



Willow Creek Watershed Study

BPW

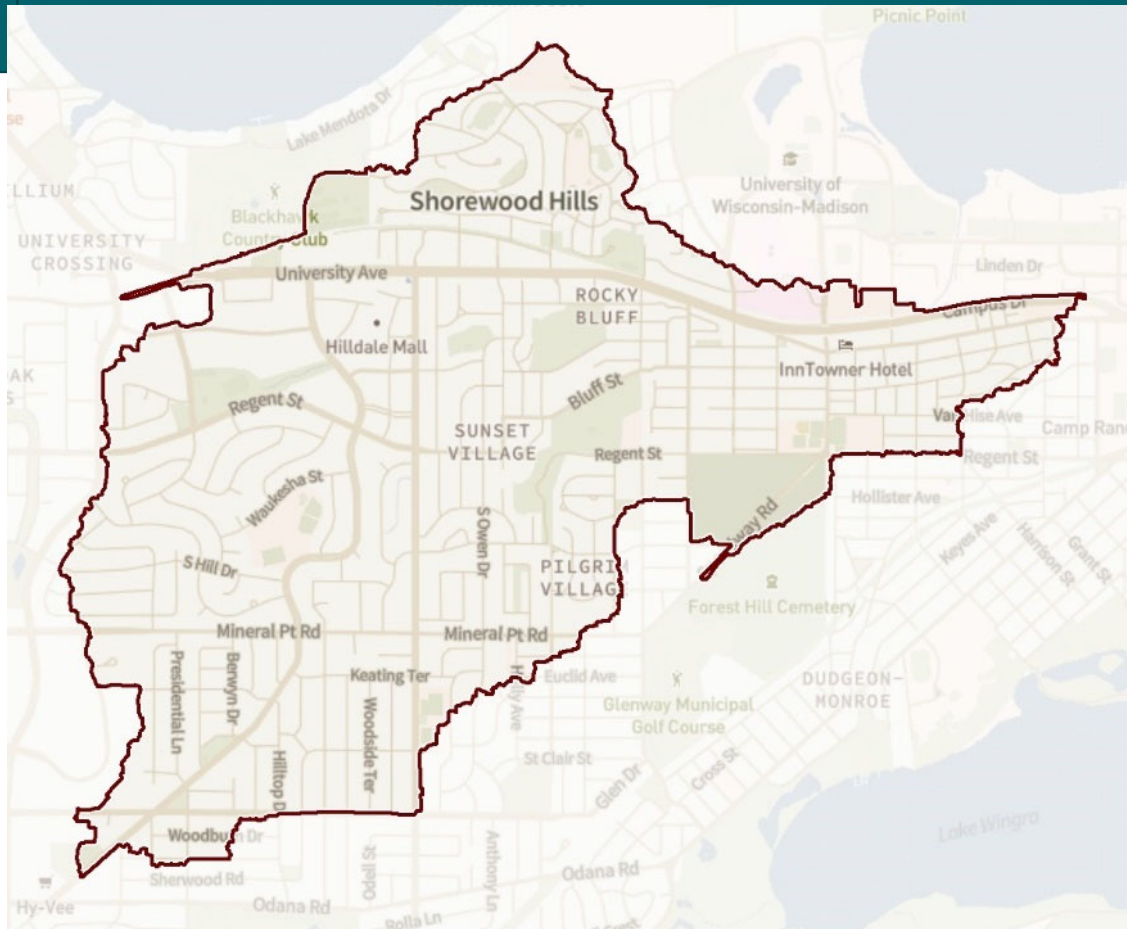
December 13, 2023

Janet Schmidt – Principal Engineer

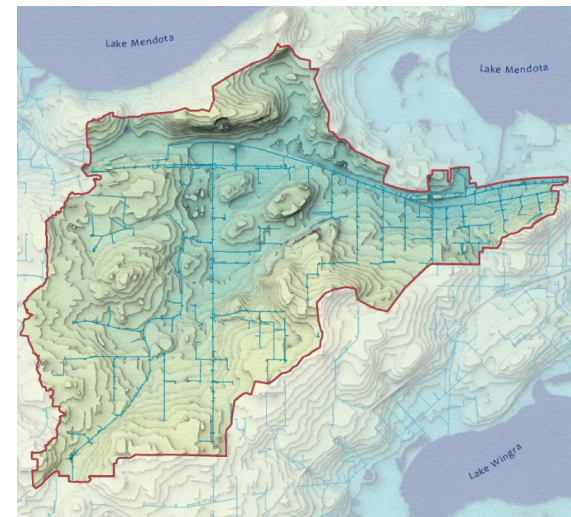
Outline

1. Location
2. August 2018 Rainfall
3. Watershed Study Targets
4. Existing Conditions Results
5. Proposed Solutions Process
6. Alternatives Reviewed
7. GI's Help towards Targets
8. Final Thoughts
9. Next Steps

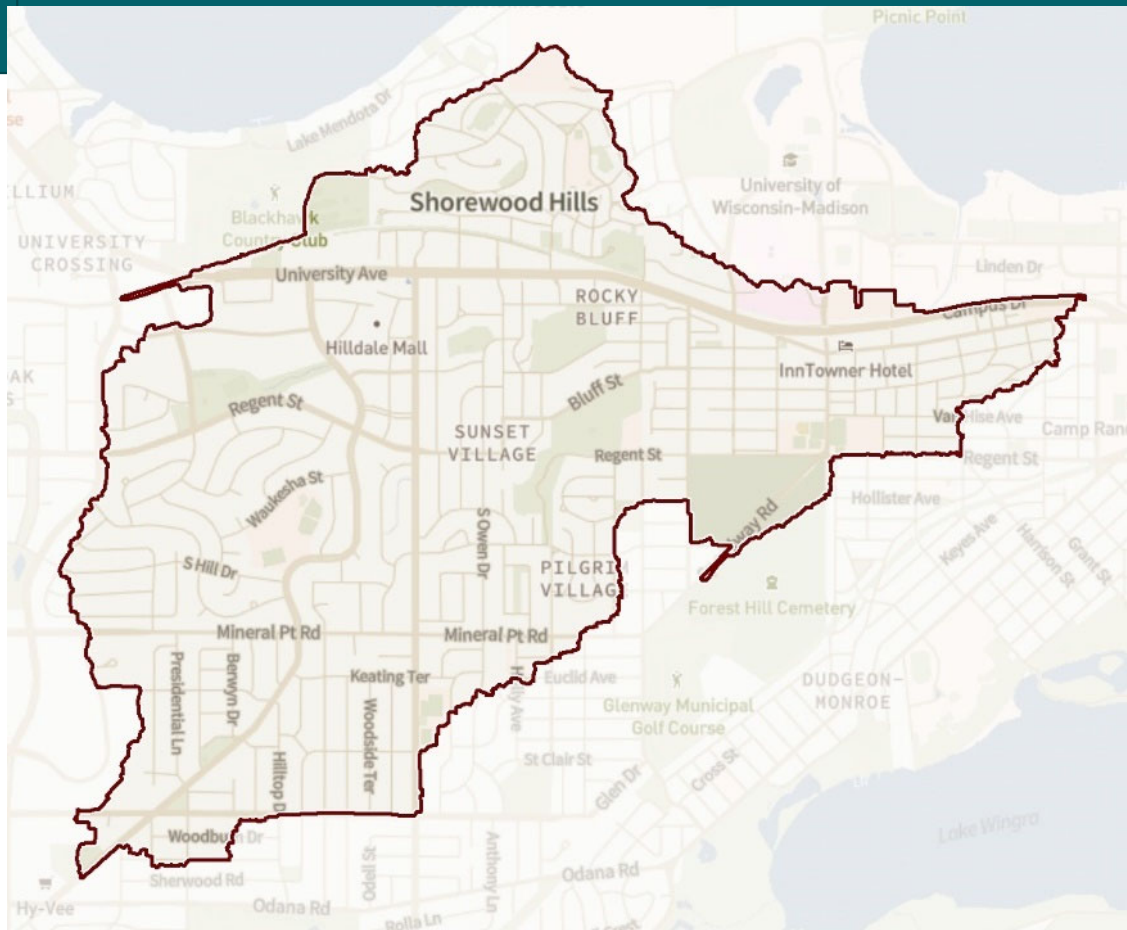
Project Location



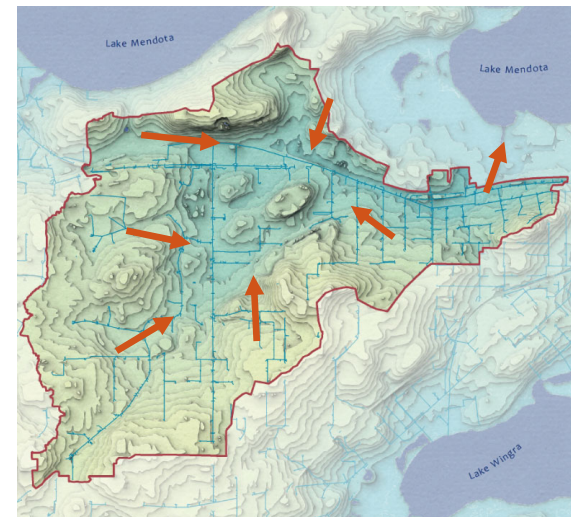
This is the Willow Creek watershed in the City of Madison.



Project Location

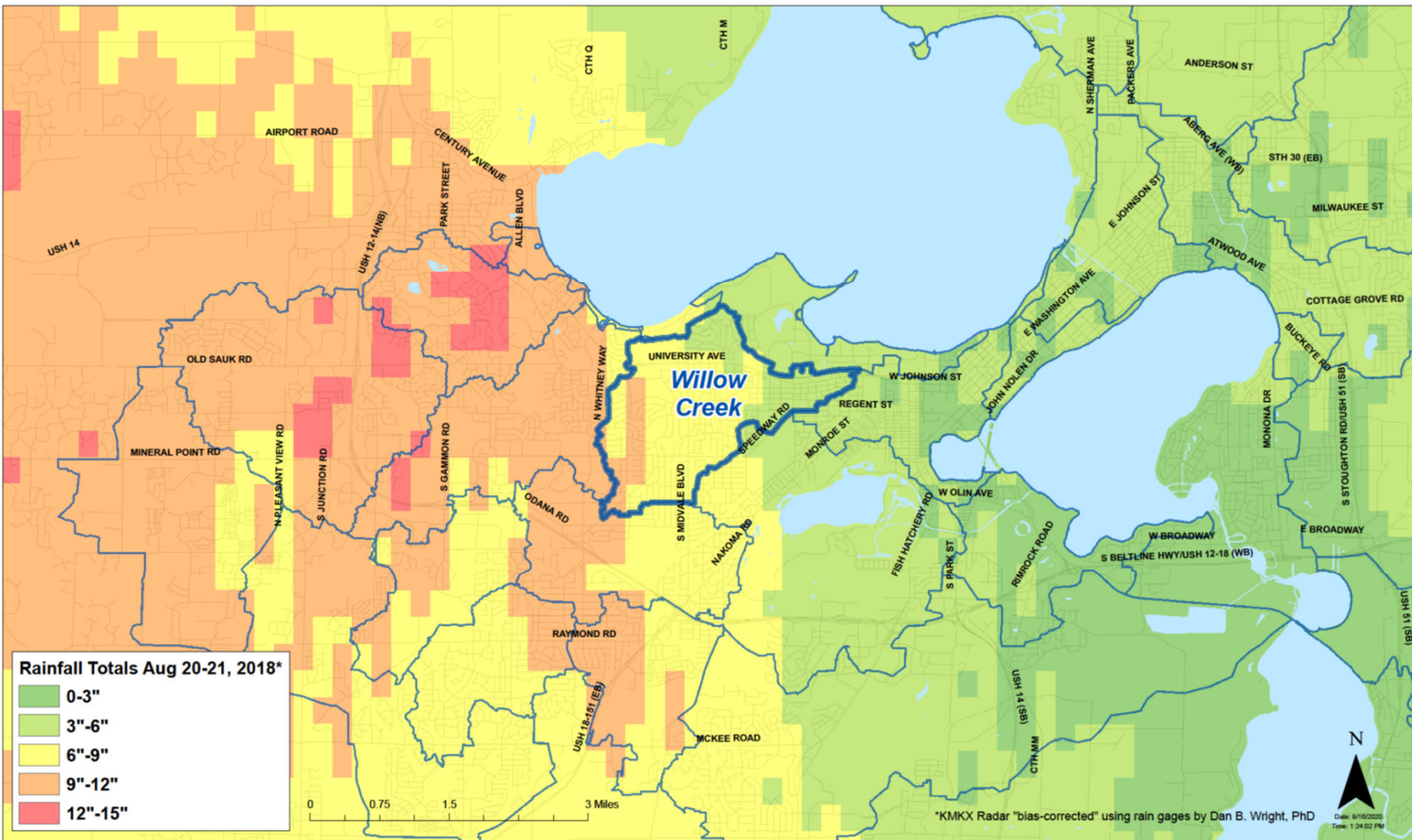


This is the Willow Creek watershed in the City of Madison.



Rainfall Totals August 20-21, 2018

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



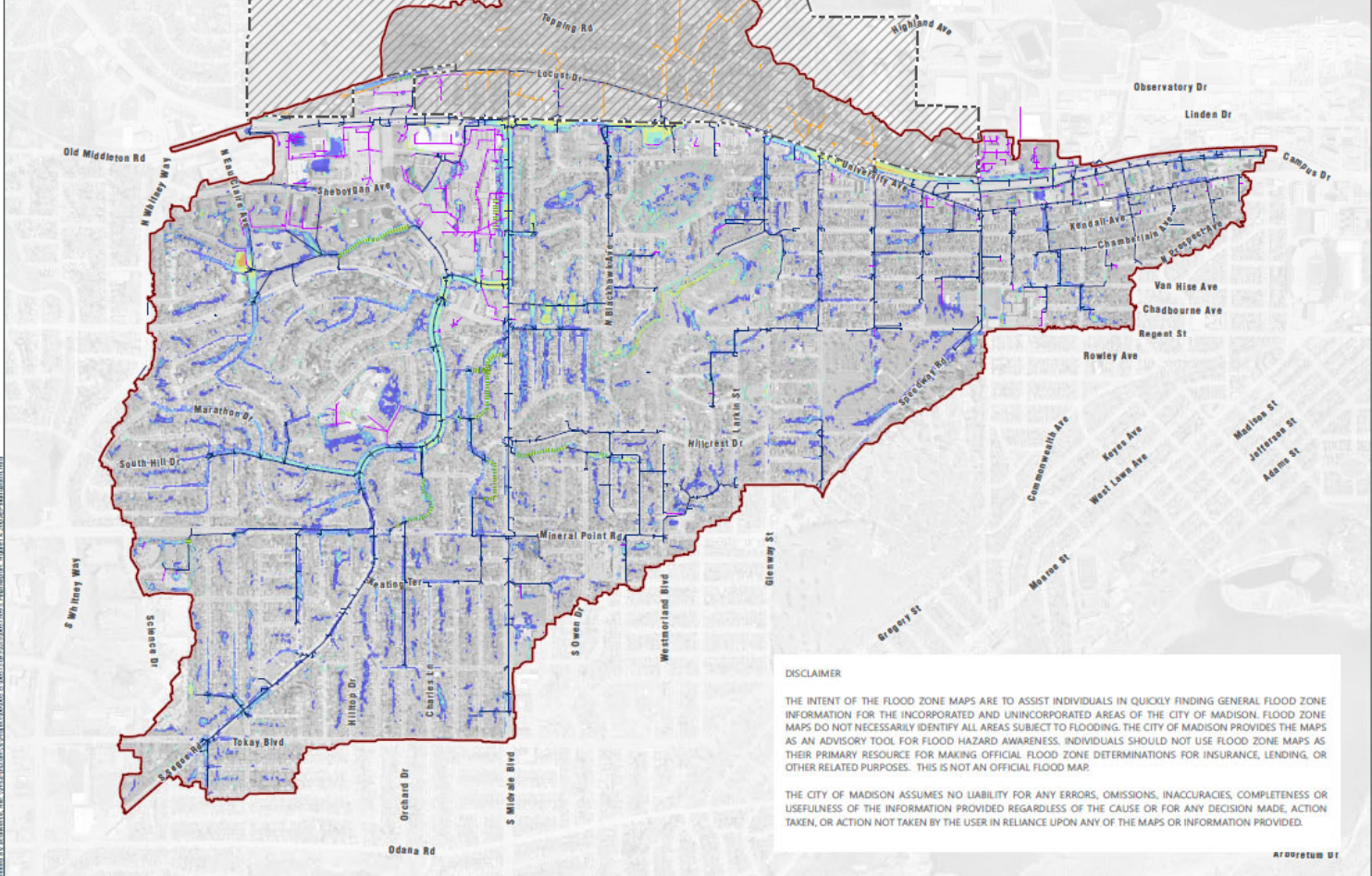
Typical Flood Mitigation Program Targets

- 10% Chance Event (4.09" rain/24 hours)
 - No surcharging of storm sewer onto roadway (storm sewer pipes are sized to carry storm)
- 4% Chance Event (5.01" rain/24 hours)
 - 0.5' at Centerline of Road (roads passable for emergency vehicles)
- 1% Chance Event (6.66" rain/24 hours)
 - No structure (home/building) flooding
 - No greenway crossing overflow (stormwater does not come out of greenway and flow over the road)
- 0.2% Chance Event (8.81" rain/24 hours)
 - Safe conveyance of overflow

Willow Creek Specific Targets

- Watershed characteristics resulted in unique approach
 - Fully developed
 - Major urban corridor in an “enclosed depression”
- Studied numerous times before (back to the 50’s, and multiple times since 2000)
- Evaluated what it *would take* to meet City’s flood targets
- Limitations resulted in unique target for this particular watershed
 - Typical targets for larger storms resulted in increase in flooding in major corridor unless relief tunnel is constructed
 - Typical targets also requires fully developed/established acquisition of residential areas for conversion to detention
- *Unique for this watershed*
 - Flood mitigation target is 20% Chance Event (3.45” rain/24 hours – aka 5-year event)
 - Provide as even level of service as possible while not making one area much better at the expense of another area.

Willow Creek Watershed Existing Conditions 20% Chance Storm Event Maximum Water Depth



20% AEP Inundation

FIGURE 14
Willow Creek Watershed
Study Report
City of Madison
Dane County, WI

Typically 10%
AEP* Event for
Other Studies

- Watershed Study Area
 - Village of Shorewood Hills
 - Public Storm System
 - Private Storm System
 - Shorewood Hills Storm System
 - Open Channel Flow
- 20% Annual Exceedance Probability Storm
Maximum Water Depth (ft)
- 0.1 - 0.25
 - 0.25 - 0.5
 - 0.5 - 1
 - 1 - 3
 - 3 - 6
 - >6

Data Sources:
Aerial: City of Madison (2018)
Watershed Boundaries: MSA
Stormwater System: City of Madison

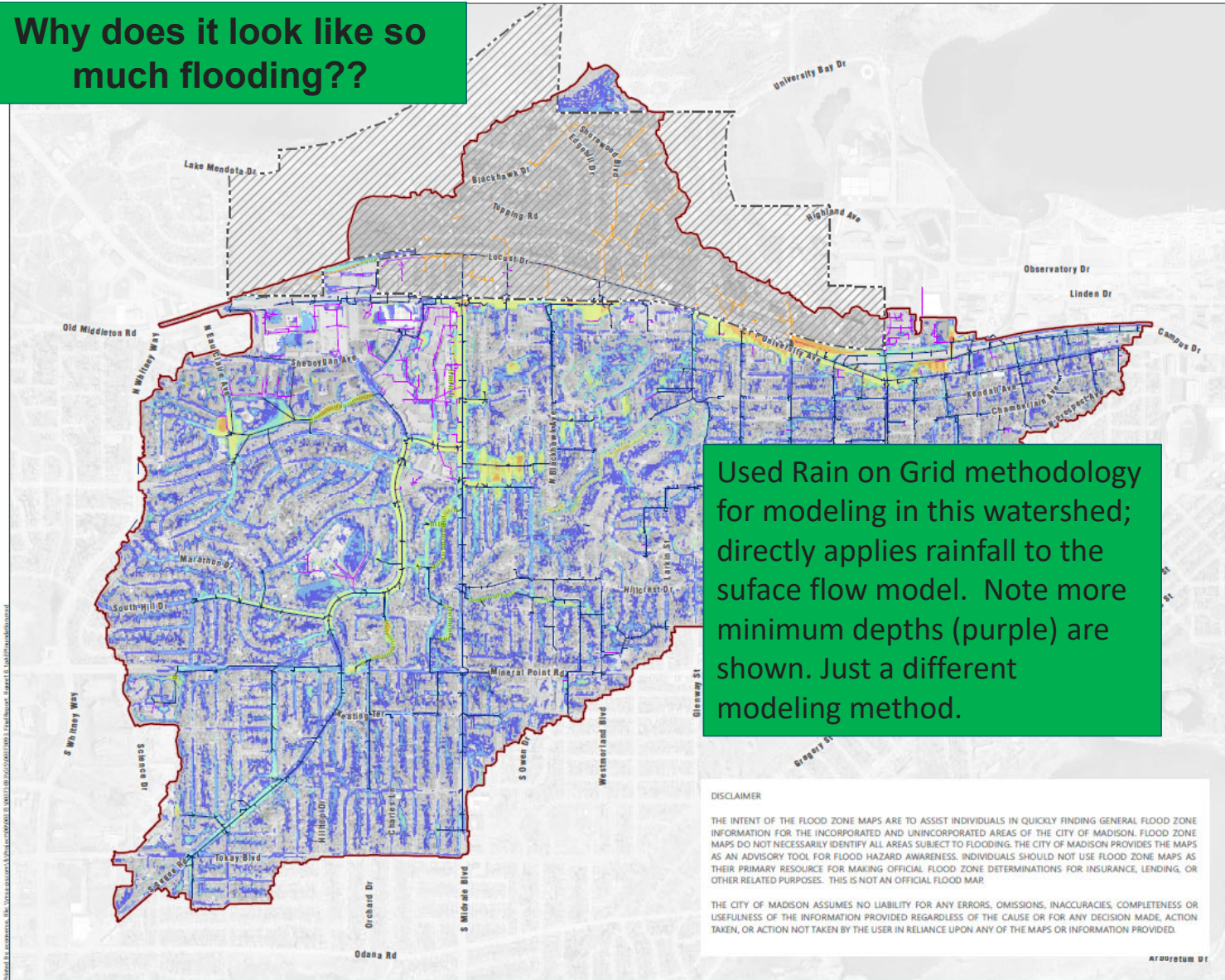
*AEP meaning: Annual
Exceedance Probability

Why does it look like so much flooding??

1% AEP Inundation

FIGURE 18
Willow Creek Watershed
Study Report

City of Madison
Dane County, WI



- Watershed Study Area
- Village of Shorewood Hills
- Public Storm System
- Private Storm System
- Shorewood Hills Storm System
- Open Channel Flow
- 1% Annual Exceedance Probability Storm
- Maximum Water Depth (ft)
- 0.1 - 0.25
- 0.25 - 0.5
- 0.5 - 1
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- 3 - 6
- > 6

Used Rain on Grid methodology for modeling in this watershed; directly applies rainfall to the surface flow model. Note more minimum depths (purple) are shown. Just a different modeling method.

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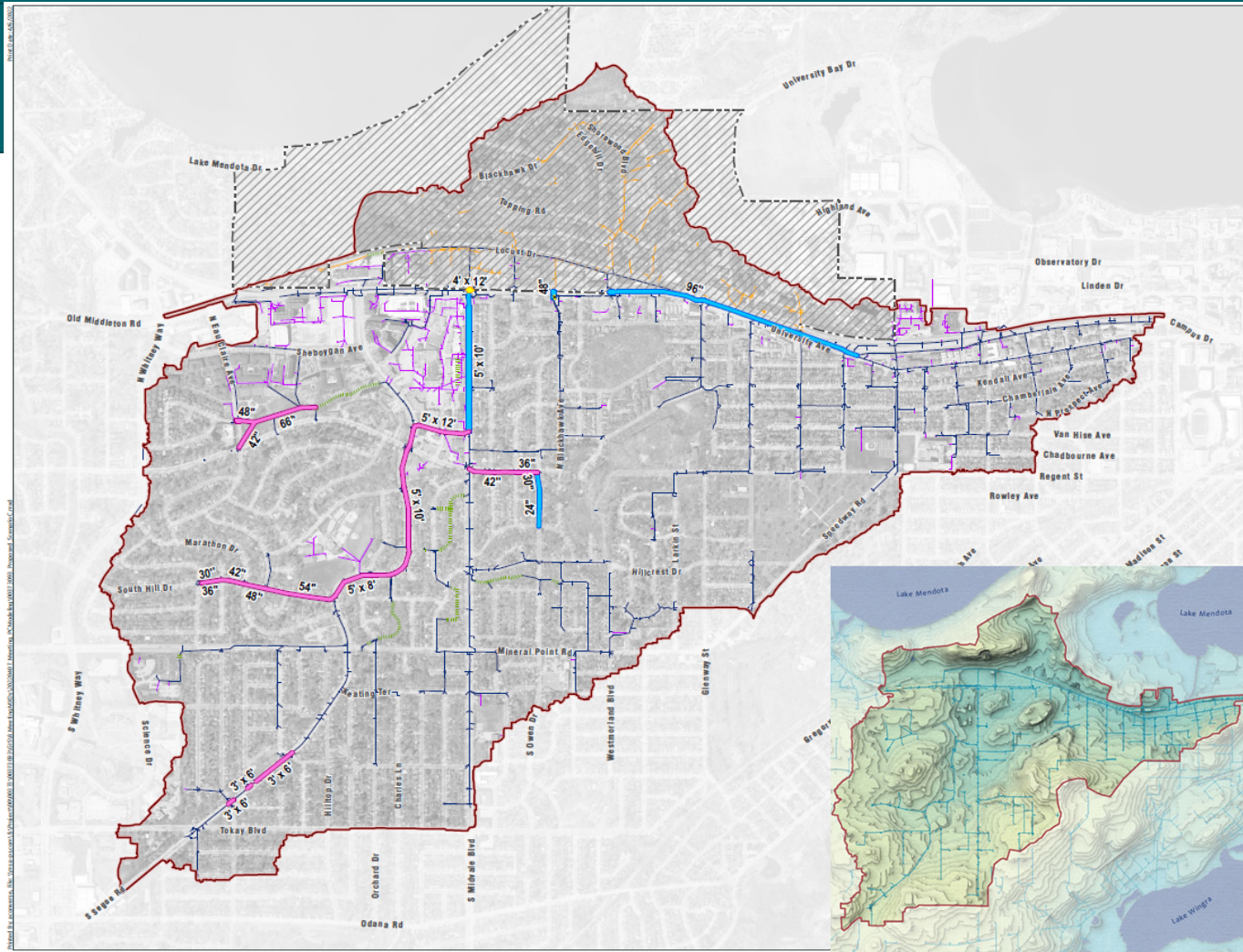
Flood Mitigation Targets – Existing Conditions

Existing Conditions

- 20% Chance Event (unique to this watershed)
 - 15.2 curb-miles of street out of 104.2 curb-miles (14.6%) – with .25' in gutter
- 10% Chance Event
 - 17.3 curb-miles of street out of 104.2 curb-miles (16.6%) – with .25' in gutter
- 4% Chance Event
 - 7.7 miles of street out of 58.1 miles (13.2%) – with .5' or more depth at CL of roadway
- 1% Chance Event
 - 353 buildings/structures out of 5,040 (7.0%)

Recommended Alternative - C

- Meets 20% Chance Event Targets in Watershed
- Makes progress towards meeting other targets



Proposed Scenario C

-Scenario A
-Upsize trunk sewer mains and branches to the 5-year "Level of Service" event. (Midvale Blvd, Vernon Blvd, Segoe Rd, S Hill Dr, N Eau Claire Ave, Regent St, Owens Dr, Meadow Ln)

City of Madison
Dane County, WI

- Watershed Study Area
- Village of Shorewood Hills
- Proposed Improvement**
 - New Pipe
 - Replacement Pipe
 - New Connection
 - Remove Pipe
 - Public Storm System
 - Private Storm System
 - Shorewood Hills Storm System
 - Open Channel Flow

Data Sources:
Aerial: Dane County (2020)
Watershed Boundary: MSA
Stormwater System: City of Madison

Flood Mitigation Targets - Progress

Proposed Conditions

- 20% chance event (unique to this watershed)
 - 12.6 curb-miles out of 104.2 curb-miles (12.1%) – with .25' of depth in gutter
 - Improved by 2.6 miles
- 10% chance event
 - 15.4 curb-miles of street out of 104.2 curb-miles (14.8%) – with .25' of depth in gutter.
 - Improved by 1.9 miles
- 4% chance event
 - 6.4 miles of street out of 58.1 miles (11.0%) – with .5' of depth at street center line
 - Improved by 1.3 miles
- 1% chance event
 - 322 buildings/structures out of 5,040 (6.4%)
 - Improved for 31 buildings/structures

Flood Mitigation Targets – Willow Creek Specific

Proposed Conditions

- 20% chance event (unique to this watershed)
 - removed approximately 33 structures from flooding. Best Guess on property value (not including land) is \$15M
- 10% chance event
 - Removed approximately 13 MORE structures from flooding. Best guess on property value (not including land) is \$18M MORE
- Total best guess building value* (not including land) removed from flooding is approximately \$23-25M
 - *may not be representative of cost of damage since basements and lower levels are mostly impacted

Proposed Solutions

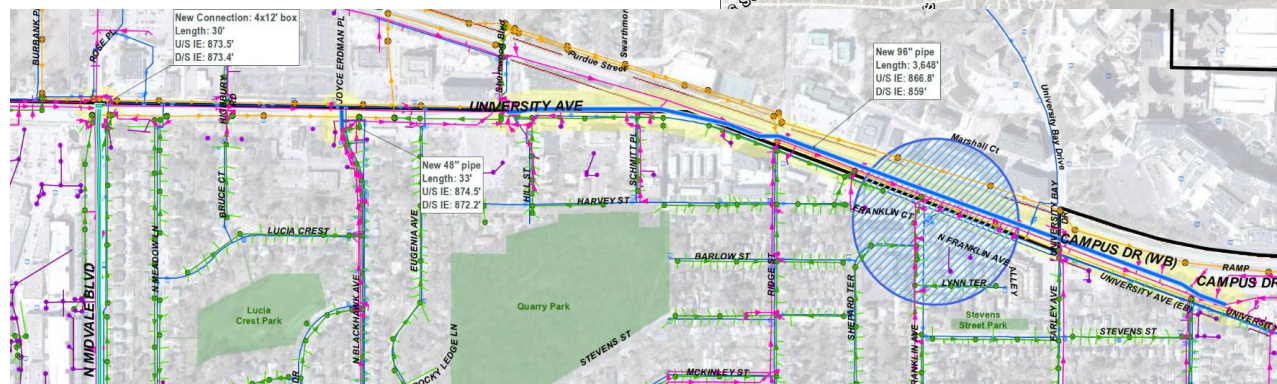
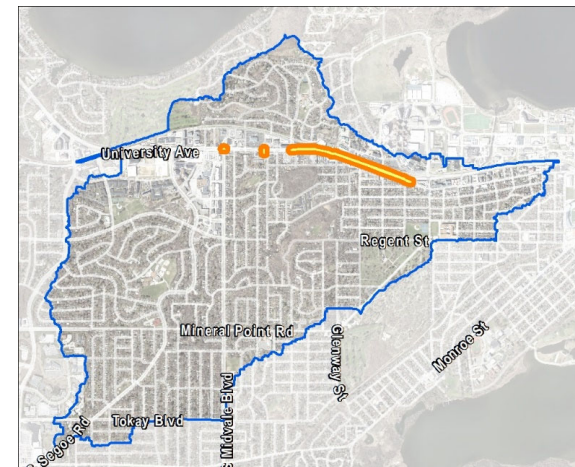
1. University Ave 96" Storm Sewer – Under construction
2. N Midvale Blvd Storm Sewer
3. South Hill Dr, Segoe Rd and Vernon Blvd Storm Sewer
4. Regent St & Owen Dr Storm Sewer – Owen scheduled 2024
5. N Eau Claire Ave, Regent St and Rennebohm Park Storm Sewer
6. S Segoe Rd Storm System Improvements

Implementation Order

- Construct downstream to upstream in order noted above

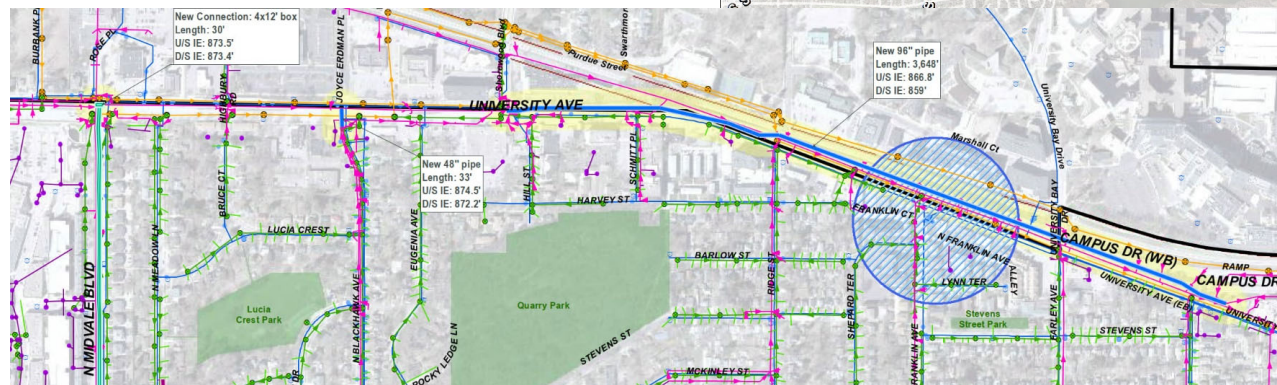
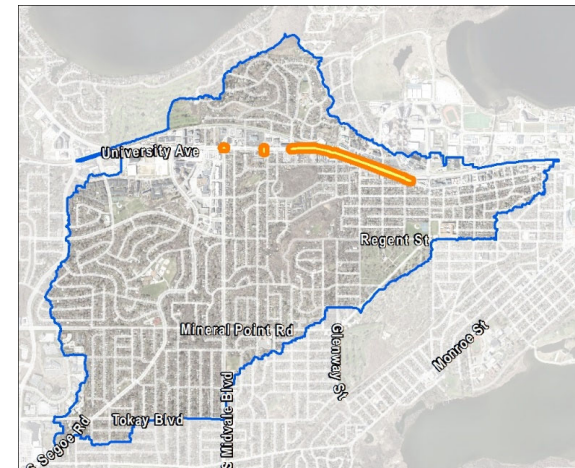
1. University Ave Storm System Improvements

- **Goal: Reduce flooding during 10%, 4%, and 1% events**
- New 96" pipe along University Ave (Shorewood Blvd → east of Grand Ave)
- Reconnecting the box at Midvale Blvd and University Ave
- New Connection at N Blackhawk Ave and University
- Reduces street ponding for more frequent events
- 18 less buildings/structures impacted by 1% event



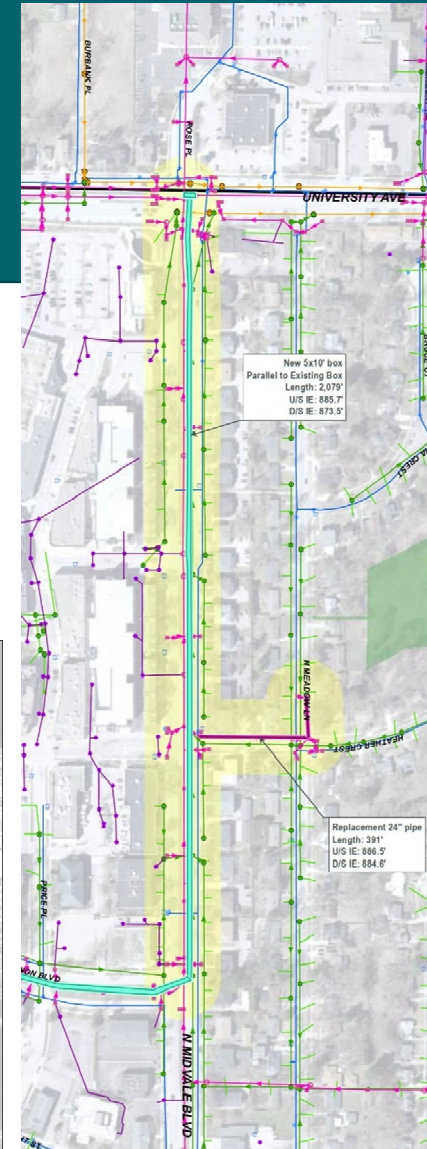
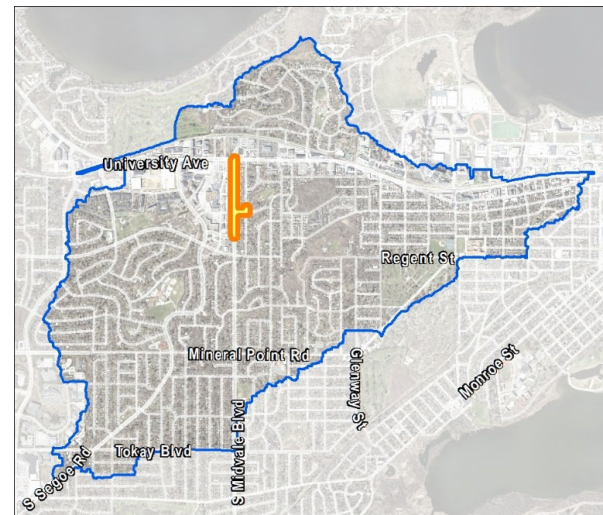
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- New 96" pipe along University Ave (Shorewood Blvd → east of Grand Ave)
- Reconnecting the box at Midvale Blvd and University Ave
- New Connection at N Blackhawk Ave and University
- Reduces street ponding for more frequent events
- 18 less buildings/structures impacted by 1% event
- **Under construction now (2022-2023). Approx \$8M**



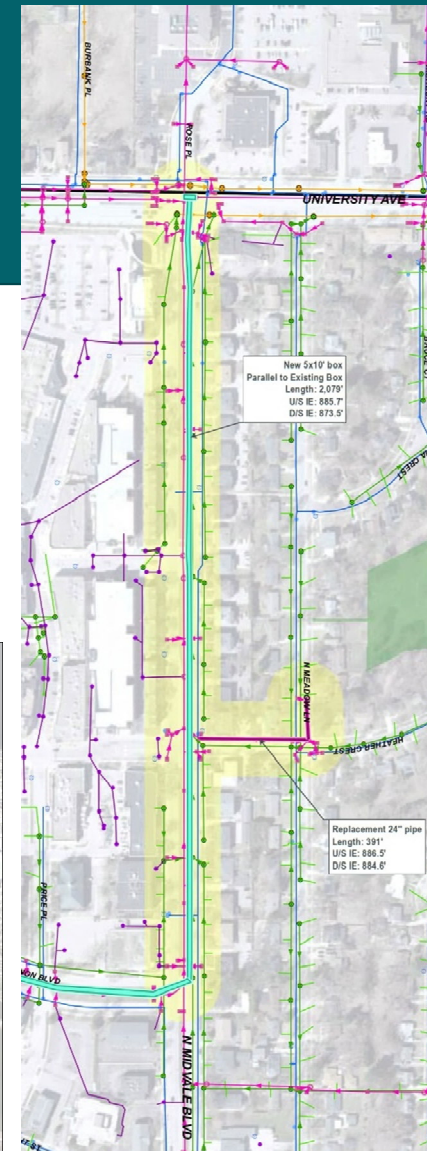
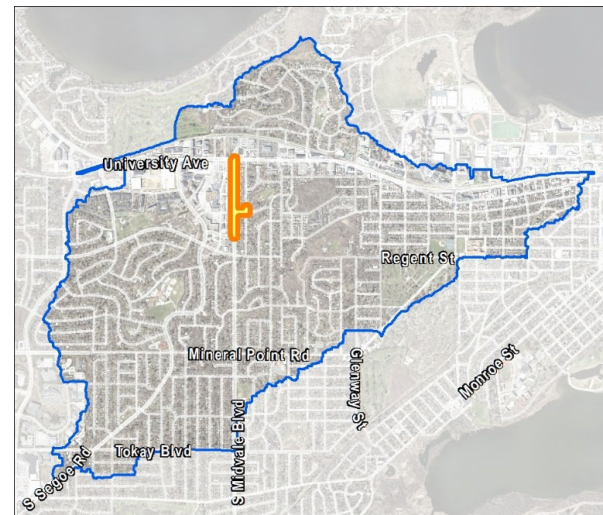
2. N Midvale Blvd Parallel Storm System Improvements

- **Goal: Reduce flooding during 10%, 4%, and 1% events**
- Install a second, parallel 5' x 10' box culvert under Midvale Blvd
- Upsize 2-pipes on Heather Crest and N Meadow Ln to meet 20% event capacity
- 5 less buildings/structures impacted by 1% event
- Est. Cost: \$16.8M



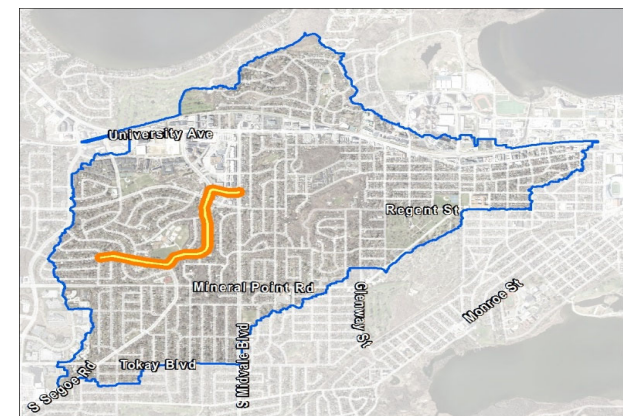
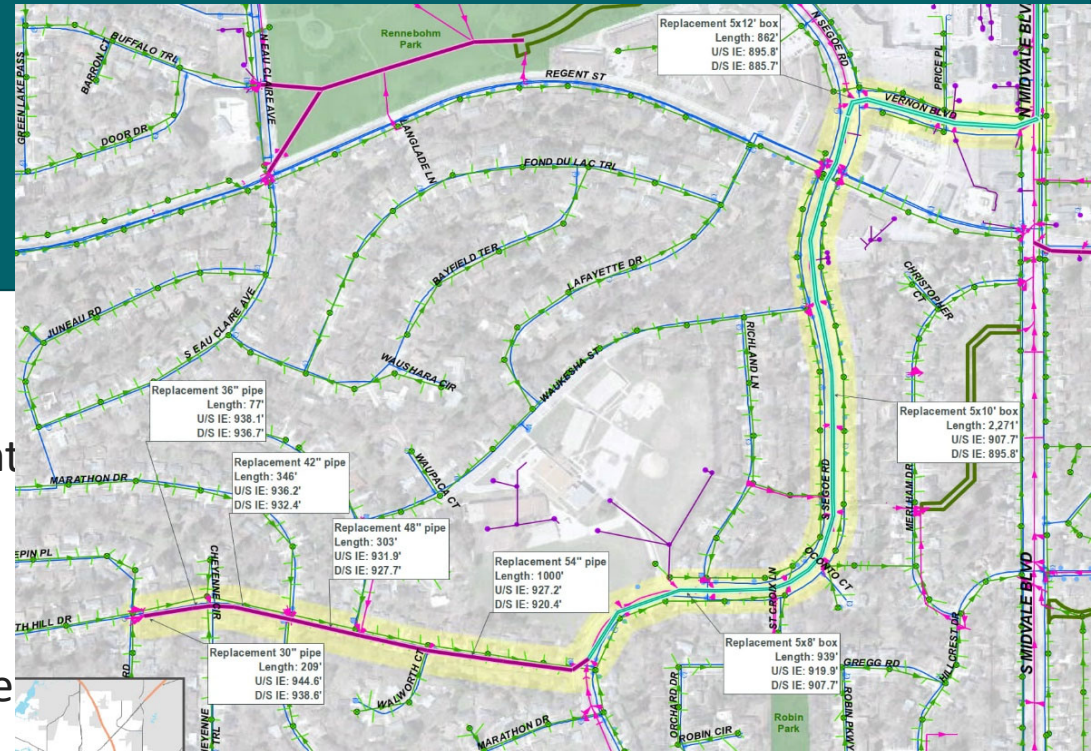
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- Upsize 2-pipes on Heather Crest and N Meadow Ln to meet 20% event capacity
- 5 less buildings/structures impacted by 1% event
- Est. Cost: \$16.8M
- **Incrementally if done with street project:**
 - **\$5.4M**



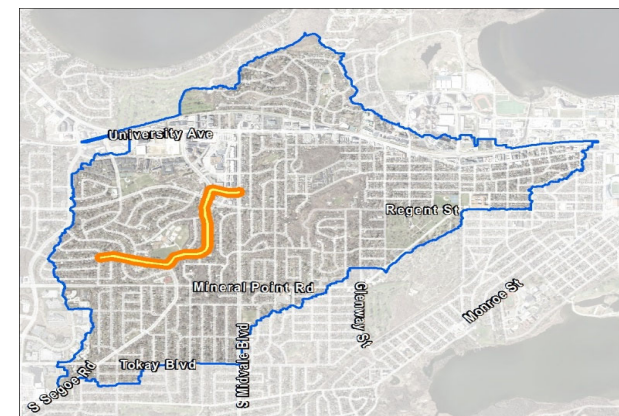
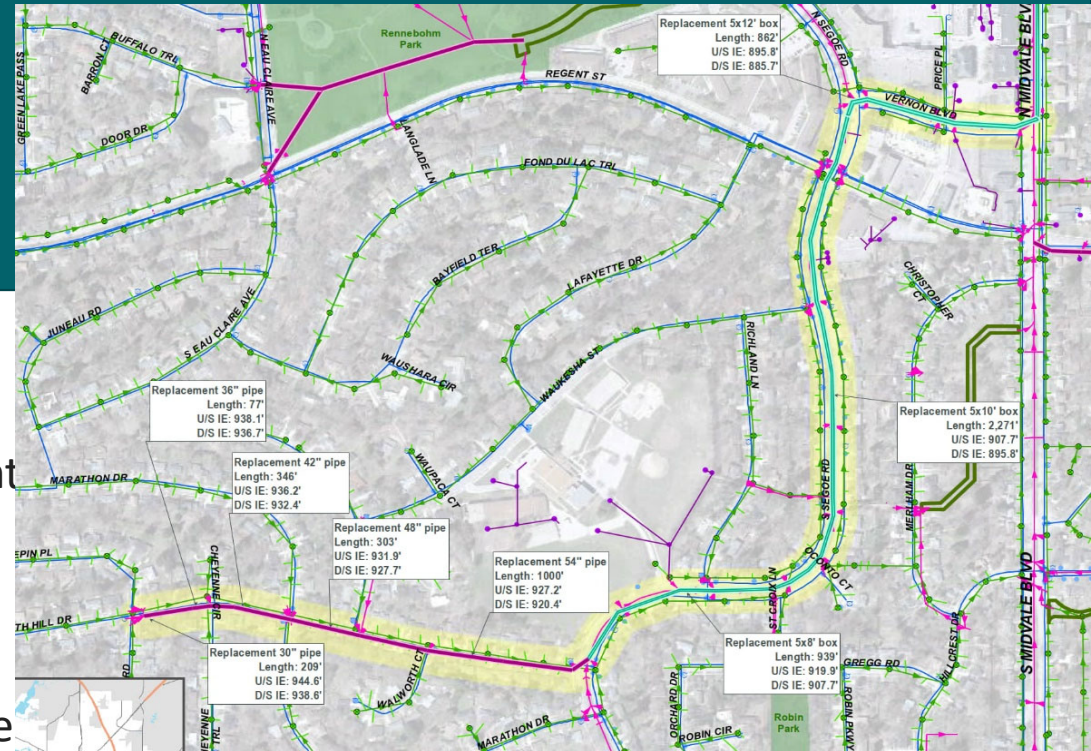
3. South Hill Dr, Segoe Rd and Vernon Blvd Storm System Improvements

- **Goal: Reduce flooding during 10%, 4%, and 1% events**
- Install larger pipes to serve the 20% design event (limited capacity downstream)
- Starts with a 30" pipe, increasing to a 54" pipe when the South Hill intersects with Segoe Rd.
- 0.4 miles of curbside no longer inundated for the 10% event
- 0.25 miles of centerline now passable for the 4% event
- No structure impact for the 1% chance event
- Est. Cost: \$20.9M
- **Portions of Segoe to be constructed in 2024; will not include new box culvert at this time. Need downstream improvements in place first.**



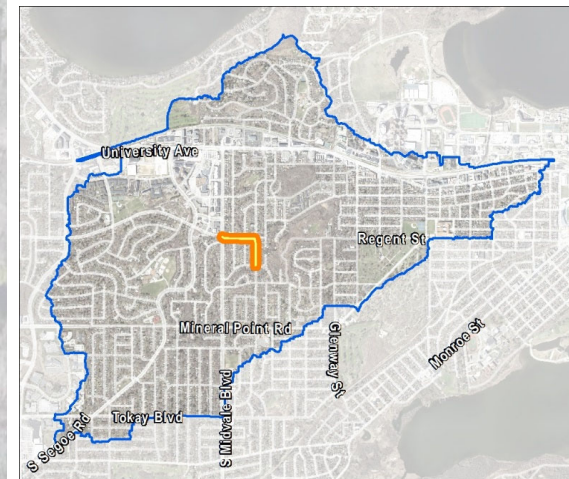
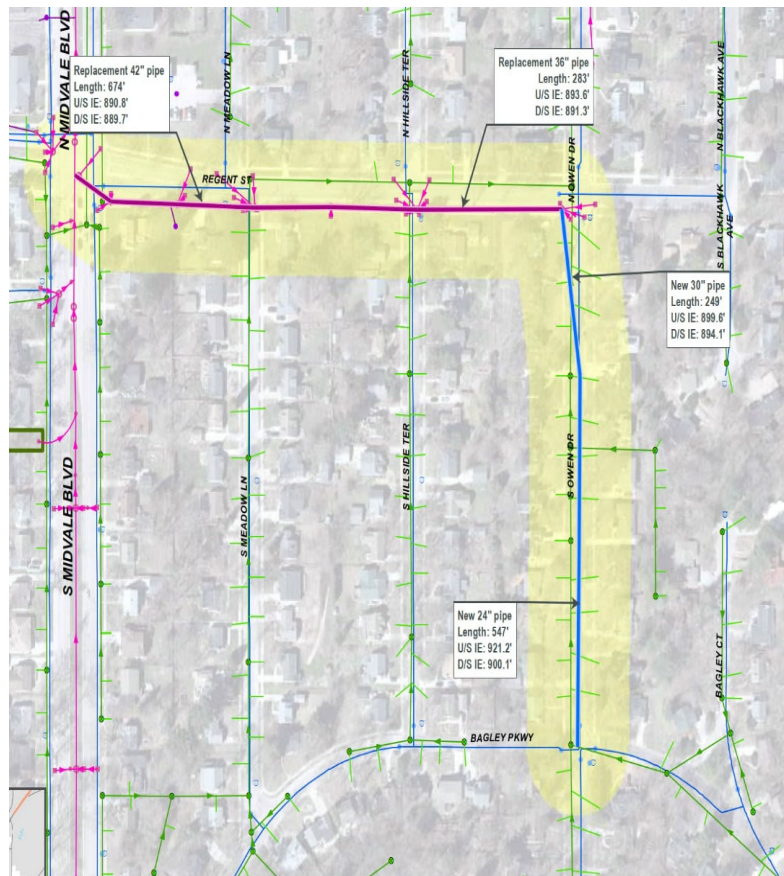
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- Install larger pipes to serve the 20% design event (limited capacity downstream)
- Starts with a 30" pipe, increasing to a 54" pipe when the South Hill intersects with Segoe Rd.
- 0.4 miles of curbline no longer inundated for the 10% event
- 0.25 miles of centerline now passable for the 4% event
- No structure impact for the 1% chance event
- Est. Cost: \$20.9M
- **Incremental cost for box and larger pipe \$6.9M**



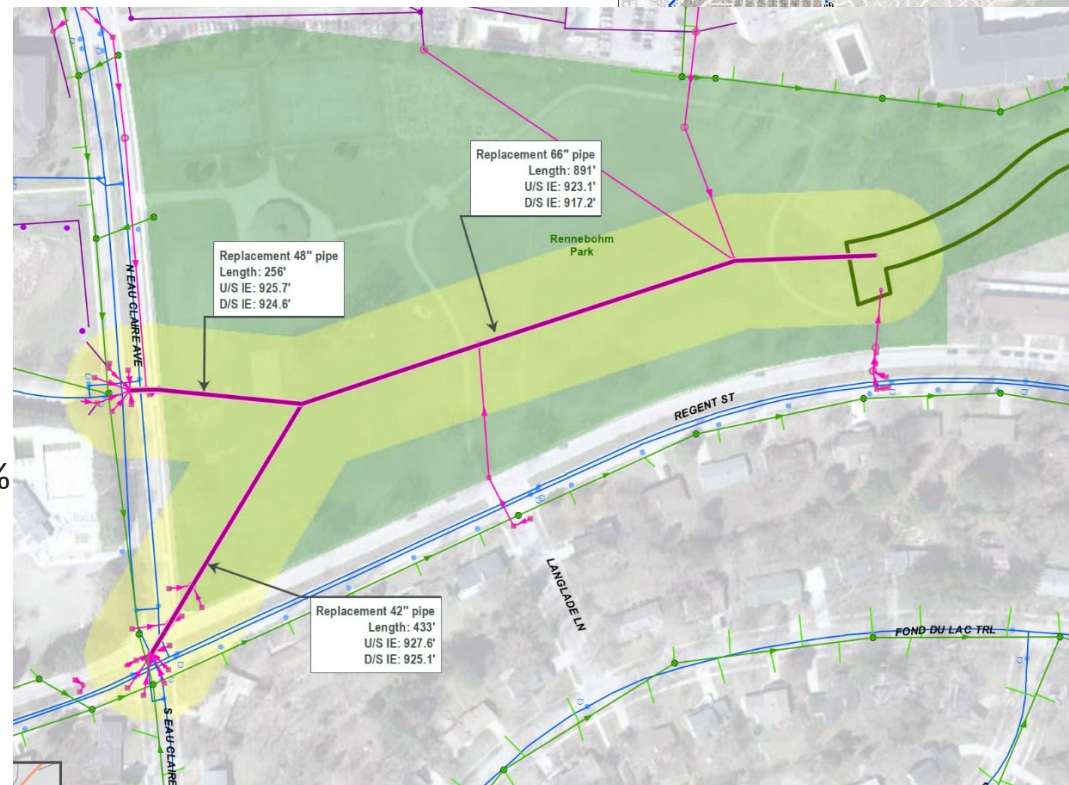
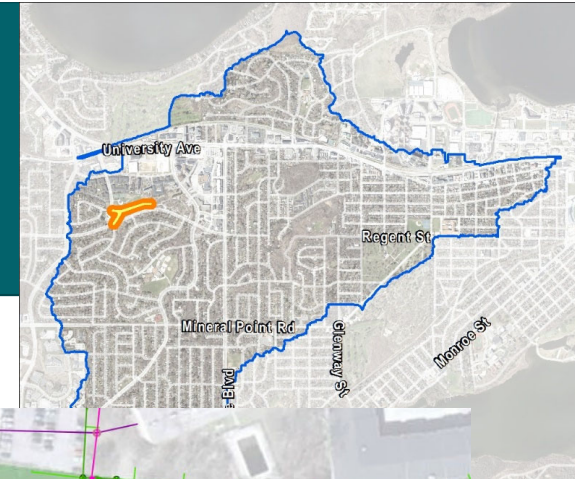
4. Regent St and Owen Dr Storm System Improvements

- **Goal: Reduce flooding during 10%, 4%, and 1% events**
- Install larger pipes to serve the 20% design event (limited capacity downstream)
- On Owen St, start with a 24" pipe, increasing to a 30" pipe before the intersection with Regent St
- On Regent St, start with 36" transitioning to a 42" pipe before the connection at Midvale Blvd
- 7 buildings/structures no longer impacted by 1% event
- Est. Cost: \$1.9M



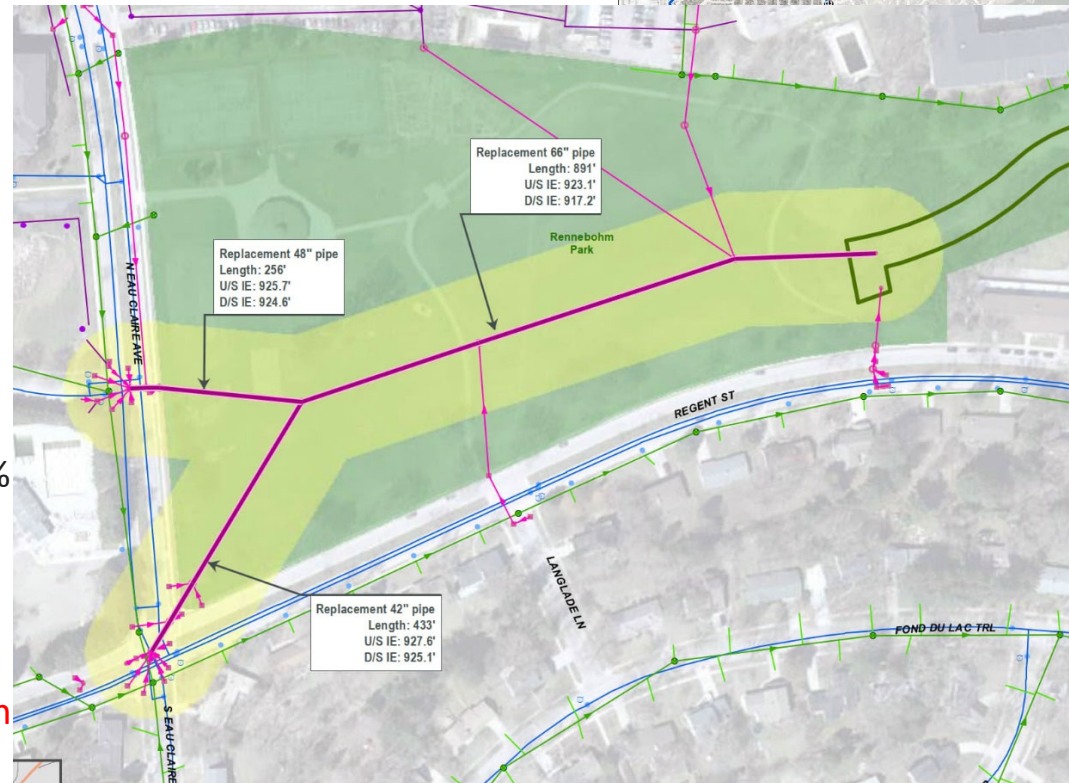
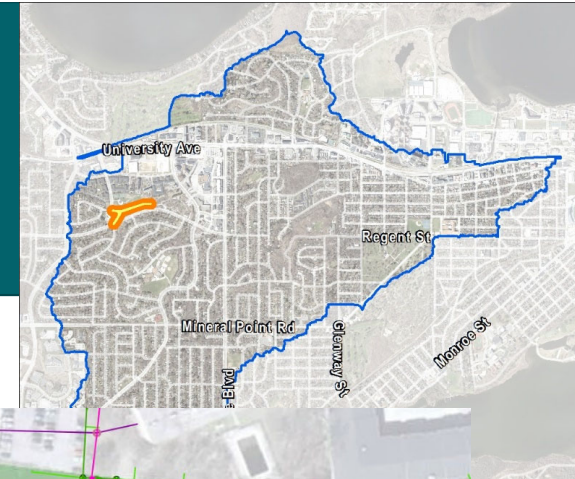
5. N Eau Claire Ave, Regent St and Rennebohm Park Storm System Improvements

- **Goal: Reduce flooding during 10%, 4%, and 1% events**
- Install larger pipes to serve the 20% design event (limited capacity downstream)
- At the N Eau Claire Ave and Buffalo Trl intersection, increased to a 48" pipe
- At the N Eau Claire Ave and Regent St intersection, increased to a 42" pipe
- Pipe underneath Rennebohm park increased to 66" pipe
- 0.3 miles of curbline no longer inundated for 10% event.
- One less structure impacted by 1% event
- Est. Cost: \$1.1M



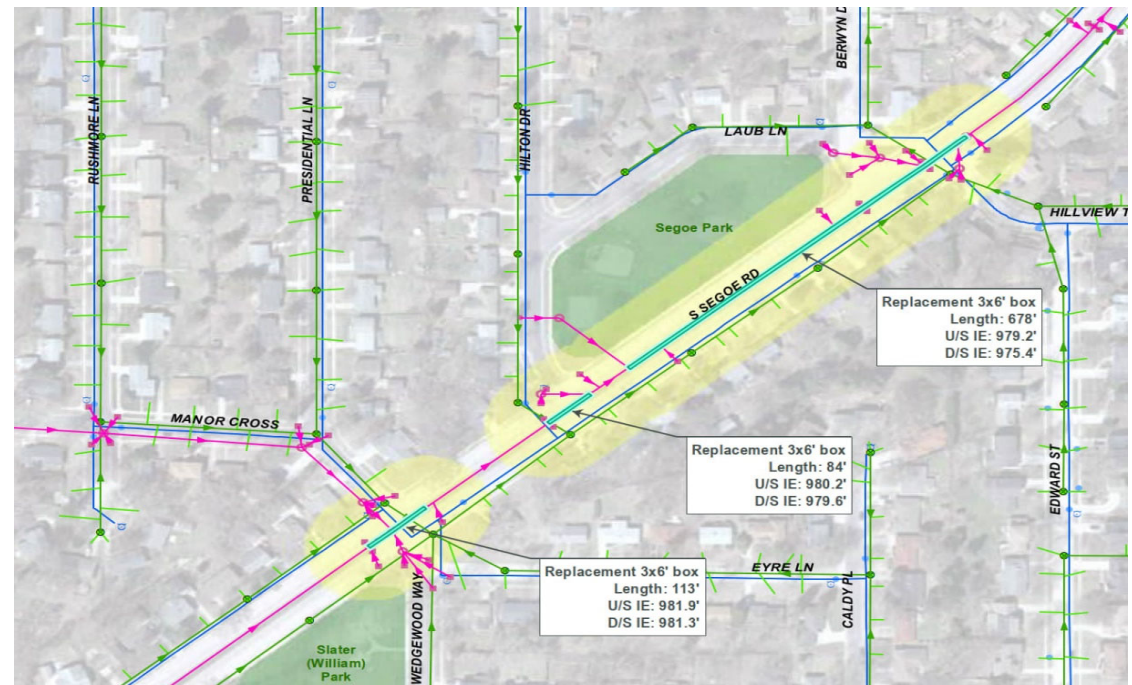
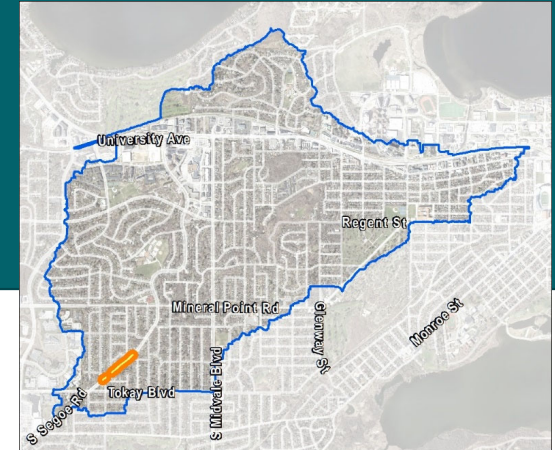
5. N Eau Claire Ave, Regent St and Rennebohm Park Storm System Improvements

- **Goal: Reduce flooding during 10%, 4%, and 1% events**
- Install larger pipes to serve the 20% design event (limited capacity downstream)
- At the N Eau Claire Ave and Buffalo Trl intersection, increased to a 48" pipe
- At the N Eau Claire Ave and Regent St intersection, increased to a 42" pipe
- Pipe underneath Rennebohm park increased to 66" pipe
- 0.3 miles of curbline no longer inundated for 10% event.
- One less structure impacted by 1% event
- Est. Cost: \$1.1M
- **Consider installing in Street during reconstruction to supplement existing pipe capacity.**



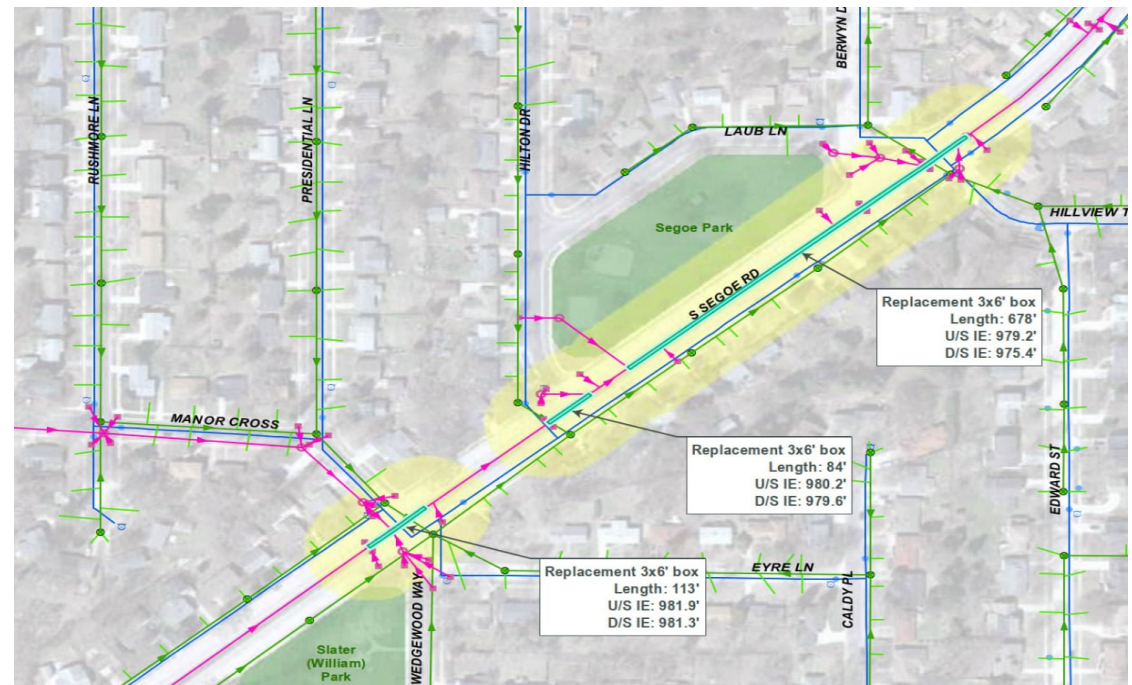
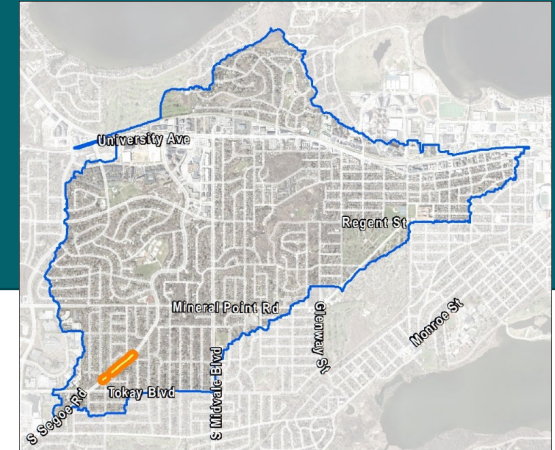
6. S Segoe Rd Storm System Improvements

- **Goal: Reduce flooding during 10%, 4%, and 1% events**
- Replace all smaller pipes with a 3' x 6' box culvert
- 0.5 miles of curblines no longer inundated for 10% event.
- 0.25 miles of centerline now passable for the 4% event
- No structure impact for the 1% chance event
- Est. Cost: \$3.9M



6. S Segoe Rd Storm System Improvements

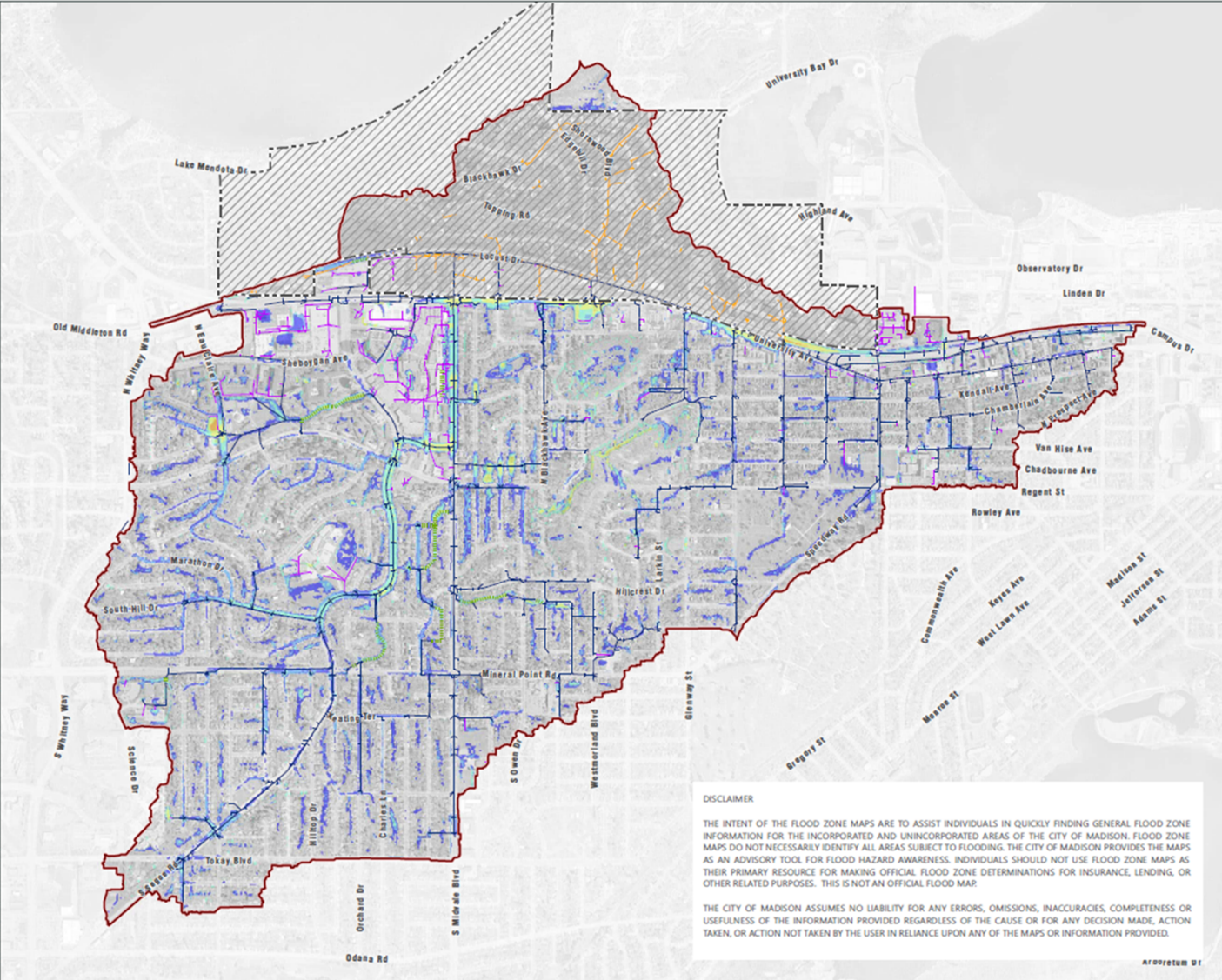
- **Goal: Reduce flooding during 10%, 4%, and 1% events**
- Replace all smaller pipes with a 3' x 6' box culvert
- 0.5 miles of curbline no longer inundated for 10% event.
- 0.25 miles of centerline now passable for the 4% event
- No structure impact for the 1% chance event
- Est. Cost: \$3.9M
- **Incremental Cost \$800,000**



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20% AEP Inundation

FIGURE 14
 Willow Creek Watershed
 Study Report
 City of Madison
 Dane County, WI



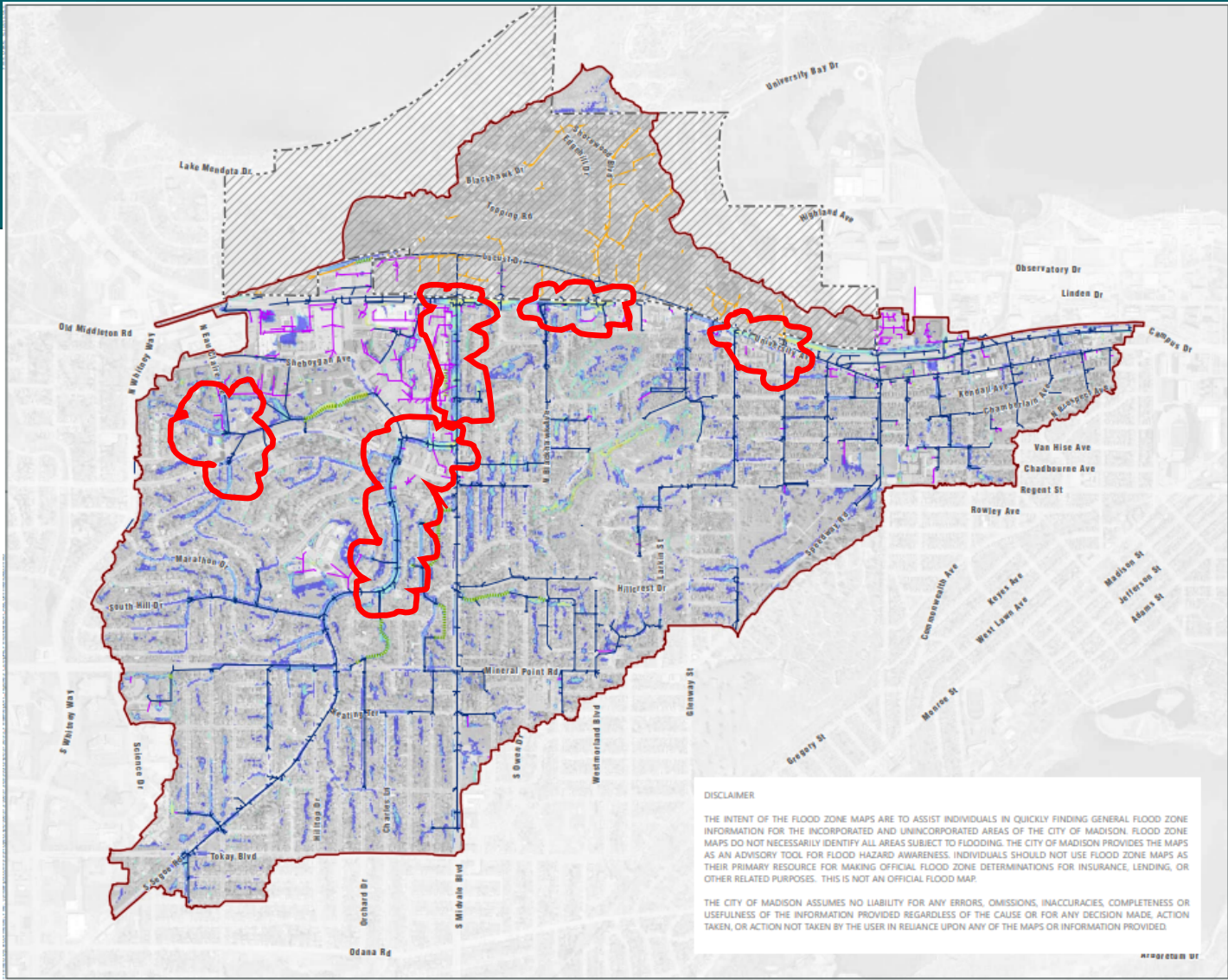
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 - Village of Shorewood Hills
 - Public Storm System
 - Private Storm System
 - Shorewood Hills Storm System
 - Open Channel Flow
- 20% Annual Exceedance Probability Storm
- Maximum Water Depth (ft)
- 0.1 - 0.25
 - 0.25 - 0.5
 - 0.5 - 1
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 Watershed Boundaries: MSA
 Stormwater System: City of Madison



20% AEP Inundation Recommended Conditions

FIGURE 31
Willow Creek Watershed
Study Report

City of Madison
Dane County, WI

- Watershed Study Area
 - Village of Shorewood Hills
 - Public Storm System
 - Private Storm System
 - Shorewood Hills Storm System
 - Open Channel Flow
- 20% Annual Exceedance Probability Storm
Maximum Water Depth (ft)
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Stormwater System: City of Madison

1% AEP Inundation

FIGURE 18
Willow Creek Watershed
Study Report

City of Madison
Dane County, WI

-  Watershed Study Area
 -  Village of Shorewood Hills
 -  Public Storm System
 -  Private Storm System
 -  Shorewood Hills Storm System
 -  Open Channel Flow
- 1% Annual Exceedance Probability Storm
Maximum Water Depth (ft)
-  0.1 - 0.25
 -  0.25 - 0.5
 -  0.5 - 1
 -  1 - 3
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Watershed Boundaries: MSA
Stormwater System: City of Madison

Map Date: 10/20/2023

GI's Help Towards Targets

- Can Green Infrastructure help us meet our Flood Targets?
- Yes, but...

GI's Help Towards Targets

- Can Green Infrastructure help us meet our Flood Targets?
- Yes, but...
- Modeling simulation conducted:
 - Scenario C – Recommended scenario
 - Aggressive GI

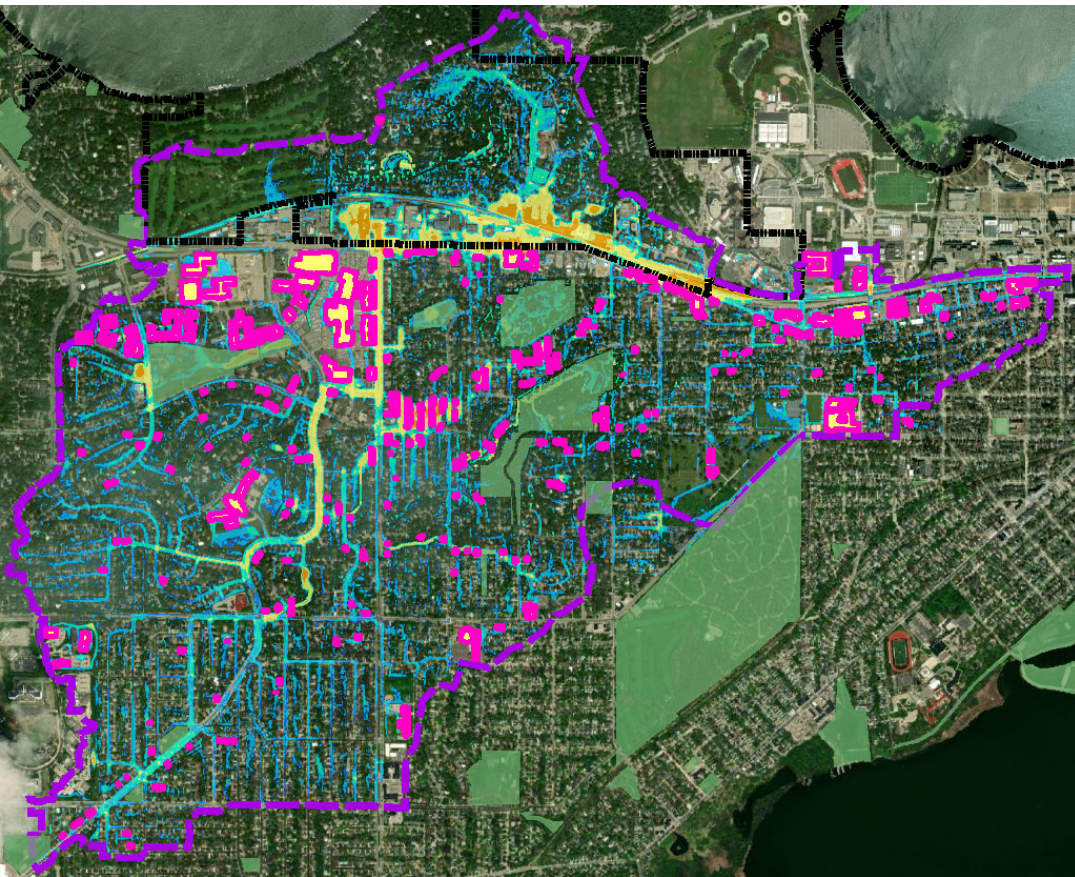
Proposed Solution Alternative Matrix

Model Scenario Name	Existing	Prop-A	Prop-B	Prop-C
University Ave 96" Storm Sewer. N Blackhawk Ave SS connection. Midvale/University Box Wall Removed.	N	Y	Y	Y
University Bay Dr 72" relief sewer.	N	N	Y	N
5-Year Level of Service SS Upsizing (Midvale Blvd, Vernon Blvd, Segoe Rd, S Hill Dr, N Eau Claire Ave, Regent St, Owens Dr, Meadow Ln)	N	N	N	Y
Storage Basins proposed at Robin Park, Merlham Dr, and the Hillcrest Cunette.	N	N	N	N
Storage Basins proposed at Rennebohm Park/Karen Arms, Wholefoods, and low lying residential area north of Regent St.	N	N	N	N
12' Diameter Deep Tunnel to lake Mendota.	N	N	N	N
9' Diameter Deep Tunnel to Lake Mendota.	N	N	N	N

GI's Help Towards Targets

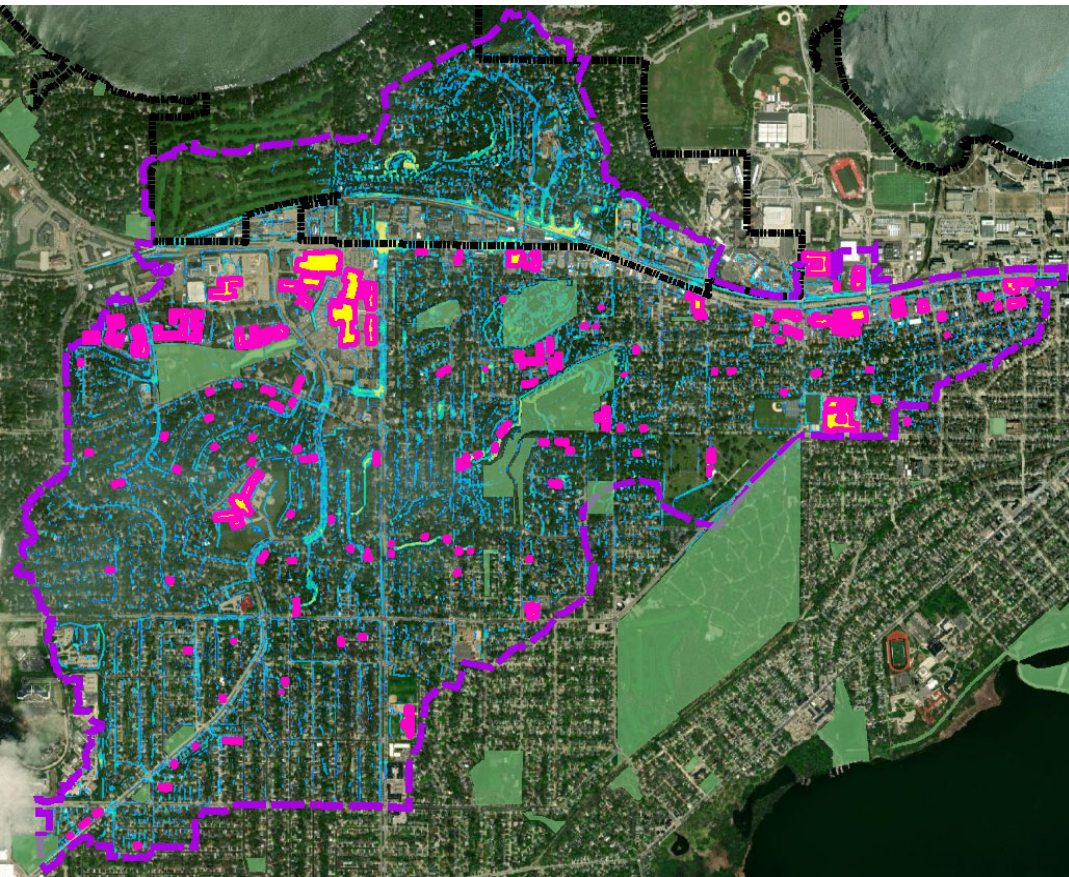
- Can Green Infrastructure help us meet our Flood Targets?
- Yes, but...
- Modeling simulation conducted:
 - Scenario C – Recommended scenario
 - Aggressive GI
 - Assumed enough GI installed to **turn impervious into pervious except roads**
 - All roofs, sidewalks, driveways, parking lots, etc within 1,913 Acre Watershed
 - Looked at 10% and 25% DCIA (Direct Connected Impervious Area) reductions
 - **Reduced impervious by 191.3 and 382.6 Acres, respectively**
 - All pervious is assumed to be HSG A – the highest infiltrating type of soil
 - All roads remained impervious

GI's Help Towards Targets



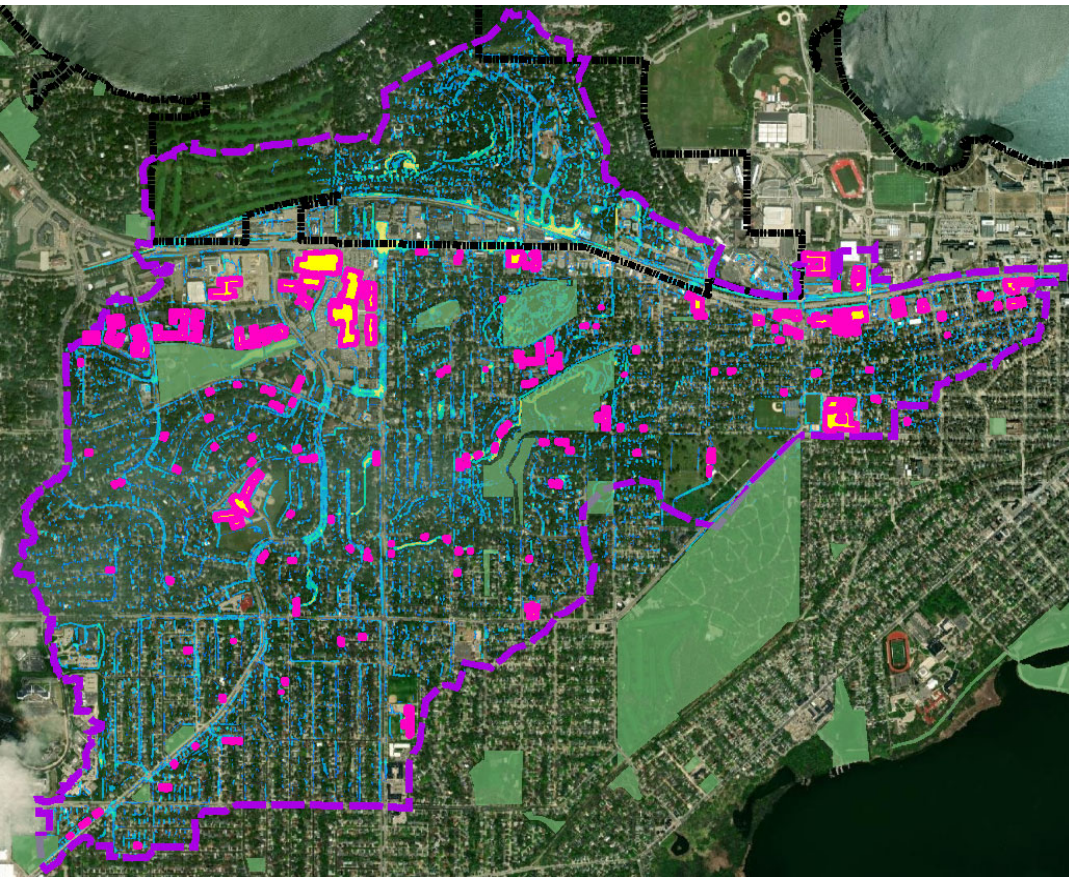
- Scenario C
- 1% Chance Inundation Mapping
- 322 Structures at Risk
 - Structures are outlined with pink and have a bright yellow center

GI's Help Towards Targets



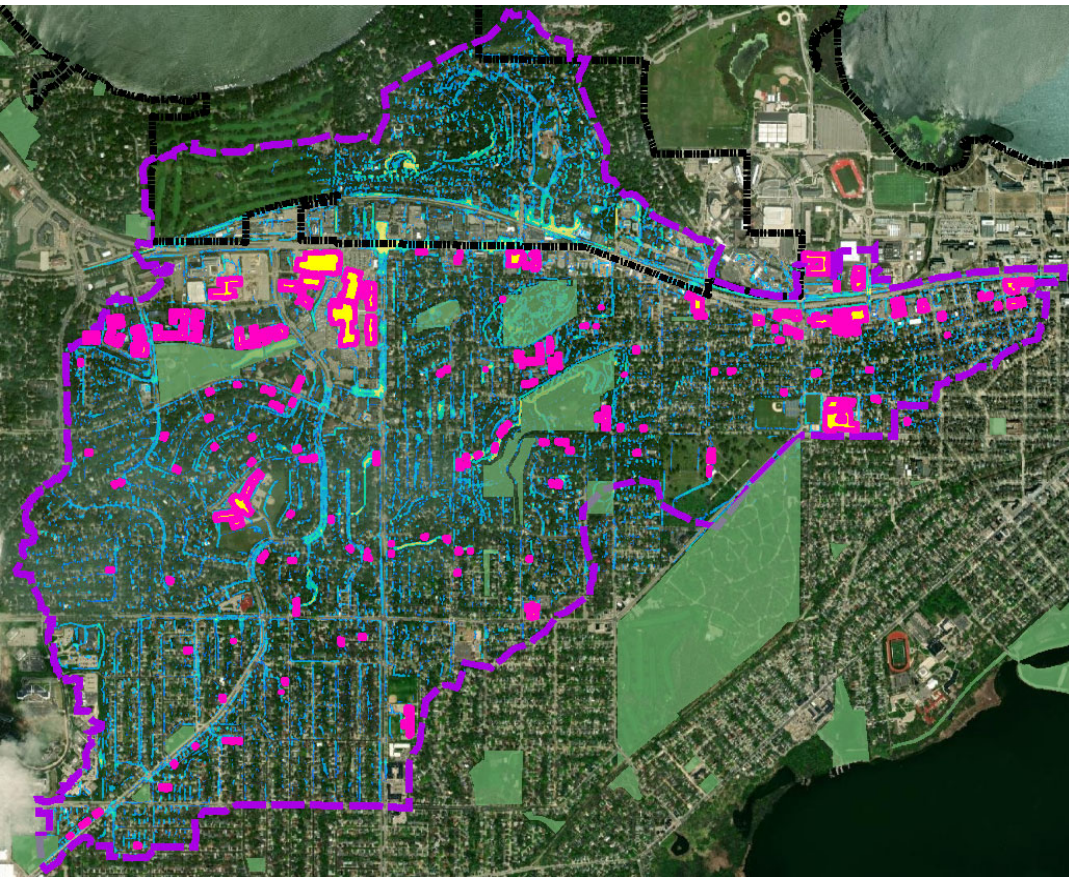
- Scenario C with Aggressive GI
- 1% Chance Inundation Mapping
- 169 Structures Still at Risk
 - Structures are outlined with pink and have a bright yellow center

GI's Help Towards Targets



- IS THIS EVEN REASONABLE??

GI's Help Towards Targets

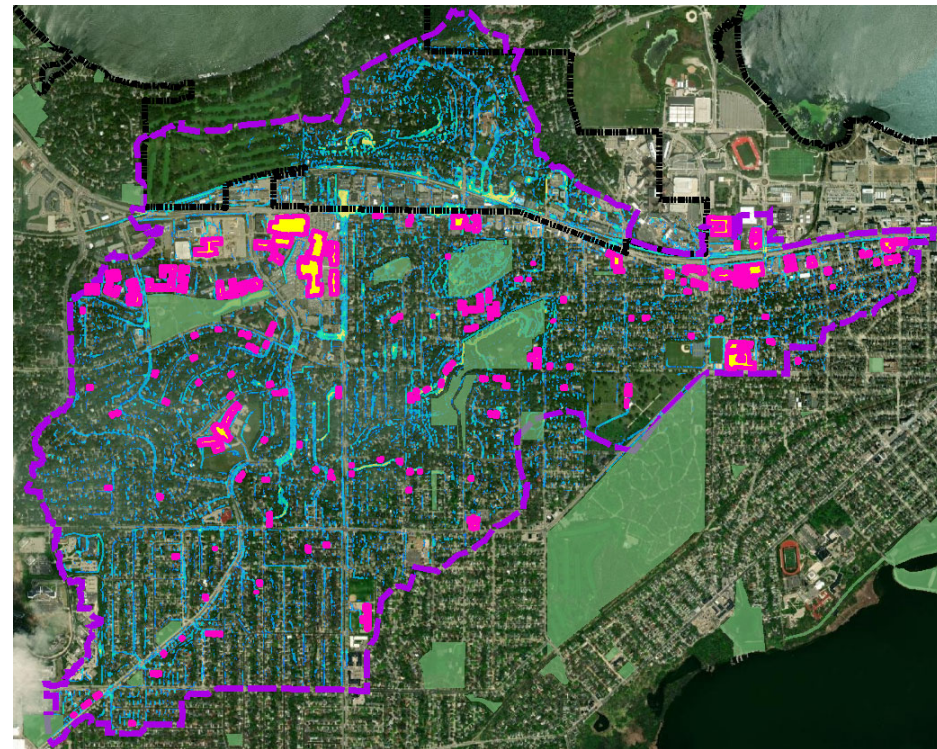


- IS THIS EVEN REASONABLE??

Unfortunately, it is very ambitious and likely cannot ever be fully implemented.

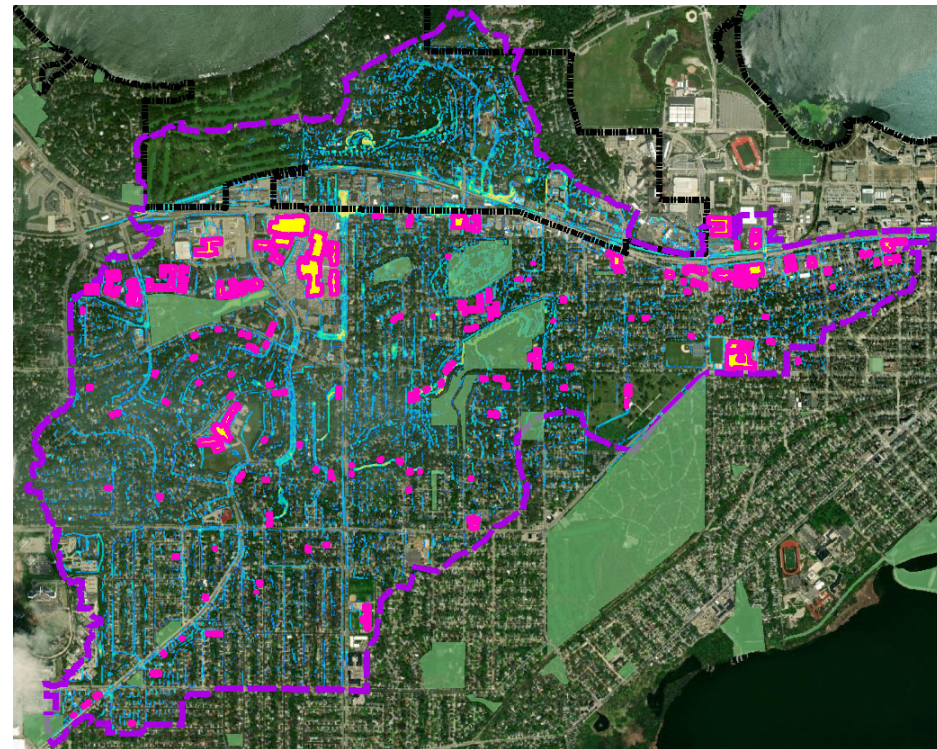
GI's potential help towards a reduced target

- Over a generation (or more) it might be possible for GI implemented over the watershed to help reach an increased level of service over existing but less than the 1%
- In other words, currently this watershed has a 20% risk level of service and GI could help **move it to a 10% risk level of service.**
- Engineering Dept cannot impact 1 & 2 family homes (other than by a potential grant program).
- However, a zoning overlay could potentially impact all properties within this watershed



GI's potential help towards a reduced target

- Full developed watershed – can't easily leverage or mandate change until redevelopment occurs
- Will take private property owners to help finance, build and maintain solutions
- Most of the flood improvements are evident in smaller storms (50% chance – or 2 year storm)
- Public Green Infrastructure is expensive to build and more expensive to maintain, which is an operating cost
 - Limited areas to put public GI
 - Still a good idea but won't solve extreme flooding



GI's potential help towards a reduced target

The City has completed additional [Green Infrastructure Effectiveness Analysis](#) on this and other watersheds in the City to evaluate the potential of Distributed Green Infrastructure (DGI) to address flooding issues. For this watershed specifically an additional DGI analysis included a review of the impact of installing DGI **treating every impervious surface** apart from streets. This would include every roof, sidewalk, driveway, parking lot etc. The model also assumed that the pervious area was also the **highest infiltration soil (HSG A)**. With this amount of DGI, there is a significant amount of flood reduction, and it reduces structures within the City of Madison that flood in 1% chance flood when the solutions are built by ~50%. **However, the assumptions used to generate those results were not realistic and building that amount of DGI is not possible.** Additionally, a preliminary estimate of the cost to complete that work would be **\$37,000,000** in 2023 dollars.

Final Thoughts...

- Watershed is fully developed and difficult to modify in a meaningful way since it's draining to an enclosed depression
- To 'fix' the flooding to higher levels of service would require acquisition of lands for upstream for detention or a large tunnel that would be over \$50-70M -> otherwise should expect flooding to still occur
- University Ave is under construction so largest solutions will be in place; more projects would be implemented as funds are available and with street projects.
- Information is valuable to make decisions on re-development and flood awareness and preparedness when emergencies arise.
- Green infrastructure will help incrementally but is not reasonable to solve issues
 - GI should be considered for smaller storms, water quality and the environmental benefits
 - City will promote private and public installations of GI within the watershed where practical
- Although didn't meet citywide goals, in more frequent storms these solutions provided additional protection for over 46 structures estimated at \$25M +/-

Next Steps

- Post Draft Final Report for 30-day Public Comment
- Revise based on Public Comments, if necessary
- Finalize Report
- Take Final Report to City of Madison Board of Public Works for acceptance
- Recommended solutions constructed with City street projects

Questions?