GREEN FOR GRAY: CSO CONTROL USING GREEN INFRASTRUCTURE

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GREEN FOR GRAY: CSO CONTROL USING GREEN INFRASTRUCTURE
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
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

<table>
<thead>
<tr>
<th>STORMWATER VOLUME CONTROL RATIO</th>
<th>CONSTRUCTION COST RANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Landscape Restoration (Source Removal)</td>
<td>Pavement Removal (lawn)</td>
</tr>
<tr>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>$8,000 - $15,000 per acre</td>
<td>$8,000 - $15,000 per acre</td>
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<tr>
<td>Meadow Conversion</td>
<td>Low</td>
</tr>
<tr>
<td>$10,000 - $15,000 per acre</td>
<td>$10,000 - $15,000 per acre</td>
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<tr>
<td>Street Trees</td>
<td>Low</td>
</tr>
<tr>
<td>$80 to $250 per tree</td>
<td>$80 to $250 per tree</td>
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<tr>
<td>Reforestation</td>
<td>Low</td>
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<td>$25,000 - $35,000 per acre</td>
<td>$25,000 - $35,000 per acre</td>
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<tr>
<td>Floodplain Restoration</td>
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<tr>
<td>$5,000 - $15,000 per acre</td>
<td>$5,000 - $15,000 per acre</td>
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<tr>
<td>Community Gardens (on Vacant Lots)</td>
<td>Low</td>
</tr>
<tr>
<td>$15,000 - $20,000 per acre</td>
<td>$15,000 - $20,000 per acre</td>
</tr>
</tbody>
</table>

**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 LF

**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

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.

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 (i.e. sidewalks, roadways, utilities, culverts) can be expansive
- Must be designed to allow for flood control and erosion

<table>
<thead>
<tr>
<th>Potential Applications</th>
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<tr>
<td>Residential</td>
<td>Yes</td>
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<tr>
<td>Commercial</td>
<td>Limited</td>
</tr>
<tr>
<td>Ultra Urban</td>
<td>Limited</td>
</tr>
<tr>
<td>Industrial</td>
<td>Yes</td>
</tr>
<tr>
<td>Retrofit</td>
<td>Yes</td>
</tr>
<tr>
<td>Highway</td>
<td>Limited</td>
</tr>
<tr>
<td>Road</td>
<td>Limited</td>
</tr>
<tr>
<td>Recreational</td>
<td>Yes</td>
</tr>
</tbody>
</table>
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

1. Identify Priority Catchment Areas (PCA)
   - Impervious surfaces
   - Development coordination potential
   - Potential off-road capability

2. Determine Required Water Storage Volume
   - Alternatives:
     - Overflow

3. Select & Test BMP(s)
   - Identify areas for potential BMP:
     - Perform a tiered strategy with the targeted capacity, independent of BMPs
     - Is all estimated RAVy managed or are all feasible BMP(s) considered?
     - Step 3a Calculate remaining RAVY
     - Step 3b Select alternative BMP(s) or additional BMP(s) for RAVY

4. Determine Remaining Gray Infrastructure

5. Estimate Construction Costs

6. Construction Cost Analysis
   - Calculate and test all combinations of Priority Areas and integrated economics. Proceed to Step 7.
   - In Areas controlled by tunnels, GI may be considered as a demonstration project. Proceed to Step 7.

7. Estimate Life Cycle and O&M Costs

8. Estimate Co-Benefits

9. Finalize Recommended Plan
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**
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
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

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<tr>
<th>Description</th>
<th>Details</th>
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<tr>
<td>Parcels</td>
<td>6702985 6759124</td>
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<tr>
<td>Vacant Lots</td>
<td>2</td>
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<td>Occupied Structures</td>
<td>N/A</td>
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<tr>
<td>Non-Conforming</td>
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<td>Tax Delinquent Total</td>
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<td>Parcel Acreage</td>
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<td>BMP Type</td>
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<tr>
<td>BMP Acreage</td>
<td>0.065</td>
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<tr>
<td>Stormwater Volume</td>
<td>8,300 CF</td>
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<td>Lead Pipes to Replace</td>
<td>0</td>
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<tr>
<td>Cost per CF</td>
<td>$23.02</td>
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Application of GI Toolbox:
Step 5: Conceptual Costs
Step 5: Estimate Construction Costs

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<tr>
<th>ITEM</th>
<th>DESCRIPTION</th>
<th>QUANTITY</th>
<th>UNIT</th>
<th>UNIT COST</th>
<th>TOTAL COST</th>
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<tbody>
<tr>
<td>51</td>
<td>Excavation (BMP only)</td>
<td>2,113</td>
<td>CY</td>
<td>$14.00</td>
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<td>52</td>
<td>Constructed Stormwater Wetland</td>
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<td>ACFT</td>
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<td>$65,500.00</td>
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<tr>
<td>53</td>
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<td>1</td>
<td>LS</td>
<td>$25,000.00</td>
<td>$25,000.00</td>
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<tr>
<td>54</td>
<td>18&quot; Storm Sewer (ODOT Type &quot;B&quot; RCP)</td>
<td>2,073</td>
<td>LF</td>
<td>$150.00</td>
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<td>55</td>
<td>Catch Basin Installation/Modification</td>
<td>18</td>
<td>EA</td>
<td>$2,200.00</td>
<td>$39,600.00</td>
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<tr>
<td>56</td>
<td>Manhole Installation/Modification</td>
<td>7</td>
<td>EA</td>
<td>$4,800.00</td>
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<td>57</td>
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<td>58</td>
<td>Construction Cost Contingency (50%)</td>
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<td>$411,142.02</td>
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**McKinley Ave PCA Sitework and Stormwater Collection**

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<tr>
<th>ITEM</th>
<th>DESCRIPTION</th>
<th>QUANTITY</th>
<th>UNIT</th>
<th>UNIT COST</th>
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<tbody>
<tr>
<td>59</td>
<td>SWPP, Mobilization</td>
<td>1</td>
<td>LS</td>
<td>$8,000.00</td>
<td>$8,000.00</td>
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<tr>
<td>60</td>
<td>Clearing and Grubbing</td>
<td>211</td>
<td>SY</td>
<td>$7.29</td>
<td>$1,539.99</td>
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<tr>
<td>61</td>
<td>Excavation (BMP only)</td>
<td>246</td>
<td>CY</td>
<td>$14.00</td>
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<td>62</td>
<td>Bioretention</td>
<td>1,900</td>
<td>SF</td>
<td>$20.00</td>
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<td>63</td>
<td>Trees (ODOT 661)</td>
<td>15</td>
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<td>401</td>
<td>LF</td>
<td>$150.00</td>
<td>$60,150.00</td>
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<tr>
<td>65</td>
<td>Catch Basin Installation/Modification</td>
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<td>EA</td>
<td>$2,200.00</td>
<td>$15,400.00</td>
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<tr>
<td>66</td>
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<td>EA</td>
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<td>$9,600.00</td>
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<td>67</td>
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<td>LF</td>
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<td>$45,714.00</td>
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<td>68</td>
<td>Curb Cuts (saw cut existing curbs)</td>
<td>3</td>
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<td>$150.00</td>
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<td>69</td>
<td>Construction Cost Contingency (50%)</td>
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**Bittaker St PCA Sitework and Stormwater Collection**

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<tr>
<td>70</td>
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<td>LS</td>
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<tr>
<td>71</td>
<td>Clearing and Grubbing</td>
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<td>Constructed Stormwater Wetland</td>
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<td>74</td>
<td>Bioretention Bump Ins</td>
<td>8,446</td>
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<td>79</td>
<td>Trench Drain</td>
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<td>81</td>
<td>Construction Cost Contingency (50%)</td>
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**Green Infrastructure Construction Cost Subtotal including Contingency**

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<tr>
<th>ITEM</th>
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<th>UNIT COST</th>
<th>TOTAL COST</th>
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<tbody>
<tr>
<td>82</td>
<td>Green Infrastructure Construction Cost</td>
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<td>$6,300,135</td>
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**Construction Costs Total Including Contingency**

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<tr>
<th>ITEM</th>
<th>DESCRIPTION</th>
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<th>UNIT</th>
<th>UNIT COST</th>
<th>TOTAL COST</th>
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<tbody>
<tr>
<td>83</td>
<td>Construction Bond and Insurance (ODOT 2.5% of construction)</td>
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<td>$141,125</td>
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**Indirect Costs**

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<td>84</td>
<td>Indirect Costs</td>
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<td>$2,758,013</td>
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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**

<table>
<thead>
<tr>
<th></th>
<th>Total Capital&lt;sub&gt;pv&lt;/sub&gt;</th>
<th>Operation and Maintenance (O&amp;M)&lt;sub&gt;pv&lt;/sub&gt;</th>
<th>Total Project&lt;sub&gt;pv&lt;/sub&gt;</th>
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<tbody>
<tr>
<td>2.1 MG Storage Basin</td>
<td>$19.6M</td>
<td>$2M</td>
<td>$21.6M</td>
</tr>
<tr>
<td>Optimized Underflow + Some GI</td>
<td>$9.8M</td>
<td>$3.3M</td>
<td>$13.1M</td>
</tr>
<tr>
<td>All GI + Upsized Underflow</td>
<td>$12.4M</td>
<td>$5M</td>
<td>$19.4M</td>
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<tr>
<td>Complete Sewer Separation</td>
<td>$37.5M</td>
<td>$1M</td>
<td>$38.5M</td>
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**Step 7:**

**Estimate Co-benefits**

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

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<th>Criteria</th>
<th>2.4 M Storage Basin</th>
<th>Optimized Underflow &amp; Some GI</th>
<th>All GI &amp; Upsized Underflow</th>
<th>Notes</th>
</tr>
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<tbody>
<tr>
<td>Construction costs</td>
<td>-</td>
<td>+</td>
<td>0</td>
<td>Storage basin has the highest cost.</td>
</tr>
<tr>
<td>O&amp;M requirement/costs</td>
<td>+</td>
<td>0</td>
<td>-</td>
<td>Storage has the lowest relative maintenance cost.</td>
</tr>
<tr>
<td>Site access</td>
<td>+</td>
<td>0</td>
<td>0</td>
<td>Basin is one location—the underflow route disrupts roadways.</td>
</tr>
<tr>
<td>Land acquisition</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Land would need to be acquired for all three scenarios.</td>
</tr>
<tr>
<td>Site geology and hydrogeology</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Potential geology and hydrogeology risks are unknown but assumed similar.</td>
</tr>
<tr>
<td>Construction disturbance</td>
<td>0</td>
<td>-</td>
<td>-</td>
<td>Green streets are bump-ins behind the curb in the ROW, but minor sewer excavation is required to convey the stormwater to the centralized BMP.</td>
</tr>
<tr>
<td>Construction risks</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>There is nothing unique about these scenarios to add risk - typical construction is expected.</td>
</tr>
<tr>
<td>Utility or other significant impacts</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>There are typical utility risks for all scenarios. The storage basin location has utilities along east edge of parking lot on concrete supports.</td>
</tr>
<tr>
<td>Community impacts (odor, aesthetics)</td>
<td>0</td>
<td>+</td>
<td>+</td>
<td>Streetscapes associated with the GI provide aesthetic benefits to the community.</td>
</tr>
<tr>
<td>Cultural resources (archaeological, historic and architectural)</td>
<td>0</td>
<td>+</td>
<td>+</td>
<td>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.</td>
</tr>
<tr>
<td>Environmental site assessment findings</td>
<td>0</td>
<td>+</td>
<td>+</td>
<td>ROW's typically do not have ESA findings.</td>
</tr>
<tr>
<td>Environmental benefits (including GI and BMP measures)</td>
<td>0</td>
<td>+</td>
<td>+</td>
<td>Added trees and reducing heat island effect add environmental benefits.</td>
</tr>
<tr>
<td>CSO volume elimination</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>For these GI scenarios, attenuation BMPs are proposed, not offloading or infiltration. Therefore no added benefit associated with CSO volume elimination.</td>
</tr>
<tr>
<td>Permitting</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Similar permits are needed for all three scenarios.</td>
</tr>
</tbody>
</table>

**Summary**

<table>
<thead>
<tr>
<th>Category</th>
<th>Negative</th>
<th>Neutral</th>
<th>Positive</th>
<th>Totals</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>11</td>
<td>2</td>
<td>+1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8</td>
<td>8</td>
<td>+4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>5</td>
<td>+2</td>
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</tbody>
</table>

**Key**

+ Favorable
0 Neutral
- Unfavorable
Step 8: Finalize Recommendation Plan
Kelly (CSO Rack 3): Final Design

KELLY GREEN PROJECT (CSO RACK 3)

McKinley Avenue PCA
SITE CONCEPT - Craft Garden

STREET VIEW
Kelly (CSO Rack 3): Final Design

**Kelly Green Project (CSO Rack 3)**

*Weeks Street PCA*

SITE CONCEPT - A New Way to Work

**STREET VIEW**

*Alcon Waterways Remedial*

*Environmental Design Group*

GREEN FOR GRAY: CSO CONTROL USING GREEN INFRASTRUCTURE
Kelly (CSO Rack 3): Final Design

Kelly Avenue PCA
SITE CONCEPT - Catch Nature

STREET VIEW
Kelly (CSO Rack 3): Final Design

- 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
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
Section Existing

GREEN FOR GRAY: CSO CONTROL USING GREEN INFRASTRUCTURE
Balance of Green + Complete

Opportunities
- Less utility conflicts
- Majority of stormwater collection on most cost effective side of street
- Less conflicts for trash pickup
- Single dedicated bike lane uphill
- Less on-street parking loss
- Opportunity to plant trees that won’t conflict with utility lines
- Excellent traffic calming impact

Constraints
- Reduced paved roadway area creates greater chance of conflict between vehicles and GI improvements
- Bike lane only in one direction
- Some eastern trees affected

<table>
<thead>
<tr>
<th>Project</th>
<th>Total Capital <em>pv</em></th>
<th>O&amp;M <em>pv</em></th>
<th>Total Project <em>pv</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5 MG Storage Basin</td>
<td>$20.3M</td>
<td>$2M</td>
<td>$22.3M</td>
</tr>
<tr>
<td>All GI and Upsized Underflow</td>
<td>$13.1M</td>
<td>$4.2M</td>
<td>$17.3M</td>
</tr>
<tr>
<td>Upsized Underflow and Some GI</td>
<td>$5.4M</td>
<td>$1.1M</td>
<td>$6.5M</td>
</tr>
<tr>
<td>Complete Sewer Separation</td>
<td>$35.7M</td>
<td>$1M</td>
<td>$36.7M</td>
</tr>
</tbody>
</table>