

## **STATE HAZARDS INVENTORY AND RISK ASSESSMENT (HIRA) BY HAZARD TYPE**

### **Floods**

We know that flooding has hit Vermont in the past and that it will again in the future. The flooding has been of two types – rain and/or snowmelt events that are more widespread in nature and cause flooding in the major rivers' floodplains, and localized flash flooding caused by unusually large rainstorms over a small area. Both kinds of events can be worsened by ice or debris dams and the failure of infrastructure (especially culverts), private dams and beaver dams.

The worst flood disaster to hit the State occurred on November 3, 1927. This event was caused by nearly 10 inches of heavy rain from the remnants of a tropical storm that fell on frozen ground. 84 Vermonters, including the Lieutenant Governor were killed. The most recent widespread flood occurred on June 28-30 in 1973, when up to six inches of rain fell. This was the worst flooding since 1927 in many places. A Presidential disaster was declared for the entire state and damage was estimated at \$64 million.

Within the last several years there have been several floods that have affected limited areas of the State and were usually the result of intense summer thunderstorms. An example of this was torrential rains in the summer of 1998 that the Bristol, Lincoln, Warren, Randolph and Bradford areas received. This flooding was part of many floods over limited areas during a two-month period that became a Presidentially declared disaster (FEMA-DR-1228-VT) covering June 17 to August 17, 1998.

Recent studies have shown that the majority of flooding in Vermont is occurring along upland streams, as well as along road drainage systems that fail to convey the amount of water they are receiving. Due to steep grades, flooding covers these areas only briefly, but it has more force that can cause erosion severe enough to destroy roads and collapse homes located too close to streams. These areas are often not mapped as being flood prone and property owners in these areas are not typically required to have flood insurance (*DHCA, 1998*). Furthermore, precipitation trend analysis suggests that intense, local storms are occurring more frequently.

Frequency: Frequent to Unusual  
Severity: Minor to Extensive  
Risk: High

### **Winter Snow and Ice Storms**

Severe winter storms include a blizzard on December 26-27 in 1969, which left 18-36 inches of snow in northwestern Vermont and a whopping 45 inches in Waitsfield. Governor Dean Davis declared a state disaster. Drifts of snow from that storm piled up to 30 feet in places. Very recently, a string of storms in March 2001 hit the state, beginning with 15-30 inches on March 5-6 (later declared a federal disaster), 10-30 inches on the 22<sup>nd</sup> and 10-20 inches on the 30<sup>th</sup>.

The worst winter storm to hit the state recently was not a snow storm, but an ice storm. In January of 1998, just the right combination of rain and temperature led to more than three inches of ice in spots, closing roads, downing power lines, and snapping thousands of trees. This storm was estimated as a 200-500 year event. Power was out up to 10 days in some areas and 700,000 acres in of forest were damaged in Vermont. Amazingly, we had no fatalities, unlike Quebec where 3 million people lost power and 28 were killed. Thankfully, the temperature rose after the storm, melting the ice and permitting crews to reopen roads and keeping many residents from freezing in their unheated homes.

Frequency: Unusual to rare  
 Severity: Serious to extensive  
 Risk: Moderate

### **Extreme Weather (Hurricanes, Tropical Storms, Thunderstorms, Lightning, High Winds, Hail, and Tornadoes)**

Thunderstorms can generate high winds, such as parts of eastern Vermont on July 6, 1999, downing hundreds of large trees in a few minutes. The State can also experience tornadoes, which are capable of damaging or destroying structures, downing trees and power lines and creating injuries and death from collapsing buildings and flying objects. Tornadoes are less common than hail storms and high winds, but have occurred throughout Vermont. In fact, 34 tornadoes were recorded in the State between 1950 and 1999, injuring 10 people and causing over \$8.4 million dollars in estimated property damage. Nearly all of these occurred from May through August and most of these occurred in the afternoon.

Frequency: Locally unusual to unlikely statewide  
 Severity: Minor to Catastrophic (if widespread)  
 Risk: High for severe thunderstorms and associated weather  
 Moderate for other extreme weather

### **Extreme Temperatures**

Extreme cold or heat, while often associated with other disasters, can create emergencies by themselves if they continue for several days. Extreme cold, especially when the ground is not insulated by snow, can freeze water lines, overburden power and heating systems, hamper transportation and directly threaten individuals exposed to weather with frostbite and hypothermia. Extreme heat can overload power and cooling systems, buckle rail lines, wither crops and threaten people with heat exhaustion and stroke.

Luckily, Vermont has a climate where extreme cold is unusual and extreme heat is unlikely. However, these types of events do occur. In February of 1979, for over two weeks the state had an average temperature of only 9° F, with minimum recordings of -40° F. On the other end of the scale, in July of 1911, Northfield had a 12-day average of 90.75° F. The summer of 1949 was also very hot with 25 days above 90 ° F. While certainly uncomfortable, these occurrences create only minor emergencies, even though they are regional in scope.

Frequency: Unlikely  
 Severity: Minor  
 Risk: Low

### **Droughts & Wildfires**

Several severe droughts have occurred in the last century while mild to moderate droughts are more normal to Vermont. Between 1964 and 1966 a severe drought was recorded in the state. Droughts can cause the loss of potable drinking water due to wells running dry, and can have severe impacts on crops and livestock. Droughts also make conditions ripe for wildfires and during 1966 there were fourteen class C wildfires in Vermont ranging from 10-100 acres.

Wildfire conditions in Vermont are usually at their worst in spring when the dead grass and fallen leaves from the previous year are dry and new growth has not yet started. In drought conditions the risk is obviously higher and these conditions have prompted state-wide outdoor burning bans in 1966 and 1999.

Frequency: Unlikely  
 Severity: Minor  
 Risk: Moderate

### **Structural Fire**

Vermont has the highest per capita death rate from fire in the nation. This is in fact the deadliest form of disaster throughout the state. In 2000, there were 831 structural fires in the state, 12 of which resulted in 22 civilian deaths, 20 of which occurred at residences. Although there have been requirements for smoke detectors in rental housing for over 20 years, and requirements for smoke detectors in single family dwellings since 1994, there was only one building involved in the fatal fires in 2000 that had evidence of working smoke alarms.

Less frequent than the individual fires are the major downtown fires that can destroy town centers and necessitate a large response and often requiring economic aid for recovery. A fire in an unprotected downtown can be devastating. For example, in a 15-month period between December of 1991 and July of 1992, 55,000 square feet of the Randolph Village business district was lost to fire. All were accidents or acts of nature.

Frequency: Frequent to Unusual  
 Severity: Locally Extensive  
 Risk: High

### **Landslides**

Vermont actually has a relatively high danger due to landslides, though this type of disaster rarely occurs. Landslides can be caused by seismic events, manmade or natural changes to groundwater flow that cause pore pressure changes in bank materials, removal of vegetation and manmade or natural undercutting of steep banks. A recent major slide in Jeffersonville,

Vermont demonstrates that we are vulnerable to this type of event. There was also a sizable slide in Bethel and a slide in Georgia is threatening a number of homes.

Frequency: Unlikely  
 Severity: Locally Serious  
 Risk: Low

### Global Warming

The state of the science behind global warming is now mature enough to be highly confident that warming is occurring. The results of warming will differ considerably depending on where you live, and computers models are not yet sophisticated enough to give us short-term or state-level impacts. Models of projected change are currently looking at the next 100 years. The latest report on the subject and its effects on New England state that if climate change occurs as projected, it will “fundamentally change both the character and quality of life in the New England Region.” The two models used for New England suggest generally warmer temperatures, while one predicts more dramatic warming and some droughts, and the other predicts a dramatic increase in precipitation. Either model predicts greater climate variation than New England has seen for at least 10,000 years, and global temperatures that have not been experienced in over two million years.

The effects of global warming are generally going to occur over decades, and may slowly shift the native vegetation of Vermont, allowing the introduction of new species and possibly terminating our maple syrup industry. A warmer climate could also allow diseases into the state that our climate had previously precluded. Winters are expected to generally be less severe and summers slightly hotter. It is possible that extreme weather events would become more common. More drastic effects, such as the shutdown of the Gulf Stream, are not very probable at this point, but would have widespread ramifications. Global warming itself does not have a frequency, as it is a new long-term process. The severity of its effects are difficult to anticipate, as it has not happened to us before.

Frequency: Not Applicable  
 Severity: Uncertain, potential for serious economic and ecological disruption  
 Risk: Moderate

### Technological Hazards

Technological hazards are *accidental* hazards created by man-made substances, facilities or actions that threaten people or property. This includes train derailments, airplane crashes, vehicle crashes, hazardous materials spills or leaks, explosions, radiation hazards, noxious or poisonous fumes, dam failure and structure collapse. Since the State has busy highways and Interstates, active rail lines, fuel storage facilities, a nuclear plant, large dams and hazardous materials storage and transport there is certainly the potential for these types of events. In fact, though these types of events are uncommon, they are not unknown, including several derailments, a propane rail car explosion in Fairlee in 1974 and a multitude of hazardous materials spills. Data on what substances are transported over roads and rails is very limited, but by volume and accident data the most probable events are petroleum re-

lated. These events are difficult to predict, but they will certainly threaten individual parts of the State again.

Frequency: Unusual  
 Severity: Serious to locally Extensive  
 Risk: Moderate to High

### **Terrorism and Civil Hazards**

The terrifying events of Sept. 11, 2001, in New York City dramatically illustrate our vulnerability to acts of terrorism. This one-day event, while not directly affecting Vermont, created an environment of fear. Terrorism and civil hazards include actions intentionally aimed at threatening lives and property. They may range from a single person on a shooting rampage to a cyber attack that harms computer systems, to the organized use of weapons of mass destruction (WMD). WMD events could involve chemical, biological, explosive or radioactive weapons. VEM and Vermont State Police conducted a risk/threat assessment of potential WMD attacks in 2000 that ranked potential targets by State Police district. At that time, no known or suspected terrorists (potential threat elements) were operating in Vermont, but the FBI was aware that many terrorist organizations have cells in the Montreal area, only 40 miles away.

Additional analysis of the threat from terrorism is ongoing, due to the actual use of hijacked aircraft as flying bombs and biological weapons (anthrax in letters) in September and October 2001. A vulnerability analysis has been done by Vermont Department of Environmental Conservation Dam Safety Section (11/1/01) on the potential of an intentional breach of dams that normally hold back at least 1,000 acre-feet of water. This study identified 15 sites where security could be focused. Vulnerability studies resulted have in Vermont Yankee, the State Buildings Department and Burlington International Airport upgrading security. Vermont has a Terrorism Task Force that outlined immediate needs of the State (Conceptual Synopsis, 11/6/01) to better anticipate and respond to terrorism, and is in charge of conducting a broader needs assessment due in early 2002.

The most probable form of terrorism to affect Vermont would be in the form of conventional bombing, hijacking, kidnapping or shooting incidents. A WMD attack must still be considered a rare event, but with the potential for catastrophic consequences. Many state Agencies and Departments have created internal protocols outlining their actions in a terrorism incident, and the Governor has established the State of Vermont Terrorism Task Force to create the statewide plan to deal with terrorism.

Frequency: Unlikely to Rare  
 Severity: Minor to Catastrophic  
 Risk: Low

### **Epidemics and other Health Threats**

Contagious diseases that are fatal or cause serious illness are generally not thought of a hazard, but even the annual flu season causes thousands of deaths nationwide. The great

influenza epidemic of 1918 killed millions worldwide and would likely cause hundreds to thousands of deaths in Vermont should a similar outbreak occur again. In fact, it is anticipated that a more serious strain of the usual flu will occur some year and that vaccines would not be ready before it arrived in Vermont. State Epidemiologists indicate that a fatal outbreak of the influenza virus is not a matter of “if”, but “when”.

Other diseases such as HIV/AIDS, cholera, malaria or resistant tuberculosis are major disasters in some parts of the world, but not prevalent here. A major disaster that caused water supplies to become contaminated or resulted in people eating spoiled food could also have health implications. Rabid animals could be a local threat. A health threat might also be as a result of a bioterrorist act covered above.

Frequency: Rare  
 Severity: Extensive to Catastrophic  
 Risk: Moderate

## Earthquakes

Surprising as it is to some, Vermont is classified as an area with “moderate” seismic activity. This can be compared to the west coast of the United States, which is classified as “very high” and the north-central states classified as “very low.” Sixty-three known or possible earthquakes have been centered in Vermont since 1843 (*Ebel, et. al. 1995*). The two strongest recorded quakes measured in Vermont were of a magnitude 4.1 on the Richter scale. One was centered in Swanton and occurred on July 6, 1943, and the second occurred in 1962 at Middlebury. The Swanton quake caused little damage, but the Middlebury quake broken windows and cracked plaster.

In addition, earthquakes centered outside the state have been felt in Vermont. Twin quakes of 5.5 occurred in New Hampshire in 1940. In 1988, an earthquake with a magnitude 6.2 on the Richter scale took place in Saguenay, Quebec and caused shaking in the northern two-thirds of Vermont (*Ebel, et. al. 1995*).

A computer earthquake damage simulation (HAZUS program) conducted by the Vermont State Geologist's Office suggests that there is little earthquake risk in Vermont at 100 and 250 year recurrence intervals; however, there is a potential risk at the 500-year recurrence level. A Report on The Seismic Vulnerability of the State of Vermont (*Ebel, et al., 1995*) postulated five once in 500 Year “strong” earthquake epicenters in the Northeast that could be expected to cause damage in Vermont are located at Middlebury (5.7 magnitude), Swanton (5.7 magnitude), Montreal, Quebec (6.8 magnitude), Goodnow, New York (6.6 magnitude), and Tamsworth, New Hampshire (6.2 magnitude). Using these epicenters and magnitudes, further HAZUS runs confirmed that each of these earthquakes could cause ground shaking in certain parts of Vermont sufficient to result in millions of dollars in damage.

Of the six possible once-in-500-year quakes analyzed, the greatest geographical threat varies depending on the epicenter. All of the quakes have predicted peak ground accelerations greater than 0.1 g and would cause widespread damage resulting in tens to hundreds of millions of dollars in structural and economic losses, and undetermined casualties. The Swanton and Middlebury quakes were estimated to have PGAs of 0.4 g and total losses exceeding \$300 million dollars each (HAZUS).

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Frequency: Rare  
 Severity: Minor to Catastrophic  
 Risk: Low to Moderate

## Shortages

Shortages of electrical power, fuel, food and water are likely to be temporary and the indirect result of a localized disaster creating disruption in transportation and supply systems or of a widespread weather event. Loss of power has occurred in the past and utility crews have been able to call in resources from other parts of the state or country. Fuel should not be a problem except in a very unusual extended event that would affect the entire northeast.

Food and water can become critical needs as a result of some other disaster and disaster relief organizations such as the Red Cross and National Guard can respond quickly to natural disasters. If transportation becomes an issue the forces of the National Guard, Vermont AOT and the Army Corps of Engineers Cold Weather Unit can be used to access isolated communities.

Frequency: Unlikely  
 Severity: Minor  
 Risk: Low

## Infestations/Invasive Species

Infestations by pests or invasive species do not generally pose a direct health threat, but they are capable of altering ecosystems, damaging fields and forests, clogging waterways and water supply intakes, and even causing problems with vehicles and air systems. While most of Vermont does not have to deal with these occurrences, a historical invasion of “worms” occurred in 1770. These “worms” were most likely the army worms that very recently caused over \$8 million in damage to hay in eastern Vermont. Other non-native species from Eurasian Milfoil to Zebra Mussels cause millions more in damage to Vermont.

Frequency: Unlikely  
 Severity: Minor  
 Risk: Low