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Floodway Analysis: Comparing Results Between Unsteady and Steady HEC-RAS

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Presentation Overview

Glenn

- Floodway Standards
- Unsteady Floodway Modeling Guidance
- Why is ISWS working with Unsteady FWs?

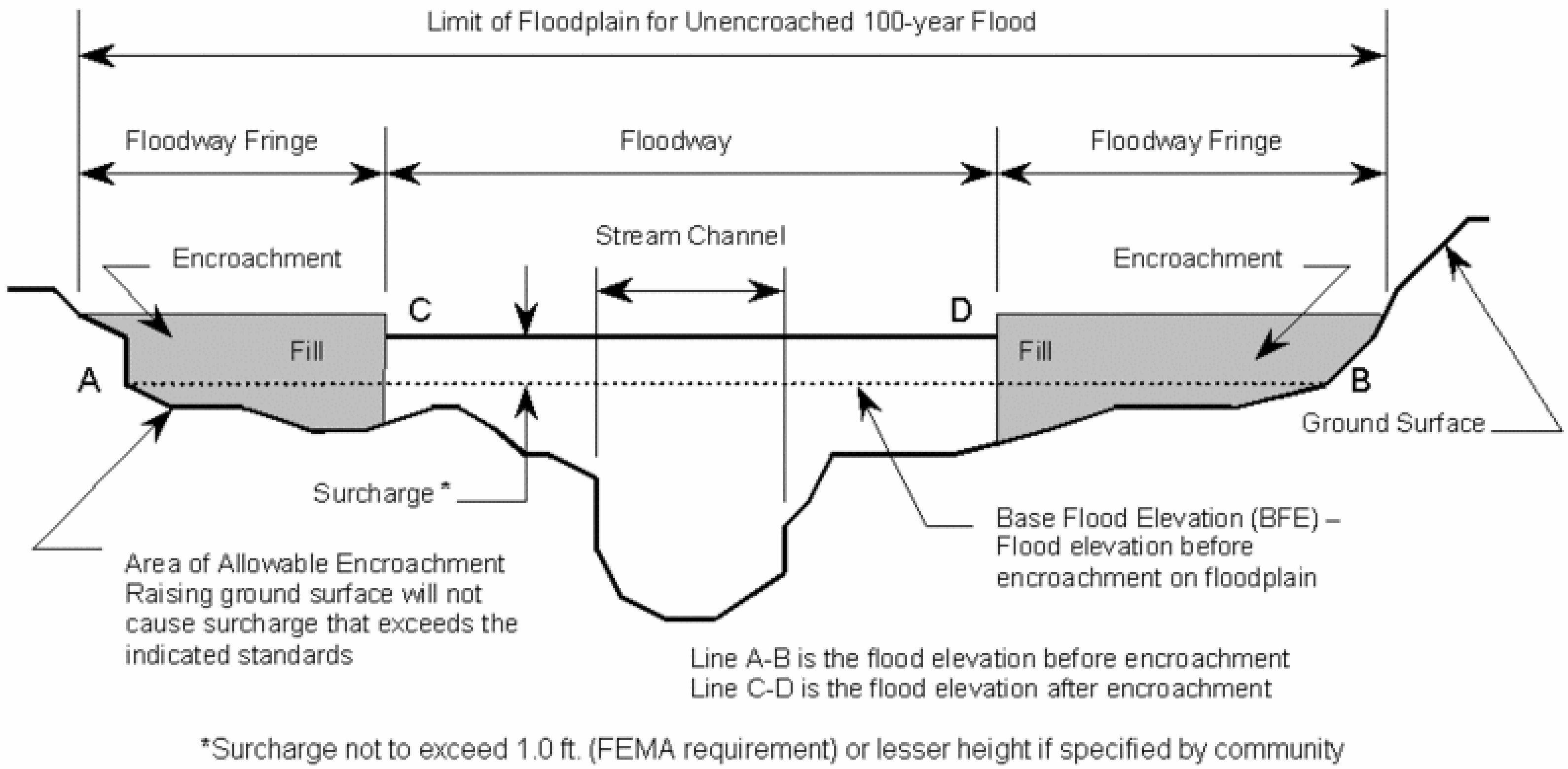
Sherif

- Steady/Unsteady FW Comparison Examples
- Floodway Coverage Comparison

Glenn

- Findings of Steady/Unsteady FW Comparison
- Unsteady Floodway Modeling Challenges
- Questions

Regulatory Floodway



Floodplain Encroachment and Floodway

A "Regulatory Floodway" means the channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than a designated height.

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Floodway Standards

1. FEMA Requirements:
   - 1.0 ft maximum rise
   - Equal conveyance reduction (Method 4, then Method 1)

2. Illinois Requirements:
   - 0.1 ft maximum rise
   - Equal conveyance reduction (Method 4, then Method 1)
   - Maximum velocity increase = 10%
   - Maximum flow-area decrease = 10%

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Unsteady FW Modeling Guidance

1. HEC-RAS User's Manual (HEC, 2010), Chapter 10, Floodway Encroachments with Unsteady Flow.
2. FEMA Guidelines and Specifications for Flood Hazard Mapping Partners (November 2009), Section C.4.4.1, Floodway Determination Using Unsteady State Modeling.
3. USGS Water-Resources Investigations Report 97-4037 (1997), Section 4.7.
4. Computing Floodways With Unsteady Flow Models (May, 1997), Dewberry & Davis, Camp Dresser & McKee, Proceedings of the 21st Annual Conference of the ASFPM.
5. Floodways and One-Dimensional Unsteady-State Flow Models (May 1995), Dewberry & Davis, FEMA, Proceedings of the 19th Annual Conference of the ASFPM.

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Why Unsteady?

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Detailed Watershed Plan (DWP)

Metropolitan Water Reclamation District of Greater Chicago (MWRDGC)

Physical Map Revision (PMR)

FEMA

MWRDGC HEC-RAS Models:

- Developed for storm water management analysis and design
- 321 Linear miles of streams

Watersheds:

- Calumet Sag Channel
- Little Calumet River
- Upper Salt Creek
- North Branch Chicago River

Cook County

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Graphical Comparison of Unsteady and Steady Floodways

Four Streams in Cook County, Illinois

Calumet Sag Watershed

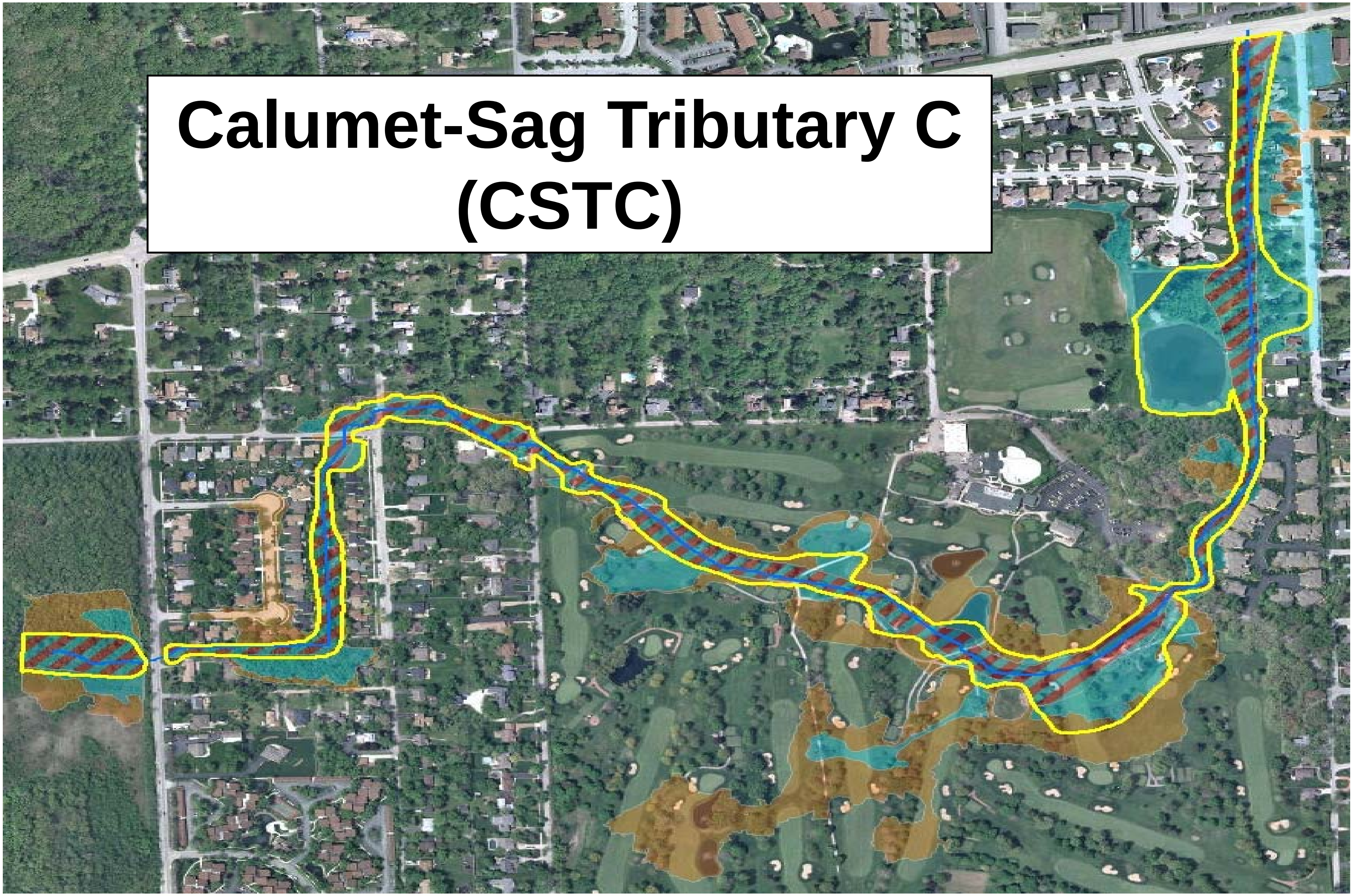
1. Calumet-Sag Tributary C

2. Calumet-Sag Tributary B

3. Illinois & Michigan Canal Tributary A

4. Crooked Creek

Calumet-Sag Tributary C (CSTC)



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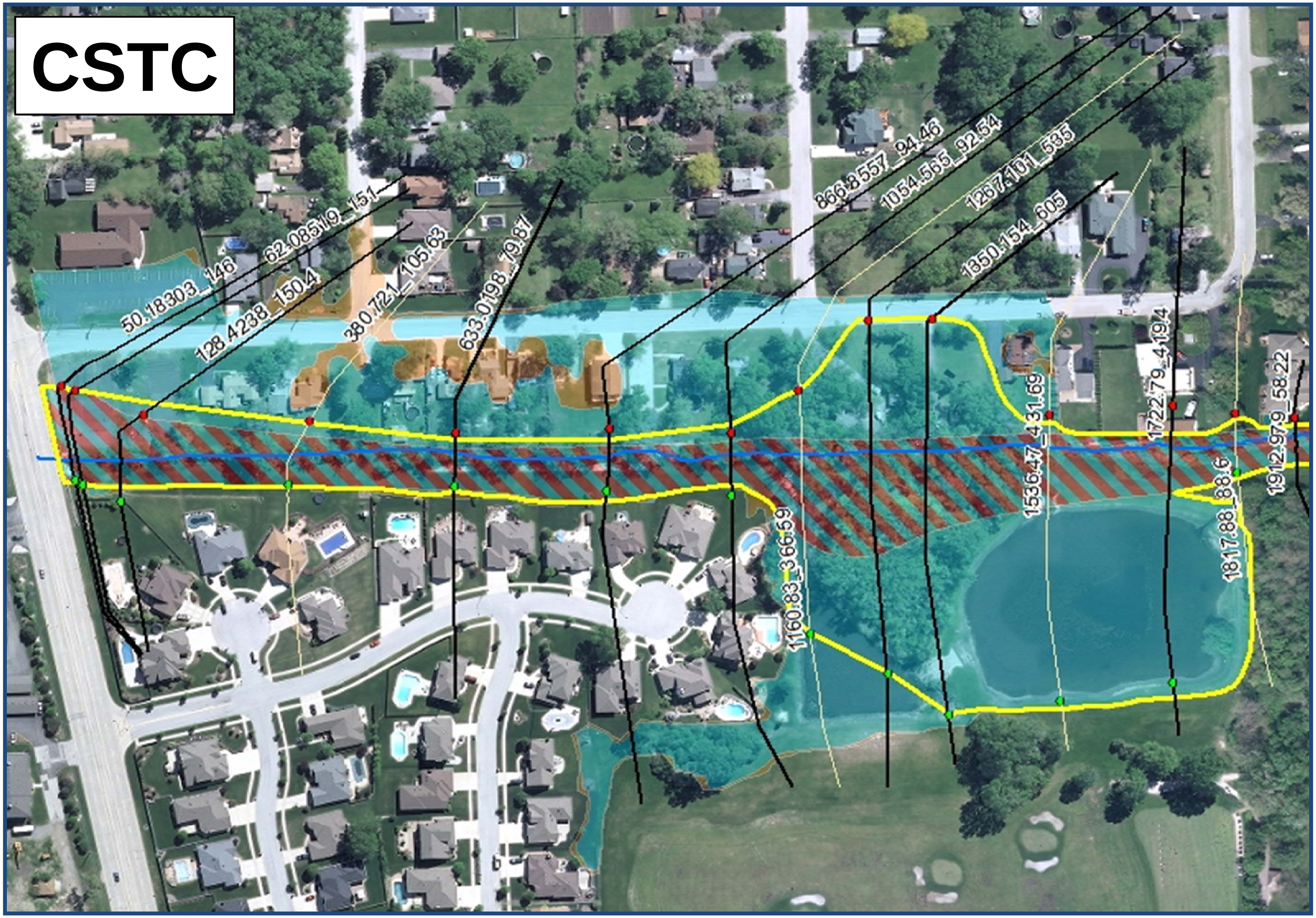

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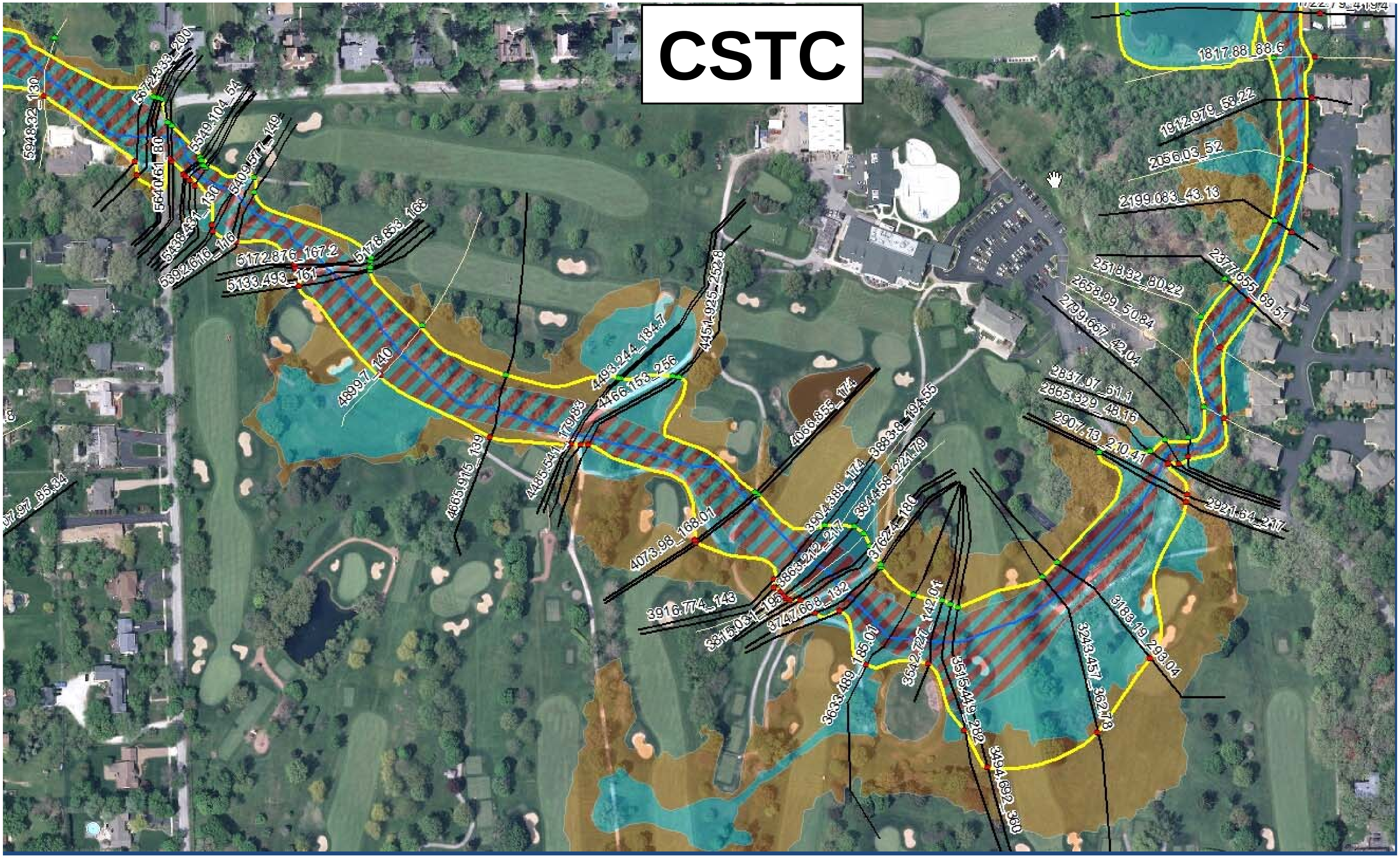
CSTC



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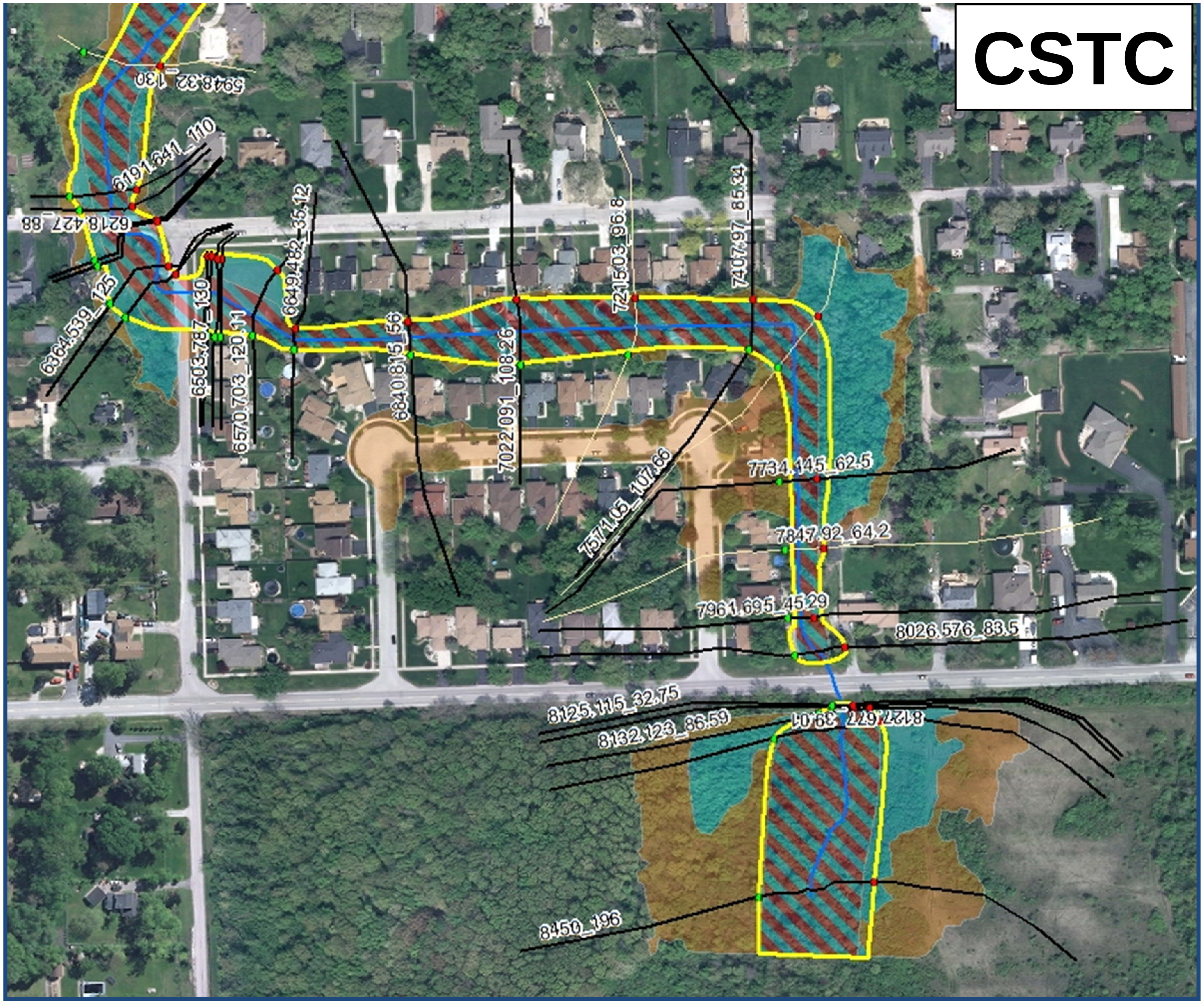

Steady FW
Unsteady FW

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Calumet-Sag Tributary B (CSTB)

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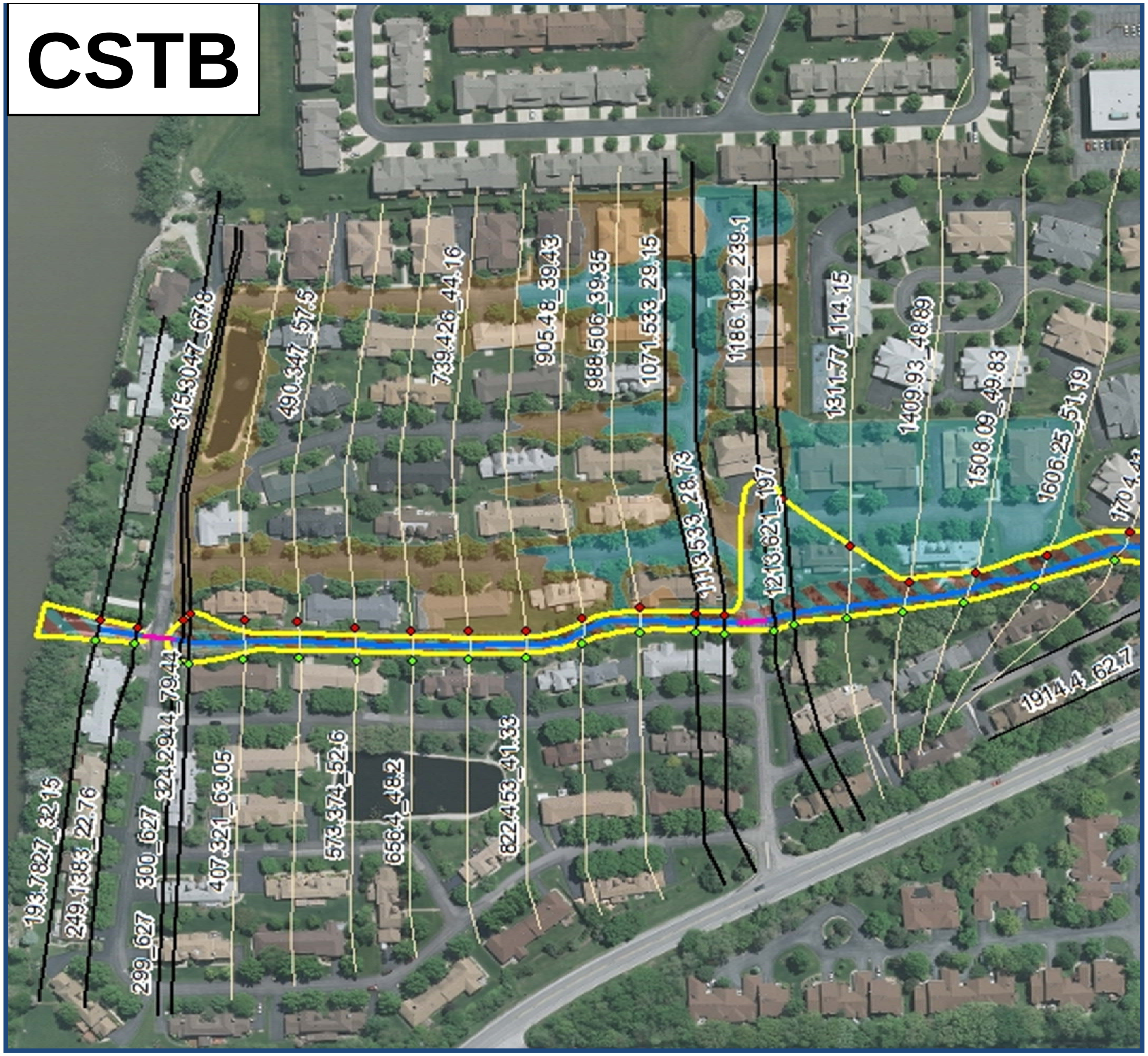
CSTB



Steady FW
Unsteady FW

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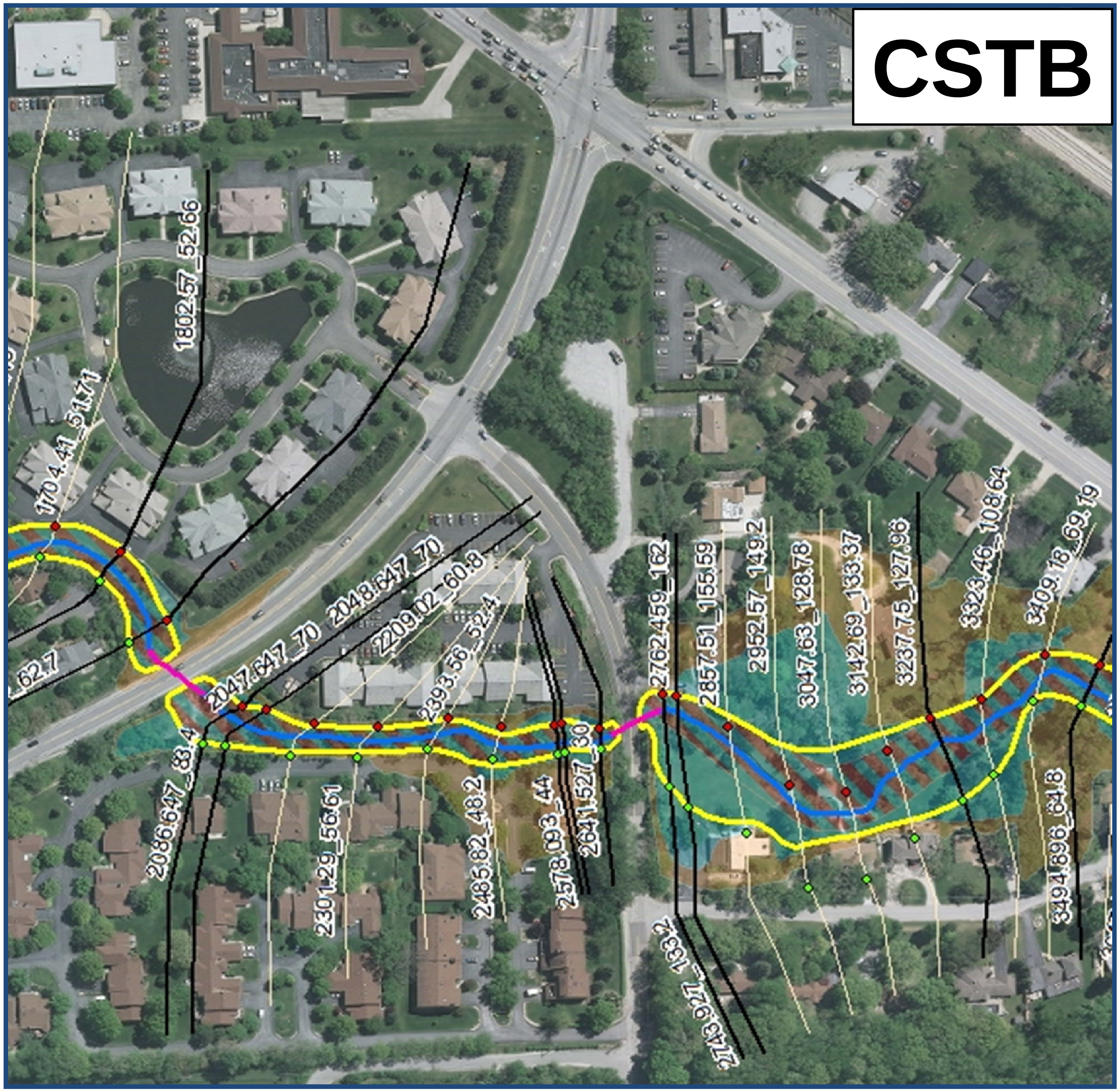

Steady FW
Unsteady FW

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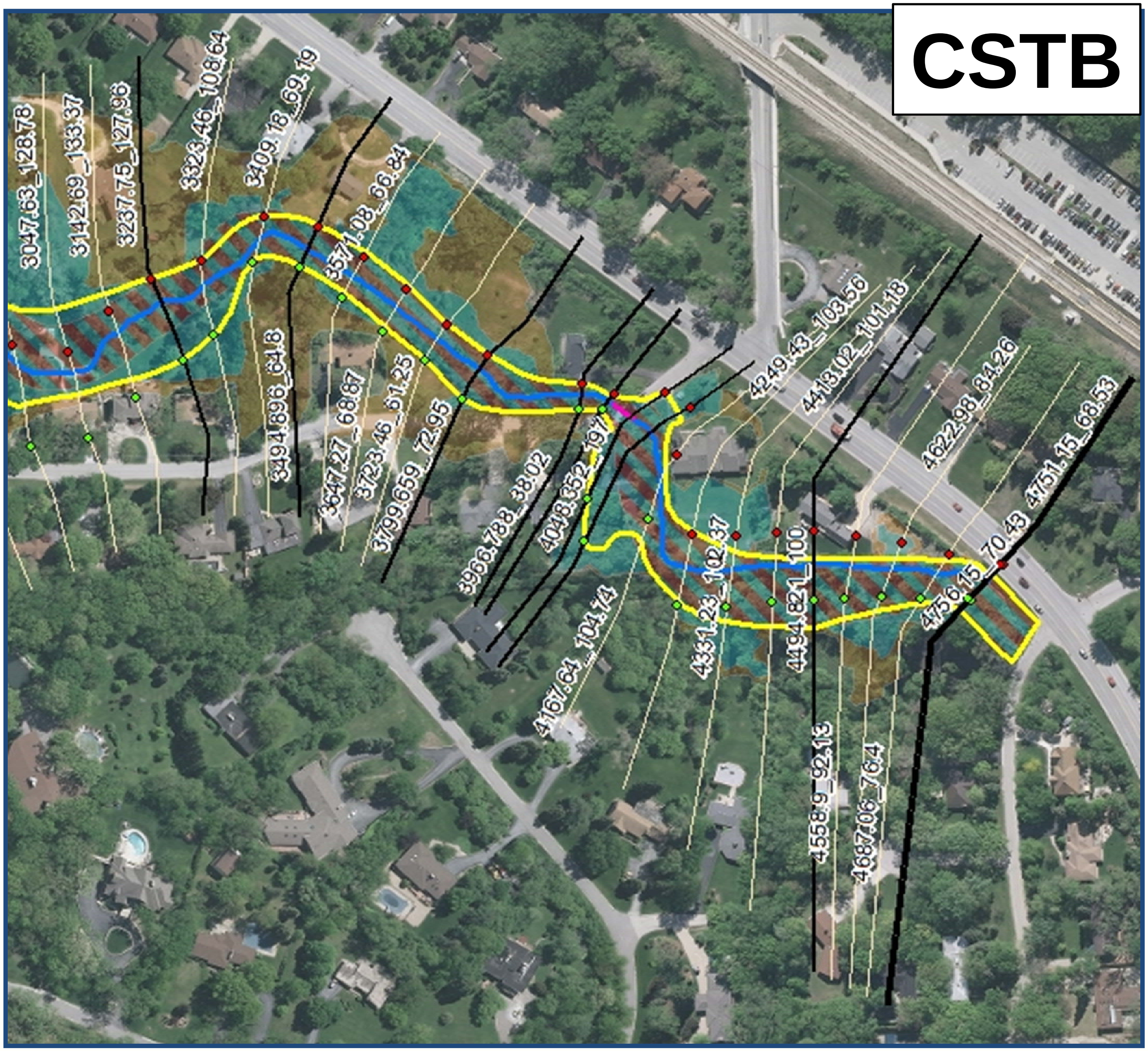

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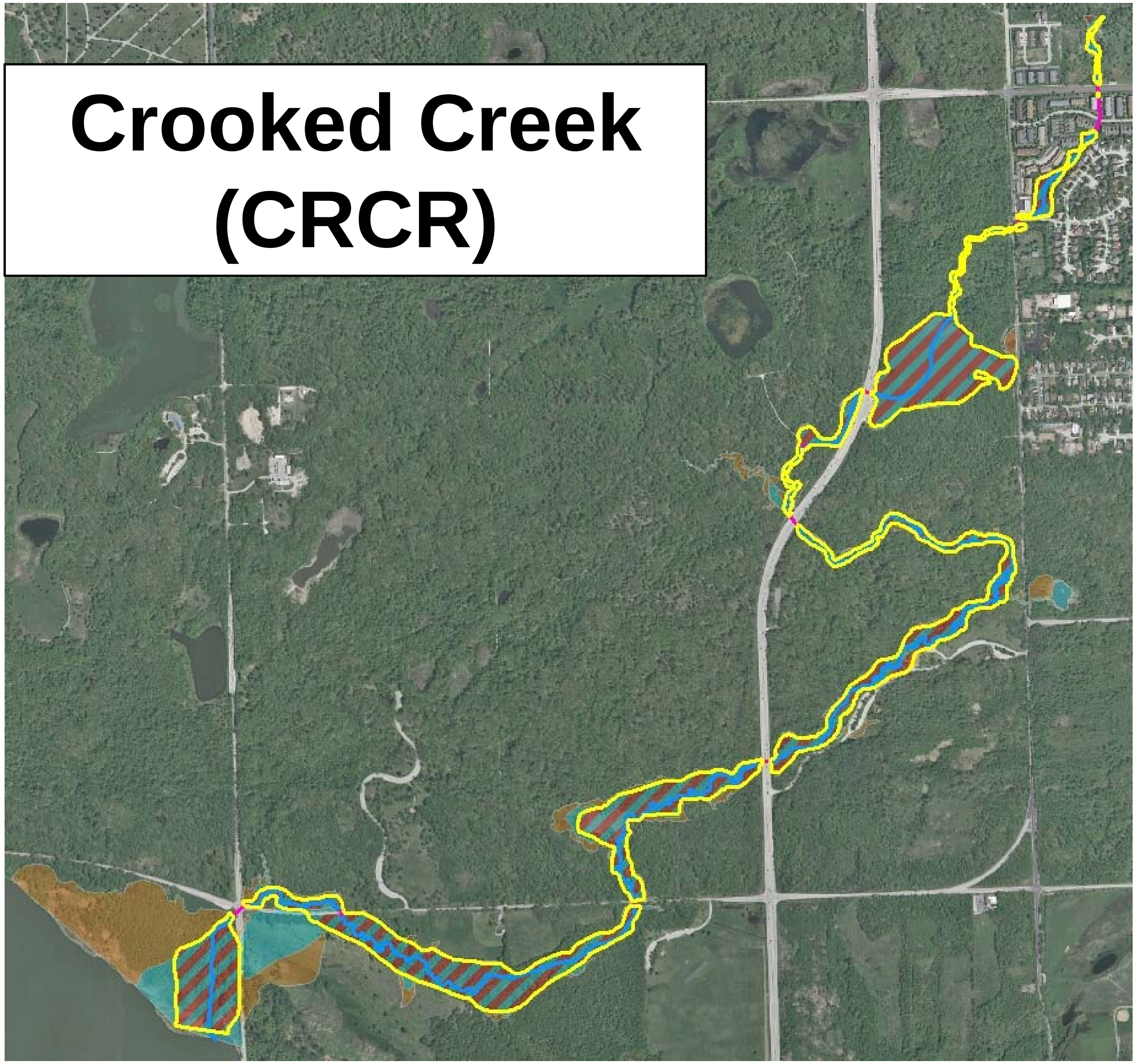
Steady FW
Unsteady FW

Crooked Creek (CRCR)



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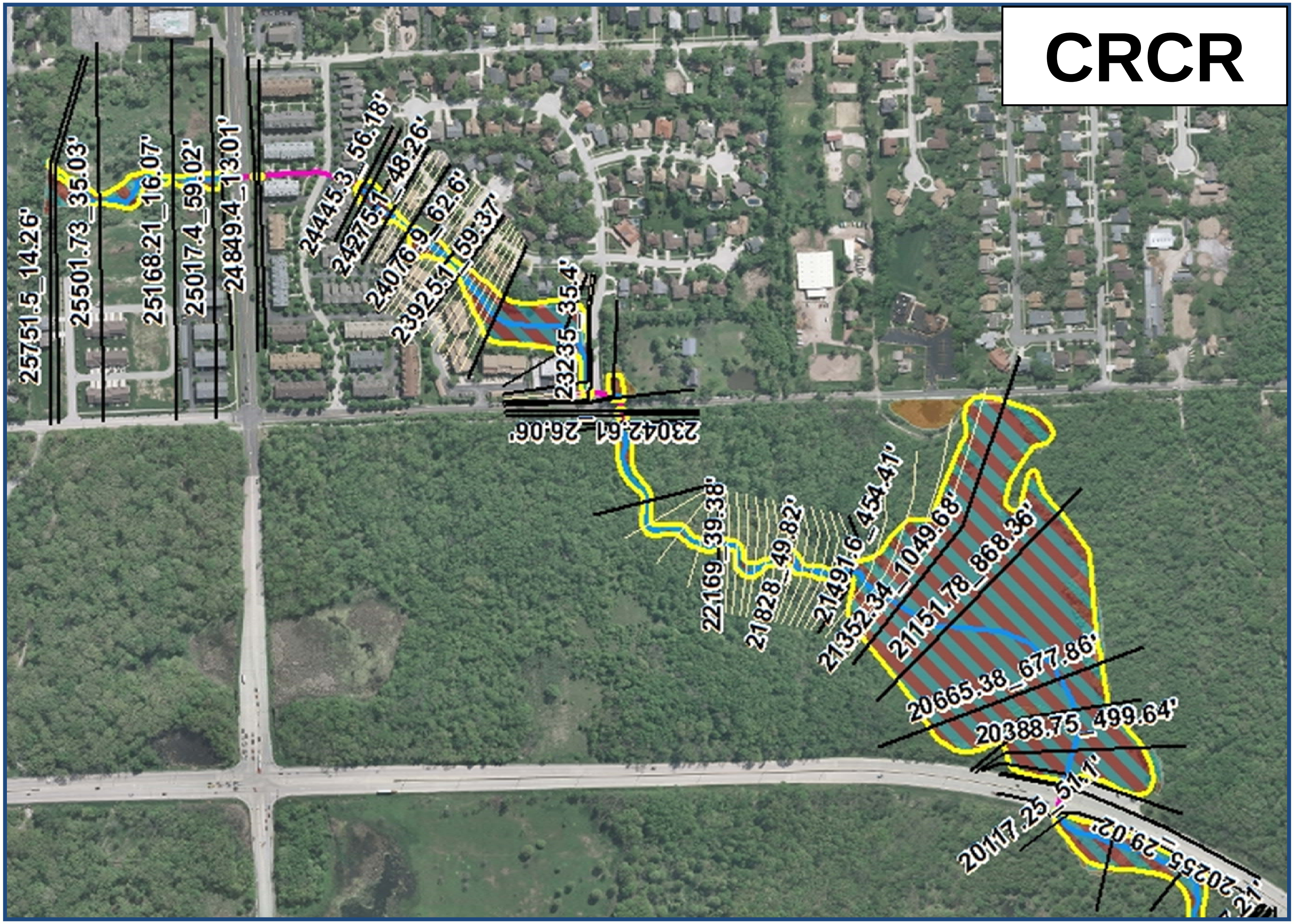

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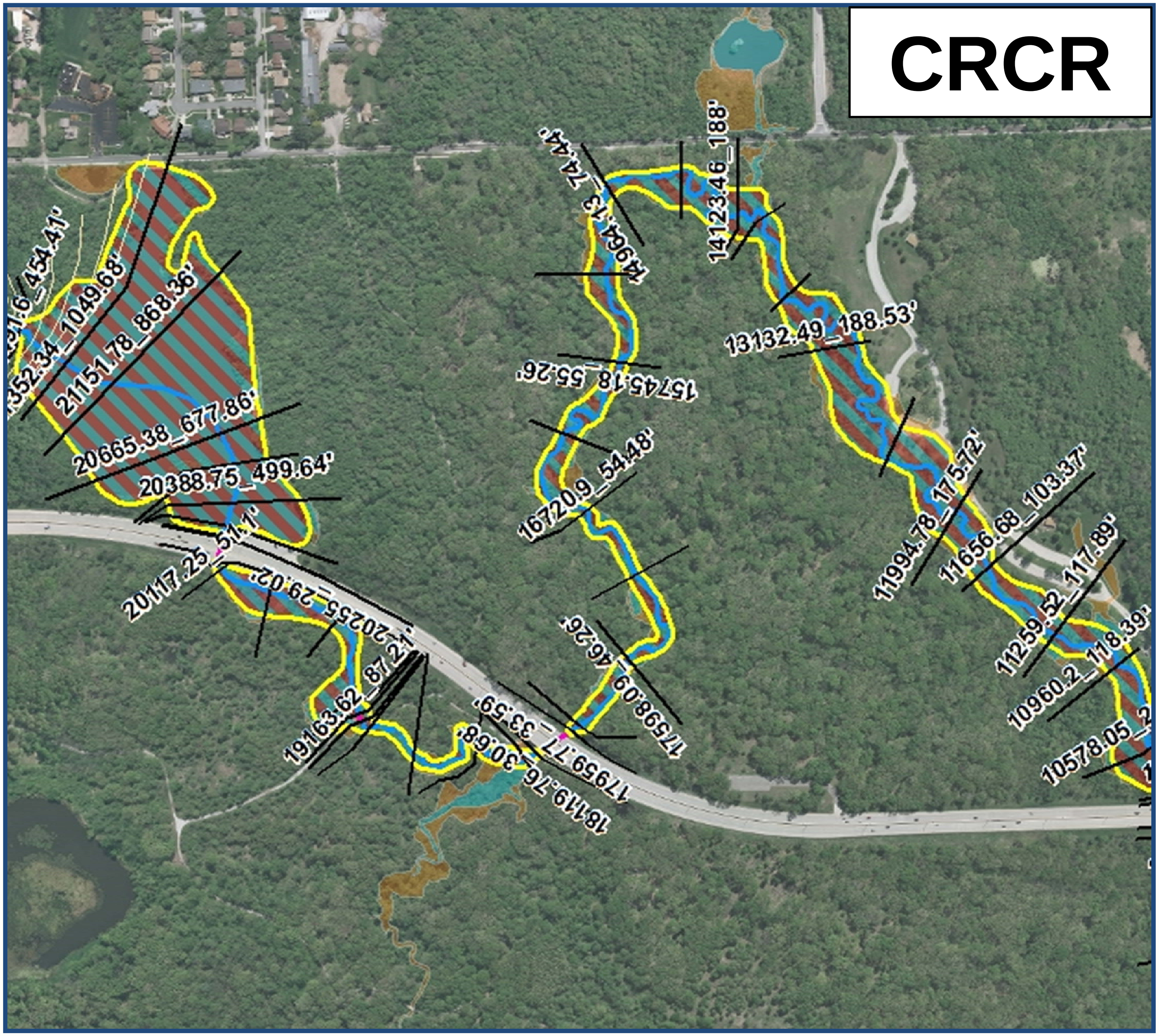
Steady FW
Unsteady FW



Steady FW
Unsteady FW

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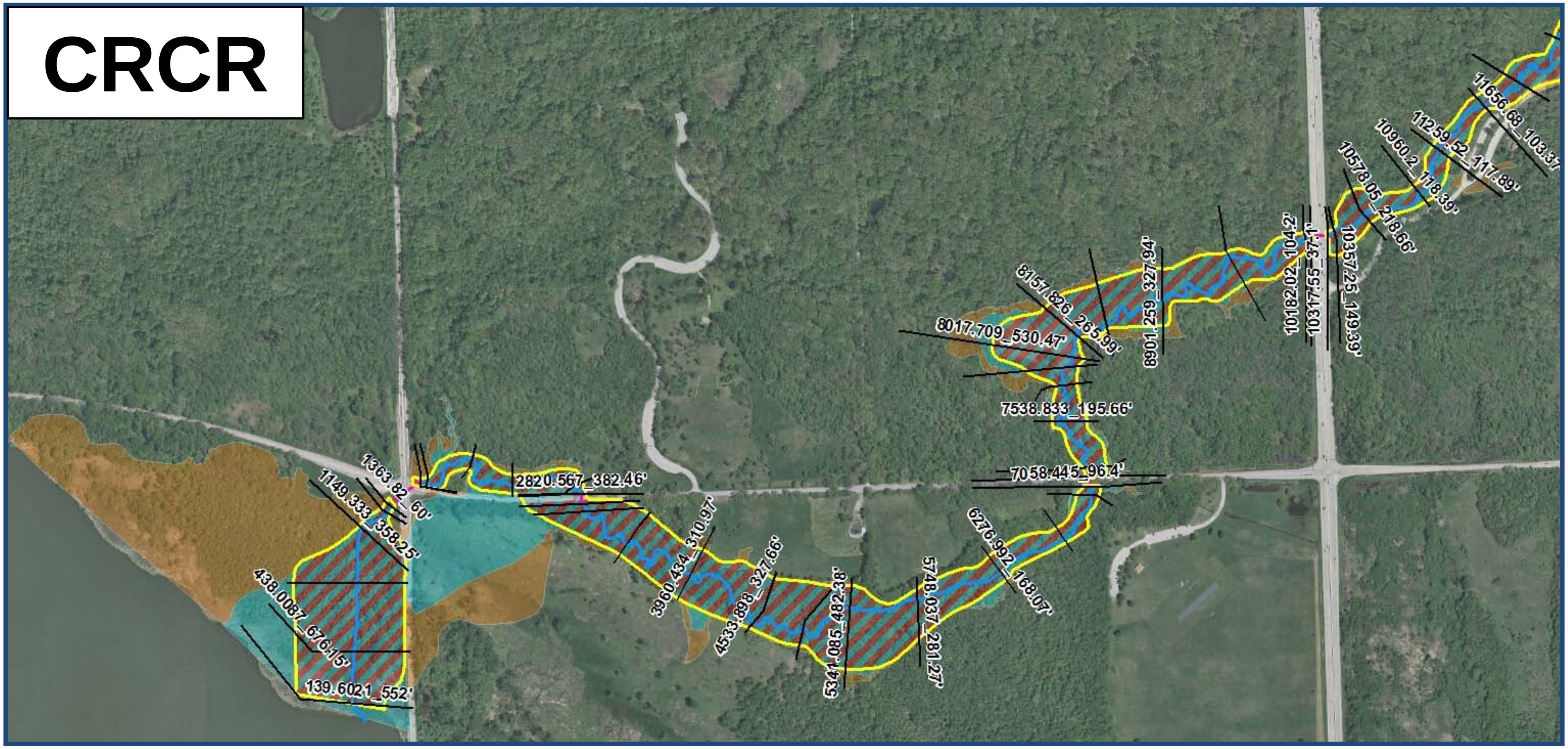
CRCR



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Steady FW
Unsteady FW

Floodway Coverage Comparison

	CSTC	CSTB	IMTA	CRCR
Percent of 1% Annual Chance Floodplain Covered By UNSTEADY Floodway =	71%	52%	95%	83%
Percent of 1% Annual Chance Floodplain Covered By STEADY Floodway =	43%	42%	85%	83%
Percent Change In Floodway Areas Between UNSTEADY And STEADY Floodways =	**28%**	**10%**	**10%**	**0%**
Average Stream Slope =	0.3%	0.8%	1.7%	3.9%
Approx. Storage Area (ft^2)=	4×10^5	3.2×10^5	1.3×10^5	0.3×10^5
Stream Miles =	1.6	0.9	1.2	4.9

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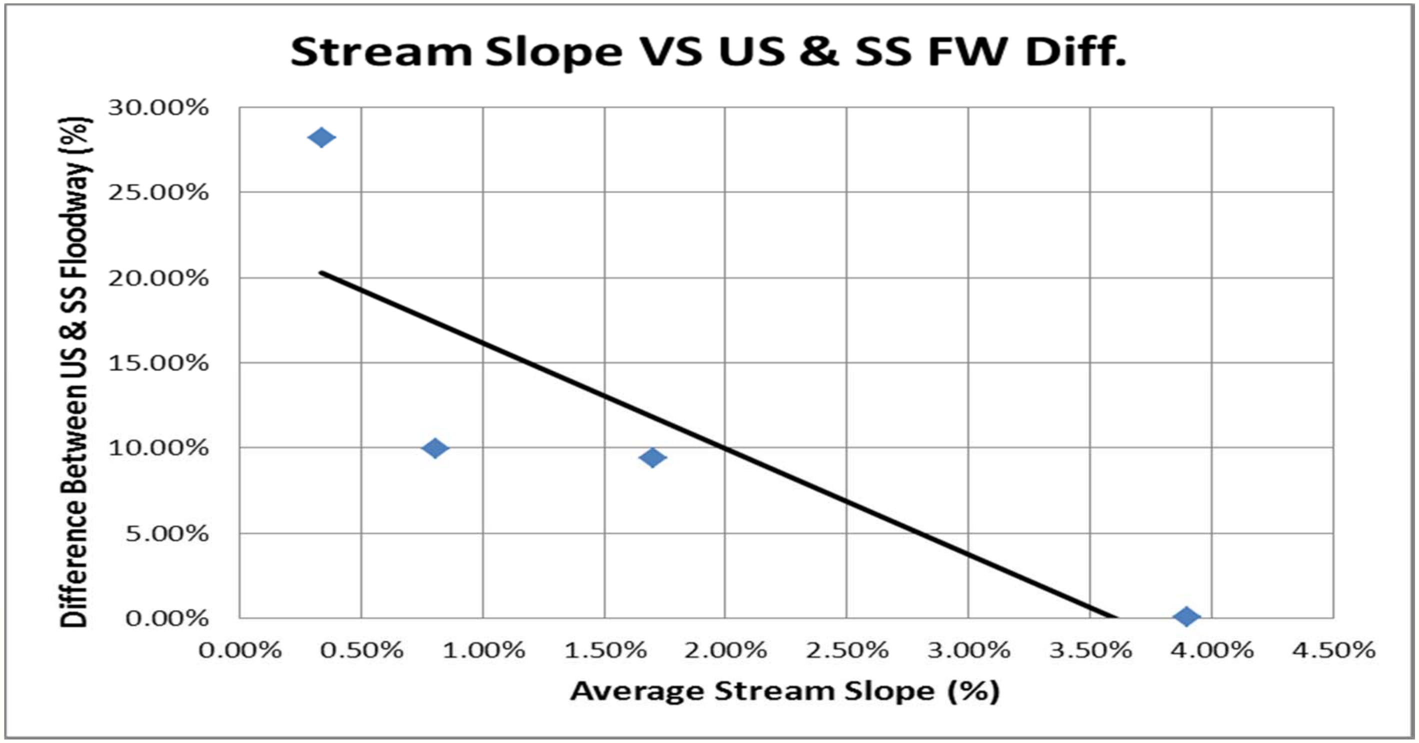
Observations & Hypothesis

1. Steeper Stream Slope Correlates to Smaller Difference Between Unsteady and Steady Floodways



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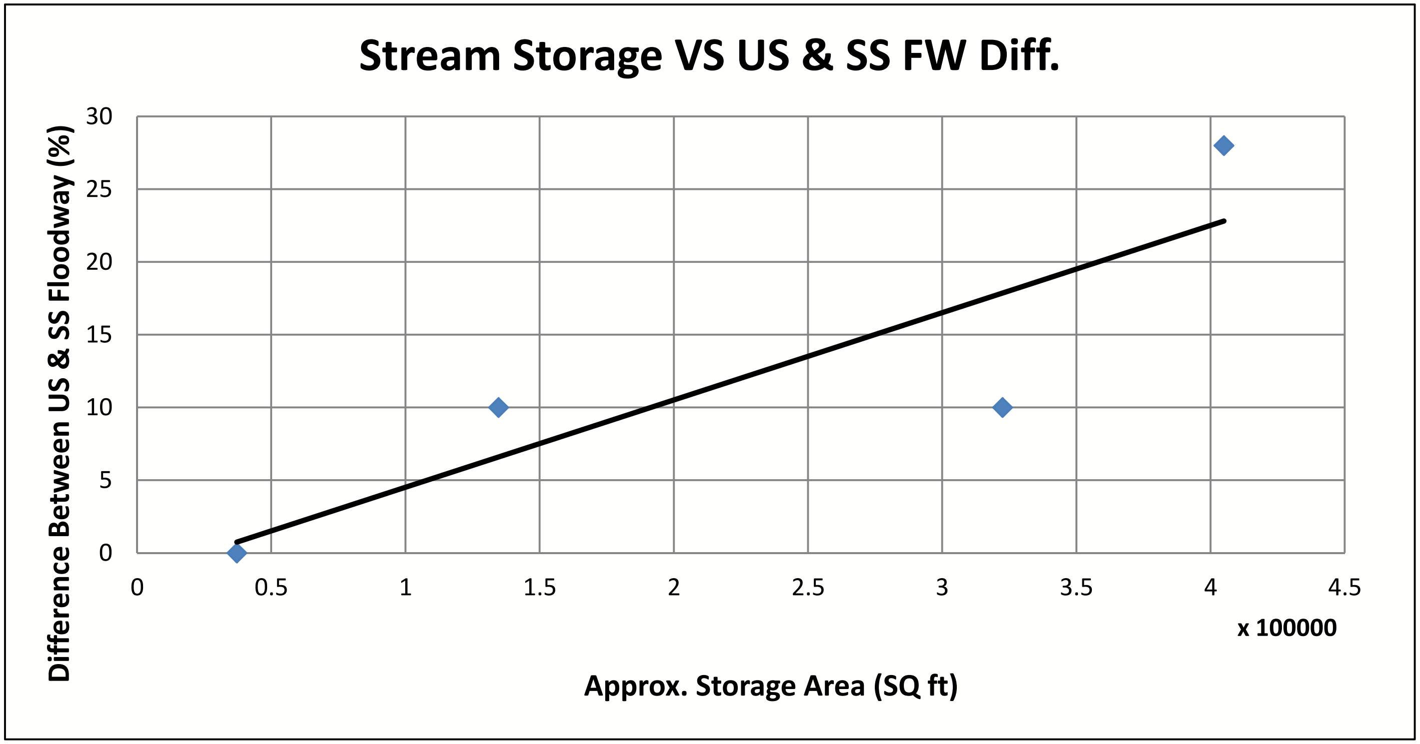
Observations & Hypothesis

2. More Storage Correlates to Larger Difference Between Unsteady and Steady Floodways



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Observations & Hypothesis

- *These Conclusions Warrant Additional Testing to Verify Findings…*

Unsteady Floodway Modeling Challenges

1. Interpolated cross-sections require encroachments and present mapping challenges
2. Unsteady models take long time to run
3. Changes upstream affect downstream & vice-versa
4. Model instability, especially at culverts, lateral structures, & junctions when floodways added
5. FW iterations – no Method 4, only Method 1

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Unsteady Floodway Modeling Challenges

6. Stream storage affects unsteady floodways

7. Stream slope affects unsteady floodways

8. Computational options and tolerances must match

9. Computational intervals (time-steps) must match

10. Additional boundary conditions needed to address additional degrees of freedom associated with upstream and downstream effects.

Summary

- Floodway tools are insufficiently implemented in unsteady HEC-RAS (v4.1).
- Stream slope and storage is expected to affect the floodway comparison between unsteady and steady models.
- Unsteady floodways present unique modeling challenges and defy the FEMA definition of "Floodway".

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