Chapter 2

Hazard Analysis

Hazard Analysis

In this chapter the hazards that Luce County is most susceptible to are discussed. Descriptions of some of the major hazards are included. Information on hazard history is included where that information was available. A short description of the technological hazards is included although this Plan is concentrating mainly on the natural hazards as many of the technological hazards described are due to the natural hazards that affect the County.

Transportation Accidents/Hazardous Materials Transportation Accidents

Transportation

Land Transportation Accidents

A land transportation accident in Luce County could involve a local public transit bus, a school bus, recreational vehicles, or a train. Although these modes of land transportation have a good safety record, accidents do occur. Typically, the bus slipping off a roadway in inclement weather, or colliding with another vehicle causes bus accidents. 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.

Luce County has hundreds of miles of recreational trails used by both non-motorized and motorized vehicles. Accidents in remote areas with lack of communication capability or location identification can make it difficult on the emergency response team.

Historical: Most recently in summer of 2004 a car collided with a train in the Village of Newberry. There was serious injury to the conductor and damage to the vehicles.

Vulnerable Areas: Highway M-28, Highway M-123, Railroad corridor and spur, recreational trails.

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 or radioactive materials; and 5) providing crash site security, crowd and traffic control, and protection of evidence.

Vulnerable Areas: Luce Co. Airport

Water Transportation Accidents

A water transportation accident could have significant life safety consequences. With the many rivers and Lake Superior as the northern border, Luce County is susceptible to water transportation accidents with the many recreational users of this natural resource.

In the past year January through December, 2004 the Coast Guard was involved in 140 cases of Search and Rescue (group wide) (58 cases handled by Station SSM), 181 Waterway Restrictions which is any incident (fog, snow, ice) which forces a commercial vessel to stop and that action delays the movement of any other vessel(s), 5 Groundings, 2 Collisions, and 13 Vessel Casualties (loss of engine, steering, gyro).

The one commonality all transportation accidents share – whether air, land or water-based – is that they can result in mass casualties. Air transportation accidents, in particular, can result in tremendous numbers of deaths and injuries and major victim identification and crash scene management problems. Water transportation accidents, on the other hand, may require a significant underwater rescue and recovery effort that few local jurisdictions may be equipped or trained to handle.

Vulnerable Areas: Lake Superior, Manistique Lake, North Manistique Lake, Muskallonge Lake, Tahquamenon River, Two Hearted River

Hazardous Materials Transportation Accident

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. Local and state emergency responders and hazardous material response teams usually effectively deal with a small hazardous material transportation accident. Larger incidents, however, pose a whole new set of problems and concerns for the affected community. Large-scale or serious hazardous material transportation incidents that involve a widespread release of harmful material (or have the potential for such a release) can adversely impact the life safety and/or health and well-being of those in the immediate vicinity of the accident site, as well as those who come in contact with the spill or airborne plume. In addition, damage to property and the environment can be severe as well. Statistics show almost all hazardous material transportation incidents are the result of an accident or other human error. Rarely are they caused simply by mechanical failure of the carrying vessel.

Having a northern border on Lake Superior, one of the most dangerous hazardous material transportation accident scenarios that could occur in Luce County would be a spill or release of oil, petroleum or other harmful materials into one of the lakes from a marine cargo vessel. Such an incident, if it involved a large quantity of material, could cause environmental contamination of unprecedented proportions. Fortunately, the Great Lakes states, working in partnership with oil and petroleum companies and other private industry, have taken significant steps to ensure that a spill of significant magnitude is not likely to occur on the Great Lakes.

Fixed Site – Hazardous Material Incidents

Hazardous materials are present in quantities of concern in business and industry, agriculture, universities, hospitals, utilities, and other facilities in our communities. Hazardous materials are materials or substances that because of their chemical, physical, or biological nature pose a potential risk to life, health, property, or the environment if they are released. Examples of hazardous materials include corrosives, explosives, flammable materials, radioactive materials, poisons, oxidizers, and dangerous gasses.

Hazardous materials are highly regulated by federal and state agencies to reduce risk to the general public and the environment. Despite precautions taken to ensure careful handling during the manufacture, transport, storage, use, and disposal of these materials, accidental releases do occur. Often, these releases can cause severe harm to people or the environment if proper mitigation action is not immediately taken.

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

Potential Losses: With any accident there is there is the cost of emergency response, the potential loss of life, most probably property damage and loss of function. An accident on the Lakes may cause environmental contamination. Transportation accidents may cause a re-routing of traffic and hazardous material/pipeline accidents would also cause loss of function.

Vulnerable Areas: Highways M-28, M-123; Railroad corridor and spurs, industrial park

Infrastructure Failures

Citizens are dependent on the 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.

These are just some examples of the types of infrastructure failures that can occur, and all of these situations can lead to disastrous public health and safety consequences if immediate mitigation actions are not taken.

Historical Events: Luce County has had numerous widespread and severe electrical power outages and telephone/communications disruptions, caused mostly by severe weather such as windstorms or ice and sleet storms and are discussed more under those categories. However, damage has also been known to occur by man with construction equipment cutting underground lines. Other infrastructures such as water and sewer lines are damaged due to extreme temperatures or ground heaving. The transportation network is always affected by the heaving movement of frozen ground and must be attended to each spring.

Frequency: Luce County can expect power/communication outages possibly numerous times a year usually due to severe weather conditions. Freezing ground is also expected annually.

Safety: Typically, it is the most vulnerable members of society (i.e., the elderly, children, impoverished individuals, and people in poor health) that 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.

Health: When the water or wastewater treatment systems in a community are inoperable, serious public health problems 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.

Buildings: During cold weather months, homes that rely on electric for heat are more vulnerable.

Critical Facilities: Hospitals, emergency response facilities, shelters should all have back-up power capabilities.

Economic Impact: Loss of infrastructure has a great economic impact on all area businesses and people within the County.

Potential Losses: Depending on the situation loss of infrastructure such as electric power can affect area businesses due to having to close. Citizens may experience loss of heat, which may lead to frozen pipes and damage if power outage occurs during the cold months for an extended period of time. In warmer months an extended power outage could result in loss of food and business. Damage caused by heaving to the road system can be very costly to repair, in some cases whole sections of the road must be re-built.

Vulnerable Areas: Areas of population dependent infrastructure, Village of Newberry, Pentland Township.

Thunderstorms/High Wind/Lightning/Hail

Thunderstorms are most likely to happen in the spring and summer months and during the afternoon and evening hours but can occur year-round and at all hours. The biggest threats from thunderstorms are flash flooding and lightning. In most cases, flash flooding occurs in small drainage areas where water quickly accumulates before it drains to the flood plains. When taken together, these local drainage problems can be as great a problem as over bank flooding.

Lightning, which occurs during all thunderstorms, can strike anywhere. Generated by the buildup of charged ions in a thundercloud, the discharge of a lightning bolt interacts with the best conducting object or surface on the ground. The air in the channel of a lightning strike reaches temperatures higher than 50,000°F. The rapid heating and cooling of the air near the channel causes a shock wave which produces thunder.

Other threats from thunderstorms include downburst winds, **high winds**, **hail** and **tornadoes**. Downburst winds are strong, concentrated, straight-line winds created by falling rain and sinking air that can reach speeds of 125 mph (200 km/h).

Hailstones are ice crystals that form within a low-pressure front due to warm air rising rapidly into the upper atmosphere and the subsequent cooling of the air mass. Frozen droplets gradually accumulate on the ice crystals until, having developed sufficient weight, they fall as precipitation. The size of hailstones is a direct function of the severity and size of the storm. Significant damage does not result until the stones reach 1.5 inches in diameter, which occurs in less than half of all hailstorms.

The National Weather Service classifies a thunderstorm as severe if its winds reach or exceed 58 mph, produces a tornado, or drops surface hail at least 0.75 inch in diameter. Compared with other atmospheric hazards such as tropical cyclones and winter low-pressure systems, individual thunderstorms affect relatively small geographic areas. The average thunderstorm system is approximately 15 miles in diameter (75 square miles) and typically lasts less than 30 minutes at a single location. However, weather monitoring reports indicate that coherent thunderstorm systems can travel intact for distances in excess of 600 miles.

Historical Events: During the period January, 1950 through April, 2004 the National Weather Service recorded 21 Thunderstorms/High Wind events and 11 Hail events that affected Luce County.

On the 23rd anniversary of the 1975 storm that sank the Edmond Fitzgerald on Lake Superior, a deep low-pressure system (central pressure 28.41 inches of mercury) developed over the central plains and tracked northeast across western Lake Superior. Strong winds spread over Michigan's Upper Peninsula with sustained speeds of 30 to 40 mph and gusts as high as 87 mph. The Ontonagon County Road Commission recorded a gust of 94 mph. Damage was reported across the region with business signs blown down and roofs damaged as well as damage to homes, vehicles, utility poles, power lines and transformers from falling trees and branches. The strong winds even blew away a city's holiday decorations. Widespread power outages were reported due to downed trees and limbs across power lines. Some residents in rural areas of Delta

and Schoolcraft counties were without power for up to three days following the storm as power companies struggled to clear downed trees and repair broken lines. Beach erosion due to 8 to 15 foot waves was reported along the western Lake Superior shoreline and on the north shore of Lake Michigan. The U.S. Forest Service reported that at least 10 million dollars worth of timber was lost in the Ottawa and Hiawatha National Forests. Property damage was reported to be $450,000.

A deep low-pressure center north of Lake Superior moved slowly east with strong northwest winds blowing across Lake Superior and northern Upper Michigan. Winds of 30 to 40 knots with gusts up to as high as 67 knots were reported. There were numerous reports of local power and telephone outages caused by limbs and trees blown down across power and phone lines in the counties along Lake Superior. Downed trees blocked roads near Eagle Harbor. Fourteen-foot waves caused minor shoreline erosion in a few locations along the western shoreline of the Keweenaw Peninsula from Ontonagon to Copper Harbor. Twenty-foot waves pounded the shores of Lake Superior from east of Munising to Whitefish Point with minor beach erosion and shoreline flooding in a few locations. Over $20,000 was reported in property damage with $2,000 reported in crop damage.

On the afternoon of May 17, 2001, 6 to 8 inch diameter trees were downed by a cold front moving east across Upper Michigan that produced severe thunderstorms with hail and high winds over the eastern Upper Peninsula and over eastern Lake Superior.

A line of severe thunderstorms with damaging winds crossed the northern counties of Upper Michigan on the morning of August 8, 2001. The thunderstorms developed ahead of a warm front and produced wind gusts in excess of 60 mph. There were numerous reports of downed trees as the squall line quickly moved east. Several 20-inch diameter trees blown down across County Road 438.

Widespread severe thunderstorms struck Upper Michigan on August 1, 2002 as a strong surface low-pressure center moved northeast into Ontario and its attendant warm and cold fronts interacted with a warm, moist and unstable air mass over the northwest Great Lakes. A 60 mph wind gust broke off a 16-inch diameter tree branch that fell on a motor home. Thunderstorms first developed in Upper Michigan during the pre-dawn hours over the west, then continued off and on through the day before exiting Luce and Schoolcraft Counties late in the afternoon. There were numerous reports of wind damage, large hail, and torrential flooding rains. Wind gusts estimated as high as 80 mph near Houghton peeled a roof off a warehouse, overturned a truck, and downed numerous trees and power lines. One thunderstorm bombarded Escanaba with golf ball-sized hail and dropped enough rain to inundate the intersection of US-2, M-35, and US-41 with a foot of water. Nearby Gladstone measured 2.06 inches of rain...and Wetmore in Alger County logged 2.40 inches in a short time.

On October 19, 1995 a mobile home southwest of McMillan was reported to have minor hail damage. On July 7, 2003 hail 2 1/2 inches in diameter was reported near the shore at Two Hearted.

Frequency: The Luce County area averages 20 to 30 thunderstorms events each year. 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.

It is estimated that only five storms each year have the hailstorms and high winds to be considered a severe thunderstorm. Assuming the average severe storm affects 100 square miles, the odds of a severe thunderstorm hitting any particular square mile in Luce County are 2 to 1 or about 200 percent.

Safety: The threat to life varies by the cause of death. Toppling trees, debris in roadways can cause potential accidents. Downed power lines and lightning are potential killers.

Health: No special health problems are attributable to thunderstorms, other than the potential for tetanus and other diseases that arise from injuries and damaged property.

When lightning strikes a human being, serious burns or death are the common outcomes. For every person killed by lightning, three people are injured. For those who survive their injuries can lead to permanent disabilities. Seventy percent of the survivors suffer serious long-term effects, such as memory loss, sleep disorders, depression, and fatigue.

Buildings: As with tornadoes, mobile homes are at a high risk to damage from thunderstorms. Wind and water damage can result when windows are broken by flying debris or hail. Lightning can cause direct damage to structures (especially those without lightning protection systems) and can cause fires that damage forests and structures.

Hail can inflict severe damage to roofs, windows and siding, depending on hailstone size and winds.

Critical Facilities: Critical facilities are susceptible to the same damage and disruption from thunderstorms as other buildings. Emergency operations can be disrupted as thunderstorms and lightning affect radio communications and antennas are a prime target for lightning.

Economic Impact: Thunderstorms, flash flooding, wind and hail can all (or separately) destroy crops in the field. Long stemmed vegetation, such as corn and wheat, is particularly vulnerable to hail. Winds greater than 39 miles per hour can damage crops during the growing season. Lightning is one of the major causes of forest fires. Fortunately, these impacts are relatively localized.

Thunderstorms can impact transportation and utilities. Airplanes have crashed when hit by downbursts or lightning. Automobiles and their windshields are subject to damage by hail.

Power lines can be knocked out by lightning or knocked down by wind and debris. Lightning can also cause power surges that damage appliances, electronic equipment and computers.

Potential Losses: Power outages, power surges, damages from wind and hail could create potential loss of function and property damage. Emergency response may be required and there is a potential for casualties.

Vulnerable Areas: The whole county can be affected by the weather. Heavily treed areas, communication towers, power facilities are more vulnerable to damage.

Tornadoes

A tornado is a swirling column of air extending from a thunderstorm to the ground. Tornadoes can have wind speeds from 40 mph to over 300 mph. A majority of tornadoes have wind speeds of 112 mph or less. Tornadoes in Michigan are most frequent in the spring and early summer when warm, moist air from the Gulf of Mexico collides with cold air from the polar regions to generate severe thunderstorms.

Debris hurled by the wind can hit with enough force to penetrate walls. Tornadoes create localized low-pressure areas that can make a building explode. Window, chimneys and roofs are the most vulnerable parts of building to tornado damage.

Tornadoes can move forward at up to 70 mph, pause, slow down and change directions. Most have a narrow pat, less than 100 yards wide and a couple of miles long. However, damage paths can be more than 1 mile wide and 50 miles long.

The northern Michigan tornado season runs from March into October with the most active period occurring during June and July. The most active time of the day for tornadoes is during the late afternoon and early evening.

The Fujita Scale of Tornado Intensity

F-Scale Number	Intensity Descriptor	Wind Speed (mph)	Type/Intensity of Damage
F0	Gale tornado	40-72	Light damage. Some damage to chimneys; breaks branches off trees; pushes over shallow-rooted trees; damages sign boards.
F1	Moderate tornado	73-112	Moderate damage. The lower limit is the beginning of hurricane wind speed; peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos pushed off the roads; attached garages may be destroyed.
F2	Significant tornado	113-157	Considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars pushed over; large trees snapped or uprooted; light object missiles generated.
F3	Severe tornado	158-206	Severe damage. Roof and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted; heavy cars lifted off ground and thrown.
F4	Devastating tornado	207-260	Devastating damage. Well-constructed houses leveled; structures with weak foundations blown off some distance; cars thrown and large missiles generated.
F5	Incredible tornado	261-318	Incredible damage. Strong frame houses lifted off foundations and carried considerable distances to disintegrate; automobile-sized missiles fly through the air in excess of 100 meters; trees debarked; steel reinforced concrete structures badly damaged; incredible phenomena will occur.
F6	Inconceivable tornado	319-379	These winds are very unlikely. The area of damage they might produce would be unrecognizable.

NOTE: When describing tornadoes, meteorologists often classify the storms as follows: F0 and F1 - weak tornado; F2 and F3 - strong tornado; F4 and F5 - violent tornado (Source: The Tornado Project; Storm Data, National Climatic Data Center)

Historical Events: According to the National Weather Service during the time frame of 1950-2002 Luce County has experienced two tornadoes. In August, 1977 a F1 tornado was reported to have caused $25,000 in property damage. A smaller tornado hit in May, 1983 causing about $300 in property damage.

Frequency: With two occurrences over 52 years, the likelihood of a tornado hitting somewhere in the county is about 3.85 percent in any given year. Assuming a tornado affects one square mile and there are 910 square miles in Luce County, the odds of a tornado hitting any particular square mile in the County is 1 in 23,636 each year or a 0.0001 percent chance.

Safety: Although tornadoes in Luce County did not kill anyone, tornadoes are still killers. The residents in mobile homes are at greatest risk. There is one mobile home park within Luce County.

Health: The major health hazard from tornadoes is physical injury from flying debris or being in a collapsed building or mobile home. Based on national statistics for 1970-1980, for every person killed by a tornado, 25 people were injured and 1,000 people received some sort of emergency care.

Within a building, flying debris or missiles are generally stopped by interior walls. However, if a building has no partitions any glass, brick or other debris blown into the interior is life threatening. Following a tornado, damaged buildings are a potential health hazard due to instability, electrical system damage, and gas leaks. Sewage and water lines may also be damaged.

Building Damage: Although tornadoes strike at random, making all building vulnerable, three types of structures are more likely to suffer damages:

1. Mobile Homes
2. Homes on crawlspaces (more susceptible to lift), and
3. Buildings with large spans, such as airplane hangers, gymnasiums and factories.

Structures within the direct path of a tornado vortex are often reduced to rubble. However, structures adjacent to the tornadoes path are often severely damaged by high winds flowing into the tornado vortex, known as inflow winds.

Critical Facilities: Because a tornado can hit anywhere in the County, all critical facilities are susceptible to being hit. Schools are a particular concern, though for two reasons:

1. They have a large number of people present, either during school or as a storm shelter, and
2. They have large span areas, such as gyms and theaters.

Economic Impact: The major impact of a tornado on the local economy is damage to businesses and infrastructure. A heavily damaged business, especially one that was barely making a profit, often has to be closed.

Infrastructure damage is usually limited to above ground utilities, such as power lines. Damage to utility lines can usually be repaired or replaced relatively quickly.

Damage to roads and railroads is also localized. If it can't be repaired promptly, alternate transportation routes are usually available.

Public expenditures include search and rescue, shelters, and emergency protection measures. The large expenses are for repairs to public facilities and clean up and disposal of debris. Most public facilities are insured, so the economic impact on the local treasury may well be small.

Clean up and disposal can be a larger problem, especially with limited landfill capacity near the damage site.

Potential Losses: Property damage and loss of function are potential losses as well as emergency response and casualties.

Vulnerable Areas: Depending upon the area the tornado was to touch down the entire County would be vulnerable.

Fires – Wildfires

A wildfire is an uncontrolled fire in forested areas, grass or brushlands. The most immediate dangers from wildfires are the destruction of homes and timber, wildlife, and injury or loss of life to persons who live in the affected area or who are using the recreational facilities in the area. Long-term effects can be numerous and include scorched and barren land, soil erosion, landslide/mudflows, water sedimentation, and loss of recreational opportunities.

Forests cover the largest area in Luce County covering almost half the County. The forest cover is good for both industry and recreation. However, it also makes many areas of the county potentially vulnerable to wildfires. Most Michigan wildfires occur close to where people live and recreate, which puts people, property and the environment at risk. Development in and around rural forested areas often increases the potential for loss of life and property from wildfires.

Areas of pine located in northern Luce County present the biggest threat for wildfire. Combination of dry seasons and influx of campers, the potential for wildfires in this area can be extremely high. Luce County relies on volunteer fire fighters from the Columbus Township Fire Department, the Village of Newberry and also the Department of Natural Resources. Due to the rural nature of the area, many places may not be easily reached. (See Map 11 – Wildfire/High Risk Area)

The MDNR Forest Management Division directs and coordinates wildfire prevention, containment and suppression activities on all non-federal lands in the state, as well as Indian Reservations (under contract with the U.S. Bureau of Indian Affairs). The MDNR places great emphasis on wildfire prevention and public education, since the vast majority of wildfires in Michigan are caused by human activity. The MNDR Forest Management Division's philosophy is that preventing fires from starting in the first place, and taking precautionary measures around rural homes to stop the spread of wildfires, are the best means of avoiding or minimizing wildfire losses. When conditions of extreme fire hazard exist, the MDNR can request the Governor to issue an outdoor burning ban to mitigate the potential for wildfire in all or part of the state. Such a ban restricts smoking, fireworks, and outdoor burning activities to approved locations.

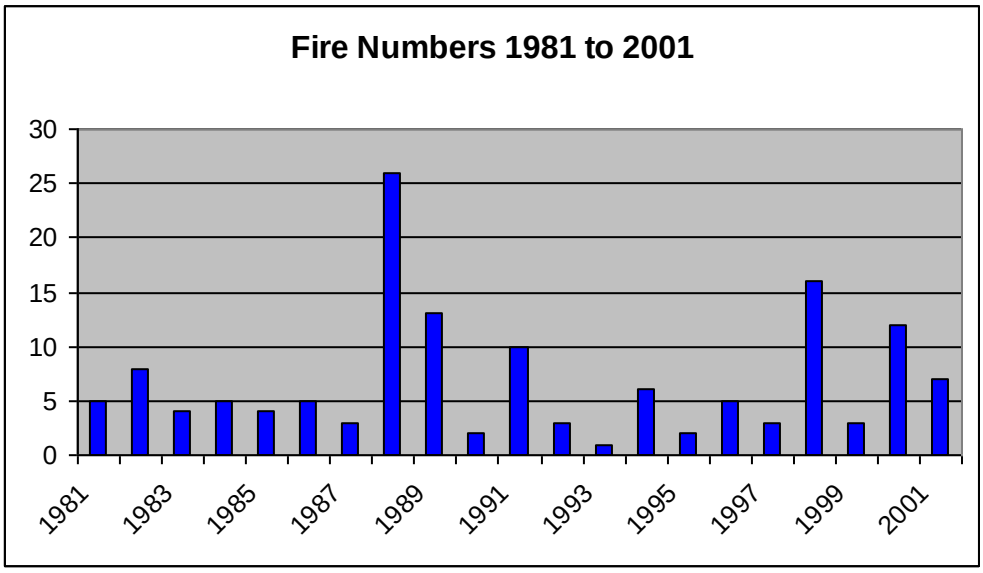
Historical Events: The tables below depict the wildfires that have occurred in Luce County and reported by MI DNR from 1981 through 2001.

Frequency: In a 20 year period there have been 143 wildfire occurrences in Luce County or approximately 7 per year. Out of those 143 fires 470 acres have been burned

Safety: In Luce County there are concerns for safe evacuations if wildfire starts in the northern area where campgrounds are located and there is limited road access out of the area. Warnings for evacuation may not be easily disseminated to campers who do not have radio or television. The time it takes for emergency personnel to respond to the area may be critical and the lack of water supplies in the rural areas are major factors to consider for the safety of people and property.

Health: Loss of life, burns and/or smoke inhalation can result from fire.

Cause	Total	Cause	Total
Campfire - Fisherman	6	Equipment Use - Fuel	1
Campfire - Hunter	1	Equipment Use - Other	2
Campfire - Other	1	Incendiary - Grudge Fire	1
Campfire - Recreationist	7	Incendiary - Habitat Improvement	2
Children - Fireworks	2	Incendiary - Other	1
Children - Other	1	Incendiary - Pyromania	1
Children - Playing with Fire	3	Lightning	41
Debris Burning - Dumps	2	Miscellaneous - Burning Building	4
Debris Burning - Land Clearing	11	Miscellaneous - Other	9
Debris Burning - Other	3	Railroad - Carbon Sparks	1
Debris Burning - Slash	2	Railroad - Other	1
Debris Burning - Trash	18	Smoking - Berry or Mushroom Picker	2
Equipment Use - Electrical	5	Smoking - Other	1
Equipment Use - Exhaust	7	Unknown	7



Buildings: Many structures throughout the northern part of Luce County are hunting cabins or seasonal residences whose owners may only be there for a limited time. Age of the structures, building materials and maintenance of surrounding areas may be contributing factors to wildfire destruction.

Critical Facilities: State Forest Campgrounds are the most vulnerable for wildfires in Luce County as they are located within the high-risk forested areas. Electrical and utility lines are vulnerable to destruction in wildfires.

Economic Impact: Wildfire could have a major impact on the economics of Luce County as it relies heavily on tourism. Destruction of forested areas and/or recreational facilities could result in the loss of tourism dollars for many years. The effects of wildfire could also have a great impact on the logging industry for loss of timber economic resources.

Potential Losses: Wildfires can cause potential loss of property and lives. Destruction of vegetation and contamination of soils can occur. Emergency response is necessary. There is a good probability that there will be some form of function loss such as power if lines are destroyed or transportation re-routing.

Vulnerable Areas: Remote areas of northern Luce County not easily accessible by emergency vehicles. Forested, cropland and grassland areas as well as wetland habitation can be destroyed if the area is dry enough.

Terrorism/Sabotage/WMD/Nuclear Attack

Although small, the possibility exists for Luce County to encounter a hazardous situation through the act of terrorism, sabotage, weapons of mass destruction or a nuclear attack. Any such incident would stress the local capability to the maximum. The ability for Luce County

emergency responders to respond appropriately will rely on developing a plan specific to this type of scenario.

The Committee does recognize that these potential hazards can affect Luce County and planning, training, cooperation among agencies and practice drills will help the County to be prepared for such events.

Extreme Temperatures

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

Extreme Summer Heat

Extreme summer weather is characterized by a combination of very high temperatures and exceptionally humid conditions. When persisting over a long period of time, this phenomenon is commonly called a heat wave.

Because the combined effects of high temperatures and high humidity are more intense in urban centers, heatstroke and heat exhaustion are a greater problem in cities than in suburban or rural areas. Nationwide, approximately 200 deaths a year are directly attributable to extreme heat. Extreme summer heat is also hazardous to livestock and agricultural crops, and it can cause water shortages, exacerbate fire hazards, and prompt excessive demands for energy. Roads, bridges, railroad tracks and other infrastructure are susceptible to damage from extreme heat.

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

Extreme Winter Cold

Like heat waves, periods of prolonged, unusually cold weather can result in a significant number of temperature-related deaths. Each year in the United States, approximately 700 people die as a result of severe cold temperature-related causes. This is substantially higher than the average of 200 heat-related deaths each year. It should be noted that a significant number of cold-related deaths are not the direct result of "freezing" conditions. Rather, many deaths are the result of illnesses and diseases that are negatively impacted by severe cold weather, such as stroke, heart disease and pneumonia. It could convincingly be argued that, were it not for the extreme cold

temperatures, death in many cases would not have occurred at the time it did from the illness or disease alone.

Historical Events: Excessive Heat was a problem the first two weeks in August, 2001 across all of northern Michigan. Temperatures reach the mid to upper 90s, on average, a few days each year; however, for a 5 day (8/5 - 8/9) stretch overnight low temperatures failed to fall below the lower 70s in most areas. This very humid air mass was unusual for northern Michigan, an area which typically sees cool nighttime temperatures and for this reason has very few homes with air conditioners. No heat related deaths or injuries were reported; however, most outdoor events were modified due to the forecasts of hot and humid conditions. County fairs sent animals home, yet still there were livestock losses at fairs in some counties. Attendance at county fairs was well below normal and this was attributed to the heat.

Frequency: Luce County can see up to 31.6 days annually of temperatures that fall below 0 degrees F. The months of January and February one can expect 10 days where temperatures are below 0 degrees F, according to the National Weather Service. On the other hand, the County may only see 2 days annually for temperatures that rise above 90 degrees F usually during the month of July.

Tahquamenon Falls
Temperature Threshold Climatology
Derived from 1971-2000 Averages
*Annual/seasonal totals may differ from the sum of the monthly totals due to rounding.

Month	# Days Total ≥ 90 F	# Days Max ≤ 32 F	# Days Min ≤ 32 F	# Days Min ≤ 0 F
JAN	0	26.2	30.8	10.1
FEB	0	20.2	27.9	10.6
MAR	0	10.6	29	5.7
APR	0	1.8	23.9	0.3
MAY	0	0	10.6	0
JUN	0.5	0	3	0
JUL	1.2	0	0.3	0
AUG	0.4	0	0.5	0
SEP	0	0	5.7	0
OCT	0	0.1	15.8	0
NOV	0	6.7	24.8	0.2
DEC	0	20.5	30.7	4.4
Annual	2.1	85.5	202.3	31.6
Winter	0	67	89.4	25.2
Spring	0	12.7	63.4	5.9
Summer	2	0	3.8	0
Fall	0	6.4	45.7	0.2

Temperature Extremes Tahquamenon Falls Period of Record: 1968-2001				
Month	1-Day Max Degrees F	Date	1-Day Min Degrees F	Date
JAN	47	1/19/1996	-25	1/14/1982
FEB	56	2/27/2000	-36	2/17/1979
MAR	68	3/15/1990	-25	3/3/1972
APR	85	4/23/1985	-5	4/6/1972
MAY	90	5/31/1988	14	5/5/1983
JUN	94	6/14/1988	21	617/1986
JUL	98	7/6/1988	28	7/2/200
AUG	94	8/1/1975	25	8/30/1976
SEP	92	9/8/1976	21	9/30/1993
OCT	79	10/2/1971	14	10/27/1985
NOV	70	11/10/1999	-9	11/29/1976
DEC	56	12/6/2001	-32	12/30/1976
Annual	98	7/6/1988	-36	2/17/1979

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

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

Hypothermia usually occurs in one of two sets of circumstances. One situation involves hypothermia associated with prolonged exposure to cold while participating in outdoor sports such as skiing, hiking or camping. Most victims of this form of hypothermia tend to be young, generally healthy individuals who may lack experience in dealing with extreme cold temperatures. The second situation involves a particularly vulnerable person who is subjected to

only a moderate, indoor cold stress. A common example would be that of an elderly person living in an inadequately heated home. In such circumstances, hypothermia may not occur until days or perhaps weeks after the cold stress begins.

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

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

Public Health Emergencies

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.

Luce County's Health Department efforts are aimed at preventative measures such as vaccinations, public awareness programs, and inspections of food service facilities throughout the County.

Frequency: Infectious illness outbreaks: Small-scale outbreaks of infectious disease occur nearly weekly. Many are single cases that may signal the beginning of a larger outbreak and therefore, are usually investigated. Larger outbreaks involving 5 to 10 people occur several times each year and widespread illness outbreaks occur once every year or two.

Safety: 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 a specific organization or segment of the population. The spread of communicable disease or epidemics is also an area for concern.

Health: Although no area in Luce County is immune to public health emergencies, areas with high population concentrations will always be more vulnerable to the threat. In addition, the more vulnerable members of society – the elderly, children, impoverished individuals, and people in poor health – are also more at risk than the general population.

Critical Facilities: Medical facilities, nursing homes, schools would be areas that are most vulnerable as they house a number of the most vulnerable population – the elderly, children or those who are sick.

Economic Impact: 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. Hospitals and medical facilities are often stretched to the limit of their resources. Depending upon the emergency, the economic impact can be devastating for area residents. 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 action is not taken.

Vulnerable Areas: Communities with schools, health facilities, water/sewer services including the Village of Newberry, Pentland Township.

Potential Losses: Depending on the extent of an emergency the potential loss could include a school having to close due to illness, disinfecting costs, extending operations to make-up time, loss of employment. Contamination of a critical facility such as the only hospital that serves the entire county as well as neighboring communities could be devastating for the area and would cause severe economic losses as well as loss of a major health care facility. Contamination of water supplies could result in communities having to boil their water or having to buy clean water as well as the cost of cleaning up and fixing the source of contamination.

Severe Winter Weather

There are many ways for winter storms to form, but certain key ingredients are needed. First temperatures must be below freezing in the clouds and near the ground. There must be a source of moisture in the form of evaporating water. Then lift in the atmosphere causes the moisture to rise and form clouds of precipitation.

Canadian and Arctic cold fronts that push snow and ice deep into the interior region of the United States cause winter storms in the Midwest. Our area is also subject to lake effect snowstorms that develop from the passage of cold air over the relatively warm surface of Lake Superior which can cause heavy snowfall and blizzard conditions.

Winter storms can occur as heavy snowfalls, ice storms or extreme cold temperatures. Winter storms can occur as a single event or they can occur in combination, which can make an event more severe. For example, a moderate snowfall could create severe conditions if freezing rain and subsequent extremely cold temperatures followed it. The aftermath of a winter storm can impact a community or region for weeks, and even months.

Snow: Heavy snowfalls can range from large accumulations of snow over many hours to blizzard conditions with blowing snow that could last several days. The National Weather Service's snow classification is in the table on the next page.

Snow Classifications	
Blizzard	Winds of 35 miles per hour or more with snow and blowing snow reducing visibility to less that ¼ mile for at least 3 hours.
Blowing Snow	Wind-driven snow that reduces visibility. Blowing snow may be falling snow and/or snow on the ground picked up by the wind.
Snow Squalls	Brief, intense snow showers accompanied by strong, gusty winds. Accumulation may be significant.
Snow Showers	Snow falling at varying intensities for brief periods of time. Some accumulation possible.
Snow Flurries	Light snow falling for short duration with little or no accumulation.
Source: National Weather Service	

As a result of being near Lake Superior, Luce County experiences large differences in snowfall in relatively short distances.

Ice Storms: An ice storm occurs when freezing rain falls from clouds and freezes immediately upon impact. Freezing rain is found in between sleet and rain. It occurs when the precipitation falls into a large layer of warm air and then does not have time to refreeze in a cold layer (near or below 32°F) before it comes in contact with the surface which is also near or below 32°F.

Historical Events: Historical data shows that Luce County receives an annual average of 187.8 inches of snow. The National Weather Service recorded 59 Snow and Ice Events during the period between January 1, 1950 and April 30, 2004. Of the 59 events, 40 were categorized as heavy snow, 12 as winter storms, two as freezing rain (one of which accompanied heavy snow), four as an ice storm and one lake effect snow.

Tahquamenon Falls
Snowfall Extremes
Period of Record: 1968-2001
*Annual/seasonal totals may differ from the sum of the monthly totals due to rounding.

Month	High (in)	Year	1-Day Maximum	Date
JAN	103	1971	14	1/3/2000
FEB	70.1	2001	10.5	2/1/1977
MAR	38.7	1972	13.2	3/18/1983
APR	20.9	1977	13.2	4/5/1977
MAY	3.4	1990	3.4	5/10/1990
OCT	9.3	1972	8.5	10/18/1972
NOV	66	1976	13	11/14/1982
DEC	87.4	1976	15.8	12/7/1995
Season (July – June)	333.2	1976-1977	15.8	12/7/1995

On December 9, 1995 a low pressure system moved across Upper Michigan and stalled near Sault Ste. Marie for nearly 24 hours. The low finally moved to the east on the morning of the

10th. What followed were intense northwest oriented lake effect snow bands that brought 59 inches of snow to Bumbletown, 53 inches to Munising, 43 inches to Ontonagon and 34 inches to Silver City, Houghton and **Pine Stump Junction** (10 miles north of Newberry). Blowing snow with northwest winds at 15 to 30 mph closed Highway M-28 between Harvey and Munising for most of the period and made travel very difficult elsewhere.

On January 2, 2000 a winter storm moved northeast from Kansas, across Lake Michigan, and into Quebec, bringing heavy snow to the Upper Peninsula of Michigan. Snowfall totals were 9.6 inches in Negaunee, 10 inches in Escanaba, 10.5 in Iron Mountain, 11.0 in Munising, 11.5 inches in Melstrand, **Newberry** and Kingsford, 12.0 inches in Gwinn and Grand Marais, 12.7 inches at **Pine Stump Junction**, 14.0 inches in **Two Hearted**, and 16.0 inches in Manistique.

Frequency: According to the National Weather Service Luce County can expect to receive 5 inches of snow or more about 9.9 days out of the year. About 3.5 days in December and 3 days in January it is anticipated to receive 5 or more inches of snowfall.

Snowfall Tahquamenon Falls Period of Record: 1968-2001				
Month	# Days Total ≥ 0.1"	# Days Total ≥ 1.0"	# Days Total ≥ 2.0"	# Days Total ≥ 5.0"
JAN	22.3	16.3	11.2	3.1
FEB	16.1	10.5	6.3	1.1
MAR	10.9	7.2	4.1	0.9
APR	4.3	2.8	1.5	0.3
MAY	0.2	0.2	0	0
JUN	0	0	0	0
JUL	0	0	0	0
AUG	0	0	0	0
SEP	0	0	0	0
OCT	1.2	0.4	0.2	0
NOV	9.2	6.5	4	1.1
DEC	18.8	14.3	14.3	3.5
Annual	81.2	57.1	36.9	9.9

Safety: Loss of power is a major concern during the winter months for those who rely on electric for heat. Driving conditions are also a concern during winter storms. Winter white-outs and icy road conditions can make hazardous conditions day or night.

Health: People and animals are vulnerable when winter shows its fury.

Buildings: Snow and ice accumulation upon roofs make all buildings vulnerable to damage.

Critical Facilities: Critical facilities are susceptible to the same damage from winter storms as other buildings. Emergency operations can be disrupted as travel may become extremely difficult

or impossible. Power loss may occur from downed lines. Telephone communications may also be lost.

Economic Impact: Winter storms can shut down entire communities, which would result in the economic loss of many businesses. Snow removal costs are increased which increases the burden on the County Road Commission.

Potential Losses: Potential losses from severe winter weather could include structure collapses, increased cost in snow removal, increased potential for transportation accidents, increased potential for infrastructure failures, and possibly severely limiting emergency response time and ability.

Vulnerable Areas: The whole County would be vulnerable during severe winter weather. Areas along the northern shoreline typically get hit the hardest with a northwest wind.

Drought

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. Drought differs from normal arid conditions found in low rainfall areas in that aridity is a permanent characteristic of that type of climate. Drought is the consequence of a natural reduction in the amount of precipitation expected over an extended period of time, usually a season or more in length. The severity of a drought depends not only on its location, duration, and geographical extent, but also on the water supply demands made by human activities and vegetation. This multi-faceted nature of the hazard makes it difficult to define a drought and assess when and where one is likely to occur.

Drought differs from other natural hazards in several ways. First, it is difficult to determine the exact beginning and end of a drought, since its 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 often makes it difficult to determine 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 greatly hinder a community's response capability when a drought does occur.

Droughts can cause many severe impacts on communities and regions, including: 1) water shortages for human consumption, industrial, business and agricultural uses, power generation, recreation and navigation; 2) a drop in the quantity and quality of agricultural crops; 3) decline of water quality in lakes, streams and other natural bodies of water; 4) malnourishment of wildlife and livestock; 5) increase in wildfires and wildfire-related losses to timber, homes and other property; 6) declines in tourism in areas dependent on water-related activities; 7) declines in land values due to physical damage from the drought conditions and/or decreased economic or functional use of the property; 8) reduced tax revenue due to income losses in agriculture, retail,

tourism and other economic sectors; 9) increases in insect infestations, plant disease, and wind erosion; and 10) possible loss of human life due to food shortages, extreme heat, fire, and other health-related problems such as diminished sewage flows and increased pollutant concentrations in surface water.

Historical Events: In the September, 2001 Luce County was one of 73 counties in Michigan requesting federal assistance from devastating crop losses due to severe drought. The request was based on 30 percent or more loss estimates in at least one commodity. From the middle of June through the middle of August, less than ¾ inch rain fell in most areas and in addition temperatures exceeding 100 degrees F were common during the last two weeks of July, exacerbating the already dry conditions.

Frequency: In 2 years out of 10, the rainfall in April through September is less than 14 inches at Tahquamenon Falls State Park. The growing season for most crops falls within this period.

Potential Losses: With a severe drought the County can expect function loss of some sort, infrastructure failure if the wells run dry, possible casualties and emergency response costs.

Vulnerable Areas: More inland areas but possibly the whole County would be affected.

Flooding

Riverine Flooding

The most common and most damaging floods occur along rivers and streams and this is called overbank flooding. One or more of three factors can cause overbank flooding of rivers and streams:

1. Too much precipitation in the watershed for the channels to convey.
2. Obstructions in a channel, such as an ice jam or beaver dam, and
3. Large release of water when a dam or other obstruction fails.

All three of these factors are reviewed in this section, but most floods are caused by the first, too much precipitation in the watershed.

Flooding can also occur in streets when rainwater cannot flow into a storm sewer. Basements can flood when rainwater cannot flow away from the house or when the sewers back up. These problems are usually caused by heavy local rains and are often not related to overbank flooding or floodplain locations.

The following terminology is used when describing floods:

The term **Minor Flooding** is used to indicate minimal or no property damage. However, some public inconvenience is possible.

The term **Moderate Flooding** is used to indicate the inundation of secondary roads. Transfer to higher elevation may be necessary to save property. Some evacuation may be required.

The term **Major Flooding** is used to indicate extensive inundation and property damage, usually characterized by the evacuation of people and livestock, and the closure of both primary and secondary roads.

Watersheds:

A "watershed" is an area of land that drains into a lake, stream or other body of water. (See Map 12 – Watershed Drainage Basins and Map 13 – Major Lakes and Rivers.) The runoff from rain or snowmelt is collected by smaller channels (tributaries), which send the water to larger channels and eventually to the lowest body of water in the watershed (main channel). When a channel receives too much water, the excess flows over its banks and into the adjacent area – causing a flood.

Manistique River Basin – This basin consists of the Manistique River, the Indian River and many small tributaries which include the drainage of all of Schoolcraft County plus a small portion of Delta, Alger, Luce, and Mackinac Counties.

Tahquamenon River Basin – This basin originates in Luce County and covers the southern half of Luce County and part of western Chippewa County. This basin consists of the Tahquamenon River, plus numerous small tributaries, with discharge into Whitefish Bay on Lake Superior in the western part of Chippewa County.

Two Hearted River Basin – located in northern Luce County, this basin consists of the Two Hearted River, plus a number of tributaries, with discharge into Lake Superior.

Betsy River Basin – a small portion of the Betsy River Basin includes Betsy Lake in northeast portion of Luce County and also continues through western Chippewa County to discharge into Whitefish Bay.

Shoreline Flooding

Flooding and erosion of shoreline areas caused by high Great Lakes water levels, storm surges, or winds is known as shoreline flooding. Luce County has approximately 33 miles of shoreline on Lakes Superior. Great Lakes water level information is shown in the following table:

Lake Superior
Period of Record: 1918-2003
English Units (feet)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean	601.51	601.31	601.21	601.31	601.64	601.90	602.13	602.20	602.23	602.13	602.00	601.77
Max	602.69 **1986**	602.46 **1986**	602.40 **1986**	602.62 **1986**	602.82 **1986**	602.89 **1986**	603.08 **1950**	603.22 **1952**	603.22 **1985**	603.38 **1985**	603.31 **1985**	603.05 **1985**
Min	599.84 **1926**	599.61 **1926**	599.54 **1926**	599.48 **1926**	599.61 **1926**	599.90 **1926**	600.26 **1926**	600.46 **1926**	600.79 **1926**	600.72 **1925**	600.43 **1925**	600.13 **1925**

Chart Datum 601.1 feet

Chart Datum, also known as Low Water Datum, is a reference plane on each lake to which water depths on navigation charts are referred. The International Great Lakes Datum of 1985 has its zero base at Rimouski, Quebec near the mouth of the St. Lawrence River (approximate sea level).

Lake Superior at Point Iroquois, MI
Possible Storm Induced Rises (in feet)

	Probability of Exceedance				
	20%	10%	3%	2%	1%
January	1.20	1.40	1.70	1.90	2.00
February	0.90	1.00	1.20	1.30	1.30
March	0.90	1.00	1.20	1.30	1.40
April	0.90	1.10	1.40	1.50	1.70
May	0.90	1.10	1.30	1.50	1.60
June	0.80	0.90	1.10	1.20	1.30
July	0.70	0.90	1.20	1.40	1.60
August	0.80	0.80	0.90	1.00	1.10
September	1.00	1.10	1.30	1.50	1.60
October	1.20	1.40	1.70	1.90	2.20
November	1.40	1.60	1.80	2.00	2.10
December	1.20	1.40	1.60	1.70	1.80

NOTE:
The rises shown here, should they occur, would be in addition to still water levels indicated on the Monthly Bulletin. Values of wave runup are not provided in this table.

A Gage or water-stage recorder is located on the Tahquamenon River in the NE 1/4 of Sec.11, T.48 N., R.8 W., Luce County, Hydrologic Unit 04020202, on left bank 0.7 miles upstream from Tahquamenon (Big) Falls, 11.5 miles west of Paradise, and 19 miles northeast of Newberry.. Datum of gage is 698.03 ft above sea level. Information has been accrued since 1953 by USGS and can be accessed via the internet at http://waterdata.usgs.gov/mi/nwis.

Precipitation: Luce County receives an average of 35.8 inches of rain annually, including an annual average of 187.8 inches of snow (generally, 7 inches of snow has the equivalent water content of one inch of rain). However, it is not spread out evenly over the year. The amount of rain that falls varies from storm to storm and varies over an area. The total number of days in which rainfall exceeds 1 inch is about 5 per year. (Historical Climate Data, Tahquamenon Falls State Park)

Flash Floods: Flash floods are generated by severe storms that drop much rainfall in a short time. All flash floods strike quickly and end swiftly. Areas with steep slopes and narrow stream valleys are particularly vulnerable to flash flooding, as are the banks of small tributary streams. In hilly areas, the high-velocity flows and short warning time make flash floods hazardous and very destructive.

Obstructions: Obstructions can be channel obstructions, such as small bridge openings or log jams, or floodplain obstructions, such as road embankments, fill and buildings. Channel obstructions will cause smaller more frequent floods, while floodplain obstructions impact the larger, less frequent floods where most of the flow is overbank, outside the channel.

Obstructions can be natural or man made. Natural obstructions, like log jams, can be cleared out or are washed away during larger floods. The great problem is man made obstructions, which tend to be more permanent.

Ice Jams: Ice jams occur when warm weather and rain break up frozen rivers or any time there is a rapid cycle of freezing and thawing. The broken ice floats downriver until it is blocked by an obstruction such as a bridge or shallow area. An ice dam forms, blocking the channel and causing flooding upstream. Ice jams present three hazards:

1. Sudden flooding of areas upstream from the jam, often on clear days with little or no warning,
2. Sudden flooding of areas downstream when an ice jam breaks. The impact is similar to a dam break, damaging or destroying buildings and structures.
3. Movement of ice chunks that can push over trees and crush buildings.

Dam Failures: Dams are made to hold back large amounts of water. If they fail or are overtopped, they can produce a dangerous flood situation because of the high velocities and large volumes of water released. A break in a dam can occur with little or no warning on clear days when people are not expecting rain, much less a flood. Breaching often occurs within hours after the first visible signs of dam failure, leaving little time for evacuation.

Dam failures are usually caused by either structural problems with the dam or by hydrologic problems. Structural problems include seepage, erosion, cracking, sliding and overturning that are a result of the age of the dam or lack of maintenance. Hydrologic problems typically occur when there is excessive runoff due to heavy precipitation. A dam failure can occur if the dam has to impound (hold back) more water than it is designed to, or if the spillway capacity is inadequate for the amount of water needing to pass downstream.

The series of tragic dam failures that occurred across the United States in the 1970s prompted government action to more stringently regulate dams and heightened public concern about hazards created by unsafe dams. Both the Michigan Department of Environmental Quality (MDEQ) and the Federal Energy Regulatory Commission (FERC) classify and regulate dams in Michigan. This statute requires the MDEQ to rate each dam as either "high", "significant", or "low" hazard potential, according to the potential downstream impact if the dam were to fail (not according to the physical condition of the dam). The MDEQ has identified and rated over 2,400 dams in Michigan. Dams over 6 feet in height that create an impoundment with a surface area of more than 5 acres are regulated by this statute.

For Luce County seven of the 11 dams have been rated low hazard and four have no rating. There have been no dam failures on record in Luce County. (See Map 14 – Dam Sites.)

Transportation: Loss of road access is a major flood impact that affects all residents and businesses, not just those who own property in the floodplain. Sometimes the loss is temporary, such as during the flood.

Sometimes the loss of transportation lasts well after the disaster. When roads, bridges or railroads are washed out by a flood, it can be weeks or months before they are repaired and reusable.

Historical Events: In 1984, due to a combination of human error and an excessive spring run-off there was a near flooding incident on the Tahquamenon River downriver from the Dollarville Dam. This dam is regulated each spring by MDNR. Due to the inexperience of a new employee the dam began to overflow causing potential flooding downriver near the logging museum and Village of Newberry. Emergency officials were notified and a warning was passed on to the few residents that would have been affected. DNR officials worked through the day and night, hauling in fill and correcting the problem. Flooding also occurred that spring along the Sage and Hendrie Rivers where they intersected with Highway M-28 causing overflow across the highway.

Flooding was reported in 2004 along the Two Hearted River. No damage was reported, as this is a remote area in the County.

Although no major flooding has occurred in Luce County, the potential is present due to the many rivers that traverse the area. Many areas along all the rivers get inundated during spring thaw, especially if it is a very wet spring or water levels are above normal. The Village of Newberry lies downriver of the Dollarville Dam, and the Tahquamenon Logging Museum borders the shoreline of the Tahquamenon River. Many rivers and their tributaries cross the major transportation routes.

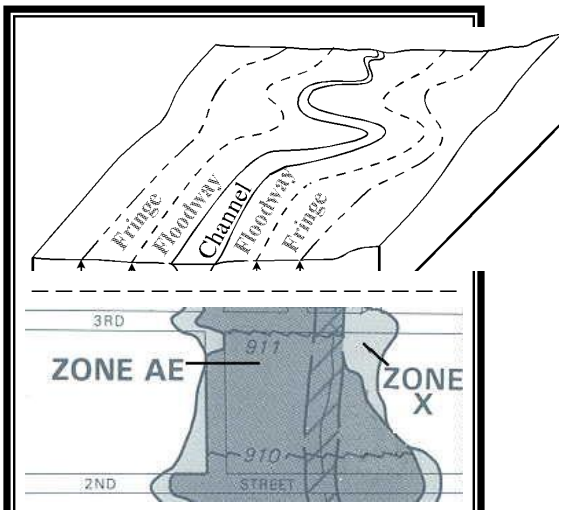
Future Flood Risk: Past floods are indications of what can happen in the future, but flood studies and mitigation plans are based on the *risk* of future flooding. Flood studies extrapolate from historical records to determine the statistical potential that storms and floods of certain magnitude will recur. Such events are measured by their "recurrence interval," i.e., a 10-year storm or a 50-year flood.

These terms are often misconstrued. Commonly, people interpret the 50-year flood definition to mean "once every 50 years." This is incorrect. Statistically speaking, a 50-year flood has a 1/50 (2%) chance of occurring in any given year. In reality, a 50-year flood could occur two times in the same year, two years in a row, or four times over the course of 50 years. It is possible to not have a 50-year flood over the course of 100 years.

The base flood is the one percent chance flood, i.e., the flood that has a one percent (one out of 100) chance of occurring in any given year. The one percent chance flood has also been called the 100-year flood. This *Plan* uses the base flood as a basis for determining the flood risk in Luce County.

Another term used is the "500-year flood." This has a 0.2% chance of occurring in any given year. While the odds are more remote, it is the national standard used for protecting critical facilities, such as hospitals and power plants.

The base floodplain: The area inundated by the base flood is the "base floodplain." FEMA maps (called Flood Insurance Rate Maps, or FIRMs) also call this the Special Flood Hazard Area or A Zone. The central part of the floodplain is called the "floodway." The floodway is the channel and that portion of the adjacent floodplain which must remain open to permit passage of the base flood. Floodwaters generally are deepest and swiftest in the floodway, and anything in this area is in the greatest danger during a flood. The remainder of the floodplain is called the "fringe," where water may be shallower and slower. There are no base floodplains mapped for Luce County.



Floodplain/Floodway Delineation

The upper schematic identifies the channel, floodway and fringe portions of the base floodplain, which is shown in the lower map as a Zone AE on the Flood Insurance Rate Map (FIRM). The floodway is shown on the FIRM with diagonal lines. The Zone X is the area mapped as higher than the base

The depth and velocity of a river are also important considerations in mitigation efforts. The faster the water moves, the more pressure it puts on a structure and the more it will erode stream banks and scour the earth around a building's foundation.

While buildings may be easy to protect in areas of low velocities, people are not always safe. The total impact of moving water is related to the depth of the flooding. Studies have shown that deep water and low velocities can cause as much damage as shallow water and high velocities. Any summary data presented in this Plan should be augmented by site-specific data, such as depths and velocities, when looking at mitigation alternatives at any single location.

Impact: Impacts can be classified in four categories: impact on people (e.g., safety and health), damage to buildings, damage to critical facilities, and economic disruption (damage to businesses and infrastructure).

Safety: A car will float in less than 2 feet of moving water and can be swept downstream into deeper waters. This is one reason floods kill more people trapped in vehicles than anywhere else.

Victims of floods have often put themselves in perilous situations by ignoring warnings about travel or mistakenly thinking that a washed-out bridge is still there. People die of heart attacks, especially from exertion during a flood fight. Electrocution is a cause of flood deaths, claiming lives in flooded areas that carry a live current created when electrical components short out. Floods also can damage gas lines, floors, and stairs, creating secondary hazards such as gas leaks, unsafe structures, and fires. Fires are particularly damaging in areas made inaccessible to fire-fighting equipment by high water or flood-related road or bridge damage.

Warning and evacuation: The threat to life posed by a flood can be avoided if people can evacuate before the waters reach their buildings or close their evacuation routes. This requires advance notice that a flood is coming and a system to disseminate flood warnings.

Bridges: A key evacuation and safety concern is when roads and bridges go under water. Generally, the larger the road, the more likely it will not flood, but this is not always the case. A review of the Flood Insurance Rate Map and accompanying flood profiles identified 58 bridges and culverts that will be underwater during a base flood. These are shown in Map 14 in Chapter 1. They are listed in Appendix E.

In addition to the locations listed in Appendix F, there are bridges and culverts in areas that are not included in the Flood Insurance Rate Map study areas, such as those located along small tributary streams.

Health: While such problems are often not reported, three general types of health hazards accompany floods. The first comes from the water itself. Floodwaters carry whatever was on the ground that the upstream runoff picked up, including dirt, oil, animal waste, and lawn, farm and industrial chemicals. Pastures and areas where cattle and hogs are kept can contribute polluted waters to the receiving streams.

Flood waters saturate the ground which leads to infiltration into sanitary sewer lines. When wastewater treatment plants are flooded, there is nowhere for the sewage to flow. Infiltration and lack of treatment lead to overloaded sewer lines which back up into low lying areas and some homes. Even though diluted by flood waters, raw sewage can be a breeding ground for bacteria, such as e coli, and other disease causing agents.

The second type of health problem comes after the water is gone. Stagnant pools become breeding grounds for mosquitoes, and wet areas of a building that have not been cleaned breed mold and mildew. A building that is not thoroughly and properly cleaned becomes a health hazard, especially for small children and the elderly.

Another health hazard occurs when heating ducts in a forced-air system are not properly cleaned after inundation. When the furnace or air conditioner is turned on, the sediments left in the ducts are circulated throughout the building and breathed in by the occupants.

If the water system loses pressure, a boil order may be issued to protect people and animals from contaminated water.

The third problem is the long-term psychological impact of having been through a flood and seeing one's home damaged and irreplaceable keepsakes destroyed. The cost and labor needed to repair a flood-damaged home puts a severe strain on people, especially the unprepared and uninsured. There is also a long-term problem for those who know that their homes can be flooded again. The resulting stress on floodplain residents takes its toll in the form of aggravated physical and mental health problems.

Building damage: In a few situations, deep or fast moving waters will push a building off its foundation, but this is rare. More often, structural damage is caused by the weight of standing water, known as "hydrostatic pressure."

Basement walls and floors are particularly susceptible to damage by hydrostatic pressure. Not only is the water acting on basement walls deeper, a basement is subjected to the combined weight of water and saturated earth. In addition, water in the ground underneath a flooded building will seek its own level, resulting in uplift forces that can break a concrete basement floor.

Soaking causes the most common type of damage inflicted by a flood. When soaked, many materials change their composition or shape. Wet wood will swell and, if dried too quickly, will crack, split or warp. Plywood can come apart. Gypsum wallboard will fall apart if it is bumped before it dries out. The longer these materials are wet, the more moisture, sediment and pollutants they will absorb.

Soaking can cause extensive damage to household goods. Wooden furniture may become so badly warped that it cannot be used. Other furnishings such as upholstery, carpeting, mattresses, and books usually are not worth drying out and restoring. Electrical appliances and gasoline engines will not work safely until they are professionally dried and cleaned.

In short, while a building may look sound and unharmed after a flood, the waters can cause a lot of damage. To properly clean a flooded building, the walls and floors should be stripped, cleaned, and allowed to dry before being recovered. This can take weeks and is expensive.

Floods can be slow, or fast rising but generally develop over a period of days. Investing in mitigation steps now, such as, engaging in floodplain management activities, constructing barriers, such as levees, and purchasing flood insurance will help reduce the amount of structural damage to a home and financial loss from building and crop damage should a flood or flash flood occur. Monitoring of current weather conditions and weather forecasts gives advanced notification of potential flooding. Hazardous weather outlooks and forecasts give vital information on the amounts of precipitation, wind intensity and direction, time and extent, etc. Thus, the severity of potential flooding can be assessed and prepared for effectively.

Potential Losses: Property damage, loss of function, and emergency response costs.

Vulnerable Areas: Shoreline areas of major lakes and rivers and a more clay soil base, towards the central and eastern areas of the county.

Pipeline Accidents

Petroleum and natural gas pipelines pose a real threat in the Eastern Upper Peninsula. 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 are caused by third party damage to the pipeline, often due to construction or

some other activity that involves trenching or digging operations. However, some natural events such as subsidence can also cause damage to a pipeline. 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.

The only natural gas pipeline in the County is located in the greater Newberry area provided by Semco Energy of Negaunee.

Potential Losses: With any accident there is there is the cost of emergency response, the potential loss of life, most probably property damage and loss of function. An accident on the Lakes may cause loss of shipping. Transportation accidents may cause a re-routing of traffic and hazardous material/pipeline accidents would also cause loss of function.

Vulnerable Areas: Areas with pipeline, major transportation routes, railroad corridor, industrial areas, shipping channels, airports, hazardous material sites.

Civil Disturbances

Large-scale civil disturbances rarely occur, but when they do they are usually an offshoot or result of one or more of the following events: 1) labor disputes where there is a high degree of animosity between the participating parties; 2) high profile/controversial judicial proceedings; 3) the implementation of controversial laws or other governmental actions; 4) resource shortages caused by a catastrophic event; 5) disagreements between special interest groups over a particular issue or cause; 6) a perceived unjust death or injury to a person held in high esteem or regard by a particular segment of society; or 7) a "celebration" of an important victory by a sports team.

Prison uprisings are normally the result of perceived injustice by inmates regarding facility rules, operating policies and/or living conditions, or insurrections started by rival groups or gangs within the facility.

Prison uprisings are handled first by Michigan Department of Corrections riot units composed of trained Corrections Officers. Additional units may be brought in from other nearby facilities, if necessary, to quell the disturbance. If those resources are not sufficient to manage and end the uprising, specially trained officers from the Michigan State Police can be activated to assist Department of Corrections personnel. The Michigan State Police may also be mobilized to provide perimeter security around the facility, and to augment resource needs. In extreme cases, Michigan National Guard military police personnel can be activated to assist with the restoration of order within the facility.

Potential Losses: With any civil disturbance there will be a cost for emergency response. The potential for casualties exist. There may be a loss of function and/or property damage.

Vulnerable Areas: Pentland Township, Village of Newberry

Subsidence

Subsidence is the lowering or collapse of the 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.

Historical Events: No significant historical events of subsidence have been reported for Luce County.

Potential Losses: Function loss, environmental contamination, property damage, possible casualties and emergency response.

Vulnerable Areas: Areas with steep slopes such as those greater than 35%.

Conclusions

This chapter provides information on the hazards that can affect Luce County: transportation accidents, hazardous materials incidents, public health emergencies, severe winter weather, thunderstorms, wildfires, extreme temperatures, tornadoes, flooding, drought and subsidence. Data on the hazards are provided in terms of severity, frequency and historical occurrences. Technological hazards such as hazardous materials incidents will need more in-depth analysis than this plan provides, which is concentrating more on the natural hazards.

The impacts of these hazards are reviewed under four categories: how they impact people, how they impact property, what critical facilities may be damaged and economic disruption (damage to businesses or infrastructure).

While it is hard to compare different natural phenomena, a general summary can show how they impact the County. This is done in Table 1, "Impact of the Hazards."

Frequency: The annual chance column in the table shows the likelihood of occurrence in any given year. These numbers are discussed in the "Frequency" section of each hazard.

Location: The location and area affected by a single occurrence is shown.

Safety: The safety hazard rating for thunderstorms and winter/ice storms is relatively high because of the dangerous conditions they may cause.

Property Damage: The property damage column is a factor of the estimated damage per structure times the number of structures likely to be damaged by the hazard.

Critical Facilities: The types of critical facilities and infrastructure that are affected are listed.

Economic disruption: Typical impacts on businesses and utilities are listed in this column.

Table 2 “Vulnerable Areas” shows the hazards and the municipalities which may be impacted.

Overall, there is adequate data on the hazards affecting the County as a whole. However, to measure the impact on individual communities and locations, such as critical facilities, requires addition effort beyond the scope of this county-wide plan. It is recommended that each critical facility be investigated further to determine its vulnerability to damage by the hazards reviewed in this chapter.