Public Works Department

Orange County Rainfall Characterization for Stormwater Design

Discussion Item

April 22, 2025

Outline

- Purpose
- County project background
- Rain gauge evaluations
- Design storm standards
- Climate resiliency
- Summary
- Recommendations
- Next Steps

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Purpose

- Review historical rainfall patterns and identify observed changes
- Recommend potential updates for planning and design

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Background

October 25, 2022 BCC Discussion

- Discussion on stormwater management concerns:
  - –Intensity of future rainfall events
  - –Sufficiency of existing design standards
  - –Current maintenance standards
- Following the discussion, Mayor Demings directed staff to research and update the Board regarding potential modifications to our stormwater program and standards

Background

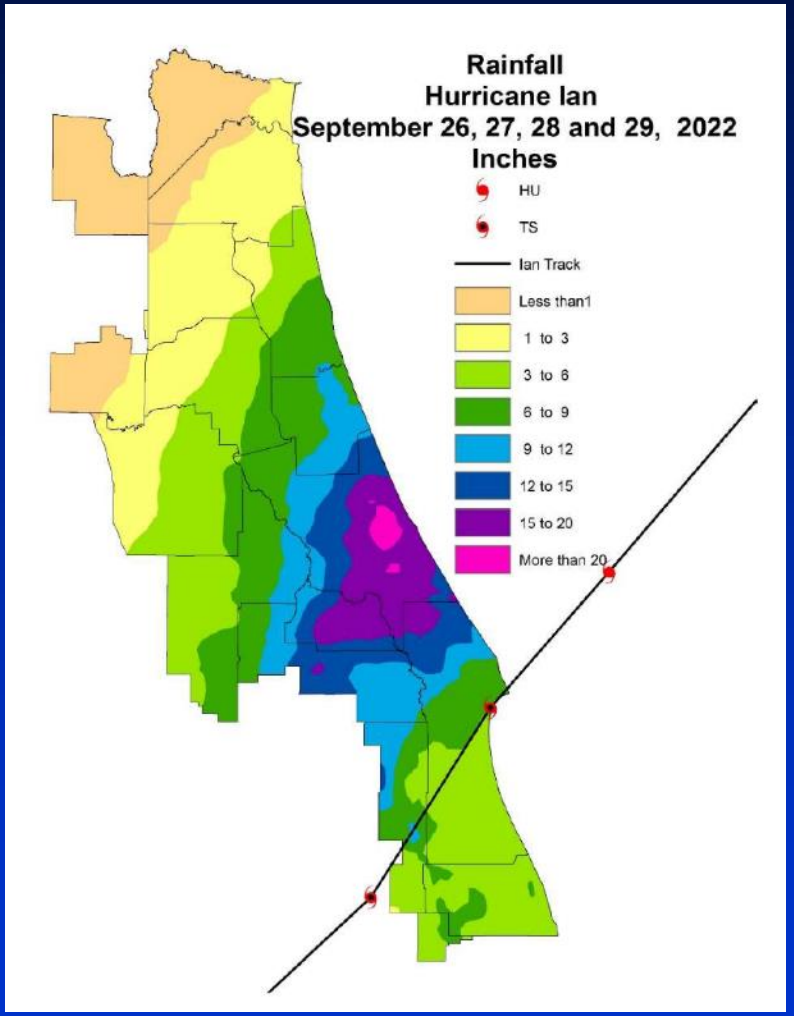
May 2, 2023 BCC Discussion

- 2022 flooding was due to historic rainfall well beyond the traditional design storm
- Most homes that flooded were older or built in or near the floodplain
- The County's current design standards are in line with other jurisdictions
- We need to revisit the rainfall intensity data that we currently use for our design standards

Background

May 23, 2023 BCC Discussion

- How will climate change affect the rainfall intensity/frequency of storms in the future?
- Are our standard design storm intensities still accurate for future conditions?
- Are we able to still meet our stormwater level of service (LOS) criteria in the future using the existing data?



Background

June 2, 2024 BCC Presentation

- **Rainfall Intensity Study**

– **Start Date: September 22, 2023**

– **Purpose: Evaluate rainfall records to determine spatial variability in both depth and frequency and compare to the County's current design criteria**

– **Scope of Work included:**

  - **Analyzing Orange County, Water Management Districts and National Oceanic and Atmospheric Administration (NOAA) rainfall datasets, and performing frequency analysis**
  - **Coordinating with other agencies on rainfall studies: South Florida Water Management District ([SFWMD] Future Extreme Rainfall Change Factors Analysis, NOAA Atlas 15, United States Geological Survey [USGS]/East Central Florida Regional Planning Council [ECFRPC])**

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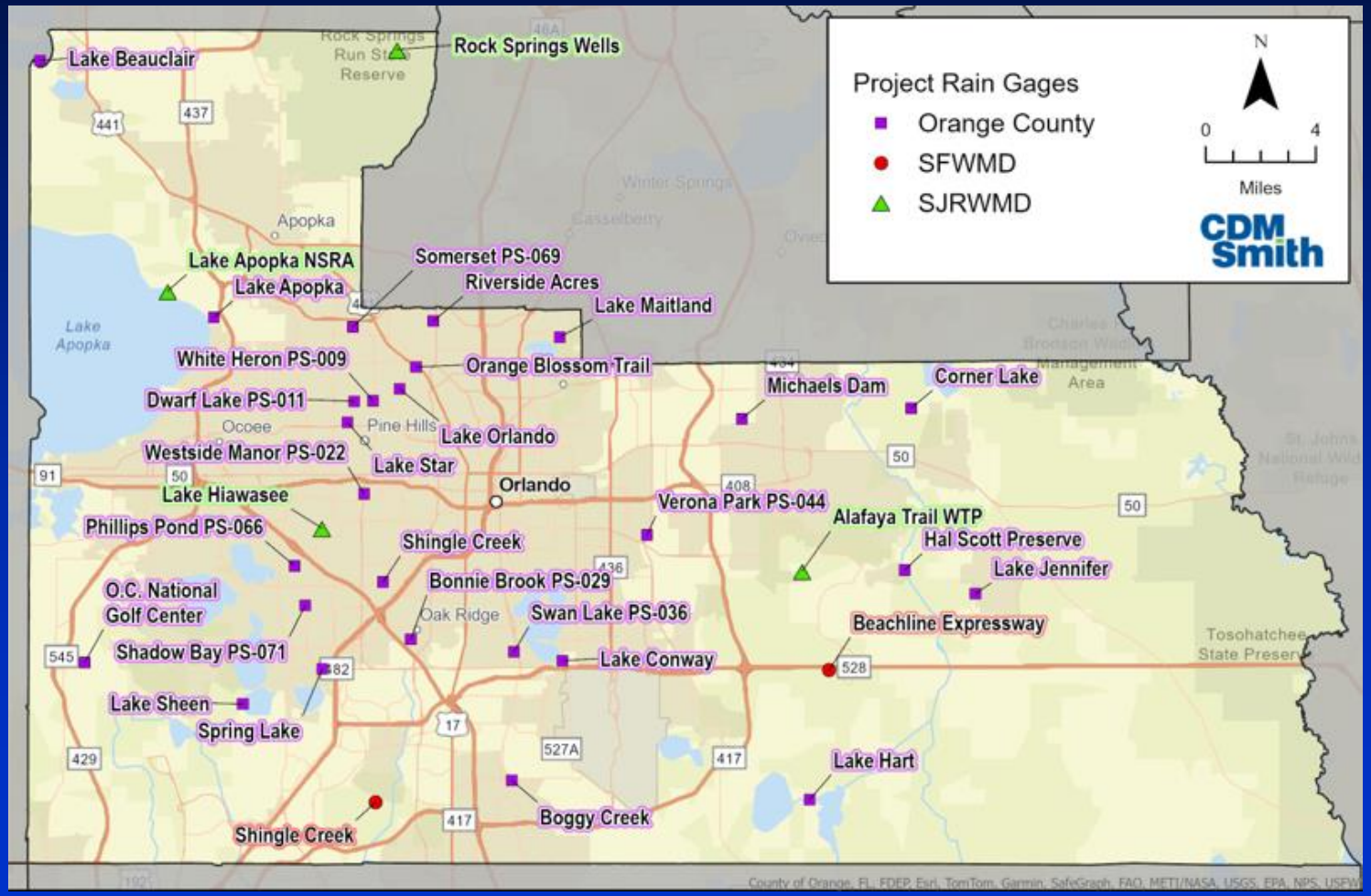
Rain Gauges Considered in the Study

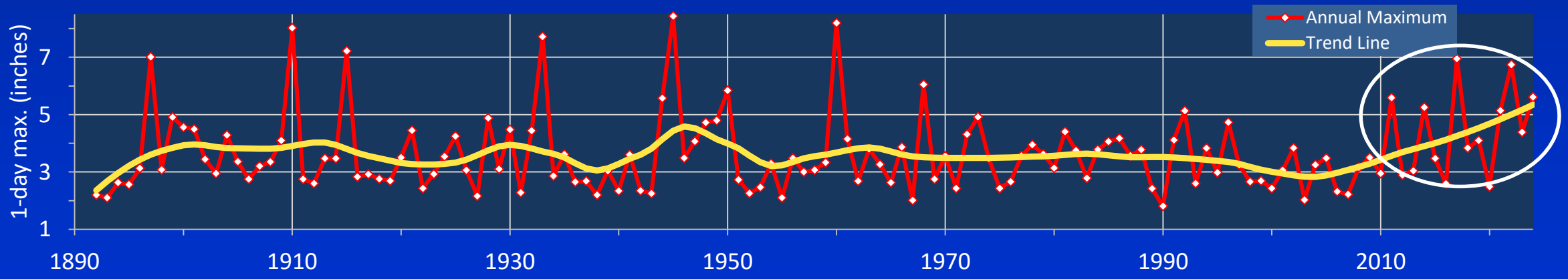
- Reviewed available County rainfall data
  - Orange County – 27
  - National Oceanic and Atmospheric Administration (NOAA) – 12
  - St. Johns River Water Management District (SJRWMD) – 4
  - South Florida Water Management District (SFWMD) – 2

- Data from the Orlando International Airport coupled with the Executive Airport were used for long-term rainfall analysis



Changing Rainfall Patterns To-Date

- Over 130 years of historical rainfall data evaluated
- Several large storm events have occurred in recent years
- However, no *statistically* significant trends in heavy rainfall were identified
- Experts expect this trend to “statistically” change over the next 75 years
- Data since 2010 shows a general increase in rainfall maximums



Rainfall Trend Analysis

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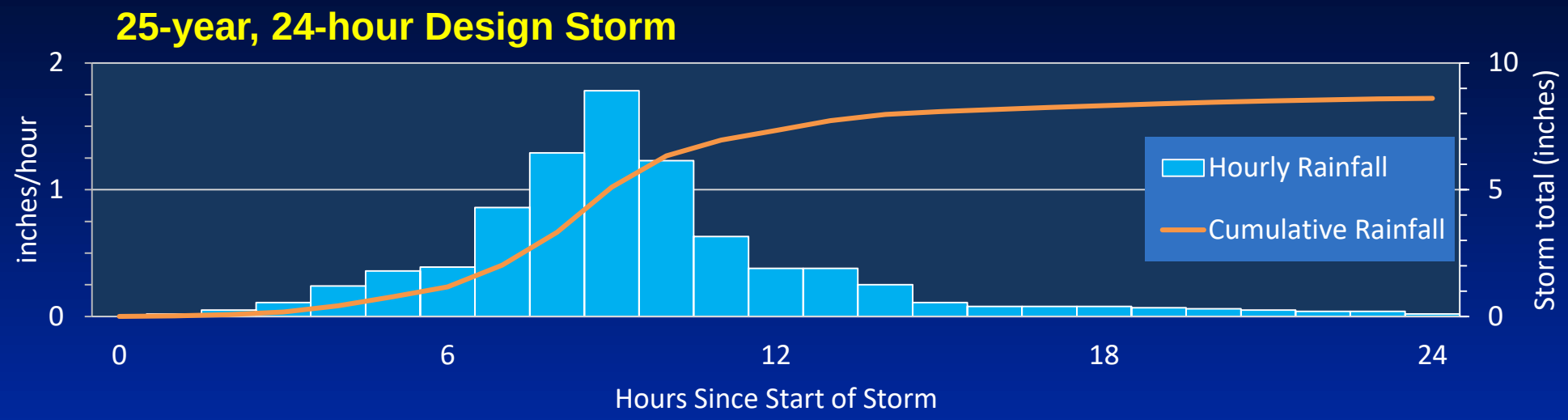
Purpose of Design Rainfall Events

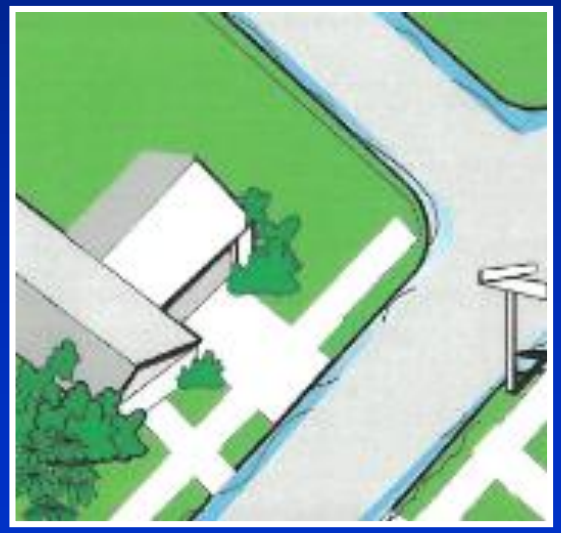


- A design storm is a statistically developed event characterized by:
  - Rainfall volume, duration, and intensity
  - Probability of annual occurrence
    - 100-year design storm represents a 1% chance of occurring in any year

- Engineers use design storms to:
  - Evaluate, design, and permit new stormwater infrastructure
    - Culverts
    - Stormwater pipe networks
    - Stormwater ponds

Level-of-Service Classifications

Service Level A
Flow Contained within Systems



Service Level B
Water Contained within Right-of-Way

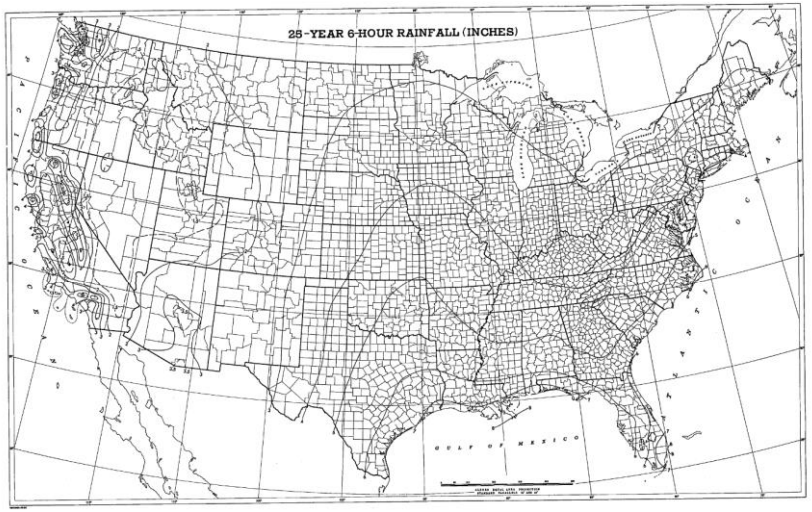
Service Level C
Water Contained within Front Yard

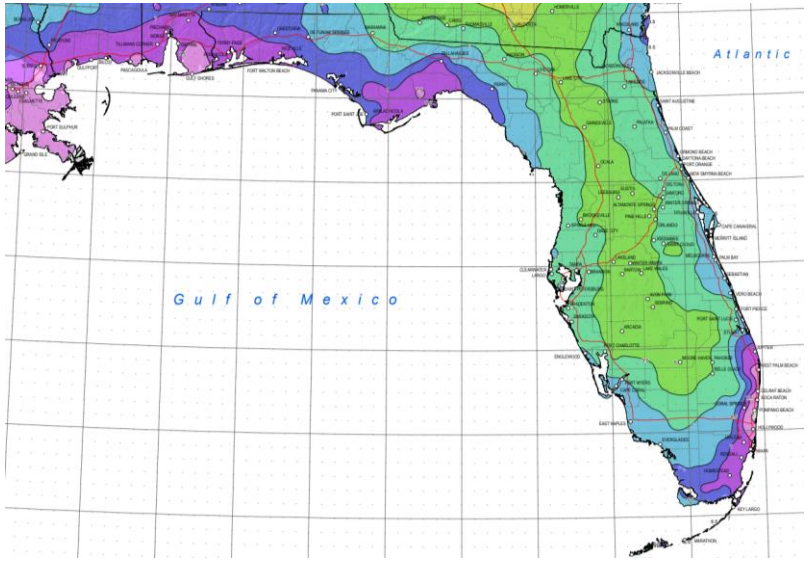
Service Level D
Structure Flooding

Service level descriptions apply to street facilities only.

Regulatory Standards Define Design Storm Selection

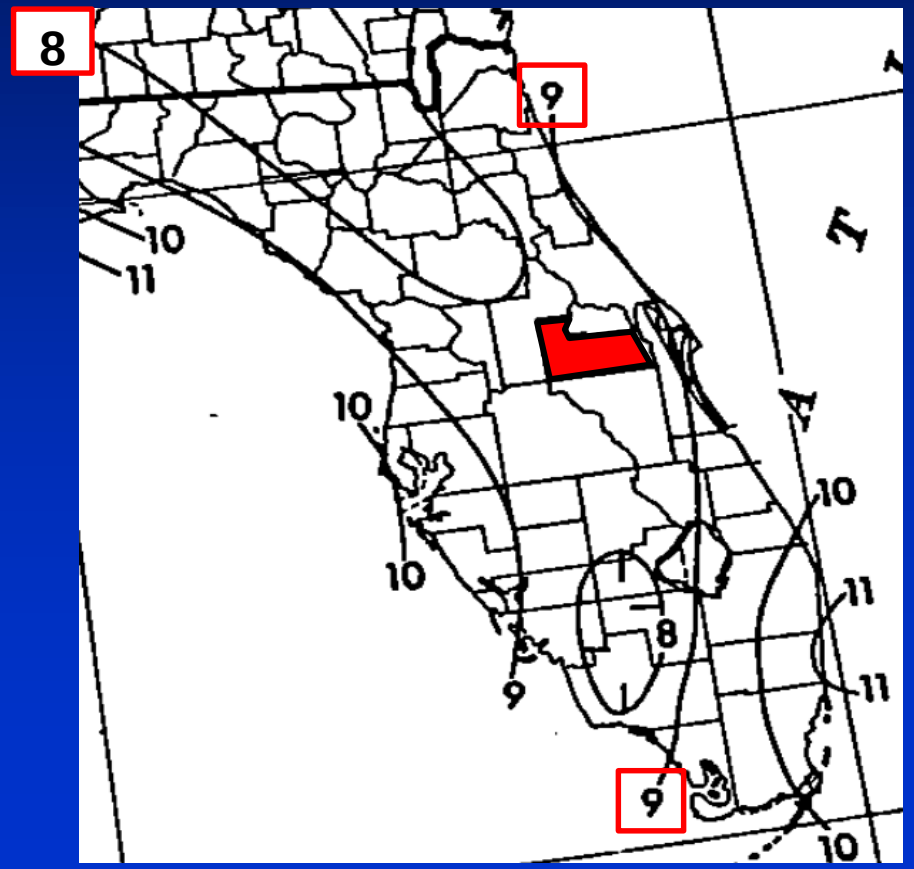
- **1961 National Weather Bureau TP-40**
  - 1-year through 100-year, 30-minute through 24-hour rainfall depths
  - Widely used until 1990s
- **1994 Orange County Ordinance 94-4**
  - Provides 10-year, 25-year, and 100-year 24-hour design storm event requirements
- **2013 NOAA Atlas 14 Volume 9 for Southeast**
  - 1-year through 1,000-year, 5-minute through 60-day rainfall depths
  - Currently followed by both the SJRWMD and the SFWMD
- **2026 NOAA Atlas 15 for contiguous US**
  - Draft 3rd quarter 2025
  - ***NOAA will provide future design storm selection guidance***



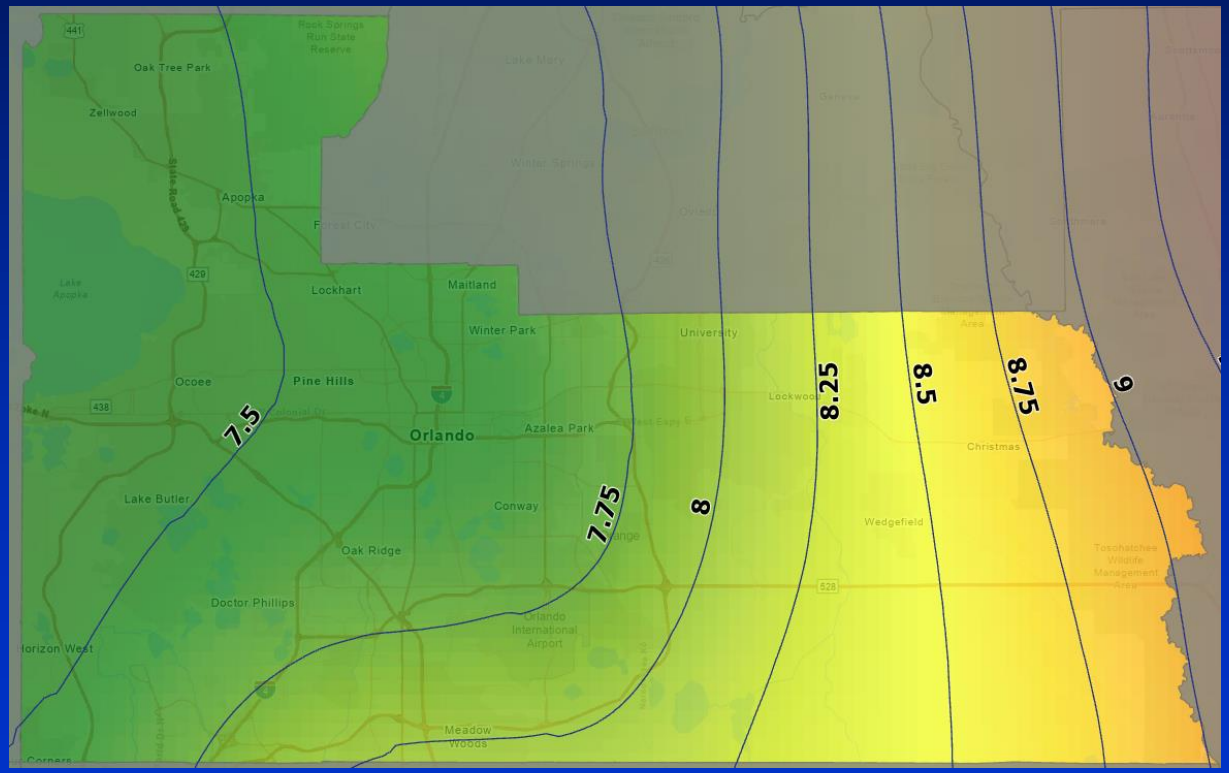


Orange County 25-Year/24-Hour Rainfall Volume

- TP-40 (1961): 8 to 9 inches
- Orange County 94-4: 8.6 inches



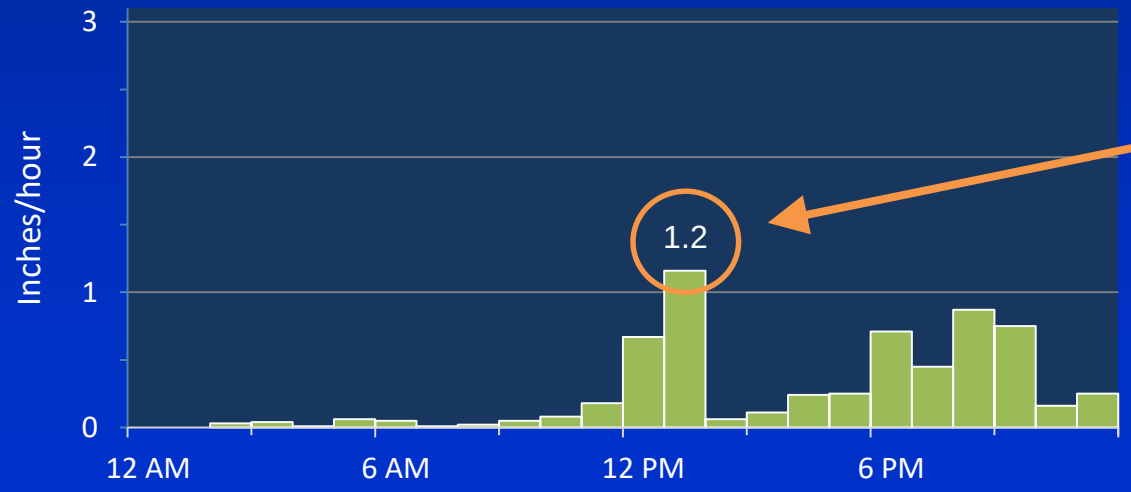
- Atlas 14 (2013): 7.4 to 9.0 inches
- Orlando average: 7.53 inches



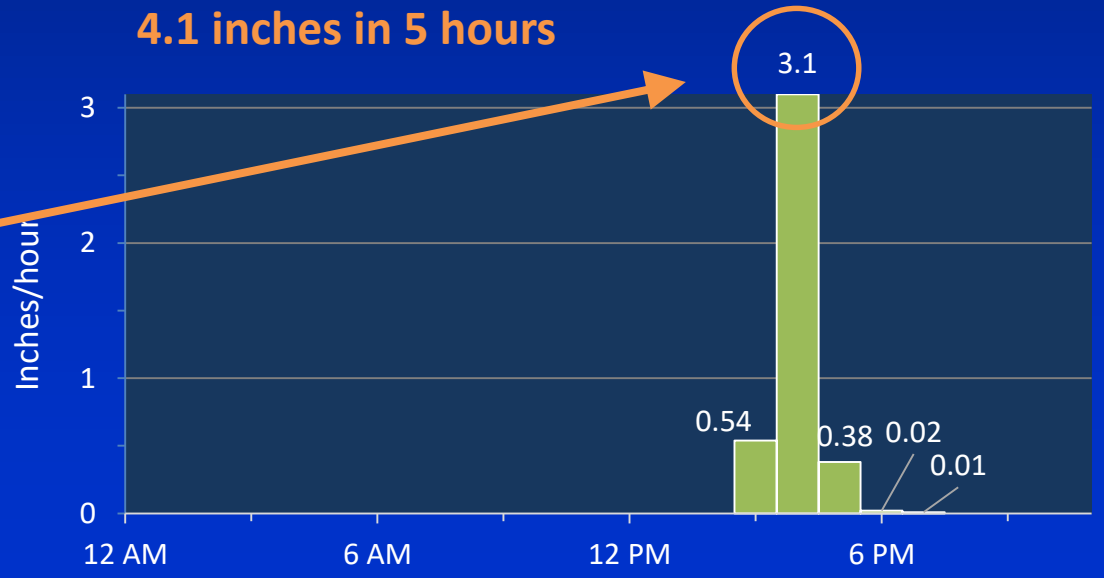
Storm Frequency Characterization

- Hurricane Irma (September 2017) and the September 2020 storm both have an average recurrence interval (ARI) of 25 years
- Irma has nearly a 25-year/*24-hour* ARI, while September 2020 storm approximates 25-year/*1-hour* ARI
- The differences in rainfall intensity can result in different peak flows for the same 25-year ARI

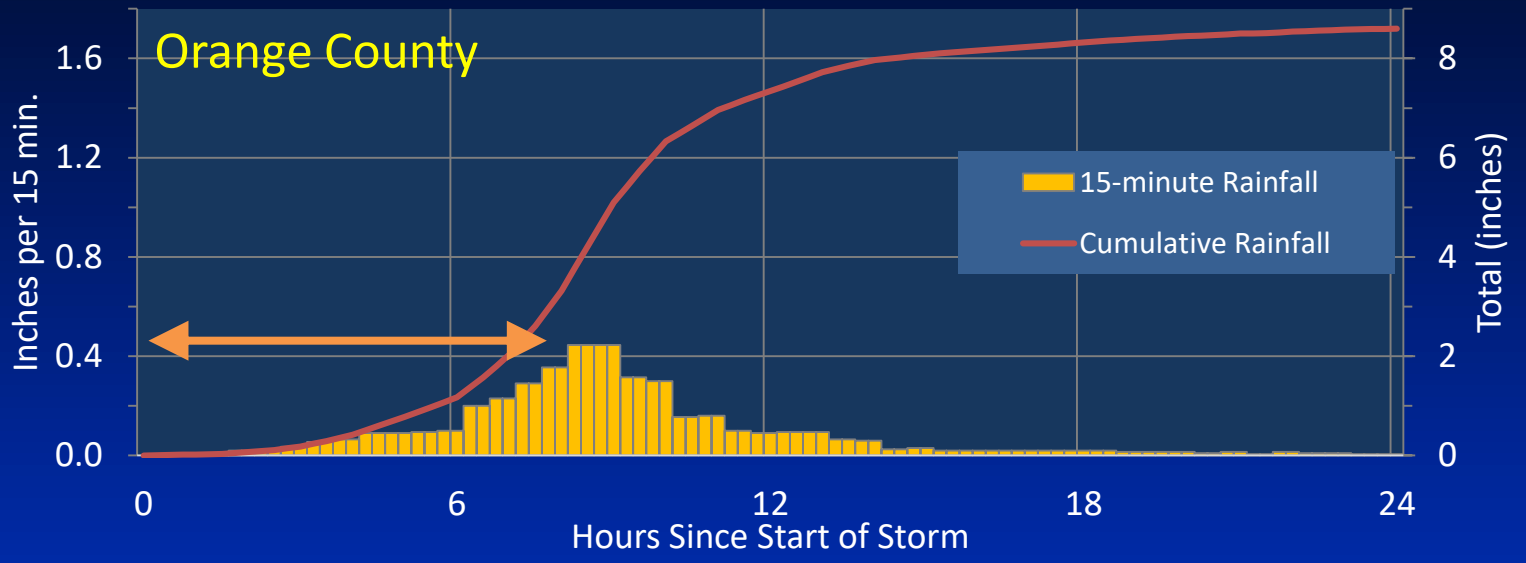
September 10, 2017 (Hurricane Irma):
7.2 inches in 25 hours

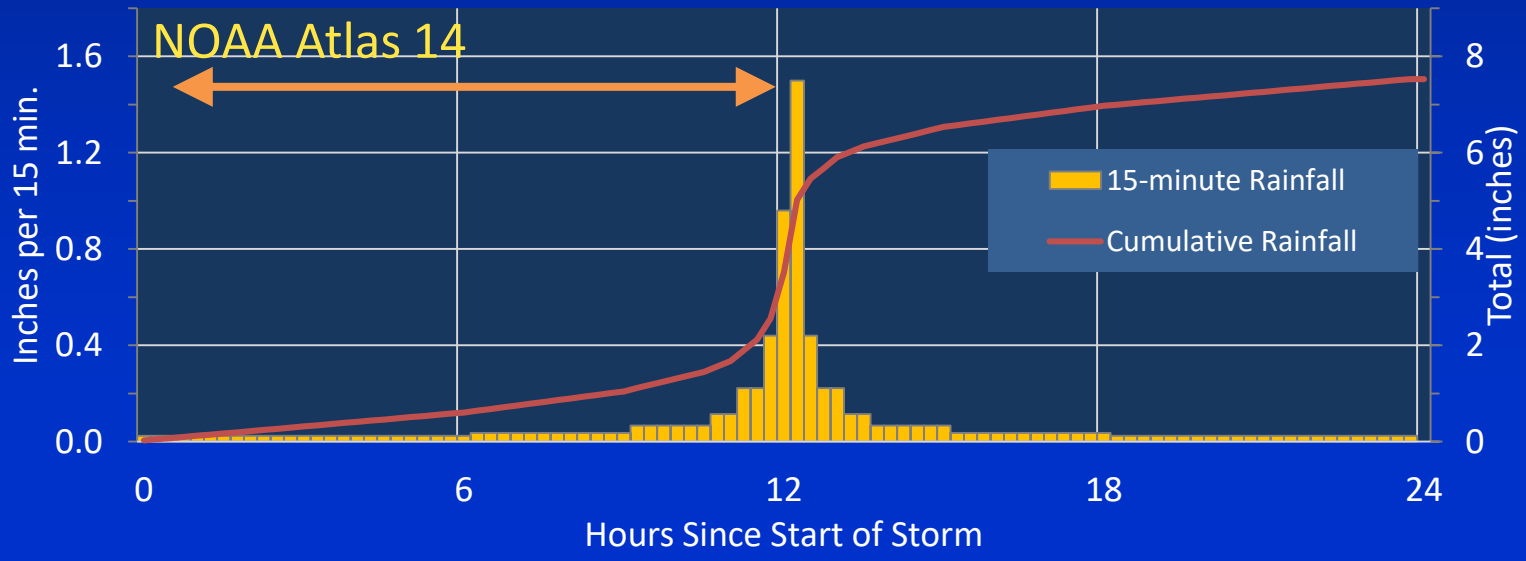


September 9, 2020:
4.1 inches in 5 hours



Orange County 94-4 Design Storm vs. NOAA Atlas 14 Design Storm





25-Year/24-Hour Event

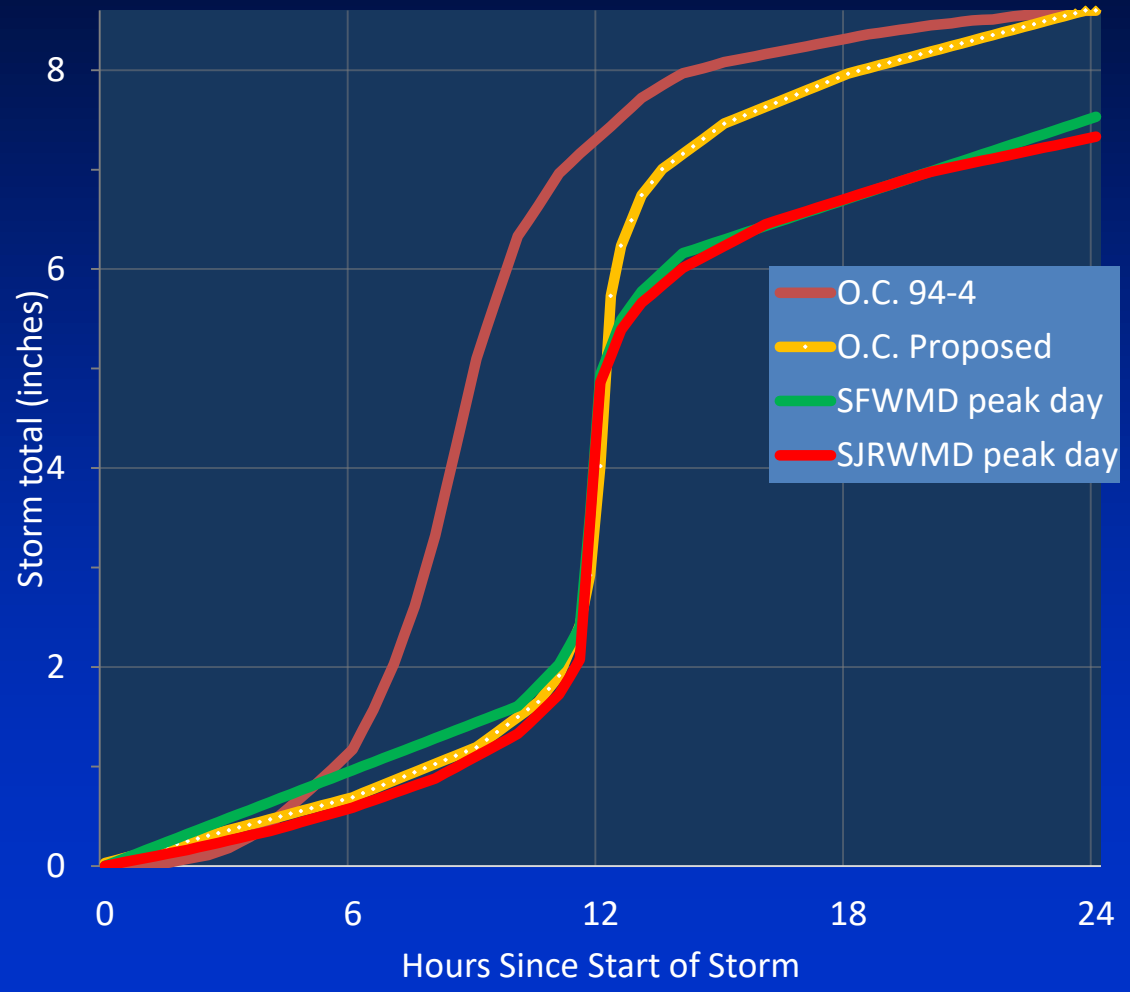
Duration	Rainfall maxima (inches)	
	Orange County 94-4	Atlas 14
15 minutes	0.45	1.50
30 minutes	0.89	2.46
1 hour	1.78	3.34
2 hours	3.12	4.23
3 hours	4.30	4.69
6 hours	6.19	5.49
12 hours	7.01	6.37
24 hours	**8.60**	**7.53**

The County's design storm criteria may result in an undersized stormwater collection system.

Rainfall Distribution Comparison 25-year/24-hour Design Storm

Duration	25-Year/24-Hour Design Storm Rainfall maxima (inches)			
	O.C. 94-4	O.C. Proposed	SFWMD	SJRWMD
15 minutes	0.45	1.71	1.41	1.39
30 minutes	0.89	2.81	2.54	2.78
1 hour	1.78	3.81	3.46	3.31
2 hours	3.12	4.81	3.75	3.93
3 hours	4.30	5.33	4.17	4.33
6 hours	6.19	6.24	4.88	5.13
12 hours	7.01	7.25	5.84	6.12
24 hours	8.60	8.60	7.53	7.32

Atlas 14 is comparable to the methodologies used by both SJRWMD and SFWMD use for design storm analysis



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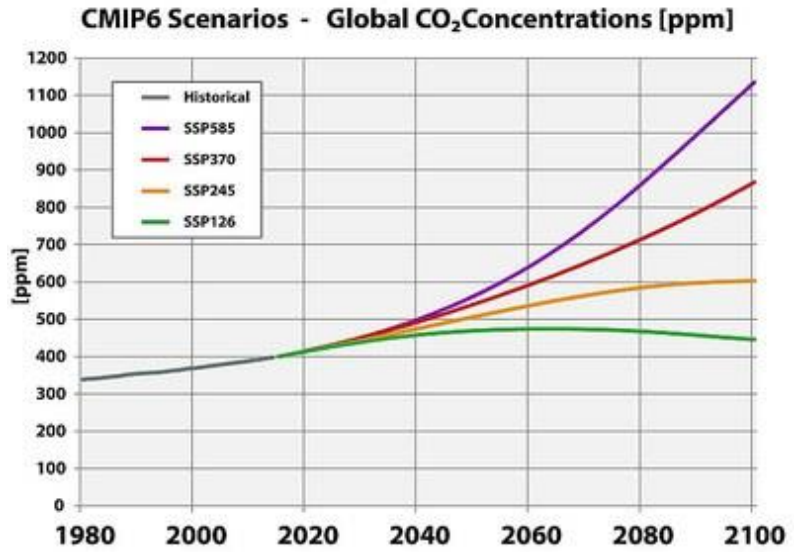
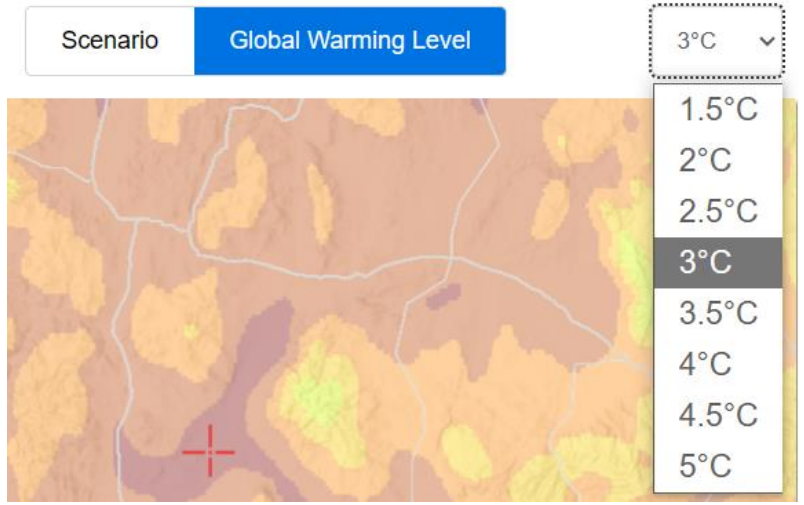
Atlas 15 Climate Model Projections

- Global warming is expected to continue and will likely increase rainfall volumes
- NOAA Atlas 15 is not expected to show meaningful differences from Atlas 14 in terms of Orange County rainfall volume based upon historical data evaluations (looking backward)
- Climate models predict carbon dioxide levels to increase, raising both temperature and rainfall volumes through the study period of 2080 (looking forward)
- Atlas 15 will not prescribe firm guidance, but note that climate models predict as much as a 15% increase in rainfall by 2080.



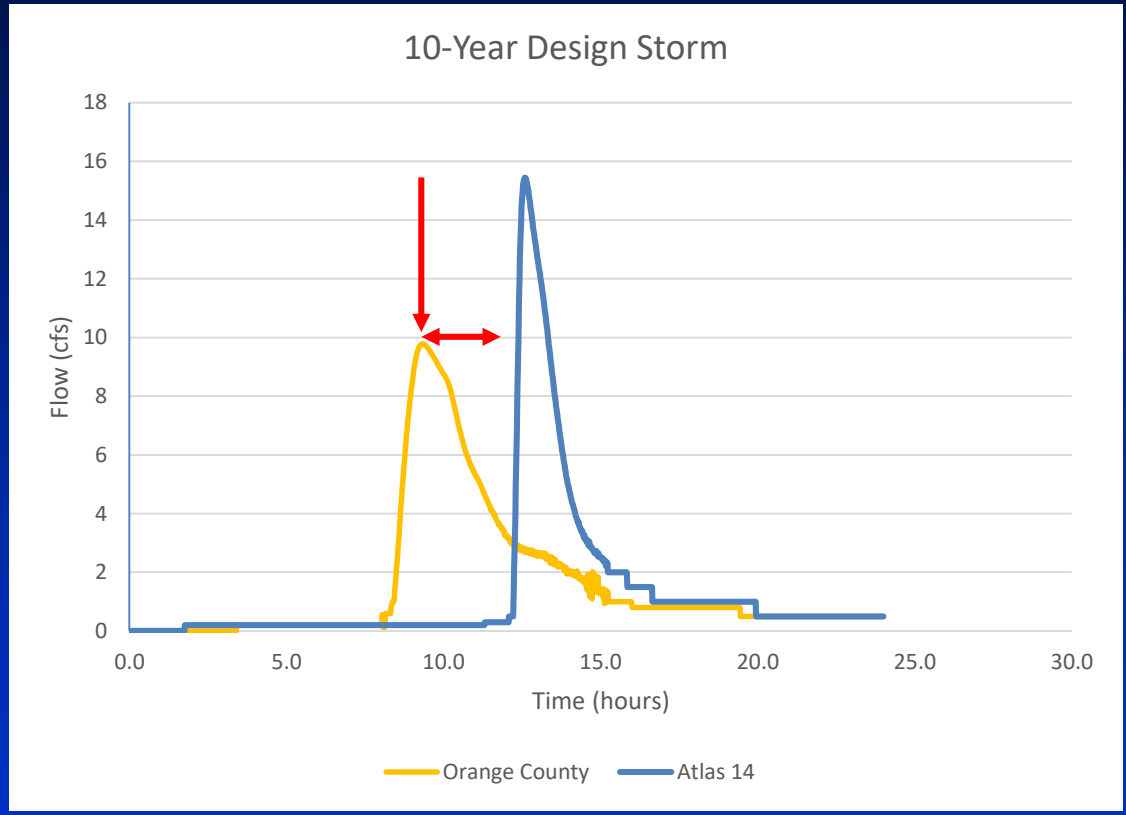


South McKinley Avenue Project

- Comparison of Orange County rainfall distribution versus the NOAA Atlas 14 derived rainfall distribution
- <u>Conveyance Example:</u> 10-Year/24-hour design storm event (7.5 inches of rainfall)
- <u>Storage Example:</u> 100-Year/24-hour design storm event (10.6 inches of rainfall)

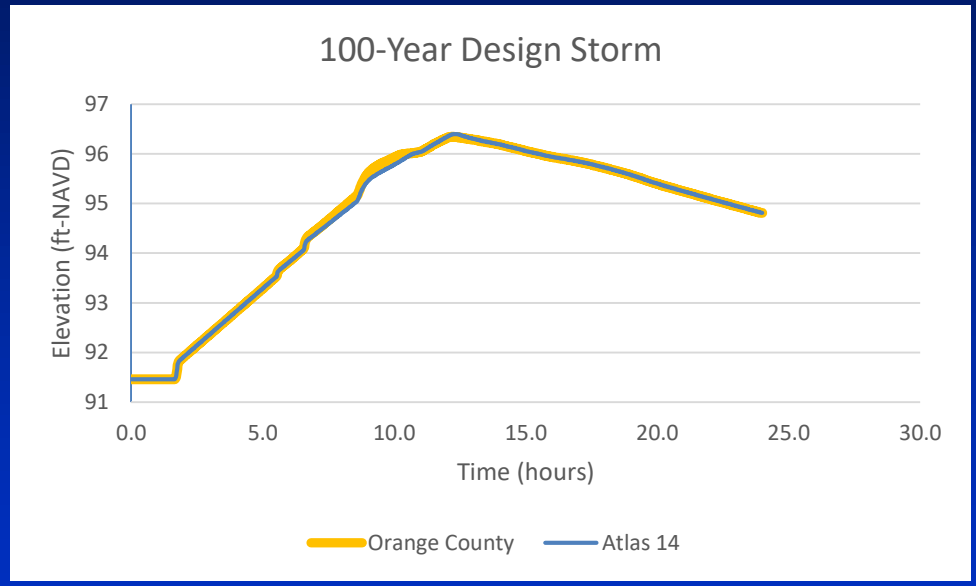
Flow Comparison for 24-inch Diameter Pipe

- 10-year design storm peak flows are predicted to be less when using County rainfall distribution
- Higher intensity design storms may result in undersized conveyance structures (e.g., pipes, channels, swales, etc.)
- Difference in intensity will impact flows for all design storm events



Stage Comparison at Storage Facility (e.g., Pond)

- 100-year design storm peak stages are predicted to be approximately the same when using the County rainfall distribution
- Higher intensity design storms may have limited impact on storage focused infrastructure (e.g., ponds)

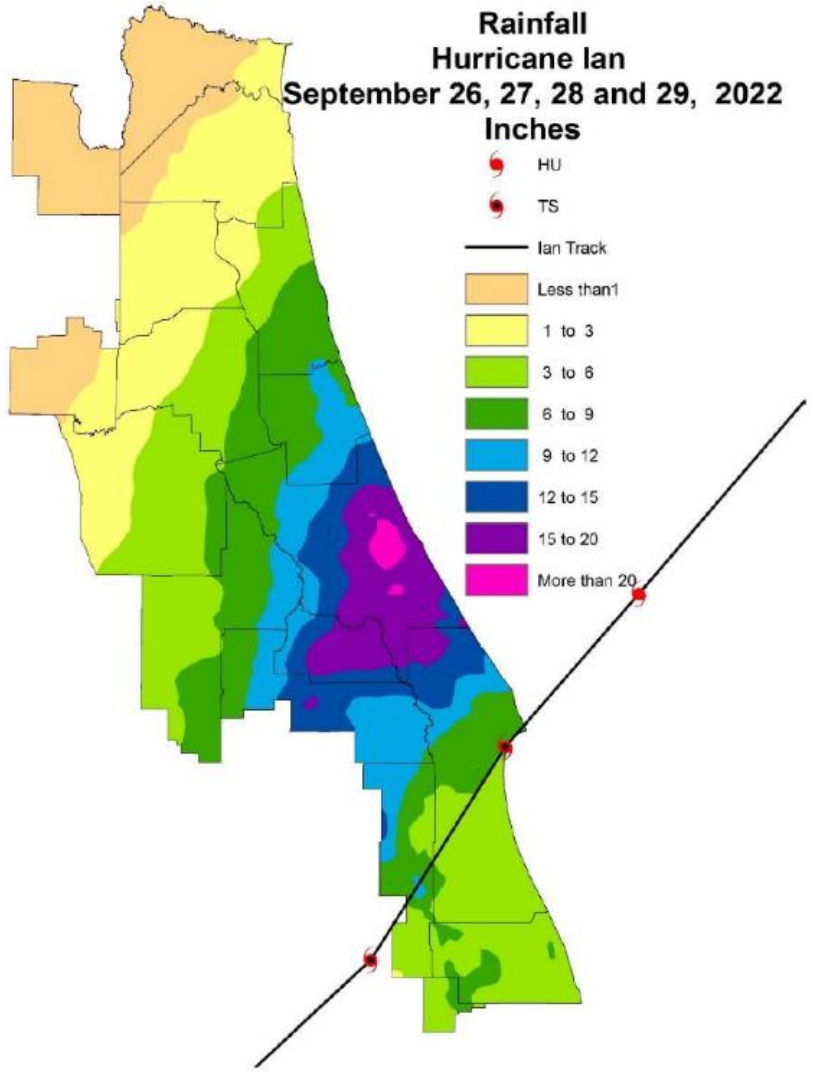


May 23, 2023 BCC Presentation

Question 1 Response

How will climate change affect the rainfall intensity/frequency of storms in the future?

- NOAA expects rainfall volumes to increase by as much as 15% by 2080
- No statistical analysis of historic data indicates a significant change in rainfall volumes, though recent years show larger storms occurring more frequently (post 2010)
- Orange County should consider adopting the NOAA Atlas 14/15 design storm-based rainfall distributions to better accommodate the higher intensity rainfall events (SJRWMD and SFWMD already have)



May 23, 2023 BCC Presentation

Question 2 Response

Are our standard design storm intensities still accurate for future conditions?

- The total rainfall volumes defined in Ordinance 94-4 are adequately represented for "today's" condition and greater than those published in Atlas 14
- The rainfall analysis indicates that higher intensity events are not adequately represented in the County's adopted rainfall distribution (Ordinance 94-4)
- The expected 15% increase in rainfall volume through 2080 is not accounted for in the County's standards as well as most governmental agencies

County Design Storm Depths

Event	Rainfall (inches)
10-year / 6-hour	5.25
25-year / 6-hour	5.75
10-year / 24-hour	7.5
25-year / 24-hour	8.6
100-year / 24-hour	10.6

May 23, 2023 BCC Presentation

Question 3 Response

Are we able to still meet our stormwater Level-of-Service (LOS) criteria in the future using the existing data?

- **No**, there is a current and future concern about meeting the desired Level-of-Service for flood control for the high intensity rainfall events
- To date, integration of climate models has not been accounted for in existing ordinances.
- Recently, communities are beginning to consider the results of climate change in their resiliency studies.

County LOS Criteria

Facility	Design Storm
Canals, ditches, or culverts for drainage external to the development	25-year
Cross drains, storm sewers	10-year
Roadside swales for drainage internal to the development	10-year
Detention basins	25-year
Retention basins (no positive outfall)	100-year

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Summary

- Changing rainfall patterns impact on stormwater management is at the forefront of concerns across the Unites States
- Orange County is one of the leading governments in Florida to evaluate this concern with a recommended plan of action
- The recommended action is to adopt a design storm rainfall distribution with higher peak intensities (inches per hour) for both the 24-hour and 6-hour design storms referenced in County Ordinance 94-4
- If adopted, conveyance systems may need to be upsized for new stormwater infrastructure (cost impact)

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Recommendations: All Design Storms

- Adopt rainfall distributions derived from NOAA 14 Atlas to account for high intensity storms
- Maintain current County design rainfall volumes for all design storms
- Consider revisiting an increase in design rainfall volumes based upon climatic data changes every 10 years

25-year rainfall maxima

Rainfall Duration	Orange County Ordinance 94-4 Rainfall Distribution (inches)	Proposed Orange County Rainfall Distribution (inches)
15 minutes	0.45	1.71
30 minutes	0.89	2.81
1 hour	1.78	3.81
2 hours	3.12	4.81
3 hours	4.30	5.33
6 hours	6.19	6.24
12 hours	7.01	7.25
24 hours	8.60	8.60

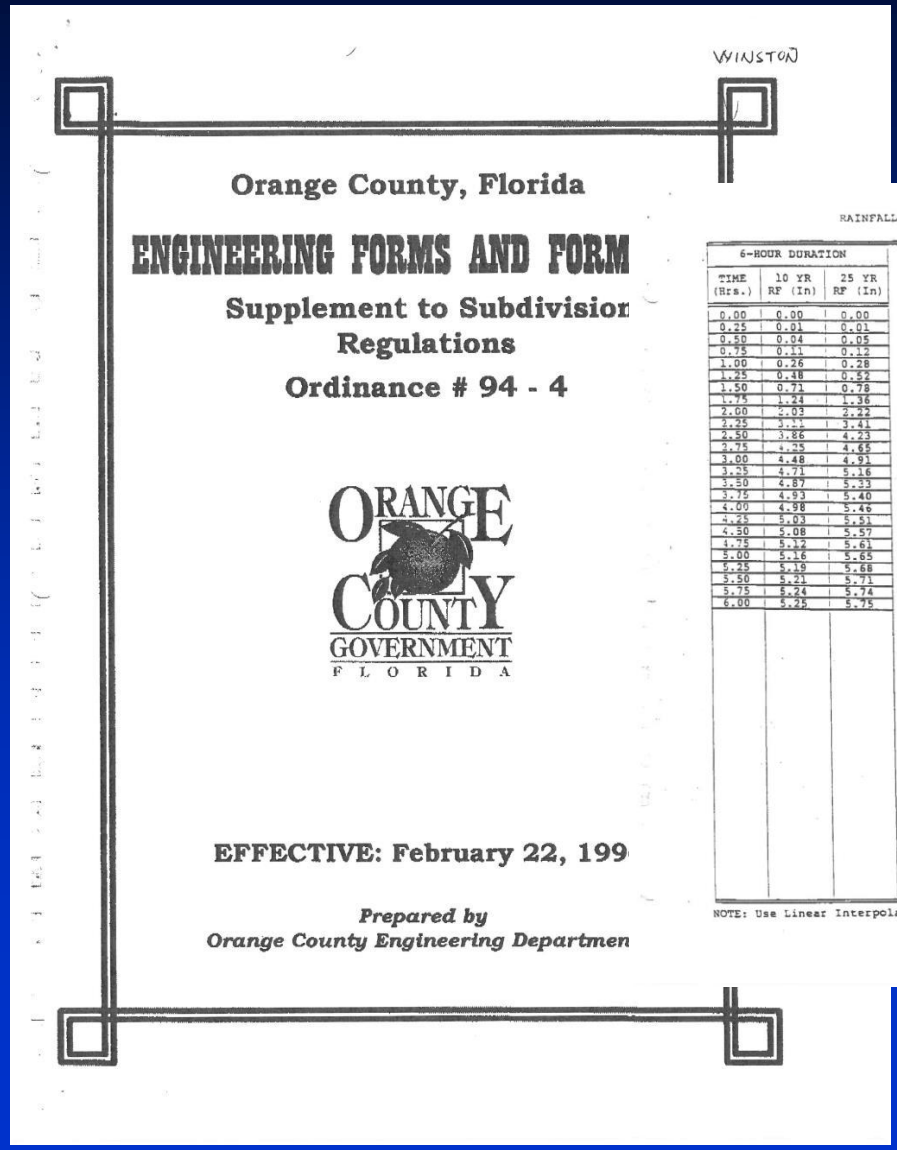
Recommendations: County

- County CIPs can immediately incorporate Atlas 14 rainfall distribution on all new/future projects

- Provides enhanced LOS to County built stormwater systems

Recommendations:
Land Development Applications

- Substitute the Rainfall Distributions derived from NOAA 14 Atlas into Orange County Code
  - Chapter 30 (Site Development)
  - Chapter 34 (Subdivision Regulations)



WINSTON

Orange County, Florida

ENGINEERING FORMS AND FORM

Supplement to Subdivision Regulations

Ordinance # 94 - 4

ORANGE COUNTY GOVERNMENT FLORIDA

EFFECTIVE: February 22, 199

Prepared by
Orange County Engineering Departmen

RAINFALL DISTRIBUTIONS

6-HOUR DURATION			24-HOUR DURATION			
TIME (Hrs.)	10 YR RF (In)	25 YR RF (In)	TIME (Hrs.)	10 YR RF (In)	25 YR RF (In)	100 YR RF (In)
0.00	0.00	0.00	0.0	0.00	0.00	0.00
0.25	0.01	0.01	0.5	0.01	0.01	0.01
0.50	0.04	0.05	1.0	0.02	0.02	0.02
0.75	0.11	0.12	1.5	0.03	0.03	0.04
1.00	0.26	0.28	2.0	0.06	0.07	0.08
1.25	0.48	0.52	2.5	0.10	0.11	0.14
1.50	0.71	0.78	3.0	0.16	0.18	0.22
1.75	1.24	1.36	3.5	0.26	0.29	0.36
2.00	2.03	2.22	4.0	0.37	0.42	0.52
2.25	3.11	3.41	4.5	0.53	0.60	0.74
2.50	3.86	4.23	5.0	0.68	0.78	0.96
2.75	4.25	4.65	5.5	0.85	0.97	1.20
3.00	4.48	4.91	6.0	1.02	1.17	1.44
3.25	4.71	5.16	6.5	1.37	1.57	1.94
3.50	4.87	5.33	7.0	1.77	2.03	2.50
3.75	4.93	5.40	7.5	2.28	2.61	3.22
4.00	4.98	5.46	8.0	2.90	3.32	4.09
4.25	5.03	5.51	8.5	3.68	4.21	5.19
4.50	5.08	5.57	9.0	4.45	5.10	6.29
4.75	5.12	5.61	9.5	5.00	5.73	7.06
5.00	5.16	5.65	10.0	5.52	6.33	7.80
5.25	5.19	5.68	10.5	5.79	6.64	8.18
5.50	5.21	5.71	11.0	6.07	6.96	8.58
5.75	5.24	5.74	11.5	6.24	7.16	8.82
6.00	5.25	5.75	12.0	6.41	7.34	9.05
			12.5	6.57	7.53	9.29
			13.0	6.74	7.72	9.52
			13.5	6.85	7.85	9.68
			14.0	6.95	7.97	9.83
			14.5	7.00	8.02	9.89
			15.0	7.04	8.08	9.95
			15.5	7.08	8.12	10.01
			16.0	7.12	8.16	10.06
			16.5	7.15	8.20	10.10
			17.0	7.19	8.24	10.15
			17.5	7.22	8.28	10.21
			18.0	7.26	8.32	10.26
			18.5	7.29	8.36	10.30
			19.0	7.32	8.39	10.35
			19.5	7.34	8.42	10.38
			20.0	7.37	8.45	10.42
			20.5	7.39	8.47	10.44
			21.0	7.41	8.50	10.47
			21.5	7.43	8.51	10.49
			22.0	7.45	8.54	10.53
			22.5	7.46	8.56	10.55
			23.0	7.49	8.58	10.58
			23.5	7.49	8.59	10.59
			24.0	7.50	8.60	10.60

NOTE: Use Linear Interpolation if smaller time increments are needed.

F8 (BCC Amended/05-13-85)

Next Steps:

- Board Direction to move forward with Ordinance Development
  - Draft ordinance with County Attorney's Office
  - Stakeholder Education
  - Advisory Boards (Summer 2025)
  - Adoption Public Hearings (Late 2025)
    - Planning & Zoning/Local Planning Agency
    - Board of County Commissioners