Westlawn Cemetery Detention

ORSDM Update

Perrin Niemann, P.E.

Sediment and Erosion Control Seminar

February 13, 2025

Little Papillion Creek

Omaha Regional Stormwater Design Manual

1 – Introduction

2 – Hydrology

3 – Storm Drainage System

4 – Design of Culverts

5 – Open Channels

6 – Storage Facilities

7 – Energy Dissipators

8 – Stormwater Best Management Practices

9 – Erosion and Sediment Control

Purpose is "to provide guidance to design engineers, hydrologists, water quality specialists, and others involved in the management of stormwater runoff."

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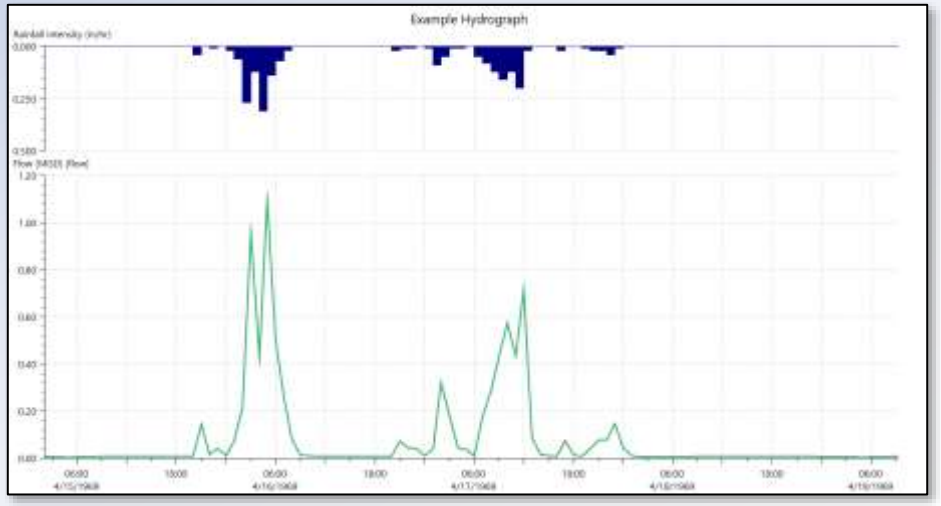
Chapter 2 - Hydrology

- Hydrology is the study of water in the environment
- Chapter 2 provides guidance on estimating how much of a storm's precipitation turns into runoff and developing hydrographs
- The hydrograph is then used to design stormwater facilities
- Estimation errors can result in wrong facility sizes:
  - Undersizing could cause flooding
  - Oversizing increases costs



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Omaha's Design Storms

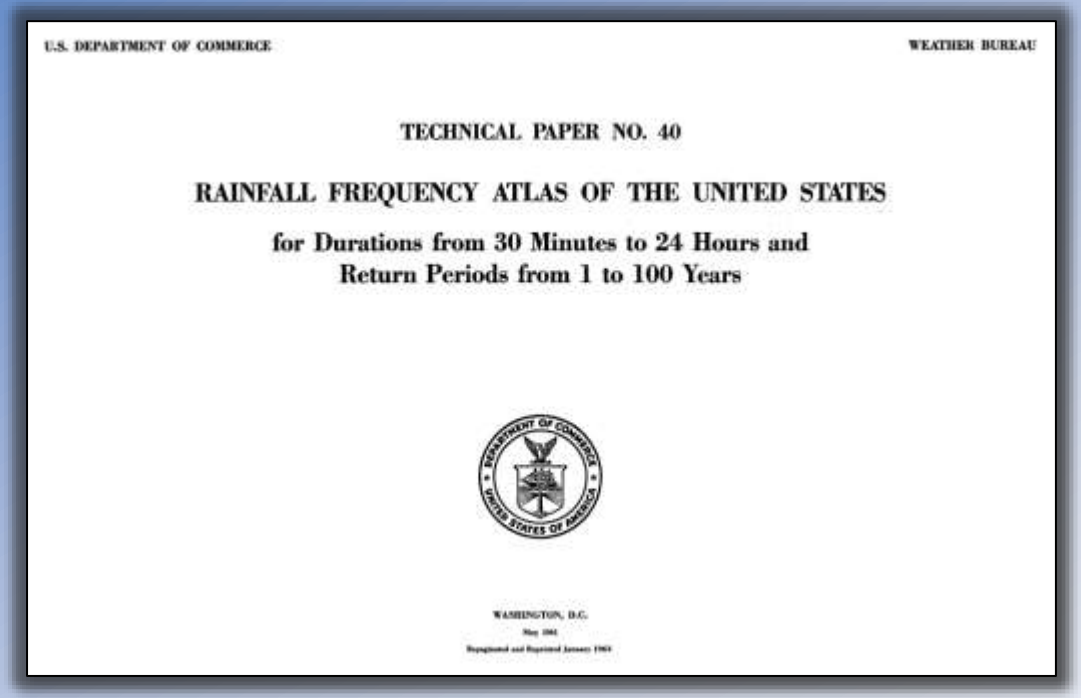
- Design storms are often named with return periods
- 100-year storm has an exceedance probability of 1%
- Detention and retention facilities need to manage the 2-, 10-, and 100-year storms
- Storm pipes and inlets: 10-year storm
- Cross drainage (under roadways): 50-year storm

Omaha's Current 24-Hour Design Storms

Return Period	24-Hour Depth (in)	24-Hour Intensity (in/hr)
2-year	3.0	0.125
5-year	3.9	0.163
10-year	4.6	0.192
25-year	5.3	0.221
50-year	6.0	0.250
100-year	6.7	0.279

Design Storm Precipitation Depth

- Current ORSDM uses data from Technical Paper No. 40 (1961)
- Update uses data from NOAA Atlas 14 (2013)



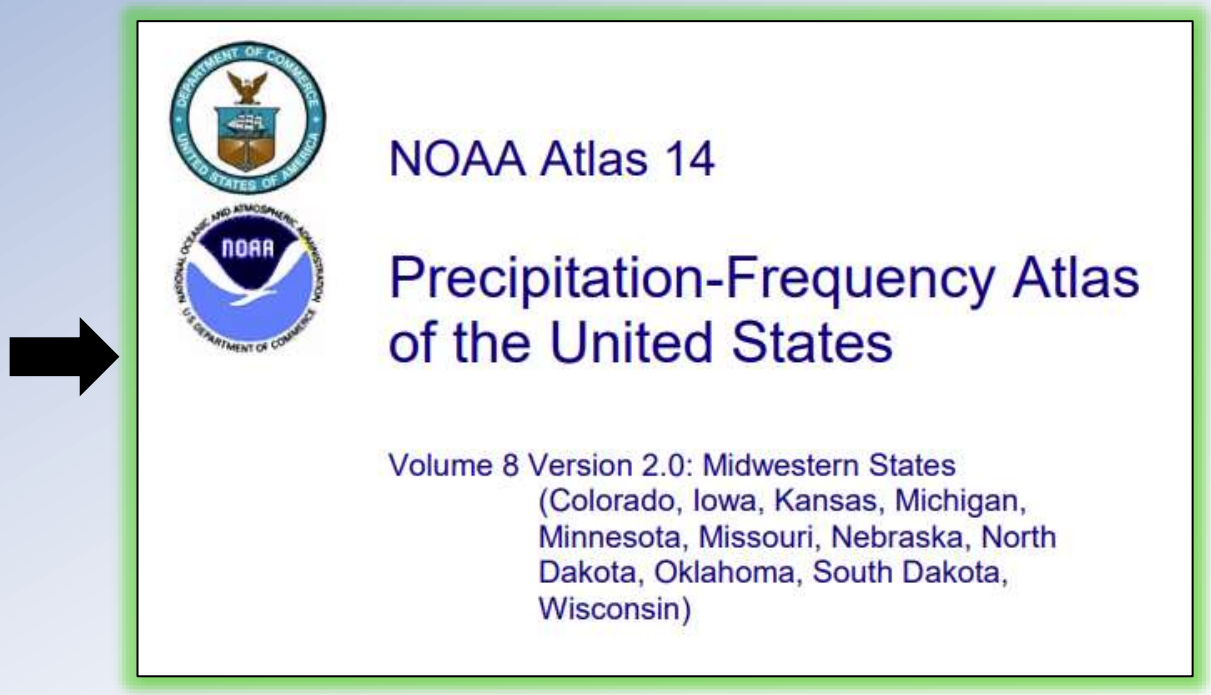
U.S. DEPARTMENT OF COMMERCE — WEATHER BUREAU

TECHNICAL PAPER NO. 40

RAINFALL FREQUENCY ATLAS OF THE UNITED STATES

for Durations from 30 Minutes to 24 Hours and
Return Periods from 1 to 100 Years

WASHINGTON, D.C.



NOAA Atlas 14

Precipitation-Frequency Atlas of the United States

Volume 8 Version 2.0: Midwestern States
(Colorado, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Oklahoma, South Dakota, Wisconsin)

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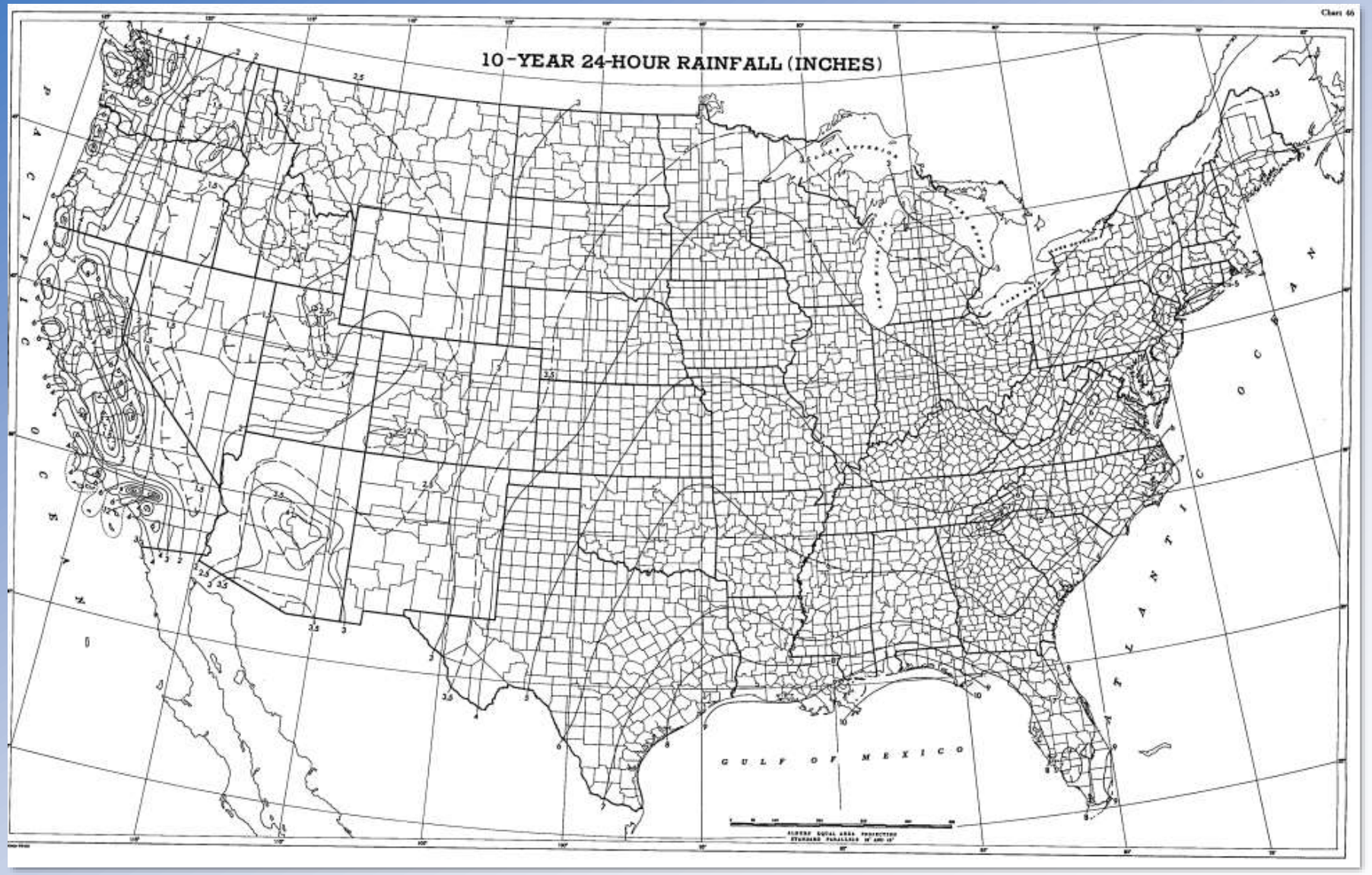
Superseded Publications

- Weather Bureau's Technical Paper No. 40
  - *Rainfall Frequency Atlas of the United States for Durations from 30 Minutes to 24 Hours and Return Periods from 1 to 100 Years* (Hershfield, 1961)
- Weather Bureau's Technical Paper No. 49
  - *Two- to Ten-Day Precipitation for Return Periods of 2 to 100 Years in the Contiguous United States* (Miller, 1964)
- NOAA Technical Memorandum NWS HYDRO-35
  - *Five- to 60-Minute Precipitation Frequency for the Eastern and Central United States* (Frederick et al., 1977)

How We Used Tech Paper No. 40…



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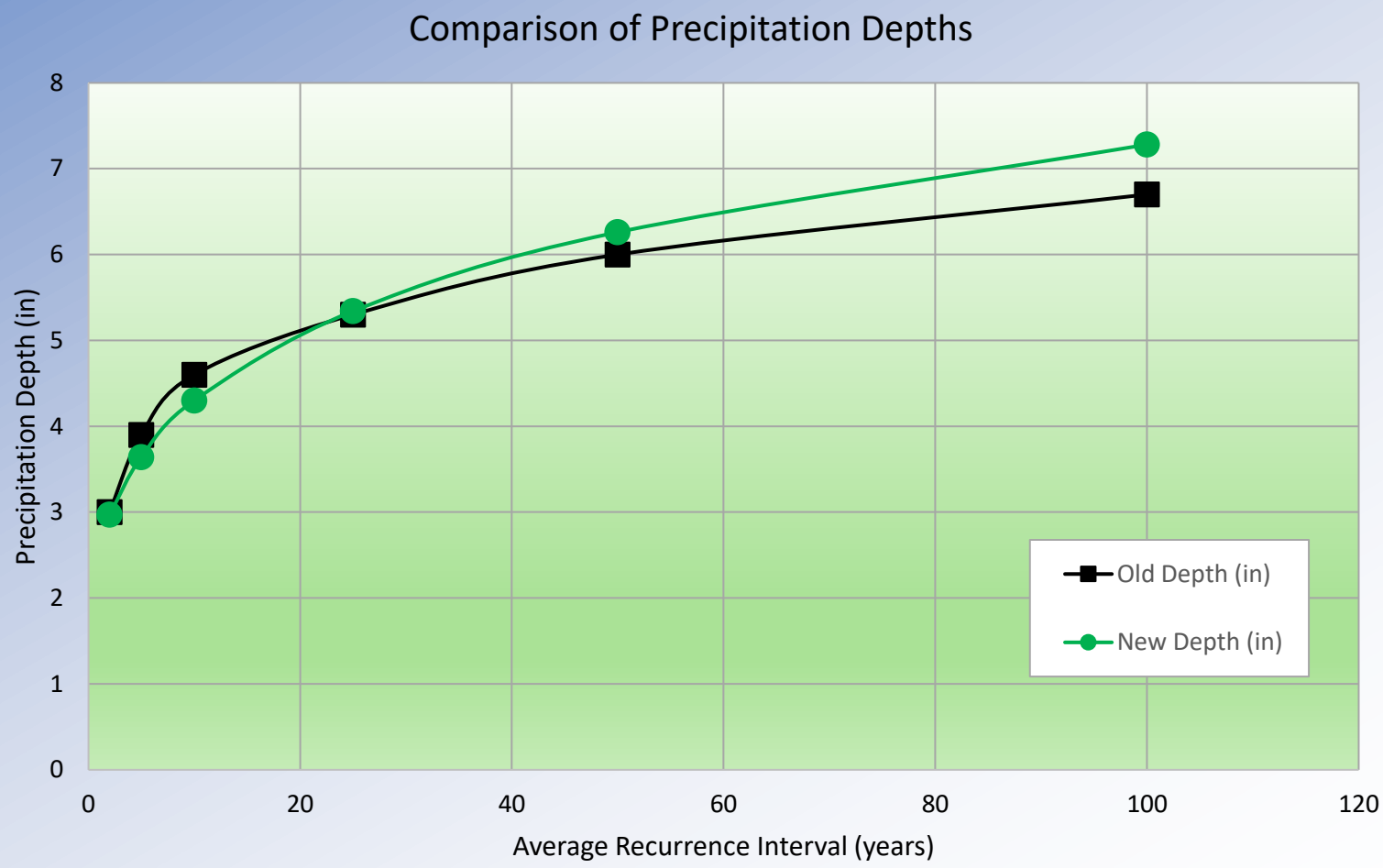
NOAA Atlas 14

- Newer and more comprehensive precipitation data
- Daily, hourly, sub-hourly data set record lengths:
  - Daily data – 18 to 159 years
  - Hourly data – 19 to 69 years
  - Sub-hourly data – 19 to 43 years
- Volume 8 (Midwest) used over 400 rain gauge data sets in Nebraska
- Data are available from NOAA's Precipitation Frequency Data Server
- Can be generated for specific NE stations, by lat/lon, or by address

Comparison of Rainfall Depths (24-hr duration)

Return Period	Tech Paper No. 40	Atlas 14 (Eppley Airfield)
2-year	3.0 in	2.97 in
5-year	3.9 in	3.64 in
10-year	4.6 in	4.30 in
25-year	5.3 in	5.34 in
50-year	6.0 in	6.26 in
100-year	6.7 in	7.28 in



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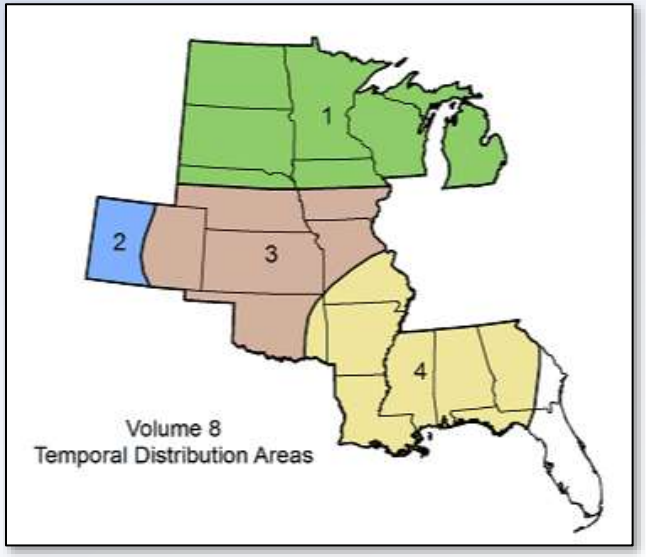
Design Storm Temporal Distribution

- A temporal distribution describes how rain occurs over time
- Current ORSDM specifies use of SCS Type II distribution
- Use of Type II distribution with Atlas 14 rain data could lead to errors
- Nebraska NRCS is working on a supplement to the Engineering Field Handbook, Chapter 2 (Estimating Runoff and Peak Discharges)



Source: NOAA

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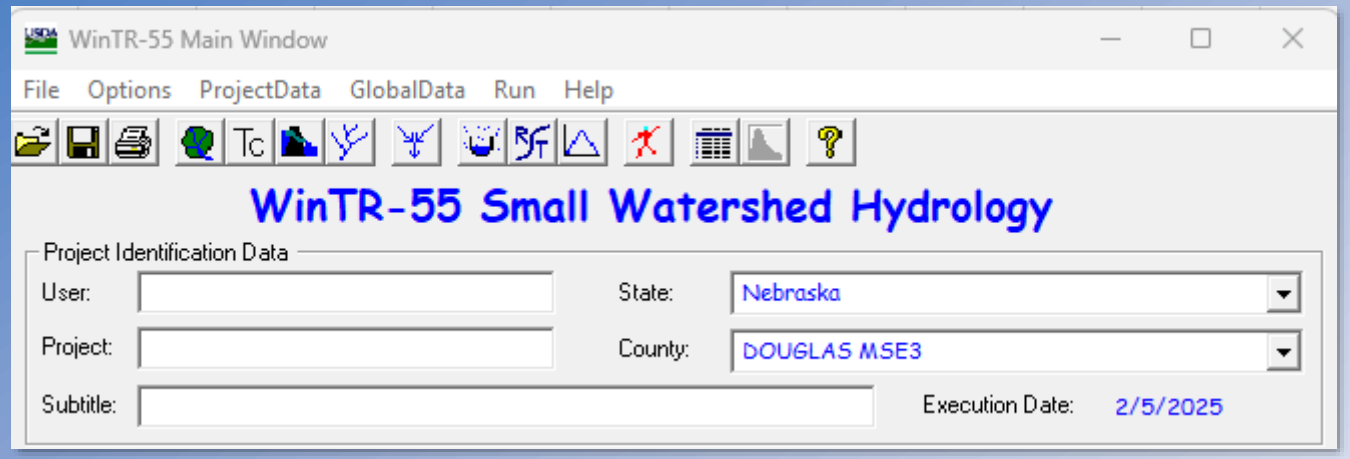
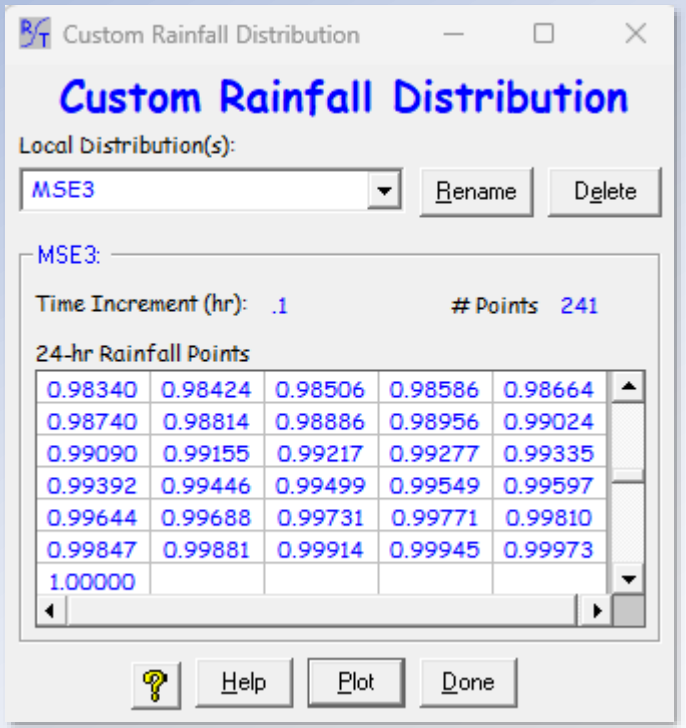
Distribution Incorporated Into Some Software



Source: WinTR-55



Source: WinTR-55

- Also WinTR-20, EFH-2, HydroCAD, maybe others
- User-defined distributions also possible
  - e.g., Innovyze provides a .xpx file for download

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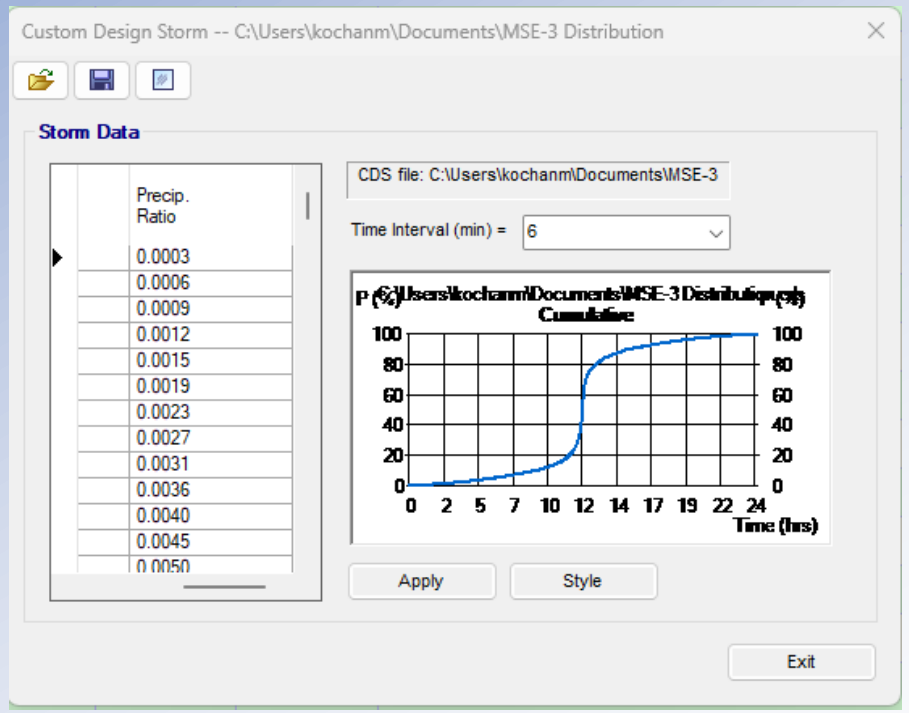
Custom Design Storm – Civil 3D/Hydraflow

- Not just a "button press" like SCS Type II
- A custom design storm must be created to use the MSE3 Distribution
- ORSDM Update will describe the step-by-step process for creating the custom distribution
- May look into providing a spreadsheet for download



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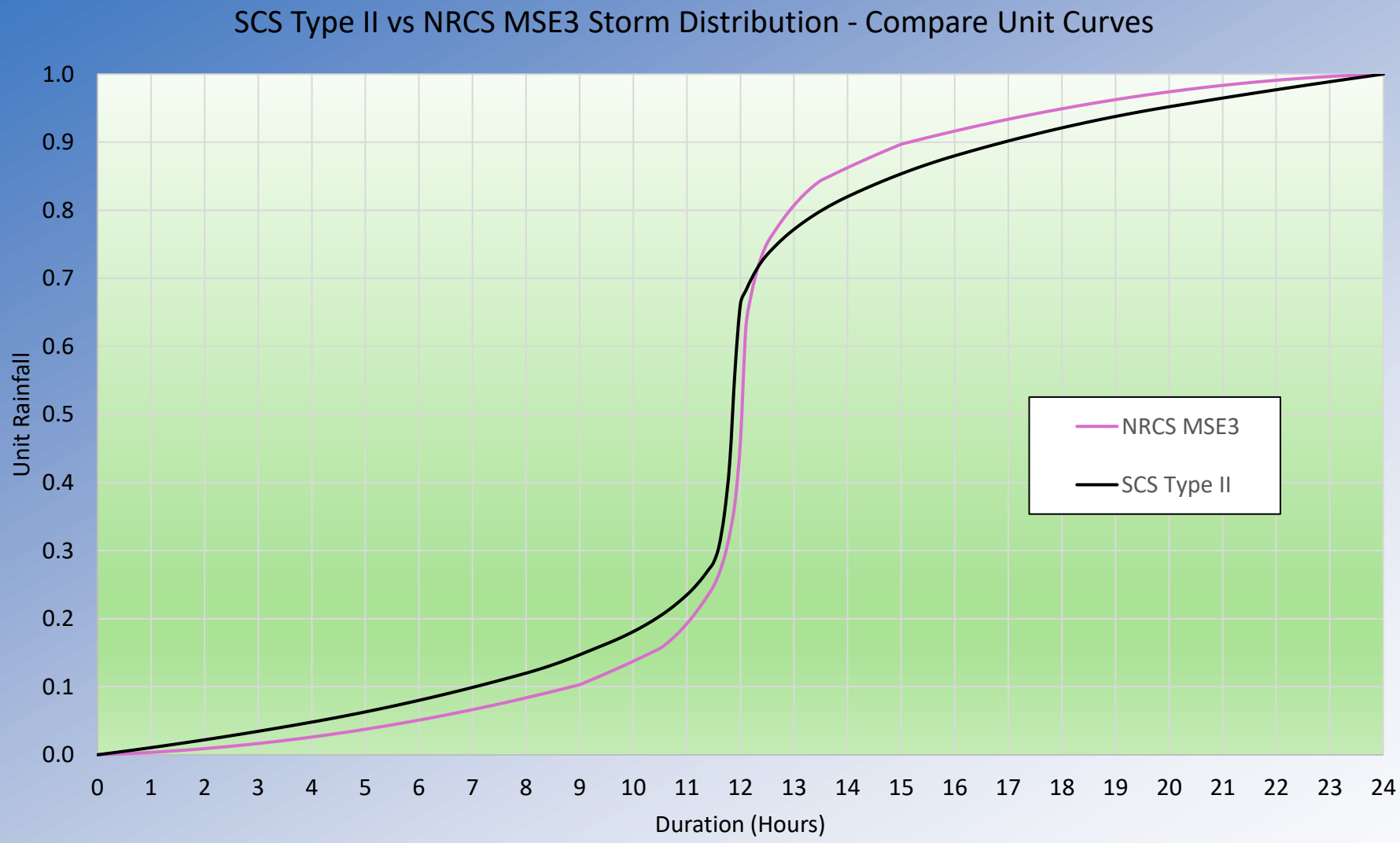
Comparison of 24-Hour Cumulative Distributions



- Curves are similar and will result in similar hydrograph shapes

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How Will the Changes Impact Flows/Volumes?

- Compared TP-40/SCS Type II to Atlas 14/MSE3 (10-yr & 100-yr events)
- 10-yr rain depth went down, but 100-yr depth went up
- Temporal rainfall distributions are very similar
- Results are dependent on individual variables, but generally we found:
  - 10-yr storm: slight decrease in peak flows and runoff volumes
  - 100-yr storm: higher peak flows and runoff volumes

Other Changes to Chapter 2 – Hydrology

- Triangular Hydrograph Equation has been removed
  - Early/simplistic approach; much better tools available now
- Simplified SCS Method has been removed (graphical/tabular estimation approach)
  - Method was developed specifically for SCS rainfall distributions
- Travel time for sheet flow – equation/approach updated.
  - Previous equation embedded assumptions that were valid for only a limited range of precipitation intensities

Chapter 6 – Storage Facilities

- Updating language and providing information per current design trends, consistency, etc.
- Clarifying submittal requirements to facilitate design review
  - ORSDM currently focuses on manual/hand calculations
  - Many designers use computer programs
- Adding example storage facility design using AutoCAD Civil 3D with Hydraflow Hydrographs Extension
- Enhancing instructions for outlet structure design and drawdown curves
- Engineers must use appropriate judgment

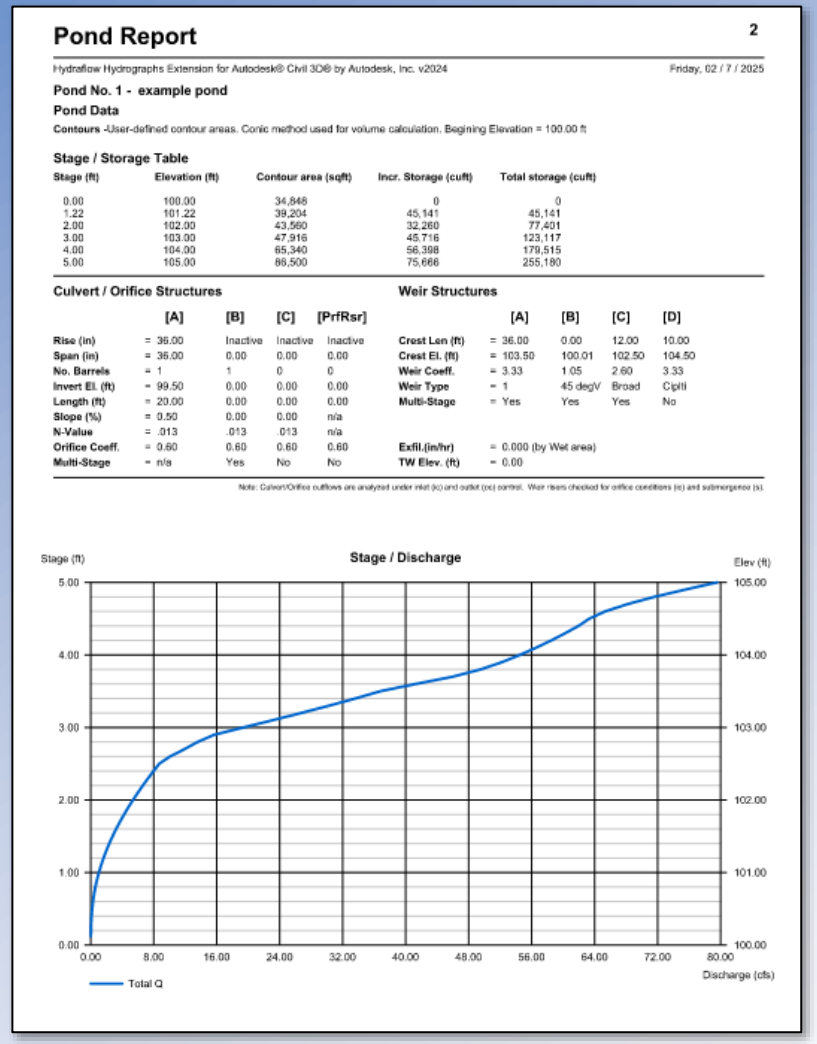
Chapter 6 – Submittal Requirements

Adding a detailed list of information and exhibits to include for design reviews for storage facilities, such as:

- Summary tables comparing pre-development flows at the downstream study point to post-developed routed flows through the detention basin or BMP
- Pond sizing tables/graphs/drawings
- Contributing drainage area exhibits
- Outlet control structure detail drawings
- Plan view and section view of detention riser structure
- Drawdown curves

Chapter 6 – Example Submittal Items

- Pond Reports:
  - Stage-storage table
  - Combined stage-discharge graph
  - Outlet structure sizes
  - Hydrographs



Pond Report 2

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2024 Friday, 02 / 7 / 2025

Pond No. 1 - example pond

Pond Data

Contours -User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 100.00 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	100.00	34,848	0	0
1.22	101.22	39,204	45,141	45,141
2.00	102.00	43,560	32,260	77,401
3.00	103.00	47,916	45,716	123,117
4.00	104.00	65,340	56,398	179,515
5.00	105.00	86,500	75,666	255,180

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 36.00	Inactive	Inactive	Inactive
Span (in)	= 36.00	0.00	0.00	0.00
No. Barrels	= 1	1	0	0
Invert El. (ft)	= 99.50	0.00	0.00	0.00
Length (ft)	= 20.00	0.00	0.00	0.00
Slope (%)	= 0.50	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	Yes	No	No

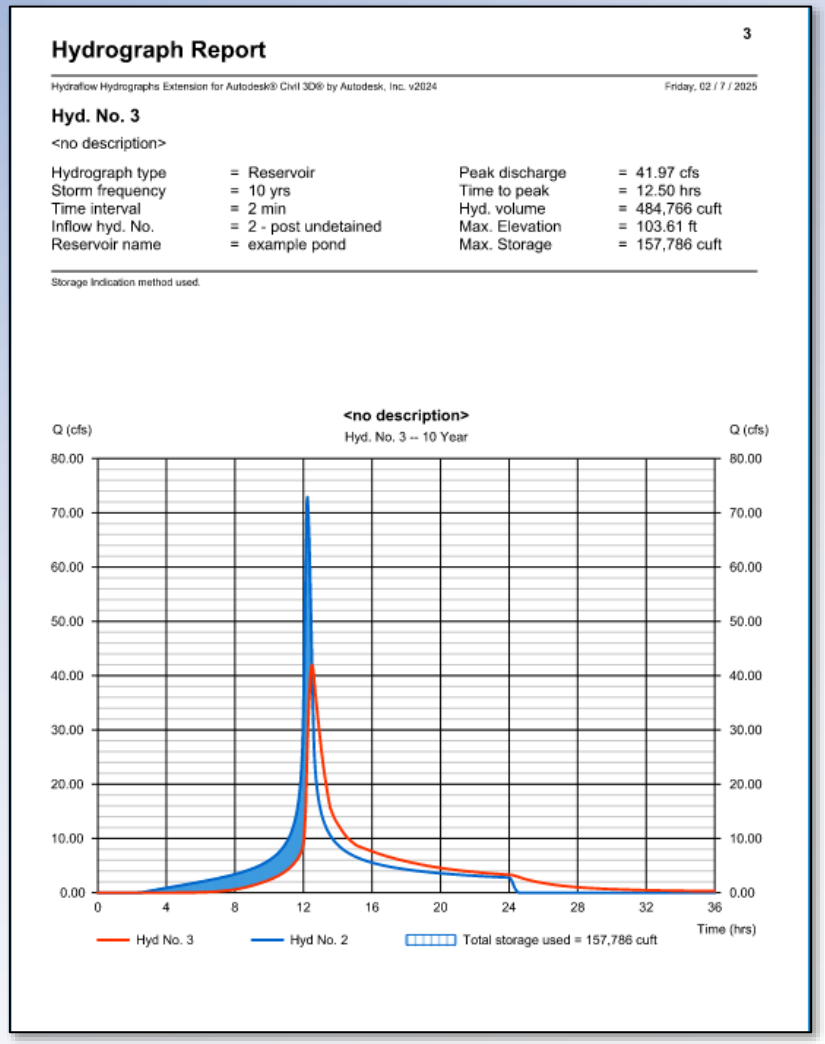
Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 36.00	0.00	12.00	10.00
Crest El. (ft)	= 103.50	100.01	102.50	104.50
Weir Coeff.	= 3.33	1.05	2.60	3.33
Weir Type	= 1	45 degV	Broad	Cipiti
Multi-Stage	= Yes	Yes	Yes	No

Exfil.(in/hr) = 0.000 (by Wet area)

TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).



Hydrograph Report 3

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2024 Friday, 02 / 7 / 2025

Hyd. No. 3

<no description>

Hydrograph type	= Reservoir	Peak discharge	= 41.97 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.50 hrs
Time interval	= 2 min	Hyd. volume	= 484,766 cuft
Inflow hyd. No.	= 2 - post undetained	Max. Elevation	= 103.61 ft
Reservoir name	= example pond	Max. Storage	= 157,786 cuft

Storage Indication method used.

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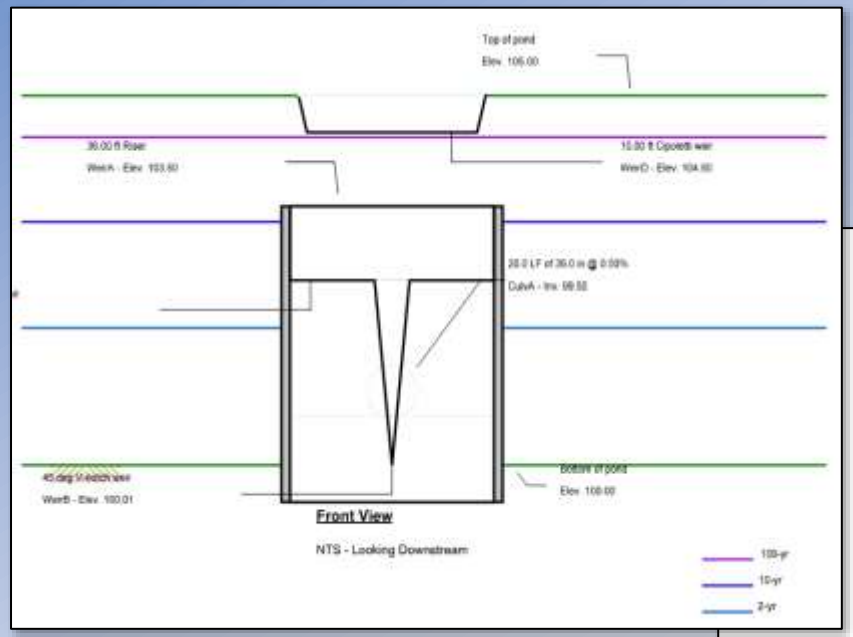
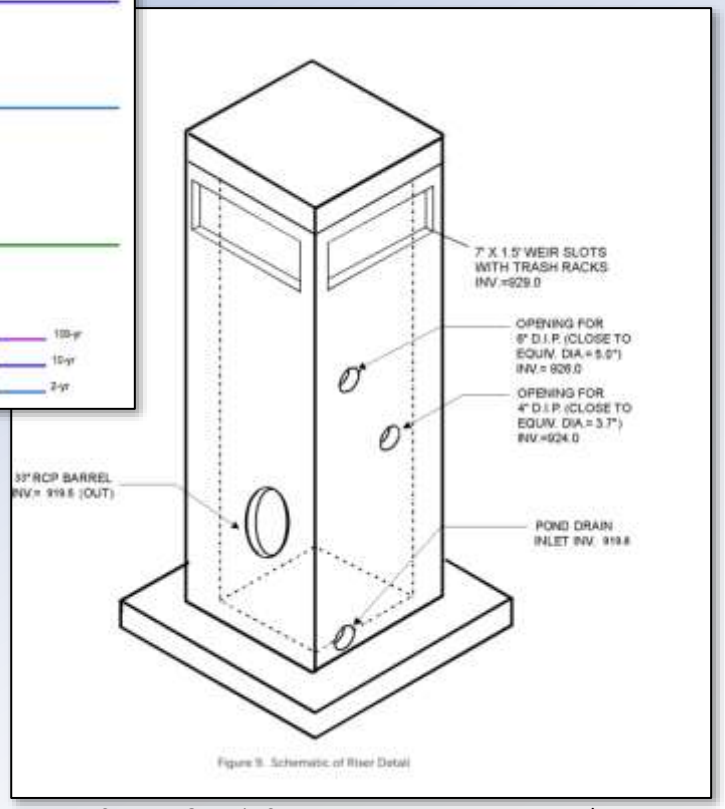
Chapter 6 – Example Submittal Items

- Compound outlet control structure detail:
  - Water surface elevations (2, 10, 100 yr)
  - Outfall invert elevations
  - Pond top/bottom elevations





Source: Georgia Stormwater Management manual technical handbook – Vol 2 p.504

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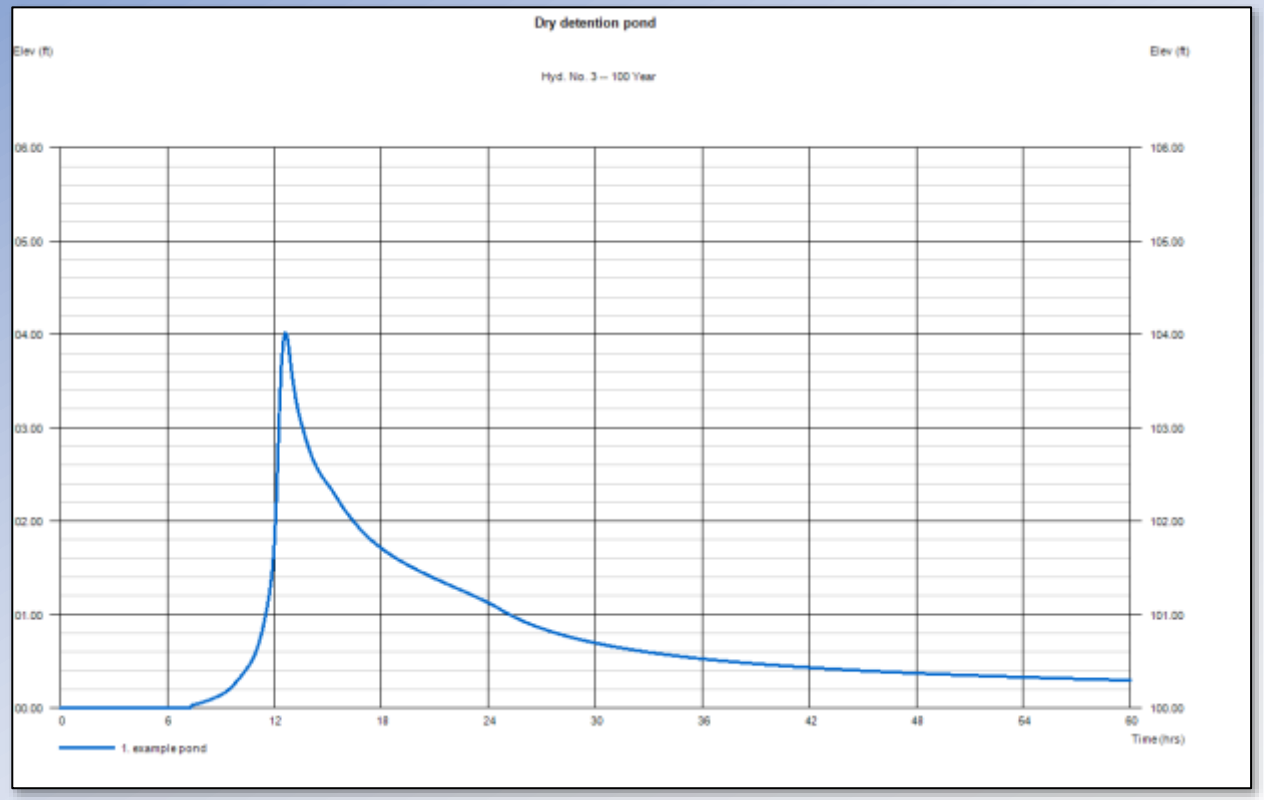
Chapter 6 – Example Submittal Items

- Drawdown curves for each design storm
- Calculations to demonstrate min/max requirements for detention periods



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Still to Come…

- City is working on updates to:
  - Chapter 8 (Stormwater Best Management Practices)
  - Chapter 9 (Erosion and Sediment Control)
  - Minor corrections, reference updates
- Keep an eye out for an opportunity to comment on the updates. Will be posted on City's website.
- Questions? Contact Selma Kessler, Selma.Kessler@CityofOmaha.org

Miller Park outfall to Pershing Basin

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Questions?