Tips for Using Atlas 14 – Precipitation Data Frequency Server

April 5, 2013

MnDOT Bridge Hydraulics

Outline

- Precipitation Frequency Data Server
  - Note slides currently use Illinois data because as of April 1 Minnesota data has not been published. This will be updated once Minnesota data published
- Rainfall Distributions
- Intensity-Duration-Frequency data for Rational Method
- Resources

NOAA Atlas 14

- National Oceanic and Atmospheric Administration (NOAA) is working on project to update precipitation frequency information for the US
- This replaces TP-40 and Hydro-35 for design precipitation information
- Data will be provided through the Precipitation Frequency Data Server (PFDS)

NOAA Atlas 14 – Impacts to Transportation Design

Precipitation Frequency data is used with rainfall/runoff methods

- NRCS/Hydrograph methods
- Rational Method

Does not affect statistical flow models

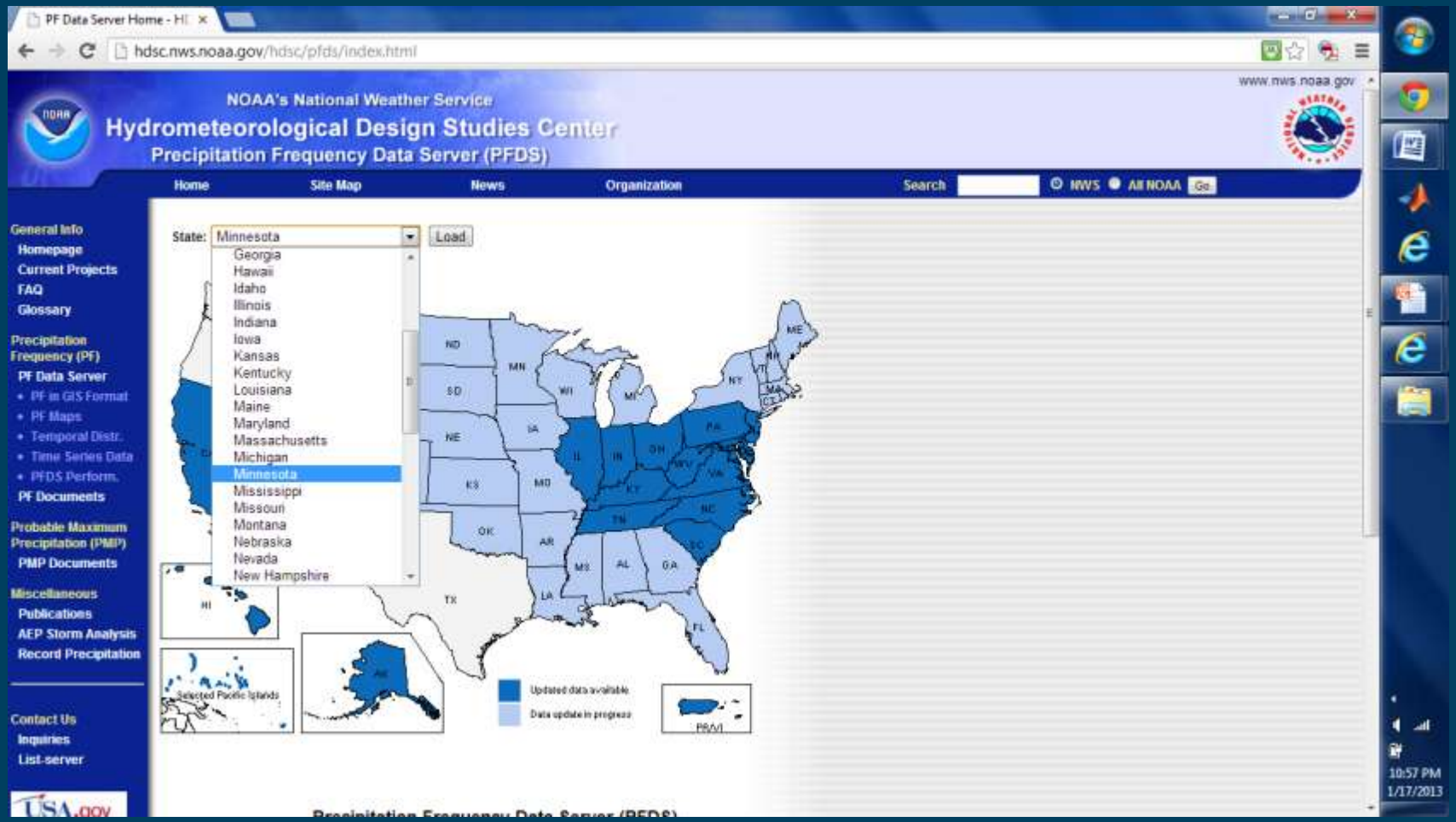
- USGS Regression Equations
- Gauges

Unknown impacts for Water Quality Design

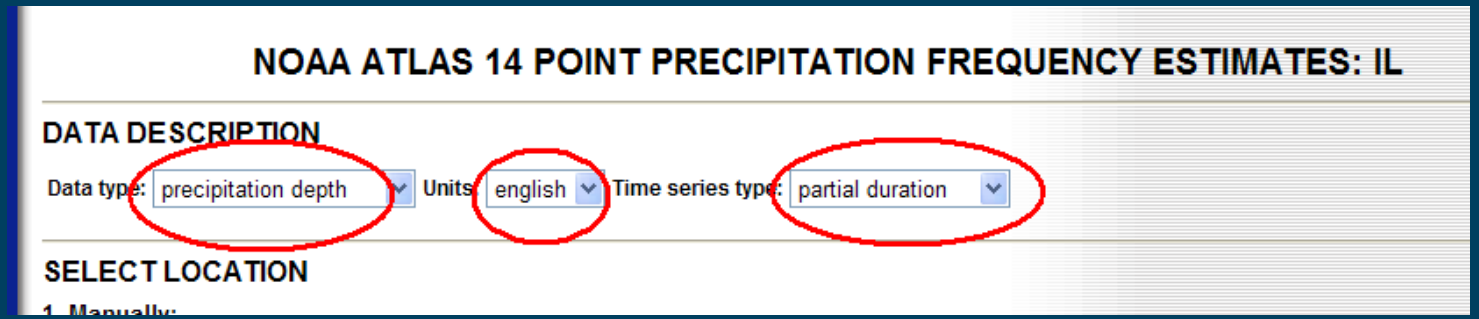
NOAA Precipitation Frequency Data Server (PFDS)

- http://hdsc.nws.noaa.gov/hdsc/pfds/
- Select State
- Data Description – use defaults
- Get Location Options
  - Use tools to navigate to
  - Enter latitude longitude
  - Select Station

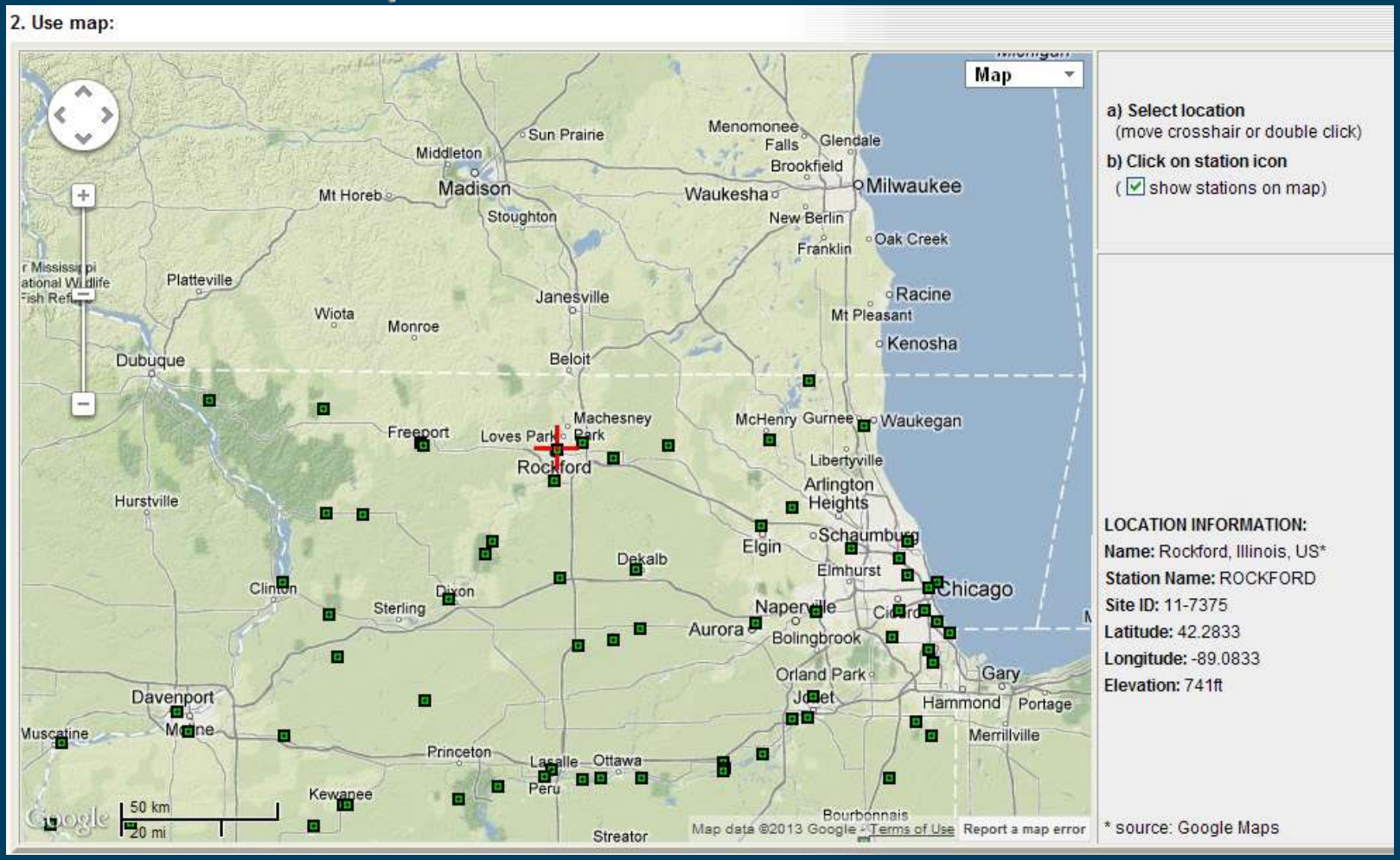
Once Data released, go to website and select Minnesota



Upper Part – select depth, English and partial duration



Enter location/Select Station/Navigate on Map to select location – move red cross or double click on map



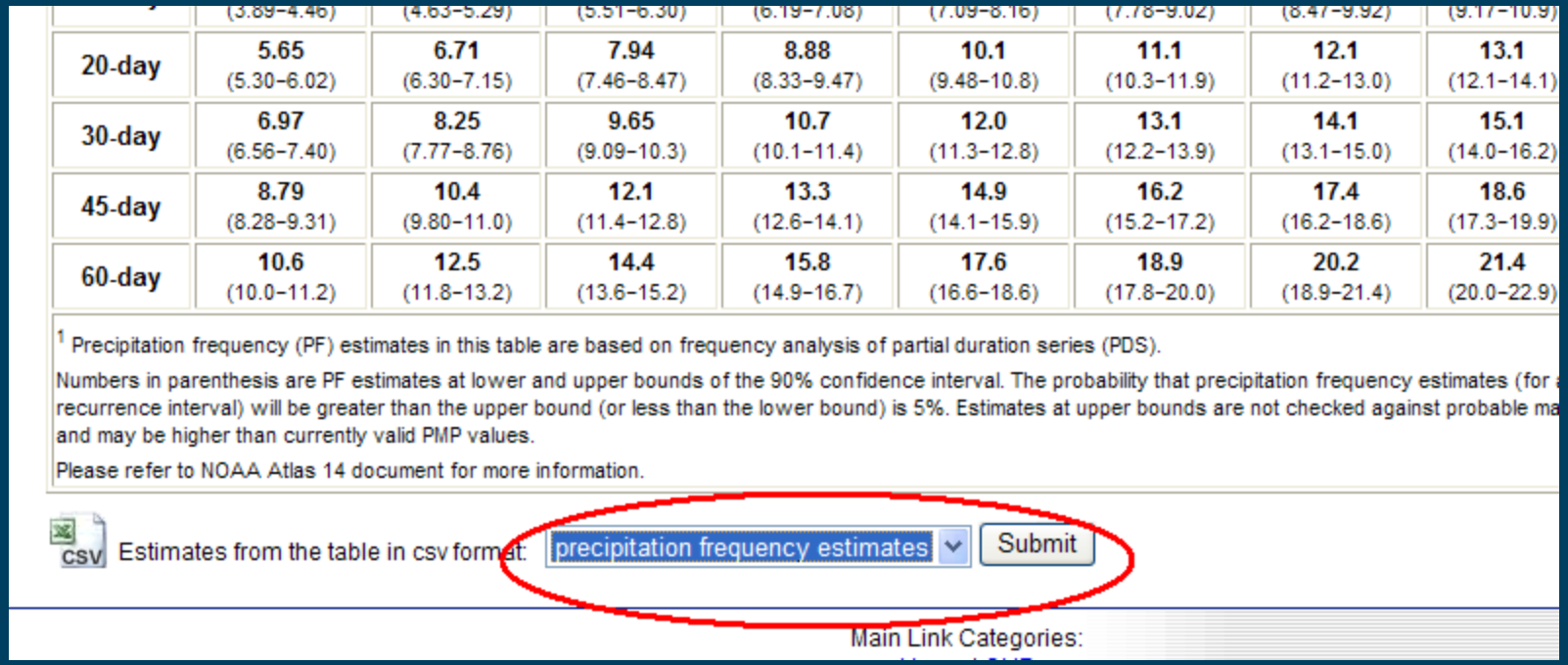
Depth/Duration/Frequency at bottom of page along with 90% confidence interval

PF tabular | PF graphical | Supplementary information | Print Page

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	0.236 (0.165–0.307)	0.290 (0.203–0.377)	0.366 (0.256–0.475)	0.426 (0.298–0.554)	0.510 (0.357–0.664)	0.578 (0.405–0.751)	0.648 (0.454–0.843)	0.728 (0.509–0.946)	0.832 (0.582–1.08)	0.911 (0.638–1.19)
10-min	0.413 (0.289–0.537)	0.508 (0.355–0.660)	0.640 (0.448–0.832)	0.745 (0.522–0.969)	0.893 (0.625–1.16)	1.01 (0.708–1.32)	1.[illegible] (0.794–[illegible])	1.27 (0.891–1.66)	1.46 (1.02–1.89)	1.60 (1.12–2.07)
15-min	0.590 (0.413–0.767)	0.725 (0.508–0.943)	0.914 (0.640–1.19)	1.07 (0.745–1.38)	1.28 (0.893–1.66)	1.45 (1.01–1.88)	1.[illegible] (1.14–[illegible])	1.82 (1.27–2.37)	2.08 (1.46–2.70)	2.28 (1.60–2.96)
30-min	0.826 (0.579–1.07)	1.02 (0.711–1.32)	1.28 (0.896–1.66)	1.49 (1.04–1.94)	1.79 (1.25–2.32)	2.02 (1.42–2.63)	2.[illegible] (1.59–[illegible])	2.55 (1.78–3.31)	2.91 (2.04–3.79)	3.19 (2.23–4.15)
60-min	1.18 (0.826–1.54)	1.45 (1.02–1.89)	1.83 (1.28–2.38)	2.13 (1.49–2.77)	2.55 (1.79–3.32)	2.89 (2.02–3.76)	3.[illegible] (2.27–[illegible])	3.64 (2.55–4.73)	4.16 (2.91–5.41)	4.56 (3.19–5.92)
2-hr	1.34 (0.940–1.75)	1.66 (1.16–2.15)	2.10 (1.47–2.73)	2.45 (1.71–3.18)	2.94 (2.06–3.82)	3.33 (2.33–4.32)	3.[illegible] (2.61–[illegible])	4.19 (2.93–5.44)	4.79 (3.35–6.23)	5.24 (3.67–6.82)
3-hr	1.50 (1.05–1.96)	1.86 (1.30–2.42)	2.36 (1.66–3.07)	2.76 (1.93–3.59)	3.32 (2.32–4.31)	3.76 (2.63–4.89)	4.[illegible] (2.96–[illegible])	4.74 (3.31–6.16)	5.41 (3.79–7.04)	5.93 (4.15–7.70)
6-hr	1.85 (1.30–2.41)	2.31 (1.61–3.00)	2.94 (2.06–3.82)	3.44 (2.41–4.47)	4.15 (2.90–5.39)	4.71 (3.30–6.13)	5.[illegible] (3.71–[illegible])	5.97 (4.18–7.76)	6.84 (4.79–8.89)	7.51 (5.25–9.76)
12-hr	2.12 (1.48–2.75)	2.62 (1.83–3.41)	3.34 (2.34–4.35)	3.94 (2.76–5.12)	4.79 (3.35–6.23)	5.50 (3.85–7.14)	6.[illegible] (4.37–8.12)	7.14 (5.00–9.28)	8.32 (5.82–10.8)	9.21 (6.44–12.0)
24-hr	2.[illegible] (1.67–[illegible])	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]28 ([illegible]–8.17)	7.20 (5.04–9.37)	8.35 (5.84–10.8)	9.85 (6.90–12.8)	11.0 (7.70–14.3)
2-day	2.73	3.34	4.23	4.97	6.06	6.97	7.94	9.12	10.7	11.9

Go to Bottom of Table to export Table as a csv file



	(3.89–4.46)	(4.63–5.29)	(5.51–6.30)	(6.19–7.08)	(7.09–8.16)	(7.78–9.02)	(8.47–9.92)	(9.17–10.9)
20-day	5.65 (5.30–6.02)	6.71 (6.30–7.15)	7.94 (7.46–8.47)	8.88 (8.33–9.47)	10.1 (9.48–10.8)	11.1 (10.3–11.9)	12.1 (11.2–13.0)	13.1 (12.1–14.1)
30-day	6.97 (6.56–7.40)	8.25 (7.77–8.76)	9.65 (9.09–10.3)	10.7 (10.1–11.4)	12.0 (11.3–12.8)	13.1 (12.2–13.9)	14.1 (13.1–15.0)	15.1 (14.0–16.2)
45-day	8.79 (8.28–9.31)	10.4 (9.80–11.0)	12.1 (11.4–12.8)	13.3 (12.6–14.1)	14.9 (14.1–15.9)	16.2 (15.2–17.2)	17.4 (16.2–18.6)	18.6 (17.3–19.9)
60-day	10.6 (10.0–11.2)	12.5 (11.8–13.2)	14.4 (13.6–15.2)	15.8 (14.9–16.7)	17.6 (16.6–18.6)	18.9 (17.8–20.0)	20.2 (18.9–21.4)	21.4 (20.0–22.9)

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

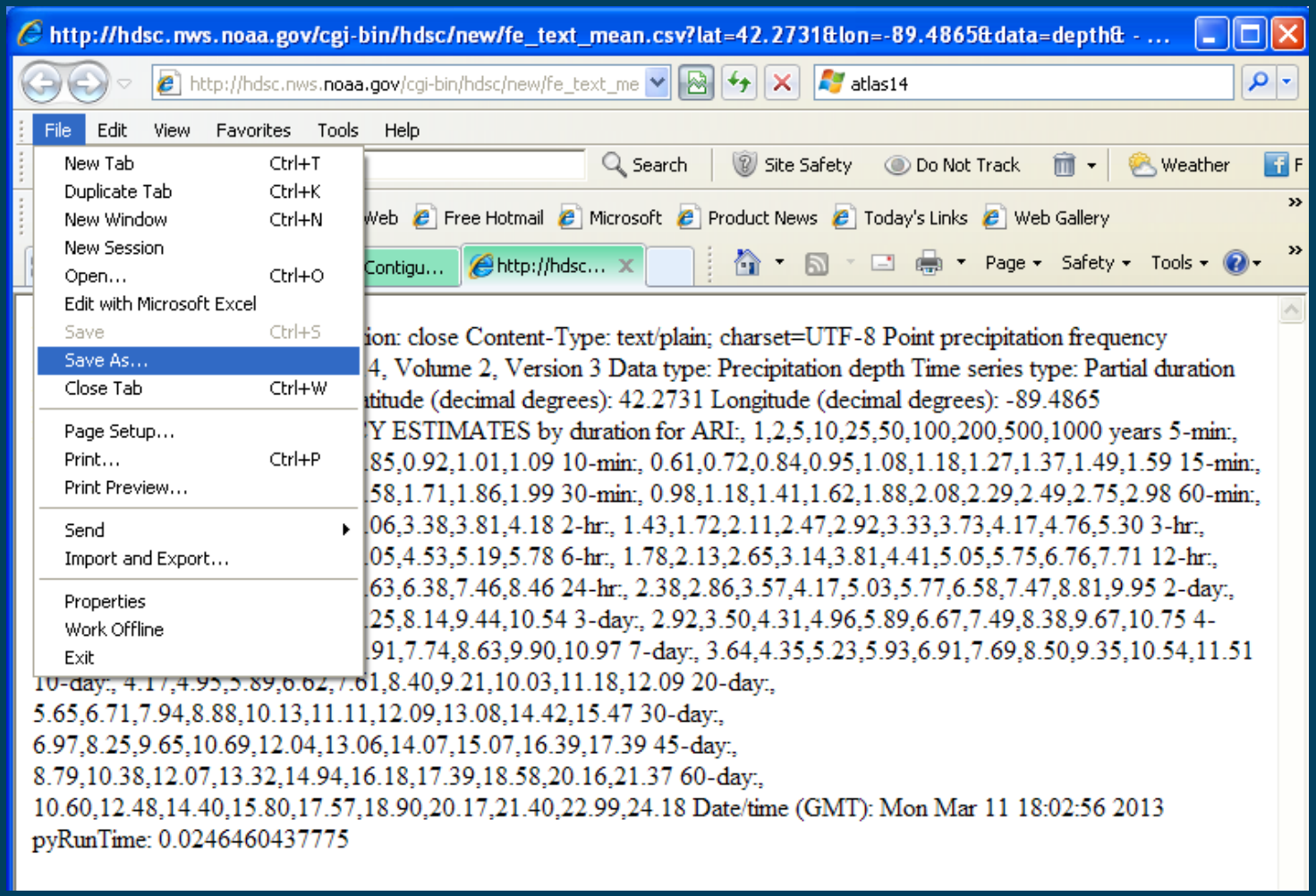
Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against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

Please refer to NOAA Atlas 14 document for more information.

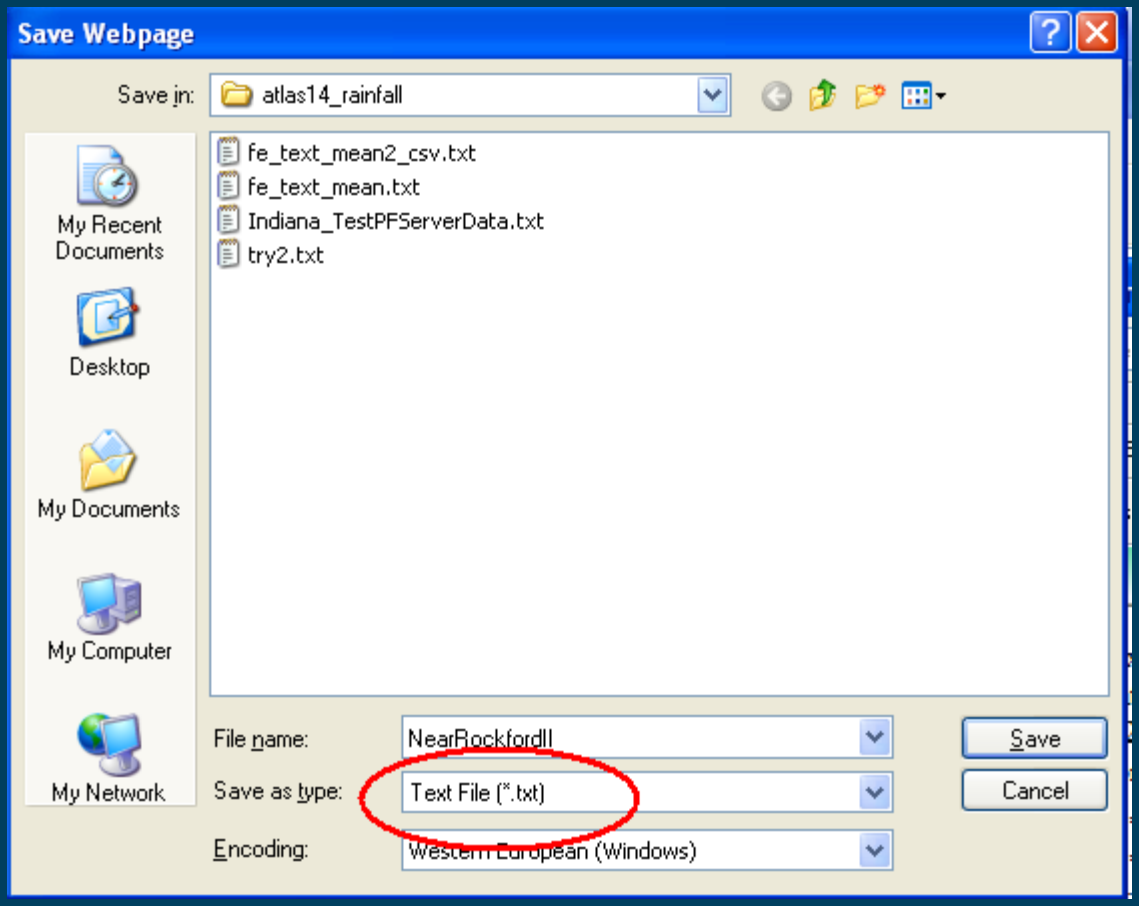
CSV Estimates from the table in csv format: precipitation frequency estimates Submit

Main Link Categories:

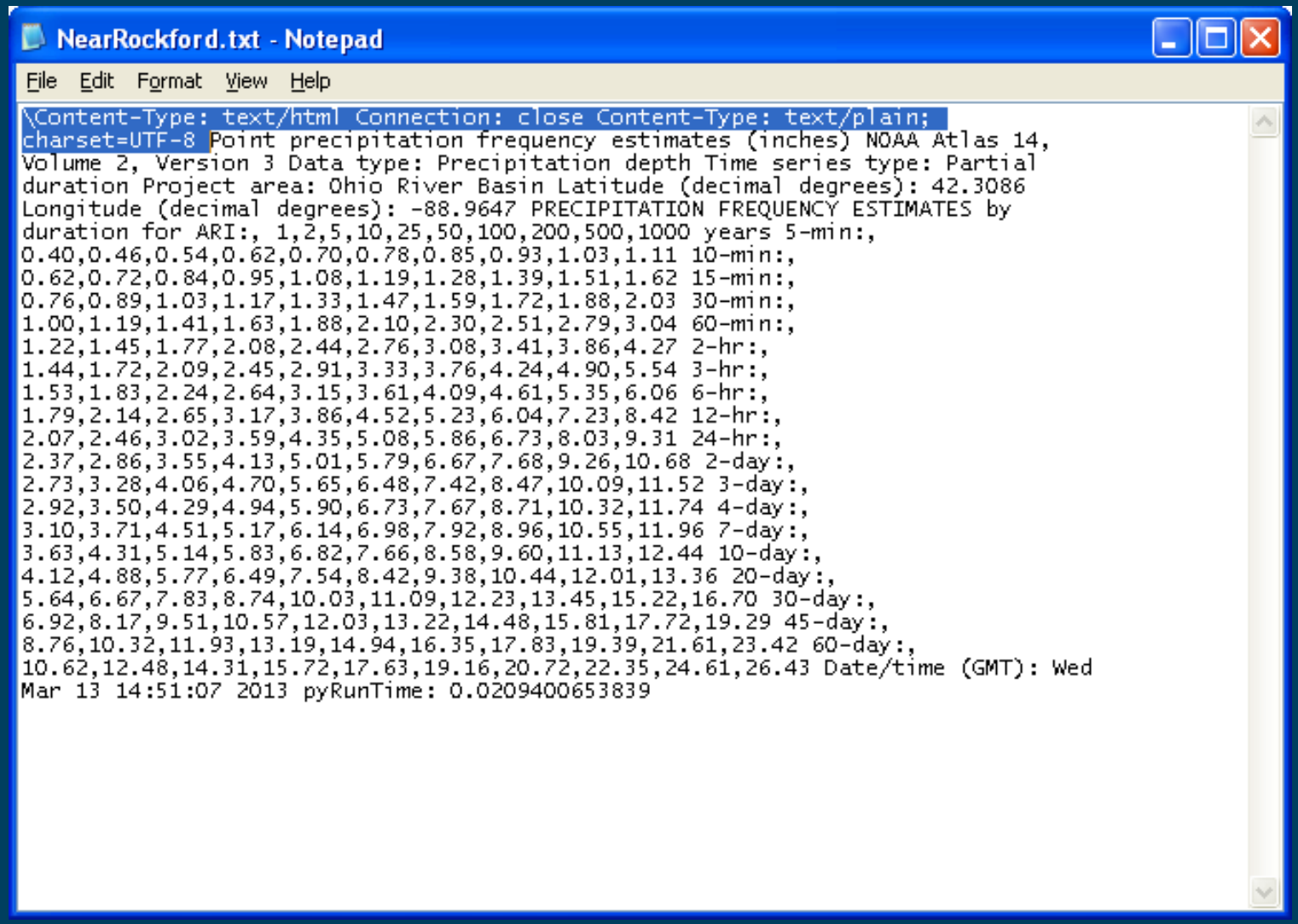
Should get screen with data, select File > Save As (Internet Explorer) – steps may be slightly different depending on Browser



Select Text File as type

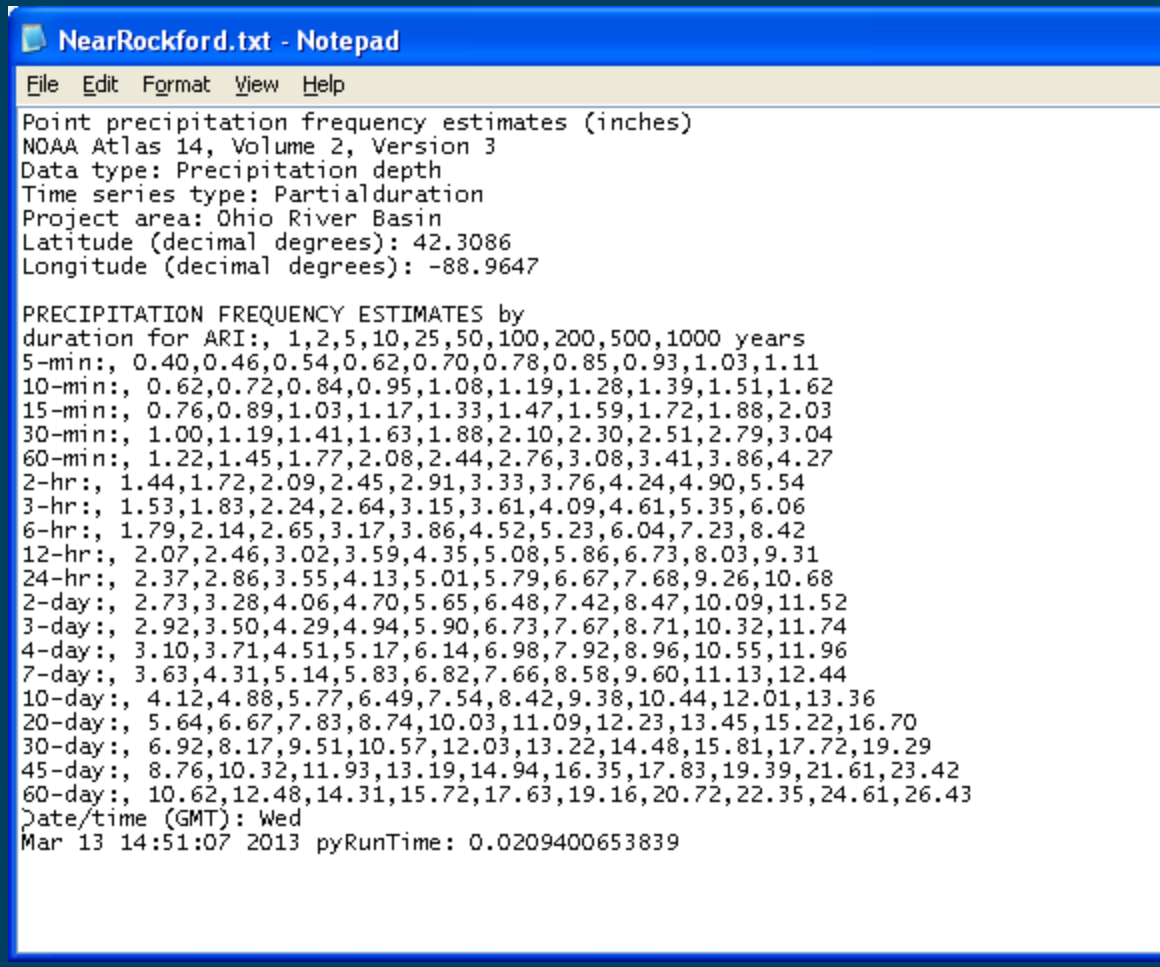


Open text file in Notepad



Edit Text if necessary to get following format:

- This will make it easy to open in Excel
- Depending on Browser/ Browser settings, may not need to edit



Atlas 14 – Other Products

- Rainfall Data can be exported as intensity – an option for Rational Method Analysis
- Graphics of Curves for Depth/Intensity Duration Frequency
- 90% Confidence Interval
- Maps for various return periods/durations
- GIS Grids of Data
- Analysis of temporal, seasonality
- NOAA working on project to develop areal reduction factors (PFDS is point rainfall)

Atlas 14 – Rainfall Distribution

- A rainfall distribution can be developed directly from the Atlas 14 Rainfall Information

Steps in developing a nested distribution

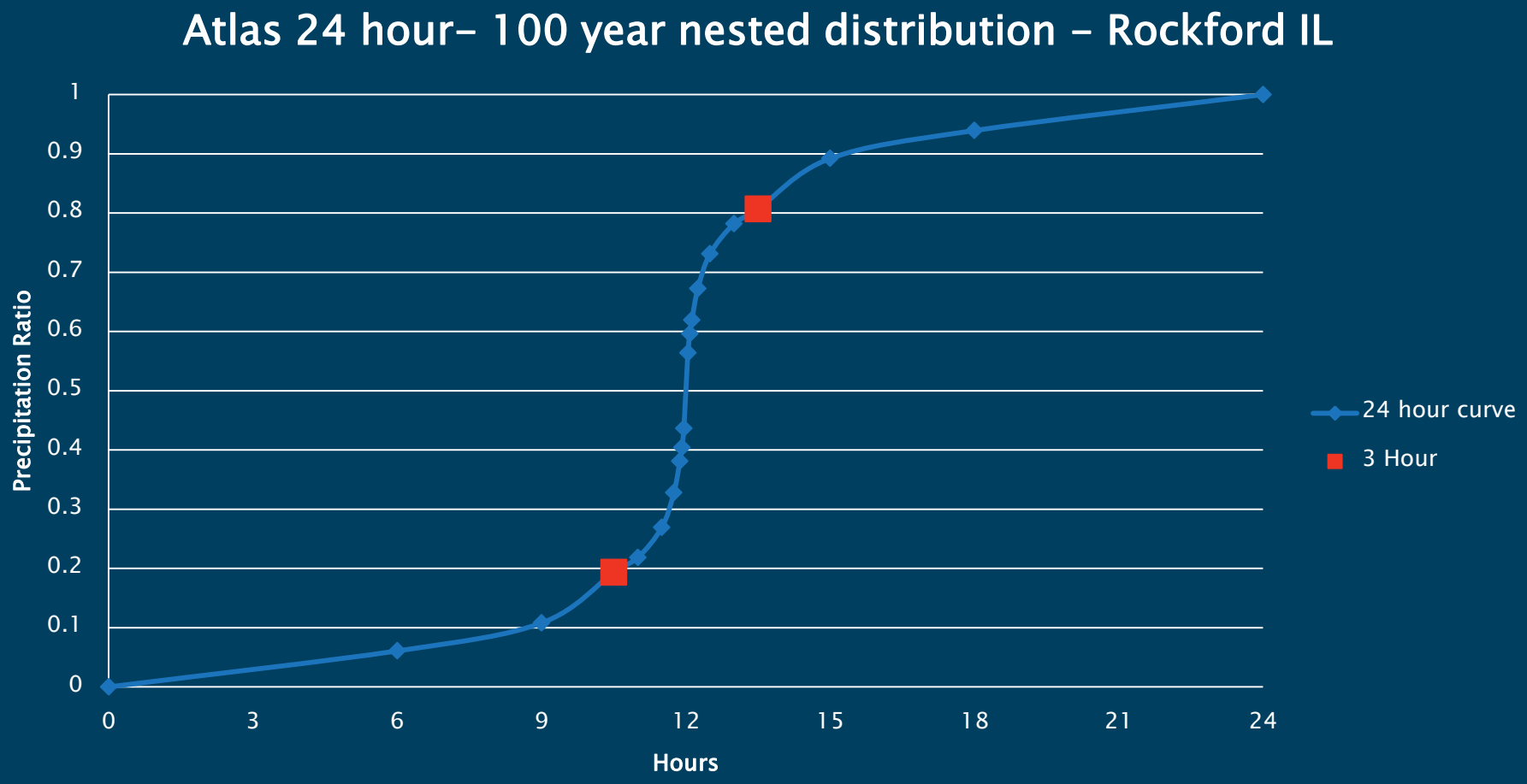
- Determine ratios of x hour / 24 hour rainfall.
- Place the rainfall ratio for the shortest duration in the center of the distribution.
- Symmetrically place each larger duration to include the shorter durations.

(From NRCS Presentation)

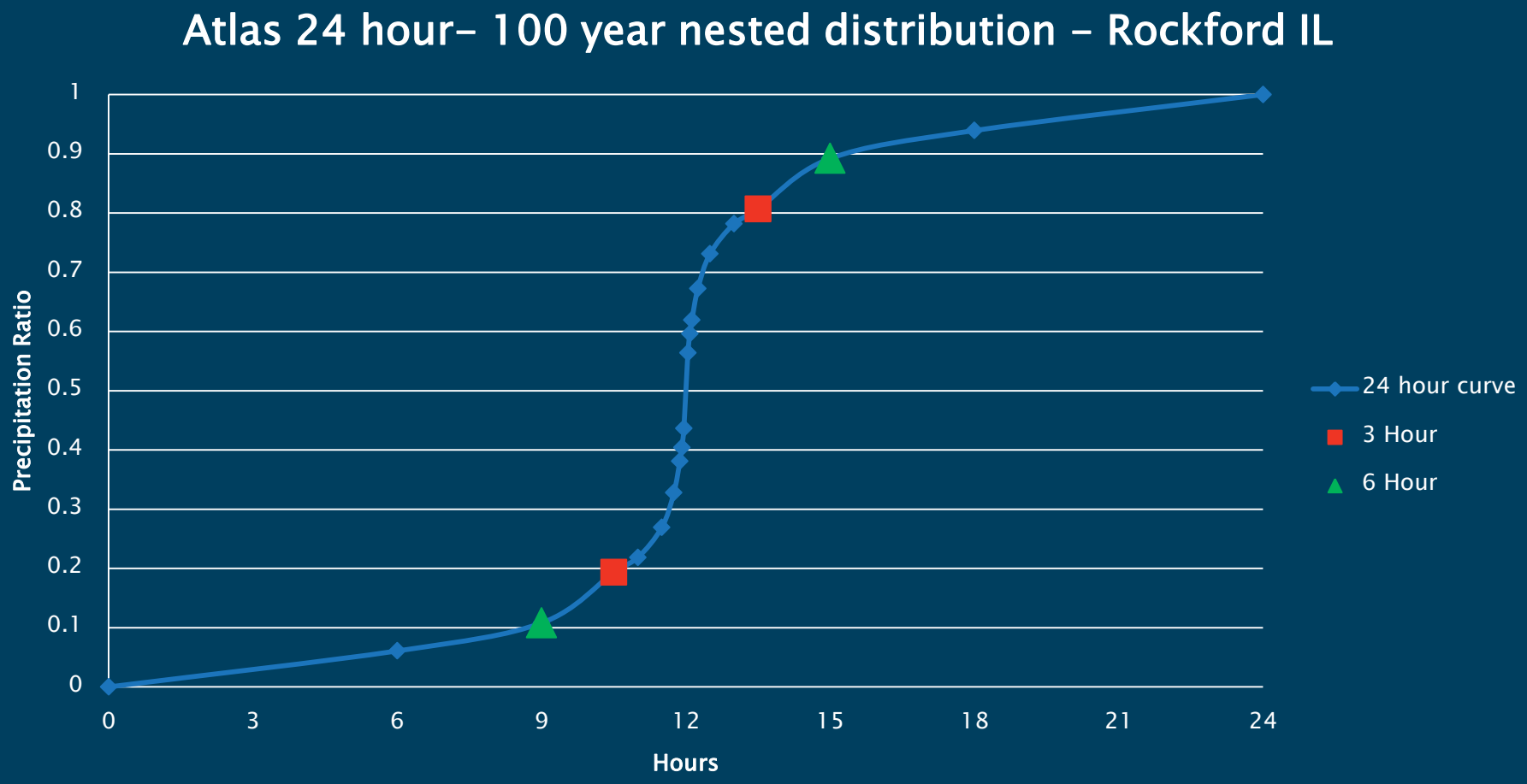
Example Calculation

- 24 Hour total = 6.67
- 3 Hour total = 4.09
  - 4.09/6.67 = 0.613
  - Centered around Precipitation ratio of 0.5 and Time of 12, ordinates are
    (10.5,0.193) and (13.5,0.806)
- 6 Hour total = 5.23
  - 5.23/6.67 = 0.784
  - Ordinates are: (9,0.108) and (12,0.0.892)

Example of a Nested Distribution



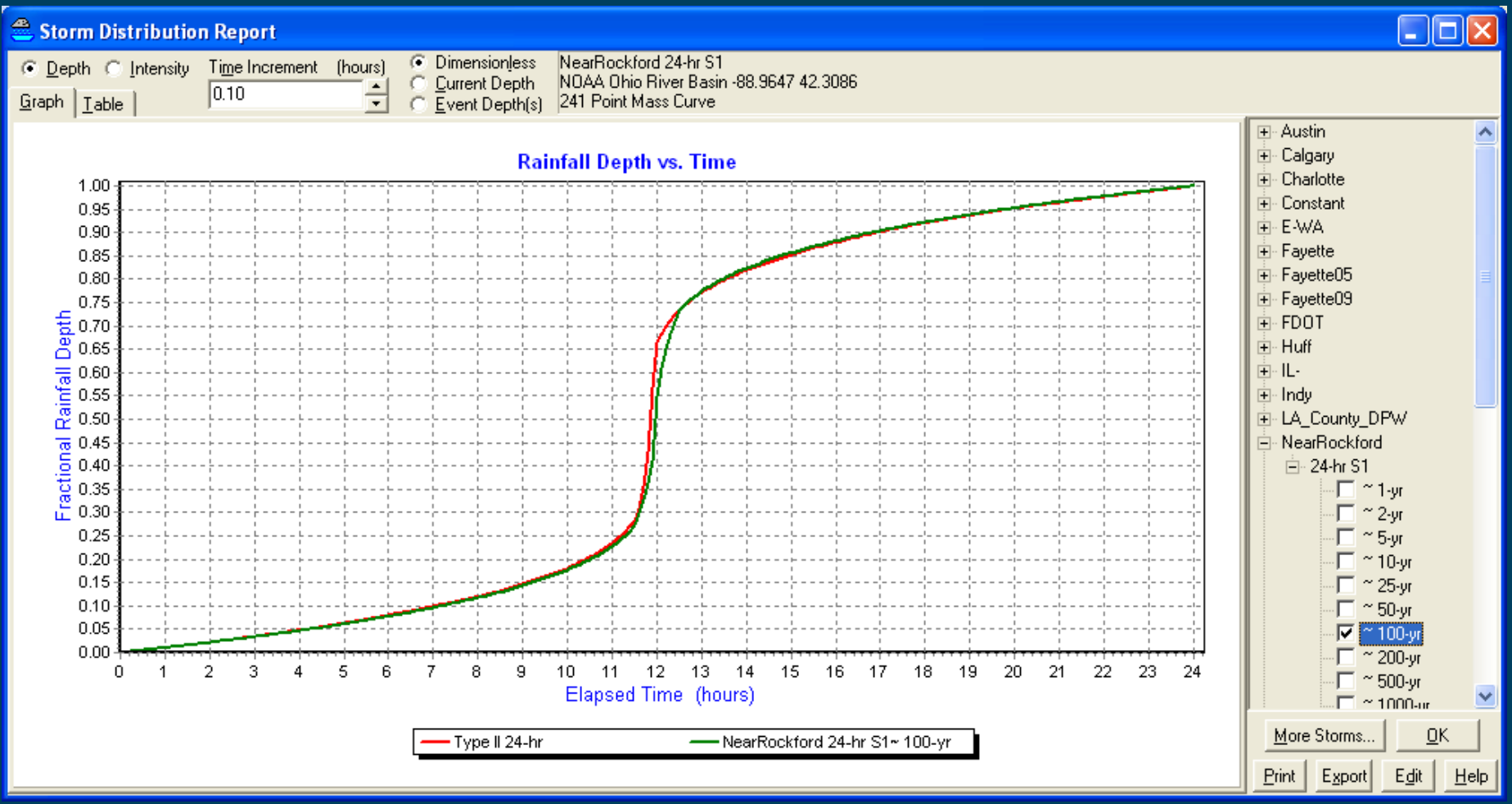
Example of a Nested Distribution



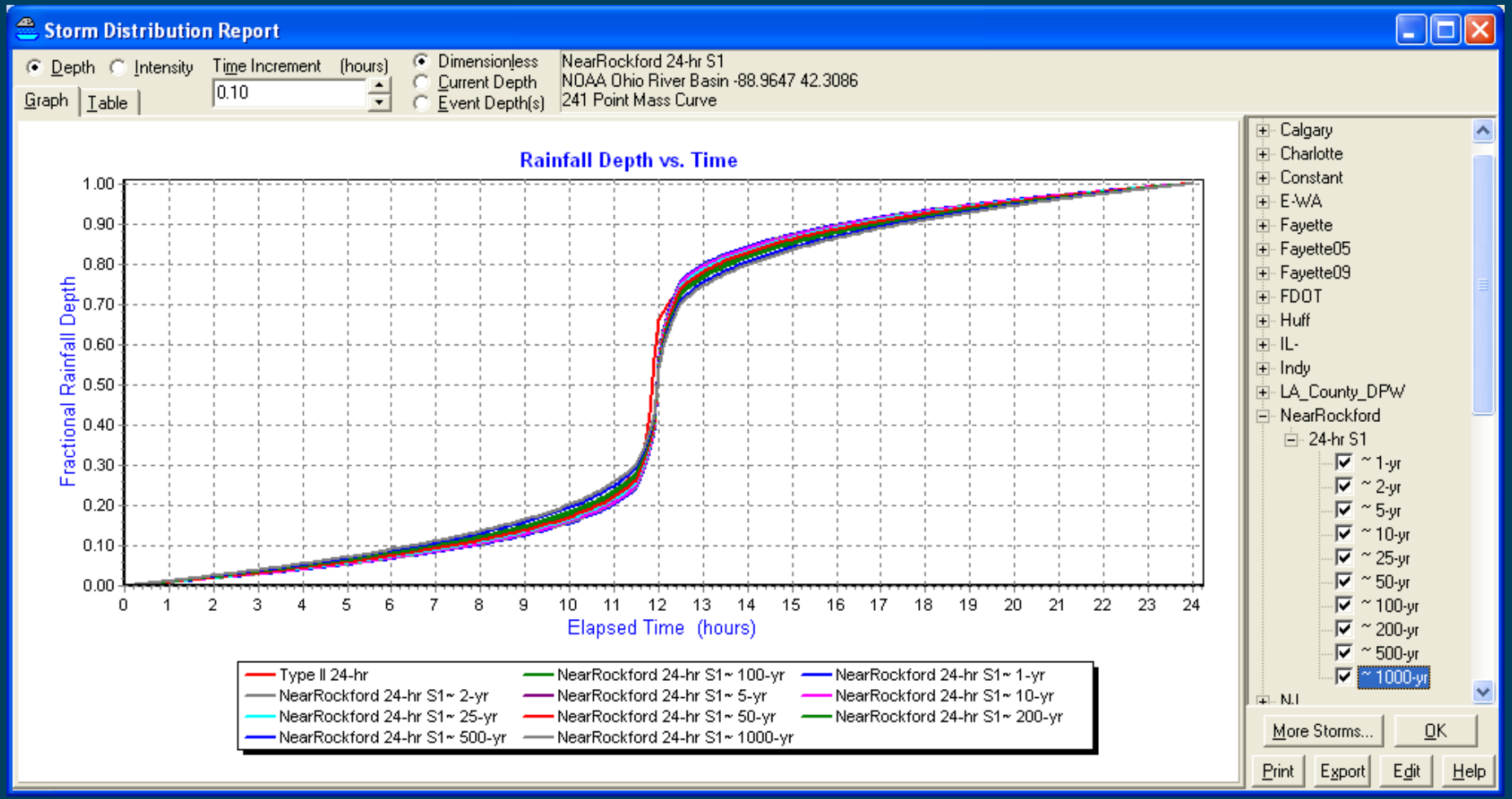
Atlas 14 vs. NRCS Type II Distributions

- Standard NRCS Type II distribution developed in 1960's
- NRCS is adopting NOAA Atlas 14 in the states where it is applicable
- WinTR-20 has been updated to use Atlas 14 rainfall distribution
- NRCS has developed new rainfall distributions to use with peak flow method for Ohio River Valley states where Atlas 14 was released in 2006

Atlas 14 Rockford IL vs. SCS Type II



Atlas 14 Rockford IL vs. SCS Type II



Atlas 14 vs. NRCS Type II Distributions

- Recommend using Atlas 14 derived rainfall distribution when using NRCS method
- If that is not feasible, continue to use Type II distribution for near future. Do not use Type I Distribution.
- NRCS may in future have rainfall distribution curves derived from Atlas 14 for Minnesota
- See NRCS Websites for further information on NRCS rainfall distributions

http://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/water/manage/?cid=stelprdb1042793

http://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/?ss=16&navtype=BROWSEBYSUBJECT&cid=stelprdb1042901&navid=140100000000000&position=Not%20Yet%20Determined.Html&ttype=detailfull

Using Atlas 14 Data in HydroCAD

- HydroCAD 10 will import PFDS data and can create rainfall distributions from the Atlas 14 data
- Good Help Information on HydroCAD Web Site http://hydrocad.net/rainfall/pfd.htm
  - Help Sheet
  - Webinar on Rainfall

Atlas 14 Data for Rational Method

- Unique Intensity-Duration-Frequency (IDF) curve can be developed for every location
- Atlas 14 data supersedes the IDS Tables/Curves/Regions in the MnDOT Drainage Manual
- Once data has been released, MnDOT plans to analyze and may be able to regionalize. For now, recommend develop IDF curve for every project using Rational Method.

Atlas 14 PFDS – Rainfall Intensity

Table now has Intensity-Duration-Frequency Information

PF tabular | PF graphical | Supplementary information

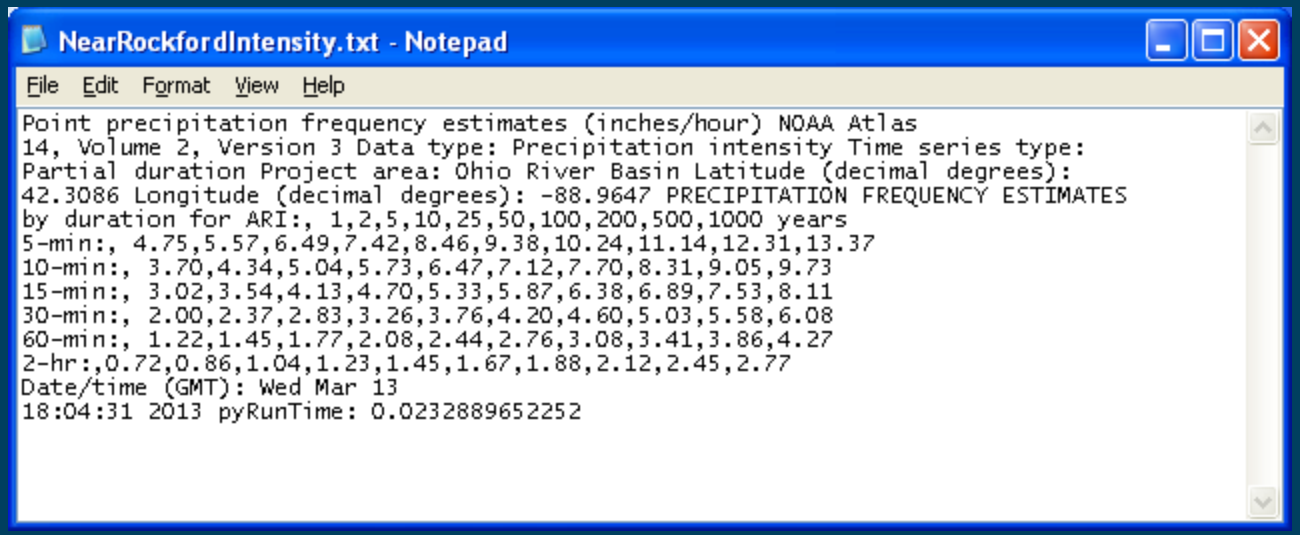
Print Page

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

Duration	Average recurrence interval(years)								
	1	2	5	10	25	50	100	200	500
5-min	4.76 (4.33-5.24)	5.57 (5.09-6.12)	6.50 (5.93-7.14)	7.44 (6.77-8.17)	8.50 (7.68-9.34)	9.43 (8.46-10.4)	10.3 (9.17-11.4)	11.2 (9.89-12.5)	12.4 (10.8-13.9)
10-min	3.70 (3.37-4.07)	4.35 (3.97-4.78)	5.05 (4.60-5.54)	5.74 (5.22-6.31)	6.50 (5.87-7.14)	7.15 (6.41-7.87)	7.75 (6.90-8.56)	8.37 (7.39-9.31)	9.13 (7.95-10.2)
15-min	3.02 (2.75-3.33)	3.55 (3.24-3.90)	4.14 (3.77-4.54)	4.71 (4.28-5.18)	5.35 (4.84-5.88)	5.90 (5.29-6.49)	6.42 (5.72-7.09)	6.94 (6.12-7.72)	7.59 (6.62-8.52)
30-min	2.00 (1.82-2.20)	2.37 (2.17-2.61)	2.83 (2.58-3.11)	3.27 (2.97-3.59)	3.78 (3.42-4.15)	4.22 (3.78-4.64)	4.63 (4.13-5.12)	5.06 (4.47-5.63)	5.62 (4.90-6.31)
60-min	1.22 (1.11-1.35)	1.46 (1.33-1.60)	1.78 (1.62-1.95)	2.08 (1.89-2.29)	2.45 (2.22-2.69)	2.78 (2.49-3.06)	3.10 (2.76-3.42)	3.44 (3.03-3.82)	3.89 (3.39-4.36)
2-hr	0.723 (0.658-0.794)	0.860 (0.782-0.944)	1.05 (0.950-1.15)	1.23 (1.11-1.34)	1.46 (1.31-1.59)	1.67 (1.50-1.83)	1.90 (1.68-2.07)	2.14 (1.88-2.35)	2.48 (2.15-2.75)
3-hr	0.512 (0.466-0.565)	0.610 (0.556-0.673)	0.747 (0.680-0.821)	0.881 (0.799-0.967)	1.05 (0.948-1.15)	1.21 (1.08-1.33)	1.37 (1.22-1.51)	1.55 (1.36-1.71)	1.80 (1.56-2.01)
6-hr	0.301 (0.274-0.333)	0.358 (0.326-0.396)	0.443 (0.402-0.489)	0.531 (0.479-0.584)	0.647 (0.580-0.710)	0.760 (0.674-0.834)	0.881 (0.773-0.970)	1.02 (0.881-1.13)	1.22 (1.04-1.37)
12-hr	0.172	0.205	0.251	0.299	0.363	0.424	0.490	0.565	0.675

Intensity Data

- Depending on Browser, may need to edit text data to get rows correct

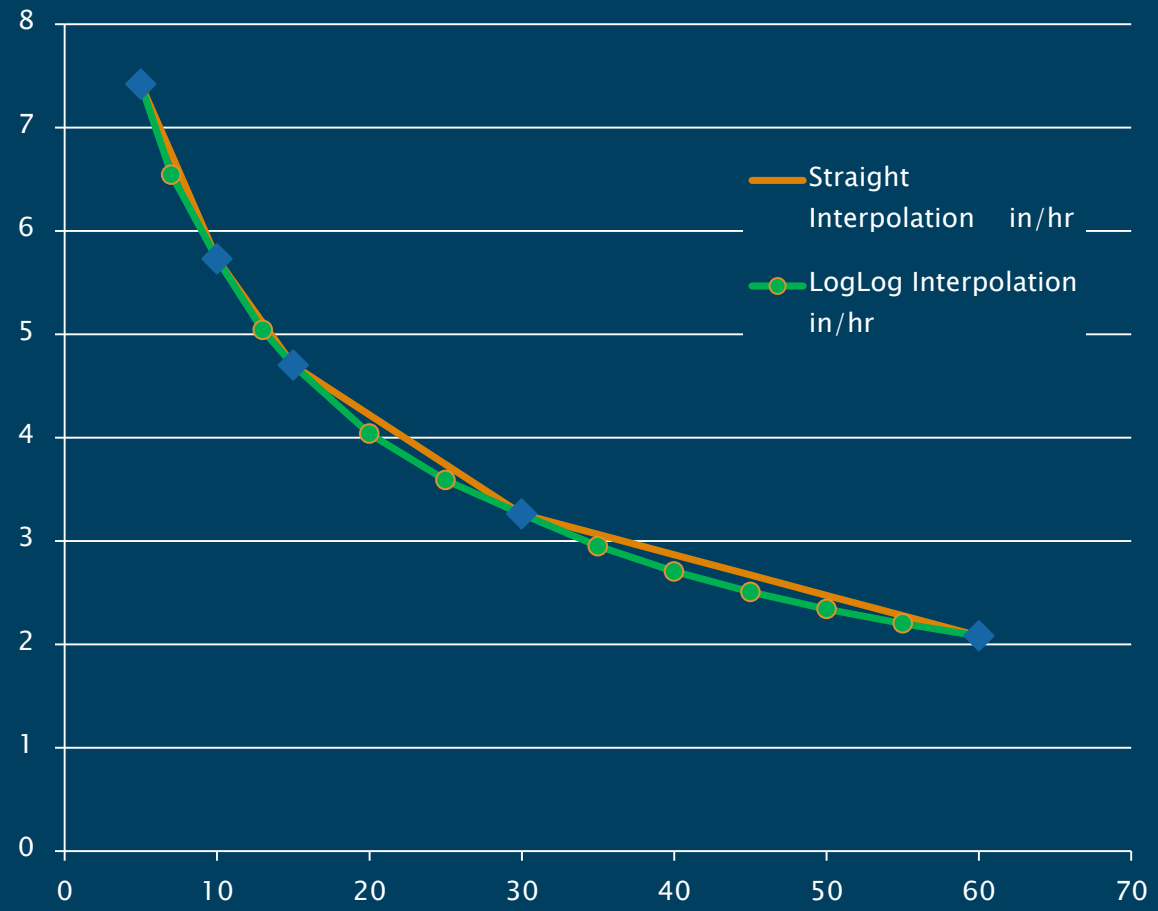


Intensity Data – Duration Interpolation

- PFDS server gives values for 5, 10, 15, 30, 60, 120 etc. minutes
- Need to interpolate for durations between those values – a log/log interpolation gives a smoother curve
- Adding Interpolated values at 22.5 minutes and 45 minutes to the given values give a fairly smooth curve for software applications

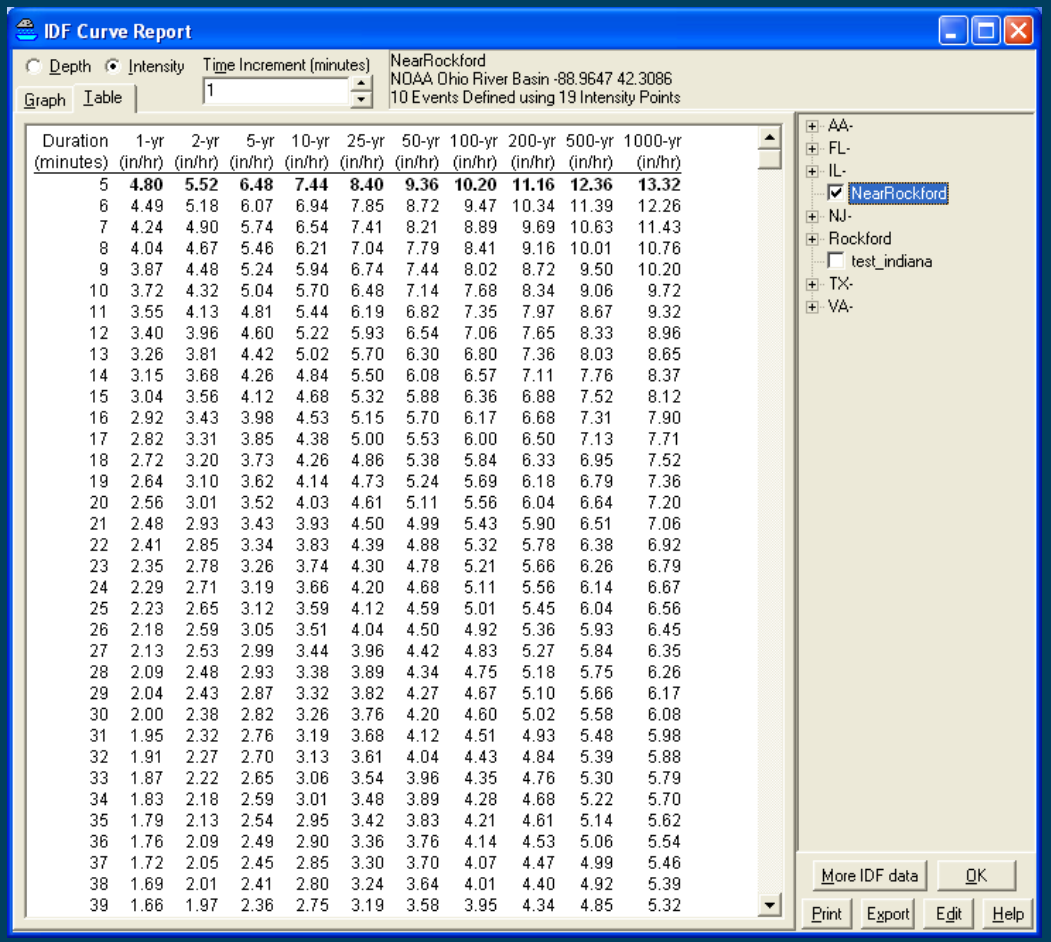
Intensity Duration Frequency Data for Rational Method
Log Log Interpolation gives smoother results than a straight line interpolation

Rockford IL



Intensity Duration Frequency Data for Rational Method

- In HydroCAD v10 – Select View > IDF Curve Report
- Select imported distribution
- Table can be exported for other software
- Values interpolated on log log scale



Intensity Data – Frequency Interpolation

- PFDS server gives values for 2, 5, 10, 15, 30, 60, 120 etc. minutes
- Need to interpolate for durations between those values
- Adding Interpolated values at 22.5 minutes and 45 minutes to the given values give a fairly smooth curve for software applications

IDF Data – Return Period Interpolation

- Atlas 14 gives data for return periods of 1, 2, 5, 10, 25, 50, 100, 200, 500 and 1000 years
- For storm drain design, a 3 year return period may sometimes be used
- Interpolate between the 2 and 5 year values – little difference between the log/log and straight line interpolation for Rockford example.

Formula for straight line interpolation:

$$\frac{\quad}{\quad}$$

Implementation Recommendation

- Use for all new projects.
- Where feasible, use for projects where hydraulic design is underway.
- MnDOT will develop guidance for State Aid projects.

Resources

- NOAA Atlas 14 for Minnesota

http://hdsc.nws.noaa.gov/hdsc/pfds/other/mn_pfds.html

- NOAA is planning to develop webinars, may be local webinars as well

- Atlas 14 Resource Website on MnDOT Bridge Hydraulics – we will add links, help sheets, and information about webinars/training

http://www.dot.state.mn.us/bridge/hydraulics/atlas14/index.html