Knife River Stormwater Plan Public Meeting

December 20, 2023

Knife River Recreation Center

5-7 pm

June 2023

September 2023, the river rose almost 9 feet

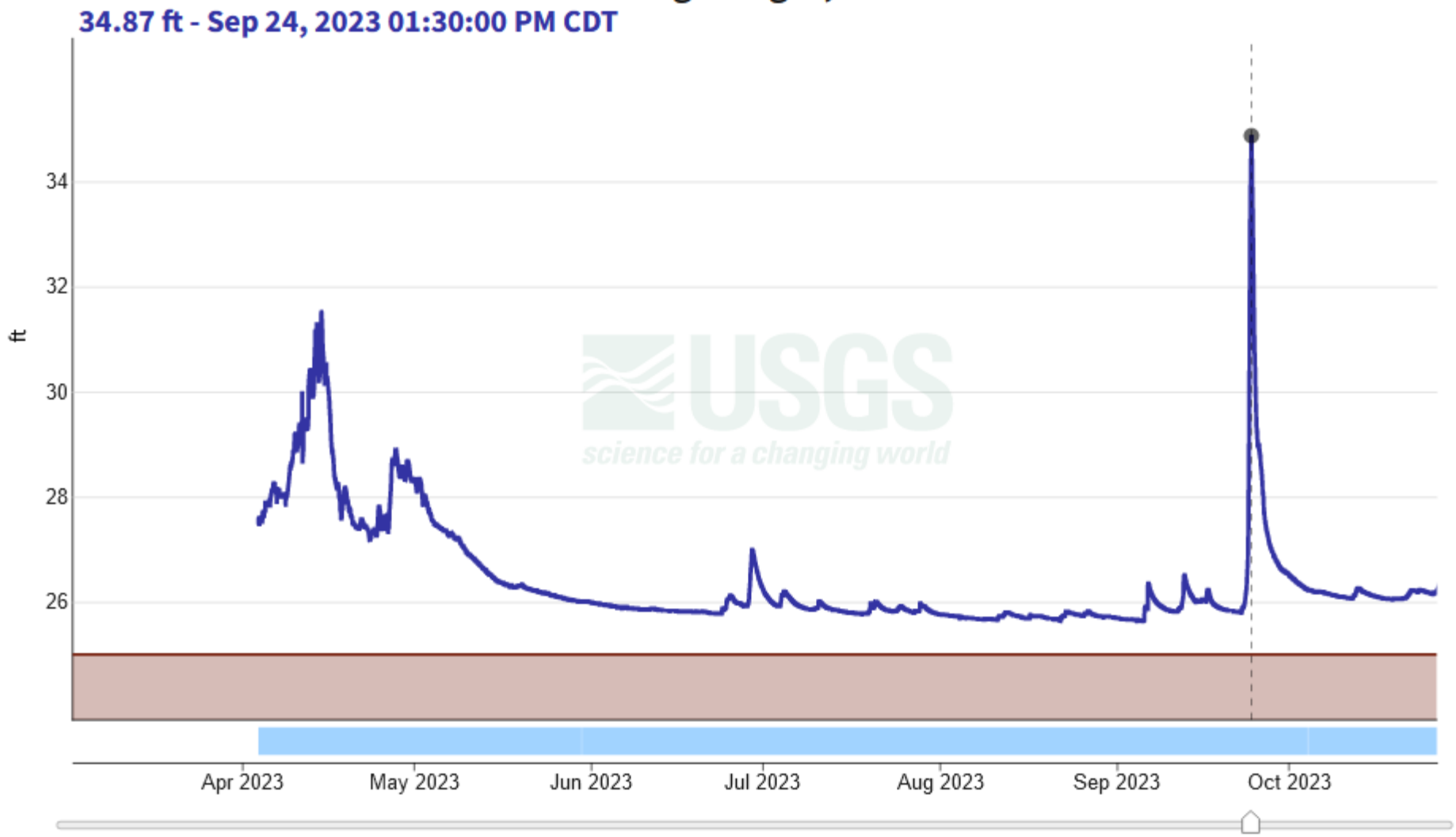
7 days 30 days 1 year

- using graph zoom -

Knife River Near Two Harbors, MN - 04015330

December 18, 2022 - December 18, 2023

Gage height, feet



Public Works Department • Richard H. Hansen Transportation & Public Works Complex
4787 Midway Road, Duluth, MN 55811 • Phone: (218) 625-3830

James T. Foldesi, P.E.
Public Works Director/Highway Engineer

NEWS RELEASE

FOR IMMEDIATE RELEASE:
September 24, 2023

MEDIA CONTACT: Brian Boder, Deputy Director of Public Works
218-625-3836

Heavy rains lead to flooding and washed out roads

This weekend's rainfall has led to flooding in several areas of southern St. Louis County. Most notably, the intersection of Maple Grove Road and Mall Drive in Duluth has been closed most of the day.

Several other lesser traveled county roads also have been damaged due to washouts, including portions of:

- Cant Road south of Lismore Road
- Pioneer Junction Road between Smith River Road and Pioneer Road
- App Road between West Knife River Road and Two Harbors Road
- Strand Road between Jean Duluth Road and Washburn Road.

St. Louis County Public Works crews have been monitoring road conditions throughout the weekend and making repairs as able. Motorists are reminded to not drive through standing water as it may hide hazards between the surface. Anyone encountering unsafe road conditions should call 911 to report them.

The Lester River looking down from the Superior St. Bridge in Duluth on Sunday after high levels of rain elevated river levels and caused flooding in North Shore communities. Dan Kraker | MPR News

Listen *Duluth deals with citywide flooding after several inches of rain; more wet weather ahead*

Share

Updated: 8:36 a.m.

Roads are still slick Monday morning after more than four inches of rain fell in Duluth over the weekend, forcing water up from sewers and leading to flooding across the city.

As of Monday, Duluth has received just under 10 inches of rain in September — more than seven inches above average, according to the National Weather Service.

"Knife River itself rose about nine feet over the course of the morning hours yesterday and it did cause river levels to get pretty elevated there and even flooded the Knife River Park by Highway 61 even got some flooding," said Cory Rothstein, a meteorologist with the NWS Duluth office.

One public report documented 6.3 inches of rain in Duluth's Hillside neighborhood as of Monday morning, Rothstein said.

A rain gauge is measured outside of the National Weather Service station in Duluth showing the largest 6-hour measurement of 1.67 inches between 1 a.m. and 7 a.m. on Sunday. Courtesy of National Weather Service via X

Meeting Agenda

- Purpose of the Stormwater Plan
- Overview of the Stormwater Model
  - Data Collection
  - Modeling Process
  - Model Outcomes
- Next Steps

Funding

- DNR Coastal STAR Grant
- MN Pollution Control Agency Climate Resiliency Grant
- Lake Superior North One Watershed One Plan
- Lake County Highway Department

Stormwater Plan Purpose

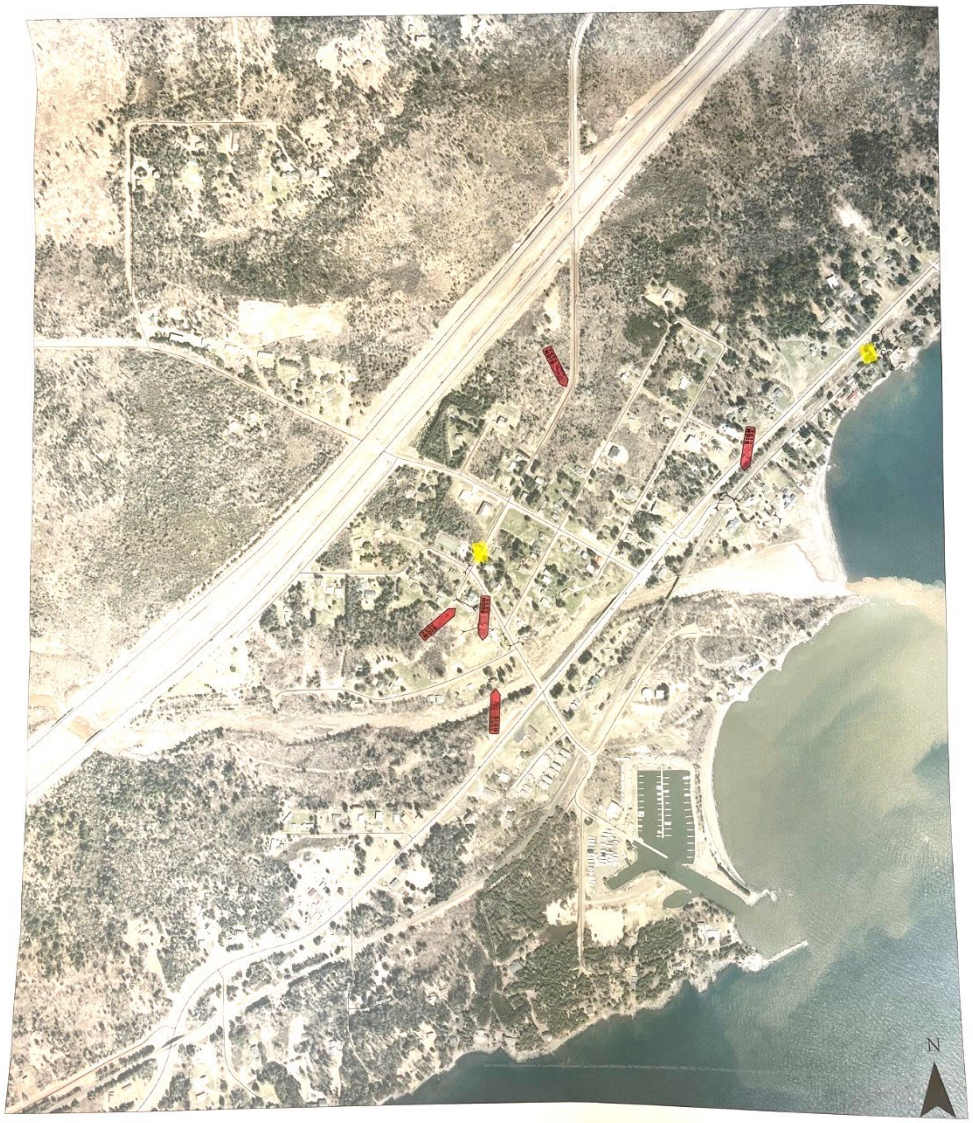
Why Build a Stormwater Model?

- Weather extremes becoming more frequent
- Planning helps us:
  - Compile community-wide information on current infrastructure
  - Map effects of flooding at different storm intensities
  - Propose solutions
  - Create cost/benefit analysis of solutions
  - Leverage additional funding

Data Collection

First public meeting, May 2023

Knife River 2017 Aerial Photo



0 0.15 0.3 0.6 0.9 1.2 Miles

Current Knife River Drainage Culverts August 2022

Existing culverts are marked in orange.

A large portion of Knife River (red dots) drains to culvert A (Church Street) and then on to B (Third Ave).

Another portion (yellow dots) drains directly into culvert B.

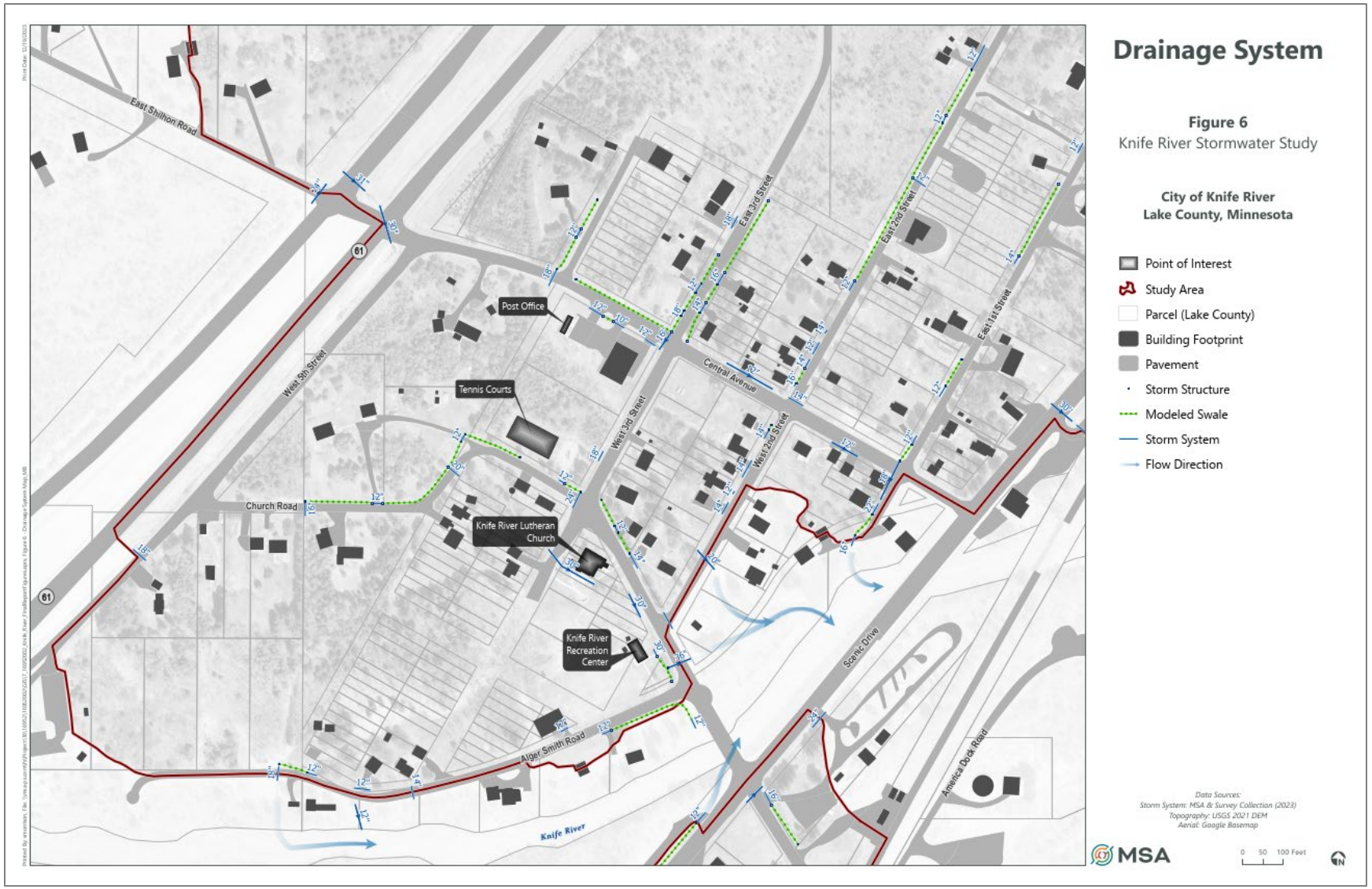
All of the runoff from the red and yellow areas ends up in the church Garden culvert (C).

Building the Model

Modeling Study Sub-Agenda

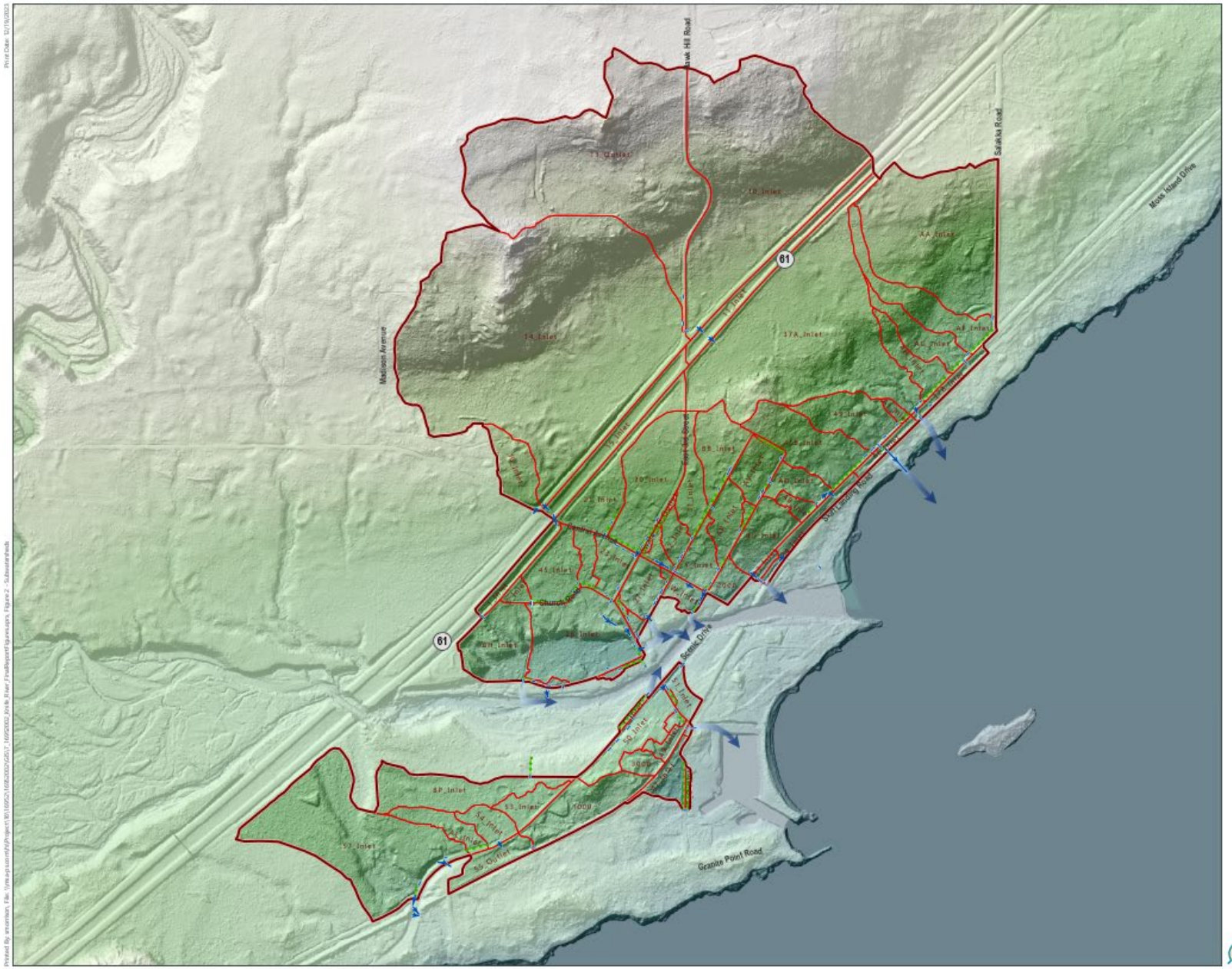
1) Study Areas Limits and Description
2) Model Assumptions/Limitations
3) Major Drainage Patterns (Video of Drainage System)
4) Existing Conditions Inundation Mapping
5) Proposed Solutions
6) Proposed Solutions Inundation Mapping
7) Cost Estimates & Project Planning
8) Stormwater Water Quality

Study Area – Areas of Interest



Total Watershed Area

467 acres



Subwatersheds

Figure 2
Knife River Stormwater Study

City of Knife River
Lake County, Minnesota

- Study Area
- Watersheds
- Modeled Swale
- Storm System
- Flow Direction

Value

- High: 1020.56'
- Low: 601.89'

Data Sources:
Storm System: MSA & Survey Collection (2023)
Topography: USGS 2021 DEM
Aerial: Google Basemap

MSA 0 500 1,000 Feet

Total Watershed Area

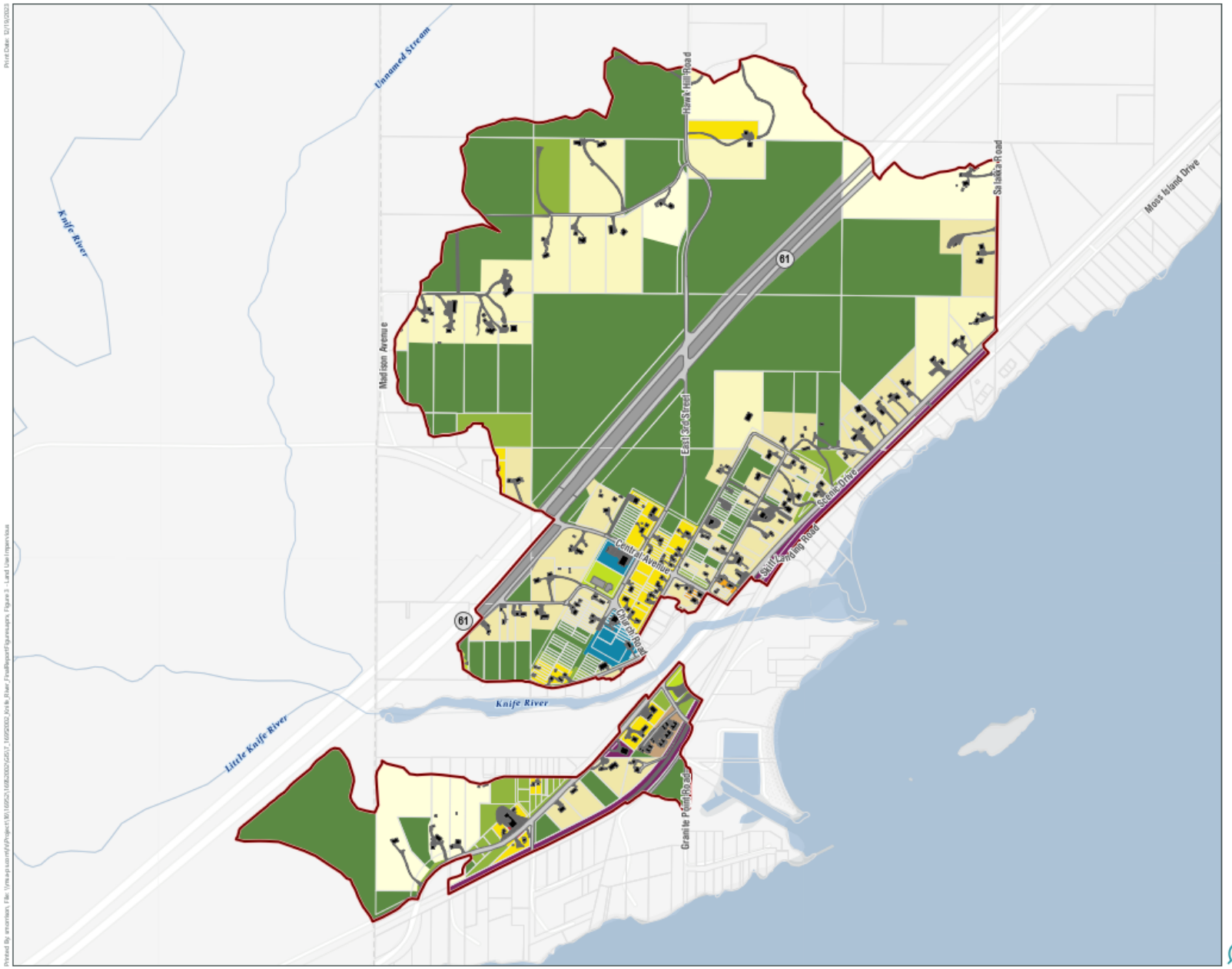
467 acres

Study Evaluated

69 subwatersheds

Min = 0.1 acre

Max = 90 acres



Land Use & Impervious Areas

Figure 3
Knife River Stormwater Study

City of Knife River
Lake County, Minnesota

- Study Area
- River/Stream

Impervious Areas
- Roof
- Driveway/Parking
- Sidewalk
- Street

Existing Land Use
- Commercial, Strip
- Highway
- Industrial, Light
- Institutional, Misc
- Open Space
- Park
- Residential, Suburban
- Residential, Low Density
- Residential, Medium Density
- Residential, High Density without alley
- Residential, Duplex
- Residential, MultiFamily
- Wooded

Data Sources:
Storm System: MSA & Survey Collection (2023)
Land Use/Impervious: MSA (2023)
Waterways: MN DNR
Aerial: ESRI Basemap

MSA 0 500 1,000 Feet

<u>Total Watershed Area</u>

467 acres

<u>Study Evaluated</u>

69 subwatersheds

Min = 0.1 acre

Max = 90 acres

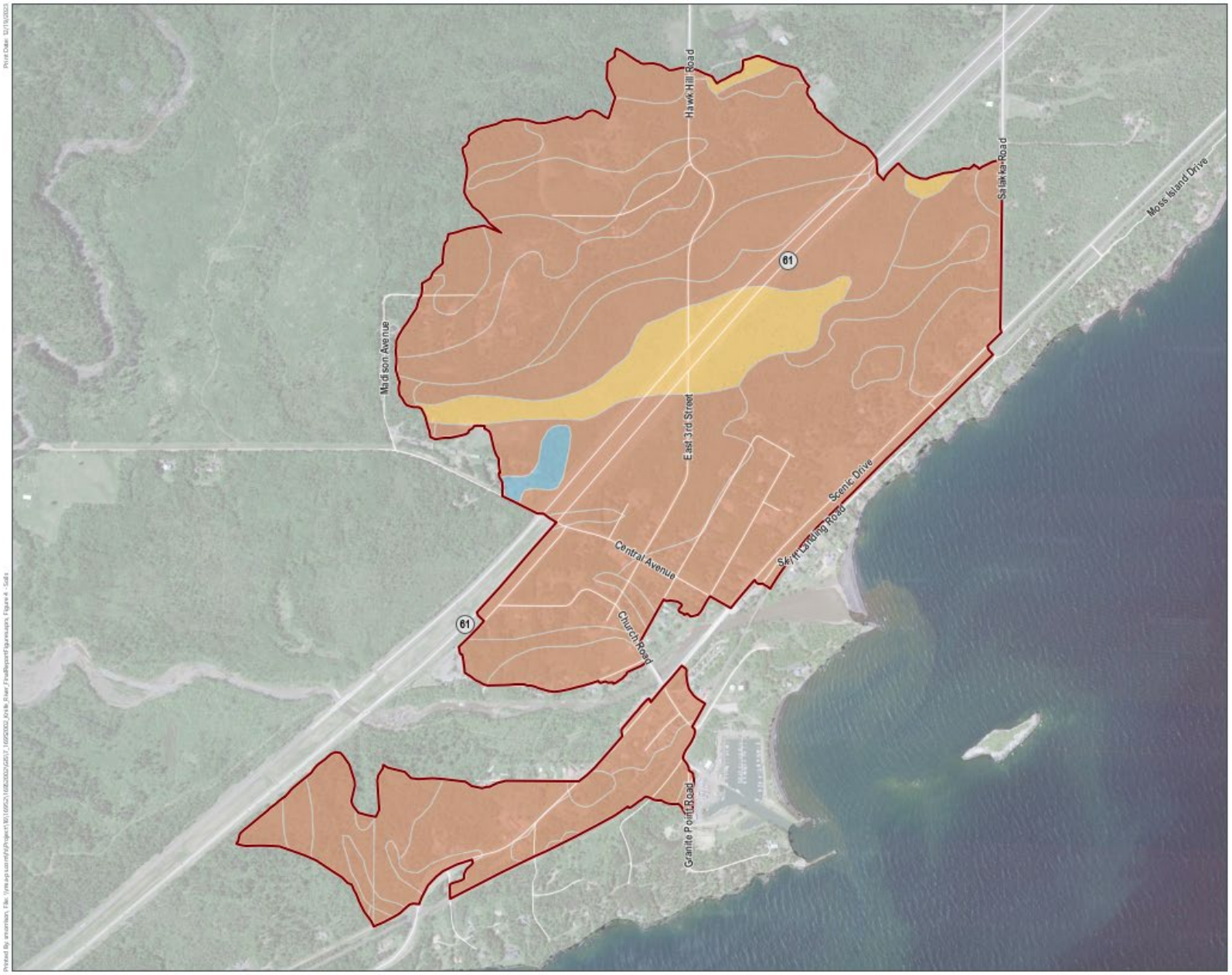
<u>Total Impervious</u>

43 acres (9%)

<u>Total Connected Imperv.</u>

36 acres (8%)

Streets = 24 acres



Soils

Figure 4
Knife River Stormwater Study

City of Knife River
Lake County, Minnesota

- Study Area
- Parcel (Lake County)
- River/Stream

Modeled Hydrologic Soil Group

- B (Silt)
- C (Clay)
- D (Clay)

Data Sources:
Aerial: Google Basemap
Soils: NRCS Web Soil Survey

MSA 0 500 1,000 Feet

Total Watershed Area

467 acres

Study Evaluated

69 subwatersheds

Min = 0.1 acre

Max = 90 acres

Total Impervious

43 acres (9%)

Total Connected Imperv.

36 acres (8%)

Streets = 24 acres

Hydrologic Soil Group

Texture

A ~ Sandy	(4.0-1.0 in/hr)
B ~ Silty	(2.0-0.5 in/hr)
C ~ Clayey	(1.0-0.2 in/hr)
D ~ Clayey	(0.5-0.1 in/hr)

Infiltration Rate

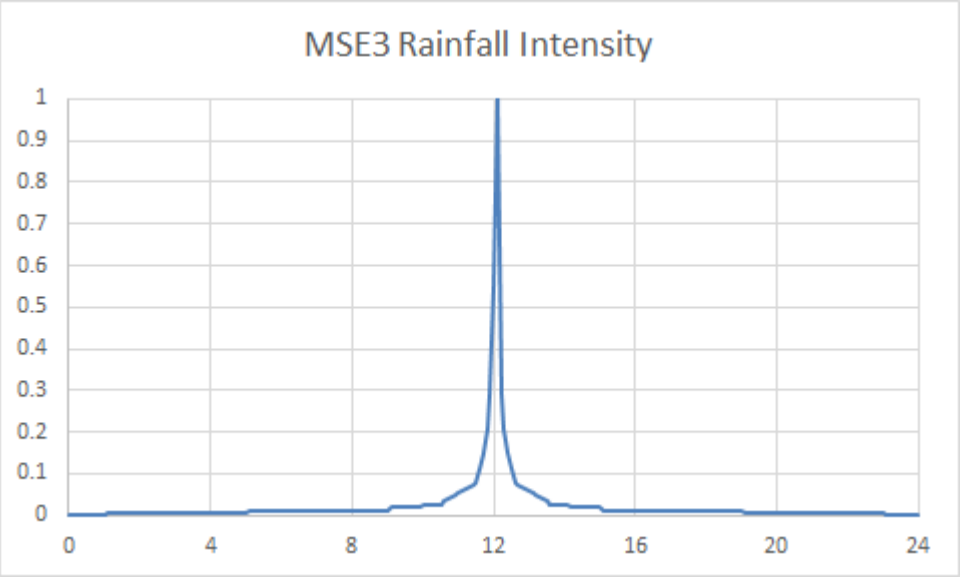
Modeling Study Sub-Agenda

1) Study Areas Limits and Description
2) Model Assumptions/Limitations
3) Major Drainage Patterns (Video of Drainage System)
4) Existing Conditions Inundation Mapping
5) Proposed Solutions
6) Proposed Solutions Inundation Mapping
7) Cost Estimates & Project Planning
8) Stormwater Water Quality

Model Assumptions/Limitations

Single-event, 24-hr statistical 'worst-case' rainfall event

i. 10-yr = 3.59 inches
ii. 25-yr = 4.40 inches
iii. 100-yr = 5.79 inches



A very 'peaky' intensity distribution

50% of all rainfall occurs in middle 1 hour
61% of all rainfall occurs in middle 2 hours
73% of all rainfall occurs in middle 3 hours

Model Assumptions/Limitations

The entire drainage system is well maintained

Actual photos from Knife River area taken during field work for this project

Model Assumptions/Limitations

The ground surface in the model is simulated as a series of flat 10-ft x 10-ft grid cells.

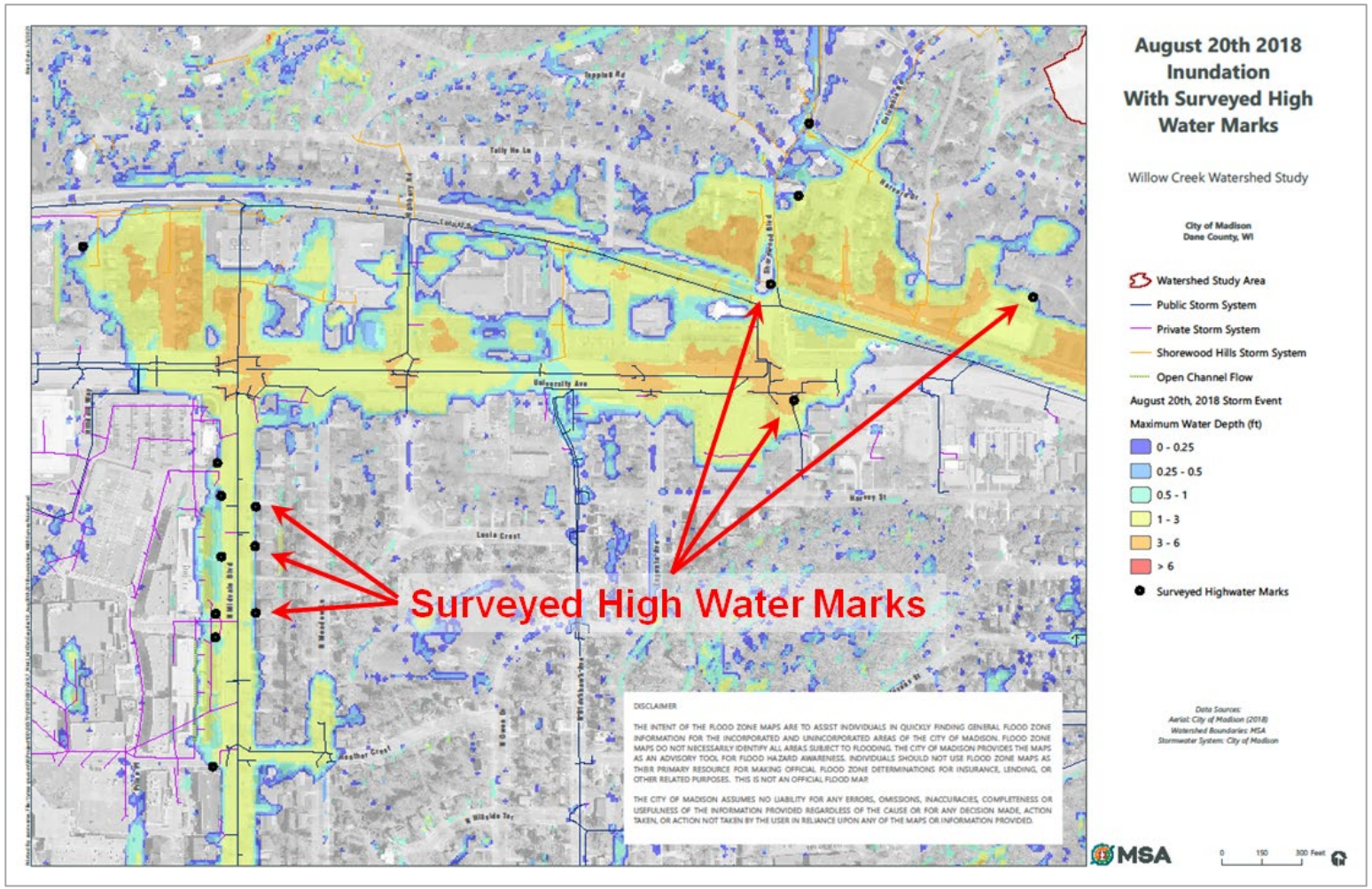
The model world looks like Minecraft

Not all topographic detail is included

Model Assumptions/Limitations

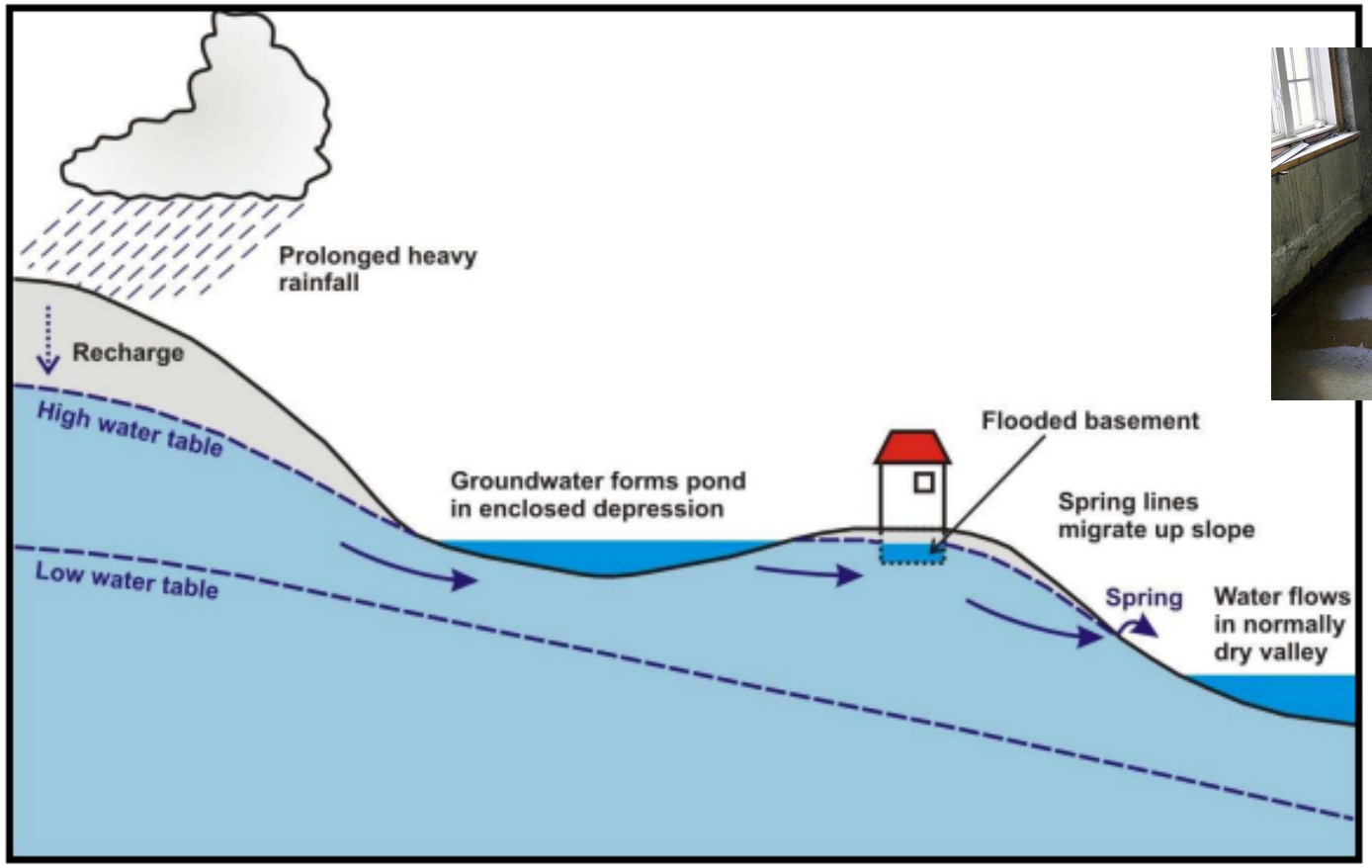
The model is not calibrated

(This is common for this kind of study and the results are very good)



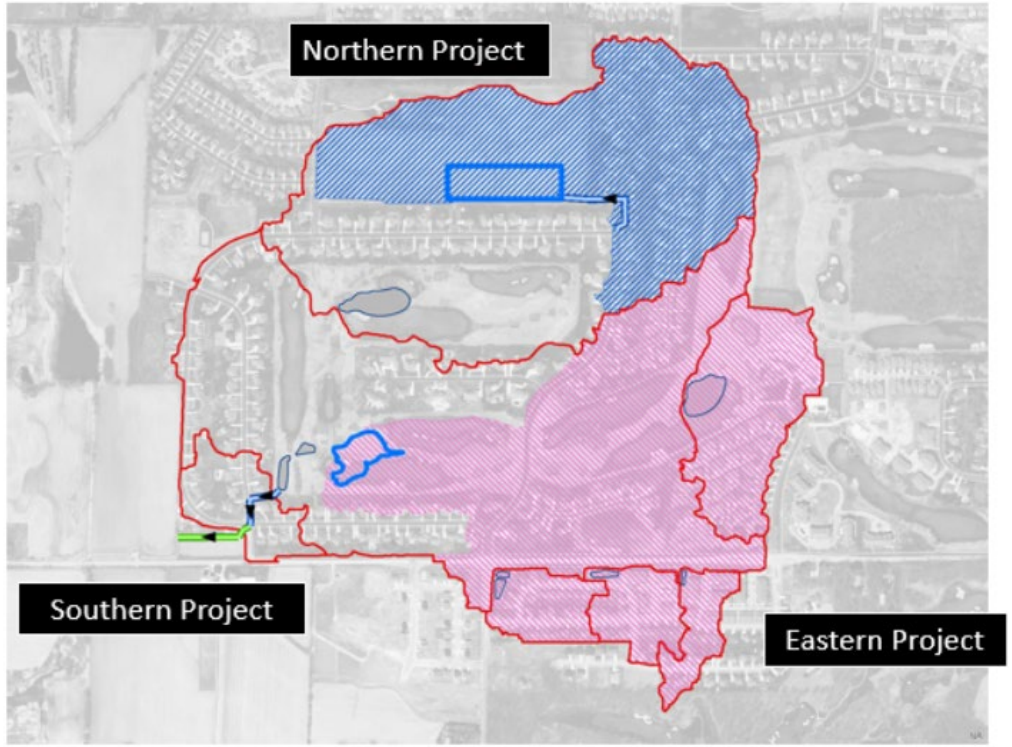
Model Assumptions/Limitations

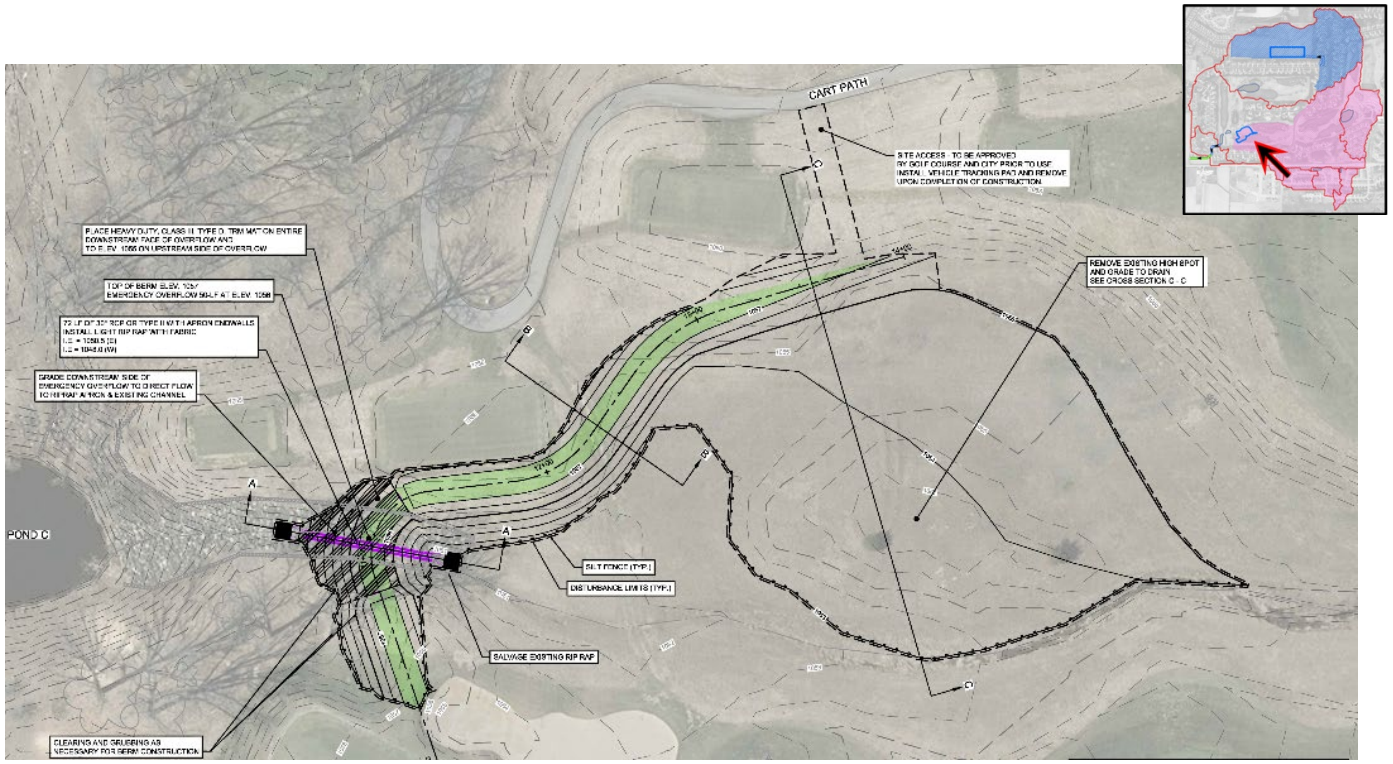
The model does not simulate the effects of groundwater



~~Model~~ Study Assumptions/Limitations

This is a planning level study. There is much more work that needs to be completed before construction can begin





Above: Model-Level Solution Evaluation
Right: Design Level Detail

Modeling Study Sub-Agenda

1) Study Areas Limits and Description
2) Model Assumptions/Limitations
3) Major Drainage Patterns (Video of Drainage System)
4) Existing Conditions Inundation Mapping
5) Proposed Solutions
6) Proposed Solutions Inundation Mapping
7) Cost Estimates & Project Planning
8) Stormwater Water Quality

Major Drainage Patterns

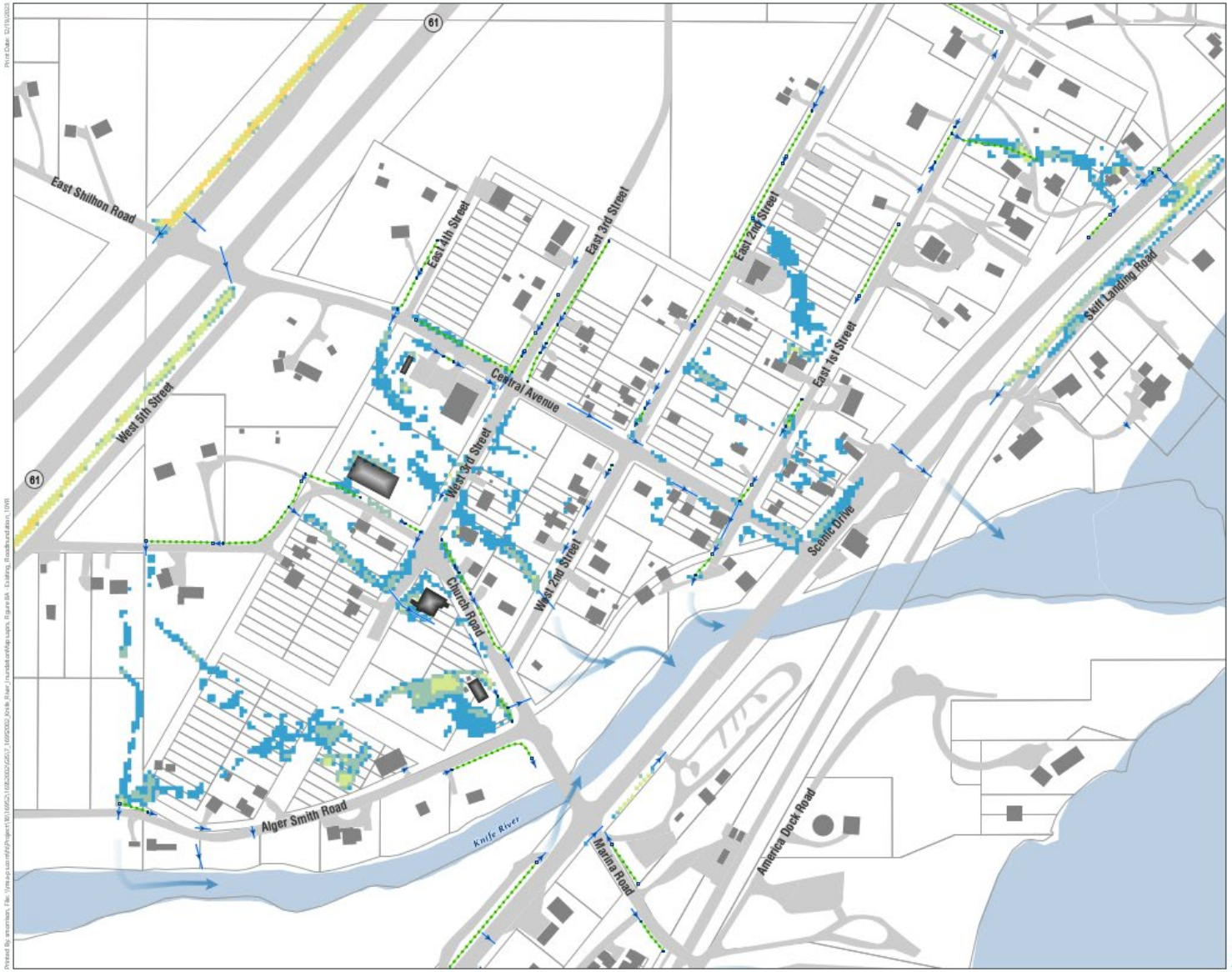
The image to the left is a 'Hazards' map generated by the XP-SWMM software used for this study. The blue shading represents the numerical peak value of flood depth times velocity (d x v). This map has many different uses; however, in this case it is used to identify existing surface drainage patterns.

Pause for Model Video

Modeling Study Sub-Agenda

1) Study Areas Limits and Description
2) Model Assumptions/Limitations
3) Major Drainage Patterns (Video of Drainage System)
4) Existing Conditions Inundation Mapping
5) Proposed Solutions
6) Proposed Solutions Inundation Mapping
7) Cost Estimates & Project Planning
8) Stormwater Water Quality

Existing 10-yr Peak Inundation Extents



Existing Conditions: 10-YR Flood Event

Figure 8A
Knife River Stormwater Study

City of Knife River
Lake County, Minnesota

- Point of Interest
- Storm Structure
- Storm System
- Modeled Swale
- Flow Direction
- Waterbody
- River/Stream

Maximum Water Depth (ft)

- 0.1 - 0.25
- 0.26 - 0.5
- 0.51 - 1
- 1.01 - 3
- 3.01 - 5
- > 5.0

Data Sources:
Storm System: MSA & Survey Collection (2023)
Aerial: Lake County Ortho

MSA

0 50 100 Feet

Existing 25-yr Peak Inundation Extents

Existing Conditions: 25-YR Flood Event

Figure 8B
Knife River Stormwater Study

City of Knife River
Lake County, Minnesota

- Point of Interest
- Storm Structure
- Storm System
- Modeled Swale
- Flow Direction
- Waterbody
- River/Stream

Maximum Water Depth (ft)

- 0.1 - 0.25
- 0.26 - 0.5
- 0.51 - 1
- 1.01 - 3
- 3.01 - 5
- > 5.0

Data Sources:
Storm System: MSA & Survey Collection (2023)
Aerial: Lake County Ortho

MSA

0 50 100 Feet

Existing 100-yr Peak Inundation Extents

Existing Conditions: 100-YR Flood Event

Figure 8C
Knife River Stormwater Study

City of Knife River
Lake County, Minnesota

- Point of Interest
- Storm Structure
- Storm System
- Modeled Swale
- Flow Direction
- Waterbody
- River/Stream

Maximum Water Depth (ft)

- 0.1 - 0.25
- 0.26 - 0.5
- 0.51 - 1
- 1.01 - 3
- 3.01 - 5
- > 5.0

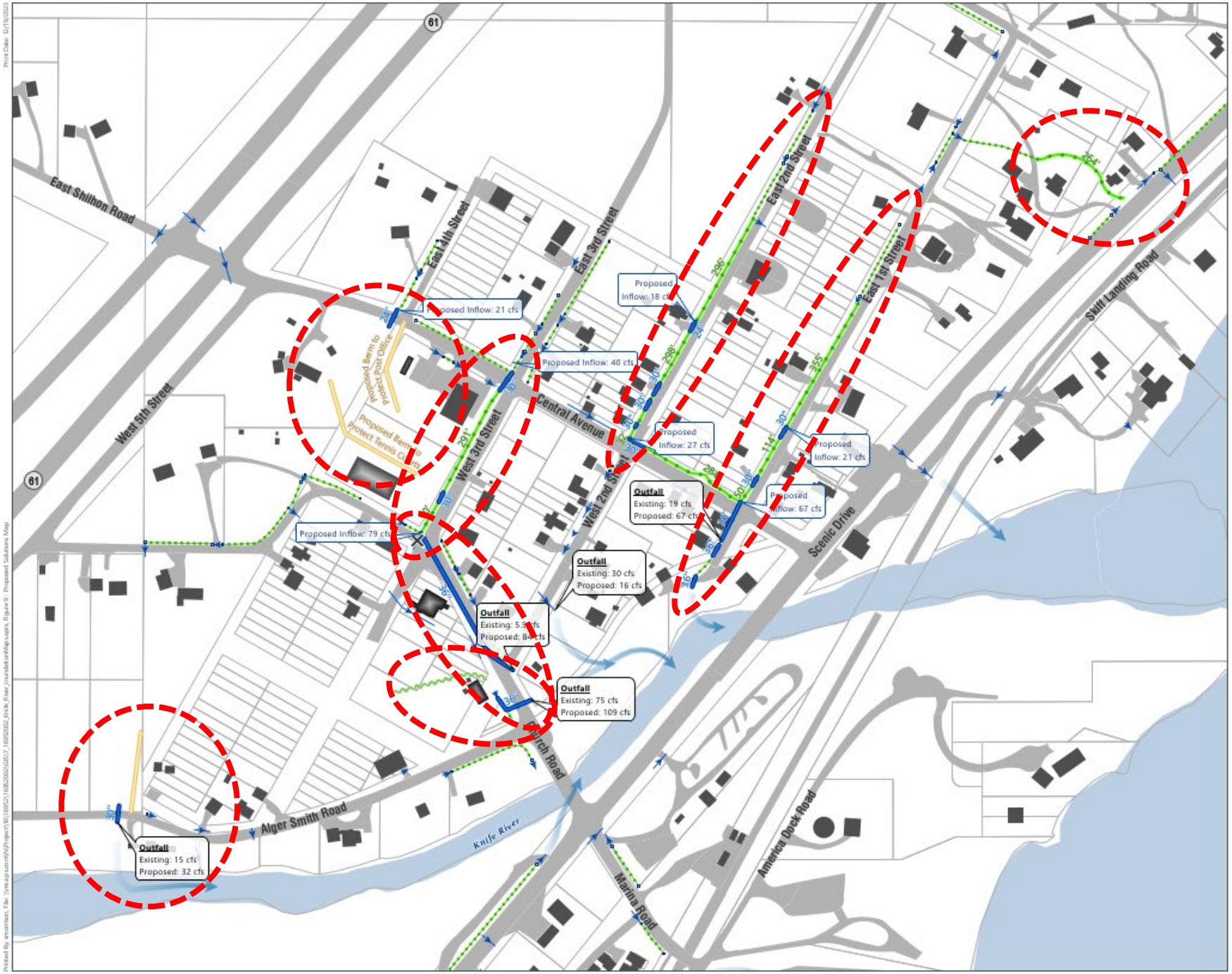
Data Sources:
Storm System: MSA & Survey Collection (2023)
Aerial: Lake County Ortho

MSA

0 50 100 Feet

Modeling Study Sub-Agenda

1) Study Areas Limits and Description
2) Model Assumptions/Limitations
3) Major Drainage Patterns (Video of Drainage System)
4) Existing Conditions Inundation Mapping
5) Proposed Solutions
6) Proposed Solutions Inundation Mapping
7) Cost Estimates & Project Planning
8) Stormwater Water Quality



Proposed Solutions

Figure 9
Knife River Stormwater Study

City of Knife River
Lake County, Minnesota

- Point of Interest
- Parcel (Lake County)
- Storm Structure
- Modeled Swale
- Existing Storm System
- Flow Direction

Proposed Improvement

- Remove Culvert
- 123' Upgraded Swale Length
- Improve Swale
- Replace or Install New Culvert
- Embankment
- Ditch

Data Sources:
Storm System: MSA & Survey Collection (2023)
Modeling & Proposed Improvements: MSA (2023)
Basemap: ESRI

MSA

0 50 100 Feet

Modeling Study Sub-Agenda

1) Study Areas Limits and Description
2) Model Assumptions/Limitations
3) Major Drainage Patterns (Video of Drainage System)
4) Existing Conditions Inundation Mapping
5) Proposed Solutions
6) Proposed Solutions Inundation Mapping
7) Cost Estimates & Project Planning
8) Stormwater Water Quality

Existing 100-yr Peak Inundation Extents

Existing Conditions: 100-YR Flood Event

Figure 8C
Knife River Stormwater Study

City of Knife River
Lake County, Minnesota

- Point of Interest
- Storm Structure
- Storm System
- Modeled Swale
- Flow Direction
- Waterbody
- River/Stream

Maximum Water Depth (ft)

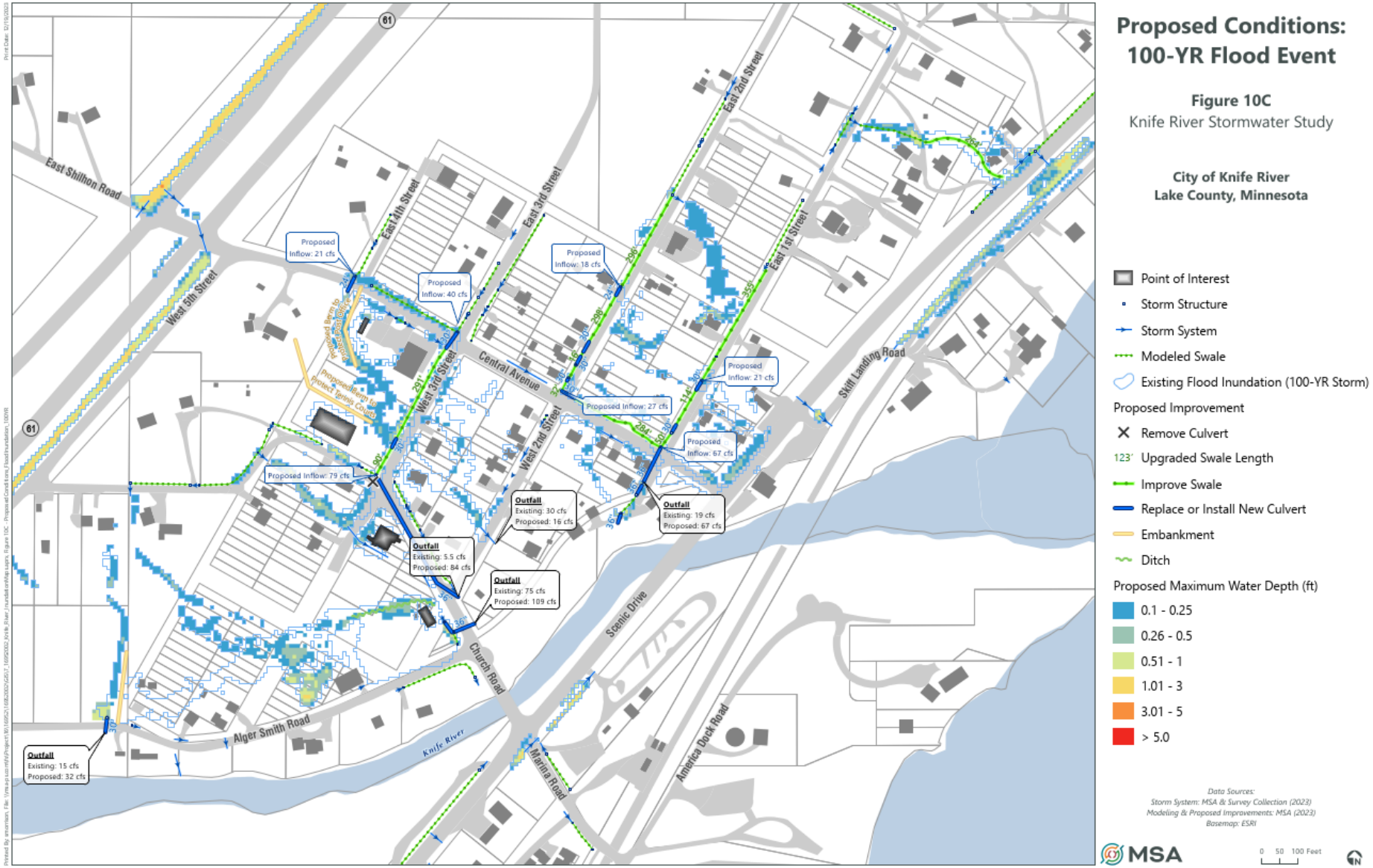
- 0.1 - 0.25
- 0.26 - 0.5
- 0.51 - 1
- 1.01 - 3
- 3.01 - 5
- > 5.0

Data Sources:
Storm System: MSA & Survey Collection (2023)
Aerial: Lake County Ortho

MSA

0 50 100 Feet

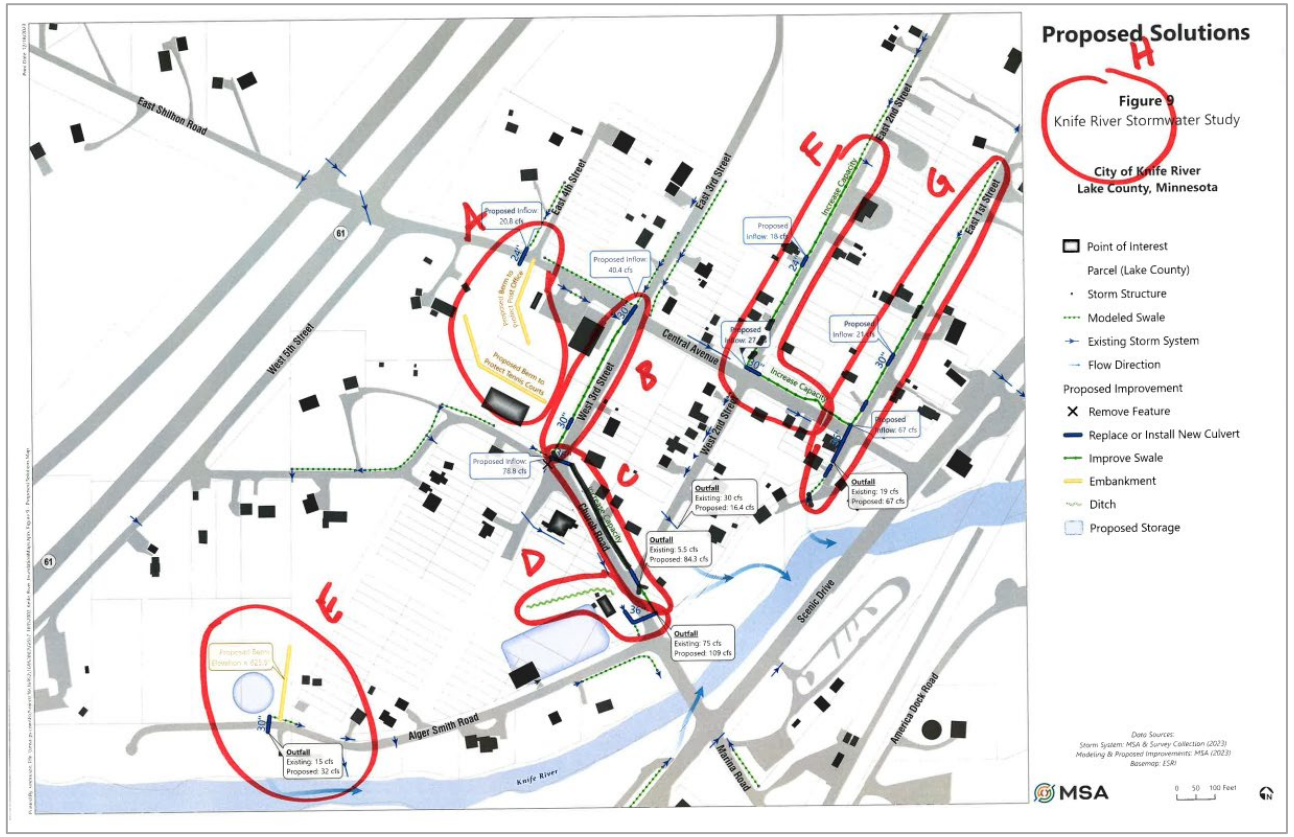
Proposed 100-yr Peak Inundation Extents



Modeling Study Sub-Agenda

1) Study Areas Limits and Description
2) Model Assumptions/Limitations
3) Major Drainage Patterns (Video of Drainage System)
4) Existing Conditions Inundation Mapping
5) Proposed Solutions
6) Proposed Solutions Inundation Mapping
7) Cost Estimates & Project Planning
8) Stormwater Water Quality

Cost Estimates and Project Planning



Preliminarily grouped into eight (8) project areas.

Total estimated construction cost = $1.5M *(all projects)*

Includes design and contingency, but not land/easement acquisition

Project implementation is generally from downstream to upstream, but will depend upon:

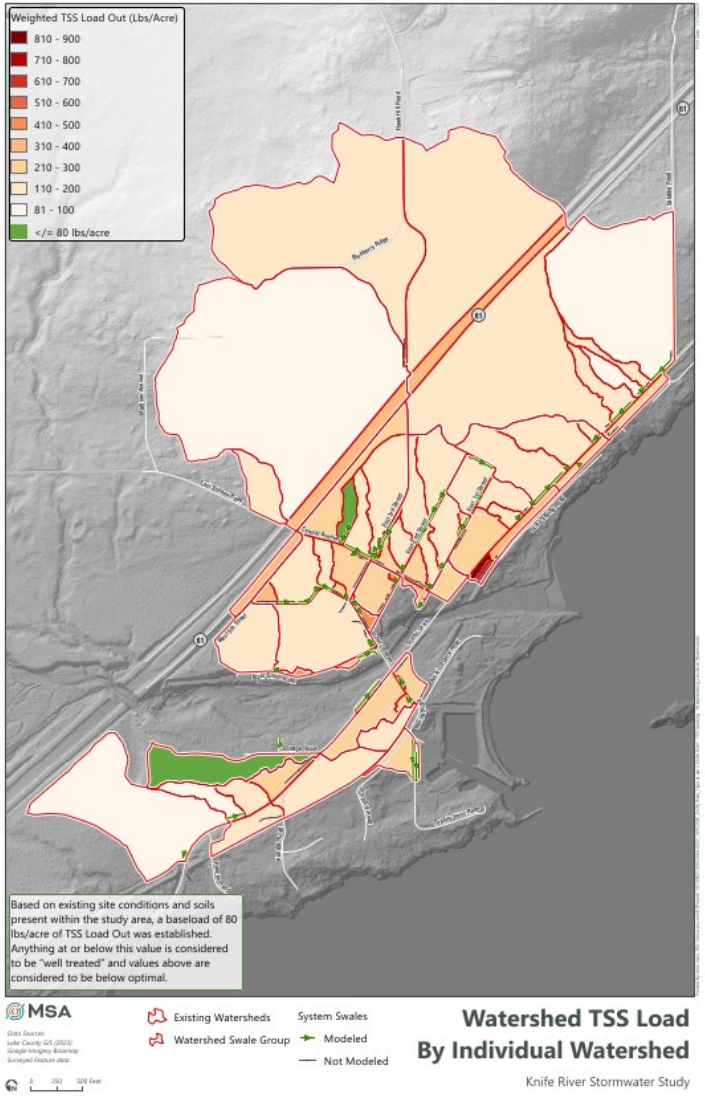
- Available funding (including grants)
- Coordination with other non-drainage projects
- Landowner cooperation

Modeling Study Sub-Agenda

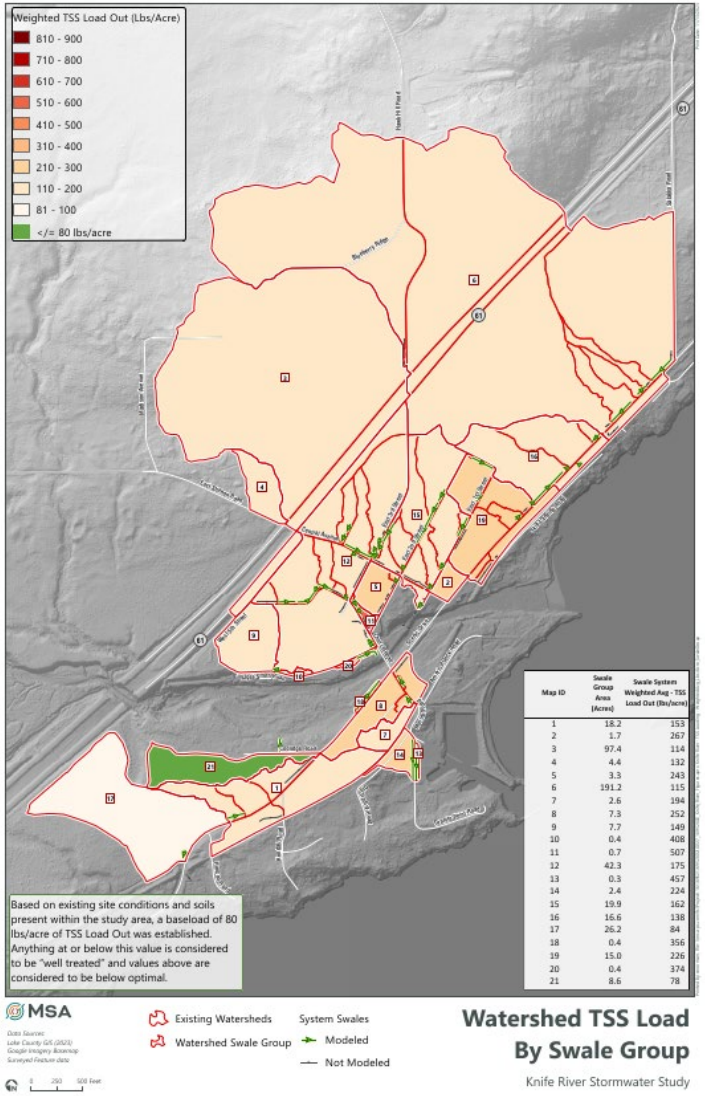
1) Study Areas Limits and Description
2) Model Assumptions/Limitations
3) Major Drainage Patterns (Video of Drainage System)
4) Existing Conditions Inundation Mapping
5) Proposed Solutions
6) Proposed Solutions Inundation Mapping
7) Cost Estimates & Project Planning
8) Stormwater Water Quality

Stormwater Quality

Existing TSS loads by subwatershed



Existing TSS loads by system



Map ID	Swale Group Area (Acres)	Swale System Weighted Avg - TSS Load Out (lbs/acre)
1	18.2	153
2	1.7	267
3	97.4	114
4	4.4	132
5	3.3	243
6	191.2	115
7	2.6	194
8	7.3	252
9	7.7	149
10	0.4	408
11	0.7	507
12	42.3	175
13	0.3	457
14	2.4	224
15	19.9	162
16	16.6	138
17	26.2	84
18	0.4	356
19	15.0	226
20	0.4	374
21	8.6	78

<u>Evaluation completed using WinSLAMM Model</u>

Predevelopment Total Suspended Solids (TSS) Load =
80 lbs/ac/yr

Typical Northern Minnesota Urban TSS Load =
234 lbs/ac/yr

Existing Conditions TSS Load (by land use) =
139 lbs/acre/year

Existing Conditions TSS Discharge (to river/lake) =
133 lbs/acre/year

- *5% reduction achieved by swales*
  - *Reduction a function of 'swale density' and infiltration rate.*
  - *Infiltration could be enhanced by drain tile system added to swale drainage improvements.*
    - *Proposed Projects = 2.5% TSS reduction improvement*

Next Steps

Questions?

Contact: Kari Hedin (Lake SWCD)
kari.hedin@co.lake.mn.us
or 218-834-8514

Jason DiPiazza (County Highway)
jason.dipiazza@co.lake.mn.us
or 218-834-8509

Recording will be posted on the Lake SWCD website

https://tinyurl.com/KRStormwater