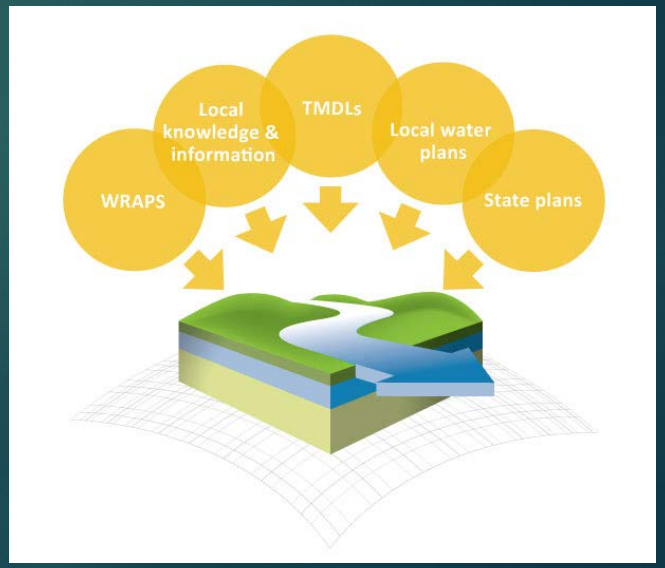
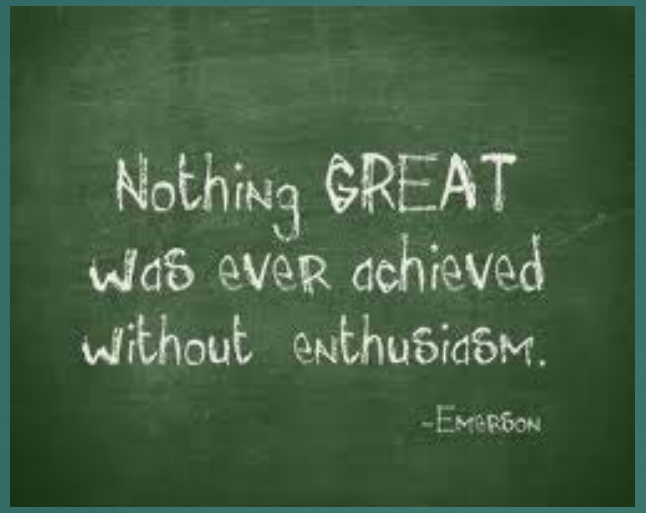
# Red Lake River Watershed

ONE WATERSHED ONE PLAN



# How did we get here?





Issues → Priority Statements → Resources → Goals → Implementation Plan & Schedule → Draft Plan → Internal Review → External Review

# BWSR Guidance



- Plan with **prioritized, targeted, and measurable** implementation actions
- Plan will strive for **systematic, watershed-wide**, science-based approach to watershed management, driven by the participating **local** governments
- Plans will embrace the concept of **multiple benefits** in the development and prioritization of implementation **strategies** and actions
- Planning and implementation efforts will recognize **local commitment** and contribution

# BWSR Guidance



- MN 8410 – Integrated Comprehensive Plan with public and agency involvement
- Surface water & ground water quality protection, restoration, & improvement, including prevention of erosion and soil transport into surface waters
- Restoration, protection, & improvement of surface water & groundwater storage and retention systems
- Promotion of groundwater recharge
- Flood damage reduction, especially to minimize future public expenditures needed to correct flooding problems
- Wetland enhancement, restoration, & establishment
- Shoreland and riparian zone management & buffers
- Protection and enhancement of fish and wildlife habitat & water recreational facilities

# One Watershed, One Plan

Plan Content Requirements

January 27, 2015

**Purpose:** This document outlines plan content requirements for developing comprehensive watershed management plans as per Minnesota Statutes §103B.801.

## Introduction

This document contains specific content requirements for drafting a comprehensive watershed management plan through the One Watershed, One Plan program. Full operating procedures for developing the plan - including initiating the planning process through review, approval, and adoption - are contained in the *One Watershed, One Plan Operating Procedures* document.

The following Guiding Principles provided sideboards and direction in the plan content requirements outlined in this document:

- One Watershed, One Plan will result in plans with prioritized, targeted, and measurable implementation actions that meet or exceed current water plan content standards.
- One Watershed, One Plan will strive for a systematic, watershed-wide, science-based approach to watershed management, driven by the participating local governments.
- Plans developed within One Watershed, One Plan should embrace the concept of multiple benefits in the development and prioritization of implementation strategies and actions.
- One Watershed, One Plan planning and implementation efforts will recognize local commitment and contribution.
- One Watershed, One Plan is not intended to be a one-size–fits-all model.

The requirements in this document are also supported by the vision of the Local Government Water Roundtable that future watershed-based plans will have sufficient detail that local government units can, with certainty, indicate a pollutant of concern in a water body, identify the source(s) of the pollutant, and provide detailed projects that address that particular source. This vision also includes a future of limited wholesale updates to watershed-based plans; with a streamlined process to incorporate collected data, trend analysis, changes in land use, and prioritization of resource concerns into the watershed-based plan; and an emphasis on watershed management and implementation through shorter-term work plans and budgeting. This vision includes acknowledging and building off of existing plans and data (including local and state plans and data), as well as existing local government services and capacity.

# The Process



- Early Steps
  - Issues
  - Resources
  - Planning Zones
  - PTMApp Pour Points
  - Plan Outline
  - Priority Statements
- Later Steps
  - Rank Priority Statements
  - Assignment of Resources to Priority Statements
  - Measurable Goals for each Resource

# RLR1W1P

STRUCTURE AND USE

# Basic Plan Layout



- Executive Summary
- Key Terms
- Introduction
- Planning Zones
- Issues and Resources
- Prioritization and Goals
- Targeting and Implementation Programs
- Figures and Tables
- Appendices

# Executive Summary



Plan will have an Executive Summary. The purpose of the executive summary is to provide a brief look into the contents of the plan. The summary includes:

- A general map and description of the planning boundary and smaller planning units
- A summary of the priority issues and goals that are addressed in the plan
- A summary of the implementation actions and programs
- A brief description of the process used to identify the measurable goals and targeted implementation actions
- An outline of the responsibilities of participating local governments

# Introduction



## 3. Introduction

### 3.1. 1W1P Background

Minnesota has a long history of water management by local government (BWSR 2015). One Watershed, One Plan (1W1P) is rooted in this history and the idea that the local governments responsible for water management should organize and develop focused implementation plans on a watershed scale. Recent legislation (Revision of Statutes 2014) permits the Board of Water and Soil Resources (BWSR) to adopt methods that allow comprehensive plans, local water management plans, or watershed management plans to serve as substitutes for one another; or to be replaced with one comprehensive watershed management plan. This legislation is referred to as One Watershed, One Plan (1W1P). The Red Lake River 1W1P was developed to consolidate existing policies, programs and implementation strategies from multiple stakeholders to provide a single, concise, and coordinated approach to watershed management.

BWSR's vision for 1W1P is to align local watershed planning with state strategies towards prioritized, targeted and measurable implementation plans. BWSR has developed several guiding principles for the development of the Red Lake River 1W1P:

- The Red Lake River 1W1P will prioritize, target, and outline how to measurable implementation actions that meet or exceed current water plan content standards.
- The Red Lake River 1W1P is not an effort to change local governance.
- The Red Lake River 1W1P strives for a systematic, watershed-wide, science-based approach to watershed management; driven by the participating local governments.
- The Red Lake River 1W1P uses the state's delineated major watersheds (8-digit hydrologic unit codes or HUC8) as the starting point for defining the preferred scale for local watershed management planning.
- The Red Lake River 1W1P involves a broad range of stakeholders to ensure an integrated approach to watershed management.
- The Red Lake River 1W1P embraces the concept of multiple benefits in the development and prioritization of implementation strategies and actions.
- The Red Lake River 1W1P implementation will be accomplished through formal agreements among participating local governments on how to manage and operate the watershed.
- The Red Lake River 1W1P planning and implementation efforts recognize local commitment and contribution.
- The Red Lake River 1W1P is not intended to be a one size fits all model.

The Red Lake River 1W1P was developed under a Memorandum of Agreement (Appendix A) between project partners. These included:

- Red Lake, Pennington and Polk Counties
- Pennington, Red Lake County and West Polk Soil and Water Conservation Districts, and
- The Red Lake Watershed District.

Tthe following resulted from the Red Lake River 1W1P:

# Planning Zones

## Issues, Resources, Measurable Goals and Targeted Implementation Plan

- Analysis & Prioritization of Issues

| Priority Issues |
|---|
| Surface water quality |
| Soil erosion and sedimentation |
| Altered hydrology |
| Drainage system management |
| Flood damage reduction |
| Habitat |
| Shoreland and riparian management |
| Groundwater protection |
| Source water protection |

| Issue | Ranking |
|---|---|
| Wetland loss and/or impacts | 1 |
| Drinking water quality | 2 |
| Soil erosion and sedimentation | 3 |
| Invasive species | 4 |
| Drainage system effectiveness (e.g., ditches) | 5 |
| Flood damage | 6 |
| Runoff into lakes, streams, etc. | 7 |
| Water quality | 8 |
| Public understanding of watershed issues | 9 |
| Drinking water supply sustainability | 10 |
| Soil health | 11 |
| Contaminants and pollutants | 12 |
| Effects of land use change (e.g., field to homes) | 13 |
| Drought | 14 |
| Irrigation water supply sustainability | 15 |
| Wildlife habitat loss | 16 |
| Climate trend issues (precipitation, temperature fluctuation, etc.) | 17 |

| Issue | BWSR | DNR | MDA | MDH | MPCA | Beltrami Co | Pennington Co. | Polk Co. | Red Lake Co. | MSTRWD | RLWD | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Soil erosion and sedimentation | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 10 |
| Water quality | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 10 |
| Altered hydrology | 1 | 1 | | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 9 |
| Drainage system management | 1 | 1 | 1 | | | 1 | 1 | 1 | 1 | 1 | 1 | 9 |
| Flood damage reduction | 1 | 1 | 1 | | | 1 | 1 | 1 | 1 | 1 | 1 | 9 |
| Habitat for fish and wildlife/natural resources | 1 | 1 | 1 | | | 1 | 1 | 1 | 1 | 1 | 1 | 9 |
| Shoreland and riparian management | 1 | 1 | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 9 |
| Groundwater (drinking water supply, protection, conservation) | | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 9 |
| Wetland management | 1 | 1 | | | | 1 | 1 | 1 | 1 | 1 | 1 | 8 |
| Education, Outreach, Civic Engagement | | | 1 | | | 1 | 1 | 1 | 1 | 1 | 1 | 7 |
| Impaired waters/TMDLS | | | | | 1 | | | 1 | 1 | 1 | 1 | 5 |
| Maintenance of core services | | | | | | 1 | 1 | | 1 | 1 | | 4 |
| Invasive Species | | | | | | 1 | | 1 | 1 | | | 3 |
| Wastewater management | | | 1 | | 1 | | | | | | | 2 |
| Emerging Issues (e.g., land cover change, climate) | 1 | | | | | 1 | | | | | | 2 |
| Feedlots | | | | | 1 | | | | | 1 | | 2 |
| Recreational Uses | | | | | | | | | 1 | | 1 | 2 |
| Contaminants of emerging concern | | | | 1 | | | | | | | | 1 |
| Soil health | | | 1 | | | | | | | | | 1 |
| Subsurface soil treatment systems | | | | | 1 | | | | | | | 1 |
| Drought/Irrigation | | | | | | | | | | | | 0 |

# Planning Zones

## Issues, Resources, Measurable Goals and Targeted Implementation Plan

- Resources

| Management Class | Class Description | Management Strategy |
|---|---|---|
| **High Quality** | Un-impaired stream segments greater than 5% from the impairment listing standard for any given parameter | Maintain |
| **Needs Protection** | Un-impaired stream segments within 5% of the impairment listing standard for any given parameter | Protection |
| **Restorable** | Impaired stream segments within 5% of the impairment listing standard for any given parameter | Restoration |
| **Low Quality** | Impaired stream segments greater than 5% from the impairment listing standard for any given parameter | Secondary Restoration |
| **Not Assessed** | No monitoring data available at the time of plan writing | Assess |

# Pla

Issue

Impl

greatest risk of becoming impaired by targeting implementation in subwatersheds with highest export.

**PRIORITY:** Inventory, evaluate and assign management classes to stream and river reaches and prioritize those most susceptible to altered hydrology effects on bank and bed stability.

**PRIORITY:** Reduce runoff-driven sediment transport to other impaired waters by targeting implementation in subwatersheds with highest export.

## ISSUE: Altered Hydrology

**PRIORITY:** Reduce runoff rates by targeting implementation in subwatersheds with high runoff.

**PRIORITY:** Identify ideal locations for flood control structures that include multifunctional design.

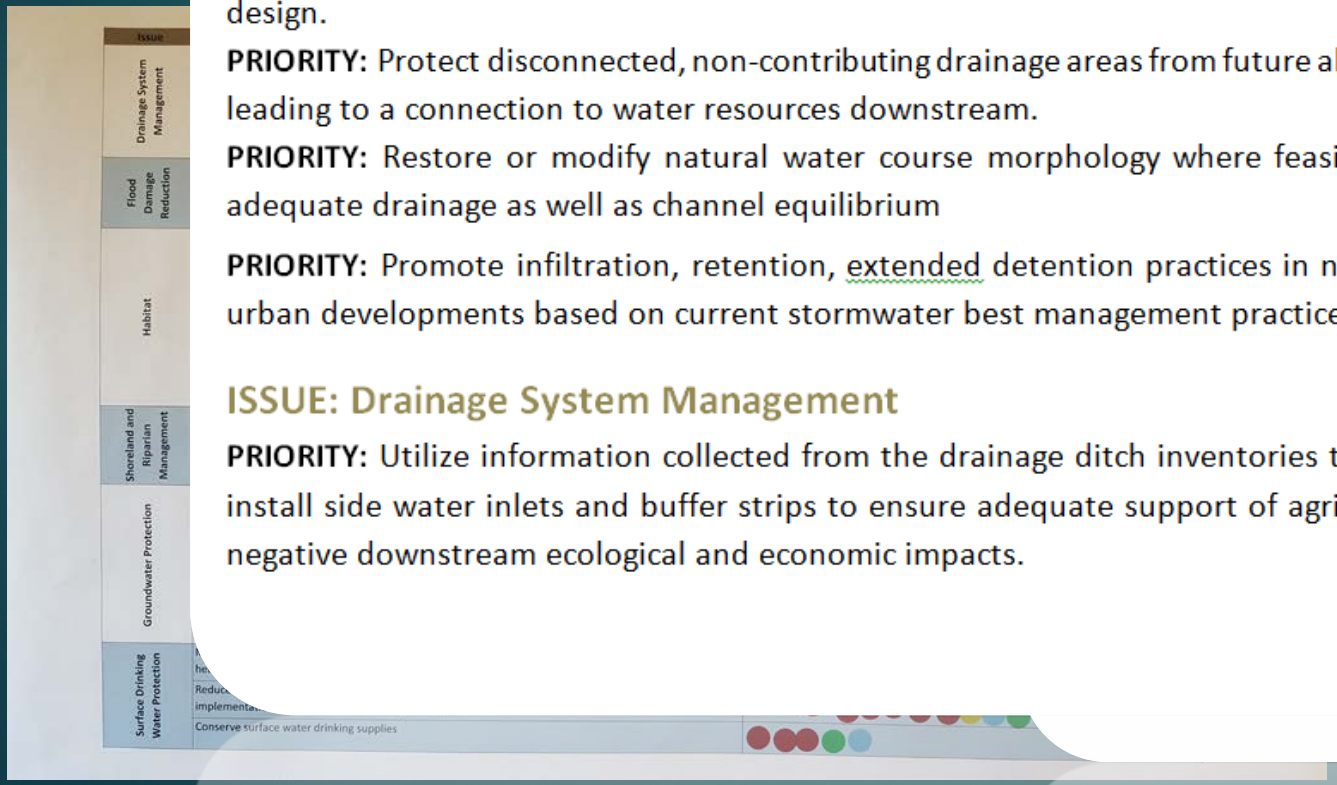
**PRIORITY:** Protect disconnected, non-contributing drainage areas from future altered hydrology leading to a connection to water resources downstream.

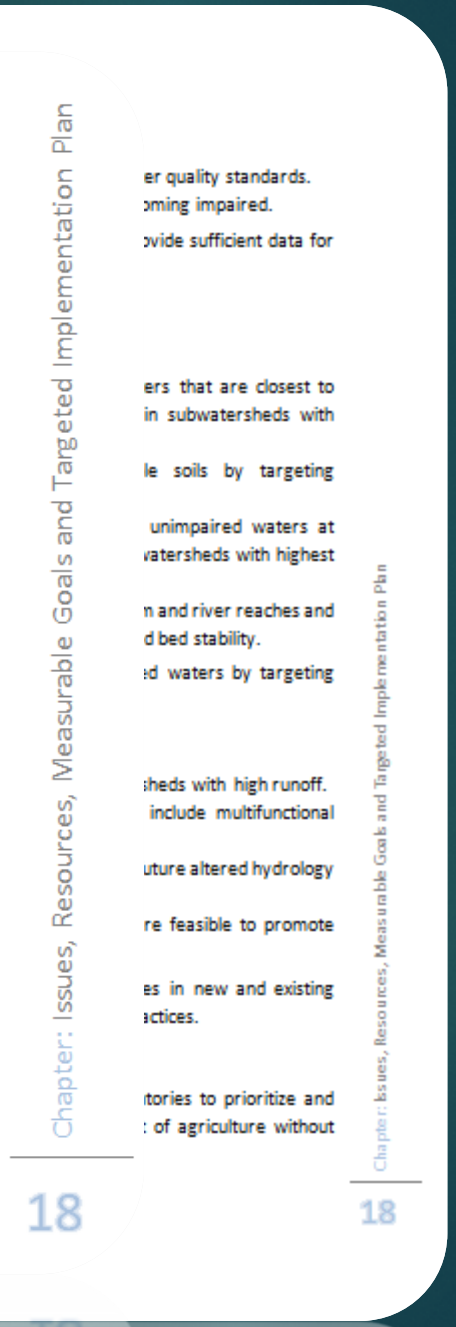
**PRIORITY:** Restore or modify natural water course morphology where feasible to promote adequate drainage as well as channel equilibrium

**PRIORITY:** Promote infiltration, retention, extended detention practices in new and existing urban developments based on current stormwater best management practices.

## ISSUE: Drainage System Management

**PRIORITY:** Utilize information collected from the drainage ditch inventories to prioritize and install side water inlets and buffer strips to ensure adequate support of agriculture without negative downstream ecological and economic impacts.

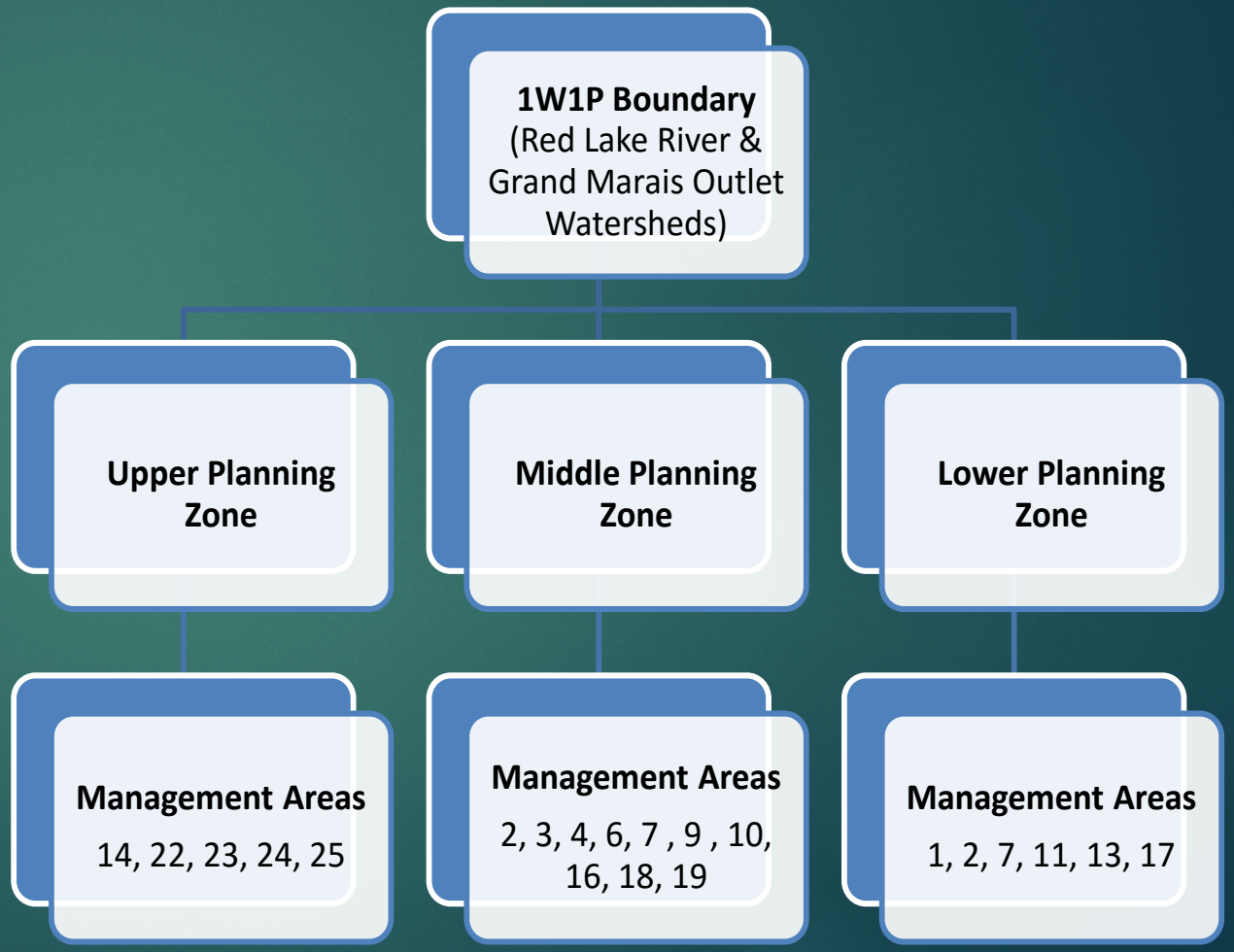


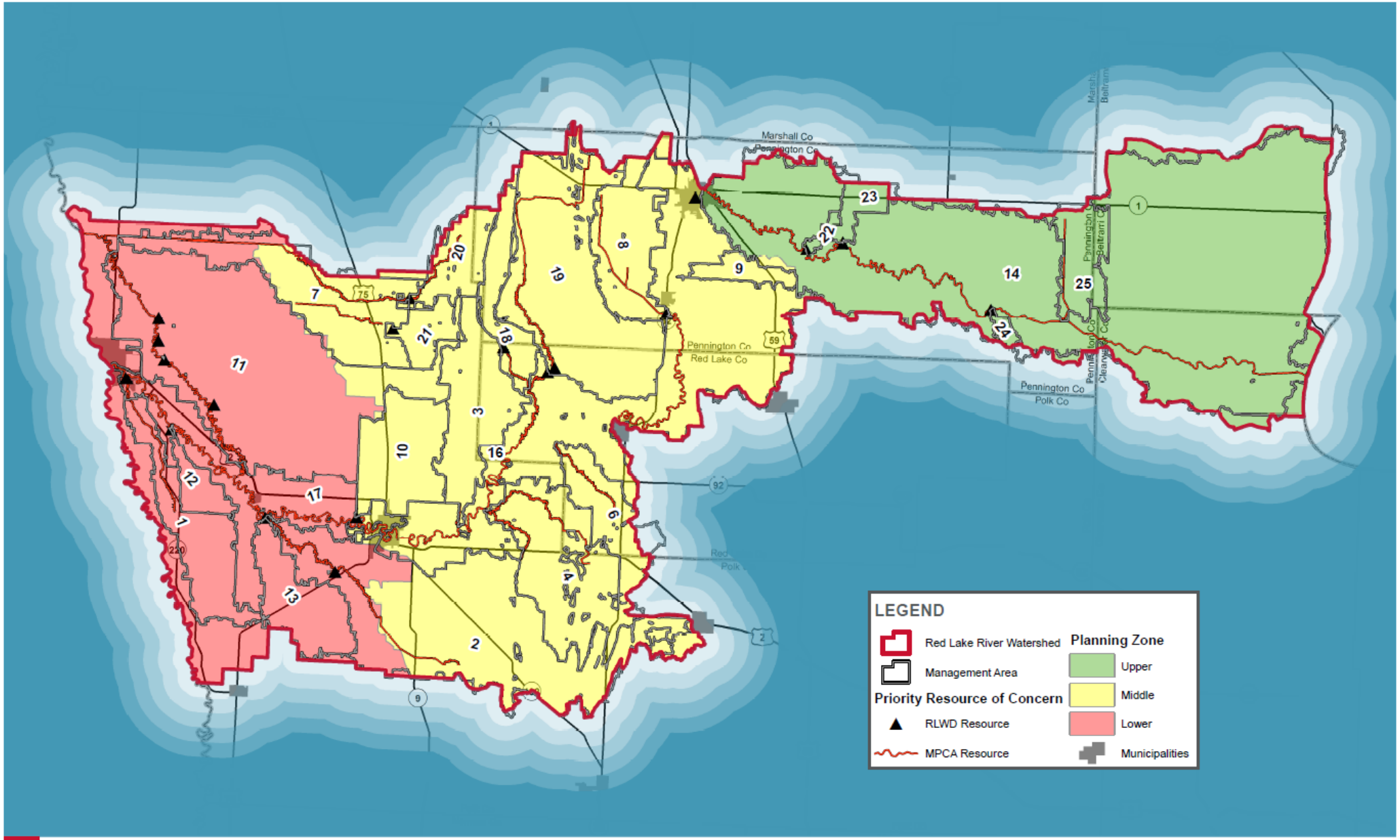



# Planning Zones

## Issues, Resources, Measurable Goals and Targeted Implementation Plan

- Management Areas






RED LAKE RIVER WATERSHED, ONE WATERSHED ONE PLAN
MANAGEMENT AREAS OVERVIEW
FIGURE 8
(REPORT NAME)

# Priority Statements – Lead to Resource alignment and Measurable Goals development

## Priority Statement

"Improve water quality within river and stream reaches designated as *Restorable* by establishing appropriate best management and conservation practices in the watershed that ensure restoration of its designated use classification."

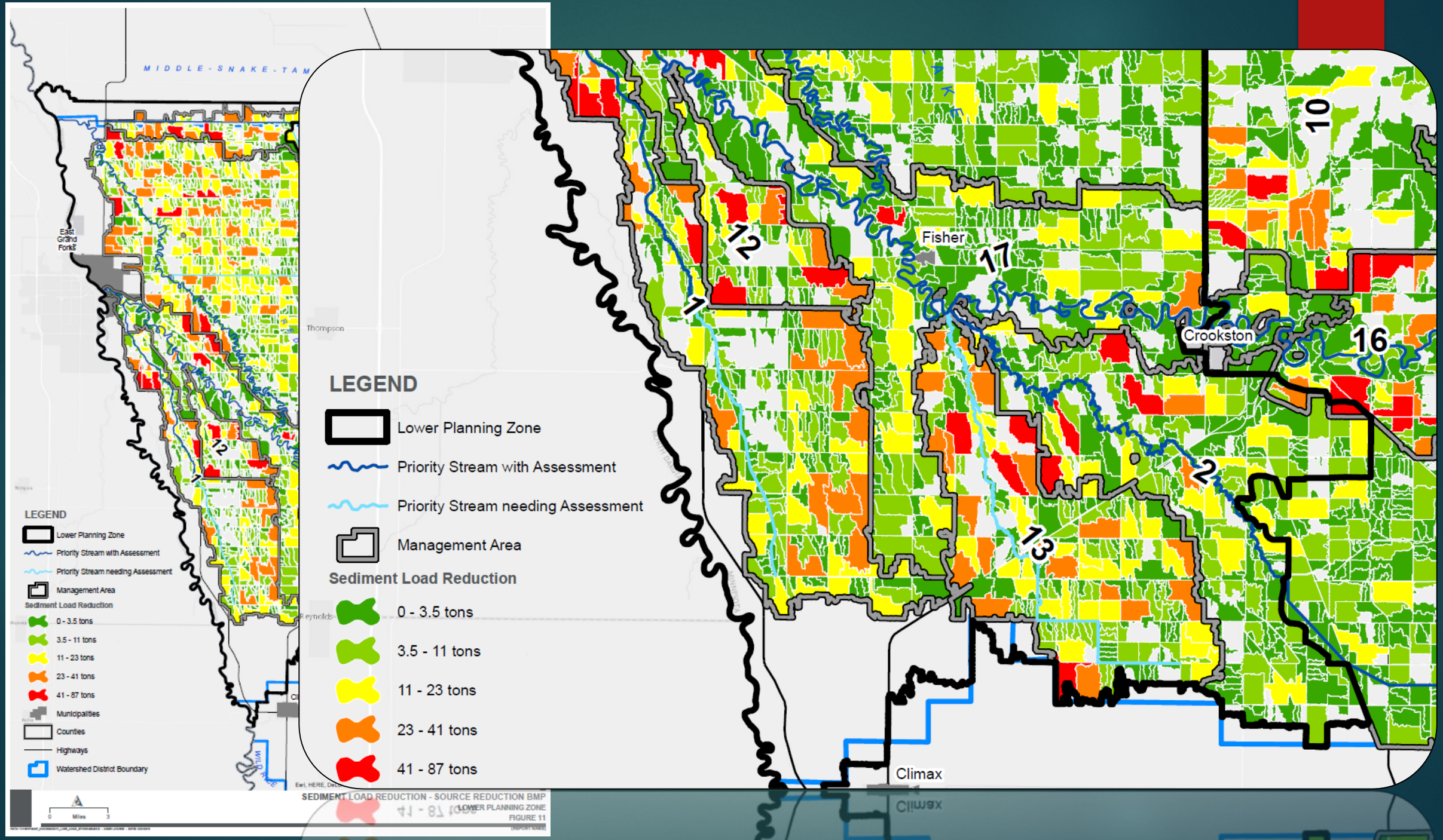
## Resources

1. Red Lake River Segment XX
2. Grand Marais Creek Segment XX
3. County Ditch XX

## Measurable Goals

1. Reduce TP delivery by XX% within 10 years
2. Reduce TSS delivery by XX% within 5 years
3. Reduce Fecal Coliform by XX% in 10 years

**Implementation Plan**


MIDDLE-SNAKE-TAM
East Grand Forks
Thompson
Reynolds
Climax
Fisher
Crookston
12
1
17
10
16
2
13
LEGEND
Lower Planning Zone
Priority Stream with Assessment
Priority Stream needing Assessment
Management Area
Sediment Load Reduction
0 - 3.5 tons
3.5 - 11 tons
11 - 23 tons
23 - 41 tons
41 - 87 tons
Municipalities
Counties
Highways
Watershed District Boundary
SEDIMENT LOAD REDUCTION - SOURCE REDUCTION BMP
LOWER PLANNING ZONE
FIGURE 11

# Setting Measureable Goals

# Plan

## Issues, Impler

- T

**Table 6.** PTMApp non-urban management strategies and their respective best management practices considered for the Red Lake River One Watershed, One Plan

| Source Reduction | Storage | Infiltration | Filtration | Protection | Bioinfiltration |
|---|---|---|---|---|---|
| **Conservation Tillage** | Alternative Tile Intake - Perforated Riser Intake | Alternative Tile Intake - Dense Pattern Tiling | Alternative Tile Intake - Gravel Inlet | Critical Area Planting | Bioretention Basin |
| **Contour Farming** | Constructed Wetlands | Infiltration Trench | Alternative Tile Intake - Blind Intake | Grade Stabilization Structure | Saturated Buffer |
| **Forage and Biomass Planting** | Culvert Sizing | Lined Waterway or Outlet | Alternative Tile Intake - Perforated Riser Intake | Channel Bed & Stream Channel Stabilization | |
| **Irrigation Water Management** | Dam | Multi-Stage Ditch | Conservation Cover | Streambank and Shoreline Protection | |
| **Nutrient Management** | Drainage Water Management | Strip Cropping | Contour Buffer Strips | Tree/Shrub Establishment | |
| **Prescribed Grazing** | Pond for Water Use | | Cover Crop | | |
| **Rotational Grazing** | Sediment Basin | | Filter Strips | | |
| | Storm Water Retention Basins | | Grassed Waterway and Swales | | |
| | Structure for Water Control | | Riparian Forest Buffer | | |
| | Water and Sediment Control Basin | | Riparian Herbaceous Cover Terrace | | |
| | Water Reuse | | | | |
| | Wetland Creation | | | | |
| | Wetland Restoration | | | | |

rategies and their respective best management practices
shed, One Plan

| | Filtration | Protection | Bioinfiltration |
|---|---|---|---|
| e Tile ense ling | Alternative Tile Intake - Gravel Inlet | Critical Area Planting | Bioretention Basin |
| | Alternative Tile Intake - Blind Intake | Grade Stabilization Structure | Saturated Buffer |
| or | Alternative Tile Intake - Perforated Riser Intake | Channel Bed & Stream Channel Stabilization | |
| e | Conservation Cover | Streambank and Shoreline Protection | |
| ping | Contour Buffer Strips | Tree/Shrub Establishment | |
| | Cover Crop | | |
| | Filter Strips | | |
| | Grassed Waterway and Swales | | |
| | Riparian Forest Buffer | | |
| | Riparian Herbaceous Cover Terrace | | |

ces, Measurable Goals and Targeted Implementation Plan

Chapter: Issues, Resources, Measurable Goals and Targeted Implementation Plan

11

# Plannin

Issues, Resou

| Management Area | Management Strategy | Best Management Practice | Number of BMPs | Cost | Lead Entity | Year(s) |
|---|---|---|---|---|---|---|
| | | Restoration | | | | |
| | | Watershed Basin | 1 | | Pennington | 2022 |
| | Filtration | Cover Crop | 1 | | Pennington | 2018 |
| | | Grassed Waterway | 1 | | Pennington | 2019 |
| | | Conservation Cover | 4 | | Pennington | 2017-2025 |
| | | Filter Strip | 14 | | Pennington | 2017-2025 |
| 24 | Protection | Critical Area Planting | 1 | | Pennington | 2019 |
| | | Channel Stabilization | 1 | | Pennington | 2019 |
| | | Streambank | 1 | | Pennington | 2019 |
| | | Riparian Trees | 4 | | Pennington | 2017-2025 |
| | | Grade Stabilization | 50 | | Pennington | 2017-2025 |
| | Source Reduction | Rotational Grazing | 1 | | Pennington | 2019 |
| | | Conservation Tillage | 1 | | Pennington | 2019 |
| | Storage | Wetland Restoration | 1 | | Pennington | 2021 |
| | | Watershed Basin | 1 | | Pennington | 2021 |
| | | Drainage Water Management | 1 | | Pennington | 2022 |
| | Filtration | Cover Crop | 1 | | Pennington | 2020 |
| | | Grassed Waterway | 1 | | Pennington | 2020 |
| | | Conservation Cover | 1 | | Pennington | 2020 |
| | | Filter Strip | 4 | | Pennington | 2017-2025 |
| | Protection | Critical Area Planting | 1 | | Pennington | 2022 |
| | | Channel Stabilization | 1 | | Pennington | 2022 |
| | | Streambank | 1 | | Pennington | 2022 |

| Management Area | Management Strategy | Best Management Practice | Number of BMPs | Co |
|---|---|---|---|---|
| 14 | Protection | Channel Stabilization | 1 | |
| | | Streambank | 20 | |
| | | Riparian Trees | 30 | |
| | | Grade Stabilization | 300 | |
| | Source Reduction | Rotational Grazing | 3 | |
| | | Nutrient Management | 16 | |
| | | Conservation Tillage | 10 | |
| | Storage Filtration Infiltration | Wetland Restoration | 2 | |
| | | Cover Crop | 2 | |
| | | Grassed Waterway | 2 | |
| | | Conservation Cover | 10 | |
| | | Filter Strip | 30 | |
| | | 2-Stage Ditch | 1 | |
| 22 | Protection | Critical Area Planting | 1 | |
| | | Channel Stabilization | 1 | |
| | | Streambank | 1 | |
| | | Riparian Trees | 3 | |
| | | Grade Stabilization | 50 | |
| | Storage | Watershed Basin | 1 | |
| | Filtration | Grassed Waterway | 1 | |
| | | Conservation Cover | 1 | |
| | | Filter Strip | 6 | |
| 23 | Protection | Critical Area Planting | 1 | |
| | | Channel Stabilization | 1 | |
| | | Streambank | 1 | |
| | | Riparian Trees | 6 | |
| | | Grade Stabilization | 150 | |
| | Source Reduction | Nutrient Management | 1 | |
| | | Conservation Tillage | 1 | |
| | Storage | Wetland | 1 | |

| Best Management Practice | Number of BMPs | Cost | Lead Entity | Year(s) |
|---|---|---|---|---|
| Cover Crop | 1 | | Pennington | 2022 |
| Grassed Waterway | 1 | | Pennington | 2022 |
| Conservation Cover | 2 | | Pennington | 2022 |
| Filter Strip | 14 | | Pennington | 2017-2025 |

| ...on statement | Action | Cost | Lead Entity | Year(s) |
|---|---|---|---|---|
| | WEPS Plan | | Pennington | 2017 |
| ...nd erosion with priority ...erodible soils by ...mplementation in ...heds with highest | Unprotected highly wind-erodible soils | | Pennington | 2018-2025 |
| | Protected highly wind-erodible soils | | Pennington | 2018-2025 |
| ...evaluate and assign ...nt classes to stream ...reaches and prioritize ...t susceptible to altered ...effects on bank and bed | Reach Risk Evaluation and Management Plan | | Pennington | 2017 |
| | Protect stable, at-risk reaches | | Pennington | 2018-2025 |
| | Restore unstable, at-risk reaches | | Pennington | 2018-2025 |

(Ctrl)

...asurable Goals and Targeted Implementation Plan

Chapter: Issues, Resources, Measurable Goals and Targeted Implementation Plan

30

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### .1.5. Assessment and Evaluation

The Assessment and Evaluation of plan implementation will be made by the Planning Group at quarterly meetings. The planning group will continue to meet after the adoption of the Red Lake River 1W1P. One member of the planning group will be responsible for organizing and hosting the quarterly meetings on a rotating annual basis. New programs, laws, funding, projects, and duties of LGUs can change quickly and needs may be amended in the 1W1P. A more detailed evaluation and assessment will need to be discussed that meets the measurability requirement stated in the targeted implementation schedule.

#### 5.1.5.1. ANNUAL EVALUATION

Annual evaluation of progress be made by the planning group at quarterly meetings. The planning group will report to the combined TAC/Policy Committee at the annual meeting. The planning group will prepare a summary of progress and projects completed or in progress for the watershed. Monitoring data may be used to show reductions in pollutants.

#### 5.1.5.2. BIENNIAL EVALUATION

Same process as annual evaluation

#### 5.1.5.3. FIVE YEAR EVALUATION

Same process - Evaluation of progress and goals made by planning group with recommendation to TAC/Policy Committee. Completed projects can be checked off. Include input from BWSR and other state agencies? Re-run PTMApp? Are the initial goals set realistic or do they need to be changed. Determine if there are new models available to include in the plan. Possible project tours.

#### 5.1.5.4. REPORTING

Various forms of reporting were discussed by the Planning Group. LGUs are required to

rams

n and Coordination

ng

ING)

continuance of the Policy Committee and the Technical
doption of the 1W1P. The Planning Group thought one
e existing Advisory and Policy Committee sufficient for the
One Plan. The meeting would address topics such as
s, other State, Federal, Foundation, and non-governmental
w projects. The Planning Group would continue to meet
would be quarterly and one LGU will be responsible for
uarterly or yearly rotation.

ARED SERVICES (STAFFING)

sting shared services and staff such as TSA Engineers, WCA
ologist. The group discussed a possibility for future
ch services, buffer technician, MN Ag Water Quality
P), and surveying or engineering services. More shared
the goals of the plan are established.

units of government (not part of the formal

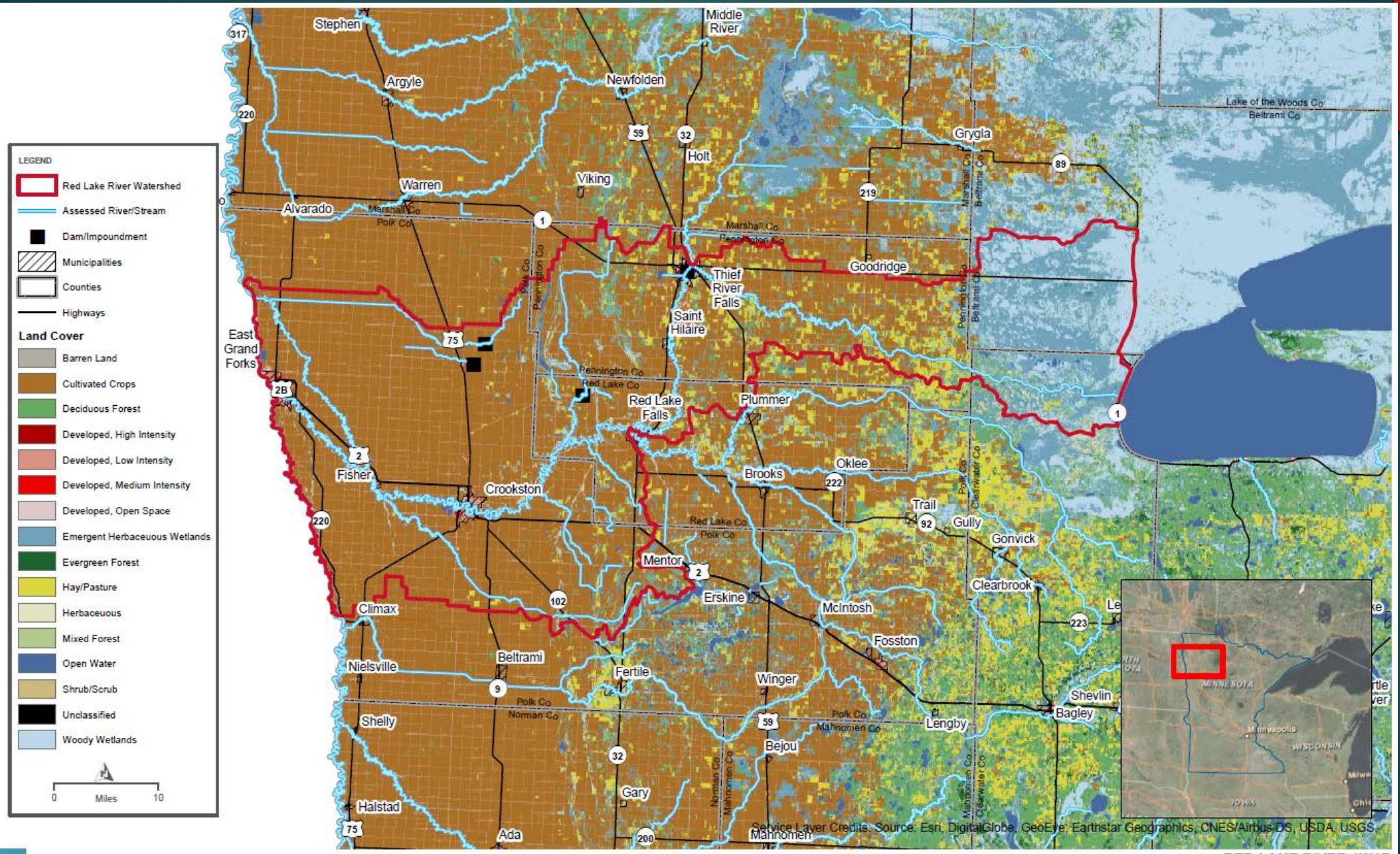
g Group to maintain individual LGU identity, not a joint
other units of government will occur as needed and a
y the two or more parties. We also need to recognize
Federal, State, and County partnerships. Other special
Minnesota Conservation Corps (MCC) were discussed to
priate category.

NRBG: Water Plan, WCA, Shoreland, SSTS, Feedlot, SSTS
MPCA), Taxing Authority, County Appropriation, Aquatic
d management, Permit fees, (not including most Red Lake

# Appendices



- **Appendix A: Land and Water Resources Inventory**
- **Appendix B: State and Regional Plan Summaries and Relevance to the Red Lake River 1W1P**
- **Appendix C: Manually entered public survey results relative to priority issues**
- **Appendix D. Priority statement ranking within each planning zone by relevant issues**
- **Appendix E: Resources of Concern**
- **Etc.**




RED LAKE RIVER 1W1P
LAND COVER
APPENDIX B

# Lessons Learned

- Evaluate People Styles and personality of core team
- Maintain an active website and communications plan
- Anticipate level of effort, budget, and timeline….plan for challenges
- Facilitate with an end-goal in mind

http://westpolkswcd.com/1w1p.html

1W1P - WEST POLK Soil & ...

File Edit View Favorites Tools Help

Convert Select

Suggested Sites Web Slice Gallery

Page Safety Tools

# WEST POLK Soil & Water Conservation District

Home | History | Supervisors & Areas | Buffers | 1W1P | Clean Water Legacy Fund | more...

One Watershed
One Plan

## Red Lake River Watershed


8:57 AM
3/16/2016

# Lessons Learned

- Involve planning group early on with definition of implementation schedule and measureable goals
- Involve planning group and TAC early on in reviewing sections of the draft plan

# Work Plan



| ID | TASK | SCOPE ID | DESCRIPTION | COMPLETION |
|---|---|---|---|---|
| 19 | Stakeholder agreement on Priority Statements | 3.2.2 | TAC meeting(s): Ahead of meeting, provide initial examples of priority statements (derived from existing plans). May require 2 meetings. | August 31 |
| 20 | Resource of Concern to Priority Statements | 3.2.2 | CONSULTANT: Assign Resources to the various Priority Statements | September 18 |
| 21 | Measurable Goals for each Resource Of Concern | 3.2.2 | CONSULTANT: Develop Draft Resources-Measurable Goals and Timelines | October 2 |
| 22 | Stakeholder agreement on #20 and #21 | 3.2.2 | TAC: Draft Resources-Measurable Goals and Timelines review and comments<br>CONSULTANT: Incorporate comments | October 16 |
| 23 | Targeted and Measurable Implementation Plan and Schedule | 3.2.3 | CONSULTANT: Build out Draft Targeted and Measurable Implementation Plan and Schedule section | October 16 |
| 24 | Stakeholder review and comment on #23 | 3.2.3 | TAC: Targeted and Measurable Implementation Plan and Schedule review and comments<br>CONSULTANT: Incorporate comments | October 30 |
| 25 | Implementation Programs | 3.2.4 | TAC: Draft Implementation Programs section | October 16 |

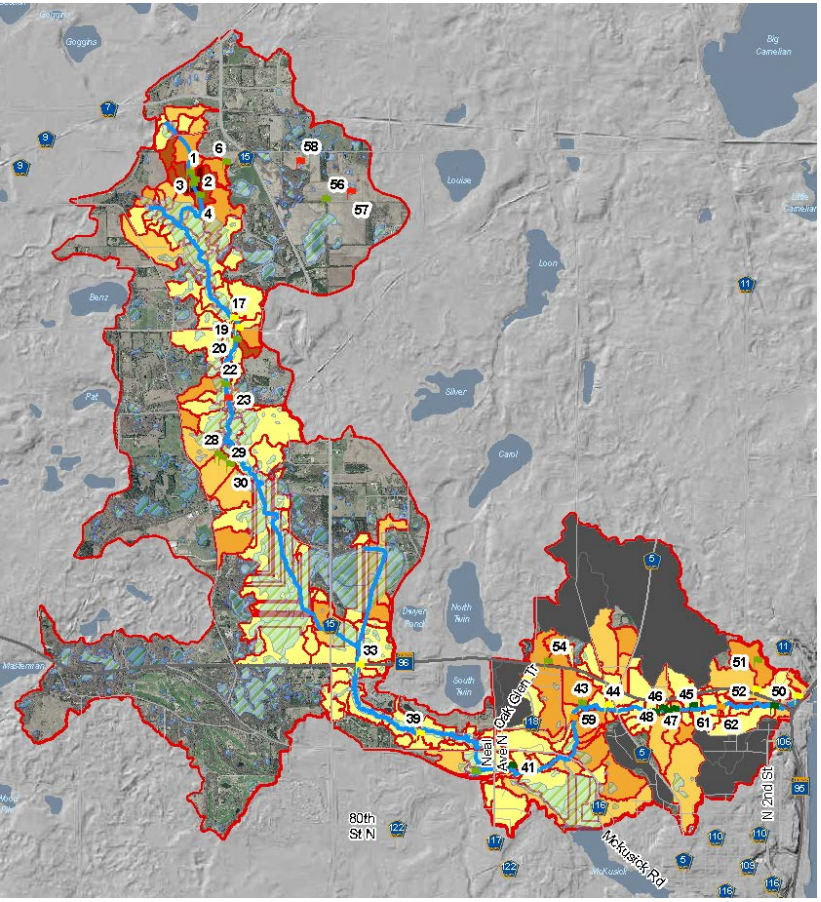
# Lessons Learned

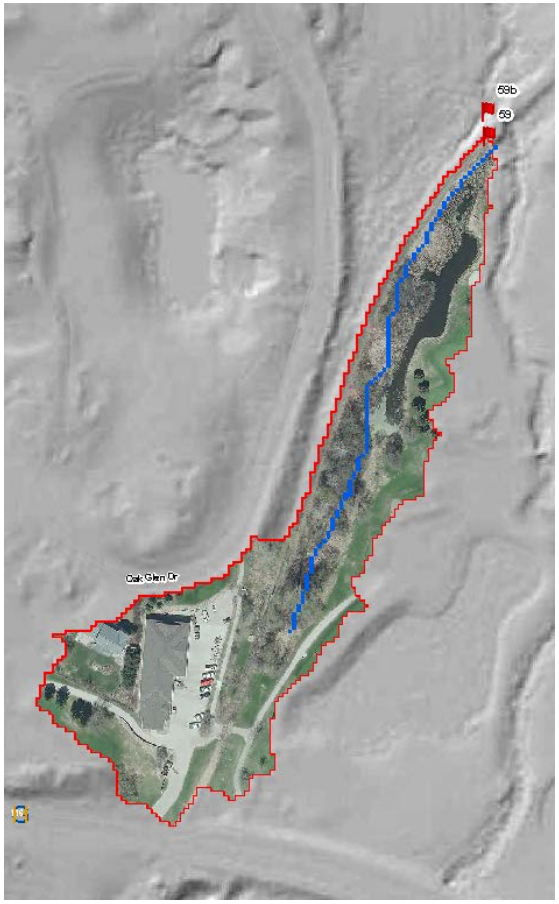
- Clearly outline process expectations and define editing and review processes, # of reviews, and timeline
- Adapt. It's a great plan!

# QUESTIONS

# Small Watershed Modeling

## Water Resources Conference - St. Paul, MN Oct. 19, 2016




# Implementing the PTMapp GIS Toolset at Smaller Watershed Scales: Results and Lessons Learned

**Presented by: Joe Pallardy, Biologist & Jason Ulrich, Hydrologist**
**From: Emmons & Olivier Resources, Inc. (EOR) / www.eorinc.com**

# Watershed Planning:
## Nearshore vs. Landscape has Emerged as a "Key Issue"

*Development near lakeshore*

*Development near channel*

*Development volume control*

**Incremental increases in runoff volume and/or intensity over time is the crux of the problem**

# Watershed Modeling: Two Choices?


***Occam's Razor***

*"The **simplest explanation** for the condition of a waterbody and consequently implementation priority should be considered correct until proven otherwise."*

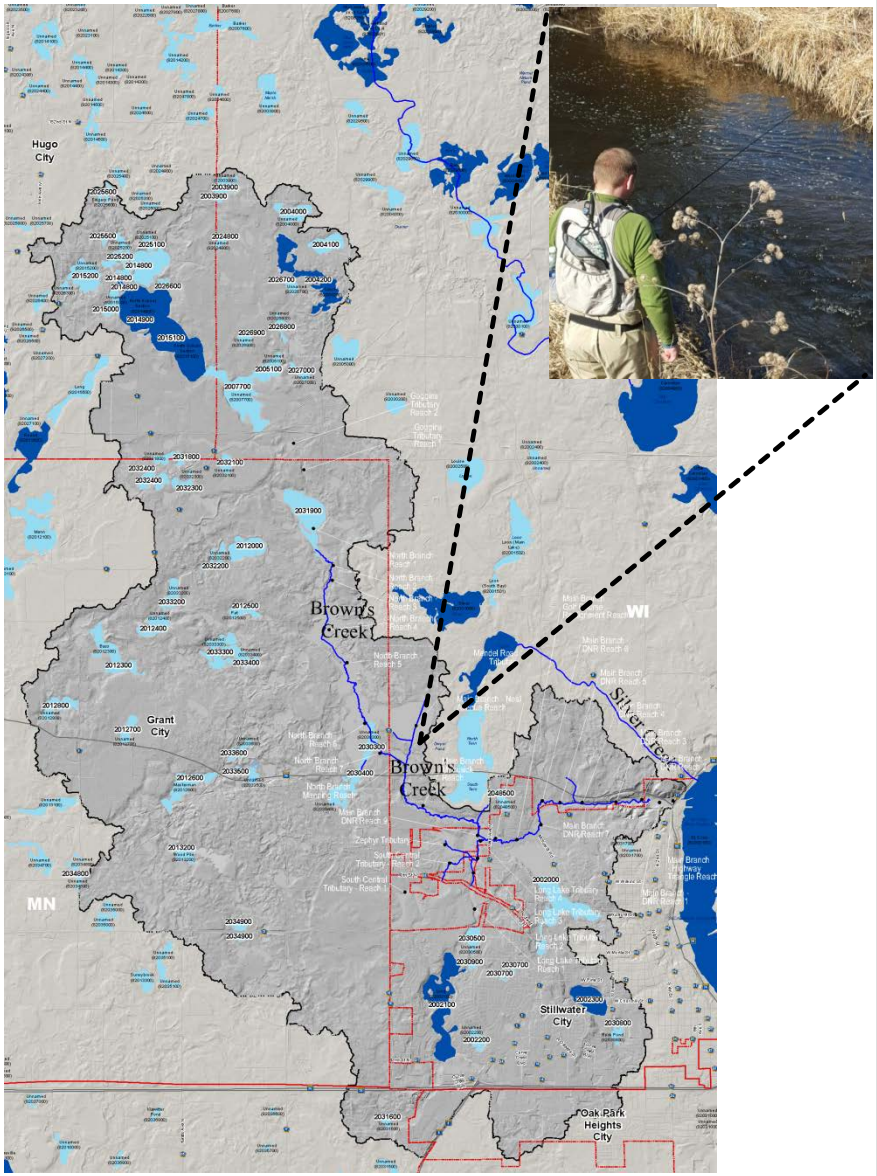
***Hickam's Dictum***

*"A waterbody can **have as many diagnoses as it darn well pleases**". Multiple ailments are likely accounting for the symptoms being expressed.*

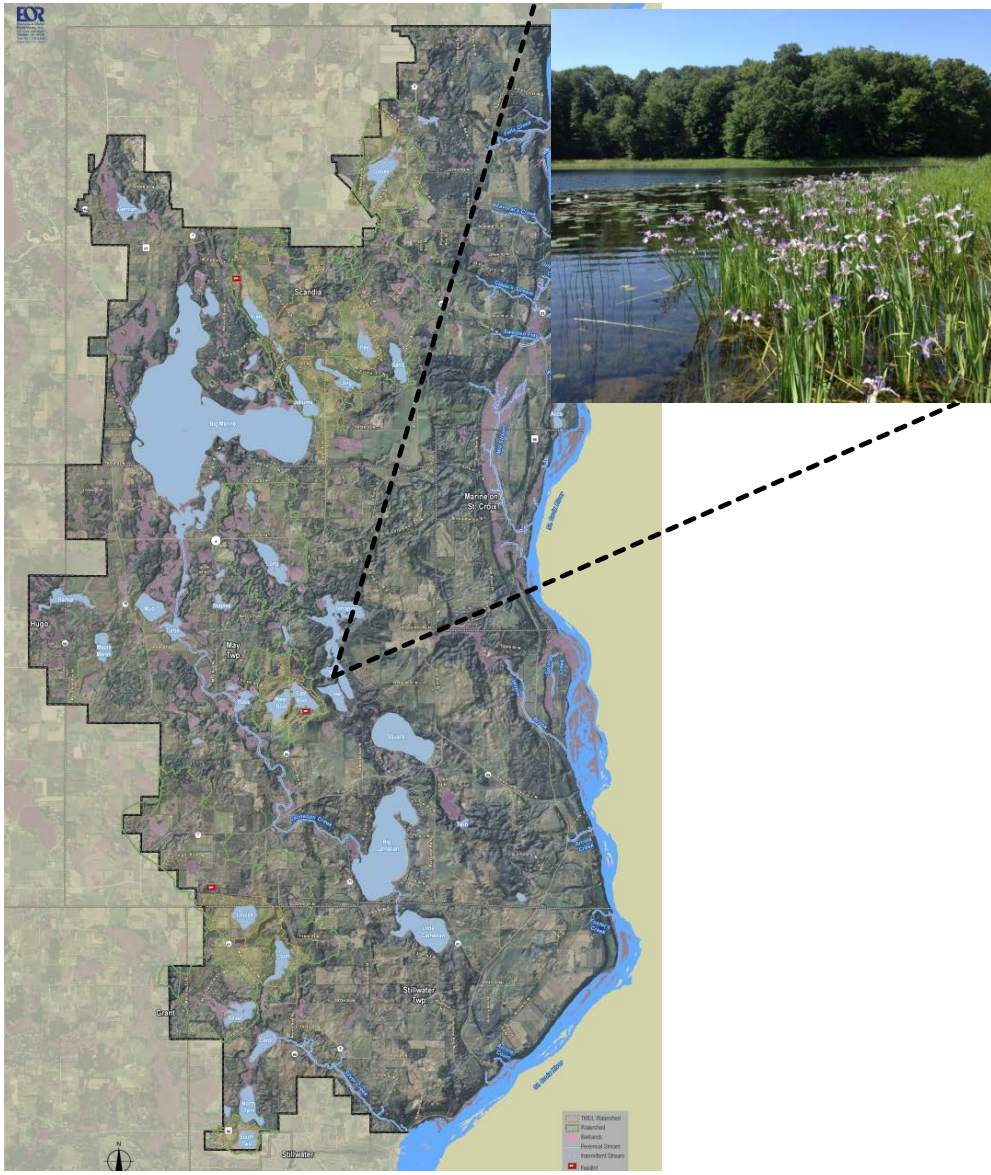
# Watershed Models

- Are **NOT** substitutes for the collection of field data
- Allow us to change watershed characteristics in **space and time** in ways that support prioritization and planning efforts.

# PTMapp: Watersheds



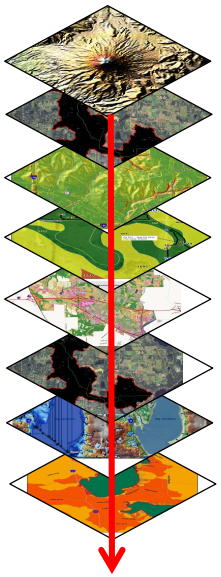

Brown's Creek Watershed



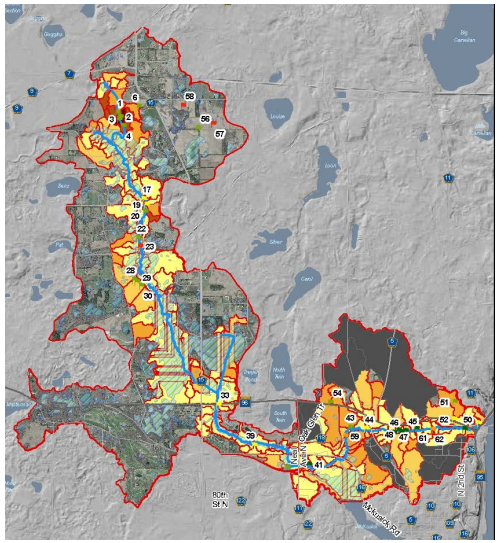

Carnelian Marine Watershed

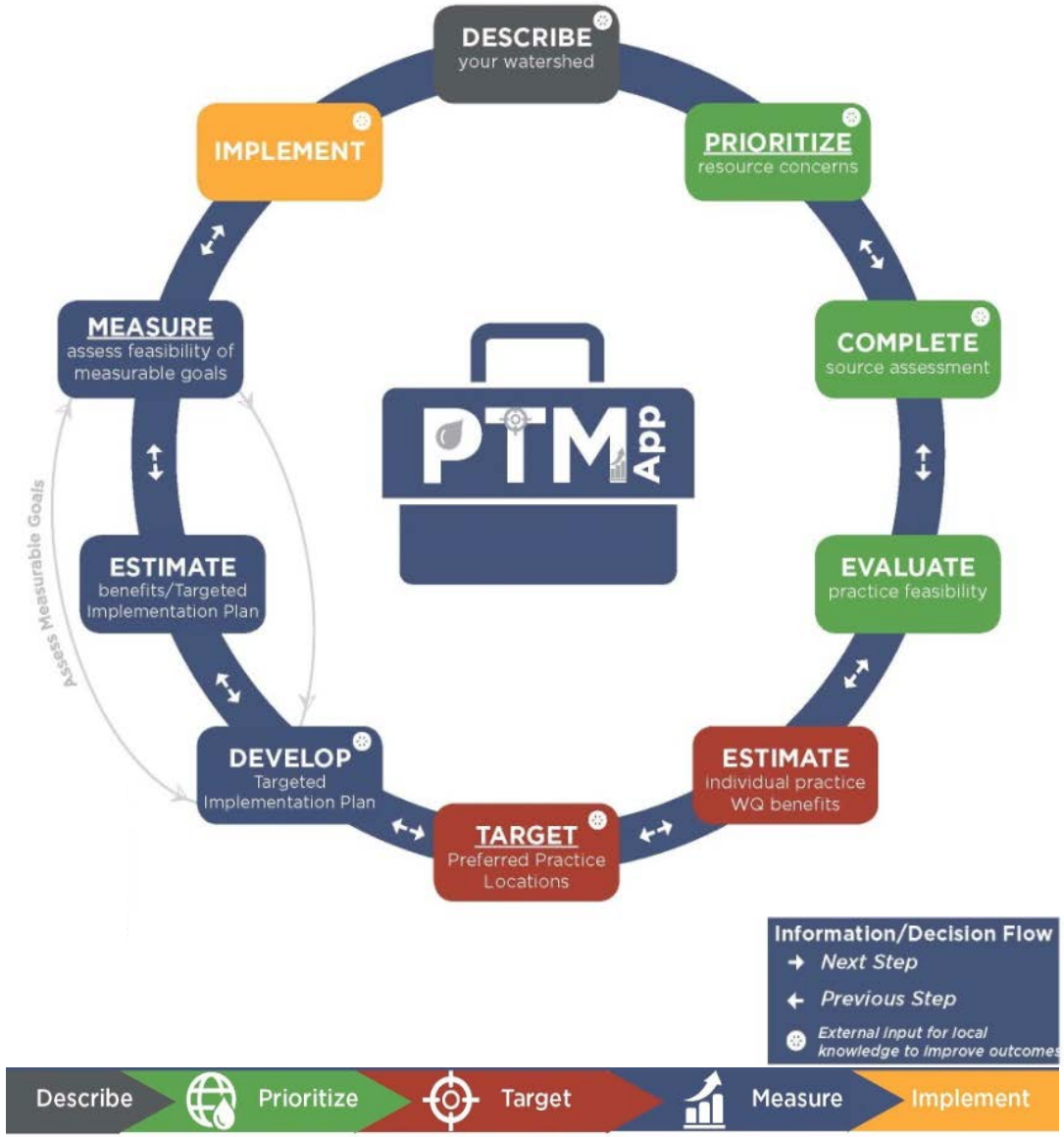
# PTMapp Overview

## GIS Inputs



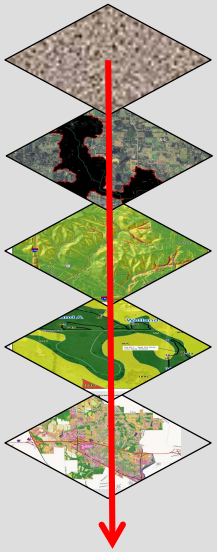
- LiDAR (Conditioned DEM)
- DNR Travel Time
- RUSLE
- SSURGO Soils Data
- MLCSS Land Cover
- Curve Number Grid
- Landlocked Basins
- Depressional Watersheds





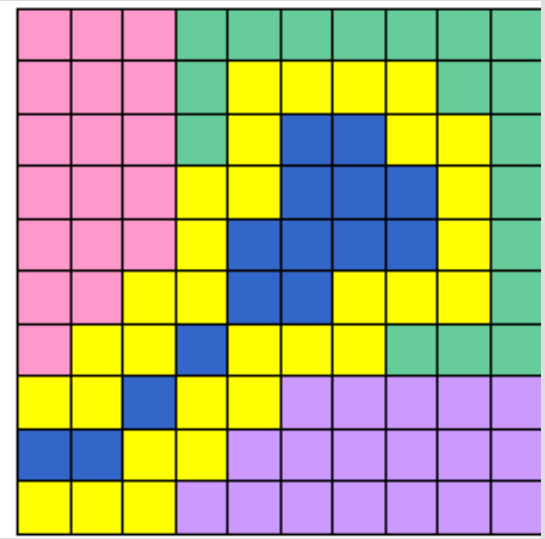
# PTMapp: Landscape Yield vs. Delivery

## Sediment Yield-RUSLE



- K-Factor – (SSURGO Values)
- R-Factor – (NRCS Value)
- LS- Factor – (LiDAR Value)
- P-Factor – (Existing BMPs)
- C-Factor – 2011 MLCCS Layer

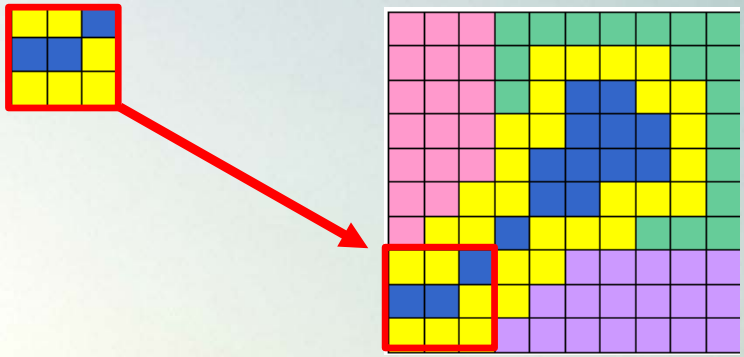
## Landscape Yield Raster (High Resolution)



# PTMapp: Landscape Yield vs. Delivery

## Sediment Delivery Ratio (SDR)

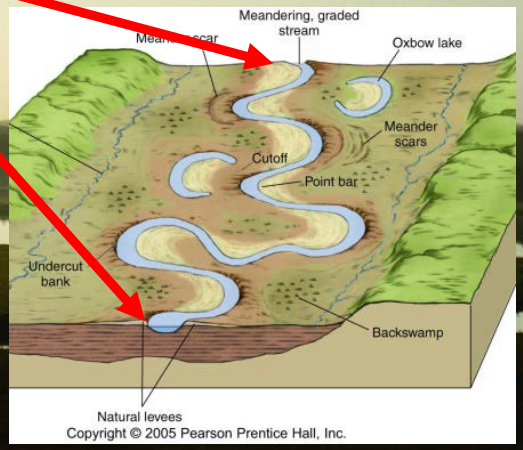
**SDR is a function of drainage area and distance from each raster cell to channelized flow.**



**RUSLE X SDR =**
**Load to Channelized Flow Path**

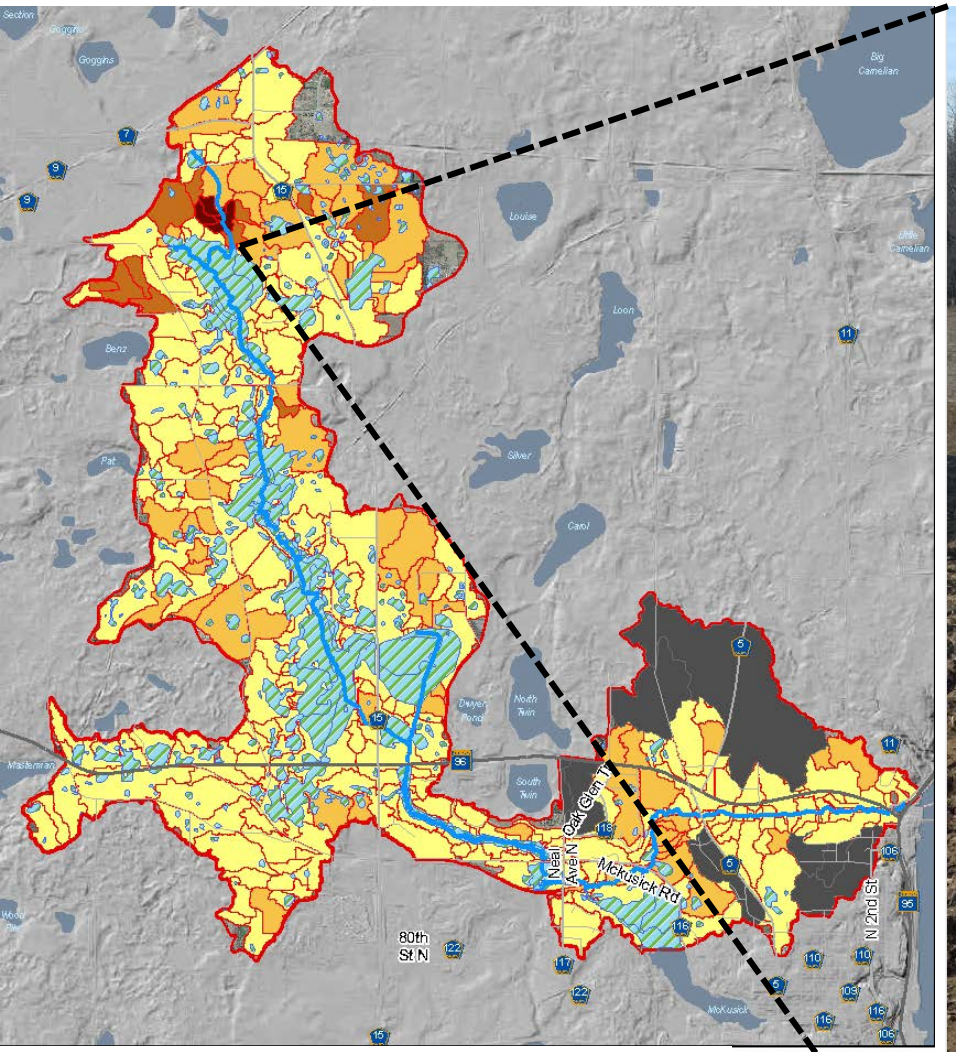
**In-channel transport correction factor follows an exponential decay function**

- ***Travel time & diameter of sediment***




**SDR X Correction Factor =**
**Load to the end of the catchment**

# PTMapp: Source Load Identification




**Legend**

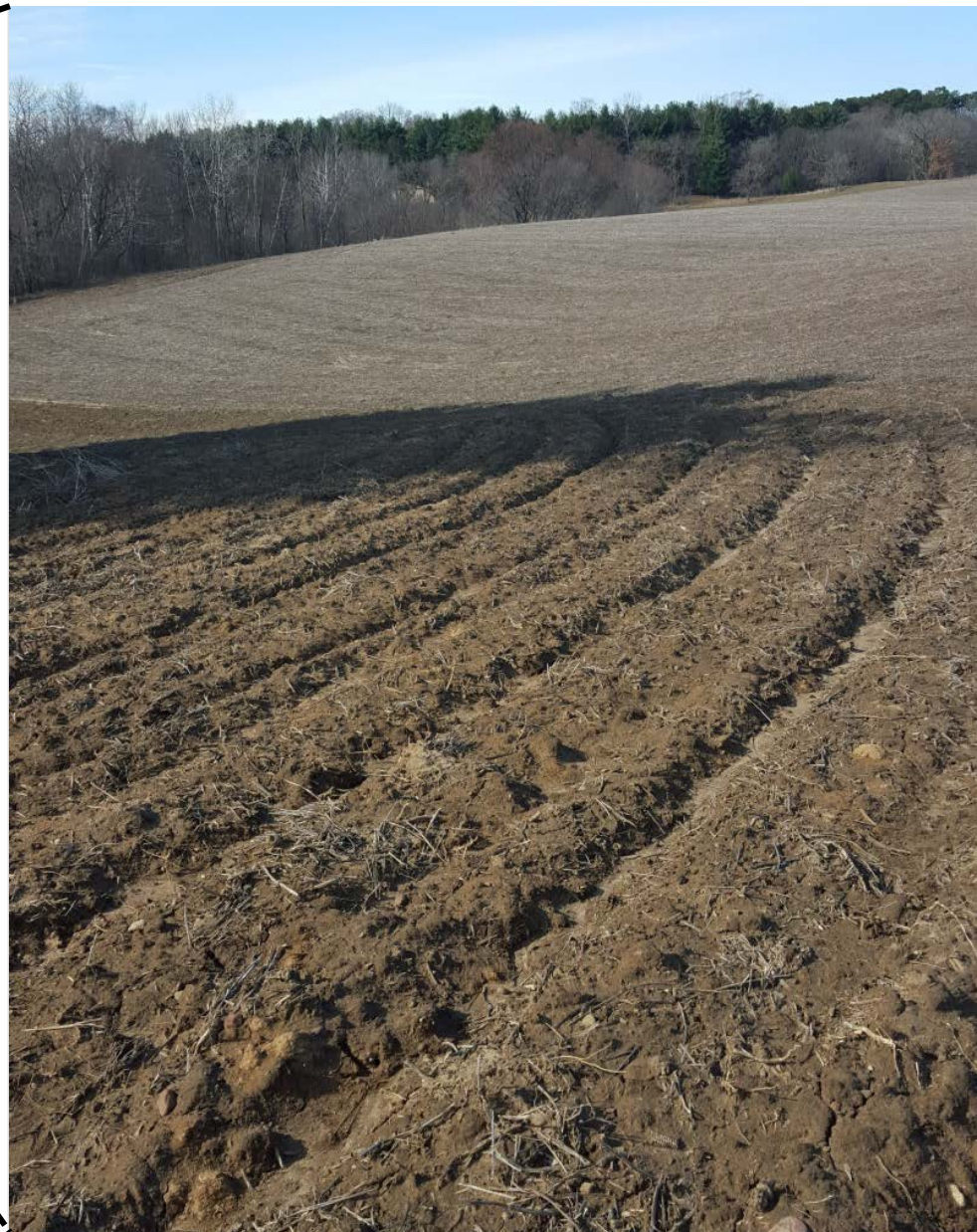
PTMApp
Sediment Loads- FL (Tons/Acre)
0.00 - 0.34
0.35 - 1.03
1.04 - 2.05
2.06 - 4.88

Wetlands

Landlocked Basins

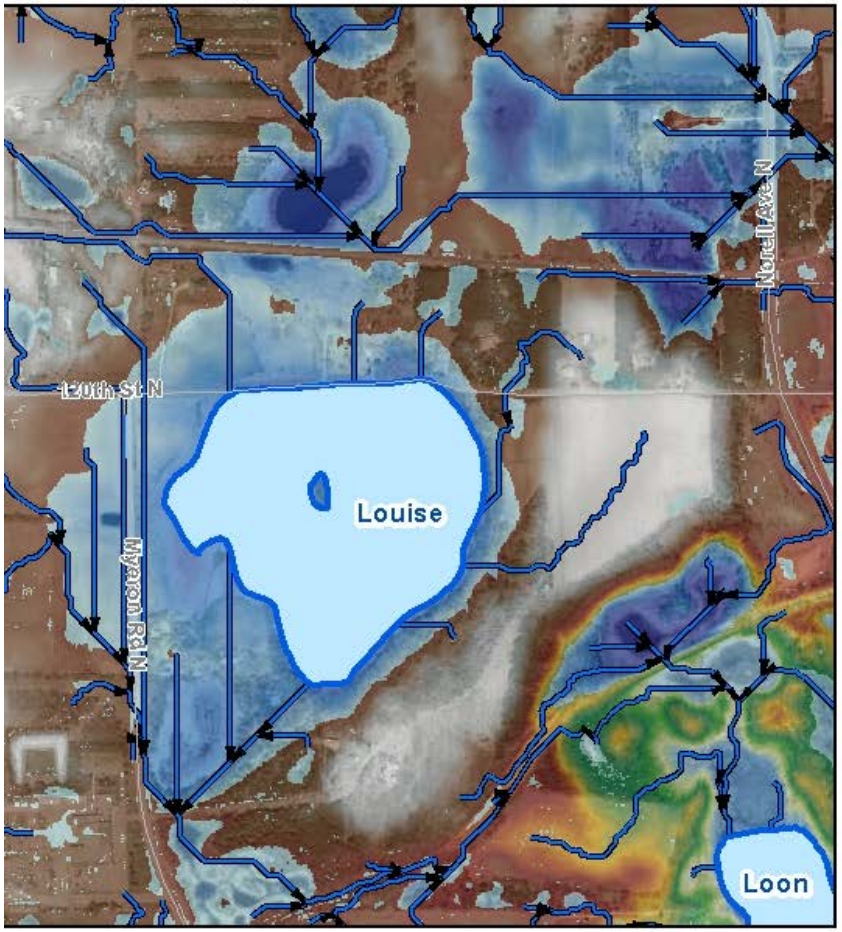
**Sediment Analysis**

Catchment Loading

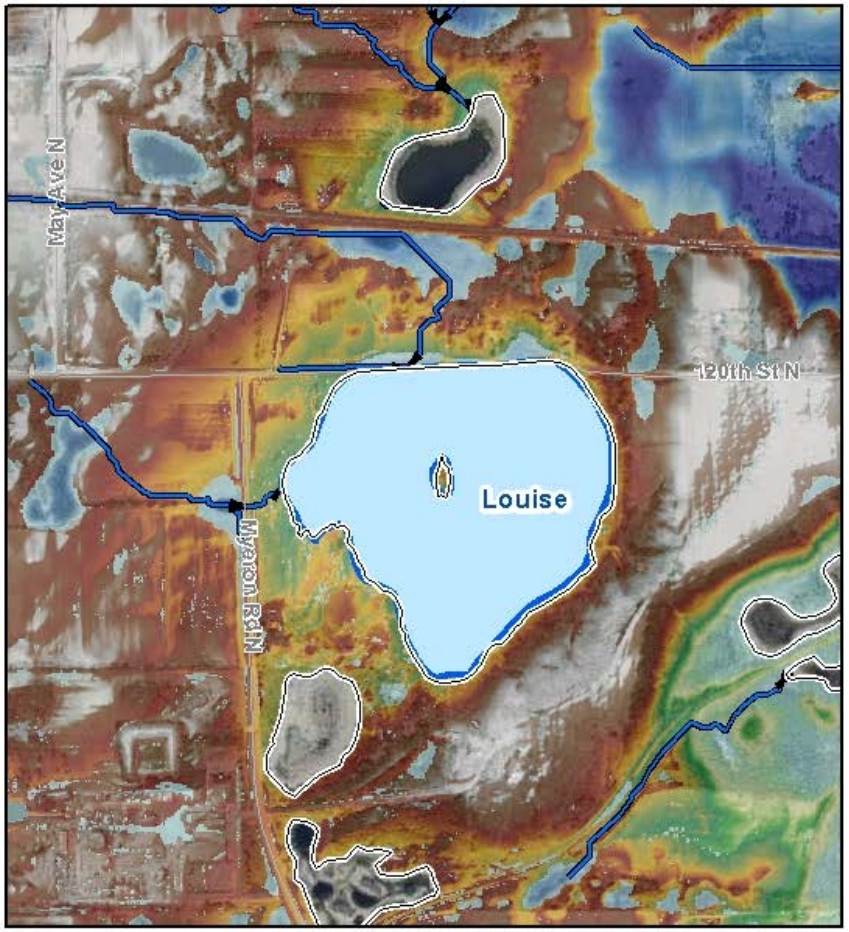


# PTMapp: Refinement
## – Landlocked Basins

### Depressions in DEM




### Depressions Removed




**Legend**

**PTMApp Stream**

**Land Locked Basins**

**Corrected DEM Value**

High : 306.982

Low : 276.918

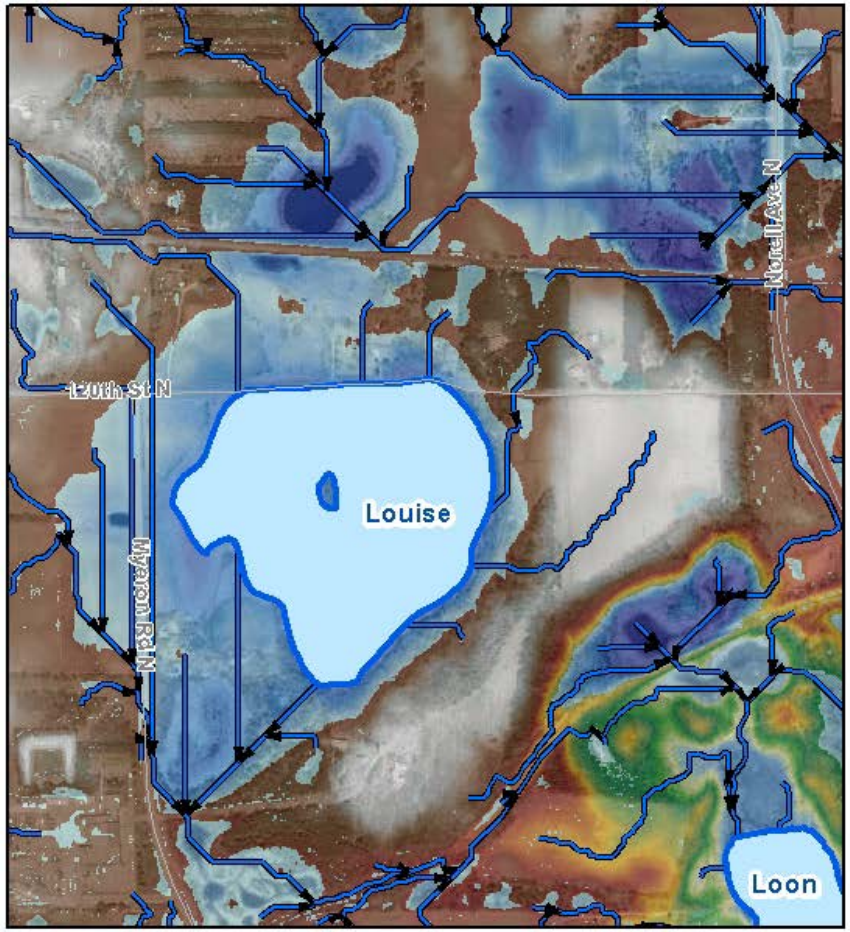
**CMSCWD BMP Targeting**

**DEM Extraction**

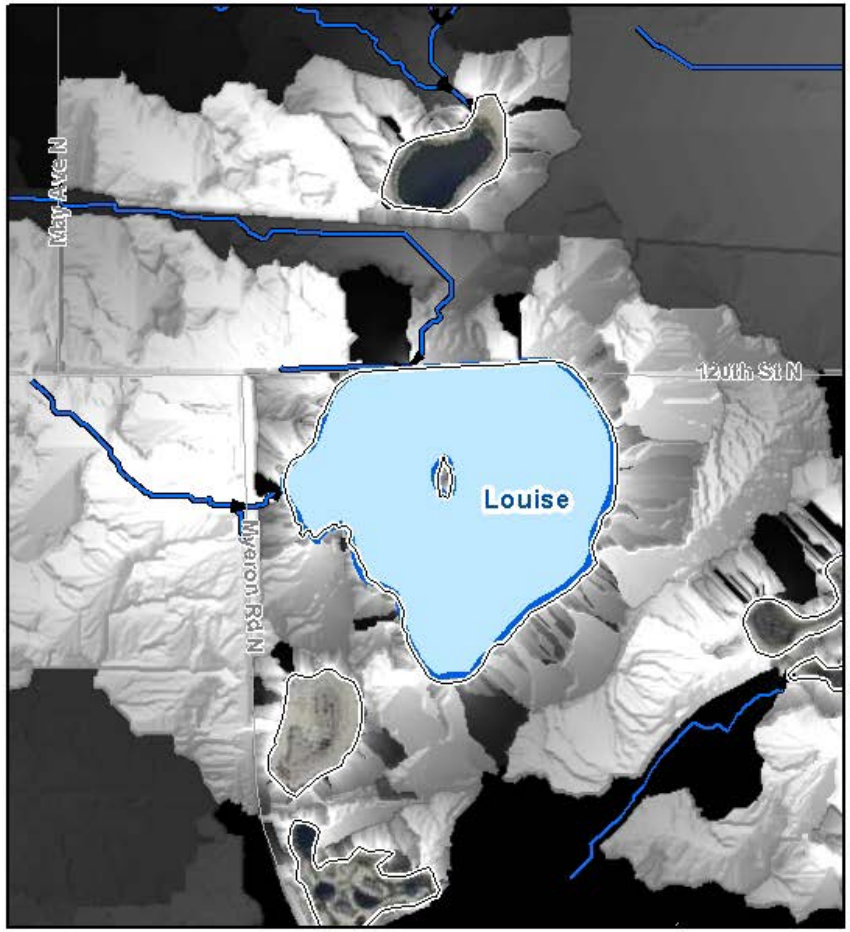
0 250 500 1,000 Feet

# PTMapp: Refinement
## – SDR Adjustment

### Depressions in DEM




### SDR Adjustment




**Legend**

- Land Locked Basins
- Impaired Waterbody
- PTMApp Stream

**Overland SDR (Adjusted)**

High : 1

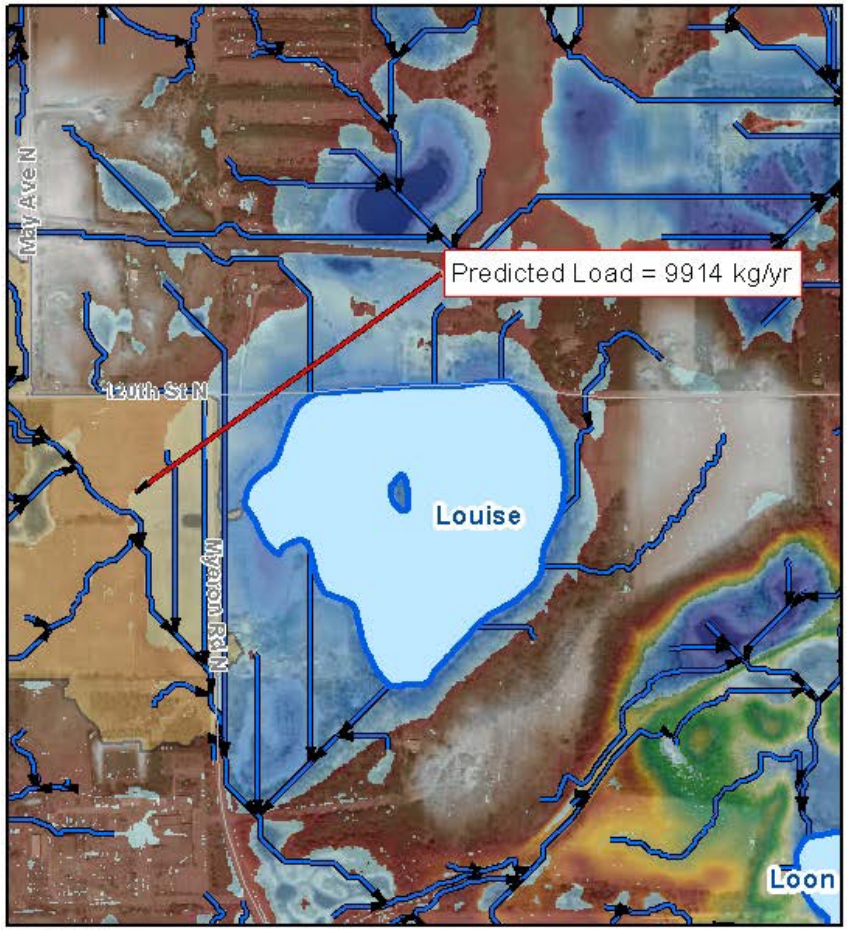
Low : 0.000819564

**CMSCWD BMP Targeting**
SDR Adjustment

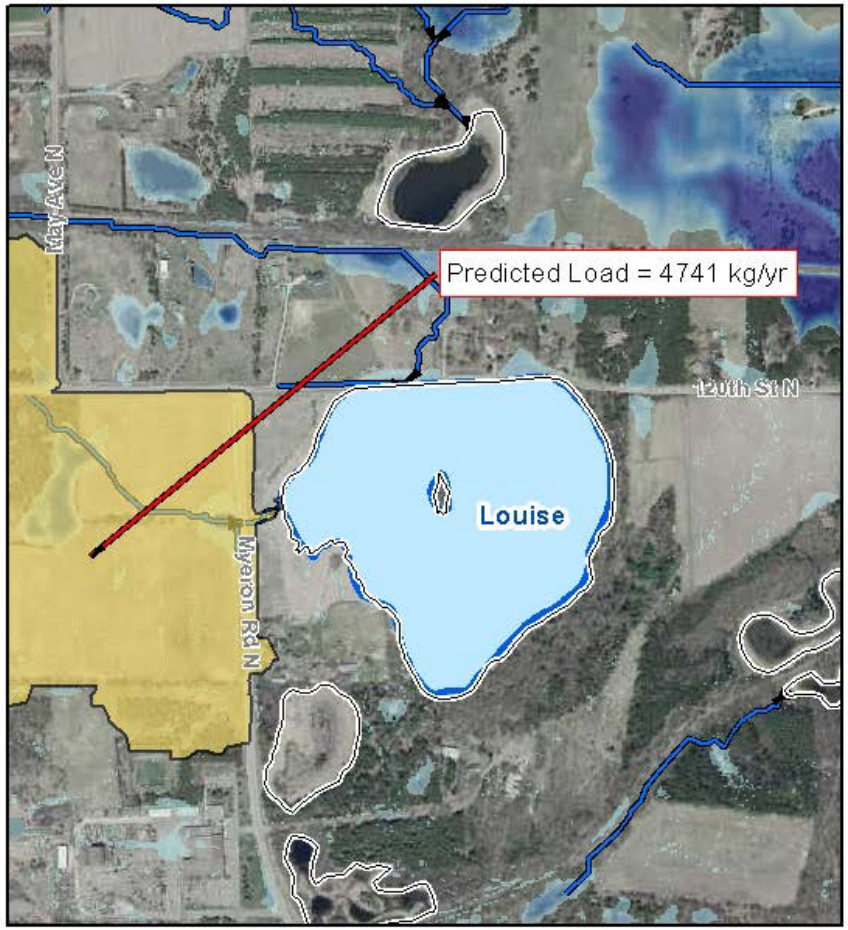
0 250 500 1,000
Feet

# PTMapp: Refinement
## – SDR and LL Adjustment

### Depressions in DEM




### Landlocked & SDR Adjustment




**Legend**

- Land Locked Basins
- Impaired Waterbody
- PTMApp Stream

**Sediment Mass**
SUM

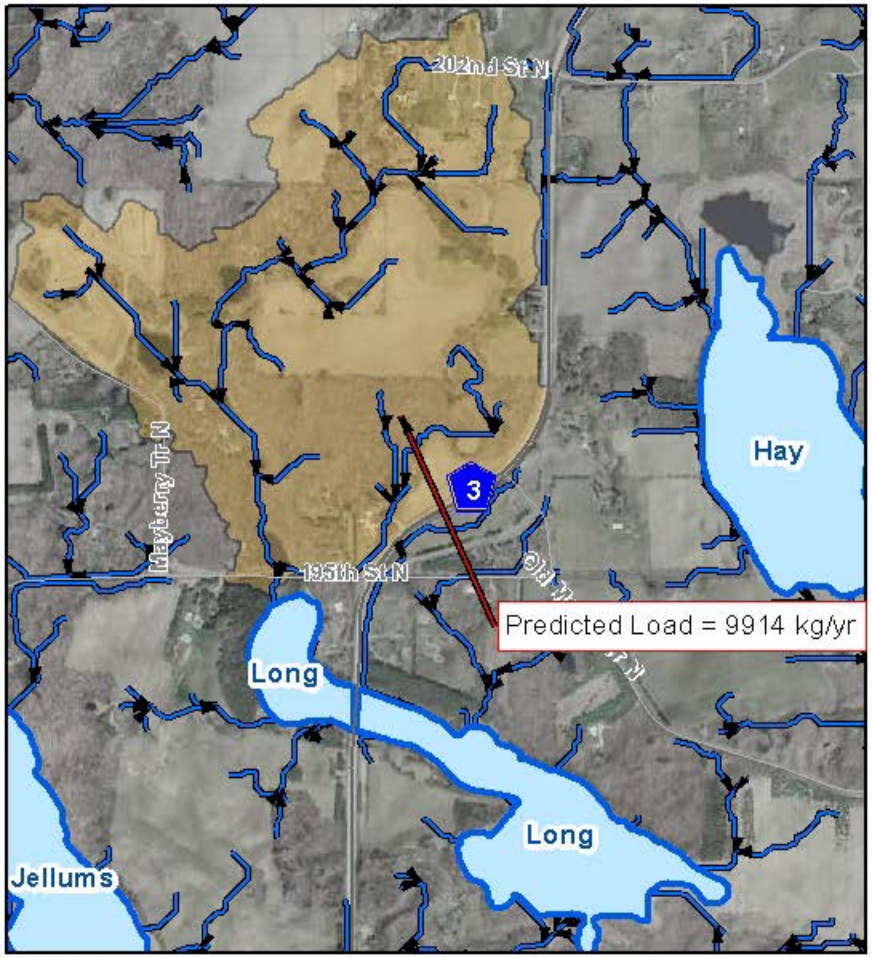
- 0 - 1927
- 1928 - 8196
- 8197 - 21610
- 21611 - 48249
- 48250 - 119478
- 119479 - 268035

**CMSCWD BMP Targeting**
DEM Extraction

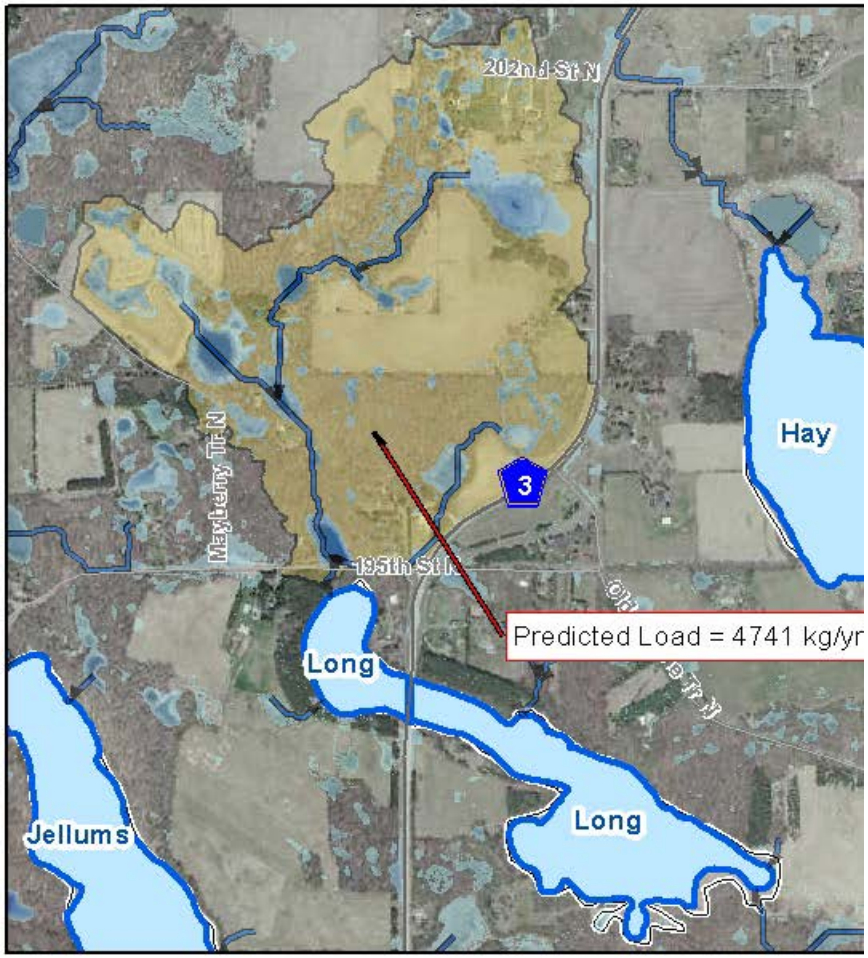
0 250 500 1,000
Feet

# PTMapp: Refinement
## – Wetland Analysis

### Depressions in DEM




### Depressions Removed




**Legend**

| Sediment Mass SUM | | |
|---|---|---|
| 0 - 1927 | 8197 - 21610 | Flow Network |
| 1928 - 8196 | 21611 - 48249 | Impaired Waterbody |
| | 48250 - 119478 | Land Locked Basins |
| | 119479 - 268035 | |

**CMSCWD BMP Targeting**
**DEM Extraction**

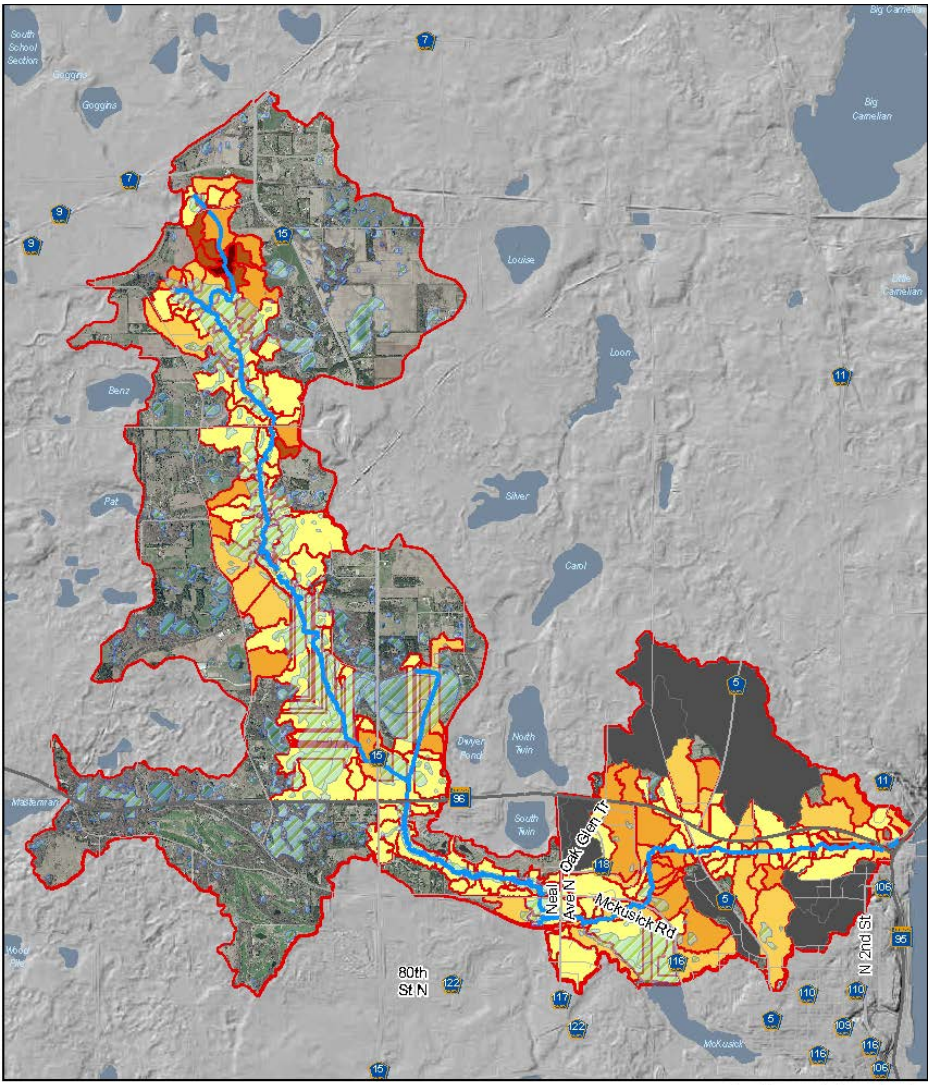
0 250 500 1,000 1,500 Feet

# Sediment Sources Budget- Brown's Creek

| | | | | | |
|---|---|---|---|---|---|
| Total Sediment Load (WOMP station) | = | Landscape Sediment Load (PTMapp) | + | Near-channel Sediment Load | • Gullies/Ravines<br>• Streambanks<br>• Streambed<br>• Bluffs |
| 1,140,000 kg/yr | ≈ | 473,000 kg/yr | + | Near-channel Sediment Load | • Gullies/Ravines<br>• Streambanks<br>• Streambed<br>• Bluffs |

**Therefore, an estimate of average near-channel sediment load ≈ 667,000 kg/year (60% of total average load)**

# Landscape Loads



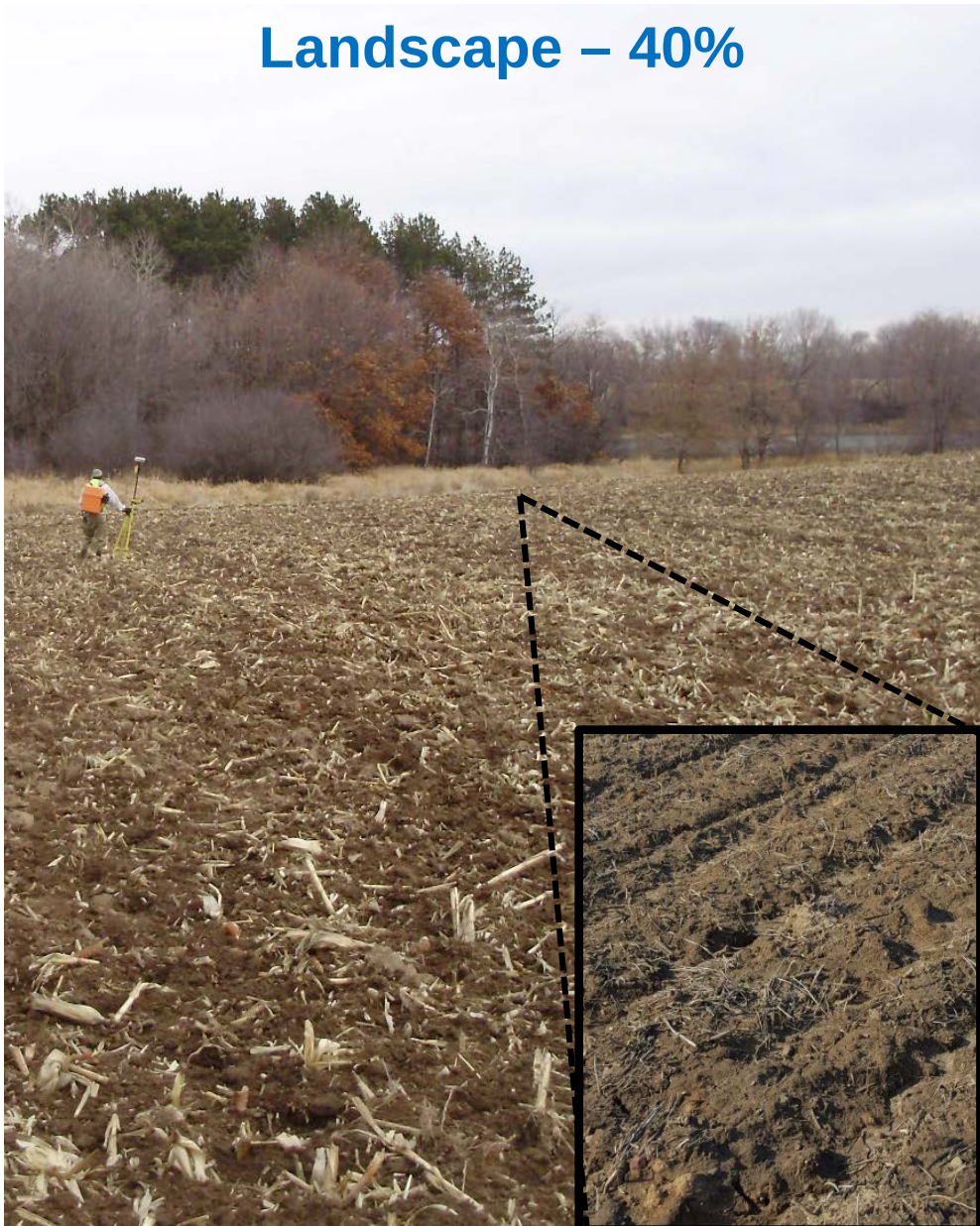

**Legend**

PTMApp
Sediment Loads- FL (Tons/Acre)
0.00 - 0.34
0.35 - 1.03
1.04 - 2.05
2.06 - 4.88
Wetlands
Landlocked Basins

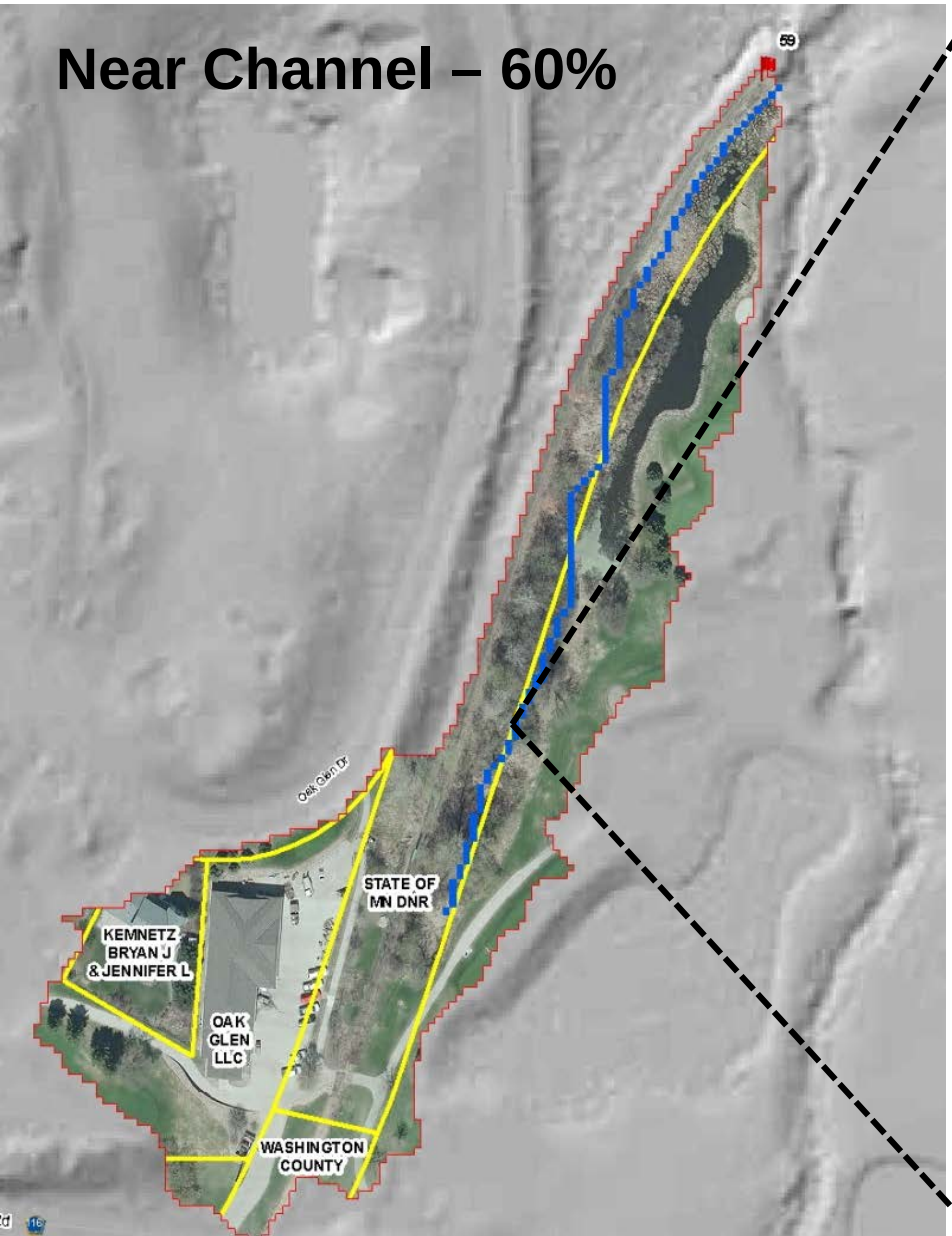
**Sediment Analysis**

Catchment Loading

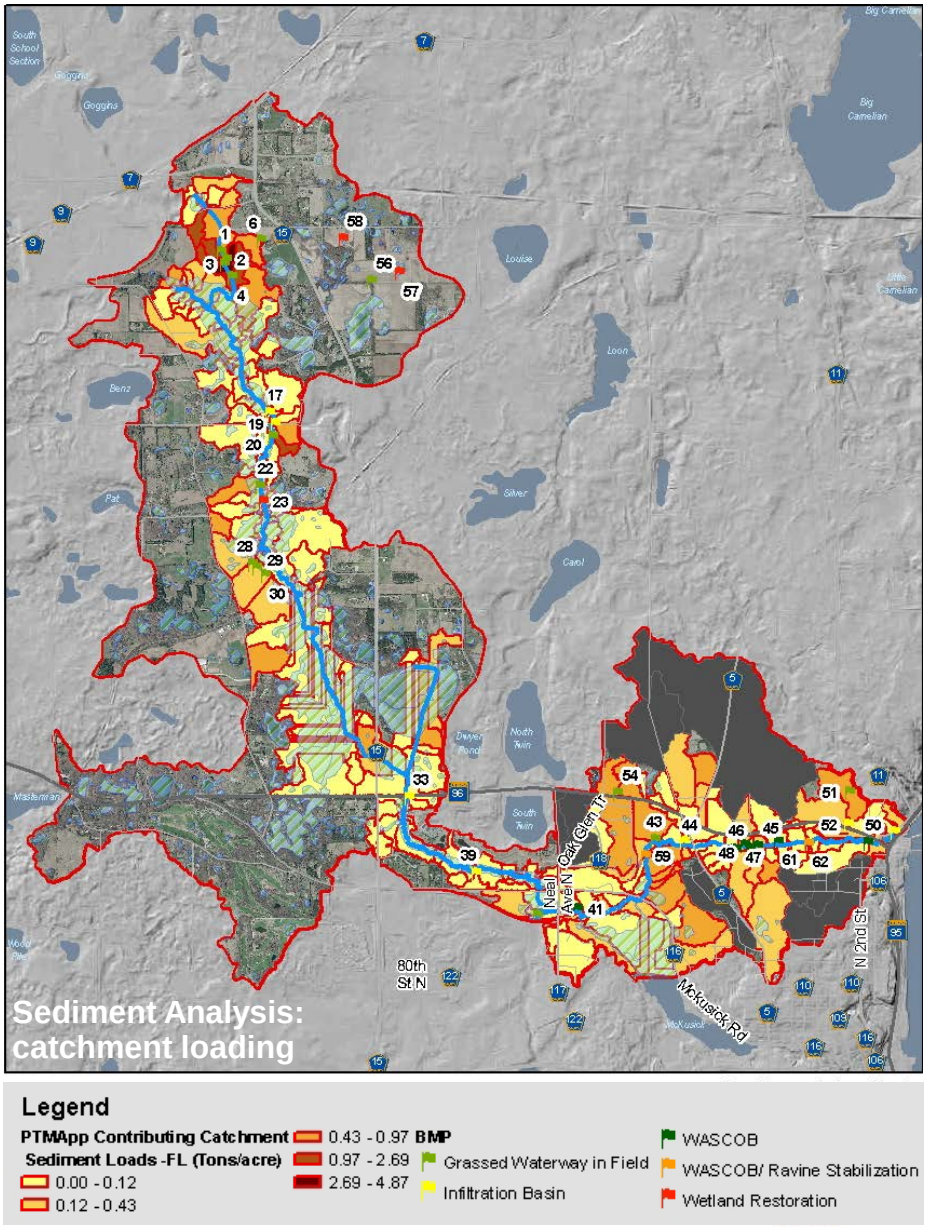
## Landscape – 40%



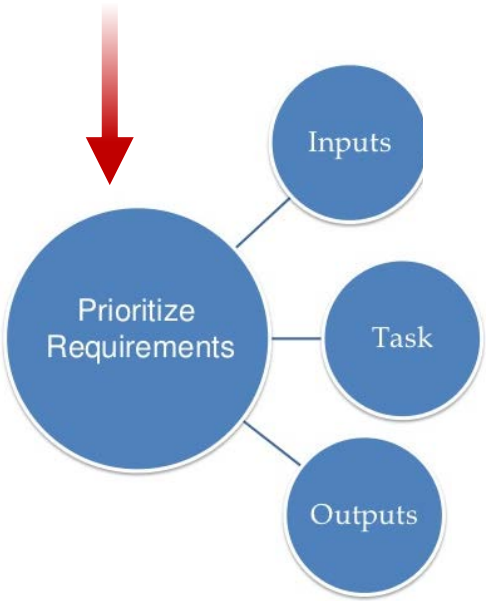
# Near Channel Loads




# Field Verification



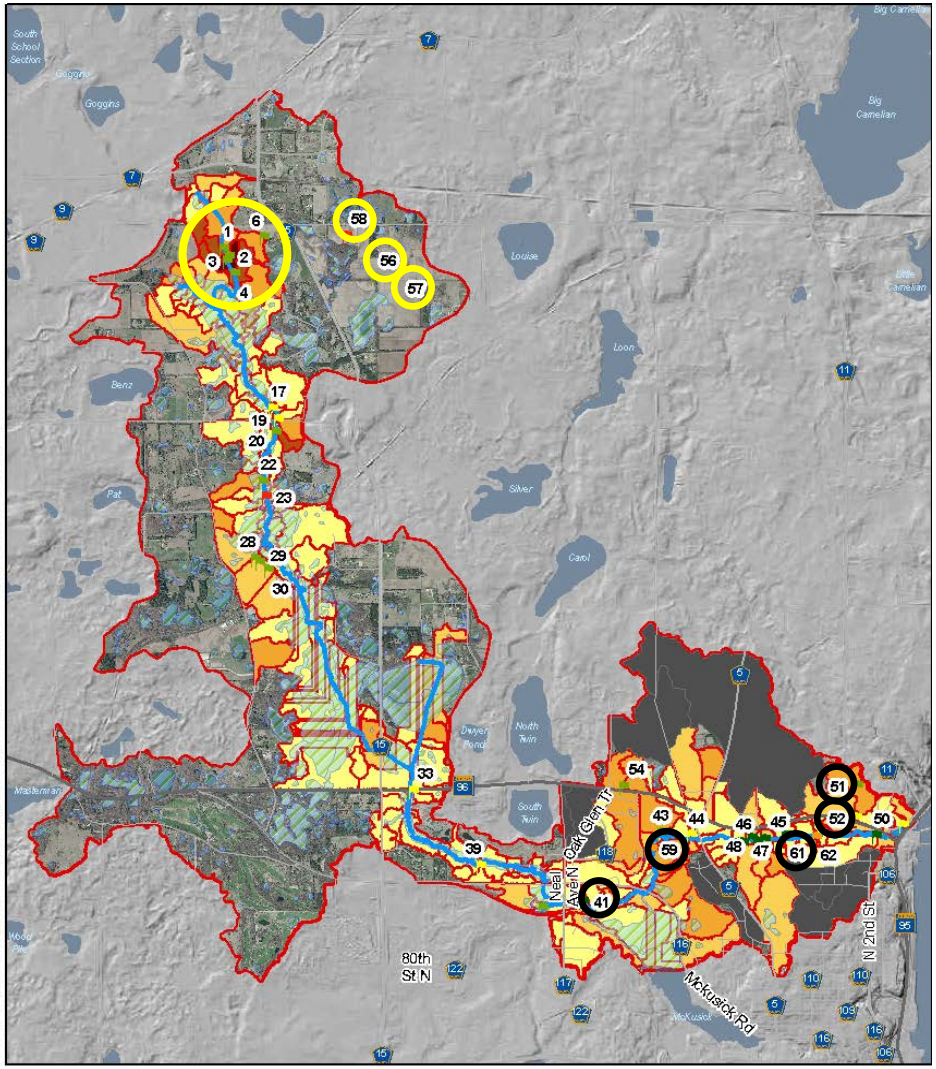

- **Active Near Channel Source**
- **Ownership**
- **Convey Landscape Load Directly to Brown's Creek**
- **Feasibility of Implementation**
- **Magnitude of Landscape Load**
- **Affected Resource**
- **Source of Erosion**
- **Potential Cost**



# BMP Prioritization

| ID | Initial Prioritization Criteria | Desktop Aerial/ LIDAR Review | Ownership | Results of Field Verification | | | PTMapp Magnitude | Source | Priority | Reason |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Active Near Channel | Hydrologic Connectivity | Implementation Accessibility | | | | |
| 59b | Moderate SPI Signature | Visible signature on aerial photograph | Public -DNR | Y | Y | Good | Moderate | Both | H | Active gully, field verified, storm water pond upstream, flashy nature from residential runoff, yard waste |
| 52 | Multiple SPI Signatures | No visible signature | Private Residential | Y | Y | Moderate-Ravine | Low | Both | H | Multiple SPI Signatures, Low landscape TSS Load, major near channel source, unstable, active. |
| 61 | Moderate SPI | No visible signature | Private Agricultural | Y | Y | Watershed only | Moderate | Both | M | Low landscape TSS Load, Direct to BC, active erosion appears to be relatively new. Implementation would be difficult. |
| 59 | Moderate SPI | Visible on LiDAR | Public -DNR | Y | Y | Good | Moderate | Both | M | Public access, downstream of golf cart washing facility |
| 51 | Converge Two Moderate SPI | No visible signature | Private Residential | N | Y | Good | Moderate | Landscape | M | Moderate landscape TSS Load, livestock present, Directly upstream of BMP 51 which is an unstable ravine |
| 41 | Moderate SPI | No visible signature | Private Residential | Y | Y | Good | Low | Both | M | Low landscape TSS Load, direct to BC, active near channel source, gully formation appears to be relatively new. |
| 17 | Moderate SPI | No visible signature | Private Residential | N | Y | Good | Low | Landscape | L | Low landscape TSS Load, grassed, Direct to BC, no erosion, well vegetated. Wetland treatment |
| 54 | Moderate SPI | No visible signature | Private Residential | N | Y | Good | Low | Landscape | L | Moderate watershed TSS Load but well vegetated, high quality uplands |

# Results




## 6 Priority Sites *Within*

**Direct Drainage to Brown's Creek**

- **5 Locations Recommended in St. Croix River Assoc. Grant Application (see black circles)**
- **2 High Priority Locations**
  - **59/59b**
  - **51/52**

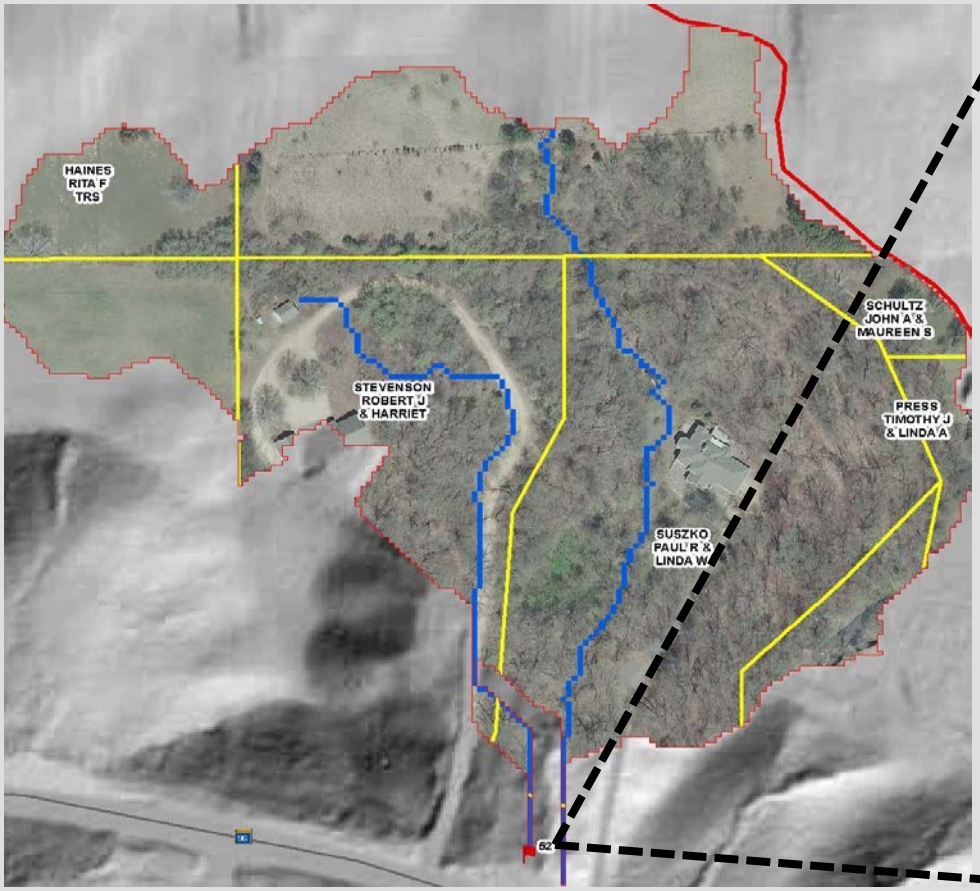
## 8 Secondary Sites *Outside*

**Direct Drainage to Brown's Creek**

# BMP Project ID: 52

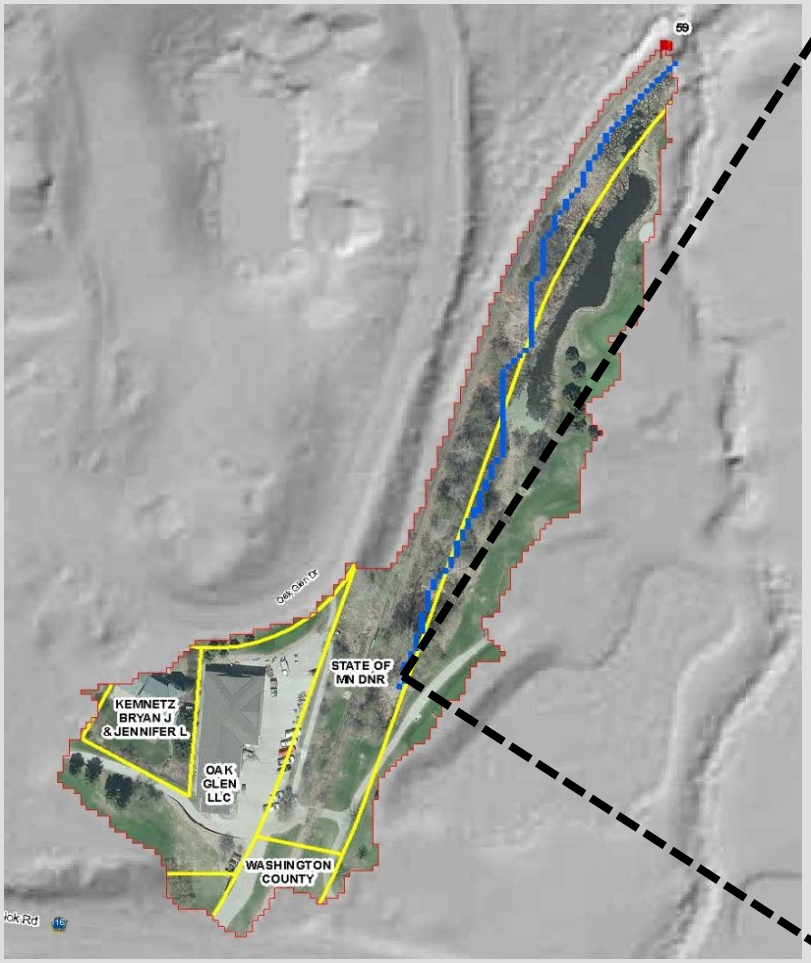
| BMPID | BMP Description | Total Load (kg/year) |
|---|---|---|
| 52 | Ravine stabilization w/ check dams | 14,716 |

- **Steep ravine immediately downstream of BMP 51.**
- **Active erosion/unstable, un-vegetated soils**
- **Bank sluffing**




# BMP Project ID: 59

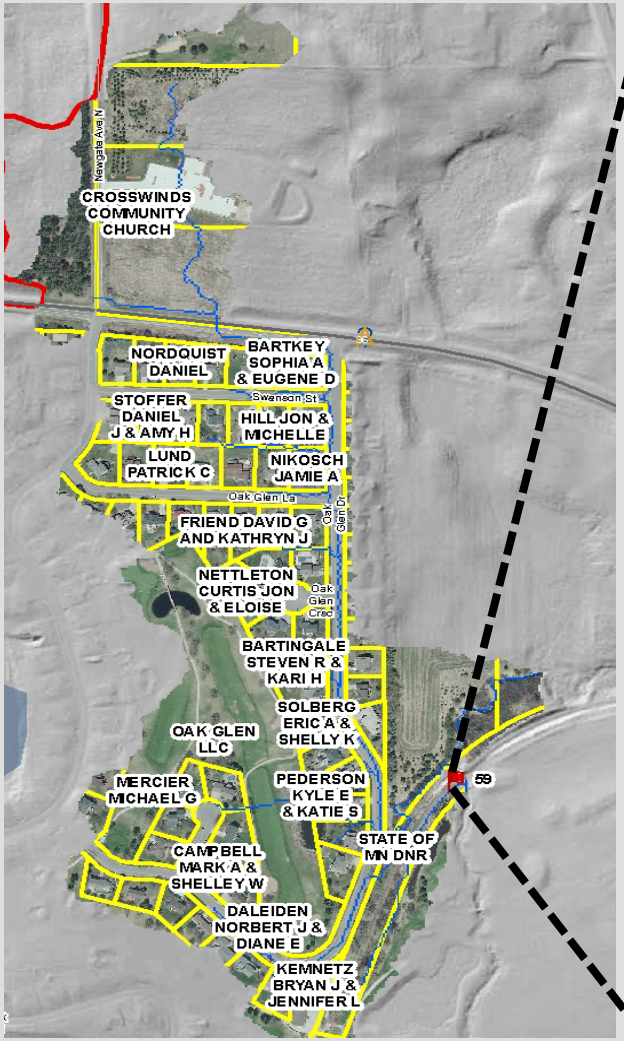
| BMPID | BMP Description | Total Load (kg/year) |
|---|---|---|
| 59 | Gully stabilization at ravine downstream of Oak Glen Golf Course cart washing facility or retention basin to capture runoff from cart washing facility. | 170.79 |





# BMP Project ID: 59B

| BMPID | BMP Description | Total Load (kg/year) |
|---|---|---|
| 59B | Ravine stabilization w/ potential SW pond upgrades | 2,563.6 |




# Take Home Messages

1.


2.

3.

| ID | Initial Prioritization Criteria | Desktop Aerial/ LIDAR Review | Ownership | | | | PTMapp Magnitude | Source | Priority | Reason |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Active Near Channel | Hydrologic Connectivity | Implementation Accessibility | | | | |
| 59b | Moderate SPI Signature | Visible signature on aerial photograph | Public -DNR | Y | Y | Good | Moderate | Both | H | Active gully, field verified, storm water pond upstream, flashy nature from residential runoff, yard waste |

# Thank you!

**Joe Pallardy & Jason Ulrich**

651.203.6035 / www.eorinc.com

# Reference Slide: DNR Travel Time

*This script creates a raster whose cells measure the length of time in seconds that it takes water to flow across it and then accumulate the time from the cell to the outlet of the watershed. Water velocity is calculated as a function of hydraulic radius, Manning's N and slope using a DEM as a source, flow direction, flow accumulation and slope (percent) is calculated. Using flow accumulation, each cell is assigned one of three flow regimes. Slopes are processed so that there are no cells with zero slopes.*

*Landcover is used to assign flow N and R values to non-channelized cells. Users can use various landcover sources but these must be matched to the N and R table that is stored in the /data folder in this distribution. The N and R table must contain one record for each of the raster values in the landcover grid and there must be the same fields in that table for the program to work. R and N values are assigned based on landcover and flow regime.*

*Hydraulic Radius is calculated using:*

*(X)a + Y where:*

*X = hydraulic radius factor 1 (User setting, 0.0032 default)*

*a = drainage area in square miles (calculated from Flow Accumulation)*

*Y = hydraulic radius factor 2 (User setting, 1.7255 default)*

*Velocity is calculated as:*

*vel(feet/second) = (1.49 * Hydraulic Radius^0.667 * slope^0.5) / Mannings N*

# Reference Slide: Sediment yield

Once the sediment yield leaving the landscape is estimated for a cell, the sediment reaching a channel or flowline within a catchment is estimated using a sediment delivery ratio. The estimated sediment delivery ratio (SDR) for the catchment is a function of area (see Handbook of Hydrology, DATE).

$$\text{Overland SDR} = 0.41 * \text{catchment drainage area (sq. km)}^{-0.3}$$

The SDR for each cell within a catchment raster is estimated as a function of the catchment SDR adjusted by the distance from a cell to the flowline.

$$\text{Overland SDR Adjustment Factor} = 1 - \frac{\dfrac{Flow\ Length}{Maximum\ Flow\ Length\ in\ Catchment}}{0.75 + \dfrac{Flow\ Length}{Maximum\ Flow\ Length\ in\ Catchment}}$$

Therefore, the SDR for each cell is computed as Overland SDR (for the catchment) * Overland SDR Adjustment Factor (for the cell).

# Reference Slide: Sediment yield

The sediment transported downstream from each cell to the subwatershed and watershed pour points is further reduced using a first-order transport function.

In-channel downstream transport and loss follows a simple exponential decay function (i.e., first order loss) using travel time and median diameter of sediment (Williams 1977):

$$SY = Ye^{-\beta T\sqrt{d_{50}}}$$

Where Y is sediment yield from sub-basin, β is transport coefficient, T is travel time, $d_{50}$ is mean sediment diameter. The channel routing will occur between pour points. The user can insert known transport coefficients and median sediment diameters if available. Default values of 0.2 and 0.1 are used for β and the $d_{50,}$ respectively.

Essentially, four products are produced for each cell in the raster: 1) sediment yield leaving the landscape; 2) sediment yield reaching the catchment pour point; 3) sediment yield delivered to a user defined downstream subwatershed pour point; and 4) sediment yield reaching the watershed pour point. Mass reaching the watershed pour point can be adjusted using the calibration factor to achieve the interquartile range yield (e.g., assuming 50% washload and 50% in channel process) for the ecoregion as computed by Klemitz and Simon (2009).

# Reference Slide: Nutrient yield

## Nutrients (Total Phosphorus and Total Nitrogen)

*Annual Yield*

Nutrient annual yields leaving the landscape are estimated using a method similar to sediment (i.e., they are computed for each cell in the raster). However different methods are used to compute yield leaving the landscape and reaching the catchment pour point. TP and TN annual yields are estimated using the values in Table 2 and Table 3 applied to each National Land Cover Dataset (NLCD) land use class.

**Table 2: Total Phosphorus Loading Lookup Table for NLCD Land Use Classification**

| NLCD # | Description | TP Loading [kg/ha/yr] | Source |
|---|---|---|---|
| 11 | Open Water | 0 | |
| 21 | Developed, Open Space | 1 | |
| 22 | Developed, Low Intensity | 0.91 | LimnoTech 2007 |
| 23 | Developed, Medium Intensity | 1.15 | LimnoTech 2007 |
| 24 | Developed, High Intensity | 1.5 | LimnoTech 2007 |
| 31 | Barren Land | 1.35 | |
| 41 | Deciduous Forest | 0.075 | LimnoTech 2007 |
| 42 | Evergreen Forest | 0.075 | LimnoTech 2007 |
| 43 | Mixed Forest | 0.075 | LimnoTech 2007 |
| 52 | Shrub/Scrub | 0.075 | LimnoTech 2007 |
| 71 | Grassland/Herbaceous | 0.17 | LimnoTech 2007 |
| 81 | Pasture/Hay | 0.17 | LimnoTech 2007 |
| 82 | Cultivated Crops | 0.38 | LimnoTech 2007 |
| 90 | Woody Wetlands | 0 | LimnoTech 2007 |
| 95 | Emergent Herbaceous Wetlands | 0 | LimnoTech 2007 |

# Reference Slide: Nutrient yield

The nutrient mass loss from the location of the cell to the flow line and as transported downstream is represented using a first order loss equation, as a function of travel time:

$$W = \exp(-kT)$$

where *W* is the portion of the yield leaving the landscape and delivered to the catchment pour point, *k* is the decay rate and *T* is travel time from one location to the next (e.g., cell to a catchment pour point). The default values for k are 0.1 for travel to the flowline and 0.4 for in-channel transport. The delivery raster ($W_{raster}$) is created using the travel time raster[2] to determine the portion of the mass leaving the landscape which reaches the catchment pour point. The portion of mass reaching downstream pour points is also computed using the above equation.

Default values are used when creating the nutrient yield (**Tables 1 and 2**) and when applying the decay functions to delivery rasters. However, the users can modify these including the data shown in **Table 1** and **Table 2**, when creating the products.

**Post-Processing of the Data**

A variety of products can be developed using the enhanced geographic information system water quality data products. For example, the cell values comprising a raster for a catchment or subwatershed can be summed, providing total yields at the catchment or subwatershed pour points. The yield data can be

# Grid-Cell SWAT Modeling Breaks New Ground on Isolating Pollutant Source Areas and Quantifying BMP Benefits

Minnesota Water Resources Conference

Greg Wilson and Evan Christianson,
Barr Engineering

October 19, 2016

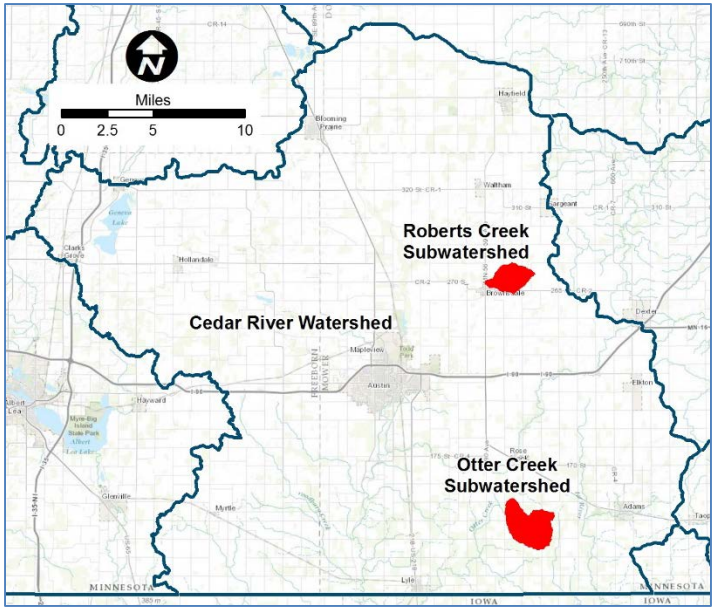
CRWD
CEDAR RIVER WATERSHED DISTRICT
REVIVING OUR RIVER

# Project overview

- Watershed-scale models normally lump input parameters
  - Landscape interactions unaccounted for
  - Response unit loads individually routed
  - Non-specific relationship to stream network or conveyances
- Planning tools/terrain analysis can target sites, but don’t explicitly simulate pollutant fate/transport or account for BMPs in series

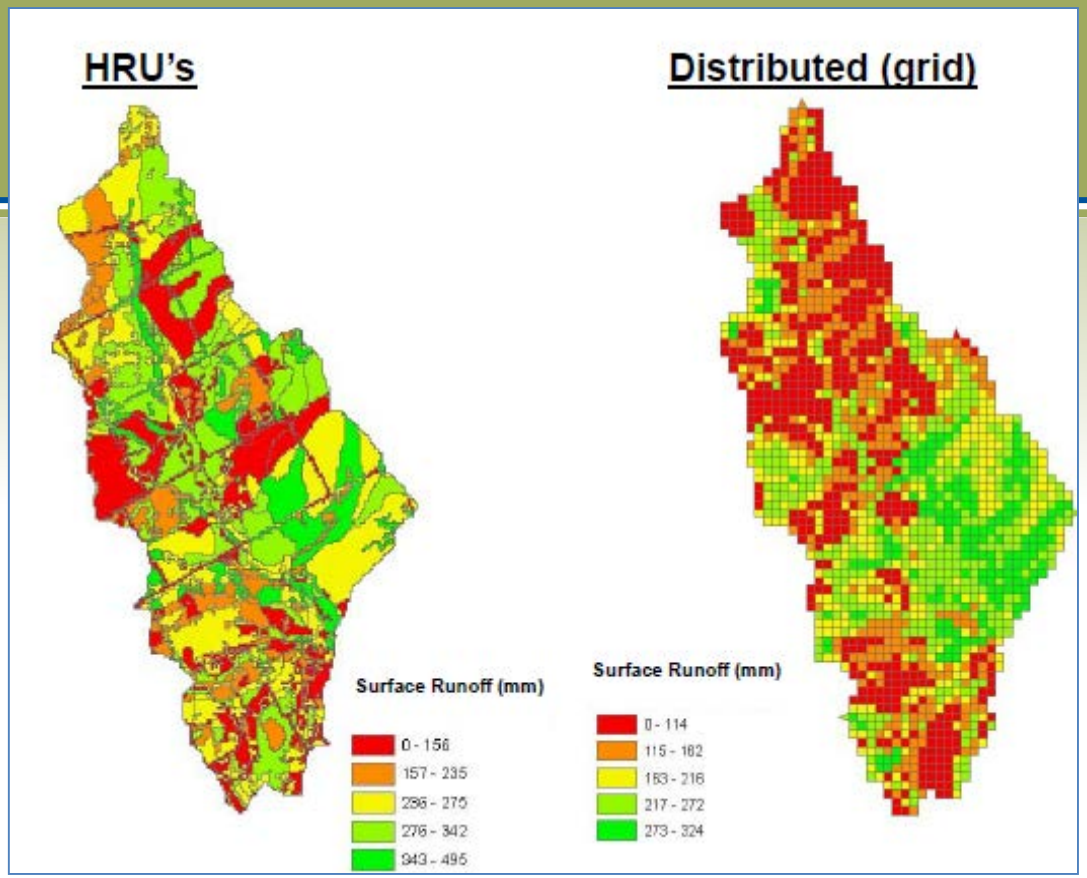
# Project goals

- Produce feasible modeling scenarios
  - Small-scale GIS output for discussions with farming community
- Account for
  - Current crops/rotations
  - Tillage and residue
  - Fertilization
  - Conservation drainage
  - Grassed waterways/filter strips
  - Wetland restoration

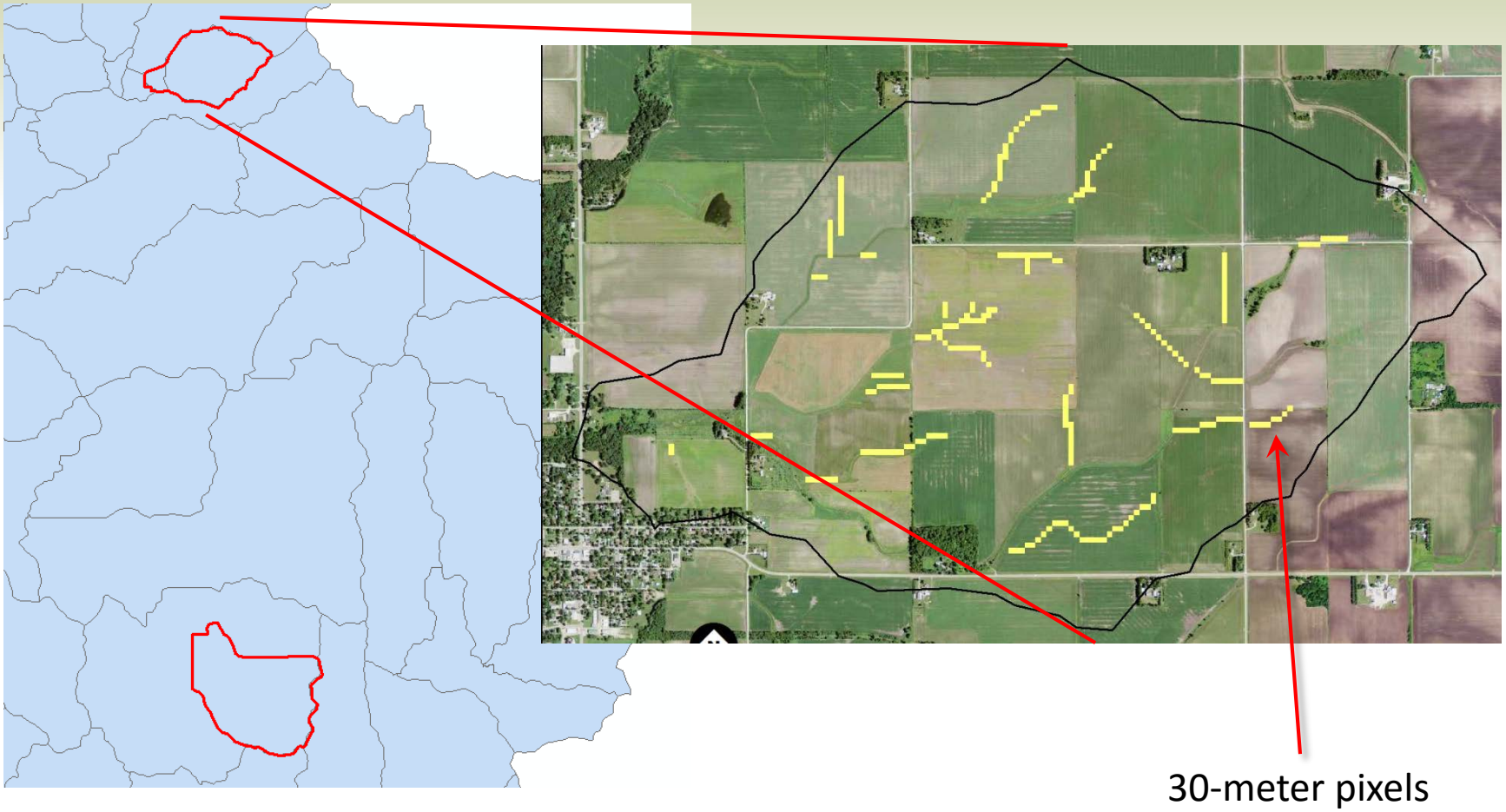


# SWAT Model

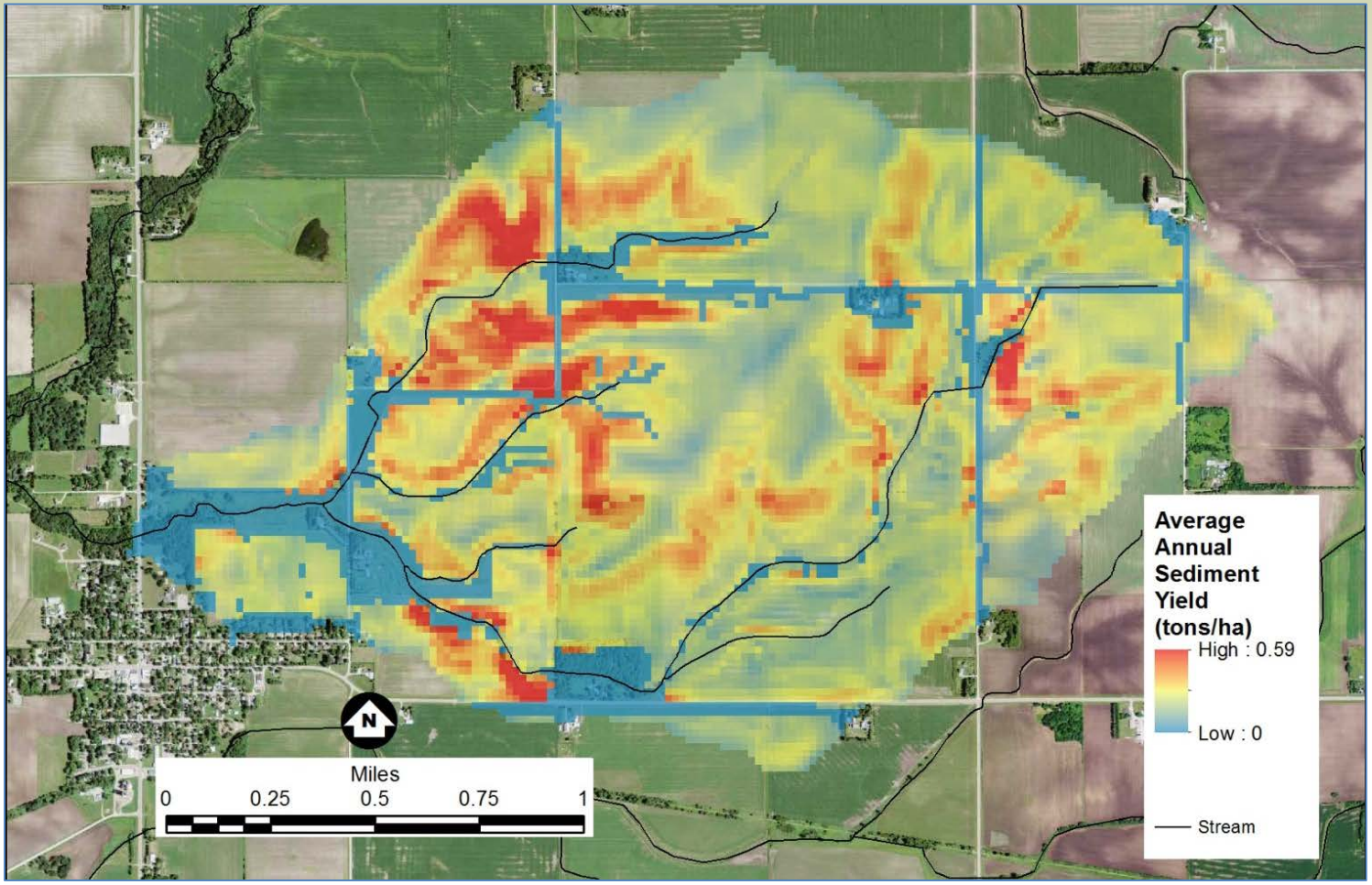
- Continuous, distributed water quality simulation model—predicts effects of land management changes and BMPs
- Physically-based



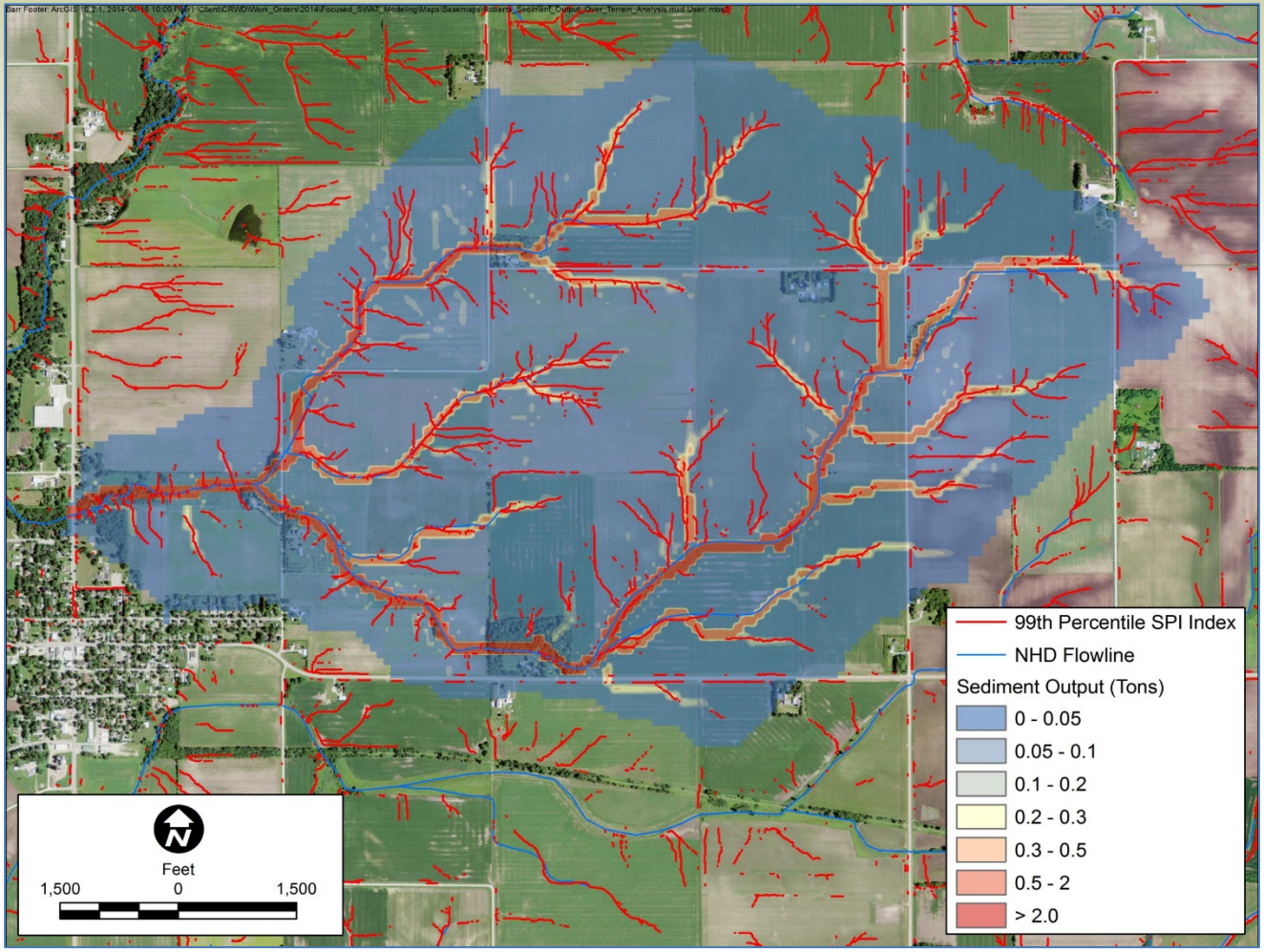
# Modeling scales



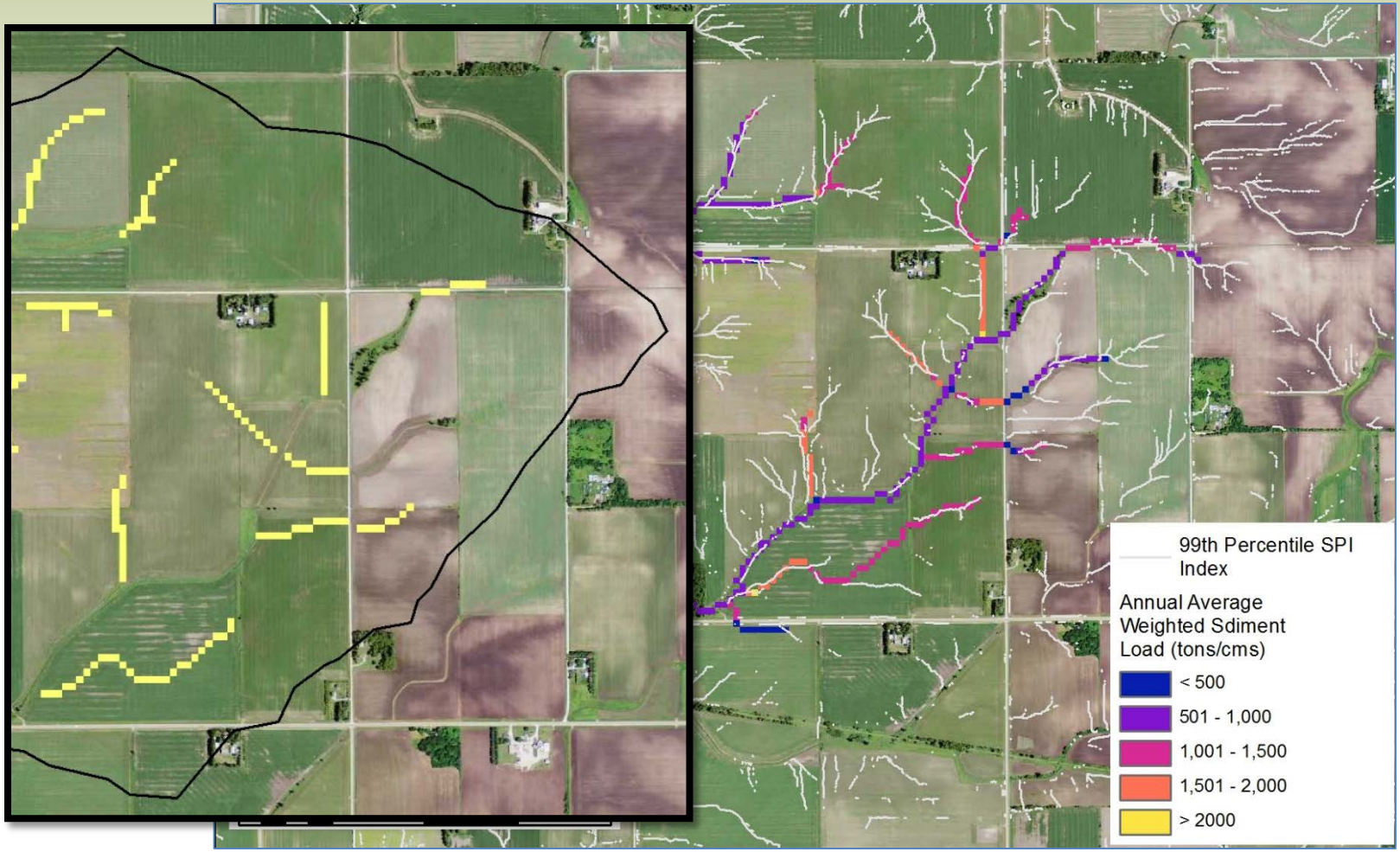
# Sediment yield



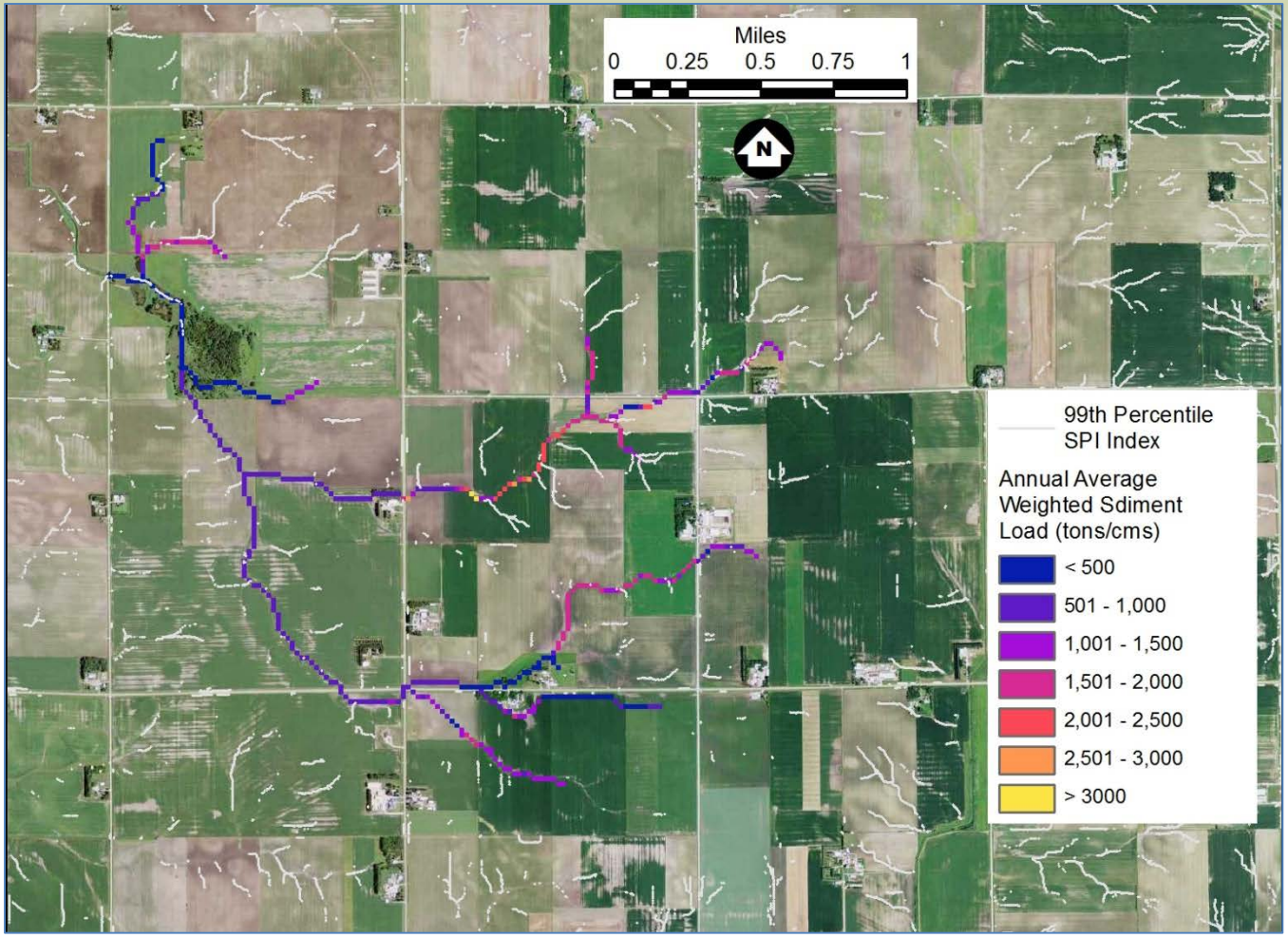
# Sediment transport



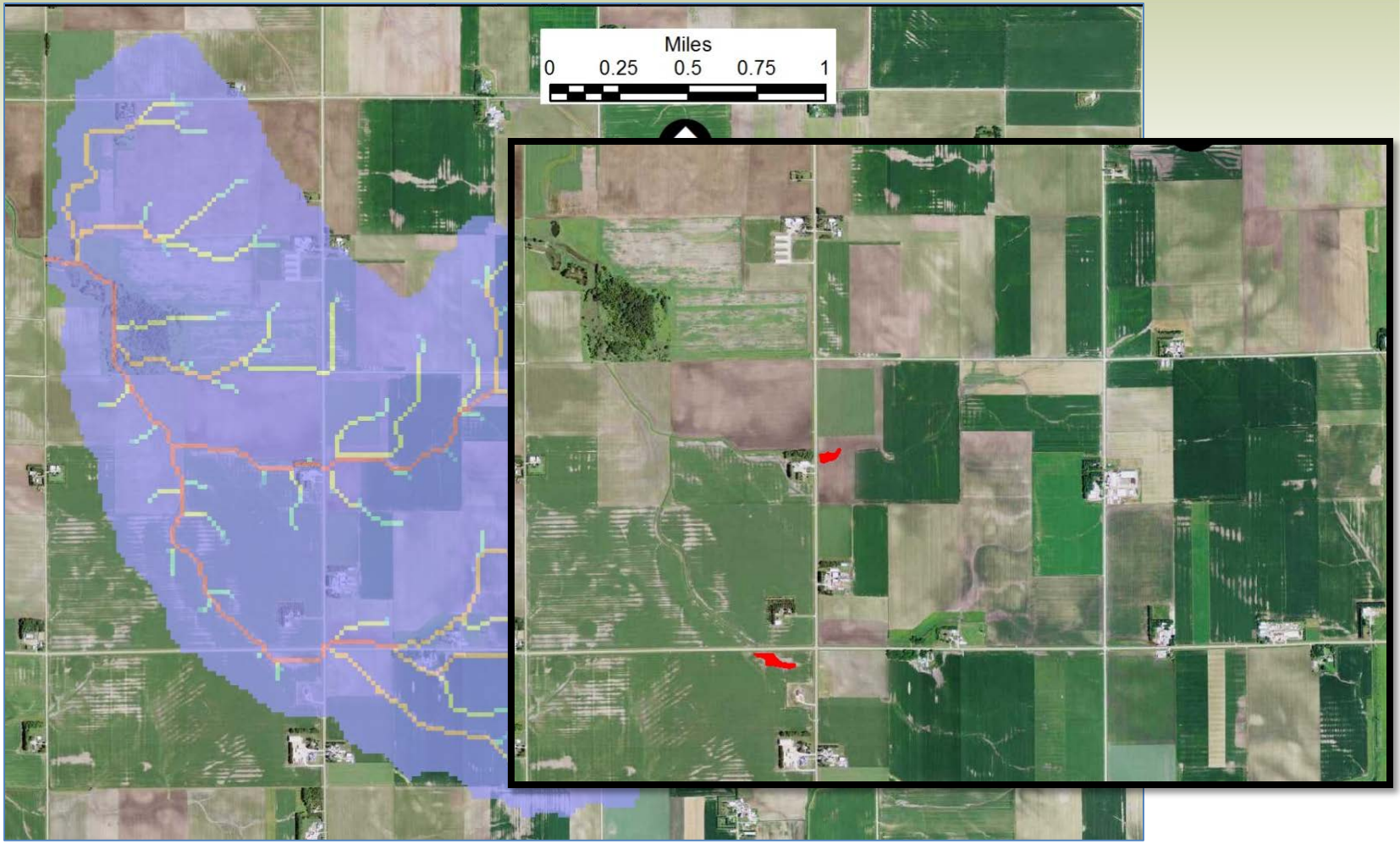
# Sediment flow-weighted mean concentration



# Otter Creek sediment concentration



# Otter Creek nitrate



# Model Results

- Sediment loads significantly reduced by
  - Conservation tillage, drainage water management and strategic application of grassed waterways/filter strips
- Phosphorus reductions from conservation tillage
- Nitrate loads significantly reduced by
  - Drainage water management, agronomic fertilization rates and strategic application of wetland restoration

# Overall conclusions and recommendations

- Model performed well for what was intended
- Future efforts could
  - Define critical timeframes
  - Evaluate how multiple conservation practices can be combined to optimize water quality benefits for all pollutants
  - Better account for volume loss from DWM

# Questions??

gwilson@barr.com
952-832-2672

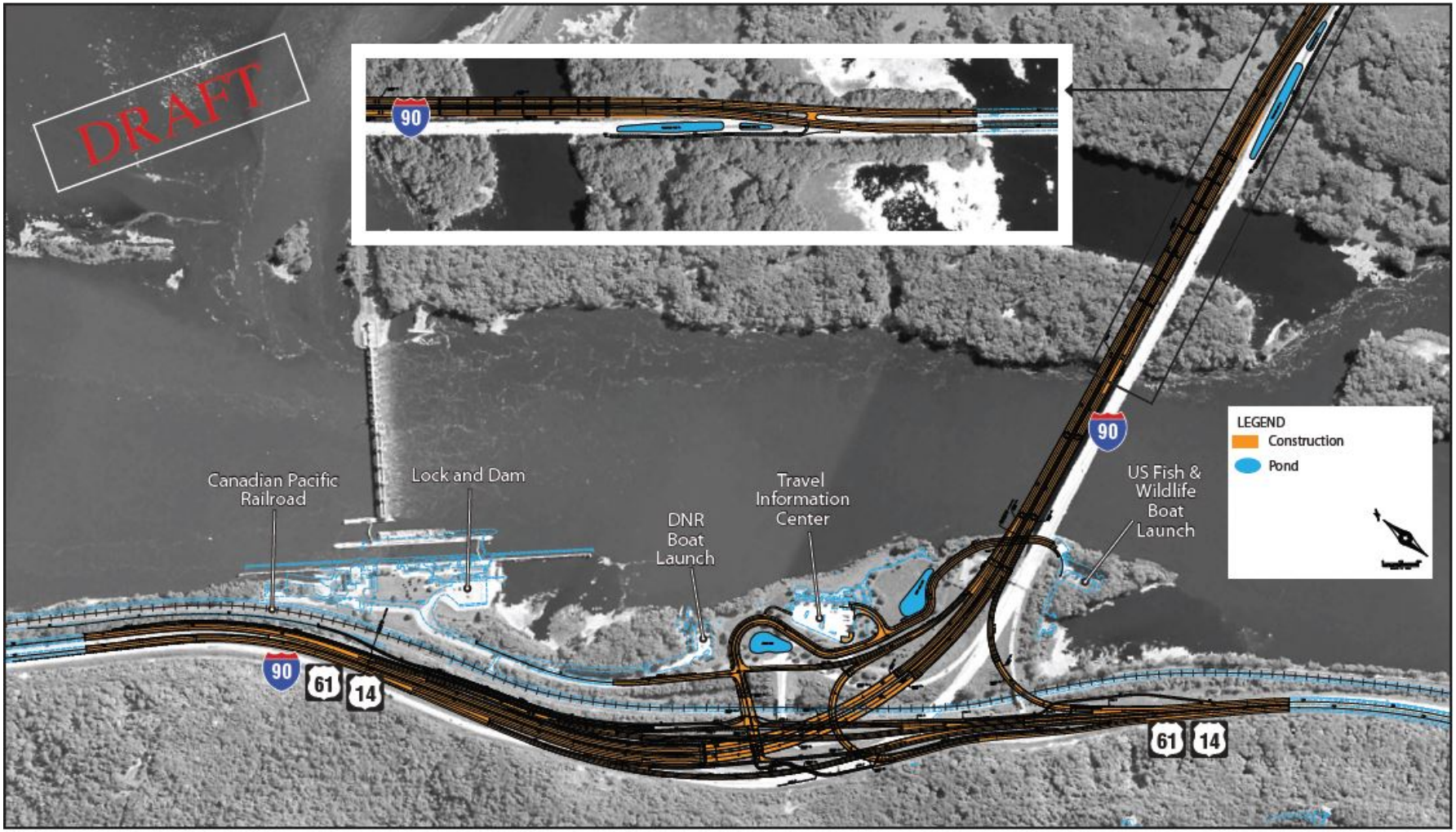
# Mitigating Bridge Scour

## Case Study from the I-90 River Bridge and Interchange Reconstruction

Nicole Bartelt and Petra DeWall, MnDOT
Lisa Goddard, SRF

We all have a stake in A B

# Project Overview




Credit: Project Website

DRESBACH INTERCHANGE
2012 – 2016

# Project Need

- Aging bridge with worsening structural deficiencies
  - Fracture critical design
- Narrow shoulders
  - Stalled vehicles caused lane closures
- Adjacent I-90 / US 61 interchange with geometric deficiencies
  - Locations with higher than average accident rates

# Project issues

- Wide floodplain
- Limestone bedrock overlain with
  - Topsoil and granular soils of varying thickness
  - Coarse alluvium
- West approach = very dramatic elevation change in narrow corridor
  - Resulted in very tall walls and terraced walls
  - Global stability analysis

# Birds Eye View

# Constructing in a floodplain

Photo Credit: Dustin Thomas

# Scour numbers

- Over 40-ft of scour computed at Pier 1
  - 43-ft for the 100-yr
  - 45-ft for the 500-yr
- Width of scour hole = 2 * Scour Depth
- Piers are designed to be stable for the computed scour

# Scour Issues

- Pier 1 close to west river bank, toe of the abutment slope
- Scour from Pier 1 potentially undermines the retaining walls and west abutment slope
- Velocity and depth of river makes placement of filter and riprap difficult

# West Abutment

Credit: Project Website

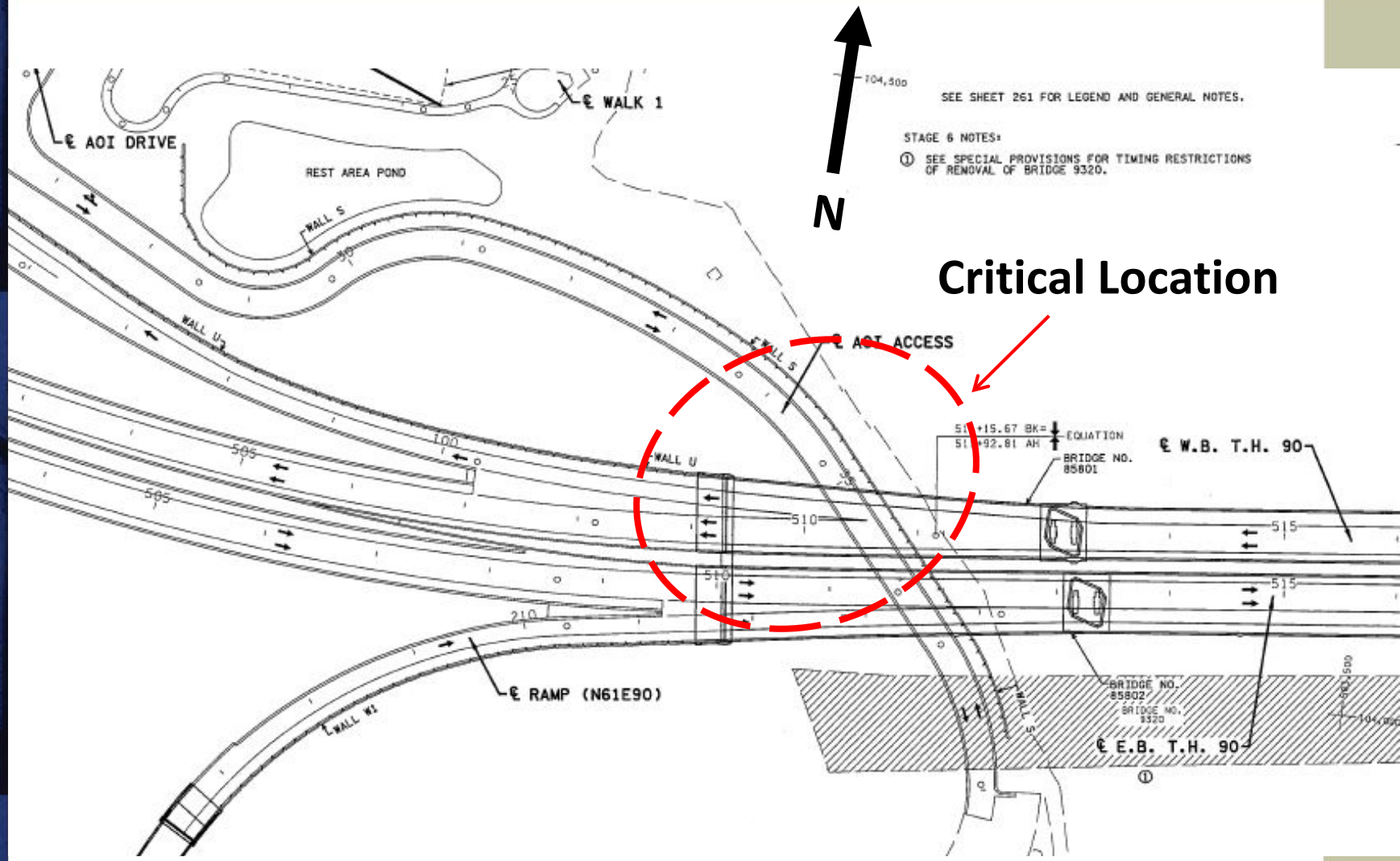
# Pier 1 proximity to West Bank


Photo Credit: Dustin Thomas

# Toe of West Bank

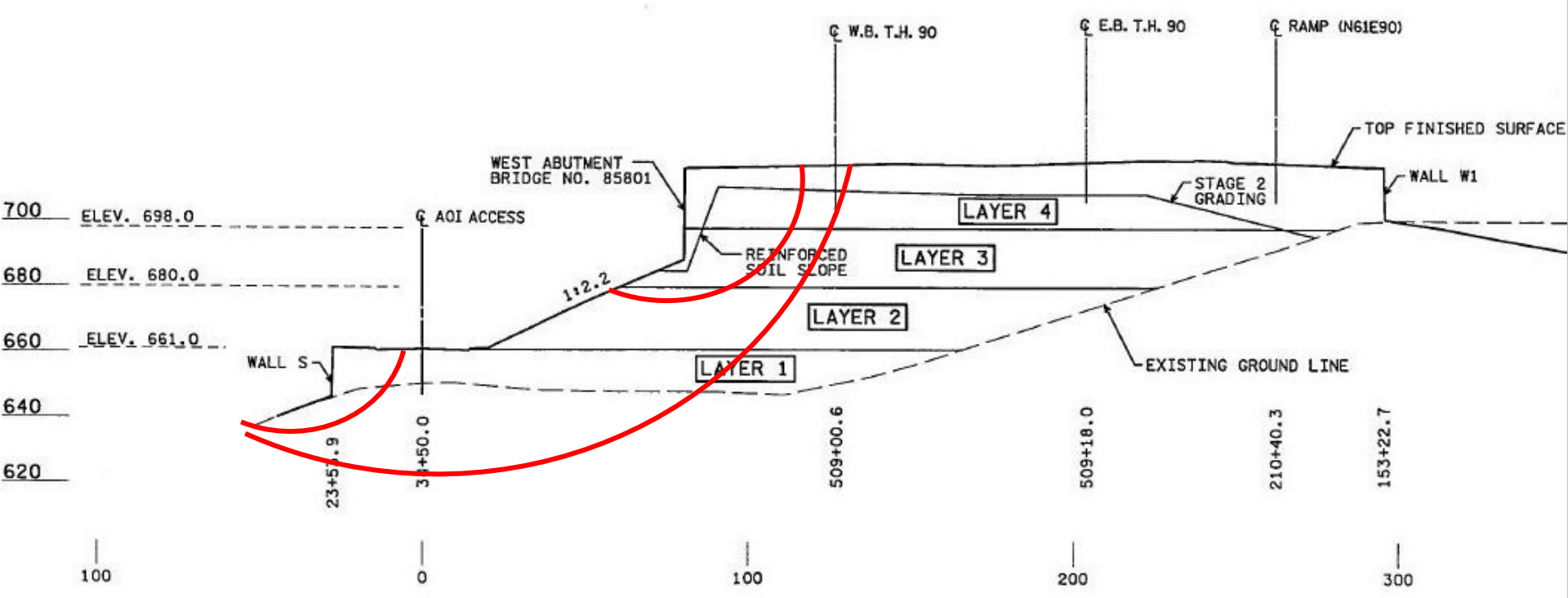
Photo Credit: Dustin Thomas

# West Abutment Stability



# West Abutment Stability

## Example Failure Surfaces

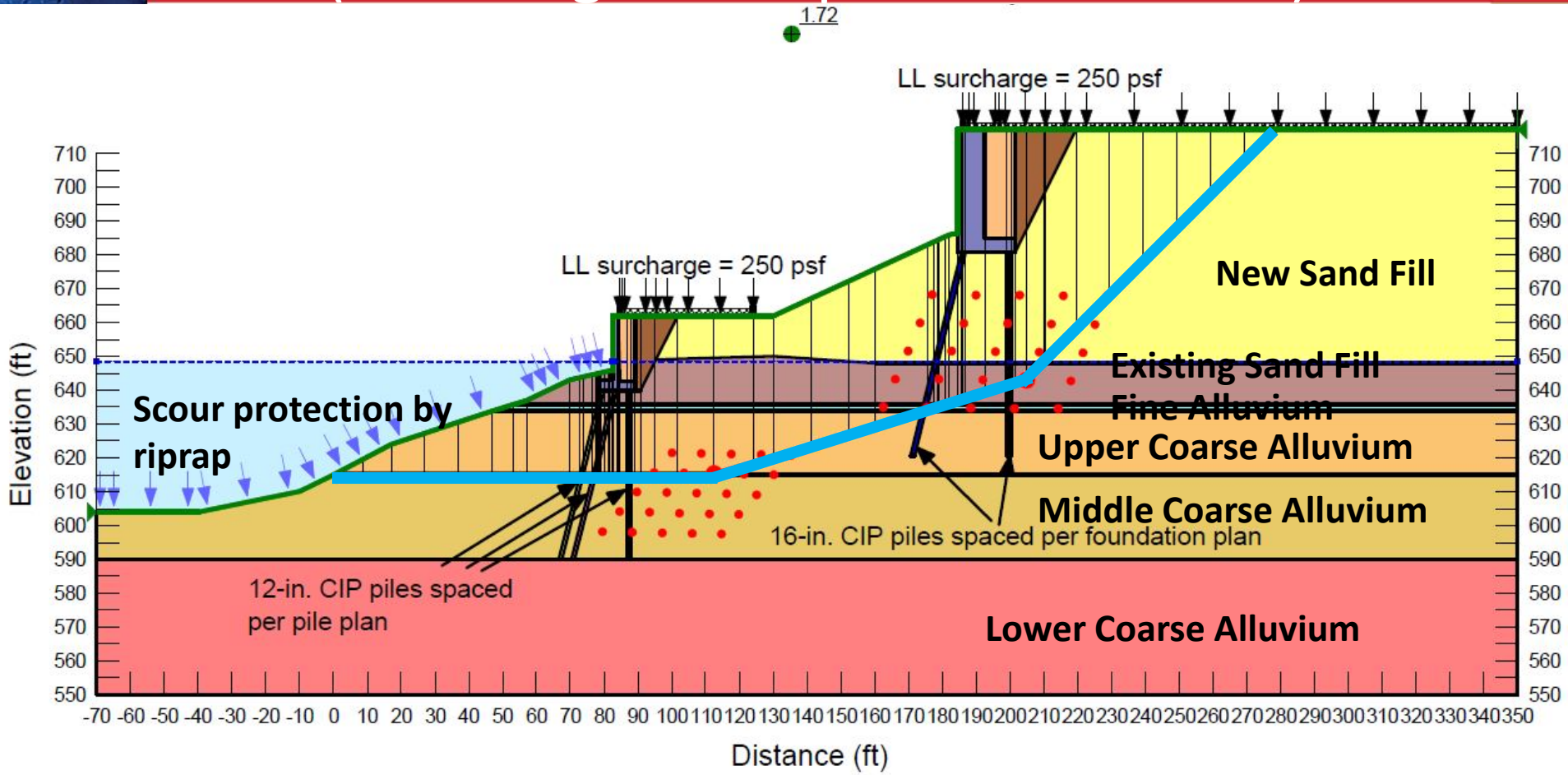



## Could we neglect the piles?

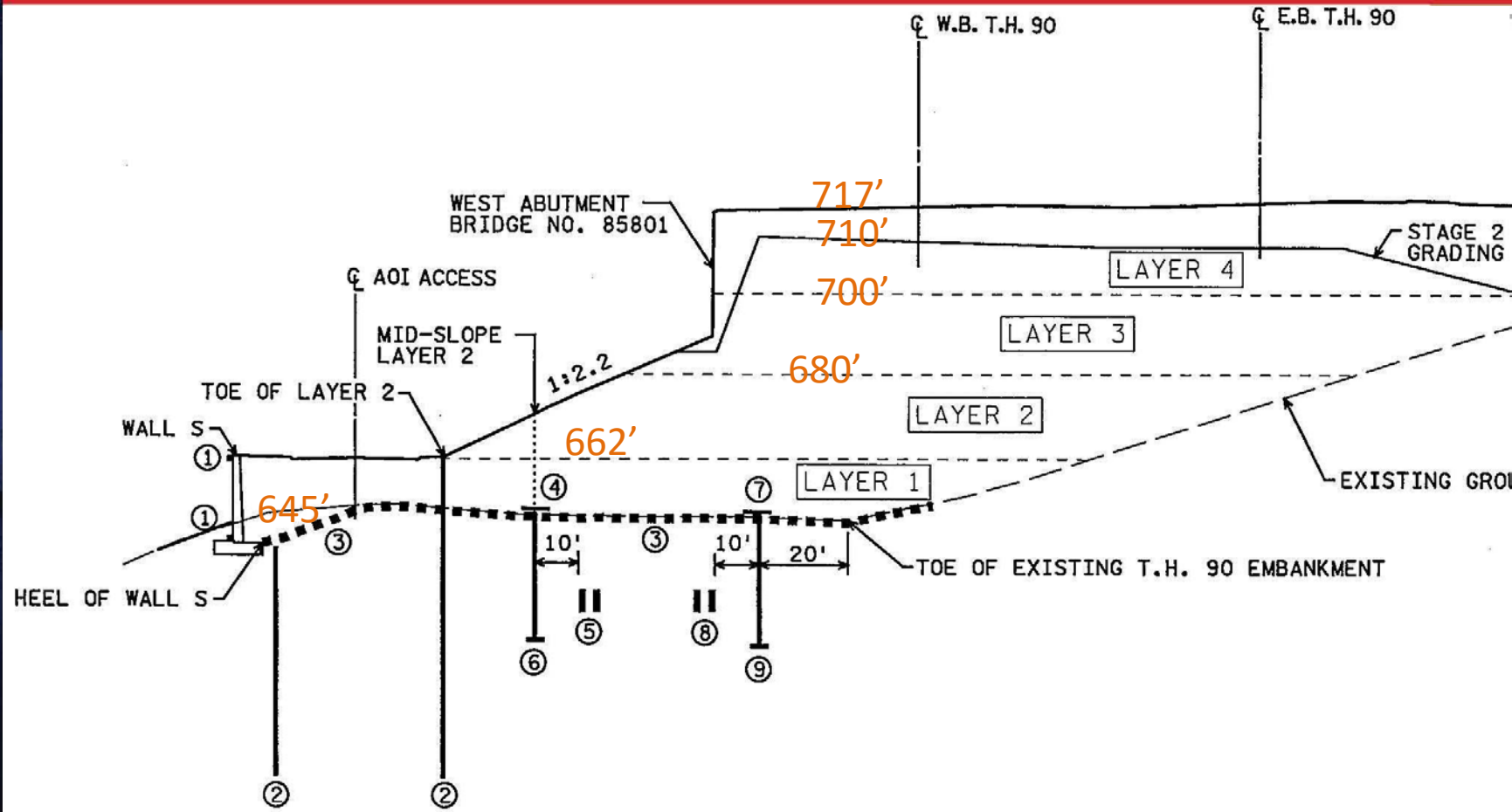
# West Abutment Stability

- Embankment/walls were <u>not stable</u> on their own for each and every case (e.g. floods, scour)
- Our analyses showed West Abutment was stable (FS>1.2) if piles were neglected, but it was not found to be stable enough (needed FS>1.5); hence <u>could not neglect piles in analysis</u>

# Example 3-Part Wedge SLOPE/W Analysis (including lateral pile contribution)



# Final Design – staging & instrumentation



# West embankment construction

Photo Credit: Dustin Thomas

# Solution

- Protect Pier 1 so scour doesn't happen
  - Geobags
  - Riprap layer
  - Scour monitoring

# Geobags

Photo Credit: Solomon Woldeamlak

# Filling


Photo Credit: Solomon Woldeamlak

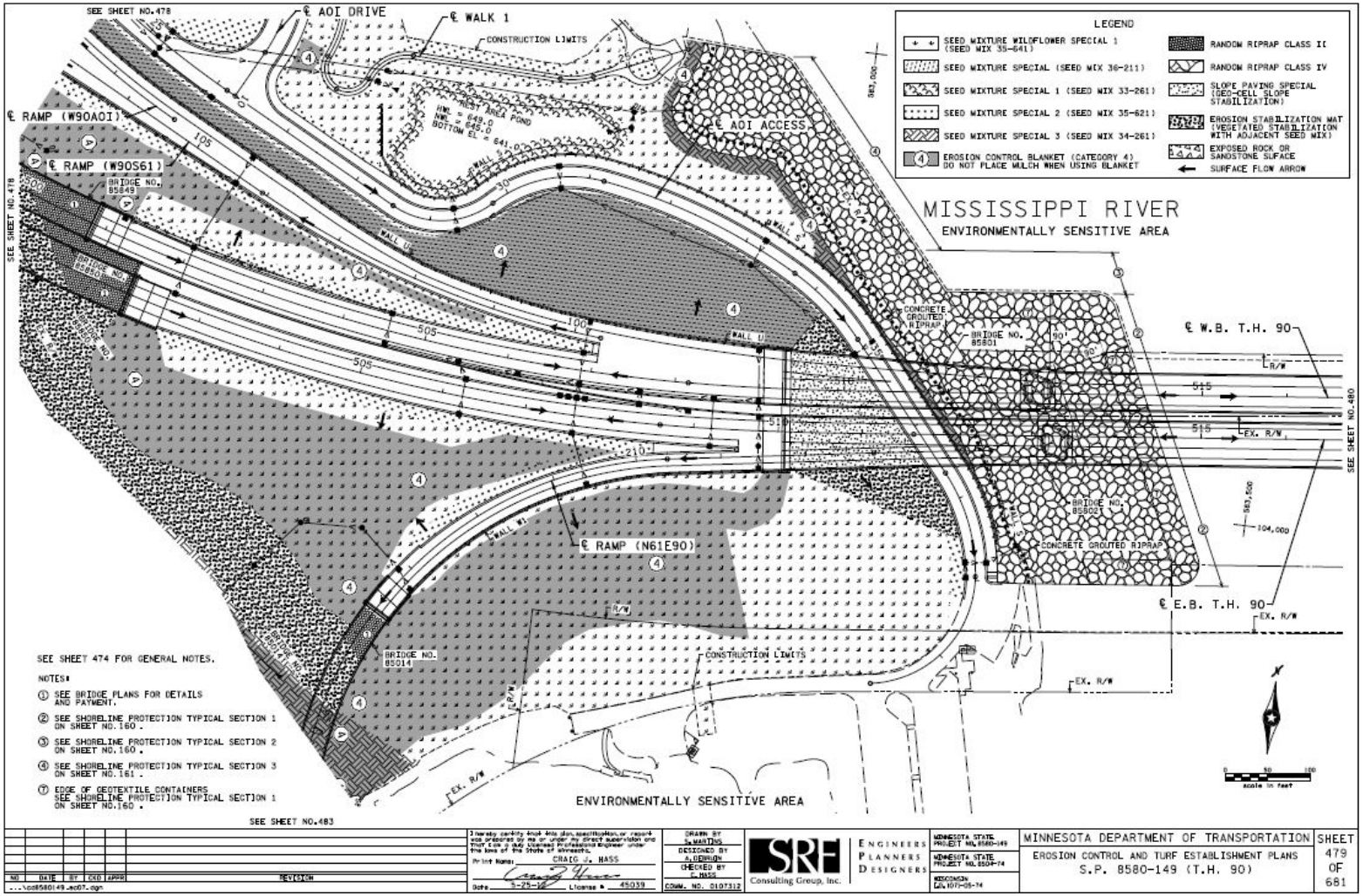
# Stitching

Photo Credit: Solomon Woldeamlak

# Placing

- 3_Geobag placement.mp4

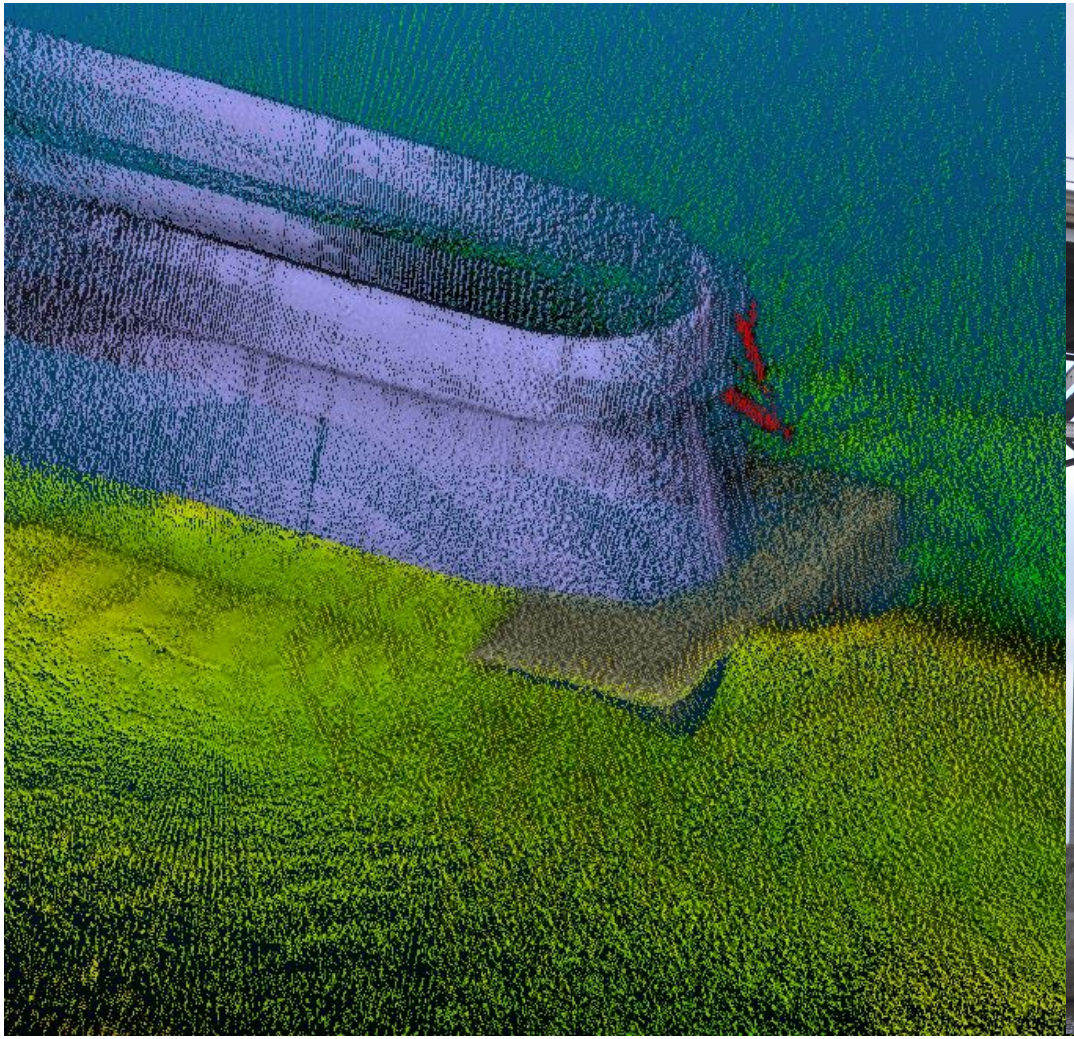
# Riprap


SEE SHEET NO.478
℄ AOI DRIVE
℄ WALK 1
CONSTRUCTION LIMITS
℄ RAMP (W90AOI)
℄ RAMP (W90S61)
BRIDGE NO. 85849
℄ AOI ACCESS
LEGEND
SEED MIXTURE WILDFLOWER SPECIAL 1 (SEED MIX 35-641)
SEED MIXTURE SPECIAL (SEED MIX 36-211)
SEED MIXTURE SPECIAL 1 (SEED MIX 33-261)
SEED MIXTURE SPECIAL 2 (SEED MIX 35-621)
SEED MIXTURE SPECIAL 3 (SEED MIX 34-261)
EROSION CONTROL BLANKET (CATEGORY 4) DO NOT PLACE MULCH WHEN USING BLANKET
RANDOM RIPRAP CLASS II
RANDOM RIPRAP CLASS IV
SLOPE PAVING SPECIAL (GEO-CELL SLOPE STABILIZATION)
EROSION STABILIZATION MAT (VEGETATED STABILIZATION WITH ADJACENT SEED MIX)
EXPOSED ROCK OR SANDSTONE SURFACE
SURFACE FLOW ARROW
MISSISSIPPI RIVER
ENVIRONMENTALLY SENSITIVE AREA
CONCRETE GROUTED RIPRAP
BRIDGE NO. 85801
℄ W.B. T.H. 90
℄ E.B. T.H. 90
EX. R/W
BRIDGE NO. 85802
CONCRETE GROUTED RIPRAP
℄ RAMP (N61E90)
BRIDGE NO. 85014
CONSTRUCTION LIMITS
ENVIRONMENTALLY SENSITIVE AREA
SEE SHEET NO.480
SEE SHEET 474 FOR GENERAL NOTES.
NOTES:
① SEE BRIDGE PLANS FOR DETAILS AND PAYMENT.
② SEE SHORELINE PROTECTION TYPICAL SECTION 1 ON SHEET NO.160 .
③ SEE SHORELINE PROTECTION TYPICAL SECTION 2 ON SHEET NO.160 .
④ SEE SHORELINE PROTECTION TYPICAL SECTION 3 ON SHEET NO.161 .
⑦ EDGE OF GEOTEXTILE CONTAINERS SEE SHORELINE PROTECTION TYPICAL SECTION 1 ON SHEET NO.160 .
SEE SHEET NO.483
SRF Consulting Group, Inc.
ENGINEERS PLANNERS DESIGNERS
MINNESOTA DEPARTMENT OF TRANSPORTATION
EROSION CONTROL AND TURF ESTABLISHMENT PLANS
S.P. 8580-149 (T.H. 90)
SHEET 479 OF 681

# Scour monitoring

- Fixed-Sonar
- Tilt meters (during construction)
- Float-outs

# Fixed Sonar



# Tilt meters

Photo Credit: Dustin Thomas

Photo Credit: Dustin Thomas

# Float-outs

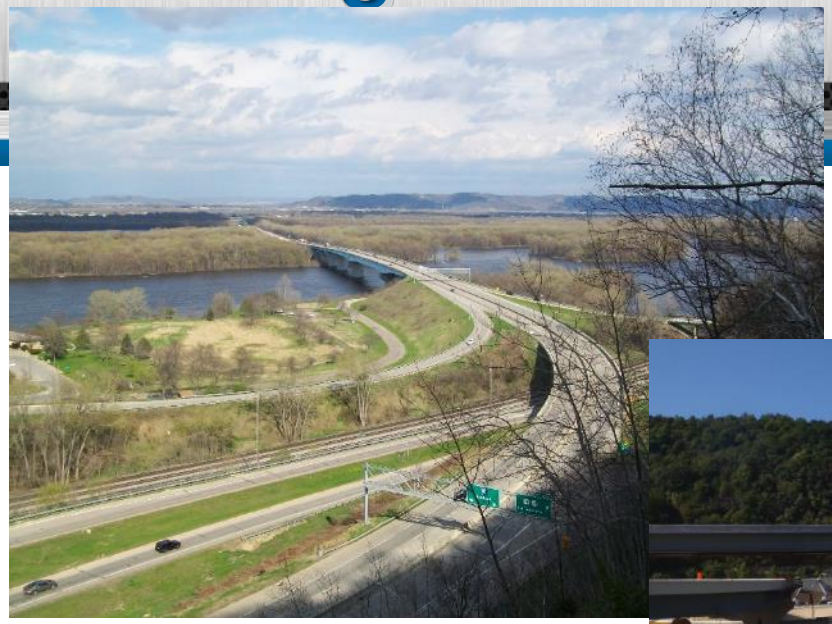
# Size

# Float-out placement

# Project Completion

Credit: Project Website

# Drainage Dilemmas in Bluff Country



## Case Studies from the I-90 River Bridge and Interchange Reconstruction

Jeremy Nielsen, P.E.
October 19, 2016

# Project Background

# Project Participants

- Owners
  - MnDOT
  - WisDOT
- Stakeholders
  - FHWA
  - US FWS
  - MnDNR
  - WisDNR
  - Mn Office of Tourism
  - USACE
  - US Coast Guard
  - FAA
  - BWSR
  - MPCA
  - Cities of LaCrosse, Onalaska and La Crescent
  - Counties of Houston, Winona and LaCrosse
  - LAPC
  - LaCrosse Area Chamber of Commerce
  - LaCrosse Area Convention and Visitors Bureau

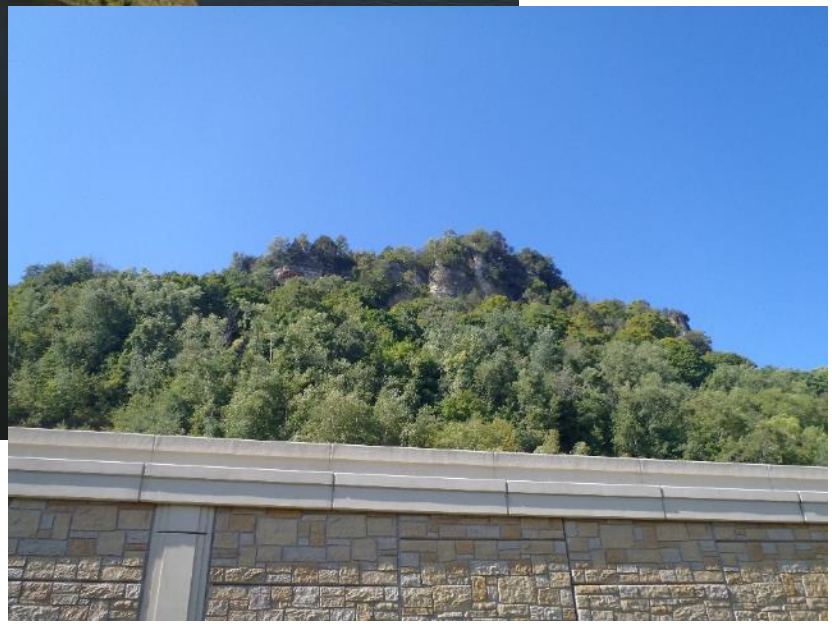
# Consultant Team

- SRF Consulting Group
- Parsons Transportation Group
- Kimley-Horn and Associates
- American Engineering Testing
- Widseth Smith Nolting and Associates
- Isthmus Engineering
- Project Information Services
- Design Center
- Karl Weissenborn
- Goliath Hydro-Vac
- Visu-Sewer
- M-P Consultants
- FIGG (River Bridge)

# Project Timeline and Cost

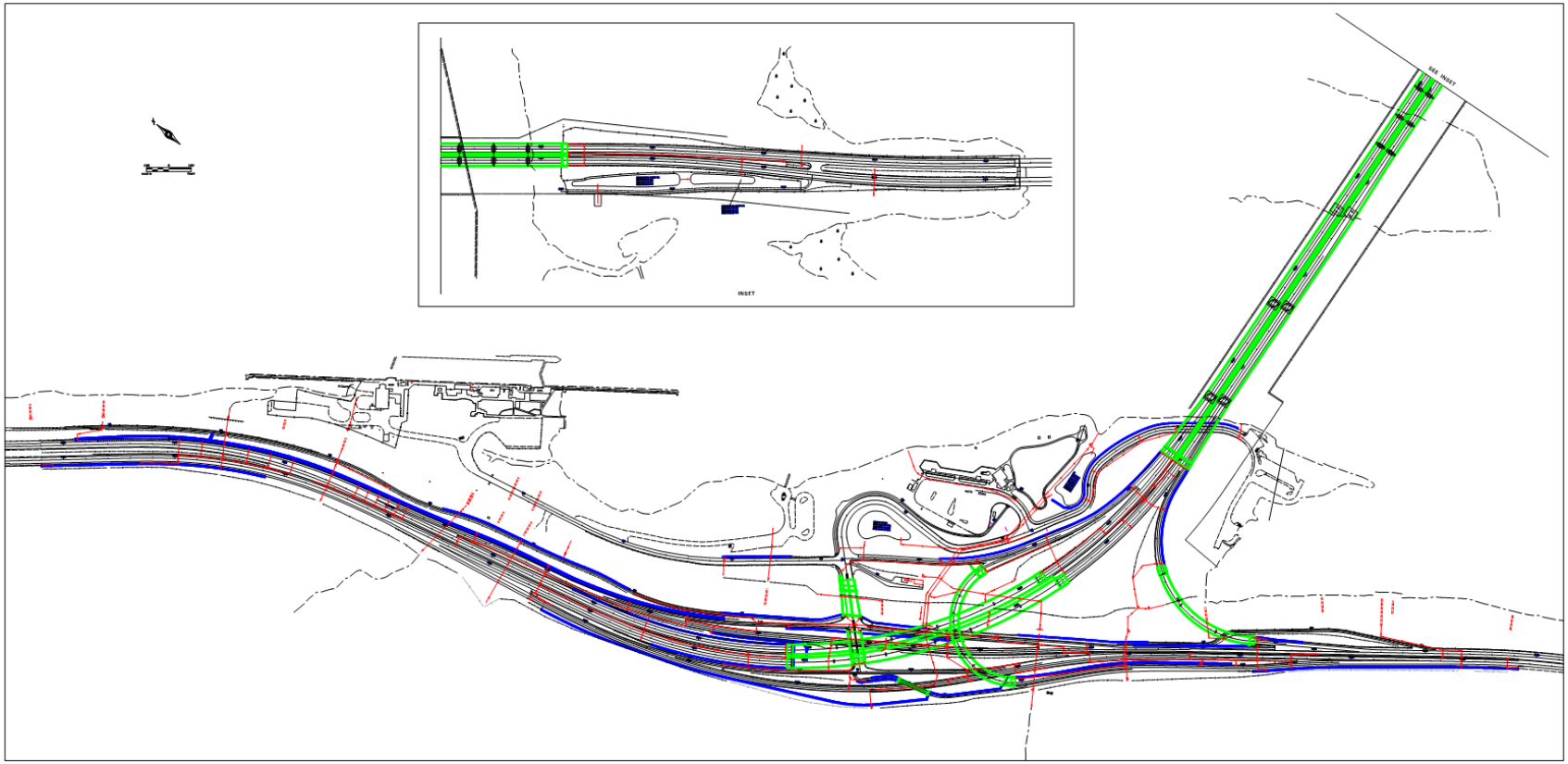
- Final Design 2011-2012
- Construction Began 2013 (Ames Construction)
- Ribbon Cutting Ceremony – October 21, 2016
- Construction Cost - $188M
  - Bridges - $105M

# Project Constraints

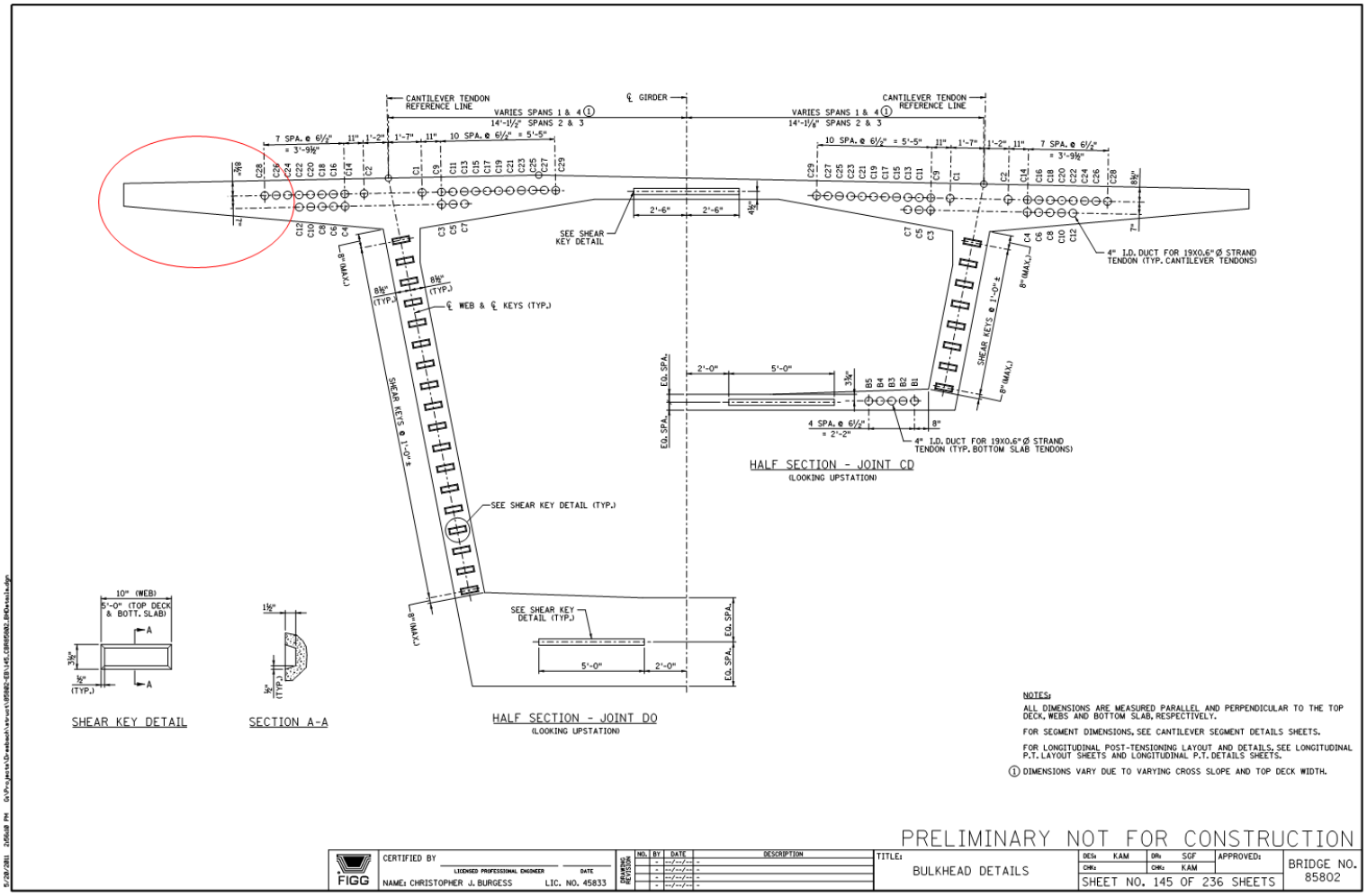
# Complex Design

- 7 Inland Bridges plus River Bridge
- 3 miles of Retaining Walls (MSE and CIP)
- 5 miles of Storm Sewer



# Bridge Deck Drainage

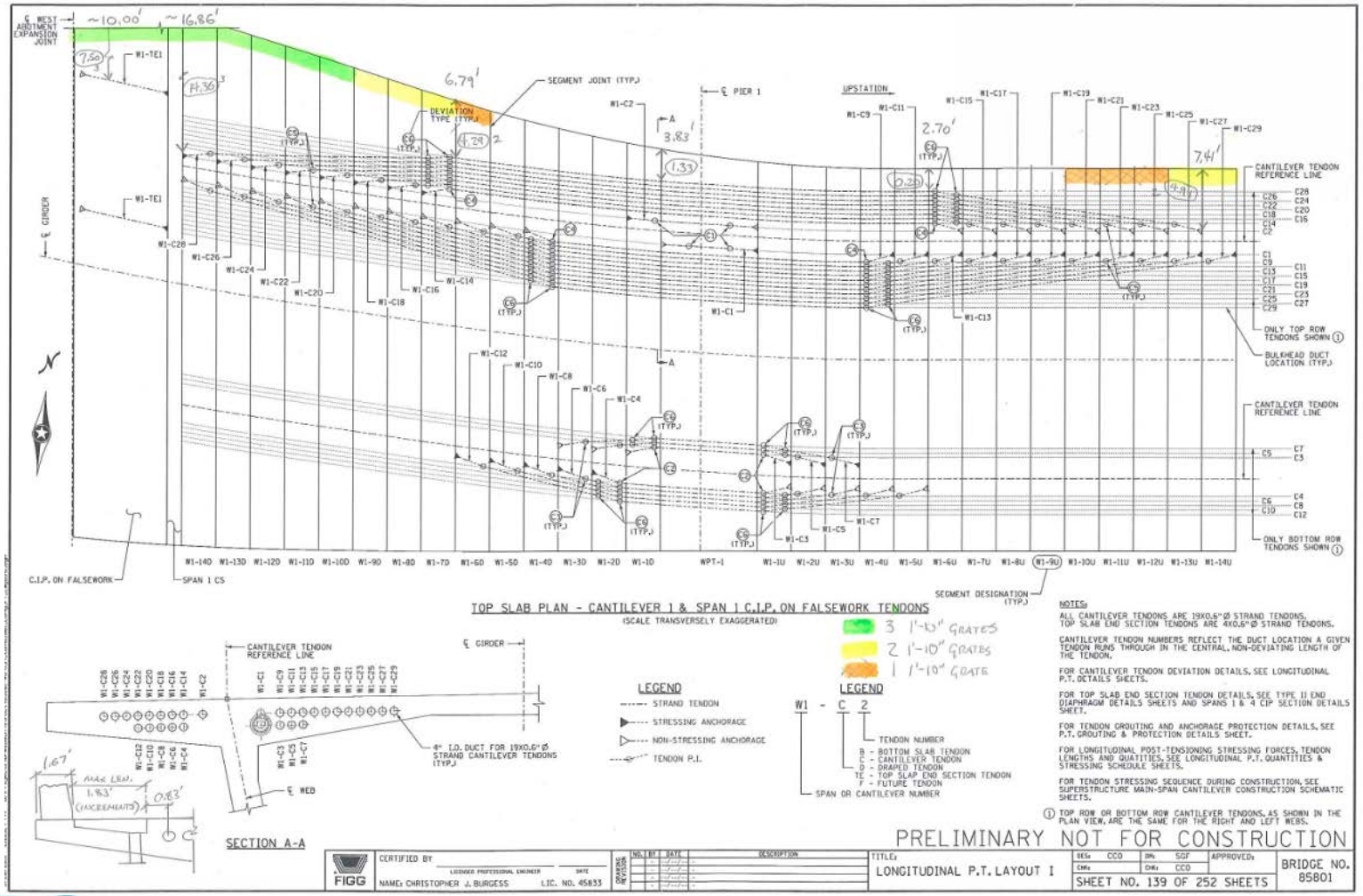
# Bridge Deck Drainage




DRESBACH INTERCHANGE

I-90 RIVER BRIDGE AND INTERCHANGE RECONSTRUCTION

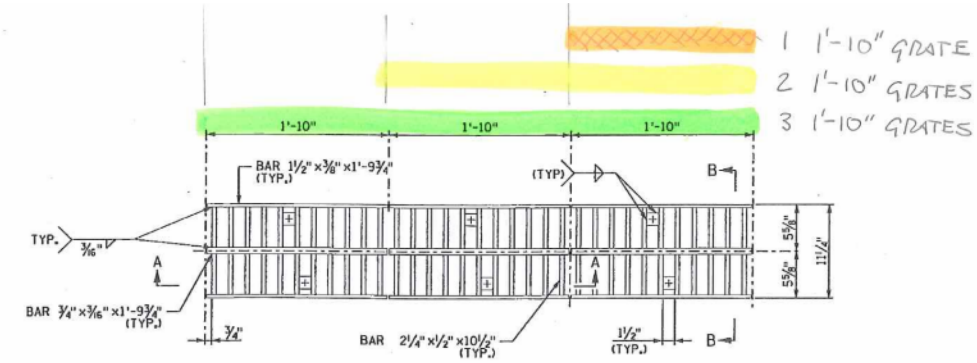
# Bridge Deck Drainage




DRESBACH INTERCHANGE

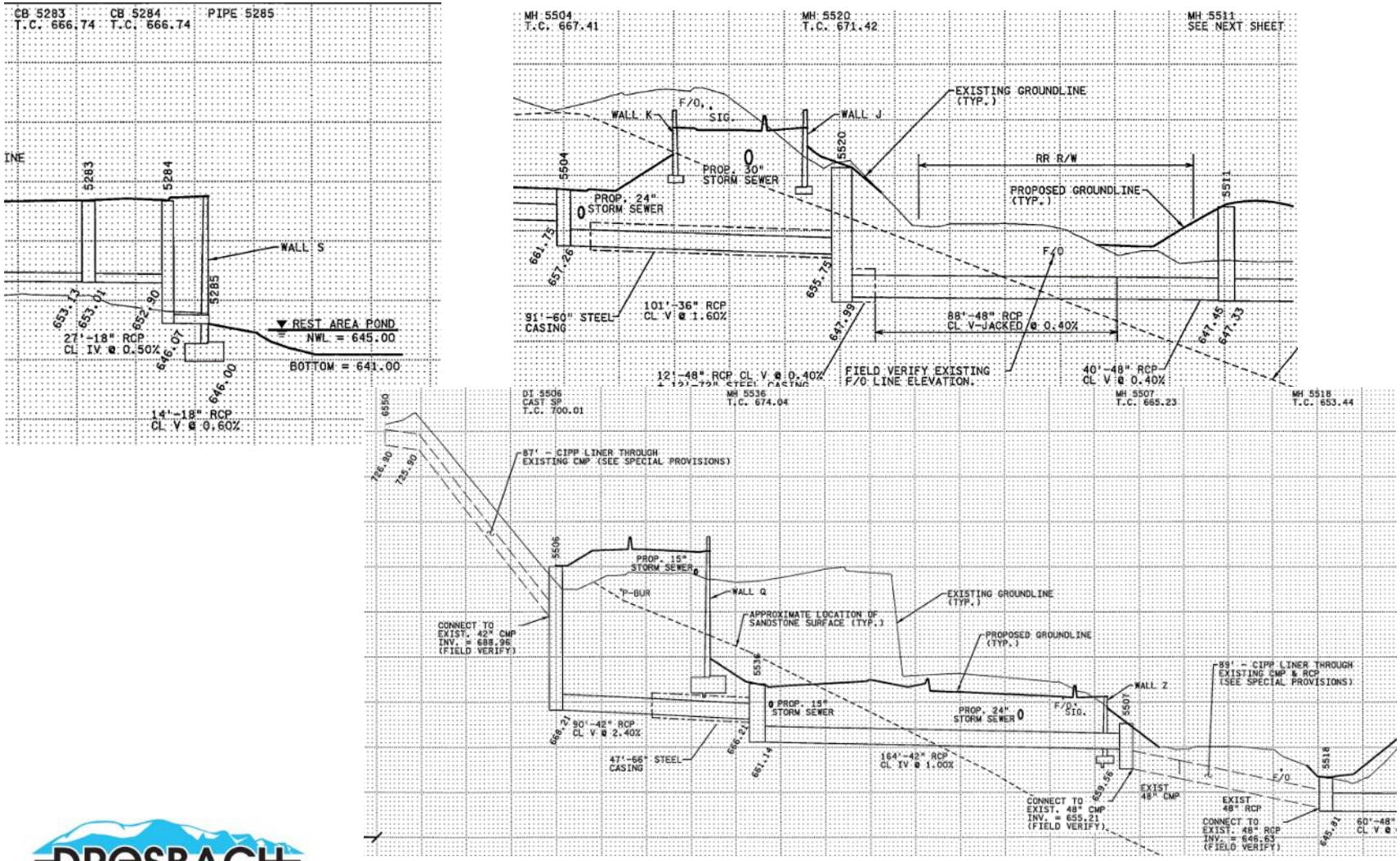
I-90 RIVER BRIDGE AND INTERCHANGE RECONSTRUCTION

# Bridge Deck Drainage




DRESBACH INTERCHANGE

# Wall Coordination




DRESBACH INTERCHANGE

# Wall Coordination

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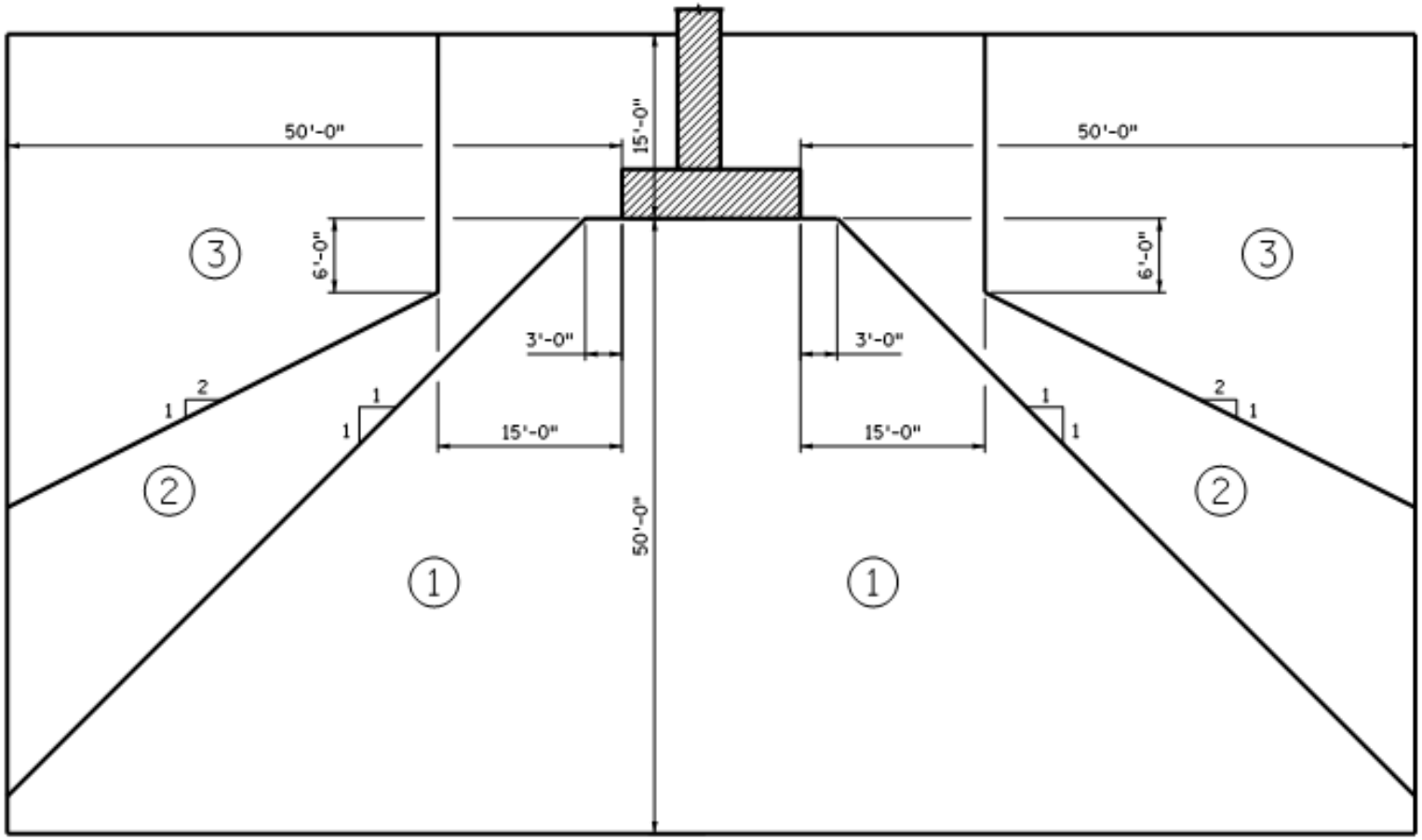


# Bluff Flume Analysis

# Bluff Flume Analysis

# Bluff Flume Analysis

# Bluff Flume Analysis

# Bluff Flume Analysis

# Analysis of Existing Pipe Conditions

# Analysis of Existing Pipe Conditions




# Analysis of Existing Pipe Conditions


DRESBACH INTERCHANGE

# Analysis of Existing Pipe Conditions

- Pipe condition
- Cover depth
- Difficulty of replacement
- Peak flow
- Velocity
- Energy dissipation options
- Connection to RR drainage system

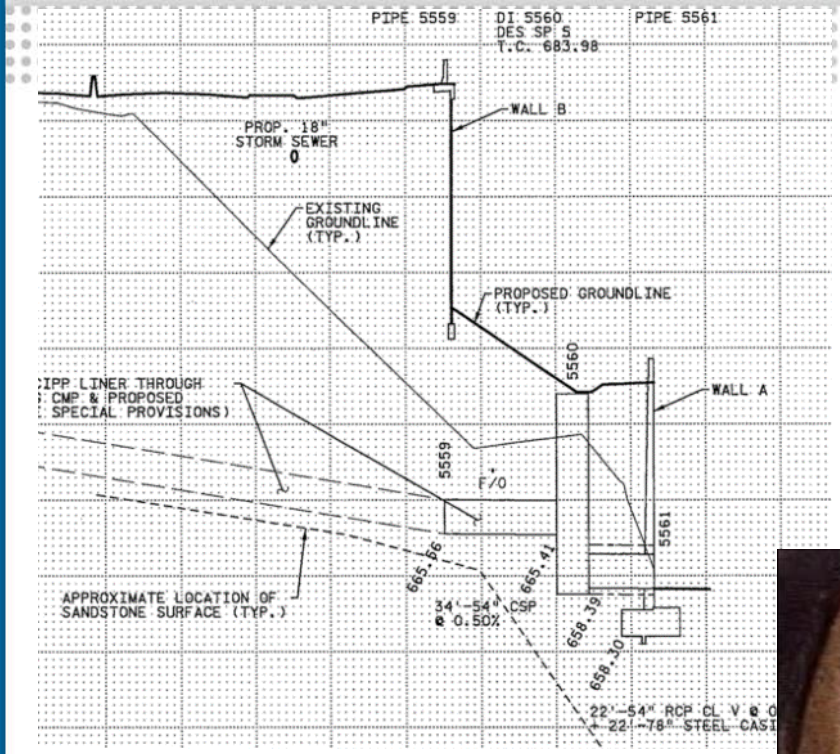
# Analysis of Existing Pipe Conditions

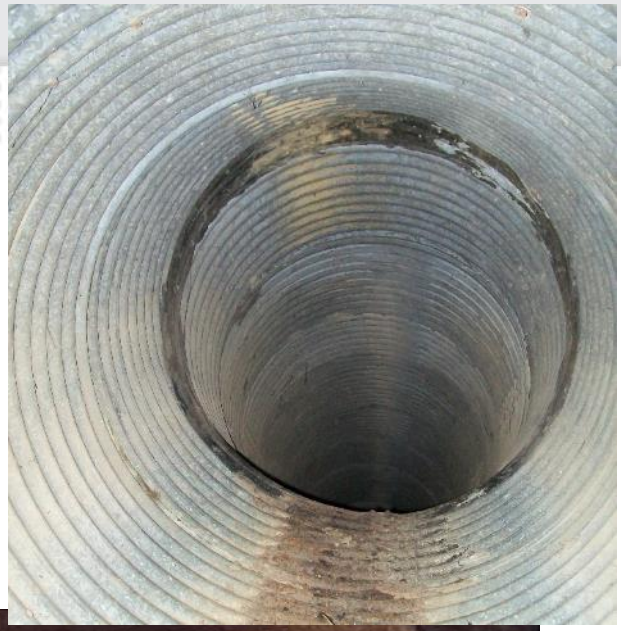
I-90/US Hwy 61/14 Interchange
Existing Storm Sewer, Pipe Lining and Energy Dissipation Recommendations

Dresbach Interchange
SRF # 7312
1/6/2012

| Visu-Sewer No. | Approx. portion to remain (by footage) | Align-ment | STA | Size/ Material | Condition | Location in Relation to RR | Recommendation for Project Work | Recommendation for RR Work | Existing max cover (ft) | Proposed max cover (ft) | Existing Q (cfs) 10-yr 50-yr | Proposed Q (cfs) 10-yr 50-yr | Existing vel. (ft/s) 10-yr 50-yr | Proposed vel. (ft/s) 10-yr 50-yr | Energy Dissipation Options |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 160 - 245 | I90EB | 462+10 | 30" CMP | Rust with pitting on invert, rock ballast in pipe from buried DI to end of pipe | Crosses under RR (does not daylight upstream), buried(?) DI west of tracks (in RR R/W?), crosses under existing retaining wall west of tracks (in RR R/W) | Clean debris from pipe, line pipe to remain (extends under RR and retaining wall, includes bends) | Uncover DI at upstream side of tracks and adjust to surface (OR) Abandon DI (pipe lining will go through DI) | 17 | 17 | 18<br>27 | 20<br>29 | 11.4<br>13.0 | 19.0<br>22.1 | -Riprap Basin (extends into both RR R/W and Lock and Dam R/W) |
| 2 (upstream of 3) | None | I90EB | 466+95 | 24" CMP | Rust (pitting possible) on invert, fiber optic line plowed through pipe (in portion to be removed) | Discharges west of RR, end is in RR R/W, crosses under small existing retaining wall west of tracks (in RR R/W) | Replace pipe from highway (insignificant portion remaining after replacement due to connections and to control velocity) | N/A | Replace pipe (pipe, riprap and/or transition into existing RR culvert will extend into RR R/W) | | | | | | |
| 3 | All | I90EB | 466+95 | 21" CMP/ 21" RCP/ 20" Cast Iron | Pipes appear sound, 3 pipe type transitions, small joint offsets at transitions | Culvert under RR, not connected to pipe from roadway | N/A | Align joints/replace pipe if not under tracks, seal joints (OR) Line pipe | - | | | | | | |
| 4 (upstream of 5A and 5B) | All | I90EB | 472+50 | 36" CMP | Small area of exposed rebar at upstream headwall, rocks in invert of headwall, rust (pitting possible) on invert | Discharges west of RR, end is slightly outside of RR R/W | Line all pipe, repair exposed rebar at headwall | N/A | 29 | 40 | 27<br>44 | 25<br>41 | 16.0<br>18.3 | 21.9<br>25.3 | -Add drop manhole and extend pipe and riprap into RR R/W |
| 5A | All | I90EB | 472+96 | 48" RCP | Minor debris in invert, significant areas with rebar exposed and rusting, aggregate exposed on invert, possible cracks | Culvert under RR, not connected to pipe from roadway | N/A | Clean and line pipe | - | | | | | | |
| 5B | All | I90EB | 473+02 | 48" RCP | Minor sediment in invert, significant areas with rebar exposed and rusting, spalling on invert | Culvert under RR, not connected to pipe from roadway | N/A | Clean and line pipe | - | | | | | | |
| 6 (upstream of 7) | 44-322 | I90EB | 475+75 | 54"CMP/ 8'x8' CIP Box | Box section - Exposed and rusting rebar CMP - Rusted invert (some pitting), minor rusting in other isolated locations, rocks at upstream end | Discharges west of RR, end is slightly outside of RR R/W | Remove box section, extend and line CMP section, remove rocks | N/A | 44 | 55 | 48<br>79 | 48<br>79 | 14.0 (1)<br>16.1 (1) | 19.5<br>22.6 | -Add drop manhole and extend pipe (riprap into RR R/W) |
| 7 | All | I90EB | 475+90 | 47" x 71" CM-Arch | Minor sediment in invert, sag in invert near center, deformation on invert of pipe (approx. 4-inch high x 3-feet wide), rust on welded joint | Culvert under RR, not connected to pipe from roadway | N/A | Clean invert, straighten deformation if possible, spot repair rust, monitor condition | - | | | | | | |
| 8A | None | I90EB | 488+15 | 36" CMP | Significant rust, piping/voids around upstream apron, downstream submerged (below surrounding grade), downstream end 1/2+ full of sediment (approx. 100' up pipe) - sediment extends about 180' into | Downstream of railroad, does not extend into RR R/W | Replace pipe (extends under driveway and parking area for boat launch) | N/A | Replace | | | | | | |
| 9 | 155 - 240 | E90S61 | 201+20 | 48" CMP/ 48" RCP | CMP - Rusted invert (pitting possible) RCP - Small cracked area at joint, single area of rebar rusting at joint, leaking joint | Crosses under RR (does not daylight on either side), transitions to CMP with tees out both sides draining RR ditch on west side of RR | Line pipe under RR (includes tee), remove CMP portion on east side (west side transition approx. 5' from nearest rail) both sides in RR R/W | Investigate condition of pipe ends and tee draining ditch west of RR | Connects to storm sewer | | | | | | |
| 9-Rev (upstream of 9) | All | E90S61 | 200+30 | 42" CMP | Rusted invert (pitting possible), some rust on sides (not fully viewed, sloped portion viewed from ends only) | Outside RR R/W | Line pipe to connection point (includes bends) with new storm sewer (MH 5506) | N/A | Connects to storm sewer | | | | | | |
| 10 (upstream of 11) | None | E90S61 | 204+90 | 24" CMP | Rusted invert, likely pitting (upstream portion to be removed has numerous holes and voids in invert) | Discharges west of RR, end is in RR R/W | Replace pipe from highway (undersized) | N/A | Replace and connect to new pipe jacked under RR (crossing 11) | | | | | | |
| 11 | None | E90S61 | 204+90 | 20" Cast Iron | Large joint displacement (50%) between center track and west track, longitudinal cracks near joint, not fully viewed due to displacement, possible displacement beyond viewed section | Crosses under RR, concrete headwall separates highway pipe from RR pipe on upstream side, downstream will be connected to proposed MH | Jack replacement pipe and abandon existing pipe (jack lower than existing pipe and include DI on upstream side of tracks to allow pipe from highway to connect directly) | N/A | Jack replacement under RR<br>Abandon existing pipe | | | | | | |

# Pipe Lining

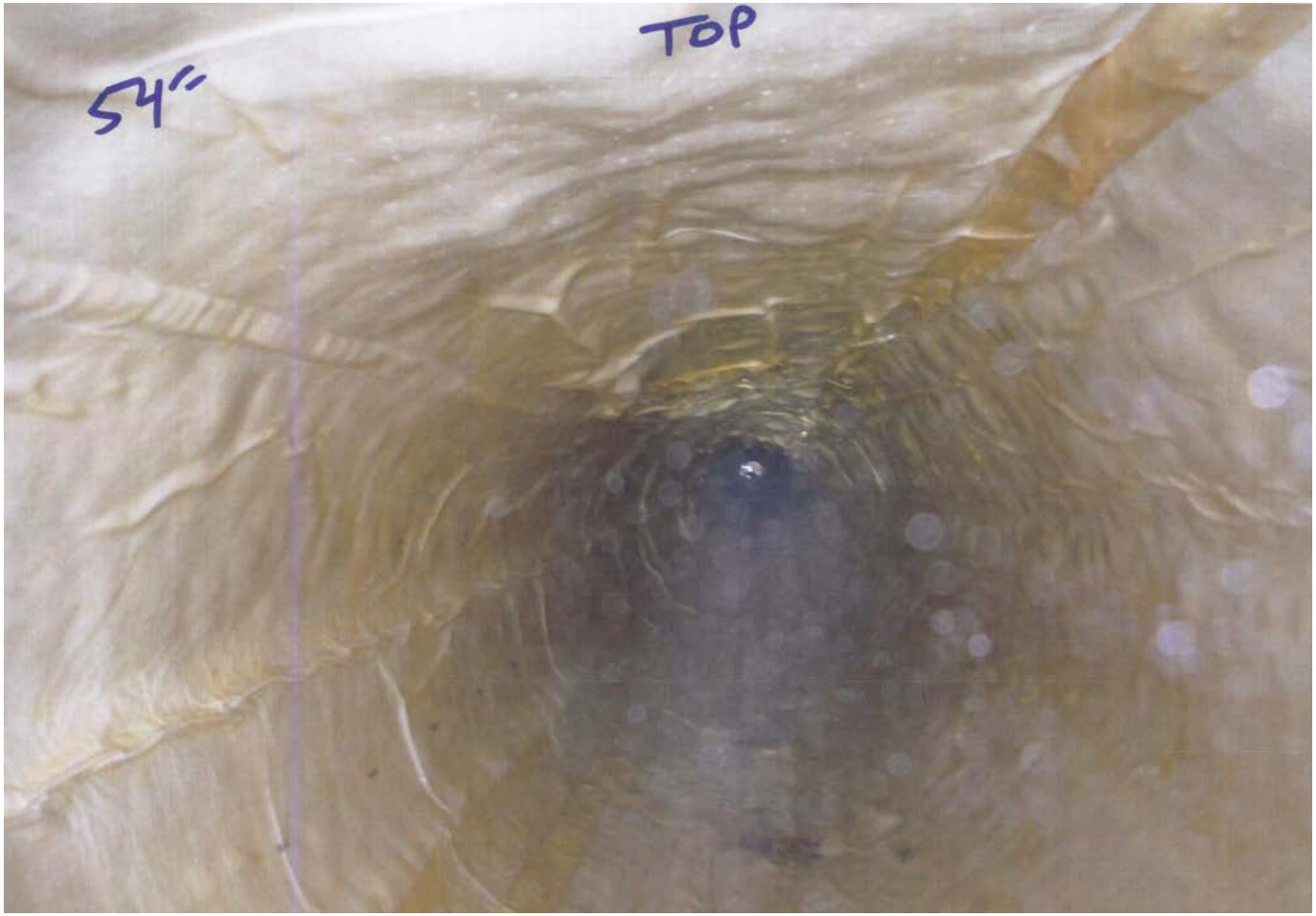

PIPE 5559
DI 5560
DES SP S
T.C. 683.98
PIPE 5561
WALL B
PROP. 18"
STORM SEWER
0
EXISTING
GROUNDLINE
(TYP.)
PROPOSED GROUNDLINE
(TYP.)
5560
WALL A
CIPP LINER THROUGH
CMP & PROPOSED
SPECIAL PROVISIONS)
5559
F/O
5561
665.86
665.41
APPROXIMATE LOCATION OF
SANDSTONE SURFACE (TYP.)
34"-54" CSP
@ 0.50%
658.39
658.30




Upstream MH: 13
Downstream MH: 13
Feet: 0042.1

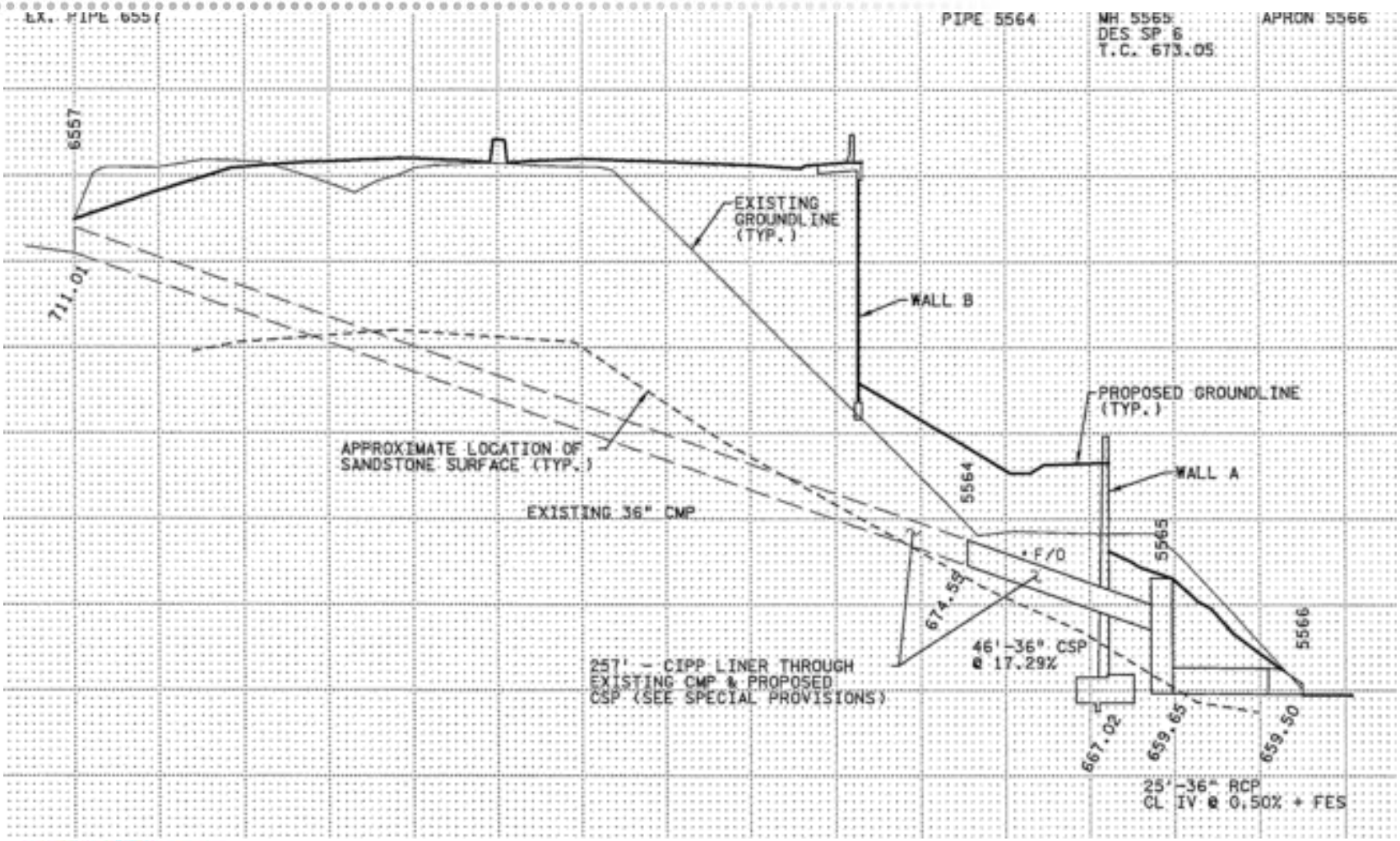
# Pipe Lining

# Pipe Lining

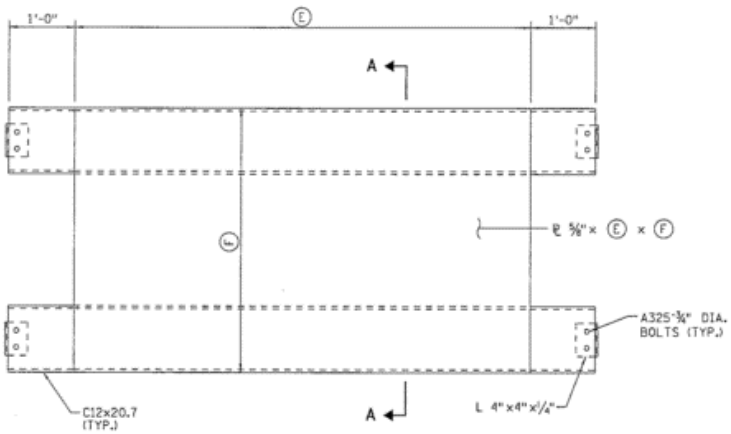


# Pipe Lining

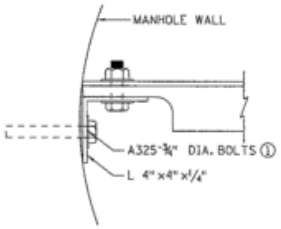
# Energy Dissipation



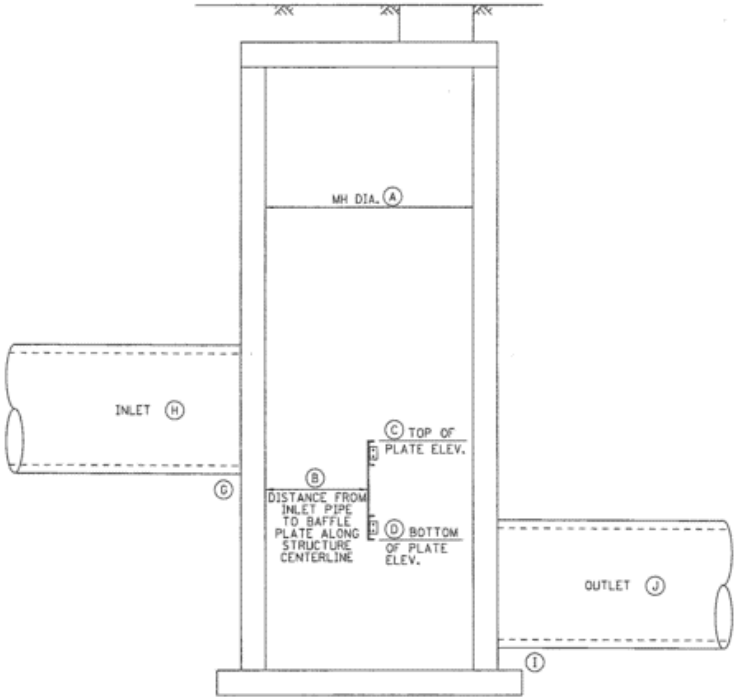
# Energy Dissipation




ENERGY DISSIPATION BAFFLE ELEVATION
NOT TO SCALE




SECTION B-B
NOT TO SCALE




ENERGY DISSIPATION BAFFLE - DESIGN SPECIALS 5 & 6
NOT TO SCALE

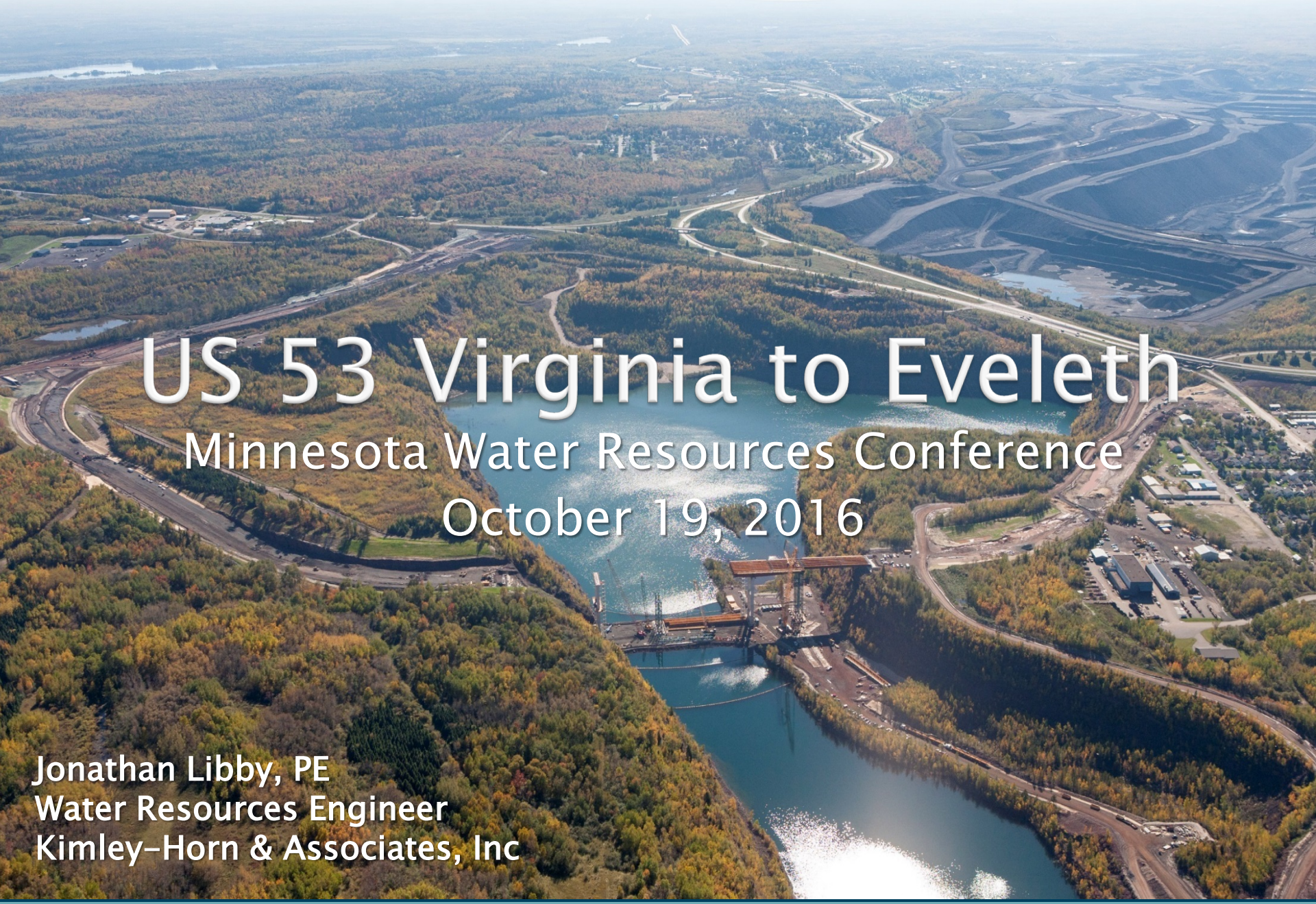
NOTES:

1. PIPE SUPPLIER TO PROVIDE INSERTS IN MH WALL TO ACCEPT BOLTS.
2. HOT DIP GALVANIZE ALL PIECES AFTER FABRICATION.
3. PIPES WILL BE PAID FOR SEPARATELY.
4. MANHOLE SHALL BE A MNDOT 4020 STRUCTURE.

# Energy Dissipation

# Unique Project

DRESBACH INTERCHANGE



# US 53 Virginia to Eveleth

## Minnesota Water Resources Conference

## October 19, 2016

Jonathan Libby, PE
Water Resources Engineer
Kimley-Horn & Associates, Inc

Kimley»Horn

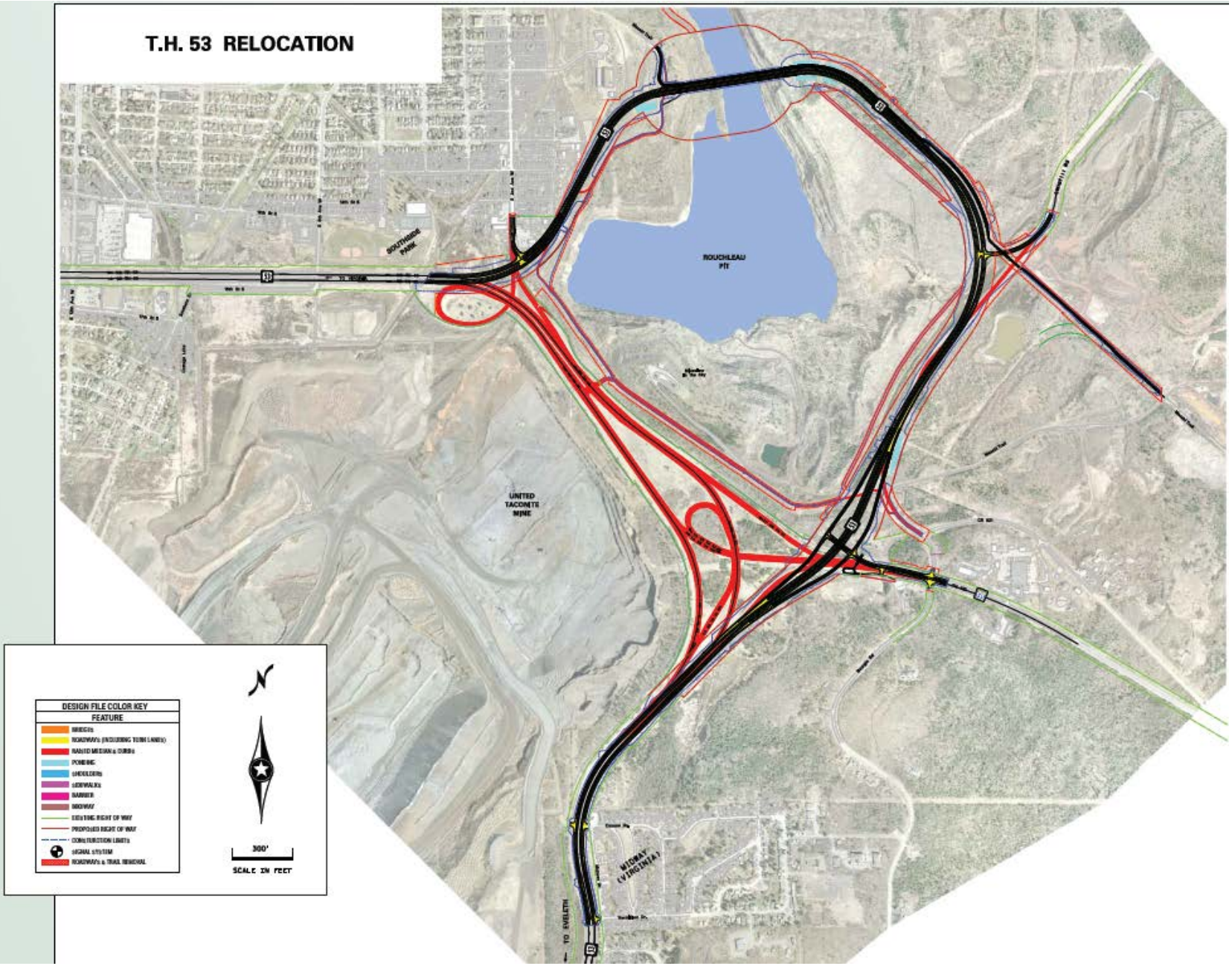
# Project Background

- 1960
  - MnDOT acquired an easement that allowed US 53 in Virginia to operate on land that has significant mineral resources. This easement could be terminated on 3 years notice.
- May 2010
  - RGGS (land owner) and United Taconite (UTAC) (lessee) gave notice that the US 53 easement would terminate in 3 years
- Fall 2017
  - In 2012 RGGS, UTAC, and MnDOT negotiated this as the new termination date, based on project development requirements for a highway relocation project

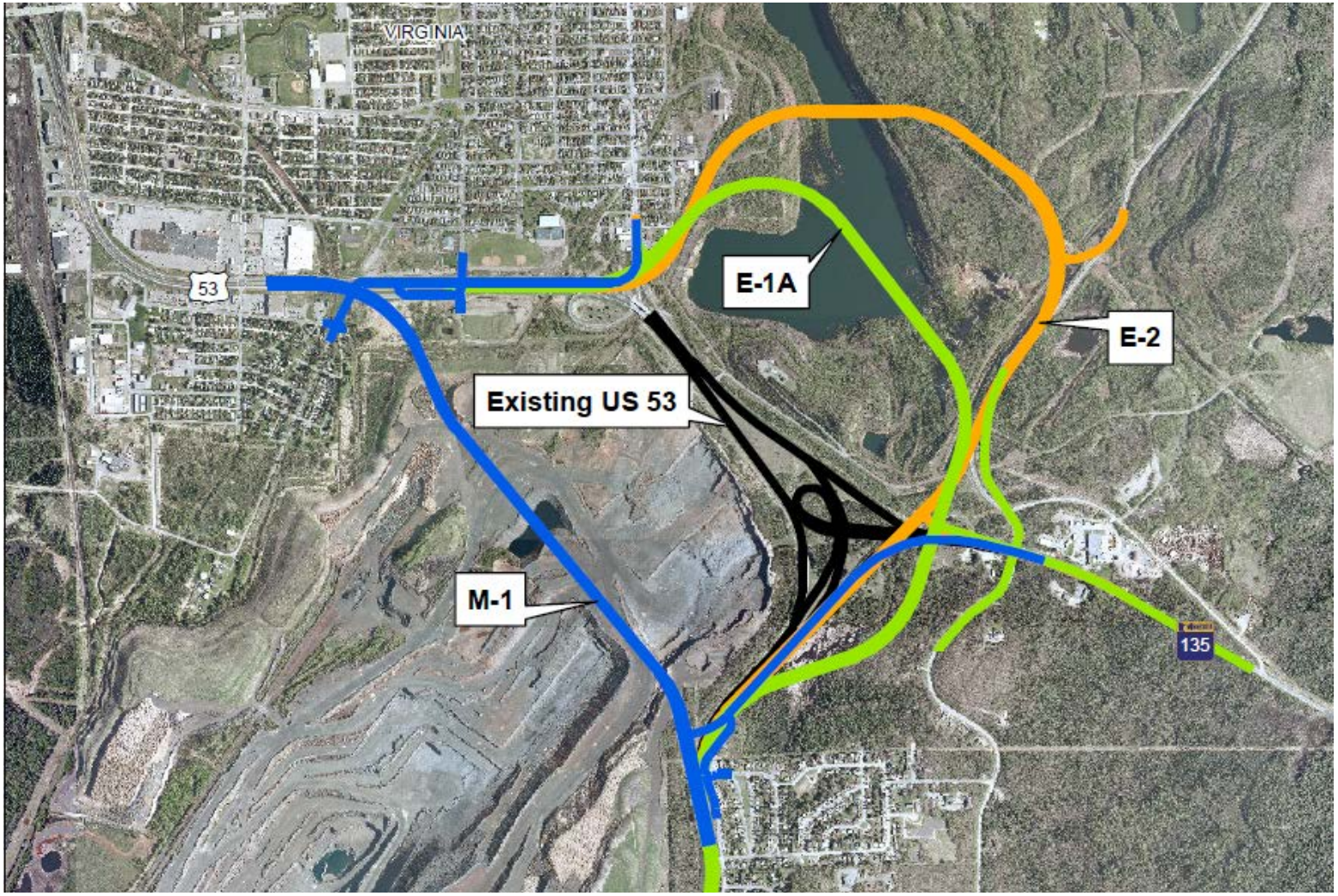
# Project Overview


Kimley»Horn

# T.H. 53 RELOCATION



# Final Alignments in DEIS



# Alternative M-1

# Alternative E-1A – Alignment (Fill)

# Alternative E-1A – Alignment Bridge

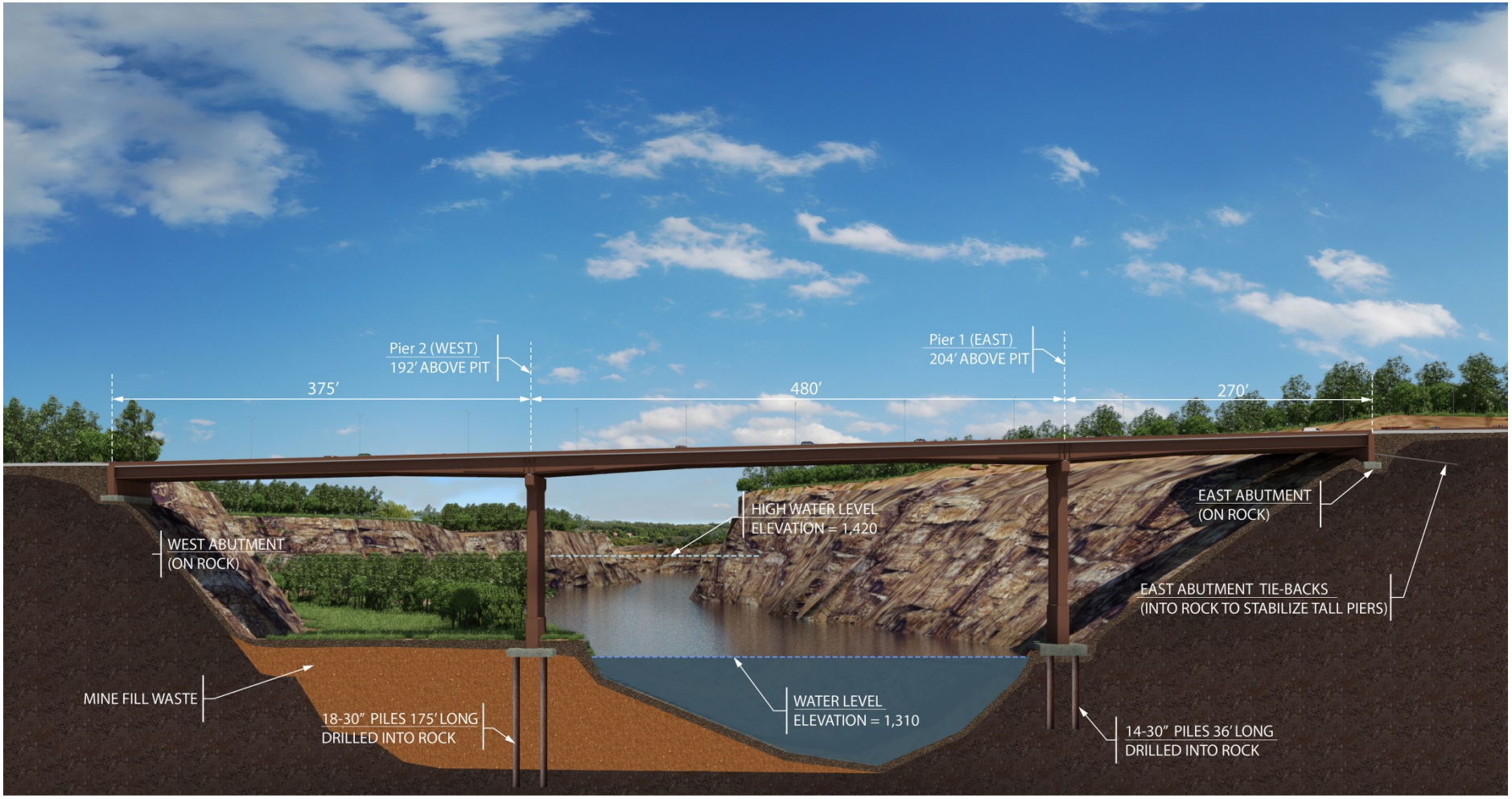

PRELIMINARY – Bridge Type and Pier Location TBD

# Alternative E-2

# Overview of Alternative E2

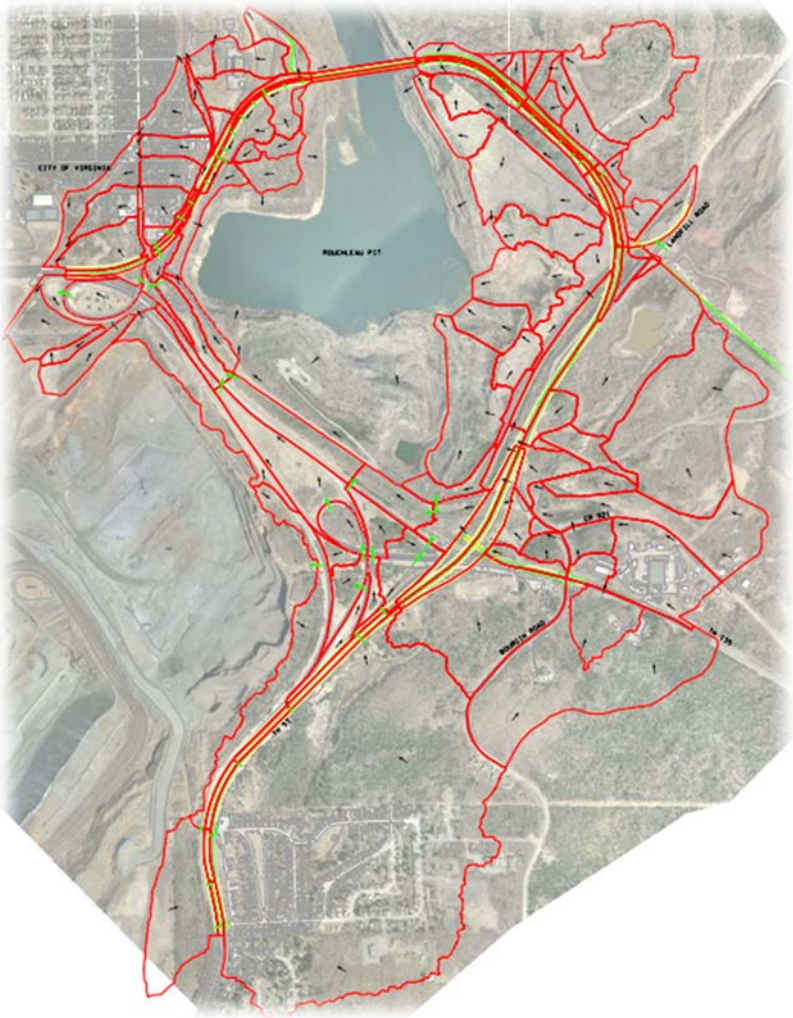
- The project includes:
  - 3.2 mi of new four-lane highway construction
  - 1,132 ft. bridge across a former mine pit now filled with water
    - The bridge will be the tallest in Minnesota (204')
  - A new interchange at Highway 53/Highway135
  - Utility and trail relocation
  - The total project cost of $240 million
  - Construction cost of $156 million

# Bridge Profile



# Water Resources Components

- Stormwater Management
  - Water Quality BMPs
  - Diversion Swale
- Rouchleau Pit
- East Bridge Abutment



# Stormwater Management

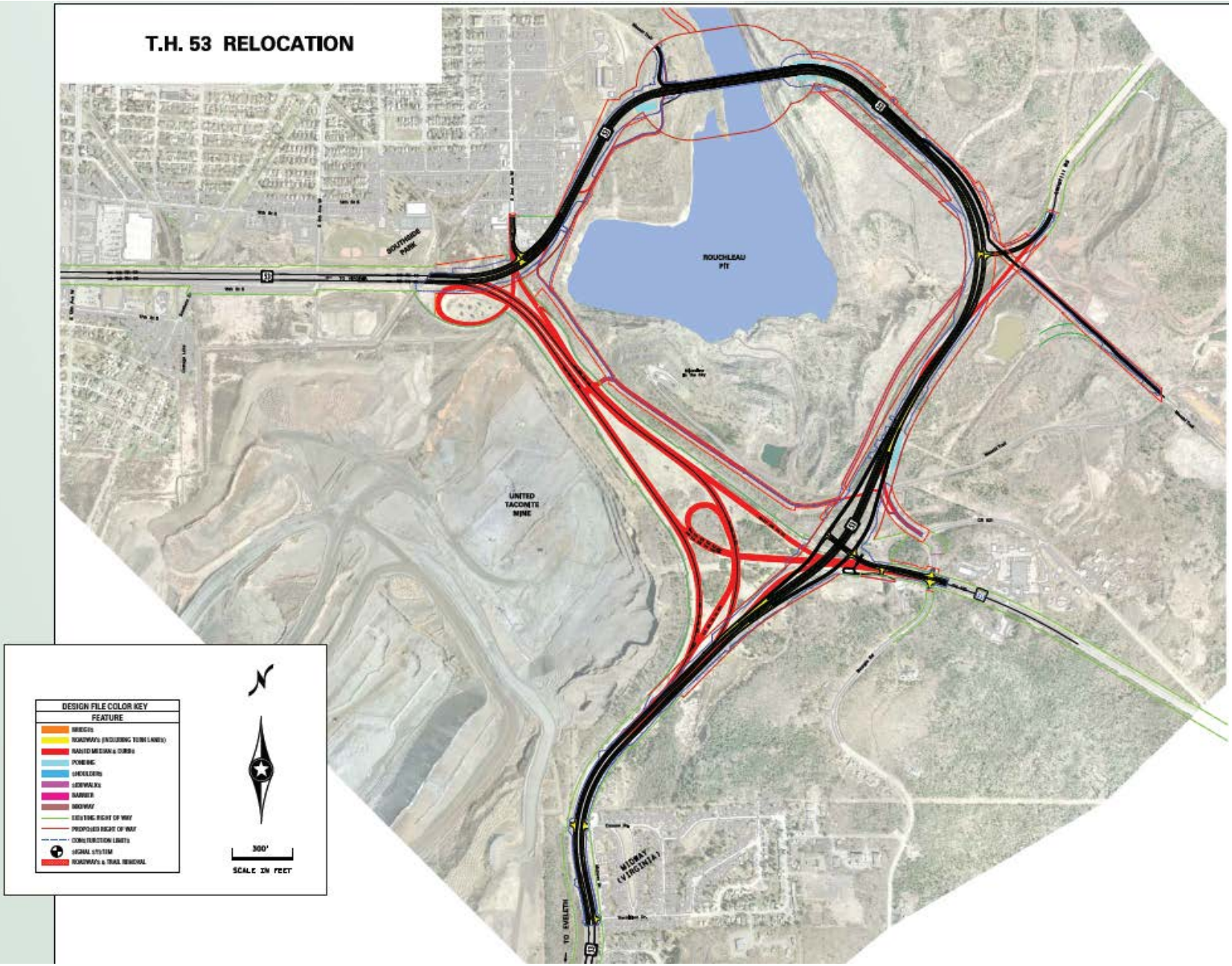
- Water Quality Overview
  - Designed to Minimal Impact Design Standards (MIDS)
  - • Removed Impervious = 34.06 ac
  - • Proposed Impervious = 46.61 ac
  - • Net Increase in Impervious = 12.55 ac
- Exceeds requirements of MPCA Construction General Permit

# Stormwater Management

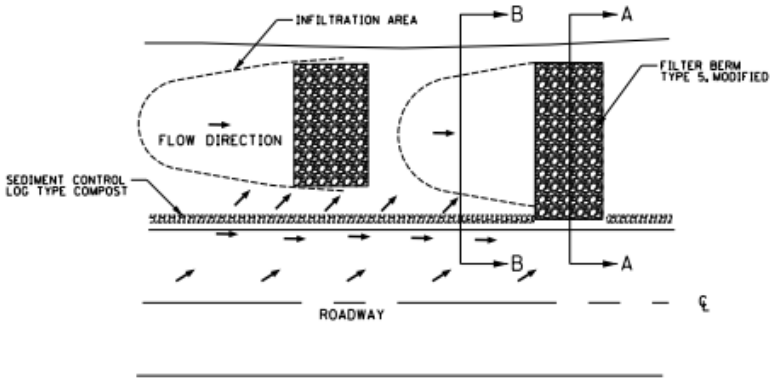
- Best Management Practices:
  - Wet Sedimentation Basin – 1
  - Dry Detention Basins – 2
  - Filtration Basins – 3
  - Infiltration Basins – 39

| | LOCATION | BOTTOM ELEV. | NORMAL WATER ELEV. | OUTLET CONTROL | HIGH WATER ELEV. | POND TYPE |
|---|---|---|---|---|---|---|
| **POND 1** | NB TH53 STA 143+00 RT | 1578.00 | 1584.50 | CULVERT | 1588.03 | TYPE 1 WET POND |
| **POND 2** | SB TH53 STA 194+00 LT | 1531.00 | NA | FILTER BERM | 1533.00 | DRY BIO-DETENTION BASIN |
| **POND 3** | NB TH53 STA 194+00 RT | 1533.00 | NA | FILTER BERM | 1533.00 | DRY BIO-DETENTION BASIN |
| **POND 4** | SB TH53 STA 197+00 LT | 1520.00 | NA | DRAIN TILE, OUTLET CTRL STR | 1522.00 | FILTRATION BASIN |
| **POND 5** | NB TH53 STA 197+00 RT | 1520.00 | NA | DRAIN TILE, OUTLET CTRL STR | 1522.00 | FILTRATION BASIN |
| **POND 6** | NB TH53 STA 215+00 LT | 1472.00 | 1476.00 | BERM, OUTLET CTRL STR, DRAIN TILE | 1478.74 | WET SEDIMENTATION BASIN, FILTRATION BASIN |

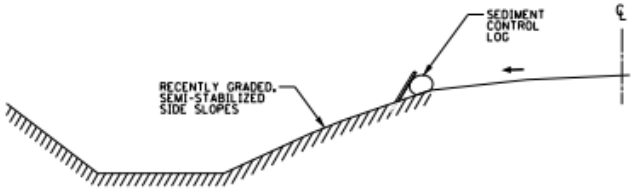
# T.H. 53 RELOCATION



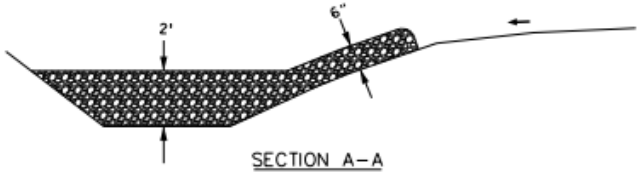
# Infiltration – Modified Filter Berm



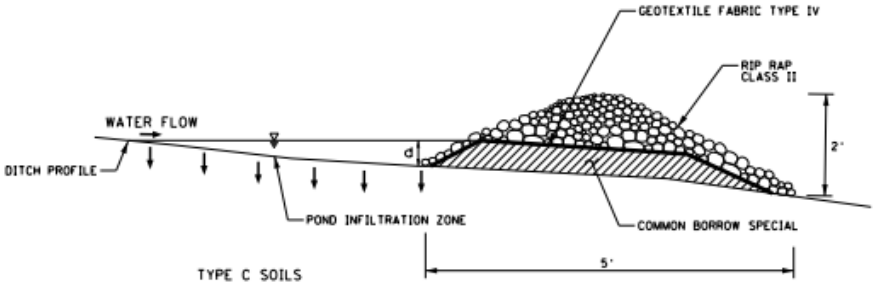

PLAN VIEW




SECTION B–B




SECTION A–A




TYPE C SOILS

d = 0.8 FT.

ASSUME INFILTRATION RATE OF 0.2"/HR PER MN S/W MANUAL

$\frac{0.2"}{HR}$ × 48 HR DRAWDOWN = 0.8 FT. = d

FILTER BERM TYPE 5, MODIFIED

# Rouchleau Pit

- Drinking Water Source for City of Virginia
  - Best management practices to prevent water quality impacts to Rouchleau Pit

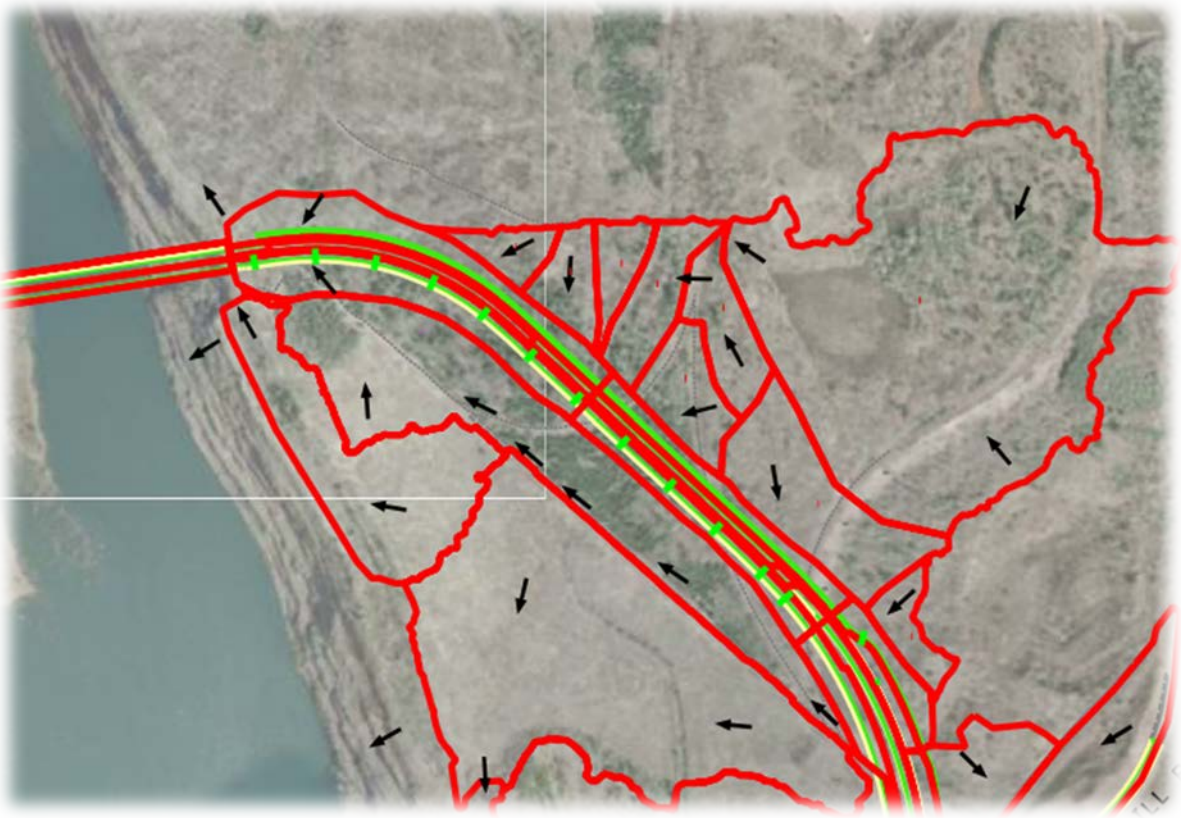
- No deck drains in new bridge
- Treat water prior to discharge
- No infiltration within 500’ due to bedrock and geologic concerns

# Rouchleau Pit

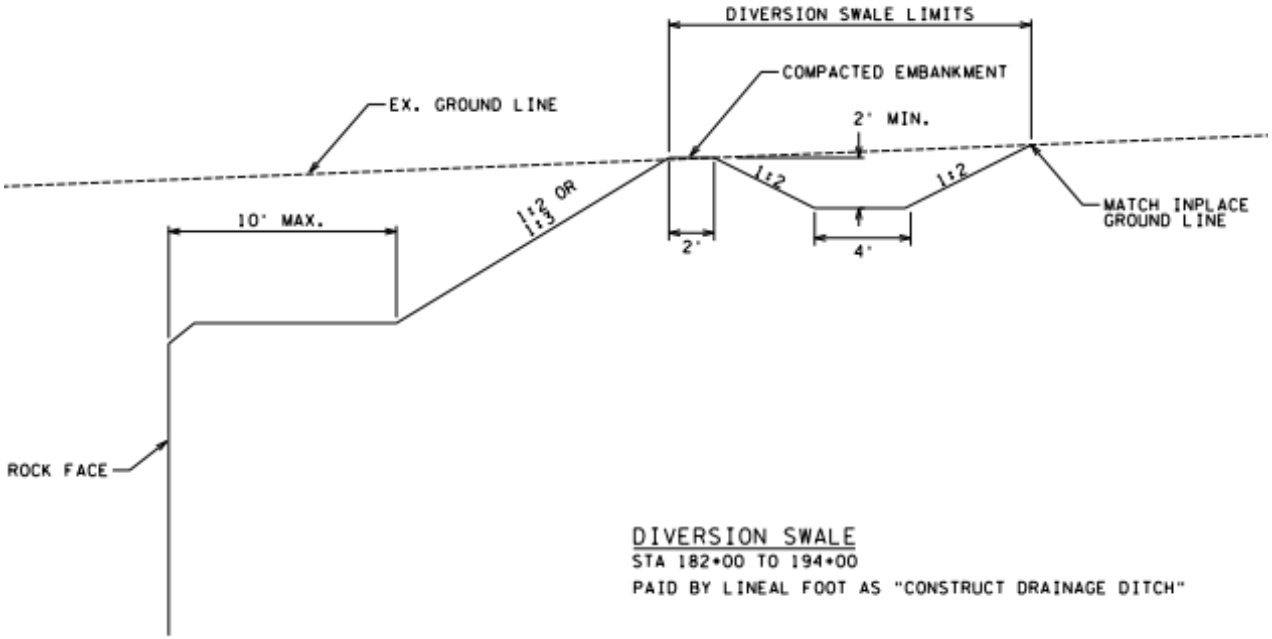
# Rouchleau Pit

# Diversion Swale

- 36.8 acre drainage area tributary to highway
- Divert water away from highway and east bridge abutment
- Capacity for 100-year design event
- Difficult to access
- Minimal maintenance needs



# Diversion Swale

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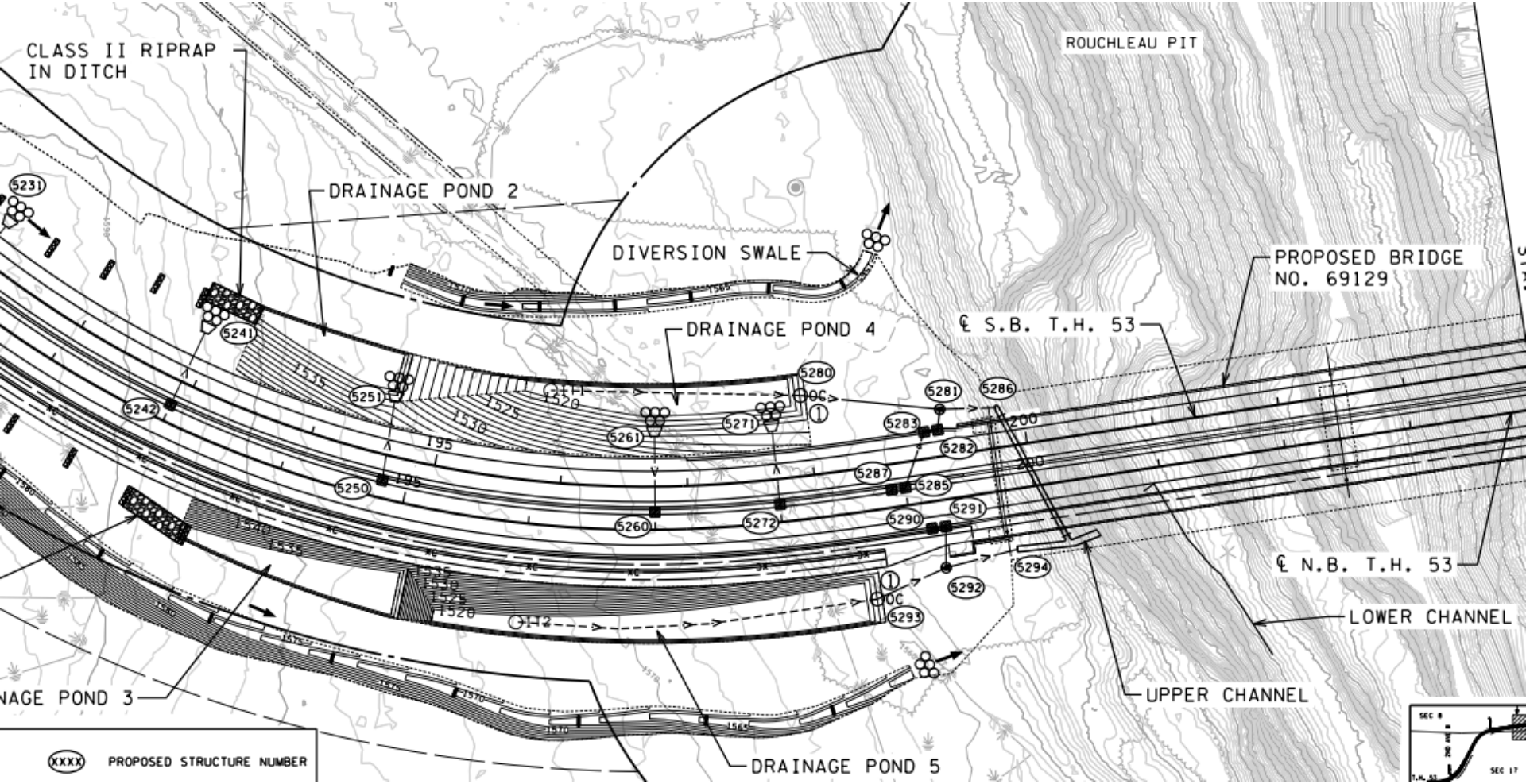
# East Abutment Outfall

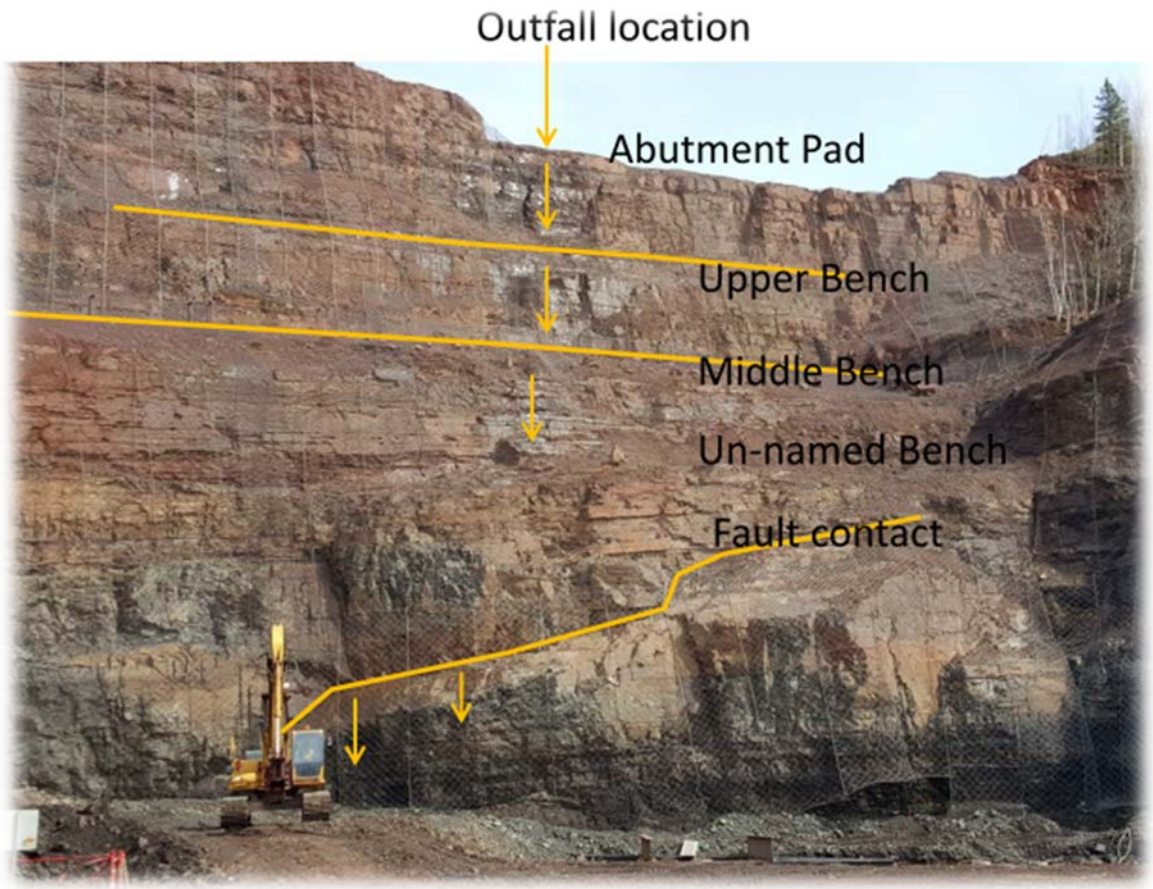


# East Abutment Drainage Path

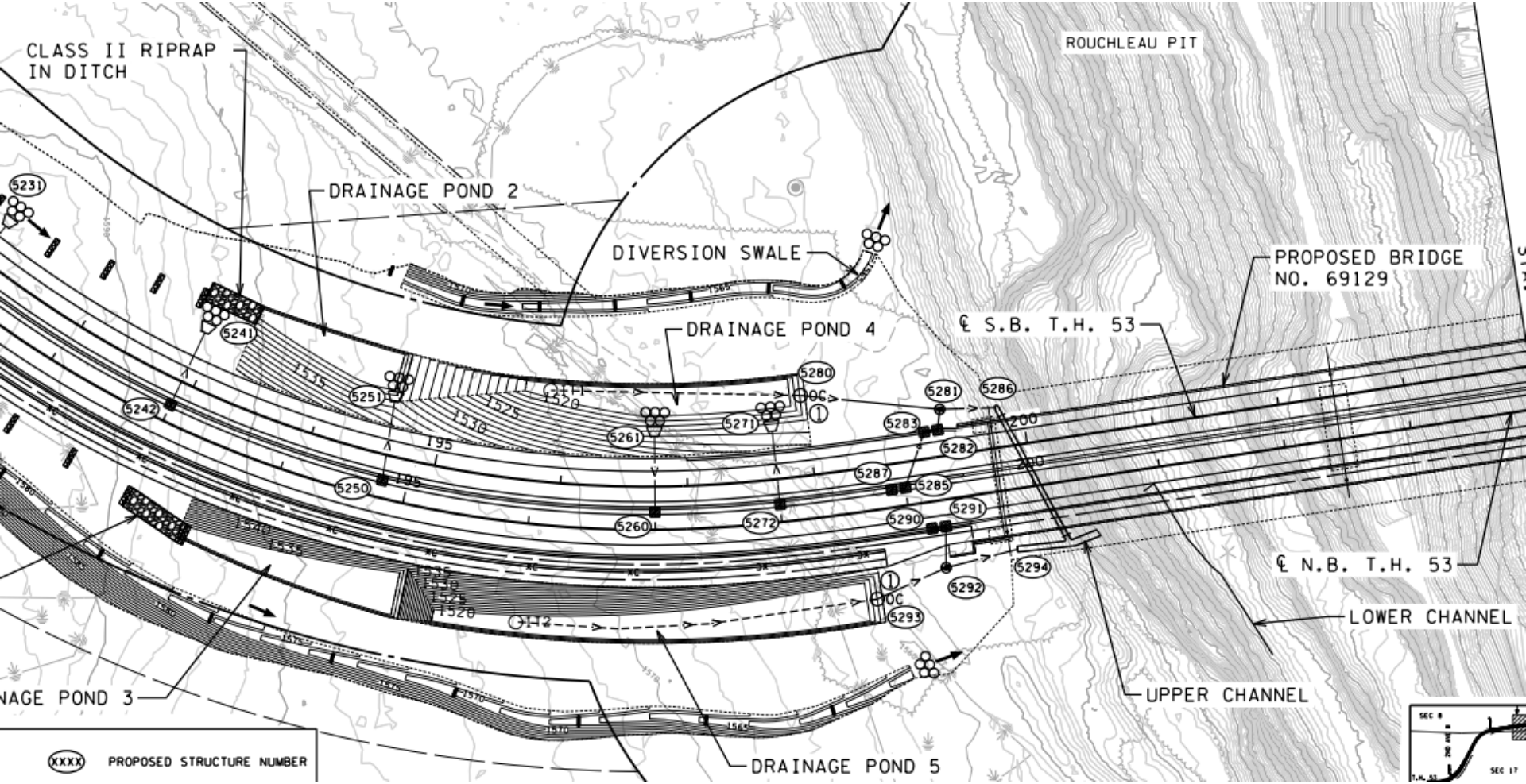
# East Abutment Outfall

- Waterfall Test
  - March, 2016 – 2500 gallons released in 10 minutes

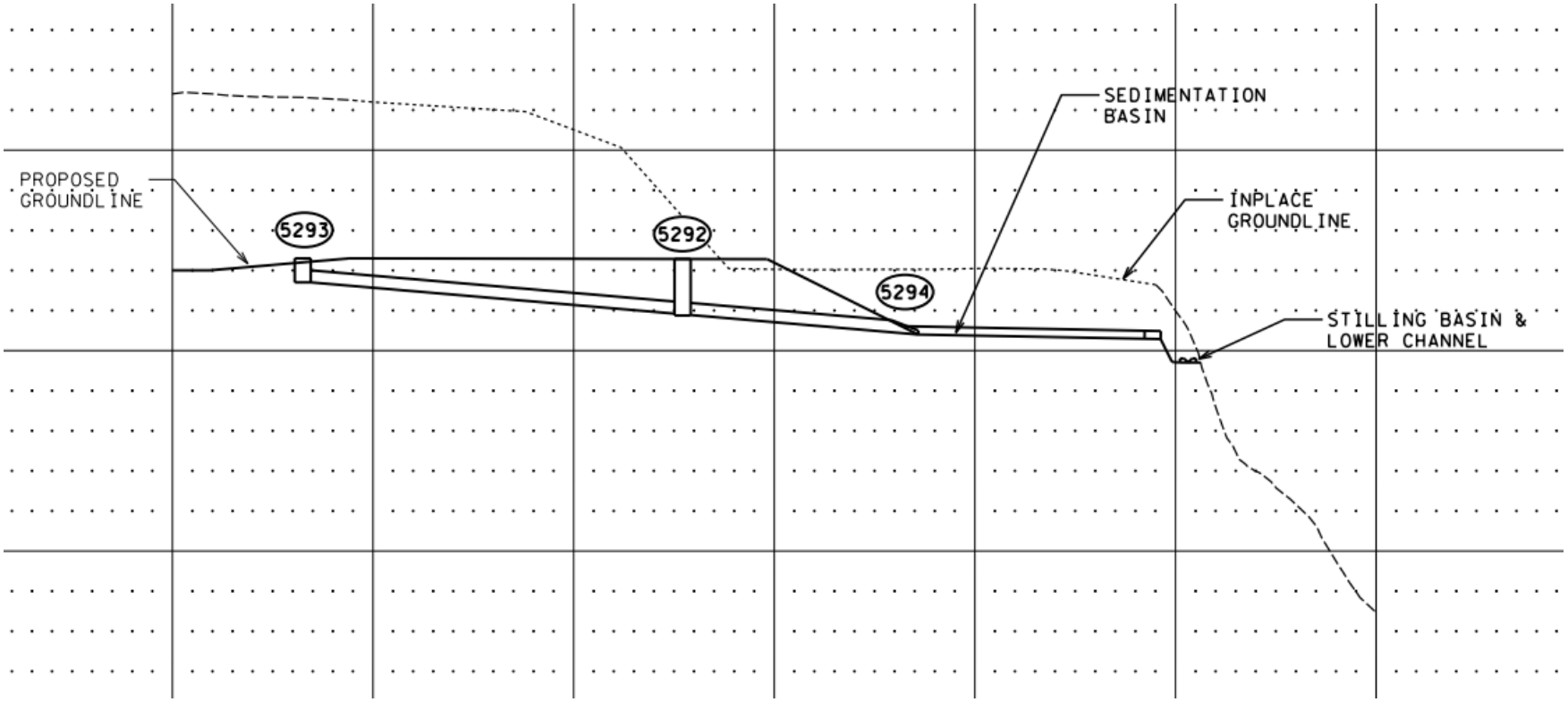
# East Abutment Waterfall Test

# East Abutment Outfall

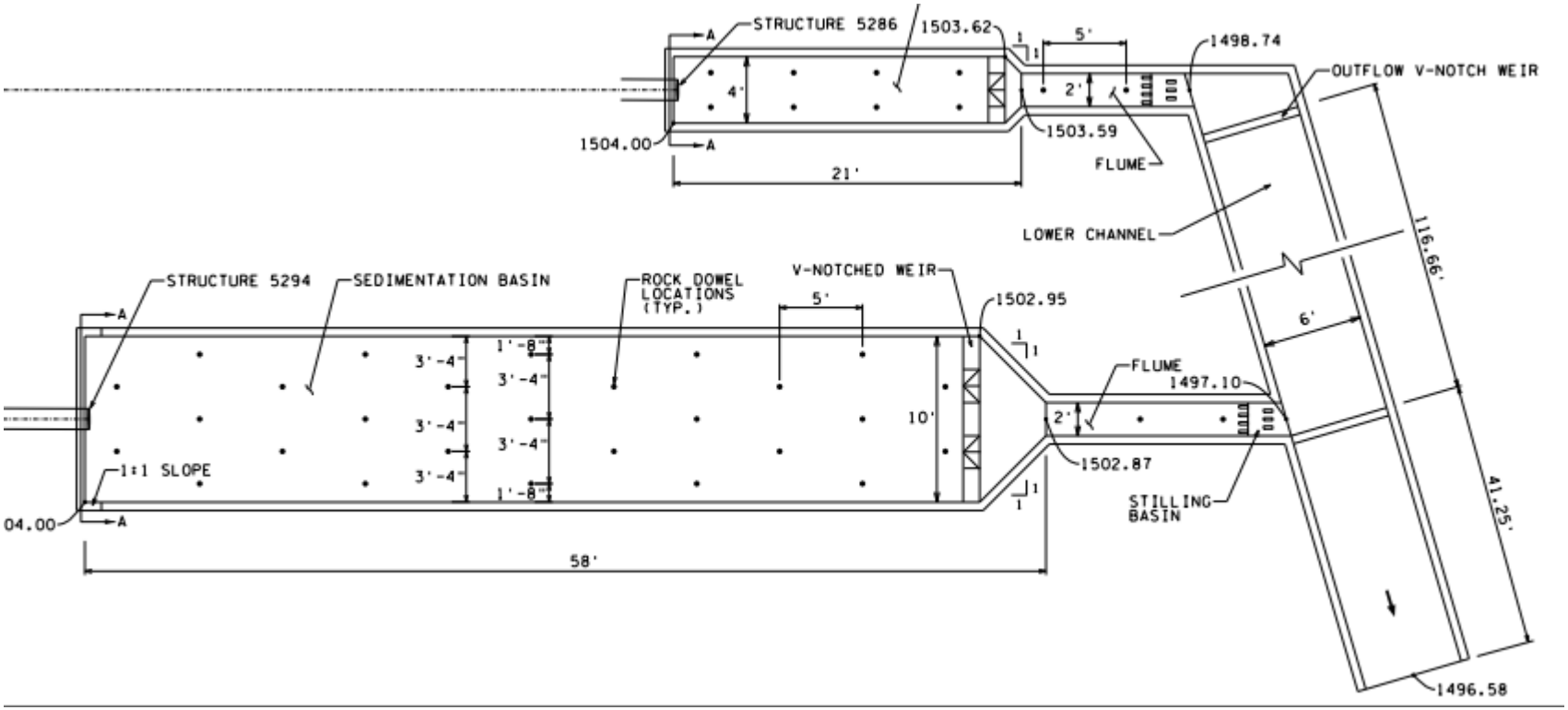


# East Abutment Outfall – Initial

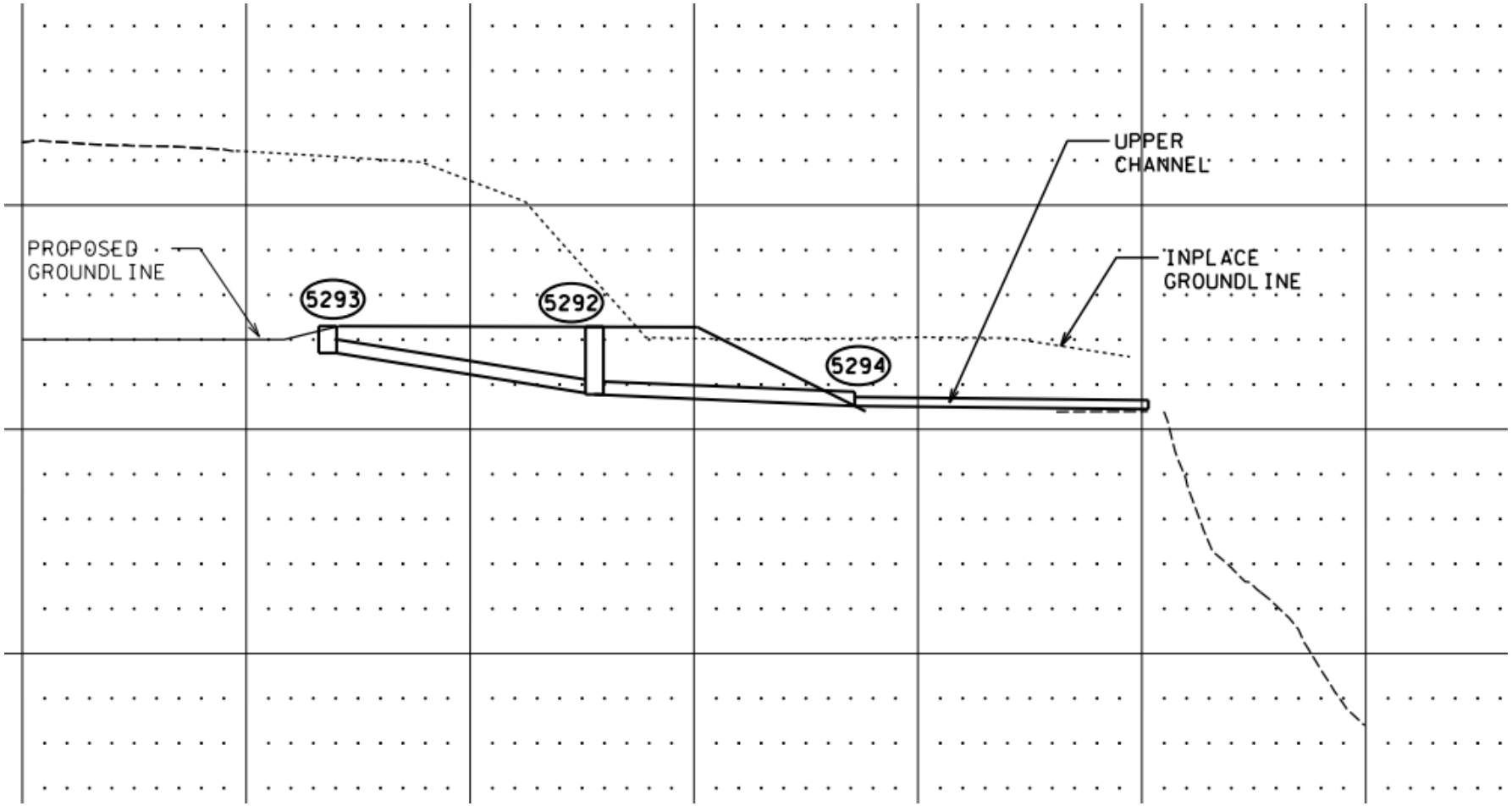


# East Abutment Outfall – Initial

- Upper Channel Design
  - Energy dissipation using St. Anthony Falls Laboratory design research
  - Stilling basin, weirs and baffle blocks

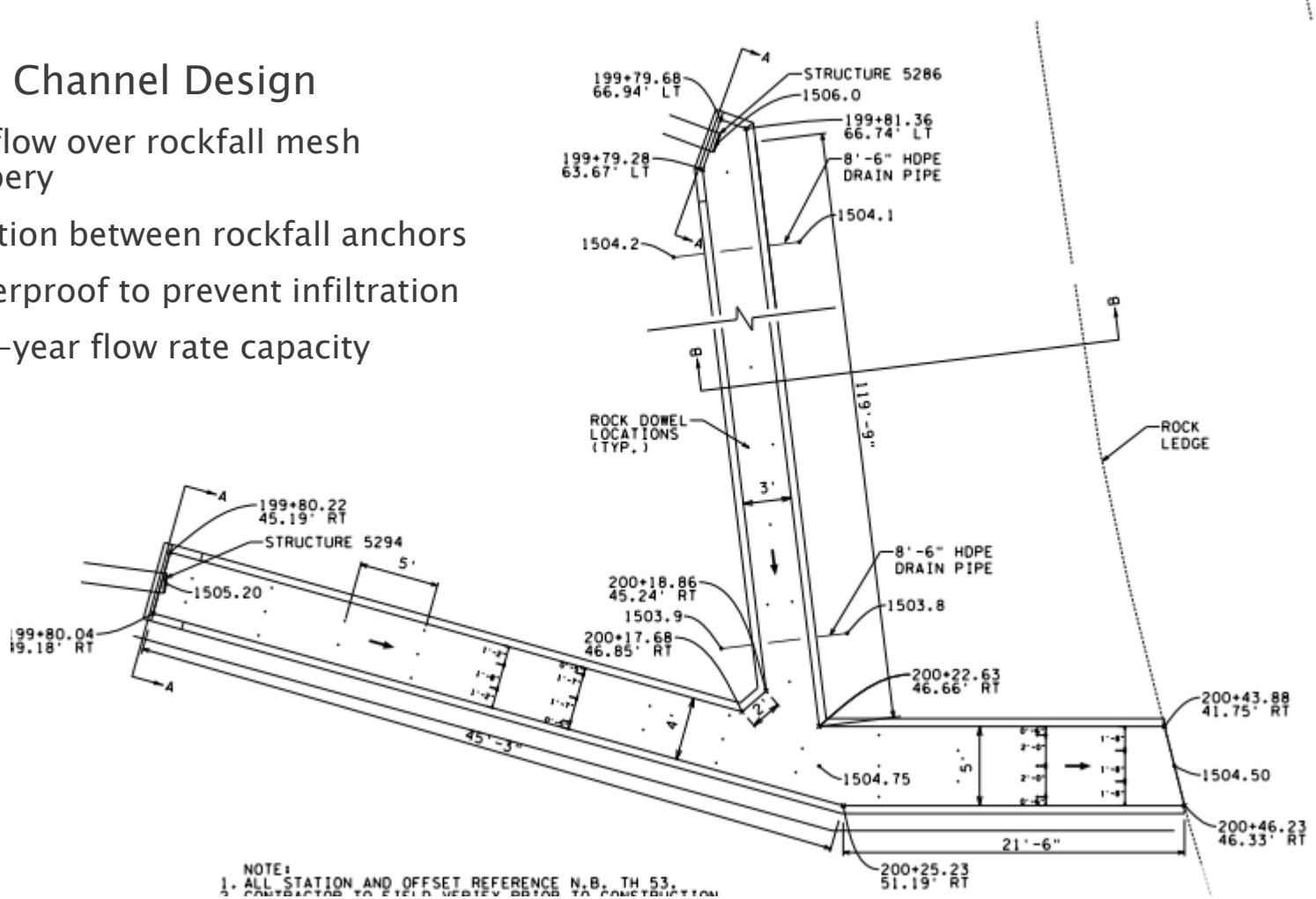


# East Abutment Outfall – Final



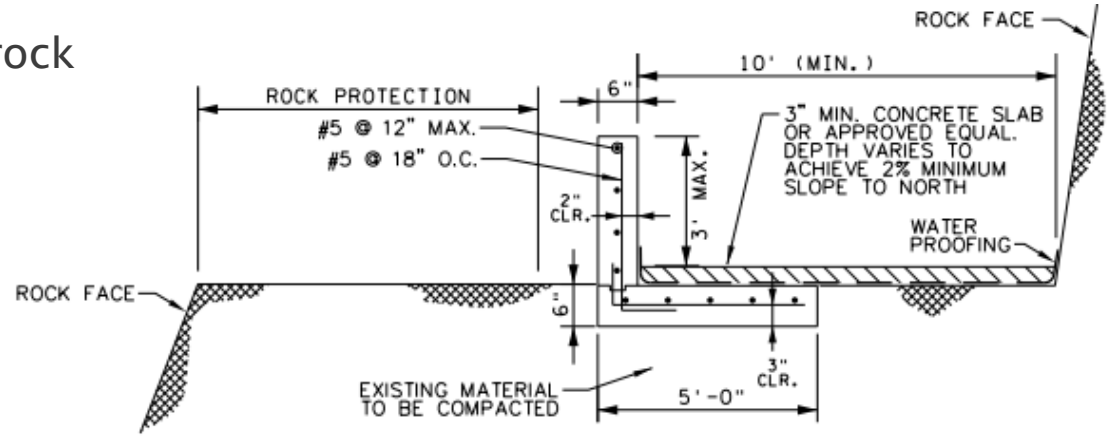
# East Abutment Outfall – Final

- Upper Channel Design
  - Outflow over rockfall mesh drapery
  - Position between rockfall anchors
  - Waterproof to prevent infiltration
  - 100-year flow rate capacity



# East Abutment Outfall

- Lower Channel Design
  - Waterproof bottom, prevent infiltration
  - Freeze-thaw concerns
  - Impact from falling rock




NOTES:
1) CONCRETE SHALL HAVE A MINIMUM 28-DAY COMPRESSIVE STRENGTH OF 4,000 PSI.
2) REINFORCING STEEL SHALL BE DEFORMED BARS CONFORMING TO ASTM A615 GRADE 60.
3) ACI STANDARD 90° BENDS SHALL BE USED AS SHOWN. BAR SUPPORTS SHALL BE NONMETALLIC.

LOWER CHANNNEL WALL DETAIL


Kimley»Horn


Kimley»Horn

# Construction Schedule

- November 2015: Start of Construction
- November 2017: Open to traffic and vacate existing easement
  - Currently on track for September 2017
- The project is now 60% complete
- June 2018: Final Completion and Landscaping

# Girder Fabrication 4/12/16


Kimley»Horn


Kimley»Horn


Kimley»Horn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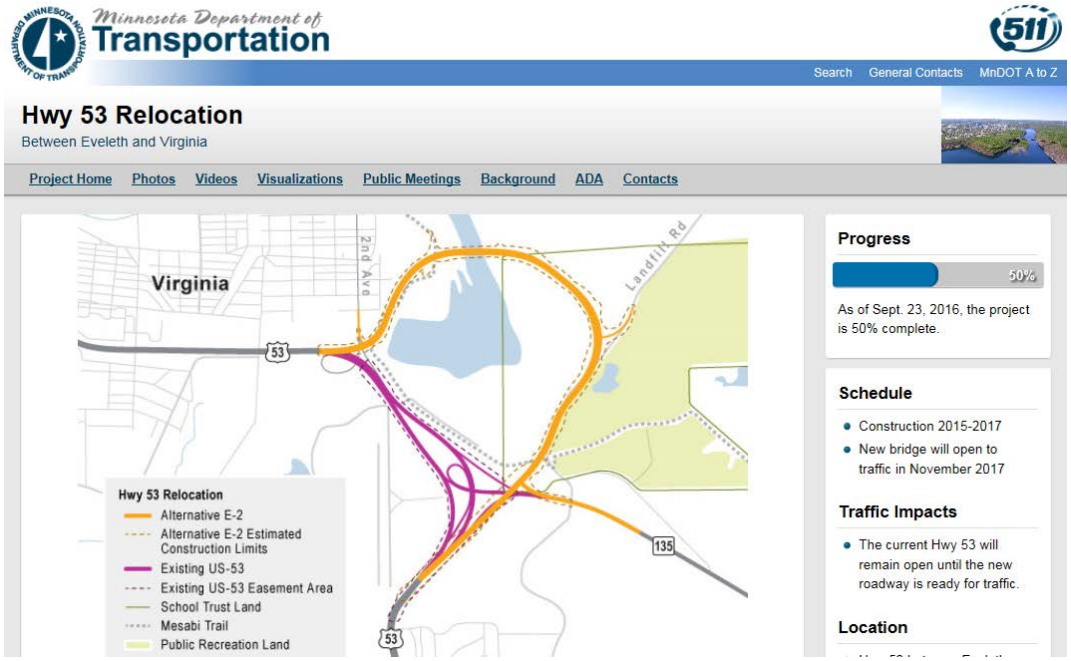
# Project Website

- http://www.dot.state.mn.us/d1/projects/hwy53relocation/index.html
- Google "MnDOT Highway 53"
- Updated information on construction
- Updated photos
- Webcam
- Project Hotline: (218)820-8532



# Mitigating Geyser Events in the Minneapolis Tunnel Systems

Minnesota Water Resources Conference
October 19, 2016

Brandon Barnes, PE
Greg Fransen
Lulu Fang
Christian Frias, PhD
Omid Mohseni, PhD, PE

Minneapolis
City of Lakes

BARR

# overview

- case studies for two stormwater tunnel systems
- hydraulic evaluation
- structural modifications to tunnel connections
- conclusions

- numerous stormwater tunnels located in Minneapolis
- stormwater directed to Mississippi River
- increased stormwater runoff
- rapid pressurization can result in geyser events

# Minneapolis stormwater tunnels

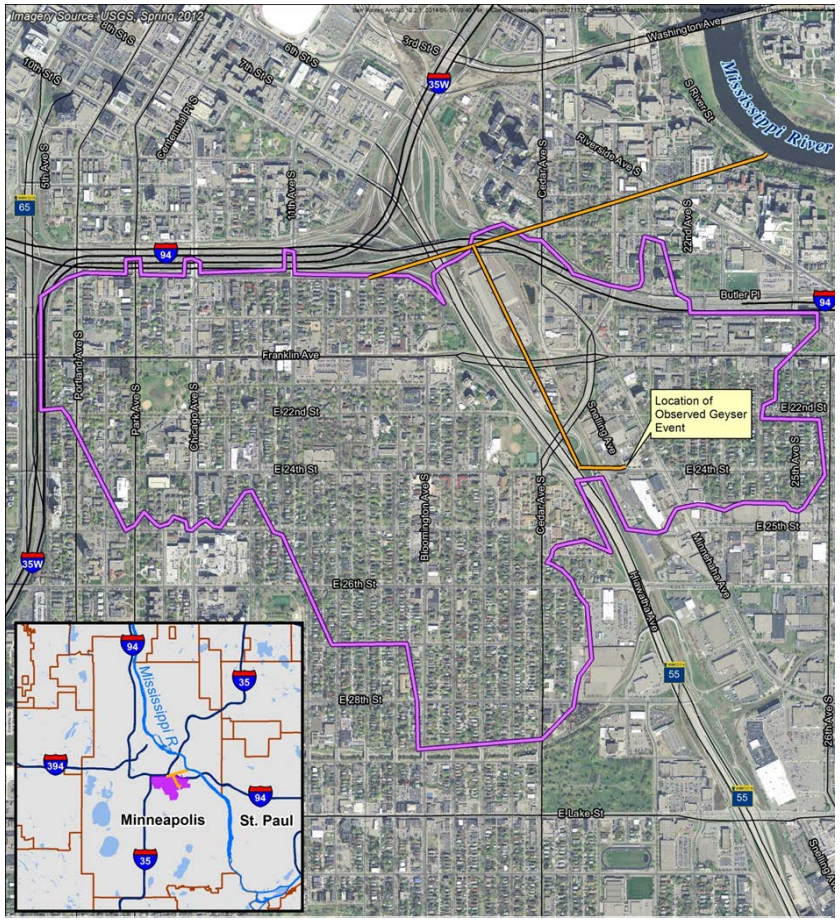
August 1, 2011 geyser event at Como Ave SE and 24th Ave SE
(Source: https://www.youtube.com/watch?v=eO8TP-erR4k)

May 19, 2013 geyser event at Como Ave SE and 25th Ave SE
(Source: https://youtu.be/eeItLdLUA-g)

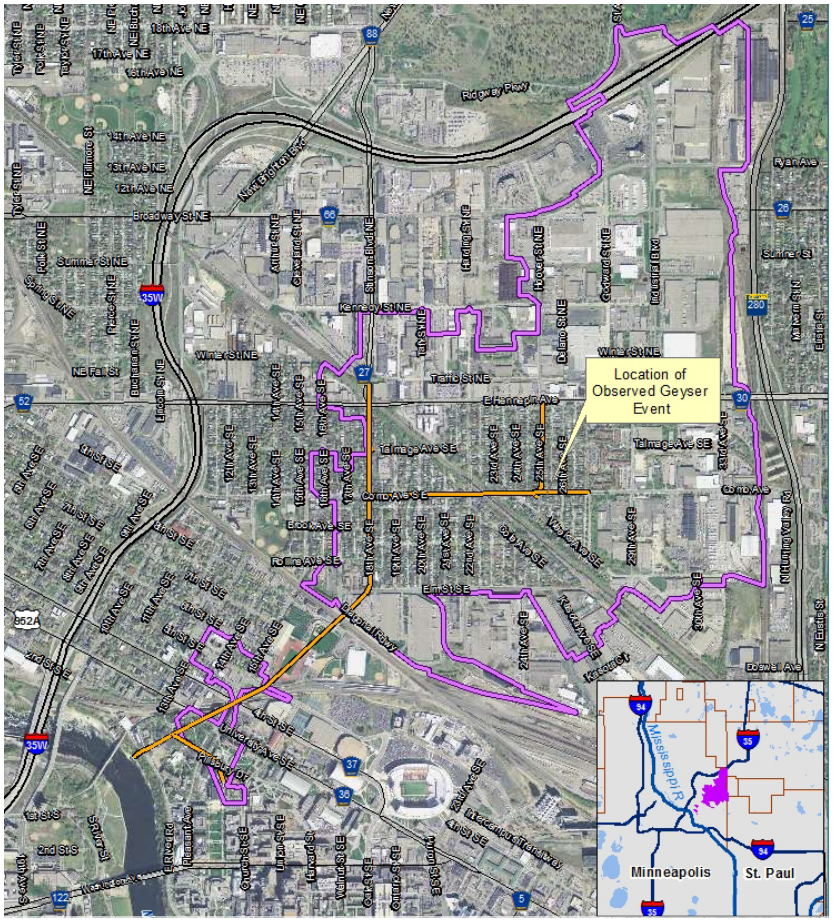
June 24, 2010 geyser event at 24th Street East and Snelling Avenue
(Source: https://www.youtube.com/watch?v=GIt4AekMWBM)

***geyser*** – rapid upward movement of an air/water mixture through a tunnel connection

# two case studies



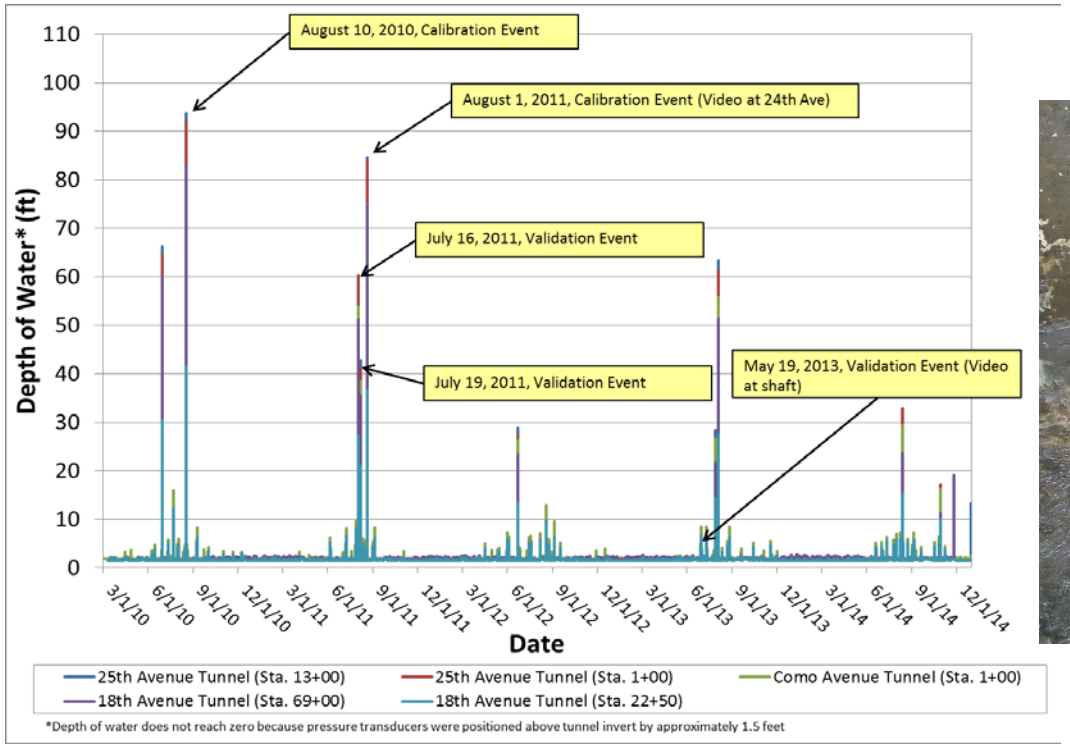

St. Mary's stormwater tunnel system



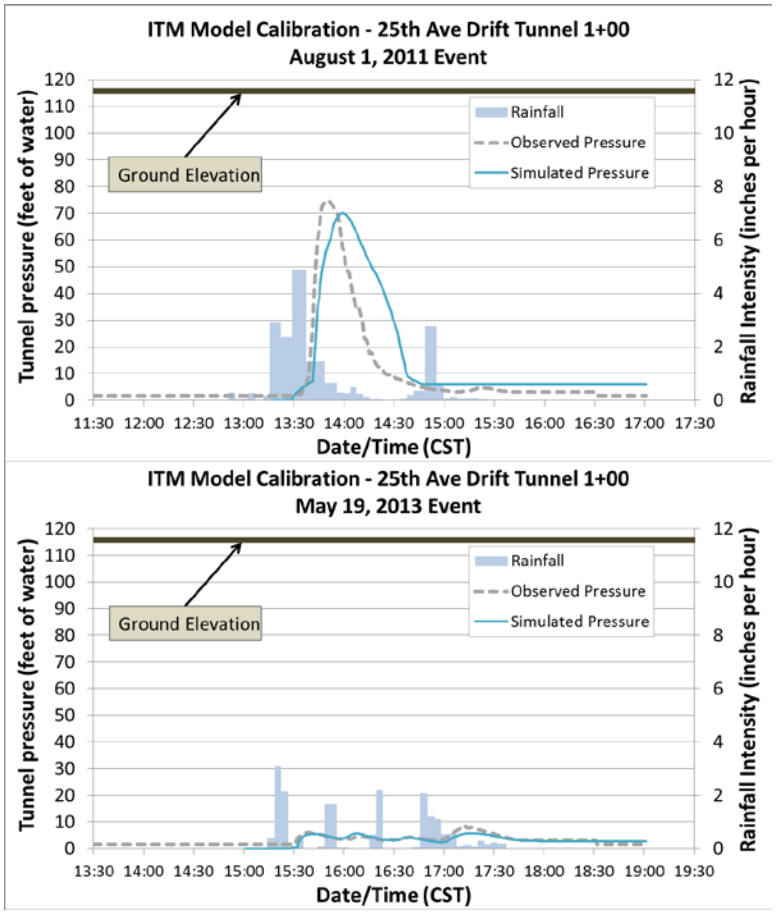

Como Avenue stormwater tunnel system

# hydraulic evaluation

- XP-SWMM used for hydrologic calculations
- ITM used for hydraulic analysis
- OpenFOAM used for two-phase flow analysis



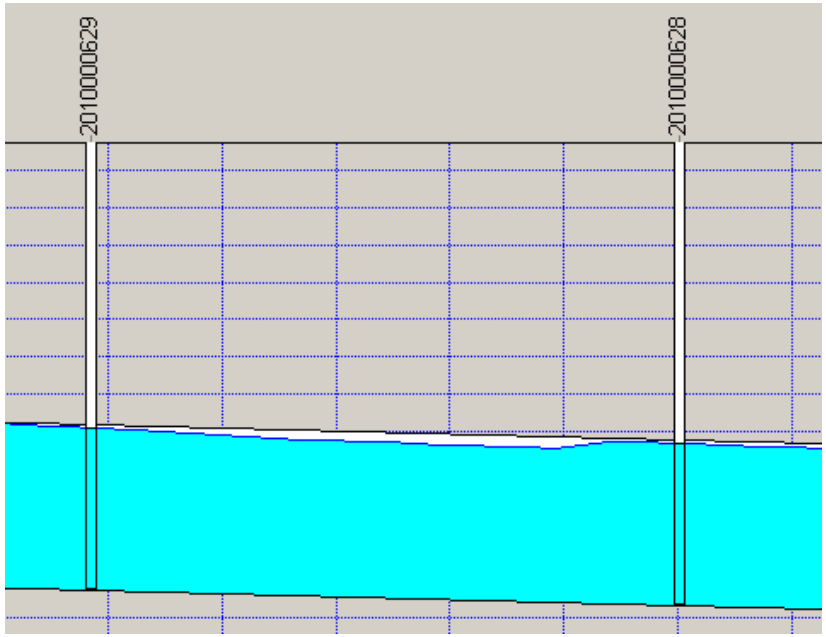

# hydraulic evaluation



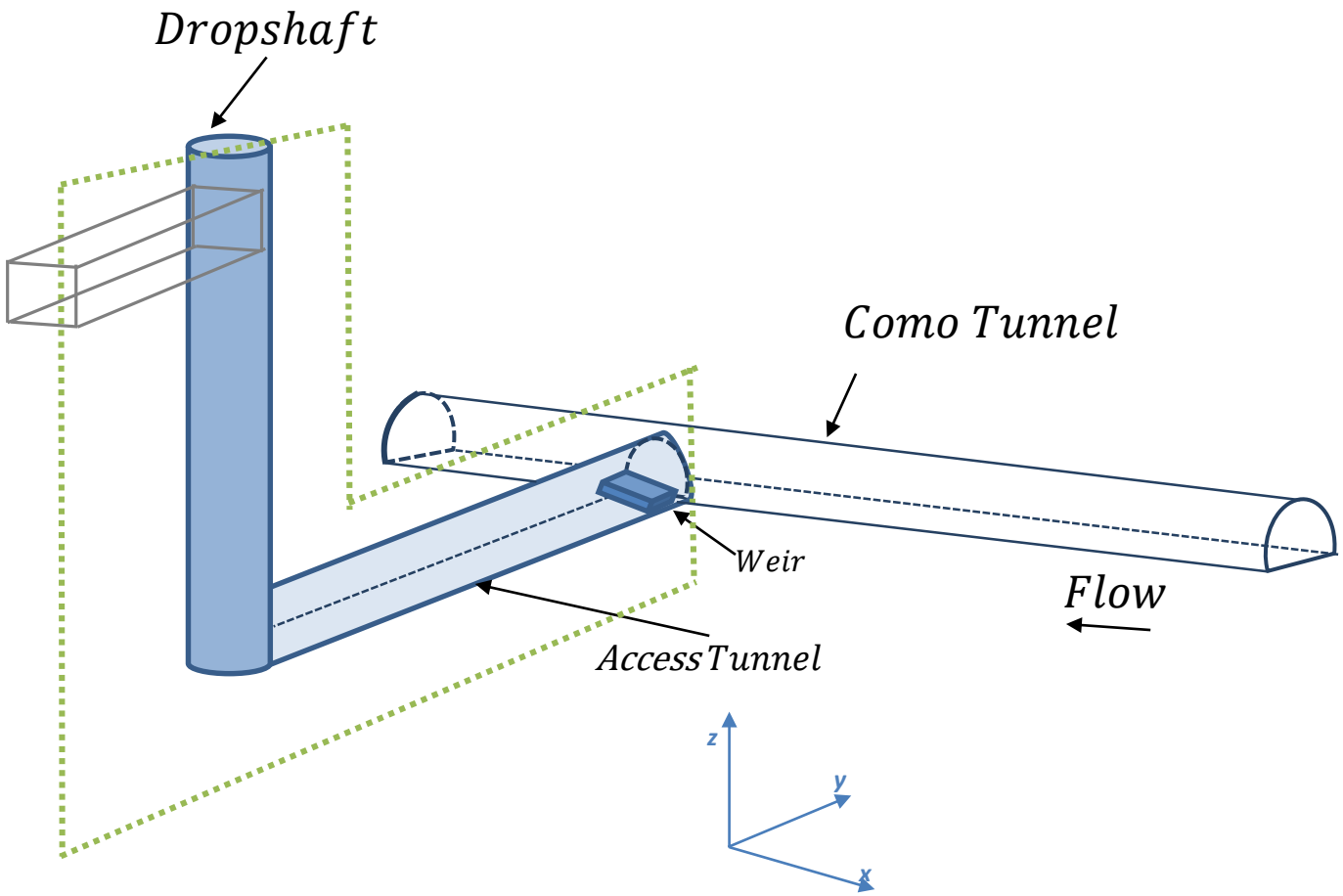

- simulation results used to define boundary conditions for OpenFOAM simulations

- measured pressure simulated with XP-SWMM and Illinois transient model

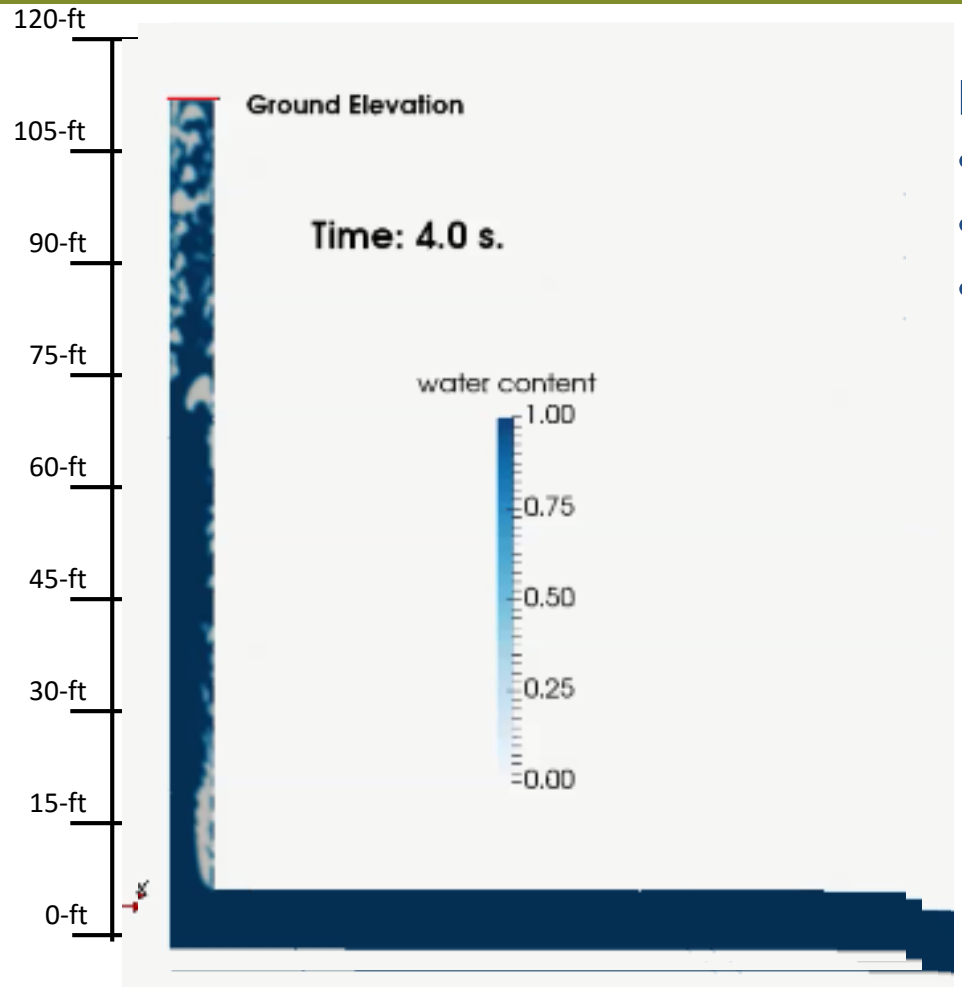
- Illinois Transient Model identified potential air pocket locations



# OpenFOAM schematic



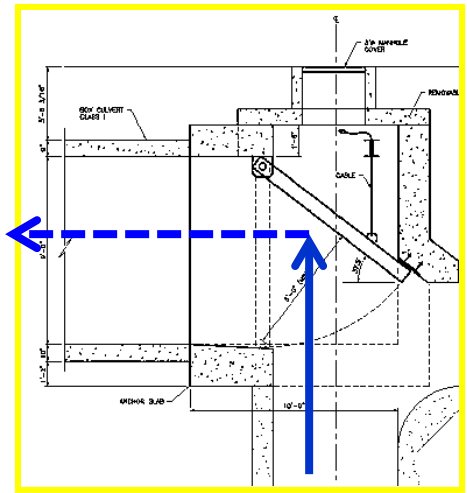
# sample OpenFOAM simulation

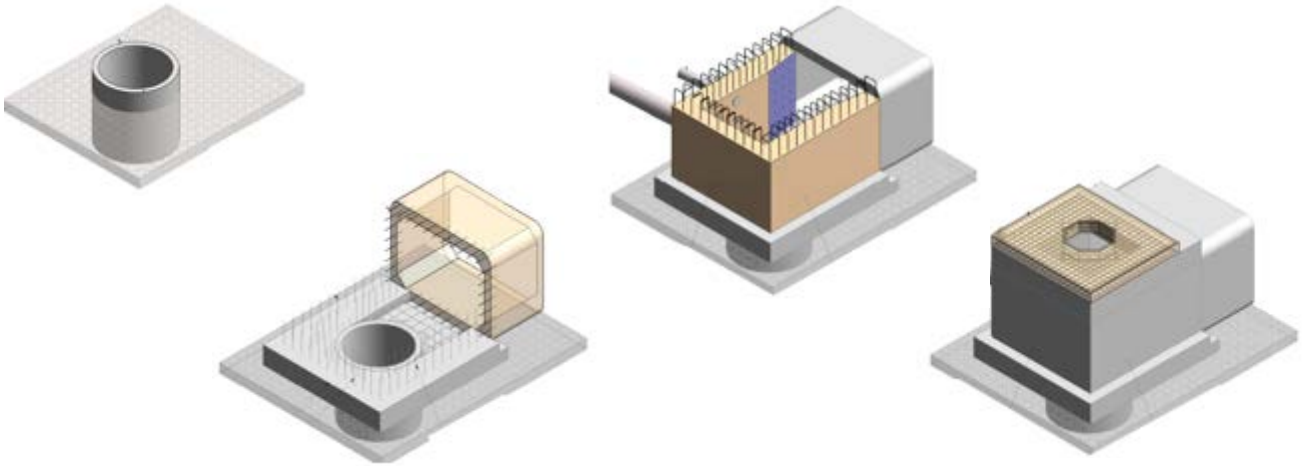


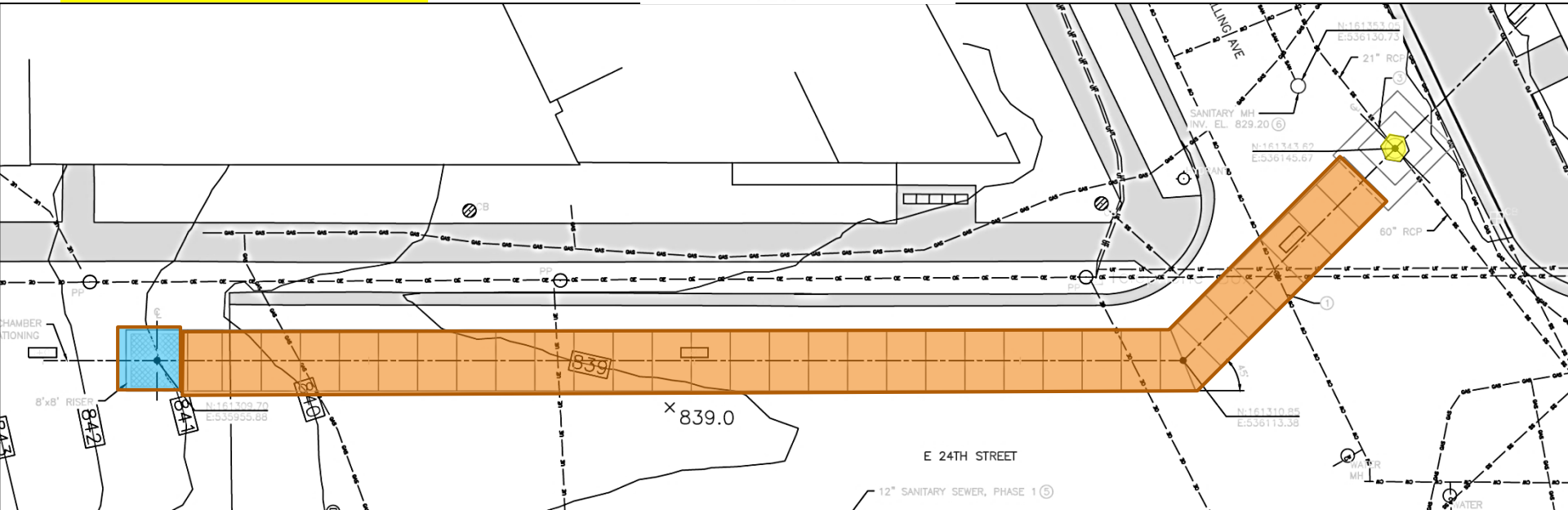

**hydraulic design criteria**

- vertical force
- chamber volume
- open area

# surge chamber schematic





# surge chamber construction

# conclusions

- hydraulic evaluation can identify design criteria for surge chambers
- surge chamber construction based on hydraulic evaluation allows pressure release without geyser events
- monitoring of existing tunnels is critical to identify issues

June 24, 2010 geyser event at 24th Street East and Snelling Avenue
(Source: https://www.youtube.com/watch?v=GIt4AekMWBM)

October, 2015 24th Street East and Snelling Avenue

# thank you.

Brandon Barnes, PE

Barr Engineering

bbarnes@barr.com

952-832-2737

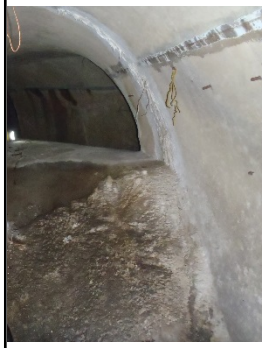
# sample OpenFOAM simulation

**design criteria**

force

volume

ea



# Development of Planning Toolsets using XP-SWMM and GIS Systems

October 19, 2016

WENCK ASSOCIATES

Responsive partner.
Exceptional outcomes.

Coon Creek Watershed District

City of Fridley

BLAINE

COON RAPIDS Minnesota

City of Ham Lake

CITY OF ANDOVER

SLP


*Presented by*
Ed Matthiesen, P.E.
Bryce Cruey, P.E., C.F.M.

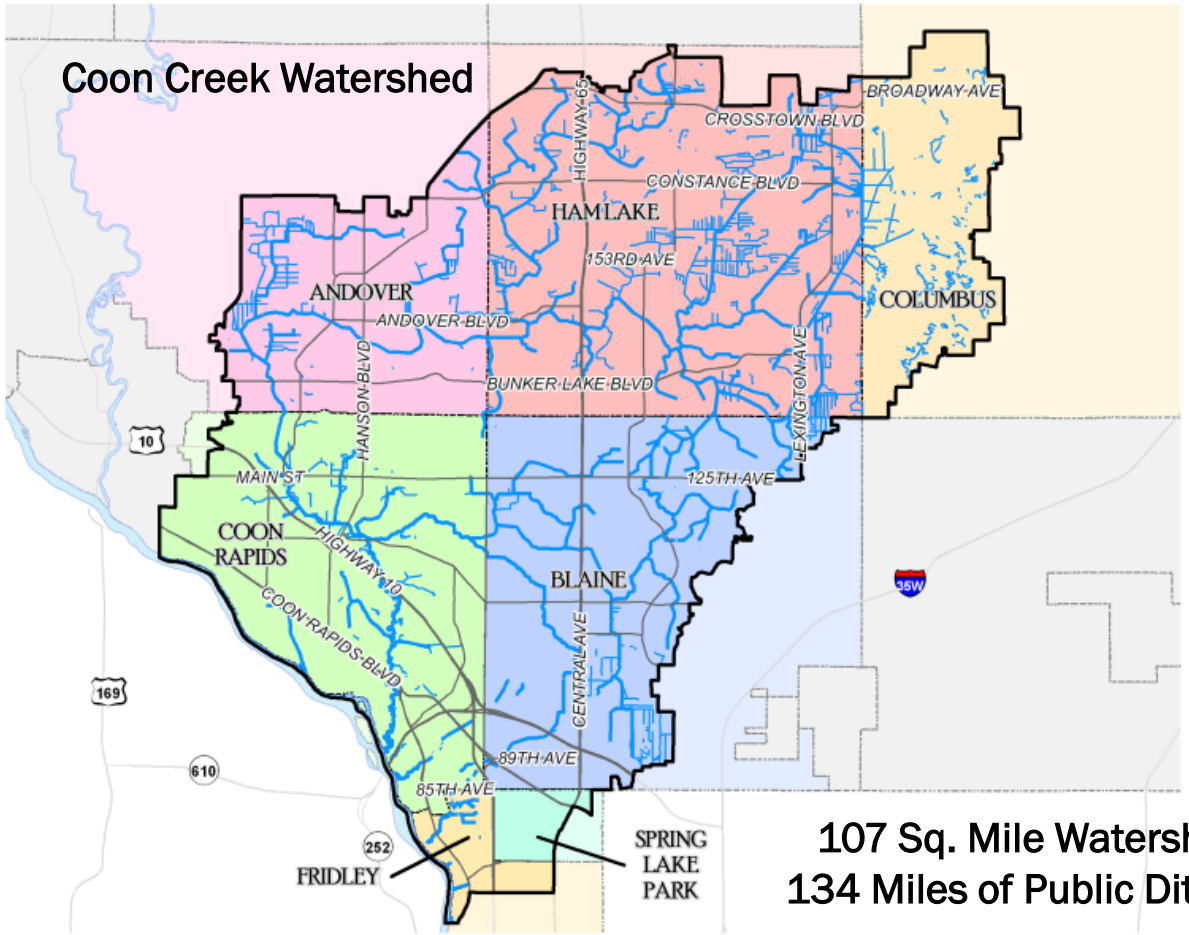

Coon Creek Watershed District

WENCK ASSOCIATES

# Agenda

- Introduction to The System
- Developing a Watershed Model
- Data Management and Workflow
- Developing Practical Management Tools
- Q & A

# Introduction to the System




107 Sq. Mile Watershed
134 Miles of Public Ditches

- Groundwater
- Surface Water
- Water Quality
- Floodplain
- Wildlife Habitat

Floodplain

- Zero net loss policy
- Property Damage and Public Safety





WENCK ASSOCIATES

# Model Development

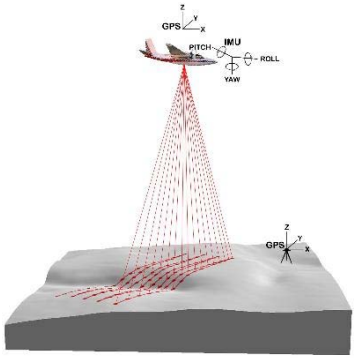
In 2013 and 2014, Wenck Associates worked with the District to update its XP-SWMM model.

**Cross Section Surveys**

**Datum Conversion**

NGVD 1929
to
NAVD 1988

**LiDAR**




**City Cooperation**

- Storm Sewer Data
- New Bridge Crossings
- As-built data

NOAA Atlas 14

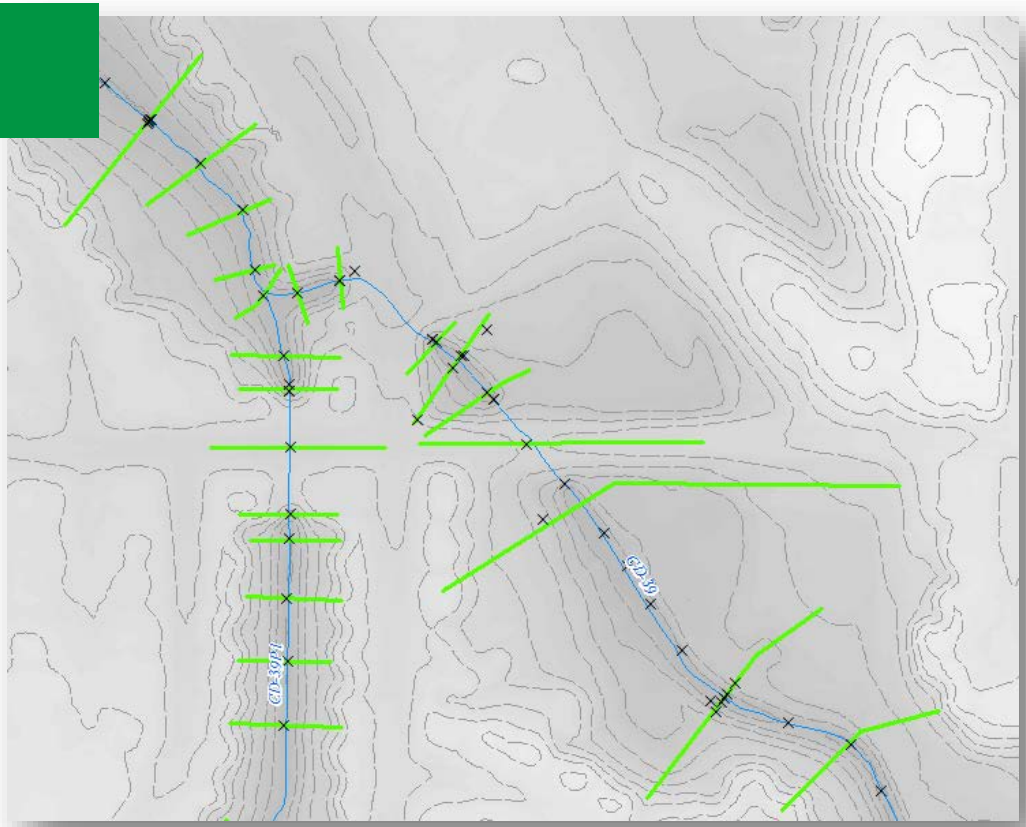
Precipitation-Frequency Atlas of the United States



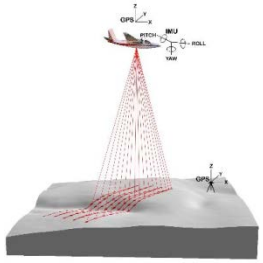
WENCK ASSOCIATES

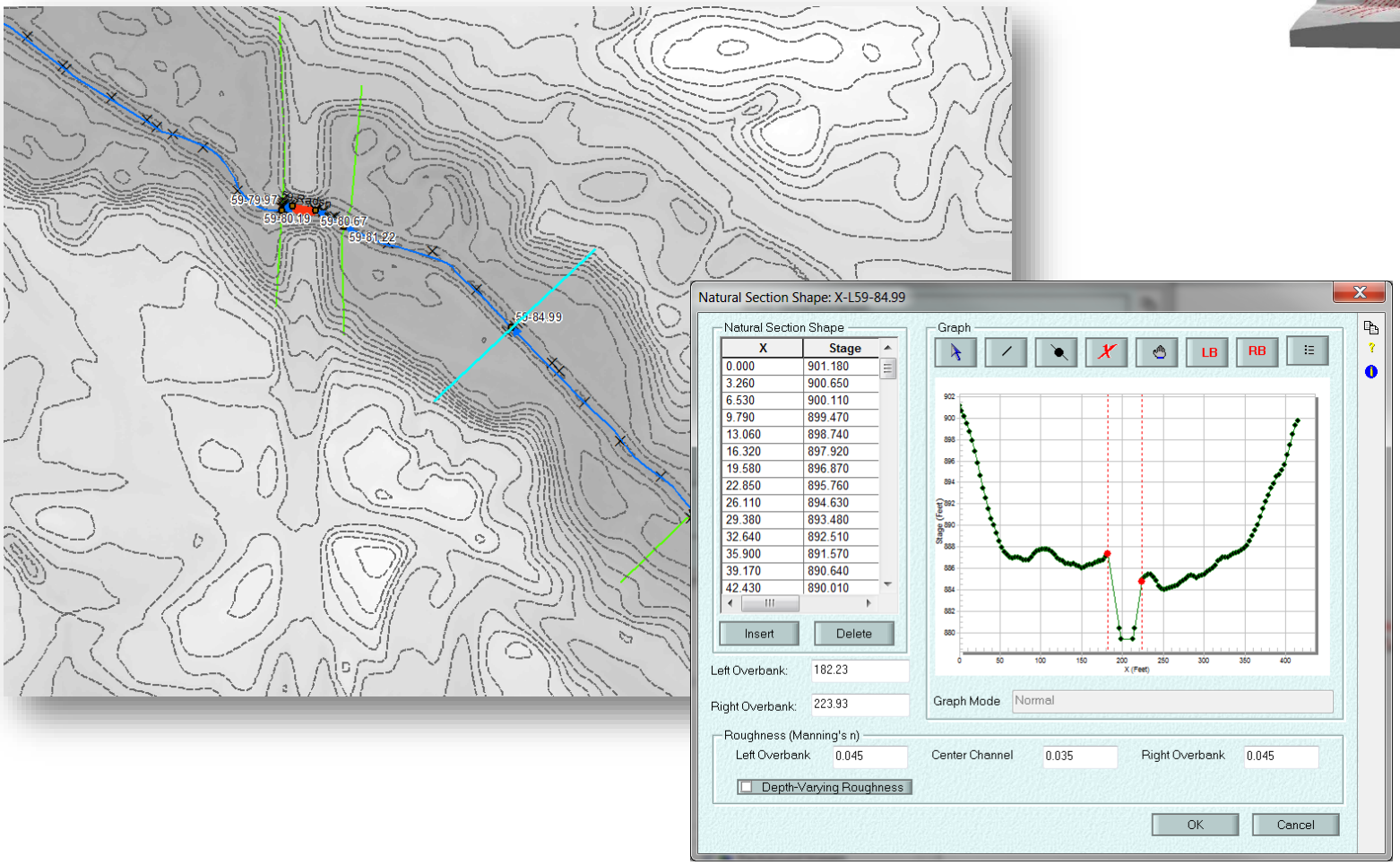
# Cross Section Surveys

- [redacted]
  sections
- Improve floodplain hydraulics



# LiDAR







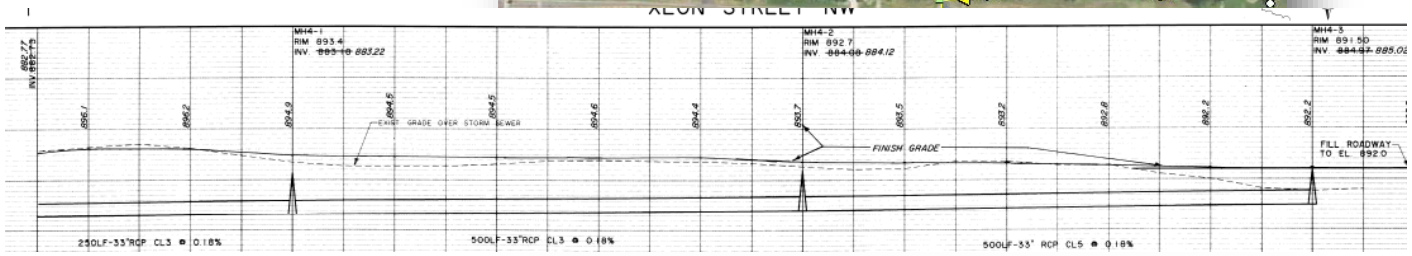



WENCK ASSOCIATES

# City Data

- [redacted]
  model for urbanized areas

- Account for rate control projects within the District.








WENCK ASSOCIATES

# Challenge

How to best manage a large collection of data and incorporate it into a stormwater model??

# Geodatabase

## Management of an Organized Collection of Data

GEODATABASE

CCWD Data
City Data
Geometry Inputs
Hydrology Inputs
Model Outputs



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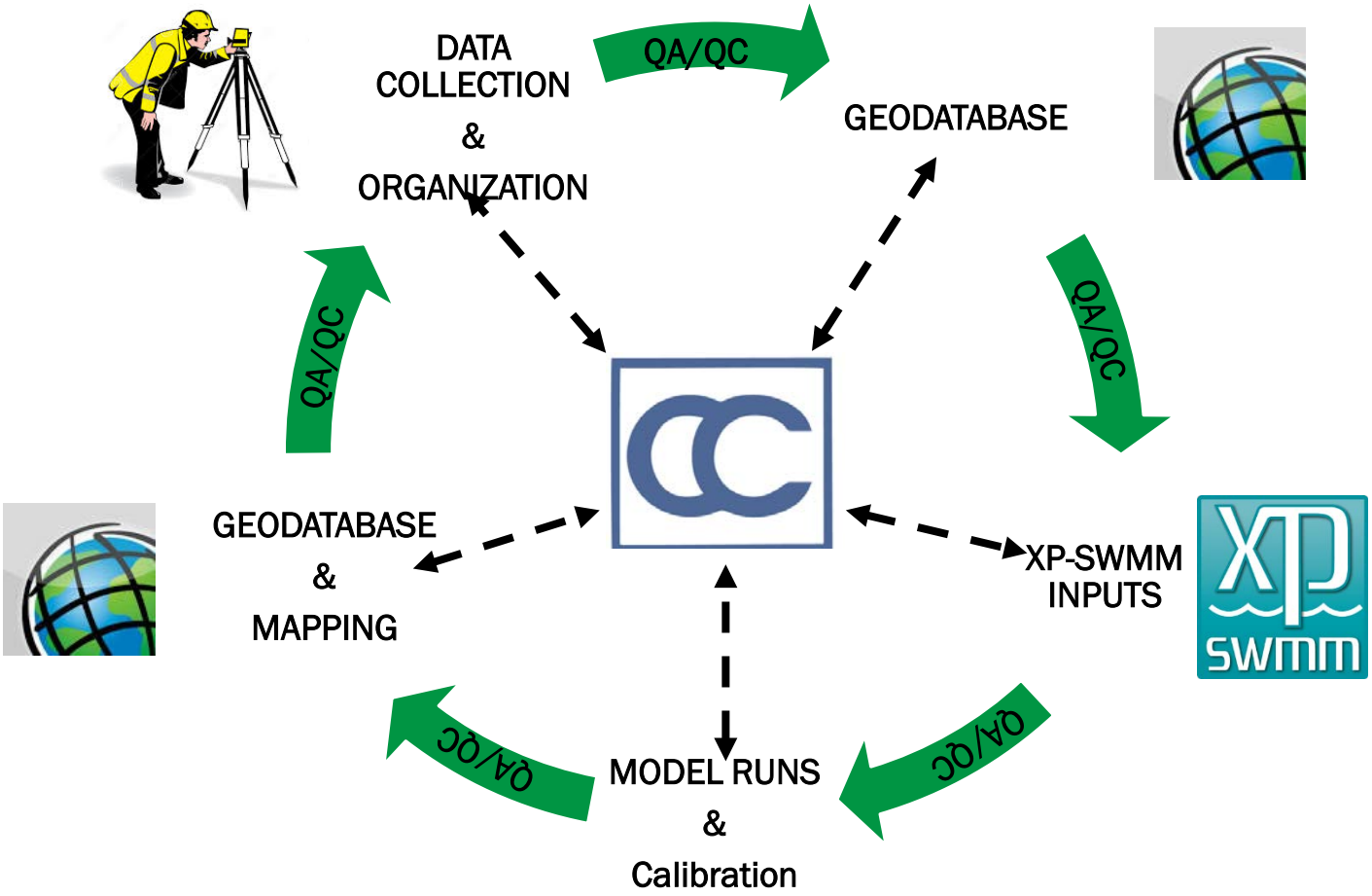
# Workflow



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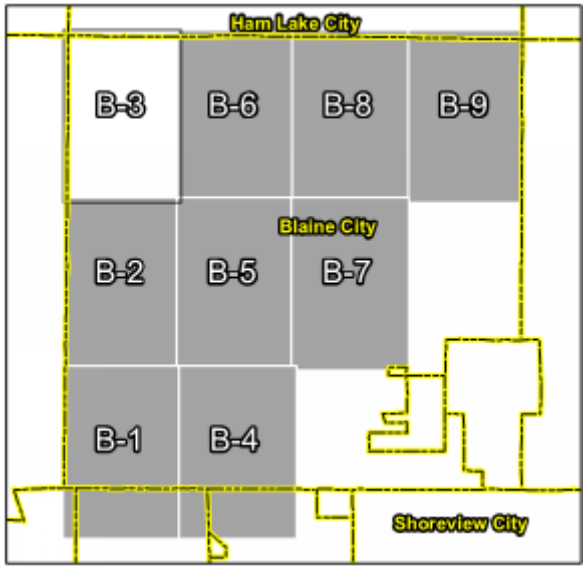
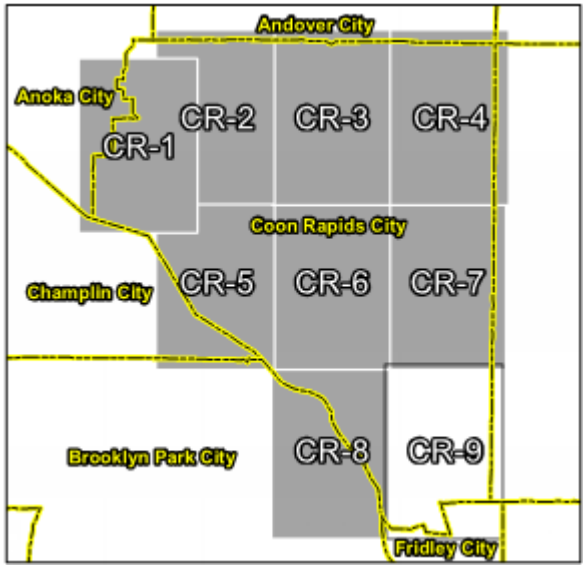
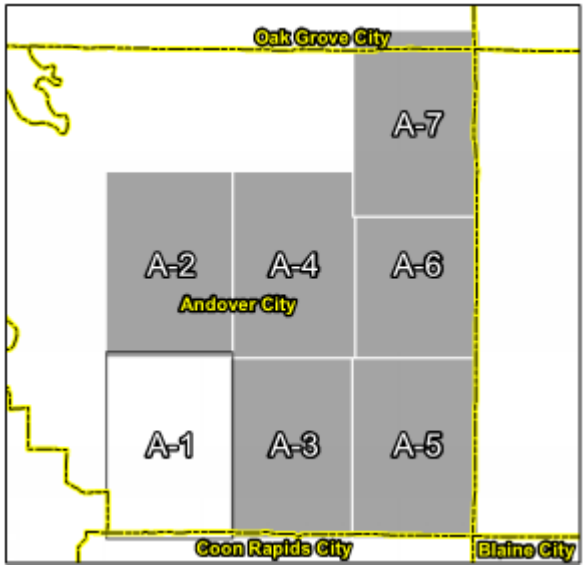
# Developing Practical Management Tools

- Floodplain Management
- Development Projects
- Asset Management





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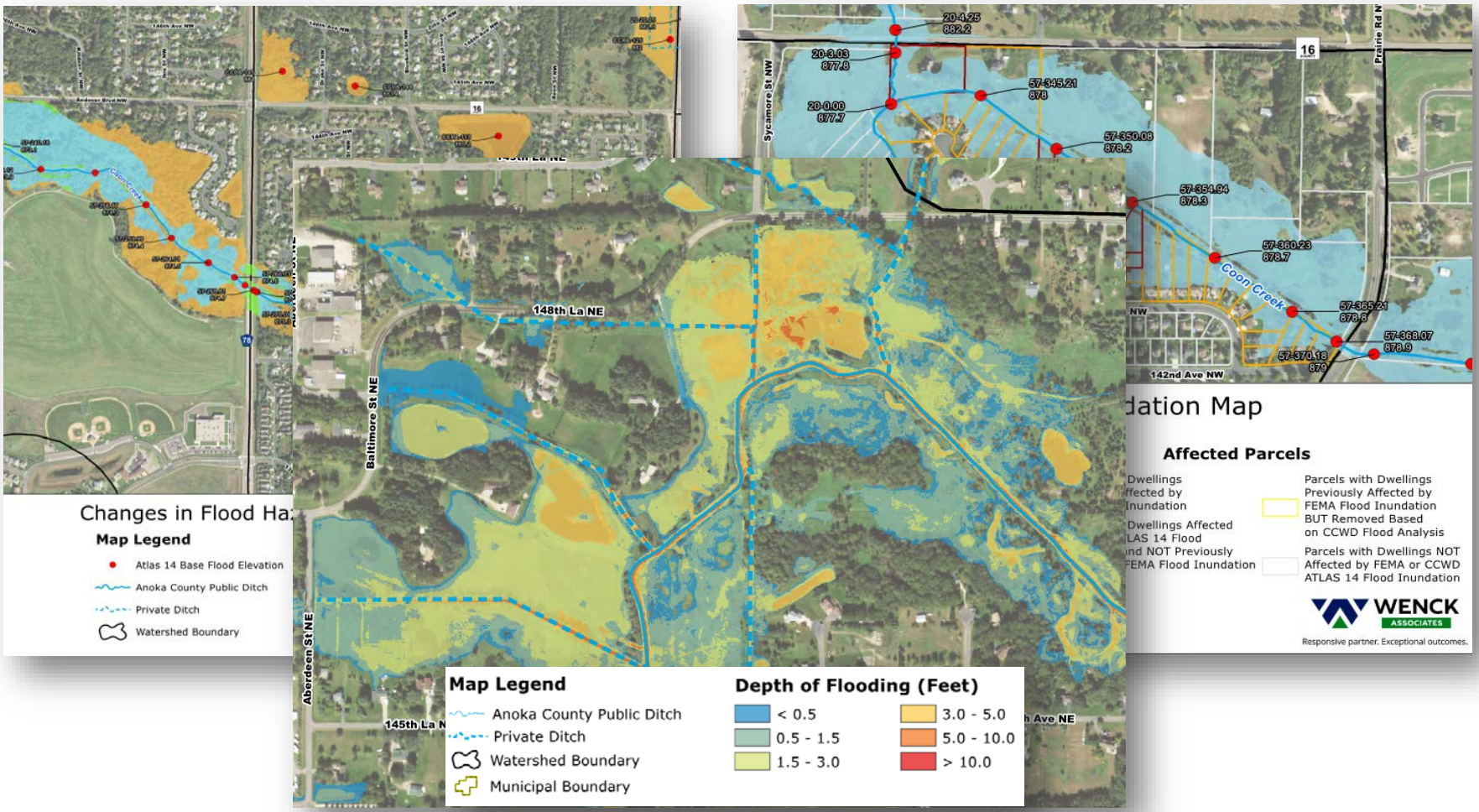
# Developing Practical Management Tools





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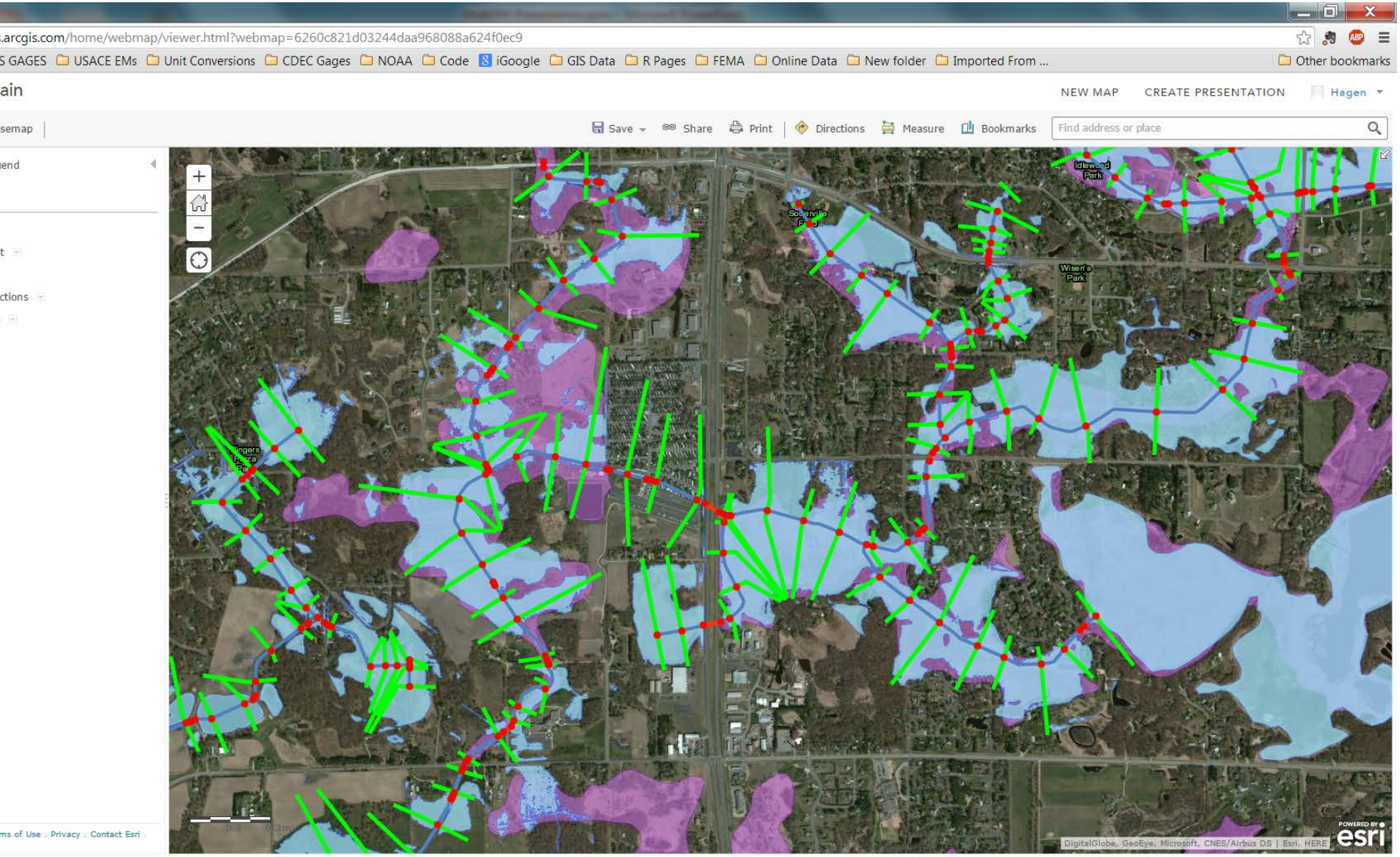


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# Questions

**Contact Information**
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Water Resources Engineer, Associate
bcruey@wenck.com
D – 763.479.4241
C – 612.418.0565

Coon Creek Watershed District

City of Fridley

BLAINE

COON RAPIDS Minnesota

City of Ham Lake

CITY OF ANDOVER

SLP



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# CULVERT INVENTORY AND RANKING PROTOCOL

AMANDA HILLMAN
MNDNR
STREAM HABITAT PROGRAM

# OUTLINE

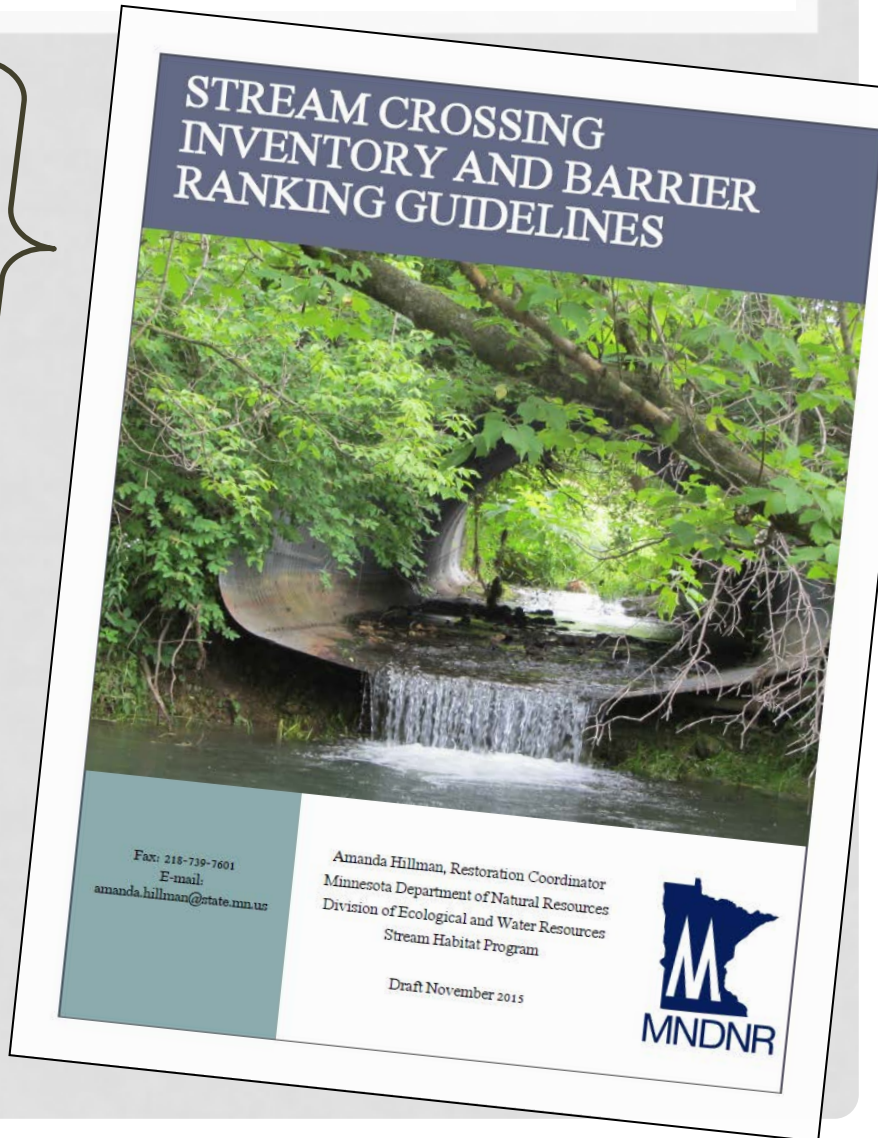
- Purpose of Stream Crossing Guidelines
- New Culvert Legislation
- Stream Impacts from Culverts
- Overall Inventory Process
- Review of Ranking Parameters
- Watersheds Applying Ranking Guidelines
- Next Steps
- Culvert Training
- Summary

# STREAM RESTORATION – SYSTEMS PERSPECTIVE

- 5 Components
  - Hydrology
  - Connectivity
  - Water Quality
  - Geomorphology
  - Biology
- Used for ranking restoration projects
- All 5 can be affected by stream crossings (culverts)

# PURPOSE OF STEAM CROSSING INVENTORY

- **Inventory All Stream Crossings**
- **Assign Culverts with a Barrier Ranking**
- Use assigned Barrier Rankings to prioritize culverts for replacement or restoration



# NEW LEGISLATION

Sec. 91. Minnesota Statutes 2014, section 103G.245, subdivision 2, is amended to read:

Subd. 2.**Exceptions.**A public waters work permit is not required for:

(1) work in altered natural watercourses that are part of drainage systems established under chapter 103D or 103E if the work in the waters is undertaken according to chapter 103D or 103E; ~~or~~

(2) a drainage project for a drainage system established under chapter 103E that does not substantially affect public waters~~.~~; or

(3) culvert restoration or replacement of the same size and elevation, if the restoration or replacement does not impact a designated trout stream.

# MN STREAM PRACTITIONERS WHITEPAPER

- DRAFT – In Review
  - Road crossings as barriers
  - Types of barriers
  - Documented impacts
  - Endangered species
  - Sediment impacts
  - Advances in culvert design
  - Cost effectiveness of properly designed culverts
- Intended for the public, DNR Management and Legislators

*Written by:*

Minnesota Stream Practitioners

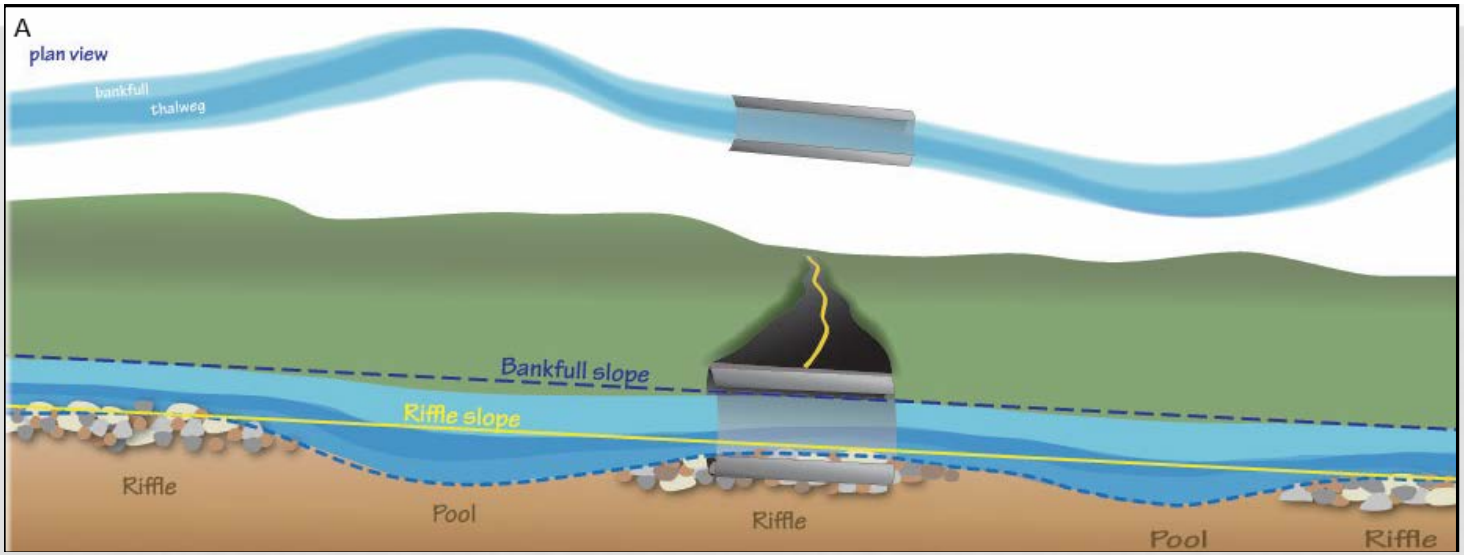
September 2016

***A Response to*** **Minnesota Statutes 6459, Section 547G.689, Subd. 2. Exceptions. A public waters work permit is not required for: (3) culvert restoration or replacement of the same size and elevation, if the restoration or replacement does not impact a designated trout stream.**

Upholding Minnesota Statutes 2015, Section 103G.245, subdivision 2, (CHAPTER 4--S.F.No. 5 ., page/line 152.20 – 152.28) will have the unintended consequence of perpetuating existing and future negative impacts to Minnesota streams due to improper culvert design. This statute creates an exception to the need for a Department of Natural Resources (DNR) Public Waters Work Permit for culvert restoration and replacement (on non-trout streams) when replaced with a culvert of the same size and elevation. Eliminating the need for a permit ensures that ecological damage caused by improper culvert placement in the past will persist. The loss of oversight provided by permitting could lead to further degradation of these biological systems. The perpetuation of ecological damage supported by this statute is counter to the mandate set by Minnesota (MN) voters when they approved the Clean Water, Land and Legacy Amendment to 'protect enhance and restore fish, game and wildlife habitat; and to protect, enhance and restore rivers and streams.'

Road-stream crossings have the potential to negatively affect the physical and biological function of our streams if designed and installed improperly. Methods used in the past for sizing and installing stream crossings were based on a less complete understanding of these potential impacts. Currently, many of the culverts dispersed throughout our watersheds are negatively impacting the biological and physical function of these stream networks. DNR Public Waters Work Permits can mitigate harmful impacts and provide a tool for education that influences future culvert designs.

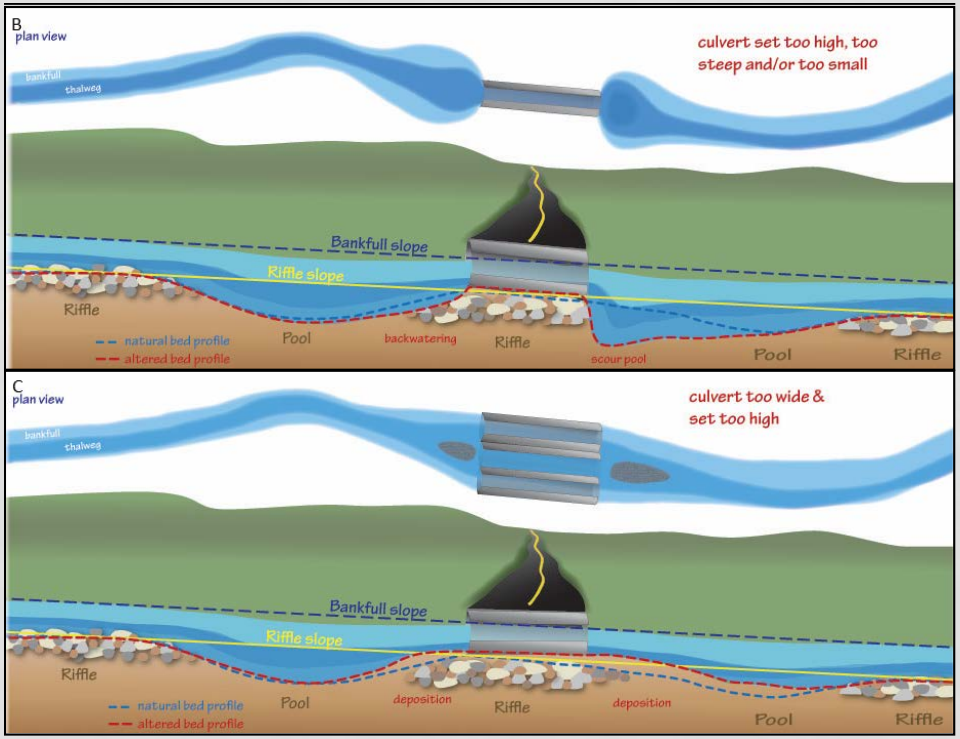
# MESBOAC – A GUIDE FOR CULVERT PLACEMENT




- **M**atch culvert and bankfull width
- **E**xtend culvert length through side slope toe
- **S**et culvert slope same as stream slope
- **B**ury culvert 4” to 2’
- **O**ffset Multiple culverts
- **A**lign culverts with the stream (riffle)
- **C**heck headcuts with grade control (below and/or above)

# MAJOR DESIGN MISTAKES

- Setting the culvert too high
- Improper sizing of culvert
- Poor alignment
- Not aligning slope with stream slope



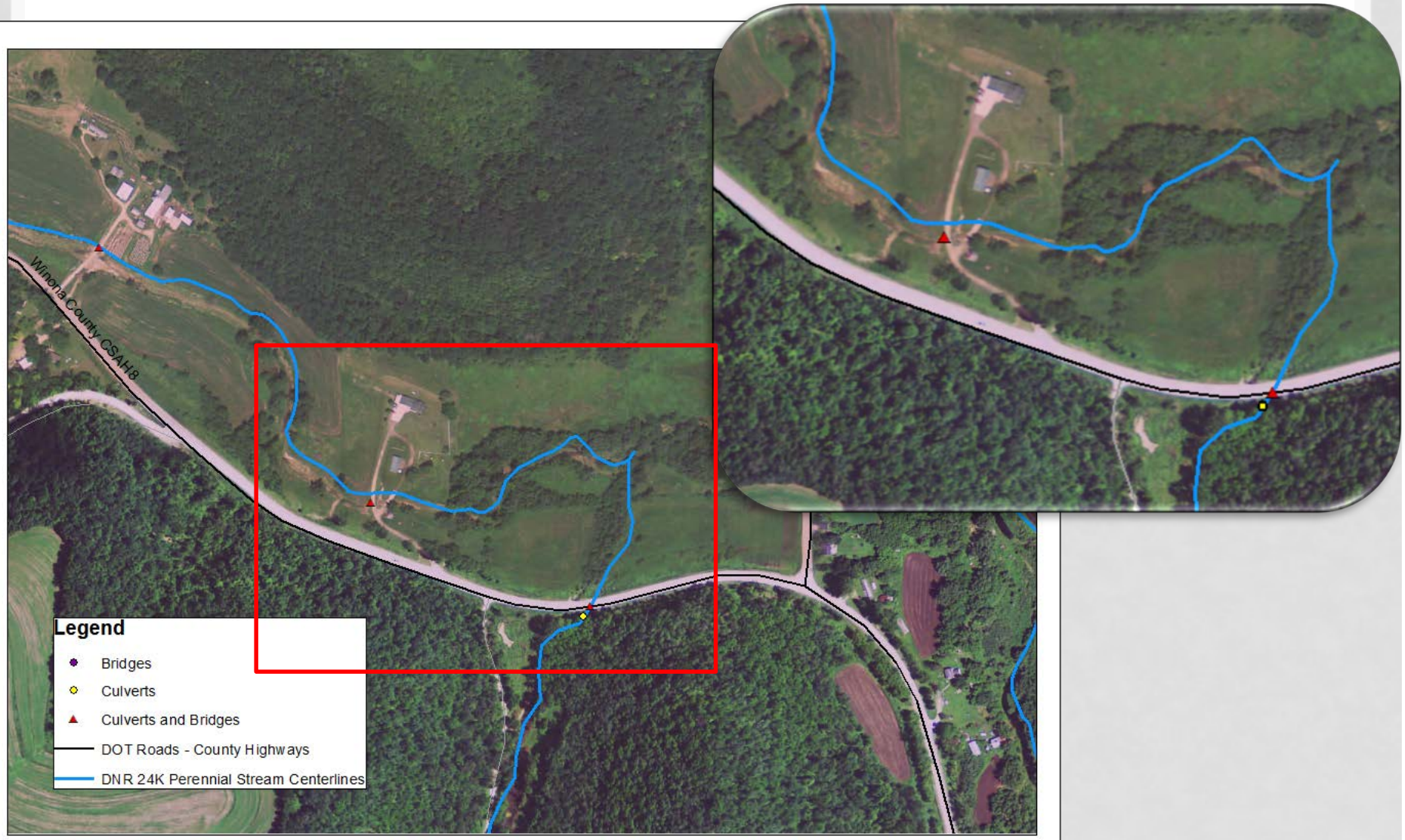
# STREAM IMPACTS FROM IMPROPERLY DESIGN CULVERTS

- Fish Migration Barrier
  - Jump, Velocity, Depth, Turbulence, Lack of substrate and Debris
- Alter aquatic habitat assemblages
- Geomorphological Impacts
  - Alter sediment transport dynamics
- Alter flow regimes
  - Velocity
  - Depths
- Alter water quality
  - Turbidity
  - Water temperatures

# INVENTORY PROCESS

- Overall Inventory Process
  - Digitizing Site Locations
  - Photo documentation
  - Data Collection
  - Onsite Barrier Assessment

# DIGITIZING


Winona County CSAH 8
Legend
Bridges
Culverts
Culverts and Bridges
DOT Roads - County Highways
DNR 24K Perennial Stream Centerlines

# PHOTO DOCUMENTATION

| | Structure | River |
|---|---|---|
| Downstream |  |  |
| Upstream |  |  |

# DATA COLLECTION

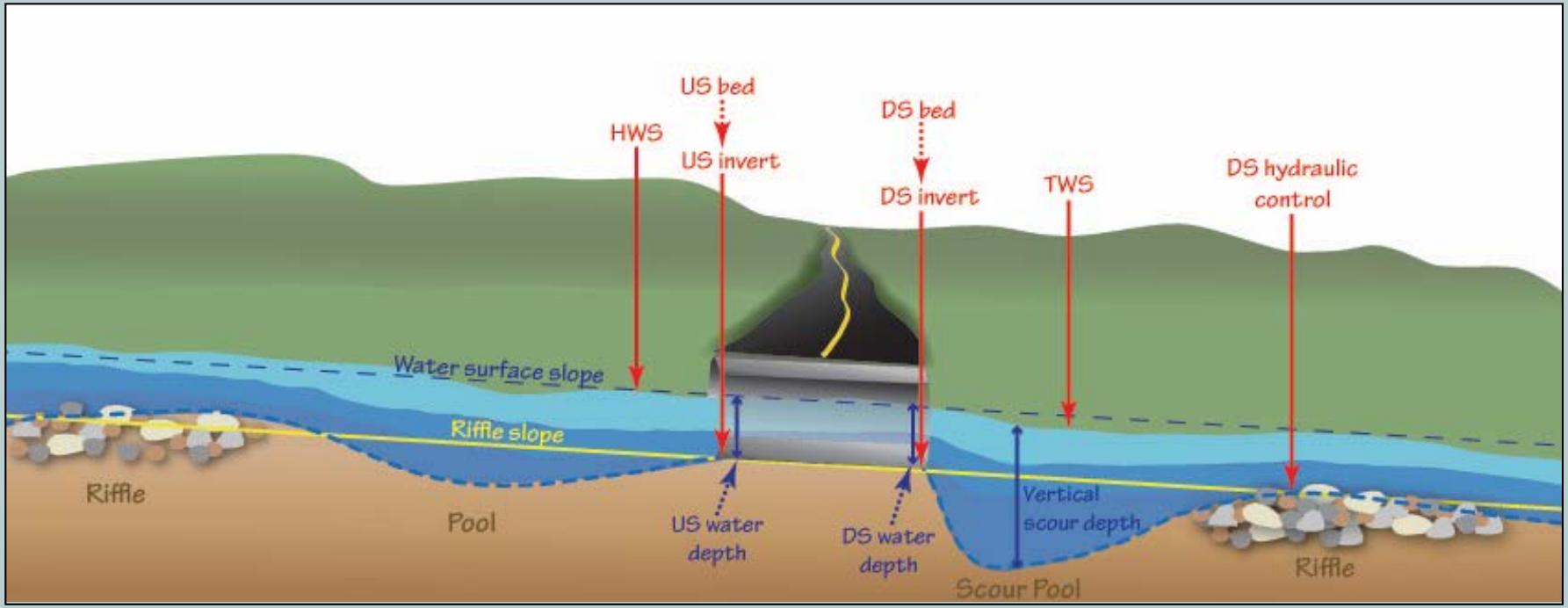



Figure 13: General locations of survey points (**elevations** and **water depths**). Measurements include: headwater surface (HWS), tailwater surface (TWS), upstream (US) and downstream (DS) invert elevations, US and DS stream bed elevations, DS hydraulic control, US and DS water depths in the deepest part of each opening, and vertical scour water depth.

- Site information
- General crossing information
- Culvert dimensions
- Degree of perching

# ONSITE BARRIER RANKING

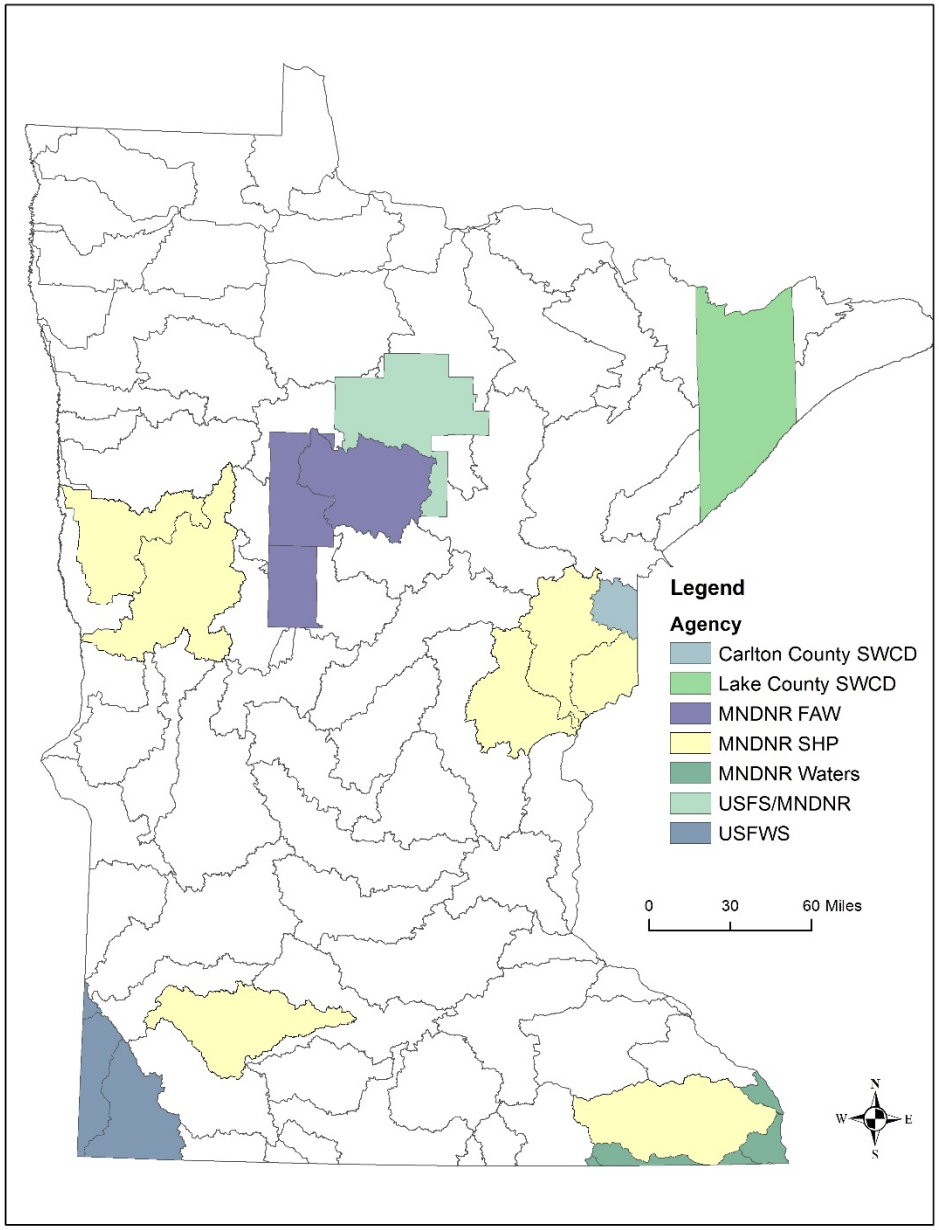
- Determine if site is a fish barrier
  - Outlet drop
  - Velocity
  - Depth
  - Substrate
- Determine if site has an impact of geomorphic stream stability

# BARRIER RANKING PARAMETERS

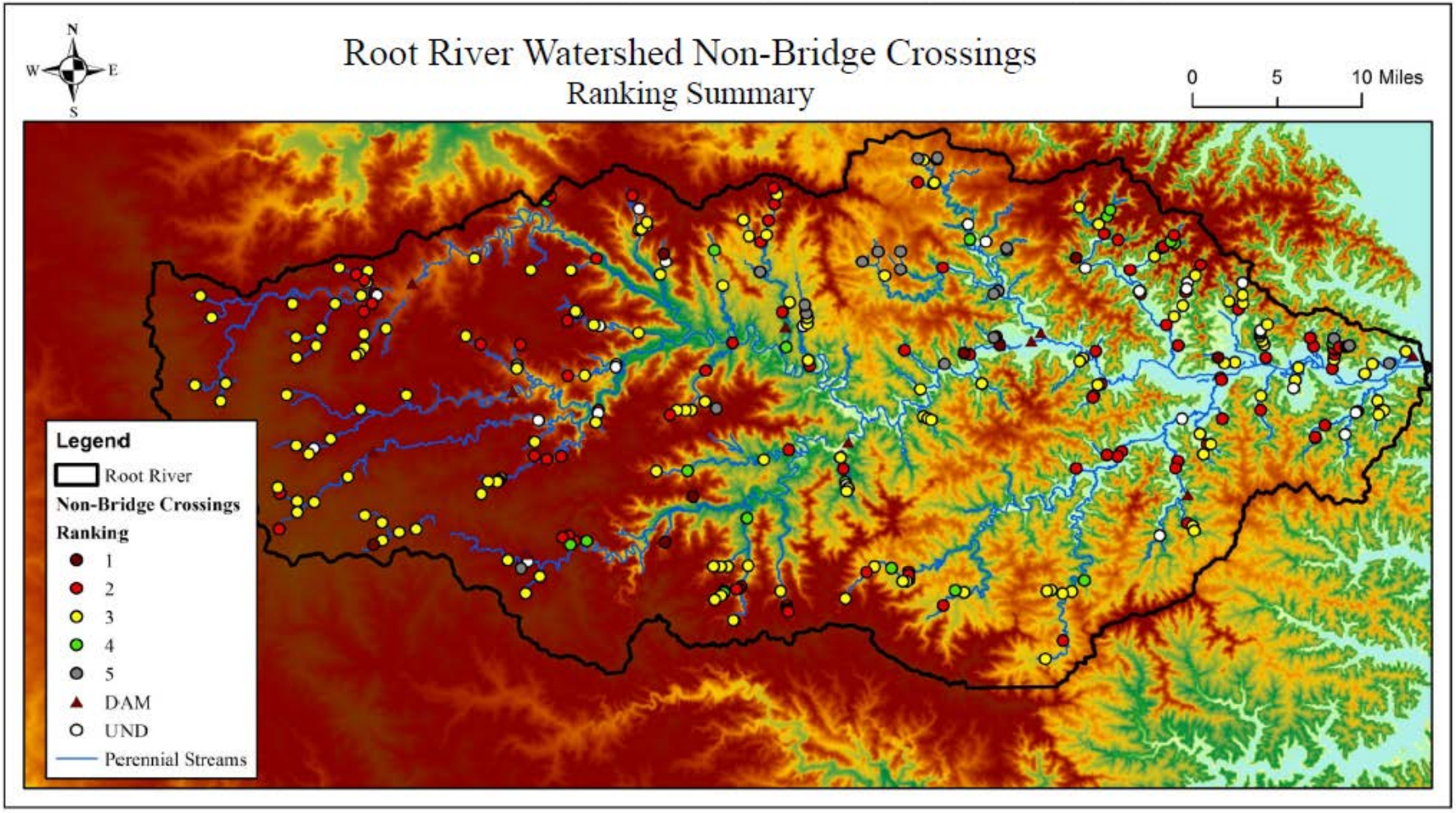
| Ranking | Degree of Barrier | Parameters Characterizing Barrier Type |
|---|---|---|
| 1 | Complete | >2.0 ft perched (Aadland, personal communications, September 9th, 2014) |
| 2 | Significant | 0.5-2.0 ft perched (WDFW, USFS et al. 2011)<br><0.8 sizing width ratio (constricted)<br>Not countersunk and one or both:<br>• Water/Culvert Slope >1% (WDFW 2000)<br>• Headloss of >1.0 ft |
| 3 | Partial/ Seasonal | Water depth <0.2 ft (USFS et al. 2011)<br>Upstream Pool or evidence of backwatering (USFS et al. 2011, Verry 2011)<br>Downstream scour pool (USFS et al. 2011)<br>>2.0 sizing width ratio (overwide) |
| 4 | Passable | No parameters exceed set limits |
| 5 | Dry | No data collected at dry crossings |

# WATERSHEDS IMPLEMENTING THESE GUIDELINES

- Nemadji
- Root River
- Buffalo
- Cottonwood
- Snake Otter Tail
- Kettle
- St. Croix
- Miss R La Crescent
- Miss R Reno
- Upper Iowa
- Upper Wapsipinicon



# ROOT


Root River Watershed Non-Bridge Crossings
Ranking Summary
N
W
E
S
0
5
10 Miles
Legend
Root River
Non-Bridge Crossings
Ranking
1
2
3
4
5
DAM
UND
Perennial Streams

# ROOT STATISTICS

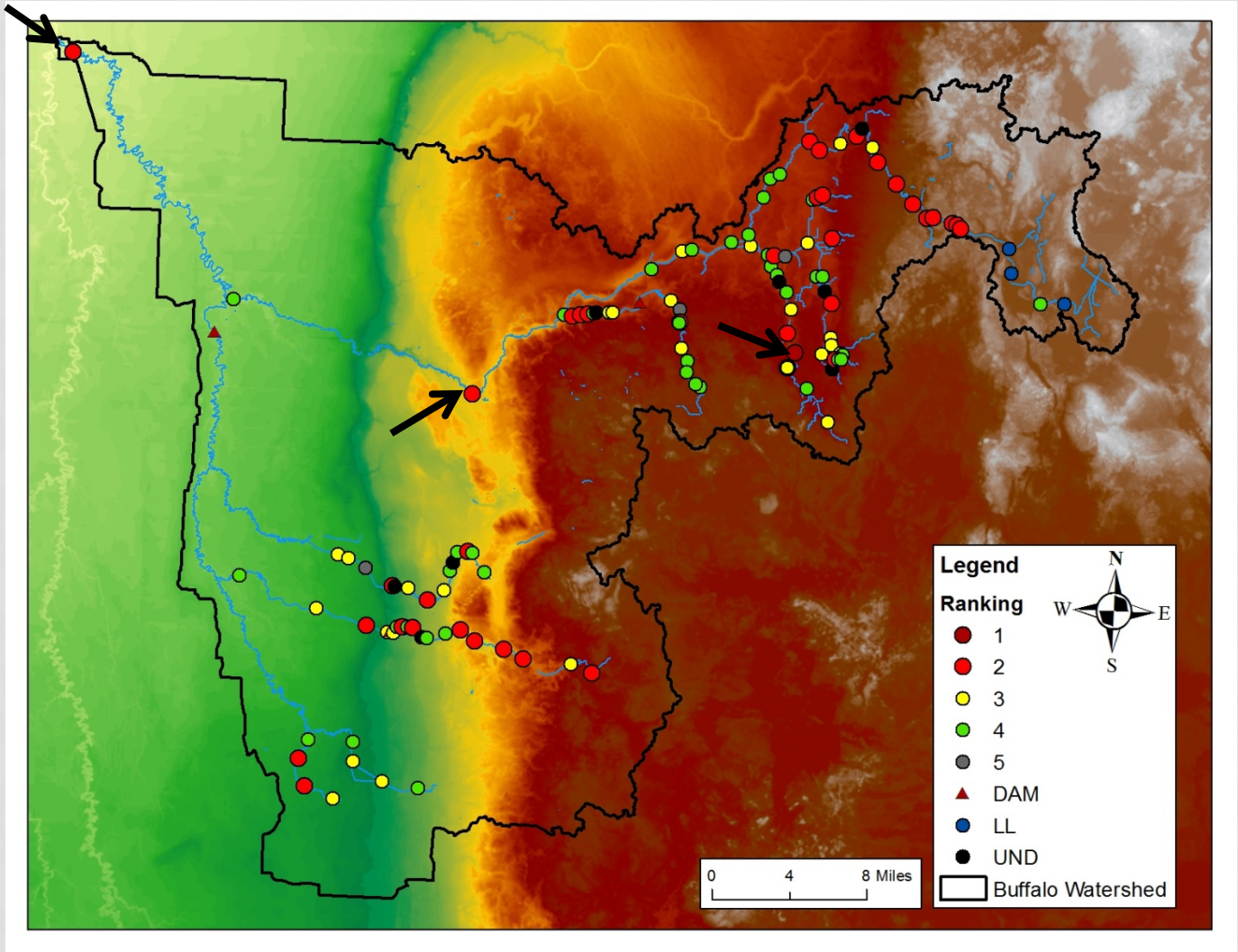
| Ranking Level | Number of Sites | Percent of all Non-bridge Crossings |
|---|---|---|
| 1 | 8 | 2.5 |
| 2 | 88 | 27.3 |
| 3 | 147 | 45.7 |
| 4 | 19 | 5.9 |
| 5 | 24 | 7.5 |
| DAM | 10 | 3.1 |
| UND | 26 | 8.1 |
| Bridges | 300 | NA |

- 5.6 % of sites are complete barriers
  - Ranking Level 1
  - Dams
- 75.5% of sites (Levels 1, 2 and 3) were a barrier of some degree
- Only 5.9% of sites were ranked as passable
- 48.2% of crossings were bridges

# BUFFALO RIVER
# NUMBER OF SITES IN EACH RANKING

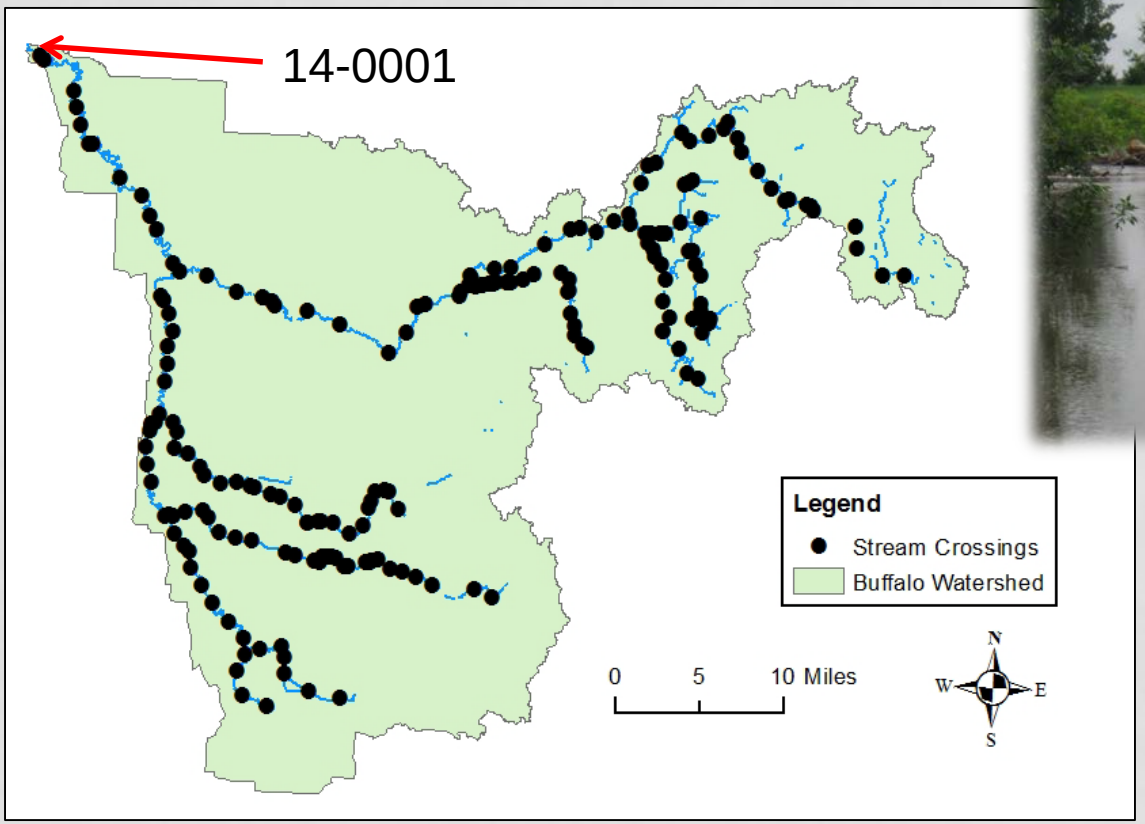
| Ranking Level | Number of each Rank | % of Non-bridge Crossings |
|---|---|---|
| Rank 1 | 1 | 1 |
| Dam | 3 | 2 |
| Rank 2 | 38 | 31 |
| Rank 3 | 27 | 22 |
| Rank 4 | 39 | 32 |
| UND | 8 | 7 |

# BUFFALO WATERSHED RANKINGS

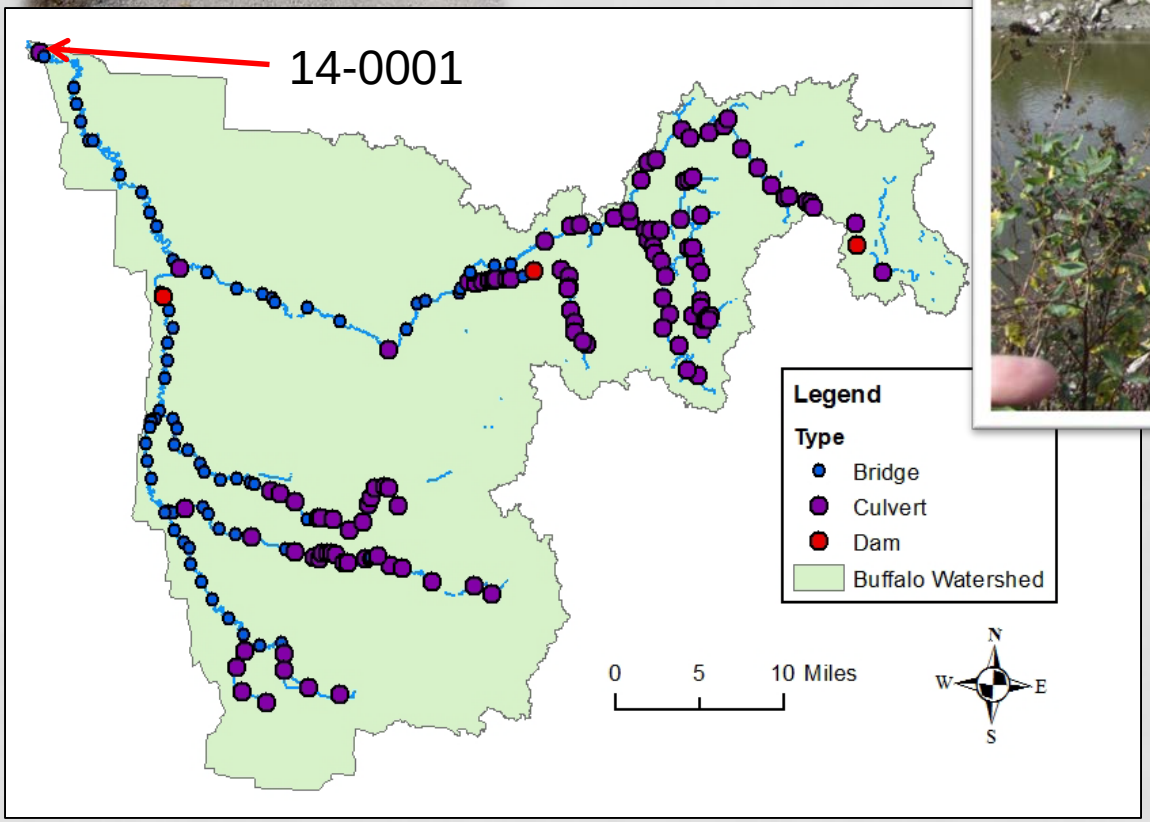


# SITE 14-0001

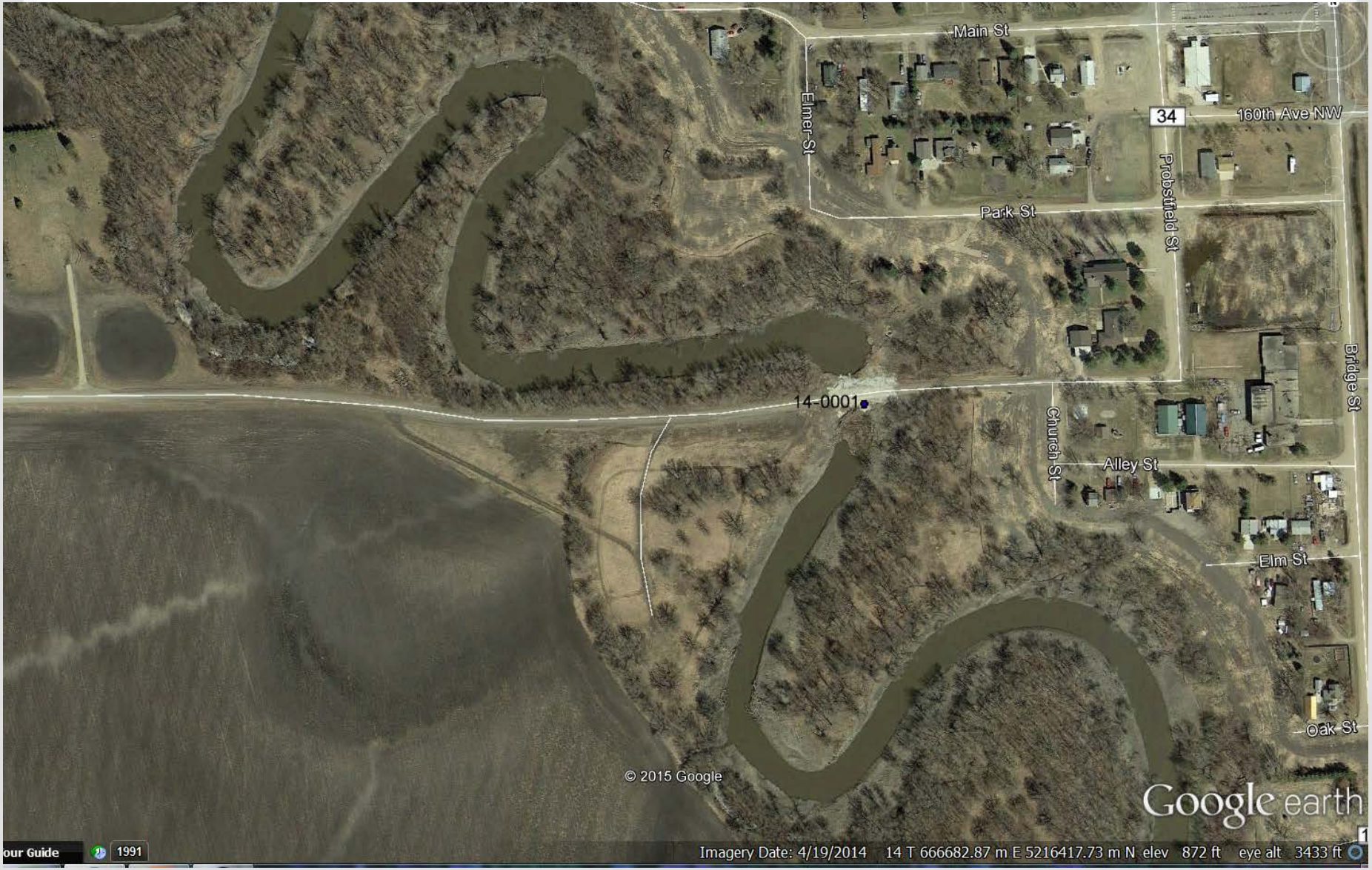
- June 2014
- DS most site of watershed
- Assumed it was a bridge




# SITE 14-0001 OCTOBER 2015



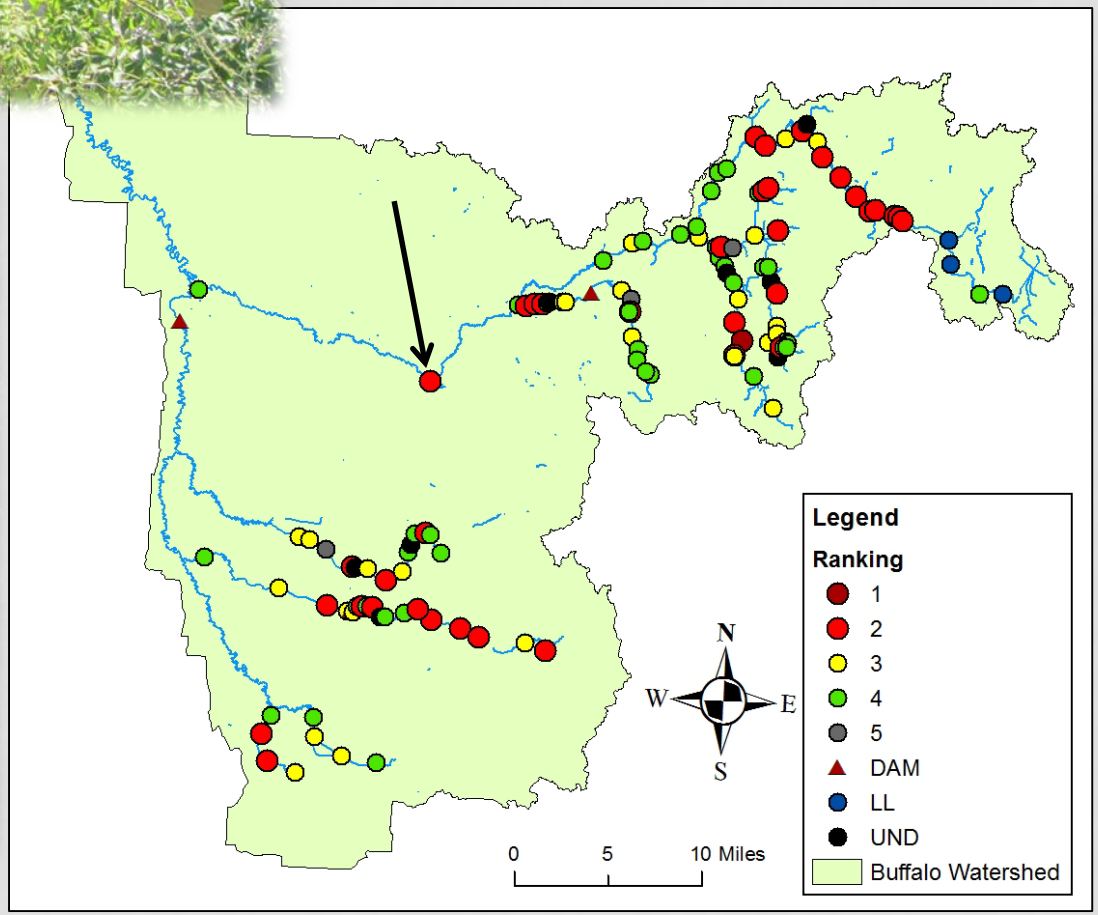

- Entire watershed is draining through 2 pipe-arch culverts
- Culverts are cemented in place
- Sizing width ratio: 0.5


Main St
Elmer St
34
160th Ave NW
Probstfield St
Park St
Bridge St
14-0001
Church St
Alley St
Elm St
Oak St
© 2015 Google
Google earth
our Guide
1991
Imagery Date: 4/19/2014 14 T 666682.87 m E 5216417.73 m N elev 872 ft eye alt 3433 ft


Main St
Elmer St
34
Georgetown
Park St
14-0001
Alley St
Elm St
75
100
14-0002
14-0003
Hwy 75
Bridge St
15th St NW
© 2015 Google
Google

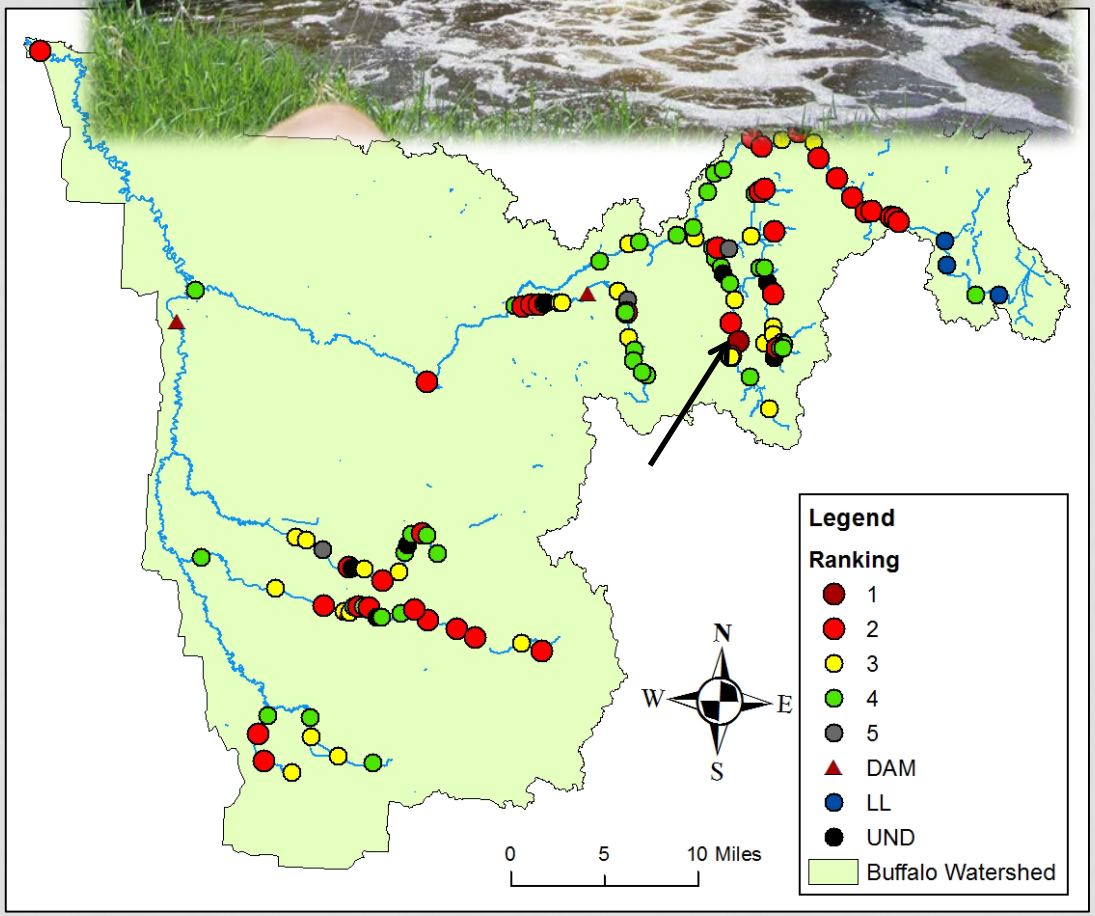
# SITE 14-0100

- Sizing Width Ratio: 0.54

# SITE 3-0116

- Water slope: 6.3%
- Headloss: 3.51 ft
- Culvert Slope: 2.5%
- Perched >2.0 ft
- Large DS Scour Pool

# CULVERT TRAINING

- Attendees
  - Local Fisheries Staff
  - Local Hydrologists
  - SHP
- In office training for about 1 hour
  - Datasheets
  - Measurement locations
  - Culvert Issues
  - Ranking
- Field data collection on-site
- Others interested in a similar type of training?

# NEXT STEPS

- Continue with watershed culvert inventories
- Develop prioritization methods
- Culvert remediation funding package
- Seek out other groups to consolidate/collect data
- Training

# SUMMARY

- Methodology can be replicated
  - assign each crossing a barrier ranking
- A complete statewide inventory is needed
- Necessity for
  - improved culvert design and
  - permitting regulation
- CONTACT INFORMATION:
  - Amanda Hillman
  - Amanda.hillman@state.mn.us
  - 218-739-7576 ext. 276

MNDNR

CLEAN WATER LAND & LEGACY AMENDMENT

MINNESOTA STATE UNIVERSITY
MANKATO

# Flocculation BMPs for Reducing the Sediment in Construction Water Discharges

Nazli Yilmaz Wodzinski, PhD
Stephen J. Druschel, PhD, PE

# Construction Waters

<u>Sources</u>

- Stormwater
- Dewatering fluids
- Tremie slurries

<u>BMPs</u>

- Prevent run-on / erosion
- Trap and settle
- Filter

# But: What If Not Enough Site Room, or Sediments Won't Settle?

# Sediments = Dead Critters or No Critters

- Sediments entomb stream bottom animals
- Habitat loss
- Disruption to food chain
- Sterile, muddy waters

# Flocculation Treatment

Make particles bigger
to settle faster & filter better

*"Chemical Velcro"*

- Reduces settlement time from
  days to minutes (performance)
- Move from big basins
  to small tanks (space saving)

# Flocculation for Water Treatment

- **Inject flocculant chemical into turbid water**
- **Flash mix – blend chemical throughout water**
- **Slow mix – "caress" water to slowly form flocs**
  - < Mixing too much at this stage can break flocs up
- **Gravity clarify water – sedimentation**
  - < Sediment becomes sludge (bottom mud)
- **Possibly: filter water**
  - < Sand or geotextile

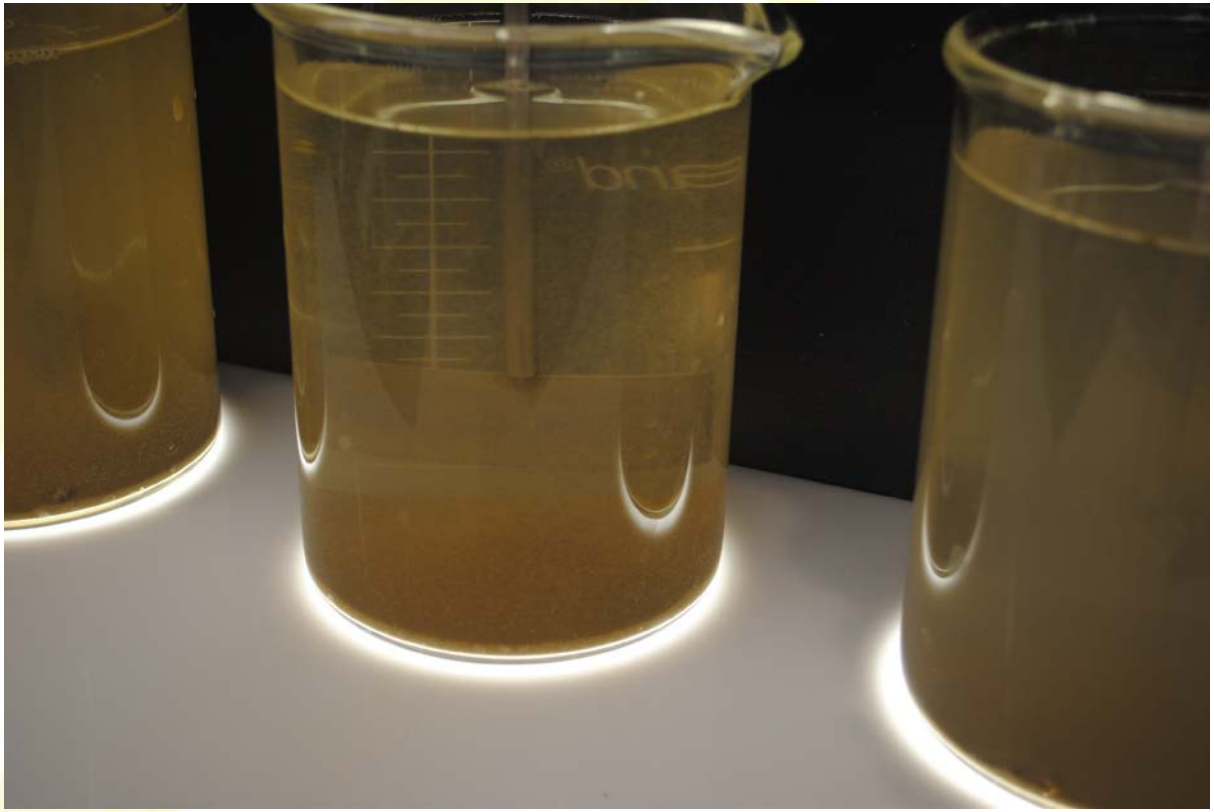
# Previous Work: Jar Testing of 21 Flocculant Chemicals on 57 Soil Sources

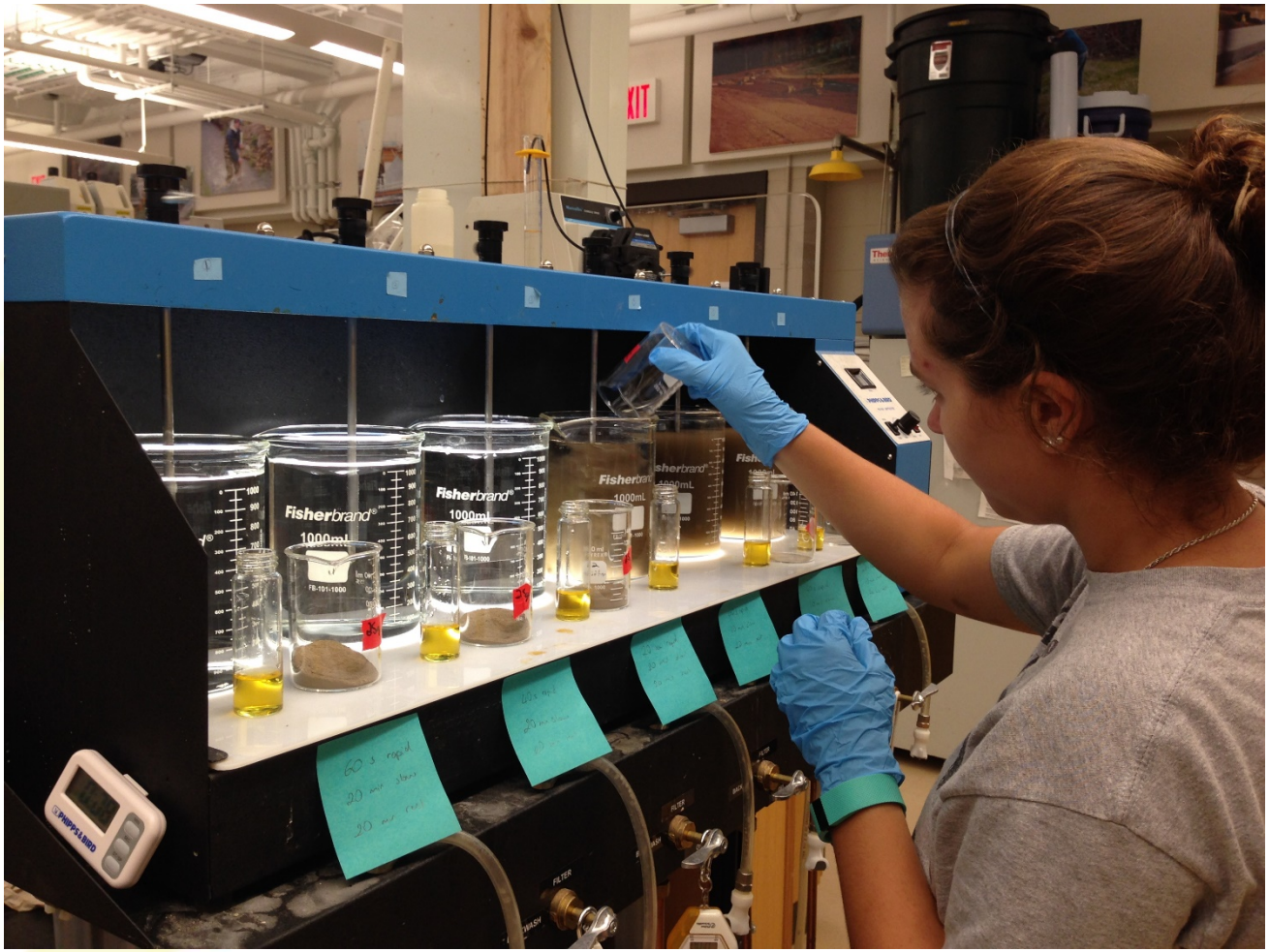
- **Jar Testing: Bench scale beaker tests**
  - < Effectiveness
  - < Reaction timing – basis for treatment facility size

- **Phase I: Effects screening**
  - < Every soil-chemical combination done twice
- **Phase II: Dose assessment**
  - < Optimization with selected flocculant chemicals & all soils

- **4500 total determinations**

# Flocs Capture Colloidal Particles




Fisherbrand
1000mL
60 s rapid
20 min slow
20 min rapid

# Bench Scale Mixing Tests

- **How best to flash mix on a construction site?**
  - < Blending in flocculant
  - < Evenly disperse throughout water
  - < Reduce “fish eyes”, over treatment, or under treatment
- **How best to slow mix on a construction site?**
  - < Cause particles to bump into each other
  - < Form flocs big enough to settle
  - < Aggregate flocs for quicker cleaning
- **How best to use gravity to clear water?**
  - < Will flocs drop fast enough?

# MnDOT Research Report 2014-25

## Flocculation Treatment BMPs for Construction Water Discharges

Minnesota Department of Transportation

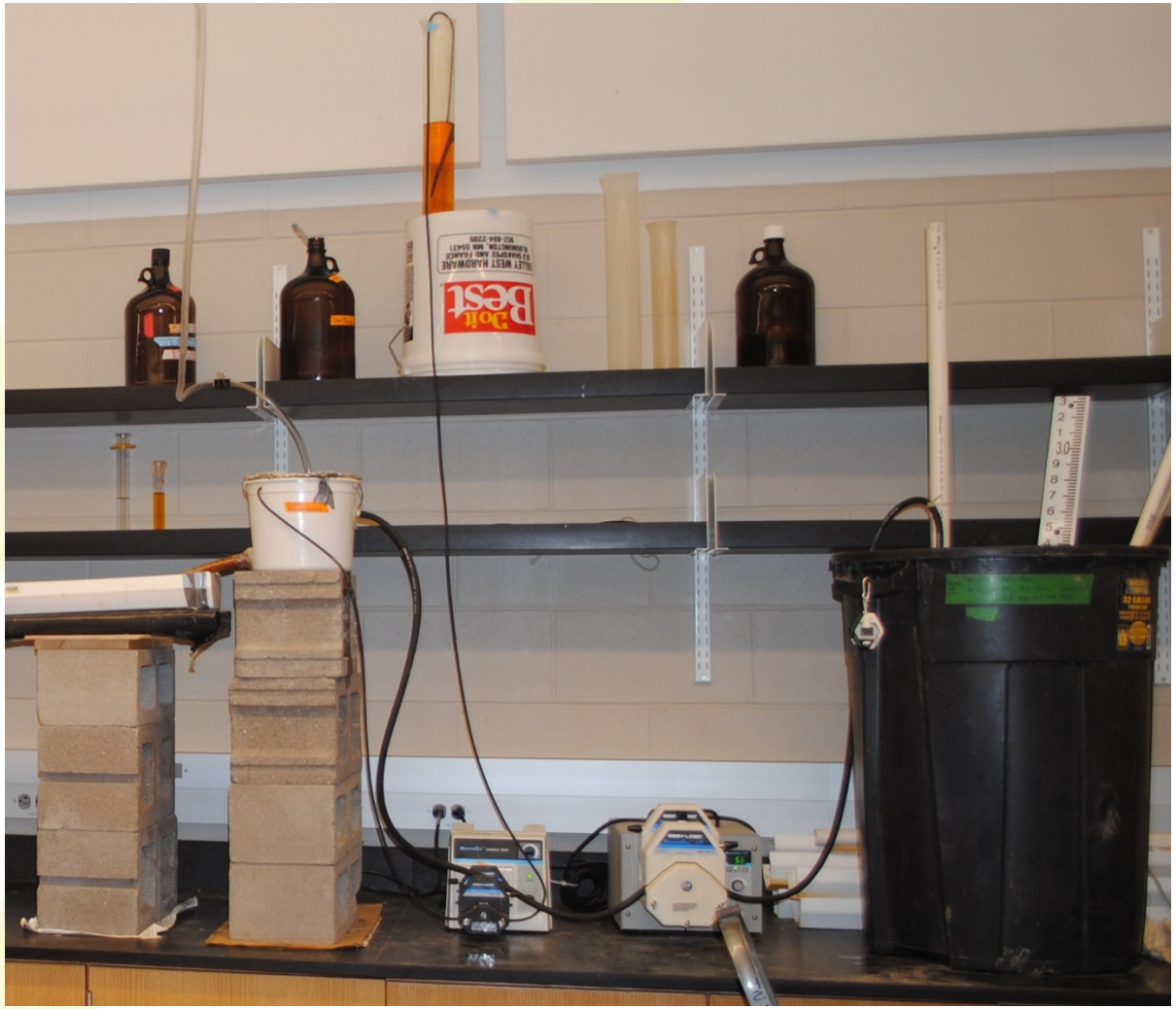
RESEARCH SERVICES & LIBRARY

Office of Transportation System Management

# Experiment Setup

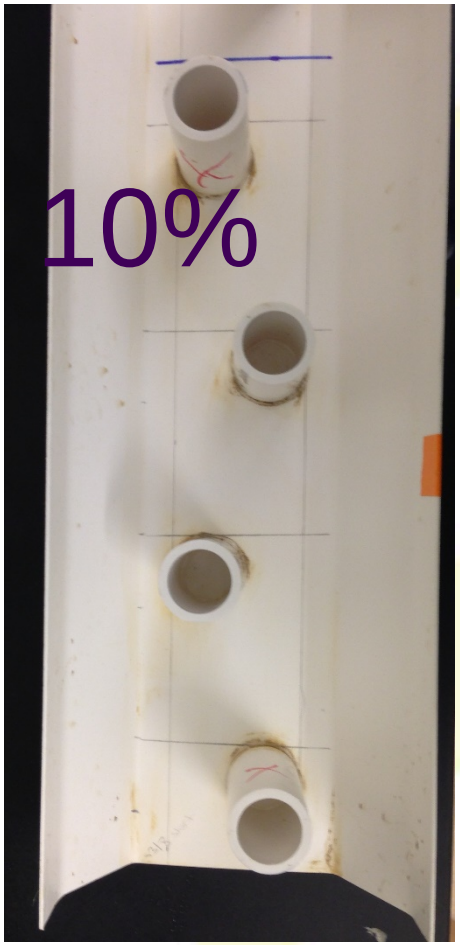
# Preparing the river silt – water mix by air lance

# Flash mixing by air lance

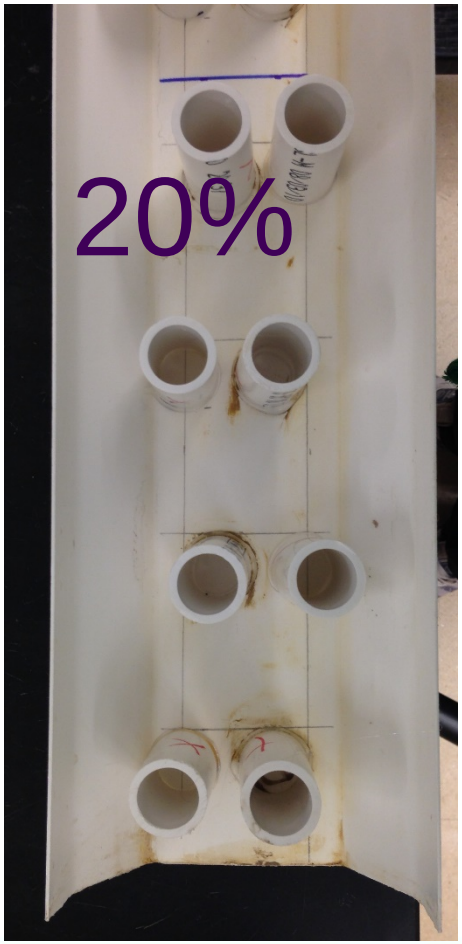


# Different flumes used for slow mixing

- 9 ft. flume with 1.0 in. diameter cylinders arranged as obstacles.







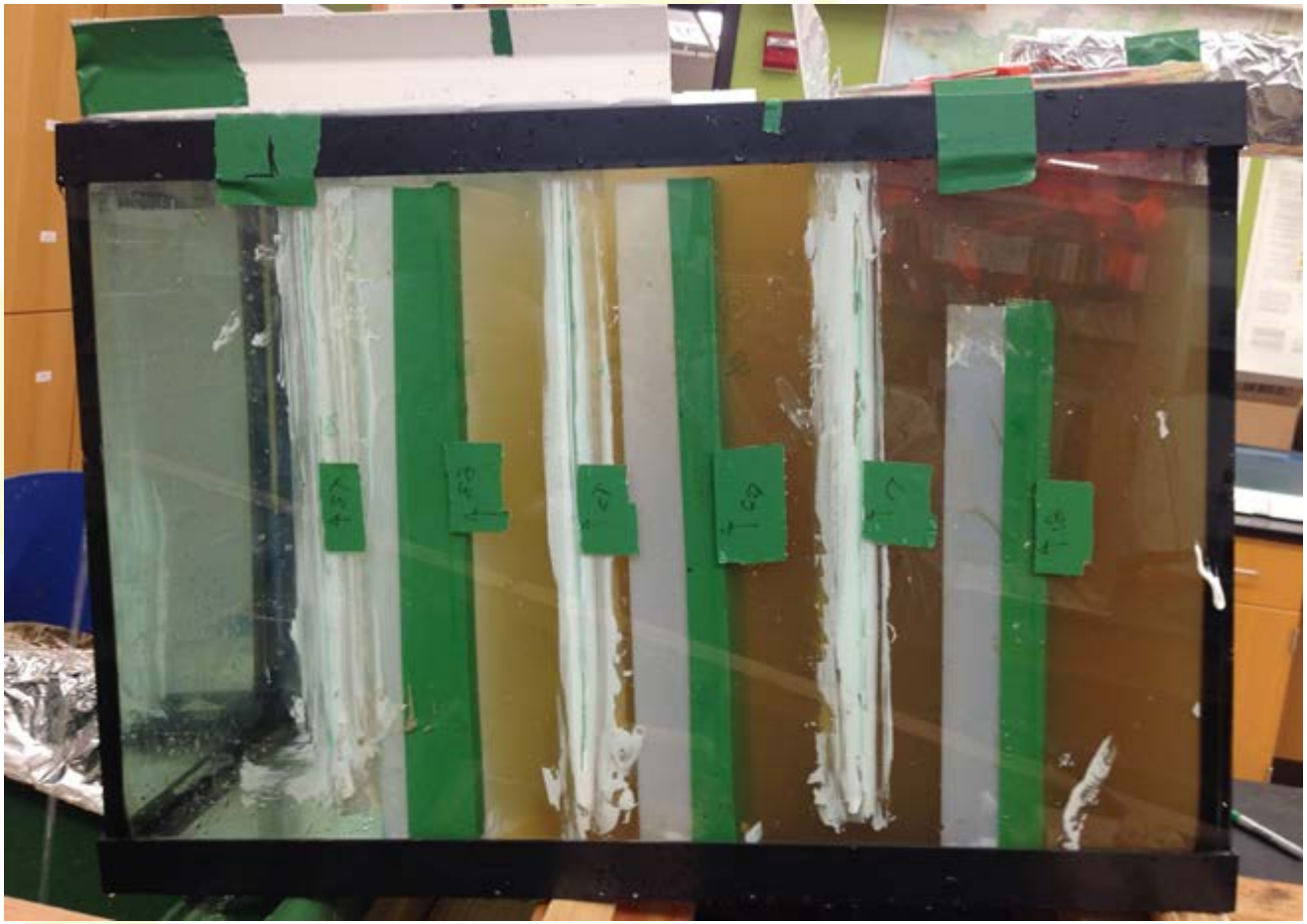
# Different flumes used for slow mixing

- 9 ft. flume with 6 ft. of pea rocks and 3 ft. of 1.0-1.5 in. river washed rocks used as obstacles.

# Different flumes used for slow mixing

- 9 ft. flume with 9 ft. of 1.0-1.5 in. river washed rocks used as obstacles.

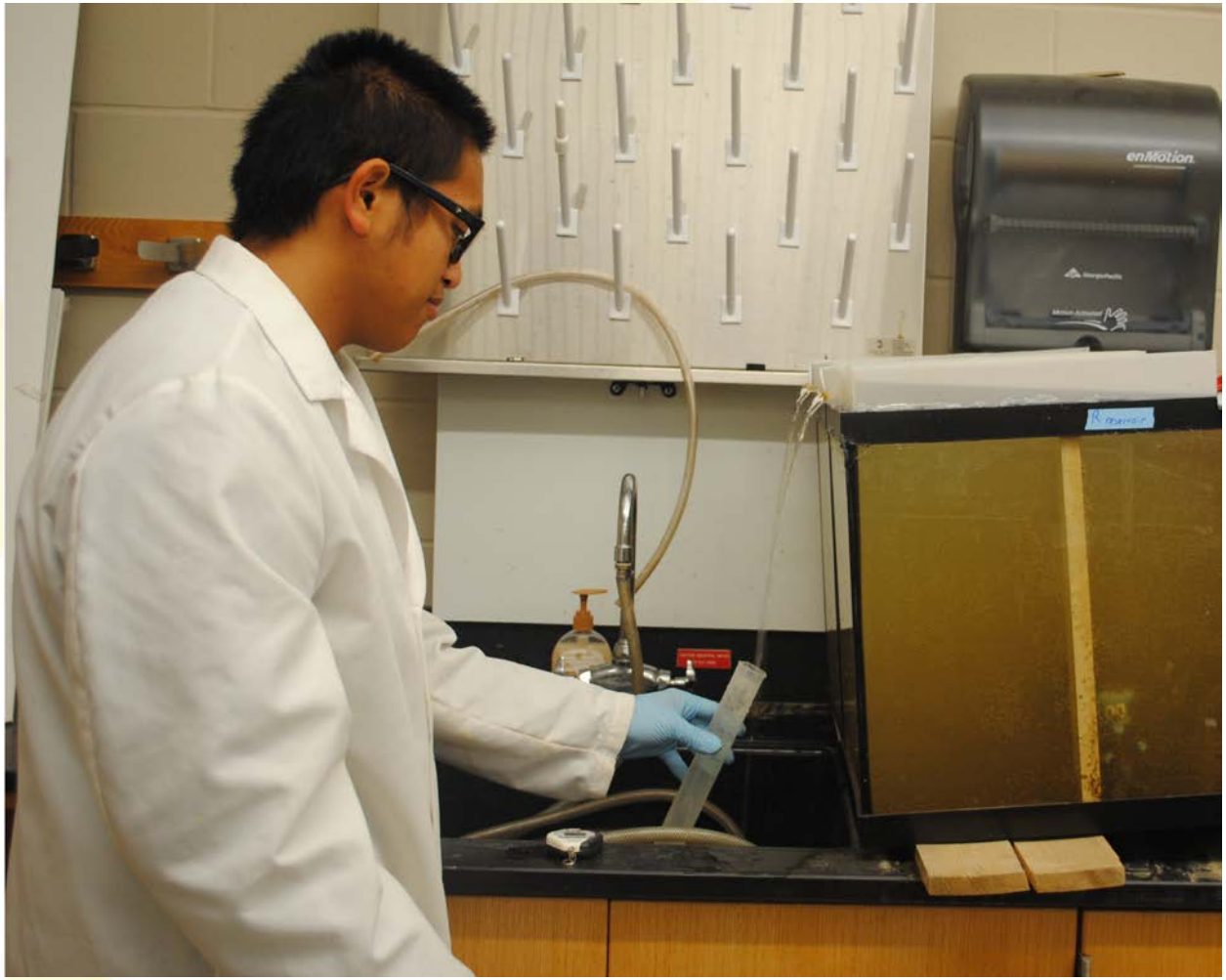
# Clarification in a sedimentation “Pond”



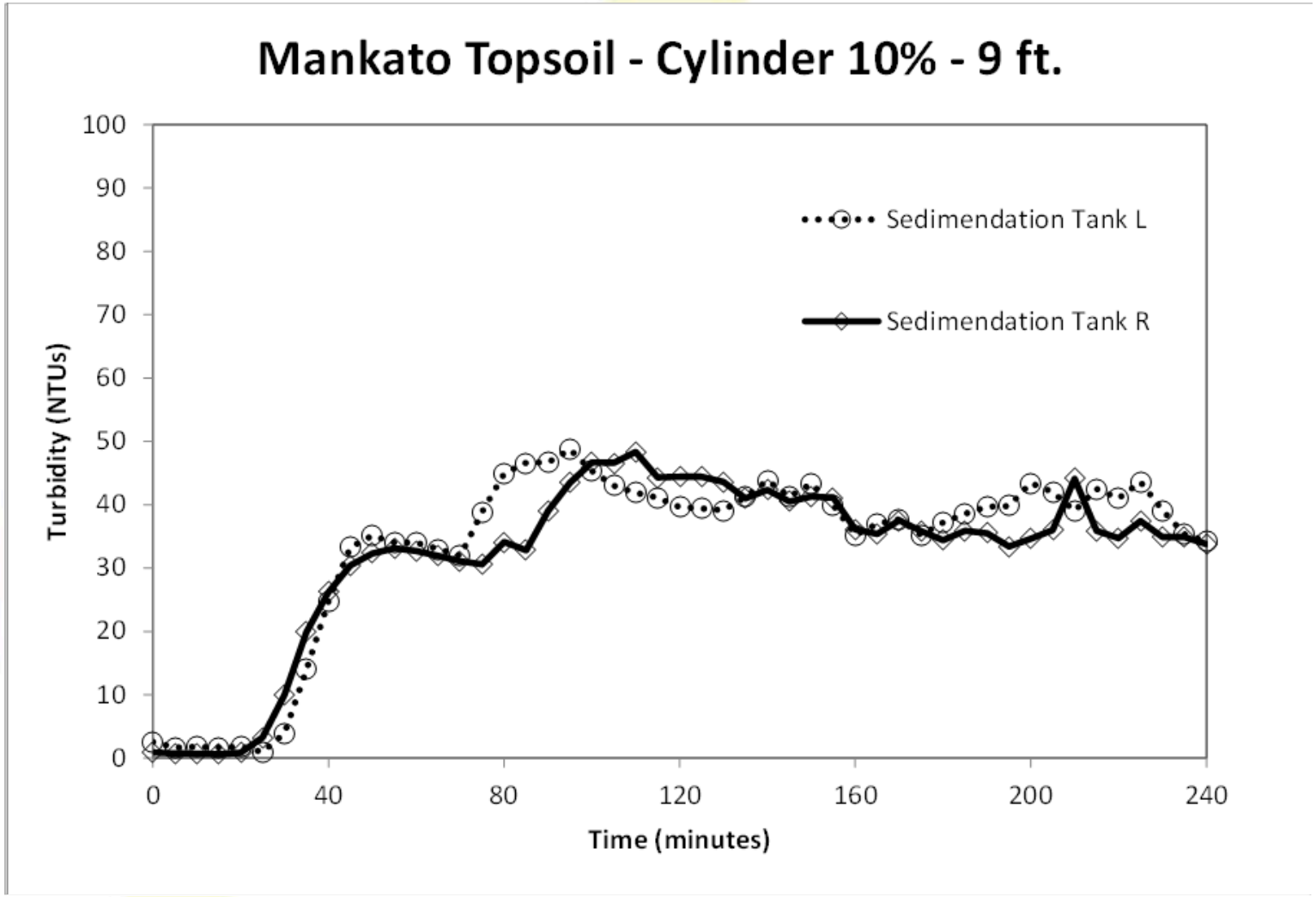
# Clarification in a sedimentation “Pond”

# Experiment Results:

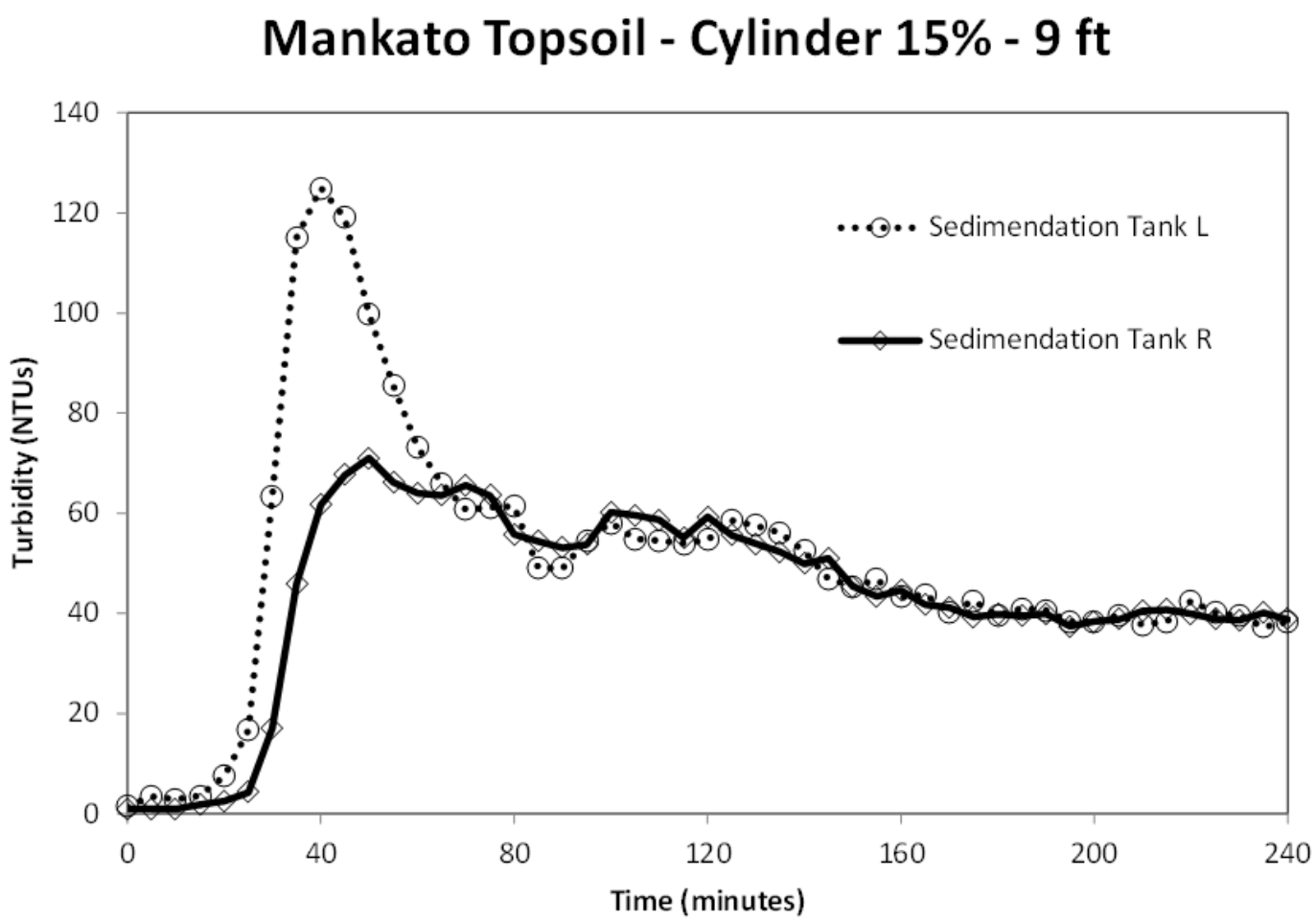
# Experiment Results:



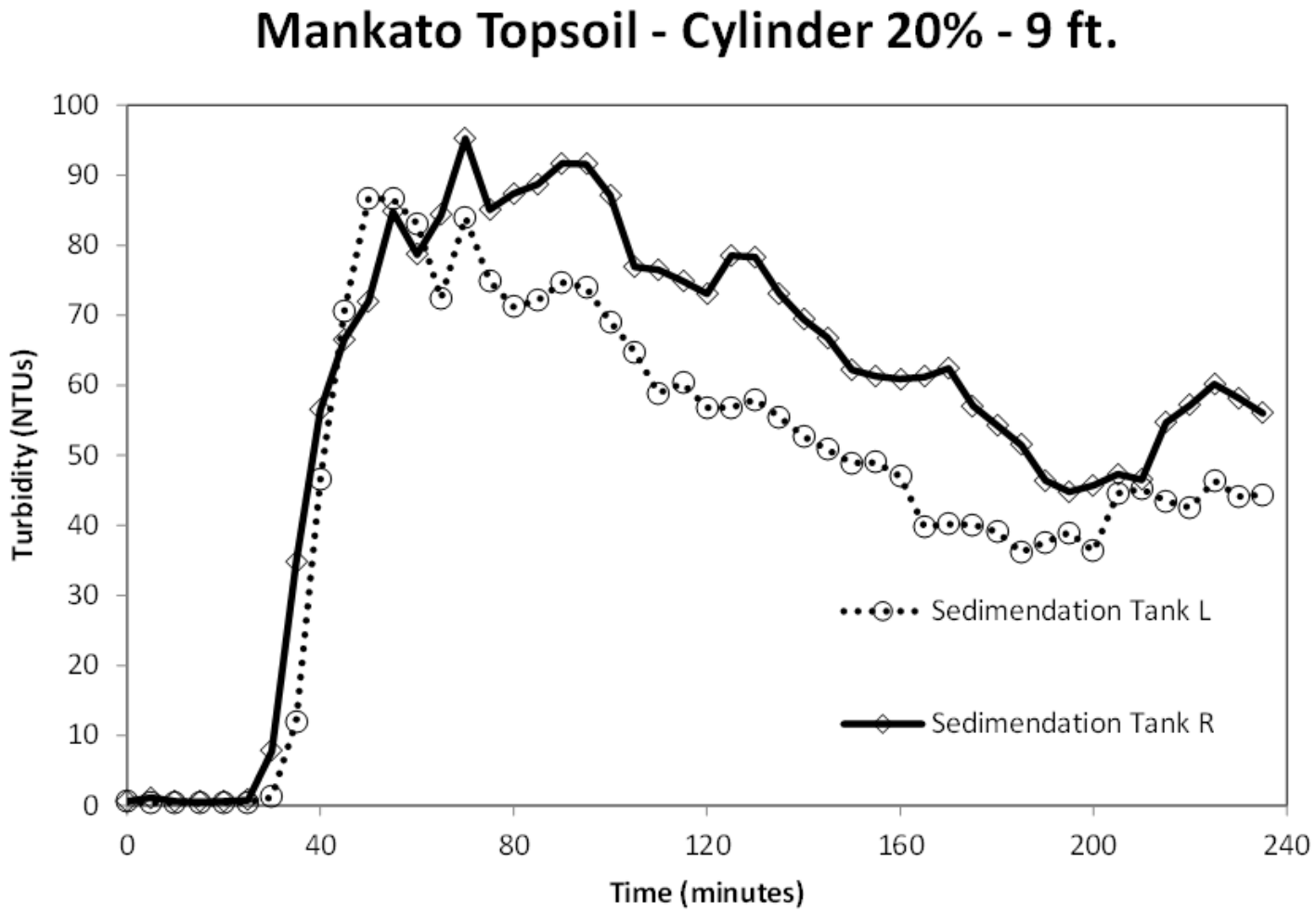
# Experiment Results: 95% removal av. (35 – 50 NTU)



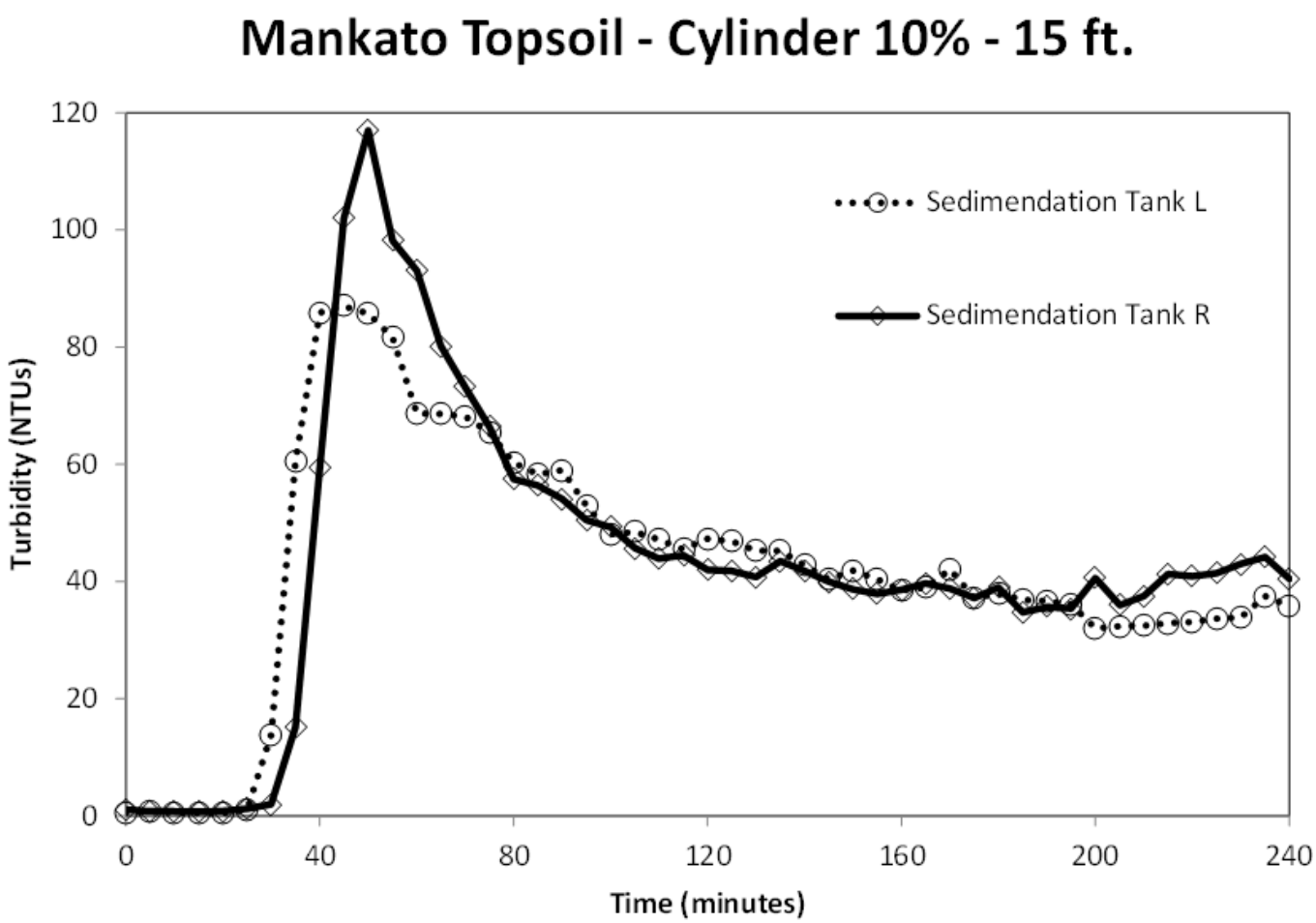
# Experiment Results: 94% removal av. (40 – 140 NTU)



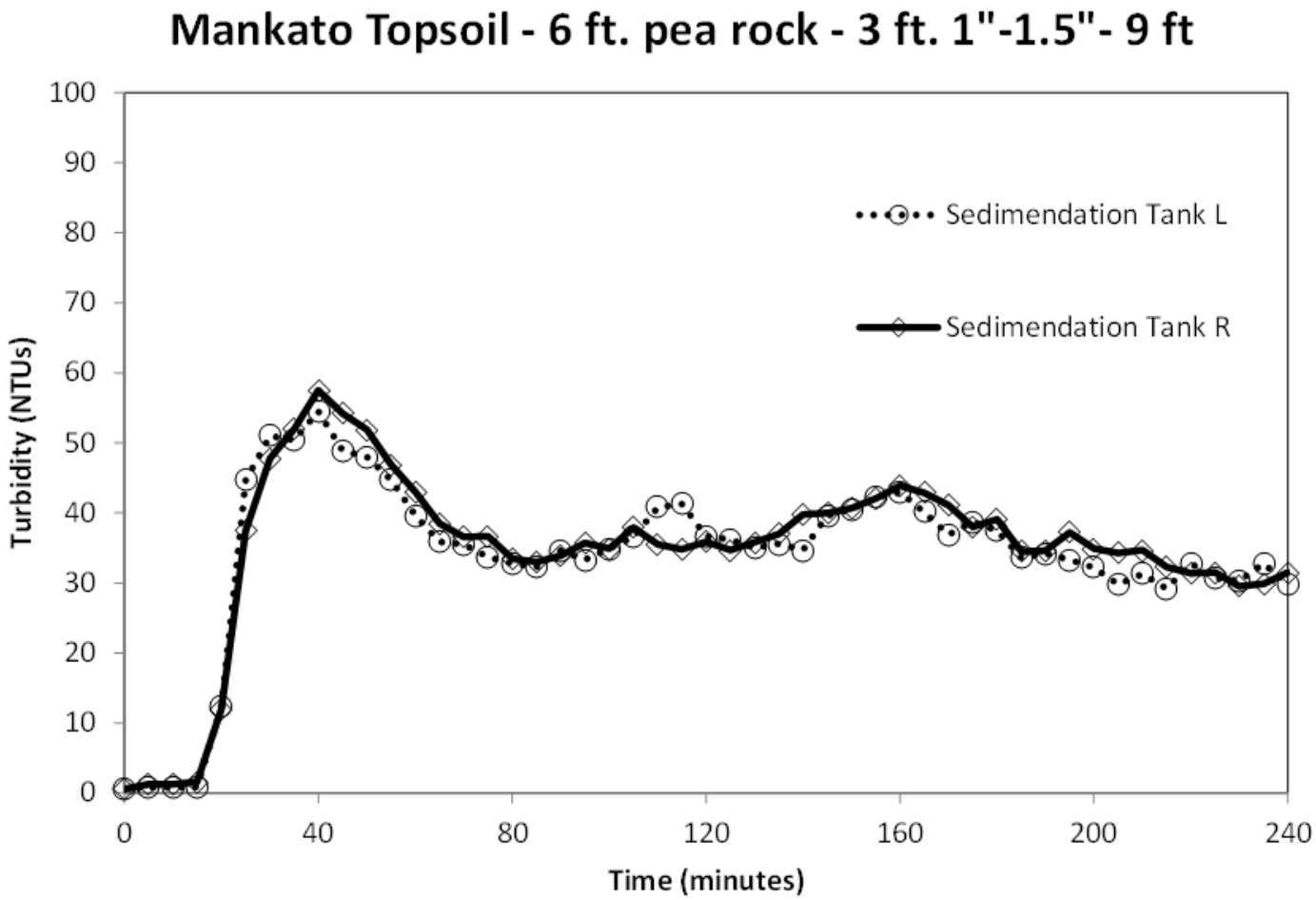
# Experiment Results: 93% removal av. (40 – 100 NTU)



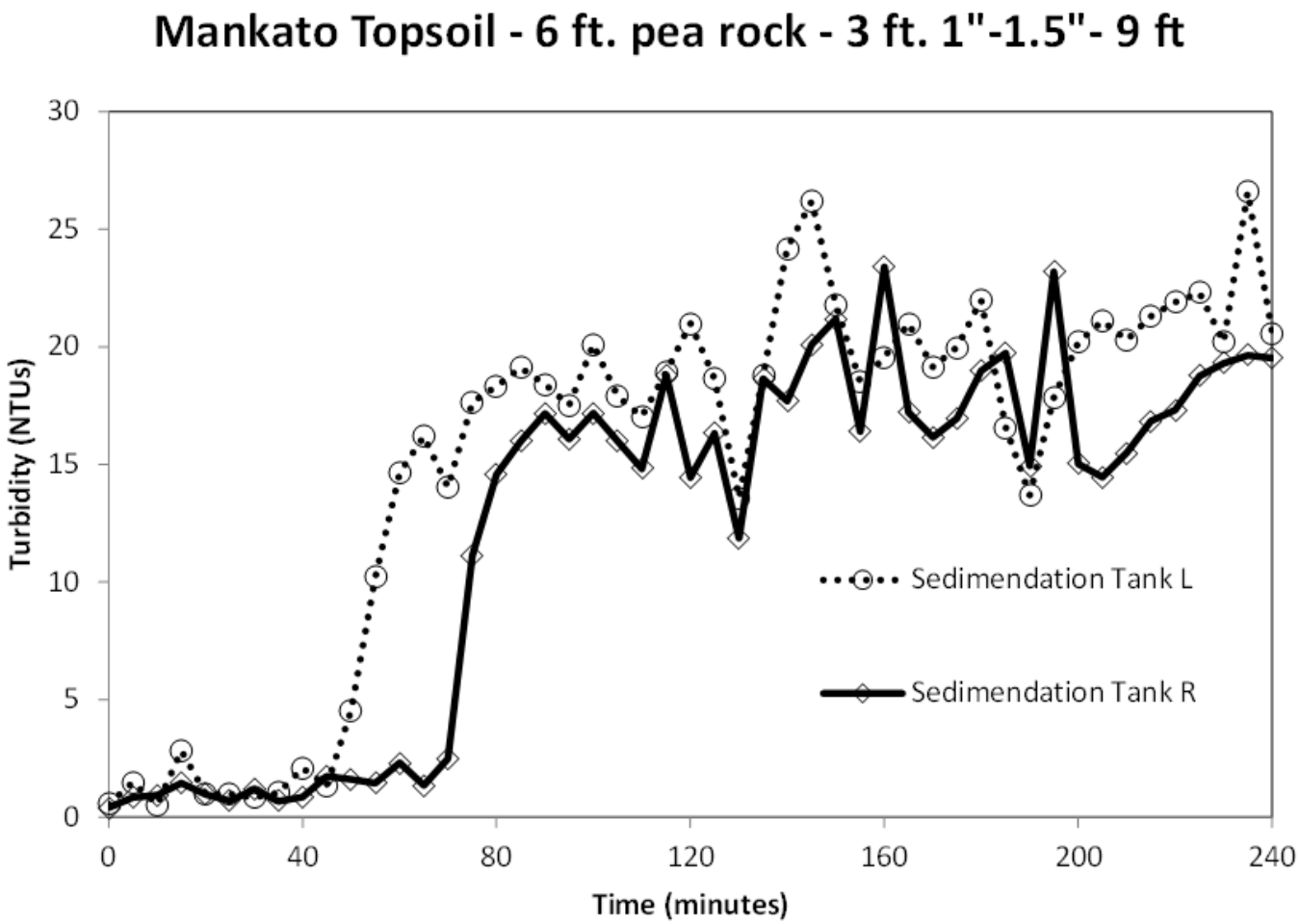
# Experiment Results: 94% removal av. (32 – 120 NTU)



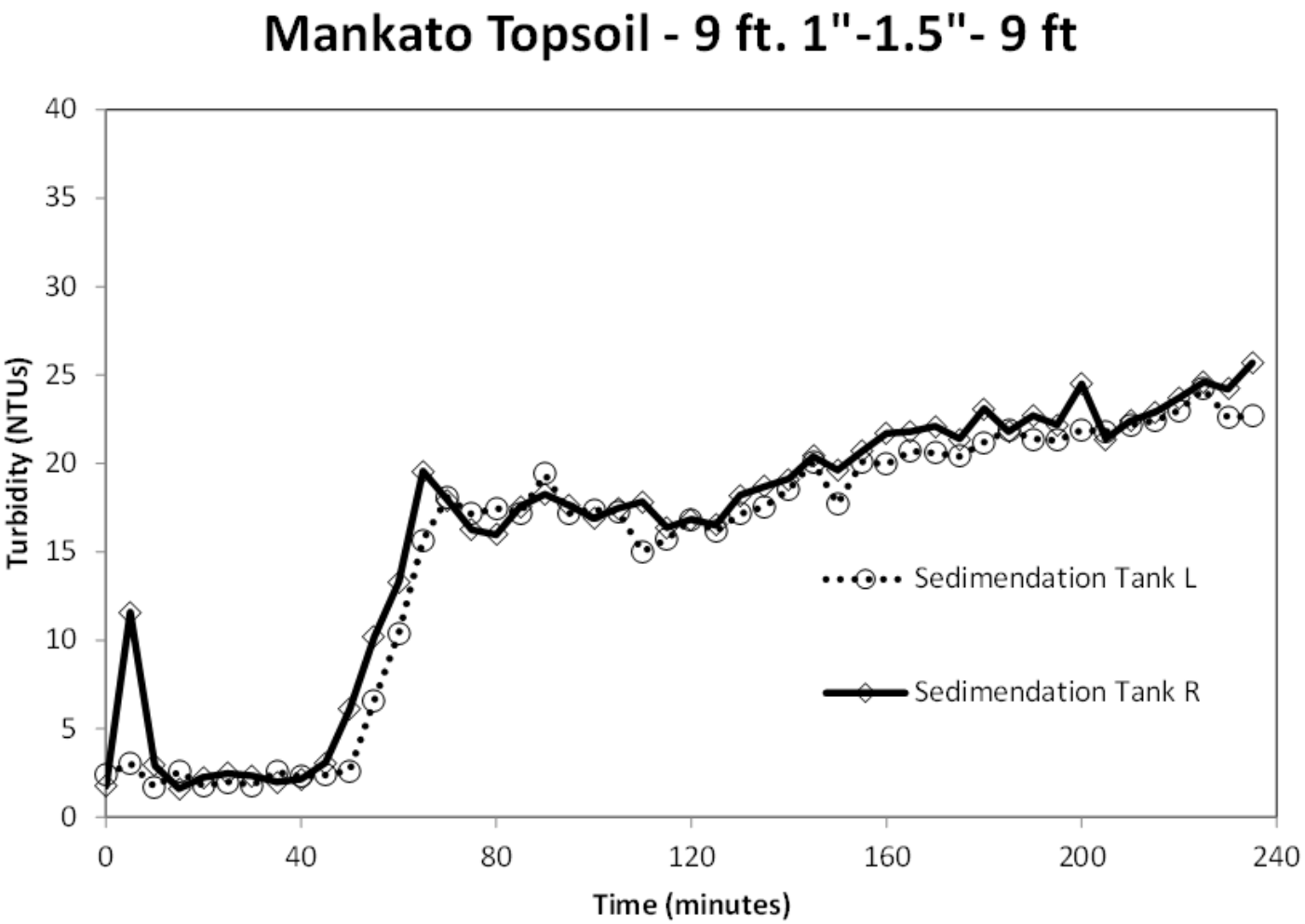
# Experiment Results: 95% removal av. (29 – 60 NTU)



# Experiment Results: 98% removal av. (NTU < 25)



# Experiment Results: 99% removal av. (NTU < 25)



# Implementation:
# 250 gpm = 1 acre foot / 24 hours

- **Flow rate of 250 gpm can be managed on construction site**
  - < Diaphragm pumps run by an air compressor (noise?)
  - < Bigger flow rates may need ductile iron piping and a crane…

- **Chemical and dose rate**
  - < Use ferric chloride for Minnesota soils – broadly effective
  - < Mixes well – quickly and uniformly
  - < Dose rate of 0.2 mL/L = 65 gal/acre foot

# Implementation:
# 250 gpm = 1 acre foot / 24 hours

- **Mixing and clarification in three stages:**
  - < Flash mix – 6 seconds & a lot of energy
    - 25 gal volume at 250 gpm – outboard motor in 55 gal drum?
  - < Slow mix – 20 minutes & slow pulsing/turning
    - 5,000 gal vol at 250 gpm – 25 cy roll off with air injection?
  - < Gravity clarify – 60 minutes of quiet, peaceful time
    - 15,000 gal vol at 250 gpm – sedimentation pond forebay?
- **In channel mixing – effectiveness likely to slip over time**
  - < Channel likely to smooth over due to sediment deposition
  - < Needs further evaluation on site

# Implementation: 250 gpm = 1 acre foot / 24 hours

- **Sediment sludge collection**
  - < Likely 5 – 10% solids
  - < Can calculate likely volumes using TSS tests
  - < e.g., at 100 mg/L TSS, 12 cy sediment sludge per ac-ft treated
- **Sediment sludge disposal**
  - < Need to dry out before excavate and haul?
  - < Will contain flocculant constituents
    - Ferric chloride = “salty iron”
  - < Use for soil improvement?
    - Will add water holding capacity when blended in

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