The New Cedar River and Turtle Creek Hydrologic and Hydraulic Model

Model Roll Out Meeting

January 10, 2012

Agenda

1. Introduction and Background
2. Building the model and the GIS Data Files
3. Ensuring Model Accuracy (Calibration)
4. Possible Model Uses

Our presentation will be placed on the Cedar River Watershed District's web site

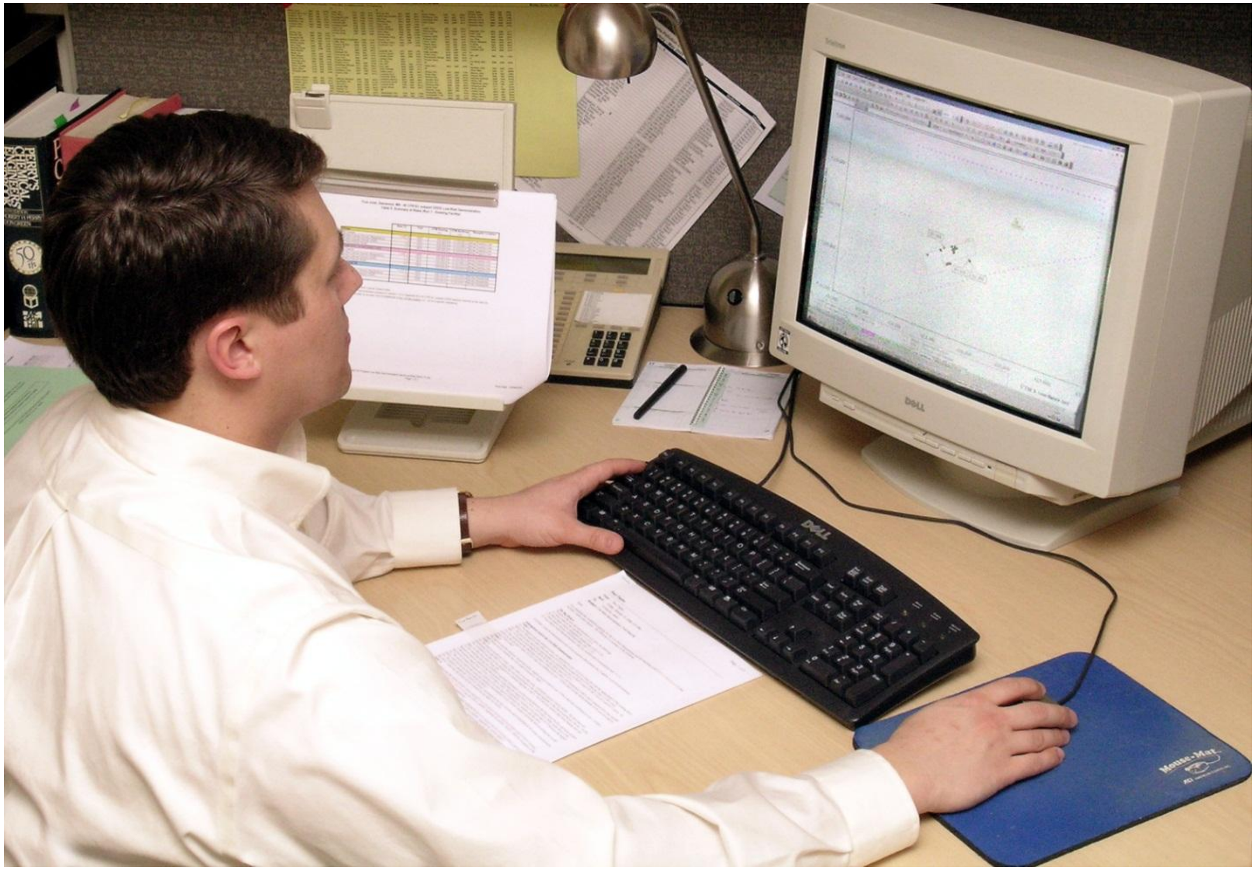
Background

- CRWD was established in 2007
- Purpose: Reduce flooding and improve water quality throughout the watershed
- Need to understand how the water flows through a watershed
- Needed to establish an accurate existing conditions flow model

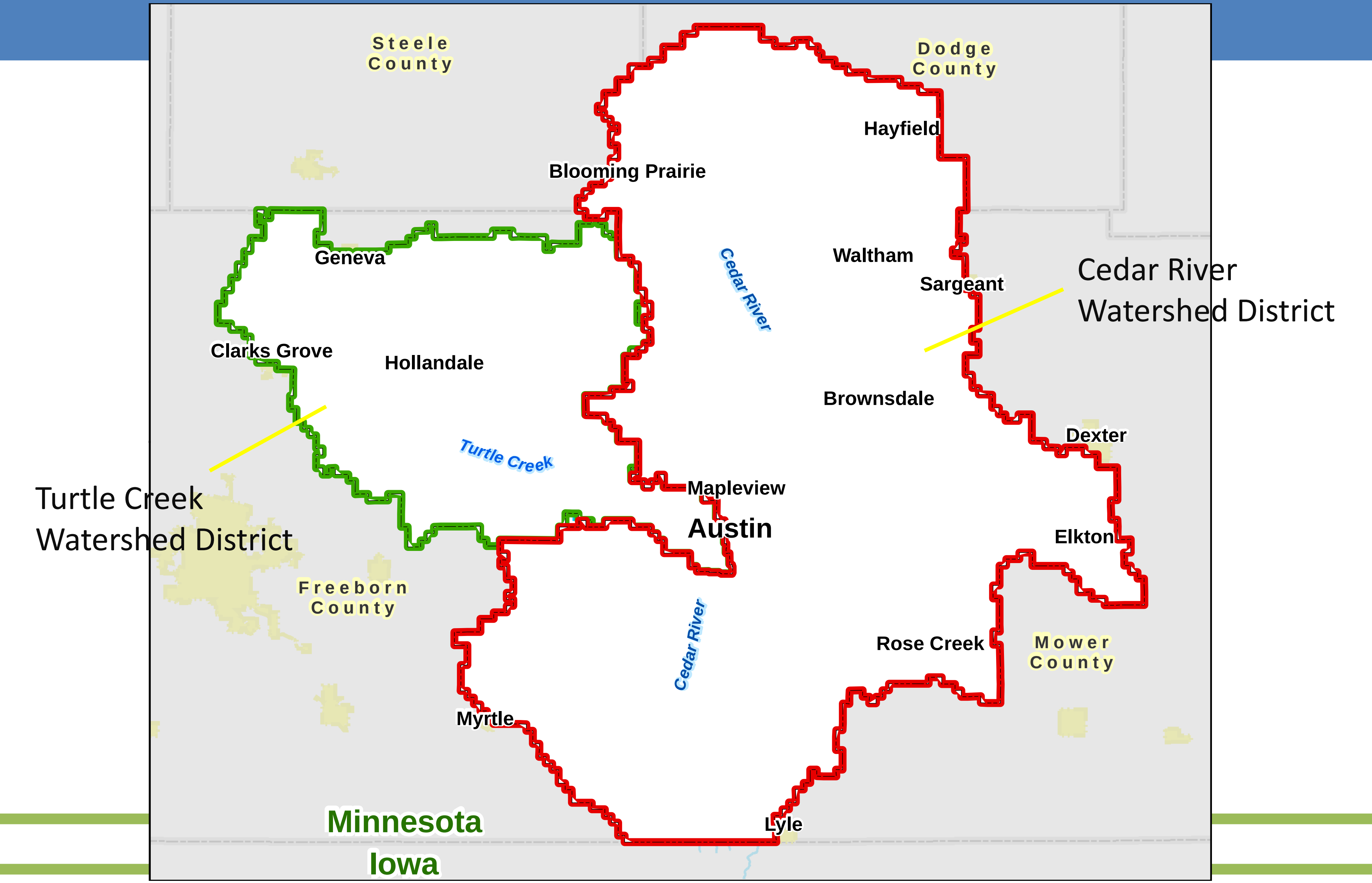
Existing Conditions Flow Model

- Project was funded by CRWD, TCWD, MPCA, and Hormel
- The model will be a tool for watershed districts, counties, townships, MnDOT, and SWCDs
- Used to design projects and/or evaluate impacts of potential projects on flood reduction

Building the Model and the GIS Data Files



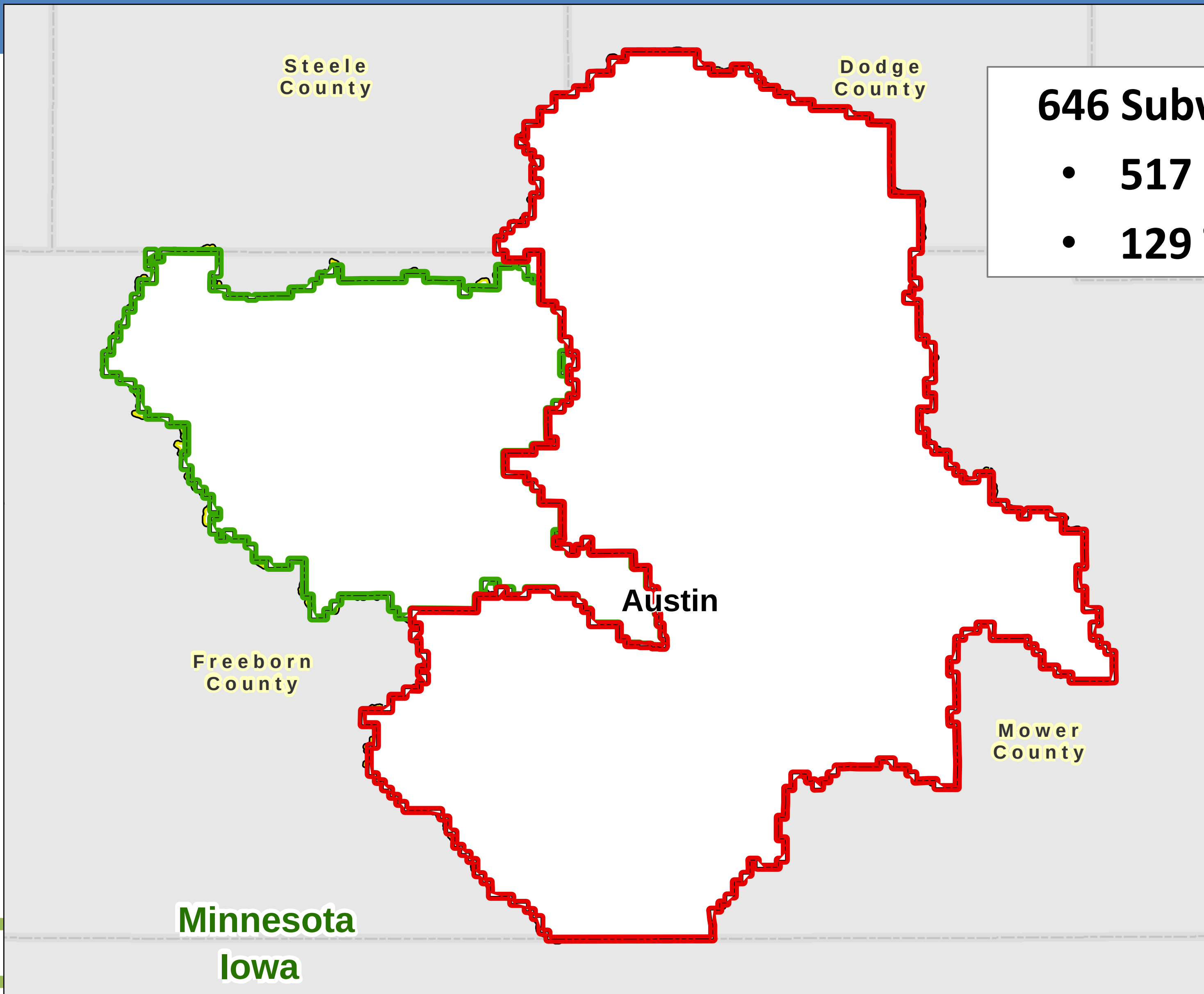
Cedar River and Turtle Creek Watersheds



What goes into a model?

- Subwatersheds
- Land use information
- Soils information
- Topography
- Rainfall Depths/Distributions
- Flow control devices (bridges, culverts)

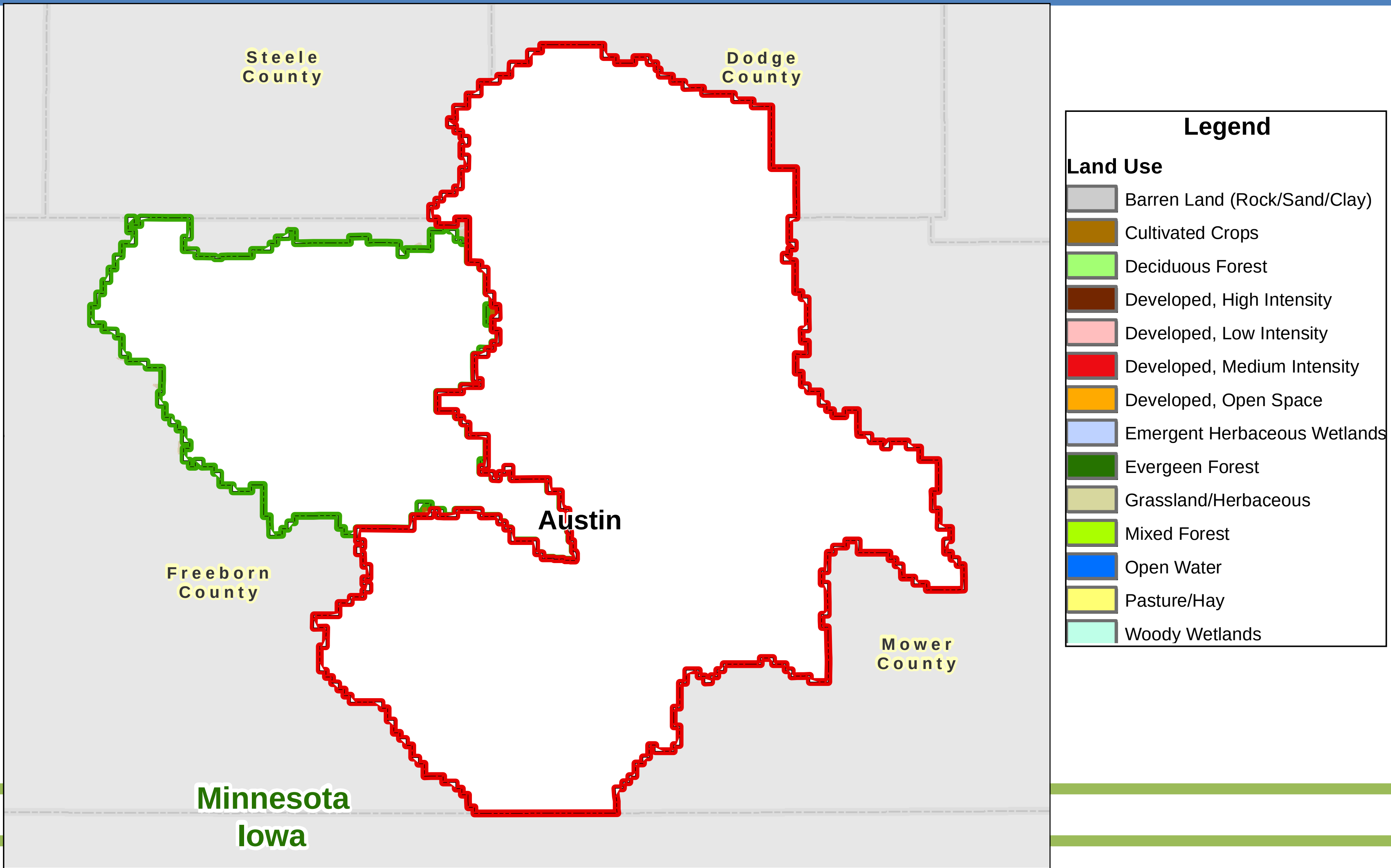
Subwatershed Divides



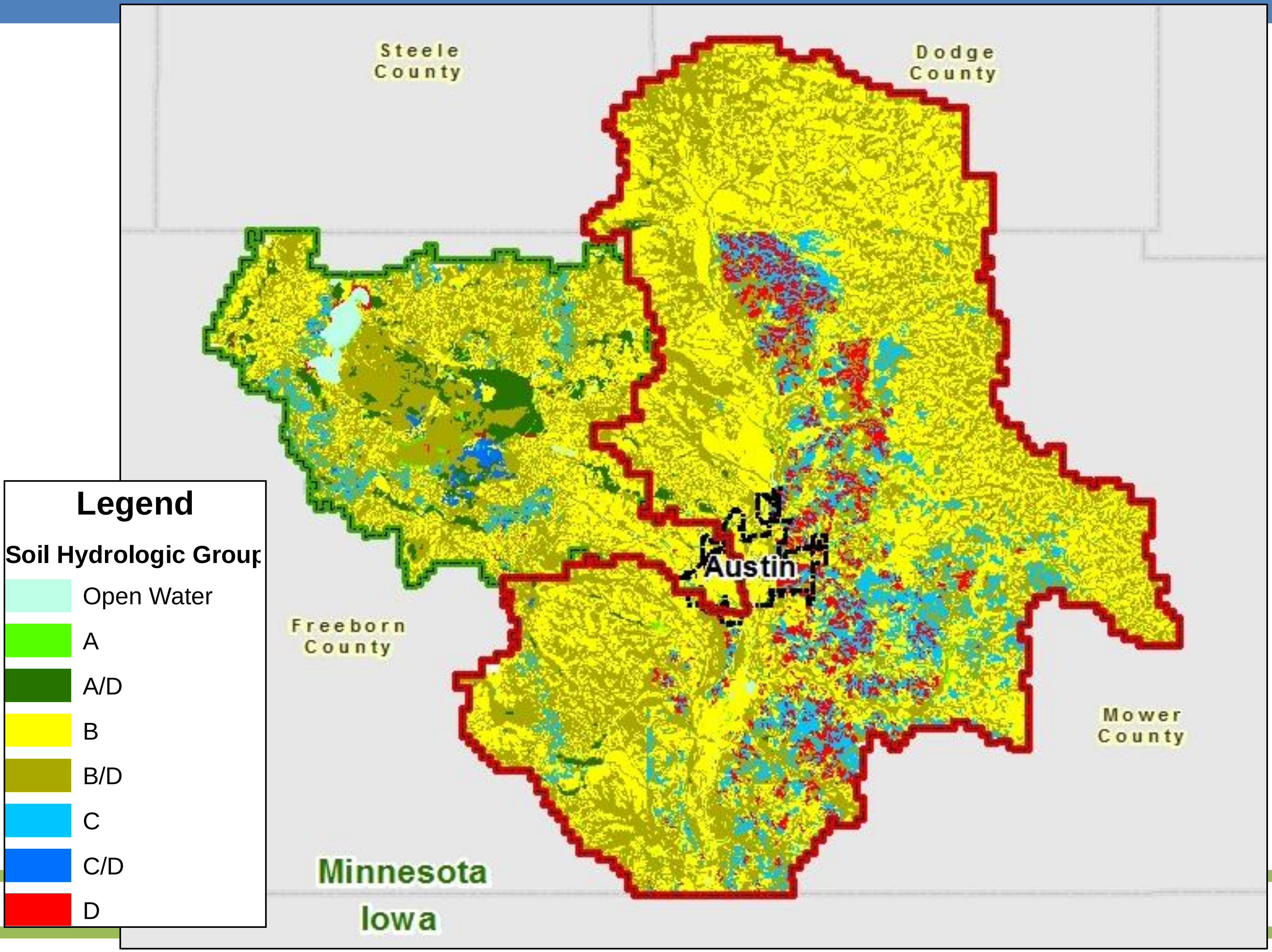
646 Subwatersheds

- 517 Cedar River
- 129 Turtle Creek

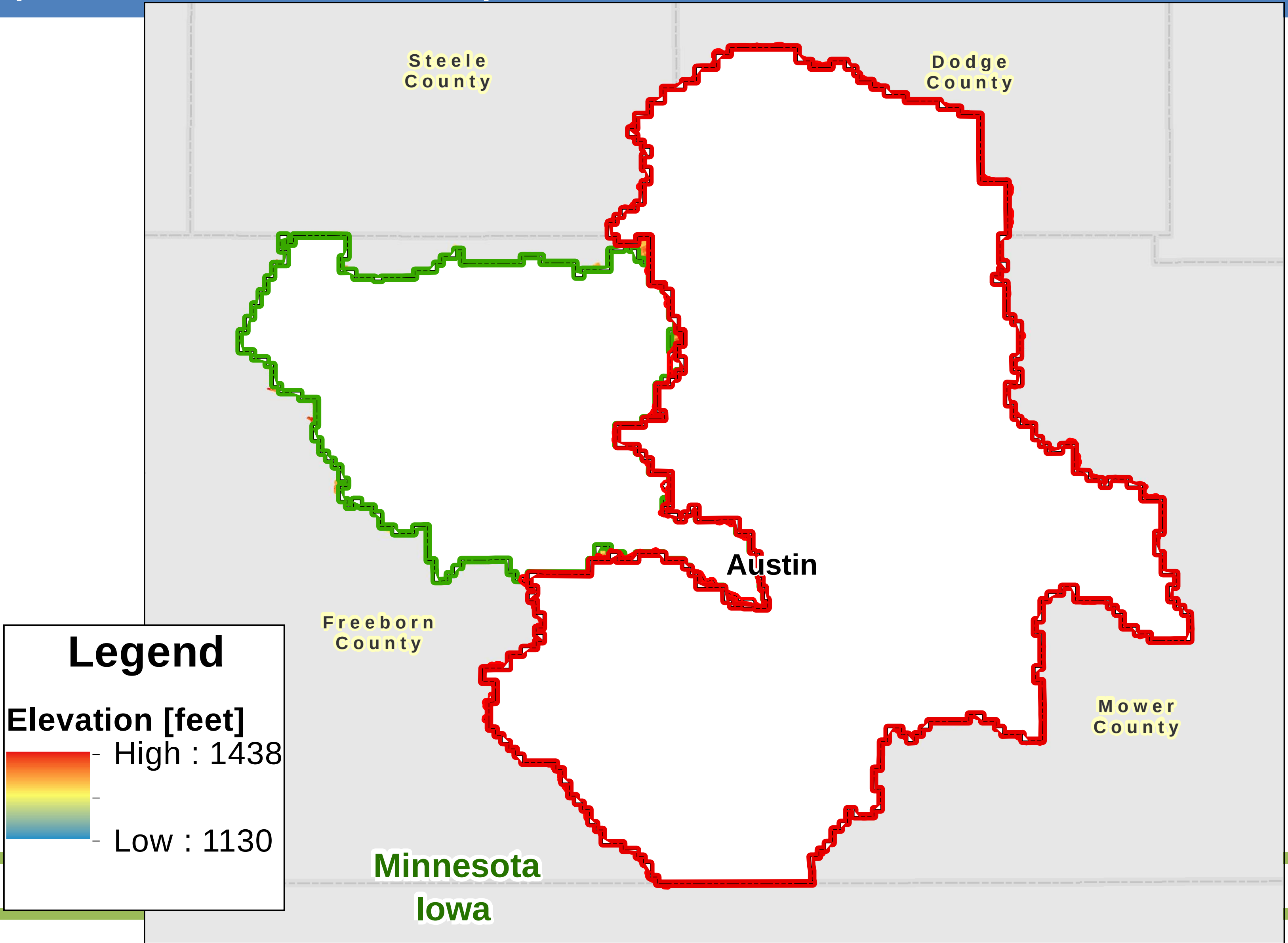
Land Use – to evaluate percent impervious and flow resistance



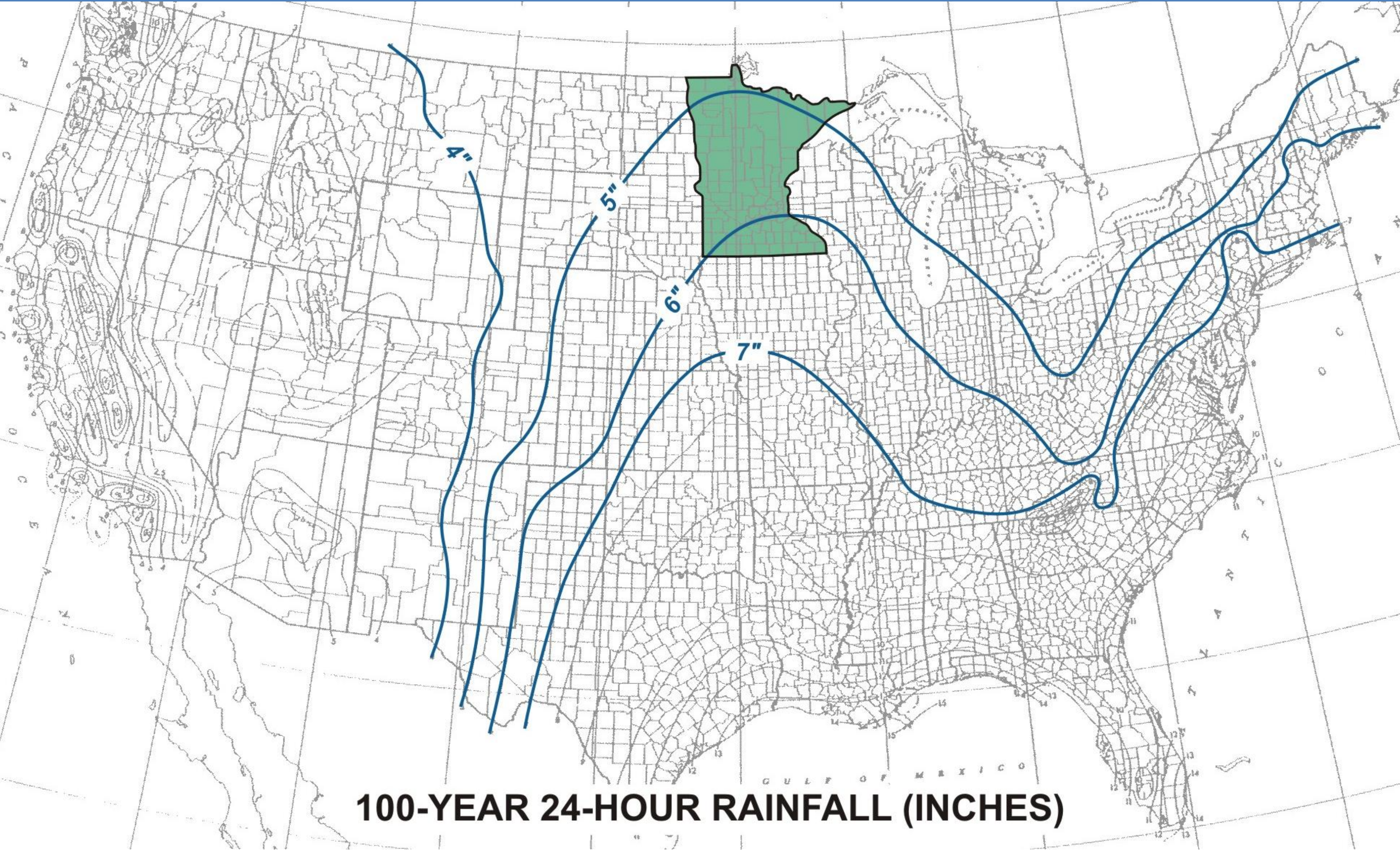
Soil Type – to determine infiltration



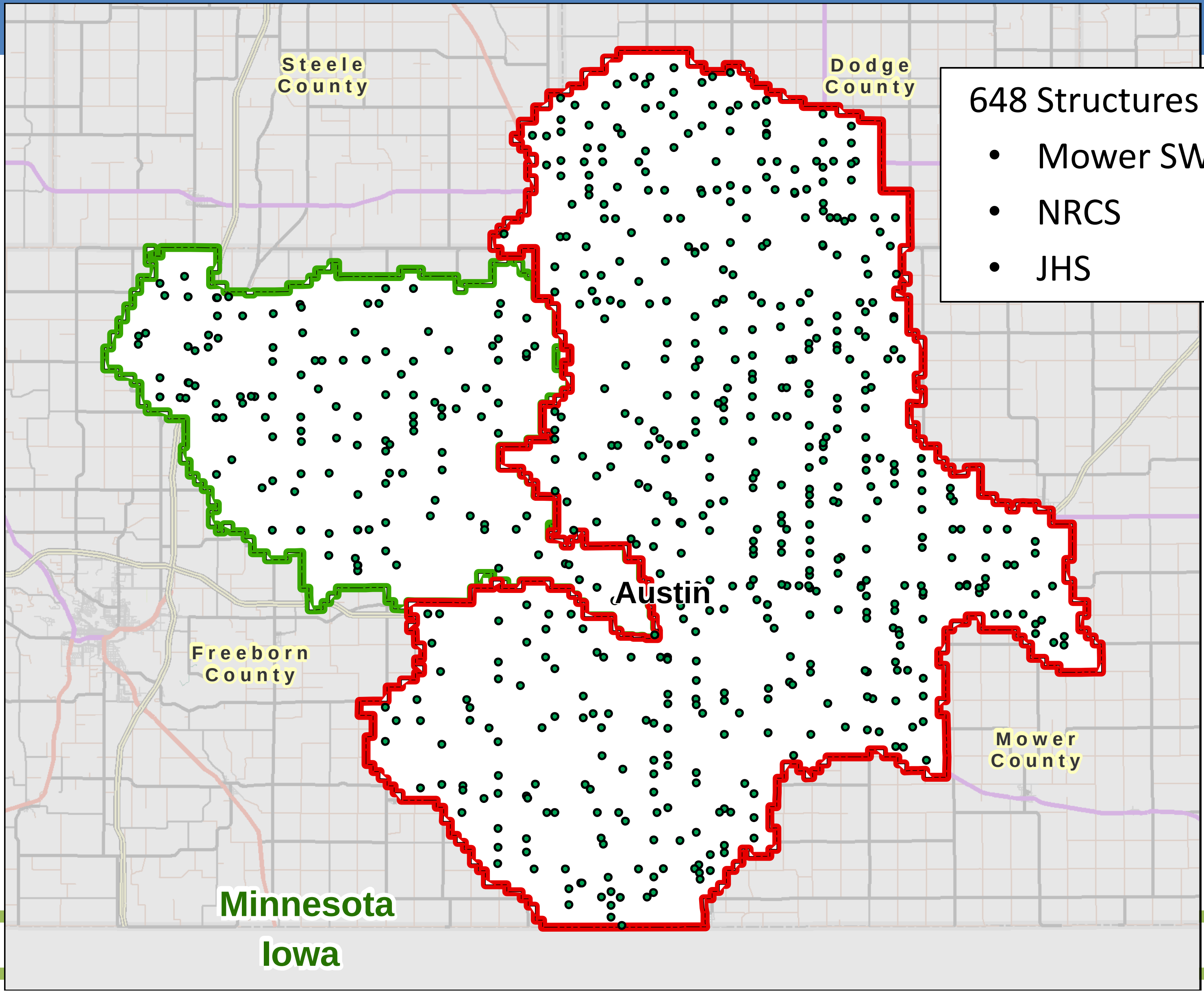
Topography – to determine drainage patterns and speed of runoff



Rainfall Depth and Duration



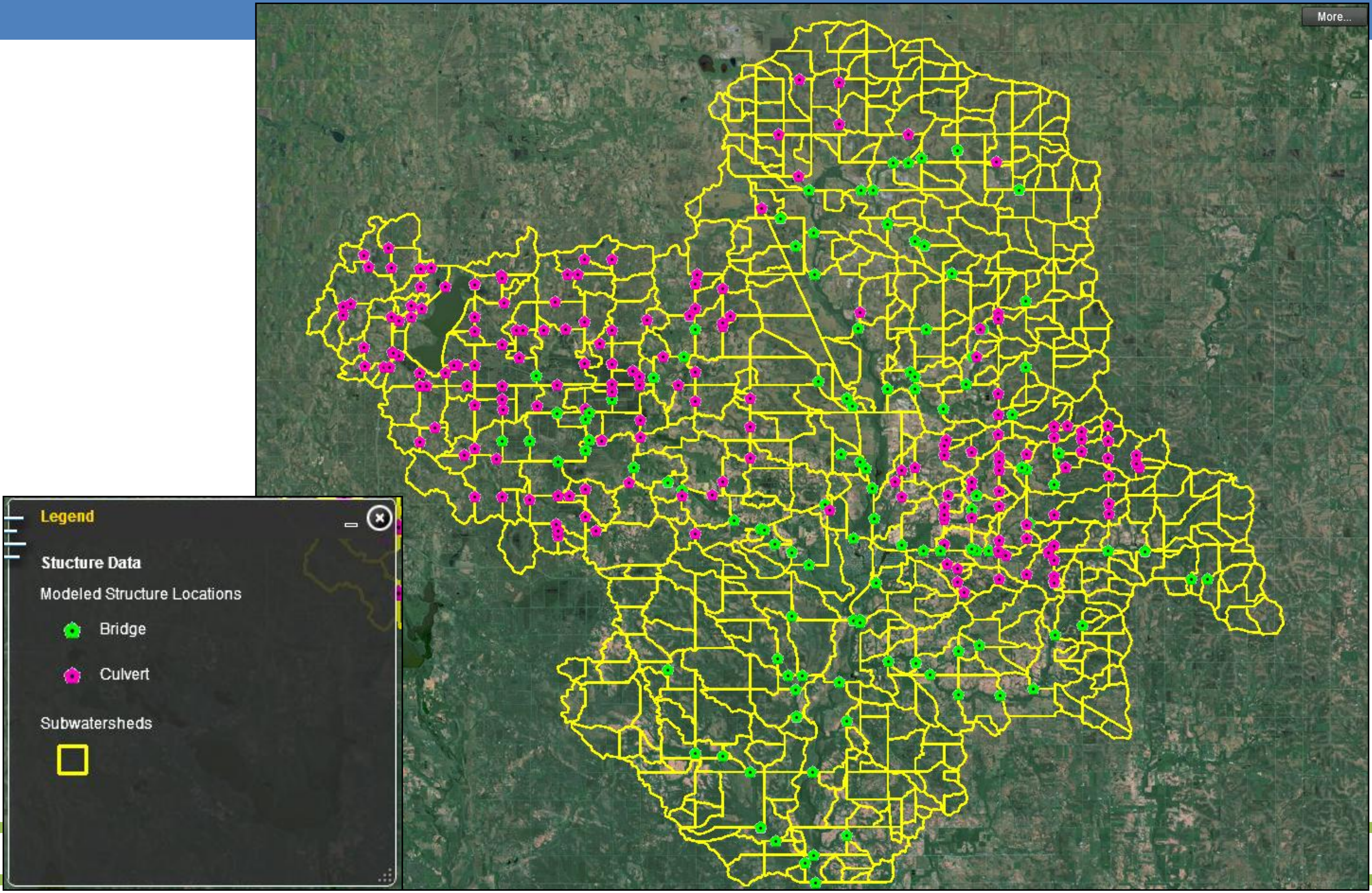
Existing Flow Control Structures



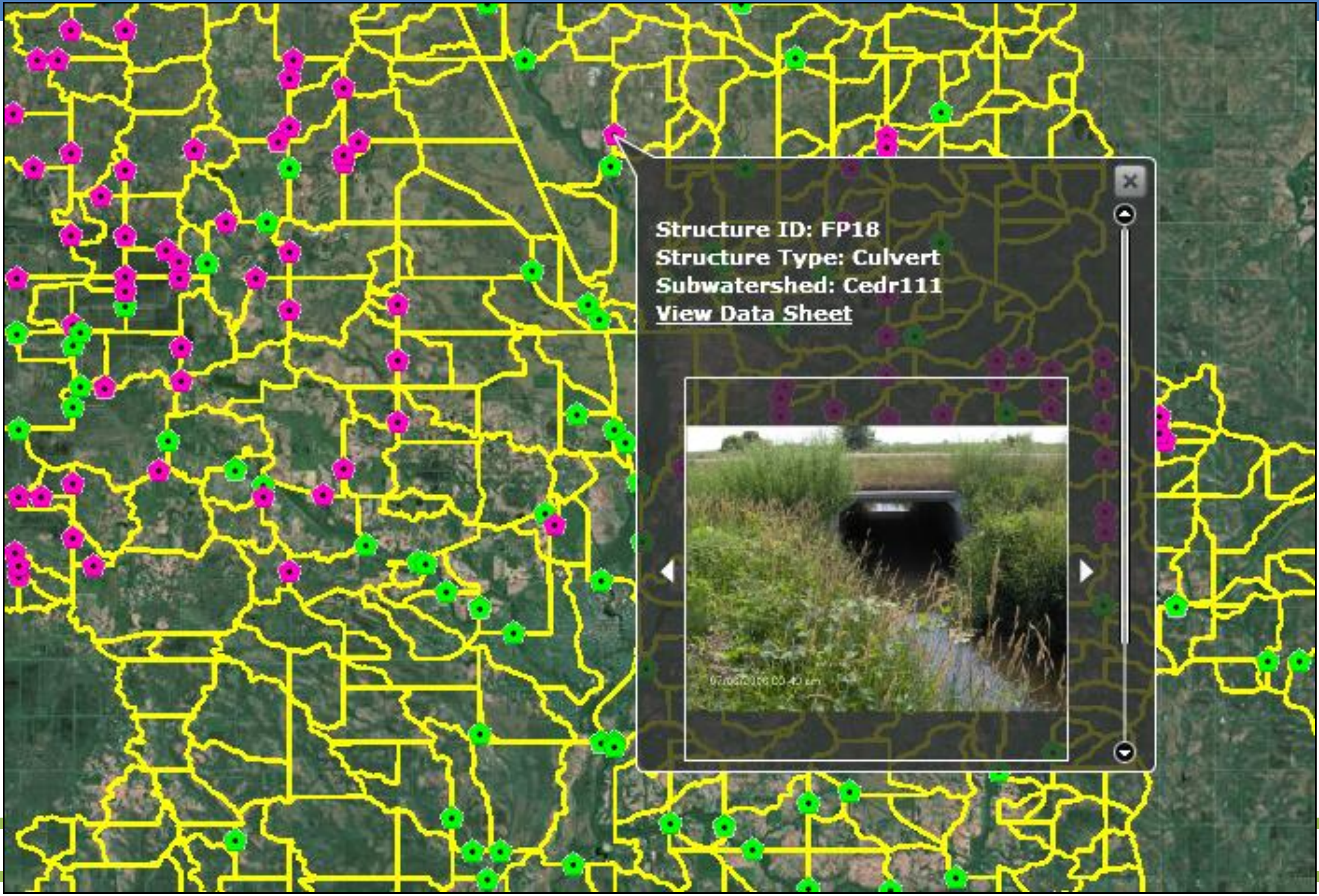
648 Structures Surveyed

- Mower SWCD
- NRCS
- JHS

Using the GIS Inventory – Flow Control Structures



Using the GIS Inventory – Structure Photos



Using the GIS Inventory – Survey Data Sheets

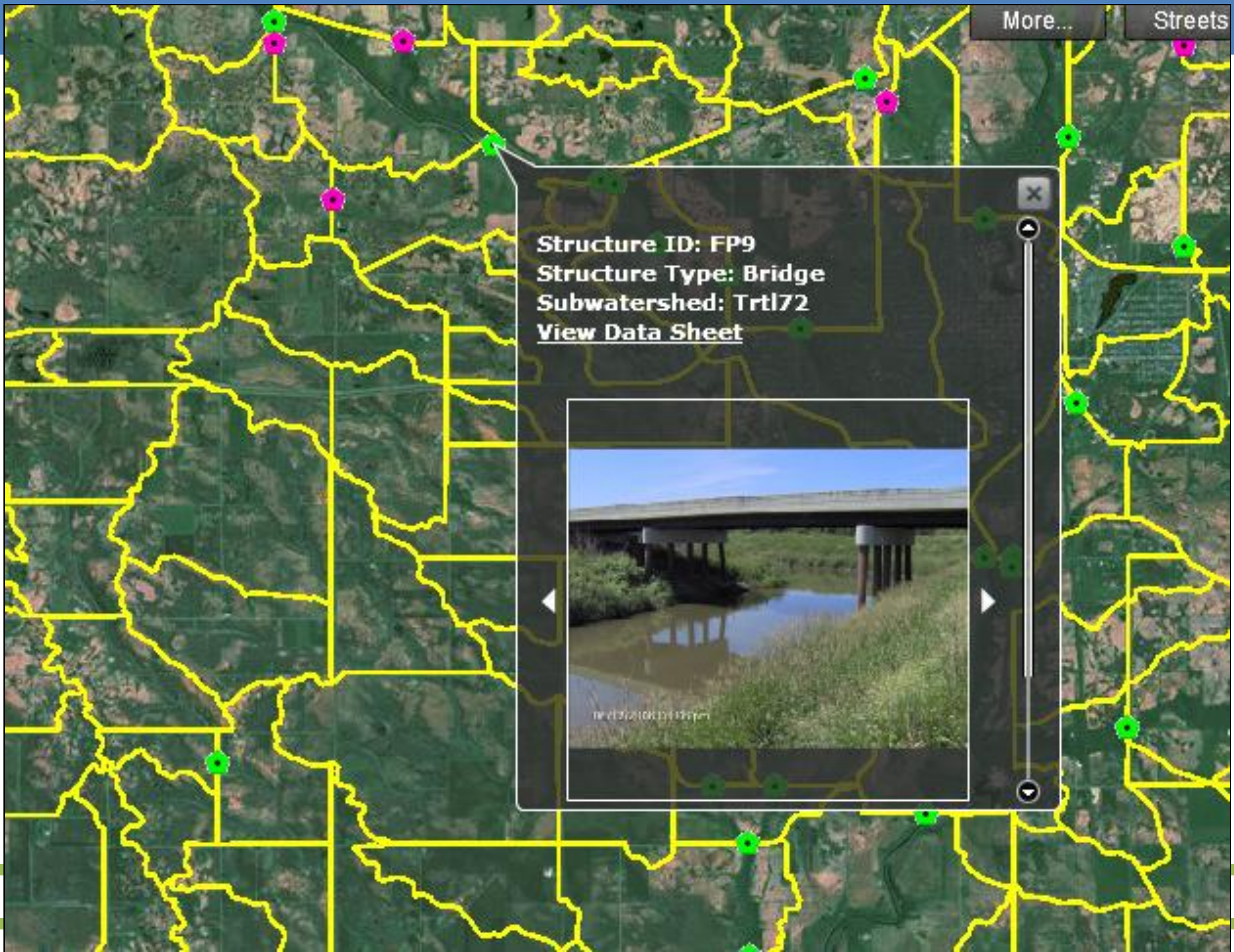
LIMITED DETAIL STUDY
HYDRAULIC STRUCTURE DATA WORKSHEET

Date	7-6-06	**Stream Name**	
Time	9:40 AM	**Road Name**	540 AV
Taken By	AKP	**Structure Number**	FP 18
County	Mower	**GPS Point Number**	
Type of Structure	Bridge Culvert Weir Dam Other		
Hydraulic Width (ft)	58'	(Length from US side to DS side of structure)	
Approximate Skew	90°	(Angle btwn structure CL & road CL. 0-90°. 90° = ⊥)	
Railing Height (ft)		(Height of railing on bridge or culvert)	
Deck Thickness (ft)		(Distance from top of road to top of culvert or low chord of bridge)	

Culverts: (See back of sheet for descriptions, diagrams, and sketch space if required)

	Barrel #1	Barrel #2	Barrel #3	Barrel #4	Barrel #5
Barrel Type	RCP Box				
Inlet Type	Concrete Wingwalls				
Rise or Diameter (ft)	6'				
Span (ft)	10'				
Invert Elevation (ft) Upstream/Downstream	1229.82 / 1229.81	/	/	/	/
% Blocked	None				

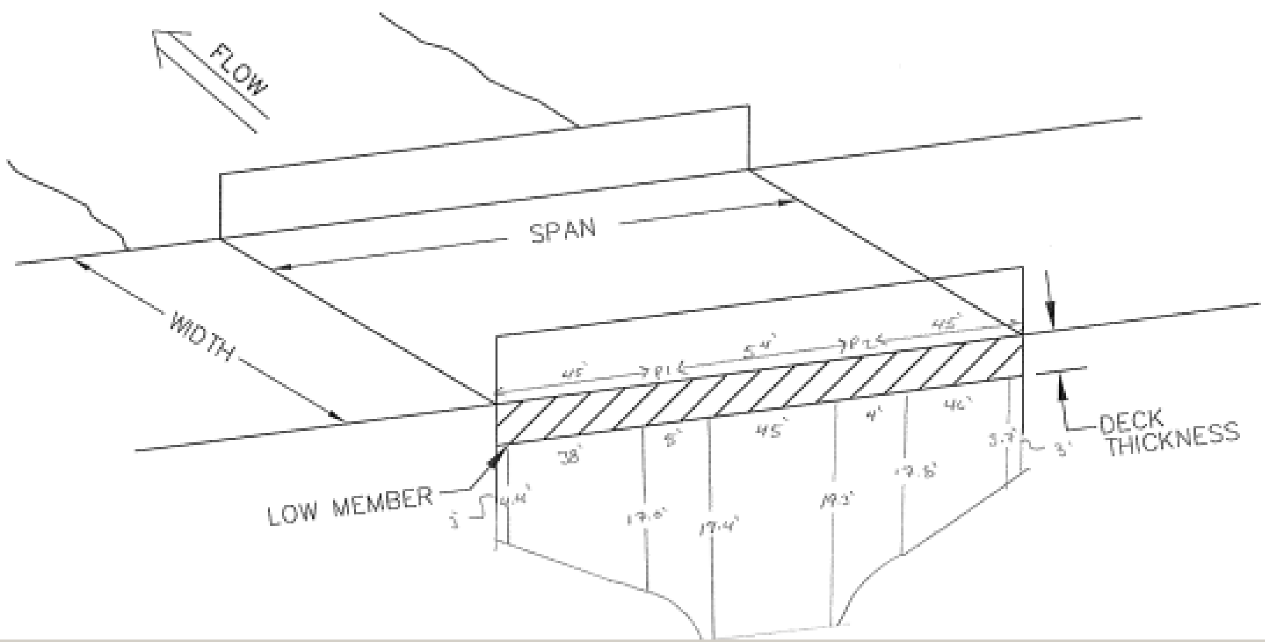
Using the GIS Inventory – Structure Photos



Using the GIS Inventory – Survey Data Sheets

TAKEN BY	AKP	DECK THICKNESS	3.2'
STREAM NAME	TURTLE CREEK	RAIL HEIGHT	2.65'
ROAD NAME	230 ST	NUMBER & PIER TYPE	2 - ROUND
STRUCTURE NUMBER	FP 9	PIER WIDTH	20"
LOCATION	S 1/4 COR 25-103-19	LOW MEMBER ELEV	1201.82

BRIDGE # 24526



Now the model is built,

but how accurate is it?

Ensuring Model Accuracy (Calibration)

- First step with model building is to input suggested starting value within a published range of values for model hydrologic parameters
  - Infiltration Rates

    (example range: 1in/hr to 5in/hr –> starting point 3in/hr)
  - Depression storage and vegetation interception

    (example range 0.1 in to 0.5 in –> starting point 0.2)
- NEXRAD rainfall data obtained for two storms (intensity and amount) – September 2004, September 2010
- Run the model using the published starting values and recorded NEXRAD rainfall

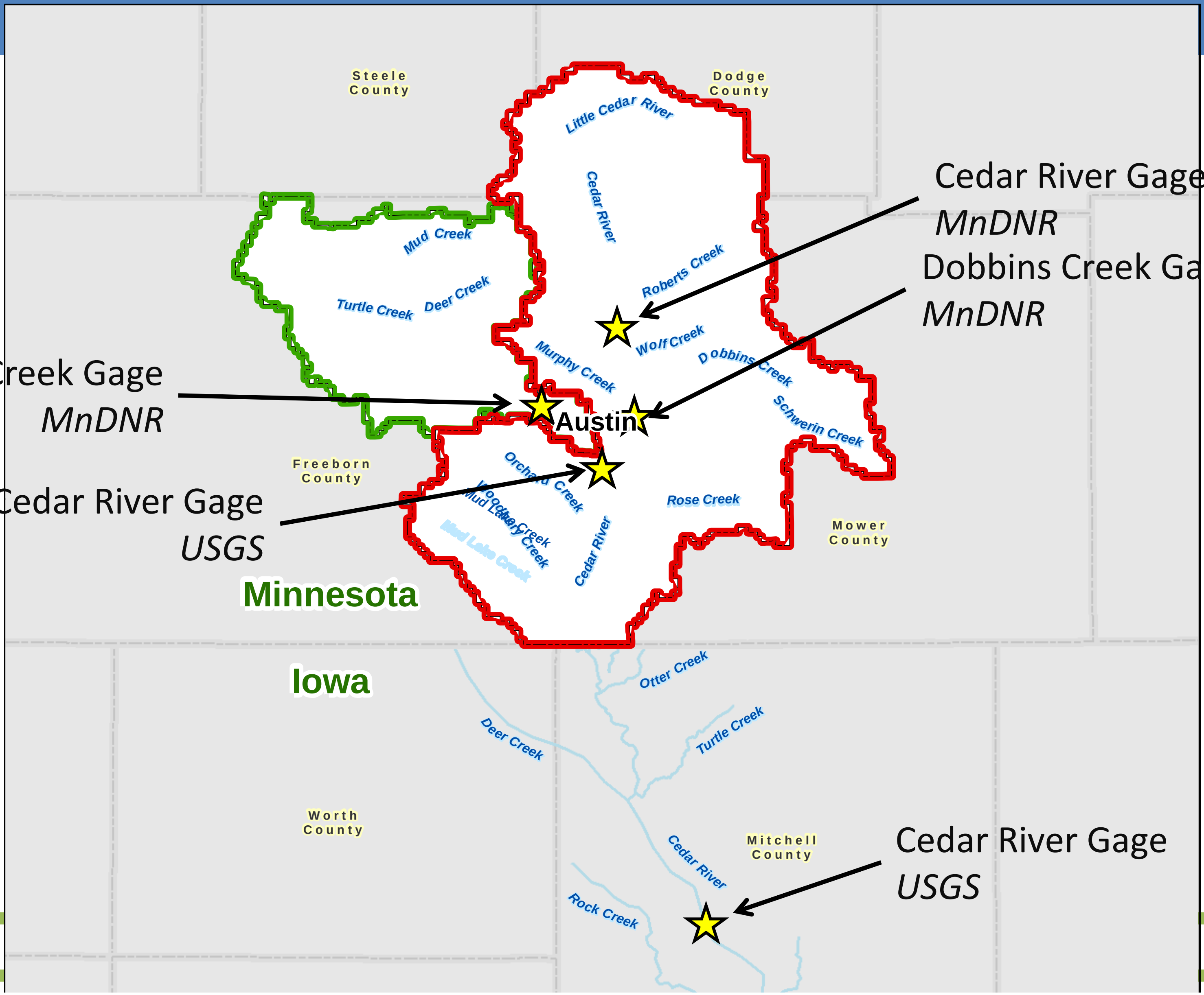
Ensuring Model Accuracy (Calibration)

- Then compare model results against actual measured flow gage data at various points in the watershed
- The published starting values typically need adjustments to make the modeling results more closely match the measured data
- These model adjustments are typically known as “calibration”

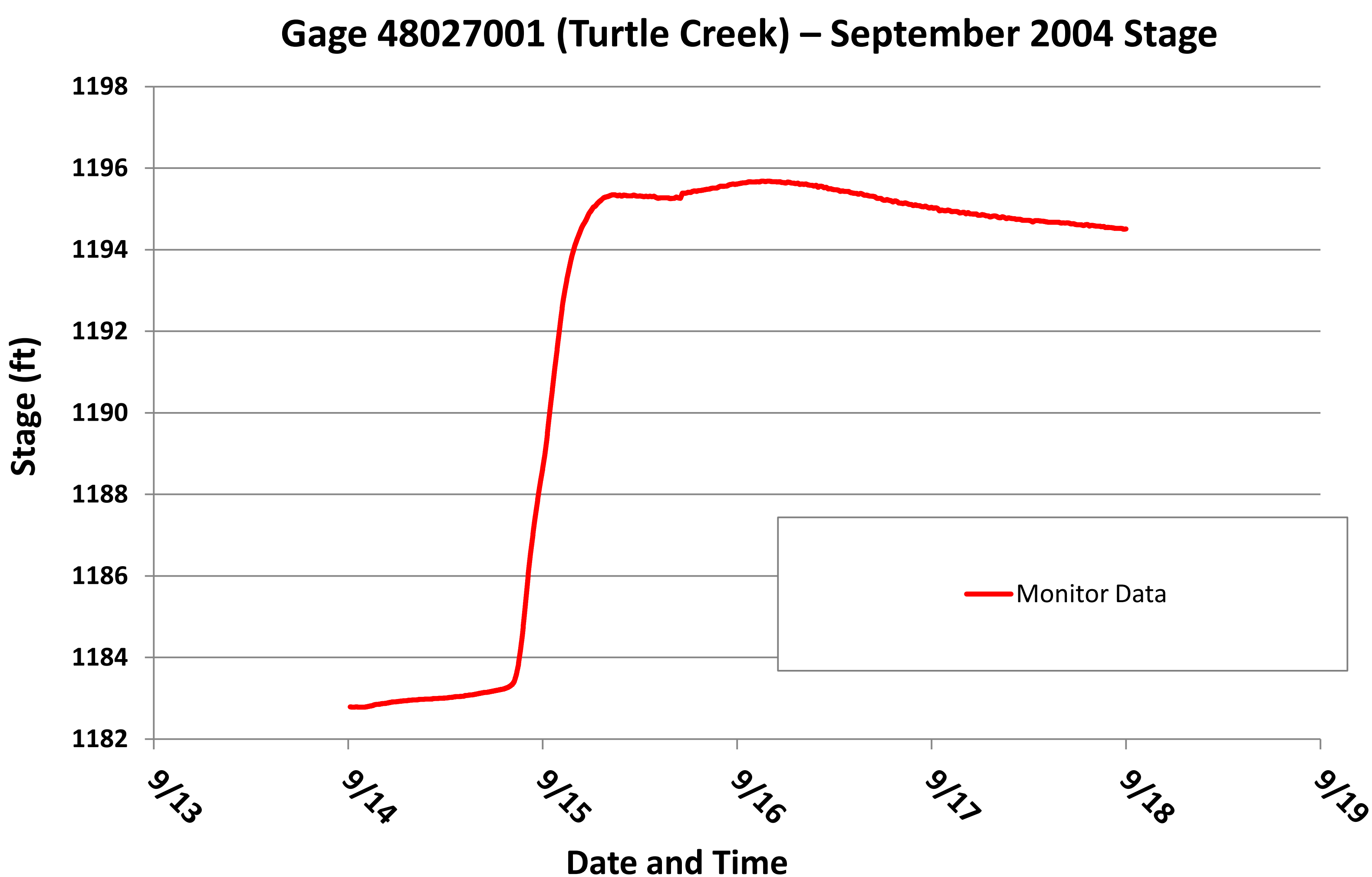
Model Adjustments

- We continue to adjust model inputs within the published range
- After each adjustment, modeled data is compared to measured flow gage data
- Additional adjustments are made until modeled flow data accurately resembles measured flow data

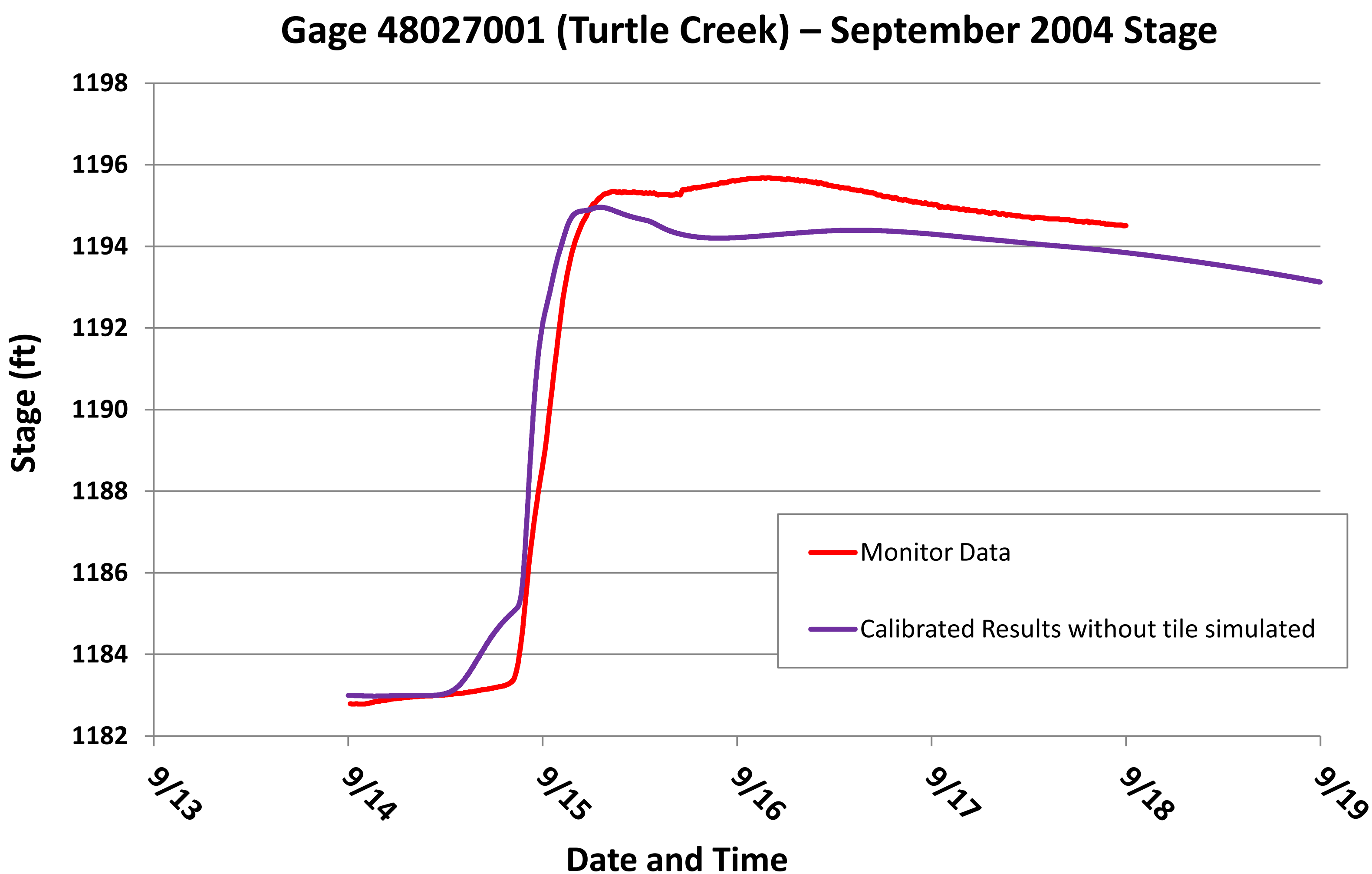
Five Gage Locations



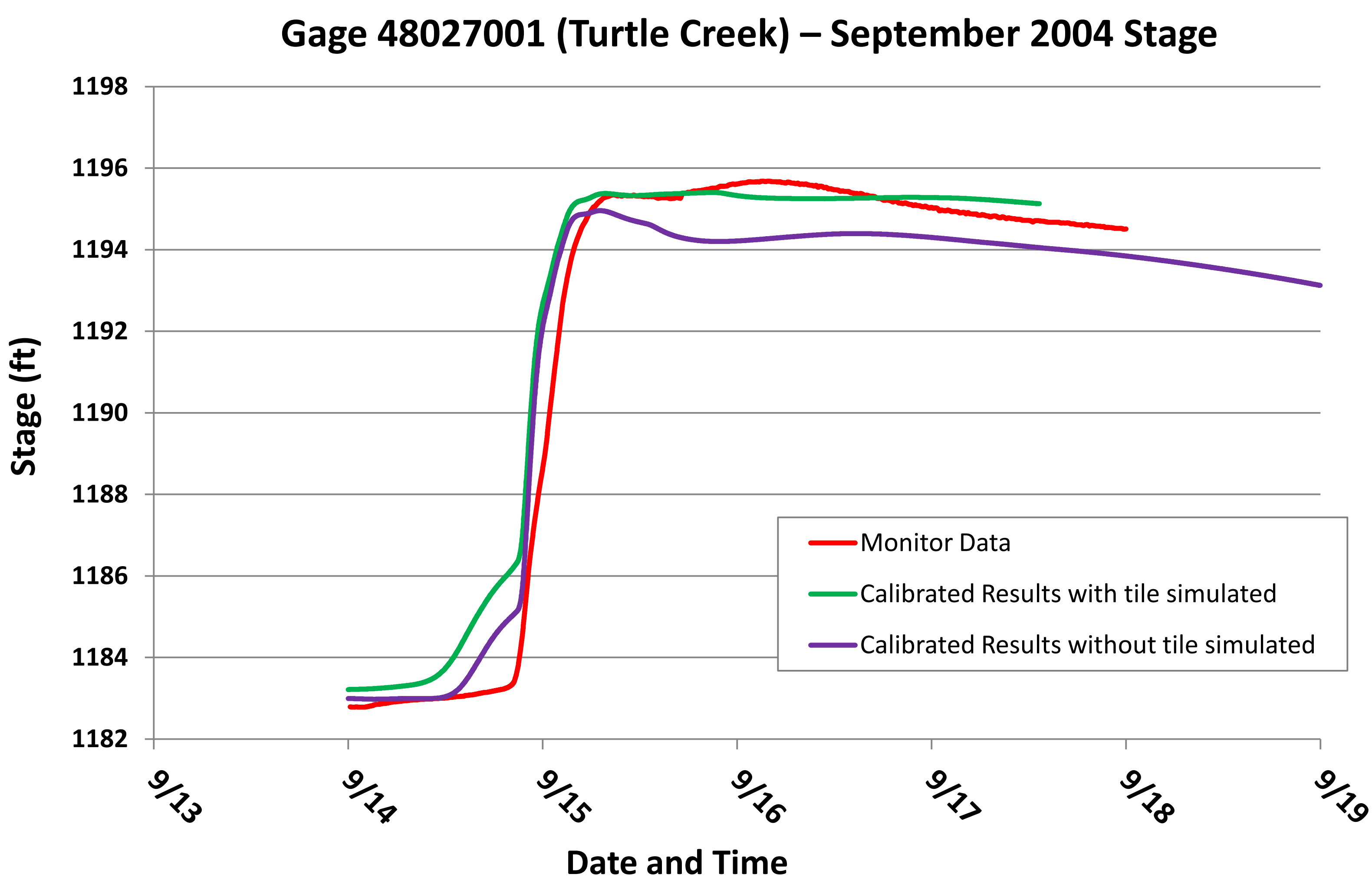
Measured Data (Monitored Data)



Calibrated Results



Calibrated Results – with and without tile simulated



Model Applications

- Designing flood reduction and water quality improvement projects
- Help townships, counties, and MnDOT design and evaluate new road crossings and their proposed changes
- Simulate land use changes or development impacts
- Determine the effect of upstream watershed changes on flood elevations anywhere in watershed
- Aid in FEMA “No Rise” determinations in areas where FEMA DFIRMs exist
- Aid in levee certifications

Example 1: Red Rock Township Road Crossing (250th Street)

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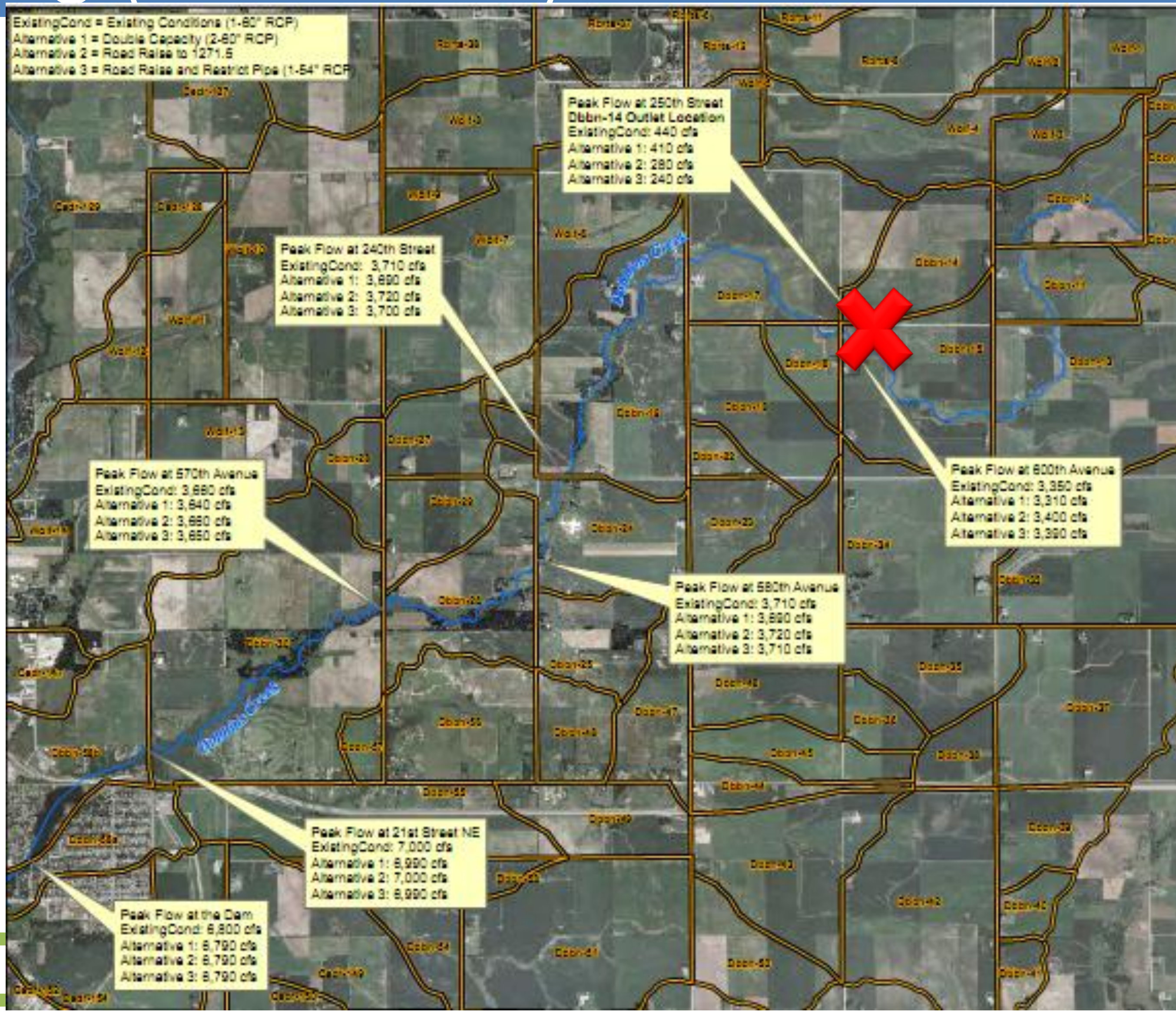


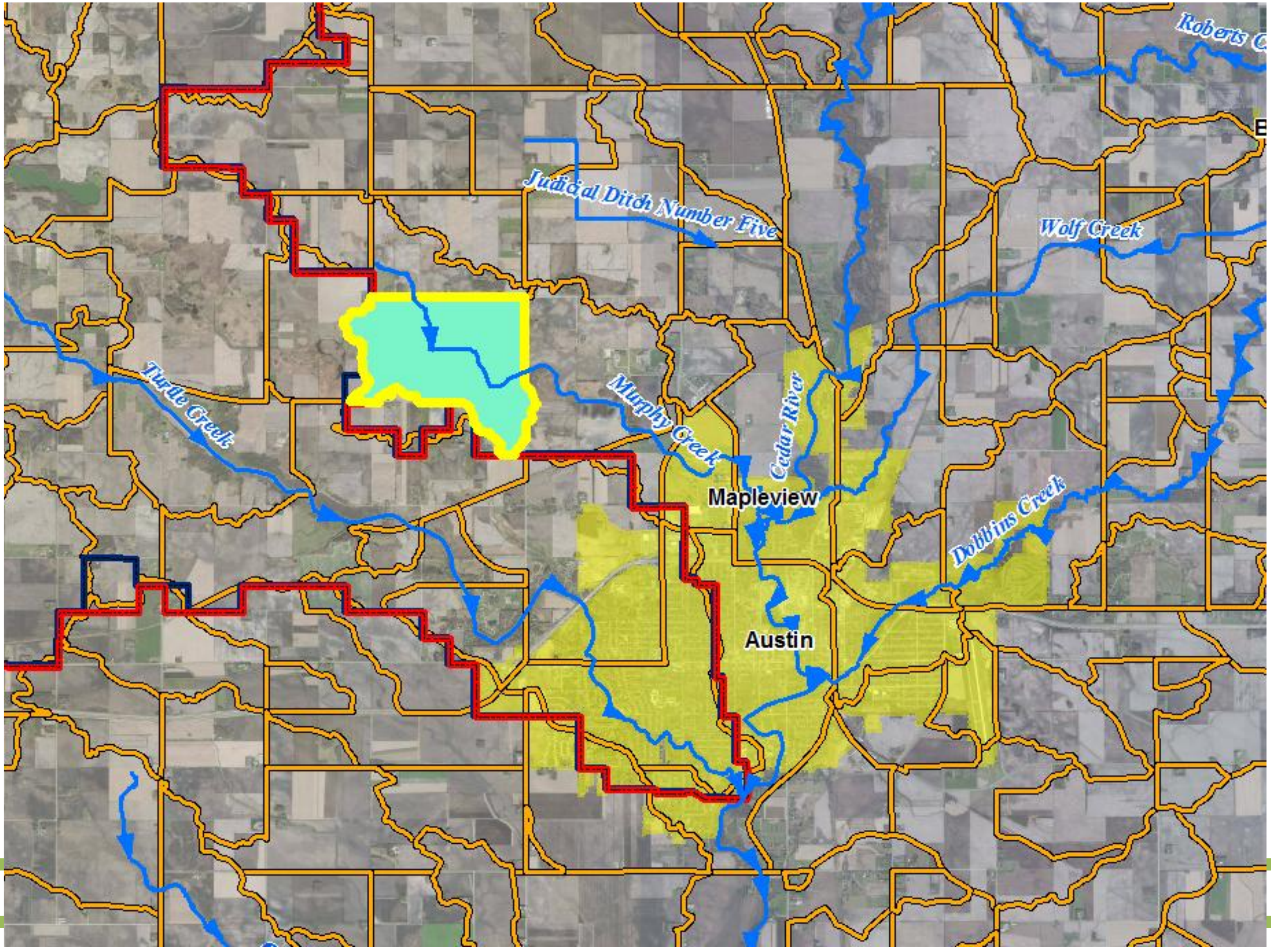
Example 1: Red Rock Township Road Crossing (250th Street)

- 250th Street was overtopping during large storm events
- Construction options discussed with township
  - Double culvert capacity
  - Raise the road
  - Restrict culvert capacity and raise the road and potentially see flood reduction benefits downstream
- Model results showed that road raise only was the best option.
- The analysis took about 10 hours
- Cost for this evaluation was about $1,000

Example 2: Wetland Restoration along Murphy Creek

- Mower SWCD wanted to evaluate four projects’ impacts on flood reduction along Murphy Creek
- Restoration involved breaking tile, adding storage capacity, and restoration of the cropland to native grasses

Example 2:
Wetland Restoration along Murphy Creek



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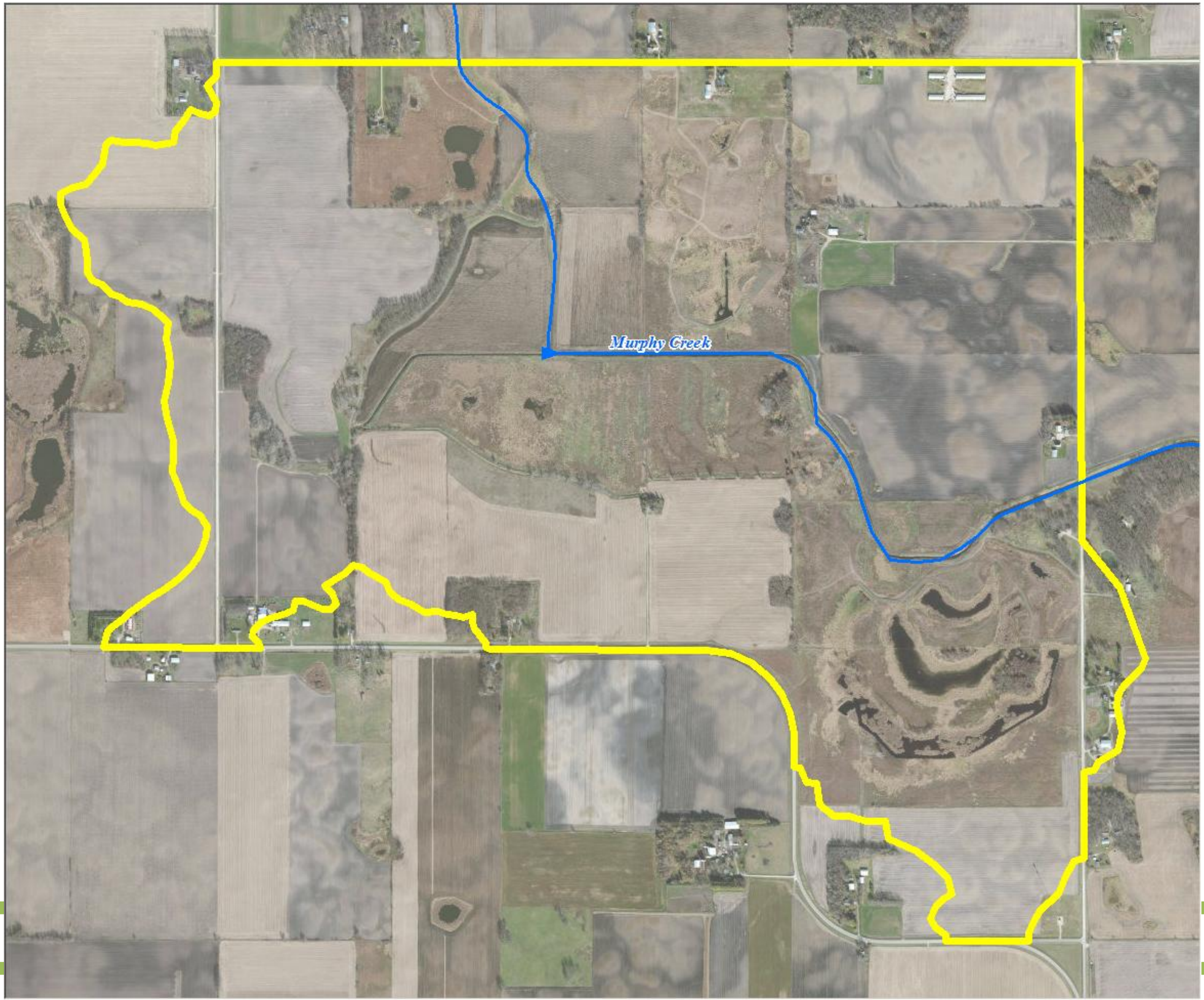

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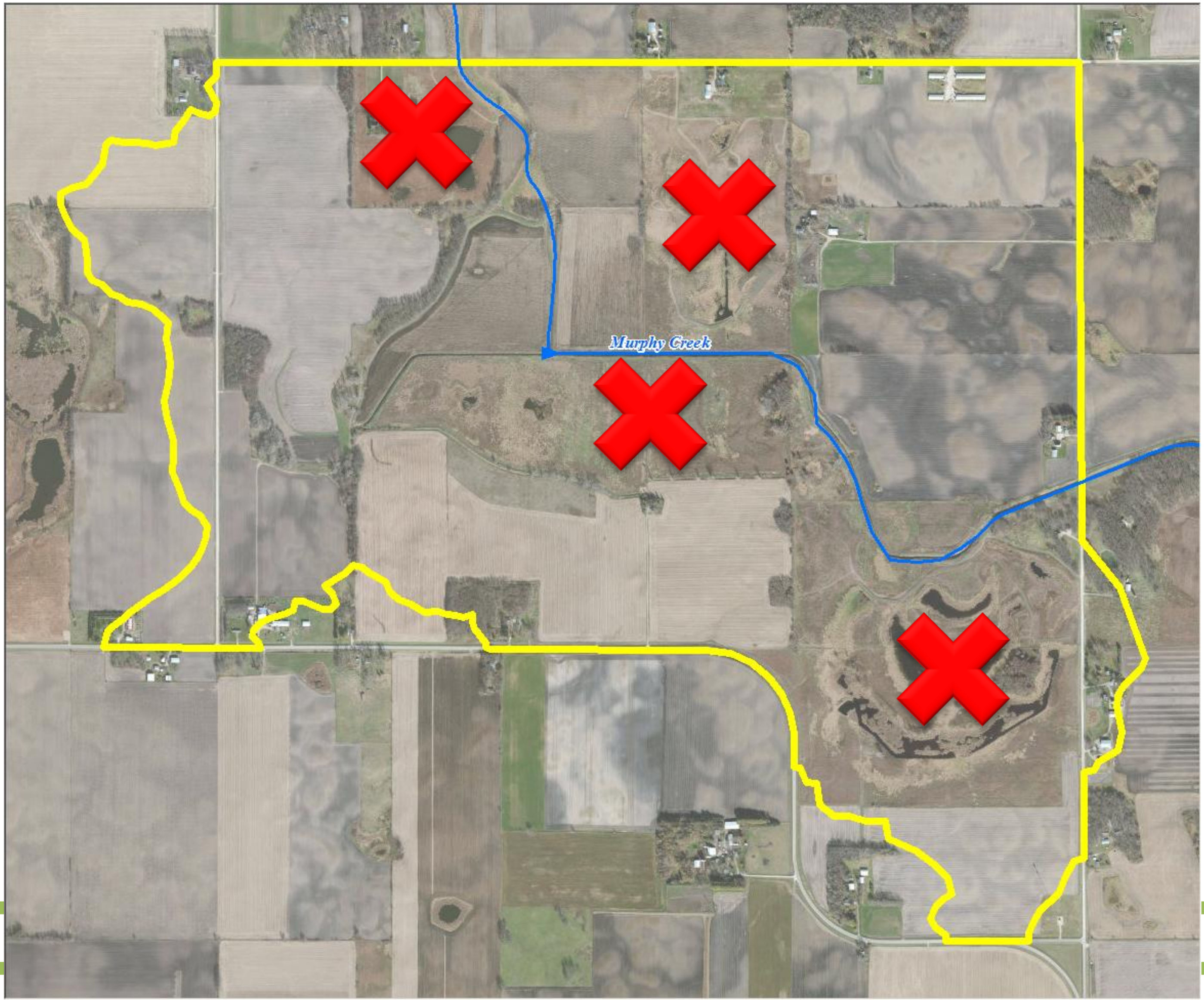

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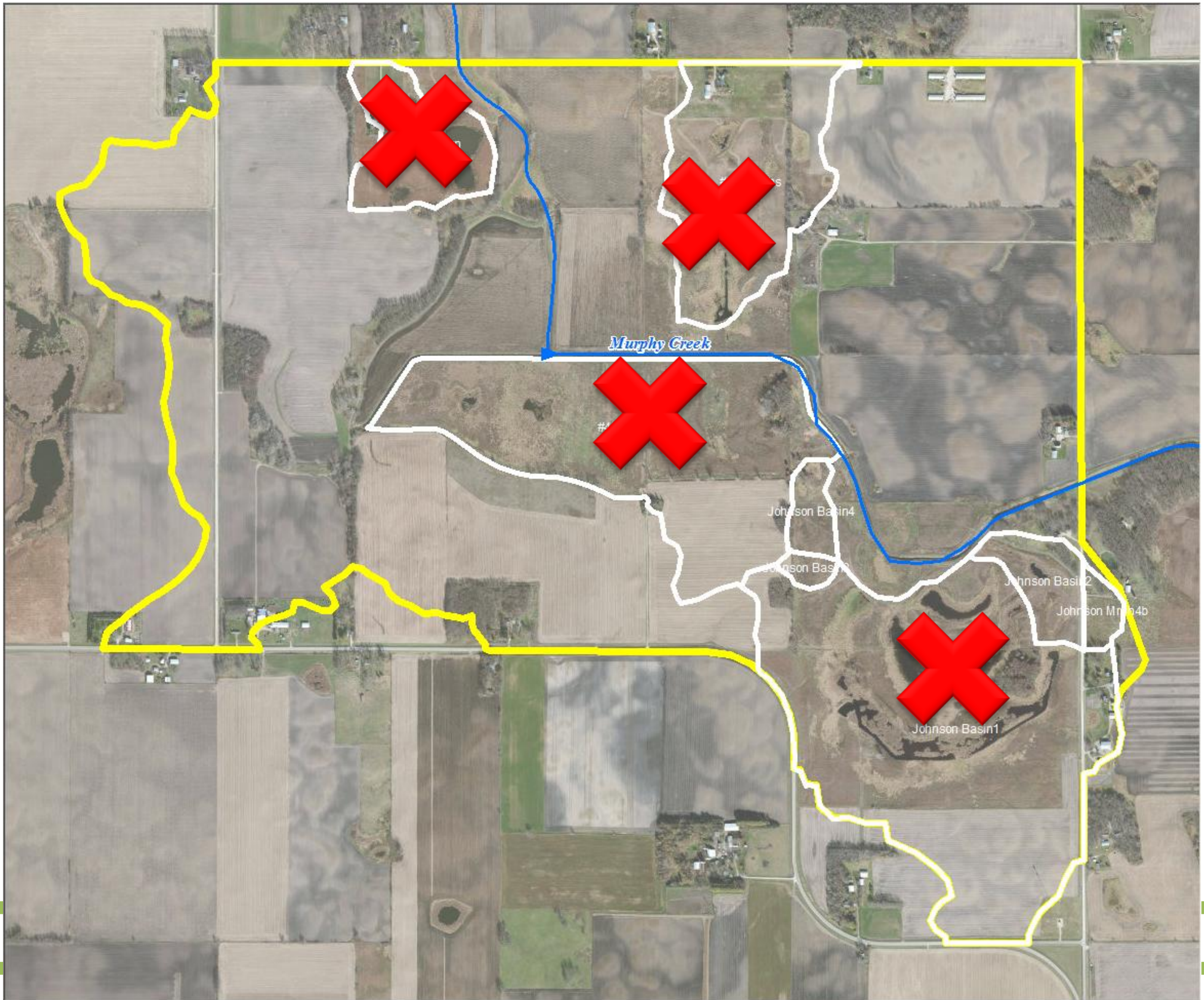
Wetland Restoration along Murphy Creek



Example 2:
Site Restoration along Murphy Creek

- Volume of runoff from the watershed was reduced by 8% from 460 acre-ft to 420 acre-ft during the 100-year storm event.
- Peak runoff rate in Murphy Creek was reduced by about 10% (approximately 40 cfs reduction) during the 100-year storm event
- The analysis took 7 hours per site
- Cost for this evaluation was $800 per site or $3,200 for all four sites

Questions?

Cedar River Watershed District Web Site
www.cedarriverwd.org