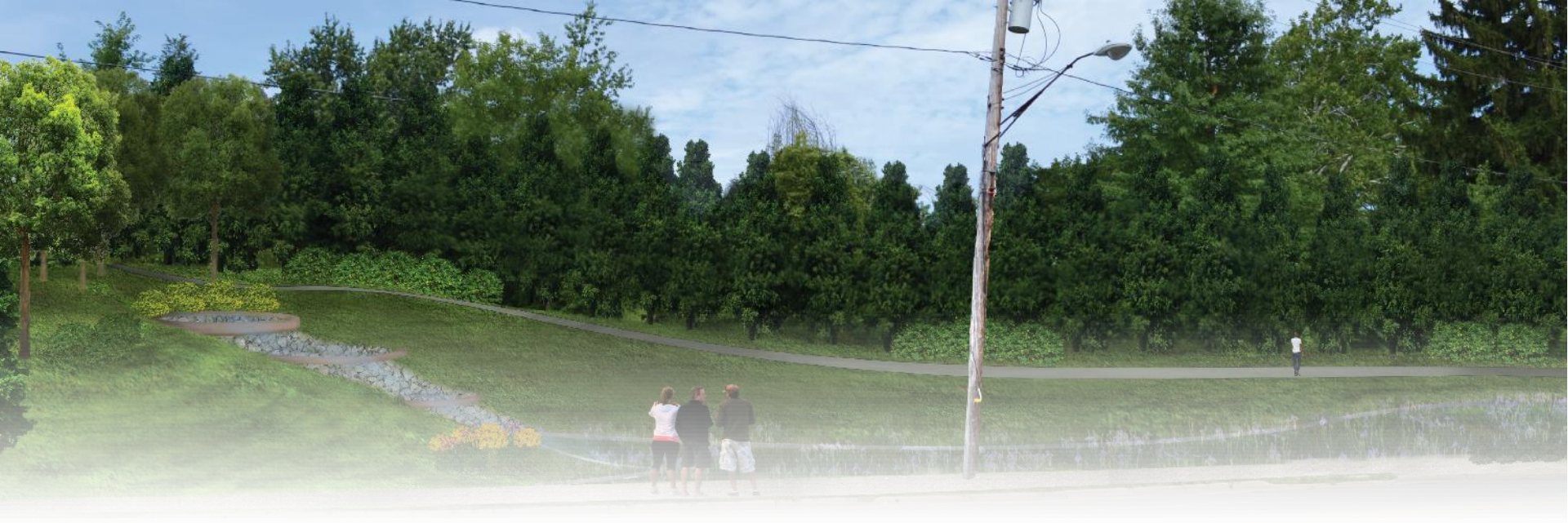


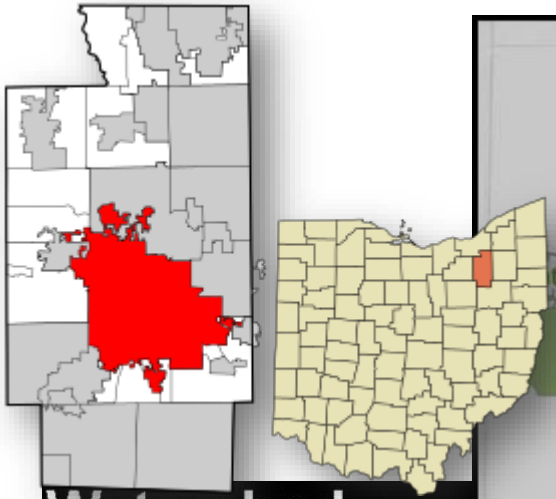
2018
One Water
Conference

GREEN FOR GRAY: CSO CONTROL USING GREEN INFRASTRUCTURE

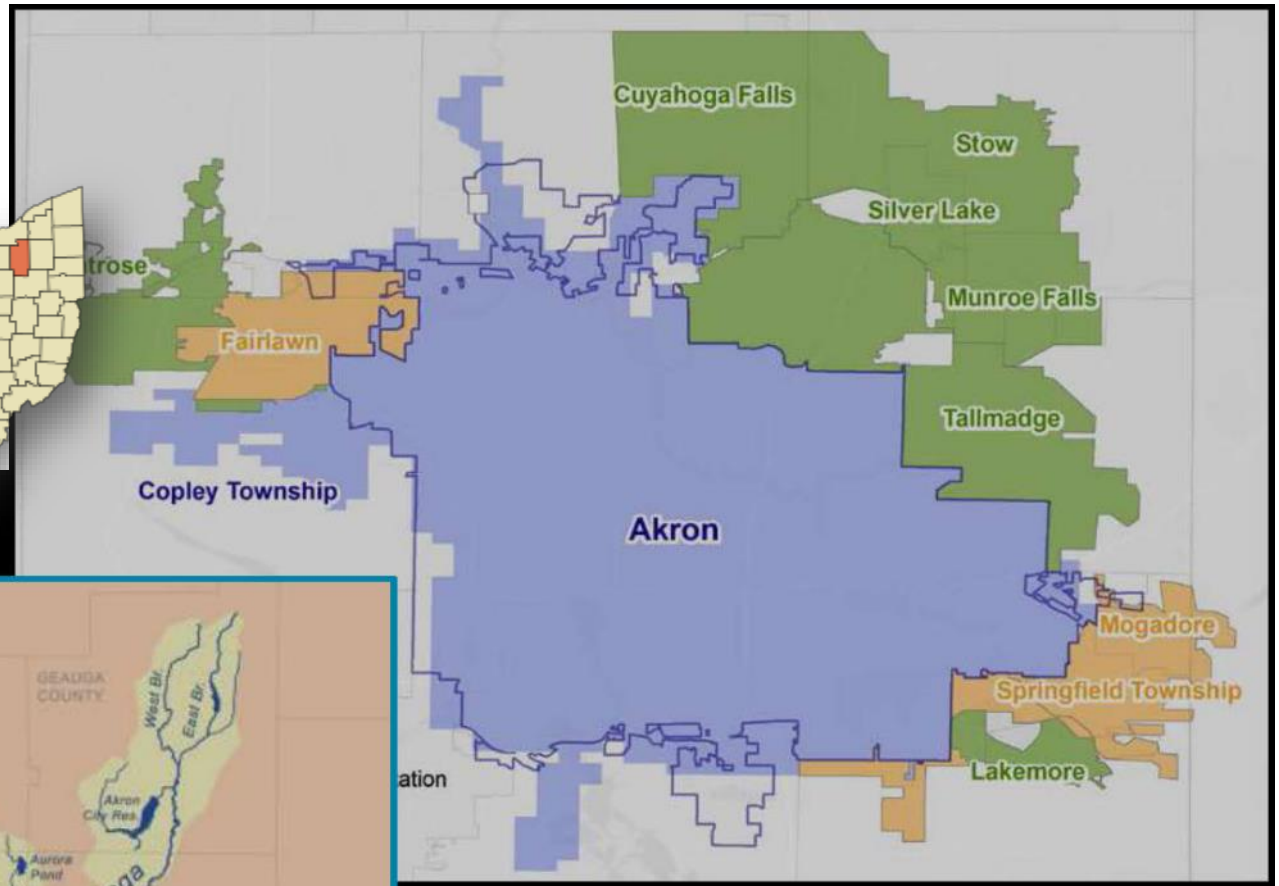
Katherine G. Holmok, ASLA – kholmok@envdesigngroup.com
3302.375.1390

Environmental Design Group
The community impact people.

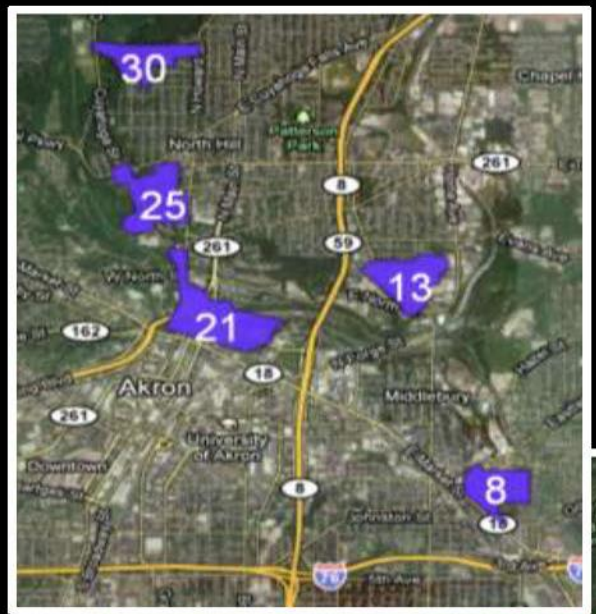
Akron Waterways Renewed!

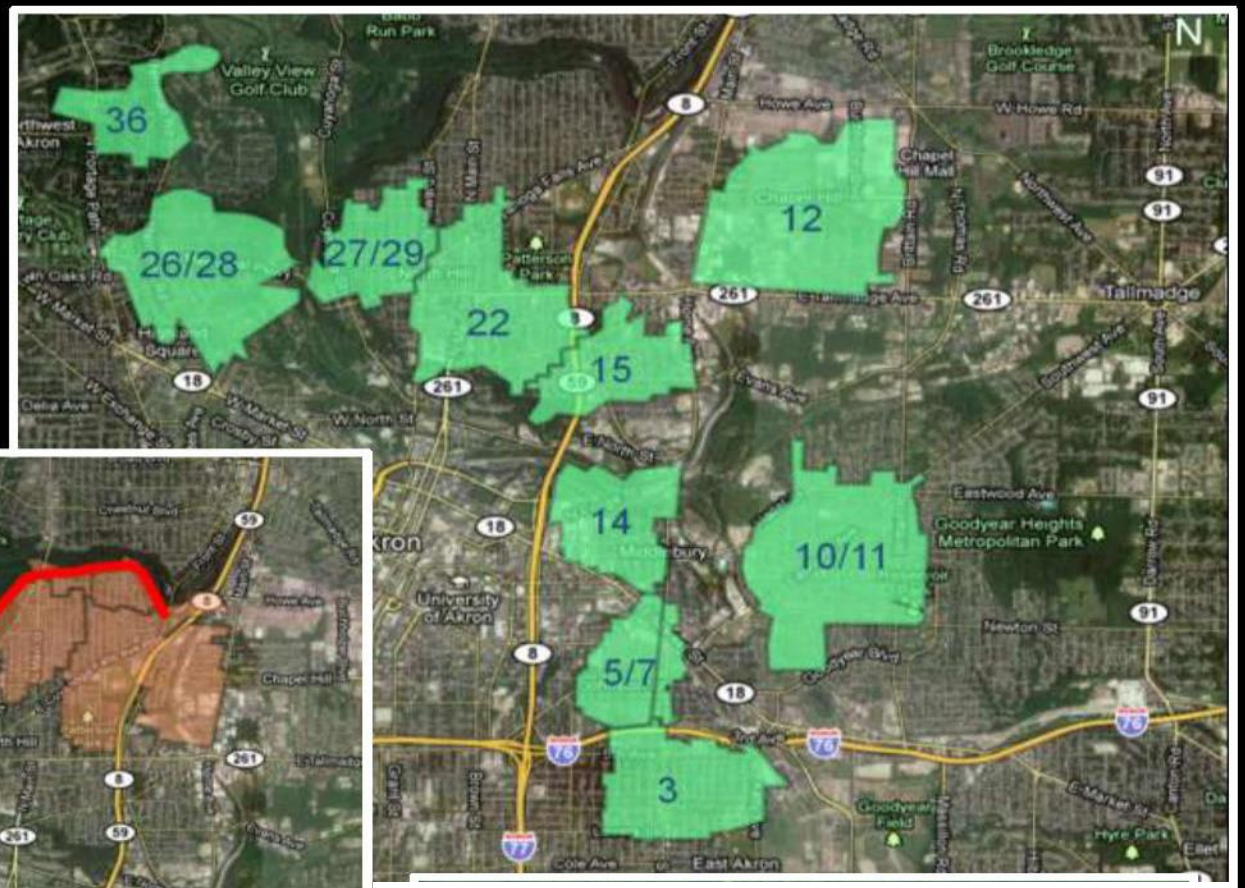


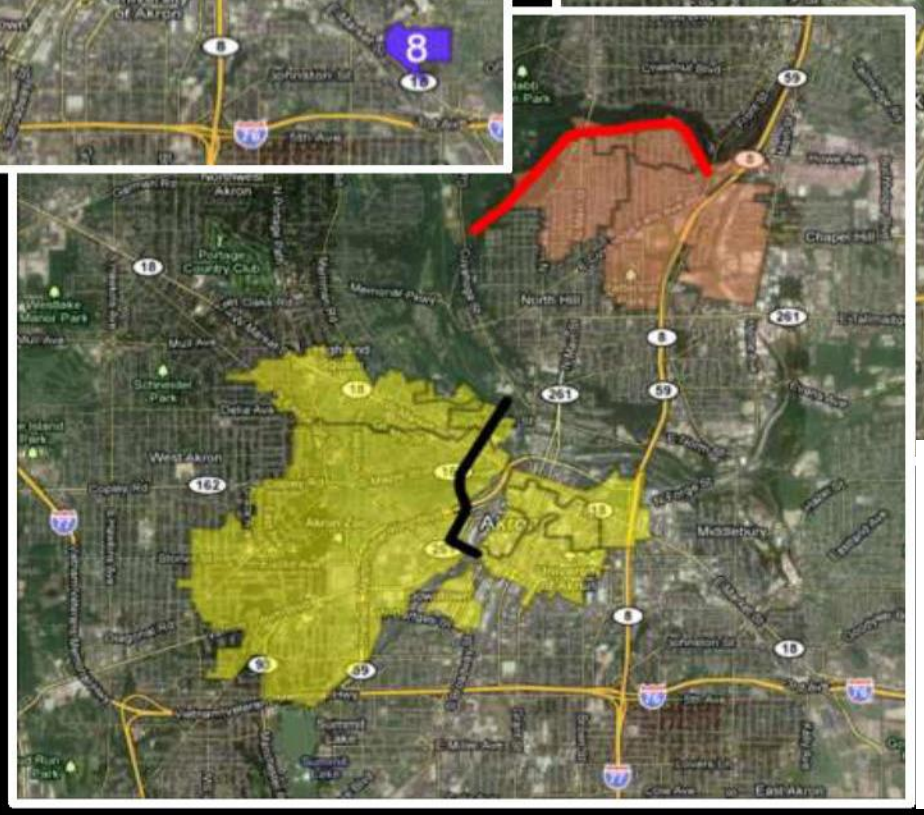
Watershed



Sewershed







Consent Decree

Filed: Nov. 2009

LTCP Update: Nov. 2011

CD entered: Jan. 2014

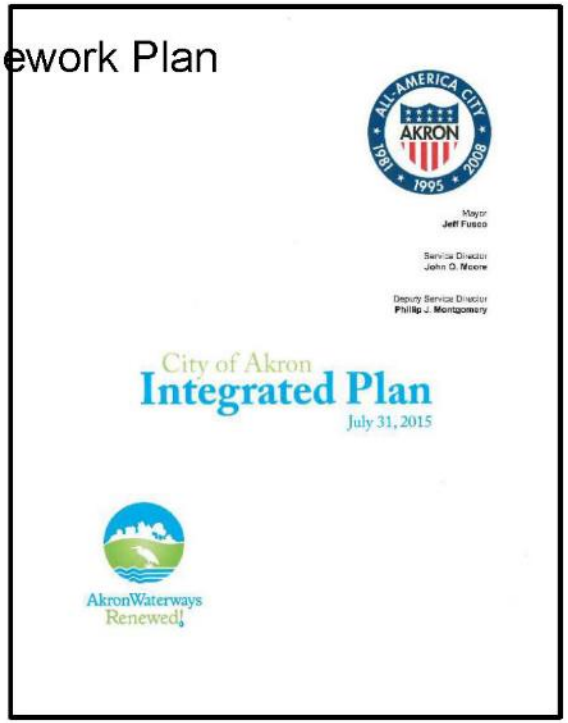
LTCP Update: Oct. 2027

CD Complete all LTCP Projects: Oct. 2028

2012 US EPA Integrated Municipal Storm Water Wastewater Planning Approach Framework

Also using Exhibit 3 Green Infrastructure substitution option for minor modifications

- Akron Integrated Planning Framework Plan
  - Develop Project List
  - Stakeholder Involvement
  - Triple Bottom Line Evaluation
  - Water Quality Activities
  - Financial Analysis
  - Final Integrated Plan
  - Ongoing Plan Improvements



Green Infrastructure Toolbox

EXHIBIT 3: Potential Green Infrastructure Projects to Reduce Effective Storage Volume Requirements

Green Infrastructure shall be used to "store, infiltrate, evapotranspirate, or reuse stormwater and reduce flows to the combined sewer system."

How Green Infrastructure Works

Attenuating

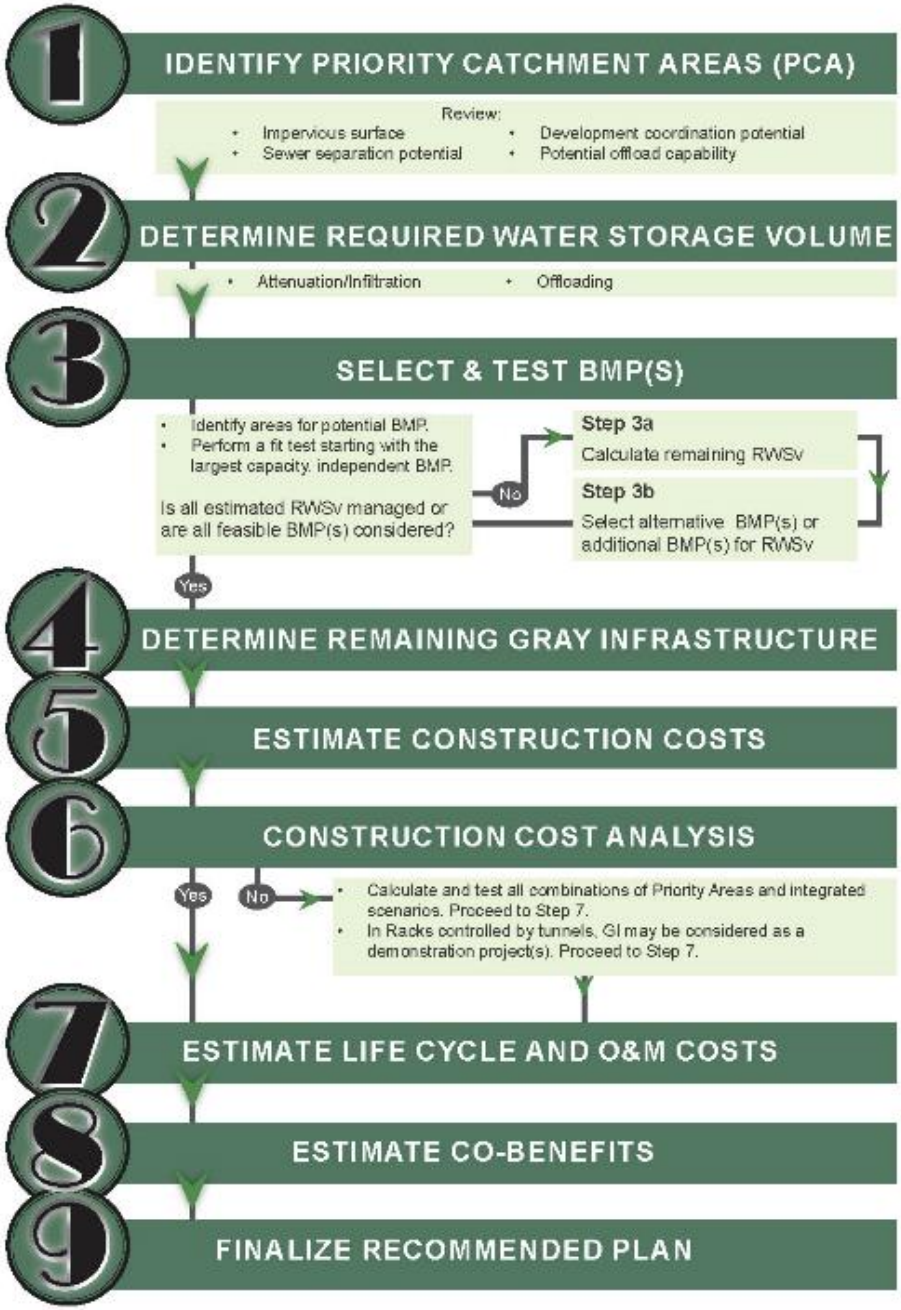
Infiltrating

Offloading

Green Infrastructure Toolbox

Defendable Metric-based Document that references:

- City of Akron's BMP Guidance Document
- ODNR's Rainwater and Land Development Manual
- Other BMP/GI Documents



Green Infrastructure Toolbox

	STORMWATER VOLUME CONTROL RATIO	CONSTRUCTION COST RANGE
Landscape Restoration (Source Removal)		
Pavement Removal (lawn)	Low	$8,000 - $15,000 per acre
Meadow Conversion	Low	$10,000 - $15,000 per acre
Street Trees	Low	$80 to $250 per tree
Reforestation	Low	$25,000 - $35,000 per acre
Floodplain Restoration	Low	$5,000 - $15,000 per acre
Community Gardens (on Vacant Lots)	Low	$15,000 - $20,000 per acre
Centralized Green Infrastructure		
Detention Basin	Large	$25,000 - $45,000 per acre-foot storage
Retention Basin/Wet Pond/Irrigation Pond	Large	$35,000 - $60,000 per acre-foot storage
Constructed Stormwater Wetland	Large	$30,000 - $65,000 per acre-foot storage
Mid-sized Green Infrastructure		
Bioretention Pond	Med.	$24 - $36 per SF
Infiltration Basin/Trench	Med.	$5 per CF storage
Subsurface Gravel Wetland	Med.	$22,500 per treated acre
Distributive Green Infrastructure		
Raingarden	Low	$3 - $10 per SF
Bioretention	Low	$5 - $15 per SF
Flow-Through Planter Box	Low	$6,000 - $15,000 per 36 SF unit
Filter Strip	Low	$800 to $1,200 per SF
Porous Pavement		
Porous Asphalt	Low	$8 - $15 per SF
Porous Concrete	Low	$10 - $15 per SF
Permeable Pavers	Low	$20 - $30 per SF
Grass Pavers	Low	$8 - $12 per SF
Green Streets/Vegetated Curb Extension	Low	$120 - $250 per LF
Tree Trench	Low	$10 - $15 per SF
Conveyance Systems		
Downspout Disconnection		$100 per downspout
Imperious Surfaces Disconnection		$250 - $500 per catch basin
Combined Sewer Separation		$150 to $500 per LF
Stream Daylighting		$100 to $300 per LF
Green Streets (See Distributive Green Infrastructure)		$120 - $250 per LF

References Exhibit 3 requirements:

- Life cycle Cost ranges
- Co-Benefits Analysis
- Examples

Green Infrastructure Toolbox

Centralized GI

- Detention Basin
- Retention Basin/Wet Pond/Irrigation Pond
- Constructed Wetland

- Includes large, singular BMPs with ≥0.5-acre footprint
- Works well in separate sewer areas
- Can manage large capture areas
- Economic O&M

Green Infrastructure Toolbox

Mid Sized GI

- Bioretention Pond
- Infiltration Basin/Trench
- Subsurface Gravel Wetland

- Includes multiple, mid-sized BMPs with 0.1 to 0.5 acre footprints
- Works well in partially-separated sewer areas
- Easy to integrate into neighborhoods
- Vacant land reutilization potential
- Multi-site O&M

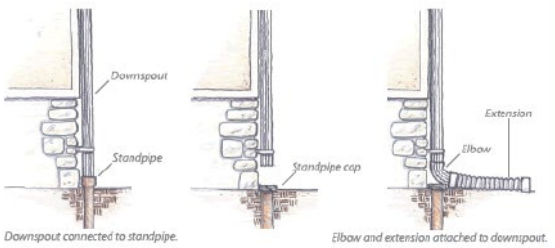
Green Infrastructure Toolbox

Distributed GI

- Raingarden
- Bioretention
- Flow-Through Planter Box
- Filter Strip
- Porous Pavement
- Green Streets/Vegetated Curb Extension
- Tree Trench

- Includes multiple, mid/small-sized BMPs
- Sewer separation not necessary
- Neighborhood revitalization
- Requires significant public involvement
- Maintenance is key to success - scattered site O&M

Green Infrastructure Toolbox



Conveyance Systems

- Downspout/Impervious Surface Disconnection
- Combined Sewer Separation
- Stream Daylighting

Stream Daylighting
CONVEYANCE SYSTEMS

Overview

Stream daylighting is the process of recreating a stream channel to collect and redirect stormwater to a GI element. Stream daylighting provides a cost effective way to collect large volumes of stormwater while providing habitat, community recreation and open space. Stream daylighting allows the water to remain at the surface, unlike sewer separation, which can shrink the depth of the receiving BMP.

Potential Applications	
Residential	Yes
Commercial	Limited
Ultra Urban	Limited
Industrial	Yes
Retrofit	Yes
Highway	Limited
Road	Limited
Recreational	Yes

Advantages

- Opportunity to create habitat
- Potential to provide bike and pedestrian paths in conjunction with daylighting
- Ability to include floodplain/in-line stormwater storage for volume control
- Provide a natural amenity for the community
- Reduce runoff velocities and erosion

Disadvantages

- Subsurface and surface challenges include potentials for hazardous soils, underground and above ground utilities, archeological sites, and bedrock
- Property acquisition can be expansive
- Surface infrastructure replacement (ie. sidewalks, roadways, utilities, culverts) can be expansive
- Must be designed to allow for flood control and erosion

Stream Daylighting 1

Green Infrastructure Toolbox

THREE APPROVED EXHIBIT 3 MINOR MODIFICATIONS

Merriman (Rack 36) – Sewer Separation with Centralized Wetland

Middlebury (Rack 5/7) – Sewer Separation with Centralized Subsurface Gravel Wetland

~~*Howard (Rack 22) – Partial Sewer Separation with Wetland and upsized underflow*~~

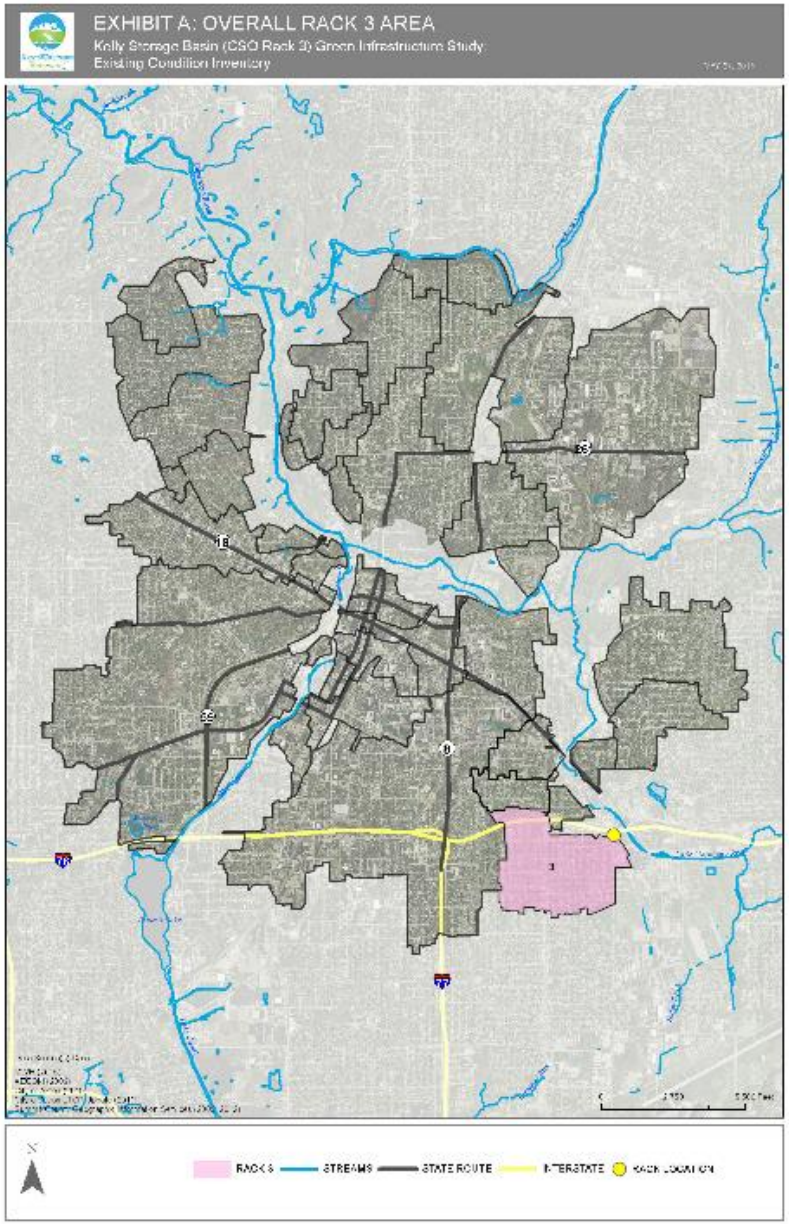
TWO FULL CONSENT DECREE MODIFICATIONS

Aqueduct (Rack 26/28) – Green Street with Upsized Underflow

Kelly (Rack 3) – 4 Midsized Green Infrastructure with Upsized Underflow

Kelly

(CSO Rack 3)

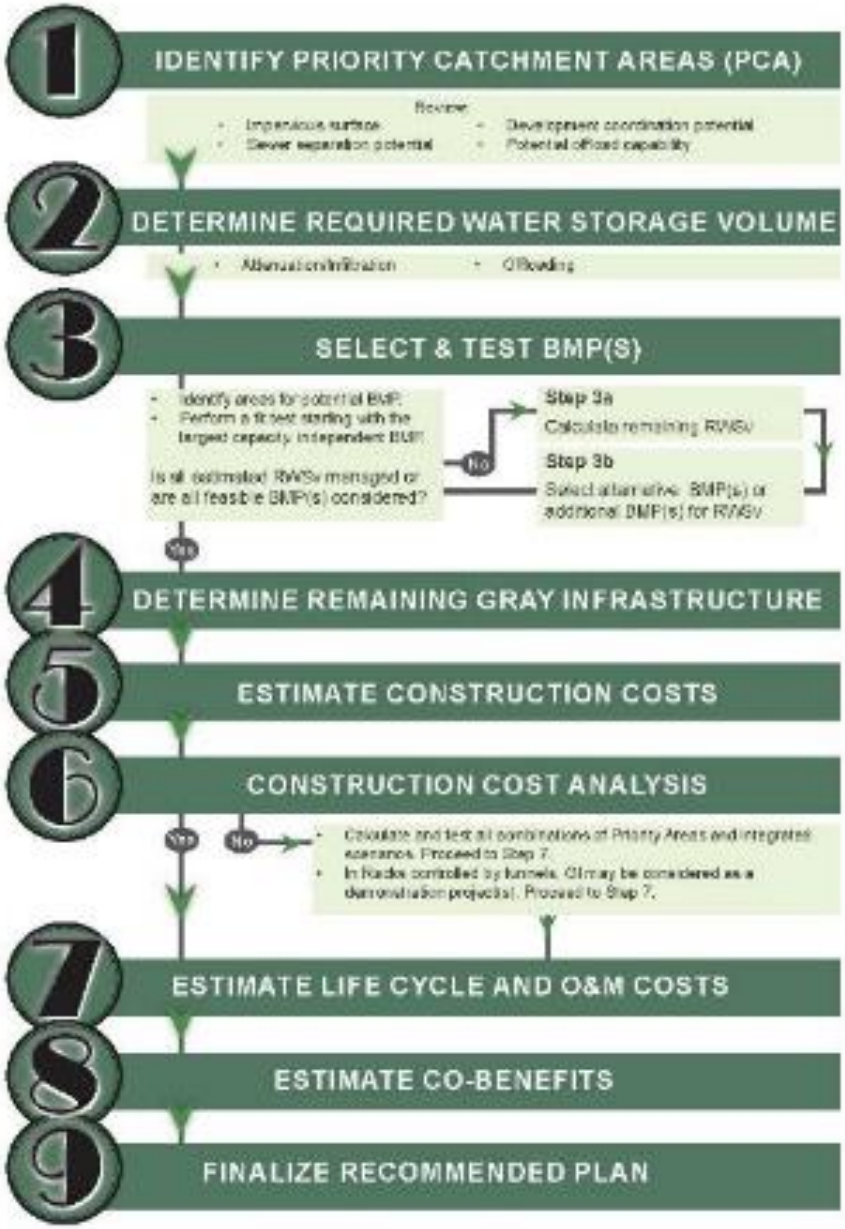


CSO Rack 3 Integrated Plan Recommendations

- CSO Rack 3 storage requirement: **2.1 MG**
- IP Recommendation Memo identified 8 GI elements and upsizing of underflow

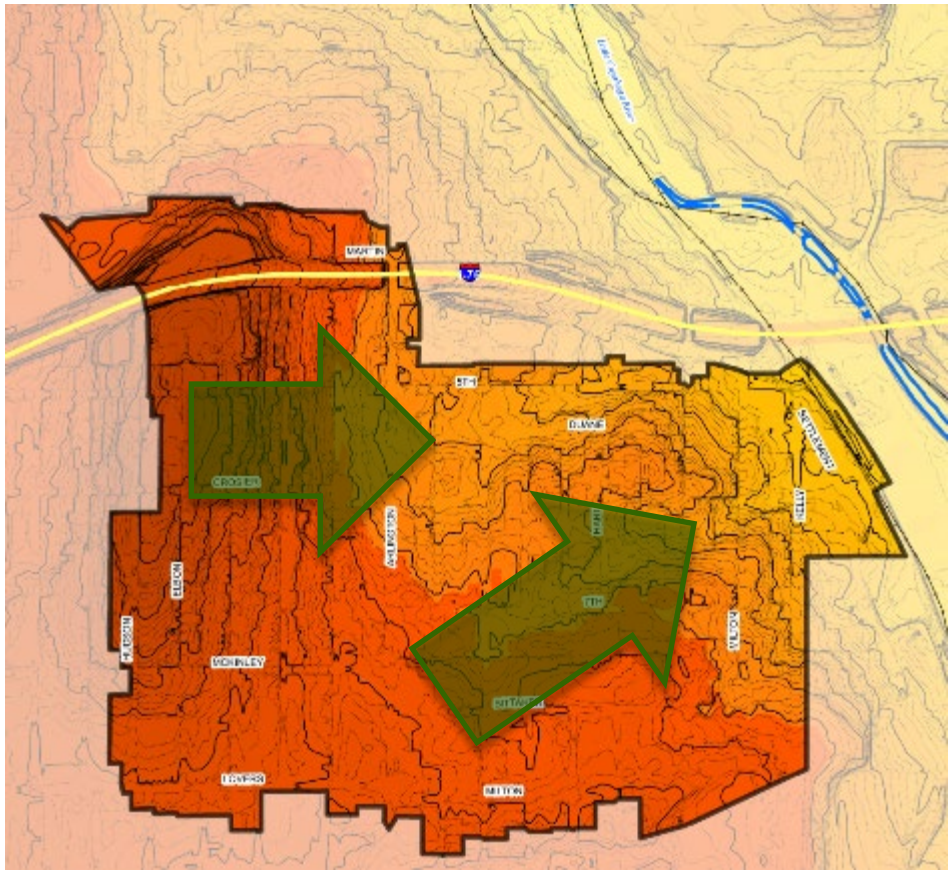
16-feet of water!

GI Toolbox Flow Chart

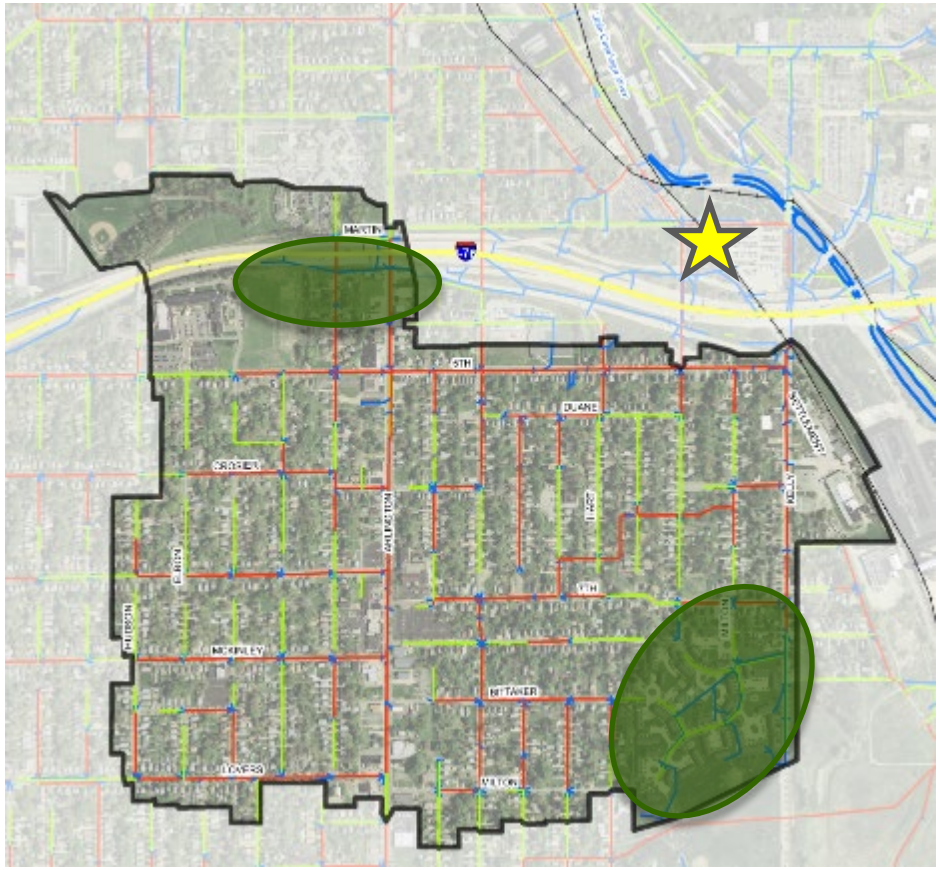


Application of GI Toolbox:

Step 1: Identify Priority Areas



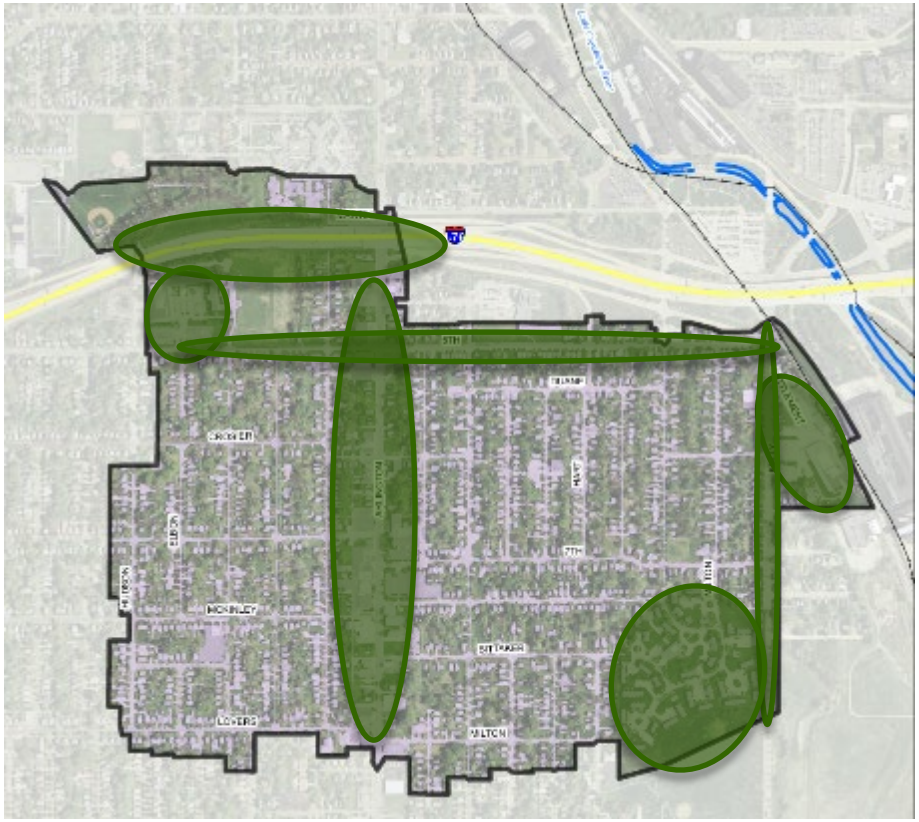
Topography



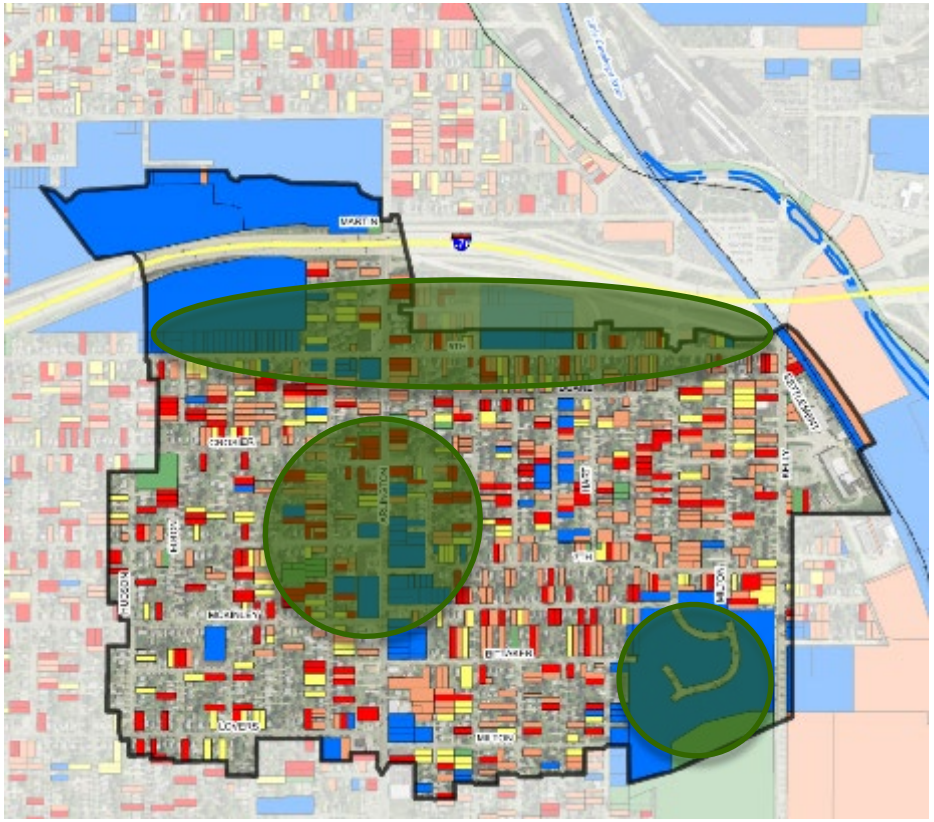
Existing Sewers & Proposed Rack Location

Application of GI Toolbox:

Step 1: Identify Priority Areas



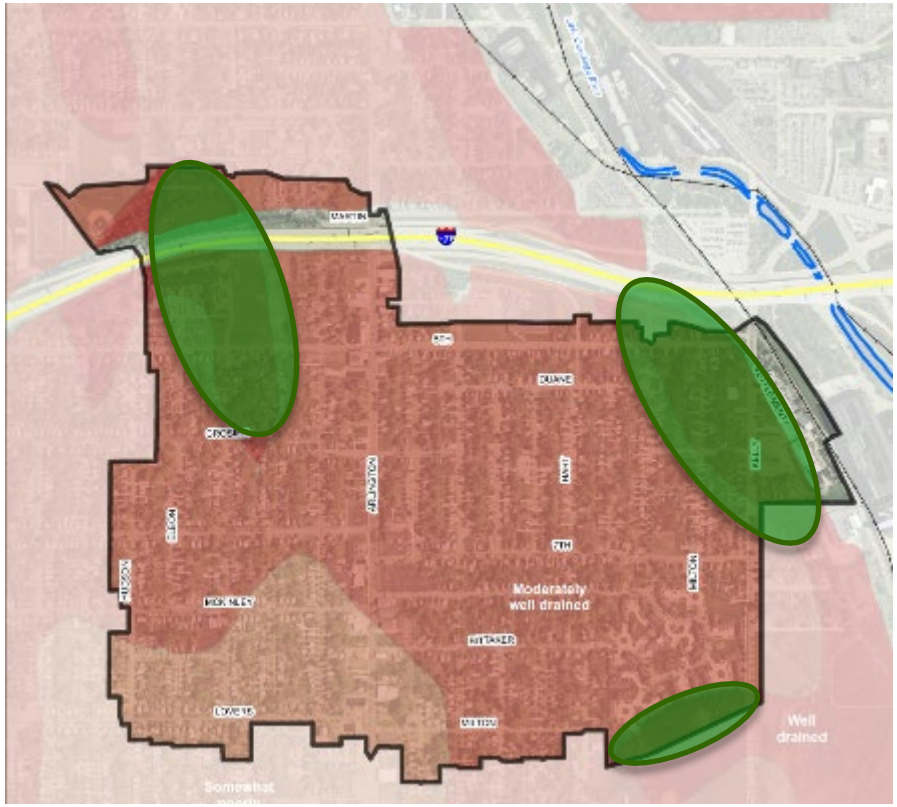
Impervious Surfaces



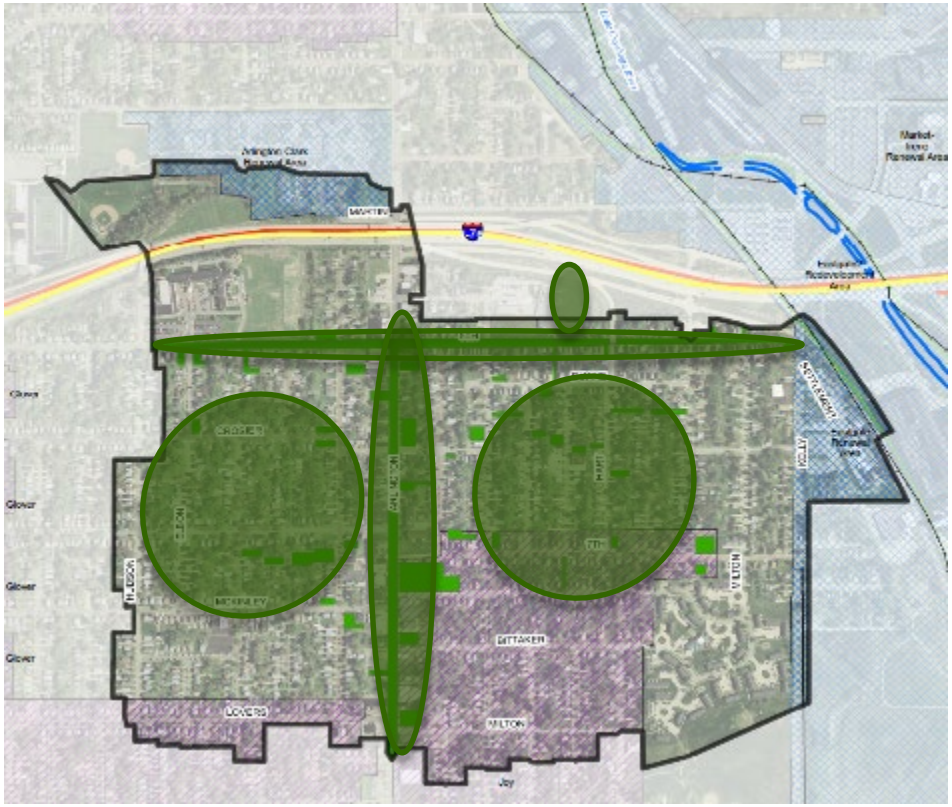
Potential Partners

Application of GI Toolbox:

Step 1: Identify Priority Areas



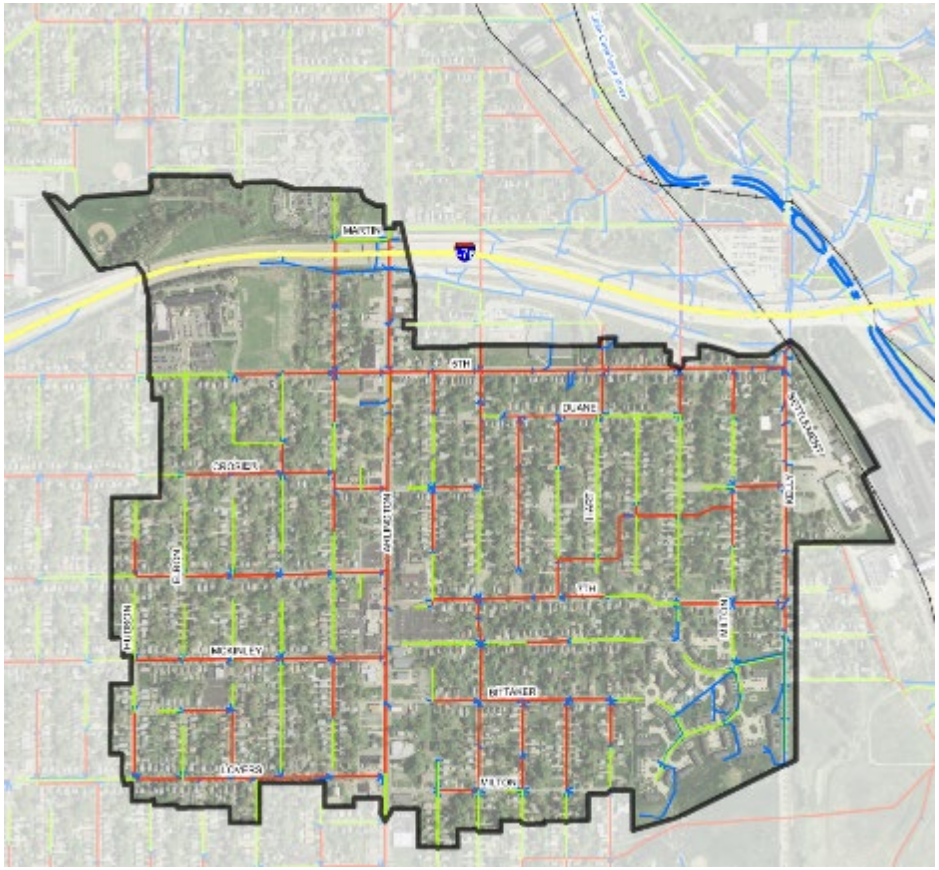
Soil Drainage Class



Redevelopment Footprint

Application of GI Toolbox:

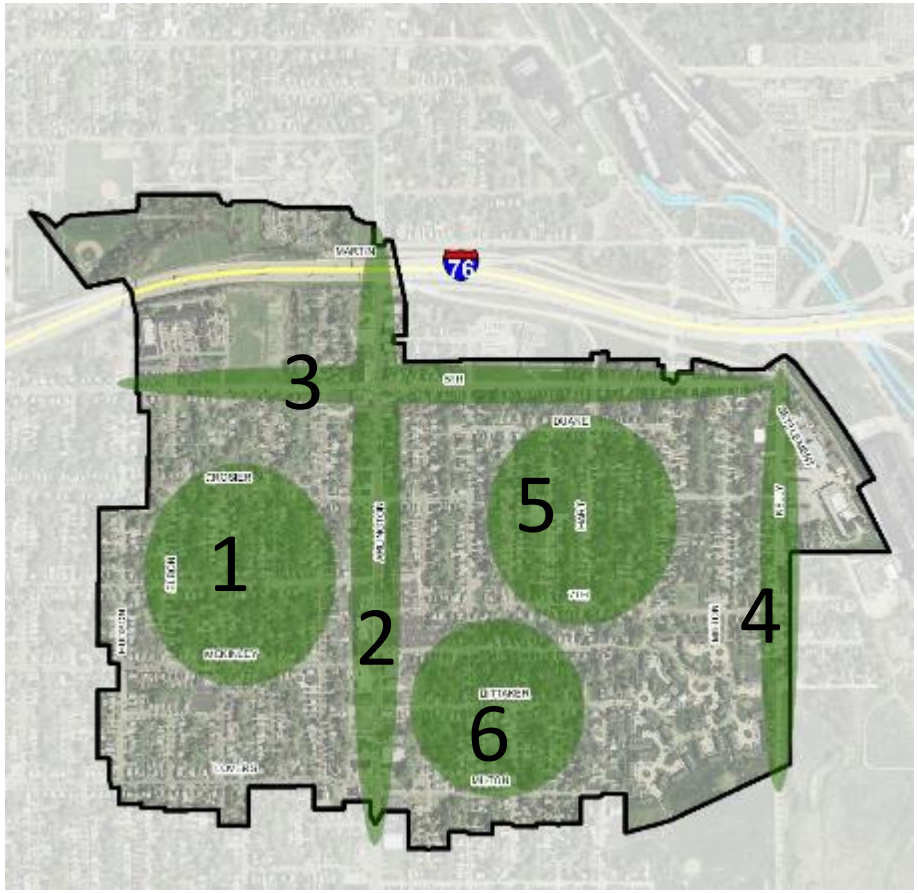
Step 1: Identify Priority Areas



- Part of East Akron Redevelopment Plan – already identified GI
- Lots of vacant land
- Limited green space
- Limited existing separate sewers
- Few areas of well drained soils

Application of GI Toolbox:

Step 1: Identify Priority Areas

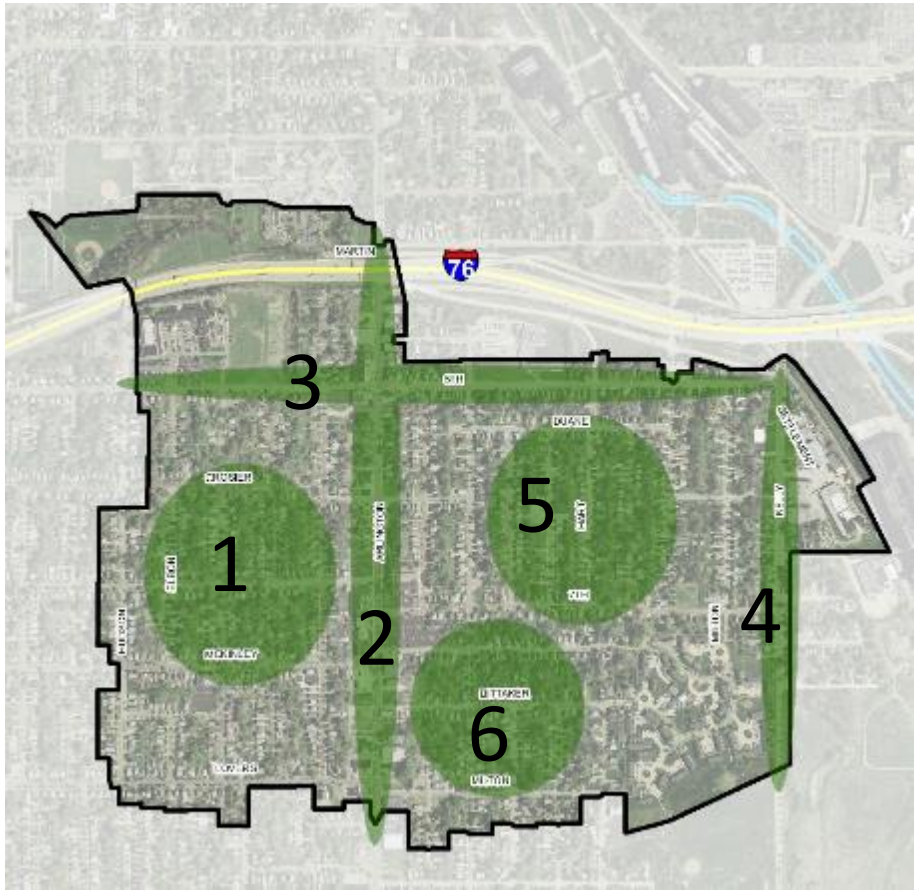


GI OPPORTUNITY AREAS

1. **Talbot Park**
   - City owned park
   - Identified as GI greenspace on EA plan
2. **South Arlington St.**
   - Numerous vacant lots
   - Identified as GI greenspace on EA plan
3. **5th Ave**
   - Well drained soils at low point
   - Potential partnership with schools
   - Identified as GI greenspace on EA plan

Application of GI Toolbox:

Step 1: Identify Priority Areas



GI OPPORTUNITY AREAS

4. **Kelly Ave**
   - Existing separated sewers
   - Well drained soils
5. **Duane Ave**
   - Numerous vacant lots
   - Identified as GI greenspace on EA plan
6. **Bittaker St.**
   - Potential partnership with East Akron NDC owned lots
   - Identified as GI greenspace on EA plan

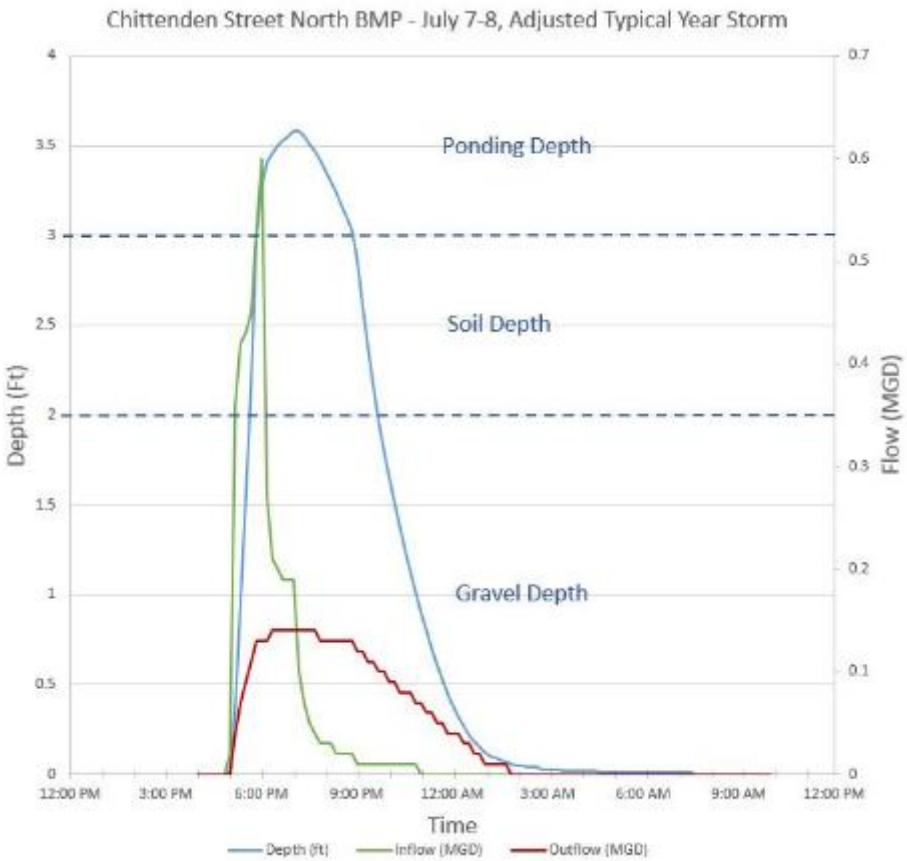
Application of GI Toolbox:

Step 2: Determine Required Water Storage Volume

USEPA SWMM models for each PCA created for Preliminary Conceptual Designs to determine the Required Water Storage Volume (RWSv)

Assumptions applied for every adjusted typical year storm:

- Goal: Any visual ponding in a BMP should drain within 24 hours
- Each BMP drains completely within 48 hours



Attenuating

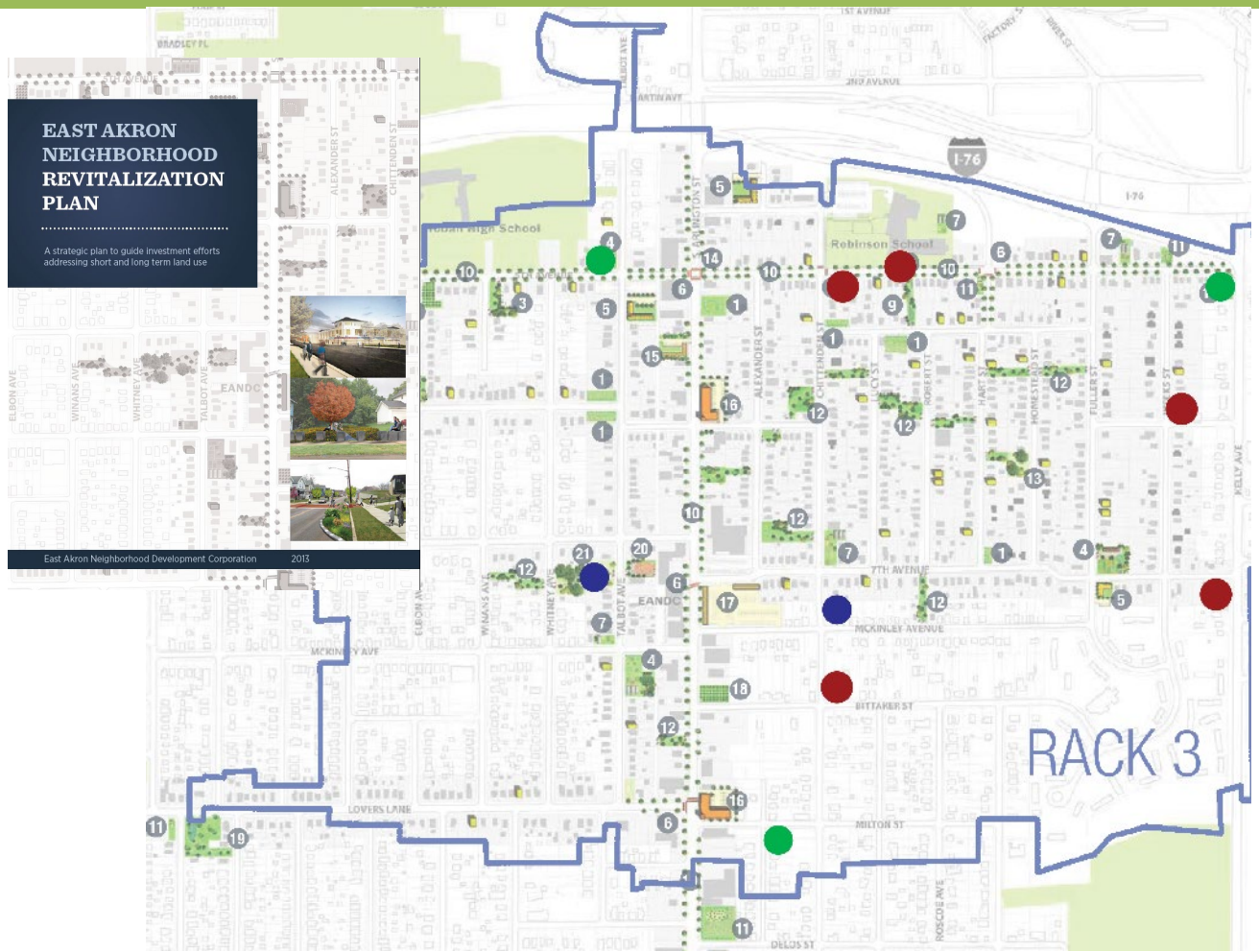
Application of GI Toolbox:

Step 3: Perform Fit Test of BMPs

Identify potential GI sites

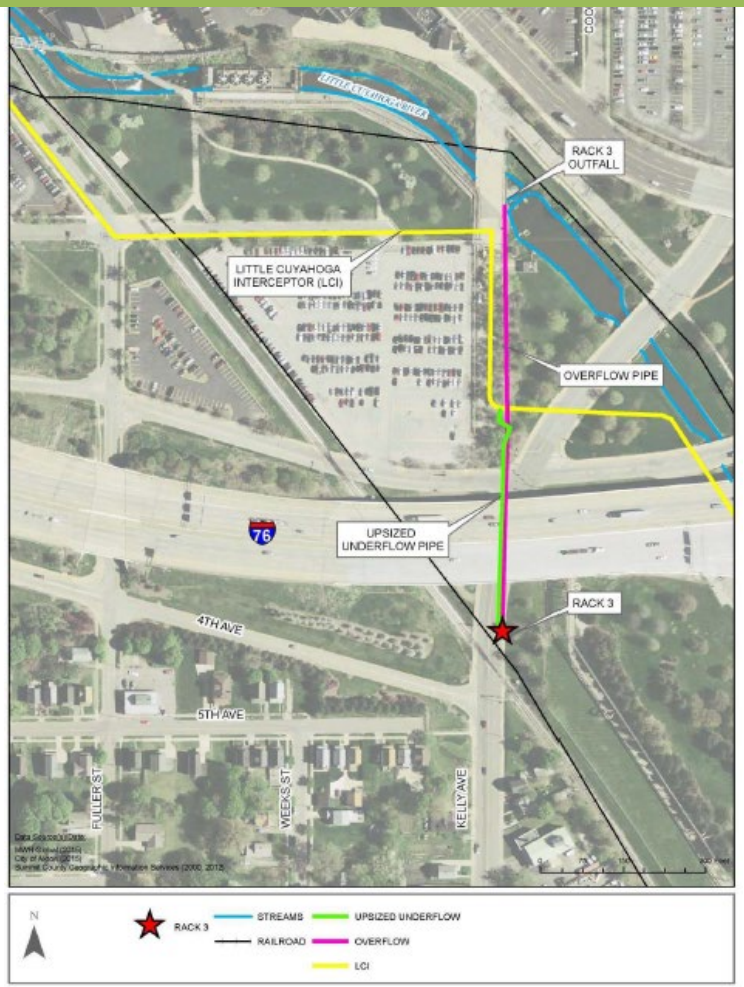
Apply planning setbacks to determine usable area – 10' parcel line offset, 5- ROW offset

Preliminary identify what type of GI can be applied on site – infiltrating, irrigation, etc.



Application of GI Toolbox:

Step 4: Determine Remaining Gray Infrastructure



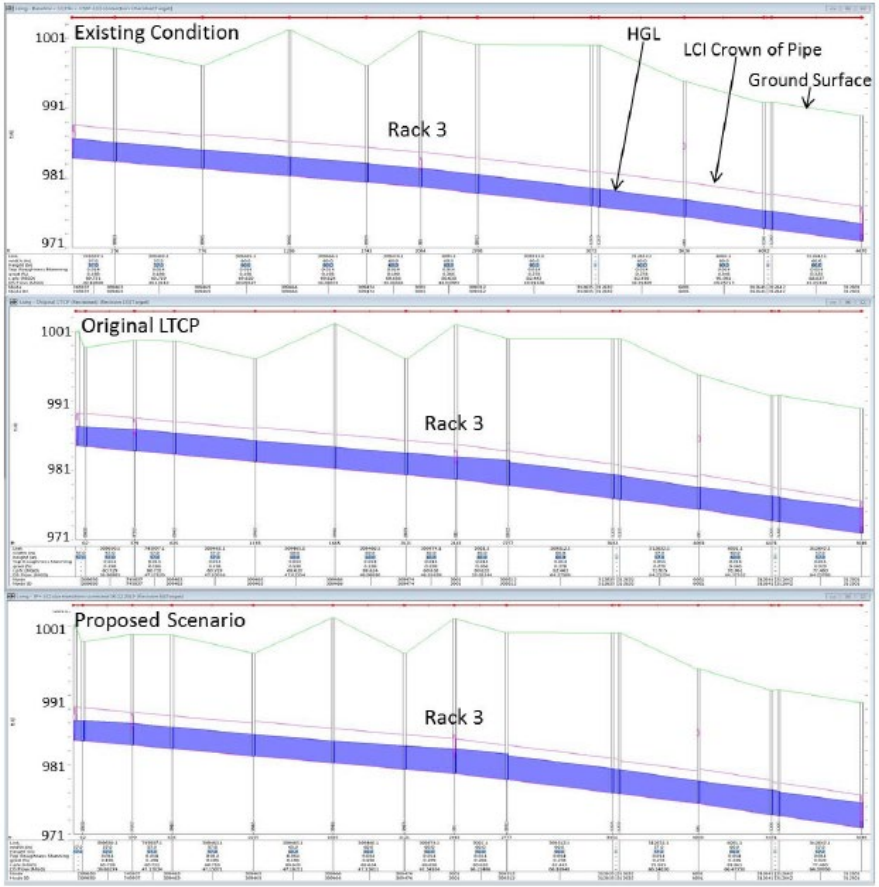
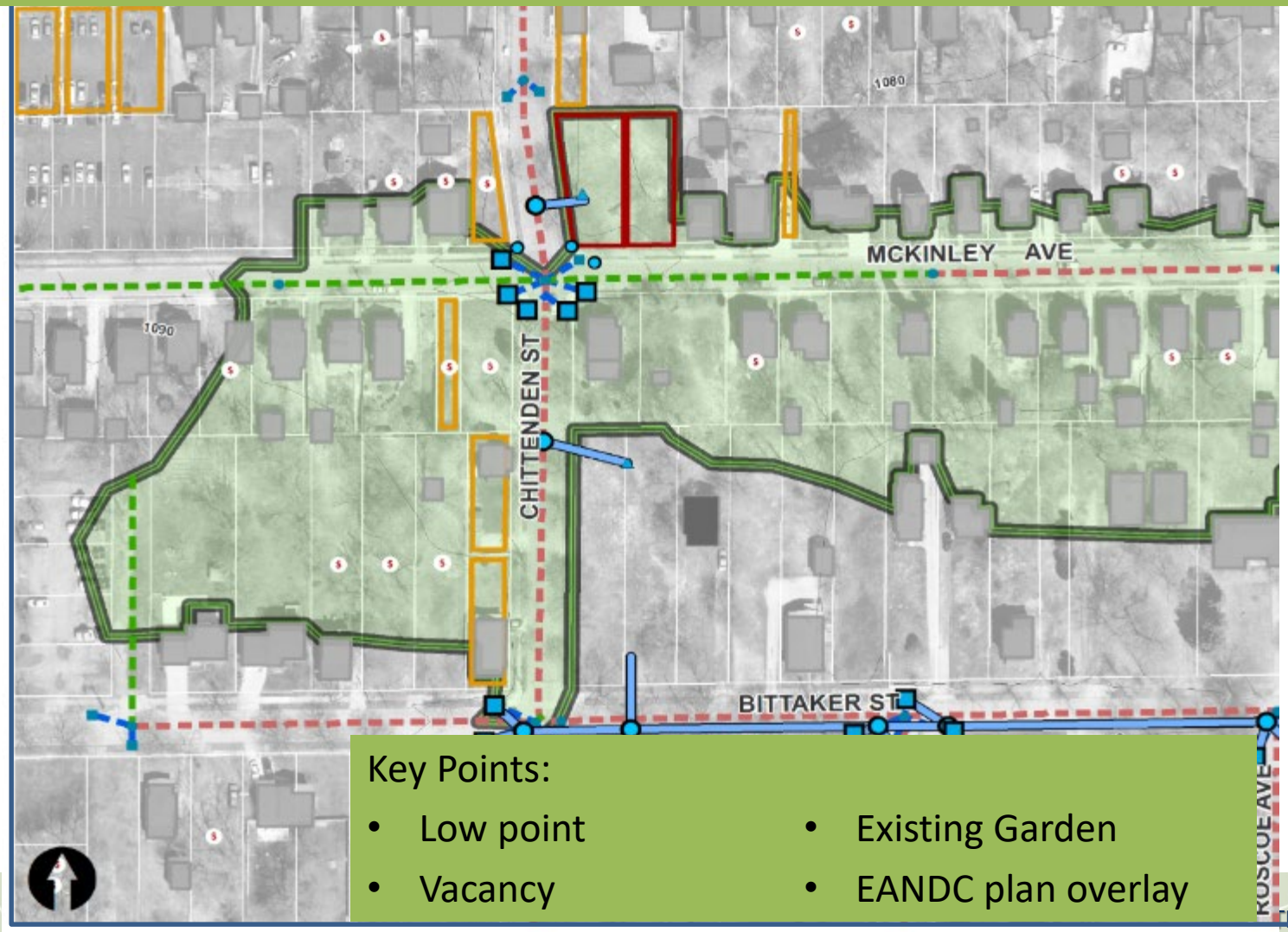
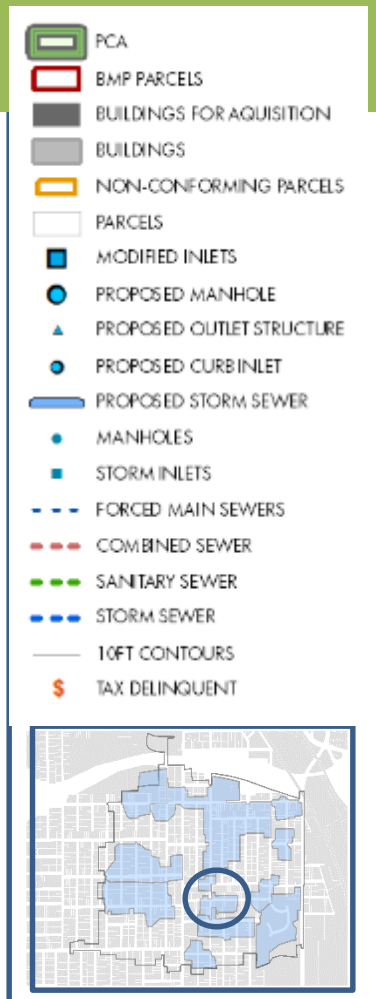


Figure 2: Hydraulic Grade Line of LCI in Existing Conditions, Original LTCP and Resulting From Proposed Underflow Upsizing

Application of GI Toolbox:

Step 5: Conceptual Costs



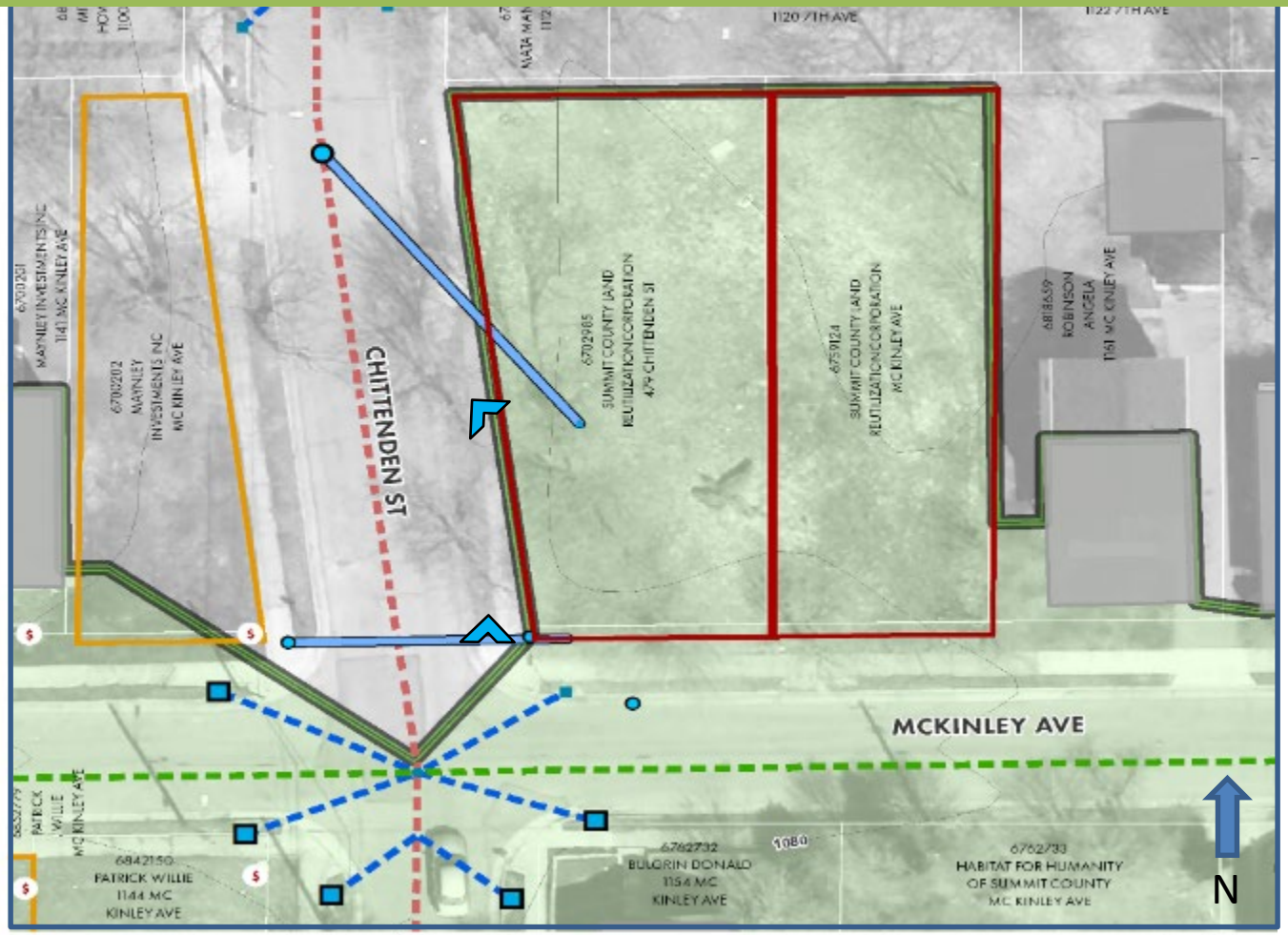


Key Points:

- Low point
- Vacancy
- Existing Garden
- EANDC plan overlay

Application of GI Toolbox:

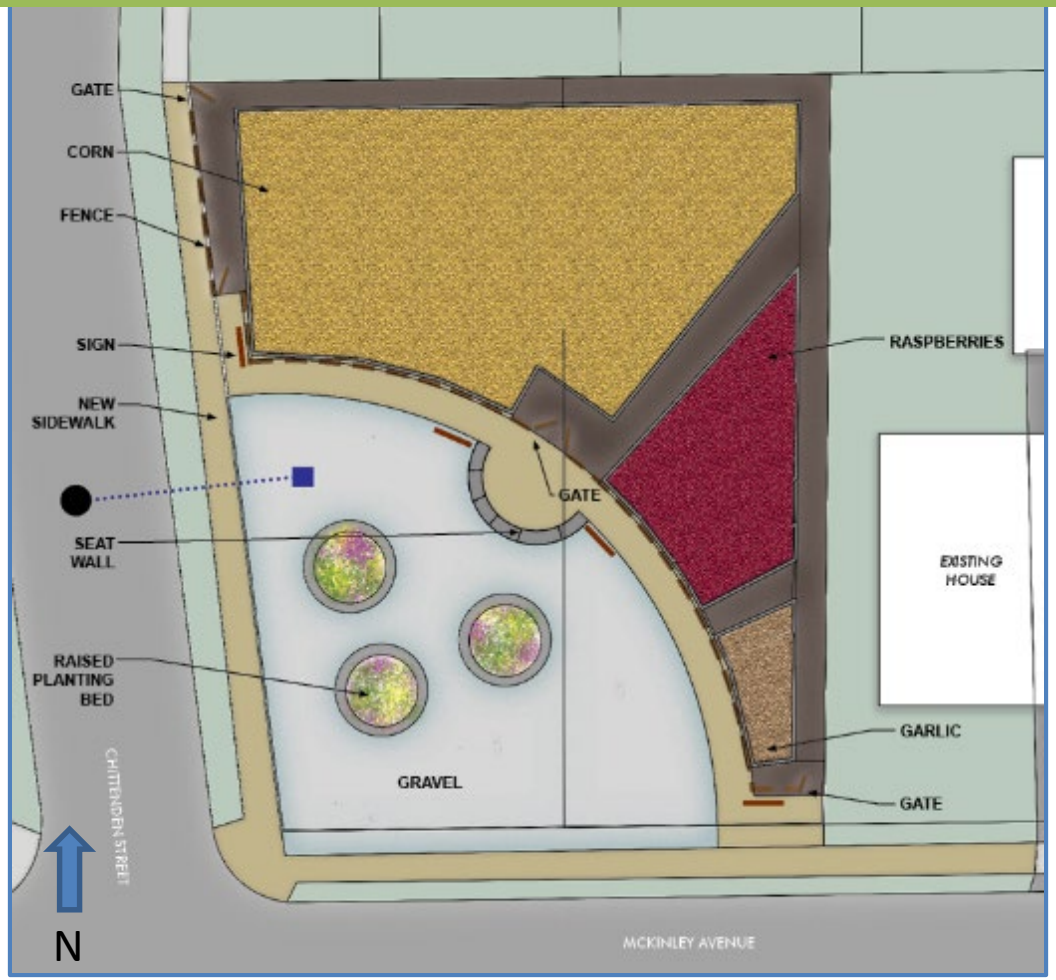
Step 5: Conceptual Costs



Property Details	
Parcels	6702985 6759124
Vacant Lots	2
Occupied Structures	N/A
Non-Conforming	0
Tax Delinquent Total	**$0.00**
Parcel Acreage	0.21
BMP Type	Bioretention
BMP Acreage	0.065
Stormwater Volume	8,300 CF
Lead Pipes to Replace	0
Cost per CF	$23.02

Application of GI Toolbox:

Step 5: Conceptual Costs



N.T.S.

Step 5:

Estimate Construction Costs

AKRON WATERWAYS RENEWED Class 4 Estimate CONCEPTUAL OPINION OF PROBABLE COSTS: June 05, 2015					
Kelly (CSO Rack 3) Underflow Upsizing with Green Infrastructure Costs					
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL COST
51	Excavation (BMP only)	2,113	CY	$14.00	$29,588.53
52	Constructed Stormwater Wetland	1.31	ACFT	$50,000.00	$65,500.00
53	Landscape and Tree Restoration	1	LS	$25,000.00	$25,000.00
54	18" Storm Sewer (ODOT Type "B" RCP)	2,073	LF	$150.00	$310,950.00
55	Catch Basin Installation/Modification	18	EA	$2,200.00	$39,600.00
56	Manhole Installation/Modification	7	EA	$4,800.00	$33,600.00
57	Roadway Restoration	2,073	LF	$114.00	$236,322.00
58	Construction Cost Contingency (50%)				$411,141.02
	McKinley Ave PCA Sitework and Stormwater Collection				**$278,627**
59	SWPP, Mobilization	1	LS	$8,000.00	$8,000.00
60	Clearing and Grubbing	211	SY	$7.29	$1,539.00
61	Excavation (BMP only)	246	CY	$14.00	$3,448.15
62	Bioretention	1,900	SF	$20.00	$38,000.00
63	Trees (ODOT 661)	15	EA	$250.00	$3,750.00
64	18" Storm Sewer (ODOT Type "B" RCP)	401	LF	$150.00	$60,150.00
65	Catch Basin Installation/Modification	7	EA	$2,200.00	$15,400.00
66	Manhole Installation/Modification	2	EA	$4,800.00	$9,600.00
67	Roadway Restoration	401	LF	$114.00	$45,714.00
68	Curb Cuts (saw cut existing curbs)	3	EA	$50.00	$150.00
69	Construction Cost Contingency (50%)				$92,875.57
	Bittaker St PCA Sitework and Stormwater Collection				**$1,664,292**
70	SWPP, Mobilization	1	LS	$30,000.00	$30,000.00
71	Clearing and Grubbing	3,049	SY	$7.29	$22,228.67
72	Excavation (BMP only)	1,016	CY	$14.00	$14,229.60
73	Constructed Stormwater Wetland	0.24	AF	$50,000.00	$12,000.00
74	Bioretention Bump Ins	8,446	SF	$20.00	$168,920.00
75	Landscape and Tree Restoration	1	LS	$25,000.00	$25,000.00
76	18" Storm Sewer (ODOT Type "B" RCP)	2,155	LF	$150.00	$323,250.00
77	Catch Basin Installation/Modification	27	EA	$2,200.00	$59,400.00
78	Manhole Installation/Modification	6	EA	$4,800.00	$28,800.00
79	Trench Drain	510	LF	$239.00	$121,890.00
80	Roadway Restoration	2,665	LF	$114.00	$303,810.00
81	Construction Cost Contingency (50%)				$554,764.13
	Green Infrastructure Construction Cost Subtotal Including Contingency				**$6,309,135**
	Construction Costs Total Including Contingency				**$7,062,509**
	Indirect Costs				**$2,758,013**
82	A. Contractor Bond and Insurance (ODOT 2.00% of construction)				$141,250

Application of GI Toolbox:

Step 6: Construction Costs Analysis

- Include design, CA and land acquisition costs
- Include O&M (gray and green)
- Look at life cycle costs

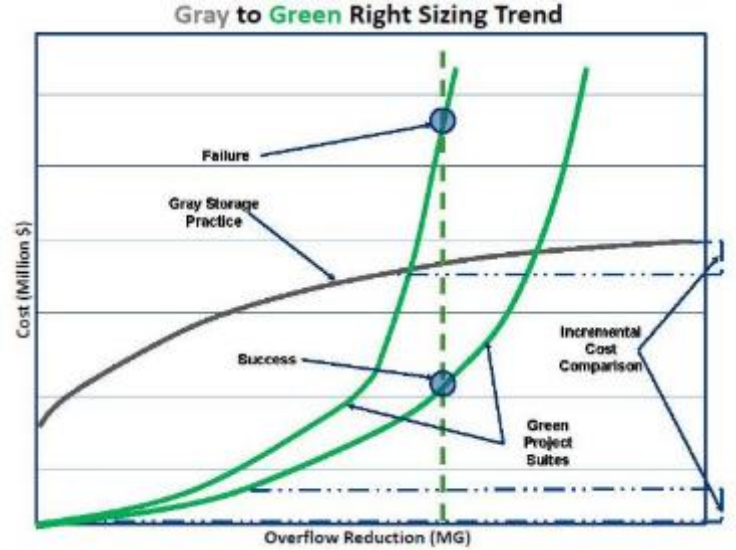


Table 5: Summary of Alternative Total Project Costs

	Total Capital$_{pv}$	Operation and Maintenance (O&M)$_{pv}$	Total Project$_{pv}$
2.1 MG Storage Basin	$19.6M	$2M	$21.6M
Optimized Underflow + Some GI	$9.8M	$3.3M	$13.1M
All GI + Upsized Underflow	$12.4M	$5M	$19.4M
Complete Sewer Separation	$37.5M	$1M	$38.5M

Step 7:

Estimate
Co-benefits

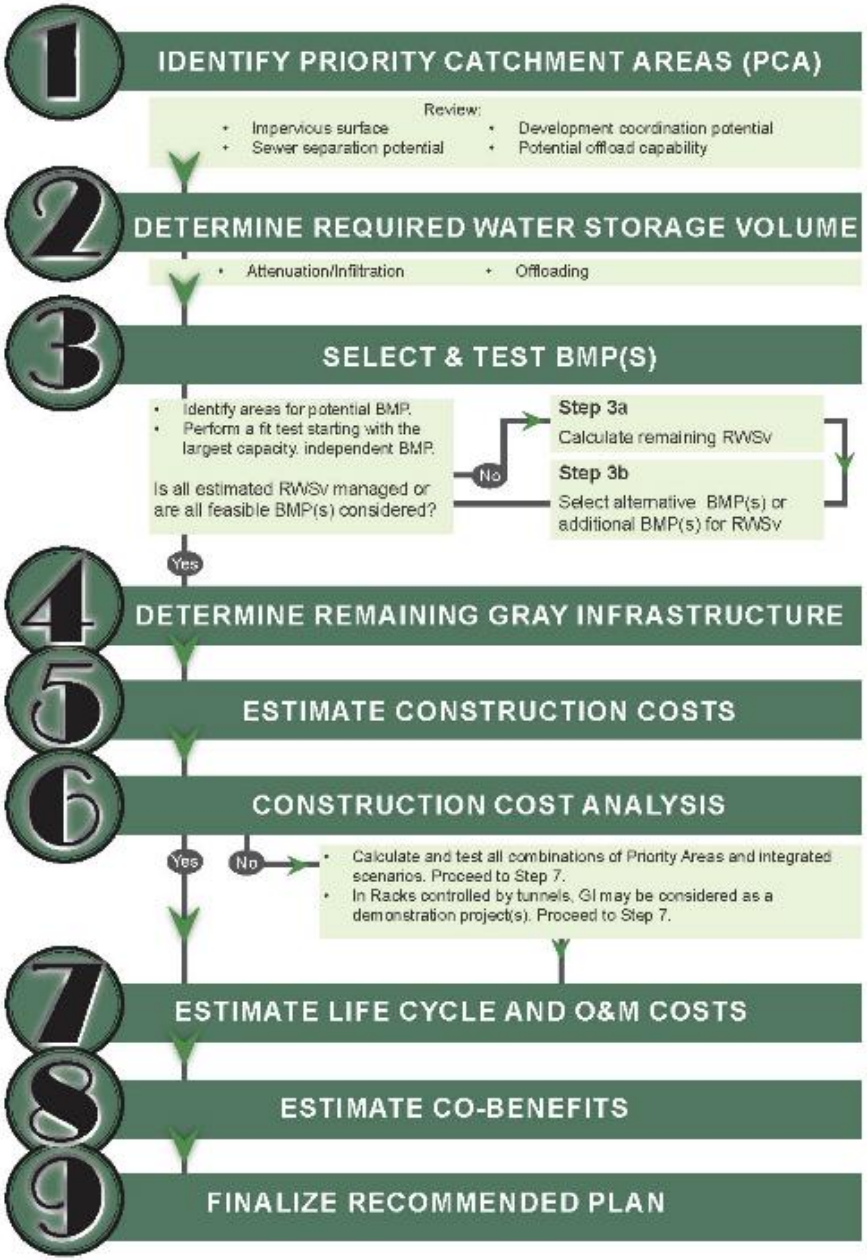
Table 6: Mini IP Results for Kelly (CSO Rack 3)

Criteria	2.1 MG Storage Basin	Optimized Underflow & Some GI	All GI & Upsized Underflow	Notes
Construction costs	-	+	0	Storage basin has the highest cost.
O&M requirements/costs	+	0	-	Storage has the lowest relative maintenance cost.
Site access	+	0	0	Basin is one location—the underflow route disrupts roadways.
Land acquisition	0	0	0	Land would need to be acquired for all three scenarios.
Site geology and hydrogeology	0	0	0	Potential geology and hydrogeology risks are unknown but assumed similar.
Construction disturbance	0	-	-	Green streets are bump-ins behind the curb in the ROW, but minor sewer separation is required to convey the stormwater to the centralized BMP.
Construction risks	0	0	0	There is nothing unique about these scenarios to add risk - typical construction is expected.
Utility or other significant impacts	0	0	0	There are typical utility risks for all scenarios. The storage basin location has utilities along east edge of parking lot on concrete supports.
Community impacts (odor, aesthetics)	0	+	+	Streetscapes associated with the GI provide aesthetic benefits to the community.
Cultural resources (archaeological, historic and architectural)	0	+	+	Cultural within the right of way typically isn't an issue, and it would not have to be surveyed or have to be part of the loan.
Environmental site assessment findings	0	+	+	ROWs typically do not have ESA findings.
Environmental benefits (including GI and BMP measures)	0	+	+	Added trees and reducing heat island effect add environmental benefits.
CSO volume elimination	0	0	0	For these GI scenarios, attenuation BMPs are proposed, not offloading or infiltration. Therefore no added benefit associated with CSO volume elimination.
Permitting	0	0	0	Similar permits are needed for all three scenarios.
Summary				
Negative	1	1	2	
Neutral	11	8	8	
Positive	2	5	4	
Totals	**+1**	**+4**	**+2**	

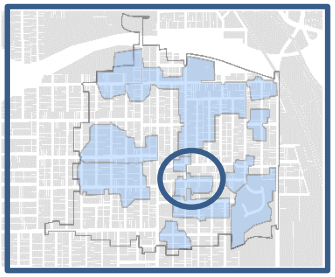
Key: + Favorable 0 Neutral - Unfavorable

Step 8:

Finalize Recommendation Plan



Kelly (CSO Rack 3): Final Design

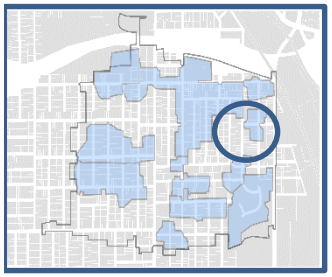


Kelly (CSO Rack 3): Final Design

KELLY GREEN PROJECT (CSO RACK 3)

WEEKS STREET PCA

SITE CONCEPT - *A New Way to Work*

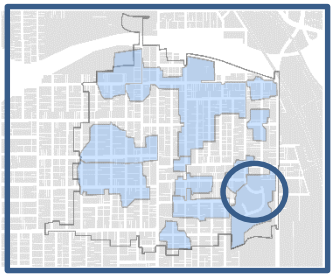


Kelly (CSO Rack 3): Final Design

KELLY GREEN PROJECT (CSO RACK 3)

KELLY AVENUE PCA

SITE CONCEPT - *Catch Nature*



Kelly (CSO Rack 3): Final Design

Table 5: Summary of Alternative Total Project Costs

	Total Capital$_{pv}$	Operation and Maintenance (O&M)$_{pv}$	Total Project$_{pv}$
2.1 MG Storage Basin	$19.6M	$2M	$21.6M
Optimized Underflow + Some GI	$9.8M	$3.3M	$13.1M
All GI + Upsized Underflow	$12.4M	$5M	$19.4M
Complete Sewer Separation	$37.5M	$1M	$38.5M

- 172,000 CF of storage + upsizing of underflow + additional flood storage
- 12” above ground temporary ponding depth
- Neighborhood integrated design
- Staggered construction
- 3 separate bid packages enabling smaller construction companies to bid projects

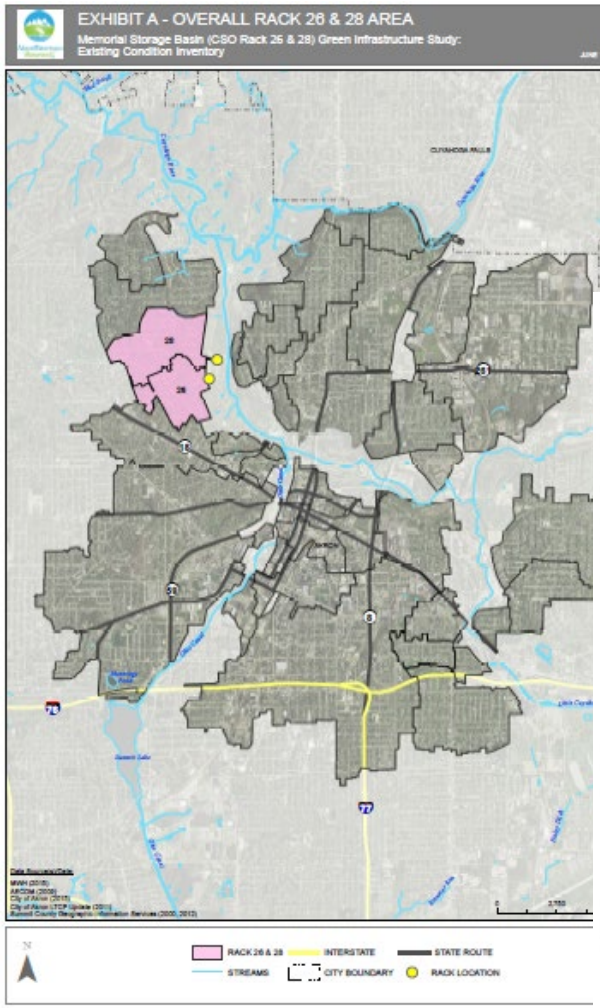
Environmental Design Group
The community impact people.

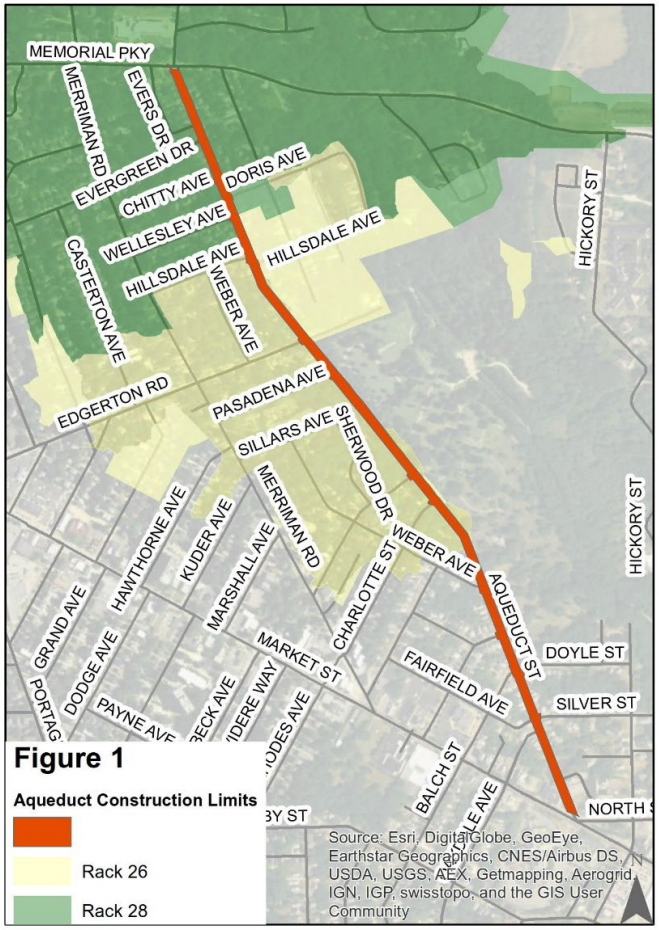
Balancing ecology, engineering, and aesthetics.

Katherine G. Holmok, ASLA *kholmok@envdesigngroup.com* *330.375.1390*

Memorial

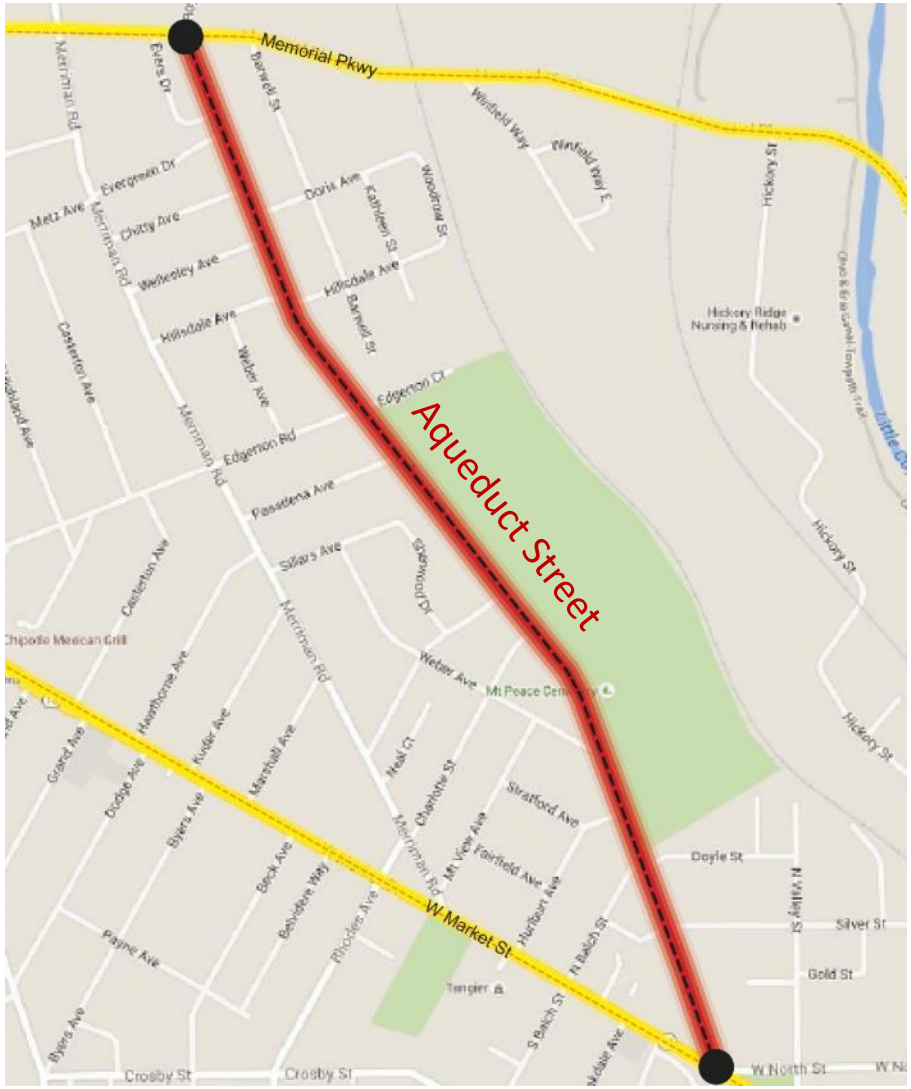
(CSO Rack 26/28)





AQUEDUCT STREET

- Project Limits: 1.13 miles
- Residential Collector
- Originally built as a Brick Street in 1921
- 30’ Wide Pavement
- On-Street Parking



AQUEDUCT STREET

- Aged Pavement
  - Potholes
- Drainage Problems
- Combined Sewers
- Wide Pavement Area
  - Encourages Speeding

COMPLETE STREETS

- "For Everyone"
- Safer
- Bike and Pedestrian Friendly
- Connect Neighbors
- Safe Route to School
- Live, Work, and Play

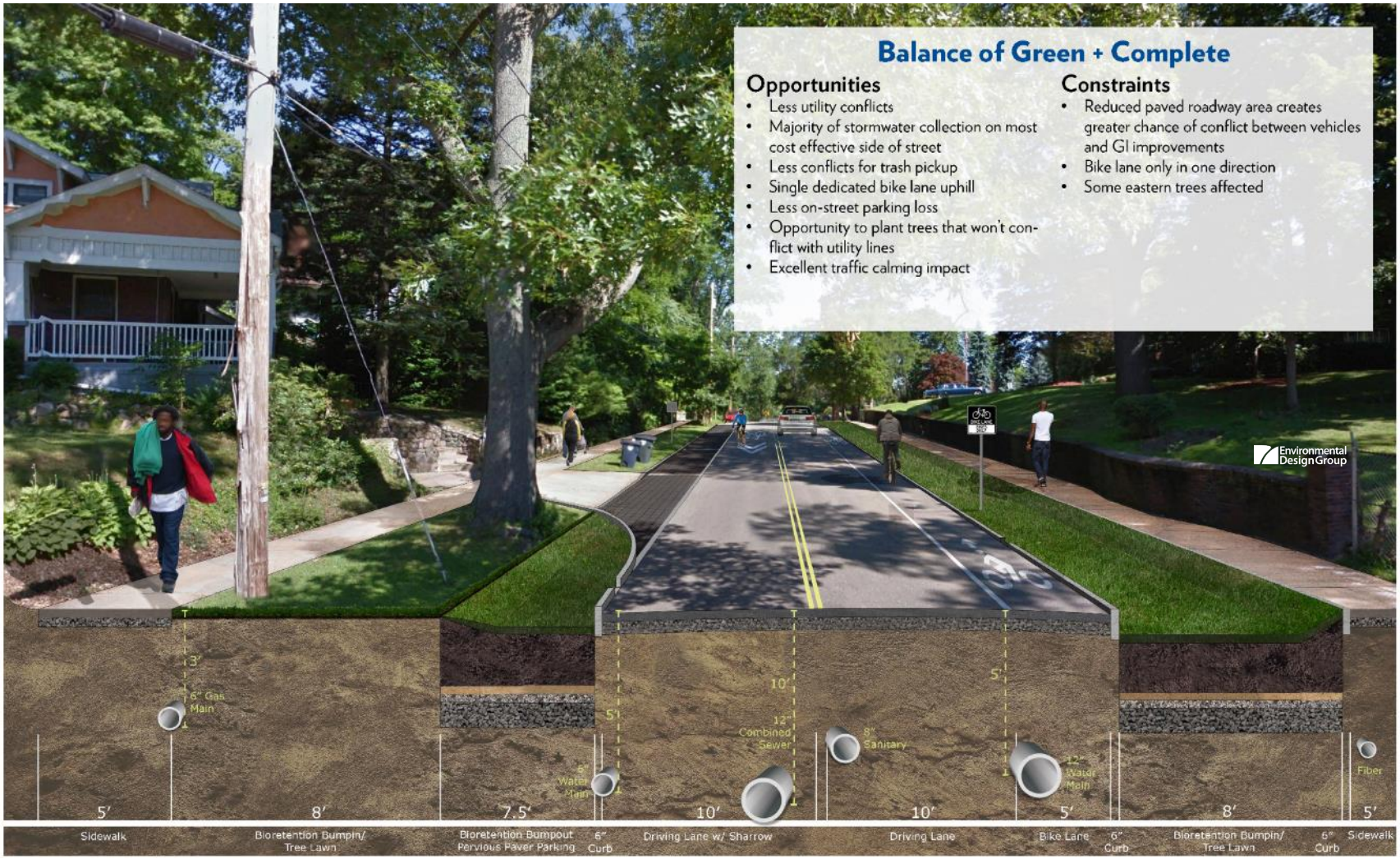
GREEN STREET ELEMENTS

- Lawn Style Bioretention
- Porous Pavement Parking
- Underground Infiltration


Firestone Pkwy.


Frank Blvd.


Section
Existing
Environmental Design Group
3'
6" Gas Main
5'
6" Water Main
10'
12" Combined Sewer
8" Sanitary
5'
12" Water Main
Fiber
0'-1'
5-6'
8'
8'
11'
11'
9'
5'-6'
Sidewalk
Tree Lawn
6" Curb
Parking
Driving Lane
Driving Lane
6" Curb
Tree Lawn
Sidewalk



	Total Capital $_{pv}$	O&M$_{pv}$	Total Project $_{pv}$
1.5 MG Storage Basin	$20.3M	$2M	$22.3M
All GI and Upsized Underflow	$13.1M	$4.2M	$17.3M
Upsized Underflow and Some GI	$5.4M	$1.1M	$6.5M
Complete Sewer Separation	$35.7M	$1M	$36.7M