History of Design Storm Development
What is emerging...
Hydrologic Applications

- 100-yr Design Storm
- Watershed Model
- 100-yr Design Flow
Design Storm Parameters

- Storm Rainfall Depth
- Spatial Distribution
- Temporal Distribution
NOAA Atlas 14
Point Frequency Estimates

Location information:
Name: Eden, Texas, USA*
Latitude: 31.1800°
Longitude: -99.9400°
Elevation: 2109.7 ft **

* Source: ESRI Maps
** Source: USGS

POINT PRECIPITATION FREQUENCY (PF) ESTIMATES
WITH 90% CONFIDENCE INTERVALS AND SUPPLEMENTARY INFORMATION
NOAA Atlas 14, Volume 11, Version 2
<table>
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PDS-based precipitation frequency estimates with 90% confidence intervals (in inches)
Design
Spatial
Distribution
Uniform Distribution
Uniform Distribution
Convert Point to Uniform Areal Estimate

$$D_P F \times D A R F \rightarrow D_A F$$

$$P_{24} F_{10} \times D A R F \rightarrow A_{24} A_{10}$$
Depth Area Reduction Factors

[Image of depth area reduction factors graph from NWS TP 29]

- Percent of point rainfall for given area
- Area (square miles)

- 24-hour
- 6-hour
- 3-hour
- 1-hour
Limited Data

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<tr>
<td>TOTAL</td>
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Ave: 12 years
Temporal Distribution
10-Year, 24-Hour Design Storm
15-Minute Time Steps
NOAA Atlas 14 for Lat. 33.566 deg N and Long. -112.00 deg W

10-Year Frequency
Duration Depth (in)
15 min 0.77
30 min 1.04
1 hour 1.29
2 hour 1.45
3 hour 1.54
6 hour 1.76
12 hour 1.94
24 hour 2.40

Rainfall (in/15 minutes)
Time (Minutes)
New Technology

GEOMETRIC PROPERTIES OF STORMS
Fit ellipses to cells.
Determine geometric properties.

Idealized shape.
Normalized 15-Minute Cell Size

Peak Intensity (iph)
- 8.073
- 6.991
- 6.054
- 5.242
- 4.540
- 3.931
- 3.404
- 2.955
- 2.555
- 2.211
- 1.914
- 1.658
- 1.436
- 1.243
- 1.077
- 0.932
- 0.807
- 0.699
- 0.605
- 0.524
- 0.454
- 0.393
- 0.340
- 0.295
- 0.255
- 0.221

Idealized Cell Shape

% Peak Intensity vs. % 15-Minute Storm Cell Area

- Low Intensity
- High Intensity
Normalized 15-Minute Cell Size

%Peak Intensity vs % 15-Minute Storm Cell Area

Idealized Cell Shape

Characteristic 15-Minute Cell Shape for >2-Year Recurrence

Peak Rainfall Intensity (iph)
- 6.054
- 5.242
- 4.540
- 3.931
- 3.404
- 2.948

Normalized 15-Minute Cell Size Graph
Depth Area Reduction Factors
1-Hour Depth Area Reduction Factor

- 2 yr
- 10 yr
- 25 yr

NWS TP 29

Area (mi²)
Lessons Learned

- Seasonal variation
- Regional variation
- Frequency variation
- Storm type
- Precipitation products used
- DARF methods
- Storm/Watershed size
- Watershed shape
- Climate change
New Statewide Design Storm Studies

Texas

Arizona
Arizona Design Storm Study
Motivation for Texas Storm Study

Blanco River at Wimberley, Texas

- 100-Year Estimate
- 95% Confidence Limits
- Annual Peak Flows

Variation equals 20-feet of Depth

Current 100-yr Estimate

1997 100-yr Estimate

C. Landon Erickson, P.E., USACE FTW
Texas Storm Study Objective

Develop a new method(s) to better characterize complex design storms so that the results from single event and longer duration continuous simulations for larger watersheds (>200 mi²) will produce frequency peak discharges results that are accurate and consistent with rainfall return values for the state of Texas.
Texas Design Storm Considerations

Texas Rainfall

Texas River Basins

Legend: (in inches)
- 14 to 20
- 10 to 14
- 5 to 10
- 2 to 5
- 0 to 2

Texas Major River Basins, Coastal Basins and Major Bays

- Houston Ship Canal
- Brazos River Basin
- Trinity River Basin
- Colorado River Basin
- Trinity-Effort Canal Basin
- San Bernard River Basin
- Galveston Bay
- Matagorda Bay
- South Bay
- Corpus Christi Bay
- Laguna Madre
Design Storm vs Basin Shape
Texas Design Storm

1. Develop regional approaches considering:
   - Storm type,
   - Climatology,
   - Meteorology,
   - Topography,
   - Coastal influence,
   - Geographical extent,
   - Watershed size/Shape

2. Identify homogeneous regions.

We’ve come a long way.
Thanks for Listening!

DAVID C. CURTIS, WEST CONSULTANTS, DCURTIS@WESTCONSULTANTS.COM
Fundamental Question

- How do we measure rainfall?

8” rain gage opening
0.00000001253 mi²
Inverse Distance Weighting
Data points taken from Cases 1-5 from Geronimo, 2004, radar based DARF study in the Denver, CO, area.
Dynamic Design Storm Processor
10-Year, 24-Hour Design Storm

15-Minute Time Steps

NOAA Atlas 14 for Lat. 33.566 deg N and Long. -112.00 deg W

Target Design Storm

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<th>Duration</th>
<th>Depth (in)</th>
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10-Year, 24-Hour Design Storm
15-Minute Time Steps
NOAA Atlas 14 for Lat. 33.566 deg N and Long. -112.00 deg W

Standard Nested Design Storm Distribution

Dynamic Design Storm Processor Output

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National Comparison (I)

Areal Reduction Factors by HUC02 using PRISM-daily data and M5 fitting
1-day Duration | 10-y Return Period

- 01 (New England)
- 02 (Mid Atlantic)
- 03 (South Atlantic-Gulf)
- 04 (Great Lakes)
- 05 (Ohio)
- 06 (Tennessee)
- 07 (Upper Mississippi)
- 08 (Lower Mississippi)
- 09 (Souris-Red-Rainy)
- 10 (Missouri)
- 11 (Arkansas-White-Red)
- 12 (Texas-Gulf)
- 13 (Rio Grande)
- 14 (Upper Colorado)
- 15 (Lower Colorado)
- 16 (Great Basin)
- 17 (Pacific Northwest)
- 18 (California)

![Map of the United States with HUC02 regions highlighted.](image-url)
National Comparison (II)

Areal Reduction Factors by HUC02 using PRISM-daily data and M5 fitting
1-day Duration

- Avg. AMS
- 10-y
- 100-y

ARF
- 0.54 - 0.56
- 0.56 - 0.58
- 0.58 - 0.60
- 0.60 - 0.62
- 0.62 - 0.64
- 0.64 - 0.66
- 0.66 - 0.68
- 0.68 - 0.70
- 0.70 - 0.72
- 0.72 - 0.74
- 0.74 - 0.76
- 0.76 - 0.78
- 0.78 - 0.80
- 0.80 - 0.82
- 0.82 - 0.84
- 0.84 - 0.86
- 0.86 - 0.88
- 0.88 - 0.90
- 0.90 - 0.92
- 0.92 - 0.94
- 0.94 - 0.96
- 0.96 - 0.98