

Sediment Management Research Group

The Tuttle Creek Lake Water Injection Dredging Demonstration Project

John Shelley, Ph.D., P.E.

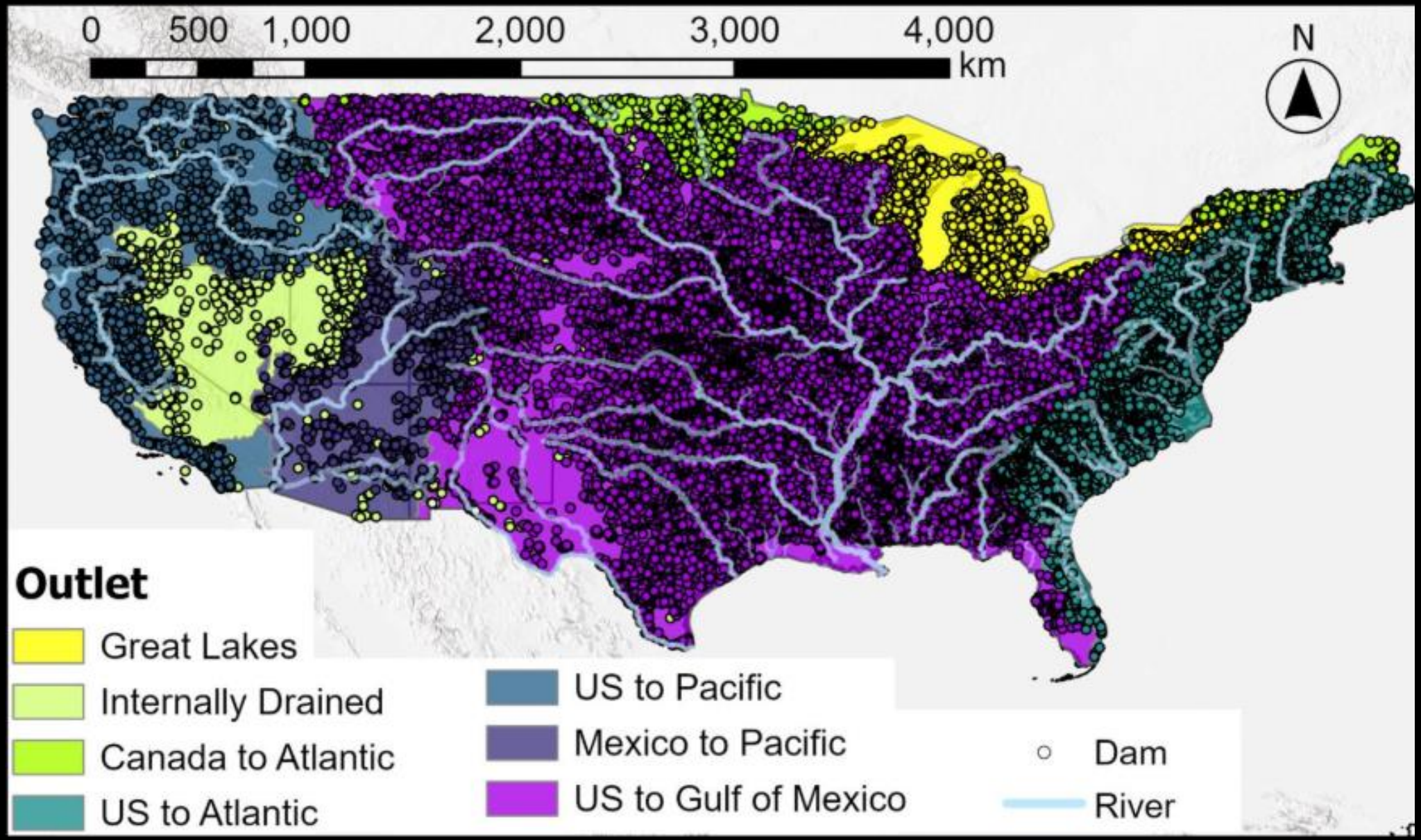
Sediment Management Research Group
Civil, Environmental, and Architectural Engineering | University of Kansas

Kansas Water Office





There are over 57,000 water storage reservoirs in the United States, 832 km^3 of water storage

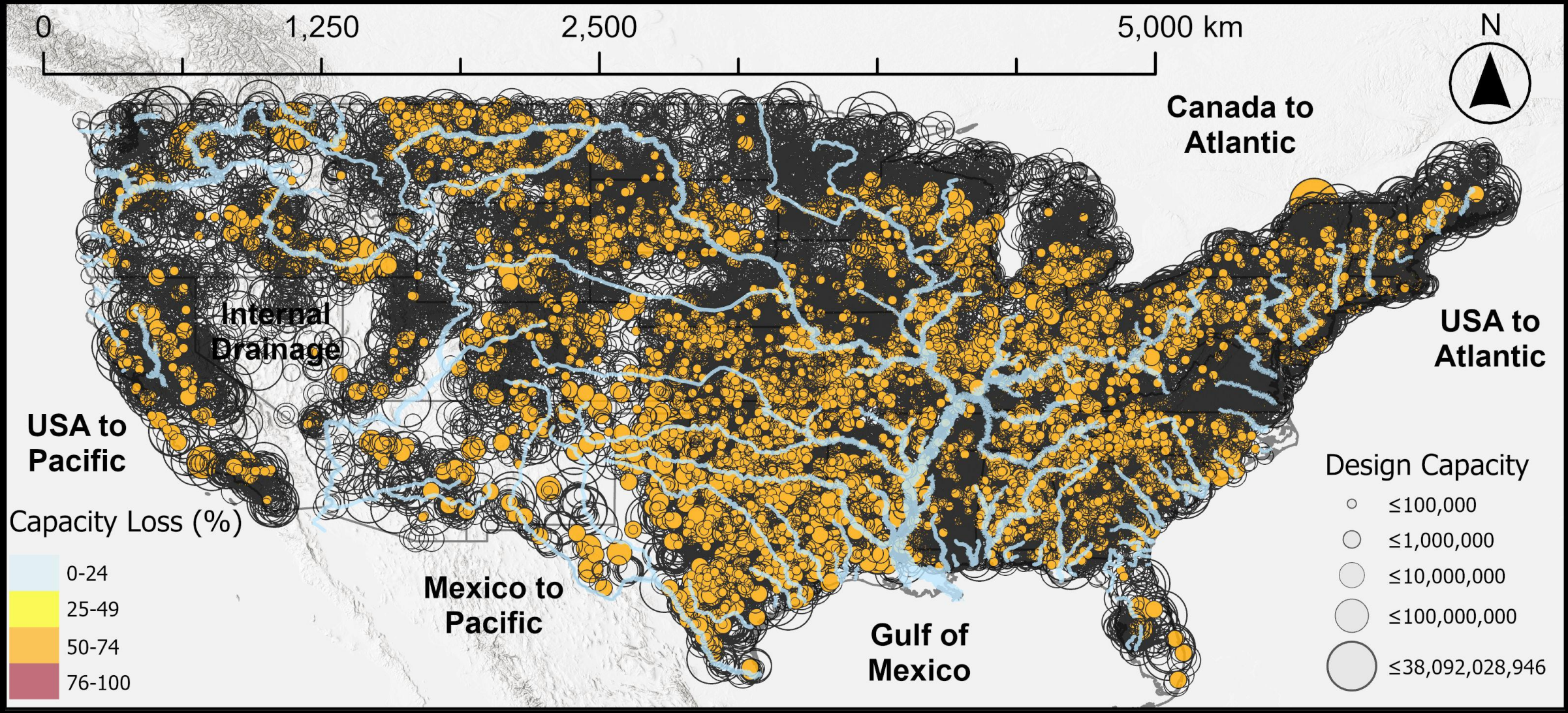


Slide Credit: Melissa Foster

Hurst et al., 2025 (*Scientific Data*)

25%+ capacity loss: 23,775 reservoirs in 2025 and 33,743 reservoirs in 2050

50%+ capacity loss: 5,393 reservoirs in 2025 and 12,007 reservoirs in 2050

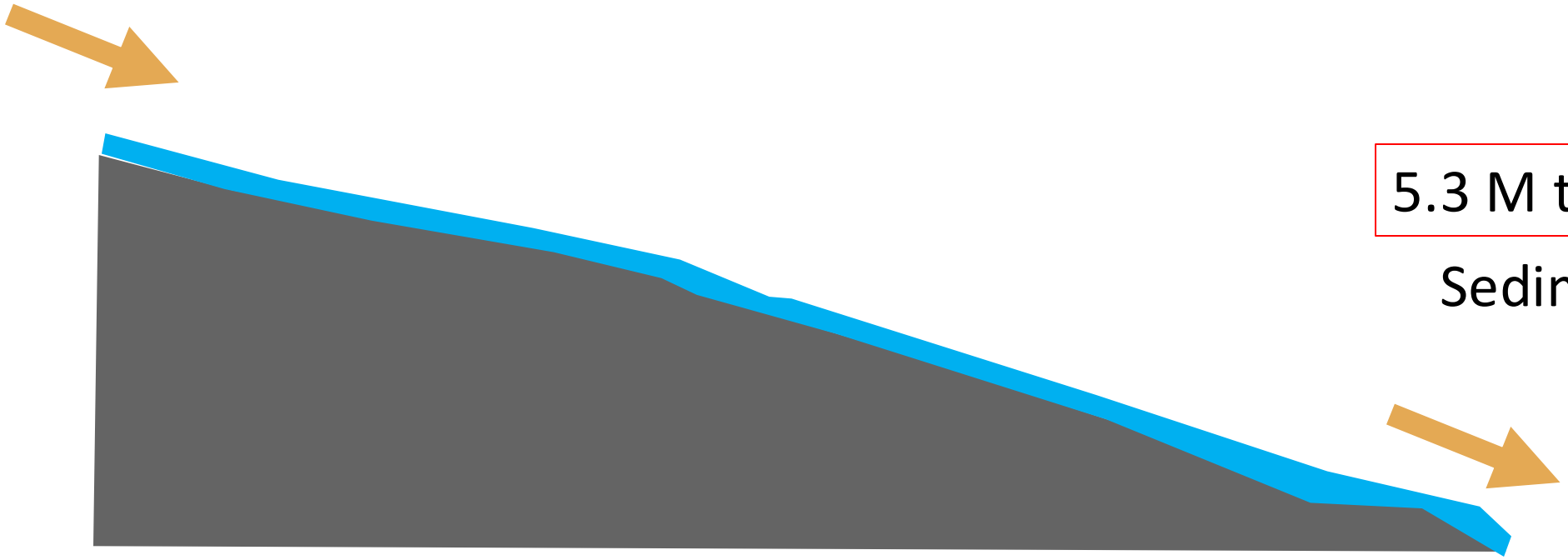


Slide Credit: Melissa Foster

Big Blue River

5.3 M tons/year

Sediment In



5.3 M tons/year

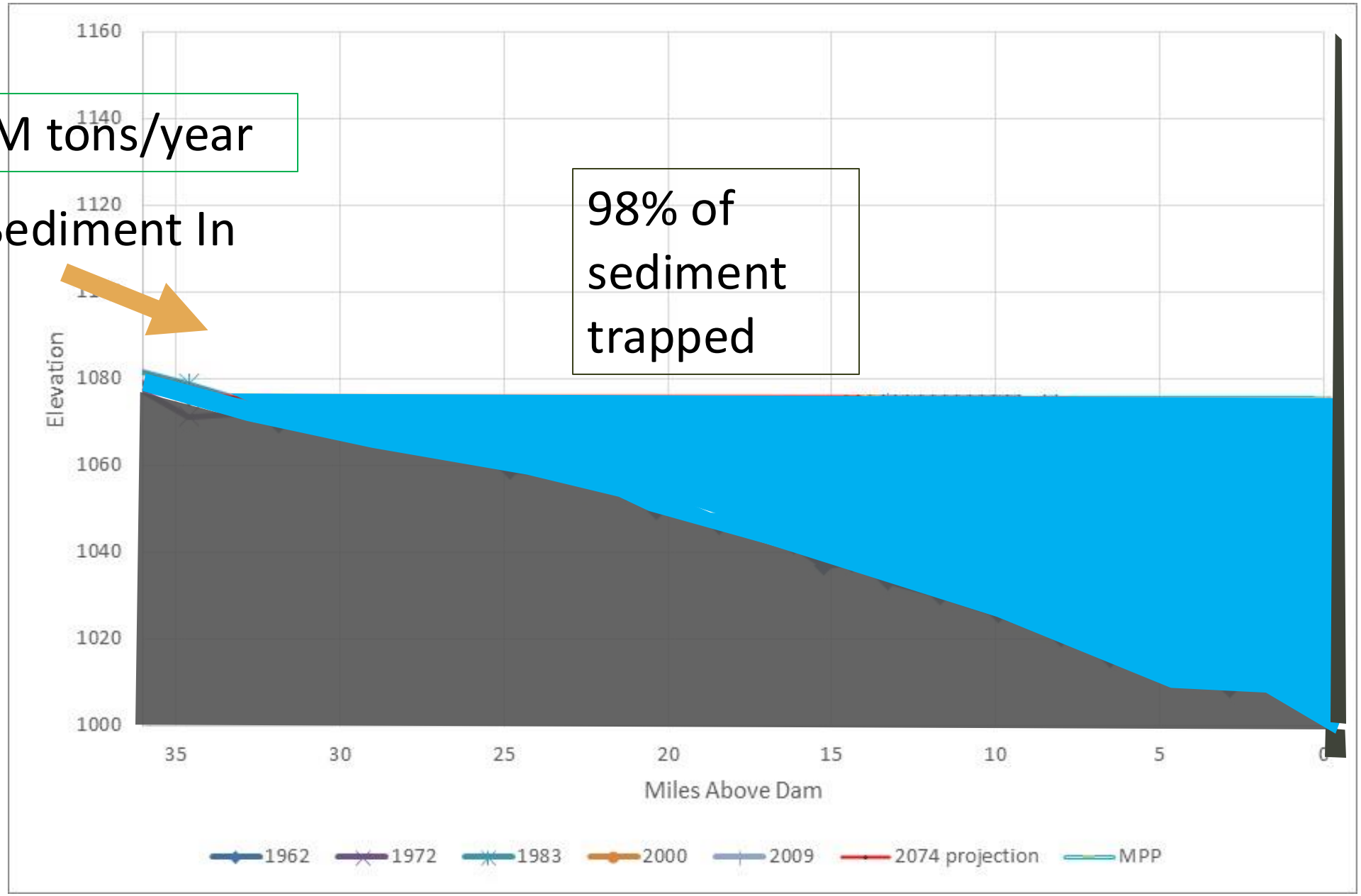
Sediment Out

Tuttle Creek Lake

5.3 M tons/year

Sediment In

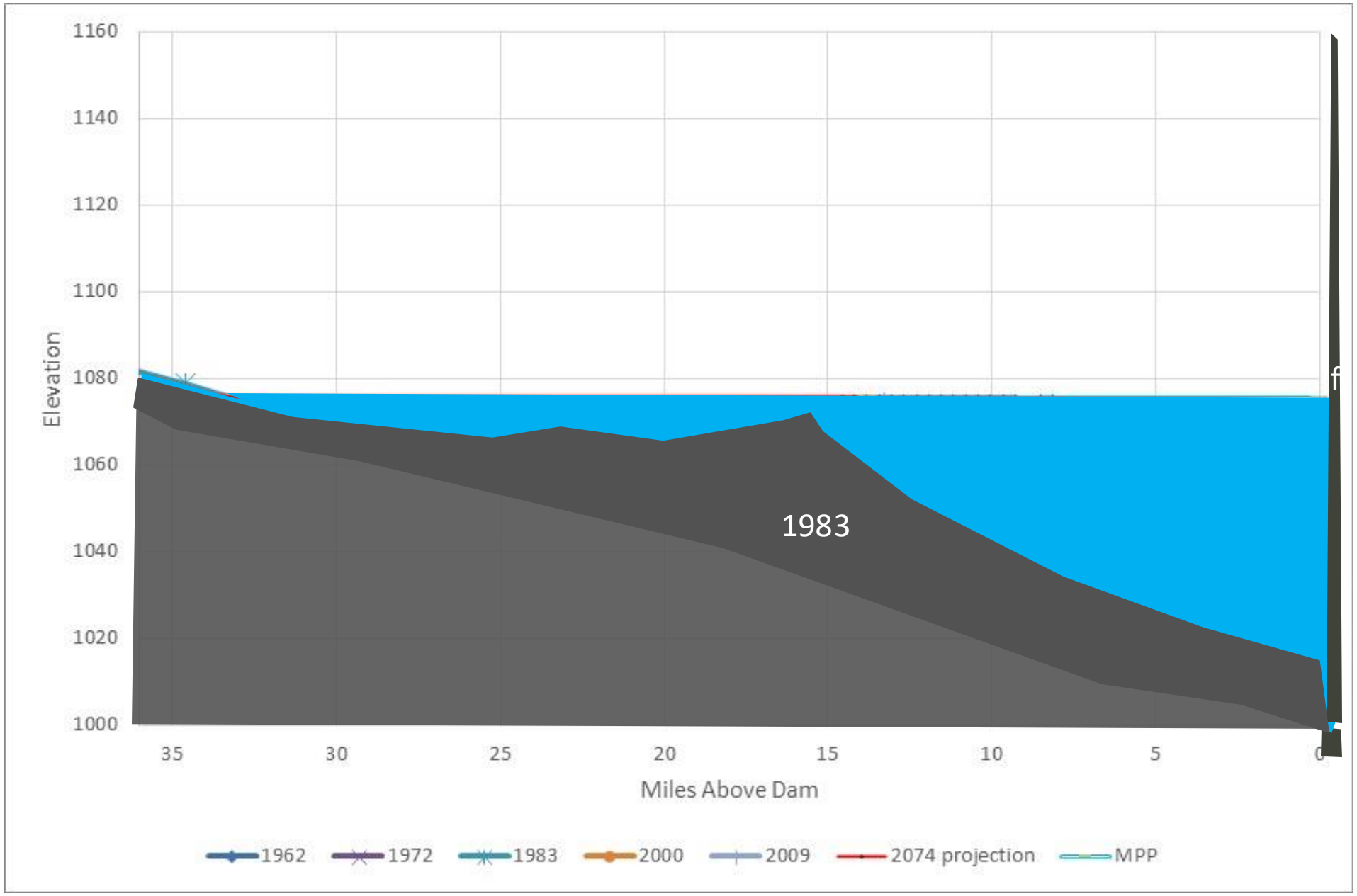
98% of sediment trapped



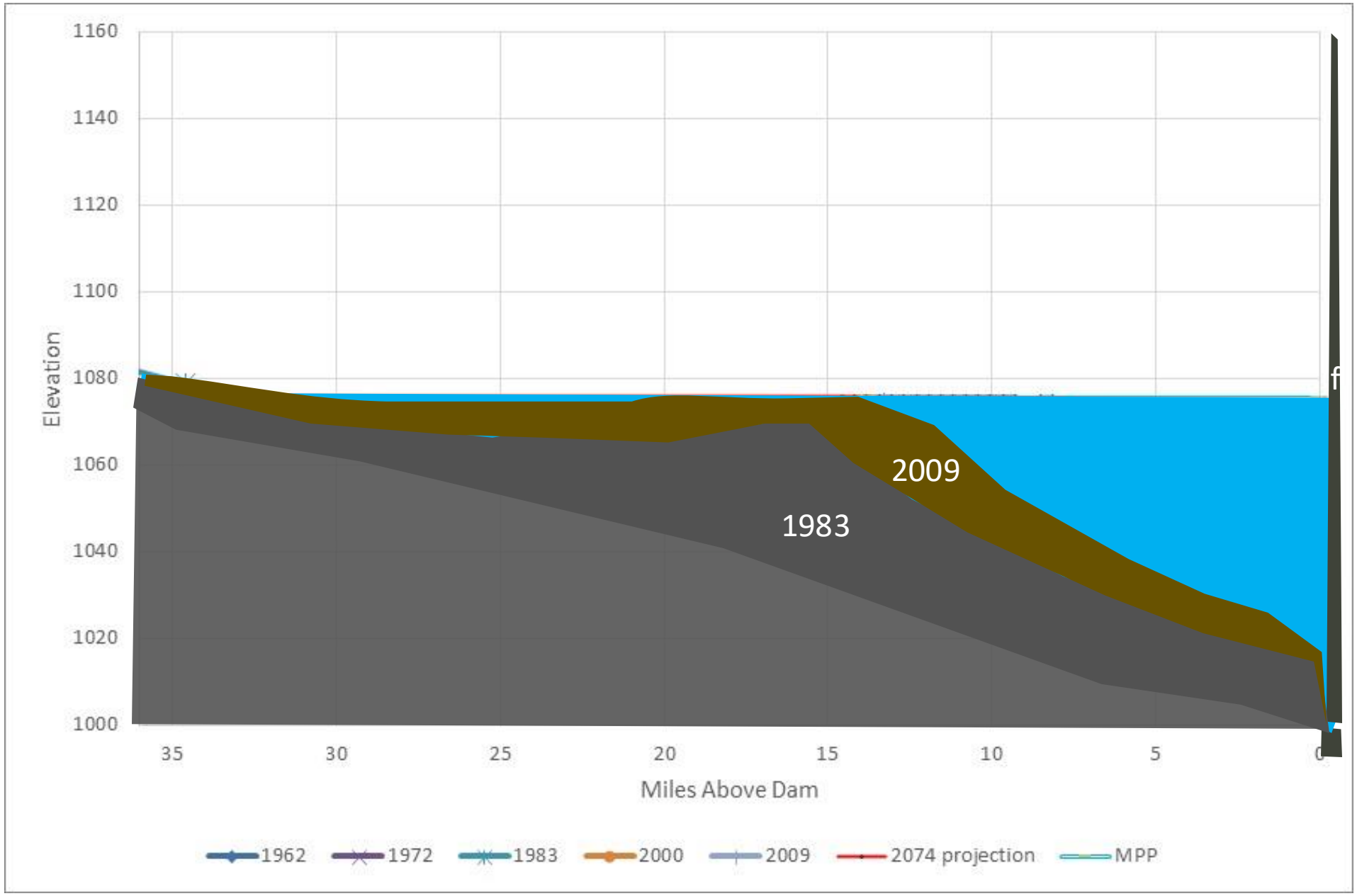
Sediment Out

107k tons/year

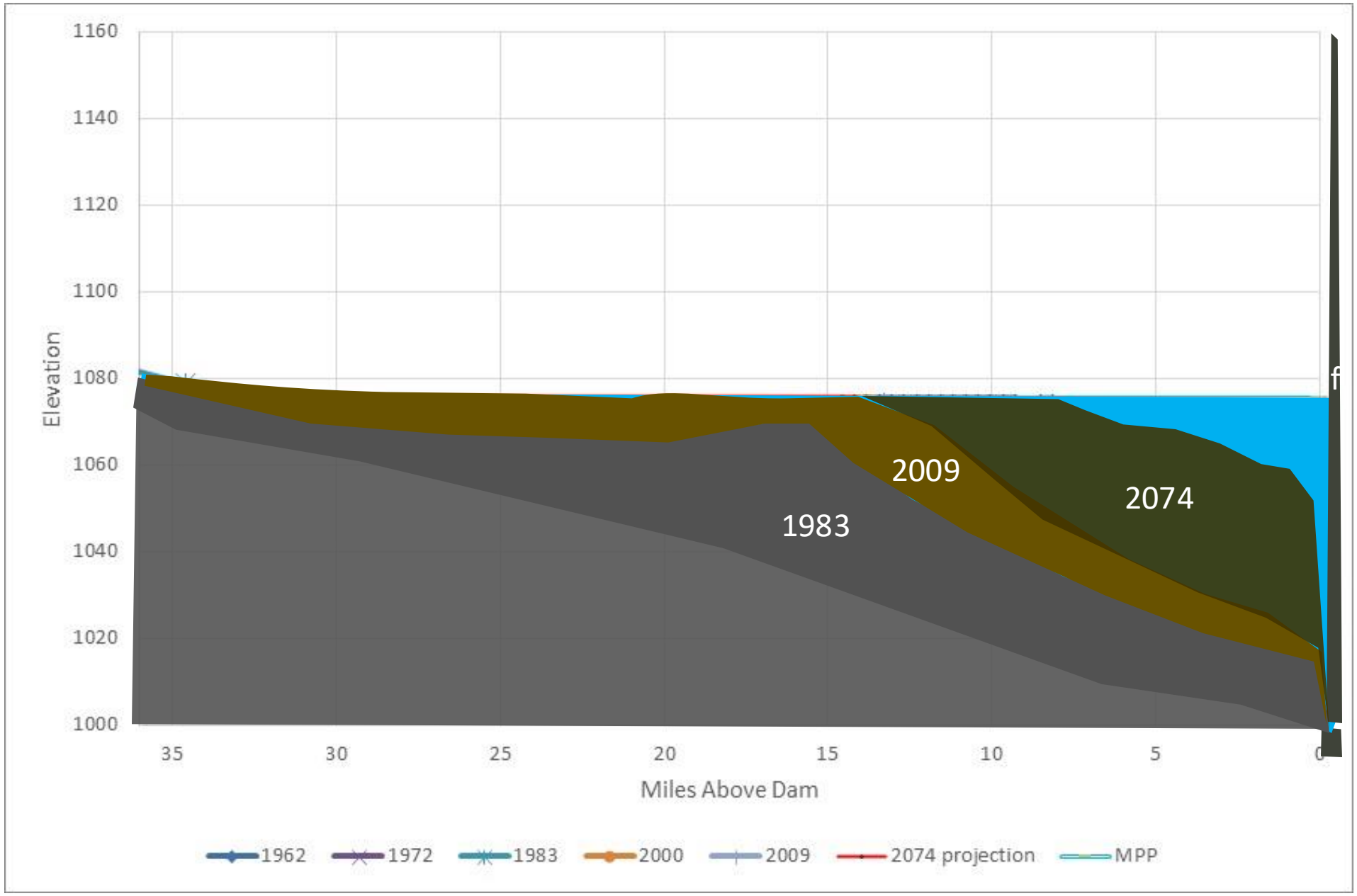
Tuttle Creek Lake



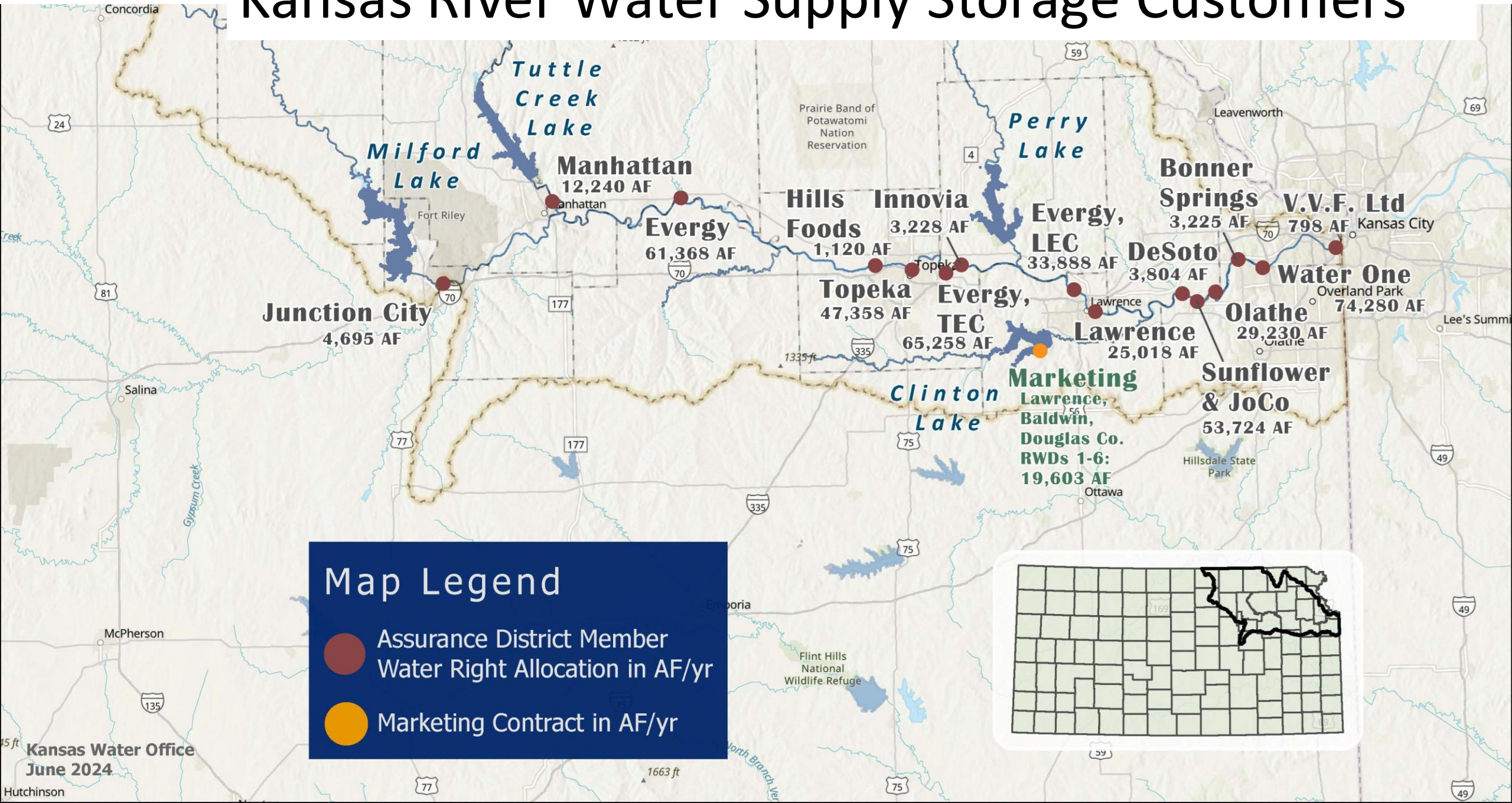
Tuttle Creek Lake



Tuttle Creek Lake



Kansas River Water Supply Storage Customers



Degradation in the Downstream Channels

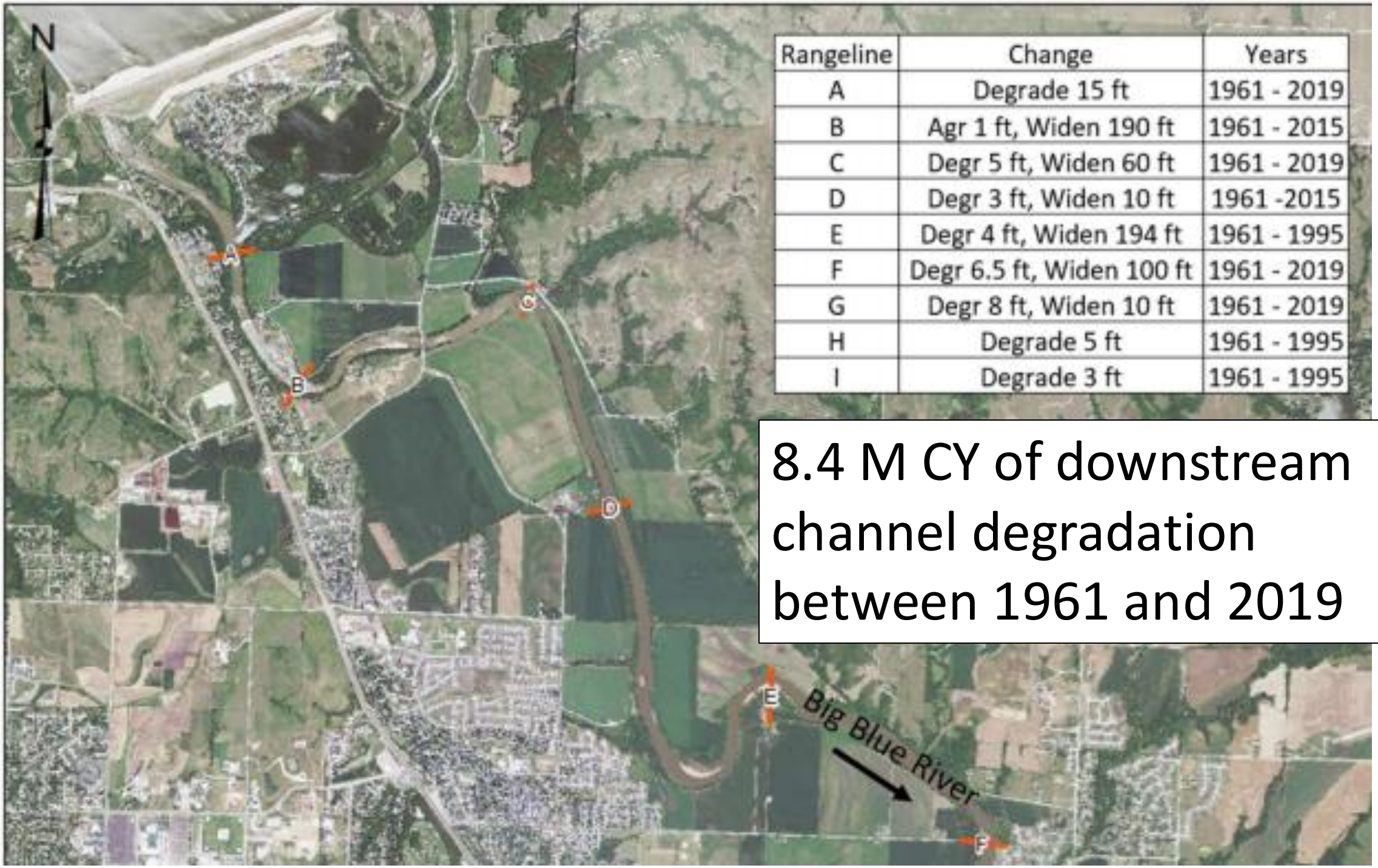
Sediment starved water erodes bed and banks

- Land loss
- Exposed pipelines
- Exposed bridge piers
- Groundwater lowering

Sediment starved channels may have higher losses



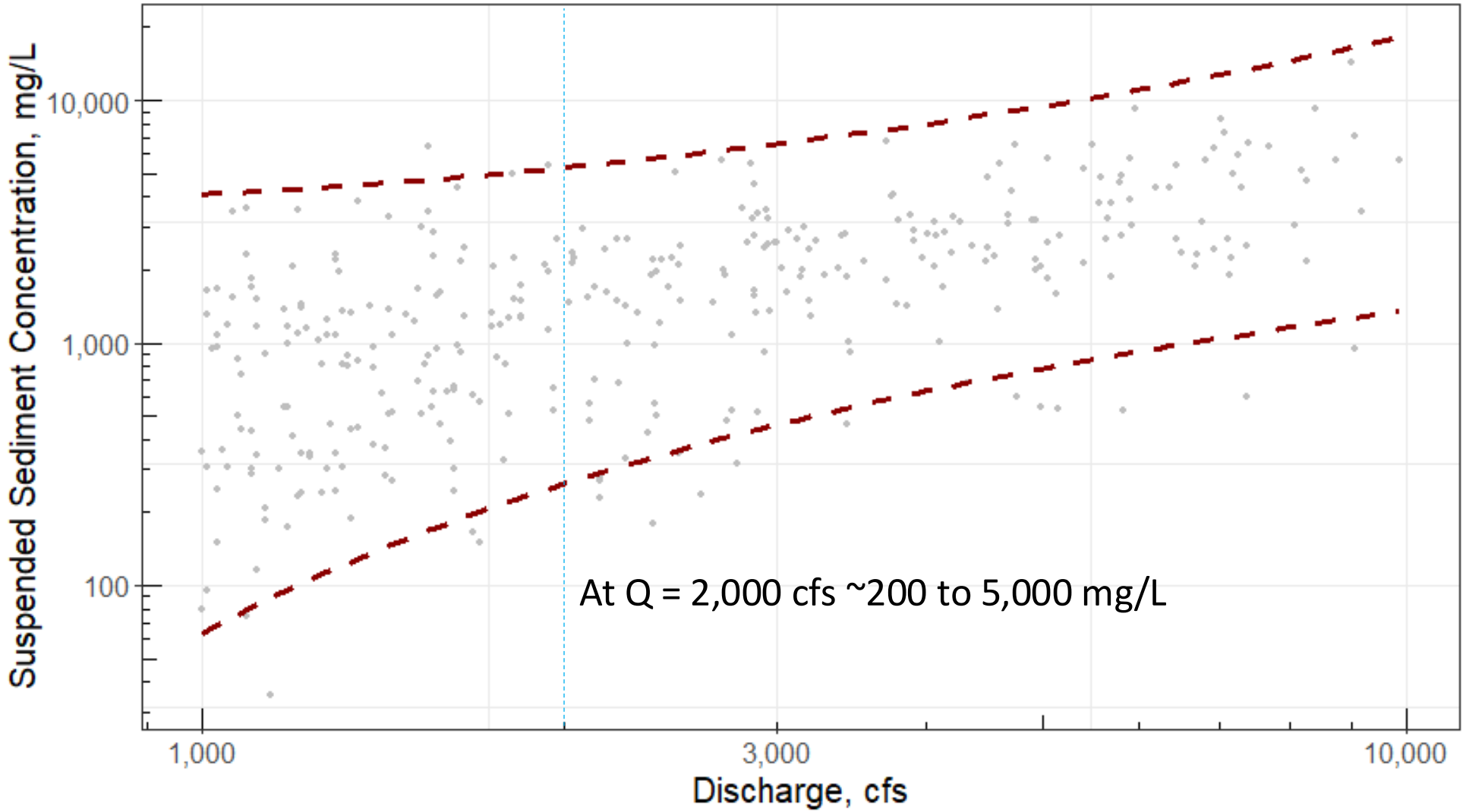
Creek in Missouri



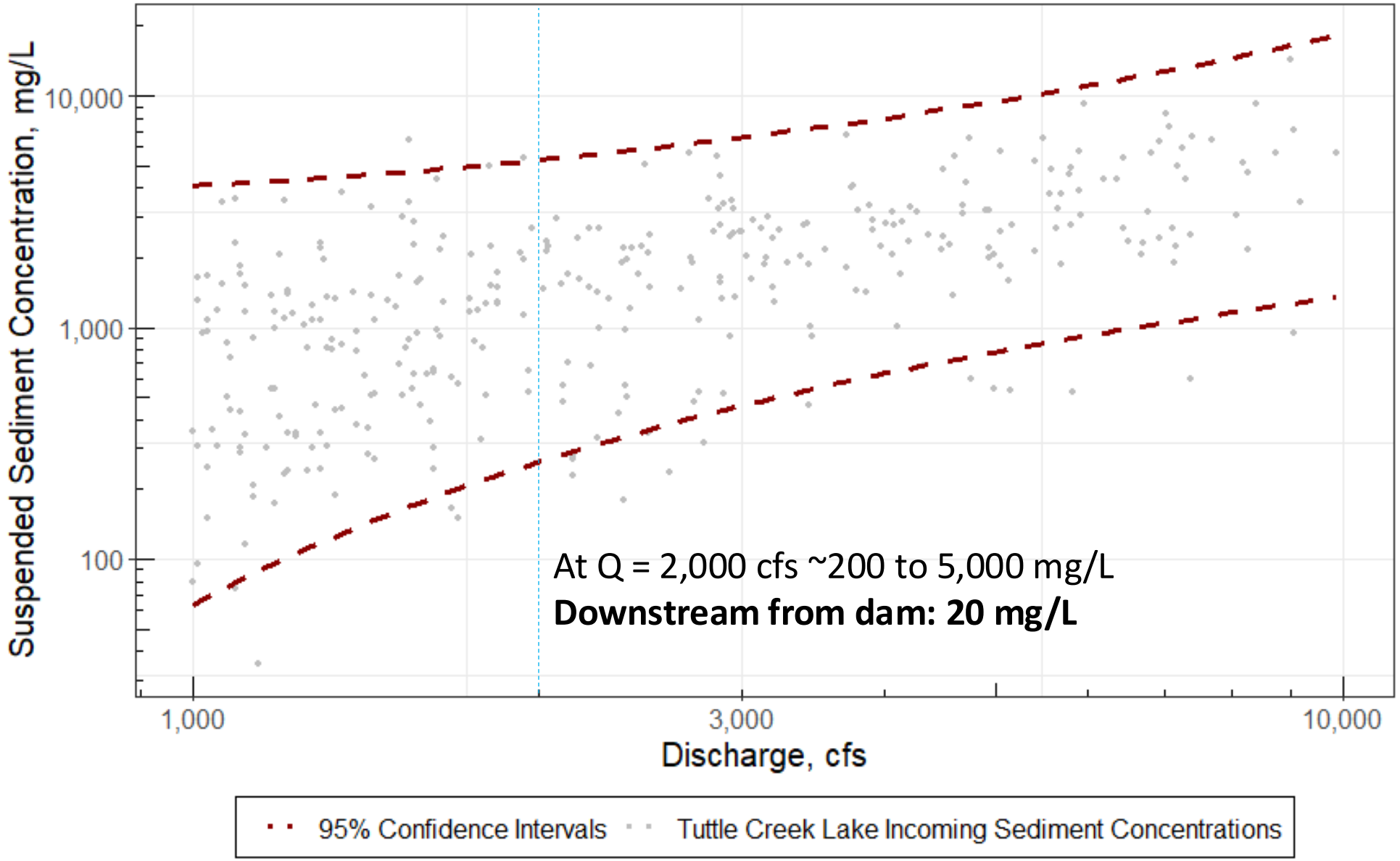
Rangeline	Change	Years
A	Degrade 15 ft	1961 - 2019
B	Agr 1 ft, Widen 190 ft	1961 - 2015
C	Degr 5 ft, Widen 60 ft	1961 - 2019
D	Degr 3 ft, Widen 10 ft	1961 -2015
E	Degr 4 ft, Widen 194 ft	1961 - 1995
F	Degr 6.5 ft, Widen 100 ft	1961 - 2019
G	Degr 8 ft, Widen 10 ft	1961 - 2019
H	Degrade 5 ft	1961 - 1995
I	Degrade 3 ft	1961 - 1995

8.4 M CY of downstream channel degradation between 1961 and 2019

Sediment Regime Flowing Into Tuttle Creek Lake



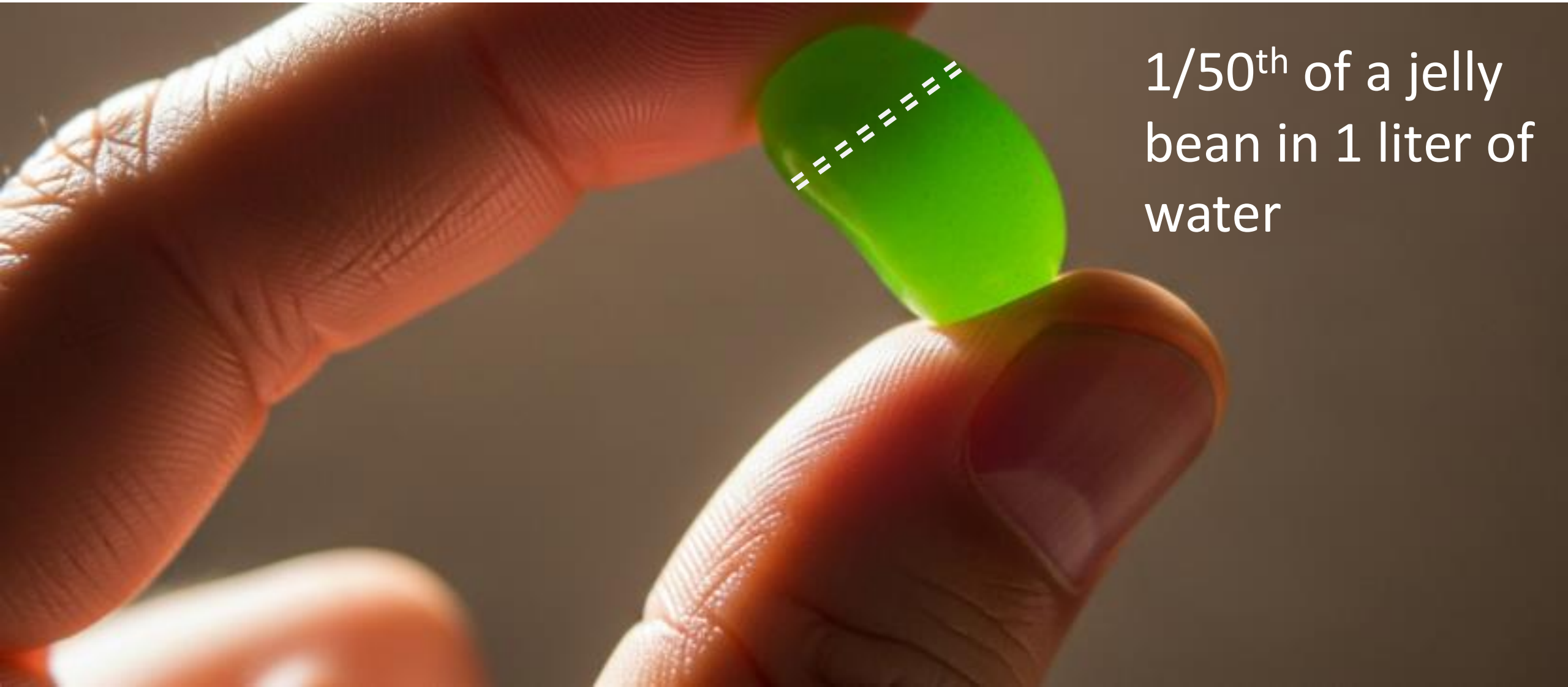
Sediment Regime Flowing Into Tuttle Creek Lake



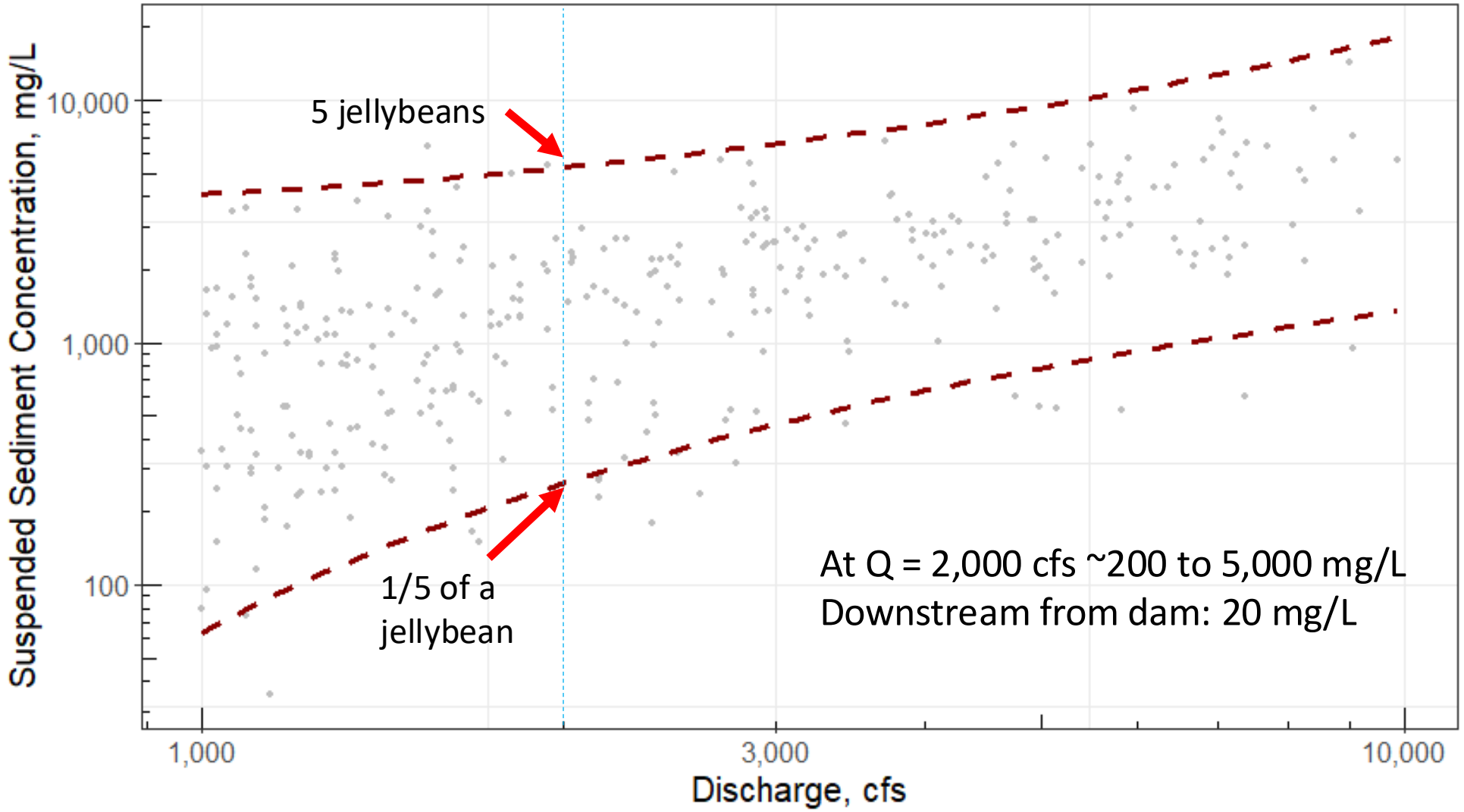
How much sediment is 20 mg/L?



How much sediment is 20 mg/L?



Sediment Regime Flowing Into Tuttle Creek Lake



Outline

1. Introduction
2. **Traditional Hydraulic Dredging**
3. Water Injection Dredging

John Redmond Reservoir Dredging
May - October 2016



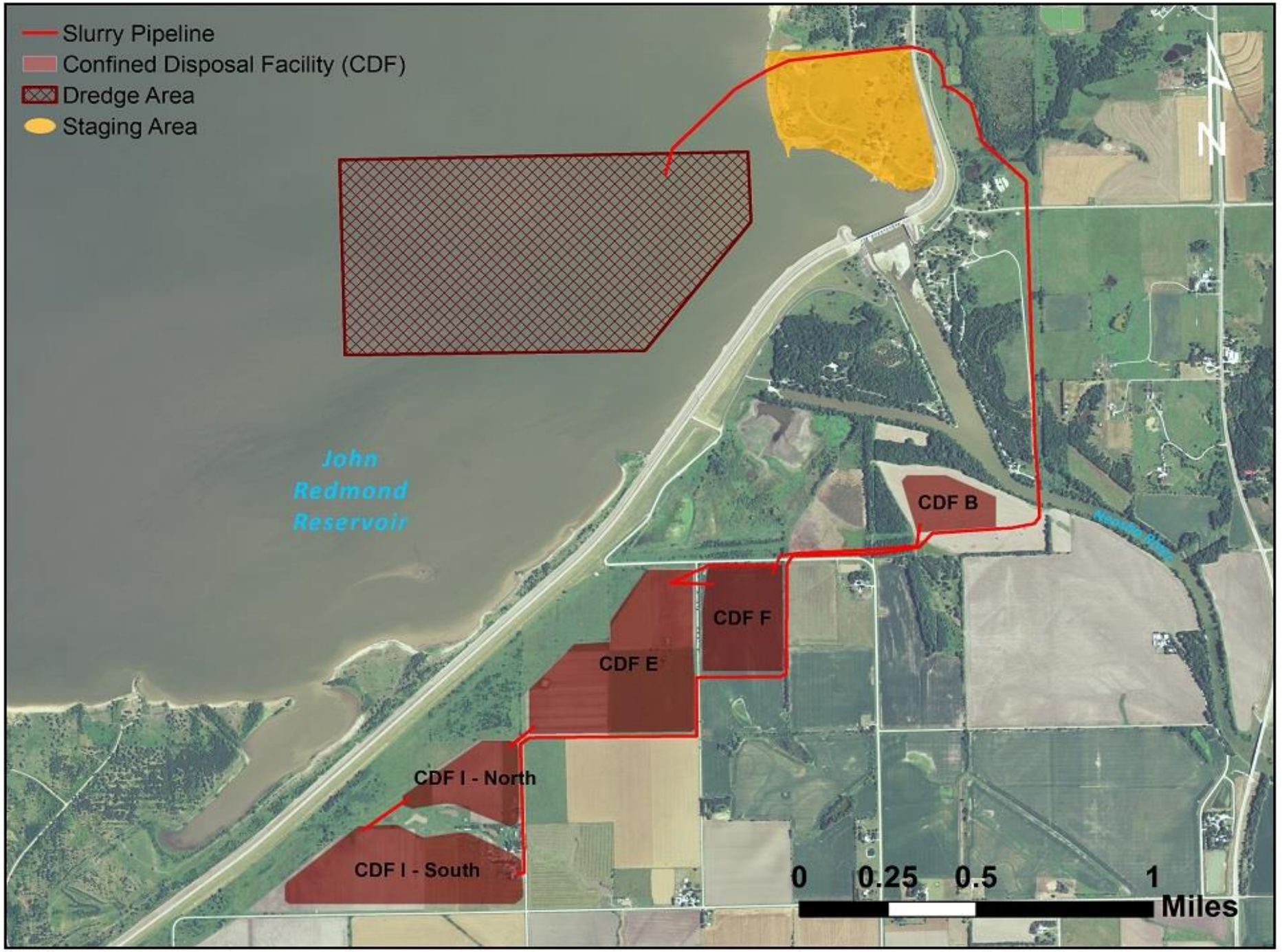


Traditional Dredging with Confined Disposal Facilities



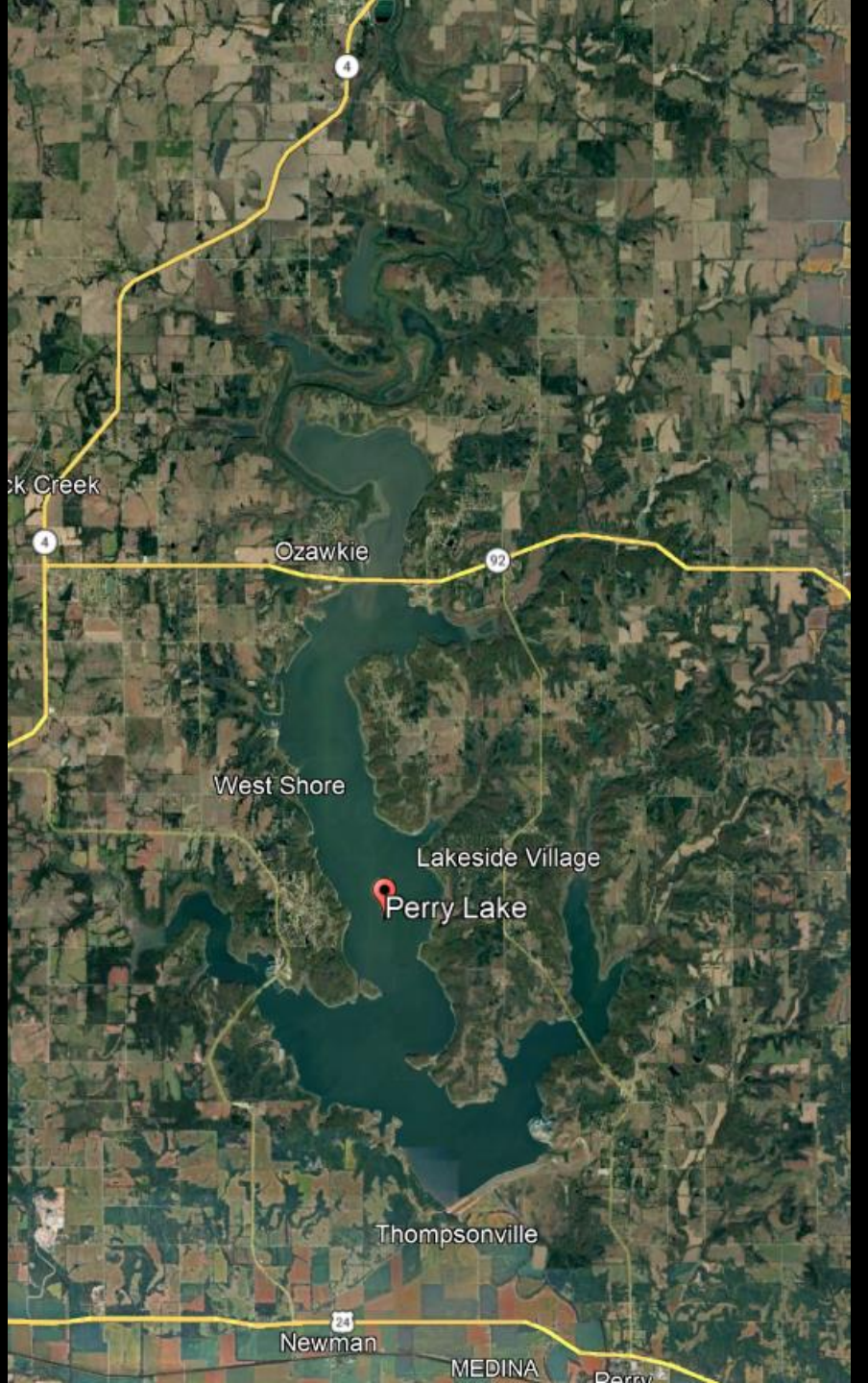
2016 John Redmond Reservoir Dredging

- 3M yd^3 of sediment removed
- $20M
- $6.67/CY (2016) → ~$11/CY (2025)


Slurry Pipeline
Confined Disposal Facility (CDF)
Dredge Area
Staging Area
John Redmond Reservoir
CDF B
CDF F
CDF E
CDF I - North
CDF I - South
0 0.25 0.5 1
Miles
N

Why not remove the sediment and place it on the land?

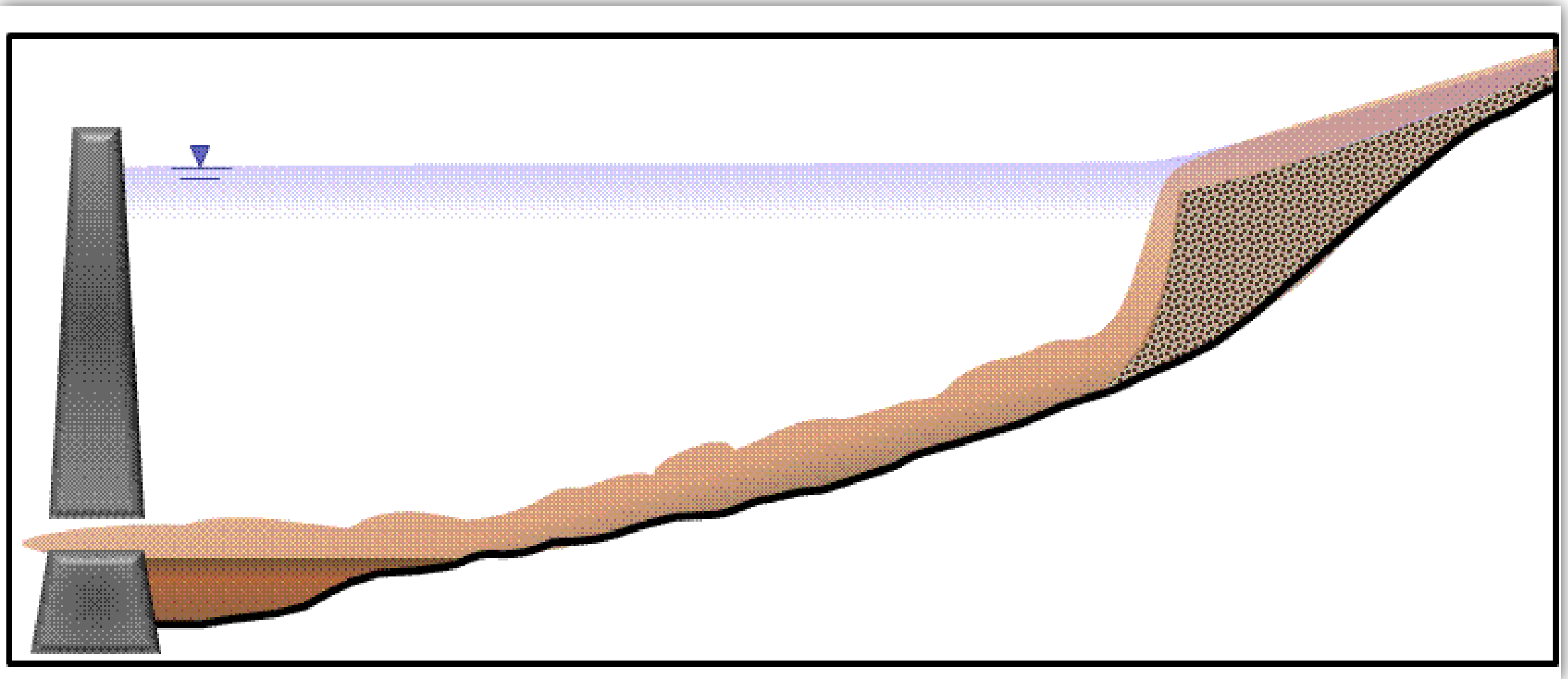
- Need a lake's worth of land
- Doubles the cost of a dredging project



Outline

1. Introduction
2. Traditional Hydraulic Dredging
3. **Water Injection Dredging**

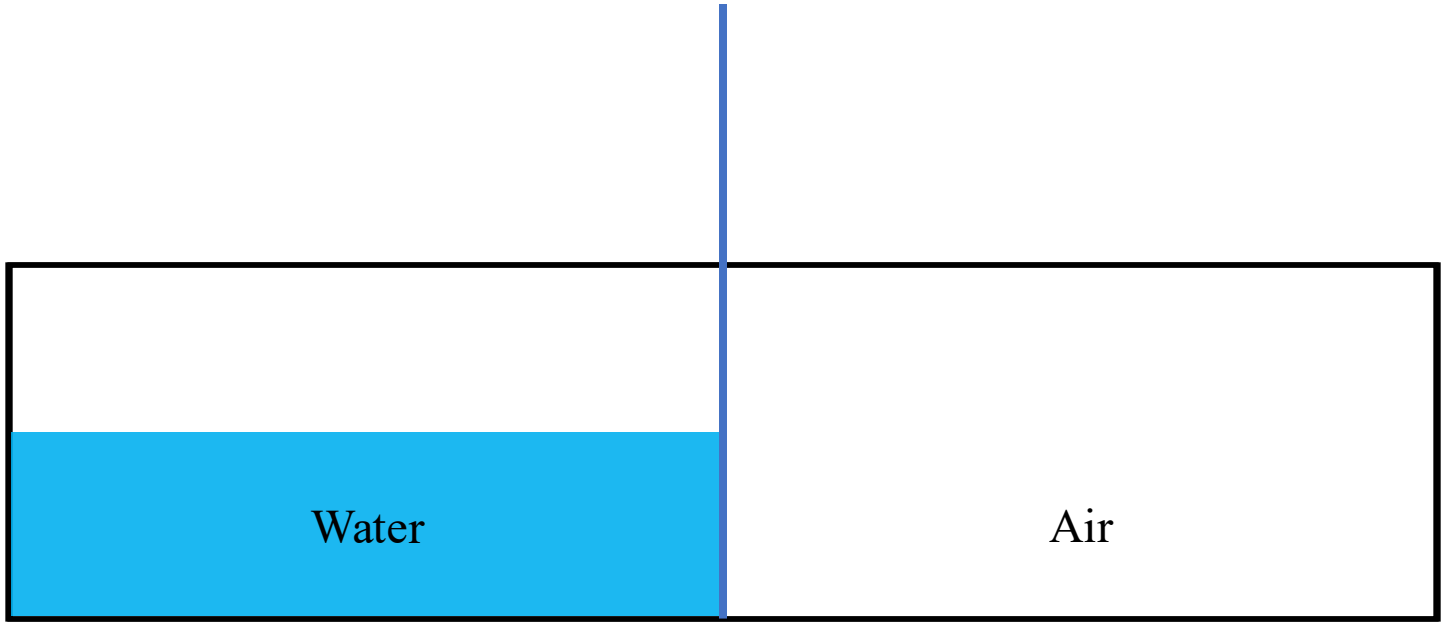
Density Currents



Heavy things sink

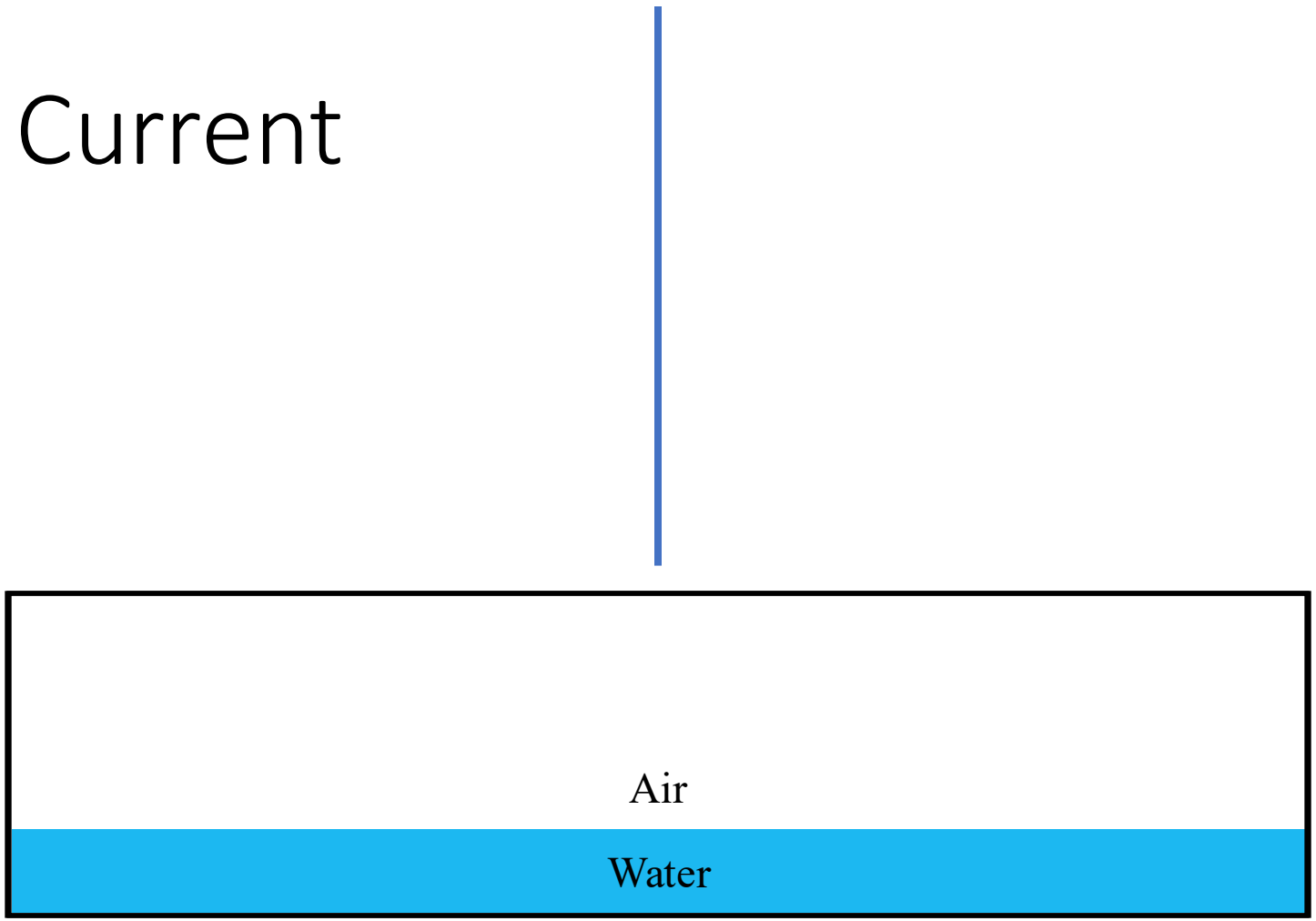


Density Current



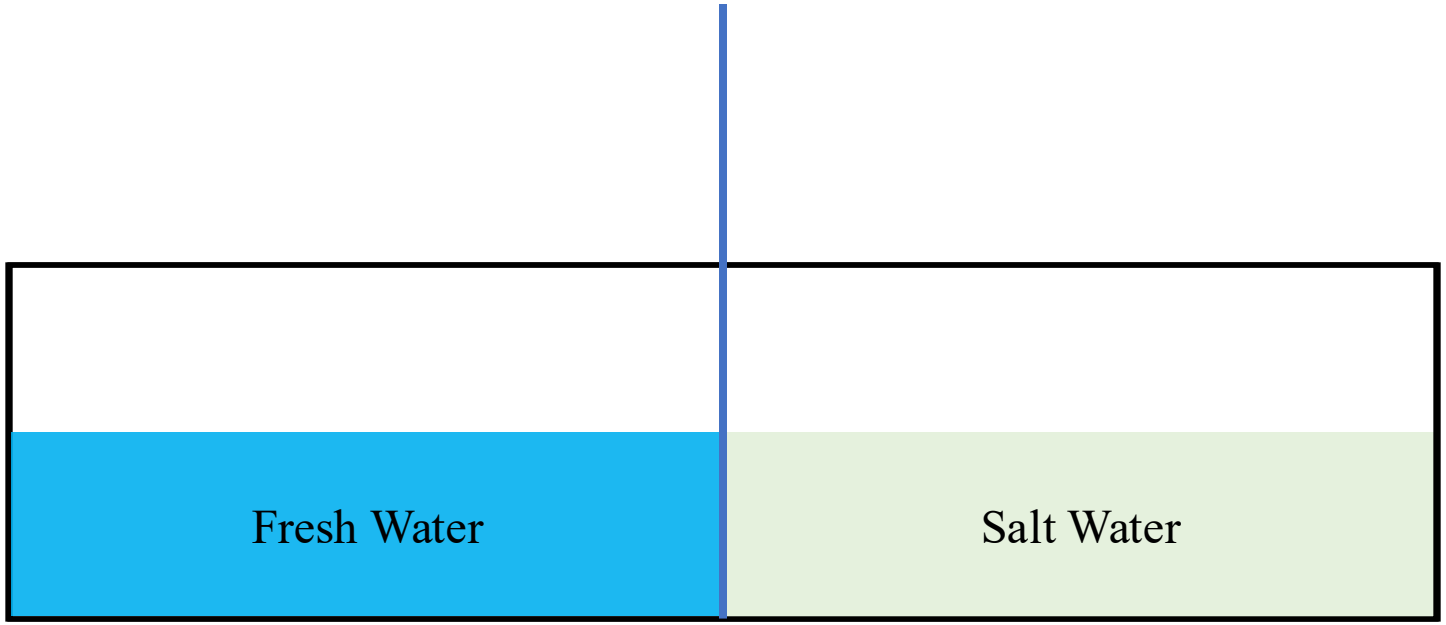
Slide Credit: Michael Mansfield

Density Current



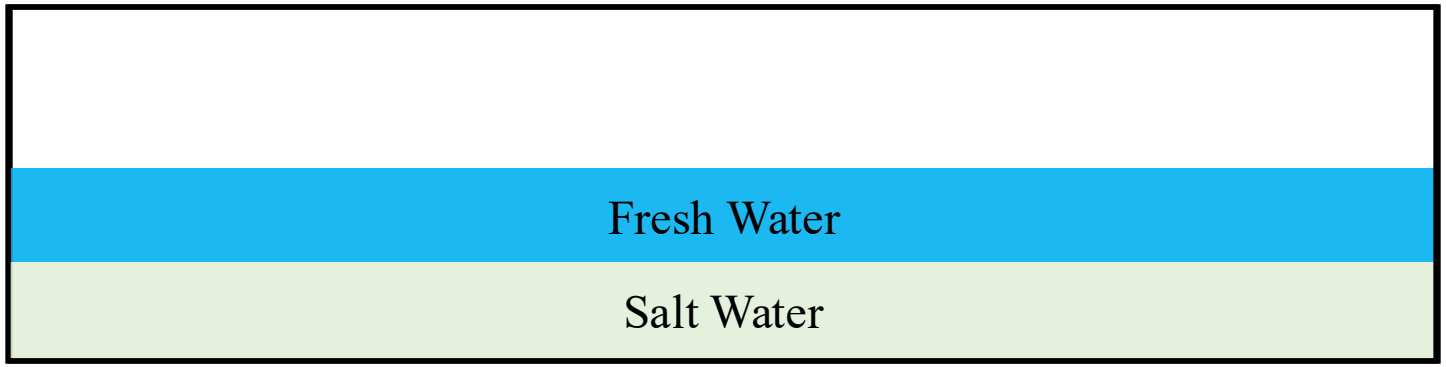
Slide Credit: Michael Mansfield

Density Current



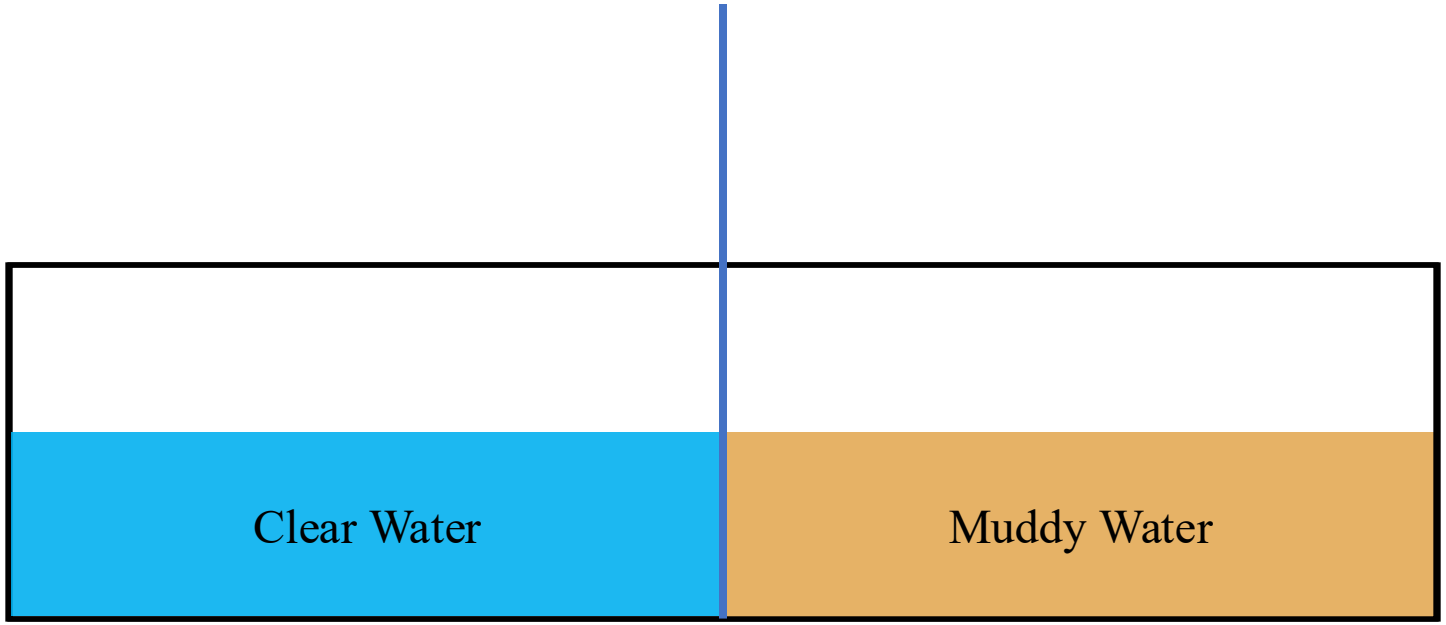
Slide Credit: Michael Mansfield

Density Current



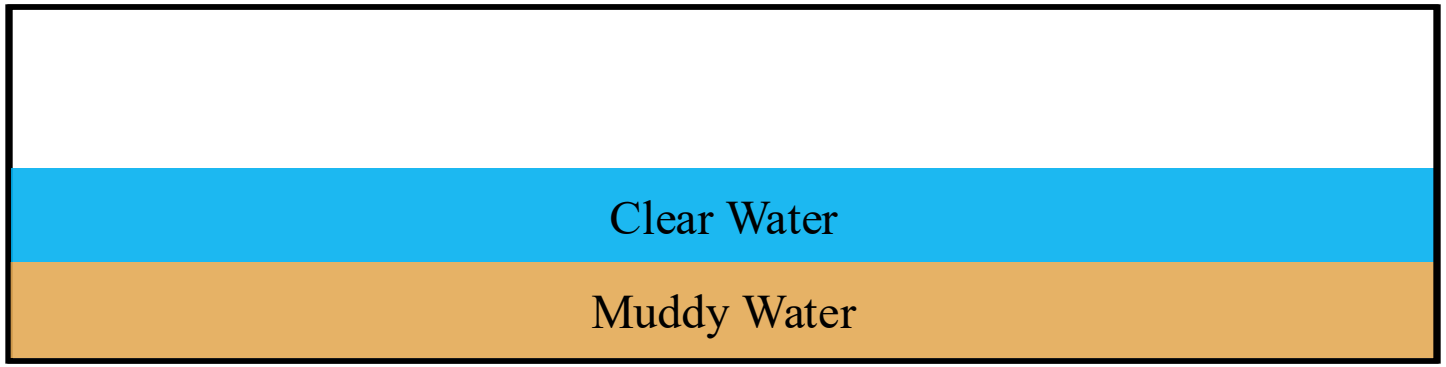
Slide Credit: Michael Mansfield

Density Current



Slide Credit: Michael Mansfield

Density Current



Slide Credit: Michael Mansfield

Density currents

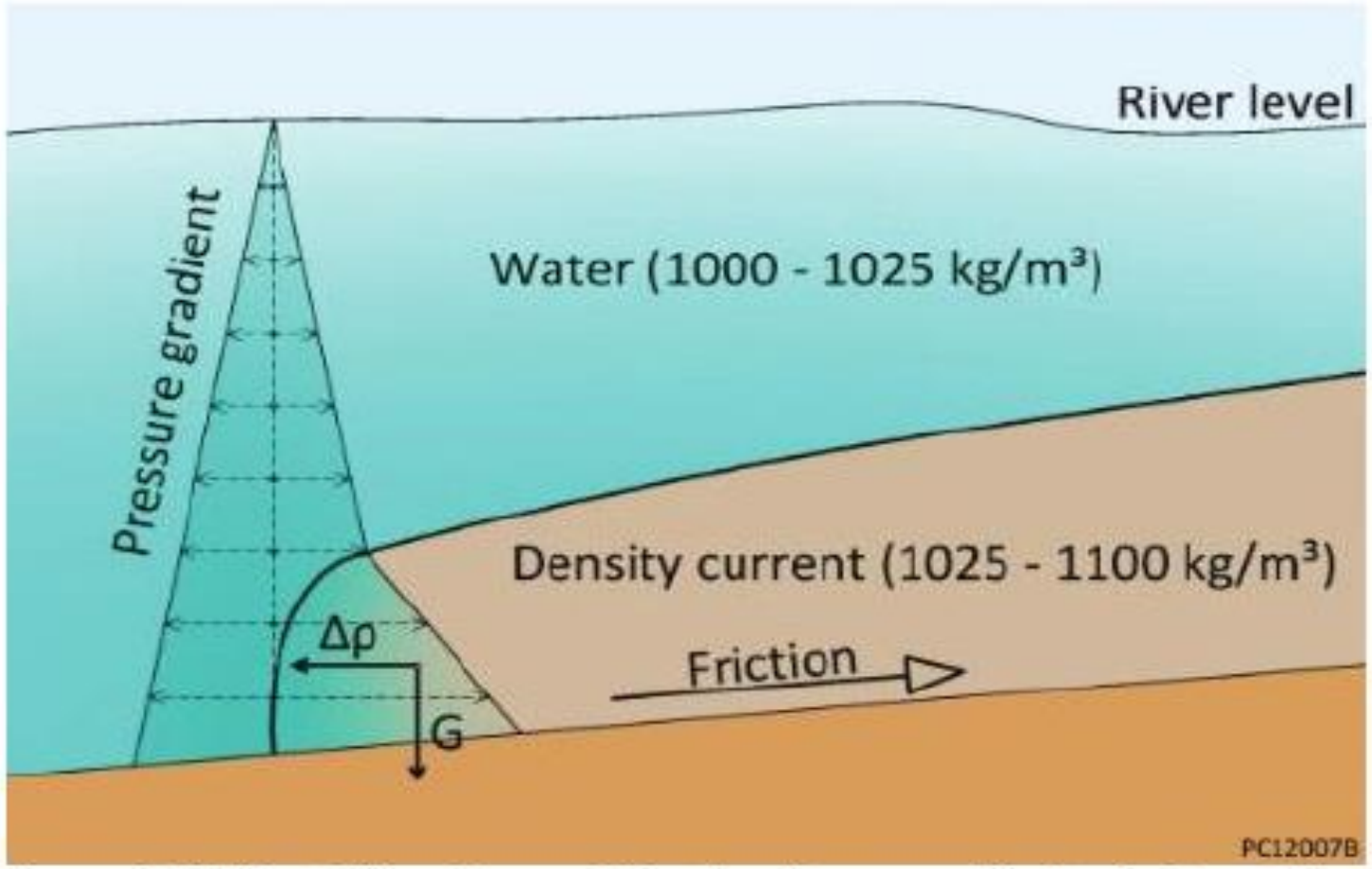
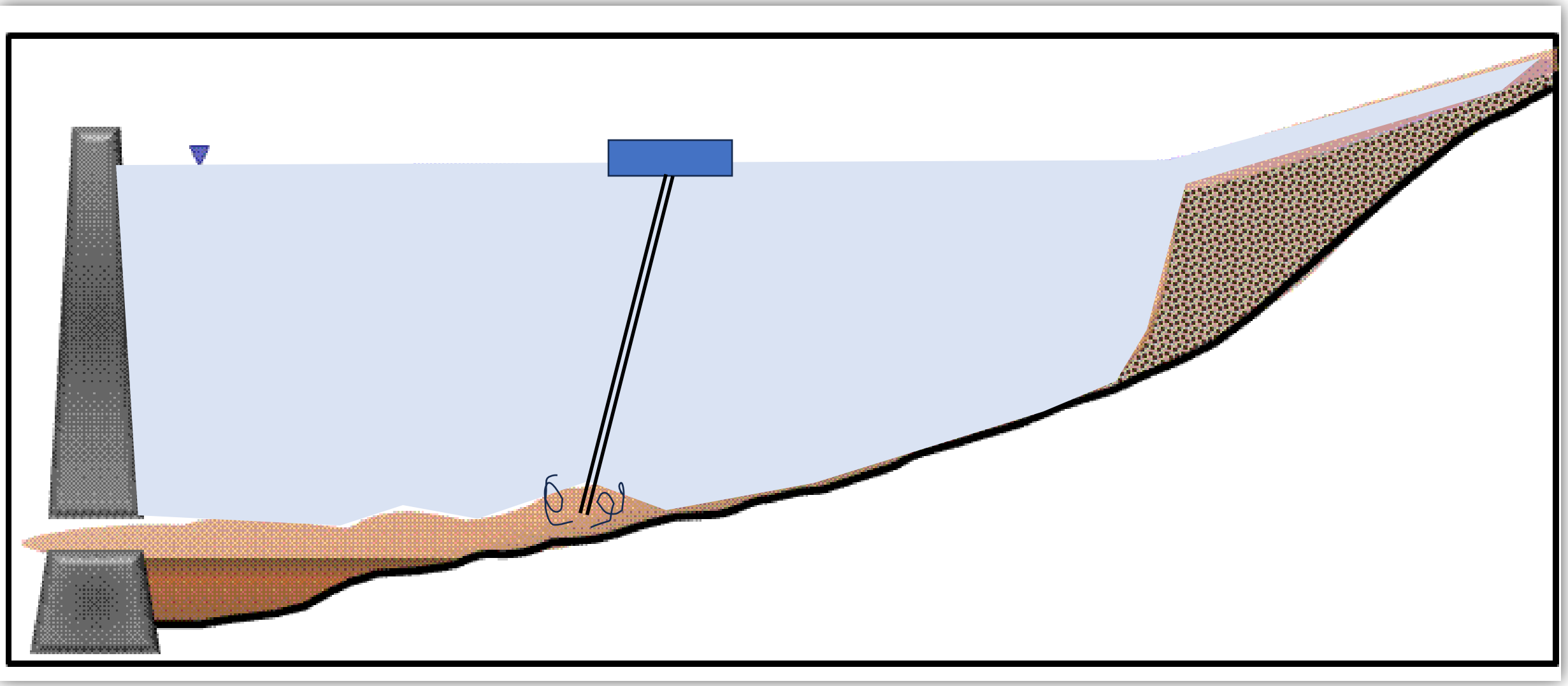


Figure 4.1: The driving force of the density current is the hydrostatic pressure difference and the restoring force is the friction with the bed. Source: PIANC (22)

Water Injection Dredging: Induce a Density Current Closer to the Dam



Turbidity current discharges downstream through bottom service gates




https://www.youtube.com/watch?v=J2Zikq6Zx68

Traditional Dredging

- Land disposal
- Miles of pipelines
- Pump sediment slurry 1000s of ft
- $$$
- Total control of discharge rate and timing

Water Injection Dredging

- Recharge to river
- No pipelines
- Pump clear water 10s of feet
- $
- Less control over discharge rate and timing

Tuttle Creek Lake Water Injection Dredging Demonstration

- **Authorization:** Flood Control Act of 1938

- **Funding**: Total Project Cost $9.1M
  - Federal: Consolidated Appropriations Act FY22 ($1.3M); FY23 ($2.8M) Operations and Maintenance – Water Supply (WS); and $3M reprogrammed from Tuttle Creek operations project
  - State: State of Kansas - Kansas Water Office contributed an additional $2M directly to USACE for the project.

- **Project Managers**: Laura Totten (USACE); Josh Olson (KWO)
- **Technical Lead**: Michael Mansfield (USACE)
- **Water Quality Lead**: Marvin Boyer (USACE)

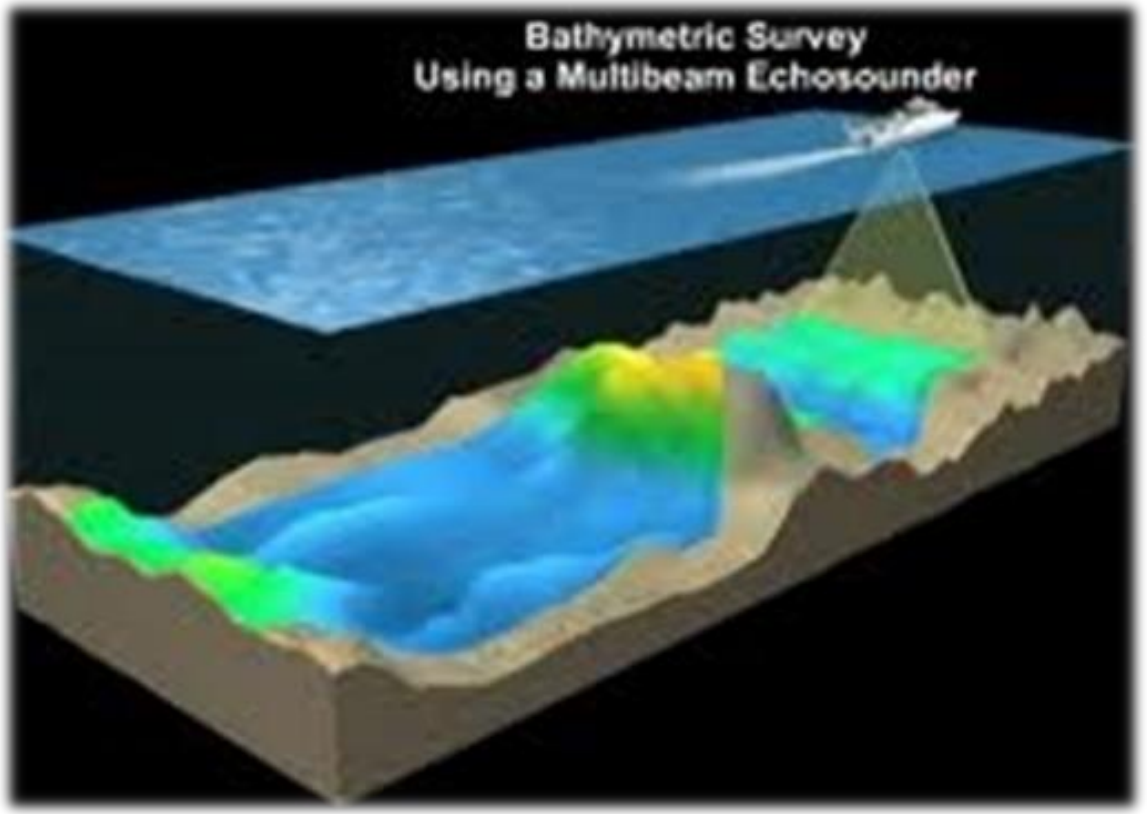
Demonstration Objectives

Test of the technology– not a typical dredging project

- Goal: Answer questions
- Not: Dredge to a certain elevation or volume

Tuttle Creek Lake Primary Questions

- How much sediment can WID move?
- WID production rate (cubic yards/hour)
- How much will it cost per cubic yard?
- What are the downstream effects? (water quality/ecological/geomorphology)
- Fully successful if we answer these questions.



Extensive multibeam bathymetric data and downstream sediment and water quality monitoring

Collaborators

State

Kansas Water Office
Kansas Department of Wildlife and Parks
Kansas Department of Health and Environment

Academic

University of Kansas (Engineering)
Kansas Biological Survey
Kansas Geological Survey
Kansas State University (Aquatic Biology, Engineering)
Virgina Tech
University of Delft

USACE

Kansas City District
Omaha District
ERDC - DOER Program
ERDC - EMMRP Program
IWR - Sustainable Rivers Program

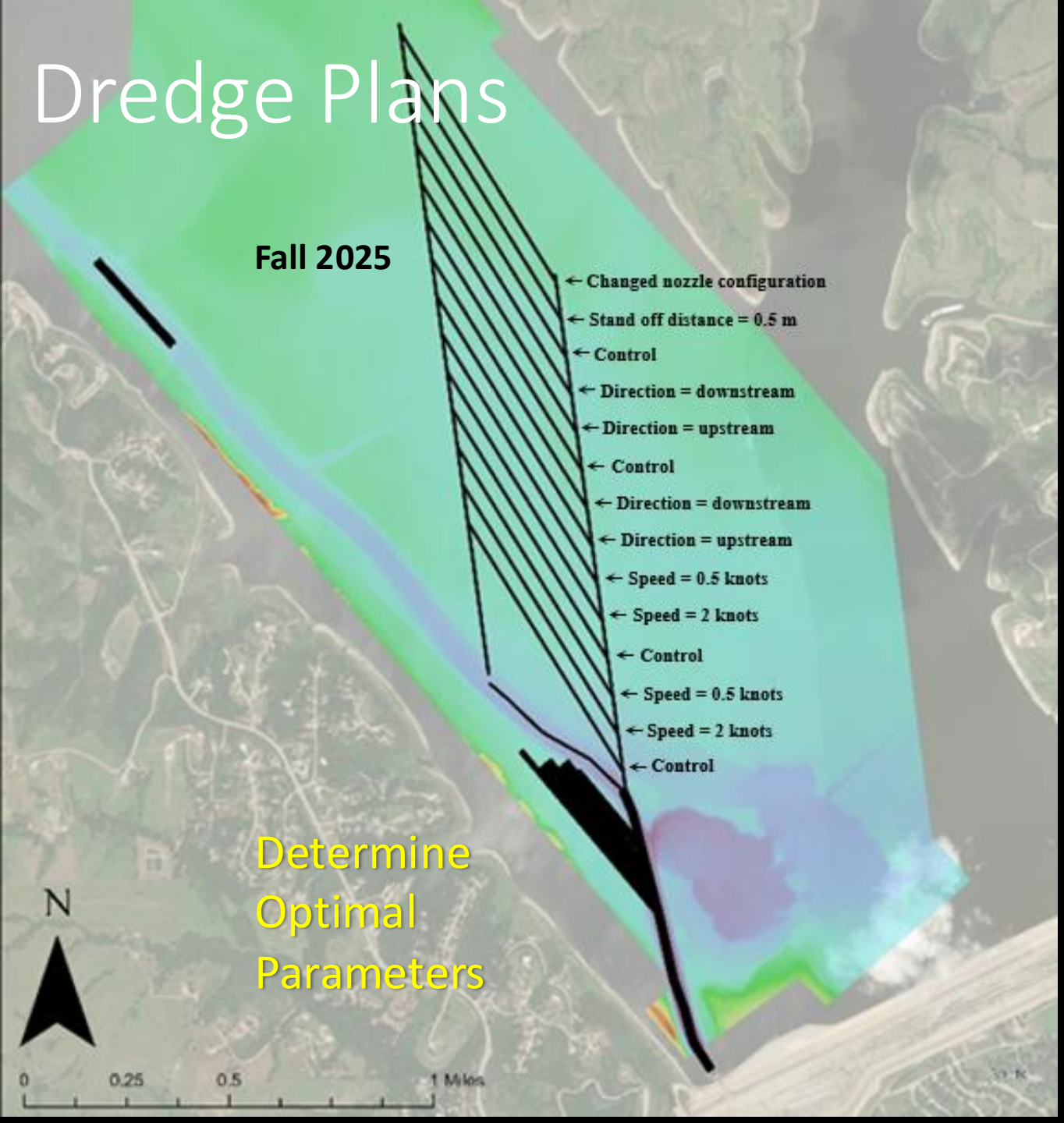
Other Federal

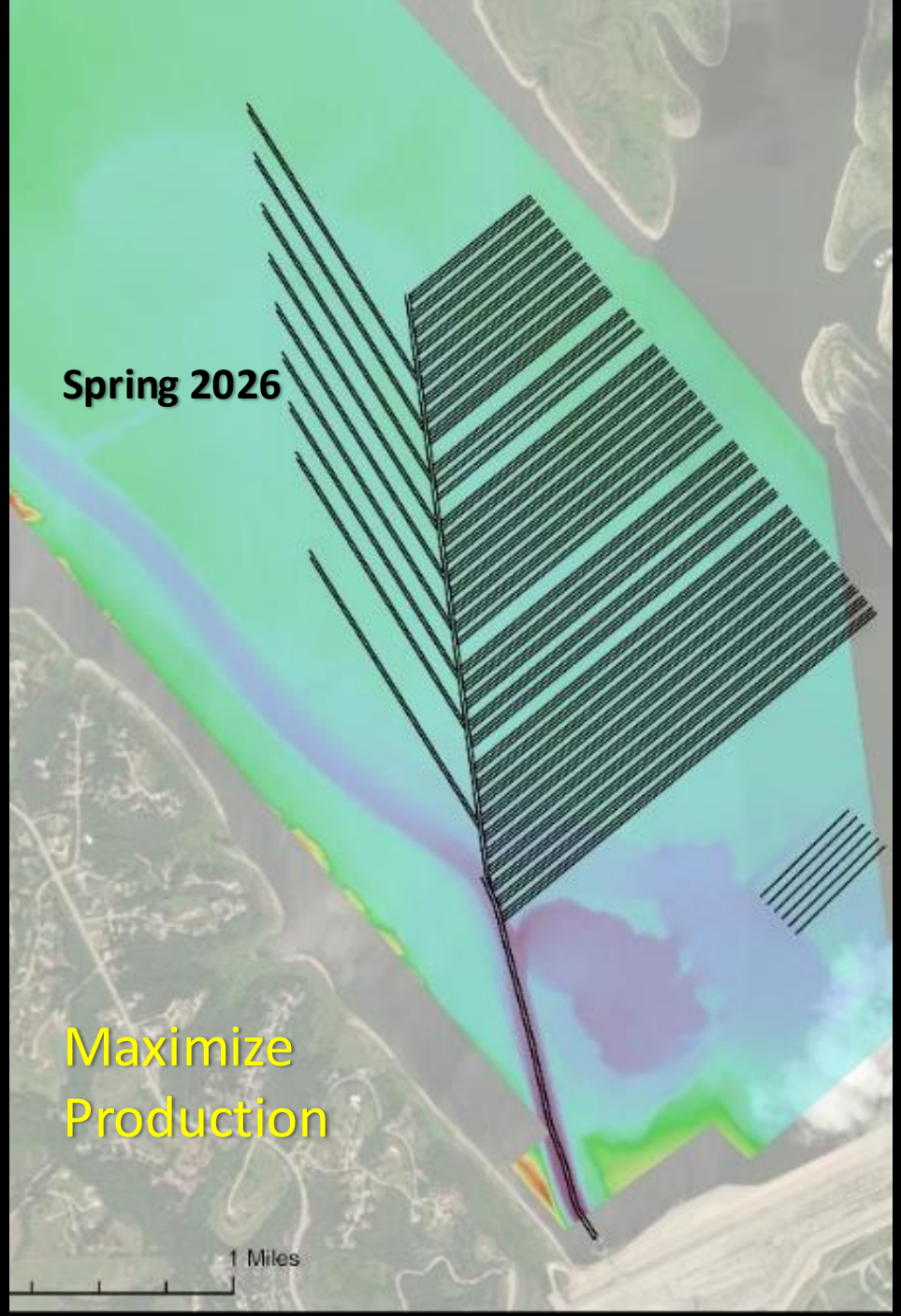
USGS
Bureau of Reclamation
National Science Foundation

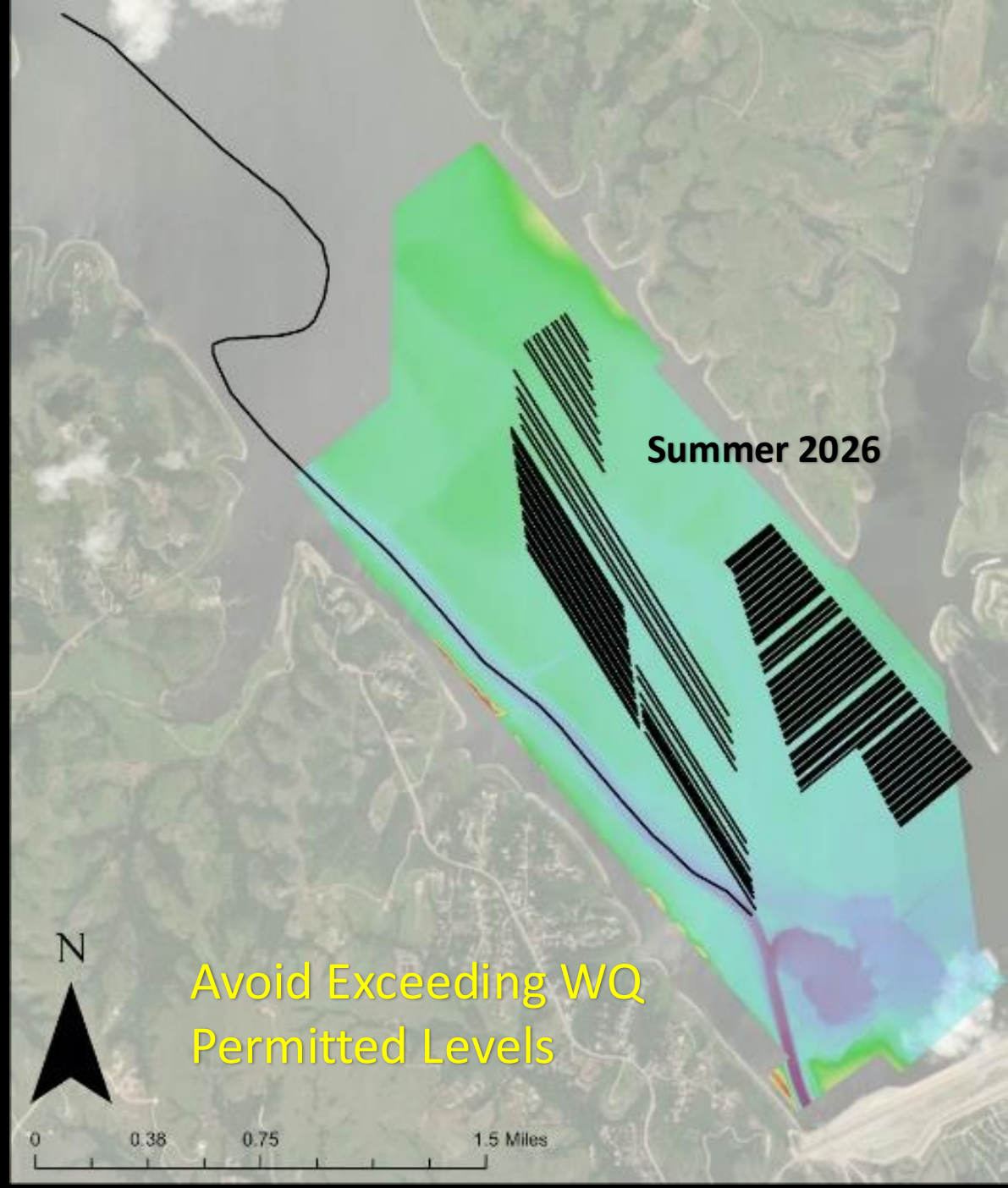
WID Demonstration Schedule

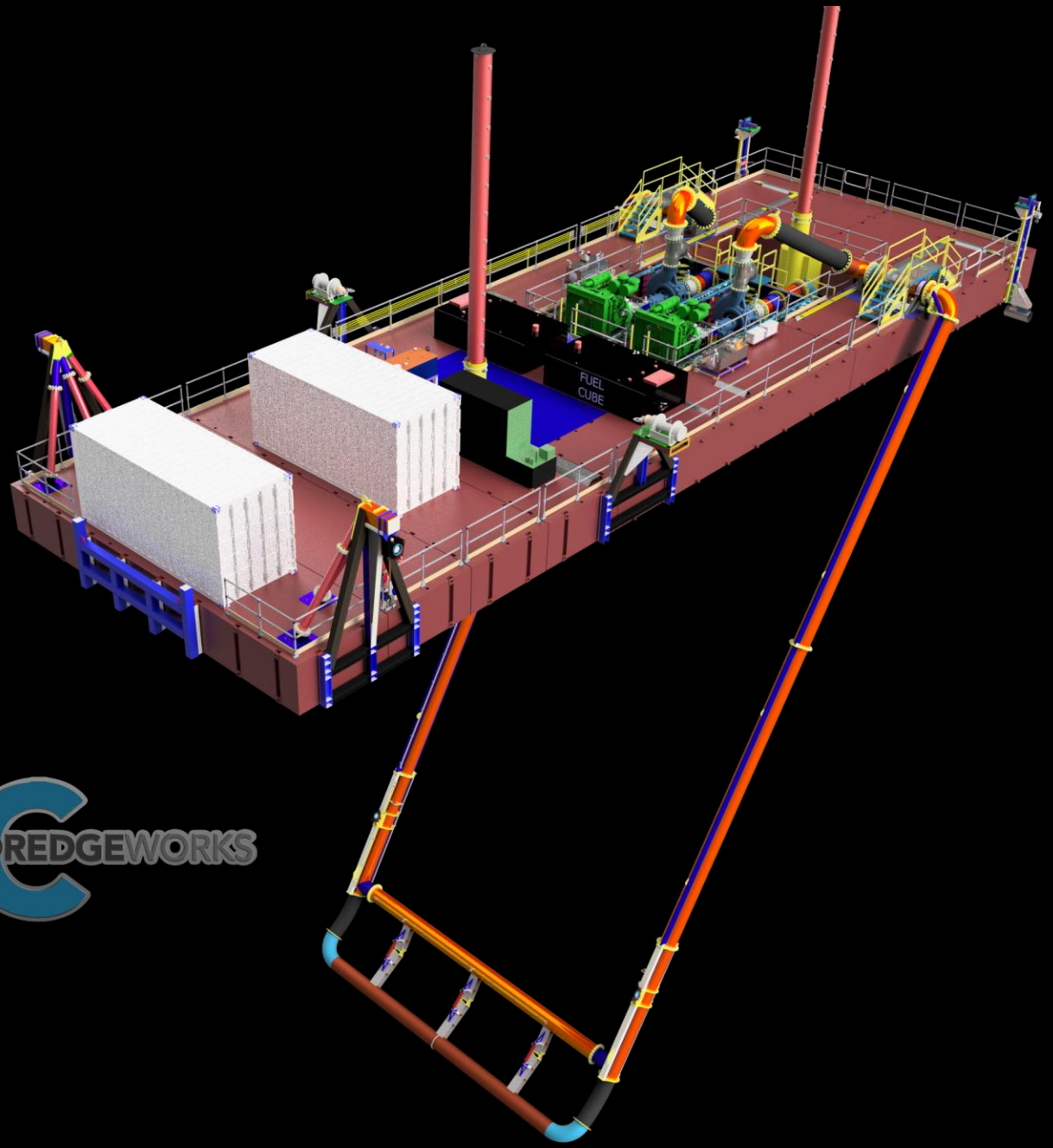
- **WID Demonstration Fall 2025 – September 17 – September 27**
  - Dredging operation for 10 total days and demobilization. (**200 hours** of active dredging)
- **WID Demonstration Spring 2026 – March 2026**
  - Dredging operation for 14 total days and demobilization. (**200 hours** of active dredging)
- **WID Demonstration Summer 2026 – June**
  - Dredging operation for 10 total days and demobilization. (**200 hours** of active dredging)

Dredge Plans




Spring 2026
Maximize Production
1 Miles


Summer 2026
N
Avoid Exceeding WQ Permitted Levels
0
0.38
0.75
1.5 Miles



Kansas Water Office

CUSTOM DREDGEWORKS

KU



Drone footage by Alan Peterson, Tony Layzell, Kansas Geological Survey



Dredging began around 11:45 AM on Wednesday, September 17th.



Dredging operations continued during the night.

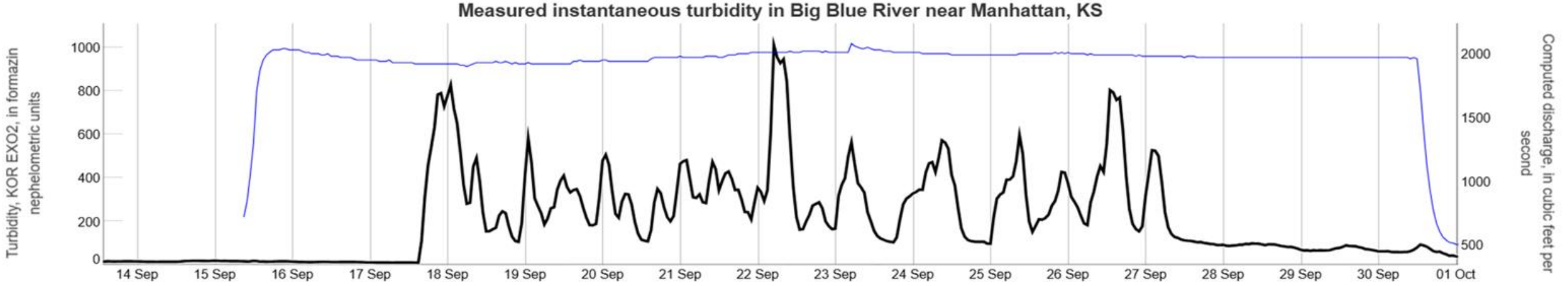


Maximum In-lake Density Current Physical Sample SSC = 46 g/L



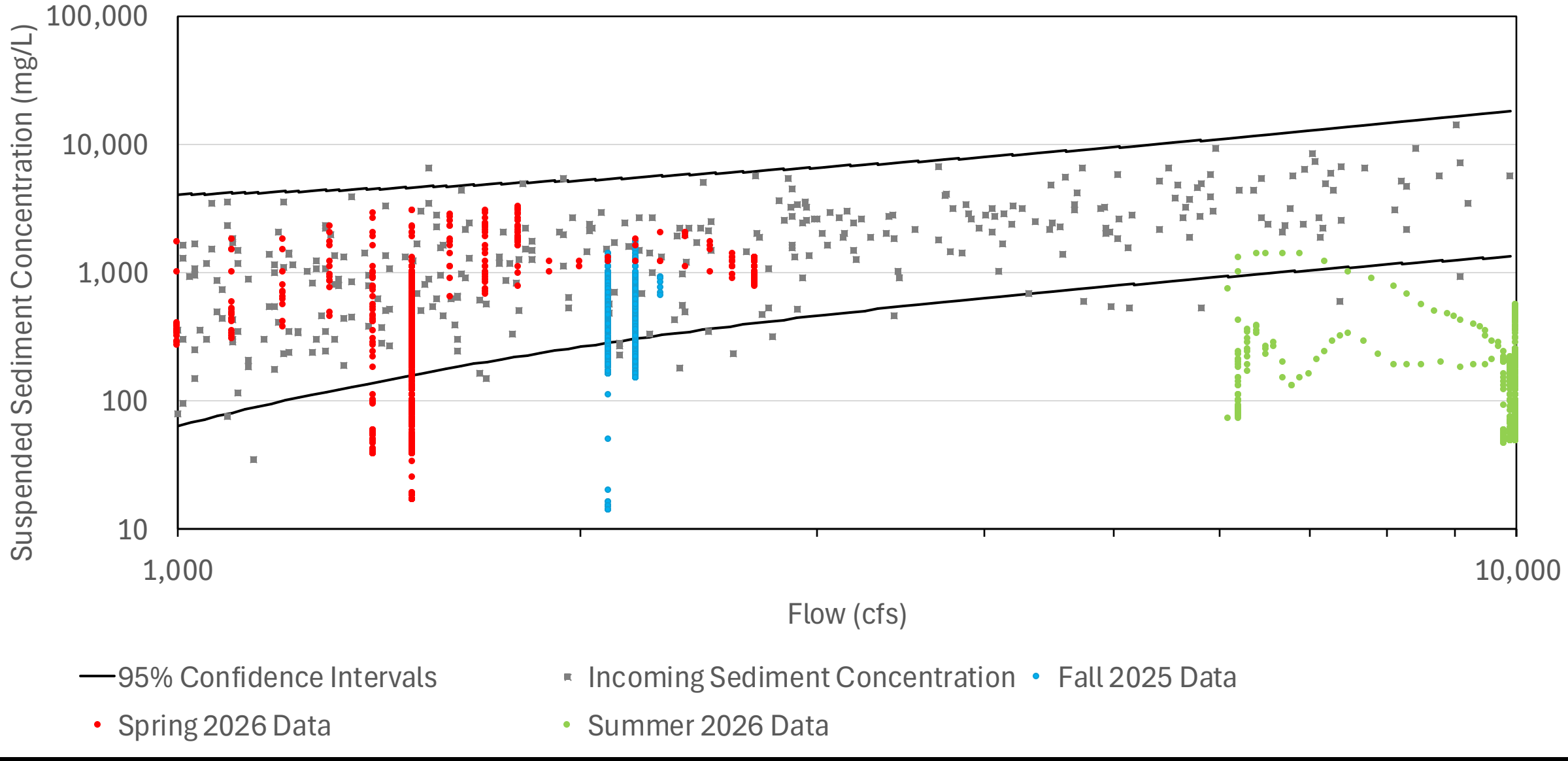




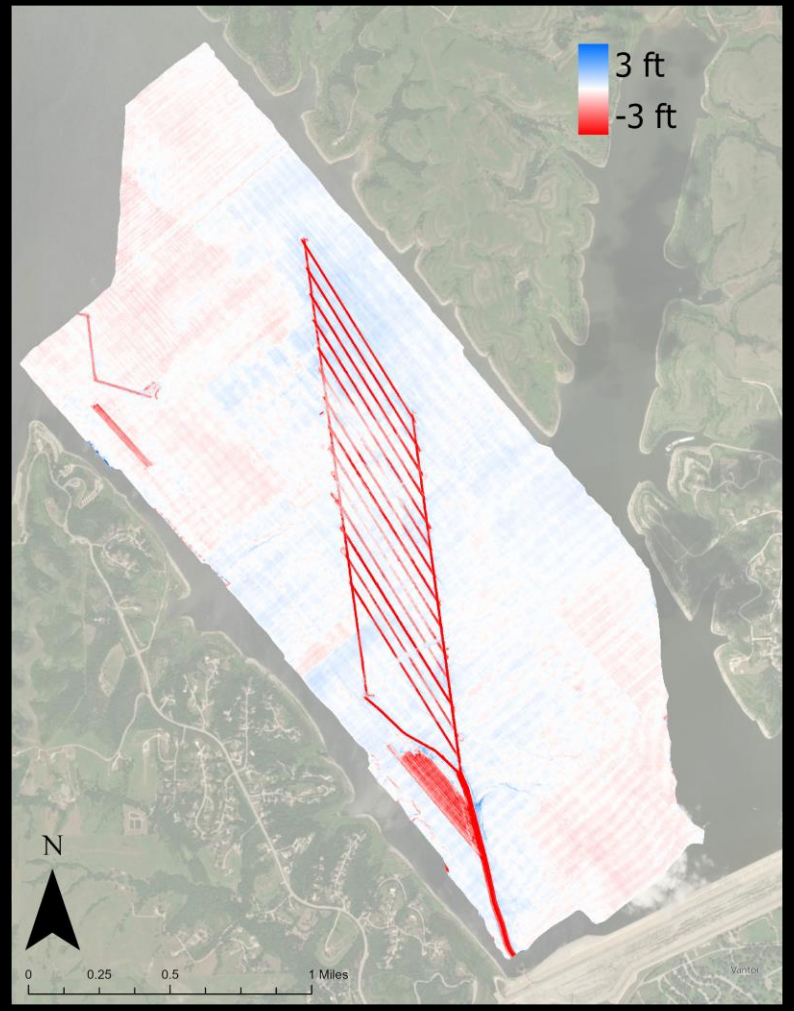


Discharge (blue line) and turbidity (black line) in the channel downstream of Tuttle Creek Lake September 2025, showing a very significant release of sediment during the Water Injection Dredging Demonstration Project.

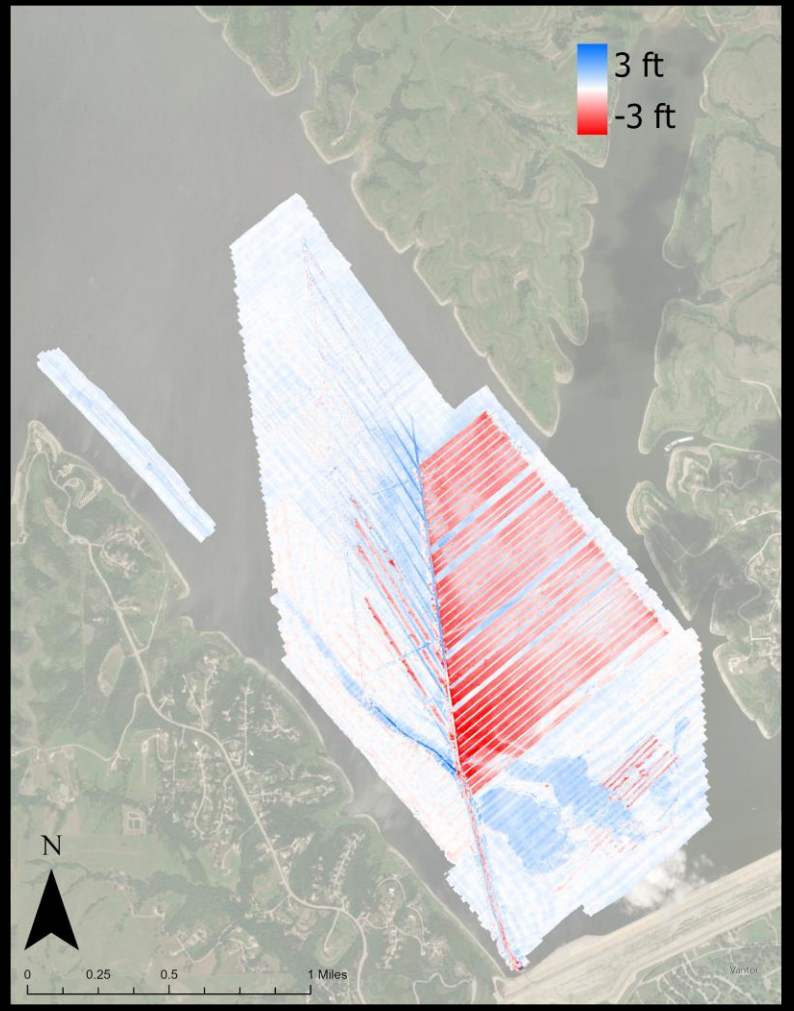
Suspended Sediment Concentration: Within Upstream Natural Variability



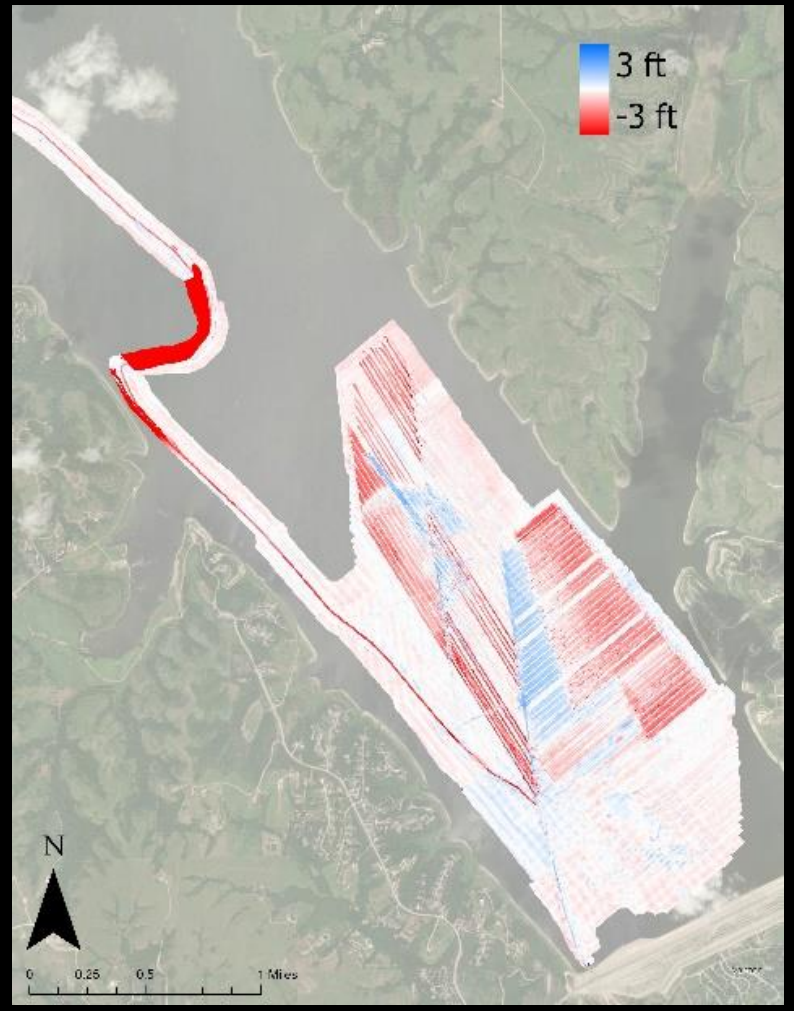
Digital elevation model of difference



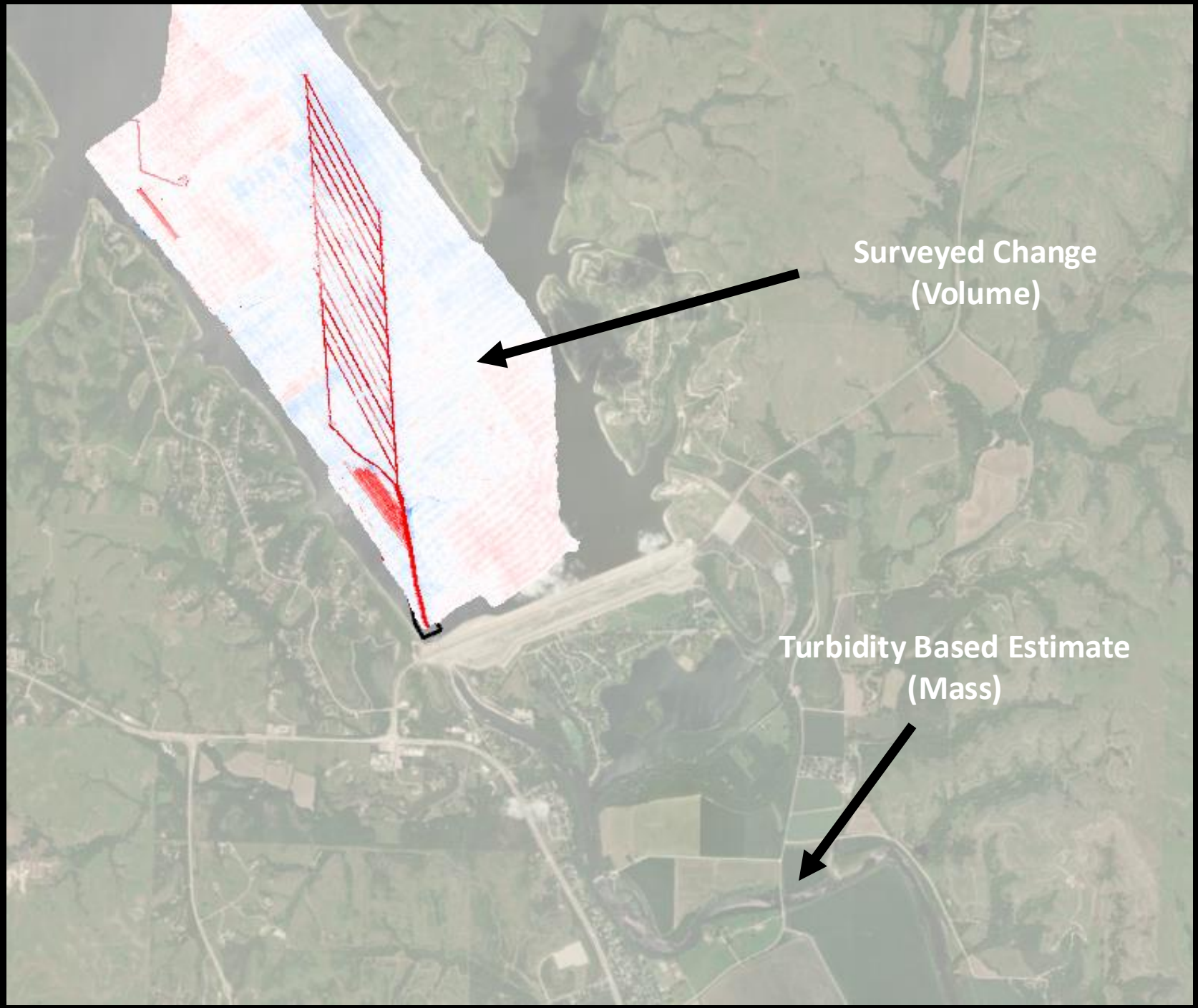
Fall 2025



Spring 2026



Summer 2026


Surveyed Change
(Volume)
Turbidity Based Estimate
(Mass)

Production Values (Preliminary USACE Values)

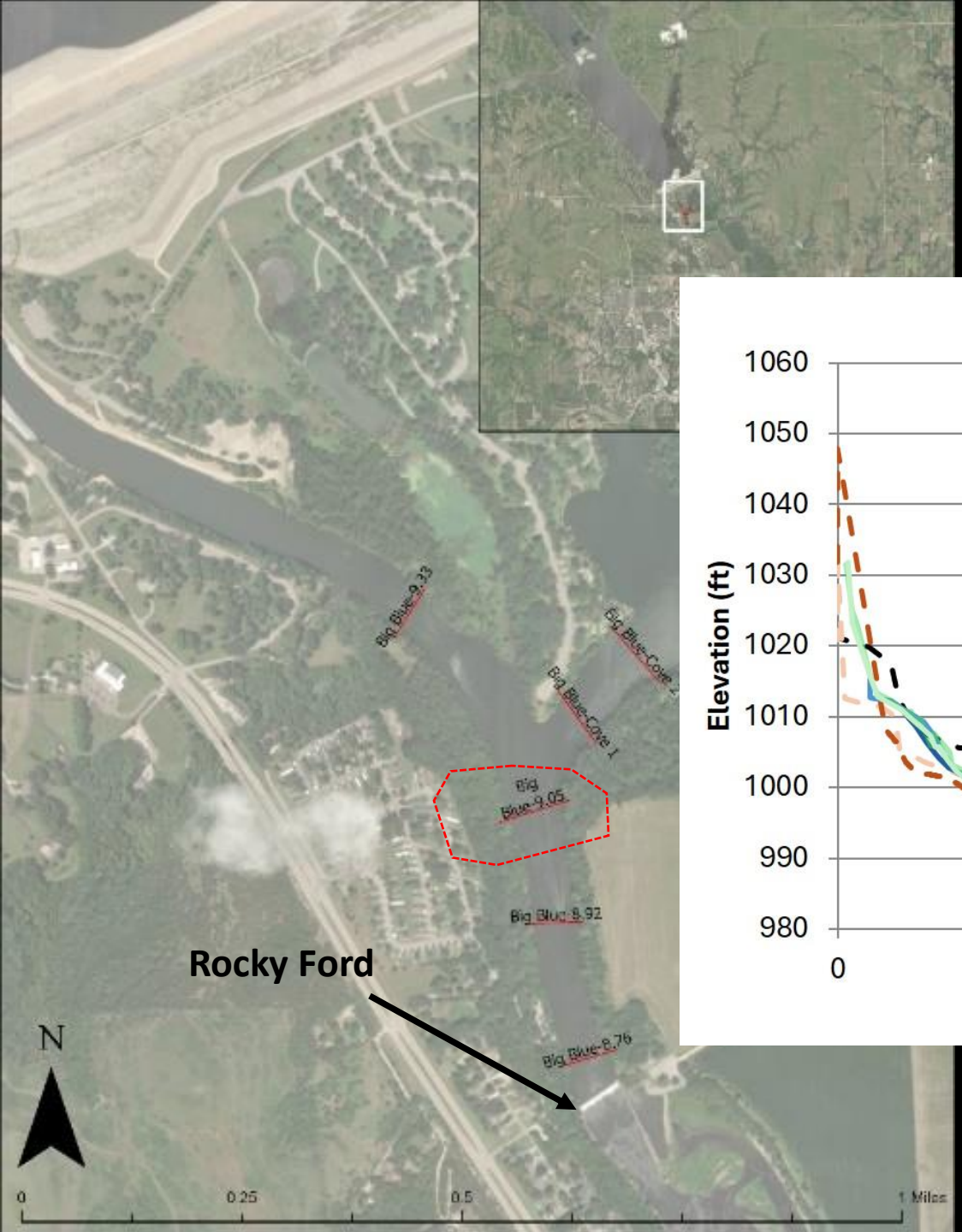
	Surveyed Estimate	Turbidity based Estimate	Turbidity based Lower Estimate	Turbidity based Upper Estimate	**Best Estimate**
	(acre-ft)	(acre-ft)	(acre-ft)	(acre-ft)	**(acre-ft)**
Fall	82	68	56	89	**82**
Spring	165	135	111	176	**165**
Summer	197[t]	60	49	78	**72**
Total	444	263	216	343	**319**

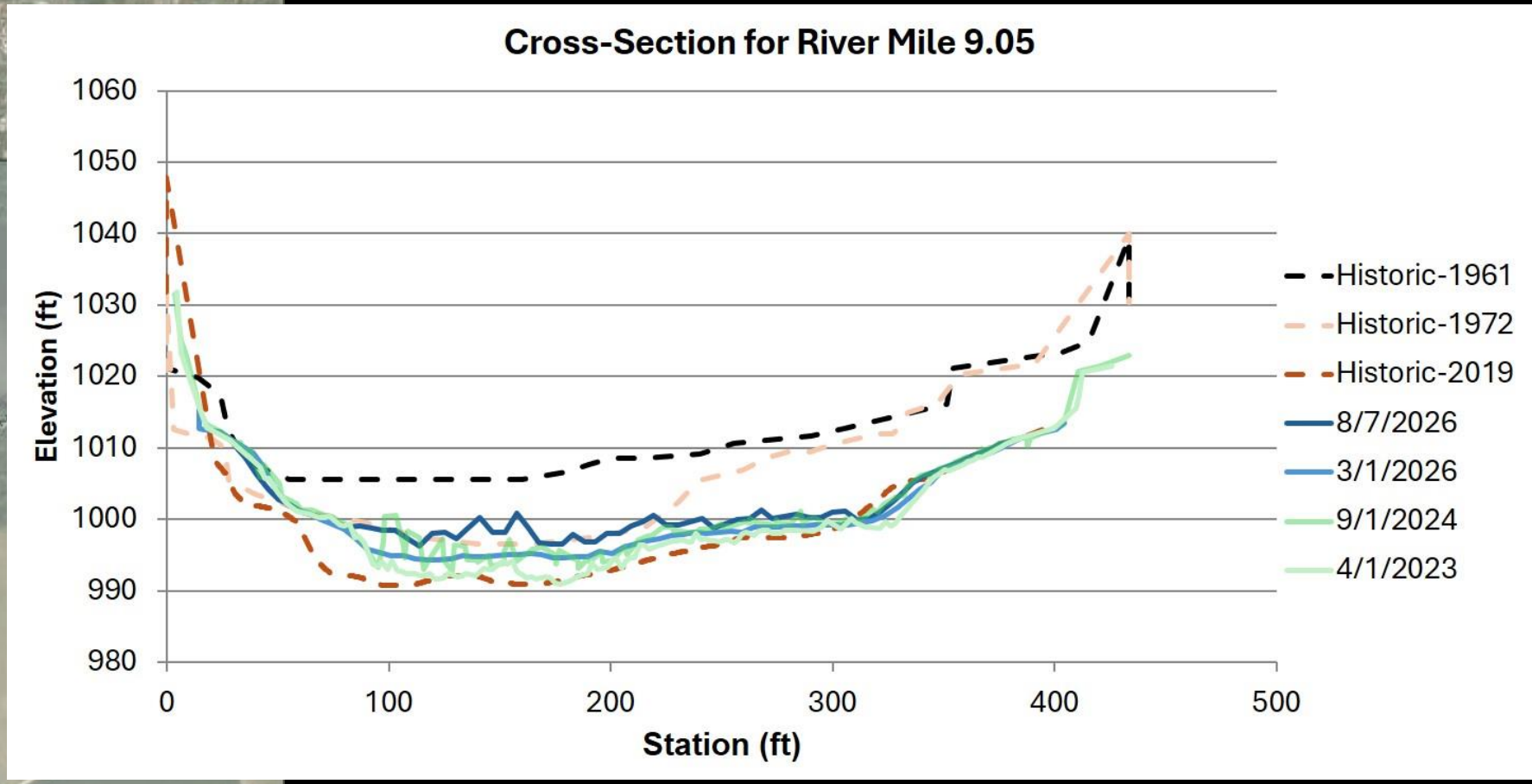
*Multibeam data subtracted out incoming depositional volume

**Turbidity based estimates based on downstream gage date, normalized for baseline load

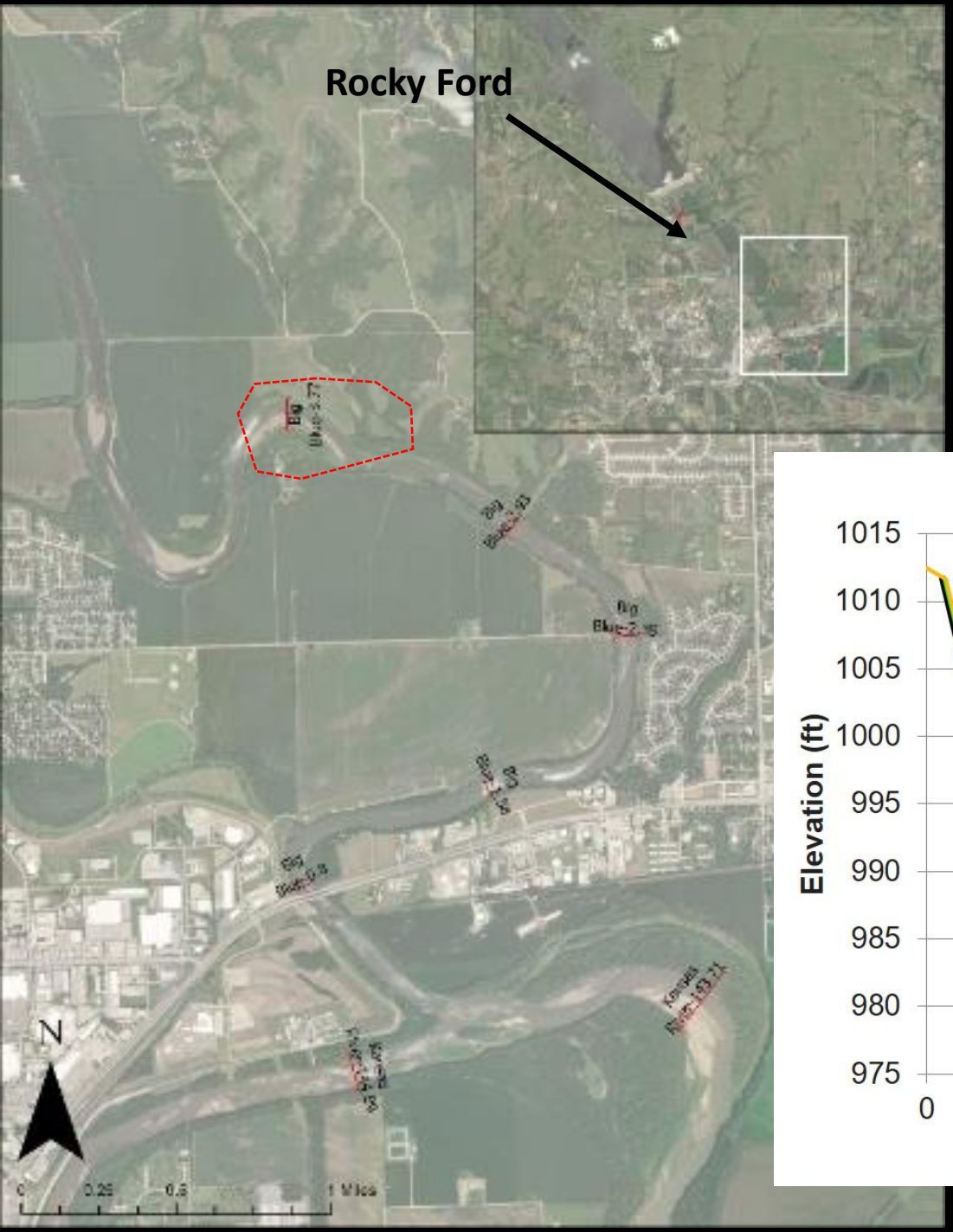
[t] Survey deemed unreliable

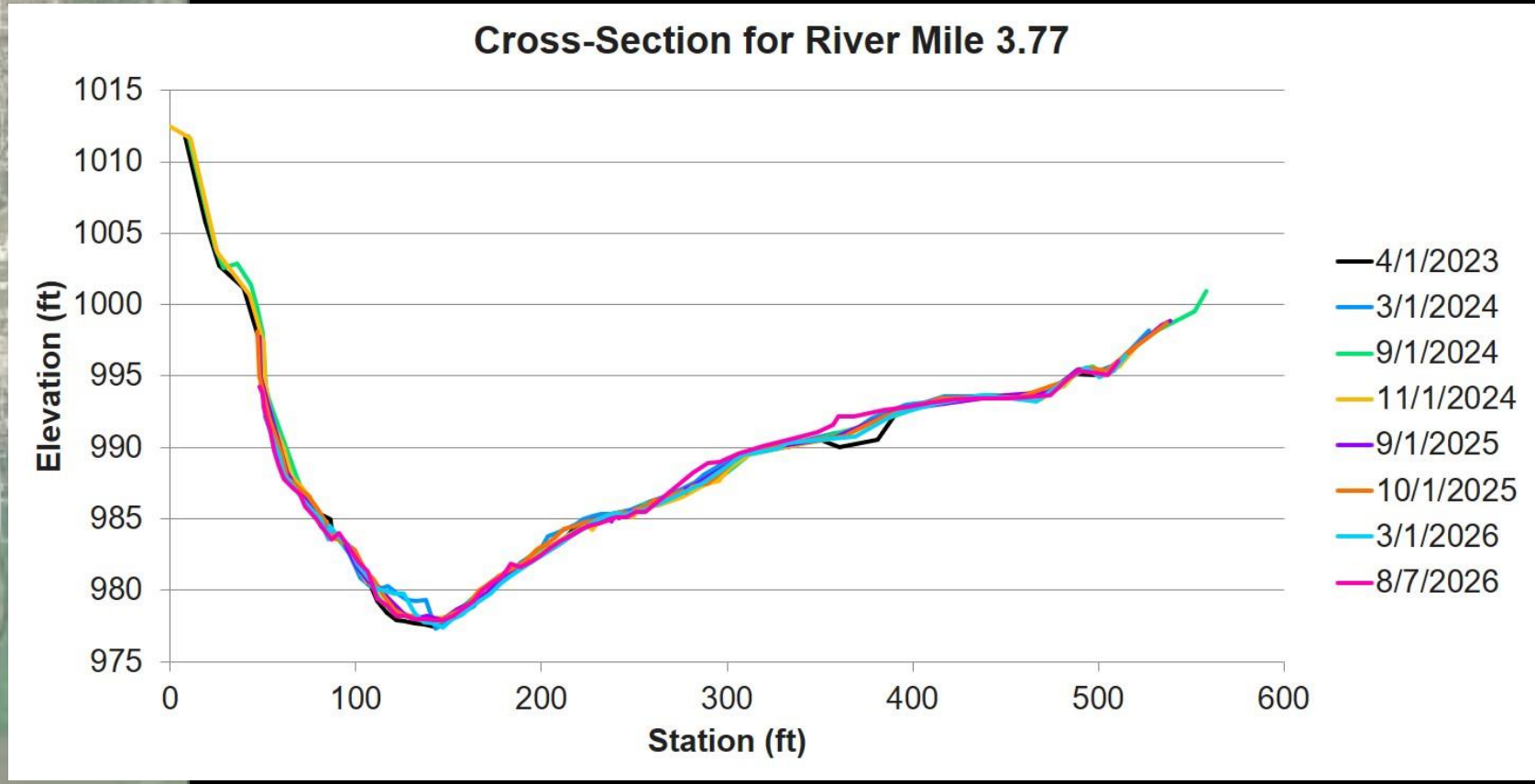
Downstream Transect monitoring





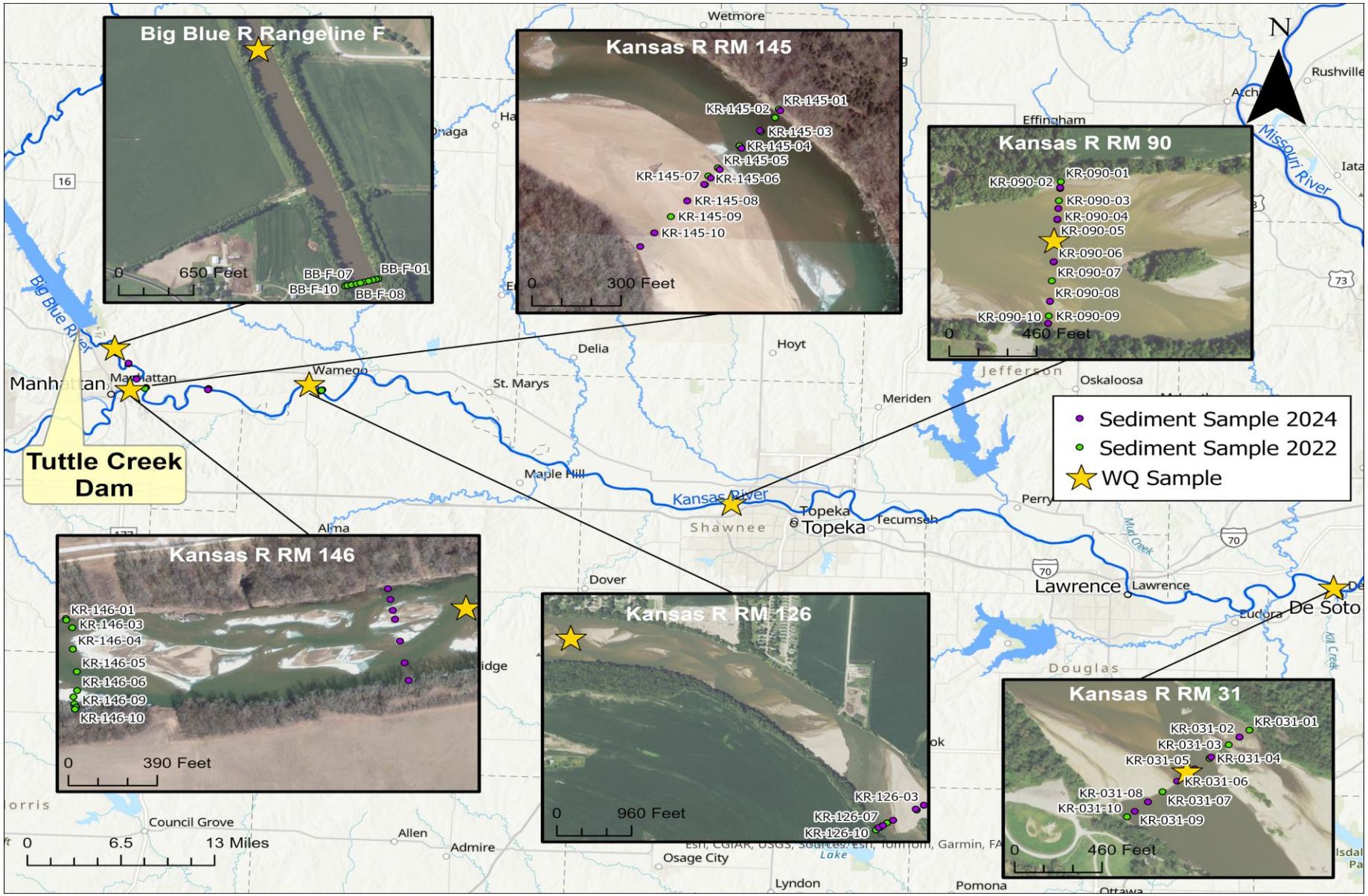
Downstream Transect monitoring





Downstream Channel Monitoring

- 5 continuous gage stations (turbidity/water quality)
- Additional pre/post water/sediment quality measurements
- Cross-sections
- Bed/sandbar sediment
- Invertebrates



Conclusion

- Very successful project at moving sediment downstream
- Impacts confined to region upstream from Rocky Ford
- Cost information forthcoming (USACE official report to be released in March 2027)

Questions?