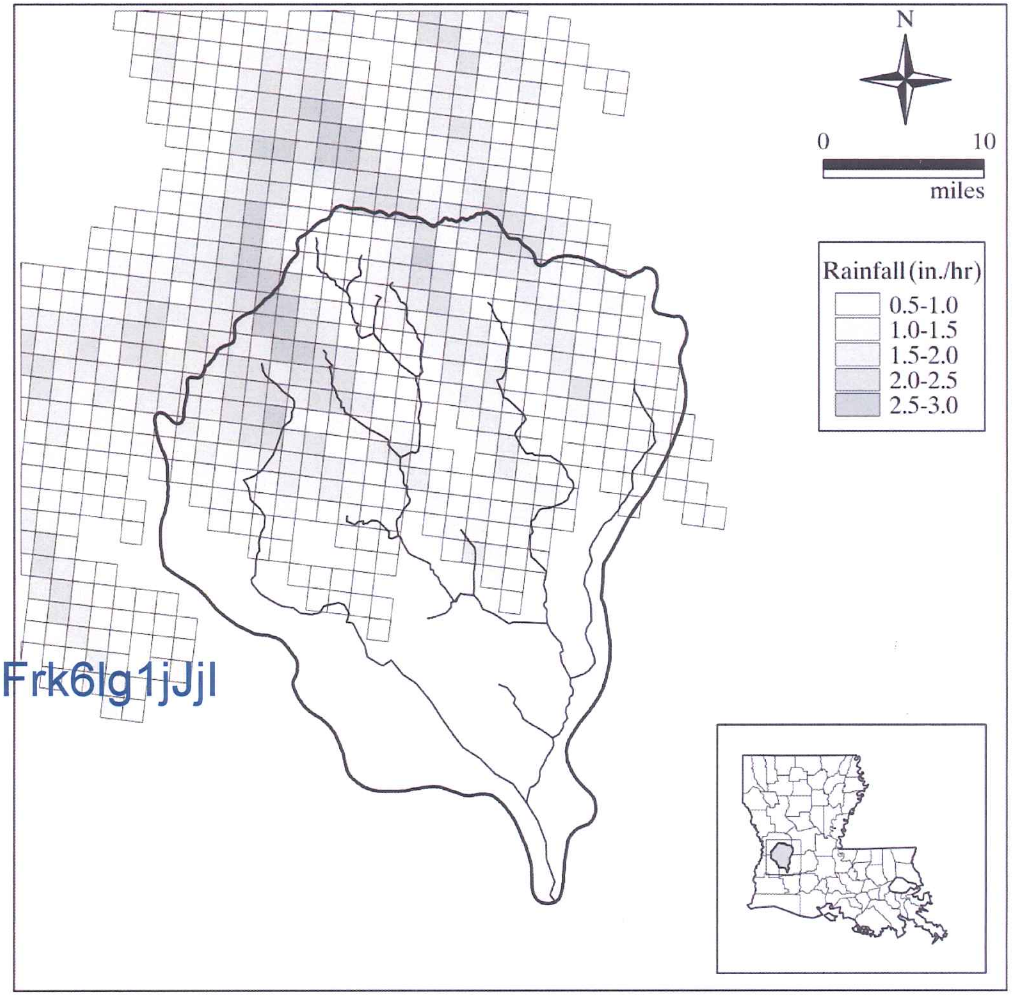
Cont. on Precipitation
Lecture 3, 04/09/2013

Arturo Leon, Oregon State University (Spring 2013)

Adapted from textbook and Bedient notes
(http://doctorflood.rice.edu/bedient/handouts.html)

Typical NEXRAD Rainfall Data for a Watershed Located in Central Louisiana

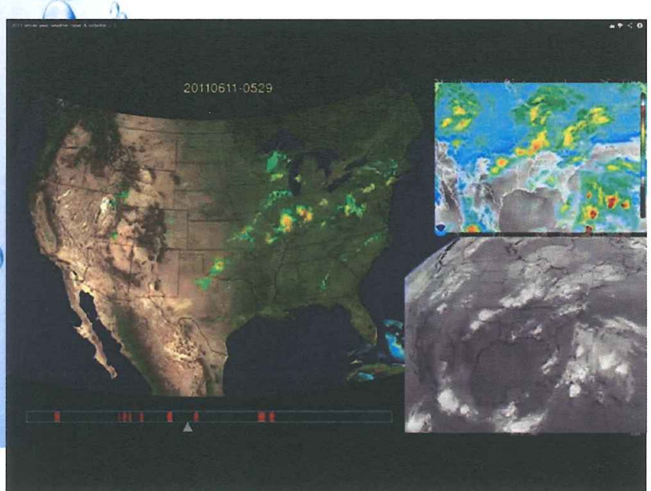


Video of Radar based precipitation

https://www.youtube.com/watch?v=Frk6lg1jJjl

3

2011 Weather Radar & Satellite Images for the United States



https://www.youtube.com/watch?v=D13pthfl0bM

Return echoes from targets ("reflectivity") are analyzed for their intensities to establish the precipitation rate in the scanned volume

How to read reflectivity on a radar display

For example, the U.S. National Doppler Radar sites use the following scale for different levels of reflectivity:

- magenta: 65 dBZ (extremely heavy precipitation, possible hail)
- red: 52 dBZ
- yellow: 36 dBZ
- green: 20 dBZ (light precipitation)

Strong returns (red or magenta) may indicate not only heavy rain but also thunderstorms, hail, strong winds, or tornadoes.

Typical Rainfall Data from a Recording Gage

Cumulative rainfall

4

= (0.02-0)/0.25

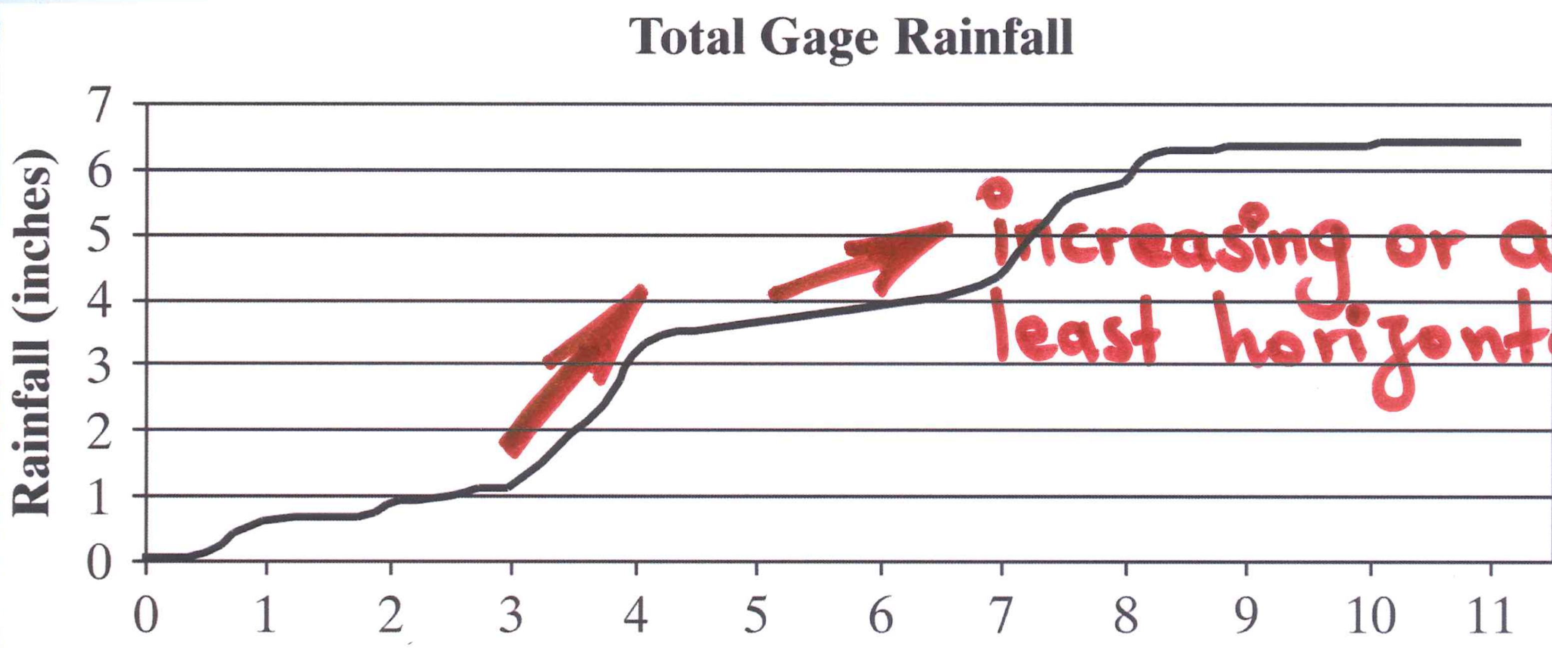
Table E1–2 Rainfall Data from a Recording Gage

Time (hr)	Gage Rainfall (in.)	Gage Intensity (in./hr)	Time (hr)	Gage Rainfall (in.)	Gage Intensity (in./hr)
0	0	0	5.75	3.78	0.24
0.25	0.02	0.08	6	3.84	0.24
0.5	0.07	0.2	6.25	3.9	0.24
0.75	0.4	1.32	6.5	3.95	0.2
1.0	0.55	0.6	6.75	4.1	0.6
1.25	0.6	0.2	7.0	4.3	0.8
1.5	0.62	0.08	7.25	4.93	2.52
1.75	0.62	0	7.5	5.4	1.88
2.0	0.82	0.8	7.75	5.61	0.84
2.25	0.88	0.24	8.0	5.77	0.64
2.5	0.92	0.16	8.25	6.17	1.6
2.75	1.06	0.56	8.5	6.22	0.2
3.0	1.1	0.16	8.75	6.27	0.2
3.25	1.47	1.48	9.0	6.29	0.08

(5)

Total gage rainfall

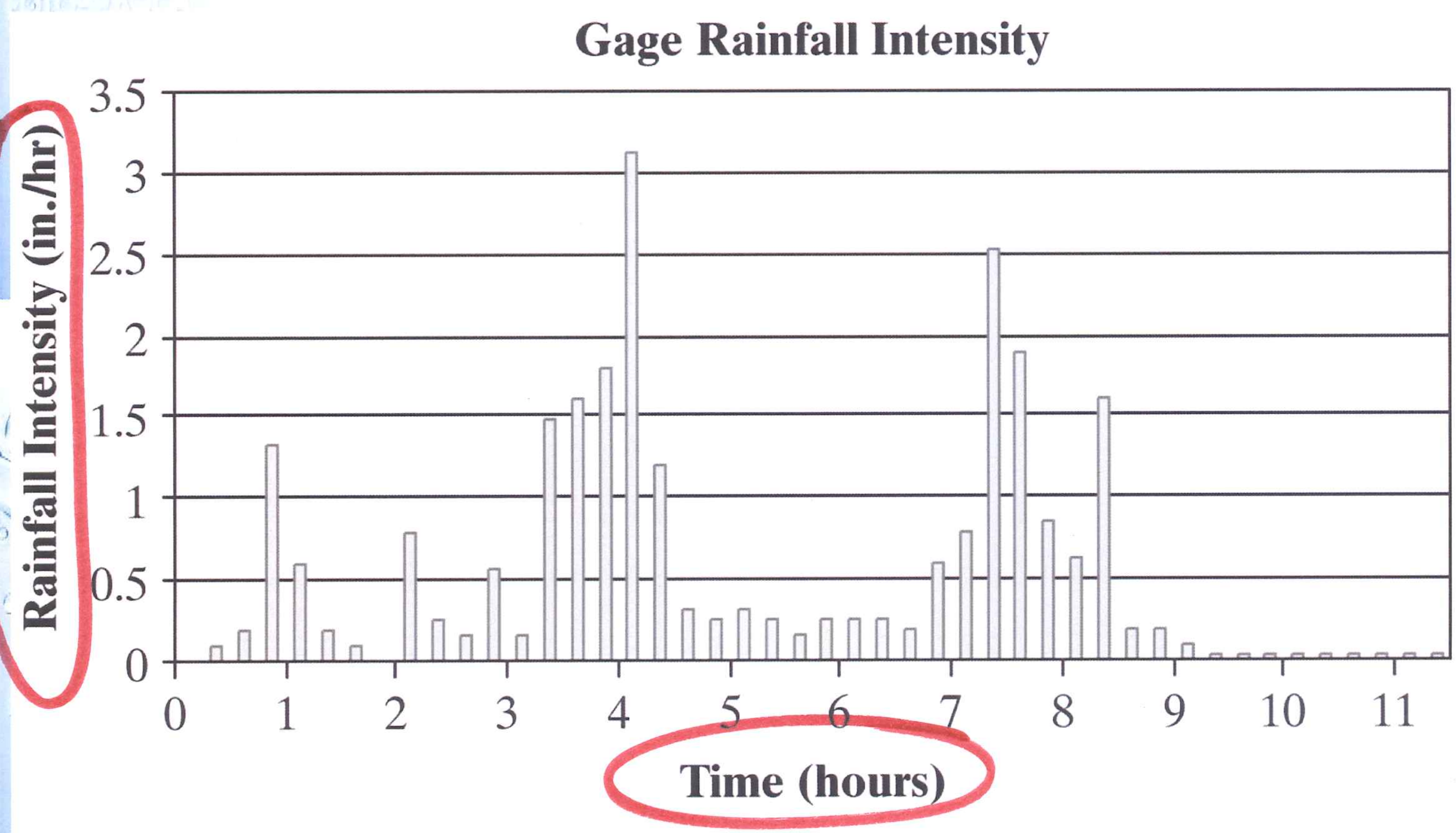
Cumulative rainfall: Plot of cumulative rainfall as a function of time.



(a)

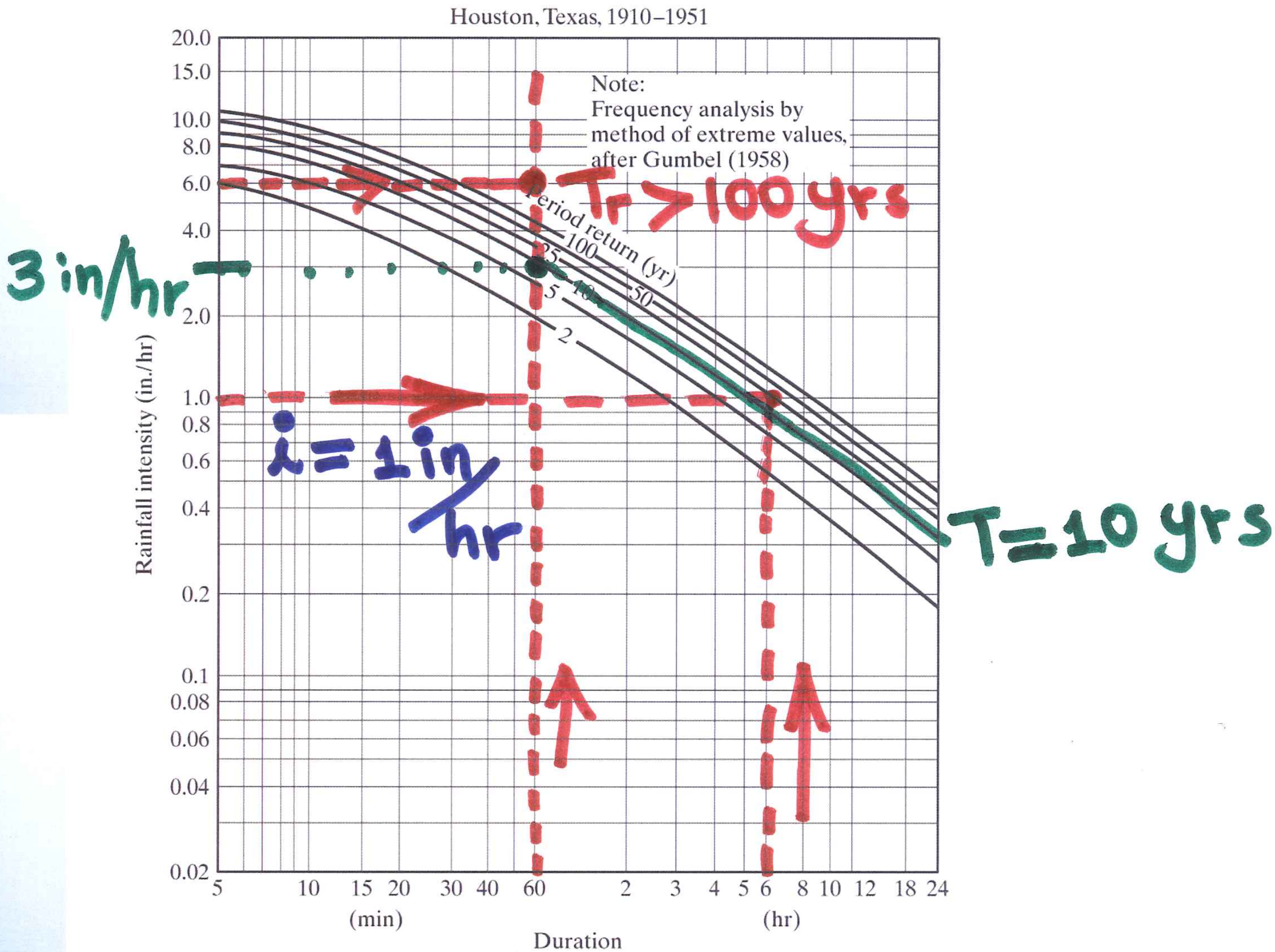
6

Rainfall Hyetograph: Plot of rainfall depth or rainfall intensity as a function of time

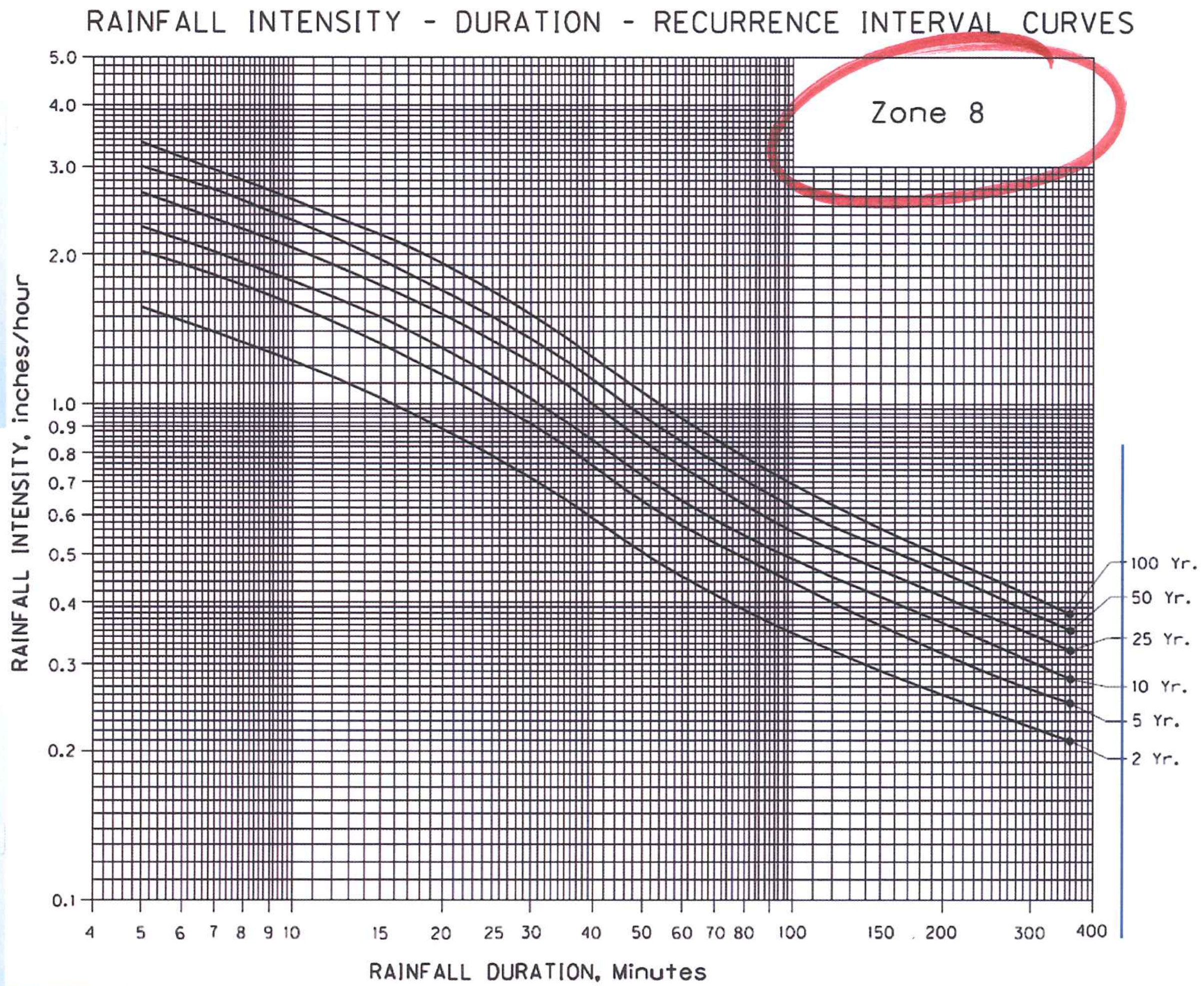


(b)

Intensity-duration frequency curves for Houston, TX.



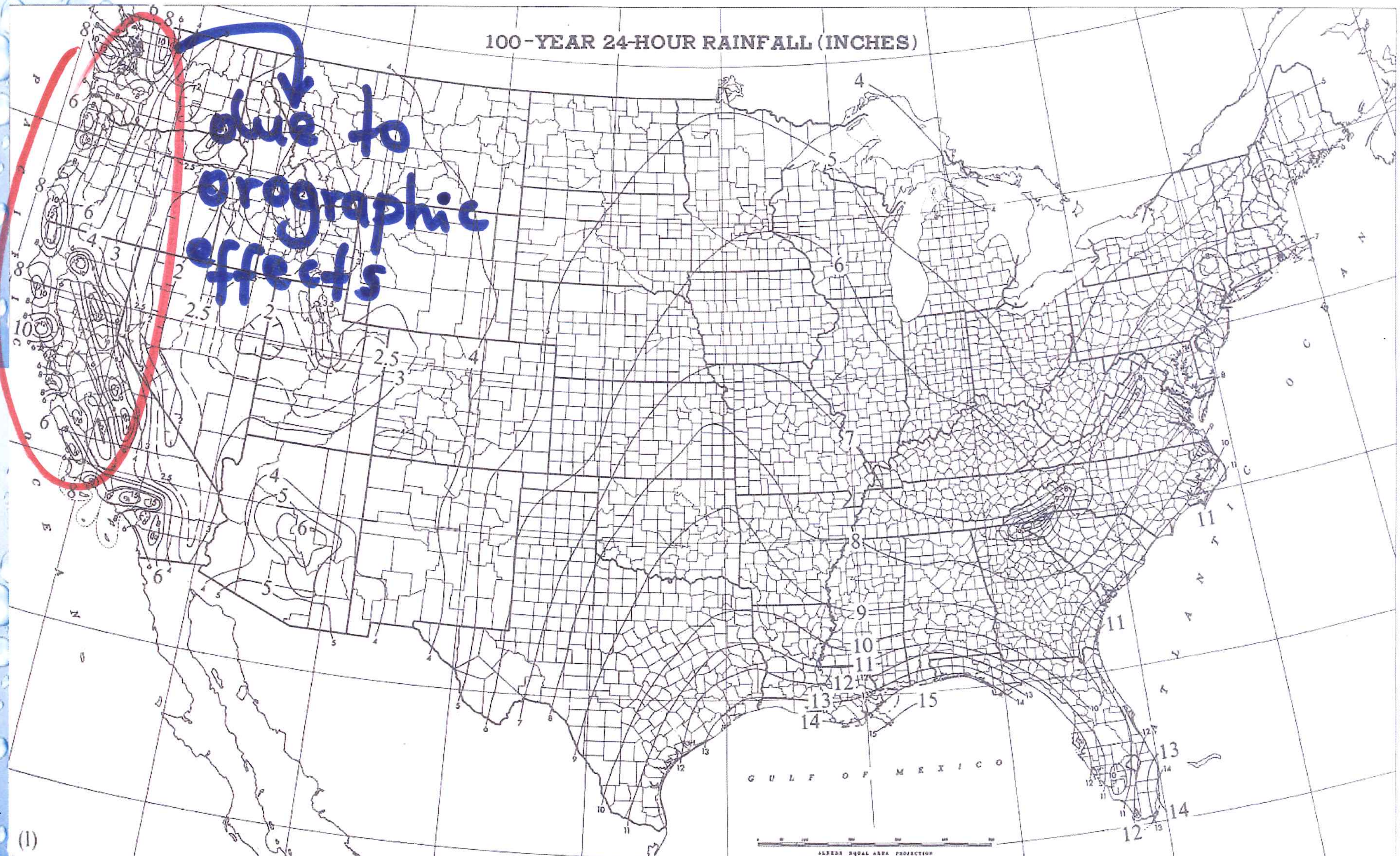
Intensity-Duration-Frequency (IDF) Curves for Corvallis, OR



Source: ODOT Hydraulics manual

100-year 24 hour rainfall isohyets for the United States

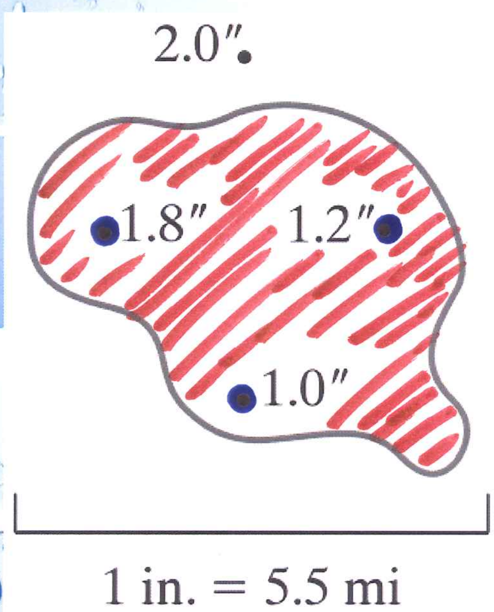
(9)



10

Areal Precipitation
Arithmetic-Mean Method

$$\overline{P} = \frac{P_1 + P_2 + P_3 + \dots + P_n}{n} = \frac{1}{n}\sum_{i=1}^{n} P_i$$



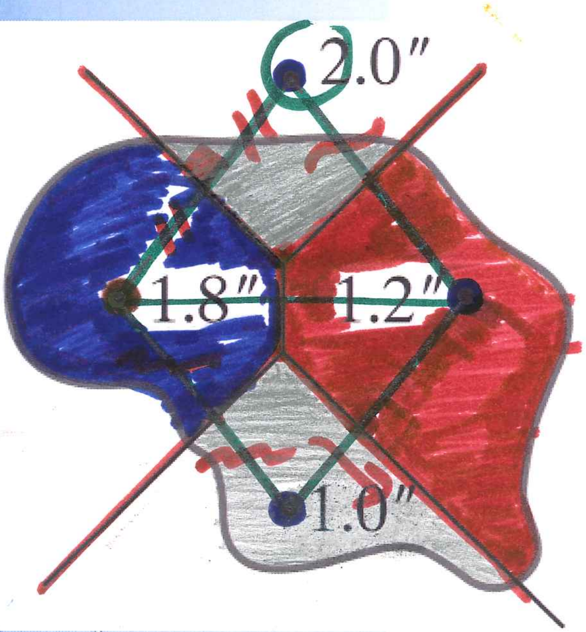
$$\frac{1.8 + 1.2 + 1.0}{3} = 1.33 \text{ in.}$$

This method is suitable if the rain gage stations are uniformly distributed over the entire area and individual variations are not far from the mean rainfall

11

Thiessen Polygon Method

Allows for areal weighting of rainfall from each gage. This method doesn't account for orographic effects (those due to elevation changes).



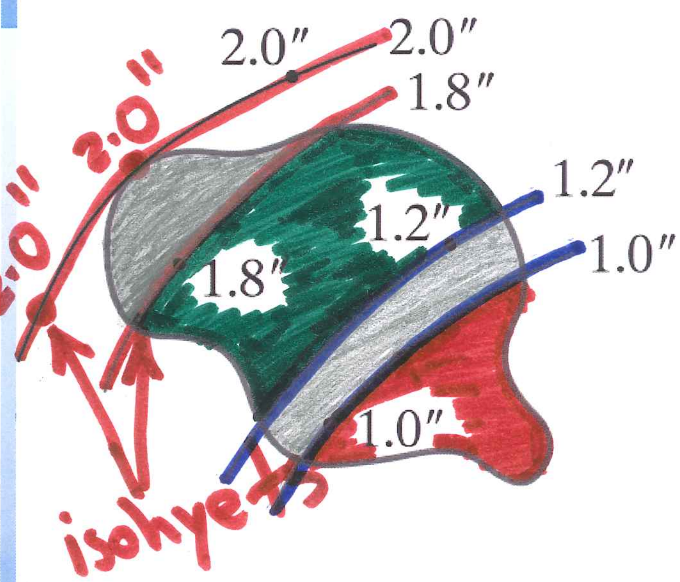
P_i (in.)	A_i (mi^2)	A_i/A_r	$(P_i)(A_i/A_r)$ (in.)
2.0	1.5	0.064	0.13
1.8	7.2	0.305	0.55
1.2	5.1	0.216	0.26
1.0	9.8	0.415	0.42
$\Sigma =$	23.6	1.000	1.35 in.

$0.064 = \frac{1.5}{23.6}$

2.0×0.064

Isohyetal Method

- An isohyet is a contour of equal rainfall.
- This method considers spatial variation of rainfall (can include orographic effects and storm morphology). Hence, it is considered the best method for computing average depth of rainfall.

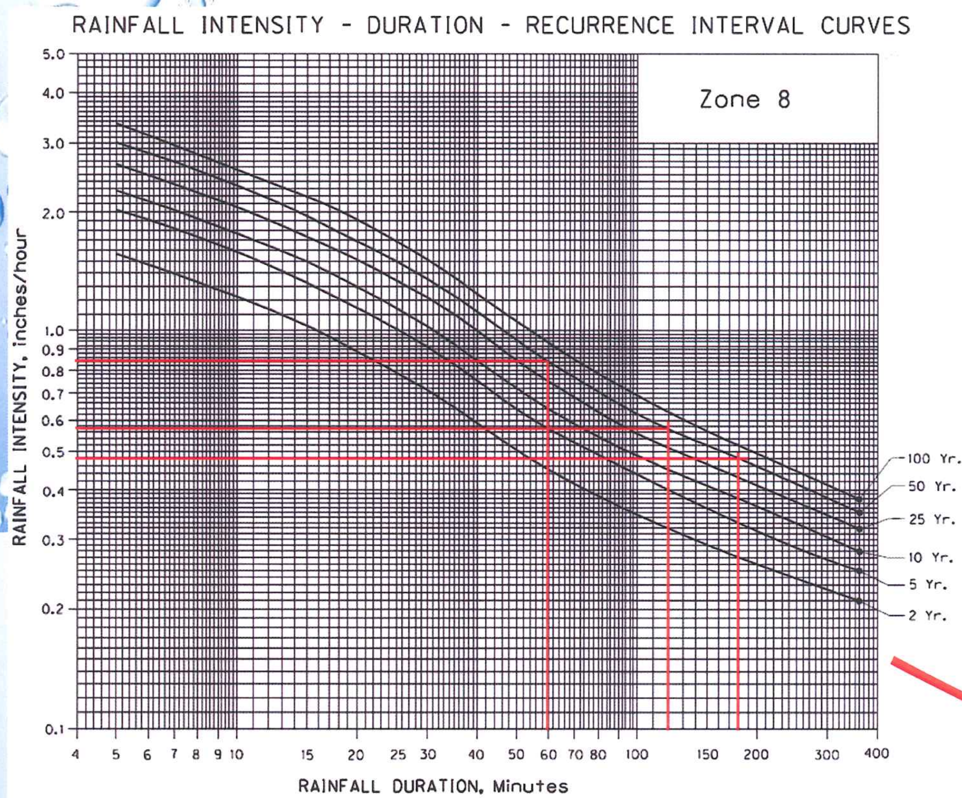


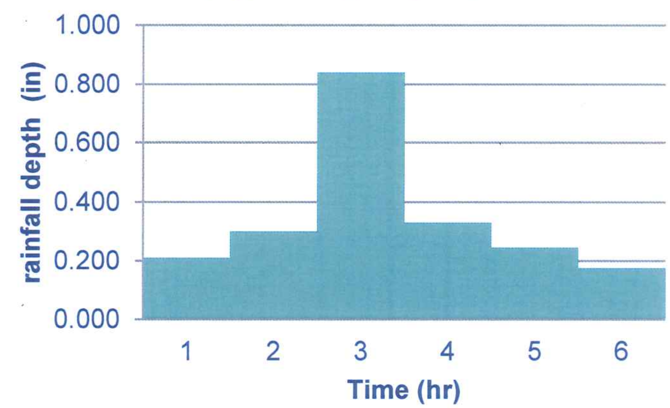
Isohyet (in.)	A (mi^2)	P_{av} (in.)	V (in.– mi^2)
2.0	5.1	1.9	9.69
1.8	9.8	1.5	14.7
1.2	3.1	1.1	3.41
1.0	5.6	0.5*	2.8
	23.6		30.6

Average rainfall = 30.6/23.6 = 1.30 in.

* Estimated

Design Storms





(14)

Example 1: 50-yr, 6-hr Design Storm for Corvallis, OR (show Excel spreadsheet)

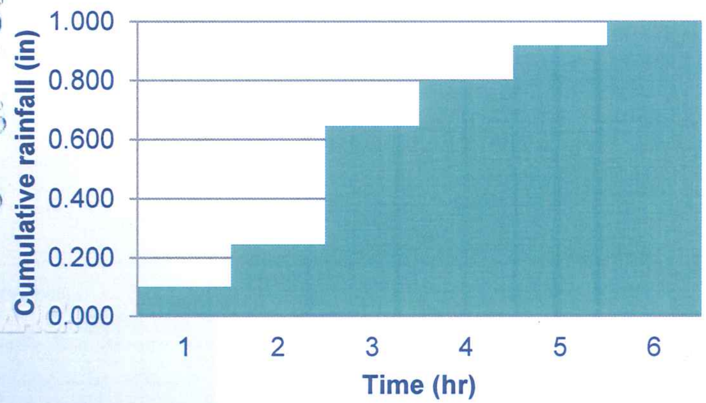
0.300 = 1.140 − 0.840

Development of 6-hour dimensionless cumulative design storms for Corvallis, Oregon

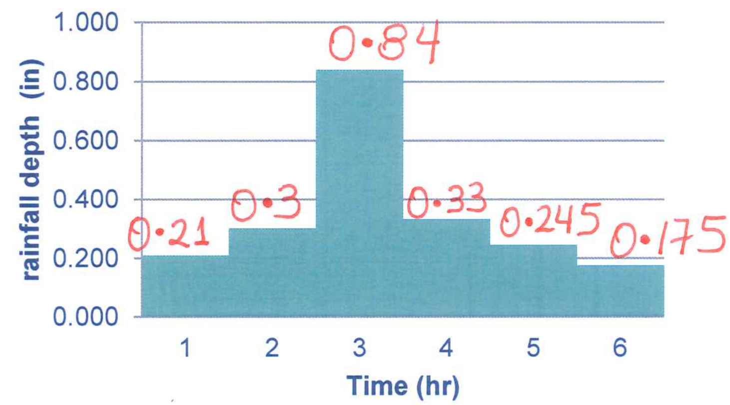
(1) Return Period (years)	(2) Duration (hr)	(3) Intensity (in/hr)	(4) Depth (in)	(5) Incremental Depth (in)	(6) Design storm (in)	(7) Cumulative Design storm (in)	(1) Dimensionless Cumulative Design storm
50	1	0.840	0.840	0.840	0.210	0.210	0.100
	2	0.570	1.140	0.300	0.300	0.510	0.243
	3	0.490	1.470	0.330	0.840	1.350	0.643
	4	0.420	1.680	0.210	0.330	1.680	0.800
	5	0.385	1.925	0.245	0.245	1.925	0.917
	6	0.350	2.100	0.175	0.175	2.100	1.000

2.100 = 0.350 × 6

50-yr, 6-hr dimensionless cumulative design storm



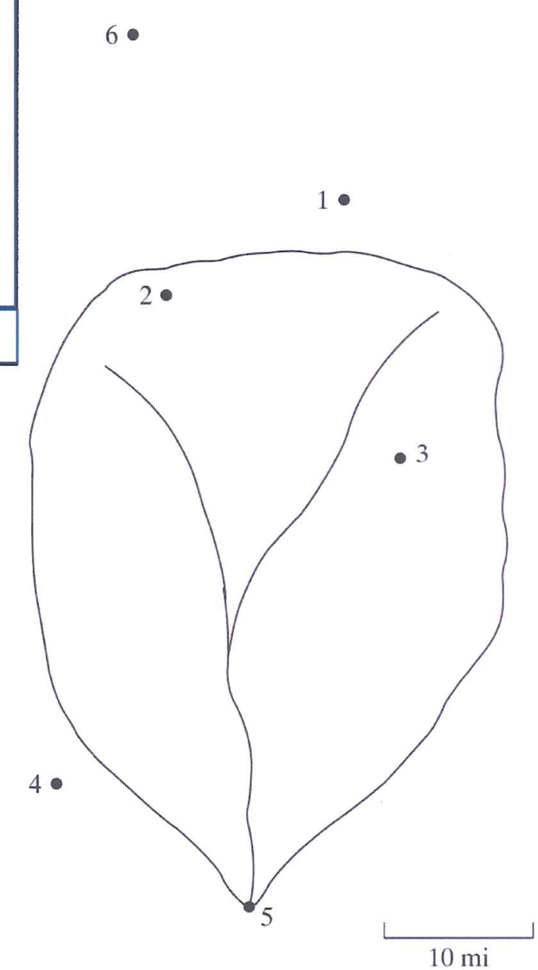
50-yr, 6-hr Design storm (hyetograph)



In-class Assignment 2: Thiessen Polygon Method and Design Storm

Student Name:

Gage	Area (sq mi)	Area (%)	Rainfall (cm)	Weighted Rainfall (cm)
1			5.5	
2			4.5	
3			4	
4			6.2	
5			7	
6			2.1	
SUM		100		



16

Design Storm: 100-yr, 6-hr Design Storm for Corvallis, OR

Development of 6-hour dimensionless cumulative design storms for Corvallis, Oregon

(1) Return Period (years)	(2) Duration (hr)	(3) Intensity (in/hr)	(4) Depth (in)	(5) Incremental Depth (in)	(6) Design storm (in)	(7) Cumulative Design storm (in)	(1) Dimensionless Cumulative Design storm
100	1						
	2						
	3						
	4						
	5						
	6						