

WALTER P MOORE



# FLOODFEED: YOU WON'T BELIEVE THESE THREE NOMOGRAPHS THAT PREDICT YOUR FLOOD ELEVATION!

**June 20, 2018**

**ASFPM 2018 Conference**

**Jim Keith, PE, CFM – Walter P Moore**

**Andy Yung, PE, CFM – Walter P Moore**

**Stephanie Griffin, PE, CFM – City of Grand Prairie**

**Nick Fang, PhD, PE – University of Texas at Arlington**

**Christina Hughes, CFM, ENV SP – Walter P Moore**

## → Presentation Overview

- Phase 1 Backstory
- Hydrologic / Hydro-Met Analysis
- Nomograph Development
- System Dashboard
- Debugging Recent Events
- Phase 2



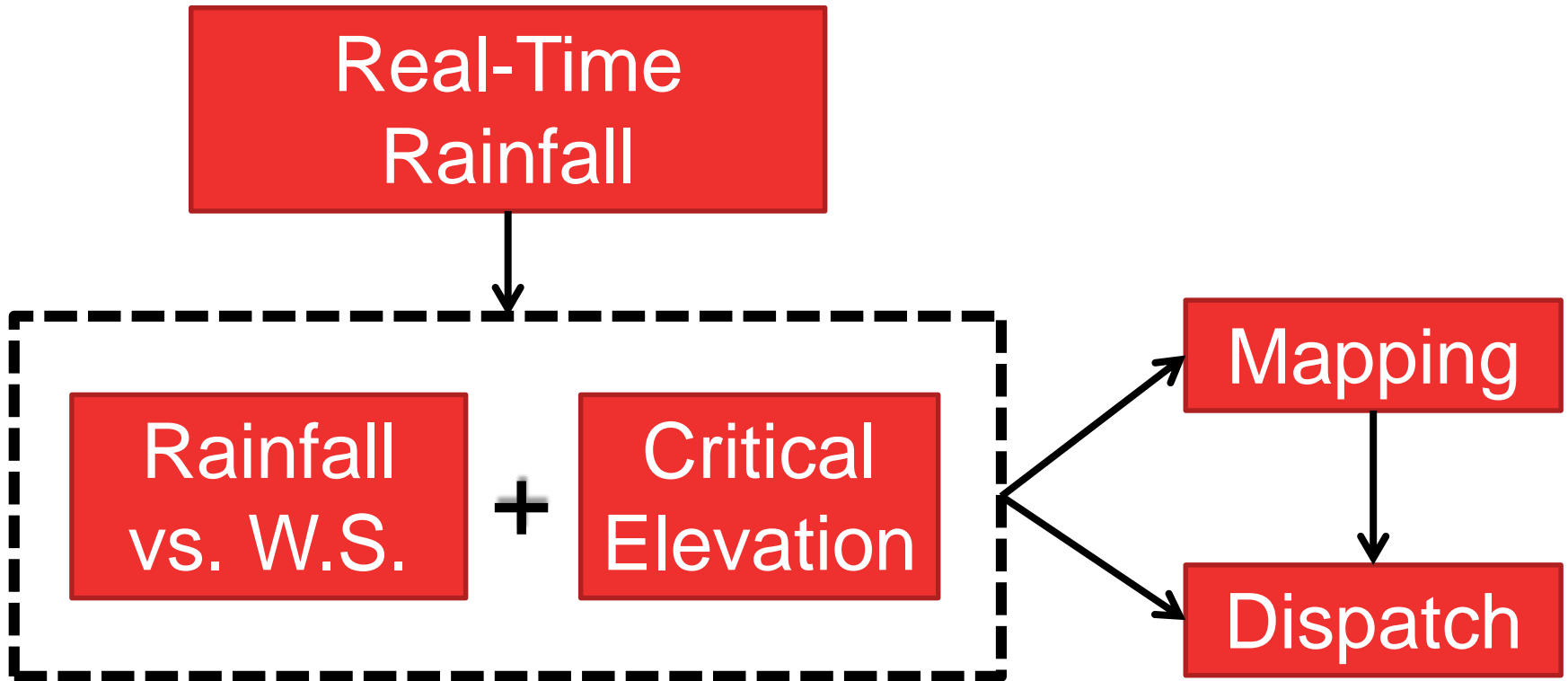
# Grand Prairie Flood Warning System

## Phase 1 Backstory

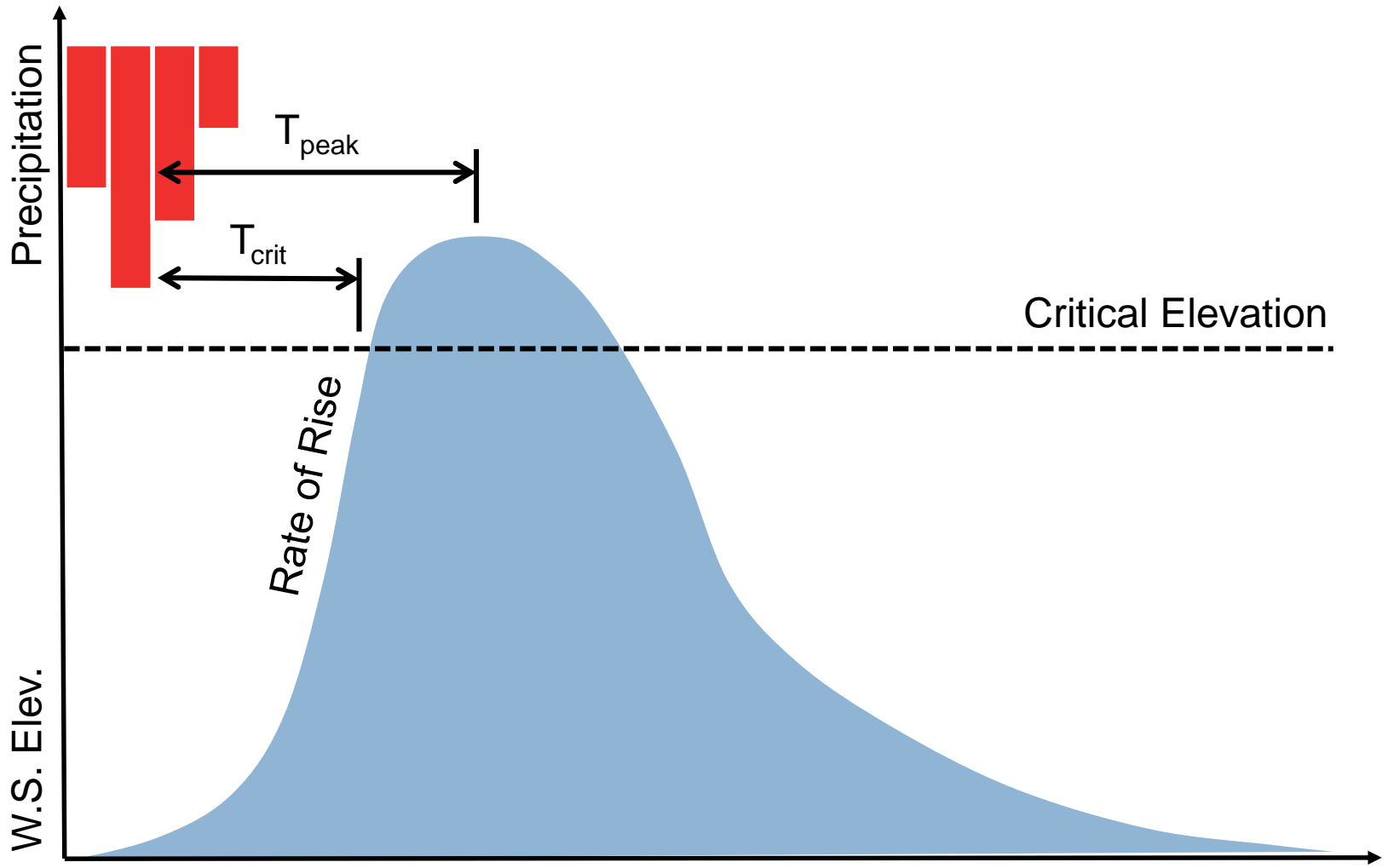
- City engaged Walter P Moore and UTA in December 2016
- Phased approach – Phase 1 started with 5 gauges & 6 watch points
- Objective: *To provide a flood warning / forecasting system that will permit City Emergency Managers to identify areas of inundation and allow the timely dispatch of first responders to these areas to close roads, evacuate, shelter-in-place, and/or begin rescue operations.*
- Focus is *Implementation and Decision Support*
- Phase 1 completed in October 2017

# Grand Prairie Flood Warning System Project Overview

**GOAL: Maximize Lead Time**



# Grand Prairie Flood Warning System Project Overview



# Grand Prairie Flood Warning System

## Phase 1 Study Extents



# Grand Prairie Flood Warning System

## Phase 1 Gauges and Watch Points

Stream Name	Crossing	Owner	Gauge No.	Type	Location (upstream or downstream of bridge)	Gauge Elevation
Mountain Creek	Jefferson St	City	6173	Pressure Transducer	US of eastbound lanes	409.67
Cottonwood Creek	Beltline Rd	City	6103	Pressure Transducer	US	456.40
Cottonwood Creek	North Bridge at S. Carrier Pkwy	City	6363	Pressure Transducer	US	474.87
Cottonwood Creek	South Bridge at S. Carrier Pkwy	City	6303	Pressure Transducer	US	474.38
Fish Creek	S. Carrier Pkwy	City	6133	Pressure Transducer	US	460.67

Watch Point	Critical Elevation Location	Critical Elevation	Source
Mountain Creek at Jefferson St	Willow Bend Mobile Home Park West (left) overbank	430.00	LiDAR
Cottonwood Creek at Beltline Rd	Fox Hollow Apartments (lowest breezeway elevation) 1008 S Beltline Rd	468.97	Survey
Cottonwood Creek at SW 3 <sup>rd</sup> St	North (left) overbank	477.78	Survey
Cottonwood Creek North Bridge at S. Carrier Pkwy	North (left) overbank	481.76	Survey
Cottonwood Creek South Bridge at S. Carrier Pkwy	South (right) overbank	480.85	Survey
Fish Creek at S. Carrier Pkwy	South (right) overbank	477.90	Survey

# Grand Prairie Flood Warning System

## Hydrologic Analysis

### → Hydrologic Analysis

- Utilized Existing HEC-HMS Models
  - 8 models representing Cottonwood Creek, Fish Creek, Mountain Creek, and tributaries
- Defined relationships between the following:
  - Rainfall Intensity
  - Storm Duration
  - Time of Concentration
  - Lead Time
  - Rate of Rise of Flood Wave



### → Hydrologic Analysis

- Analyzed Four Recent Historical Storms
  - May 26, 2015 & November 27, 2015
  - June 2, 2017 & June 23, 2017
- Multi-Radar Multi-Sensor (MRMS) Data
  - Processed into sub-basin weighted rainfall, 15-min increments
  - Flow converted to stage hydrographs using rating curves
  - Compared to stream gage records
  - Hydrograph parameters used to develop nomograph relationships

# Grand Prairie Flood Warning System

## Hydrologic Analysis

### → Historical Storms Rainfall Totals and Estimated Peak Flow

Watch Point	May 26, 2015		Nov 27, 2015		Jun 2, 2017		Jun 23, 2017	
	Storm Total (in)	Estimated Peak Flow (cfs)	Storm Total (in)	Estimated Peak Flow (cfs)	Storm Total (in)	Estimated Peak Flow (cfs)	Storm Total (in)	Estimated Peak Flow (cfs)
Mountain Creek at Jefferson St	6.6	32,900 (26,900)	8.0	19,800	3.4	12,700	3.0	13,300
Cottonwood Creek at Beltline Rd	6.1	7,500 (6,100)	7.7	4,000	4.2	4,100	4.1	3,800
Cottonwood Creek at SW 3 <sup>rd</sup> St	6.2	6,900 (5,600)	7.6	3,900	4.1	4,000	4.1	3,900
Cottonwood Creek North Bridge at S. Carrier Pkwy	6.2	4,500 (3,500)	7.6	2,500	3.9	2,700	4.1	2,900
Cottonwood Creek South Bridge at S. Carrier Pkwy	6.2	2,500 (2,000)	7.7	1,500	4.3	1,400	4.1	1,200
Fish Creek at S. Carrier Pkwy	6.5	14,600	7.9	9,900	3.2	3,100	3.1	5,400

### → Hydrologic Analysis Continued

- Analyzed 21 Hypothetical Design Storms
  - 3-hr, 6-hr, and 24-hr storm durations
  - 2-, 5-, 10-, 25-, 50-, 100-, and 500-year frequency events
- Rainfall hyetographs assumed 5-min intensity duration and peak intensity position at 50% of the storm duration
- Provided more robust dataset of hydrologic parameters for nomograph development

# Grand Prairie Flood Warning System

## Hydrologic Analysis

### → Hypothetical Storm Rainfall Totals and Estimated Peak Flow

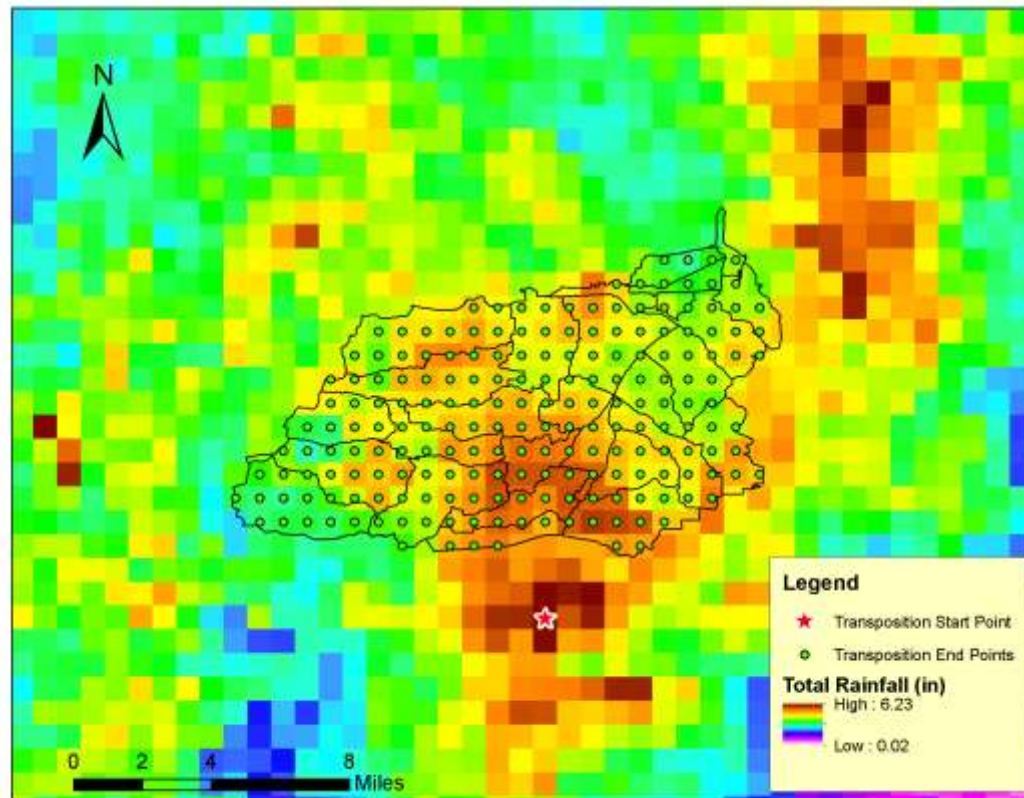
Watch Point	Return Period (years)													
	2		5		10		25		50		100		500	
	Peak Flow (cfs)	Storm Total (in)	Peak Flow (cfs)	Storm Total (in)	Peak Flow (cfs)	Storm Total (in)	Peak Flow (cfs)	Storm Total (in)	Peak Flow (cfs)	Storm Total (in)	Peak Flow (cfs)	Storm Total (in)	Peak Flow (cfs)	Storm Total (in)
Mountain Creek at Jefferson St	11,800		19,500		24,000		30,000		36,000		43,900		61,200	
Cottonwood Creek at Beltline Rd	3,200		6,000		8,000		10,500		12,200		14,600		20,900	
Cottonwood Creek at SW 3 <sup>rd</sup> St	3,300		6,000		8,200		10,300		12,000		14,000		19,700	
Cottonwood Creek North Bridge at S. Carrier Pkwy	2,300	2.45	4,200	3.30	5,700	3.85	7,100	4.55	8,100	5.15	9,300	5.70	12,900	7.40
Cottonwood Creek South Bridge at S. Carrier Pkwy	1,400		2,200		2,800		3,700		3,900		5,200		7,100	
Fish Creek at S. Carrier Pkwy	6,400		10,100		12,700		16,600		20,300		24,400		32,100	

# Grand Prairie Flood Warning System

## Hydro-Meteorologic Analysis

### → Storm Transposition Study

- Real Precipitation (varied in space) vs. Design Storms (uniform)
- MRMS data for May 2015 event transposed over 191 different locations

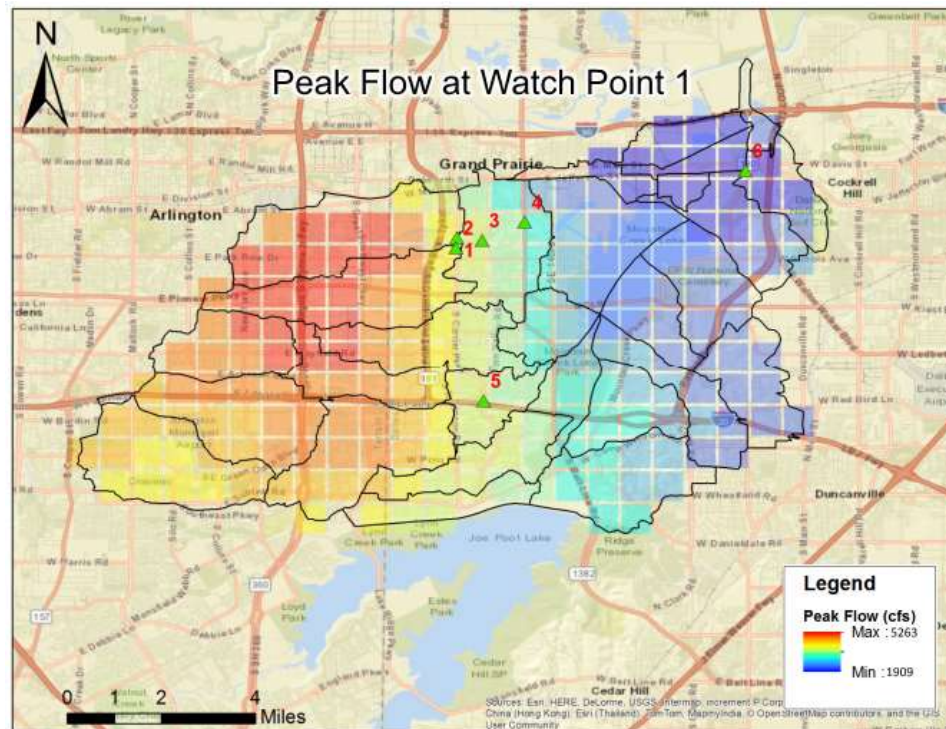


# Grand Prairie Flood Warning System

## Hydro-Meteorologic Analysis

### → Storm Transposition Study Results

- Identified portions of watersheds that are greatest contributors to peak runoff
- Useful for future rain gage site selection



# Grand Prairie Flood Warning System

## Nomograph Development

### → Each Watch Point Utilizes Three Nomographs

- Lead Time
- Rate of Rise
- Stage-Discharge

### → Product is Two Types of Information

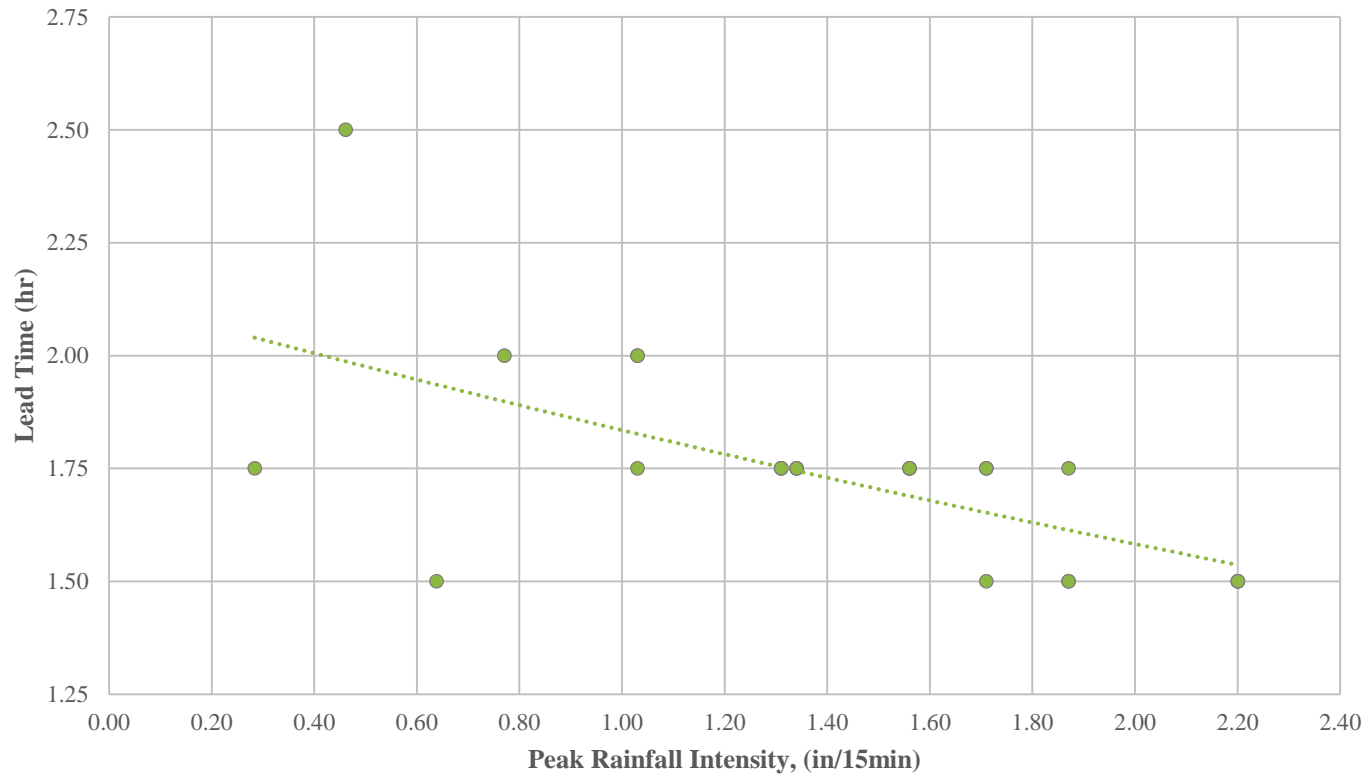
- Predicted Lead Time (time to critical & peak stages)
- Predicted Stage (estimated future WSEL used for inundation mapping)

# Grand Prairie Flood Warning System Nomograph Development

## → Lead Time Nomograph

6133 - Fish Creek @ Carrier

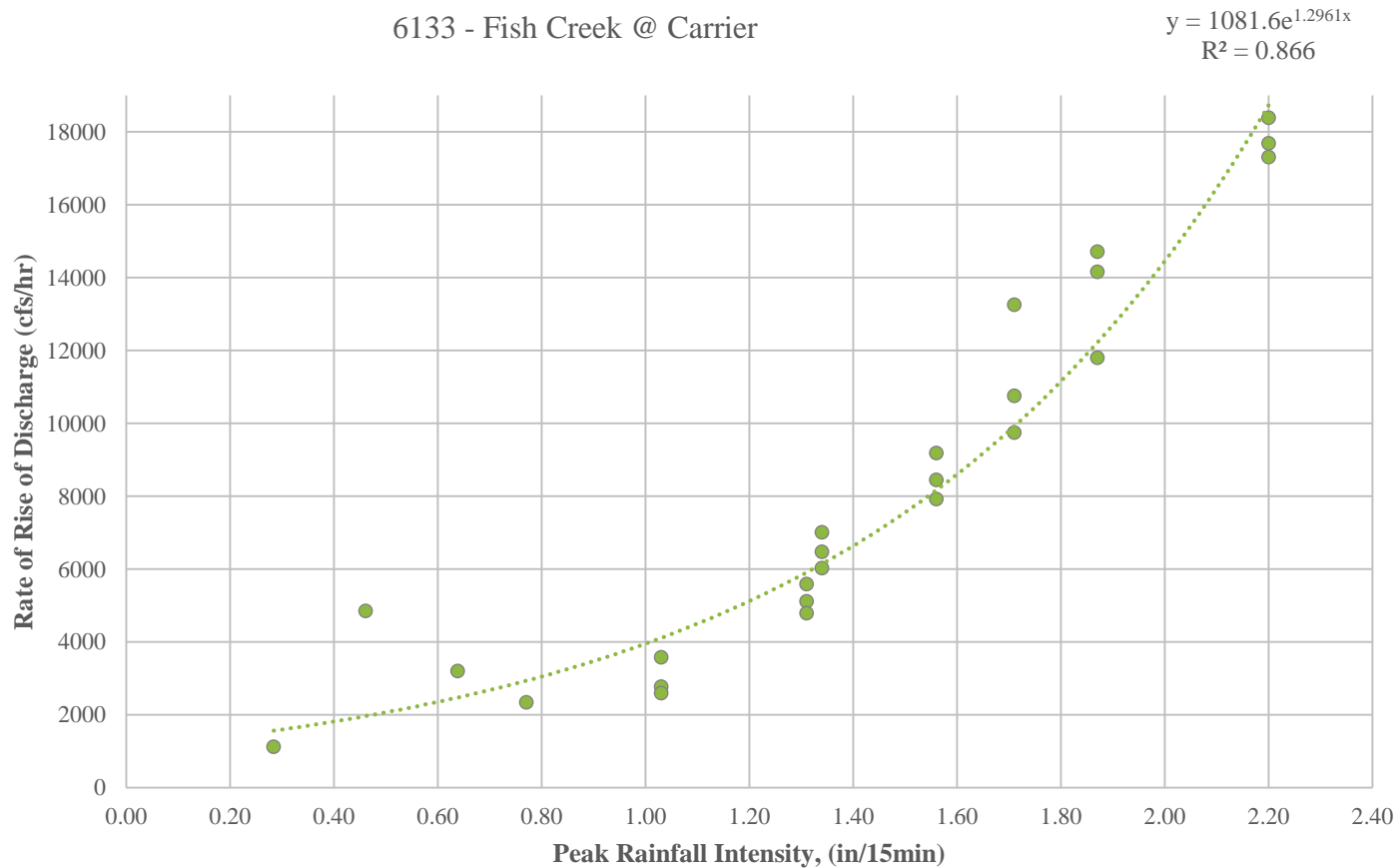
$$y = 2.1275e^{-0.148x}$$
$$R^2 = 0.4139$$





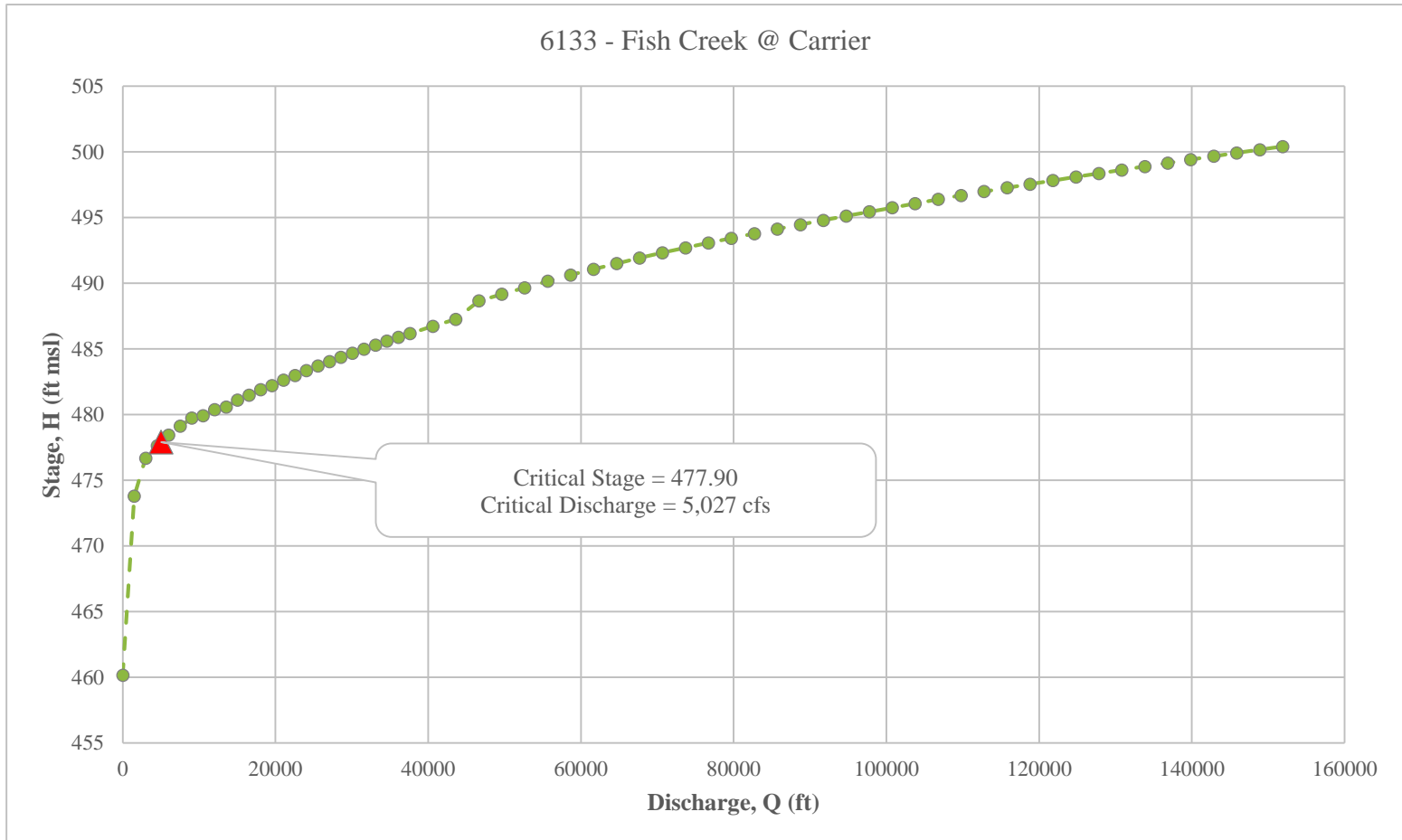
# Grand Prairie Flood Warning System Nomograph Development

## → Rate of Rise Nomograph



# Grand Prairie Flood Warning System Nomograph Development

## → Stage-Discharge Nomograph



# Grand Prairie Flood Warning System

## Nomograph Development

### → Three Nomographs Working Together!

1. Observed peak rainfall intensity
2. Critical Discharge determined from Critical Stage
3. Rate of Rise determined based on observed peak 15-min intensity
4. Critical Discharge / Rate of Rise = Lead Time (15-min interval)
5. Peak Lead Time is also computed (Time to Peak Stage)

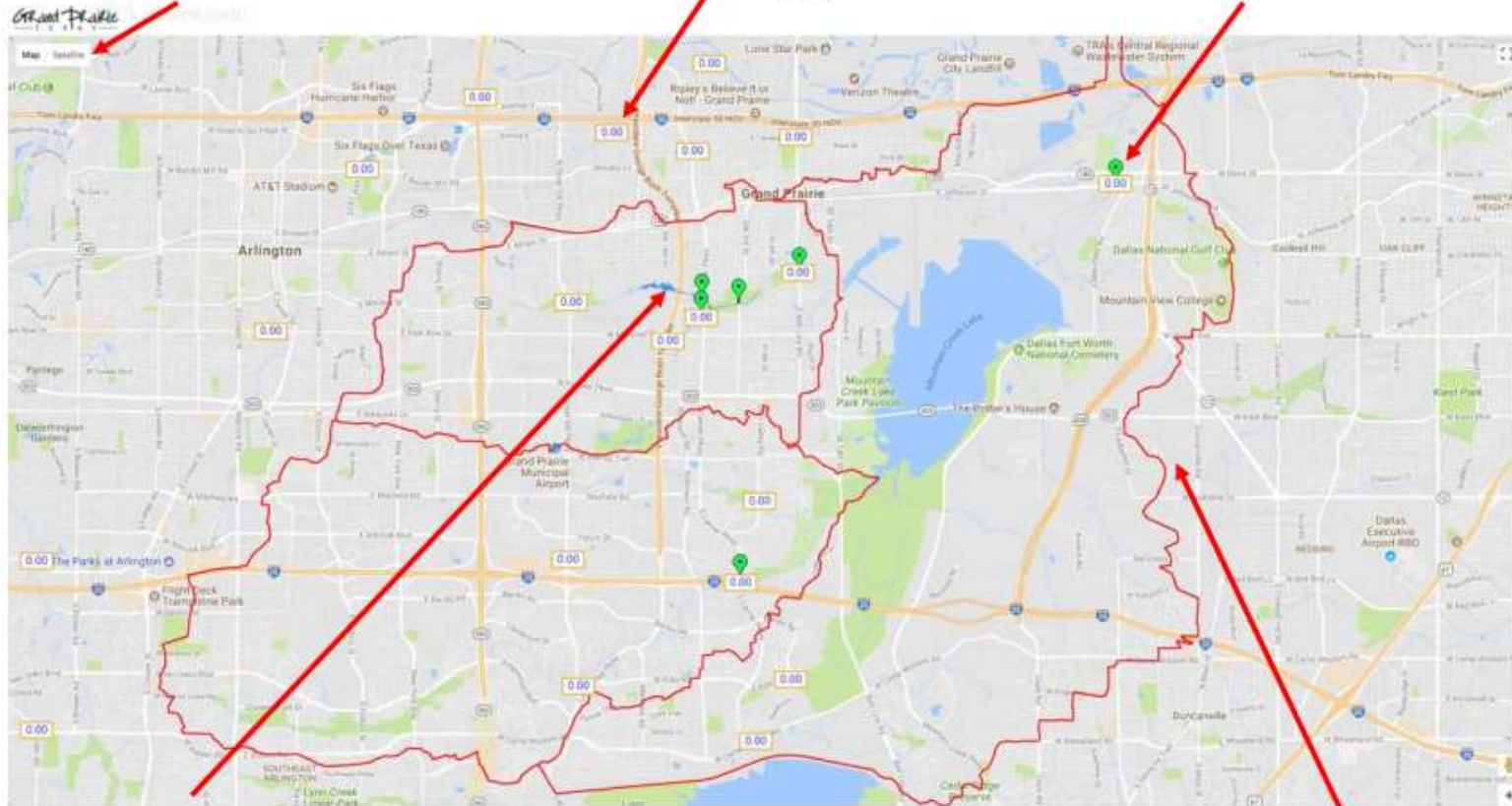
# Grand Prairie Flood Warning System System Dashboard

**Home page:** Return to this page by clicking on “Grand Prairie” logo.

Change base map  
between roadmap and  
satellite.

Rain Gauge information.  
A gauge shows the cumulative  
rainfall in the past 24 hours.  
Detail see page 2.

Flood watch point.  
See page 3.



Flood extent map.

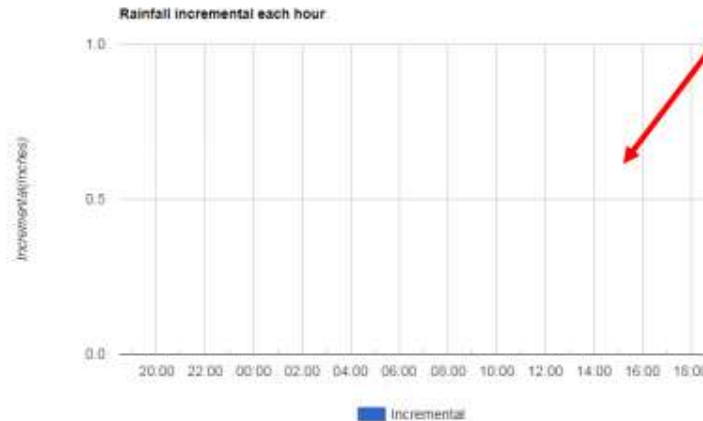
Mountain Creek watershed boundary.

# Grand Prairie Flood Warning System System Dashboard

**Rain Gauge Details:** Regulated rainfall for different time intervals (5, 15, 60 mins) during the past 24 hours.

Showing rainfall totals in last 24 hours

Rainfall hyetograph for the past 24 hours.



60mins ▾

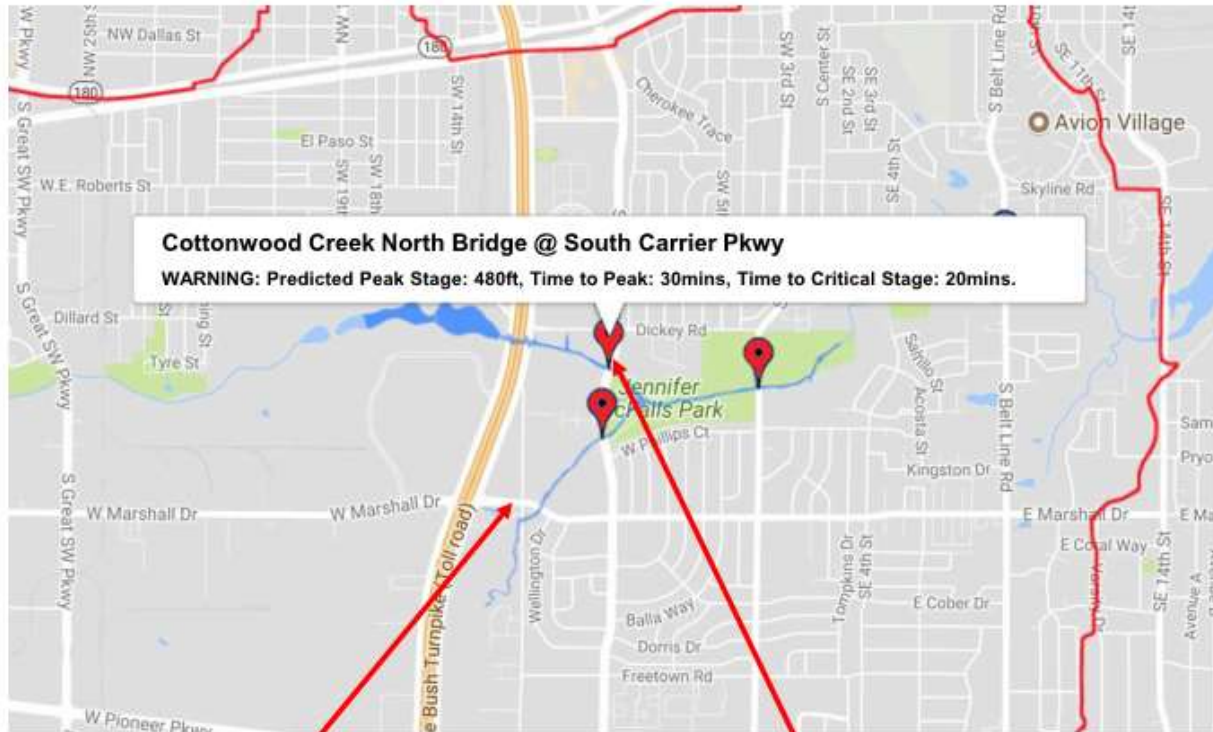
	Date	Incremental
1	Sun, Oct 8, 19:00	0
2	Sun, Oct 8, 20:00	0
3	Sun, Oct 8, 21:00	0
4	Sun, Oct 8, 22:00	0
5	Sun, Oct 8, 23:00	0
6	Mon, Oct 9, 00:00	0
7	Mon, Oct 9, 01:00	0
8	Mon, Oct 9, 02:00	0
9	Mon, Oct 9, 03:00	0
10	Mon, Oct 9, 04:00	0
11	Mon, Oct 9, 05:00	0
12	Mon, Oct 9, 06:00	0
13	Mon, Oct 9, 07:00	0

Time interval setup for the rainfall time series table with options of 5, 15 and 60 minutes.

Rainfall time series table for the past 24 hours.

# Grand Prairie Flood Warning System System Dashboard

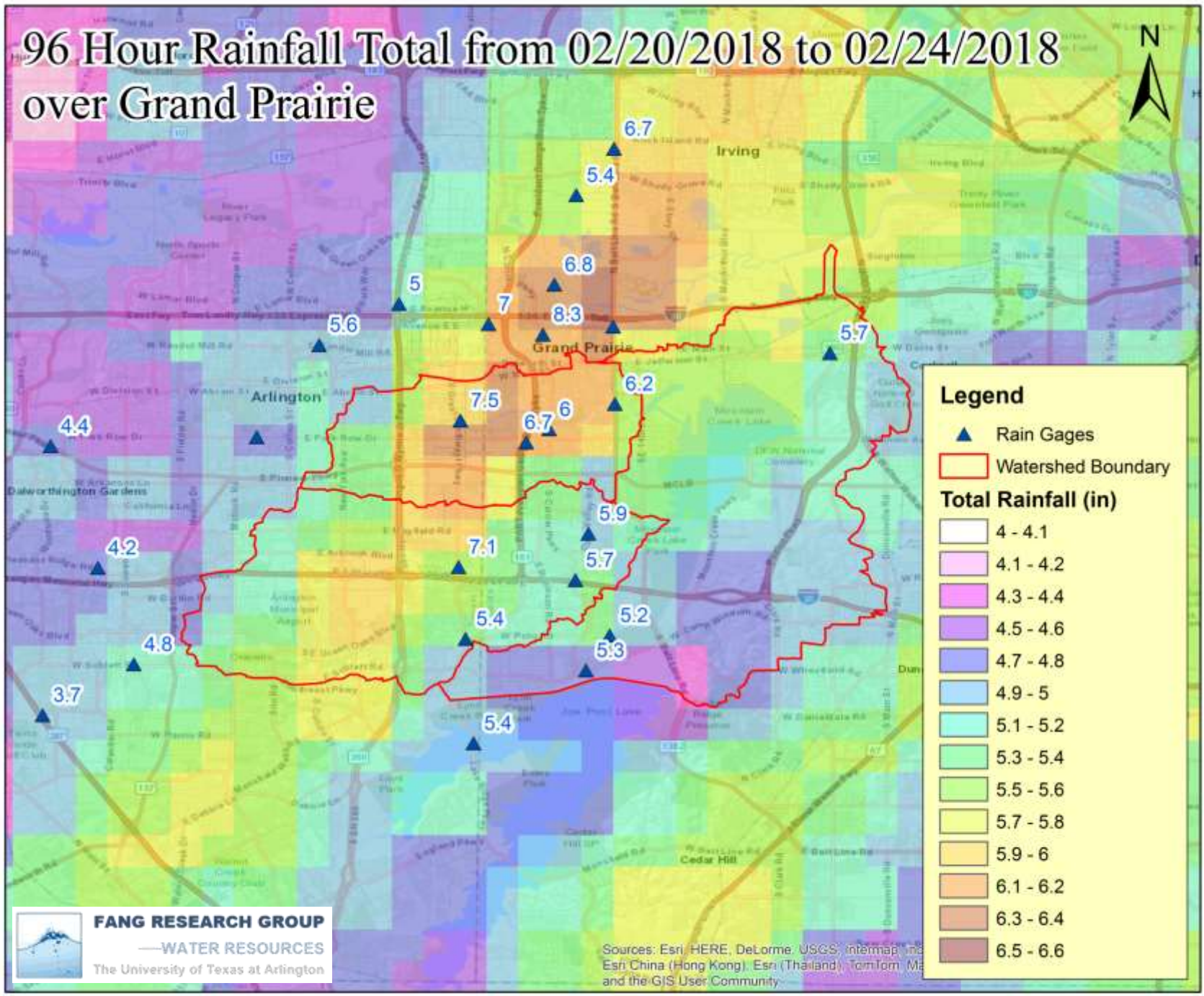
**Flood extent map:** Predicated flood extent map and water surface elevation at flood watch points.



Flood extent maps are issued based on hydrologic analysis regarding to discharge, stage elevation and time to peak.

A flood watch point shows the forecast information of predicated peak stage, time to peak and time to critical stage.

# 96 Hour Rainfall Total from 02/20/2018 to 02/24/2018 over Grand Prairie



# Grand Prairie Flood Warning System

## Debugging Recent Events

### → Debugging The System

- New Flood Warning Systems must be tested with real storms
- Near end of Phase 1, City switched data providers
- Input data feeds and system coding adjusted, but not all bugs were found
- February 20 - 24, 2018 event first good rainfall since Nov 2017
- First use of new automated flood gates at Carrier Parkway / Cottonwood Creek
- Team worked quickly to resolve issues with data format
- City changed signage at Carrier Pkwy flood gates



# Grand Prairie Flood Warning System

## Phase 2

### → Kicked off Phase 2 in February

- Five new watch points in northern portion of City
  - Johnson Creek at Avenue J
  - Riverside Parkway at West Fork Trinity River
  - Dalworth Creek at Carrier Parkway
  - Dorchester Levee
  - Gopher Branch at Beltline Road
- Additional system enhancements and debugging

### → Summary and Conclusions

- Nomographs still useful in modern systems
- Simplified system up and running for Phase 1
- Testing will continue during summer storms
- Phase 2 provides system expansion and enhancements
- Improve coordination between all parties (City, Data Provider, WPM/UTA)
- Continue working closely with City to focus on providing timely decision support to increase public safety

# Grand Prairie Flood Warning System Questions

→ Any Questions?

