



Photo courtesy of The Denver Post

2007
UDFCD FLASH FLOOD PREDICTION
PROGRAM - ANNUAL REPORT

Submitted by
Genesis Weather Solutions, LLC & Skyview Weather

303-927-6522

November 26, 2007

TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
1.0: Introduction.....	1
2.0: 2007 Operational Season	1
3.0: 2007 Operational Products.....	2-5
4.0: 2007 Message Statistics	5
4.1: Message Verification.....	5-7
4.2: County/City Message Statistics	7-8
5.0: Notable Weather Events	9-10
6.0: Recommendations.....	10-12

LIST OF TABLES

Table 1: 2007 F2P2 Products Description	3
Table 2: Message Definitions	4
Table 3: 2007 Product/Communication Summary.....	5
Table 4: Message Criteria	6
Table 5: Monthly Message verification	7
Table 6: Message Verification	8

LIST OF FIGURES

Figure 1: The UDFCD Boundary and Forecast Area.....	2
Figure 4: Flooding in Southern Denver on July 27, 2007.....	9
Figure 7: Flooding of Bear Canyon Creek in Boulder, August 15, 2007.....	10
Figure 8: GRLevel Storm Track	11

Appendix A: 2007 Cloud to Ground Lightning Climatology. Table 7.

Appendix B: Radar Estimated Rainfall Maps. Figures 2, 3, 5 and 6.

1.0 Introduction

The Urban Drainage and Flood Control District (District or UDFCD) has used the forecasting and notification services of a private sector meteorologist for the Flash Flood Prediction Program (F2P2) since 1979. The services of a Private Meteorological Service (PMS) supplement the forecast and warning services of the National Weather Service (NWS) in Boulder, Colorado for the seven-county District area. This year is the 29th year UDFCD has funded the F2P2.

The UDFCD forecast area supported by the PMS is shown in Figure 1 and contains a population of approximately 2.8 million people. The forecast area of approximately 3,000 square miles includes the upper basin areas of watercourses that flow into the District. Terrain in the forecast area varies in elevation of around 5,000 feet above sea level to as high as 10,500 feet above sea level.

A team comprised of Genesis Weather Solutions, a Highlands Ranch, Colorado based company and Skyview Weather, a Castle Rock, Colorado based company was selected as the 2007 PMS.

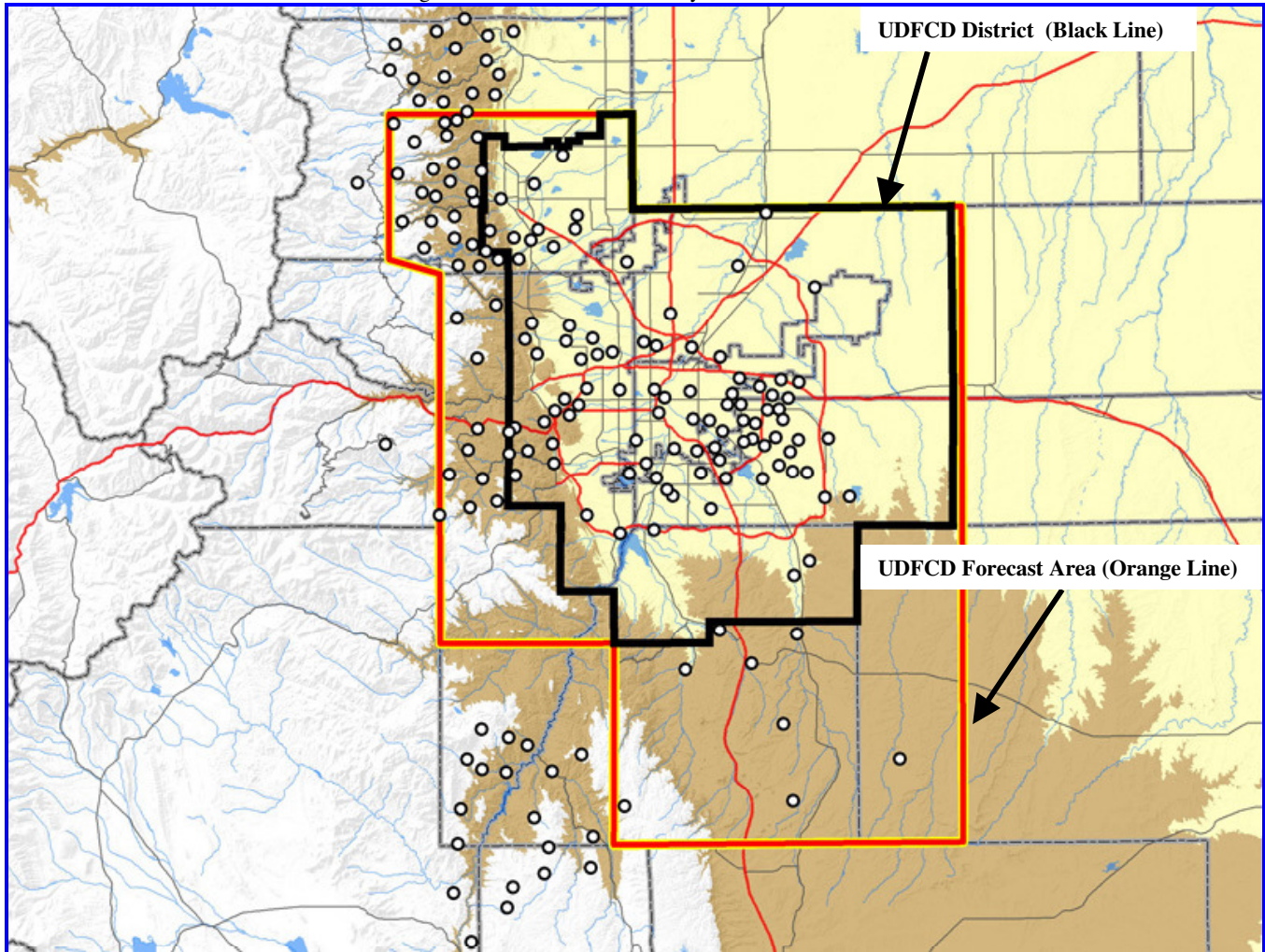
Weather prediction personnel Bryan Rappolt, Tim Tonge, Paul Potter and Brad Simmons provided the F2P2 prediction and notification services. Bryan Rappolt was as the Project Manager and Chief Operational Meteorologist.

Bryan Rappolt worked his 14th season on the F2P2 while Paul Potter worked his 3rd, Tim Tonge his 2nd and Brad Simmons his 1st.

2.0 2007 Operational Season

The 2007 F2P2 season began on April 15 and concluded on September 15; a total of 154 operational days. Normal operational hours were from 7:00 AM to 10:00 PM. A total of 1502 man-hours were expended by the PMS providing operational support during normal operational hours. During the time period from 10:00 PM to 7:00 AM the PMS provided an additional 364 man-hours of operational support.

Figure 1: The UDFCD boundary and forecast area.



3.0 2007 Operational Products

The F2P2 is designed to provide rainfall prediction and notification services of urban flooding and flash flooding threats to the seven District counties and the cities and towns within those counties. Direct support is provided to the District basin-specific flood warning plans, which include the Westerly Creek, Boulder Creek, Toll Gate Creek, Lena Gulch, Ralston Creek, Goldsmith/Harvard Gulch, and the Bear Creek drainage basins.

Five specific F2P2 products were produced by the PMS. The products included the Heavy Precipitation Outlook (HPO), the Internal Message Status (IMS), the Quantitative Precipitation Forecast (QPF), Storm Track (ST), and Messages. Table 1 provides a description of the first 4 products and table 2 provides a description of Messages. Table 3 depicts the number of F2P2 products that were produced and the number of communication contacts made or received by the PMS in 2007.

Table 1. F2P2 products description.

Heavy Precipitation Outlook (HPO)/Internal Message Statement (IMS). This HPO is available by 11:00 AM every day during our primary flood season as noted above. It provides a weather forecast for the District with emphasis on possible rainfall amounts and where storms are most likely to occur. When flood potentials threaten the District, the HPO will be revised and renamed "Internal Message Status" or IMS. This report will indicate the message status for each primary contact point within the District. The contact points include the counties of Adams, Arapahoe, Boulder, Broomfield, Denver, Douglas and Jefferson, and the City of Aurora.

Quantitative Precipitation Forecast (QPF). This text product is only available on days when the rainfall potential exceeds 1.5 inches in one-hour or less. The QPF product contains more basin-specific information than the HPO or IMS, and requires some knowledge of the regional major drainage basins, streams and associated flood hazards that impact the District. Storm types, expected rainfall totals, storm duration, peak intensities and associated probabilities of occurrence are presented in this forecast product.

Storm Track (ST). This combination map/text product is a short lead-time forecast showing where a storm has formed or is forming, the approximate size of the storm(s), the direction (or track) of the storm(s), and the estimated arrival times along the forecast track(s). This is probably the most-anticipated hard copy product of the F2P2, but keep in mind that generally it is only available within an hour or less of storm impact. Also, the Storm Track is not prepared for storms that do not pose a flood threat. The map includes a captured radar image whenever possible.

All of the above products were delivered to F2P2 participants using Premiere Global Services (formally Xpedite), an Internet-based broadcast facsimile and e-mail service, as well as and made available on the UDFCD ALERT web site, <http://f2p2.udfcd.org/>.

Voice communication is the principal means of disseminating F2P2 threat Messages. Four hundred eighty-nine (489) telephone contacts were made to eleven F2P2 communication points by the PMS for subsequent fan-out.

Denver Office of Emergency Management and Denver Wastewater received notification of the issuance of Messages and Storm Tracks through pagers and by Short Message Service (SMS) email. There were a total of ninety-six (96) text pages and SMS disseminations made to these two organizations.

Table 2: Message definitions.



URBAN DRAINAGE AND FLOOD CONTROL DISTRICT FLASH FLOOD PREDICTION PROGRAM (F2P2) MESSAGE DEFINITIONS

MESSAGE 1 (*Nuisance Flood Advisory*)

This advisory message is to inform key people that weather conditions are such that nuisance flooding of streets, low-lying areas, and small streams could develop later in the day. It will be issued by PMS after consultations with NWS. If PMS considers the threat imminent, the message will be identified as a **RED FLOOD ALERT**.

MESSAGE 2 (*Flash Flood Watch*)

This advisory message is to inform key people that either a Flash Flood Watch has been issued by NWS or PMS believes that weather conditions are such that a life-threatening flash flood may occur later in the day. Significant stream flooding and property damage is possible. PMS will add any additional information that is available.

MESSAGE 3 (*Flash Flood Warning*)

This warning message will be issued to inform key people that a Flash Flood Warning has been issued by NWS or PMS feels that a life-threatening flash flood is imminent. Significant stream flooding and property damage is expected. PMS will add any additional information that is available. This warning message should be disseminated as quickly as possible.

MESSAGE UPDATE

This message will be used by PMS to update any of the previous messages. 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 considers the threat imminent, the message will be identified as a **RED FLOOD ALERT**.

MESSAGE 4 (*All Clear*)

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

CONCERNING RED FLOOD ALERT

The term **RED FLOOD ALERT** is used when PMS believes that a flooding rainstorm is imminent. When a MESSAGE 2 is in effect, **RED FLOOD ALERT** may be used with a MESSAGE UPDATE to indicate imminent nuisance flooding that does not warrant a MESSAGE 3. When a MESSAGE 3 is in effect, **RED FLOOD ALERT** may be used with a MESSAGE UPDATE to indicate that an approaching storm is expected to cause nuisance flooding outside the warning area. In summary, **RED FLOOD ALERTS** are short lead notifications of imminent flood threats (low to moderate risk to life and property) that should be disseminated as quickly as possible.

ABBREVIATIONS:

NWS.....National Weather Service
PMSPrivate Meteorological Service

NOTE: For Boulder County only, MESSAGE Numbers **1, 2, 3 and 4** will be issued as **A, B, C and D** respectively to avoid confusion with their MACS operational "MODE" Numbers 1-4.

Table 3: 2007 product/communication summary.

Product/Communication	Number
Heavy Precipitation Outlook (HPO)	196
Message, Message Updates and Red Flood Alerts	368
Internal Message Status (IMS)	94
Basin-Specific Quantitative Precipitation Forecasts (QPF)	44
Storm Tracks (ST)	124
Message Potential SMS E-Mails (UDFCD Listserv)	121
Weather Update E-mail (SMS) and Text Pages (Denver County Specific)	96
PMS Initiated Telephone Contacts	489
F2P2 Participant Initiated Telephone Contacts	164
Total	1,696

One hundred twenty-one (121) emails identifying daily Message potential were disseminated to F2P2 participants. This new product was added in early May to provide an abbreviated daily flood threat for F2P2 participants. The SMS email included a convenient link to the morning HPO for those wanting more information.

4.0 2007 Message Statistics

The primary service provided to F2P2 participants is early prediction and notification of the potential for flash flooding, urban and small stream flooding, and locally heavy rainfall events that can initiate nuisance flooding. The PMS indicated the potential for these events in a series of products issued to F2P2 participants by phone, facsimile, email and Internet.

4.1 Message Verification

This year marks the second year in the 29-year history of the F2P2 in which Message statistics have been determined by UDFCD and not the PMS. A Message day is defined as any day in which a Message 1, Message 2 or Message 3 is issued based on the criteria depicted in Table 4. Messages were issued on 42 days during the 2007 F2P2 between April 15 and September 15, 2007. Of the 42 Message days, 33 of these days had at least one Message verify, based on the criteria listed in Table 4. The result was a 79% verification rate of Messages days on a District-wide basis. Table 5 depicts the number of Message days and the number of Messages issued and verified for each month of the 2007 F2P2.

Table 4: Message Criteria.

Message 1 “Nuisance Flood Advisory” Criteria (Boulder County Message A)	
•	Message-1 (Nuisance street or gutter flooding): 0.50"/10 minutes or 1.00"/60 minutes
•	Message-1 (Significant urban street and stream flooding): 1.00 to <3.00"/ 60 minutes
•	Red Flood Alert: Rainfall intensity: 0.50"/10 minutes or 1.00"/60 min AND occurrence is imminent
Message 2 Flash Flood Watch Criteria (Boulder County Message B)	
•	Option A: National Weather Service issues a Flash Flood Watch affecting the District
•	Option B: PMS predicts rainfall that will equal/exceed 3.00"/hour (No NWS Flash Flood Watch exists)
Message 3 Flash Flood Warning Criteria (Boulder County Message C)	
•	Option A: National Weather Service issues a Flash Flood Warning affecting the District
•	Option B: PMS issues a Flash Flood Warning for a specific District river/stream/drainageway (No NWS Flash Flood Warning exists)
Message 4 (Boulder County Message D)	
•	Message 4 (“All Clear”) is issued whenever Messages are rescinded before their expiration time.

There were 3 “nearby hit” days where a Message 1 was issued for a portion of the District and Message level rainfall was not observed within the District; however Message level rainfall was observed within the “nearby hit” zone outside of the District. This marks the second year that this statistic has been calculated. Including “near hit” days in the Message day statistics results in a 86% verification rate of Message level rainfall being observed within or near the District on the 42 Message days.

Of the 42 Message days, only 2 of these days (5/17, 6/26) had no Message level rainfall observed within the District or within the “nearby hit” zone. On May 17 Message 1’s were issued for the entire District and on June 26 only 3 Message 1’s (Boulder, Jefferson and Douglas Counties) were issued.

There were 5 days (5/14, 7/4, 7/10, 8/14, 8/24) where Message level rainfall was observed within a portion of the District and a Message 1 was issued with short lead-time (< 30 minutes) or zero lead-time.

There were 3 days (7/30, 8/10, 8/24) where Message level rainfall was observed within a portion of the District and no Message 1 was issued by the PMS for that location. On 2 of these 3 days a Message 1 was issued for other portions the District with adequate lead-time.

There were 2 days (7/4, 7/10) where a Message 1 was issued for a portion of the District, the Message 1 was rescinded and then re-issued due a renewed threat of Message level rainfall.

Table 5: Monthly Message verification.

Month	Number of Message Days	Verified Message Days	Percent of Verifying Message Days	Messages Issued	Verified Messages	Percent of Verified Messages
April	1	1	100%	1	1	100%
May	4	2	50%	29	8	28%
June	5	3	60%	35	9	26%
July	14	11	79%	94	37	39%
August	17	15	88%	98	50	51%
September	1	1	100%	4	4	100%
Total	42	33	79%	261	109	42%

A Red Flood Alert was issued when the PMS felt that there is a 90% or greater probability that Message level rainfall will be observed across a portion of the District. There were a total of 29 Red Flood Alert days, of which 23 of these Red Flood Alert days verified somewhere within the District; resulting in a verification rate of 79%.

The 42 Message days ties for the 5th highest number of Message days in the 29-year history of the F2P2. The 42 Message days is the highest total since 1999, which had a total of 45 Message days.

There were 4 Flash Flood Watch days and subsequently the same number of Message 2 days. Four Message 2 days is the average number of Message 2 days in the 29-year history of the F2P2.

The National Weather Service in Boulder issued two Flash Flood Warnings for portions of the District. The first warning was issued for east Aurora, during the evening of July 21, due to heavy rainfall of 1.93" being observed by the Murphy Creek ALERT rain gage in a 75-minute time period. The PMS concurred with this warning. The second Flash Flood Warning was issued for Denver County, and western Arapahoe County during the early evening of July 27, due to heavy rainfall of 1.50 to 2.50" that was observed in 45-60 minutes. The PMS concurred with this warning as well.

4.2 County/City Message Statistics

Each Message issued within the F2P2 is disseminated to a primary contact point in which flooding potential has been predicted. The counties and cities that receive Messages are listed in Table 6.

A Message is verified as a "hit" when a rainfall event meeting the Message criteria depicted in Table 4 is observed in the District-portion of that City/County or in the drainage area of a watercourse that flows into the jurisdiction. Table 6 contains the results of the Message verification on a City/County basis.

Verification of Messages issued for the City of Aurora is included in the County statistics because Aurora is a primary contact point. The cities of Arvada, Lakewood and Wheat Ridge receive Message 1 notifications from Jefferson County dispatch, but also receive Red Flood Alerts, Message 2's and Message 3's directly from the PMS.

Table 6: Message Verification.

Primary Message Contact Points	Messages Issued	Message Hits	% Message Hits	Red Flood Alerts Issued	Red Flood Alert Hits	% Message Red Flood Alert Hits	Events Missed	Event < 30 min Lead Time
Adams	34	17	50%	14	11	79%	3	0
Arapahoe	33	14	42%	12	8	67%	2	1
Aurora	33	11	33%	12	7	58%	2	1
Boulder	32	8	25%	8	4	50%	3	0
Broomfield	26	4	15%	5	4	80%	1	1
Denver	34	14	41%	10	6	60%	3	0
Douglas	34	24	71%	12	10	83%	1	1
Jefferson	35	17	49%	11	8	73%	3	1
TOTAL	261	109	42%	84	58	69%	18	5
Red Flood Alert Contact Points	Messages Issued	Message Hits	% Message Hits	Red Flood Alerts Issued	Red Flood Alert Hits	% Message Red Flood Alert Hits	Events Missed	Event < 30 min Lead Time
Arvada	N/A	N/A	N/A	3	2	67%	0	0
Lakewood	N/A	N/A	N/A	3	3	100%	0	0
Wheat Ridge	N/A	N/A	N/A	2	2	100%	0	0
TOTAL	N/A	N/A	N/A	8	7	88%	0	0
GRAND TOTAL	261	109	42%	92	65	71%	18	5

A total of 261 Message 1's were issued to the 8 primary contact points within the District. Of the 261 Message 1's that were issued, 109 verified, resulting in a verification rate of 42%. Douglas County had the highest verification rate, 71%, while Broomfield County, the smallest County within the District, had the lowest verification rate of 15%.

A total of 92 Red Flood Alert's were issued. Of the 92 Red Flood Alerts issued, 65 of them verified, resulting in a verification rate of 71%. Douglas County had the highest Red Flood Alert verification rate, 83%, while Boulder County had the lowest Red Flood Alert verification rate of 50%.

The PMS took the liberty of preparing a cloud-to-ground lightning climatology that covered the forecast period of April 15, 2007 through September 15, 2007. Archived cloud-to-ground lightning data was reviewed for each of the 154 operational days of the F2P2. The climatology revealed that of the 154 days, 100 of the days (65% of the total days) cloud-to-ground was observed within or near the District. Of the 100 "thunderstorm days" within the District only 42 of the days had Messages issued for them. The cloud-to-ground lightning climatology can be found in Appendix A.

5.0 Notable Weather Events

The spring and summer of 2007 was rather active with respect to the number of days that thunderstorms and precipitation was observed within the District. However, there were only a few notable flooding events and flood damage was minimal. Some of the notable weather events observed during the 2007 F2P2 are listed below:

April 23 & 24: A potent slow-moving spring storm system produced heavy wet snow across the higher elevations of the District and produced 1.50” to as much 4.00” of rainfall across the lower elevations of the District in a 30-hour period. Due to long duration of the rainfall only minor flooding of rivers and streams was experienced.

May 14: A thunderstorm developed rapidly due to multiple thunderstorm outflow boundaries that were initiated by weak and moderate thunderstorms across western Jefferson and western Boulder Counties. The thunderstorm produced heavy rainfall of 0.75” to 1.50” in 10-30 minutes (Figure 2, located in Appendix B) across eastern Jefferson, Denver, western Arapahoe and southwest Adams Counties. Short lead Red Flood Alerts were issued for these 4 counties. Two-year-old Jose Matthew Jauregui Jr. was swept away by rapidly rising water along a bike path that was adjacent to Lakewood Gulch. His body was later recovered along the South Platte River.

Figure 4: Flooding in southern Denver on July 27, 2007.
(Courtesy Denver Post)



July 27: A Flash Flood Watch and Message 2's were issued for the entire District due to the threat of very heavy rainfall that could initiate flash flooding and urban flooding. Strong thunderstorms developed late in the afternoon across the southern portion of the District. The storms moved very slowly to north producing heavy rainfall of 1.50" to 2.50" in 30-60 minutes (Figure 3, located in Appendix B) prompting a Flash Flood Warning and Message 3's for Denver, Arapahoe and Adams Counties. Figure 4 shows some of the urban flooding that was experienced across southern Denver County.

August 2: Message 1's were issued for the entire District and heavy rainfall 0.75" to 1.50" was observed across the central and northern portion of the District during the early evening hours. Later that night strong thunderstorms developed over Larimer and Weld Counties. Multiple thunderstorms moved over the same areas (thunderstorm training) resulting in very heavy rainfall of 3.00" to 5.00" in Fort Collins and up to 6.50" in southern Weld County (Figure 5, located in Appendix B). The heavy rainfall resulted in nuisance flooding within the District. .

August 15: A severe thunderstorm developed over the City of Boulder during the late afternoon and moved slowly to the southeast. The thunderstorm produced large hail and heavy rainfall of 1.25 to 2.00 inches in 30-45 minutes (Figure 6, located in Appendix B) across the southern portion of the City of Boulder. The heavy rainfall produced isolated, but significant urban flooding and caused Bear Canyon Creek that runs along Table Mesa Drive to leave its banks (Figure 7).

Figure 7: Flooding of Bear Canyon Creek in Boulder, August 15, 2007
(Courtesy Denver Post)



6.0 Recommendations

The PMS has made the following recommendations for future improvements to the F2P2:

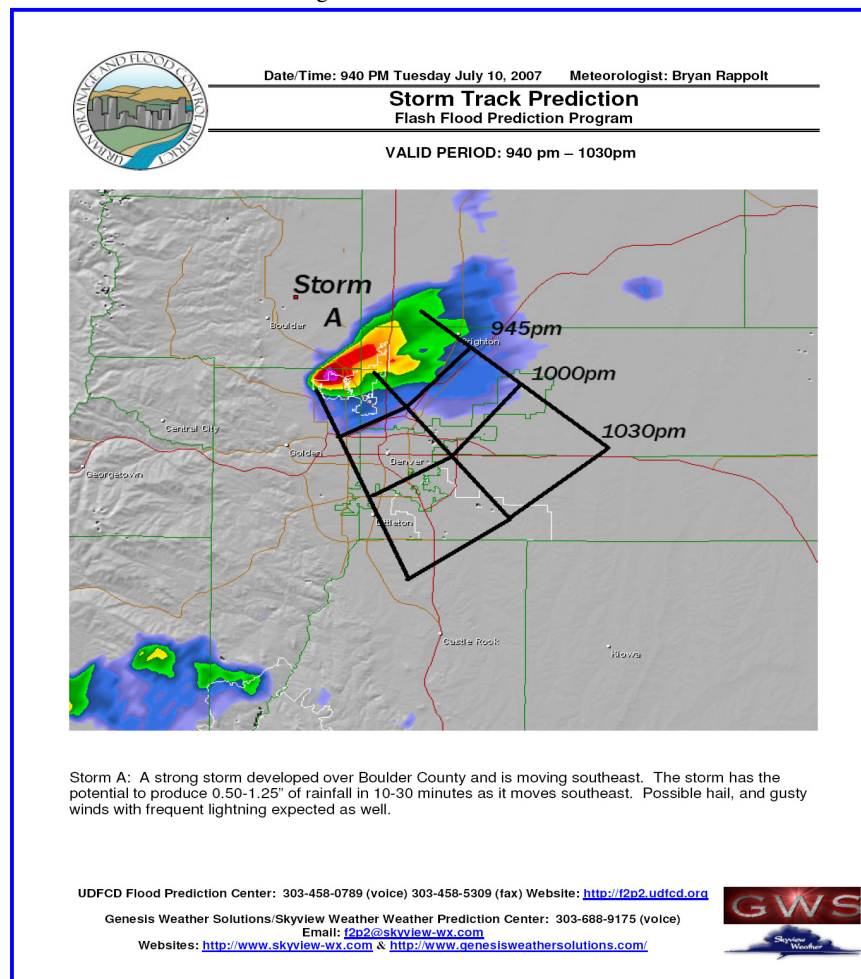
Product Dissemination

The PMS experienced issues with the Global Premier Services Internet-based broadcast fax and email delivery service with regard to occasional slow product dissemination. The PMS recommends that UDFCD utilize the Via West ListServ, as a means for product dissemination, as the primary product dissemination source and that Global Premier Services be utilized as a back up.

Storm Track

The PMS recommends that a back-up Storm Track application be put in place that would be used if the primary GIS-based Storm Track application fails. The PMS experienced latency issues of the GIS-based WDT radar data that is overlaid on the UDFCD Storm Track application. The PMS developed a Storm Track product alternative using GRLevel, a level II and level III radar display application that both UDFCD and the PMS subscribes to and was used operationally within the 2007 F2P2. Perhaps this Storm Track product could be specified as a back up to the storm track application. Figure 8 is an example of a storm track produced by GRLevel software.

Figure 8: GRLevel Storm Track



Flood Prediction Equipment

The PMS recommends that the two “older” computers running Microsoft Windows be replaced with one new computer that can provide video to multiple (two or more) LCD monitors simultaneously. The new computer should be used to produce Storm Tracks with ArcGIS and view Doppler radar using GRLevel simultaneously. In addition, EMWIN can be running in the background.

APPENDIX A

Table 7: 2007 F2P2 Thunderstorm (TRW) Days

Date	Comments	TRW DAY (1=yes, 0=no)
15-Apr	Per NWS	0
16-Apr	Per NWS	0
17-Apr	Snow Foothills/No TStrms	0
18-Apr	Per NWS	0
19-Apr	Per NWS	0
20-Apr	Per NWS	0
21-Apr	Per NWS	0
22-Apr	Per NWS	0
23-Apr	Per NWS	1
24-Apr	Rain/Snow Mix	0
25-Apr	Rain/Snow Mix	0
26-Apr	Per NWS	1
27-Apr	Per NWS	0
28-Apr	Per NWS	0
29-Apr	Thunderstorm noted by T. Tonge daily notes	1
30-Apr	Per NWS	0
1-May	Strikes concentrated over western suburbs and foothills	1
2-May	Strikes over north Douglas along I-25	1
3-May	One solitary strike north of Boulder, and some strikes in Larimer County near Eagle Rock	0
4-May	Strikes eastern areas of District, lots of lightning just east and north of area in Morgan and Adco	1
5-May	Strikes scattered over District and explosion of strikes east of District on plains	1
6-May	Few strikes near Castle Rock bordering District	1
7-May	Few strikes in southern El Paso and Park County	0
8-May	Few strikes south of COS and 1-3 strikes in Gilpin County	0
9-May	Small area of strikes in NW Jefferson County and near Eagle Rock	1
10-May	Few strikes Gilpin and Clear Creek County	0
11-May	Few strikes in Teller and Park County	0
12-May	Concentration of strikes southern Douglas, line of scattered strikes within District	1
13-May	Lots of strikes over mountains to the west only a few strikes lower elevations	1
14-May	Strikes northeastern areas of District and north Boulder/Larimer Cnty line and COS south	1
15-May	High concentration of strikes within District	1
16-May	Lots of strikes over Pikes Peak region and Park County, one strike south of Castle Rock	0
17-May	Many strikes just outside District Jefco, Douglas, Boulder County	1
18-May	Widely scattered strikes	1
19-May	Isolated pockets of dense strike activity	1
20-May	Scattered strikes with areas of dense strike activity eastern areas of District and plains	1
21-May	Concentration of strikes over Boulder and plentiful strikes over eastern plains	1
22-May	Widely scattered strikes over the District with a heavy concentration of strikes over SE Douglas	1
23-May	Strikes centered within the District and eastern Douglas County	1
24-May	No strikes observed	0
25-May	No strikes observed	0
26-May	Widely scattered strikes with pocket of strikes just north of Adams County	1
27-May	No data plots for USPLN, Per Denver climate summary thunder was observed and recorded	1
28-May	No data plots for USPLN, Per Denver climate summary thunder was observed and recorded	1
29-May	No data plots for USPLN, Per Denver climate summary thunder and hail was observed	1
30-May	Strikes scattered all over but nothing in or very close to the district	0

31-May	No strikes observed	0
1-Jun	Couple strikes ENE Greeley	0
2-Jun	Nothing within the District, but strikes observed in Jefco and Hayman Burn area.	1
3-Jun	Couple lines of strikes within District Very active lightning in Park, Teller and El Paso County	1
4-Jun	NW to SE lines of strikes around District, but only a couple strikes within District boundaries	1
5-Jun	Good line of strikes through southern areas of the District	1
6-Jun	Strikes well outside District in Arapahoe, Morgan and Weld Counties	0
7-Jun	No strikes observed east of Continental Divide	0
8-Jun	No strikes observed	0
9-Jun	Strikes observed in South Douglas and El Paso County	1
10-Jun	Couple strikes within District otherwise just a line of scattered strikes along Palmer Divide	1
11-Jun	Widely scattered strikes in and around District	1
12-Jun	Few strikes north of I-70 then scattered to dense strike areas in southeastern Douglas, Elbert	1
13-Jun	Strikes indicated in El Paso and far east of the District, but nothing really close	0
14-Jun	No strikes observed	0
15-Jun	No strikes close, but a good cluster of strikes just west of Pikes Peak in Teller and Park counties	0
16-Jun	Good area of strikes in Boulder County and in foothills west and south of District	1
17-Jun	Just about a dozen strikes within District in Adams County, strikes se and ne of District	1
18-Jun	Nothing Close to the District, but some strikes mountains and NE Colo	0
19-Jun	No strikes observed	0
20-Jun	Just a couple strikes over Pikes Peak	0
21-Jun	Only a couple strikes within District, good line of strikes just south of District in Douglas County	1
22-Jun	Nothing within District, but plethora of lightning just east and strikes over foothills	1
23-Jun	Overall not many strikes but a cluster along and south of District line in Douglas County	1
24-Jun	Good amount of strikes over DIA and Adams County	1
25-Jun	Dense lightning coverage over the Hayman Burn area, not much else other areas	1
26-Jun	Dense strike coverage SE District, Douglas, Elbert, El Paso County	1
27-Jun	Nothing within the District, good strike coverage near Hayman in Park, Teller, and a cluster Boco	1
28-Jun	Scattered strikes within District, good coverage in Mountains and Hayman area	1
29-Jun	Strikes observed DIA and Adams County	1
30-Jun	Area of strikes SE areas of District	1
1-Jul	Few strikes within District in Adams County, plethora of strikes in Weld and Morgan Counties	1
2-Jul	Areas of strikes to NE and SW of District	0
3-Jul	Strikes all along Front range foothills extend south and eastward through El Paso County	1
4-Jul	Cluster of strikes over central portions of District	1
5-Jul	Strikes over the mountains with a cluster in north Douglas and a few within the District	1
6-Jul	Strikes west of Continental Divide	0
7-Jul	Mountains, Foothills and central District	1
8-Jul	Strikes all over the state	1
9-Jul	Not many but a few in Jefferson County foothills extending southward	1
10-Jul	Good concentration of strikes within NW areas of District	1
11-Jul	Few strikes in Jefco part of District, scattered strikes rest of the state	1
12-Jul	Strikes in Douglas and Jefco portions of District and dense strikes over rest of the state	1
13-Jul	Just a few strikes over the mountains	0
14-Jul	Strikes over mountains and foothills only a few within the District	1
15-Jul	None inside District, but cluster of strikes over Jefco Foothills	1
16-Jul	Strikes over the mountain areas of the continental divide westward	0
17-Jul	Strikes all over mountains and foothills, just a few western areas of District	1
18-Jul	Jefco portion of District and all over the mountains to the west	1

19-Jul	Good amount of strikes over eastern areas of District	1
20-Jul	Strikes in the high country only	0
21-Jul	Nice line of dense strikes through the district	1
22-Jul	Just over the high country well to the west	0
23-Jul	Small cluster of strikes in Jefco lots of lightning over the western mountains	1
24-Jul	Strikes well west and south of the District	0
25-Jul	Strikes everywhere	1
26-Jul	Widely scattered strikes within district and good line of strikes along and east of I25 in Douglas	1
27-Jul	Lightning everywhere	1
28-Jul	Not much activity within District, good concentration of strikes in Douglas County	1
29-Jul	Widely scattered strikes	1
30-Jul	Strikes east of I-25 within District and good amount of strikes south and east Douglas	1
31-Jul	Few areas of strikes in Park and Chaffee Counties	0
1-Aug	Few strikes along Douglas/Arapahoe County line	1
2-Aug	Strikes central District and very active lightning just north of district	1
3-Aug	Good amount of strikes N Douglas and DIA extending NE	1
4-Aug	North Jefco area and dense area of strikes Teller and El Paso Counties	1
5-Aug	Active lightning day within District and extending southward	1
6-Aug	SE area of District, and just plethora of strikes south and east	1
7-Aug	DIA area northeastward and lines of dense strikes south and east	1
8-Aug	Just a few strikes near Fort Collins	0
9-Aug	Good amount of strikes along Weld Adams County line	1
10-Aug	West to East line of strikes through the center of the District	1
11-Aug	Borderline Yes with a line of strikes in El Paso County to extreme SE Douglas	0
12-Aug	Areas of scattered strikes NW and SE District	1
13-Aug	Widely scattered strikes all over	1
14-Aug	Dense areas of strikes in and around District	1
15-Aug	Good amount of strikes within District and impressive amount of activity just south	1
16-Aug	Few strikes within western areas of District, better coverage SW of District	1
17-Aug	West and southern areas of District	1
18-Aug	Large areas of lightning coverage relatively few strikes within district, best concentration Dougco	1
19-Aug	Lines of strikes within in District, western and southern areas	1
20-Aug	No strikes observed	0
21-Aug	No strikes observed	0
22-Aug	Good line of strikes through central and southern areas of District	1
23-Aug	Line of strikes north of I-70 within District and SE areas	1
24-Aug	Dense areas of strikes within District	1
25-Aug	No strikes within area	0
26-Aug	Isolated strikes in and around district	1
27-Aug	No strikes within District Isolated strikes just outside District	1
28-Aug	Far eastern areas of District and good areas of strikes to the northeast	1
29-Aug	Strikes north central District and foothills to the west	1
30-Aug	Borderline Yes with strikes west of District in mtns and foothills	1
31-Aug	Just west of District in foothills, and isolated storm in areas of central District	1
1-Sep	Very isolated in district, but some strikes Boulder Cnty	1
2-Sep	Widespread storms over Denver and Douglas	1
3-Sep	Widespread storms over Douglas County	1
4-Sep	Storms Boulder Cnty with lightning right on the UDFCD boundary in Boulder Cnty	1
5-Sep	Widespread storms across the district	1

6-Sep	Quiet day across district	0
7-Sep	Dry day	0
8-Sep	Dry day with exception of couple strikes N El Paso Cnty	0
9-Sep	Lightning detected Douglas Cnty within the district	1
10-Sep	Cold with drizzle only	0
11-Sep	Sunny and dry	0
12-Sep	Sunny and dry	0
13-Sep	Sunny and dry	0
14-Sep	Minimal lightning but several strikes noted SW Jeffco and 1 strike in district by DIA	1
15-Sep	Western Boulder and Cntrl Weld but not in district	
Totals		100
Percent of Thunderstorm Days in or nearby the District (100/154)		64.9%

APPENDIX B

Figure 2. Radar estimated rainfall for May 14, 2007 produced by National Weather Service and UDFCD.

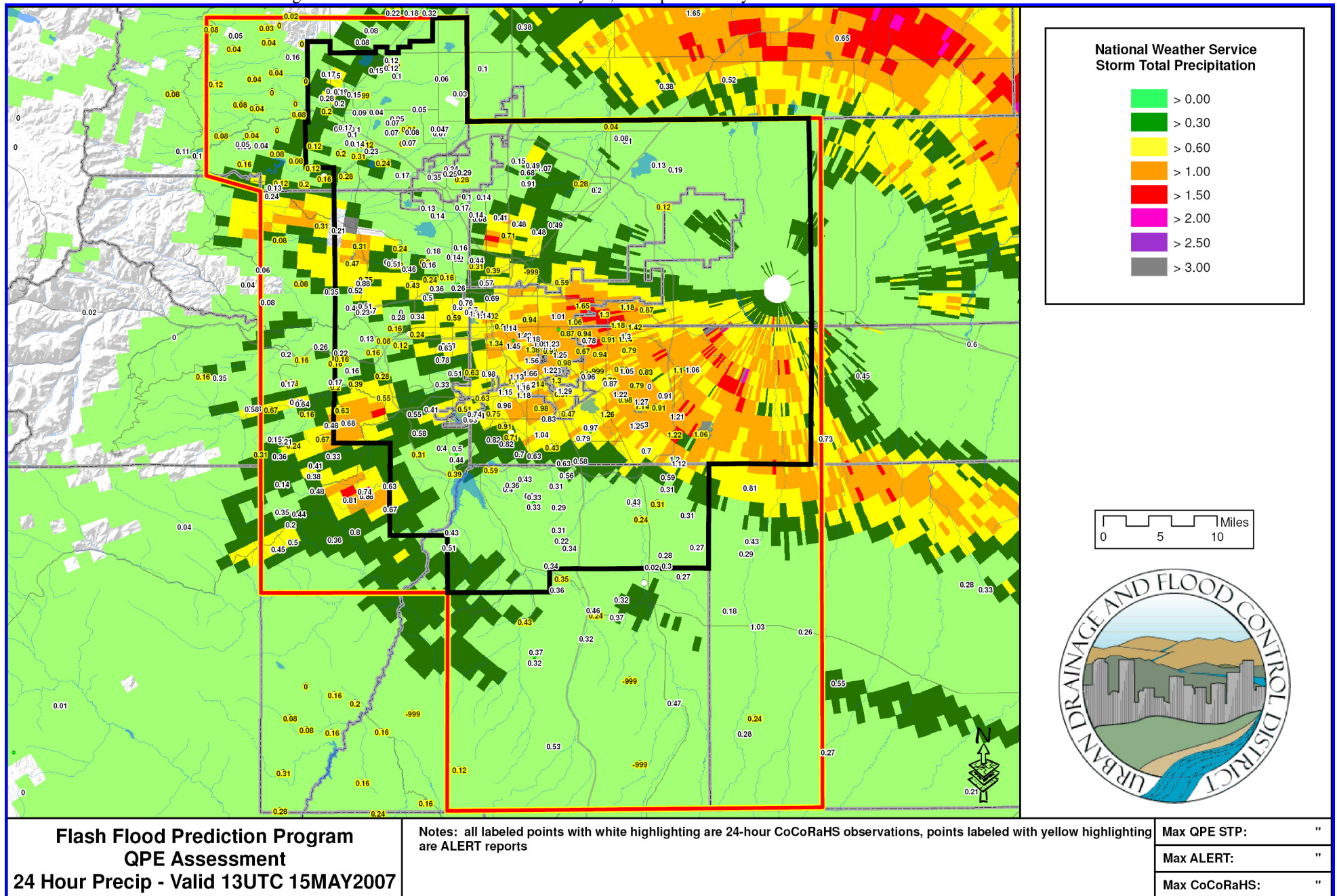


Figure 3. Rain gage adjusted rainfall for July 27, 2007 produced by Weather Decision Technologies and UDFCD.

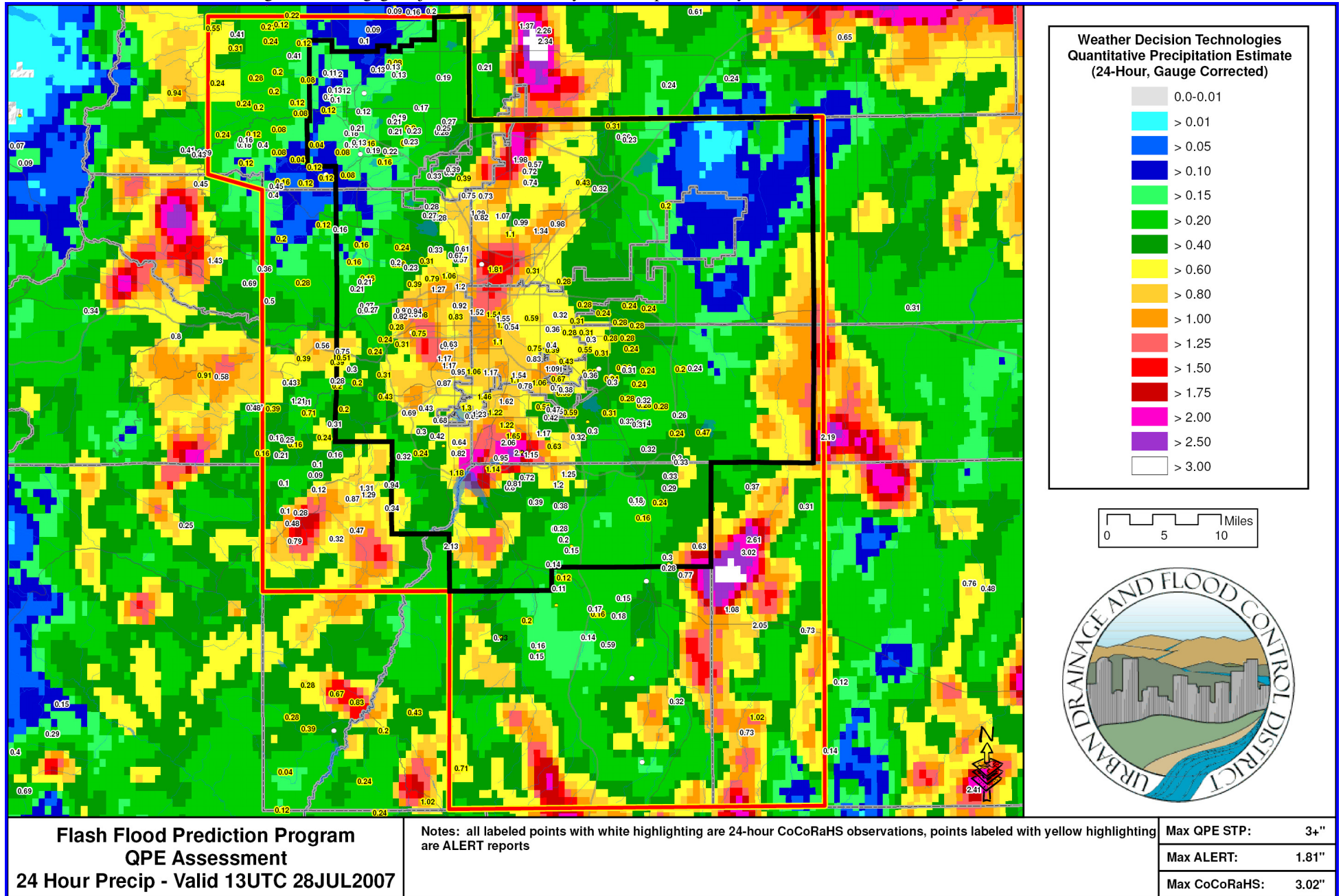


Figure 5. Rain gage adjusted rainfall for August 2, 2007 produced by Weather Decision Technologies and UDFCD.

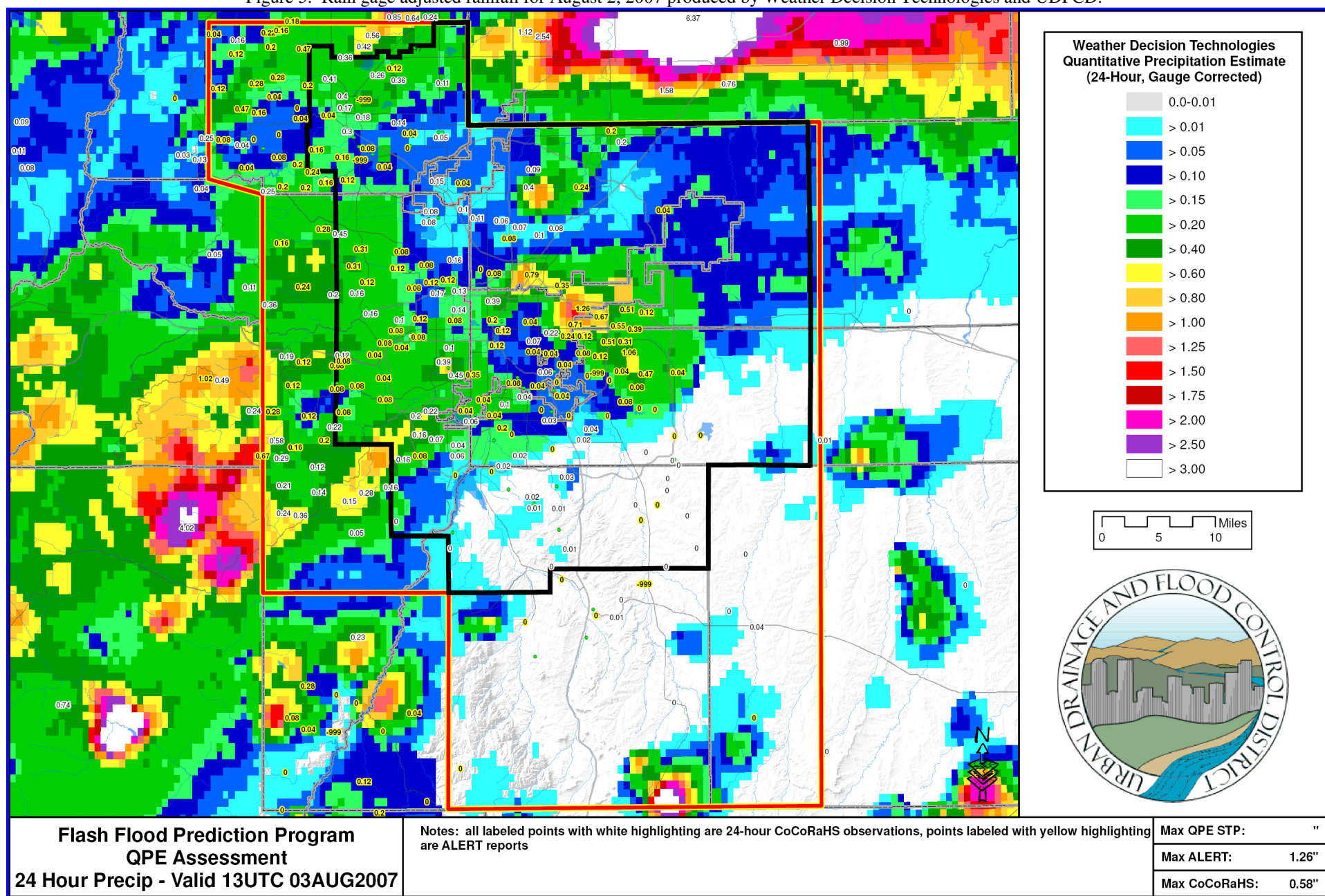


Figure 6. Rain gage adjusted rainfall for August 15, 2007 produced by Weather Decision Technologies and UDFCD.

