STEP 1b: HAZARD IDENTIFICATION

Overview of the Hazards Identification Process

An introduction to the hazards faced by Michigan communities can be obtained in the Michigan Hazard Analysis (EMD Publication 103). That document can be consulted as a first step in the hazards identification process. It is a comprehensive study of the various types of natural, technological, and human-related disasters and emergencies that have confronted the State of Michigan, or have the potential to occur. It provides an overview of the State's vulnerability to various hazards. From that document, it is possible to generally identify potential hazards in your community's area and to estimate information about potential risk from and vulnerability to those hazards.

While that document provides an excellent starting point, it is not all-encompassing. Because the Michigan Hazard Analysis examines hazards from a *statewide* perspective, it focuses on those hazards that have the potential to cause the greatest amount of damage and impact. It does not always examine "smaller," more localized events that may have occurred (or have the potential to occur) in a single community or even a portion of a community. Such events may be critically important to the communities in which they have an impact, but they may not have been reported to the State of Michigan or included in the statewide document. That being the case, localized sources of information also need to be tapped to more accurately determine the nature and scope of a community's hazards. Research can be conducted through local statistics, records, libraries, historical organizations, newspapers, broadcast media, chambers of commerce, insurance companies, private citizens, and other appropriate community entities. These sources should be able to provide more comprehensive insight and information about past disaster events and local hazard areas to determine where (and how frequently) your community is affected.

Use of Existing Documents and Studies

Among the many documents that may be helpful to you in collecting information for a community profile (and for identifying area hazards) are the following:

- U.S. Department of Agriculture soil surveys (handled by the National Resource Conservation Service) contain good historical profiles of the counties for which they were completed, an overview of important natural and environmental features, and information on climate and soils which can be extremely useful for analyzing flood hazards. The information in soil survey reports might also be ideal to help link comprehensive planning to hazard mitigation considerations, since the reports include assessments of soil erosion, drainage capacity, presence of steep slopes, proneness to flooding, and suitability for development. 67 of Michigan's 83 counties have had a soil survey produced for them since 1960, and 10 others have only soil surveys that were made before 1960. Nine counties currently have new soil surveys being developed for them, which should be complete by 2005 (six of which will update or replace older plans.) Thus, potentially useful information from this source is potentially available for 80 of the 83 counties in Michigan (the as-yet unsurveyed ones being Iosco, Marquette, and Otsego). For more information, refer to http://www.statlab.iastate.edu/soils/nssc/ (and http://www.ftw.nrcs.usda.gov/stat_data.html for geographic data). Also noteworthy: Coastal Zone Management Plans www.ocrm.nos.noaa.gov/czm/czmmichigan.html
- U.S. Forest Service studies can provide information about forest types which will be needed for assessing wildfire risks. This sort of forest information is also available from the Michigan Department of Natural Resources (see the GIS resource page at http://www.state.mi.us/webapp/cgi/mgdl/ and the digital orthophotos site at http://www.michigan.gov/dnr/0,1607,7-153-10371_14546---,00.html). Nearby forest and fire management offices may also be contacted for more information—a list of them appears at the site http://www.michigan.gov/dnr/0,1607,7-153-10367_11851-34287--,00.html.
- Local Emergency Planning Committee (LEPC) plans and related site plans/information are very useful for considering what risks your community may have from hazardous materials. For hazardous materials that are being transported by road, rail, or water, additional information will be helpful. The Michigan Department of Transportation, county road commissions, and regional and local planning offices have a great amount of data that can be used to assess risks from transportation hazards that may include hazardous material releases. Information about traffic counts, the number and types of commercial vehicles on highways or designated routes, oil well and pipeline locations, train shipments, and airport activities—all these can contribute to assessing technological risks.

- Information on dam locations and types can be obtained by authorized persons from the U.S. Army Corps of Engineers.
- Local public health and environmental offices may need to be contacted to get information about some hazards. Other community organizations may also be helpful for identifying hazards. Finally, don't forget about public input from ordinary citizens!

Be sure to customize the information for local hazard mitigation uses. Avoid repetitive and unnecessary information, but use text, tables, maps as appropriate. Sometimes, there will be gaps in the document that you may need to fill in with your own knowledge or research. Local emergency managers should include in their hazard analysis the information they know about their community's capabilities, preparedness, and response to the different sorts of hazards which it may experience. Special political or social conditions that may affect a community's vulnerability can also be explained in the hazard analysis. For example, special events or seasonal population shifts may cause increases and decreases in the number of people needing protection, warning, evacuation, or services during an emergency. Such shifts may require different plans and responses to address different levels of need and risk. Shortcomings in a community's capabilities should also be identified as part of an analysis, such as needs for extra equipment, coordination, or training for personnel.

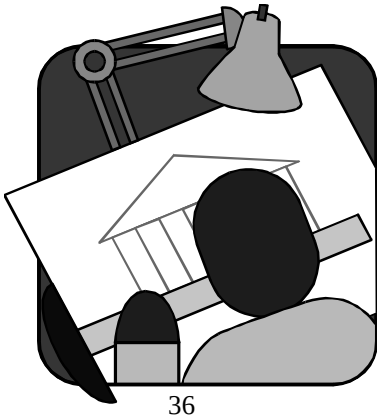
There are numerous internet sites that can provide information on the many hazards that might affect your community. A list of identified hazards in Michigan appears on the following pages, with a brief description of each hazard followed by one or two web sites that can provide more information. Some introductory hazard descriptions like the ones provided below should appear for each hazard in your hazard analysis, so that readers who know nothing about emergency management can be introduced to these threats and better understand the analysis that follows. If your community has identified hazards that are not listed below, it is important that these new hazards be identified and described in your hazard analysis.

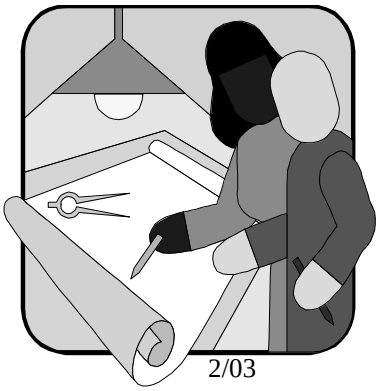
A copy of EMD-PUB 103, Michigan Hazard Analysis, can be obtained upon request from the Michigan State Police, Emergency Management Division.

NOTE: Again, there is some overlap here between step 1b (Hazard Identification) and step 1c (Risk Assessment). In the course of identifying which hazards have occurred and could occur in your community, you will already begin to gain a sense of the frequency with which these hazards could cause a problem, the intensity with which they appear, and so on. Don't worry about making a neat division between these substeps of the hazard analysis. In fact, your document will probably be easier to read if, after a community profile (from step 1a), each hazard is identified in its own section, with a definition and introduction that would lead neatly into an assessment of risk and an assessment of the community's vulnerability to this hazard (produced from steps 1b, 1c, and 1d, following).

Many of the web links and resources listed under step 1a (Community Profile) on pages 26 and 27 may also be helpful for identifying and analyzing hazards.

Probably the best all around web reference for analyzing your hazards is the National Climatic Data Center database, searchable by county, located at http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwevent~storms. It contains historic data and event descriptions for drought, extreme temperatures, wildfires, flooding & precipitation, lake events, hail, lightning, severe winds, tornadoes, thunderstorms, and winter storms. Its data include injuries, deaths, and dollar estimates of reported property and crop damage from each event.





Known Hazards in Michigan

Each local hazard mitigation plan should at least include a brief description of all of these hazards. Even if some of these hazards pose no known threat in the plan's area, some reference to them should be included in the plan so that reader and reviewers understand that risks from that hazard were actually considered in the hazard analysis. A community that has no nuclear plant located within hundreds of miles, for example, may decide that that hazard is not pertinent to it, but it should still include some statements in the text of its plan, explaining why the hazard is not considered significant. That way, persons, businesses, or organizations that are concerned about that hazard may be reassured by such a statement. If such hazards are simply ignored in the plan, readers may wonder if some hazards actually are significant but were merely overlooked or forgotten about by plan writers and local officials. It is best to include a few extra pages so as to address all of the listed hazards below, even if the "analysis" of one or more of them consists only of a small paragraph that states why the hazard is not considered a local threat.

Civil Disturbances:

A civil disturbance is defined as a public demonstration or gathering (such as a sports event), or an uprising in a prison or other institution, that results in some disruption of essential community functions, or in rioting, looting, arson or other unlawful behavior. 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 two dissenting 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; or 6) a perceived unjust death or injury to a person held in high esteem or regard by a particular segment of society. Areas subject to civil disturbances may encompass large portions of a community. Types of facilities that may be subject to or adversely impacted by civil disturbances may include government buildings, military bases, nuclear power plants, universities, businesses, and critical service facilities such as police and fire stations.

Prison uprisings are normally the result of perceived injustice by inmates regarding facility rules, operating procedures and living conditions, or insurrections started by rival groups or gangs within the facility. Civil disturbances (including prison uprisings) often require the involvement of multiple community agencies in responding to and recovering from the incident.

For a list of prison and correctional camp locations with maps and descriptions, see the "Prisons and Camps" link from http://www.michigan.gov/corrections/0,1607,7-119-1381_1387---,00.html. Other types of institutions with civil disturbance risks, and any special areas or sites of major public assembly that also have disturbance potential, should be identified using local knowledge of your community's features, social/economic conflicts, and civil disturbance history. For example, a search can be done in local newspapers such as The Detroit News or Free Press at http://www.freep.com/newslibrary/ and http://detnews.com/ using their web sites' search engines.

Drought:

A prolonged period with precipitation levels well below average, particularly during the planting and growing seasons in agricultural areas. Drought can also adversely affect urban areas—particularly those dependent on reservoirs for their water. Decreased water levels due to insufficient rain can lead to restriction of water uses and amounts. It is difficult to predict or forecast when a drought will begin, and how long it will last. Increased pumping of groundwater and surface irrigation in drought periods can result in land subsidence problems in some areas of the country. Virtually all areas of the country are subject to impact from drought - whether it be reduced agricultural outputs, reduced water supply, land subsidence, power outages caused by excessive energy use, increase in wildfires, reduced marine navigation capabilities, etc. The most vulnerable regions of the country for drought are the arid southwest and the Great Plains.

Drought information can be found at http://www.drought.unl.edu/index.htm and http://water.usgs.gov/dwc/ .

Earthquakes:

An earthquake is a sudden motion or trembling in the earth caused by an abrupt release of slowly accumulating strain which results in ground shaking, surface faulting, or ground failures. Most areas of the United States are subject to earthquakes (including parts of Michigan), and they occur literally thousands of times per year. Most earthquake occurrences are minor tremors and result in little or no damage. However, when moderate or severe earthquakes occur, the results can be devastating in terms of loss of life, property and essential services. One of the most dangerous characteristics of earthquakes is their ability to cause severe and sudden loss. Within 1 to 2 minutes, an earthquake can devastate an area through ground shaking, surface fault ruptures, and ground failures. Most deaths and injuries are not directly caused by the earthquake itself, but rather indirectly through the collapse of structures.

Earthquakes are measured by their magnitude and intensity. Magnitude is a measure of the amount of energy released at the epicenter or origin of the event. The Richter Magnitude Scale is commonly used to determine earthquake magnitude.

An earthquake of 5.0 is a moderate event, 6.0 characterizes a strong event, 7.0 is a major earthquake, and 8.0 is a catastrophic earthquake. Earthquake intensity is the measure of damage done at a given location. In the U.S., the most commonly used intensity scale is the Modified Mercalli Intensity Scale, which describes 12 increasing levels of intensity ranging from imperceptible to catastrophic.

Although earthquake risks in Michigan are generally quite low, this often means that structures or utilities (such as gas mains) may not have been built to withstand even the forces of relatively gentle seismic occurrences. Thus, although *risks* may be low, *vulnerabilities* may be moderate or high in such cases. Mitigation strategies in Michigan would mainly focus on evaluating and improving the seismic-resistance of vulnerable utility systems that did not take seismic disturbances into account.

Earthquake mapping information can be found at http://www.esri.com/hazards/makemap.html and http://geohazards.cr.usgs.gov/eq/ .
Also of interest is http://neic.usgs.gov/neis/states/michigan/michigan_history.html .

In areas with potential landslide or ground subsidence (from old mining tunnels, etc.) there may be noted similarities between those risks and earthquake events. Plans should therefore include a consideration of these sorts of disturbances in addition to those from more traditional forms of seismic events. Those in the southern part of Michigan should note their higher risk (including from a major event in the New Madrid fault zone) and include such considerations in their hazard analysis.

Extreme Temperatures:

Prolonged periods of very high or very low temperatures, often accompanied by exacerbating conditions such as high humidity and lack of rain, or heavy snowfall and high winds. Extreme temperatures - whether it be extreme heat or extreme cold - share a commonality in that they both primarily affect the most vulnerable segments of society such as the elderly, children, impoverished individuals, and people in poor health. The major threats of extreme heat are heatstroke (a major medical emergency), and heat exhaustion. Extreme heat is a more serious problem in urban areas, where the combined effects of high temperature and high humidity are more intense. The major threats of extreme cold are hypothermia (also a major medical emergency) and frostbite. Michigan is subject to both temperature extremes.

A useful site is at http://weather.noaa.gov/fax/miscella.shtml#mprecip .

Fire Hazards:

A. Scrap Tire Fires:
Any instance of uncontrolled burning at a scrap tire storage or recycling site. Each year in the U.S., an estimated 250 million vehicle tires have to be disposed of. Michigan alone generates 7.5-9 million scrap tires annually. Many of these scrap tires end up in disposal sites (legal or illegal), some of which may have several hundred thousand tires. Michigan currently has more than 24 million scrap tires at disposal sites scattered across the state. Tire disposal sites can be fire hazards due to the large quantity of "fuel" onsite, coupled with the fact that the shape of a tire allows air to flow into the interior of a tire pile, rendering standard fire fighting practices nearly useless. Flowing burning oil released by the burning tires spreads the fire to adjacent areas. Some scrap tire fires have burned for months, creating acrid smoke and an oily residue which can leach into the soil, creating long-term environmental problems. Scrap tire fires differ from conventional fires in several respects: 1) even relatively small scrap tire fires can require significant resources to control and extinguish; 2) the costs of fire management are often far beyond that which local government can absorb; 3) the environmental consequences of a major tire fire can be significant; and 4) the extreme heat from the fire converts a standard passenger vehicle tire into about two gallons of oily residue, which can then leach into the soil or migrate to streams.

For registered storage locations, see http://www.deq.state.mi.us/documents/deq-wmd-stp-collect.pdf. Information on storage violations is at http://www.michigan.gov/deq/0,1607,7-135-3312_4122-18416--,00.html.

B. Structural Fires:
Any instance of uncontrolled burning which results in structural damage to residential, commercial, industrial, institutional, or other properties in developed areas. In terms of average annual loss of life and property, structural fires - often referred to as the "universal hazard" because they occur in virtually every community - are by far the biggest hazard facing most communities in Michigan and across the country. Each year in the U.S., fires result in approximately 5,000 deaths and 300,000 injuries requiring medical treatment. According to some sources, structural fires cause more loss of life and property damage than all types of natural disasters combined. Particularly devastating are large urban conflagrations, in which multiple structures are damaged or destroyed. Not surprisingly, Michigan's structural fire experience mirrors the national figures. The State Fire Marshal estimates that a structural fire occurs in Michigan approximately every 33 minutes. Of accidental fires, 46.3% occur through neglect or carelessness with items such as candles, cigarettes, pipes, cigars, matches, lighters, and fireworks—especially when used by children. Another main cause is from improper maintenance or

use of items such as clothes dryers, holiday decorations (Christmas trees, decorations, extension cords/plugs), and cooking equipment and ingredients. Most of these causes could probably be prevented through awareness and education of their dangers and proper means of use.

Safety information appears at
http://www.nfpa.org/Education/Consumers_and_Families/Fire_Safety_Information/fire_safety_information.html

C. 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 recreational facilities in the area. Long-term effects can be numerous and include scorched and barren land, soil erosion, landslides/mudflows, water sedimentation,, and loss of recreational opportunities. Forests cover approximately one-half of Michigan's total land base. As a result, much of the state is vulnerable to wildfire. In addition, development in and around forests and grasslands is increasing rapidly, making public safety a primary consideration in wildfire mitigation and suppression efforts.

Information for mapping and risk assessment is at http://www.fs.fed.us/land/wfas/map_list.htm .
For mitigation strategies and information of all kinds on the subject, see the FIREWISE communities web site at http://www.firewise.org/www/active_win.htm .

Flooding Hazards:

A. Dam Failures:
The collapse or failure of an impoundment resulting in downstream flooding. Dam failures can result in loss of life and extensive property or natural resource damage for miles downstream from the dam. Failure of a dam does not only occur during flood events, which may cause overtopping of a dam. Failure can also result from poor operation, lack of maintenance and repair, and vandalism. Such failures can be catastrophic because they occur unexpectedly, with no time for evacuation. Michigan has experienced over 260 dam failures in its history.

The worst recorded dam failure in U.S. history occurred in Johnstown, Pennsylvania, in 1889. More than 2,200 people were killed when a dam upstream from Johnstown failed, sending a huge wall of water downstream which completely inundated the town.

To locate dams and obtain information for risk assessment, an impressive web site is located at http://crunch.tec.army.mil/nid/webpages/nid.cfm. If you have trouble accessing it, data can be obtained (by authorized persons) from the U. S. Army Corps of Engineers, or by inquiring with Mike Sobocinski of the Michigan State Police Emergency Management Division at sobocinm@michigan.gov or (517) 336-2053.

B. Riverine and Urban Flooding:
Riverine flooding is defined as the periodic occurrence of overbank flows of rivers and streams resulting in partial or complete inundation of the adjacent floodplain. Riverine floods are generally caused by prolonged, intense rainfall, snowmelt, ice jams, dam failures, or any combination of these factors. Such overbank flows are natural events that may occur on a regular basis. Riverine floods occur on river systems whose tributaries may drain large geographic areas and encompass many independent river basins. Floods on large river systems may continue for several days. Many areas of Michigan are subject to riverine flooding.

Flash flooding differs from riverine flooding in extent and duration. Flash floods are brief, heavy flows on small streams or in normally dry creeks. Flash floods are normally the result of locally-intense thunderstorms resulting in significant rainfall. Flash floods are typically characterized by high velocity water, often carrying large amounts of debris.

Urban flooding involves the overflow of storm sewer systems and is usually caused by inadequate drainage following heavy rainfall or rapid snowmelt.

For approximate floodplain mapping , see http://esri.com/hazards/makemap.html. For current conditions, see http://www.nws.noaa.gov/oh/hic/current/streamflow.shtml. To download digital floodplain data, see http://www.state.mi.us/webapp/cgi/mgdl/?rel=thext&action=thmname&cid=6&cat=Flood+Insurance+Rate+Maps+%28Q3+FIRMs%29. For FEMA information on communities (the Community Status Book for Michigan) that participate in the National Flood Insurance Program (NFIP), identifying dates of known Flood Insurance Rate Maps (FIRMs) that map out community floodplain areas, see http://www.fema.gov/cis/mi.pdf. (This is the basic data source for the digital floodplain maps referred to above.)

NOTE: Hazard analyses and mitigation plans designed to meet planning requirements for the Flood Mitigation Assistance program must meet specific requirements. These requirements will be addressed in later sections of this workbook – see Appendices B and C.

C. Shoreline Flooding/Erosion:

Flooding and erosion along Michigan's 3,200 mile long Great Lakes shoreline is typically caused by high Great Lakes water levels, storm surges, or high winds. Shoreline flooding and erosion are natural processes that occur at normal and even low Great Lakes water levels. During periods of high water, however, flooding and erosion are more frequent and serious, causing damage to homes, businesses, roads, water distribution and wastewater treatment facilities, and other structures in coastal communities. Windstorms and differences in barometric pressure can temporarily tilt the surface of a lake up at one end as much as 8 feet. This phenomenon is called a storm surge and can drive lake water inland over large areas.

For mapping, see http://esri.com/hazards/makemap.html .For current conditions, see http://www.nws.noaa.gov/oh/hic/current/streamflow.shtml .

Hazardous Material Incidents:

A. Fixed Site:

An uncontrolled release of hazardous materials from a fixed site, capable of posing a risk to health, safety, property and the environment. Hazardous materials are present in quantities of concern in business and industry, agriculture, universities, hospitals, utilities, and other community facilities. Hazardous materials are materials or substances which, because of their chemical, physical, or biological nature, pose a potential threat to life, health, property and the environment if they are released. Examples of hazardous materials include corrosives, explosives, flammable materials, radioactive materials, poisons, oxidizers, and dangerous gases.

Hazardous materials are highly regulated by the government to reduce risk to the general public, property and the environment. Despite precautions taken to ensure careful handling during the manufacture, transport, storage, use and disposal of these materials, accidental releases are bound to occur. Areas at most risk are within a 1-5 mile radius of identified hazardous material sites. Many communities have detailed plans and procedures in place for responding to incidents at these sites, but releases can still cause severe harm to people, property and the environment if proper mitigative action is not taken in a timely manner.

The world's deadliest hazardous material incident occurred on December 4, 1984 in Bhopal, India. A cloud of methyl isocyanate gas, an extremely toxic chemical, escaped from a Union Carbide chemical plant, killing 2,500 people and injuring tens of thousands more. This incident triggered historical Federal legislation intended to minimize such disasters from occurring in the United States.

The following sites provide information on LEPCs, types of hazardous materials, Superfund sites, and identifies locations of major industrial users of hazardous materials:
http://www.epa.gov/swercepp/ehs/ehsalpha.html (extremely hazardous materials)
http://www.deq.state.mi.us/documents/deq-ead-sara-lepcroster.pdf (LEPC contacts and locations)
http://www.epa.gov/enviro/html/cerclis/cerclis_query.html (superfund sites)
http://www.atsdr.cdc.gov/hazdat.html (haz mat locations)
http://gis.cdc.gov/ (geographic tool for analysis)

For industrial accident information, see http://www.michigan.gov/cis/0,1607,7-154-11407_15349---,00.html and http://www.michigan.gov/cis/0,1607,7-154-11407_15355_15371---,00.html.

B. Transportation Incidents:

An uncontrolled release of hazardous materials during transport, capable of posing a risk to health, safety, property or the environment. All modes of transportation - highway, railroad, seaway, airway, and pipeline - are carrying thousands of hazardous material 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. The U.S. Department of Transportation regulates the transportation and shipping of over 18,000 different materials. Areas most at risk are within a 1-5 mile radius of a major transportation route along which hazardous material shipments move. All areas in Michigan are potentially vulnerable to a hazardous material transportation incident, although the heavily urbanized and industrialized areas in southern Michigan are particularly vulnerable due to the highly-concentrated population, the large number of transportation routes that criss-cross the area, and the large number of hazardous material shipments that occur on a daily basis.

See http://www.epa.gov/swercepp/ehs/ehsalpha.html for descriptions of extremely hazardous materials, and http://www.michigan.gov/deq/0,1607,7-135-3312_7235---,00.html for an MDOT site about some transportation regulations on hazardous materials shipping. Helpful sites regarding transportation issues include highway traffic count information available at http://www.michigan.gov/mdot/1,1607,7-151-9622_11033_11149-22141--,00.html and information on railroad safety available at http://safetydata.fra.dot.gov/officeofsafety/ and at http://www.fra.dot.gov/safety/ers/index.htm.

Infrastructure Failures:

A failure of critical public or private utility infrastructure resulting in a temporary loss of essential functions and/or services. Such interruptions could last for periods of a few minutes to several days or more. Public and private utility infrastructure provides 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 inter-related systems fails 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. 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. All of these situations can lead to disastrous public health and safety consequences if immediate mitigative steps are not taken. Typically, it is the most vulnerable segments of society - the elderly, children, ill or frail individuals, etc., that are 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 even regions can be negatively impacted.

Much infrastructure is handled locally and not described on web sites that can be listed here, but the sections on dam failure, lightning, extreme temperatures, drought, and so on, may be helpful when considering this multifaceted issue.

Nuclear Attack:

Any hostile attack against the United States, using nuclear weapons, which results in destruction of military and/or civilian targets. All areas of the United States are conceivably subject to the threat of nuclear attack. However, the strategic importance of military bases, population centers and certain types of industries place these areas at greater risk than others. The nature of the nuclear attack threat against the U.S. has changed dramatically with the end of the "Cold War" and the conversion of previous adversaries to more democratic forms of government. Even so, the threat still exists for a nuclear attack against this country. Despite the dismantling of thousands of nuclear warheads aimed at U.S. targets, there still exists in the world a large number of nuclear weapons capable of destroying multiple locations simultaneously. In addition, controls on nuclear weapons and weapons components are sporadic at best in the former Soviet Union, and the number of countries capable of developing nuclear weapons continues to grow despite the ratification of an international nuclear non-proliferation treaty. The possibility of nuclear materials being used in a terrorist attack is also becoming uncomfortably plausible. It appears that the threat of nuclear attack will continue to be a hazard in this country for some time in the future.

At this point, attack planning guidance prepared by the Federal government in the late 1980s still provides the best basis for a population protection strategy for Michigan. That guidance has identified 25 potential target areas in Michigan, and 4 in Ohio and Indiana that would impact Michigan communities, classified as follows: 1) commercial power plants; 2) chemical facilities; 3) counterforce military installations; 4) other military bases; 5) military support industries; 6) refineries; and 7) political targets. For each of these target areas, detailed plans have been developed for evacuating and sheltering the impacted population, protecting critical resources, and resuming vital governmental functions in the post-attack environment. While it is possible for a device to be detonated accidentally in unintended or seemingly random locations due to error, technological device limitations, or mission failure, it is still a good assumption that the locations that are at the greatest risk of attack are those that are most vital to our country's operation. In addition to specific ground target areas, some high-altitude detonation sites may be selected with the intention of maximizing the disruptive effects of a nuclear weapon's electromagnetic pulse on our country's electronic infrastructure.

For information on the nuclear threat, see http://www.acq.osd.mil/bmdo/bmdolink/html/threat.html .

Nuclear Power Plant Accidents:

An actual or potential release of radioactive material at a commercial nuclear power plant or other nuclear facility, in sufficient quantity to constitute a threat to the health and safety of the off-site population. Such an occurrence, though not probable, could affect the short and long-term health and safety of the public living near the nuclear power plant, and cause long-term environmental contamination around the plant. As a result, the construction and operation of nuclear power plants are closely monitored and regulated by the Federal government. Communities with a nuclear power plant must develop detailed plans for responding to and recovering from such an incident, focusing on the 10 mile Emergency Planning Zone (EPZ) around the plant, and a 50 mile Secondary EPZ that exists to prevent the introduction of radioactive contamination into the food chain. Michigan has 3 active commercial nuclear power plants and 1 inactive one, in addition to 4 small nuclear testing/research facilities located at 3 state universities and within the City of Midland.

For plant and nuclear reactor locations, information, and response plans, see the Nuclear Regulatory Commission web site at http://www.nrc.gov/reactors/ql-reactors.html.

Oil and Gas Well Accidents:

An uncontrolled release of oil or gas from wells, or its poisonous by-product, hydrogen sulfide (see the section on Petroleum and Natural Gas Pipeline Accidents for more information).

Oil and gas are produced from fields in over 60 counties in the Lower Peninsula. Over 40,000 wells have been drilled in these counties. Of that total, approximately one-half (20,000) have produced oil or gas. Over 1.1 billion barrels of crude oil and 3.6 trillion cubic feet of gas have been withdrawn from these wells.

For identification and risk assessment of oil & gas wells, a list can be downloaded from the MDEQ site at http://www.deq.state.mi.us/gsd/WellLoc/Index.html along with regulations relating to their operation. The locations of sites for which permits were given are described using rectangular land descriptions. Not all permitted locations actually have active wells, and not all well sites produce the harmful gas, hydrogen sulfide. If wells appear to be situated near populated, developed, or highly-traveled areas, information can be requested from MDEQ about whether the wells actually exist, and whether hydrogen sulfide was found in them. Requests should refer to the specific permit number obtained from the web list. Some permitted sites have never actually had wells dug or drilled. Others have been filled in ("plugged") and no longer pose any threat. A helpful mapping reference for Statewide or general overview purposes can be found at http://www.michigan.gov/deq/0,1607,7-135-3311_4111_4231-14421--CI,00.html and more detailed county maps can be found through http://www.michigan.gov/dnr/1,1607,7-158-12540_13817_13818_14398-30992--,00.html. The State also has a useful online geographic data library at http://www.state.mi.us/webapp/cgi/mgdl/ that allows this sort of information to be downloaded for use in GIS.

Petroleum and Natural Gas Pipeline Accidents:

An uncontrolled release of petroleum or natural gas, or the poisonous by-product hydrogen sulfide, from a pipeline. As a major petroleum and natural gas consumer in the United States, vast quantities of petroleum and natural gas are transported through and stored in Michigan. Though often overlooked as a threat because much of the petroleum and gas infrastructure in the state is located underground, petroleum and gas pipelines can leak, erupt or explode, causing property damage, environmental contamination, injuries and loss of life. In addition to these hazards, there is also a danger of hydrogen sulfide release. Hydrogen sulfide is an extremely poisonous gas that is also explosive when mixed with air temperatures of 500 degrees or above. In addition to pipelines, these dangers 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.

Unfortunately, no comprehensive source of information about pipeline locations has yet been found on the internet by our staff. However, a map of approximate locations of major pipelines appears in the Michigan Hazard Analysis document produced by the Michigan State Police Emergency Management Division.

Public Health Emergencies:

A widespread and/or severe epidemic, incident of contamination, or other situation that presents a danger to or otherwise negatively impacts the general health and well-being of the public. Public health emergencies can take many forms: 1) disease epidemics; 2) large-scale incidents of food or water contamination; 3) extended periods without adequate water and sewer services; 4) harmful exposure to chemical, radiological or biological agents; or 5) large-scale infestations of disease-carrying insects or rodents. Public health emergencies can occur as primary events by themselves, or they may be secondary events 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. For mapping information on diseases, see http://gis.cdc.gov/. Other types of information can likely be found in various sections of the Michigan DEQ website.

Sabotage/Terrorism:

An intentional, unlawful use of force or violence against persons or property to intimidate or coerce a government, the civilian population, or any segment thereof, in furtherance of political, social, or religious objectives. Sabotage/terrorism can take many forms or have many vehicles for delivery, including: 1) bombings; 2) assassinations; 3) organized extortion; 4) use of nuclear, chemical, radiological, and biological weapons; 5) information warfare; 6) ethnic/religious/gender intimidation (hate crimes); 7) state and local militia groups that advocate overthrowing the U.S. Government; 8) eco-extremism, designed to destroy or disrupt specific research or resource-related activities; and 9) widespread and organized narcotics smuggling and distribution organizations. Because sabotage/terrorism objectives are so widely varied, so too are the potential targets of such actions. Virtually any public facility or infrastructure, or place of public assembly, can be considered a potential target. In addition, certain types of businesses engaged in controversial activities are also potential targets, as are large computer systems operated by government agencies, banks, financial institutions, large businesses, health care facilities, and colleges/universities.

One of the first acts of domestic sabotage/terrorism ever carried out occurred in Michigan on May 18, 1927, in Bath. A disgruntled taxpayer and farmer detonated 1,000 pounds of explosives under the newly constructed Bath Consolidated School, killing 38 students and 3 teachers and injuring 58 others. The perpetrator then blew himself up, along with the school superintendent. As tragic as that event was, it could have been worse were it not for the fact that half of the explosives failed to detonate as planned, which certainly would have killed many more students and teachers. Concentrated activities to prevent terrorist activities have become even more vital with the passage of time and in the wake of the 9/11 events of destruction in New York City and Washington, D.C. Many more resources may be anticipated to be mobilized to prevent terrorist activities in the near future.

Some of the useful sites available at this time include http://www.nlectc.org/ccfp/, http://www.state.gov/s/ct/, http://www.fbi.gov:80/library/terror/terroris.htm .

Subsidence:

Depressions, cracks, and sinkholes in the ground surface, which can threaten people and property. Subsidence depressions, which normally occur over many days to a few years, may damage structures with low strain tolerances, such as dams, nuclear reactors, and utility infrastructure. The sudden collapse of the ground surface to form sinkholes poses an immediate threat to life and property. Such ground movements may continue for several days, weeks, months or even years, until the walls stabilize. The population most at risk would be in areas where industrial or residential development has occurred above active or abandoned mines where underground cavities are present near the surface, as well as areas where an extensive amount of groundwater has been withdrawn.

See http://www.osmre.gov/aml/inven/zintroin.htm or http://www.mg.mtu.edu/mining/ab.htm for general information, and http://www.mg.mtu.edu/mining/abmine/mtrg.htm for information about the Michigan Abandoned Mineland Inventory.

Thunderstorm Hazards:

A. Hail:
A condition where atmospheric water particles from thunderstorms form into rounded or irregular lumps of ice that fall to the earth. Hail is a product of the strong thunderstorms that frequently move across the state. As one of these thunderstorms passes over, hail usually falls near the center of the storm, along with the heaviest rain. Sometimes, however, 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. Hailstones range in size from a pea to a golf ball, and hailstones larger than baseballs are possible in the most severe thunderstorms. Hail is formed when strong updrafts in thunderstorms provide a medium for the growth and accumulation of ice crystals. A hailstone continues to grow until updrafts can no longer hold its weight aloft. Hailstones then descend to the ground, battering crops, denting autos, and injuring wildlife and people. Hail causes $1 billion in damage nationwide each year. Large hail is a characteristic of severe thunderstorms, and it can be associated with the occurrence of a tornado.

See http://www.esri.com/hazards/makemap.html for some historical events, http://www.wrh.noaa.gov/sacramento/hail.html and http://weather.noaa.gov/weather/MI_cc_us.html more other information. Thunderstorm frequencies can be estimated from http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvent~Storms.

B. Lightning:
The discharge of electricity from within a thunderstorm. Although lightning is often perceived as a minor hazard, it damages many structures and kills and injures more people in the U.S. per year, on average, than tornadoes or hurricanes. Many lightning deaths and injuries could be avoided if people would have more respect for the threat that lightning presents. Michigan ranks second in the nation in both lightning-related deaths and lightning-related injuries.

See http://www.lightningsafety.com/nlsi_lhm.html for information on lightning risk assessment and hazard mitigation. A detailed hazard analysis will use an estimate of annual lightning flash density. A rough area-estimate of this risk can be found at http://www.lightningsafety.com/nlsi_info/lightningmaps/US_FDightning.html but it should be noted that site-specific factors such as elevation and building type/height must be taken into account for greater accuracy.

C. Severe Winds (Windstorms):
According to the National Weather Service, winds 58 miles per hour or greater are classified as a windstorm. Windstorms are a fairly common occurrence in many areas in Michigan. Along the Great Lakes shoreline, strong winds occur with regularity, and gusts of over 74 miles per hour (hurricane velocity) do occasionally occur in conjunction with a storm system. Severe windstorms can cause damage to homes and businesses, power lines, trees and agricultural crops, and may require temporary sheltering of individuals without power for extended periods of time. Windstorms occur in all areas of Michigan, although more often along the lakeshore and in central and southern lower Michigan.

Estimate thunderstorm frequencies at http://www.lightningsafety.com/nlsi_info/lightningmaps/US_TDightning.html . "Wind Zone" areas are identified at http://www.fema.gov/graphics/library/wmap.gif .

D. Tornadoes:
A violently rotating column of air extending downward to the ground from a cumulonimbus cloud. The funnel cloud associated with a tornado may have winds up to 300 miles per hour and an interior air pressure that is 10-20 percent below that of the surrounding atmosphere. The typical length of a tornado path is approximately 16 miles, but tracks much longer than that - some even up to 200 miles - have been reported. Tornado path widths are generally less than one-quarter mile wide, but can be over one mile wide. Historically, tornadoes have resulted in the greatest loss of life of any natural hazard, with the mean national annual death toll being 111 persons. Property damage from tornadoes is in the hundreds of millions of dollars every year. Michigan averages approximately 18 tornadoes per year, most occurring in the southern Lower Peninsula.

See http://www.esri.com/hazards/makemap.html for some historical occurrences. Thunderstorm frequencies can be estimated from http://www.lightningsafety.com/nlsi_info/lightningmaps/US_TDightning.html and http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvent~Storms. For general info, http://www.spc.noaa.gov/faq/tornado/. For more specific and descriptive information, http://www.nssl.noaa.gov/hazard/.

Air, Land and Water Transportation Accidents:

A crash or accident involving an air, land or water-based commercial passenger carrier resulting in death or serious injury. Vulnerable areas would include: 1) communities with, or near, an airport offering commercial passenger service; 2) communities with railroad tracks on which commercial rail passenger service is provided; 3) communities in which commercial intercity passenger bus or local transit bus service is provided; 4) communities with school bus service; and 5) communities in which commercial marine passenger ferry service is provided. A serious accident involving any of the above modes of passenger transportation could result in a mass casualty incident, requiring immediate life-saving community response. In addition, a marine transportation accident would require a water rescue operation, possibly under dangerous conditions on the Great Lakes.

In terms of commercial passenger transportation service, Michigan has approximately: 1) 19 airports that offer commercial air passenger service; 2) 130 certified intercity passenger bus carriers providing service to 220 communities; 3) 72 local bus transit systems serving 85 million passengers; 4) 19 marine passenger ferry services; and 5) 3 intercity rail passenger routes operating on 568 miles of track, along 3 corridors, serving 22 communities.

See the MDOT site at http://www.michigan.gov/mdot/1,1607,7-151-9622_11033_11149-22141--,00.html for traffic volume information. An introductory web site about traffic accident mitigation through road redesign can be found at http://www.statefarm.com/di/lowcost.htm.

Severe Winter Weather Hazards:

See the NOAA sites at http://weather.noaa.gov/fax/miscella.shtml#mprecip, http://www.nws.noaa.gov/om/winter/index.shtml and http://www.nws.noaa.gov/oh/hic/current/snow.shtml.

A. Ice and Sleet Storms:
A storm that generates sufficient quantities of ice or sleet to result in hazardous conditions and/or property damage. Sleet storms differ from ice storms in that sleet is similar to hail (only smaller) and can be easily identified as frozen rain drops (ice pellets) when bounce when hitting the ground or other objects. Sleet does not stick to trees and wires, but sleet in sufficient depth does cause hazardous driving conditions. Ice storms are the result of cold rain that freezes on contact with the surface, coating the ground, trees, buildings, overhead wires, etc. with ice, sometimes causing extensive damage. When electric lines are downed, inconveniences are felt in households and economic loss and disruption of essential services is often experienced in affected communities. Michigan has had numerous damaging ice storms over the past few decades.

B. Snowstorms:
A period of rapid accumulation of snow often accompanied by high winds, cold temperatures, and low visibility. Blizzards are the most dramatic and perilous of all snowstorms, characterized by low temperatures and strong winds bearing enormous amounts of snow. Most of the snow accompanying a blizzard is in the form of fine, powdery particles of snow which 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. As a result of being surrounded by the Great Lakes, Michigan experiences large differences in snowfall in relatively short distances. The annual mean accumulation ranges from 30 to 170 inches of snow. The highest accumulations are in the northern and western parts of the Upper Peninsula. Because of the "lake effect" on weather patterns, snowstorms tend to be more severe if prevailing winds bring them in from over one of the Great Lakes.

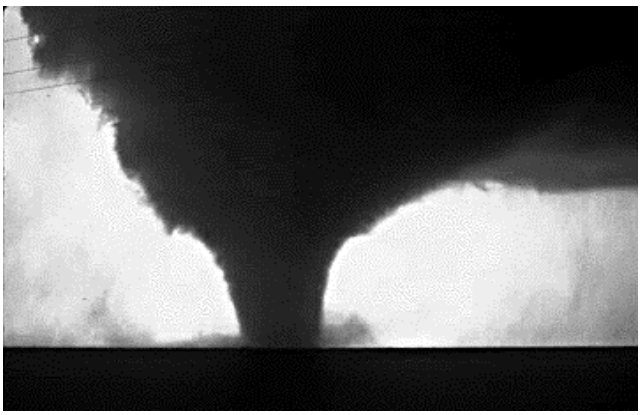
Formatting a Hazard Analysis Document

It may make sense in some cases to have closely related hazards combined into a single section of a hazard analysis or mitigation plan. To help organize plan content, it may also be useful to order the hazards so that those of greatest concern are presented first and are analyzed in the greatest detail. Others may prefer to have separate sections dealing with natural, technological, and social/societal hazards, each of which has been prioritized within these subsections according to the risk it poses. For example:

> Natural hazards:
> floods, wildfires, drought, thunderstorm hazards (severe winds, tornadoes, hail, lightning), severe winter weather (ice, sleet, and snow storms), extreme temperatures
>
> Technological hazards:
> structural fires (including explosions and industrial accidents), dam failures, hazardous material incidents (fixed site and transportation related), infrastructure failure (water distribution, storm & sanitary sewers, electrical power system, communications systems), oil and gas well/pipeline accidents, land subsidence, transportation accidents (airplane, rail, multi-passenger/multi-vehicle incidents, marine incidents).
>
> Human-related hazards:
> nuclear attack/civil defense emergency, weapons of mass destruction/terrorism/sabotage, public health emergencies, civil disturbances (riots, prison uprisings, etc.)

Note that in this example, the ordering of hazards above may not match their priorities in your community. For more information about prioritizing hazards, see the following sections on risk and vulnerability assessments (steps 1c and 1d).

Regardless of how the hazards are ordered, is it usually easiest to read about all aspects of each hazard (identification, risk, and vulnerability) at the same time. Therefore, as information is gathered during additional steps of the analysis, it can be placed in specific hazard sections, following up the initial hazard identification descriptions with a discussion of specific threats to vulnerable parts of the community. Interactions between multiple hazards can be addressed in community or sector overview sections of your plan.



EXAMPLE OF A QUESTIONNAIRE THAT COULD BE USED FOR THE LOCAL HAZARD IDENTIFICATION PROCESS:

Dear **(NAME OF LOCAL OFFICIAL FROM WHOM INFORMATION IS REQUESTED)**:

The **(INSERT NAME OF AGENCY DOING THE RESEARCH AND PLAN WRITING)** is seeking information about various hazards that might eventually affect people, property, or the environment in the area of **(INSERT NAME OF COMMUNITY BEING PLANNED FOR)**.

The goal of this research is to fulfill federal requirements for the creation of a hazard mitigation plan. Communities that wish to receive funding for hazard mitigation projects from the Hazard Mitigation Grant Program will be required (by the Federal Emergency Management Agency) to create, or participate in the creation of, an approved local hazard mitigation plan satisfying the requirements of the Disaster Mitigation Act of 2000 and 44 CFR 201.6. The **(INSERT NAME OF AGENCY DOING THE RESEARCH AND PLAN WRITING)** is beginning the research that is necessary to complete such a plan, and your input will help the community of **(INSERT NAME OF COMMUNITY THAT INFORMATION IS BEING REQUESTED FOR)** to be eligible for Hazard Mitigation Grant Program funding in the future.

Please take some time to consider the following topics and how your community may potentially be affected by them. **Any conditions which may bring harm to people or property, or interfere significantly with business or community infrastructure, should be noted and described below.** If you need more room for your responses, feel free to use additional sheets of paper.

(A map of your community is enclosed with this questionnaire. **(PLEASE ENCLOSE THE COMMUNITY'S BASE MAP IF THIS SENTENCE IS USED IN YOUR QUESTIONNAIRE.)** Please mark any locations on this map that relate to the hazards you have identified below. If you have any questions about this questionnaire or hazard identification project please contact **(INSERT NAME OF RESEARCHER)** at **(INSERT RESEARCHER'S PHONE NUMBER)**.)

IDENTIFICATION OF HAZARDS FOR (insert community name here)

1. FLOODING: Please describe the extent and locations of any known flood damages or risks in your community, whether from a lake shoreline, from river, creek, or drain overflow, or from problems with area sewer systems.

2. WILDFIRES: Please describe any known events or risks from wildfires in or near your community.

3. GROUND MOVEMENT: Please describe any events or known risks from earthquake activity, landslides, mudslides, erosion, or ground subsidence (such as that from collapsing mine tunnels).

4. SEVERE WINTER WEATHER: Please describe the potential impact of severe winter weather conditions on your community, including the extent of possible snow, sleet and ice and accumulation, extremely cold temperatures, and their impact on people, structures, infrastructure, business and services.

5. SEVERE STORMS: Please describe the potential impacts of severe storms on your community, including the effects of heavy rains, hail, lightning, severe winds, and tornadoes; and their impact on people, structures, infrastructure, business and services.

6. TECHNOLOGICAL HAZARDS: Please describe the potential impacts of industrial accidents or mishaps such as explosions, hazardous materials release, nuclear material incidents, accidents involving oil and gas wells and pipelines, structural fires, scrap tire fires, dam failures, or similar events.

7. WEATHER PATTERNS: Please describe how your community may be particularly affected by extreme summer heat, or by drought events.

8. HUMAN-CAUSED INCIDENTS: Please describe how your community might be vulnerable to acts of terrorism, sabotage, or civil disturbances.

9. PUBLIC HEALTH EMERGENCIES: Please describe how your community might be particularly affected by conditions of disease outbreak, contamination, etc. that would threaten public health.

10. LARGE-SCALE EMERGENCY EVENT: Please describe any special concerns relating to your community if some large-scale event (such as an enemy military attack, nuclear explosion, asteroid impact, etc.) were to occur.

11. TRANSPORTATION ACCIDENTS: Please describe any special concerns or vulnerabilities your community might have from a larger-scale incident involving vehicles (aircraft, buses, ferries, ships, trains, etc.) carrying many passengers, or transporting hazardous materials.

12. INFRASTRUCTURE FAILURE: Please describe the concerns, potential impacts, or vulnerabilities your community might have as a result of a breakdown in critical services, energy shortages, etc. that are necessary for the normal functioning of your community.

Please identify on these sheets (in the sections above, or on the back of this page) which of the described hazards are the most threatening to your community.