

**BOULDER CREEK FLOOD WARNING PLAN  
TABLE OF CONTENTS**

<u>Section</u>	<u>Title</u>	<u>Page</u>
I	INTRODUCTION	I-1
II	THE BOULDER CREEK DRAINAGE BASIN	II-1
	Drainage Basin Descriptions	II-2
	Flood History	II-4
	Hydrology and Flooding Extents	II-7
III	DECISION AIDS	III-1
	General	III-1
	The Decision Making Process	III-2
IV	REQUIRED ELEMENTS OF THE WARNING PLAN	IV-1
	Detection and Evaluation of the Flood Threat	IV-1
	Dissemination of Warnings, Watches and Advisories to the Public	IV-2
	Response of the Public to the Warning	IV-5
V	COMMUNICATIONS DATA	V-1
	Telephone Numbers and Radio Frequencies	V-2
VI	METEOROLOGICAL SUPPORT	VI-1
VII	FLOOD THREAT RECOGNITION AND WARNING PROCESS	VII-1
	Detection and Evaluation of the Flood Threat	VII-1
	Dissemination of the Warning	VII-2
	Step by Step Procedure	VII-2
VIII	PROCEDURES AND GENERAL RESPONSIBILITIES	VIII-1
	National Weather Service and Private Meteorological Service	VIII-1
	Multiple-Agency Coordinating System (MACS)	VIII-3
	Flood Modes	VIII-3
IX	PUBLIC DISSEMINATION	IX-1
	Citizen Alert Messages	IX-2
	Evacuation Message	IX-4
	Emergency Vehicle Message (city area & county east of Boulder)	IX-5
	Emergency Vehicle Message (Boulder County west of Boulder)	IX-6
	Emergency Vehicle Messages (University of Colorado)	IX-7
	Outdoor Warning Siren Messages (University of Colorado)	IX-8
	Outdoor Warning Siren Protocols (University of Colorado)	IX-9
	Public Radio Tape Loop	IX-10
X	MEDIA CONTACTS	X-1
XI	ANNUAL REVISIONS AND PRACTICES	XI-1

**BOULDER CREEK FLOOD WARNING PLAN  
LIST OF FIGURES**

<u>Figures</u>	<u>Title</u>	<u>Page</u>
II-1	Boulder Creek Watershed	II-2
II-2	South Boulder Creek Watershed	II-4
II-3	Elapsed Time from Center of Flood Producing Rainfall to Peak of 100-Year Flood	II-10
II-4	Probably Areas of Loss of Life and Property Damage in Canyon Areas	II-11
III-1	Mountain Canyon Flash Flood Guidance	III-4
III-2	Boulder County Flood Detection Network	III-8
III-3	Typical ALERT Stream Gage Graphics	III-9
III-4	Approximate Flood Hazard Areas (North Boulder)	III-11
III-5	Approximate Flood Hazard Areas (South Boulder)	III-12
V-1	Internal Communications Flow Chart	V-3
VIII-1	City of Boulder Flood Evacuation Sectors for Boulder Creek	VIII-5

**LIST OF TABLES**

<u>Tables</u>	<u>Title</u>	<u>Page</u>
III-1	UDFCD Urban Flash Flood Guidance	III-5
III-2	UDFCD Convective Storm Characteristics	III-5
III-3	Flood Detection Network – Boulder Creek & South Boulder Creek	III-6
III-4	Flood Detection Network – Boulder County Plains	III-6
III-5	Flood Detection Network – Left Hand Canyon & Saint Vrain Creek	III-7
III-6	Flow Travel Times for Various Flood Return Periods	III-10

## I. INTRODUCTION

A flash flood on Boulder Creek could result in a major disaster for the City of Boulder, Boulder County and the University of Colorado. In 1976 the U.S. Army Corps of Engineers estimated that flood damages within the City of Boulder resulting from a 100-year flood (*a flood having a 1% chance of being exceeded every year*) could exceed \$22 million. For a 500-year (*0.2% chance*) flood, they estimated 1976 damages at \$38.5 million. At about the same time, Tom Downing from the University of Colorado estimated that more than 90 people could be killed during a 100-year flood on Boulder Creek. Soon after the COE figures were released, they conducted a re-analysis of the flood hydrology for the Boulder Creek drainage basin. This study resulted in increasing the estimated 100-year discharge at Boulder from 7,400 cfs to 12,000 cfs. The State Geologist has listed Boulder Canyon as one of the most dangerous canyons in Colorado as far as the potential for loss-of-life from flash flooding is concerned. This flood warning plan was prepared with these facts and figures in mind.

The flood warning plan for the Boulder Creek drainage basin is supplemental to local emergency operation plans. As such, it provides a set of operational procedures to be carried out before and during a flood on Boulder Creek and its tributaries (South Boulder Creek, Fourmile Canyon Creek, Wonderland Creek, Goose Creek, Sunshine Canyon Creek, Gregory Creek, Skunk Creek, Bear Canyon Creek and others). The Boulder Creek drainage basin is located in both the City of Boulder and unincorporated Boulder County. Therefore, planning and emergency response must be a multi-jurisdictional effort.

The Boulder Creek Flood Warning Plan is designed primarily to reduce the potential for loss of life resulting from flash floods on Boulder Creek, South Boulder Creek and other major tributary streams. This plan has been prepared by the Urban Drainage and Flood Control District (UDFCD), the City of Boulder, Boulder County and the University of Colorado in cooperation with the National Weather Service. UDFCD acknowledges the valuable contributions by the many individuals that assisted in preparing this plan.

Users of this plan should be aware of the area-wide meteorological support services provided through UDFCD's Flash Flood Prediction Program; the weather and flood forecast information available via the Internet, fax and email communications; and the real-time rainfall and stream level data from the automated flood detection network known as the ALERT System.

Plan holders should read the entire plan carefully to be aware of all of its elements. Users should also understand the following:

*The local governments participating in this flood warning plan believe that the early flood detection system described herein is a key component of the complete flood warning system. They recognize, however, that the possibility of inadvertent error in design or failure of equipment to function may prevent the system from operating perfectly at all times. Therefore, nothing contained herein may be construed as a guarantee of the system or its operation, or create any liability on the part of any party or its directors, officers, employees or agents for any damage that may be alleged to result from either operating or failing to operate the detection system or any of its component parts.*

NOTE: Similar language found in Agreement No. 96-08.07 between UDFCD and Boulder Regional Communications Center

## II. THE BOULDER CREEK DRAINAGE BASIN

This section provides an overview of the watersheds and flood hazards associated with Boulder Creek and South Boulder Creek including descriptions of the drainage basins, historic floods, flood hydrology and flooding extents. Much of the information in this section of the warning plan was excerpted from the following flood studies:

1. Leonard Rice Consulting Water Engineers, July 1977: *Early Flood Warning Planning, Boulder Creek.*
2. Muller Engineering Company, Inc., January 1983: *Boulder Creek Flood Hazard Area Delineation.*
3. Greenhorne & O'Mara, Inc., July 1986: *South Boulder Creek Flood Hazard Area Delineation.*
4. Taggart Engineering Associates, Inc., January 2001: *South Boulder Creek Major Drainageway Planning, Alternative Formulation and Evaluation, Phase A Report.*

The following documents contain additional hydrologic data, flood history discussions, floodplain delineations and other pertinent information:

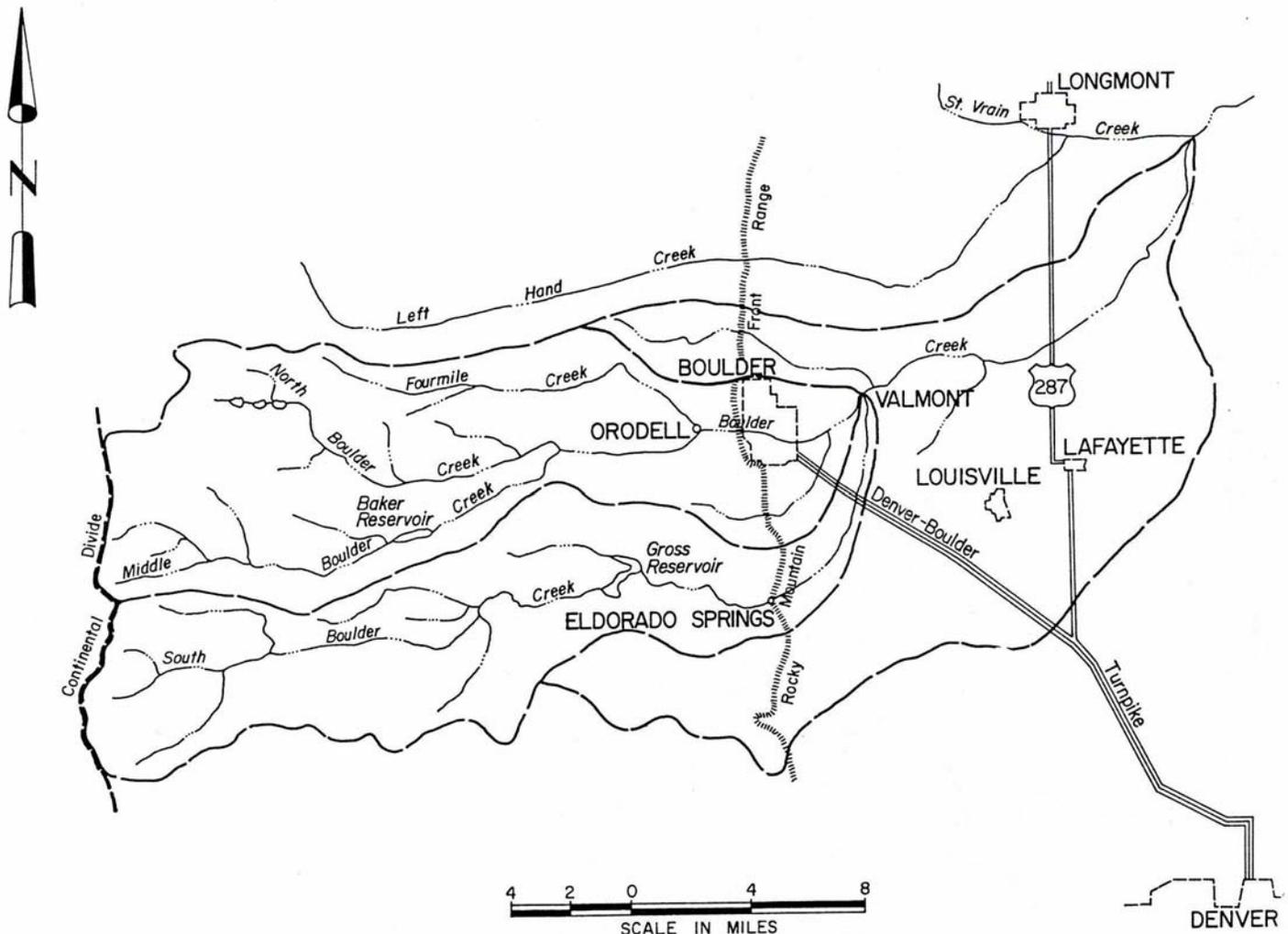
1. Boulder County and CWCB, Floodplain Information Report, Upper Boulder Creek and Fourmile Creek, prepared by Gingery Associates, Inc., December, 1981.
2. FEMA, Flood Insurance Rate Map (FIRM) and Flood Insurance Study for the City of Boulder, Revised May 3, 1990.
3. FEMA, Flood Insurance Rate Map (FIRM) and Flood Insurance Study for the Boulder County, Revised July 3, 1990.
4. UDFCD, Flood Hazard Area Delineation, Lower Boulder Creek, prepared by Muller Engineering Company, March, 1983.
5. UDFCD, Flood Hazard Area Delineation, Boulder and Adjacent County Drainageways, prepared by Greenhorne & O'Mara, Inc., May, 1987.

## DRAINAGE BASIN DESCRIPTIONS

### BOULDER CREEK

Originating at the Continental Divide, the Boulder Creek watershed encompasses 130 square miles above the City of Boulder and drains a total of 440 square miles at its confluence with Saint Vrain Creek in Weld County downstream of Longmont. The basin is oriented in a generally west to east direction and includes the major tributaries of North Boulder Creek (45 square miles), Middle Boulder Creek (44 square miles) and Fourmile Creek (24 square miles) west of Boulder. Major tributary streams within the city limits of Boulder include Sunshine Canyon Creek, Gregory Creek, Bear Canyon Creek, Goose Creek, Wonderland Creek and South Boulder Creek (132 square miles). East of Boulder major tributaries include Fourmile Canyon Creek, Dry Creek, Bullhead Gulch and Coal Creek. Figure II-1 shows the Boulder Creek drainage basin boundary.

**Figure II-1  
Boulder Creek Watershed**



Within the upper drainage basin there is scattered development along the streams. Nederland, the largest mountain town west of Boulder, is located on Middle Boulder Creek immediately above Barker Reservoir. Further upstream along Middle Boulder Creek is the town of Eldora and the Lake Eldora Ski Area. The communities of Sunnyside and Silver Spruce are located on Boulder Creek downstream of Barker Reservoir and the communities of Sunset, Wallstreet and Crisman are located along Fourmile Creek. The settlement called Orodell is located at the confluence of Fourmile Creek with Boulder Creek. Transportation routes within the basin include State Highway 119, which follows Middle Boulder and Boulder Creeks between Nederland and Boulder, State Highway 72 which runs north/south through Nederland, and County Road 118 which extends along Fourmile Creek.

Numerous small lakes fed by melting snows occur in the higher portions of the basin. Barker Reservoir, owned by the City of Boulder, stores water for electric power generation at a plant further downstream and for municipal water for the City of Boulder. A number of glaciers exist at the Continental Divide.

The Boulder Creek basin ranges in elevation from 13,409 feet above mean sea level at Navajo Peak to approximately 5,385 feet at Boulder. The basin is predominantly mountains and foothills, characterized by steep streams with rock and gravel beds. Fifteen percent of the basin lies above 11,000 feet and 46% above 9,000 feet. Main channel slopes average 2½% - 5% for Boulder Creek, 4% - 8% for North Boulder Creek, 2½% - 8½% for Middle Boulder Creek and 4% - 10% for Fourmile Creek.

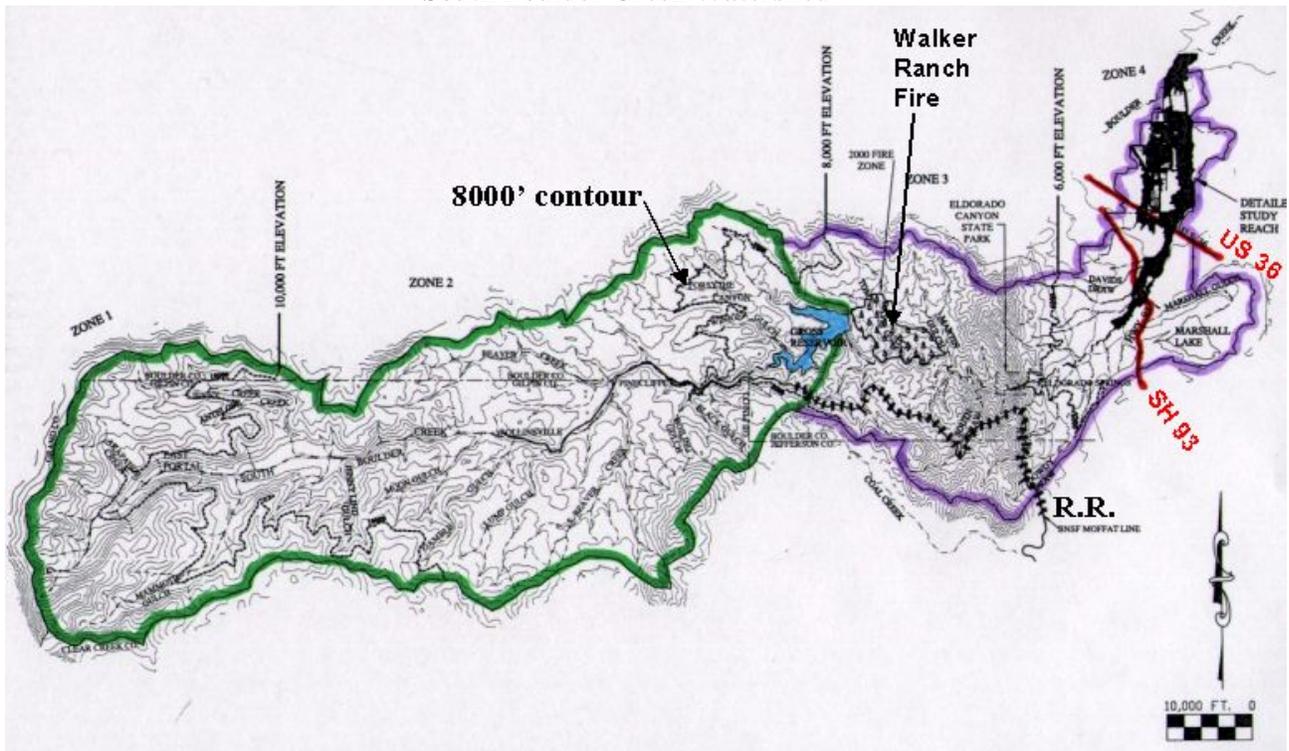
Because of the steep slopes and generally elongated basins, Boulder Creek and its principal tributaries are susceptible to flash floods caused by high intensity, short duration thunderstorms which generally occur from May through September. Rainfall rates from such storms can exceed the infiltration capacity of the surface soil, producing large runoff in short periods of time. When high runoff converges on a stream, it generally exceeds the carrying capacity of the normal channel, resulting in flooding of the adjacent floodplain.

## SOUTH BOULDER CREEK

South Boulder Creek, which drains an area of 132 square miles, is a right-bank tributary of Boulder Creek. From its headwaters at the Continental Divide, South Boulder Creek flows in an easterly direction through relatively steep, narrow mountain canyons for nearly 22 miles whereupon it emerges onto the high plains at Eldorado Springs, Colorado. From Eldorado Springs, the creek flows northeasterly through a moderately wide valley over a distance of about 9.7 miles to its confluence with Boulder Creek.

Gross Reservoir is a major water storage facility located on South Boulder Creek approximately 3.5 miles upstream of Eldorado Springs. The reservoir was constructed in 1955 and has a storage capacity of 43,000 acre-feet. The reservoir is operated by the Denver Water Department and provides conservation storage for municipal use. A U.S. Geological Survey stream gaging station is situated approximately 6.7 miles downstream of the reservoir. The drainage area at the gaging station is about 109 square miles. Figure II-2 shows the South Boulder Creek drainage basin boundary.

**Figure II-2  
South Boulder Creek Watershed**



## FLOOD HISTORY

### BOULDER CREEK

Since 1864, the City of Boulder has experienced five major flood events on Boulder Creek, ranging in estimated discharge from 2,500 cubic feet per second (cfs) to 13,000 cfs, resulting in light to severe property damage. All floods for which dates are known occurred in either May or June. The flood of June 1894 was the flood of record at Boulder and had an estimated peak discharge of 13,000 cfs. The estimated frequencies of these five major events range between 10- and 100-years as determined from discharge probability relationships developed by the U.S. Army Corps of Engineers (USACOE). The following is a brief description of what is known of each of these five major flood events:

**1876, May 21-23.** Little is known about the 1876 flood. The Greeley Tribune reported: "*The Boulder, swollen into a great river, in many places fully a mile and a half wide, inundated the land and farms and meadows and swept away fences and bridges.*"

**1894, May 29 - June 2.** Heavy rains fell over the mountains extending from the Colorado-Wyoming border southward into the Republican and Arkansas River basins. Rainfall over the Boulder and South Boulder Creek basins was particularly heavy. Rainfall records for a 96-hour period ending at 3 AM on June 2 indicate that the mountain drainage area received from 4.5 to 6 inches of precipitation. Rainfall

amounts over the high plains gradually decreased from west to east and varied from 5 inches at Boulder to approximately 2.5 inches at the mouth of Boulder Creek. The mountain rainfall combined with the snowmelt runoff produced the greatest flood known at Boulder, inundating the valley during the night of **30 May, 1894**. Buildings, bridges, roads, and railroads were washed away. Computations made 18 years later produced estimates of the peak discharge on Boulder Creek in Boulder that ranged from 9,000 cubic feet per second to 13,600 cubic feet per second.

In Boulder, floodwaters covered the entire area between Water Street (now called Canyon Boulevard) and University Hill to depths as great as eight feet. Every bridge in Boulder and a number of residences were swept away. Other types of damage included: commercial establishments, public utilities, railroad property, roads and streets, and irrigation structures. Many people were trapped in their homes and had to be rescued. Only one life was lost; this was due, in part, to the flood's slow onset.



Location: Looking down Water Street from 12<sup>th</sup> - June 12, 1894  
Photo Credit: Denver Public Library

In the valley downstream from Boulder, the floodplain was reported to have inundated an average width of approximately one-mile for several days. Agricultural damages included: loss of livestock, crops, pastures, fences, roads, and deposition of sand and silt on floodplain lands. In addition, considerable crop losses were suffered on lands outside the floodplain which were dependent on irrigation diversions from Boulder Creek.

**1914, June 1-2.** Heavy rains in the mountains that hastened the melting of a deep snowpack, estimated at 50 percent above normal, produced what newspaper accounts called "the worst flood on Boulder Creek following the 1894 flood." Boulder's water supply system and the Boulder County farm were severely damaged. Numerous roads and bridges in the mountains were also damaged or destroyed.

**1921, June 2-7.** Little is known of this flood except that it produced the highest peak discharge ever recorded at the U.S. Geological Survey Orodell gage, located about three miles upstream from Boulder and one mile upstream from Fourmile Creek. The Orodell gage has been continuously operated since 1916. A peak discharge of 2,500 cfs was recorded on June 6. Rainfall totaled 3.36 inches at Boulder through the six-day period.

**1969, May 4-8.** The 1969 flood resulted from a long duration storm. Runoff resulted from a combination of rainfall and snowmelt which was reported heaviest in the mountains. In the Boulder and South Boulder Creek basins, the rainfall continued at a moderate rate for nearly four days. Total precipitation for the storm amounted to 7.60 inches at Boulder and 9.34 inches at the Boulder Hydroelectric Plant located about three miles up the canyon from Boulder. Peak flooding at Boulder occurred on **May 7**.

Estimates of discharge at the Orodell gage indicate a peak of 1,220 cfs. The discharge near Broadway in Boulder was estimated to be between 2,500 and 3,000 cfs. Instances of erosion damage to bridges and streets, trees, and agricultural lands were recorded. Large areas were flooded downstream from Boulder.

## SOUTH BOULDER CREEK

The USGS has maintained a stream gaging station on South Boulder Creek near Eldorado Springs since 1888, however, there have been lapses in its operation. The gage was not in operation from October 1892 to May 1895, and from September 1901 to August 1904. A major flood did occur on South Boulder Creek on **May 29, 1894** when the gage not operating. For a description of the 1894 flood, see the Boulder Creek flood history section above.

The following briefly describes the two largest recorded floods on South Boulder Creek. Due to the relatively undeveloped nature of the South Boulder Creek basin, information and observations related to major flood events is somewhat lacking in comparison to the adjacent, more heavily developed Boulder Creek floodplain.

**1938, August 31-September 4.** This storm produced general rains over all of eastern Colorado. The largest amounts of precipitation occurred in the mountains where more than 6 inches was reported west of Eldorado Springs. Eldorado Springs recorded 4.42 inches of rainfall. Approximately 80 percent of the total precipitation falling in the South Boulder Creek basin fell in the late afternoon and evening of September 2. The resulting flood, with a peak discharge of 7,390 cfs passed through Eldorado Springs at approximately 10 PM on **September 2**. The resort community of Eldorado Springs suffered heavy damage and numerous buildings were destroyed when floodwaters eroded their foundations. The valley from Eldorado Springs to Boulder Creek and down Boulder Creek to St. Vrain Creek was in shambles. This flood is the highest recorded flood on South Boulder Creek.



Location: Eldorado Springs dancehall – Sept. 4, 1938  
Photo Credit: Denver Public Library

**1969, May 4-8.** The 1969 flood resulted from a long duration general storm. Runoff resulted from a combination of rainfall and snowmelt, with the heaviest precipitation reported in the mountains. Rainfall continued at a moderate rate for nearly four days. Total precipitation for the storm amounted to 7.60 inches at Boulder and 9.34 inches at the Boulder Hydroelectric Plant on Boulder Creek located about 3 miles up the canyon from Boulder. Precipitation amounts totaled 8.11 inches at Eldorado Springs and 10.05 inches at Gross



Looking west along South Boulder Road

Reservoir on South Boulder Creek. Peak flooding occurred on **May 7** at Boulder and Eldorado Springs. A peak discharge of 1,690 cfs occurred on South Boulder Creek at Eldorado Springs. Large portions of the floodplain were inundated below the confluence of South Boulder and Boulder Creeks.

Few people who presently live in the South Boulder Creek floodplain have experienced the major historic floods that have spilled over the creek's low banks flooding an area up to a mile-wide. The last major flood in the South Boulder Creek watershed occurred in 1969. Flooding occurred several times in the 1950's. The flood of record occurred in 1938. The following table lists historic flood events with peak discharges exceeding 1000 cfs.

**Historic Floods on South Boulder Creek at  
Eldorado Springs (Drainage Area 109 sq.mi.)**

<b>DATE</b>	<b>CFS</b>	<b>DATE</b>	<b>CFS</b>
1894 May 29	unknown	1938 September 2	7,390
1895 June 3	1,130	1947 June 21	1,290
1900 May 9	1,100	1949 June 6	1,430
1909 June 20	1,340	1951 June 18	2,370
1914 May 24	1,240	1952 June 4	1,080
1921 June 6	1,440	1969 May 7	1,690

## **HYDROLOGY AND FLOODING EXTENTS**

### **BOULDER CREEK**

The USACOE conducted a hydrologic study of the Boulder Creek basin in connection with a flood management study for the City of Boulder. The USACOE analysis included generation of the 10-, 25-, 50-, 100- and 500-year frequency floods over the entire basin. The 100-year design storm rainfall totaled 2.8 inches over a 6-hour period with about 1.2 inches falling in the first half of the fourth hour. While flash flood rainfall can have greater intensities than the maximum of 2.6 inches per hour used in the USACOE model, it was felt that the model could be used as the basis for estimating lead times. The relation between rainfall and runoff for the five frequency events was obtained from the Corps for 11 hydrologic design points along the stream channels.

Analysis of the data indicates which portions of the Boulder Creek basin are responsible for generating floods at specific locations, and the amount of warning time available after flood producing rainfall occurs. Figure II-3 shows the elapsed time from the midpoint of flood producing rainfall to the peak of the 100-year flood for the 11 design points within the basin. The elapsed time between rainfall and flood peak is longer for less intense storms and shorter for more intense storms. From Figure II-3 it can be seen that Barker Reservoir, located on Middle Boulder Creek, delays the flood peak.

During a regional rainfall event, two flood peaks can be expected for Middle Boulder Creek above its confluence with North Boulder Creek. The first peak is smaller and comes from the tributary area below Barker Reservoir. Below the confluence of North Boulder and Middle Boulder Creeks, the timing and magnitude of the flood peak is due to the contribution of North Boulder Creek. Boulder Creek between North Boulder Creek and Orodell has several tributary basins that contribute significant amounts of floodwater before the peak from the upper basin arrives. This causes Boulder Creek above Orodell to peak before it does below the confluence of North and Middle Boulder Creeks. A similar situation exists at the confluence of Boulder Creek and Fourmile Creek. Fourmile Creek is an elongated basin that contributes a significant amount of floodwater ahead of the peak on Boulder Creek above Orodell. In other words, Fourmile Creek peaks earlier than Boulder Creek above Fourmile Creek.

Figure II-4 shows the most probable mountain canyon areas for loss of life and property damage along Fourmile Creek and Boulder Creek.

## SOUTH BOULDER CREEK

The basin characteristics for South Boulder Creek are similar to Boulder Creek and design flood hydrology was also developed by USACOE (see above discussion for Boulder Creek). During a major flood on South Boulder Creek, floodwaters will split between two major flow paths and a number of irrigation canals and small drainage ditches. The South Boulder Creek main channel, located on the east or right side of the valley looking downstream, will carry moderate flows. At a number of locations floodwaters will spill to the west side of the valley into a second main flow path referred to as the "West Valley Overflow" or WVO. Some of the WVO floodwaters eventually make it back to the South Boulder Creek channel. However, in larger floods, spillage to Bear Canyon Creek and Boulder Creek would occur. In 1969 floodwaters followed many of the WVO routes.

Since 1954, Gross Reservoir has attenuated floods originating upstream of the dam. A significant volume of mountain runoff was trapped in Gross during the 1969 flood, which appears to have reduced downstream flooding. It should be noted that Gross Reservoir's primary function is water supply, not flood control. The reservoir is owned, operated and maintained by the Denver Water Department. Consequently, there is no guarantee that this inadvertent floodwater storage below the spillway will be available to attenuate future floods. The railroad line to the Moffat Tunnel also provides some inadvertent flood storage.

Access in and out of Boulder would effectively be cut off during a large flood on South Boulder Creek. This would exacerbate problems and impact the use and movement of emergency vehicles and equipment. The following roads are at risk of being overtopped and possibly washed out:

- State Highway 170 (Eldorado Springs Dr.)
- U.S. Highway 36
- Baseline Road
- McSorley Lane
- 55th Street
- State Highway 93 (South Broadway)
- Foothills Parkway
- Gapter Road
- Old Tale Road
- Many local streets between Foothills Parkway and South Boulder Creek
- Marshall Road
- South Boulder Road
- Dimmit Avenue
- Arapahoe Road

In 1993 it was estimated that 1050 homes, 107 apartment buildings, 132 businesses, and 87 small structures are located within the floodplain of South Boulder Creek. Additional structures have been built since then, increasing the estimate to roughly 1400 structures. Hundreds more homes located above estimated flood levels would be isolated by surrounding floodwaters in the area between Foothills Parkway and South Boulder Creek.

#### FLOODING EXTENTS

Floodplain mapping for Boulder Creek, South Boulder Creek and other tributary streams may be obtained from a number of Internet sources as well as from the studies listed at the beginning of this section. The aerial photos below show approximate 100-year floodplains for the City of Boulder and surrounding areas. The maps were created from a Google Earth application developed for UDFCD by Leonard Rice Engineers... <http://www.lrcwe-data.com/UDFCD.kml>



More information on Boulder's flood hazards can be obtained from <http://boulderfloods.org>.

Figure II-3

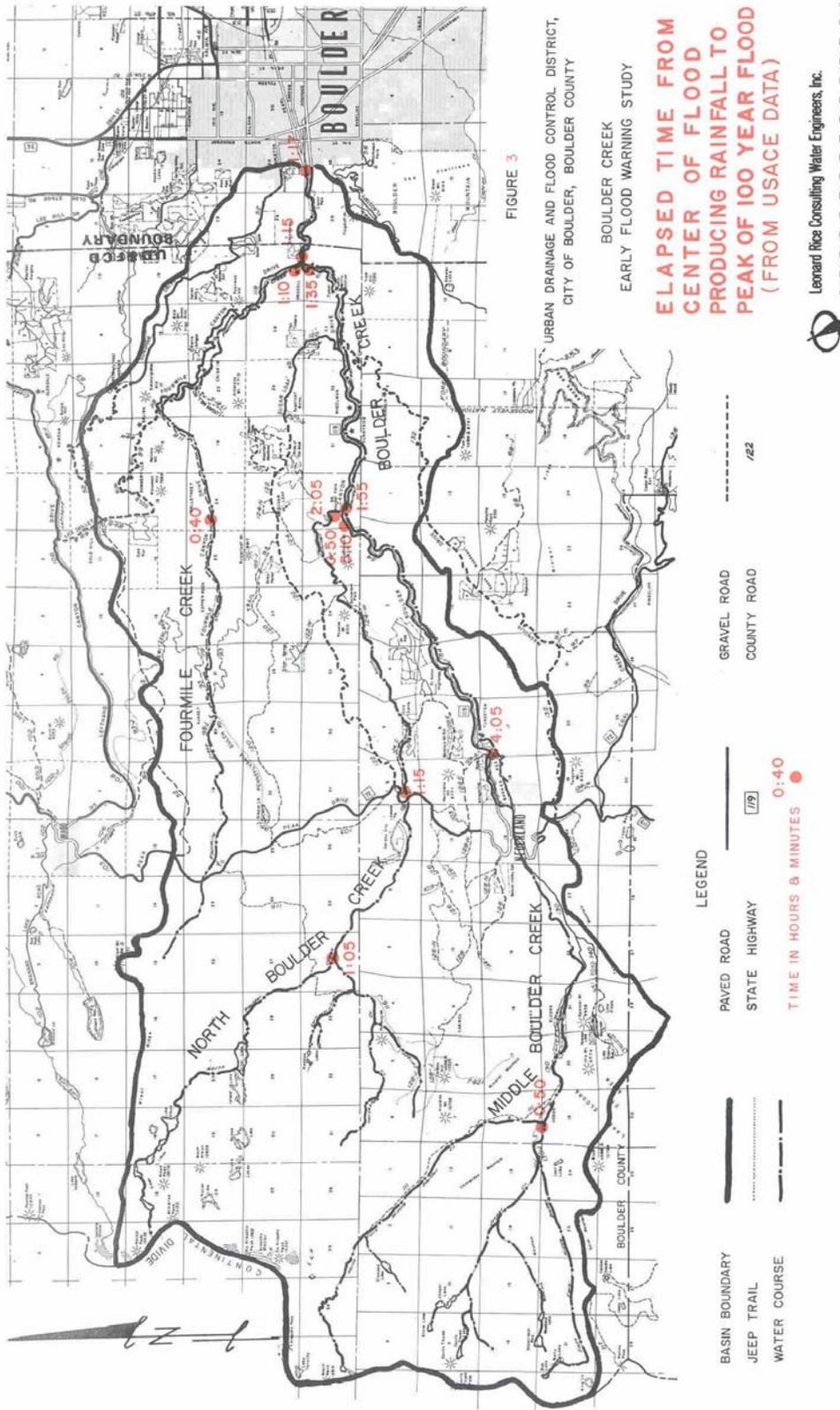
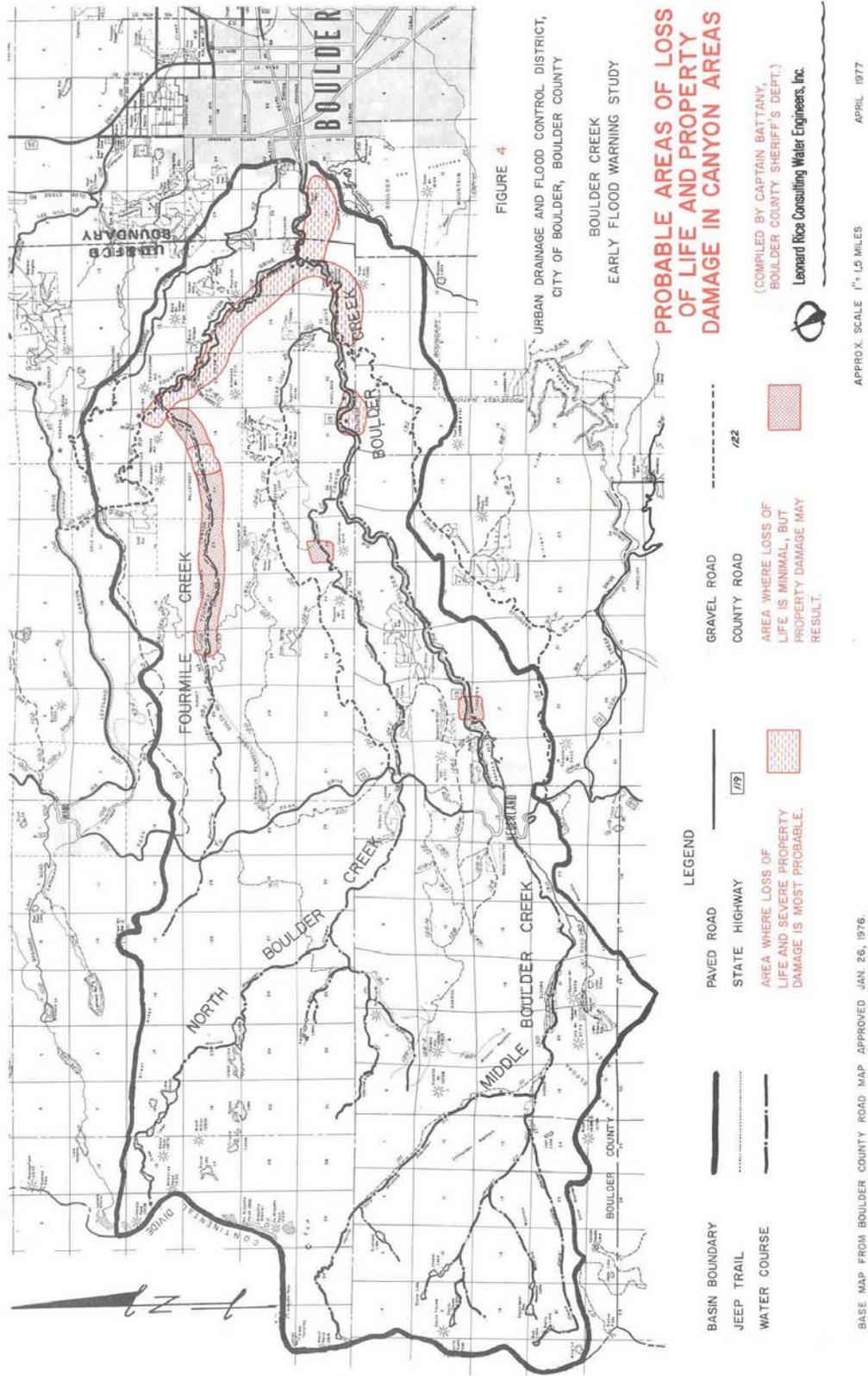


Figure II-4



### III. DECISION AIDS

#### GENERAL

A private meteorological service (PMS) retained by the Urban Drainage and Flood Control District (UDFCD) will use decision aids for issuing appropriate messages in accordance with standard operating procedures and the supplemental information contained in this flood warning plan. Site-specific decision aids and flash flood guidance for urban areas and mountain canyons are provided to help anticipate flood conditions from forecast and measured rainfall. The decision aids in this section will be updated as experience is gained and more data becomes available.

An automated flood detection network known as the ALERT System has been installed for the Boulder Creek drainage basin and other watersheds in Boulder County. It consists of self-reporting rain gages, stream gages and weather stations that relay data using battery-powered VHF radios. The Boulder County gages are part of a much larger network operated by UDFCD. ALERT base stations located at UDFCD's main office, the UDFCD Flood Prediction Center (FPC), and the Boulder Public Safety Building (PSB) collect and display data from the gaging network in real-time. The base stations also host web services that allow users to view information over the Internet and via city and county local area networks (PSB base only). Rainfall and stream level alarms will alert users of threatening conditions. Alarm notifications can be emailed automatically to warning plan participants. Data from the gaging network is used to update flood peak forecasts, estimate flow arrival times and predict flood impacts at specific locations.

PMS is responsible for monitoring the FPC base station, evaluating the real-time data and updating forecasts with use of available decision aids. Simplified charts, tables, computer graphics and hydrologic models are the principle decision aids for forecasting floods. Sections IV through VIII contain additional information concerning PMS operations and responsibilities.

City of Boulder and Boulder County personnel have access to the current PMS forecast (pager, email, fax, or Internet...<http://f2p2.udfcd.org>). ALERT gage data may be accessed from Internet websites maintained by UDFCD (<http://alert.udfcd.org> and <http://alert2.udfcd.org>), and from the PSB base station via both city and county LAN connections. Technical personnel should make their own assessments of the flood threat by using the gage data, the PMS forecasts and any observations obtained from field personnel (police, Sheriff, fire, public works, etc.) or other reliable sources. Close coordination with emergency management and other public safety agencies should be maintained throughout this process.

The following decision aids are contained in this section of the warning plan:

1. **Figure III-1, Mountain Canyon Flash Flood Guidance.** This graph and corresponding map provide very basic guidance to help estimate an expected flood flow frequency on Boulder Creek and other mountain streams using either forecast or observed rainfall. The map shows drainage

- basin boundaries and ALERT gaging station locations. The red elliptical shape on the map covers an area of 10 square miles to illustrate how average storm rainfall for that area may be estimated.
2. **Table III-1, Urban Flash Flood Guidance.** This table provides very basic rule-of-thumb guidance to associate forecast or measured rainfall amounts with the type of flooding that can be expected from heavy rainstorms that occur over urban areas.
  3. **Table III-2, Convective Storm Characteristics.** This table is used to associate forecast or measured rainfall amounts with a return period or annual probability of occurrence. Guidance is provided on how to predict flood magnitude/frequency from rainfall amounts.
  4. **Tables III-3 to III-5, Flood Detection Networks for Boulder Creek/South Boulder Creek, Boulder County Plains, and Left Hand Canyon & Saint Vrain Creek.** These tables provide basic information about the ALERT gaging stations located in the respective drainage basins. It is important to understand the location of the gages in relation to the basin boundaries and associated flood hazards (see Figure III-2).
  5. **Figure III-2, Boulder County Flood Detection Network.** This figure shows the approximate location of the ALERT gaging stations that comprise the Boulder County FDN.
  6. **Figure III-3, Typical ALERT Stream Gage Graphics.** Real-time displays showing current water levels, flow rates, and basin rainfall have been developed. These displays update automatically as data is received and provide information regarding local problem areas, historic floods, flood frequency data, alarm levels, elevation data and site details.
  7. **Table III-6, Estimated Flow Travel Times for Various Flood Return Periods.** This table can be used to predict flooding at points downstream from stream gages (see Item 6 above).
  8. **Figure III-4, Approximate Flood Hazard Areas—North Boulder.** This map shows the approximate boundary of the regulatory (i.e. 100-year) floodplains for Boulder Creek and other tributary streams that impact the northern portion of the City of Boulder.
  9. **Figure III-5, Approximate Flood Hazard Areas—South Boulder.** This map shows the approximate boundary of the regulatory (i.e. 100-year) floodplains for Boulder Creek and other tributary streams that impact the southern portion of the City of Boulder. Additional Internet-based floodplain information can be obtained from a number of websites. The UDFCD website [http://www.udfcd.org/svg/svg\\_mapping.htm](http://www.udfcd.org/svg/svg_mapping.htm) was used to develop Figures III-4 and III-5.

## THE DECISION MAKING PROCESS

The earliest indication of a potential problem will likely be the forecast from PMS or NWS. When the threat of heavy rainfall exists, PMS will provide a Quantitative Precipitation Forecast (QPF) that estimates probabilities for various precipitation amounts and identifies where the greater amounts are most likely. If the Boulder Creek or South Boulder Creek watersheds are included in the heavy precipitation forecast area, check Figure III-1 and Tables III-1 and III-2 for an indication of the event frequency and the type of problems to expect. If no problems are anticipated based on this review, a normal level of vigilance should be maintained. However, if the decision aids indicate that a flood potential exists, a higher level of awareness should be maintained.

Once rainfall has begun and the gages are reporting rainfall amounts, a further analysis of the flood potential can be made. By determining the heavier rainfall amounts (both measured and projected), estimating the size of the basin area affected and calculating the maximum average 1-hour/10-square mile basin rainfall (Figure III-1); updated projections of the flood threat can be made. Periodic projections should be made until the storm has passed and problems have either occurred or the threat no longer exists. Figures III-4 and III-5 show the approximately flood hazard areas for a 100-year magnitude event and can be used to help direct field operations (road closures, evacuations, etc.).

Real-time hydrologic models have been developed for Boulder Creek. Output from one or more of these models may assist with predicting flood magnitudes and timing. Hydrologists may use these models along with the decision aids in this section to further evaluate the flood threat.

The final confirmation that the drainage basin is indeed responding to significant rainfall is the rising stage measured by the ALERT stream gages and field reports from police, fire, public works personnel or other reliable sources. Although it is tempting to wait for this final confirmation, doing so will severely limit the time available to warn floodplain occupants and dispatch emergency personnel to critical areas. Use Table III-6 to estimate flood travel times from each ALERT stream gage at downstream locations.

Once the decision has been made that a significant flood threat exists, it is imperative that the warning and response elements of this plan be implemented.



**Table III-1**  
**URBAN DRAINAGE AND FLOOD CONTROL DISTRICT**  
**URBAN FLASH FLOOD GUIDANCE**

<b>FORECAST RAINFALL</b>	<b>FLOOD POTENTIAL</b>	<b>RECOMMENDED ACTIONS</b>
Total Amt less than 1.0"	Streets, low-lying areas, intersections	Prepare for routine nuisance
Total Amt = 1.0 to 2.0"	All of the above plus small streams, bankfull	Prepare for flooding of frequent problem areas
Total Amt = 2.0 to 3.0"	All of the above plus floodplain inundation	Prepare for street closures
Total Amt more than 3.0"	Major overbank flooding expected	Prepare for floodplain evacuations
Note: Rainfall amounts and guidance information apply to short duration storms (<= 1-hour)	Note: refer to basin flood warning plans for site specific data	Note: use judgement on when to warn public, maintain contact with meteorologist

**Table III-2**  
**URBAN DRAINAGE AND FLOOD CONTROL DISTRICT**  
**CONVECTIVE STORM CHARACTERISTICS**

(All depths in inches)

<b>Rainfall Frequency / Probability</b>	<b>10-minute Rainfall Depth</b>	<b>30-minute Rainfall Depth</b>	<b>1-hour Rainfall Depth</b>	<b>2-hour Rainfall Depth</b>
<b>2-year / 50%</b>	0.4	0.8	1.0	1.2
<b>5-year / 20%</b>	0.5	1.0	1.4	1.6
<b>10-year / 10%</b>	0.6	1.2	1.6	1.9
<b>25-year / 4%</b>	0.7	1.4	1.9	2.2
<b>50-year / 2%</b>	0.8	1.6	2.2	2.6
<b>100-year / 1%</b>	1.0	1.9	2.6	3.0

NOTES:

- 1) For "rainfall frequency" to equal "flood frequency," the coverage of rainfall must be over the entire upstream basin.
- 2) Tables III-1 and III-2 were developed to provide generalized guidance for estimating flood conditions in urban areas and for small streams draining less than 10 square miles. Site-specific guidance should be used where appropriate.

**Table III-3**  
**FLOOD DETECTION NETWORK**  
**BOULDER CREEK & SOUTH BOULDER CREEK**

<u>Station ID</u>	<u>Station Name</u>	<u>Gage Type</u>	<u>Install Date</u>	<u>Elevation</u>	<u>Location (Lat. / Long.)</u>
<b>SOUTH BOULDER CREEK</b>					
4010	Crescent	RAIN	1979-80	7760	39:55:27 N 105:21:50 W
4020	Rio Grande	RAIN	1979-80	7330	39:55:21 N 105:19:33 W
4030	Red Garden	RAIN	1979-80	6360	39:55:55 N 105:17:32 W
4040	Martin Gulch	RAIN	1979-80	6520	39:56:34 N 105:18:53 W
4050	Walker Ranch	RAIN	1979-80	7320	39:57:08 N 105:20:21 W
4060	Lakeshore	RAIN	1979-80	7700	39:57:40 N 105:22:13 W
4070	Bear Peak	RAIN	1979-80	6920	39:58:16 N 105:18:29 W
4080	Twin Sisters	RAIN	1979-80	8120	39:59:03 N 105:24:43 W
4530	Winiger Ridge	RAIN	1984-85	8130	39:56:53 N 105:25:27 W
4373	Gross Reservoir	STREAM	1997/06/04	6800	39:56:18 N 105:20:51 W
4383	Eldorado Springs	STREAM	1997/04/17	6060	39:55:51 N 105:17:44 W
4810	Shanahan Ridge	RAIN	2002/09/19	5840	39:57:41 N 105:15:55 W
4820	Doudy Draw	RAIN	2002/09/20	5740	39:55:56 N 105:15:25 W
4830 [+3]	SBC at San Souci	RAIN & STREAM	2002/09/24	5470	39:57:28 N 105:14:09 W
4840 [+3]	SBC at S. Boulder Ditch	RAIN & STREAM	2002/10/09	5400	39:58:21 N 105:13:23 W
<b>BOULDER CREEK &amp; FOURMILE CREEK</b>					
4090	Magnolia	RAIN	1978-79	7320	39:59:26 N 105:22:13 W
4100	Filter Plant	RAIN	1978-79	6360	40:00:40 N 105:20:03 W
4110	Betasso	RAIN	1978-79	6480	40:01:26 N 105:20:22 W
4130	Swiss Peaks	RAIN	1978-79	8600	40:01:22 N 105:25:42 W
4140	Logan Mill	RAIN	1978-79	7200	40:02:18 N 105:22:41 W
4150	Gold Hill	RAIN	1978-79	8120	40:03:19 N 105:24:28 W
4240	Sunset	RAIN	1981-82	8680	40:02:56 N 105:28:17 W
4360	Justice Center	RAIN	1981-82	5400	40:00:52 N 105:17:17 W
4393	Boulder Falls	STREAM	1997/04/03	6820	40:00:12 N 105:24:01 W
4403	Orodell	STREAM	1997/04/03	5825	40:00:18 N 105:19:51 W
4413	Fourmile	STREAM	1997/04/17	6520	40:03:00 N 105:22:08 W
4423	Bridge	STREAM	1997/04/03	5700	40:00:54 N 105:19:11 W
4550	Jail	RAIN	1997/06/02	5290	40:02:04 N 105:13:43 W
4570	St. Antons	RAIN	1984-85	8350	39:59:01 N 105:27:46 W
4583	Broadway	STREAM	2006/02/07	5348	40:00:54 N 105:16:43 W
4593	Green Ditch	STREAM	2006/05/07	5154	40:02:12 N 105:12:13 W
4710	Ward C-1	WEATHER	1997/07/22	9700	40:02:11 N 105:32:35 W
4730	Sugarloaf	WEATHER	1997/06/23	7860	40:01:05 N 105:24:13 W
4750	Louisville Lake	WEATHER	1998/07/26	5580	39:59:32 N 105:09:12 W
<b>FOURMILE CANYON CREEK</b>					
4160	Sunshine	RAIN	1978-79	7560	40:03:47 N 105:22:19 W
4170	Pine Brook	RAIN	1981-82	6920	40:03:09 N 105:19:20 W

**Table III-4**  
**BOULDER COUNTY PLAINS**

<u>Station ID</u>	<u>Station Name</u>	<u>Gage Type</u>	<u>Install Date</u>	<u>Elevation</u>	<u>Location (Lat. / Long.)</u>
<b>PLAINS STATIONS</b>					
1100 [+3]	Louisville Rec Center	RAIN & STREAM	1988/05/06	5464	39:58:23 N 105:09:22 W
1110 [+3]	Gunbarrel	RAIN	1991/12/01	5225	40:04:27 N 105:10:40 W
1540	Marshall Test Site	RAIN	2006/09/27	5717	39:56:57 N 105:11:43 W

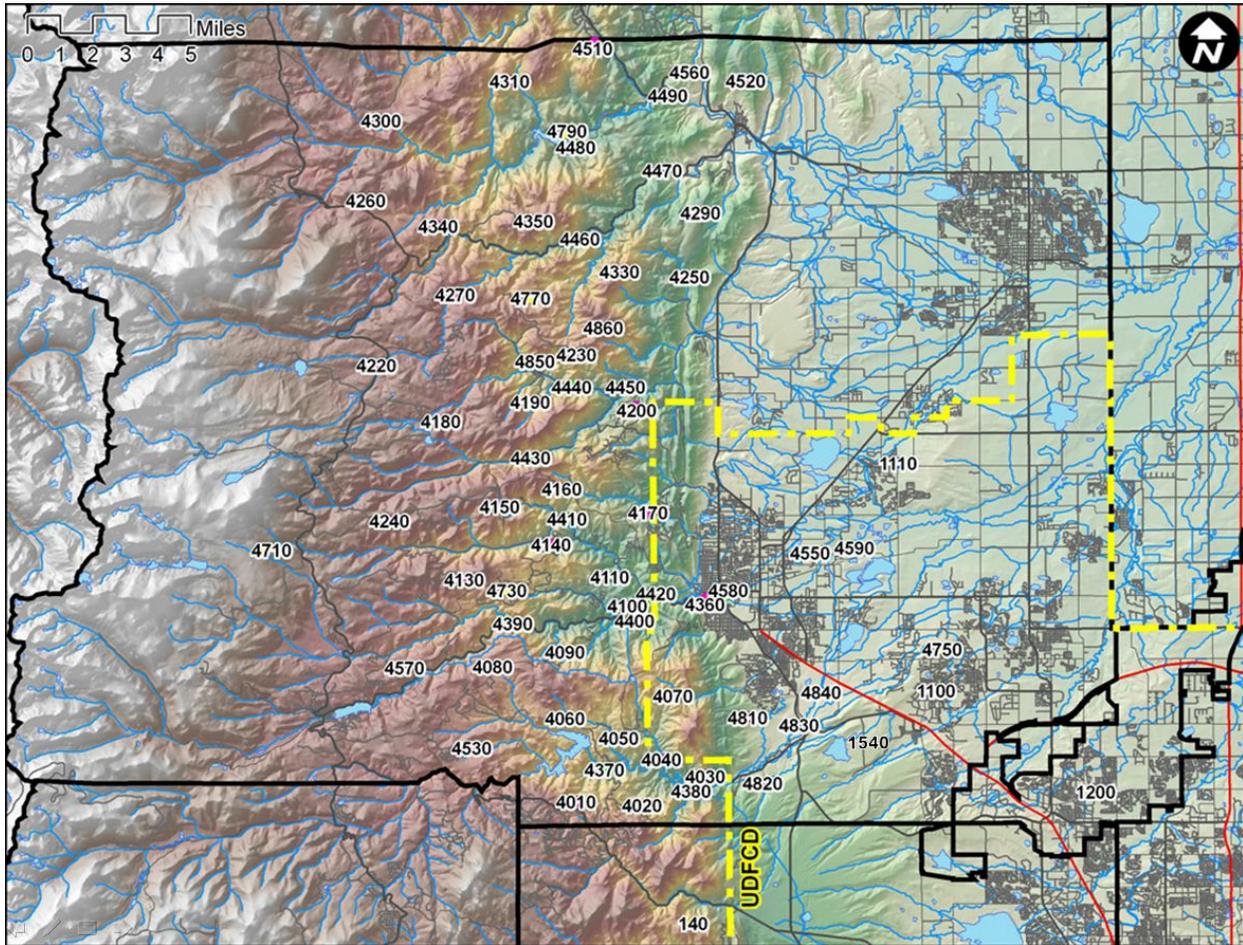
Weather Station IDs: +0 Rain, +1 Relative Humidity, +2 Air Temperature, +4 Barometric Pressure,  
-6 Peak Wind Gust, -3 Average Wind Speed & Wind Direction

**Table III-5**  
**FLOOD DETECTION NETWORK**  
**LEFT HAND CANYON & SAINT VRAIN CREEK**

<u>Station ID</u>	<u>Station Name</u>	<u>Gage Type</u>	<u>Install Date</u>	<u>Elevation</u>	<u>Location (Lat. / Long.)</u>
<b>LEFT HAND CREEK &amp; JAMES CREEK</b>					
4180	Gold Lake	RAIN	1981-82	8560	40:05:35 N 105:26:30 W
4190	Slaughterhouse	RAIN	1981-82	7400	40:06:06 N 105:23:01 W
4200	Lazy Acres	RAIN	1981-82	7020	40:05:58 N 105:19:43 W
4230	Golden Age	RAIN	1981-82	8160	40:07:22 N 105:21:58 W
4250	Geer Canyon	RAIN	1981-82	6080	40:09:26 N 105:17:52 W
4330	Indian Ruins	RAIN	1981-82	7790	40:09:34 N 105:20:18 W
4433	Rowena	STREAM	1997/05/06	7170	40:04:37 N 105:23:24 W
4443	James Creek	STREAM	1997/05/05	6680	40:06:30 N 105:21:58 W
4453	Lower Left Hand	STREAM	1997/04/30	6230	40:06:30 N 105:20:06 W
4850	Porphyry Mountain	RAIN	2004/07/07	7347	40:07:11 N 105:23:16 W
4860	Fairview Peak	RAIN	2004/08/11	8260	40:08:04 N 105:20:54 W
<b>SOUTH ST. VRAIN CREEK</b>					
4220	Fling's	RAIN	1981-82	8590	40:07:05 N 105:28:44 W
4270	Cannon Mountain	RAIN	1981-82	8120	40:08:58 N 105:26:00 W
4290	Red Hill	RAIN	1981-82	6590	40:11:08 N 105:17:29 W
4463	SSV at Berry Ridge	STREAM	1997/04/21	6495	40:10:27 N 105:21:40 W
4470 [+3]	Little Narrows	RAIN & STREAM	1997/04/21	5620	40:12:16 N 105:18:49 W
4770	Cal-Wood Ranch	WEATHER	1997/06/20	7760	40:08:52 N 105:23:23 W
<b>NORTH ST. VRAIN CREEK</b>					
4260	Taylor Mountain	RAIN	1981-82	8425	40:11:28 N 105:29:06 W
4300	Big Elk Park	RAIN	1981-82	8600	40:13:36 N 105:28:34 W
4310	Johnny Park	RAIN	1981-82	7680	40:14:39 N 105:24:06 W
4340	Riverside	RAIN	1981-82	8340	40:10:47 N 105:26:36 W
4350	Conifer Hill	RAIN	1981-82	8120	40:10:55 N 105:23:17 W
4480	Button Rock Lake	RAIN	1996/06/03	6200	40:12:57 N 105:21:49 W
4490	Apple Valley	RAIN	1984-85	5920	40:14:18 N 105:18:37 W
4510	Pinewood Springs	RAIN	1984-85	6850	40:15:40 N 105:21:08 W
4520	Eagle Ridge	RAIN/REPEATER	1996/06/01	6280	40:14:39 N 105:15:54 W
4563	Lyons Diversion	STREAM	1997/07/11	5560	40:14:53 N 105:17:51 W
4790	Button Rock	WEATHER	1992/05/11	6500	40:13:15 N 105:22:07 W

Weather Station IDs: +0 Rain, +1 Relative Humidity, +2 Air Temperature, +4 Barometric Pressure,  
-6 Peak Wind Gust, -3 Average Wind Speed & Wind Direction

**Figure III-2**  
**BOULDER COUNTY FLOOD DETECTION NETWORK**



Note: The numbers on the map represent ALERT gaging station ID's. For device ID numbers (i.e. rain gages, stream gages, and weather sensors) refer to Tables III-3, III-4 and III-5.

Figure III-3  
Typical ALERT Stream Gage Graphics

# BOULDER CREEK @ HWY 119 BRIDGE #4423

METADATA  
PAGE

May 15 2003 21:30:00

LATEST REPORT: 21:23:55  
05/15/2003  
STAGE → 3.66 FT  
DISCHARGE → 356 CFS

- ### PROBLEM AREAS
- > COLORADO HIGHWAY 119
  - > RECREATIONAL CANYON USE  
-> BIKE PATH ~ 12FT
  - > DOWNSTREAM FLOODPLAIN
  - > OVERBANK ~ 8.5FT

### SITE CHARACTERISTICS

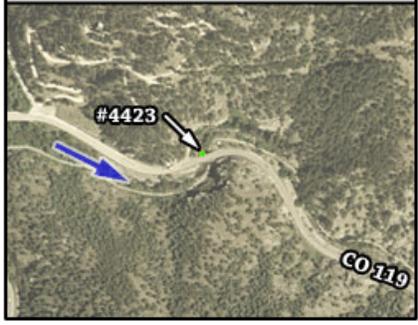
> TOP OF ROAD:	23'
> TOP OF BANK:	20'
> BRIDGE LOW CORD:	18'
> SENSOR:	0.00'

### FREQ/STAGE/DISCHG DATA

10-YR	7.6'	2,050 CFS
50-YR	13.7'	7,960 CFS
100-YR	16.2'	11,660 CFS
500-YR	21.1'	21,180 CFS

### HISTORICAL EVENTS

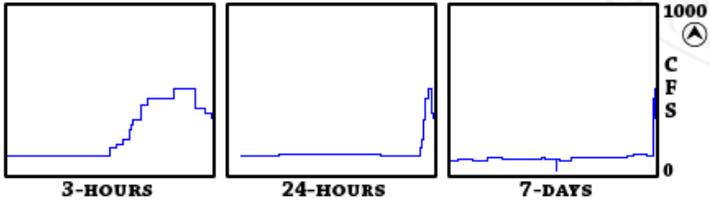
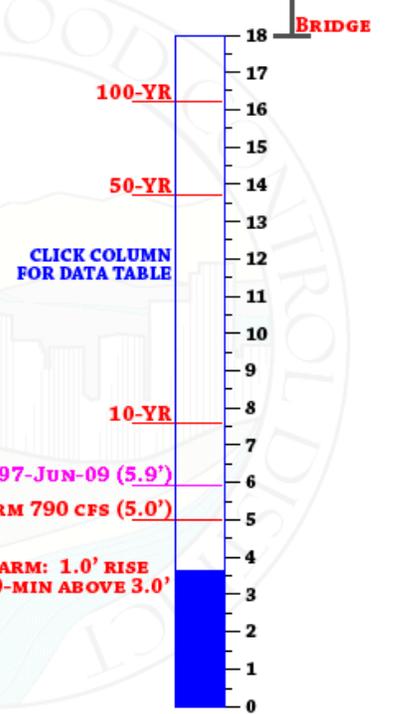
> 1997-JUN-09	1,150 CFS
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### BASIN RAINFALL SENSORS

LOCATION	10-M	1-HR	6-HR
SWISS PEAKS	0.00	0.16	0.16
GOLD HILL	0.00	0.00	0.39
TWIN SISTERS	0.00	0.12	0.28
SUGARLOAF	0.00	0.04	0.31
SUNSHINE	0.00	0.00	0.87
LOGAN MILL	0.00	0.04	0.67
MAGNOLIA	0.00	0.16	0.83
BETASSO	0.00	0.04	2.56
FILTER PLANT	0.00	0.12	1.65

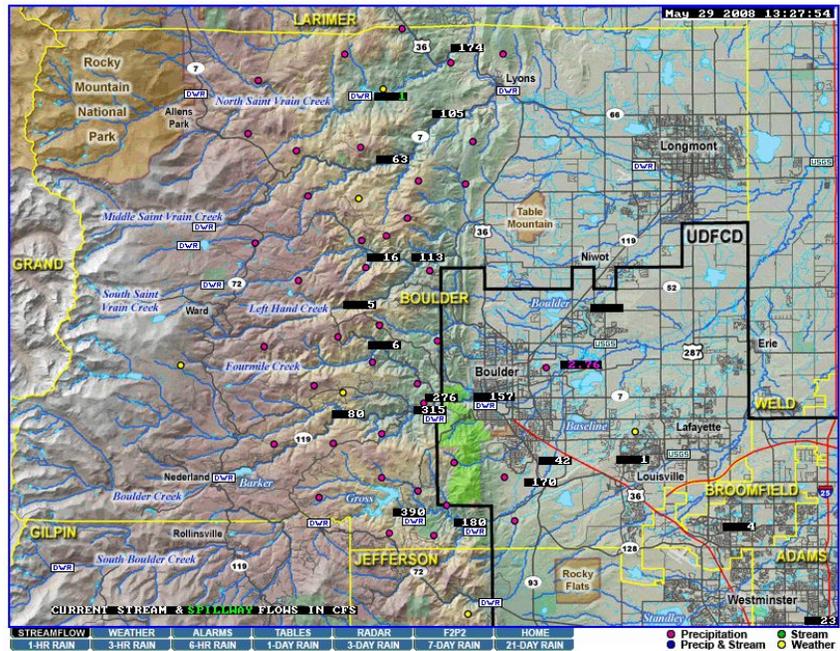
ALARM TABLE RAINFALL TABLE  
LOCATION MAP



### UPSTREAM GAGE INFORMATION

NAME	FLOW	TRAVEL TIME
BOULDER FALLS	49 CFS	-45 MIN
FOURMILE	9 CFS	-35 MIN
ORODELL	9 CFS	-15 MIN

Note: Graphic displays like the one above for ALERT stream gages may be viewed by clicking on flow rate or water level values on the streamflow map – <http://alert2.udfcd.org/cgi-bin/gdview?tpt=map21qweb>



**Table III-6  
Flow Travel Times for Various Flood Return Periods**

**from Gross Reservoir (Gage No. 4373)**

To:	10-Year	50-Year	100-Year	500-Year
Eldorado Springs	72 minutes	48 minutes	40 minutes	31 minutes
Colorado Highway 93	109 minutes	74 minutes	62 minutes	51 minutes

**from Eldorado Springs (Gage No. 4383)**

Colorado Highway 93	37 minutes	26 minutes	22 minutes	20 minutes
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**from Boulder Falls (Gage No. 4393)**

Orodell Gage #4403	46 minutes	35 minutes	33 minutes	24 minutes
Bridge Gage # 4423	64 minutes	47 minutes	46 minutes	32 minutes
Boulder	79 minutes	58 minutes	53 minutes	40 minutes

**from Orodell (Gage No. 4403)**

Bridge Gage # 4423	16 minutes	13 minutes	12 minutes	8 minutes
Boulder	33 minutes	23 minutes	20 minutes	16 minutes

**from Fourmile at Salina (Gage No. 4413)**

Bridge Gage # 4423	38 minutes	36 minutes	29 minutes	26 minutes
Boulder	53 minutes	43 minutes	40 minutes	34 minutes

**from Bridge (Gage No. 4423)**

Boulder	15 minutes	11 minutes	7 minutes	8 minutes
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Figure III-4  
APPROXIMATE FLOOD HAZARD AREAS

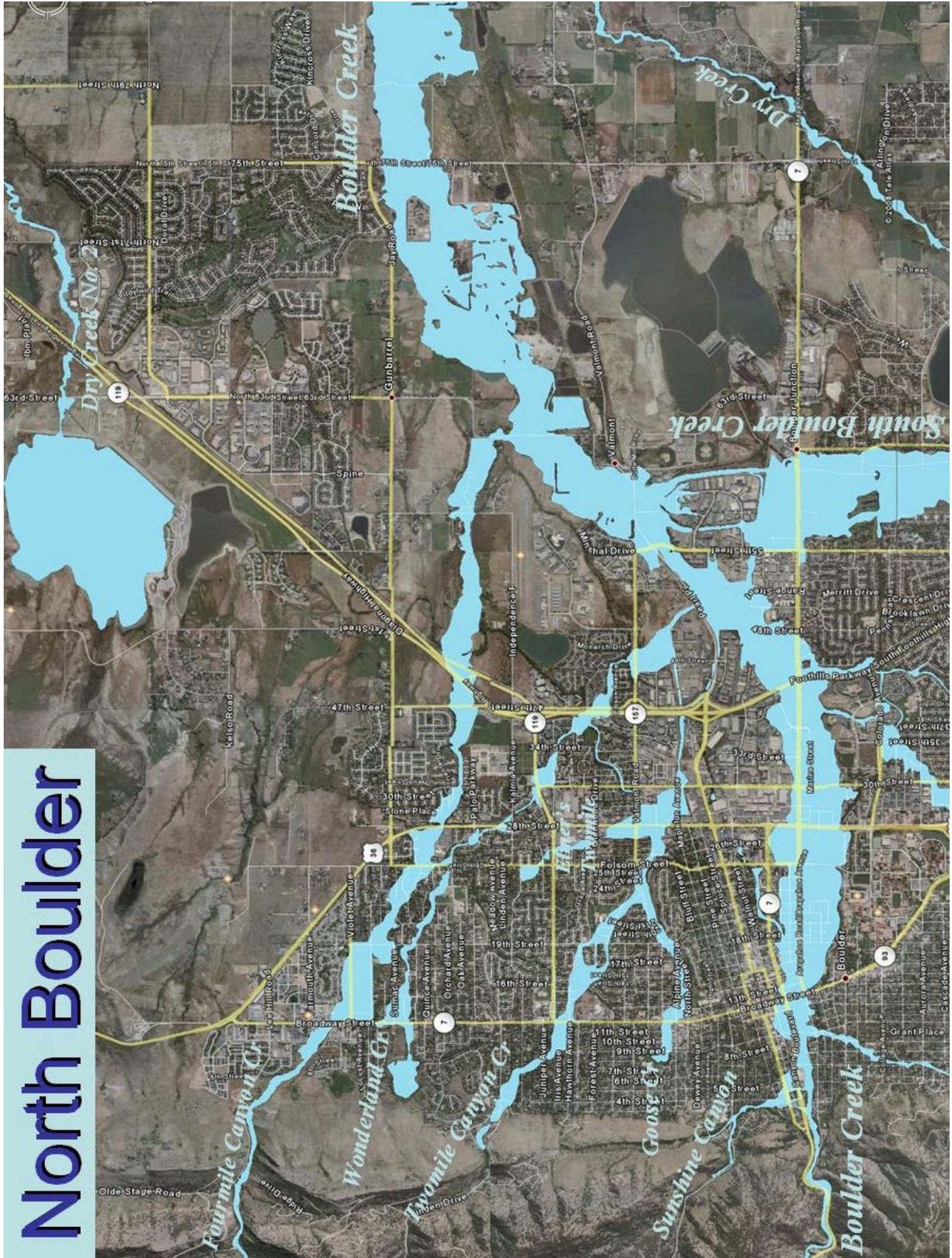


Figure III-5  
APPROXIMATE FLOOD HAZARD AREAS



## **IV. REQUIRED ELEMENTS OF THE WARNING PLAN**

A complete flood warning plan consists of three basic elements

1. Detection and evaluation of the flood threat.
2. Dissemination of the flood warnings to the public.
3. Response of the public to the warnings.

All three parts must function properly or the warning plan will fail. The main purpose of the warning plan is to minimize the potential for loss-of-life. Public safety agencies will make decisions concerning floodplain evacuations and road closures. Individuals must also make appropriate decisions to protect themselves and their families. In some instances, a limited amount of emergency floodproofing by property owners can be accomplished. For residences and businesses along Boulder Creek, South Boulder Creek and other tributary streams, a flash flood warning would not likely provide enough lead-time to safely effect damage prevention measures such as sandbagging. Emergency property protection would probably be limited to turning off main gas and electricity connections.

The following pages provide a brief description of each of the three required elements listed above relative to this flood warning plan.

### **DETECTION AND EVALUATION OF THE FLOOD THREAT**

The early flood threat detection and evaluation element consists of the following items:

#### **ORGANIZATIONS, RESOURCES AND PROCEDURES**

1. The National Weather Service (NWS) Weather Forecast Office at Boulder and their NEXRAD Doppler Radars stations located near Denver, Cheyenne and Pueblo.
2. A private meteorologist service (PMS), retained by Urban Drainage and Flood Control District (UDFCD) to coordinate with NWS; collect and analyze all pertinent weather and flood data; prepare daily heavy precipitation outlooks; provide affected jurisdictions with early notification of flood potentials; and update jurisdictions as conditions change.
3. A Flood Prediction Center (FPC) located in Denver at UDFCD providing a central data collection point and communications center staffed by PMS when flood potentials exist.
4. The Boulder County Sheriff's Office (BCSO) Communications that receives and disseminates all incoming weather and flood information, and activates the warning plan. BCSO Communications is the primary communications link between PMS, NWS and other flood warning plan participants.
5. Communication arrangements defined to insure adequate communications between all parties at all times. Primary communications are by telephone. Amateur radio operators may be contacted to provide backup communications.
6. Standard messages used by PMS to provide information to BCSO Communications for relay to affected jurisdictions.

7. An Emergency Operations Center (EOC) activated when weather conditions warrant. EOC personnel are responsible for monitoring weather and flood conditions, and determining when evacuation of flood hazard areas is advisable.
8. Officials from Boulder County, City of Boulder and volunteer fire districts who receive all critical weather and flood information and respond according to respective procedures.
9. Field personnel from various response agencies (Sheriff, police, fire departments, public works and others) dispatched to pre-determined monitoring locations to report rainfall amounts, stream and reservoir water levels, and general flood conditions to BCSO Communications.
10. Standard operating procedures and guidelines that are maintained, practiced and routinely updated by each participating local government agency, forecast service and support organization.

#### EQUIPMENT, DATA SOURCES AND DECISION AIDS

1. Satellite imagery display equipment located at NWS and FPC enabling meteorologists to see approaching weather systems and estimate arrival times.
2. Automated weather stations used to forecast flood potentials and predict storm development and movement.
3. Data communications equipment, computers and software used to collect and analyze pertinent upper air and surface data.
4. Radar product display equipment at NWS and FPC enabling meteorologists to evaluate current weather conditions; update heavy precipitation forecasts; estimate rainfall amounts at specific locations; predict storm movement, duration, and areal coverage; refine flood predictions; and anticipate specific flood problems.
5. Automated rain gages, stream gages and weather stations that transmit data in real-time to base stations located at BCSO Communications, FPC and UDFCD.
6. Internet webserver located at UDFCD that make the gaging station data available to NWS, local governments, news media and the public; and set off alarms when rainfall and stream level thresholds are exceeded.
7. Intranet webserver located at BCSO Communications that makes the gaging station data available through city and county local area networks.
8. Decision aids and automated processes used to quickly analyze the gaging station data, refine flood forecasts and predict impacts.

#### **DISSEMINATION OF WARNINGS, WATCHES AND ADVISORIES TO THE PUBLIC**

Several ways exist to disseminate flash flood warnings, watches and advisories to the public. The delivery of public warnings is dependent, to a large extent, upon the electronic news media (i.e. local radio and television) with NWS being primarily responsible for the initial release of the warning and its content. Local governments are also responsible for disseminating public warning information within their political boundaries.

Three basic types of flood information are disseminated to the public:

1. **Advisory...**meaning that nuisance or minor flooding of a "less serious" nature is either possible or occurring;
2. **Watch...**meaning that weather conditions are such that a hazardous flood may occur; and
3. **Warning...**meaning that a flood that poses a significant threat to life or property is either occurring, is imminent, or has a very high probability of occurrence.

The above types of information can be issued by NWS, the local governments or both.

NWS uses the following to convey flood information to the public and to cooperating agencies:

1. **Special Weather Statement.** This frequently issued statement may contain advisory information indicating a potential for heavy precipitation and possible flooding. It is also used to amplify watches, warnings, and advisories by reinforcing the message, indicating what is expected, and outlining appropriate response actions.
2. **Urban and Small Stream Flood Advisory.** This advisory is typically used to indicate that low impact flooding of small streams, streets, intersections and low-lying areas is imminent or occurring.
3. **Flash Flood Watch.** The watch means that flooding or flash flooding is possible within the geographic area described, but occurrence is uncertain.
4. **Flash Flood Warning.** The warning means that hazardous flooding or flash flooding is imminent or occurring within the geographic area described.

All NWS forecasts and warnings described above will be disseminated using NOAA Weather Radio and NOAA Weather Wire. Flash flood watches, warnings, and urban/small stream flood advisories will also be disseminated over NAWAS. The use of METS is limited to flash flood warnings and other types of weather warnings. EMWIN can be used to automatically send forecasts and warnings to pagers, cell phones and email addresses. These and other dissemination methods are described later in this section.

Local governments can initiate flash flood warnings and provide the public at risk with emergency information prior to an NWS issuance. PMS messages, current rain and stream level data from the ALERT system, and manual field observations can be used by officials for making warning decisions (Sections III and VI). Local warnings can be disseminated over METS. NWS will receive the information from METS and re-transmit the information as necessary and practicable. Also, NWS can be contacted directly by local governments with additional dissemination requests.

The following briefly describes several public dissemination methods mentioned in the above paragraphs along with some other available warning options:

1. **National Warning System (NAWAS)** consists of full-period, private line voice circuits. NWS uses NAWAS to disseminate flood advisories, flash flood watches and warnings to "Warning Points" in Colorado. BCSO Communications is one 24-hour "Warning Point" in this system.
2. **Metropolitan Emergency Telephone System (METS)** is a telephone network to which government agencies and the media can subscribe. BCSO Communications, Boulder/Boulder County Emergency Management and NWS can quickly pass information to the media subscribers for broadcast on radio and TV. NWS uses METS for warnings, but not for watches or advisories.
3. **Emergency Managers Weather Information Network (EMWIN)** is a NWS-supported satellite downlink/rebroadcast system implemented locally by Denver/Boulder metropolitan area emergency management agencies to customize delivery of critical weather information and warnings, and other emergency information. More information about EMWIN-Denver is available at <http://denver.emwin.org>.
4. **NOAA Weather Wire** is a satellite or Teletype-based communications system over which NWS can pass information to local governments or media subscribers for broadcast.
5. **NOAA Weather Radio** is a radio station operated by NWS (Frequencies: 162.550, 162.475, and 162.450 MHz). Special weather radio receivers or scanners can be purchased by anyone who is interested.
6. **Emergency Alert System (EAS)** consists of radio, television, and cable outlets throughout the United States who are linked together to provide live broadcasts of presidential messages during times of national emergency. On a voluntary basis, the system may also be used for broadcasting state and local emergency warnings and information. Locally, radio station KOA (850 AM) is the primary entry point for the system. Boulder County and NWS have input capability into the system along with the Colorado State Patrol and the Colorado Office of Emergency Management.
7. **Automated Emergency Call System** is a telephone notification method, also known as the *Emergency Warning and Evacuation System/Emergency Preparedness Network*, uses the 9-1-1 Qwest phone number database to automatically dial and warn homes and businesses within affected areas concerning floods and other emergencies. The system is capable of handling up to 1200 calls per minute.
8. **Cable Television Interrupt** is a warning method used by communications personnel to voice override all City of Boulder cable TV programming for emergency messages.
9. **Outdoor Warning Systems** are fixed-location outdoor warning sirens operated by the BCSO Communications that sound a steady 3- to 5-minute blast will warn people in and near the floodplain of an approaching flash flood. The University of Colorado Police Department also operates two outdoor siren/voice warning systems in cooperation with the City of Boulder that will specifically order floodplain evacuation.
10. **Emergency Vehicles** may be dispatched by local law enforcement agencies and fire departments to circulate through assigned portions of the floodplain using sirens and mobile public address systems to advise occupants to evacuate. Standard messages to be used on the public address systems are given in Section IX.

Once the decision to warn or evacuate has been made, it is necessary to quickly and efficiently disseminate the warning to floodplain occupants, motorists and others at risk. Dissemination should be made by as many different means as possible, but care should be taken to insure that warnings from different sources are similar in content. The warning message should clearly communicate the danger and recommend specific protective actions. Flood warnings can be issued by the broadcast media, loud speaker equipped vehicles, and fixed-location outdoor sirens and siren/voice warning systems. Confirmation of the initial warning is desirable whenever possible. People tend to seek confirmation before reacting to a warning.

All warning dissemination agencies, including the broadcast media, should have copies of the standard warning messages in Section IX. The media must be informed beforehand of the existing hazard and the details of the warning system; and they should be checked with periodically to insure their readiness.

## **RESPONSE OF THE PUBLIC TO THE WARNING**

If the desired response of the people in the flood hazard area to a warning is not obtained, the whole warning plan will have failed. Cultivation of the desired response must begin well in advance of any flood threat by heightening the public awareness of the flood hazard.

These steps will be taken annually to try to cultivate the desired response:

1. UDFCD will annually mail or deliver a brochure to all occupants of the Boulder Creek, South Boulder Creek and tributary floodplains within UDFCD (excluding University of Colorado buildings). The brochure will provide directions for obtaining a detailed map with an aerial photograph showing the approximate flood hazard area, and provide information on steps to take prior to flooding (plan evacuation routes, buy flood insurance, etc.) and in the event of a flood warning.
2. UDFCD will provide copies of the appropriate brochures to the University of Colorado for distribution to their floodplain occupants.
3. Boulder County will distribute a similar publication to canyon areas.
4. The City of Boulder will consider putting a notice of the flood hazard in a utility bill each spring before the flood season.
5. Media coverage of the flood hazard, including the annual practice of the warning plan, will be sought.

## V. COMMUNICATIONS

Communications among personnel within participating agencies will be by normal methods now in operation. Boulder County Sheriff's Office (BCSO) Communications is the primary contact for all communications concerning Boulder Creek, South Boulder Creek and other tributary streams. BCSO Communications is responsible for relaying weather and flood information to other flood warning plan participants. This will normally be accomplished by executing a Multi-Agency Coordinating System (MACS) page. BCSO Communications will also relay flood information to Boulder Police Department Communications using standard protocols.

During emergency operations, field personnel from one agency wishing to communicate with personnel from another agency should follow their own jurisdiction's incident command system. This will assure a system of managed communication and information flow. If the Emergency Operations Center (EOC) is activated, communications will include EOC.

Primary communications between the National Weather Service (NWS), the private meteorological service (PMS) and BCSO Communications will be by telephone. When conditions warrant, Ham radio operators can be called into each location to establish alternate communications according to previous agreements. BCSO Communications will use assigned radio frequencies to communicate with field personnel from the City of Boulder, Boulder County and the fire districts.

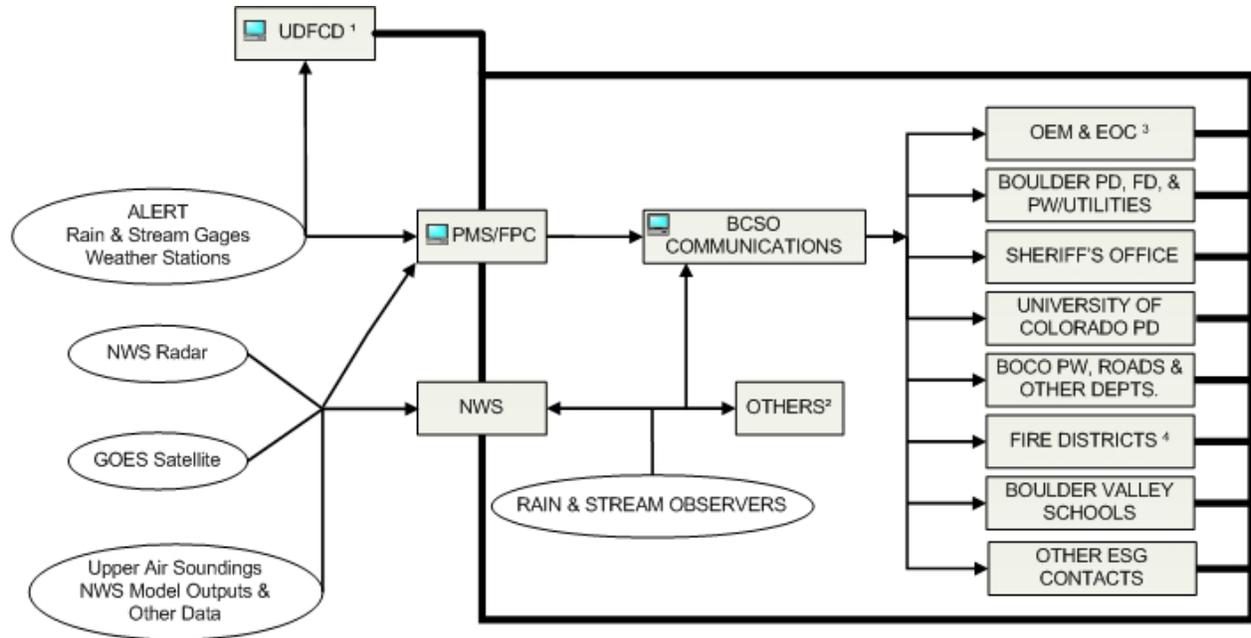
PMS initiated communications require special emphasis. During normal operating conditions (EOC not activated), PMS will contact BCSO Communications for relaying weather-related messages. When EOC is activated, local authorities may request that PMS include the EOC as an additional or alternate contact point. Any warning plan participant may initiate calls to PMS or send personnel to the EOC if continuous monitoring of the situation is desired.

The following page contains pertinent telephone numbers and radio frequencies. Figure V-1 on page V-3 illustrates the collection and dissemination of weather information from various sources and shows the intended inter-agency flow paths for data and voice communications.

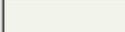
## TELEPHONE NUMBERS AND RADIO FREQUENCIES

<u>Organization</u>	<u>Phone Number</u>	<u>Frequency</u>
* Boulder County Sheriff's Office (BCSO) Communications .....	303-441-4444	
alternate #1 .....	303-441-3374	
alternate #2 (police dispatch) .....	303-441-3333	
alternate #3 (emergency only) .....	303-449-7730	
Boulder Office of Emergency Management .....	303-441-3390	
Boulder County Public Works Department .....	303-441-3900	
City of Boulder Public Works Department.....	303-441-3200	
after hours .....	303-441-3249	
City of Boulder Fire Department.....	303-441-3350	
University of Colorado Police Dispatch .....	303-492-6666	
* National Weather Service (NWS)		
coordination (duty forecaster).....	303-494-4479	
severe weather reports.....	303-494-2884	
administration .....	303-494-3210	
public weather information .....	303-494-4221	
* Urban Drainage and Flood Control District (UDFCD).....	303-455-6277	
Private Meteorological Service (PMS)		
UDFCD Flood Prediction Center (FPC).....	303-458-0789	
Skyview Weather .....	303-688-9175	
Genesis Weather Solutions .....	303-927-6522	
<u>Commonly Shared Emergency Radio Frequencies</u>		
CLEER "Colorado Law Enforcement Emergency Radio" .....		460.425
FERN "Fire Emergency Radio Network" .....		154.280
NLEC "National Law Enforcement Channel" .....		155.475
<u>Other Radio Frequencies</u>		
NOAA Weather Radio (Denver).....		162.550
NWR alternate 1 (Longmont/Mead).....		162.475
NWR alternate 2 (Fort Collins).....		162.450
Ham severe weather spotter network .....		146.940
alternate.....		147.120
<u>Websites</u>		
ALERT System (public use)	<a href="http://alert.udfcd.org">http://alert.udfcd.org</a>	
ALERT System (public safety agency use only)	<a href="http://alert2.udfcd.org">http://alert2.udfcd.org</a>	
* Principle contact for PMS ( <i>Genesis Weather Solutions with Skyview Weather is the PMS for 2008</i> )		

**Figure V-1  
BOULDER CREEK FLOOD WARNING PLAN  
INTERNAL COMMUNICATIONS FLOW CHART**



**LEGEND:**

-  Data Source
-  Agency
-  1-Way Information Flow
-  2-Way Information Flow
-  ALERT Base Station

**ABBREVIATIONS & FOOTNOTES:**

ALERT Automated Local Evaluation in Real-Time (Automated gages)  
 BOCO Boulder County  
 BCSO Boulder County Sheriff's Office  
 UDFCD Urban Drainage and Flood Control District  
 PMS UDFCD Private Meteorological Service  
 FPC UDFCD Flood Prediction Center  
 GOES Geostationary Operational Environmental Satellites  
 NWS National Weather Service  
 OEM Office of Emergency Management  
 EOC Emergency Operations Center  
 PD Police Department  
 FD Fire Department  
 PW Public Works Department  
 ESG Emergency Services Group

1 ALERT Base Station Internet access (<http://alert.udfcd.org>)  
 2 Primary local contact for field observers... BCSO or EOC  
 3 Gold Hill, Fourmile, and Coal Creek Canyon Fire Protection Districts  
 4 EOC may become additional or alternate contact for PMS upon request by local authorities.

## VI. METEOROLOGICAL SUPPORT

The National Weather Service (NWS) and the UDFCD private meteorological service (PMS) provide meteorological support to local governments participating in this flood warning plan. Following is the process by which NWS, PMS, Boulder County and the City of Boulder should coordinate, exchange information and gear up for potential flood situations along Boulder Creek, South Boulder Creek and other tributary streams:

1. PMS will prepare a daily heavy precipitation outlook (HPO) from April 15 through September 15. When warranted, a more detailed quantitative precipitation forecast (QPF) will also be developed by PMS. The current HPO and QPF are available from the Internet at <http://f2p2.udfcd.org> and may also be sent by email or fax to warning plan participants. Many NWS products are also available from the Internet at <http://www.crh.noaa.gov/den> including urban and small stream flood advisories, flash flood watches, and flash flood warnings. Email dissemination of NWS products is possible from a variety of sources like the Emergency Managers Weather Information Network ([EMWIN](#)). When a flood potential exists, NWS and PMS will carry out weather discussions as necessary to evaluate the situation.
2. When nuisance flooding rainfall is possible, PMS will issue **MESSAGE A** by phone and fax to Boulder Sheriff's (BCSO) Communications. The BCSO Communications dispatcher will disseminate **MESSAGE A** following standard protocol. Designated personnel will prepare to respond. When a **MESSAGE A** threat is considered imminent by PMS, it will be identified as a **RED FLOOD ALERT (RFA)** and a storm track (ST) prediction may be disseminated by PMS using the methods described in Item 1 above. A description of PMS messages is available at <http://f2p2.udfcd.org> along with examples of the forecast products referenced in this section.
3. NWS and PMS continue their weather discussion. If the flood potential increases one of the following actions will occur:
  - a. NWS will issue a **Special Weather Statement** or **Urban and Small Stream Flood Advisory** through normal channels (NAWAS, weather wire, weather radio) and/or PMS will send a **MESSAGE UPDATE** to **MESSAGE A (RFA)** if warranted) to BCSO Communications; or
  - b. NWS will issue a **Flash Flood Watch** through normal channels (NAWAS, weather wire, NOAA weather radio) and PMS will send **MESSAGE B** to BCSO Communications; or
  - c. PMS will send a **MESSAGE B** to BCSO Communications indicating an increase in flood potential.BCSO Communications will execute a Multi-Agency Coordinating System (MACS) page and recipients will respond according to internal procedures. Designated personnel will staff the Emergency Operations Center (EOC) and begin active monitoring of weather and flood conditions in support of field operations.
4. The senior dispatcher on duty or the EOC Situation Officer will assign field observers within each jurisdiction and collect all available rainfall and stream stage data. The person-in-charge will call PMS and/or NWS to report observations, exchange data and coordinate future actions. At this point,

- consideration should be given to establishing alternative communications by requesting that volunteer Ham radio operators report to all critical locations including PMS and NWS.
5. Regular coordination between NWS, PMS and EOC personnel will continue. PMS will send **MESSAGE UPDATES** (**RFA** if warranted) by phone or Ham radio operator as required.
  6. When conditions warrant, NWS will issue a **Flash Flood Warning** through normal channels and PMS will send a **MESSAGE C** to BCSO Communications. PMS may issue a **MESSAGE C** prior to the issuance of a NWS warning if PMS believes that a life-threatening flood is imminent.
  7. EOC staff will continue to monitor the situation and begin public dissemination of warnings when necessary. PMS will continue to send **MESSAGE UPDATES** as warranted.
  8. When the hazard has passed, PMS will send a **MESSAGE D** to BCSO Communications.

Throughout all of the above activities NWS and PMS will coordinate as necessary. It must be remembered that events may occur so rapidly that it may not be possible to carry out all of the above steps. Personnel on duty must be prepared for this possibility and pick up the process as best they can.

Also, when NWS determines very early that a high potential for flash flooding will exist later that same day, a **Flash Flood Watch** and corresponding **MESSAGE B** will likely be the first notice issued. In this case, the notices should be communicated well ahead of any heavy rainfall activity, thus allowing more time to make ready.

**RFA** is used when PMS believes that a flooding rainstorm is imminent. A storm track prediction may accompany the **RFA** (see Item 2 above). When **MESSAGE B** is in effect, **RFA** may be used with a **MESSAGE UPDATE** to indicate that nuisance or minor flooding is expected that does not warrant a **MESSAGE C**. When a **MESSAGE C** is in effect, **RFA** may be used with a **MESSAGE UPDATE** to indicate that an approaching storm may cause nuisance flooding outside the warning area. In summary, an **RFA** is typically short lead (0-30 minute) notification of an imminent flood threat not generally considered life-threatening. Flooding will likely be localized and not wide-spread. However, fast moving water even at relatively shallow depths of 2-feet or less should always be considered dangerous, particularly along rivers, streams, and normally dry gulches or drainageways. Given the short lead nature of an **RFA**, it should be disseminated as quickly as possible.

Standard message forms will be completed by PMS and faxed to BCSO Communications immediately prior to placing a phone call to BCSO Communications. This procedure is designed to insure the rapid flow of information with minimum chance for error or misunderstanding.

Boulder County is the only county within the UDFCD service area that currently uses letter codes **A, B, C and D** for PMS MESSAGES. All six other counties use numbers **1, 2, 3 and 4** respectively. This procedural change was made to avoid confusion between weather messages and operational MODE numbers (see Section VIII). PMS may inadvertently use MESSAGE numbers in their communication. BCSO Communications dispatchers should be aware of this possibility and make the proper adjustment when forwarding the weather information.

## **VII. FLOOD THREAT RECOGNITION AND WARNING PROCESS**

The first element of a local flood warning system is the ability to detect and evaluate a flood threat in its early stages and make the decision to warn before flood damages or deaths occur. The second element is the dissemination of the warning to the public at risk. The third element is the public response to the warning. This section deals with the first two elements and includes a step-by-step illustration of how the early flood threat recognition and warning process is intended to function.

### **DETECTION AND EVALUATION OF THE FLOOD THREAT**

The earliest recognition of a potential flood threat will be a heavy precipitation forecast by a meteorologist. The private meteorological service (PMS) retained by Urban Drainage and Flood Control District (UDFCD) provides the meteorological support for this plan among other responsibilities. This service supplements National Weather Service (NWS) activities by focusing its support for the seven-county geographically area comprising UDFCD and tailoring communications to the individual concerns of each local government within this area. Section VI describes the meteorological support provided by NWS and PMS.

PMS forecasts are coordinated with the NWS Weather Forecast Office at Boulder and provided to the Boulder Sheriff's (BCSO) Communications for subsequent dissemination. BCSO Communications will relay the PMS flood threat notifications by executing a Multi-Agency Coordinating System (MACS) page and/or by other means following standard protocols. Participating organizations will respond according to respective internal procedures.

Automated rain gages, stream gages and weather stations within the Boulder Creek and South Boulder Creek drainage basins use battery-operated radios to transmit data in real-time to ALERT base stations located at BCSO Communications, Boulder EOC, and UDFCD. PMS uses this and other hydro-meteorological data (radar, satellite imagery, upper air soundings, and other in-situ weather data) with the decision aids in Section III to predict flood potentials and update local officials concerning anticipated flood problems.

The Emergency Operations Center (EOC) may be activated at BCSO Communications by the Situation Officer if conditions warrant. The Situation Officer's duties are described in the local emergency operations plan. EOC participants will respond according to internal procedures and begin assessing the situation using ALERT data, radar data, the decision aids in Section III, and other available tools. EOC personnel may assume the primary flood prediction role should communication links with PMS and NWS fail. Should EOC become disabled, individual jurisdictions or field commanders will assume the decision-making responsibility.

This flood warning plan calls for higher levels of readiness as the potential for flash flooding increases. The different readiness levels are designated as Modes and defined as follows:

- MODE 0: Normal Operations
- MODE 1: The meteorological potential for flash flood producing storms has been observed.
- MODE 2: A high probability of flooding exists.
- MODE 3: Flooding is imminent in the judgment of EOC personnel.
- MODE 4: Flooding is occurring.

Section VIII provides further discussion regarding procedures and general responsibilities of the principle organizations involved with this flood warning plan. A more detailed discussion of each Mode is also provided.

## **DISSEMINATION OF THE WARNING**

Dissemination of warning information to the public will be accomplished through both the electronic media and the BCSO Communications or EOC personnel. Dissemination by the media may be channeled through NWS by local authorities or the media may be contacted directly. NWS will use NAWAS, METS, NOAA Weather Wire, NOAA Weather Radio and/or EAS; at their option to issue the public warning. Section IV describes the various methods for disseminating flood warnings to the public.

Each local government is responsible for providing flood warnings directly to the public at risk within their respective jurisdictions according to internal procedures. Standardized messages to be used by local governments are included in Section IX.

## **STEP-BY-STEP PROCEDURE**

The following step-by-step procedure is an idealized summary of how the flood threat recognition and warning process is supposed to function. **THE USER MUST BE AWARE THAT THE SYSTEM WILL NOT ALWAYS FUNCTION AS PLANNED. THE USER MUST BE PREPARED TO FUNCTION WITHIN THE FRAMEWORK OUTLINED HERE, EVEN IF ALL STEPS LISTED HEREIN DO NOT OCCUR OR OCCUR OUT OF ORDER.**

### **A. Normal Operations (MODE 0):**

1. PMS will be monitoring weather conditions on a routine basis, including appropriate coordination with NWS. It should be noted that PMS, NWS and UDFCD have an on-going relationship which involves forecasts of flood potential for the entire Denver/Boulder metro area; and the Boulder Creek Flood Warning Plan is an add-on responsibility for meteorologists and other technical support personnel.
2. When weather conditions warrant, and after consultation with NWS, PMS will issue a **MESSAGE A** by telephone to BCSO Communications. If PMS considers the threat imminent, the message will be identified as a **RED FLOOD ALERT**. The official in charge should consider calling for Mode 1 operations upon notification of a **RED FLOOD**

**ALERT.** Section V contains details regarding weather-related communications and the flow of critical information. Section VI contains a detailed description of the messages and terms used by the PMS.

3. BCSO Communications will forward the **MESSAGE A** by executing a MACS page in accordance with MACS procedures. **REMEMBER THAT A MESSAGE A IS A FORECAST OF A POTENTIAL FOR FLOODING. IT IS NOT INTENDED FOR PUBLIC DISSEMINATION SIMPLY BECAUSE IT IS TOO EARLY TO TELL WHAT WILL ACTUALLY DEVELOP.**

**B. Increased Awareness (MODE 1):**

1. PMS will continue to monitor the situation and will issue appropriate **MESSAGE UPDATES (RED FLOOD ALERT** if warranted) to keep local officials advised of significant changes since the previous message.
2. NWS may issue a Special Weather Statement or other appropriate communication concerning heavy precipitation through normal channels described in Section IV. PMS may follow this with a **MESSAGE UPDATE** providing a more detailed interpretation of how this affects Boulder Creek, South Boulder Creek or other tributary streams.
3. BCSO Communications will execute a MACS page and each subsequent contact should follow internal procedures for updating key people concerning the increased flood potential.
4. Contingency plans should be established to ensure that future steps in this warning plan can be carried out if needed and the Situation Officer should consider activating the EOC.

**C. Flash Flood Watch (MODE 2):**

1. As the flood potential becomes more apparent or threatening, NWS will issue a **Flash Flood Watch** for a geographic area. The **Flash Flood Watch** will be issued on NAWAS, Weather Radio and Weather Wire.
2. PMS will issue a **MESSAGE B** to BCSO Communications for MACS page execution. **MESSAGE B** will not only indicate the issuance of a **Flash Flood Watch** by NWS but will also attempt to provide additional information concerning severity of the threat and a more definitive identification of areas at risk. PMS may also issue a **MESSAGE B** without a NWS issuance of a **Flash Flood Watch** if PMS feels the risk is high that a life-threatening flood may occur later in the day.
3. The emergency service official in charge will consider calling for Mode 2 operations.
4. PMS will continue to monitor all available data and will initiate an analysis of potential flood peaks based on predicted rainfall and decision aids provided in Section III.
5. As additional data (including rainfall and stream gage data) becomes available, PMS will update rainfall forecasts and flood peak projections and will provide information to BCSO Communications in the form of **MESSAGE UPDATES (RED FLOOD ALERT** if warranted).
6. BCSO Communications will relay all updates by executing a MACS page.
7. Local authorities will send rain and stream observers to pre-determined locations. Stream gage readings and field observations will be reported to PMS and NWS through BCSO Communications or EOC personnel.

8. PMS will confer as needed with NWS. When rainfall estimates or measurements, and flood peak predictions indicate an imminent flood danger; or when automated stream gages or field observations confirm the threat, a **Flash Flood Warning** will be issued by NWS and EOC personnel will call for Mode 3 operations.

**D. Flash Flood Warning (MODE 3):**

1. NWS will issue a **Flash Flood Warning** through NAWAS, METS, Weather Radio, Weather Wire and perhaps EAS. A **Flash Flood Warning** means that flooding is imminent or occurring.
2. PMS will issue a **MESSAGE C** to BCSO Communications for MACS page execution. PMS may also issue a **MESSAGE C** without a NWS issuance of a **Flash Flood Warning** if PMS feels that a life-threatening flood is imminent.
3. Responsible BCSO Communications or EOC officials should then disseminate the warning according to internal procedures using standard public messages where appropriate (Section IX).
4. PMS, NWS and stream observers will continue to monitor the situation to either confirm flooding or determine that the hazard has passed.
5. When the threat of flooding has passed (whether a flood has occurred or not), PMS will issue a **MESSAGE D**.
6. If flooding has occurred, EOC personnel will call for Mode 4 operations and follow their disaster response plan.

**E. Other Considerations:**

1. As noted above, this is an idealized scenario. It is unlikely that any flood event would be handled exactly as outlined. Each entity must be cognizant of the probable necessity to deviate from their respective plan in order to react to the real situation.
2. NWS is the only federal agency that can officially issue a **Flash Flood Watch** or **Flash Flood Warning** to the public. In the event of a difference of opinion between NWS and PMS, PMS will advise BCSO Communications or EOC officials of the difference of opinion as follows:
  - a. If PMS feels a watch or warning should be issued but NWS doesn't agree, PMS will use a **MESSAGE B** or **MESSAGE C** to inform local authorities of their forecast and prompt each jurisdiction to make their own warning decision.
  - b. If NWS issues a watch or warning but PMS doesn't feel it is warranted, PMS will still issue the appropriate **MESSAGE B** or **MESSAGE C**, but indicate their misgivings. The standard message forms in Section VI are designed to clearly indicate either concurrence or disagreement between PMS and NWS.
3. In the event of a local decision to warn, the EOC official in charge should immediately contact NWS to avoid public confusion. Also, NWS may be the quickest means of notifying the public via the electronic news media. NWS may acknowledge the involvement of local authorities (i.e., Boulder County, City of Boulder, UDFCD, etc.) when issuing their warning.

4. In the Boulder area, flood warnings can be issued by local officials using the siren/public address systems, emergency vehicle loud speakers, door-to-door notification and other methods deemed appropriate.

## VIII. PROCEDURES AND GENERAL RESPONSIBILITIES

Procedures and general responsibilities for the operational elements of this flood warning plan are contained in this section. Three points regarding these procedures need to be emphasized:

1. The operating procedure for each organization addresses only those actions and activities that organization must accomplish in order to effect a coordinated response to a flood situation along Boulder Creek, South Boulder Creek and other tributaries streams in the Boulder Creek drainage basin.
2. Every individual responsible for the implementation of any part of this warning plan should be familiar with the entire plan.
3. This section does not contain detailed operating procedures but provides an overview of technical support activities, communications, emergency operations and general responsibilities of each participating organization. Specific task assignments and responsibilities are described in local emergency operation plans, agency procedures and other supplemental documents maintained by local governments. Similarly, the technical support organizations including National Weather Service (NWS) and Urban Drainage and Flood Control District (UDFCD) and their private meteorological service (PMS) routinely update their own internal operating procedures, policies and duty manuals.

### NATIONAL WEATHER SERVICE AND PRIVATE METEOROLOGICAL SERVICE

The NWS Weather Forecast Office at Boulder has the responsibility for issuing Flash Flood Watches, Flash Flood Warnings, general Flood Warnings, and many other types of weather warnings, advisories and forecasts for northeastern Colorado, including Boulder County, in which the Boulder Creek drainage basin is located. PMS has been retained by UDFCD to supplement NWS flood-related activities within UDFCD boundaries, which includes the lower portion of the Boulder Creek drainage basin. PMS is responsible for monitoring weather and flood conditions, forecasting flood potentials, issuing standardized internal messages, and directly advising local officials concerning specific flood threats. UDFCD provides PMS with access to weather radar, satellite data, lightning data and ALERT base stations, that collect real-time rain, stream levels, and surface weather data from the Boulder Creek/South Boulder Creek Flood Detection Network and other detection networks operating in or near the Denver/Boulder metropolitan area. PMS acquires additional meteorological data, performs their own analyses and prepares forecasts tailored to local government needs. Coordination between NWS and PMS will be as follows:

1. Coordination between NWS and PMS may be initiated by either party when it is deemed that the potential for flash flood producing storms exists. A private line at the Flood Prediction Center (FPC) located at UDFCD in Denver has been established for this purpose. NWS and PMS will consult on when to issue a **MESSAGE A** (see Section VI for MESSAGE descriptions) to the

Boulder Sheriff's (BCSO) Communications. **MESSAGE A** will be communicated by phone and fax. PMS personnel will establish support operations at the FPC either before or soon after a **MESSAGE** is issued.

2. If PMS believes the **MESSAGE A** concerns an imminent threat, the message will be identified as a **RED FLOOD ALERT** and the information should be disseminated as soon as possible.
3. Coordination between NWS and PMS will continue at two-hour intervals or less as needed until the potential passes or a more serious situation develops. NWS may issue a **Special Weather Statement** or **Urban and Small Stream Flood Advisory** through normal channels if conditions warrant. Section IV describes these and other NWS products.
4. If the situation is upgraded to a **Flash Flood Watch** by NWS, they will notify PMS and put the watch out on NOAA Weather Wire, NOAA Weather Radio, and NAWAS. After being contacted by NWS, PMS will immediately issue a **MESSAGE B** to BCSO Communications.
5. If PMS feels the flood potential has increased but NWS does not want to issue a **Flash Flood Watch**, PMS can either issue a **MESSAGE UPDATE** to BCSO Communications indicating an increase in flood potential or upgrade the message status to a **MESSAGE B** if they feel a life-threatening flood potential exists.
6. Following receipt of a **MESSAGE B** or **MESSAGE UPDATE**, BCSO Communications should pass along any rainfall or other data available to them and inform PMS and NWS of such observations.
7. Communications between NWS, PMS and BCSO Communications will continue as needed.
8. If the situation is upgraded to a **Flash Flood Warning** by NWS, they will notify PMS and put the warning out on NOAA Weather Wire, NOAA Weather Radio, NAWAS and METS. After being contacted by NWS, PMS will immediately issue a **MESSAGE C** to BCSO Communications. PMS can also issue a **MESSAGE C** without a NWS **Flash Flood Warning** if PMS believes a life-threatening flood is imminent.
9. PMS can issue a **MESSAGE UPDATE** (**RED FLOOD ALERT** if warranted) to BCSO Communications at any time an update of the current message in effect is warranted but the next higher or lower message is not appropriate.
10. Local government officials may recognize the equivalent of a **Flash Flood Warning**, independent of NWS or PMS, if they feel the situation warrants. NWS and PMS should be immediately advised of this circumstance.
11. Local government officials will make their own decision to evacuate floodplains, close roads or take some other appropriate emergency action. NWS and PMS will be informed of the situation immediately. NWS will disseminate this information over their communications network wherever possible.
12. Consultations between NWS, PMS, BCSO Communications and other flood warning plan participants should continue as needed until the potential has passed or a flood is occurring.
13. When NWS and PMS agree that the potential has passed, PMS should issue a **MESSAGE D** to BCSO Communications.

PMS will have forecaster(s) on duty from 7 AM until 10 PM each day. If a flash flood potential exists at 10 PM, PMS will continue to staff the FPC until the potential has ended. If weather conditions change after 10 PM and a potential flood situation develops, NWS will notify the PMS duty person. This individual will respond to the FPC and begin the coordination process described above.

## **MULTI-AGENCY COORDINATING SYSTEM (MACS)**

Flash flood detection, rainfall and streamflow forecasting for Boulder County and its municipalities are performed on a centralized basis through MACS. The purpose of the operation is to collect, evaluate, analyze and display information pertaining to the potential occurrence of flooding in any of the Boulder County drainages, and to make that information available on a timely basis to persons charged with making decisions affecting the safety of the public.

Flood detection functions involve two of the three MACS branches: the Emergency Operations Center (EOC) and the Facilitator. EOC staff is primarily responsible for monitoring the event and reducing available information to location, probability and time of potential flooding. The facilitator function is responsible for coordinating the flow of information to and from EOC, initiating and maintaining communications with affected jurisdiction heads and representatives, overseeing the dissemination of information to the public, and documenting MACS activities.

The MACS flood detection function is staffed by emergency agency personnel available at the time of the incident, typically from Boulder County Sheriff's Department, Boulder City Police, Fire, or Public Works Departments.

The principles of organization and management utilized in the Incident Command System apply to the MACS flood detection operation, with the facilitator being analogous to the incident commander, and the incident mission being flood detection. However, MACS' role is limited to informing affected jurisdictions of the probable time, location and severity of flooding. Each jurisdiction is responsible for activating the public safety response it determines to be appropriate for the situation.

## **FLOOD MODES**

The rapidity with which flash floods can occur requires that public safety agencies mobilize to prepare for warning well before the necessity of disseminating warnings is known. This has led to a staged mobilization effort known as MODES. Each succeeding mode is a higher degree of mobilization, with a greater range of agencies involved. The following describes the operational status relative to current weather or flood conditions for each mode:

MODE 0: Normal operations and monitoring are in effect. BCSO Communications is responsible for monitoring NWS radar, ALERT gage rainfall and stream levels, PMS messages, NWS advisories and field reports. Upon receipt of information, BCSO Communications makes notification to appropriate personnel.

MODE 1: The meteorological potential of a flood producing storm is being observed. Rain may or may not be occurring, and stream levels are substantially below flood levels. However, weather conditions warrant transfer of flood detection responsibility from BCSO Communications to the Emergency Services Group (ESG). ESG personnel then make decisions on further mobilization and staffing of EOC.

MODE 2: The possibility of flooding in the near future is recognized, and mobilization of public safety agencies in the affected floodplains is required in preparation for warning or to secure flood prone facilities. Responsibility for preparatory mobilization is transferred to the various agencies affected.

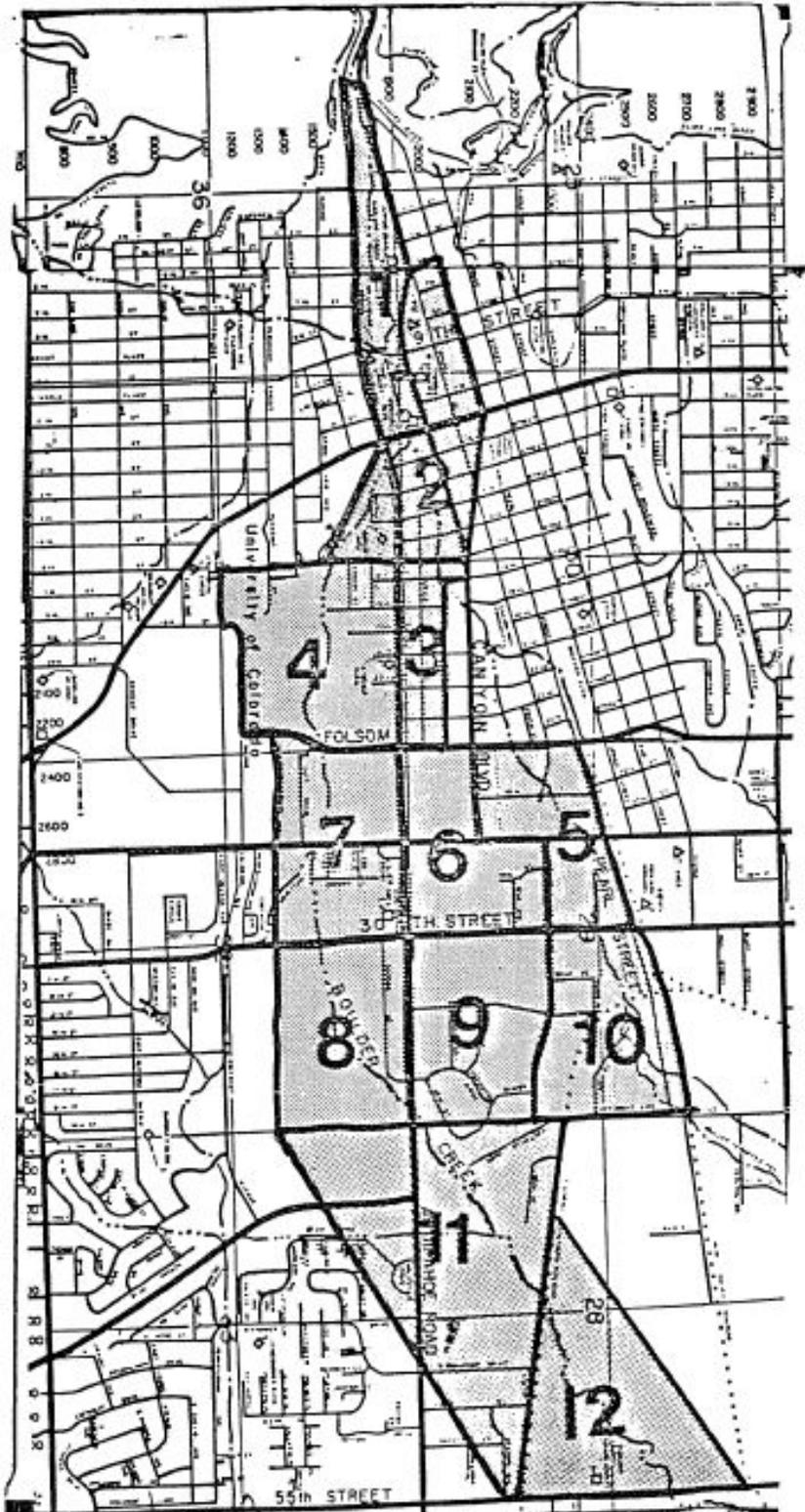
MODE 3: In the judgment of EOC personnel, flooding will occur on specific drainages at roughly estimated levels of severity. Affected jurisdictions will be advised, and will determine and execute appropriate warning and evacuation measures. EOC personnel assist in the preparation and dissemination of warning messages and evacuation orders and monitors progress.

The City of Boulder is responsible for actual oversight and control of operations within the City of Boulder. The warnings within the inundation zones are the responsibility of the City of Boulder and the University of Colorado. The division of responsibilities has been coordinated between the City and the University and specific sectors of responsibility have been assigned. Figure VIII-1 shows the assigned flood evacuation sectors within the Boulder Creek floodplain.

MODE 4: Flooding is occurring, and the flood detection phase is complete. The MACS operation shifts to coordination of jurisdictional flood search, rescue and recovery operations. The MACS organization expands to include the Board of Directors and Resource Allocation Center, if not already activated.

During this mode, the City of Boulder shares the capabilities of the MACS organization with Boulder County and the University of Colorado. However, direction and control of field operations is through the Boulder Incident Command System.

**Figure VIII-1  
City of Boulder  
Flood Evacuation Sectors for Boulder Creek**



- AREA 1 BOULDER P.D.
- AREA 2 BOULDER FIRE
- AREA 3 BOULDER FIRE
- AREA 4 C.U. POLICE
- AREA 5 BOULDER P.D.
- AREA 6 BOULDER FIRE
- AREA 7 BOULDER P.D.
- AREA 8 C.U. POLICE
- AREA 9 BOULDER FIRE
- AREA 10 BOULDER P.D.
- AREA 11 BOULDER FIRE
- AREA 12 BOULDER P.D.

## **IX. PUBLIC DISSEMINATION**

The first response of many people when they hear a warning is to try to confirm it from another source. Therefore, it is very important that all public messages present the same information. The messages in this Section are written to insure that consistent information is given from all possible sources. Public messages will be disseminated by the designated public information officer (PIO) whenever possible according the local emergency operation plans and standard agency procedures. The final message wording is the responsibility of the PIO or local official in charge.

This Section contains two types of messages:

1. Messages provided to the media or broadcast directly to the public; and
2. Messages used by public address systems or emergency vehicles circulating through the floodplain.

The following messages are fill-in-the-blank formatted. Inserted information will be provided by local authorities from Boulder County, the City of Boulder or the University of Colorado.

## CITIZEN ALERT MESSAGE A1

The following message may be used when the National Weather Service has issued a Flash Flood Watch:

THE NATIONAL WEATHER SERVICE HAS ISSUED A FLASH FLOOD WATCH FOR \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

*(geographic area)*

A FLASH FLOOD WATCH MEANS FLOODING IS POSSIBLE WITHIN THE WATCH AREA.

PERSONS IN THE WATCH AREA ARE ADVISED TO PREPARE FOR POSSIBLE FLASH

FLOODING, KEEP INFORMED, AND BE READY FOR QUICK ACTION IF FLASH FLOODING IS

OBSERVED OR A FLASH FLOOD WARNING IS ISSUED.

## CITIZEN ALERT MESSAGE A2

The following message may be used if the National Weather Service has not issued a Flash Flood Watch but local government officials believe that flash flooding is possible:

\_\_\_\_\_ PERSONNEL  
*(local government agency or agencies)*

HAVE DETERMINED THAT A FLASH FLOOD IS POSSIBLE WITHIN \_\_\_\_\_

\_\_\_\_\_  
*(geographic area)*

PERSONS WITHIN THIS AREA ARE ADVISED TO PREPARE FOR POSSIBLE FLASH FLOODING, KEEP INFORMED, AND BE READY FOR QUICK ACTION IF FLASH FLOODING IS OBSERVED OR A FLASH FLOOD WARNING IS ISSUED.

## EVACUATION MESSAGE

The following message may be used if a decision has been made to warn people in the floodplain to evacuate:

THE \_\_\_\_\_ WARNS  
*(responsible agency)*

THAT FLOODING WILL BEGIN AT \_\_\_\_\_ AT  
*(location)*

APPROXIMATELY \_\_\_\_\_ .  
*(estimated time)*

\_\_\_\_\_ HAS URGED EVERYONE IN THE  
*(person in authority)*

FLOOD HAZARD AREAS TO EVACUATE THE AREA IMMEDIATELY. PERSONS  
EVACUATING THE AREA SHOULD MOVE AWAY FROM THE CREEK. DO NOT ATTEMPT TO  
OUT-RUN A FLOOD IN YOUR VEHICLE. DISPLACED PERSONS SHOULD GO TO \_\_\_\_\_  
\_\_\_\_\_. *(Add any confirmed reports of flooding*  
*(place)*

*or heavy rainfall.*) DO NOT ATTEMPT TO CROSS A FLOODED AREA ON FOOT OR IN YOUR  
VEHICLE.

SUPPLEMENTAL *(check appropriate statements):*

\_\_\_\_\_ DO NOT ENTER BARRICADED AREAS.

\_\_\_\_\_ ABANDON YOUR VEHICLE IMMEDIATELY WHEN WATER RISES ABOVE THE  
ROAD ON WHICH YOU ARE DRIVING.

\_\_\_\_\_ IF YOU ARE DRIVING IN A MOUNTAIN CANYON, ABANDON YOUR VEHICLE  
IMMEDIATELY AND CLIMB TO HIGH GROUND.

**EMERGENCY VEHICLE MESSAGE**  
**(city area & county east of Boulder)**

The following message may be used over public address systems or by emergency vehicles circulating in the floodplain within the City of Boulder and in unincorporated areas east of Boulder:

THIS IS \_\_\_\_\_  
*(emergency service agency)*

FLOODING WILL BEGIN AT \_\_\_\_\_ AT  
*(location)*

APPROXIMATELY \_\_\_\_\_.  
*(estimated time)*

\_\_\_\_\_ HAS URGED EVERYONE IN THE FLOOD HAZARD  
*(person in authority)*

AREAS TO EVACUATE THE AREA IMMEDIATELY. PERSONS EVACUATING THE AREA SHOULD MOVE AWAY FROM THE CREEK. DO NOT ATTEMPT TO OUT-RUN A FLOOD IN YOUR VEHICLE. DISPLACED PERSONS SHOULD GO TO \_\_\_\_\_  
\_\_\_\_\_. *(Add any confirmed reports of flooding*  
*(place)*

*or heavy rainfall.)* DO NOT ATTEMPT TO CROSS A FLOODED AREA ON FOOT OR IN YOUR VEHICLE.

SUPPLEMENTAL *(check appropriate statements):*

\_\_\_\_\_ DO NOT ENTER BARRICADED AREAS.

\_\_\_\_\_ ABANDON YOUR VEHICLE IMMEDIATELY WHEN WATER RISES ABOVE THE ROAD ON WHICH YOU ARE DRIVING.

**EMERGENCY VEHICLE MESSAGE**  
**(Boulder County west of Boulder)**

The following message may be used over public address systems by emergency vehicles circulating in the mountain canyons west of Boulder:

THIS IS \_\_\_\_\_ .  
*(emergency service agency)*

DANGEROUS FLOODING IS IMMINENT ON BOULDER CREEK *(and/or name other tributary streams such as South Boulder Creek, Fourmile Creek, Fourmile Canyon Creek, etc.)*.

\_\_\_\_\_ HAS URGED EVERYONE NEAR THE CREEK TO  
*(person in authority)*

EVACUATE THE AREA IMMEDIATELY. CLIMB TO HIGH GROUND. DO NOT CROSS THE CREEK. DO NOT ATTEMPT TO DRIVE OUT OF THE CANYON. *(Add any confirmed reports of flooding or heavy rainfall.)*

SUPPLEMENTAL *(check appropriate statements)*:

\_\_\_\_\_ DO NOT ENTER BARRICADED AREAS.

## EMERGENCY VEHICLE MESSAGES (University of Colorado)

The following messages may be used over public address systems by emergency vehicles circulating in the Boulder Creek floodplain near the University of Colorado (CU). The three messages are designed for different sections of specific warning areas assigned to CU. See Section VIII for a map of the specific warning areas.

### **Area 4 (South Section)**

THIS IS A MESSAGE FROM THE CHIEF OF THE UNIVERSITY POLICE DEPARTMENT. IT HAS BEEN DETERMINED THAT FLOODING WILL OCCUR AT \_\_\_\_\_ . WE  
*(estimated time)*

URGE EVERYONE SOUTH OF ATHENS STREET TO EVACUATE THE AREA IMMEDIATELY. PLEASE GO TO THE UNIVERSITY FIELDHOUSE. CROSS BOULDER CREEK WITHOUT DELAY NOW. THE BRIDGE ACROSS THE CREEK WILL BE BLOCKED OFF AT \_\_\_\_\_.  
*(estimated time)*

### **Area 4 (North Section)**

FLOODING IS IMMINENT ON BOULDER CREEK. THE CHIEF OF THE UNIVERSITY POLICE DEPARTMENT HAS URGED EVERYONE IN THE FLOODPLAIN TO EVACUATE THE AREA IMMEDIATELY. PERSONS EVACUATING SHOULD GO TO \_\_\_\_\_  
*(location)*

OR \_\_\_\_\_. DO NOT ATTEMPT TO CROSS THE CREEK.  
*(location)*

### **Area 8 (East Campus)**

THIS IS THE CHIEF OF THE UNIVERSITY POLICE DEPARTMENT. FLOODING IS IMMINENT AND WILL BEGIN AT \_\_\_\_\_ .  
*(estimated time)*

IMPLEMENT YOUR FLOOD DISASTER PLAN IMMEDIATELY. DO NOT ATTEMPT TO TRAVEL WEST OR NORTH. FOLLOW THE INSTRUCTIONS OF YOUR DISASTER WARDEN.

## OUTDOOR WARNING SIREN MESSAGES (University of Colorado)

The following messages may be used over the outdoor public address siren system by the University of Colorado Police Department to warn occupants in Flood Evacuation Sector Areas 3, 4, 6, 7, 8 and 9. Three pre-recorded messages will be used corresponding to the MACS Flood Mode. For specific warning areas, see the map in Section VIII.

### **MODE 2**

ATTENTION! A FLASH FLOOD WATCH HAS BEEN ISSUED FOR BOULDER CREEK.  
EVACUATION MAY BE NECESSARY. STANDBY FOR INFORMATION.

*(repeat 3 times per direction)*

### **MODE 3**

WARNING! FLASH FLOODING OF BOULDER CREEK IS IMMINENT. LEAVE IMMEDIATELY.  
PROCEED TO HIGHER GROUND. DO NOT CROSS BOULDER CREEK.

### **MODE 3 (URGENT)**

WARNING! FLASH FLOODING OF BOULDER CREEK IS IMMINENT. LEAVE IMMEDIATELY.  
PROCEED TO HIGHER GROUND. DO NOT CROSS BOULDER CREEK.

*(repeat 3 times per direction)*

**NOTE: Urgent message assumes rapid onset flash flood requiring immediate alert and evacuation.**

# OUTDOOR WARNING SIREN PROTOCOLS (University of Colorado)

The following procedure is used by the University of Colorado Police to warn occupants in Boulder Creek Flood Evacuation Sectors 3, 4, 6, 7, 8 and 9. Pre-recorded messages will be used corresponding to the MACS Flood Mode. For specific warning areas, see the map in Section VIII.

<u>Protocol</u>	<u>Siren Alert</u> <u>Preceding message</u>	<u>Message</u>	<u>Revised Message</u> <u>Proposed:</u>	<u>MACS MODE</u>	<u>Authorization by:</u>
1.	(none-voice only)	"Attention. A severe Flash Flood Watch has been issued for Boulder Creek. Evacuation May be Necessary. Standby for Information" <b>(Repeats 3 times per direction)</b>	(to be determined)	MODE 2	Command Staff/ OIC and/or MACS
2.	5-minute alert tone)	"Warning. Flash Flooding of Boulder Creek is imminent. Leave Immediately. Proceed to Higher Ground. Do not Cross Boulder Creek."	(to be determined)	MODE 3	Command Staff/ OIC and/or MACS
3.*	air horn/"whoop tones for 2 min.	"Warning. Flash Flooding of Boulder Creek is imminent. Leave Immediately. Proceed to Higher Ground. Do not cross Boulder Creek." <b>(Repeats 3 times per direction)</b> <b>*-assumes rapid onset flash flood requiring immediate alert and evacuation!</b>	(to be determined)	MODE 3 *(URGENT)	Command Staff/ OIC and/or MACS
4.	air horn	"Cancellation. All Warnings Cancelled." (Repeats 3 times per direction)		MODE 4	
5.	air horn/"whoop	"This is a Warning System Test" <b>(Repeats 3 times per direction)</b>			
6.	5-minute alert (or " air-horn/ whoop" depending on urgency	Announcement of specific instructions to deal with specific situations or hazards via radio transmissions to siren/p.a. (e.g. tornado, hazardous materials evacuation, follow-up flood messages, etc.)		(MODE_ (to be determined)	

## PUBLIC RADIO TAPE LOOP

The Boulder Office of Emergency Management will attempt to work with local radio stations to have them use a pre-recorded tape loop at reasonable intervals following the issuance of Citizen Alert Message A1 or A2. A sample message follows:

A FLASH FLOOD POTENTIAL PRESENTLY EXISTS FOR BOULDER CREEK AND OTHER TRIBUTARY STREAMS. IF A FLASH FLOOD APPEARS TO BE IMMINENT, POLICE AND FIRE VEHICLES WILL CIRCULATE THROUGH THE FLOOD HAZARD AREA, WHEN POSSIBLE, ADVISING OCCUPANTS TO EVACUATE. CIVIL DEFENSE SIRENS WILL BE SOUNDED. WARNINGS WILL ALSO BE BROADCAST ON THIS STATION AND OTHER RADIO AND TV STATIONS.

This above message would be a 15-second loop. Consider adding information regarding specific actions individuals can take. The Public Information Officer (PIO) or other designated local official should work closely with the radio stations broadcasting this tape loop message.

## **X. MEDIA CONTACTS**

Each year, prior to the flood season, the Urban Drainage and Flood Control District (UDFCD) will inform the news media of the flood hazard associated with Boulder Creek, South Boulder Creek and other tributaries. The media will be requested to publicize the hazard by providing information about this flood warning plan, including steps occupants of the hazard area should take when a flash flood warning is issued.

UDFCD will also, on an annual basis, work with local public information offices to make the broadcast media aware of how the sample advisory and warning messages contained in Section IX may be used.

## **XI. ANNUAL REVISIONS AND PRACTICES**

Each year, prior to the beginning of the active flood season, the Urban Drainage and Flood Control District (UDFCD) will issue appropriate revisions to this document after consulting with affected emergency managers and other appropriate local officials. If no revisions are needed, UDFCD will inform plan holders accordingly.

UDFCD will also schedule at least one annual practice exercise. The exercise may take various forms including tabletop simulations, message dissemination/communication tests, functional exercises involving field operations, combinations of the preceding examples, or a less complex orientation meeting. The exercise may be publicized by local public information offices or by UDFCD to further increase public awareness of the flood hazard and help attain the desired public response when flash flood warnings are issued.