



Urban Stormwater BMP Performance and Cost-Effectiveness in the Capitol Region Watershed District

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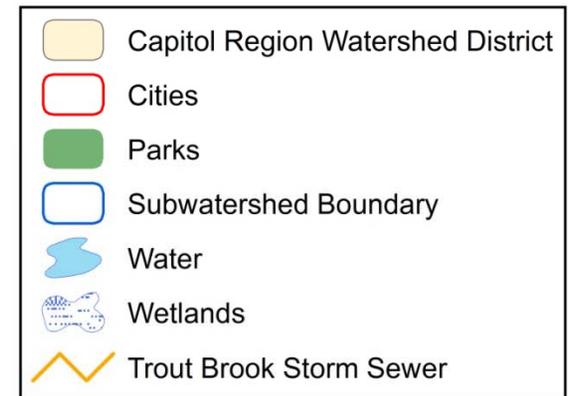
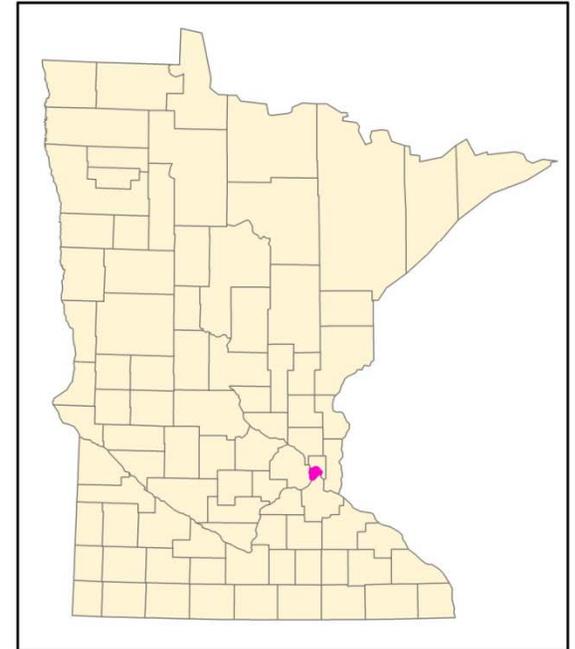
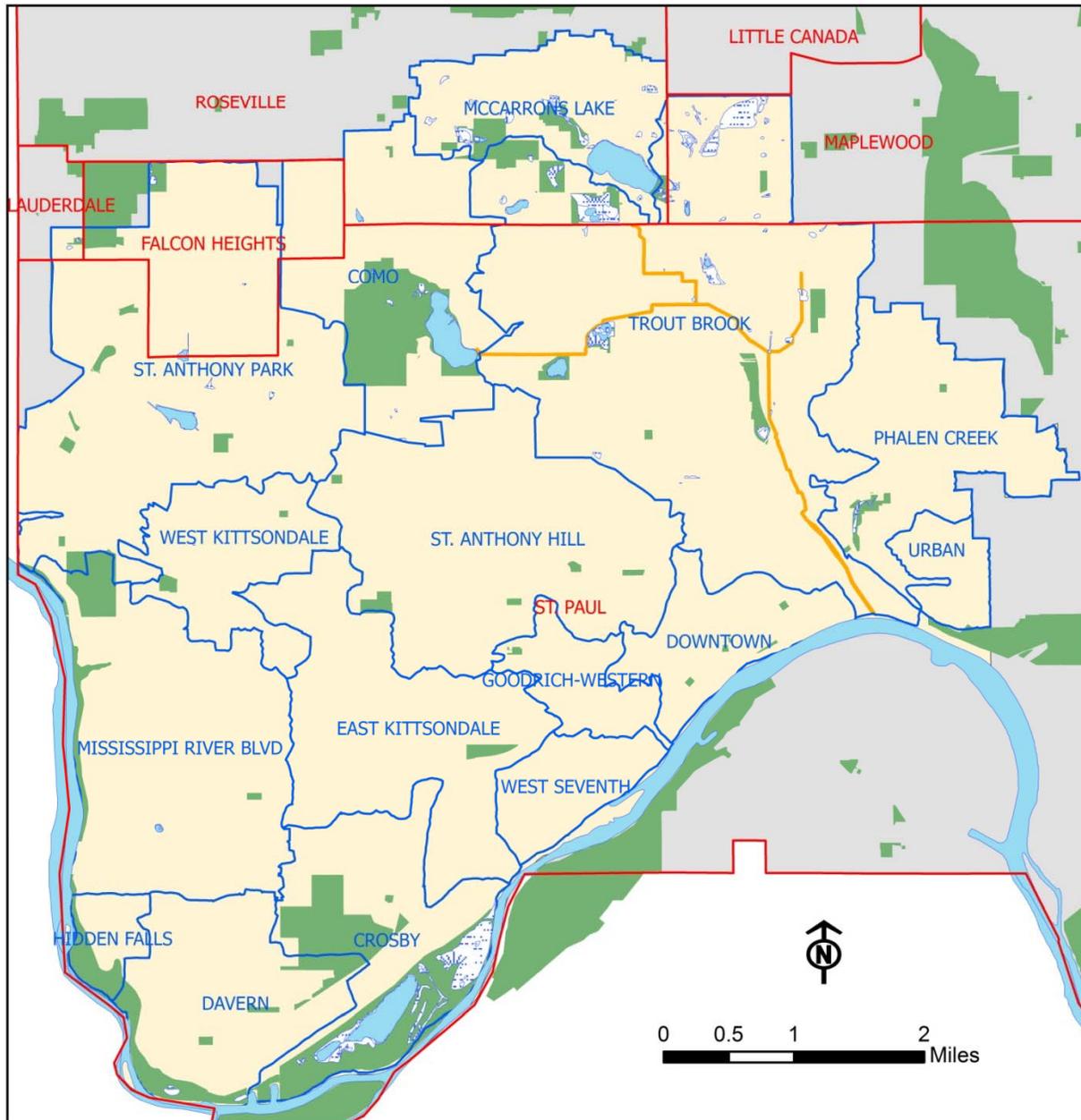
Outline

- Background
- Model Results
- Operation and Maintenance (O & M) Results
- Cost-Benefit Analysis Results
- Conclusions

Capitol Region Watershed District

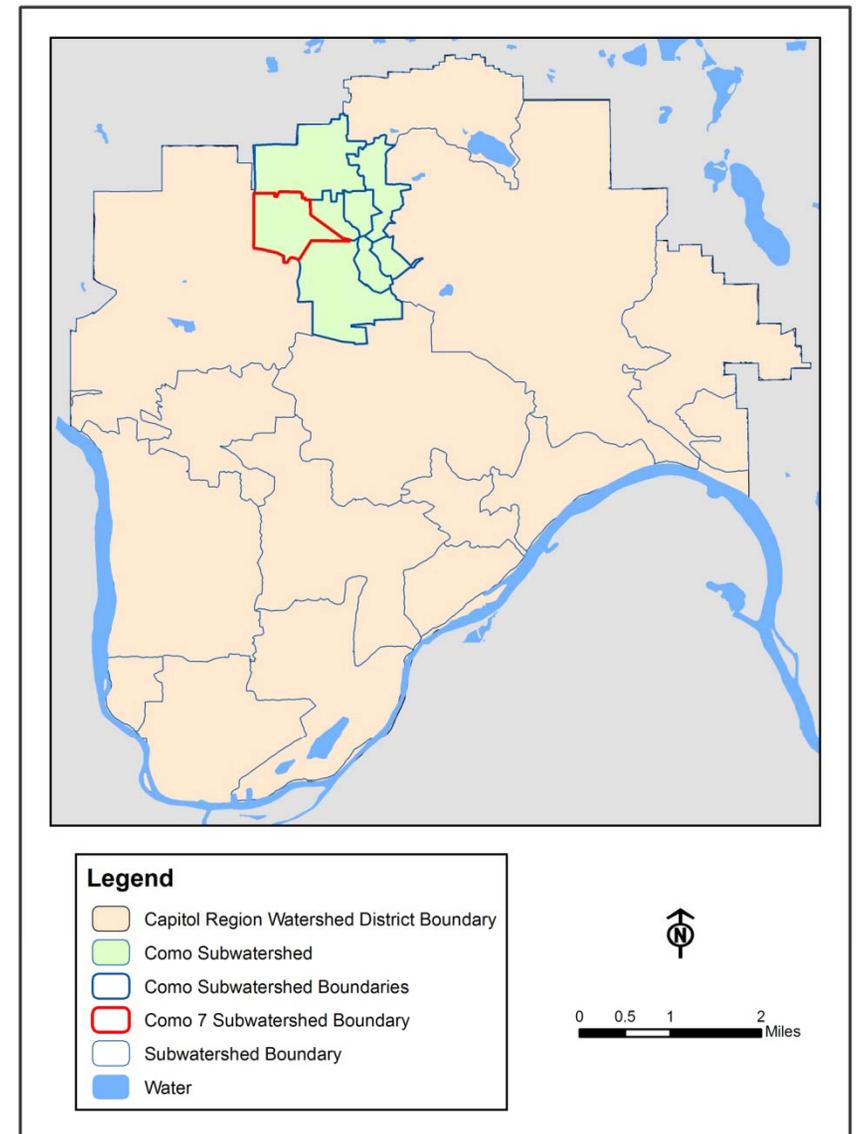
- 41 Square Miles
- Portions of 5 Cities
- Population: 245,000
- 42% Impervious Surfaces
- All Runoff Ultimately Flows to the Mississippi River





Arlington Pascal Stormwater Improvement Project

- Multi-Jurisdictional Project in the Como 7 Subwatershed
- Goals:
 - Reduce Flooding
 - Address Storm Sewer Improvements
 - Improve Water Quality of Como Lake
 - Determine Equitable Distribution of Costs



Arlington Pascal Stormwater Improvement Project

- Original Project Cost: \$2.5 Million

- 60" Storm Sewer Pipe
- No Water Quality Benefits

- Final Project Cost: \$2.0 Million

- 18 Stormwater BMPs

*Costs do not include bond interest

- **Final Total Project Capital Cost: \$2.7 Million**

*Total Capital Cost = Design + Construction + Bond Interest

Stormwater BMPs Constructed

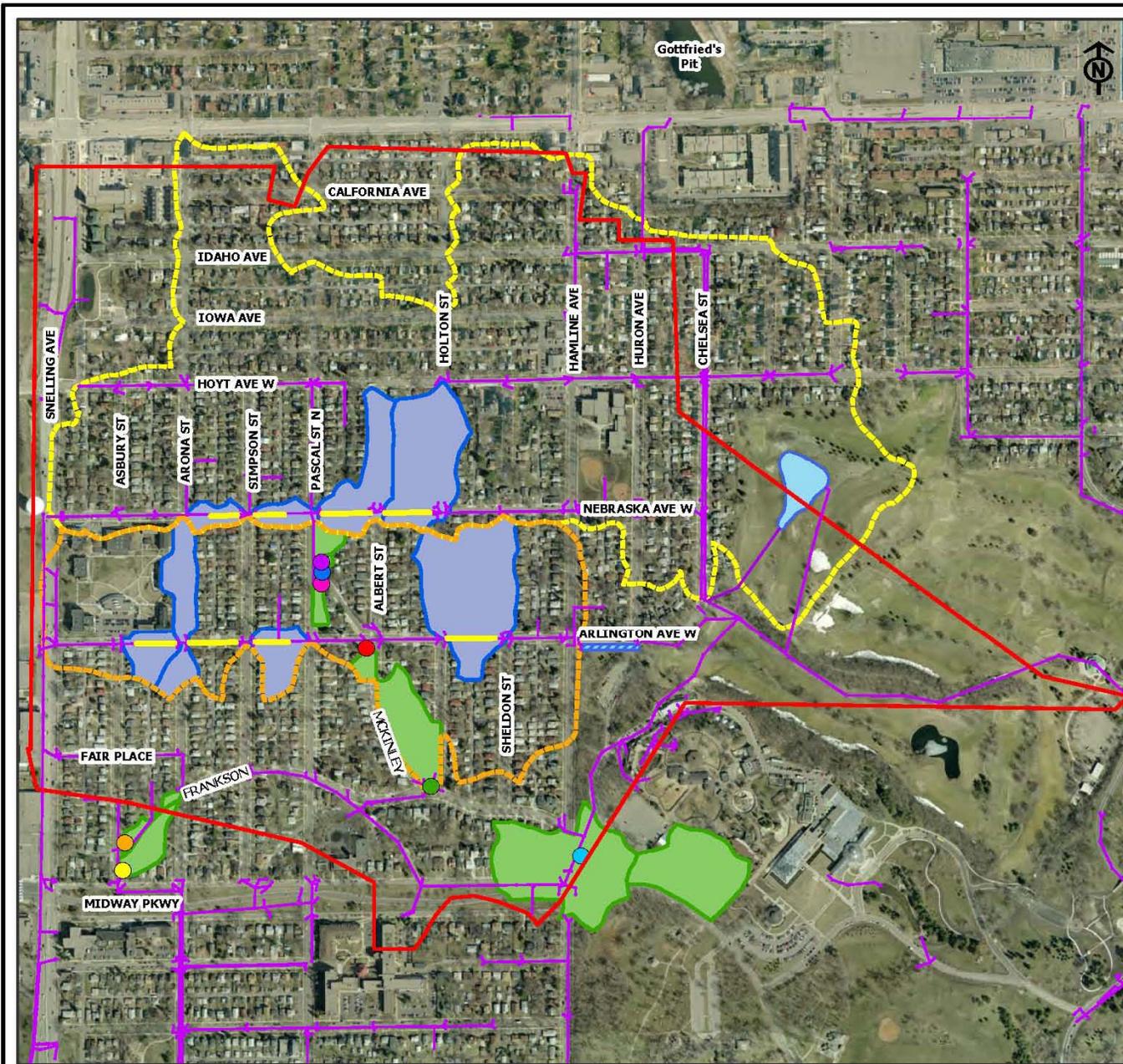
- Underground Stormwater Storage and Infiltration System (Arlington-Hamline Facility)
- Regional Stormwater Pond (Como Park Regional Pond)
- 8 Underground Infiltration Trenches
- 8 Rain Gardens



Stormwater BMPs

- Treatment Train of BMPs
- Total Drainage Area: 190 Acres
- Combined Storage Area: 141,553 ft²
- Combined Storage Volume: 444,390 cf





Legend

- Como 7 Subwatershed Boundary
- Storm Sewer

BMP

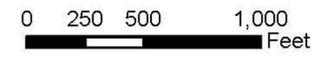
- Arlington-Hamline Facility
- Como Park Regional Pond
- Infiltration Trench

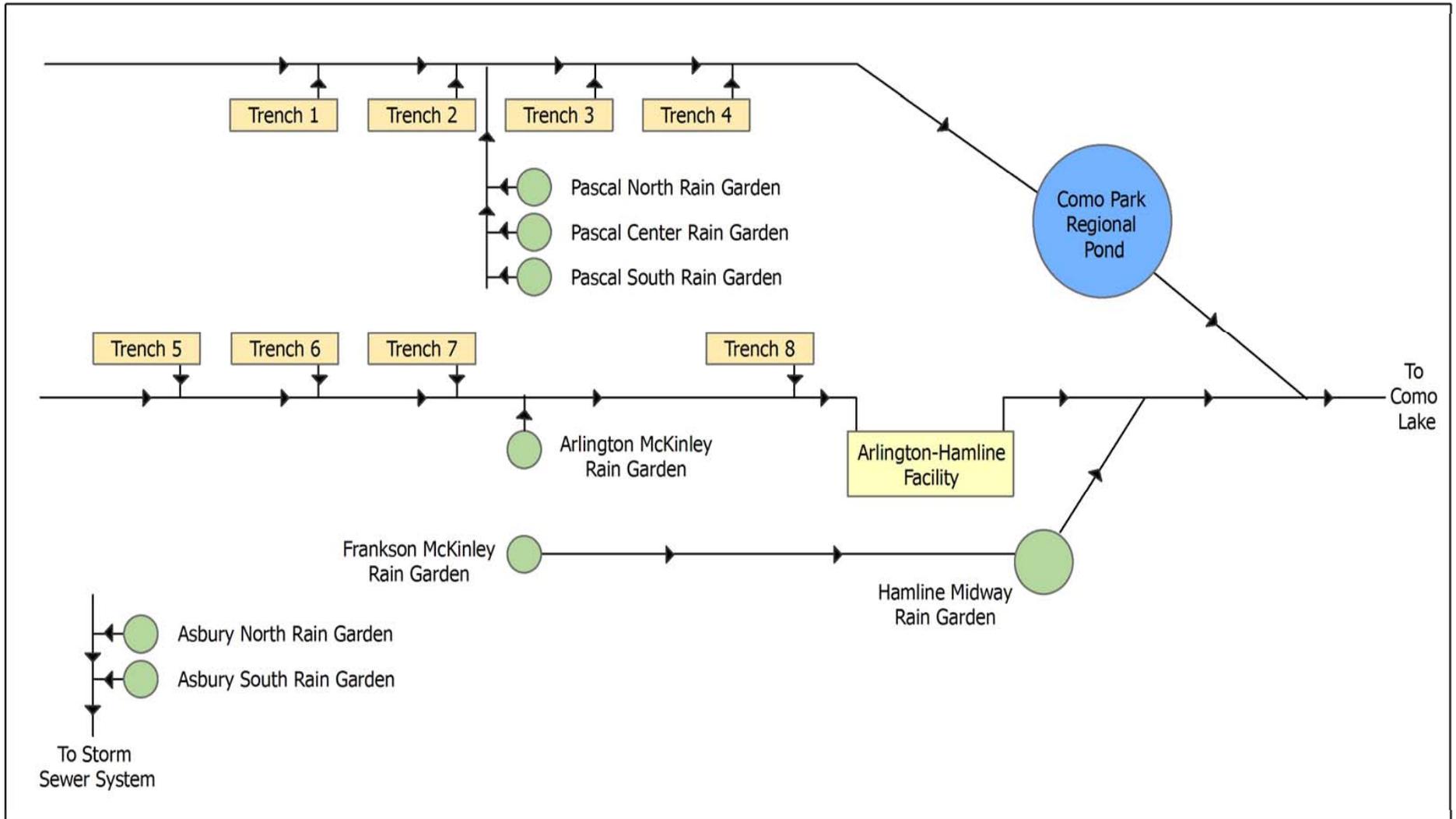
Rain Garden

- Arlington - McKinley
- Asbury North
- Asbury South
- Frankson - McKinley
- Hamline Midway
- Pascal Center
- Pascal North
- Pascal South

Drainage Area

- Arlington-Hamline Facility
- Como Park Regional Pond
- Rain Gardens
- Infiltration Trenches





BMP Stormwater Monitoring

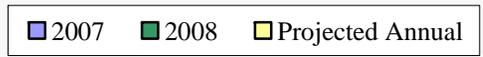
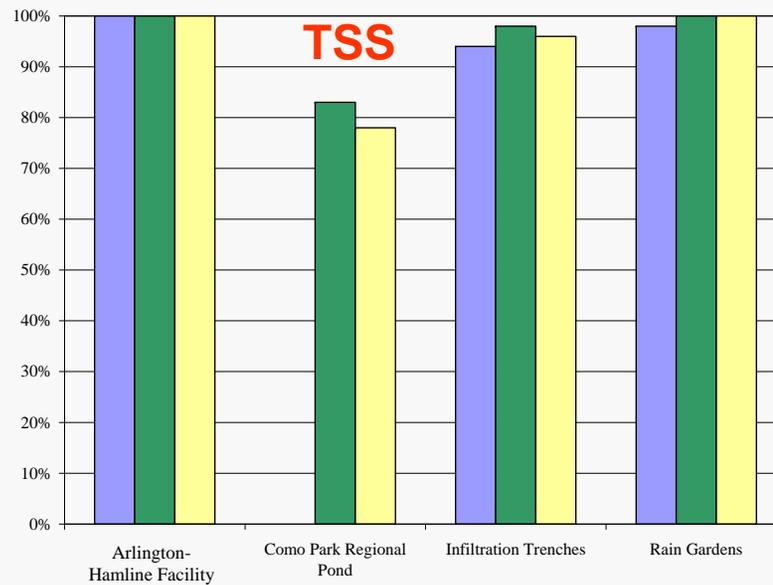
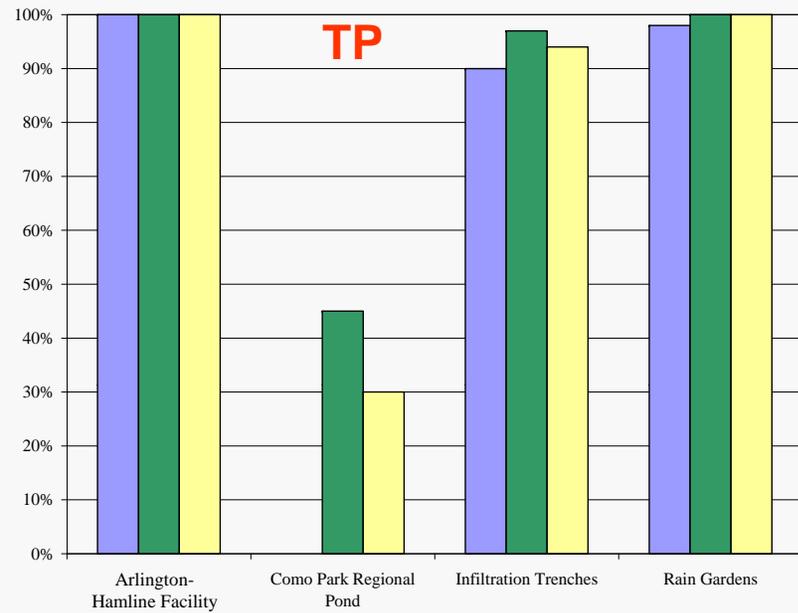
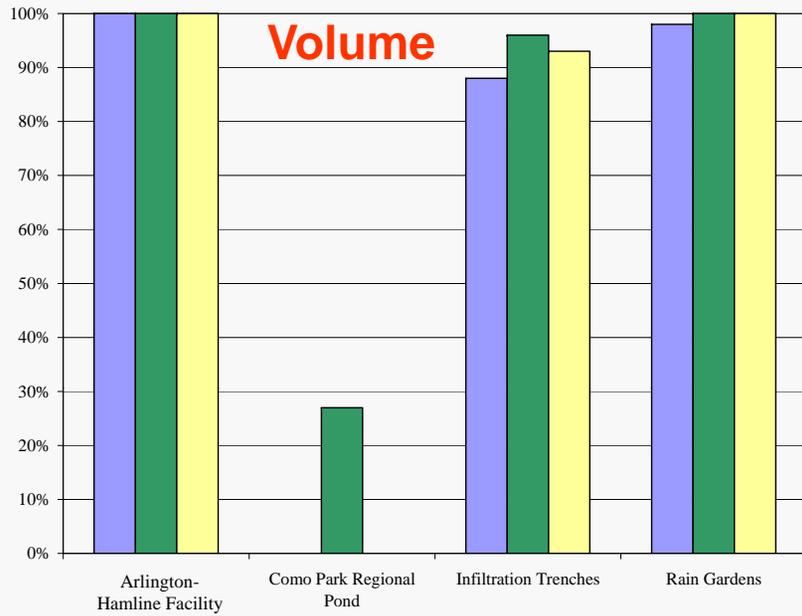


- **2007 & 2008**
 - Arlington-Hamline Facility
 - 2 Infiltration Trenches (Trenches 4 and 5)
 - 8 Rain Gardens
 - Como Park Regional Pond (2008 Only)

P8 Model

- Simulated the Performance of Each BMP over an Entire Year
 - Total Discharge and TP and TSS Loads
- Calibrated Using Actual Precipitation Data and 2008 BMP Monitoring Data
- Annual Results for 2007, 2008, and an Average Precipitation Year (Projected Annual)

Removal Efficiencies



Total Solids Removal Results

		Arlington-Hamline Facility	Como Park Regional Pond	Infiltration Trenches	Rain Gardens
Subwatershed Area (acres)		50	128	23	16
2007	Rainfall (in)	29.72	29.72	29.72	29.72
	Total Solids Load Removed (lbs)	70,142	NA	76,991	53,014
	Total TSS Load Removed: BMP	16,420	NA	6,605	3,089
	Settleable Solids Removed: BMP	28,130	NA	NA	49,925
	Settleable Solids Removed: Pretreatment Units	25,592	NA	70,386	NA
2008	Rainfall (in)	21.67	21.67	21.67	21.67
	Total Solids Load Removed (lbs)	48,159	197,932	39,144	26,122
	Total TSS Load Removed: BMP	5,869	30,175	4,158	1,305
	Settleable Solids Removed: BMP	28,130	167,757	NA	24,817
	Settleable Solids Removed: Pretreatment Units	14,160	NA	34,986	NA
Projected Annual	Rainfall (in)	26.02	26.02	26.02	26.02
	Total Solids Load Removed (lbs)	51,110	210,434	39,767	26,597
	Total TSS Load Removed: BMP	8,820	42,677	4,781	1,780
	Settleable Solids Removed: BMP	28,130	167,757	NA	24,817
	Settleable Solids Removed: Pretreatment Units	14,160	NA	34,986	NA

BMP Operation and Maintenance

2007 & 2008

- Arlington-Hamline Facility
 - Vortech[®] Unit
- 8 Infiltration Trenches
 - 30 Sumped Catch Basins
 - 16 Sumped Manholes
- 8 Rain Gardens
- Como Park Regional Pond (2008 Only)



Arlington-Hamline Facility

2007, 2008, and Projected Activities

- Pipe Gallery Inspections
- Vortech[®] Sediment Inspections
- Manhole Sediment Inspections
- Debris Removal From Vortech[®] Unit

Additional Projected Activities

- Debris Removal From Pipe Gallery



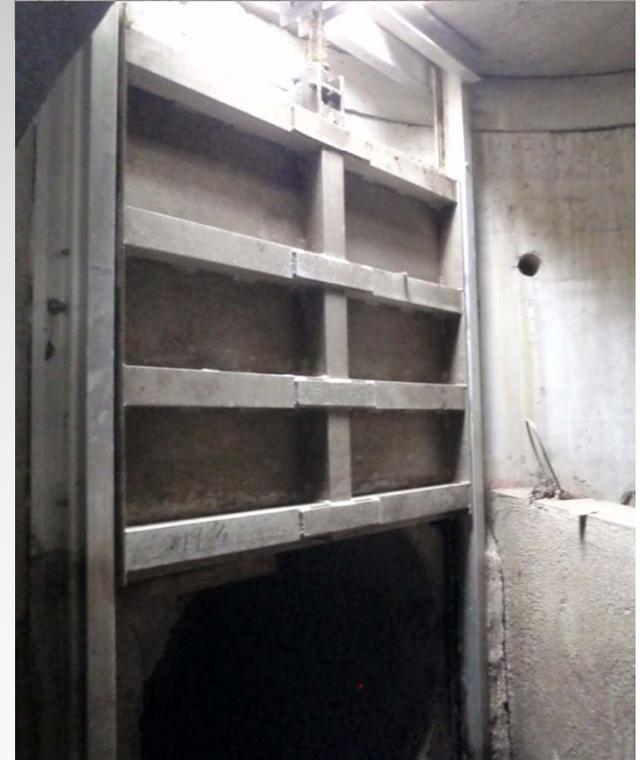
Como Park Regional Pond

2008 and Projected Activities

- Sluice Gate and Gate Valve Maintenance
- Debris Removal From Pond Perimeter and Outlet Structure
 - Completed by City of St. Paul

Additional Projected Activities

- Bathymetric Survey of Pond
- Debris Removal From Pond (Dredging)



Infiltration Trenches

2007, 2008, and

Projected Activities

- Manhole and Catch Basin Sediment Inspections
- Post-Rain Trench Infiltration Inspections
- Debris Removal From Sumped Catch Basins and Manholes

Additional Projected Activities

- Jet Out and Remove Debris Accumulated in Perforated Pipes



Rain Gardens

2007, 2008, and Projected Activities

- Monthly Inspections
- Post-Rain Inspections
- Maintenance
 - Mulching, Weeding, Mowing, Leaf Removal



Annual O & M: Costs & Hours

- Annual O & M Cost =
Total Cost of Labor + Equipment and Materials + Contract Services

	2007		2008		Projected Annual O & M Cost
	O & M Cost	Hours	O & M Cost	Hours	
Arlington-Hamline Facility	\$531	13	\$2,025	14	\$2,867
Como Park Regional Pond	NA	NA	\$6,558	78	\$4,550
Infiltration Trenches	\$5,509	138	\$12,405	88	\$12,339
Rain Gardens	\$14,851	640	\$7,544	406	\$5,803
APSIP Total:	\$20,891	791	\$28,532	585	\$25,559

Cost-Benefit Analysis

- Volume Reduction and Pollutant Removal Costs (\$/cf, \$/lb)
 - Annual Operating Cost / Volume or Pollutant Reduction

Reference Document:

A Public Works Perspective Regarding Cost vs. Benefit for Various Stormwater Best Management Practices (BMPs) Utilized to Manage Stormwater

(Minnesota Public Works Association, 2007)

Annual Capital Costs

- Total Capital Cost Amortized Over 35 Years

	2007	2008	Projected Annual
Arlington-Hamline Facility	\$24,605	\$24,605	\$24,605
Como Park Regional Pond	NA	\$38,981	\$38,981
Infiltration Trenches	\$11,430	\$11,430	\$11,430
Rain Gardens	\$4,578	\$4,578	\$4,578
APSIP Total:	\$40,614	\$79,595	\$79,595

*Total Capital Cost = Construction + Design + Bond Interest

Annual Operating Costs

- Sum of Annual O & M Cost and Annual Capital Cost

	2007	2008	Projected Annual
Arlington-Hamline Facility	\$25,136	\$26,630	\$27,473
Como Park Regional Pond	NA	\$45,539	\$43,531
Infiltration Trenches	\$16,939	\$23,835	\$23,769
Rain Gardens	\$19,429	\$12,122	\$10,381
APSIP Costs:	\$61,505	\$108,127	\$105,154

Volume Reduction and Pollutant Removal Costs

- **Volume Reduction Costs** = Annual Operating Cost (\$) / Volume Reduction (cf)
- **Pollutant Removal Costs** = Annual Operating Cost (\$) / TP or Total Solids Load Removed (lbs)

		Arlington- Hamline Facility	Como Park Regional Pond	Infiltration Trenches	Rain Gardens
Annual Operating Cost	2007	\$25,136	NA	\$16,939	\$19,429
	2008	\$26,630	\$45,539	\$23,835	\$12,122
	Projected	\$27,473	\$43,531	\$23,769	\$10,381
TP Removal Cost (\$/lb)	2007	\$1,007	NA	\$1,126	\$3,494
	2008	\$2,517	\$888	\$2,221	\$4,329
	Projected	\$1,828	\$714	\$1,909	\$2,791
Total Solids Removal Cost ^a (\$/lb)	2007	\$0.36	NA	\$0.22	\$0.37
	2008	\$0.55	\$0.23	\$0.61	\$0.46
	Projected	\$0.54	\$0.21	\$0.60	\$0.39
Volume Reduction Cost (\$/cf)	2007	\$0.03	NA	\$0.02	\$0.06
	2008	\$0.07	\$0.02	\$0.03	\$0.07
	Projected	\$0.05	NA	\$0.03	\$0.04

Conclusions

- BMP monitoring is important
- BMPs are performing as or better than expected
- Properly **designed**, **constructed**, and **maintained** BMPs are exhibiting high removal efficiencies
- Pond had the lowest removal costs, however, scale is important
- Pretreatment units are very beneficial
- Few studies which have this type of comprehensive analysis
- Continue research

Questions

Stormwater BMP Performance Assessment and Cost-Benefit Analysis

Report is available online at:

www.capitolregionwd.org

