Tooele County Hazards Analysis

Tooele County is the second largest county in Utah in land area, with 6,923 square miles. Salt Lake and Utah Counties bound the county to the east, Juab County to the south, Davis and Box Elder Counties to the north, and to the west, the State of Nevada. Three fourths of the population lives in the eastern valleys where most of the irrigated and dry farm land is located. The western sectors make up the Great Salt Lake Desert and are more arid and generally uncultivated. Tooele County includes seven municipalities (*Grantsville*, *Ophir*, *Rush Valley*, *Stockton*, *Tooele City*, *Vernon*, and *Wendover*) and nine unincorporated areas (*Burmeister*, *English Village*, *Erda*, *Ibapah*, *Lakepoint*, *Loftgreen*, *Pine Canyon*, and *Stansbury Park*). Percent of land ownership is 78.5% Federal, 5.9% State, 0.3% Native American, 11.2% Private and Local Government and 4.1% water.

I. EARTHQUAKES

Ground motion is recorded by instruments known as seismographs. The magnitude of an earthquake is a measure of the size of seismic waves and is measured on the Richter Scale (RM) as a number between 2 and 8. Earthquake intensity is a measure of the damage caused by a quake and it is measured on an index known as the Modified Mercalli Intensity Scale (MMI). This scale is based on observation, describes the ground shaking effects on people and structures and has twelve levels of intensity (I to XII).

Utah experiences approximately 700 earthquakes every year. Of this number only six may be of a magnitude of 3.0 or greater. The smaller magnitude earthquakes are rarely felt by people and cause no damage, but helps seismologists to study local vulnerability to larger earthquakes over time.

Tooele County is a seismically active area with continuously recorded earthquake rumblings and several active faults near population centers. Within the over 6,300 square mile area of Tooele County are six separate mountain ranges and the partial boundaries of several others. All of these north-south treading mountain blocks are bounded on at least one side by a zone of geologically recent faulting.

Tooele Valley contains two major fault zones, the Oquirrh Marginal Fault on the east and the Six Mile Creek Fault between Marshall and Interstate 80.

A sixteen-inch natural gas line crosses the fault in Middle Canyon and a portion of Tooele City's culinary water supply is located west of the fault in Middle Canyon. Rupture of the ground along the Oquirrh Marginal Fault may cause severe damage to these facilities and others which lie on or adjacent to the fault. See Figures 7, 8 and 9 to view this fault and the gas line. An 18" refined fuel pipeline was constructed in Tooele County in 2010. This pipeline carries gasoline, diesel and jet fuel from the refineries in North Salt Lake, south to Las Vegas. The pipeline enters the county on the north near I-80 and parallels S.R. 36 just west of Tooele City and continues south, exiting the county at the Juab county line.

In Rush Valley, seven potentially active fault zones have been identified from South Mountain on the north to the Sheeprock and Tintic ranges to the south.

Seismicity recorded by the University of Utah Seismograph Stations indicates ongoing crustal adjustment, especially between Skull Valley and Tooele Valley. Less frequent events are recorded in other areas of the county.

Tooele County is also adjacent to the Wasatch and Magna fault zones to the east, and may experience significant shaking from an event centered on one of these or other distant fault zones.

Ground shaking will be the primary cause of damage to manmade structures in the cities of Tooele County. Communities within Tooele and Rush Valley can probably expect ground shaking of intensity VII and greater from a large magnitude event on the major fault zones in the county.

Amplification of ground motion, liquefaction, and earthquake-induced landslides, rock falls and other types of slope failure could be secondary effects of earthquakes which could cause damage in Tooele County. Slope failure is usually confined to mountainous or canyon areas, but can be experienced within city limits. If the earthquake occurs in the winter months, snow avalanches may constitute the greatest slope failure hazard.

Other consequences of these geologic effects of earthquake can be fires, flooding, and hazardous materials incidents, as well as transportation limitations, power failures and loss of other utilities.

From a hazard standpoint the most important faults or seismically active areas are those which have the potential to generate an earthquake large enough to cause loss of life, injury or property damage. Based on this, the area most vulnerable are Tooele Valley and Rush Valley.

II. TOOELE VALLEY

The Tooele Valley is bounded on the east by the Oquirrh Mountains and on the west by the Stansbury Mountains. As with all the mountain ranges within the basin and range province (a large area extending from the Wasatch Mountains and Colorado Plateau west to the Sierra Nevada), these mountains developed as a result of crustal uplift and east-west extension with the intervening valley being dropped or tilted down to fill in the space as the area becomes wider.

The resulting mountain block is termed a "horst" and the valley a "graben".

Both the Oquirrh and Stansbury ranges were uplifted by a "tilt block" process.

This process causes a detachment or fault plane to develop on the western margin of the range while leaving the eastern flank relatively stable. Based on surface expressions, the potentially active faults in Tooele Valley are located on the east side of the Valley and in the north central area just south of I-80. However, the actual configuration of all faults in this area is complex.

The fault to the east is termed the Oquirrh Marginal Fault and has been recognized since the 1920's. This fault has been mapped, in truncated segments, from just south of Middle Canyon, north to Lake Point, a distance of over 12 miles. Everitt and Kaliser (1980), give a detailed summary of scarp lengths and other data for much of Tooele County.

The significance of this fault is its proximity to Tooele City and the lifeline systems which cross the fault. A sixteen-inch natural gas line crosses the fault in Middle Canyon and a large portion of Tooele City's culinary water supply is near the main fault trace.

A. Fault Movement

The Oquirrh Marginal Fault is considered to be "potentially active" (Lund, 1984) with movement occurring during Pleistocene time (10,000 to 1.6 million years before present), or "active" (Everitt 1980), indicating the fault cuts Lake Bonneville deposits.

The Six Mile Creek Fault is a mid-valley fault located between Marshall and Interstate 80, and is considered to be "active" with movement occurring in Holocene time (within the last 10,000 years).

Movement along these faults would probably be in conjunction with an earthquake of greater than magnitude 6 and would cause heavy damage to any structure crossing the faults. Direct damage may also be incurred to structures which lie near the fault (within several hundred feet, especially on the down-dropped side), and are subject to heavy ground subsidence and cracking as a result of fault movement.

B. Ground Shaking

A moderate to large magnitude earthquake (5-7) with an epicenter in the area of Tooele Valley would cause damaging vibrations or ground shaking in all areas of the valley. These vibrations may be amplified in a relatively small local area and cause increased damage depending on the structures affected.

Algermissen (1976) assigned a modified Mercalli intensity of VI to VII for the general area of Tooele County with a 90% probability this would not be exceeded within 50 years. Intensity VII translates into considerable damage to structures of poor construction such as unreinforced masonry, chimneys and brittle concrete pipe.

Although most residential, commercial and public buildings in Tooele County are under three stories, many structures in Tooele and Grantsville Cities, and some in outlying areas are of older unreinforced masonry construction materials which typically perform poorly during earthquake shaking. Such structures should be expected to suffer significant damage which may involve a total financial loss of the building.

All public buildings such as schools, fire stations and city and county complexes should be surveyed and the necessary retrofitting procedures implemented so they will remain functional after the earthquake.

Because Tooele City, Grantsville and other communities within the County do not have many buildings over three or four stories, the probability of severe structural damage such as collapse is low. More likely buildings and homes will move off their foundations; there will be damage to unreinforced masonry structures, falling chimneys and other loosely connected appendages; and, the disruption of the water, natural gas, power, and telephone systems. Nonstructural damage, such as falling cabinets, food stuffs, unsecured equipment and other objects, will create a hazard to people and increase financial loss.

In addition to these vulnerabilities, Lund (1984) assessed the hazards related to Tooele City's culinary water supply system and Settlement Canyon Dam. Ground shaking can cause a sloshing effect which can damage or fail tanks. He concluded that three of Tooele City's water tanks may need seismic retrofitting and suggested further study on the seismic stability of Settlement Canyon Dam.

When the Great Salt Lake is at record high levels, there is the possibility of ground shaking and fault displacement causing an oscillation of the lake known as a "seiche". Shoreline areas surrounding the lake are the most vulnerable to this type of hazard. Secondary geologic effects such as liquefaction and earthquake induced landslides may also cause damage. Liquefaction is the temporary transformation of soil into a liquid mass, and low lying areas with a high ground water table are most susceptible. The greatest effect of a landslide may be the damming of Middle, Settlement or other canyons and the resulting flood causing damage to roads, towns, and lifelines.

III. RUSH VALLEY

Rush Valley is bordered on the east by the southern Oquirrh range, the Thorpe Hills and the East Tintic Mountains. To the west are the Stansbury, Onaqui and Sheeprock Mountains. South Mountain and the Stockton Bar form the northern boundary.

In Everitt and Kaliser (1980, p.12), there are seven potentially active fault zones listed within Rush Valley. Most of these zones show a very complex "sandwich" character with several individual slivers running parallel to each other. Listed below are the seven faults and their approximate location.

Fault Zone	Location
1. South Mountain Marginal Fault	East flank of South Mountain
2. Mid Valley Horst	East of St. John near Highway 36
3. Onaqui East Marginal Fault	East flank of the Onaqui Mountains, south of Clover
4. Sheeprock Marginal Fault	Northeast flank of Sheeprock range, south of Vernon
5. Vernon Hills Marginal Fault	Northeast of Vernon and Highway 36
6. Southern OBT* Fault Zone	Southeast edge of Rush Valley
7. Northern OBT* Fault Zone	Western flank of Southern Oquirrh range, east of Tooele Army Depot

(*Oquirrh Boulter Tintic)

A moderate to large magnitude event on any of these faults would cause moderate to severe shaking in Rush and Tooele Valleys. If ground rupture accompanied the earthquake, damage would occur to structures which cross or lie near the fault. Roads and other lifeline systems or facilities in Rush Valley at a high risk due to their proximity to the fault include Highway 36, Highway 73, and Tooele Army Depot.

Because Rush Valley contains only about 6% of the total population of Tooele County, and there are very few structures over two stories, the probability of severe structural damage such as collapse is very low. Structures which are not connected to a foundation nor have weak facades and other appendages will probably suffer the greatest damage and pose the greatest life threat.

IV. OTHER FAULTS

A. Stansbury West Marginal Fault

This fault is located on the western side of the Stansbury Mountains flanking Skull Valley. Everitt and Kaliser (1980) suggest that this fault is the most recently active in the area. Even though the fault is separated from the most populous areas of the County by the Stansbury range, a moderate to large magnitude earthquake on the fault could cause damaging ground shaking in Tooele and Rush Valley. Dugway may be most at risk from this active fault.

B. Distant Events

Earthquake vibrations generated by faults which seem to be a safe distance away can also cause damaging ground motion under certain conditions. An earthquake in Salt Lake, Davis, Utah, or Box Elder County may cause shaking in Tooele County which will appear out of proportion to its distance from the epicenter. This phenomenon, referred to as "ground motion amplification" or "local site amplification," was most recently observed in the 1985 Mexico City earthquake. The effect is caused by the relatively thick soil columns underlying an area being excited by ground waves which vibrate at the same frequency as the soil. Depending on many variables, including distance from the source and regional damping effects, this type of ground motion amplification may affect a wide variety of soil conditions and, consequently, building types.

Although these distant events may cause less damage to structures in Tooele County, they can be expected to occur more frequently than large earthquakes.

C. Other Areas of Tooele County

Seismicity in Tooele County appears to be localized along the trend of mountain ranges and near the already identified faults.

The Cedar Mountains, west of Skull Valley, exhibit some minor activity and have tilt-block associated faults on the west side but, relatively speaking, do not have the level of seismicity seen in valleys and ranges to the east. This pattern is generally the rule proceeding west, except near the Great Basin-Sierra Nevada Border where activity picks up dramatically (Arabasz, et. al., 1978).

Significant activity has been recorded near the Lakeside Mountains on the western shore of Great Salt Lake and on the Tooele and Juab County line in the Thomas Range. Minor and infrequent events have been recorded near Wendover.

V. SUMMARY AND MITIGATION

Tooele County should expect some deaths and injuries from earthquakes, especially in the more populated areas of the County. These areas include Tooele City, Stansbury Park and Grantsville.

Following the methodology used by the U.S. Geological Service in calculating death and injuries for large magnitude earthquakes in Los Angeles, San Francisco and Salt Lake City, Tooele County can expect approximately six (6) deaths and two hundred (200) injuries from a local event. Actual death and injury figures could increase dramatically due to mass casualties in a single collapsed building.

Although researchers investigating the area conclude that earthquakes in Tooele County probably occur at greater time intervals and have smaller maximum magnitudes than those quakes on the Wasatch Fault, the number of faults in the area and the possibility of shaking from more frequent remote events adds up to a significant geologic hazard. All areas of the County have the potential for ground shaking, while the most populated areas have a multiple risk due to the threat of fault rupture and loss of lifeline services.

In order to mitigate the hazard to the greatest degree possible, several strategies should be employed at the County, city and individual level. Listed below are several techniques which can lead to successful mitigation of damage during an earthquake.

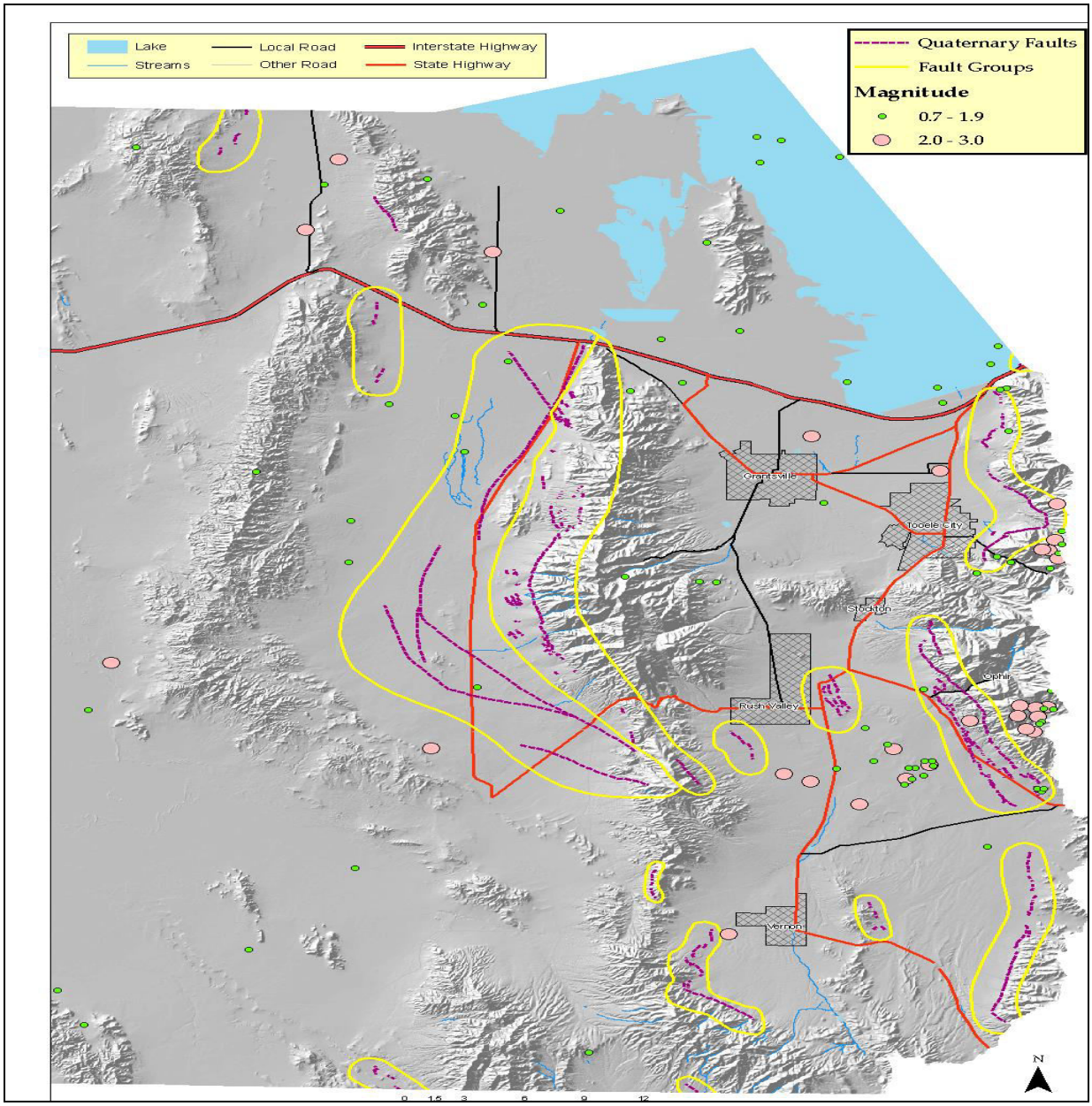
FUNDAMENTAL MEASURES	Response Exercises Preparedness and Response Planning Public Education and Awareness Regional Hazard Analysis
ADVANCED MEASURES	Zoning Ordinances Enhanced Building Codes Retrofit Ordinances Disclosure Ordinances Detailed Systems Risk Analysis

Fundamental measures are those which can be implemented for little or no cost, as part of normal government or business activity. Advanced measures are those which require legislative action and ongoing enforcement.

Although examination of important facilities such as water tanks, power connections and lines, substations, and public buildings could help in mitigating damage to such structures, an experienced engineer should be able to evaluate most city or county systems and give an appraisal as to their ability to withstand the expected shaking or other ground movement.

Emergency management has a proactive public affairs program and residents are being instructed in how to prepare their homes, families, and businesses so that damage and injury can be kept to a minimum. The Tooele County School District and individual schools also maintain and exercise an emergency plan which includes earthquake contingencies.

NOTE: ADDITIONAL EARTHQUAKE HAZARD MAPS ARE LOCATED IN THE EOC.



Historical Earthquake Epicenters and Fault Zones, Eastern Tooele County (Source: UUSS)

VI. FLOODING

Flooding in Tooele County is associated primarily with heavy rainfall from cloudburst storms and from lake flooding around the Great Salt Lake. Stream flooding is limited due to the desert climate. Most streams in the County are intermittent. Intermittent stream water usually flows only after intense, short-duration rain events. Eastern areas of the county see sustained flows from spring and summer snowmelt.

Current flood insurance rate maps (FIRMS) exist only for the communities of Tooele City, Rush Valley, Stockton and Wendover. These maps haven't been updated in several years making the accuracy of the data suspect given the significant amount of recent development in the County. Floodplain information from these maps can be found at the County EOC. Much of the flood hazards present in the maps are in the form of alluvial fans/debris flows. These flood events occur with the aforementioned short duration, heavy rainfall events. These flood events can be compounded if the heavy precipitation event causes rapid snowmelt during the spring months.

A secondary effect of flooding due to severe thunderstorms or snow melt can be landslides. The steep topography on the flanks of the mountain ranges in Tooele County is very conducive to the formation of potential landslide areas. Urban areas most vulnerable to landslide activity are those on or at the base of steep slopes, in drainage areas near the mountains or in established flood and debris slide areas, such as Western Grantsville, Hickman Canyon, Settlement Canyon and areas to the north along the western slope of the Oquirrh mountains affecting eastern areas of Erda and Lakepoint with the potential to affect the Stansbury Park community.

The broad, gently valley ward sloping alluvial fans of Tooele and Rush Valleys were formed as a result of outwash from the mountain canyons, much of it in torrential fashion. These areas are periodically subject to mud and debris flow and debris flood type discharge.

The following canyons adjacent to urban areas show evidence of debris flows as indicated by Everitt and Kalister (1980).

Canyon	Location
Swensons Canyon	East of Lincoln
Pine Canyon	East of Lincoln
Middle Canyon	East of Tooele
Settlement Canyon	Southeast of Tooele
Pope Canyon	West of Grantsville
North Willow Canyon	Southwest of Grantsville
Coal Pit Canyon	Southwest of Grantsville
South Willow Canyon	Southwest of Grantsville

Other less conspicuous drainage areas and steep slopes may also pose a risk. All areas near the urban settings of the County should be monitored during the snow melt season and wet years for slope failure process.

Lake flooding can occur along the Great Salt Lake (GSL) and in the West Desert. The 1983-84 flood events resulted in much of the area near Lake Point was flooded by the GSL. The operation of the west desert pumping station resulted in an inundation of a large area of the west desert. During periods of excessive precipitation, areas of the west desert and Bonneville Speedway are often underwater. More than $8 Million was reimbursed to the county by the Federal Emergency Management Agency (FEMA) for repairs and future mitigation.

VII. DAM FAILURE

There is sixty-nine dams located in Tooele County, two of which are listed as a high hazard threat. Meaning, if they fail, they have a high probability of causing loss of life and extensive economic loss. Four dams are listed as a moderate hazard threat meaning if they fail they have a low probability of causing loss of life. Both threats would cause appreciable property damage and mitigation efforts should be developed and pursued.

Fifty-eight dams have a low hazard threat, meaning if they were to fail there would be a minimal threat to life and economic losses would be minor and the damage would be limited to the owner of the dam. However they should still be monitored. No hazard rating is provided for five dams.

It should be noted that Dam Safety hazard classifications are in the event of the failure of a dam, based upon the consequences of failure of the dam given by the State Engineer. Therefore, the classification of a high hazard dam does not mean that the dam has a high probability of failure.

Significant dams in Tooele County:

Settlement Canyon/UT00270 (High Hazard)
Grantsville/UT00343 (High Hazard)
Grantsville Regulating Pond/UT00577
Vernon/UT00312
Wrathal-Johnson/UT00139

VIII. SEVERE THUNDERSTORMS AND LIGHTNING

All thunderstorms are dangerous. Every thunderstorm produces lightning. Nationwide, an average of 300 people are injured and 80 people killed each year by lightning. Although most lightning victims survive, people struck by lightning often report a variety of long-term, debilitating symptoms. Utah has on average, 2 lightening-caused deaths each year. Other associated dangers of thunderstorms include tornadoes, strong winds, hail, and flash flooding. Flash flooding is responsible for more fatalities—more than 140 annually—than any other thunderstorm-associated hazard.

Dry thunderstorms that do not produce rain but reach the ground are most prevalent in the western United States. Falling raindrops evaporate, but lightning can still reach the ground and can start wildfires. Thunderstorms typically produce heavy rain for a brief period, anywhere from 30 minutes to an hour.

Thunderstorm Facts

- Thunderstorms and lightning can happen anywhere at any time; however, they most often occur during the spring, summer and fall months and favor warm, humid conditions.
- About 10 % of thunderstorms are considered severe – ones that cause winds that reach more than 57 miles per hour, hail 3/4 inch or larger in diameter, or produces a tornado.
- Whether the thunderstorm is “severe” or not, the lightning is always dangerous and often knocks out electrical power. Severe thunderstorms can occur with little or no warning.
- Thunderstorms may occur singly, in clusters, or in lines. Some of the most severe occur when a single thunderstorm affects one location for an extended period of time.

A lightning bolt can reach 500,000 degrees Fahrenheit, five times hotter than the surface of the sun. Lightning cannot occur without thunder; however, the lightning bolt may occur too far away for you to hear the thunder.

Lightning is drawn to three things: water, metal and the tallest things standing in open fields. If you are in an open field or on open waters get to a building quickly. If you cannot get to a building, stay in a clear area and crouch low to the ground.

Stay inside a hard topped car, stay there. If inside, stay away from windows, water, faucets, sinks and bathtubs because water conducts electricity. Because lightning can travel down phone wires, DO NOT use the telephone or a computer. For increased safety and to mitigate damages, unplug all electrical appliances. Stay away from metal objects such as golf clubs, tractors, fences, etc.

FACTS ABOUT LIGHTNING

- Lightning’s unpredictability increases the risk to individuals and property.
- Lightning often strikes outside of heavy rain and may occur as far as 10 miles away from any rainfall.
- "Heat lightning" is actually lightning from a thunderstorm too far away for thunder to be heard. However, the storm may be moving in your direction!
- Most lightning deaths and injuries occur when people are caught outdoors in the summer months during the afternoon and evening.
- The odds of being struck by lightning are estimated to be 1 in 600,000, but could be reduced even further by following safety precautions.
- Lightning strike victims carry no electrical charge and should be attended to immediately

IX. SEVERE WINTER STORMS

Snow can occur at any temperature near or below freezing. In the US, snow most commonly occurs between 20 and 30 degrees Fahrenheit. Snow is likely to occur: when winds are easterly to northeasterly; temperatures are near or below freezing; a low is forecast to move immediately to the south or east; the pressure is falling, and a thickening cloud layer is advancing from the south or west. Severe winter storms often bring heavy snow and/or drifting snow, dangerous driving conditions, sleet or freezing rain, increased wind speeds, extremely cold temperatures, and sometimes loss of electrical power. In years of heavy snowfall, spring flooding and mudslides are also more likely to occur.

Winter storms are classified as watches or warnings and include:	
WINTER STORM "WATCH"	Severe winter weather may affect the area.
HEAVY SNOW "WARNING"	Snow, at least 4 inches in 12 hours or 6 inches in 24 hours is expected.
BLIZZARD "WARNING"	Heavy snow and/or blowing snow, cold air, and winds of at least 35 miles per hour, continuing for several hours or more, are expected.
SEVERE BLIZZARD "WARNING"	Very heavy snowfall, with winds at least 45 miles per hour or temperatures of ten degrees or lower.
ICE STORM "WARNING"	Significant, possibly damaging ice accumulation is expected. If raining, rain expected to freeze as soon as it hits exposed surfaces.

To prepare for the possibility of severe winter storms, consider the following:

1. Monitor radio, local TV or local weather channel, once alerted.
2. Winterize vehicles before winter storm season.
3. Prepare a family first aid/safety kit in vehicles/home that includes extra prescription medications, a portable radio, candles, matches, and a working flashlight.
4. Keep extra blanket(s) on hand and in vehicles.
5. Make sure portable radio(s) is/are in working order.
6. Be extremely careful using a portable heater.
7. Be careful walking on snowy/icy surfaces.
8. Don't over exert in the cold/snow.
9. Keep gas tanks full for emergency use and to keep fuel line from freezing.
10. If traveling during a storm, let someone know destination and when arrival is expected in case of delays.

X. SEVERE WEATHER REPORTING IN REAL-TIME

In the event of any major damage from severe weather events such as high winds, hail, tornadoes, winter storms, etc., notify the National Weather Service through the Salt Lake City Forecast Office at:

1-800-882-1432.

Select Option 1.

Be prepared to give eyewitness information. Try to the report, such as estimating the size of hailstones in inches or comparisons (pea, dime, nickel, etc.). Report any damage such as trees down, power lines down, roofs off homes, and trucks or equipment blown over. Give wind direction and speed estimation. Be prepared to report rain accumulation and any flooding. Specify any road closures and visibility.

XI. WILDFIRE

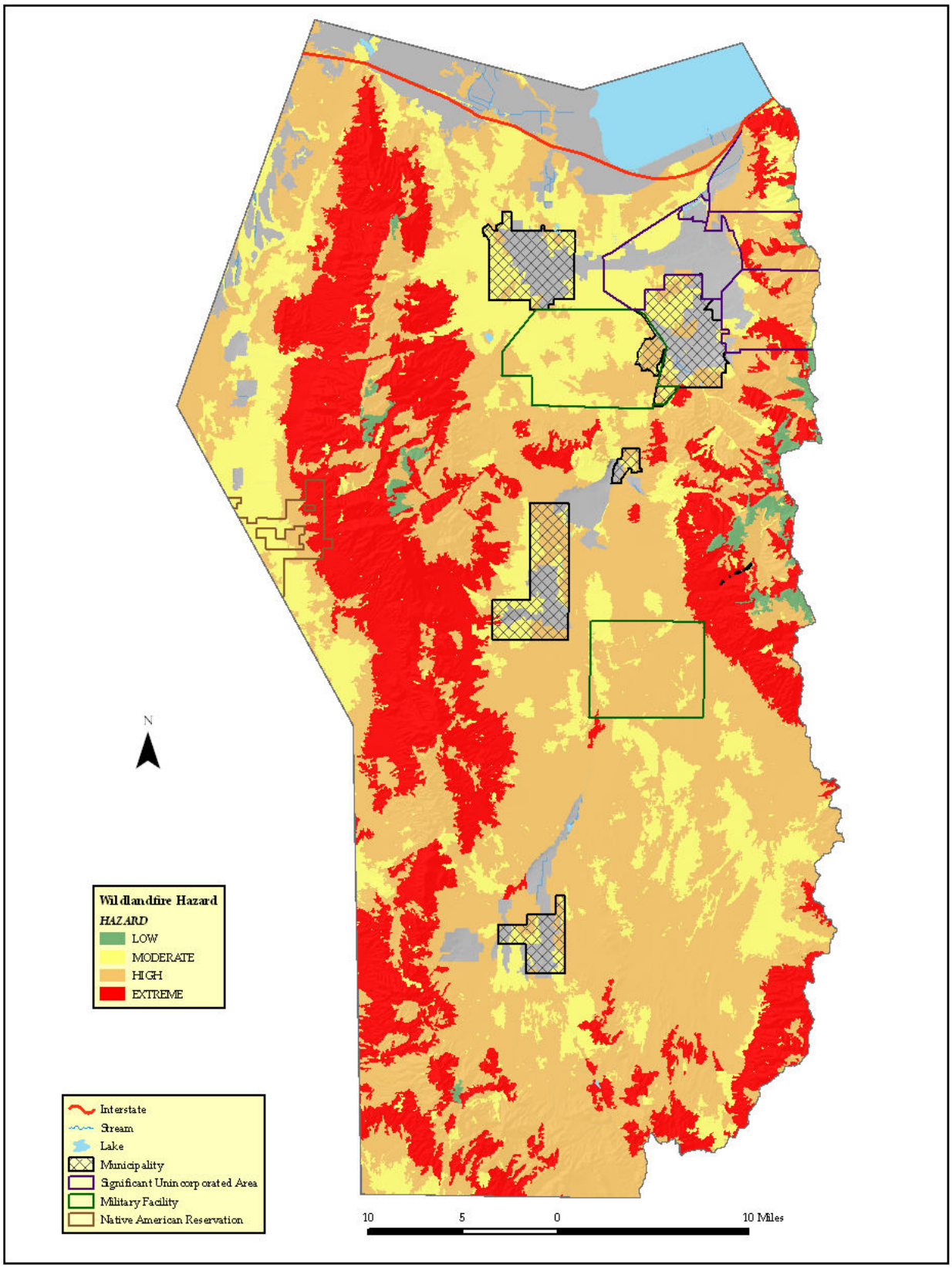
A. Potential wildfire hazard within Tooele County is growing as population growth is spreading into the wildland-urban interface (WUI). Over the past 10 years urban sprawl has encroached upon forested foothill areas and wildland areas threatening life and property.

B. The wildfire threat in Tooele County in the past has had a significant effect on the watersheds, including landslides, debris flows and other forms of erosion. Federal, state and local agencies have worked together to enforce ordinances and other programs such as re-vegetation zones to protect watersheds.

C. Wildland fire risk for Tooele County can be found on the following map. The map layers were provided by the Utah Division of Forestry, Fire, and State Lands and show four categories of wildfire risk (Extreme, High, Medium and Low). These ratings cover all of Tooele County and are based on the type and density of vegetation in each area as well as vulnerable population. Additional factors that influence wildfires (weather conditions, wind speed and direction) are not considered in this risk assessment.

D. The entire county is at moderate or greater risk for wildfires. Areas potentially affected include: Loftgreen, Vernon, Ophir, Deseret Chemical Depot, Rush Valley, Terra, Dugway Proving Grounds, Skull Valley Reservation, Stockton, Tooele Army Depot, Pine Canyon, Grantsville and Erda.

E. Development has been advancing further and further into the WUI, with many of the most vulnerable homes also the most costly to replace. Without effective fuel reduction measures and sufficient defensible space, these areas are likely to see considerable losses.


N
Wildlandfire Hazard
HAZARD
LOW
MODERATE
HIGH
EXTREME
Interstate
Stream
Lake
Municipality
Significant Unincorporated Area
Military Facility
Native American Reservation
10
5
0
10 Miles