Digitalizing a StormTrap™ Detention Basin

C.M. Foley, PE, PhD, FASCE N.J. Hornyak, PE, PhD
P4 Infrastructure, Inc. – Brown Deer, WI

Jodie Ledat, CPWP-M Gabby Proce, EIT
City of University Park, TX

Katie Barron, PE, ENV-SP

2026 TX-APWA Public Workshop & Equipment Roadeo
Dallas / Fort Worth Marriott Hotel & Golf Club at Champions Circle

February 2, 2026

Session Objectives

- Explain the motivations for digitalizing below-ground stormwater infrastructure systems
- Describe systems that document performance data for below-ground stormwater infrastructure
- Use digitalization systems in stormwater engineering practice and asset management

Session Outline

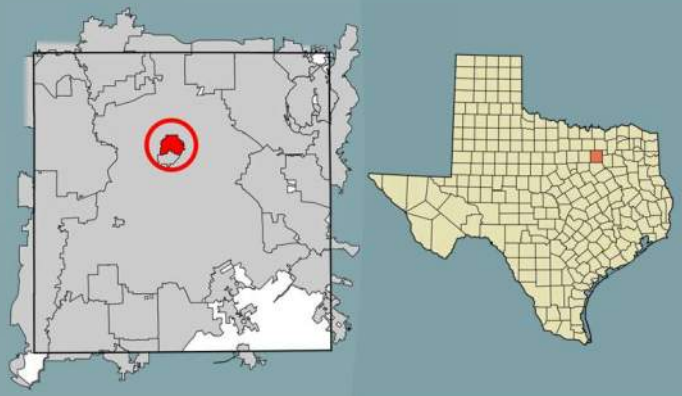
I. City of University Park, Texas
II. StormTrap Digitalization System
III. Measured Data (Viewing, Synthesis & Use)
IV. Value of Digitalization

University Park, TX

Watershed Description

Multi-Phase Stormwater Improvement Plan

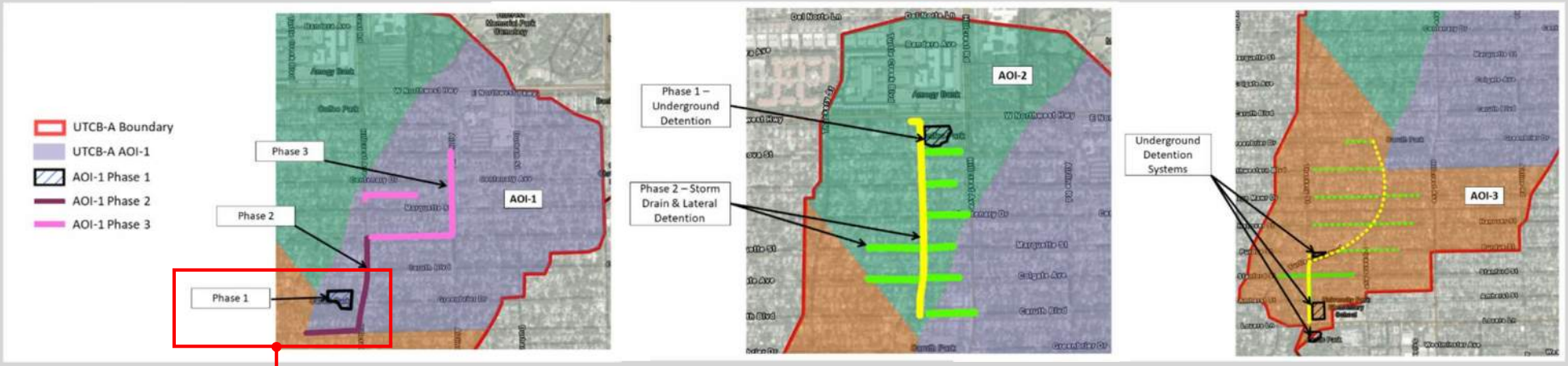
Vision for Digitalization



By Ixnayonthetimmay
https://commons.wikimedia.org/w/index.php?curid=2541009

University Park – Stormwater Improvement Plan

Area of Interest – 1 **Area of Interest – 2** **Area of Interest – 3**



Multi-Phase Stormwater Infrastructure Effort

- Three Areas of Interest Identified
- Multi-Year Effort (Three Phases)
- Multiple Below-Ground Detention Systems Planned
- **Caruth Park Detention System – Completed in Phase 1**
- Caruth Park Detention System “Downstream” in Watershed

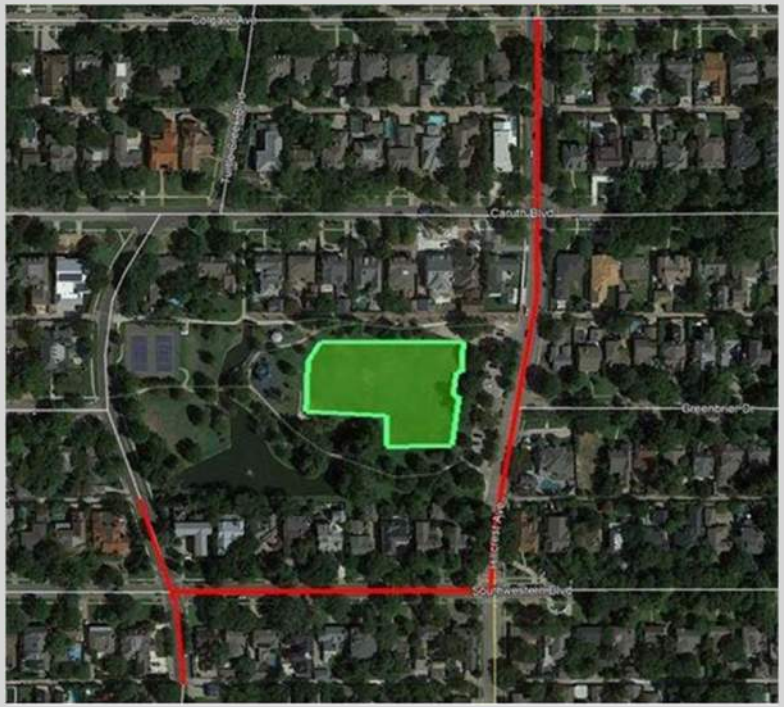
University Park – Stormwater Improvement Plan – Phase 1

First Phase Completed in 2020

- Installation of Below-Ground StormTrap Detention Structure
- Capacity of City's Stormwater System Increased by 11 acre-feet (3.5 million gallons)
- Preservation of Valuable Recreational Space

Above-Ground Improvements

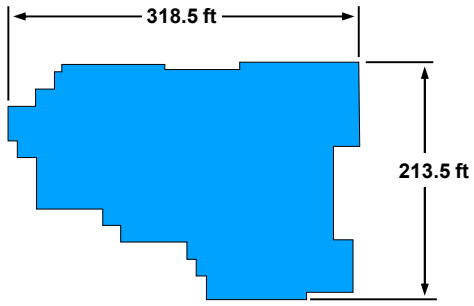
- 10,000 Square Yards of Tiff Bermuda Sod above the Detention Structure
- Preservation of Park Playing Surface
- Improved Drainage (after heavy rain events),
- New Irrigation System with Advanced Spray Head Technology and Smart Controllers
- New Decorative Light Poles
- New Accessible Parking Spaces and Ramps



Caruth Park StormTrap Detention Basin

Vision for Digitalization

- Understand Hydrology (Rainfall & System Response)
- Document System Performance
- Calibrate Hydrologic Models (SWMM)
- Data-Driven Decision Making
- Stakeholder Transparency



Contributing Watershed:
Approx. 150 Acres

Water Storage:
463,579.24 cu-ft (10.64 ac-ft)

Unit Headroom:
10'-0" DoubleTrap

Unit Quantity:
788 units (fast, clean install)

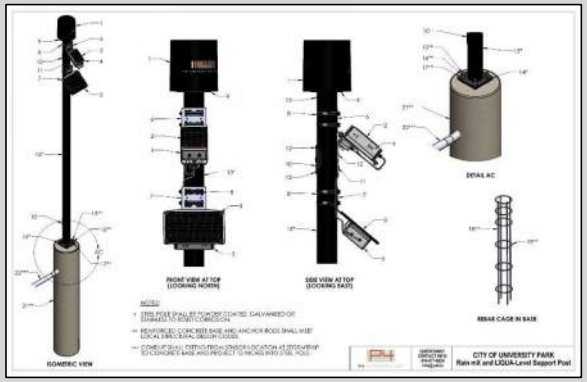
StormTrap Digitalization

System Description

System Features

Images Courtesy of www.stormtrap.com

Digitalization System



Digitalization Tools – P4 Infrastructure, Inc.

- Rain-mX – Rainfall & Environmental Conditions
- LIQUA-Level – Water-Level in Detention Basin
- Modular Battery Pack(s) – **Battery Health Remotely Monitored**
- Modular Computer System(s)
- Stand-Alone Power (solar recharging)
- Plug-and-Play Exchange

Data Acquired – Autonomous & Remote (cellular)

- Rainfall in Local Watershed
  - ✓ Recorded (stored) every 10 minutes
  - ✓ 24-hour and 7-day rainfall aggregation
  - ✓ Temperature
  - ✓ Barometric Pressure
  - ✓ Relative Humidity
- LIQUA-Level
  - ✓ Recorded (stored) every 10 minutes
  - ✓ Peak Water Levels Correlated with Rainfall Event
  - ✓ Discharge Characteristics and Rate
  - ✓ Definition of “Activation Events”

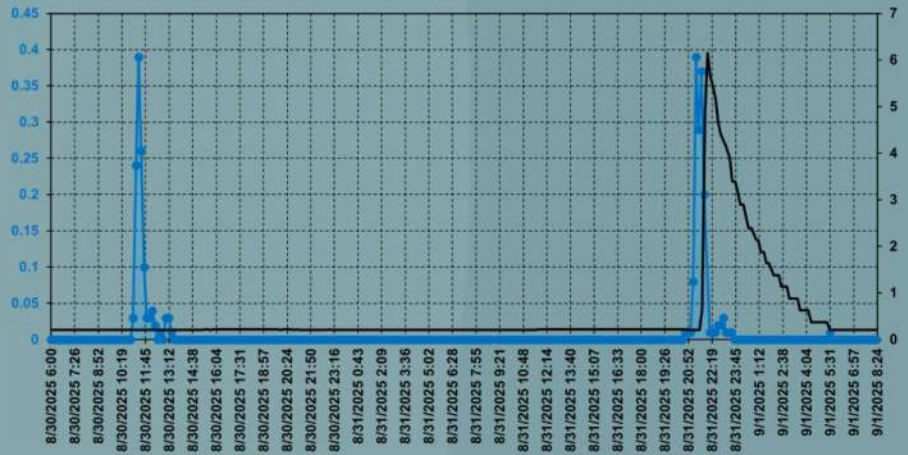
Measured (REAL) Data

Viewing & Access

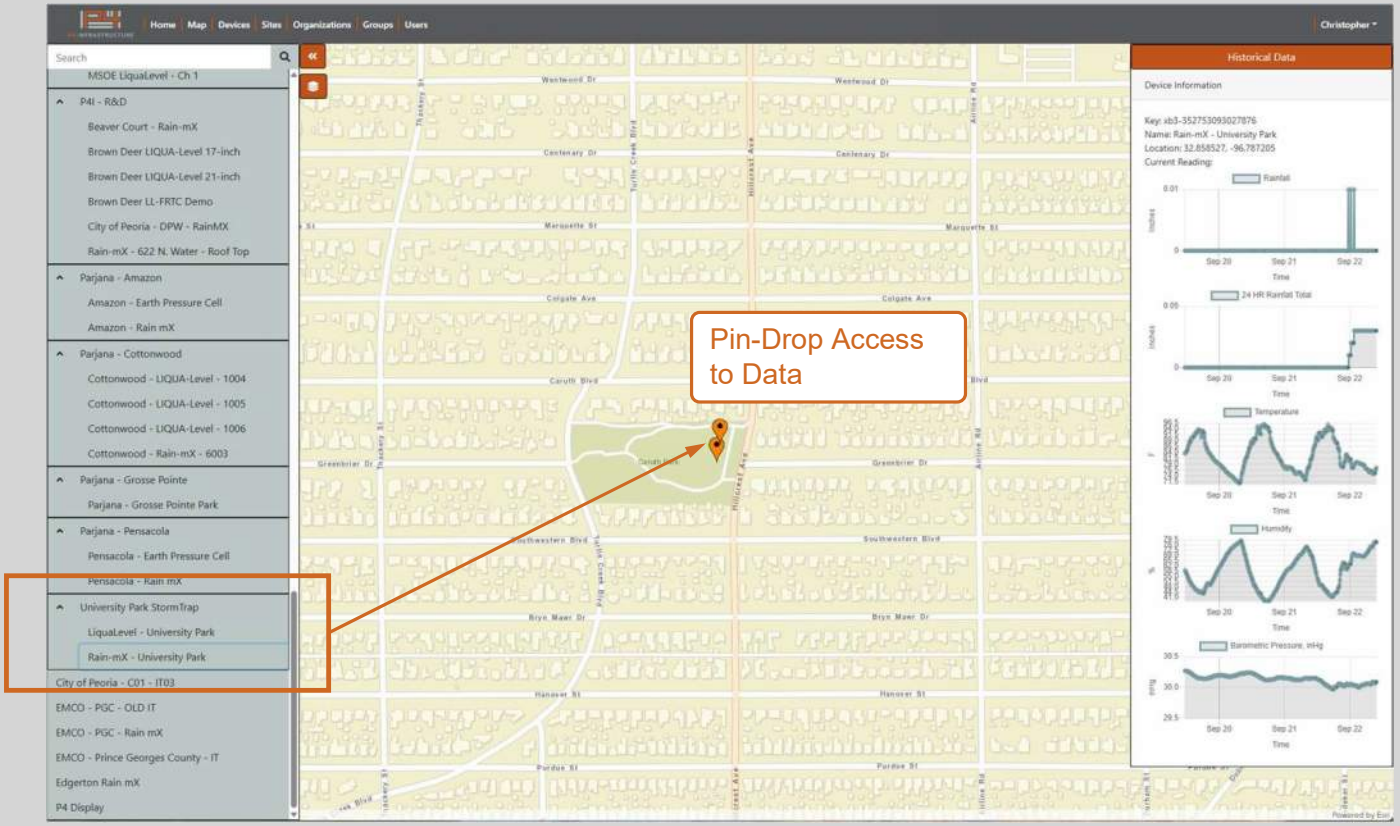
Data Interpretation & Synthesis

Maintenance Considerations

Performance Assessment



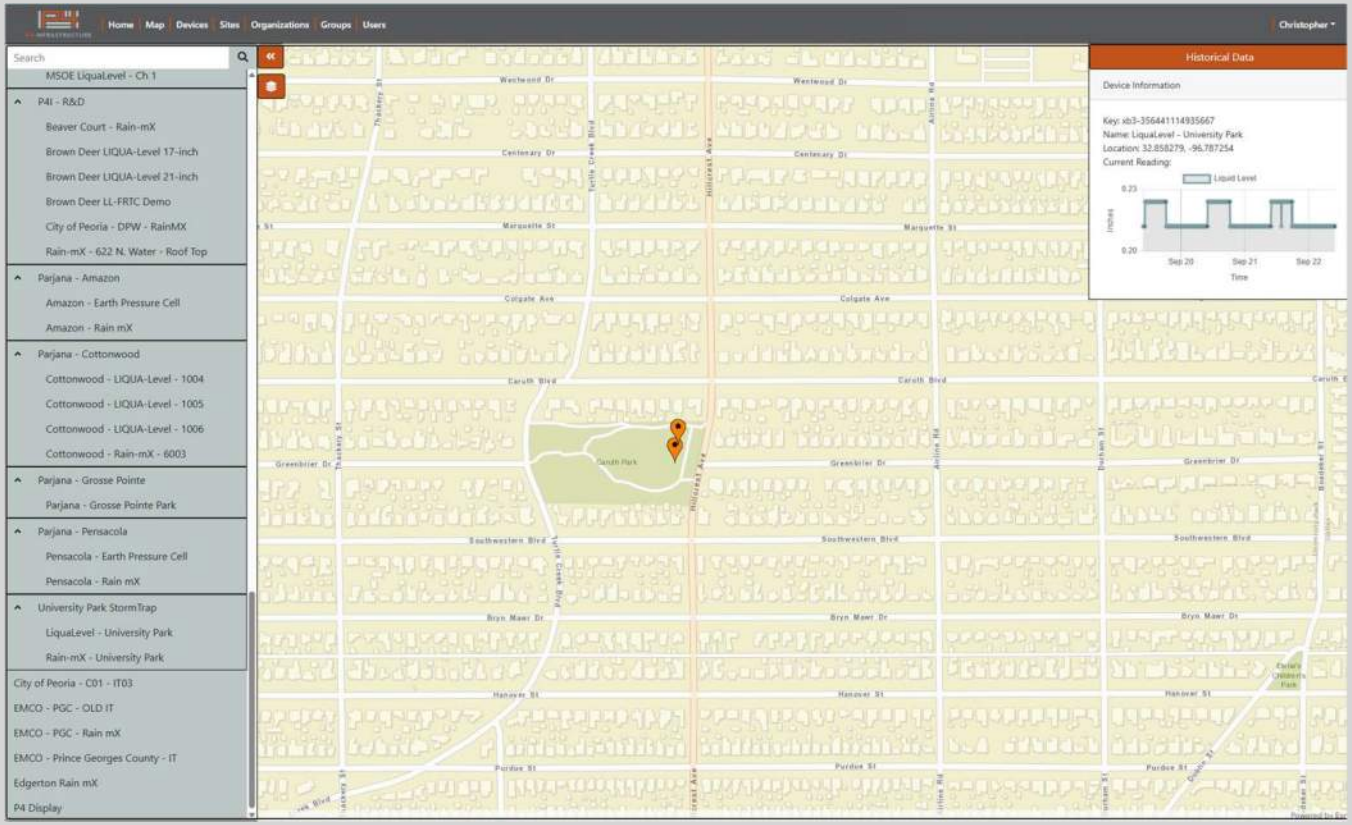
Data Viewing & Access



Browser-Based Dashboard Access to Data

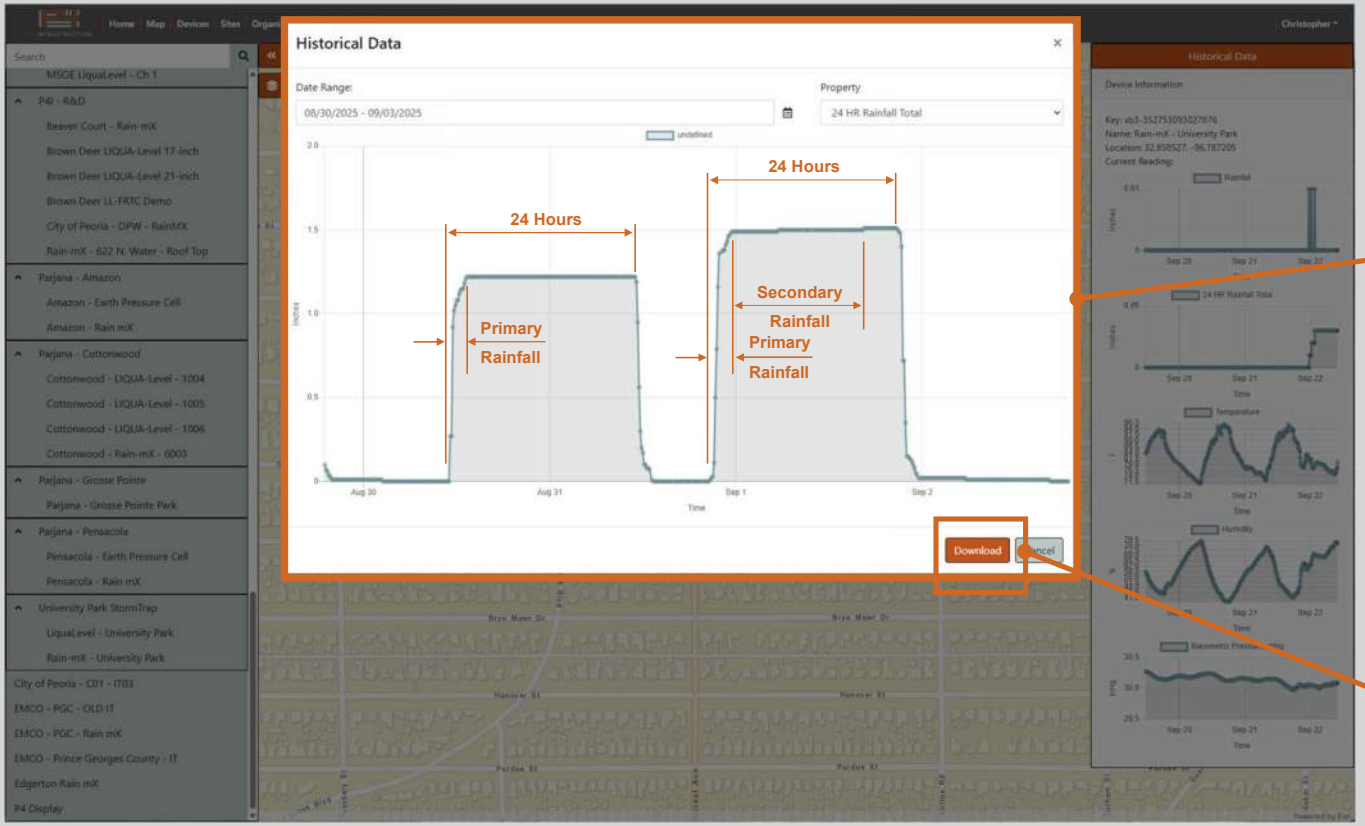
3-day Snapshot of Measured Environmental Data Including Rainfall

Data Viewing & Access (continued)



3-day Snapshot of Measured Water Level in Basin

Data Interpretation & Synthesis

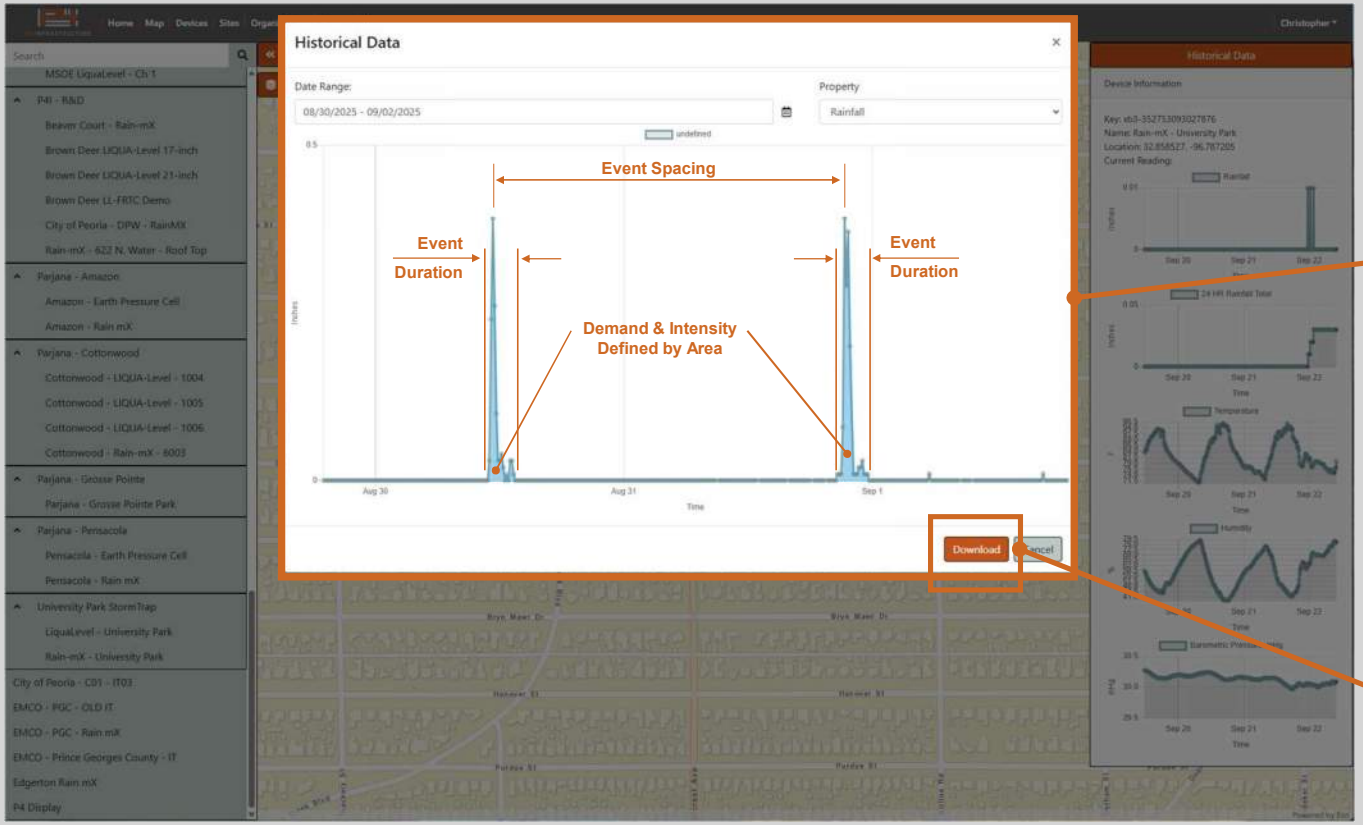


24-Hour Rainfall Aggregation

Primary and Secondary Rainfall During Events

Download Data to CSV

Data Interpretation & Synthesis (continued)



10-minute Rainfall Measurement (Events)

- Duration
- Amount
- Intensity

Sequential Rainfall Events Identified

Download Data to CSV

Data Interpretation & Synthesis (continued)

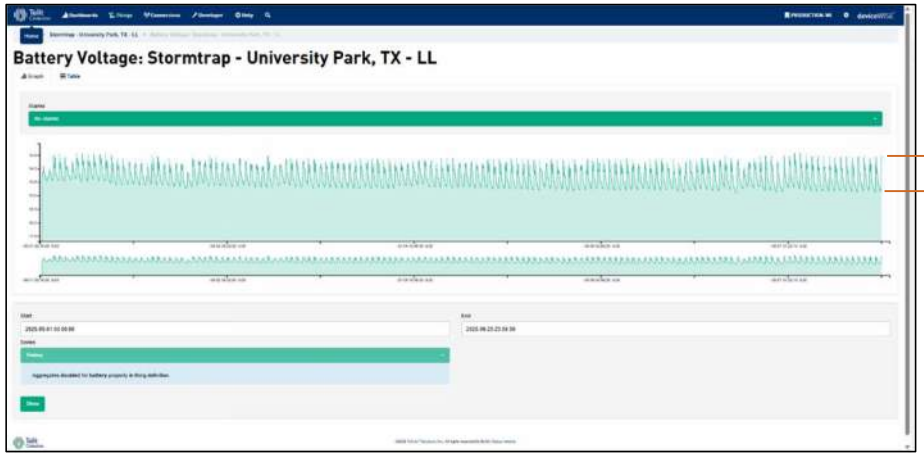
Peak Water Level (Staged Volume)

Vault Discharge Curve Characteristics

Vault Discharge Duration

Download Data to CSV

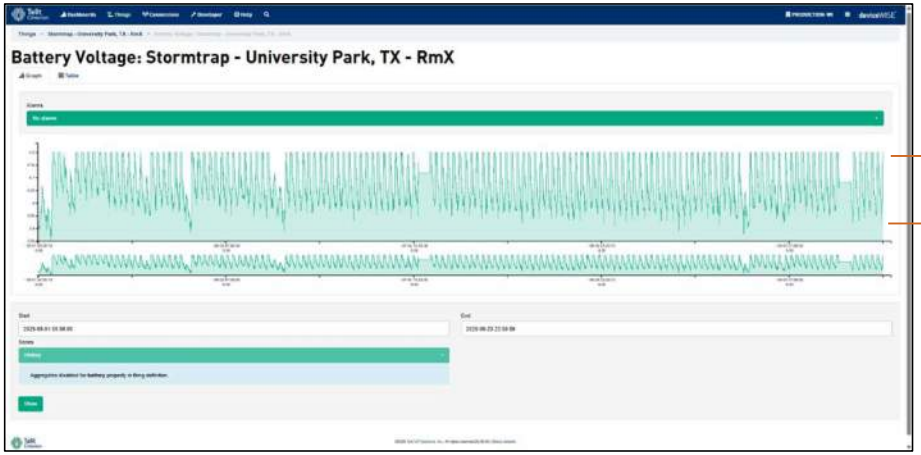
Digitalization System Health Monitoring



Peak LIQUA-Level Voltage (~14.4 VDC)

Low LIQUA-Level Voltage (~13.1 VDC)

Solar Recharge Cycle



Peak Rain-mX Voltage (~4.2 VDC)

Low Rain-mX Voltage (~3.9 VDC)

Solar Recharge Cycle

Digitalization Components

- ➢ LIQUA-Level – Water-Level
- ➢ Rain-mX – Rainfall

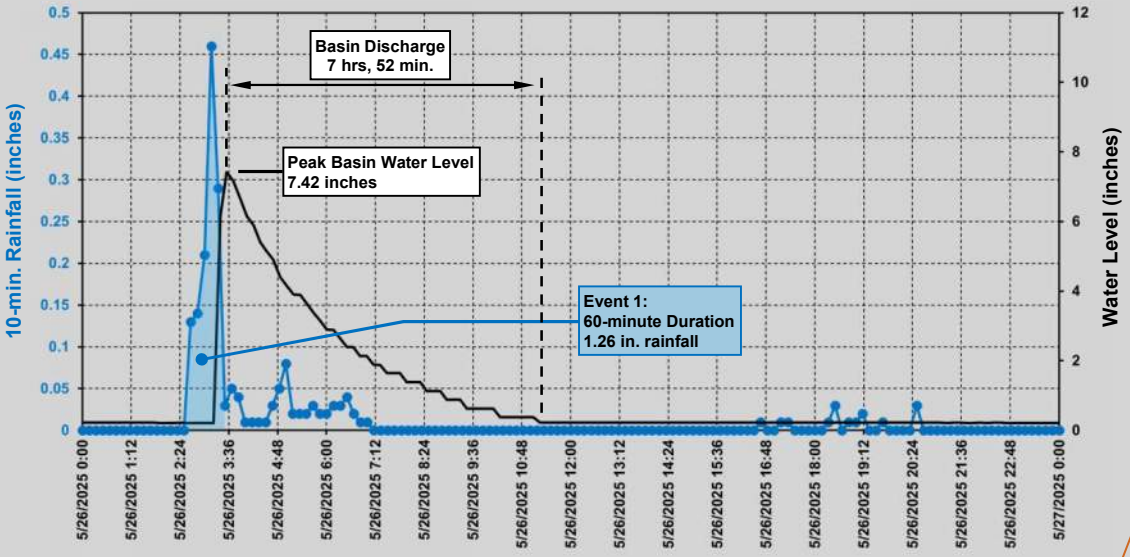
Remote Health Monitoring

- ✓ System Maintenance Trigger
- ✓ Module Replacement Trigger

Plug-and-Play Replacement

- ✓ Battery Module
- ✓ Computer Module
- ✓ Solar Panel
- ✓ Tipping Bucket

Data Synthesis – Measured Performance



Event Date: 5/26/25
Average Intensity: 1.26 in/hr
Peak Water Level: 7.42 inches
ATLAS-14 1-yr MRI, 1-Hr Event

Peak Water Level → Peak Detention Volume

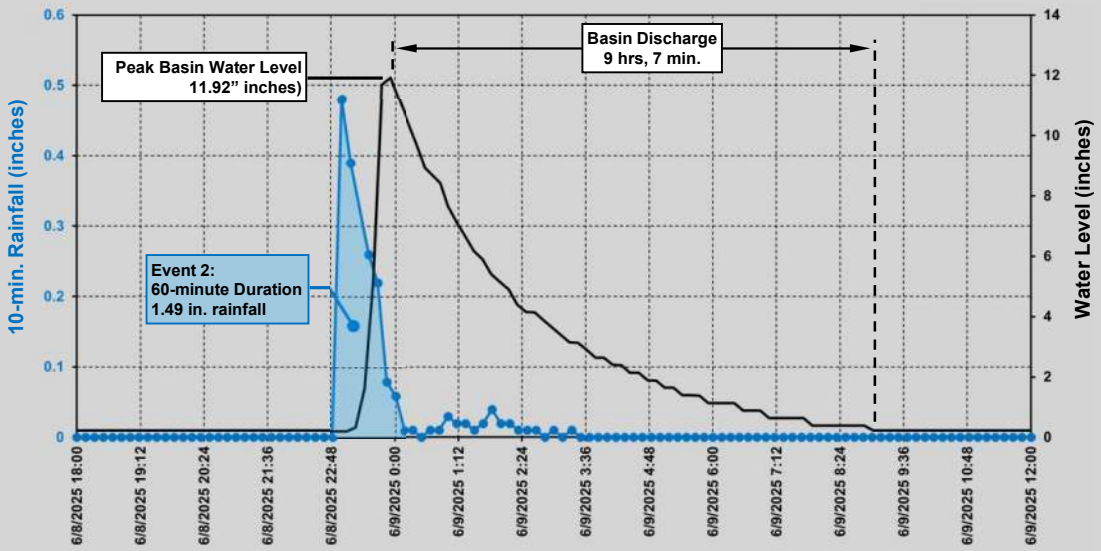
NOAA ATLAS-14 IDF Data
Station ID: 79-0088
DALLAS LOVE FLD

PDS-based precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.421 (0.319-0.556)	0.488 (0.374-0.641)	0.599 (0.457-0.788)	0.690 (0.518-0.918)	0.812 (0.590-1.11)	0.904 (0.640-1.27)	0.996 (0.687-1.43)	1.09 (0.733-1.60)	1.22 (0.790-1.84)	1.31 (0.830-2.04)
10-min	0.672 (0.509-0.888)	0.779 (0.597-1.02)	0.957 (0.730-1.26)	1.10 (0.828-1.47)	1.30 (0.945-1.78)	1.45 (1.03-2.03)	1.60 (1.10-2.29)	1.74 (1.17-2.56)	1.93 (1.26-2.93)	2.07 (1.31-3.22)
15-min	0.844 (0.639-1.11)	0.976 (0.744-1.28)	1.19 (0.905-1.56)	1.37 (1.03-1.82)	1.62 (1.18-2.22)	1.82 (1.29-2.55)	2.01 (1.39-2.89)	2.20 (1.48-3.23)	2.43 (1.58-3.68)	2.60 (1.64-4.04)
30-min	1.18 (0.897-1.56)	1.37 (1.04-1.79)	1.67 (1.27-2.19)	1.92 (1.44-2.55)	2.26 (1.64-3.09)	2.52 (1.78-3.53)	2.78 (1.92-3.99)	3.04 (2.04-4.46)	3.38 (2.19-5.12)	3.63 (2.30-5.64)
60-min	1.54 (1.17-2.04)	1.79 (1.37-2.35)	2.20 (1.68-2.89)	2.53 (1.90-3.37)	2.98 (2.16-4.06)	3.31 (2.34-4.63)	3.65 (2.52-5.24)	4.01 (2.70-5.90)	4.50 (2.93-6.84)	4.89 (3.10-7.59)
2-hr	1.88 (1.44-2.46)	2.21 (1.71-2.86)	2.74 (2.11-3.56)	3.18 (2.41-4.19)	3.79 (2.78-5.12)	4.26 (3.04-5.90)	4.75 (3.30-6.73)	5.26 (3.57-7.64)	5.98 (3.92-8.96)	6.56 (4.18-10.0)
3-hr	2.08 (1.60-2.70)	2.46 (1.91-3.16)	3.07 (2.38-3.96)	3.59 (2.74-4.69)	4.31 (3.18-5.79)	4.88 (3.50-6.71)	5.47 (3.82-7.70)	6.10 (4.16-8.79)	6.99 (4.59-10.4)	7.69 (4.92-11.7)
6-hr	2.44 (1.90-3.14)	2.92 (2.28-3.69)	3.67 (2.87-4.68)	4.32 (3.33-5.59)	5.24 (3.91-6.95)	5.97 (4.33-8.11)	6.74 (4.76-9.37)	7.58 (5.20-10.8)	8.74 (5.79-12.8)	9.68 (6.24-14.5)
12-hr	2.85 (2.25-3.62)	3.42 (2.70-4.28)	4.32 (3.42-5.45)	5.10 (3.98-6.52)	6.20 (4.68-8.14)	7.09 (5.20-9.51)	8.03 (5.72-11.0)	9.05 (6.27-12.7)	10.5 (7.01-15.2)	11.7 (7.58-17.2)
24-hr	3.31 (2.64-4.16)	3.98 (3.18-4.92)	5.04 (4.03-6.28)	5.95 (4.69-7.52)	7.25 (5.52-9.39)	8.28 (6.13-11.0)	9.39 (6.75-12.7)	10.6 (7.41-14.7)	12.3 (8.30-17.6)	13.7 (8.99-19.9)
2-day	3.85 (3.10-4.78)	4.62 (3.74-5.65)	5.84 (4.73-7.20)	6.89 (5.50-8.61)	8.38 (6.45-10.7)	9.56 (7.14-12.5)	10.8 (7.86-14.5)	12.2 (8.63-16.7)	14.3 (9.60-20.0)	15.9 (10.5-22.8)
3-day	4.20 (3.41-5.18)	5.04 (4.11-6.12)	6.36 (5.19-7.80)	7.50 (6.02-9.31)	9.11 (7.06-11.6)	10.4 (7.80-13.5)	11.8 (8.58-15.6)	13.3 (9.42-18.0)	15.5 (10.6-21.5)	17.3 (11.4-24.5)
4-day	4.46 (3.64-5.47)	5.34 (4.37-6.45)	6.73 (5.52-8.21)	7.93 (6.41-9.80)	9.65 (7.51-12.2)	11.0 (8.30-14.2)	12.5 (9.13-16.4)	14.1 (10.0-18.9)	16.4 (11.2-22.7)	18.3 (12.2-25.8)
7-day	5.00 (4.12-6.08)	5.98 (4.94-7.15)	7.51 (6.22-9.08)	8.85 (7.21-10.8)	10.8 (8.46-13.5)	12.3 (9.37-15.7)	14.0 (10.3-18.2)	15.8 (11.3-21.0)	18.4 (12.7-25.1)	20.5 (13.7-28.5)
10-day	5.47 (4.53-6.61)	6.53 (5.42-7.76)	8.17 (6.80-9.82)	9.61 (7.88-11.7)	11.7 (9.22-14.5)	13.3 (10.2-16.9)	15.1 (11.2-19.5)	17.0 (12.3-22.5)	19.8 (13.7-26.8)	22.0 (14.8-30.4)
20-day	7.08 (5.94-8.46)	8.30 (7.02-9.82)	10.2 (8.66-12.2)	11.9 (9.87-14.3)	14.2 (11.3-17.4)	16.0 (12.3-20.0)	17.8 (13.3-22.7)	19.8 (14.4-25.8)	22.7 (15.8-30.3)	25.0 (16.9-34.0)
30-day	8.44 (7.13-10.0)	9.78 (8.36-11.6)	12.0 (10.2-14.2)	13.8 (11.5-16.5)	16.3 (13.1-19.8)	18.2 (14.1-22.5)	20.1 (15.1-25.4)	22.2 (16.2-28.6)	25.1 (17.6-33.2)	27.4 (18.6-36.9)
45-day	10.3 (8.78-12.2)	11.9 (10.3-14.0)	14.5 (12.5-17.1)	16.6 (14.0-19.7)	19.5 (15.8-23.6)	21.7 (17.0-26.7)	23.9 (18.1-30.0)	26.2 (19.2-33.5)	29.3 (20.6-38.3)	31.6 (21.6-42.2)
60-day	12.0 (10.3-14.1)	13.8 (12.0-16.1)	16.8 (14.5-19.6)	19.2 (16.3-22.7)	22.5 (18.3-27.1)	25.0 (19.7-30.6)	27.5 (20.9-34.3)	30.0 (22.1-38.1)	33.2 (23.5-43.2)	35.6 (24.4-47.2)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).
Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.
Please refer to NOAA Atlas 14 document for more information.

Data Synthesis – Measured Performance (continued)



Event Date: 6/8/25 to 6/9/25
Average Intensity: 1.49 in/hr
Peak Water Level: 11.92 inches
ATLAS-14 1 to 2 yr MRI, 1-Hr Event

Peak Water Level → Peak Detention Volume

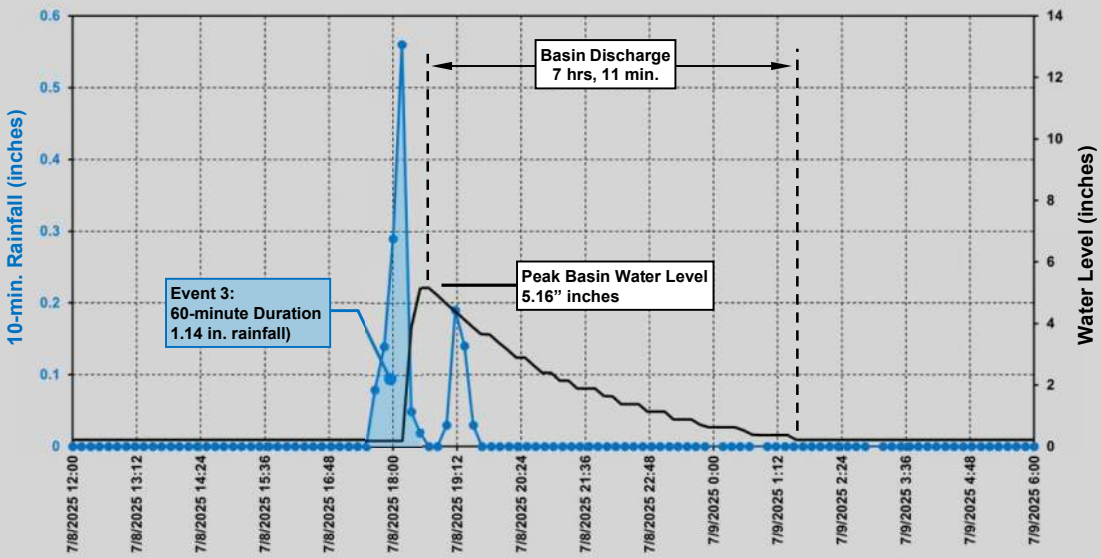
NOAA ATLAS-14 IDF Data
Station ID: 79-0088
DALLAS LOVE FLD

PDS-based precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.421 (0.319-0.556)	0.488 (0.374-0.641)	0.599 (0.457-0.788)	0.690 (0.518-0.918)	0.812 (0.590-1.11)	0.904 (0.640-1.27)	0.996 (0.687-1.43)	1.09 (0.733-1.60)	1.22 (0.790-1.84)	1.31 (0.830-2.04)
10-min	0.672 (0.509-0.888)	0.779 (0.597-1.02)	0.957 (0.730-1.26)	1.10 (0.828-1.47)	1.30 (0.945-1.78)	1.45 (1.03-2.03)	1.60 (1.10-2.29)	1.74 (1.17-2.56)	1.93 (1.26-2.93)	2.07 (1.31-3.22)
15-min	0.844 (0.639-1.11)	0.976 (0.744-1.28)	1.19 (0.905-1.56)	1.37 (1.03-1.82)	1.62 (1.18-2.22)	1.82 (1.29-2.55)	2.01 (1.39-2.89)	2.20 (1.48-3.23)	2.43 (1.58-3.68)	2.60 (1.64-4.04)
30-min	1.18 (0.897-1.56)	1.37 (1.04-1.79)	1.67 (1.27-2.19)	1.92 (1.44-2.55)	2.26 (1.64-3.09)	2.52 (1.78-3.53)	2.78 (1.92-3.99)	3.04 (2.04-4.46)	3.38 (2.19-5.12)	3.63 (2.30-5.64)
60-min	1.54 (1.17-2.04)	1.79 (1.37-2.35)	2.20 (1.68-2.89)	2.53 (1.90-3.37)	2.98 (2.16-4.06)	3.31 (2.34-4.63)	3.65 (2.52-5.24)	4.01 (2.70-5.90)	4.50 (2.93-6.84)	4.89 (3.10-7.59)
2-hr	1.88 (1.44-2.46)	2.21 (1.71-2.86)	2.74 (2.11-3.56)	3.18 (2.41-4.19)	3.79 (2.78-5.12)	4.26 (3.04-5.90)	4.75 (3.30-6.73)	5.26 (3.57-7.64)	5.98 (3.92-8.96)	6.56 (4.18-10.0)
3-hr	2.08 (1.60-2.70)	2.46 (1.91-3.16)	3.07 (2.38-3.96)	3.59 (2.74-4.69)	4.31 (3.18-5.79)	4.88 (3.50-6.71)	5.47 (3.82-7.70)	6.10 (4.16-8.79)	6.99 (4.59-10.4)	7.69 (4.92-11.7)
6-hr	2.44 (1.90-3.14)	2.92 (2.28-3.69)	3.67 (2.87-4.68)	4.32 (3.33-5.59)	5.24 (3.91-6.95)	5.97 (4.33-8.11)	6.74 (4.76-9.37)	7.58 (5.20-10.8)	8.74 (5.79-12.8)	9.68 (6.24-14.5)
12-hr	2.85 (2.25-3.62)	3.42 (2.70-4.28)	4.32 (3.42-5.45)	5.10 (3.98-6.52)	6.20 (4.68-8.14)	7.09 (5.20-9.51)	8.03 (5.72-11.0)	9.05 (6.27-12.7)	10.5 (7.01-15.2)	11.7 (7.58-17.2)
24-hr	3.31 (2.64-4.16)	3.98 (3.18-4.92)	5.04 (4.03-6.28)	5.95 (4.69-7.52)	7.25 (5.52-9.39)	8.28 (6.13-11.0)	9.39 (6.75-12.7)	10.6 (7.41-14.7)	12.3 (8.30-17.6)	13.7 (8.99-19.9)
2-day	3.85 (3.10-4.78)	4.62 (3.74-5.65)	5.84 (4.73-7.20)	6.89 (5.50-8.61)	8.38 (6.45-10.7)	9.56 (7.14-12.5)	10.8 (7.86-14.5)	12.2 (8.63-16.7)	14.3 (9.60-20.0)	15.9 (10.5-22.8)
3-day	4.20 (3.41-5.18)	5.04 (4.11-6.12)	6.36 (5.19-7.80)	7.50 (6.02-9.31)	9.11 (7.06-11.6)	10.4 (7.80-13.5)	11.8 (8.58-15.6)	13.3 (9.42-18.0)	15.5 (10.6-21.5)	17.3 (11.4-24.5)
4-day	4.46 (3.64-5.47)	5.34 (4.37-6.45)	6.73 (5.52-8.21)	7.93 (6.41-9.80)	9.65 (7.51-12.2)	11.0 (8.30-14.2)	12.5 (9.13-16.4)	14.1 (10.0-18.9)	16.4 (11.2-22.7)	18.3 (12.2-25.8)
7-day	5.00 (4.12-6.08)	5.98 (4.94-7.15)	7.51 (6.22-9.08)	8.85 (7.21-10.8)	10.8 (8.46-13.5)	12.3 (9.37-15.7)	14.0 (10.3-18.2)	15.8 (11.3-21.0)	18.4 (12.7-25.1)	20.5 (13.7-28.5)
10-day	5.47 (4.53-6.61)	6.53 (5.42-7.76)	8.17 (6.80-9.82)	9.61 (7.88-11.7)	11.7 (9.22-14.5)	13.3 (10.2-16.9)	15.1 (11.2-19.5)	17.0 (12.3-22.5)	19.8 (13.7-26.8)	22.0 (14.8-30.4)
20-day	7.08 (5.94-8.46)	8.30 (7.02-9.82)	10.2 (8.66-12.2)	11.9 (9.87-14.3)	14.2 (11.3-17.4)	16.0 (12.3-20.0)	17.8 (13.3-22.7)	19.8 (14.4-25.8)	22.7 (15.8-30.3)	25.0 (16.9-34.0)
30-day	8.44 (7.13-10.0)	9.78 (8.36-11.6)	12.0 (10.2-14.2)	13.8 (11.5-16.5)	16.3 (13.1-19.8)	18.2 (14.1-22.5)	20.1 (15.1-25.4)	22.2 (16.2-28.6)	25.1 (17.6-33.2)	27.4 (18.6-36.9)
45-day	10.3 (8.78-12.2)	11.9 (10.3-14.0)	14.5 (12.5-17.1)	16.6 (14.0-19.7)	19.5 (15.8-23.6)	21.7 (17.0-26.7)	23.9 (18.1-30.0)	26.2 (19.2-33.5)	29.3 (20.6-38.3)	31.6 (21.6-42.2)
60-day	12.0 (10.3-14.1)	13.8 (12.0-16.1)	16.8 (14.5-19.6)	19.2 (16.3-22.7)	22.5 (18.3-27.1)	25.0 (19.7-30.6)	27.5 (20.9-34.3)	30.0 (22.1-38.1)	33.2 (23.5-43.2)	35.6 (24.4-47.2)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).
Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.
Please refer to NOAA Atlas 14 document for more information.

Data Synthesis – Measured Performance (continued)



Event Date: 7/8/25
Average Intensity: 1.14 in/hr
Peak Water Level: 5.16 inches
ATLAS-14 1 yr MRI, 1-Hr Event
Peak Water Level → Peak Detention Volume

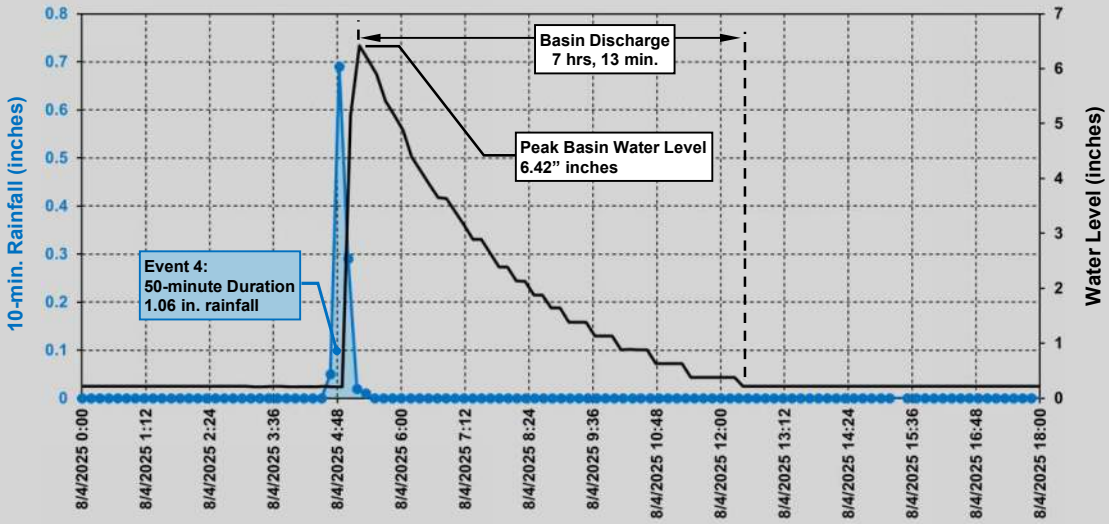
NOAA ATLAS-14 IDF Data
Station ID: 79-0088
DALLAS LOVE FLD

PDS-based precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.421 (0.319-0.556)	0.488 (0.374-0.641)	0.599 (0.457-0.788)	0.690 (0.518-0.918)	0.812 (0.590-1.11)	0.904 (0.640-1.27)	0.996 (0.687-1.43)	1.09 (0.733-1.60)	1.22 (0.790-1.84)	1.31 (0.830-2.04)
10-min	0.672 (0.509-0.888)	0.779 (0.597-1.02)	0.957 (0.730-1.26)	1.10 (0.828-1.47)	1.30 (0.945-1.78)	1.45 (1.03-2.03)	1.60 (1.10-2.29)	1.74 (1.17-2.56)	1.93 (1.26-2.93)	2.07 (1.31-3.22)
15-min	0.844 (0.639-1.11)	0.976 (0.744-1.28)	1.19 (0.905-1.56)	1.37 (1.03-1.82)	1.62 (1.18-2.22)	1.82 (1.29-2.55)	2.01 (1.39-2.89)	2.20 (1.48-3.23)	2.43 (1.58-3.68)	2.60 (1.64-4.04)
30-min	1.18 (0.897-1.56)	1.37 (1.04-1.79)	1.67 (1.27-2.19)	1.92 (1.44-2.55)	2.26 (1.64-3.09)	2.52 (1.78-3.53)	2.78 (1.92-3.99)	3.04 (2.04-4.46)	3.38 (2.19-5.12)	3.63 (2.30-5.64)
60-min	1.54 (1.17-2.04)	1.79 (1.37-2.35)	2.20 (1.68-2.89)	2.53 (1.90-3.37)	2.98 (2.16-4.06)	3.31 (2.34-4.63)	3.65 (2.52-5.24)	4.01 (2.70-5.90)	4.50 (2.93-6.84)	4.89 (3.10-7.59)
2-hr	1.88 (1.44-2.46)	2.21 (1.71-2.86)	2.74 (2.11-3.56)	3.18 (2.41-4.19)	3.79 (2.78-5.12)	4.26 (3.04-5.90)	4.75 (3.30-6.73)	5.26 (3.57-7.64)	5.98 (3.92-8.96)	6.56 (4.18-10.0)
3-hr	2.08 (1.60-2.70)	2.46 (1.91-3.16)	3.07 (2.38-3.96)	3.59 (2.74-4.69)	4.31 (3.18-5.79)	4.88 (3.50-6.71)	5.47 (3.82-7.70)	6.10 (4.16-8.79)	6.99 (4.59-10.4)	7.69 (4.92-11.7)
6-hr	2.44 (1.90-3.14)	2.92 (2.28-3.69)	3.67 (2.87-4.68)	4.32 (3.33-5.59)	5.24 (3.91-6.95)	5.97 (4.33-8.11)	6.74 (4.76-9.37)	7.58 (5.20-10.8)	8.74 (5.79-12.8)	9.68 (6.24-14.5)
12-hr	2.85 (2.25-3.62)	3.42 (2.70-4.28)	4.32 (3.42-5.45)	5.10 (3.98-6.52)	6.20 (4.68-8.14)	7.09 (5.20-9.51)	8.03 (5.72-11.0)	9.05 (6.27-12.7)	10.5 (7.01-15.2)	11.7 (7.58-17.2)
24-hr	3.31 (2.64-4.16)	3.98 (3.18-4.92)	5.04 (4.03-6.28)	5.95 (4.69-7.52)	7.25 (5.52-9.39)	8.28 (6.13-11.0)	9.39 (6.75-12.7)	10.6 (7.41-14.7)	12.3 (8.30-17.6)	13.7 (8.99-19.9)
2-day	3.85 (3.10-4.78)	4.62 (3.74-5.65)	5.84 (4.73-7.20)	6.89 (5.50-8.61)	8.38 (6.45-10.7)	9.56 (7.14-12.5)	10.8 (7.86-14.5)	12.2 (8.63-16.7)	14.3 (9.60-20.0)	15.9 (10.5-22.8)
3-day	4.20 (3.41-5.18)	5.04 (4.11-6.12)	6.36 (5.19-7.80)	7.50 (6.02-9.31)	9.11 (7.06-11.6)	10.4 (7.80-13.5)	11.8 (8.58-15.6)	13.3 (9.42-18.0)	15.5 (10.6-21.5)	17.3 (11.4-24.5)
4-day	4.46 (3.64-5.47)	5.34 (4.37-6.45)	6.73 (5.52-8.21)	7.93 (6.41-9.80)	9.65 (7.51-12.2)	11.0 (8.30-14.2)	12.5 (9.13-16.4)	14.1 (10.0-18.9)	16.4 (11.2-22.7)	18.3 (12.2-25.8)
7-day	5.00 (4.12-6.08)	5.98 (4.94-7.15)	7.51 (6.22-9.08)	8.85 (7.21-10.8)	10.8 (8.46-13.5)	12.3 (9.37-15.7)	14.0 (10.3-18.2)	15.8 (11.3-21.0)	18.4 (12.7-25.1)	20.5 (13.7-28.5)
10-day	5.47 (4.53-6.61)	6.53 (5.42-7.76)	8.17 (6.80-9.82)	9.61 (7.88-11.7)	11.7 (9.22-14.5)	13.3 (10.2-16.9)	15.1 (11.2-19.5)	17.0 (12.3-22.5)	19.8 (13.7-26.8)	22.0 (14.8-30.4)
20-day	7.08 (5.94-8.46)	8.30 (7.02-9.82)	10.2 (8.66-12.2)	11.9 (9.87-14.3)	14.2 (11.3-17.4)	16.0 (12.3-20.0)	17.8 (13.3-22.7)	19.8 (14.4-25.8)	22.7 (15.8-30.3)	25.0 (16.9-34.0)
30-day	8.44 (7.13-10.0)	9.78 (8.36-11.6)	12.0 (10.2-14.2)	13.8 (11.5-16.5)	16.3 (13.1-19.8)	18.2 (14.1-22.5)	20.1 (15.1-25.4)	22.2 (16.2-28.6)	25.1 (17.6-33.2)	27.4 (18.6-36.9)
45-day	10.3 (8.78-12.2)	11.9 (10.3-14.0)	14.5 (12.5-17.1)	16.6 (14.0-19.7)	19.5 (15.8-23.6)	21.7 (17.0-26.7)	23.9 (18.1-30.0)	26.2 (19.2-33.5)	29.3 (20.6-38.3)	31.6 (21.6-42.2)
60-day	12.0 (10.3-14.1)	13.8 (12.0-16.1)	16.8 (14.5-19.6)	19.2 (16.3-22.7)	22.5 (18.3-27.1)	25.0 (19.7-30.6)	27.5 (20.9-34.3)	30.0 (22.1-38.1)	33.2 (23.5-43.2)	35.6 (24.4-47.2)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).
Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.
Please refer to NOAA Atlas 14 document for more information.

Data Synthesis – Measured Performance (continued)



Event Date: 8/4/25
Average Intensity: 1.27 in/hr
Peak Water Level: 6.42 inches
ATLAS-14 1 yr MRI, 30-min to 1-Hr Event

Peak Water Level → Peak Detention Volume

NOAA ATLAS-14 IDF Data
Station ID: 79-0088
DALLAS LOVE FLD

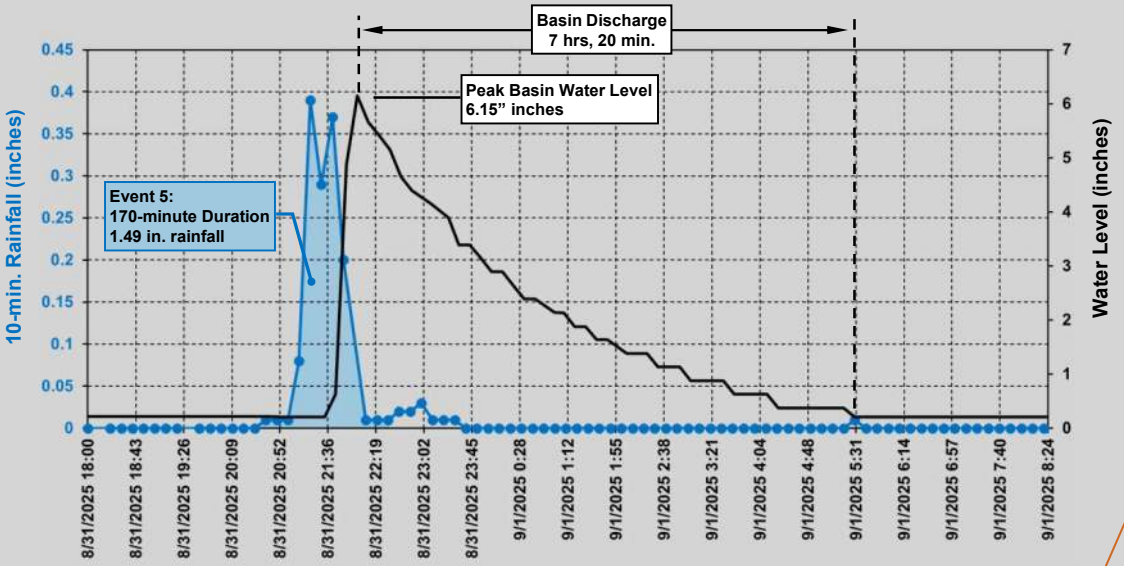
PDS-based precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.421 (0.319-0.556)	0.488 (0.374-0.641)	0.599 (0.457-0.788)	0.690 (0.518-0.918)	0.812 (0.590-1.11)	0.904 (0.640-1.27)	0.996 (0.687-1.43)	1.09 (0.733-1.60)	1.22 (0.790-1.84)	1.31 (0.830-2.04)
10-min	0.672 (0.509-0.888)	0.779 (0.597-1.02)	0.957 (0.730-1.26)	1.10 (0.828-1.47)	1.30 (0.945-1.78)	1.45 (1.03-2.03)	1.60 (1.10-2.29)	1.74 (1.17-2.56)	1.93 (1.26-2.93)	2.07 (1.31-3.22)
15-min	0.844 (0.639-1.11)	0.976 (0.744-1.28)	1.19 (0.905-1.56)	1.37 (1.03-1.82)	1.62 (1.18-2.22)	1.82 (1.29-2.55)	2.01 (1.39-2.89)	2.20 (1.48-3.23)	2.43 (1.58-3.68)	2.60 (1.64-4.04)
30-min	1.18 (0.897-1.56)	1.37 (1.04-1.79)	1.67 (1.27-2.19)	1.92 (1.44-2.55)	2.26 (1.64-3.09)	2.52 (1.78-3.53)	2.78 (1.92-3.99)	3.04 (2.04-4.46)	3.38 (2.19-5.12)	3.63 (2.30-5.64)
60-min	1.54 (1.17-2.04)	1.79 (1.37-2.35)	2.20 (1.68-2.89)	2.53 (1.90-3.37)	2.98 (2.16-4.06)	3.31 (2.34-4.63)	3.65 (2.52-5.24)	4.01 (2.70-5.90)	4.50 (2.93-6.84)	4.89 (3.10-7.59)
2-hr	1.88 (1.44-2.46)	2.21 (1.71-2.86)	2.74 (2.11-3.56)	3.18 (2.41-4.19)	3.79 (2.78-5.12)	4.26 (3.04-5.90)	4.75 (3.30-6.73)	5.26 (3.57-7.64)	5.98 (3.92-8.96)	6.56 (4.18-10.0)
3-hr	2.08 (1.60-2.70)	2.46 (1.91-3.16)	3.07 (2.38-3.96)	3.59 (2.74-4.69)	4.31 (3.16-5.79)	4.88 (3.50-6.71)	5.47 (3.82-7.70)	6.10 (4.16-8.79)	6.99 (4.59-10.4)	7.69 (4.92-11.7)
6-hr	2.44 (1.90-3.14)	2.92 (2.28-3.69)	3.67 (2.87-4.68)	4.32 (3.33-5.59)	5.24 (3.91-6.95)	5.97 (4.33-8.11)	6.74 (4.76-9.37)	7.58 (5.20-10.8)	8.74 (5.79-12.8)	9.68 (6.24-14.5)
12-hr	2.85 (2.25-3.62)	3.42 (2.70-4.28)	4.32 (3.42-5.45)	5.10 (3.98-6.52)	6.20 (4.68-8.14)	7.09 (5.20-9.51)	8.03 (5.72-11.0)	9.05 (6.27-12.7)	10.5 (7.01-15.2)	11.7 (7.58-17.2)
24-hr	3.31 (2.64-4.16)	3.98 (3.18-4.92)	5.04 (4.03-6.28)	5.95 (4.69-7.52)	7.25 (5.52-9.39)	8.28 (6.13-11.0)	9.39 (6.75-12.7)	10.6 (7.41-14.7)	12.3 (8.30-17.6)	13.7 (8.99-19.9)
2-day	3.85 (3.10-4.78)	4.62 (3.74-5.65)	5.84 (4.73-7.20)	6.89 (5.50-8.61)	8.38 (6.45-10.7)	9.56 (7.14-12.5)	10.8 (7.86-14.5)	12.2 (8.63-16.7)	14.3 (9.68-20.0)	15.9 (10.5-22.8)
3-day	4.20 (3.41-5.18)	5.04 (4.11-6.12)	6.36 (5.19-7.80)	7.50 (6.02-9.31)	9.11 (7.06-11.6)	10.4 (7.80-13.5)	11.8 (8.58-15.6)	13.3 (9.42-18.0)	15.5 (10.6-21.5)	17.3 (11.4-24.5)
4-day	4.46 (3.64-5.47)	5.34 (4.37-6.45)	6.73 (5.52-8.21)	7.93 (6.41-9.80)	9.65 (7.51-12.2)	11.0 (8.30-14.2)	12.5 (9.13-16.4)	14.1 (10.0-18.9)	16.4 (11.2-22.7)	18.3 (12.2-25.8)
7-day	5.00 (4.12-6.08)	5.98 (4.94-7.15)	7.51 (6.22-9.08)	8.85 (7.21-10.8)	10.8 (8.46-13.5)	12.3 (9.37-15.7)	14.0 (10.3-18.2)	15.8 (11.3-21.0)	18.4 (12.7-25.1)	20.5 (13.7-28.5)
10-day	5.47 (4.53-6.61)	6.53 (5.42-7.76)	8.17 (6.80-9.82)	9.61 (7.88-11.7)	11.7 (9.22-14.5)	13.3 (10.2-16.9)	15.1 (11.2-19.5)	17.0 (12.3-22.5)	19.8 (13.7-26.8)	22.0 (14.8-30.4)
20-day	7.08 (5.94-8.46)	8.30 (7.02-9.82)	10.2 (8.66-12.2)	11.9 (9.87-14.3)	14.2 (11.3-17.4)	16.0 (12.3-20.0)	17.8 (13.3-22.7)	19.8 (14.4-25.8)	22.7 (15.8-30.3)	25.0 (16.9-34.0)
30-day	8.44 (7.13-10.0)	9.78 (8.36-11.6)	12.0 (10.2-14.2)	13.8 (11.5-16.5)	16.3 (13.1-19.8)	18.2 (14.1-22.5)	20.1 (15.1-25.4)	22.2 (16.2-28.6)	25.1 (17.6-33.2)	27.4 (18.6-36.9)
45-day	10.3 (8.78-12.2)	11.9 (10.3-14.0)	14.5 (12.5-17.1)	16.6 (14.0-19.7)	19.5 (15.8-23.6)	21.7 (17.0-26.7)	23.9 (18.1-30.0)	26.2 (19.2-33.5)	29.3 (20.6-38.3)	31.6 (21.6-42.2)
60-day	12.0 (10.3-14.1)	13.8 (12.0-16.1)	16.8 (14.5-19.6)	19.2 (16.3-22.7)	22.5 (18.3-27.1)	25.0 (19.7-30.6)	27.5 (20.9-34.3)	30.0 (22.1-38.1)	33.2 (23.5-43.2)	35.6 (24.4-47.2)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).
Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.
Please refer to NOAA Atlas 14 document for more information.

Rainfall Events Greater than 1.00 in/hr
Basin "ACTIVATION"

Data Synthesis – Measured Performance (continued)



NOAA ATLAS-14 IDF Data
Station ID: 79-0088
DALLAS LOVE FLD

PDS-based precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.421 (0.319-0.556)	0.488 (0.374-0.641)	0.599 (0.457-0.788)	0.690 (0.518-0.918)	0.812 (0.590-1.11)	0.904 (0.640-1.27)	0.996 (0.687-1.43)	1.09 (0.733-1.60)	1.22 (0.790-1.84)	1.31 (0.830-2.04)
10-min	0.672 (0.509-0.888)	0.779 (0.597-1.02)	0.957 (0.730-1.26)	1.10 (0.828-1.47)	1.30 (0.945-1.78)	1.45 (1.03-2.03)	1.60 (1.10-2.29)	1.74 (1.17-2.56)	1.93 (1.26-2.93)	2.07 (1.31-3.22)
15-min	0.844 (0.639-1.11)	0.976 (0.744-1.28)	1.19 (0.905-1.56)	1.37 (1.03-1.82)	1.62 (1.18-2.22)	1.82 (1.29-2.55)	2.01 (1.39-2.89)	2.20 (1.48-3.23)	2.43 (1.58-3.68)	2.60 (1.64-4.04)
30-min	1.18 (0.897-1.56)	1.37 (1.04-1.79)	1.67 (1.27-2.19)	1.92 (1.44-2.55)	2.26 (1.64-3.09)	2.52 (1.78-3.53)	2.78 (1.92-3.99)	3.04 (2.04-4.46)	3.38 (2.19-5.12)	3.63 (2.30-5.64)
60-min	1.54 (1.17-2.04)	1.79 (1.37-2.35)	2.20 (1.68-2.89)	2.53 (1.90-3.37)	2.98 (2.16-4.06)	3.31 (2.34-4.63)	3.65 (2.52-5.24)	4.01 (2.70-5.90)	4.50 (2.93-6.84)	4.89 (3.10-7.59)
2-hr	1.88 (1.44-2.46)	2.21 (1.71-2.86)	2.74 (2.11-3.56)	3.18 (2.41-4.19)	3.79 (2.78-5.12)	4.26 (3.04-5.90)	4.75 (3.30-6.73)	5.26 (3.57-7.64)	5.98 (3.92-8.96)	6.56 (4.18-10.0)
3-hr	2.08 (1.60-2.70)	2.46 (1.91-3.16)	3.07 (2.38-3.96)	3.59 (2.74-4.69)	4.31 (3.16-5.79)	4.88 (3.50-6.71)	5.47 (3.82-7.70)	6.10 (4.16-8.79)	6.99 (4.59-10.4)	7.69 (4.92-11.7)
6-hr	2.44 (1.90-3.14)	2.92 (2.28-3.69)	3.67 (2.87-4.68)	4.32 (3.33-5.59)	5.24 (3.91-6.95)	5.97 (4.33-8.11)	6.74 (4.76-9.37)	7.58 (5.20-10.8)	8.74 (5.79-12.8)	9.68 (6.24-14.5)
12-hr	2.85 (2.25-3.62)	3.42 (2.70-4.28)	4.32 (3.42-5.45)	5.10 (3.98-6.52)	6.20 (4.68-8.14)	7.09 (5.20-9.51)	8.03 (5.72-11.0)	9.05 (6.27-12.7)	10.5 (7.01-15.2)	11.7 (7.58-17.2)
24-hr	3.31 (2.64-4.16)	3.98 (3.18-4.92)	5.04 (4.03-6.28)	5.95 (4.69-7.52)	7.25 (5.52-9.39)	8.28 (6.13-11.0)	9.39 (6.75-12.7)	10.6 (7.41-14.7)	12.3 (8.30-17.6)	13.7 (8.99-19.9)
2-day	3.85 (3.10-4.78)	4.62 (3.74-5.65)	5.84 (4.73-7.20)	6.89 (5.50-8.61)	8.38 (6.45-10.7)	9.56 (7.14-12.5)	10.8 (7.86-14.5)	12.2 (8.63-16.7)	14.3 (9.68-20.0)	15.9 (10.5-22.8)
3-day	4.20 (3.41-5.18)	5.04 (4.11-6.12)	6.36 (5.19-7.80)	7.50 (6.02-9.31)	9.11 (7.06-11.6)	10.4 (7.80-13.5)	11.8 (8.58-15.6)	13.3 (9.42-18.0)	15.5 (10.6-21.5)	17.3 (11.4-24.5)
4-day	4.46 (3.64-5.47)	5.34 (4.37-6.45)	6.73 (5.52-8.21)	7.93 (6.41-9.80)	9.65 (7.51-12.2)	11.0 (8.30-14.2)	12.5 (9.13-16.4)	14.1 (10.0-18.9)	16.4 (11.2-22.7)	18.3 (12.2-25.8)
7-day	5.00 (4.12-6.08)	5.98 (4.94-7.15)	7.51 (6.22-9.08)	8.85 (7.21-10.8)	10.8 (8.46-13.5)	12.3 (9.37-15.7)	14.0 (10.3-18.2)	15.8 (11.3-21.0)	18.4 (12.7-25.1)	20.5 (13.7-28.5)
10-day	5.47 (4.53-6.61)	6.53 (5.42-7.76)	8.17 (6.80-9.82)	9.61 (7.88-11.7)	11.7 (9.22-14.5)	13.3 (10.2-16.9)	15.1 (11.2-19.5)	17.0 (12.3-22.5)	19.8 (13.7-26.8)	22.0 (14.8-30.4)
20-day	7.08 (5.94-8.46)	8.30 (7.02-9.82)	10.2 (8.66-12.2)	11.9 (9.87-14.3)	14.2 (11.3-17.4)	16.0 (12.3-20.0)	17.8 (13.3-22.7)	19.8 (14.4-25.8)	22.7 (15.8-30.3)	25.0 (16.9-34.0)
30-day	8.44 (7.13-10.0)	9.78 (8.36-11.6)	12.0 (10.2-14.2)	13.8 (11.5-16.5)	16.3 (13.1-19.8)	18.2 (14.1-22.5)	20.1 (15.1-25.4)	22.2 (16.2-28.6)	25.1 (17.6-33.2)	27.4 (18.6-36.9)
45-day	10.3 (8.78-12.2)	11.9 (10.3-14.0)	14.5 (12.5-17.1)	16.6 (14.0-19.7)	19.5 (15.8-23.6)	21.7 (17.0-26.7)	23.9 (18.1-30.0)	26.2 (19.2-33.5)	29.3 (20.6-38.3)	31.6 (21.6-42.2)
60-day	12.0 (10.3-14.1)	13.8 (12.0-16.1)	16.8 (14.5-19.6)	19.2 (16.3-22.7)	22.5 (18.3-27.1)	25.0 (19.7-30.6)	27.5 (20.9-34.3)	30.0 (22.1-38.1)	33.2 (23.5-43.2)	35.6 (24.4-47.2)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

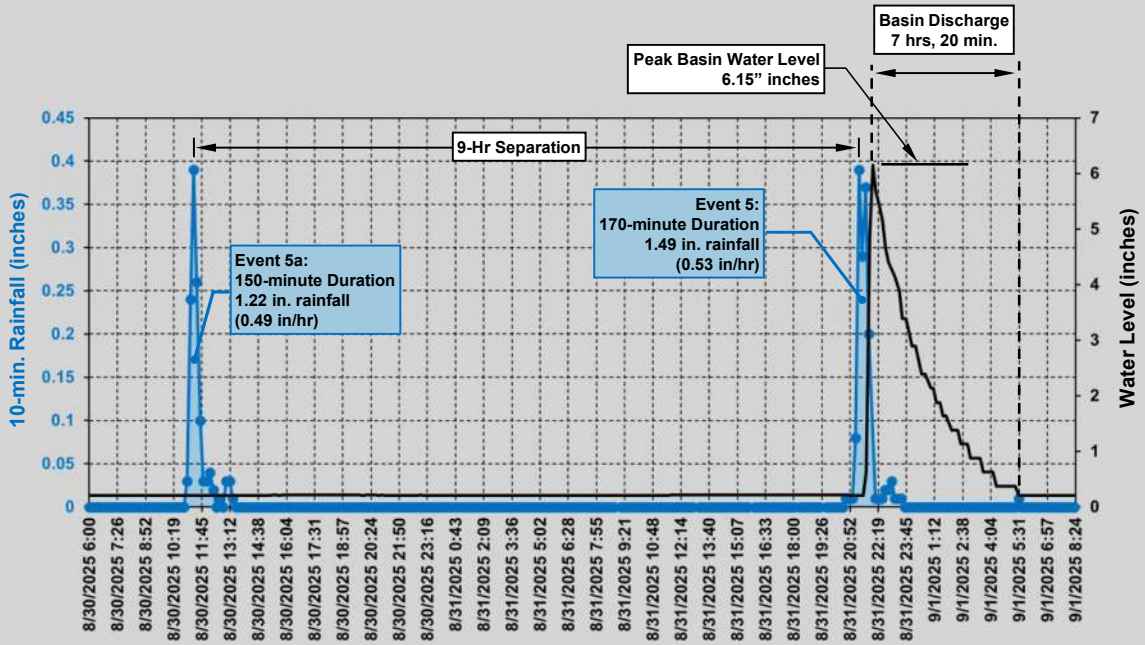
Please refer to NOAA Atlas 14 document for more information.

Event Date: 8/31/25
Average Intensity: 0.53 in/hr
Peak Water Level: 6.15 inches
ATLAS-14 1 yr MRI, 2 to 3-HR Event

Peak Water Level → Peak Detention Volume

(??) 0.53 in/hr should NOT have "ACTIVATED" Basin (??)

Data Synthesis – Measured Performance (continued)



Event 5a Date:	8/30/25
Average Intensity:	**0.49 in/hr**
Peak Water Level:	N.A.

Antecedent Event (separation) ~ 9 hrs

Event 5 Date:	8/31/25
Average Intensity:	**0.53 in/hr**
Peak Water Level:	6.15 inches

Closely-Spaced Events Change Surface Runoff Characteristics

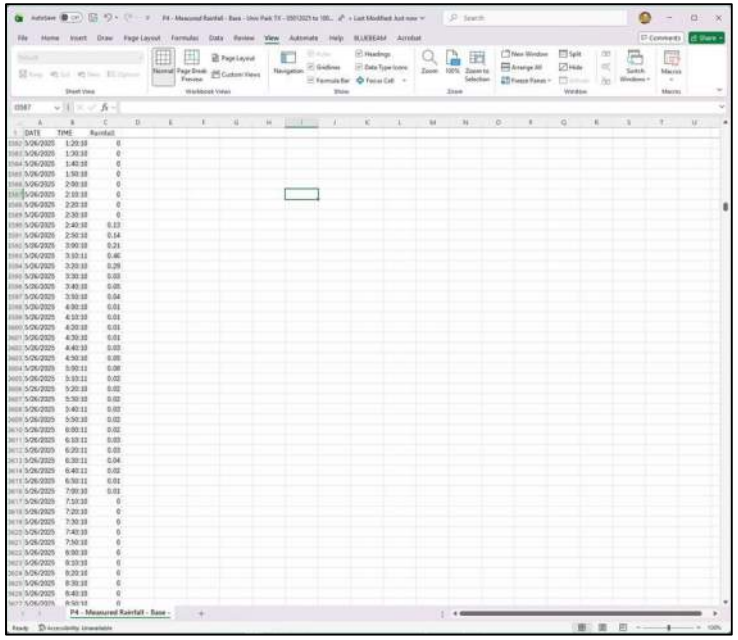
Data Synthesis & Use – SWMM & WinSLAMM

Phase I in Workflow

1.) Existing SWMM or WinSLAMM Model Built with Design

2.) Rain-mX Data (10-minute) Downloaded in CSV Format

3.) CSV File Easily Parsed to DATE, TIME, Rainfall Columns within Excel (or another spreadsheet tool)



Phase II in Workflow

4.) Generate Measured (real) Rainfall Input Files:

- ✓ `?.ran` – WinSLAMM Input Rain File
- ✓ `?.txt` – SWMM Input Rain File

Options for Generation:

- User-Written Scripts (e.g., Python, R, Bash)
- Large Language Models (LLM) and Artificial Intelligence (AI):
  - ChatGPT
  - Grok
  - Gemini
  - DeepSeek
- P4 Infrastructure, Inc. Service

REAL Rainfall for Hydrologic Modeling

- ✓ Calibrate (improve) an Accepted Hydrologic Model with REAL Rainfall Input
- ✓ Document Annual Pollutant Capture with Accepted Model and REAL Rainfall (MS4 & TMDL Regulatory Compliance Reporting)

City of University Park Value

By Carol M. Highsmith
https://commons.wikimedia.org/w/index.php?curid=151169892

By Michael Barera
https://commons.wikimedia.org/w/index.php?curid=50251100

By Drumguy8800,
https://commons.wikimedia.org/w/index.php?curid=4489667

Digitalization Value

Data-Driven Decision Making

- Understanding Rainfall Events and their Impact on Stormwater Infrastructure
  - ✓ Document Activation Events
  - ✓ Correlation to ATLAS-14 (-15) IDF Data
- Inform Phase 2 and Phase 3 Design
  - ✓ Calibrate Future Models
  - ✓ Better Prediction of Storage Need
- Consideration of Water-Quality Enhancements
  - ✓ Hydrodynamic Separators Upstream
  - ✓ MS4 and TMDL Requirements

Transparency

- City Council Presentations
- Public Works Meetings
- Opportunity for GIS Integration

Performance Documentation & Maintenance

- Maintenance
  - ✓ Avoid Arbitrary Visits and Interventions
  - ✓ Data-Driven Scheduling
- Performance – MS4 and TMDL Documentation
  - ✓ Data-Based Documentation
  - ✓ Pollutant Capture using Accepted Model and REAL Annual Rain Data

Bang for the Buck

- Digitalization Capital Expenditure
  - ✓ Passive Systems Described are VERY LOW
  - ✓ Active Systems are VERY HIGH
- Annual Data Transmission and Viewing Expenditures Small
- Passive Digitalization System Maintenance Cost Minimal
  - ✓ Remote & Autonomous Health Monitoring
  - ✓ Systems are Maintenance Free
  - ✓ Modular Systems
  - ✓ Plug-and-Play Exchange

THANK YOU