

HAZARD ANALYSIS - BOULDER COUNTY

Hazard / Definition

Flood/Flash Flood:

Periodic overflow of rivers and streams (*riverine or slow rising*). Quickly rising small streams after heavy rain or rapid snowmelt (*flash flood*). Overflow of storm sewer systems usually due to poor drainage, following heavy rain or rapid snowmelt (*urban flood*).

Description / Frequency

Floods and flash floods almost always occur during or after a period of heavy precipitation. Flash floods occur swiftly and without warning. The immediate danger is from the strength of the water current as it surges through an area, carrying debris and causing injuries and drowning. A flood would most likely result from a very heavy rainstorm that stalls over any of the creek basins. It could rain for as little as three to four hours in the foothills before water starts overflowing stream banks. In addition to Boulder Creek there are 11 other drainages that flow through the City of Boulder. They are: Four Mile, Wonderland, Twomile, Elmer's Twomile, Goose, Sunshine Canyon, Gregory, Bluebell Canyon, Kings Gulch, Skunk and Bear Canyon. Four Mile Canyon Creek, Lefthand Creek, St. Vrain Creek, and South Boulder Creek impact other portions of Boulder County. Many flood studies have been done in Boulder County for the different drainage basins. Information was taken from these studies.

Historical Score: 5

Numerous floods have occurred in the Boulder area, with the most damaging flood occurring in 1894. This was considered a slow rising flood, and designated as a 100-year event.

Approximately 3 inches of rain fell in a period of 30 minutes in the Town of Lyons on August 10, 1994. An *urban flash flood* resulted when the drainage system was unable to manage the large amounts of water. Damage to streets alone was \$65,000.

Boulder received record rainfall (9.37 inches) during May of 1995. This, along with above average snowfall in the mountains, caused concern about the threat of flooding. As a result of the heavy rain, flooding occurred throughout Boulder County as well as in the City of Boulder. St. Vrain Creek in Lyons and Longmont, as well as lesser streams throughout the county overflowed. Boulder Creek, which holds the biggest risk of serious flooding, ran at its highest level for the year, but stayed in its banks within the city limits. The biggest threat was a mudslide at the base of Flagstaff Road that threatened 6 homes.

Mitigation Options / Strategies

- C Adoption of codes and ordinances that prohibit or control building in the floodplain.
- C Participation in the National Flood Insurance Program. The City of Boulder entered the program in 1978.
- C The City of Boulder purchased property and removed houses in certain areas of the floodplain (near Boulder High School). This area has been turned into park areas and parking lots.
- C A hydraulic flood gate has been installed outside the new Library Auditorium. This will help keep flood water out of the north end of the building which lies in the floodplain.
- C The City constructed a flood wall around the Municipal Building which is in the Boulder Creek floodplain. Gates installed in the wall are automatically activated and rise from underground when sensors detect floodwater approaching the building.
- C "Climb to Safety" signs have been placed along roads in canyons designated with flood potential. Flood hazards areas, including bike paths, have been marked with signs warning of possible flooding.
- C Mitigation plans have been completed for the City of Boulder, and the Towns of Lyons and Jamestown.
- C Boulder County has a sophisticated flood warning and detection system made up of stream and rain gauges throughout all the drainage areas in Boulder County. These gauges are connected to a computer in the Boulder Regional Communications Center that sound an alarm when significant amounts are recorded.

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Boulder Creek:

Large floods in the basins were reported in 1864, 1876, 1894, 1914, 1923, 1941, 1956, and 1969.

May 23, 1876: General storm over the basin created flooding on the plains of Boulder County up to 1-1/2 miles wide.

May 29, - June 2, 1894: Rainfall over the Boulder and South Boulder Creek basins was heavy. Records for a 96 hour period indicate 4.5 to 6.0 inches of precipitation. Mountain rainfall, combined with snowmelt runoff, produced the greatest flood known at Boulder and inundated the valley. Buildings, bridges, roads and railroads were washed away. All bridges were swept away in Boulder Canyon destroying the highway and railroads as far up the canyon as Four Mile Creek. Buildings were destroyed at Crisman, Sunset and Copper Creek. Computations made 18 years later produced estimates of the peak discharge in Boulder that ranged from 9,000 cfs to 13,600 cfs. In Boulder, floodwater covered the entire area between Water Street (Canyon Boulevard) and University Hill to depths as great as eight feet. Many people were trapped in their homes and had to be rescued. Due to the flood's slow onset, only one life was lost. In the valley downstream from Boulder, the floodplain was reported to have been inundated for several days to an average width of approximately one mile. Agricultural damages included loss of livestock, crops, pastures, fences, roads and deposition of sand and silt on floodplain lands.

June 1-2, 1914: The peak discharge was estimated at 5,000 cfs. Numerous bridges were washed out between Colburn Mill and Boulder Falls. A portion of the main line for Boulder's water system was destroyed.

June 2-7, 1921: Rainfall totaled 3.36 inches at Boulder through this period. A peak discharge of 2,500 cfs was recorded on June 6, 1921.

September 4, 1938: A maximum discharge of 4,410 cfs occurred near the mouth of Boulder Creek.

Mitigation Options / Strategies

- C SCC Communications and US West partnered together for a warning and evacuation system for Boulder County. It is called the Emergency Warning and Evacuation Service (EWES) and is part of the Emergency Preparedness Network (EPN). The existing 9-1-1 database of telephone numbers and addresses is used in combination with detailed maps to help determine the geographic boundaries of an area impacted. The system is capable of calling up to 2,000 numbers in one minute. It is designed to deliver recorded information to endangered people in advance of a disaster or any major event. Messages can be delivered in various languages, as well as to pagers or the Emergency Alert System (EAS). Multiple floodplain areas can be handled during a single event with priority given to the area most impacted.
- C A public awareness campaign is done during the months of April, May, June, July and August. Sirens are tested on the first Mondays of these months to educate the public on how they work and what they should do when they hear them.
- C The NOAA Weather Lab in Boulder is working in cooperation with the City and County of Boulder using an experimental forecasting system. A weather display installed in the EOC is linked with the NOAA Lab. The system is experimental and final decisions are not made on this system alone.
- C The Boulder County Multiple Agency Coordinating System (MACS) group, consists of representatives from all agencies and jurisdictions within the County. This group makes plans and agreements for the procurement of resources needed during emergencies.

Flood mitigation measures and projects:

- C Flood protection measures have been completed along Wonderland Creek. These include ponding areas and channelization projects. The 26th Avenue crossing culvert and drop structure was constructed and designed to contain the 100 year floodflow.

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May 6-8, 1969: This flood was the result of a combination of snowmelt in the mountains and 4 days of continuous rainfall. Total precipitation for the storm amounted to 7.60 inches at Boulder and 9.34 inches at the Hydroelectric Plant located in Boulder Canyon. Peak flooding occurred on the 7th of May on Boulder Creek and South Boulder Creek. Bear Canyon Creek, Skunk Creek and Twomile Creek overflowed their banks. Damages from this storm were estimated at \$325,000.

Four Mile Canyon Creek: Occasional flooding with notable events occurring in 1916, 1941, and 1951. Railroad bridges were washed out in 1916 and 1941. Localized flooding along the lower reaches of Four Mile Canyon Creek occurs frequently. Damages and losses have generally been low because the area is undeveloped.

Goose Creek: Significant flooding occurred in 1951 and July 1954. The 1954 event damaged an addition to the Community Hospital that was under construction.

Two-Mile Creek: The worst flood on Twomile Creek occurred in September 1933, while others occurred in 1909, 1941, 1942, 1949 and 1965.

South Boulder Creek:

Flood Dates: (peak discharges in excess of 1,000 cfs)

June 3, 1895:	1,130 cfs
May 9, 1900:	1,100 cfs
June 20, 1909:	1,340 cfs
May 24, 1914:	1,240 cfs
June 6, 1921:	1,440 cfs
September 1938:	7,390 cfs
June 21, 1947:	1,290 cfs
June 6, 1949:	1,430 cfs
June 18, 1951:	2,370 cfs
June 4, 1952:	1,080 cfs
May 7, 1969:	1,690 cfs

just south of Iris (behind K-Mart) will attenuate the 100 year peak flood discharge from 615 to 510 cfs.

Mitigation Options / Strategies

C Detention ponds constructed on Elmer's Twomile Creek

study for the City of Boulder was performed for FEMA by the U.S. Army Corps of Engineers.

- C Detention pond on Twomile Creek upstream of Linden Avenue will control only moderate flows.
- C Flood protection measures along Skunk Creek include channelization of the stream and several detention/siltation ponds.
- C Improvement of Bear Canyon Creek channel to convey moderate flood flows downstream, however major storms will continue to cause flooding.
- C Flood protection measures along Goose Creek include channelization of North and South Goose Creek.
- C Flood protection measures along Dry Creek include channelization and construction of a new bridge at Flatirons Parkway.
- C Flood protection measures along Four Mile Canyon Creek include channelization through Palo Park Subdivision.

Numerous studies developing flood risk data for the Cities and Towns and unincorporated areas in Boulder County have helped establish flood insurance rates and assisted in efforts to promote sound floodplain management. Following are some examples of those hydrologic and hydraulic analyses.

August 1974: Analysis of the original study for the unincorporated areas of Boulder County was performed for FEMA by the U.S. Soil Conservation Service.

October 1975: Analysis of the original

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September 1938: This was the highest recorded flood on South Boulder Creek. In the mountains west of Eldorado Springs, 6 inches of rain fell. The Town of Eldorado Springs recorded 4.42 inches of rainfall. This resulted in a peak discharge of 7,390 cfs. The resort community suffered heavy damage and numerous buildings were destroyed.

May 4-8, 1969: Precipitation amounts totaled 8.11 inches at Eldorado Springs and 10.05 inches at Gross Reservoir. A peak discharge of 1,690 cfs occurred at Eldorado Springs.

Records were not kept for the major flood event that occurred in 1894, but flooding did occur on South Boulder Creek. Analysis of gaging records show that floods the size of the 1969 storm occur on an average of about once every seven years on South Boulder Creek.

Lefthand Creek:

Significant flooding on Lefthand Creek occurred in 1864, 1876, 1894, 1896, 1918, 1921, 1938, 1949, 1951, 1963, 1969, and 1973.

June 1894: Heavy rains combined with high spring runoff caused extensive flooding throughout Boulder County. Damage was extensive along Lefthand Creek. All bridges and roads were washed out. Boarding houses in Ward were washed away and damage to nearby mines was extensive. Rowena was all but washed away. Many residences and businesses were lost. The creek was reported to be 250 feet wide in some locations. In Glendale, hardly a building was left undamaged. Trees were uprooted, roads and railroads were destroyed, and ten families lost houses. Towns along James Creek suffered heavy damages as well. Every building on the north side of the creek was affected by the floodwater. Ten houses were swept away, and a church was destroyed. Local businesses suffered damage. Most houses in Springdale and a portion of the Seltzer House Hotel were washed into James Creek.

Mitigation Options / Strategies

March 1976: Analysis of the initial study for the City of Longmont was performed for FEMA by Ginergy Associates, Inc. An additional analysis for a revised study for the City of Longmont was done by Gingery Associates, Inc., Simons, Lee and Associates, and Water Resources Consultants, Inc. for the Colorado Water Conservation Board. This included floodplain information reports for Lefthand Creek, Dry Creek No. 1, and St. Vrain Creek.

February 1978: Analysis was performed for FEMA by Howard, Needles, Tammen and Bergendorff. This work covered all significant flooding sources affecting Lafayette, Jamestown, Lyons, Nederland and Superior.

July 1982: Revised analysis was done by Leonard Rice Consulting Water Engineers for the City of Boulder in the area of the confluence of Boulder and South Boulder Creeks. Channelization on South Boulder Creek and Dry Creek in the Flatiron Industrial Park area was a result of this analysis.

January 1983: Revised analysis done by Muller Engineering Company, Incorporated for the City of Boulder for Boulder Creek was completed and incorporated into flood study.

April 1985: Analysis was completed for the City of Boulder for Wonderland, Four Mile Canyon, Skunk Canyon, Bear Canyon, Twomile, and Goose Creeks.

July 1986: Revised analysis for the City of Boulder for Sunshine Canyon, Bear Canyon, Gregory Canyon, Skunk Canyon, Bluebell Canyon, and Four Mile Canyon Creeks and Kings Gulch was done by Greenhorne and O'Mara, Inc. A revised hydraulic analysis for South Boulder Creek was completed and incorporated into flood study.

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August 1913: Flooding damaged or destroyed most of the houses along James Creek. All wagon and footbridges were destroyed and the road to Jamestown was out for two weeks.

June 2-6, 1921: The maximum recorded rainfall was 5.29 inches and the greatest recorded rainfall intensity was 4.3 inches in six hours at Longmont. The storm lasted for 5 days. This flood was produced by a combination of rainfall and snowmelt. Although this storm caused overbank flooding, neither discharges nor damages were recorded.

September 3, 1938: During this storm, showers were general over the Lefthand Creek basin accompanied by isolated cloud bursts along the foothills and the lower elevations. A maximum peak discharge of 812 cfs was recorded at US Highway 287 near Longmont.

June 4, 1949: Heavy and prolonged rainfall, accompanied by runoff from snowmelt, caused overbank flooding on Lefthand Creek during May and early June. The high flow caused minor damages to irrigation headworks, bridges, and farmlands. The peak discharge was 1,140 cfs.

August 3, 1951: A heavy rainstorm occurred over the front range and foothills east of the Continental Divide from the vicinity of Boulder to near Ft. Collins, a distance of approximately 50 miles. One of the storm centers was on Lefthand Creek near the town of Niwot. At this storm center, total precipitation was **unofficially** reported to have been over 6 inches. Overbank flows occurred along most of the length of Lefthand Creek. Bridges, roads, crops, and irrigation structures were damaged.

May 1969: Three days of heavy snow and rain, along with spring runoff, caused a flood that damaged houses and businesses in Jamestown and caused major erosion damage to roads and bridges along James Creek. Peak discharge measurement on James Creek was 1,970 cfs. Precipitation totals of approximately eight inches were recorded in the James Creek Basin.

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St. Vrain Creek:

Accounts of flooding date back as early as 1844. Flooding occurred also in 1864, 1876, 1894, 1914, 1919, 1921, 1938, 1941, 1949, 1951, 1957, 1969, 1973, and 1976. Over the course of 100 years floods occurring along the St. Vrain Creek have destroyed farmland, roads and bridges.

May 31, 1894: All of the lower part of Lyons was washed away, and 20 houses were destroyed or ruined. The St. Vrain Valley looked like a lake 3 miles wide. Peak discharge was estimated at 9,800 cfs which made it greater than a 50 year event.

August 2, 1919: Bridges on the North St. vrain for about 5 miles up and 5 miles downstream were destroyed. Longmont and Lyons water mains up the canyon were torn out in many places. People living on the lowlands along the banks of the St. Vrain were flooded out. Peak discharge was estimated at 9,400 cfs.

June 2, 1921: North and South St. Vrain Creeks carried large volumes of water. Damage was done to bridges, sheds, and barns. The peak discharge at Lyons of 2,020 cfs was not indicative of conditions at Longmont because of heavy rain downstream from Lyons. Longmont recorded 5.87 inches. No estimate of the discharge at Longmont is available.

September 1-4, 1938: Precipitation for the 3 day period totaled 4.54 inches at Longmont. The peak discharge at Lyons was only 1,650 cfs, while near the mouth of the St. Vrain creek it was estimated to be 8,360 cfs. Highways were underwater, some bridges were washed out, and many residents near the creek were forced from their homes.

June 2, 1941: The peak discharge was 10,500 cfs. The creek overflowed its banks as a result of 4 inches on rain in the Longmont area.

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June 4, 1949: All bridges between Longmont and Lyons were impassable when the St. Vrain peaked at 6,700 cfs. A total of 16 bridges were damaged with 2 completely destroyed. Irrigation headworks were extensively damaged. In Longmont 10 homes and 5 businesses were flooded.

August 3, 1951: Lyons received 6.3 inches from a cloudburst and flooding resulted. The peak discharge at Lyons was 3,700 cfs and 6,200 cfs at a point 7 miles east of Longmont. Railroad and highway bridges near Longmont were severely damaged.

May 1957: Three to five inches of rain fell over the entire St. Vrain basin, peaking at 3,060 cfs in Lyons. Irrigation works and bridges between Lyons and Longmont were damaged or destroyed.

May 4-8, 1969: Roads and bridges along streams were damaged, stream banks were eroded, and farmlands were flooded. The peak discharge at Lyons was 2,900 cfs on May 7th and 10,300 cfs on May 8th.

Potential Score: 5

A **flash flood** has never occurred in the City of Boulder, but because of its large population and location at the mouth of the narrow Boulder Canyon, Boulder has the greatest potential for loss of life from a flash flood of any community in Colorado. An estimated 6,000 people live and work in the floodplain of Boulder Creek, which runs through the heart of the city. Since Boulder County has a history of flooding, the potential is there for more floods in the future, so this hazard has been rated as high.

Impact on Life and Property:

If a flash flood were to occur within the City of Boulder, many lives would be lost and damage to property would be extensive. This is due largely to the City's location and the number of people that live and work in the floodplain. Among the buildings that might be damaged are Boulder High School, the City of Boulder administration buildings, businesses along Broadway, Arapahoe, Folsom and 28th Streets, University family housing and homes in the Goss-Grove neighborhood. Downtown, shallow floodwater might extend as far north as the

Daily Camera at Pearl and 11th Streets and as far south as Alfalfa's Market on

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Broadway. Floodwater would lap at the west end of the Downtown Mall, though most of the four-block promenade would probably remain dry.

Broken sewage lines, water supply pollution, broken gas lines, downed power lines and fire can impact communities during and after a flood. Power interruptions will occur and roads will become impassable. People may become stranded in their homes or unable to reach their homes. Disruption occurs in communities until utilities are restored, debris is cleared and property is repaired. Mudslides and landslides are secondary hazards caused from flooding.

Mitigation Options / Strategies

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