



# Redesigning Design Rainfall

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# Introduction/Disclaimer

- This presentation is intended to identify parameters of concern for rainfall analysis, and offer a possible approach/resolution.
- This presentation does not answer every issue concerning long duration design precipitation
- Continued collaborative work is needed.



# Design Rainfall Parameters

- Storm Intensity
- Storm Volume
- Storm Duration
- Storm Pattern



# Design Rainfall Parameters

- **STORM INTENSITY**
- **STORM VOLUME**
  - Storm Duration
  - *storm pattern*

# Design Rainfall Parameters

- Storm Intensity
- Storm Volume
- Storm Duration
- **Storm Pattern**



# The Processing (Laundering) of Rainfall Data

- Start out with raw precipitation data (incremental depth and time)
- Determine the maximum annual depth for defined storm durations (for consecutive-day storms requires lumping adjacent rain volume to obtain one total depth)
- Perform the statistical (frequency) analysis (eradicates the original pattern)
- Redistribute the rainfall through contrived temporal patterns

# Single vs. Multiple “Cloudburst” Rainfall Event Considerations

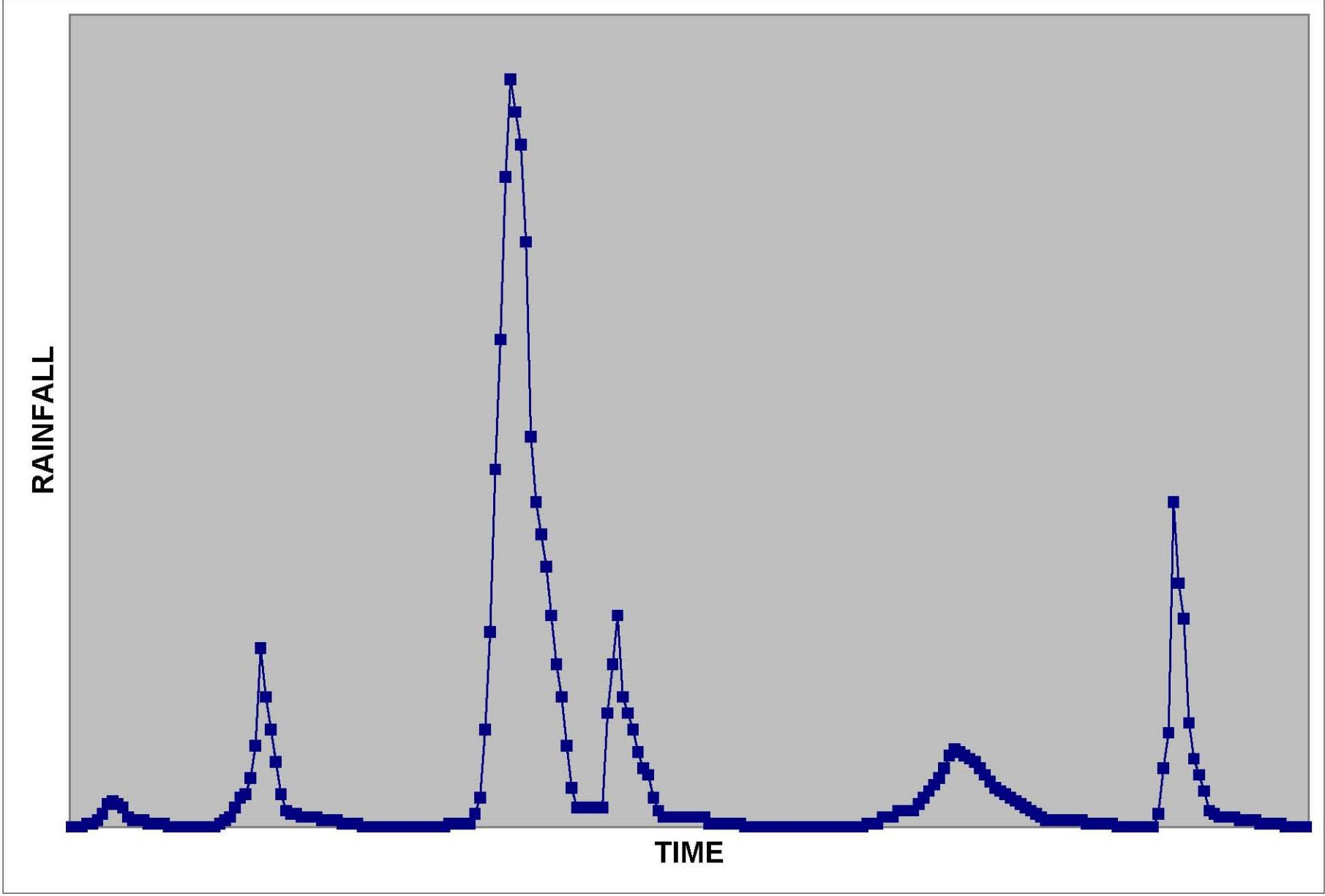
- Design Rainfall should reflect region-specific meteorological patterns, particularly for longer duration events
- Shorter duration (<24 hours) storms typically reflect single cloudburst rainfall
- Longer duration storms should reflect multiple cloudbursts as applicable to the area.

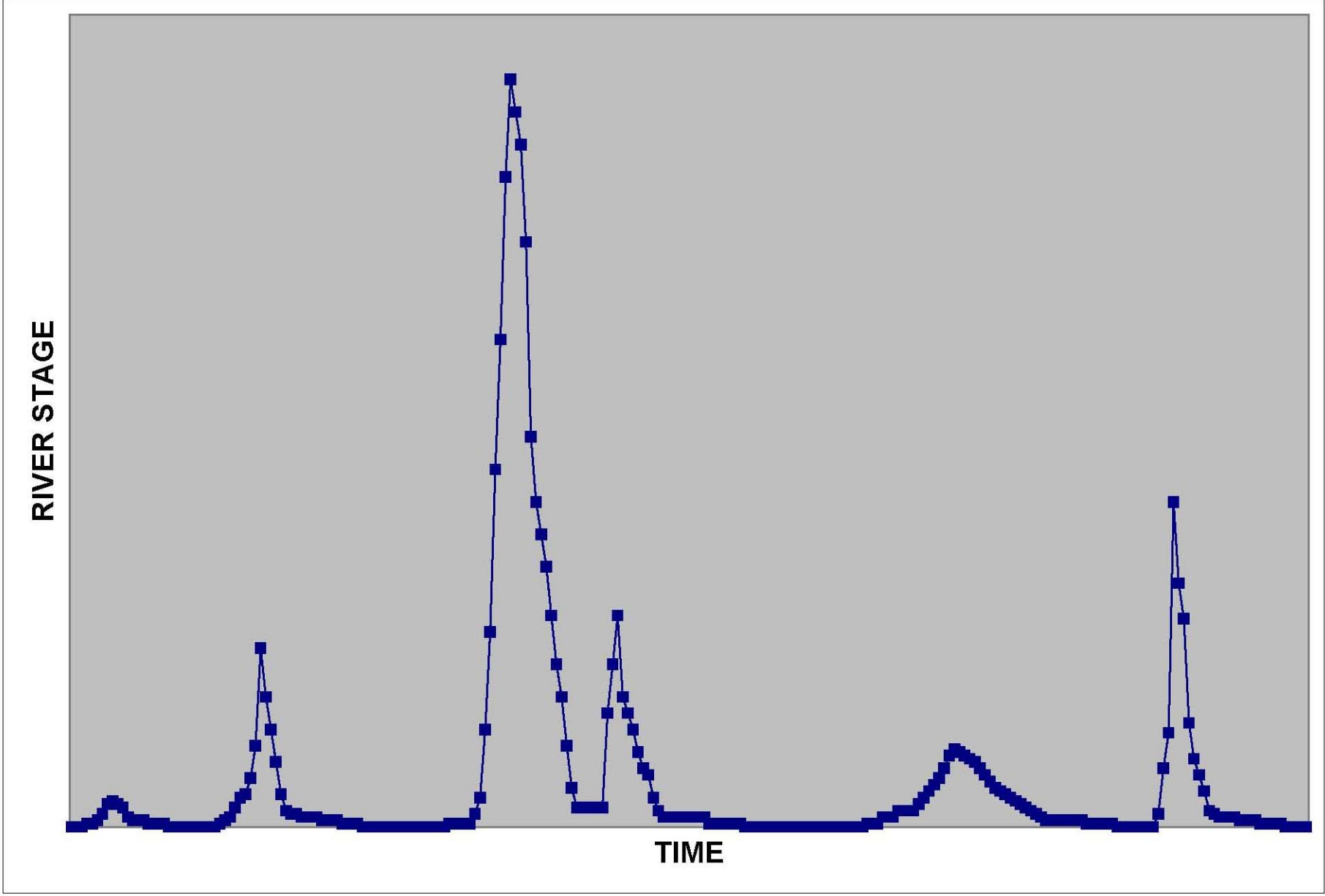
# Conveyance vs. Storage

- Systems governed by conveyance must look at higher intensity, shorter duration storms considering the time of concentration of the watershed
- Systems governed by storage must look at lower intensity, higher volume storms with longer durations.

# High Peak Rainfall Events

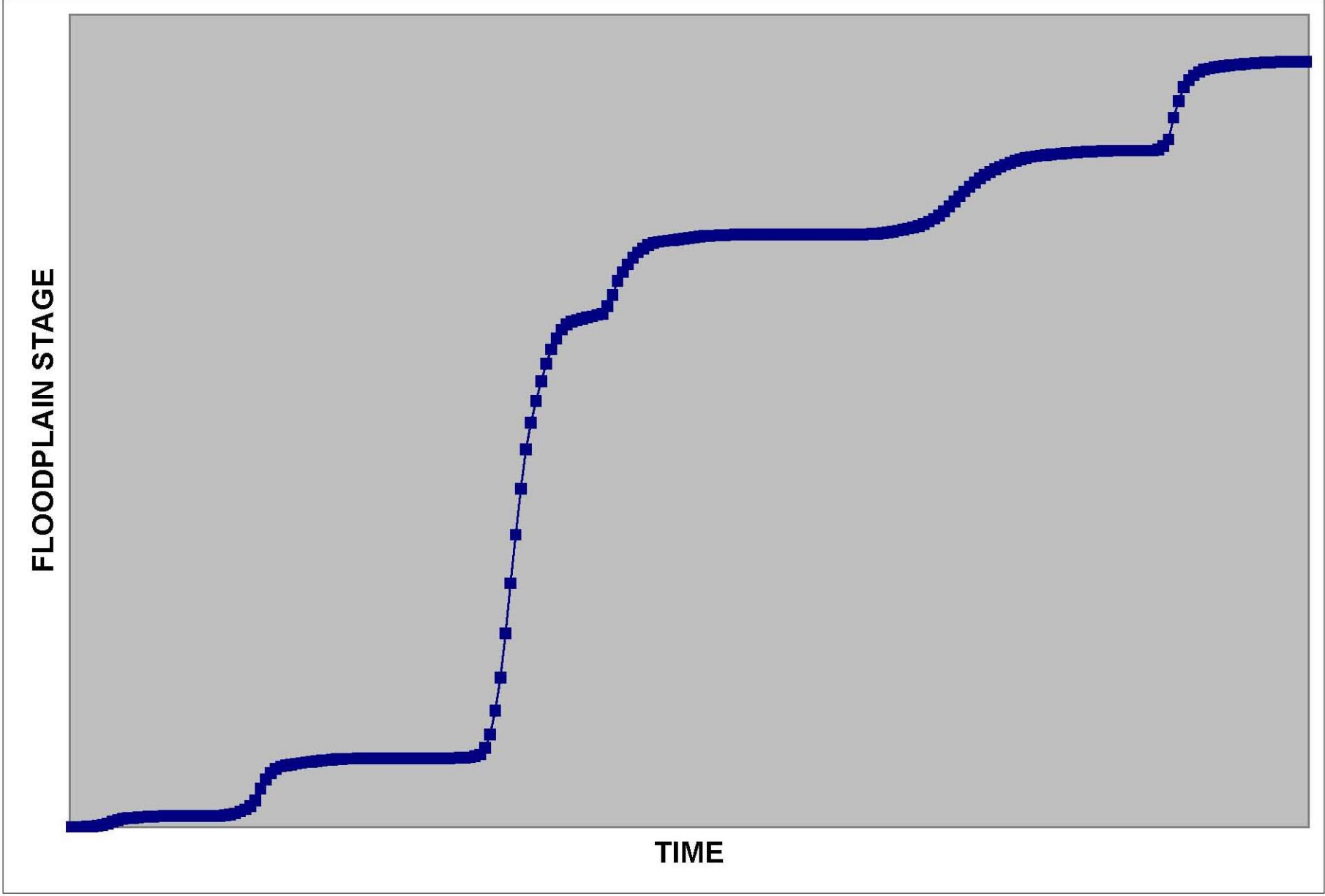
- Single Cloudburst events will generally govern conveyance systems
  - High intensity correlates with high peak flow
  - The design community generally has a good grasp on associating peak rain and peak flow, as a result of direct rainfall/runoff





# High Volume Rainfall Events

- More problematic to define, generally longer storm durations
- Hydraulics and attenuation/storage influence system response.
- Some regions have meteorological conditions for “no break” long events while some have “broken” patterns.



# Example



# Reality Check

- Engineers/hydrologists/statisticians must translate rainfall frequency depths back into realistic storm patterns before applying them to watersheds.



	24-hour	2-day	3-day	4-day	5-day	6-day	7-day	8-day	9-day	10-day
Max Value	4.45	4.65	4.75	6.05	7.25	9.1	9.1	10.12	10.75	11.87
1/1/2100	0.25	0.35	0.35	0.35	0.35	0.49	0.49	0.49	1.27	1.69
1/2/2100	0.1	0.1	0.1	0.1	0.24	0.24	0.24	1.02	1.44	1.44
1/3/2100	0	0	0	0.14	0.14	0.14	0.92	1.34	1.34	1.34
1/4/2100	0	0	0.14	0.14	0.14	0.92	1.34	1.34	1.34	1.34
1/5/2100	0	0.14	0.14	0.14	0.92	1.34	1.34	1.34	1.34	1.34
1/6/2100	0.14	0.14	0.14	0.92	1.34	1.34	1.34	1.34	1.34	1.34
1/7/2100	0	0	0.78	1.2	1.2	1.2	1.2	1.2	1.2	2.22
1/8/2100	0	0.78	1.2	1.2	1.2	1.2	1.2	1.2	2.22	2.22
1/9/2100	0.78	1.2	1.2	1.2	1.2	1.2	1.2	2.22	2.22	4.52
1/10/2100	0.42	0.42	0.42	0.42	0.42	0.42	1.44	1.44	3.74	6.09
1/11/2100	0	0	0	0	0	1.02	1.02	3.32	5.67	5.67
1/12/2100	0	0	0	0	1.02	1.02	3.32	5.67	5.67	5.67
1/13/2100	0	0	0	1.02	1.02	3.32	5.67	5.67	5.67	5.67
1/14/2100	0	0	1.02	1.02	3.32	5.67	5.67	5.67	5.67	10.12
1/15/2100	0	1.02	1.02	3.32	5.67	5.67	5.67	5.67	10.12	10.12
1/16/2100	1.02	1.02	3.32	5.67	5.67	5.67	5.67	10.12	10.12	10.12
1/17/2100	0	2.3	4.65	4.65	4.65	4.65	9.1	9.1	9.1	9.1
1/18/2100	2.3	4.65	4.65	4.65	4.65	9.1	9.1	9.1	9.1	10.22
1/19/2100	2.35	2.35	2.35	2.35	6.8	6.8	6.8	6.8	7.92	9.67
1/20/2100	0	0	0	4.45	4.45	4.45	4.45	5.57	7.32	7.32
1/21/2100	0	0	4.45	4.45	4.45	4.45	5.57	7.32	7.32	7.77
1/22/2100	0	4.45	4.45	4.45	4.45	5.57	7.32	7.32	7.77	9.07
1/23/2100	4.45	4.45	4.45	4.45	5.57	7.32	7.32	7.77	9.07	10.69
1/24/2100	0	0	0	1.12	2.87	2.87	3.32	4.62	6.24	7.36
1/25/2100	0	0	1.12	2.87	2.87	3.32	4.62	6.24	7.36	9.37
1/26/2100	0	1.12	2.87	2.87	3.32	4.62	6.24	7.36	9.37	9.37
1/27/2100	1.12	2.87	2.87	3.32	4.62	6.24	7.36	9.37	9.37	11.87
1/28/2100	1.75	1.75	2.2	3.5	5.12	6.24	8.25	8.25	10.75	10.75
1/29/2100	0	0.45	1.75	3.37	4.49	6.5	6.5	9	9	9
1/30/2100	0.45	1.75	3.37	4.49	6.5	6.5	9	9	9	9.24
1/31/2100	1.3	2.92	4.04	6.05	6.05	8.55	8.55	8.55	8.79	9.16
2/1/2100	1.62	2.74	4.75	4.75	7.25	7.25	7.25	7.49	7.86	7.97
2/2/2100	1.12	3.13	3.13	5.63	5.63	5.63	5.87	6.24	6.35	6.35
2/3/2100	2.01	2.01	4.51	4.51	4.51	4.75	5.12	5.23	5.23	5.28
2/4/2100	0	2.5	2.5	2.5	2.74	3.11	3.22	3.22	3.27	3.27
2/5/2100	2.5	2.5	2.5	2.74	3.11	3.22	3.22	3.27	3.27	3.27
2/6/2100	0	0	0.24	0.61	0.72	0.72	0.77	0.77	0.77	1.31

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1/6/2100	0.14	0.14	0.14	0.92	1.34	1.34	1.34	1.34	1.34	1.34
1/7/2100	0	0	0.78	1.2	1.2	1.2	1.2	1.2	1.2	2.22
1/8/2100	0	0.78	1.2	1.2	1.2	1.2	1.2	1.2	2.22	2.22
1/9/2100	0.78	1.2	1.2	1.2	1.2	1.2	1.2	2.22	2.22	4.52
1/10/2100	0.42	0.42	0.42	0.42	0.42	0.42	1.44	1.44	3.74	6.09
1/11/2100	0	0	0	0	0	1.02	1.02	3.32	5.67	5.67
1/12/2100	0	0	0	0	1.02	1.02	3.32	5.67	5.67	5.67
1/13/2100	0	0	0	1.02	1.02	3.32	5.67	5.67	5.67	5.67
1/14/2100	0	0	1.02	1.02	3.32	5.67	5.67	5.67	5.67	10.12
1/15/2100	0	1.02	1.02	3.32	5.67	5.67	5.67	5.67	10.12	10.12
1/16/2100	1.02	1.02	3.32	5.67	5.67	5.67	5.67	10.12	10.12	10.12
1/17/2100	0	2.3	4.65	4.65	4.65	4.65	9.1	9.1	9.1	9.1
1/18/2100	2.3	4.65	4.65	4.65	4.65	9.1	9.1	9.1	9.1	10.22
1/19/2100	2.35	2.35	2.35	2.35	6.8	6.8	6.8	6.8	7.92	9.67
1/20/2100	0	0	0	4.45	4.45	4.45	4.45	5.57	7.32	7.32
1/21/2100	0	0	4.45	4.45	4.45	4.45	5.57	7.32	7.32	7.77
1/22/2100	0	4.45	4.45	4.45	4.45	5.57	7.32	7.32	7.77	9.07
1/23/2100	4.45	4.45	4.45	4.45	5.57	7.32	7.32	7.77	9.07	10.69
1/24/2100	0	0	0	1.12	2.87	2.87	3.32	4.62	6.24	7.36
1/25/2100	0	0	1.12	2.87	2.87	3.32	4.62	6.24	7.36	9.37
1/26/2100	0	1.12	2.87	2.87	3.32	4.62	6.24	7.36	9.37	9.37
1/27/2100	1.12	2.87	2.87	3.32	4.62	6.24	7.36	9.37	9.37	11.87
1/28/2100	1.75	1.75	2.2	3.5	5.12	6.24	8.25	8.25	10.75	10.75
1/29/2100	0	0.45	1.75	3.37	4.49	6.5	6.5	9	9	9
1/30/2100	0.45	1.75	3.37	4.49	6.5	6.5	9	9	9	9.24
1/31/2100	1.3	2.92	4.04	6.05	6.05	8.55	8.55	8.55	8.79	9.16
2/1/2100	1.62	2.74	4.75	4.75	7.25	7.25	7.25	7.49	7.86	7.97
2/2/2100	1.12	3.13	3.13	5.63	5.63	5.63	5.87	6.24	6.35	6.35
2/3/2100	2.01	2.01	4.51	4.51	4.51	4.75	5.12	5.23	5.23	5.28
2/4/2100	0	2.5	2.5	2.5	2.74	3.11	3.22	3.22	3.27	3.27
2/5/2100	2.5	2.5	2.5	2.74	3.11	3.22	3.22	3.27	3.27	3.27
2/6/2100	0	0	0.24	0.61	0.72	0.72	0.77	0.77	0.77	1.31

# Conclusions

- The hypothetical designed storm for designing facilities or mapping should not amplify portions of longer duration storms to produce bursts that exceed shorter duration statistics.
- More work needs to be done to determine region-specific design storm patterns without violating the rules of nested frequencies

# Recommendations

- Each system should be evaluated for governance of peak (conveyance) or storage and have corresponding hydrology.
- Long duration storms could embed shorter duration cloudbursts and/or patterns, without exceeding shorter frequencies within longer frequencies.

# CONSIDERATIONS FOR POTENTIAL SOLUTIONS

- Evaluate Meteorological Rainfall Distributions
- Define Shorter Duration Distributions and Add Additional Rainfall Bursts to Build Longer Duration Distributions
- Define Shorter Duration Distributions and Redefine Peaks of Long Duration Distributions to Be More “Evenly” Distributed
- Check Frequency Depths to Ensure Consistency While Building the Pattern(s)



Questions?