City and County of Denver

Hazard Identification and Risk Assessment

October 2011

Mayor's Office of Emergency Management

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Executive Summary

Three specific factors must be considered when drafting emergency management plans for a city: what are the hazards that affect the city, what are the capabilities of the city to respond to those hazards and what are the social vulnerabilities within that city. This risk assessment focuses on what hazards Denver must prepare for (based on history and science), what are its response organizations and what is the current make up of the community (based on Census 2010 data).

Emergency Management must also take into account two new trends when assessing its hazards: the increase in extreme weather and the changing demographics in the United States. After a particularly bad weather year in 2011, the National Weather Service said that extreme weather is becoming the new normal. According to the National Oceanic and Atmospheric Administration (NOAA), the nation is increasingly vulnerable to extreme weather and 2011 was a record breaking year. Damages from weather disasters in 2011 have already surpassed the record set in 2008 when the government recorded nine disasters, each with economic losses topping $1billion. Federal officials say total losses from severe weather this year have reached more than $35 billion. Climate change and vulnerability of the population account for most of these severe weather events and the increase in economic losses.

In addition to the problems associated with extreme weather, there are significant changes to US demographics that will change the way emergency managers plan for disasters. The overall US population is projected to grow significantly over the next 15-20 years. Within this growth, there are three specific shifts that could become major drivers in drafting emergency management plans and how Denver assesses its risk: first, the increased aging population; second, the continued migration of people to densely populated centers which increases social vulnerability; and third, the continued changes in racial and ethnic diversity.

How will these demographic changes affect emergency management in Denver? The growing US population could further stretch local and state government budgets and create resource issues or constraints. People tend to expect the government to take care of them during emergency situations and this will create more challenges for emergency management as the City and County of Denver continues to grow. Language and communication will become more difficult as we become more diverse and more people do not use English as their first language. In addition, cultural sensitivities will need to be considered as some cultures have a distrust of government. The cultural differences will change not only how we draft the public's emergency communications but also how all emergency responders interact with the community. Finally, the increase in the elderly population will create a stress on the health care system. In the case of an evacuation, this group will most likely need additional assistance (for example transportation out of the affected area). The elderly also tend to be less compliant to public warnings and the city will need to build strong community social networks before a disaster strikes. (Strategic Foresight Initiative, "US Demographics Shifts" Aug 2010)

For the purposes of this risk assessment, the hazards that we address either have historical precedence or are remote possibilities that would cause much destruction if they did occur (for example, Earthquakes). Potential Denver hazards include the following: Communicable Disease Outbreak, Dam Failure, Drought, Earthquakes, Energy Disruptions, Extreme Heat, Flood, Hail, Hazardous Material Incidents, Lightning, Terrorism, Tornados and Winter Storms. We have not included a discussion of Wildfire in our risk assessment based on the fact that Denver only has .01% of area that is considered at risk for wildfire, according to the Colorado State Forest Service. However, fire in general is a potential hazard that Denver faces but it is often a secondary hazard (ie lightning is a major cause of structural fires). It is not treated as a separate category in this assessment.

Some general thoughts about the hazards Denver faces:

- Denver has a history of large and small magnitude flooding, with quick developing flash floods occurring every year.
- The failure of Cherry Creek Dam would cause catastrophic damage to life and property.
- Denver's tornados do not typically get high intensity ratings, but the potential for death/injury or property damage remains high due to their unpredictability.
- Damage from hail is our costliest hazard.
- Although Denver has had only 3 lightning deaths in the past 40 years, Colorado ranked fourth in the nation for lightning deaths between 1995 and 2009.
- Denver just experienced its hottest August in its history in 2011. Extreme heat claims more lives each year in the US than hurricanes, floods, tornados, and lightning combined.
- Two of the three Presidential declarations in Colorado have been related to winter weather events.
- Based on past history, scientists predict that Colorado could have an earthquake of magnitude 6 ½ to 7 ¼ somewhere in the state. Many of our downtown buildings are not built to withstand an earthquake.
- There are at least 185 facilities in Denver that store or use hazardous materials and these materials are transported through town by rail or by truck.
- There are known links to both domestic and international terrorist groups in Colorado.

Analysis and Evaluation

Denver is currently included in the Denver Regional Natural Hazard Mitigation Plan (Nov 2010) but is beginning the process of writing its own plan to cover the hazards specific to Denver. The Denver plan will include both natural and manmade hazards and will be completed by 2013. The first step in this process is to identify the risks and vulnerabilities within the city.

Hazard mitigation cannot be prioritized until we understand which hazards pose the most risk to life, property and the City's critical functions. The following rankings of hazards will enable Denver to develop strategies to mitigate, plan and prepare for the potential disasters that are most likely to occur, as well as those that are less likely to occur but will cause more damage. While these rankings are based on factual evidence, there is some level of interpretation that is expected when conducting risk assessments.

In order to rank the hazards according to their risk, the following evaluation was made for each hazard. Each hazard was given two scores: one for its impact and one for its likelihood. In the impact score, the following parameters were taken into consideration: Geographic Extent (size of the affected area); Duration of the event; Environment (what was the damage to the environment); Health Effects (fatalities and injuries); Displacement and Suffering (refers to vulnerable populations); Economy (did the hazard impact the local economy); Infrastructure (including utilities); Transportation (can people get the resources they need); Critical Services (i.e. medical, social, financial, etc); Confidence in Government (would confidence in government be shaken); Cascading Effects (what are the secondary effects of the hazard). These parameters were derived from FEMA and the Emergency Management Accreditation Program (EMAP). A score was given for each parameter and then all the scores were added together to get a total Impact and Vulnerability Assessment Score.

Key Findings from the Risk Scores:

- Denver's most likely reoccurring hazards are: Winter Weather, Hazardous Materials Incidents, Extreme Heat, Hail, and Floods
- The hazards that will impact the area the most are Dam Failure, Earthquakes, Terrorism, Communicable Disease Outbreaks and Winter Weather. Of these, only Winter Weather is a hazard that occurs regularly.

Impact and Vulnerability Score:

Parameter	Definition	One	Two	Three	Four	Five
Geographic Extent	Size of the affected area. Includes areas not damaged but strongly affected by the incidents. For example, areas backed up by a transportation accident.	Single site. One or two blocks.	Single site. Multiple blocks.	Community (all of downtown)	City-wide	Regional. Winter Storms.
Duration	How long does the acute crisis part of the disaster last?	Less than 24 hours	1-3 days	4-7 days	7-30 days	30+ days
Environment	How damaging is the disaster for the natural environment?	No damage/ temporary minor damage	Degradation of ecosystem that will repair itself	Degradation of ecosystem that requires intervention	Functional loss of ecosystem, but restoration is possible	Permanent loss of ecosystem
Health Effects (Deaths and Injuries)	How dangerous is the disaster for the natural environment?	No deaths or injuries	1-10 deaths and/or 1-100 injuries	11-50 deaths and/or 101-500 injuries	51-500 deaths and/or 501-1500 injuries	Over 501 deaths and/or 1501 injuries
Displacement and Suffering	How likely is the hazard to negatively impact the exposed population in terms of displacement, personal property loss and increased indebtedness?	No displaced people	Vulnerable populations begin to have problems with food, water, access to shelter.	Vulnerable populations having serious difficulties. General population starting to have problems.	251-1000 people displaced. 5-30% of population facing acute shortages.	1000+ displaced people. More than 30% of population facing acute shortages of basic supplies and access to services.
Economy	How does the hazard affect the local economy?	No measurable impacts	No impacts to overall economy but isolated businesses experience hardship.	Entire sectors experience loss of revenue and capital.	Core sectors of economy are affected and unable to generate revenue. Capital losses between 1- 10%	Physical losses equal to 10% to assess value. Loss of ability to generate revenue.
Built Environment (Property, Facilities, Infrastructure)	How does the hazard affect buildings and physical infrastructure? (Includes utilities)	No effects.	1-10 structures uninhabitable (red tagged). Up to 25% loss of one utility.	11-250 structures red tagged. Multiple utilities affected up to 25%.	251-1000 structures red tagged. Multiple utilities affected 25-50%.	1000+ structures red tagged. At least two major utilities degraded at least 50%.
Transportation	How does the hazard affect the ability of residents and workers to access the resources they need?	No effects on mobility	All critical services accessible, but delays reaching work or non essential services	One critical service inaccessible. Degradation of at least one mode. Major corridors open, but minor streets degraded or impassible.	Many critical services inaccessible. One major mode inoperable. One major corridor inoperable.	Most critical services inaccessible. Multiple modes inoperable. Most high volume corridors impassible.
Critical Services (Continuity of Operations and Responders)	How likely is the hazard to reduce the ability of government and business to provide critical services? (Medical, Public Safety, Social, Financial, etc)	No impairment on critical services	Temporary degradation of 1 critical service	Temporary degradation of multiple critical services. Long term degradation of 1 critical service	Temporary degradation of most critical services. Long term degradation of multiple services.	Unable to deliver most critical services.
Confidence in Government	Would public's confidence in government be shaken?	No	(Not used)	Somewhat	(Not used)	Yes
Cascading Effects	How severe and complex will the secondary effects be?	Hazard extremely unlikely to cause secondary hazards. If they occur, would have minor effect.	Secondary hazards may occur, but are likely to be minor compared to primary hazard	Secondary hazards occur that extend the impact of the disaster and hamper response, but are not disasters in their own right.	Secondary effects generated that significantly increase the magnitude of the disaster. Secondary impacts would likely be considered disasters if they occurred by themselves.	Secondary effects generated and rival or exceed primary hazard. Secondary impacts would definitely be disasters in their own right.

Hazard Likelihood Score:

The Hazard Likelihood score comes from the hazard's past history. Each hazard's history was looked at to get the best estimate of when that particular hazard might reoccur and was given a score based on its past frequency.

Hazard Likelihood

Measure of likelihood	Return period in years	Rank
Frequent or very likely	Every 1-3 years	6
Moderate or likely	Every 3-10 years	5
Occasional, slight chance	Every 10-30 years	4
Unlikely, improbable	Every 30-100 years	3
Highly unlikely, rare event	Every 100-200 years	2
Very rare event	Every 200-300 years	1

Frequent or very likely to occur events usually have a high number of recorded incidents or anecdotal evidence. (For example, an area that is subject to flooding every year or so)

Moderate or likely to occur hazards also have a historical record but occur with a frequency of 3-10 years. (For example, an area that faces an infectious disease outbreak every few years)

Occasional or slight chance means events are those that occur infrequently. There may be little recorded historical evidence and a return interval of 10-30 years. (For example, a rail accident where dangerous chemicals are released)

Unlikely or improbable refers to hazards that are not expected to occur more frequently than once every 30-100 years. There may be no historical incidents in the community. (For example, a plane crash with total loss of life)

Highly unlikely or rare events are extremely unlikely and have a return period of 100-200 years. (For example, a "one hundred year flood")

Very rare events may happen every 200+ years. (For example, a large earthquake)

These two scores were then multiplied to give a risk factor:

Impact and Vulnerability Assessment x Hazard Likelihood=Risk

Below are the individual scores that show how the first number (the impact and vulnerability assessment) was derived. Again, each category (1-11) was given a score and then added together to get a total vulnerability score.

Table A: Impact and Vulnerability Assessment Score

Hazard	1	2	3	4	5	6	7	8	9	10	11	Total
Communicable Disease	5	5	1	4	1	3	1	1	3	3	1	28
Dam Failure	5	1	2	4	4	3	4	4	3	1	4	35
Drought	4	4	3	1	1	2	1	1	1	1	4	23
Earthquakes	5	1	1	3	3	4	3	4	3	1	4	32
Energy Disruptions												
Extreme Heat	4	4	2	2	2	2	2	2	1	3	2	26
Flood	2	1	2	2	1	2	1	2	2	1	2	18
Hail	3	1	1	3	1	2	2	3	1	1	2	20
Hazardous Materials Incident	3	2	3	2	3	2	2	3	2	1	3	26
Lightning	1	1	2	2	1	1	2	1	1	1	1	14
Terrorism	2	1	3	4	3	3	4	3	2	3	4	32
Tornados	2	1	1	2	1	2	2	2	1	1	3	18
Winter Weather	5	2	1	2	2	3	2	4	2	3	2	28

1=Geographic Extent; 2=Duration; 3=Environment; 4=Health Effects; 5=Displacement; 6=Economy;7=Built Environment; 8=Transportation; 9=Critical Services; 10=Confidence in Government; 11=Cascading Effects

Each hazard was assigned a Likelihood score based on past history. The Impact and Vulnerability Score from Table A was multiplied by the Likelihood score (Table B).

Table B: Total risk scores for Denver hazards:

Hazard	**Impact and Vulnerability**	**Likelihood**	**Risk Factor**
Winter Weather	25	6	**150**
Hazardous Materials Incidents	25	6	**150**
Extreme Heat	23	6	**138**
Communicable Disease Outbreak	25	5	**125**
Hail	20	6	**120**
Drought	23	5	115
Flood	17	6	102
Earthquakes	31	3	93
Tornados	17	4	68
Lightning	13	5	65
Dam Failure	34	1	34
Terrorism	29	1	29
Energy Disruptions (placeholder)			

Denver Community Profile

Denver is the capital and second most populous city of the state of Colorado. It is located just east of the eastern foothills of the Rocky Mountains and earned its nickname as the "Mile-High City" due to its elevation of one mile, or 5280 feet, above sea level. The 105the meridian west of Greenwich passes through Union Station, making it the reference point for the Mountain Time Zone.

According to the 2010 census, the population of Denver was 600,158 which is an increase of 45% since 2000. The proximity to the mountains, the abundance of parks and rivers, and 300 days of sunshine per year has drawn many outdoor enthusiasts to Denver. One example of Denver's love for the outdoors is exemplified through the Denver B-Cycle program, the first large-scale municipal bike sharing system in the United States, where you can rent a bicycle to get anywhere within the city.

In addition to its outdoor appeal, Denver is economically and strategically important as a key trade point for the country. It supports storage and distribution services for the Mountain States, Southwest States, and all the Western States.

Key Community Factors:

Geography

Major Geographical Features: Denver is located in the center of the Front Range Urban Corridor, between the Rocky Mountains and the High Plains. The South Platte River bisects the city, and many creeks, small lakes, and reservoirs grace the metropolitan area. The city encompasses an area of 154.9 square miles, of which 1.4 miles is water.

Climate: Denver's climate is semi-arid and has four distinct seasons, with typically dry falls and winters and wetter springs and summers. Fall is often pleasant and dry. Denver's winters can vary from mild to cold, and although large amounts of snow can fall on the mountains just west of the city, the air frequently dries out before passing over the Front Range, shadowing the city from precipitation for much of the season. Additionally, warm Chinook winds occasionally occur, quickly melting snow accumulations and making Denver's winters milder than surrounding areas. Denver averages 61 inches of seasonal snowfall. The winter/snow season in Denver generally starts around October 8 and goes until around April 27. Approximately every 3 to 4 years, Denver will experience an extreme snowstorm or large blizzard. Spring can be windy with highly changeable weather, an occasional blizzard, large temperature changes and an occasional gentle soaking rain or wet snow. Summers are usually hot with low humidity and the threat of big thunderstorms is always there due to the unique positioning of the city off the eastern slope of the Rocky Mountains. These thunderstorms can be large with damaging hail.

Property:

Neighborhoods: The city and county of Denver has 80 official neighborhoods. Many of these neighborhoods are defined not only by their location but their unique building styles. Generally the neighborhoods closest to the city center are denser and have more brick buildings built around the turn of the twentieth century. Many of the neighborhoods away from the city center have buildings built with more modern materials and style. The neighborhoods farthest away from the city center are generally more recent developments with suburban characteristics or new urban developments that attempt to recreate the feel of older neighborhoods. The city center is comprised of a mix of old and new multiple story buildings or skyscrapers.

Building Codes: The purpose of Denver's Building Code is to provide minimum standards to safeguard life, health, property and public welfare by regulating and controlling the design, construction, quality of materials, use, occupancy, location and maintenance of all buildings and structures within the City and County of Denver. It was last amended in 2011.
http://www.denvergov.org/Portals/696/documents/2011_Amendments_Final.pdf

Critical Facilities: There are three sports venues in Denver: Coors Field (approx 50K capacity), the Pepsi Center (approx 19K capacity) and the Sports Authority at Mile High Stadium (approx 76K capacity).

Infrastructure:

Utilities: Denver Water serves 1.3 million people in the city of Denver and many surrounding suburbs. Established in 1918, the utility is a public agency not funded by taxes, but by water rates and new tap fees. It is Colorado's oldest and largest water utility. Xcel Energy (which operates) in 8 states is Denver's electricity and natural gas company. Comcast, CenturyLink, AT&T, and Cricket all offer phone service in Denver. The Wastewater Management Division plans, designs, constructs, operates and maintains Denver's sanitary and storm sewer systems. It maintains more than 1,500 miles of sanitary sewers and 550 miles of storm drainage facilities.

City Streets: The city streets of Denver are aligned in a grid system that are oriented to the cardinal directions. The downtown streets of Denver run northeast-southwest and northwest-southeast. The NW-SE streets are numbered, while the NE-SW streets are named.

Freeways and Highways: Denver is situated almost on the intersection of Interstate 25 and Interstate 70, both major interstates that run north-south from New Mexico to Wyoming and east-west from Utah to Maryland. The intersection of the two interstates is referred to locally as the "mousetrap", because when airborne, the junction resembles a mouse trap. Interstate 225 was built to link the neighboring city of Aurora with I-25. The city supports two other interstates that serve the purpose of linking neighboring cities: Interstate 270 that runs concurrently with US Highway 36; and Interstate 76 that

begins from I-70 in the northwest corner of the city and runs northeast to Nebraska where it ends at I-80. US 36 connects Denver with Boulder and the Rocky Mountain National Park. US 6 connects the west-central suburbs of Golden and Lakewood to Denver and I-25.

Denver also has a beltway that runs nearly all the way around the city known as the "470". SH 470, or C-470, is a freeway that allows the Southwest Metro area to traverse around the southwestern part of the metro area. E-470 and Northwest Parkway connect and are both toll ways that commuters use to traverse around the metro area from the southeast metro area east towards the northwest metro area.

Mass Transit: Mass transit in Denver is managed by the Regional Transportation District (RTD). RTD operates over 1,000 buses that serve over 10,000 stops in eight counties around the Denver and Boulder metropolitan areas. RTD also operates 5 light rail lines with a total of 34.9 miles of track that serves 36 stations. In 2008, RTD was voted the best transit organization in North America by *American Public Transportation Association (APTA).*

Denver also maintains an Amtrak rail system that allows passengers to travel east-west between California and Chicago and south to Albuquerque.

B-Cycle Program: Denver B-cycle is the first large-scale municipal bike sharing system in the United States. Dozens of special bike stations (B-stations) were placed in downtown Denver as well as the Cherry Creek and Denver University neighborhoods. Denver B-cycle members are able to pick up one of the red bikes at any B-station and drop it off at any B-station around the city. There are currently 510 bikes at 51 stations.

Freight rail: The Union Pacific and Burlington Northern Sante Fe (BNSF) are the primary freight operators in Denver.

Airports: The Denver International Airport (DIA) is the primary airport for Denver. It is located 18.6 miles east-northeast of the Colorado State Capitol. DIA is tenth busiest airport in the world and the fourth busiest in the United States. It covers more than 53 square miles making it the largest airport by land area in the U.S. Denver serves as a major hub for United Airlines and was the headquarters for Frontier Airlines until 2009.

There are three other general aviation airports that serve Denver: Rocky Mountain Metropolitan Airport, Centennial Airport, and Front Range Airport.

Demographics: Metro Denver exceeds 2.9 million people, and by 2030, Metro Denver's population is anticipated to increase to almost 3.8 million. The ethnic and minority population comprises 32.5 percent of Metro Denver's population with continued growth forecasted during the next decade. The Hispanic population is Denver's largest minority group comprising 31.8 percent of the population in 2010.

Population and 2010 Census Data: According to the 2010 census, the city of Denver had a population of 600,158 (a 45% increase since 2000) making Denver the second most

populous city in Colorado. El Paso County (home to Colorado Springs) surpassed Denver as the state's most populous county in the 2010 census count.

Below are some quick statistics about Denver County from the 2010 Census:

- Denver is 68.9% non Hispanic white;
- Denver is 31.8% Hispanic or Latino
- 40.6% of the city's households are composed of a person living alone.
- Ratio of male to female is 50/50. (Males-300, 089; Females-300,069)
- Denver is a relatively young town with a median age of 33.7 years. Only 10.4% of Denver's population is 65 or older. 74.8% of the population is 21 or older

The table below gives a breakdown of race in Denver County.

Race	**Percent**
White	68.9%
Black or African American	10.2%
Native American	1.4%
Asian	3.4%
Native Hawaiian/Other Pacific Islander	0.1%
Hispanic or Latino	31.8%
Mexican Americans	24.9%

Vulnerable Populations

- 22.3% of the households in Denver have children under the age of 18
- There are 7,446 males and 16,240 females over the age of 65 living alone.
- Denver has 51 Long Term Care Facilities/Nursing Homes and 8 hospitals.
- Approximately 28% of households in Denver speak a language other than English at home.

Interesting statistics about Denver's population:

- Colorado has one of the nation's most educated workforces, ranking second among the 50 states (behind Massachusetts) for percentage of residents with a bachelor's degree or higher, at 35.9 percent.
- In Metro Denver, 39.7 percent of residents have a bachelor's degree or higher. Also, Colorado ranks eighth in the country for Ph.D. scientists and engineers as a percent of the workforce

Organizations

Denver Police Department: The Denver Police Department (DPD) provides the full spectrum of police services to the entire county, and may provide contractual security police services to special districts within the county. DPD is broken into several divisions: Patrol, Administration, Special Operations, Criminal Investigations and Research, Training & Technology.

Over the past couple of years, Public Safety was enhanced by modernizing the Police Department via technology, by creating an internal affairs filtering process, by creating a DPD strategic plan forming the governance structure Integrated Criminal Justice and by removing 2.9 million square feet of graffiti.

Patrol Division: Denver is divided geographically into six decentralized district commands, each with a stand-alone station as its primary base of operations. Each district command is comprised of patrol and investigative personnel, tasked with round the clock coverage. Each district and bureau has its own command staff, reporting directly to the Division Chief of Patrol. The Division Chief of Patrol serves as the administrator of the department's largest division, with over 800 sworn personnel.

District 1 – northwest
District 2 – northeast / central
District 3 – southeast
District 4 – southwest
District 5 – northeast
District 6 – central Denver & downtown
Gang Bureau – citywide responsibility
Metro / Swat – citywide responsibility
Public Nuisance Abatement – citywide responsibility

The Patrol Division provides a variety of services, including uniformed patrol, crime prevention, emergency incident response, accident investigation, traffic enforcement, ordinance and statute enforcement, preliminary crime scene investigation, nuisance and criminal investigations and community problem-solving and partnerships. The Office of the Division Chief of Patrol is staffed by five sworn personnel and one administrative assistant.

Special Operations Division: The Special Operations Division includes several active bureaus and units of the Denver Police Department to include the DIA

International Airport Police Bureau, Traffic Operations Bureau, Traffic Investigations Bureau, Juvenile Intake Section and Executive Security.

The Criminal Investigations Division is the primary command for the Crimes against Persons Bureau, the Pattern Crimes Bureau, the Vice and Narcotics Bureau, the Special Investigations Bureau, and the Crime Laboratory Bureau. The Denver Crime Lab is comprised of nine units, including the Crime Scene Investigations Unit, the Forensic Chemistry Unit, the Trace Evidence Unit, the Firearms/Toolmarks Unit, the Latent Print Unit, and the Photography Lab, the Forensic Biology/DNA Section, the Quality Assurance Unit, and the Crime Scene Volunteer Unit.

Specialized units include:

- Denver Police Department Mounted Patrol
- S.W.A.T. Special Weapons And Tactics-The SWAT Team deals with hostage negotiation, drug busts and counterterrorism
- HALO (High Activity Location Observation) Program-The HALO Program is a collaborative effort between Denver Police, community groups and local businesses. Established in 2006, the program utilizes networked video cameras to deter crime and enhance public safety through faster response to incidents. Monitored locations include high-traffic intersections, areas where drug activity and street crime are prevalent, and public facilities and parks. Cameras are also used to protect tourist sites, healthcare facilities and areas with homeland security importance. Mobile cameras are used to help manage crime hotspots. Police point to successes, including HALO's help in controlling major drug and street crime issues on notorious East Colfax Avenue.

Denver Sheriff's Department: The Denver Sheriff Department is responsible for the care, custody and transport of prisoners for the City and County of Denver. The department is comprised of three divisions:

County Jail Division: The Denver County Jail is the largest single county jail in the Rocky Mountain region. The County Jail Division is responsible for the long term care and custody of prisoners and is the holding facility for convicted felons awaiting transfer to the Colorado Department of Corrections, Work Release and Community Corrections.

The Downtown Division is comprised of the Van Cise-Simonet Detention Center which is the prisoner intake center where prisoners are processed into the system and housed until such a time that they are able to make bond or have been given an advisement by the court. The Civil Division, Court Services Unit and the Correctional Care Medical Facility (located at Denver Health) also reside under this division.

Technology, Support and Special Projects Division is responsible for the Department's overall administration and special projects, the Training Academy and the Vehicle Impound Facility.

Denver Fire Department: The Denver Fire Department (DFD) is dedicated to providing quality, timely, and professional emergency services to those who live in, work in, and visit the City and County of Denver. The main service of the DFD is fire suppression and medical response capabilities. DFD firefighters are EMT-B certified to provide Basic Life Support for any medical emergency. Working together with the Paramedics from Denver Health Paramedic Division, DFD can respond to any medical emergency.

Six Emergency Response Districts: The city is divided into six response Districts with Denver International Airport designated as a separate Division. Each District operates under the direction of Assistant Chiefs assigned to oversee the operation of up to eight pieces of apparatus. Assistant Chiefs are the Incident Commander at all incidents involving two or more pieces of apparatus.

The DFD has 27 Engine Companies responsible for fire extinguishment, 14 Truck Companies designated to perform search and rescue, forcible entry and victim rescue and 1 Heavy Rescue Company which is the nucleus of the Special Operations Technical Rescue Team, responsible with providing the expertise necessary to rescue Citizens and Firefighters trapped in life-treating situations.

Special Operations: DFD can also provide response services in the following areas:

- Hazardous Materials
- Collapse/Confined Space
- High Angle Rescue
- Underwater Rescue

The Fire Prevention and Investigation Division is dedicated to promoting life safety throughout the City and County of Denver. It is responsible for inspections, permits, life-safety system testing, licensing, public event safety, hazardous material code enforcement, fire investigation, juvenile fire setter intervention, and public education.

Denver Health: Denver Health is Colorado's primary "safety net" institution, providing billions of care of the uninsured. Twenty five percent of all Denver residents (approx 150,000 individuals) receive their health care at Denver Health, and one of every three children in Denver is cared for by Denver Health physicians. Denver Health meets the special health needs of the entire population, with services

including trauma care and the Rocky Mountain Poison and Drug Center. It also meets the health needs of special populations such as the poor, uninsured, mentally ill, pregnant teens, persons addicted to alcohol and other substances, victims of violence, the homeless and those with AIDS. Denver Health integrates acute hospital and emergency care with public and community health to deliver preventive, primary and acute care services. This integration promotes continuity of care for each patient. Integration also assures health care that is delivered in the most efficient, cost-effective setting. Denver Health is a comprehensive, integrated organization with multiple components, which includes the Denver Paramedics and Denver Public Health.

Denver Paramedics: The Denver Paramedics are a division of the Denver Health and Hospital Authority. They provide 911 services to the all residents in the City and County of Denver, and respond to over 80,000 calls a year. Most calls are handled by one of 26 Advanced Life Support ambulances, staffed by two highly-trained paramedics and outfitted with lifesaving equipment and medications. Additionally, three Emergency Service Patrol vans transport public inebriates to Denver CARES for detoxification.

Denver Public Health: Denver Public Health (DPH) serves as the center for communicable disease reporting, surveillance, investigation and control for the City and County of Denver. An integral part of Denver Health, infectious disease physicians from DPH attend to hospital patients, and clinical staff perform disease prevention and treatment throughout the hospital and family health centers. Through numerous grant-funded programs, DPH conducts important research on infectious diseases, including hepatitis surveillance; tuberculosis clinical trials; HIV/AIDS prevention, counseling, testing and treatment; and vaccine trials.

Economy (Information from the Metro Denver Economic Council): The Metro Denver area has historically enjoyed higher household incomes than the rest of the nation due the high education attainment levels of the Metro Denver workforce and a higher-than-average concentration of two-earner households. CNBC ranked Colorado No. 3 in America's Top States for Business in 2010 for the second consecutive year. The state ranked especially high for business friendliness, economy, and access to capital. In addition, *Forbes* ranked Colorado No. 1 for labor prospects and No. 6 for growth prospects in 2010. Denver is ranked the third-best metro region in the nation for business (*MarketWatch, 2009*). Following are some of the industries located in the Denver area:

Aerospace - Metro Denver is first among the 50 largest metros for total private aerospace workers with 19,170 people employed at aerospace companies. Colorado has the nation's third-largest aerospace economy and is home to four military commands, eight major space contractors, and nearly 400 aerospace companies and suppliers.

Aviation - Denver International Airport, three reliever airports, and top aircraft manufacturing companies create a solid foundation for 15,060 workers directly employed by aviation companies.

Bioscience- Ten local higher education institutions with bioscience programs and numerous bioscience research assets support the region's bioscience industry. The industry is also enhanced by the opportunities to bring together academic, research, and corporate biotechnology institutions at the 578-acre, $5 billion Fitzsimons Life Science District and the adjacent Anschutz Medical Campus.

Broadcasting & Telecommunications- Metro Denver's Mountain Time Zone location makes it the largest U.S. region with one-bounce satellite uplinks, providing companies real-time connects to six of seven continents. With a broad mix of broadcasting and telecommunications firms, the region ranks third out of the 50 largest metros for employment concentration.

Energy - The integration of clean tech and the state's rich energy resource base place the region at the forefront of energy development. The National Renewable Energy Laboratory (NREL) in Golden is the Department of Energy's laboratory for renewable energy and energy efficiency R&D.

Financial Services - The region is one of the few areas outside of the Northeast with a substantial financial services industry in three key market segments. A variety of trade associations and service firms supports the diverse financial services industry base of over 11,150 companies and 87,460 employees in the region.

Information Technology - Software- Colorado has the third-highest concentration of high-tech workers per capita in the nation according to TechAmerica's *Cyberstates 2010* report.

Research Labs - Colorado has one of the highest concentrations of federally funded science and research labs in the nation. Employing nearly 7,000 scientists and engineers and generating an over $1.1 billion annual economic impact to the region, these federal labs have contributed greatly to the evolution of Metro Denver's high-tech industries.

Sports - In the past 15 years, four new venues have been constructed for the region's seven major sports franchises. Over six million fans attend sporting events in Metro Denver each year.

Climate Change in Colorado

There is widespread scientific consensus that societal emissions of greenhouse gases are impacting the Earth's climate system, threatening the productivity and even the survival of our natural and economic systems. Societal emissions of the three dominant greenhouse gases — carbon dioxide (CO2), methane (CH4) and nitrogen oxides (NOx) — come almost entirely from the burning of fossil fuels such as coal, natural gas, gasoline, and diesel. The supply of cheap fossil fuels is on the decline and the United States is highly dependent on vulnerable foreign supplies to meet its demand for fossil fuels. Clean and stable energy supplies are one of the most important challenges to the sustainability of our society. Adverse public health impacts from the burning of fossil fuels, particularly gasoline and coal, have long been understood and are becoming increasingly evident. Fine particulate matter generated can lodge in the lungs and cause irritation and other pulmonary difficulties. The elderly, the young, and asthmatics are particularly susceptible. Nitrogen oxides and unburned fuels (containing volatile organic compounds or VOCs) combine with sunlight to form ozone which results in ground-level smog — an issue of special concern in Denver's high-altitude environment. Indirect health impacts from climate change are beginning to occur as well. Summer heat waves and extreme weather events are increasing in duration and intensity, leading to distress and fatalities.

As our climate continues to change, we are likely to see disruption of certain sectors of the economy. Scientists forecast dramatic changes in agricultural output due to unpredictable weather patterns and water production, which is also likely to be reflected at the local level, where semi-arid, dry-land farming is a challenge in much of the region. Many winter sports, including the skiing and snowmobiling industries, are dependent upon cold temperatures and adequate snowfall to thrive. With reductions in cold weather and potential disruptions in precipitation, these industries would be negatively impacted. Significant reductions in total snow pack, related river flows and water supply would also have major implications for both growth and tourism statewide. With a better understanding of the real and potential environmental, economic, public health, and security impacts associated with traditional energy sources, there has been a dramatic increase in recent years in cleaner and more efficient energy sources and technologies. Many of these new industries and programs bring with them exciting new technologies and strong economic growth opportunities. As a leader in both traditional energy sources and emerging technologies, Colorado stands poised to become a leader in the transition from extractive to renewable resources; and Denver to become the nexus of this effort.

(*Denver's Climate Action Plan 2007*)

Some of the specific findings regarding climate change in Colorado are listed below:

Temperature Increase

- In less than 30 years, the temperatures in Colorado have increased by approximately 2 degrees Fahrenheit.
- Projections suggest that typical summer monthly temperatures will be as warm or warmer than the hottest 10% of summers that occurred between 1950 and 1999.
- Climate models project **Colorado will warm by 2.5ºF by 2025 and 4ºF by 2050**, relative to the 1950–99 baseline.

- Mid-21st century summer temperatures on the Eastern Plains of Colorado are projected to shift westward and upslope, bringing into the Front Range temperature regimes that today occur near the Kansas border.
- **Colorado has warmed faster than the U.S. average**, with more dramatic temperature increases seen at higher altitudes.
- Climate change **temperatures will disproportionately affect municipalities**, as temperature increases in developed regions could be an additional 7 to 10 degrees warmer than surrounding suburbs due to heat dissipation by greenery in outlying areas.

Water

- Changes in the quantity and quality of water may occur due to warming even in the absence of precipitation changes – specific current challenges may be further exacerbated by projected climate change.
- **75 percent of yearly water flow for the major rivers of the Rockies comes from spring snowmelt**, but with snow packs estimated to decrease by as much as 80 percent in parts of Colorado and melting earlier, **summer and fall water stress could be a regular occurrence**.

Fire

- Arid weather, coupled with longer periods of warm temperatures, is expected to **increase the risk of drought and forest fires**.
- Climate change will lead to longer fire seasons for Colorado.

Ecosystem Effects

- Increasing temperature and soil moisture changes may shift mountain habitats toward higher elevation.
- Changes in air, water, and soil temperatures may affect the relationships between forests, surface and ground water, wildfire, and insect pests.
- Increase in western spruce budworm, the piñon ips beetle and the mountain pine beetle. The mountain pine beetle alone killed 1.2 million acres of alpine trees in 2004, with a cost of about $2,000 an acre to thin infected trees.
- Stream temperatures are expected to increase as the climate warms, which could have direct and indirect effects on aquatic ecosystems, including the spread of in-stream non-native species and diseases to higher elevations, and the potential for non-native plant species to invade riparian areas.
- Warmer temperatures could facilitate the growth of algae and harmful bacteria in bodies of water, causing fish kills and water contamination.
- Western Trout populations in Colorado may decline by as much as 64 percent as a result of climate change.

Climate Change and the Colorado Ski Industry

- Changes in the character and timing of snowpack and the ratio of snowfall to rainfall will continue to influence winter recreational activities and tourism.
- Seasonal temperature changes and overall increased precipitation, less of which is falling as now, have led to less snow pack and earlier spring thaw on average for the Rocky Mountains.
- Colorado's ski industry employs 30,890 workers, or about 14 percent of all tourism employment in the state.
- The industry also generated $2 billion to $2.5 billion in revenues during the 2001-2002 season.
- At the current rate, the snow line could increase by more than 1,000 feet and the ski season could end 30 days earlier.

Health Effects

- Ground-level ozone could increase in Denver and other larger cities due to warmer summer temperatures, which can lead to an increase in asthma attacks and other respiratory disorders.
- Heat related illness**,** such as heat stroke or illnesses exacerbated by heat, may disproportionately affect the poor and elderly due to projected increases in energy and cooling costs.

Sources

http://cwcb.state.co.us/Home/ClimateChange/ClimateChangeCOReport.htm

http://www.coloradoski.com/

National Conference of State Legislatures (2008).*Climate Change and the Economy*.

Colorado. Assessing the Costs of Climate Change.

Hayes, David J. (2009). A Resilient West – Climate Adaptation Strategies. PowerPoint presentation from December 18, 2009. U.S. Department of the Interior.

Denver's Climate Action Plan, October 2007

Hazards (Manmade and Natural)

For purposes of this hazard analysis, each hazard will be evaluated on four different areas of consideration:

1. **Definition and Characteristics**: a general definition and characteristics of each hazard is included to provide a common understanding as to what the hazard is and why Denver should be concerned about it.
2. **Previous Occurrences**: a description of previous occurrences helps to understand what has happened before and where. This section will include associated deaths, injuries, and total damage for each event if known.
3. **Future Probability**: to help determine the likelihood of a hazard occurring again, we will look at the frequency of past occurrences.
4. **Magnitude and Severity**: expressed in terms of impacts such as injuries and deaths, negative effects on economy and the environment, damage to property or infrastructure, and the degree to which the hazard affects ability to provide essential services.

The hazards have been partitioned into three groups: Natural, Adversarial/Human Caused and Technological/Accident. Based on consultation with subject matter experts and a review of past history, the following table depicts the hazards most likely to affect Denver.

Denver Hazards

Natural	Adversarial/Human Caused	Technological/Accident
Disease Outbreak	Terrorism	Dam Failure
Drought		Energy Disruption
Earthquake		Hazardous Material Incident
Extreme Heat		
Flood		
Hail		
Lightning		
Tornados		
Winter Storms		

Natural Hazards

Communicable Disease Outbreak: Denver's Department of Environmental Health (DEH) and Denver Public Health work together to conduct communicable disease reporting, investigation, and control for Denver. Public and environmental health functions and regulatory authority remains with DEH. Denver Health and Hospital Authority (DHHA) provides communicable disease surveillance and medically-oriented public health functions through their Denver Public Health (DPH) department. Within DPH, the Public Health Inspections (PHI) agency works to minimize the risk of communicable and infectious diseases through conducting inspections, investigations, providing technical assistance, education and enforcement actions in regulated facilities. This includes food service operations (restaurants, grocery stores, cafeterias, food carts), child care facilities and residential health and housing complaints.

Definition: The scale of a biological incident is described by the extent of the spread of disease in the community. An outbreak can be classified as an endemic, an epidemic or a pandemic depending on the prevalence of the disease locally and around the world. An endemic is defined as something that is natural to or characteristic of a particular place, population, or climate. For example, threadworm infections are endemic in the tropics. An epidemic is defined as a disease that spreads rapidly through a demographic segment of the human population, such as everyone in a given geographic area, a military base, or similar population unit, or everyone of a certain age or sex, such as the children or women of a region. A pandemic is defined as a widespread epidemic that affects whole countries or the entire world.

Many potential devastating diseases are spread through physical contact, ingestion, insects and inhalation. Airborne diseases and those spread through physical contact pose higher risks to the community because they are difficult to control. Diseases such as influenza, Pertussis, Tuberculosis, and meningitis are all spread through these methods and pose a threat to all communities. Health agencies closely monitor for diseases with the potential to cause an epidemic and seek to develop immunizations.

Previous Occurrence: Throughout the 20th century several epidemics and pandemics have occurred in the United States:

- Influenza, 1918-1919
- Influenza (Asian Flu), 1957-1958
- Influenza (Hong Kong Flu), 1968-1969
- E Coli, 1993
- Pertussis, 2002-2005
- Influenza, 2009

The following table denotes the communicable reportable diseases for 2009 in Denver County:

Communicable Reportable Diseases (2009)

Diagnosis	Denver County
AMEBIASIS	
ANIMAL BITES	15
ANTHRAX	
BOTULISM, FOODBORNE	
BOTULISM, INFANT	
BOTULISM, OTHER	
BRUCELLOSIS	
CAMPYLOBACTER	71
CARBON MONOXIDE POISONING	
CHOLERA	
CRYPTOSPORIDIOSIS	14
CYCLOSPORIASIS	
DENGUE FEVER	
DIPHTHERIA	
ENCEPHALITIS OTHER	1
GIARDIASIS	72
GROUP A STREP INVASIVE	41
GROUP B STREP INVASIVE	51
HAEMOPHILUS INFLUENZAE	11
HANTAVIRUS PULMONARY SYNDROME	
HEMOLYTIC UREMIC SYNDROM	1
HEPATITIS A	4
HEPATITIS B, ACUTE	7
HEPATITIS B, CHRONIC	149
HEPATITIS B, PERINATAL INFECTION	
HEPATITIS C, ACUTE	9
HEPATITIS C, CHRONIC	636
HEPATITIS D	
INFLUENZA-hospitalized	474
INFLUENZA-pediatric death	2

Future Probability: Although it is impossible to predict the next disease outbreak, there is recent history that shows these outbreaks are not uncommon and are likely to reoccur.

Magnitude and Severity: A flu pandemic is not the same as the annual flu season. Flu Pandemic is caused by a new, much more serious and contagious virus to which humans have little or no natural resistance. If a new highly contagious strain of influenza began to infect humans, it would probably cause widespread illness and death within a matter of months and the outbreak could last up to 2 years. The Center for Disease and Control and Prevention (CDC) predicts that as much as 25-30% of the U.S. population would become ill, that many would require hospitalization and that many might die. Historically, communicable disease outbreaks have claimed more lives than any other type of disaster.

A new flu virus called H1N1 was first detected in people in the United States in April 2009. The virus was found all over the world and spread from person-to-person, probably in much the same way that more common seasonal influenza viruses spread. This virus was first referred to as

"swine flu" because testing showed it was similar to flu viruses in North American pigs. CDC believes that more than 1 million people were infected with the virus and it was eventually elevated to a pandemic. The potential threat of this virus created a need for Denver Public Health (DPH) to plan for distribution of H1N1 shots. DPH launched a media blitz to deliver awareness and prevention messages. DPH had the responsibility for ensuring that limited amounts of early vaccine were directed to priority groups. The process of tracking and distributing this limited supply allowed DPH to establish important partnerships with more than 200 different health care providers throughout Denver. Partnering with Denver Environmental Health, DPH held public H1N1 vaccination clinics in late fall, immunizing thousands of children and adults against H1N1. Throughout the flu season, DPH dispensed 16,602 doses of H1N1 vaccine.

Even though Denver has a strong healthcare system, these disease outbreaks can strain and overwhelm our community resources if there is a significant outbreak. Denver's vulnerable populations, young children, the elderly, the poor and those with underlying health conditions, will be the hardest hit during any disease outbreak.

Sources:

Colorado Department of Health website
http://www.cdphe.state.co.us/hs/communicabledata/communicabledata.html

Denver Public Health
http://denverhealth.org/Services/PublicHealth.aspx

Denver Public Health Annual Report 2009
http://denverhealth.org/LinkClick.aspx?fileticket=1Yc31r5Ul20%3D&tabid=1976&mid=3084

Drought: Drought can occur with unpredictable frequency and variable intensity, affecting multiple areas of the state at the same time in different ways. For example, during drought, flows into Denver Water's reservoirs may be below normal. This reduced reservoir storage from decreased runoff in the mountains can lead to voluntary, or in severe cases, mandatory municipal and/or industrial water usage restrictions on the Front Range. On the other hand, droughts that occur in populated areas may increase the threat of wildfire in the wildland urban interface areas.

Definition: Drought may be defined several different ways depending upon the source or impact. The following definitions of drought are considered for this plan:

- *Meteorological drought* – a period of below-average precipitation.
- *Agricultural drought* – a period of inadequate water supply to meet the needs of the state's crops and other agricultural operations such as livestock.
- *Hydrological drought* – deficiencies in surface and subsurface water supplies. Generally measured as streamflow, snowpack, and as lake, reservoir, and groundwater levels.
- *Socioeconomic drought* – occurs when drought impacts health, well-being, and quality of life, or when a drought starts to have an adverse economic impact on a region.

Characteristics: With its semiarid conditions, drought is a natural part of the Colorado climate. Due to natural variations in climate and precipitation, single season droughts over some portion of the state occur nearly every year. Hydrologic conditions constituting a drought for water users in one location may not constitute a drought for water users elsewhere, or for water users that have a different water supply. Individual water suppliers may use criteria, such as rainfall/runoff, amount of water in storage, or expected supply from a water wholesaler, to define their water supply conditions. The drought issue is further influenced by water rights specific to a state or region. Water is a commodity regulated under a variety of legal doctrines.

Previous Occurrences: Several times since the late 1800s, Colorado has experienced widespread, severe drought. The most dramatic occurred in the 1930s and 1950s when many states, Colorado included, were affected for several years at a time. There have been six multi-year droughts experienced in Colorado since 1893.

1. **The 1930's Drought:** The Dust Bowl drought severely affected much of the United States during the 1930s.
2. **The 1950s Drought:** During the 1950s, the Great Plains and the southwestern U.S. withstood a five-year drought, and in three of these years, drought conditions stretched coast to coast. The 1950s drought was characterized by both decreased rainfall and excessively high temperatures. The area from the Texas panhandle to central and eastern Colorado, western Kansas, and central Nebraska experienced severe drought conditions.
3. **The 1977 Drought:** During 1976 and 1977, the state experienced record-low stream flows at two-thirds of the major stream gages, records that held until the 2002 drought.
4. **1980-1981 Drought:** Short lived, beginning in the fall of 1980 and lasting until the summer of 1981.

5. **1994 Drought:** Significant impacts reported included an increase in wildfires statewide, loss to the winter wheat crops, difficulties with livestock feeding, and impacts to the State‘s fisheries.
6. **1996 Drought:** July 29, the Governor issued an Executive Order proclaiming a Drought Disaster Emergency Declaration for fifteen counties.
7. **2002 Drought:** Based on studies of tree rings and archaeological evidence from aboriginal cultures, the 2002 drought was the most severe in the recorded history of the state.

During 1976 and 1977, the State experienced record-low stream flows at two-thirds of the major stream gages, records that held until the 2002 drought. In addition, the Colorado ski industry estimated revenue losses at $78.6 million; agriculture producers incurred higher crop production costs due to water supply shortages; and numerous municipalities were forced to impose water use restrictions on their customers. The state‘s agriculture producers and municipalities received over $110 million in federal drought aid as a result of the 1976-1977 drought.

The drought of 2002 is considered the most intense drought on record for Colorado. Statewide snowpack was at or near all time lows. What made 2002 so unusual was that all of the State was dry at the same time. By all accounts, soil moisture was nearly depleted in the upper one-meter of the soil profile over broad areas of Colorado by late August 2002. 2002 was clearly the driest year in over 100 years of record based on stream flow. This was an extremely dry year embedded in a longer dry period (2000-2006). These conditions were rated exceptional by the U.S. Drought Monitor and were the most severe drought experienced in the region since the Dust Bowl.

Future Probability: Historical analysis of precipitation shows that drought is a frequent occurrence in Colorado. Short duration drought as defined by the three-month Standardized Precipitation Index (SPI) occur somewhere in Colorado in nearly nine out of every ten years. However, severe, widespread multiyear droughts are much less common. According to the *2004 Drought Water Supply Assessment*, there have been six recorded drought incidents totaling 36 dry years which impacted the State of Colorado since 1893, or a span of 111 years. (2004-1893 = 111 years). This formula evaluates that the probability of a drought occurring in any given year is 32.4 percent. Figure 3-1, from the National Drought Mitigation Center, indicates that most of Colorado has experienced severe or extreme drought between 15 and 19.9 percent of the time from 1895-1995.

The majority of Denver’s water comes from rivers and streams fed by mountain snowmelt. The South Platte River, Blue River, Williams Fork River and Fraser River watersheds are Denver Water’s primary water sources, but it also uses water from the South Boulder Creek, Ralston Creek and Bear Creek watersheds. Dillon Reservoir is Denver Water’s largest storage facility and holds nearly 40 percent of Denver’s water. When there is less snowmelt, there is less water for Denver. When there is less water in the reservoirs, Denver Water helps enforce water restrictions that may become necessary.

Denver Water drafted its Drought Response Plan after the 2002 drought. This plan calls for various actions depending on how full the Denver Water reservoirs are on July 1st every year. (July 1st was chosen as the trigger date because storage in Denver Water’s system usually

reaches its annual maximum around that date.) Four stages of drought, each signaled by a specific storage level trigger, are designated:

Drought Stage	Trigger
Stage 1	Reservoirs are less than 80% full
Stage 2	Reservoirs are less than 65% full
Stage 3	Reservoirs are less than 40% full
Stage 4	Reservoirs are less than 25% full

Magnitude and Severity: Drought impacts are wide-reaching and may come in different forms, such as economic, environmental, and/or societal. Drought is one of the few hazards with the potential to directly or indirectly impact the entire population of the State, be it from water restrictions, higher water and food prices, reduced air or water quality, or restricted access to recreational areas.

The most significant impacts associated with drought in Colorado are those related to water intensive activities such as agriculture, wildfire protection, municipal usage, commerce, tourism, recreation, and wildlife protection. Since 2003, there have been 16 USDA Secretarial Disasters declared for various counties in Colorado. These declarations provided financial assistance to what can be devastating losses in crop production and associated agricultural crop or rangeland revenues. Tourism in Colorado is strengthened by protected areas that are owned and managed by the State. Drought impacts to these assets translate to declines in tourism and related industries. Furthermore, decreased revenues for state agencies resulting from drought can reduce management budgets, which can have a detrimental impact on lands and wildlife.

Droughts may also result in a reduction of electric power generation and water quality deterioration. Drought conditions can also cause soil to compact, decreasing its ability to absorb water, making an area more susceptible to flash flooding and erosion. A drought may also increase the speed at which dead and fallen trees dry out and become more potent fuel sources for wildfires. Drought may also weaken trees in areas already affected by mountain pine beetle infestations, causing more extensive damage to trees and increasing wildfire risk, at least temporarily.

Sources

Colorado Drought Mitigation and Response Plan (2010)

State of Colorado Natural Hazards Mitigation Plan (Jan 2011)

Denver Water Drought Response Plan (May 2004)

Earthquakes: Colorado is comprised of areas with low to moderate potential for damaging earthquakes, based on research by geologists and geophysicists who specialize in seismology. There are about 90 potentially active faults that have been identified in Colorado, with documented movement within the last 2 million years. However, there are several thousand other faults that have been mapped in Colorado that have not been sufficiently studied to know whether they are capable of generating earthquakes or not. It is not possible to accurately estimate the timing or location of future dangerous earthquakes in Colorado. The lack of an adequate network of seismometers in Colorado makes it difficult to detect and locate small earthquakes. Moreover, the historical record is quite short (~150 years). Nevertheless, the available seismic hazard information can provide a basis for a reasoned and prudent approach to seismic safety.

Not all of Colorado's potentially active faults are in the mountains and some cannot be seen at the earth's surface. For example, the Cheraw fault, which is in the Great Plains Physiographic Province in southeast Colorado, appears to have had movement during the recent geologic past. The Derby fault near Commerce City lies thousands of feet below the earth's surface but has not been recognized at ground level. Several potentially active faults in Colorado are thought to be capable of causing earthquakes as large as magnitude 6½ to 7¼.

Definition: An earthquake is simply the vibrations caused by fault movement. The bigger the movement, the bigger the earthquake. Because the mountains are still rising in Colorado, earthquakes will continue to accompany the faulting that enables them to grow.

Earthquakes generate seismic waves that can be detected by sensitive instruments called seismographs. Records of seismic waves (called seismograms) are used by seismologists to locate and measure the size of earthquakes.

Previous Occurrence: There are no active fault lines in Denver County, however there have been several earthquakes that have impacted the Denver area:

- November 7, 1882 (6.6)
- June 5, 1963 (5.0)
- January 4, 1966 (5.0)
- August 9, 1967 (5.3)
- November 27, 1967 (5.2)

More than 500 earthquake tremors of magnitude 2½ or higher have been recorded in Colorado since 1867. More earthquakes of magnitude 2½ to 3 probably occurred during that time, but were not recorded because of the sparse distribution of population and limited instrumental coverage in much of the state. The largest known earthquake in Colorado occurred on November 7, 1882 and had an estimated magnitude of 6½. The location of this earthquake was in the northern Front Range west of Fort Collins

The Big One - November 7, 1882 Magnitude 6.6
On November 7, 1882 at about 6:30 p.m. local Denver time, a moderately strong earthquake shook much of Colorado and parts of southern Wyoming and northeastern Utah. The earthquake was apparently felt as far east as Salina, Kansas and perhaps even in Plattsmouth, Nebraska

(Rockwood, 1883; Oaks and Kirkham, 1986). An aftershock followed on the morning of November 8 (local time) and was felt in Denver, Boulder, Greeley, Laramie, and near Meeker. The main event was the largest earthquake to occur in the Colorado region during the historical period and has received considerable study by numerous researchers.

Denver - August 9, 1967 Magnitude 5.5

The most economically damaging earthquake in Colorado's history occurred on August 9, 1967 in the northeast Denver metropolitan area. This magnitude 5.3 earthquake, which was centered near Commerce City, caused more than a million dollars damage in Denver and the northern suburbs. This earthquake is believed to have been triggered by the deep injection of liquid waste into a borehole at Rocky Mountain Arsenal. Damage was reported in Northglenn, where plate glass windows broke, many walls, ceilings, foundations, and concrete floors cracked, and several businesses sustained damage due to fallen merchandise. A liquor store estimated damage at $10,000 to $20,000. Damage was also reported in 28 locations, many of which suffered considerable cracked plaster and mortar, broken windows, damaged foundations and chimneys, and damage to household goods. The earthquake was felt as far as Sterling, Pueblo, and Laramie.

It was followed by an earthquake of magnitude 5.2 three months later in November 1967. Although these events cannot be classified as major earthquakes, they should not be discounted as insignificant. They occurred within Colorado's Front Range Urban Corridor, an area where nearly 75% of Colorado residents and many critical facilities are located. Since March 1971, well after the initial injection of fluids ceased, 15 earthquakes of approximate magnitude 2½ or larger have occurred in the vicinity of the northern Denver suburbs.

Future Probability: Based on the historical earthquake record and geologic studies in Colorado, an event of magnitude 6½ to 7¼ could occur somewhere in the state. Scientists are unable to accurately predict when the next major earthquake will occur in Colorado, only that one will occur. The major factor preventing the precise identification of the time or location of the next damaging earthquake is the limited knowledge of potentially active faults. Given Colorado's continuing active economic growth and the accompanying expansion of population and infrastructure, it is prudent to continue the study and analysis of earthquake hazards.

Magnitude and Severity: At least two published articles propose that a magnitude 6.0 earthquake is possible on the fault that passes under the Arsenal. Such an earthquake would cause more than $10 billion dollars damage.

The Colorado Geological Survey has analyzed the following faults for Denver County. While none of these are located in Denver County, an earthquake from these faults could impact the Denver area causing loss to property and life: Chase Gulch, Cheraw, Frontal, Golden, Mosquito, Rampart, Rocky Mountain Arsenal, N Sangre de Cristo, N Sawatch, S Sawatch, Ute Pass, Valmont, Walnut Creek, and Williams Fork.

HAZUS Risk:

Name of Fault	Magnitude	Number of Deaths	Total Economic Loss
Chase Gulch	6.75 WUS	0	$39.6M
	6.75 CEUS	4	$523M
Cheraw	7.0 CEUS/WUS	0	Can't reach
Frontal	7.0 WUS	0	$39.2M
Golden	**6.5 Reverse WUS**	**114**	**$3.24B**
	6.5 Normal WUS	**164**	**$4.73B**
	6.0 Reverse WUS	17	$1.2B
	6.0 Normal CEUS	41	$2.57B
	5.5 Reverse WUS	2	$374M
	5.5 Normal CEUS	5	1.03B
	5.0 Reverse WUS	0	$98.3M
	5.0 Normal CEUS	0	$325M
Mosquito	7.0 WUS	0	$38.1M
Rampart	7.0 WUS	6	$569M
	7.0 CEUS	99	$3.19B
	6.5 WUS	1	$129M
	6.5 CEUS	6	$737M
	6.0 CEUS	1	$194M
	5.5 CEUS	0	$37M
Rocky Mountain Arsenal	**6.5 CEUS**	**201**	**$5.18B**
	5.5 CEUS	6	$1.13B
N. Sangre	7.5 WUS	0	$29.9M
	7.5 CEUS	8	$593M
	7.0 WUS	0	$8.0M
	6.5 WUS		Can't reach
	6.5 CEUS	0	$5.0M
N. Sawatch	7.0 WUS	0	$15.5M
	7.0 CEUS	2	$298M
S. Sawatch	7.25 WUS	0	$18.7M
	7.25 CEUS	4	$422M
Ute Pass	7.0 CEUS	27	$1.59B
	5.5 CEUS	0	$22M
Valmont	5.0 WUS	0	$10.3M
	5.0 CEUS	0	$47.4M
Walnut Creek	6.0 CEUS	50	$2.8B
Williams Fork	6.75 WUS	0	$24.5M
1882 Earthquake	6.2 WUS	0	$13.1M
	6.2 CEUS	1	$111.8M

HAZUS Risk data came from scenarios performed in FEMA's HAZUS-MH software. Default attenuation functions for the Western United States (WUS) and the Central United States (CEUS) were used for each scenario. These functions were taken from the USGS National Seismic Hazard Maps. The attenuation, or decrease in height of seismic waves over time, is greater in the WUS region. This means that a 6.5 earthquake will be more damaging in the CEUS than in the WUS. Areas in Colorado fall in both the WUS and CEUS.

Source: Colorado Geological Survey

Extreme Heat: Over the last 30 years in the United States, excessive heat accounts for more reported deaths annually than hurricanes, floods, tornadoes, and lightning combined. The extreme heat hazard in Colorado is often underestimated because other natural hazards occur more frequently and its effects can vary based on region and vulnerable population within the State.

Definition: Extreme heat conditions are defined by summertime weather that is substantially hotter and/or more humid than average for a location at that time of year. This definition for extreme heat may be refined with considerations such as summertime temperatures that hover 10 degrees or more above the average high temperature for the region and last for several weeks. The Heat Index (HI) or the "Apparent Temperature" is an accurate measure of how hot it actually feels when the Relative Humidity (RH) is added to the actual air temperature. The heat index may be used to help determine when an extreme heat event is occurring. Heat alert procedures from the National Weather Service (NWS) are based mainly on Heat Index Values.

Previous Occurrence: In August 2011, Denver had its hottest August in its history. There were six record high temperatures either tied or broken during the month and it was the sixth hottest month in Denver history. During 2008, Denver's 87 year-old record for the number of consecutive days above 90 degrees F was broken. The new record of twenty-four consecutive days surpassed the previous record by almost a week. On August 1st, it reached 104 degrees, breaking arecord set in 1938 and on August 2nd, it reached 103 degrees, breaking a record set in 1878. The table below shows Denver's historic count of 90 degrees or higher days since 1960. The average number of 90 degree days per in Denver is 33.

Denver's 90 Degree Days

2000	61
1994	60
2002	56
2005	55
2007	54
2006	54
1978	52
1874	51
1964	50
1960	50

Source: NWS

Future Probability: Since the record hot year of 1998, six of the years from 1998 to 2007 have had annual average temperatures that fall in the hottest 10 percent of all years on record for the United States. This example supports a shift towards a warmer climate with an increase in extreme high temperatures and a reduction in extreme low temperatures. These types of changes have been apparent in the western half of North America. (High Plains Regional Climate Center)

Magnitude and Severity: For nearly all cities, including Denver, the number of heat-related deaths is declining. This indicates that there has been a decrease in heat-related deaths over time—meaning that the population has become better adapted to heat waves. This adaptation is

most likely a result of improvements in medical technology, access to air-conditioned homes, cars, and offices, increased public awareness of potentially dangerous weather situations, and proactive responses of municipalities during extreme weather events.

Regardless of any trends indicating heat-related deaths are declining, extreme heat events remain a danger. Specific high-risk groups typically experience a disproportionate number of health impacts from extreme heat conditions: the elderly, the sick, the poor, homeless people, people who have mobility restrictions or mental impairments, people who are under the influence of drugs and alcohol. Those at greatest risk of death in heat waves are the urban-dwelling elderly without access to an air-conditioned environment for at least part of the day.

Other problems associated with heat waves include impacts on transportation. Aircraft lose lift at high temperatures and major airports have been closed due to periods of extreme heat that made aircraft operations unsafe. Highways and roads are damaged by excessive heat as asphalt roads soften and concrete roads have been known to "explode" lifting 3 to 4 foot pieces of concrete. During the 1980 heat wave, hundreds of miles of highways buckled. Stress is placed on automobile cooling systems, diesel trucks and railroad locomotives which lead to an increase in mechanical failures. Train rails develop sun kinks and distort. Refrigerated goods experience a significant greater rate of spoilage due to extreme heat.

In addition , the electric transmission system is impacted when power lines sag in high temperatures and can lead to power outages. The combination of extreme heat and the added demand for electricity to run air conditioning causes transmission line temperatures to rise. The demand for electric power during heat waves is well documented.

The demand for water increases during periods of hot weather. In extreme heat waves, water is used to cool bridges and other metal structures susceptible to heat failure. This causes a reduced water supply and pressure in many areas. This may also contribute to fire suppression problems for both urban and rural fire departments. The rise in water temperature during heat waves contributes to the degradation of water quality and negatively impacts fish populations. It can also lead to the death of many other organisms in the water ecosystem. High temperatures are also linked to rampant algae growth that may result in fish kills in rivers and lakes.

Sources

Colorado Department of Emergency Management

National Weather Service (NWS)

National Oceanic and Atmospheric Administration (NOAA)

Federal Emergency Management Agency (FEMA)

United States Centers for Disease Control (CDC)

Floods: Extreme rainfall is not required to produce flooding. In 2009, after the busiest year of flood threats in 20 years, the Urban Drainage and Flood Control District (UDFCD) evaluated the correlation of extreme rainfall and flooding. Several observations were made at that time (*Flood Hazard News, December 2010, Kevin Stewart)*:

1. Big floods happen (Many historic flood accounts in this area can be traced to 1860's)
2. Big rains happen often
3. Big rains do not always cause big floods
4. Rainfall of a given magnitude (normally expressed as annual probability of occurrence or return period) never cause a like-magnitude flood on the receiving stream
5. Small floods can be deadly (ex. Lakewood Gulch in 2007)
6. Big floods occur in dry years (ex. Big Thompson 1976 and Cherry Creek at Denver 2008)
7. Small rains can cause big floods (ex. Hayman, Buffalo Creek)

The question is how much rain will it take to seriously threaten lives and properties? For areas in and immediately downstream, the answer is not much. Even though Denver is not in an area of immediate danger, the possibility of flooding from rainfall does exist.

Definition: A flood is a general and temporary condition of partial or complete inundation of normally dry land areas from: (1) the overflow of stream banks, (2) the unusual and rapid accumulation of runoff of surface waters from any source, or (3) mudflows or the sudden collapse of shoreline land. Flooding results when the flow of water is greater than the normal carrying capacity of the stream channel or accumulates faster than surface absorbency allows. The floodplain is land adjoining the channel of a river, stream, lake or other water course or water body that is susceptible to flooding.

The causes of floods relate directly to the accumulation of water from precipitation, rapid snowmelt, or the failure of human made structures, such as dams or levees. (Dam Failure will be handled separately.) Floods caused by precipitation are further classified as coming from:

- Rain in a general storm system
- Rain in a localized intense thunderstorm
- Melting snow
- Rain on melting snow
- Ice jams

Previous Occurrence: Denver has a history of large and small magnitude flooding. The most damaging flood in Colorado occurred in June 1965 on the South Platte River when over $2.7 billion in damages (2010 dollars) was sustained in the Denver metro area.

Below is a table showing the floods of large magnitude in Denver:

*Denotes federal disaster declaration event

Year	Location	Deaths	Damages (2010 $)
1864	Cherry Creek	0	$7,365,830.37
1912	Cherry Creek	2	$164,152,791.04
1965*	South Platte River	8	$2,735,879,850.68
1973*	South Platte River	10	$531,392,047.92

Small magnitude flooding also has the potential for loss of life and damage and is most likely what we face in Denver. The threat to life in Denver by flooding has been greatly diminished thanks to extensive mitigation projects and the creation of the Urban Drainage and Flood Control District in 1969. However, three years ago, a small magnitude flood on Lakewood Gulch in Denver claimed the life of a child. Due to the unpredictability of storms, we can't rule out the continued threat to life from flash flooding.

In the past, problem areas included Cherry Creek. The building of the Cherry Creek Flood Control Reservoir in 1950 alleviated most of this problem. The last big flash flood occurred on August 8, 2008 at Cherry Creek, but there was no significant damage. This was the largest flood in that location since the Castlewood Canyon Dam failed in August, 1933.

Harvard Gulch was another problem area. Prior to 1965, Harvard Gulch experienced regular flooding due to summer thunderstorms. The Harvard Gulch Flood Control Project, completed in 1966, was designed for the 10-year flood and has alleviated this problem. The largest flood event since the completion of the project occurred on June 8, 1969. The flow was confined within the drainage improvements. There remains a continued threat to property from flash flooding along Harvard Gulch, Goldsmith and Westerly Creek.

Future Probability: Flooding will continue to occur in Denver. However, Denver has taken measures to reduce the historic large magnitude flooding caused by Cherry Creek and the South Platte River by building the Cherry Creek Flood Control Reservoir in 1950, the Chatfield Flood Control Reservoir in 1973 and the Bear Creek Flood Control Reservoir in 1980. Additionally in the 1990's and 2000's, the T Rex drainage structure was built and Stream Warning Plans were created. There were also numerous warning notifications programs implemented to warn Denver of potential flooding:

> **Warning Notification Programs supporting Denver**: The Urban Drainage and Flood Control District (UDFCD) serves 33 local governments in Colorado, including Denver. It provides early notifications for flash flood potential so that local emergency managers can take defensive action. Denver is fortunate to have the hydro-meteorological support team of Genesis Weather Solutions and Skyview Weather provide us with heavy precipitation forecasts and flood threat notifications for the past 32 years. This program, called the Flash Flood Prediction Program (F2P2), was established after the deadly 1976 Big Thompson Canyon flash flood and serves the Denver/Boulder metropolitan area. F2P2 operates from April 15 through September 15. The forecast services focus

primarily on heavy rain and flash flood threats over an approximate 3,000 square mile area (includes the UDFCD area and the drainage areas upstream). During the snowmelt runoff season, late spring to early summer, mountain streams typically overflow their banks. This information is watched by the F2P2 and relayed to affected local governments. In addition, F2P2 relays information regarding reservoir releases made by the Tri Lakes Office of the US Army Corps of Engineers from Chatfield, Cherry Creek and Bear Creek Dams.

Another potential warning source is the Community Collaborative Rain, Hail and Snow (CoCoRaHS) network. The group is operated by the Colorado Climate Center at Colorado State University in Fort Collins. This is a nationwide network that provides precipitation data to many public, private and academic sectors of the weather and climate enterprise.

The Emergency Managers Weather Information Network (EMWIN) provides timely weather warnings and advisories to 22 counties in NE Colorado, including Denver.

The City and County of Denver is also well covered with alert systems, which Denver owns but UDFCD maintains. UDFCD's ALERT System currently collects data from 217 stations, including 8 radio repeaters, 188 rain gages, 96 stream gages and 24 weather stations. Heavy rainfall caused the ALERT system to set off alarms on only 17 days in 2010 compared to 32 days the previous year.

However, even with all these warning and notification systems, the potential for flooding in Denver remains. Flooding can be a secondary hazard from wildfire occurring in a nearby county.

Magnitude and Severity: Denver does have a history of tragic flood events. The most damaging flooding in Colorado occurred in Denver in 1965. Damages in Denver were evaluated at over $2.7 billion (in 2010 dollars) due to a South Platte River flood. Even though the City and County of Denver has mitigated against flooding by increasing warning systems and by building flood control reservoirs, a flooding event remains possible.

Sources:

State of Colorado Hazard Mitigation Plan January 2011

Flood Hazard News December 2010

Urban Drainage and Flood Control District Activity Summary March 2011

Discussions with Kevin Stewart, UDFCD

Hail: Colorado's Front Range is located in the heart of "Hail Alley" which receives the highest frequency of large hail in North America and most of the world. Residents can usually count on three to four catastrophic (defined as at least $25 million insured damage) hailstorms every year. In the last 10 years, hailstorms have caused more than $3 billion in insured damage in Colorado.

Definition: Hail is described as showery precipitation in the form of irregular pellets or balls of ice. Formation of hail occurs inside a thunderstorm where there are strong updrafts of warm air and downdrafts of cold air. If a water droplet is picked up by the updrafts it can be carried high enough to where temperatures fall below 32 degrees where it freezes. As the frozen droplet begins to fall as it is carried by cold downdrafts, it may thaw as it moves into warmer air toward the bottom of the thunderstorm. The half-frozen droplet may get picked up again by another updraft where it is carried back into very cold air and refreezing it. With each trip above and below the freezing level the frozen droplet adds another layer of ice. The frozen droplet eventually falls to the ground as hail which can reach speeds up to 120 MPH. Research has shown that damage occurs after hail reaches around 1" in diameter and larger. Hail of this size will trigger a severe thunderstorm warning from the National Weather Service (NWS). The NWS uses the following standard hail size descriptions:

Hail Diameter Size	Description
1/4"	**Pea**
1/2"	**Plain M&M**
3/4"	**Penny**
7/8"	**Nickel**
1" (severe)	**Quarter**
1 1/4"	**Half Dollar**
1 1/2"	**Walnut/Ping Pong Ball**
1 3/4"	**Golf Ball**
2"	**Hen Egg/Lime**
2 1/2"	**Tennis Ball**
2 3/4"	**Baseball**
3"	**Teacup/Large Apple**
4"	**Grapefruit**
4 1/2"	**Softball**
4 3/4"- 5"	**Computer CD-DVD**

Source: NWS

In North America, hail is most common in the area where Colorado, Nebraska, and Wyoming meet, known as "Hail Alley." Hail in this region occurs between the months of March and October during the afternoon and evening hours. Colorado's damaging hail season is considered to be from mid-April to mid-August.

Previous Occurrences: There is a high occurrence of hail events on the eastern side of Colorado. Since 1950, ninety-three percent (93%) of all reported hail events occurred in the

eastern part of the state, with most of the events concentrated in the northeast. There are three (3) counties with over 500 reported hail events between 1950 and 2010.
El Paso County has the highest number of hail events with 884, followed by Weld County with 600 and Yuma County with 578. Although these counties account for twenty-four percent (24%) of total reported events combined, they only account for one percent (1%) of total reported damage. Areas with higher density, including Denver, have more reported damage than other areas in Colorado with less density. Denver actually had the costliest hail storm since 1990 in terms of insured losses in the Rocky Mountain region. On the night of July 20th, 2009, a strong storm hit the northwest suburbs of Denver, dumping as much as an inch of rain in less than an hour and hail that was one-inch in diameter. The storm damaged numerous cars, windows and roofs. A greenhouse containing plants worth more than $250,000 was destroyed. Straight-line winds of 80 miles per hour uprooted mature trees and damaged roofs. The storm also left 50,000 residents without power. To date, RMIIA has identified $767.6 million in damages from the storm.

The following lists the most expensive hailstorms in the Denver Metro region. Costs are in the millions.

Date	Location	Cost When Occurred (Millions)	2009 Dollars (Millions)*
July 20, 2009	Denver Metro	$767.6	---
July 11, 1990	Denver Metro	$625.0	$1.03 Billion
June 6-15, 2009	Denver Metro	$353.3	---
June 13-14, 1984	Denver Metro	$276.7	$571.3
October 1, 1994	Denver Metro	$225.0	$325.7
July 13, 2011	CO Front Range	$164.8	---
June 8-9, 2004	Denver Metro	$146.5	$166.4
August 11, 1997	Denver Metro	$128.0	$171.1
May 22, 1996	Denver Metro	$122.0	$166.8

Source: Rocky Mountain Insurance Information Association, 2010
*2009 estimated cost calculations based on the Consumer Price Index

- One example of the rippling economic effects that a hailstorm can have occurred in July 2011. On July 13, 2011, golf ball-sized hail pummeled the Denver International Airport for about 15 minutes. Hundreds of flights were cancelled, numerous planes were damaged and at least 1000 people were stranded in the airport overnight. This storm and its destruction caused problems throughout the country with airline flights for the next few days.

Future Probability: Hailstorms resulting in property or agricultural damage are an annual occurrence. Atmospheric convection activity producing conditions prone to hail are expected to occur in similar frequency and extent in the future as in the past.

Magnitude and Severity: Since 1990, the majority of the costliest hazard events in Colorado are hailstorms. While hailstorms do not threaten lives to the same degree as a flood or a tornado, they do pose significant risks to roofs, windows, cars, crops and other forms of property. Vehicles, roofs of buildings and homes, and landscaping are the property most commonly damaged by hail. A significant amount of damage inflicted by hail is to crops. Even small hail can cause significant damage to crops in a short period of time.

During the period from 1950-2010, Denver had the following damage due to hail:

Number of events	Deaths	Injuries	Property Damage	Crop Damage	Total Damage
170	0	21	$156,500,000	$0	$156,500,000

Source: National Climatic Data Center, NOAA, 2010

Sources

Colorado State Demography Office

National Weather Service (NWS)

National Climatic Data Center (NCDC)

National Severe Storms Laboratory

Rocky Mountain Insurance Information Association (RMIIA)

Colorado Department of Emergency Management

Lightning: Lightning kills an average of 58 people a year around the U.S. Colorado ranked 18th compared to other states in the total number of cloud-to-ground lightning flashes recorded between 1996 and 2008. In any given day in July or August, over 4,000 lightning flashes are expected to occur in Colorado**.**

Definition: Lightning is a luminous, electrical discharge in the atmosphere caused by the electric charge separation of precipitation particles within a cumulonimbus (thunderstorm) cloud. Thunder is the resulting sound wave caused by the sudden expansion of air heated by a lightning discharge.

Previous Occurrence: Three people have been killed by lightning in Denver County and 22 have been injured from 1980-2010.

- July 30th, 1997: 27 year old male killed and woman injured when they took cover under a tree on a golf course.
- June 7, 1997: A 39 year old male plumber was killed and his accomplice (age and gender unknown) was injured while working on a pipe at a construction site.
- May 29, 1982: 1 man was killed (age unknown) and 2 others (age and gender unknown) injured as they stood under a tree in Washington Park

Date	Time	Male Killed	Male Injured	Female Killed	Female Injured	Unknown Injured	Total Killed	Total Injured
Aug 1, 2001	1600	0	1	0	0	0	0	1
July 17, 2000	1500	0	0	0	1	0	0	1
May 22, 1998	1900	0	1	0	0	0	0	1
July 30, 1997	1545	1	0	0	1	0	1	1
June 7, 1997	1400	1	0	0	0	1	1	1
June 12, 1991	1430	0	5	0	2	0	0	7
July 2, 1988	1500	0	1	0	0	0	0	1
June 11, 1988	Night	0	1	0	0	0	0	1
Sept 2, 1987	Night	0	2	0	0	0	0	2
Aug 16, 1982	2040	0	0	0	1	0	0	1
June 23, 1982	1530	0	0	0	0	3	0	2
May 29, 1982	Noon	1	0	0	0	2	1	2
		3	11	0	5	6	3	22

Future Probability: SHELDUS assigned Denver with a moderate risk for personal injury from lightning. Calculations were based on giving the number of total deaths and injuries a number value and the number of lightning flashes per county another number value. The value of deaths/injuries was added to the value assigned to the lightning flashes. The resulting values range from 0 to 6. Values from 5 to 6 represent areas determined to be at high risk. Values from 3 to 4 represent areas with moderate risk and values less than 3 represent areas with low risk. With 3 deaths, 25 injuries and 1,200 lightning flashes, Denver received a value of 3 which is in the moderate risk category.

Magnitude and Severity: Death and injury is the greatest risk lightning poses to people. Between 1995 and 2009, Colorado ranked fourth in the nation for lighting deaths with 44 (National Weather Service).

In a study in Denver, it was found that one (1) out of every 52 lightning flash results in an insurance claim; while nationwide the ratio is 1 to 57. (NWS) With Colorado averaging 529,000 flashes per year and an average of one insurance claim per 52 strikes, the state is averaging over 10,000 insurance claims per year. In addition to direct damages from lightning, wildfire ignition is of great concern. Deaths and injuries to livestock and other animals, thousands of forest and brush fires, as well as millions of dollars in damage to buildings, communications systems, power lines, and electrical systems are also the result of lightning. Total property damage reported from lightning strikes in Colorado is $19.4 million over the last 50 years. In Denver, the following statistics were reported in SHELDUS for 1960 to 2008:

Lightning Event	Deaths	Injuries	Property Damage	Crop Damage	Total Damage
51	3	22	$1,308,525	18,125	$1,326,650

Sources

Colorado Division of Emergency Management (CDEM)

Spatial Hazard Events and Losses Database for the United States (SHELDUS)

National Weather Service (NWS)

National Observation and Atmospheric Association (NOAA)

Tornados: Most tornados in the United States occur in the central plains, with the greatest likelihood of twisters in the southern plains around Kansas, Texas and Oklahoma. Colorado lies of the western fringe of "Tornado Alley", but our state still averages between 40 and 60 tornadoes per year. The peak season for tornadoes is in the spring and early summer with June the most active month. This is due to the fact that the weather patterns that are needed for tornado development are most common in the spring and early summer.

Tornados can occur any time of the day, but the majority of tornados occur in the afternoon or evening and usually move southwest to northeast. While they occur statewide, the largest number develops in eastern Colorado to the east of I-25.

Definition: Tornado can be defined as a localized, violently destructive windstorm occurring overland, especially in the Midwestern United States and characterized by a long, funnel shaped cloud, composed of condensation and containing debris that extends to the ground and marks the path of greatest destruction. Tornadoes are generated by severe thunderstorms.

Most tornadoes are not powerful enough to cause widespread damage – most are weak and according to the National Weather Service, 89 percent have a life span of less than 10 minutes and result in less than 5 percent of tornado fatalities. These weaker tornadoes typically have wind speeds less than 110mph which will damage a wood frame construction home but may completely destroy a mobile home or outbuilding.

Of the 10 percent of tornadoes that are considered strong, some may last 20 minutes or more and cover distances in excess of 20 miles. These major tornadoes can have speeds to 165mph, account for 30 percent of tornado deaths and will cause considerable damage to almost any type of structure.

The remaining 1 percent of tornadoes are considered violent in nature and result in 70 percent of tornado fatalities. They simply destroy everything in their paths, can last more than an hour and travel more than 50 miles. The only chance for survival in a violent tornado is inside a safe roof or underground shelter.

Previous Occurrence: From 1950 to 2010, there were 12 reported tornados in Denver County. There have been no deaths and 13 injuries, and total damage from these 12 tornados was $32,575,000.

Compared with other States, Colorado ranks number 10 for frequency of tornados. The high altitude and drier air make it harder for the monster supercells that spawn the biggest tornados to form. Most of our tornados are small and short lived. Since 1950, the three counties with the most tornados have been Weld County, Adam County and Washington County.

Below is a list of tornados reported for Denver County:

	Time	Deaths	Injuries	Category
April 11, 1966	1200	0	0	F0
June 9, 1967	1150	0	0	F1
May 28, 1981	1648	0	0	F1
June 3, 1981	1425	0	0	F2
June 3, 1982	1436	0	0	F0
June 8, 1986	1710	0	6	F2
May 12, 1987	1705	0	0	F1
June 12, 1987	1440	0	0	F0
June 15, 1988	1616	0	0	F2
June 15, 1988	1624	0	7	F3
May 29, 1990	1231	0	0	F0
June 2, 1993	1230	0	0	F1

- June 15, 1988: a tornado outbreak occurred in metro Denver with 5 tornados resulting in 7 injuries and damage of excess of $15M.
- June 7, 2008: F1 tornado struck Aurora, Southlands Mall with one significant injury and causing 3K in damages. Caused a power outage for 1 ½ hours. While not in Denver County, this is a neighboring county.

The peak season is mid May through mid August, with June the most active month. However, there is no hard and fast rule for when tornadoes strike, as Colorado witnessed on March 29, 2007 when Holly, Colorado was struck by an EF-3 tornado with winds of 165 mph. Two women lost their lives as a result of that event and 160 homes were damaged.

Future Probability: The infrequency and unpredictability of where tornados will strike make mitigation difficult. Conditions that foster tornados (severe thunderstorm activity) will continue to exist in Denver.

Magnitude and Severity: Tornados in the Denver area do not typically get high intensity ratings, however in 1988 an F3 was recorded in Denver County. (The Fujita scale rates the intensity of tornados with F0 for weak storms with wind rotation below 116 kw/hr and F5 for violent storms with rotation speeds of 419-512 kw/hr.) However, even though most of the tornados occurring in our area are rated as relatively weak compared to those in the Midwest, the potential for injury, loss of life and property damage remains high. Most of the injuries in these events are due to flying glass or debris.

Sources

http://www.disastercenter.com/colorado/tornado.html

http://www.tornadoproject.com/alltorns/cotorn.htm

Winter Weather: Winter storms occur frequently and have great impact on Denver's vulnerable populations. In Colorado, blizzards may occur during fall, winter and spring on the eastern high plains. While Colorado blizzards are less frequent and drop less snow than in areas further east and north, they can still be devastating. As recently as 1997 several fatalities were directly attributable to an October blizzard which caught many travelers unprepared. Late spring snow storms are not uncommon in Colorado. On May 3, 2001, a late spring storm hit, dumping snow across a large area of the state. In Denver, measurable snow has been recorded as late as June 12 back in 1947.

Definition: Hazardous winter weather includes events related to heavy snow, blowing snow, ice, sleet or freezing rain, and extreme cold temperatures. Blizzards are severe winter storms that pack a combination of blowing snow and wind resulting in very low visibilities. While heavy snowfalls and severe cold often accompany blizzards, they are not required. Sometimes strong winds pick up snow that has already fallen, creating a blizzard. Hazardous winter weather may also result from bitterly cold temperatures and may not involve snow.

Previous Occurrence: Two of the past three presidential declarations in Colorado have been related to severe winter weather events. In 2003, Colorado received a presidential declaration for snow emergency for the winter snowstorms of March 17th through the 20th and again in 2007 for the storms in December 2006. Denver received money for both of those events. Past significant winter storms in Denver include:

- 1983 (November)-extreme cold with mercury dipping 21 degrees below zero (coldest recorded temperature in over 20 years); storm lingered unexpectedly lingered over Denver dumping 21.5 inches of snow
- 1991 (November) snowstorm with 21.1 inches of snow
- 1997 (October)-blizzard dumped as much as 31 inches of snow on metro Denver; four thousand travelers were stranded at the Denver International Airport costing air carriers more than $20 million. State declared an emergency.
- 1998 (December)-extreme cold. For six days, the temperatures dipped below 0 degrees F with a low of -19 degrees F. There were power outages, cracked water pipes, 5 deaths and 15 injuries reported from this storm.
- 2001 (April) DIA lost power two times in two consecutive weekends due to two severe spring storms; high winds and ice; snapped power poles and downed power lines left many residents/businesses without power.
- 2003 (March) –largest snowstorm since 1946 with 31.8 inches of snow
- 2006 (December)-Multiple storms and below normal temperatures created severe ice build-up on local streets and dumped 20.7 inches of snow. The first storm occurred on Dec 20th, closing down grocery stores, retailers, the airport, the city of Denver, and US Mail service at the height of holiday travel. A state wide disaster was declared.

Future Probability: Atmospheric activity producing conditions prone to winter weather such as ice, snow, extreme cold, and high winds are expected to continue to occur. Denver is at risk from severe winter weather effects including cold temperatures, ice, heavy snow, and high winds.

Magnitude and Severity: Winter storms can result in flooding, closed highways, blocked roads, downed power lines and hypothermia. It is not unusual for motorists and residents to become stranded or for power outages to occur. Annually, heavy snow loads and frozen pipes cause damage to residences and businesses. Late season heavy snows will typically cause some plant and crop damages.

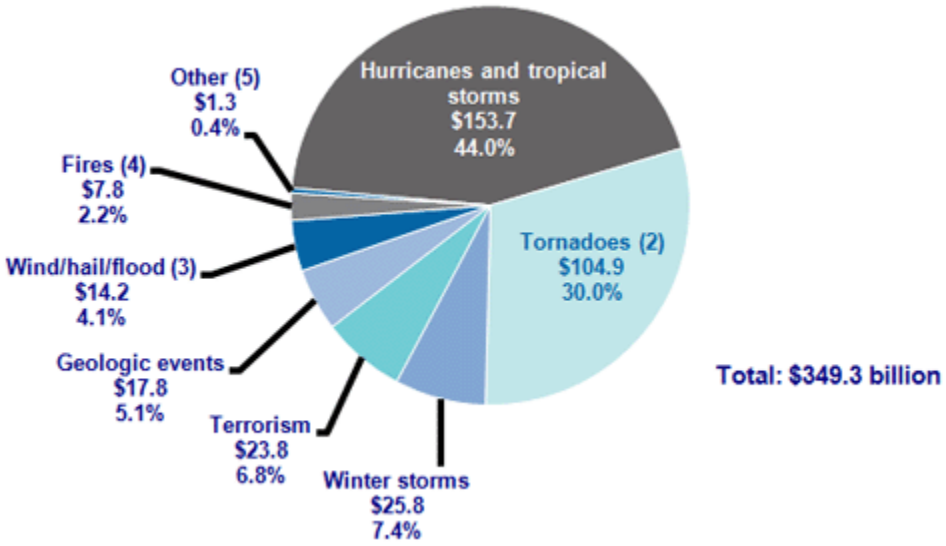
The Rocky Mountain Insurance Information Association (RMIIA) estimates the blizzard of March 2003 was the most expensive winter storm from snow and ice damage in Colorado history. RMIIA reports that the majority of 2003 blizzard damage was the result of wet, heavy snow that collapsed roofs, porches, awnings, carports and outbuildings. There was also significant damage from downed trees and limbs, along with claims for wind, snow melt leakage, food spoilage and out-of-pocket living expenses for people forced out of their home due to storm damage. Most of the vehicle damage was due to being crushed rather than weather-related accidents. For the 2003 storms, the average cost per homeowner insurance claim was more than $3,500 and many homes were completely destroyed due to roof collapses and structural damage.

In Denver, the winter weather deaths, injuries, and damage amounts are listed below for period from 1960 to 2008. (These are totals for the 48 year time period):

# of events	Deaths	Injuries	Property Damage	Crop Damage	Total Damage
60	20	6	$7,675,826	$110,159	$7,785,985

According to NOAA, winter storms in the U.S. resulted in about $25 billion in insured losses (in 2009 dollars) from 1990-2009. Insured losses due to winter storm events in the U.S. in 2010 totaled nearly $ 2.8 billion (in 2010 dollars), the largest loss total in eight years and one of the top five largest annual winter storm losses in the nation's history. See the below graph for the breakdown of costs by type of storm. Winter weather is roughly 26% of the economic losses.

INFLATION-ADJUSTED U.S. CATASTROPHE LOSSES BY CAUSE OF LOSS, 1991-2010 (1)(2010 $ billions)



Sources

State of Colorado Natural Hazard Mitigation Plan January 2011

Rocky Mountain Insurance Information Center (RMIIA)

Colorado Climate Center (CCC)

National Weather Service Weather Forecast Office
http://www.crh.noaa.gov/bou/?n=snowstat

Insurance Information Institute. (2010). Winter Storms.
http://www.iii.org/facts_statistics/winter-storms.html

NWS/NOAA's Value of a Weather-Ready Nation (9/13/2011)
http://www.ppi.noaa.gov/wp-content/uploads/PPI-Weather-Econ-Stats.pdf

Adversarial/Human Caused

Terrorism (both international and domestic): Terrorism by nature is unpredictable and can occur with little warning. Denver is one of the largest metropolitan population centers in the Western United States. The large population, government buildings, military installations, financial buildings, environmental practices, school campuses, sports stadiums and an international airport all contribute to making Denver a potential terrorist target for both domestic or international terrorist groups.

Definition: Terrorism is the use of force or violence against persons or property in violation of the criminal laws of the United States for purposes of intimidation, influence, coercion, or ransom. Terrorists often use threats to:

- Create fear among the public.
- Try to convince citizens that their government is powerless to prevent terrorism.
- Get immediate publicity for their causes.

Characteristics: Terrorism generally is a tool used by a group or organization to draw attention to a political or social issue. In recent decades violent terrorism has been demonstrated globally in the form of attacks on civilian populations, transportation infrastructure, financial infrastructure, and government facilities. The most common tactic used by terrorists has been the employment of explosive devices and the use of fire arms. Homeland security advisories indicate international terrorists continue seek resources conduct attacks using conventional and non-conventional weapon systems, including chemical, biological, and nuclear.

In the state of Colorado, international and domestic terrorist groups are present. The following international groups have known links in Colorado: Hamas, Hezbollah, MS13, Al Jihad, and Al Qaeda. The following domestic groups are known to have links in Colorado: Street Gangs, National Alliance (Neo-Nazi), Neo-Confederate, KKK, Constitutionalists, Animal Liberation Front (ALF), the Earth Liberation Front (ELF), and Outlaw motorcycle gangs including Hells Angels, Banditos, Nazi Low Riders. Both types of groups pose threats to life and property within Denver and cannot be overlooked in a hazard profile.

Lone wolves have also conducted terrorist attacks in the United States and cannot be discounted as a threat in Denver. A lone wolf is someone who commits violent acts in support of some group, movement, or ideology, but does so alone, outside of any command structure. There has been an increase in lone wolves acting on behalf of Al Qaeda within the United States over the past two years.

Previous International Terrorism Instances: Colorado has been the home to two confirmed Al Qaeda influenced Jihadists.

- Najibullah Zazi, an Afghan taxi driver living in Aurora, CO who was arrested in 2009 for plotting to set off suicide bombs in the NY train system

- Jamie Ramirez (aka Jihad Jane), the woman from Leadville, CO, accused of traveling to Europe to support and support an assassination against a Swedish cartoonist in 2010.

Previous Domestic Terrorism Instances: There have been domestic terrorist groups operating in Colorado for many decades. For example, the Klu Kluk Klan has had a presence in the Denver Metro area since the 1920's.

- In 1998, ELF made national headlines when it claimed responsibility for the arson of a ski resort in Vail, Colorado, causing $12 million in damages

Future Probability: The number of cases of homegrown terrorism has sharply increased since 2009. The influence of the internet has made individuals accessible to international terror organizations for recruitment. More cases of U.S. radicalization have been reported in 2009 and 2010 than any other years. Homegrown recruits may represent the best chance for Al Qaeda and other international terrorist organizations to launch attacks in the United States and these individuals represent a very real threat to all communities, including Denver.

There are several state and federal agencies in Denver that were specifically created or plumped up after 9/11 to help thwart terrorist threat. Denver's Joint Terrorism Task Force (JTTF)—officially created in 1997 to leverage the resources and skills of the FBI and many partner agencies—was strengthened in the days following the attacks. A Denver Field Intelligence Group was also established in 2003 to proactively gather information on key security and criminal threats. These new and strengthened capabilities were instrumental in the investigation of Zazi.

In addition, the Colorado Information Analysis Center (CIAC) is a multi agency intelligence fusion center designed to link all stakeholders in Colorado. It emphasizes detection, prevention, and information-driven response to protect the citizens and critical infrastructure of Colorado. The CIAC launched a Terrorism Liaison Officer Program for law enforcement and first responders in 2007. This program creates a statewide network of personnel dedicated to fighting criminal and terrorist threats, linking local fire and law enforcement resources to federal and state assets.

Magnitude and Severity: It is impossible to accurately define what the magnitude and severity could be for a potential terrorist attack in Denver. Traditionally, terrorists look for symbolic targets and the attacks are designed to kill as many people as possible. One of the worst scenarios here could include the use of chemical, biological, radiological or nuclear weapons at an event with large numbers of people. This would impact potentially thousands of people and would create economic damage for many years, perhaps decades. Other possible scenarios are limited attacks carried out by individuals targeting specific facilities or personalities.

Sources

Colorado Information Analysis Center (CIAC)

FBI Website

Technological/Accident

Dam Failure: *Dams are a critical part of the nation's infrastructure and provide vital benefits such as flood protection, water supply, hydropower, irrigation and recreation. As downstream development of dams increases and dams continue to age and deteriorate, they demand greater attention and investment to assure their safety*. (Association of State Dam Officials)

Definition: Dam Failure is the unintended release of impounded waters. Dams can fail for one or a combination of the following reasons:

- Overtopping caused by floods that exceed the capacity of the dam.
- Deliberate acts of sabotage
- Structural failure of materials used in dam construction
- Poor design and/or construction methods
- Movement and/or failure of the foundation supporting the dam
- Settlement and cracking of concrete or embankment dams
- Piping and internal erosion of soil in embankment dams
- Inadequate maintenance and upkeep

Failures may be categorized into two types: component failure of a structure that does not result in a significant reservoir release and uncontrolled breach failure that leads to a significant release. With an uncontrolled breach failure of a manmade dam, there is a sudden release of the water, sometimes with little warning.

The Colorado Division of Water Resources runs the Dam Safety Program in Colorado. Of the non-federal dams in Colorado, approximately 677 are classified as dams that, in the event of a failure, would be expected to cause loss of life and/or significant property damage within the flood plain areas below the dams. These dams are referred to as Class I or Class II.

Classification Description
Class I - High Loss of human life is expected.
Class II - Significant damage is expected, but not loss of human life. Significant damage refers to structural damage where humans live, work, or recreate or public or private facilities exclusive of unpaved roads and picnic areas. Damage refers to making the structures uninhabitable or inoperable.
Class III -Low Loss of human life and damage to structures and public facilities not expected.
Class IV - No Public Hazard No loss of human life is expected and damage will only occur to the dam owner's property in the event of dam failure.

(Colorado Division of Water Resources)

Denver has 7 Class I dams and 3 Class II dams.

Dam Name	Class	Owner
Marston Lake-East Dam	1	Denver Water
Marston Lake-North Dam	1	Denver Water
Marson Lake-Northwest Dike	1	Denver Water
Marston Lake-South Dam	1	Denver Water
Skeel	1	Wellshire Golf Course/Denver County
Westerly Creek	1	Lowry Redevelopment Authority
Windsor	1	Fairmont Cemetery
Fort Logan Dam	2	U.S. Veterans Administration
Kelly Road Detention	2	Lowry Redevelopment Authority
Ferril Lake	2	Denver Wastewater Management

Denver also has three federally owned dams in neighboring counties that would cause significant damage if they failed:

Cherry Creek Dam (Owned by Federal Government): Cherry Creek Dam was the first of the three dams to be built to protect the Denver region from catastrophic South Platte River floodwater that plagued the area for more than 100 years. Located at the southeast edge of Denver in Aurora, Colorado, construction of the dam was begun in 1948 and was completed in 1950. The 140-foot-high (43 m) Cherry Creek Dam forms Cherry Creek Reservoir in Cherry Creek State Park, providing flood control and irrigation. The dam lies immediately southeast and southwest of the Denver and Aurora city limits, respectively, approximately 8 miles (13 km) from the creek's confluence with the South Platte. Prior to the construction of the Cherry Creek Dam, the creek's water level rose and fell regularly. Since the dam's completion, however, this flood cycle has been interrupted. Now, the flow is regulated almost exclusively by the dam's operators. The level of the creek is kept constant except when water needs to be vented from the Cherry Creek Reservoir. When the dam's floodgates are opened for this venting, the creek's level may rise as much as two feet, sometimes in less than an hour. This dam is the highest priority in the Denver area due to the downstream population (SE Denver and Aurora) and property. (As of the 1990s, the Corps estimated more than 120,000 people and $30 billion worth of property were below this dam.) It is also located directly adjacent to Interstate 225. Efforts to improve the dam's safety are underway. A Probable Maximum Precipitation (PMP) study was directed by Congress in 2010/early 2011 and a Dam Safety Study was scheduled to begin sometime in 2011-2012.

Chatfield Dam (Owned by Federal Government): Chatfield Dam was the second of three dams built to protect the Denver region from floods. Chatfield Reservoir is a flood-control reservoir on the South Platte River owned and operated by the U.S. Army Corps of Engineers. Both the reservoir and the dam were built in response to the devastating

floods of 1965 that caused millions of dollars of damage in Denver. In addition to its primary purpose of flood control, it serves as one of many water supply reservoirs for the city of Denver, Colorado. Construction of the project was begun in 1967 and the dam was completed in 1975. The reservoir has the ability to store more than 350,000 acre-feet of flood waters from the South Platte River and Plum Creek. The land at Chatfield is leased to the state, which operates Chatfield State Park. The dam is located in Littleton.

Bear Creek Dam (Owned by Federal Government): Bear Creek Dam was the last of three dams built to protect the Denver region from floods. Located on the southwest edge of suburban Lakewood at the confluence of Bear Creek and Turkey Creek, construction of the dam was authorized in 1968 and was completed in 1982. The dam was constructed in two segments including the main embankment and the south embankment. It is located just west of Denver near Morrison, on CO 8.

One other dam to mention: **Cheeseman Dam (Owned by Denver Water)**: This dam was built in 1895 and is a critical part of Denver's water supply. It was the first reservoir to serve Denver giving the city a more secure water supply, instead of relying on river water from mountain runoff. The dam was closed on January 1, 2010 and will remain closed until May 1, 2012 for upgrades.

Previous Occurrence: The last major Colorado dam failure happened in 1982. Gradual deterioration of the earthen Lawn Lake dam in Rocky Mountain National Park led to a breech that released 220 million gallons of water, killing three people and causing $31 million in damage around the town of Estes Park. There have been no dam failures in Denver that have cost any lives or damage to property.

Future Probability: Based on a report in February 2011, a review of dam safety records showed that many of Colorado's dams needed repairs. This report said that a breach at any of the high hazard dams (Class I) would likely kill people living or working nearby. Failures at the significant hazard dams (Class II) would cause major property damage. Since dam owners do not have the funds to make the repairs, the state's approach has been to send out inspectors and, if they find deficiencies, impose restrictions on how much water can safely be held in the reservoirs to prevent blow outs. Currently none of the dams in Denver have restrictions.

Magnitude and Severity: A dam break/inundation study is performed for the purpose of determining the impact of a dam failure flood**.** If a dam break floods a roadway (like in the case of the Cherry Creek Dam), the possibility for loss of life to motorists and pedestrians is possible. In that case, several scenarios are plausible: a vehicle could be swept downstream by floodwater or the driver could lose control and subsequent crash the vehicle due after hitting the floodwater. Sidewalks, bicycle path and walking/hiking trails could become flooded quickly in this scenario.

Source: Cherry Creek Dam, Chatfield Dam, Cheeseman Dam websites and plans

Hazardous Material Incidents: The 1984 disaster in Bhopal, India that killed over 2,000 people focused world-wide attention on the dangers of toxic chemical releases. In the US, it led to the 1986 Emergency Planning and Right to Know Act (EPCRA), also known as SARA Title III. The federal government plays a large role in managing hazardous materials. Users of these hazardous materials are required to report what chemicals they are using and releasing into the air and how they will respond in case of an emergency. Under EPCRA, the Environmental Protection Agency (EPA) delegates implementation of the law to the states. Colorado State has subsequently passed the responsibility to local districts know as Local Emergency Planning Committees (LEPCs). LEPC's collect information from facilities that are storing and/or using hazardous chemicals to help with emergency planning in their communities.

Definition: Substances that (because of their chemical or physical characteristics) are hazardous to humans and living organisms, property and the environment are regulated by the Environmental Protection Agency (EPA) and when transported, by the U.S. Department of Transportation (DOT). A hazardous material incident is defined as any actual or threatened uncontrolled release of a hazardous material, its hazardous reaction products or the energy released by its reactions that pose a significant risk to human life and health, property and/or the environment.

EPA regulations address "hazardous substances" and "extremely hazardous substances." Hazardous substances are generally materials that, if released into the environment, tend to persist for long periods and pose long term health hazards for living organisms. They are primarily chronic rather than acute health hazards. Regulations require that spills of these materials into the environment in amounts at or above their individual "reportable quantities" must be reported to the EPA. Extremely hazardous substances are generally toxic materials that are acute health hazards. When these substances are released, they are immediately dangerous to the life of humans and animals and will cause serious damage to the environment. When facilities have these materials in quantities at or above their threshold planning quantities (TPQ), they must submit "Tier II" information to their local Fire Department, as well as the State and Local Emergency Planning Committees. The LEPC retains this data and uses it for emergency planning. It is available to the public for their review under the Community Right to Know Act.

DOT defines hazardous material as a substance that is capable of posing an unreasonable risk to health, safety and property when transported in commerce. When a hazardous material meets the DOT definition of a hazardous material, it must be transported under safety regulations providing for appropriate packaging, communication of hazards and proper shipping controls.

In addition to EPA and DOT regulations, the National Fire Protection Association (NFPA) develops codes and standards for the safe storage and use of hazardous materials. These codes are generally adopted locally and include the use of the NFPA 704 standard for communication of chemical hazards in terms of health, fire, instability and other special hazards (such as water reactivity and oxidizer characteristics). Diamond shaped NFPA 704 signs ranking the health,

fire and instability hazards on a numeric scale from zero (least) to four (greatest) along with any special hazards, are usually required to be posted on chemical storage buildings, tanks, other facilities, and individual containers stored or used inside facilities.

Previous Occurrence: The Colorado Department of Public Health and Environment receives reports of spills and releases that occur throughout the state. These calls are all followed up on to determine if there was an actual release that would threaten life, property or the environment. Within the City and County of Denver during the period of March 1 - July 24, 2011, there were 30 reported spills. These reports are available for the LEPC to review at any time.

Releases must also be reported to the National Reporting Center (NRC). A query can be run to see what kind of releases have occurred in Denver, where they occurred, what was the substance and what happened to cause the release.

Future Probability: There are two types of potential problems with hazardous materials in Denver. First there are fixed sites that store and use chemicals daily within city limits. There are currently over 170 companies in Denver that report they use or store hazardous materials in their daily operations. While almost half do not hold chemicals other than those used in batteries, there are several companies that use ammonia and chlorine daily. Second, there is hazardous material that is transported throughout the city on a regular basis. There is always the potential for a release from either the fixed sites or from a train going through the city.

Magnitude and Severity: Hazardous Material incidents often occur suddenly and with little or no warning. Such events usually affect a relatively limited area with limited injuries and typically no deaths. However, several companies in Denver hold substantial quantities of extremely hazardous materials. These companies are located close to I-25, neighborhoods and sports venues and could cause major problems if there is an incident and an immediate evacuation is necessary. All of these companies are required by law to hold emergency plans that would go into effect if there is an accidental release.

The possibility also exists for a problem with one of the trains transporting hazardous material. Some of our train stations are located right next to I-25 which could be impacted if there is a release at a station or along the train route.

Sources

Denver's Tier II Database

Environmental Protection Agency Website

Department of Transportation Website

Colorado Department of Public Health Spills Report