Certain nonnative species are very successful in their new habitats because they out-compete native plants or animals and have no natural controls (predators, diseases, etc.) in the new area. At least 200 well-known, high-impact, non-native species presently occur in the United States. They range from the European gypsy moth and emerald ash borer to crabgrass, dandelions, and German cockroaches, annually costing well over a billion dollars to control. Some even pose human health risks. Others, like the zebra mussel, threaten widespread disruption of ecosystems and the displacement or loss of native plants and animals.

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

detection of invaders, track established invaders, and to coordinate containment, control, and effective habitat restoration.

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

Similarly, a widespread insect infestation, such as that of the Emerald Ash Borer, can create serious public safety threats (especially in densely populated urban areas) due to dead and dying trees being fire prone because of their dry, brittle nature or to partial/total collapse due to high winds or ice/snow accumulation. The falling trees or limbs can also bring down power lines, cause damage to public and private structures, and cause injuries or even death. The invasive species hazard has not yet been identified as one of the most significant hazards in any of Michigan's local hazard mitigation plans. *(Source: 2014 Michigan Hazard Mitigation Plan, P.247)*

Jurisdictions Impacted: All jurisdictions could be impacted.

Geological Hazards

Earthquakes

Description: Earthquakes range in intensity from slight tremors to great shocks. They may last from a few seconds to several minutes, or come as a series of tremors over a period of several days. 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 faults, which are formed where tectonic forces in the earth's crust cause the movement of rock bodies against each other. Risk maps have been produced which show areas where an earthquake is more likely to occur. Earthquake monitoring is conducted by the U.S. Geological Survey, the National Oceanic and Atmospheric Administration, and universities throughout the country.

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

A fault line is where a fault meets the ground's surface, but many faults dip at an angle away from their surface location, and therefore earthquakes that occur at some depth will often not line up with the fault at the surface. Faults do not only occur at the boundaries of large geological plates. There are many small plates that exist, as well as faults that are internal to or perpendicular to plate boundaries.

Analysis: While very minor earthquakes occur constantly in Tuscola, none are significant enough to pose hazards and they warrant no further analysis.

Jurisdictions Impacted: Earthquakes could impact all jurisdictions equally but are not considered a risk of any significance.

Change in Risk from 2008 Plan: No Change in risk from 2008 plan.

Land Subsidence

Description: Subsidence is the lowering or collapse of a land surface, due to loss of subsurface support. It can be caused by a variety of natural or human-induced activities. Natural subsidence occurs when the ground collapses into underground cavities produced by the solution of limestone or other soluble materials by groundwater. Human-induced subsidence is caused principally by groundwater withdrawal, drainage of organic soils, and underground mining. In the United States, these activities have caused more than 17,000 square miles of surface subsidence, with groundwater withdrawal (10,000 square miles of subsidence) being the primary culprit. In addition, approximately 18% of the United States land surface is underlain by cavernous limestone, gypsum, salt, or marble, making the surface of these areas susceptible to collapse into sinkholes.

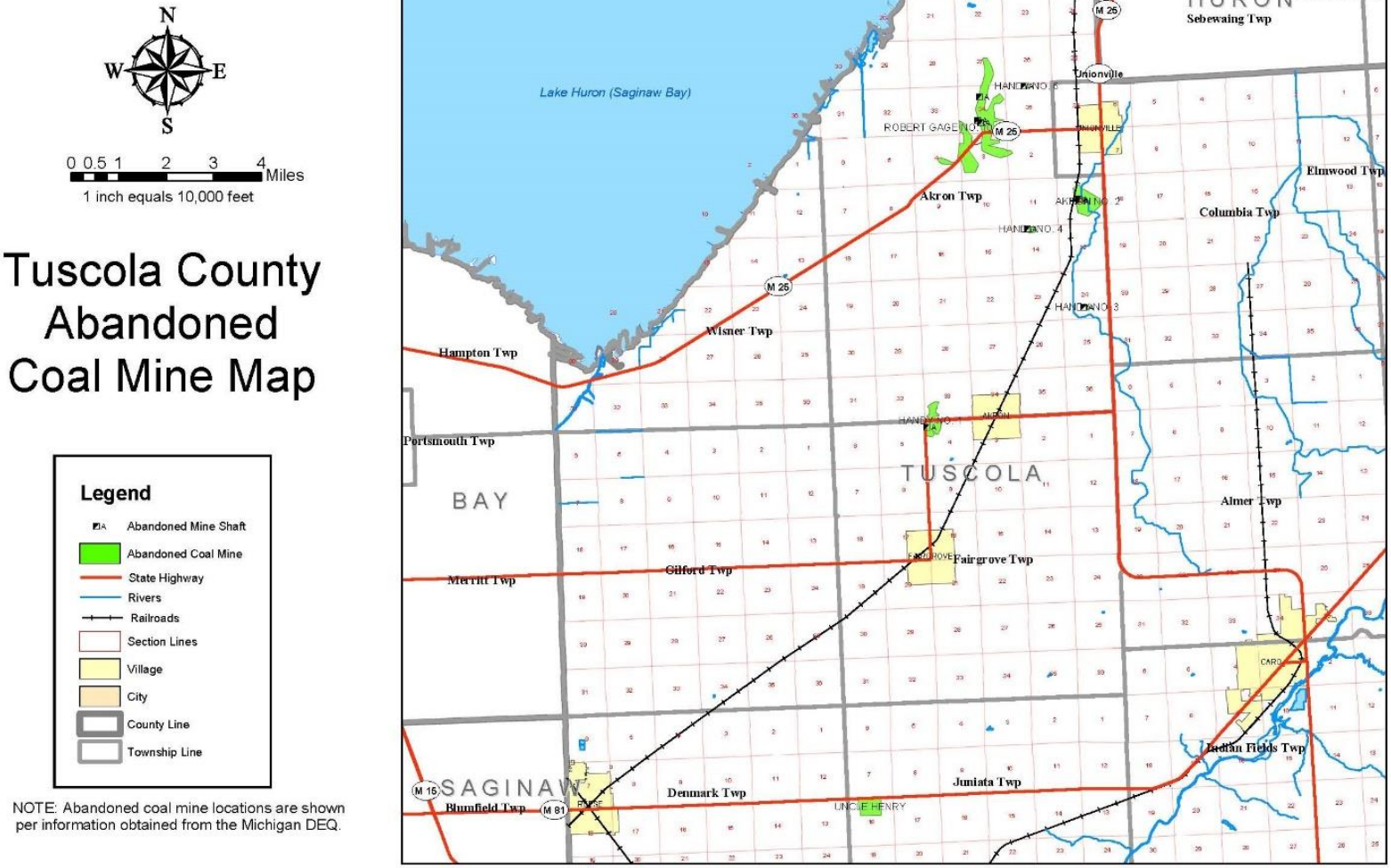
Analysis: Although there are no active coal mines in Michigan today, Tuscola County is located at the edge of Michigan's coal basin and is home to seven abandoned coal mines. Coal mines pose a real risk of collapse and release of mine gases that can cause subsidence, but when or if such events will occur is difficult to predict. It should be noted that the underground extent of coal mines exceeds their appearance on the surface, so detailed information about the mines would be helpful for future planning. Unfortunately, coal mining in Michigan was never regulated, so it is difficult to locate comprehensive information about the mines. The county should remain aware of the existence of these mines and try to plan development in such a way to avoid building near them to mitigate the damage created by land subsidence (see Map 12).

Jurisdictional impact: Abandoned coal mines are located in:

- Akron Township
- Tuscola Township
- Juniata Township

Change in Risk from 2008 Plan: No Change in risk from 2008 plan.

Map 12 Abandoned Coal Mines Map



Change in Risk from 2008 Plan: No Change in risk from 2008 plan.

Celestial Impact

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

Much more common is the flare-up of energy and charged particles that are emitted and ejected by the Sun and impact upon the Earth's atmosphere. These solar geomagnetic storms (also known as space weather) can cause widespread failures of important satellite, electronic, communication, navigation, guidance and electric power systems—which have all formed a very important part of our modern technology and lifestyles. Because of the amount and complexity of information concerning the potential impacts from space objects, a great deal of this section has been devoted to an explanation and analysis of that hazard. However, it is important to note at the outset that the solar storm hazard is far more likely in the near term to cause disruptive effects, large economic impacts, and risks to human life. The smaller amount of text dedicated to space weather in this document should not mislead readers into a sense that it is considered less important, or that it is expected to cause less impact in the near future. Rather, the conclusion of the analysis presented here is that the effects of space weather have already had, and are much more likely to have, strong impacts upon Michigan within the normal historical timeframe that is typical for this type of plan. By contrast, the extensive discussion of impacting physical objects is given primarily to be "on the safe side" so that readers and emergency managers can be well-informed in the unlikely event that a very serious incident does occur, or threaten to occur.

Although it has been estimated that a major impact from a physical body upon the Earth occurs approximately once per century, recent discoveries (and the fact that much more of the Earth has been covered by human developments within the recent past) have caused increasing concern over this hazard. Although most meteorites would be expected to strike an ocean rather than a continent, the effects of a large enough ocean strike can still be widely damaging, through resulting tsunami and seismic activities.

An important type of celestial impact involves the interference or disruption of modern electronic and communications systems, including those upon which our modern aviation networks rely. Solar flares and storms (also known as "space weather") are highly relevant for their potential impacts and possible disruption of these complex modern communication systems—satellites, television, radio, GPS, power supply networks, and the extensive human and technological

infrastructure that relies upon those communication and utility networks. Extensive evidence of previous celestial impacts upon Earth has been discovered, including evidence of a historic crater site located in southwest Michigan, but the vast majority of historical Earth impacts have had their evidence erased from normal observation by the ongoing geological processes that take place over time. Even the largest of impact sites would no longer be evident to normal observation after a period of about 200 million years (usually much, much less). Such an amount of time is less than 5% of the Earth's overall age, but it has been found that impacts used to occur much more frequently during the earlier periods in Earth's history (i.e. nearer to the period of planetary formation) than they do in recent geological periods. Clearer evidence of the many historical impacts can be seen on other celestial bodies that are less geologically active, such as Earth's own Moon.

Analysis: It is estimated that a major impact from a physical body upon the Earth occurs approximately once per century. Extensive evidence of previous celestial impacts upon Earth have been discovered with relevant events identified in the Michigan Hazard Mitigation Plan. One crater site was identified in southwest Michigan, however there is no evidence to suggest an impact is likely or expected in Tuscola County. Space weather is a term that denotes the impacts of the Sun's activity upon the bodies within this sphere inside the heliopause, including our own Earth. As with the weather on Earth, there are some clear patterns that are exhibited by space weather. More turbulent space weather is produced during times when more sunspots are present (called a solar maximum), and space weather is calm during times when sunspots are rare and small (or not even seen to be present at all, called a solar minimum). Space weather can be very expensive for those who use or rely upon satellites. During a solar maximum, the Earth's upper atmosphere expands and increases the drag upon satellites within low orbits, which will then require boosting in order to remain aloft. While a major impact is incredibly unlikely, space weather could cause an infrastructure failure as a result of satellite failures. Events of this nature involving Tuscola County poise no greater risk than those for Michigan as a whole.

Jurisdictional Impact: Celestial Impacts could impact all jurisdictions equally but are not considered a risk of any significance seeing as the Michigan State Hazard Mitigation Plan does not anticipate any events within Michigan.

Change in Risk from 2008 Plan: No Change in risk from 2008 plan.

TECHNOLOGICAL HAZARDS

Technological hazards result from accidents or the failures of systems and structures, such as hazardous materials spills or dam failures.

Industrial Hazards

Fire Hazards – Structure Fires

Description: A fire, of any origin, which ignites one or more structures, causing loss of life and/or property. This includes any instance of uncontrolled burning that result in structural damage to residential, commercial, industrial, institutional, or other properties in developed areas. In terms of average annual loss of life and property, structure fires are by far the biggest hazard facing most Michigan communities. Most of these fires occur through neglect and carelessness and are preventable through awareness and education programs.

Analysis: Structure fires remain a risk for Tuscola County as they do for all Michigan communities. The POET Ethanol Plant in Caro adds a special element to fire hazard planning in Tuscola. In 2004, the ethanol plant experienced a significant fire, which lasted thirteen hours and injured six people. The Michigan Occupational Safety and Health Administration investigated this fire and immediately found that the plant was not properly equipped to handle fires. Since this fire, POET has taken corrective measures to reduce the chance of future fires. (*Source: ABC12 News*)

Seasonal patterns that contribute to the potential for occurrence of fires should be considered in fire hazard mitigation. If the county is experiencing a dry spring or summer season, brushfires are at a high risk of occurrence. During the winter, holiday lights and kerosene heaters create increased risk of fires at this facility. (*Source: NFIRS*)

An additional risk for structure fires in Tuscola County derives from the county's strong agricultural sector. Many of Tuscola's communities feature grain elevators for the collection and distribution of farm produce. Grain elevators can generate intense heat and the collected dust from grain is highly explosive. Grain elevators thus pose a substantial fire and explosion hazard to their communities. Additionally, grain elevators are often collocated with farm supply businesses that sell fertilizers that can also be volatile, particularly when misused intentionally.

Table 10: Grain Elevators in Tuscola County

Business Name	Address
Cooperative Elevator Co	3615 Davis St, **Akron**
Star of the West Milling Co.	6210 Main St, **Cass City**
Star of the West Milling Co.	4073 N Cemetery Rd, **Cass City**
Star of the West Milling Co.	462 N. Vassar Rd, **Fairgrove**
Star of the West Milling Co.	2211 N Main St., **Fairgrove**
Vita Plus	6506 Mill Street, **Gagetown**
Cooperative Elevators Co	6678 Gage St, **Gagetown**

Millington Elevator & Supply	8457 Elevator St, **Millington**
Star of the West Milling Co.	9774 Center St., **Reese**
Star of the West Milling Co.	9770 Overton St., **Reese**
Star of the West Milling Co.	2050 Williams St., **Reese**
Star of the West Milling Co.	203 S Bradleyville Rd, **Reese**
Star of the West Milling Co.	9715 Saginaw St, **Reese**
Star of the West Milling Co.	3269 S Van Buren Rd, **Richville**
POET	1551 Empire Dr., **Caro**
Star of the West Milling Co.	112 N. Sherman St., **Vassar**

Source: Tuscola County Emergency Management

Jurisdictions Impacted: See Table 10 and Map 13 for locations of grain elevators.

Change in Risk from 2008 Plan: The Michigan Department of Licensing and Regulatory Affairs reports structural fire data for the years 2013 and 2014.

Table 11 - Tuscola County Fire Data

Recent Tuscola County Fire Incidents	2014	2013
Total Fires	146	134
Arson	10	7
Suspicious	29	35
Total Estimated Loss	$ 2,864,500	$ 22,333,600
Avg # of Fires per County (Statewide)	309	304
Avg Loss per County (Statewide)	$ 6,195,526	$ 7,765,796

This data wat not included in the 2008 plan, so a comparison with previous years cannot be made. Through conversations with county emergency personnel, the annual number of fires remains relatively the same from year to year. The estimated loss may vary dramatically from year to year, depending on the type of structure (and the materials within the structure) fire. Overall, the risk of structural fires has not changed from the previous plan.

Since the 2004 POET Ethanol plant fire, there have been two other reported fires at the facility: (Source: https://sites.google.com/site/metropolitanenvironmental/the-fire-and-explosion-risks-associated-with-ethanol-production-and-transportation)

- September 2008 – fire in hot spots in ductwork

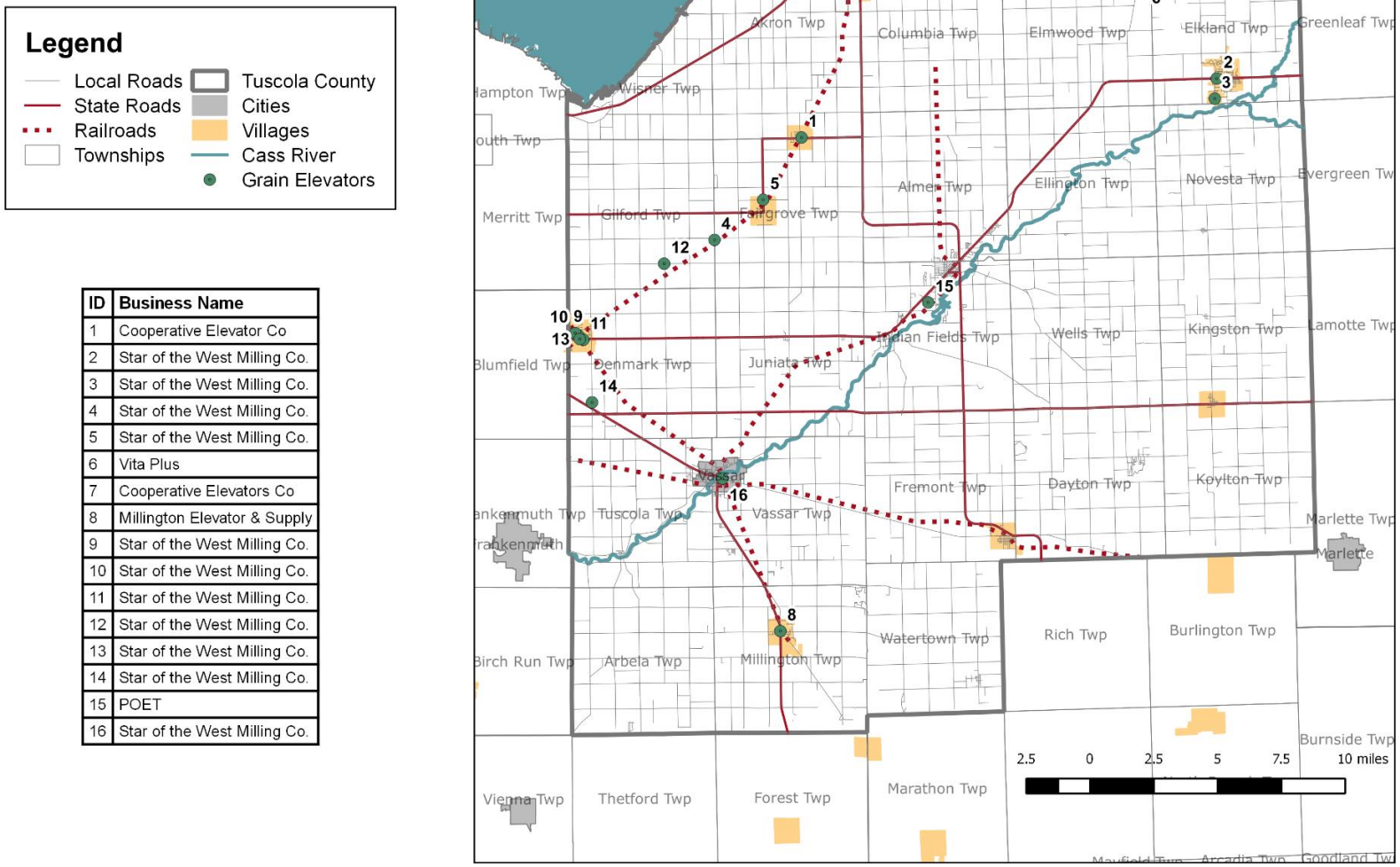
- October 2010 – fire in ductwork between driers; thermal oxidizer also caught fire

Perhaps as a result of the 2004 fire, POET and the City of Caro fire department now work closely on emergency training. At least twice each year they collaborate on training, including "confined space training," which prepares staff from each organization to respond to crises like rescuing farmers trapped in a grain bin. (Source: http://vitalbypoet.com/stories/first-in-the-wolverine-state#sthash.Ztunc54a.dpuf) In 2009 and again in 2014, it was reported that several local fire departments participated in a practice ethanol burn at the POET facility. The burn was an opportunity for firefighters to gain experience in firefighting techniques and learn the layout of the ethanol plant. *(Source: Tuscola Today, Oct. 4, 2009)*.

Finally, there have been no changes in the number of grain elevators in the county. However, several grain elevators have changed ownership since the last plan.

Map 13 Agricultural Facility Map

Tuscola County Agricultural Facility Map



ID	Business Name
1	Cooperative Elevator Co
2	Star of the West Milling Co.
3	Star of the West Milling Co.
4	Star of the West Milling Co.
5	Star of the West Milling Co.
6	Vita Plus
7	Cooperative Elevators Co
8	Millington Elevator & Supply
9	Star of the West Milling Co.
10	Star of the West Milling Co.
11	Star of the West Milling Co.
12	Star of the West Milling Co.
13	Star of the West Milling Co.
14	Star of the West Milling Co.
15	POET
16	Star of the West Milling Co.

Fire Hazards – Scrap Tires

Description: A large fire that burns scrap tires being stored for recycling or re-use. Michigan generates 7.5-9 million scrap tires per year, many of which end up in disposal sites along with hundreds of thousands of other tires. Because the material that tires are made of is flammable, and their shapes allows for maximum air flow to keep a fire supplied with oxygen, tire fires, once started, are very difficult to extinguish. The fires spread as the tires melt and break down. Tire fires may burn for months, generating large quantities of acrid smoke.

Analysis: Scrap tires are regulated by the Michigan Department of Environmental Quality (MDEQ). MDEQ registers companies as commercial scrap tire haulers, commercial scrap tire collection sites and commercial scrap tire processors.

There is one registered commercial scrap tire hauler in the county:

- Diva Disposal LLC, 6608 Lincoln St, Gagetown MI 48735

There are no licensed tire collection sites or processing facilities within the county. The Tuscola County Recycling Material Recovery Facility in Caro holds residential scrap tire collection events throughout the year. The tires collected at these events are not stored on-site for more than a few days, before being transferred to appropriate disposal sites.

Jurisdictions Impacted: The risk of scrap tire fires is greatest in:

- Elmwood Township

Change in Risk from 2008 Plan: There have been two registered scrap tire haulers each year since 2008, with the exception of 2014, when there were three registered scrap tire haulers. The two other scrap tire haulers have let their registrations expire. Since there is only a single scrap tire hauler in the county, the risk of a scrap tire fire at a discrete location is reduced. However, fewer scrap tire haulers may lead to additional illegal dumping of scrap tires. So, the risk of a scrap tire fire may shift from discrete locations to dispersed locations. For example, the Michigan Coalition for Clean Forests lists two known illegal dump sites in the county, with each dump site containing tires. With fewer registered scrap tire haulers, tires may be illegal dumped on roadsides, rivers and streams, vacant properties and forest lands.

Point Source Air Emissions from Regulated Facilities

Description: Michigan Air Pollution Control Rule R336.202 (Rule 2) requires an annual report from a commercial, industrial, or governmental source of emission of an air contaminant if, in the judgment of the Department, information on the quantity and composition of an air contaminant emitted from the source is considered by the Department as necessary for the proper management of the air resources. In addition, other state rules and federal statutes and regulations require sources to report air emissions if certain conditions are met.

Sources are only required to report emissions information for “criteria pollutants” (those related to a National Ambient Air Quality Standard). Emissions information must be reported for following pollutants: Ammonia, Carbon Monoxide, Lead, Oxides of Nitrogen, Particulates

(smaller than 10 microns in diameter), Particulates (smaller than 2.5 microns in diameter), Sulfur Dioxide, and Volatile Organic Compounds.

The criteria pollutants are an indicator of air quality. The National Ambient Air Quality Standards establish for each of them a maximum concentration above which adverse effects on human health may occur. When an area does not meet the air quality standard for one of the criteria pollutants, it may be subject to the formal rule-making process which designates it as nonattainment. The Clean Air Act further classifies ozone, carbon monoxide and particulate matter nonattainment areas based on the magnitude of an area's problem. Nonattainment classifications may be used to specify what air pollution reduction measures an area must adopt, and when the area must reach attainment.

Analysis: The federal Clean Air Act requires that each state maintain an inventory of air pollution emissions for certain facilities and update this inventory every year. Michigan's emission inventory is the Michigan Air Emissions Reporting System (MAERS). The Michigan Department of Environmental Quality (DEQ), Air Quality Division maintains MAERS reports for commercial, industrial, and governmental sources of air pollution in Michigan. Emissions data is submitted to the United States Environmental Protection Agency (U.S. EPA) to be added to the national data bank. This information is used to track air pollution trends, determine the effectiveness of current air pollution control programs, serve as a basis for future year projections of air quality, track source compliance, provide information for permit review, and calculate the emissions portion of the air quality fee. The following facilities are currently required to submit annual reports on air emissions.

- Ace – Saginaw Paving Co – Plant 10 (Watertown Township)
- ADS US Inc (Millington)
- DTE Electric – Wilmot Peaking Facility (Kingston Township)
- DTE Electric – Putnam Peaking Facility (Village of Mayville)
- Michigan Ethanol dba POET Biorefining (City of Caro)
- Michigan Sugar Company (City of Caro)
- TI Group Automotive Systems LLC (Caro)
- TPOP LLC – Vassar Foundry – closed (Vassar)
- Tri City Aggregates (Millington)
- Tuscola Minerals Co - closed (Vassar)

Tuscola County current meets all federal and state air quality standards.

Jurisdictions Impacted: The release of criteria air pollutants impacts all jurisdictions in the county, since the pollutants will travel throughout the county and beyond. Those jurisdictions where the emissions are being created, are not necessarily at a higher risk from the actual emissions. However, those jurisdictions may be at a higher risk for other technological hazards, depending on the activities occurring at each location that create the emissions. These aforementioned facilities are located in the following jurisdictions:

- Watertown Township
- Village of Millington

- Kingston Township
- Village of Mayville
- City of Caro
- City of Vassar

Change in Risk from 2008 Plan: The MAERS data was not included in the 2008 plan. But, the air quality in Tuscola County has improved since the 2008 plan. Total criteria air pollutant emissions have declined nearly 40% since 2008. The number of facilities reporting emissions have also declined in that time period, from 12 facilities to 10 facilities. While no one factor can be identified as the sole reason for the decline in emissions, it likely that the broad economic decline due to the recession from 2008 to 2010 was the driving force behind these emission reductions. The recession reduced economic opportunities, resulting in facility closures or reduced production – ultimately leading to fewer emissions. Thus, there is less risk to human health from industrial emissions in 2014 than 2008.

Table 11: Air Quality Changes in Tuscola

Pollutant (all units tons)	2004 – 2008	2009 - 2013	Amount of Change	% Change
Ammonia	14.86	12.59	(2.27)	15.3%
Carbon Monoxide (CO)	1,646.56	820.60	(825.96)	50.2%
Lead	50.09	5.82	(44.27)	88.4%
Nitrous Oxide (NO_X)	1,597.39	1,269.71	(327.68)	20.5%
PM_{10}	936.45	436.31	(500.14)	53.4%
$PM_{2.5}$	2,849.15	2,004.54	(844.61)	29.6%
Sulfur Dioxide (SO_2)	103.41	50.00	(53.41)	51.6%
Volative Organic Compounds (VOCs)	1,325.94	546.24	(779.70)	58.8%
Grand Total	**8,523.85**	**5,145.81**	**(3,378.04)**	**39.6%**

Source:

Air, Land and Water Discharges from Regulated Facilities

Description: Controlled and permitted releases of chemicals or chemical components from a regulated facility. An inventory of this information was established under the Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA) and expanded by the Pollution Prevention Act of 1990. EPCRA's primary purpose is to inform communities and citizens of chemical hazards in their areas. EPCRA require businesses to report the locations and quantities of chemicals stored on-site to state and local governments in order to help communities prepare to respond to chemical spills and similar emergencies.

Analysis: Federal law requires EPA and states to annually collect data on releases and transfers of certain toxic chemicals from industrial facilities and make the data available to the public in the Toxics Release Inventory (TRI). TRI is a publicly available EPA database that contains information on toxic chemical releases and other waste management activities reported annually by certain covered industry groups as well as federal facilities.

Between 2009 and 2013, three facilities reported emissions and discharges through the Toxic Release Inventory, totaling 507,575.80 pounds. The biggest discharges were to off-site landfills, accounting for 63% of all discharges during that five year period. Approximately 36% of discharges during that period were released into the air, either as fugitive emissions or emission from a stack. Less than 1% of discharges were to surface waters. The facilities discharged six heavy metals, six hazardous air pollutants and two other chemicals. Appendix C for a description of the pollutants.

Table 12: Air, Land Water Discharges from Regulated Facilities in Tuscola County

		2009 - 2013 EMISSIONS				
Facility	**Chemical**	**Fugitive Air Emissions (lbs)**	**Point Source Air Emissions (lbs)**	**Surface Water Discharges (lbs)**	**Total Off-site Disposal (lbs)**	**Subtotal (lbs)**
METAVATION LLC						
700 E HURON AVE, VASSAR	4,4'-ISOPROPYLIDENEDIPHENOL	-	2,101.00	-	20,447.00	22,548.00
	ANTIMONY	-	58.00	-	4,260.00	4,318.00
	CHROMIUM	-	387.00	-	35,319.00	35,706.00
	COPPER	-	205.00	-	18,108.00	18,313.00
	FORMALDEHYDE	-	-	-	-	-
	LEAD	-	2,118.00	-	113,263.00	115,381.00
	MANGANESE	-	217.00	-	84,743.00	84,960.00
	NICKEL	-	360.00	-	32,857.00	33,217.00
	PHENOL	807.00	104,173.00	-	10,957.00	115,937.00
	ZINC COMPOUNDS	-	-	-	-	-
MICHIGAN ETHANOL LLC						
1551 EMPIRE DR, CARO	ACETALDEHYDE	10.00	13,092.00	-	-	13,102.00
	AMMONIA	1,440.00	4,561.00	-	-	6,001.00
	ACROLEIN	10.00	9,039.00	-	-	9,049.00
	BENZENE	-	-	-	-	-
	CYCLOHEXANE	-	-	-	-	-
	METHANOL	10.00	2,057.00	-	-	2,067.00
	N-HEXANE	1,301.80	13,403.00	-	-	14,704.80
	TOLUENE	-	-	-	-	-
	XYLENE (MIXED ISOMERS)	-	-	-	-	-
	ZINC COMPOUNDS	-	-	-	-	-
MICHIGAN SUGAR CO						
819 PENNINSULAR ST, CARO	AMMONIA	-	24,550.00	2,990.00	-	27,540.00
	HYDROCHLORIC ACID	-	3,809.00	-	-	3,809.00
	LEAD COMPOUNDS	-	1,236.00	-	87.00	1,323.00
	Grand Total (lbs)	**3,578.80**	**181,366.00**	**2,990.00**	**320,041.00**	**507,975.80**

Closed

The TRI data is valuable for emergency preparedness because it helps communities and first responders better prepare for potential chemical spills or other emergencies.

Jurisdictions Impacted: The possibility of hazardous materials being released into the air impacts all jurisdictions in the county, since the pollutants will travel throughout the county and beyond. Those jurisdictions where the emissions are being created are not necessarily at a higher risk from the actual emissions. However, those jurisdictions may be at a higher risk for other technological hazards, depending on the activities occurring at each location that create the emissions. These facilities are located in the following jurisdictions:

- City of Caro
- City of Vassar

Change in Risk from 2008 Plan: The TRI data was not included in the 2008 plan. Total emissions have declined nearly 52% since 2008. The number of facilities reporting emissions have also declined in that time period from 5 facilities to 3 facilities. While no one factor can be identified as the sole reason for the decline in emissions, it likely that the broad economic decline due to the recession from 2008 to 2010 was the driving force behind these emission reductions. The recession may have reduced economic opportunities, resulting in facility closures or reduced production – ultimately leading to fewer emissions. There will also be fewer emissions in the future if the number of reporting facilities remains the same, because the Metavation LLC facility in Vassar closed in October 2013. Thus, there is far less risk to human health from industrial emissions in 2014 than 2008. The risk of accidental releases of hazardous materials is significantly reduced, as only two reporting facilities remained in 2014.

Table 13: Reductions in Air, Land, Water Discharges from Regulated Facilities

	2009 - 2013 Emissions				2004 -2008 Emissions			
	Air Emissions (lbs)	Surface Water Discharges (lbs)	Total Off-site Disposal (lbs)	Subtotal (lbs)	Air Emissions (lbs)	Surface Water Discharges (lbs)	Total Off-site Disposal (lbs)	Subtotal (lbs)
Heavy Metals								
ANTIMONY	58.00	-	4,260.00	4,318.00	139.00	-	2,221.00	2,360.00
CHROMIUM	387.00	-	35,319.00	35,706.00	10,462.00	-	172,364.00	182,826.00
COPPER	205.00	-	18,108.00	18,313.00	797.00	-	13,271.00	14,068.00
LEAD	3,354.00	-	113,350.00	116,704.00	5,890.00	-	39,536.00	45,426.00
MANGANESE	217.00	-	84,743.00	84,960.00	1,002.00	-	31,101.00	32,103.00
NICKEL	360.00	-	32,857.00	33,217.00	9,566.00	-	72,562.00	82,128.00
ZINC COMPOUNDS	-	-	-	-	111.00	-	1,860.00	1,971.00
Hazardous Air Pollutants								
ACETALDEHYDE	13,102.00	-	-	13,102.00	13,915.73	-	-	13,915.73
ACROLEIN	9,049.00	-	-	9,049.00	-	-	-	-
BENZENE	-	-	-	-	262.00	-	-	262.00
FORMALDEHYDE	-	-	-	-	5,500.00	-	4,700.00	10,200.00
HYDROCHLORIC ACID	3,809.00	-	-	3,809.00	66,044.00	-	-	66,044.00
N-HEXANE	14,704.80	-	-	14,704.80	15,535.32	-	-	15,535.32
METHANOL	2,067.00	-	-	2,067.00	-	-	-	-
PHENOL	104,980.00	-	10,957.00	115,937.00	235,573.00	-	21,444.00	257,017.00
XYLENE (MIXED ISOMERS)	-	-	-	-	13,880.00	-	-	13,880.00
Other Chemicals								
4,4'-ISOPROPYLIDENEDIPHENOL	2,101.00	-	20,447.00	22,548.00	4,799.00	-	21,105.00	25,904.00
AMMONIA	30,551.00	2,990.00	-	33,541.00	281,866.00	3,830.00	-	285,696.00
	184,944.80	2,990.00	320,041.00	507,975.80	**665,342.05**	**3,830.00**	**380,164.00**	**1,049,336.05**
% Decline from 2004 - 2008 Period	72%	22%	16%	52%				

Underground Storage Tanks

Description: Underground Storage Tanks (UST) are defined as tanks and any underground piping connected to a tank that has at least 90 percent of its combined volume underground. USTs, used to store petroleum products, are regulated in the United States to prevent release of petroleum and the subsequent contamination of groundwater. Many USTs installed before 1980 consisted of bare steel pipes which corrode over time and eventually result in leakage. Faulty installation and inadequate handling may also cause leaks. In 1988, the US EPA published stringent underground storage tank regulations, including a 10-year phase-in period that required all operators to upgrade their USTs with spill prevention and leak detection equipment.

Analysis: USTs are in place throughout Tuscola County at gas stations, industrial sites and government facilities. According to the Michigan Department of Environmental Quality (MDEQ) Storage Tank Information Database, there are 133 active Underground Storage Tanks (USTs) in Tuscola County. Of these USTs, 115 are currently in use; 15 are temporarily out-of-use; 3 USTs have been closed in the ground. The USTs currently in use must meet all federal requirements for spill prevention and leak detection, eliminating nearly all risk of a leak resulting in the contamination of groundwater.

The MDEQ also reports 76 “open” Leaking Underground Storage Tanks (LUSTs). An open LUST site means a location where a release has occurred from an underground storage tank system, and where corrective actions have not been completed to meet the appropriate land use criteria. An open LUST site may have more than one confirmed release. Most of the open LUSTs in Tuscola County have released gasoline or diesel fuel.

According to US EPA, the greatest potential threat from a leaking UST is contamination of groundwater, the source of drinking water for nearly half of all Americans. Because most LUST sites are contaminated by gasoline, the following constituents of gasoline are the typical contaminants of concern of LUST sites: Benzene, toluene, ethylbenzene, and xylenes - together referred to as the BTEX compounds.

The impact of a LUSTs site on groundwater supplies is significant. A 10-gallon leak of gasoline contains enough benzene to contaminate, above the MCL, 12 million gallons groundwater.

In addition, LUST sites may contain methyl tertiary butyl ether (MTBE), which is an additive used to increase the oxygen content of gasoline to improve air quality. At concentrations as low as 20 parts per billion (ppb), MTBE makes drinking water unfit for human consumption because of taste and odor. Currently, MTBE is classified as a potential human carcinogen, but as yet there is no MCL for drinking water. MTBE is highly soluble in groundwater. The high solubility of MTBE allows it to be readily dissolved into groundwater from leaked gasoline and transported over great distances. In some cases, MTBE transport has exceeded the transport distances of BTEX compounds by 10 times. Compared to MTBE, the BTEX compounds are less soluble and more readily absorbed to aquifer sediments.

Jurisdictions Impacted:

- Tuscola County
- Akron Township
- Almer Township
- Columbia Township
- Denmark Township
- Elkland Township
- Elmwood Township
- Fairgrove Township
- Fremont Township
- Indianfields Township
- Kingston Township
- Koylton Township
- Millington Township
- Novesta Township
- Tuscola Township
- Vassar Township
- Watertown Township
- Wells Township

- Wisner Township
- City of Vassar
- City of Caro
- Village of Akron
- Village of Cass City
- Village of Fairgrove
- Village of Gagetown
- Village of Kingston
- Village of Mayville
- Village of Millington
- Village of Reese
- Village of Unionville

Change in Risk from 2008 Plan: This data was not included in the 2008 plan. Since 2007, only two LUST sites in Tuscola County have been closed. The risk of groundwater contamination from a LUST site depends on the extent of the leak and the proximity to groundwater. It is probably that many, if not all, of these tanks have been drained of fuel, eliminating the risk of an on-going leak. As water percolates through the soil around the tank, it will pick-up contaminates for the initial leak and carry them to groundwater. Even though sites may not have active leaks, there is still a risk of groundwater contamination.

Hazardous Materials Incidents – Transportation Incidents

Description: As a result of the extensive use of chemicals in our society, all modes of transportation – highway, rail, air, marine, and pipeline – are carrying thousands of hazardous materials shipments on a daily basis through local communities. A transportation accident involving any one of those hazardous material shipments could cause a local emergency affecting many people.

Analysis: Hazardous materials move through the county regularly via truck and train. The POET Ethanol plant in Caro ships ethanol fuel from its premises using tanker trucks only. Trains and trucks are used to ship the denaturant which is blended with the finished product. Nationally, ethanol train accidents have resulted in multiple car derailments that have sparked significant fires.

In April 2014, a tanker truck containing 13,000 gallons of ethanol from the POET Ethanol plant crashed near Reese, killing the driver and creating a large fire which burned for five hours. *(Source:http://www.mlive.com/news/saginaw/index.ssf/2014/04/all_ethanol_consumed_in_the_fi.html)*

The greatest risks from hazardous materials transportation arise when proper safety procedures are not observed, so enforcing those safety measures, including speed limits for tanker trucks, is of paramount importance to ensuring safe hazardous materials transport.

Jurisdictions Impacted: Hazardous materials transportation incidents are most likely to occur in jurisdictions with major all season roads. These are:

- Wisner Township
- Akron Township
- Gilford Township
- Fairgrove Township
- Denmark Township
- Juniata Township
- Tuscola Township
- Vassar Township
- Millington Township
- Village of Reese
- City of Vassar
- Village of Fairgrove
- Village of Millington
- Columbia Township
- Village of Unionville
- Almer Township
- City of Caro
- Indianfields Township
- Fremont Township
- Elmwood Township
- Ellington Township
- Dayton Township
- Elkland Township
- Village of Cass City
- Kingtson Township
- Village of Kingston
- Koylton Township

Change in Risk from 2008 Plan: The risk of transportation incidents involving hazardous materials have likely increased since 2008 because of increased production at the POET Ethanol facility. The facility had a nameplate capacity of 45 million gallons when it opened in 2002. The facility is now producing 54 million gallons annually. (Source: http://vitalbypoet.com/stories/first-in-the-wolverine-state). Greater annual production leads to increases train and tanker traffic, which means statistically, there are likely to be more incidents.

Oil and Gas Storage Facilities

Description: An uncontrolled release of hazardous material from a fixed site, capable of posing a risk to health, safety, property and the environment. Hazardous materials, materials that, because of their chemical, physical, or biological nature pose a potential threat to life, are found in business and industry, agriculture, universities, hospitals, utilities, and other community facilities. Areas within a one- to five-mile radius of these sites are at most risk. Examples of

hazardous materials include corrosives, explosives, flammable materials, radioactive materials, poisons, oxidizers, and dangerous gases.

Analysis: Private propane storage facilities and propane sales businesses are found throughout Tuscola County. While usually very safe, these facilities store large amounts of propane gas that could be ignited through accident or sabotage. Although such an event could cause severe damage in Tuscola County, the chances of an explosion or leakage are relatively small and easily mitigated through proper safety and maintenance procedures. However, in the event of an explosion or fire, homes and businesses within a mile radius would likely be evacuated.

While propane tank exchanges are available at many gas stations and convenience stores in the county, these sites pose far less risk for an explosion than propane filling stations and storage sites. Thus, the following commercial propane filling stations and storage sites have been identified:

- Cass City Oil & Gas Co, 6413 Main St, Cass City (filling station)
- Ferrell Gas, 10333 State Rd, Millington (storage facility)
- Self Serve Lumber, 6957 Cass City Rd, Cass City, MI (filling station) (Elkland Twp)
- All Season Rental, 4519 Nestle St, Cass City, MI (filling station) (Village of Cass City)
- Clark Gas Station, 3511 Mertz Rd, Caro, MI 48723 (filling station) (Fremont Twp)
- Ferrell Gas, 2700 W. Caro Rd., Caro. MI (storage) (Indianfields Twp.)
- Ferrell Gas, 4234 M-25, Unionville, MI (storage) (Wells Twp.)
- Thumb Electric, 2437 E. Dayton Rd, Caro, MI (storage) (Wells Twp)
- Fairgrove Oil, 1788 N. Main St., Fairgrove, MI (storage) (Village of Fairgrove, Fairgrove Twp)
- Cass City Gas & Oil, 32 E. Ohmer Rd, Mayville, MI (storage) (Village of Mayville)
- Mr. Chips, 505 E. Main St., Mayville, MI (filling) (Village of Mayville)
- Caro Rental, 466 Ellington St., Caro, MI (filling) (City of Caro and Indianfields Twp)

Jurisdictions Impacted:

- City of Caro
- Elkland Township
- Fremont Township
- Indianfields Township
- Village of Cass City
- Village of Fairgrove
- Village of Mayville
- Village of Millington
- Wells Township

Change in Risk from 2008 Plan: There is no change in risk from the 2008 plan.

Oil and Gas Well Accidents

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

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

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

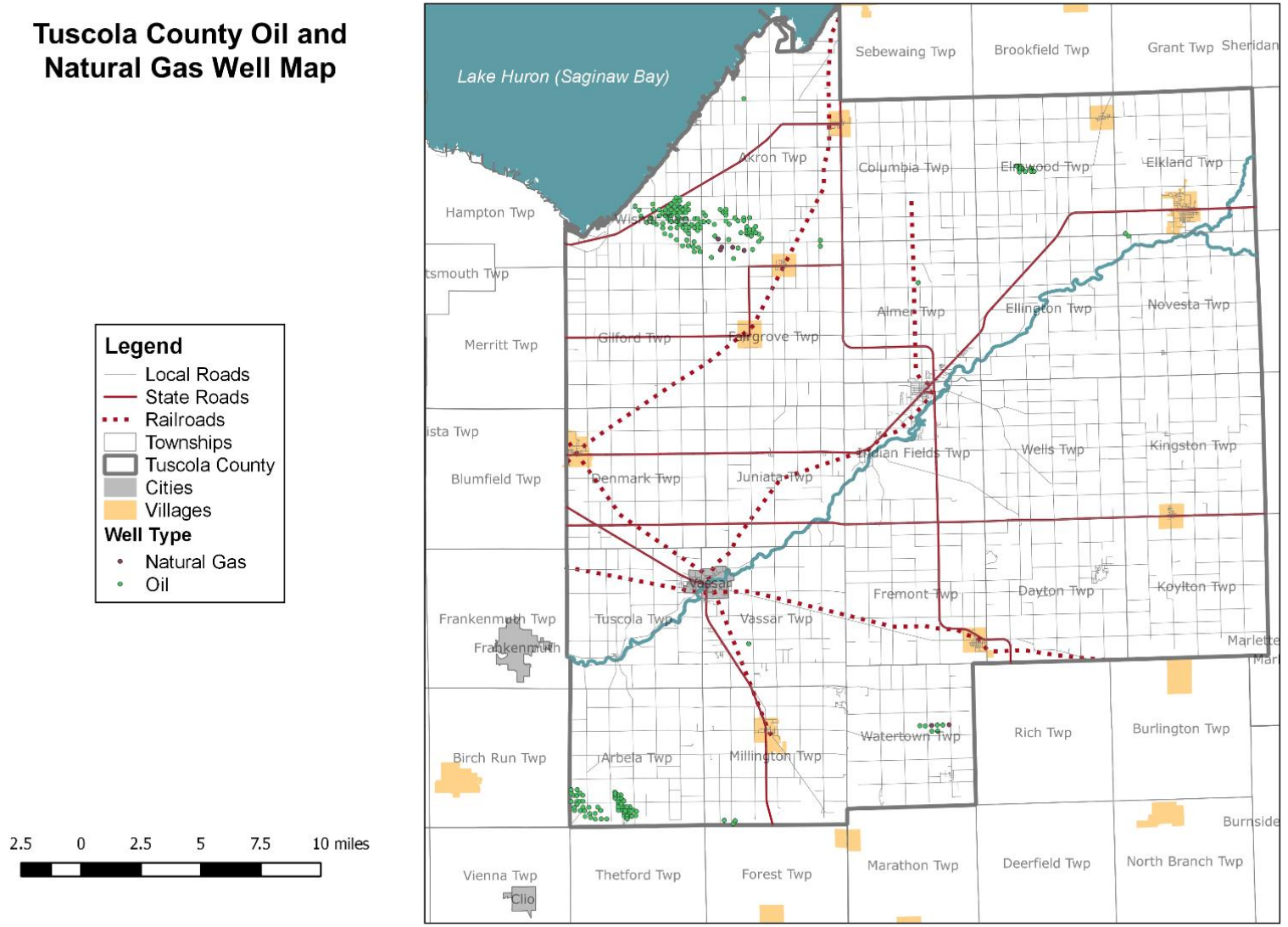
An unplugged abandoned well, also known as an orphan well, can be a hazard to the health and safety of the surrounding people and environment. There are many situations where an unplugged well can become dangerous. For example, a rusted-out casing in a gas well can let natural gas flow underground and accumulate in the basement of a nearby building, possibly causing an explosion. Occasionally, gas leaking from an old well can contaminate a nearby water well. An old well might also be a conduit for salt brine from deeper formations to pollute fresh groundwater, or to discharge at the surface. In some cases, oil leaks from abandoned wells, polluting soil and water. In the vicinity of a coal mine, an old well can be a conduit for explosive gas to enter the mine, a 364 Technological Hazards – Industrial (Hazardous Materials – Oil and Gas Well Accidents) serious mine safety problem. Also, where coal mining has occurred, an old well can allow acidic mine water to discharge at the surface.

Analysis: Tuscola County is home to several oil and gas wells that are found throughout the county. Accidents at these wells could cause major damage to the nearby communities and the environment. Currently, there are two operators with active and producing oil wells in the county - Mid State Employment Services LLC and Tuscola Energy Inc. These two companies are producing oil 38 active leases. Countywide, there are 396 wells on record, with 186 currently associated active leases. *(Source: DrillingEdge.com and Michigan DEQ)* All of the active leases and wells are for oil production – there are no active gas wells in the county. The following map identifies the locations of Tuscola's gas and oil wells, along with other mining operations. *(Source: Michigan DEQ)*

Jurisdictions Impacted: One operating oil well is located in Akron Township and shown on the map on the following page. Multiple gas wells, both open and closed are located in Tuscola County in:

- Wisner Township
- Akron Township
- Almer Township
- Vassar Township
- Arbela Township
- Millington Township

Map 14 Gas and Oil Wells in Tuscola County



Change in Risk from 2008 Plan: Since 2008, the active oil wells have produced over 270,000 barrels of oil, averaging 45,118 barrel per year. However, oil production has declined by an average of 5,000 barrels per year, since production peaked in 2007 at 50,593 barrels. In the last several years, there has been renewed interest in oil and gas exploration in the county. This renewed interest corresponded with record prices for oil and gas, making marginally productive areas economical. *(Source: http://www.tuscolatoday.com/index.php/2013/01/12/interest-renewed-in-local-gas-oil/)* However, the number of new leases since 2008 is not known. Despite the reduction in productivity, the risk of oil and gas well accidents in the county remains unchanged.

Petroleum and Natural Gas Pipeline Accidents

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

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

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

While it is true that the petroleum and natural gas industries have historically had a fine safety record, and that pipelines are by far the safest form of transportation for these products, the threat of fires, explosions, ruptures, and spills nevertheless exists. In addition to these hazards, there is the danger of hydrogen sulfide (H2S) release. These dangers (fully explained in the Oil

and Natural Gas Well Accidents section) can be found around oil and gas wells, pipeline terminals, storage facilities, and transportation facilities where the gas or oil has a high sulfur content. Hydrogen sulfide is not only an extremely poisonous gas, but is also explosive when mixed with air at temperatures of 500 degrees Fahrenheit or above.

In 2010, Michigan suffered what may be the largest inland oil release in the country, when a pipeline in Calhoun County failed and released large quantities of crude which ended up in the Kalamazoo River and flowed downstream for many miles. Although a description of this event appears later in this section, it must be noted here that because the recovery activities for this disaster are still ongoing, an after-action report was not yet available for use in this analysis, to efficiently relay "lessons learned" and the final results of the extensive cleanup activities.

Analysis: There are two major gas pipelines in Tuscola County, one that runs centrally through the County that is owned by Consumer's Energy, and another that cuts across the bottom of the County that is owned by Enbridge Energy. Both pipelines transport large quantities of natural gas.

Major incidents involving natural gas pipelines typically involve broken gas mains, which can usually be repaired within two hours. On occasion, a broken gas main will require evacuation because it creates a fire hazard. (*Source: Michigan DEQ*)

Jurisdictional impact: Gas lines run through five townships. Maps swing the location of these gas lines are not permitted to be reprinted by the company to protect the location of lines and deter sabatoge.

- Denmark Township
- Tuscola Township
- Vassar Township
- Fremont Township
- Watertown Township
- Juniata Township
- Indianfields Township
- Wells Township
- Kingston Township
- Village of Reese
- City of Vassar

Change in Risk from 2008 Plan: There is no change in risk from the 2008 plan.

Nuclear Power Plant Accidents

Description: Though the construction and operation of nuclear power plants is closely monitored and regulated by the Nuclear Regulatory Commission (NRC), accidents at these plants are considered a possibility, and appropriate on-site and off-site emergency planning is conducted. An accident could result in the release of potentially dangerous levels of radioactive materials into the environment and could affect the health and safety of the public living near the nuclear power plant. A nuclear power plant accident might involve both a release of airborne radioactive materials and radioactive contamination of the environment around the plant. The

degree and area of environmental contamination could vary greatly, depending on the type and amount of release, and the weather conditions that are present. Response to a nuclear power plant accident requires specialized personnel who have been trained to handle radioactive materials safely, who have specialized equipment to detect and monitor radiation, and who are trained in personal radiation exposure control.

After a period of decline following the 1979 Three Mile Island accident and the 1986 incident at Chernobyl, there is a recent renewed interest in nuclear energy because it could partially address problems of dwindling oil reserves and global warming, with far fewer emissions of greenhouse gases than the use of fossil fuels. However, the use of nuclear power is controversial because of the problems of storing radioactive waste for indefinite periods, the potential for radioactive contamination by accident or sabotage, and the possibility that its use could in some countries lead to the proliferation of nuclear weapons. The United States produces the most nuclear energy of any country in the world, but many other countries actually use nuclear energy as a larger percentage of their overall energy production.

Analysis: Tuscola County is not located in either the primary or secondary Emergency Planning Zone of any of Michigan's four nuclear power plants. Nuclear plant accidents are not a risk for Tuscola County.

Jurisdictional Impact: None.

Change in Risk from 2008 Plan: There is no change in risk from the 2008 plan.

Infrastructure Hazards

Infrastructure Failure – Water, Sewer, Electrical, Communications

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

These are just some examples of the types of infrastructure failures that can occur, and all of these situations can lead to disastrous public health and safety consequences if immediate actions are not taken. Typically, it is the most vulnerable members of society (i.e., the elderly, children, impoverished individuals, and people in poor health) who are the most heavily impacted by an infrastructure failure. If the failure involves more than one system, or is large enough in scope and magnitude, whole communities and possibly even regions can be severely impacted. (Note: Refer to the Dam Failures and Petroleum and Natural Gas Pipeline Accidents sections for more information on those particular types of infrastructure failures.)

Analysis: Failure of electrical power infrastructure in Michigan has mostly been the result of severe weather incidents, such as severe winds and ice storms. Temporary loss of electrical power as a result of severe weather conditions is not uncommon but these failures are usually remedied within a few minutes or hours. Residents occasionally go without electrical power for a few days. Because outages and duration of outages varies so widely, accurate loss of power in terms of frequency can only be estimated based on the estimated frequency of severe weather incidents. Because larger storms could cause more severe damage to the power infrastructure, it is important that facilities that require power for essential and life-sustaining services maintain long-lasting backup power systems.

In Tuscola County, severe flood conditions have overwhelmed the drainage infrastructure in the past, which exacerbates the flood. Recognizing this threat, Tuscola officials have undertaken a number of projects to expand floodwater drainage capacity. Periodic flooding remains a problem, however, in various locations throughout the county (the west side of the City of Caro, for example). In some cases the problem is one of inadequate drain capacity, while others may benefit from more regular drain cleaning.

One of the biggest challenges for Tuscola County is ensuring the safety of all residents' drinking water. While some municipalities have centralized water distribution systems, many of the county's residents rely on private wells for their water. Many hazards can arise from the use of these wells if they are not properly installed and maintained. One problem that pervades many communities in the county is shallow, uncapped wells which are susceptible to dangerous runoff from farms and flooding. Although an individual event of well contamination may only affect a very limited part of the population, the aggregate potential hazard from all of the uncapped wells in the county presents a major issue.

Jurisdictions Impacted: Water, sewer, electrical and communication failure impacts all jurisdictions in the county. Indianfields and Almer Townships have sewer systems. Indianfields Township and a part of Fairgrove Township has a water system or water distribution system.

See Maps 7 and 8 of the Water System and the Sewer System.

Change in Risk from 2008 Plan: In November 2014, DTE Energy and Consumers Energy released a report that warns of a potential electricity generation capacity shortfall in Michigan as soon as 2016. According to the report, a capacity loss of as much as 1.3 gigawatts - enough to power Detroit, Grand Rapids and Lansing - is expected under the planned retirement of nine coal-fired power plants over the next two years. Utilities will have to stretch resources to provide adequate electricity to customers during peak demand, which is usually the hottest summer days. Currently, many residents of Tuscola County receive their electricity from Thumb Electric Cooperative from electric generating facilities in Caro and in Ubly, so it is not clear what impact an electricity generating shortfall might have on Tuscola County residents. All utility plants in Tuscola County are used to supplement power during peak usage. DTE Energy maintains two diesel-powered, remote operated peaking facilities in the county, which provide additional electricity to the grid during high demand periods. Consumers Energy has constructed a 105-megawatt wind farm, called Cross Winds Energy Park, which will generate enough electricity to power 31,000 homes. While these facilities do contribute electricity to the electrical grid, it is

unclear the extent to which Tuscola County residents would benefit from these sources in the event of an outage.

Energy Emergencies

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

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

The second type of energy emergency involves a sharp, sudden escalation in energy prices, usually resulting from a curtailment of oil supplies. Michigan experienced this type of energy emergency in the 1970s, due to events in the world oil market, and in 1990, following Iraq's invasion of Kuwait. The winter of 2000/2001 saw a sharp spike in natural gas costs, due to reduced availability. However, many Michigan customers were unaffected, due to a price freeze on Michigan's major gas utilities. When oil reserves in Louisiana were blocked during Hurricane Katrina (August 2005), the effects were felt in Michigan and the Governor issued a

State of Energy Emergency due to a gasoline shortage. Since 2001, energy costs for the average U.S. household have more than doubled, and sharply escalating gasoline prices have again strained the budgets of lower and middle class families. The summer of 2008 had the highest oil prices on record, following a dramatic rise in prices from 2007 to 2008, and gasoline prices peaked at more than $4 per gallon. This contributed to the economic downtown beginning in 2007, as well as a move toward more fuel-efficient vehicles.

The third type of energy emergency is a sudden surge in energy demand caused by a national security emergency involving mobilization of U.S. defense forces. National defense, in a time of crisis, will demand an increase in 392 Technological Hazards – Infrastructure Problems (Energy Emergencies) energy. Although the regulated natural gas and electric utilities have approved state and federal priority allocation systems that are in place, regulatory changes to introduce competition into natural gas and electric markets have not fully addressed how such shortages might be managed once these markets are fully opened.

Michigan uses coal, nuclear power, natural gas, renewable power, petroleum, and hydroelectric power for energy.

Analysis: Tuscola County residents receive electricity through Thumb Electric Cooperative and DTE Energy. Natural gas service is provided to residents in larger cities by Consumers Energy. Homeowners in rural areas of the county rely on propane, fuel oil or biomass for heating fuel. There are several dozen service stations throughout the county, providing gasoline and diesel fuel. Additionally, there are likely private fueling facilities on farms and industrial sites. Energy disruptions, particularly for gasoline, diesel and propane, are generally short-term, market-based fluctuations, that are experienced by residents throughout Michigan. These disruptions are rooted in temporary supply shortages elsewhere in the United States and result in short-term price increases. Generally, these price increase do not last more than a few weeks.

Jurisdictional Impact: An energy emergency would impact every jurisdiction in the county.

Change in Risk from 2008 Plan: Generally, the price of propane and fuel oil has remained relatively constant since the 2008 Plan. However, in the winter of 2013/2014, a confluence of events resulted in an historic regional propane emergency, which drove propane prices up 28% and fuel oil prices up 2% over the previous winter. Michigan was one of several Midwestern States that declared an energy emergency and waived hours-of-service requirements for propane deliveries. The prime factors leading to the emergency included:

- Low Pre-Season Inventories – Propane inventories were 20% below the five year average at the start of the winter.

- Crop Drying Demands – Propane is commonly used in agriculture for drying crops. In 2013, agricultural propane use was 500% higher than the previous year, due a late season and record corn and soybean harvest. Agricultural use was a significant draw on propane inventories, which created shortages for residential customers

- Colder than Normal Weather – Winter arrived early in 2013 and was colder than normal, exacerbating the issues with low inventories.

- Infrastructure – Two infrastructure interruptions due to repairs and upgrades limited the available propane supply, as demand for propane peaked.

"The result of all of the above was that propane supply was so tight in Michigan that dealers had extreme difficulty obtaining adequate propane to fully supply customers… In addition to, and largely resulting from, the restricted supply issues, retail prices steadily increased as the heating season progressed. In January 2014, wholesale propane prices spiked to over $4.00 a gallon, which sent retail prices soaring. Dealers were forced to "short fill" customers in an effort to manage both supply and the financial impact of high retail prices. At the very peak of the price spike, the average for a gallon of propane in Michigan was $3.76… Prices in the four to five dollar range were seen sporadically for the weeks following the wholesale price spike. Prices and inventories eventually returned to normal levels. However, the winter of 2013/2014 illustrated just how quickly an energy emergency could emerge." *(Source: Michigan Public Service Commission)*

See **Infrastructure Failure** for more information on utility services.

Transportation Accidents – Air, Land, and Water

Description: Air Transportation Accidents: There are four circumstances that can result in an air transportation accident: 1) an airliner colliding with another aircraft in the air; 2) an airliner crashing while in the cruise phase of a flight due to mechanical problems, sabotage, or other cause; 3) an airliner crashing while in the takeoff or landing phases of a flight; or 4) two or more airliners colliding with one another on the ground during staging or taxi operations. When responding to any of these types of air transportation accidents, emergency personnel may be confronted with a number of problems, including: 1) suppressing fires; 2) rescuing and providing emergency first aid for survivors; 3) establishing mortuary facilities for victims; 4) detecting the presence of explosive, radioactive, or other hazardous materials; and 5) providing for crash site security, crowd and traffic control, and protection of evidence.

Major Land Transportation Accidents: A major land transportation accident in Michigan has the potential to create a local emergency event, or to seriously strain or overwhelm local response and medical services. It could involve a commercial intercity passenger bus, a local public transit bus, a school bus, or an intercity passenger train. Although these modes of land transportation have a good safety record, accidents do occur. Typically, bus accidents are caused by the bus slipping off a roadway in inclement weather or colliding with another vehicle. Intercity passenger train accidents usually involve a collision with a vehicle attempting to cross the railroad tracks before the train arrives at the crossing. Unless the train accident results in a major derailment, serious injuries are usually kept to a minimum. Bus accidents, on the other hand, can be quite serious—especially if the bus has tipped over. Numerous injuries are a very real possibility in those types of situations. Sometimes, "ordinary" highway crashes can be of unusual significance, when they either involve a large number of vehicles or in some manner cause the entire shut-down of a major highway for a significant period of time. (For example, on July 3, 2010, in the City of Flint, a tanker accident and fire caused I-475 to be closed down for many hours, in both directions.)

Michigan's High Speed Rail Program: In 1999, Michigan began the implementation of its High Speed Rail Program. As one of the first projects, train speeds will be increased from 79 miles

per hour to over 100 miles per hour on a segment of Amtrak's passenger train route between Detroit and Chicago. The existing rail corridor between Kalamazoo and Grand Beach has been upgraded with improvements to the track, the signal and communication system, and the at-grade crossing warning devices. The state-of-the-art signal and communication system uses advanced technology to communicate between the at-grade crossings and the train, and also uses a Differential Global Positioning (DGP) train location system. These improvements will ensure the highest level of passenger safety. The goal of Michigan's High Speed Rail Program is to reduce travel time on the entire Detroit-to-Chicago rail corridor from approximately six hours to three and one-half hours. Future plans also include an increase in trip frequencies along the corridor, from the current four daily round trips up to eight or possibly even 10 daily round trips. The fastest passenger trains now operating in the United States are on the Northeast Corridor, traveling between Washington D.C. and New York City at approximately 125 miles per hour. Although this high-speed passenger rail service is relatively new to the United States, similar systems have been in place for quite some time in Europe and Japan, with an outstanding safety record. From a hazard perspective, the higher-speed train service will provide new challenges for communities on the Detroit-to-Chicago rail corridor to address in their emergency planning and preparedness efforts. To ensure that all communities are adequately prepared, the Federal Railroad Administration (FRA), the Michigan Department of State Police (MSP), the Michigan Department of Transportation (MDOT), and the affected communities' 407 Technological Hazards – Infrastructure Problems (Transportation Accidents) emergency managers have all been working with the Operation Respond Institute to install an emergency information system along the corridor. This system is designed to quickly provide detailed railroad equipment information to emergency responders.

Water Transportation Accidents: A water transportation accident involving one of the 20 commercial marine passenger ferries operating from Michigan's Great Lakes shoreline communities could have significant life safety consequences. Most of these marine ferry services operate on a seasonal basis (typically May through November). Vessel sizes vary, but it is not uncommon for 100-200 passengers or more to be on board many of the ferries at the peak of tourist season. In a typical year, these ferries make thousands of trips across Great Lakes waters. Although the vessels have an excellent safety record and must pass rigorous Coast Guard inspections, the potential for an accident is always present. Accidents in other states or countries involving similar vessels validate the need for rigorous emergency preparedness actions to prevent loss of life in an open water setting such as the Great Lakes. For instance, the Ethan Allen tour boat that capsized in Lake George, New York, in 2005 took the lives of 20 senior citizens.

Analysis: Three rail lines serve Tuscola County. Although accidents are rare, there is potential for train-train or train-vehicle collisions and derailment due to human error, obstructions, inadequate track maintenance, or flooding. If any of these trains is carrying hazardous materials at the time, the risks are increased.

Major roads in Tuscola County include M-15, M-24, M-25, M-46, M-81, and M-138. Traffic along these routes includes private and commercial passenger vehicles as well as shipping/freight. Accidents are common and may require an emergency response, but they rarely trigger major disasters.

The only airport within Tuscola County is Tuscola Area Airport. Although many Tuscola County residents live under flight paths that service this and other airports, the safety record for such flights is excellent. The hazard presented by air crashes to the county is minimal.

(*Source: Tuscola County General Development Plan, 2002*)

Jurisdictional Impact: See County Road Map (Map 5). Major roads are located in:

- Wisner Township
- Akron Township
- Gilford Township
- Fairgrove Township
- Denmark Township
- Juniata Township
- Tuscola Township
- Vassar Township
- Millington Township
- Village of Reese
- City of Vassar
- Village of Fairgrove
- Village of Millington
- Columbia Township
- Village of Unionville
- Almer Township
- City of Caro
- Indianfields Township
- Fremont Township
- Elmwood Township
- Ellington Township
- Dayton Township
- Elkland Township
- Village of Cass City
- Kingtson Township
- Village of Kingston
- Koylton Township

Change in Risk from 2008 Plan: Crash statistics and traffic volumes are not available to compare to 2008.

Human-Related Hazards

Catastrophic Incident

Description: A catastrophic incident is any natural or manmade incident, including terrorism, which results in extraordinary levels of mass casualties, damage, or disruption severely affecting the population, infrastructure, environment, economy, national morale, and/or government

functions. A catastrophic incident could result in sustained nationwide impacts over a prolonged period of time; almost immediately exceeds resources normally available to State, tribal, local, and private-sector authorities in the impacted area; and significantly interrupts governmental operations and emergency services to such an extent that national security could be threatened. These factors drive the urgency for coordinated national planning to ensure accelerated Federal and/or national assistance. Such incidents are likely to require coordination activities from many states, including Michigan, even if the event took place in a distant location.

Analysis: A catastrophic incident would like trigger a Presidential disaster declaration and the implementation of the Catastrophic Incident Annex to the National Response Framework. This framework establishes the context and overarching strategy for implementing and coordinating an accelerated, proactive national response to a catastrophic incident.

Examples of catastrophic incidents impacting Tuscola County could include celestial impact, chemical, biological, radiological, nuclear and high-yield explosive incidents, cyber-attacks and electrical grid failure.

The likelihood of a catastrophic incident in the county, as defined by FEMA, is extremely low.

Jurisdictional Impact: All jurisdictions in Tuscola County would be impacted.

Change in Risk from 2008 Plan: There is no change in risk from the 2008 plan.

Nuclear Attack

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

The threat of nuclear attack has primarily been associated with the Cold War between the United States and the Soviet Union in the last half of the 20th Century. Although the Cold War is over, there remains a threat of nuclear attack. More nations have developed nuclear weapons and there is also the possibility that terrorists could use a nuclear weapon against the United States.

Analysis: The threat of nuclear attack remains consistent since the 2008 plan, based on the number of nations that have access to nuclear weapons. Currently, the United States and its allies believe they control the only significant nuclear weapons capable of striking Tuscola County. Of these, those located in North Korea pose the greatest risk, especially if they are taken over by terrorists. However, because Tuscola County has nothing of major military, political, or symbolic importance for terrorists to attack, it is an extremely unlikely target for nuclear attack.

Jurisdictional impact: None.

Terrorism

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

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

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

Analysis: Despite increased concern about international terrorism after the terrorist attacks of September 11, 2001, international terrorism remains an insignificant threat for most populations. For the same reasons that Tuscola County is not likely to be targeted for nuclear attack, it is an unlikely target for international terrorist attacks.

Domestic terrorists including anti-government terrorists, anti-abortion terrorists, and eco-terrorists pose a slightly greater threat to Tuscola County than any threat by international terrorists, but the absence of significant targets in the county makes threats from these groups of minimal concern.

As an agricultural community, Tuscola County utilizes many crop dusters to apply pesticides to its fields. Heightened concern about chemical and biological weapons attacks using crop dusters after September 11, 2001 has produced a large amount of analysis of the threat. It takes a year of training and a comprehensive knowledge of wind patterns to operate a crop duster with a full payload of pesticides. The combination of extremely heavy payloads with a lightweight plane makes crop dusters difficult to operate over fields; the shifting wind patterns of an urban environment would make operating a crop duster almost impossible. The use of biological weapons is further impeded by the hardware of crop dusters; the nozzles are too large to sufficiently atomize biological agents to make large impact. Overall, the threat of terrorist utilization of the county's many crop dusters is negligible.

Concern remains about the possibly of the drinking water supply being contaminated for residents who rely on municipal water. The locations of community water supplies is apparent but there is no way to predict a terrorist event involving them.

Jurisdictional impact: Any jurisdiction in the county could be impacts by terrorism activities.

Change in Risk from 2008 Plan: There is no change in risk from the 2008 plan.

Public Health Emergencies

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

Perhaps the greatest emerging public health threat would be the intentional release of a radiological, chemical, or biological agent with the potential to adversely impact a large number of people. Such a release would most likely be an act of sabotage aimed at the government or at a specific organization or segment of the population. Fortunately, Michigan has not yet experienced such a release aimed at mass destruction. However, Michigan has experienced hoaxes and it may only be a matter of time before an actual incident of that nature and magnitude does occur. If it does, the public health implications—under the right set of circumstances—could be staggering.

Analysis: Public Health emergencies can occur as primary events or as secondary events related to incidents such as floods, tornadoes, or hazardous materials problems. The risk for public health emergencies in Tuscola is low, as there is no historical precedent. (*Source: CDC*)

Jurisdictional impact: Since public health emergencies related to natural disasters or biological problems cannot be predicted, all jurisdictions would be impacted equally.

Change in Risk from 2008 Plan: There is no change in risk from the 2008 plan.

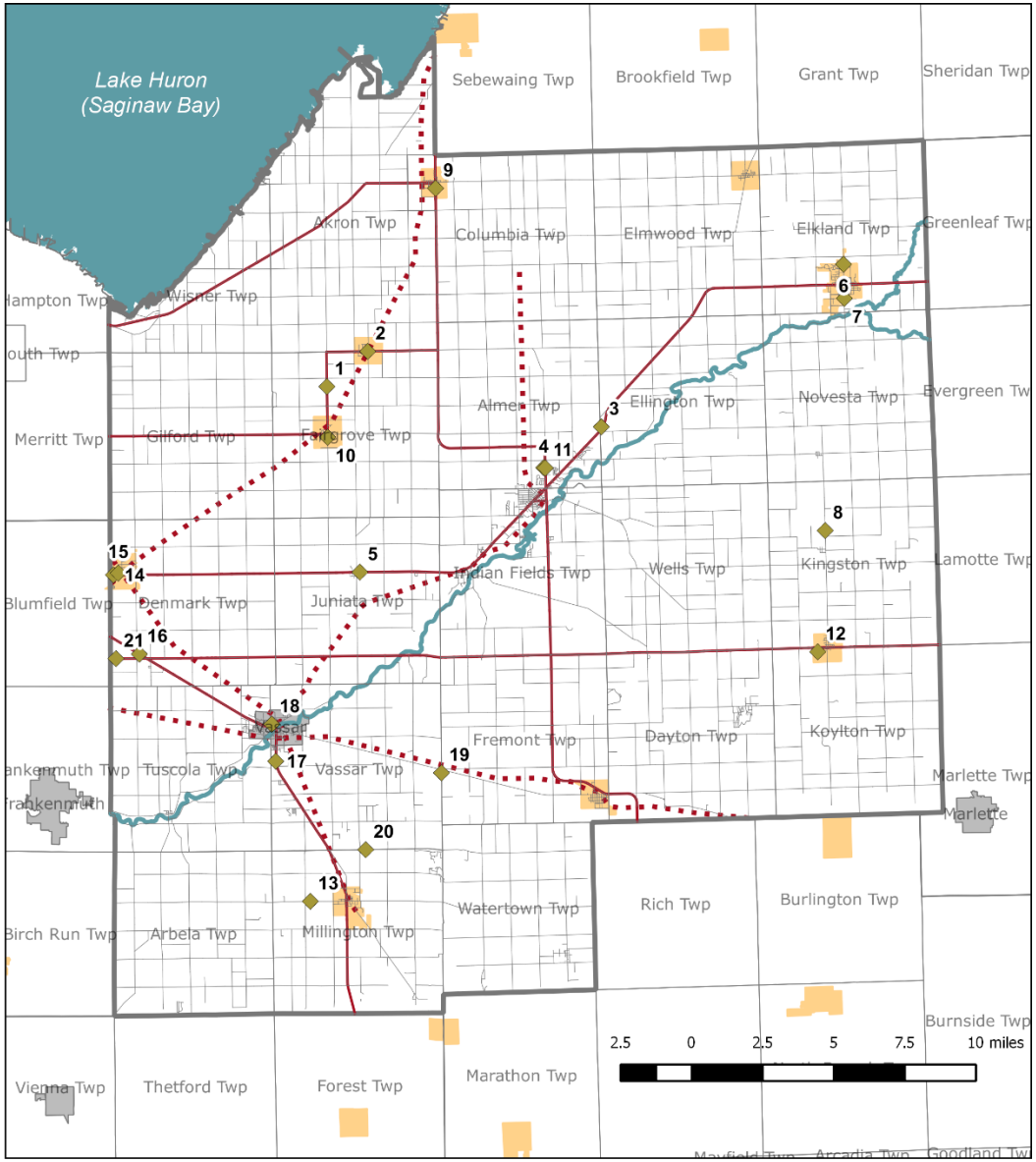
Map 15 Map of Emergency Shelters

Tuscola County Emergency Shelter Map

Legend

- Local Roads
- State Roads
- Railroads
- Townships
- Tuscola County
- Cities
- Villages
- Cass River
- Emergency Sheltes

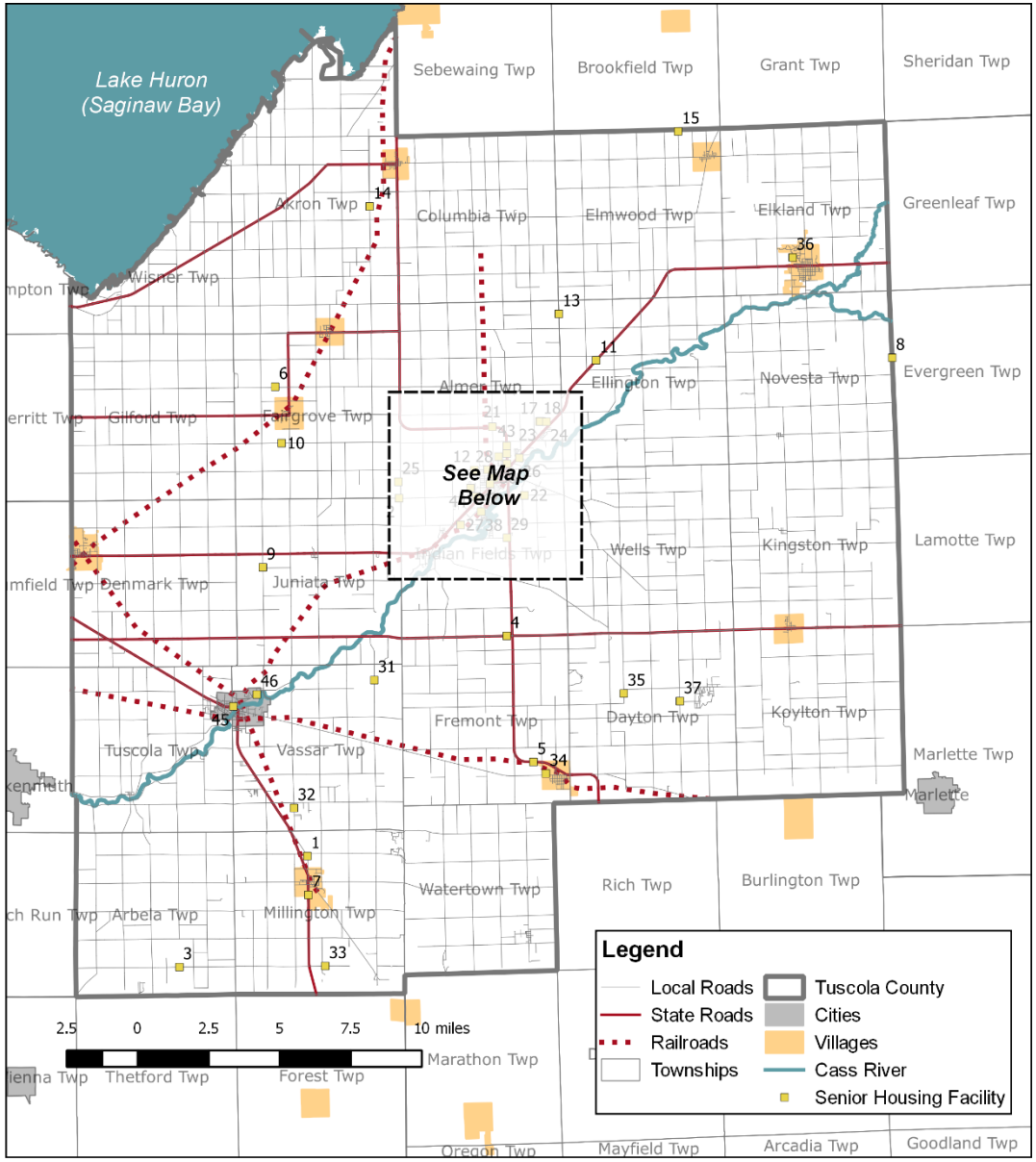
ID	Shelter Name
1	Akron Fairgrove High School
2	Akron United Methodist Church
3	Colwood United Brethren Church
4	Tuscola Intermediate School District
5	Watrousville United Methodist Church
6	Cass City High School
7	Cass City United Methodist Church
8	Deford Community Church
9	St. Paul Lutheran Church
10	Grace Evangelical Lutheran Church
11	Highland Pines School
12	Kingston High School
13	American Legion Post #164
14	Reese Blumfield Fire/Rescue
15	Trinity Lutheran Church and School
16	St. Michaels Lutheran School
17	Chapter Hill Assembly of God
18	First United Methodist Church
19	Juniata Baptist Church
20	Pineview Mennonite Church
21	Alvin Miller American Legion Post 400



Map 16 Map of Senior Housing Facilities

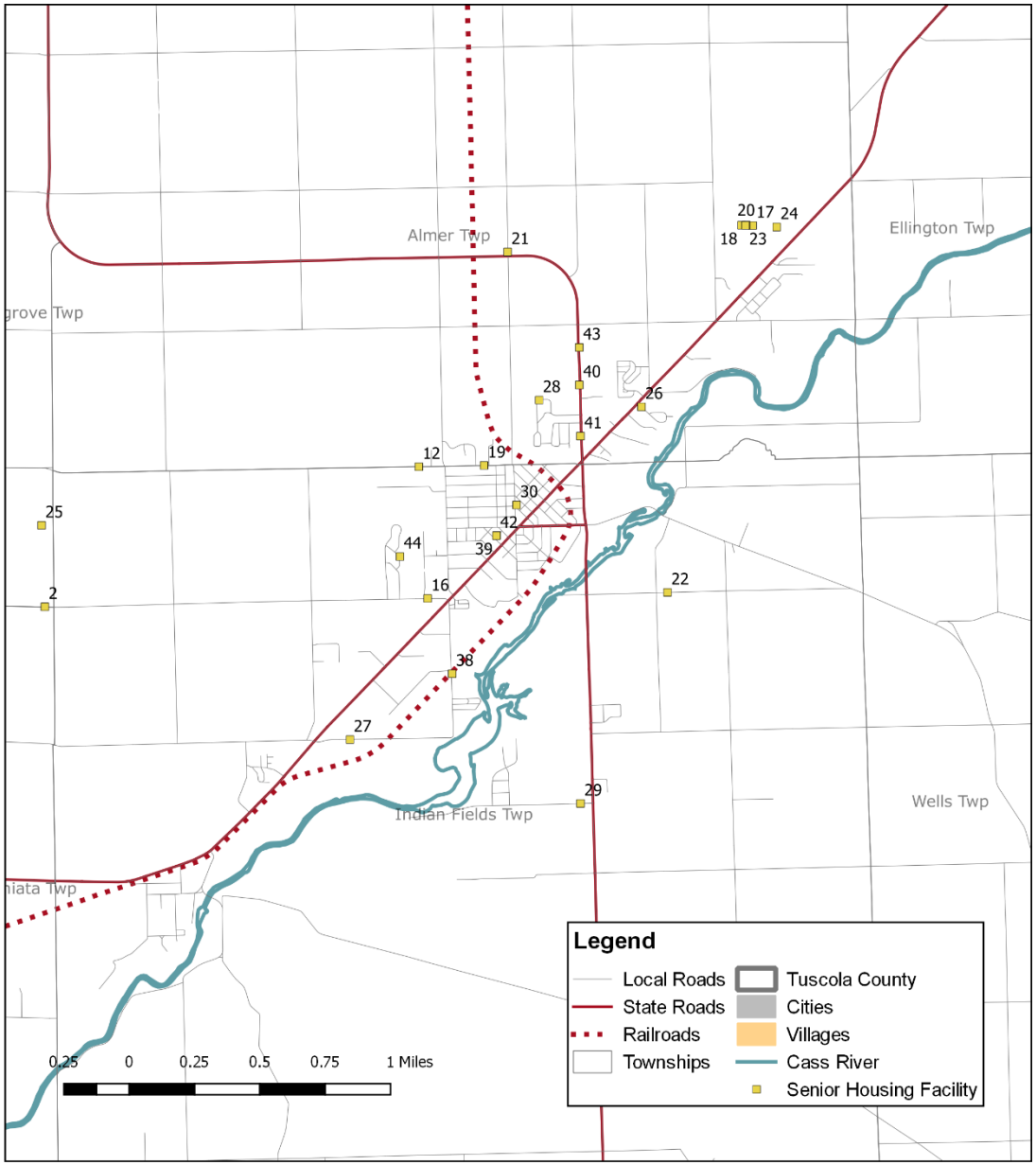
Tuscola County
Senior Housing Facility Map

ID	Name
1	A Friends Place
2	Agape Care System
3	Arbela Road AFC
4	Sandra Little Touch of Nature
5	Fisher Convalescent
6	Hecht AFC home
7	Jeanette Smith AFC
8	Johnson AFC Home
9	Luebbert County Care
10	Meadow Brook
11	Satchells Christian Retirement Home
12	Caro Senior Commons
13	Timberline Lodge
14	Vadavilla Retiree Home
15	Willow Tree Haven
16	Janet's Villa
17	North Star
18	Southern Cross
19	Hilltop House
20	Harbor Light
21	Anchor Hill
22	Gun Club Home
23	Mission Pointe (AFC)
24	Sheperds Crossing
25	Amazing Love
26	Ashbreck AFC Home
27	Maple Ridge Home
28	Northview CLF
29	Pineland
30	Stoney Brooke
31	Dekett Family Home
32	Robyn Empey AFC
33	Field of Dreams
34	Autumn Acre Senior Living
35	Moncman AFC
36	The Crow's Nest
37	Clinesmith AFC
38	Redon's Young at Heart
39	That Touch of Class
40	Tuscola County Medical Care Facility
41	Lewis
42	A Touch of Home
43	Heritage Hill Assisted Living
44	Arlington Dr
45	Stratman's Manor
46	Thumb Area Commossion on Aging



Caro Area
Senior Housing Facility Map

ID	Name
1	A Friends Place
2	Agape Care System
3	Arbela Road AFC
4	Sandra Little Touch of Nature
5	Fisher Convalescent
6	Hecht AFC home
7	Jeanette Smith AFC
8	Johnson AFC Home
9	Luebbert County Care
10	Meadow Brook
11	Satchells Christian Retirement Home
12	Caro Senior Commons
13	Timberline Lodge
14	Vadavilla Retiree Home
15	Willow Tree Haven
16	Janet's Villa
17	North Star
18	Southern Cross
19	Hilltop House
20	Harbor Light
21	Anchor Hill
22	Gun Club Home
23	Mission Pointe (AFC)
24	Sheperds Crossing
25	Amazing Love
26	Ashbreck AFC Home
27	Maple Ridge Home
28	Northview CLF
29	Pineland
30	Stoney Brooke
31	Dekett Family Home
32	Robyn Empey AFC
33	Field of Dreams
34	Autumn Acre Senior Living
35	Moncman AFC
36	The Crow's Nest
37	Clinesmith AFC
38	Redon's Young at Heart
39	That Touch of Class
40	Tuscola County Medical Care Facility
41	Lewis
42	A Touch of Home
43	Heritage Hill Assisted Living
44	Arlington Dr
45	Stratman's Manor
46	Thumb Area Commossion on Aging



Map 17 Emergency Medical Facilities

Tuscola County Emergency Medical Facility Map

Legend

- Local Roads
- State Roads
- Railroads
- Townships
- Tuscola County
- Cities
- Villages

Medical Facility

- Hospital
- Mental Health Facility
- Head Injury Treatment Center
- Health Clinic

ID	Facility Name
1	Hills and Dales General Hospital
2	Tuscola County Medical Care Facility
3	Caro Community Hospital
4	The Lighthouse
5	Tuscola Behavioral Health System
6	Caro Center
7	Caro Community Health Services
8	Caro Family Physicians
9	Caro Family Physicians
10	Caro Medical Clinic
11	Hills and Dales Community Health Clinic
12	Thumb Pediatric
13	Fairgrove Medical Clinic
14	Genesys Integrated Physicians

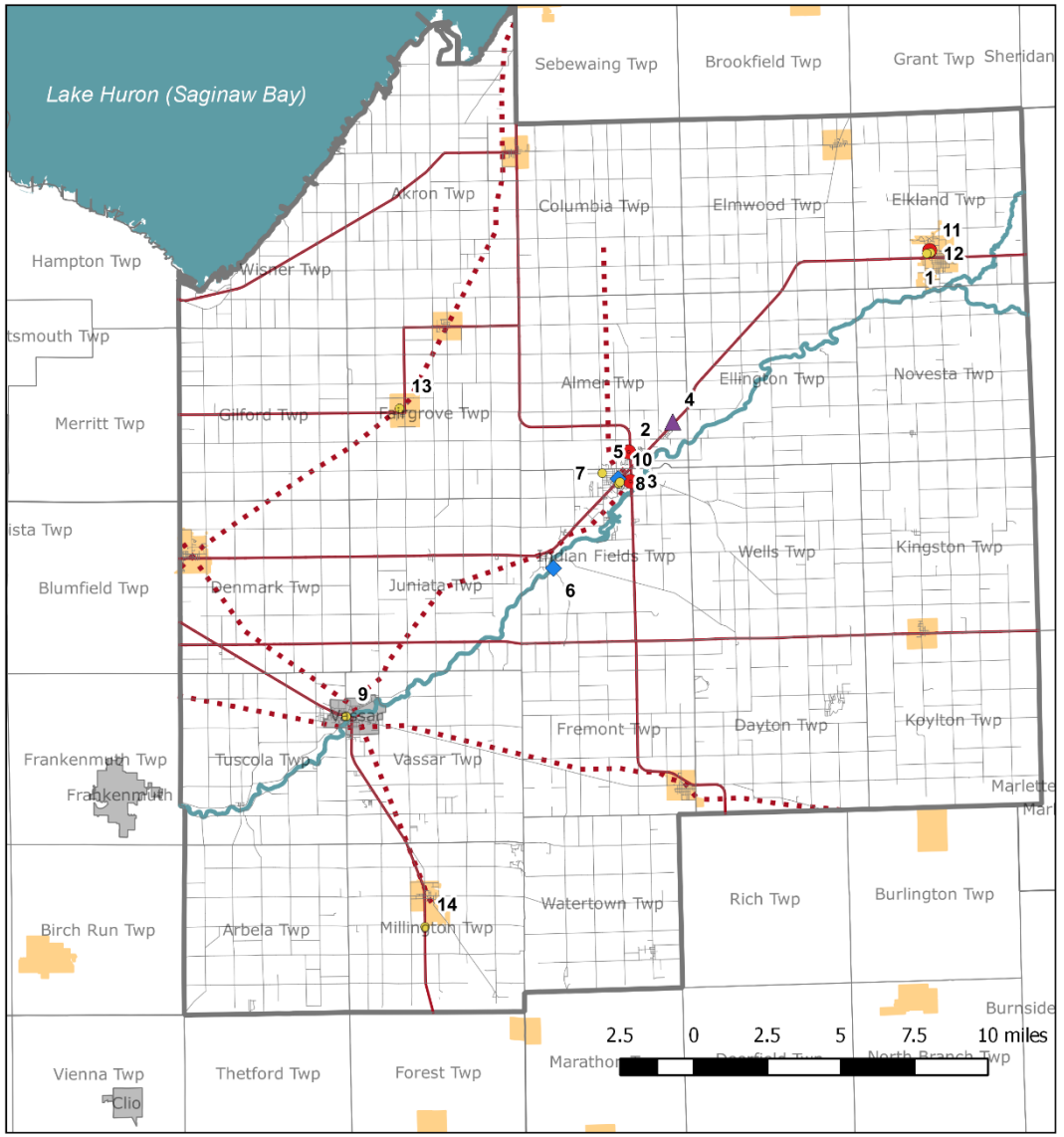


Table 14: Shelter Sites in Tuscola County

Shelter Name	Address
Akron Fairgrove High School	2800 N. Thomas Rd., Fairgrove
Akron United Methodist Church	4243 Beach St (M138), **Akron**
Colwood United Brethren Church	1840 North Colwood Rd, **Caro**
Tuscola Intermediate School District	1385 Cleaver Rd, **Caro**
Watrousville United Methodist Church	4446 West Caro Rd, **Caro**
Cass City High School	4868 North Seger St, **Cass City**
Cass City United Methodist Church	5100 North Cemetery, **Cass City**
Deford Community Church	1392 Kingston Rd, **Deford**
St. Paul Lutheran Church	6356 Center St., **Unionville**
Grace Evangelical Lutheran Church	1809 South Main St, **Fairgrove**
Highland Pines School	1381 Cleaver Rd., **Caro**
Kingston High School	5790 State St, **Kingston**
Four Occasions Banquet Center	5397 Millington Rd, **Millington**
Reese Fire/Rescue	1955 River St, **Reese**
Trinity Lutheran Church and School	9858 North St., **Reese**
St. Michael's Lutheran School	9444 West Saginaw Rd, **Richville**
Chapel Hill Assembly of God	800 South State Rd, **Vassar**
First United Methodist Church	139 North Main St, **Vassar**
Juniata Baptist Church	5656Washburn Rd, **Vassar**
Pineview Mennonite Church	4415 Swaffer Rd, **Vassar**
Alvin Miller American Legion Post 400	9890 W. Sanilac Rd., **Richville**

Civil Disturbances

Description:

Civil disturbances can be classified within the following four types: (1) acts or demonstrations of protest, (2) hooliganism, (3) riots, or (4) insurrection. The descriptions that follow, while roughly organized by type of disturbance, provide information of interest in evaluating and understanding all types of civil disturbance, and therefore should not be treated as independent subsections or read in isolation from each other.

The first type, protest, usually contains some level of formal organization or shared discontent that allows goal-oriented activities to be collectively pursued. This first category includes political protests and labor disputes. Many protest actions and demonstrations are orderly, lawful, and peaceful, but some may become threatening, disruptive, and even deliberately malicious (on the part of at least some of those involved either in the protest itself or in reaction to the protest). It is only the latter type of event that should properly be

classified as a civil disturbance. The destruction of property, interruption of services, interference with lawful behaviors of ordinary citizens and/or emergency responders, the use of intimidation or civil rights violations, and threats or actual acts of physical violence may all occur during civil disturbance events. Actual Michigan events have included the willful destruction of property and impeded property access during labor strikes, and heated conflicts between opposing participants at political rallies or issue-driven demonstrations. Different risks and forms of disturbance are connected with the nature and perceived importance of the cause, the degree of organization among those who are active in the protest, and the amount of group cohesion among those who are involved.

The second category of civil disturbance, hooliganism, is relatively unorganized and involves individual or collective acts of deviance inspired by the presence of crowds, in which the means (and responsibility) for ordinary levels of social control are perceived to have slackened or broken down. Certain types of events, such as sporting events, “block parties,” or concerts, become widely publicized and, in addition to normal citizens who merely seek entertainment, tend to also attract certain types of persons who seek situations in which anonymity, confusion, and a degree of social disorder may allow them to behave in unlawful, victimizing, or unusually expressive ways that would normally be considered unacceptable by most ordinary people. Examples include the disorder that has followed various sporting events and college parties. Although the majority of persons present are ordinary citizens (although many may have some level of intoxication), a minority of persons begins making itself known through unlawful or extreme acts of deviance, and it is from this part of the crowd that the hazard primarily stems. This minority may include persons affected by the use of illegal drugs and alcohol, and may include criminals and persons with mental illnesses (such as antisocial personality disorder) who may either be reacting with extreme hostility to the crowding, noise and disorder, or may have deliberately sought out such crowds and disorder so as to gain opportunities to behave in ways that ordinary circumstances would not allow.

Common problems include the widespread destruction of property, numerous types of assault and disorderly conduct, and criminal victimization. It should also be noted that many persons who are normally law-abiding may temporarily behave in unusually aggressive ways during these events, often prompted by an understandably defensive anxiety about the disorder and behavior exhibited by the deviant minority, but also possibly exacerbated by a level of alcoholic intoxication as well as the temptation by some to engage in appealing deviant behaviors that under normal circumstances of social control would not be selected. Many citizens remain law-abiding, but may remain in the area of a civil disturbance either because they live in the area, have activities (including social and recreational ones) that they wish to continue engaging in, have legitimate business to conduct, or because they are curious or concerned and wish to observe or witness the situation as it occurs. The majority of such law abiding citizens will leave the area in an orderly way when given clear instructions by a legally-recognized 436 Human-Related Hazards – Civil Disturbances authority to do so. There are cases in which hooliganism may become combined with protest, and thus complicate the situation for law enforcement personnel. In some circumstances, elements of protest are added only by a small minority of participants after the disturbances have already begun, but in other

circumstances, protest activity may arise out of concerns regarding the extent and nature of pre-emptive law enforcement activities that were intended to prevent a civil disturbance.

The third type, riots, may stem from motivations of protest, but lacks the organization that formal protests include. Although legitimate and peaceful protests may spontaneously form when people gather publicly with the perception that they already share certain values and beliefs, riots tend to involve violent gatherings of persons whose level of shared values and goals is not sufficiently similar to allow their collective concerns or efforts to coalesce in a relatively organized manner. Instead, there tends to be a diffuse sense of shared discontent, but relatively few norms to shape these strivings into clearly coherent action. For example, widespread discontent within a community that is sufficiently cohesive may quickly take on a set of shared leaders and clear organization, such as a march or chant that is clearly in the form of a protest or demonstration, but in an area that doesn't have the same cohesiveness and shared norms and values, a relatively chaotic form of expression may take place instead, involving assaults, intimidation, and unlawfully destructive expressions of discontent, possibly including the victimization of innocent citizens or businesses who have been selected by part of the crowd to function as scapegoats during their expression of discontent.

In addition to the sentiments of discontent that may have sparked the initial activities, however, elements of hooliganism may emerge and even come to predominate, as certain persons may attempt to exploit the social disorder for their own individual ends. In other cases, elements of legitimate protest may also form within this type of civil disturbance, and pockets of organized protest may help to channel and contain the negative elements of hooliganism, looting, etc. that might otherwise threaten all area residents. The complexity of these events for law enforcement can be very great, demanding carefully calculated efforts to analyze the nature of the disturbance, and difficult decisions about how to approach and possibly involve the numerous types of persons, gatherings, groups, and behaviors that may have the potential to either mitigate or exacerbate the situation.

The fourth type of civil disturbance, insurrection, involves a deliberate collective effort to disrupt or replace the established authority of a government or its representatives, by persons within a society or under its authority. Some prison uprisings may fall into this category, although others may more properly be classified as riots or protests, depending upon the presence and extent of specific goals and organization, and the type of action used in achieving such goals. The map at the end of this section shows the locations of major correctional facilities in Michigan. An insurrection has the deliberate goal of either replacing established authorities with a new distribution of power, or with the destruction of established power structures in favor of (usually temporary) anarchy or a smaller-scale set of recognized criminal (gang), ethnic, or other group networks and power structures.

The latter circumstances tend to involve disturbances that exist on a relatively small scale, such as in a single local area or involving a prison network or "cult compound" (or any other similarly self-aware group or subculture with identified collective interests and a

network that allows rapid communication and collective action). However, larger-scale insurrections are also possible, involving issues of class conflict or other widespread social inequalities, highly divisive political issues, or other important large-scale events that disrupt the social equilibrium because they illuminate areas in which cultural values are not sufficiently shared throughout the society or region that is experiencing the conflict, disruption, or strain. In many cases, this kind of large-scale social strain has developed gradually over time, and involves an entire series of compromises, concessions, and migrations that may temporarily relieve the disruptive social and value conflicts, only to reemerge after another period of changes and population growth has caused a breakdown in previous arrangements. This description of the causes of social discontent applies to many protests and riots, as well as insurrection. In cases involving the formation or emergence of significant subcultures or counterculture, such as during the Vietnam era, or when dominant values break down or fail to be established on important key issues or mores, there is the potential for insurrection on a larger scale.

The Civil War of 1861-1865 was one such instance, in which the authority of the federal government was either accepted or rejected by various states which then aligned themselves in opposition to each other. Between these two extremes (of a purely localized civil disturbance and a 437 Human-Related Hazards – Civil Disturbances national civil war) are numerous other possibilities for regional, political, class, or ethnic conflicts that may involve one or more categories of citizen in conflict with others. Examples could include prisoners versus law enforcement personnel, a countercultural group versus the establishment, or a violent political activist group in conflict with selected representatives of a contrary viewpoint. (Some such actions may overlap with those of terrorism)

Analysis: The Caro Regional Center (2000 Chambers Rd, Caro, MI see map of Emergency Medical Facilities, Map 27 above) mental health facility also presents a small risk in this area, as escapes from mental health institutions are considered civil disturbances. There have been escapes from this facility in the past. Tuscola officials should anticipate the threat of more escapes, particularly because some patients at the Caro Center are forensic patients.

Large public gatherings, such as those occurring at sporting events or at Tuscola's many annual festivals always create the potential for a civil disturbance. Although these gatherings usually occur without serious incident, law enforcement must maintain a heightened level of vigilance when managing crowds. Most recently, in 2015, there were outdoor protests regarding the possibility of immigrant refugee children being housed in a juvenile facility in Vassar.

Jurisdictional impact: This list includes jurisdictions with police stations, fire stations, medical facilities or mental health facilities.

- Unionville Township
- Village of Kingston
- Kingston Township
- City of Caro

- Village of Mayville
- Village of Fairgrove
- Cass City
- Elkland Township
- Almer Township
- Indianfields Township
- Koylton Township
- Akron Township
- Village of Reese
- Ellwood Township
- Watertown Township
- City of Vassar
- Denmark Township
- Village of Millington
- Village of Gagetown
- Arbela Township

CLIMATE CHANGE AS A HAZARD

Description: Climate change refers to any significant change in the measures of climate lasting for an extended period of time. In other words, climate change includes major changes in temperature, precipitation, or wind patterns, among others, that occur over several decades or longer *(source: USEPA, Definition for Climate Change*). Anthropogenic Climate Change is caused by an increase in emissions of pollutants into the air including but not limited to Carbon Dioxide, Methane, Nitrous Oxide, and Chlorofluorocarbons (CFC's). The primary anthropogenic sources of these pollutants are the burning of fossil fuels in the fields of electrical generation, transportation, industry, and agriculture *(source: USEP, Sources of Greenhouse Gas Emissions)*. These greenhouse gasses act as a shield that traps infrared radiation reflected off of the earth surface within the atmosphere, with an end result of long term alteration of weather patterns and systems.

Global warming and climate change has already altered weather patterns in the Midwest and Michigan and these changes are projected to continue through the end of the century. Climate change has been linked to an increased average air temperature and storm intensities, as well as changes in seasonal precipitations patterns. Climate Change alone is not a single threat to Tuscola County, but can greatly affect other natural hazards, including weather hazards and hydrological hazards, identified previously in this document. The following section will identify the hazards that are most effected by climate change, and their potential impacts.

Analysis:

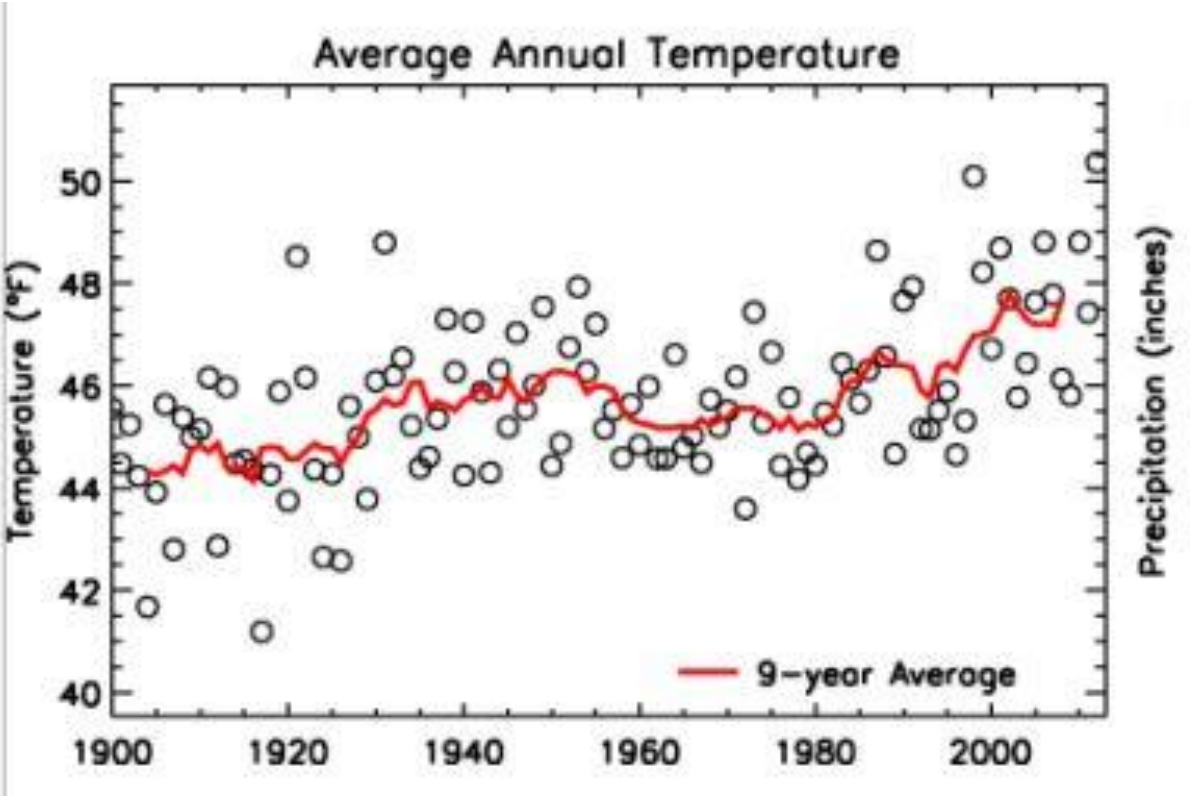
Extreme Temperatures

Table 15: Observed and Projected Changes in Temperature.

	Current (degrees F)	Observed Changes (Degrees F)	Projected Change (degrees F)
Annual	46.70	1.24	3.39 to 7.71
Winter	24.49	2.32	2.98 to 8.46
Spring	44.72	1.37	2.24 to 8.16
Summer	68.04	.70	2.70 to 8.78
Fall	49.52	0.52	2.75 to 7.71

Current conditions are 1981-2010 average temperature, observed change is the difference between the current 1981-2010 period and the historical 1951-1980 period, and projected changes are the difference between the projected period of 2041-2070 and current conditions 1981-2010. Winter: December, January February. Spring: March, April, May. Summer: June, July, August. Fall: September, October, November**.** *(Source: Cities Impacts & Adaptation Tool (CIAT)).*

Figure 12: Mean annual air temperature from 1931 to 2011



An open circle represents the average temperature of a single year. The solid line represents the 9-year running mean. (Cities Impacts & Adaptation Tool (CIAT)).

Over the past few decades, alterations in the average air temperatures have been observed in Michigan. For example, Michigan's new heat records outnumbered new cold records by 3X during the 1990's, and 6X in the 2000's (MI Hazard Mitigation Plan). Over the past two decades, average winter air temperatures in the Saginaw Bay region of Michigan have increased by .52 degrees when compared to the previous decades (Table 12).

Extreme Cold

Despite the fact that average air temperatures have increased, and the duration of the winter season has been shrinking, the changing climate has also demonstrated that the extreme differences in temperature between polar and temperate regions can make it easier for polar weather fronts to move southward towards the central United States. While this weather phenomena occurs most every winter, the 2013-2014 winter season demonstrated the potential increased severity of this seasonal trend. This phenomena, also referred to as the "Polar Vortex", brought with it a series of challenging weather events including heavy snow, extreme cold temperatures, and high winds. This weather phenomena had dramatic effects through the Lower Peninsula of Michigan and in the Saginaw Bay region. *(Source: 2014 Michigan Hazard Mitigation Plan, P.152)*

Extreme Heat

Climate Change has shown the potential to shorten the duration of winters, while increasing its severity and decreasing its predictability. Forecasts also project increasingly hot summers throughout Michigan. Over the past two decades, average summer air temp in the Saginaw Bay region of Michigan has increased by .7 degrees when compared to the previous decades (table 1). By 2040-2070, summer temperatures are expected to rise by 2.7 to 8.78 degrees. *(Source: 2014 Michigan Hazard Mitigation Plan, P.152)*

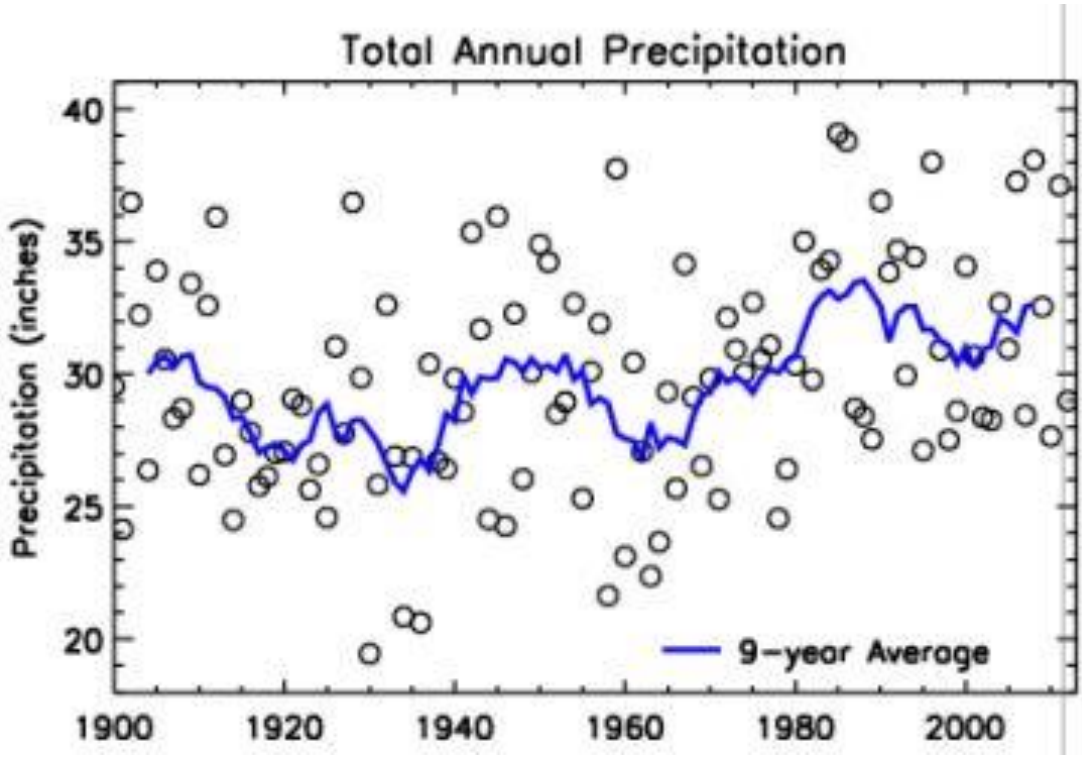
Precipitation:

Table 16: Observed and Projected Changes in Precipitation.

	Current (In)	Observed Changes (%)	Projected Change (%)
Annual	32.2	11.5 %	-7.55 to 14.69
Winter	5.39	5.27 %	4.82 to 31.54
Spring	7.97	8.44 %	-7.28 to 26.85
Summer	9.59	7.87 %	-21.27 to 16.27
Fall	9.29	23.70 %	-21.31 to 12.70

Current conditions are 1981-2010 total precipitation, observed change is the percentage change between the current 1981-2010 period and the historical 1951-1980 period, and projected changes are the percentage change between the projected period of 2041-2070 and current conditions 1981-2010. Winter: December, January February; spring: March, April, May. Summer: June, July, August. Fall: September, October, November. Source: "Cities Impacts & Adaptation Tool (CIAT)".

Figure 13: Mean total precipitation from 1931 to 2011.



An open circle represents the average precipitation of a single year. The solid line represents the 9-year running mean. (Source: Cities Impacts & Adaptation Tool (CIAT)

Over the past 50 years there have been notable changes to precipitation patterns in Tuscola County. Comparing the average precipitation between 1951-1980 and 1981-2010 in the Saginaw Bay region, there was significant increases in precipitation throughout all seasons, with annual average change in inches per year of 11.5%. Looking into the future, this trend is expected to continue. Comparing annual precipitation between 1981-2010 and 2040-2070 projections, the annual amount of precipitation is forecasted to change by -7.55% to 14.69%. These projections show there is a chance that precipitation will decrease, but the projections are weighted more strongly on the likelihood of increased precipitation. The potential changes in seasonal precipitation has the potential to alter the natural the hydrological hazards of riverine flooding/erosion, drought, snowstorms, and ice and sleet storms

Ice and Sleet Storms

Climate change effects appear likely to cause an increase in the number of ice and sleet storms in Tuscola County. Ice and sleet storms are expected to increase because the average temperatures are expected to increase during winter months, moving closer to the freezing point. It is around this temperature which ice and sleet storms most frequently occur. Winter precipitation amounts are projected to increase by 4.82% to 31.54%, and air temperatures are projected to increase by 2.98 to 8.46 degrees. As the amount of precipitation increases, and average air temperatures increase Tuscola can expect to see more thawing episode, followed by refreezing. This can result in treacherous ice cover on frozen surfaces, weighed down power lines and branches, and cause breakages which can lead to infrastructure damage and potential failure. *(Source: 2014 Michigan Hazard Mitigation Plan, p.91)*

Heavy Snow Storms

Climate change is expected to cause an increase in the amount of precipitation throughout the year in Tuscola County, with the greatest increases expected during winter months. Even though the length of Tuscola's winter has been decreasing, its intensity will remain. The projected increase in precipitation will results in an increase of the frequency of significant snowstorm events (e.g. 8 or more inches, higher snowdrifts, cancelled school sessions, etc.). Michigan Meteorologist Paul Gross notes "contrary to what most would expect, the warming climate is causing an increase in snowfall in those winters where the storm track brings more frequent winter storms to the Great Lakes." *(Source: 2014 Michigan Hazard Mitigation Plan, p.116)*

Riverine Flooding

Climate change is expected to cause an increase in the amount of precipitation throughout the year in Tuscola. Not only is overall precipitation expected to increase, but the intensity of storms is expected to increase as well. As mentioned in the winter weather sections of the Plan, a larger proportion of snow precipitation occurring in snowstorm events can cause more extensive snow accumulation which, under unlucky temperature patterns, may add to the drainage burdens of the normal melting and rainfall patterns of

the spring season. In short, spring flood risks are likely to worsen, as are ice jam related winter flood risks. *(Source: 2014 Michigan Hazard Mitigation Plan, p.170)*

Drought

Although the effect of climate change on Tuscola has been an overall increase in precipitation, and the severity of droughts has generally been decreasing over the past half-century, there will still be drought events and dryer seasonal phases. With sufficient planning and water infrastructure, the climate change effects upon this hazard may actually be beneficial on the whole, although the hazard will not disappear." *(Source: 2014 Michigan Hazard Mitigation Plan, p.219)*

Change in Risk from 2008 Plan: The "Climate Change as a Hazard" section was not in 2008 version so no comparison can be made.

Table 17: Summary of Risk Analysis by Jurisdiction

	Natural Hazard											Technological Hazards											
	Extreme Temps	Flooding/Erosion	Snow/Ice/Sleet Storms	Drought	Severe Wind	Thunderstorms/Fog	Hail	Lighting	Invasive species	Tornadoes/Earthquakes	Wildfires	Fire – Scrap Tire	Fire - Structural	Dam Failure	Haz. Mat. Fixed	Emissions/Discharges	Haz. Mat – Trans.	Infrastructure Failure	Oil/Gas Well/Pipeline	Petroleum/Gas pipeline	Land Subsidence	Transportation Accident	Public Health/Civil Disturbance
Akron Township	X		X	X		X	X	X	X	X	X		X				X	X	X		X	X	X
Almer Township	X		X	X	X	X	X	X	X	X	X		X				X	X	X			X	X
Arbela Township	X		X	X	X	X	X	X	X	X	X		X				X	X	X			X	X
Columbia Township	X		X	X	X	X	X	X	X	X	X		X				X	X				X	X
Dayton Township	X		X	X	X	X	X	X	X	X	X		X				X	X				X	X
Denmark Township	X		X	X	X	X	X	X	X	X	X		X		X		X	X		X		X	X
Elkland Township	X		X	X	X	X	X	X	X	X	X		X		X		X	X				X	X
Ellington Township	X		X	X	X	X	X	X	X	X	X		X				X	X				X	X
Elmwood Township	X		X	X	X	X	X	X	X	X	X		X				X	X				X	X
Fairgrove Township	X		X	X	X	X	X	X	X	X	X		X				X	X				X	X
Fremont Township	X		X	X	X	X	X	X	X	X	X		X				X	X		X		X	X
Gilford Township	X		X	X	X	X	X	X	X	X	X		X				X	X				X	X
Indianfields Township	X	X	X	X	X	X	X	X	X	X	X		X	X			X	X		X		X	X
Juniata Township	X	X	X	X	X	X	X	X	X	X	X		X				X	X		X		X	X
Kingston Township	X		X	X	X	X	X	X	X	X	X	X	X				X	X		X		X	X
Koylton Township	X		X	X	X	X	X	X	X	X	X		X				X	X				X	X
Millington Township	X		X	X	X	X	X	X	X	X	X	X	X				X	X	X			X	X
Novesta Township	X		X	X	X	X	X	X	X	X	X		X				X	X				X	X
Tuscola Township	X	X	X	X	X	X	X	X	X	X	X		X				X	X		X		X	X
Vassar Township	X	X	X	X	X	X	X	X	X	X	X		X	X			X	X		X		X	X
Watertown Township	X		X	X	X	X	X	X	X	X	X		X				X	X		X		X	X
Wells Township	X		X	X	X	X	X	X	X	X	X		X				X	X		X		X	X
Wisner Township	X		X	X	X	X	X	X	X	X	X		X				X	X	X		X	X	X
City of Caro	X	X	X	X	X	X	X	X	X	X	X		X	X	X		X	X				X	X
City of Vassar	X	X	X	X	X	X	X	X	X	X	X		X	X	X		X	X		X		X	
Village of Akron	X		X	X	X	X	X	X	X	X	X		X				X	X				X	X
Village of Cass City	X		X	X	X	X	X	X	X	X	X		X	X	X		X	X				X	X
Village of Fairgrove	X		X	X	X	X	X	X	X	X	X		X				X	X				X	X
Village of Gagetown	X		X	X	X	X	X	X	X	X	X		X		X		X	X				X	X
Village of Kingston	X		X	X	X	X	X	X	X	X	X		X				X	X				X	X
Village of Mayville	X		X	X	X	X	X	X	X	X	X		X				X	X				X	X
Village of Millington	X		X	X	X	X	X	X	X	X	X		X		X		X	X				X	X
Village of Reese	X		X	X	X	X	X	X	X	X	X		X		X		X	X		X		X	X
Village of Unionville	X		X	X	X	X	X	X	X	X	X		X		X		X	X				X	X

Table 18: Numerical Risk Analysis and Ranking

Hazard	Occurrence Probability (30%)	Warning Time (15%)	Local Capability (20%)	Property & Pop Affected (25%)	Economic Impact (10%)	Weighted Total (100%)
Snowstorms	4.50	4.20	3.89	4.09	2.89	4.07
Thunderstorms	4.17	4.10	3.67	3.45	2.44	3.71
Ice and Sleet Storms	3.75	4.10	3.44	3.82	3.00	3.68
Sever Wind	3.75	4.00	3.56	3.73	2.89	3.66
Extreme Temperatures	3.33	4.60	3.00	3.55	2.44	3.42
Fire Hazards - Structure Fires	4.08	1.11	4.56	2.36	2.33	3.13
Drought	2.67	4.22	2.33	3.36	3.56	3.10
Lightning	3.42	3.70	3.00	2.64	1.89	3.03
Tornadoes	2.50	3.20	3.67	2.82	3.33	3.00
Riverine Flooding/Erosion	3.25	3.30	2.67	2.73	2.78	2.96
Hail	2.92	3.60	2.89	2.82	2.33	2.93
Infrastructure Failure - Water, Sewer, Electrical, Communications	2.91	1.75	3.13	3.20	3.25	2.89
Public Health Emergencies	2.64	2.38	3.13	3.10	2.75	2.82
Fog	2.83	3.20	2.67	3.00	1.33	2.75
Wildfires	2.83	2.22	3.56	2.36	2.44	2.73
Invasive Species	2.67	3.00	1.67	2.45	3.00	2.50
Shoreline Flooding/Erosion	2.75	3.10	2.22	1.82	2.11	2.40
Hazardous Materials Incidents - Transportation Incidents	2.55	1.25	3.75	1.90	2.00	2.38
Energy Emergencies	2.20	1.75	1.75	3.20	2.88	2.36
Catastrophic Incident	1.22	1.00	2.29	3.44	4.14	2.25
Civil Disturbances	1.50	2.57	3.71	1.78	2.00	2.22
Air, Land, and Water Discharges from Regulated Facilities	2.18	1.75	2.25	2.60	1.57	2.17
Petroleum and Natural Gas Pipeline Accidents	1.75	1.22	3.22	2.09	2.67	2.14
Transportation Accidents - Air, Land, and Water	2.25	1.00	3.00	1.90	2.38	2.14
Point Source Air Emissions from Regulated Facilities	1.82	1.63	2.13	2.90	1.75	2.11
Impaired Waters	2.10	1.86	2.29	2.00	2.29	2.09
Oil and Gas Storage Facilities and well Accidents	1.67	1.67	3.00	1.82	2.44	2.05
Earthquakes	1.08	1.11	2.22	2.91	3.78	2.04
Underground Storage Tanks	2.17	1.56	2.67	1.64	1.89	2.01
Fire Hazards - Scrap Tires	1.42	1.22	3.67	1.64	2.33	1.98
Dam Failure	2.00	1.88	1.63	2.00	2.63	1.97
Nuclear Attack	1.10	1.00	1.00	3.11	4.43	1.90
Terrorism	1.45	1.00	2.38	2.00	2.75	1.84
Nuclear Power Plant Accidents	1.00	1.14	1.43	2.22	2.57	1.57

Celestial Impact	0.90	1.25	1.13	2.10	3.00	1.51
Land Subsidence	1.29	1.40	2.00	1.43	1.40	1.49

Participants in the July 15 and August 12, 2015 meeting were asked to rate each listed hazard for its probability of occurrence, the amount of warning time likely to be available, local capability to respond, and the expected impact on people and the economy. This table represents the average (mean) of their responses. Each was rated on a scale of 1 to 5, 5 representing the highest level of severity. Hazards are listed in order of priority according to this analysis. Please not that this is only one tool for establishing hazard priorities used in this plan.

CONCLUSION

Although it is important in any hazard mitigation planning to remain aware of risks from a wide variety of hazards, for the sake of creating an effective plan it is necessary to evaluate which hazards are likely to pose the biggest threat to the community. Future hazard mitigation strategies should focus on those hazards that represent the most severe risks. Through analysis of history, local capabilities, likely hazard impacts, and community sentiment, five most important hazards emerged. They are:

- Transportations accidents, especially involving hazardous materials
- Structure fires
- Winter weather including snowstorms, ice/sleet storms, and cold waves
- Severe wind
- Failure in water infrastructure including drinking water safety and sewage

It may be noted that the above list is not identical to the ranking in the table on the previous page, the mathematically determined ranking of hazards. This table was only one of the tools used to decide the county's top hazards; historical impact, likely cost to the community, and existing local preparedness were also considered. The most important factor influencing the above list was community sentiment. If the community is to be expected to actually utilize this plan in a meaningful way, it must address the hazards that it feels are most important.

Chapter 2: Goals and Objectives

The first chapter of this plan discussed the risk of various hazard scenarios in Tuscola County. Identifying risks is an important part of hazard mitigation, but it is also necessary that the community take positive steps to try to eliminate hazards and reduce their impacts. This Plan will discuss very specific actions to be taken, but it is important to first have an overall guiding vision for hazard preparation and mitigation. To this end, participants in a public meeting held on August 12, 2015 in Tuscola selected seven goals for the county relevant to hazard mitigation that maintain commitment to the overall visions of the county. The goals are:

- Increase community preparedness for a variety of hazard situations.
- Provide adequate warning time to residents in the event of a disaster.
- Maintain a safe, reliable, and efficient transportation infrastructure.
- Encourage and aid private hazard mitigation activities including those that protect private property.
- Reduce losses and damage from repetitive disasters.
- Maintain a safe, reliable, and efficient sewer and water infrastructure. Improve safety and consistency of electrical, gas and water service where applicable.
- Encourage and aid public hazard mitigation activities including those that protect private property.

These goals are designed to be very broad and unspecific in order to serve as long-term guides for the community's hazard mitigation efforts. In order to chart a more specific course for the community, residents also identified limited, attainable objectives that would help to accomplish each overall goal. The objectives related to each goal are laid out in the table below.

Table 19: Tuscola County Goals and Objectives

	Goal	Goal-specific Objectives
1	Increase community preparedness for a variety of hazard situations.	▪ Educate residents and community leaders about personal hazard mitigation and preparedness focusing especially on educating residents about the countywide resources that exist. ▪ Continue to equip and train the county's emergency responders, emphasizing especially cross-municipality training. ▪ Create and improve plans for mutual assistance between municipalities in the county ▪ Update and maintain local records about the owners and operations of oil and gas wells, pumping stations, and pipelines. ▪ Address Caro Dam maintenance and future plans for the structure
2	Provide adequate warning time to residents in the event of a disaster.	▪ Test and expand countywide warning systems. Map system to identify gaps. ▪ Where there are warning system gaps plan to use alternative warning systems such as radios, the Red Cross phone app ▪ Expand the cooperative, countywide system of telephone alerts (Mass notification system).
3	Maintain a safe, reliable, and efficient transportation infrastructure.	▪ Improve cooperation with utilities companies on roadside safety issues such as downed power lines. Obtain a list of contact people for utilities in case of these events.

		▪ Improve safety around deep drainage ditches that run alongside roadways within the county. ▪ Update and adopt the Tuscola County Airport Plan ▪ Map all rail lines and roads where hazardous or flammable materials are transported.
4	Encourage and aid private hazard mitigation activities including those that protect private property.	▪ Offer incentives to businesses and individuals to modify existing property, including relocation and retrofitting, to lessen hazard risks. ▪ Provide sample zoning language to permit or require green infrastructure to lessen flooding. ▪ Encourage municipalities to require burying utility lines in their site plan requirements for new construction. ▪ Discourage the use of mobile homes for dwellings through promoting alternative low income housing.
5	Protect the drinking water supply	▪ Ensure that all new wells in the county are capped and reach a proper depth. Expand awareness of current well-capping programs and improve mapping of uncapped wells. ▪ Begin education program on over irrigation to prevent additional Sulphur and impurities in the water supply. ▪ Monitor fracking operations in the county that may disrupt or contaminate drinking and irrigation water supplies. ▪ Promote and educate agricultural and residential areas on proper disposal of household hazardous materials and agricultural chemicals.

		▪ Map well and septic systems that do not meet separation requirements, wells that are too shallow or septic systems that do not exist for future mitigation activities. ▪ Provide backup power for drinking water systems that rely on city wells. ▪ Create a list of backup generators that maybe utilized in the event of an emergency. ▪ Install monitoring equipment at access points to detect potential tampering with the water supply.
6	Reduce losses and damage from repetitive flooding	▪ Clean excessive growth in ditches and drains to improve drainage to reduce losses and damage from flooding. ▪ Work with DNR to begin consistent maintenance of drainage features on state land. ▪ Improve collaboration among county and regional municipalities to address poor drainage across the watershed. ▪ Prevent excessive growth in ditches by reducing nutrient run off and soil sedimentation from farms and fields. Begin farmer education and incentive programming. ▪ Update the City of Vassar Flood Mitigation Plan. ▪ Encourage all municipalities to join the FEMA flood insurance program. ▪ Replace culverts on public land that are undersized and create obstructions in water flow.

These goals and objectives were agreed to at the public meetings as the most important for Tuscola County prior to the plan's adoption. For the Plan to remain a relevant document, the goals and objectives should be periodically revisited and updated to reflect changing conditions in the county. This revision should include the addition of new goals and the elimination of irrelevant ones as well as the removal of completed objectives. The Emergency Management Director will oversee all progress on action items in this plan.

Chapter 3: Alternatives for Problem Solving

Chapter 2 of this plan identified goals and objectives to serve as guidelines for Tuscola County's hazard mitigation efforts. This chapter will evaluate alternative methods for accomplishing the goals and objectives described in the previous chapter. Generally speaking, the following strategies can be used to effectively mitigate hazards:

- Modify the hazard or eliminate it. Modification reduces the size or amount, or controls the rate of release of the hazard.
- Segregate the hazard as a method to keep the hazard away from people.
- Prevent or limit development in locations where people and structures will be at risk.
- Alter design or construction to make it less vulnerable to disaster damage.
- Engage in early warning and public education to ensure that the public is aware of potential hazards and that proper warning and communication systems are in place to save lives and protect property.

Tuscola County governments have a number of tools at their disposal to help realize these strategies. These tools fall into several broad categories:

- Corrective measures – These generally involve physical relocation, acquisition of land or structures, development or modifications.
- Public Works measures – These include special protection measures to structures or physical changes to the landscape to reduce a hazard.
- Planning and Regulatory measures – This tool involves planning and zoning options such as zoning, code enforcement, open space planning and purchase of development rights.
- Public Education and Awareness – This effort is generally a dissemination of information to a target audience as well as generally education to the whole community.

The alternatives for problem solving discussed in this chapter represent attempts to apply the tools and strategies of this chapter to satisfactorily achieve the goals and objectives of the plan. The alternatives discussed in this chapter represent those that were considered at the time of the plan's adoption, but should not be construed as a limitation on future mitigation efforts; rather, they should serve to provide a design under which all mitigation strategies can be evaluated.

Evaluation Criteria

The alternatives proposed in this part of the plan were intended to be comprehensive rather than limited, and as such some alternatives may be completely unworkable in the county, while others may simply be preferable to others. In order to help decide between alternatives this plan uses set criteria against which each alternative can be evaluated. The criteria are summarized here.

Cost Effectiveness

Budgeting is an integral part of hazard mitigation planning. While we would like to say that one can't put a price on public safety, the realities of funding for local governments demand that the costs of hazard mitigation proposals are weighed against their expected benefits. While certain high-tech or labor-intensive strategies may be the most effective at mitigating a hazard, if they are prohibitively expensive they are not ideal for the county. The format for this criterion is an estimate of costs of the project considered against an estimate of the expected benefits, all used to determine a net positive or negative cost. It should be noted that while in some cases the costs of a project can be accurately estimated, evaluating the expected benefits of a hazard mitigation project in dollar amounts is necessarily an inexact science; cost effectiveness estimates at this stage provide a useful guideline but they should not be considered the final word on actual costs and benefits of a project. More accurate estimations will be given for actual projects in Chapter 4.

Viability

If a mitigation project is to be seriously considered by the county it must be determined to be technically feasible, legally permissible, and within the capability of the county to execute. The most effective way to defend against nuclear attack may be, for example, to reconstruct the entire county a mile underground, but this is not technically feasible. While for the most part alternatives proposed in this chapter are not as ludicrous as the preceding example, the viability of any proposed project is an important initial consideration.

Acceptability for Community

Many of the hazard mitigation alternatives considered here require the involvement of members of the Tuscola County community. For these projects to effectively achieve their ends they must be widely accepted by the community, particularly any specific groups within the community expected to help carry out the project. Projects must not unduly infringe on the existing authority of groups or place undue burdens on any community members.

Environmental Impact

It is of paramount importance that all hazard mitigation projects are evaluated in terms of the way they will affect the natural environment of Tuscola County. In the choice between two projects that are otherwise equal, it is obvious that one that positively or at least neutrally affects the environment is superior to one that causes damage. Impacts on the environment are not just problems for nature; they adversely affect the resident human populations in the present and in the future. It may be that for some projects concerns for immediate human safety override environmental concerns, but in all projects environmental impact should be taken into account.

It should be noted that this evaluation was not intended to identify one alternative as the exclusive best option for achieving a particular objective; it is entirely likely that more than one alternative proposed for an objective should be implemented to most effectively solve the problem.

Table 20: Goal-Objective Tables A-N

A: Improve Training and Equipment						
GOAL: Increase community preparedness for a variety of hazard situations	**EVALUATION CRITERIA**					
OBJECTIVE: Continue to equip and train the county's emergency responders, emphasizing especially cross-municipality training	Cost Effectiveness:			Viable? (Y/N)	Acceptable for Community Potential Participants? (Y/N)	Environmental Impact (Positive, Negative, or Neutral)
Range of Alternative Solutions:	(expressed in dollar amounts)					
	Costs ($)	Benefits ($)	Net ($)			
Expect municipalities to cooperate in their emergency response training independently without any guidance from the county level[1]	0	unknown	unknown	Y	Y	Neutral
Establish a schedule of voluntary cross-municipal training so that each municipality's emergency responders have trained with a variety of other groups of emergency responders	100	unknown	unknown	Y	Y	Neutral
Create additional grain elevator extraction systems	3,000/each	5,000	2,000	Y	Y	Neutral
Purchase additional fire trucks capable of reaching higher buildings	$1,000,0000 each	1,000,000	0	N	N	Neutral

Notes: [1]This may fail to solve the problem.

B: Educate Residents and Community Leaders						
GOAL: Increase community preparedness for a variety of hazard situations.	**EVALUATION CRITERIA**					
OBJECTIVE: Educate residents and community leaders about personal hazard mitigation and preparedness focusing especially on educating residents about countywide resources.	Cost Effectiveness:			Viable? (Y/N)	Acceptable for Community Potential Participants? (Y/N)	Environmental Impact (Positive, Negative, or Neutral)
Range of Alternative Solutions:	(expressed in dollar amounts)					
	Costs ($)	Benefits ($)	Net ($)			
Design, publish, and distribute a series of brochures containing useful personal hazard mitigation advice	5,000	25,000	15,000	Y	Y	Neutral
Host a series of countywide seminars that provide hazard mitigation information	300	1,000	700	Y	Y	Neutral
Create a recurring program to inform elected officials of the county's hazard capabilities and mitigation strategies	150/year	10,000/yr	9850/year	Y	Maybe	Neutral
Provide doctors' offices with hazard mitigation pamphlets and information designed especially for elderly patients and patients with special needs	5,000	25,000	15,000	Y	Y	Neutral
Create a group that school districts may call on to give hazard safety presentations to students and parents	500	1,000	500	Y	?	Neutral
Design and host programs specifically designed to address the hazard needs of special-needs populations; offer these programs in places where special-needs populations come together	500	10,000	9,500	Y	Y	Neutral
Design and sponsor an advertising campaign that promotes personal hazard preparedness and may also advertise hazard information events and programs. Provide free hazard preparedness pamphlets to influential organizations like fire departments and churches.	5,000	25,000	20,000	Y	Y	Neutral

C: Cooperation Between Municipalities						
GOAL: Increase community preparedness for a variety of hazard situations.	**EVALUATION CRITERIA**					
OBJECTIVE: Create and improve plans for mutual assistance between municipalities in the county	Cost Effectiveness:			Viable? (Y/N)	Acceptable for Community Potential Participants? (Y/N)	Environmental Impact (Positive, Negative, or Neutral)
Range of Alternative Solutions:	(expressed in dollar amounts)					
	Costs ($)	Benefits ($)	Net ($)			
Update and revise chain-of-authority plan for hazard response, addressing particularly who takes authority in a municipality when its emergency responders are unavailable	0	1,000	1,000	Y	Y	Neutral
Create a list for phone alerts (including cell phone and pager numbers) to expedite contact of emergency responders in case of serious hazards	0	1,000	1,000	Y	Maybe	Neutral
Host countywide events for emergency responders, fire chiefs and fire association meetings and other officials (these should include food and prizes) to promote networking and cooperation	$500	unknown	unknown	Y	Y	Neutral
Maintain existing plans	0	Variable	Variable	Y	Y	Neutral

D: Gas and Oil Records						
GOAL: Increase community preparedness for a variety of hazard situations.	**EVALUATION CRITERIA**					
OBJECTIVE: Update and maintain local records about the owners and operations of oil and gas wells, pumping stations, and pipelines	Cost Effectiveness:			Viable? (Y/N)	Acceptable for Community Potential Participants? (Y/N)	Environmental Impact (Positive, Negative, or Neutral)
Range of Alternative Solutions:	(expressed in dollar amounts)					
	Costs ($)	Benefits ($)	Net ($)			
Continue police and municipal officials' enforcement of laws requiring owner identification and reporting	0	500	500	Y	Y	Neutral
Create a countywide computer database of ownership information available only to municipal officials	5,000	1,000	(4,000)	Y	Y	Neutral
Create a county standard format for recording this ownership information to make it easier for municipalities to effectively record and maintain records	50	50	0	Y	Y	Neutral

E: Warning Systems						
GOAL: Provide adequate warning time	**EVALUATION CRITERIA**					
OBJECTIVE: Test and expand countywide warning systems	Cost Effectiveness:			Viable? (Y/N)	Acceptable for Community Potential Participants? (Y/N)	Environmental Impact (Positive, Negative, or Neutral)
Range of Alternative Solutions:	(expressed in dollar amounts)					
	Costs ($)	Benefits ($)	Net ($)			
Continue periodic testing of all existing sirens in the county	0	25,000	25,000	Y	Y	Neutral
Replace aging and antiquated sirens with up to date technology	~20,000/ siren (~1.5 m)	unknown	unknown	Y	Y	Negative
Publish information about warning sirens so the public can understand what the alerts mean	$1,000	unknown	unknown	Y	Y	Neutral

F: Mass Notification System						
GOAL: Provide adequate warning time	**EVALUATION CRITERIA**					
OBJECTIVE: Create a cooperative, countywide system of telephone alerts (Mass notification System)	Cost Effectiveness:			Viable? (Y/N)	Acceptable for Community Potential Participants? (Y/N)	Environmental Impact (Positive, Negative, or Neutral)
Range of Alternative Solutions:	(expressed in dollar amounts)					
	Costs ($)	Benefits ($)	Net ($)			
Contract with mass notification system to provide countywide telephone alert system[1]	20,000/year	Hundreds of Thousands	Hundreds of Thousands	Y	Y	Neutral
Purchase equipment to create a localized countywide telephone alert system[2]	25,000 for dialing equipment, plus cost of phone lines	Hundreds of Thousands	Hundreds of Thousands	Y	Y	Neutral
Expect each municipality to contract individually with mass notification system to provide telephone alert service to their area	0 to county, variable to municipalities depending on population	Hundreds of Thousands	Hundreds of Thousands	N	N	Neutral
Expect each municipality to purchase and maintain its own telephone alert system	6-10,000 for dialing equipment, plus cost of phone lines	Hundreds of Thousands	Hundreds of Thousands	N	N	Neutral
Create a decentralized, "call list" system for community alerts[3]	0	Thousands	Thousands	Y	Y	Neutral
Rely on current warning systems without creating a new telephone system[4]	0	0	0	Y	Y	Neutral

Notes:

[1] Most reliable system

[2] Subject to technical failure; could be disabled by certain hazards

[3] Would be highly unreliable

[4] May fail to achieve objective

G: Utility Safety						
GOAL: Maintain a safe, reliable, and efficient transportation infrastructure	**EVALUATION CRITERIA**					
OBJECTIVE: Improve cooperation with utilities companies on roadside safety issues such as downed power lines. Obtain a list of contact people for utilities in case of these events	Cost Effectiveness:			Viable? (Y/N)	Acceptable for Community Potential Participants? (Y/N)	Environmental Impact (Positive, Negative, or Neutral)
Range of Alternative Solutions:	(expressed in dollar amounts)					
	Costs ($)	Benefits ($)	Net ($)			
Request list of contact information for fast response to roadside safety issues from utility companies[1]	0	Hundreds per incident	Hundreds per incident	N Lack of cooperation with utilities	Y	Neutral
Require emergency responders to stay at the scene of roadside utility hazards, diverting traffic as necessary, until utility company repair crew arrives. Bill utility companies for time spent by emergency responders guarding hazard.[2]	0	0	0	N	Y	Neutral

Notes:

[1] Utilities reluctant to provide numbers – DTE des not cooperate

[2] Emergency Responders must be willing to stay – only if a threat to public safety

H: Drainage Ditches						
GOAL: Maintain a safe, reliable, and efficient transportation infrastructure.	**EVALUATION CRITERIA**					
OBJECTIVE: Improve safety around deep drainage ditches that run alongside roadways within the county	Cost Effectiveness:			Viable? (Y/N)	Acceptable for Community Potential Participants? (Y/N)	Environmental Impact (Positive, Negative, or Neutral)
Range of Alternative Solutions:	(expressed in dollar amounts)					
	Costs ($)	Benefits ($)	Net ($)			
Construct guardrails around drainage ditches that run alongside major roads[1]	3,000,000	unknown	unknown	N	N	Negative
Eliminate drainage ditches that run next to roads.	1,000,000	unknown	unknown	N	N	Positive
Improve program of drain cleaning to improve storm water management capacity.	1,000,000	5,000	(995,000)	Y	N	Positive
Relocate drainage ditches to a safe distance away from the roadway	2,000,000	unknown	unknown	N	N	Negative
Improve roadside shoulders to help prevent drainage ditch accidents	1,000,000	unknown	unknown	N	N	Neutral
Make drainage ditches less deep so that accidents inside them will be more quickly noticed and attended to	1,000,000	unknown	unknown	N	N	Neutral
Do nothing	0	0	0	Y	Y	Neutral
Notes: [1] Rails are more dangerous to drivers than not having rails						

I: Infrastructure Reliability						
GOAL: Maintain a safe, reliable, and efficient sewer and water infrastructure.	**EVALUATION CRITERIA**					
OBJECTIVE: Improve safety and consistency of electrical, gas and water service where applicable.	Cost Effectiveness:			Viable? (Y/N)	Acceptable for Community Potential Participants? (Y/N)	Environmental Impact (Positive, Negative, or Neutral)
Range of Alternative Solutions:	(expressed in dollar amounts)					
	Costs ($)	Benefits ($)	Net ($)			
Work with energy companies to trim trees and brush around power lines, pumping stations, sewer access, etc.	1,000,000	Millions	Millions	Y	Y	Positive
Provide emergency power supply for provision of wells, pump stations and treatment facilities.	Hundreds of Thousands	Millions	Millions	Y	Y	Positive
Promote knowledge of MISS DIG, and infrastructure presence during construction.	NA	responsibility of the utility		Y	Y	Positive

J: Relocation and Retrofitting						
GOAL: Encourage and aid private hazard mitigation activities including those that protect private property.	**EVALUATION CRITERIA**					
OBJECTIVE: Offer incentives to businesses and individuals to modify existing property, including relocation and retrofitting, to lessen hazard risks.	Cost Effectiveness:			Viable? (Y/N)	Acceptable for Community Potential Participants? (Y/N)	Environmental Impact (Positive, Negative, or Neutral)
Range of Alternative Solutions:	(expressed in dollar amounts)					
	Costs ($)	Benefits ($)	Net ($)			
Offer free installation of additional building fire sprinkler systems	Tens of Thousands	Hundreds of Thousands	Hundreds of Thousands	N	N	Neutral
Offer free fire sprinkler systems to at-risk businesses, including installation	Hundreds of Thousands	Hundreds of Thousands	Variable	N	N	Neutral
Purchase fire sprinkler systems in bulk and offer them to businesses at a discounted rate	Hundreds of Thousands	Hundreds of Thousands	Variable	N	N	Neutral
Offer free fire extinguisher testing and refills for businesses and individuals through municipal fire departments	Hundreds of Thousands	Hundreds of Thousands	Hundreds of Thousands	N	N	Neutral
Provide community guidelines for businesses and individuals seeking to retrofit their property to resist severe wind damage	0	Hundreds of Thousands	Hundreds of Thousands	Y	Y	Neutral

Relocation and Retrofitting (Continued)						
GOAL: Encourage and aid private hazard mitigation activities including those that protect private property.	**EVALUATION CRITERIA**					
OBJECTIVE: Offer incentives to businesses and individuals to modify existing property, including relocation and retrofitting, to lessen hazard risks.	Cost Effectiveness: (expressed in dollar amounts)			Viable? (Y/N)	Acceptable for Community Potential Participants? (Y/N)	Environmental Impact (Positive, Negative, or Neutral)
Range of Alternative Solutions:	Costs ($)	Benefits ($)	Net ($)			
At the request of property-owners, remove trees that could cause property damage if knocked down by severe wind	Hundreds of Thousands	Hundreds of Thousands	Hundreds of Thousands	N	Y	Positive
Offer free inspections of private structures, especially outbuildings which tend to be particularly vulnerable, for wind damage vulnerability, and recommend proper retrofitting actions	Tens of Thousands	Hundreds of Thousands	Hundreds of Thousands	Y	Y	Neutral
Provide snowstorm "survival kits" to residents at a discounted price.	Hundreds of Thousands	Tens of Thousands	(Tens of Thousands)	Y	Y	Neutral
Provide money to retrofit and modify structures repetitively damaged by flooding where possible; where impossible, purchase and eliminate structures	Millions	Tens of Millions	Millions	Y	Y	Positive

K: Well Capping						
GOAL: Encourage and aid *private* hazard mitigation activities including those that protect private property	**EVALUATION CRITERIA**					
OBJECTIVE: Ensure that all new wells in the county are capped and reach a proper depth. Expand awareness of current well-capping programs and improve mapping of uncapped wells	Cost Effectiveness:			Viable? (Y/N)	Acceptable for Community Potential Participants? (Y/N)	Environmental Impact (Positive, Negative, or Neutral)
Range of Alternative Solutions:	(expressed in dollar amounts)					
	Costs ($)	Benefits ($)	Net ($)			
Create well safety awareness advertising campaign including information about free capping program	10,000	50,000	40,000	Y	Y	Neutral
Establish and advertise a free well-water safety testing system	50,000	50,000	0	Y	Y	Positive
Continue enforcement of well-digging policies and standards	0	0	0	Y	Y	Positive

L: Construction Code Enforcement						
GOAL: Encourage and aid *public* hazard mitigation activities including those that protect private property	**EVALUATION CRITERIA**					
OBJECTIVE: Ensure that all new construction in the county is consistent with the County's Master Plan and Zoning ordinances to prevent construction in hazardous or inappropriate locations where structures or infrastructure are likely to be damaged or operate poorly.	Cost Effectiveness:			Viable? (Y/N)	Acceptable for Community Potential Participants? (Y/N)	Environmental Impact (Positive, Negative, or Neutral)
Range of Alternative Solutions:	(expressed in dollar amounts)					
	Costs ($)	Benefits ($)	Net ($)			
Coordinate building permit and well and septic permits with the Emergency Management resources regarding hazardous locations.	0	Millions	Millions	Y	Y	Positive
Review the Master Plan for consistency with hazard avoidance where possible and opportunities to encourage new land development and uses in suitable locations.	0	Millions	Millions	Y	Y	Positive

M: Improve Sewer and Drainage						
GOAL: Reduce losses and damage from repetitive disasters	**EVALUATION CRITERIA**					
OBJECTIVE: Improve drainage and sewer systems to reduce losses and damage from flooding	Cost Effectiveness:			Viable? (Y/N)	Acceptable for Community Potential Participants? (Y/N)	Environmental Impact (Positive, Negative, or Neutral)
Range of Alternative Solutions:	(expressed in dollar amounts)					
	Costs ($)	Benefits ($)	Net ($)			
Expand storm water drains in highly-flood prone areas like Western Caro	Millions	Millions	Variable	Y	Y	Neutral
Thoroughly clean out existing storm drains in all municipalities twice each year	Millions	Millions	Hundreds of Thousands	N	N	Neutral
Purchase drain cleaning equipment to be used throughout the county on a scheduled basis	Millions	Millions	Variable	Y	Y	Neutral
Create countywide PSAs about storm drain pollution, connecting storm drain pollution with property damage	10,000	500,000	490,000	Y	Y	Positive
Impose harsher penalties for illegally polluting storm drains	0	250,000	250,000	Y	Y	Positive
Expand sewer and drainage systems in areas most affected by floods	Millions	Millions	Variable	N	Y	Positive

N: Floodplain Protection						
GOAL: Reduce losses and damage from repetitive disasters	**EVALUATION CRITERIA**					
OBJECTIVE: Prohibit construction in floodplains without proper flood proofing measures.	Cost Effectiveness:			Viable? (Y/N)	Acceptable for Community Potential Participants? (Y/N)	Environmental Impact (Positive, Negative, or Neutral)
Range of Alternative Solutions:	(expressed in dollar amounts)					
	Costs ($)	Benefits ($)	Net ($)			
Hire private engineering firms to provide maps of the floodplain	Hundreds of Thousands	Millions	Hundreds of Thousands	Y	N	Neutral
Encourage all municipalities who have not already done so to join the NFIP and wait for FEMA to conclude its mapping of the region	0	Millions	Millions	Y	N	Neutral

Chapter 4: Mitigation Projects

This plan began by analyzing the risk posed by certain hazards to Tuscola County and identifying which hazards were most important to the county. After selecting hazard mitigation goals and objectives the plan considered a large number of alternatives for accomplishing goals through specific action items. This part of the plan builds on the analysis of alternatives from Chapter 3 to outline more specifically projects for hazard mitigation that will be implemented after the adoption of the plan. The specific jurisdictions that are impacted by each mitigation action are shown in summary in Table 15.

The projects described below are those that were selected by the county as the most relevant for mitigating top hazards. While many alternatives analyzed in Chapter 3 passed all identified evaluation criteria, only those that were preferred by county residents and officials are developed here in complete project form. Limitations of resources including time and money made it necessary to include only a limited number of projects in the initial version of the plan. This list of projects should not be seen as a limitation; indeed, it is expected that in future revisions of this plan new projects will be added, including further development of some of the alternatives suggested in Chapter 3. These projects are not listed is order of priority. The priority is broadly specified as high, medium or low.

Projects are prioritized according to a number of factors including expected impact on county hazard preparedness, availability of funds and partners, and importance to the community. In general, high priority items should be undertaken first, followed by moderate and low priority items. Timeframes are also given for the expected beginning of each project, but these have been left very general to give local officials the flexibility they need to adequately respond to the changing hazard-related needs of the community.

Several projects have been given high priority but are also prohibitively expensive for the county and municipalities to undertake alone. If federal and state grants can be obtained these projects are feasible, but due to the unpredictable and highly competitive nature of the granting procedure these projects can only be undertaken as high priorities after that funding is secured. These projects would have significant impact for countywide hazard preparedness and should therefore be undertaken immediately upon the availability of funds. In the plan, these projects are listed as high priority with the “with funding” caveat.

SMART 911 (GOAL 2)

Cost: $20,000/year

Potential Funding sources: Hazard Mitigation Grant Program, Pre disaster Mitigation Program (especially if outdoor sirens are needed)

Priority: High

Timeframe: Within one year of plan's adoption

Partners: Mass notification provider

Location: Impact is county wide. Action is specific to the Emergency Management Departments the lead agency, partnering with all fire and police agencies.

The impact of nearly every hazard can be lessened if people are warned well enough in advance and given instructions about what actions they need to take. Adequate warning is a challenge in all hazard situations. Mass-warning systems such as sirens have the advantage of being able to reach people throughout an area regardless of what they are doing, but can convey almost no information about the impending hazard or what actions are proper to take. Additionally, these systems are very expensive and could be difficult to maintain. Emergency Broadcast Systems, which interrupt regular radio and television broadcasts with hazard warnings and information, are inexpensive and can effectively communicate hazard response information but can only be used by people who happen to be listening to the radio or watching television at the time. EBS lacks the ability to target the specific area affected by a hazard; they can cause unnecessary anxiety in large areas. Neither system adequately addresses the needs of the county.

Action: The mass notification system is a system that alerts county residents via their telephones. The system is able to call all residents or call only those within a specific area affected by a hazard. County officials can record a message including hazard information and instructions that will be played on phone calls and can be left on answering systems. The system meets Tuscola County's warning needs by both actively contacting residents and providing them with adequate information. It is also significantly less expensive than countywide siren coverage would be. Unlisted numbers and cell phone numbers can be added to the system if they are reported by their owners.

IDENTIFY SPECIAL NEEDS POPULATIONS (GOAL 2)

Cost: $0

Priority: High

Timeframe: Within one year of plan's adoption

Partners: Health Department, Local Hospitals, nursing homes, residents

Location: Impact is county wide. The action may be coordinated by public health officials as the lead agency.

Hazards can have a large effect on all people, but people with special needs are often more acutely affected by hazard events. Whether they have limited mobility, a reliance on mechanical or electrical support systems, or increased physical vulnerability to extreme conditions, special needs populations require additional support during hazards. Unfortunately, records about special needs individuals are neither complete nor coordinated. If a major hazard struck requiring evacuation to a shelter site, it is likely that some people with special needs would be missed and have to weather the disaster unaided.

Action: The County must develop a voluntary registry of people with special needs in order to be able to inform and assist them during hazards. The utmost care must be given to protect the privacy of special needs individuals and to comply with all relevant personal privacy laws. The registry can be used to great advantage in evacuation and shelter situations, and it can also be used in coordination with the Community Alert Network to provide customized messages to people with special needs.

The registry will be maintained at the office of the Emergency Management Director with input from county health officials. Because privacy is of paramount importance, inclusion in the registry must be the voluntary choice of the individual. It is important, however, that individuals are informed of the benefits of inclusion in the registry before they make their decision. A summary of benefits will be prepared by the Emergency Management Director's office and distributed to health workers responsible for obtaining special needs individuals' consent.

See the Emergency Shelter map (Map 25), Senior Housing Facility map (Map 26) and the Emergency Medical Facility map (Map 27).

EDUCATION OF ELECTED OFFICIALS (GOAL 1, 7)

Cost: $150/year

Priority: High

Timeframe: Within one year of plan's adoption

Partners: The Emergency Management office will take the role of the lead agency.

Location: Impact is county wide. Action is located at municipal and county centers.

It is one of the merits of American democracy that the faces of local elected officials are constantly changing as the people exercise their right to choose their own leaders. While this may be good for governance in general it can be bad for hazard planning; newly minted political leaders may be uninformed about the county's hazard mitigation programs and when their constituents look to them for leadership they will be unable to give the best information.

Action: This problem could be solved if all elected officials were made aware of or reminded of the county's hazard mitigation strategy on a regular basis. After each election in the county, within a month of assumption of office, all elected officials (new and incumbent) should be invited to a program that will inform them about hazard mitigation strategies and the special role they play in educating citizens, ensuring public ordinances and plans support hazard mitigation activities and how to lead people in the event of an emergency. This will not only prepare elected officials to serve as leaders during a hazard event but also give them the necessary information to provide to their constituents who are concerned about hazards in the county.

The Emergency Management Director will design the program and invite elected officials to it at appropriate times. Elected officials cannot be required to attend, but any official that is truly concerned about the safety and well being of his or her constituents will surely make this meeting a priority.

REPETITIVE FLOOD DAMAGE MITIGATION (GOAL 4)

Cost: Variable, depending on properties covered

Potential Funding sources: Hazard Mitigation Grant Program, Pre-Disaster Mitigation Program, Flood Mitigation Assistance Program, Repetitive Flood Claims Program, local

matches from private or public or nonprofit organizations (or equivalent soft-match "in kind" contributions)

Priority: High (with funding)

Timeframe: Ongoing

Partners: FEMA, Michigan State Police Emergency Management and Homeland Security, involved property owners, local communities

Location: Various locations; see flood risk analysis, above (pages 36-47)

Although the specific times and locations of flooding events are unpredictable, planners can say with certainty that areas that have been affected by flooding in the past will at some time in the future flood again. Ideally no structures would be built in floodplains in the first place, but the realities of historical development have led for various reasons to construction in areas that are in some cases extremely prone to flooding. Every effort must be made to protect these properties from the repetitive losses associated with flooding, and where such protection should prove impossible the structures must be eliminated. The county must throughout this process be aware of and responsive to property owners' concerns.

Action: For those locations identified by planners as vulnerable to flood damages, it may become possible to protect at-risk structures (including those suffering repetitive losses) by elevating, retrofitting, or relocating them out of harm's way. Alternatives may include the acquisition and removal of structures that are too frequently and heavily damaged to merit further repair or rebuilding.

FLOOD DRAINAGE EXPANSION (GOAL 5)

Cost: Variable, depending on extent of improvements

Potential Funding sources: Hazard Mitigation Grant Program, Pre-Disaster Mitigation Program, Flood Mitigation Assistance Program, Repetitive Flood Claims Program, local matches from private or public or nonprofit organizations (or equivalent soft-match "in kind" contributions)

Priority: High (with funding)

Timeframe: Within one year of securing of funds

Partners: FEMA, Michigan State Police Emergency Management and Homeland Security, involved utility providers and their local communities, area property owners (if easements or land transfers are needed)

Location: Locations identified above as being at risk for flooding due to insufficient drainage; see flooding section of the hazard analysis, above (pages 36-47)

For many areas that suffer damage during flooding, damages are compounded by inadequate drainage systems, which cause floodwaters to linger excessively, overwhelming damage prevention measures and extending the economic costs of the flood. By expanding drainage systems in those areas where such expansion is feasible, damage from flooding will be greatly reduced as floodwaters will recede more quickly, allowing the community to recover and lessening damage from extended exposure to floodwaters.

Action: In those areas identified by planners as vulnerable to flood damages and where study by engineers deems it to be feasible, the county and the appropriate jurisdiction will work to improve drainage and sewer systems by expanding their capacity to handle area waters. It should be noted that the funding sources listed above will cover only the expansion of drainage systems, and that their maintenance and cleaning remains the responsibility of the appropriate jurisdiction.

EMERGENCY POWER SUPPLIES (GOAL 6)

Cost: Variable, depending on extent and type of backup system

Potential Funding sources: Hazard Mitigation Grant Program, Pre-Disaster Mitigation Program, local matches from private or public or nonprofit organizations (or equivalent soft-match "in kind" contributions)

Priority: High (with funding)

Timeframe: Within one year of securing of funds

Partners: FEMA, Michigan State Police Emergency Management and Homeland Security, involved facilities/utilities, property owners, local communities

Location: Locations identified throughout the plan as being at-risk for power failure and that are identified as critical infrastructure, especially those locations that are essential to the survival of the community in the event of a disaster

When hazards occur, the worst damages are not necessarily the direct result of the hazard itself, but happen after a hazard damages critical infrastructure, such as the power supply, thus crippling the community's ability to effectively respond to the emergency and protect the lives of community members. It is therefore essential that critical infrastructure be protected against failure with various backup systems. Since electricity is essential to almost any emergency response, ensuring that all critical infrastructure is equipped with adequate electrical backup systems is a key priority.

Action: For those locations identified as both essential to community hazard response and recovery and that currently lack adequate backup power supplies, such generators and other backup systems as are deemed necessary and adequate will be purchased and/or maintained. The Emergency Management Director will work with local officials to determine which infrastructure is considered most essential and will then contact those in charge of each specific piece on infrastructure to determine backup power needs and capabilities. Once funding has been obtained, the Emergency Management Director will work with on-site staff at identified infrastructure to ensure that backup power systems are purchased and installed as quickly as possible.

COOPERATION WITH UTILITIES (GOAL 3, 5, 7)

Cost: $0 (Volunteer Effort)

Priority: Moderate

Timeframe: Within two years of plan's adoption

Partners: County Residents

Location: The impact is county wide. The Action is located at the emergency responder level and will serve as the lead agency and among volunteer citizens.

While hazards such as downed power lines are dangerous to Tuscola County, the sole responsibility for their repair rests with utility companies. When power lines break, county emergency responders can waste hours simply guarding the hazard and waiting for the central bureaucracies of to dispatch a repair crew. This situation is dangerous and unacceptable. Some utility companies are willing to provide local officials with phone numbers that directly contact decision makers to expedite repairs, while others insist that county emergency responders waste hours of their time calling through a central office computer system used to direct all phone calls. When lives are at risk from downed power lines, county emergency responders should not be expected to spend their valuable time on hold or punching through computerized menus because a utility company is inefficient and insufficiently aware of the public good.

Action: County emergency response officials should request phone numbers for expedited repair service from all utility companies. Those that comply should be commended for their public service, while those that refuse should be pressured to change their policy. In order to apply this pressure, a grassroots effort should be organized in the county to lobby the Public Service Commission to require utilities to provide this information, at the very least to county 911. The campaign must emphasize the dangers of downed power lines and the strain they put on local responders who are powerless to repair them.

Truly effective grassroots efforts must be voluntary, so an *ad hoc* committee of concerned citizens and emergency responders will carry out this project. County residents must be made aware of the dangers of the present situation. When enough residents have committed to the campaign, the case can be taken to the Public Service Commission, which is capable of putting strong pressure on the utilities.

CARO WATER DETENTION (GOAL 5, 6, 7)

Cost: $500,000

Potential Funding sources: Hazard Mitigation Grant Program, Pre disaster Mitigation Program, Flood Mitigation Assistance Program

Priority: Moderate, as funding becomes available

Timeframe: Within two years of plan's adoption

Partners: FEMA, Drain Commissioner, Caro Community Schools (Land Owner)

Location: Impact is in the City of Caro and Indianfields Township. The Action is in the County Drain Commissioner's department as the lead agency.

During heavy rains and snowmelt, water collects in high land to the northwest of the City of Caro and rapidly discharges, flowing throughout the village and causing widespread urban flooding damage.

Action: In order to prevent future damage from this recurring hazard, it must be attacked at the source. To prevent water from flowing down from the high area to the northwest of the city, a series of retention ponds and flow constrictors should be built. These modifications to the land will help store the excessive flows of water that cause flooding in Caro until the water has time to dissipate.

This project will be handled by the Tuscola County Drain Commissioner in cooperation with Caro officials. Surveyors will be employed to determine the optimal location for retention ponds. Because most of the land that requires modification is located on land owned by the Caro Community Schools, it will be necessary to either reach an agreement to make the modifications with the Schools' permission or to purchase the land needed for the ponds. Effort should be made to cooperate with Caro Community Schools in this project, but, should it become necessary, eminent domain would clearly apply in this circumstance.

NATIONAL FLOOD INSURANCE PROGRAM (GOAL 1, 4, 5, 6, 7)

Cost: $0

Priority: Moderate

Timeframe: Within two years of plan's adoption

Partners: FEMA

Location: The impact is in mapped flood areas. The Action is located with the Emergency Management Department as the lead agency and municipal officials to encourage mapping flood areas.

Major floods can cause severe damage that is made worse by their unpredictability. Catastrophic floods are sporadic enough that many communities fail to adequately prepare for them. These communities lack accurate flood maps to predict which areas will be hardest hit by flooding and lack the financial resources to recover from flood damage.

Action: Joining FEMA's National Flood Insurance Program can solve both of these problems. Besides acting as a financial insurance program in the event of a real flooding disaster in insured communities, the NFIP provides the additional benefit of automatic federal flood mapping for all areas that participate in the program. Up-to-date maps of floodplains and other affected areas are invaluable in planning for floods. In particular, they allow a community to identify which structures are at risk.

In order to obtain countywide flood maps, all jurisdictions within the county must register for the NFIP. The Emergency Management Director should help convince jurisdictions of the advantages of doing so and should also aid them in the application process. Once a sufficient number of communities have registered for the program FEMA will be responsible for the mapping process.

HAZARD PREPAREDNESS NEWSLETTER (GOALS 1, 2, 3, 4, 5, 6, 7)

Cost: $500

Priority: Moderate

Timeframe: Within two years of plan's adoption

Partners: The Emergency Management Director will serve as the lead agency.

Location: Impact is county Wide. The Action through available distribution channels, newspapers, direct mail, public postings.

No matter how many hazard preparedness services a community offers to its residents, the preparation is mostly useless if residents remain unaware of available services. Even today, lack of awareness is a problem in Tuscola County as current hazard mitigation services are underutilized. If the county is going to invest substantial resources in some of the projects described in this plan residents must be made aware of their availability.

Although many options exist for advertising the services available in Tuscola County a newsletter is one of the most efficient and cost-effective options. A newsletter could include descriptions of hazard prevention programs and services, advice for personal hazard preparedness, and phone numbers and other contact information for county officials concerned with hazard mitigation. Cost of publication could be very low, and distribution could be handled in a number of ways; direct mailing would probably be most effective, but distribution with county newspapers or at county buildings are other options. It is important that the newsletter be simple, direct, and interesting to be of maximum utility to county residents.

The office of the Emergency Management Director will be ultimately responsible for publication and distribution of the newsletter, but anyone concerned with hazard mitigation is encouraged to offer articles or information.

HAZARD PAMPHLETS (GOAL 1, 2, 3, 4, 5, 6, 7)

Cost: $10,000

Priority: Low

Timeframe: Within three years of plan's adoption

Partners: Doctors' Offices, Churches, Civic Organizations, Fire Departments will serve as the lead agency

Location: Impact is county wide. The Action is varied and relies on multiple parties in multiple locations.

It is an unfortunate reality of hazard mitigation that people tend not to think about hazard preparation until it is too late. It is of great importance for hazard mitigation that individuals prepare themselves and their families for hazards, and to do so they need information. It is unlikely that individuals will seek out this information on their own, but if they encounter it in other situations in the county they will probably show an interest.

Action: The best way to passively provide this information to a large number of residents at various county functions is to prepare a pamphlet about personal and family hazard preparedness. The pamphlet will be distributed to doctors' offices, churches, civic organizations, and other important bodies within the county who can in turn offer the pamphlet to their members at their already planned functions.

The pamphlet should be oriented to personal hazard preparedness: what supplies to keep, what plans to have, etc. It should be engaging and easy to follow. Above all, it must emphasize the crucial role played by the individual in the county's overall mitigation strategy.

The Emergency Management Director will oversee design, publishing, and distribution of the pamphlet. All county businesses that serve the public and all county organizations that attract a large and diverse portion of the citizenry will be encouraged to distribute copies of the pamphlet.

Table 21: Summary of Mitigation Project Impact by Location

Chapter 5: Implementation and Maintenance

IMPLEMENTATION

This plan will be implemented through cooperation between county and municipal governments. The Master Land Use Plan, County Planning Commission and staff, local police and fire departments, other emergency responders, county agencies, utilities, public works and municipal officials will integrate applicable parts of the plan into their planning and response documentation. Conversely, the Tuscola Hazard Mitigation Plan will incorporate applicable portions of any dam safety plans, the Master Plan and Flood Preparedness Plan into its text as they are prepared or updated. The Master Plan, a key factor in planning for emergencies, was updated in 2002 and includes excellent maps and resources. The Tuscola County Department of Homeland Security and Emergency Management will also receive a copy of the plan to amend to their existing hazard planning protocol. The projects described in the plan will be implemented by the means described in Chapter 4.

MAINTENANCE AND MONITORING

Primary responsibility for monitoring the progress of implementation of this plan will lie with the Emergency Management Director. The Emergency Management Director will work to ensure that all relevant local bodies and agencies are aware of their responsibilities in implementing the plan and are carrying out those responsibilities. The Emergency Management Director must also remain open to the concern of those bodies and citizens as the plan is implemented as to the effectiveness of the measures being carried out and if there are any unforeseen undesirable consequences to aspects of the plan's implementation. As the plan is implemented, the Emergency Management Director and the various implementing bodies should make every effort to keep local officials and the general public appraised of the progress of the plan's implementation, which will encourage public participation in and awareness of the measures being taken to reduce hazard risks. It is recognized that a large degree of flexibility is demanded by the unpredictable nature of hazard planning, but the Emergency Management Director should make every effort to see that this plan is carried out in a timely manner.

In an effort to ensure that the Tuscola County Hazard Mitigation Plan remains useful and current, the Emergency Management Department will update the Plan contents as needed. At least once each year the Plan will be reviewed by a subset of the members of the Hazard Planning Committee to determine if additional changes need to be made. This process also serves as an introduction to the Plan for staff that may use the document but were not on the Planning Committee or possibly not yet involved with emergency preparedness when the Plan was written.

The Hazard Mitigation Planning Committee will be called together to conduct a formal review and update of the Plan at least every five years. Updating will include all aspects

of the plan, particularly in areas where there were hazard events in the last five years. Mitigation options and opportunities will also be reviewed and updated.

The criteria used to evaluate the plan will include a determination regarding whether the nature or seriousness of hazards has changed, the status of hazard mitigation projects, if priorities have changed among the hazards or communities, and changes in demographics and density that impact hazard mitigation issues.

The Plan is intended to be a fluid document, meaning one that is used regularly and is able to be changed to respond to current needs. Many items listed in the implementation portion of the plan are intended to be carried out through existing programs where funding and staffing permit. Priorities may change over time as will the proposed implementation strategies.

Continued public involvement will be encouraged by making the Plan available on the County's web site and holding an open house to explain and inform the public, neighboring communities, schools and businesses of the contents of the Plan in years when formal updates take place. This forum could be similar to the public meetings held during the writing of the current Hazard Mitigation Plan. The Plan will be accessible digitally on the county's website as well as in print at the County Clerk's office, the Emergency Management office and the County Planning Department. Municipalities will be encouraged to make copies available to their residents or give them information on how to contact the Emergency Management office to view or purchase a copy.

Appendix A: Assessment of Hazard Risks

Table 22 Assessment of Hazard Risks for Tuscola County

Hazard	Occurrence Probability (30%)	Warning Time (15%)	Local Capability (20%)	Property & Pop Affected (25%)	Economic Impact (10%)	Weighted Total (100%)
Snowstorms	4.50	4.20	3.89	4.09	2.89	4.07
Thunderstorms	4.17	4.10	3.67	3.45	2.44	3.71
Ice and Sleet Storms	3.75	4.10	3.44	3.82	3.00	3.68
Sever Wind	3.75	4.00	3.56	3.73	2.89	3.66
Extreme Temperatures	3.33	4.60	3.00	3.55	2.44	3.42
Fire Hazards - Structure Fires	4.08	1.11	4.56	2.36	2.33	3.13
Drought	2.67	4.22	2.33	3.36	3.56	3.10
Lightning	3.42	3.70	3.00	2.64	1.89	3.03
Tornadoes	2.50	3.20	3.67	2.82	3.33	3.00
Riverine Flooding/Erosion	3.25	3.30	2.67	2.73	2.78	2.96
Hail	2.92	3.60	2.89	2.82	2.33	2.93
Infrastructure Failure - Water, Sewer, Electrical, Communications	2.91	1.75	3.13	3.20	3.25	2.89
Public Health Emergencies	2.64	2.38	3.13	3.10	2.75	2.82
Fog	2.83	3.20	2.67	3.00	1.33	2.75
Wildfires	2.83	2.22	3.56	2.36	2.44	2.73
Invasive Species	2.67	3.00	1.67	2.45	3.00	2.50
Shoreline Flooding/Erosion	2.75	3.10	2.22	1.82	2.11	2.40
Hazardous Materials Incidents - Transportation Incidents	2.55	1.25	3.75	1.90	2.00	2.38
Energy Emergencies	2.20	1.75	1.75	3.20	2.88	2.36
Catastrophic Incident	1.22	1.00	2.29	3.44	4.14	2.25
Civil Disturbances	1.50	2.57	3.71	1.78	2.00	2.22
Air, Land, and Water Discharges from Regulated Facilities	2.18	1.75	2.25	2.60	1.57	2.17
Petroleum and Natural Gas Pipeline Accidents	1.75	1.22	3.22	2.09	2.67	2.14
Transportation Accidents - Air, Land, and Water	2.25	1.00	3.00	1.90	2.38	2.14
Point Source Air Emissions from Regulated Facilities	1.82	1.63	2.13	2.90	1.75	2.11
Impaired Waters	2.10	1.86	2.29	2.00	2.29	2.09
Oil and Gas Storage Facilities and well Accidents	1.67	1.67	3.00	1.82	2.44	2.05
Earthquakes	1.08	1.11	2.22	2.91	3.78	2.04
Underground Storage Tanks	2.17	1.56	2.67	1.64	1.89	2.01
Fire Hazards - Scrap Tires	1.42	1.22	3.67	1.64	2.33	1.98
Dam Failure	2.00	1.88	1.63	2.00	2.63	1.97

Nuclear Attack	1.10	1.00	1.00	3.11	4.43	1.90
Terrorism	1.45	1.00	2.38	2.00	2.75	1.84
Nuclear Power Plant Accidents	1.00	1.14	1.43	2.22	2.57	1.57
Celestial Impact	0.90	1.25	1.13	2.10	3.00	1.51
Land Subsidence	1.29	1.40	2.00	1.43	1.40	1.49

Appendix B: Pollutant Descriptions

Heavy Metals

Antimony is a silvery-white metal that is found in the earth's crust. Antimony ores are mined and then mixed with other metals to form antimony alloys or combined with oxygen to form antimony oxide. Antimony is alloyed with lead to increase lead's durability. Antimony alloys are also used in batteries, low friction metals, type metal and cable sheathing, among other products. Antimony compounds are used to make flame-proofing materials, paints, ceramic enamels, glass and pottery. Exposure to antimony occurs in the workplace or from skin contact with soil at hazardous waste sites. Breathing high levels of antimony for a long time can irritate the eyes and lungs, and can cause problems with the lungs, heart, and stomach.

Chromium is often used in the make of steel or for chrome plating, dyes pigments and wood preserving. In the atmosphere, chromium compounds are generally present as a fine dust that eventually settles on land and water. The EPA considers chromium a Priority Pollutant and Hazardous Air Pollutant.

Copper is a metal that occurs naturally in the environment, and also in plants and animals. Low levels of copper are essential for maintaining good health. High levels can cause harmful effects such as irritation of the nose, mouth and eyes, vomiting, diarrhea, stomach cramps, nausea, and even death. Copper is released into the environment by mining, farming, and manufacturing operations and through waste water releases into rivers and lakes. Copper is also released from natural sources, like volcanoes, windblown dusts, decaying vegetation, and forest fires. The EPA considers copper a Priority Pollutant and Hazardous Air Pollutant.

Lead is an element that the EPA has regulated since 1978. Lead gasoline additives, non-ferrous smelters, and battery plants are the most significant contributors to atmospheric Pb emissions. Exposure to lead can happen from breathing workplace air or dust, eating contaminated foods, or drinking contaminated water. Children can be exposed from eating lead-based paint chips or playing in contaminated soil. Lead can damage the nervous system, kidneys, and reproductive system. The EPA's long term goal is to reduce lead exposure to the fullest extent possible. The EPA considers lead a Priority Pollutant and Hazardous Air Pollutant.

Manganese is a trace element and eating a small amount from food or water is needed to stay healthy. Exposure to excess levels of manganese may occur from breathing air, particularly where manganese is used in manufacturing, and from drinking water and eating food. At high levels, it can cause damage to the brain, liver, kidneys, and the developing fetus. Manganese can also be combined with carbon to make organic manganese compounds. It enters the air from iron, steel and power plants, coke ovens and mining operations.

Nickel is a naturally occurring element. Pure nickel is a hard, silvery-white metal used to make stainless steel and other metal alloys. It enters the atmosphere through oil and coal burning power plants and manufacturing processes that make or use nickel, nickel alloys or nickel compounds. Skin effects are the most common effects in people who are sensitive to nickel. Workers who breathed very large amounts of nickel compounds developed chronic bronchitis and lung and nasal sinus cancers.

Hazardous Air Pollutants and Volatile Organic Compounds

Ammonia is found throughout the environment in the air, soil, and water, and in plants and animals including humans. Exposure to high levels of ammonia can cause irritation and serious burns on the skin and in the mouth, throat, lungs, and eyes. At very high levels, ammonia can even cause death.

Hydrochloric Acid is used in the production of chlorides, fertilizers, and dyes, in electroplating, and in the photographic, textile, and rubber industries. Hydrochloric acid is corrosive to the eyes, skin, and mucous membranes. Acute (short-term) inhalation exposure may cause eye, nose, and respiratory tract irritation and inflammation and pulmonary edema in humans. Acute oral exposure may cause corrosion of the mucous membranes, esophagus, and stomach and dermal contact may produce severe burns, ulceration, and scarring in humans. Chronic (long-term) occupational exposure to hydrochloric acid has been reported to cause gastritis, chronic bronchitis, dermatitis, and photosensitization in workers. Prolonged exposure to low concentrations may also cause dental discoloration and erosion. Hydrochloric acid is considered a hazardous air pollutant under the 1990 Clean Air Act.

n-Hexane is mixed with solvents for a number of uses. Inhaling n-hexane causes nerve damage and paralysis of the arms and legs. Some people abuse products containing n-hexane by inhaling it to get "high." n-Hexane enters the environment during is manufacture and use.

Methanol is commonly used as a solvent in industrial applications. Methanol is considered a hazardous air pollutant under the 1990 Clean Air Act. It is also a volatile organic compound.

Phenol is both a manufactured chemical and a natural substance. Phenol is used as a disinfectant and is found in a number of consumer products. Skin exposure to high amounts can produce skin burns, liver damage, dark urine, irregular heartbeat, and even death. Ingestion of concentrated phenol can produce internal burns. The EPA lists phenol as Priority Pollutant and Hazardous Air Pollutant.

Other Wastes and Pollutants

4,4'-Isopropylidenediphenol comes in the form of white flakes or crystals. Its primary use, or 53% of its total, is for epoxy resins; 31% is used as a chemical intermediary for polycarbonate resins; and 16% is used in miscellaneous applications, including as a chemical intermediary for phenoxy and polysufone resins. It is also used as a fungicide, and in the manufacturing of flame retardants and rubber chemicals. Solid 4,4'-isopropylidenediphenol is irritating to the skin and eyes; the dust is irritating to upper respiratory passages. The most probable routes of human exposure are inhalation and dermal contact of workers involved in the manufacture, use, transport, or packaging of the chemical.

Acetaldehyde is mainly used as an intermediate in the synthesis of other chemicals. It is ubiquitous in the environment and may be formed in the body from the breakdown of ethanol. Acute (short-term) exposure to acetaldehyde results in effects including irritation of the eyes, skin, and respiratory tract. Symptoms of chronic (long-term) intoxication of acetaldehyde resemble those of alcoholism. Acetaldehyde is considered a probable human carcinogen (Group B2) based on inadequate human cancer studies and animal studies that have shown nasal tumors in rats and laryngeal tumors in hamsters.

Acrolein is a colorless or yellow liquid with a disagreeable odor. It dissolves in water very easily and quickly changes to a vapor when heated. It also burns easily. Small amounts of acrolein can be formed and can enter the air when trees, tobacco, other plants, gasoline, and oil are burned. Acrolein is used as a pesticide to control algae, weeds, bacteria, and mollusks. It is also used to make other chemicals. Exposure to acrolein occurs mostly from breathing it in air. Acute (short-term) inhalation exposure may result in upper respiratory tract irritation and congestion.