

# Madison Ordinance Changes in Response to Flooding City of Madison, WI



City Engineering  
Greg Fries P.E.  
Janet Schmidt, P.E.



# Presentation Overview

- **BRIEF** FLOODING REVIEW - AUGUST 2018/19
  - Flash Flooding (2018)
  - Lake Level Flooding (2018/19)
- WHAT DOES THE FUTURE HOLD
  - Climate Change Concerns
  - Changing Rainfall Patterns
- CITY OF MADISON ORDINANCES
  - Design Changes
  - Existing Stormwater Ordinance
  - Proposed Ordinance Modifications
- Examples

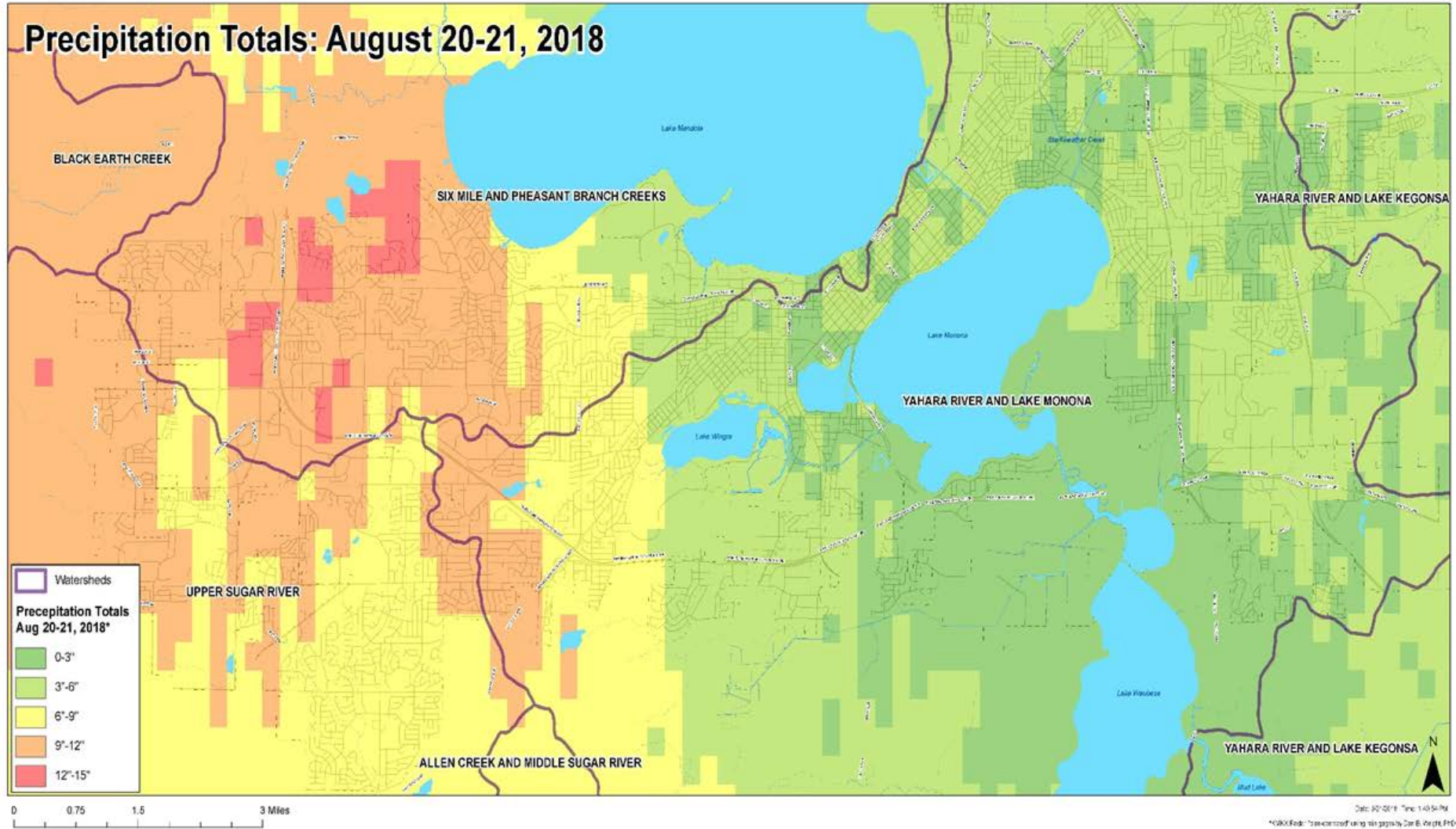


Flooding in Madison as a result of August 20, 2018 storm event had two parts:

- 1) Urban Flash Flooding
  - 2) Lake Level Flooding
- 



# Flash Flooding Rainfall August 20/21, 2018



KMKX Radar that was  
"bias corrected" using  
rain gauges by UW  
Professor Dan Wright



# Historic Flooding: Flash Flooding



## Recurrence Interval

**PDS-based precipitation frequency estimates with 90% confidence intervals (in inches)<sup>1</sup>**

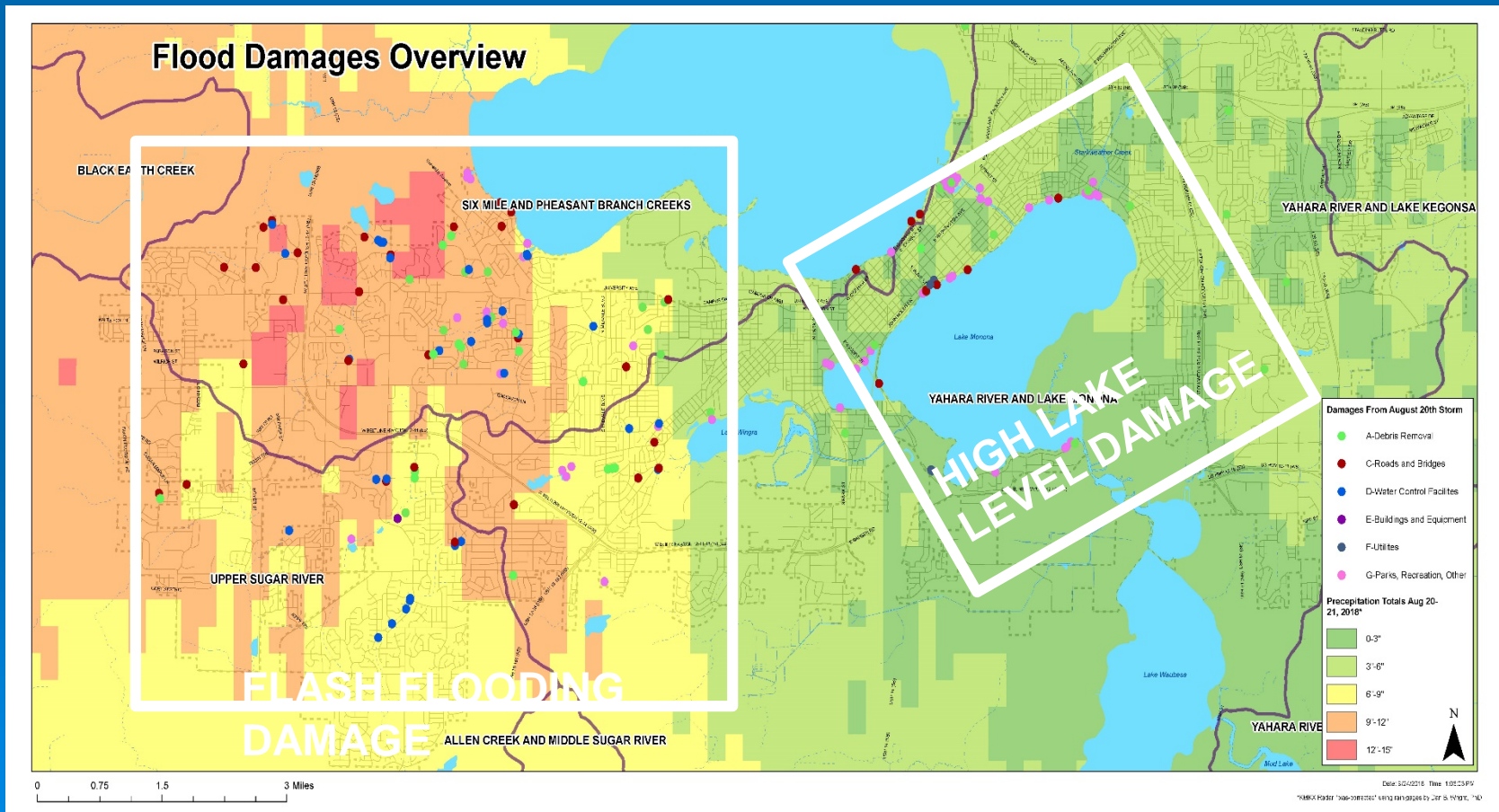
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.381 (0.327-0.447)	0.437 (0.373-0.511)	0.531 (0.453-0.623)	0.613 (0.520-0.722)	0.732 (0.605-0.889)	0.829 (0.670-1.02)	0.929 (0.728-1.16)	1.04 (0.782-1.32)	1.18 (0.861-1.54)	1.30 (0.922-1.71)
10-min	0.559 (0.478-0.654)	0.639 (0.547-0.749)	0.777 (0.663-0.912)	0.898 (0.761-1.06)	1.07 (0.886-1.30)	1.21 (0.981-1.49)	1.36 (1.07-1.70)	1.52 (1.14-1.93)	1.73 (1.26-2.25)	1.90 (1.35-2.50)
15-min	0.681 (0.583-0.798)	0.780 (0.667-0.913)	0.948 (0.808-1.11)	1.10 (0.928-1.29)	1.31 (1.08-1.59)	1.48 (1.20-1.81)	1.66 (1.30-2.07)	1.85 (1.40-2.36)	2.11 (1.54-2.75)	2.32 (1.65-3.05)
30-min	0.939 (0.804-1.10)	1.08 (0.921-1.26)	1.31 (1.12-1.54)	1.52 (1.29-1.79)	1.82 (1.50-2.20)	2.06 (1.66-2.52)	2.30 (1.81-2.88)	2.57 (1.94-3.27)	2.93 (2.13-3.81)	3.21 (2.28-4.22)
60-min	1.19 (1.02-1.40)	1.38 (1.18-1.62)	1.71 (1.46-2.01)	1.99 (1.69-2.35)	2.40 (1.99-2.92)	2.74 (2.21-3.36)	3.09 (2.42-3.85)	3.45 (2.60-4.40)	3.96 (2.88-5.15)	4.36 (3.09-5.72)
2-hr	1.45 (1.25-1.69)	1.69 (1.46-1.97)	2.11 (1.81-2.45)	2.47 (2.11-2.88)	2.99 (2.49-3.61)	3.42 (2.78-4.17)	3.87 (3.05-4.80)	4.34 (3.30-5.49)	4.99 (3.66-6.46)	5.51 (3.94-7.18)
3-hr	1.60 (1.39-1.86)	1.88 (1.62-2.17)	2.35 (2.03-2.73)	2.77 (2.37-3.22)	3.38 (2.83-4.07)	3.88 (3.17-4.72)	4.41 (3.49-5.46)	4.97 (3.79-6.28)	5.75 (4.24-7.42)	6.37 (4.57-8.28)
6-hr	1.89 (1.65-2.17)	2.20 (1.91-2.53)	2.75 (2.38-3.16)	3.24 (2.79-3.74)	3.98 (3.36-4.78)	4.60 (3.79-5.56)	5.26 (4.20-6.48)	5.97 (4.60-7.51)	6.98 (5.18-8.96)	7.79 (5.62-10.1)
12-hr	2.20 (1.93-2.51)	2.52 (2.21-2.87)	3.10 (2.71-3.54)	3.64 (3.16-4.18)	4.47 (3.82-5.36)	5.19 (4.32-6.25)	5.96 (4.81-7.31)	6.81 (5.28-8.52)	8.02 (6.01-10.3)	9.02 (6.55-11.6)
24-hr	2.51 (2.21-2.84)	2.87 (2.53-3.25)	3.53 (3.10-4.00)	4.14 (3.62-4.71)	5.08 (4.36-6.03)	5.88 (4.93-7.03)	6.76 (5.48-8.23)	7.71 (6.02-9.58)	9.08 (6.84-11.5)	10.2 (7.46-13.0)



# Historic Flooding:

## 1- FLASH FLOOD

## 2- LAKE LEVEL FLOODING





# Historic Flooding: Flash Flooding



Odana Golf Course, Madison, WI

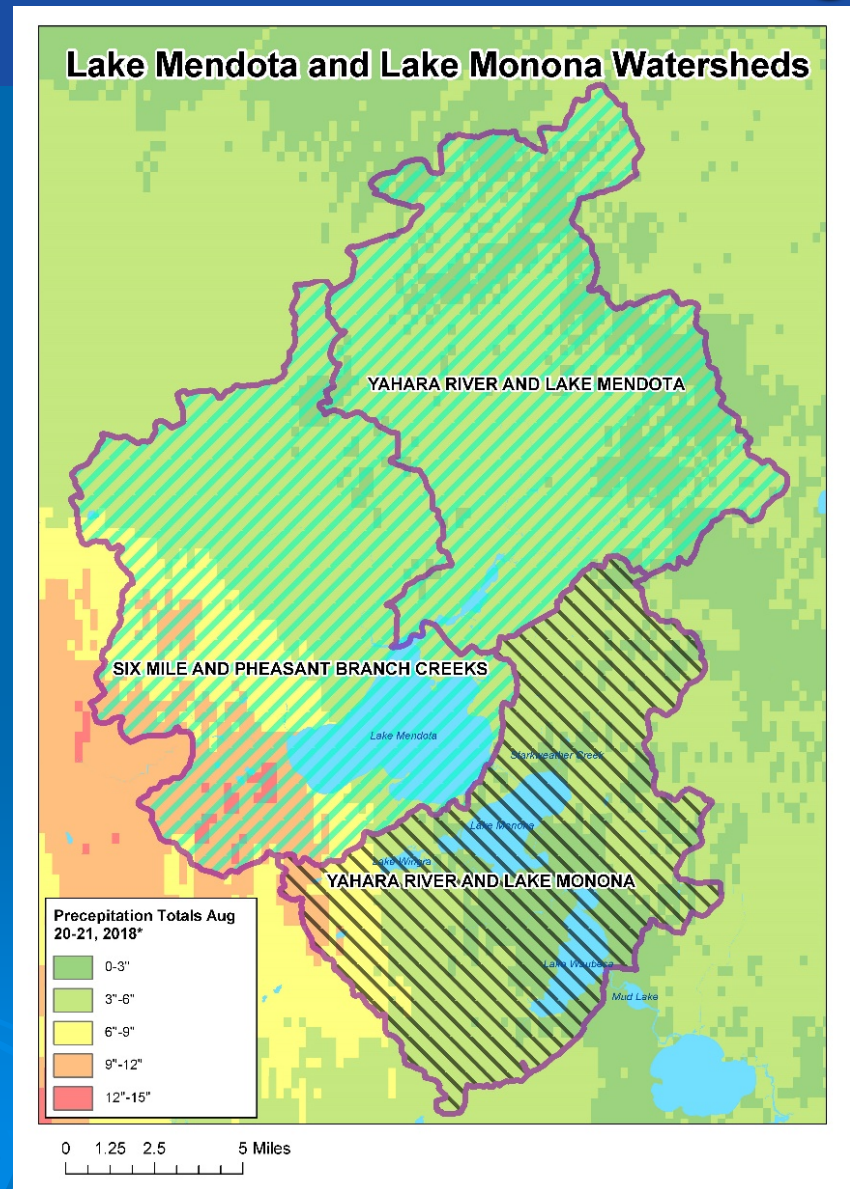


Commerce Dr, Madison, WI



# Historic Flooding: Lake Level Flooding

- It typically takes about 2-3 days for water from the watershed to get to Lake Mendota.
- This storm hit mostly the urbanized area so lake response was faster.
- **Caution – look at the limited watershed area hit by this storm.**





# Historic Flooding: Lake Level Flooding

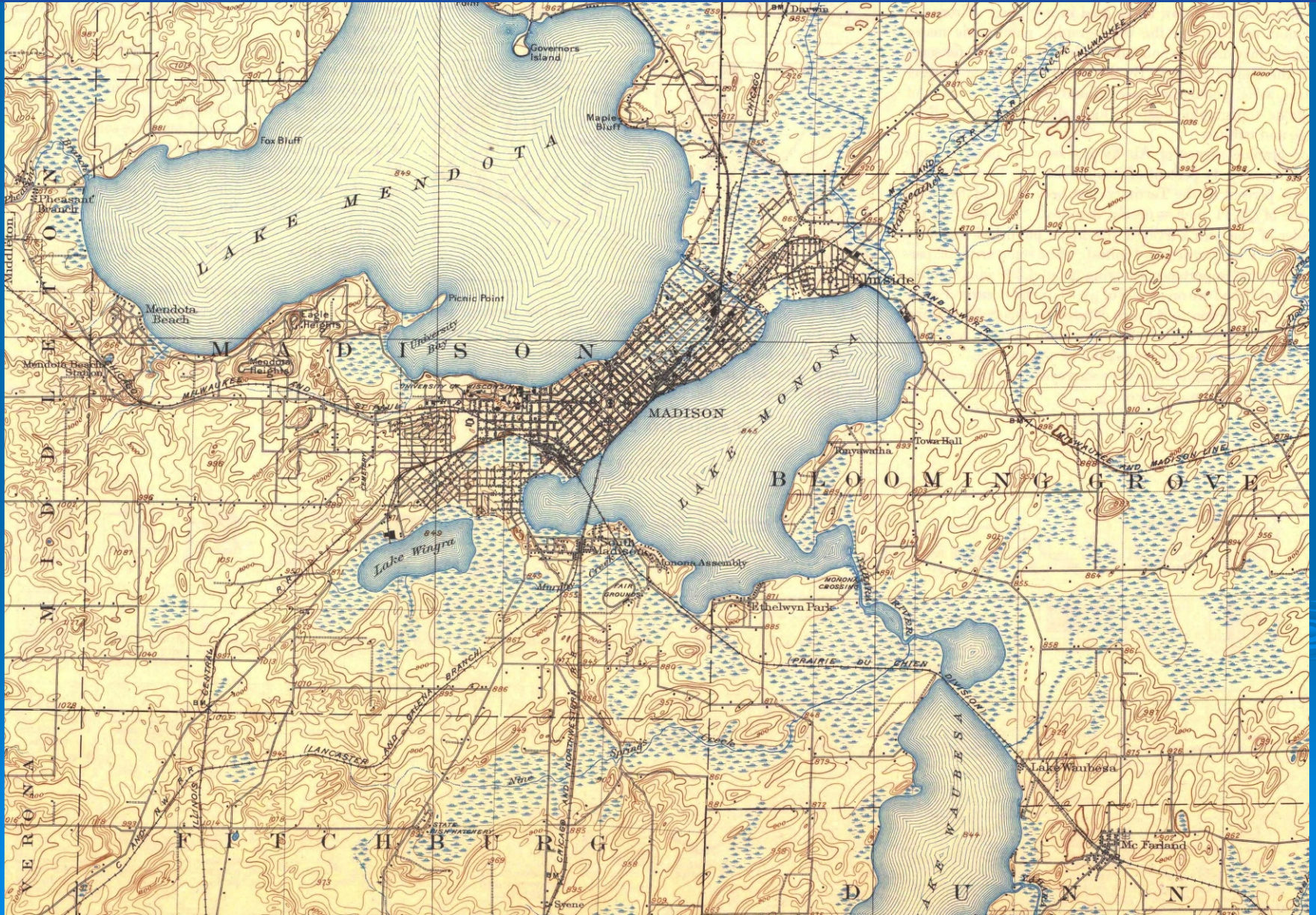
## The Issues:

- Low and Enclosed Areas
- Submerged Storm Sewer System
- Historic Wetlands



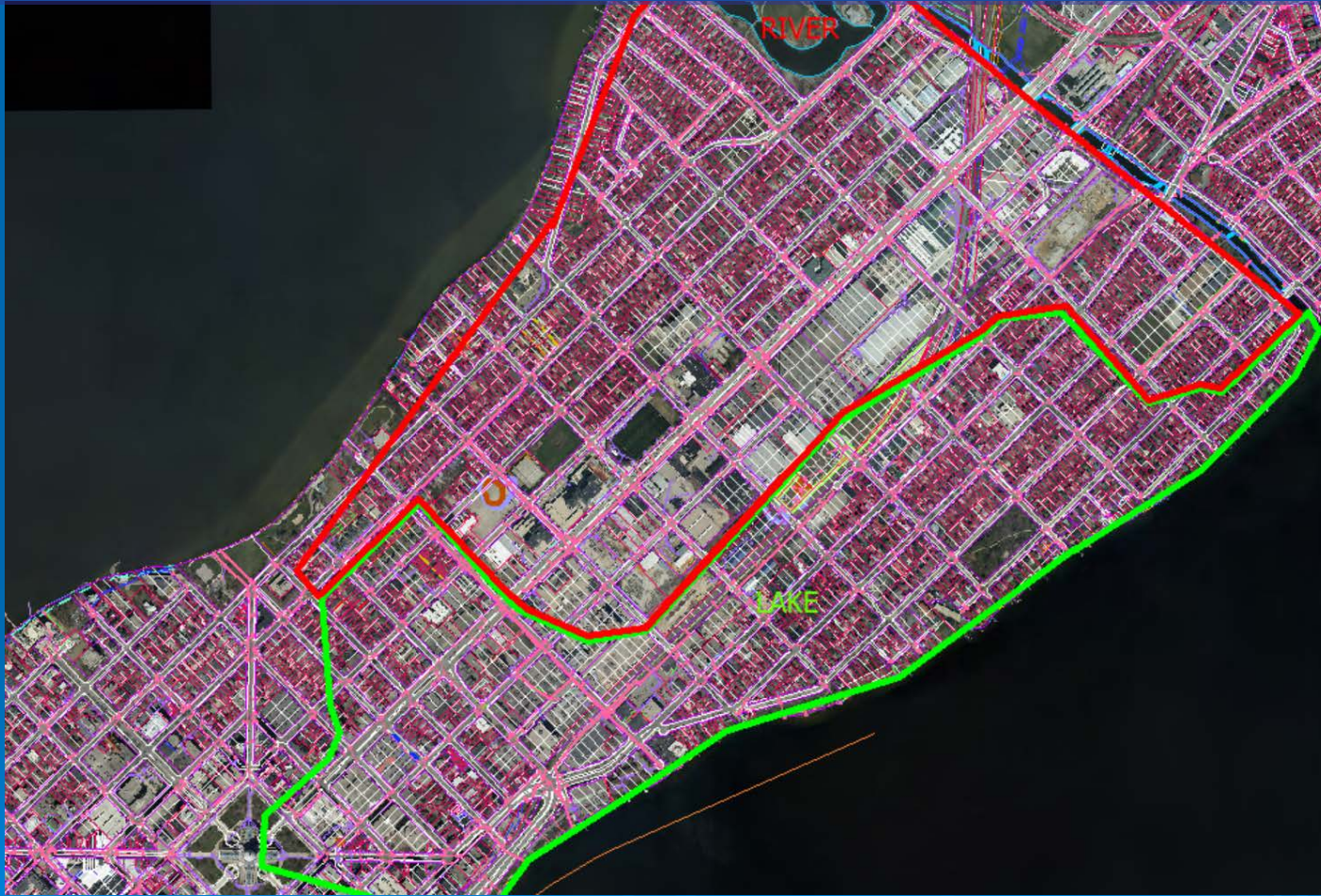


# Historic Flooding: Lake Level Flooding





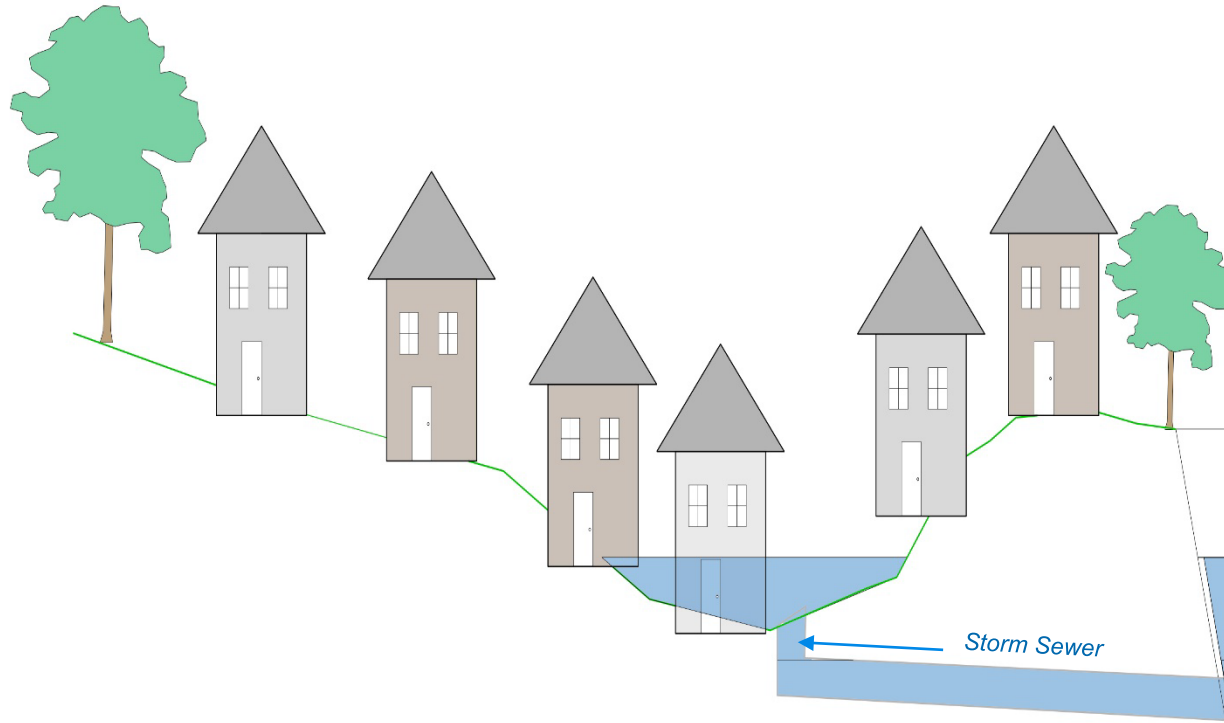
# Historic Flooding: Lake Level Flooding



- These low areas became a backwater of Lake Monona and the Yahara River



# Historic Flooding: Lake Level Flooding



- Storm sewers drain Isthmus during rain events
- Large amounts of water released from Mendota → higher water levels in Yahara River
- Sewers act in reverse, water travels "up" them
- Water standing in isthmus is part of the lake





# Historic Flooding: Lake Level Flooding





# Lake Level Flooding – what are we doing?

Lake Level Management - Look at ways to move the water out of Monona, Waubesa and Kegonsa faster.

**Dane County is proceeding with the following:**

- Dredging Monona to Waubesa (to start spring of 2020)
- Aggressive Aquatic Plant Management
- Structural changes at Tenney Lock house allowing water elevation to reach regulatory 100 year elevation.



Tenney Locks



# What Does the Future Hold

- The Westside of Madison experienced flash flooding events in 2016, 2017 & 2018
- The isthmus area flooded in 2018 and was very close to flooding again in 2019.
- Where does the data indicate rainfalls are headed in the future?

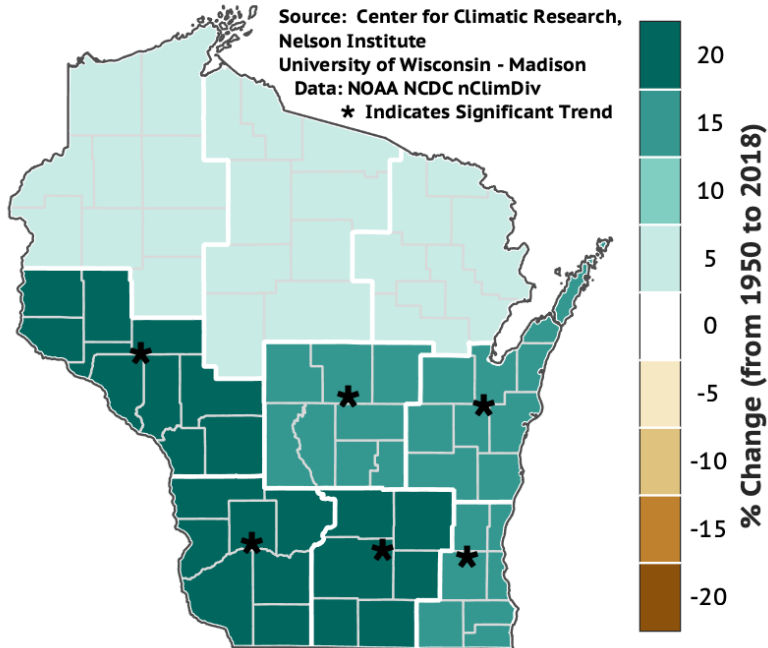


# What Does the Future Hold?

## Climate Change Concerns

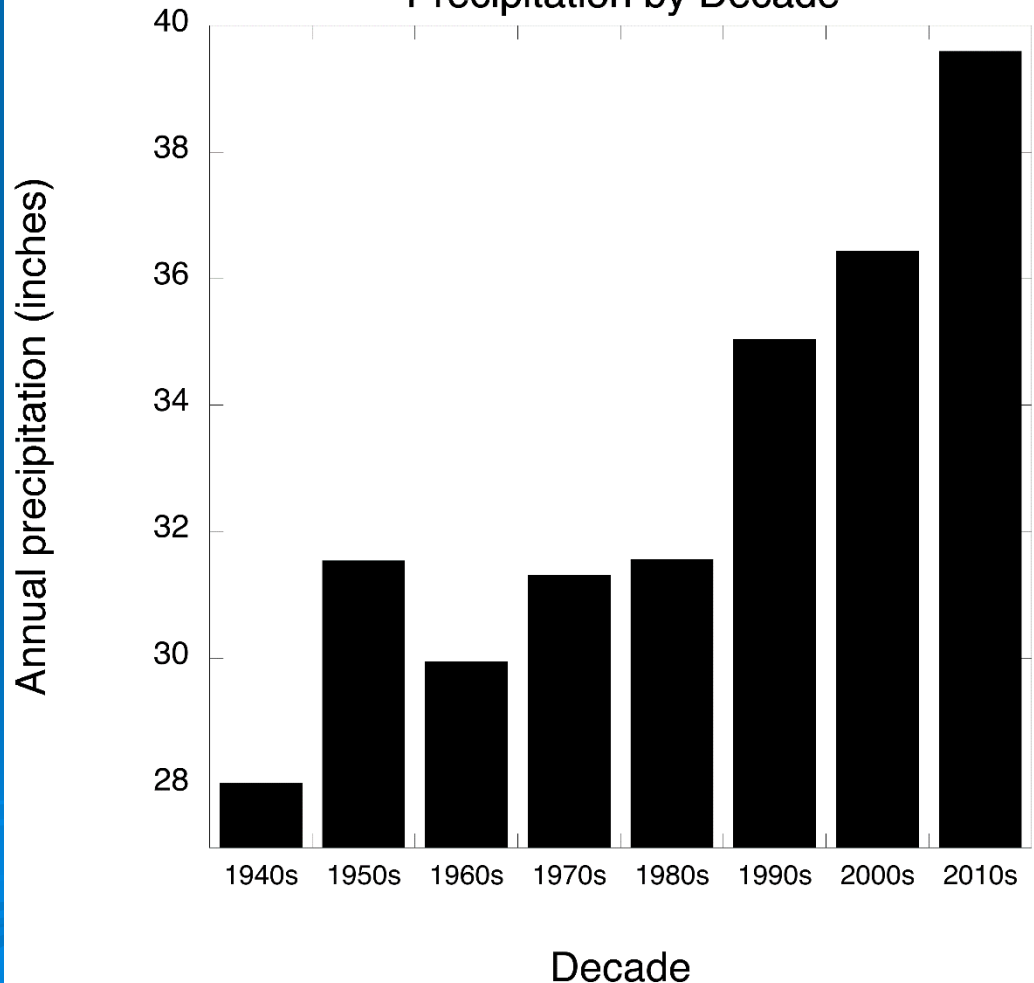
### Historical Change in Annual PRECIP (%) from 1950 to 2018

Source: Center for Climatic Research,  
Nelson Institute  
University of Wisconsin - Madison  
Data: NOAA NCDC nClimDiv  
★ Indicates Significant Trend



Rain and snow has increased  
by 15% since 1950

### Madison Annual Average Precipitation by Decade

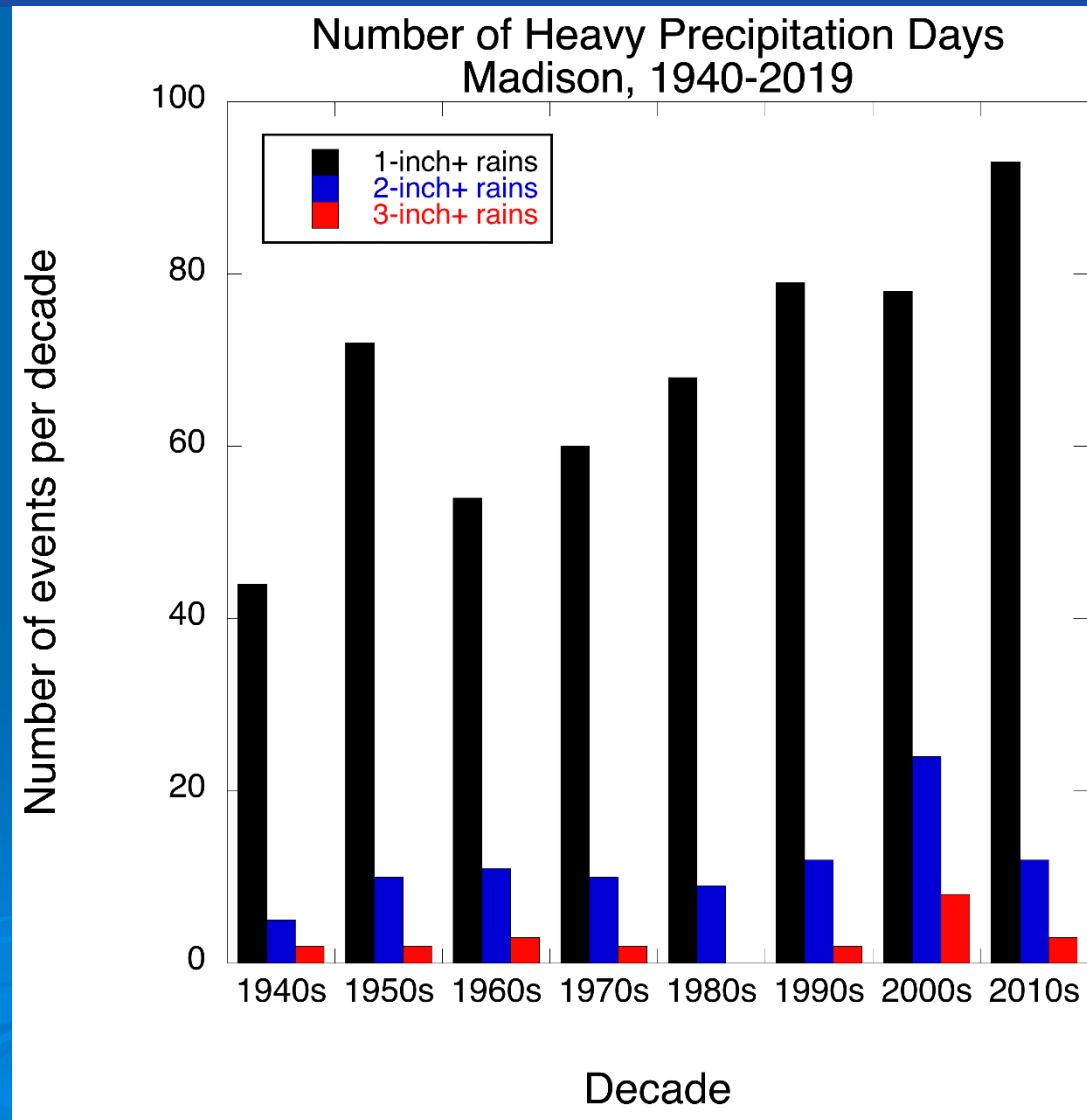




# What Does the Future Hold?

## Climate Change Concerns

- More rain
- More significant rain events.

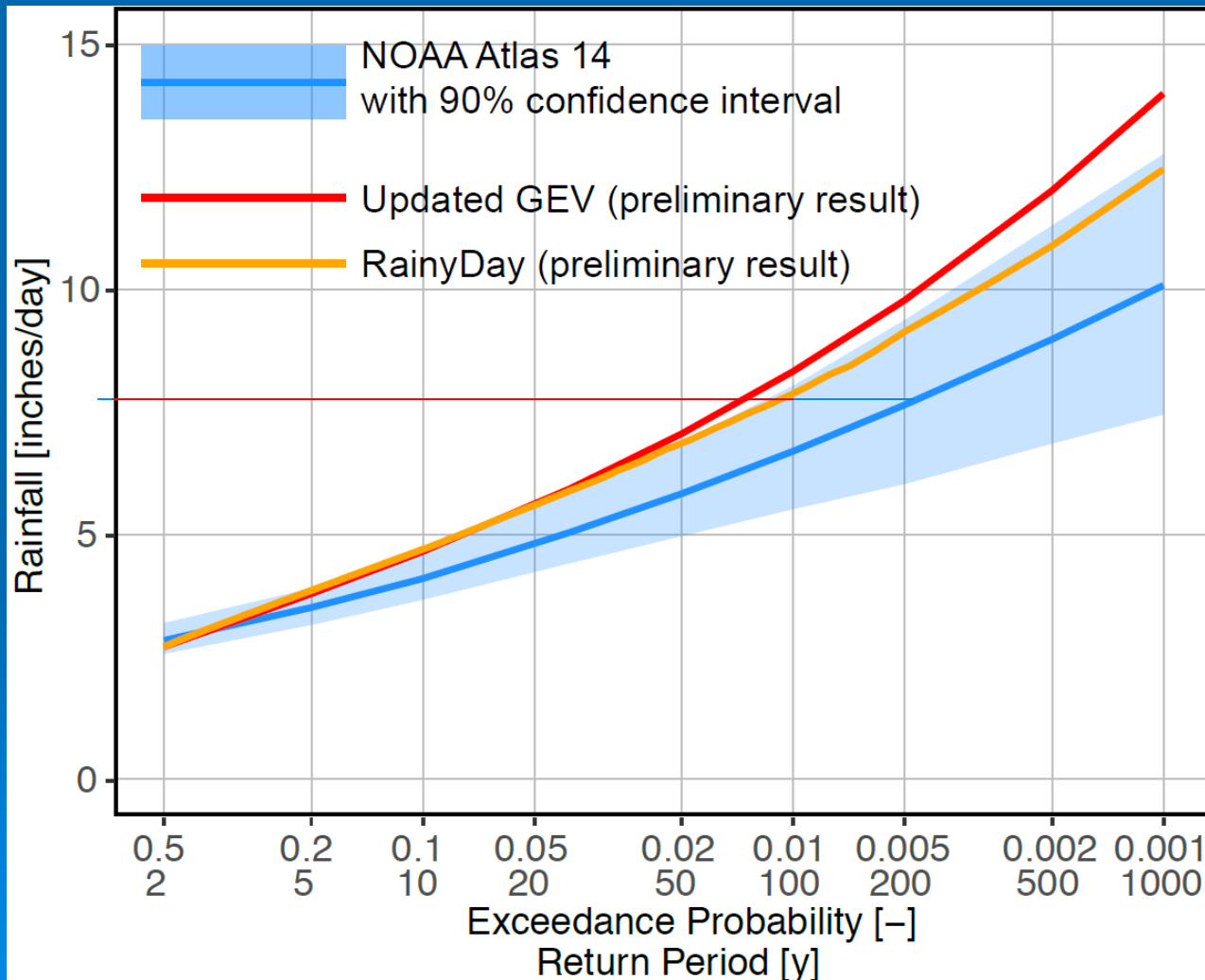




# What Does the Future Hold?

## Changing Rainfall Patterns

### Professor Dan Wright - RainyDay



24-hour rainfall  
return periods:

Blue = NOAA  
Atlas 14

Orange from  
RainyDay

Red is based on  
our analysis of  
roughly 60 years  
of data from the  
"Charmany Farm"  
rain gage, which  
is off Mineral  
Point near S.  
Rosa Rd.



# City of Madison Ordinances: Existing MGO– New Development

## Existing QUANTITY Madison Design Standards for New Development (prior to last August):

- Storm Sewer Pipes – 10 Year Event
- Culverts under a road - 25 or 50-Year Event
- Drainage of enclosed depressions – 25 Year Event
- Roads are expected to act as overflow during extreme events – not modeled in a rigorous manner.
- Detention basins designed to detain the 100-yr event.



# City of Madison Ordinances: Existing MGO– New Development

## ➤ Existing **QUALITY** New Development standards:

- Reduce Total Suspended Solids from new development by 80%
- Treat Oil & Grease from parking lots
- Infiltrate 90% of predevelopment infiltration (average annual basis not event driven)
- Detention of the 1,2,10 & 100 year events to predevelopment levels



# City of Madison Ordinances:

## Proposed MGO– New Development

- Culverts under a road – 100 Year event
- Storm Sewer Pipes – 10 Year event
- Drainage of enclosed depressions – 100 Year event
- Roads are expected to act as overflow during extreme events – elevations are be modeled
- Public outlots dedicated at low points draining to ponds or greenways. Easements not allowed.
- Lots with prior approved detention at the plat level meeting the 10 year event no longer grandfathered – lots requiring detention (over 20K SF impervious) meet current 100-year detention standard.
- **PROPOSED ORD CHANGE** - Detention for new development to include the design for the 200-year event.



# City of Madison Ordinances: Proposed MGO– New Development

## Proposed Madison Design Standards for New Development:

- No water leaves ROW or public property in 100 Year event.
- 500-year event is routed through the development – water may leave ROW or public lands but no structural flooding.
- Deed restrict properties for minimum opening elevation on buildings where critical (next to ponds/greenways).



# City of Madison Ordinances: Proposed MGO– New Development

**NEW DEVELOPMENT** – what do these changes mean:

- 1) More work by staff to review and design systems
- 2) More dedication of land by developers for overflows
- 3) More dedication of land for additional detention
- 4) Potentially larger pipes
- 5) Increase in volume needed for detention approximately 10-15% - that does not necessarily translate to area directly.



# City of Madison Ordinances: Existing MGO– Re-Development

- Existing Re-development QUALITY standards:
  - Reduce Total Suspended Solids from new pavement by 60%
  - Treat Oil & Grease from parking lots
- Existing Re-development QUANTITY standards:
  - NONE



# City of Madison Ordinances: Proposed MGO— Re-Development

## Madison Design Standards for Re-development:

If re-development has proposed impervious cover that exceeds 80% of the existing site impervious cover, the site shall meet the following criteria:

- Reduce peak runoff rates from the site by 15% compared to existing conditions during a 10-year design storm.
- Reduce runoff volumes from the site by 5% compared to existing conditions during a 10-year design storm.
- The required rate and volume reductions using green infrastructure for at least the first 1/2 inch of rainfall.



# City of Madison Ordinances: Proposed MGO– Re-Development

RE-DEVELOPMENT – what do these changes mean:

- 1) Re-development has never had a detention or volume reduction requirement.
- 2) The requirement may be difficult to meet and add expense to projects.
- 3) Requirement to treat with Green Infrastructure (GI) will push new buildings towards the use of green roofs.



# City of Madison Ordinances:

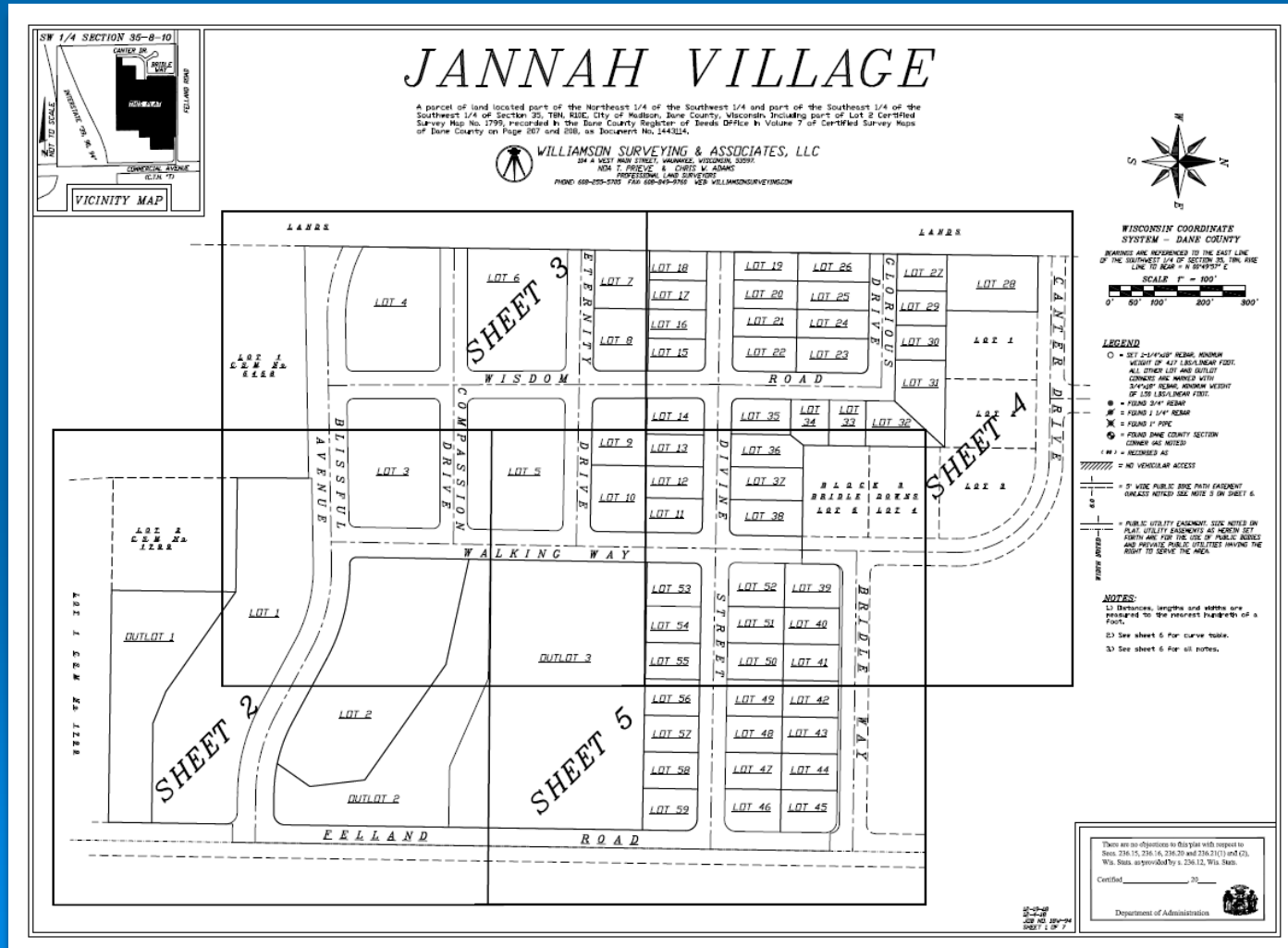
## What did we not propose??

- Considered the use of a Madison specific IDF curve – we opted to go to detention of the 200 year in new development using the NOAA Atlas 14.



# EXAMPLES: New Development

## Jannah Village - New Subdivision





# EXAMPLES:

## New Development

### Jannah Village - New Subdivision

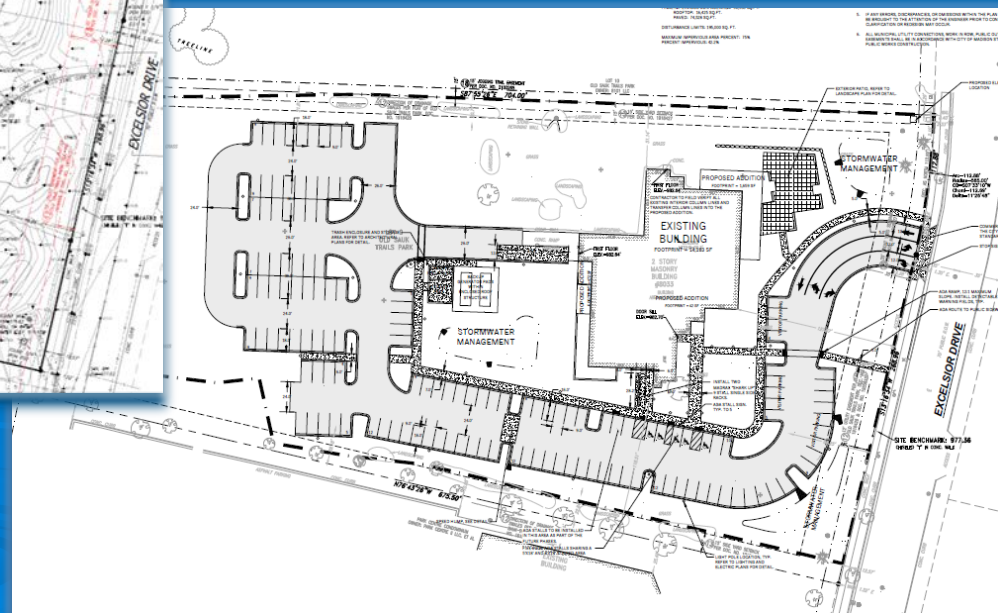
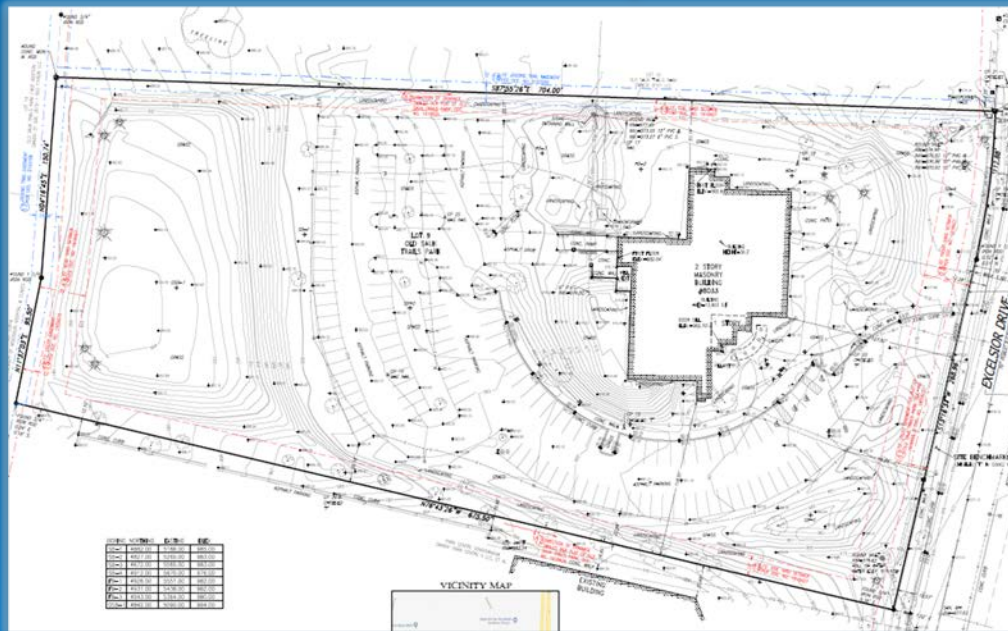
- 200-year storm was run through HydroCAD models
- The required storage went from 322,277 cubic feet (100 yr storm) to 353,342 cubic feet (200 yr storm). **An increase of 31,065 cubic feet or ~10%.**
- The additional water wasn't causing the ponds to overtop so they wouldn't have had to change the design.



# EXAMPLES:

## New Development and Redevelopment

### Case #1 Old Sauk Trails Business Park – Building additions and minor exterior modifications (Excelsior Dr)





# EXAMPLES:

## New Development and Redevelopment

### Case #1 Old Sauk Trails Business Park (cont.)

**This is considered both new development and redevelopment**

New Development portion:

- Adding 130,800+/- impervious
  - Added impervious area exceeds 20,000 sf
  - **NEW REQUIREMENTS WOULD APPLY**
- Ex. ordinance 100-yr rate control req'd.
  - PROPOSED ordinance 200-yr rate control is req'd. The increase in volume from the 10-yr to 200-yr is 61,000 cf (19%).



# EXAMPLES:

## New Development and Redevelopment

### Case #1 Old Sauk Trails Business Park (cont.)

Redevelopment portion:

➤ Impervious area exceeds 80% of the existing site impervious area

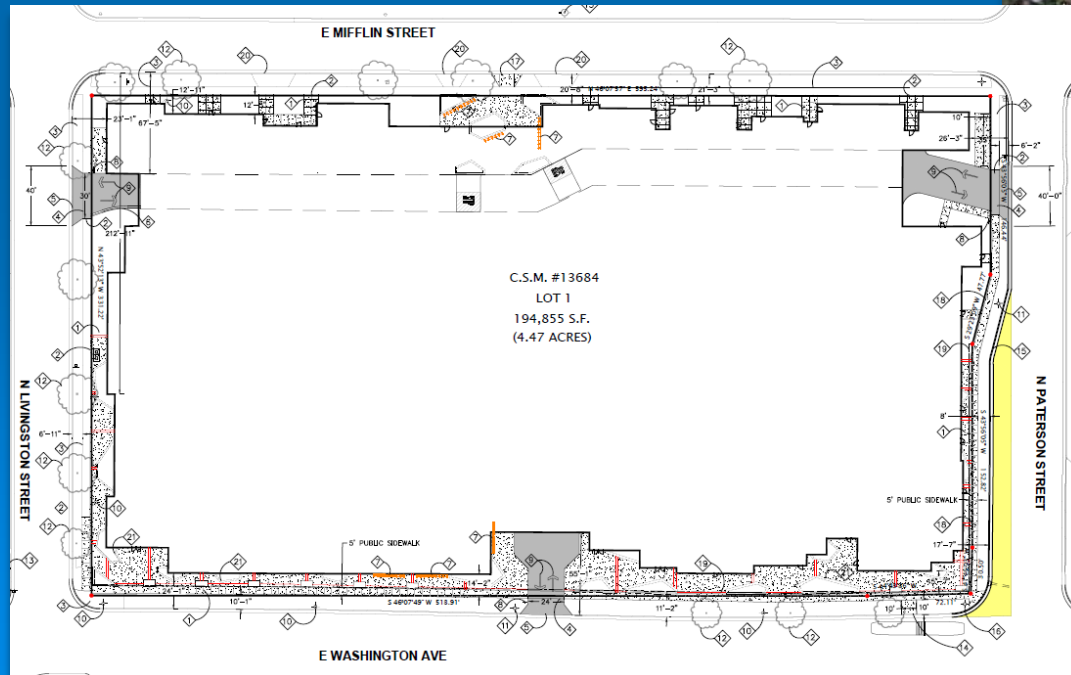
- **NEW REQUIREMENTS WOULD APPLY**

- Reduce the 10-year storm event peak discharge rate by 15% compared to existing conditions
- Reduce the 10-year storm event site runoff volume by 5% compared to existing conditions
- Green infrastructure req'd for the first 0.5" of rain over the total site impervious area.



# EXAMPLES: Redevelopment

## Case #2 Galexie on E. Washington – full demolition and construction of new building





# EXAMPLES: Redevelopment

## Case #2 Galexie on E. Washington (cont.)

Existing ordinance – site was fully impervious – no Stormwater requirements.

➤ Impervious area exceeds 80% of the existing site impervious area

⇒ **NEW REQUIREMENTS WOULD APPLY**





# EXAMPLES: Redevelopment

## Case #2 Galexie on E. Washington (cont.)

- Reduce the 10-year storm event peak discharge rate by 15% compared to existing conditions
- Reduce the 10-year storm event site runoff volume by 5% compared to existing conditions
- Green infrastructure required that captures at least the first 0.5" of rain over the total site impervious area.
- LIKELY BEST WAY TO COMPLY IS GREEN ROOF OR WATER REUSE



# Questions and Discussion

