Identifying Priority Management Zones for BMP Implementation

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STEARNS COUNTY SOIL & WATER
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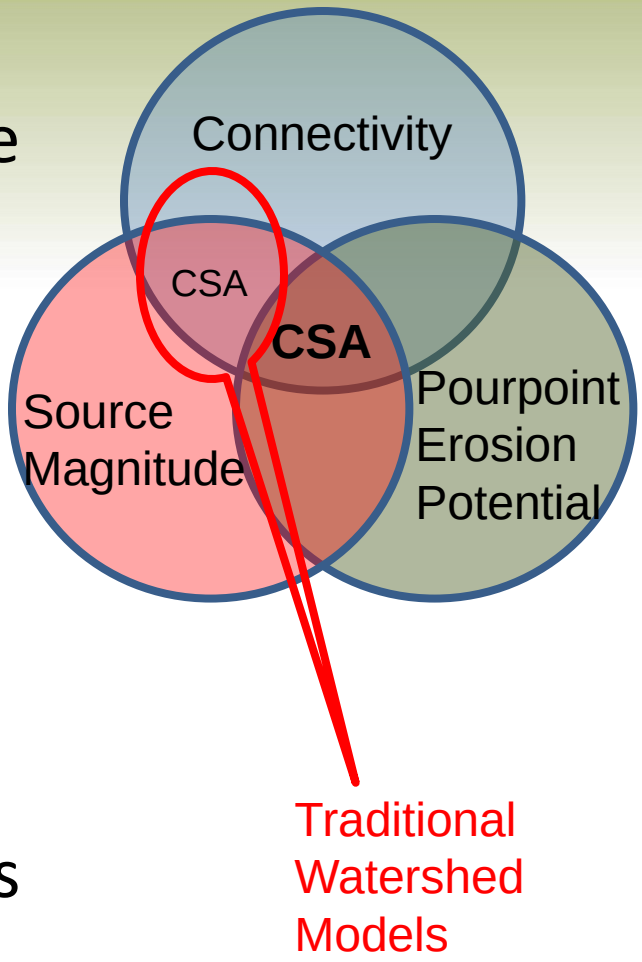
CLEAN WATER LAND & LEGACY AMENDMENT

Minnesota Department of Agriculture

CSAs and PMZs

- Critical Sources Areas (CSAs) are defined as portions of the landscape that combine high pollutant loading with a high propensity to deliver runoff to surface waters, either by an overland flow path or by sub-surface drainage
- Priority Management Zones (PMZs) are regions of the watershed targeted for conservation practices that address disproportionate pollutant loads associated with CSAs



Need for methods/strategies to identify PMZs

- USDA's Conservation Effects Assessment Project
  - Little Bear River—13% of watershed characterized as CSAs; 26% of CSAs had existing conservation practices, but 75% of practices were in areas with low potential pollutant load
  - Cheney Lake Watershed—only 22% of implemented conservation practices were located in CSAs
- MN Watershed Accountability Act
  - identify NPS with sufficient specificity to prioritize and geographically locate watershed actions
  - describe load reduction from each source to meet TMDLs
  - prioritize potential restoration and protection actions
  - account for water quality outcomes, cost-effectiveness, landowner financial need

Project objectives

- Develop a process and stepwise guidance that:
  - provides scalable, streamlined approach to pinpoint CSAs with GIS techniques and targeted site visits
  - provides repeatable/measurable methods for ranking sites
  - is flexible and allows for incorporating other data (modeling, land cover, stability, P indices, etc.) with terrain attributes
  - facilitates development of watershed restoration activities
  - supports funding requirements to be prioritized, targeted and measurable
  - assists with initiating conversations with agricultural producers

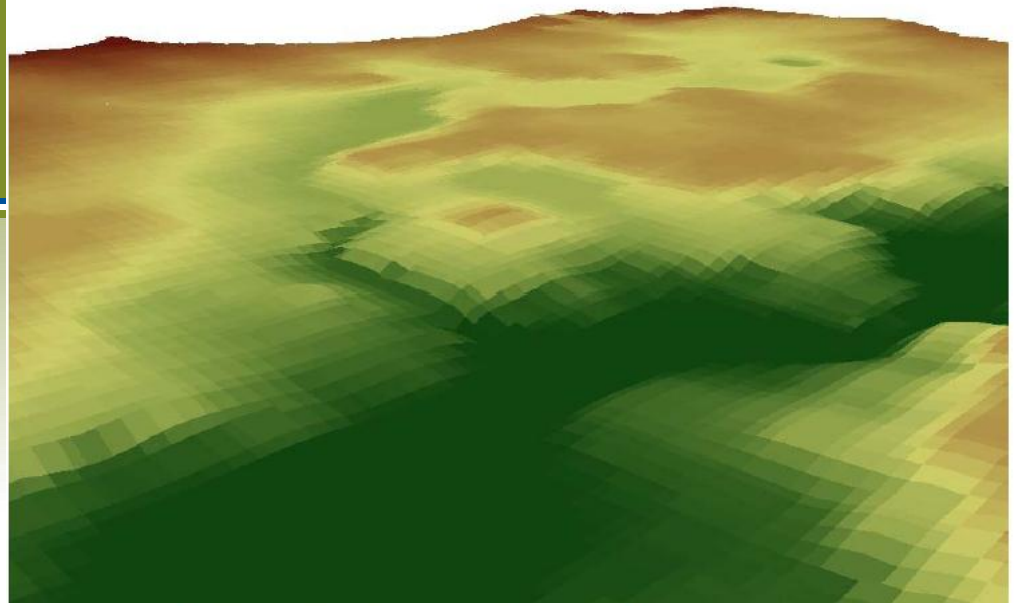
Three Major Elements of Guidance

- Terrain analysis
  - Identification of flow paths and erosion risk
  - Source area delineation/mapping
- Field assessment
  - Ground-truthing for sources, delivery mechanisms & stability or treatment
- Case Studies
  - Integrate above elements with tools/modeling—quantification of relative pollutant loadings/stressors
  - Further targeting and prioritization of candidate areas for implementation of conservation practices

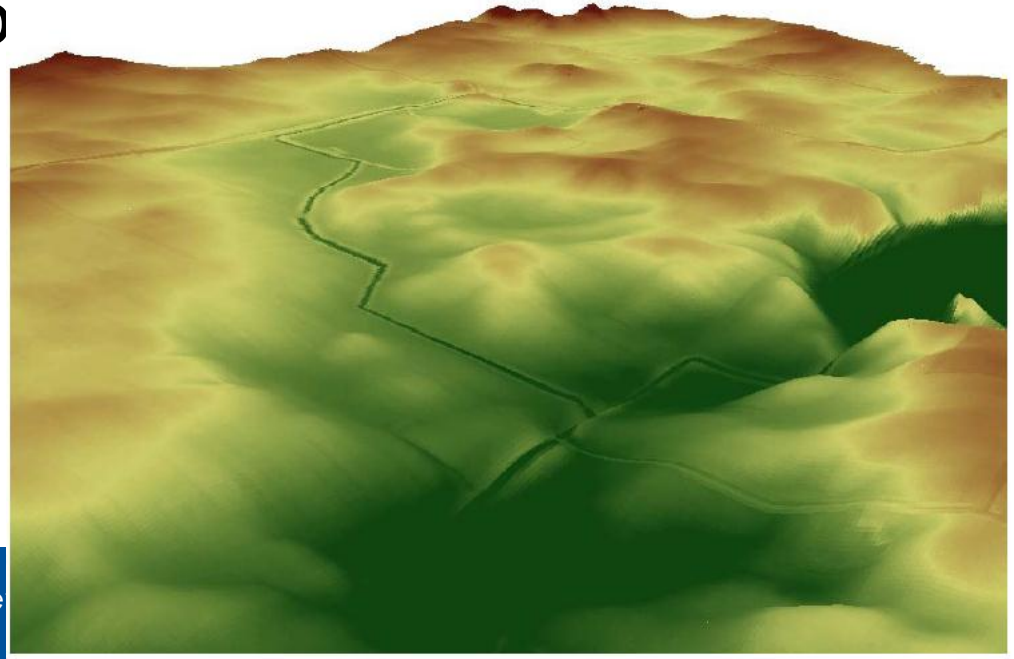
Terrain Analysis

- Concept is more than 20 years old
- Uses digital elevation data
- Quantitative process to spatially represent landscape features
- Primary attributes—slope and flow accumulation

USGS 30-m Elevation data



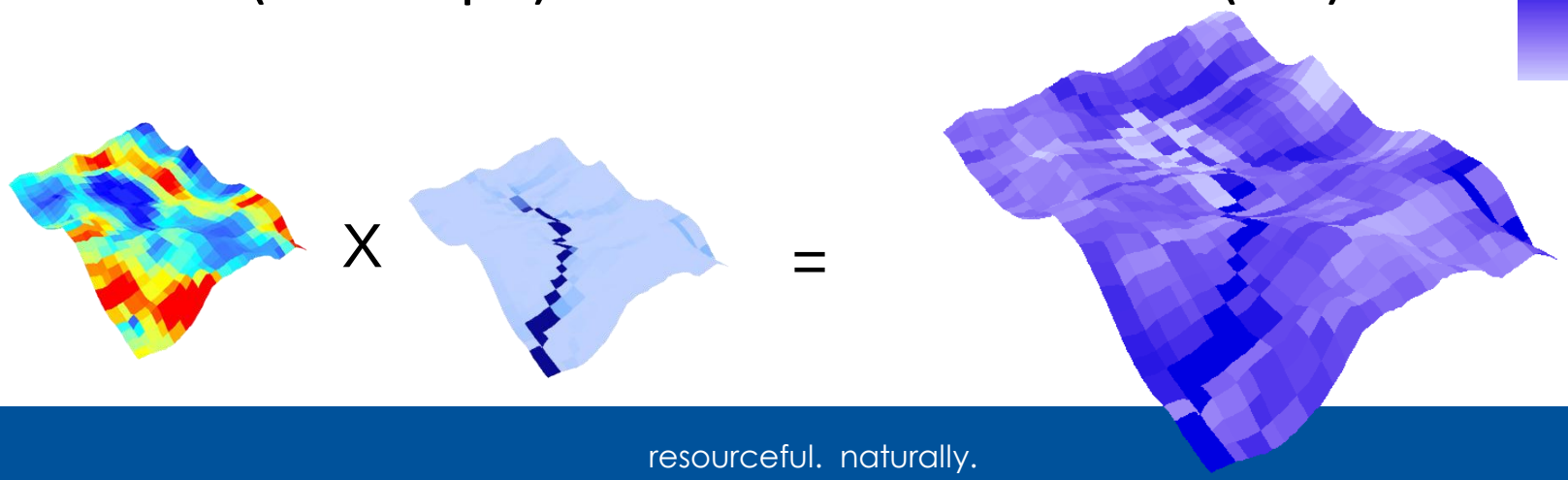
LiDAR 3-m Elevation data



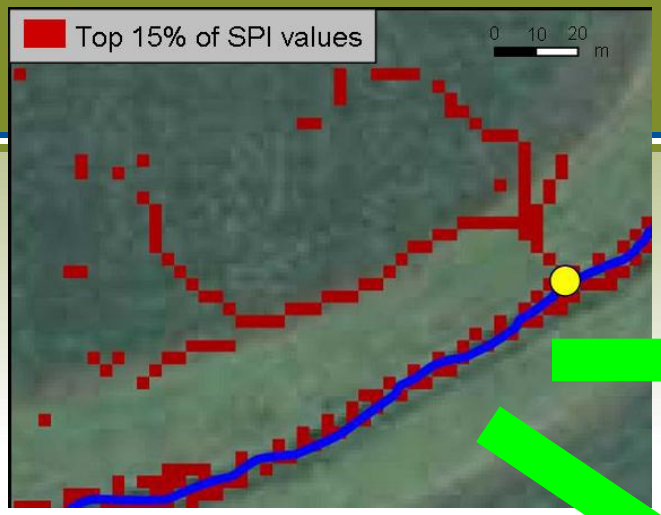
Terrain Attributes: Stream Power Index

- Secondary attribute: product of Slope and Flow Accumulation
- Quantifies the potential erosive power of overland flow
- Isolates areas with large catchments and steep slopes

ln (A * Slope) = Stream Power Index (SPI)

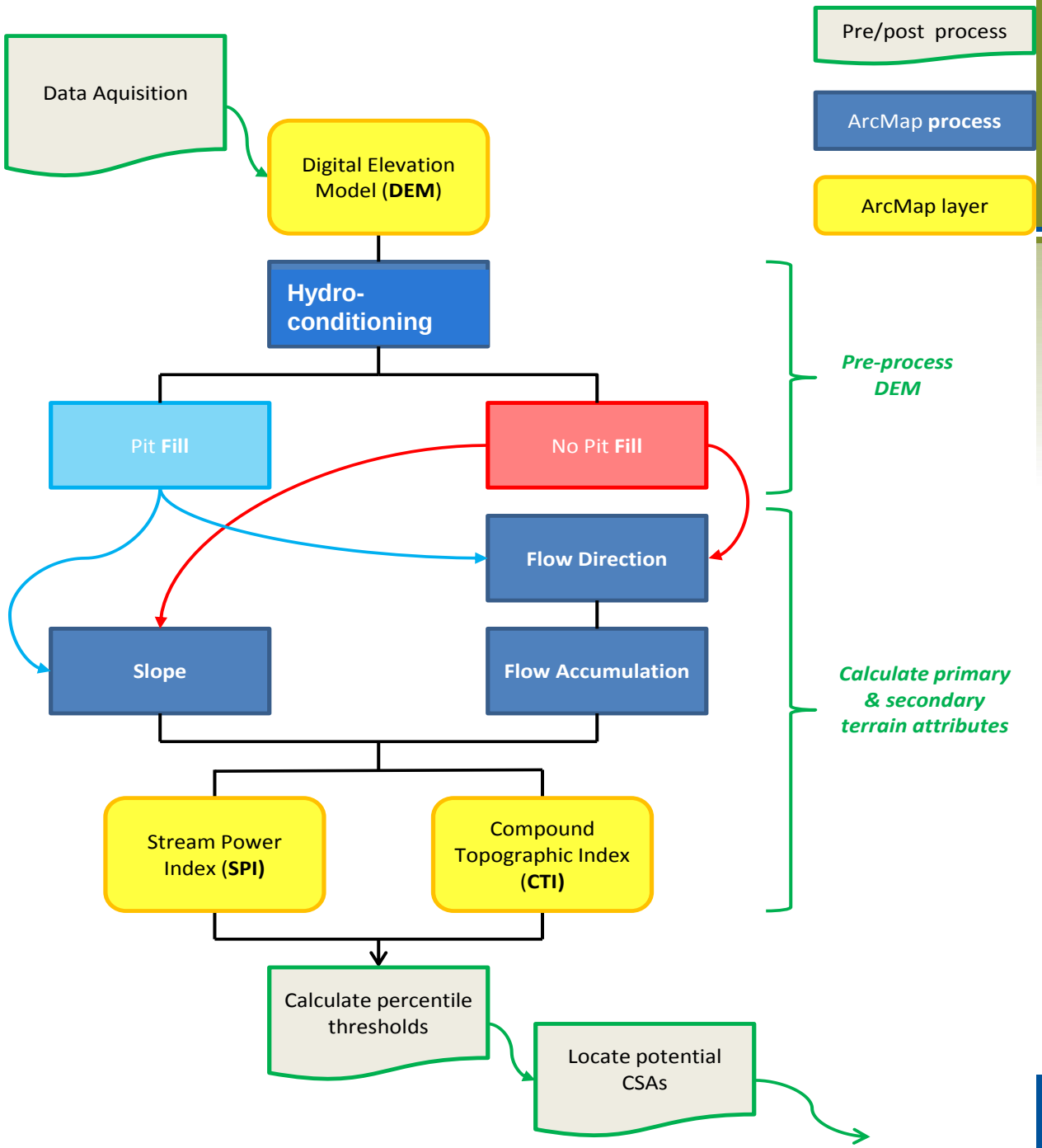


Stream Power Index



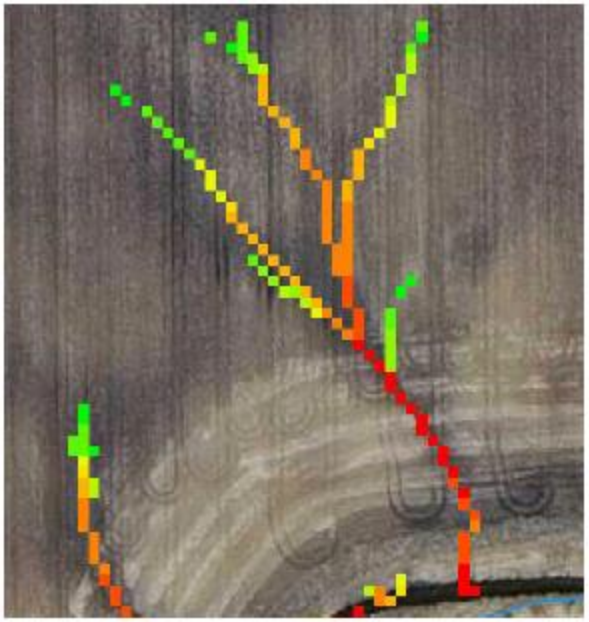
- Doesn't account for
  - flow volume and erosion differences from soil types, imperviousness & land cover
  - flow resistance and time of concentration

Digital terrain analysis flow chart



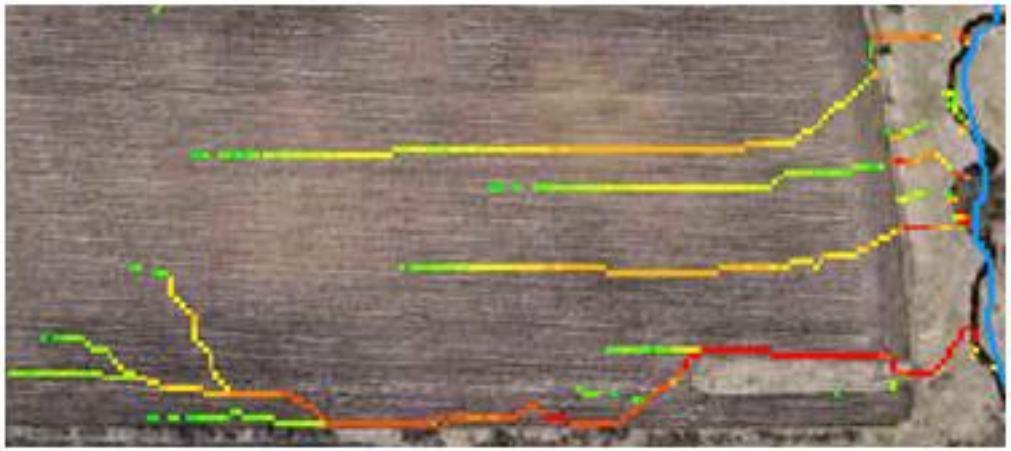
Terrain analysis output

- Visualizing SPI signatures as flow paths:



Terrain analysis output

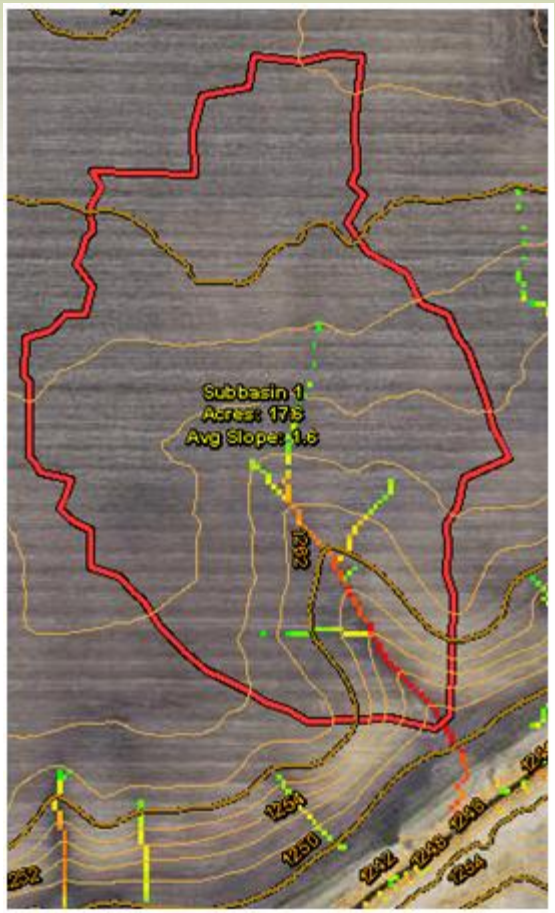
– Average SPI value – The portions of a signature with the highest SPI values have the greatest potential to erode the landscape



The figure on left shows differences between signatures of different average SPI values. The signature on the bottom has a noticeably higher overall SPI value than the top three signatures.

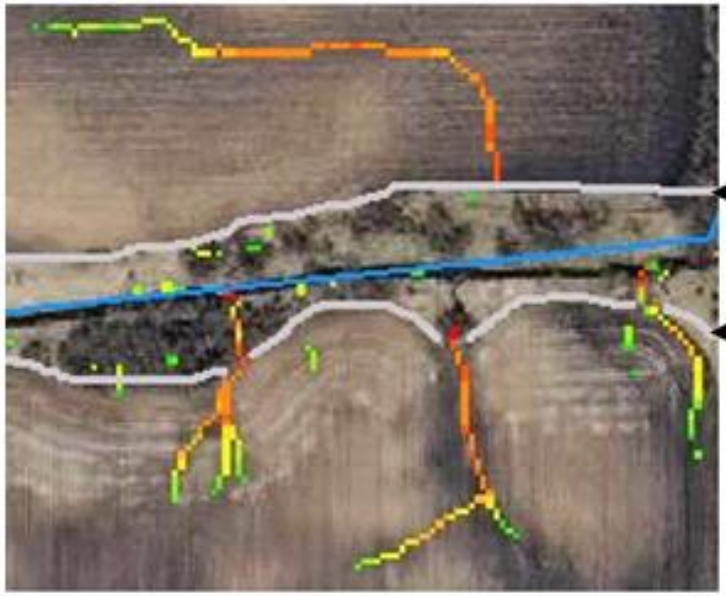
Terrain analysis output

- Contributing area - The contributing area upland of CSAs can be used to estimate the amount of potential sediment and nutrient delivery at those pour points



Terrain analysis output

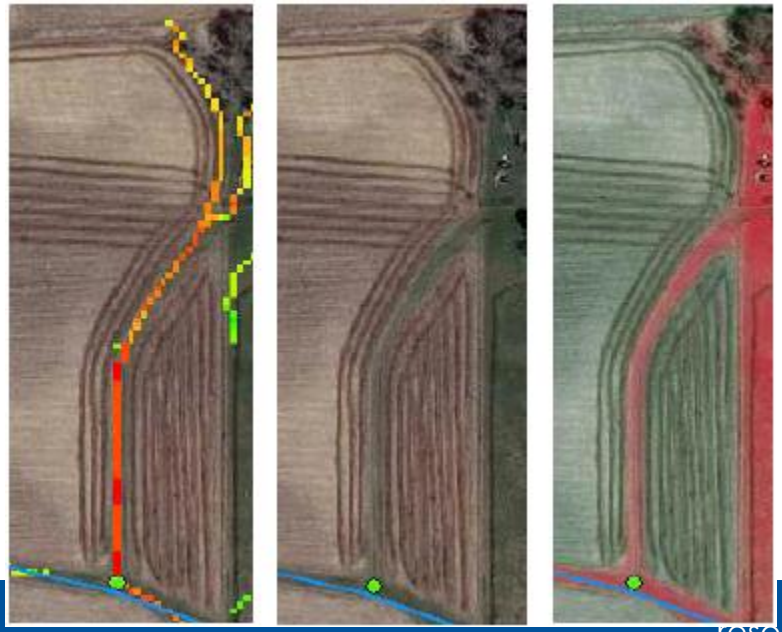
– Proximity to water – Typically, signatures that terminate in or near surface waters are of highest concern, though the exact location of the CSA point placement may vary depending on project goals



The grey horizontal lines represent the extent of the stream buffer. The top signature terminates at the buffer-field edge. The lower signatures terminate at the stream edge. *Note:* the bottom middle signature terminates just past the buffer. A field visit verified a steep knick point drop to water level at the signature terminus.

Terrain analysis output

– Existing conservation – Conservation practices may already exist at potential CSAs, some of which may be evident using various GIS layers

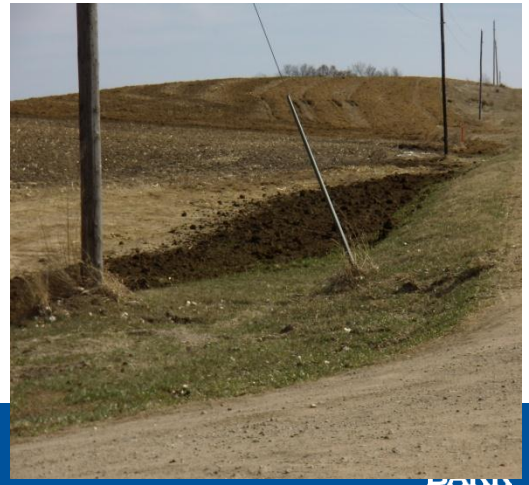


Terrain analysis output

– Sub-catchment soil characteristics – A Soil Erosion Risk raster layer can be used to display areas with high soil erosion risk

The image on left shows a series of small SPI signatures originating in an upland cultivated crop field. The large, tan colored shape represents the top 15% of the Soil Erosion Risk values (30 meter pixels). A field visit confirmed slight erosion occurring from the signature nearest the high Soil Erosion Risk percentile values (circled in red).

Field Verification Benefits



Pour Point Identification

1. Pour Point Identification Form and/or USLE Review Form

(Use this sheet to record information about the ability of SPI and/or USLE to identify pour points and erosion risk in different settings. This evaluation will help determine if these GIS analyses are appropriate tools for given watershed characteristics.)

Site ID: _____ ***Worksheet #:*** _____

A. Pour Point Identification Form

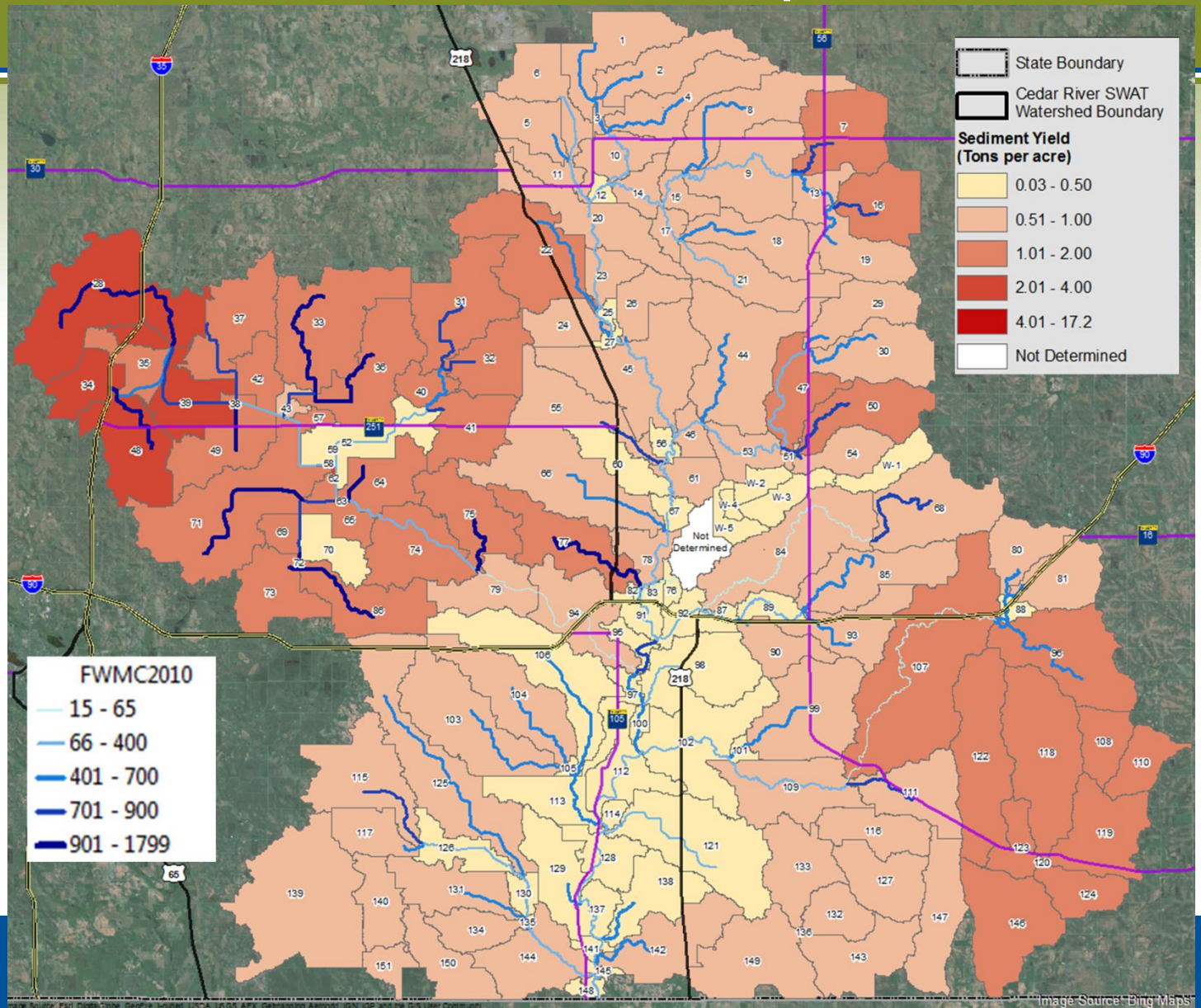
Pour Point Map ID #						
Was Pour Point Indicated by SPI?	Yes	No	Yes	No	Yes	No
Flow Type at Pour Point (Circle one)	Sheet Flow Tile Outlet	Ephemeral gully (< 2ft) Gully	Sheet Flow Tile Outlet	Ephemeral gully (< 2ft) Gully	Sheet Flow Tile Outlet	Ephemeral gully (< 2ft) Gully
Gully Characteristics	Width _____ Depth _____ Length _____		Width _____ Depth _____ Length _____		Width _____ Depth _____ Length _____	
General Characteristics at Pour Point (Circle all that apply)	Bermed with side inlet Gentle slopes Slight erosion		Bermed with side inlet Gentle slopes Slight erosion		Bermed with side inlet Gentle slopes Slight erosion	
Upland Land Use *	Hay/Pasture Row Crop/Small Grain		Hay/Pasture Row Crop/Small Grain		Hay/Pasture Row Crop/Small Grain	
Pour Point Flows to **:	Receiving Water Natural Vegetation Corridor		Receiving Water Natural Vegetation Corridor		Receiving Water Natural Vegetation Corridor	
If Flows to Natural Vegetation Corridor, is there a Noticeable Pour Point from the Corridor to the Water Resource?	Yes	No	Yes	No	Yes	No

* If the upland land use is hay / pasture, complete Form 2A; if the upland land use is row crop / small grain, complete Form 2B.

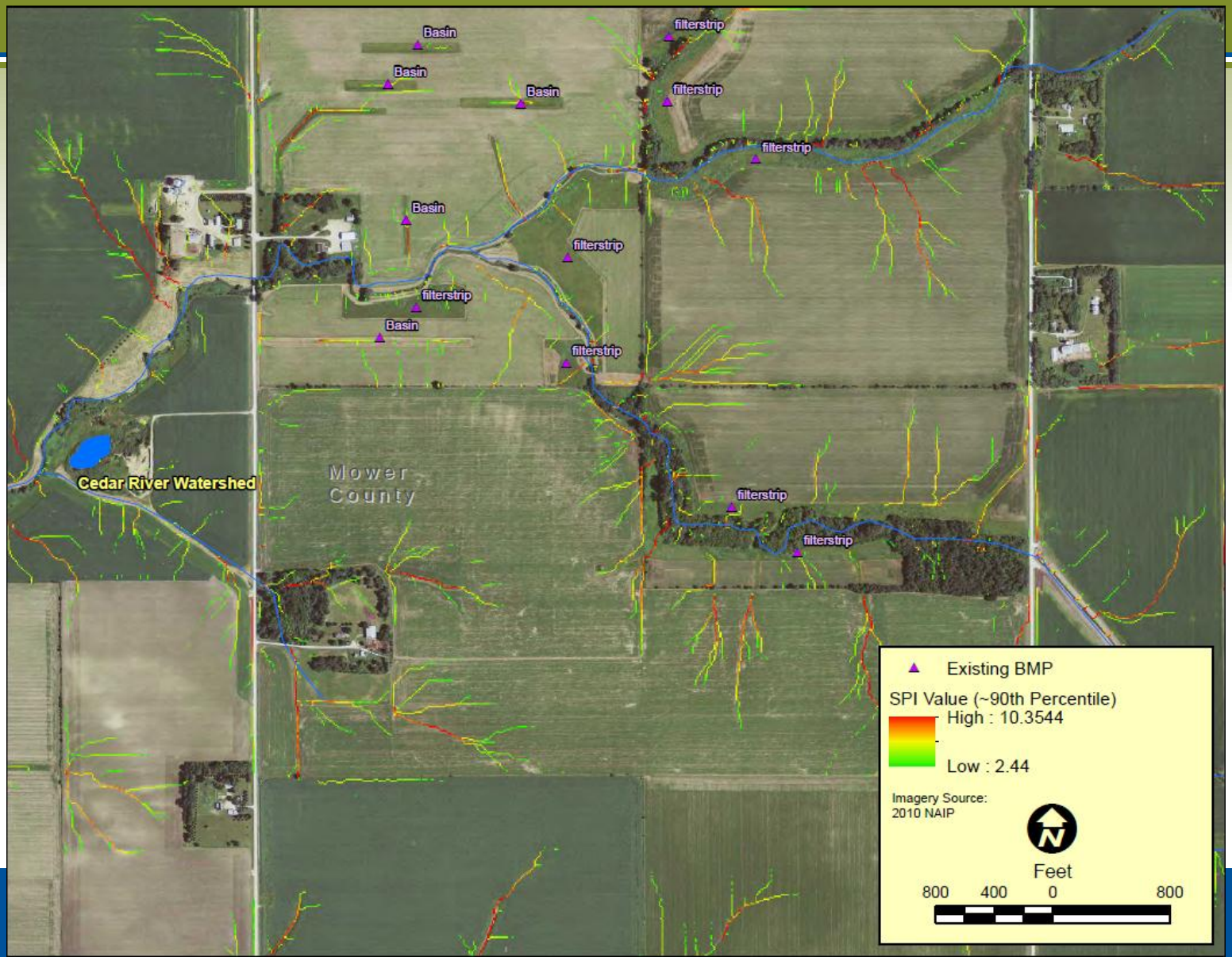
** If the pour point flows to a natural vegetation corridor, also complete Form 2C.

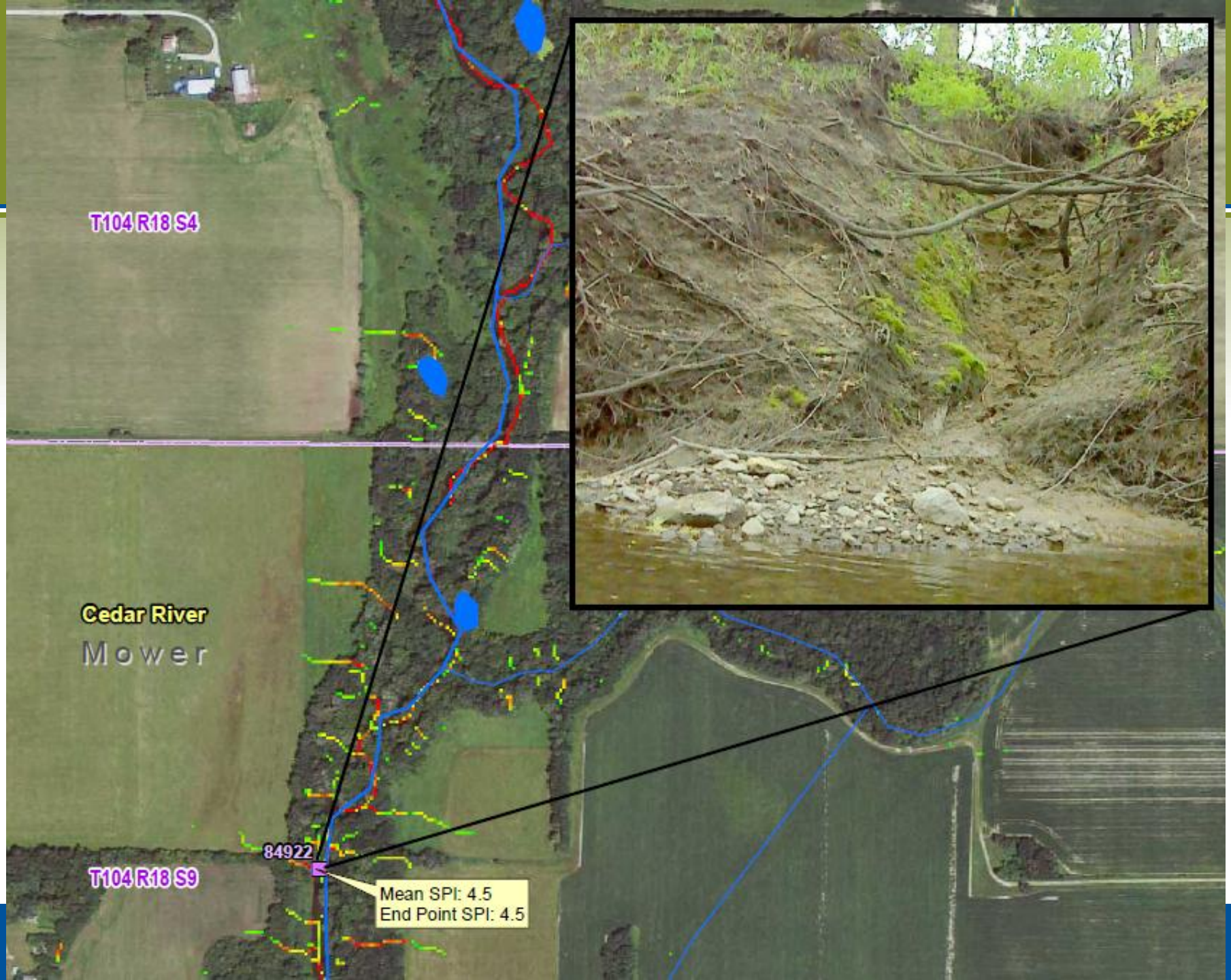
Notes:

Watershed examples—Cedar



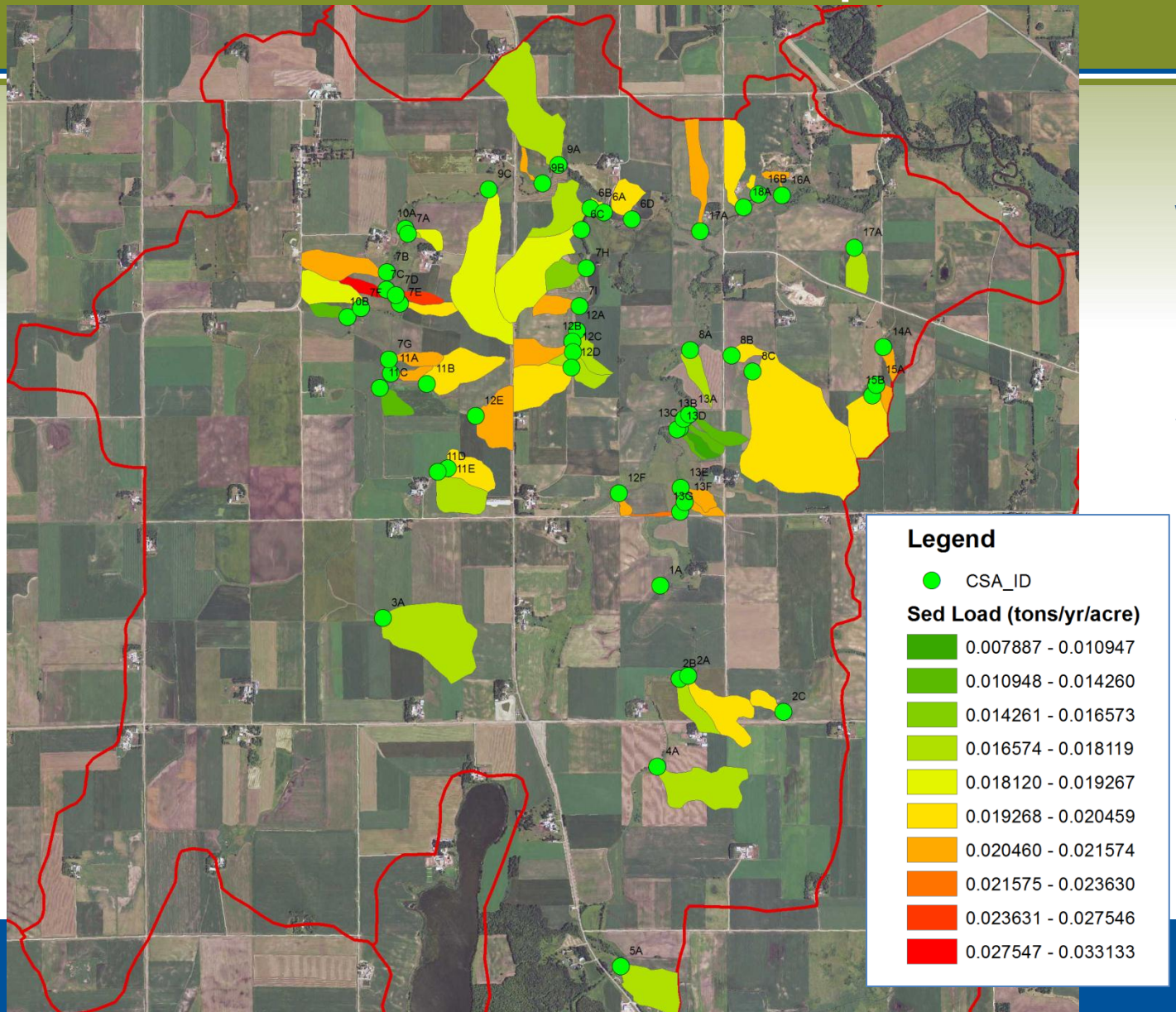
Watershed examples—Cedar




T104 R18 S4
Cedar River
Mower
84922
T104 R18 S9
Mean SPI: 4.5
End Point SPI: 4.5

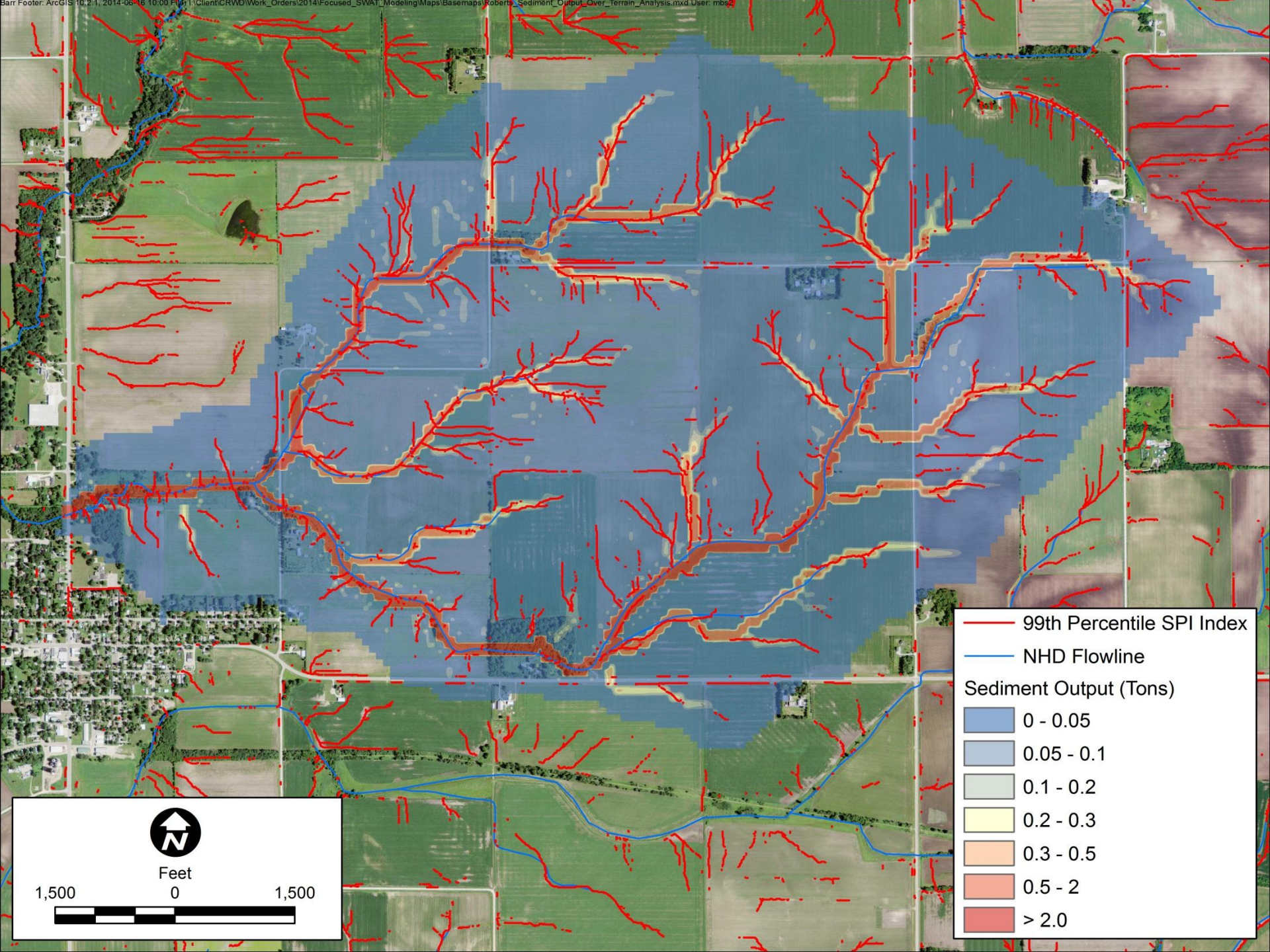

22.143856
4.8597
6.2214
4.9058
4.1758
9.431765
17.298637
16.854878

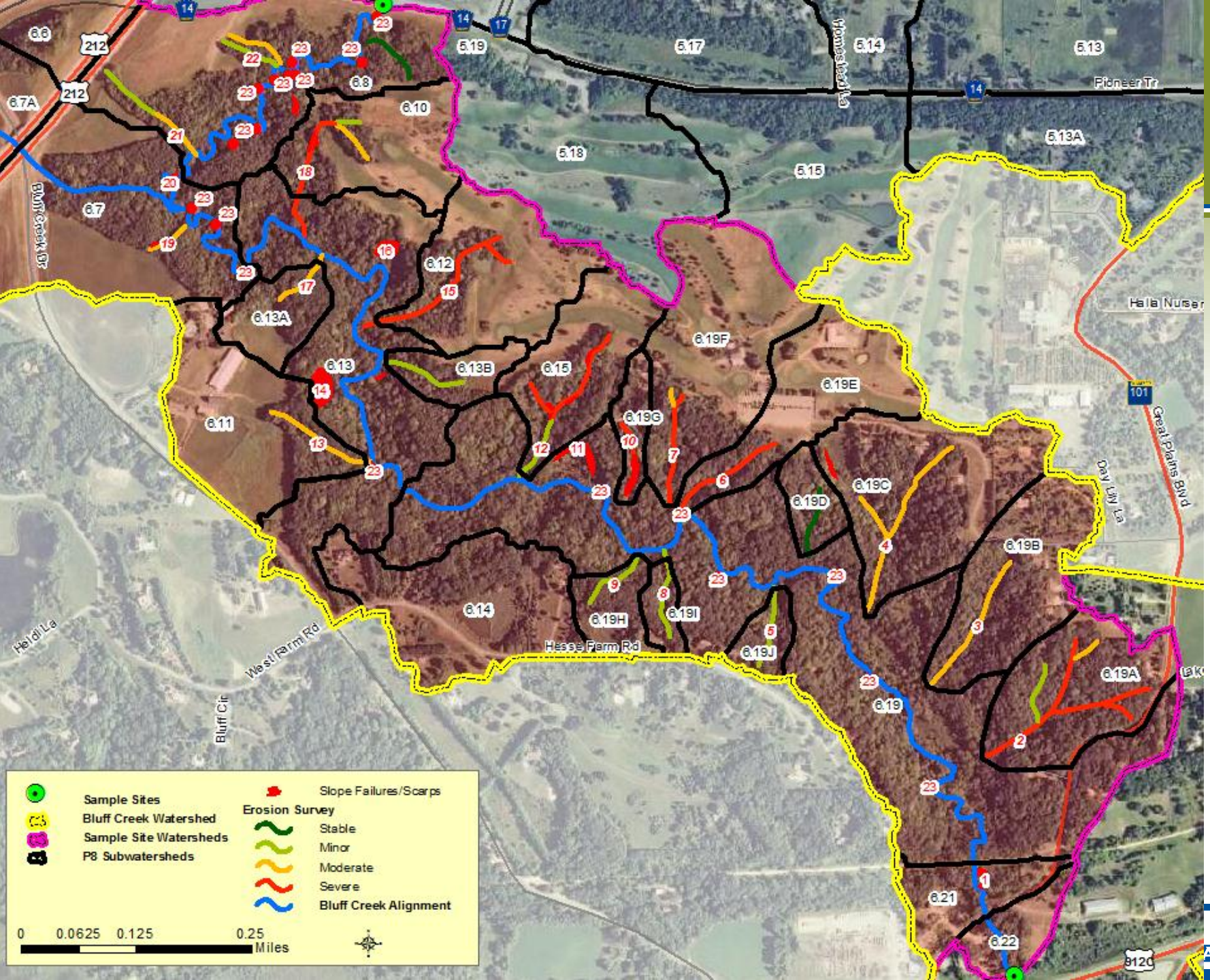
Watershed examples—Stearns

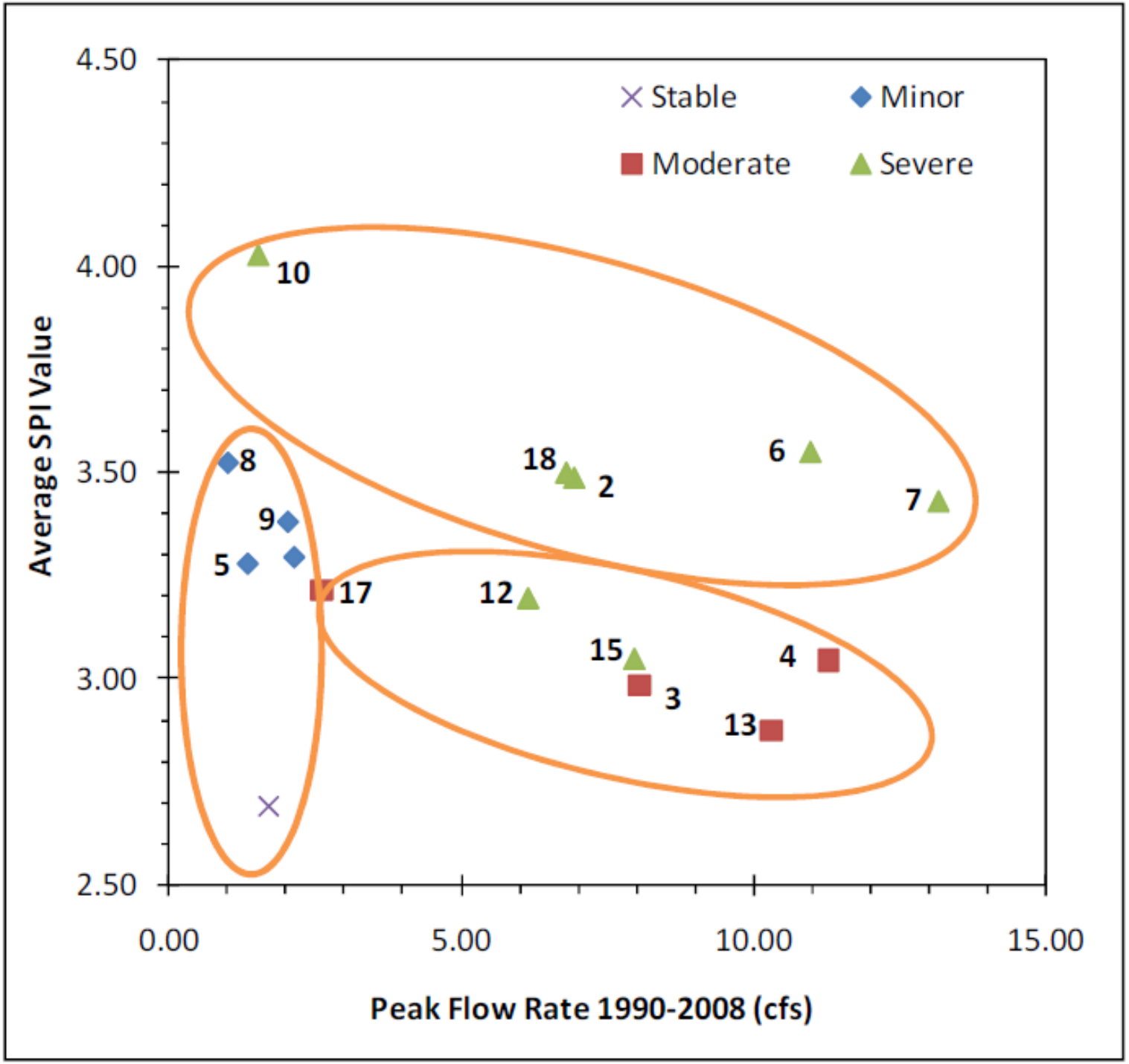


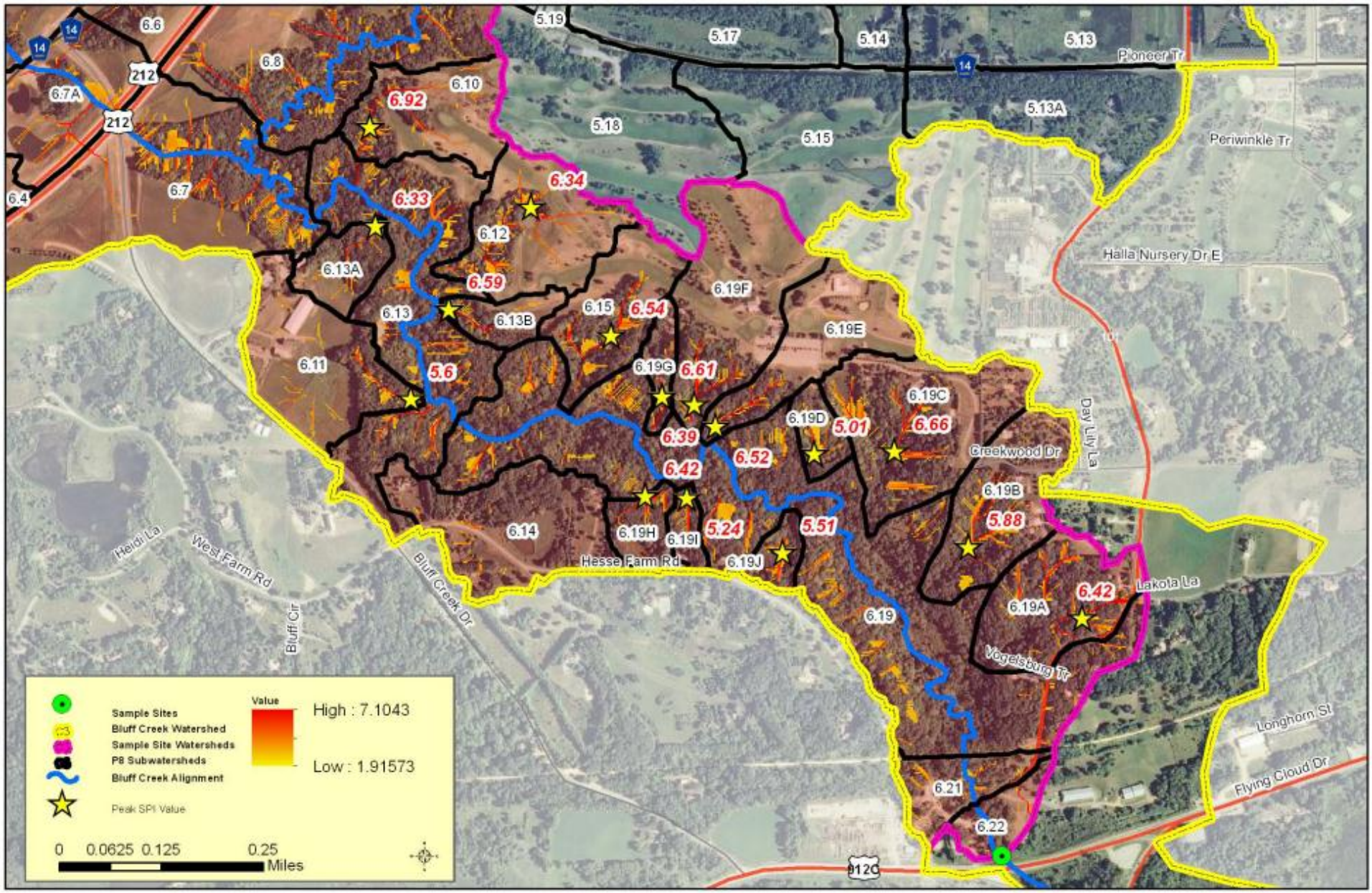
Unnamed Creek Watershed

Integration with HSPF land segment output

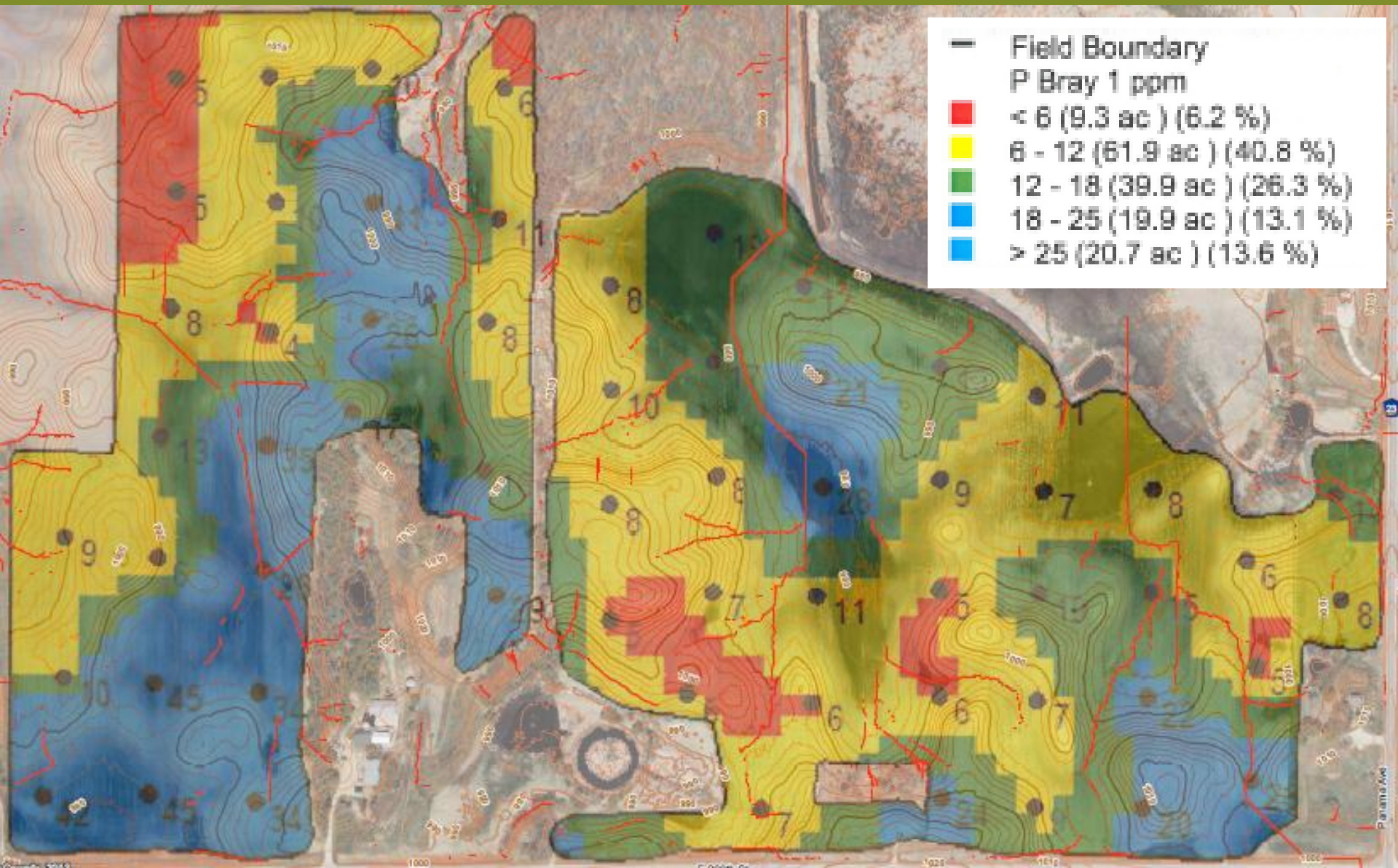



Sample Sites
Bluff Creek Watershed
Sample Site Watersheds
P8 Subwatersheds
Slope Failures/Scarps
Erosion Survey
Stable
Minor
Moderate
Severe
Bluff Creek Alignment
0 0.0625 0.125 0.25
Miles
Pioneer Tr
Homestead La
Great Plains Blvd
Day Lily La
Heidi La
West Farm Rd
Hesse Farm Rd
Bluff Cir
Bluff Creek Dr
6.6
6.7A
6.7
6.8
6.10
6.11
6.12
6.13
6.13A
6.13B
6.14
6.15
6.17
6.18
6.19
6.19A
6.19B
6.19C
6.19D
6.19E
6.19F
6.19G
6.19H
6.19I
6.19J
6.21
6.22
5.13
5.13A
5.14
5.15
5.17
5.18
5.19
212
14
17
101


4.50
4.00
3.50
3.00
2.50
Average SPI Value
0.00
5.00
10.00
15.00
Peak Flow Rate 1990-2008 (cfs)
Stable
Minor
Moderate
Severe
10
8
18
2
6
7
9
5
17
12
15
4
3
13


6.6
6.8
6.7A
6.4
6.7
6.10
6.92
6.34
6.33
6.12
6.13A
6.59
6.13
6.13B
6.11
5.6
6.15
6.54
6.19F
6.19E
6.19G
6.61
6.39
6.42
6.52
6.19D
5.01
6.19C
6.66
6.19B
5.88
6.14
6.19H
6.19I
5.24
6.19J
5.51
6.19
6.19A
6.42
6.21
6.22
5.19
5.17
5.14
5.13
5.13A
5.18
5.15
212
14
Pioneer Tr
Periwinkle Tr
Halla Nursery Dr E
Day Lily La
Creekwood Dr
Lakola La
Yogelsburg Tr
Longhorn St
Flying Cloud Dr
Heidi La
West Farm Rd
Bluff Cir
Bluff Creek Dr
Hesse Farm Rd
912C
Sample Sites
Bluff Creek Watershed
Sample Site Watersheds
P8 Subwatersheds
Bluff Creek Alignment
Peak SPI Value
Value
High : 7.1043
Low : 1.91573
0 0.0625 0.125 0.25
Miles

Field-scale example



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  - BWSR
  - MDNR
  - MPCA
  - NRCS

questions?

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