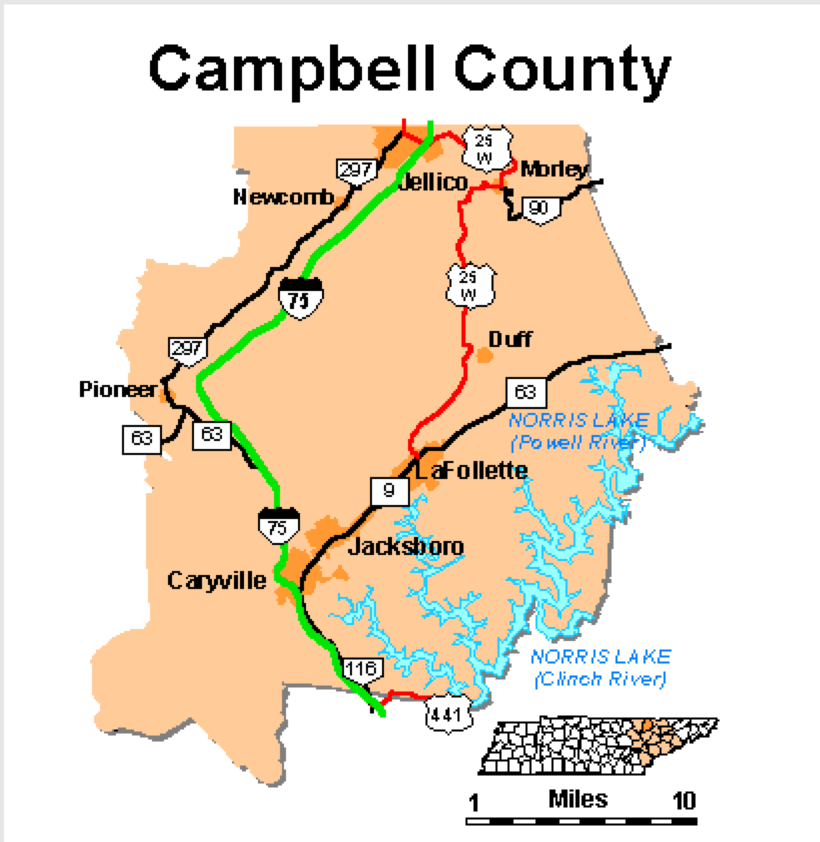
MULTI-JURISDICTIONAL HAZARD MITIGATION PLAN



CAMPBELL COUNTY TENNESSEE 2012

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SECTION 4 RISK ASSESSMENT - HAZARD IDENTIFICATION

4.1 INTRODUCTION

Multi-hazard Requirement §201.6(c)(2)(i): The risk assessment shall include a description of the type of all natural hazards that can affect the jurisdiction. A. Does the new or updated plan include a description of the types of all natural hazards that affect the jurisdiction?
CRS Step 4: Assess the Hazard: CRS requires at the minimum that the flood hazard be identified including addressing the repetitive loss areas. However, additional credit can be earned for including discussion of all other natural hazards.

According to the Federal Emergency Management Agency (FEMA) Guidance 386-2, "risk assessment is the process of measuring the potential loss of life, personal injury, economic injury, and property damage resulting from natural hazards by assessing the vulnerability of people, buildings, and infrastructure to natural, technological, and human-caused hazards." The risk assessment process used for this 2011 Plan update is consistent with the process and steps presented in the Federal Emergency Management Agency 386-2, State and Local Mitigation Planning How-to-Guide, Understanding Your Risks – Identifying Hazards and Estimating Losses (FEMA, 2001).

The first step of the risk assessment process is to identify the hazards of concern. This section identifies natural, technological, and human-caused hazards that may impact Campbell County and its communities.

4.2 NATURAL HAZARD IDENTIFICATION METHODOLOGY

FEMA's current regulations require only identification, profiling, and evaluation of natural hazards that threaten lives, property, and other assets. However, FEMA strongly suggests including technological and human-caused hazards in jurisdictional hazard mitigation plans.

In addition, as new developments occur and the environment changes, new hazards may become evident and must be considered for inclusion in mitigation plan. Examples include a new industry that introduces a hazardous material, a political climate (i.e., 9/11, which introduced terrorism), and human, animal, and plant disease/infestation incidents.

Campbell County is vulnerable to a wide array of hazards that threaten life and property. This Risk Assessment – Hazard Identification section provides background information for these hazards. It is important that all natural hazards be initially considered for relevance in advancing through the hazard mitigation planning process. Subsequent sections of the updated Plan – Section 5 Hazard Profiles and Section 6 Assessing Vulnerability – address the hazards of specific concern to the county. The Campbell County Hazard Mitigation Planning Committee considered and evaluated all natural hazards in terms of their potential risk to Campbell County and its citizens. The end result was identifying the same natural hazards identified in the State of Tennessee 2007 Hazard Mitigation Plan. The Table below documents the hazards included in the Campbell County 2012 Plan and their disposition in Sections 4, 5, and 6 of this 2012 Plan.

Table 4.1: 2012 Mitigation Plan Hazard Status			
2011 Hazard	**Exp**	**Risk/Threat**	**2011 Updated Plan Status**
Drought	Possible	Moderate/Slight	Identified/profiled, detailed vulnerability assessment
Earthquake	Possible	Low/Moderate	Identified/profiled, detailed vulnerability assessment
Extreme Temperature	Possible	Moderate/Minimal	Identified/profiled, detailed vulnerability assessment
Flooding	Probable	Moderate/High	Identified as Tropical Storms/Hurricanes, Thunderstorms, Dam/Levee Failure, profiled and detailed vulnerability assessment
Hail	Probable	Moderate/Minimal	Identified/profiled, detailed vulnerability assessment
High Winds	Probable	High/High	Identified as Tropical Storms/Hurricanes, Thunderstorms, Tornadoes, profiled and detailed vulnerability assessment
Ice/Snow Storms	Probable	Moderate/Moderate	Identified/profiled, detailed vulnerability assessment
Land Subsidence	Probable	Moderate/Minimal	Identified/profiled, detailed vulnerability assessment
Landslides/ Mudslides	Probable	Moderate/Minimal	Identified/profiled, detailed vulnerability assessment
Lightning	Probable	Moderate/Low	Identified/profiled, detailed vulnerability assessment
Wildfires	Probable	Moderate/Moderate	Identified/profiled, detailed vulnerability assessment
Hazardous Materials	Probable	Moderate/High	Identified/profiled, detailed vulnerability assessment
Illegal Meth Labs	Probable	Moderate/Slight	Identified/profiled, detailed vulnerability assessment
Terrorism	Possible	Slight/Moderate	Identified/profiled, detailed vulnerability assessment
Urban Fires	Probable	Moderate/Moderate	Identified/profiled, detailed vulnerability assessment
Pandemic	Possable	Low/High	Identified/profiled, detailed vulnerability assessment

4.3 STATE OF TENNESSEE HAZARD IDENTIFICATION (2007 Plan)

The initial step in the State of Tennessee risk assessment was the identification of hazards that could probably/possibly occur in the State of Tennessee. Utilizing degrees of probability and possibility, the natural hazards identified in the Tennessee Emergency Management Plan were reviewed by the State Hazard Mitigation Planning Committee/Hazard Mitigation Council for the State's Hazards of Prime Concern. (See Tables below.)

Table 4.2: State of Tennessee 2007 Plan Hazard Identification				
HAZARD	**Probable**	**Possible**	**Unlikely**	**No Threat**
Avalanche[1]			X	
Drought		X		
Extreme Temperatures	X			
Earthquake		X		
Erosion[2]				X
Famine[1]			X	
Fire	X			
Flood	X			
Geologic	X			
Glacier/Iceberg[2]			X	X
Hurricane[1]			X	
Range Fire[1]			X	

Severe Storm	X			
Severe Winter Storm	X			
Sleet (Included in SWS)	X			
Tornado	X			
Tropical Cyclone[2]			X	X
Tsunami[2]			X	X
Volcano[2]			X	X
1 Due to the unlikelihood of occurrence, Avalanche, Famine, Hurricane, and Range Fire were excluded from the in-depth review/evaluation process.				
2 Some incidents were conceivable but highly improbable. Consequently, Erosion, Glacier/Iceberg, Tropical Cyclone, Tsunami, and Volcano were considered NO THREAT to the state.				

Table 4.3: State of Tennessee 2007 Identified Hazards		
HAZARD	**Probable**	**Possible**
Flood (Riverine/Flash)	X	
Severe Storm (Hail/Lightning/Wind/Etc.)	X	
Severe Winter Storm (Snow/Ice/Sleet)	X	
Tornado	X	
Earthquake		X
Extreme Temperatures	X	
Drought		X
Fire (Wildland/Urban.)	X	
Geologic (Landslides/Expansive Soils/Subsidence)	X	

4.4 NATURAL HAZARDS IDENTIFICATION

4.4.1 Avalanche Identification

An avalanche is a sudden rapid flow of snow down a slope, occurring when either natural triggers or human activity causes a critical escalating transition from the slow equilibrium evolution of the snow pack. Typically occurring in mountainous terrain, an avalanche can mix air and water with the descending snow. Powerful avalanches have the capability to entrain ice, rocks, trees, and other material on the slope. Avalanches are primarily composed of flowing snow, and are distinct from mudslides, rockslides, and serac collapses on an icefall. In contrast to other natural incidents that cause disasters, avalanches are not rare or random incidents and are endemic to any mountain range that accumulates a snow pack. In mountainous terrain, avalanches are among the most serious hazards to life and property with their destructive capability resulting from their potential to carry an enormous mass of snow rapidly over large distances.

Figure 4.1: Depiction of an Avalanche

Source: NWS

Avalanches are classified by their morphological characteristics, and are rated by either their destructive potential, or the mass of the downward flowing snow. Some of the morphological characteristics used to classify avalanches include the type of snow involved, the nature of the failure, the sliding surface, the propagation mechanism of the failure, the trigger of the avalanche, the slope angle, direction, and elevation. Avalanche size, mass, and destructive potential are rated on a logarithmic scale, typically of 5 categories, with the precise definition of the categories depending on the observation system or forecast region.

Avalanches only occur when the stress on the snow exceeds the shear, ductile, and tensile strength either within the snow pack or at the contact of the base of the snow pack with the ground or rock surface. A number of the forces acting on a snow pack can be readily determined. For example, the weight of the snow is straightforward to calculate, but it is very difficult to estimate the shear, ductile, and tensile strengths within the snow pack or relative to the ground below. These strengths vary with the type of snow crystal and the bonding between them. The thermo-mechanical properties of the snow crystals in turn depend on the local conditions they have experienced, such as temperature and humidity. One of the aims of avalanche research is to develop and validate computer models that can describe the time evolution of snow packs and predict the shear yield stress. A complicating factor is the large spatial variability that is typical.

All avalanches share common elements: a trigger which causes the avalanche, a start zone from which the avalanche originates, a slide path along which the avalanche flows, a run out where the avalanche comes to rest, and a debris deposit which is the accumulated mass of the avalanched snow once it has come to rest. Avalanches also have a failure layer that propagates the failure and the bed surface along which the snow initially slides. In most avalanches the failure layer and the bed surface are the same. Slab avalanches have a crown fracture at the top of the start zone, flank fractures on the sides of the start zones, and a shallow staunch fracture at the bottom of the start zone. The crown and flank fractures are vertical walls in the snow delineating the snow that was entrained in the avalanche from the snow that remained on the slope. The nature of the failure of the snow pack is used to morphologically classify the avalanche.

Slab avalanches are generated when an additional load causes a brittle failure of a slab that is bridging a weak snow layer; this failure is propagated through fracture formation in the bridging slab. Loose snow, point release, and isothermal avalanches are generated when a stress causes a shear failure in a weak interface, either within the snow pack, or at the base. When the failure occurs at the base they are known as full depth avalanches. Spindrift avalanches occur when wind-lifted snow is funneled into a steep drainage from above the drainage. Slab avalanches account for around 90% of avalanche-related fatalities, and occur when there is a strong, cohesive layer of snow known as a slab. These are usually formed when falling snow is deposited by the wind on a lee slope, or when loose ground snow is transported elsewhere. When there is a failure in a weak layer, a fracture very rapidly propagates so that a large area, that may be hundreds of meters in extent and several meters thick, starts moving almost instantaneously.

Loose snow avalanches occur in freshly fallen snow that has a lower density and are most common on steeper terrain. In fresh, loose snow the release is usually at a point and the avalanche then gradually widens down the slope as more snow is entrained, usually forming a teardrop appearance. This is in contrast to a slab avalanche.

A wet snow avalanche or isothermal avalanche occurs when the snow pack becomes saturated by water. These tend to also start and spread out from a point. When the percentage of water is very high they are known as slush flows and they can move even on very shallow slopes.

Powder snow avalanches are one of the largest and most powerful of avalanches and can exceed speeds of 300 km/h, and masses of 10,000,000 tons. Their flows can travel long distances along flat valley bottoms and even up hill for short distances. A powder snow avalanche is a powder cloud that forms when an avalanche accelerates over an abrupt change in slope, such as a cliff band, causing the snow to mix with air.

4.4.2 Drought Identification

Figure 4.2: Depiction of Drought

Source: NWS

The National Weather Service (NWS) Climate Prediction Center (CPC) defines drought as a deficiency of moisture that results in adverse impact on people, animals, or vegetation over a sizeable area. Drought is a normal, recurrent feature of climate. It occurs almost everywhere, although its features vary from region to region. In general, drought originates from a deficiency of precipitation over an extended period of time, resulting in a water shortage for some activity, group, or environmental sector.

Other climatic factors, such as high temperatures, prolonged high winds, and low relative humidity, can aggravate the severity of a drought. These conditions are caused by anomalous weather patterns when shifts in the jet stream block storm systems from reaching an area. As a result, large high-pressure cells may dominate a region for a prolonged period, thus reducing precipitation.

This natural hazard differs from others in several ways. First, there is no universally accepted definition of drought. Second, drought onset and recovery are usually slow. Third, droughts can cover a much larger area and last many times longer than most other natural hazards. Fourth, they are part of the natural climate variability. According to the Federal Emergency Management Agency (FEMA), the National Drought Mitigation Center (NDMC), and the NWS, there are four ways that drought can be defined:

Meteorological drought is a measure of departure of precipitation from normal. It is defined solely on the degree of dryness. Due to climatic differences, what might be considered as a drought in one location of the country may not be considered as a drought in another location.

Agricultural drought links various characteristics of meteorological drought to agricultural impacts, focusing on precipitation shortages, differences between actual and potential evapotranspiration, soil water deficits, reduced ground water or reservoir levels, etc. It occurs when there is not enough water available for a particular crop to grow at a particular time. Agricultural drought is defined in terms of soil moisture deficiencies relative to water demands of plant life, primarily crops.

Hydrological drought is associated with the effects of periods of precipitation (including snowfall) shortfalls on surface or subsurface water supply and occurs when these water supplies are below normal. It is related to the effects of precipitation shortfalls on stream flows and reservoir, lake, and groundwater levels.

Socioeconomic drought is associated with the supply and demand of some economic good with elements of meteorological, hydrological, and agricultural drought. This differs from the aforementioned types of drought because its occurrence depends on the time and space processes of supply and demand to identify or classify droughts. The supply of many economic goods depends on weather (e.g., water, forage, food grains, fish, and hydroelectric power). Socioeconomic drought occurs when the demand for an economic good exceeds supply as a result of a weather-related shortfall in water supply.

4.4.3 Earthquake Identification

Figure 4.3: Earthquake Example

Source: University of Colorado

An earthquake is "sudden motion or trembling caused by an abrupt release of accumulated strain in the tectonic plates that comprise the earth's crust." These rigid plates, known as tectonic plates, are some 50 to 60 miles in thickness and move slowly and continuously over the earth's interior. The plates meet along their edges, where they move away, past, or under each other at rates varying from less than a fraction of an inch up to five inches per year. While this sounds small, at a rate of two inches per year, a distance of 30 miles would be covered in approximately one million years (FEMA, 1997). The tectonic plates continually bump, slide, catch, and hold as they move past each other, which causes stress to accumulate along faults. When this stress exceeds the elastic limit of the rock, an earthquake occurs, immediately causing sudden ground motion and seismic activity.

The vibration or shaking of the ground during an earthquake is described by ground motion. The severity of ground motion generally increases with the amount of energy released and decreases with distance from the fault or epicenter of the earthquake. Ground motion causes waves in the earth's interior, known as seismic waves, and along the earth's surface, known as surface waves. The following are the two kinds of seismic waves:

P (primary) waves are longitudinal or compressional waves similar in character to sound waves that cause back-and-forth oscillation along the direction of travel (vertical motion), with particle motion in the same direction as wave travel. They move through the earth at approximately 15,000 mph.

S (secondary) waves, also known as shear waves, are slower than P waves and cause structures to vibrate from side-to-side (horizontal motion) due to motion at right angles to the direction of wave travel. Unreinforced buildings are more easily damaged by S waves.

There are also two kinds of surface waves, Raleigh waves and Love waves. These waves travel more slowly and typically are significantly less damaging than seismic waves.

The location of an earthquake is commonly described by its focal depth and the geographic position of its epicenter. The focal depth of an earthquake is the depth from the earth's surface to the region where an earthquake's energy originates (the focus or hypocenter). The epicenter of an earthquake is the point on the earth's surface directly above the hypocenter (Shedlock and Pakiser, 1997). Earthquakes usually occur without warning and their effects can impact areas a great distance from the epicenter (FEMA, 2001).

4.4.4 Extreme Temperatures Identification

Extreme temperatures include both heat and cold incidents, which can have a significant impact to human health, commercial/agricultural businesses, and primary and secondary effects on infrastructure (e.g., burst pipes and power failure). Based on what the population is accustomed to, what constitutes "extreme heat" or "extreme cold" varies across different areas of the country**.**

4.4.4.1 Extreme Heat

The CDC defines temperatures that hover 10 degrees or more above the average high temperature for a region and last for several weeks as extreme heat. A heat wave is a prolonged period of excessively hot weather, which may be accompanied by high humidity. There is no universal definition of a heat wave because the term is relative to the usual weather in the area. Temperatures that people from a hotter climate consider normal can be termed a heat wave in a cooler area if they are outside the normal climate pattern for that area. Also, the term is applied both to routine weather variations and to extraordinary spells of heat, which may occur only once a century.

Figure 4.4: Depiction of Extreme Heat

Source: State of Tennessee Mitigation Plan

4.4.4.2 Extreme Cold

What constitutes extreme cold and its effects can vary across different areas of the country. In regions relatively unaccustomed to winter weather, near freezing temperatures are considered extreme cold. Extreme cold incidents occur when temperatures drop well below normal in an area. Extremely cold temperatures often accompany a winter storm, so individuals may have to cope with power failures and icy roads. Although staying indoors as much as possible can help reduce the risk of car crashes and falls on the ice, individuals may also face indoor hazards. Many homes will be too cold – either due to a power failure or because the heating system is not adequate for the weather. As people use space heaters and fireplaces to stay warm, the risk of household fires and carbon monoxide poisoning increases. Exposure to cold temperatures can lead to serious or life-threatening health problems such as hypothermia, cold stress, frostbite, or freezing of the exposed extremities such as fingers, toes, nose, and ear lobes.

4.4.5 Flooding Identification

Flooding is an overflowing of water onto normally dry land and is one of the most significant and costly of natural disasters. The principle types of floods are dam or levee failure, flash floods, riverine floods, and storm surge flooding.

<u>Dam/Levee Failure floods</u> usually result from intense rainfall or snow melt that produces water quantities that breach dams or levees because of faulty design, construction, or operational inadequacies. Levee failures may also result from storm surge in coastal areas.

<u>Flash floods</u> result from quickly rising streams after heavy rain or rapid snowmelt, ice jams (ice that accumulates at a natural or human-made obstruction and slows the flow of water) or the absence or overflow of storm sewers in a relatively small drainage area and produce localized

floods of great volume and short duration. Flash floods usually result from tropical storm/hurricane or thunderstorm weather incidents.

Riverine floods result from precipitation or snowmelt over large areas and occur in river systems and tributaries that may drain large geographic areas. The precipitation usually results from tropical storm/hurricane or thunderstorm weather incidents.

Storm Surge floods result from tropical storm/hurricane weather incidents.

Tsunami floods are the result of an extreme ocean wave breaking on shore, usually generated by extremely high winds or a seismic incident occurring in adjacent oceans.

Figure 4.5: Depiction of a Flood

Source: NOAA

Other flood-related definitions:

Floodplain - Any land area susceptible to inundation by floodwaters from any source.

100/500-Year Floodplain is defined as the area adjoining a river, stream, or watercourse covered by water in the event of a 100/500-year flood.

The term "100-year flood" is misleading. It is not a flood that will occur once every 100 years. Rather, it is the flood elevation that has a 1 percent chance of being equaled or exceeded each year. Thus, the 100-year flood could occur more than once in a relatively short period of time. The 100-year flood, which is the standard used by most federal and state agencies, is used by the National Flood Insurance Program (NFIP) as the standard for floodplain management and to determine the need for flood insurance. A structure located within a special flood hazard area shown on a map has a 26 percent chance of suffering flood damage during the term of a 30-year mortgage. One hundred year floodplains have been identified, mapped and used for further analysis using the county's Geographic Information System (GIS).

The 500-year standard (0.2-percent-annual-chance) follows the same logic as the 100-year flood definition.

Floodway: The channel of a river or watercourse and the adjacent areas that must be reserved in order to discharge the 100-year flood without cumulatively increasing the water surface elevation more than one foot.

Flood Fringe: That portion of the floodplain outside the floodway that is inundated by floodwaters in which encroachment is permissible.

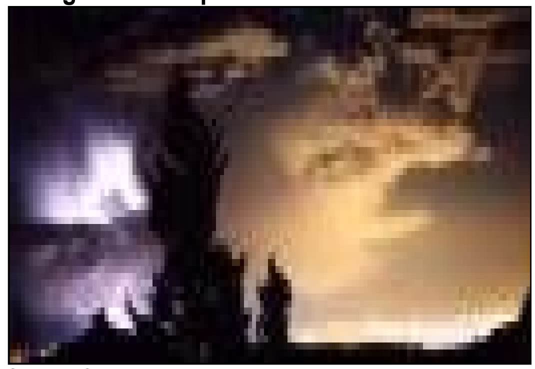
Encroachment: Any man-made obstruction in the floodplain that displaces the natural passage of floodwaters.

Surcharge: An increase in flood elevation due to destruction of the floodplain that reduces conveyance capacity.

Described below are the major causes of natural hazard flooding: Thunderstorms, Tropical Storms/Hurricanes, and Storm Surge.

4.4.5.1 Flooding Thunderstorm Identification

Figure 4.6: Depiction of a Thunderstorm



Source NOAA

Thunderstorms are associated with heavy rains that can lead to riverine, dam/levee failure, and flash flooding. Thunderstorms are formed from a combination of moisture, rapidly rising warm air, and a force capable of lifting air (such as a sea breeze, a warm and cold front, or a mountain). Thunderstorms may occur singly, in clusters, or in lines. The most severe weather occurs when a single thunderstorm affects one location for an extended time.

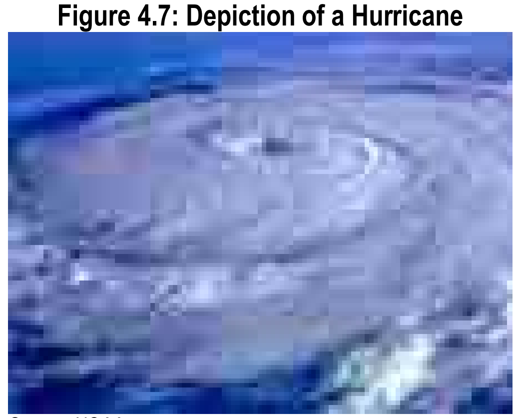
Thunderstorms affect relatively small, localized areas. Thunderstorms can strike in all regions of the U.S., but, are most common in the central and southern states. The atmospheric conditions in these regions of the country are ideal for generating these powerful storms (NVRC, 2006). More than 100,000 thunderstorms occur each year in the U.S.; however, only about 10% are classified as severe.

4.4.5.2 Flooding Tropical Storm/Hurricane Identification

As a tropical storm/hurricane nears land, it usually brings torrential rains that can last for days. These torrential rains cause dam/levee failure, riverine, and flash flooding**.**

A Tropical Storm is an organized system of strong thunderstorms with maximum sustained winds between 34 to 63 knots (39 to 73 mph) (FEMA, 2007). In time, the storm becomes more organized and begins to become more circular in shape, resembling a hurricane.

Figure 4.7: Depiction of a Hurricane



Source: NOAA

A Hurricane is an intense tropical cyclone with wind speeds reaching a minimum constant speed of 74 mph (FEMA, 2004). It is a category of tropical cyclone characterized by thunderstorms and defined surface wind circulation. Hurricanes are caused by the atmospheric instability created by the collision of warm air with cooler air. They form in the warm waters of tropical and sub-tropical oceans, seas, or Gulf of Mexico (NWS, 2000). Hurricanes begin when areas of low atmospheric pressure move off the western coast of Africa and into the Atlantic, where they grow and intensify in the moisture-laden air above the warm tropical ocean. Air moves toward these atmospheric lows from all directions and circulates clockwise under the influence of the Coriolis effect, thereby initiating rotation in the converging wind fields. When these hot, moist air masses meet, they rise up into the atmosphere above the low-pressure area, potentially establishing a self-reinforcing feedback system.

4.4.5.3 Flooding Dam/Levee Failure Identification

A dam is a barrier constructed across a watercourse for the purpose of storage, control, or diversion of water. A levee is a barrier constructed along the side of a watercourse or along a coastal or bay shoreline for the purpose of preventing water-flow to extend beyond the watercourse, ocean, or bay. Dams and levees generally fall into the following categories**:**

Earth Dams/Levees make up the vast majority of dams and levees and are safe if properly constructed and maintained.

Concrete Gravity Dams/Levees are designed to resist sliding and overturning.

Buttress Concrete Dams/Levees have a strong foundation and are resistant to sliding, overturning, and overflowing.

Arch Concrete Dams are used to narrow sites and have strong abutments.

Gravity Arch Concrete Dams are a conservative design of the Arch.

Stone Masonry Dams are constructed of stone or block with masonry joints.

Figure 4.8: Depiction of a Dam Break

Source: NEMA

The degree and extent of damage from a dam failure depends on the size of the dam or levee. The greatest threat to people and property is in the area immediately below a dam since the volume of water decreases as the flood wave moves downstream.

The degree and extent of damage from a levee failure depends on the height and length of the levee preventing water from inundating the area protected by the levee and the elevation of the land or structures at risk. The greatest threat to people and property is in the area immediately adjacent to the waterway, ocean, or bay. A levee failure resulting from storm surge would have an effect similar to a dam break, whereas a levee failure along a watercourse generally affects an area with a lower volume of water over a longer time.

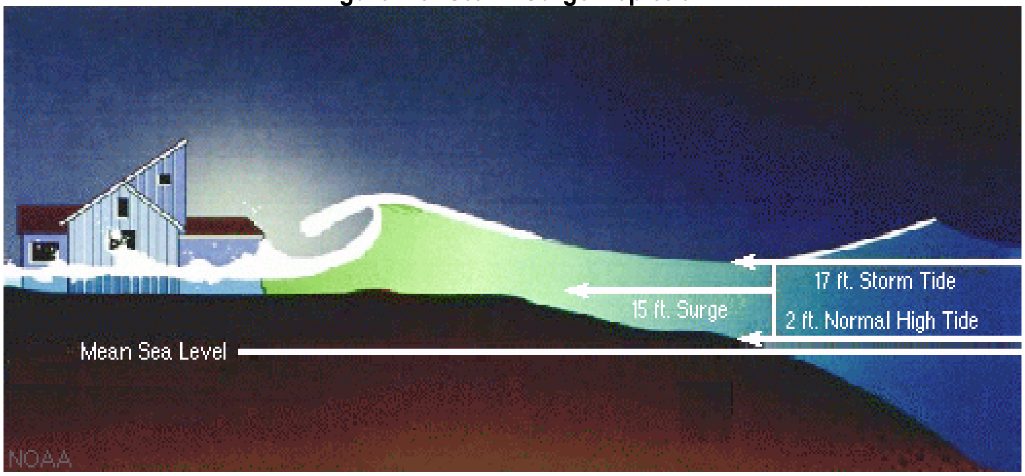
4.4.5.4 Flooding Storm Surge Identification

Storm surge is water that is pushed toward the shore by the force of the winds swirling around a tropical storm or hurricane. This advancing surge combines with the normal tides to raise the water level. Wind driven waves are superimposed on the storm surge. A rise in water level can cause severe flooding in coastal areas, particularly when the storm tide coincides with the normal high tides. The storm surge creates a large dome of water, often 50 to 100 miles wide that sweeps across the coastline near where the hurricane makes landfall.

The stronger the hurricane and the shallower the offshore water, the higher the storm surge will be (NWS, 2000). Storm surges are particularly damaging when they occur during a high tide, combining the effects of the surge and the tide. As the water slams into shoreline structures, even well built structures can quickly be demolished. As the water moves inland, carrying debris, it can cause further damage.

Because storm surge is produced by the high winds circulating a tropical/storm or hurricane, the resulting storm surge can occur from any direction when the hurricane is over the ocean or large bodies of waters such as bays.

Figure 4.9: Storm Surge Depiction



Source: NOAA

4.4.5.5 Tsunami Identification

A tsunami is the generation of an extreme ocean wave breaking on-shore, generally as a result of extremely high winds or a seismic incident occurring in adjacent oceans.

Characteristics of Tsunamis

Debris: As the tsunami wave comes ashore, it brings with it debris from the ocean, including man-made debris like boats, and as it strikes the shore, creates more on-shore debris. Debris can damage or destroy structures on land.

Distance from shore: Tsunamis can be both local and distant. Local tsunamis give residents only a few minutes to seek safety and cause more devastation. Distant tsunamis originating in places like Chile, Japan, Russia, or Alaska can also cause local damage.

High tide: If a tsunami occurs during high tide, the water height will be greater and cause greater inland inundation, especially along flood control and other channels.

Outflow: Outflow following inundation creates strong currents, which rip at structures and pound them with debris, and erode beaches and coastal structures.

Water displacement: When a large mass of earth on the ocean bottom sinks or uplifts, the column of water directly above it is displaced, forming the tsunami wave. The rate of displacement, the motion of the ocean floor at the earthquake epicenter, the amount of displacement of the rupture zone, and the depth of water above the rupture zone all contribute to tsunami intensity.

Wave run-up: is the height that the wave extends upon steep shorelines, measured above a reference level (the normal height of the sea, corrected to the tide at the time of wave arrival).

Wave strength: Even small wave heights can cause strong, deadly surges. Waist-high surges can cause strong currents that float cars, structures, and other debris.

The following factors will affect the severity of a tsunami:

Coastline configuration: Tsunamis impact long, low-lying stretches of linear coastlines, usually extending inland for relatively short distances. Concave shorelines, bays, sounds, inlets, rivers, streams, offshore canyons, and flood control channels may create effects that result in greater damage. Offshore canyons can focus tsunami wave energy, and islands can filter the energy. The orientation of the coastline determines whether the waves strike head-on or are refracted.

Coral reefs: Reefs surrounding islands in the western North Pacific and the South Pacific generally cause waves to break, providing some protection to the islands.

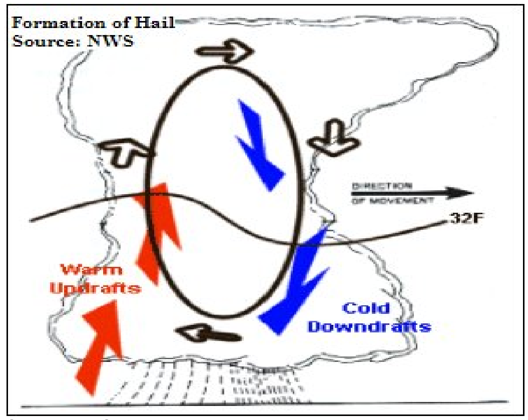
Earthquake characteristics: Several characteristics of the earthquake that generates the tsunami contribute to the intensity of the tsunami, including the area and shape of the rupture zone.

Fault movement: Vertical movements along a fault on the seafloor displace water and create a tsunami hazard. Earthquakes with greater magnitude cause more intense tsunamis. Shallow-focus earthquakes also have greater capacity to cause tsunamis.

Human activity: With increased development, property damage increases, multiplying the amount of debris available to damage or destroy other structures.

4.4.6 Hail Identification

Figure 4.10: Formation of Hail



Source: NWS

Hailstones are products of thunderstorms and are developed by downdrafts and updrafts that develop inside cumulonimbus clouds of a thunderstorm, where super cooled water droplets exist. The transformation of droplets to ice requires a temperature below 32°F and a catalyst in the form of tiny particles of solid matter, or freezing nuclei. Continued deposits of super cooled water cause ice crystals to grow into hailstones.

The size of hailstones varies and is related to the severity and size of the thunderstorm that produced them. The higher the temperatures at the earth's surface, the greater the strength of the updrafts, and the greater the amount of time the hailstones are suspended, giving the hailstones more time to increase in size. Hailstones vary widely in size. Penny size or larger hail is considered severe.

Hailstorms occur most frequently during the late spring and early summer, when the jet stream moves northward across the Great Plains. During this period, extreme temperature changes from the surface up to the jet stream, resulting in the strong updrafts required for hail formation.

4.4.7 High Winds Identification

Wind is defined as the motion of air relative to the earth's surface. In the mainland United States, the mean annual wind speed is reported to be eight to 12 mph, with frequent speeds of 50 mph and occasional wind speeds greater than 70 mph. High winds are generally the result of thunderstorms, tornadoes, and tropical storms/hurricanes.

4.4.7.1 High Winds Tropical Storm/Hurricane Identification

Tropical Storm/Hurricane winds can quickly decimate the tree population, down power lines and utility poles, knock over signs, and damage/destroy homes and buildings. Flying debris can also cause damage to both structures and the general population. When hurricanes first make landfall, it is common for tornadoes to form.

A Tropical Storm is an organized system of strong thunderstorms with maximum sustained winds between 34 to 63 knots (39 to 73 mph) (FEMA, 2007). In time, the storm becomes more organized and begins to become more circular in shape, resembling a hurricane.

A Hurricane is an intense tropical cyclone with wind speeds reaching a minimum constant speed of 74 mph (FEMA, 2004). It is a category of tropical cyclone characterized by thunderstorms and defined surface wind circulation. Hurricanes are caused by the atmospheric instability created by the collision of warm air with cooler air. They form in the warm waters of tropical and sub-tropical oceans, seas, or Gulf of Mexico (NWS, 2000). Hurricanes begin when areas of low atmospheric pressure move off the western coast of Africa and into the Atlantic, where they grow and intensify in the moisture-laden air above the warm tropical ocean. Air moves toward these atmospheric lows from all directions and circulates clockwise under the influence of the Coriolis effect, thereby initiating rotation in the converging wind fields. When these hot, moist air masses meet, they rise up into the atmosphere above the low-pressure area, potentially establishing a self-reinforcing feedback system.

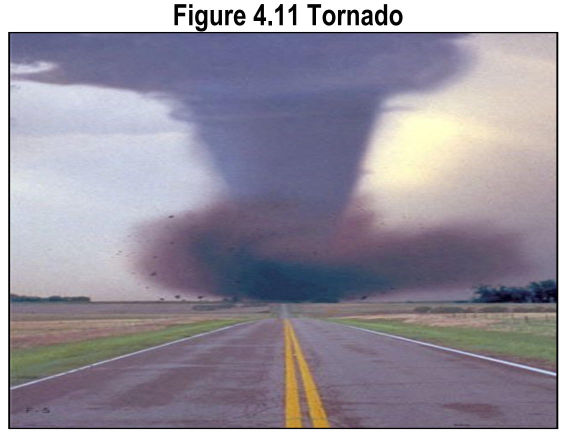
4.4.7.2 High Winds Thunderstorm Identification

High winds can result from thunderstorm inflow and outflow or from downburst winds when the storm cloud collapses, and can result from strong frontal systems, or gradient winds from high or low-pressure systems. Thunderstorms produce downdraft winds, which are defined as a small-scale column of air that rapidly sinks toward the ground, usually accompanied by precipitation as in a shower or thunderstorm. A downburst is the result of a strong downdraft. The downburst can cause damage equivalent to a tornado. The outflow of cool or colder air can also create damaging winds at or near the surface. As these downburst winds spread out they are often referred to as straight-line winds, which exceed 130 miles per hour.

Thunderstorms are formed from a combination of moisture, rapidly rising warm air, and a force capable of lifting air (such as a sea breeze, a warm and cold front, or a mountain). Thunderstorms usually occur singly and affect relatively small, localized areas; however, they may occur in clusters, or in lines. The most severe weather occurs when a single thunderstorm affects one location for an extended time.

4.4.7.3 High Winds Tornado Identification

Figure 4.11 Tornado



Source NOAA

Tornadoes are violent windstorms characterized by a twisting, funnel-shaped cloud. A tornado is spawned by a thunderstorm or hurricane and produced when cool air overrides a layer of warm air, forcing the warm air to rise rapidly. A funnel does not need to reach to the ground for a tornado to be present. Tornados occur at any time of the year; however, the season is generally March through August.

The most violent tornadoes are capable of tremendous destruction with wind speeds of 250 mph or more. Damage paths can be in excess of 1 mile wide and 50 miles long. Even with advances in meteorology, adequate warning time for tornadoes is short or sometimes not possible. A debris cloud beneath a thunderstorm is all that is needed to confirm the presence of a tornado. The damage from a tornado is a result of the high wind velocity and wind-blown debris.

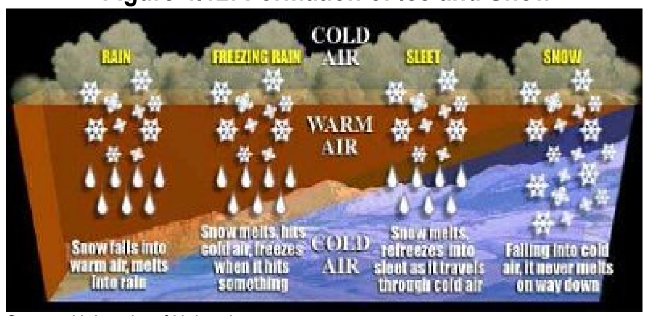
4.4.8 Ice/Snow Storm Identification

Winter storms produce an array of hazardous weather conditions including heavy snow, blizzards, freezing rain, ice pellets, and extreme cold. Severe Ice/Snow storms are extra-tropical cyclones (storms that form outside of the warm tropics) fueled by strong temperature gradients and an active upper-level jet stream. The definitions of winter storms include:

Blizzards: The occurrence of the following conditions lasting for three hours or longer: wind speeds of 35 miles per hour (mph) or more; considerable falling and/or blowing snow (reducing visibility frequently to less than ¼ mile); and generally temperatures of 20° F or lower.

A severe blizzard has wind speeds of 45 mph or more; a great density of falling and/or blowing snow (reducing visibility to near zero); and temperatures of 10° F or lower.

Figure 4.12: Formation of Ice and Snow



Source: University of Nebraska

Ice and Sleet Storms are defined as storms that generate a sufficient quantity of ice or sleet to result in hazardous conditions and/or property damage. An ice storm (freezing rain) is probably the most serious of the winter storms. It occurs during a precipitation incident when warm air aloft exceeds 32°F while the surface remains below the freezing point. When precipitation originating as rain or drizzle contacts physical structures on the surface, ice forms on all surfaces, creating traffic issues and downed utility lines and tree limbs.

Sleet forms when precipitation originating as rain falls through a large layer of the atmosphere that has below freezing temperatures allowing raindrops to freeze before reaching the ground. Sleet is also referred to as ice pellets. Sleet storms are usually of shorter duration than freezing rain and generally create fewer problems.

4.4.9 Landslides/Mudslides Identification

Landslides (rockslides, mudslides, etc.) are among the most common natural hazards. Unlike most natural hazards, however, most damage is not caused by extreme incidents, but by uncounted (and often unreported) minor slides. The hazards associated with landslides are as diverse as the types of failure.

Falls may damage roads or buildings at the base of a steep slope, injure climbers, or remain on a road as a hazard to transportation.

Slumps usually damage utilities within or below the slide mass, but seldom cause a threat to life.

Flows surround well-built structures causing damage from water and mud.

Figure 4.13 Landslide Depiction

Source: NOAA

Translational slides can be the most catastrophic. In addition to presenting a hazard to structures and utilities, they can cause damage and death both far from and slightly below the source.

In addition to the direct hazards of a landslide moving out from under or onto structures or utilities, there is a major indirect hazard. Large slides generally do not stop moving until they reach the bottom of a valley where they block streams, usually resulting in flooding and damage to the system ecology.

4.4.10 Land Subsidence Identification

Figure 4.14: Depiction of Land Subsidence

Source: FEMA

Subsidence is a phenomenon that combines soil compaction and geological/tectonic forces. Subsidence is the formation of depressions, cracks, and sinkholes in the earth's surface, which normally occurs over many days to a few years, usually a result of karst topography. Karst topography develops when beds of relatively soft limestone and dolomite are present. The diluted organic acids present in water percolate downward and dissolve these formations. In such places, rock is honeycombed with cracks, fissures, and potentially large caverns that can collapse.

Subsidence results from a number of factors including: compaction/consolidation of shallow strata caused by the weight of river delta deposits, soil oxidation, and aquifer draw-down (shallow component); consolidation of deeper strata (intermediate components); and tectonic effects (deep component). This last element was only recently quantified, and research indicates that it accounts for 50% or more of subsidence.

In some areas natural drainage occurs below ground rather than via surface streams. These underground passages are commonly connected to the surface by funnel-shaped depressions called sinkholes. The formation of these sinkholes often leads to ground subsidence or collapse. This results from the settlement or collapse of overlying materials into openings beneath the surface, such as caves or enlarged joints. Sinkhole development is usually a slow process; however, they may occur suddenly. In addition to sinkholes, land subsidence also occurs when abandoned mines, mine shafts, and tunnels give way.

4.4.11 Lightning Identification

Figure 4.15: Depiction of Lightning

Source: NWS

Lightning is generally associated with thunderstorms and is an electrical discharge that results from the buildup of positive and negative charges. When the buildup becomes strong enough, lightning appears as a "bolt." This flash of light usually occurs within the clouds or between the clouds and the ground. A bolt of lightning reaches a temperature approaching 50,000 degrees in a split second.

Lightning casualties can happen at the beginning of an approaching storm; however, more than half of lightning deaths occur after a thunderstorm has passed. The lightning threat diminishes after the last sound of thunder, but may persist for more than 30 minutes. When thunderstorms are in the area, but not overhead, the lightning threat can exist when skies are clear. Lightning has been known to strike more than 10 miles from the storm in an area with clear sky above.

According to the National Oceanic and Atmospheric Administration (NOAA), an average of 20 million cloud-to-ground flashes are detected every year in the continental United States. About half of all flashes have more than one ground strike point, so at least 30 million points on the ground are struck on the average each year. In addition, there are roughly 5 to 10 times as many cloud-to-cloud flashes as there are to cloud-to-ground flashes (NOAA, July 7, 2003).

4.4.12 Wildfire Identification

Figure 4.16: **Depiction of a Wildfire**

Source: FEMA

A wildfire is any instance of uncontrolled burning in grasslands, brush, or woodland. A wildfire is further defined as an uncontrolled fire spreading through vegetative fuels, possibly consuming structures (FEMA, 2001). Wildfires often begin unnoticed and spread quickly. The Federal Emergency Management Agency (FEMA) Fire Management Assistance Grant Program (FMAGP) indicates that a wildfire, also known as a forest fire, vegetation fire, grass fire, or brush fire, is an uncontrolled fire requiring suppression action.

Common causes of wildfires include lightning, negligent human behavior, and arson. Many sources indicate that arson, defined as an intentional and willful "crime of setting a fire for an unlawful or improper purpose," is the leading cause of wild land fires in most states.

FEMA indicates that there are four categories of wildfires that are experienced throughout the U.S. These categories are defined as follows:

Interface or intermix fires – Urban wild land interface fires are wildfires in a geographical area where structures and other human development meet or intermingle with wild land or vegetative fuels. Vegetation and the built-environment provide fuel to urban/wild land fires.

Firestorms – Fires of such extreme intensity that effective suppression is virtually impossible. Firestorms occur during extreme weather and generally burn until conditions change or the available fuel is exhausted.

Prescribed fires and prescribed natural burns – fires that are intentionally set or selected natural fires that are allowed to burn for beneficial purposes (FEMA, 1997).

Wild land fires are wildfires in an area where development is essentially nonexistent except for roads, railroads, power lines, and similar facilities. Wild land fires are fueled almost exclusively by natural vegetation. Wild land fires can be classified as surface fires, ground fires, and/or crown fires. Surface fires are the most common type and burn along the floor of a forest, moving slowly and killing or damaging trees. A ground fire (muck fire) is usually started by lightning or human carelessness and burns on or below the forest floor. Crown fires are spread rapidly by wind and move quickly by jumping along the tops of trees.

The potential for wildfire depends upon fuel characteristics, climate conditions, meteorological conditions, and fire behavior. Hot, dry summers and dry vegetation increase susceptibility to fire.

The potential for wildfire, and its subsequent development and severity, is determined by the area's topography, the presence of fuel, and weather.

Topography can have a powerful influence on wildfire behavior. The movement of air over the terrain tends to direct a fire's course. Gulches and canyons can funnel air and act as a chimney, intensifying fire behavior and inducing faster spread rates. Saddles on ridge tops tend to offer lower resistance to the passage of air and will draw fires. Solar heating of drier, south-facing slopes produces upslope thermal winds that can complicate behavior.

Slope is an important factor. If the uphill slope doubles, the rate at which the wildfire spreads will most likely double. On steep slopes, fuels on the uphill side of the fire are closer physically to the source of heat. Radiation preheats and dries the fuel, thus intensifying fire behavior. Terrain can inhibit wildfires: fire travels down slope much more slowly than it does upslope, and ridge tops often mark the end of wildfire's rapid spread (FEMA, 1997).

Fuels are classified by weight or volume (fuel loading) and by type. Fuel loading can be used to describe the amount of vegetative material available. If this doubles, the energy released can also double. Each fuel type has a burn index, which is an estimate of the amount of potential energy that may be released. Different fuels have different burn qualities. Grass releases relatively little energy but can sustain very high rates of spread (FEMA, 1997). According to the U.S. Forest Service, a forest stand may consist of several layers of live and dead vegetation in the understory (surface fuels), midstory (ladder fuels), and overstory (crown fuels). Fire behavior is strongly influenced by these fuels.

Surface fuels consist of grasses, shrubs, litter, and woody material lying on the ground. Surface fires burn low vegetation, woody debris, and litter. Under the right conditions, surface fires reduce the likelihood that future wildfires will grow into crown fires.

Ladder fuels consists of live and dead small trees and shrubs, live and dead lower branches from larger trees, needles, vines, lichens, mosses, and any other combustible biomass located between the top of the surface fuels and the bottom of the overstory tree crowns.

Crown fuels are suspended above the ground in treetops or other vegetation and consist mostly of live and dead fire material. When historically low-density forests become overcrowded, tree crowns may merge and form a closed canopy. Tree canopies are the primary fuel layer in a forest crown fire (U.S. Forest Service, 2003).

4.4.13 Volcano Identification

Figure 4.17: Mt St. Helens Volcano - Skamania County, Washington

Source: Wikipedia

A volcano is an opening or rupture, in a planet's surface or crust, which allows hot magma, volcanic ash, and gases to escape from below the surface.

Volcanoes are generally found where tectonic plates are diverging or converging. A mid-oceanic ridge, for example the Mid-Atlantic Ridge, has examples of volcanoes caused by divergent tectonic plates pulling apart; the Pacific Ring of Fire has examples of volcanoes caused by convergent tectonic plates coming together. By contrast, volcanoes are usually not created where two tectonic plates slide past one another. Volcanoes can also form where there is stretching and thinning of the earth's crust (called "non-hotspot intraplate volcanism"), such as in the East African Rift, the Wells Gray-Clearwater Volcanic Field, and the Rio Grande Rift in North America. Volcanoes can be caused by mantle plumes. These so-called hotspots, for example at Hawaii, can occur far from plate boundaries. Hotspot volcanoes are also found elsewhere in the solar system, especially on rocky planets and moons.

The most common perception of a volcano is of a conical mountain, spewing lava and poisonous gases from a crater at its summit. This describes just one of many types of volcano, and the features of volcanoes are much more complicated. The structure and behavior of volcanoes depends on a number of factors. Some volcanoes have rugged peaks formed by lava domes rather than a summit crater, whereas others present landscape features such as massive plateaus. Vents that issue volcanic material (lava, which is what magma is called once it has escaped to the surface, and ash) and gases (mainly steam and magmatic gases) can be located anywhere on the landform. Active mud volcanoes tend to involve temperatures much lower than those of igneous volcanoes, except when a mud volcano is actually a vent of an igneous volcano.

4.5 TECHNOLOGICAL/HUMAN-CAUSED HAZARDS IDENTIFICATION

The Tennessee Emergency Management Agency, Planning Branch and Mitigation Section, performed a technical review and evaluation of the technological/human-caused hazards documented in the Federal Emergency Management Agency State and Local Mitigation Planning How-To Guide" entitled "Integrating Manmade Hazards Into Mitigation Planning." Additionally, further review/evaluation of possible other technological/human-caused hazards in all 95 counties of the State were accomplished through in-depth surveys (Office of Domestic Preparedness (ODP) Jurisdiction Assessment Report). Coupled with information derived from local planning efforts, as well as numerous other state and federal documents/data sources, the surveys provided a point of embarkation toward the State's final hazard identification decision, made in similar fashion as that for the natural side of the hazard triad.

Table 4.4: State of Tennessee Technological and Human-Caused Hazards			
HAZARD	PROBABILITY OF OCCURRENCE	HISTORICAL OCCURRENCE	SOURCES
Hazardous Materials			
Chemical	M	Y	TEMA, FEMA, DOE, NRC, TDEC
Radiological	L	Y	TEMA, FEMA, TDEC, TDOT,TDOS
Transportation			
Air	L	Y	TDOT, NTSB, FAA
Highway	H	Y	TDOT, TDOS, NTSB, TEMA
Rail	M	Y	TDOT, NTSB, TEMA
Water	L		TDOT, USCG, NTSB
Communications Failure	L	Y	TEMA, TDF&A
Energy Failure	L	Y	TDE&CD, TVA, TRA, TEMA
Dam Failure	L	Y	TVA, USCOE, TDEC, TDOS
Biologic- Human/Animal Disease Epidemic	L	Y	TDH, TDA, TWRA, CDC
Enemy Attack*	L	Y	History
Civil Disturbance	L	Y	TDOS, TEMA, TBI,
Terrorism – Chemical, Biological, Radiological, Conventional, Cyber	M	Y	TDOS, HS, TEMA, FBI, TBI, TDH

4.5.1 Attack Identification

Attack is defined as 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 remain 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 nonproliferation 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.

Currently, attack planning guidance prepared by the federal government in the late 1980s still provides the best basis for a population protection strategy. That guidance has identified potential target areas in 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.

4.5.2 Civil Disorder Identification

Civil disorder is most commonly thought of as racial tension, racial unrest, or other connotations and implications regarding race. Civil disorder is defined however, as "unlawful actions by a civilian population with the intent to demonstrate unlawfully against the peace and welfare of the government." Also known as rioting, it is further defined by law as "...a public disturbance involving an assemblage of three or more persons; which by disorderly and violent conduct, or the imminent threat of disorderly or violent conduct, results in injury or damage to persons or property, or creates a clear and present danger of injury or damage to persons or property."

Civil disorders can take the form of small gatherings or large groups blocking or impeding access to a building, or disrupting normal activities by generating noise and intimidating people. They can range from a peaceful sit-in to a full-scale riot, in which a mob burns or otherwise destroys property and terrorizes individuals.

Generally, there are two types of large gatherings typically associated with disorders: a crowd and a mob. A crowd may be defined as a casual, temporary collection of people without a strong, cohesive relationship. Crowds can be classified into four categories:

Casual Crowd – A casual crowd is a group of people who happen to be in the same place at the same time. The likelihood of violent conduct is non-existent.

Cohesive Crowd – A cohesive crowd consists of members who are involved in some type of unified behavior. Members of this group are involved in some type of common activity, such as worshiping, dancing, or watching a sporting event. Although they may have intense internal discipline, they require substantial provocation to arouse to action.

Expressive Crowd – An expressive crowd is one held together by a common commitment or purpose. Although members may not be formally organized, they are assembled as an expression of common sentiment or frustration. Members wish to be seen as a formidable influence. One of the best examples of this type is a group protesting something.

Aggressive Crowd – An aggressive crowd is comprised of individuals who have assembled for a specific purpose. This crowd often has leaders who attempt to arouse the members or motivate them to action. Members are noisy and threatening and will taunt authorities. They tend to be impulsive and highly emotional, and require only minimal stimulation to arouse them to violence. Examples of this type of crowd include demonstrators and strikers.

A mob can be defined as a large disorderly crowd. Mobs are usually emotional, loud, tumultuous, violent, and lawless. Similar to crowds, mobs have different levels of commitment and can be classified into four categories:

Aggressive Mob – An aggressive mob is one that attacks, riots, and terrorizes. The object of violence may be a person, property, or both. An aggressive mob is distinguished from an aggressive crowd only by lawless activity. Examples of aggressive mobs are the inmate mobs in prisons and jails, mobs that act out their frustrations after political defeat, or violent mobs at political protests or rallies.

Escape Mob – An escape mob is attempting to flee from something such as a fire, bomb, flood, or other catastrophe. Members of escape mobs have lost their capacity to reason and are generally impossible to control. They are characterized by unreasonable terror.

Acquisitive Mob – An acquisitive mob is one motivated by a desire to acquire something. Riots caused by other factors often turn into looting sprees. This mob exploits a lack of control by authorities in safeguarding property. Examples of acquisitive mobs would include the looting in south central Los Angeles in 1992.

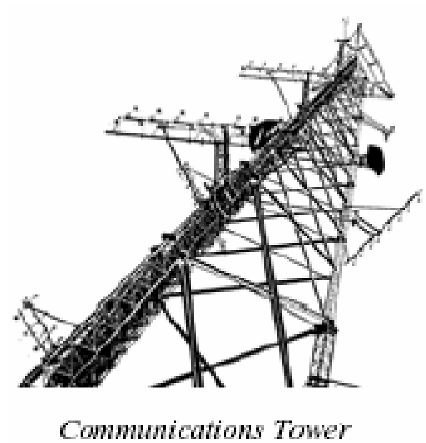
Expressive Mob – An expressive mob is one that expresses fervor or revelry following some sporting event, religious activity, or celebration. Members experience a release of pent up emotions in highly charged situations. Examples of this type of mob include the June 1994 riots in Canada following the Stanley Cup professional hockey championship, European soccer riots, and those occurring after other sporting events in many countries, including the United States.

Although members of mobs have differing levels of commitment, as a group they are far more committed than members of a crowd. As such, a "mob mentality" sets in, which creates a cohesiveness and sense of purpose that is lacking in crowds.

4.5.3 Communications Failure Identification

Communication failure is defined as the severe interruption or loss of private and/or public communications systems, including but not limited to transmission lines, broadcast, relay, switching and repeater stations, as well as communications satellites, electrical generation capabilities, and associated hardware and software applications necessary to operate communications equipment.

Figure 4.18 Communications Tower



Source: FEMA

Communication systems, like other utilities may suffer disruption from natural or manmade disasters. Seismic bracing should be reviewed on a regular basis to ensure system stability. Transmission stations, land lines, satellites, celllar, and other facilities cannot be made completely secure and are therefore vulnerable to disruption.

Satellites are vital in the respect that they provide communication capabilities with the world outside of our local area. We depend on them daily for news, weather forecasts and national defense. They are subject to the effects of natural disasters such as cosmic debris and mass coronal ejections (MCE). They are also subject to mechanical and electrical system failure like any other communication device. These disruptions may result from equipment failure, human acts (deliberate or accidental), or the results of natural or human-caused disasters. A communications failure would affect essential facilities and the day-to-day operations of local government, as well as the business community. Sites of concern would range from dispatch agencies, SCADA systems, satellite uplink and downlink sites, internet service provider sites, and the telecommunication industry switching sites.

4.5.4 Hazardous Materials Identification

Varying quantities of hazardous materials are manufactured, used, or stored at an estimated 4.5 million facilities in the United States – from major industrial plants to local dry cleaning establishments and gardening supply stores. Hazardous materials are transported by highway, railway, waterway, and pipeline daily, so any area is vulnerable to a hazardous materials incident.

Hazardous materials incidents typically take three forms: transportation incidents, pipeline incidents, and fixed facility chemical and radiological incidents. It is reasonably possible to identify and prepare for a fixed site incident, as laws require those facilities to notify state and local authorities as to what is being used or produced. Transportation and pipeline incidents are much harder to prepare for as the incident location, and often the material involved are not known until the accident actually occurs.

Fixed Facility Incident is any occurrence of uncontrolled release of materials from a fixed site that poses a risk to health, safety, and property as determined in the EPA's Resource Conservation and Recovery Act. These materials are classed identically to those specified in the section on transportation accidents

Figure 4.19: Hazmat Train Accident

Source: TVA

Transportation Incident is any hazardous material release during transport that poses a risk to health, safety, and property, as defined by Department of Transportation materials transport regulations. Hazardous materials transportation incidents can occur at any time and place, although the majority occurs on interstate highways, major federal or state highways, or on the major rail lines

Figure 4.20: Hazmat Pipeline

Source: Petroleum Institute

Pipeline Incident is a release of hazardous materials that are transported by a pipeline. In the U.S., pipelines are the principle mode for transportation of oil and petroleum products such as gasoline, and virtually all natural gas is moved by pipeline. The potential risk of pipeline accidents is a significant national concern. Much of the oil pipeline infrastructure is old, requiring regular safety and environmental reviews to ensure its safety and reliability. Energy pipelines are also extremely vulnerable to sabotage and disruption, and the resulting spills can generate large-scale environmental damage and require extensive clean-up and remediation. Recently, the U.S. Department of Homeland Security identified the energy sector as one of the 14 primary Critical Infrastructures, and pipelines in particular must be evaluated to determine the impact of loss or damage. In 2004, the Hazardous Materials Pipeline Act required all pipeline owners to conduct an analysis of pipeline exposures.

Radiological Incident is defined as the unintentional exposure to materials that emit ionizing radiation. Nuclear power plants are a significant potential source of ionizing radiation. The health and environment impacts from the Three-Mile Island and Chernobyl, Russia disasters illustrate the potential hazards from nuclear power plants. Other sources of ionizing radiation include medical and diagnostic X-ray machines, certain surveying instruments, some imaging systems used to check pipelines, radioactive sources used to calibrate radiation detection instruments, and even some household fire detectors.

Figure 4.21: Nuclear Facility

Source: TVA

4.5.5 Illegal Methamphetamine Labs Identification

Typically methamphetamine (“meth”) is a white powder that easily dissolves in water. Another form of meth is clear, chunky crystals called crystal meth, or ice. Meth can also be in the form of small, brightly colored tablets. The pills are often called by their Thai name, yabba. Street terms for methamphetamine are meth, poor man's cocaine, crystal meth, ice, glass, and speed.

Amphetamine, dextroamphetamine, methamphetamine, and their various salts are collectively referred to as amphetamines. In fact, their chemical properties and actions are so similar that even experienced users have difficulty knowing which drug they have taken. Methamphetamine is the most commonly abused.

Figure 4.22 Methamphetamine

Source: DEA

Illegal domestic labs that produce meth are dependent on supplies of the precursor ephedrine or pseudoephadrine. Sometimes it is smuggled in quantity from Canada and Mexico, but may be readily purchased over-the-counter in some states in the form of the decongestant Sudafed and other pseudoephadrine-containing cold tablets. Depending on the method used, meth is “cooked” using the cold medicine and other easily obtained items such as coffee filters, lye, battery acid, matchbook striker plates, iodine, lithium batteries, and Coleman fuel.

The process of cooking meth leaves behind a hazardous coating on walls, floors, and in ventilation systems. State law requires meth-contaminated property be quarantined until clean up operations have been completed and the property tested by a certified contractor as safe for habitation. Cost for cleaning and certifying a 1,200 square foot house is about $9,000. In hotels, rooms adjacent, above, and below must also be certified as safe.

In recent years, reports of a simplified "Shake 'n Bake" synthesis have surfaced. The method is suitable for such small batches that pseudoephedrine restrictions are less effective, it uses chemicals that are easier to obtain (though no less dangerous than traditional methods), and it is so easy to carry out that some addicts have made the drug while driving.

Drug Enforcement Agency officials estimate that for each pound of meth produced, a lab operator winds up with 6 pounds of toxic waste, including leftover chemicals such as anhydrous ammonia, lye, and solid meth residue.

4.5.6 Terrorism Identification

The Federal Bureau of Investigation (FBI) defines terrorism as "the unlawful use of force against persons or property to intimidate or coerce a government, the civilian population, or any segment thereof, in the furtherance of political or social objectives." Incidents typically would be expected in urban areas near public gatherings, government facilities, or highly visible areas. Terrorism is generally categorized as one of two types.

Domestic terrorism involves groups or individuals whose terrorist activities are directed at elements of our government or population without foreign direction.

International terrorism involves groups or individuals whose terrorist activities are foreign-based and/or directed by countries or groups outside the U.S., or whose activities transcend national boundaries.

Figure 4.23 9/11 Terrorist Attack

Source: Dept. of Agriculture

A terrorist attack can take several forms including involving the use of Weapons of Mass Destruction (WMD). The term "Weapons of Mass Destruction" has various definitions. Common to all of them is the assumption that WMDs comprise incendiary, chemical, biological, radiological, nuclear and/or explosive agents. 50 U.S.C., § 2302 defines WMD as "any weapon or device that is intended, or has the capability, to cause death or serious bodily injury to a significant number of people through the release, dissemination, or impact of a toxic or poisonous chemicals or their precursors, a disease organism, or radiation or radioactivity."

4.5.6.1 Bombings

Bombings are the most frequently used method terrorist incident in the U.S. This includes the 1993 bombing of the World Trade Center in New York, the U.S. Capitol, Mobil Oil's corporate headquarters in New York City, and the bombing of the Alfred P. Murrah federal building in Oklahoma City. The World Trade Center Buildings and the Pentagon were the targets of a well-planned terrorist attack involving the use of commercial aircraft as flying bombs.

4.5.6.2 Chemical/Biological Agents

Chemical/Biological agents have been developed by several nations for use in warfare. Such agents are selected or adapted from bacteria, fungi, viruses, or toxins that cause various diseases in humans, animals, or food crops. Currently, the development of biological agents as weapons has kept pace with our ever-evolving day-to-day technology. Despite the widespread ban, international diplomatic efforts have not been entirely effective in preventing the enhancement and proliferation of offensive biological warfare programs. There are four major categories under which the chemical agents may be classified:

Blister agents are intended to incapacitate, rather than kill. These agents were used extensively during World War I. Their use by a terrorist group largely depends on the group's objectives and moral views. If the intent of an attack were to injure numerous people and overload the area's medical facilities without causing many deaths, a blister agent would be the best choice.

Choking agents were the agents most used during WW I. With the advent of nerve agents, they have lost much of their usefulness. These substances are intended to cause death and are convenient and readily available to terrorists.

Blood agents are cyanide-based compounds. Unsuited for use on multitudes of people, the primary use would be the assassination of targeted individuals.

Nerve agents are the most recently developed chemical weapons. Originally developed by German scientists 1930s as insecticides, nerve agents were used as chemical weapons by the Nazi military. Hundreds of times more lethal than blister, choking, or blood agents, nerve agents have been stockpiled as the primary chemical weapon. These chemicals are the most useful to terrorists due to the small quantity needed to inflict a substantial amount of damage.

4.5.6.3 Radiation Devices

Radiation devices, including a nuclear bomb, produce five primary potential effects:

- Overpressure: When a nuclear weapon explodes in the atmosphere, a blast or shock wave is created that initially moves at speeds higher than the speed of sound.
- INR/EMP: Initial nuclear radiation (INR) is radiation in the first minute after detonation and is hazardous to unprotected people within about 1.5 miles. Electromagnetic radiation pulse (EMP) is the conversion of nuclear energy into electromagnetic frequency and occurs when a nuclear weapon is detonated outside of earth's atmosphere. EMP disrupts electrical and electronic equipment across entire continents. The equipment is unusable until repaired.
- Fire Risk: The combined effects of blast overpressure damage and the thermal pulse or fireball can ignite combustible materials, causing sustained fires. Primary fires are those ignited directly by the thermal pulse. Secondary fires are generated by damage and destruction from blast overpressures and result from the disruption of furnaces and gas and electric lines.
- Fallout Risk: A nuclear explosion near the ground makes a big crater. Earth from the crater is changed from solids into hot gas and fine dust. This hot gas and dust, together with vaporized materials, form a giant fireball that rises rapidly and becomes the top part of the nuclear mushroom cloud. The heavier particles of earth become the stem of the mushroom cloud. The earth in the stem and in the mushroom cloud becomes radioactive. The top of the mushroom is a cloud of fine particles. While the larger, heavier particles settle close to the point of explosion, the small particles float several hundred miles in the wind. The first 24 hours are the most dangerous as the initial fallout is highly radioactive. The delayed fallout particles lose much of their radioactivity and reach the earth in rain or snow over periods ranging from days to years.
- The three kinds of dangerous radiation in fallout are alpha, beta and gamma. Alpha radiation is stopped by the outer skin layers and does not usually present an external hazard. However, if contaminated air, food, or water enter the body in sufficient quantity, considerable internal damage can occur. Beta radiation is more penetrating and may

cause burns on the skin. Gamma radiation penetrates the body, causing damage to organs, blood and bones. Large doses of gamma radiation can cause sickness or death. Small doses incurred over a long period of time may not have an immediate effect, but may cause various forms of illness later in life. Genetic damage in subsequent generations may also result.

The effects of a nuclear/radiation attack have varying effects on populations. Those people located near the explosion would be killed or seriously injured by the blast, heat, or initial nuclear radiation. People a few miles away would be subject to blast, heat, and fires. A high percentage of the population residing in the lighter damaged areas would probably survive, but might subsequently be endangered by radioactive fallout.

4.5.6.4 Cyber-Terrorism:

Figure 4.24 Cyber Attack

Source: DHS

Cyberterrorism is a phrase used to describe the use of Internet based attacks in terrorist activities, including acts of deliberate, large-scale disruption of computer networks, especially of personal computers attached to the Internet, by the means of tools such as computer viruses.

Cyberterrorism can also be defined as any computer crime targeting computer networks without necessarily affecting real world infrastructure, property, or lives. There is much concern from government and media sources about potential damages that could be caused by cyber terrorism, and this has prompted official responses from government agencies.

The U.S. interest in promoting cyber-security extends well beyond its borders. Critical domestic information infrastructures are directly linked with Canada, Mexico, Europe, Asia, and South America. The nation's economy and security depend on far-flung U.S. corporations, military forces, and foreign trading partners that require secure and reliable global information networks to function. The vast majority of cyber attacks originates or passes through systems abroad, crosses several borders, and requires international cooperation to stop.

4.5.7 Transportation Accident Identification

A transportation accident is an incident related to a mode of transportation (highway, air, rail, waterway, port, harbor) where an emergency response is necessary to protect life and property. Transportation accidents are generally of four types:

<u>An air transportation incident</u> may involve a military, commercial, or private aircraft. Air transportation is playing a more prominent role in transportation as a whole; airplanes, helicopters, and other modes of air transportation are used to transport passengers for business and recreation as well as to move thousands of tons of cargo. A variety of circumstances can result in an air transportation incident; mechanical failure, pilot error, enemy attack, terrorism, weather conditions, and on-board fire can all lead to an incident at or near the airport. Air transportation incidents can occur in remote unpopulated areas, residential areas, or downtown business districts. Incidents involving military, commercial, or private aircraft can also occur while the aircraft is on the ground.

A railway transportation incident is a train accident that directly threatens life and/or property, or adversely impacts a community's capabilities to provide emergency services. Railway incidents may include derailments, collisions, and highway/rail crossing incidents. Train incidents can result from a variety of causes. Human error, mechanical failure, faulty signals, and problems with the track can all lead to railway incidents. Results of an incident can be range from minor "track hops" to catastrophic hazardous materials incidents, and even passenger casualties. With the many miles of track in the U.S., there are numerous at-grade crossings at which vehicles must cross the railroad tracks.

Figure 4.25 Transportation Accident

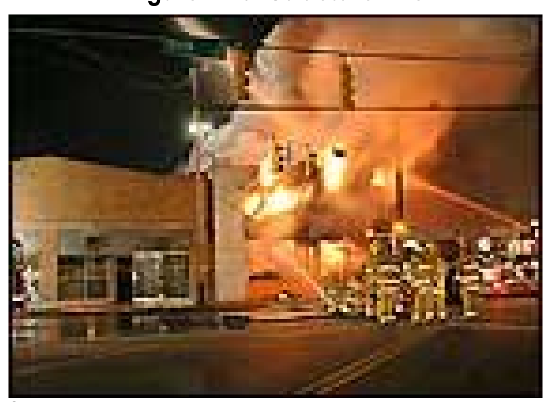
Source: FEMA

A highway transportation incident can be single or multi-vehicle accidents requiring responses exceeding normal day-to-day capabilities. Hundreds of thousands of trips a day are made on the streets, roads, highways, and interstates in the state; if the designed capacity of the roadway is exceeded, the potential for a major highway incident increases. Weather conditions play a major factor in the ability of traffic to flow safely in and through the state, as does the time of day (rush hour) and day of week.

A Waterway Transportation incident can involve ships, barges, ferries, and large and small pleasure craft. There have been hundreds of significant accidents involving ships and barges colliding with bridges and each other, resulting in significant property loss and loss of life. Ferry accidents have claimed thousands of lives.

4.5.8 Urban Fire Identification

Figure 4.26: Structure Fire



Source: NFPA

Fire is a rapid, persistent chemical reaction that releases heat and light, especially the exothermic combination of a combustible substance with oxygen. A fire is categorized as both a natural hazard and a manmade hazard. The types of fires include:

Residential: single family dwellings, apartments, mobile homes, hotels, and motels.

Public and Mercantile: stores, restaurants, grocery stores, institutions, churches, public facilities, education.

Industrial, Manufacturing: basic industry, manufacturing, storage, residential garages, and vacant buildings.

Vehicle Fires: aircraft, automobiles, trucks, trains, buses, boats.

There are many causes of fire as a technological hazard including careless smoking, cooking, arson, improper building wiring, industrial mishaps, and incidents such as train derailments or transportation collisions.

4.5.9 Utility Power Failure Identification

A major electrical power failure is defined as a failure of the electrical distribution system that will exceed twenty-four hours in duration and effect greater than 33% of a given geographical area. Electrical distribution systems can be interrupted for a number of reasons, but those that have historically been the main cause are high winds, severe thunderstorms, lightning, and winter storms.

The electric system in the U.S. is an interconnected, multi-modal distribution system that consists of three major parts: generation, transmission and distribution, along with control and communications. Generation assets include fossil fuel plants, hydroelectric dams, and nuclear power plants. Transmission systems link areas of the grid. Distribution systems manage and control the distribution of electricity into homes and businesses. Control and communications systems operate and monitor critical infrastructure components.

The nation's power and utility infrastructure has grown increasingly complex and interdependent; consequently, any disruption could have far-reaching effects. Large-scale power and utility failures may result from a variety of natural causes such as geomagnetic storms, severe weather, and earthquakes. They may also result from a variety of manmade causes such as technological accidents, equipment failures, or deliberate interference.

Almost every form of productive activity – whether in businesses, manufacturing plants, schools, hospitals, or homes – requires electricity. Utility power systems are critical components to the overall health and safety of citizens. A prolonged major electrical system failure during extreme temperatures can have dramatic effects on a population**.**

4.5.10 Water Contamination Identification

The water sector consists of two basic and vital components: fresh water supply and wastewater collection and treatment. Water sector infrastructures are diverse, complex, and range from rural to urban distribution systems. The primary focus of critical infrastructure protection efforts are the public water systems that depend on reservoirs, dams, wells and aquifers, as well as treatment facilities, pumping stations, aqueducts, and transmission pipelines.

Drinking water comes from surface water and from ground water. Large-scale water supply systems tend to rely on surface water resources such as rivers, lakes, and reservoirs. Smaller water systems tend to use ground water pumped from wells that are drilled into aquifers, geologic formations that contain water.

Wastewater tertiary treatment is sometimes defined as anything more than primary and secondary treatment in order to allow rejection into a highly sensitive or fragile ecosystem (estuaries, low-flow rivers, coral reefs,...). Treated water is sometimes disinfected chemically or physically (for example, by lagoons and microfiltration) prior to discharge into a stream, river, bay, lagoon or wetland, or it can be used for the irrigation of a golf course, green way or park. If it is sufficiently clean, it can also be used for groundwater recharge or agricultural purposes

The primary concerns with regard to water infrastructure are (1) adequate water supply and (2) the damage or disruption of service that could be caused by natural, technological, or human-caused hazards. Potential hazards includes:

- The introduction of pollutants into public groundwater and/or surface water supplies**;**
- Chemicals from leaking underground storage tanks, feedlots and waste disposal sites;

- Human wastes and pesticides that may be carried to lakes and streams;
- Physical damage to or destruction of water assets, including intentional releases of toxic chemicals;
- Actual or threatened contamination of the water supply;
- Cyber attack on water management systems or other electronic systems;
- Interruption of services from other infrastructure.

The Safe Drinking Water Act of 1974 sets uniform nationwide minimum standards for drinking water. State public health and environmental agencies have the primary responsibility for ensuring that federal and state drinking water standards are met by each public water supplier. The EPA requires an ongoing water quality monitoring program to ensure water systems are working properly, and require suppliers to inform the public if a supply becomes contaminated.

4.5.11 Pandemics/Epidemics/Vectors Identification

Pandemics occur when disease affects large numbers of the population worldwide. Epidemics occur when large numbers are affected in a more localized area such as a city, region, state, or nation. Vector-based threats – bacteria, insects, and animals – are threats that pose a direct or indirect hazard to humans, their food supply, or the economy**.**

Human Pandemic/Epidemic Hazards

Influenza occurs every year and nations attempt to prepare for the "flu season" which brings one to two weeks of symptoms, even pneumonia, and death. The cost in the U.S. is $71 to $167 billion annually. Some 36,000 in the U.S. and 250,000 to 500,000 worldwide die annually.

Three types of influenza viruses exist: A, B, and C. Type A viruses are of most concern for humans, pigs, marine mammals, and birds. Type B virus has been identified in the seal population and is fatal. Influenza C virus is associated with ticks.

Influenza viruses are constantly evolving. The viruses undergo minor and major modifications through antigentic drift and antigentic shift. Antigentic drift is the mechanism responsible for creating small changes in the genetic composition of the virus. Antigentic drift occurs in Type A and B influenza. Antigentic shift describes significant changes in the genetic structure of the virus. It occurs only in type A when two different virus strains are simultaneously present in a host, or after transmission of viruses from different hosts. The two viruses swap genetic material creating a "new" virus. The ability to jump species, the constant changes in the generic makeup of the influenza virus, the potential for vaccine loss, and the rapid spread of flu viruses are some of the reasons influenza is always a threat to the world's population.

Avian flu was first discovered in Canada. It is estimated that 50% of wild ducks in Canada carry forms of the flu. Highly infectious forms are destructive to domestic poultry. Three strains of avian influenza viruses are known to jump the species barrier from birds to non-human animals to humans: A(H9n2), A(H7N7) and A(H5N1). The most lethal, A(H5N1) causes death in 68% of humans infected. Coughing or sneezing, victims spew infectious droplets at a rate of 150 feet per second. Shaking hands or contact with contaminated public washrooms and doorknobs can spread the disease very quickly.

Scientists expect that an Avian H5 Flu virus, which has swept through chickens and other poultry in Asia, will transform into a flu that can be transmitted to humans. It has emerged as a highly pathogenic strain of influenza virus that is affecting the entire western component of Asia. The CDC is preparing for a possible pandemic. Humans have no immunity to this new avian flu.

Confirmed cases of human infection from several subtypes of avian influenza infection have been reported since 1997. Most cases of avian influenza infection in humans have resulted from contact with infected poultry (e.g., domesticated chicken, ducks, and turkeys) or surfaces contaminated with secretion/excretions from infected birds. The spread of avian influenza viruses from one ill person to another has been reported very rarely.

Small Pox (variola major) was last seen in the U.S. in 1949. The last naturally occurring case was in Somalia in 1977. Smallpox vaccination in the U.S. ended in 1972 except for military personnel.

When smallpox was considered eradicated worldwide, only two laboratories were designated to keep the virus. One lab was the CDC in Atlanta, Georgia, and the other lab was in Russia. When the USSR break-up occurred, the location of Russia's smallpox virus became unknown. It was widely thought that at least four other countries received part of the virus.

Variola is classified as a biological weapon, included on the "A" list by the CDC. The virus can be transmitted from person to person, may result in high mortality rate (30%), and cause panic and social disruption. Variola has a moderate to high potential for large-scale dissemination and requires special action for public health preparedness and response.

Hepatitis A Virus results from eating food or drinking water contaminated with human excrement. Outbreaks are associated with consumption of produce. Hepatitis A virus attacks the liver, is highly infectious, and can lead to varying degrees of illness, hospitalization, and death.

Emerging Pathogens: Severe Acute Respiratory Syndrome (SARS) started in China in late 2002. The World Health Organization reported 29 countries were affected by the end of July 2003. There were 8,500 cumulative cases and 774 deaths. In the United States, 29 cases were confirmed. SARS is closely associated with influenza.

Emerging Pathogens: Monkey Pox Virus is an orthopoxvirus, which also includes cowpox and smallpox. It is a viral disease occurring in the rain forests of central and West Africa. Monkey pox is milder than smallpox. It was seen in the U.S. June 14, 2003. It was introduced to this country by prairie dogs infected by Gambian rats imported by a distributor of exotic pets. By June 18, 2003, 87 persons in six states were confirmed with the virus.

Animal and Vector-Based Agriculture Hazards

An "emerging" series of threats to communities is vector-based threats – bacteria, insects, and animals – that pose a direct or indirect hazard to humans, their food supply, or the economy.

Mad Cow Disease (Bovine spongiform encephalopathy [BSE]), is a fatal neurodegenerative disease in cattle that causes a spongy degeneration in the brain and spinal cord. BSE has a long incubation period, about 30 months to 8 years, usually affecting adult cattle at a peak age onset of four to five years, all breeds being equally susceptible

The first animal to fall ill with the disease occurred in 1984 in Britain. Lab tests the following year indicated the presence of BSE; it was only in November 1986 that the British Ministry of Agriculture accepted it had a new disease on its hands. A British inquiry into BSE concluded that the epizootic was caused by cattle, which are normally herbivores, being fed the remains of other cattle in the form of meat and bone meal, which caused the infectious agent to spread. The origin of the disease itself remains unknown. The infectious agent is distinctive for the high temperatures at which it remains viable; this contributed to the spread of the disease in Britain, which had reduced the temperatures used during its rendering process. Another contributory factor was the feeding of infected protein supplements to very young calves.

In 2006, Hematech, Inc, a biotechnology company based in Sioux Falls, South Dakota, announced that it had used genetic engineering and cloning technology to produce cattle that lacked a necessary gene for prion production – thus theoretically making them immune to BSE.

The disease may be most easily transmitted to human beings by eating food contaminated with the brain or spinal cord of infected carcasses. However, it should also be noted that the infectious agent, although most highly concentrated in nervous tissue, can be found in virtually all tissues throughout the body, including blood. In humans, it is known as new variant Creutzfeldt–Jakob disease (vCJD or nvCJD).

Foot and Mouth Disease (FMD) is a highly infectious and difficult-to-control disease of cloven-hoofed mammals including cattle, swine, wild sheep, goats, deer, and pigs. Although many people don't consider Foot and Mouth Disease to be a "threat," an outbreak of the disease in Europe caused widespread concern over the safety of the meat supply, as well as the possibility of resulting infection of humans. Federal, state and local officials, including the emergency services community, have plans and procedures for handling incidents involving these threats. Should an outbreak occur anywhere in the United States, routine livestock movements could rapidly spread the disease making early detection, combined with immediate eradication of affected animals, crucial for controlling the disease. Left unchecked, the economic impact of FMD could reach billions of dollars in the first year. Deer and other wildlife would likely become infected and be a source for re-infection of livestock. FMD is not known to cause illness in humans.

Figure 4.27 Foot and Mouth Disease Animals

Source: Dept. of Agriculture

Avian influenza in birds (AI) is a viral disease characterized by respiratory signs, depression, and reduced feed and water intake. In egg-laying birds, there is a decline in egg production and quality. There are two pathotypes of AI virus: the most common is low pathogenic AI (LPAI) and the other is highly pathogenic AI (HPAI). The most virulent form (HPAI) was once called fowl plague. At the 1981 International Symposium on Avian Influenza, the term fowl plague was replaced with the term "highly virulent" influenza virus infection. The AI epidemic of 1983-1984 required yet new terms to describe relative pathogenicity of different isolates of the same stereotypes (nonpathogenic, low-pathogenic, highly pathogenic).

Infected birds shed influenza virus in their saliva, nasal secretions, and feces. Susceptible birds become infected when they have contact with contaminated secretions or excretions or with surfaces that are contaminated with secretions or excretions from infected birds. Domesticated birds may become infected with avian influenza virus through direct contact with infected waterfowl or other infected poultry, or through contact with surfaces (such as dirt or cages) or materials (such as water or feed) that have been contaminated with the virus. Lyme disease is an emerging infectious disease caused by at least three species of bacteria belonging to the genus Borrelia. Lyme disease is the most common tick-borne disease in the Northern Hemisphere. Borrelia is transmitted to humans by the bite of infected ticks belonging to a few species of the genus Ixodes ("hard ticks"). The disease is named after the town of Lyme, Connecticut, where a number of cases were identified in 1975. Although Allen Steere realized in 1978 that Lyme disease was a tick-borne disease, the cause of the disease remained a mystery until 1981, when B. burgdorferi was identified by Willy Burgdorfer.

Figure 4.28 Mosquito-borne Virus

Source: Dept. of Agriculture

West Nile Virus (WNV) is one of several mosquito-borne viruses in the United States. The virus was first detected in the New York City area in 1999. The virus has since been identified in all 48 continental states and the District of Columbia. WNV may cause a wide range of clinical illness ranging from mild "flu-like" symptoms to encephalitis (inflammation of the brain) that may be fatal to both humans and horses. Some horses infected with WNV do not develop clinical illness and recover uneventfully. Currently, there is no specific treatment for WNV. Mosquitoes acquire WNV from feeding on infected birds then pass the virus on to other birds, animals, and humans. Migratory birds are an important reservoir for WNV and have served as the major vector for the spread of the virus to new areas. Mosquitoes have not demonstrated the ability to feed on an infected horse and ingest enough virus to transmit it to other animals. Less than one percent of humans infected may develop meningitis or encephalitis.

Fire Ants are a variety of stinging ants with over 280 species worldwide. A typical fire ant colony produces large mounds in open areas, and feeds mostly on young plants, seeds, and sometimes crickets. Fire ants nest in the soil, often near moist areas, such as riverbanks, pond edges, watered lawns and highway edges. Usually the nest will not be visible, as it will be built under objects such as timber, logs, rocks, pavers, bricks, etc. If there is no cover for nesting, dome-shaped mounds will be constructed, but this is usually only found in open space, such as fields, parks, and lawns. These mounds can reach heights of 40 cm (15.7 in). The mounds that the fire ants live in can also be as deep as five feet. Fire ant colonies can quickly become a human health hazard.

Pests and diseases threaten agricultural food crops. The damage they cause can be economic (through lost output, income, and investment) as well as psychological (manifested in shock and panic). Plant pests and animal diseases pose the greatest immediate threat when they move as plagues or when they are introduced for the first time into ecologically favorable conditions where there are few natural factors to limit their spread and people do not have experience in managing them. Such occurrences often have the most evident economic impact and, in many cases, affect marginalized people most severely.