The UNIVERSITY of OKLAHOMA
Gallogly College of Engineering
School of Civil Engineering and Environmental Science

CREW
Center for Restoration of Ecosystems and Watersheds
University of Oklahoma

Geospatial Distribution of Soil Trace Metals Concentrations in a Mining Impacted Agricultural Watershed

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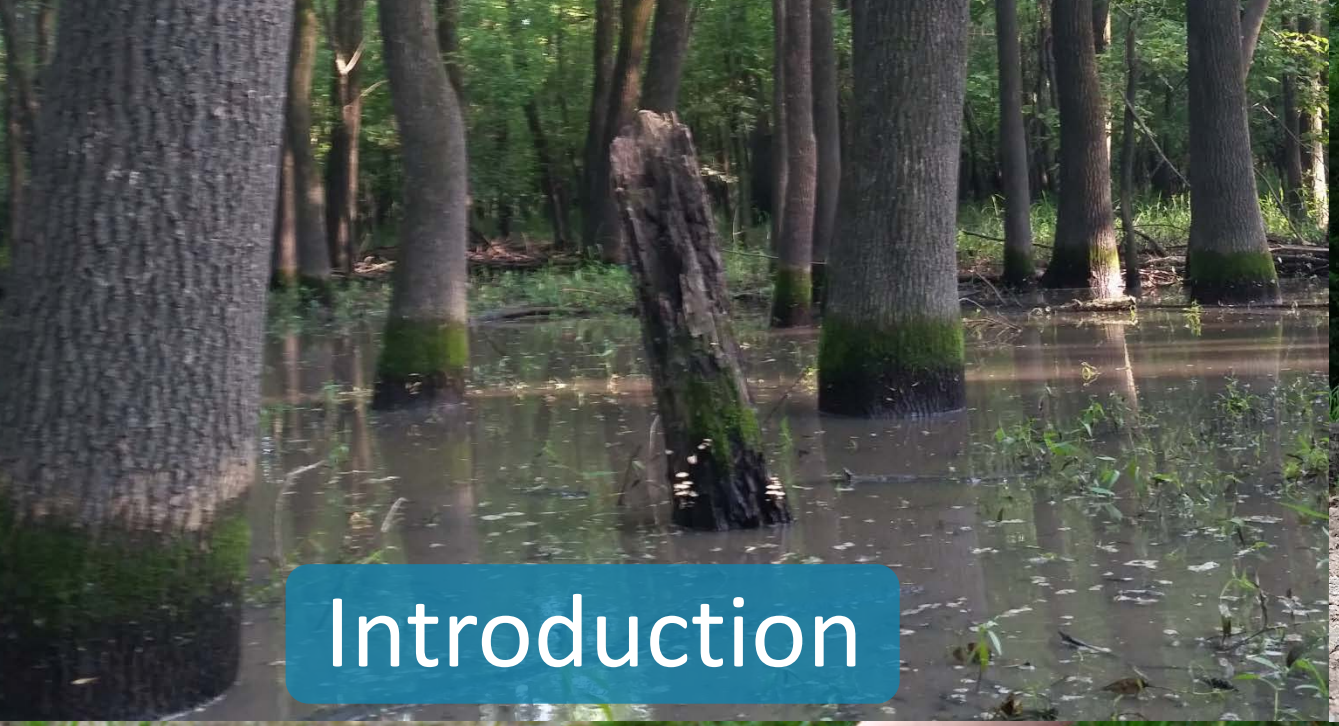
School of Civil Engineering and Environmental Science

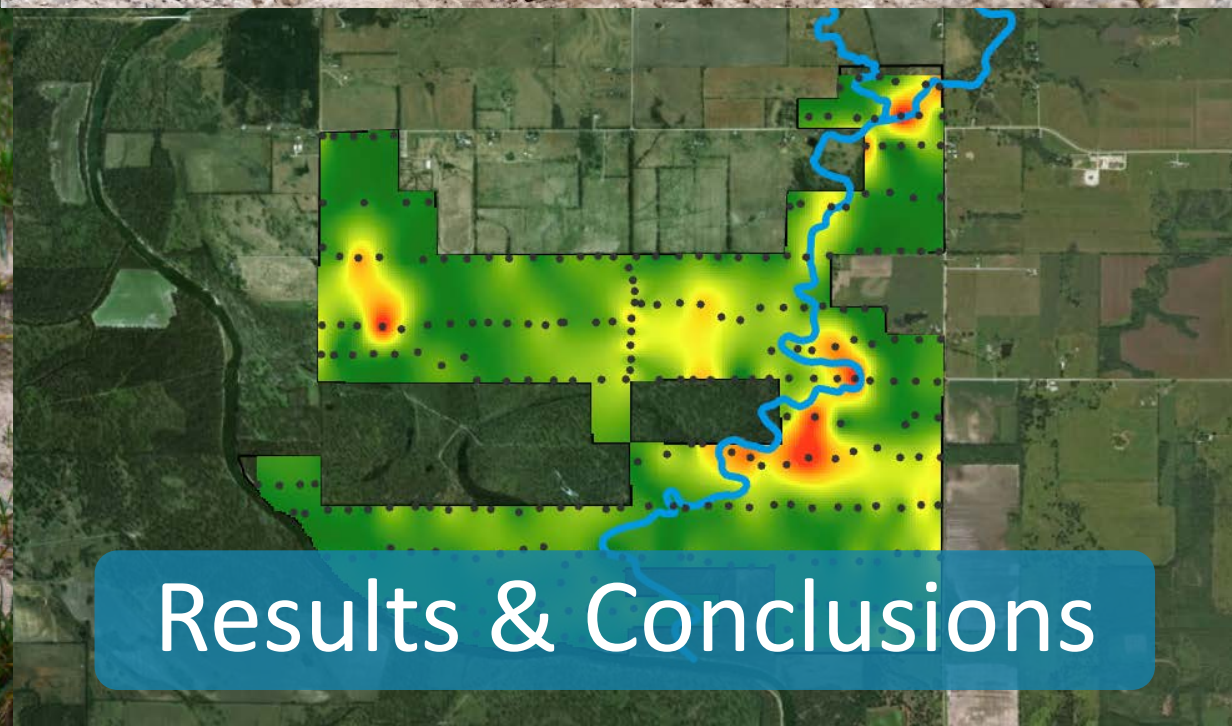
University of Oklahoma

June 5, 2018


Introduction

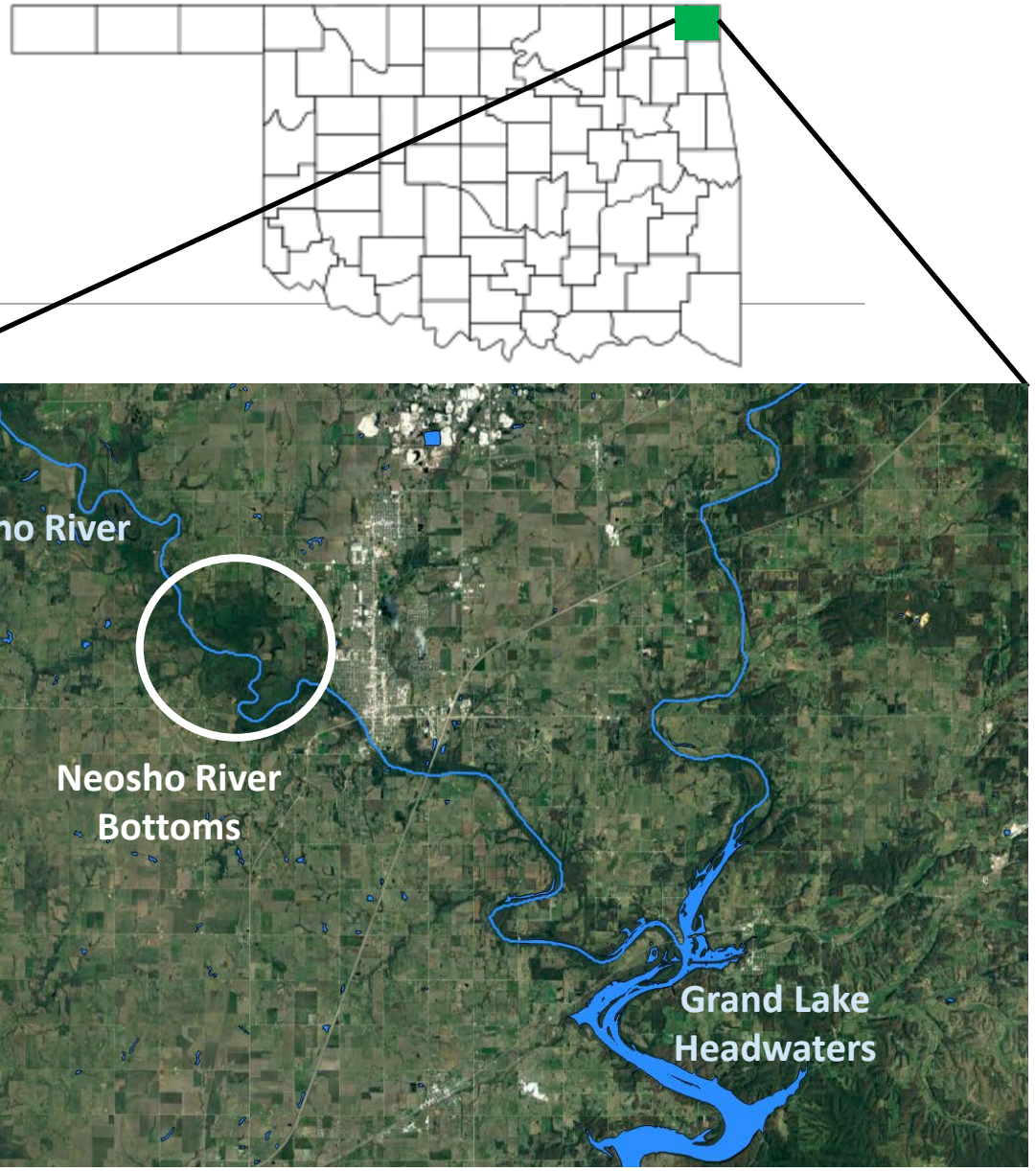

Objectives


Methods & Locations


Results & Conclusions

Introduction

Neosho River Bottoms



- ~25,000 acre floodplain and upland area
- Significant restoration opportunities
  - Bottomland hardwood forest
  - Oxbow lakes
  - Scrub shrub wetland
  - Eastern tall grass prairie
- GRDA acquired 3,600 acres along the Neosho River

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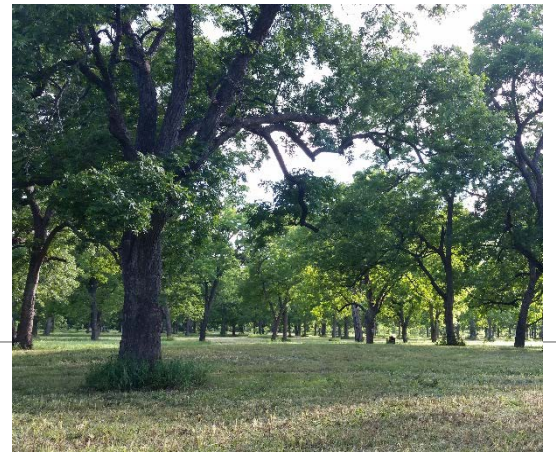
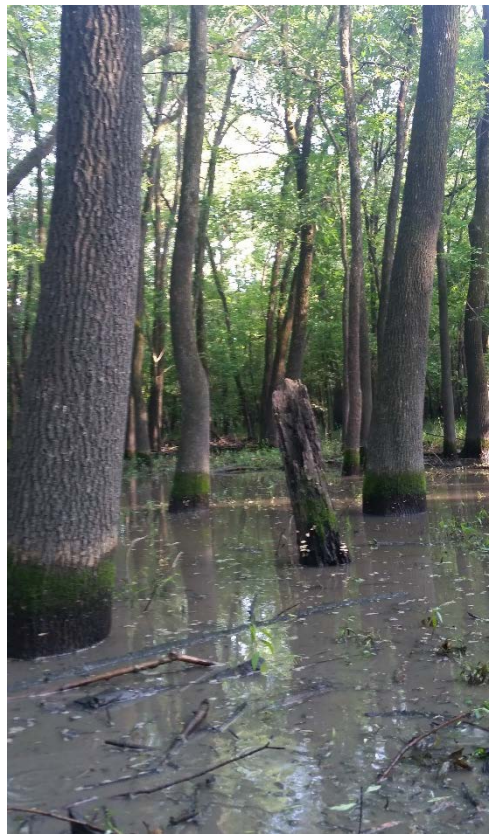
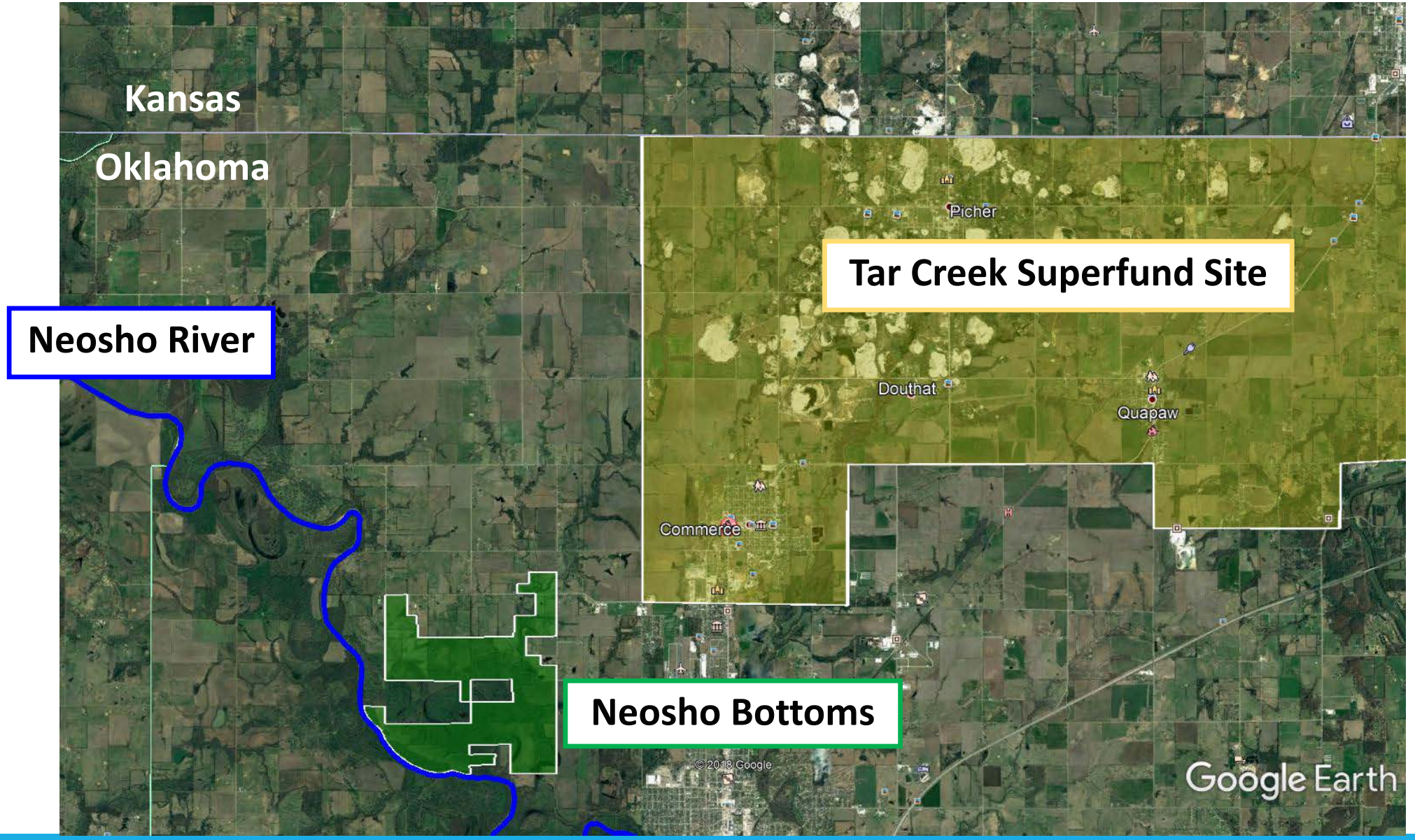




The area of interest south of Superfund Site



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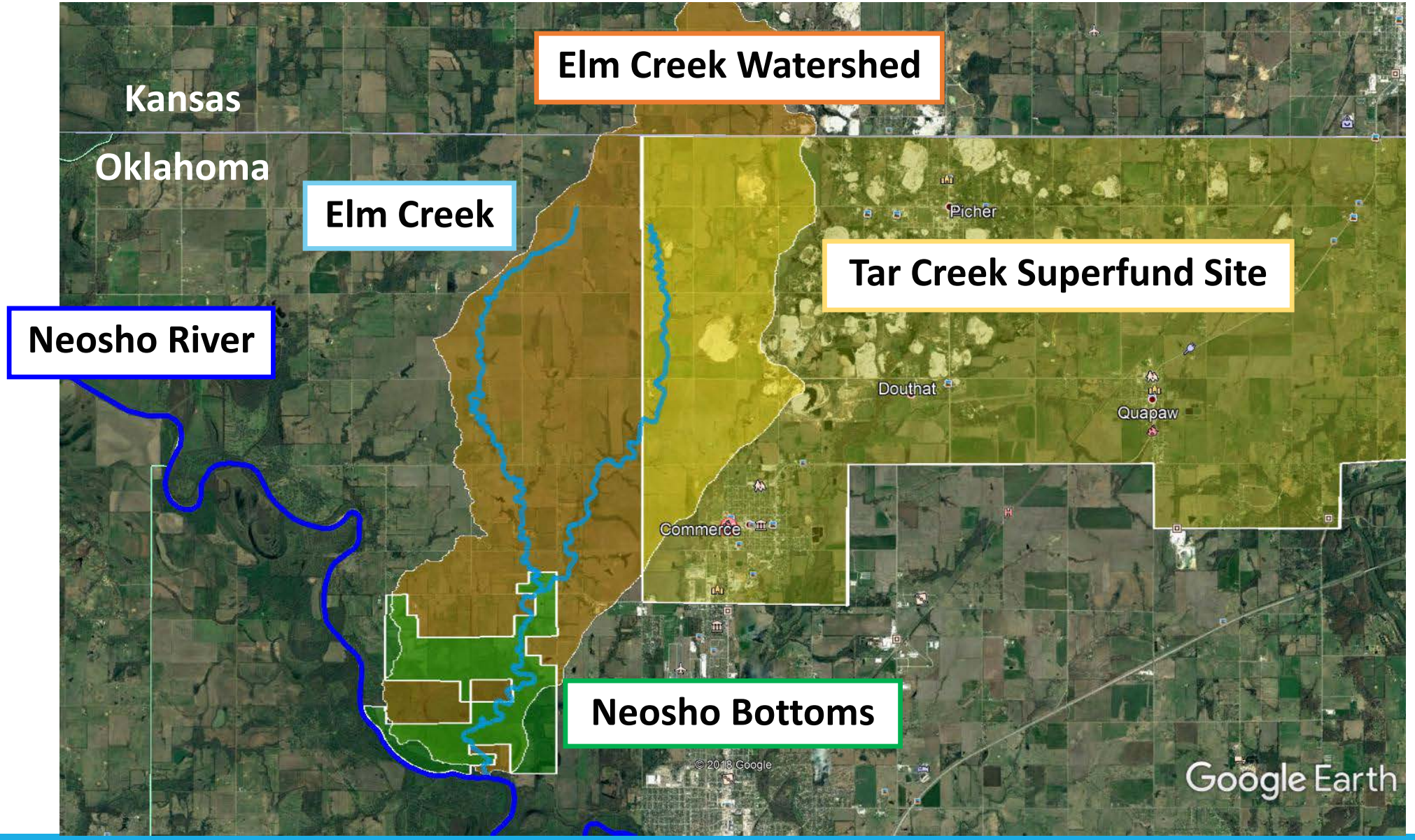

Soil Trace Metals Detection

- Inductively coupled plasma optical emission spectrometry (ICP-OES)
- Inductively coupled plasma mass spectrometry (ICP-MS)
- X-ray fluorescence (XRF)
  - On-site fast screening method for soil metals
  - Cost effective when compared to ICP-OES
  - Viewed by the environmental community as an acceptable analytical approach for field applications

Objectives

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1. Evaluate soil lead, zinc, and cadmium concentrations in stream terraces and upland environments in this mining impacted agricultural watershed.
2. Generate a spatial perspective of the distribution of lead, zinc, and cadmium concentrations.

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Methods & Locations

The soil metal concentration in the floodplain were determined three different ways

Method 1:

In Situ

Field Portable XRF Analyses (EPA 6200)
Bulk Sample

The soil metal concentration in the floodplain were determined three different ways

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In Situ

Field Portable XRF Analyses (EPA 6200)
Bulk Sample

- Soil samples were collected using stainless steel shovel
  - 13 cm X 13 cm X 10 cm cuttings
  - Sealed tightly in 3 mil or thicker plastic bag
- Sample locations were recorded with GPS
- Transported back to laboratory

The soil metal concentration in the floodplain were determined three different ways

Method 1:

In Situ

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Bulk Sample

Method 2:

Laboratory

Field Portable XRF Analyses (EPA 6200)
Dried and < # 60 Sieve Fraction

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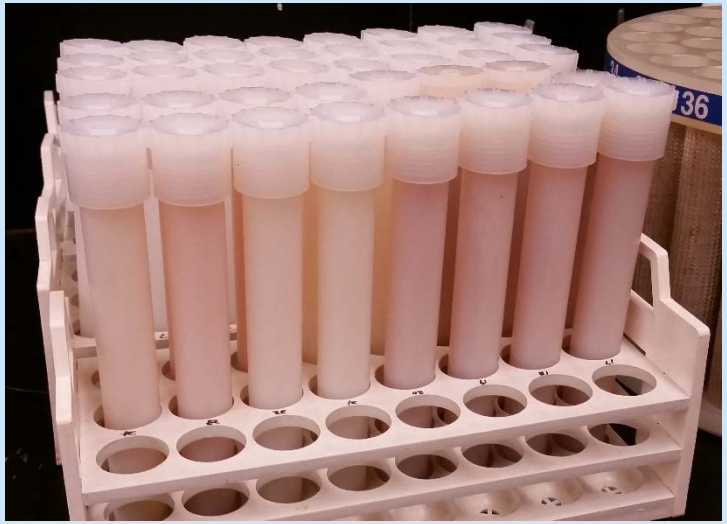

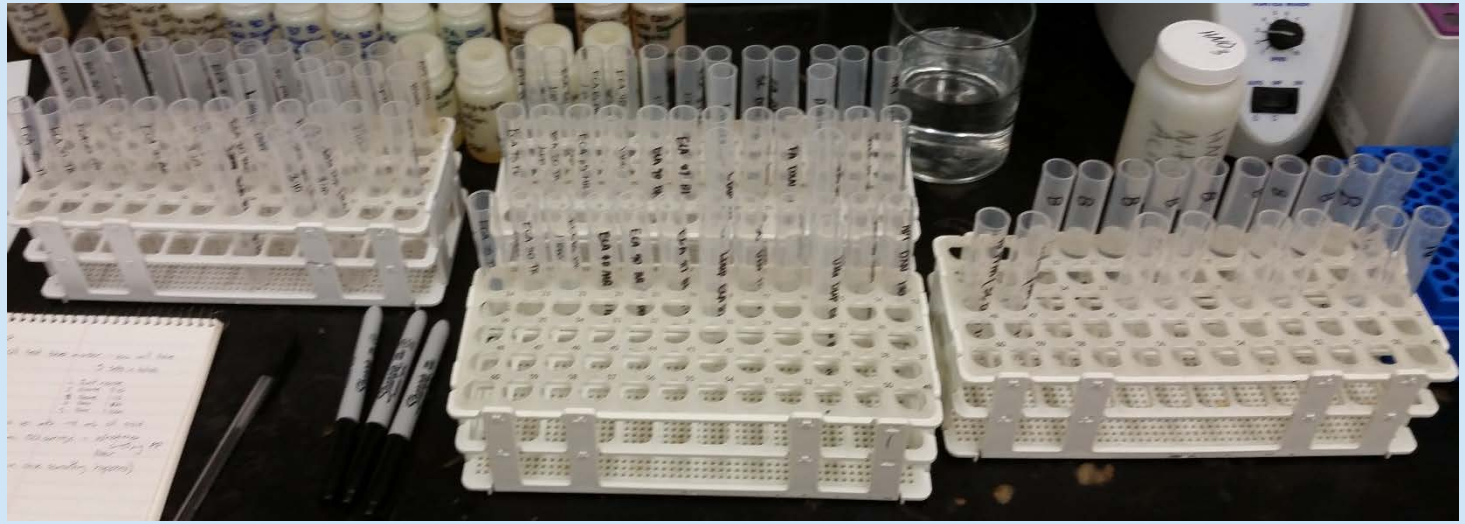

Method 3:

Laboratory

Microwave HNO_3 digestion (EPA 3051)
Inductively Coupled Plasma-Optical Emission Spectrometry (ICP-OES) Analyses (EPA 6010)
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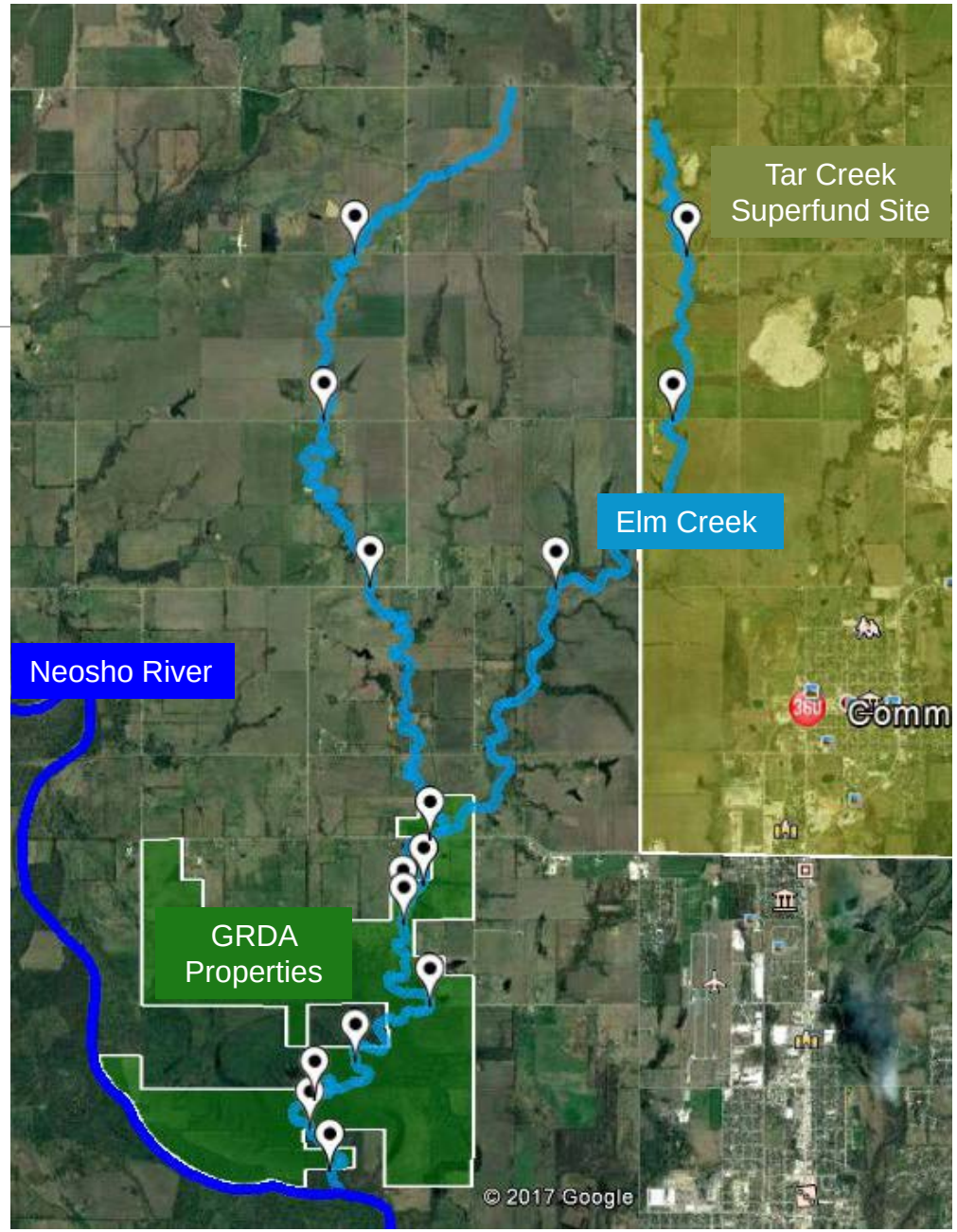
Sampling Locations

- Elm Creek road crossings (intersecting the stream)

- Properties owned by GRDA
  - Elm Creek riparian zone
  - Neosho Bottoms uplands

Elm Creek Riparian Zone

- Samples taken from 15 locations
  - 7 sites at road crossings
  - 8 sites in GRDA properties
- Left and right side of creek
  - Top of Bank
  - Primary Terrace
  - Lower Terrace
- 106 soil samples



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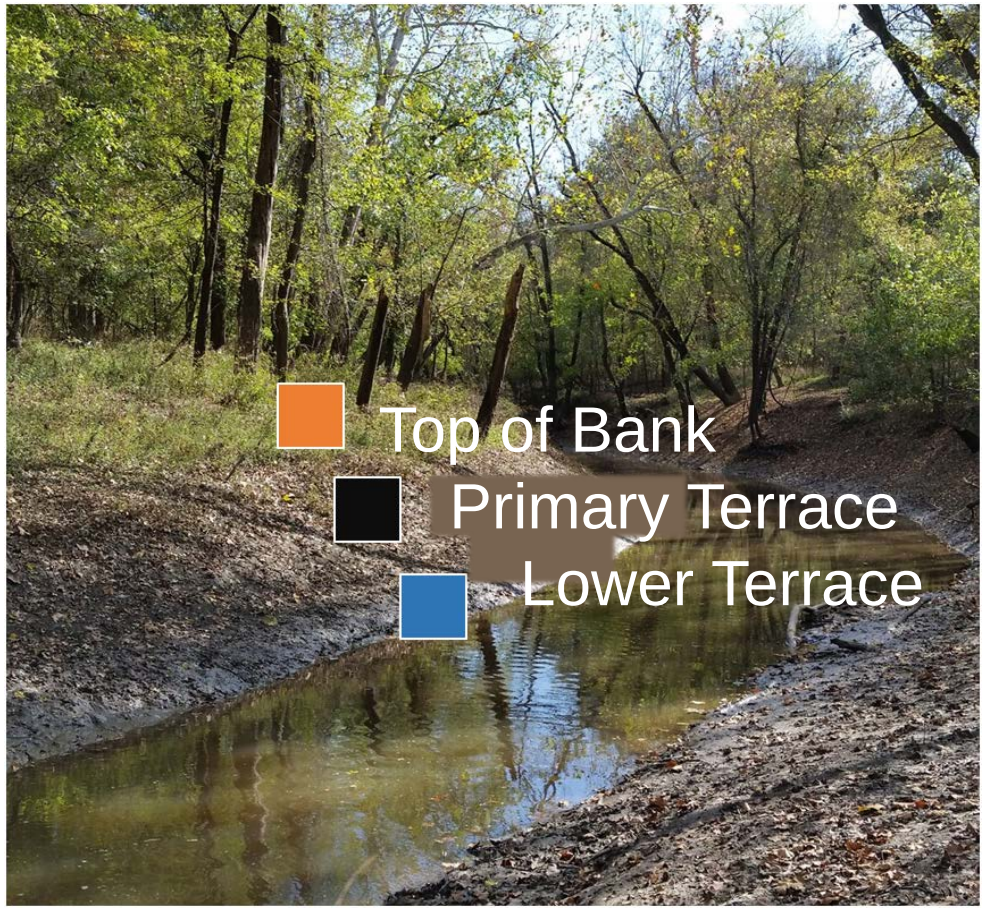
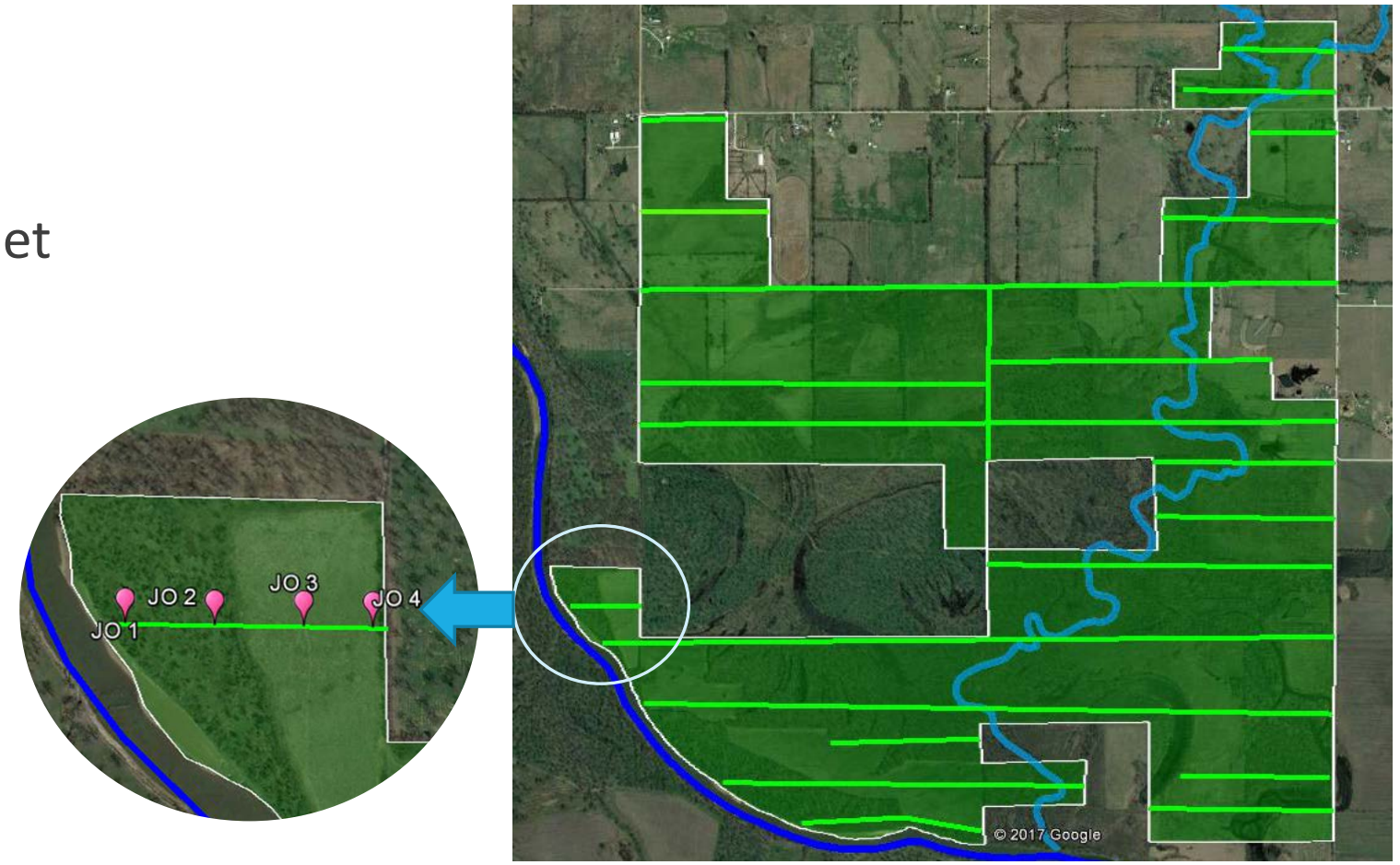


Neosho Bottoms Upland Sites

- Series of transects
  - Total length of 13.2 miles
- Samples taken every 360 feet
- Locations entered on GPS before sampling
- Exact GPS locations taken in field
- 278 soil samples



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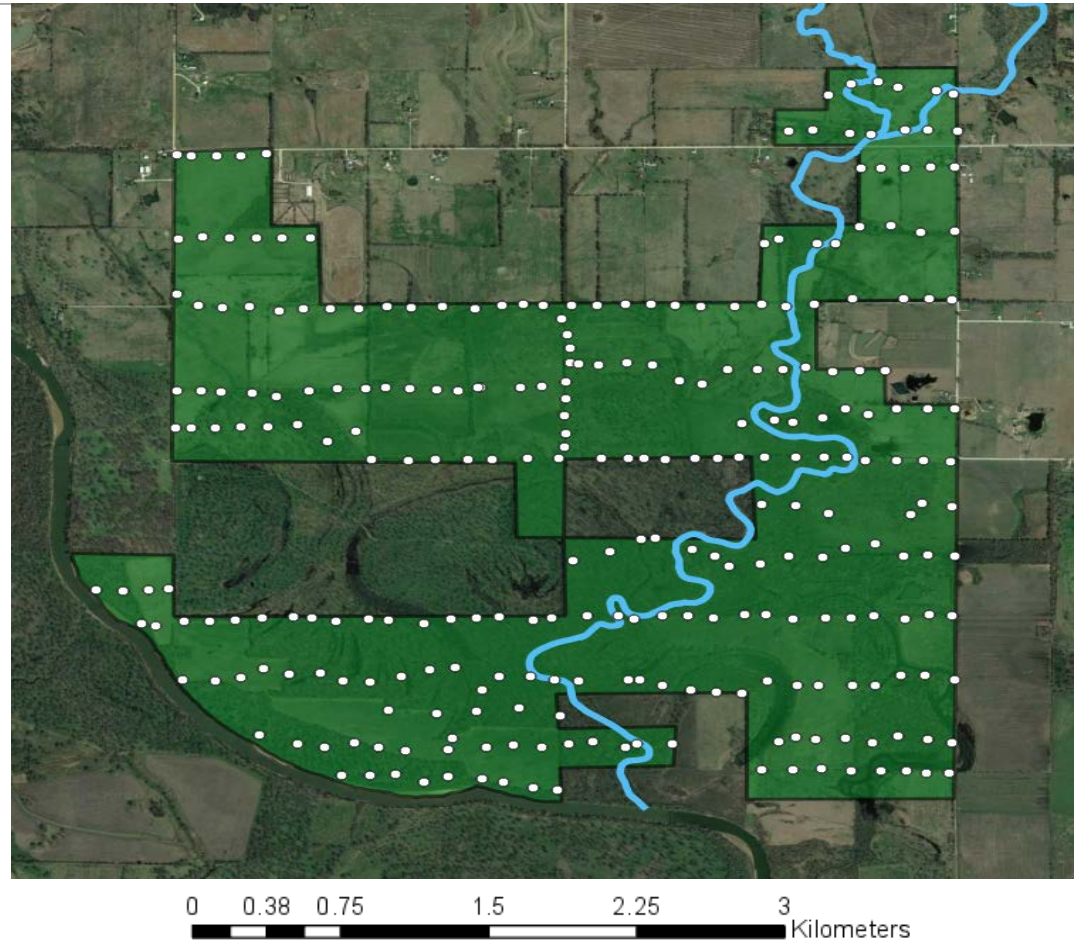
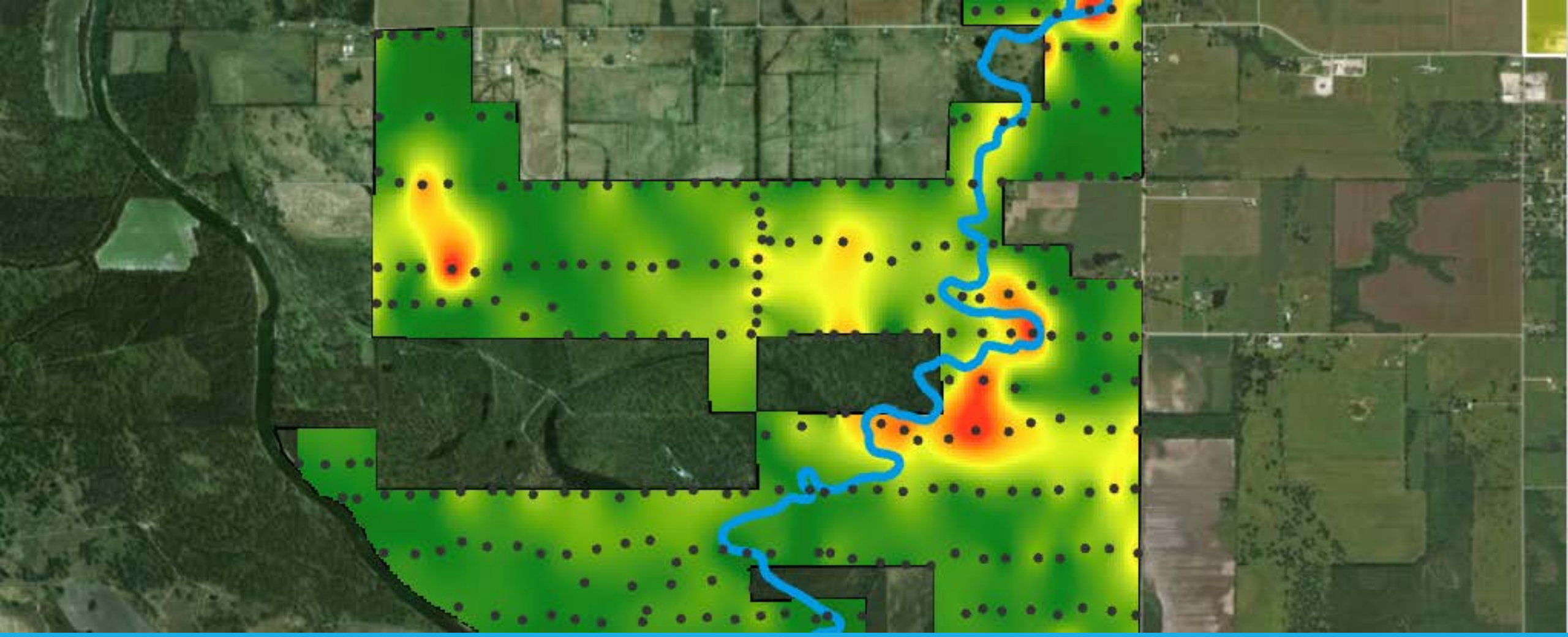
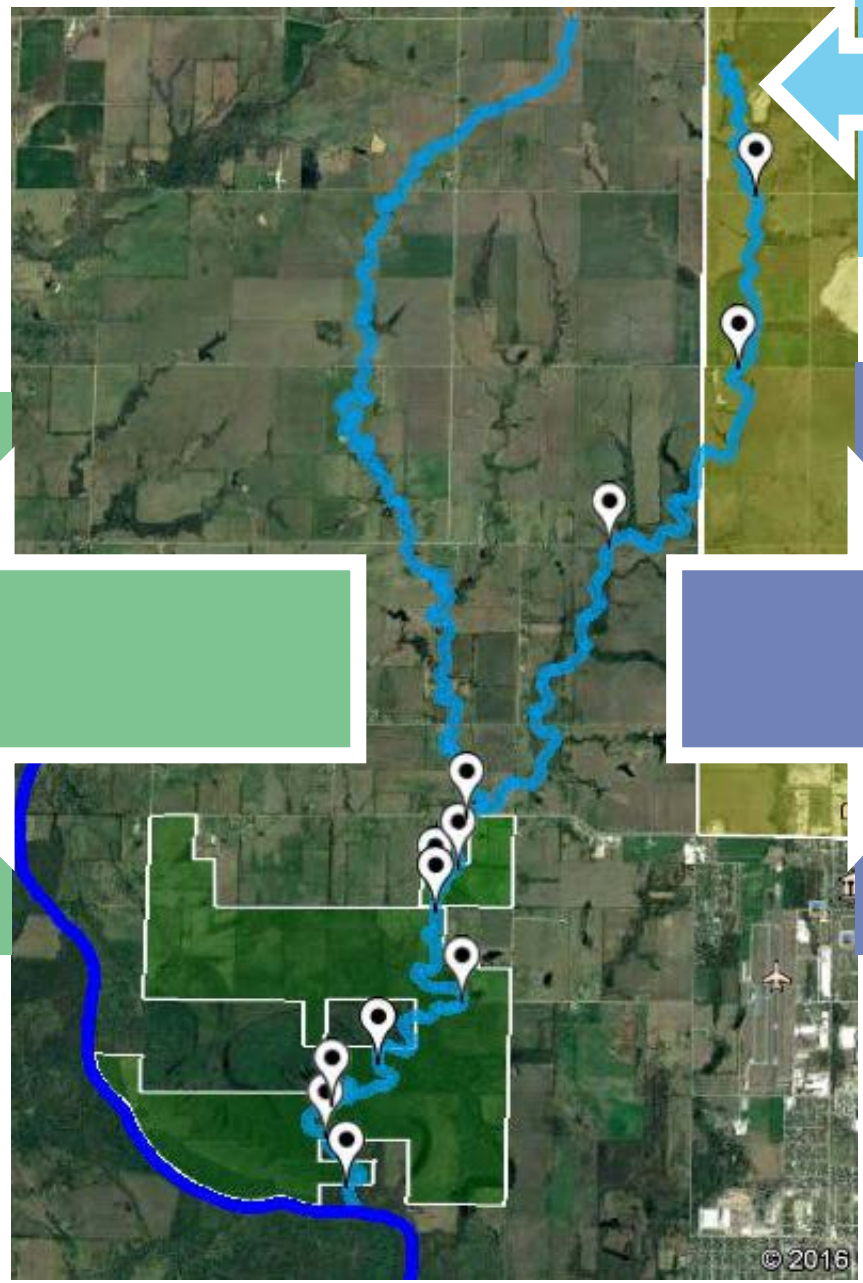




Results & Conclusions

Head Waters

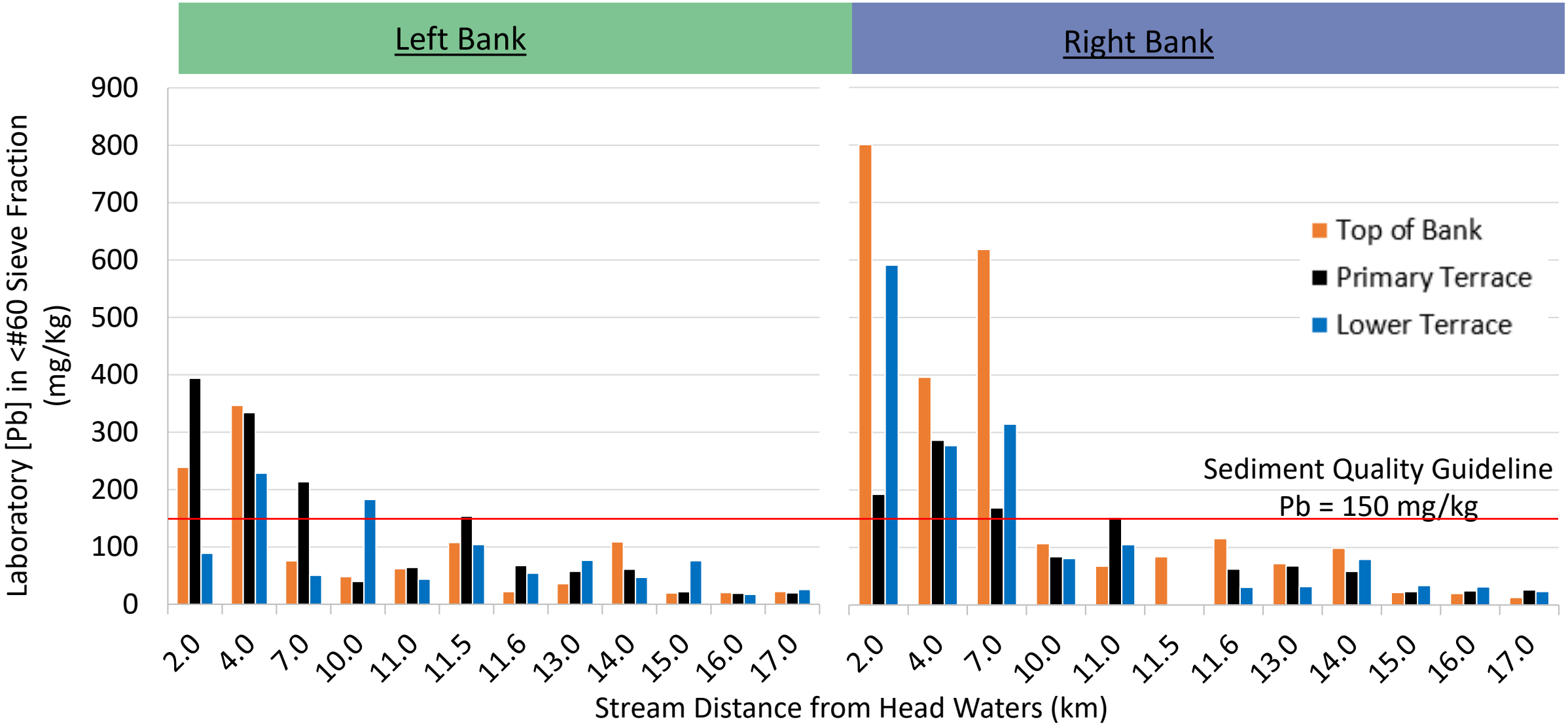
Left Bank



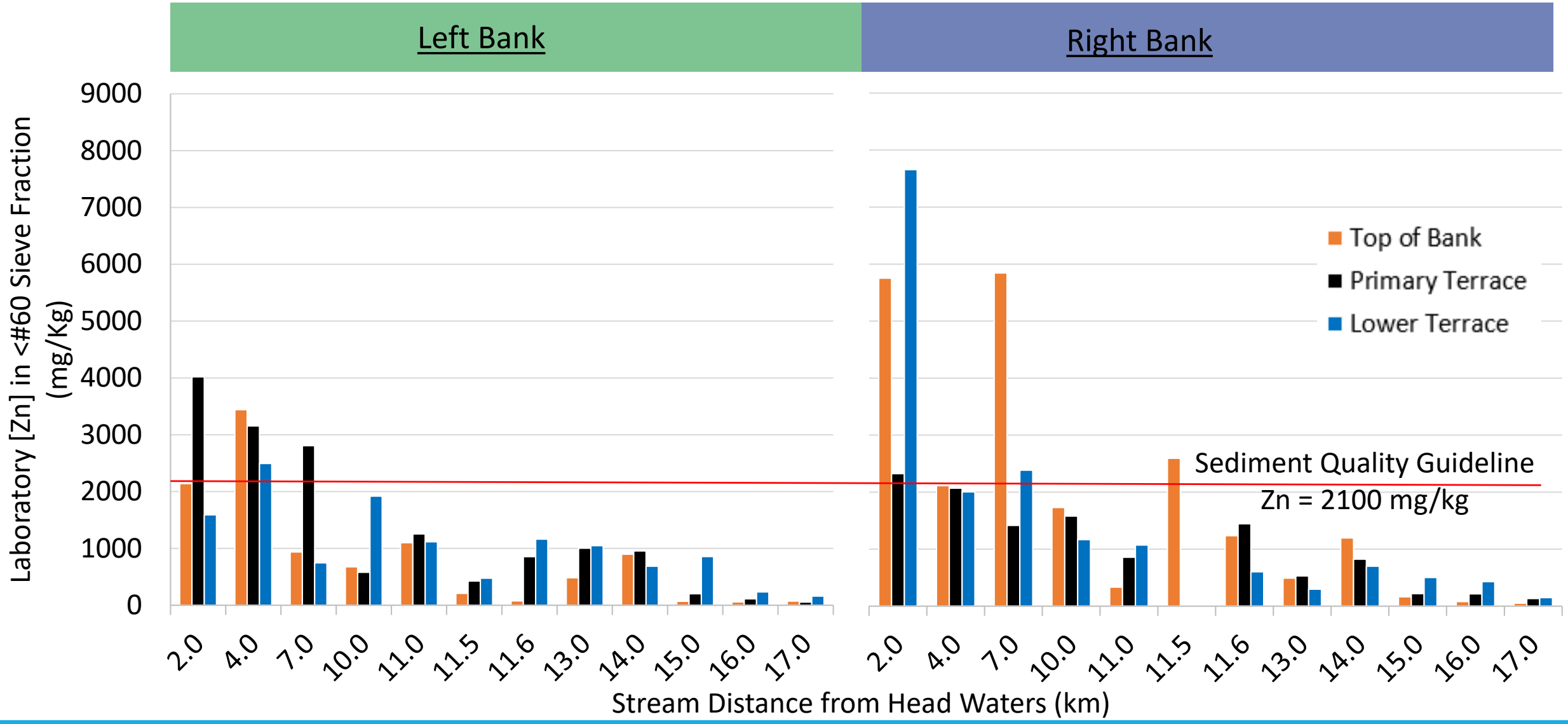
Right Bank

Elm Creek Riparian Zone Lead Concentrations

82
Pb
207.2
Lead

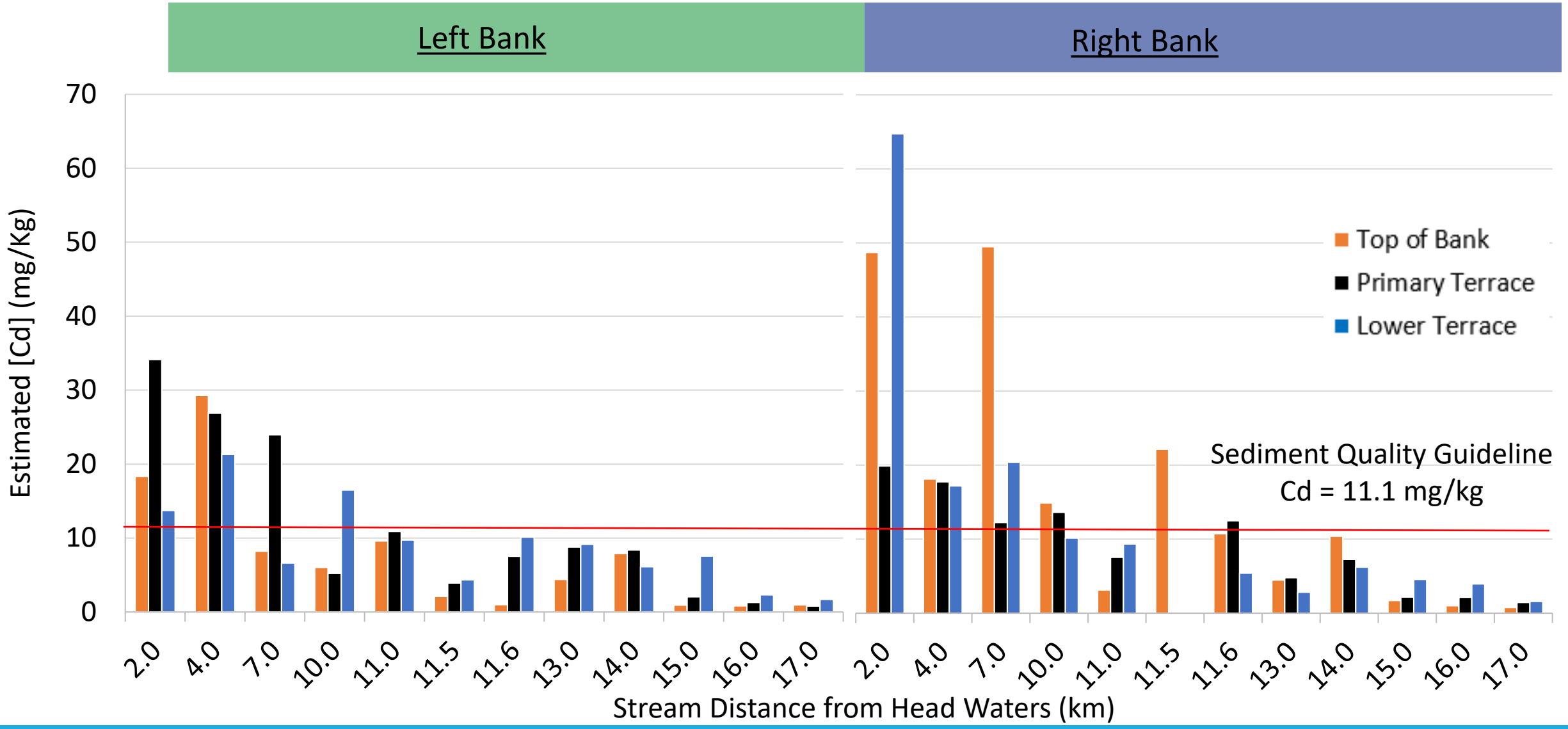


Elm Creek Riparian Zone Zinc Concentrations

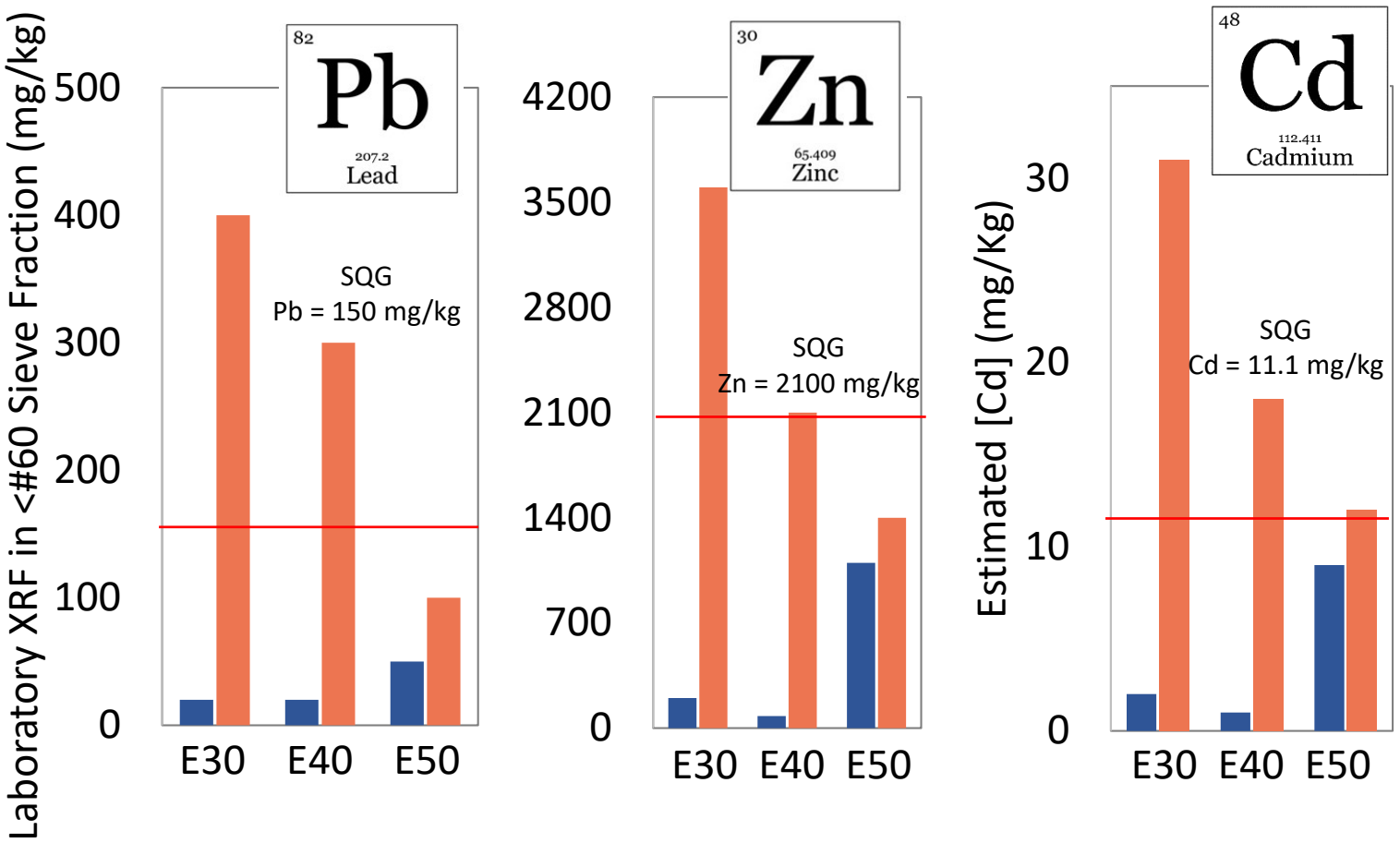


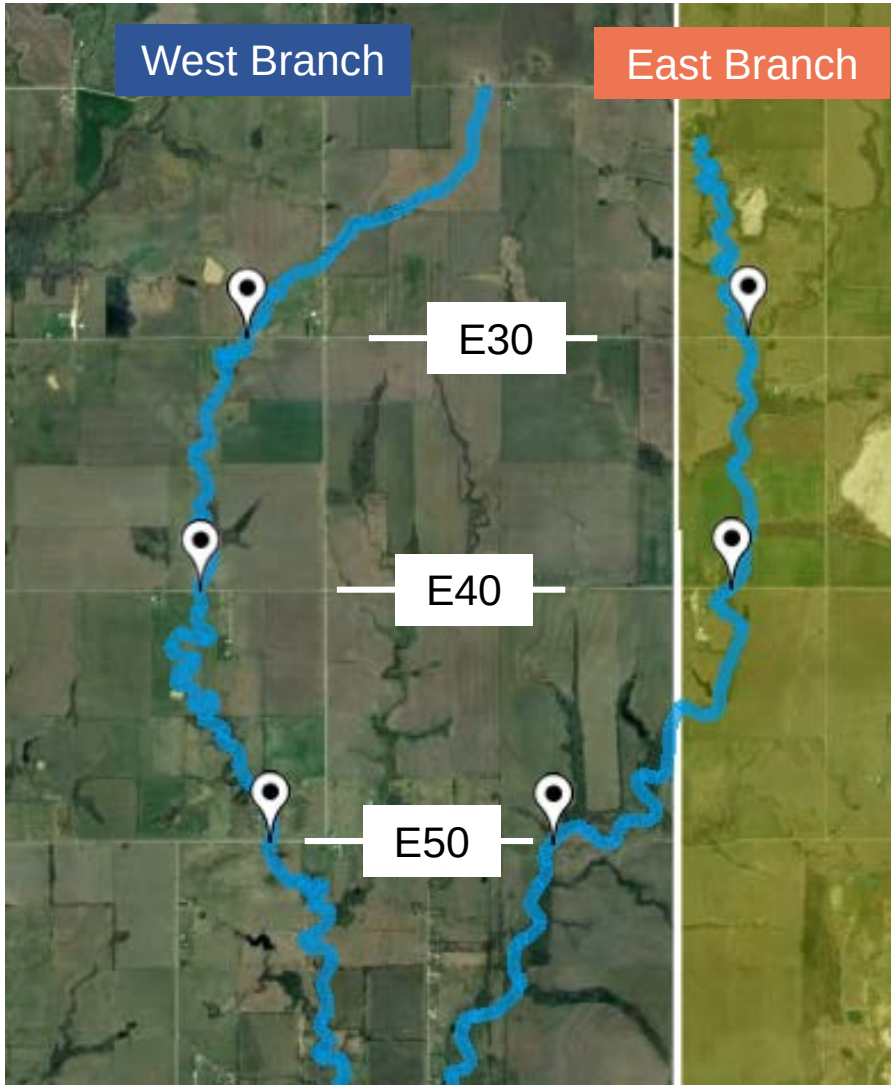
Elm Creek Riparian Zone Estimated Cadmium Concentrations

48 Cd 112.411 Cadmium

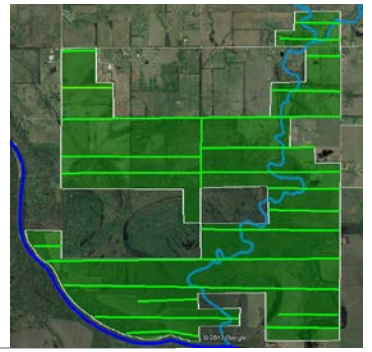


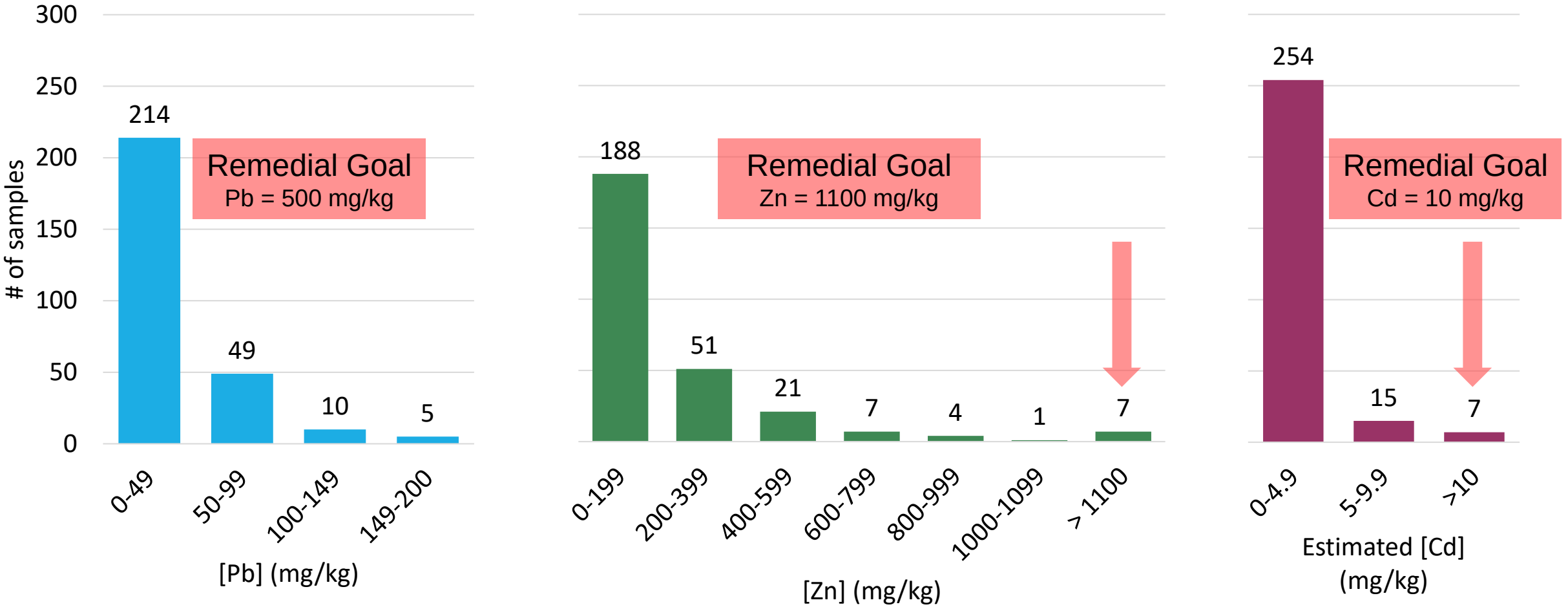
Elm Creek East and West Branches

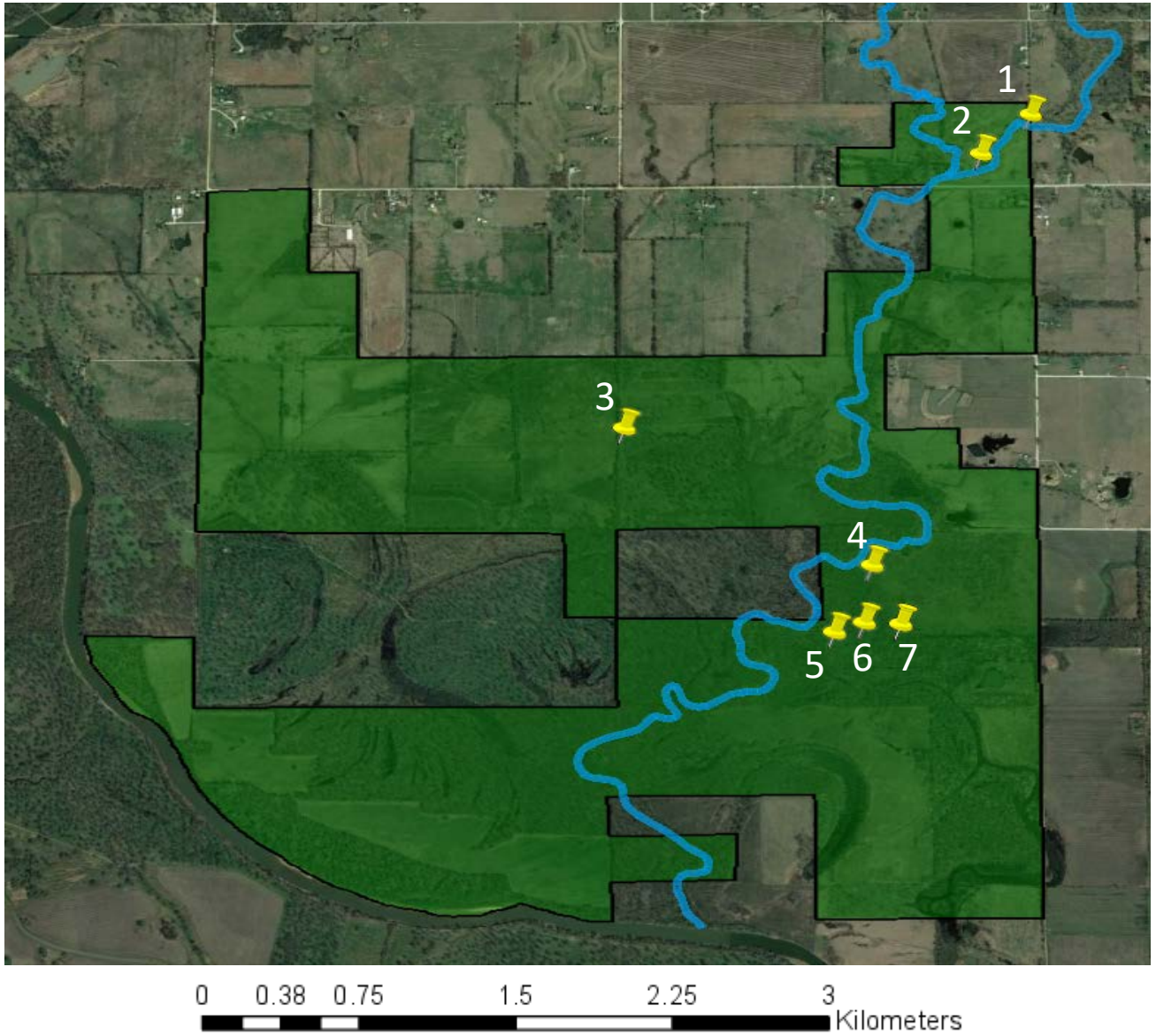




Upland Frequency Distribution

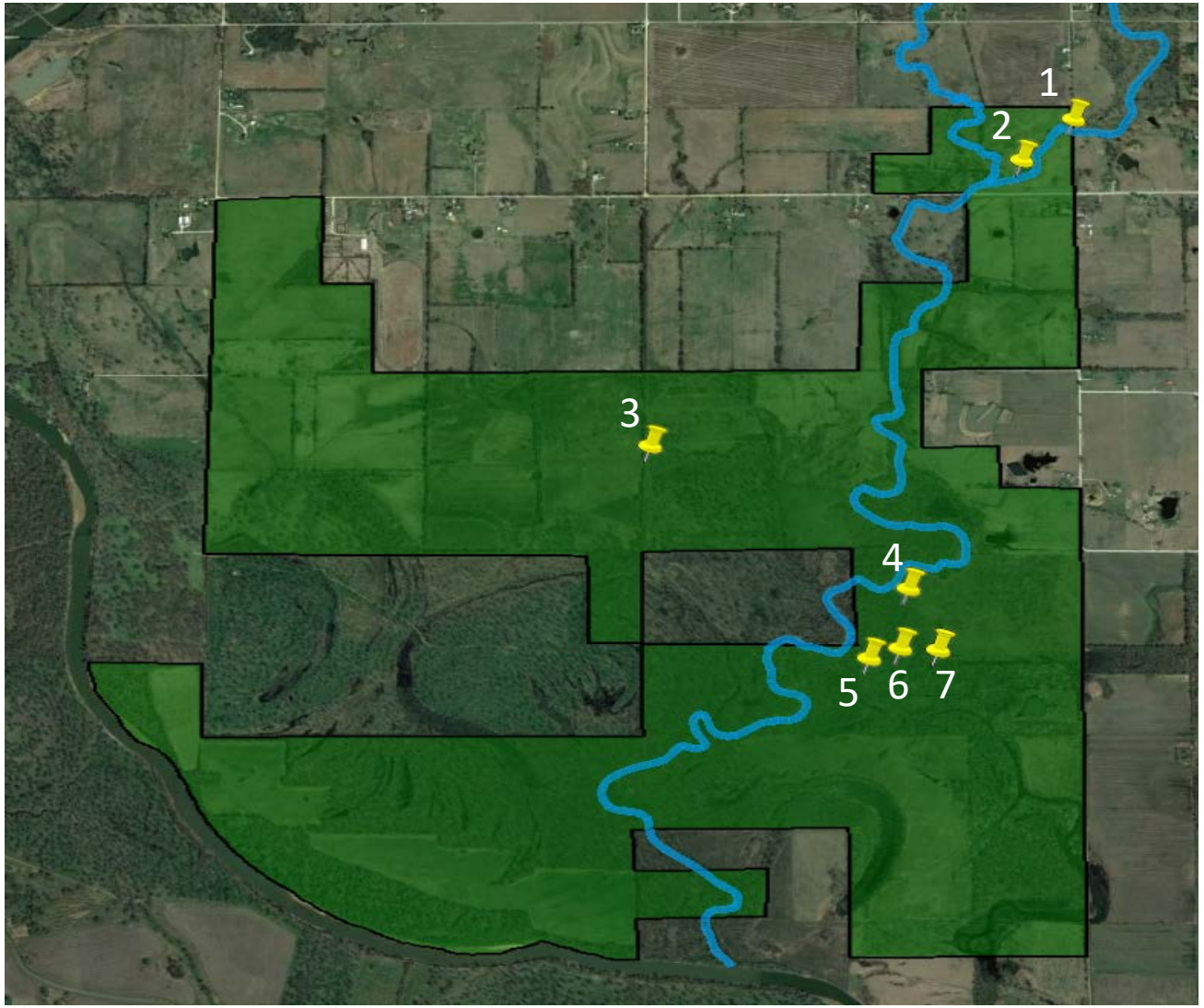






Legend

- GRDA Properties
- Soil Sampling Location Exceeding RG
- Elm Creek



Legend

- GRDA Properties
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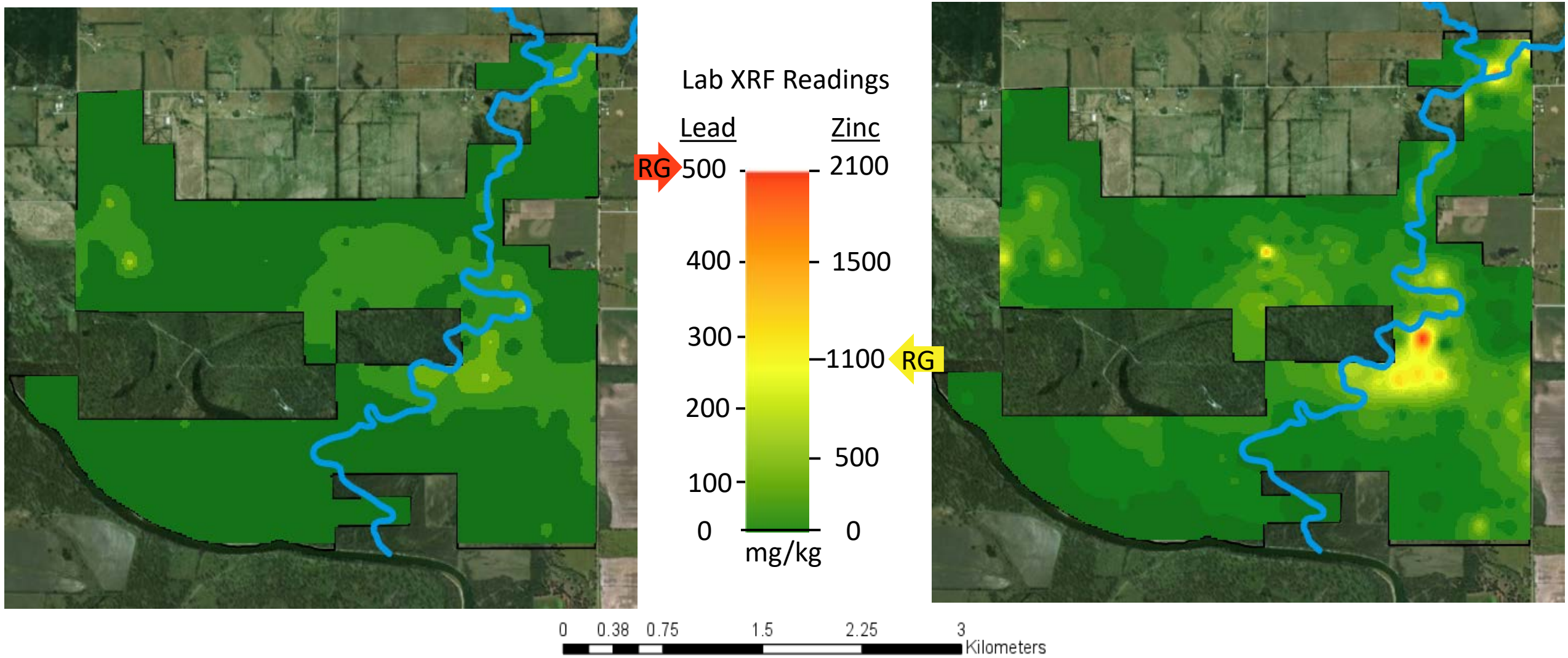
- Elm Creek

	Zn (mg/kg)		Cd (mg/kg)	
	RG	**1100**	**10.0**	
Location	XRFS	ICP	Estimated	ICP
1	1260	1070	10.9	9.80
2	1766	1440	15.2	16.5
3	1474	1380	12.7	12.8
4	2068	1630	17.7	17.2
5	1277	1200	11.1	10.0
6	1232	995	10.7	8.31
7	1285	1230	11.1	9.50

Concentration Distribution Interpolation

Lead

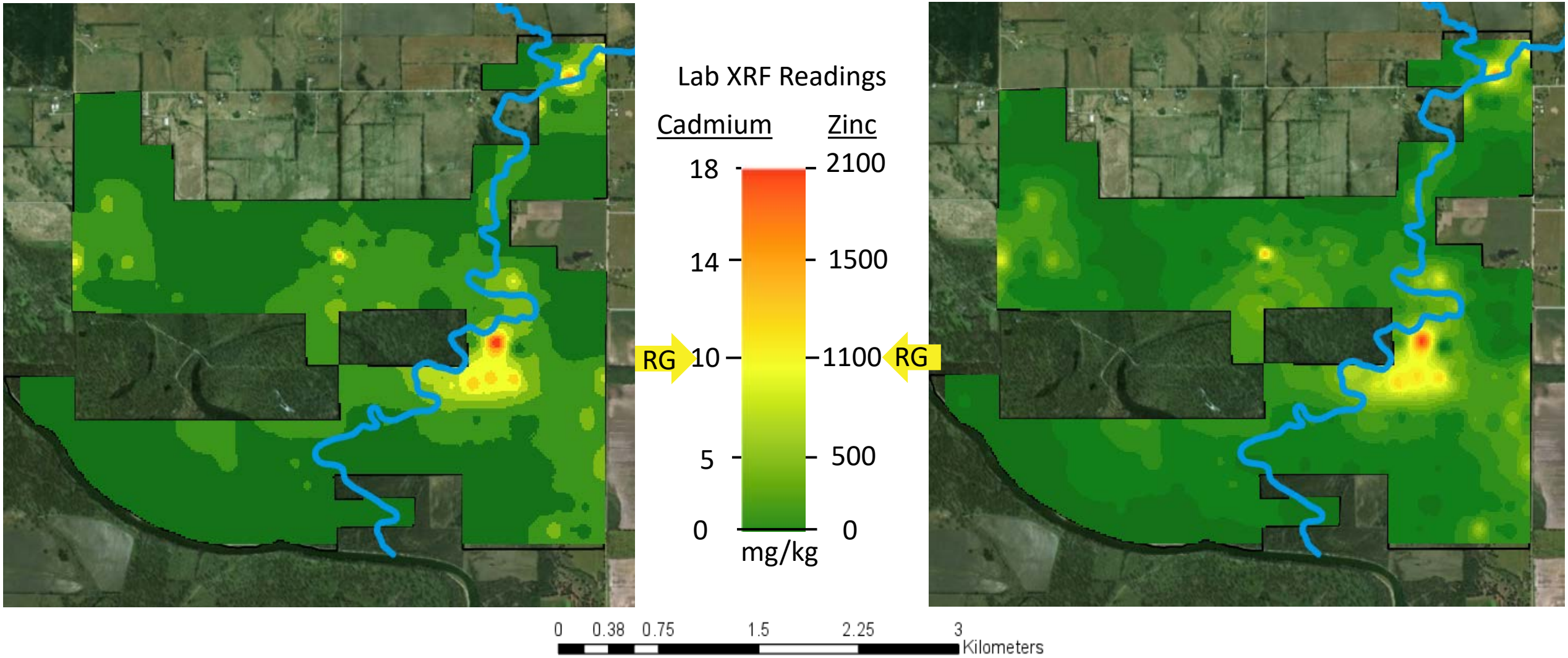
Zinc



Concentration Distribution Interpolation

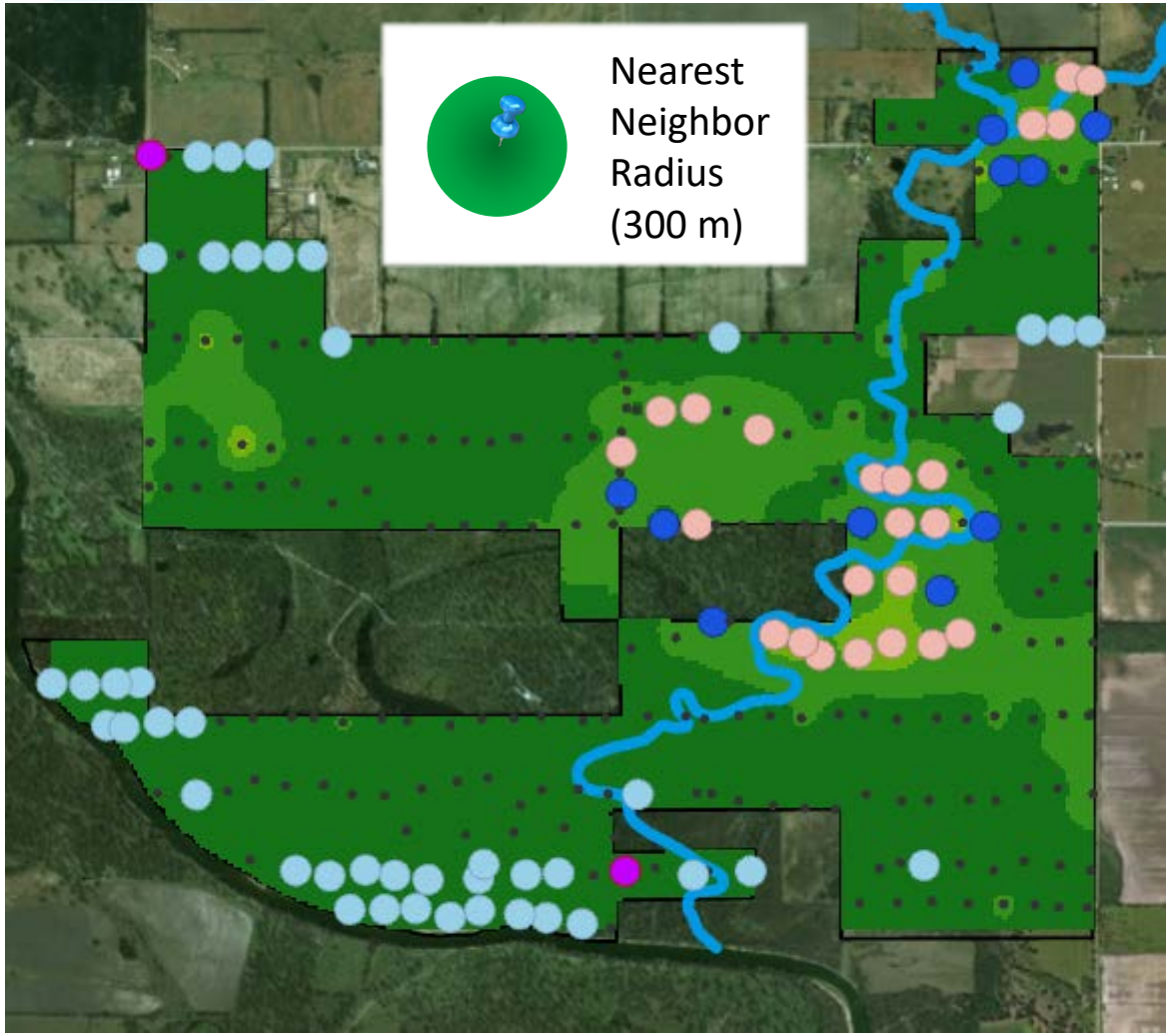
Cadmium

Zinc



Cluster and Outlier Analysis

Lead



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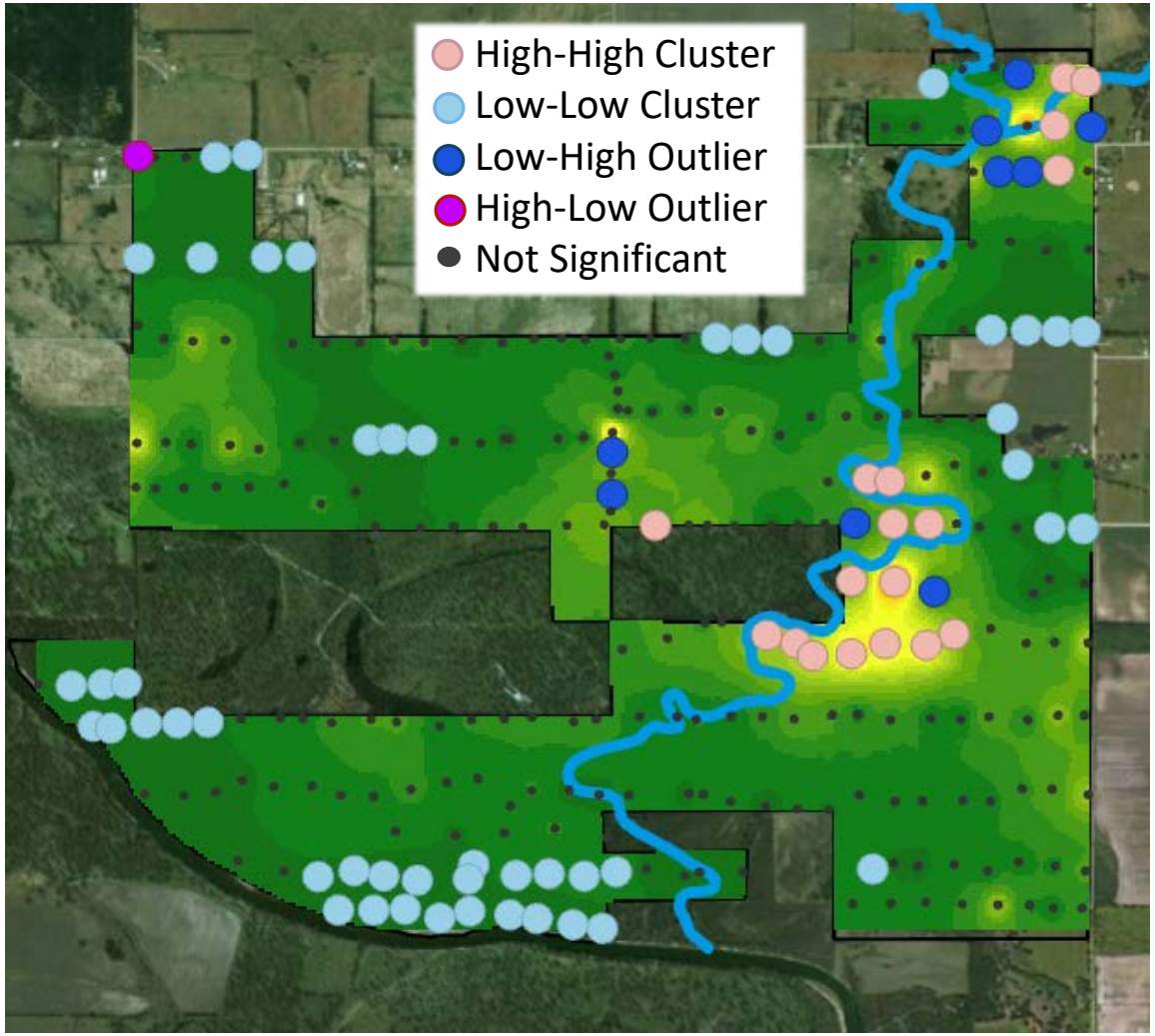

0 0.38 0.75 1.5 2.25 3
Kilometers

Cluster and Outlier Analysis

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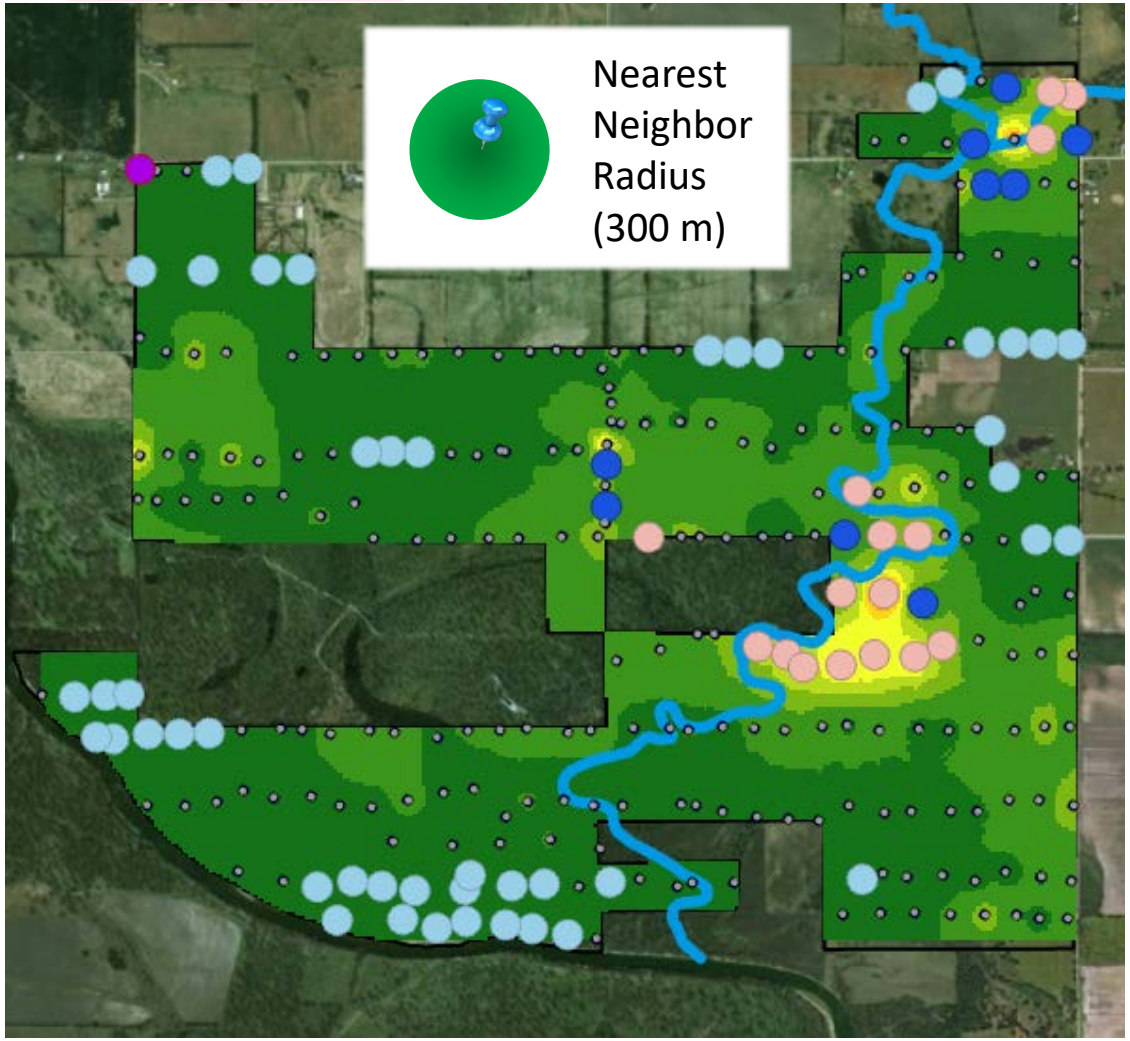

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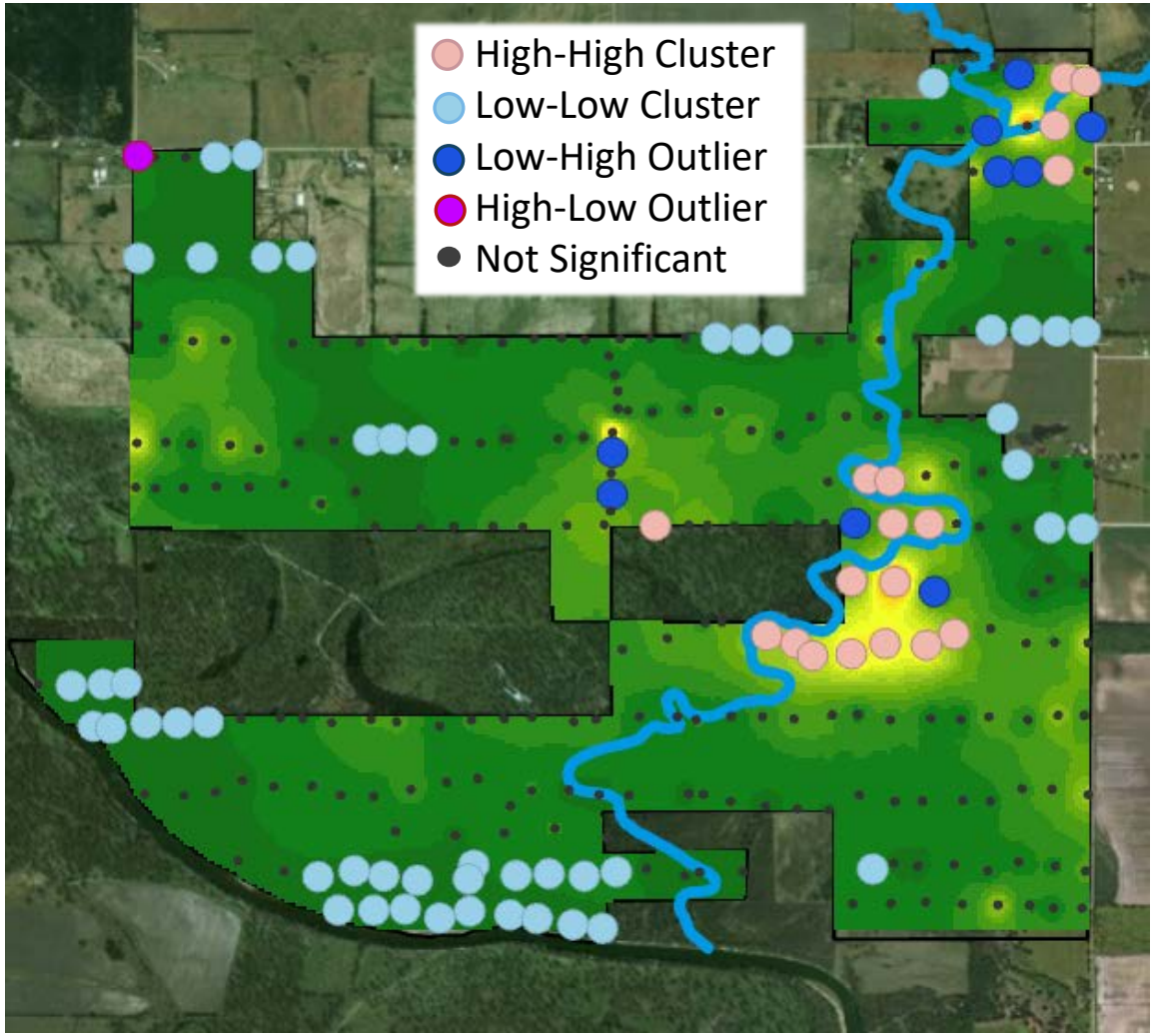

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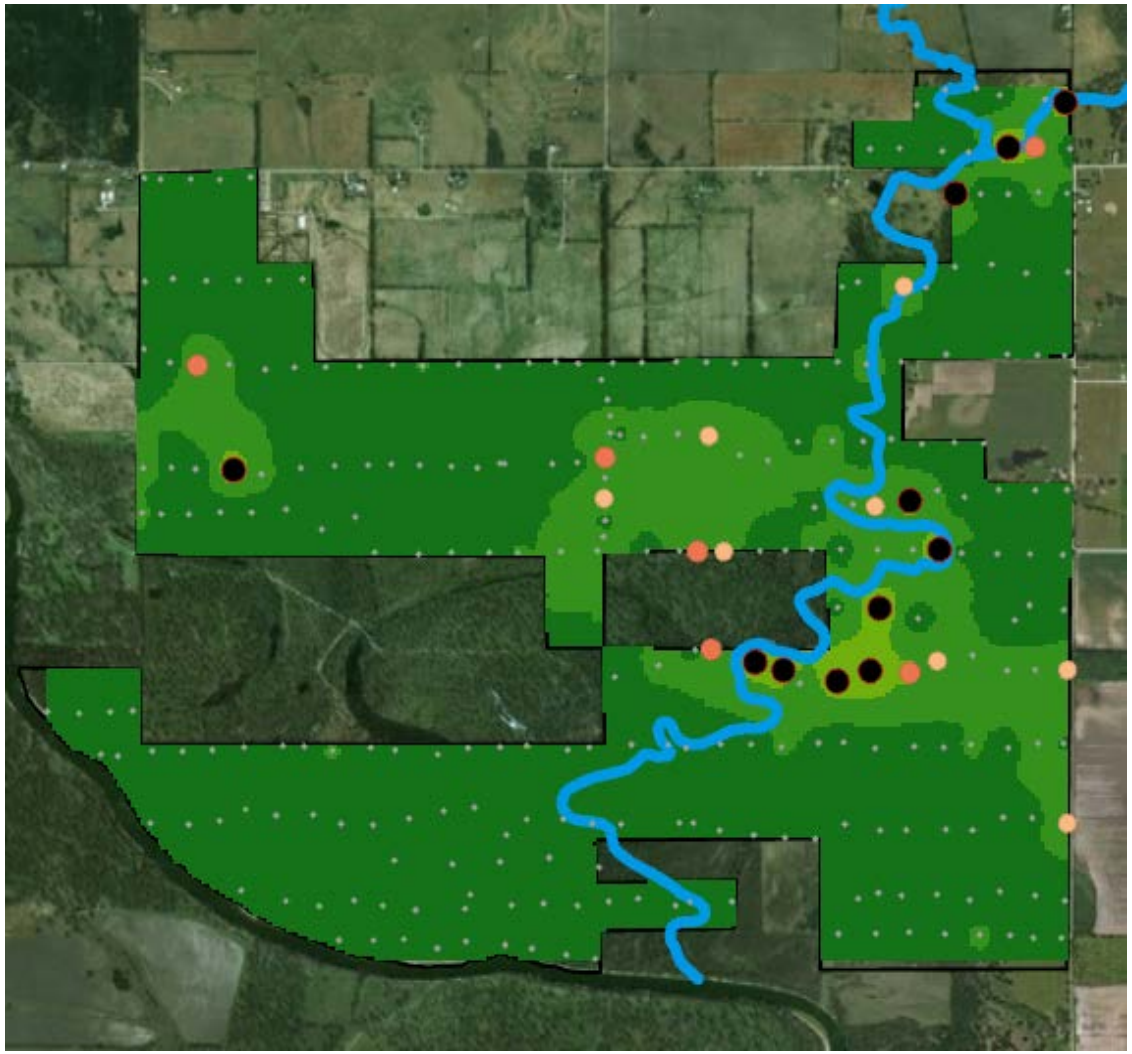
Hot Spot Analysis

Lead



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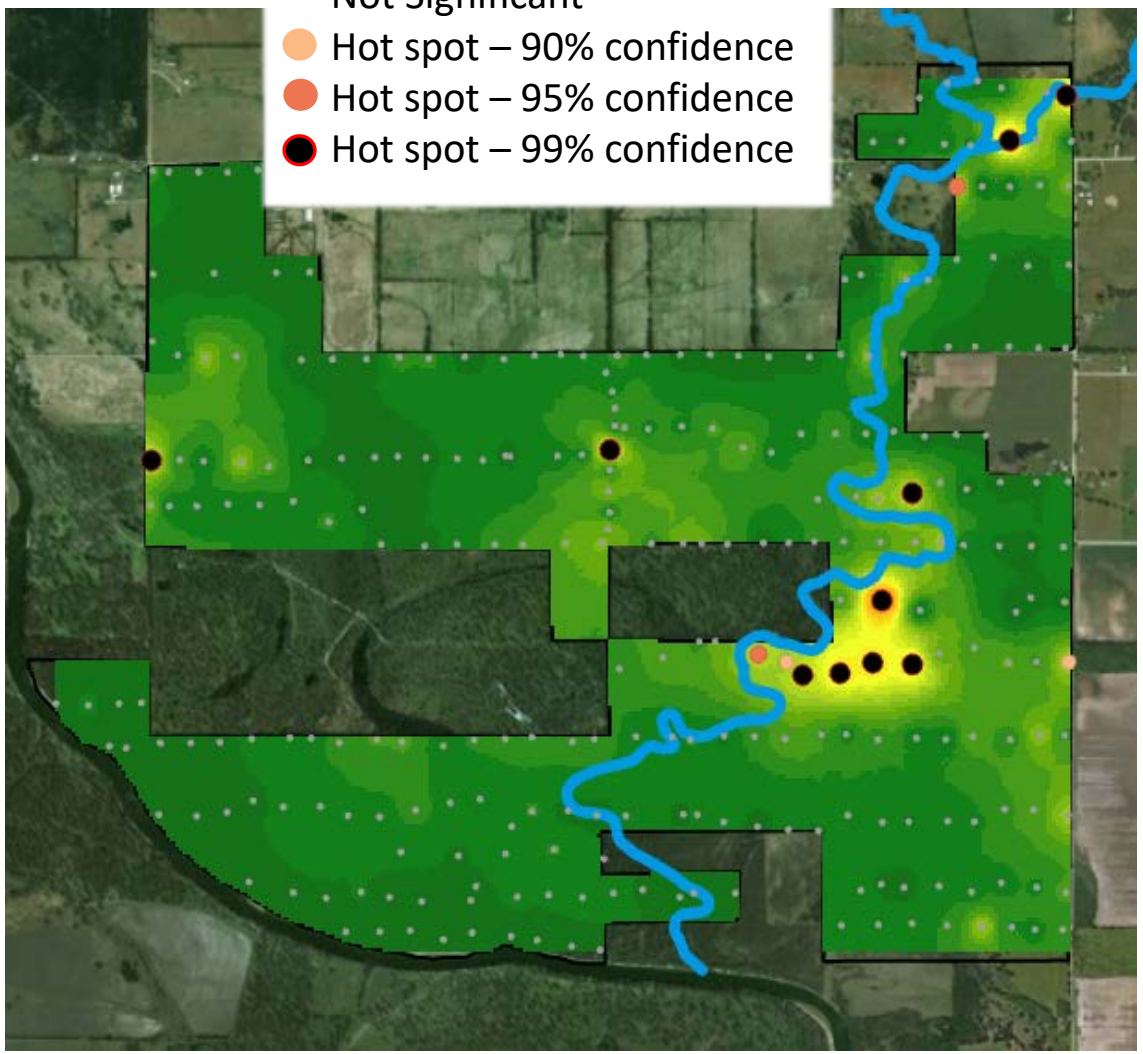

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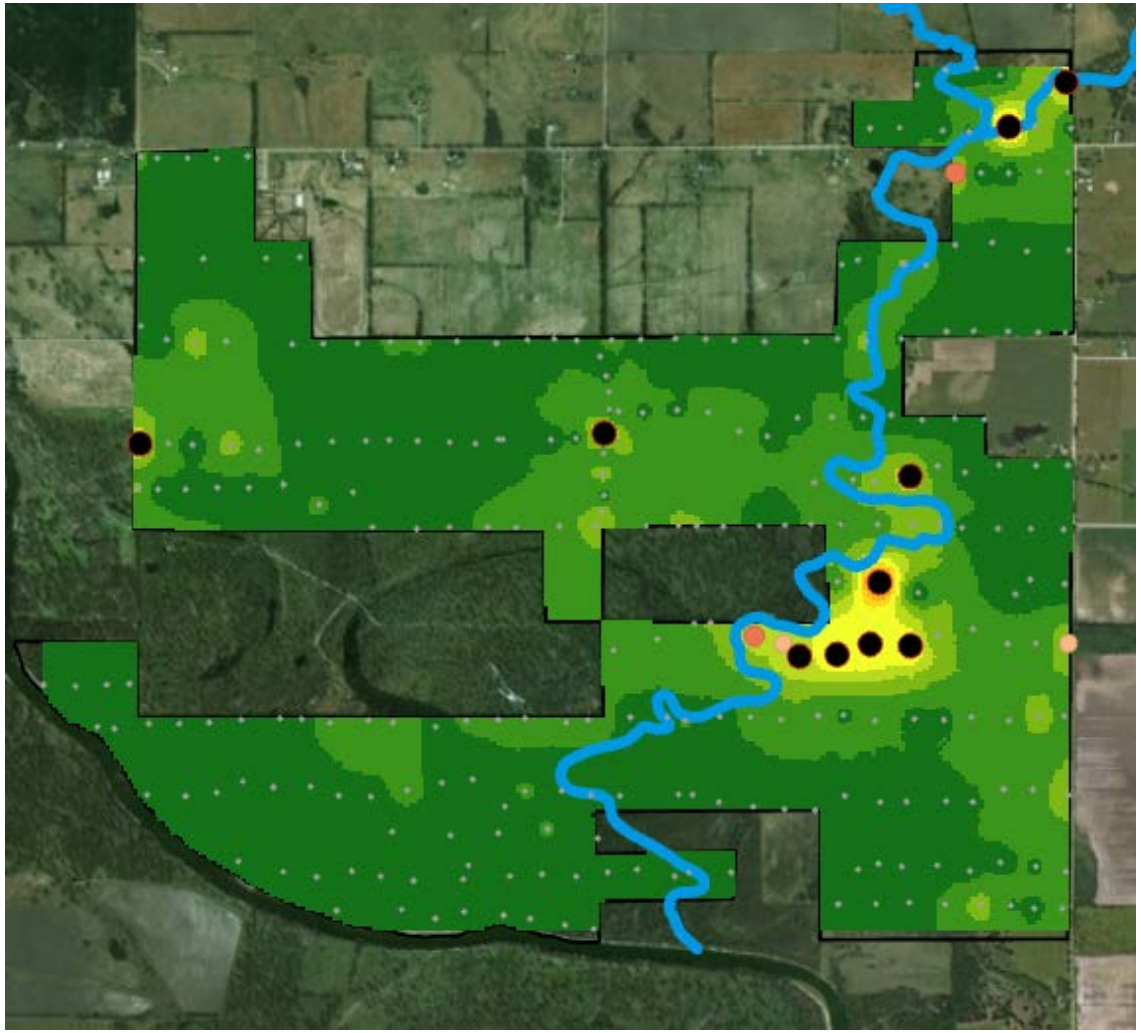

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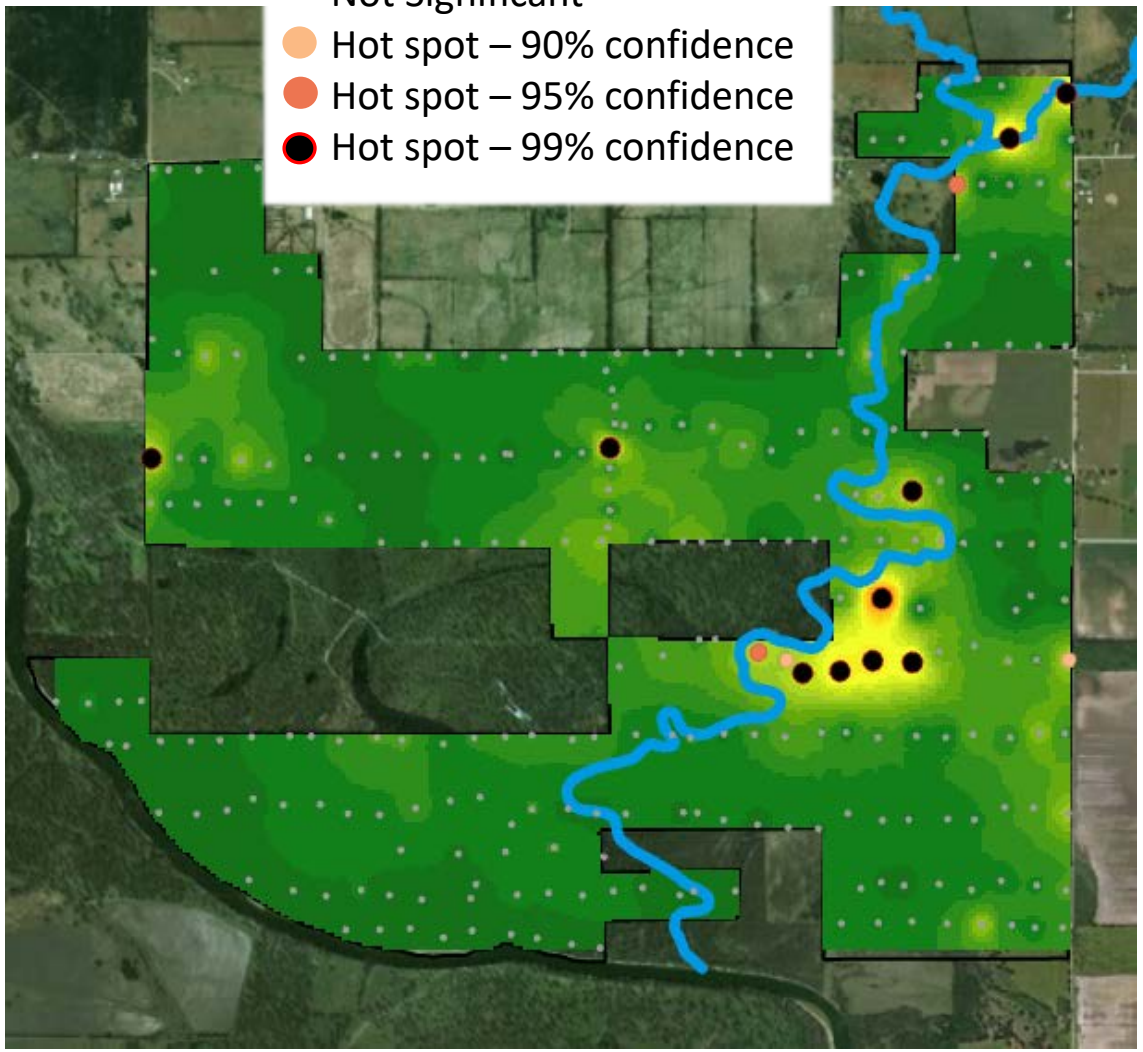

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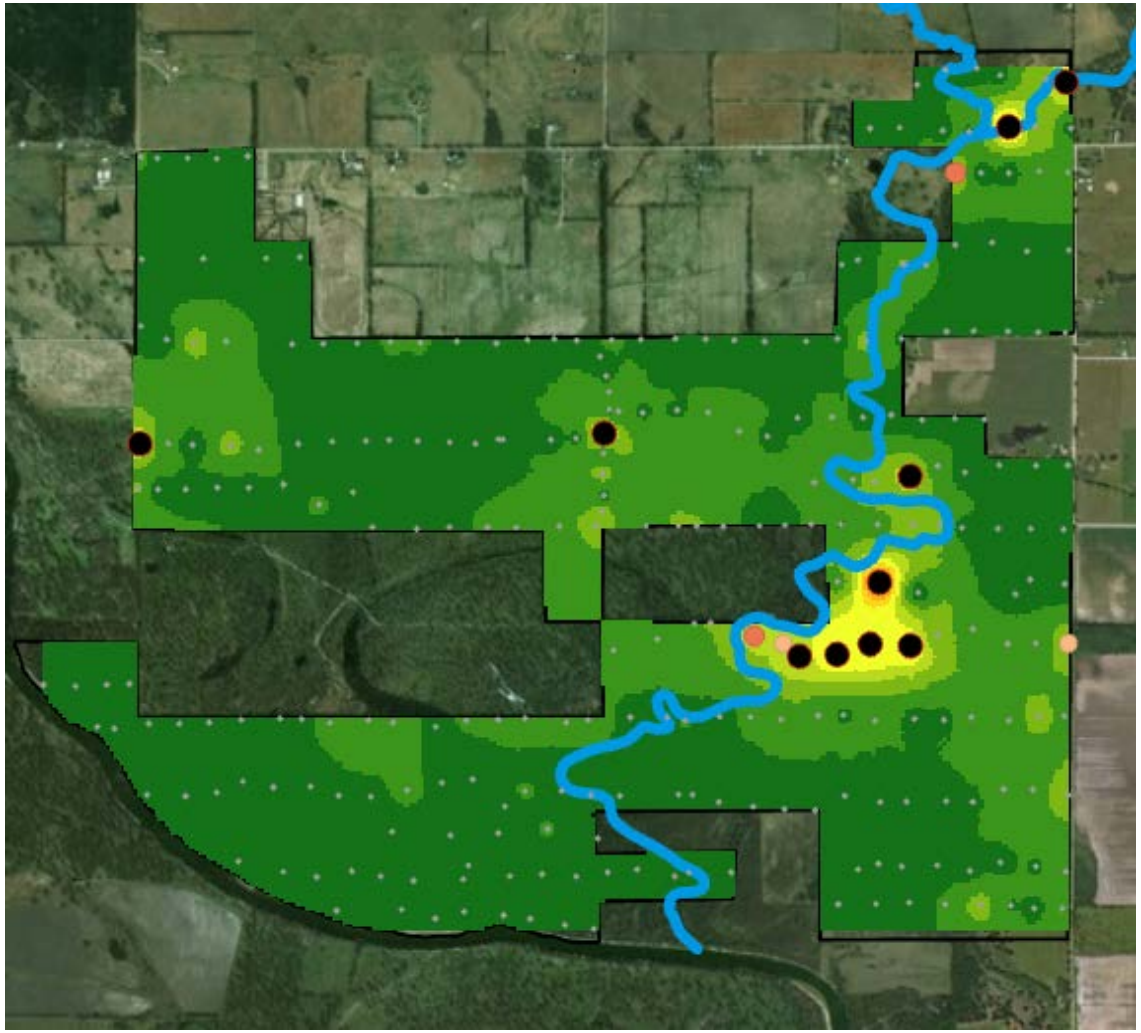

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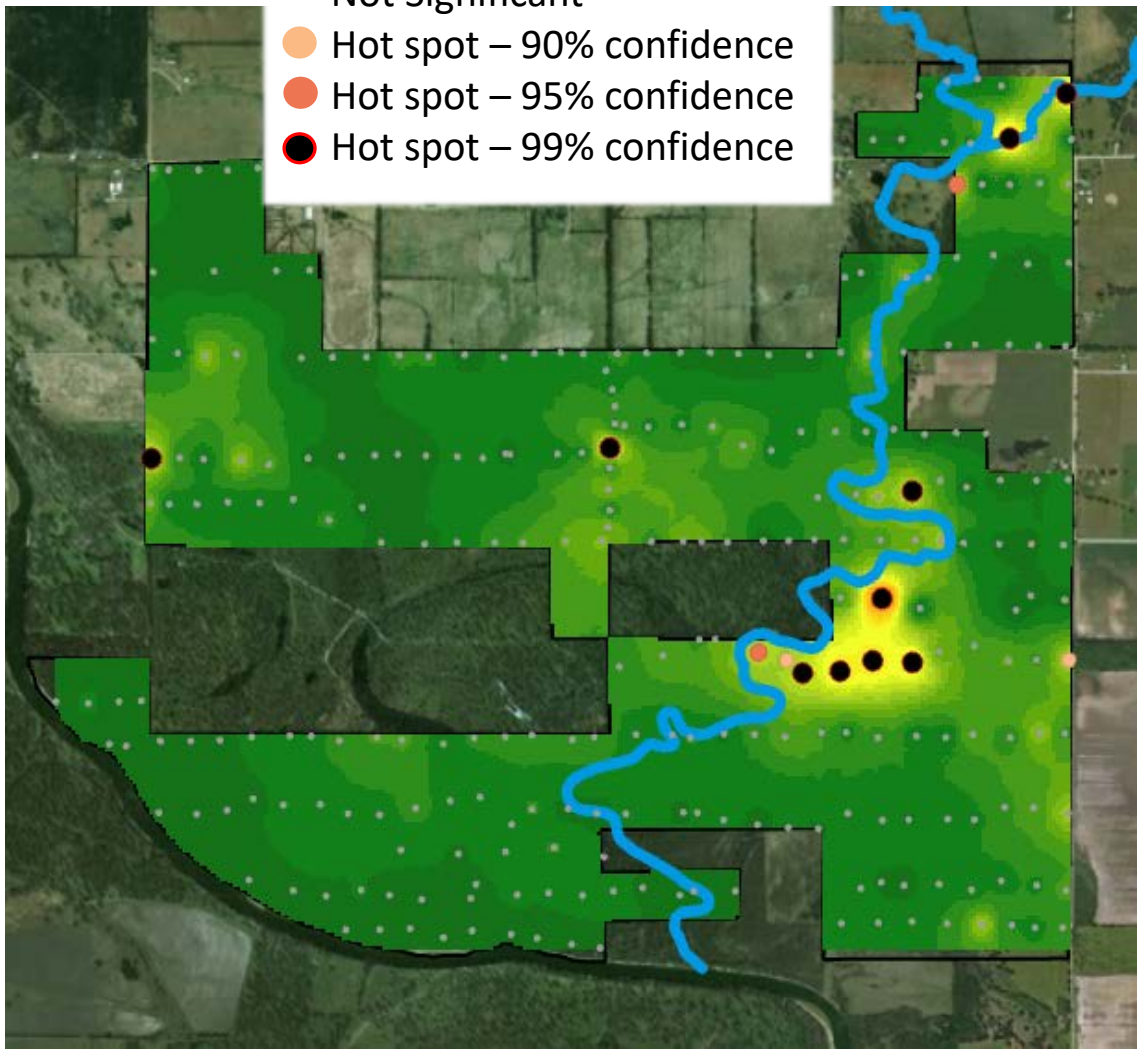

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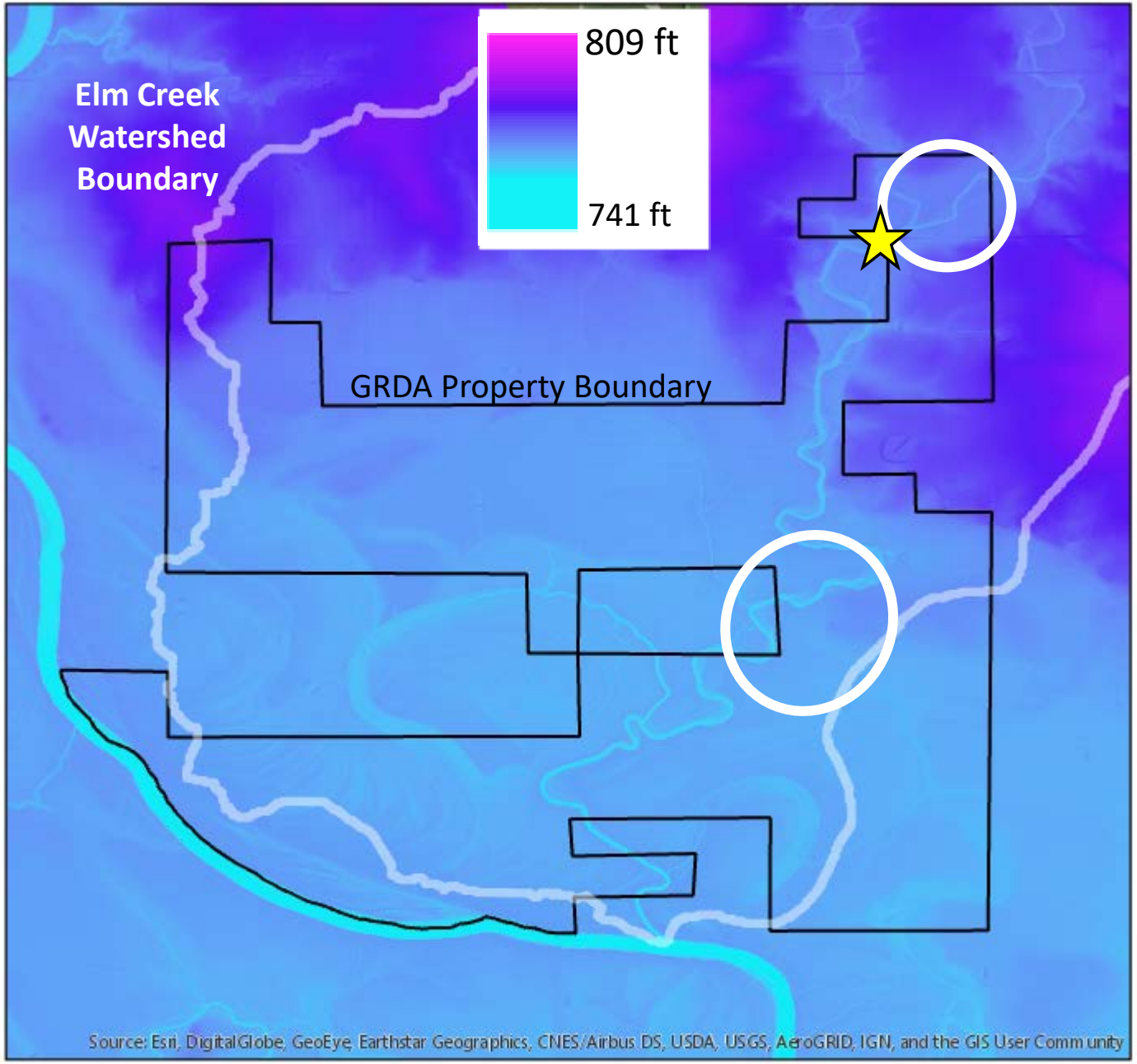
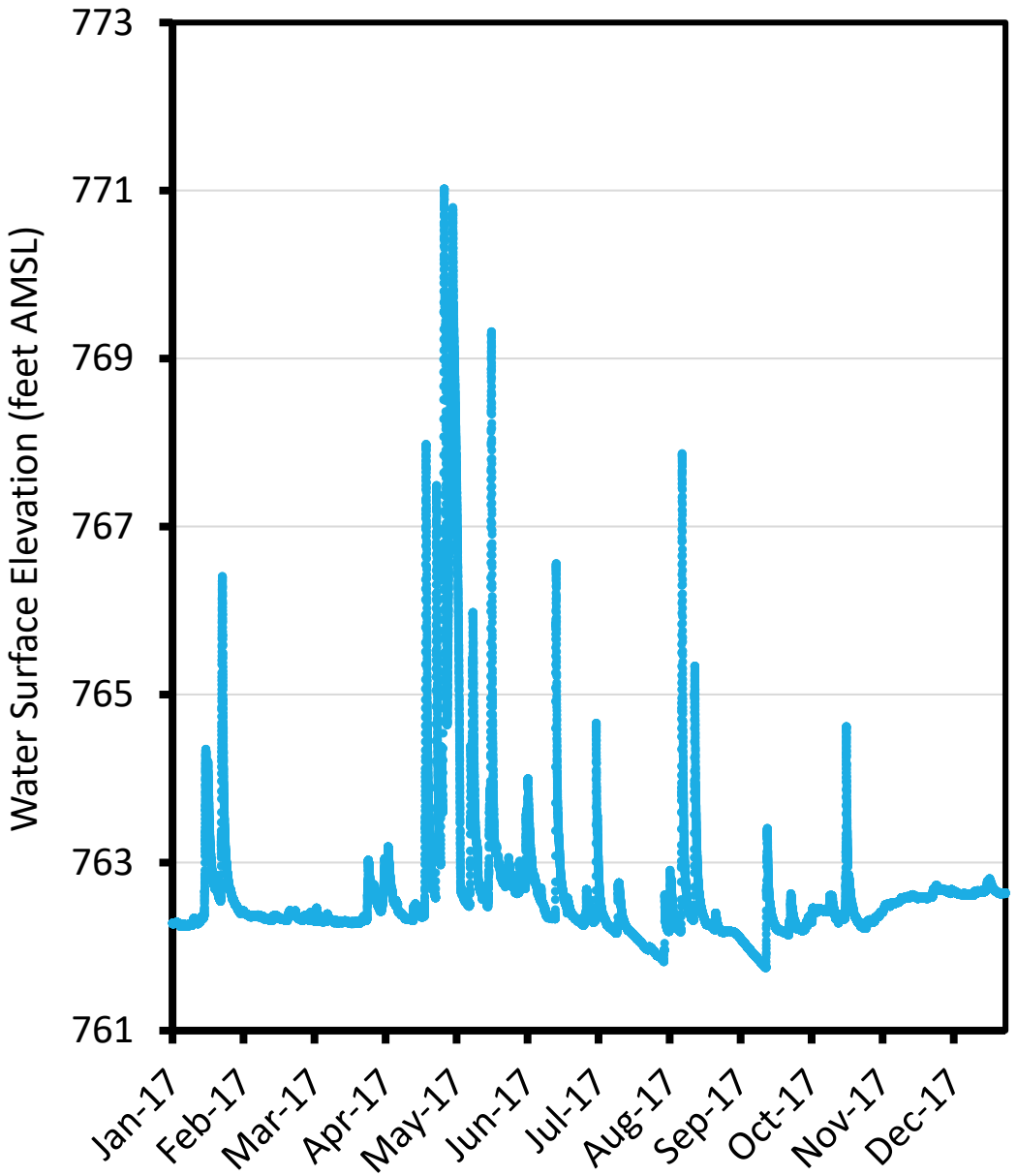
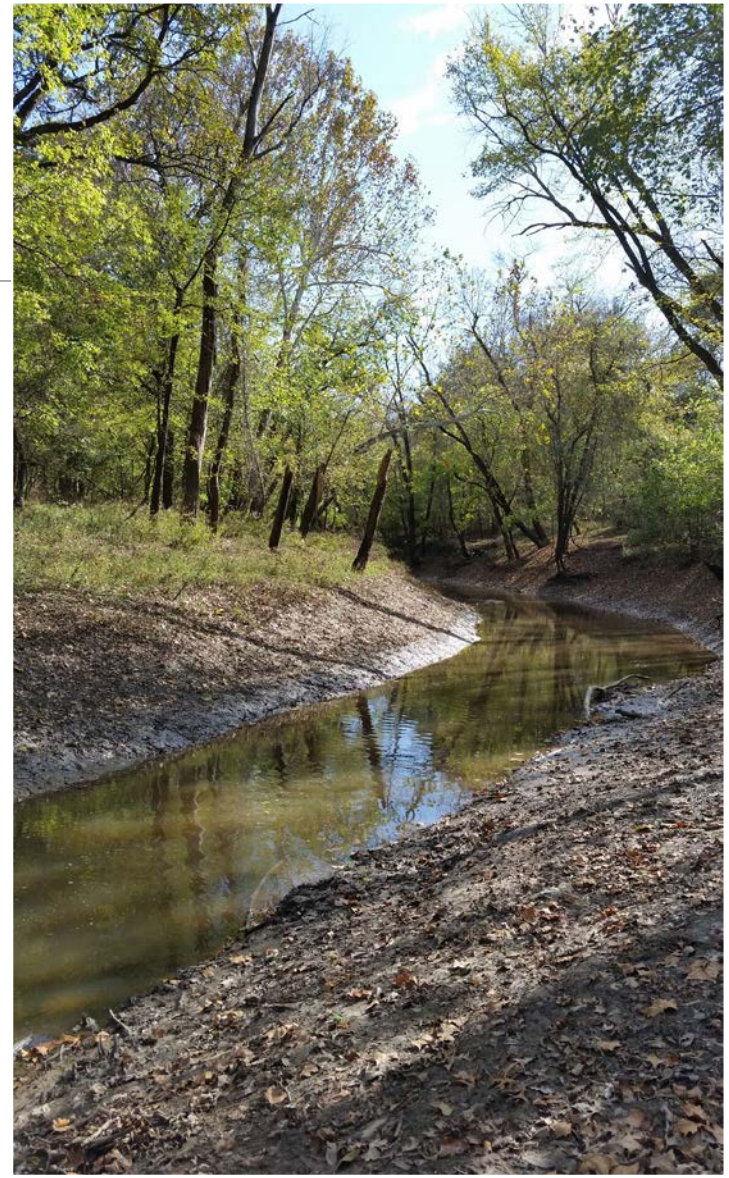

809 ft
741 ft
Elm Creek Watershed Boundary
GRDA Property Boundary
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
N
0 0.38 0.75 1.5 2.25 3
Kilometers


Water Surface Elevation (feet AMSL)
773
771
769
767
765
763
761
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
Oct-17
Nov-17
Dec-17

Conclusions

- Elm Creek riparian area
  - Decreasing trend in trace metals concentrations as distance downstream increases
  - Trace metals influence from Tar Creek Superfund Site
- Upland concentration distribution
  - Elevated trace metals influence from gravel roads
  - Elevated concentrations are likely due to upstream source materials being transported downstream
- Cleanup of source material!



Acknowledgements

- GRDA grant #1053733
- Aaron Roper, GRDA
- OU CREW
  - Thank you to everyone who helped with field sampling, laboratory analysis, and data reduction!
- Darren Shepherd

Questions?