

## Green and Gray Stormwater Infrastructure



CONSERVATION DESIGN FORUM



## Green vs Gray Economic Factors

- Construction Cost
- Maintenance/Longevity
- Site Utilization
- Marketing/Aesthetics

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## BMP Impacts on Cost

BMP	Construction Cost	Site Utilization	Marketing/Aesthetics	Maintenance/Longevity
Green Roof	-	+	+	+
Permeable Pavers	0/-	+	+	+
Bioretention	+/-	+	+	0
Native Landscapes	+	0	+	+
Natural Drainage	+	-	0	0

+ Positive Impact, - Negative Impact

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## Ann Arbor Municipal Center



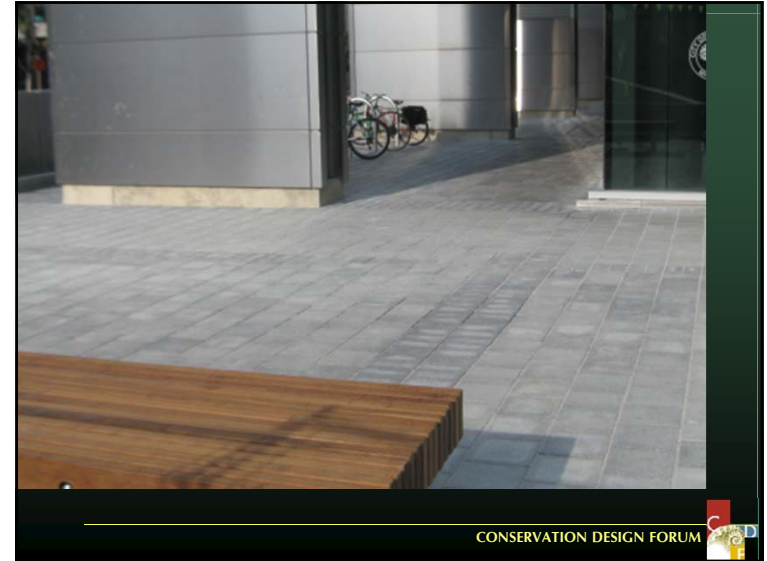
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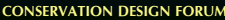




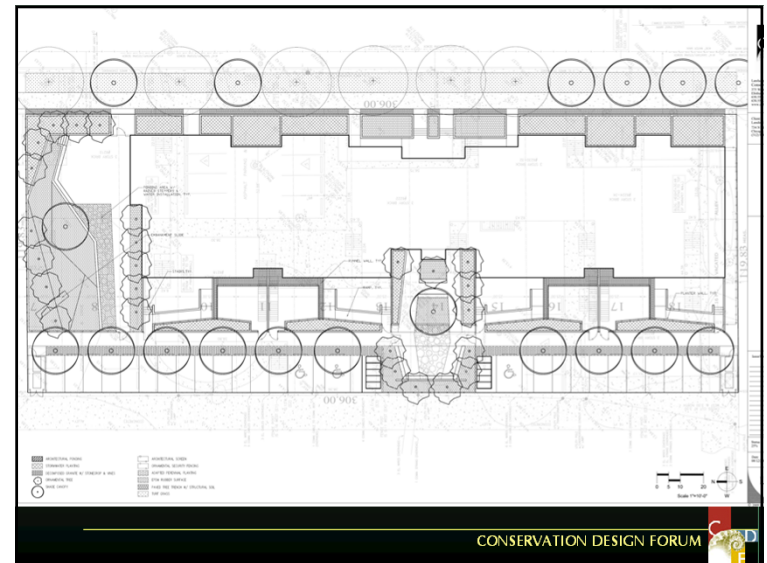
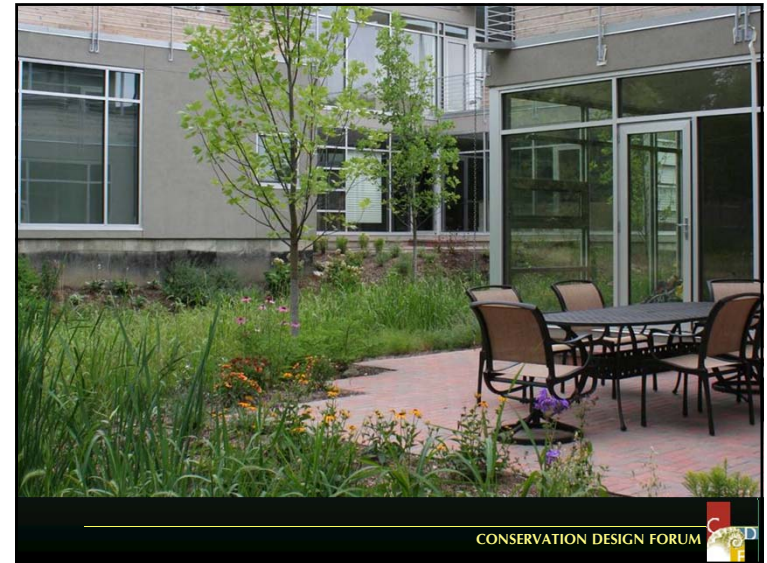
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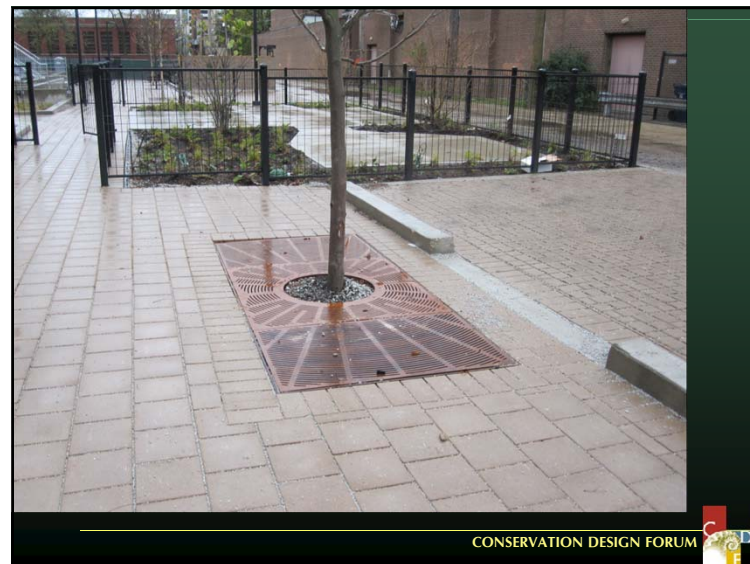
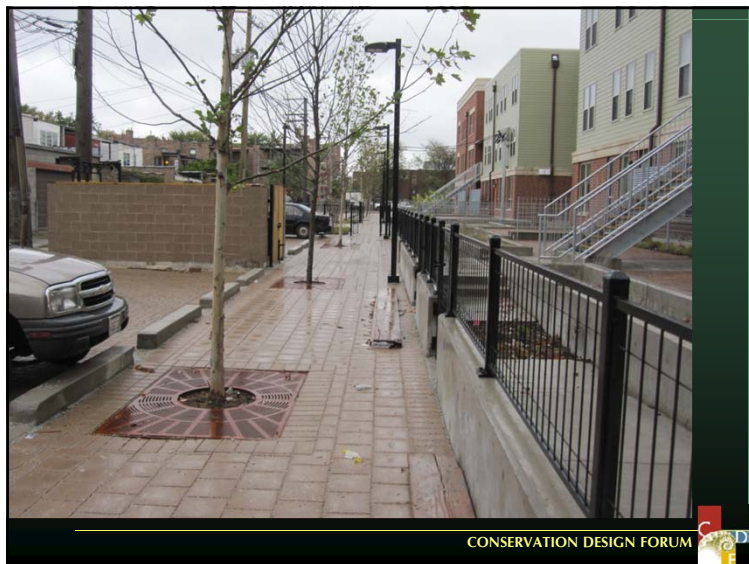
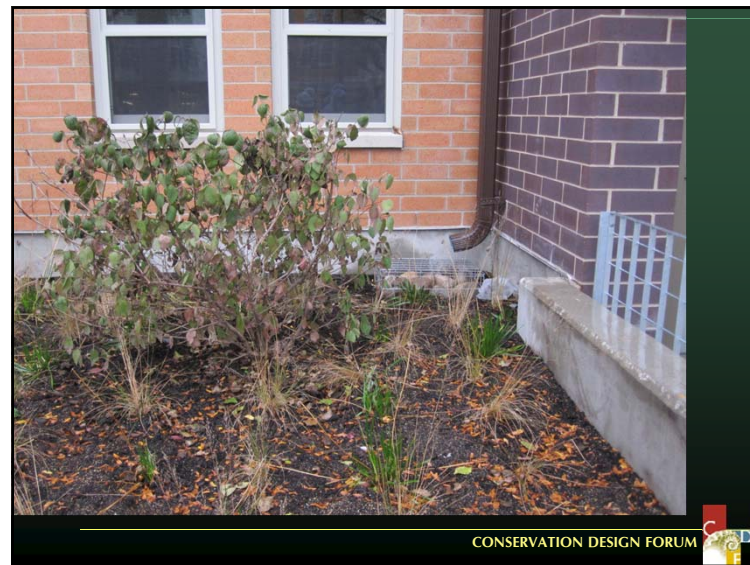
















## Changing Cost Perceptions: An Analysis of Conservation Development

### The Costs of Low Impact Development (LID) vs. Conventional Development

Tom Price, PE

Director, Water Resource  
Engineering

Conservation Design  
Forum



Prepared for: Chicago Wilderness

Prepared by: Conservation Research Institute &  
Conservation Design Forum

## Changing Cost Perception: An Analysis of Conservation Development

- Sponsored by Chicago Wilderness
- Advisory Committee composed of local practitioners
- Analysis by Conservation Research Institute and Conservation Design Forum

### Advisory Group Included:

- Local Government
- Developers
- Design Consultants
- Federal, State and Regional Agencies
- Environmental Organizations

### Three Study Components

- Literature Review
- Built Site Case Studies
- Hypothetical Design Templates

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- Literature Review
- Built Site Case Studies**
- Hypothetical Design Templates

### Built-Sites Cost Analysis - Limitations

- Actual costs, but indirect comparisons
- Data types and assumptions vary
  - Data obtained from multiple sources
  - Cost categories vary from site to site

### Built-Sites Cost Analysis

#### Separate Site Comparison

- Mill Creek vs. Sunset Prairie (residential)

#### Same Site Comparison (actual LID vs hypothetical conventional)

- Bielinski Homes Developments (residential)
- Prairie Crossing (residential)
- Tellabs Corporate Campus (commercial/industrial)
- Street Edge Alternatives (SEA) Street (residential retrofit)

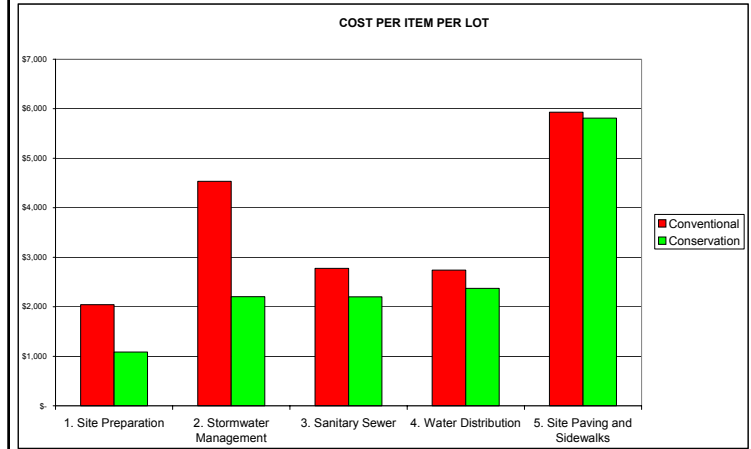


### Mill Creek vs. Sunset Prairie



### Mill Creek vs Sunset Prairie

Conventional \$937,000 (\$18,000/lot) / Conservation \$902,000 (\$14,000/lot)

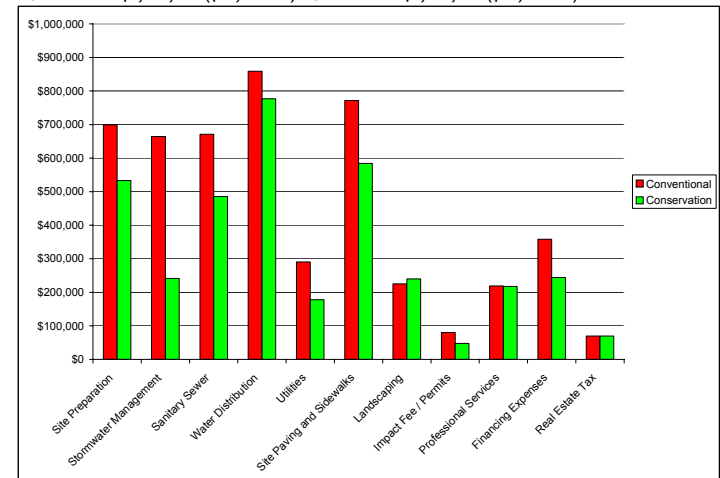


### Bielinski Homes Developments - Auburn Hills



### Auburn Hills

Conventional \$4,907,000 (\$36,700/lot) / Conservation \$3,618,000 (\$27,000/lot)

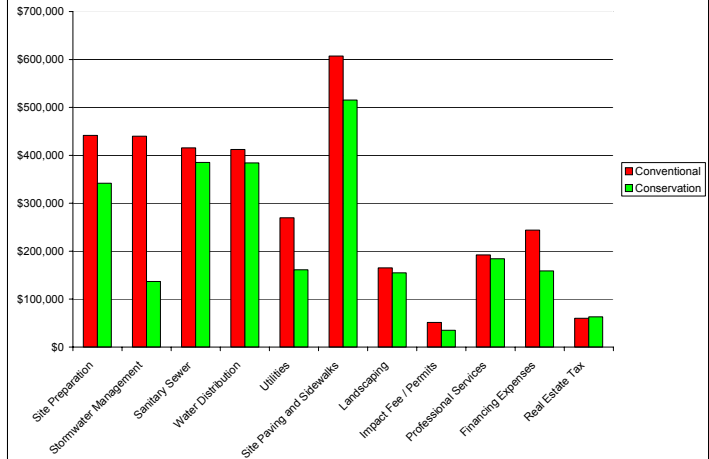


### Bielinski Homes Developments - Laurel Springs



### Laurel Springs

Conventional \$3,300,000 (\$27,000/lot) / Conservation \$2,522,000 (\$20,700/lot)



### Prairie Crossing





## Prairie Crossing

SAVINGS	ITEM	Savings Per Item	Savings Percentage
NET SAVINGS	Reduced Road Width <sup>1</sup>	\$ 178,000	12.9%
	Curb and Gutter <sup>2</sup>	\$ 339,000	24.7%
	Sidewalk <sup>3</sup>	\$ 648,000	47.1%
	Storm Sewer <sup>4</sup>	\$ 210,000	15.3%
TOTAL SAVINGS		\$ 1,375,000	100.0%
	Total Savings Per Lot	\$ 3,798	
	Total Savings Per Acre	\$ 2,028	
LANDSCAPING SAVINGS From Prairie (Conservation) v.s. Turf (Conventional)	Year One per acre	\$ 4,695	27.6%
	Year Two per acre	\$ 2,275	13.4%
	Year Three per acre	\$ 2,015	11.8%
	Year Four per acre	\$ 5,365	31.5%
	Year Five per acre	\$ 2,680	15.7%
TOTAL SAVINGS	Average Savings Per Year Per Acre	\$ 3,406	100.0%
	Total Prairie Landscaping Savings Per Year	\$ 572,889.2	

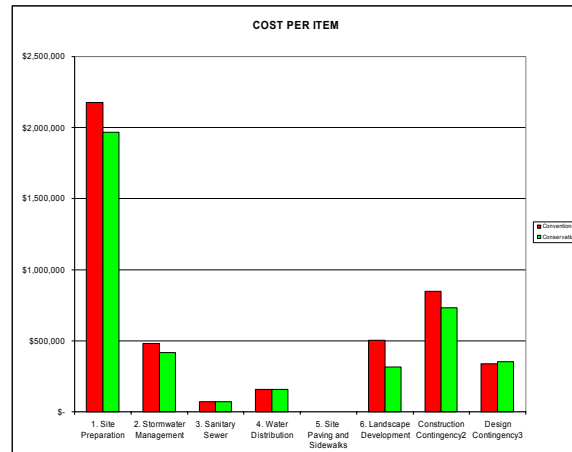
Adapted from: Building Green

## Tellabs Corporate Campus



## Tellabs

Conventional \$4,576,000 (\$10/sf) / Conservation \$4,012,000 (\$8/sf)

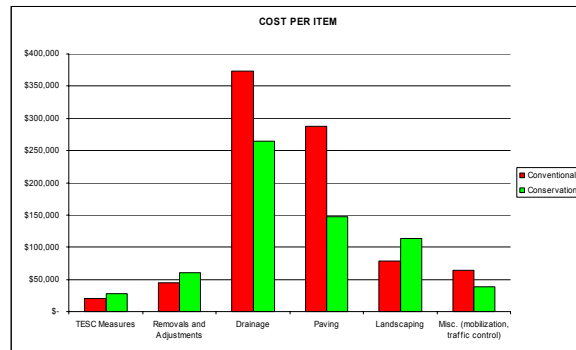


## Street Edge Alternatives (SEA) Street



**SEA Street**

Conventional \$868,802 / Conservation \$651,549

**Built-Sites Cost Analysis - Conclusions**

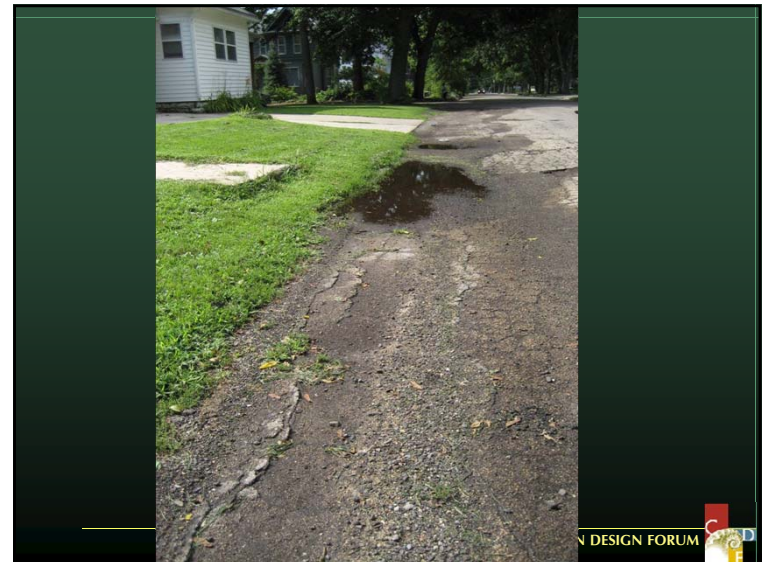
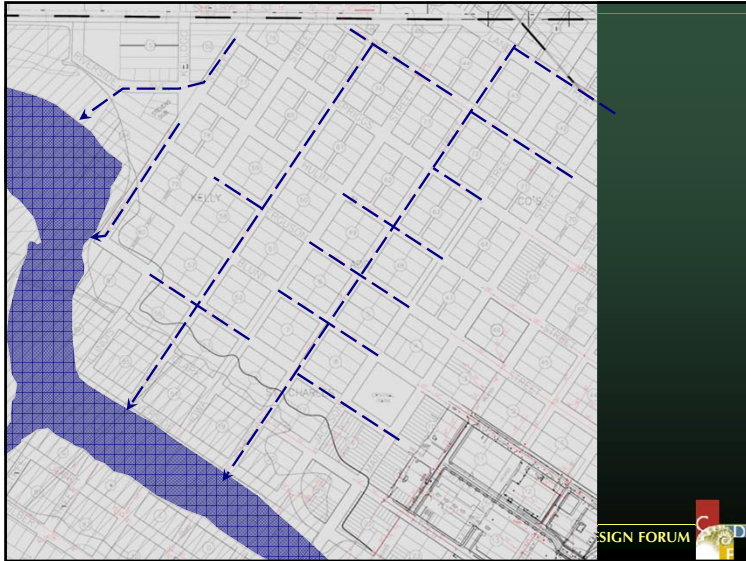
- LID development 20% to 30% less than conventional (for these examples)
- No relationship found between development density or type and cost savings
- Greatest cost savings in stormwater management & site preparation (due to cluster)
- Site paving also large cost saver (due to clustering)
- Increasingly intense clustering results in increasingly greater cost savings
- Additional potential savings due to reduced maintenance costs
- Higher revenues due to higher housing values (additional open space)

**Charles City Permeable Streets**

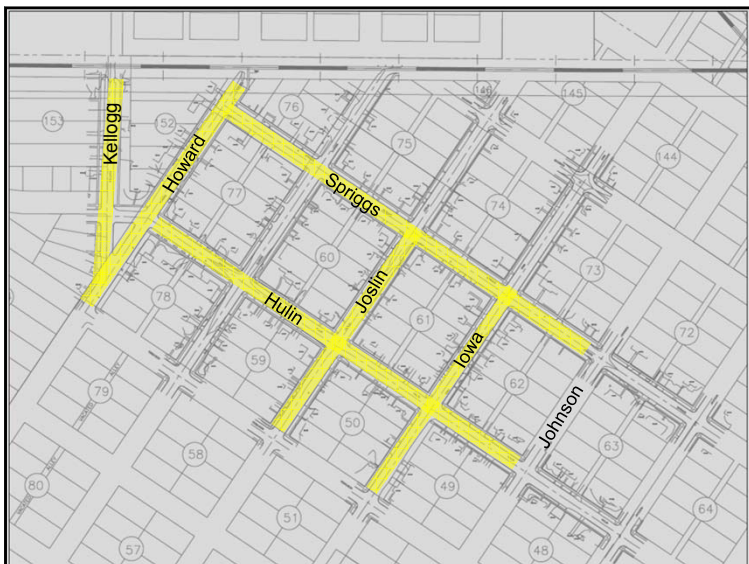
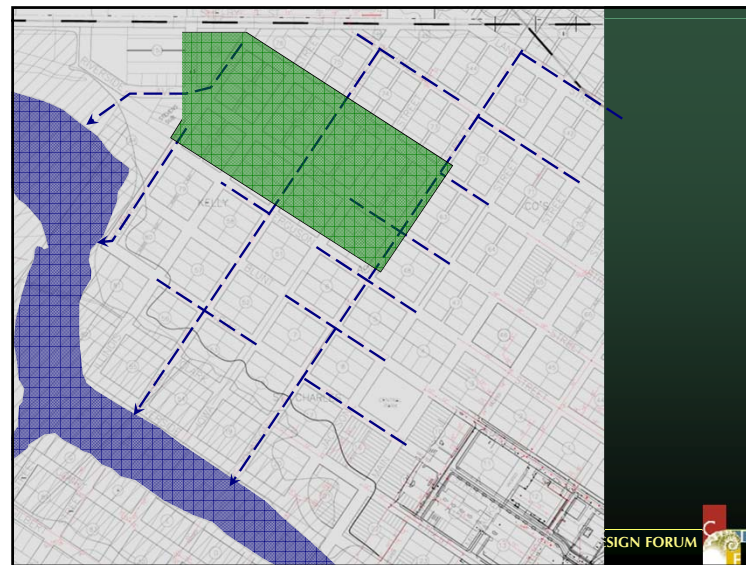
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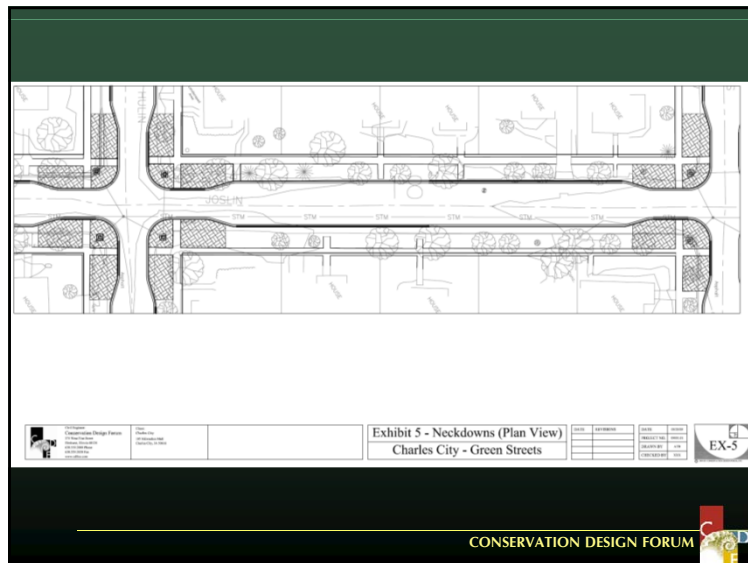
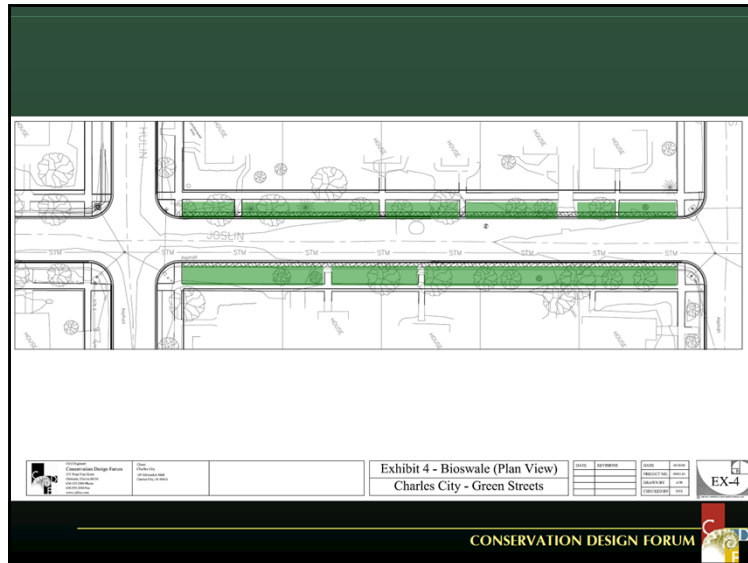




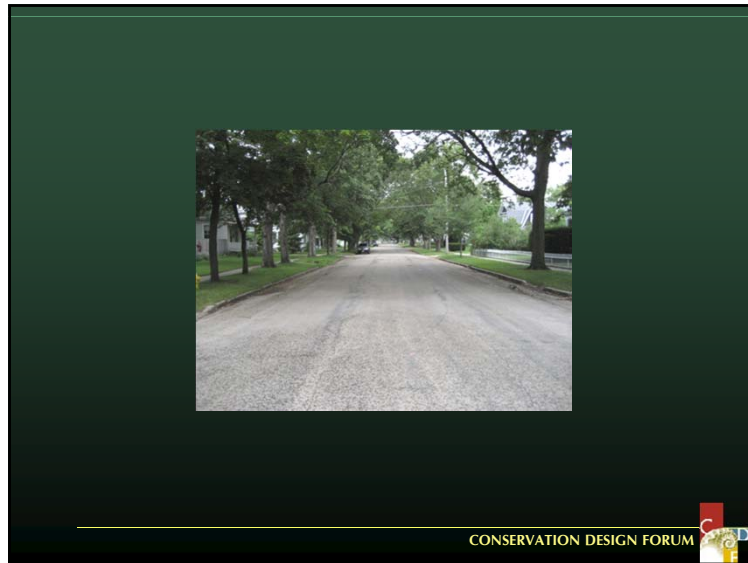


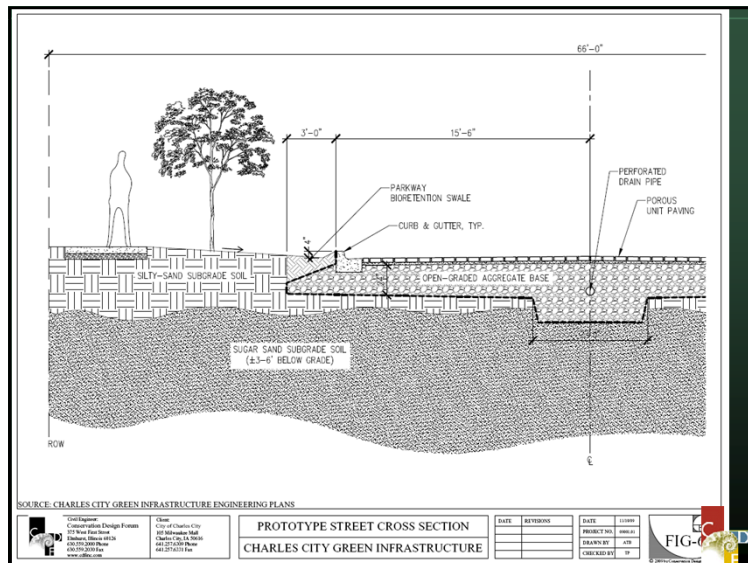
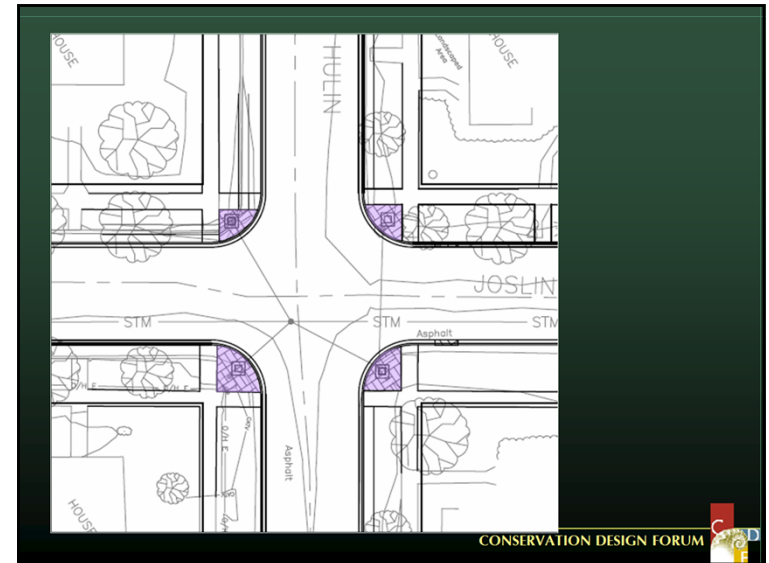
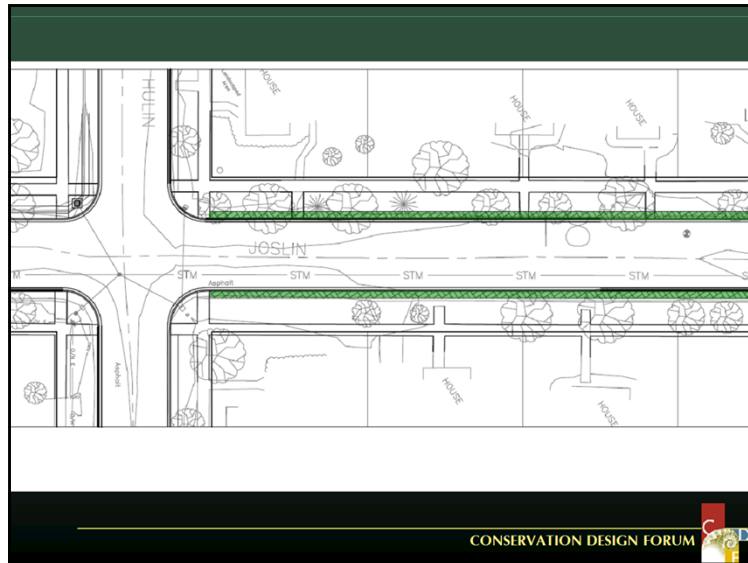








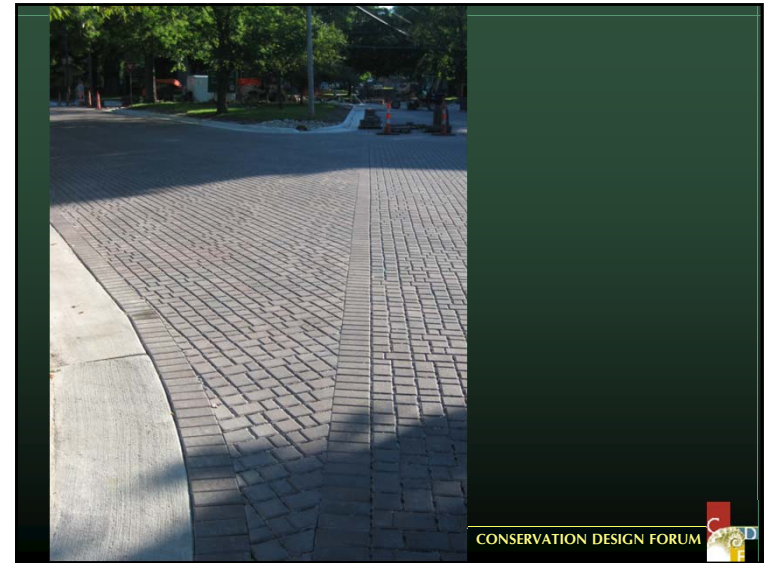












**TABLE 2: PROTOTYPE MODEL RESULTS**

	Rainfall*	Existing	Proposed	% Reduction
<b>6-Month Event</b>				
Runoff volume (inches)*	1.91	0.28	0	100%
Runoff Rate (cfs)**	-	0.59	0	100%
<b>1-Year Event</b>				
Runoff volume (inches)*	2.36	0.45	0	100%
Runoff Rate (cfs)**	-	0.79	0	100%
<b>2-Year Event</b>				
Runoff volume (inches)*	2.98	0.75	0	100%
Runoff Rate (cfs)**	-	1.1	0	100%
<b>10-Year Event</b>				
Runoff volume (inches)*	4.38	1.59	0.59	63%
Runoff Rate (cfs)**	-	1.7	0.12	93%
<b>100-Year Event</b>				
Runoff volume (inches)*	7.07	3.6	2.46	32%
Runoff Rate (cfs)**	-	3.3	2.2	33%

\* Based on 24-hour rainfall  
 \*\* Based on critical duration storm

## Project Costs

- Remove & replace existing pavement & curbs
  - 17 City Blocks
  - 112,000 square feet
- Excavation
- Gravel Base
- Permeable Paving
- Water main & services
- Sanitary sewer services
- \$3.7M construction cost
- \$3.9M construction, engineering, fees

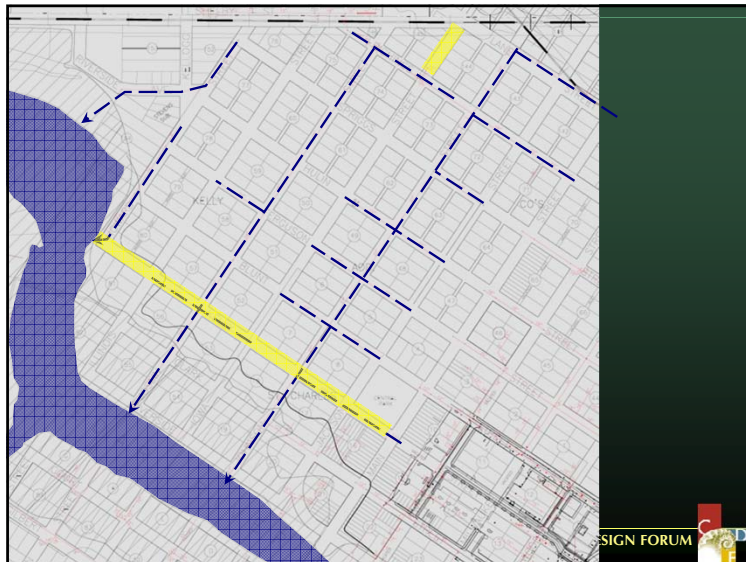
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## Funding/Financing

- Financing Costs
  - Legal/admin \$3,300
  - Grant application assistance \$5,000
- Funding sources
  - ARRA - \$631,000
  - I-Jobs - \$100,000
  - SRF - \$2.32M (20% forgivable)
  - Water Utility - \$589,000
  - Wastewater utility - \$278,000

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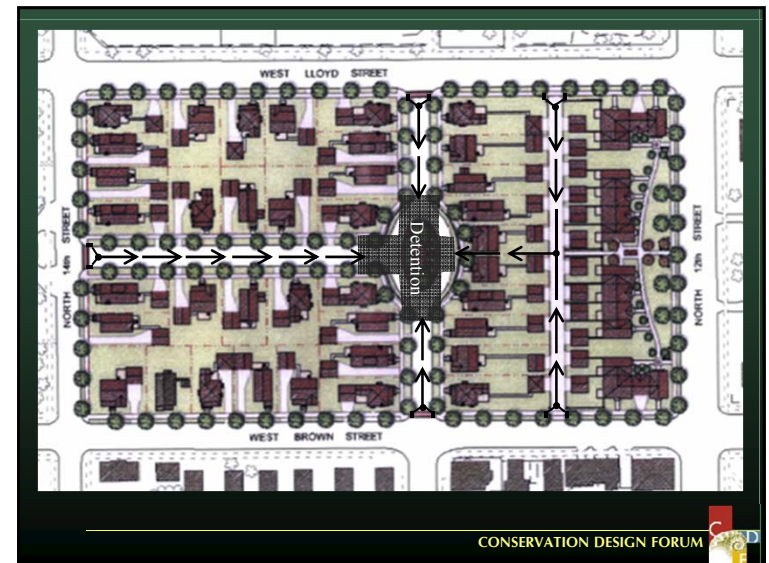
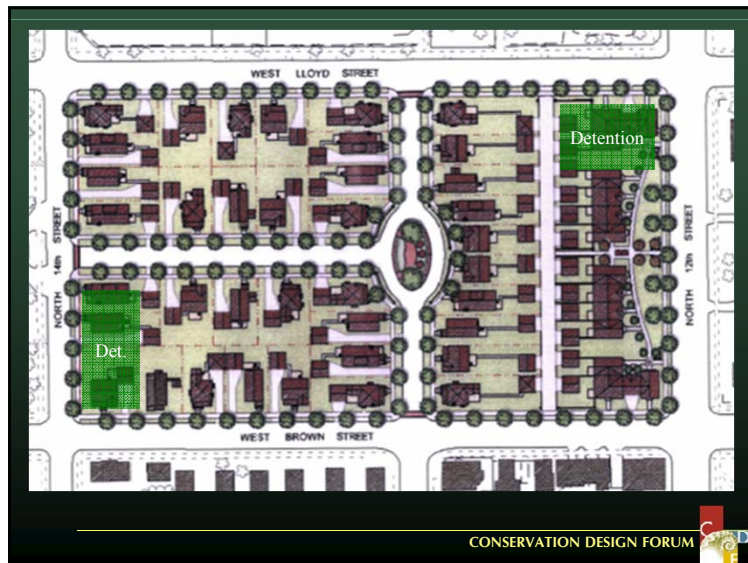


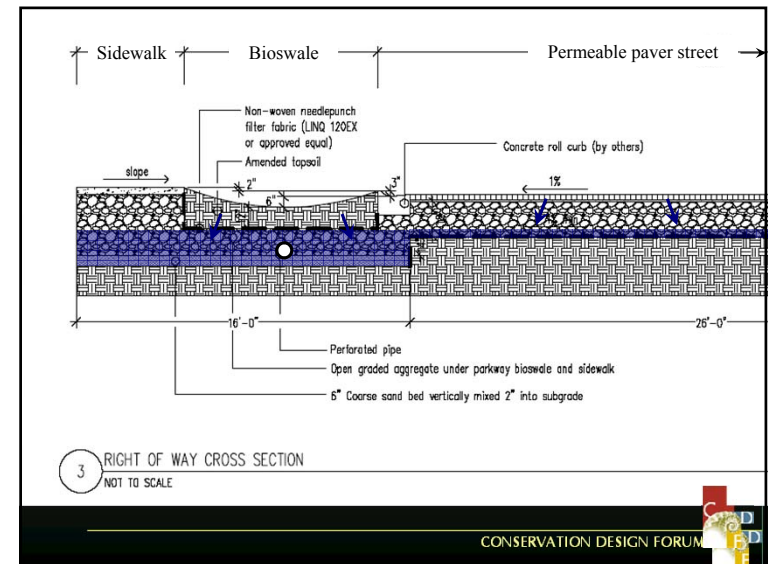
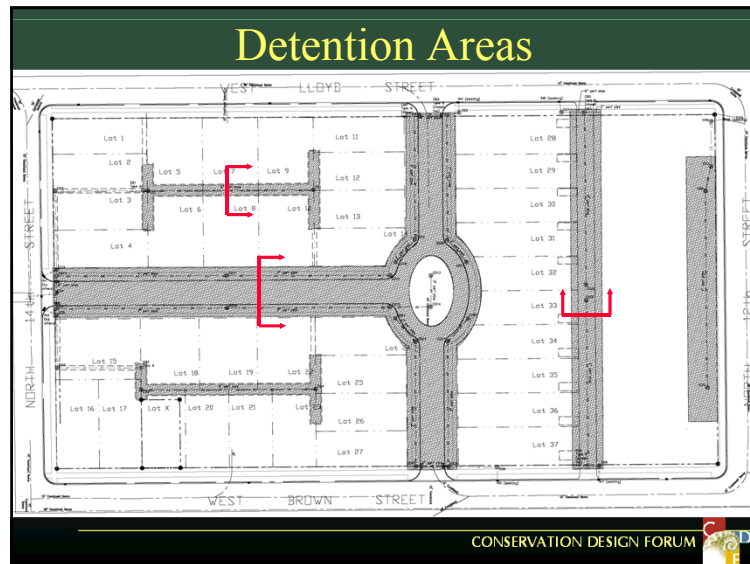
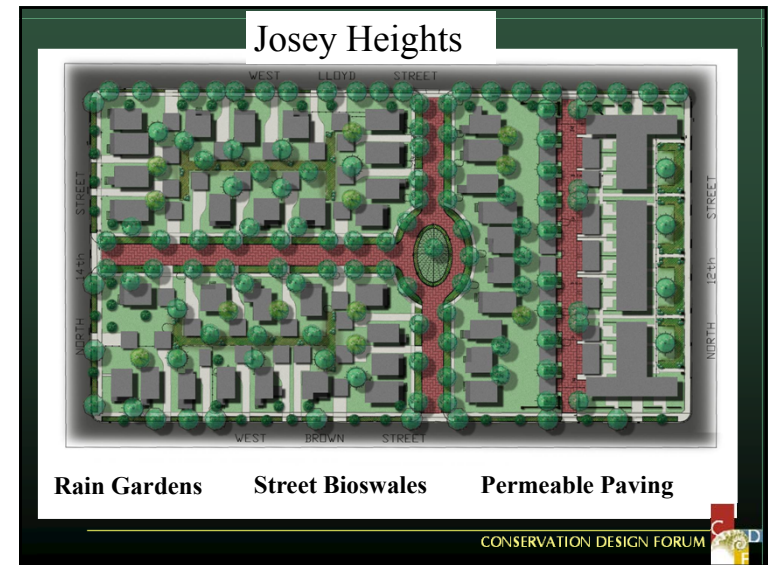
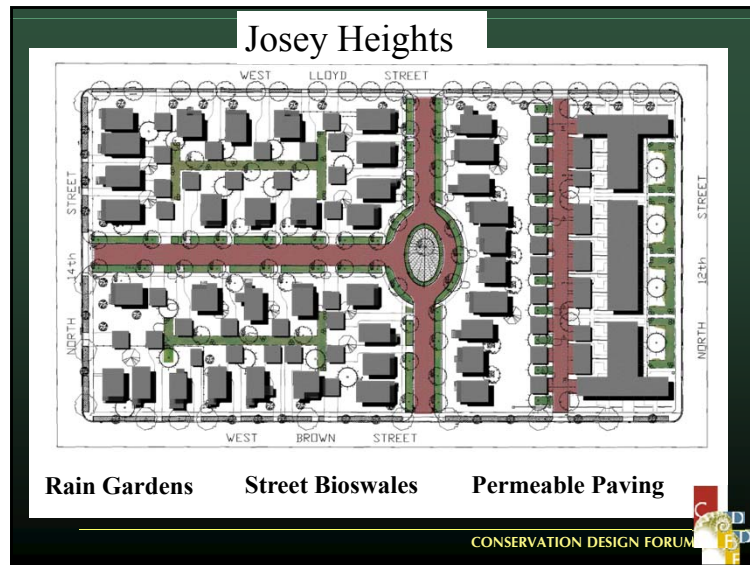
### Josey Heights Milwaukee, WI

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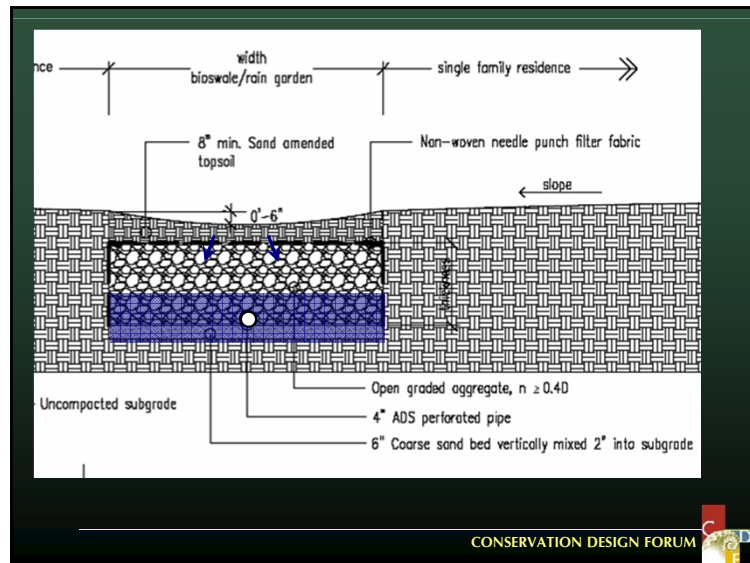










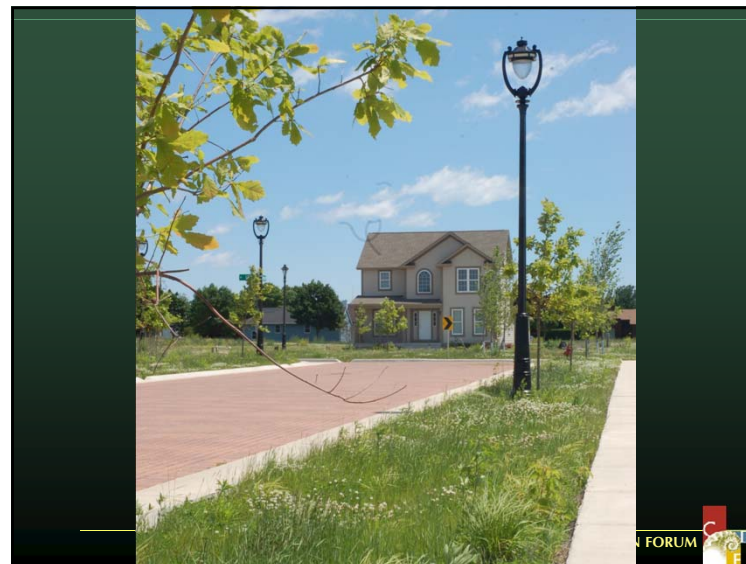
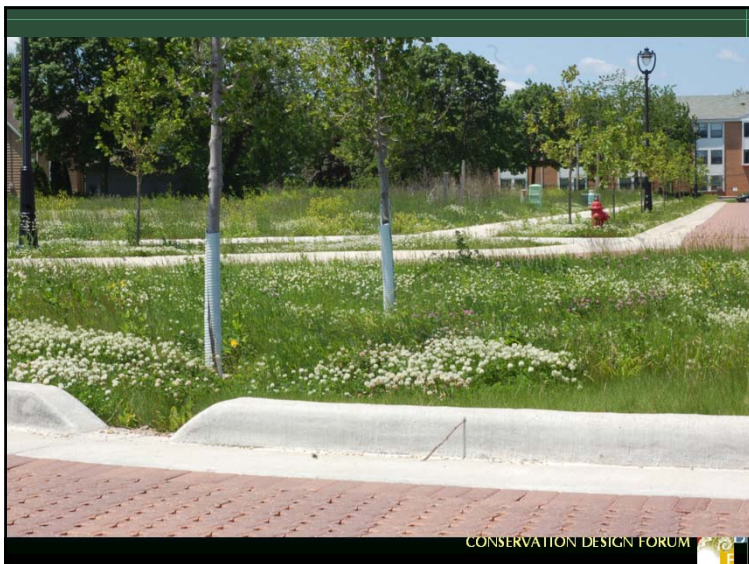
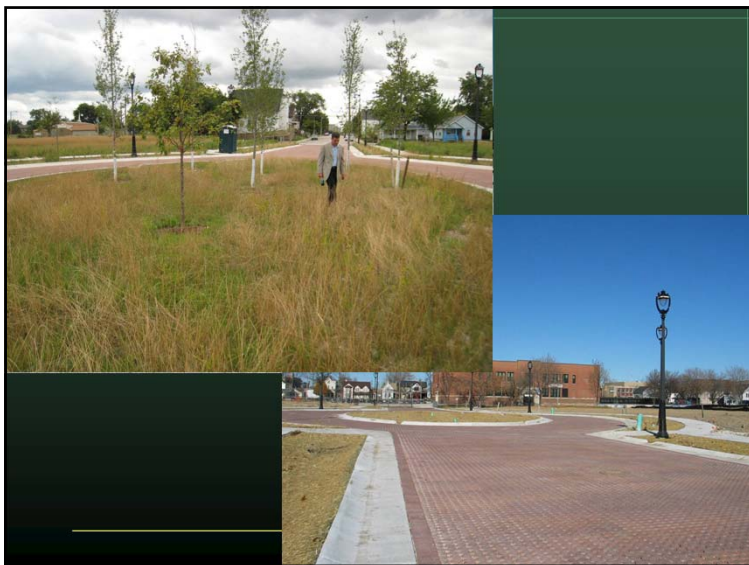


## Estimated Project Performance

Event	24-hour Rainfall	Existing Conditions	Proposed w/o Detention	Proposed w/ Detention
2-yr Flow	-	1.6 cfs	8.0	1.4 cfs
100-yr Flow	-	9.1 cfs	26.1	5.7 cfs
2-yr VDP		4.3 cfs-hrs		4.3 cfs-hrs
100-yr VDP		20.9 cfs-hrs		20.8 cfs-hrs
2-yr Runoff	2.57"	0.65"	1.30"	0.46**
100-yr Runoff	5.88"	3.08"	4.29"	3.13**

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### Josey Heights Stormwater System - Conventional System

Stormwater Tools	Treatment Area	Run Red.	Approximate Cost/AF
Underground Vault	Site	0.0	\$392,000
Storm sewer system	Site	0.0	\$114,000
Technology BMP (VortSentry)	Site	0.0	\$48,000
<b>Notes:</b>		0.0	\$554,000

- 1) Underground vault to be located under pavement with manhole access
- 2) Storm sewer system serves streets and backyards
- 4) Stormwater system designed to meet Chapters 13 and 120 stormwater s
- 6) Impervious surfaces require approximately 0.12 and 0.29 ac-ft/acre
- 7) Pervious surface require approximately 0.0 and 0.06 ac-ft/acre to m
- 9) Approximate cost provided for comparison only, should not be used f

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## Carol Stream Recreation Center



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### Josey Heights Stormwater System - Alternative 2

Stormwater Tools	Treatment Area	Run Red. (Ac-ft)	Approximate Cost
Permeable street	Street	0.12	\$68,000
10' wide parkway bioswale	1/2 yard, roof, & drive	0.19	\$173,000
10' wide neighborhood Rain Garden	1/2 yard & roof	0.04	\$46,000
Permeable alleyway	Roof Ridge to Roof Ridge	0.06	\$75,000
Townhome rain garden	Roof Ridge to 12th St.	0.02	\$19,000
		0.43	\$381,000

#### Notes:

- 1) Cost for permeable paving is cost premium over asphalt
- 2) Aggregate is continuous under street permeable paving and parkway bioswale
- 3) Parkway bioswale occurs along interior streets and along Lloyd, Brown, and 14th streets
- 4) Aggregate under alley permeable paving is continuous from garage face to garage face
- 4) Stormwater system designed to meet Chapters 13 and 120 stormwater standards for entire site.
- 6) Impervious surfaces require approximately 0.12 and 0.29 ac-ft/acre to meet 2-yr & 100-yr release
- 7) Pervious surface require approximately 0.0 and 0.06 ac-ft/acre to meet 2-yr and 100-yr release r
- 8) All sizes approximate and assume no infiltration (conservative) and aggregate porosity = 0.40
- 9) Approximate cost provided for comparison only, should not be used for budgeting

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## Life Cycle Cost Analysis

Carol Stream Park District Recreation Center  
Porous Unit Paving Parking Lot Life Cycle Cost Analysis

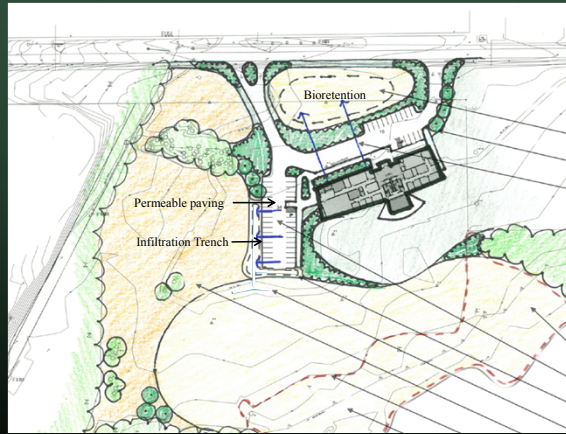
Porous Unit Paving				Hot-Mix Asphalt Paving (+ additional bioretention)			
Year	Item	Cost	Cumulative Cost	Notes	Item	Cost	Cumulative Cost
1	Installation	\$338,415	\$338,415	Engineer's estimate	Installation	\$287,515	\$287,515
3	Stripping	\$1,809	\$340,224	Engineer's estimate	Crack Filling, Seal Coating, Stripping	\$15,587	\$274,099
5	Stripping & Clearing	\$17,139	\$357,363	Engineer's estimate	Minor Patching, Crack Filling, Seal Coating, Stripping	\$31,914	\$306,013
7	Stripping	\$1,809	\$359,172	Engineer's estimate	Crack Filling, Seal Coating, Stripping	\$15,587	\$322,600
9	Stripping & Clearing	\$17,139	\$376,311	Engineer's estimate	Minor Patching, Crack Filling, Seal Coating, Stripping	\$47,243	\$369,843
11	Stripping	\$1,809	\$378,120	Engineer's estimate	Crack Filling, Seal Coating, Stripping	\$15,587	\$385,430
13	Stripping & Clearing	\$17,139	\$395,259	Engineer's estimate	Minor Patching, Crack Filling, Seal Coating, Stripping	\$62,573	\$448,003
15	Stripping	\$1,809	\$397,068	Engineer's estimate	Mill & Overlay, Minor Patching, Stripping	\$130,088	\$578,091
17	Stripping & Clearing	\$17,139	\$414,207	Engineer's estimate	Crack Filling, Seal Coating, Stripping	\$15,587	\$593,678
19	Stripping	\$1,809	\$416,016	Engineer's estimate	Minor Patching, Crack Filling, Seal Coating, Stripping	\$31,914	\$625,592
21	Stripping & Clearing	\$17,139	\$433,215	Engineer's estimate	Crack Filling, Seal Coating, Stripping	\$15,587	\$641,179
23	Stripping	\$1,809	\$435,024	Engineer's estimate	Minor Patching, Crack Filling, Seal Coating, Stripping	\$47,243	\$688,422
25	Stripping & Clearing	\$17,139	\$452,163	Engineer's estimate	Crack Filling, Seal Coating, Stripping	\$15,587	\$703,009
27	Stripping	\$1,809	\$453,972	Engineer's estimate	Minor Patching, Crack Filling, Seal Coating, Stripping	\$62,573	\$765,582
29	Stripping & Clearing	\$17,139	\$471,111	Engineer's estimate	Mill & Overlay, Minor Patching, Stripping	\$130,088	\$895,670
31	Stripping	\$1,809	\$472,920	Engineer's estimate	Crack Filling, Seal Coating, Stripping	\$15,587	\$911,257
33	Stripping & Clearing	\$17,139	\$490,059	Engineer's estimate	Minor Patching, Crack Filling, Seal Coating, Stripping	\$31,914	\$943,171
35	Stripping	\$1,809	\$491,868	Engineer's estimate	Crack Filling, Seal Coating, Stripping	\$15,587	\$958,758
37	Stripping & Clearing	\$17,139	\$509,007	Engineer's estimate	Minor Patching, Crack Filling, Seal Coating, Stripping	\$47,243	\$1,006,001
39	Stripping	\$1,809	\$510,816	Engineer's estimate	Crack Filling, Seal Coating, Stripping	\$15,587	\$1,021,588
41	Stripping & Clearing	\$17,139	\$527,955	Engineer's estimate	Minor Patching, Crack Filling, Seal Coating, Stripping	\$62,573	\$1,084,161
43	Stripping	\$1,809	\$529,764	Engineer's estimate	Mill & Overlay, Minor Patching, Stripping	\$130,088	\$1,214,249
45	Stripping & Clearing	\$17,139	\$546,903	Engineer's estimate	Crack Filling, Seal Coating, Stripping	\$15,587	\$1,230,836
47	Stripping	\$1,809	\$548,712	Engineer's estimate	Minor Patching, Crack Filling, Seal Coating, Stripping	\$31,914	\$1,262,750
49	Stripping & Clearing	\$17,139	\$565,851	Engineer's estimate	Crack Filling, Seal Coating, Stripping	\$15,587	\$1,278,337
51	Stripping	\$1,809	\$567,660	Engineer's estimate	Minor Patching, Crack Filling, Seal Coating, Stripping	\$47,243	\$1,325,580
53	Stripping & Clearing	\$17,139	\$584,799	Engineer's estimate	Crack Filling, Seal Coating, Stripping	\$15,587	\$1,341,167
55	Stripping	\$1,809	\$586,608	Engineer's estimate	Minor Patching, Crack Filling, Seal Coating, Stripping	\$62,573	\$1,403,740
57	Stripping & Clearing	\$17,139	\$603,747	Engineer's estimate	Mill & Overlay, Minor Patching, Stripping	\$130,088	\$1,533,828

#### Notes

- 1 Maintenance schedules taken from Morton Arboretum Main Parking Lots Seminar, November 18, 2004, prepared by Hanscomb Faithful & Gould.
- 2 Additional Benefits for porous unit paving include: water quality improvements such as reduced thermal, metals, hydrocarbons, and chloride loadings, reduced

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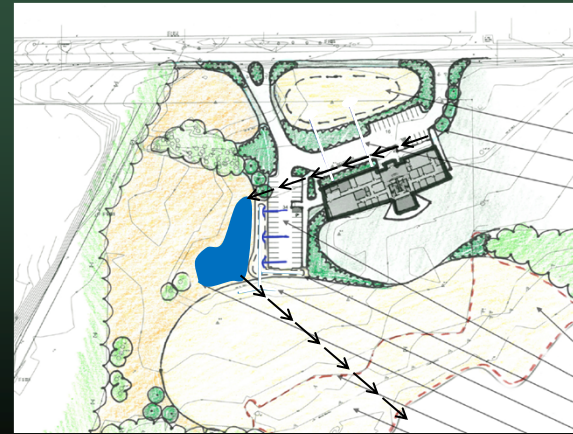
## Fox River Water Reclamation District



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## Fox River Water Reclamation District



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## FRWRD Cost Comparison

### Gray Infrastructure

- Asphalt Paving
- Storm sewer
- Detention
- Wetland permitting
- \$153,000

### Green Infrastructure

- Permeable paving
- Bioretention
- \$140,000

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