Targeted Water Reuse for Irrigaton

Developing a Stormwater Reuse Irrigation Assessment Planning Tool to Reduce Reliance on Groundwater

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RICE CREEK WATERSHED DISTRICT

Rachel Olm, Drew Kessler, Mark Deutschman

HOUSTON ENGINEERING, INC.

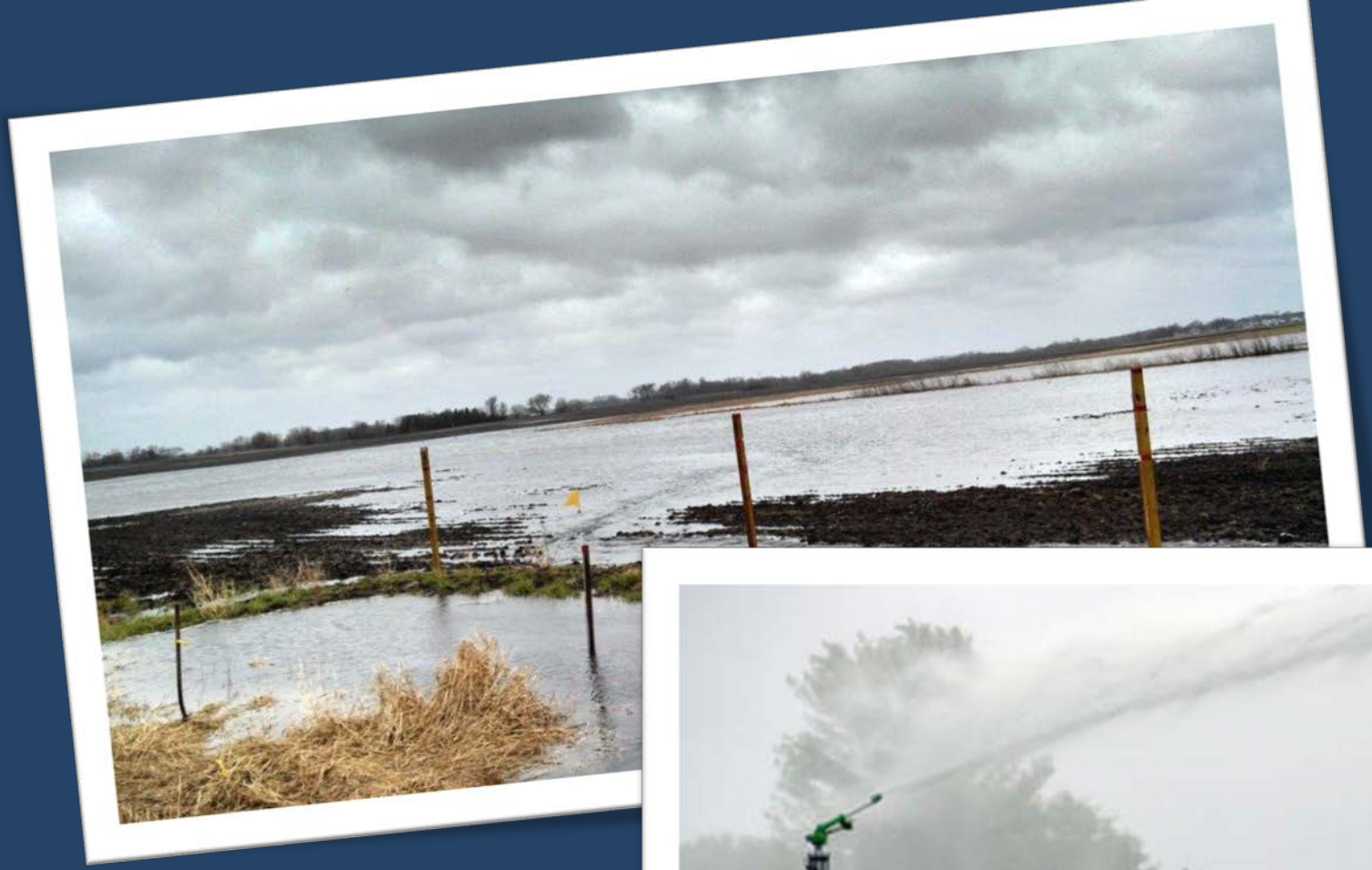

Photo Credit: Met Council

Background

- Grant from Board of Water and Soil Resources
- Reduce reliance on groundwater through stormwater reuse
- Use stormwater for “non-essential” irrigation
  - i.e. Public parks, golf courses, semi-public open spaces

The Project Goal

GOAL:
Reduce groundwater consumption through reuse

Targeted by

Watershed-scale assessment methodology

Objectives of the Assessment Methodology:

1. What locations are technically-feasible for stormwater reuse irrigation projects?
2. How do we prioritize the most promising sites?

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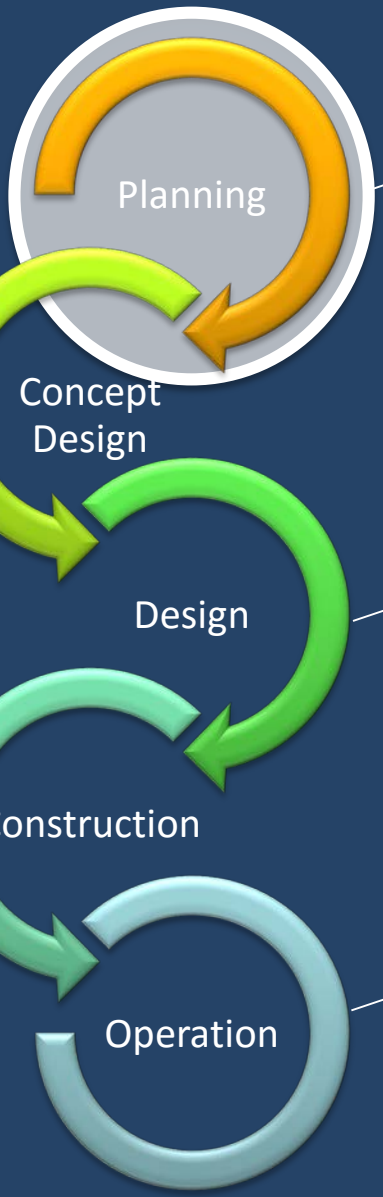
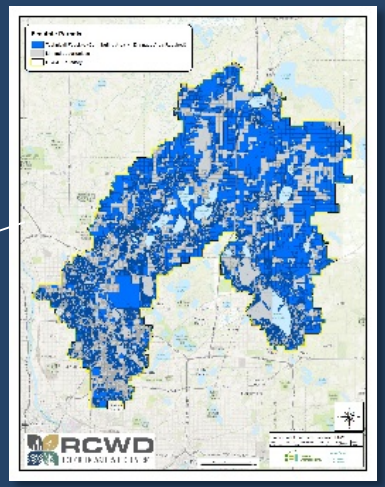
Scale of Work





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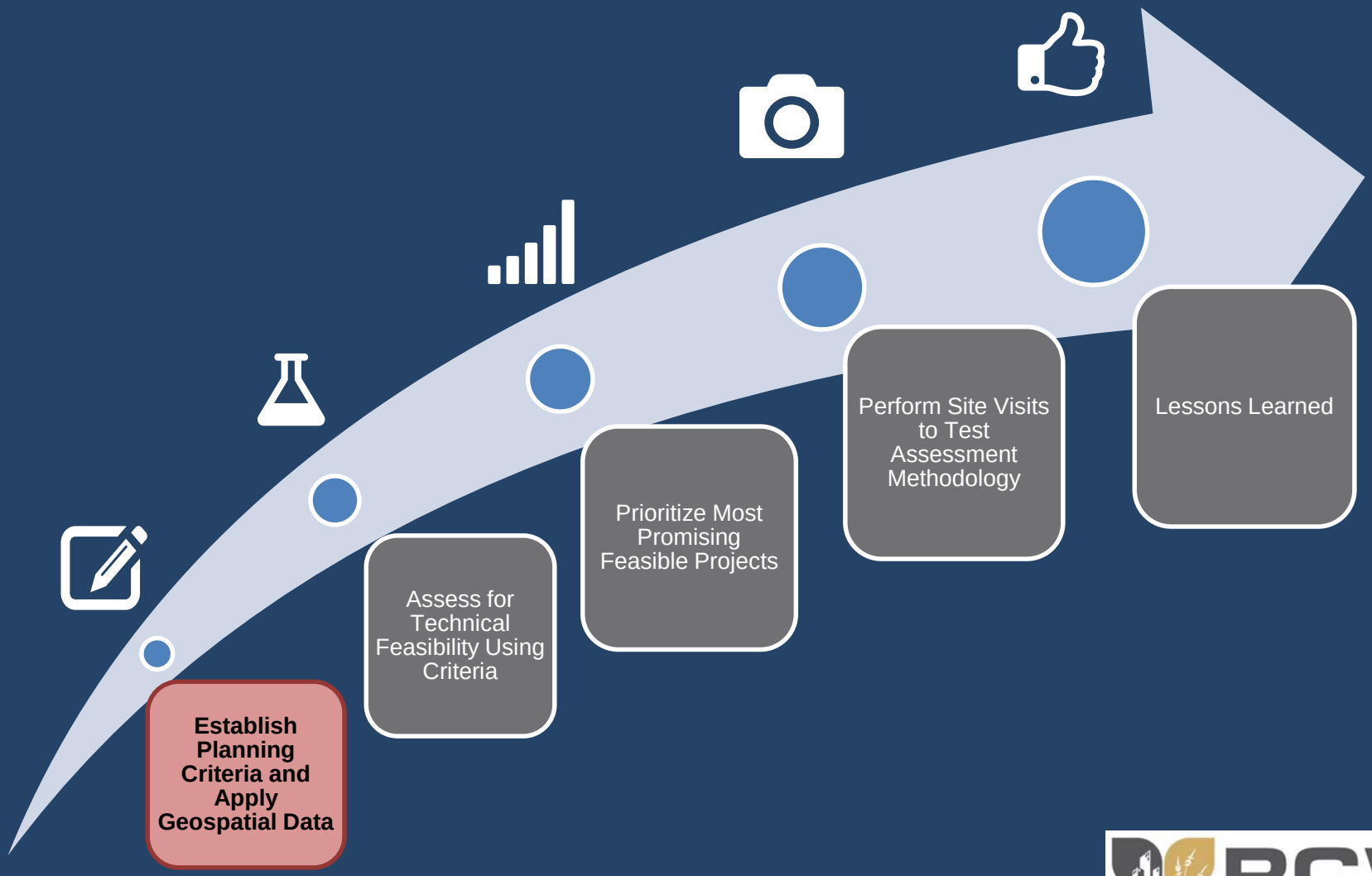
Overview of Process



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Planning Criteria

Technical

examples

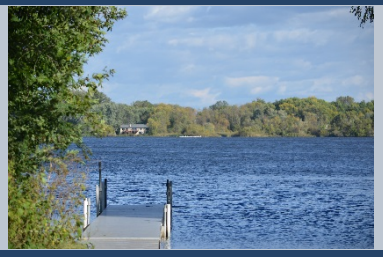
- Is the location near a ditch?

- What's the site's potential demand for irrigation?

Qualitative

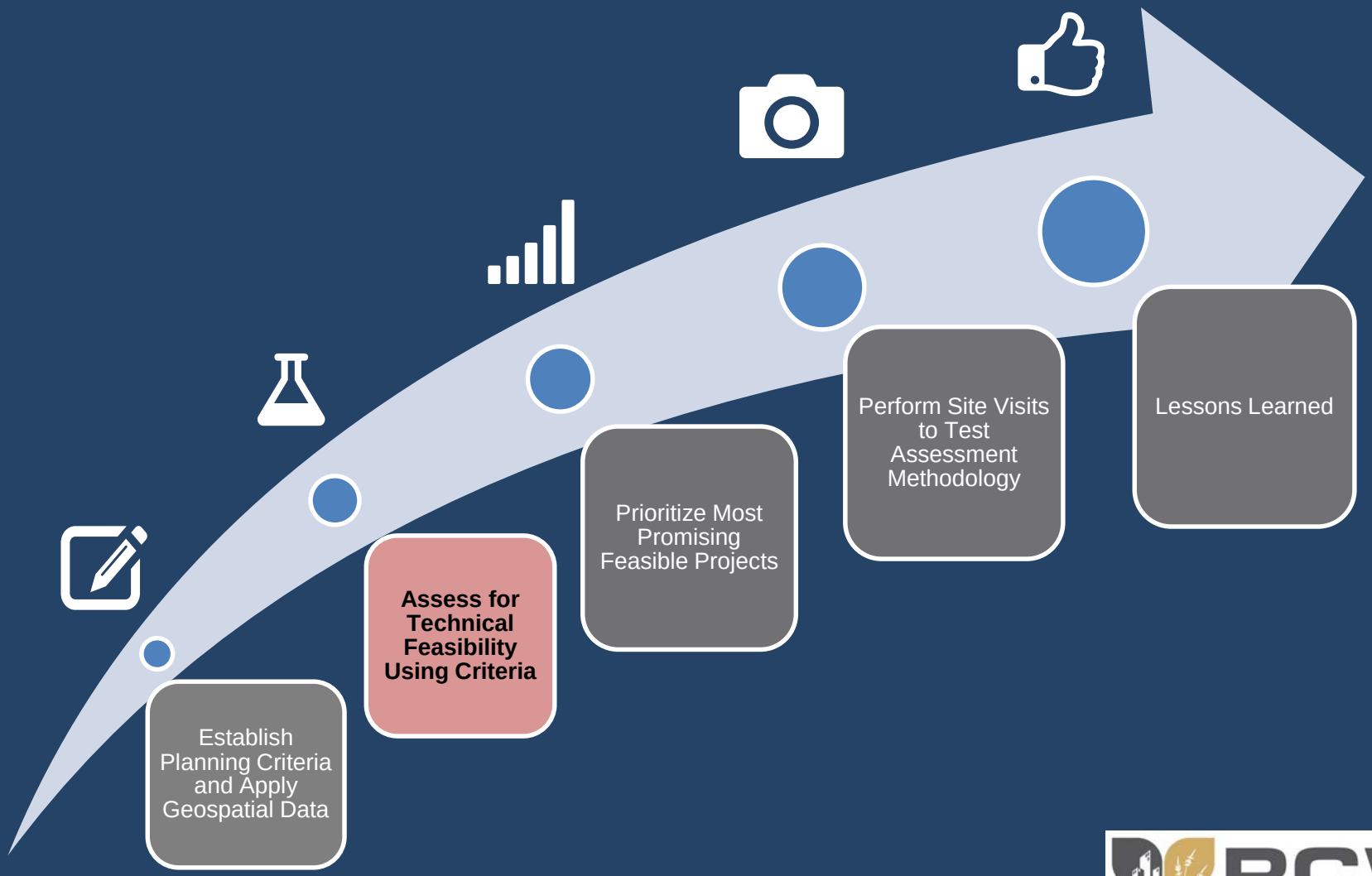
examples

- Is the site close to a high demand user?



- Is the site close to a sensitive landscape?

Overview of Process



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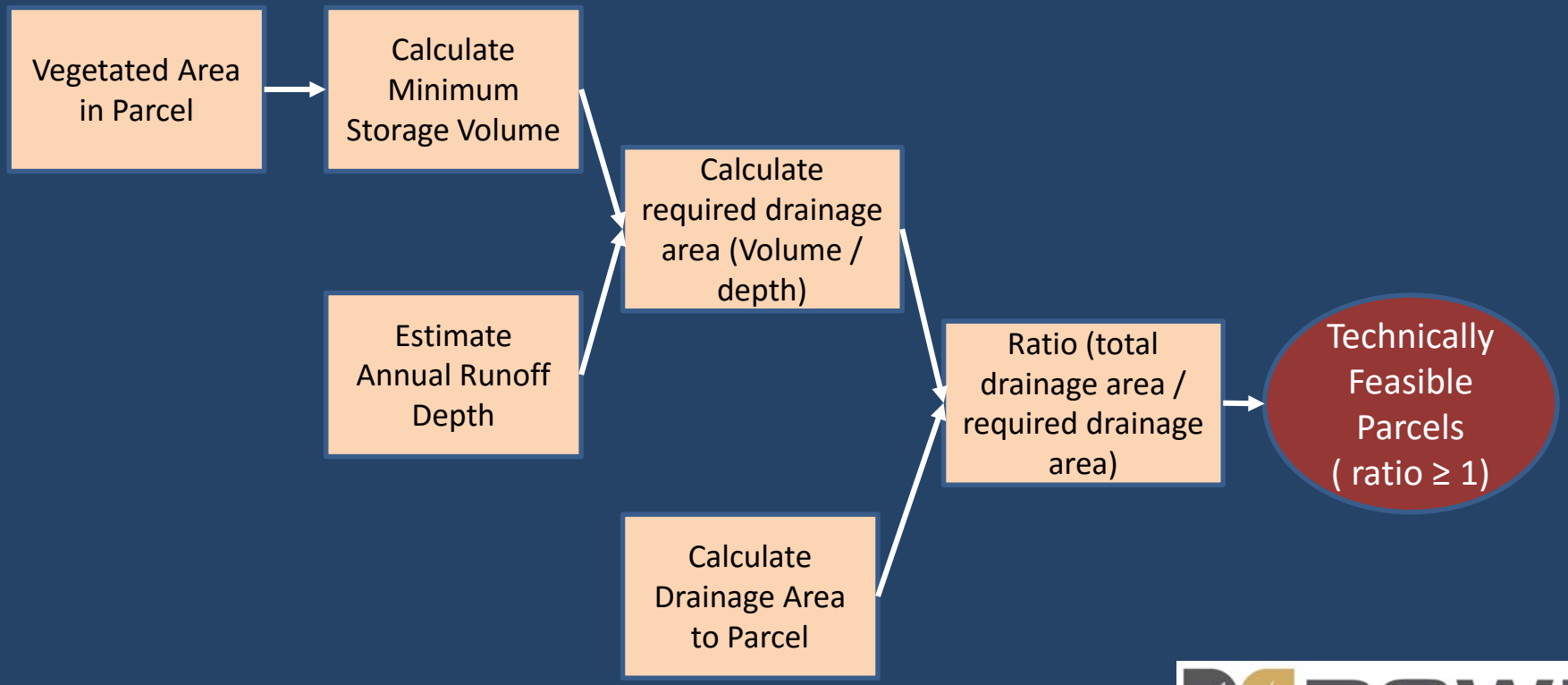
Technical Feasibility

Is there enough drainage area to support demand?

(Met Council, 2011)



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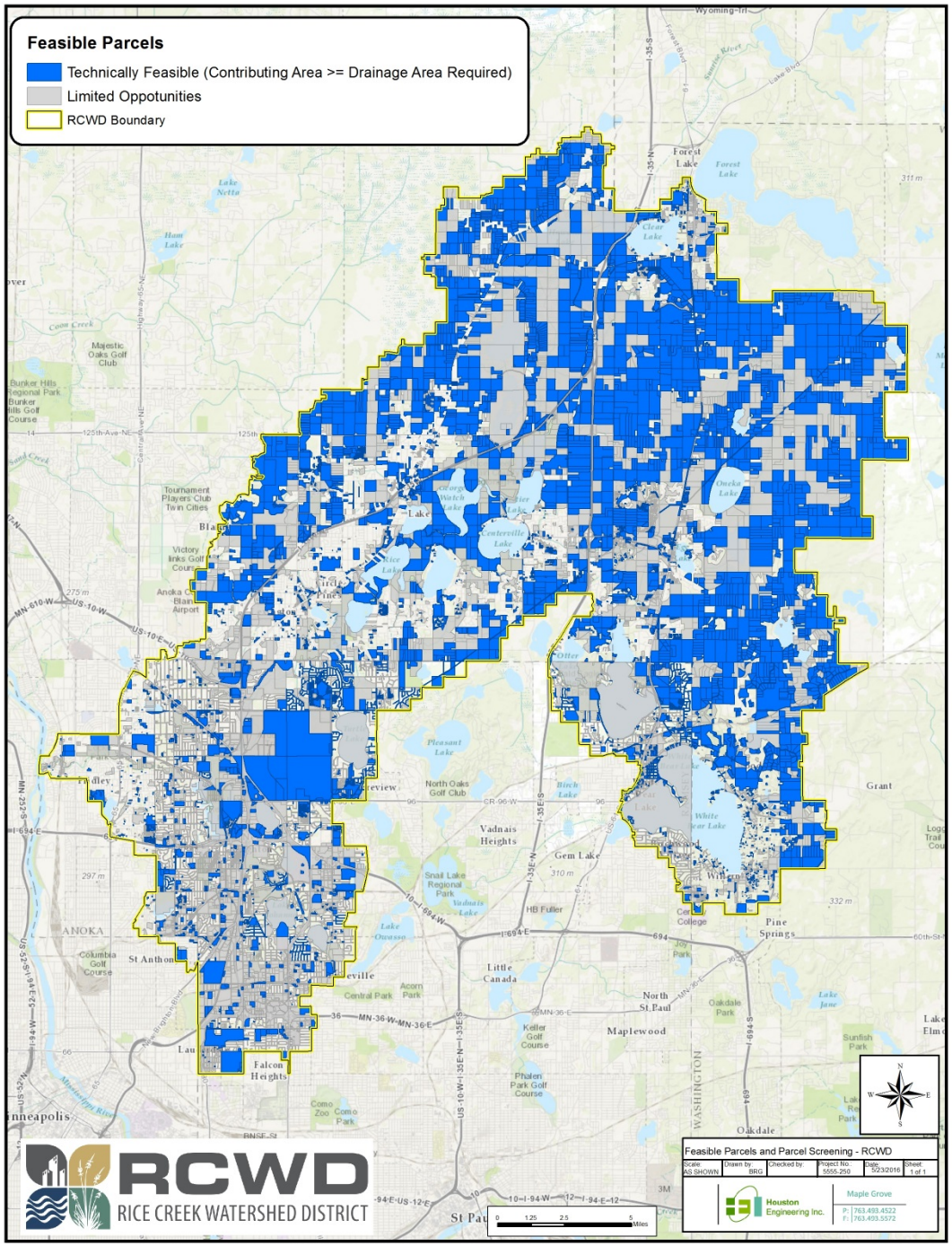
Technical Feasiblity

Is there enough potential groundwater demand?

Technically Feasible Parcels



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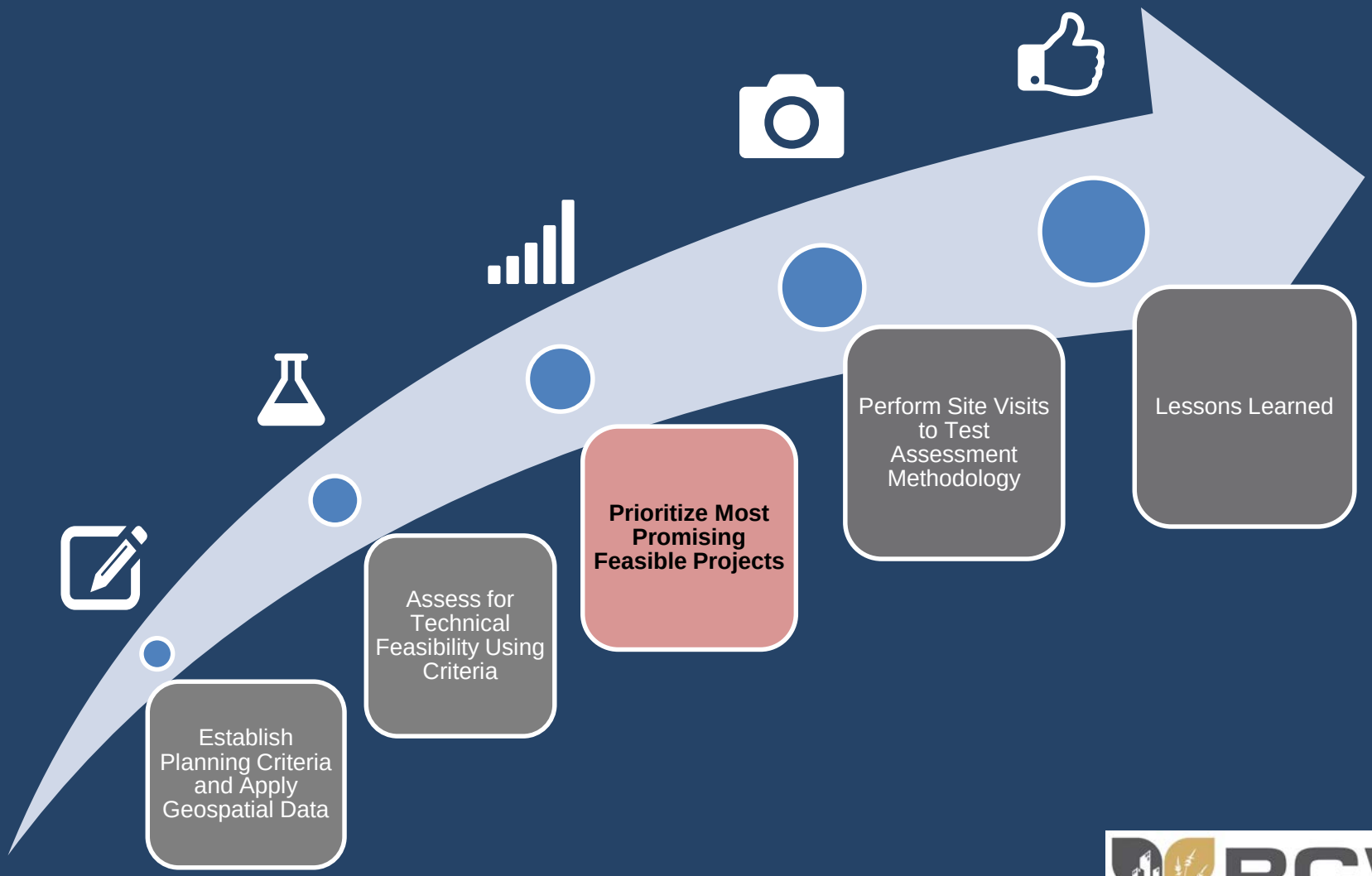

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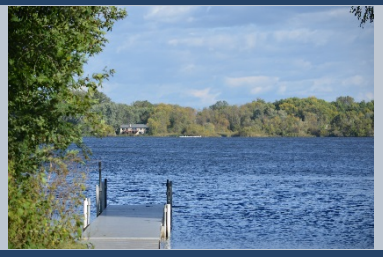

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Planning Criteria

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examples

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How do you prioritize?

Select sites that will offset the most groundwater use

Potential Demand for Irrigation

Demand from local high demand users

Final calculated groundwater offset

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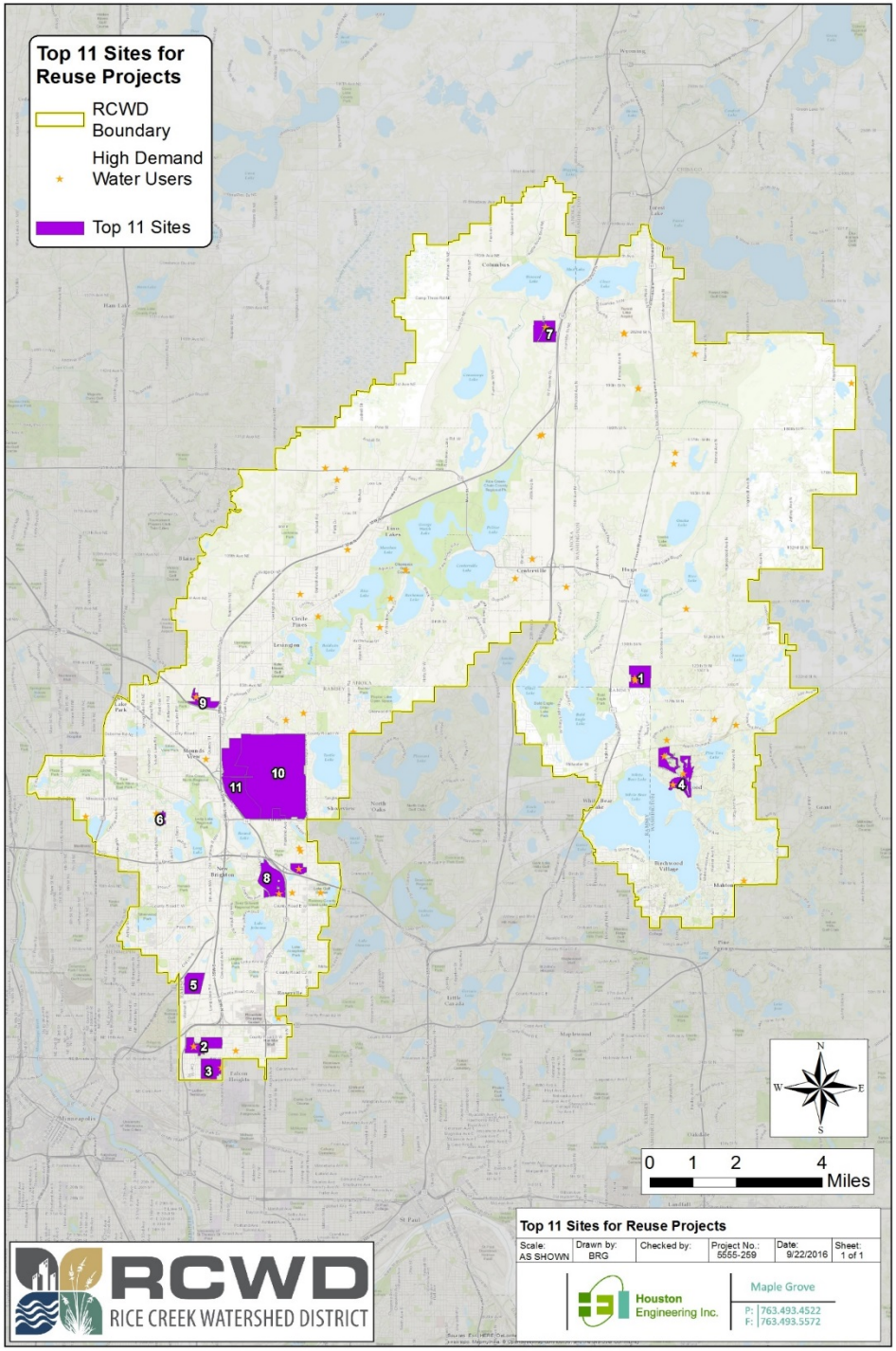
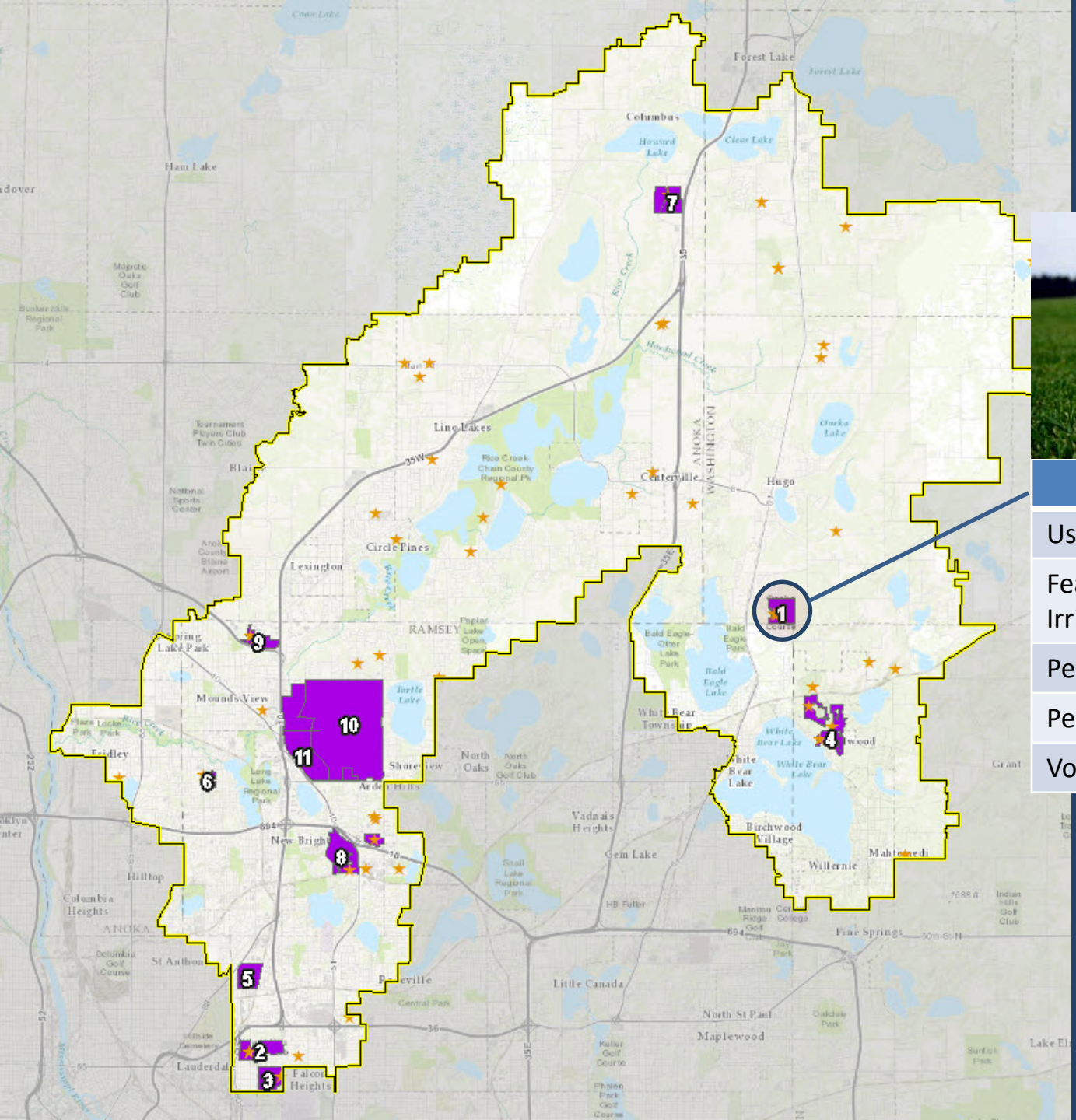
Most Promising Potential Water Reuse Sites





SITE STATS	
Use	Golf Course
Feasible Area for Irrigation	58 Acres
Permitted	Yes
Permitted Use	21.7 MGY
Volume Offset	21.7 MGY

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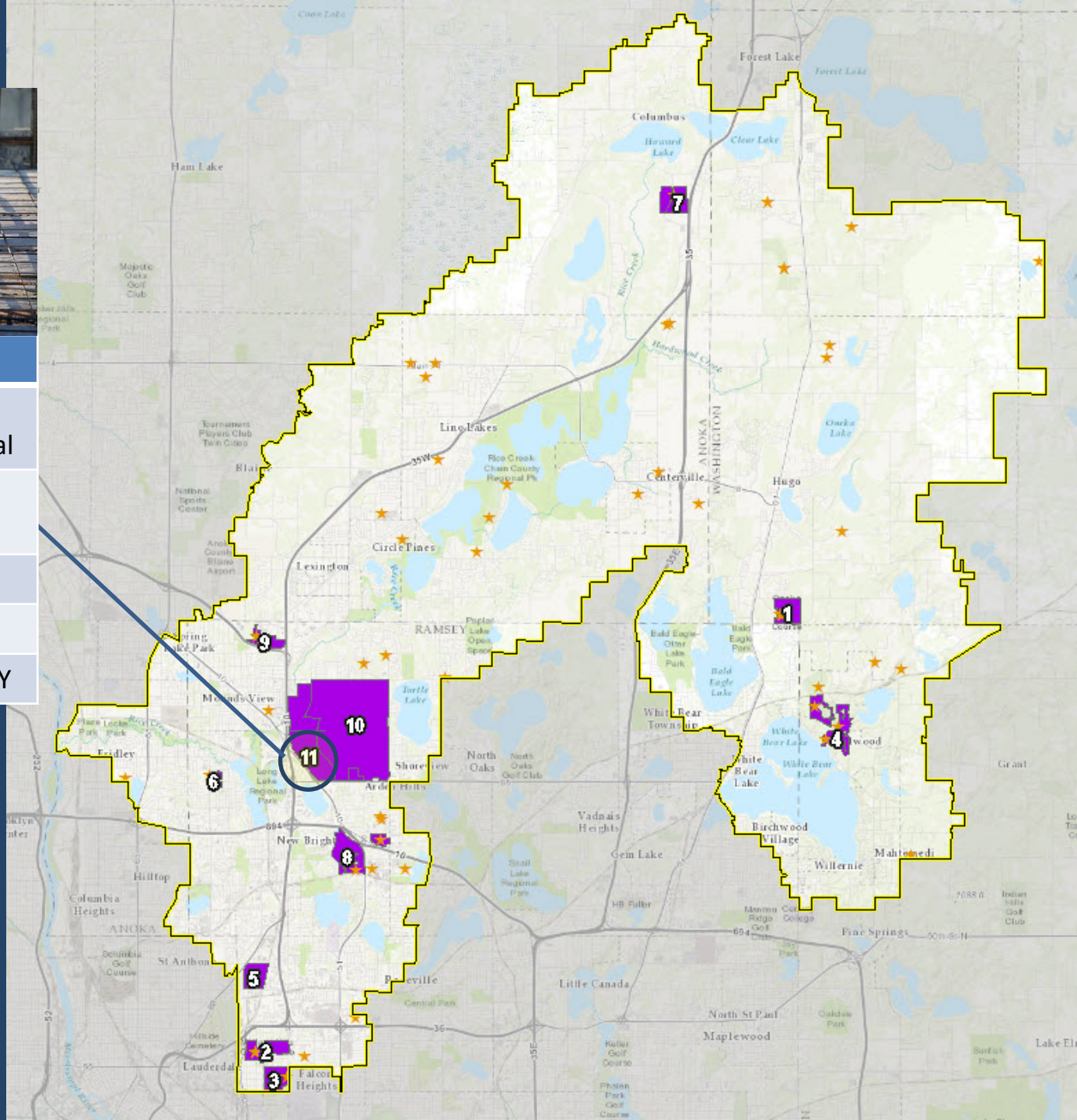
SITE STATS	
Use	Future Commercial
Feasible Area for Irrigation	367 Acres
Permitted	No
Permitted Use	N/A
Volume Offset	137.4 MGY



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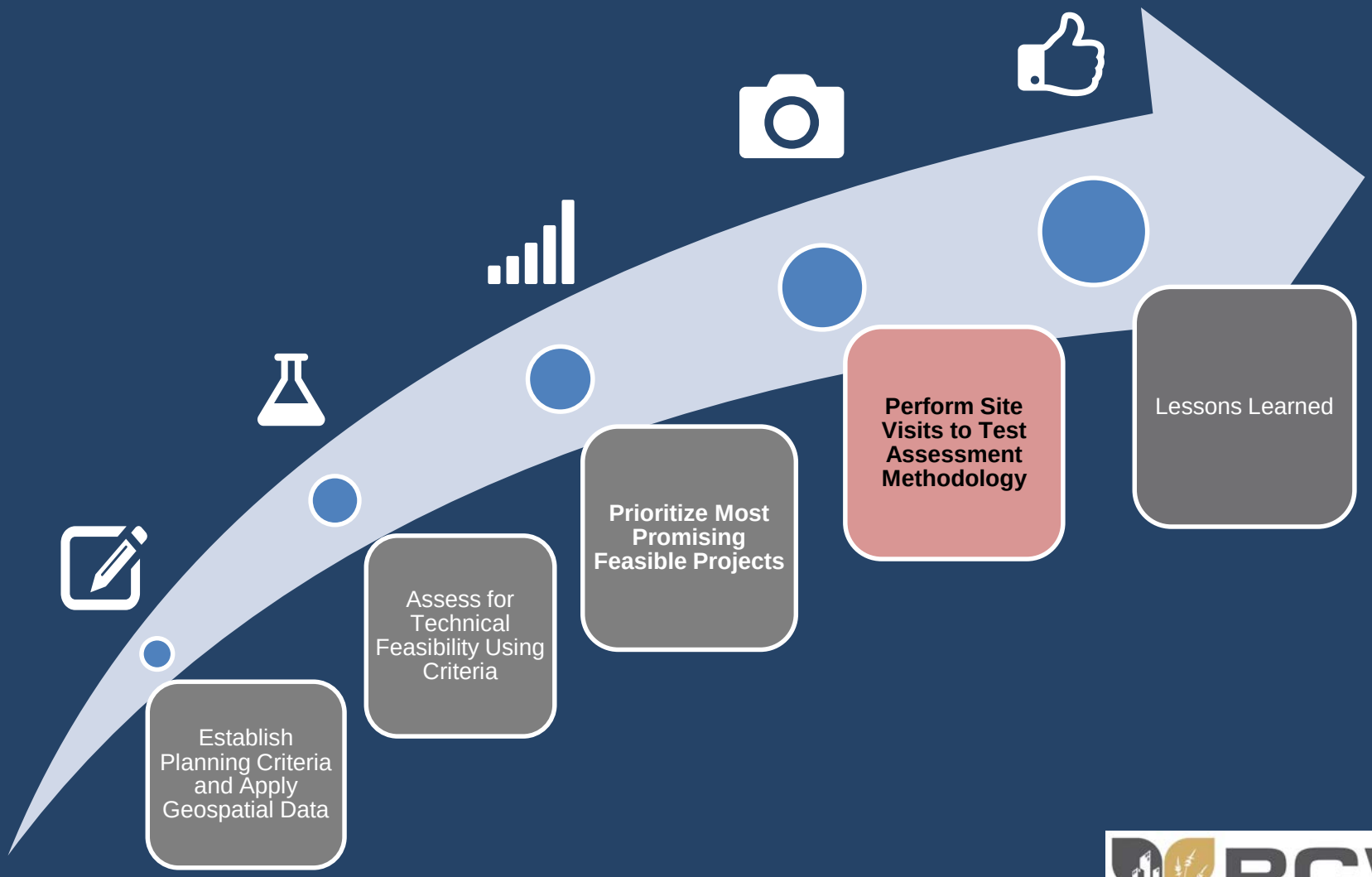

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Field Verification: Confirmed Priority

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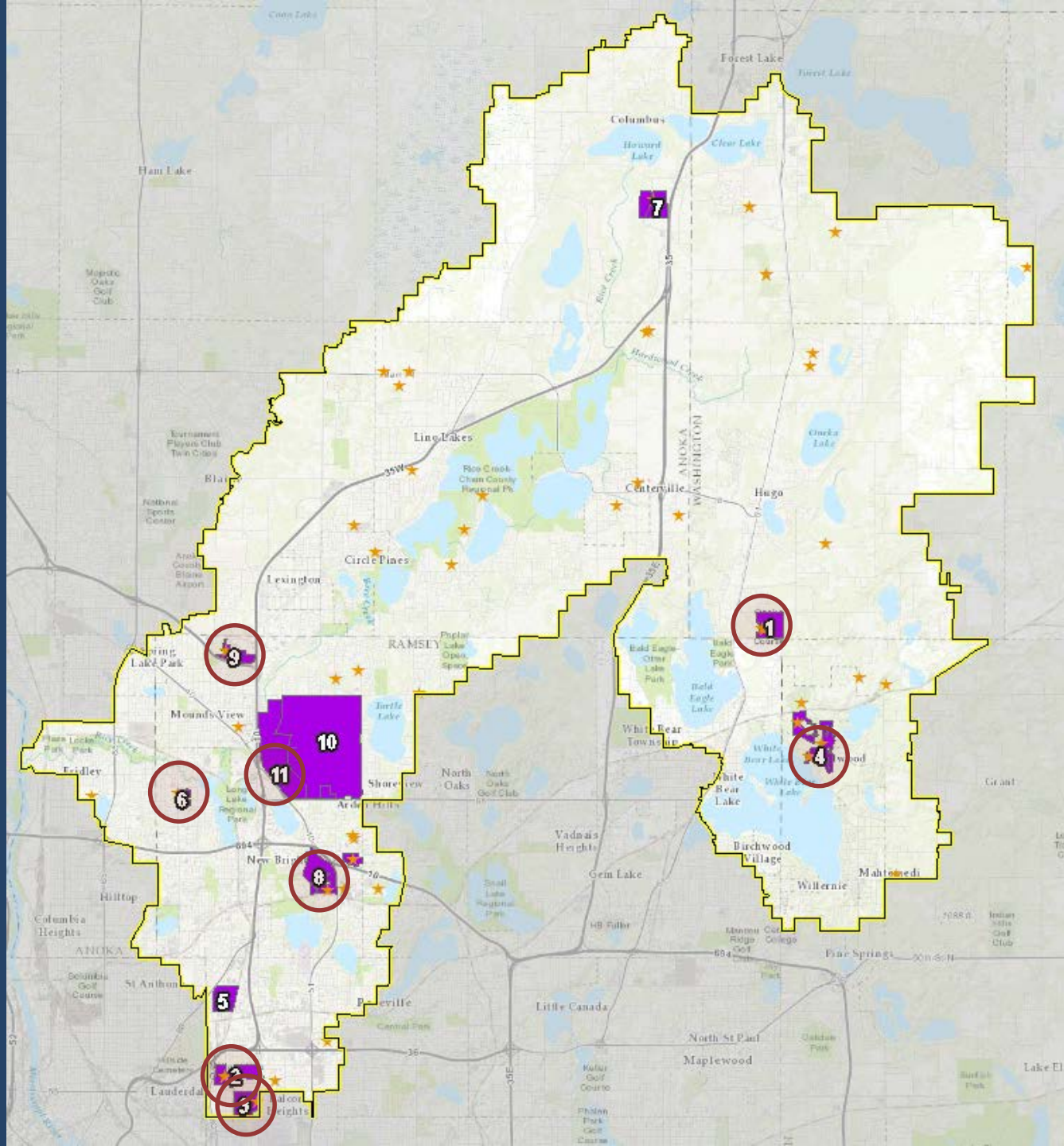

Field Verification: False Priority

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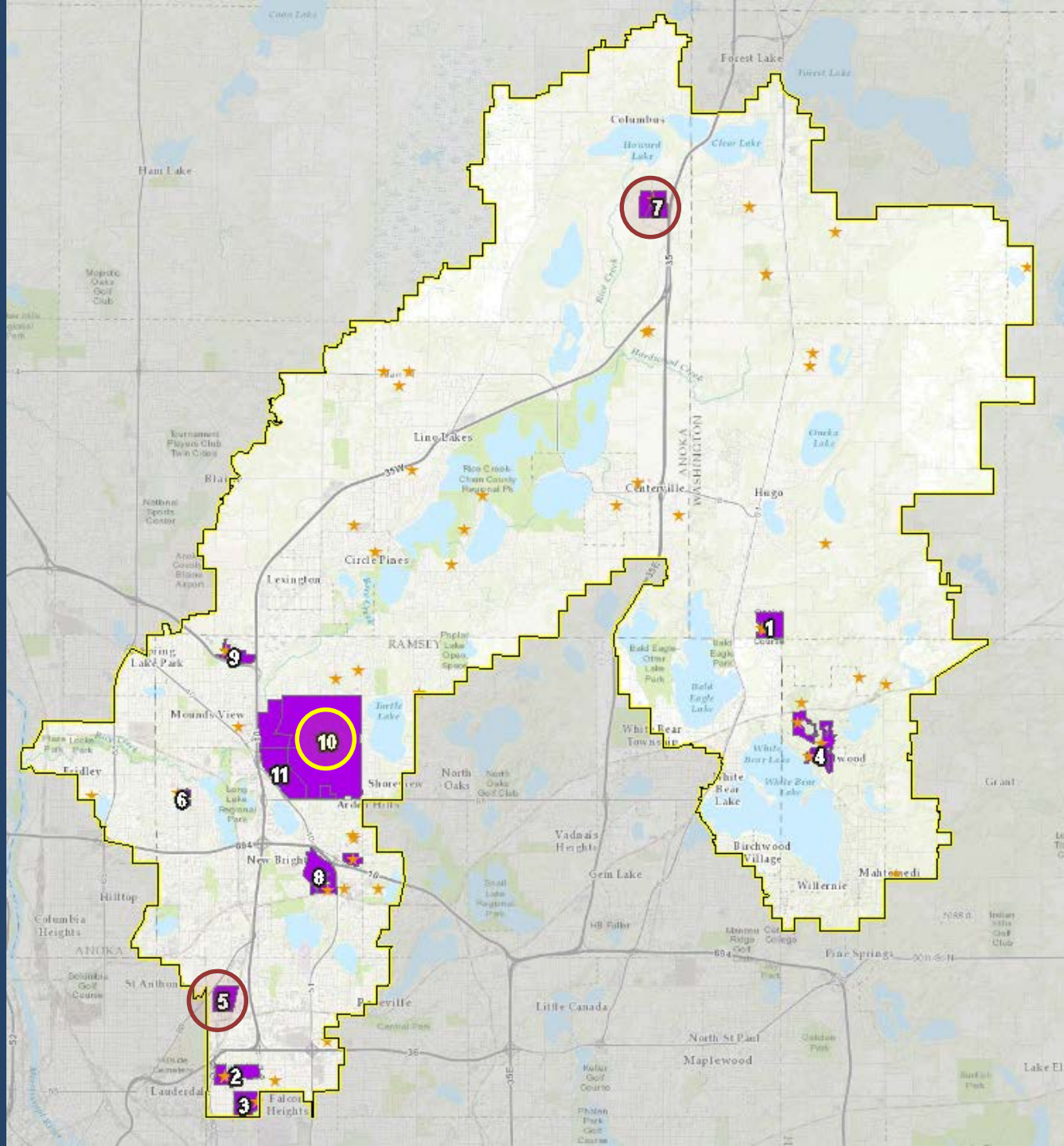

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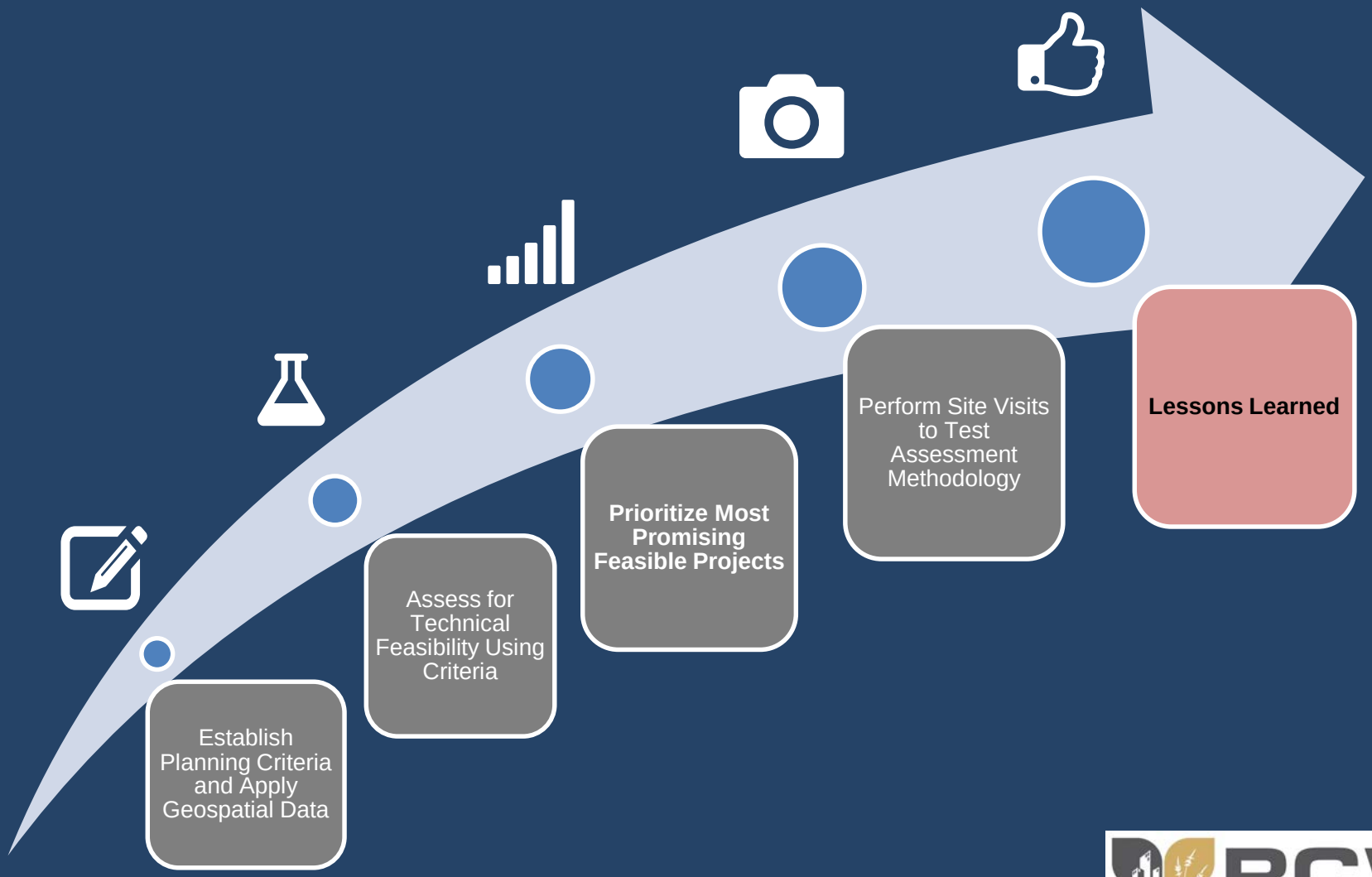

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Lessons Learned

- Leverage more detailed GIS data
- Screen sites based on type of vegetation present for the pervious area
- Exclude sites with existing reuse projects by placing a simple phone call

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Moving Beyond Today

- Accelerate targeting and implementation of sites for reuse irrigation projects which are:
  - Technically feasible
  - Prioritized based on intended impact

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Questions?

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□mm²m km²ℓ mm³m mm mℓ

□mm²mm kg mm³cm mm³mℓ mm³tin.

Site Scale	Size (acre)	Percentage Impervious	Impervious Area (sq. ft.)	Irrigation Area (sq. ft.) (pervious area)	Total Storage Required (ft³)	Total Drainage Area Required (sq. ft.)
Residential (small lot)	0.25	38%	4,138	6,752	9,107	21,857
Residential (large lot)	10	10%	43,560	392,040	707,119	1,697,085
Commercial	6	80%	209,088	52,272	38,720	92,929
Industrial	10	80%	348,480	87,120	64,534	154,882
Open Areas	4	5%	8,712	165,528	307,818	738,763

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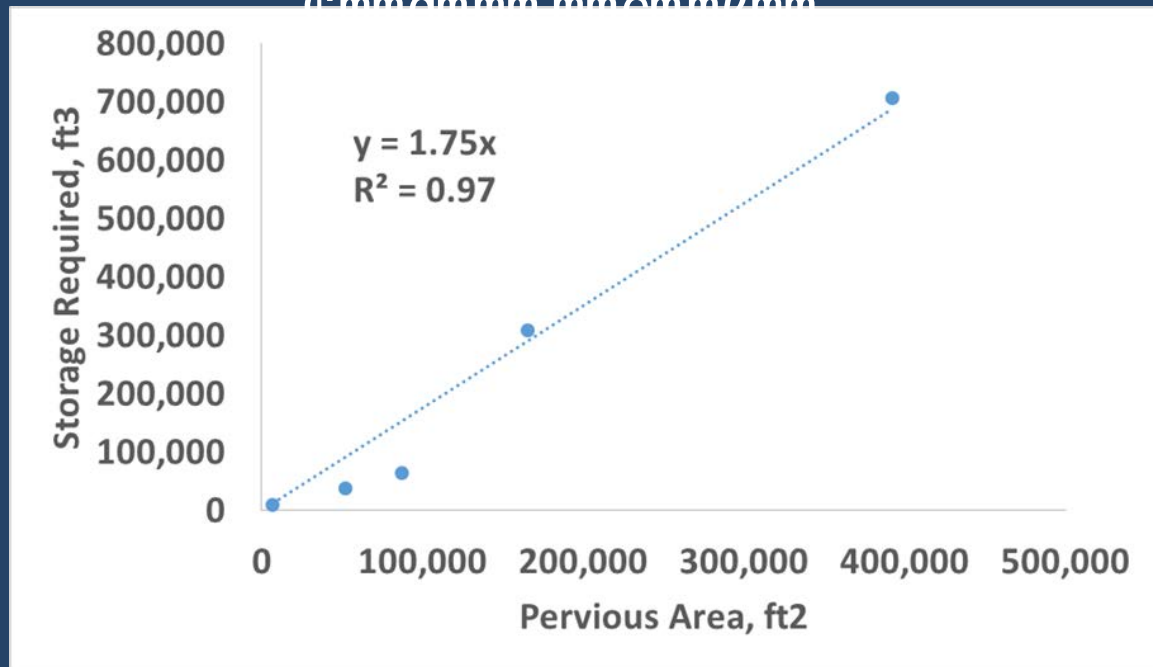

Existing Models

Model / Tool Name	Project Development Phase	Publicly Available (Yes / No)	Description	Comment on Use (If publicly available)	Reference
P8 (Program for Predicting Polluting Particle Passage through Pits, Puddles and Ponds)	Planning	Yes	Model used for predicting the generation and transport of stormwater runoff and pollutants in urban watersheds. Used to simulate the stormwater runoff and phosphorus loads generated from hypothetical development sites with varying levels of imperviousness to represent variation in typical development density.	Does not assess potential sites based on feasibility for water reuse projects	MPCA 2016
Urban Subwatershed Restoration Manual Series	Planning	Yes	Manual provides guidance on choosing the best locations in a subwatershed for retrofitting is provided in a series of 13 profile sheets. The manual then presents a method to assess retrofit potential at the subwatershed level, including methods to conduct a retrofit inventory, assess candidate sites, screen for priority projects, and evaluate their expected cumulative benefit. The manual concludes by offering tips on retrofit design, permitting, construction, and maintenance considerations.	Does not have an associated GIS desktop analysis for use.	Center for Watershed Protection 2007
Metropolitan Council Stormwater Reuse Guide	Planning	Yes	Tools and a step-by-step process guide that moves stormwater reuse projects from concept through implementation.	Does not have an associated GIS desktop analysis for use.	Met Council 2011
Stormwater Reuse Calculator	Concept Design	Yes	Developed to estimate the runoff volume reduction and water quality benefits of stormwater reuse using a daily time step mass balance of stormwater runoff volume and phosphorus load assuming non-conservative phosphorous mixing. The model simultaneously calculates annual volume reduction and phosphorus removal as a percent of the annual watershed load, in addition to annual evaporation losses and phosphorus sedimentation over a dry, average, and wet year.	Does not have an associated GIS desktop analysis for use.	EOR 2013
Minimal Impact Design (MIDS) Calculator	Concept Design	Yes	The MIDS BMP calculator is a tool used to determine stormwater runoff volume and pollutant reduction capabilities of various low impact development (LID) BMPs. The tool includes user inputs for harvest and re-use/cistern.	Does not identify locations for potential BMP sites	MPCA 2016
Stormwater Rate-Efficiency-Volume (REV) curve model	Design	Yes	Design tool for stormwater reuse ponds that relate runoff volume to reuse rates for a selected reuse efficiency (the amount of stormwater reused as a percentage of total runoff).	Model developed in Florida. Modifications are needed to apply this model to a cold climate like Minnesota.	EOR 2013
Rainwater Harvesting Cistern Design Spreadsheet	Design	Yes	The Stormwater Design Specification for Rainwater Harvesting allows runoff reduction credits for rainwater harvesting based on the total amount of annual internal water reuse, outdoor water reuse, and tank dewatering discharge. These values can be calculated using the Cistern Design Spreadsheet.	Does not assess potential sites based on feasibility for water reuse projects	EOR 2013
Rainwater Harvester Computer Model	Design	Yes	Developed to assist design of residential or municipal rainwater harvesting cisterns. Includes cost-benefit estimates in the output.	Does not assess potential sites based on feasibility for water reuse projects	EOR 2013
Stochastic and Reliability Estimation Tool (SARET)	Design	Yes	Model can be used to determine the efficiency of stormwater reuse systems under variable rainfall regimes. The SARET model could be used to test the reliability of a stormwater reuse pond with Minnesota historic precipitation data.	Does not assess potential sites based on feasibility for water reuse projects	EOR 2013
HydroCAD	Planning	No	Computer Aided Design tool used for modeling stormwater runoff.	N/A	Appendix D
Western Washington Hydrology Model	Planning	No	Model uses the EPA HSPF software program to calculate rainfall-runoff and routing computations as part of Low Impact Development design plans.	N/A	EOR 2013
Sustainable Systems Integration Model (SSIM)	Concept Design	No	Sustainable Systems Integrated Model (SSIM) is an integrated land planning tool that optimizes sustainable development programs in terms of project goals and provides environmental performance and cost analysis as a validation method. Used to evaluate the effects of the water conserving strategies.	N/A	WERF 2011
Source Loading and Management Model (WinSLAMM)	Design	No	Developed for evaluation of nonpoint pollution in urban areas, with a focus on small storm hydrology and particulate washoff. Used to calculate production functions that can be used to size storage water tanks to maximize irrigation use for residential locations throughout the U.S. Example of how this was accomplished for Kansas City, MO, as part of a current U.S. EPA demonstration project on green infrastructure use to reduce the magnitude and volume of combined sewer overflows.	N/A	WERF 2011

Planning Criterion	Criterion Purpose	Criterion Type	Geospatial Data Layer	Use Rules
Estimated Irrigation Volume	Assess the potential magnitude of reduced groundwater use	Technical	Runoff Depth	Parcels with insufficient irrigation areas are not feasible
Surface Water Drainage Area Size	Generate sufficient runoff volume to meet storage requirement of water reuse project (**Appendix C**)	Technical	LiDAR data	Parcels with insufficient drainage area size are not feasible
Impervious Cover in Subwatershed (%) (***For use in absence of runoff depths***)	Generate sufficient runoff volume to meet storage requirement of water reuse project	Technical	NLCD 2011	Parcels with insufficient drainage area size are not feasible
Presence of Known Water Quality Risk Factors	Evaluate probable water quality of stormwater harvested for reuse	Technical	CERCLIS database	Parcels intersecting these features are not feasible
Groundwater Contamination Potential*	Depth to water table to provide sufficient zone of treatment, avoiding contamination of groundwater from stored stormwater runoff	Qualitative	Drinking Water Supply Management Areas	Parcels intersecting these features are not feasible
			Source Water Assessment Area	Parcels intersecting these features receive a lower rank for implementation
			High Water Table Sensitivity	Parcels intersecting these features are not feasible
			Wellhead Protection Area	Parcels intersecting these features receive a lower rank for implementation
			High Drinking Water Supply Vulnerability	Parcels intersecting these features are not feasible
Proximity to Sensitive Landscape Features	Proximity upstream or downstream to sensitive landscapes features reliant on stormwater runoff as a source of water, or, within sensitive landscape features which would be disrupted by water reuse projects	Qualitative	Wildlife Management Areas	Parcels intersecting these features receive a more moderate rank for implementation
			Public Conservation Lands	Parcels intersecting these features receive a more moderate rank for implementation
			High Quality Wetlands	Parcels intersecting these features are not feasible
			MCBS sites of biodiversity significance	Parcels intersecting these features receive a more moderate rank for implementation
Water Quality Benefit Index	Evaluate if site is upstream of impaired water / surface waterbody, and would therefore reduce stormwater discharge to receiving water body	Qualitative	RCWD NWI Wetlands	Parcels intersecting these features receive a more moderate rank for implementation
			24K water features	Parcels intersecting these features receive a lower rank for implementation
			Impaired wetlands	Parcels intersecting these features receive a lower rank for implementation
			Impaired streams	Parcels intersecting these features receive a lower rank for implementation
			surface waters	Parcels intersecting these features receive a lower rank for implementation
Potential Local Flood Damage Reduction Benefits	Proximity to flood prone areas to determine flood protection benefits from storage provided by water reuse projects	Qualitative	RCWD NWI Wetlands	Parcels intersecting these features receive a more moderate rank for implementation
			100 year floodplain	Parcels intersecting these features receive a more moderate rank for implementation. Parcels in near proximity to a floodplain may receive higher rank for flood reduction benefits.
			railroad	Parcels intersecting these features are not feasible
			ditches	Parcels intersecting these features receive a lower rank for implementation
			24K water features	Parcels intersecting these features receive a lower rank for implementation
			surface waters	Parcels intersecting these features receive a lower rank for implementation
Potential for Use Conflict for Irrigated Area	Evaluate public access to irrigated areas: Public access is controlled in "restricted" areas (i.e. golf courses, highway medians) and not controlled in "unrestricted" areas (i.e. parks, playgrounds)	Qualitative	Wildlife Management Areas	Parcels intersecting these features receive a more moderate rank for implementation
			Public Conservation Lands	Parcels intersecting these features receive a more moderate rank for implementation
			High Quality Wetlands	Parcels intersecting these features are not feasible
			MCBS sites of biodiversity significance	Parcels intersecting these features receive a more moderate rank for implementation
Likelihood of Treatment Needed Prior to Reuse	Evaluate probable quality of stormwater harvested for reuse, based on land use	Qualitative	County Parcels and MLCCS land cover	N/A
Proximity to Existing High Volume Groundwater Use	Target high-volume users that are technically feasible for supporting water reuse projects	Qualitative	SWUDS database	Parcels intersecting these features receive a higher rank for implementation

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Planning Criterion	Response Count	Relative Weight (0-1)
Estimated Irrigation Volume (demand for irrigation)	9	0.60
Availability and amount of publicly owned land / open spaces	8	0.53
Locations and volumes of existing storage systems	7	0.47
Soil Hydraulic Conductivity (soil type and infiltration rate)	5	0.33
Surface Water Drainage Area Size	5	0.33
Groundwater Contamination Potential (distance to groundwater)	2	0.13
Impervious Cover in Subwatershed (%)	2	0.13
Water Quality Benefit Index (Distance from reuse site to impaired waters / surface waters)	1	0.07
Potential Local Flood Damage Reduction Benefits	0	0.00

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Most Promising Sites for Reuse

Rank	Site	Pervious Area (acres)	Offset Volume of Water (gallons/year)	If High-Volume User… Volume Offset (gallons/year)
1	Oneka Ridge Golf Course	150	21,700,000	21,700,000
2	Midland Hills Country Club	144	53,805,000	18,820,800
3	U of Mn Les Bolstad Golf Course	133	17,611,200	17,611,200
4	White Bear Yacht Club	219	20,081,700	8,341,670
5	Land O Lakes Inc.	27	10,016,900	8,335,800
6	New Brighton - Brightwood Hills Golf	26	9,642,100	6,962,500
7	Running Aces	154	21,610,500	6,202,300
8	Bethel University	118	44,042,600	2,495,830
9	Medtronic Inc.	65	24,369,800	1,583,330
10	Arden Hills Army Training Site (AHATS)	1258	139,695,000	0
11	Rice Creek Commons	367	137,431,000	0

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Technical

Estimated Irrigation Volume
Surface Water Drainage Area Size
Impervious Cover in Subwatershed (%) (For use in absence of runoff depths)
Presence of Known Water Quality Risk Factors

Qualitative

Groundwater Contamination Potential
Proximity to Sensitive Landscape Features
Water Quality Benefit Index
Potential Local Flood Damage Reduction Benefits
Potential for Use Conflict for Irrigated Area
Likelihood of Treatment Needed Prior to Reuse
Proximity to Existing High Volume Groundwater Use

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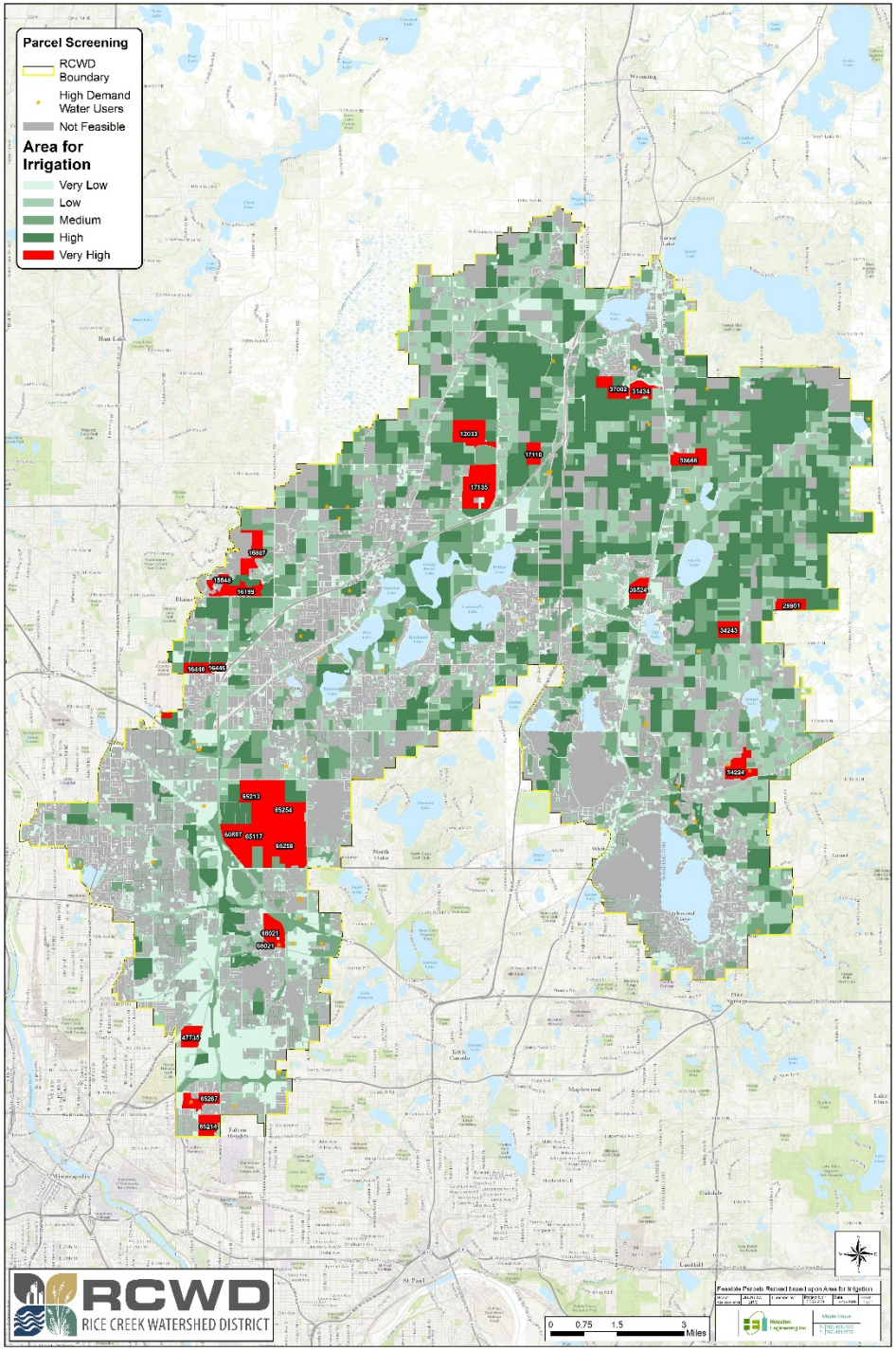
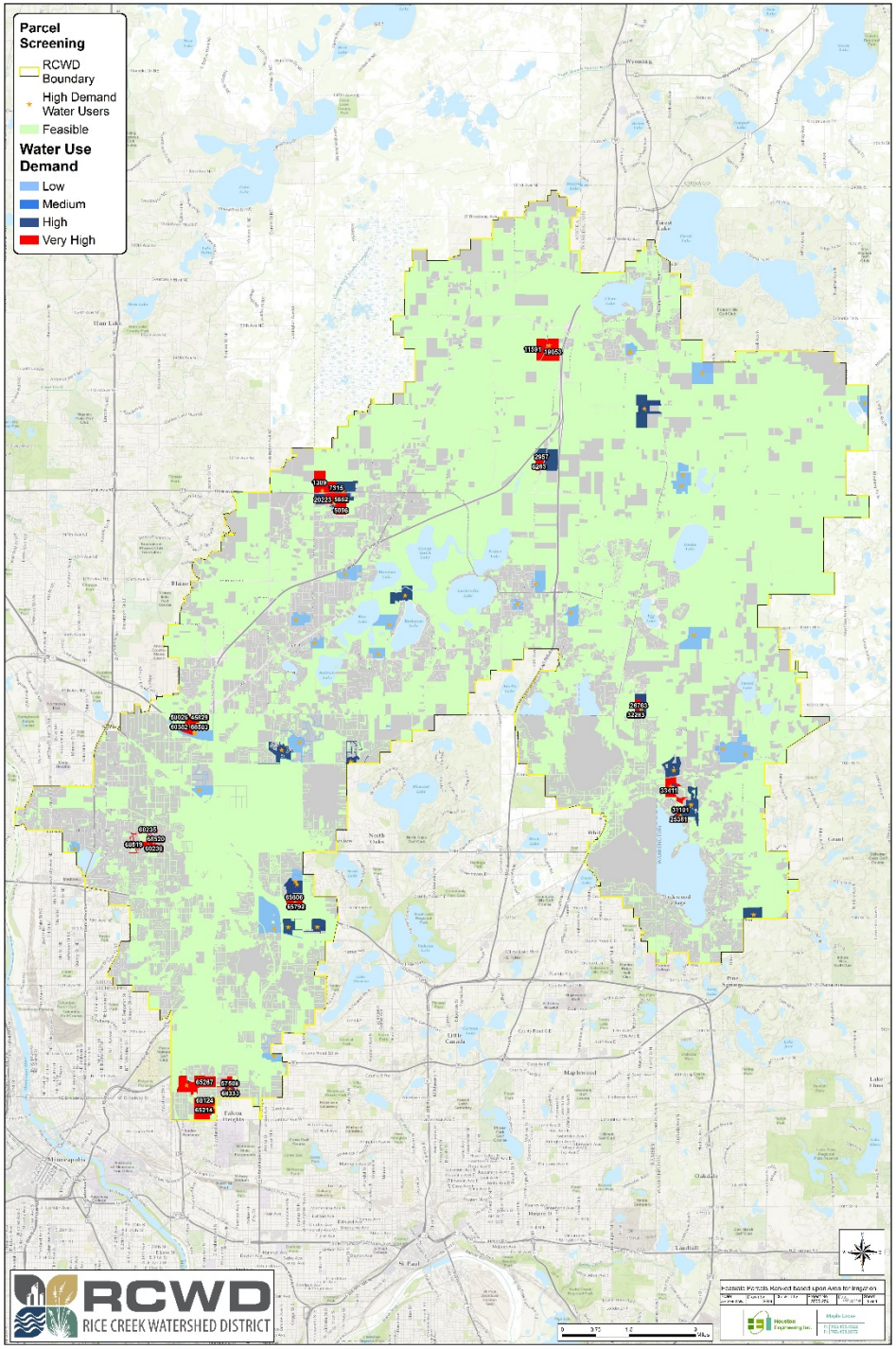
Feasible parcels ranked by area available for irrigation



Feasible parcels ranked by high demand water users



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City of Hopkins

CLEAN WATER LAND & LEGACY AMENDMENT

Water Resources Conference

Cottageville Park: Integrating Land Use and Water Resources Planning

Renae Clark, Minnehaha Creek Watershed District
Chris Meehan, Wenck Associates

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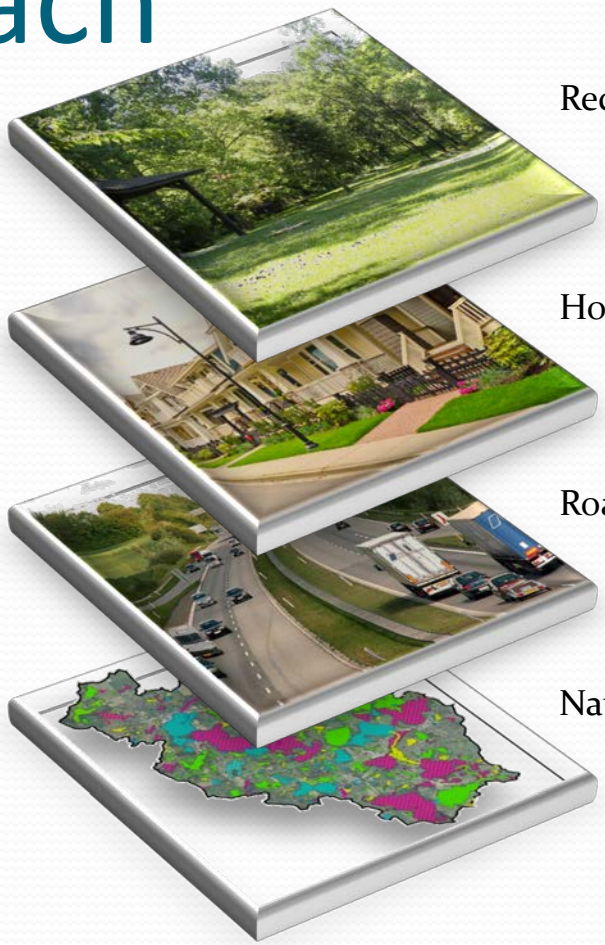
Planning Approach

1. Develop a common understanding of natural resource issues and drivers
2. Understand local priorities by assessing partner agencies' existing plans and policies
3. Integrate natural resource goals with local plans and policies
4. Develop a strategic implementation and investment framework



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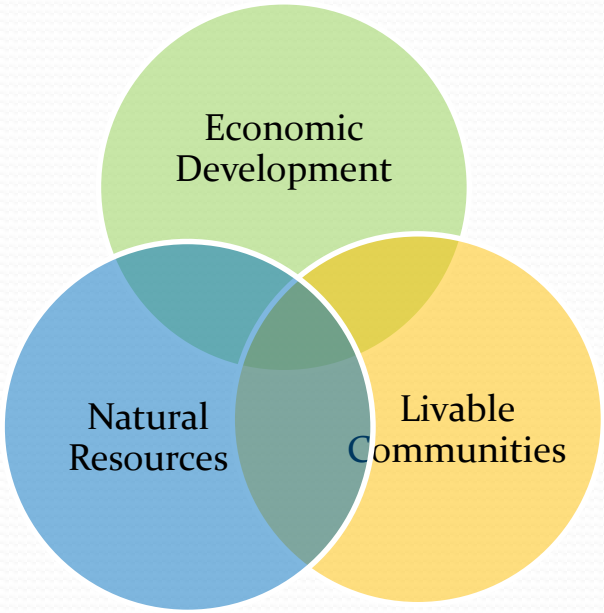
Partnership Model: Understanding mutual interests to achieve clean water and thriving communities

- Focused understanding of public and private partner goals
- Remain flexible, opportunistic and streamline regulation
- Value added partner
- District is more successful when working across disciplines to achieve broad goals.
- Great public ROI



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Call for Integration

- 2007 *Evaluation Report on Watershed Management* (Legislative Auditor)
- 2009 *Land and Water Policy Project* (MEI)
- 2011 *Water Governance Study* (Hennepin County/Humphrey School)
- 2013 *Water Regulation and Governance* (MPCA)
- 2016 APA

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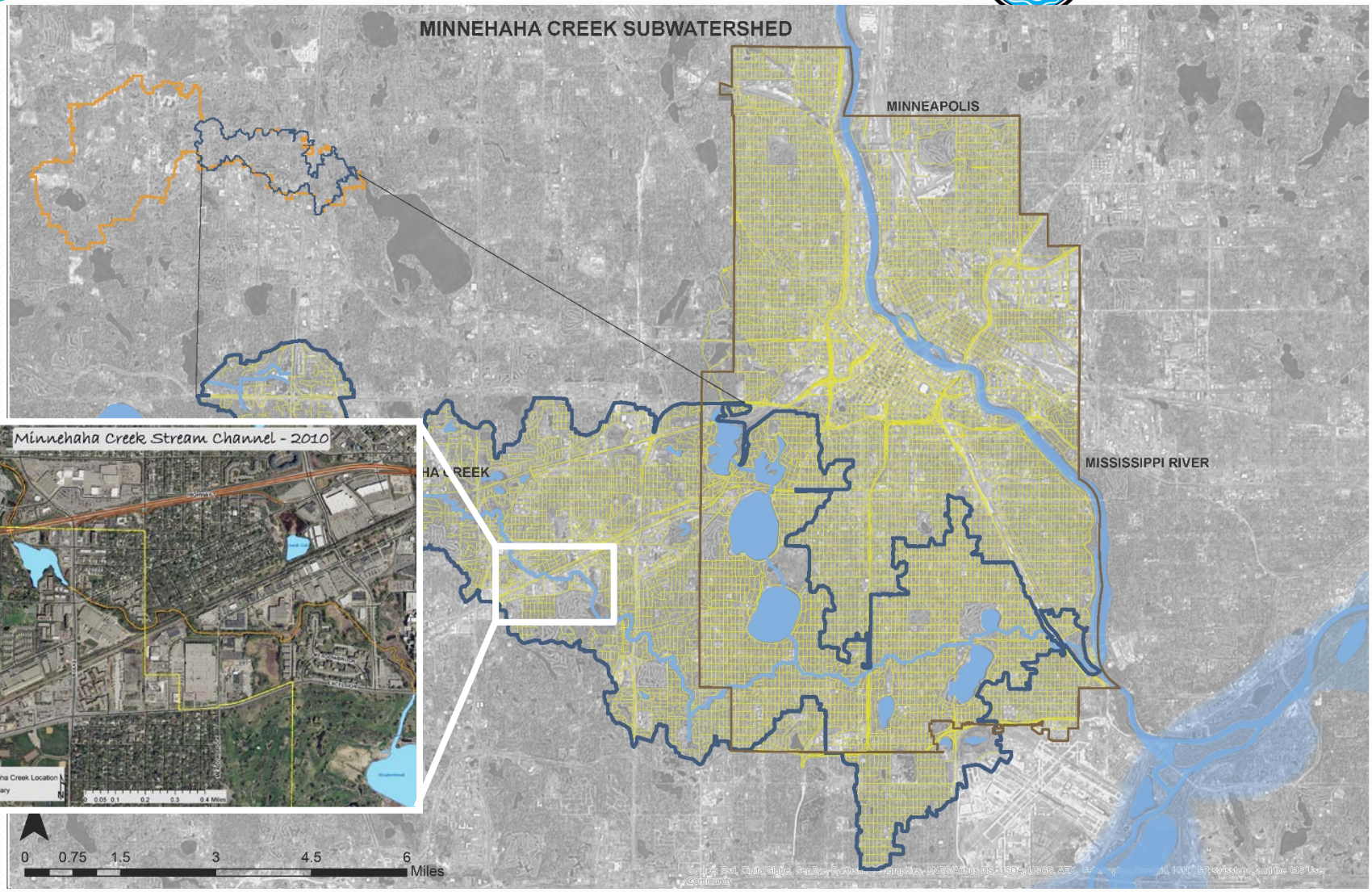

Highest Pollutant Loading to Lake Hiawatha

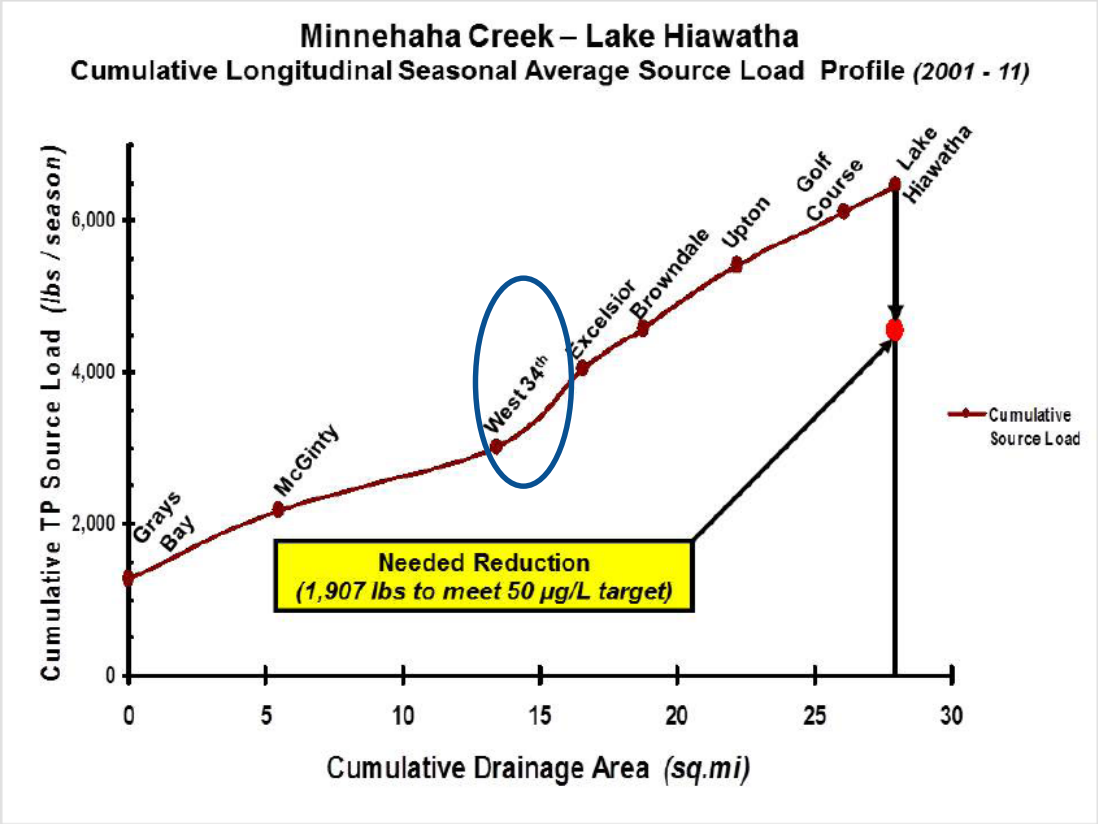

Figure 1-2. Minnehaha Creek total phosphorus cumulative load longitudinal profile (Drainage Area)

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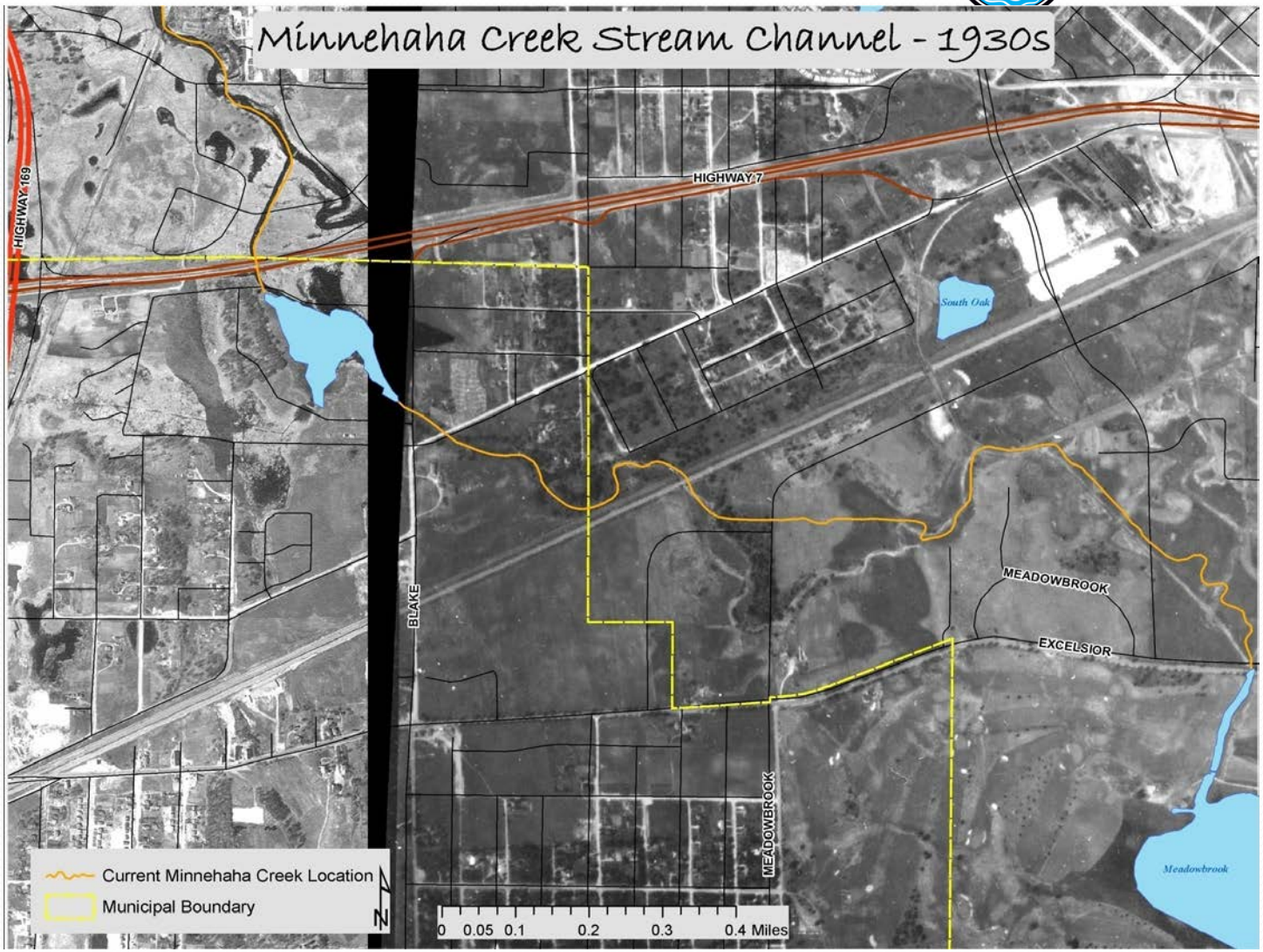

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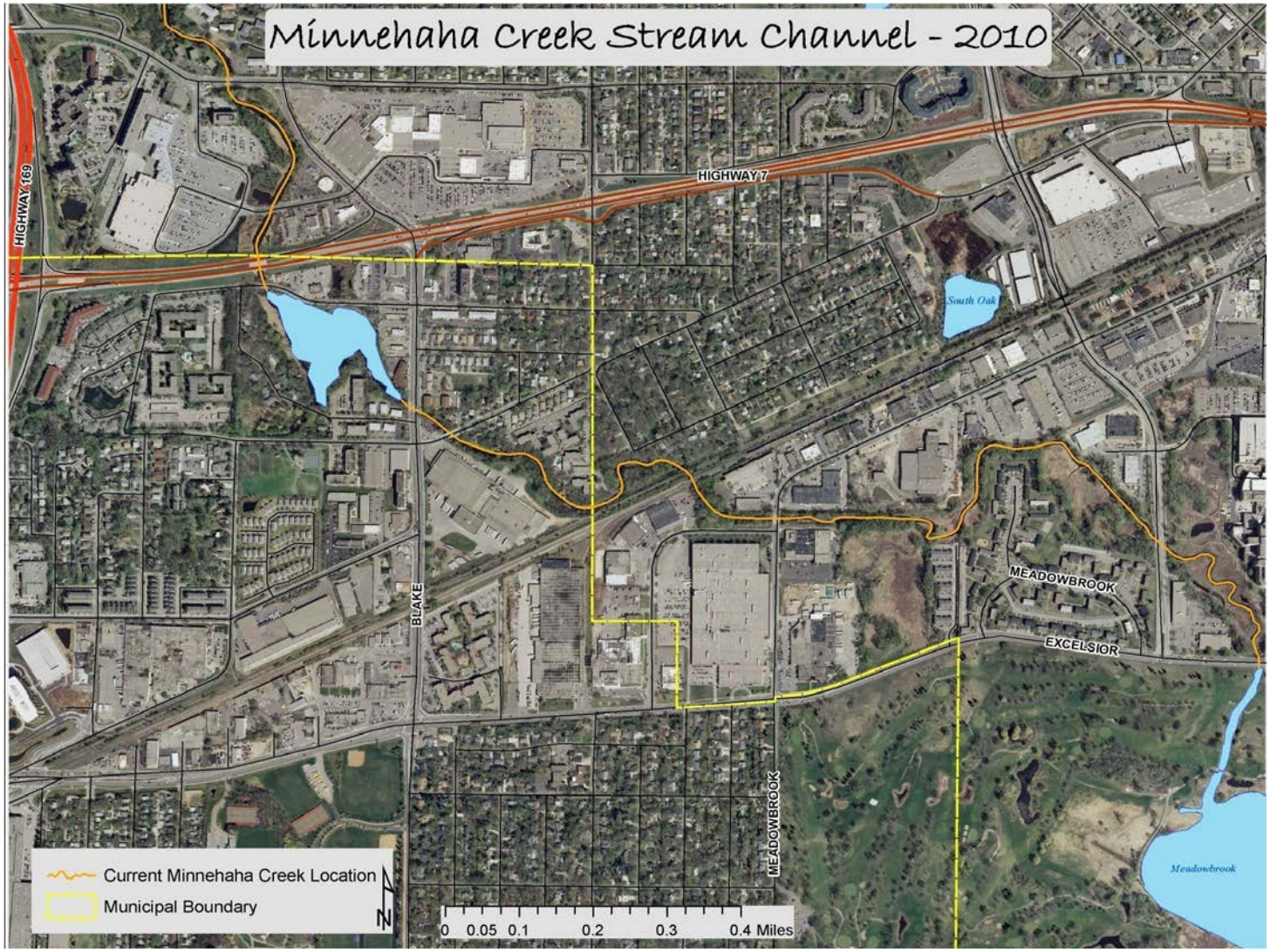

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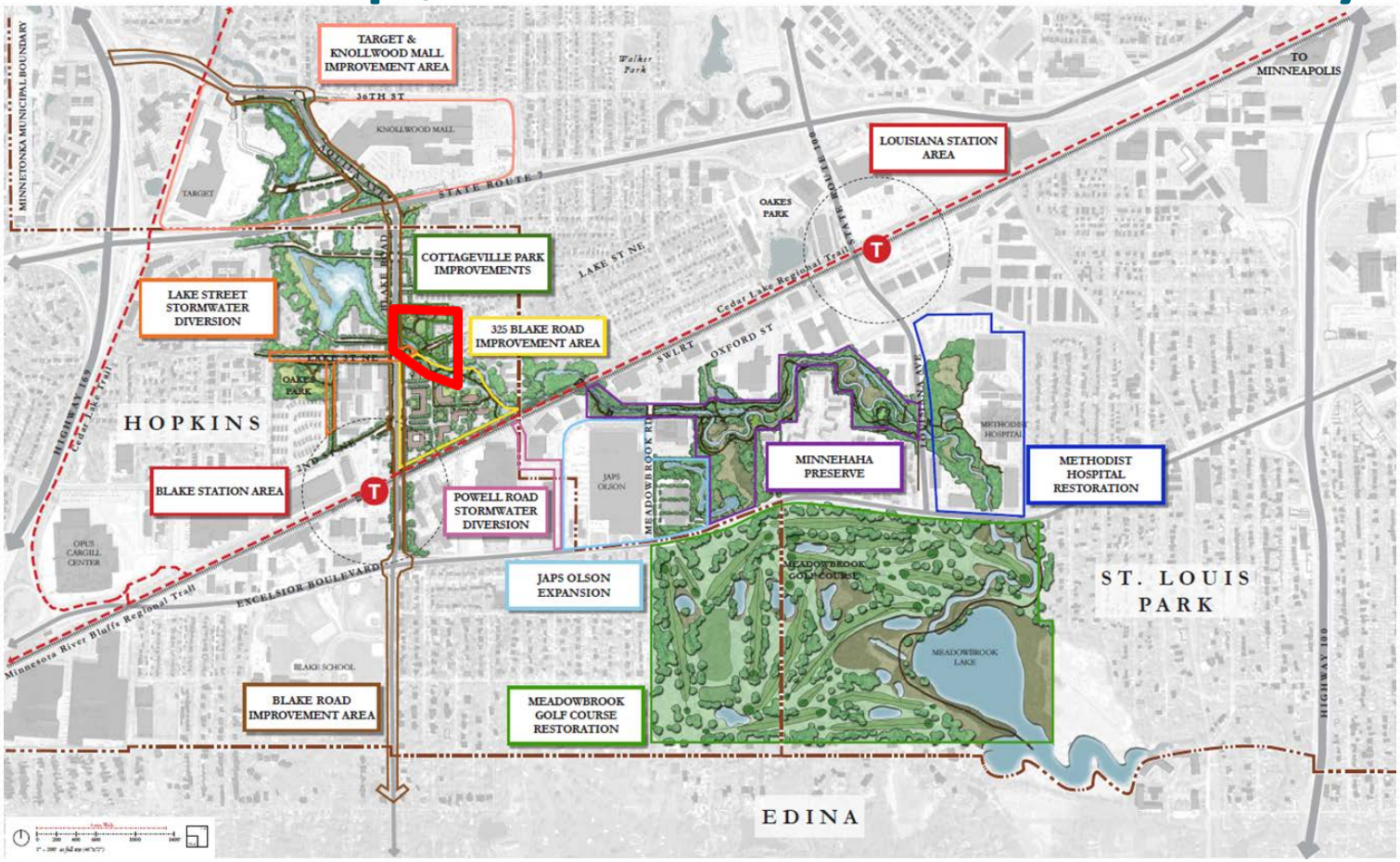
Minnehaha Creek Greenway: Partnership, Focus and Flexibility



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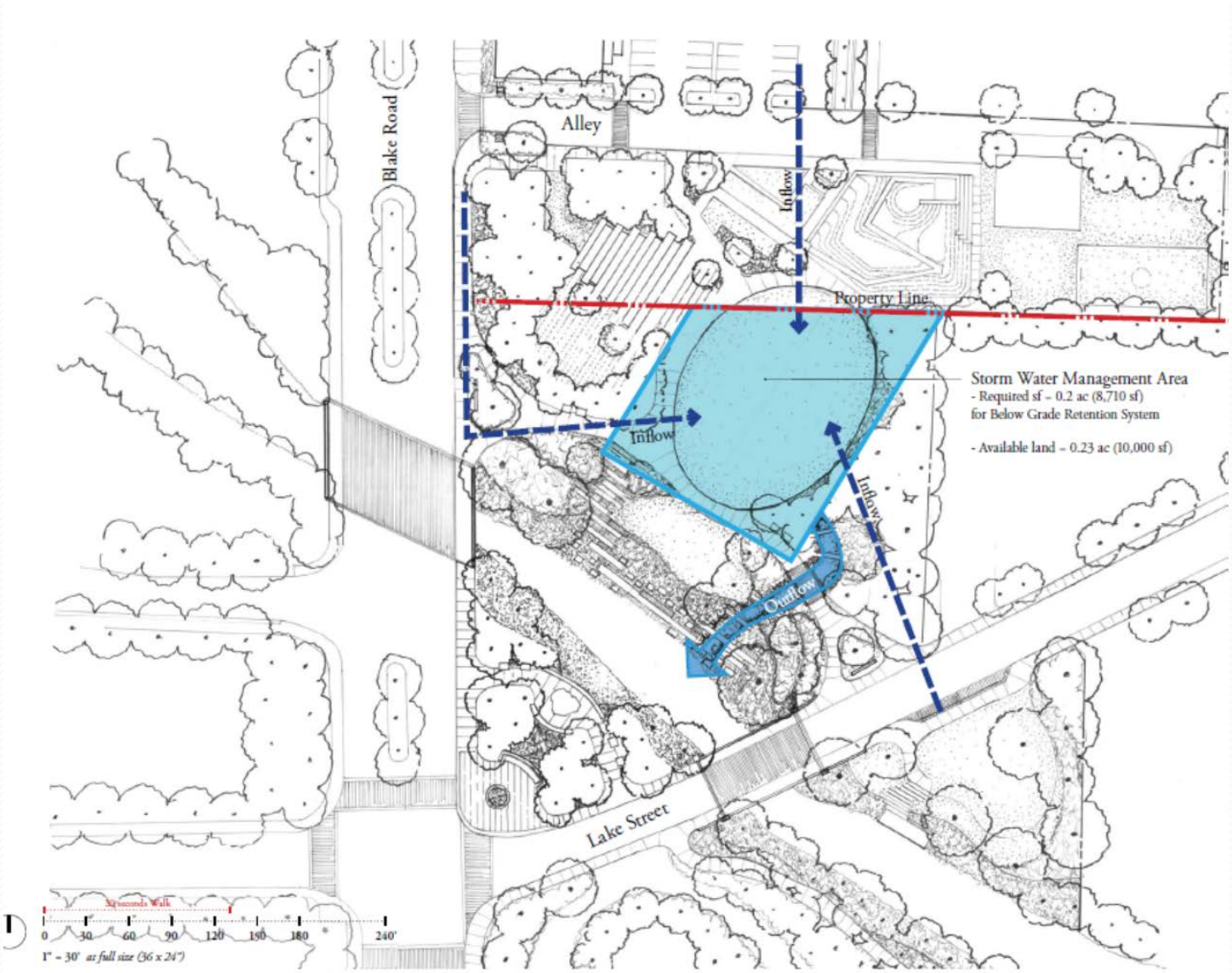
Cottageville Park

City of Hopkins

MINNEHAHA CREEK WATERSHED DISTRICT

CLEAN WATER LAND & LEGACY AMENDMENT



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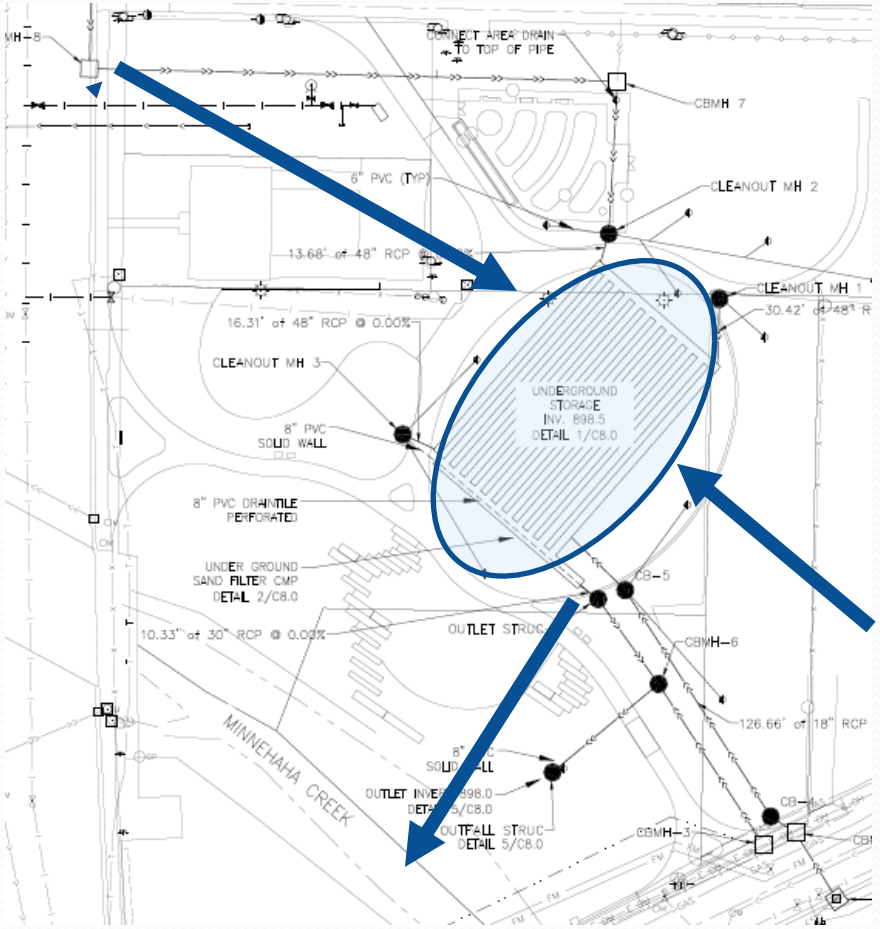

City of Hopkins

MINNEHAHA CREEK
WATERSHED DISTRICT

CLEAN WATER LAND & LEGACY AMENDMENT

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WATERSHED DISTRICT

CLEAN WATER LAND & LEGACY AMENDMENT

City of Hopkins

MINNEHAHA CREEK WATERSHED DISTRICT

Integrated Planning for Partnerships

- Not everyone cares about your issue as much as you do
- Step outside comfort zone and understand other people's objectives and constraints
- Plan projects with equal attention to issues outside primary discipline
- Breeds holistic projects, spanning multiple systems, creating layered benefit
- It takes longer than you think it should – Be patient
- Keep the vision in mind and focus on shared goals

MINNEHAHA CREEK WATERSHED DISTRICT

Creating Sustainable Communities Through Collaborative Planning

- 450 acres stormwater management
- 50 acres newly accessible green space
- 1.5 miles restored urban stream
- 2 miles new trail network connecting 600 housing units to transit
- 4.6 million of partner investment

SOUTHWEST
Green Line LRT Extension

SWLRT Regulatory Complexity

Earth Evans
2016 WR Conference
Oct 18, 2016

Brady Busselman, Sambatek; Charlie Howley, HTPO

METROPOLITAN COUNCIL | Metro Transit | FTA | Counties Transit Improvement Board | Minnesota Department of Transportation | Hennepin

EDEN PRAIRIE | MINNETONKA | EDINA | HOPKINS | ST. LOUIS PARK | MINNEAPOLIS

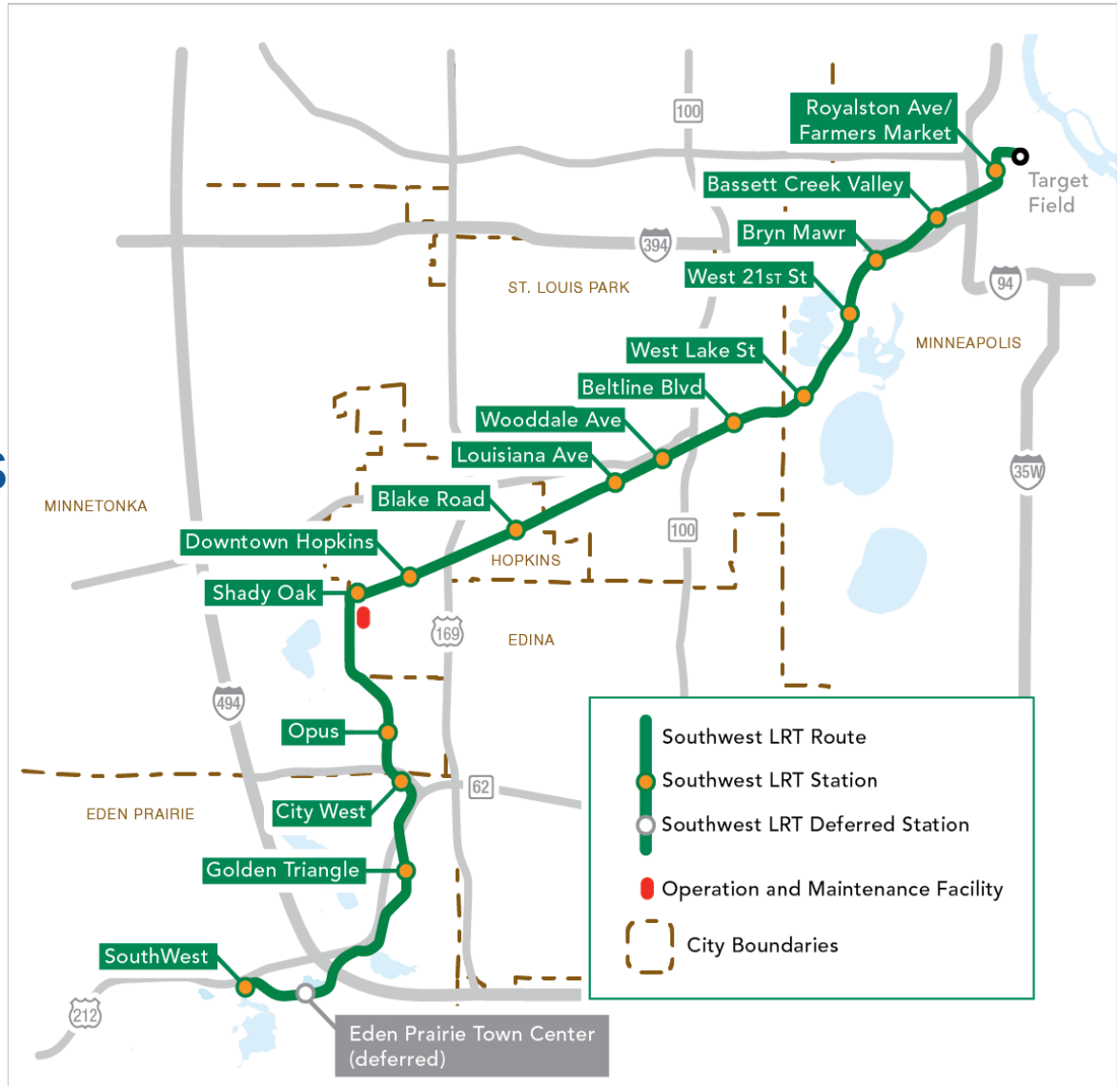
Today's Topics

- Project Overview
- Project Schedule
- Environmental Regulatory Agencies
  - Federal
  - State
  - Local
- Environmental Regulatory Coordination

Project Overview

Southwest LRT

- 14.5 miles new track
- 32 bridges
- 2 LRT tunnels
- Over 7 lineal miles of retaining walls
- 15 new stations
  - 1 deferred station
- 34,000 average weekday rides in 2040



Project Status

Project Readiness: Milestones Completed

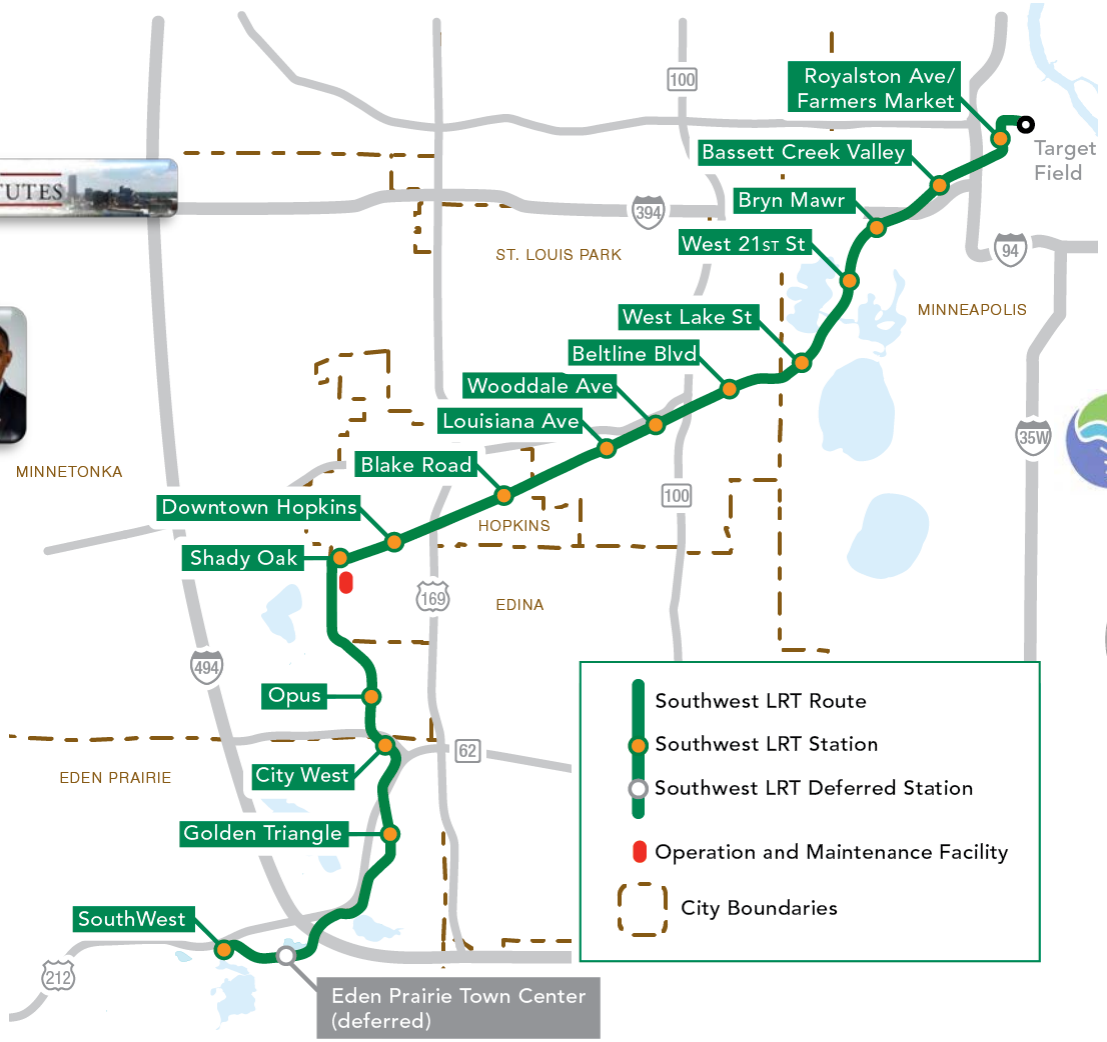
- Environmental reviews complete
  - Final Environmental Impact Statement: May 2016
  - Record of Decision: July 2016
  - FEIS Determination of Adequacy: Aug 2016
- Funding commitments for 100% ($928.8M) of the local share complete Aug 2016
- Application for Entry into Engineering for FTA New Starts Program Aug 2016
- 90% design plans complete
- 90% cost estimate complete

Milestones Look Ahead:

Milestone	Rev. 10.0 Submitted 8/19/16
FTA Approves Entry into Engineering	Nov 2016
Complete 100% Design Package for Civil	Dec 2016
Submit FFGA Application	Early 2017
Complete 100% Design Package for Systems	March 2017
Complete 100% Design Package for OMF	May 2017
FTA Approves FFGA	July 2017
Heavy Construction	2017-2020
Revenue Service	2021

Environmental Regulatory Agencies

Federal and State



Federal Approvals

FEIS

Published 5/13/16

ROD

Signed by FTA 7/15/16;
All NEPA requirements met

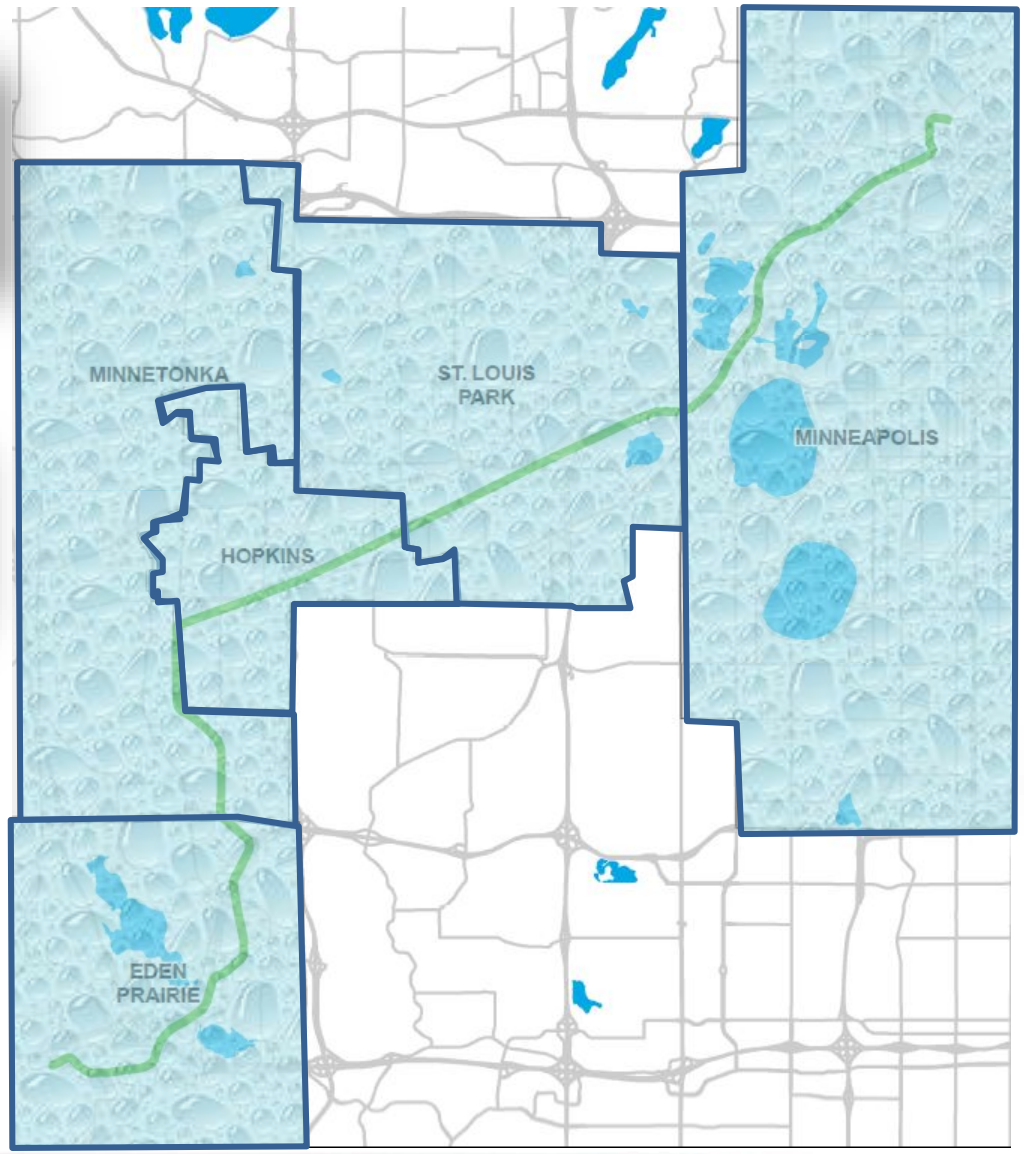
DEIS

Published 10/11/2012

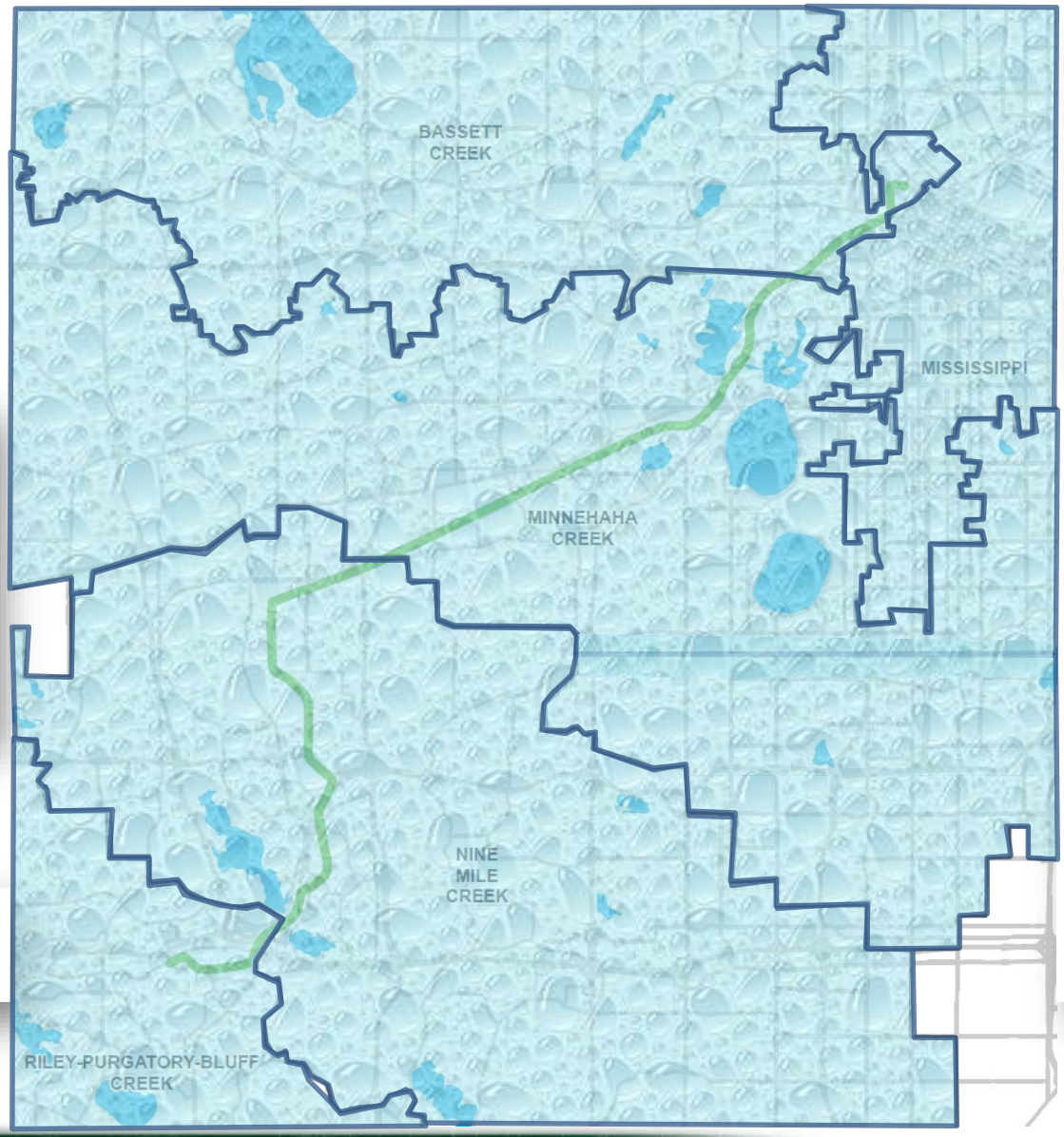
SDEIS

Published 5/22/15

Local / Stakeholders



Local / Watershed



Bassett Creek Watershed Management Commission

MWMO Protect it. Pass it on. MISSISSIPPI WATERSHED MANAGEMENT ORGANIZATION

9 MILE CREEK WATERSHED DISTRICT

Riley Purgatory Bluff Creek Watershed District

MINNEHAHA CREEK WATERSHED DISTRICT

Environmental Regulatory Coordination

Environmental Regulatory Coordination

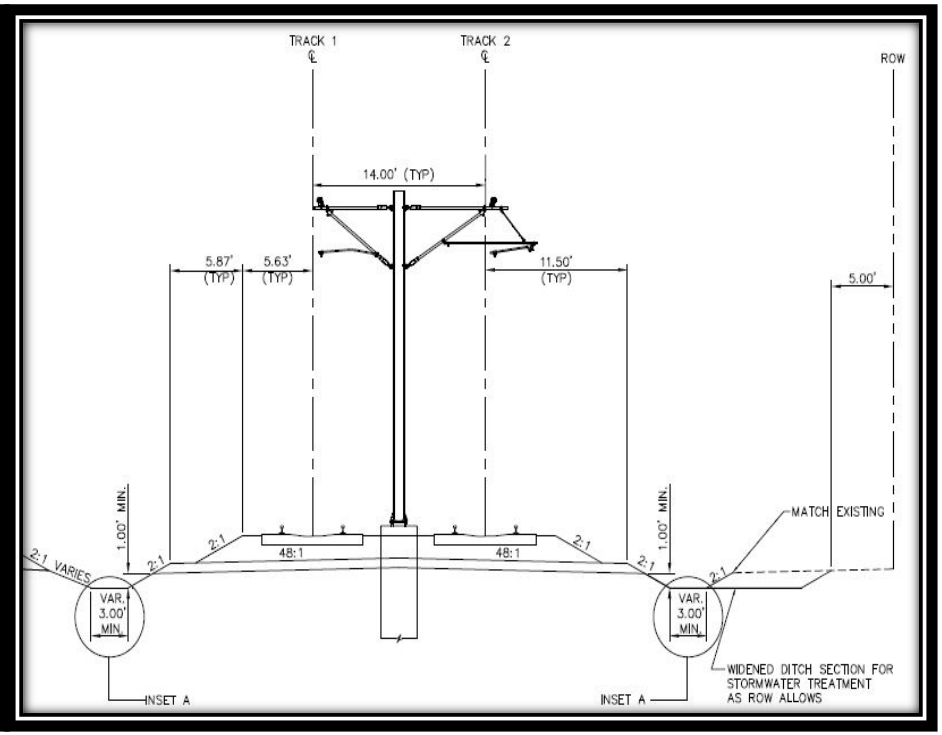
What makes this project unique?

- Size: 14.5 miles of track
- Numerous Stakeholders
- Overlapping Requirements
- Public and Private Scrutiny
- Fully Developed Urban Environment
- Contamination

Size

- Linear Corridor – used linear BMPs adjacent to track where feasible

Example: Ditch checks



Track Typical Cross Section

Extensive Coordination with Stakeholders

- Weekly meetings with municipal staff starting in 2013
- Technical Evaluation Panel meetings monthly starting in 2013
- Plan submittals to Municipalities at 30%, 60%, 90%, 95%, 100%
- Ongoing meetings and formal submittals to Watersheds at 60%, 95%, and 100%. Presentations to Boards at 60%
- Public Outreach Staff from Metro Transit

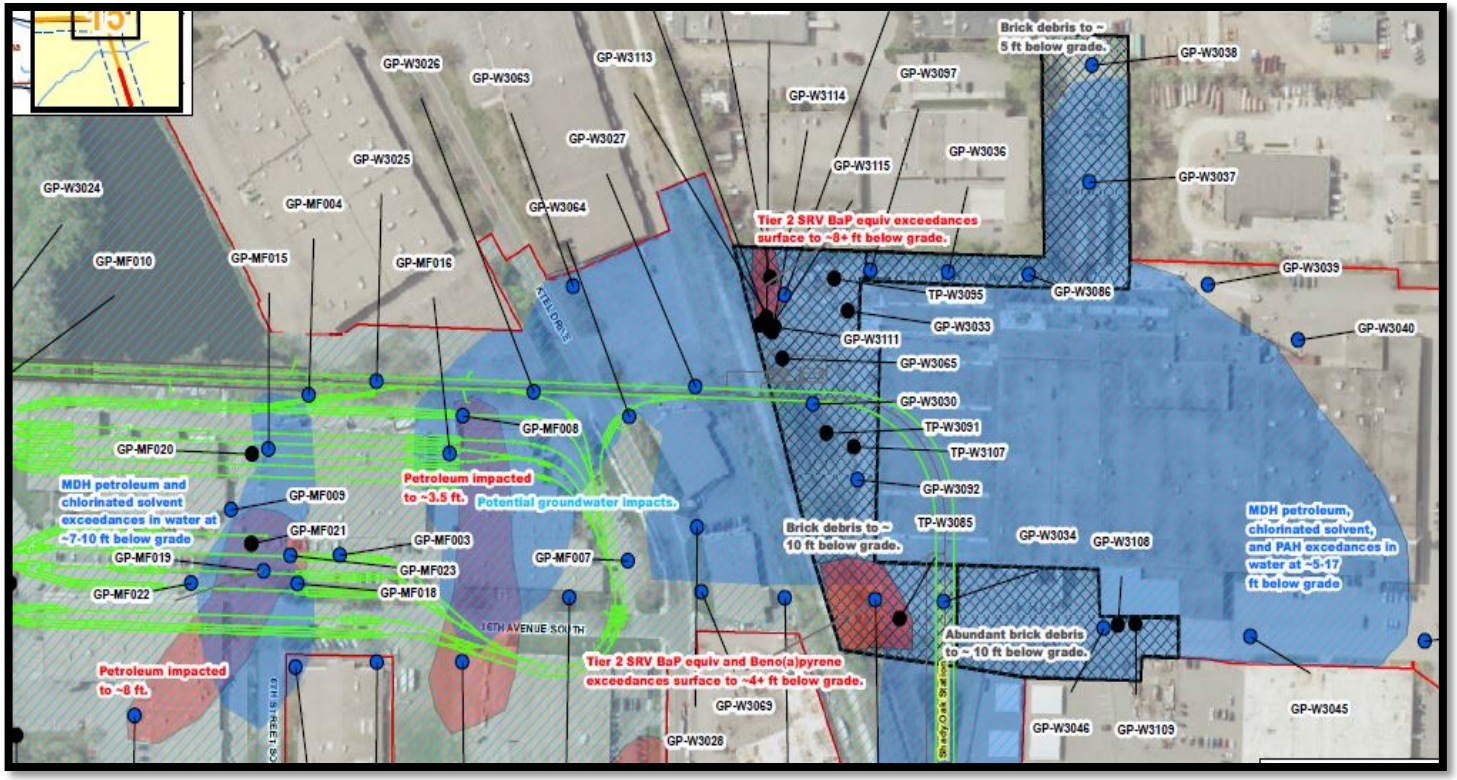
Urban Environment

- Oversized corridor BMPs
  - Retrofit water quality for densely impervious corridor where feasible
  - Routed public ROW impervious to proposed BMPs
  - Length of linear corridor was an advantage
  - Flexibility to meet standards within Watershed or City boundary versus by waterbody

Source: Empire WWTP Infiltration Basin

Contamination

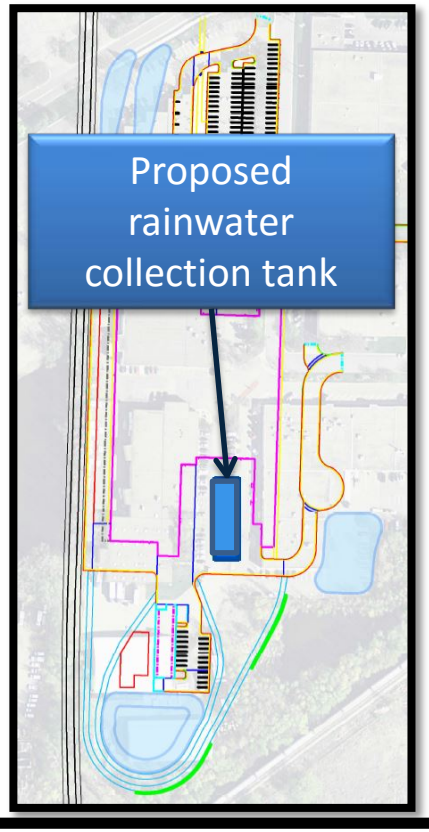
- Challenge
  - Groundwater and Soil contamination for half of the project corridor

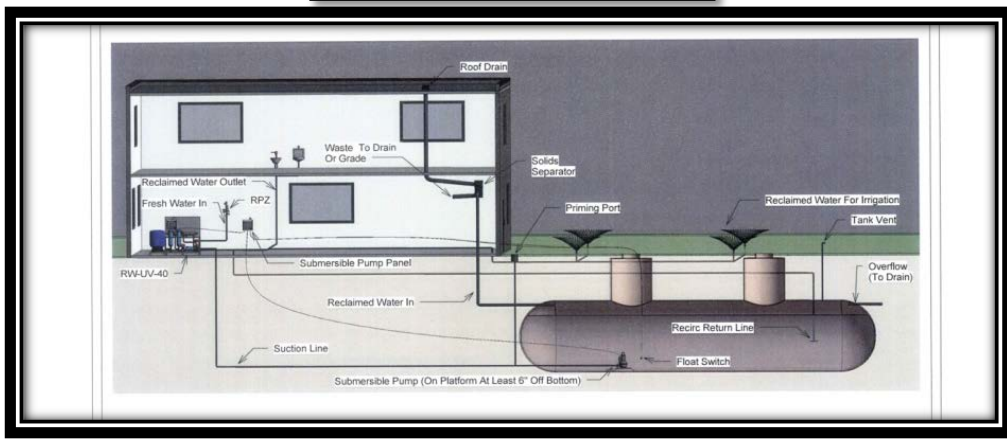


Response Action Plan graphic at proposed Shady Oak Park and Ride

Contamination

- MULTIPLE BMP TYPES TO ADDRESS CONTAMINATION
  - Meet water quality requirement with ponds and bioretention
  - Store roof runoff in a collection tank and use for train washing
  - Rainwater collection tank size restricted by frequency of train washing (not feasible to use larger tank and reuse all the water)
  - Meeting B3 rate control and water quality requirements
  - Reconstructing existing non-functioning wetland outlet
  - Net reduction in impervious surfaces





OMF Reuse Tank

Regulatory Compliance

- Determination of Adequacy under MEPA on August 10, 2016
- CWA Section 404 Permit in progress and 401 certification issued
- DNR waived jurisdiction
- Eden Prairie and Minnetonka WCA Notice of Decision
- Watershed District and City permits in process; approvals expected in Nov-Dec

More Information

Online:

www.SWLRT.org

Email:

SWLRT@metrotransit.org

Twitter:

www.twitter.com/southwestlrt

Embracing Sustainable Stormwater Management at the U

October 18, 2016

SRF

Project Design Team

- Civil Design, Utilities, Construction Admin, and Project Management – HTPO
- Landscape Architecture and Historic Review - Damon Farber Landscape Architects
- Stormwater Management, Lighting, Traffic Signal – SRF Consulting Group, Inc.

University Team

- Capital Planning and Project Management (CPPM)
- Landcare
- Parking and Transportation Services
- Engineering and Utilities

Project Need

- Street deterioration, localized flooding, limited storm sewer capacity
- Need for traffic redesign to meet University priorities for pedestrians, bikes, and vehicles
  - Non-functioning intersection with temporary signal
- Planned extension of chilled water lines through corridor
- 53 Ash trees in corridor selected for removal and replaced with diverse species mix

Stormwater Management Goals

- University's 'Guiding Principles'
  - Treat stormwater close to where it falls; reduce downstream impacts; recharge groundwater through infiltration where possible
- B3 Requirements
  - Post development site runoff must be controlled to match the runoff rates for native soil and vegetation conditions for the 2-year and 10-year, 24-hour design storms
  - Prohibit discharge from the site for 1.1 inches of runoff for all new/redeveloped impervious surfaces
  - Provide treatment systems to remove 80% of post-development TSS and 60% of post-development TP

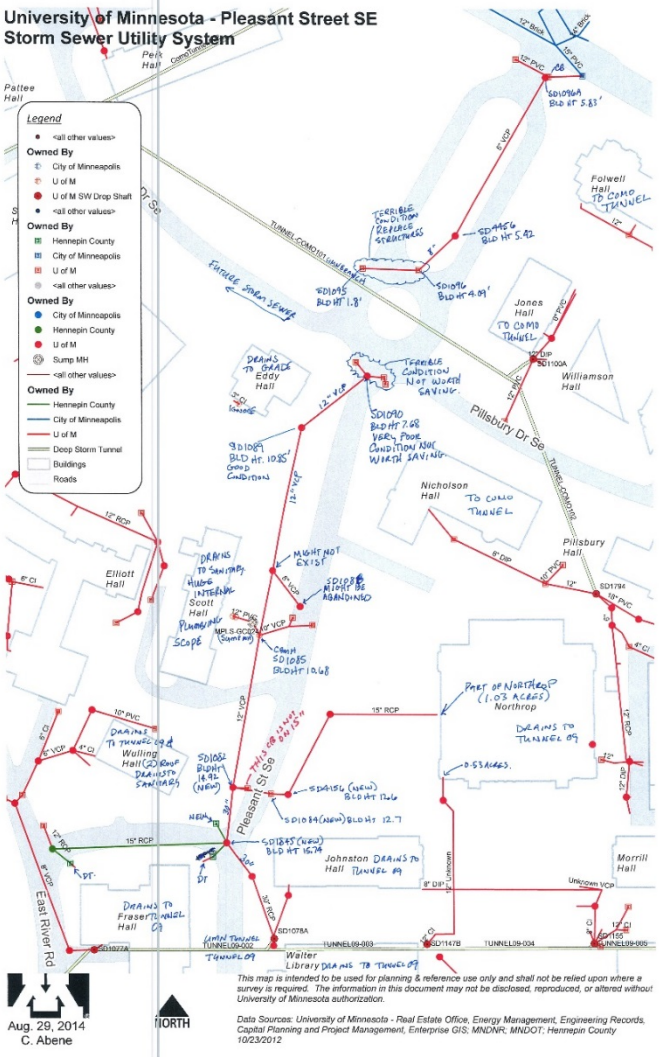
Stormwater Management Goals

- Project Goals
  - Reduce runoff rate for 2-year and 10-year, 24-hour design storms, ensure no capacity issues at connection to Minneapolis system
  - Retain 1.1 inches of runoff from the new/redeveloped impervious
  - Retain 0.5 inches of runoff from the impervious area if infiltration is infeasible
  - Remove 80% of TSS and 60% of TP

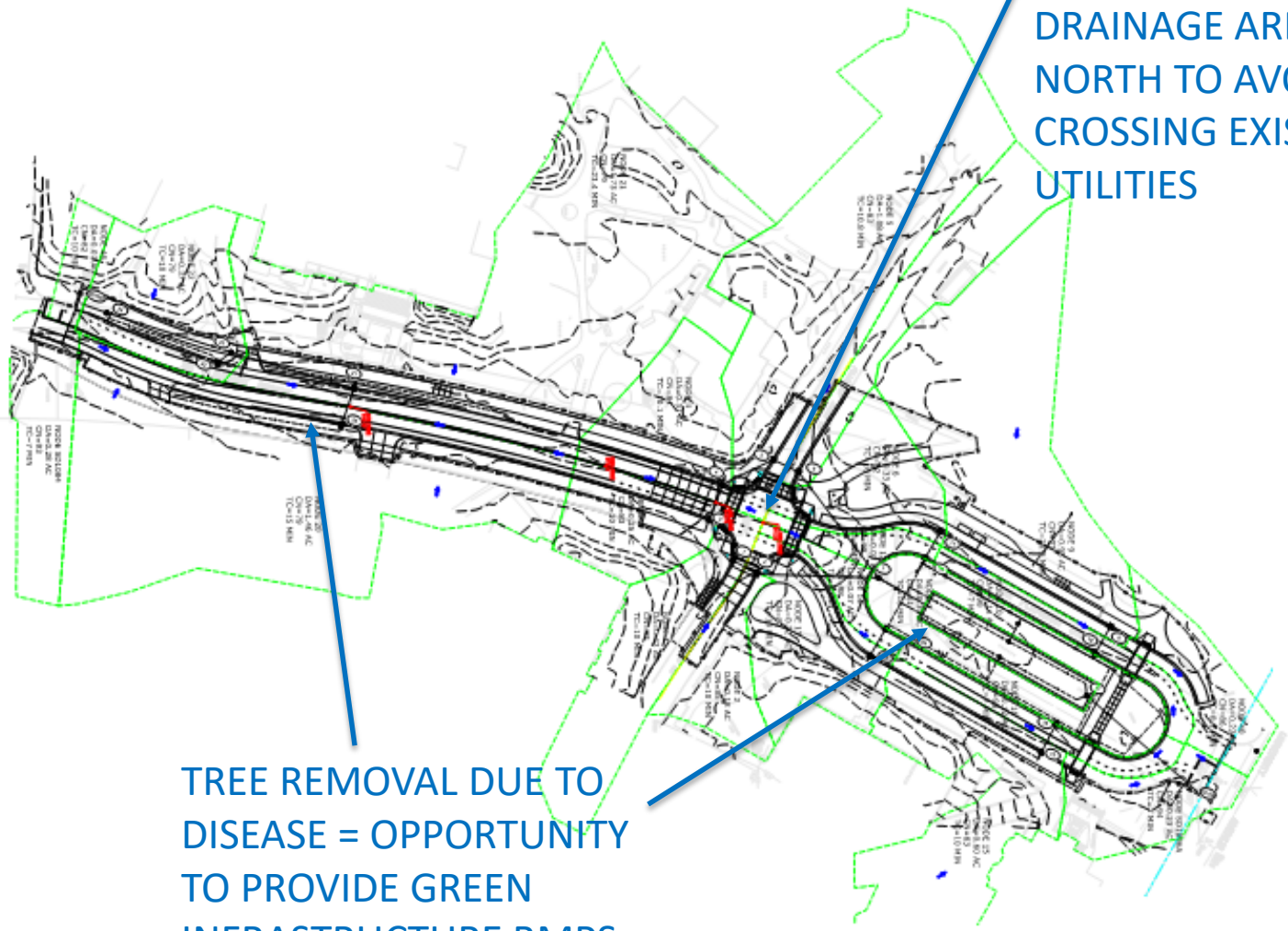
Existing Drainage

Drainage divide at Pleasant and Pillsbury

- North system discharges to Minneapolis storm sewer
- South system discharges to University storm tunnel
- Existing storm sewer in southern area is located in an area that is not to be disturbed and has capacity issues



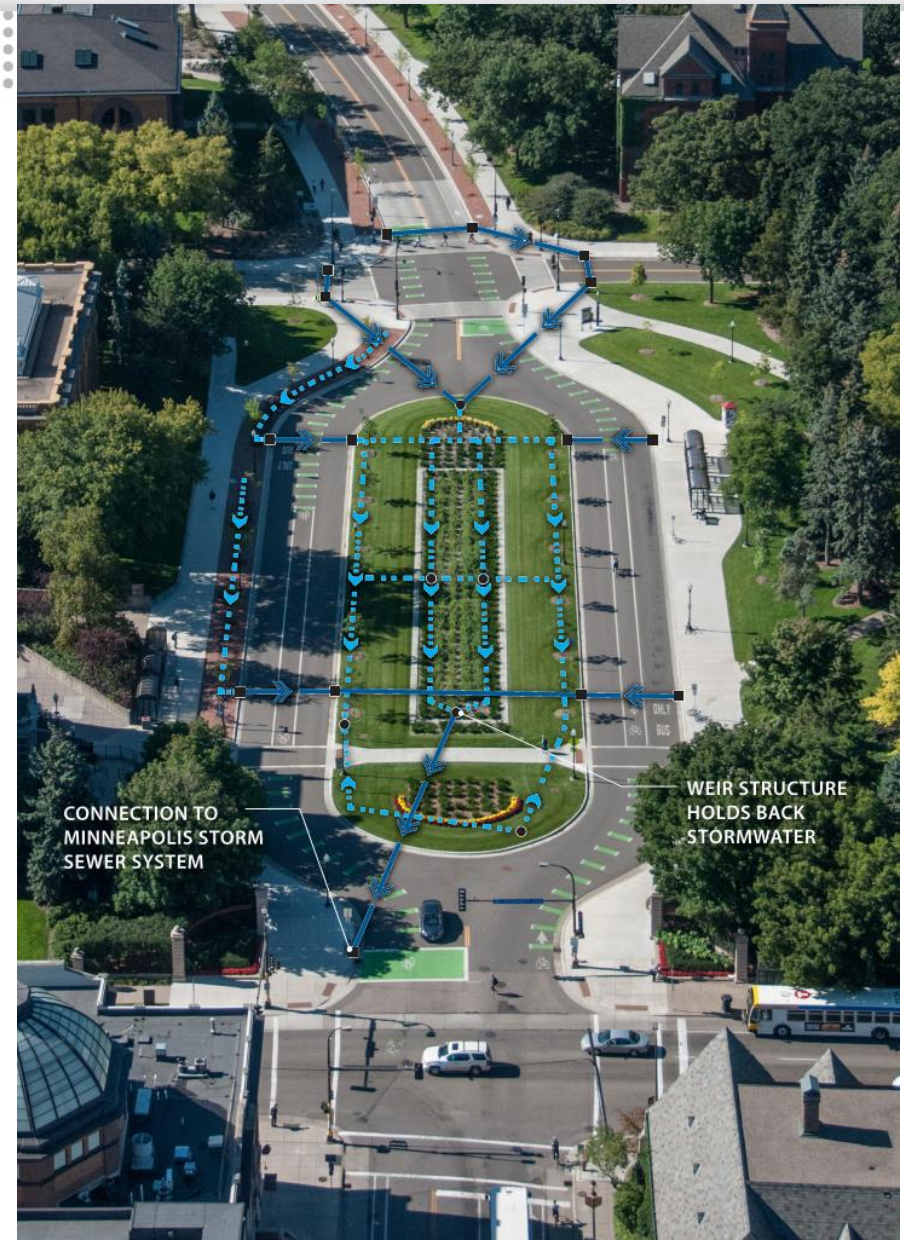
Proposed Drainage



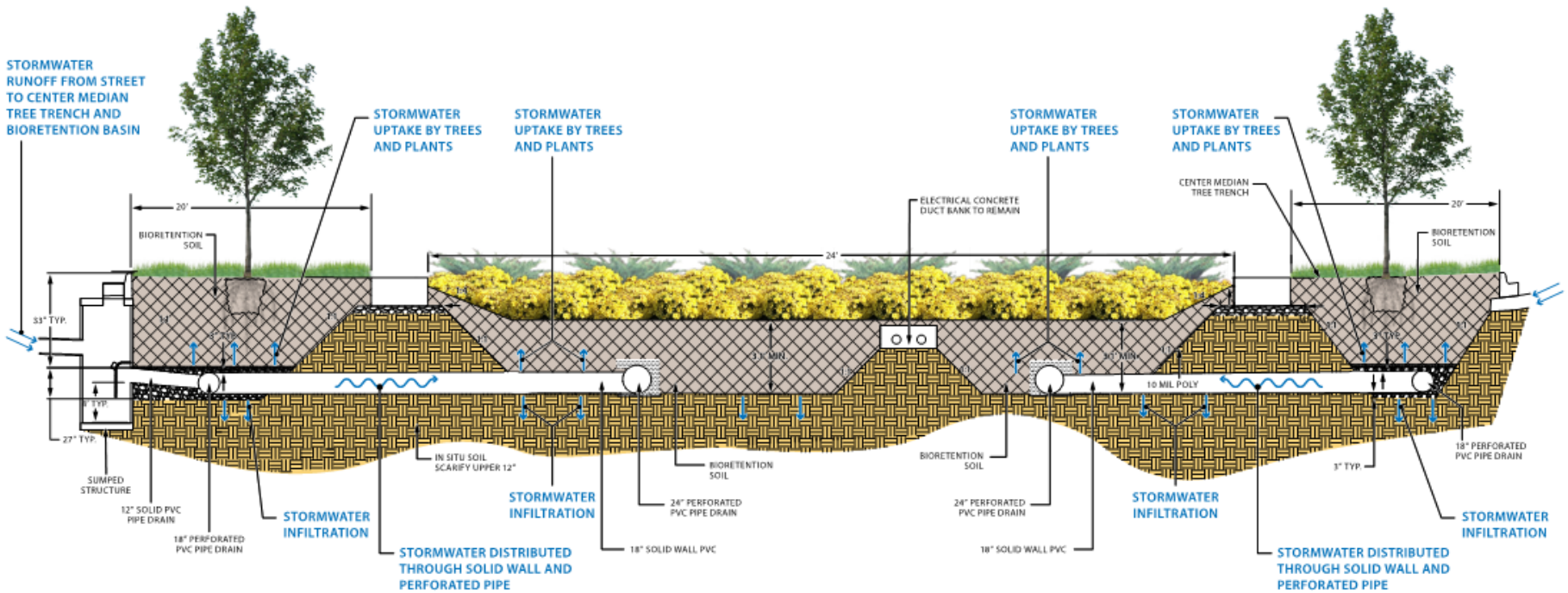
ADDITIONAL 2+ ACRES OF DRAINAGE AREA TO NORTH TO AVOID CROSSING EXISTING UTILITIES

TREE REMOVAL DUE TO DISEASE = OPPORTUNITY TO PROVIDE GREEN INFRASTRUCTURE BMPS

Center Median BMP

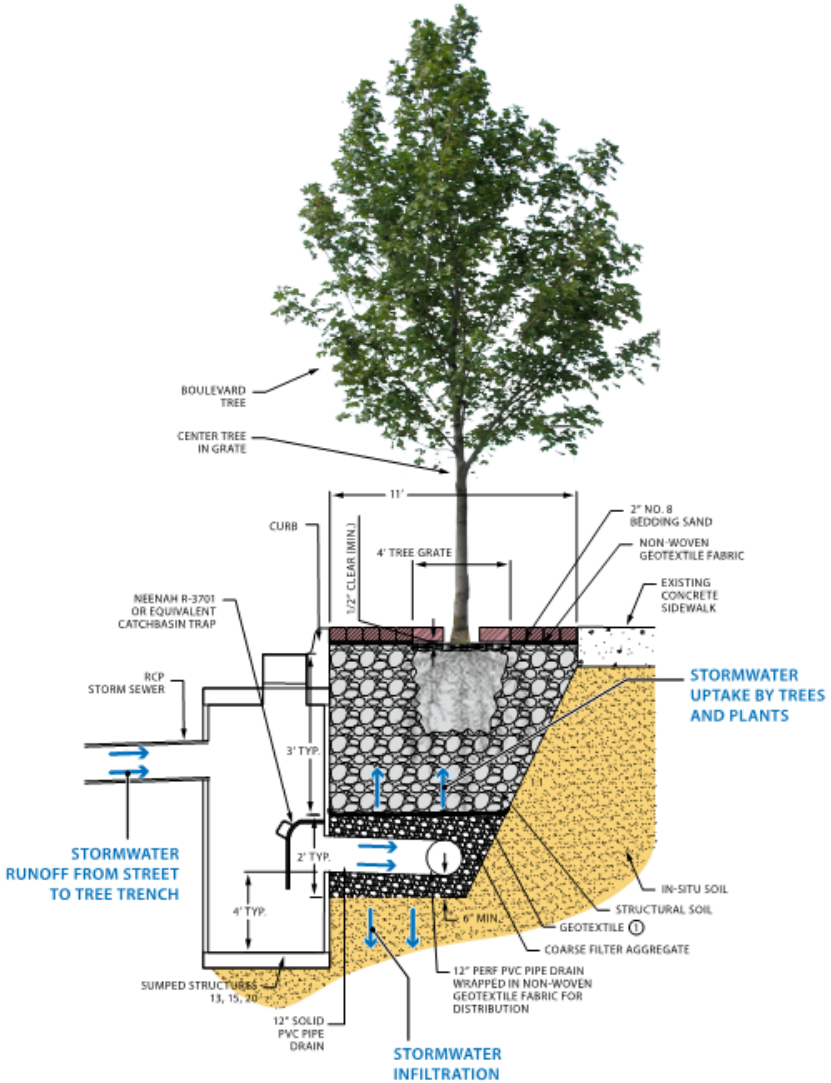


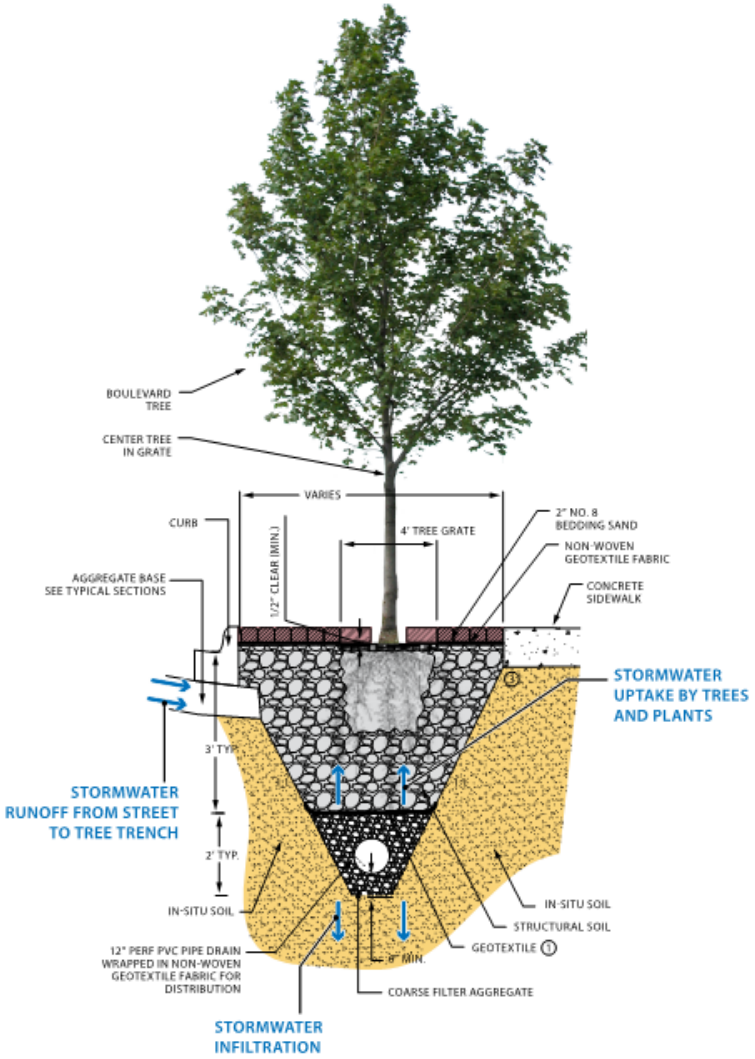
Center Median BMP



Tree Trenches/Permeable Paver Boulevard

Tree Trenches/Permeable Paver Boulevard





Results - Rate Control

North Section

	Existing Conditions	Proposed Conditions
2-year, 24-hour Peak Discharge Rate	6.0	1.3
10-year, 24-hour Peak Discharge Rate	9.8	6.6
100-year, 24-hour Peak Discharge Rate	15.4	15.2

South Section

	Existing Conditions	Proposed Conditions
2-year, 24-hour Peak Discharge Rate	6.2	3.0
10-year, 24-hour Peak Discharge Rate	7.8	7.1
100-year, 24-hour Peak Discharge Rate	9.5	10.6

Results – Water Quality & Volume Control

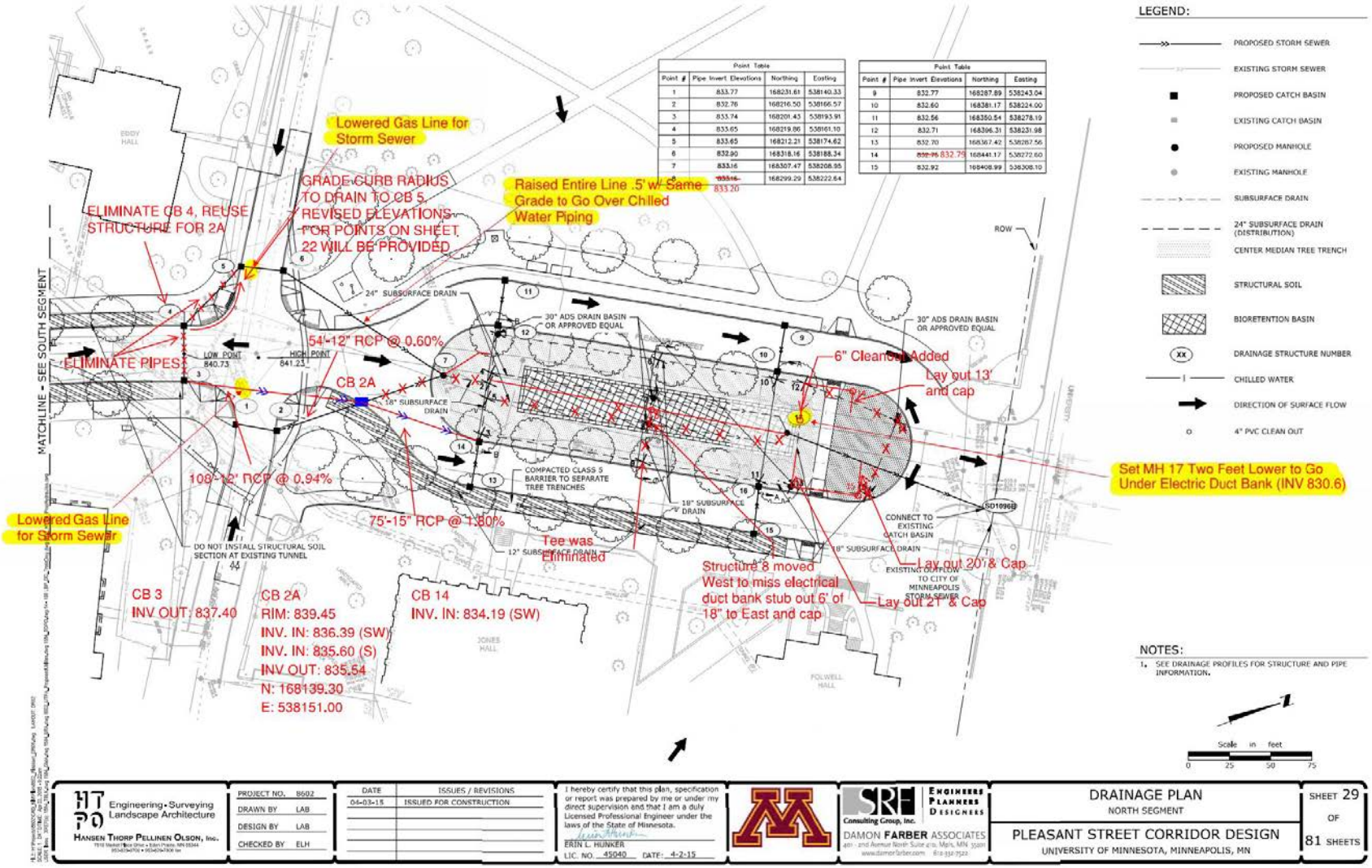
- North Drainage Area

Volume Goal (1.1” over impervious area)	5,300 cubic feet
Volume Required (0.5” over impervious area)	2,400 cubic feet
Volume Provided	8,900 cubic feet
Percent TSS Removed	100%
Percent TP Removed	100%

- South Drainage Area

Volume Goal (1.1” over impervious area)	2,000 cubic feet
Volume Required (0.5” over impervious area)	900 cubic feet
Volume Provided	1,200 cubic feet
Percent TSS Removed	79%
Percent TP Removed	79%

Changes During Construction



Point Table			
Point #	Pipe Invert Elevations	Northing	Easting
1	833.77	168231.61	538140.33
2	832.76	168216.50	538166.57
3	833.74	168201.43	538193.91
4	833.65	168219.86	538161.10
5	833.65	168212.21	538174.62
6	832.90	168318.16	538188.34
7	833.16	168307.47	538208.95
8	~~833.16~~ 833.20	168299.29	538222.64

Point Table			
Point #	Pipe Invert Elevations	Northing	Easting
9	832.77	168287.89	538243.04
10	832.60	168381.17	538224.00
11	832.56	168350.54	538278.19
12	832.71	168396.31	538231.98
13	832.70	168367.42	538267.56
14	~~832.96~~ 832.79	168441.17	538272.60
15	832.92	168408.99	538308.10

Construction

Construction

Construction

Questions?

Erin Hunker, PE, CFM, SRF Consulting Group
Cathy Abene, PE, University of Minnesota

Building an Urban Stormwater Treatment Testbed

St. Anthony Regional Stormwater Treatment & Research System

Marcy Bean, Mississippi Watershed Management Organization

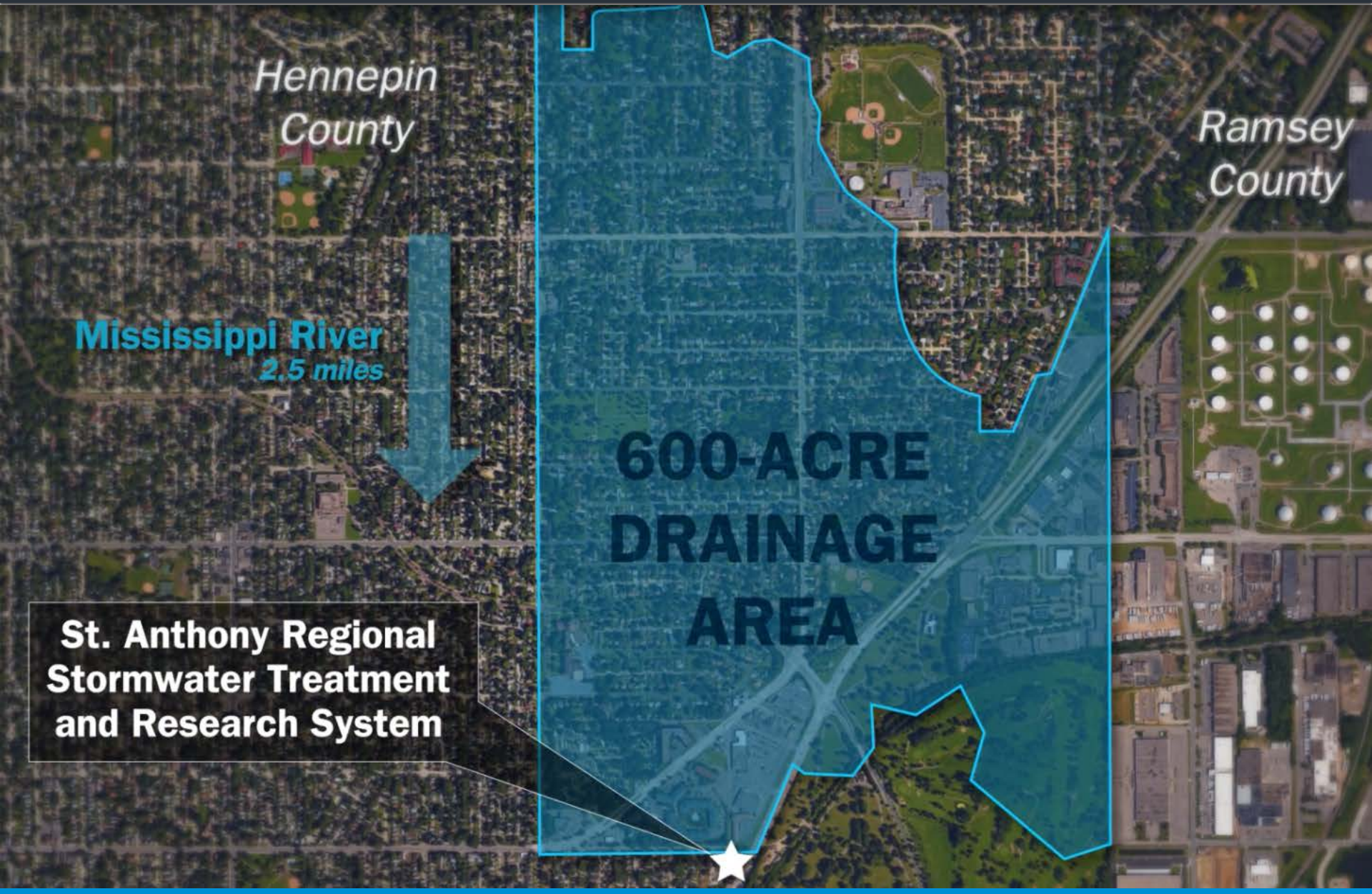
Bill Alms, WSB Engineering

October 18, 2016

St. Anthony Regional Treatment & Research System

- Project Overview
- Partnerships
- Design + Construction
- Research

ST. ANTHONY REGIONAL TREATMENT



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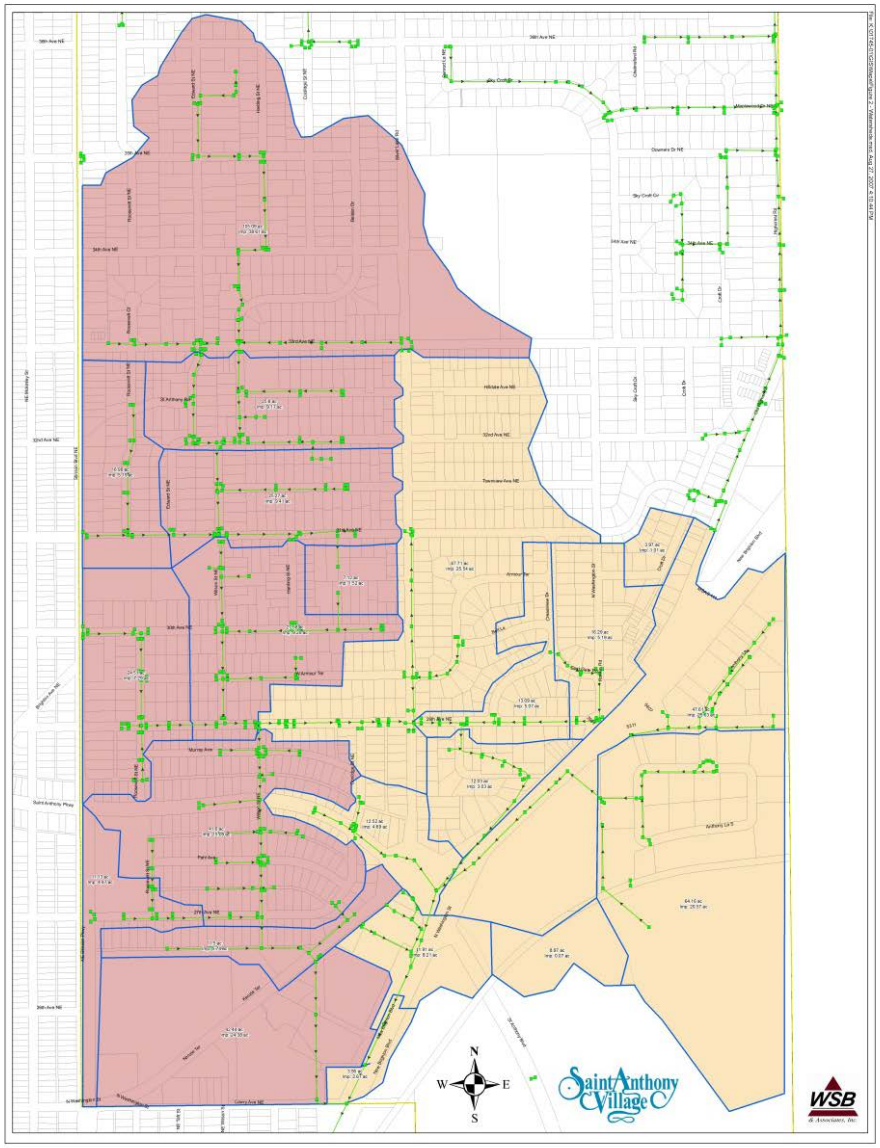
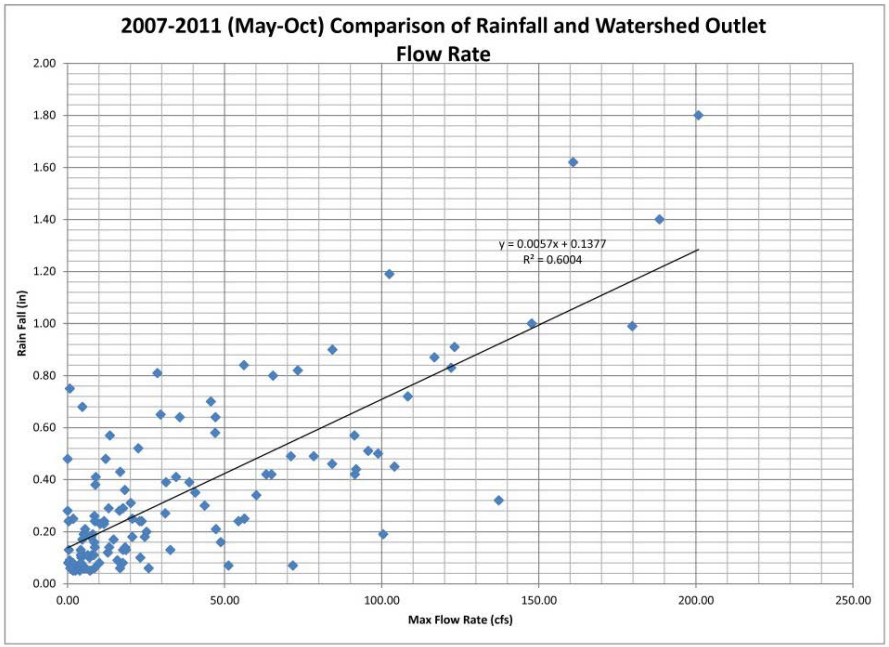




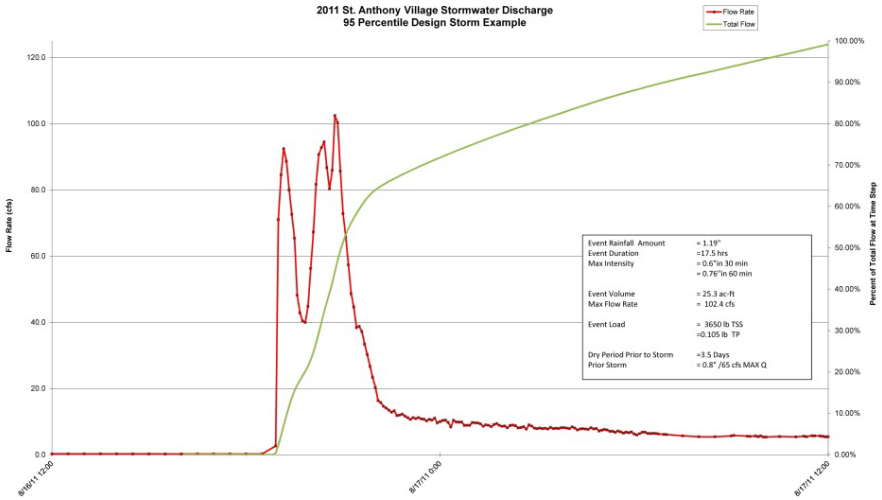


Figure 1: Annual Mass of TSS Removed at Specific Design Flow Rate

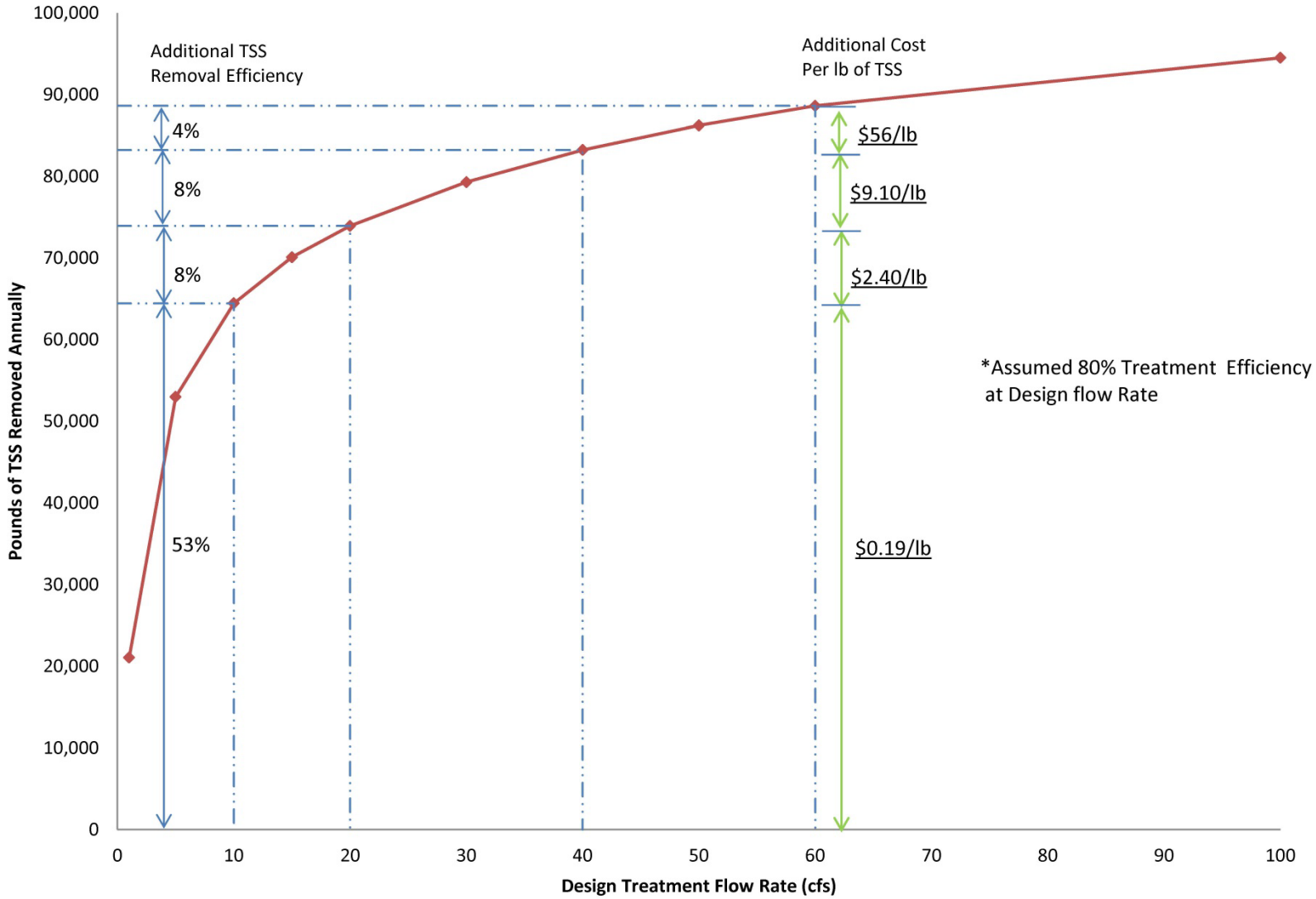
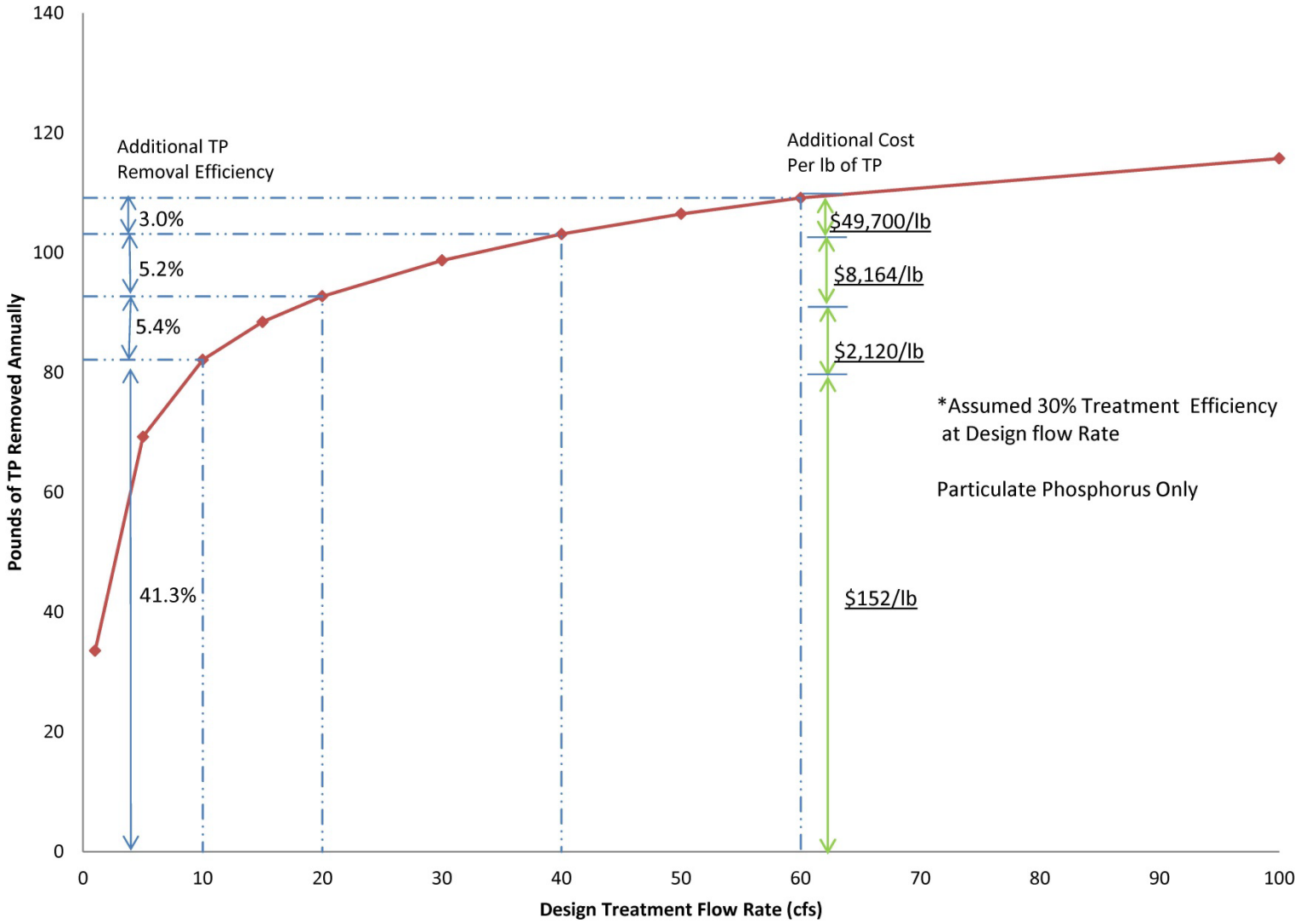


Figure 1: Annual Mass of TP Removed at Specific Design Flow Rate



ST. ANTHONY REGIONAL TREATMENT

A Aluminum Swirl Chamber
"Primary Treatment" in a chamber designed to swirl water to separate out total suspended solids (TSS), dropping them to the bottom of the chamber. The solids can be vacuumed out of the tank as part of standard City maintenance.

B Distribution Well
If the system is full, the water will flow out after 90% of the TSS has been removed.

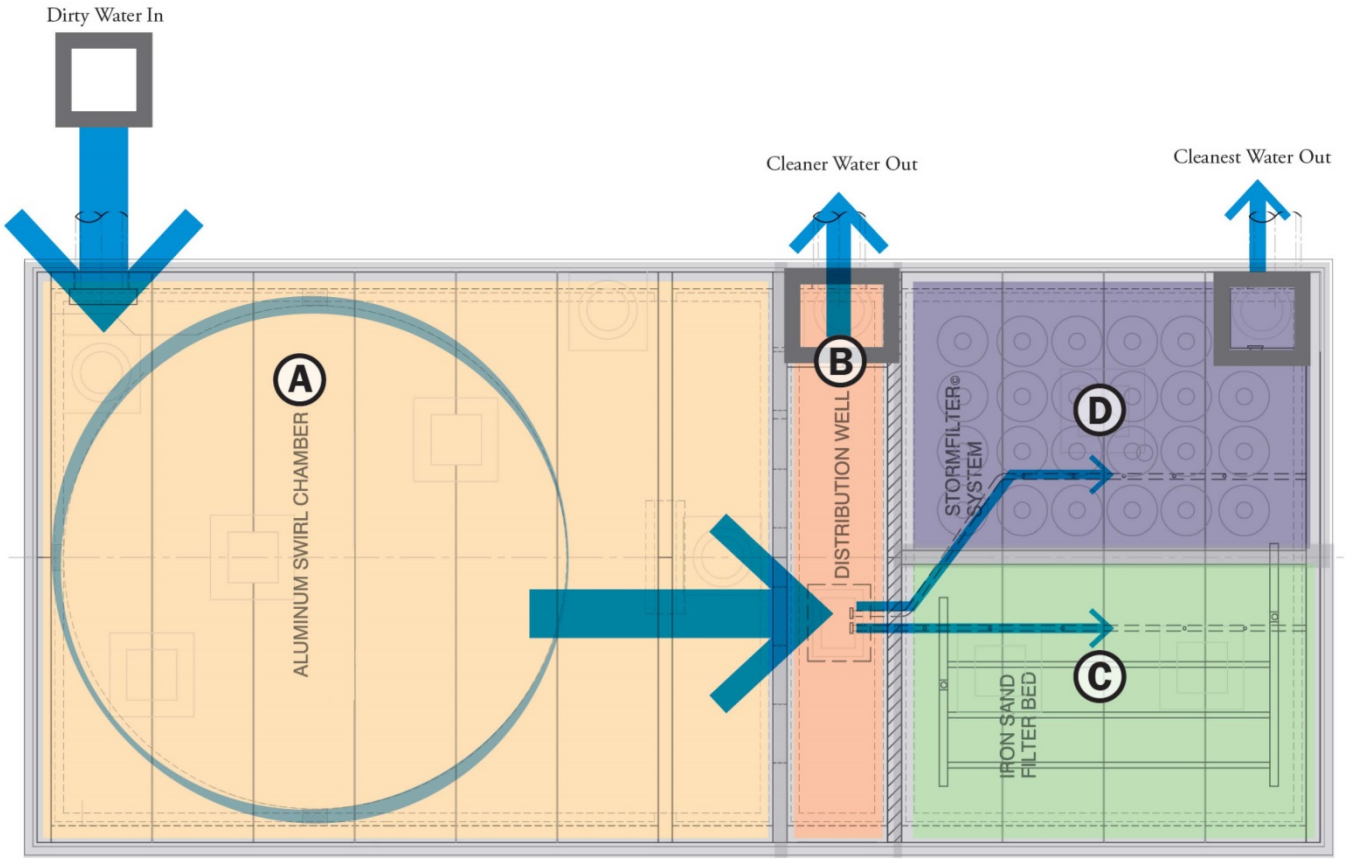
Some of the water will enter the last two chambers that contain "filter media" that the MWMO will monitor to see how effective they are at removing dissolved pollutants. These chambers can be modified to allow the MWMO to study other methods of treatment.

C Iron Sand Filter (Trial)
Iron helps removed dissolved pollutants from water, particularly phosphorus. Iron is mixed with sand, which acts as secondary treatment to test removal of the dissolved pollutants.

D StormFilter System® (Trial)
StormFilter is a proprietary system that consists of cartridges filled with filter media customized to the pollutant you're trying to remove from the water. As of 2015, the MWMO will be targeting dissolved phosphorus.

MWMO Stormwater Monitoring Locations

Project completed in collaboration with:
City of Saint Anthony Village, City of Minneapolis, WSB Associates



CONSTRUCTION

WSB

MWMO MISSISSIPPI WATERSHED MANAGEMENT ORGANIZATION

CONSTRUCTION

WSB

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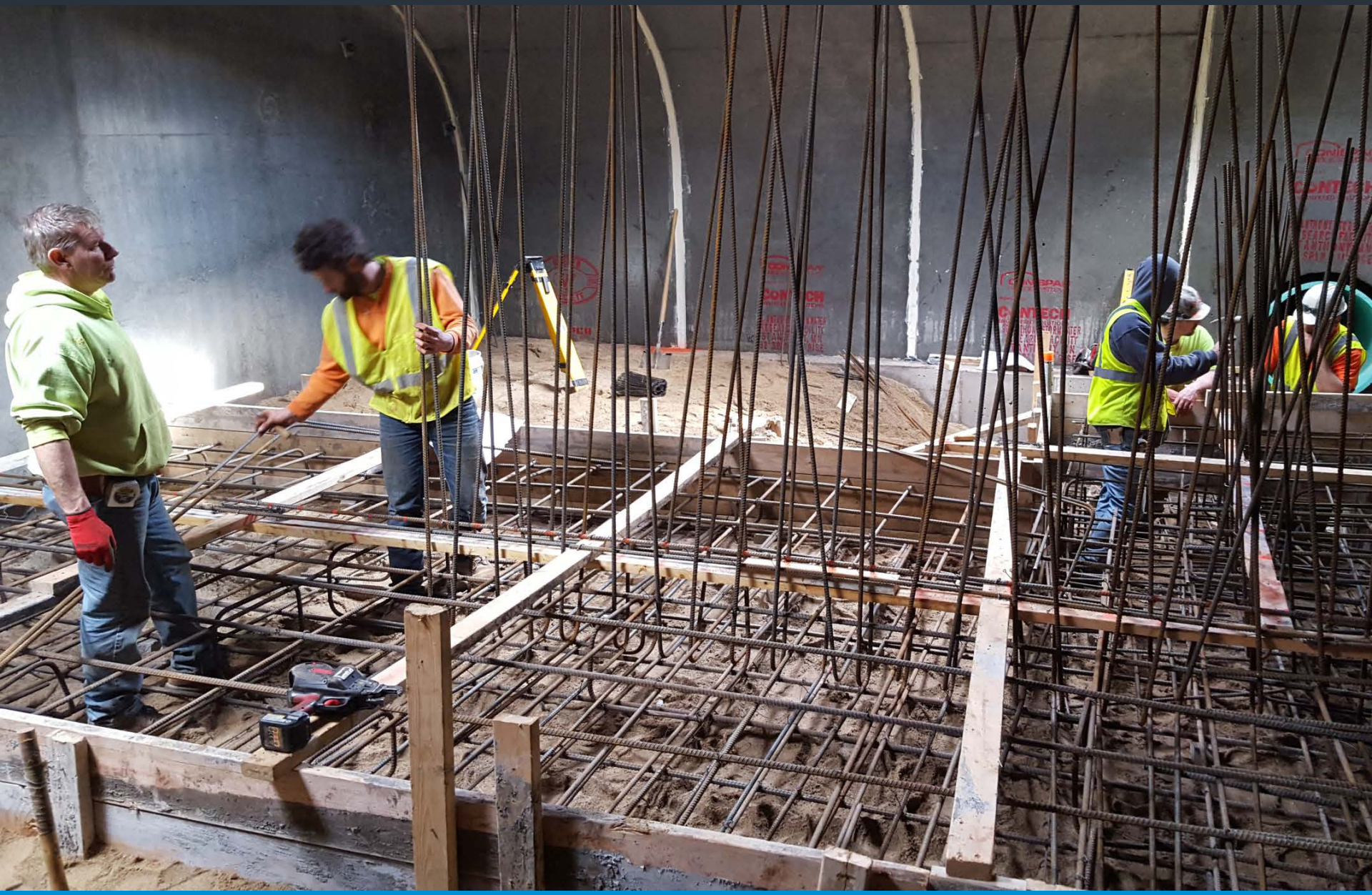
MWMO MISSISSIPPI WATERSHED MANAGEMENT ORGANIZATION

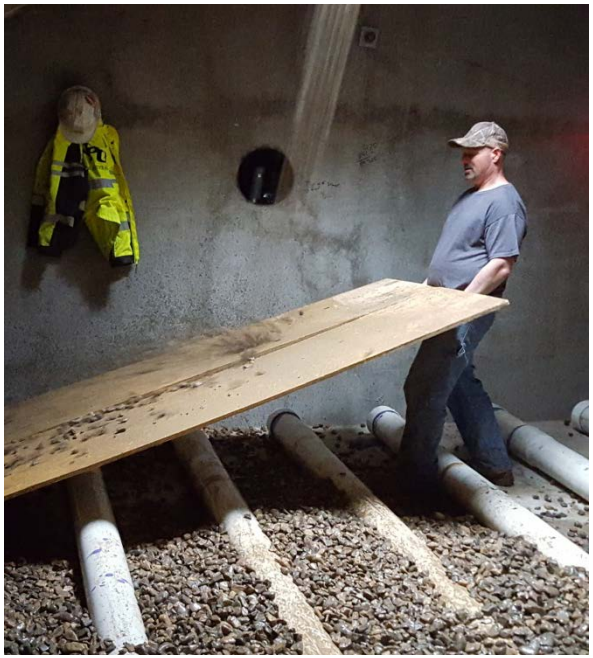


CONSTRUCTION

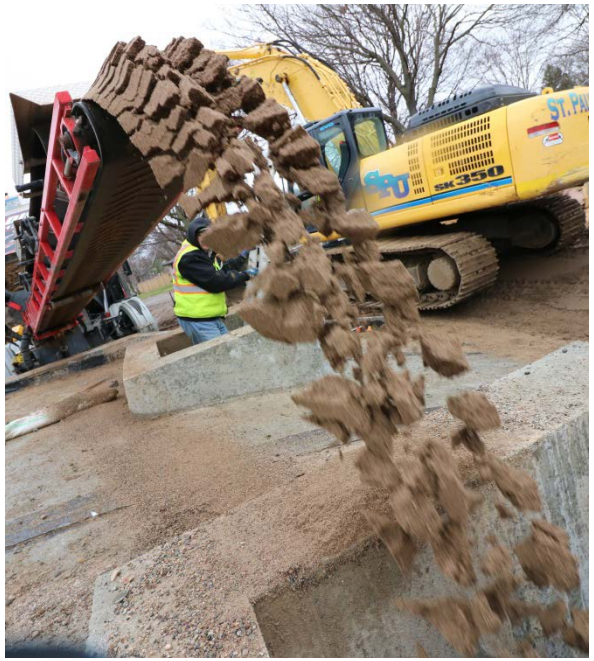
WSB

MWMO MISSISSIPPI WATERSHED MANAGEMENT ORGANIZATION

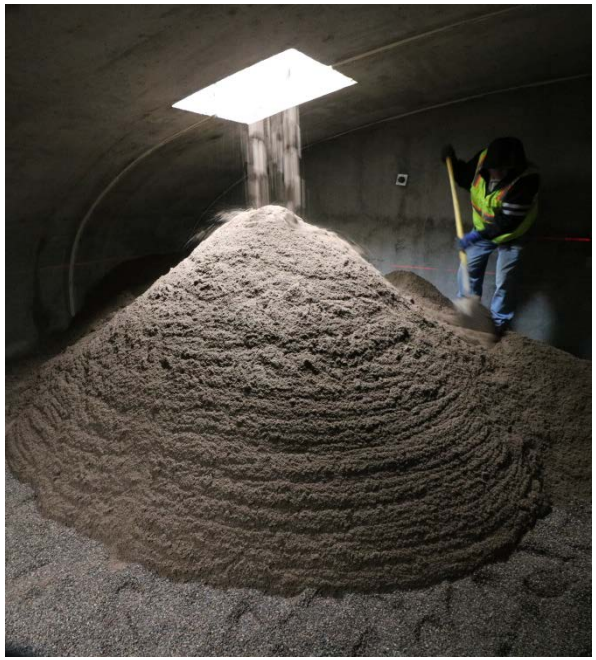
SECONDARY TREATMENT - IESF



Underdrain Rock

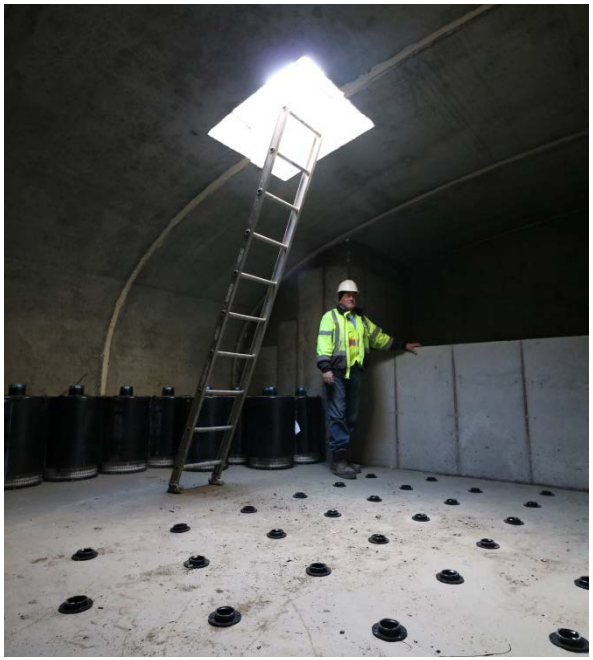


Conveyor



Iron Enhanced Sand

SECONDARY TREATMENT – MEDIA FILTER



Cartridge Chamber

StormFilter®

Phosphosorb®

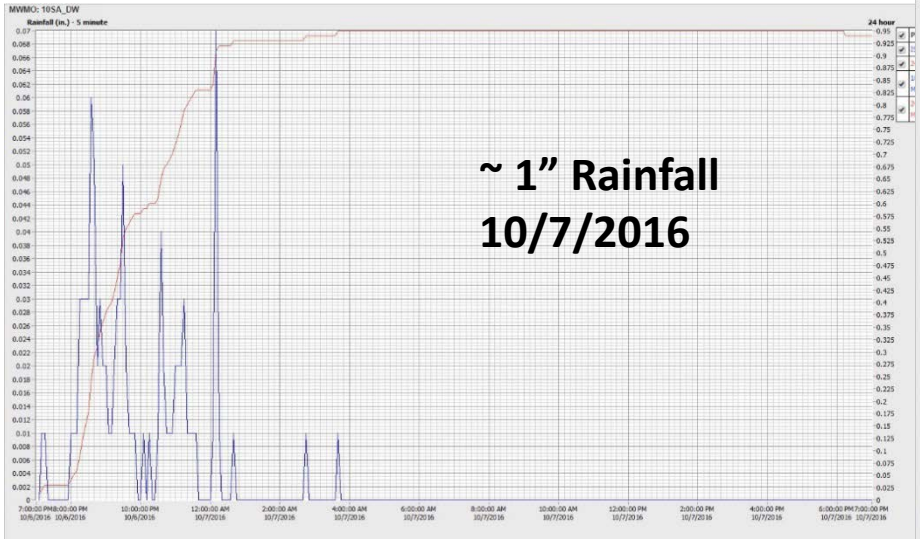
MONITORING

Sampling

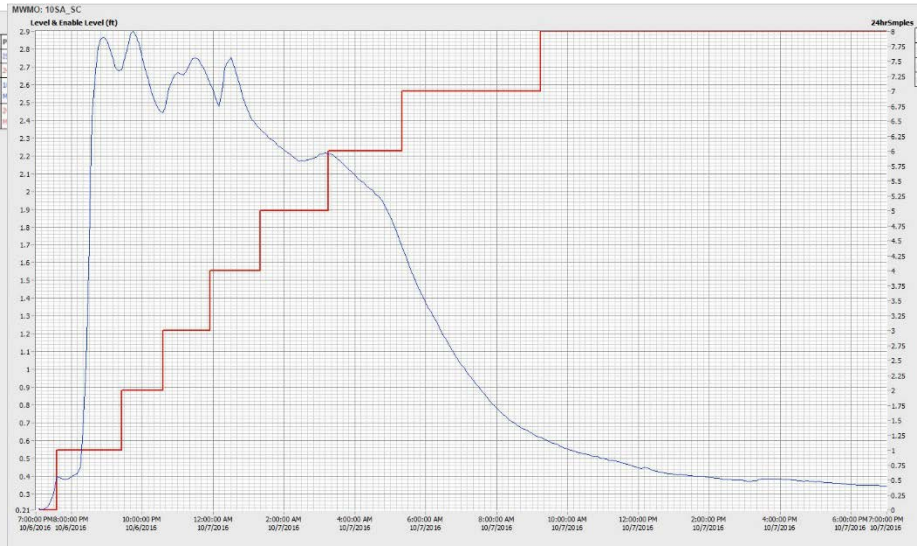
Observation

Controls

MONITORING



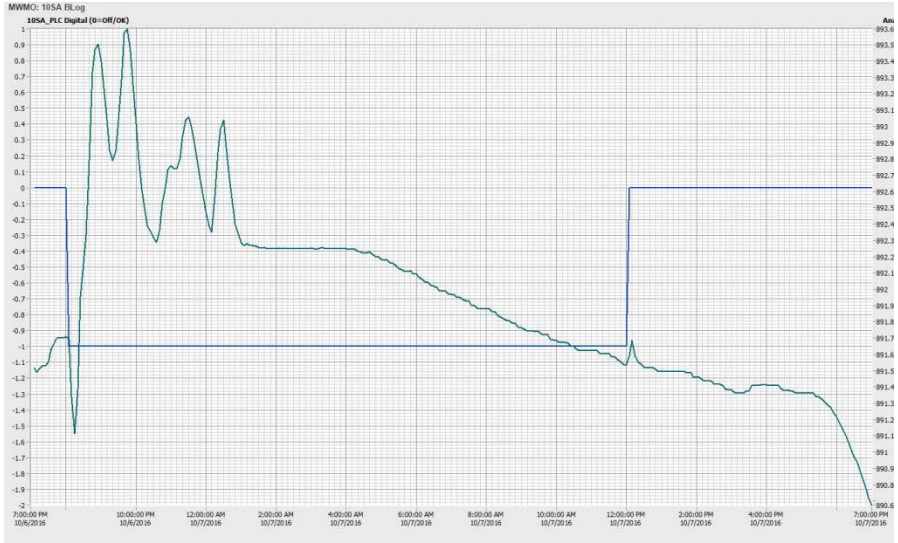
~ 1" Rainfall
10/7/2016



SWIRL CHAMBER INLET

Water level

Samples collected



DISTRIBUTION WELL

Water level

Pump 1 on/off : 0=off; -1=on

Questions?

Marcy Bean

Capital Projects & Stewardship Specialist

mbean@mwmo.org

Bill Alms

Water Resources Project Engineer

BAlms@wsbeng.com

Irrigate, Infiltrate, Automate;
Upper Villa Park Stormwater Project

MN Water Resources Conference, 2016
St. Paul, MN

Forrest J. Kelley, PE
Capitol Region Watershed District

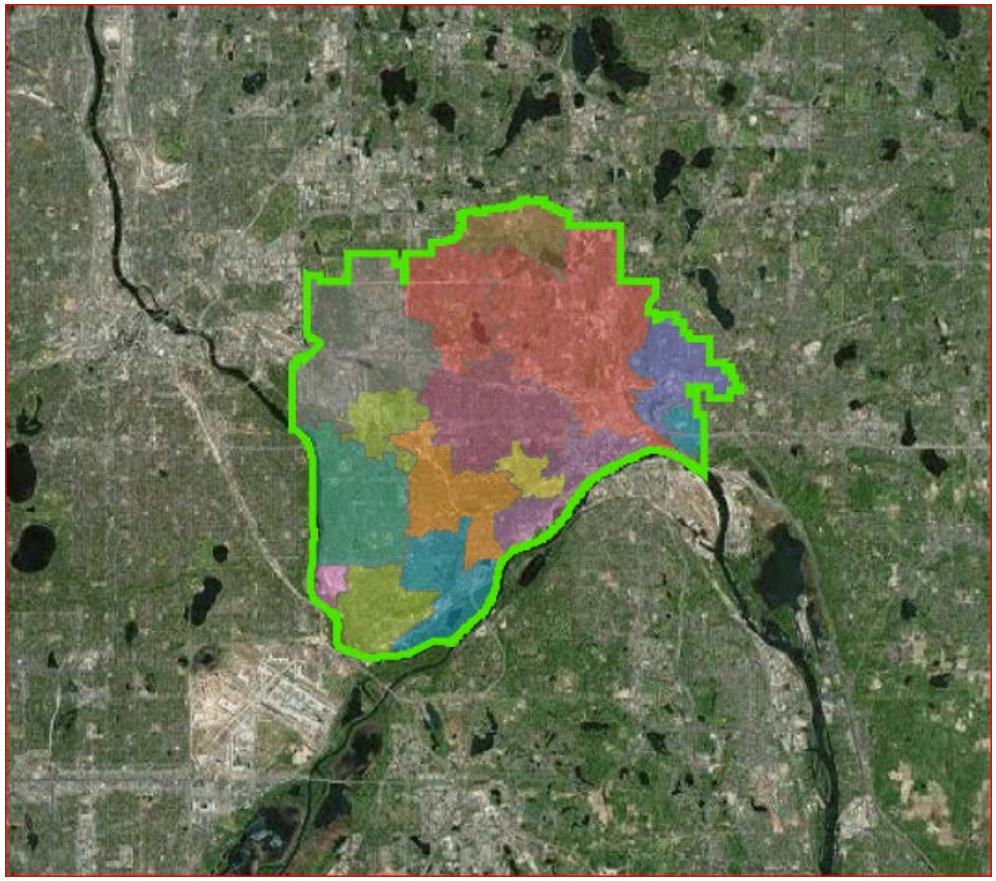
Overview

- Background
- The Water Resources
- The Problem
- The Project
- Challenges
- Next Steps

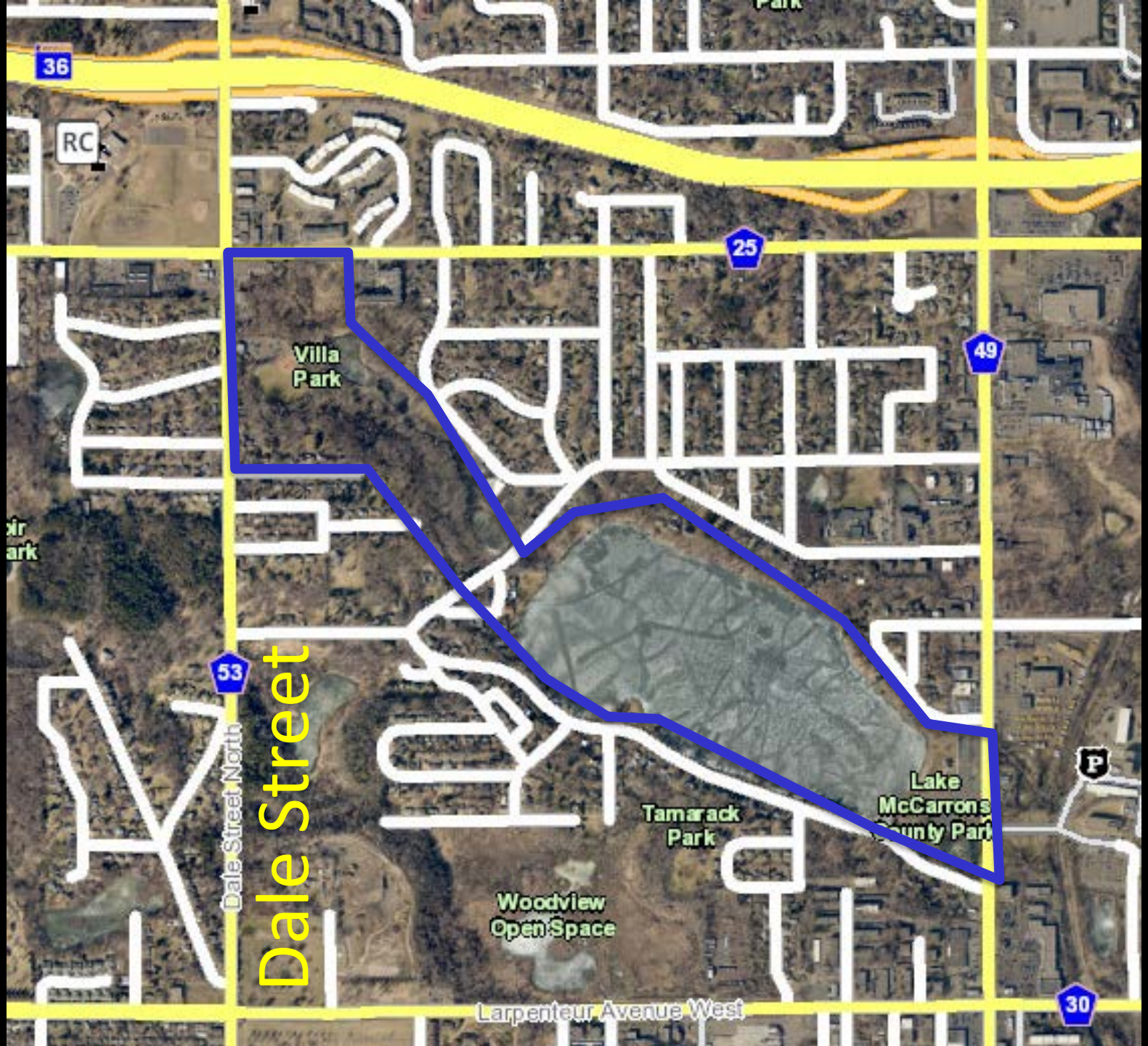
CAPITOL REGION WATERSHED DISTRICT

Capitol Region Watershed District

- 41 Square Miles (25,965 acres)
- Portions of 5 Cities
- 5 Lakes (Como, McCarrons, Big Crosby, Little Crosby, Loeb)
- Numerous wetlands
- 42% Impervious surfaces




All of CRWD Drains to Mississippi River


36
RC
25
49
Villa
Park
53
Dale Street North
Dale Street
Tamarack
Park
Lake
McCarrons
Woodview
Open Space
P
Larpenteur Avenue West
30

The Water Resources – Lake McCarrons

- 81-acre recreational lake - swimming beach, boating, and fishing
- Deep lake classification 57-ft max depth
- Primarily residential land use within the fully developed 1,044-acre drainage area.

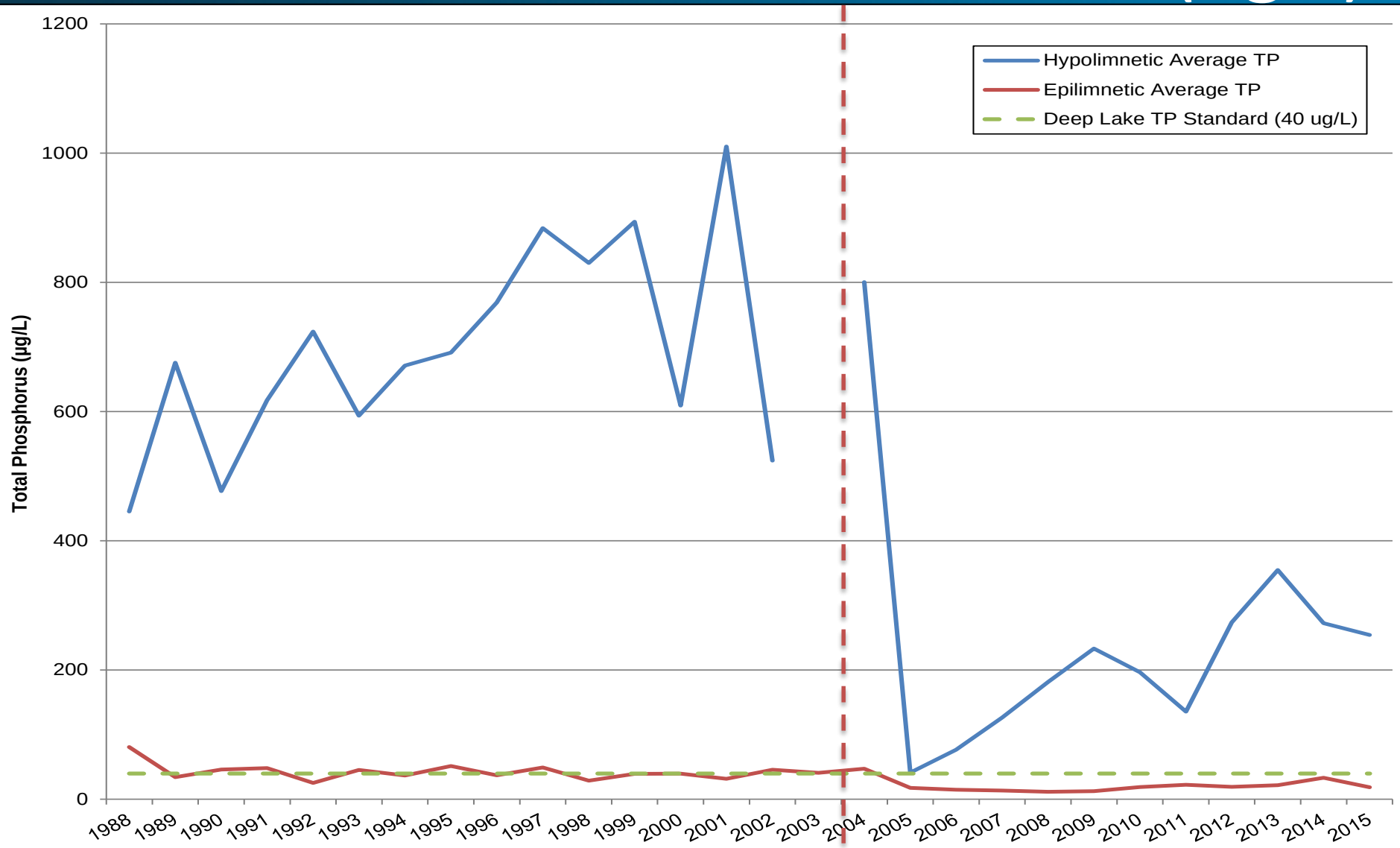
The Water Resources –Villa Park Wetlands

- Villa Park Wetland System Constructed in 2004
- Series of weirs created pools and wetland cells
- Slow water and enhance sedimentation
- Drains 753 acres to Lake McCarrons

The Problem

- McCarrons has historically good water quality, but trending downward
- Villa Park Wetland System undersized for its drainage area
- Determined to be a source of Total Phosphorus to Lake McCarrons

McCarrons – TP Concentrations (ug/l)



Subwatershed Analysis Report

Lake McCarrons Subwatershed
BMP Clean Water Partnership Project

Capitol Region Watershed District

December 2012

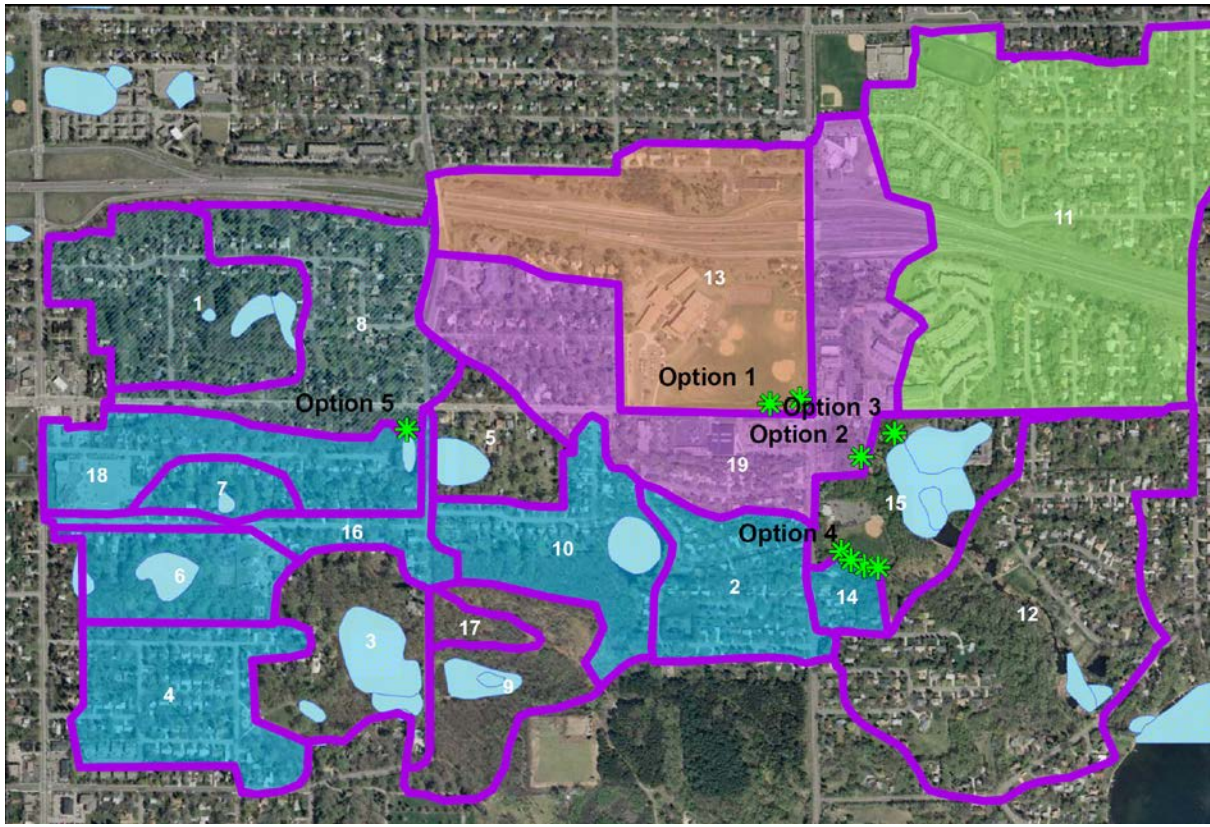
SRF

Previous Analysis recommended:

- Upstream volume reduction
- 45 pound annual TP removal goal

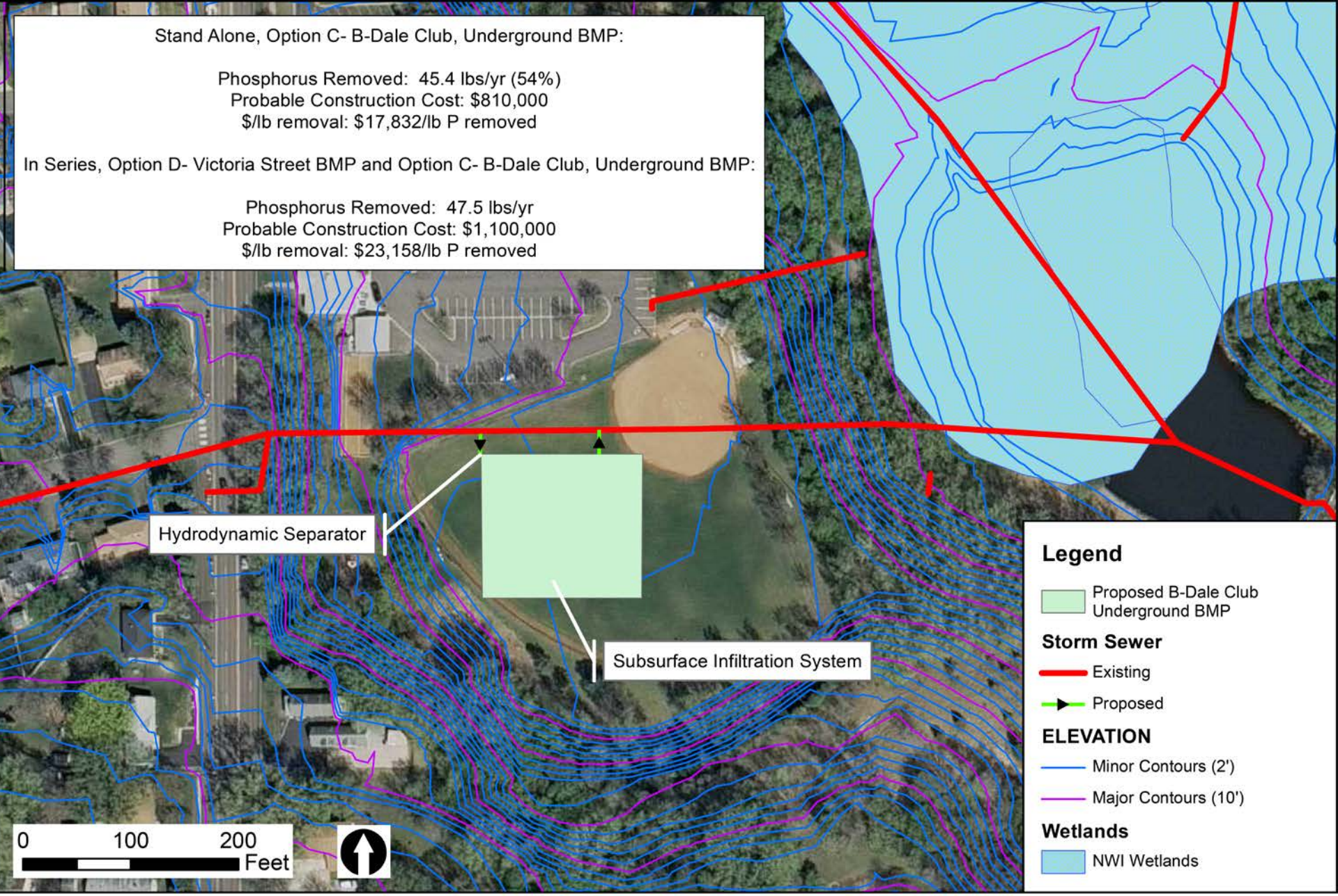
The Project

- CRWD received $275K MPCA grant to identify, design, and construct volume reduction BMPs
- Five BMP options ranging from $300K to $1.5M
- Prioritized by effectiveness and land ownership



The Project

- Underground infiltration system below City of Roseville Park.
- Divert runoff from 250 acres of drainage in 36 inch pipe beneath existing softball field.
- Assumed 80,000 cf of storage could remove 45 pounds at cost of $810K



SRF Consulting Group, Inc.

Option C- B-Dale Club (Site 4), Underground BMP

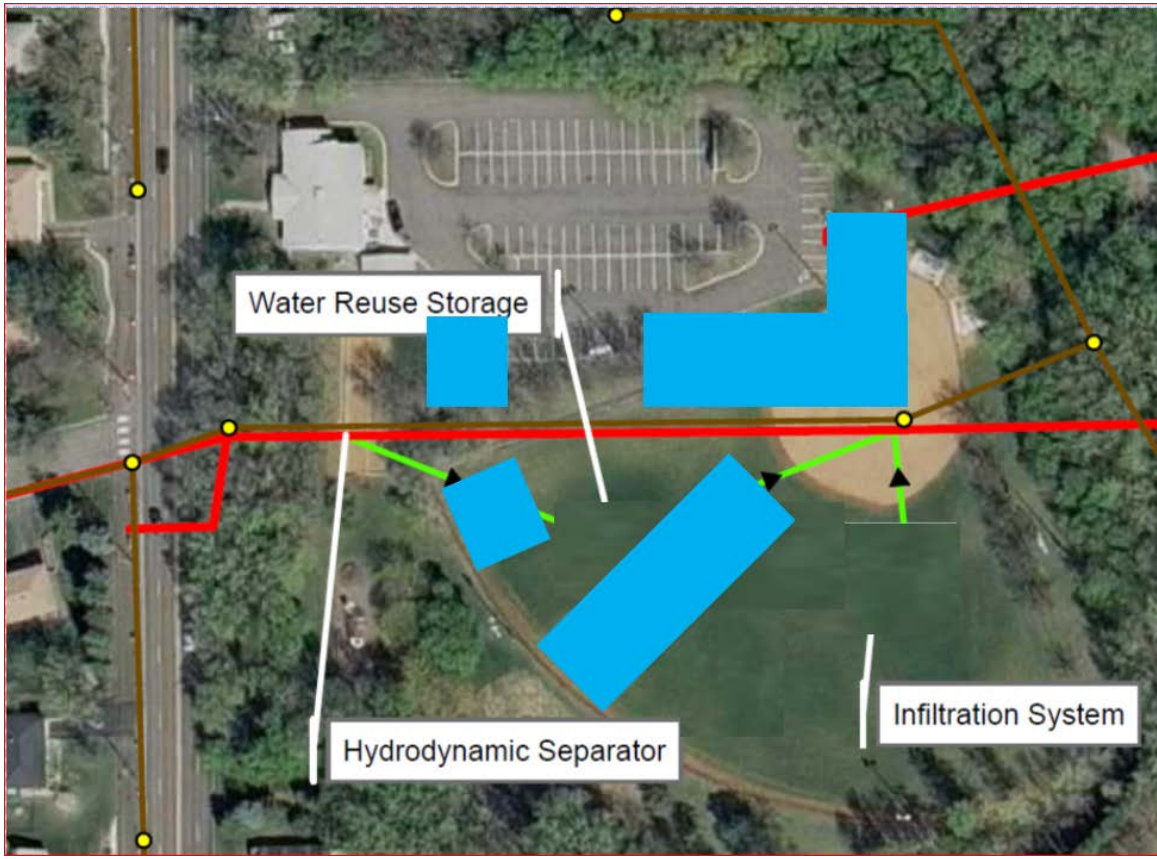
Lake McCarrons Subwatershed BMP CWP Project

Capitol Region Watershed District

Figure 6

Concept Refinement

- Additional $360K grant for storm water reuse
- No MHs allowed in outfield
- Balance size and location with cost and paving
- Soils



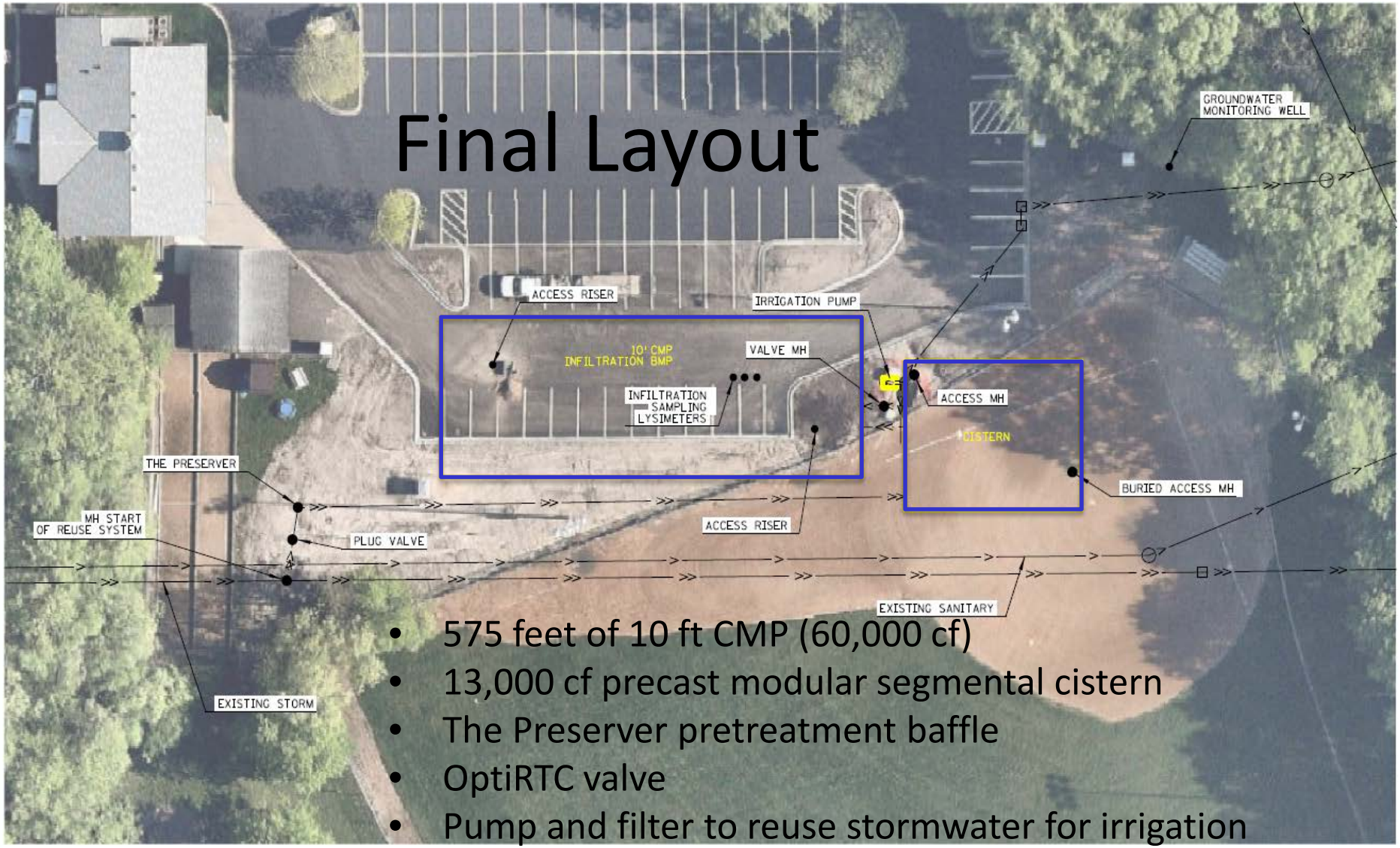
Stormwater Reuse

- Additional grant funds provided to add stormwater harvest and reuse
- Reuse feasibility study conducted for water balance and cistern sizing
- 13,000 cf StormTrap cistern provides 2-weeks of irrigation
- Optimized Real Time Controls (OptiRTC) system determined to remove additional 5-lbs TP/yr

OptiRTC

- Cloud based technology to actively manage stormwater retention
- Level sensors in the cistern and infiltration system
- CMP and concrete vault connected by 10” DIP with actuated butterfly valve
- Opti logic analyzes the NOAA forecasted precipitation and drains the cistern into the CMP in advance of a rain event

Final Layout



- 575 feet of 10 ft CMP (60,000 cf)
- 13,000 cf precast modular segmental cistern
- The Preserver pretreatment baffle
- OptiRTC valve
- Pump and filter to reuse stormwater for irrigation

SRF Consulting Group, Inc.
Job 7738
6/7/2016

CAPITOL REGION WATERSHED DISTRICT
UPPER VILLA PARK INFILTRATION AND REUSE
RAMSEY COUNTY

Construction

- Tight construction window due to softball schedule and community events Nov 2, 2015 Start-Dec 31 substantial completion
- Irrigation, pump installation and OptiRTC commissioning in Spring 2016
- Constrained construction limits, active parking lot with private business and parkgoers
- Field usable for April 20 softball season opener


Bobcat

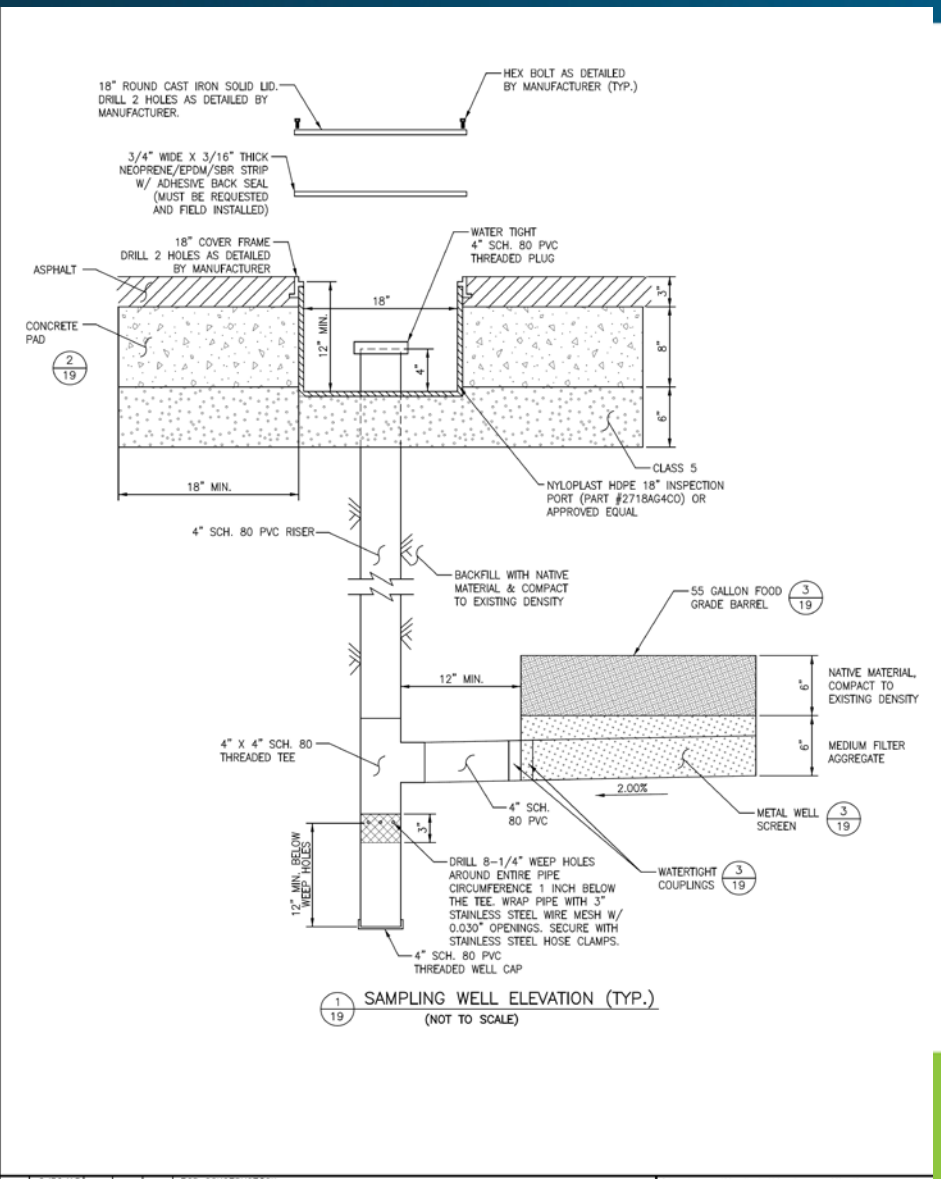

PATENT-STORMTRAP.COM/PATENT


PATENT-STORMTRAP.COM/PATENT
UPPER VILLA PARK
RABBITTER HOUSE
ROSEVILLE, MN
2'4" TOP


ConSeal
CONCRETE
SEALANTS


VIC'S

Exfiltration Sampling Wells



- Three custom built pan-lysimeters
- Abstract samples beneath infiltration pipes
- Determine effectiveness of native soils

9/30/15			FOR CONSTRUCTION	

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Print Name WALTER ESHENAUR

Screen and Well

Collection Barrels

Standpipes and Pea Gravel

CAPITOL REGION WATERSHED DISTRICT


KOBELCO
KOBELCO


KOBELCO
KOBELCO


WATERSHED DISTRICT

Pump Sled

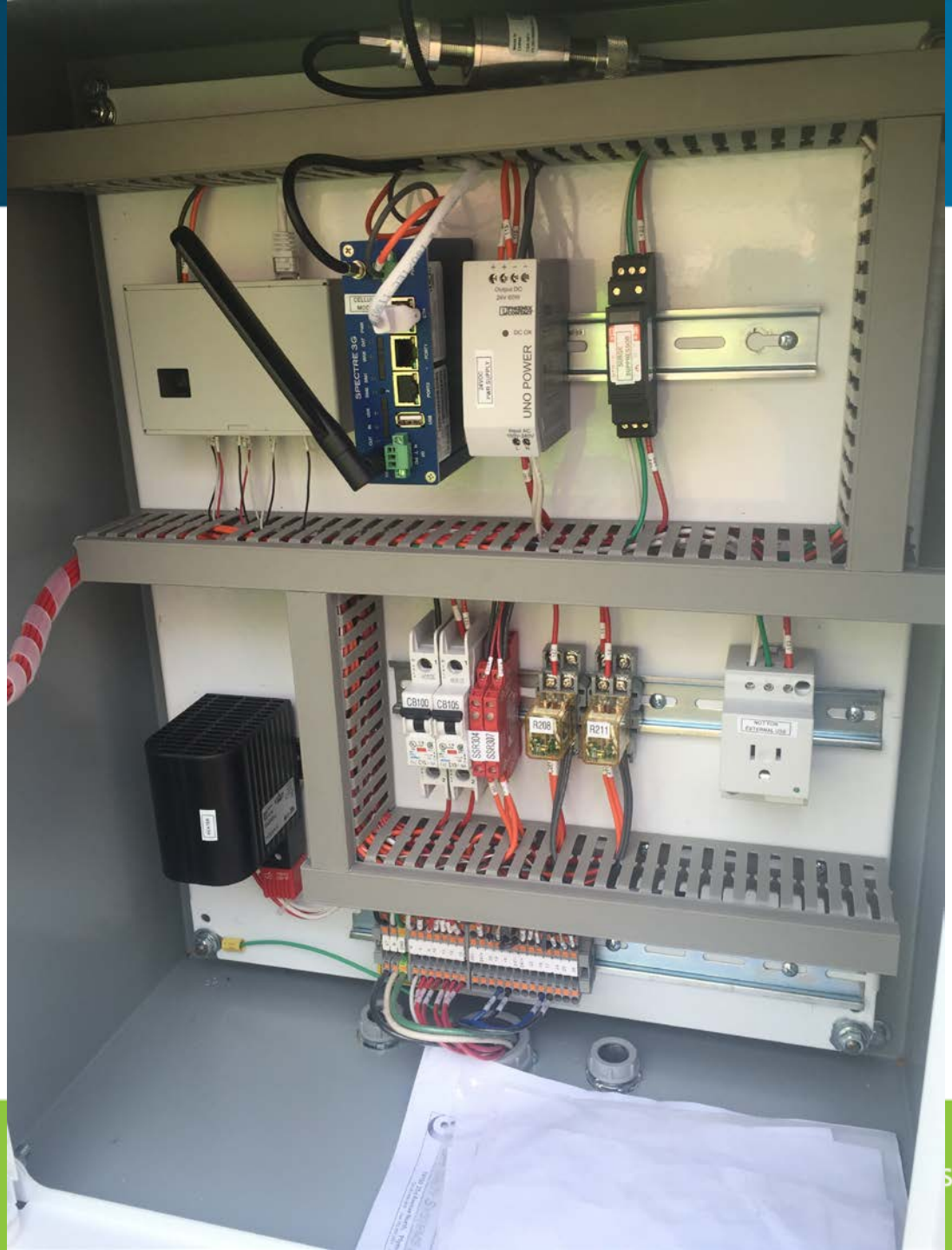
- Variable speed pump
- 300 micron filter
- Backflush capabilities
- Low level municipal source


WATER Max


VILLA PARK

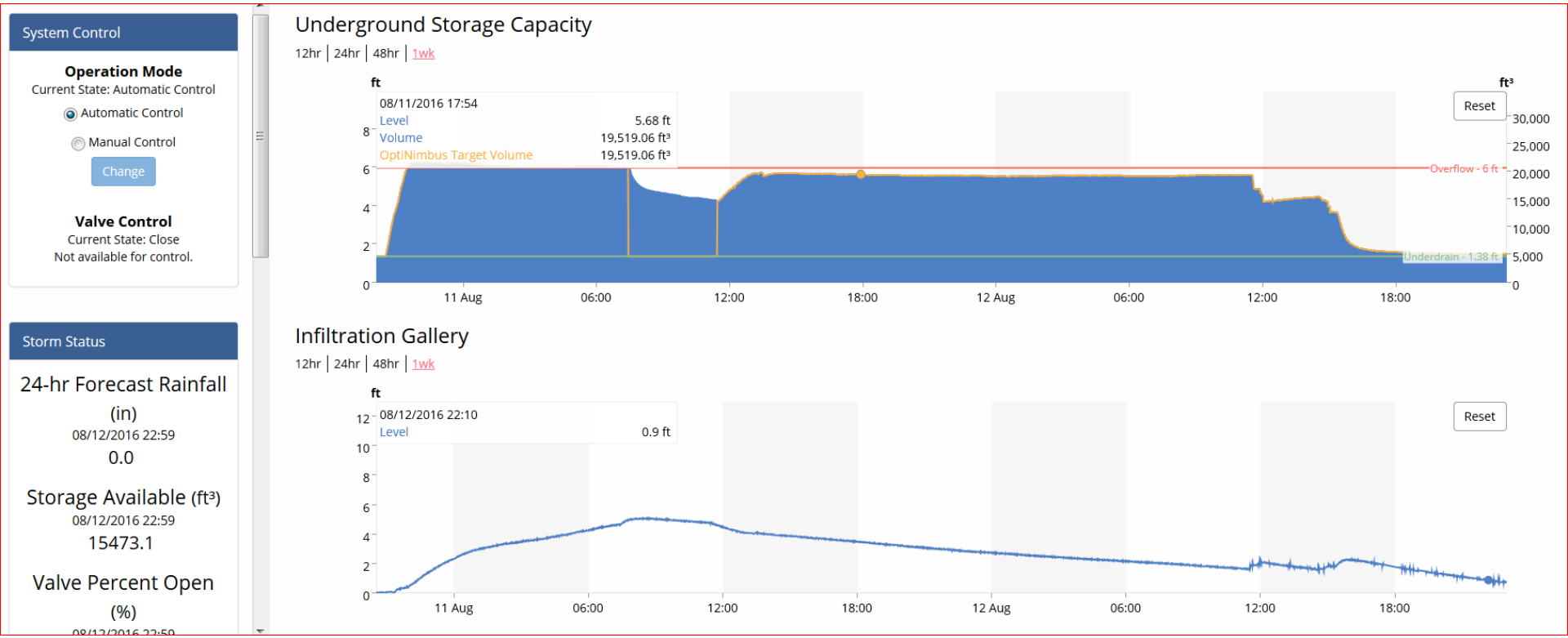
OptiRTC


CONTROL POWER
OFF ON
VALVE POSITION
OPEN CLOSE AUTO
VALVE TRAVEL
STOP RUN AUTO
VALVE FULLY OPEN
VALVE OVER TORQUE
VALVE FULLY CLOSED



SHED DISTRICT

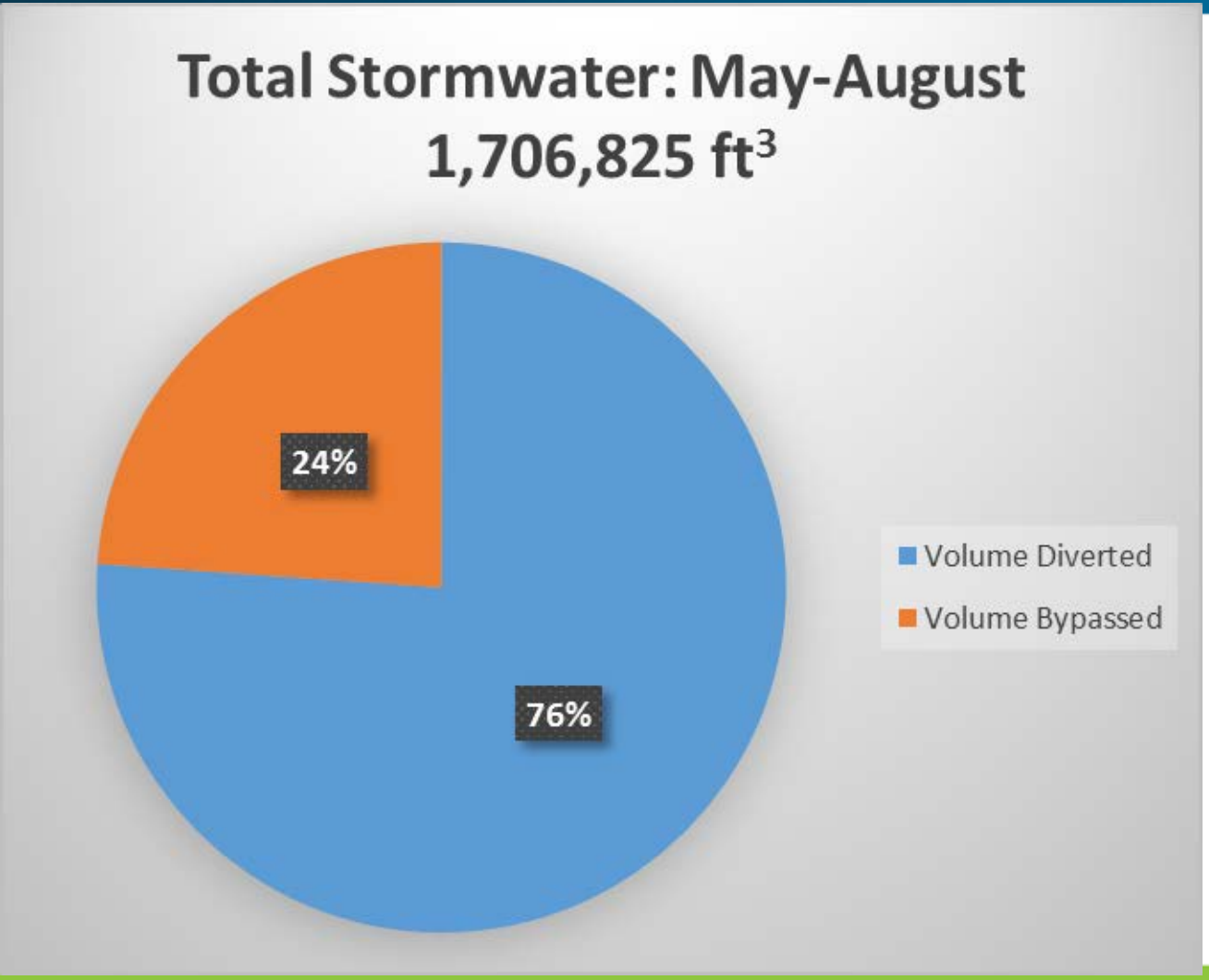
OptiRTC


System Control
Operation Mode
Current State: Automatic Control
Automatic Control
Manual Control
Change
Valve Control
Current State: Close
Not available for control.
Storm Status
24-hr Forecast Rainfall (in)
08/12/2016 22:59
0.0
Storage Available (ft³)
08/12/2016 22:59
15473.1
Valve Percent Open (%)
Underground Storage Capacity
12hr | 24hr | 48hr | 1wk
ft
ft³
08/11/2016 17:54
Level 5.68 ft
Volume 19,519.06 ft³
OptiNimbus Target Volume 19,519.06 ft³
Reset
Overflow - 6 ft
Underdrain - 1.38 ft
11 Aug
06:00
12:00
18:00
12 Aug
Infiltration Gallery
12hr | 24hr | 48hr | 1wk
ft
08/12/2016 22:10
Level 0.9 ft
Reset

Monitoring

- Automated Isco sampler, level, velocity
- Measure TP, TSS, metals, bacteria, Chloride, etc.
- Calculate flow upstream and downstream of diversion
- Exfiltration wells at 1.5, 3, and 7 feet below CMP
- Similar constituents

Preliminary Results



- 1.3M cf volume reduction
- 24 lbs TP
- 4,900 lbs TSS

Challenges

- Field Schedule – temporary ag-lime in outfield

Challenges

- Clay soils encountered – Wells raised
- 6 inches removed in east corner of infiltration bottom

Challenges

- Calibration and alignment of ultrasonic sensors –pressure transducer

Challenges

- Cistern drained in 5 days
- Likely pipe boot seals
- Contractor vac’ed and cleaned cistern
- Completed internal joint sealant

Next Steps

- Refine Exfiltration monitoring
- Determine need for small weir in diversion
- Vac pre-treatment manhole
- Restore outfield turf and irrigation
- Monitor

Partners

MN Clean Water Fund (BWSR)

Minnesota Pollution Control Agency

Capitol Region Watershed District

City of Roseville

B-Dale Club

SRF Consulting Group, Inc.

New Look Contracting, Inc.

Questions

Forrest Kelley, PE, Capitol Region Watershed District
forrest@capitolregionwd.org

https://webapp.senserasystems.com/C1/view-device.html?bs=409129

https://portal.onopti.com/dashboard/951/

Tree Trench and Permeable Pavers in the Edison High School Parking Lot

Minnesota Water Resources Conference
October 18, 2016

Stantec

MWMO
Protect it. Pass it on.
MISSISSIPPI WATERSHED MANAGEMENT ORGANIZATION

Agenda

1 Project Background and Partners

2 BMP Design and Construction

3 Education and Outreach

4 Stormwater Research and Monitoring

1

Project Background & Partners

NORTHEAST GREEN CAMPUS

Stantec

Phase I (Completed 2013)

Minneapolis
City of Lakes

Stantec

MPS

Holland Neighborhood Improvement Association
Art Energy Innovation

MWMO
Protect it. Pass it on.
Mississippi Watershed Management Organization

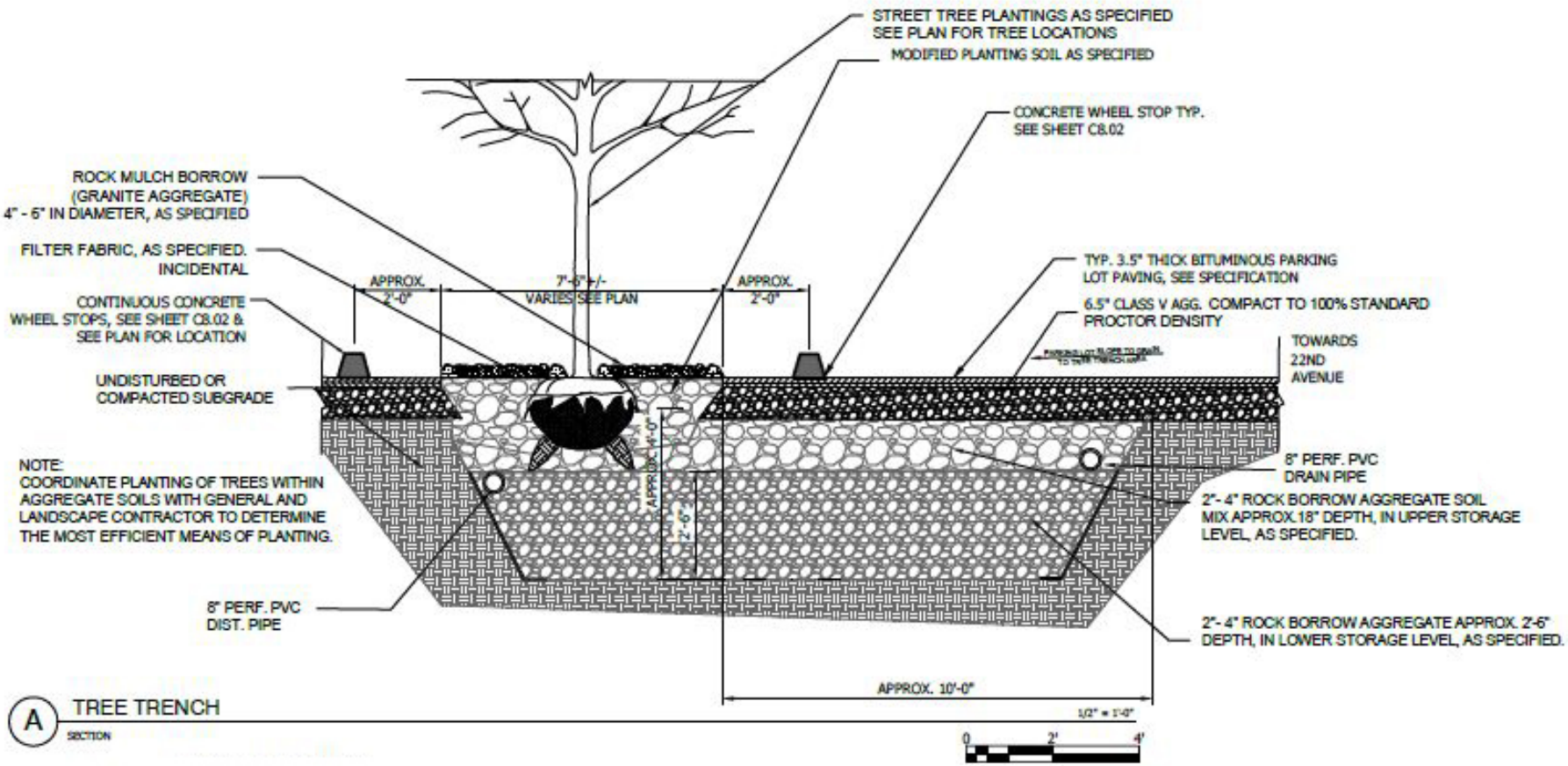
2

BMP Design & Construction

- Tree trench
- Permeable pavers
- Rain garden
- Infiltration Curb

BMP DESIGN & CONSTRUCTION

Stantec



TREE TRENCH DESIGN

Stantec

TREE TRENCH CONSTRUCTION

Stantec

TREE TRENCH CONSTRUCTION

Stantec

COMPLETED TREE TRENCH

Stantec

PAVER AND INFILTRATION CURB CONSTRUCTION

Stantec

COMPLETED PAVERS AND INFILTRATION CURB

Stantec

RAIN GARDEN CONSTRUCTION

Stantec

COMPLETED RAIN GARDEN

Stantec

Phase II (Completed 2016)

Minneapolis
City of Lakes

Spark-Y
YOUTH ACTION LABS

MPS

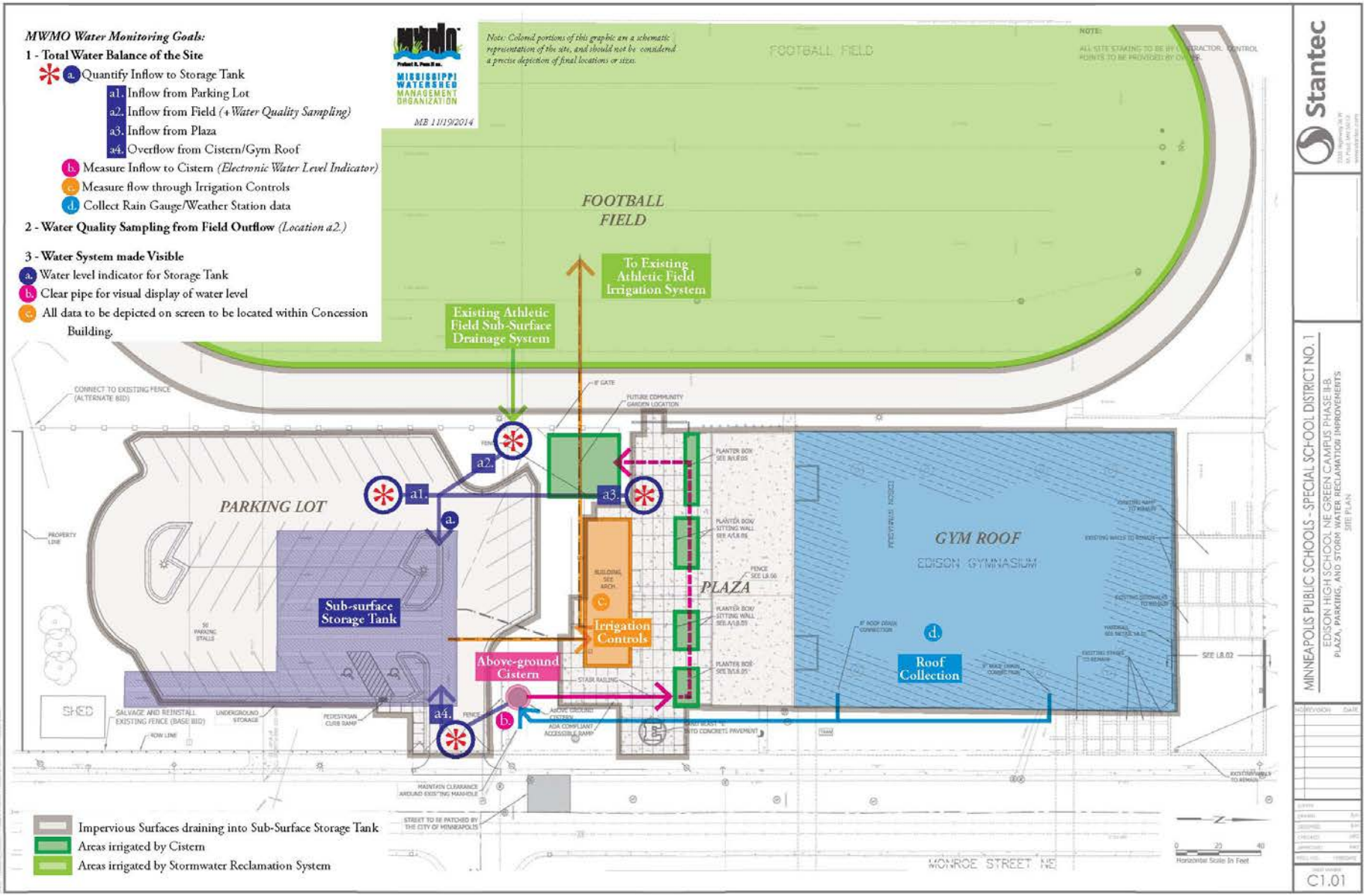
LISC
Twin Cities
Helping people and places prosper

Edison
COMMUNITY & SPORTS FOUNDATION

Stantec

HOLLAND NEIGHBORHOOD
ART
ENERGY
INNOVATION
IMPROVEMENT ASSOCIATION

MWMO
Protect it. Pass it on.
MISSISSIPPI WATERSHED MANAGEMENT ORGANIZATION



STORMWATER REUSE SCHEMATIC

Stantec

Green Elements

- Engineered soil amendments for football Field
- Filtration planting beds on plaza
- Underground storage/stormwater reuse for irrigation of football field and practice field
- Community gardens/greenhouse
- Future stormwater reuse in toilets/urinals
- Future solar canopy and electric car charging

UNDERGROUND STORAGE CONSTRUCTION

Stantec

UNDERGROUND STORAGE CONSTRUCTION

Stantec

3

Education & Outreach

ART

Using art as a way to fold our work into the goals of the local arts community.

DEMONSTRATION

Working with teachers to find ways to bring our work into their classrooms.

INTERPRETATION

Using plain language & infographics to communicate our message.

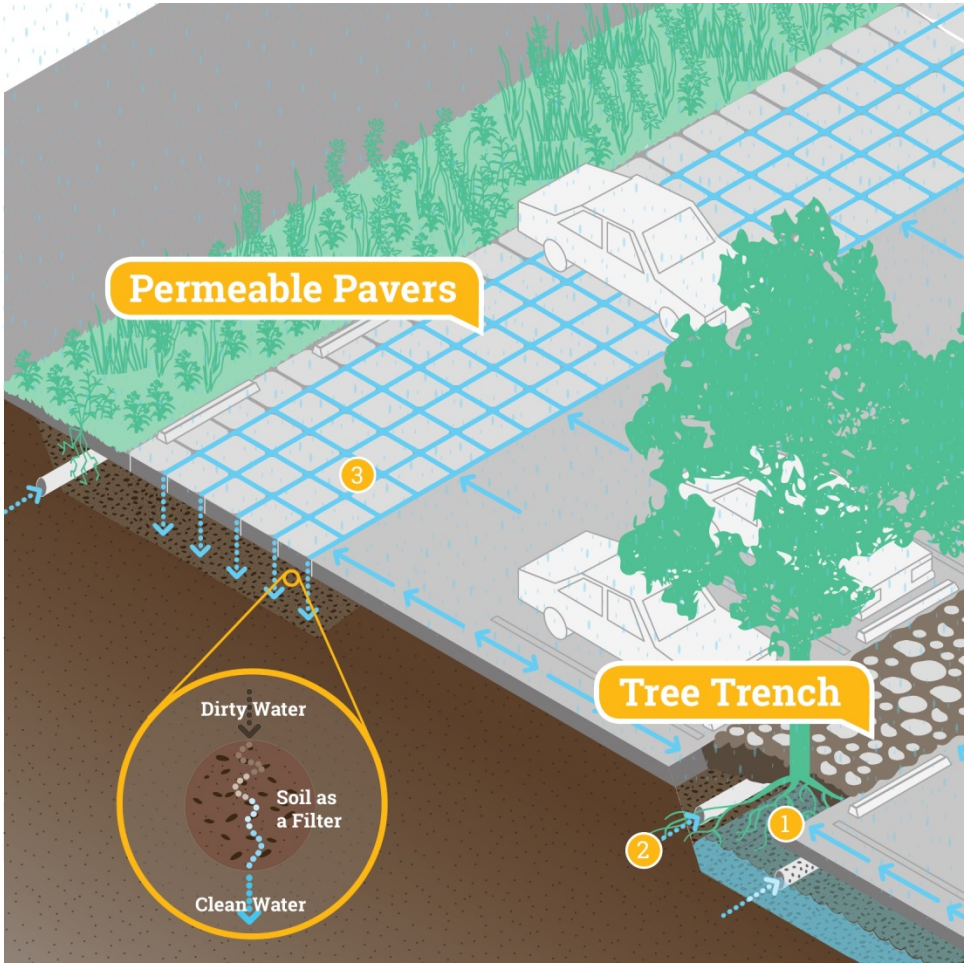
Tree Trench

A tree trench holds water after it rains, providing water for the trees to use and helping to filter out pollutants. This reduces the amount of stormwater and pollution that goes into the stormdrains.

Permeable Pavers

Permeable pavers allow water to pass through the surface and soak into the ground. Diverting water from the stormdrain and into the ground allows plants and soil to filter out pollutants, which keeps our rivers and lakes healthy!

1. Stormwater flows into the tree trench, where it is absorbed and filtered by trees, or soaks into the ground.
2. If the tree trench gets full, excess water flows into an overflow pipe and goes into the stormdrain to prevent flooding.
3. Stormwater flows to and between the pavers.



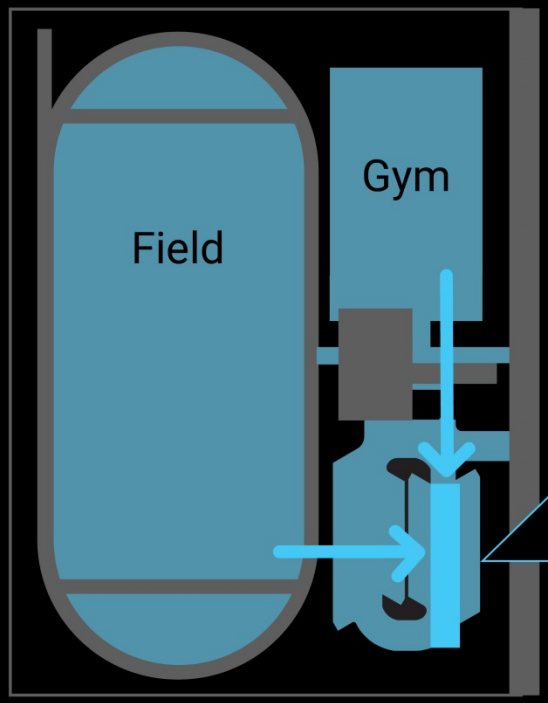
Stantec


In Nature
In Cities
What is Stormwater?
EDISON GREEN CAMPUS
What is a Watershed?

COMPLETED PLAZA

Stantec

Stormwater Collection



The tank is 65% full

This can water the field for **9** days

These **72,498** gallons could fill **10.3** school buses

Stantec

4

Stormwater Monitoring

MONITORING

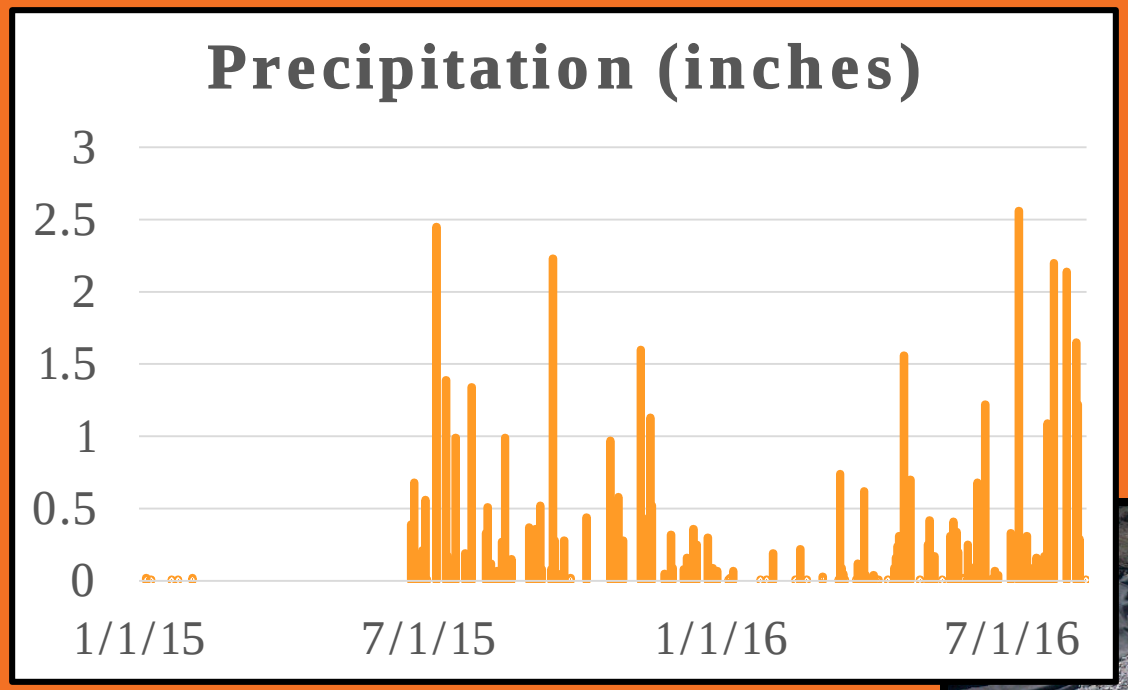
- **Rainfall**
- **Runoff volume**
- **TP loading**
- **TSS loading**

INFLOW
Capturing the runoff into the trench

INFLOW
Monitoring flow and pollutants going in

OUTFLOW
Monitoring flow and pollutants coming out

RESULTS (SO FAR) ……



IT'S WORKING

Summary and Lessons Learned

1 Engage the community

2 Look to the future

3 Follow up

QUESTIONS?

Michaela Neu
mneu@mwmo.org

Mark Statz, PE
mark.statz@stantec.com

Sustainable
Stormwater Management

CAPITOL REGION WATERSHED DISTRICT

SAINT PAUL
The Most Livable City in America

FORD SITE
A 21st Century Community

BARR

Impact Infrastructure, LLC

Ford site: A 21st Century Community

FORD SITE
A 21st Century Community

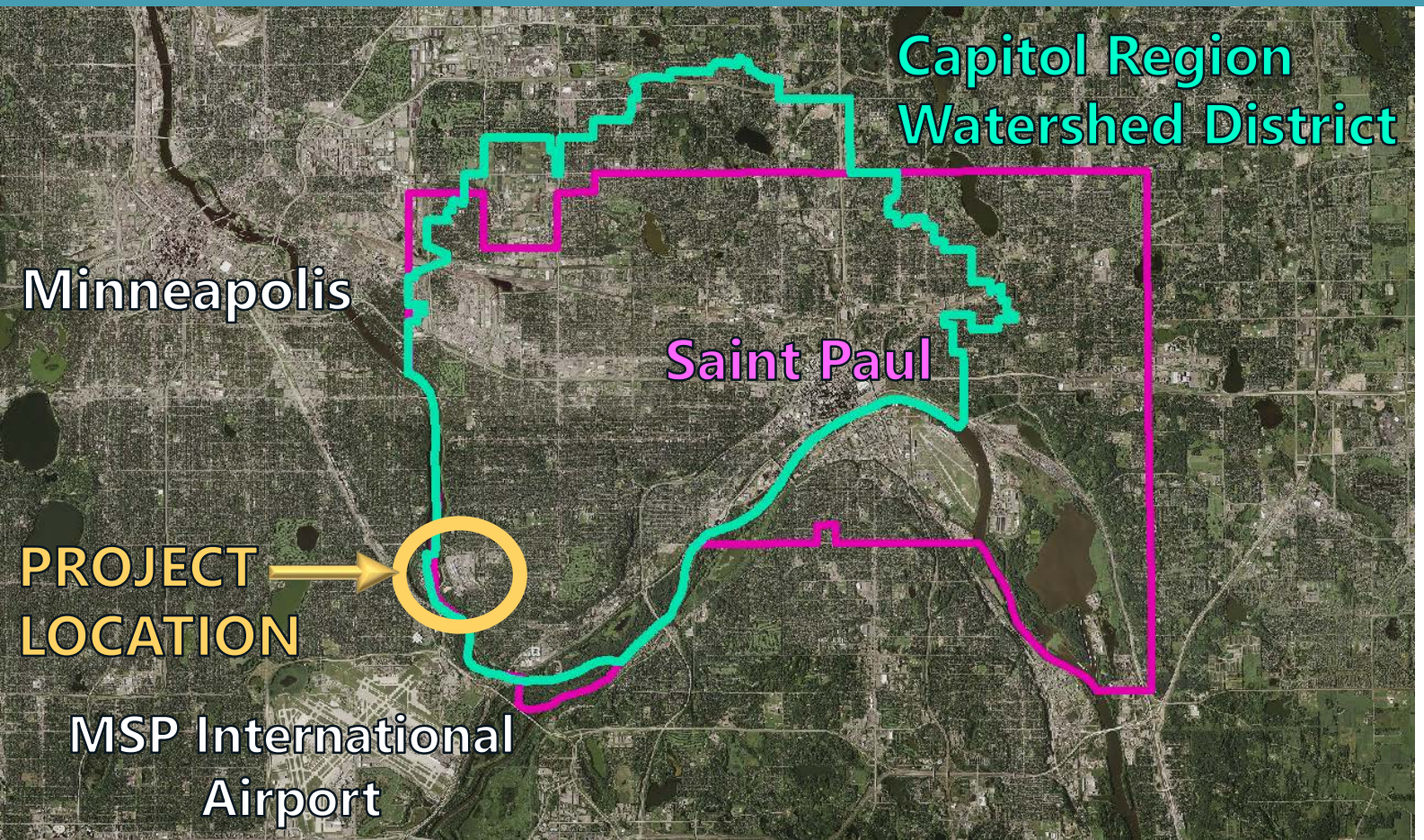
Key Principles:

- Mix of Uses & Activity
- Housing Variety
- Jobs & Tax Base
- Energy & Sustainability

  Regional, national, and global model for sustainable planning, design, and day-to-day living that protects our air, water and natural resources for future generations
- Transportation Choice
- Parks & Amenities

Mayor Chris Coleman, with Councilmember Tolbert

Site location map



- Ford Plant closed in 2011
- 135 acre site, industrial, mostly impervious
- Located above the Mississippi River bluffs and connected to Hidden Falls Regional Park
- Drains to Hidden Falls Creek and Mississippi River

Assembly plant closure in 2011

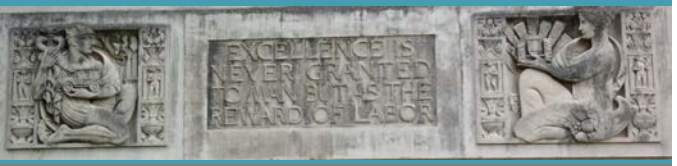


Image courtesy of Chris Tolbert / City of St. Paul

Excellence is never granted to man (woman) but as the reward of labor

Pre-demolition

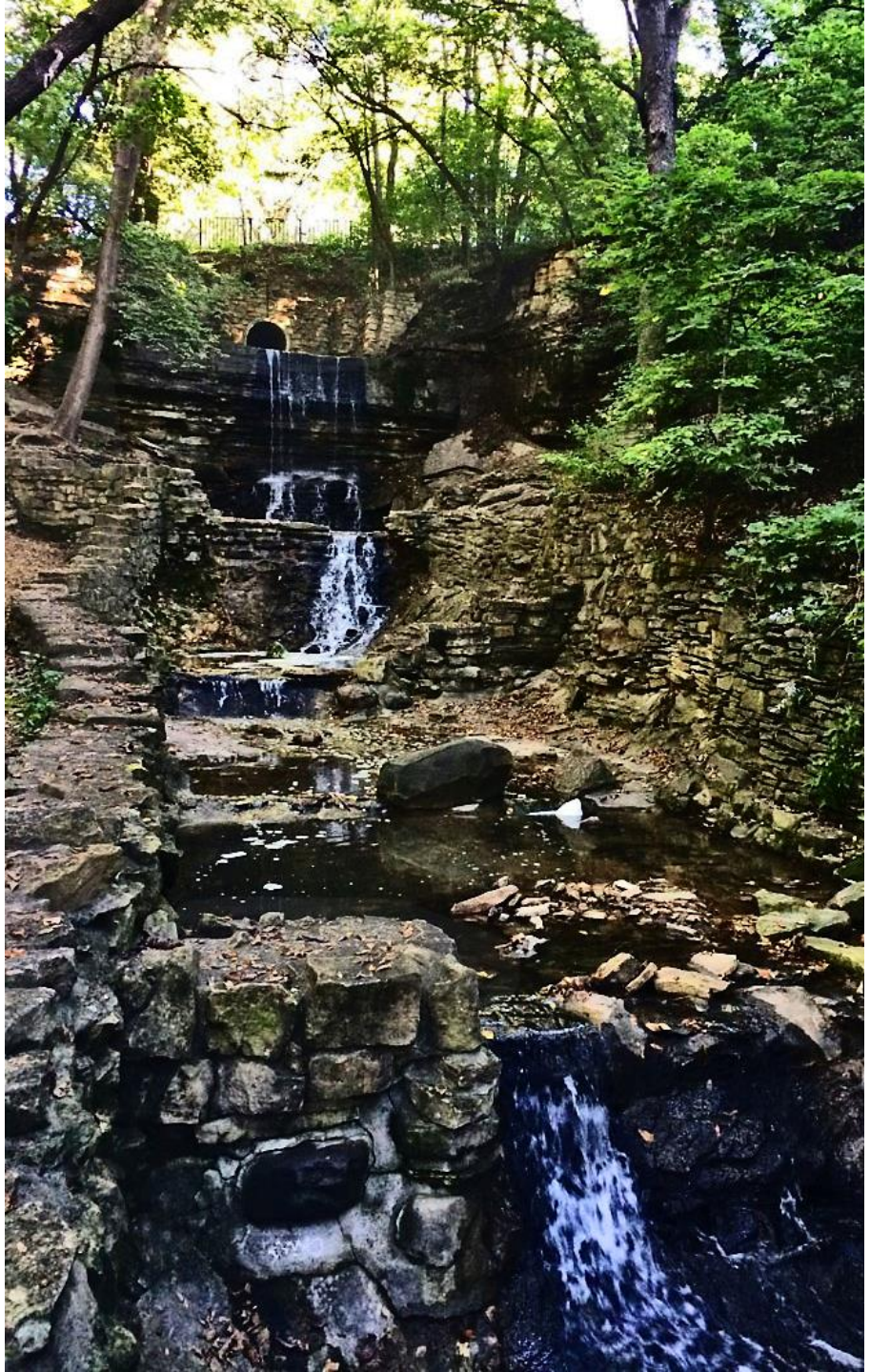
(Ford Motor Company Archives)

Post-demolition (fall 2015)

(Pioneer Press: Scott Takushi)

Hidden Falls and Hidden Falls Creek today

degraded stream quality, bank erosion, costly scour protection



The Driving Question

How could managing rainwater as a vital resource within the urban landscape — instead of a neglected waste stream— factor into future planning ?

Baseline
vs.
Hidden Falls
Headwaters

A comparative analysis was performed

Stormwater Management

Restoration

Life Cycle Costs, Impacts

Sustainability, SROI

Community Benefits

using 5 broad assessment themes.

Project scope: Compare two stormwater management alternatives

Baseline

Stormwater management

under ground

- Conventional approach, managed separately
- Meets runoff from each parcel current standards (city, watershed, state)
- Fewer amenities but greater developable acreage

Centralized

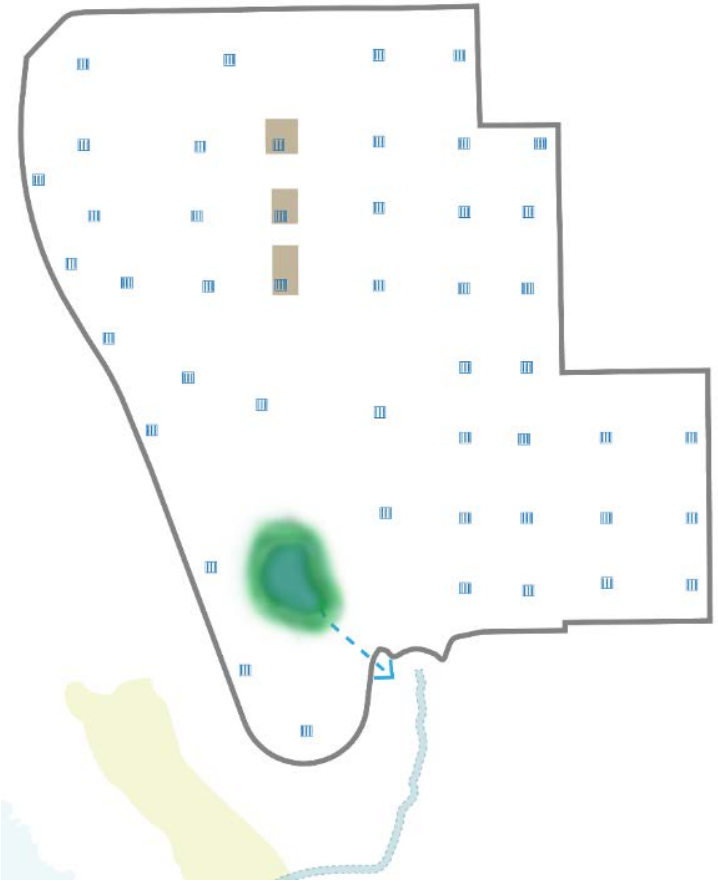
Stormwater management

above ground

- Runoff from entire site managed in centralized green corridor, recreating Hidden Falls Headwaters feature
- Enhanced stormwater management goals

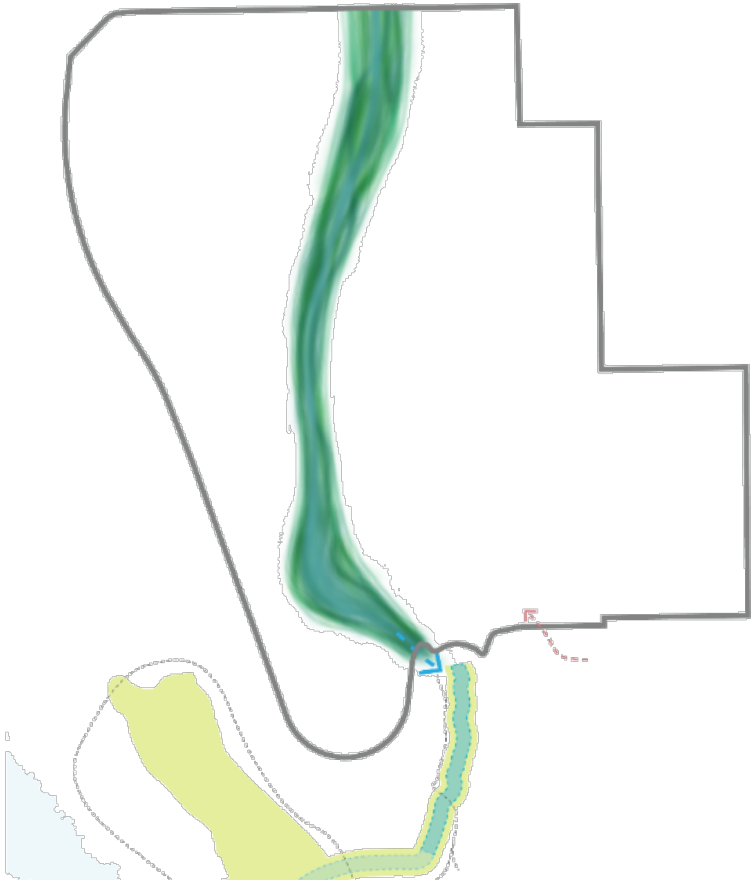
Two alternatives

B **Baseline:** Conventional stormwater management



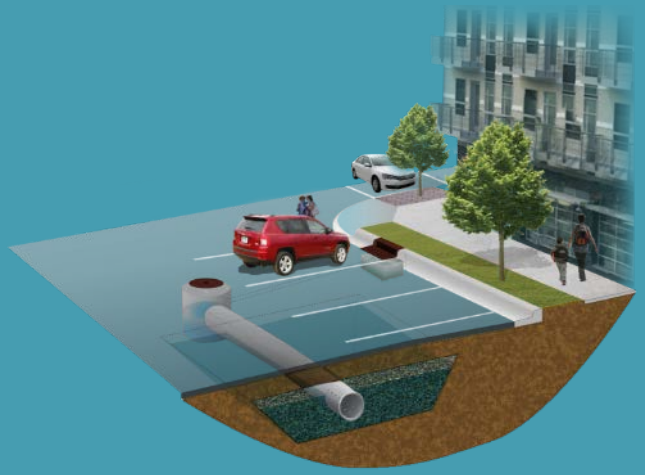
Under ground features **meet** Saint Paul and District stormwater regulations

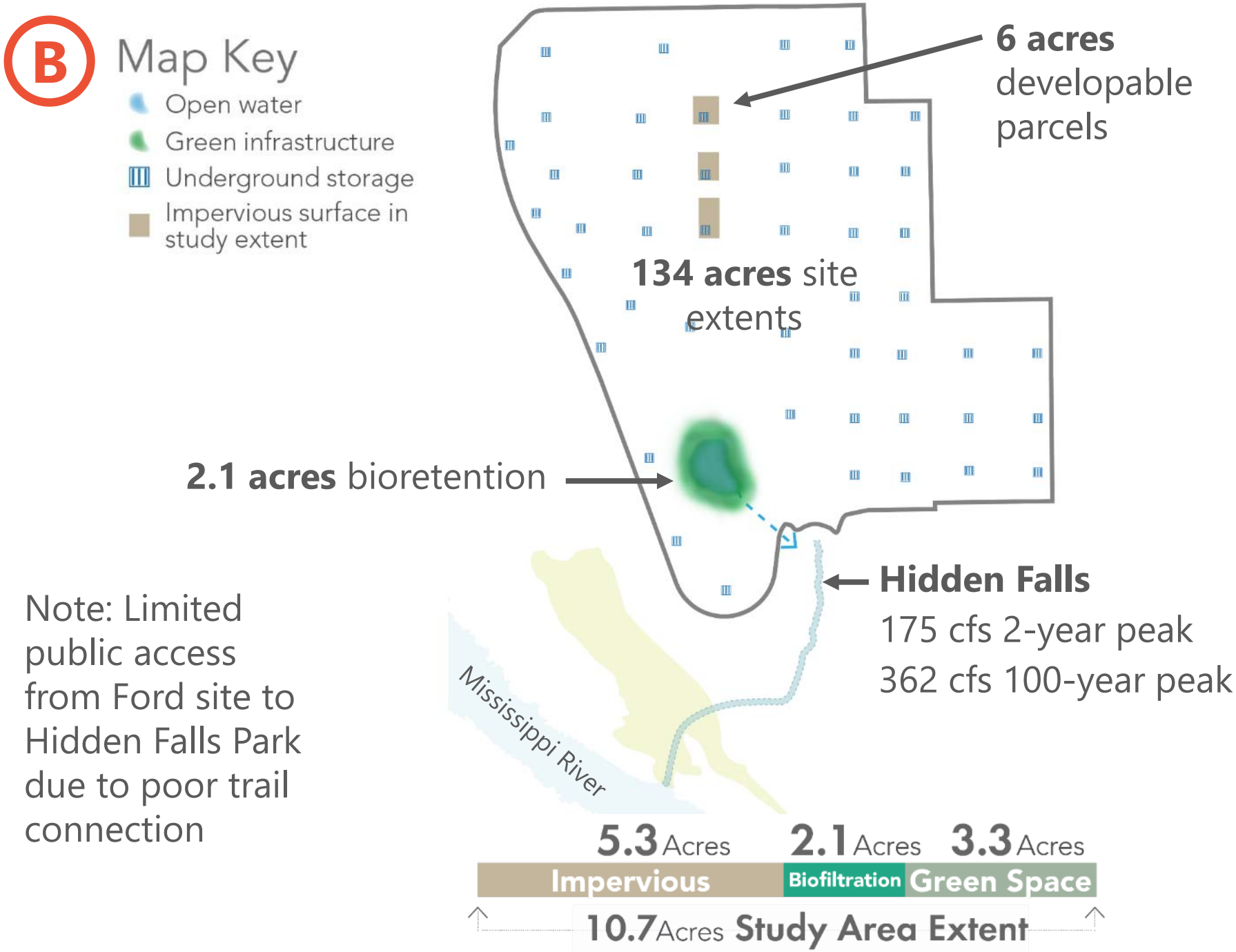
H **Hidden Falls Headwaters** (Centralized): stormwater treated in green infrastructure corridor



Above ground features **exceed** Saint Paul and District stormwater regulations

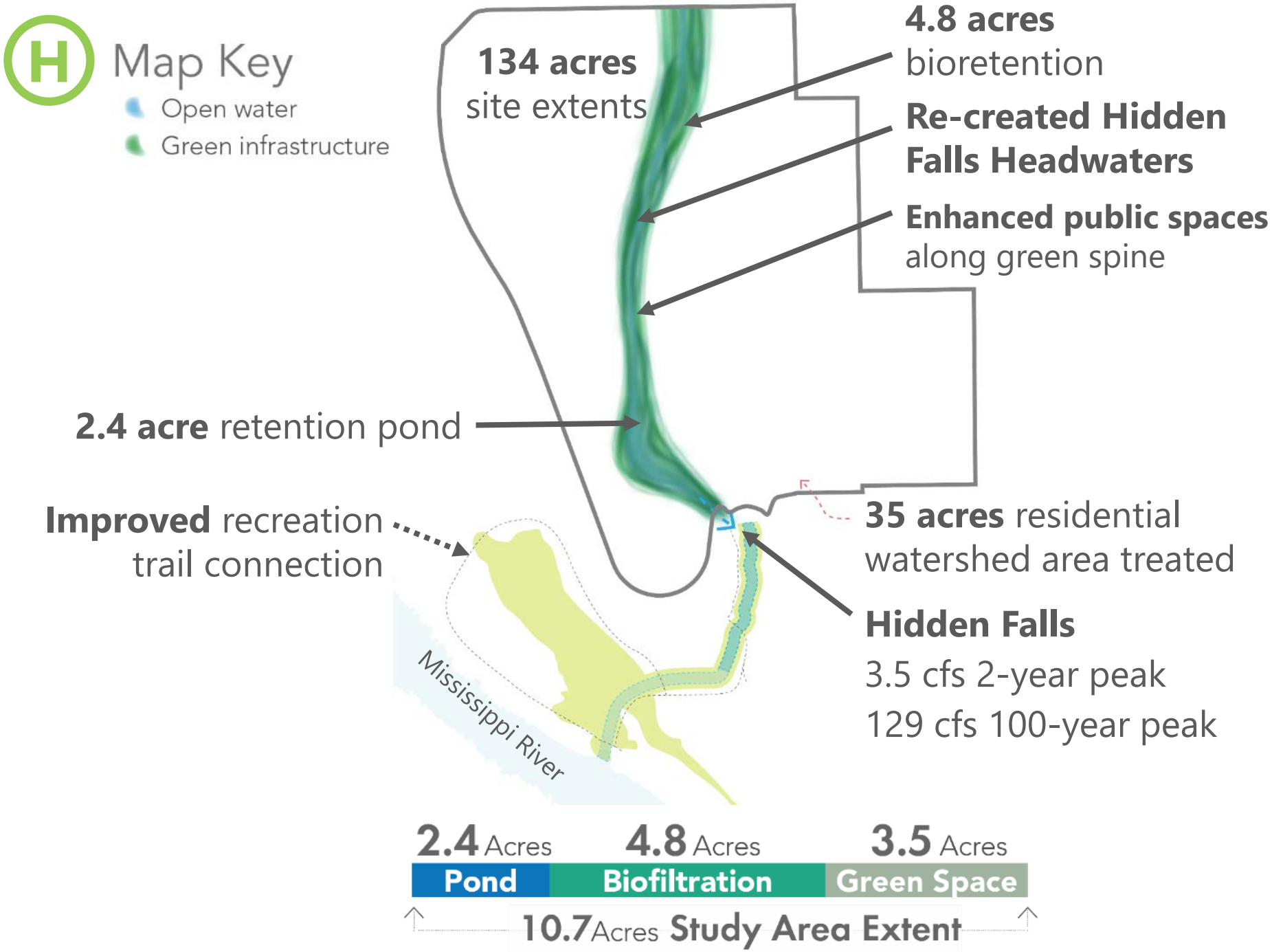
Baseline alternative





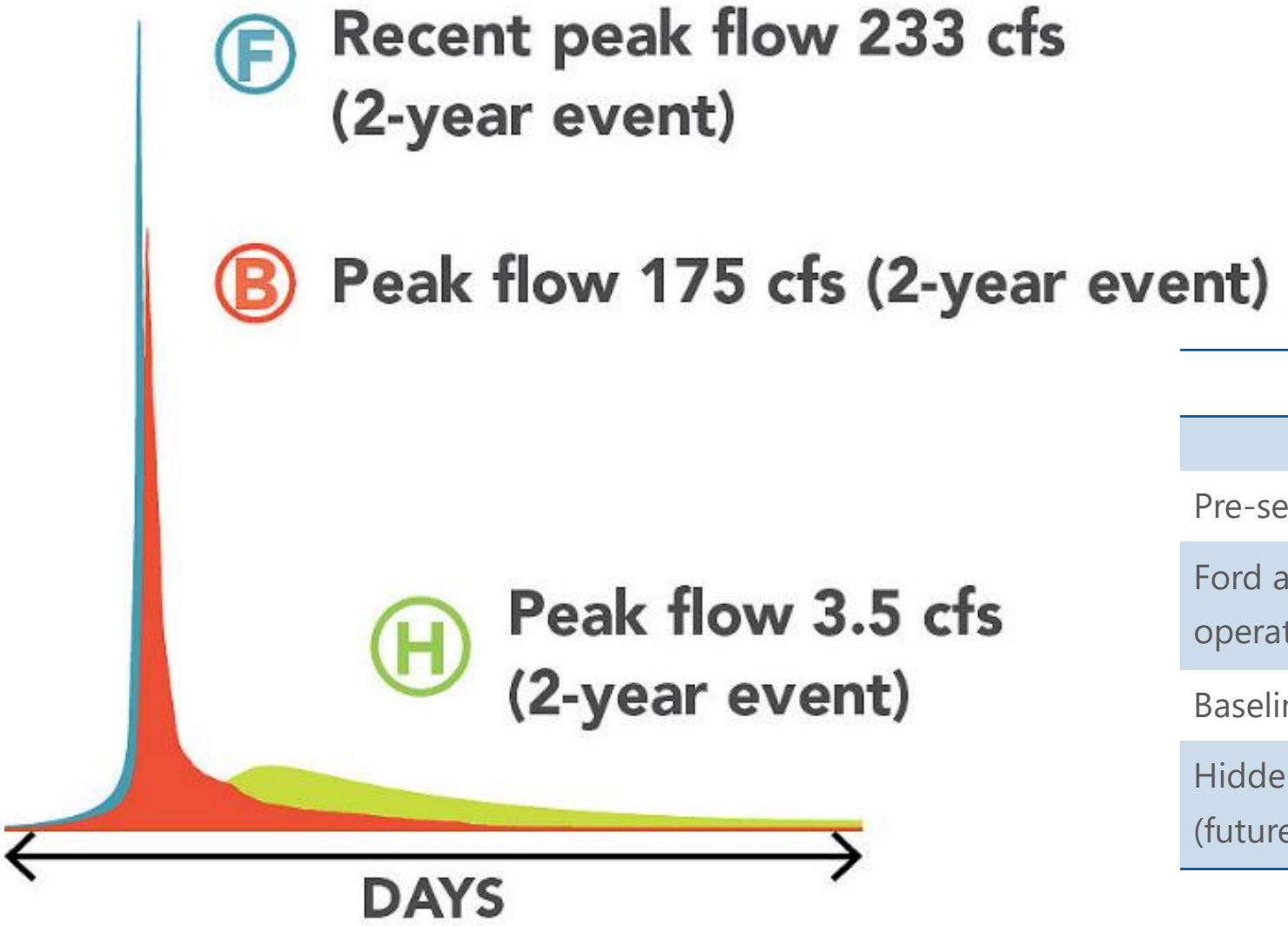
Note: Limited public access from Ford site to Hidden Falls Park due to poor trail connection

Hidden Falls Headwaters alternative



Key takeaways: Hidden Falls restoration/Hidden Falls Creek

The Hidden Falls Headwaters alternative restores natural hydrology



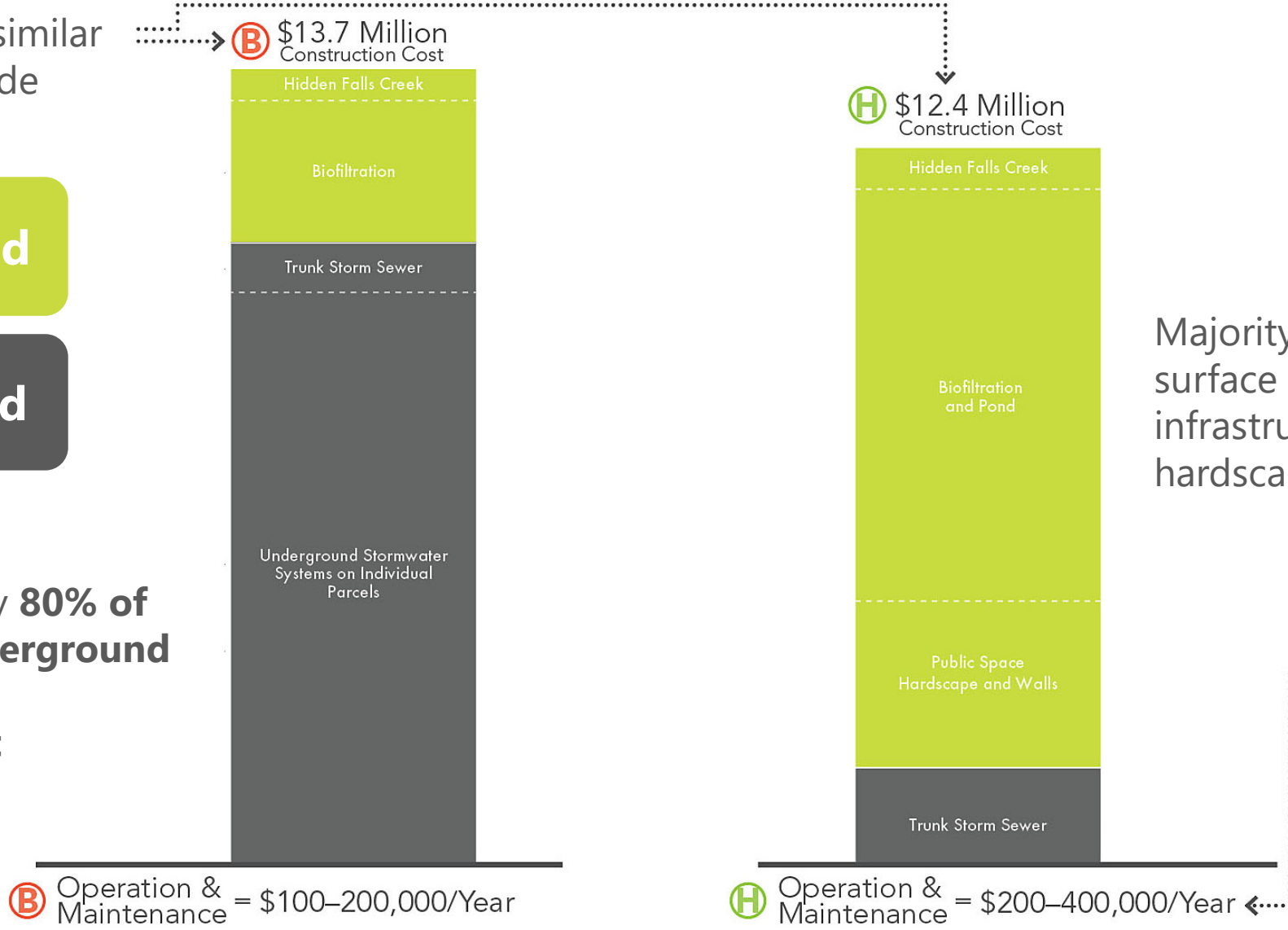
Storm Event Maximum Discharge (cfs)			
	2 Year	10 Year	100 year
Pre-settlement (past)	4	31	161
Ford assembly plant in operation (recent past)	233	401	792
Baseline (future)	175	268	362
Hidden Falls Headwaters (future)	4	31	129

Baseline vs. Hidden Falls Headwaters: Estimated Costs

Construction costs similar in order of magnitude

Above Ground

Below Ground



Approximately **80% of costs for underground stormwater management**

Majority of costs are for surface green infrastructure, walls, hardscape features

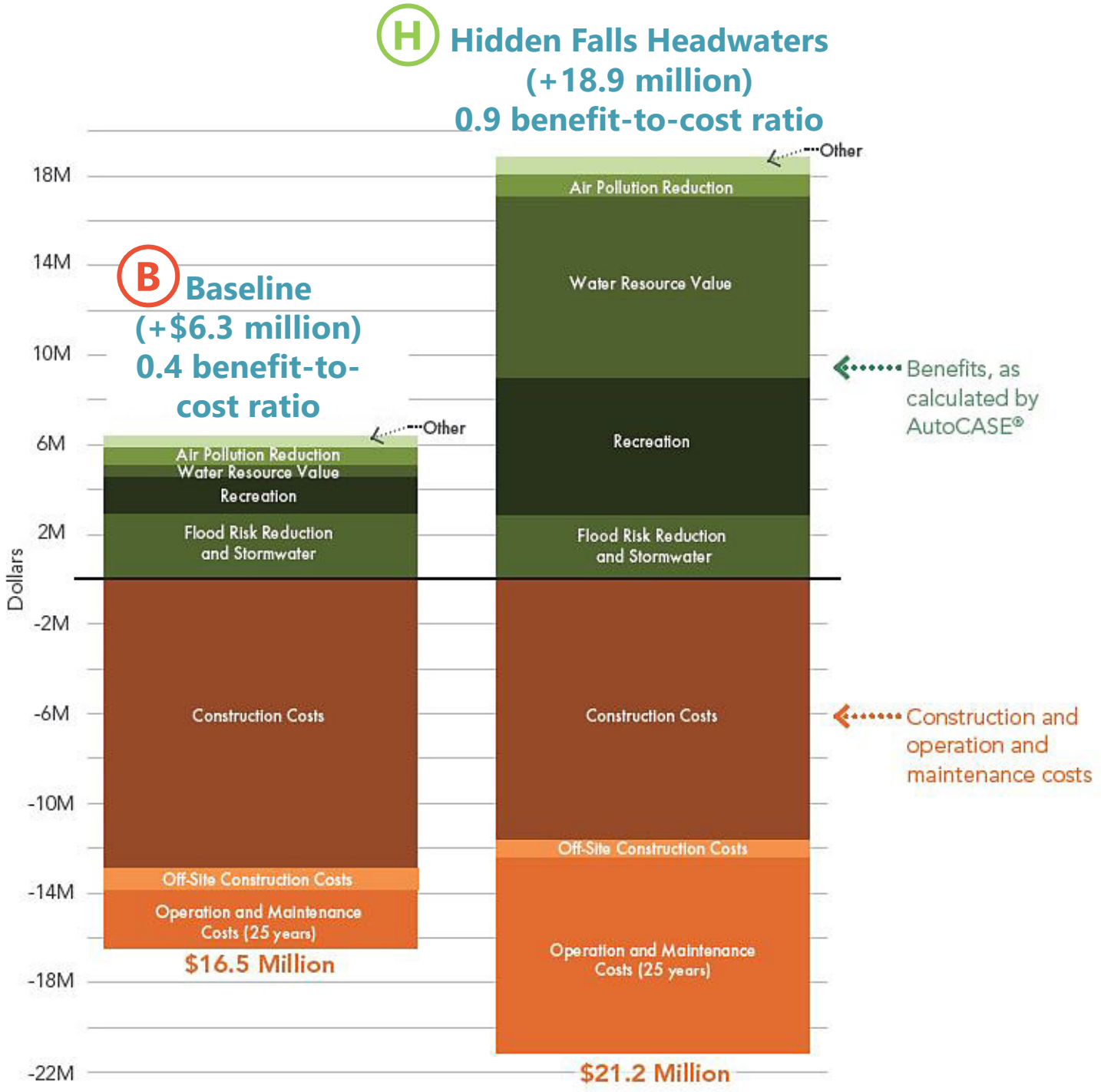
Estimated O&M costs could be double those of Baseline alternative

Baseline vs. Hidden Falls Headwaters:

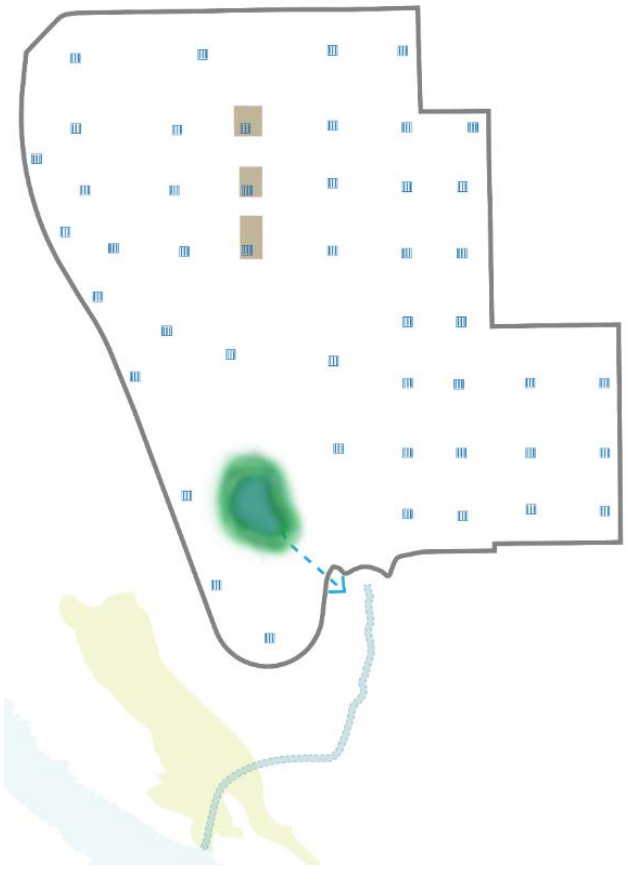
25 Year AutoCASE Model

Benefits

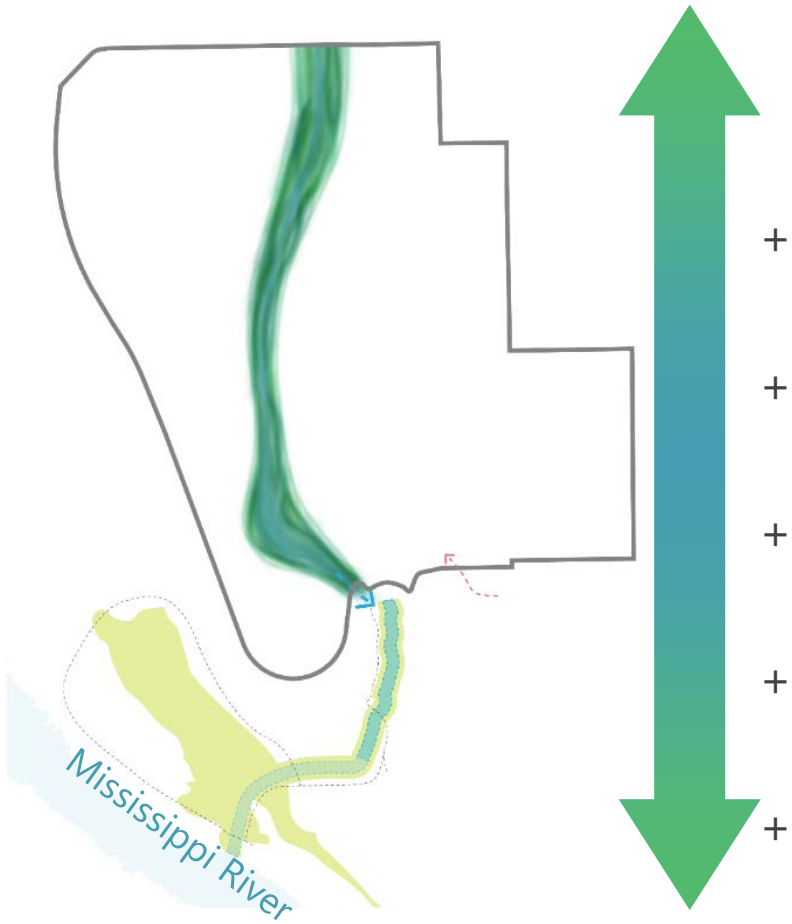
Costs



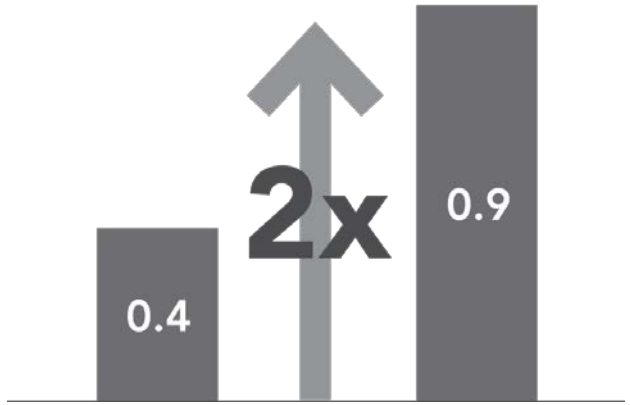
B **Baseline:** conventional stormwater management



H **Hidden Falls Headwaters** (Centralized): stormwater treated in green infrastructure corridor



Benefit-to-Cost Ratio



+ Green infrastructure ecosystem services
+ Enhanced public spaces and recreation
+ More resource awareness, users & uses
+ Connection to Hidden Falls Park
+ Restoration of Hidden Falls Creek

Baseline
vs.
Hidden Falls
Headwaters

A comparative analysis was performed

Stormwater Management

Restoration

Life Cycle Costs, Impacts

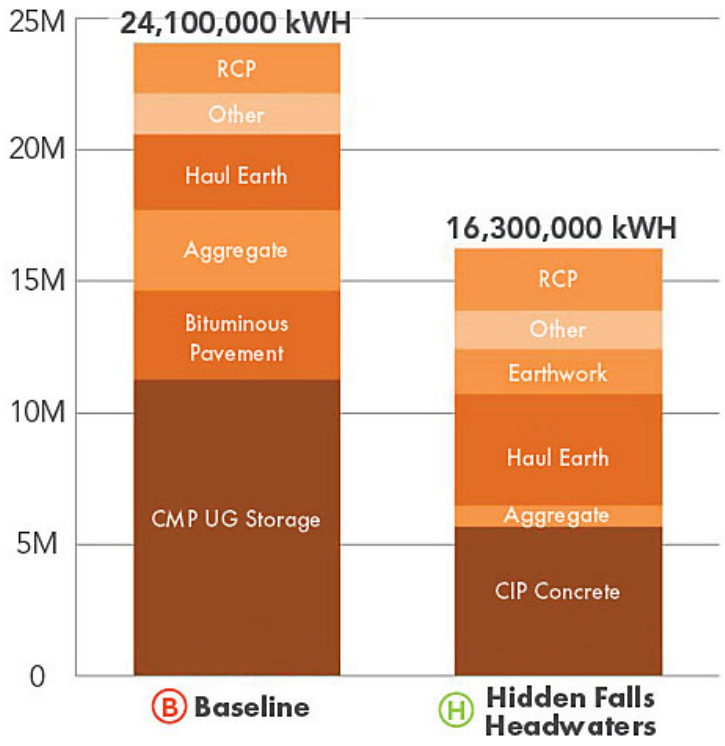
Sustainability, SROI

Community Benefits

using 5 broad assessment themes.

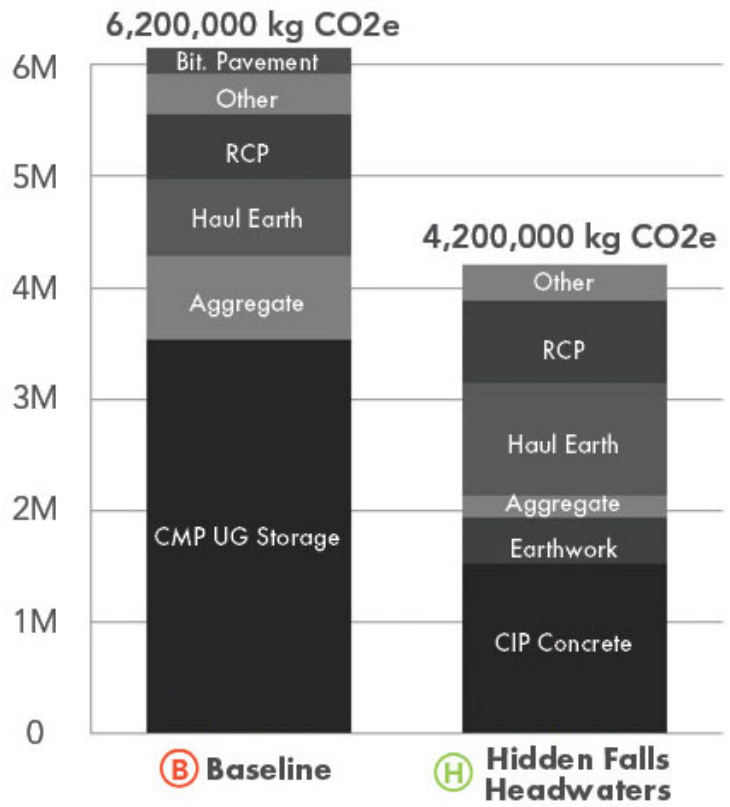
Baseline vs. Hidden Falls Headwaters: life cycle assessment (LCA)

Estimated Embodied Energy Footprint (kWH)



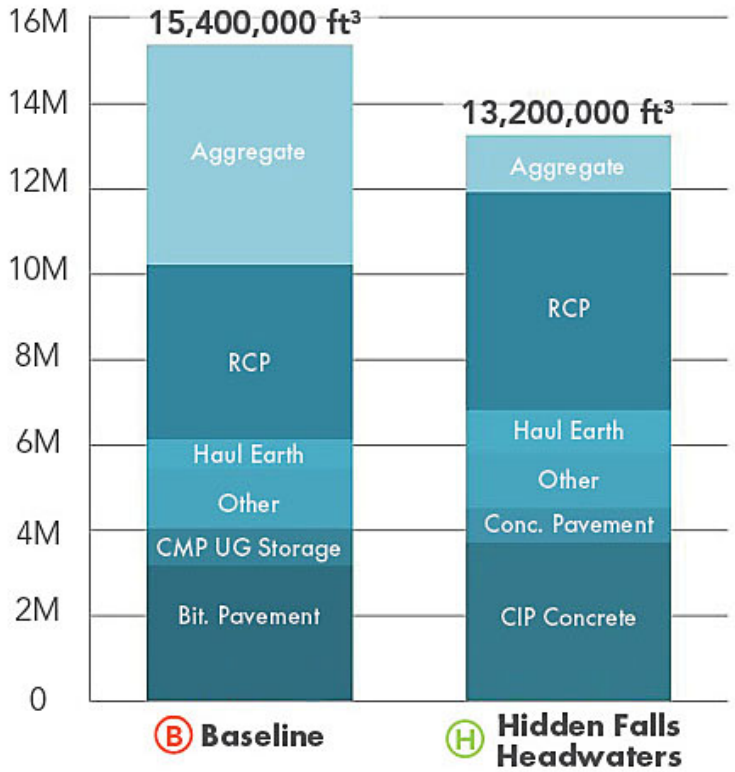
B H

Estimated Greenhouse Gas Footprint kg CO2e



B H

Estimated Water Footprint (ft³)

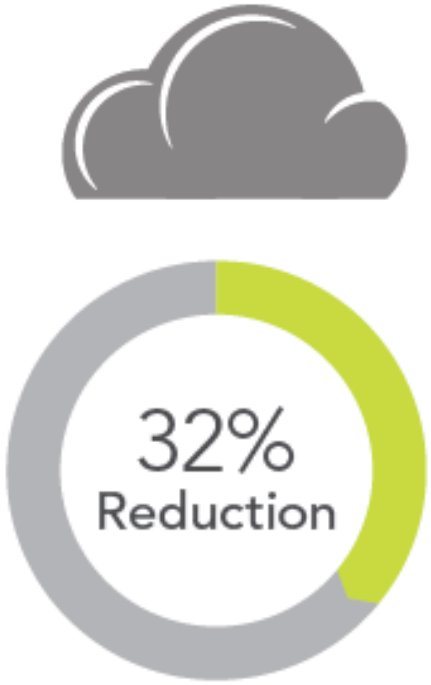


B H

Key takeaways: life cycle assessment (LCA)

H The Hidden Falls Headwaters alternative resulted in a lower footprint for three key sustainability indicators

Estimated embodied energy footprint



Estimated greenhouse gas footprint

Estimated water footprint

Key takeaway: Sustainability indicators

Roadmap to Sustainability
Saint Paul Ford Site

The Ford Site Energy Study

Ford Site Open Space Guidelines
City of Saint Paul

big-picture metrics of success as envisioned by the City

18 sustainability indicators

H

Hidden Falls Headwaters Alt. outperformed on

17 indicators

This alternative was conceptualized with the sustainability indicators in mind

B

Baseline Alt. outperformed on

1 indicator

Baseline vs. Hidden Falls Headwaters: Findings

H *The Hidden Falls Headwaters alternative best supports sustainable redevelopment and the protection of water resources.*

- ✓ Doubles the overall benefit-to-cost ratio over 25 years
- ✓ Reduces unit cost to manage stormwater by 40%
- ✓ Better on 17 of 18 sustainability indicators
- ✓ Nearly 75% more effective in protecting Hidden Falls downstream
- ✓ More successful in mitigating urban heat island effects and reducing air impacts
- ✓ Reduces energy and materials necessary by 32%

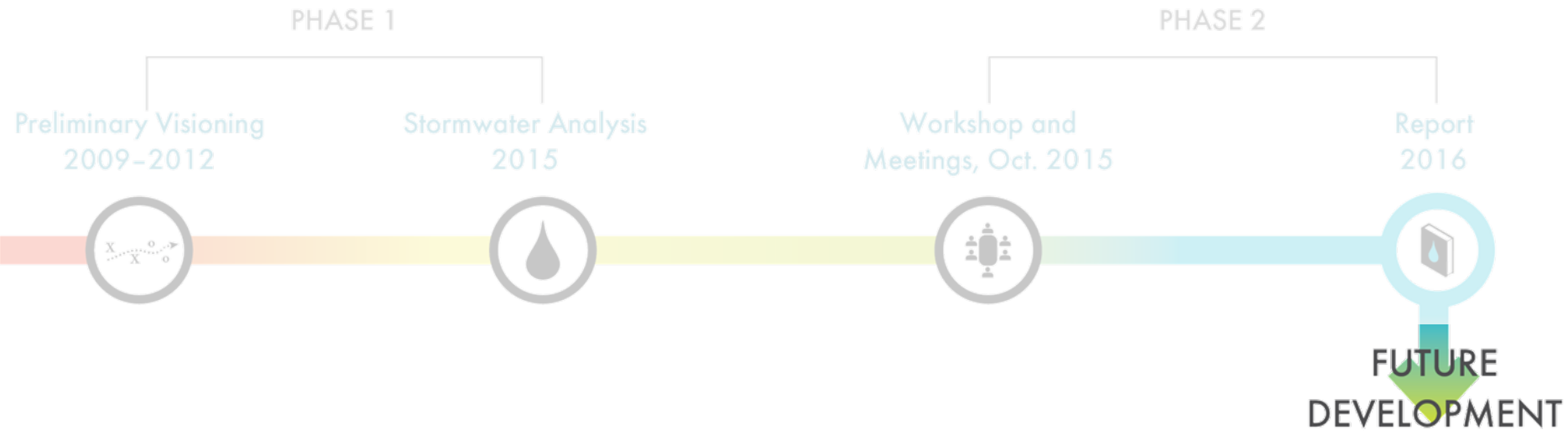
Baseline vs. Hidden Falls Headwaters: Tradeoffs

- 6 acres of 135-acre site required for green infrastructure
- Runoff from adjacent neighborhood(s) will need to be routed to the Hidden Falls Headwaters
- Green infrastructure demands greater operation and maintenance expense
- Additional policy support required because Hidden Falls Headwaters reflects above-standard conditions

Recommendations

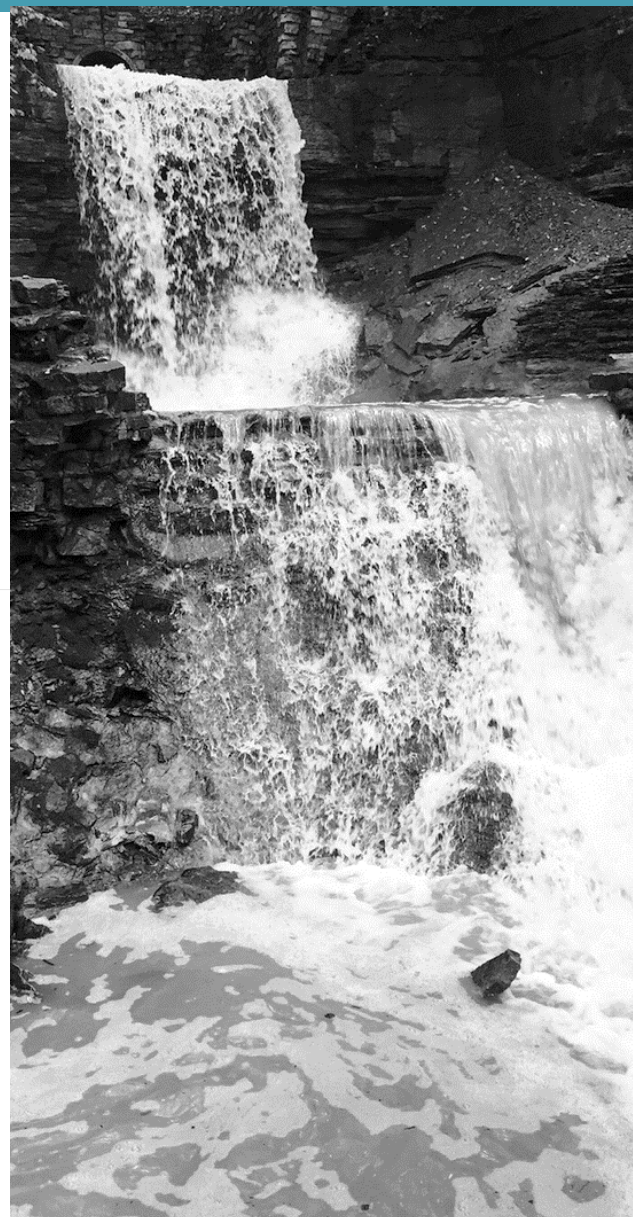
- Use *centralized* Hidden Falls Headwaters approach to stormwater infrastructure
- Achieve pre-settlement discharge rates
- Cost-benefit ratio for stormwater design should not be less than 0.9

Implementation Road map



- Concept refinement
- Conceptual design development
- Zoning master plan

- Preliminary/schematic design development
- Detailed design & construction documents
- Construction



Thank you! Questions ?

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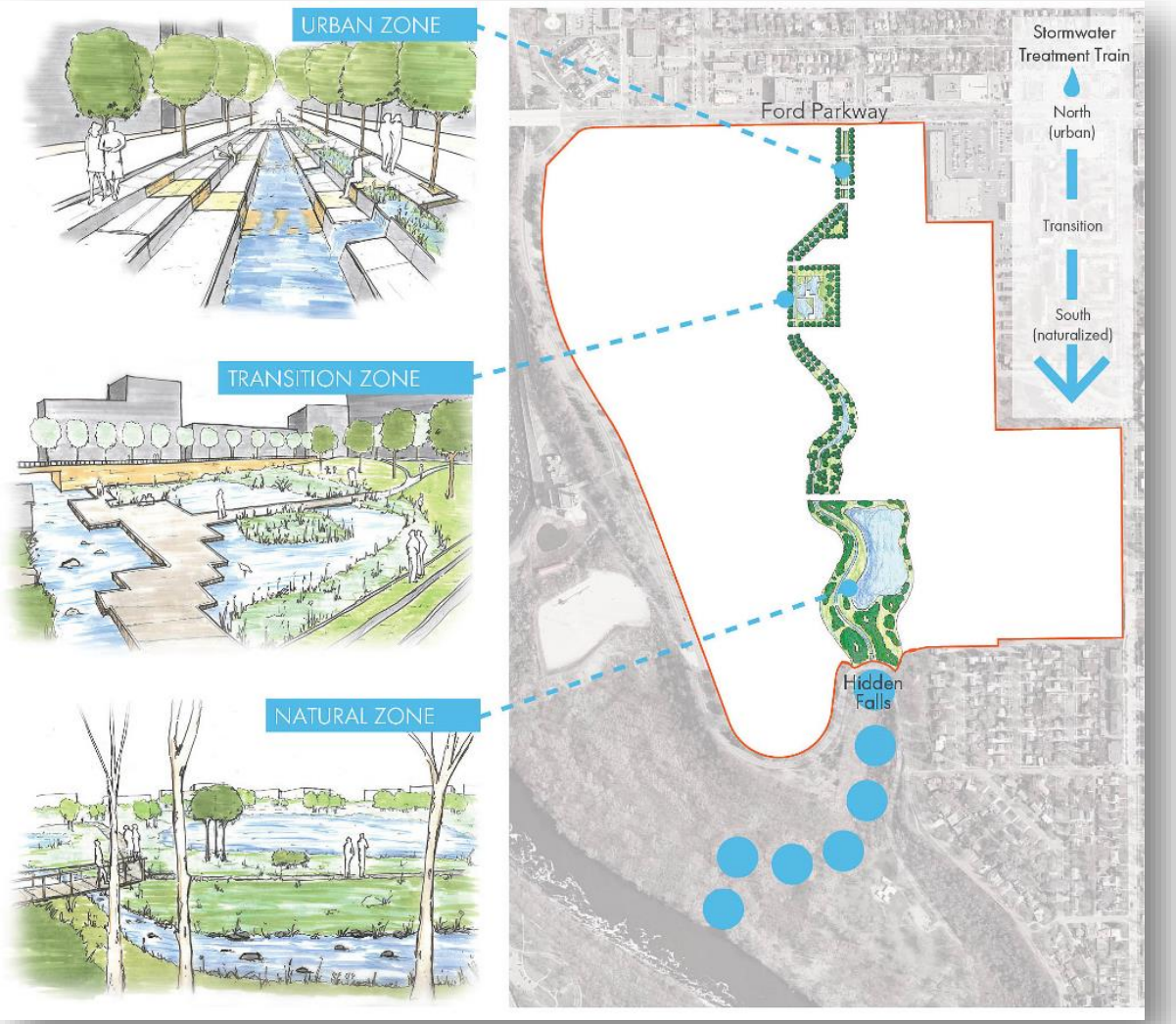


BARR

Impact Infrastructure, LLC

Iron-Enhanced Check Dams for Capturing Phosphorus in Runoff

Poornima Natarajan
John S. Gulliver
University of Minnesota

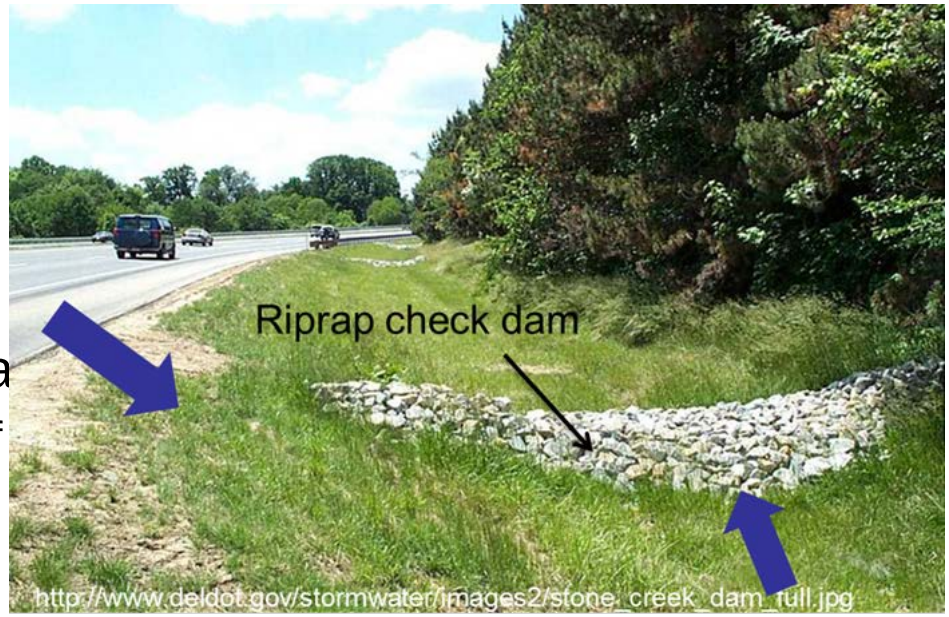
Barbara Loida, Nick Olson, David Bauer, James Michael, Scot Way
Minnesota Department of Transportation

Kristine Giga and Ryan Johnson
City of Roseville

Roadside Swales/Drainage Ditches

- Convey, infiltrate stormwater runoff
- Filter out solids and associated pollutants
- Dissolved pollutant capture – low; by volume reduction

- *Dissolved phosphorus*
  - ~45% total P load in runoff
    (*Maestre and Pitt 2005; Kayhanian et al. 2012*)
  - Bioavailable
  - Treatment with engineered media
    - Not accounted for in typical design of swales



- *Maestre, A., and Pitt, R. (2005). The National Stormwater Quality Database, Version 1.1: A Compilation and Analysis of NPDES Stormwater Monitoring Information. University of Alabama, Tuscaloosa, AL, and Center for Watershed Protection, Ellicott City, MD.*
- *Kayhanian, M., B. Fruchtman, J. S. Gulliver, C. Montanaro, E. Raniere and S. Wuertz, (2012). "Review of Highway Runoff Characteristics:: Comparative Analysis and Universal Implications," Water Res., 46(9), 6609-6624.*

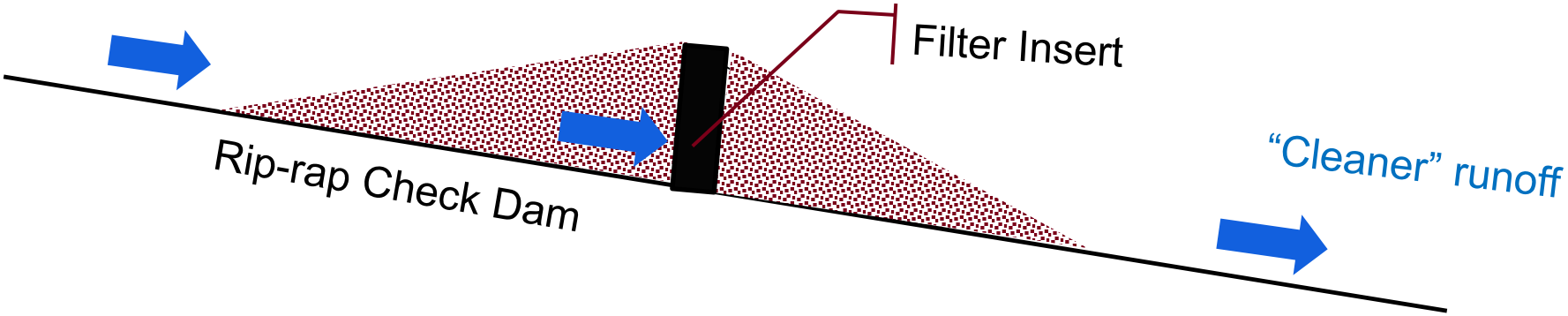
Iron-Enhanced Sand Filtration (IESF) for Stormwater Treatment

- Sand filter containing iron filings/shavings
  - Specifically for dissolved phosphorus capture
- Laboratory research and modeling *(Erickson et al. 2006, 2012)*
  - In media w/ 5% iron (by wt), 4.8 mg P retained/g Fe
- Current Application: Pond-perimeter filter trenches
  - Vertical flow filtration

- *Erickson, A. J., Gulliver, J. S. and Weiss, P. T. (2007). "Enhanced sand filtration for storm water phosphorus removal." J. Environ. Eng., 133(5), 485-497.*
- *Erickson, A. J., Gulliver, J. S., and Weiss, P. T. (2012). "Capturing phosphate with iron enhanced sand filtration." Water Res., 46(9), 3032-3042.*

Iron-Enhanced Check Dam

- Incorporate iron-enhanced sand filter as an "insert" in a check dam



Applications/Advantages:

- Relatively inexpensive
- Installation in limited right-of-way, poor drainage soils

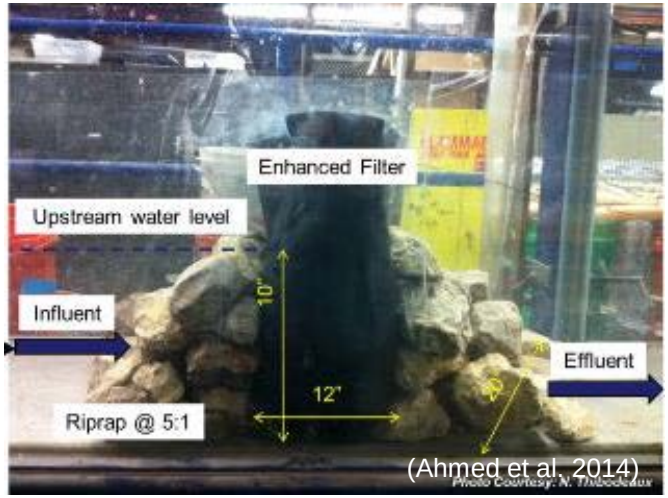
Objectives and Tasks

<u>Design, install, and assess iron-enhanced check dams for dissolved phosphorus capture in swales</u>

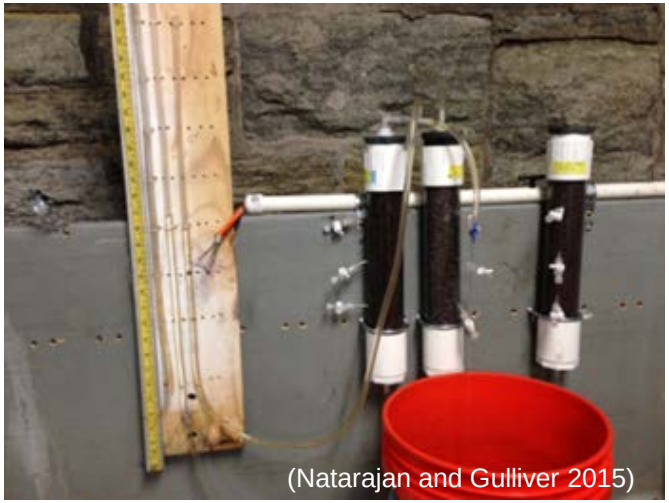
- Design development
  - Laboratory tests
  - Full-scale design
- Construction
  - MnDOT and City of Roseville Swales
- Performance Assessment
  - Field monitoring and field testing
    - Season 1 (2015)

Design Development

- Laboratory prototype
  - Flume tests
    - C-33 sand-iron filings media
    - Steel wool media
- *Re-design* w/ coarser sand-iron media
  - Sand (D_{50} = 1.18 mm)
  - Column tests (92.5% Sand - 7.5% Iron)
    - Ksat = 0.046 cm/s (79 in/hr)
  - Two designs for MnDOT and City of Roseville swales



(Ahmed et al. 2014)


(Natarajan and Gulliver 2015)

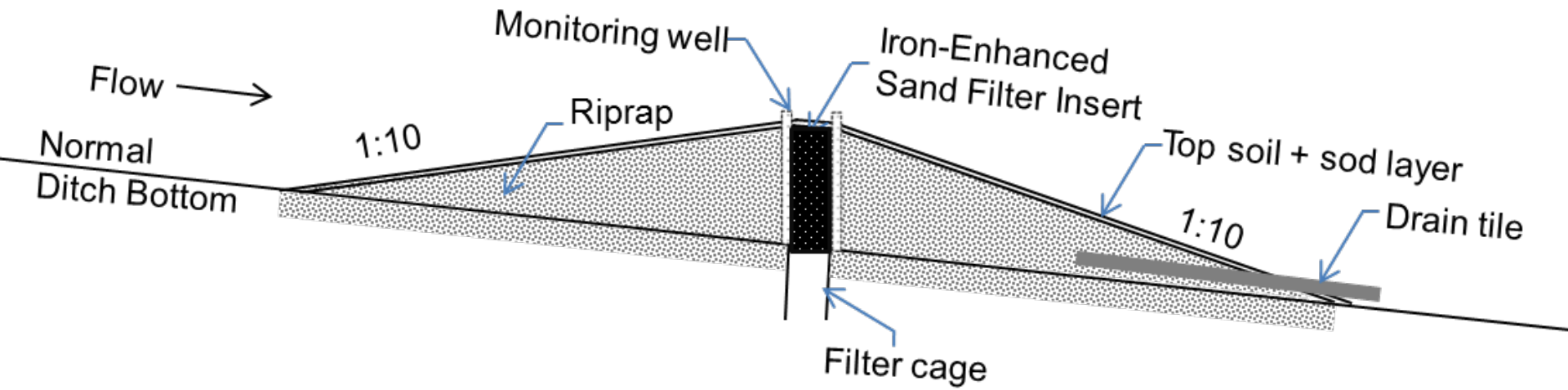
- *Ahmed, F., Natarajan, P., Gulliver, J.S., Weiss, P.T. and Nieber, J.L. (2014). Assessing and Improving Pollution Prevention by Swales, Final Report 2014-30, Research Services and Library, Office of Transportation System Management, Minnesota Department of Transportation, St Paul, MN. <http://www.lrrb.org/PDF/201430.pdf>*
- *Natarajan, P., and Gulliver, J.S. (2015). "Assessing iron-enhanced swales for pollution prevention." Final Report prepared for the U.S EPA Section 319 Program and Minnesota Pollution Control Agency. University of Minnesota Digital Conservancy, http://hdl.handle.net/11299/175560.*

Design #1: Stillwater Check Dam

Stillwater, Washington County, MN

- Filter insert
  - Depth = 0.38 m (15 in.)
  - Height = 0.61 m (24 in.)

Not drawn to scale




1

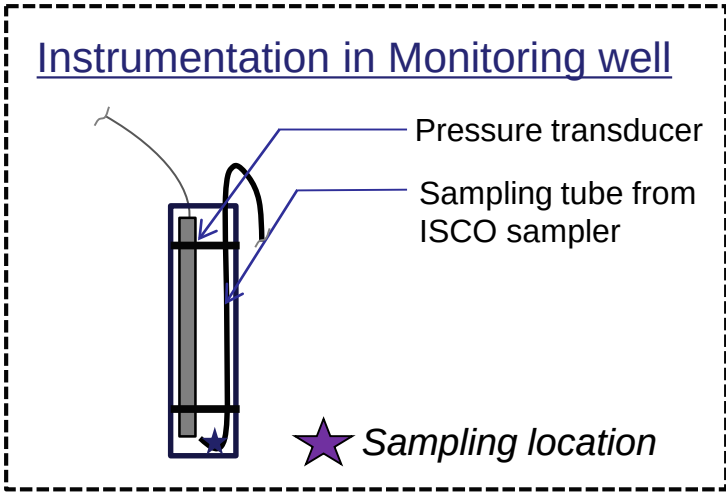

2

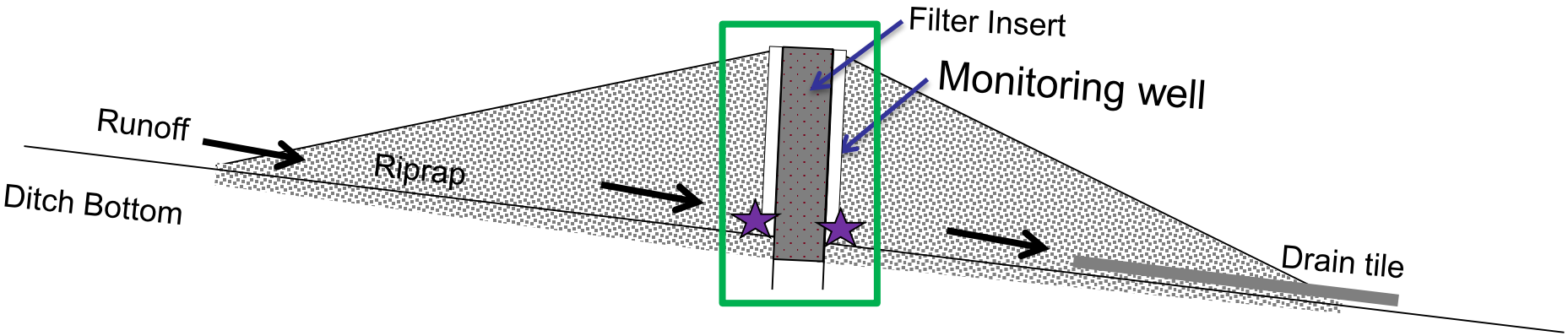

4


3
9/2014

Performance Assessment: Field Monitoring

- Sand-iron filter insert performance
  - Storm events (Summer 2015)
  - Water levels, filter outflow *(Dupuit's equation)*
  - Composite WQ Samples
    - Soluble reactive phosphorus (SRP)
  - P mass removed in treated volume





Not drawn to scale

2015 Field Monitoring Results

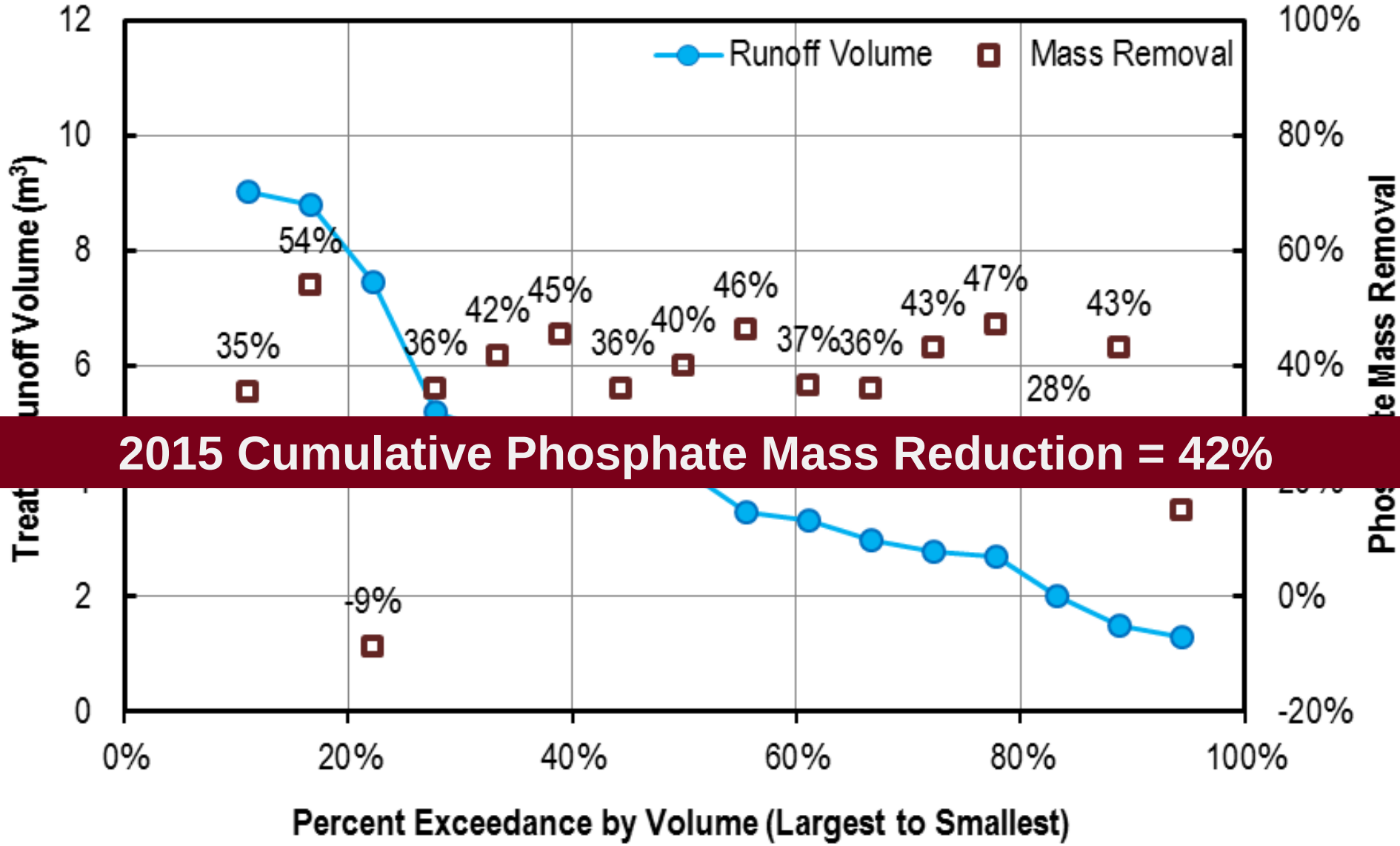
Stillwater Check Dam

Phosphate = Soluble Reactive Phosphorus
EMC = Event Mean Concentration

Date	Rainfall Depth (in)	Phosphate EMC in (µg/L)	Phosphate EMC out (µg/L)	Date	Rainfall Depth (in)	Phosphate EMC in (µg/L)	Phosphate EMC out (µg/L)
5/03/15	0.45	666	352	6/13/15	0.70	168	98
5/10/15	0.36	885	504	6/17/15	1.00	114	74
5/14/15	0.45	627	401	6/22/15	0.49	128	81
5/17/15	0.40	561	302	6/28/15	0.30	283	241
5/24/15	1.23	1000	461	6/29/15	0.74	116	69
5/29/15	0.63	417	228	7/28/15	0.31	202	115
6/03/15	0.75	280	179	8/18/15	1.39	274	175
6/11/15	0.42	457	328	8/22/15	1.62	184	200

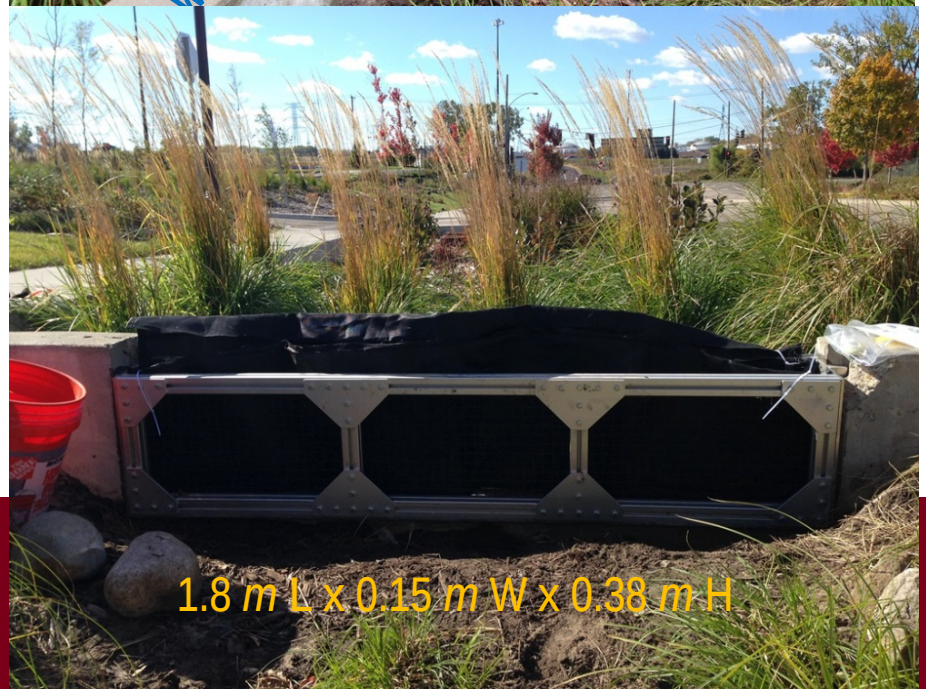
Volume Exceedance and Phosphate Mass Reduction

Stillwater Iron-Enhanced Check Dam Insert



2015 Cumulative Phosphate Mass Reduction = 42%

Design #2: City of Roseville Check Dam

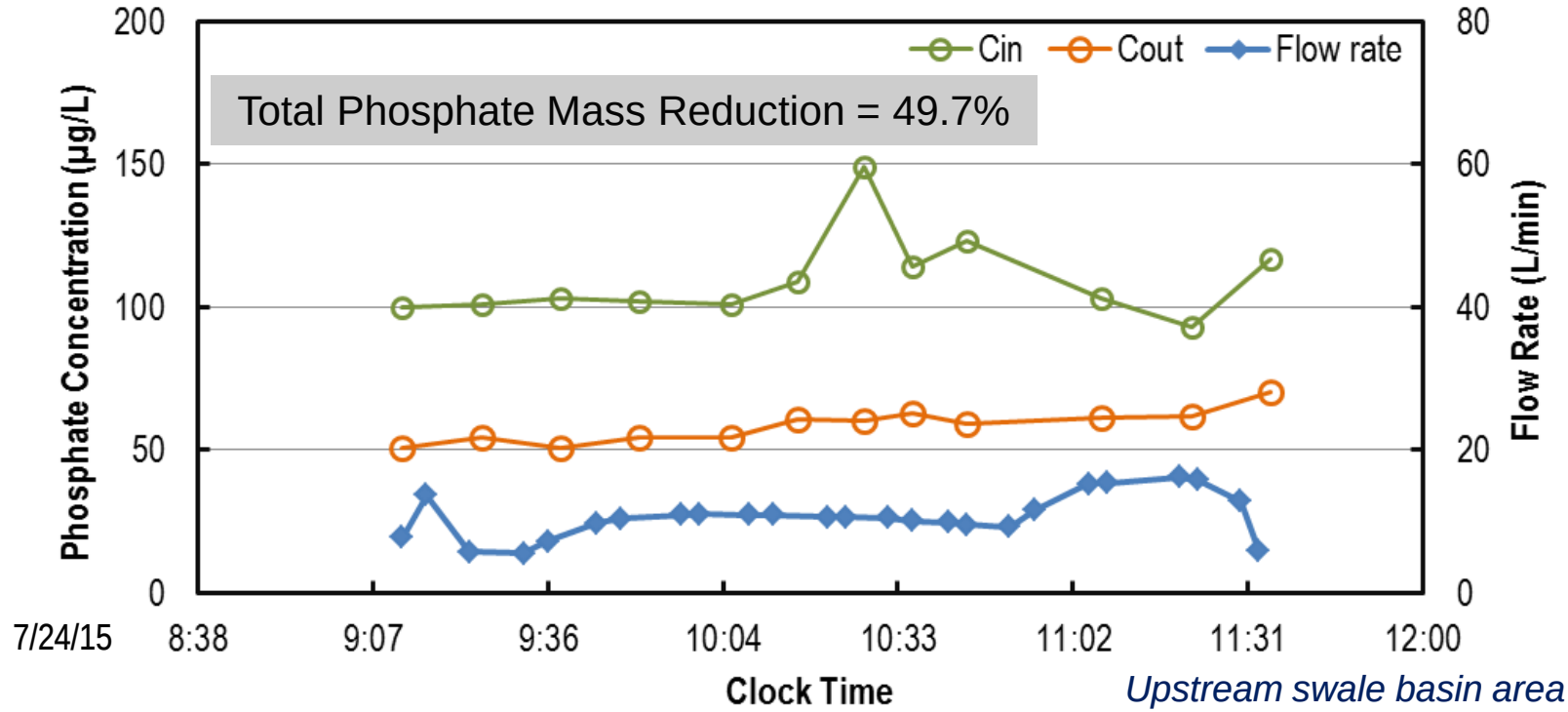


Field Testing

- Water truck (~7600 L capacity)
- Phosphorus added to water
- ~2.5-hr tests
- Filter outflow @ 10-min (catch and weigh method)
- Grab water samples @10- or 20-min for [SRP]
- Water input rate, upstream head at check dam also monitored
  - Infiltration loss
- 3 tests in Summer 2015

Field Testing: Test #1 Results

Upstream head at check dam = ~0.15 m (6 in)

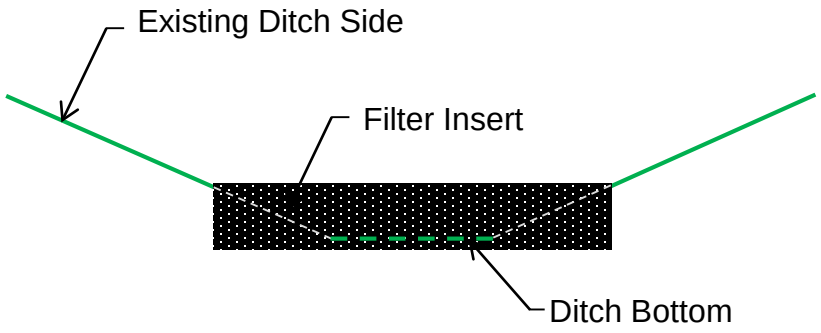


Upstream swale basin area = 38 m²

Date	Test Scenario	Volume Input (m^3/m^2)*	Phosphate C_{in} (mean)	Phosphate C_{out} (mean)	Phosphate $Mass_{in}$	Total Mass Removal
Test #2 8/7/15	High head, high P input	0.25	320 µg/L	240 µg/L	0.936 g	26.7%
Test #3 8/14/15	Low head, high P input	0.22	330 µg/L	190 µg/L	0.464 g	42.2%

Iron-Enhanced Check Dam Inserts

- Reduce phosphate in runoff
  - 30 to 50% mass reduction
- In-series installation for greater P reduction
- Long-term performance and maintenance needs yet to be investigated



Challenges, Lessons, Guidelines

- Design and construction feasibility, weather delays
- Proper sealing (and width) to prevent leakage, flow bypass
- Alternate design with multiple filter socks
  - Site conditions, future maintenance, cost
  - Filter frame enclosure
- Quality of iron filings

Acknowledgements

Project Sponsors and Partners

- Minnesota Pollution Control Agency (US EPA 319 Grant)
- MN Department of Transportation
- City of Roseville
- Local Road Research Board

Project Support

- Prof. Peter Weiss, Valparaiso University
- St. Anthony Falls Laboratory (D. Christopher, C. Ellis, B. Erickson, A. Ketchmark)
- Undergraduate research assistants (D. Liddell, A. Poovey, T. Olsen, J. Pham)

Contact Information: Poornima Natarajan

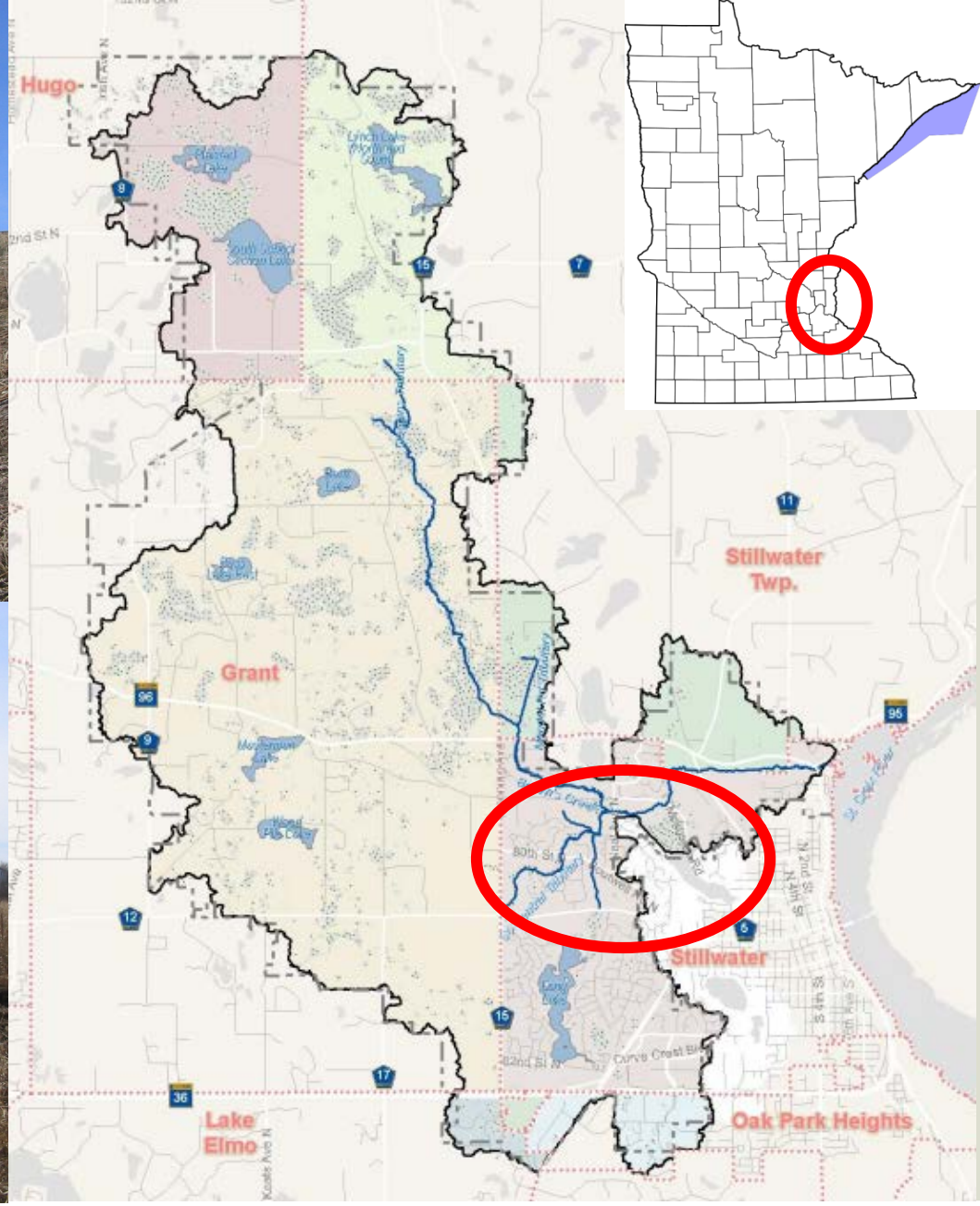
pnataraj@umn.edu

Pump and Treat Iron Enhanced Stormwater Treatment

October 18, 2016

Karen Kill, BCWD Administrator
Ryan Fleming, EOR

BCWD IESF Settlers Glen Neighborhood, Stillwater, MN

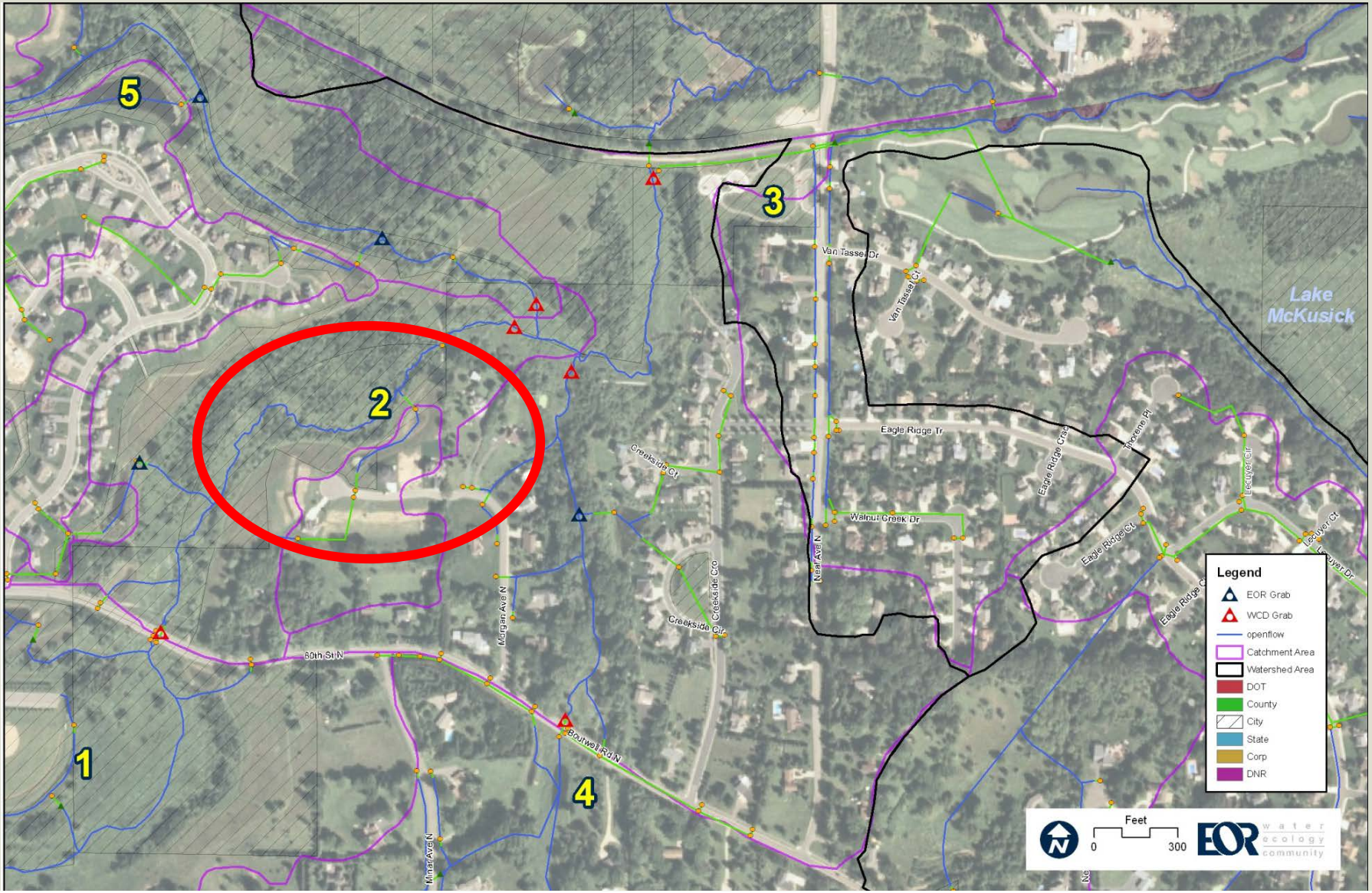


BCWD IESF Settlers Glen Neighborhood, Stillwater, MN

Collaboration

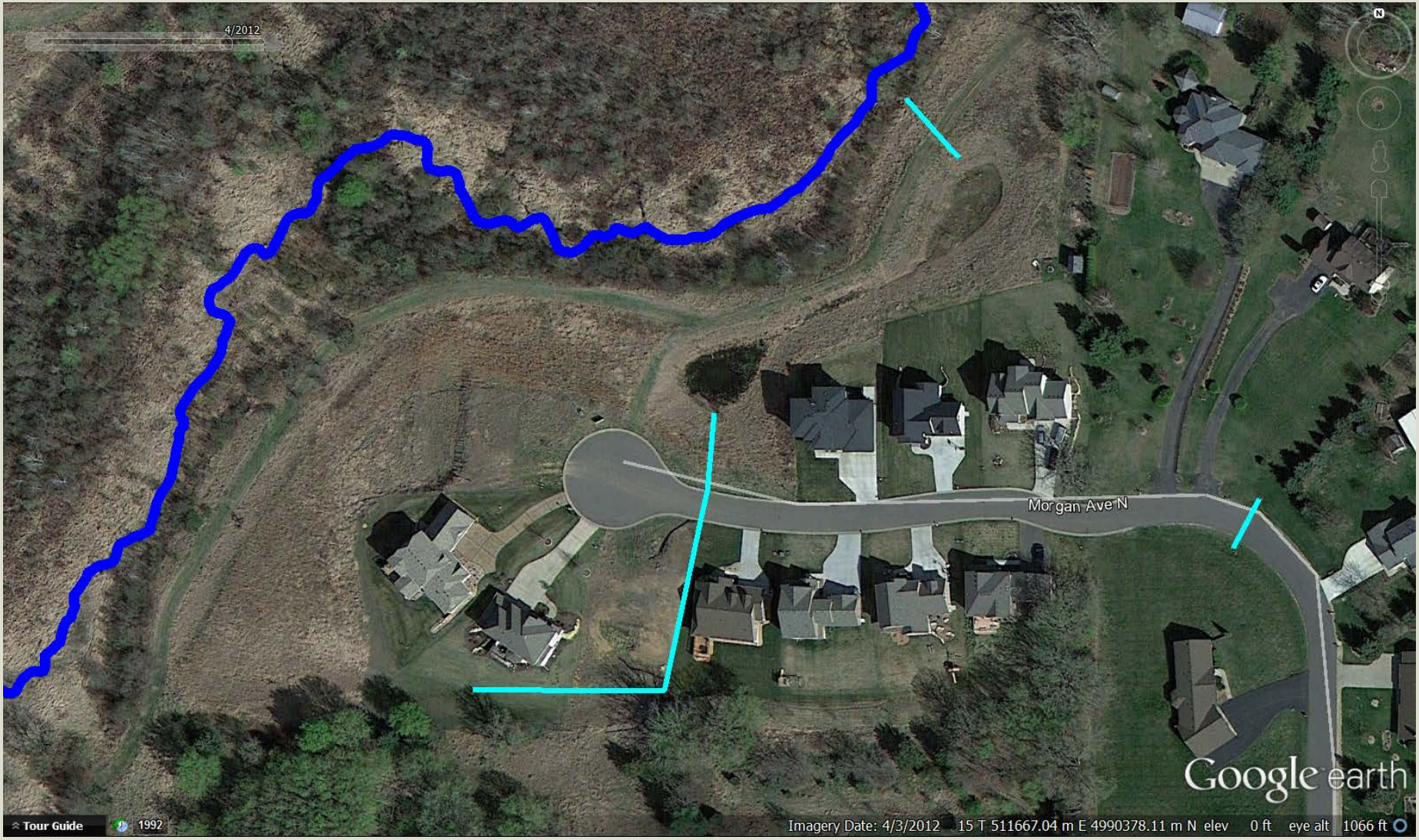
- Brown's Creek Watershed District
- City of Stillwater (also WCA LGU)
- MN DNR Waters
- Saint Anthony Falls Lab
- Neighborhood Residents

Site Selection - Location

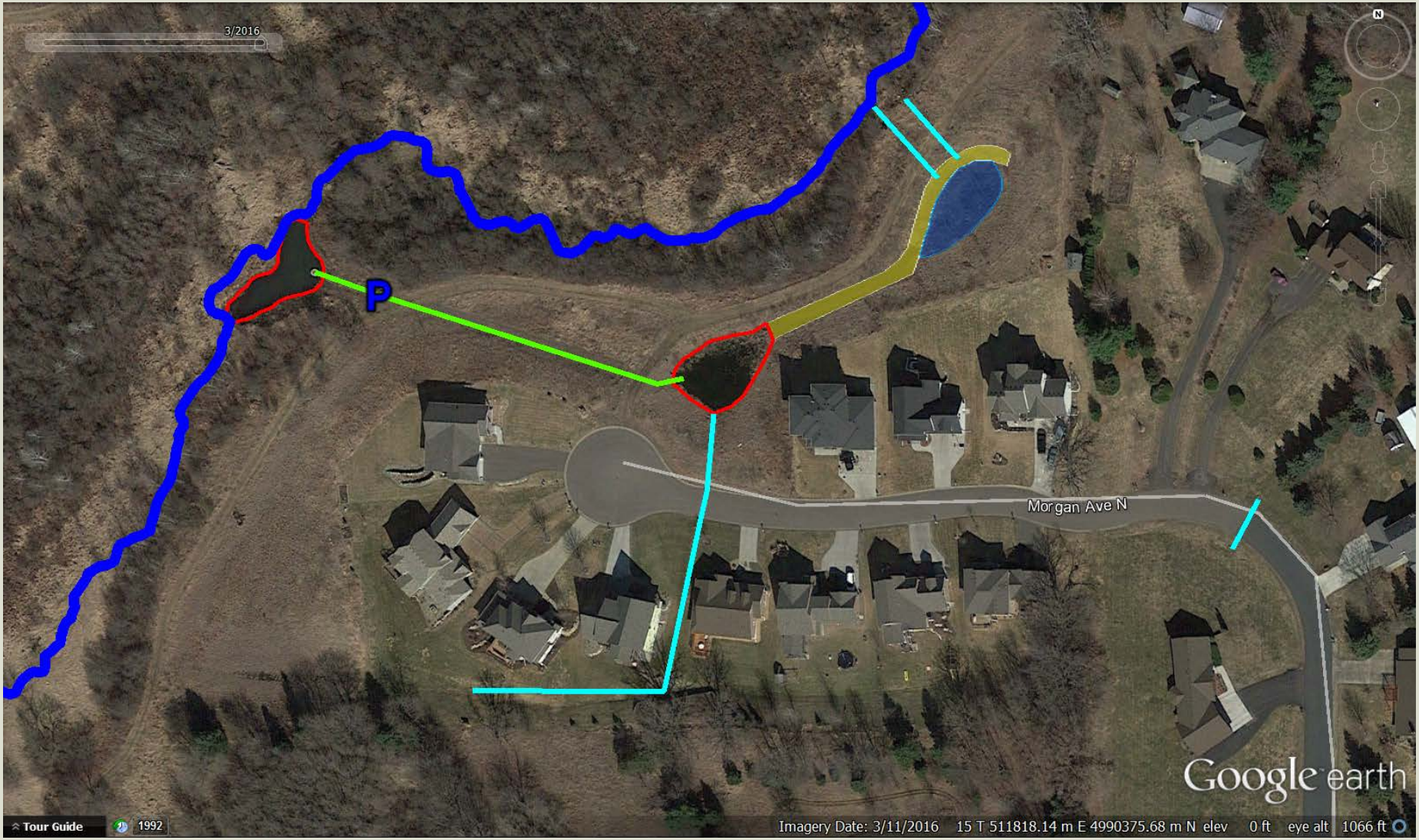


Site Selection – Drainage Area

Pre-Project - 2012



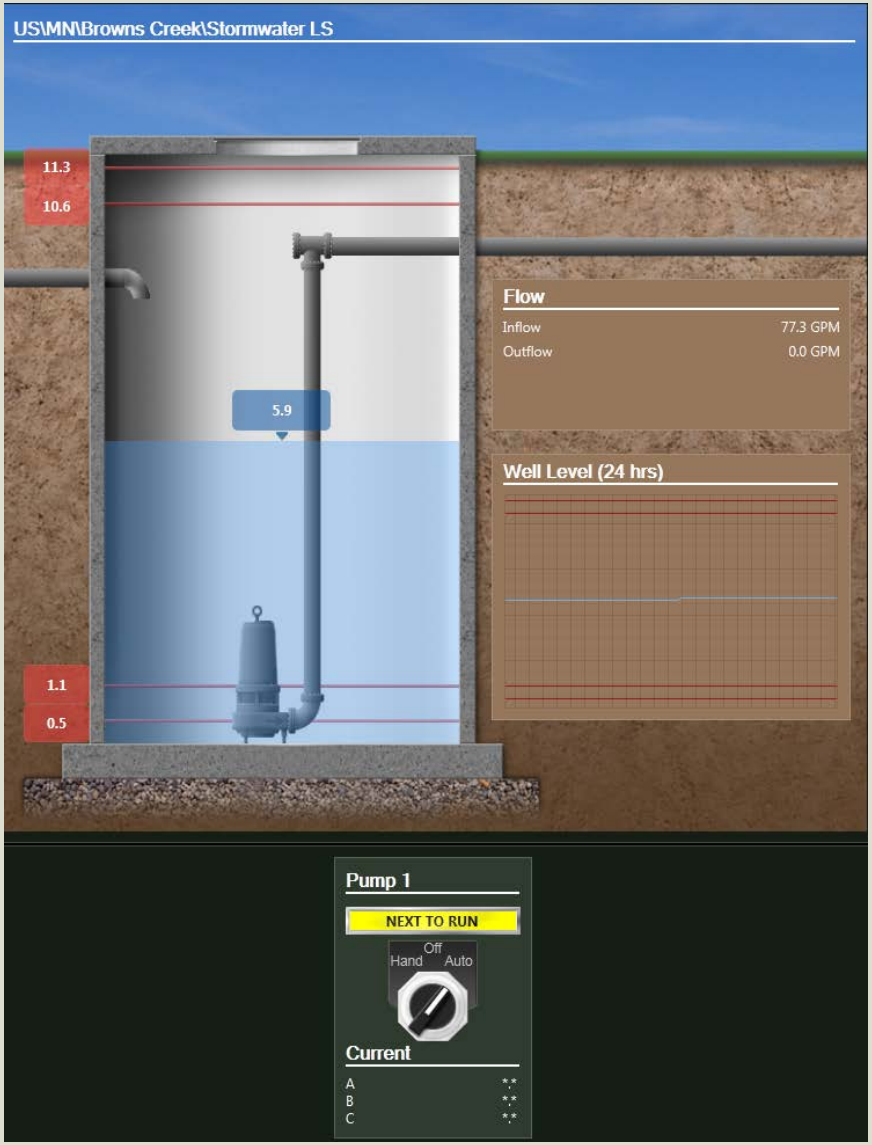
System Components



System Components - Pump Harvest Pond

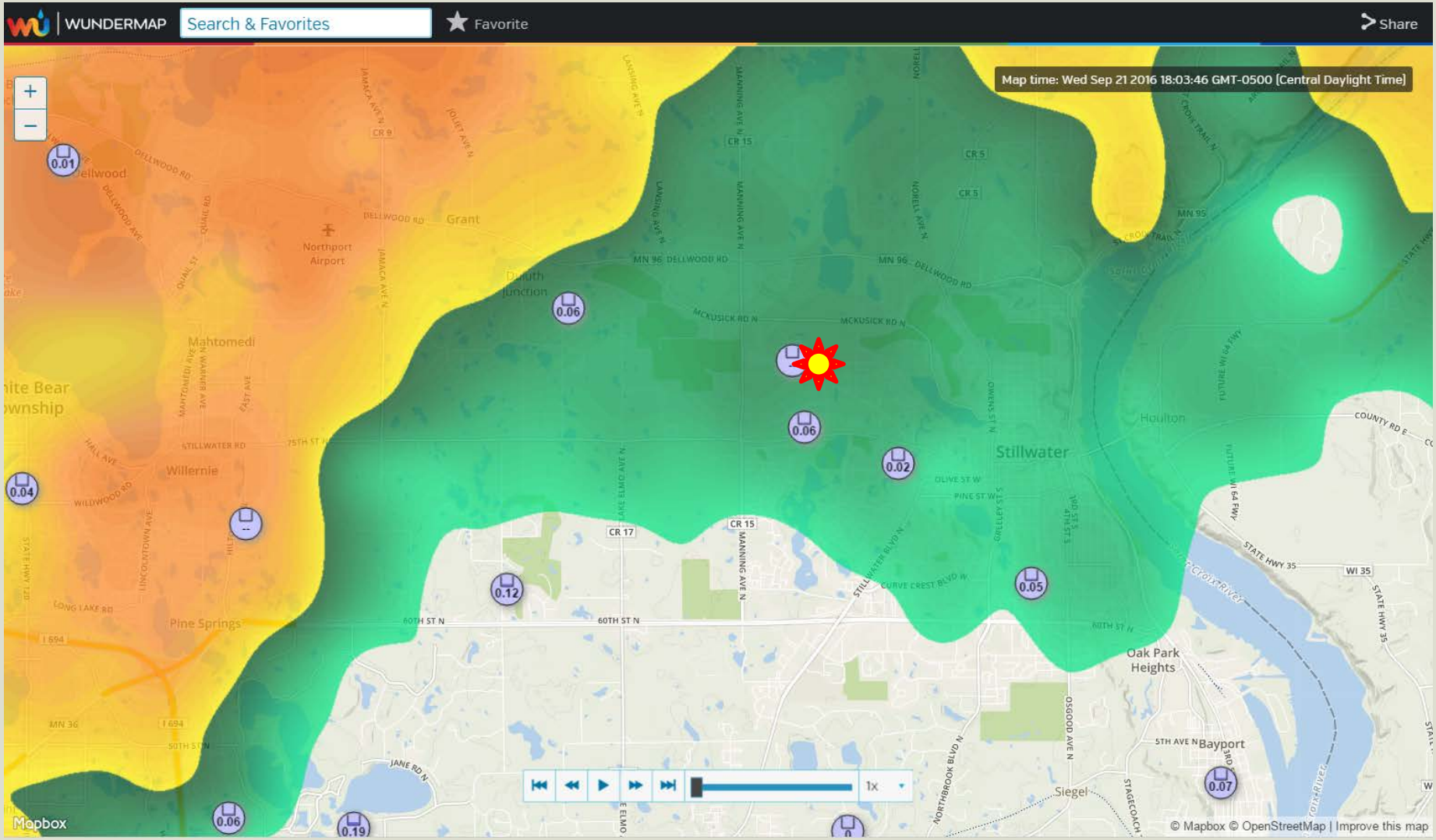
System Components - Lift Station Control Cabinet

System Components - Pump Upgrades



- Inline Magnetic Flow Meter
  - Accuracy within 1%
  - Reduced Monitoring Staff Time
- Automatic Pump Speed Controlled by Water Level
  - Scalable to Reduce Bypass During Higher Flow Events
- Remote Monitoring & Control via Web Interface
  - Reduced Staff Time for Routine Checks, Trigger Point Adjustment, Response to Pump Faults, Downloading of Data

Remote Operation

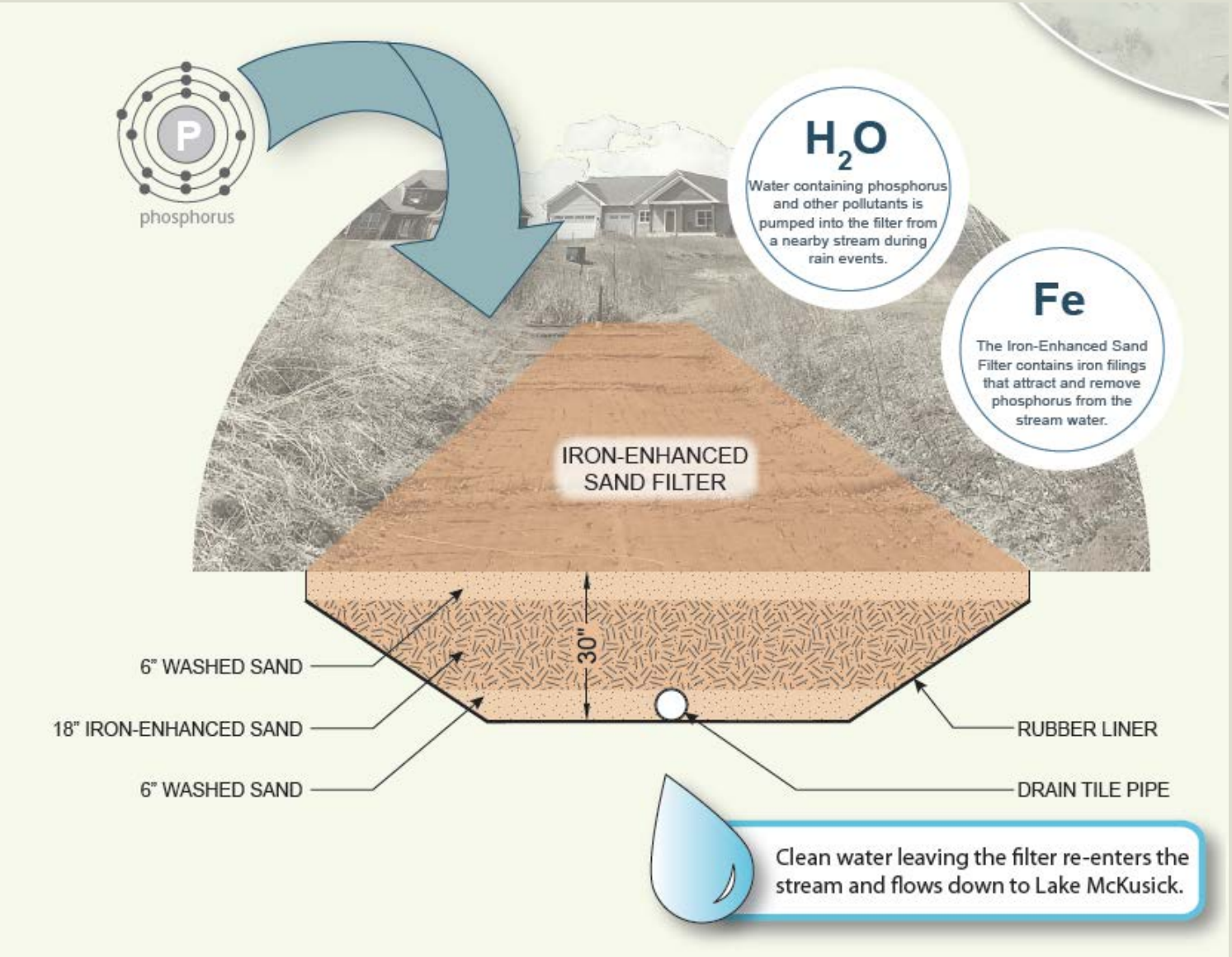


System Components - Lift Station Control Cabinet

System Components – Pre-Project Pretreatment

System Components - Pretreatment

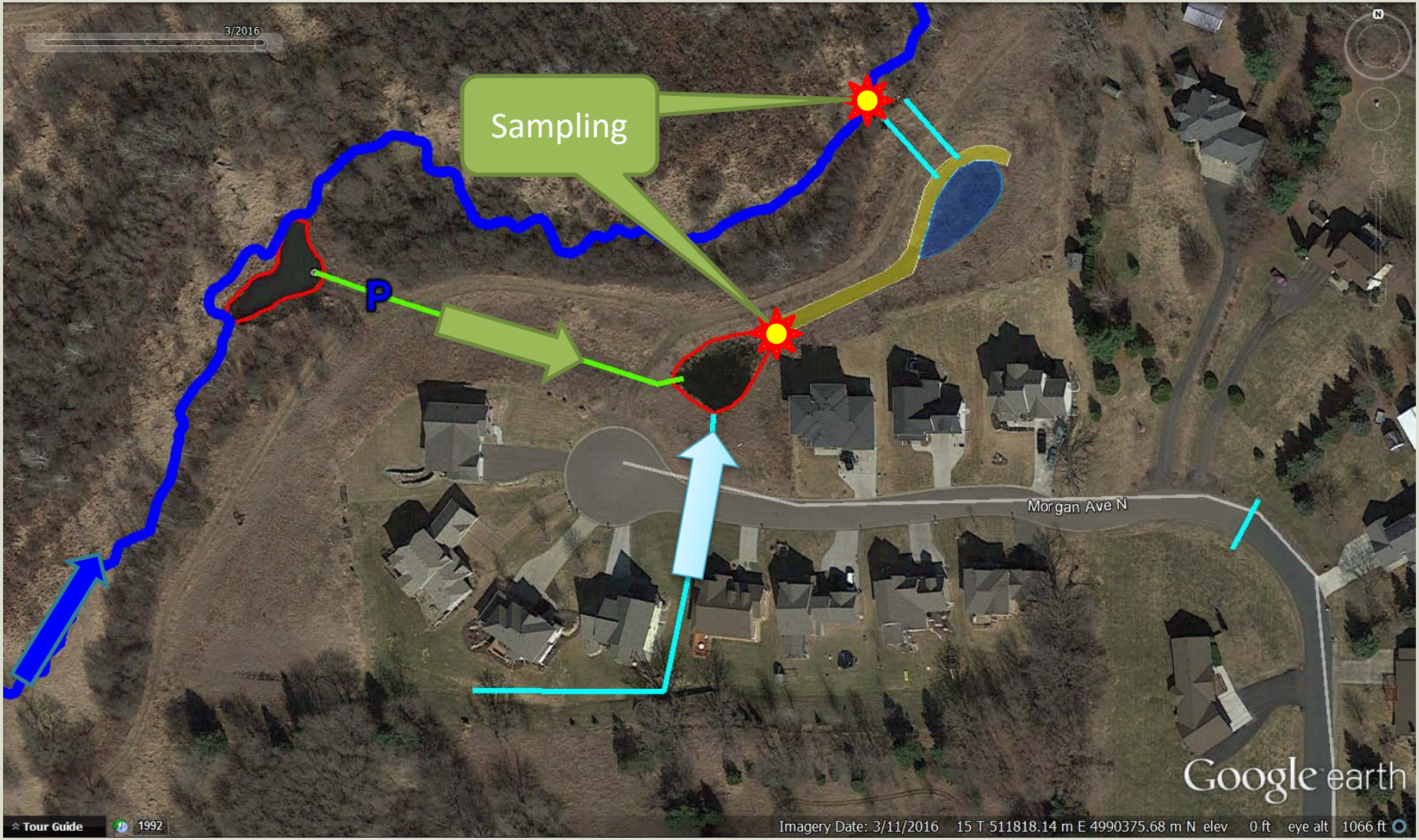
System Components – Sand Filter



System Components - Sand Filter

System Components – Sand Filter

Monitoring Locations



Monitoring & Sampling

October 2014 samples at inlet and outlet

- Rainfall (2014-2016) ~ 107 inches
- 23 Sample Events:
  - Ave. Phosphorus IN 0.248 mg/L
  - Ave. Phosphorus OUT 0.033 mg/L
  - Range of influent concentration (0.06 to 0.390 mg/L)
  - 80-90% Consistent Removal
  - Phosphorus Removed ~ 55 Pounds (18 months of pump operation)

Project Costs

- Engineering & Construction = $298,462 (CWF Grant = $158,800)
- 2016 Upgrades = $13,473
- O&M, Electric, Remote Monitoring Subscription = $21,600/Yr
- Filter Media Replacement = $50,000 (10-18 Years)
- 25 Year Lifecycle ~ $650 - $950/lb of Phosphorus

Operation & Maintenance

- Activities
  - Annual Commission/Decommission
  - Routine Observation
  - Vegetation
  - Filter Surface Maintenance
  - Remote Monitoring
  - Harvest Pond Clean Out
  - Filter Media Replacement

Project Challenges

- Catchment Drainage Characterization
  - Limited Pre-Project Monitoring
  - Harvest Pond Sizing & Pump trigger sensitivity
  - Sediment Loading to Harvest Pond
- Contractor Understanding of Project
  - Unique Operating Criteria
  - Shallow Groundwater
- Neighborhood Understanding of Project
- Heavy Spring 2014 Rainfall

Questions?

Thank You

Multiple Benefits of Privately Shared Stormwater Systems:

From Conceptual Design to Construction

Water Resources Conference, October 18, 2016

INTRODUCTION:
TOWERSIDE DISTRICT STORMWATER

- Towerside Innovation District and the stormwater project site
- Planning and design process

Prospect North Partnership

Green Fourth Properties, LLC

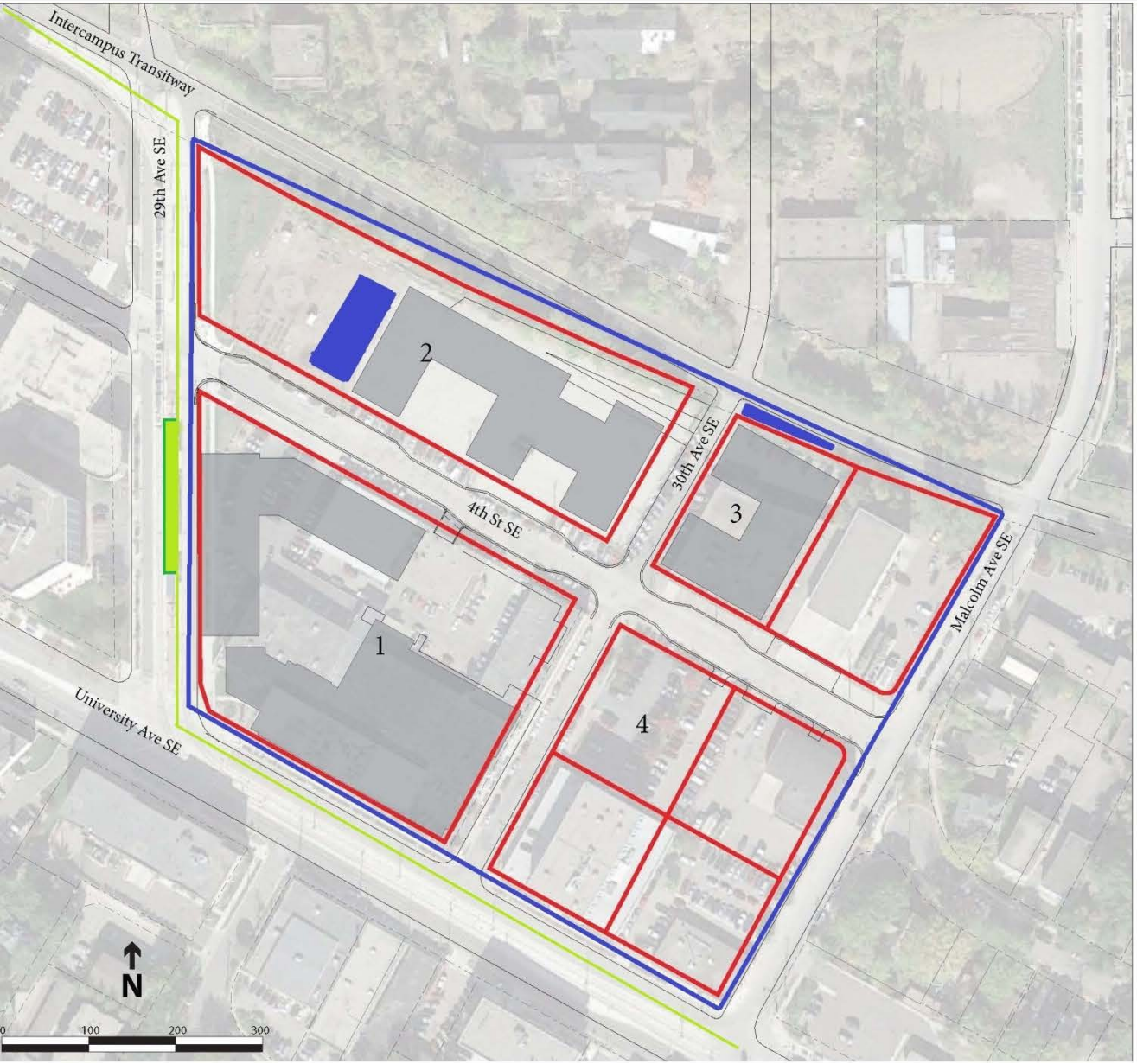
TOWERSIDE INNOVATION DISTRICT LOCATION

Towerside, the MSP Innovation District (370 acres)

District Stormwater (9 acres)

Metro Transit Green Line LRT

TOWERSIDE DISTRICT STORMWATER PROJECT SITE



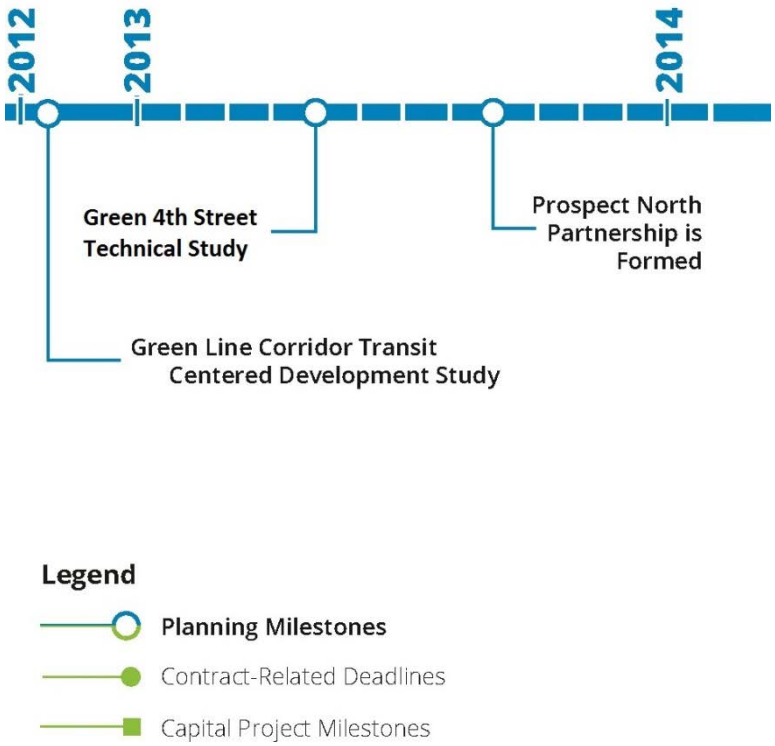
Parcel Number	Owners
1	Harlem Irving Companies
2	The Cornerstone Group
3	Aeon
4	Green Fourth Properties, LLC

TOWERSIDE DISTRICT STORMWATER PROJECT SITE

MISSISSIPPI WATERSHED MANAGEMENT ORGANIZATION

BARR

Planning Initiative

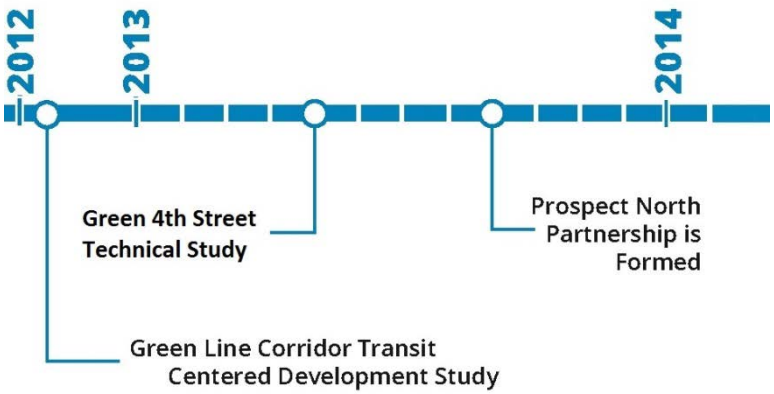


Shared Stacked Green Infrastructure

- Shared treatment systems
- Stacked land use

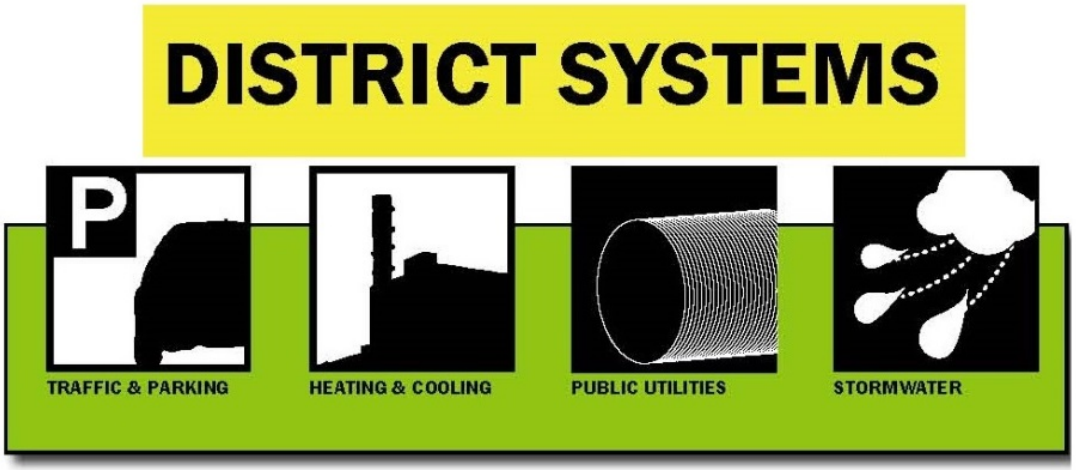
TOWERSIDE DISTRICT STORMWATER 2012–2013

Planning Initiative



Legend

- Planning Milestones
- Contract-Related Deadlines
- Capital Project Milestones

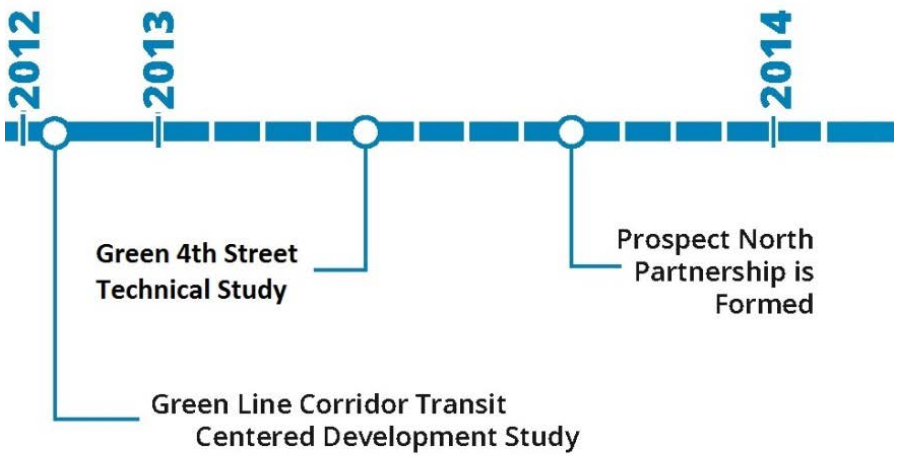


Integrated systems thinking:

- Box culvert conveyance pipes double as sidewalks or bench seating
- Walls of underground parking for water storage
- Water storage areas for District Energy heating and cooling
- **Basin of the treatment area is park infrastructure**

TOWERSIDE DISTRICT STORMWATER 2012–2013

Planning Initiative



Legend

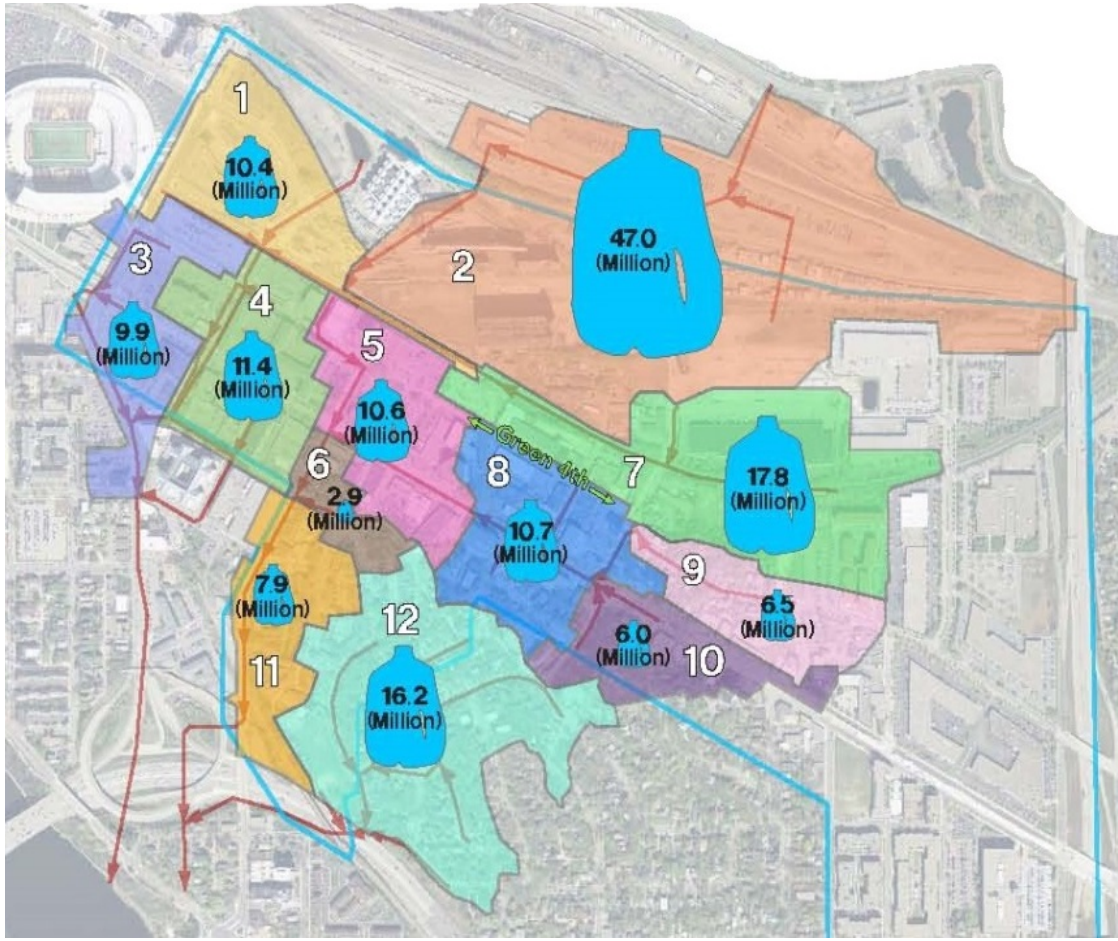
- Planning Milestones
- Contract-Related Deadlines
- Capital Project Milestones

TOWERSIDE DISTRICT STORMWATER 2014–2015

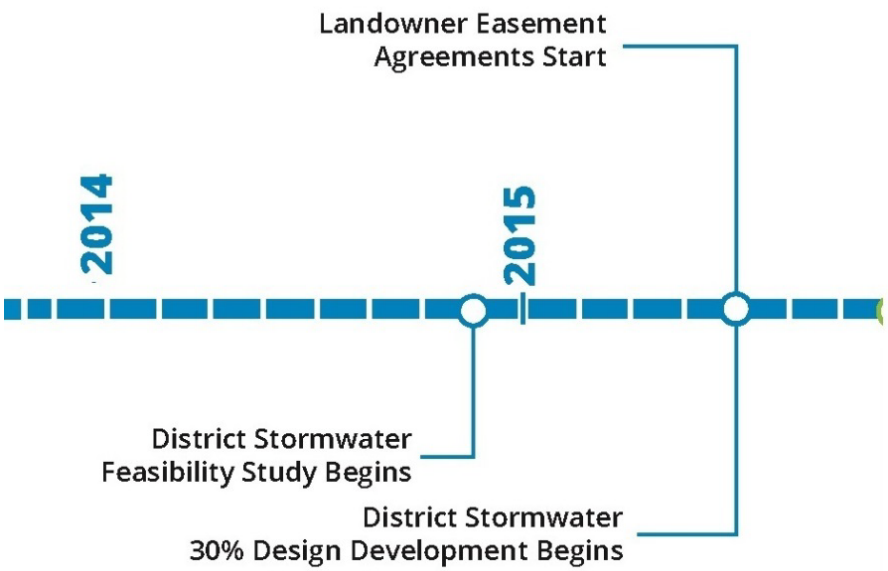
Planning Initiative

Gallons of Rain and Snowmelt Available Annually

- 4 million gallons generated on the 9 acre site



Planning Initiative

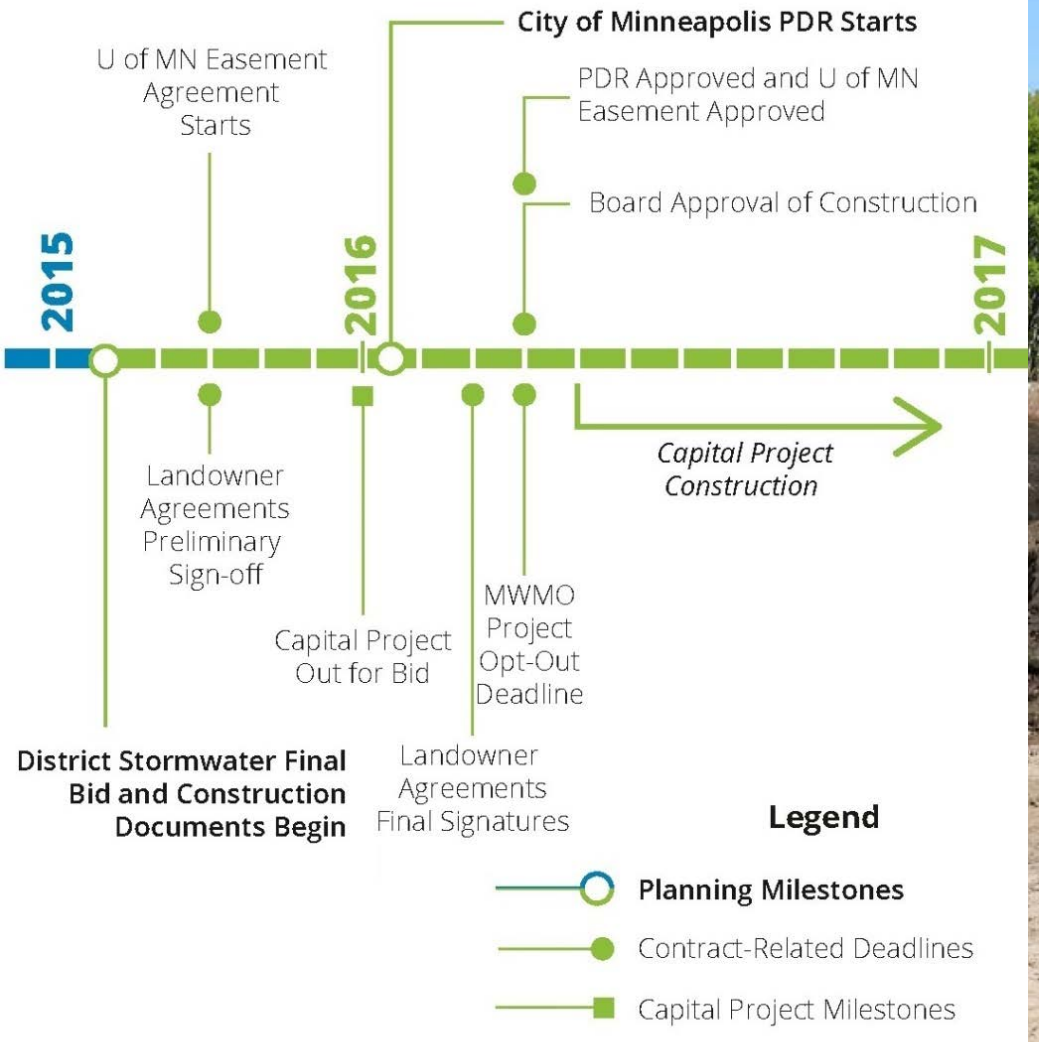


Legend

- Planning Milestones
- Contract-Related Deadlines
- Capital Project Milestones

TOWERSIDE DISTRICT STORMWATER 2016–2017

Capital Project

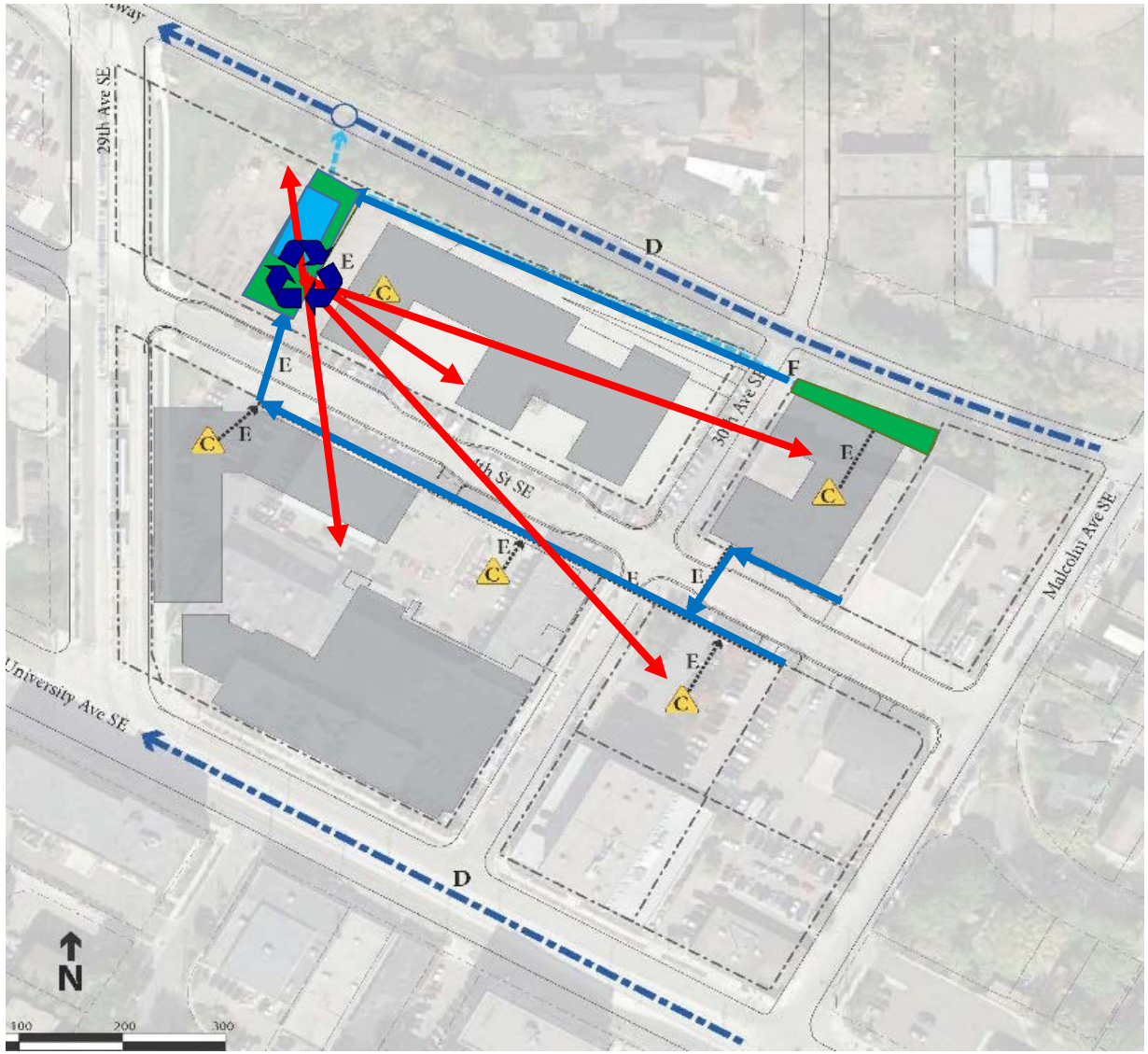


DISTRICT STORMWATER SYSTEM

- Tributary area: 8–9 acres of brownfields redevelopment
- Four primary components:
  1. **Conveyance** from parcels to treatment
  2. **Treatment** to City of Minneapolis standard
  3. **Underground storage** sized for 1.1” off impervious (MIDS)
  4. **Reuse** system for irrigation and future industrial use

STORMWATER COMPONENTS

1. Conveyance
2. Treatment (filtration basins)
3. Underground Storage
4. Reuse System



STORMWATER COMPONENTS

Conveyance

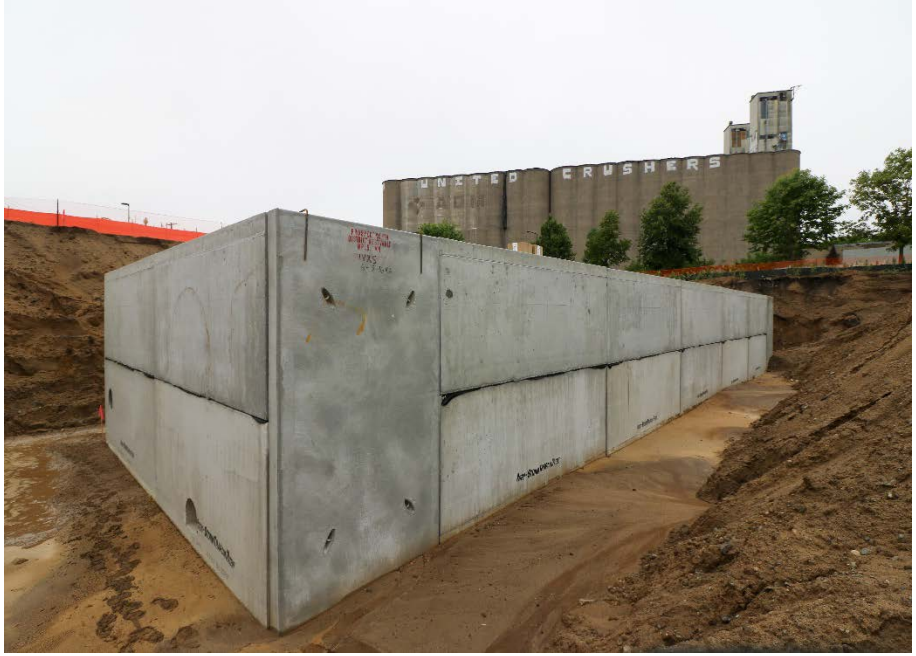
1,600 lineal feet of pipe conveys stormwater from four parcels to district stormwater system.

Treatment Biofiltration

Two basins capture and treat runoff from 8–9 acres, cleaning to city standard.

Creation of a **stormwater park**.

STORMWATER COMPONENTS



Underground Storage

StormTrap system holds 207,000 gallons of filtered water for use by future development.

Reuse System

Reuse system delivers stormwater back to parcels for irrigation and possible industrial use. System online 2017.

TOTAL PROJECT COSTS AND O&M

Landowner Costs: ~$430,000

Planning, Design, Legal, and Engineering Services;

Construction: Treatment and 50% Conveyance

MWMO Costs: ~$1,045,000

Planning, Design, Legal, and Engineering Services;

Construction: Storage, Reuse and 50% Conveyance

TOTAL: ~$1,475,000

- **Landowners pay all O&M**
- **MWMO manages system and O&M for five years, then transfers to landowners**

CLEAN & READY FOR USE

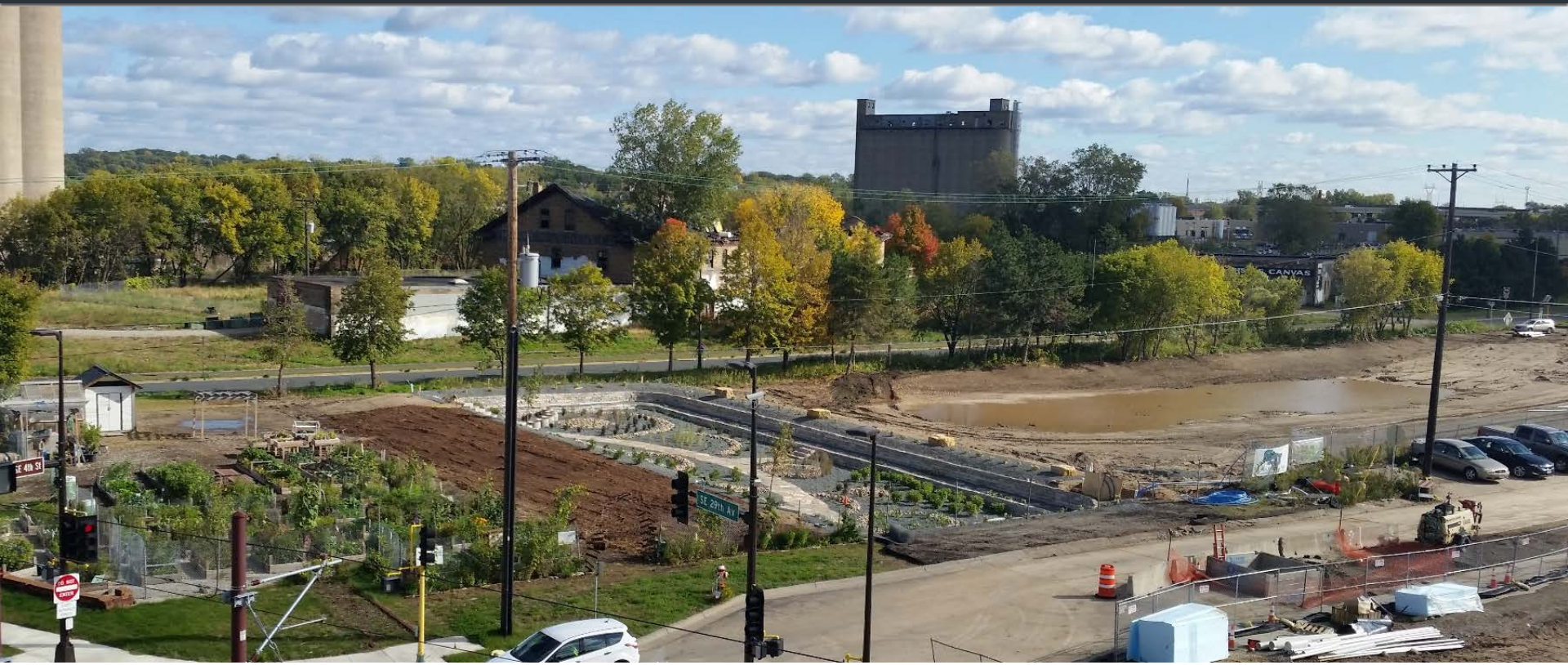
District Management of Water

Estimated **15% cost savings** by managing stormwater in a district system.

Stormwater Feature as a Park

The biofiltration cell designed to act as a public **Stormwater Park**.

CLEAN & READY FOR USE



District Management of Water

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CLEAN & READY FOR USE

District Management of Water

Estimated **15% cost savings** by managing stormwater in a district system.

Stormwater Feature as a Park

The biofiltration cell designed to act as a public **Stormwater Park**.

PROJECT LESSONS LEARNED

- Scale is critical, **regional treatment saves money** (15%).
- Implementing stormwater on **brownfields** is challenging, but can be accomplished. Grants help.
- **Legal surveys** to ID easements and property boundaries/disputes should be performed early on.
- **Patience is critical** when working with so many stakeholders. **Stakeholders are critical** to implement district systems.

SUCCESSES AND INNOVATIONS WE WANT TO SEE REPLICATED

- District systems to **manage stormwater on larger scale** for lower cost.
- **Public/private partnerships** to develop new and innovative approaches to **manage urban stormwater.**
- Collaboration among multiple landowners to turn **brownfields into Privately Owned Public Spaces** (POPS), i.e. stormwater park.
- Residential and industrial **stormwater reuse** to attract water-dependent **economic growth.**

Thanks!

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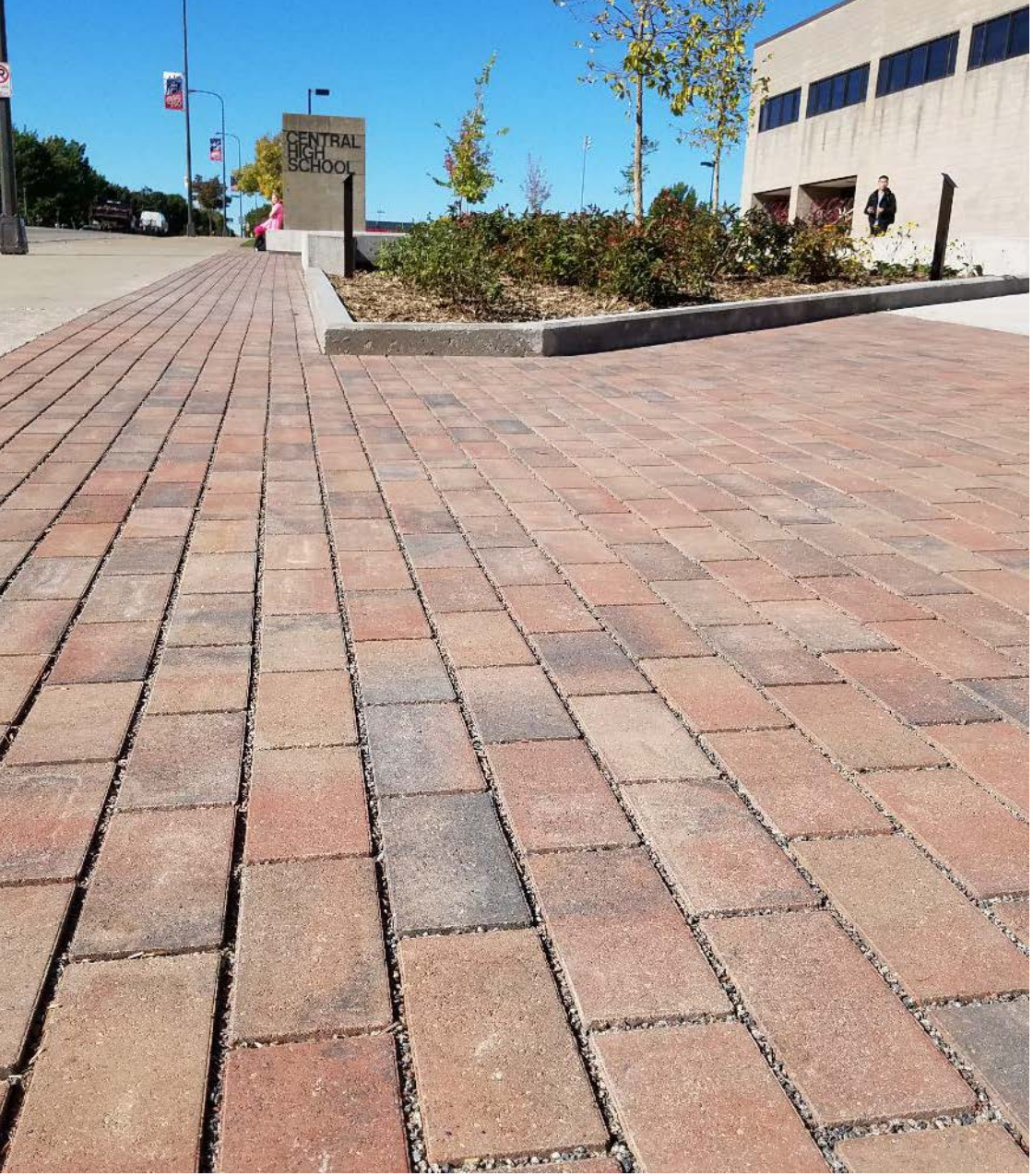


URBAN SCHOOL RETROFITS: SENDING STORMWATER TO DETENTION

2016 MINNESOTA WATER RESOURCE CONFERENCE

NATE ZWONITZER
WATER RESOURCE PROJECT MANAGER

CAPITOL REGION WATERSHED DISTRICT

Urban School Retrofits

- Four case studies
- Design innovations
- Lessons learned

CASE STUDY 1: HARAMBEE ELEMENTARY

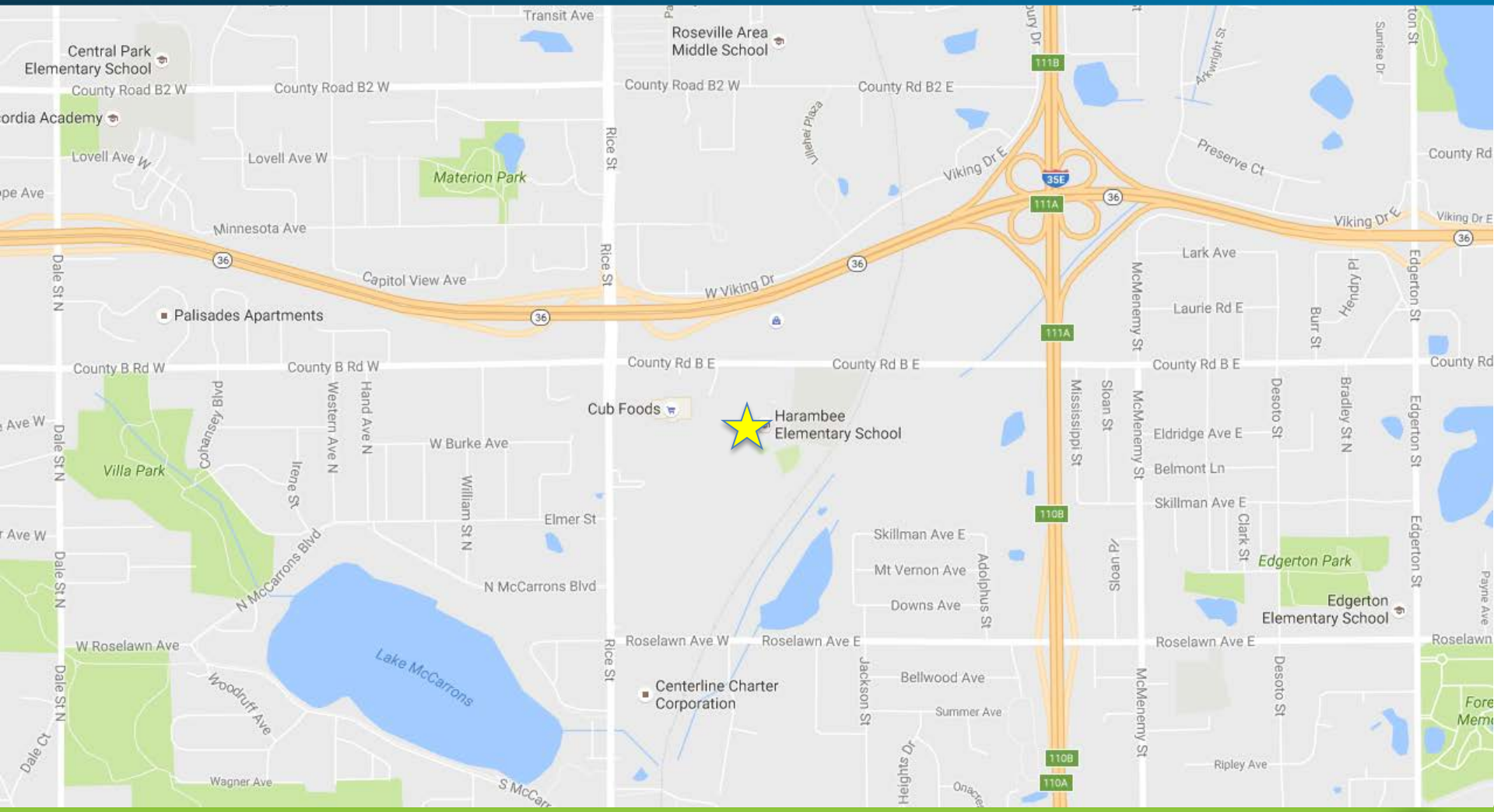
ROSEVILLE AREA SCHOOLS

Roseville Area Schools
Quality Teaching & Learning for All...Equity in All We Do

Ramsey Conservation District

CAPITOL REGION WATERSHED DISTRICT

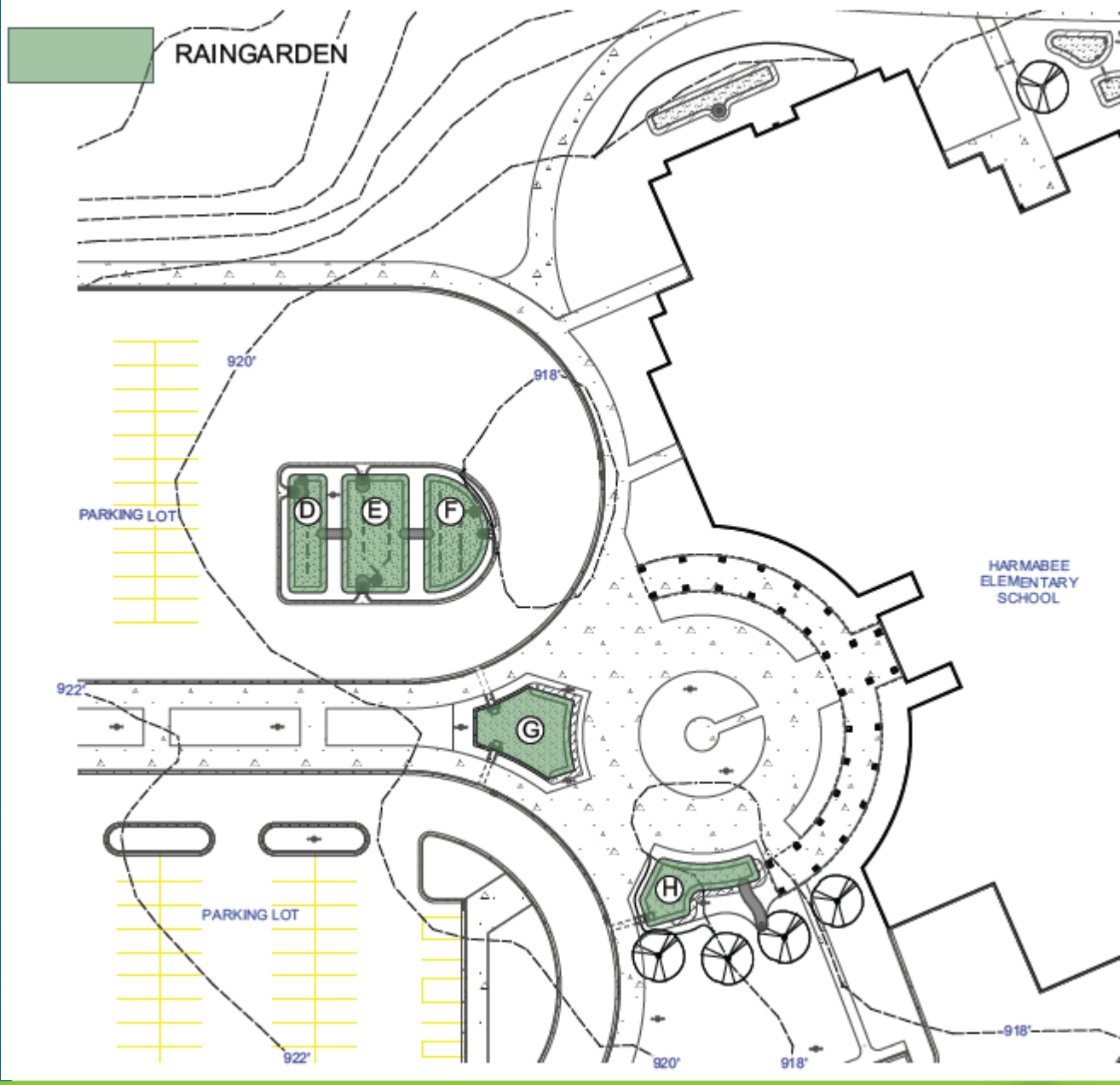
Harambee Elementary



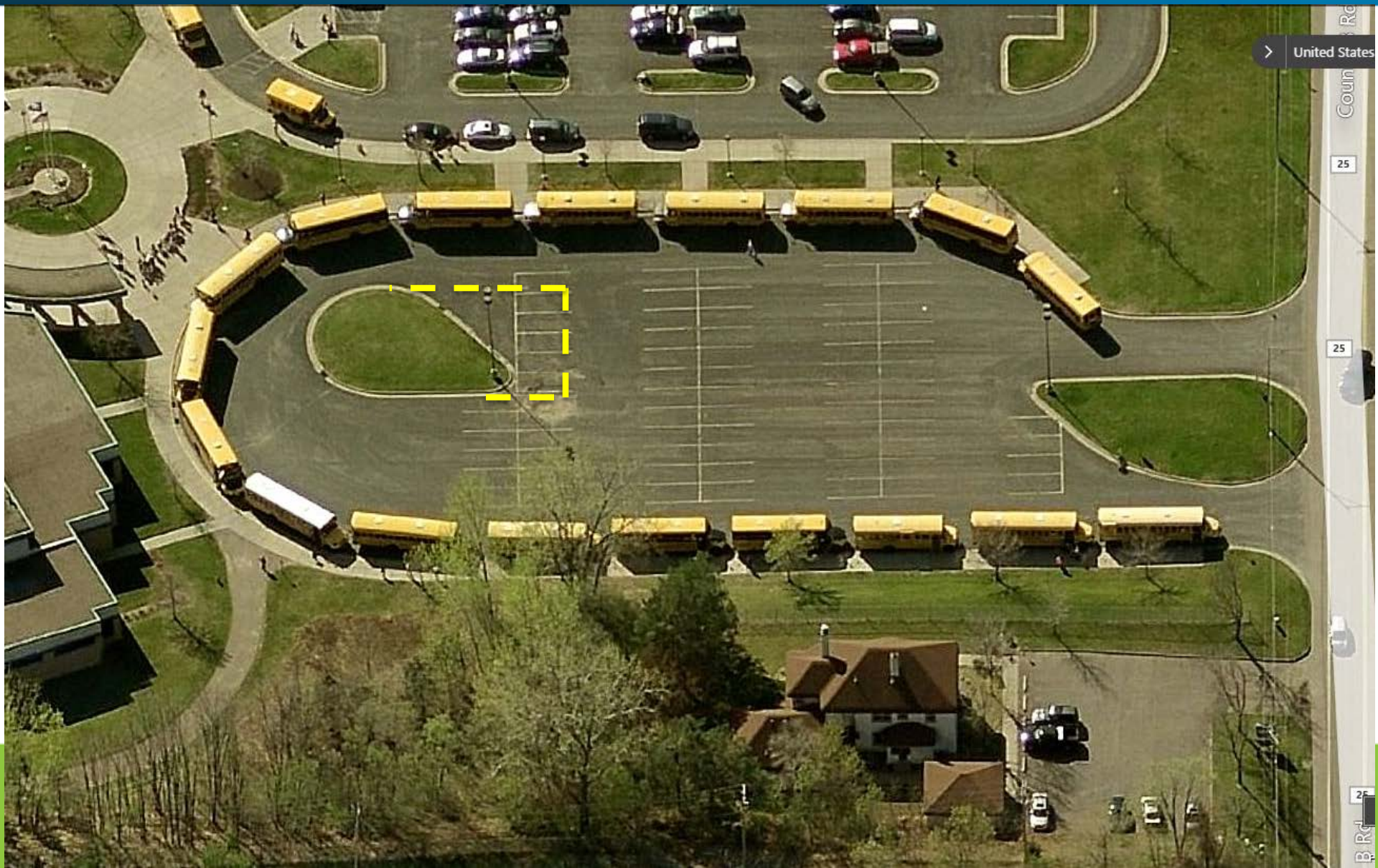
Harambee Elementary

Harambee Elementary

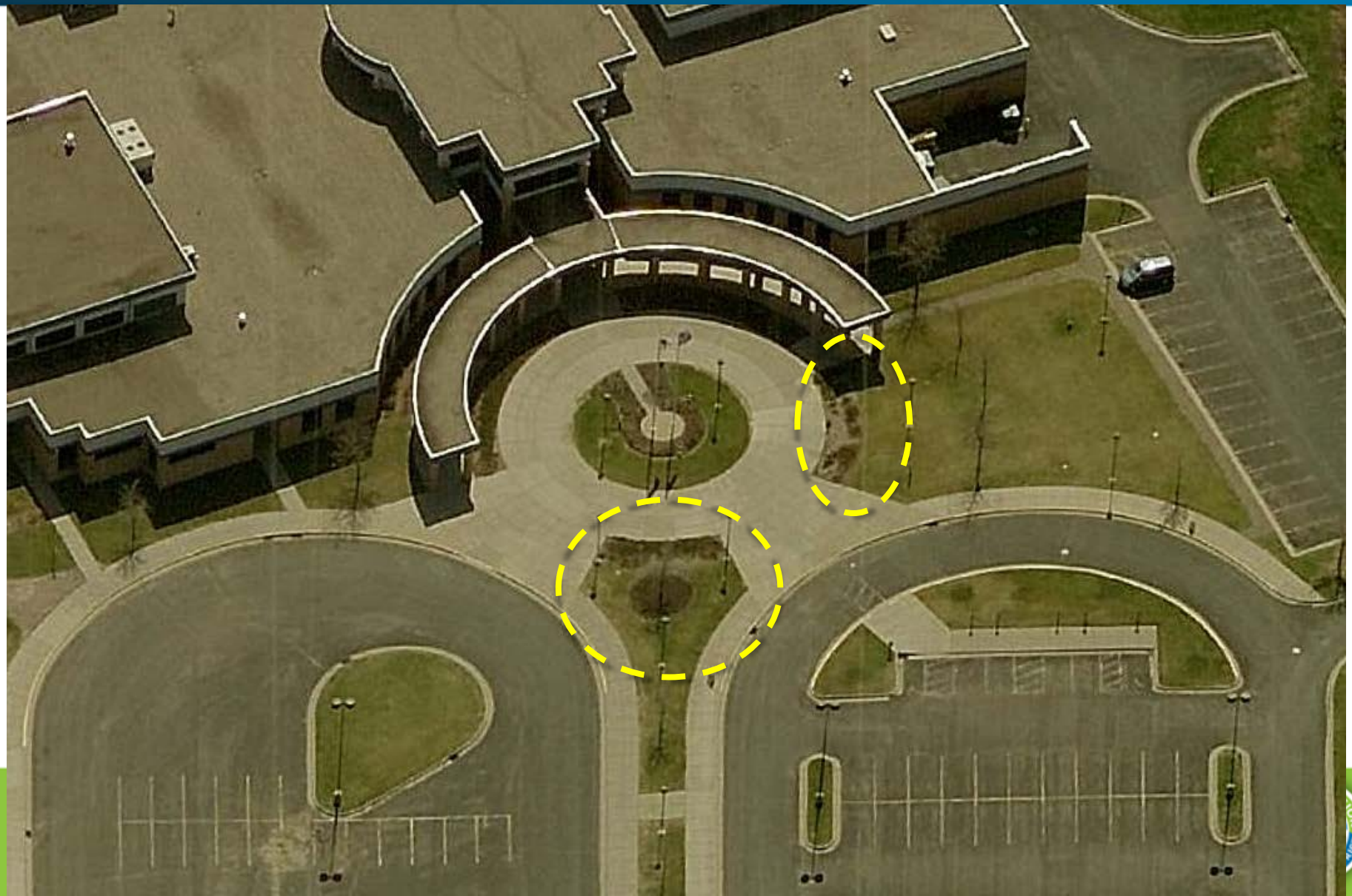
- 5 rain gardens
- 1.36 acres treated
- 85% reduction in Volume, TSS, and TP
- $100,000 for design and construction
- $88,000 covered by grants



Parking Lot Island Expansion



Entry Rain Gardens




NO
PARKING


NO
PARKING

CASE STUDY 2:

TWIN CITIES GERMAN IMMERSION SCHOOL (TCGIS)

K-8 CHARTER SCHOOL, SAINT PAUL

CAPITOL REGION WATERSHED DISTRICT

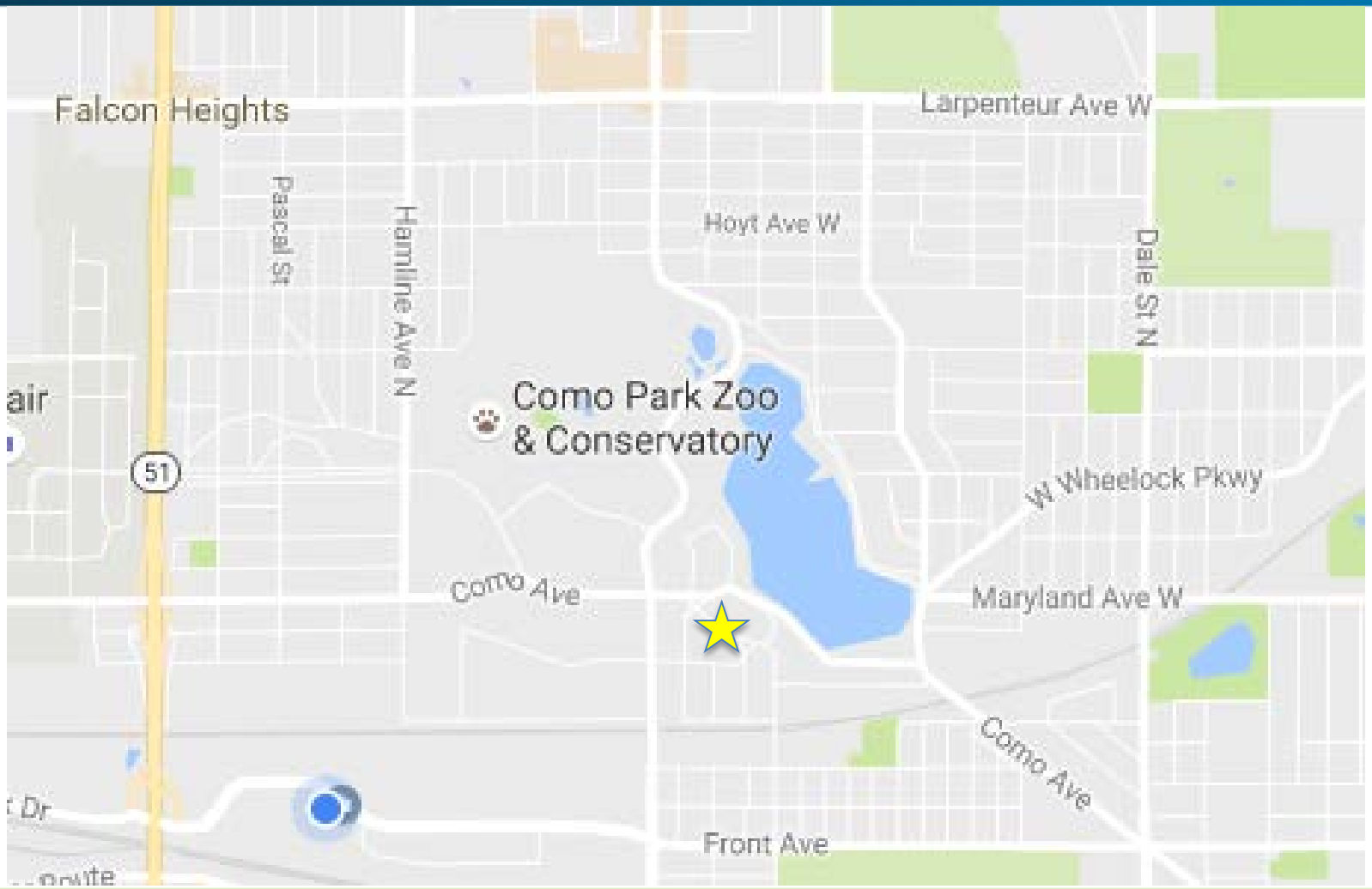
CLEAN WATER LAND & LEGACY AMENDMENT

TWIN CITIES GERMAN IMMERSION SCHOOL

Ramsey Conservation District

CAPITOL REGION WATERSHED DISTRICT

TCGIS


Falcon Heights
Larpenteur Ave W
Pascal St
Hamline Ave N
Hoyt Ave W
Dale St N
Como Park Zoo
& Conservatory
51
W Wheelock Pkwy
Como Ave
Maryland Ave W
Como Ave
Front Ave

TCGIS

- Enhanced underground treatment
- 4 Rain Gardens
- Porous Pave permeable play surfaces
- 3 Educational Signs

TCGIS

- 1.3 acres treated
- 90% reduction in Vol, TSS, and TP
- $190,000 for design and construction
- ~$50,000 covered by grants

Twin Cities German Immersion School

Twin Cities German Immersion School

Porous Pave

Twin Cities German Immersion School

Twin Cities German Immersion School

PUTTING DOWN ROOTS

Raingardens help reduce pollution in Como Lake. Here's how–

It starts when polluted rainwater flows from streets into storm drains. Polluted rainwater usually drains directly to the lake. But not here. Curb openings let water flow into the garden's layers of mulch and soil. Plant roots guide water deeper to seep slowly into the ground. The roots absorb pollution and take up some of the water to nourish the plants.

Polluted rainwater enters the garden

Soil and plants filter pollution

Cleaner water in Como Lake

Why?

Polluted rainwater carries dirt, oil and trash into Como Lake when it flows from streets into storm drains. Raingardens, stormwater planters and rock trenches on the side streets were built to clean polluted rainwater before it reaches lakes and rivers.

Ramsey Conservation District

More information and multilingual signs at capitolregionwd.org.

CASE STUDY 3:

GREAT RIVER SCHOOL

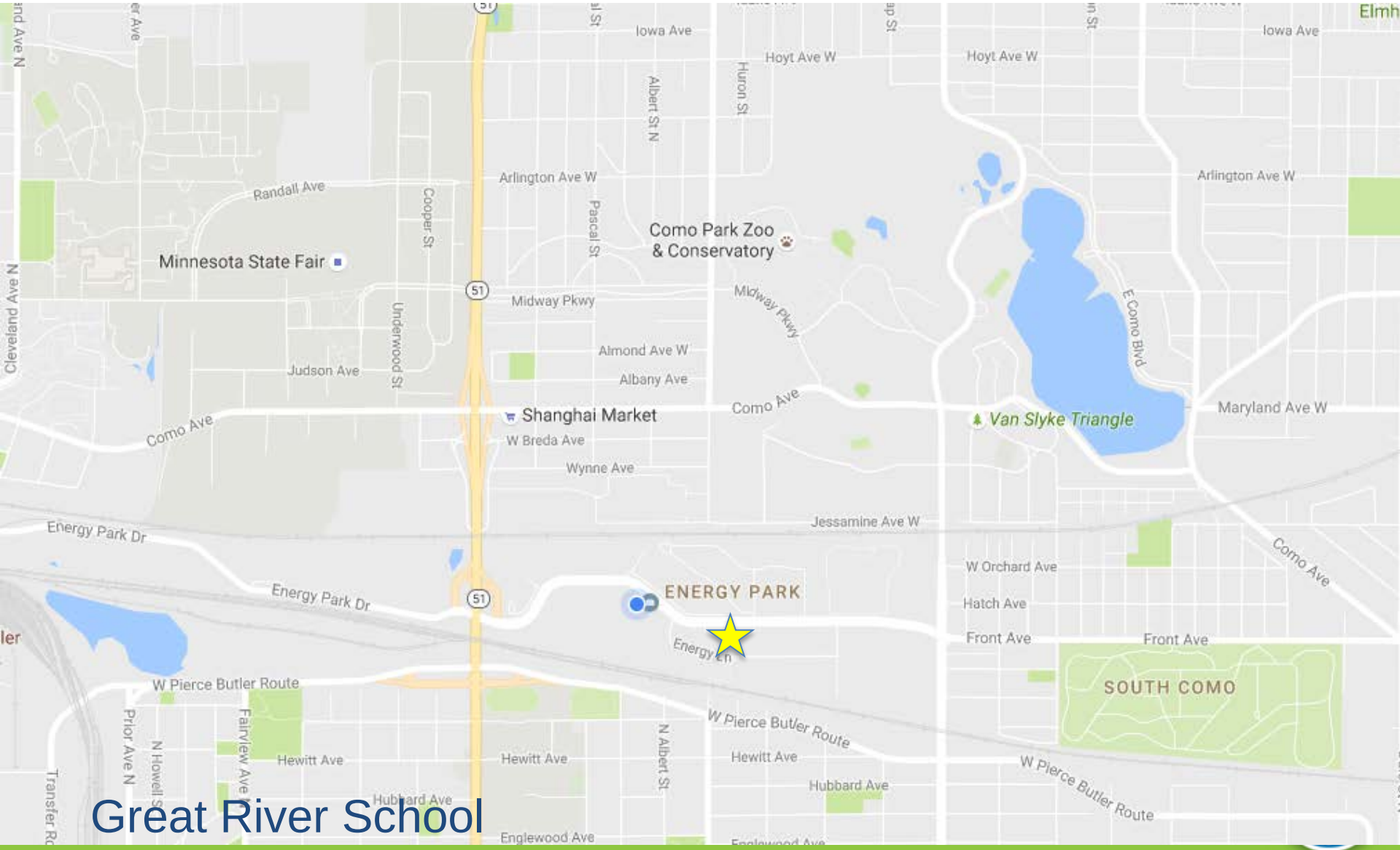
1-12 GRADE CHARTER MONTESSORI SCHOOL SAINT PAUL

Great River School

WENCK

CAPITOL REGION WATERSHED DISTRICT

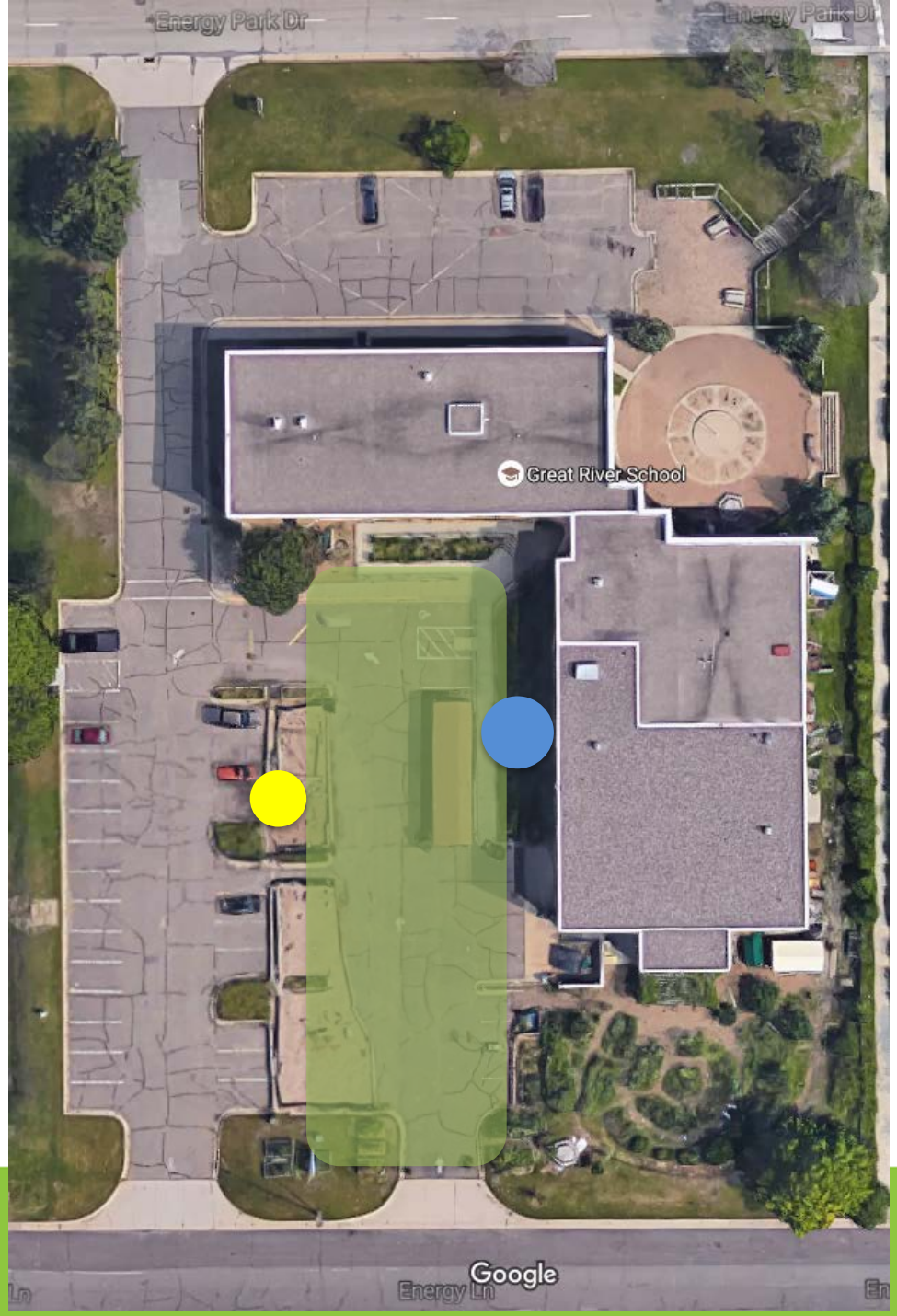
Great River School



Great River School

Great River School

- New Play Surface
- Underground Membrane Filtration
- Rainwater Harvesting for Irrigation



New Play Surface:

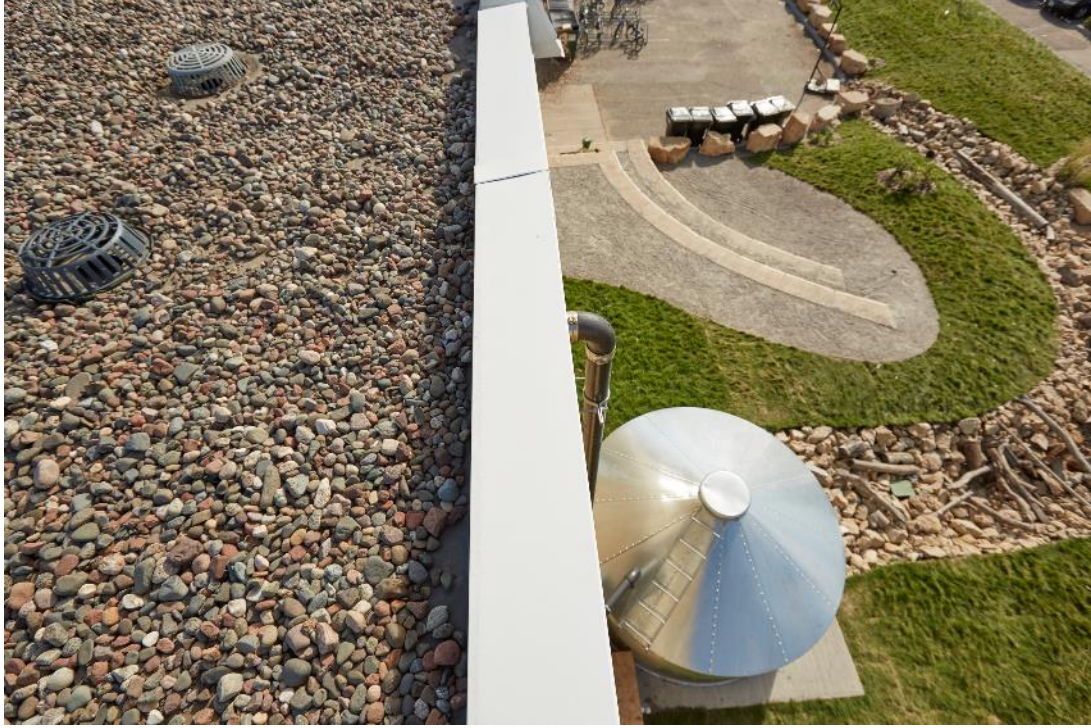
- Converted 0.17 acres of parking to turf
- Pavement left in place as cap
- Drain tile provides drainage for stability/filtration

Jellyfish Filter:

- Treats <u>all</u> parking areas onsite (0.5 ac.)
- Easy maintenance
- Removals
  - 99% Trash/Debris
  - 90% TSS
  - 60% TP

Rainwater Harvesting:

- 4,500 gallon cistern
- 7,700 SF of roof
- WISY Prefiltration, UV disinfection
- 45,000 gallons saved per year (70% of demand)



CASE STUDY 4: CENTRAL HIGH SCHOOL

SAINT PAUL PUBLIC SCHOOLS
OLDEST HIGH SCHOOL IN MN

CAPITOL REGION WATERSHED DISTRICT

CLEAN WATER LAND & LEGACY AMENDMENT

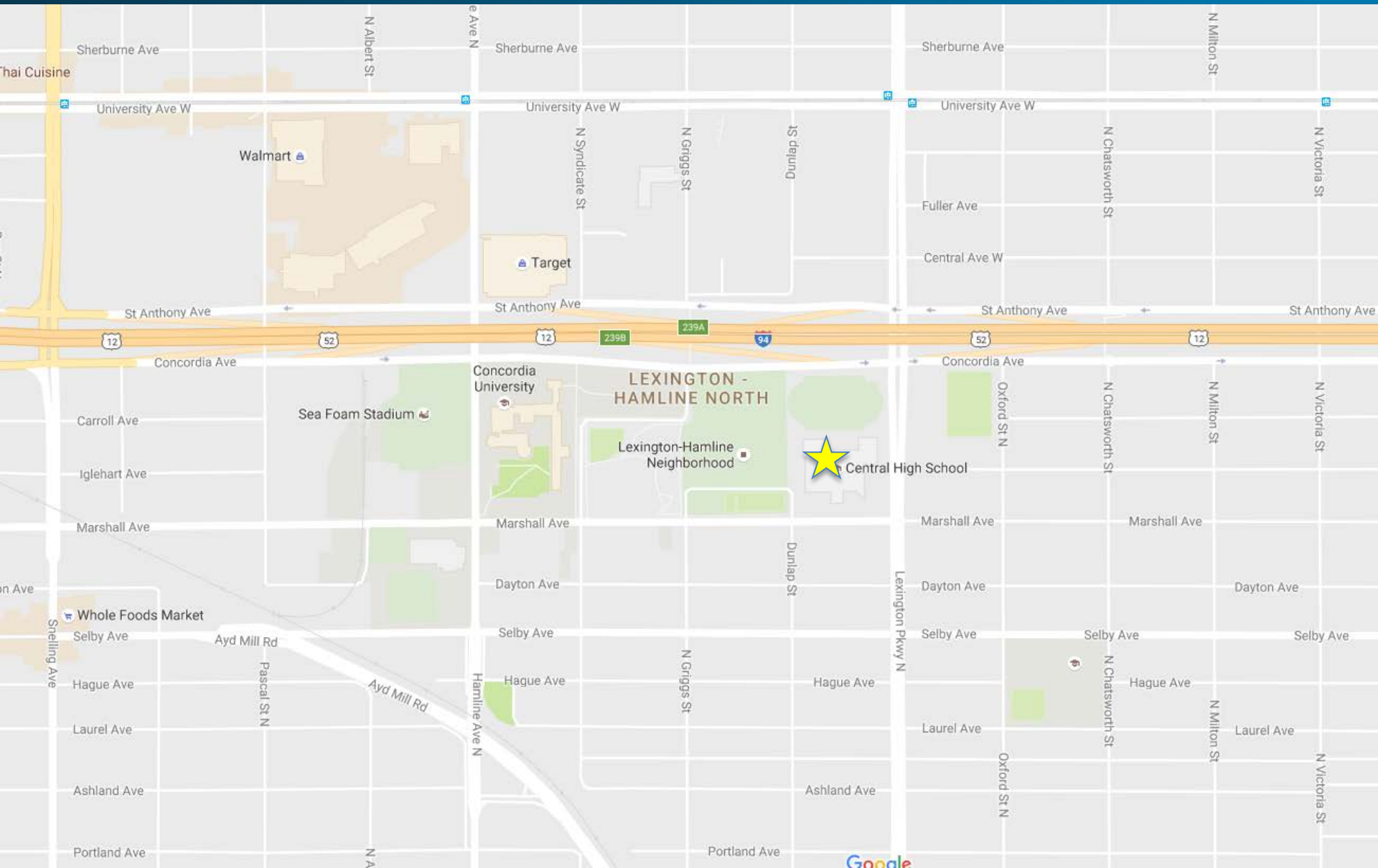
Saint Paul Public Schools — A World of Opportunities

Transforming Central

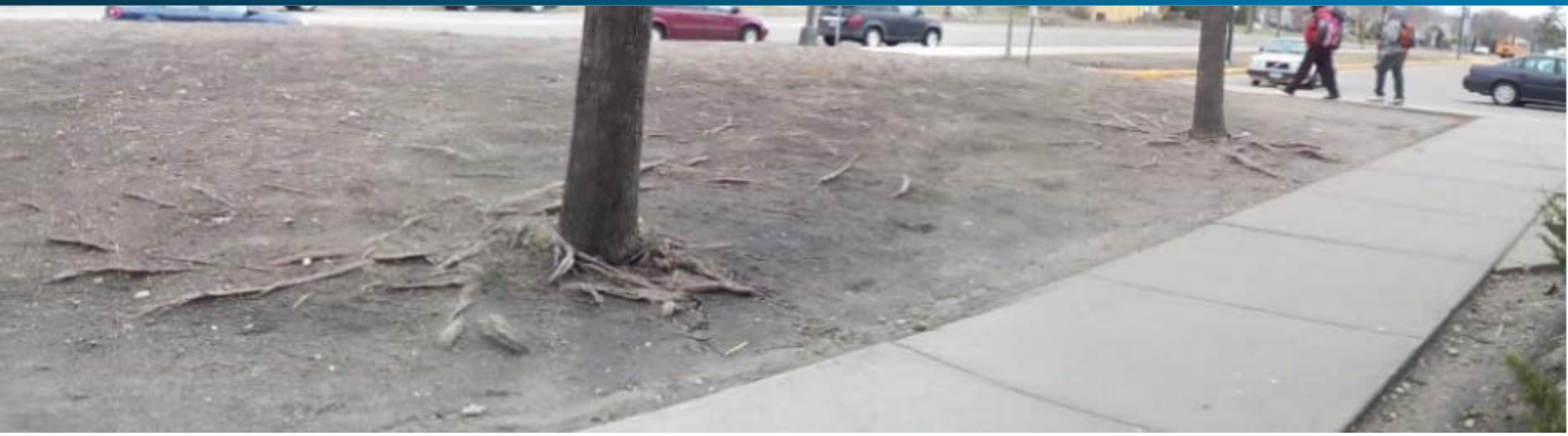
EOR water ecology community

CAPITOL REGION WATERSHED DISTRICT

Central High School



Existing Conditions



Existing Conditions

Central High School

CAPITOL REGION WATERSHED DISTRICT

Central High School

- 2.5 acres treated
- >90% reduction in Vol, TSS, and TP
- ~$500,000 for design and construction
- >$430,000 covered by grants

Site Plan


LEGEND
Watershed Boundary
Sub-Surface Water Flow
Surface Water Flow
CENTRAL HIGH SCHOOL
watershed boundary
watershed boundary
watershed boundary
LEXINGTON AVENUE
N

Pipe Gallery

Central High School

CAPITOL REGION WATERSHED DISTRICT

Central High School

CAPITOL REGION WATERSHED DISTRICT

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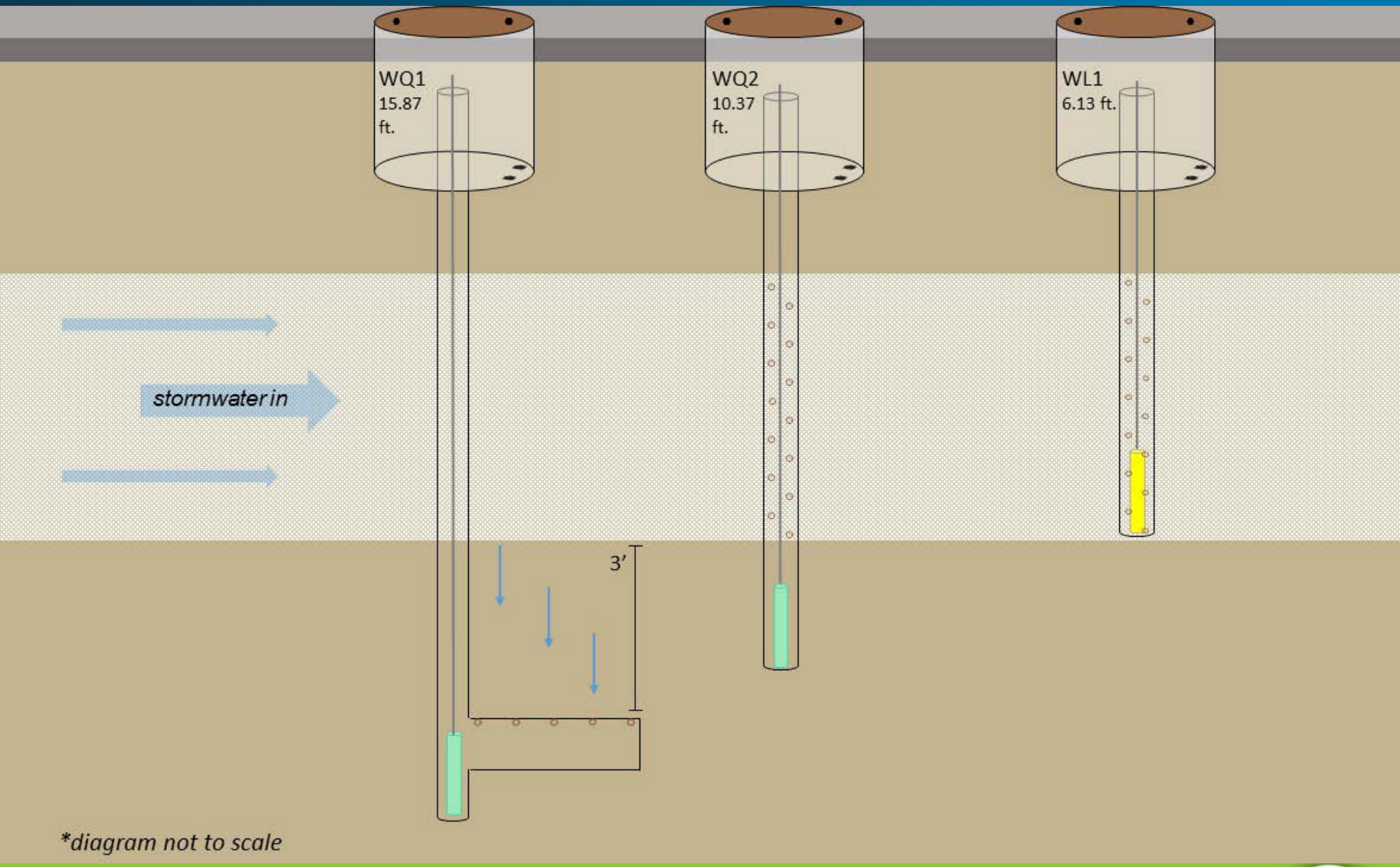
CAPITOL REGION WATERSHED DISTRICT



Central High School

CAPITOL REGION WATERSHED DISTRICT

Tree Trenches & Permeable Pavers

Central High School

CAPITOL REGION WATERSHED DISTRICT

Tree Trenches & Permeable Pavers

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Tree Trenches & Permeable Pavers

Central High School

CAPITOL REGION WATERSHED DISTRICT


CENTRAL
HIGH
SCHOOL


CENTRAL
HIGH
SCHOOL

Central High School

CAPITOL REGION WATERSHED DISTRICT

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CAPITOL REGION WATERSHED DISTRICT

Central High School

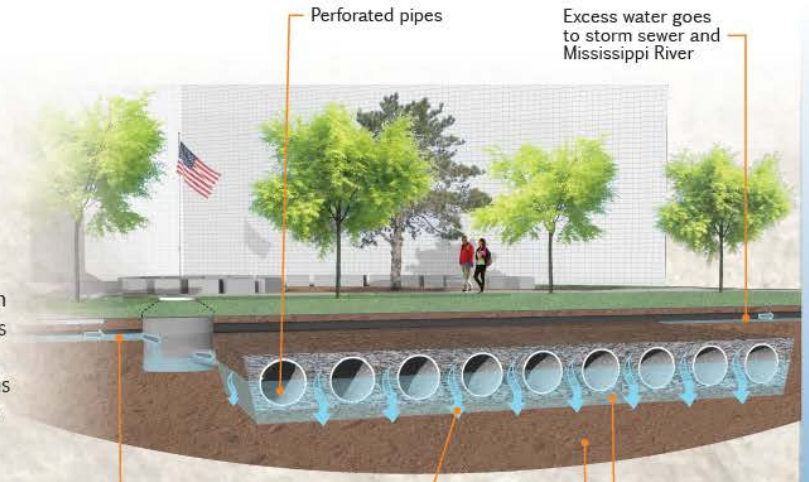
CAPITOL REGION WATERSHED DISTRICT

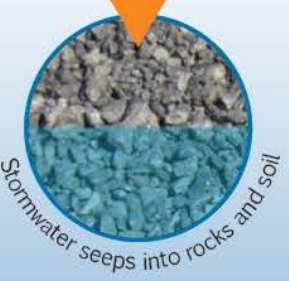
Educational Signage

WHAT'S BENEATH YOUR FEET?

Underground rock trenches at Central High School help reduce pollution in the Mississippi River. Here's how —

Polluted stormwater runoff from Central used to flow from rooftops, parking lots and sidewalks to storm drains and then the Mississippi River. The school installed underground pipes with thousands of holes (perforated) and buried them in rock-filled trenches. The rock trench can store 49,400 gallons of stormwater runoff from around campus where it can seep through the holes into the surrounding rock and soil instead of flowing to the river untreated.





Why?

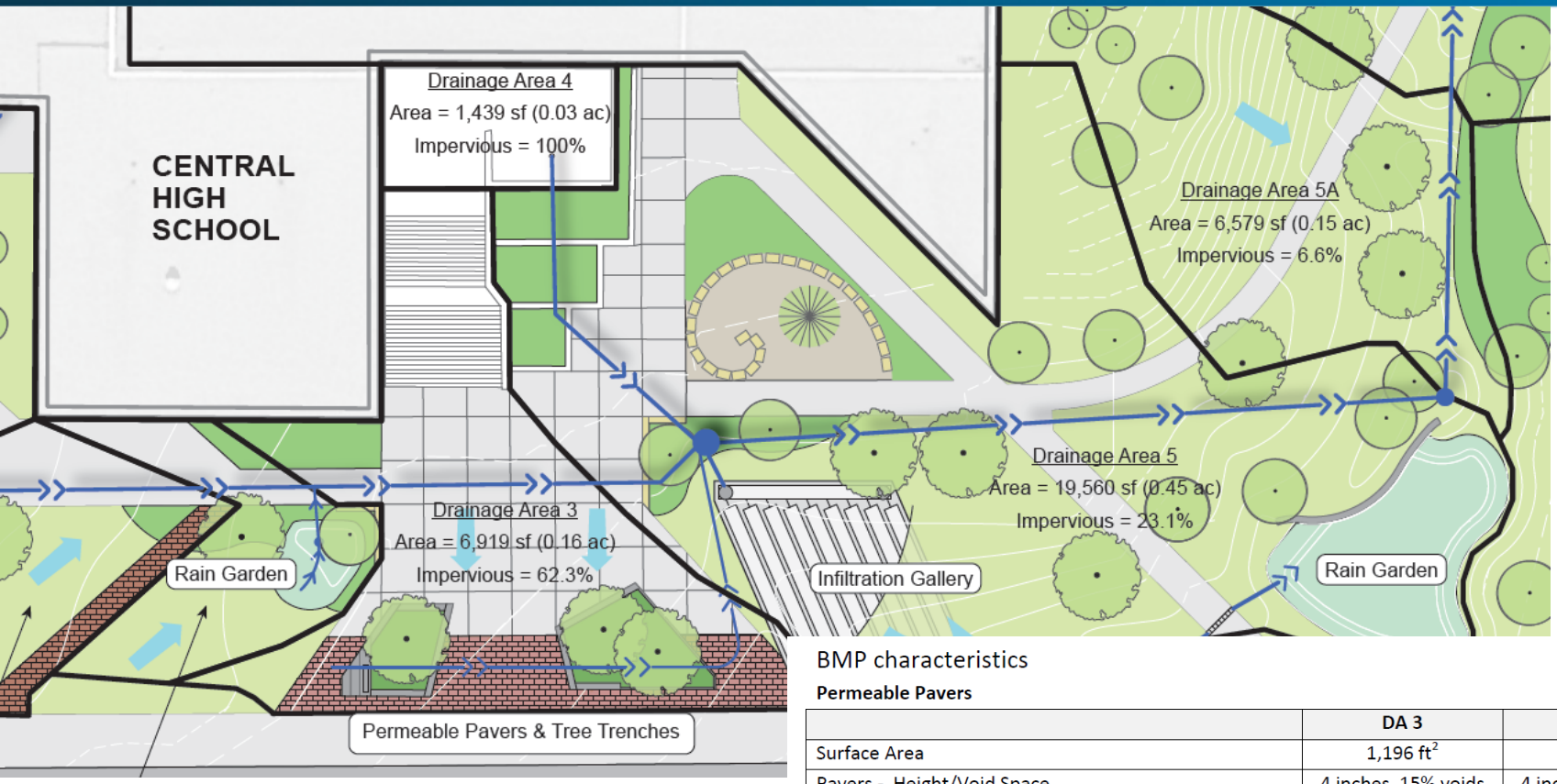
Did you know that when it rains or snow melts, water carries trash, dirt, oil, pet waste, grass and leaves to the Mississippi River? Water that flows over hard surfaces is called runoff. Projects like this one at Central are essential to capture, clean and reduce runoff before it reaches nearby lakes and rivers. Saint Paul Public Schools completed this project in partnership with Capitol Region Watershed District.

Curriculum Integration

Central High School

CAPITOL REGION WATERSHED DISTRICT

Curriculum Integration



BMP characteristics

Permeable Pavers

	DA 3	DA 3B
Surface Area	1,196 ft^2	449 ft^2
Pavers - Height/Void Space	4 inches, 15% voids	4 inches, 15% voids
Pea Gravel - Height/Void Space	2 inches, 40% voids	2 inches, 40% voids
Quarry Stone (diameter ¾ - 1 in) - Height/Void Space	4 inches, 40% voids	4 inches, 40% voids
Quarry Stone (diameter 1 ½ - 3 in) - Height/Void Space	24 inches, 40% voids	6 inches, 40% voids
Infiltration Rate of Subsoils	0.3 in/hr	0.3 in/hr

Tree Trenches - can be treated as permeable pavement, installed the same as pavers in drainage area 3, for the sake of hydrologic calculations

	Tree Trench #1	Tree Trench #2
Tree Box Surface Area	228 ft^2	459 ft^2

Central High School

Lessons Learned

- Involve the right people EARLY
  - District office, school admin, teachers, parent committees
  - facilities management

- Consider education opportunities
  - New students every year
  - Sign locations, monitoring, BMP design

- Work with site constraints
  - School operations, facility maintenance, space, foot traffic

- Plan on securing grants/fundraising

Questions?

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nate@capitolregionwd.org
651-644-8888