

A decorative horizontal bar with a dark red top section and a light gray bottom section.

## 2020 MHFD Heavy Rainfall Threat Analysis Tool

### FINAL REPORT

January 4, 2021

Submitted by:

**Dewberry**

8100 East Maplewood Avenue, Suite 150  
Greenwood Village, CO 80111

Submitted to:

**Kevin Stewart**

**Mile High Flood District**  
2480 W 26<sup>th</sup> Ave, #156B  
Denver, CO 80211

## CONTENTS

OVERVIEW .....	1
METHODOLOGY .....	3
VALIDATION .....	6
CONCLUSIONS & RECOMMENDATIONS.....	13
REFERENCES.....	15
APPENDIX A .....	16
APPENDIX B .....	21

### Submitted to:



### Contributors

**Ken Cecil, P.E., CFM**  
Principle-in-Charge  
kcecil@dewberry.com  
720.463.2661

**Danny Elsner, P.E., CFM**  
Project Manager  
eelsner@dewberry.com  
303.951.0639

**Dana McGlone**  
Hydrometeorologist  
dmcglone@dewberry.com  
720.943.5923

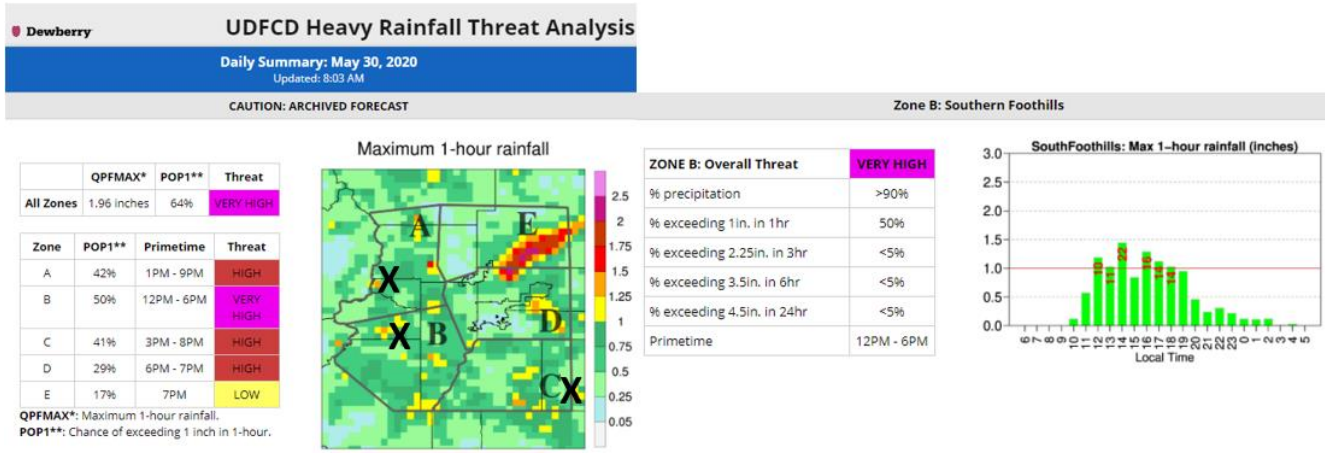
## OVERVIEW

In early 2015, Dewberry designed and developed a Heavy Rainfall Threat Analysis (formally known as the Heavy Rainfall Guidance Tool and hereafter, Tool) for the Mile High Flood District (hereafter, MHFD or District) to address four crucial questions regarding the summertime daily heavy rainfall threat across the District area: (i) timing, (ii) location, (iii) intensity and (iv) confidence. The Tool is based on an ensemble of high-resolution weather models that are able to directly simulate convective rainfall. The original 2015 operational version of the Tool was based on raw model data. In 2016, a Technical Memo documenting the 2015 Tool performance noted, among other things, a noticeable “overconfidence” bias where heavy rainfall was being predicted with higher frequency and higher probability than was being observed. Thus, a significant processing step was added for the 2016 operational season to reduce this bias. After the 2016 operational season, further research on bias correction was undertaken, and flow dependent biases were noted and corrections were applied to the Tool from 2017 and onward. Prior to the start of the 2018 operational season, the Tool was reduced from six to five forecast zones with the existing zones trimmed from south to north and east to west. The objective was to reduce the rainfall influence of the climatological active regions of the eastern plains and southern half of the Palmer Divide, whose rainfall had no effect on runoff over the District. At the beginning of 2018, the NCAR and NSSL ensembles used in the previous three seasons were discontinued due to research projects ending. To replace these 18 models, the 9 member High-Resolution Rapid Refresh Ensemble (hereafter, HRRRE) was added to the Tool. Upgrades to the model continued for the 2019 operational season with eight more model members added from the 4km Texas Tech University WRF Ensemble (hereafter, TTU-WRFens). The HRRR 00Z, 06Z and 12Z runs were also extended out to 24-hours (previously 18-hours), and updates were made to the website display.

### Tool description

The Tool accesses hourly Quantitative Precipitation Forecast (QPF) data from up to 36 high resolution weather model simulations from the National Severe Storms Laboratory (NSSL), the National Centers for Environmental Prediction (NCEP), and the National Center for Atmospheric Research (NCAR). All models have horizontal resolution of 4 km (2.4 miles) or less allowing for a more realistic representation of thunderstorm-based rainfall compared to weather models with coarser resolution. QPF data from the model “ensemble” is re-gridded to a common ~3.9 km grid across an area centered on the MHFD, after which maximum hourly QPF (hereafter, QPF-Max) and Probability of Exceedance (POE; for example, chance of exceeding 1 inch per hour) are computed for each of five forecast Zones (see Figure 1). Although MHFD’s service area is about 1,600 sq. miles, the Tool’s area covers about 5,700 sq. miles for two main reasons. First, to ensure that rainfall is captured within contributing watershed boundaries that extend outside of the official MHFD boundary, and second, due to the imperfect (but improving) nature of heavy rainfall forecasts.

Tool output is displayed on a web-based user interface, and is publicly available at: <https://qpf.udfcd.org>. Snapshots of the “Daily Summary” and “Zone Forecasts” sections of the Tool’s web interface are shown in Figure 1 from May 30th, when rainfall exceeding 1 inch in 1 hour was observed over areas marked with the black “X” (Stage IV data). During 2017, a notable upgrade in the Tool’s operations allowed for three updates per day compared to two daily updates during 2015 and 2016. In the 2020 season, this upgrade continued to improve the visual and statistical heavy rainfall threat for the Tool throughout the day. This, in turn, kept the end-users up to date on the evolving threat for heavy rainfall over their area. An archive of the Tool’s output is available by clicking on the “Archives” link at the top right of the website.



**Figure 1:** Snapshot of the "Daily Summary" and "Zone-Specific Forecasts" of the Tool's website for the 8AM update of May 30th, 2020. Heavy rainfall was observed in two of the five Forecast Zones during the afternoon and evening hours, which is marked by the black "X".

**2020 Upgrades**

Improvements to the Tool continued over the 2020 season. Hindcast performance of the Tool in 2019 showed better performance without the TTU-WRFens, so the ensemble was excluded this season. However, data was still collected with a goal that a bias correction in 2021 can help correct the QPF data. Additionally, the 4km WRF model run by Colorado State University (CSU-WRF) was collected for input into the Tool's ensemble. In this validation we examine the performance of the Tool with and without the CSU-WRF, which will shed light on the importance of a bias correction and inclusion of the model in 2021. Unlike the TTU-WRFens, the CSU-WRF was able to undergo a bias correction due to the research group's collection of previous years' data. Finally, a bias correction was added to the HRRRE after the collection of QPF data over the last two years.

At the beginning of the season, additional non-QPF variables for the post-processing equations were examined. This included looking into gradient changes across the District, which included well-known atmospheric variables such as Precipitable Water (PW) and convective potential energy (CAPE). None showed significant change in the performance of the equations. In fact, variables used previously in the All Zones and Zone-Specific equations showed no significance with the inclusion of the 2019 data. This was likely due to the low number of flood days (26 days) last season. Since the equations performed well in the 2018-2019 season, no updates were made to the All Zones and Zone-Specific equations. It was also found that there were no significant changes that needed to be made to the threat classification system (All Zones or Zone-Specific; Table 2). For consistency, these also remained the same for the 2020 season, and will continue to be examined at the beginning of each season. The threat classification system is best calibrated after more active years due to higher data counts leading to more robust conclusions.

Changes to the Tool in the off season included the addition of the N4 update at 7PM MDT. This will help provide better awareness of an overnight heavy rainfall threat, or it will drop the threat if the heavy rainfall threat has ended (downtick in probability). Lastly, the bias corrections were examined at the end of the 2020 season. Typically, bias corrections are performed for the high elevation zones (A and B) and the low elevation zones (C, D, and E) for the Zone-Specific equations. Results show that a separate bias correction for the Palmer Divide (Zone C) only very slightly improved the model performance. So, for consistency, the Palmer Ridge will continue to be calculated with Zones D and E for the 2021 season.

Overall, the season was historically slow with only 12 flood days (precipitation exceeding 1 inch in 1-hour). Of the 12 days, only 3 days had Quantitative Precipitation Estimation (QPE) greater than 1 inch in 1-hour over more than one zone. There were no days where QPE greater than 1 inch in 1-hour occurred in more than 2 zones, which means the heavy rainfall threat was more localized than widespread. The social media campaign continued from last season, however, only one tweet was posted on May 30<sup>th</sup>. Heavy rainfall ended up occurring over the foothill regions (Zone A and B) and southern portion of Zone C (Palmer Ridge), which verified the tweet (Figure 1). On August 5<sup>th</sup> a training was completed for the Tool. There were 35 participants in the virtual learning event, and the training was recorded and slides were provided from the presentation for the District. Feedback was positive, and some local media participated in the training, so this will hopefully continue to build awareness about the Tool and confidence in Tool's output.

In this report, we first discuss the methodology for the validation effort and present Tool validation statistics, as well as an example of a noteworthy heavy rainfall event this season. Finally, we provide conclusions and recommendations for future operations.

## METHODOLOGY

Validating the performance of rainfall forecasts is notoriously difficult due to the large spectrum of possible metrics. This is especially relevant when data from multiple weather models are involved, as is the case with the Tool. For the purposes of this report, we must recall that the Tool was designed to predict the *maximum* rainfall potential on any given day. While it is possible and potentially useful to investigate other aspects of rainfall statistics (for example, distribution across the domain, relation to climatology, etc.), the primary focus of this report will be on analyzing maximum rainfall amounts in (i) each of the five Forecast Zones individually and (ii) across the five Zones collectively. Furthermore, since we are interested in relatively short-term rainfall capable of producing flash flooding, **the focus of the validation will be on the 1-hour time period for the morning run (produced at 8AM MDT) over the 153 day operational season.**

### Rainfall Observations

We used MHFD's roughly 200 active ALERT rainfall gages as one of the primary inputs to the validation. Raw tipping bucket data was obtained from TriLynx (special thanks to Steve Malers) and processed maximum 30-minute and hourly accumulations with a sliding window. Note that this is an important upgrade beginning in 2017, where ALERT data in 2015-2016 was binned into hourly increments before a maximum value was calculated. The 2015-2016 method was found to underestimate maximum rainfall by up to 40%. To supplement the ALERT data, we use two additional products: (i) gridded gauge-adjusted radar estimates provided by the National Oceanic and Atmospheric Administration's Stage IV product at roughly 4 km resolution and (ii) volunteer-based observations from the Community Collaborative Rain, Hail & Snow Network (CoCoRaHS) network. The benefit of Stage IV is that it has full coverage in space and is especially useful due to MHFD's proximity to the Denver NEXRAD Doppler radar. However, Stage IV's limitations are that (i) because it is first derived from radar reflectivity (and then gage corrected) it does not always accurately reflect the true rainfall, (ii) because the Stage IV product is on a 4-km grid, this may act to smooth out rainfall amounts, especially for spatially explicit storms, and (iii) the data is produced in hourly increments, which causes Stage IV maximum hourly rainfall to be *lower* than corresponding ALERT data during most heavy rainfall events. CoCoRaHS observations were used mainly for quality control especially during cases where only one or two ALERT gages measured heavy rainfall or when Stage IV two hour rainfall totals were over 1 inch.

For our validation, ***we use the maximum hourly rainfall from either processed ALERT data or Stage IV.*** This represents the best readily available estimate of maximum rainfall, which is what the Tool is designed to forecast. For All Zones

in 2020, the daily maximum rainfall was measured by ALERT 33% of the time when POP-1hr was realized. Daily summaries of zone-aggregated and Zone-Specific precipitation amounts are shown in Appendices A and B, respectively.

Table 1 describes the characteristics of the five forecast zones. All five zones are between 1,000 and 1,100 square miles, while Zone B (Southern Foothills) is the exception at about 1,300 square miles due to its extension to the Continental Divide. The roughly equal area size of the new five zones (as opposed to the prior zones) makes post-processing of the QPF data more consistent and validation between the zones more comparable. Table 1 also shows that each Zone had a widely varying number of gages within it (note that not all gages may be active at all times), ranging from 16 in Zone E (North Metro) to 100 in Zone D (Central Metro). The right two columns of Table 1 show rainfall statistics for the 2020 season, and note that in the two right columns of Table 1, the sum of the values across each Zone do not equal the total: this occurs because there are often instances when multiple zones record rainfall accumulations exceeding these thresholds *simultaneously*. The number of days where maximum hourly rainfall exceeded 0.5 inches ranged from 9 in Zone E (North Metro) to 19 in Zone C (Palmer Divide). There were only 37 days during the 153 day operational season when at least one Zone measured 0.5 inches in 1 hour, which is well-below what is expected from climatology. Regarding the more important threshold of 1 inch over 1 hour, there were only 12 such days, which just over half of the climatological average from 2017 to 2019. All Zones had at least 1 day of 1 inch over 1 hour with the climatologically active region of the Palmer Divide (Zone C) reaching the highest number of days (7 days). To be brief, **2020 can be described as a very dry operational season with much below normal precipitation (bottom 10%). Portions of southwest Arapahoe County, northwest Douglas County and northwest Clear Creek County recorded their driest May to September on record (West Wide Drought Tracker, 2020).**

**Table 1:** Summary of Forecast Zones and 2020 statistics. Note that there are 153 days in the 2020 operational season.

Forecast Zone	Area (sq. mi.)	# of ALERT gages	# of days with rainfall >= 0.5 in/hr	# of days with rainfall >= 1.0 in/hr
(A) Northern Foothills	1,034	68 gages	14 days	2 days
(B) Southern Foothills	1,317	27	10	2
(C) Palmer Divide	1,131	47	17	7
(D) Central Metro	1,151	100	19	3
(E) Northern Metro	1,130	16	9	1
<b>All Zones</b>	<b>5,763</b>	<b>258</b>	<b>37 (2017 - 64; 2018 - 49; 2019 - 63)</b>	<b>12 (2017 - 19; 2018 - 22; 2019 - 26)</b>

### Threat Classification System

Although the Tool outputs forecasted rainfall amounts, its broader purpose is to act as a decision support tool for various groups such as emergency managers. Accordingly, a translation between rainfall intensity and probability into a threat level(s) is required. As in 2015 through 2019, five threat levels were used: No Threat, Low, Moderate, High and Very High. The Threat Level is based on two considerations: rainfall intensity and probability of exceedance. The following four rainfall duration thresholds are used to identify a possible threat: **1 inch per 1 hour, 2.25 inches per 3 hours, 3.5 inches per 6 hours and 4.5 inches per 24 hours**. Using multiple durations captures the wide array of rainfall events, ranging from very intense, short-duration events (e.g. 1 hour) to low-to-moderate intensity, long-duration events (e.g. 6+ hours). In addition to the threshold itself, the probabilistic capabilities of the Tool were leveraged to quantify the confidence of a threshold being exceeded. Intuitively, assuming atmospheric model QPF has some skill, a higher POE warrants a higher threat level (as was shown to be true during 2015 through 2019). The classifications are determined using the protocol in Table 2. Note that in

In addition to the Zone-Specific thresholds, an “All Zones” threshold was also used to assign a single threat across the entire Tool domain. As can be expected, the thresholds for the All Zones threat levels were significantly higher than Zone-Specific ones, due to the increased skill that exists as a larger area is considered.

**Table 2:** Threat classification system.

Threat	Zone-Specific Threshold	All Zones Threshold
LOW	POE >= 8%	POE >= 25%
MODERATE	POE >= 19%	POE >= 39%
HIGH	POE >= 29%	POE >= 78%
VERY HIGH	POE >= 45%	POE >= 90%

Table 3 shows the number of threats identified for each Zone, categorized by threat level during 2020. Of the 153 days in the 2020 operational season, there were 13 days where at least a Low threat was present for All Zones and 15 days a Moderate threat was forecast. The Palmer Divide and Central Metro had the most threats issued, and had three High threats between the two Zones. However, only the high elevations (Northern and Southern Foothills) had a Very High Threat issued this season on May 30<sup>th</sup>, which verified.

**Table 3:** 2020 Threat Level Summary, by zone

Zone	None	Low	Mod	High	Very High	Threats Issued
(A) Northern Foothills	143	9	0	0	1	10
(B) Southern Foothills	142	8	2	0	1	11
(C) Palmer Divide	139	9	3	2	0	14
(D) Central Metro	140	11	1	1	0	13
(E) Northern Metro	148	3	2	0	0	5
All Zones	125	13	15	0	0	28

Table 4 shows the 2020 All Zones threat summary next to the 2017 through 2019 All Zone summary for reference. Take note that the area size of the Tool changed after 2017, the number of operational days was less in the 2018 season and the High threat threshold was different in 2017 and 2018 (>64%), so this is not a true apple to apple comparison. The number of All Zone threat days decreased by 5 days when compared to the 2019 season, and this was the first season (since 2017) that no High or Very High threat days were issued. Compared to previous seasons there were little to no change in the amount of Low threats issued, and the number of Moderate threats issued was only slightly below the 2017 to 2019 average. Overall, 2020 was a less active and severe season, when taking into consideration the shorter 2018 season (140 days). Also included in Table 4 is the F2P2 Heavy Precipitation Outlook (HPO) provided each morning by Skyview Weather. The HPO issued 5 less threats days than the Tool, but issued 10 more high-end threat days.



**Table 4:** All Zones Threat Comparison between 2017 to 2020 and 2020 HPOs for reference. Note the 2017 season had a different All Zone domain and 2018 had a shorter operational season, so use caution when comparing the data.

All Zones	None	Low	Mod	High	Very High	Threats Issued
2020	125	13	15	0	0	28
2019	120	13	19	1	0	33
2018	115	15	9	0	1	25
2017	87	13	28	24	1	66
2020 HPO	130	6	7	10	--	23

## VALIDATION

### Worst-case scenario analysis

A key output of the Tool is the daily 1-hour QPF-Max, which is analogous to the *realistic* worst-case scenario estimate. It is important to appreciate the significance of the term “realistic”. From a simple theoretical standpoint, one can assign a maximum potential rainfall intensity (i.e. worst-case scenario) based on historical rainfall climatology such as NOAA Atlas 14. For example, the 1-in-100 year hourly point rainfall in the Denver area is ~2.45 inches, while the 1-in-1000 year amount is ~3.67 inches. Unfortunately, these values will drastically overestimate observed maximum rainfall the vast majority of the time, decreasing their utility in operations. To add realism, consideration of factors such as Precipitable Water content, atmospheric flow, and seasonality, will allow for a better estimate of the daily worst-case scenario. The Tool accomplishes this by considering the simulations from many weather models, in order to capture the variety of outcomes that are possible given an initial atmospheric state.

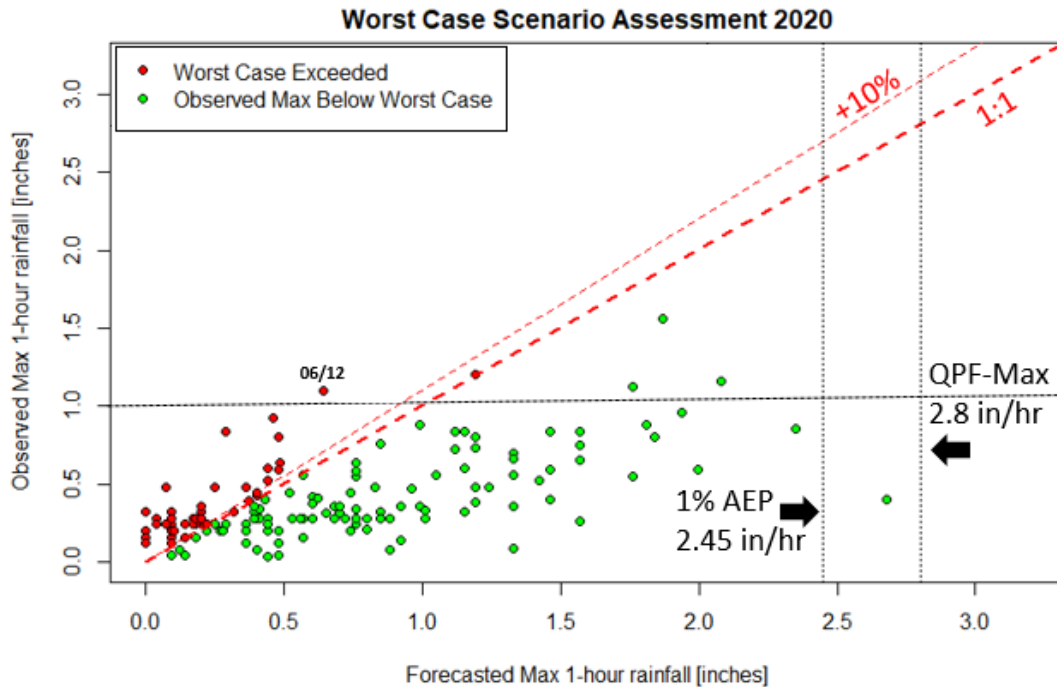
In a perfect system, the worst-case scenario intensity will be higher than observed maximum rainfall, though occasionally the worst-case scenario will be realized.

Figure 2 shows this worst-case scenario assessment during the 2020 season. Note that the vast majority of the time, the QPF-Max is indeed higher than, or equal to the observed maximum (hereafter, QPE-Max) rainfall. Of the 41 days when hourly rainfall intensity exceeded 0.5 inches, QPF-Max was higher 78% of the time (80% of the time if a 10% margin of error is added), which is much higher than 2018 (61%) and on par with the 2016, 2017 and 2019 operational seasons (81%, 83%, 78%, respectively). Concentrating only on the 12 days when hourly intensity exceeded 1 inch, QPF-Max was higher or equal to observed intensity 75% of the time (83% of the time if a 10% margin of error is added). The correlation between QPF-Max and QPE-Max dropped from 0.79 to 0.61, implying the worst-case scenario to observed intensity relationship is not as strong this season.

Prior to the start of the 2018 operational season, the max 1-hour QPF bias correction was increased from 2.45 inches (~1% AEP) to 2.8 inches to ensure the worst-case scenario was captured for the higher end threats (see second vertical line in Figure 2). This value was determined by averaging the top two QPE values from the ALERT gages starting in 2015. For reference, the QPE-Max record is from August 30, 2016 where 2.96 inches was observed. During the 2018 season, the max 1-hour ALERT value observed was 2.76 inches on July 23<sup>rd</sup> near Buckley Air Force Base. Thus, the 2.8 inch max 1-hour QPF bias correction seemed reasonable to use for the 2020 operational season. After reviewing the 60-minute peak intensities at all gages from 1986–2019, 2.8 inches is the 99.9th percentile of all gaged data, which indicates this is a reasonable value to truncate the max 1-hour QPF. Lastly, during the 2020 season, the top max 1-hour ALERT QPE was 1.56 inches (June 26<sup>th</sup>), which remains well below 2.8 inches. Therefore, it is recommended that this max 1-hour QPF threshold remains reasonable for



the 2021 season. The worst-case scenario, when rainfall was greater than 1 inch, was realized only once this season on June 12<sup>th</sup> (marked on Figure 2).



**Figure 2:** Comparison of bias-corrected daily 1-hour QPF-Max (i.e. “Realistic Worst-Case Scenario”) and highest observed 1-hour rainfall across all Forecast Zones. Green dots show instances where QPF-Max was higher than observed, while red dots show where observed rainfall exceeded QPF-Max. The thick red dashed line shows a one-to-one relationship (while the light-dashed line shows a 10% buffer, for reference). Note that the highest allowable QPF-Max increased from 2.45 inches in 1 hour (~1% Annual Exceedance Probability) to 2.8 inches in 1 hour prior to the 2018 season based on the two highest QPE values from prior seasons (see 2016 Technical Memo for further explanation).

Table 5 shows the number of days per month when moderate (0.75 inch in 1 hour) and heavy (1 inch in 1 hour) rainfall rates were observed, compared to climatology. Of the 20 days when moderate intensity was observed, 8 days occurred during July and 6 days occurred in May accounting for 70% of the moderate intensity rainfall days. This is much greater than climatology for May and slightly greater than climatology for July. The highest count of moderate intensity rainfall days in July is consistent with climatology. Of the 12 days when heavy intensity rainfall rates were observed, 67% of those days occurred in June and July. July, August and September were below climatology for heavy intensity rainfall, while May and June were above climatology.

**Table 5:** Monthly statistics of heavy rainfall occurrence during the 2020 season.

Month	# of days with rainfall exceeding		Climatological daily probability of exceeding	
	0.75 inch / hour	1 inch / hour	0.75 inch / hour	1 inch / hour
May	6	2	5%	3%
June	3	4	7%	4%
July	8	4	20%	14%
August	3	2	13%	7%
September	0	0	4%	4%
<b>Total</b>	<b>20</b>	<b>12</b>	N/A	N/A

Table 6 shows the only day when QPF-Max underestimated the observed rainfall in instances where QPE was over 1 inch and was not within the 10% margin of error. This event on June 12<sup>th</sup> only affected the Palmer Ridge (Zone C) over rural, southeast Douglas County. With only one zone affected, this suggests local heavy rainfall rather than a large-scale event capable of producing widespread flooding across the District. The QPE greater than 1 inch was indicated by Stage IV data with the highest ALERT gage reading at 0.84 inches. While models are improving, isolated events such as this remain harder for models to predict. Finally, implementation of these higher end QPE-Max events each season into the quantile mapping analysis is important to keep reducing the number of future instances where the 1-hour QPF-Max is underestimated.

**Table 6:** Summary of when 1-hour QPF-Max underestimated rainfall intensity (only shown when QPE exceeded 1 inch in 1 hour).

Date	Max hourly observed	Hourly QPF-Max	# of Zones with > 1 in per hour
June 12	1.10 inches	0.64 inches	1

## Contingency Table

The Contingency Table is a useful metric for evaluating the effectiveness of the Tool’s forecasts; Table 7 summarizes the information that can be obtained from such a table. A day is categorized as a Flood Day when the Tool forecasts a non-zero threat level. In turn, a Flood Day is observed when maximum 1-hour rainfall across all the Forecast Zones exceeds 1 inch (note that this does not actually indicate that flooding occurred, but acting as a proxy for flooding).

**Table 7:** Flood Day Contingency Table.

		Flood Day Forecasted	
		YES	NO
Flood Day Observed	YES	HIT	MISS
	NO	FALSE ALARM	HIT

By adding up all of the total Hits and dividing by the number of total days (153), we find the “Accuracy” rate. Meanwhile, we are also interested in the quantifying the occurrence of Misses and False Alarms; these statistics are essential for guiding future refinement of the Tool. We run these calculations for each zone separately. For completeness and a reference point, we also calculate a contingency table across All Zones to answer the broader question: “if a threat was forecast anywhere in the domain, did it verify anywhere in the domain?” Such a domain-wide contingency table is likely to yield higher Accuracy numbers than each Zone since there is more leniency in the spatial dimension. However, it is still a useful metric given the

imperfect nature of heavy rainfall prediction. A HPO Contingency Table was also created to quantify the performance of the Tool (objective forecast) to a more subjective forecast.

## Results

As mentioned, the 2020 operational season was rather quiet and produced a smaller sample size from which to determine Zone-Specific statistics, which in turn, means less weight should be placed on the 2020 results. The number of Flood Days (QPE exceeded 1 inch in 1 hour) was between one and seven (North Metro and Palmer Ridge, respectively). Table 8 indicates the Tool's performance showed slight variation across the Forecast Zones, with Accuracy ranging from 96.1% in Zone E (North Metro) to 91.5% in forecast Zone C (Palmer Ridge). The higher Accuracy this season reflects the number of Correct Negatives (Dry Hits) rather than Hits. The low number of Flood Days also skewed the Miss Rates upwards, which ranged from 33.3% (Zone D, Central Metro) to 100% (Zone E, North Metro). This is well above the goal <15%, but it's important to note that Zone E had only one event this year, so it's hard to draw any solid conclusions about the Tool's performance. Again, missed flood events affected only one or two of the Zones, so no large, widespread events were missed by the Tool. The False Alarm Rate dropped across each of the Zones, and remained well-below the industry standard of 20% (3.3% to 7.3%). Finally, the biases (not shown) were between two and five, indicating over-forecasting by the Tool. However, a higher False Alarm Rate than Miss Rate (bias over 1) is always preferred for emergency management operations.

Across all Forecast Zones (Table 8, panel f) Accuracy remained similar to 2019 at 84% (85%, 2019). The False Alarm Rate increased a little from 11.8% to 14.9%, but is still below the target goal <20%. The Miss Rate also increased about 2.5% to 33.8%. Although this was a slight increase from 2019 (30.8%), it is still lower than 2018 (36.4%) so the Tool continues to show some improvements. Since there were only 12 Flood Days this season, the statistics presented here should be interpreted with caution. Although there is an optimal tradeoff between the False Alarm Rate and Miss Rate for the Tool, reassessing this prior to the start of the 2021 season will be difficult due to the small sample size from this season.

**Table 8:** Contingency Tables of the Tool's performance for each zone separately and for all zones together. Bottom image has the number of Flood Days for reference.

		Flood Day Forecasted			
		YES	NO		
Flood Day Observed	a) Zone A	YES	NO	Accuracy: 93.5 %	
	YES	1	1	False Alarm: 6.0%	
	NO	9	142	Misses: 50.0%	
Flood Day Observed	b) Zone B	YES	NO	Accuracy: 92.8%	
	YES	1	1	False Alarm: 6.6%	
	NO	10	141	Misses: 50.0%	
Flood Day Observed	c) Zone C	YES	NO	Accuracy: 91.5%	
	YES	4	3	False Alarm: 6.8%	
	NO	10	136	Misses: 42.9%	
Flood Day Observed	d) Zone D	YES	NO	Accuracy: 92.2%	
	YES	2	1	False Alarm: 7.3%	
	NO	11	139	Misses: 33.3%	
Flood Day Observed	e) Zone E	YES	NO	Accuracy: 96.1%	
	YES	0	1	False Alarm: 3.3%	
	NO	5	147	Misses: 100%	

		Flood Day Forecasted			
		YES	NO		
Flood Day Observed	f) All Zones	YES	NO	Accuracy: 83.7%	
	YES	8	4	False Alarm: 14.9%	
	NO	21	120	Miss: 33.3%	

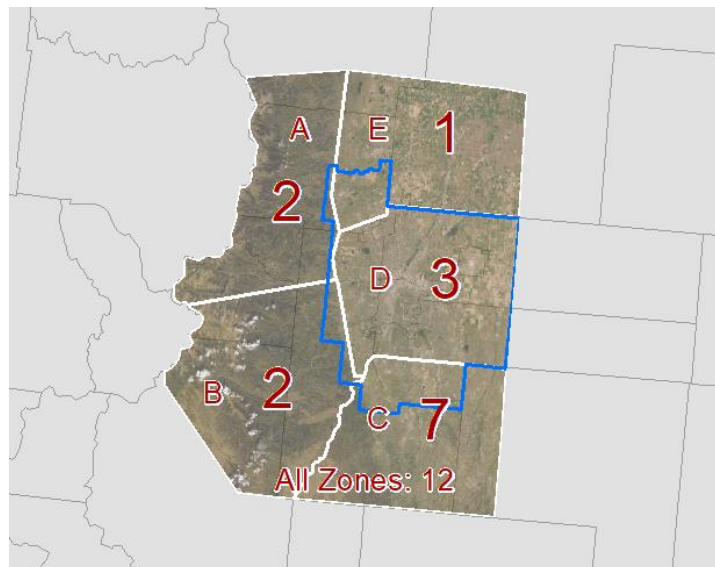


Table 9 shows Contingency Tables for All Zones without the addition of the CSU-WRF and for the HPOs delivered by Skyview each morning, for reference. Panel A indicates that there would have been no change in the All Zone statistics with the addition of the CSU-WRF model. This is likely due to the fact the model is only run once each evening, which makes its contribution to the Tool's ensemble smaller. Additionally, the low number of Flood Days this season could have distorted its usefulness. Over the 2020 Flood Days, the QPF-Max was produced by the CSU-WRF on four of the 12 days, and it helped produce a threat classification change (Table 2) to successfully boost the threat on August 26<sup>th</sup>. This indicates the model can have a positive effect on the QPF-Max or worst-case scenario value. However, the model unsuccessfully boosted the threat classification on four occasions where a Flood Day was not experienced. It's still a bit too early to draw any conclusion about how the model affects the Tool, and it is recommended to keep it in the ensemble for 2021. One of the main reasons is that the CSU-WRF is run on a different server than most of the models and was available 90% of the time in 2020 making it very reliable. When the Tool is compared to the HPOs, the Tool had a lower Miss Rate (33.3% compared to 40.0%) with only a slightly higher False Alarm Rate (~1%). Accuracy was slightly less, 83.7% compared to 86.3%, but still well above the industry standard of >75%. Steps will continue to be taken in the off season to limit the Miss Rate as this is the most important metric for the Tool.

**Table 9:** (a) Contingency Table with CSU-WRF; (b) Contingency Table for HPO.

		Flood Day Forecasted		
		YES	NO	
<b>(a)</b>	<b>All zones</b>			Accuracy: 83.7% False Alarm: 14.9% Miss: 33.3%
	<b>Flood Day Observed</b>	<b>YES</b>	<b>NO</b>	
		<b>8</b>	<b>4</b>	
	<b>NO</b>	<b>21</b>	<b>120</b>	

		Flood Day Forecasted		
		YES	NO	
<b>(b)</b>	<b>All Zones</b>			Accuracy: 86.3% False Alarm: 14.0% Miss: 40.0%
	<b>Flood Day Observed</b>	<b>YES</b>	<b>NO</b>	
		<b>6</b>	<b>4</b>	
	<b>NO</b>	<b>17</b>	<b>126</b>	

Lastly, Table 10 shows the Hit Rate (Accuracy) and False Alarm Rate as a function of the Tool threat level (for All Zones). An important feature of a good forecast system is the ability to discriminate between the lower and higher threat days. Indeed, Table 10 shows that the Hit Rate climbs from 23.1% for the Low threats to 33.3% for the Moderate threats. Since there were no High or Very High threats issued this season, results aren't conclusive for these threats. However, the lack of a widespread flooding event (more than two zones) and no High threats issued indicates the Tool did perform up to standards. Using the High threat threshold from 2017 (64%), there would have been three additional High threat days, but only two would have verified for a 100% Hit Rate. It may be possible to lower the High threat threshold from 78 to 70 and maintain the 80% Hit Rate goal for next season. This will be discussed and evaluated with the MHFD Project Manager in the off season. Another interesting finding in Table 10 is that the number of threats does not decrease as one moves to a higher threat level, which would be expected. This would be resolved if the High threat threshold (78%) was dropped slightly. Another cause for this disparity may be that several days had particularly threatening atmospheric ingredients for heavy rainfall, but no trigger mechanism to initiate the convection. For a third year in a row, decreasing the southern and western extent of the Tool's domain continues to improve the Tool's reliability.

**Table 10:** Hit and False Alarm Rate as a function of threat level across All Zones (compare with **Table 8**, panel f).

<b>Threat Level</b>	<b># Cases</b>	<b>Hit Rate</b>	<b>False Alarm</b>
Low	13	23.1%	76.9%
Moderate	15	33.3%	66.7%
High	0	N/A	N/A
Very High	0	N/A	N/A
Total	28	28.6%	71.4%

## CONCLUSIONS

The MHFD Heavy Rainfall Threat Analysis Tool concluded its sixth season of operation on September 30<sup>th</sup>, 2020. The Tool incorporates a large number of state-of-the-art high-resolution weather models to objectively estimate the chances of seeing heavy rainfall across the District. The Tool's methodology has undergone two major upgrades since the inaugural 2015 season. In 2016, model bias correction and post-processing was included, which resulted in a notable drop in the False Alarm Rate but a rise in the Miss Rate. In 2017, flow dependent post-processing was included, as well as an estimate of the threat level across all Forecast Zones. While this improved the Miss Rate, the False Alarm Rate increased. For the 2018 season, the southern and western edge of the domain were cutback (climatologically more active and don't affect the District), and the remaining 5 forecast zones were adjusted to be more equal in area and to fall on county boundaries. Results from 2018 and 2019 indicate this may have helped improve the Accuracy of the Tool as well as helped to drop the Miss Rate. Models and ensembles continue to be evaluated each season to ensure they only help enhance the Tool's performance. Overall, 2020 was the least active season to date in regards to 1 inch in 1-hour events (12 events), which suggests less weight should be placed on the results presented in this report.

This season the North Metro (Zone E) was the least active with one Flood Day, and the Northern (Zone A) and Southern Foothills (Zone B) only had two Flood Days. In addition, the Central Metro (Zone D) area was quiet with only three Flood Days. No flood events occurred in more than two zones indicating the flood threat was more localized than widespread. The number of events greater than 0.75 inches decreased across All Zones when compared to the last two seasons (44 days vs 20 days), and May was much above climatology for moderate rainfall intensity. For heavy rainfall rates (1 inch in 1 hour), there were only 12 days that were experienced this season with a peak in June and July (8 of the 12 days). As for threats forecast, the greatest number of threats issued were located over Palmer Ridge and Central Metro (Zone C and D, respectively), and the Northern Metro (Zone E) had only five threats issued. The Tool continues to provide a good estimate of the *realistic* worst-case scenario of the daily heavy rainfall threat, which is one of the key metrics that it was designed to forecast. When more than 1 inch in 1 hour was observed, only once was the 1-hour maximum rainfall rate (QPF-Max) greater than QPE meaning the worst-case scenario was realized.

Contingency tables monitoring Hits, False Alarms and Miss Rate show that the Hit rate (or Accuracy) for All Zones was 83.7%, which was on par with 2019 (85%) and 2018 (86%). This continues to be significantly higher than the 2016 to 2017 average of 74%. The most notable reason for this is the processing algorithms (post 2016), changes in the threshold of the Probability of Exceedance (see Table 2) and decrease in area size of the Tool. The All Zone Miss Rate increased by 2.5% to 33.3%, and the False Alarm Rate slightly increased by ~3%. While the False Alarm Rate remains below industry standards, off season work will continue to be done to decrease the Miss Rate. As always, the Tool's performance is highest when more events occur, so interpret this seasons' results with caution. Performance is expected to increase next season with the potential return of the bias corrected TTU-WRFens and more data is ingested into the post-processing equations.

In conclusion, the findings of this Final Report suggest the Heavy Rainfall Threat Analysis Tool continues to show value in increasing lead time and accuracy of heavy rainfall forecasts for the District. The nearly continuous improvement in forecast metrics from the 2018 to 2020 operational seasons are reassuring results. Utility of the Tool continues to improve each season and updates to methodology to include the latest data are a large part of the Tool's success. Incorporating the latest science and data in the Tool will continue to be a priority as preparation for the 2021 operational season. The post-processing equations have been updated to include the 2020 data, and the N4 update is complete.



## RECOMMENDATIONS

A comprehensive and updated literature review is recommended prior to the 2021 season to ensure that the post-processing methods are up to date with the latest techniques in the industry. Furthermore, a slight decrease to the High threat level (All-Zones) will be discussed with the MHFD Project Manager at the end of the season. It is not recommended at this time that Zone C have its own bias correction, for consistency, although QPE vs QPF plots indicate a separate bias correction may slightly improve performance on heavy rainfall days. Prior to the start of the season, the TTU-WRFens will be evaluated with the addition of a bias correction. If it is believed to improve model performance, the ensemble members will be added back into the Tool. Off season work will continue with the MHFD Project Manager to ensure the social media campaigns remains effective at disseminating the heavy rainfall threat.

## REFERENCES

Desert Research Institute. West Wide Drought Tracker, <https://wrcc.dri.edu/wwdt/archive.php?folder=pon5per>, created December 2020.

Dewberry, 2016: UDFCD Heavy Rainfall Guidance Tool – Upgrades for 2016 Operational Season. Submitted to the Urban Drainage and Flood Control District on May 27, 2016, revised on July 26, 2016.

NOAA Atlas 14, Precipitation-Frequency Atlas of the United States. Precipitation Frequency Data Server, [www.nws.noaa.gov/oh/hdsc/](http://www.nws.noaa.gov/oh/hdsc/), created 3 Nov 2017.

NOAA Stage IV, Gridded Precipitation D. UCAR Data Server, <https://data.eol.ucar.edu/dataset/113.003>.

Perica et al., 2013: Precipitation-Frequency Atlas of the United States, Volume 8. National Oceanic and Atmospheric Administration, United States Department of Commerce, Silver Spring, MD.

## APPENDIX A – DISTRICT-WIDE FORECASTS AND OBSERVATIONS

The table below show daily summary of observations and forecasts for All Zones. See Appendix B for Zone-Specific information. Column names are described below:

Column	Units	Description
A	N/A	Date
B	Inches	Max 24-hour from CoCoRaHS gages.
C	#	Number of CoCoRaHS gages exceeding 1 inch.
D	#	Number of CoCoRaHS gages with measurable precipitation.
E	Inches	ALERT max 30 minute precipitation.
F	Inches	ALERT max 1-hour precipitation.
G	Inches	ALERT max 2-hour precipitation.
H	Inches	ALERT second highest 1-hour precipitation.
I	Inches	ALERT max 24-hour precipitation.
J	#	Number of ALERT gages exceeding 1 inch in 1 hour.
K	Inches	NOAA Stage IV max 1-hour precipitation.
L	Inches	NOAA Stage IV max 2-hour precipitation.
M	Inches	NOAA Stage IV max 24-hour precipitation. Note that this can be lower than column (L) because more gages are used during the 24-hour gage adjustment.
N	Yes/No	First guess at whether or not a Flood Day (QPE exceeding 1 inch in 1 hour) is observed.
O	Yes/No	Reassessment of (N) after manual quality control.
NZones	#	Number of zones where a Flood Day was observed.
P	Threat, %	Tool threat level (color), and probability of exceeding 1 inch in 1 hour.

**APPENDIX A – DISTRICT-WIDE FORECASTS AND OBSERVATIONS**

A	CoCoRaHS			ALERT						NOAA Stage IV			Flood Day Classification			Threat
	B	C	D	E	F	G	H	I	J	K	L	M	N	O	Nzones	P
5/1	0.04	0	9	0	0	0	0	0	0	0.03	0.14	0.07			0	4
5/2	0.71	0	273	0.56	0.56	0.56	0.28	0.56	0	0.52	0.99	0.75			0	30
5/3	0.46	0	179	0.24	0.24	0.24	0.16	0.24	0	0.42	0.81	1.13			0	4
5/4	0.05	0	18	0.52	0.52	0.52	0.08	0.52	0	0.09	0.17	0.26			0	4
5/5	0	0	0	0.08	0.16	0.28	0	0.28	0	0	0	0			0	1
5/6	0.01	0	1	0.48	0.48	0.48	0.16	0.48	0	0	0.01	0			0	1
5/7	0.07	0	63	0.48	0.48	0.56	0.04	0.64	0	0	0	0			0	3
5/8	0.02	0	6	0.43	0.43	0.43	0.04	0.43	0	0.02	0.04	0.02			0	2
5/9	0.19	0	1	0.6	0.6	0.68	0.04	0.68	0	0	0	0			0	2
5/10	0.18	0	6	0.32	0.32	0.52	0	0.52	0	0.02	0.04	0.08			0	2
5/11	0.31	0	262	0.24	0.28	0.48	0.08	0.48	0	0.16	0.32	0.69			0	5
5/12	0.05	0	6	0.12	0.12	0.12	0.04	0.12	0	0	0.01	0			0	2
5/13	0.03	0	7	0.48	0.48	0.48	0.12	0.48	0	0.02	0.03	0.11			0	2
5/14	0.59	0	230	0.88	0.88	0.88	0.32	0.88	0	0.57	1.14	0.71	YES		0	23
5/15	0.98	0	291	0.76	0.84	0.88	0.72	0.88	0	0.66	1.31	1.01	YES	YES	1	21
5/16	0.1	0	23	0.92	0.92	1.04	0.08	1.04	0	0.04	0.06	0.06			0	3
5/17	0.01	0	1	0.56	0.56	0.8	0.08	0.8	0	0.02	0.03	0.1			0	5
5/18	0.04	0	1	0.32	0.32	0.32	0.32	0.32	0	0	0	0			0	2
5/19	0.13	0	35	0.12	0.12	0.12	0.08	0.12	0	0.21	0.37	0.26			0	11
5/20	0	0	0	0.72	0.72	0.88	0.2	0.88	0	0	0.01	0			0	20
5/21	0	0	0	0.16	0.16	0.16	0.16	0.16	0	0	0	0	YES		0	3
5/22	0.04	0	1	0.08	0.08	0.08	0.04	0.08	0	0	0	0			0	8
5/23	0.07	0	12	0.8	0.84	1	0.12	1	0	0.09	0.17	0.11			0	2
5/24	1.65	96	315	0.84	0.84	1.08	0.56	2.2	0	0.45	0.85	1.66			0	48
5/25	0.11	0	21	0.24	0.32	0.44	0.32	0.44	0	0.06	0.11	0.36			0	20
5/26	0.31	0	5	0.08	0.08	0.08	0.04	0.12	0	0	0	0			0	2
5/27	0.44	0	209	0.48	0.48	0.48	0.32	0.52	0	0.32	0.61	0.51			0	23
5/28	0.36	0	35	0.32	0.32	0.4	0.12	0.4	0	0.7	1.39	0.77	YES		0	27
5/29	0.41	0	108	0.2	0.2	0.24	0.2	0.28	0	0.66	1.15	0.74	YES		0	24
5/30	0.68	0	148	0.56	0.56	0.6	0.32	0.68	0	0.85	1.5	1.93	YES	YES	2	75
5/31	0.39	0	88	0.6	0.6	0.68	0.4	0.68	0	0.73	1.24	0.81	YES		0	34
6/1	0.15	0	23	0.24	0.24	0.4	0.16	0.4	0	0.26	0.41	0.39			0	40
6/2	0.29	0	43	0.12	0.12	0.12	0.12	0.12	0	0.14	0.9	0.21			0	14
6/3	0.04	0	11	0.24	0.28	0.52	0.08	0.52	0	0.24	0.44	0.36			0	7
6/4	0.23	0	108	0.24	0.24	0.44	0.12	0.44	0	0.2	0.39	0.31			0	10
6/5	0.07	0	34	0	0	0	0	0	0	0.12	0.23	0.17			0	3
6/6	0.66	0	271	0.36	0.36	0.44	0.36	0.48	0	0.36	0.65	0.54			0	15
6/7	0	0	0	0.28	0.28	0.4	0	0.4	0	0.01	0.02	0.01			0	1
6/8	0.95	0	279	0.28	0.28	0.36	0.24	0.8	0	0.2	0.37	0.88			0	6
6/9	0.32	0	125	0.2	0.28	0.36	0.28	0.48	0	0.22	0.44	0.45			0	6
6/10	0	0	0	0.24	0.28	0.48	0	0.48	0	0.01	0.04	0.01			0	2

**APPENDIX A – DISTRICT-WIDE FORECASTS AND OBSERVATIONS**

A	CoCoRaHS			ALERT						NOAA Stage IV			Flood Day Classification			Threat
	B	C	D	E	F	G	H	I	J	K	L	M	N	O	Nzones	P
6/11	0	0	0	0.24	0.24	0.48	0.08	0.48	0	0	0	0			0	1
6/12	0.46	0	29	0.84	0.84	0.84	0.44	0.84	0	1.1	2.1	1.13	YES	YES	1	10
6/13	0.53	0	160	0.32	0.32	0.48	0.2	0.48	0	0.38	0.56	0.38			0	21
6/14	0	0	0	0.24	0.24	0.44	0.08	0.44	0	0	0.03	0			0	2
6/15	0	0	0	0.28	0.32	0.36	0.2	0.36	0	0.02	0.04	0.02			0	2
6/16	0	0	0	0.04	0.04	0.04	0	0.04	0	0	0	0			0	3
6/17	0	0	0	0.43	0.43	0.43	0.43	0.4	0	0	0.01	0	YES		0	1
6/18	1.45	2	260	0.24	0.32	0.48	0.28	1.24	0	0.31	0.6	1.92			0	14
6/19	0.58	0	225	0.32	0.36	0.36	0.32	0.44	0	0.55	1.11	0.66	YES		0	49
6/20	0.09	0	8	0.24	0.24	0.44	0.16	0.44	0	0	0.01	0			0	1
6/21	0.27	0	124	0.4	0.4	0.48	0.2	0.48	0	0.37	0.73	0.38			0	4
6/22	0.45	0	101	0.24	0.24	0.48	0.16	0.48	0	0.33	0.63	0.51			0	24
6/23	0.71	0	49	0.72	0.72	0.72	0.68	0.72	0	0.84	1.53	1.2	YES	YES	1	31
6/24	0.6	0	171	0.4	0.44	0.52	0.4	0.56	0	0.66	1.29	1.01	YES	YES	1	22
6/25	0.24	0	113	0.36	0.36	0.44	0.24	0.48	0	0.33	0.6	0.46			0	15
6/26	1.2	9	280	1.44	1.56	1.64	1.08	1.72	3	1.07	2.11	1.43	YES	YES	2	70
6/27	0.06	0	15	0.24	0.28	0.32	0.08	0.32	0	0.31	0.51	0.61			0	8
6/28	0.28	0	100	0.2	0.24	0.44	0.2	0.48	0	0.34	0.67	0.49			0	4
6/29	0.06	0	3	0.28	0.28	0.48	0.16	0.48	0	0.03	0.06	0.15			0	5
6/30	0.18	0	96	0.16	0.2	0.2	0.16	0.2	0	0.2	0.32	0.34			0	2
7/1	0.19	0	1	0.32	0.32	0.36	0.28	0.36	0	0.01	0.03	0.02			0	1
7/2	0.02	0	1	0.24	0.28	0.48	0.16	0.48	0	0.12	0.23	0.15			0	2
7/3	0.77	0	61	0.6	0.64	0.64	0.4	0.64	0	0.75	1.45	0.79	YES		0	29
7/4	1.25	3	105	0.92	1.12	1.56	1.08	1.8	4	0.84	1.56	1.46	YES	YES	2	48
7/5	0.55	0	68	0.56	0.6	0.6	0.44	0.6	0	0.48	0.91	0.54			0	39
7/6	0.34	0	22	0.64	0.64	0.64	0.12	0.64	0	0.35	0.71	0.47			0	13
7/7	0.19	0	19	0.24	0.24	0.24	0.08	0.24	0	0.24	0.47	0.25			0	6
7/8	0	0	0	0.28	0.28	0.52	0.16	0.52	0	0	0.14	0			0	1
7/9	1.35	2	11	0.4	0.4	0.48	0.36	0.48	0	0.55	1.01	0.64	YES		0	2
7/10	0	0	0	0.04	0.08	0.08	0	0.08	0	0	0	0			0	1
7/11	0	0	0	0.28	0.28	0.36	0.04	0.36	0	0.09	0.17	0.16			0	2
7/12	0.1	0	18	0.24	0.28	0.44	0.12	0.44	0	0.21	1.25	0.68	YES		0	4
7/13	0.38	0	194	0.28	0.32	0.4	0.24	0.4	0	0.23	0.45	0.33			0	10
7/14	1.12	1	277	0.48	0.48	0.48	0.4	0.48	0	0.35	0.68	0.53			0	28
7/15	0.3	0	64	0.4	0.4	0.4	0.24	0.44	0	0.4	0.77	0.44			0	31
7/16	0.44	0	61	0.36	0.36	0.52	0.2	0.52	0	0.36	0.67	0.57			0	10
7/17	0.26	0	28	0.04	0.04	0.04	0.04	0.04	0	0.09	0.16	0.22			0	18
7/18	0.11	0	12	0.28	0.28	0.52	0.16	0.52	0	0.09	0.17	0.18			0	8
7/19	0.71	0	69	0.84	0.84	0.84	0.4	0.84	0	0.61	1.19	0.79	YES		0	26
7/20	0.46	0	16	0.36	0.36	0.4	0.16	0.4	0	0.17	0.72	0.18			0	38
7/21	0.29	0	28	0.92	0.96	0.96	0.28	0.96	0	0.69	1.37	0.71	YES		0	50

**APPENDIX A – DISTRICT-WIDE FORECASTS AND OBSERVATIONS**

A	CoCoRaHS			ALERT						NOAA Stage IV			Flood Day Classification			Threat
	B	C	D	E	F	G	H	I	J	K	L	M	N	O	Nzones	P
7/22	0.69	0	194	0.44	0.44	0.48	0.28	0.48	0	0.33	0.57	0.33			0	7
7/23	0.32	0	43	0.24	0.28	0.48	0.2	0.48	0	0.48	1.3	0.55	YES		0	22
7/24	1.23	1	287	0.88	0.88	0.88	0.48	0.88	0	0.5	0.99	0.74			0	46
7/25	0.93	0	303	0.72	0.76	0.76	0.68	0.84	0	1.16	2.22	1.28	YES	YES	1	51
7/26	0.82	0	198	0.24	0.32	0.44	0.2	0.48	0	0.59	1.1	0.89	YES		0	64
7/27	0.1	0	15	0.4	0.4	0.4	0.16	0.4	0	0.16	0.28	0.18			0	29
7/28	1.05	2	223	1.12	1.2	1.2	0.72	1.2	1	0.67	1.25	1.08	YES	YES	1	44
7/29	0.12	0	30	0.24	0.28	0.48	0.08	0.48	0	0.13	0.24	0.13			0	3
7/30	1.11	1	109	0.36	0.36	0.52	0.32	0.56	0	0.65	1.23	0.72	YES		0	48
7/31	1.06	1	193	0.54	0.54	0.54	0.2	0.54	0	0.8	1.47	1.14	YES	YES	1	2
8/1	0.27	0	56	0.28	0.28	0.48	0.16	0.48	0	0.24	0.41	0.19			0	13
8/2	0.16	0	38	0.24	0.28	0.52	0.28	0.52	0	0.47	0.9	0.53			0	21
8/3	0.77	0	78	0.32	0.32	0.32	0.2	0.32	0	0.8	1.47	1.06	YES	YES	1	31
8/4	0.31	0	73	0.2	0.2	0.2	0.12	0.2	0	0.58	1	0.75	YES		0	20
8/5	0.49	0	141	0.48	0.48	0.6	0.48	0.6	0	0.8	1.53	0.81	YES		0	41
8/6	0.55	0	86	0.32	0.32	0.48	0.16	0.48	0	0.37	0.7	0.76			0	6
8/7	0	0	0	0.08	0.12	0.16	0.04	0.24	0	0	0.09	0			0	1
8/8	0	0	0	0.24	0.24	0.44	0.2	0.44	0	0	0.01	0			0	1
8/9	0	0	0	0.24	0.24	0.48	0	0.48	0	0	0	0			0	1
8/10	0.08	0	8	0.28	0.28	0.44	0.16	0.44	0	0.34	0.63	0.34			0	8
8/11	0	0	0	0.12	0.2	0.24	0.04	0.28	0	0.01	1.12	0.02	YES		0	2
8/12	0.09	0	11	0.24	0.24	0.48	0.12	0.48	0	0.13	0.25	0.18			0	1
8/13	0	0	0	0.24	0.24	0.4	0.24	0.4	0	0	0.04	0			0	1
8/14	0	0	0	0.08	0.16	0.2	0.04	0.2	0	0	0	0			0	1
8/15	0	0	0	0.28	0.28	0.48	0.12	0.48	0	0	0	0			0	2
8/16	0.89	0	2	0.28	0.28	0.48	0	0.48	0	0.64	1.17	1.08	YES		0	6
8/17	0	0	0	0.28	0.28	0.48	0.2	0.48	0	0.07	0.13	0.08			0	5
8/18	0.12	0	2	0.2	0.2	0.2	0.12	0.24	0	0.06	0.1	0.12			0	4
8/19	0.27	0	38	0.28	0.28	0.44	0.12	0.44	0	0.15	0.28	0.17			0	7
8/20	0.35	0	149	0.28	0.28	0.48	0.2	0.48	0	0.31	0.56	0.43			0	11
8/21	0	0	0	0.12	0.2	0.28	0	0.28	0	0.01	0.02	0.01			0	2
8/22	0	0	0	0.28	0.28	0.48	0.2	0.48	0	0	0	0			0	1
8/23	0.01	0	3	0.32	0.36	0.6	0	0.6	0	0.06	0.11	0.06			0	3
8/24	0.33	0	5	0.24	0.28	0.48	0.2	0.48	0	0.15	0.26	0.15			0	5
8/25	0.75	0	90	0.76	0.76	0.76	0.32	0.76	0	0.48	0.88	0.53			0	10
8/26	0.9	0	198	0.36	0.48	0.64	0.32	0.76	0	0.59	1.05	1.07	YES	YES	1	38
8/27	0.73	0	105	0.34	0.34	0.52	0.28	0.52	0	0.59	1.13	0.7	YES		0	5
8/28	1	0	294	0.48	0.52	0.64	0.4	0.76	0	0.46	0.79	0.49			0	41
8/29	0.2	0	221	0.52	0.56	0.6	0.16	0.68	0	0.31	0.6	0.49			0	31
8/30	0.08	0	39	0.24	0.28	0.44	0.04	0.44	0	0.19	0.33	0.23			0	3

**APPENDIX A – DISTRICT-WIDE FORECASTS AND OBSERVATIONS**

A	CoCoRaHS			ALERT						NOAA Stage IV			Flood Day Classification			Threat
	B	C	D	E	F	G	H	I	J	K	L	M	N	O	Nzones	P
8/31	0.8	0	289	0.32	0.44	0.6	0.16	0.6	0	0.28	0.54	0.51			0	7
9/1	0.13	0	2	0.28	0.28	0.52	0.08	0.52	0	0.01	0.02	0.06			0	2
9/2	0.06	0	1	0.28	0.32	0.52	0.12	0.52	0	0	0	0			0	1
9/3	0	0	0	0.32	0.32	0.52	0.08	0.52	0	0	0	0			0	1
9/4	0	0	0	0.16	0.16	0.16	0.12	0.24	0	0.01	0.02	0.01			0	1
9/5	0	0	0	0.28	0.32	0.48	0	0.48	0	0	0	0			0	1
9/6	0	0	0	0.28	0.28	0.48	0.04	0.48	0	0	0	0			0	1
9/7	0.6	0	251	0.12	0.12	0.2	0.12	0.44	0	0.41	0.76	0.82			0	4
9/8	1.66	16	276	0.12	0.16	0.2	0.12	0.52	0	0.16	0.28	1.19			0	9
9/9	0.79	0	210	0.28	0.36	0.52	0.32	0.96	0	0.21	0.47	0.51			0	2
9/10	0.4	0	74	0.39	0.44	0.6	0.32	1.08	0	0.25	0.47	0.6			0	4
9/11	0.02	0	5	0.39	0.39	0.44	0.31	0.88	0	0.07	0.17	0.15			0	3
9/12	0	0	0	0.2	0.2	0.2	0.04	0.2	0	0	0	0			0	1
9/13	0	0	0	0.04	0.04	0.04	0	0.04	0	0	0	0			0	1
9/14	0	0	0	0.2	0.2	0.2	0.04	0.2	0	0	0	0			0	1
9/15	0	0	0	0.04	0.04	0.04	0.04	0.04	0	0	0	0			0	1
9/16	0	0	0	0.16	0.24	0.24	0.04	0.24	0	0	0	0			0	1
9/17	0	0	0	0.16	0.24	0.24	0.08	0.24	0	0	0	0			0	1
9/18	0	0	0	0.04	0.08	0.12	0.04	0.12	0	0	0	0			0	1
9/19	0.01	0	1	0.16	0.2	0.24	0.04	0.24	0	0.01	0.03	0.04			0	2
9/20	0.01	0	2	0.16	0.2	0.2	0.08	0.2	0	0.02	0.04	0.03			0	1
9/21	0.01	0	1	0.16	0.24	0.24	0.12	0.24	0	0.11	0.19	0.19			0	3
9/22	0.18	0	35	0.08	0.08	0.08	0.08	0.08	0	0.36	0.59	0.47			0	6
9/23	0	0	0	0.2	0.28	0.28	0.2	0.32	0	0.04	0.06	0.04			0	1
9/24	0	0	0	0.16	0.2	0.2	0.04	0.2	0	0	0	0			0	1
9/25	0.03	0	1	0.16	0.16	0.16	0.08	0.28	0	0	0	0			0	1
9/26	0.03	0	1	0.2	0.24	0.24	0.04	0.24	0	0	0	0			0	2
9/27	0.08	0	105	0.16	0.2	0.2	0.08	0.2	0	0.1	0.2	0.17			0	2
9/28	0.03	0	1	0.16	0.28	0.28	0.12	0.28	0	0	0	0			0	1
9/29	0.01	0	1	0.12	0.12	0.12	0.08	0.16	0	0	0	0			0	1
9/30	0	0	0	0.16	0.24	0.24	0.16	0.24	0	0	0	0			0	1



## APPENDIX B – ZONE SPECIFIC FORECASTS AND OBSERVATIONS

The tables below show daily summaries of observations and forecasts for each of the five forecast zones (i.e. analogous to Appendix A, but for each forecast zone separately). Column names are described below:

Column	Units	Description			
A	N/A	Date	K	Inches	NOAA Stage IV max 1-hour precipitation.
B	Inches	Max 24-hour from CoCoRaHS gages.	L	Inches	NOAA Stage IV max 2-hour precipitation.
C	#	Number of CoCoRaHS gages exceeding 1 inch.	M	Inches	NOAA Stage IV max 24-hour precipitation. Note that this can be lower than column (L) because more gages are used during the gage adjustment of radar estimates.
D	#	Number of CoCoRaHS gages with measurable precipitation.	N	Yes/No	First guess at whether or not a Flood Day (QPE exceeding 1 inch in 1 hour) is observed.
E	Inches	ALERT max 30 minute precipitation.	O	Yes/No	Reassessment of (N) after manual quality control.
F	Inches	ALERT max 1-hour precipitation.	P	Threat, %	Tool threat level (color), and probability of exceeding 1 inch in 1 hour.
G	Inches	ALERT max 2-hour precipitation.			
H	Inches	ALERT second highest 1 hour precipitation.			
I	Inches	ALERT max 24-hour precipitation.			
J	#	Number of ALERT gages exceeding 1 inch in 1 hour.			

**APPENDIX B –ZONE A SPECIFIC FORECASTS AND OBSERVATIONS**

**a) Forecast Zone A: North Foothills**

A	CoCoRaHS			ALERT						NOAA Stage IV			Flood Day Classification		Threat
	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
5/1	0.02	0	1	0	0	0	0	0	0	0.02	0.02	0.07			1
5/2	0.38	0	26	0.16	0.28	0.36	0.24	0.48	0	0.14	0.28	0.42			2
5/3	0.23	0	25	0.12	0.12	0.12	0.08	0.2	0	0.14	0.23	0.27			1
5/4	0.05	0	15	0.05	0.08	0.08	0.08	0.12	0	0.07	0.14	0.26			0
5/5	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00			0
5/6	0	0	0	0	0	0	0	0	0	0.00	0.01	0.00			0
5/7	0.07	0	13	0	0	0	0	0	0	0.00	0.00	0.00			0
5/8	0.02	0	2	0.04	0.08	0.08	0.04	0.08	0	0.02	0.04	0.02			0
5/9	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00			0
5/10	0	0	0	0	0	0	0	0	0	0.02	0.04	0.08			0
5/11	0.23	0	24	0.08	0.08	0.16	0.08	0.28	0	0.14	0.28	0.69			1
5/12	0	0	0	0.04	0.04	0.04	0	0.04	0	0.00	0.01	0.00			0
5/13	0.01	0	1	0.48	0.48	0.48	0	0.48	0	0.00	0.00	0.00			1
5/14	0.27	0	25	0.24	0.24	0.24	0.2	0.32	0	0.39	0.70	0.71			2
5/15	0.32	0	24	0.24	0.24	0.28	0.24	0.28	0	0.26	0.48	0.43			3
5/16	0.02	0	1	0	0	0	0	0	0	0.01	0.02	0.00			0
5/17	0	0	0	0	0	0	0	0	0	0.00	0.01	0.10			0
5/18	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00			1
5/19	0.03	0	7	0.12	0.12	0.12	0.04	0.12	0	0.05	0.07	0.05			1
5/20	0	0	0	0.4	0.4	0.4	0.2	0.12	0	0.00	0.00	0.00			0
5/21	0	0	0	0.24	0.24	0.24	0.16	0.24	0	0.00	0.00	0.00			1
5/22	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00			1
5/23	0.04	0	7	0	0	0	0	0	0	0.07	0.13	0.08			1
5/24	1.15	1	24	0.28	0.52	0.84	0.4	1.2	0	0.27	0.50	1.06			4
5/25	0.03	0	6	0.16	0.28	0.32	0.04	0.32	0	0.04	0.11	0.33			3
5/26	0.01	0	2	0.01	0.01	0.01	0	0.01	0	0.00	0.00	0.00			0
5/27	0.43	0	12	0.32	0.32	0.32	0.32	0.36	0	0.18	0.29	0.22			4
5/28	0	0	0	0.12	0.12	0.12	0.08	0.08	0	0.01	0.03	0.03			4
5/29	0.29	0	18	0.16	0.16	0.2	0.12	0.2	0	0.54	0.98	0.68			3
5/30	0.45	0	25	0.28	0.44	0.6	0.28	0.68	0	0.85	1.50	1.93	YES	YES	45
5/31	0.39	0	18	0.48	0.48	0.54	0.4	0.54	0	0.53	0.87	0.66			9
6/1	0.08	0	4	0.08	0.08	0.08	0	0.08	0	0.26	0.41	0.39			14
6/2	0.29	0	7	0.12	0.12	0.12	0.12	0.12	0	0.14	0.20	0.21			1
6/3	0.02	0	1	0	0	0	0	0	0	0.07	0.15	0.15			0
6/4	0.06	0	9	0.04	0.04	0.04	0.04	0.04	0	0.14	0.25	0.24			1
6/5	0.07	0	8	0	0	0	0	0	0	0.10	0.20	0.17			1
6/6	0.13	0	22	0.36	0.36	0.36	0.36	0.36	0	0.24	0.35	0.36			1
6/7	0	0	0	0	0	0	0	0	0	0.01	0.02	0.01			0

**APPENDIX B –ZONE A SPECIFIC FORECASTS AND OBSERVATIONS**

A	CoCoRaHS			ALERT						NOAA Stage IV			Flood Day Classification		Threat
	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
6/8	0.3	0	25	0.12	0.12	0.16	0.12	0.24	0	0.20	0.37	0.88			1
6/9	0.01	0	1	0.08	0.16	0.2	0.12	0.24	0	0.05	0.10	0.27			0
6/10	0	0	0	0	0	0	0	0	0	0.01	0.04	0.00			0
6/11	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00			0
6/12	0	0	0	0	0	0	0	0	0	0.01	0.01	0.12			1
6/13	0.47	0	16	0.2	0.2	0.2	0.16	0.2	0	0.30	0.53	0.38			11
6/14	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00			0
6/15	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00			1
6/16	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00			1
6/17	0	0	0	1.3	1.3	1.3	0.43	0	1	0.00	0.00	0.00	YES		0
6/18	1.45	1	27	0.24	0.32	0.48	0.28	1.24	0	0.31	0.60	1.92			1
6/19	0.31	0	25	0.32	0.36	0.36	0.32	0.44	0	0.39	0.75	0.66			6
6/20	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00			0
6/21	0.15	0	27	0.4	0.4	0.4	0.2	0.4	0	0.26	0.52	0.27			0
6/22	0.04	0	5	0.08	0.08	0.08	0.08	0.08	0	0.09	0.18	0.14			1
6/23	0.28	0	11	0.2	0.2	0.2	0.04	0.2	0	0.53	0.99	0.62			5
6/24	0.54	0	28	0.4	0.44	0.44	0.4	0.44	0	0.66	1.29	1.01	YES	YES	7
6/25	0.24	0	18	0.08	0.08	0.08	0.04	0.08	0	0.20	0.36	0.31			1
6/26	0.93	0	22	0.8	0.84	0.88	0.76	1	0	0.58	1.18	0.81	YES		4
6/27	0	0	0	0	0	0	0	0	0	0.02	0.03	0.07			1
6/28	0.28	0	18	0.2	0.24	0.24	0.2	0.24	0	0.23	0.39	0.32			1
6/29	0.01	0	1	0	0	0	0	0	0	0.03	0.06	0.15			1
6/30	0.07	0	3	0.04	0.04	0.04	0.04	0.04	0	0.10	0.14	0.10			0
7/1	0	0	0	0	0	0	0	0	0	0.01	0.03	0.01			0
7/2	0.02	0	1	0	0	0	0	0	0	0.01	0.02	0.01			1
7/3	0.1	0	9	0.04	0.04	0.04	0	0.04	0	0.14	0.24	0.24			6
7/4	0.48	0	15	0.12	0.12	0.12	0.08	0.12	0	0.27	0.49	0.39			14
7/5	0.55	0	20	0.16	0.16	0.16	0.12	0.2	0	0.34	0.56	0.48			8
7/6	0.34	0	5	0.64	0.64	0.64	0.04	0.64	0	0.24	0.48	0.47			1
7/7	0.03	0	7	0.12	0.12	0.12	0.04	0.12	0	0.08	0.14	0.09			1
7/8	0	0	0	0	0	0	0	0	0	0.00	0.01	0.00			0
7/9	0	0	0	0	0	0	0	0	0	0.01	0.03	0.01			0
7/10	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00			0
7/11	0	0	0	0	0	0	0	0	0	0.01	0.01	0.16			0
7/12	0	0	0	0	0	0	0	0	0	0.04	0.09	0.06			1
7/13	0.25	0	18	0.04	0.04	0.04	0	0.08	0	0.12	0.22	0.15			1
7/14	0.17	0	25	0.08	0.08	0.12	0.08	0.2	0	0.18	0.36	0.45			1
7/15	0.01	0	1	0	0	0	0	0	0	0.05	0.08	0.12			0
7/16	0.01	0	2	0	0	0	0	0	0	0.07	0.13	0.08			2
7/17	0.01	0	1	0	0	0	0	0	0	0.09	0.16	0.13			1
7/18	0.02	0	2	0.08	0.08	0.08	0	0.08	0	0.07	0.14	0.18			1

**APPENDIX B –ZONE A SPECIFIC FORECASTS AND OBSERVATIONS**

A	CoCoRaHS			ALERT						NOAA Stage IV			Flood Day Classification		Threat
	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
7/19	0.22	0	22	0.32	0.32	0.32	0.2	0.32	0	0.36	0.68	0.36			3
7/20	0.04	0	1	0	0	0	0	0	0	0.00	0.01	0.09			1
7/21	0.02	0	3	0	0	0	0	0	0	0.03	0.03	0.04			4
7/22	0.19	0	23	0.16	0.16	0.16	0.12	0.16	0	0.15	0.26	0.17			2
7/23	0.32	0	20	0.08	0.12	0.12	0.08	0.12	0	0.48	0.83	0.55			4
7/24	0.67	0	23	0.32	0.32	0.36	0.28	0.84	0	0.38	0.68	0.62			9
7/25	0.68	0	29	0.2	0.28	0.4	0.24	0.56	0	0.30	0.58	0.75			10
7/26	0.22	0	24	0.16	0.16	0.16	0.08	0.16	0	0.10	0.19	0.23			4
7/27	0.1	0	3	0.01	0.01	0.01	0	0.01	0	0.10	0.17	0.18			6
7/28	0.22	0	7	0.72	0.72	0.72	0.44	0.72	0	0.39	0.54	0.65			16
7/29	0	0	0	0	0	0	0	0	0	0.04	0.07	0.09			0
7/30	0.43	0	22	0.36	0.36	0.36	0.32	0.36	0	0.51	1.03	0.58	YES		4
7/31	0.33	0	26	0.16	0.2	0.24	0.16	0.24	0	0.48	0.81	1.14			0
8/1	0.27	0	23	0.2	0.2	0.2	0.16	0.24	0	0.13	0.24	0.11			1
8/2	0.16	0	20	0.08	0.08	0.08	0.08	0.12	0	0.47	0.90	0.53			1
8/3	0.34	0	18	0.16	0.16	0.16	0.12	0.16	0	0.46	0.89	0.51			2
8/4	0.29	0	3	0.12	0.12	0.12	0.08	0.12	0	0.58	0.82	0.59			0
8/5	0.24	0	17	0.48	0.48	0.6	0.48	0.6	0	0.59	1.18	0.69	YES		1
8/6	0.16	0	18	0.16	0.16	0.16	0.12	0.16	0	0.16	0.30	0.20			1
8/7	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00			0
8/8	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00			0
8/9	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00			1
8/10	0.08	0	1	0.04	0.04	0.04	0.04	0.04	0	0.07	0.13	0.08			1
8/11	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00			0
8/12	0.02	0	2	0	0	0	0	0	0	0.05	0.10	0.09			0
8/13	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00			0
8/14	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00			0
8/15	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00			0
8/16	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00			1
8/17	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00			1
8/18	0.12	0	2	0	0	0	0	0	0	0.06	0.10	0.12			0
8/19	0.27	0	17	0.04	0.04	0.04	0.04	0.04	0	0.15	0.28	0.17			0
8/20	0.08	0	22	0.16	0.16	0.16	0.16	0.16	0	0.17	0.32	0.37			1
8/21	0	0	0	0	0	0	0	0	0	0.01	0.02	0.01			0
8/22	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00			0
8/23	0	0	0	0	0	0	0	0	0	0.01	0.01	0.00			1
8/24	0.05	0	2	0	0	0	0	0	0	0.03	0.06	0.05			1
8/25	0.61	0	21	0.76	0.76	0.76	0.32	0.76	0	0.44	0.88	0.46			2
8/26	0.72	0	27	0.24	0.24	0.24	0.24	0.32	0	0.20	0.39	0.47			12
8/27	0.43	0	25	0.34	0.34	0.34	0.28	0.34	0	0.59	1.13	0.70	YES		1
8/28	0.42	0	27	0.48	0.52	0.64	0.4	0.76	0	0.27	0.48	0.49			4

**APPENDIX B –ZONE A SPECIFIC FORECASTS AND OBSERVATIONS**

A	CoCoRaHS			ALERT						NOAA Stage IV			Flood Day Classification		Threat
	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
8/29	0.07	0	24	0.08	0.08	0.08	0.04	0.08	0	0.19	0.25	0.45			4
8/30	0.08	0	9	0.04	0.04	0.04	0.04	0.04	0	0.17	0.32	0.16			0
8/31	0.25	0	24	0.08	0.16	0.24	0.12	0.28	0	0.13	0.25	0.19			0
9/1	0	0	0	0.04	0.04	0.04	0	0.04	0	0.01	0.02	0.06			0
9/2	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00			0
9/3	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00			0
9/4	0	0	0	0	0	0	0	0	0	0.00	0.01	0.00			0
9/5	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00			0
9/6	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00			0
9/7	0.39	0	24	0.08	0.12	0.16	0.12	0.4	0	0.05	0.09	0.31			1
9/8	0.87	0	27	0.04	0.08	0.16	0.08	0.28	0	0.16	0.26	1.19			0
9/9	0.14	0	24	0.2	0.36	0.48	0.32	0.8	0	0.08	0.15	0.20			0
9/10	0.26	0	17	0.2	0.28	0.44	0.28	1	0	0.25	0.47	0.60			1
9/11	0	0	0	0.2	0.28	0.44	0.28	0.88	0	0.05	0.17	0.15			0
9/12	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00			0
9/13	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00			1
9/14	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00			1
9/15	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00			1
9/16	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00			1
9/17	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00			0
9/18	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00			0
9/19	0	0	0	0	0	0	0	0	0	0.01	0.03	0.04			1
9/20	0	0	0	0	0	0	0	0	0	0.02	0.04	0.03			0
9/21	0.01	0	1	0	0	0	0	0	0	0.07	0.12	0.12			1
9/22	0.14	0	17	0.08	0.08	0.08	0.04	0.08	0	0.10	0.16	0.13			1
9/23	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00			0
9/24	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00			0
9/25	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00			0
9/26	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00			0
9/27	0.01	0	1	0	0	0	0	0	0	0.03	0.06	0.04			0
9/28	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00			0
9/29	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00			0
9/30	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00			0

**APPENDIX B –ZONE B SPECIFIC FORECASTS AND OBSERVATIONS**

**b) Forecast Zone B: South Foothills**

A	CoCoRaHS			ALERT						NOAA Stage IV			Flood Day Classification		Threat P
	B	C	D	E	F	G	H	I	J	K	L	M	N	O	
5/1	0.04	0	2	0	0	0	0	0	0	0	0	0			1
5/2	0.13	0	22	0.16	0.16	0.16	0.16	0.2	0	0.17	0.3	0.24			1
5/3	0.19	0	6	0.04	0.04	0.04	0	0.04	0	0.04	0.07	0.07			0
5/4	0	0	0	0.04	0.04	0.04	0.04	0.04	0	0.04	0.07	0.03			0
5/5	0	0	0	0	0	0	0	0	0	0	0	0			0
5/6	0	0	0	0	0	0	0	0	0	0	0	0			0
5/7	0.03	0	15	0	0	0	0	0	0	0	0	0			0
5/8	0.02	0	3	0.04	0.04	0.04	0	0.04	0	0	0	0			0
5/9	0	0	0	0	0	0	0	0	0	0	0	0			0
5/10	0	0	0	0	0	0	0	0	0	0.02	0.03	0.04			0
5/11	0.09	0	21	0.04	0.04	0.08	0.04	0.08	0	0.14	0.26	0.25			1
5/12	0	0	0	0.04	0.04	0.04	0	0.04	0	0	0	0			0
5/13	0	0	0	0	0	0	0	0	0	0	0	0			0
5/14	0.05	0	9	0	0	0	0	0	0	0.12	0.24	0.22			1
5/15	0.62	0	25	0.68	0.68	0.68	0.52	0.72	0	0.26	0.48	0.6			4
5/16	0.06	0	1	0.04	0.04	0.04	0.04	0.04	0	0.03	0.05	0.06			0
5/17	0	0	0	0.04	0.04	0.04	0	0.04	0	0.02	0.03	0.02			1
5/18	0.04	0	1	0.24	0.24	0.24	0.16	0.28	0	0	0	0			1
5/19	0.07	0	7	0.04	0.04	0.04	0.04	0.04	0	0.18	0.26	0.19			1
5/20	0	0	0	0.04	0.04	0.04	0	0.04	0	0	0	0			0
5/21	0	0	0	0	0	0	0	0	0	0	0	0			1
5/22	0	0	0	0	0	0	0	0	0	0	0	0			1
5/23	0.02	0	1	0	0	0	0	0	0	0.04	0.07	0.04			1
5/24	1.24	12	25	0.28	0.44	0.68	0.44	1.2	0	0.33	0.62	1.62			7
5/25	0.05	0	1	0.16	0.24	0.32	0.12	0.32	0	0.06	0.1	0.36			2
5/26	0	0	0	0.04	0.04	0.04	0	0.04	0	0	0	0			0
5/27	0.29	0	26	0.36	0.36	0.36	0.2	0.36	0	0.32	0.61	0.51			5
5/28	0.03	0	2	0.08	0.08	0.08	0	0.08	0	0.7	1.39	0.77	YES		4
5/29	0.41	0	22	0.2	0.2	0.2	0.2	0.24	0	0.66	1.15	0.74	YES		4
5/30	0.53	0	24	0.12	0.12	0.12	0.04	0.2	0	0.71	1.35	1.47	YES	YES	52
5/31	0.22	0	15	0.08	0.08	0.08	0.04	0.08	0	0.2	0.4	0.41			11
6/1	0.15	0	10	0.04	0.04	0.04	0.04	0.04	0	0.2	0.32	0.33			22
6/2	0.04	0	5	0	0	0	0	0	0	0.1	0.19	0.13			2
6/3	0.03	0	1	0	0	0	0	0	0	0.04	0.07	0.05			1
6/4	0.08	0	6	0.04	0.04	0.04	0	0.04	0	0.15	0.23	0.27			1
6/5	0.06	0	10	0	0	0	0	0	0	0.12	0.23	0.12			1
6/6	0.18	0	21	0.16	0.16	0.16	0.08	0.16	0	0.15	0.27	0.54			2
6/7	0	0	0	0	0	0	0	0	0	0	0	0			0

**APPENDIX B –ZONE B SPECIFIC FORECASTS AND OBSERVATIONS**

A	CoCoRaHS			ALERT						NOAA Stage IV			Flood Day Classification		Threat P
	B	C	D	E	F	G	H	I	J	K	L	M	N	O	
6/8	0.35	0	24	0.12	0.2	0.32	0.16	0.4	0	0.11	0.21	0.59			1
6/9	0.01	0	1	0.12	0.12	0.16	0.08	0.16	0	0.04	0.06	0.22			0
6/10	0	0	0	0	0	0	0	0	0	0.01	0.02	0.01			0
6/11	0	0	0	0	0	0	0	0	0	0	0	0			0
6/12	0.02	0	2	0	0	0	0	0	0	0.09	0.13	0.09			1
6/13	0.22	0	21	0.12	0.16	0.16	0.08	0.16	0	0.21	0.38	0.32			5
6/14	0	0	0	0	0	0	0	0	0	0	0.01	0			1
6/15	0	0	0	0.04	0.04	0.04	0	0.04	0	0.01	0.02	0.01			1
6/16	0	0	0	0	0	0	0	0	0	0	0	0			1
6/17	0	0	0	0	0	0	0	0	0	0	0	0			0
6/18	0.79	0	26	0.12	0.16	0.28	0.16	0.52	0	0.22	0.48	1.25			1
6/19	0.26	0	24	0.24	0.24	0.24	0.24	0.28	0	0.29	0.52	0.61			7
6/20	0.01	0	2	0	0	0	0	0	0	0	0	0			0
6/21	0	0	0	0	0	0	0	0	0	0.01	0.02	0.03			0
6/22	0.45	0	12	0	0	0	0	0	0	0.33	0.63	0.51			1
6/23	0.62	0	22	0.48	0.48	0.48	0.28	0.48	0	0.84	1.53	1.2	YES	YES	5
6/24	0.12	0	18	0.04	0.04	0.08	0.04	0.08	0	0.36	0.65	0.51			7
6/25	0.18	0	19	0.04	0.04	0.04	0	0.04	0	0.3	0.51	0.46			1
6/26	0.97	0	25	0.48	0.56	0.6	0.52	0.68	0	0.54	1.06	0.78	YES		6
6/27	0.03	0	3	0	0	0	0	0	0	0.02	0.04	0.02			1
6/28	0.02	0	8	0	0	0	0	0	0	0.1	0.16	0.18			1
6/29	0	0	0	0	0	0	0	0	0	0.02	0.03	0.06			0
6/30	0	0	0	0.12	0.12	0.12	0.12	0.12	0	0.01	0.03	0.02			0
7/1	0	0	0	0	0	0	0	0	0	0.01	0.02	0.02			0
7/2	0	0	0	0	0	0	0	0	0	0.12	0.23	0.15			1
7/3	0.28	0	14	0.12	0.12	0.12	0.04	0.12	0	0.23	0.4	0.35			3
7/4	0.04	0	3	0.04	0.04	0.04	0.04	0.04	0	0.31	0.57	0.64			12
7/5	0.18	0	14	0.12	0.16	0.16	0.12	0.16	0	0.45	0.9	0.43			6
7/6	0.05	0	5	0	0	0	0	0	0	0.06	0.13	0.1			1
7/7	0.01	0	2	0	0	0	0	0	0	0.07	0.13	0.12			1
7/8	0	0	0	0	0	0	0	0	0	0	0	0			0
7/9	0	0	0	0	0	0	0	0	0	0	0	0			0
7/10	0	0	0	0	0	0	0	0	0	0	0	0			0
7/11	0	0	0	0	0	0	0	0	0	0.08	0.15	0.08			0
7/12	0.1	0	8	0	0	0	0	0	0	0.19	0.3	0.68			1
7/13	0.38	0	23	0.2	0.32	0.32	0.16	0.32	0	0.19	0.36	0.29			1
7/14	0.47	0	24	0.48	0.48	0.48	0.36	0.48	0	0.25	0.48	0.44			1
7/15	0.3	0	16	0.2	0.2	0.2	0.2	0.24	0	0.23	0.45	0.43			2
7/16	0.1	0	15	0.04	0.04	0.04	0.04	0.04	0	0.36	0.63	0.57			2
7/17	0.15	0	19	0.04	0.04	0.04	0.04	0.04	0	0.09	0.16	0.22			2
7/18	0.04	0	2	0.04	0.04	0.04	0	0.04	0	0.08	0.14	0.14			1



**APPENDIX B –ZONE B SPECIFIC FORECASTS AND OBSERVATIONS**

A	CoCoRaHS			ALERT						NOAA Stage IV			Flood Day Classification		Threat P
	B	C	D	E	F	G	H	I	J	K	L	M	N	O	
7/19	0.14	0	10	0.08	0.08	0.08	0.04	0.12	0	0.18	0.28	0.22			3
7/20	0	0	0	0	0	0	0	0	0	0.09	0.14	0.13			2
7/21	0.13	0	13	0.16	0.2	0.2	0.08	0.2	0	0.38	0.69	0.58			13
7/22	0.08	0	10	0.04	0.04	0.04	0	0.04	0	0.07	0.14	0.08			2
7/23	0.18	0	14	0	0	0	0	0	0	0.13	0.24	0.17			4
7/24	0.9	0	25	0.48	0.56	0.68	0.48	0.8	0	0.5	0.96	0.74			13
7/25	0.6	0	25	0.2	0.2	0.36	0.2	0.48	0	0.29	0.58	1.09			14
7/26	0.82	0	24	0.24	0.32	0.36	0.2	0.36	0	0.59	1.1	0.89	YES		12
7/27	0.02	0	3	0.04	0.04	0.04	0	0.04	0	0.14	0.22	0.18			14
7/28	0.4	0	25	0.08	0.16	0.16	0.12	0.16	0	0.46	0.74	0.61			6
7/29	0.03	0	8	0.04	0.04	0.04	0	0.04	0	0.08	0.16	0.13			0
7/30	0.08	0	17	0.2	0.2	0.2	0.12	0.24	0	0.37	0.56	0.37			4
7/31	0.3	0	24	0.28	0.28	0.28	0.16	0.28	0	0.8	1.47	0.9	YES		0
8/1	0.02	0	2	0.04	0.04	0.04	0	0.04	0	0.14	0.25	0.19			1
8/2	0.08	0	5	0	0	0	0	0	0	0.31	0.56	0.45			2
8/3	0.08	0	9	0.12	0.12	0.12	0.04	0.12	0	0.53	1.01	0.82	YES		2
8/4	0.03	0	2	0.2	0.2	0.2	0	0.2	0	0.24	0.46	0.26			0
8/5	0.37	0	13	0.04	0.04	0.04	0.04	0.04	0	0.45	0.87	0.51			0
8/6	0.55	0	17	0.28	0.32	0.32	0.16	0.32	0	0.27	0.52	0.4			1
8/7	0	0	0	0	0	0	0	0	0	0	0	0			0
8/8	0	0	0	0	0	0	0	0	0	0	0.01	0			0
8/9	0	0	0	0	0	0	0	0	0	0	0	0			1
8/10	0	0	0	0	0	0	0	0	0	0.03	0.08	0.04			1
8/11	0	0	0	0	0	0	0	0	0	0.01	0.02	0.02			0
8/12	0.02	0	1	0	0	0	0	0	0	0.06	0.09	0.09			0
8/13	0	0	0	0	0	0	0	0	0	0	0	0			0
8/14	0	0	0	0	0	0	0	0	0	0	0	0			0
8/15	0	0	0	0	0	0	0	0	0	0	0	0			0
8/16	0	0	0	0	0	0	0	0	0	0.07	0.11	0.09			1
8/17	0	0	0	0	0	0	0	0	0	0.04	0.06	0.04			1
8/18	0	0	0	0.2	0.2	0.2	0.12	0.2	0	0.05	0.09	0.07			0
8/19	0.02	0	12	0.04	0.04	0.04	0	0.04	0	0.09	0.18	0.13			0
8/20	0.14	0	18	0.12	0.12	0.12	0.08	0.12	0	0.29	0.56	0.43			1
8/21	0	0	0	0	0	0	0	0	0	0.01	0.02	0.01			0
8/22	0	0	0	0	0	0	0	0	0	0	0	0			0
8/23	0.01	0	2	0	0	0	0	0	0	0.06	0.11	0.06			1
8/24	0	0	0	0	0	0	0	0	0	0.07	0.12	0.07			1
8/25	0	0	0	0.04	0.04	0.04	0	0.04	0	0.33	0.6	0.35			3
8/26	0.9	0	22	0.36	0.48	0.64	0.28	0.64	0	0.59	0.86	0.75			20
8/27	0.15	0	10	0.04	0.04	0.04	0	0.04	0	0.17	0.3	0.2			1
8/28	1	0	26	0.2	0.24	0.24	0.12	0.28	0	0.46	0.79	0.45			12

**APPENDIX B –ZONE B SPECIFIC FORECASTS AND OBSERVATIONS**

A	CoCoRaHS			ALERT						NOAA Stage IV			Flood Day Classification		Threat P
	B	C	D	E	F	G	H	I	J	K	L	M	N	O	
8/29	0.11	0	21	0.08	0.12	0.12	0.04	0.12	0	0.31	0.6	0.47			3
8/30	0.04	0	7	0.04	0.04	0.04	0	0.04	0	0.06	0.1	0.11			0
8/31	0.8	0	27	0.12	0.16	0.16	0.08	0.2	0	0.24	0.44	0.19			0
9/1	0.01	0	1	0.04	0.04	0.04	0	0.04	0	0	0.02	0			0
9/2	0	0	0	0	0	0	0	0	0	0	0	0			0
9/3	0	0	0	0	0	0	0	0	0	0	0	0			0
9/4	0	0	0	0	0	0	0	0	0	0.01	0.02	0.01			0
9/5	0	0	0	0	0	0	0	0	0	0	0	0			0
9/6	0	0	0	0	0	0	0	0	0	0	0	0			0
9/7	0.38	0	20	0.08	0.08	0.12	0.08	0.28	0	0.05	0.1	0.24			0
9/8	0.87	0	26	0.04	0.04	0.04	0.04	0.04	0	0.13	0.26	0.91			0
9/9	0.11	0	20	0.08	0.16	0.24	0.12	0.4	0	0.21	0.47	0.51			0
9/10	0.4	0	17	0.39	0.39	0.52	0.32	0.88	0	0.23	0.4	0.49			1
9/11	0	0	0	0.12	0.2	0.32	0.16	0.6	0	0.01	0.02	0.01			0
9/12	0	0	0	0	0	0	0	0	0	0	0	0			0
9/13	0	0	0	0	0	0	0	0	0	0	0	0			1
9/14	0	0	0	0	0	0	0	0	0	0	0	0			1
9/15	0	0	0	0	0	0	0	0	0	0	0	0			1
9/16	0	0	0	0	0	0	0	0	0	0	0	0			1
9/17	0	0	0	0	0	0	0	0	0	0	0	0			0
9/18	0	0	0	0	0	0	0	0	0	0	0	0			1
9/19	0.01	0	1	0	0	0	0	0	0	0.01	0.01	0.01			1
9/20	0.01	0	2	0	0	0	0	0	0	0	0.01	0			0
9/21	0	0	0	0	0	0	0	0	0	0.11	0.19	0.19			1
9/22	0.18	0	4	0	0	0	0	0	0	0.36	0.53	0.36			2
9/23	0	0	0	0	0	0	0	0	0	0.04	0.06	0.04			0
9/24	0	0	0	0	0	0	0	0	0	0	0	0			0
9/25	0	0	0	0	0	0	0	0	0	0	0	0			0
9/26	0	0	0	0	0	0	0	0	0	0	0	0			0
9/27	0.01	0	1	0	0	0	0	0	0	0.02	0.04	0.04			0
9/28	0	0	0	0	0	0	0	0	0	0	0	0			0
9/29	0	0	0	0	0	0	0	0	0	0	0	0			0
9/30	0	0	0	0	0	0	0	0	0	0	0	0			0

**APPENDIX B –ZONE C SPECIFIC FORECASTS AND OBSERVATIONS**

**c) Forecast Zone C: Palmer Divide**

A	CoCoRaHS			ALERT						NOAA Stage IV			Flood Day Classification		Threat
	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
5/1	0.01	0	3	0	0	0	0	0	0	0	0	0			1
5/2	0.45	0	37	0.28	0.32	0.44	0.28	0.48	0	0.39	0.75	0.75			2
5/3	0.15	0	28	0.24	0.24	0.24	0.16	0.24	0	0.42	0.78	1.13			1
5/4	0	0	0	0.04	0.04	0.04	0	0.04	0	0	0	0			0
5/5	0	0	0	0	0	0	0	0	0	0	0	0			0
5/6	0	0	0	0	0	0	0	0	0	0	0	0			0
5/7	0.01	0	2	0	0	0	0	0	0	0	0	0			0
5/8	0	0	0	0	0	0	0	0	0	0	0	0			0
5/9	0	0	0	0	0	0	0	0	0	0	0	0			0
5/10	0.03	0	1	0	0	0	0	0	0	0	0	0			0
5/11	0.09	0	29	0.08	0.08	0.08	0.08	0.08	0	0.16	0.3	0.23			1
5/12	0.05	0	2	0	0	0	0	0	0	0	0	0			0
5/13	0	0	0	0	0	0	0	0	0	0	0	0			0
5/14	0.17	0	34	0.08	0.08	0.12	0.08	0.12	0	0.12	0.23	0.3			3
5/15	0.98	0	42	0.64	0.72	0.72	0.4	0.84	0	0.38	0.68	0.87			7
5/16	0	0	0	0	0	0	0	0	0	0.03	0.06	0.03			0
5/17	0	0	0	0	0	0	0	0	0	0.01	0.03	0.01			1
5/18	0	0	0	0	0	0	0	0	0	0	0	0			1
5/19	0.01	0	1	0.04	0.04	0.04	0	0.08	0	0.21	0.37	0.26			4
5/20	0	0	0	0.04	0.04	0.04	0	0.04	0	0	0	0			1
5/21	0	0	0	0	0	0	0	0	0	0	0	0			1
5/22	0	0	0	0	0	0	0	0	0	0	0	0			1
5/23	0	0	0	0	0	0	0	0	0	0.02	0.04	0.02			1
5/24	1.65	26	49	0.56	0.56	0.64	0.52	1.36	0	0.45	0.85	1.66			16
5/25	0.11	0	1	0.2	0.32	0.36	0.32	0.36	0	0.01	0.02	0.01			1
5/26	0	0	0	0	0	0	0	0	0	0	0	0			0
5/27	0.24	0	38	0.48	0.48	0.48	0.24	0.52	0	0.23	0.4	0.28			2
5/28	0.04	0	2	0.32	0.32	0.32	0.12	0.32	0	0.28	0.37	0.28			6
5/29	0.37	0	22	0.2	0.2	0.2	0.16	0.2	0	0.36	0.94	0.47			3
5/30	0.01	0	1	0.32	0.32	0.32	0.04	0.32	0	0.3	0.53	0.37			42
5/31	0.15	0	8	0.2	0.32	0.36	0.2	0.36	0	0.73	1.24	0.81	YES		7
6/1	0.03	0	2	0	0	0	0	0	0	0.15	0.26	0.26			12
6/2	0.03	0	1	0	0	0	0	0	0	0.04	0.07	0.04			1
6/3	0.04	0	1	0.12	0.12	0.12	0.08	0.12	0	0.24	0.44	0.36			1
6/4	0.22	0	31	0.12	0.12	0.12	0.08	0.12	0	0.2	0.39	0.31			1
6/5	0.05	0	6	0	0	0	0	0	0	0.04	0.08	0.05			1
6/6	0.66	0	41	0.2	0.2	0.2	0.16	0.2	0	0.32	0.6	0.36			2
6/7	0	0	0	0	0	0	0	0	0	0	0	0			0
6/8	0.85	0	37	0.2	0.24	0.36	0.24	0.64	0	0.09	0.16	0.61			1

**APPENDIX B –ZONE C SPECIFIC FORECASTS AND OBSERVATIONS**

A	CoCoRaHS			ALERT						NOAA Stage IV			Flood Day Classification		Threat
	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
6/9	0.32	0	32	0.2	0.28	0.36	0.28	0.48	0	0.22	0.44	0.45			0
6/10	0	0	0	0	0	0	0	0	0	0	0	0			0
6/11	0	0	0	0	0	0	0	0	0	0	0	0			0
6/12	0.46	0	19	0.84	0.84	0.84	0.44	0.84	0	1.1	2.1	1.13	YES	YES	3
6/13	0.53	0	22	0.12	0.16	0.16	0.12	0.2	0	0.18	0.34	0.33			6
6/14	0	0	0	0	0	0	0	0	0	0	0	0			1
6/15	0	0	0	0	0	0	0	0	0	0.02	0.04	0.02			1
6/16	0	0	0	0	0	0	0	0	0	0	0	0			1
6/17	0	0	0	0	0	0	0	0	0	0	0.01	0			0
6/18	0.08	0	16	0	0	0	0	0	0	0.08	0.15	0.19			1
6/19	0.19	0	18	0.04	0.04	0.04	0.04	0.04	0	0.29	0.58	0.32			14
6/20	0.01	0	1	0	0	0	0	0	0	0	0	0			0
6/21	0	0	0	0	0	0	0	0	0	0.02	0.04	0.03			0
6/22	0.25	0	17	0.12	0.12	0.12	0.08	0.12	0	0.14	0.26	0.23			10
6/23	0.71	0	11	0.72	0.72	0.72	0.68	0.72	0	0.68	1.33	0.86	YES		8
6/24	0.15	0	11	0.04	0.04	0.04	0.04	0.04	0	0.18	0.33	0.18			2
6/25	0.06	0	8	0.08	0.08	0.08	0.04	0.08	0	0.25	0.52	0.35			1
6/26	1.01	2	44	1.44	1.56	1.64	1	1.72	1	1.07	2.11	1.43	YES	YES	23
6/27	0.05	0	1	0.04	0.04	0.04	0	0.04	0	0.31	0.49	0.61			2
6/28	0.05	0	6	0.04	0.04	0.04	0.04	0.04	0	0.08	0.16	0.14			1
6/29	0	0	0	0	0	0	0	0	0	0	0	0			0
6/30	0	0	0	0	0	0	0	0	0	0	0	0			0
7/1	0	0	0	0	0	0	0	0	0	0	0	0			0
7/2	0	0	0	0	0	0	0	0	0	0.08	0.19	0.14			1
7/3	0.77	0	32	0.6	0.64	0.64	0.4	0.64	0	0.75	1.45	0.79	YES		7
7/4	0.38	0	17	0.92	1.12	1.48	1.08	1.8	2	0.76	1.45	1.05	YES	YES	24
7/5	0.39	0	16	0.56	0.6	0.6	0.44	0.6	0	0.48	0.91	0.54			3
7/6	0.07	0	7	0.04	0.04	0.04	0	0.04	0	0.06	0.13	0.1			4
7/7	0.04	0	3	0.12	0.12	0.12	0.04	0.12	0	0.24	0.47	0.25			1
7/8	0	0	0	0.12	0.12	0.12	0.08	0.12	0	0	0	0			0
7/9	0	0	0	0	0	0	0	0	0	0.04	0.04	0.08			0
7/10	0	0	0	0	0	0	0	0	0	0	0	0			0
7/11	0	0	0	0	0	0	0	0	0	0.09	0.17	0.09			0
7/12	0.05	0	10	0.04	0.08	0.08	0.04	0.08	0	0.21	0.41	0.45			1
7/13	0.33	0	41	0.28	0.28	0.28	0.24	0.28	0	0.23	0.45	0.33			1
7/14	0.53	0	41	0.24	0.24	0.24	0.16	0.28	0	0.35	0.68	0.53			3
7/15	0.22	0	23	0.2	0.2	0.2	0.08	0.2	0	0.4	0.77	0.44			7
7/16	0.44	0	35	0.36	0.36	0.36	0.2	0.44	0	0.23	0.44	0.39			2
7/17	0.26	0	4	0	0	0	0	0	0	0.03	0.06	0.07			0
7/18	0.11	0	3	0.04	0.08	0.08	0.04	0.08	0	0.03	0.04	0.03			1
7/19	0.71	0	24	0.64	0.68	0.68	0.4	0.68	0	0.57	0.99	0.79			11

**APPENDIX B –ZONE C SPECIFIC FORECASTS AND OBSERVATIONS**

A	CoCoRaHS			ALERT						NOAA Stage IV			Flood Day Classification		Threat
	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
7/20	0.46	0	15	0.36	0.36	0.36	0.16	0.4	0	0.17	0.28	0.18			1
7/21	0.29	0	6	0.92	0.96	0.96	0.28	0.96	0	0.69	1.37	0.71	YES		26
7/22	0.03	0	1	0.04	0.04	0.04	0	0.04	0	0.27	0.46	0.31			2
7/23	0.13	0	4	0.04	0.04	0.04	0	0.04	0	0.04	0.1	0.04			2
7/24	0.3	0	40	0.32	0.32	0.32	0.16	0.32	0	0.5	0.99	0.68			5
7/25	0.93	0	49	0.72	0.76	0.76	0.68	0.84	0	1.16	2.22	1.28	YES	YES	8
7/26	0.2	0	21	0.24	0.28	0.28	0.2	0.28	0	0.16	0.31	0.27			30
7/27	0.1	0	2	0.08	0.08	0.08	0.08	0.08	0	0.16	0.28	0.16			5
7/28	1.05	2	30	1.12	1.2	1.2	0.72	1.2	1	0.67	1.25	1.08	YES	YES	14
7/29	0.01	0	3	0.04	0.04	0.04	0.04	0.04	0	0.06	0.1	0.07			0
7/30	0.01	0	1	0.04	0.04	0.04	0	0.04	0	0.07	0.13	0.08			3
7/31	0.06	0	21	0.08	0.08	0.08	0.04	0.08	0	0.14	0.25	0.17			0
8/1	0.02	0	1	0	0	0	0	0	0	0.03	0.05	0.02			0
8/2	0	0	0	0	0	0	0	0	0	0.26	0.45	0.26			1
8/3	0.77	0	8	0.32	0.32	0.32	0.12	0.32	0	0.8	1.47	1.06	YES	YES	7
8/4	0.02	0	6	0.12	0.12	0.12	0	0.12	0	0.17	0.39	0.18			1
8/5	0.41	0	25	0.16	0.2	0.2	0.16	0.2	0	0.8	1.53	0.81	YES		4
8/6	0.38	0	27	0.24	0.24	0.24	0.12	0.24	0	0.37	0.7	0.76			1
8/7	0	0	0	0	0	0	0	0	0	0	0	0			0
8/8	0	0	0	0	0	0	0	0	0	0	0	0			0
8/9	0	0	0	0	0	0	0	0	0	0	0	0			1
8/10	0.05	0	1	0.08	0.08	0.08	0.04	0.08	0	0.34	0.63	0.34			2
8/11	0	0	0	0	0	0	0	0	0	0	0	0			0
8/12	0	0	0	0.24	0.24	0.24	0	0.24	0	0.06	0.12	0.06			0
8/13	0	0	0	0.04	0.04	0.04	0	0.04	0	0	0	0			0
8/14	0	0	0	0	0	0	0	0	0	0	0	0			0
8/15	0	0	0	0	0	0	0	0	0	0	0	0			0
8/16	0	0	0	0	0	0	0	0	0	0.01	0.02	0.01			1
8/17	0	0	0	0	0	0	0	0	0	0.07	0.13	0.08			1
8/18	0	0	0	0	0	0	0	0	0	0	0	0			0
8/19	0.01	0	1	0	0	0	0	0	0	0.09	0.16	0.14			1
8/20	0.02	0	3	0	0	0	0	0	0	0.19	0.32	0.22			1
8/21	0	0	0	0	0	0	0	0	0	0	0	0			0
8/22	0	0	0	0	0	0	0	0	0	0	0	0			0
8/23	0.01	0	1	0	0	0	0	0	0	0	0	0			1
8/24	0.33	0	3	0.08	0.12	0.12	0	0.12	0	0.15	0.26	0.15			1
8/25	0.75	0	35	0.16	0.16	0.16	0.12	0.2	0	0.48	0.78	0.53			2
8/26	0.57	0	43	0.32	0.36	0.52	0.31	0.76	0	0.53	1.05	1.07	YES	YES	3
8/27	0.09	0	7	0	0	0	0	0	0	0.07	0.14	0.07			1
8/28	0.2	0	44	0.12	0.16	0.2	0.16	0.2	0	0.11	0.22	0.32			7
8/29	0.2	0	40	0.52	0.56	0.6	0.16	0.68	0	0.29	0.56	0.49			11

**APPENDIX B –ZONE C SPECIFIC FORECASTS AND OBSERVATIONS**

A	CoCoRaHS			ALERT						NOAA Stage IV			Flood Day Classification		Threat
	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
8/30	0.05	0	2	0.04	0.04	0.04	0.04	0.04	0	0.19	0.33	0.23			0
8/31	0.26	0	42	0.16	0.16	0.16	0.12	0.16	0	0.28	0.54	0.17			1
9/1	0	0	0	0	0	0	0	0	0	0	0	0			0
9/2	0.06	0	1	0	0	0	0	0	0	0	0	0			0
9/3	0	0	0	0	0	0	0	0	0	0	0	0			0
9/4	0	0	0	0	0	0	0	0	0	0	0	0			0
9/5	0	0	0	0	0	0	0	0	0	0	0	0			0
9/6	0	0	0	0	0	0	0	0	0	0	0	0			0
9/7	0.55	0	36	0.12	0.12	0.16	0.12	0.4	0	0.09	0.16	0.41			1
9/8	1.03	1	38	0.12	0.16	0.2	0.12	0.32	0	0.13	0.25	1.13			0
9/9	0.16	0	23	0.24	0.24	0.32	0.24	0.44	0	0.08	0.16	0.34			1
9/10	0.01	0	2	0.28	0.44	0.6	0.32	0.8	0	0.06	0.15	0.34			1
9/11	0	0	0	0.39	0.39	0.39	0.31	0.39	0	0	0	0			0
9/12	0	0	0	0.2	0.2	0.2	0	0.2	0	0	0	0			0
9/13	0	0	0	0	0	0	0	0	0	0	0	0			1
9/14	0	0	0	0	0	0	0	0	0	0	0	0			1
9/15	0	0	0	0	0	0	0	0	0	0	0	0			1
9/16	0	0	0	0	0	0	0	0	0	0	0	0			1
9/17	0	0	0	0	0	0	0	0	0	0	0	0			0
9/18	0	0	0	0	0	0	0	0	0	0	0	0			1
9/19	0	0	0	0	0	0	0	0	0	0	0.01	0			1
9/20	0	0	0	0	0	0	0	0	0	0.02	0.03	0.02			0
9/21	0	0	0	0.12	0.12	0.12	0	0.12	0	0.06	0.11	0.09			1
9/22	0.1	0	6	0.04	0.04	0.04	0	0.04	0	0.33	0.59	0.47			3
9/23	0	0	0	0	0	0	0	0	0	0	0.01	0			0
9/24	0	0	0	0	0	0	0	0	0	0	0	0			0
9/25	0	0	0	0	0	0	0	0	0	0	0	0			0
9/26	0	0	0	0	0	0	0	0	0	0	0	0			0
9/27	0.08	0	29	0.04	0.04	0.04	0.04	0.04	0	0.09	0.18	0.14			0
9/28	0.03	0	1	0.04	0.04	0.04	0	0.04	0	0	0	0			0
9/29	0.01	0	1	0	0	0	0	0	0	0	0	0			0
9/30	0	0	0	0	0	0	0	0	0	0	0	0			0

**APPENDIX B –ZONE D SPECIFIC FORECASTS AND OBSERVATIONS**

**d) Forecast Zone D: Central Metro**

A	CoCoRaHS			ALERT						NOAA Stage IV			Flood Day Classification		Threat
	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
5/1	0	0	0	0	0	0	0	0	0	0	0.14	0			1
5/2	0.41	0	99	0.56	0.56	0.56	0.2	0.56	0	0.35	0.62	0.59			4
5/3	0.16	0	28	0.24	0.24	0.24	0.16	0.24	0	0.28	0.5	0.28			0
5/4	0	0	0	0.52	0.52	0.52	0.04	0.52	0	0.04	0.09	0.04			0
5/5	0	0	0	0.08	0.16	0.28	0	0.28	0	0	0	0			0
5/6	0.01	0	1	0.48	0.48	0.48	0.16	0.48	0	0	0	0			0
5/7	0.02	0	5	0.48	0.48	0.56	0.04	0.64	0	0	0	0			0
5/8	0	0	0	0.43	0.43	0.43	0	0.43	0	0	0	0			0
5/9	0	0	0	0.6	0.6	0.68	0.04	0.68	0	0	0	0			0
5/10	0.06	0	4	0.32	0.32	0.52	0	0.52	0	0	0	0			0
5/11	0.22	0	92	0.24	0.28	0.48	0.04	0.48	0	0.11	0.21	0.41			1
5/12	0.05	0	1	0.04	0.04	0.04	0.04	0.04	0	0	0	0			0
5/13	0	0	0	0.24	0.24	0.4	0.12	0.4	0	0	0	0			0
5/14	0.49	0	76	0.88	0.88	0.88	0.32	0.88	0	0.57	1.14	0.68	YES		5
5/15	0.86	0	106	0.76	0.84	0.88	0.72	0.88	0	0.57	1.02	1.01	YES	YES	9
5/16	0.1	0	21	0.92	0.92	1.04	0.08	1.04	0	0.04	0.06	0.05			0
5/17	0.01	0	1	0.56	0.56	0.8	0.08	0.8	0	0	0	0			0
5/18	0	0	0	0.32	0.32	0.32	0.32	0.32	0	0	0	0			1
5/19	0.13	0	20	0.08	0.08	0.08	0.08	0.08	0	0.13	0.26	0.14			2
5/20	0	0	0	0.72	0.72	0.88	0.08	0.88	0	0	0	0			1
5/21	0	0	0	1.08	1.08	1.24	0.16	1.24	1	0	0	0	YES		1
5/22	0.04	0	1	0.08	0.08	0.08	0.04	0.08	0	0	0	0			1
5/23	0.07	0	2	0.8	0.84	1	0.12	1	0	0.03	0.06	0.03			1
5/24	1.45	39	116	0.84	0.84	1.04	0.56	2.2	0	0.38	0.73	1.27			11
5/25	0.01	0	5	0.24	0.24	0.44	0.16	0.44	0	0.02	0.04	0.04			1
5/26	0.31	0	1	0.08	0.08	0.08	0.04	0.12	0	0	0	0			0
5/27	0.44	0	78	0.4	0.4	0.44	0.28	0.44	0	0.2	0.35	0.27			2
5/28	0.36	0	14	0.2	0.24	0.4	0.04	0.4	0	0.7	1.28	0.71	YES		8
5/29	0.35	0	22	0.12	0.2	0.24	0.12	0.28	0	0.6	1.14	0.61	YES		3
5/30	0.68	0	20	0.56	0.56	0.56	0.32	0.56	0	0.77	1.24	0.77	YES		30
5/31	0.05	0	8	0.6	0.6	0.68	0.04	0.68	0	0.09	0.17	0.23			10
6/1	0.07	0	7	0.2	0.24	0.4	0.16	0.4	0	0.12	0.16	0.16			5
6/2	0.01	0	1	0	0	0	0	0	0	0.04	0.9	0.04			1
6/3	0.03	0	8	0.24	0.28	0.52	0.08	0.52	0	0.08	0.3	0.1			1
6/4	0.23	0	34	0.24	0.24	0.44	0.12	0.44	0	0.19	0.37	0.19			1
6/5	0.07	0	3	0	0	0	0	0	0	0.03	0.06	0.04			1
6/6	0.34	0	98	0.24	0.24	0.44	0.2	0.48	0	0.36	0.62	0.37			2
6/7	0	0	0	0.28	0.28	0.4	0	0.4	0	0	0	0			0
6/8	0.95	0	102	0.28	0.28	0.36	0.24	0.8	0	0.09	0.19	0.65			1



**APPENDIX B –ZONE D SPECIFIC FORECASTS AND OBSERVATIONS**

A	CoCoRaHS			ALERT						NOAA Stage IV			Flood Day Classification		Threat
	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
6/9	0.23	0	65	0.12	0.16	0.24	0.12	0.32	0	0.17	0.34	0.28			0
6/10	0	0	0	0.24	0.28	0.48	0	0.48	0	0	0	0			0
6/11	0	0	0	0.24	0.24	0.48	0.08	0.48	0	0	0	0			0
6/12	0.22	0	8	0.08	0.08	0.12	0.08	0.12	0	0.11	0.21	0.17			1
6/13	0.22	0	49	0.32	0.32	0.48	0.08	0.48	0	0.18	0.3	0.27			5
6/14	0	0	0	0.24	0.24	0.44	0.08	0.44	0	0	0.02	0			1
6/15	0	0	0	0.28	0.32	0.36	0.2	0.36	0	0	0	0			1
6/16	0	0	0	0.04	0.04	0.04	0	0.04	0	0	0	0			1
6/17	0	0	0	0.2	0.24	0.4	0.08	0.4	0	0	0	0			0
6/18	0.75	0	91	0.24	0.24	0.44	0.12	0.52	0	0.25	0.53	1.28			1
6/19	0.22	0	73	0.12	0.12	0.16	0.12	0.16	0	0.37	0.69	0.37			25
6/20	0.09	0	3	0.24	0.24	0.44	0.16	0.44	0	0	0	0			0
6/21	0.15	0	32	0.28	0.32	0.48	0.08	0.48	0	0.11	0.23	0.14			0
6/22	0.1	0	63	0.24	0.24	0.48	0.16	0.48	0	0.05	0.09	0.08			1
6/23	0.03	0	1	0.12	0.16	0.16	0.12	0.16	0	0.01	0.04	0.08			2
6/24	0.6	0	54	0.24	0.28	0.52	0.12	0.56	0	0.2	0.38	0.32			1
6/25	0.14	0	59	0.36	0.36	0.44	0.24	0.48	0	0.3	0.6	0.43			1
6/26	1.2	7	101	1.26	1.26	1.34	1.08	1.62	2	0.52	1.1	0.86	YES	YES	4
6/27	0.06	0	7	0.24	0.28	0.32	0.08	0.32	0	0.03	0.51	0.03			1
6/28	0.03	0	7	0.2	0.24	0.44	0.12	0.48	0	0.07	0.25	0.09			1
6/29	0	0	0	0.28	0.28	0.48	0.16	0.48	0	0	0	0			0
6/30	0.08	0	13	0.08	0.08	0.12	0.04	0.12	0	0.15	0.25	0.16			0
7/1	0.19	0	1	0.32	0.32	0.36	0.28	0.36	0	0	0	0			0
7/2	0	0	0	0.24	0.28	0.48	0.16	0.48	0	0	0.18	0			1
7/3	0.09	0	6	0	0	0	0	0	0	0.27	0.5	0.28			10
7/4	1.25	3	59	0.8	1.12	1.56	1.08	1.68	2	0.84	1.56	1.46	YES	YES	12
7/5	0.26	0	14	0.28	0.28	0.4	0.08	0.4	0	0.18	0.33	0.19			1
7/6	0	0	0	0.32	0.32	0.36	0.12	0.36	0	0.05	0.1	0.06			1
7/7	0.19	0	7	0.12	0.12	0.12	0.08	0.16	0	0.17	0.33	0.2			1
7/8	0	0	0	0.28	0.28	0.52	0.16	0.52	0	0	0.14	0			0
7/9	1.35	2	9	0.4	0.4	0.48	0.36	0.48	0	0.55	1.01	0.64	YES		0
7/10	0	0	0	0.04	0.08	0.08	0	0.08	0	0	0	0			0
7/11	0	0	0	0.28	0.28	0.36	0.04	0.36	0	0	0	0			0
7/12	0	0	0	0.24	0.28	0.44	0.12	0.44	0	0	0.67	0			0
7/13	0.13	0	70	0.24	0.24	0.4	0.12	0.4	0	0.2	0.37	0.23			1
7/14	1.12	1	107	0.44	0.44	0.44	0.4	0.44	0	0.24	0.48	0.34			2
7/15	0.21	0	24	0.4	0.4	0.4	0.24	0.44	0	0.14	0.26	0.15			1
7/16	0.14	0	6	0.32	0.32	0.52	0.04	0.52	0	0.31	0.67	0.45			1
7/17	0.02	0	4	0.04	0.04	0.04	0	0.04	0	0.02	0.05	0.03			0
7/18	0.01	0	1	0.28	0.28	0.52	0.16	0.52	0	0.01	0.02	0.01			1
7/19	0.43	0	5	0.84	0.84	0.84	0.36	0.84	0	0.61	1.19	0.72	YES		3

**APPENDIX B –ZONE D SPECIFIC FORECASTS AND OBSERVATIONS**

A	CoCoRaHS			ALERT						NOAA Stage IV			Flood Day Classification		Threat
	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
7/20	0	0	0	0.2	0.24	0.4	0.12	0.4	0	0.01	0.43	0.01			4
7/21	0.12	0	6	0.36	0.36	0.44	0.04	0.44	0	0.1	0.17	0.12			9
7/22	0.69	0	82	0.44	0.44	0.48	0.28	0.48	0	0.33	0.57	0.33			2
7/23	0.2	0	2	0.24	0.28	0.48	0.2	0.48	0	1.22	1.22	0	YES		2
7/24	1.23	1	107	0.88	0.88	0.88	0.48	0.88	0	0.46	0.83	0.67			3
7/25	0.33	0	112	0.32	0.36	0.52	0.28	0.64	0	0.27	0.5	0.56			5
7/26	0.1	0	70	0.24	0.24	0.44	0.2	0.48	0	0.12	0.22	0.14			13
7/27	0.05	0	4	0.4	0.4	0.4	0.16	0.4	0	0	0	0			10
7/28	0.76	0	94	0.32	0.32	0.36	0.32	0.36	0	0.32	0.59	0.52			10
7/29	0.12	0	5	0.24	0.28	0.48	0.08	0.48	0	0.03	0.04	0.03			0
7/30	0.14	0	17	0.28	0.28	0.52	0.04	0.52	0	0.07	0.14	0.16			3
7/31	0.34	0	46	0.16	0.16	0.2	0.16	0.2	0	0.29	0.55	0.47			0
8/1	0.15	0	3	0.28	0.28	0.48	0.16	0.48	0	0.12	0.19	0.04			0
8/2	0.04	0	4	0.24	0.28	0.52	0.28	0.52	0	0.02	0.48	0.06			0
8/3	0.05	0	4	0.28	0.28	0.32	0.2	0.32	0	0.03	0.28	0.04			2
8/4	0.1	0	9	0.08	0.12	0.2	0.04	0.2	0	0.36	0.65	0.36			2
8/5	0.29	0	38	0.28	0.28	0.48	0.12	0.52	0	0.52	1.11	0.56	YES		10
8/6	0.29	0	19	0.32	0.32	0.48	0.12	0.48	0	0.29	0.57	0.32			1
8/7	0	0	0	0.08	0.12	0.16	0.04	0.24	0	0	0.09	0			0
8/8	0	0	0	0.24	0.24	0.44	0.2	0.44	0	0	0	0			0
8/9	0	0	0	0.24	0.24	0.48	0	0.48	0	0	0	0			1
8/10	0.04	0	5	0.28	0.28	0.44	0.16	0.44	0	0.04	0.07	0.05			1
8/11	0	0	0	0.12	0.2	0.24	0.04	0.28	0	0.01	0.33	0.01			0
8/12	0.09	0	8	0.24	0.24	0.48	0.12	0.48	0	0.13	0.25	0.18			0
8/13	0	0	0	0.24	0.24	0.4	0.24	0.4	0	0	0.04	0			0
8/14	0	0	0	0.08	0.16	0.2	0.04	0.2	0	0	0	0			0
8/15	0	0	0	0.28	0.28	0.48	0.12	0.48	0	0	0	0			0
8/16	0	0	0	0.28	0.28	0.48	0	0.48	0	0	0.23	0			0
8/17	0	0	0	0.28	0.28	0.48	0.2	0.48	0	0	0	0			0
8/18	0	0	0	0.08	0.12	0.16	0.04	0.24	0	0	0.03	0			0
8/19	0.01	0	2	0.28	0.28	0.44	0.12	0.44	0	0.05	0.09	0.07			0
8/20	0.15	0	28	0.28	0.28	0.48	0.2	0.48	0	0.31	0.48	0.32			0
8/21	0	0	0	0.12	0.2	0.28	0	0.28	0	0	0	0			0
8/22	0	0	0	0.28	0.28	0.48	0.2	0.48	0	0	0	0			0
8/23	0	0	0	0.32	0.36	0.6	0	0.6	0	0	0	0			1
8/24	0	0	0	0.24	0.28	0.48	0.2	0.48	0	0	0	0			1
8/25	0.39	0	27	0.16	0.16	0.2	0.12	0.24	0	0.28	0.53	0.39			1
8/26	0.5	0	77	0.36	0.36	0.44	0.32	0.44	0	0.31	0.59	0.4			2
8/27	0.02	0	4	0.32	0.32	0.52	0.2	0.52	0	0.07	0.16	0.14			1
8/28	0.2	0	111	0.12	0.12	0.12	0.08	0.12	0	0.12	0.27	0.22			2
8/29	0.06	0	76	0.24	0.28	0.48	0.08	0.48	0	0.16	0.35	0.27			3

**APPENDIX B –ZONE D SPECIFIC FORECASTS AND OBSERVATIONS**

A	CoCoRaHS			ALERT						NOAA Stage IV			Flood Day Classification		Threat
	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
8/30	0.04	0	14	0.24	0.28	0.44	0.04	0.44	0	0.05	0.1	0.08			0
8/31	0.47	0	110	0.32	0.44	0.6	0.16	0.6	0	0.12	0.24	0.51			0
9/1	0	0	0	0.28	0.28	0.52	0.08	0.52	0	0	0	0			0
9/2	0	0	0	0.28	0.32	0.52	0.12	0.52	0	0	0	0			0
9/3	0	0	0	0.32	0.32	0.52	0.08	0.52	0	0	0	0			0
9/4	0	0	0	0.16	0.16	0.16	0.12	0.24	0	0	0	0			0
9/5	0	0	0	0.28	0.32	0.48	0	0.48	0	0	0	0			0
9/6	0	0	0	0.28	0.28	0.48	0.04	0.48	0	0	0	0			0
9/7	0.6	0	87	0.08	0.12	0.2	0.12	0.44	0	0.41	0.76	0.69			1
9/8	1.05	1	95	0.12	0.16	0.2	0.12	0.48	0	0.13	0.28	1.03			0
9/9	0.17	0	71	0.28	0.36	0.4	0.32	0.64	0	0.09	0.17	0.27			1
9/10	0.04	0	10	0.08	0.12	0.16	0.12	0.24	0	0.03	0.11	0.44			0
9/11	0	0	0	0.08	0.08	0.08	0.08	0.12	0	0	0.02	0			0
9/12	0	0	0	0.04	0.04	0.04	0.04	0.04	0	0	0	0			0
9/13	0	0	0	0.04	0.04	0.04	0	0.04	0	0	0	0			1
9/14	0	0	0	0.2	0.2	0.2	0.04	0.2	0	0	0	0			1
9/15	0	0	0	0.04	0.04	0.04	0.04	0.04	0	0	0	0			1
9/16	0	0	0	0.16	0.24	0.24	0.04	0.24	0	0	0	0			1
9/17	0	0	0	0.16	0.24	0.24	0.08	0.24	0	0	0	0			0
9/18	0	0	0	0.04	0.08	0.12	0.04	0.12	0	0	0	0			0
9/19	0	0	0	0.16	0.2	0.24	0.04	0.24	0	0	0	0			1
9/20	0	0	0	0.16	0.2	0.2	0.08	0.2	0	0	0.01	0			0
9/21	0	0	0	0.16	0.24	0.24	0.12	0.24	0	0	0.02	0			1
9/22	0.1	0	6	0.08	0.08	0.08	0.08	0.08	0	0.12	0.19	0.12			2
9/23	0	0	0	0.2	0.28	0.28	0.2	0.32	0	0	0	0			0
9/24	0	0	0	0.16	0.2	0.2	0.04	0.2	0	0	0	0			0
9/25	0	0	0	0.16	0.16	0.16	0.08	0.28	0	0	0	0			0
9/26	0.03	0	1	0.2	0.24	0.24	0.04	0.24	0	0	0	0			0
9/27	0.04	0	37	0.16	0.2	0.2	0.08	0.2	0	0.07	0.14	0.13			0
9/28	0	0	0	0.16	0.28	0.28	0.12	0.28	0	0	0	0			0
9/29	0	0	0	0.12	0.12	0.12	0.08	0.16	0	0	0	0			0
9/30	0	0	0	0.16	0.24	0.24	0.16	0.24	0	0	0	0			0

**APPENDIX B –ZONE E SPECIFIC FORECASTS AND OBSERVATIONS**

**e) Forecast Zone E: North Metro**

A	CoCoRaHS			ALERT						NOAA Stage IV			Flood Day Classification		Threat
	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
5/1	0.02	0	3	0	0	0	0	0	0	0.03	0.11	0.03			1
5/2	0.71	0	89	0.32	0.32	0.32	0.2	0.4	0	0.52	0.99	0.62			5
5/3	0.46	0	92	0.08	0.08	0.12	0.04	0.16	0	0.3	0.81	0.45			1
5/4	0.02	0	3	0.04	0.04	0.04	0.04	0.08	0	0.09	0.17	0.09			0
5/5	0	0	0	0	0	0	0	0	0	0	0	0			0
5/6	0	0	0	0	0	0	0	0	0	0	0	0			0
5/7	0.07	0	28	0.04	0.04	0.04	0	0.04	0	0	0	0			0
5/8	0.01	0	1	0	0	0	0	0	0	0	0.02	0			0
5/9	0.19	0	1	0	0	0	0	0	0	0	0	0			0
5/10	0.18	0	1	0	0	0	0	0	0	0	0	0			0
5/11	0.31	0	96	0.08	0.08	0.12	0.08	0.24	0	0.16	0.32	0.51			1
5/12	0.02	0	3	0.12	0.12	0.12	0.04	0.12	0	0	0	0			0
5/13	0.03	0	6	0.24	0.24	0.24	0	0.24	0	0.02	0.03	0.11			1
5/14	0.59	0	86	0.32	0.32	0.32	0.2	0.32	0	0.4	0.8	0.57			5
5/15	0.63	0	94	0.2	0.24	0.24	0.12	0.24	0	0.66	1.31	0.81	YES		6
5/16	0	0	0	0	0	0	0	0	0	0.01	0.02	0.01			0
5/17	0	0	0	0	0	0	0	0	0	0	0	0			0
5/18	0	0	0	0	0	0	0	0	0	0	0	0			1
5/19	0	0	0	0	0	0	0	0	0	0.01	0.01	0.01			2
5/20	0	0	0	0.04	0.04	0.04	0	0	0	0	0.01	0			2
5/21	0	0	0	0	0	0	0	0	0	0	0	0			1
5/22	0	0	0	0	0	0	0	0	0	0	0	0			2
5/23	0.01	0	2	0	0	0	0	0	0	0.09	0.17	0.11			1
5/24	1.29	18	101	0.4	0.6	1.08	0.44	1.52	0	0.36	0.72	1.13			3
5/25	0.03	0	8	0.04	0.04	0.04	0.04	0.04	0	0.02	0.05	0.04			1
5/26	0.13	0	2	0	0	0	0	0	0	0	0	0			0
5/27	0.38	0	55	0.36	0.36	0.36	0.08	0.36	0	0.14	0.24	0.19			5
5/28	0.11	0	17	0.04	0.04	0.04	0.04	0.04	0	0.03	0.06	0.03			4
5/29	0.16	0	24	0	0	0	0	0	0	0.11	0.41	0.16			2
5/30	0.38	0	78	0.28	0.28	0.28	0.2	0.28	0	0.54	0.9	0.55			17
5/31	0.12	0	39	0.12	0.12	0.12	0.12	0.12	0	0.39	0.89	0.53			4
6/1	0	0	0	0.24	0.24	0.24	0	0.24	0	0.05	0.25	0.07			4
6/2	0.09	0	29	0.08	0.08	0.08	0.08	0.08	0	0.09	0.23	0.11			1
6/3	0	0	0	0	0	0	0	0	0	0.04	0.34	0.06			1
6/4	0.07	0	28	0	0	0	0	0	0	0.08	0.15	0.08			1
6/5	0.03	0	7	0	0	0	0	0	0	0.1	0.19	0.1			1
6/6	0.51	0	89	0.12	0.12	0.12	0.12	0.16	0	0.33	0.65	0.38			1
6/7	0	0	0	0	0	0	0	0	0	0	0	0			0
6/8	0.76	0	91	0.12	0.24	0.32	0.12	0.68	0	0.14	0.29	0.61			1

**APPENDIX B –ZONE E SPECIFIC FORECASTS AND OBSERVATIONS**

A	CoCoRaHS			ALERT						NOAA Stage IV			Flood Day Classification		Threat
	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
6/9	0.08	0	26	0.08	0.12	0.16	0.04	0.16	0	0.17	0.33	0.33			0
6/10	0	0	0	0	0	0	0	0	0	0	0	0			0
6/11	0	0	0	0	0	0	0	0	0	0	0	0			0
6/12	0	0	0	0	0	0	0	0	0	0	0	0			1
6/13	0.53	0	52	0.32	0.32	0.32	0.2	0.32	0	0.38	0.56	0.38			4
6/14	0	0	0	0	0	0	0	0	0	0	0.03	0			0
6/15	0	0	0	0	0	0	0	0	0	0	0	0			1
6/16	0	0	0	0	0	0	0	0	0	0	0	0			1
6/17	0	0	0	0	0	0	0	0	0	0	0	0			0
6/18	1.08	1	100	0.16	0.2	0.28	0.2	0.84	0	0.19	0.39	1.38			1
6/19	0.58	0	85	0.24	0.24	0.24	0.24	0.36	0	0.55	1.11	0.64	YES		7
6/20	0.07	0	2	0	0	0	0	0	0	0	0.01	0			0
6/21	0.27	0	65	0.2	0.24	0.24	0.16	0.24	0	0.37	0.73	0.38			0
6/22	0.03	0	4	0	0	0	0	0	0	0.04	0.12	0.06			1
6/23	0.1	0	4	0	0	0	0	0	0	0.24	0.46	0.25			2
6/24	0.46	0	60	0.04	0.08	0.08	0.04	0.08	0	0.48	0.92	0.76			1
6/25	0.2	0	9	0	0	0	0	0	0	0.33	0.59	0.46			1
6/26	0.73	0	88	0.76	0.8	0.8	0.56	0.84	0	0.4	0.77	0.6			6
6/27	0.02	0	4	0	0	0	0	0	0	0.03	0.24	0.03			1
6/28	0.27	0	61	0.08	0.08	0.08	0.04	0.08	0	0.34	0.67	0.49			1
6/29	0.06	0	2	0	0	0	0	0	0	0	0	0			0
6/30	0.18	0	80	0.16	0.2	0.2	0.16	0.2	0	0.2	0.32	0.34			0
7/1	0	0	0	0	0	0	0	0	0	0	0	0			0
7/2	0	0	0	0	0	0	0	0	0	0	0.12	0			1
7/3	0	0	0	0	0	0	0	0	0	0.15	0.26	0.15			4
7/4	0.34	0	11	0.16	0.16	0.16	0	0.16	0	0.75	1.42	0.85	YES		12
7/5	0.01	0	4	0	0	0	0	0	0	0.03	0.07	0.04			1
7/6	0.11	0	5	0.04	0.04	0.04	0	0.04	0	0.35	0.71	0.38			1
7/7	0	0	0	0.24	0.24	0.24	0	0.24	0	0.02	0.06	0.02			1
7/8	0	0	0	0	0	0	0	0	0	0	0	0			0
7/9	0.36	0	2	0	0	0	0	0	0	0.4	0.8	0.59			0
7/10	0	0	0	0	0	0	0	0	0	0	0	0			0
7/11	0	0	0	0	0	0	0	0	0	0	0	0			0
7/12	0	0	0	0	0	0	0	0	0	0	0	0	YES		0
7/13	0.12	0	42	0.04	0.04	0.04	0.04	0.08	0	0.16	0.43	0.18			0
7/14	0.2	0	80	0.08	0.08	0.12	0.08	0.12	0	0.11	0.22	0.21			2
7/15	0	0	0	0	0	0	0	0	0	0	0	0			1
7/16	0.03	0	3	0	0	0	0	0	0	0.06	0.1	0.1			1
7/17	0	0	0	0	0	0	0	0	0	0.02	0.07	0.03			0
7/18	0.06	0	4	0	0	0	0	0	0	0.09	0.17	0.1			1
7/19	0.04	0	8	0	0	0	0	0	0	0.16	0.76	0.21			4

**APPENDIX B –ZONE E SPECIFIC FORECASTS AND OBSERVATIONS**

A	CoCoRaHS			ALERT						NOAA Stage IV			Flood Day Classification		Threat
	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
7/20	0	0	0	0	0	0	0	0	0	0.02	0.72	0.02			3
7/21	0	0	0	0	0	0	0	0	0	0	0.52	0			12
7/22	0.24	0	78	0.08	0.08	0.08	0.04	0.08	0	0.28	0.49	0.28			1
7/23	0.07	0	3	0	0	0	0	0	0	0.03	0.03	0.03	YES		1
7/24	0.43	0	92	0.12	0.12	0.16	0.12	0.32	0	0.26	0.52	0.38			3
7/25	0.28	0	88	0.08	0.08	0.12	0.08	0.16	0	0.14	0.29	0.3			2
7/26	0.08	0	59	0.04	0.04	0.04	0.04	0.04	0	0.08	0.16	0.13			21
7/27	0.03	0	3	0	0	0	0	0	0	0	0	0			1
7/28	0.68	0	67	0.24	0.28	0.28	0.12	0.28	0	0.58	1.22	0.58	YES		22
7/29	0.05	0	14	0	0	0	0	0	0	0.13	0.24	0.13			0
7/30	1.11	1	52	0.24	0.28	0.52	0.16	0.56	0	0.65	1.23	0.72	YES		1
7/31	1.06	1	76	0.54	0.54	0.54	0.2	0.54	0	0.7	1.32	1.05	YES	YES	0
8/1	0.27	0	27	0	0	0	0	0	0	0.24	0.41	0.13			1
8/2	0.11	0	9	0.04	0.04	0.04	0.01	0.04	0	0.06	0.81	0.06			1
8/3	0.3	0	39	0.01	0.01	0.01	0	0.01	0	0.15	0.3	0.2			1
8/4	0.31	0	53	0.14	0.14	0.14	0.12	0.14	0	0.42	1	0.75	YES		1
8/5	0.49	0	48	0.16	0.16	0.16	0.12	0.16	0	0.42	0.9	0.54			4
8/6	0.09	0	5	0.08	0.08	0.08	0	0.08	0	0.23	0.34	0.41			1
8/7	0	0	0	0	0	0	0	0	0	0	0	0			0
8/8	0	0	0	0	0	0	0	0	0	0	0.01	0			0
8/9	0	0	0	0	0	0	0	0	0	0	0	0			1
8/10	0.01	0	1	0	0	0	0	0	0	0	0.01	0.01			1
8/11	0	0	0	0	0	0	0	0	0	0.01	1.12	0.01	YES		0
8/12	0	0	0	0	0	0	0	0	0	0.02	0.1	0.02			0
8/13	0	0	0	0	0	0	0	0	0	0	0	0			0
8/14	0	0	0	0	0	0	0	0	0	0	0	0			0
8/15	0	0	0	0	0	0	0	0	0	0	0	0			0
8/16	0.89	0	2	0	0	0	0	0	0	0.64	1.17	1.08	YES		1
8/17	0	0	0	0	0	0	0	0	0	0	0	0			0
8/18	0	0	0	0	0	0	0	0	0	0	0.02	0			0
8/19	0.03	0	6	0	0	0	0	0	0	0.08	0.15	0.11			0
8/20	0.35	0	78	0.28	0.28	0.28	0.16	0.36	0	0.24	0.44	0.24			1
8/21	0	0	0	0	0	0	0	0	0	0	0	0			0
8/22	0	0	0	0	0	0	0	0	0	0	0	0			0
8/23	0	0	0	0	0	0	0	0	0	0	0	0			1
8/24	0	0	0	0	0	0	0	0	0	0	0	0			1
8/25	0.06	0	7	0	0	0	0	0	0	0.23	0.31	0.23			1
8/26	0.07	0	29	0.08	0.08	0.08	0	0.08	0	0.07	0.13	0.14			2
8/27	0.73	0	59	0.12	0.12	0.12	0.08	0.12	0	0.22	0.47	0.28			0
8/28	0.2	0	86	0.12	0.16	0.16	0.04	0.16	0	0.19	0.41	0.31			2
8/29	0.05	0	60	0.04	0.04	0.04	0.04	0.04	0	0.15	0.5	0.17			2

**APPENDIX B –ZONE E SPECIFIC FORECASTS AND OBSERVATIONS**

A	CoCoRaHS			ALERT						NOAA Stage IV			Flood Day Classification		Threat
	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
8/30	0.07	0	7	0	0	0	0	0	0	0.05	0.09	0.06			0
8/31	0.16	0	86	0.04	0.08	0.08	0.08	0.12	0	0.12	0.22	0.3			0
9/1	0.13	0	1	0	0	0	0	0	0	0	0	0			0
9/2	0	0	0	0	0	0	0	0	0	0	0	0			0
9/3	0	0	0	0	0	0	0	0	0	0	0	0			0
9/4	0	0	0	0	0	0	0	0	0	0	0	0			0
9/5	0	0	0	0	0	0	0	0	0	0	0	0			0
9/6	0	0	0	0	0	0	0	0	0	0	0	0			0
9/7	0.55	0	84	0.08	0.12	0.16	0.12	0.36	0	0.39	0.68	0.82			1
9/8	1.66	14	90	0.08	0.08	0.16	0.08	0.52	0	0.11	0.22	0.85			0
9/9	0.79	0	72	0.2	0.32	0.52	0.32	0.96	0	0.03	0.08	0.15			1
9/10	0.09	0	28	0.08	0.16	0.28	0.12	1.08	0	0.07	0.14	0.11			1
9/11	0.02	0	5	0	0	0	0	0	0	0.07	0.13	0.07			0
9/12	0	0	0	0	0	0	0	0	0	0	0	0			0
9/13	0	0	0	0	0	0	0	0	0	0	0	0			1
9/14	0	0	0	0	0	0	0	0	0	0	0	0			1
9/15	0	0	0	0	0	0	0	0	0	0	0	0			1
9/16	0	0	0	0	0	0	0	0	0	0	0	0			1
9/17	0	0	0	0	0	0	0	0	0	0	0	0			0
9/18	0	0	0	0	0	0	0	0	0	0	0	0			0
9/19	0	0	0	0	0	0	0	0	0	0.01	0.01	0			1
9/20	0	0	0	0	0	0	0	0	0	0	0	0			0
9/21	0	0	0	0	0	0	0	0	0	0	0.01	0			1
9/22	0.03	0	2	0	0	0	0	0	0	0.04	0.07	0.05			1
9/23	0	0	0	0	0	0	0	0	0	0	0	0			0
9/24	0	0	0	0	0	0	0	0	0	0	0	0			0
9/25	0.03	0	1	0	0	0	0	0	0	0	0	0			0
9/26	0	0	0	0	0	0	0	0	0	0	0	0			0
9/27	0.03	0	37	0.04	0.04	0.04	0	0.04	0	0.1	0.2	0.17			0
9/28	0	0	0	0	0	0	0	0	0	0	0	0			0
9/29	0	0	0	0	0	0	0	0	0	0	0	0			0
9/30	0	0	0	0	0	0	0	0	0	0	0	0			0