URBAN DRAINAGE AND FLOOD CONTROL DISTRICT

RALSTON CREEK FLOOD WARNING PLAN

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I. INTRODUCTION

This flood warning plan for the Ralston Creek drainage basin is viewed as an annex or appendix to Arvada`s Unusual Occurrence Manual and Jefferson County's Emergency Operations Plan. As such, it provides a set of operational procedures in response to flooding on Ralston Creek and its tributaries (i.e., Leyden Creek and Van Bibber Creek). The Ralston Creek drainage basin is located in both Arvada and Jefferson County. Therefore, planning and emergency response must be a multi-jurisdictional effort.

The Ralston Creek Flood Warning Plan is designed primarily to reduce the potential for loss of life resulting from flash floods on Ralston Creek, Leyden Creek and Van Bibber Creek. This plan has been prepared by Urban Drainage and Flood Control District (UDFCD), the City of Arvada and Jefferson County in cooperation with the National Weather Service. UDFCD acknowledges the valuable contributions of 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. 87-05.01 between UDFCD, Jefferson County, and the City of Arvada

II. THE RALSTON CREEK DRAINAGE BASIN

This section provides an overview of the watersheds and flood hazards associated with Ralston Creek including descriptions of the drainage basin, 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. Urban Drainage and Flood Control District, City of Arvada, Jefferson County, Flood Hazard Area Delineation, Ralston Creek – Leyden Creek, prepared by Boyle Engineering Corporation, June 2004.
2. FEMA, Digital Flood Insurance Rate Map (FIRM) and Flood Insurance Study for Ralston Creek and Leyden Creek, June 2003.
3. NOAA, National Climatic Data Center, Flood Event Record Details.

DRAINAGE BASIN DESCRIPTION

Ralston Creek originates near SH 119 in unincorporated Gilpin County, Colorado and flows easterly to its confluence with Clear Creek in Arvada, Colorado. This watershed is located northwest of Denver, Colorado, north of Interstate 70 and west of Sheridan Boulevard. The western edge of the watershed is located within the foothills and includes Golden Gate Canyon State Park.

The entire Ralston Creek watershed drains an area of approximately 92.3 square miles (Figure II-1). Of this total, the Leyden Creek watershed contributes 11.9 square miles and VanBibber Creek contribures 17.7 square miles.

The basin originates to the west in unincorporated Gilpin County at an elevation of 10,390 feet. The creek flows east to its confluence with Clear Creek located in the City of Arvada near Sheridan Boulevard and Interstate 76 at an elevation of 5,250 feet. The western portion of the basin consists primarily of mountain and foothills terrain with rolling, grassy meadows surrounded by lodgepole pine forest, intermixed with smaller stands of aspen, fir, and spruce. The average ground slope of the upper basin varies from approximately 20 to 50 percent.

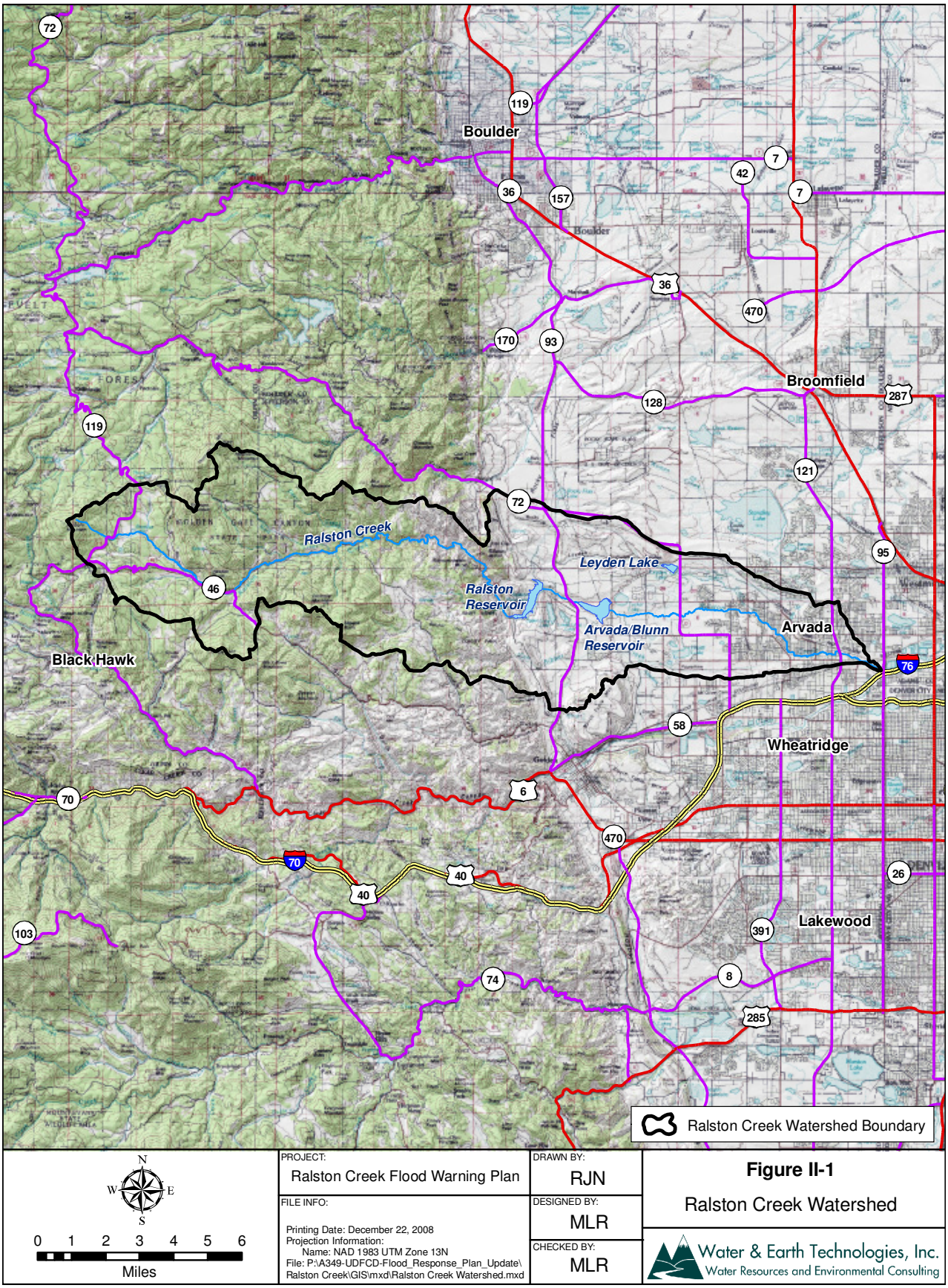
The lower basin transitions from the foothills terrain to high plains. Development below Ralston Reservoir and Leyden Lake consists of both rural and urban zones. The developed area below the confluence of Leyden and Ralston Creeks consists of residential, commercial, and industrial uses. In many cases, development has encroached into the Ralston Creek floodplain. The average ground slope of the lower basin varies from two to 18 percent.

Soils in the basin are typically C and D hydrologic classifications as defined by the Soil Conservation Service. These soils are generally characterized by low permeability and high runoff. The Leyden Creek portion of the basin extends from Leyden Lake to the confluence with Ralston Creek near Simms Street and 72nd Avenue. The elevation of this basin ranges from 7,500 feet at the headwaters to 5,400 feet at the confluence with Ralston Creek. The upper basin is sparsely developed, with the extreme lower basin developed primarily with residential uses.

The Van Bibber Creek basin begins at an elevation of 9,700 feet in the mountains and foothills just south of the Ralston Creek basin. The upper basin has similar characteristics to the upper Ralston Creek basin. Like the Leyden Creek basin, the Van Bibber Creek basin is generally undeveloped, except for the extreme downstream end, which is characterized by substantial commercial development. Portions of the channel have been relocated at the extreme downstream end. The confluence with Ralston Creek occurs near 58th Avenue and Ralston Road at an elevation of 5,300 feet.

In general, the streams within the City of Arvada are well defined with relatively narrow channels. Potential flooding problems exist due to the large developed areas that have encroached into the overbanks of the channels severely constricting the floodplain and diminishing the carrying capacity of large flood flows. Although the potential exists for severe flooding, there is little information regarding past floods.

Figure II-1 Ralston Creek Watershed



RESERVOIRS

Four reservoirs were included in the Ralston Creek watershed model developed by Boyle (2004). These include Ralston Reservoir, Arvada/Blunn Reservoir, Leyden Lake, and Hayes Lake. Storage-discharge and stage-discharge parameters used in the UDSWMM hydrologic routing model were provided by the City of Arvada for Ralston and Arvada/Blunn Reservoirs and Leyden Lake. UDFCD provided stage-storage information for Hayes Lake.

A new dam and spillway at Leyden Reservoir was constructed in 2001 to mitigate concerns raised by the Colorado State Engineer's Office. The State had declared the dam unsafe after an inspection in 1974 turned up issues regarding the stability of the earthfill dam. After the reconstruction of the Leyden Lake spillway, the hold order by the State Engineer of Colorado was removed. The reservoir at the emergency spillway crest provides sufficient capacity to store the three-hour, 100-year volume of 753 ac-ft. The emergency spillway was designed to safely pass the outflow from runoff events up to 36,000 cfs. The spillway crest has an elevation of 5608 feet, which corresponds to the maximum water surface during a 100-year event. The discharge from this lake during a 100-year flow is 373 cfs through its outlet works.

A labyrinth weir spillway was constructed at Arvada/Blunn Reservoir in late 2004. The weir will raise the overflow spillway elevation by 5 feet. The routing characteristics of the Arvada/Blunn Reservoir used in the 2004 hydrology model assume the construction of this labyrinth weir spillway. The new spillway will increase the routed l00-year discharge compared to the discharge from the current spillway configuration.

FLOOD HISTORY

Historically, little information is available on the frequency or severity of flooding in the Ralston Creek basin. Development within the basin began in the 1940s and little flood history is available in the archives for the early part of the 20th century. The City of Arvada is heavily impacted by flooding on Ralston Creek.

1991, July 22. Heavy rainfall caused flooding and flash flooding problems in central Jefferson County and on Ralston Creek specifically.

1995, June 4. Heavy rainfall caused flooding and flash flooding problems in central Jefferson County and on Ralston Creek specifically.

1995, May 18. Heavy spring thunderstorms caused flooding and flash flooding problems in central Jefferson County and on Ralston Creek specifically.

1997, August 4. Several intersections in Arvada were flooded as heavy rain producing thunderstorms struck the area between 3:00 pm and 8:00 pm. Several cars and businesses were damaged in the flooding.

1999, August 4. County-wide flooding and flash flooding developed from a slow moving thunderstorm that dumped from 2.0 to 3.5 inches of rain in a 3 hour period.

2000, July 16. Strong thunderstorms developed approximately 5 miles west of Arvada between 7:30 pm and 9:00 pm. Very moist and unstable conditions, combined with upslope during the late afternoon and evening hours, triggered widespread urban and small stream flooding in and around the Denver metropolitan

and Arvada area. Rainfall amounts generally ranged from 1 to 3 inches, with the heaviest rainfall occurring during the evening hours. Two miles east of White Ranch, an automated rain gage measured nearly 4 inches of rain (3.86 in). Since the rain fell in a relatively open area, no flood damage was reported. In Greenwood Village however, near Peoria and Bellview, the road was closed for several hours as 2 feet of standing water covered the roadway.

2001, July 10. Heavy rainfall caused flooding and flash flooding problems in central Jefferson County and on Ralston Creek specifically.

2003, July 29. A strong thunderstorm developed approximately 1 mile north of Golden near the VanBibber Creek basin between 1:00 pm and 3:00 pm. Heavy rainfall caused flooding and flash flooding problems in central Jefferson County. State Highway 93, north of Golden, was closed due to flooding. In Golden, flash floods left several backyards and basements full of standing water. At least one car was submerged in a garage. Radar estimated 1 to 1.5 inches of rain had fallen in the area in approximately 30 minutes.

2004, June 8. Heavy rain and large hail caused flooding and flash flooding across northeast Jefferson County. In Golden, heavy rains triggered a small mudslide on U.S. Highway 6, near the intersection of Colorado Highway 119. Automated gages in the area registered 2 to 3 inches of rain in one hour. Near the Colorado Mills Mall, numerous intersections were inundated from 1 to 3 feet of water and hail, stranding several vehicles, including a fire engine. Approximately 30 basements were flooded in Golden and Lakewood and many auto and home windows were broken by large hail.

2004, June 27. A deluge of very heavy rain from nearly stationary thunderstorms caused flooding and flash flooding problems over parts of Douglas and Jefferson County. In Jefferson County, an automated rain gauge in Golden measure 3.6 inches of rain in one hour. Numerous homes were flooded in Golden. In addition, State Highway 93 had to be closed from the Pine Ridge subdivision to Golden Gate Canyon Road. At the height of the storm, about 4 feet of water covered Colorado 93 through Golden, forcing its temporary closure. Rock and mudslides were reported in Golden Gate Canyon. Several intersections were flooded and impassable. At the Deer Creek Golf Course, at Colorado 470 and Kipling, the greens were completely inundated by floodwaters. Some backyards near the golf course were partially washed out.

Table II-1 Historic Flooding/High Water Measurements on Ralston Creek

Station	ALERT ID	Peak Stage (ft)	Peak Flow (cfs)	Date
Ralston Creek/Carr St. and Brooks Dr.	103	27.2	3,010	July 22, 1991
Ralston Reservoir/Hwy 93	113	48.0	390	July 10, 2001
Ralston Creek/West Woods (68th St and McIntyre-Croke Pump Sta.)	123	3.4	200	June 4, 1995
Ralston Creek/Simms and 64th	133	3.0	890	June 4, 1995
Leyden Reservoir/82nd and Indiana	203	N.A.	N.A.	
Leyden Creek/72nd and Simms	213	3.0	1,720	July 22, 1991
Van Bibber Creek/Sports Complex	323	3.7	440	July 22, 1991
Van Bibber Creek/Hwy 93	333	3.6	560	May 18, 1995

FLOOD HYDROLOGY

The UDFCD has authorized several major hydrologic studies on Ralston Creek: 1). Major Drainageway Planning Ralston/Leyden Creek by Wright - McLaughlin Engineers, September 1977. 2). Major Drainageway Planning, Lower Ralston, Van Bibber, and Leyden Creeks, Phase B Report by Wright Water Engineers, Inc., March 1984, 3). Major Drainageway Planning Lower Ralston, Van Bibber, and Leyden Creeks Phase A Report by Wright Water Engineers, Inc., February 1986, 4). Ralston/Leyden Creeks Hydrology Report, by Boyle Engineering Corporation, April 2003, and 5). Flood Hazard Area Delineation, Ralston Creek – Leyden Creek, by Boyle Engineering Corporation, June 2004. The purpose of these studies was to prepare and update flood hazard data for Ralston Creek, to produce new floodplain delineations and profiles for the 100-year event, to produce new profile information for the 10-year event and to define floodways for the stream.

The most recent hydrologic analyses were conducted in accordance with the procedures outlined in the UDFCD's Urban Storm Drainage Criteria Manual. These analyses update previous studies. The following summary of flood hydrology was excerpted from the most recent study conducted by Boyle Engineering Corporation (June 2004).

The Ralston/Leyden Creeks Hydrology Report dated April 2003, was conceived in order to convert the hydrologic model for the Ralston Creek watershed from MITCAT to CUHP and-UDSWMM to account for reductions to the 100-year floodplain as a result of the construction of and/or enlargement of various reservoirs. Because results from previous studies were used in development of the published Flood Insurance Study (FIS) and associated floodplain mapping, it was necessary to first perform a calibration procedure to insure that results from this study compared well with those previously published.

The Arvada/Blunn Reservoir was not included in previous hydrologic models. Leyden Lake was omitted from the Phase A report, but was considered as a separate model for the Phase B report. However, Leyden Lake was improved in 2000, and no longer operates as represented in the Phase B modeling. For these reasons, in order to determine consistency between the models, it was first necessary to model the Ralston Creek basin without considering effects from Arvada/Blunn Reservoir and Leyden Lake. Ralston Reservoir, which was in place before the Phase A report was published and has not been modified since, remained in the model.

Once the new CUHP-UDSWMM model was sufficiently calibrated to previously published results, effects of the new reservoirs were added to the model in order to determine an updated hydrologic response for the watershed. These results were used to determine the extent of the 100-year floodplain, as well as the magnitude of flooding for other events, for the future developed condition. Design rainfall was then prepared for various points in the watershed. Design events considered include the 10-, 50-, 100-, and 500-year events. Rainfall patterns for a number of various aerial corrections were developed and used in the analysis, to more accurately represent rainfall. The entire basin was developed into upper, central, and lower regions, with separate rainfall patterns developed for each.

RAINFALL

Subsequent to the development of the Phase A study, the rainfall section in the District's Manual was completely revised to reflect more current data used to develop rainfall patterns. The project sponsors agreed to use this new rainfall information in the development of Ralston Creek model. While the new rainfall data varies from rainfall patterns used in previously published reports, it was assumed that this would more accurately reflect hydrologic response, and the model would be calibrated accordingly.

To more accurately reflect the quickly changing rainfall patterns caused by orographic impacts in the Ralston Creek basin, the watershed was divided into three rainfall regions - western (upper), central, and eastern (lower). The western (upper) region consists only of the upper, mountainous region of the Ralston Creek watershed. The central region consists of the middle reaches of the Ralston Creek watershed and the highest regions of the Van Bibber watershed. The eastern (lower) region consists of the lower reaches of the Ralston and Van Bibber watersheds, and the entire Leyden Creek watershed. All areas below the reservoirs are in the eastern region.

Using section corners as reference points, the delineated watersheds were superimposed onto the depth-duration-frequency figures given in the District's Criteria Manual (Figures RA-l through RA-12 in the Manual). Point rainfall depths were then estimated for the 10-year, 50-year, and 100-year events for 1-hour and 6-hour durations for the western, central, and eastern regions. Point rainfall depths for the 500-year event were estimated using log-probability plots.

Because the Ralston Creek watershed is large, rainfall patterns needed to be adjusted according to aerial correction factors. There were a number of different scenarios that could produce peak events at various locations in the watershed. An uncorrected rainfall pattern is valid anywhere in the watershed with total contributing drainage area less than 10 square miles. A basin wide correction factor for 92 square miles could produce results valid anywhere in the basin. However, additional considerations must be made for localized analysis. For example, a more intense storm falling just on the eastern region (which is generally urban in nature) could produce higher flow rates at downstream design points than a less intense storm covering the entire watershed. In addition, to analyze operations of the reservoirs located on the Ralston Creek mainstem, a rainfall pattern considering a storm raining on areas contributing just to these reservoirs was needed.

As such, a total of five correction scenarios were created and modeled:

1. Uncorrected - For design points with total contributing drainage area less than 10 square miles (2-hour rainfall event),
2. 92 square mile correction considered a storm event falling uniformly over the entire basin (6-hour rainfall event),
3. 49 square mile correction considered a storm event in the areas above Arvada/Blunn Reservoir only to analyze its operations (6-hour rainfall event),
4. 40 square mile correction - Considered a storm event in the eastern region of all three watersheds only (6-hour rainfall event), and
5. 10-20 square mile correction - Used for reaches of Leyden and Van Bibber Creeks with total drainage area greater than 10 square miles (3-hour rainfall event).

For any design point of interest, results from two models were considered. The reported flow rate would be the larger of the 92 square mile correction model and the appropriate other model for the location of interest.

Rainfall patterns were developed using spreadsheet templates developed by UDFCD during the update of its Criteria Manual. These spreadsheets only considered areas up to 75 square miles, so the 92 square mile correction hyetograph was developed separately using methods outlined in the Criteria Manual.

To summarize, all five rainfall patterns were utilized for the eastern region and three patterns (uncorrected, 48 square mile correction, and 92 square mile correction) were utilized for the central and western regions. In addition, the 10-20 square mile correction was developed for the central region because it included a portion of Van Bibber Creek. This means a total of 12 rainfall patterns were developed for each design event, resulting in a total of 48 rainfall patterns developed and used in this study.

The summary of the flood hydrology for Ralston and Leyden creeks presented in this section is based on the detailed hydrology study presented in the Ralston/Leyden Creeks Hydrology Report by Boyle Engineering Corporation, updated in April 2003. Readers are referred to this report for further details concerning the hydrology of Ralston Creek.

PEAK FLOWS

Peak flows were produced by analyzing the watershed for each rainfall scenario and each design frequency. In order for the initial calibration model to be considered consistent with past published results, the peak flows at critical design points must be within 10% of those values reported in past studies. In order to make the values consistent, the following procedures were performed:

1. For all reaches basinwide for which Manning's 'n' values greater than 0.07 were computed, a reduced value between 0.06 and 0.07 was substituted. For example, if a value of 0.096 or 0.106 was computed, it was replaced with 0.066. The assumption was that despite the results of Equation RO-10, a value higher than 0.07 was not consistent with channels in this basin. The Manning's 'n' coefficient was also judged to be the most justifiably altered physical parameter for calibration purposes.
2. Leyden Creek, which was initially modeled as a broad, relatively flat floodplain, was replaced with a more-defined channel.
3. The Manning's 'n' values of the Leyden Creek mainstem were replaced with a value of 0.040 below Leyden Lake. This was needed to speed up the response of the Leyden Creek watershed to better match past published results.
4. The Manning's on' value for two upper reaches of Ralston Creek were increased to 0.070. This was needed to slow down the response of the Ralston Creek watershed to better match past results.

After each of the above procedures was executed, peak 100-year flow results were within 10% of previously published values. The model was then considered to be calibrated. A separate model was then created which included Arvada/Blunn Reservoir, Leyden Lake, and Hayes Lake. Runoff hydrographs were generated for the 10-, 50-, 100- and 500-year frequency floods (Figure II-2 and Figure II-3). Figure II-4 provides a comparison of the peak discharges computed relative to the published FIS discharges for select locations in the basin.

Figure II-2 Ralston Creek Peak Discharge (10-, 50-, 100-, and 500-year)

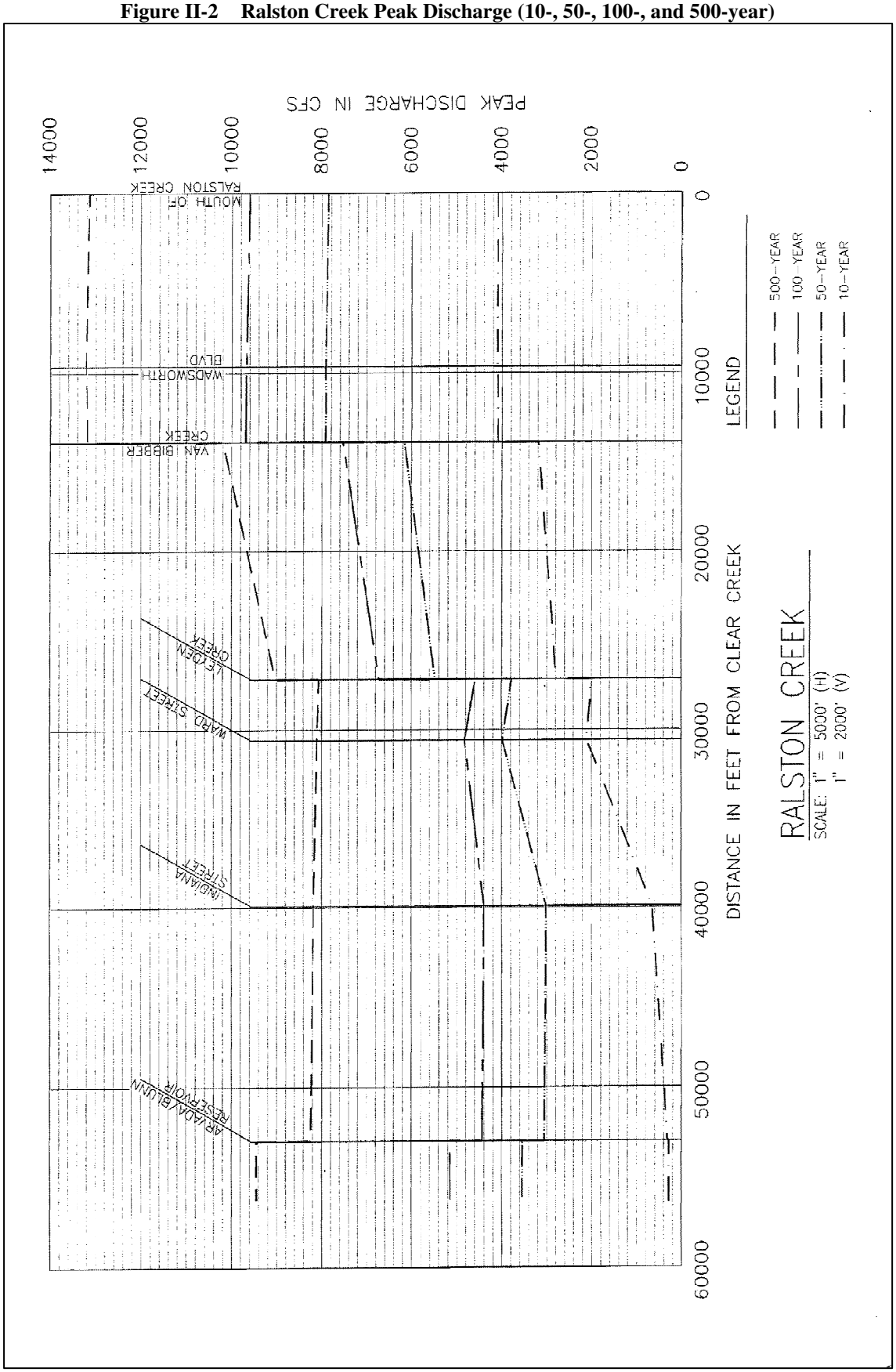


Figure II-3 Leyden Creek Peak Discharge (10-, 50-, 100-, and 500-year)

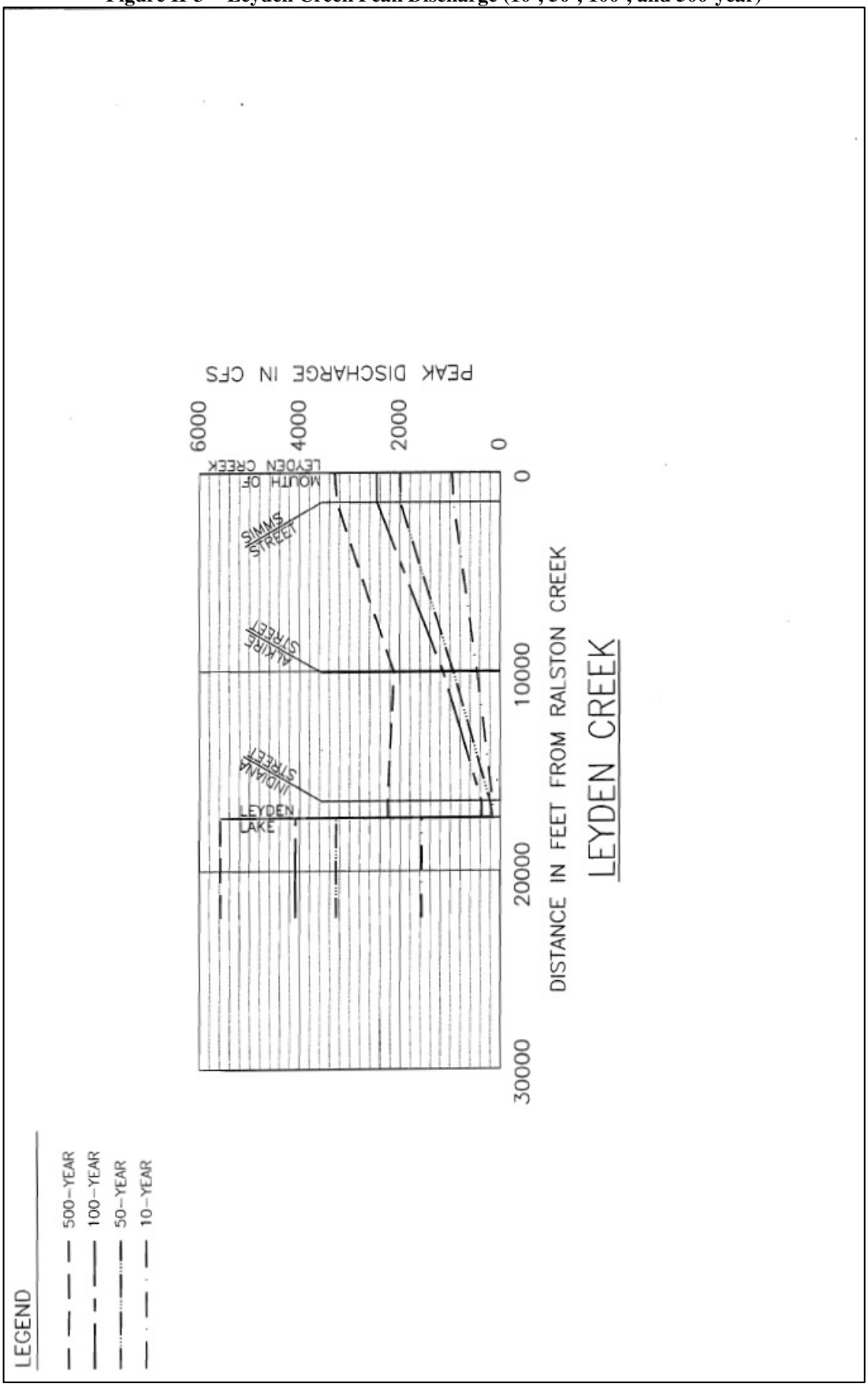


Figure II-4 Ralston Watershed – Modeled Peak Flows (cfs)

Location	Area Adjustment (Square Miles)	Future Basin Developed Conditions FIS Published Data - Arvada/Blunn Reservoir & Leyden Lake *Excluded*				Future Basin Developed Conditions 2003 Update - Arvada/Blunn Reservoir & Leyden Lake *Excluded*				Future Basin Developed Conditions 2003 Update - Arvada/Blunn Reservoir & Leyden Lake *Included (3)*			
		10-year	50-year	100-year	500-year	10-year	50-year	100-year	500-year	10-year	50-year	100-year	500-year
Ralston Creek													
Above Ralston Reservoir	48	-	-	7200	-	879	5462	7228	11486	879	5462	7228	11486
Below Ralston Reservoir	48	-	-	5000	-	283	3608	5262	9603	283	3608	5262	9603
Above Arvada/Blunn Reservoir	48	-	-	-	-	282	3499	5069	9321	282	3499	5069	9321
Below Arvada/Blunn Reservoir	48	-	-	-	-	282	3499	5069	9321	272	3052	4440	8272
Above Leyden Creek	48 / 39 (1) (2)	3200	-	4800	-	2082	3924	4903	9036	1997	3779	4588	8061
Below Leyden Creek	39	4000	-	7900	-	3384	6497	7962	10742	2789	5536	6795	9038
Above Van Bibber Creek	39	5000	-	9700	-	3854	7316	8903	12109	3191	6170	7539	10204
Below Van Bibber Creek	39	6100	-	10600	-	4742	9089	11092	15165	4091	7932	9700	13200
At Mouth	39	6300	-	11500	-	4769	9121	11134	15318	4101	7872	9617	13164
Leyden Creek													
Above Leyden Lake	0	2000	-	3800	-	1569	3269	4081	5577	1569	3269	4081	5577
Below Leyden Lake	0	2000	-	3800	-	1569	3269	4081	5577	134	148	373	2247
At Mouth	10 - 20	2500	-	4300	-	1596	3248	4042	5607	964	1999	2465	3295
Van Bibber Creek													
			-		-								
At Mouth	10 - 20	1000	-	3000	-	1068	2475	3157	4691	1068	2475	3157	4691

(1) Arvada/Blunn Reservoir "Excluded" adjusted for 48 sq. mi. for the 100- and 500-year flows, and 39 sq. mi. for the 10- and 50-year flows.
(2) Arvada/Blunn Reservoir "Included" adjusted for 48 sq. mi. for the 500-year flow, and 39 sq. mi. for the 10-, 50, and 100-year flows.
These different adjustments are due to the reservoir location between the rainfall boundaries and the reservoir attenuation affects.
The higher of the two calculated flows is listed.
(3) Flows with the Arvada/Blunn Reservoir and Leyden Lake Included were used in the FHAD modeling.

FLOODING EXTENT (100-YEAR FLOODPLAIN)

The 100-year floodplain and floodway have been delineated along Ralston Creek from the Arvada/Blunn Reservoir to its confluence with Clear Creek, and along Leyden Creek from Leyden Lake to its confluence with Ralston Creek. The limits of the 100-year floodplain and floodway represent the area in which development is often regulated to prevent increases in water levels and increased damages during a flood. Federal and state agencies such as the Federal Emergency Management Agency (FEMA) , Urban Drainage and Flood Control District, as well as local municipalities of Jefferson County and Arvada, use the floodplain and floodway delineations as a mechanism to identify areas particularly prone to damage from flooding and to oversee development activities in these floodplains.

The basis for this floodplain and floodway delineation is the hydrology, which has been summarized in an earlier section of this report. The delineation assumes full basin development, based on land use and zoning projections provided by the affected communities, and existing channel conditions. A hydraulic analysis has been performed for the 100-year discharge, the results of which were used to plot the 100-year floodplain and profile. Analyses were also performed for the 10-year, 50-year and 500-year discharges and are provided. The floodway has been computed for the 100-year event based on a maximum half-foot and one-foot rise in the energy grade line or water surface elevation, whichever was greater.

The delineation of the 100-year floodplain on Ralston Creek and Leyden Creek was accomplished using the U.S. Army Corps of Engineers HEC-RAS computer program to analyze the hydraulic response of the streams and floodplains using existing channel cross sections. The computational procedure used in the model is the Standard Step Method with the assumptions that the flow is steady, gradually varied, one dimensional, and slopes are relatively small. Major input parameters include digitized cross sections, roughness coefficients, channel lengths between sections, and flow rates. Bridges and culverts were simulated using surveyed field data input into the model. Flow in the channel was assumed sub-critical except near drainage structures; therefore a mixed flow regime was used to calculate the water surface elevations. Values of Manning's roughness coefficient "n" were estimated for the channel and the left and right overbanks along the channel. Estimates were based on field observations and were computed using the procedures outlined in the Federal Highway Administration publication "Guide for Selecting Manning's Roughness Coefficient for Natural Channels and Floodplains." This method estimates Manning's "n" by assigning a base value for a particular soil type and applying adjustments for the degree of irregularity of the channel, the variations in channel cross-sections, the effects of obstructions, the amount of vegetation, and the degree of meander of the channel. Manning's "n" used in the hydraulic model for channels varied from 0.020 to 0.035. The values for the overbanks varied from 0.020 to 0.070. These values appeared to be somewhat higher than the values used in the 1986 HEC-2 model by Wright Water Engineering, Inc., perhaps due to mature vegetation, and new fences. At the request of the Urban Drainage and Flood Control District, the maximum overbank "n" value used in the model was changed to 0.050 to more closely match the FEMA-accepted HEC-2 model.

Flow through structures is sometimes partially blocked during high flood flows due to debris accumulation. Most of the structures modeled had large openings, which reduces the amount of debris caught. Based on the size of the structures, and field observations, and District approval, an area reduction coefficient was not used in the model.

The 100-year floodplain for the existing channel condition, which includes the detention capacities of the Arvada/Blunn reservoir and Leyden Lake, is provided. The plan depicts the 100-year floodplain, areas of shallow flooding, and areas of split flow, which are hydraulically disconnected from the main flood flows. The 100-year water surface elevations and floodplain limits determined in the study represent estimates based on updated hydrology, future development, and current channel geometry in the basin. As a result, the delineation may differ from the floodplain limits identified in earlier studies.

DESCRIPTION OF 100-YEAR FLOODPLAIN

The following is a description of the 100-year floodplain based on the various reaches. The floodplain of the mainstem of Ralston Creek will be described first, followed by Leyden Creek.

Ralston Creek Reach 1 – (Clear Creek to Pierce Street)

This is the downstream reach of Ralston Creek, which begins at the confluence with Clear Creek and extends upstream to the Pierce Street crossing. The following roadway crossings occur within this reach: Pierce Street, Nolan Street, Lamar Street, Ralston Road, C&S Railroad, and W. 56th Avenue. The 100-year flood passes under Lamar Street, the railroad crossing, and W. 56th Avenue, but overtops the remaining streets. Downstream of Lamar Street, Ralston Creek has been confined to the channel along the more recently constructed Ralston Road, significantly reducing the flooding along the railroad tracks and the split flows that previously occurred. Upstream of Lamar Street, the flow is generally confined between the D&RGW railroad tracks and Ralston Road.

Ralston Creek Reach 2 – (Pierce Street to Van Bibber Creek)

This reach begins at the Pierce Street crossing and extends upstream to the Ralston Creek confluence with Van Bibber Creek. Downstream of the Wadsworth bypass, the channel and the floodplain are characterized by a grass channel with an apartment complex in both overbanks. Immediately upstream, to approximately Wadsworth Boulevard, the channel is undersized, which allows flows to spread out in this area.

From Wadsworth Boulevard through to the confluence with Van Bibber Creek, the channel flows in a well maintained park-like grassed waterway. There are minor instances of flooding which exceed this channel's capacity and floods adjacent streets and homes.

Ralston Creek Reach 3 – (Van Bibber Creek to Leyden Creek)

This reach of Ralston Creek extends from the confluence with Van Bibber Creek upstream to the Ralston Creek confluence with Leyden Creek. The hydraulic capacity of this reach is severely constricted by encroachment into the floodplain by old residential development. In areas where encroachment has not occurred on both sides of the channel, the open space areas have been developed as parkland.

Ralston Creek in this reach passes through various commercial, residential, and park properties. The channel makes some sharp bends near Garrison Street and Brooks Drive. Farther upstream, the channel is constricted as it passes through some back yards, causing a wide spread floodplain. The channel opens up again near Oak Street at a park, reducing the floodplain width, but then is restricted again as it passes through more

residences near 68th Avenue. Near the confluence with Leyden Creek, the creek passes through another open park area, reducing the floodplain width.

Ralston Creek Reach 4 – (Leyden Creek to Indiana Street)

This reach begins at the confluence with Leyden Creek, extending upstream to Indiana Street. At the lower end of this reach, residences encroach fairly closely on both sides of the channel, inundating many houses just upstream and downstream of Ward Road. The channel then opens up to an open space area from just upstream of Ward Road to Beech Street where the 100-year flow is fairly well defined. Upstream of Beech Street to Indiana Street, the floodplain is generally contained within a larger open space area between the residences.

Ralston Creek Reach 5 – (Indiana Street to Quaker Street)

This reach extends from Indiana Street upstream to Quaker Street. The channel passes through both residential and commercial properties. It also passes over two canals, the Farmer's High Line Canal and the Croke Canal. Between these two canals is a golf course with ponds located on both sides of the channel. The floodplain breaches its banks in this area and spreads out to the local ponds. The 100-year flow backs up behind the Croke Canal, but is conveyed across the canal at a single location, as modified by the Cottonwood West Industrial Park LOMR. The channel passes through residential areas near Quaker Street, but the 100-year flow is fully contained within the channel.

Ralston Creek Reach 6 – (Quaker Street to Arvada/Blunn Reservoir)

This is the uppermost reach extending from Quaker Street upstream to the Arvada/Blunn Reservoir. The residences are spread farther apart on both sides of the canal between the Church Ditch and Quaker Street, allowing for more green area and less residential flooding impacts. There is very little development upstream of the Church Ditch and higher flows in this area tend to escape the channel banks and spread out to the south of the channel. At the Arvada/Blunn Reservoir outlet works, the 100-year flow is limited to the reservoir outfall channel and the spillway area.

Leyden Creek Reach 1 – (Ralston Creek Confluence to Arvada)

This reach of Leyden Creek extends from the confluence of Ralston Creek upstream to the city limits of Arvada. This reach passes through areas already developed with homes. The channel crosses Simms Street and West 72nd Avenue. The 100-year flow overtops both of these street crossings. The crossing at West 72nd Avenue creates a backwater, which diverts flow from the channel into downstream properties.

Leyden Creek Reach 2 – (Arvada to Alkire Street)

This reach extends from the city limits of Arvada to Alkire Street, including one street crossing at West 75th Place. The channel is small, but clearly defined and more closely resembles the natural state. Floodplain development consists of rural residential homes and some greenhouses in the vicinity of Alkire Street. The Alkire Street crossing is inadequately sized to convey more than nuisance flows and results in overtopping of the street and shallow flooding to the east of Alkire Street during larger events.

Leydan Creek Reach 3 – (Alkire Street to Leyden Lake)

This reach of Leyden Creek extends from Alkire Street upstream to Leyden Lake. The channel in this reach has steep grades with resulting high velocities. In general, the channel meanders across a relatively undisturbed floodplain and local residences. Just above Alkire Street is the North Jeffco Park and Recreation District's sports complex, which has encroached into the floodplain. There has been little increase in the backwater at that crossing as a result of filling in the floodplain. In this reach, Leyden Creek crosses the Croke Canal and the Farmer's High Line Canal and Indiana Street.

Leyden Lake is the upstream limit of this reach. The Leyden Lake spillway has recently been reconstructed and a hold order by the State Engineer of Colorado has been removed. The lake now has a 100-year detention volume of 753 ac-ft. The discharge from this lake during a l00-year flow is 373 cfs through its outlet works.

The 100-year floodplain delineations are provided for the existing channel configuration with future basin development, including the detention capacity of the Arvada/Blunn reservoir and Leyden Lake.

Two different conditions were evaluated to determine the floodway limits. The first condition was a maximum one-half foot rise in base flood energy grade line or water surface elevation because of encroachment. This is a standard for Urban Drainage and Flood Control District projects. In addition to the one-half foot rise floodway, a one-foot maximum floodway rise was also determined, which is consistent with the City of Arvada's municipal floodplain management ordinance. The floodways were determined using encroachment Method 5 and Method 1 of the HEC-RAS program.

The floodway statistics for both the half-foot and one-foot rise floodways are provided along with the results of the 10-, 50-, and 500- year flood elevations for Ralston Creek and Leyden Creek respectively. The tables include flooding source identification, cross section number, station number, design flood discharges, and resulting water surface elevations. The thalweg information for each cross section is included as is the distance to the left and to the right of the thalweg, along with the total width and the floodway water surface elevation. This information is intended to provide regulatory agencies with the information necessary to apply floodplain regulations. By providing this information, agencies are in a position to regulate floodplain development. Developers or property owners in evaluating the hazards and constraints associated with sites along Ralston and Leyden Creeks can also use the tables.

Mean velocities in the floodway generally range between 3 and 11 feet per second (fps) with flow velocities in the channel exceeding 11 fps at certain locations. Velocities in the overbanks typically generally range between 0 and 6 fps; sometimes exceeding this range at certain locations. Velocities in excess of 6 to 8 fps can cause severe erosion of the stream banks, and are capable of transporting large rocks and debris. Velocities in this range can also erode fill around bridge abutments, potentially leading to bridge failure. Lower velocities of approximately 2 fps or less will deposit debris and silt.

Table II-2 Floodplain Data (Clear Creek to Old Wadsworth Blvd.)

Flooding Source				10-yr Floodplain Data		50-yr Floodplain Data		500-yr Floodplain Data	
Identification	Cross Section	Station	Thalweg Elevation (NAVD 88)	Discharge (cfs)	Flood Elevation (NAVD 88)	Discharge (cfs)	Flood Elevation (NAVD 88)	Discharge (cfs)	Flood Elevation (NAVD 88)
Clear Creek Confluence	100	2+18.09	5249.6	4091	5256.6	7932	5257.5	13200	5258.7
	101	7+04.17	5252.2	4091	5259.0	7932	5260.4	13200	5261.9
	102	8+07.68	5252.1	4091	5259.3	7932	5260.7	13200	5261.5
West 56th Avenue	102.5			Bridge		Bridge		Bridge	
	103	9+06.08	5251.9	4091	5259.5	7932	5261.2	13200	5263.9
	104	10+50.13	5257.5	4091	5262.5	7932	5264.3	13200	5266.3
	105	17+09.04	5260.6	4091	5267.4	7932	5269.5	13200	5270.9
	106	22+71.87	5263.0	4091	5270.0	7932	5272.0	13200	5273.7
	107	24+53.1	5263.5	4091	5270.6	7932	5272.7	13200	5274.7
C&S Railroad	107.5			Bridge		Bridge		Bridge	
	108	25+06.9	5263.6	4091	5271.3	7932	5273.7	13200	5275.9
	109	26+73.79	5267.8	4091	5273.4	7932	5275.3	13200	5277.8
	110	32+46.21	5268.9	4091	5277.1	7932	5279.4	13200	5282.5
	111	38+11.87	5271.5	4091	5278.1	7932	5280.3	13200	5282.9
Ralston Road	112.5			Bridge		Bridge		Bridge	
	114	42+03.94	5273.7	4091	5281.8	7932	5286.0	13200	5285.3
	115	42+88.21	5274.0	4091	5282.3	7932	5286.7	13200	5289.0
Lamar Street	115.5			Bridge		Bridge		Bridge	
	116	43+71.43	5275.6	4091	5282.4	7932	5287.9	13200	5289.4
	117	44+92.04	5275.6	4091	5283.1	7932	5287.5	13200	5289.4
	118	45+58.31	5282.0	4091	5286.3	7932	5288.0	13200	5290.3
	119	46+88.4	5282.1	4091	5287.7	7932	5289.3	13200	5291.1
	120	49+63.46	5280.9	4091	5291.6	7932	5294.3	13200	5295.7
Noland Street	120.5			Culvert		Culvert		Culvert	
	121	50+46.54	5280.9	4091	5294.9	7932	5296.2	13200	5297.3
	122	52+09.58	5282.5	4091	5294.7	7932	5295.8	13200	5296.9
	123	56+07.72	5283.7	4091	5295.7	7932	5297.5	13200	5299.2
	124	60+21.98	5286.1	4091	5295.4	7932	5298.0	13200	5299.8
Pierce Street	124.5			Bridge		Bridge		Bridge	
	125	60+77.13	5286.2	4091	5298.6	7932	5300.2	13200	5301.3
	126	62+41.49	5287.0	4091	5298.8	7932	5300.4	13200	5301.5
	127	67+77.53	5288.6	4091	5298.8	7932	5300.3	13200	5301.5
	128	73+29.32	5290.6	4091	5299.4	7932	5301.1	13200	5302.3
Wadsworth Bypass (SH 121)	128.5			Bridge		Bridge		Bridge	
	129	75+32.9	5292.6	4091	5301.2	7932	5303.0	13200	5304.3
	130	79+96.62	5295.8	4091	5304.7	7932	5306.5	13200	5307.4
	131	85+10.26	5299.3	4091	5307.5	7932	5308.8	13200	5310.1
	132	90+47.05	5300.2	4091	5311.1	7932	5313.2	13200	5315.4
	133	92+50.58	5301.4	4091	5312.7	7932	5315.3	13200	5316.5
Old Wadsworth Blvd.	133.5			Bridge		Bridge		Bridge	

Table II-3 Floodplain Data (Carr Street to Rensselaer)

Flooding Source				10-yr Floodplain Data		50-yr Floodplain Data		500-yr Floodplain Data	
Identification	Cross Section	Station	Thalweg Elevation (NAVD 88)	Discharge (cfs)	Flood Elevation (NAVD 88)	Discharge (cfs)	Flood Elevation (NAVD 88)	Discharge (cfs)	Flood Elevation (NAVD 88)
	134	93+39.9	5301.6	4091	5313.1	7932	5315.6	13200	5317.6
	135	94+82.84	5303.8	4091	5313.0	7932	5315.4	13200	5317.5
	136	101+45.3	5306.1	4091	5315.1	7932	5317.2	13200	5319.4
	137	108+35.3	5309.3	4091	5319.9	7932	5321.3	13200	5322.8
	138	113+04.81	5312.7	4091	5322.8	7932	5325.5	13200	5327.3
	139	119+80.64	5317.4	4091	5328.2	7932	5330.0	13200	5331.6
	140	122+55.79	5320.0	4091	5328.7	7932	5330.2	13200	5331.1
Carr Street	140.5			Bridge		Bridge		Bridge	
	141	123+37.71	5320.7	4091	5329.6	7932	5334.8	13200	5336.8
	142	125+98.96	5323.5	4091	5330.8	7932	5335.3	13200	5338.2
	143	130+14.98	5324.4	4091	5333.2	7932	5335.4	13200	5338.3
	144	133+10.38	5326.0	4091	5335.3	7932	5337.3	13200	5339.6
	145	139+09.27	5328.0	4091	5336.5	7932	5339.3	13200	5341.2
	146	142+73.45	5329.7	4091	5339.5	7932	5341.1	13200	5343.0
	146.5	147+86.13	5334.0	2789	5342.5	5536	5343.7	9038	5344.6
	147	153+17.	5336.0	2789	5345.1	5536	5346.0	9038	5346.8
	148	154+48.27	5336.8	2789	5346.0	5536	5346.4	9038	5347.2
Garrison Street	148.5			Bridge		Bridge		Bridge	
	149	155+21.24	5337.2	2789	5347.0	5536	5348.1	9038	5348.7
	150	156+18.29	5337.9	2789	5346.4	5536	5348.8	9038	5349.6
	150.5	160+24.56	5337.6	2789	5348.7	5536	5350.1	9038	5351.0
	151	164+47.66	5343.3	2789	5349.3	5536	5351.0	9038	5352.2
	152	168+72.67	5343.9	2789	5351.3	5536	5353.3	9038	5354.9
	153	174+18.08	5346.1	2789	5353.7	5536	5355.8	9038	5358.2
	154	176+17.96	5349.3	2789	5355.2	5536	5358.0	9038	5360.3
Brooks Drive	154.5			Culvert		Culvert		Culvert	
	155	176+92.51	5349.6	2789	5357.3	5536	5359.3	9038	5360.2
	155.5	180+33.21	5352.7	2789	5360.8	5536	5361.6	9038	5362.4
	156	184+29.78	5355.2	2789	5363.2	5536	5364.2	9038	5365.1
	157	185+49.15	5355.6	2789	5362.3	5536	5364.3	9038	5365.1
West 61st Avenue	157.5			Culvert		Culvert		Culvert	
	158	186+12.68	5356.2	2789	5365.3	5536	5364.7	9038	5365.5
	159	187+03.12	5356.8	2789	5366.0	5536	5366.0	9038	5366.6
	160	190+53.1	5358.4	2789	5366.3	5536	5367.4	9038	5368.1
	160.5	195+29.34	5361.4	2789	5369.3	5536	5370.2	9038	5370.9
	161	198+22.54	5362.6	2789	5371.5	5536	5372.5	9038	5373.1
	162	199+40.78	5363.3	2789	5371.4	5536	5373.5	9038	5374.3
Rensselaer	162.5			Culvert		Culvert		Culvert	
	163	200+14.95	5363.5	2789	5371.9	5536	5375.0	9038	5376.2
	164	204+25.69	5366.0	2789	5376.3	5536	5376.9	9038	5377.4

Table II-4 Floodplain Data (Miller Street to Ward Road)

Flooding Source				10-yr Floodplain Data		50-yr Floodplain Data		500-yr Floodplain Data	
Identification	Cross Section	Station	Thalweg Elevation (NAVD 88)	Discharge (cfs)	Flood Elevation (NAVD 88)	Discharge (cfs)	Flood Elevation (NAVD 88)	Discharge (cfs)	Flood Elevation (NAVD 88)
	165	209+72.36	5369.0	2789	5379.1	5536	5380.2	9038	5381.0
	166	216+58.19	5373.8	2789	5382.1	5536	5383.5	9038	5384.3
	167	222+22.18	5376.0	2789	5382.9	5536	5384.3	9038	5385.3
	168	224+51.48	5377.5	2789	5385.0	5536	5386.3	9038	5387.4
Miller Street	168.5			Bridge		Bridge		Bridge	
	169	225+59.49	5378.3	2789	5387.1	5536	5387.9	9038	5389.5
	170	226+74.96	5378.4	2789	5386.7	5536	5389.5	9038	5390.6
	171	231+89.62	5382.0	2789	5389.7	5536	5391.3	9038	5392.4
	172	235+34.22	5384.0	2789	5389.7	5536	5391.2	9038	5392.4
	173	239+63.88	5388.0	2789	5393.9	5536	5396.6	9038	5397.1
	174	243+03.82	5389.9	2789	5398.7	5536	5399.9	9038	5400.7
Oak Street	174.5			Culvert		Culvert		Culvert	
	175	243+80.17	5390.1	2789	5400.0	5536	5401.8	9038	5402.5
	176	248+07.65	5394.2	2789	5401.3	5536	5403.3	9038	5404.2
	177	250+92.67	5395.5	2789	5404.4	5536	5406.1	9038	5407.0
	178	254+80.72	5398.0	2789	5406.9	5536	5408.1	9038	5408.9
West 68th Avenue	178.5			Bridge		Bridge		Bridge	
	179	255+57.1	5399.0	2789	5407.2	5536	5408.7	9038	5409.5
	180	258+67.08	5404.0	2789	5411.3	5536	5412.5	9038	5413.1
	180.5	262+18.63	5404.9	2789	5412.7	5536	5413.6	9038	5414.3
	181	266+32.1	5414.0	2789	5416.7	5536	5418.1	9038	5418.7
	182	272+16.49	5415.7	2789	5420.3	5536	5421.5	9038	5422.5
	183	276+18.79	5417.7	2028	5421.7	3762	5422.6	8125	5424.7
	183.5	278+63.56	5419.4	2028	5423.4	3762	5425.0	8125	5428.5
	184	279+25.67	5420.0	2028	5424.4	3762	5426.2	8125	5430.3
Simms Street	184.5			Bridge		Bridge		Bridge	
	185	280+02.18	5420.0	2028	5426.3	3762	5429.4	8125	5433.0
	186	283+93.25	5421.9	2028	5426.6	3762	5430.0	8125	5433.5
	187	287+52.75	5424.0	2028	5429.5	3762	5430.8	8125	5433.9
	188	290+82.77	5426.6	2028	5432.5	3762	5433.8	8125	5435.4
	189	294+12.27	5429.2	2028	5434.7	3762	5435.9	8125	5437.7
	190	294+74.03	5429.6	2028	5436.5	3762	5438.0	8125	5439.7
	191	294+87.6	5430.8	2028	5436.5	3762	5438.0	8125	5439.8
	192	298+04.3	5433.8	2028	5441.5	3762	5442.0	8125	5443.0
	193	303+86.81	5441.2	2028	5446.3	3762	5446.8	8125	5448.0
	194	308+19.18	5443.7	2028	5450.0	3762	5451.6	8125	5453.1
Ward Road	194.5			Bridge		Bridge		Bridge	
	195	309+17.56	5443.6	2028	5451.3	3762	5453.0	8125	5454.1
	196	315+58.43	5448.6	2028	5455.4	3762	5456.3	8125	5457.7
	197	321+85.17	5454.0	2028	5459.8	3762	5461.0	8125	5463.0

Table II-5 Floodplain Data (Beech Street to Joyce Street)

Flooding Source				10-yr Floodplain Data		50-yr Floodplain Data		500-yr Floodplain Data	
Identification	Cross Section	Station	Thalweg Elevation (NAVD 88)	Discharge (cfs)	Flood Elevation (NAVD 88)	Discharge (cfs)	Flood Elevation (NAVD 88)	Discharge (cfs)	Flood Elevation (NAVD 88)
	198	324+84.28	5455.9	2028	5462.2	3762	5463.5	8125	5465.5
	199	331+30.84	5462.2	2028	5466.3	3762	5467.7	8125	5469.1
	200	337+82.66	5469.8	2028	5472.9	3762	5473.8	8125	5475.5
	201	344+31.33	5476.0	2028	5479.9	3762	5481.0	8125	5482.6
Beech Street	201.5			Bridge		Bridge		Bridge	
	202	345+10.37	5478.0	2028	5481.8	3762	5483.5	8125	5486.1
	203	351+60.15	5482.0	915	5485.8	3004	5487.1	8159	5489.0
	204	357+92.11	5487.9	915	5490.6	3004	5492.0	8159	5493.6
	205	364+29.5	5491.5	915	5495.3	3004	5497.1	8159	5499.3
	206	368+37.01	5496.0	915	5500.1	3004	5501.7	8159	5504.3
	207	371+39.83	5499.8	915	5503.4	3004	5507.2	8159	5509.5
Eldridge Street	207.5			Bridge		Bridge		Bridge	
	208	372+25.13	5501.0	915	5505.1	3004	5508.2	8159	5513.6
	209	375+21.61	5501.9	915	5506.9	3004	5509.7	8159	5513.7
	210	380+36.59	5506.0	915	5510.7	3004	5512.8	8159	5514.9
	211	387+83.33	5511.7	656	5516.4	3012	5518.2	8182	5519.9
	212	398+52.87	5517.1	656	5520.5	3012	5522.9	8182	5525.1
	213	407+42.06	5522.8	656	5526.6	3012	5528.6	8182	5530.4
	214	415+64.97	5530.0	656	5533.3	3012	5534.7	8182	5535.4
	215	417+65.31	5531.0	656	5534.1	3012	5535.8	8182	5538.1
Indiana Street	215.5			Bridge		Bridge		Bridge	
	216	419+15.34	5531.1	656	5534.6	3012	5538.4	8182	5541.4
	217	423+04.	5534.5	525	5539.2	3022	5541.8	8206	5543.3
	218	429+34.13	5539.9	525	5543.4	3022	5546.1	8206	5547.6
	219	430+56.16	5539.6	525	5544.0	3022	5546.4	8206	5549.3
Joyce Street	219.5			Bridge		Bridge		Bridge	
	220	431+23.25	5541.5	525	5545.3	3022	5549.6	8206	5551.3
	221	434+36.46	5545.1	525	5548.5	3022	5552.9	8206	5554.4
	221.5	437+03.97	5546.4	525	5551.9	3022	5555.8	8206	5558.5
	222	442+48.94	5552.7	525	5558.2	3022	5562.5	8206	5564.7
	223	445+56.73	5555.0	525	5561.1	3022	5565.8	8206	5569.1
	224	446+21.49	5556.0	525	5561.4	3022	5566.1	8206	5569.0
	224.5	446+62.96	5566.0	525	5569.5	3022	5571.8	8206	5571.9
	225	447+23.33	5567.1	525	5570.7	3022	5573.1	8206	5578.8
	226	447+63.82	5567.4	525	5571.2	3022	5573.5	8206	5578.9
	227	450+41.73	5569.4	314	5571.2	3052	5573.5	8272	5578.9
	228	454+70.57	5570.6	314	5571.3	3052	5573.7	8272	5578.9
	229	459+54.96	5570.6	314	5573.5	3052	5576.9	8272	5578.9
	230	464+15.13	5579.2	314	5582.6	3052	5585.4	8272	5587.0
	231	465+45.2	5579.9	314	5583.7	3052	5587.3	8272	5589.0

Table II-6 Floodplain Data (Quaker Street to Arvada/Blunn Reservoir)

Flooding Source				10-yr Floodplain Data		50-yr Floodplain Data		500-yr Floodplain Data	
Identification	Cross Section	Station	Thalweg Elevation (NAVD 88)	Discharge (cfs)	Flood Elevation (NAVD 88)	Discharge (cfs)	Flood Elevation (NAVD 88)	Discharge (cfs)	Flood Elevation (NAVD 88)
	232	467+13.83	5581.0	314	5584.9	3052	5589.3	8272	5592.2
	233	470+38.34	5585.3	314	5588.0	3052	5591.8	8272	5594.5
	234	473+72.06	5588.3	314	5591.9	3052	5596.1	8272	5598.0
	235	476+85.01	5587.5	314	5593.9	3052	5598.3	8272	5601.9
	236	482+15.65	5597.0	314	5598.7	3052	5603.2	8272	5607.7
Quaker Street	236.5			Mult Open		Mult Open		Mult Open	
	237	483+83.01	5597.9	314	5600.5	3052	5607.2	8272	5613.2
	238	489+91.94	5606.8	314	5610.4	3052	5614.3	8272	5617.2
	239	496+34.72	5617.0	314	5619.5	3052	5622.2	8272	5623.8
	240	501+16.3	5622.6	314	5624.7	3052	5628.6	8272	5630.4
	240.5	505+08.86	5626.0	314	5628.8	3052	5633.4	8272	5636.0
	241	509+58.16	5632.0	314	5634.6	3052	5638.1	8272	5640.0
	242	513+50.66	5636.9	314	5639.1	3052	5642.1	8272	5644.0
	243	516+79.31	5640.9	314	5643.3	3052	5645.8	8272	5647.6
	244	517+36.86	5640.8	314	5644.0	3052	5647.0	8272	5649.7
	245	518+49.93	5645.1	314	5649.1	3052	5652.3	8272	5653.1
	246	519+40.81	5649.0	314	5651.1	3052	5654.0	8272	5655.2
	246.5	522+38.49	5653.5	314	5655.7	3052	5658.2	8272	5659.8
	247	524+91.32	5657.5	314	5659.6	3052	5662.6	8272	5664.6
	248	525+84.05	5658.7	314	5660.6	3052	5663.8	8272	5665.6
Arvada-Blunn Reservoir Discharge	249	530+50.13	5662.0	10	5663.0	10	5664.7	10	5666.8
	249.5	533+25.18	5665.6	10	5666.7	10	5666.5	10	5666.8

Table II-7 Ralston Creek 100-Year Floodway Data (Clear Creek to Carr Street)

Flooding Source				100-yr Floodplain Data		Floodway Data							
						0.5-foot rise in EGL				1.0-foot rise in EGL			
						Floodway Width (ft)			Floodway Elevation	Floodway Width (ft)			Floodway Elevation
Identification	Cross Section	Station	Thalweg Elevation (NAVD 88)	Discharge (cfs)	Flood Elevation (NAVD 88)	Left *	Right *	Total	(NAVD 88)	Left *	Right *	Total	(NAVD 88)
Clear Creek Confluence	100	2+18.09	5249.6	9700	5257.9	234	73	308	5258.0	176	73	249	5258.2
	101	7+04.17	5252.2	9700	5261.1	127	81	208	5261.0	127	81	208	5261.3
	102	8+07.68	5252.1	9700	5261.0	92	86	178	5261.2	92	86	178	5261.4
West 56th Avenue	102.5			Bridge									
	103	9+06.08	5251.9	9700	5263.0	89	92	181	5263.0	89	92	181	5263.0
	104	10+50.13	5257.5	9700	5265.0	62	123	185	5264.8	62	123	185	5264.9
	105	17+09.04	5260.6	9700	5270.1	56	298	354	5270.6	64	116	180	5270.1
	106	22+71.87	5263.0	9700	5272.6	57	119	176	5272.7	57	119	176	5272.8
	107	24+53.1	5263.5	9700	5273.5	90	127	217	5273.6	90	127	217	5273.5
C&S Railroad	107.5			Bridge									
	108	25+06.9	5263.6	9700	5274.5	69	104	173	5274.7	90	83	173	5274.3
	109	26+73.79	5267.8	9700	5276.3	90	83	134	5276.0	78	56	134	5276.0
	110	32+46.21	5268.9	9700	5280.1	67	58	125	5280.1	59	57	116	5280.0
	111	38+11.87	5271.5	9700	5281.1	50	62	112	5281.1	50	60	110	5281.1
Ralston Road	112.5			Bridge									
	114	42+03.94	5273.7	9700	5286.5	59	54	113	5286.9	60	60	120	5287.3
	115	42+88.21	5274.0	9700	5287.5	209	84	293	5287.8	50	82	132	5288.0
Lamar Street	115.5			Bridge									
	116	43+71.43	5275.6	9700	5288.9	192	85	277	5289.1	36	78	114	5289.7
	117	44+92.04	5275.6	9700	5288.5	150	127	277	5289.1	39	75	114	5289.2
	118	45+58.31	5282.0	9700	5288.7	179	123	302	5289.2	62	91	153	5289.3
	119	46+88.4	5282.1	9700	5289.7	69	109	178	5289.7	53	89	142	5289.9
	120	49+63.46	5280.9	9700	5294.9	28	143	172	5294.7	33	111	144	5294.8
Noland Street	120.5			Culvert									
	121	50+46.54	5280.9	9700	5296.6	28	143	172	5295.3	36	108	144	5295.0
	122	52+09.58	5282.5	9700	5295.8	92	82	173	5295.8	92	62	154	5295.8
	123	56+07.72	5283.7	9700	5298.3	81	174	255	5298.7	77	140	217	5298.9
	124	60+21.98	5286.1	9700	5298.7	77	363	440	5299.2	78	162	240	5299.2
Pierce Street	124.5			Bridge									
	125	60+77.13	5286.2	9700	5300.6	221	357	578	5300.9	71	154	225	5300.0
	126	62+41.49	5287.0	9700	5300.8	286	264	550	5301.1	136	69	205	5300.8
	127	67+77.53	5288.6	9700	5300.8	248	226	474	5301.0	85	79	164	5301.0
	128	73+29.32	5290.6	9700	5301.5	99	107	206	5301.9	100	109	209	5302.5
Wadsworth Bypass (SH 121)	128.5			Bridge									
	129	75+32.9	5292.6	9700	5303.5	165	183	348	5303.9	100	165	265	5304.5
	130	79+96.62	5295.8	9700	5306.9	107	343	450	5306.9	110	235	345	5306.9
	131	85+10.26	5299.3	9700	5309.2	151	313	465	5309.6	165	250	415	5310.0
	132	90+47.05	5300.2	9700	5313.6	125	35	160	5313.5	80	63	143	5313.8
	133	92+50.58	5301.4	9700	5316.7	108	46	154	5316.7	108	46	154	5317.0
Old Wadsworth Blvd.	133.5			Bridge									
	134	93+39.9	5301.6	9700	5317.3	107	37	144	5317.3		142	142	5317.5
	135	94+82.84	5303.8	9700	5317.2	59	64	123	5317.0	89	64	153	5317.4
	136	101+45.3	5306.1	9700	5318.4	234	63	297	5318.8	140	40	180	5318.4
	137	108+35.3	5309.3	9700	5321.8	143	46	189	5321.7	100	44	144	5322.4
	138	113+04.81	5312.7	9700	5326.2	33	146	179	5326.0	33	102	135	5326.1
	139	119+80.64	5317.4	9700	5330.6	197	52	250	5331.1	160	40	200	5331.6
	140	122+55.79	5320.0	9700	5330.7	57	24	81	5331.1	50	67	117	5331.7
Carr Street	140.5			Bridge									

Table II-8 Ralston Creek 100-Year Floodway Data (Garrison Street to Oak Street)

Flooding Source				100-yr Floodplain Data		Floodway Data							
						0.5-foot rise in EGL				1.0-foot rise in EGL			
						Floodway Width (ft)			Floodway Elevation	Floodway Width (ft)			Floodway Elevation
Identification	Cross Section	Station	Thalweg Elevation (NAVD 88)	Discharge (cfs)	Flood Elevation (NAVD 88)	Left *	Right *	Total	(NAVD 88)	Left *	Right *	Total	(NAVD 88)
	141	123+37.71	5320.7	9700	5335.8	44	36	80	5336.0	40	40	80	5336.2
	142	125+98.96	5323.5	9700	5336.7	153	107	260	5336.9	48	77	125	5336.3
	143	130+14.98	5324.4	9700	5336.6	170	110	280	5337.1	47	113	160	5337.3
	144	133+10.38	5326.0	9700	5338.2	151	39	190	5338.2	111	44	155	5338.4
	145	139+09.27	5328.0	9700	5340.1	108	68	176	5339.6	103	68	171	5340.1
	146	142+73.45	5329.7	9700	5341.9	157	293	450	5341.8	111	146	257	5341.6
	146.5	147+86.13	5334.0	6795	5344.0	119	251	370	5344.5	105	220	325	5344.9
	147	153+17.	5336.0	6795	5346.4	35	295	330	5346.5	36	264	300	5347.2
	148	154+48.27	5336.8	6795	5346.7	20	405	425	5347.2	30	289	319	5347.4
Garrison Street	148.5			Bridge									
	149	155+21.24	5337.2	6795	5348.3	21	404	425	5348.1	32	327	359	5348.1
	150	156+18.29	5337.9	6795	5349.1	66	626	692	5349.3	42	371	413	5349.5
	150.5	160+24.56	5337.6	6795	5350.4	157	172	329	5350.9	102	60	162	5351.4
	151	164+47.66	5343.3	6795	5351.6	95	53	147	5351.6	50	65	115	5351.7
	152	168+72.67	5343.9	6795	5354.0	72	68	140	5353.3	59	56	115	5353.7
	153	174+18.08	5346.1	6795	5357.0	84	71	155	5356.6	53	62	115	5356.4
	154	176+17.96	5349.3	6795	5359.4	250	126	376	5358.7	260	26	286	5358.6
Brooks Drive	154.5			Culvert									
	155	176+92.51	5349.6	6795	5359.7	666	56	722	5359.7	415	30	445	5359.9
	155.5	180+33.21	5352.7	6795	5361.7	906	26	931	5362.3	499	272	771	5362.0
	156	184+29.78	5355.2	6795	5364.6	744	62	806	5364.9	526	62	588	5364.6
	157	185+49.15	5355.6	6795	5364.7	707	63	770	5364.9	461	93	554	5365.1
West 61st Avenue	157.5			Culvert									
	158	186+12.68	5356.2	6795	5365.0	640	233	873	5365.3	456	234	690	5365.8
	159	187+03.12	5356.8	6795	5366.0	692	312	1004	5366.4	404	312	716	5366.9
	160	190+53.1	5358.4	6795	5367.7	472	681	1154	5368.0	331	459	790	5368.7
	160.5	195+29.34	5361.4	6795	5370.5	131	547	678	5370.7	131	467	598	5371.2
	161	198+22.54	5362.6	6795	5372.7	131	509	640	5373.2	131	407	538	5373.4
	162	199+40.78	5363.3	6795	5373.7	144	541	685	5374.1	131	390	521	5374.6
Rensselaer	162.5			Culvert									
	163	200+14.95	5363.5	6795	5375.3	130	629	759	5375.4	128	247	375	5375.5
	164	204+25.69	5366.0	6795	5377.1	122	700	822	5377.3	164	385	549	5377.5
	165	209+72.36	5369.0	6795	5380.5	87	566	653	5380.9	87	506	593	5381.4
	166	216+58.19	5373.8	6795	5383.6	67	141	208	5384.1	67	83	150	5384.3
	167	222+22.18	5376.0	6795	5386.1	26	135	161	5385.3	20	144	164	5386.0
	168	224+51.48	5377.5	6795	5386.8	62	157	219	5386.6	62	98	160	5386.5
Miller Street	168.5			Bridge									
	169	225+59.49	5378.3	6795	5388.7	81	378	459	5388.0	80	95	175	5388.3
	170	226+74.96	5378.4	6795	5389.8	184	173	357	5389.8	51	151	202	5389.9
	171	231+89.62	5382.0	6795	5391.9	102	183	286	5392.1	54	156	210	5392.6
	172	235+34.22	5384.0	6795	5391.8	149	177	326	5392.2	21	154	175	5392.7
	173	239+63.88	5388.0	6795	5396.8	249	164	413	5396.5	80	291	371	5395.8
	174	243+03.82	5389.9	6795	5400.3	642	236	878	5400.7	98	255	353	5401.0
Oak Street	174.5			Culvert									
	175	243+80.17	5390.1	6795	5402.0	612	141	753	5402.3	142	118	260	5402.0
	176	248+07.65	5394.2	6795	5403.5	516	18	534	5403.6	133	45	178	5403.8
	177	250+92.67	5395.5	6795	5406.5	381	66	447	5406.3	99	58	157	5406.2
	178	254+80.72	5398.0	6795	5408.4	449	36	485	5408.5	341	38	379	5408.7

Table II-9 Ralston Creek 100-Year Floodway Data (West 68th Avenue to Indiana Street)

Flooding Source				100-yr Floodplain Data		Floodway Data							
						0.5-foot rise in EGL				1.0-foot rise in EGL			
						Floodway Width (ft)			Floodway Elevation	Floodway Width (ft)			Floodway Elevation
Identification	Cross Section	Station	Thalweg Elevation (NAVD 88)	Discharge (cfs)	Flood Elevation (NAVD 88)	Left *	Right *	Total	(NAVD 88)	Left *	Right *	Total	(NAVD 88)
West 68th Avenue	178.5			Bridge									
	179	255+57.1	5399.0	6795	5409.0	448	37	485	5409.4	322	36	358	5409.8
	180	258+67.08	5404.0	6795	5412.7	744	15	759	5413.1	678	15	693	5413.4
	180.5	262+18.63	5404.9	6795	5413.9	515	38	553	5414.4	426	38	464	5414.8
	181	266+32.1	5414.0	6795	5418.3	422	120	543	5418.6	145	92	237	5418.5
	182	272+16.49	5415.7	6795	5422.0	116	39	155	5422.3	145	58	203	5422.4
	183	276+18.79	5417.7	4521	5423.0	78	67	145	5423.3	69	32	101	5423.3
	183.5	278+63.56	5419.4	4521	5425.7	54	11	65	5425.7	51	9	60	5425.8
	184	279+25.67	5420.0	4521	5426.9	40	30	70	5426.9	30	31	61	5426.9
Simms Street	184.5			Bridge									
	185	280+02.18	5420.0	4521	5429.6	36	34	70	5430.0	42	42	84	5430.2
	186	283+93.25	5421.9	4521	5430.6	14	79	94	5430.6	23	64	87	5430.7
	187	287+52.75	5424.0	4521	5431.4	76	74	150	5431.9	39	64	103	5431.9
	188	290+82.77	5426.6	4521	5434.3	61	55	116	5433.9	45	45	90	5434.5
	189	294+12.27	5429.2	4521	5436.6	52	90	142	5436.8	52	60	112	5437.4
	190	294+74.03	5429.6	4521	5438.0	41	92	133	5438.3	54	66	120	5438.3
	191	294+87.6	5430.8	4521	5438.7	50	126	176	5439.2	54	66	120	5438.4
	192	298+04.3	5433.8	4521	5442.5	78	272	350	5442.7	77	273	350	5442.5
	193	303+86.81	5441.2	4521	5447.1	43	517	560	5447.3	48	326	374	5447.8
	194	308+19.18	5443.7	4521	5452.0	42	133	175	5451.7	41	134	175	5451.6
Ward Road	194.5			Bridge									
	195	309+17.56	5443.6	4521	5453.3	189	161	350	5453.0	73	92	165	5453.2
	196	315+58.43	5448.6	4521	5457.0	30	232	262	5456.7	30	193	223	5457.0
	197	321+85.17	5454.0	4521	5461.2	29	88	118	5461.6	24	71	95	5461.9
	198	324+84.28	5455.9	4521	5463.9	43	84	127	5463.7	43	38	81	5464.0
	199	331+30.84	5462.2	4521	5468.1	99	25	124	5468.4	99	25	124	5468.7
	200	337+82.66	5469.8	4521	5474.1	124	13	137	5474.2	104	11	115	5474.4
	201	344+31.33	5476.0	4521	5481.4	49	69	118	5481.5	41	54	95	5481.9
Beech Street	201.5			Bridge									
	202	345+10.37	5478.0	4521	5484.0	78	72	150	5484.0	78	81	159	5484.0
	203	351+60.15	5482.0	4389	5487.7	76	168	244	5487.7	40	120	160	5488.6
	204	357+92.11	5487.9	4389	5492.5	166	36	202	5492.8	130	36	166	5492.9
	205	364+29.5	5491.5	4389	5497.9	99	58	158	5498.0	76	44	120	5498.4
	206	368+37.01	5496.0	4389	5502.7	79	39	118	5502.5	63	35	98	5502.7
	207	371+39.83	5499.8	4389	5509.2	32	34	66	5509.7	35	36	71	5510.0
Eldridge Street	207.5			Bridge		0	0						
	208	372+25.13	5501.0	4389	5511.8	36	159	195	5510.4	38	39	77	5509.7
	209	375+21.61	5501.9	4389	5511.9	45	75	120	5511.7	30	45	75	5511.4
	210	380+36.59	5506.0	4389	5514.0	41	64	105	5514.5	41	64	105	5514.5
	211	387+83.33	5511.7	4398	5519.6	10	185	196	5519.7	49	101	150	5520.1
	212	398+52.87	5517.1	4398	5523.3	75	54	129	5523.6	58	36	94	5524.0
	213	407+42.06	5522.8	4398	5529.4	100	100	200	5529.6	100	100	200	5529.7
	214	415+64.97	5530.0	4398	5535.1	169	192	361	5535.3	156	144	300	5535.5
	215	417+65.31	5531.0	4398	5536.4	49	39	88	5536.3	42	42	84	5536.9
Indiana Street	215.5			Bridge									
	216	419+15.34	5531.1	4398	5540.2	65	16	81	5540.2	65	16	81	5540.2
	217	423+04.	5534.5	4409	5542.7	98	127	225	5542.6	98	72	170	5542.7
	218	429+34.13	5539.9	4409	5546.8	140	112	252	5547.1	102	68	170	5547.3

Table II-10 Ralston Creek 100-Year Floodway Data (Joyce Street to Arvada/Blunn Reservoir)

Flooding Source				100-yr Floodplain Data		Floodway Data							
						0.5-foot rise in EGL				1.0-foot rise in EGL			
						Floodway Width (ft)				Floodway Width (ft)			
Identification	Cross Section	Station	Thalweg Elevation (NAVD 88)	Discharge (cfs)	Flood Elevation (NAVD 88)	Left *	Right *	Total	Floodway Elevation (NAVD 88)	Left *	Right *	Total	Floodway Elevation (NAVD 88)
	219	430+56.16	5539.6	4409	5546.8	84	13	98	5547.2	48	49	97	5547.8
Joyce Street	219.5			Bridge									
	220	431+23.25	5541.5	4409	5550.5	81	19	100	5550.3	48	49	97	5551.1
	221	434+36.46	5545.1	4409	5553.4	87	124	211	5553.5	43	85	128	5553.5
	221.5	437+03.97	5546.4	4409	5556.6	234	12	246	5557.0	122	9	131	5556.9
	222	442+48.94	5552.7	4409	5563.1	159	20	179	5563.4	134	20	154	5563.6
	223	445+56.73	5555.0	4409	5567.0	46	64	110	5567.3	48	62	110	5567.6
	224	446+21.49	5556.0	4409	5567.3	23	27	50	5567.0	34	33	67	5567.6
	224.5	446+62.96	5566.0	4409	5571.8	174	26	200	5572.4	169	31	200	5572.4
	225	447+23.33	5567.1	4409	5574.1	169	32	201	5574.1	169	32	201	5574.2
	226	447+63.82	5567.4	4409	5575.5	293	28	321	5575.2	73	28	101	5574.3
	227	450+41.73	5569.4	4440	5575.9	279	104	383	5576.1	209	104	313	5576.9
	228	454+70.57	5570.6	4440	5576.4	231	9	240	5576.5	231	59	290	5577.3
	229	459+54.96	5570.6	4440	5582.0	431	251	682	5581.9	249	25	274	5581.9
	230	464+15.13	5579.2	4440	5586.0	69	53	121	5586.8	61	53	114	5586.7
	231	465+45.2	5579.9	4440	5588.1	73	60	133	5588.3	30	60	90	5588.3
	232	467+13.83	5581.0	4440	5590.5	15	74	89	5590.5	18	75	93	5591.2
	233	470+38.34	5585.3	4440	5592.7	113	87	200	5592.9	94	72	166	5593.0
	234	473+72.06	5588.3	4440	5596.7	162	66	227	5596.0	97	75	172	5597.3
	235	476+85.01	5587.5	4440	5599.6	46	28	75	5599.3	45	29	74	5599.3
	236	482+15.65	5597.0	4440	5604.6	12	41	53	5604.6	12	41	53	5604.6
Quaker Street	236.5			Mult Open									
	237	483+83.01	5597.9	4440	5609.7	16	41	57	5609.4	16	41	57	5609.4
	238	489+91.94	5606.8	4440	5615.2	39	70	115	5615.1	39	76	115	5615.1
	239	496+34.72	5617.0	4440	5622.7	115	125	240	5622.9	97	25	122	5622.9
	240	501+16.3	5622.6	4440	5629.2	34	165	199	5629.2	37	97	134	5629.2
	240.5	505+08.86	5626.0	4440	5634.9	45	52	97	5634.2	45	52	97	5634.2
	241	509+58.16	5632.0	4440	5639.1	29	255	284	5639.3	20	236	256	5639.9
	242	513+50.66	5636.9	4440	5643.2	54	44	98	5643.2	45	53	98	5643.2
	243	516+79.31	5640.9	4440	5646.7	74	111	185	5646.6	60	114	174	5646.8
	244	517+36.86	5640.8	4440	5648.0	57	84	141	5648.0	55	105	160	5648.0
	245	518+49.93	5645.1	4440	5652.7	250	162	412	5653.1	218	112	330	5653.4
	246	519+40.81	5649.0	4440	5654.0	108	210	318	5654.6	65	120	185	5654.9
	246.5	522+38.49	5653.5	4440	5658.8	65	154	219	5658.9	65	116	181	5659.2
	247	524+91.32	5657.5	4440	5663.2	56	114	170	5663.2	52	77	129	5663.5
	248	525+84.05	5658.7	4440	5664.5	98	162	260	5664.9	143	227	370	5665.5
Arvada-Blunn Reservoir Discharge	249	530+50.13	5662.0	10	5665.4	22	14	36	5665.7	22	14	36	5665.9
	249.5	533+25.18	5665.6	10	5666.5	11	13	24	5666.5	11	13	24	5666.5

Table II-11 Leyden Creek Floodplain Data

Flooding Source				10-yr Floodplain Data		50-yr Floodplain Data		500-yr Floodplain Data	
Identification	Cross Section	Station	Thalweg Elevation (NAVD 88)	Discharge (cfs)	Flood Elevation (NAVD 88)	Discharge (cfs)	Flood Elevation (NAVD 88)	Discharge (cfs)	Flood Elevation (NAVD 88)
Upstream of Ralston Creek Confluence	500	3+74.92	5665.6	933	5421.5	1994	5423.2	3252	5424.9
	501	10+81.85	5424.0	933	5428.5	1994	5429.2	3252	5429.3
Simms Street	502	15+42.21	5427.3	933	5432.5	1994	5433.2	3252	5433.2
	503	16+03.22	5427.8	933	5432.8	1994	5433.9	3252	5434.5
	504	21+10.11	5431.4	933	5436.7	1994	5437.6	3252	5437.8
	504.5	24+13.39	5434.0	933	5438.0	1994	5439.4	3252	5439.8
W. 72nd Avenue	505	28+42.95	5436.0	933	5440.7	1994	5442.2	3252	5442.6
	506	29+20.95	5436.8	933	5443.1	1994	5445.4	3252	5444.7
	507	32+76.14	5438.0	832	5443.1	1792	5445.1	2876	5444.1
	508	37+91.38	5441.8	832	5446.8	1792	5449.2	2876	5449.4
	509	44+95.33	5440.0	832	5448.4	1792	5450.1	2876	5450.4
	510	50+32.14	5452.0	568	5453.9	1251	5454.6	2247	5455.3
	511	57+91.78	5456.5	568	5459.6	1251	5460.3	2247	5460.3
	511.5	63+83.39	5460.0	391	5461.9	842	5461.8	2247	5463.4
	512	70+27.21	5463.3	391	5464.5	842	5465.7	2247	5467.2
W. 75th Place	513	76+35.97	5466.4	391	5469.0	842	5469.4	2247	5470.5
	514	78+00.98	5466.0	391	5473.0	842	5473.9	2247	5474.0
	514.5	84+42.74	5472.6	391	5473.2	842	5474.3	2247	5475.3
	515	89+07.63	5474.5	391	5477.1	842	5477.2	2247	5478.3
	516	94+71.81	5480.0	391	5484.0	842	5485.2	2247	5486.6
	517	95+50.32	5480.7	391	5485.1	842	5486.6	2247	5487.2
	517.5	99+15.94	5485.0	391	5486.5	842	5487.8	2247	5489.8
Alkire Street	518	105+30.25	5487.7	391	5490.8	842	5492.6	2247	5494.3
	519	105+92.86	5488.0	391	5494.5	842	5494.8	2247	5495.1
	520	110+08.90	5493.8	134	5494.9	148	5495.0	2247	5497.8
	520.25	112+46.51	5495.0	134	5497.2	148	5497.2	2247	5500.9
	520.75	120+48.62	5498.7	134	5500.8	148	5500.9	2247	5504.2
	521	125+46.32	5501.5	134	5503.3	148	5503.4	2247	5507.4
	521.25	129+10.15	5506.0	134	5507.5	148	5507.6	2247	5512.5
	521.75	133+05.45	5508.6	134	5510.7	148	5510.8	2247	5514.6
	522	140+54.69	5517.0	134	5517.6	148	5517.6	2247	5519.7
	522.5	145+85.54	5520.6	134	5522.0	148	5522.0	2247	5524.2
	523	151+18.01	5529.2	134	5530.4	148	5530.4	2247	5532.5
	524	155+82.10	5536.0	134	5536.7	148	5536.7	2247	5537.9
	525	162+07.97	5538.8	134	5540.6	148	5540.7	2247	5544.1
	525.5	167+56.46	5545.4	134	5546.1	148	5546.1	2247	5548.0
	526	171+47.00	5550.0	134	5551.1	148	5551.1	2247	5553.0
Croke Canal	527	175+03.30	5552.3	134	5554.9	148	5555.0	2247	5557.7
	528	176+19.79	5553.1	134	5560.4	148	5562.6	2247	5562.2
Indiana Street	529	177+18.45	5553.5	134	5560.4	148	5562.6	2247	5562.2
	530	177+85.05	5554.8	134	5563.9	148	5564.6	2247	5565.5
	531	180+66.88	5561.7	134	5563.8	148	5564.5	2247	5567.6

Table II-12 Leyden Creek 100-Year Floodway Data

Flooding Source				100-yr Floodplain Data		Floodway Data							
						0.5-foot rise in EGL				1.0-foot rise in EGL			
						Floodway Width (ft)			Floodway Elevation	Floodway Width (ft)			Floodway Elevation
Identification	Cross Section	Station	Thalweg Elevation (NAVD 88)	Discharge (cfs)	Flood Elevation (NAVD 88)	Left *	Right *	Total	(NAVD 88)	Left *	Right *	Total	(NAVD 88)
Upstream of Ralston Creek Confluence	500	3+74.92	5665.6	2456	5423.8	26	89	115	5424.3	26	89	115	5423.8
	501	10+81.85	5424.0	2456	5429.1	11	212	222	5429.3	11	137	148	5429.6
Simms Street	502	15+42.21	5427.3	2456	5433.0	11	278	289	5433.3	11	169	180	5433.6
	503	16+03.22	5427.8	2456	5434.2	65	60	125	5434.0	35	39	74	5434.2
	504	21+10.11	5431.4	2456	5437.5	177	86	263	5437.7	83	86	169	5438.2
	504.5	24+13.39	5434.0	2456	5439.5	150	9	158	5439.6	70	26	96	5439.6
W. 72nd Avenue	505	28+42.95	5436.0	2456	5442.2	210	40	250	5442.5	60	40	100	5442.6
	506	29+20.95	5436.8	2456	5444.4	178	20	198	5444.3	58	20	78	5443.3
	507	32+76.14	5438.0	2192	5444.0	35	23	58	5444.1	43	44	87	5444.8
	508	37+91.38	5441.8	2192	5449.1	7	298	304	5449.4	37	80	117	5449.4
	509	44+95.33	5440.0	2192	5450.0	94	107	200	5450.4	25	93	118	5451.0
	510	50+32.14	5452.0	1519	5454.8	135	23	158	5455.2	117	23	140	5455.6
	511	57+91.78	5456.5	1519	5460.8	32	64	96	5460.8	32	26	59	5460.9
	511.5	63+83.39	5460.0	1035	5463.1	41	36	77	5463.3	41	36	77	5463.7
	512	70+27.21	5463.3	1035	5465.5	35	34	69	5465.5	35	34	69	5465.5
W. 75th Place	513	76+35.97	5466.4	1035	5470.0	40	85	125	5470.0	40	85	125	5470.0
	514	78+00.98	5466.0	1035	5473.5	55	52	107	5473.5	36	39	75	5474.4
	514.5	84+42.74	5472.6	1035	5474.2	96	86	182	5474.4	96	86	182	5474.9
	515	89+07.63	5474.5	1035	5477.8	102	46	148	5477.6	102	46	148	5477.2
	516	94+71.81	5480.0	1035	5485.5	29	25	54	5485.5	21	18	39	5485.8
	517	95+50.32	5480.7	1035	5486.4	39	36	75	5486.9	21	36	57	5487.1
	517.5	99+15.94	5485.0	1035	5488.0	40	44	84	5488.2	40	44	84	5488.2
Alkire Street	518	105+30.25	5487.7	1035	5493.7	31	529	560	5493.1	21	6	27	5493.0
	519	105+92.86	5488.0	1035	5494.8	13	12	25	5494.1	13	12	25	5494.1
	520	110+08.90	5493.8	373	5495.6	16	18	34	5495.8	16	12	28	5496.0
	520.25	112+46.51	5495.0	373	5498.0	24	4	28	5498.1	24	4	28	5498.3
	520.75	120+48.62	5498.7	373	5502.1	15	14	28	5502.1	15	14	28	5502.0
	521	125+46.32	5501.5	373	5504.3	10	18	28	5504.3	10	18	28	5504.4
	521.25	129+10.15	5506.0	373	5508.5	12	8	20	5508.6	12	8	20	5508.6
	521.75	133+05.45	5508.6	373	5511.8	19	7	26	5512.0	19	7	26	5512.0
	522	140+54.69	5517.0	373	5518.2	21	25	46	5518.3	12	18	30	5518.7
	522.5	145+85.54	5520.6	373	5522.4	24	26	50	5522.6	16	12	28	5523.1
	523	151+18.01	5529.2	373	5530.9	42	8	50	5530.9	28	0	28	5531.3
	524	155+82.10	5536.0	373	5536.9	28	85	113	5537.2	28	33	61	5537.6
	525	162+07.97	5538.8	373	5541.4	13	17	30	5541.6	13	17	30	5541.7
	525.5	167+56.46	5545.4	373	5546.4	41	19	60	5546.7	21	19	40	5547.0
	526	171+47.00	5550.0	373	5551.5	43	36	79	5551.5	20	20	40	5551.7
Croke Canal	527	175+03.30	5552.3	373	5556.3	57	12	68	5556.3	57	12	68	5556.3
	528	176+19.79	5553.1	373	5560.9	32	29	60	5560.9	32	29	60	5561.8
Indiana Street	529	177+18.45	5553.5	373	5560.9	36	31	67	5560.9	36	31	67	5561.8
	530	177+85.05	5554.8	373	5564.3	55	27	82	5564.3	55	27	82	5565.2
	531	180+66.88	5561.7	373	5564.2	15	21	36	5564.2	15	21	36	5565.0

III. DECISION AIDS

GENERAL

A private meteorologist service (PMS), retained by 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. Flood conditions can be anticipated from the forecast. Measured rainfall and the site-specific decision aids and urban flash flood guidance are provided herein. Updates to the decision aids included with this warning plan will be made as experience is gained and more data become available.

The ALERT system is an automated flood detection network consisting of self-reporting rain, stream, weather, and reservoir gages that relay data using battery-powered VHF radios. The ALERT network in the basin consists of multiple stations that measure rainfall, stream, weather, and reservoir information. These gages are part of a much larger network operated by UDFCD. ALERT receiving base stations located at UDFCD's main office and the UDFCD Flood Prediction Center (FPC) collect and display data from the ALERT network in real-time. The UDFCD base stations also host web services that allow users to view information over the Internet. 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 are 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 the use of available decision aids. Simplified charts, tables, computer graphics and hydrologic models are the principle decision aids used to forecast flood conditions for specific problem areas. Sections IV through VIII contain additional information concerning PMS operations and responsibilities.

Flood warning plan participants and local emergency response personnel have access to the current PMS forecast (pager, email, fax, or Internet…http://f2p2.udfcd.org). ALERT gage data are available from Internet websites maintained by UDFCD (http://alert.udfcd.org and http://alert2.udfcd.org). Individuals should make their own assessments of the flood threat by using the gage data, the PMS and NWS forecasts and any observations obtained from field personnel (police, sheriff, fire, public works, etc.) or other reliable sources. Close coordination with public safety agencies should be maintained throughout this process.

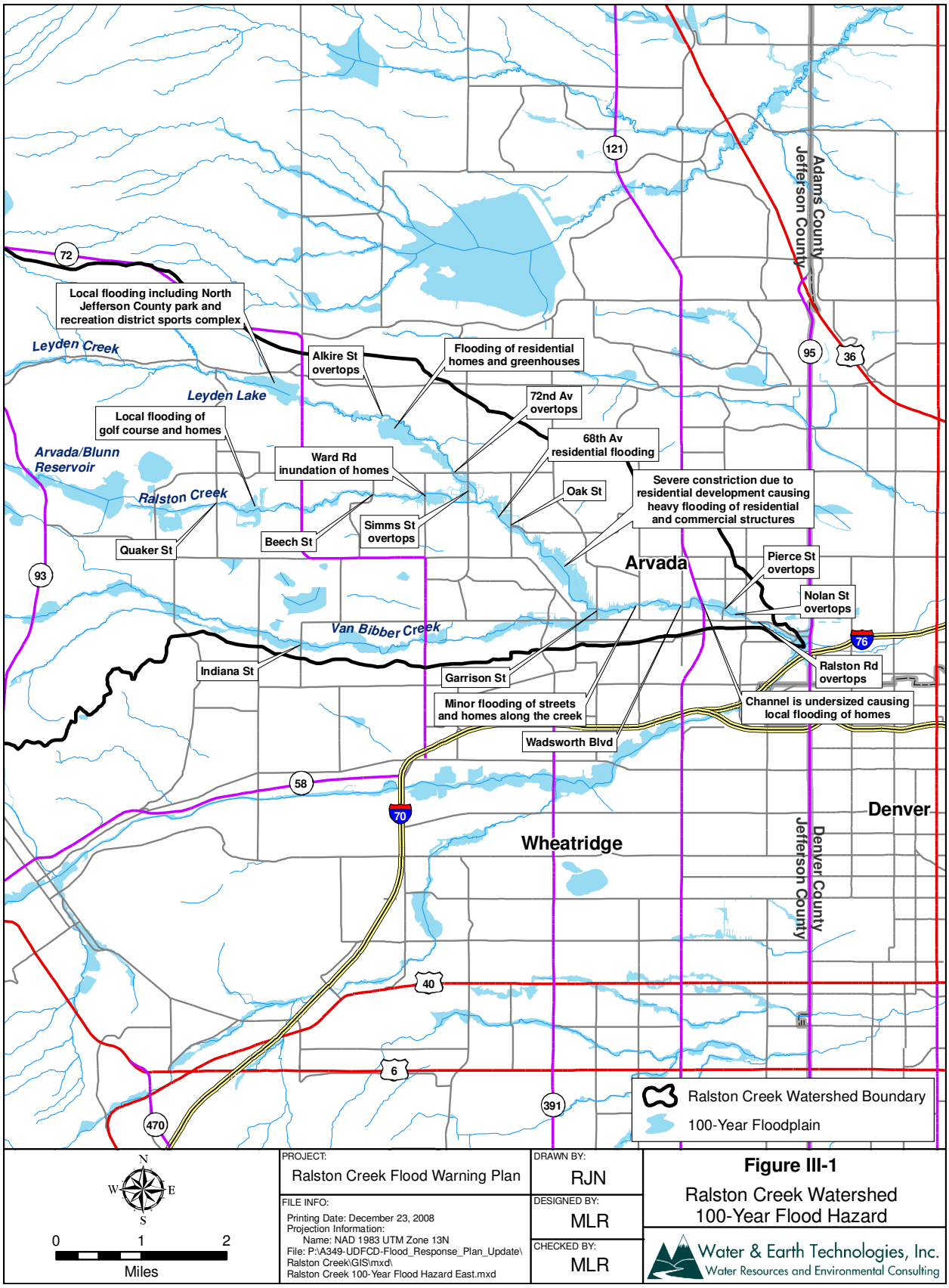
The following decision aids are contained in this section of the warning plan:

1. **Approximate Flood Hazard Areas** (Figure III-1**).** These maps show the approximate boundary of the 100-year floodplain. Brochures prepared from these GIS maps are distributed annually by the District to residences and businesses located in or near the respective floodplains.
2. **ALERT Flood Detection Network** (Figure III-2**).** This map shows the location of all ALERT gaging stations within the basin and in surrounding areas.
3. **ALERT System Summary** (Table III-1**).** This table provides basic information regarding each gage in the drainage basin.
4. **Urban Flash Flood Guidance** (Table III-2**).** This table provides very basic rule-of-thumb guidance to associate forecast or measured rainfall amounts with the type of flooding produced from heavy rainstorms that occur over urban areas.
5. **Two Hour Convective Storm Characteristics.** (Table III-3). This table is used to estimate the frequency of either forecast or measured point rainfall. Both the total rainfall and intensity columns need to be carefully considered in making this estimate. This table is designed for use by trained technical personnel (hydrologists and hydro-meteorologists). In translating an estimate of precipitation frequency into a flood prediction for a specific point, the user must also estimate the spatial distribution of rain from the ALERT gages, radar, or detailed quantitative precipitation forecast (QPF); and then calculate either a total basin average or contributing drainage area relative to storm size. Hydrologic Forecast Point (HFP) Guidance can then be used to predict flooding for specific locations.
6. **Mountain Stream Flash Flood Guidnace.** This graph (

Nomograph III-1) provides very basic rule-of-thumb guidance to help predict the magnitude of mountain stream/canyon flooding from either forecast or observed rainfall. The watershed's antecedent moisture condition and the maximum one-hour, ten square mile rainfall average must be estimated to properly use this graph.

7. **Hydrologic Forecast Point (HFP) Guidance.** A location map showing each HFP within the drainage basin is shown (Figure III-3) along with a description of each HFP location (Table III-4). Site-specific flash flood guidance for each HFP is provided on subsequent pages. Certain HFPs are co-located with ALERT stream gages. HFP decision aids can be used with either forecast or measured rainfall to anticipate flooding for known problem areas (i.e. developed floodplains, road crossings, depressions, low-lying areas, reservoirs, detention basins, etc.).
8. **Stage Sensor Computer Graphics.** Real-time displays of current water levels and basin rainfall have been developed for ALERT base station operations. These displays update automatically as data are received. Each graphics template provides information regarding local problem areas, historic floods, flood frequency data, alarm levels, elevation data and structure dimensions.

Figure III-1 100-Year Floodplain Boundary and Flood Hazard Areas



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 to occur. Table III-2 should be used to estimate the flood potential and decision-makers should consider the recommended actions. Table III-3 and the HFP decision aids (Table III-4) should than be checked to determine if the forecast rainfall will cause problems at or near the HFPs. If no problems are anticipated based on this review, a normal level of vigilance should be maintained. However, if the decision aids indicate a dangerous flood potential, a higher level of awareness should be maintained.

Decision makers should analyze flood threat once rainfall has begun and the gages are reporting. To generate a flood projection, determine the maximum 10-, 30- and 60-minute rainfall amounts that have occurred or are projected based on measured rainfall and other meteorological information (radar, satellite imagery, upper air soundings, surface weather data, etc.). Continue to make projections until the rainfall event has passed, problems have occurred, or the threat no longer exists.

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. <u>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</u>.

It is imperative to implement the warning and response elements of this plan once a significant flood hazard exists.

Figure III-2 ALERT Flood Detection Network

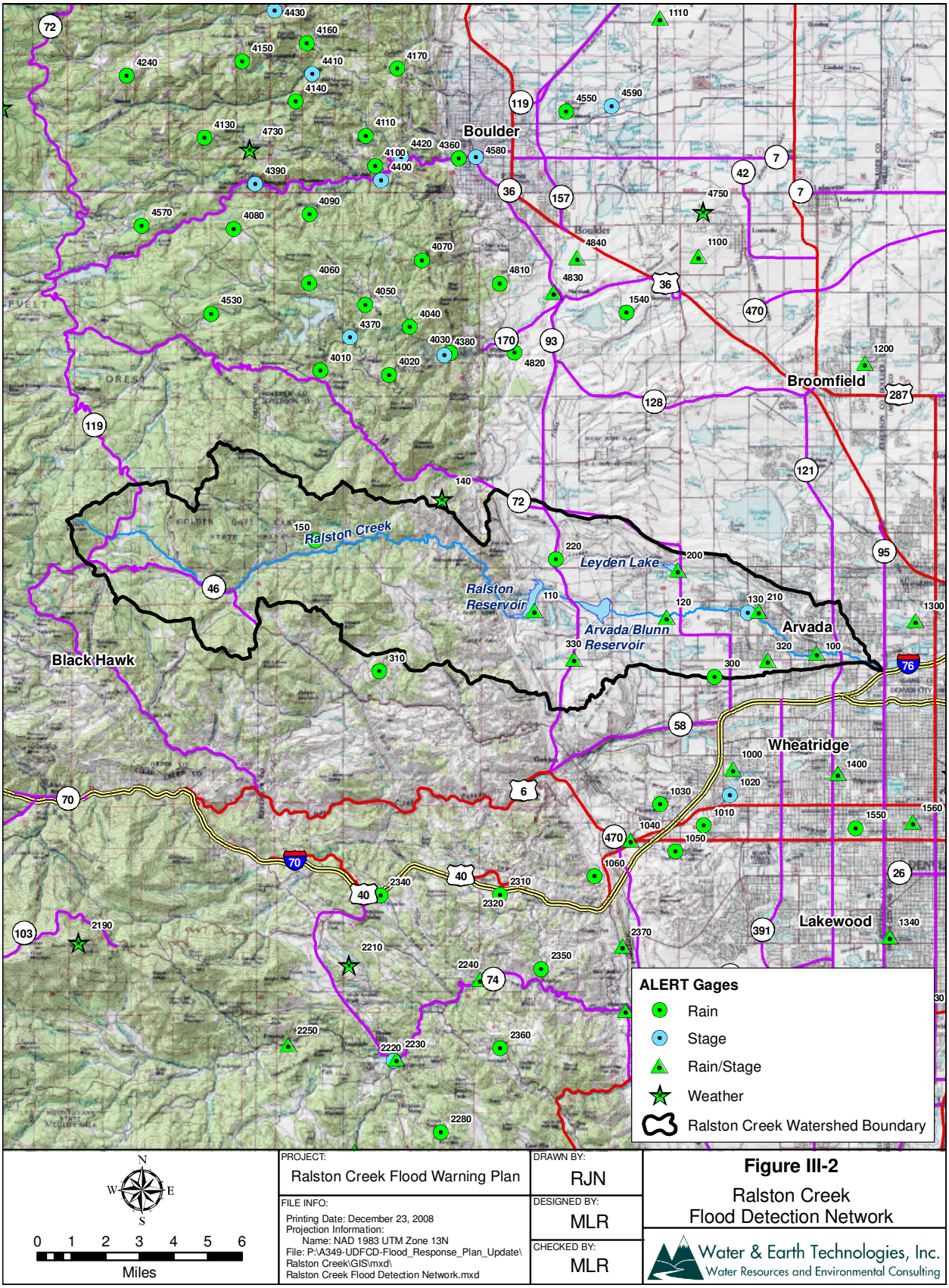


Table III-1 Ralston Creek ALERT Flood Detection Network

I.D. #	STATION NAME	GAGE TYPE	Install Date	Elev (ft)	Location (Lat./Long.)
100	Carr Street	Rain/Stage	1988/05/30	5322	39:48:17 N 105:05:27 W
110	Ralston Reservoir	Rain/Stage	1988/09/23	6033	39:49:22 N 105:14:46 W
120	West Woods	Rain/Stage	1989/08/02	5590	39:49:12 N 105:10:24 W
130	Simms Street	Stage	1990/10/25	5430	39:49:19 N 105:07:41 W
140	Blue Mountain	Weather	1991/04/25	8050	39:52:12 N 105:17:48 W
150	Nott Creek	Rain	1991/04/09	7815	39:51:08 N 105:21:58 W
200	Leyden Reservoir	Rain/Stage	1988/05/30	5603	39:50:24 N 105:10:02 W
210	Leyden Confluence	Rain/Stage	1989/08/02	5430	39:49:21 N 105:07:22 W
220	Upper Leyden	Rain	1990/08/14	6000	39:50:40 N 105:14:02 W
300	Van Bibber Park	Rain	1988/09/23	5525	39:47:41 N 105:08:47 W
310	Guy Hill Ranch	Rain	1988/05/30	8320	39:47:48 N 105:19:51 W
320	Sports Complex	Rain/Stage	1989/07/03	5420	39:48:06 N 105:07:04 W
330	Van Bibber @ Hwy 93	Rain/Stage	1990/08/14	5900	39:48:08 N 105:13:27 W

Table III-2 Urban Flash Flood Guidance

FORECAST RAINFALL	FLOOD POTENTIAL	RECOMMENDED ACTIONS
Total Amt less than 1.0”	Streets, low-lying areas, intersections	Prepare for routine nuisance flooding
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 judgment on when to warn public, maintain contact with meteorologist

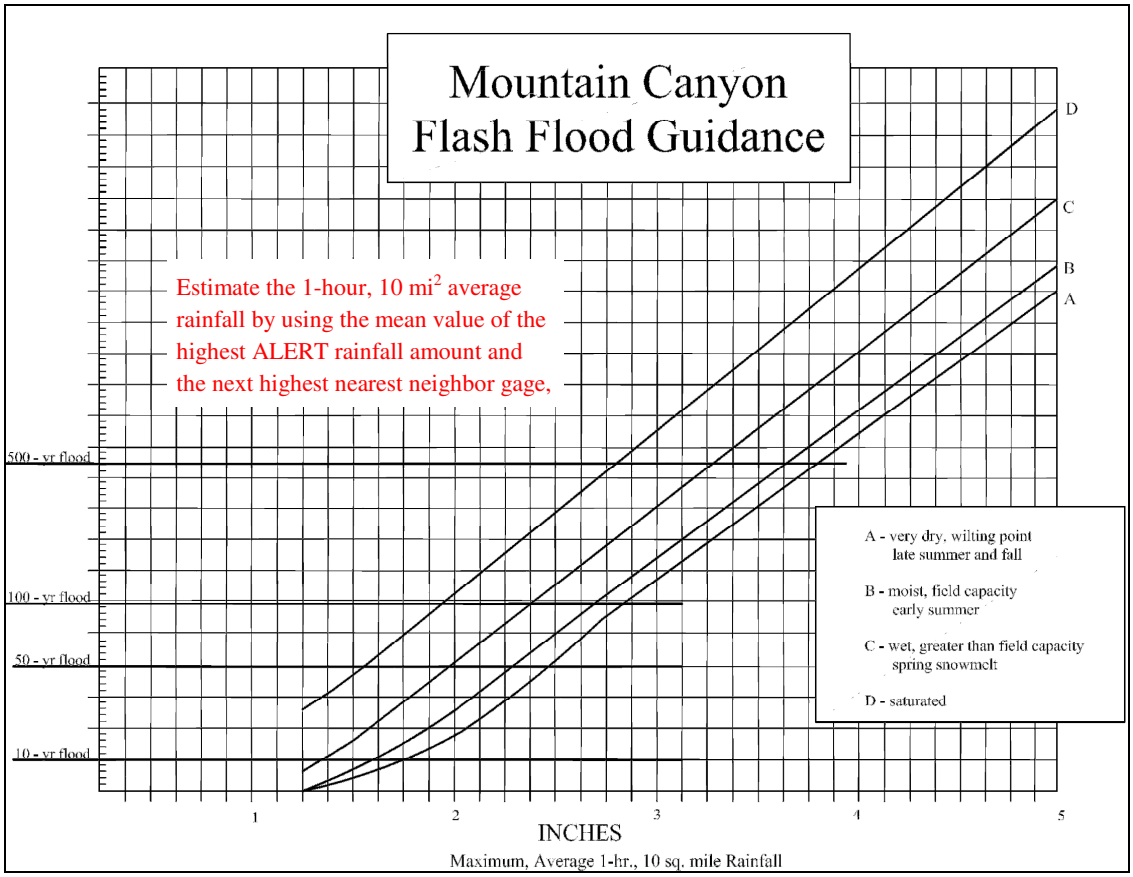
Table III-3 Convective Storm Characteristics (All depths in inches)

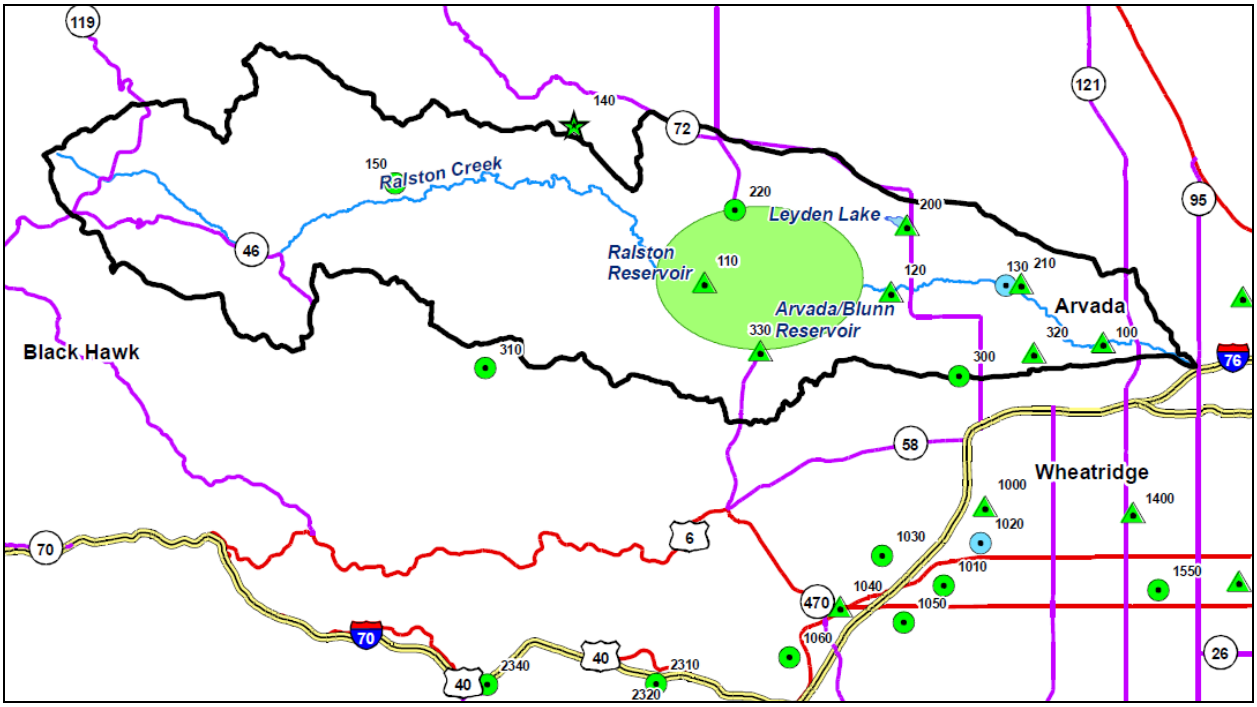
Rainfall Frequency / Probability	10-minute Rainfall Depth	30-minute Rainfall Depth	1-hour Rainfall Depth	2-hour Rainfall Depth
2-year / 50%	0.4	0.8	1.0	1.2
5-year / 20%	0.5	1.0	1.4	1.6
10-year / 10%	0.6	1.2	1.6	1.9
25-year / 4%	0.7	1.4	1.9	2.2
50-year / 2%	0.8	1.6	2.2	2.6
100-year / 1%	1.0	1.9	2.6	3.0

NOTES:

1) For "rainfall frequency" to equal "flood frequency," the coverage of rainfall must be over the entire upstream basin.
2) Tables III-2 and III-3 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.

Nomograph III-1 Mountain Stream Flash Flood Guidance





NOTE: The green-shaded ellipse above represents a 10 square mile area.

Figure III-3 Hydrologic Forecast Point Guidance

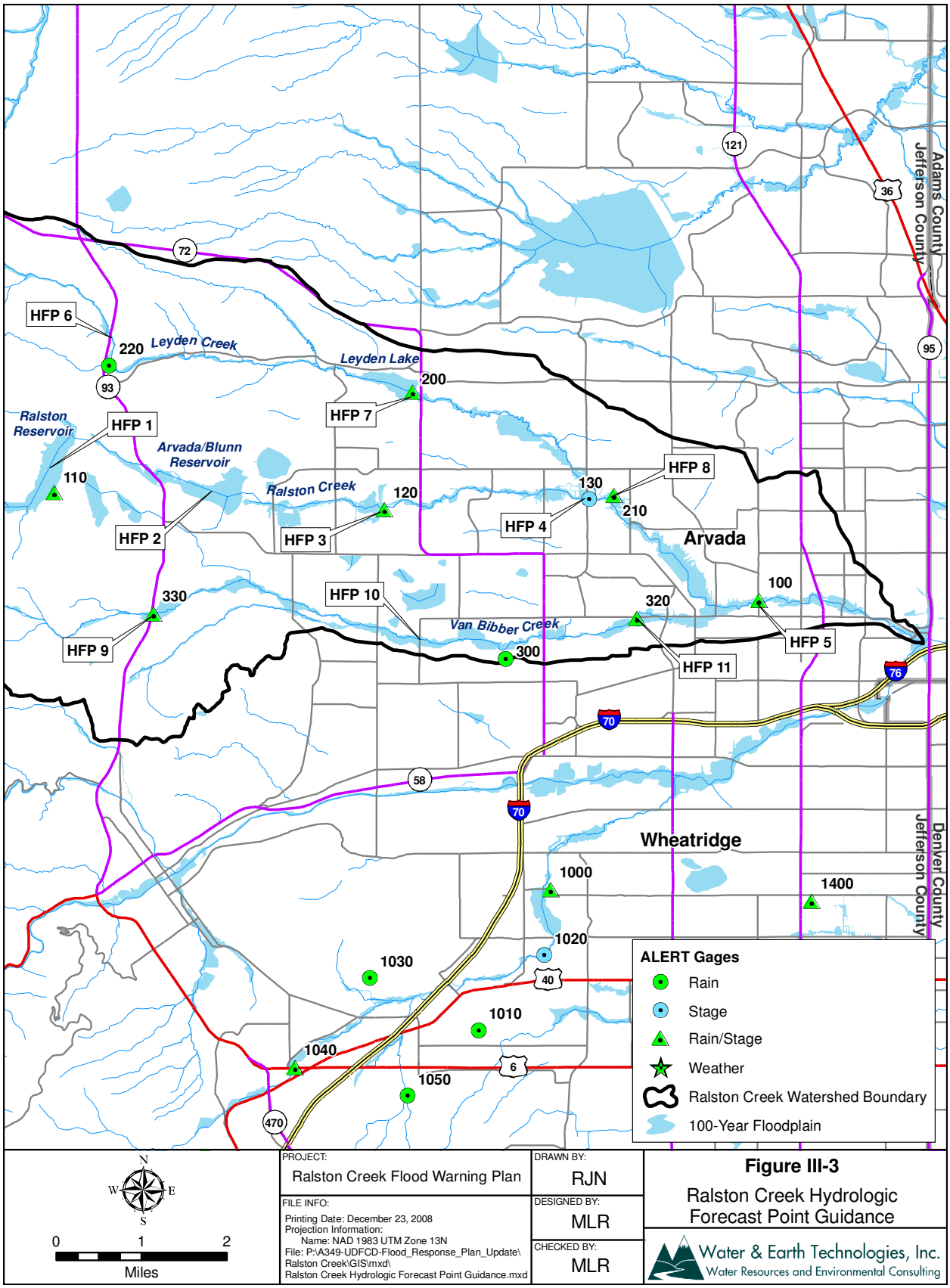
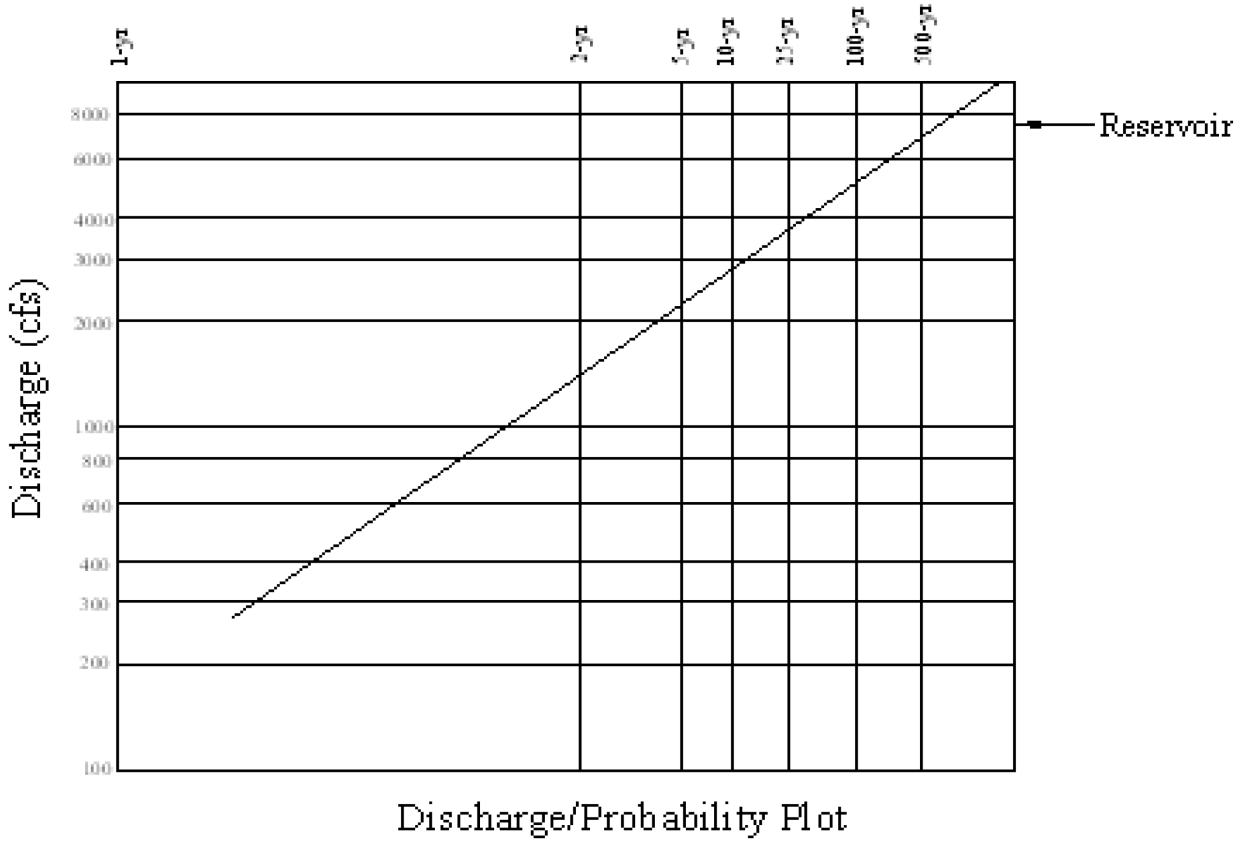


Table III-4 Hydrologic Forecast Point Location Descriptions

Hydrologic Forecast Point (HPF)	Description
HFP No. 1	Ralston Creek at Ralston Reservoir (ID 113)
HFP No. 2	Ralston Creek at Arvada Reservoir (no stage gage at location)
HFP No. 3	Ralston Creek at Croke Canal (ID 123)
HFP No. 4	Ralston Creek at Simms (ID 133)
HFP No. 5	Ralston Creek at Carr Street (ID 103)
HFP No. 6	Leyden Creek at Highway 93 (no stage gage at location)
HFP No. 7	Leyden Creek at Leyden Reservoir (ID 203)
HFP No. 8	Leyden Creek at Ralston Confluence (ID 213)
HFP No. 9	Van Bibber Creek at Highway 93 (ID 333)
HFP No. 10	Van Bibber Creek at Indiana Street (no stage gage at location)
HFP No. 11	Van Bibber Creek at 58th Avenue (ID 323)

The following pages contain site-specific flash flood guidance nomographs for each HFP. Certain HFPs are co-located with ALERT stream gages. The nomograph anticipates flooding for known problem areas (i.e. developed floodplains, road crossings, depressions, low-lying areas, reservoirs, detention basins, etc.) using forecast rainfall or measured rainfall. The output from the nomograph provides a decision aid to support the evaluation of flooding for critical areas.

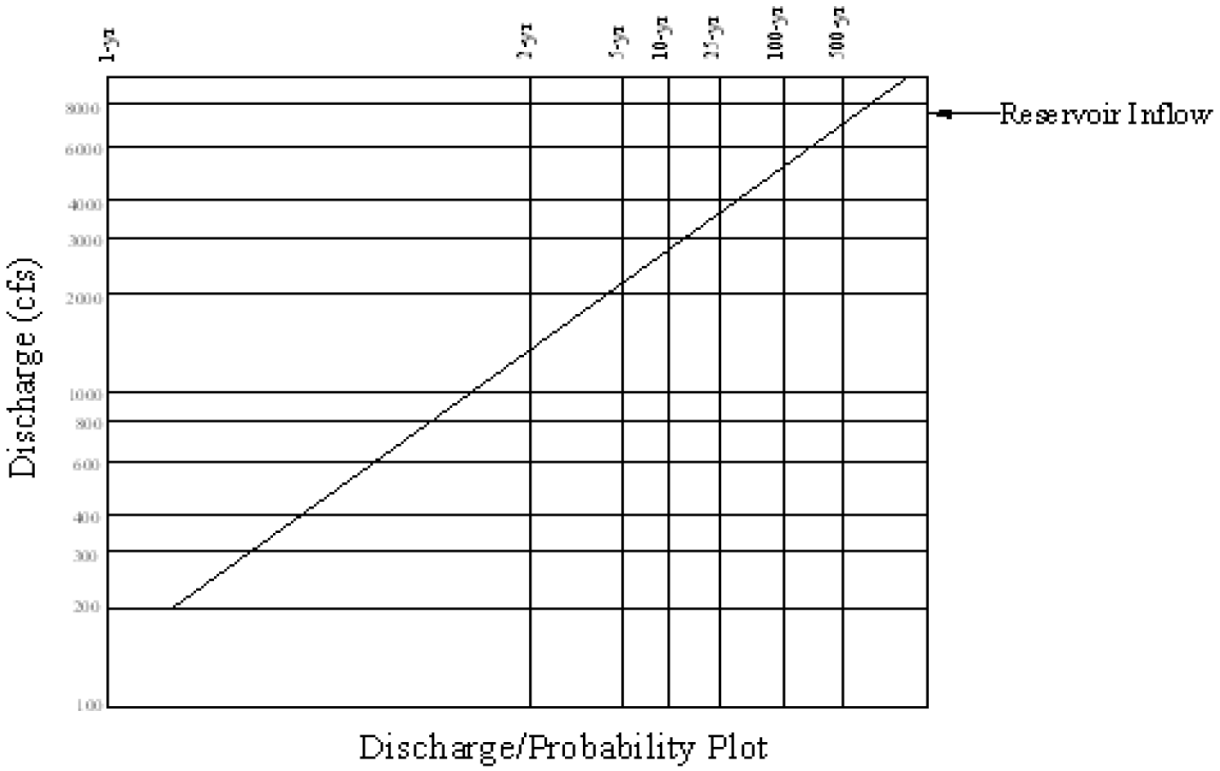
Flood Warning System:
Location: HFP#1-Ralston Creek at Ralston Reservoir



Station Name: Ralston Creek at Ralston Reservoir
Station Gage ID: 113
Rain Gage ID(s): 110
Structures: Water Supply Reservoir
Capacity: n/a
Drainage Area: 40.4 sq. mi.
Stream Station: n/a
Drawing Nos. n/a
Study Reference: na/

Problem Areas & Tech Notes:
1) Q/P plot is provided for information purposes only.
2) Elevator should monitor the reservoir water level carefully and make outflow prediction based on an estimate of basin average rainfall.

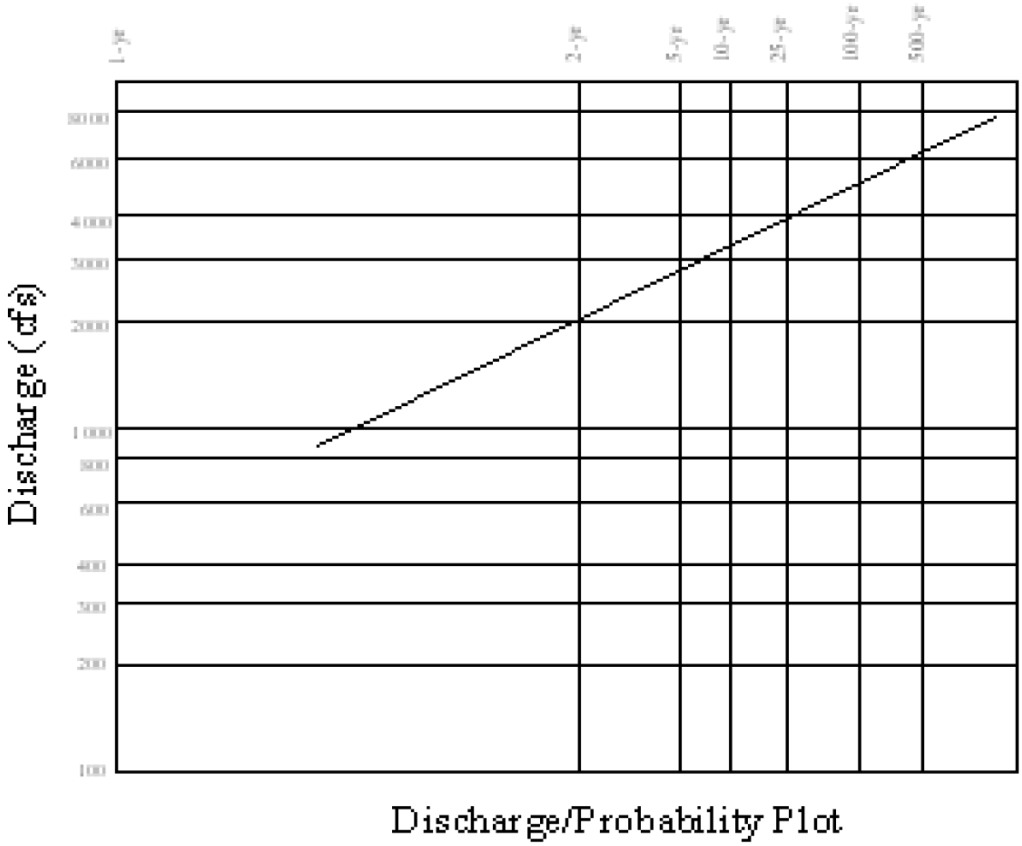
Flood Warning System:
Location: HFP#2-Ralston Creek at Arvada Reservoir



Station Name: Ralston Creek at Arvada Reservoir
Station Gage ID: n/a
Rain Gage ID(s): n/a
Structures: Water Supply Reservoir
Capacity: n/a
Drainage Area: 48.4 sq. mi.
Stream Station: n/a
Drawing Nos. n/a
Study Reference: na/

Problem Areas: & Tech Notes
1) Q/P plot is provided for information purposes only.
2) Elevator should monitor the reservoir water level carefully and make outflow prediction based on an estimate of basin average rainfall.

Flood Warning System:
Location: HFP#3-Ralston Creek at Croke Canal



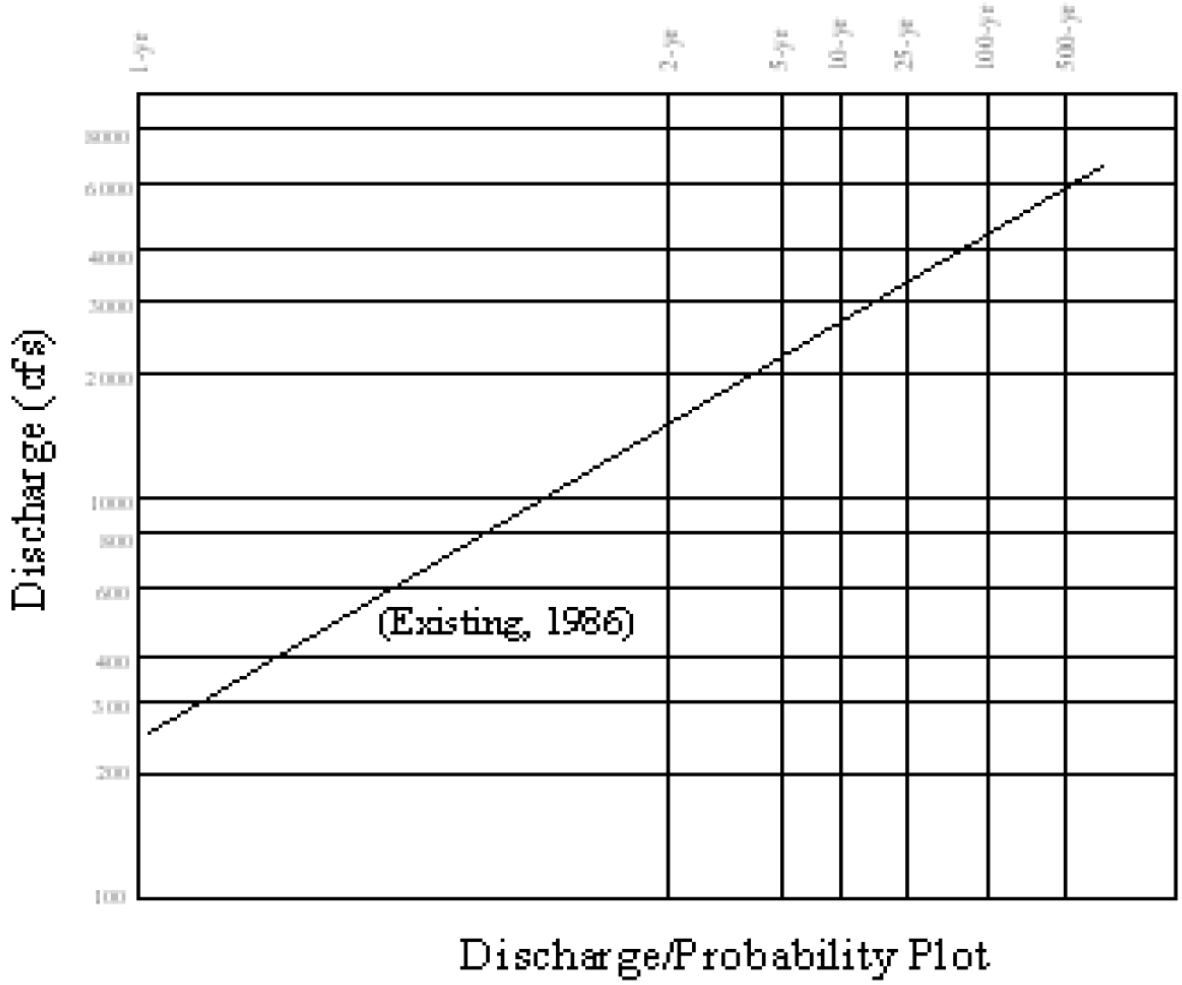
Station Name:	Ralston Creek at Croke Canal
Station Gage ID:	123
Rain Gage ID(s):	120
Structures:	Canal Overflow and Diversion
Capacity:	950 cfs (100-yr)
Drainage Area:	51.9 sq. mi.
Stream Station:	411+00
Drawing Nos.	FHAD Sheet 1
Study Reference:	Lower Ralston/Van Bibber and Leyden Creek, 1986

Problem Areas: & Tech Notes

1) Beginning in 1994, Ralston Creek flows are carried over the Croke Canal by a flow separation structure.

2) Flows in excess of the 100-yr discharge will spill into the Croke Canal, which can handle 950 cfs.

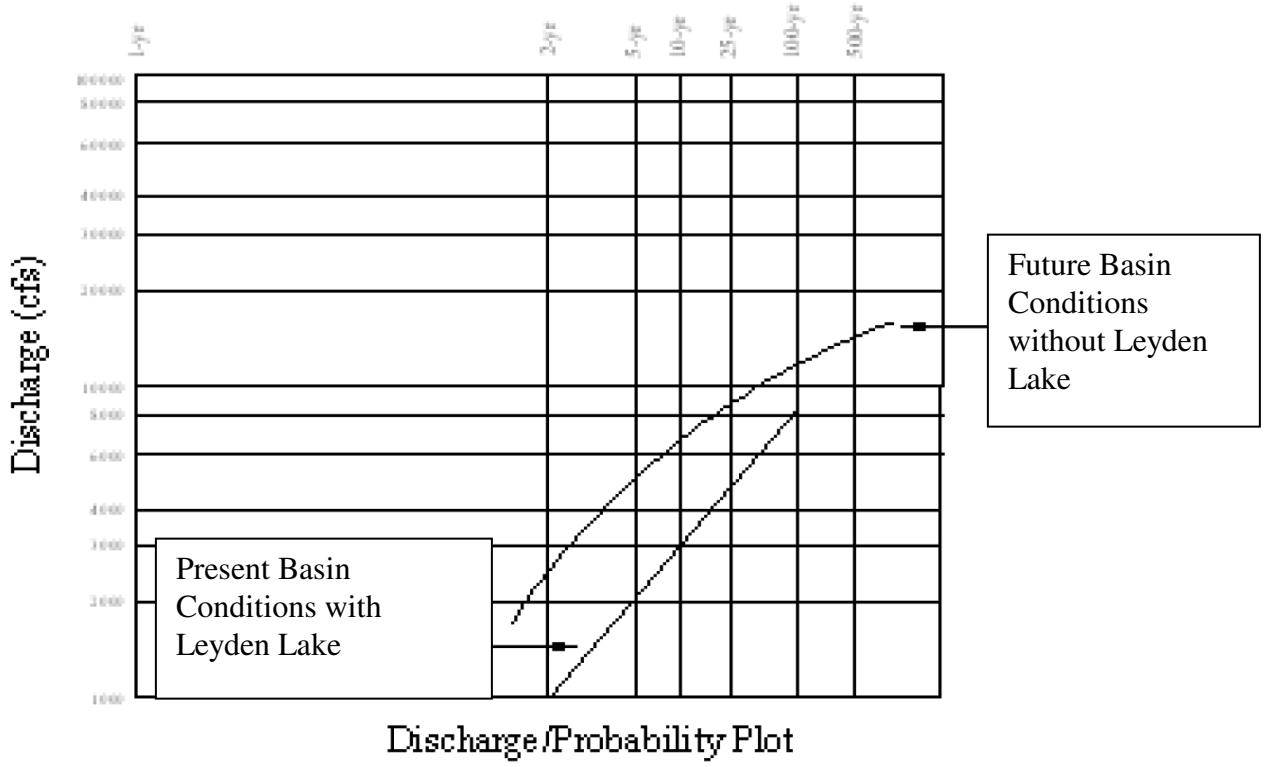
Flood Warning System:
Location: HFP#4-Ralston Creek at Simms



Station Name: Ralston Creek at Simms
Station Gage ID: 133
Rain Gage ID(s): 210 (@ Leyden Creek Confluence)
Structures: RCB: 3 @ 9'x14' & 1 @ 9'x16'
Capacity: 4,800 cfs (100-yr)
Drainage Area: 55.3 sq. mi.
Stream Station: 266+00
Drawing Nos. FHAD Sheet 5
Study Reference: MP Lower Ralston/Van Bibber and Leyden Creek, 1986
& Stefan Ridge Design and Construction, 1987

Problem Areas: 1) See developed floodplain areas shown in above referenced study.
&
Tech Notes

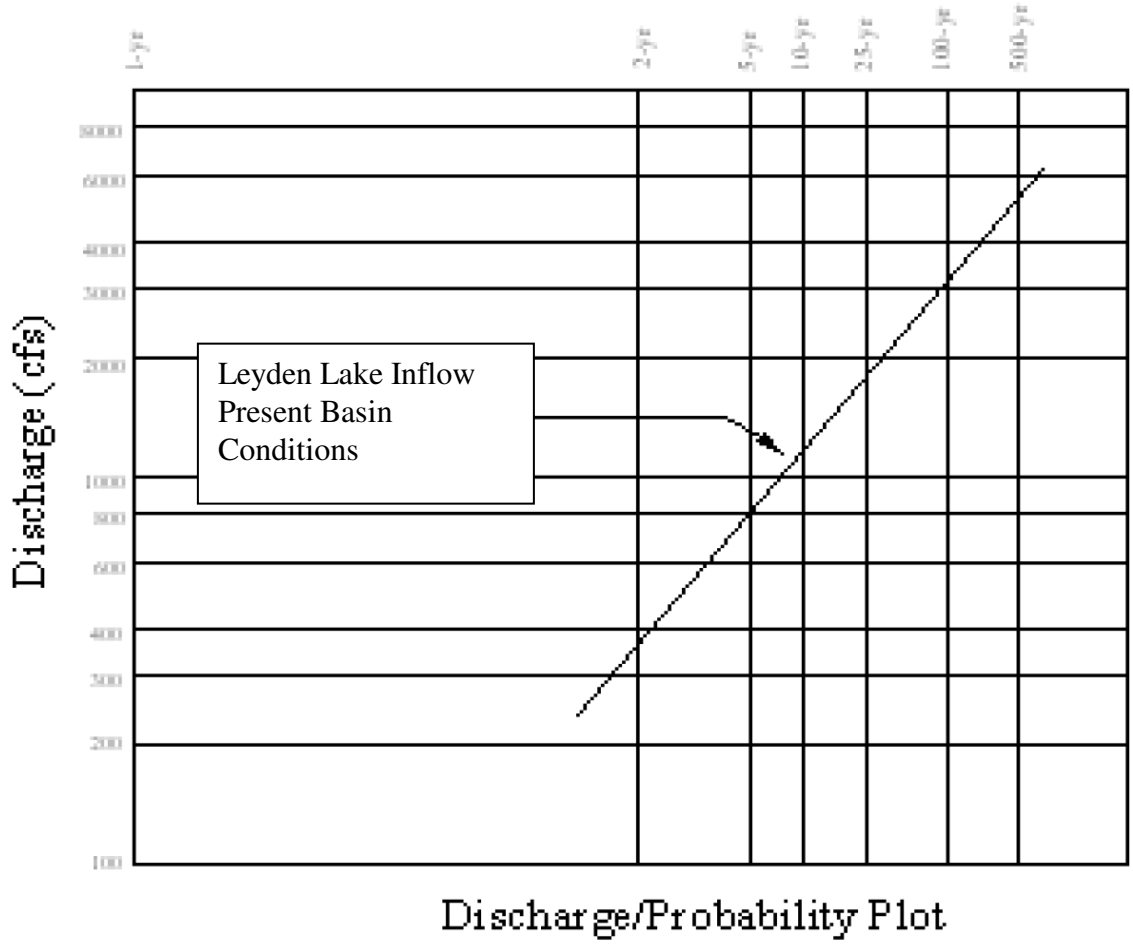
Flood Warning System:
Location: HFP#5-Ralston Creek at Carr Street



Station Name: Ralston Creek at Carr Street
Station Gage ID: 103
Rain Gage ID(s): 100
Structures: 8' x 60' Bridge
Capacity: 9,000+ cfs
Drainage Area: 67.1 sq. mi.
Stream Station: 116+00
Drawing Nos. 11
Study Reference: Lower Ralston/Van Bibber and Leyden Creek MDP, 1986

Problem Areas: 1) See developed floodplain areas shown in above referenced study.
&
Tech Notes

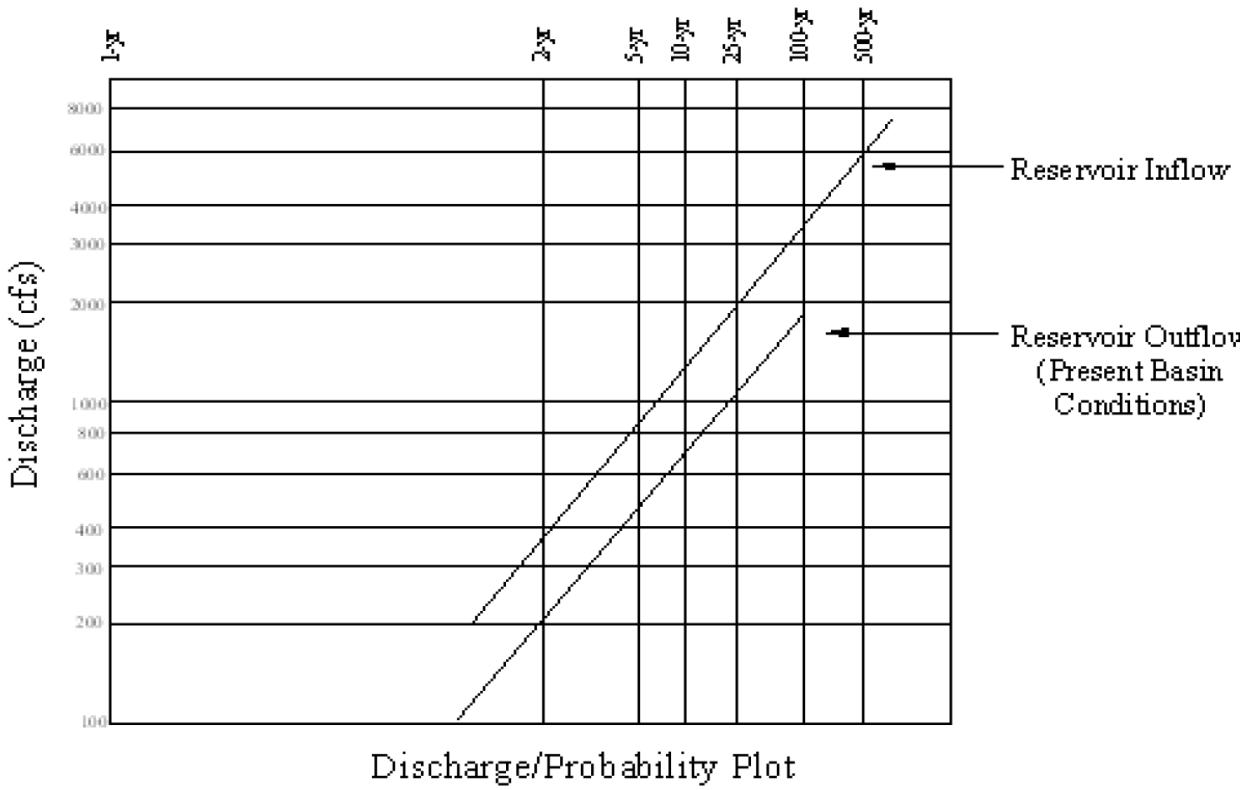
Flood Warning System:
Location: HFP#6-Leyden Creek at Highway 93



Station Name: Leyden Creek at Highway 93
Station Gage ID: n/a
Rain Gage ID(s): 220
Structures: 2 - 6.5' x 6.5' CBC
Capacity: 1,140 cfs
Drainage Area: 2.8 sq. mi.
Stream Station: n/a
Drawing Nos. n/a
Study Reference: Lower Ralston Creek MDP, 1986

Problem Areas: n/a
&
Tech Notes

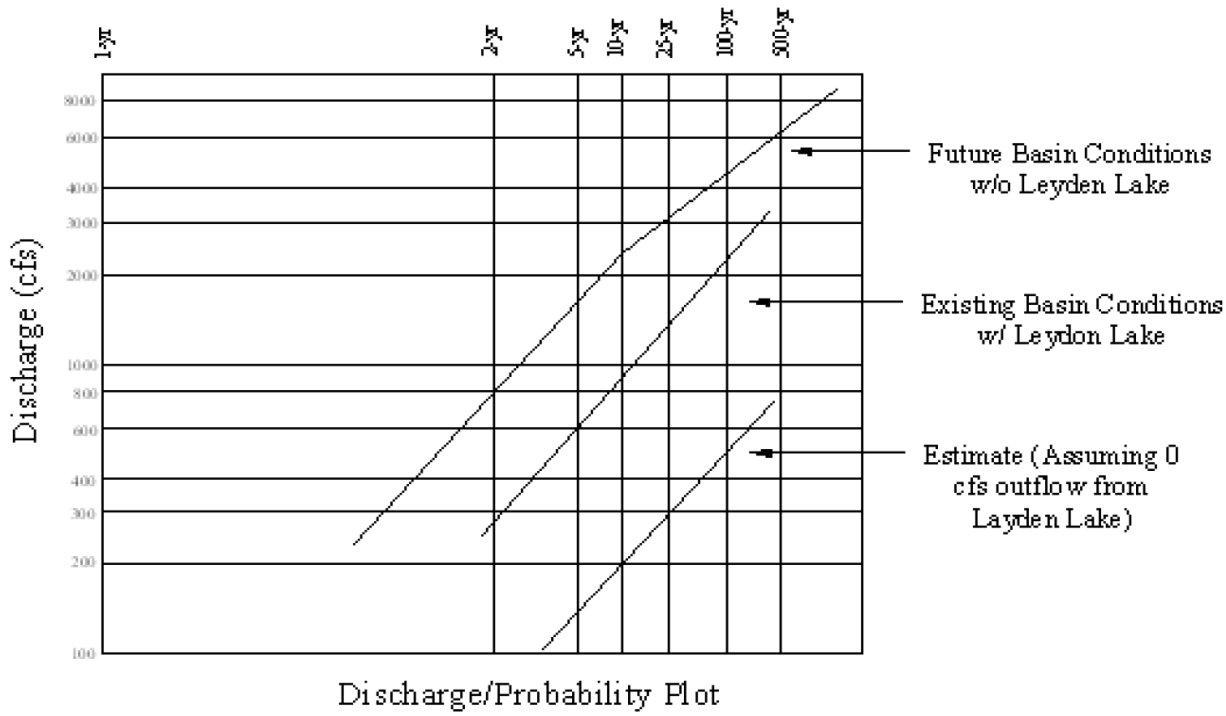
Flood Warning System:
Location: HFP#7-Leyden Creek at Leyden Reservoir



Station Name: Leyden Creek at Leyden Reservoir
Station Gage ID: 203
Rain Gage ID(s): 200
Structures: Reservoir
Capacity: n/a
Drainage Area: 9.0 sq. mi.
Stream Station: 180+00
Drawing Nos. 30
Study Reference: Lower Ralston/Van Bibber and Leyden Creek MDP, 1986

Problem Areas: & Tech Notes
1) Leyden Dam has been declared unsafe by the Colorado State Engineer's Office.
2) Water level should be carefully monitored via the ALERT Base Station and visually by emergency response personnel during times of high water and heavy runoff.

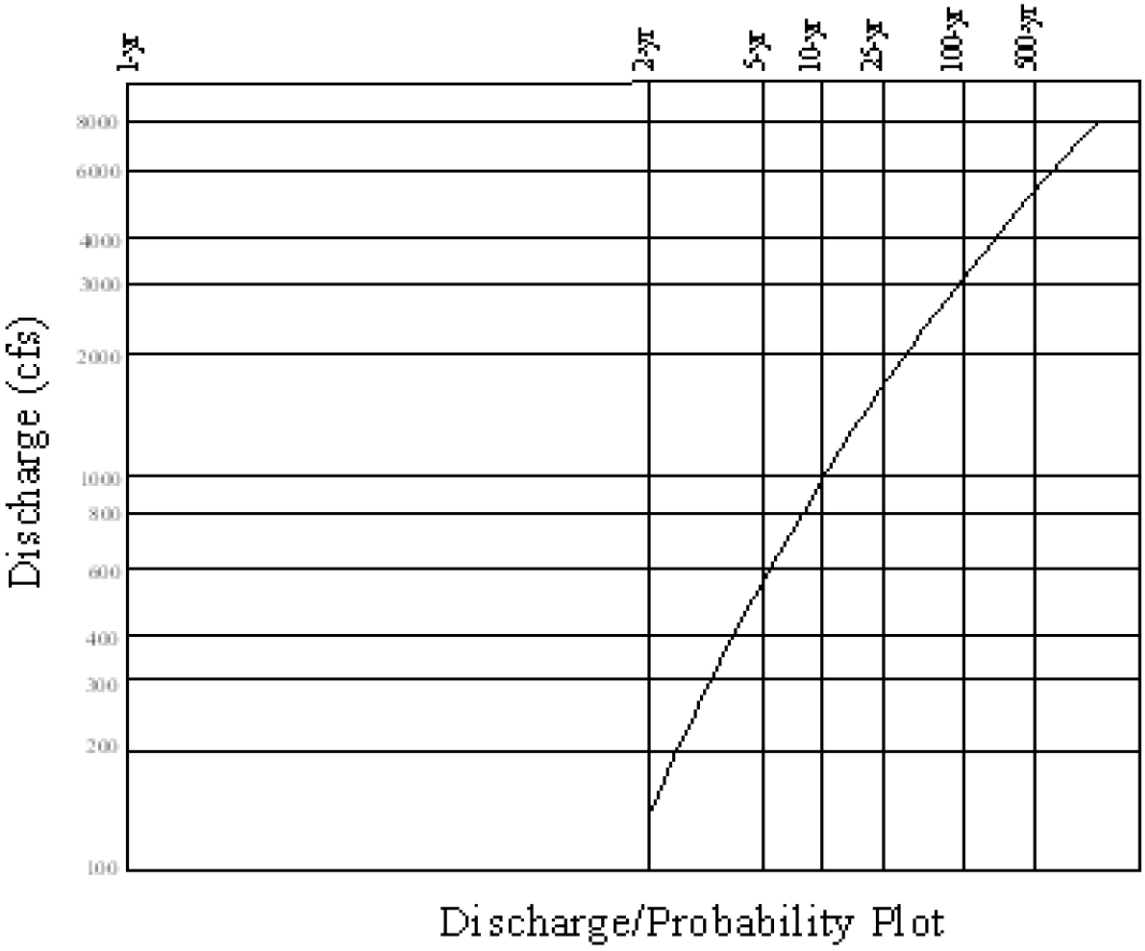
Flood Warning System:
Location: HFP#8-Leyden Creek at Ralston Confluence



Station Name: Leyden Confluence
Station Gage ID: 213
Rain Gage ID(s): 210
Structures: Check Structure
Capacity: >100-year
Drainage Area: 11.8 sq. mi.
Stream Station: 5+64
Drawing Nos. 37
Study Reference: Lower Ralston/Van Bibber and Leyden Creek MDP, 1986

Problem Areas: 1) Limited capacity upstream road crossings should be monitored for overtopping conditions
& (refer to general Urban Flash Flood Guidance on page III-7).
Tech Notes 2) Also refer to HFP/PA Decision Aid for Leyden Reservoir.

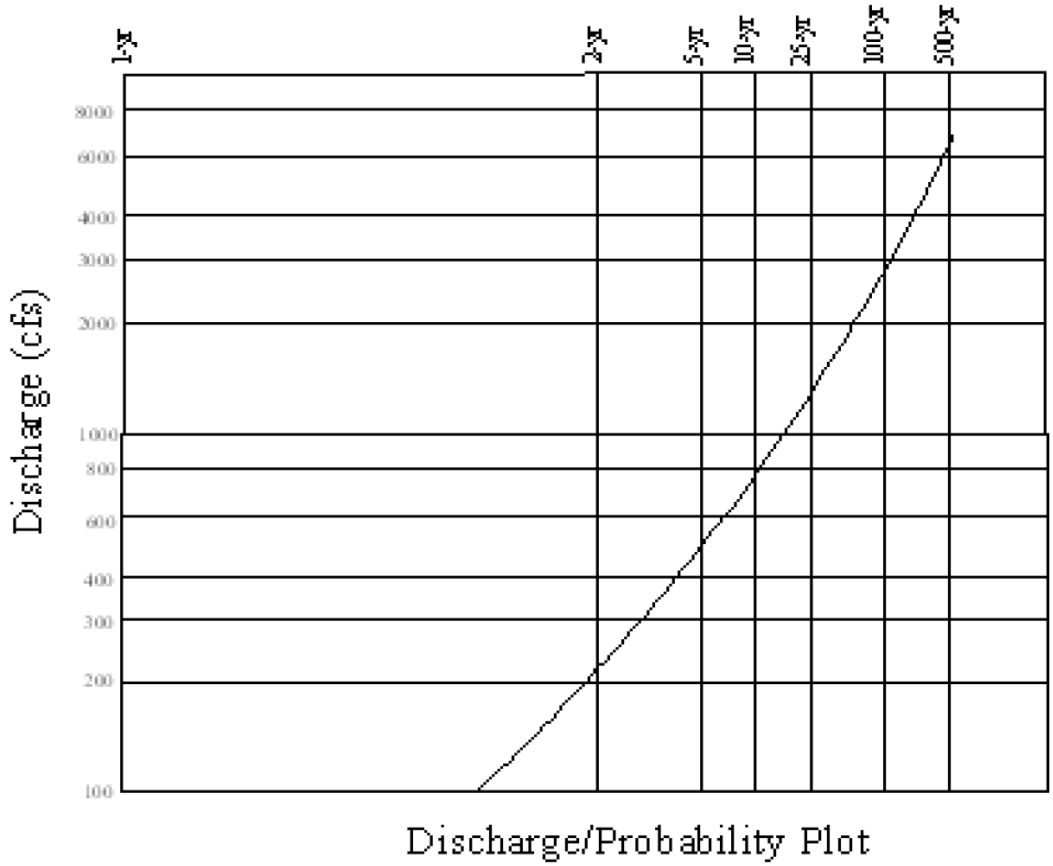
Flood Warning System:
Location: HFP#9-Van Bibber Creek at Highway 93



Station Name: Van Bibber Creek at Highway 93
Station Gage ID: 333
Rain Gage ID(s): 330
Structures: 2 - 14' x 12' CBC
Capacity: 3,920 cfs (overtopping)
Drainage Area: 8.7 sq. mi.
Stream Station: 379+00
Drawing Nos. 4
Study Reference: Major Drainageway Planning
Van Bibber Creek, March, 1977
Gingery Associates

Problem Areas: n/a
&
Tech Notes

Flood Warning System:
Location: HFP#10-Van Bibber Creek at Indiana Street

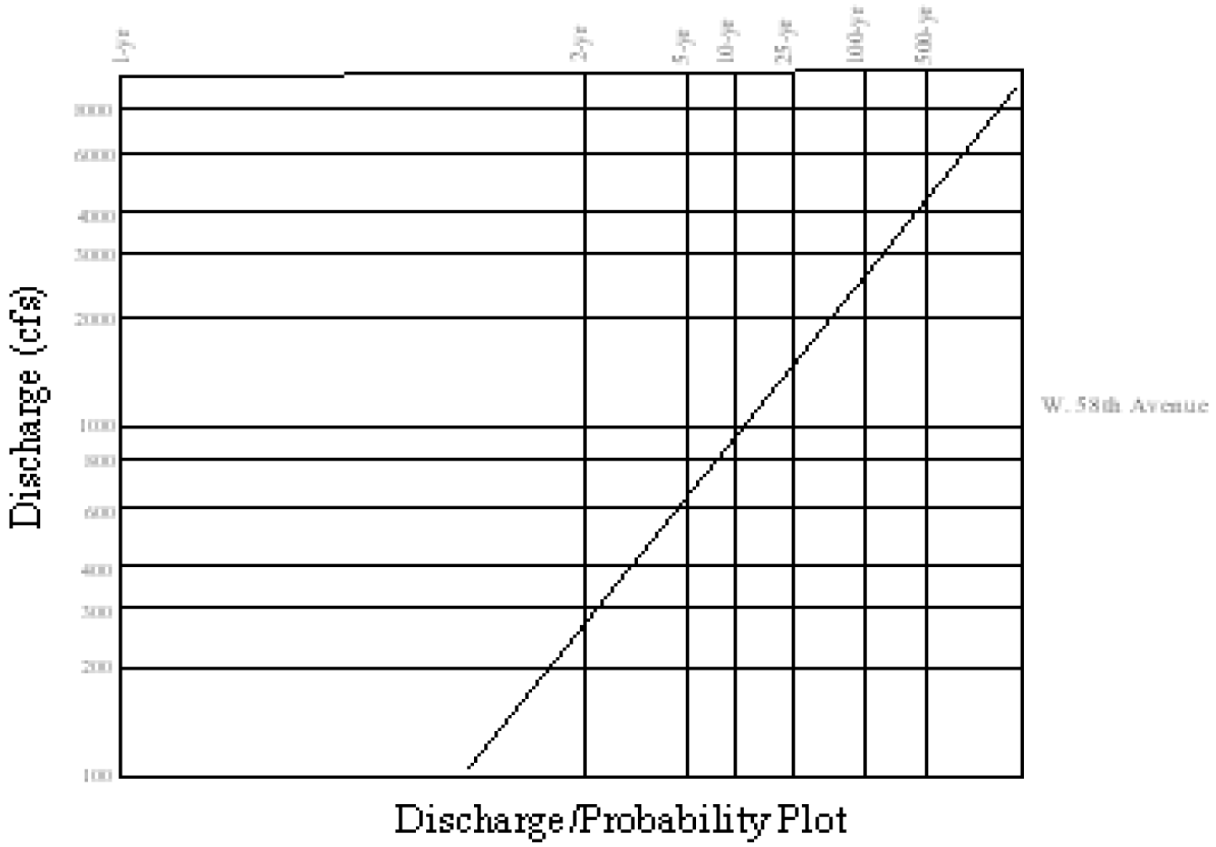


Station Name:	Van Bibber Creek at Indiana Street
Station Gage ID:	n/a
Rain Gage ID(s):	n/a
Structures:	n/a
Capacity:	n/a
Drainage Area:	13.4 sq. mi.
Stream Station:	223+15
Drawing Nos.	17
Study Reference:	Lower Ralston/Van Bibber and Leyden Creeks Master Drainage Plan, February, 1986

Problem Areas: & Tech Notes

1) Van Bibber Creek flows are intercepted by three irrigation ditches upstream of Indiana Street.
2) Therefore, this crossing is a critical point for monitoring flood conditions.
3) Visual observation is required since this site is not equipped with an automated ALERT gage.

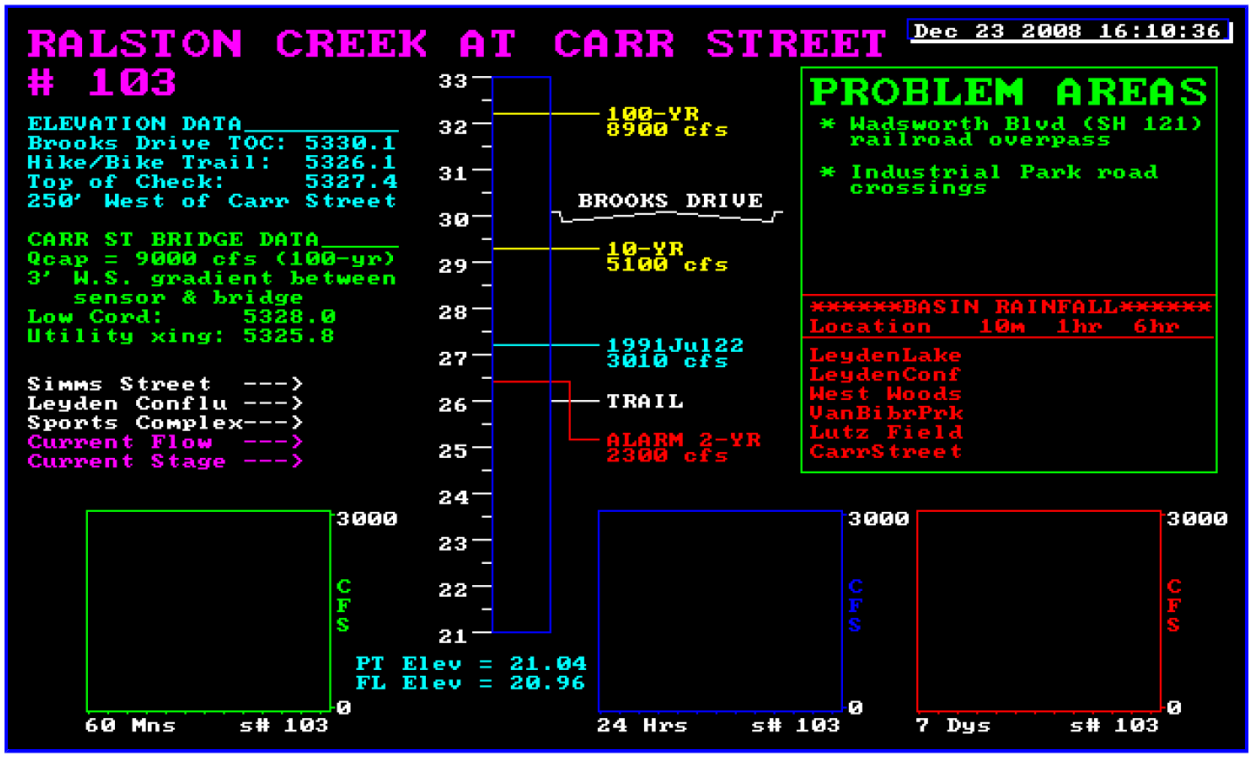
Flood Warning System:
Location: HFP#11-Van Bibber Creek at 58th Avenue



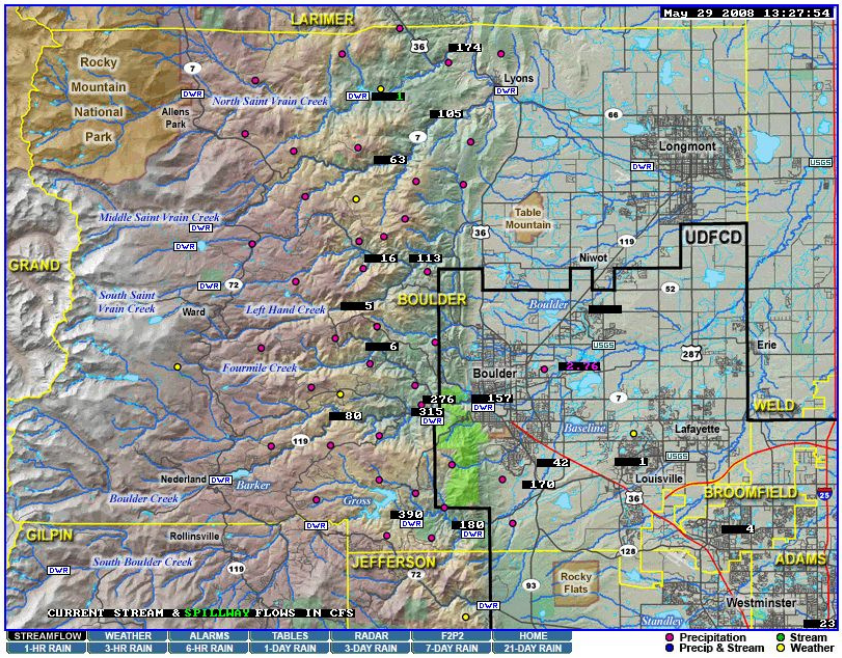
Station Name: Van Bibber Creek at 58th Avenue
Station Gage ID: 323
Rain Gage ID(s): 320
Structures: 3 - 5' x 7' CBC
Capacity: 1,134 cfs (overtopping)
Drainage Area: 16.1 sq. mi.
Stream Station: 65+00
Drawing Nos. 25
Study Reference: Lower Ralston/Van Bibber and Leyden Creeks
Phase B Master Drainage Plan

Problem Areas: 1) See developed floodplain areas shown in above referenced study.
&
Tech Notes

Figure III-4 Typical ALERT Stream Gage Graphics



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



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 flood proofing by property owners can be accomplished. For residences and businesses along the creek and its tributaries, 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 Radar 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 Jefferson County Sheriff's Department Communications Center (JCC) that receives and disseminates all incoming weather and flood information. JCC 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 JCC Communications for relay to affected jurisdictions.

7. Emergency Operation Centers (EOCs) in Jefferson County and Arvada activated in a pre-emergency mode to gather and analyze information concerning the flood potential; maintain contacts with meteorologists, hydrologists and other support personnel; take early preparedness actions; mobilize field resources; and make warning decisions.
9. Officials from Jefferson County, Arvada, and volunteer fire districts who receive all critical weather and flood information and respond according to their respective internal procedures.
10. 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 appropriate jurisdictions.
11. 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 aerial 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 FPC and UDFCD.
6. Internet webservers 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. 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 <u>possible</u> within the geographic area described, but occurrence is uncertain.
4. **Flash Flood Warning**. The warning means that hazardous flooding or flash flooding is <u>imminent or occurring</u> within the geographic area described.

All NWS forecasts and warnings described above are disseminated using NOAA Weather Radio and NOAA Weather Wire. Flash flood watches, warnings, and urban/small stream flood advisories are 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 practical. 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. JCC 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. JCC, the Jefferson County Department of 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 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. Jefferson 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 over-ride all cable TV programming for emergency messages.
9. **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 contacted 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 within the floodplain. 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.) or in the event of a flood warning.
2. Local governments will distribute a similar publication.
3. Media coverage of the flood hazard and 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. The Jefferson County Sheriff's Department Communications Center (JCC) is the primary contact for all communications and 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. JCC Communications will also relay flood information to Jefferson County 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), JCC, and Arvada will be by telephone. When conditions warrant, amateur radio operators can be called into each location to establish alternate communications according to previous agreements. Local authorities and the fire districts will use assigned radio frequencies to communicate with field personnel.

PMS initiated communications require special emphasis. During normal operating conditions (EOC <u>not</u> activated), PMS will contact JCC and Arvada Police for relaying weather-related messages. When an 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. The "Internal Communications Flow Chart" (Figure V-1) 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

Organization	Phone Number	Frequency
* Jefferson County Communications (JCC)	303-277-0211	
Jefferson County Emergency Management	303-271-4900	
Jefferson County Highways and Transportation	303-271-8480	
* Arvada Police Department Communications	720-898-6900	
Arvada Public Works/Engineering	720-898-7640	
Arvada Streets Department	720-898-7720	
Arvada Fire Protection District Communications	303-424-5566	
Fairmount Fire Protection District	303-969-0245	
Arvada EOC (when activated)	720-898-6680	
* 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	

* Principle contact for PMS (*Genesis Weather Solutions with Skyview Weather is the PMS for 2009)*

Commonly Shared Emergency Radio Frequencies

CLEER "Colorado Law Enforcement Emergency Radio"	460.425
FERN "Fire Emergency Radio Network"	154.280
NLEC "National Law Enforcement Channel"	155.475

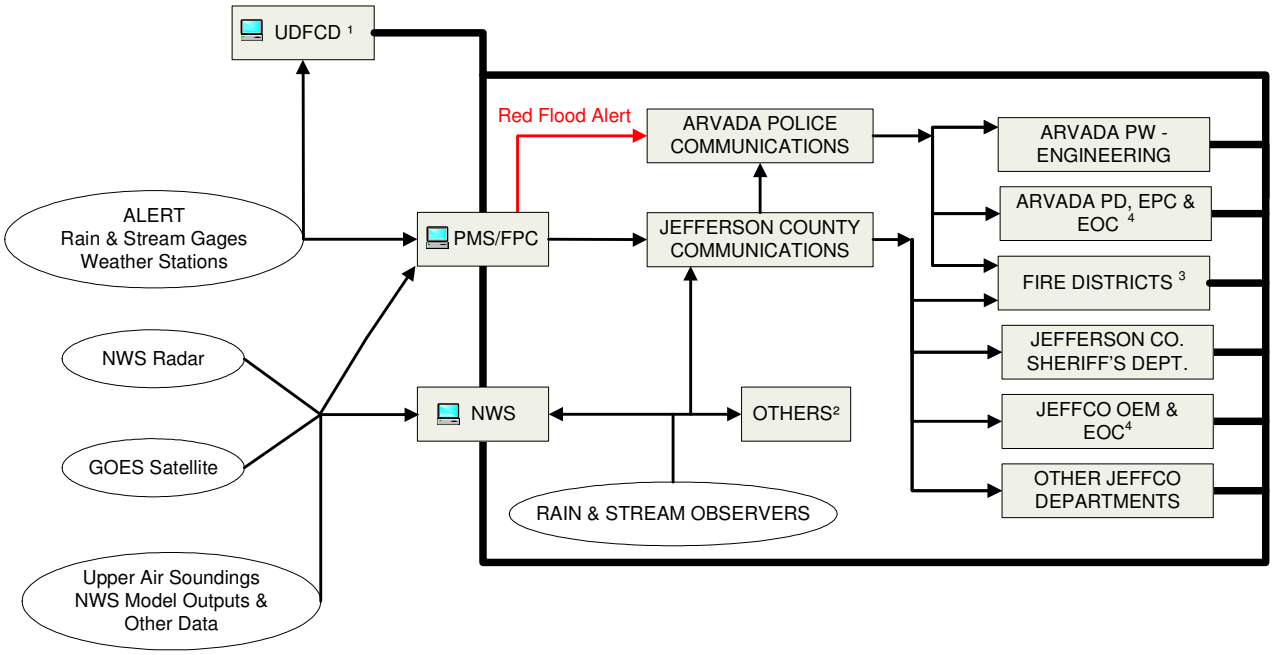
Other Radio Frequencies

ALERT repeaters (Blue Mountain & Smoky Hill)	171.875
ALERT gaging stations	169.525
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

Websites

ALERT System (public use)	http://alert.udfcd.org
ALERT System (public safety agency use only)	http://alert2.udfcd.org

Figure V-1 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)
GOES	Geostationary Operational Environmental Satellites
UDFCD	Urban Drainage and Flood Control District
FPC	UDFCD Flood Prediction Center
PMS	UDFCD Private Meteorological Service
NWS	National Weather Service
EOC	Emergency Operations Center
EPC	Emergency Preparedness Coordinator
OEM	Office of Emergency Management
PD	Police Department
PW	Public Works Department
1	ALERT Base Station Internet access (http://alert.udfcd.org)
2	Primary local contact for field observers...JCC and Arvada PW-Engineering
3	Arvada, Fairmont 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. The NWS and PMS should coordinate with local government agencies to exchange information and gear up for potential flood situations using the following process:

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 1** by phone and fax to Jefferson County Sheriff's Department Communications Center (JCC). JCC will forward the message by phone to Arvada and Jefferson County Emergency Management. The JCC dispatcher will disseminate **MESSAGE 1** following standard protocol. Designated personnel will prepare to respond. When a **MESSAGE 1** 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. The following actions will occur if the flood potential increases:
   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 1** (**RFA** if warranted); or
   b. NWS will issue a **Flash Flood Watch** through normal channels (NAWAS, weather wire, NOAA weather radio) and PMS will send **MESSAGE 2**; or
   c. PMS will send a **MESSAGE 2** to indicate an increase in flood potential.

   A Multi-Agency Coordinating System (MACS) page will be executed 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 3**. PMS may issue a **MESSAGE 3** 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 4**.

Throughout all of the above activities, NWS and PMS will coordinate as necessary. Events may occur so rapidly that it may not be possible to carry out all of the above steps. On duty personnel 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 2** will likely be the first notice issued. In this case, the notices should be communicated well ahead of any rainfall, 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 2** 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 3**. When a **MESSAGE 3** 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 immediately prior to placing a phone call. This procedure is designed to insure the rapid flow of information with minimum chance for error or misunderstanding.

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 Jefferson County Sheriff's Department Communications Center (JCC) for subsequent dissemination. JCC's principal contacts for Ralston Creek flood notifications are: Arvada Police Department, Fairmount Fire Protection District, Arvada Fire Protection District and Jefferson County Emergency Management. Participating organizations will take appropriate preparedness actions in accordance with respective internal procedures. JCC 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 drainage basin will transmit data in real-time to ALERT base stations located at UDFCD and the NWS. 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 Arvada Emergency Operations Center (EOC) will be activated by the Police Department if necessary. EOC personnel will have the opportunity to analyze current ALERT data via Internet access to the UDFCD base station, interact directly with PMS and NWS, and use the decision aids in Section III. EOC personnel may also assume the primary flood prediction role should communication links with PMS and NWS fail. A separate EOC in Jefferson County may also be activated by the Director of Emergency Management if needed. Local authorities and NWS are responsible for making decisions concerning public warning.

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 by each local government. 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 OUTLINED FRAMEWORK, 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 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 1** by telephone. 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. **MESSAGE 1** shall be forwarded to subsequent agencies by executing a MACS page in accordance with MACS procedures. REMEMBER THAT A **MESSAGE 1** 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 the watershed.
3. A MACS page will be executed and each subsequent contact should follow internal procedures for updating key people concerning the increased flood potential.
4. Contingency plans to ensure that future steps in this warning plan can be carried out should be implemented 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 2** that 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 2** 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) become available, PMS will update rainfall forecasts and flood peak projections and will provide information in the form of **MESSAGE UPDATES** (**RED FLOOD ALERT** if warranted).
6. All updates will be relayed 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 local or EOC personnel.
8. PMS will confer as needed with NWS. When rainfall estimates or measurements and flood peak predictions indicate an <u>imminent</u> 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 <u>imminent</u> or <u>occurring</u>.
2. PMS will issue a **MESSAGE 3** for MACS page execution. PMS may also issue a **MESSAGE 3** without a NWS issuance of a **Flash Flood Warning** if PMS feels that a life-threatening flood is <u>imminent</u>.
3. Responsible 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 4**.
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 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 2** or **MESSAGE 3** 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 2** or **MESSAGE 3**, but indicate their misgivings. The standard message forms 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 when issuing their warning.
4. Flood warnings can be issued by local officials using 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 affect a coordinated response to a flood situation.
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 those counties within the UDFCD. PMS supplements NWS flood-related activities within UDFCD boundaries. PMS is responsible for monitoring weather and flood conditions, forecasting flood potential, 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 within the UDFCD and other detection networks operating in or near the Denver 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 1** (see Section VI for MESSAGE descriptions). **MESSAGE 1** 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 1** concerns an <u>imminent</u> 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 2**.
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** indicating an increase in flood potential or upgrade the message status to a **MESSAGE 2** if they feel a life-threatening flood potential exists.
6. Following receipt of a **MESSAGE 2** or **MESSAGE UPDATE**, local entities 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 local jurisdictions 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 3**. PMS can also issue a **MESSAGE 3** 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) 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, local authorities 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 4**.

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.

JEFFERSON COUNTY SHERIFF'S OFFICE

Jefferson County (JCC) has the responsibility and authority to maintain an orderly flow of information between all agencies involved in the warning plan. Specific responsibilities of JCC are as follows:

1. During normal conditions JCC will be in its normal working configuration.
2. Upon receipt of MESSAGE 1 (See Section VI of this plan for MESSAGE descriptions), duty dispatchers will immediately report to the Director of Emergency Management and notify local jurisdictions and The Consolidated Mutual Water Company (Consolidated) of the alert.
3. Upon receipt of MESSAGE 2 (NWS Flash Flood Watch or equivalent), or information indicating an increased flood potential (e.g., MESSAGE 1/RED FLOOD ALERT or MESSAGE UPDATE/RED FLOOD ALERT), entire area affected will be notified immediately by duty dispatcher. This will include the Cities of Lakewood, Wheat Ridge and Golden; Pleasant View Fire Protection District, West Metro Fire Protection District and Consolidated. The Jefferson County Department of Highways and Transportation, Highway Design and Development Review Section will also be immediately notified of this situation. Watch commander should consider activating and dispatching personnel to the Situation Information Center (SIC) at Consolidated.
4. Patrol cars, as deemed necessary, will be dispatched to potential flood areas to report on the level of flooding, warn individuals in the flood hazard area and assist fire districts concerned where feasible.
5. Upon receipt of MESSAGE 3 (NWS Flash Flood Warning or equivalent), or information from other reliable sources to that effect, the Sheriff's Department will take immediate steps to secure designated and/or unincorporated areas involved; establish traffic control; assist with evacuation; preserve law and order; activate Field Command Post, if required; carry out search and rescue operations as necessary; and activate warning sirens upon approval.
6. If flooding occurs in an incorporated area, Sheriff's Department resources will stand by to assist municipal emergency response agencies within Jefferson County as needed.
7. Information received from fire district weather spotters will be consolidated and forwarded to PMS, NWS and the SIC, if activated.
8. The Sheriff's Department will establish a Field Command Post in the disaster area, if required, upon receipt of information that an evacuation due to floods has been initiated. Until such time that a Jefferson County command post is established, the fire district involved will be in control of its jurisdictional area. Once established, the overall control of the flood area will revert to the Jefferson County Field Command Post.
9. Aircraft control and aviation support will be coordinated.
10. Consolidated, pertinent fire districts and the Cities of Lakewood, Wheat Ridge and Golden will be provided with rain and stream stage information and PMS forecasts on a timely basis when potential flooding conditions exist.

JEFFERSON COUNTY EMERGENCY MANAGEMENT

1. Upon receipt of MESSAGE 2 (NWS Flash Flood Watch or equivalent) or information to that effect from Sheriff's Department; notify the County Administrator or Board of County Commissioners, Human Services Division, Public Works Division, Department of Health and Environment; and activate the Jefferson County Emergency Operations Center (EOC) if appropriate.
2. Determine resources needed for disaster area and coordinate emergency response activities with county departments.
3. Establish communications with Field Command Post and Colorado Office of Emergency Management.
4. If appropriate, notify R1 School District of designated schools required for temporary housing of flood evacuees and coordinate opening as evacuation centers.
5. Establish communications within the SIC at Consolidated if activated.

JEFFERSON COUNTY PLANNING AND DEVELOPMENT

1. Upon notification of flooding conditions, be prepared to provide crews and equipment to assist in rescue operations, provide necessary transportation, establish barricades as needed and restore county facilities in the quickest possible manner.
2. Upon activation of the Jefferson County EOC, provide a representative thereto.
3. Consider providing representative(s) to the SIC at Consolidated if activated.

JEFFERSON COUNTY HEALTH AND ENVIRONMENT

1. Upon notification of flooding conditions, provide representatives(s) on site to determine requirements for preservation of county health standards.
2. Upon activation of the Jefferson County EOC, provide a representative thereto.

JEFFERSON COUNTY HUMAN SERVICES

1. Upon notification of flooding conditions, activate resources and emergency support agencies to house, clothe and feed flood evacuees at designated evacuation centers.
2. Upon activation of the Jefferson County EOC, provide a representative thereto.

JEFFERSON COUNTY R1 SCHOOL DISTRICT

1. Upon notification of potential flood conditions, be prepared to open designated schools for use as evacuation centers when required.

ARVADA AND FAIRMOUNT FIRE PROTECTION DISTRICTS

1. Provide information to the Jefferson County Sheriff's Department, Jeffco EOC, Arvada Police and/or the Arvada EOC concerning all potential and actual flood conditions in jurisdictional areas on a timely basis.
2. Upon receipt of MESSAGE 1 (Internal Weather ALERT, notify required personnel for potential action.
3. Upon receipt of MESSAGE 2 (NWS Flash Flood Watch or equivalent) or other warning indicators (e.g., MESSAGE 1/RED FLOOD ALERT or MESSAGE UPDATE/RED FLOOD ALERT), alert all personnel for flood observation and warning requirements within jurisdictional area. Warnings should be issued to endangered individuals and residences should a flash appear imminent. Consider dispatching personnel to the operational EOCs at Jefferson County and Arvada.
4. Upon receipt of MESSAGE 3 (NWS Flash Flood Warning or equivalent) or warning from the Sheriff's Department, be prepared to evacuate threatened area by the quickest possible means. NOTE: Fire District Chiefs will use own discretion when to initiate appropriate observations, warning or evacuation at any time conditions so warrant action.
5. Consolidate weather spotter information received and transmit to Sheriff's Department and the operational EOCs on a timely basis.
6. Provide initial search and rescue operations as required.
7. Notify Sheriff's Department immediately upon flood evacuation initiation.

INDIVIDUAL WEATHER SPOTTERS

1. Provide fire districts with rainfall and stream level information on a timely basis during a major rain storm or when flooding conditions exist.
2. If not under supervision of a fire district, provide such information directly to the Sheriff's Department, the Jefferson County Department of Emergency Management, the SIC at Consolidated or NWS.

GENERAL ADMINISTRATION & LOGISTICS

1. All emergency response agencies will utilize their own resources until exhausted.
2. Requests for needed additional supplies, equipment and other resources will be made to Jefferson County Department of Emergency Management.
3. Jefferson County Department of Emergency Management will coordinate the acquisitions of all resources necessary to the existing emergency.

CITY OF ARVADA

The City of Arvada maintains an Unusual Occurrence Manual with a section specifically dedicated to emergency operations during flooding. This document should be referenced to understand the specific responsibilities of various entities within the City.

The following was excerpted from the FLOOD section of Arvada's Unusual Occurrence Manual (Revision #8, 1996).

FLOOD – Arvada Emergency Operations Plan

I. Mission

To provide essential flood warning and emergency response in order to reduce the potential loss of life resulting from flash floods and flooding of flood plains located within Arvada. Refer to the Urban Drainage and Flood Control Districts, Ralston Creek Flood Warning Plan for supplemental flood warning information. This flood warning plan for the Ralston Creek drainage basin is viewed as an annex or appendix to Arvada's Unusual Occurrence Manual and Jefferson County's Emergency Operations Plan.

II. Situation and Assumptions

A. Situation

1. Historic flooding has been relatively infrequent. Floods generally result from intense thunderstorms in the mountainous portions of the county. Occasionally, a moderate rainfall, combined with rapid snow melt, also causes flooding. The upper reaches of the streams are undeveloped and much of the water infiltrates into the ground and is removed from the flood flow. As development of the flood plain increases, less area will be available for infiltration and runoff will be more pronounced. Stream channels unable to contain flood flow under existing conditions will become further taxed and more frequent flooding will occur.

2. The ability of a channel to convey flood flow depends, to a great extent, upon its size and condition. Additionally, channel capacities are often reduced by encroachment from adjacent development. Failure to keep the channel free reduces its capacity and increases flood potential.

3. In the immediate and foreseeable future, there is an ever increasing potential for flood disaster due to population growth. Although widespread flooding is not as dangerous to life as is flash flooding, considerable property loss can occur through erosion, around roads and bridges and various types of structures and through deposition of sediments in agricultural, residential and other areas. Large scale destruction of property is a typical result.

4. Potential flood plain areas within Arvada are as follows: Ralston Creek, Leyden Creek, Van Bibber Creek, Little Dry Creek

B. Assumptions

1. Flash floods in Front Range canyons can occur at any time and particularly during the spring months because of increased precipitation and snow melt. However, it is not considered a problem in Arvada unless a dam failure occurs (see Dam Failure).

2. With adequate warning and timely reaction by local emergency response agencies, loss of life can be held to a minimum.

3. Widespread flooding allows more time for warning and for evacuation of people from endangered areas. Large groups of people may be threatened but successful evacuation to higher ground is usually possible, as long as warnings are issued.

III. Execution (Refer to "Post-Flood Recovery Assistance Plan" City of Arvada, CO)

A. Concept of Operation

The National Weather Service and/or other weather agencies will advise the Police Department Communications Center of potential flooding conditions. Subsequently, these messages will be immediately forwarded to the appropriate emergency response agencies. Depending upon circumstances and action taken, this operation will be conducted in three phases:

Phase I - Readiness

This phase usually begins with a Flash Flood Watch and/or its equivalent, which is the earliest probable time a threat to a specific area might exist. Action to be taken and potential evacuation of suspected flood locations will be considered at this time. Police personnel and other agencies will attempt to locate individuals along potential flood areas to advise them of danger and possible evacuation. Emergency information as to flooding conditions will be compiled by the Department Communications Center. If an emergency situation exists during this phase, the on-duty police supervisor or Fire Chief will use discretion whether evacuation is necessary.

Phase II – Emergency

This phase begins with a Flash Flood Warning, its equivalent and/or when information is received from designated observers that flooding conditions are imminent, occurring and are endangering the lives of the public. Depending on time available, fire district and police department personnel will warn the public through public address systems, sirens, etc. When lives are endangered, individuals will be evacuated to high ground by the quickest means possible. Contingent upon evacuation requirements, the Arvada Emergency Operations Center may be activated.

Phase III – Recovery

All city agencies will take and coordinate appropriate action to sustain life and property. Temporary housing to include food an necessary clothing may be made available to evacuation victims, in cooperation with the American Red Cross. Search and rescue operations will continue and every effort will be taken to restore public facilities as quickly as possible.

B. Involved parties

1. Arvada Police Department

2. The Emergency Preparedness Coordinator

3. Arvada Department of Public Works

4. Finance Department

5. Fire Districts

6. Risk Management Division

IV. Administration and Logistics

A. All emergency response agencies will utilize own resources until exhausted.

B. Requests for needed additional supplies, equipment and other resources will be made according to mutual aid agreements.

V. Communications and Control

A. Communications

The Communications Center of the Police Department will consist of communications dispatchers, who will operate the control center on all emergencies until the situation dictates the activation of the EOC for operations.

B. Control

1. The Arvada Police Department will establish an incident command post in the disaster area upon receipt of information that an evacuation due to floods has been initiated.

2. Until such time that the Arvada Emergency Operations Center is established, the on duty Incident Commander involved will be in control of the scene. Once established, the overall control of the flood are will revert to the Emergency Operations Center.

MESSAGE 1 (INTERNAL ALERT)

This is an advisory message which is meant to inform key people that weather conditions are such that flood producing storms could develop later in the day. It will be issued by PMS after consultations with NWS (National Weather Service). If PMS feels this weather advisory requires priority handling by the communications dispatcher, the message will be preceded with the statement: "THIS IS A RED FLOOD ALERT MESSAGE."

MESSAGE 2 (FLASH FLOOD WATCH)

THIS IS A RED FLOOD ALERT MESSAGE FOR ARVADA

This message indicates that a Flash Flood Watch has been issued by NWS and/or PMS feels the risk is high that a life-threatening flood may occur later in the day. PMS will add any additional information which is available. This message requires priority handling by the communications dispatcher.

MESSAGE 3 (FLASH FLOOD WARNING)

THIS IS A RED FLOOD ALERT MESSAGE FOR ARVADA

This message indicates that a Flash Flood Warning has been issued by NWS and/or PMS feels that a life-threatening flood is imminent. Again, PMS will add any additional information which is available. This warning message requires priority handling by the communications dispatcher.

MESSAGE UPDATE

This message will be used by PMS to update any of the previous messages, particularly in the event of a disagreement between PMS and NWS. For example, this message can be used to narrow a watch or warning area as more information becomes available or to provide more site specific data and direction during an event. If PMS feels this message requires priority handling by the communications dispatcher, the message will be proceed with the statement: "THIS IS A RED FLOOD ALERT MESSAGE."

MESSAGE 4 (ALL CLEAR)

This message cancels the flood potential status. This message is issued by PMS after consultation with NWS and other entities involved with direct PMS communications.

MULTI-AGENCY COORDINATING SYSTEM (MACS)

Information dissemination for flash flood detection, rainfall and streamflow forecasting 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 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 are 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 the Sheriff's Department, 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. Local entities are responsible for monitoring NWS radar, ALERT gage rainfall and stream levels, PMS messages, NWS advisories and field reports.

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 local entities 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.

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.

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.

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 POSSIBILE 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 or heavy rainfall).* _____*(place)*

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/PUBLIC ADDRESS MESSAGE

The following message may be used over public address systems or by emergency vehicles circulating in the floodplain:

THIS IS _____
(emergency service agency)

FLOODING WILL BEGIN AT _____ AT
(location)

APPROXIMATELY __ .
(estimated time)

_____ HAS URGED EVERYONE IN THE FLOOD
(person in authority)

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*
(place)

flooding 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.

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 local flood hazard. 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. Brochures will be created and distributed to help educate the media and citizens regarding the dangers of flash floods and the associated response actions in the event of a flash flood.

Each year, after the end of the active flood season, the local entities should compile precipitation and stage data and review records of flood incidents and response activities to inform revisions to this document, consulting with affected emergency managers and other appropriate local officials, as required.

Annual training and tabletop exercises are an excellent way to train personnel and to pin point deficiencies in incident command communications protocols. 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 with appropriate staff. Using the media to publicize the training exercise will further increase public awareness of the flood hazard and help attain the desired public response to flash flood warnings.

Public education activities should address flood preparation and flood proofing, as well as the issue of secondary flood impacts, or hazards that accrue as the result of flooding. Moving water, typical of flash flooding causes safety problems as anything that is stored outside and not securely anchored to the ground can be carried away; toys, firewood, fuel tanks, structures, boulders, tools or vehicles. Floods become more forceful as they acquire debris, which can batter or impale people and structures. Fuel tanks provide an additional combustion hazard and floodwaters can conduct electrical currents from damaged or submerged electrical transmitting equipment.

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.