City-wide Stormwater Analysis

-presented to Council in September of 2017

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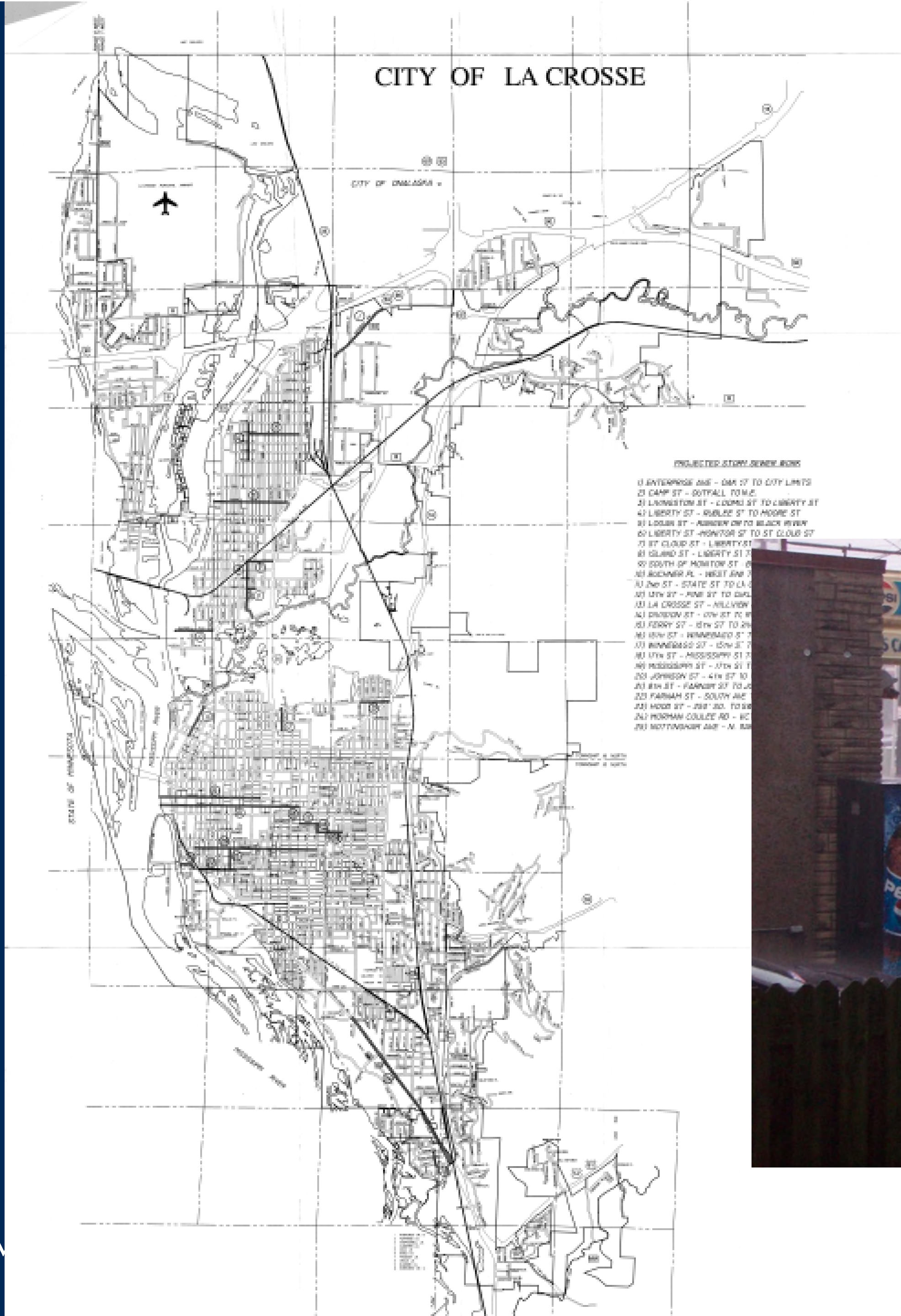
Stormwater Issues



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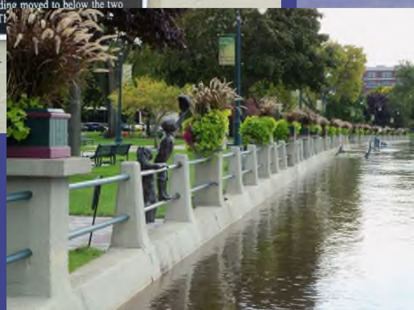
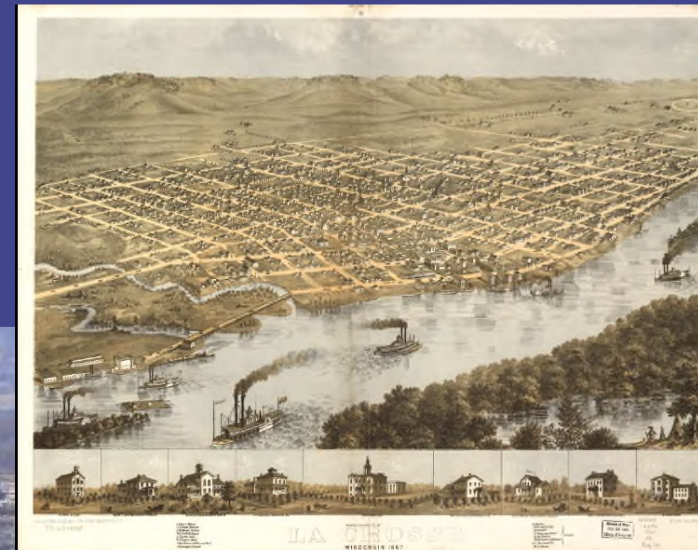
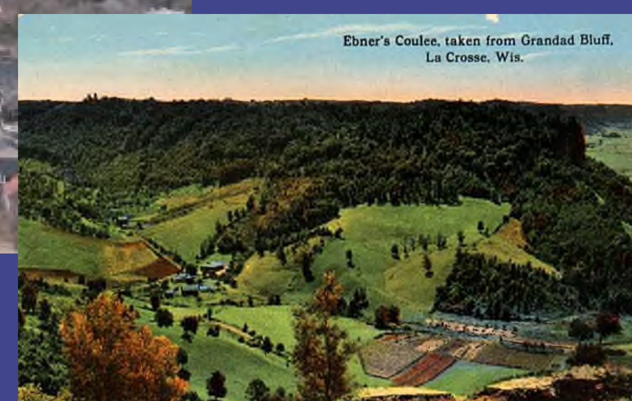
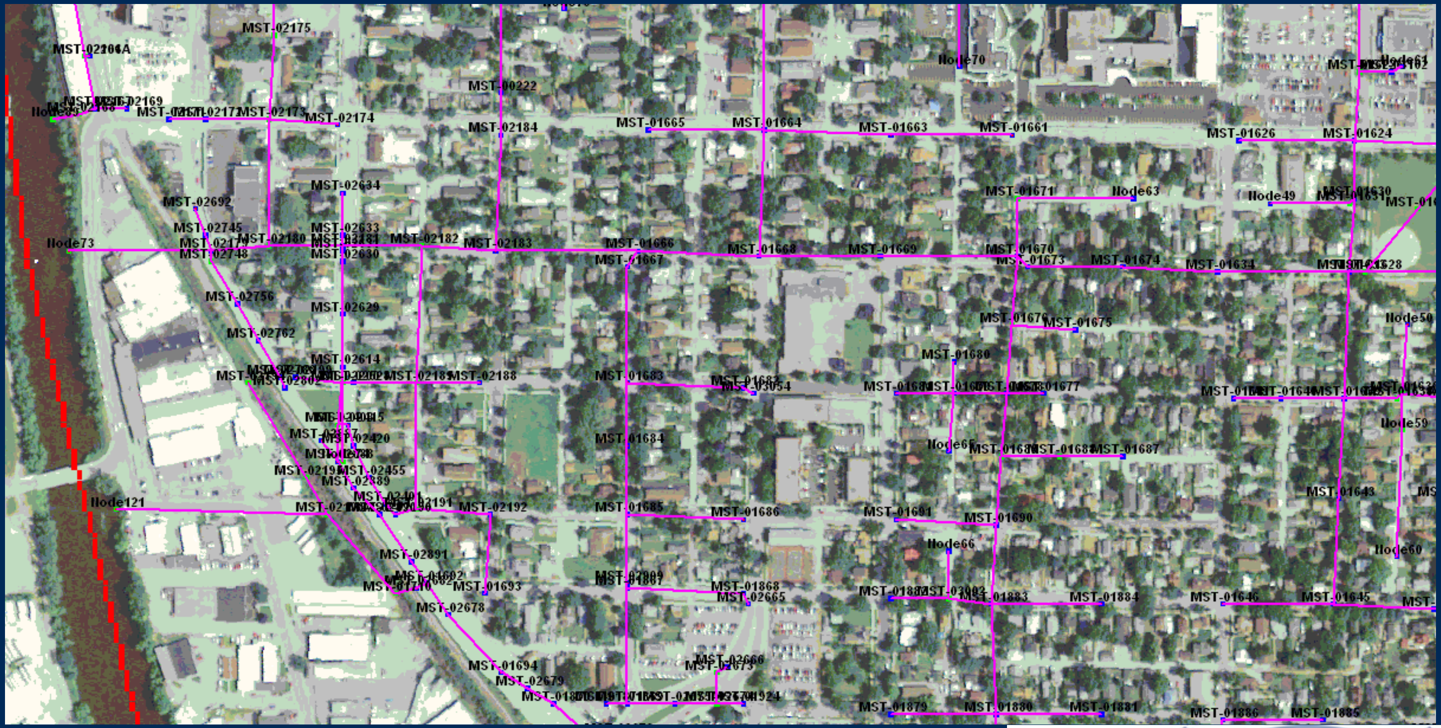
Hydraulic Driven Need







Complex, interconnected storm systems developed over time



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- Overflows from system to system

Contributing areas often change over the course of events

Why was modeling the system necessary?

- Complexity of the storm sewer system, including cross-connections
- Surface flow and flooding conditions require integrated hydrology and hydraulic simulation
- Tool for evaluating potential solutions

System Model

- FLO-2D/EPA-SWMM combination

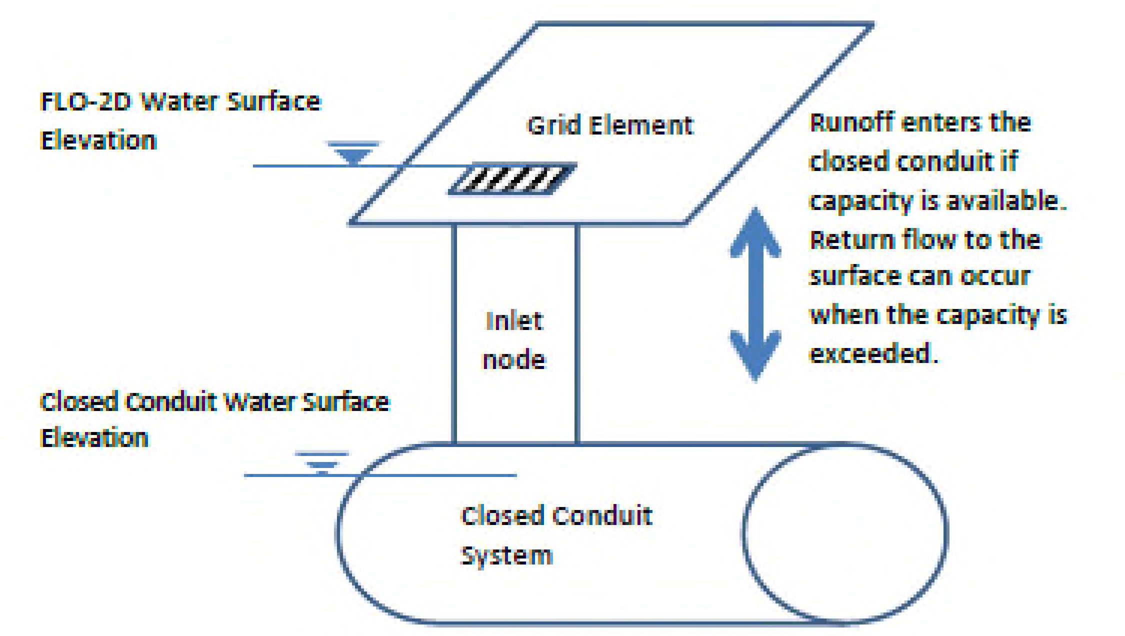
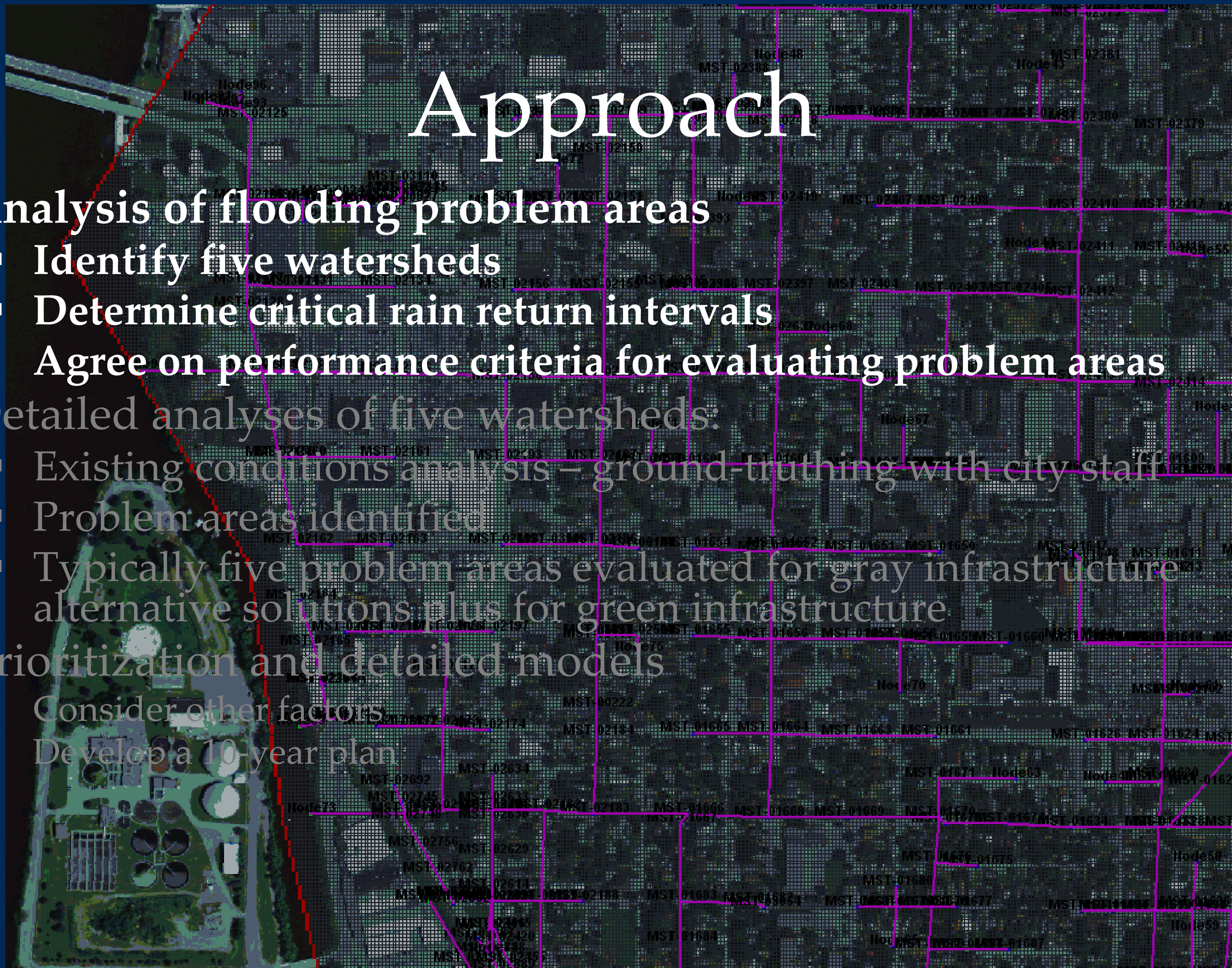


Figure 9. Surface and Closed Conduit Flow Exchange

2-D surface flow modeling using digital elevation data provided by the City at a 15-ft grid size – roads represented within DEM, buildings added as a separate layer

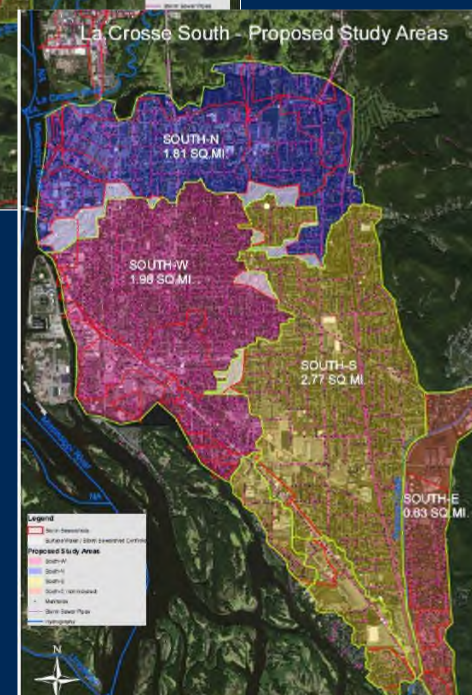
Approach



- **Analysis of flooding problem areas**
  - **Identify five watersheds**
  - **Determine critical rain return intervals**
  - **Agree on performance criteria for evaluating problem areas**
- Detailed analyses of five watersheds:
  - Existing conditions analysis – ground-truthing with city staff
  - Problem areas identified
  - Typically five problem areas evaluated for gray infrastructure alternative solutions plus for green infrastructure
- Prioritization and detailed models
  - Consider other factors
  - Develop a 10-year plan

Watersheds Defined

- Five watershed plans (detailed models)
  - North Industrial Park
  - North Watershed
  - Pine Street Watershed
  - Johnson St Watershed
  - Pammel Creek Watershed



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Design Criteria

- Goals:
  - 10 -year event -Keep water in pipes
  - 25 -year event -Reduce standing water in the street to 6 inches or less prevent intersection closures and eliminate ponding on adjacent properties
  - 100-Year event – Safe outlet
- Some solutions address flooding in one location, others address many locations

Rainfall Intensity Tested

Table 3-1. La Crosse Design Storm Rainfall Totals

	Storm Recurrence (years)				
Duration (hr)	1	2	10	25	100
0.5	0.83	1.08	1.63	1.95	2.55
1	1.05	1.37	2.07	2.48	3.23
2	1.29	1.69	2.55	3.06	3.99
3	1.43	1.87	2.82	3.38	4.40
6	1.67	2.19	3.30	3.96	5.16

Approach

- Analysis of flooding problem areas
  - Identify five watersheds
  - Determine critical rain return intervals
  - Develop goals to achieve
- **Detailed analyses of five watersheds:**
  - **Existing conditions analysis – ground-truthing with city staff**
  - **Problem areas identified**
  - **Typically five problem areas evaluated for gray infrastructure alternative solutions plus for green infrastructure**
- Prioritization and detailed models
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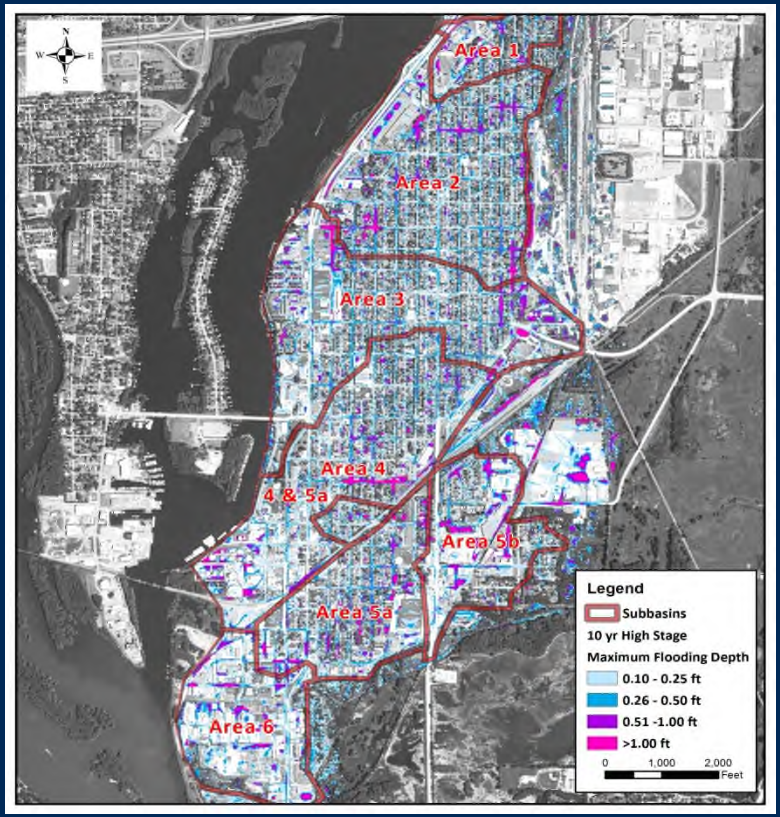
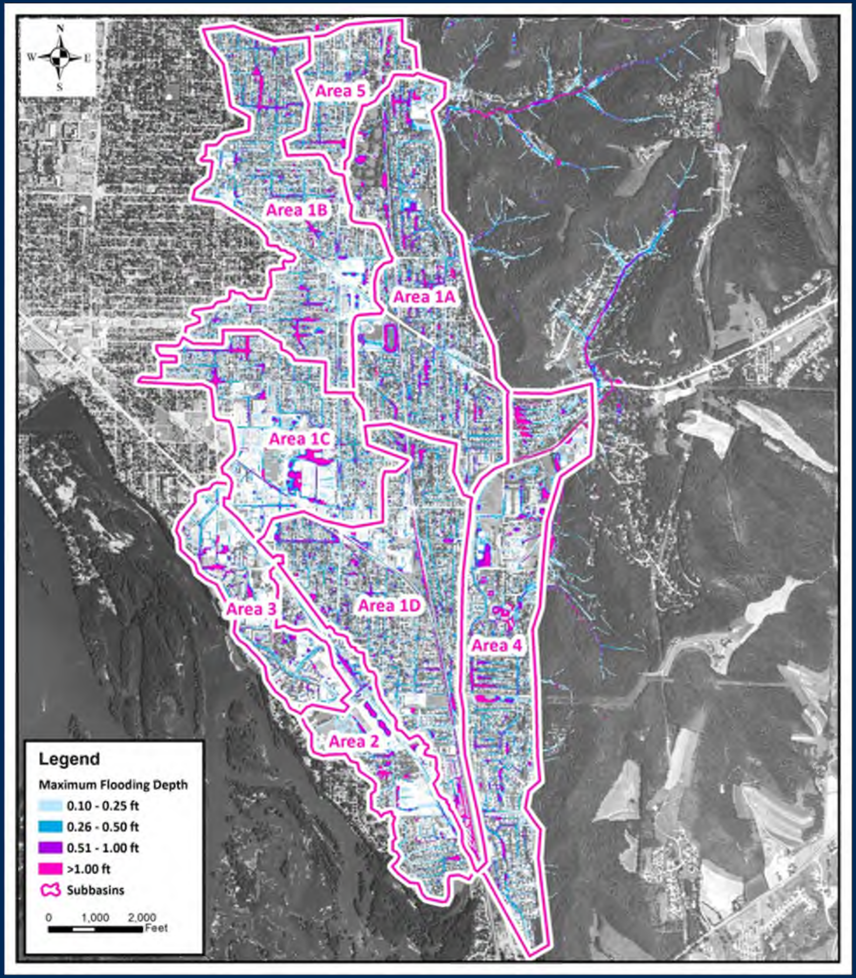
Results





Basin maps, compare to observations

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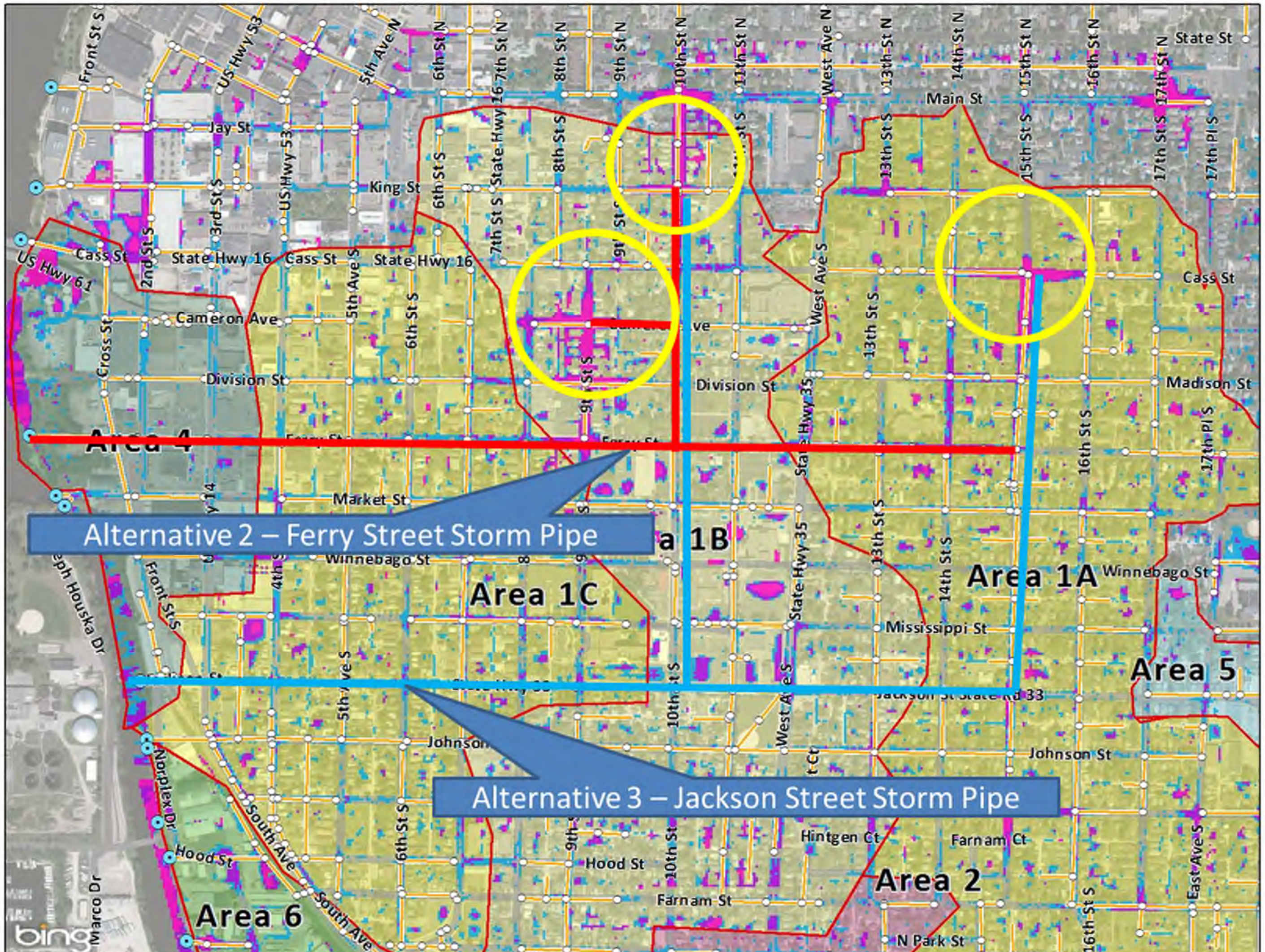
Johnson Street Watershed



Solutions – 24th/ Cass St

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Identify Solutions – Island Street

- Alternatives:
  - Alternative 4a ($1,030,000)
  - Alternative 4b ($1,180,000)

No.	Item	Unit	Est. Qty	Unit Price	Total	Sources and Assumptions
1	Remove Existing 12" RCP	LF	835	$20	$16,700	Depth - 6 or less feet
2	Remove Existing 24" RCP	LF	123	$25	$3,075	Depth - 6 to 10 feet
3	Remove Existing 42" RCP	LF	370	$25	$9,250	Depth - 6 or less feet
4	Remove Existing Manholes	EA.	5	$300	$1,500	Depth - 6 or less feet
5	Remove Existing Manholes	EA.	5	$400	$2,000	Depth - 6 to 10 feet
6	Install 24" RCP	LF	395	$60	$23,700	Depth - 6 or less feet
7	Install 30" RCP	LF	465	$130	$60,450	Depth - 6 or less feet
8	Install 30" RCP	LF	465	$140	$65,100	Depth - 6 to 10 feet
9	Install 60" RCP	LF	395	$180	$71,100	Depth - 6 or less feet
10	Install 36" RCP	LF	1025	$150	$153,750	Depth - 10 + feet
11	Install 24" RCP	LF	440	$70	$30,800	Depth - 6 to 10 feet
12	Install 18" RCP	LF	610	$60	$36,600	Depth - 6 or less feet
13	Install 48" Stormwater Manholes	EA.	4	$2,500	$10,000	Depth - 6 or less feet
14	Install 48" Stormwater Manholes	EA.	1	$2,750	$2,750	Depth - 6 to 10 feet
15	Install 60" Stormwater Manholes	EA.	2	$4,750	$9,500	Depth - 6 to 10 feet
16	Install 60" Stormwater Manholes	EA.	3	$5,000	$15,000	Depth - 10 + feet
17	Install 72" Stormwater Manholes	EA.	1	$5,750	$5,750	Depth - 6 to 10 feet
18	Install 84" Stormwater Manholes	EA.	1	$6,750	$6,750	Depth - 6 to 10 feet
19	Install 84" Stormwater Manholes	EA.	2	$7,000	$14,000	Depth - 10 + feet
20	Install 96" Stormwater Manholes	EA.	1	$8,500	$8,500	Depth - 6 or less feet
21	Install 96" Stormwater Manholes	EA.	1	$9,000	$9,000	Depth - 10 + feet
22	Install 120" Stormwater Manholes	EA.	1	$13,000	$13,000	Depth - 6 or less feet
23	Install Outfall Structure (60" RCP)	EA.	1	$2,000	$2,000	Depth - 6 or less feet
24	Upgrade Pump Station	EA.	1	$98,800	$98,800	
25	Upgrade Pump Station	LS	1	$103,330	$103,330	Provided by xylem, Pewaukee, WI
26	Stormwater Bypass	LS	1	$20,000	$20,000	
	Contingency (30%)				$237,722	
	Total Project Costs				**$1,030,000**	

Draft Estimated Costs – City Wide (Gray Infrastructure Solutions)

- North Industrial Park – $600,000
- North Watershed – $2,900,000
- Pine Street Watershed – $2,300,000
- Johnson Street Watershed – $5,300,000
- Pammel Creek Watershed – $9,400,000
- Total = $20,500,000

(Subject to revision)

Draft Estimated Costs – City Wide (Gray Infrastructure Solutions)

- Things to Remember:
  - These are the costs for stormwater components only
    - Assumed to be done as part of a larger CIP project (street, water, sewer)
    - If done as stand-alone, costs may escalate by 2-3x or more
  - Different alignments could increase costs
  - Implementation of green infrastructure can reduce need/size of projects

Approach

- Analysis of flooding problem areas
  - Identify five watersheds
  - Determine critical rain return intervals
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- **Detailed analyses of five watersheds:**
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Prioritization – Engineering Criteria

- Public Property Impacts
- Private Property Impacts
- Benefits to Street Flooding
- Benefits to Private Property Flooding
- Benefits to Intersection Closure
- Street Condition
- Water Main Condition
- Sanitary Sewer Condition
- Sustainability
- Cost

Prioritization – Engineering Criteria

Table 5-2. Ratings of Effective Alternative Projects

	Rating Objects								
Alternative	Probable Cost	Public Property Construction Impacts	Private Property Construction Impacts	Street Flooding Benefits	Private Property Flooding Benefits	Intersection Closure Benefits	Coordination with other CIP Projects	Sustainability	Rating Total
Maximum Points	15	5	5	20	20	20	5	10	100

Prioritization

		Maximum Points	Alternative A	B	C
Ratings Objects	Public Property Construction Impacts	5	1	1	5
	Private Property Construction Impacts	5	5	4	4
	Street Flooding Benefits	20	12	12	4
	Private Property Flooding Benefits	20	8	12	0
	Intersection Closure Benefits	20	16	20	20
	Coordination with other CIP Projects	20	20	20	4
	Sustainability	10	2	2	2
	Rating Total	100	64	71	39
	Construction Cost ($100,000)		20	25	15
	Cost Effectiveness		3.2	2.84	2.6

Used model output to quantify flooding benefits

Coordinate with reconstruction of aging streets and pipes

Green Infrastructure

Contrasting approach to gray infrastructure (pipes and pumps)

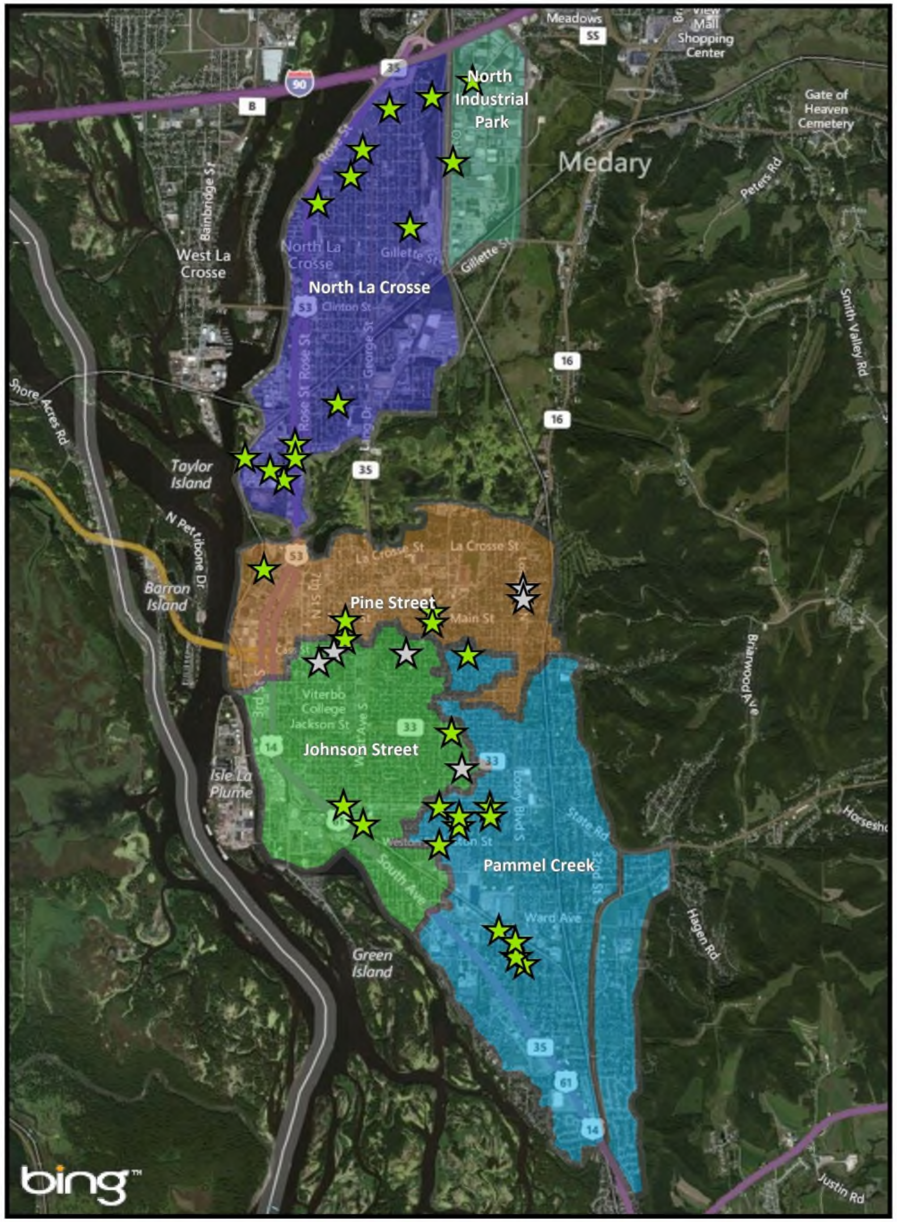
- Reduce flows by implementing throughout basin
  - Pervious pavement
  - Bio-retention
- Cumulative effects – benefits grow over time
- Implement through SWU
- Benefits occur for all storms and throughout watershed, not just one or two intersections
- Additional benefits (water quality, aesthetics)

Factors that Influence the Cost of GI to the City

- Constructed opportunistically
  - As a portion of work already being constructed
  - Over time through numerous projects
- SWU credits lead to private investment
  - Owners determine if it is better to construct GI or pay SWU fees
- MS4 compliance
  - Double credits

Green Infrastructure

- GI more effective in some areas
  - Widespread flooding driven by large volumes
  - Long pipe runs needed to address issues
- Gray infrastructure more effective in others
  - Flooding only in specific areas
  - Flooding due to relatively short constrictions
- Requires 40% implementation to be effective



What have we gained from this modeling effort?

- Better understand the mechanisms/causes of stormwater run-off flooding

- Quantified the problem
- Have an analytically derived prioritization scheme based on engineering criteria
- Integrated hydrology/hydraulic model to use as a basis for final design

Recommended Plan Based On……..

- Evaluate alternative solutions
- Street condition/repair need
- Condition of the other City utilities
- Look at other private facilities in ROW
- Bring in non-engineering criteria
- Field experience/institutional knowledge

Plan to be implemented through C.I.P.

Storm Water Utility Funds

End of Year	Balance
2012	$415,100
2013	$2,147,300
2014	$3,605,300
2015	$4,200,000
2016	$5,006,600
2017	$5,362,160
2018*	$4,700,000

(annual revenue ~2.3 Million)

Per ordinance:

-Stormwater Quality projects funded 100% by SWU

-Stormwater Quantity projects funded 50%/50% by SWU/City

- Open spreadsheet

Questions / Discussion

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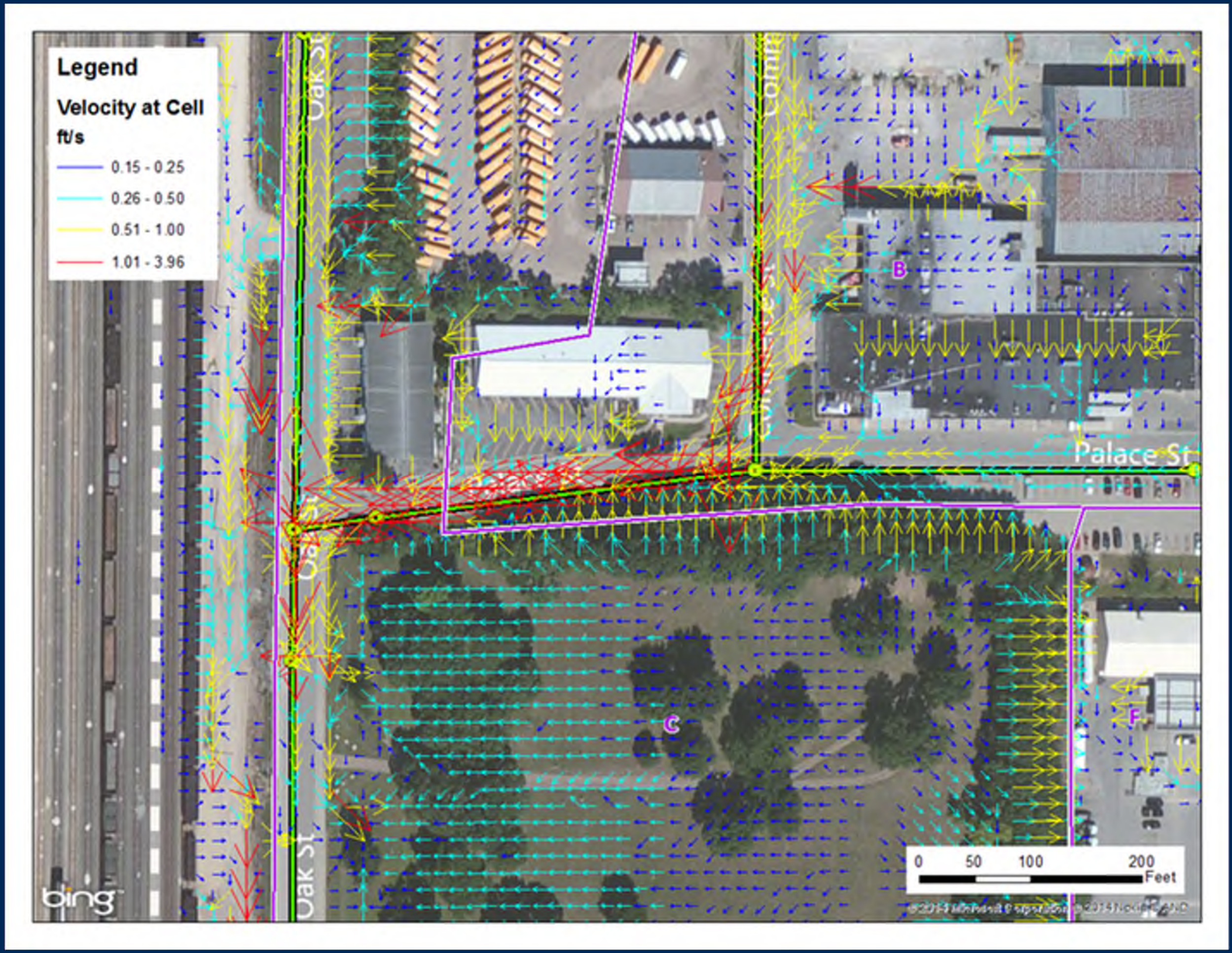
Results – North Industrial Park



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Stormwater Issues in the City of La Crosse

- Sandy, well-infiltrating soils and subsoils

Implementing green infrastructure (GI) approaches through stormwater utility

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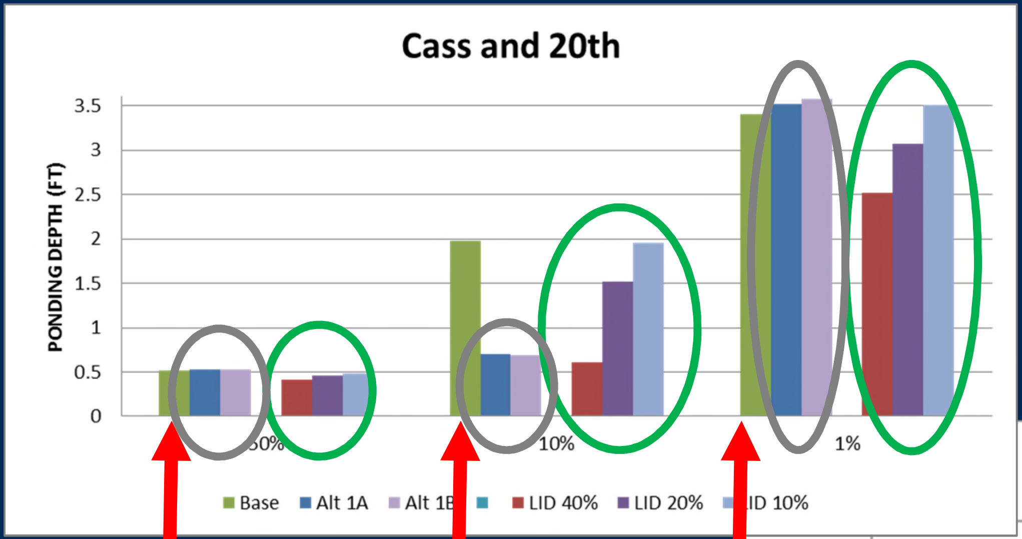
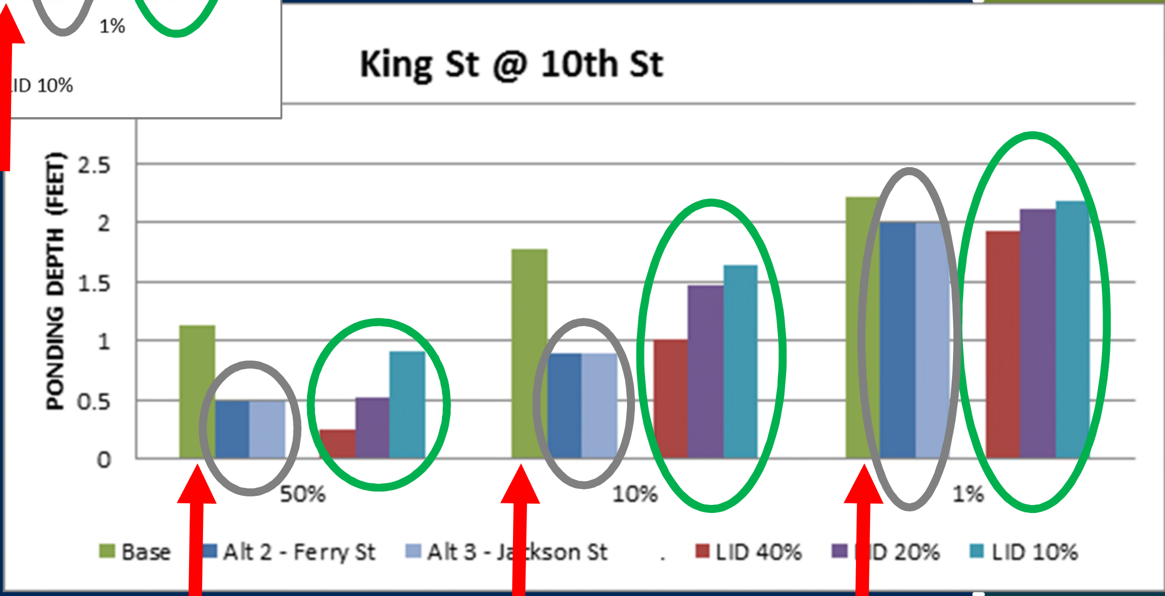
Results – Effectiveness of GI





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