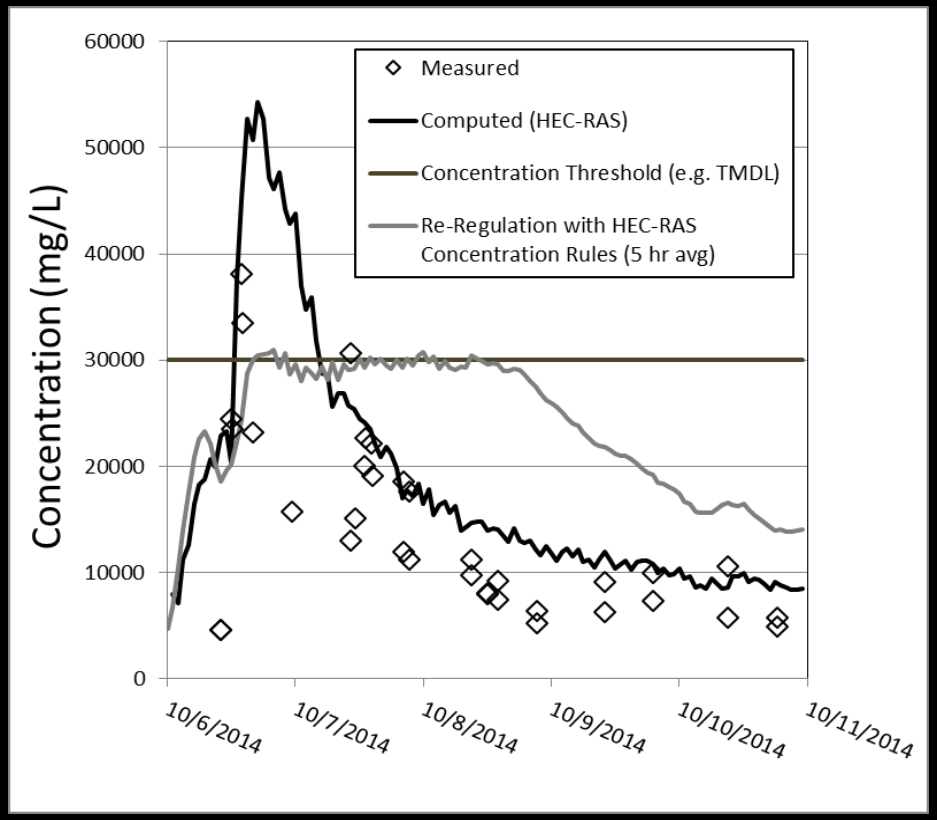
Monitoring and Modeling a Reservoir Flush:

Simulating Sustainable Reservoir Management at Spencer Dam with an HEC-RAS Unsteady Sediment Model and New Sediment Operational Rules

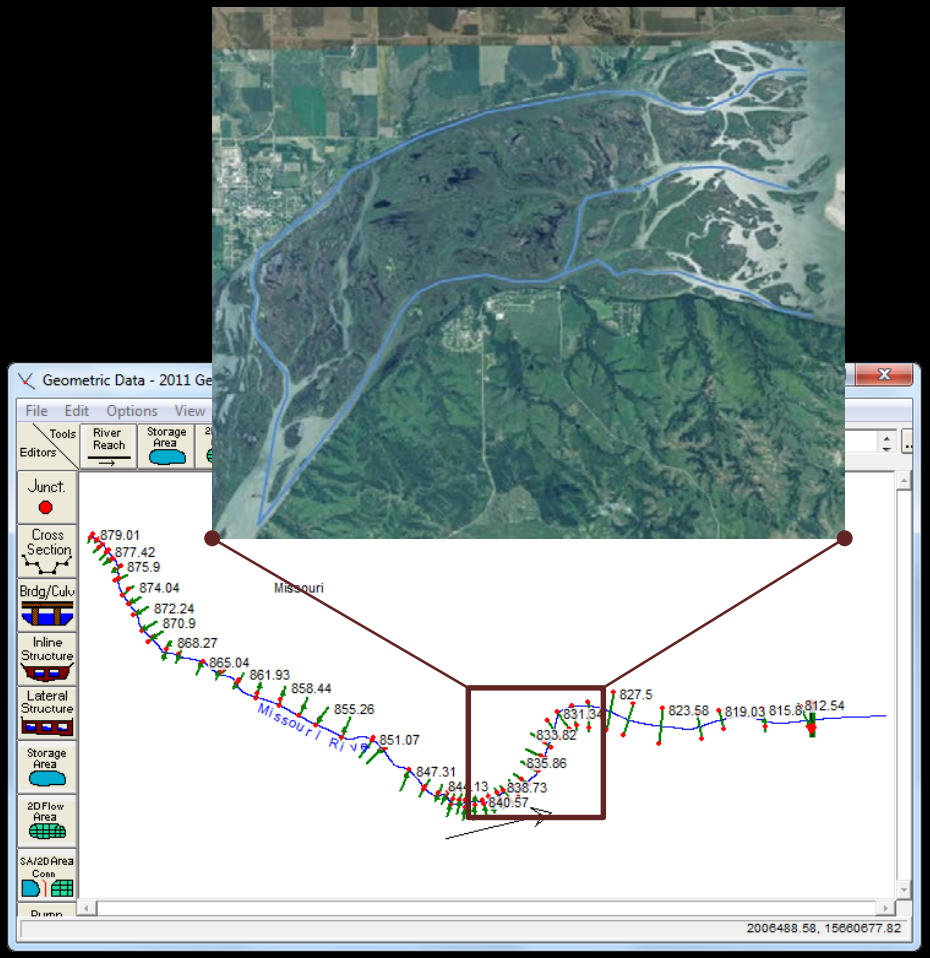


Stanford Gibson, PhD – US Army Corps of Engineers (HEC)

Paul Boyd, PhD, PE – US Army Corps of Engineers (Omaha)

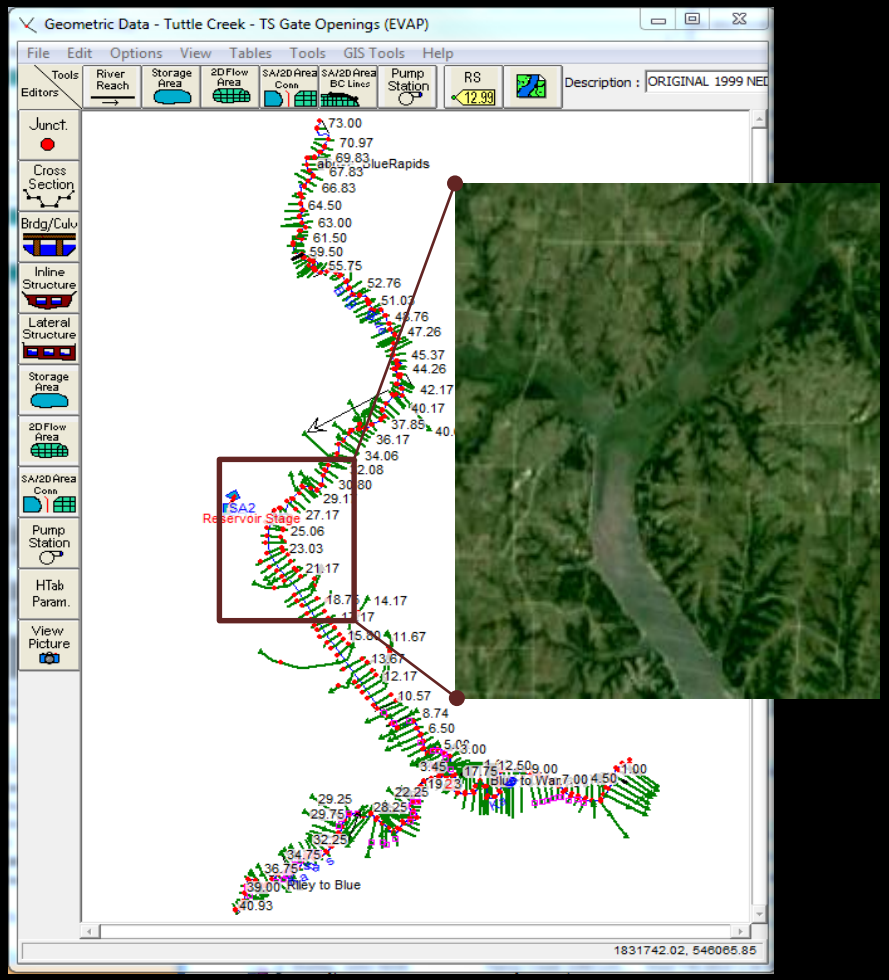
US Army Corps of Engineers®

Lewis and Clark *Flushing* Model



Gibson, S. and Boyd, P. (2014) "Modeling Long Term Alternatives for Sustainable Sediment Management Using Operational Sediment Transport Rules," *Reservoir Sedimentation* –Scheiss et al. (eds), 229-236.

Tuttle Creek Sediment *Routing* Model

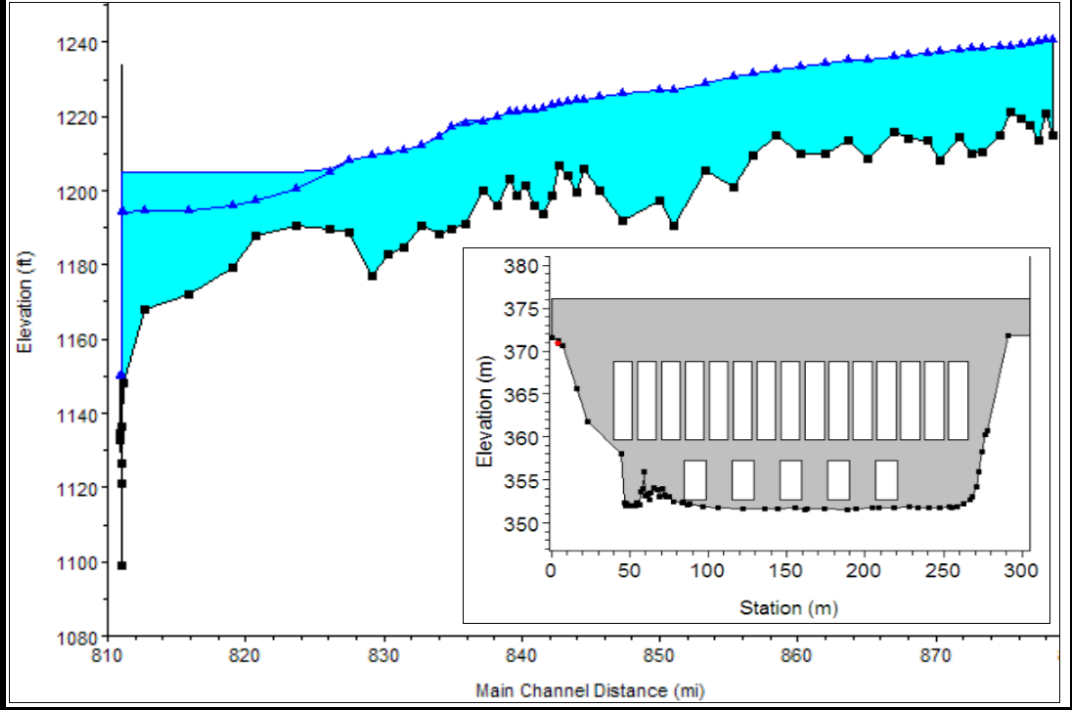


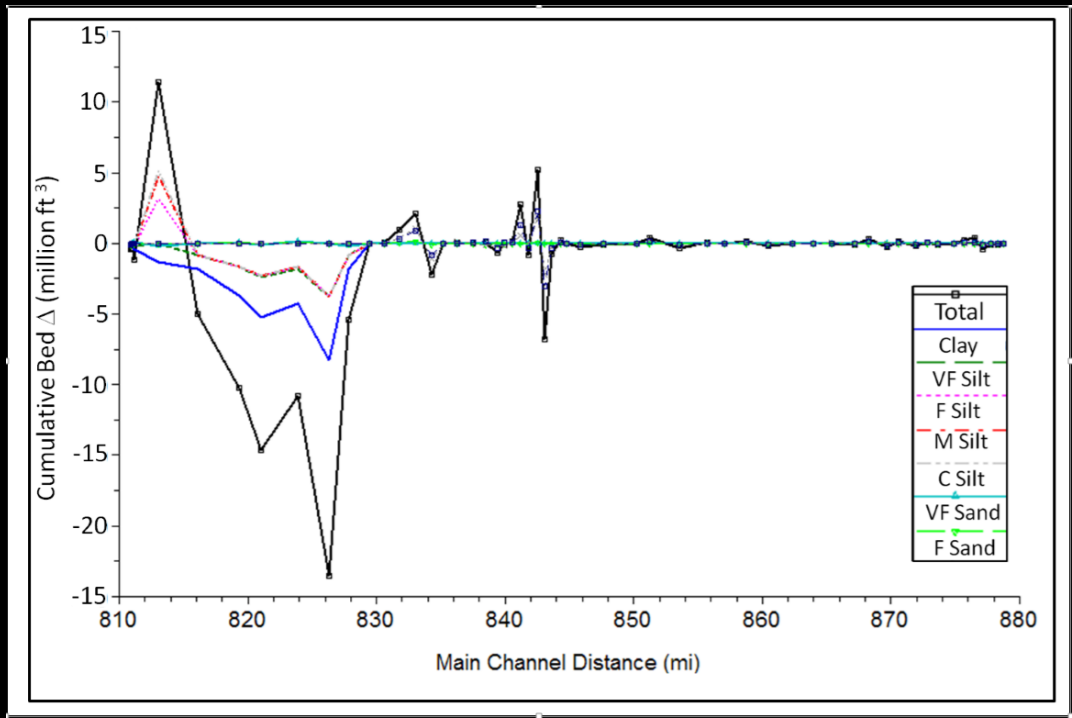
Shelley, J., Gibson, S., and Williams, A. (2015) "Unsteady Flow and Sediment Modeling in a Large Reservoir using HEC-RAS 5.0," Federal Interagency Sediment Conference, SedHyd Proceedings.

"Often the available field data are not sufficient to permit a formal calibration, but computational modeling is still the best method for analyzing the problem… The resulting studies are called computational analysis studies."

-Thomas and Chang

ASCE Manual of Practice 110

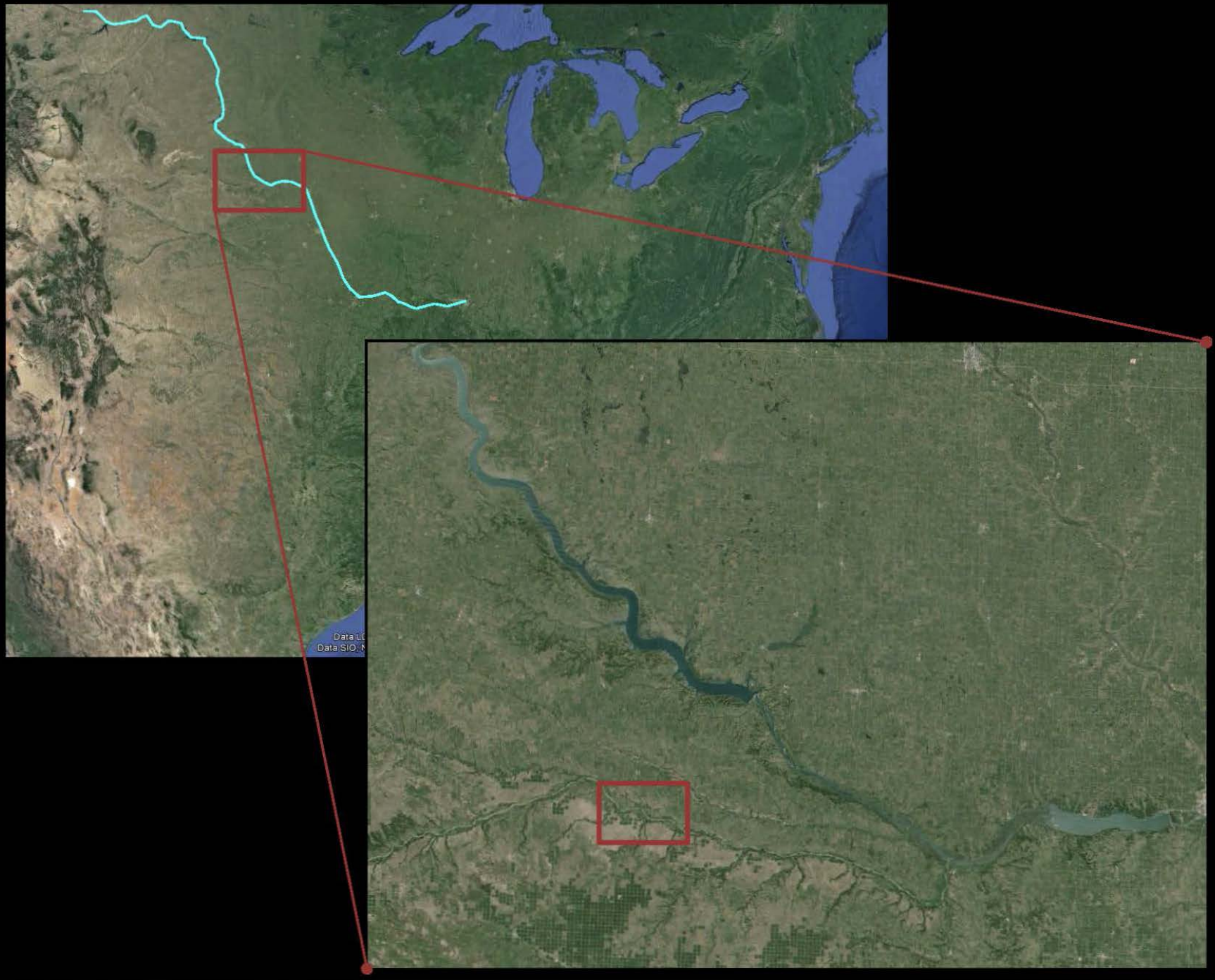


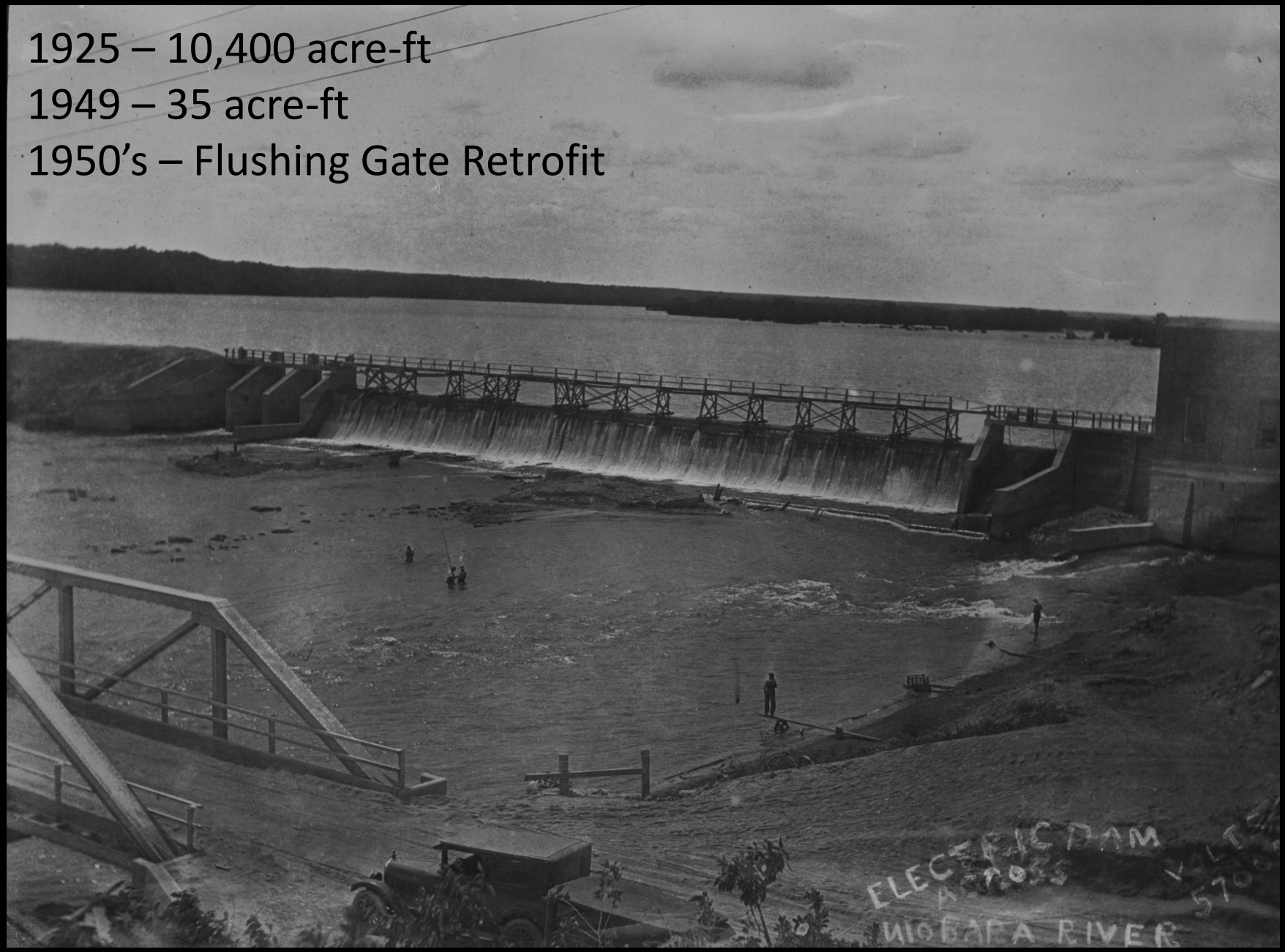


Spencer Dam on the Niobrara River

Spencer Dam Flushing Model

Funded by the Regional Sediment Management R&D Program (RSM)




1925 – 10,400 acre-ft
1949 – 35 acre-ft
1950's – Flushing Gate Retrofit


BUCYRUS-ERIE

The November 2015 Flush

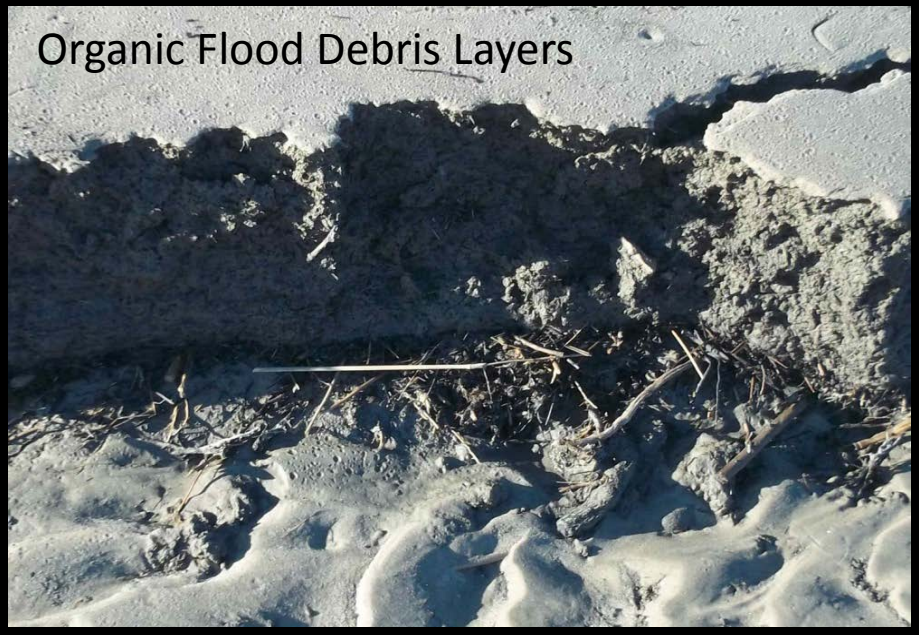

t~8hrs


t~24hrs

Reservoir Stratigraphy


Coarse Sand and Gravel Cross Bedding


Clay Seams


Organic Flood Debris Layers


Mud Flats

Qualitative Observations: Novel Bed Forms

Clay Rollers

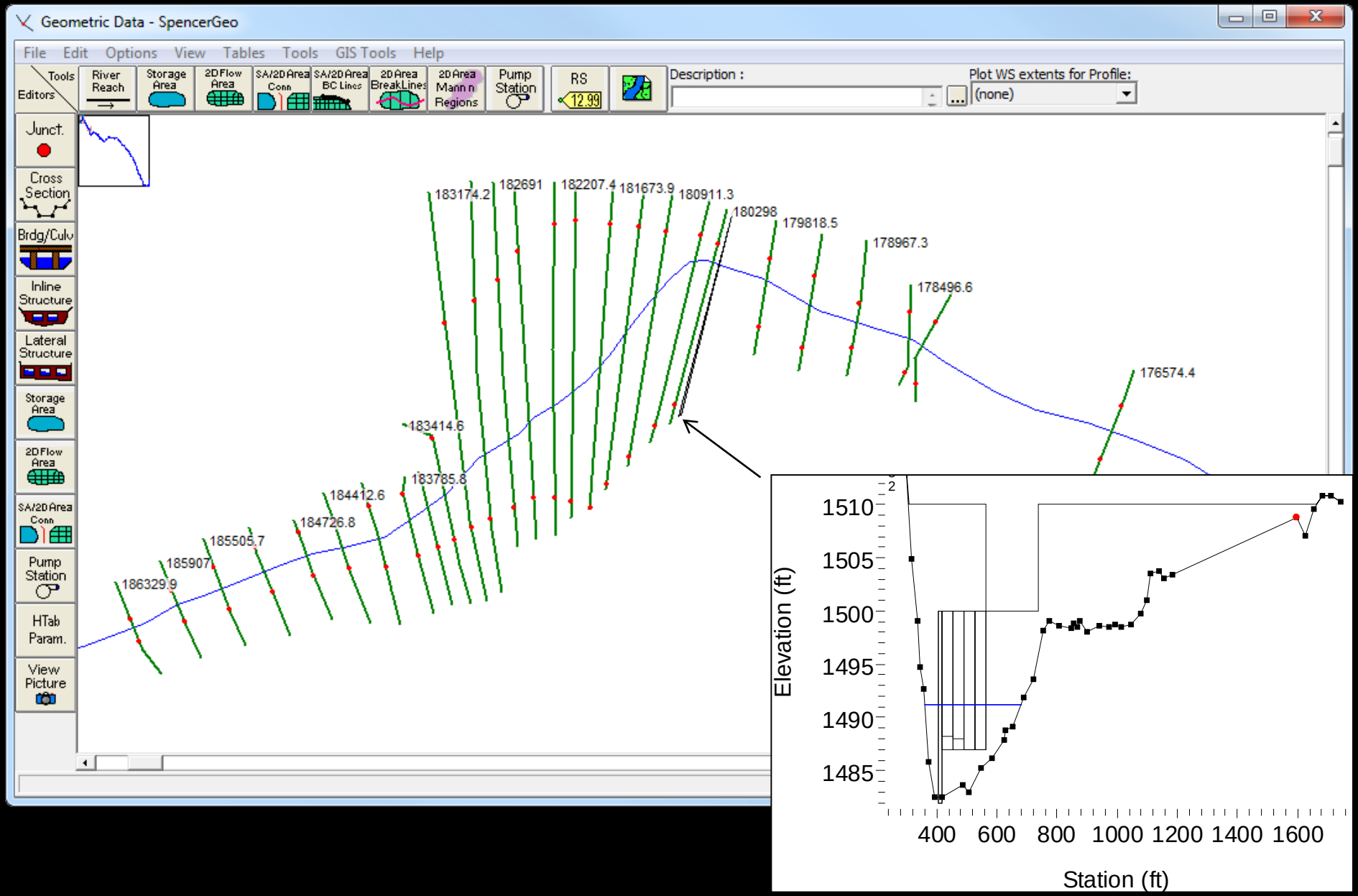
"Topographic" Bed Forms

Periodic Antidunes - 90 s cycle

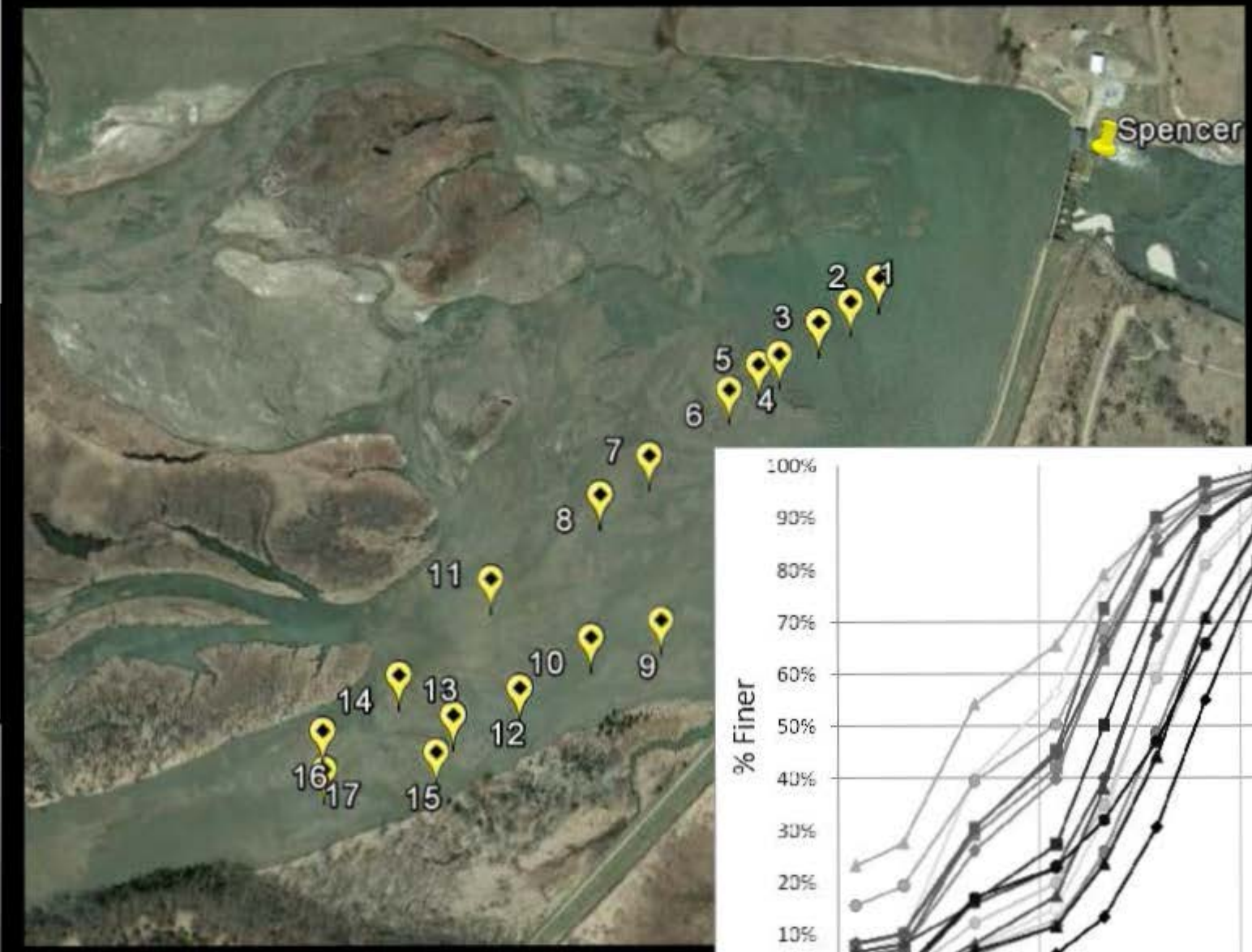
HEC-RAS Model and Calibration

Survey and HEC-geoRAS Model

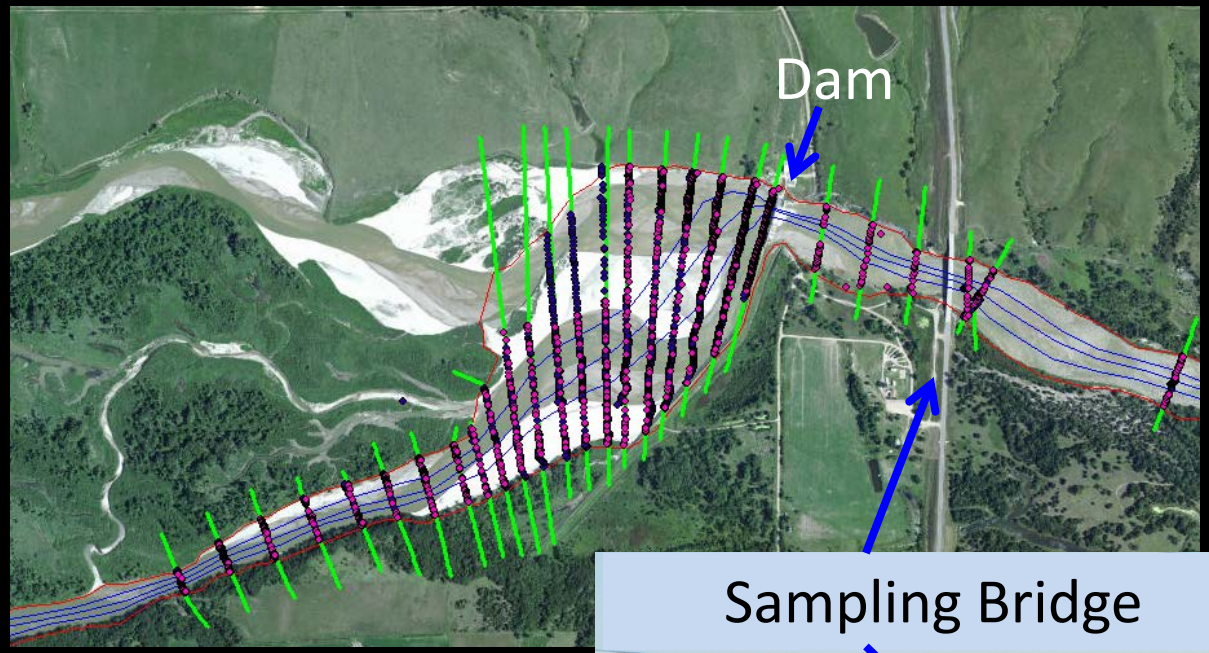
Spencer HEC-RAS Model

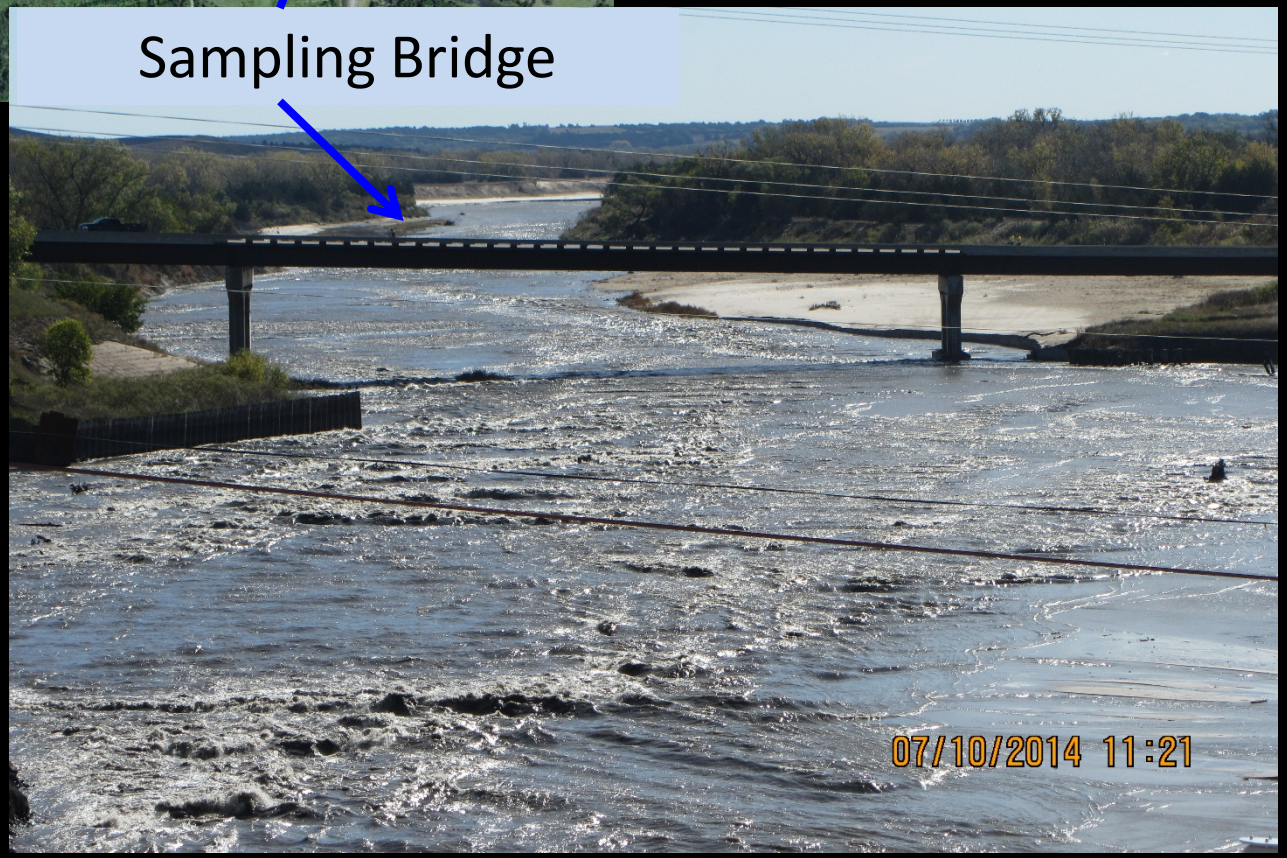


Pre-Flush Sediment Samples

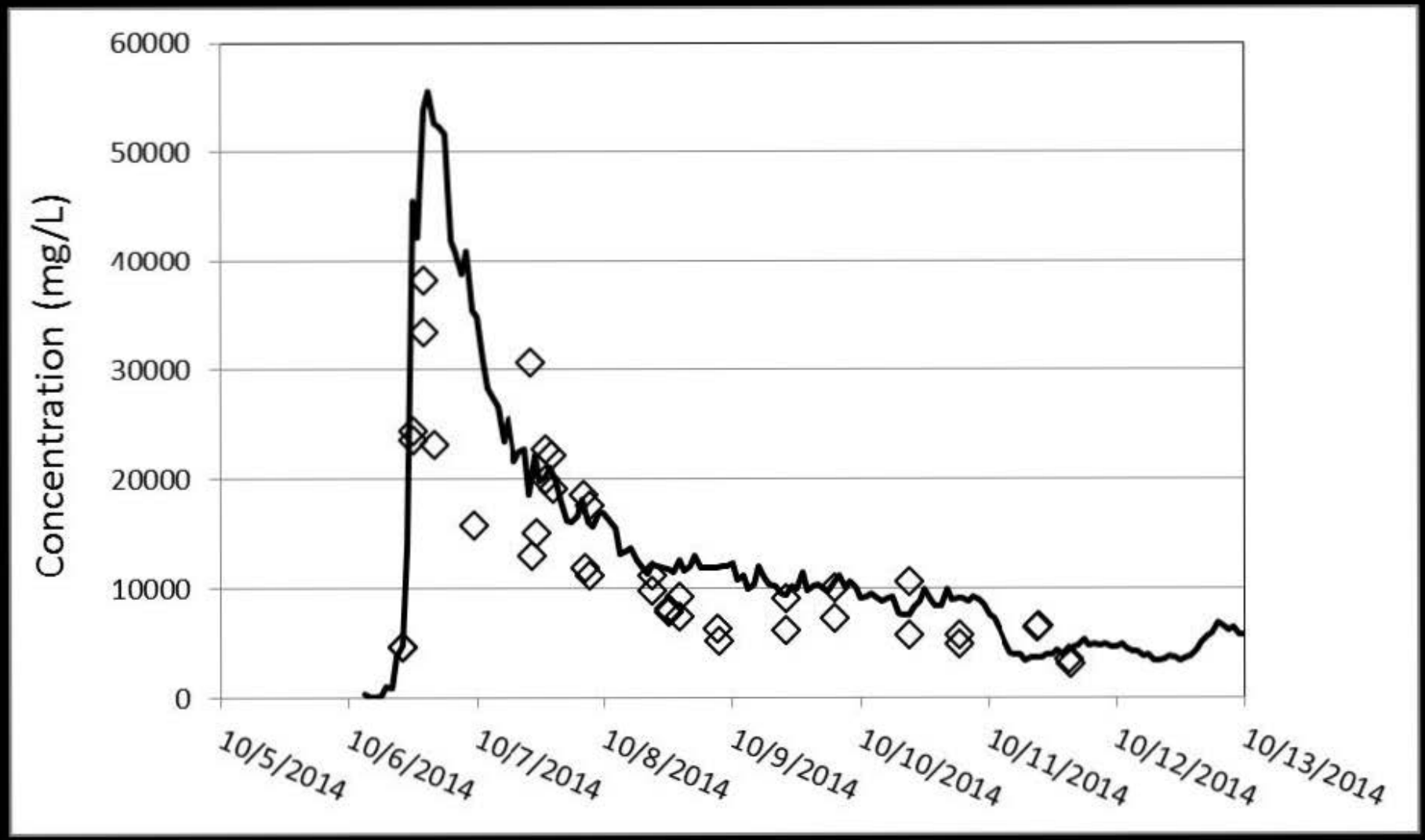


USGS Concentration Measurements

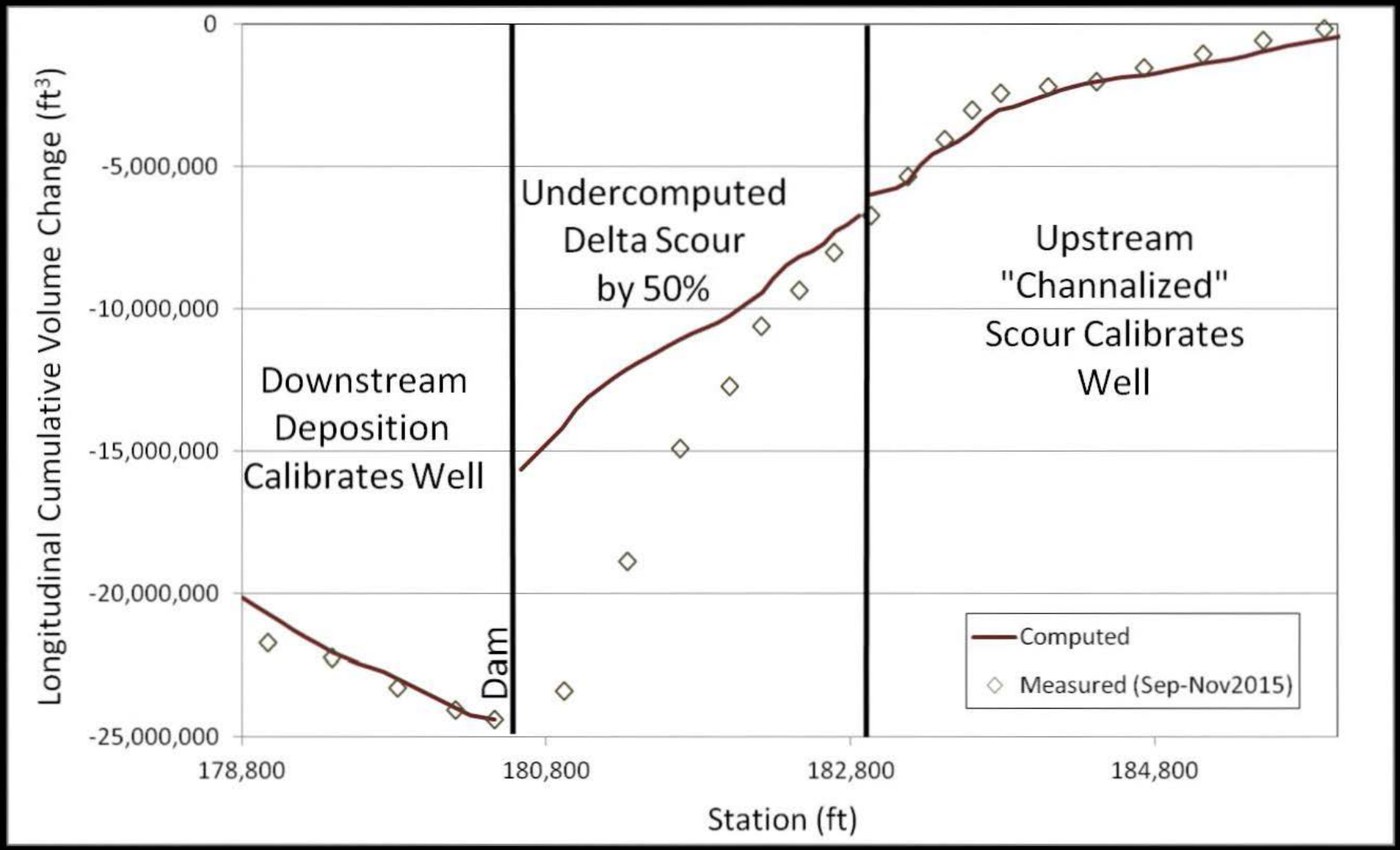




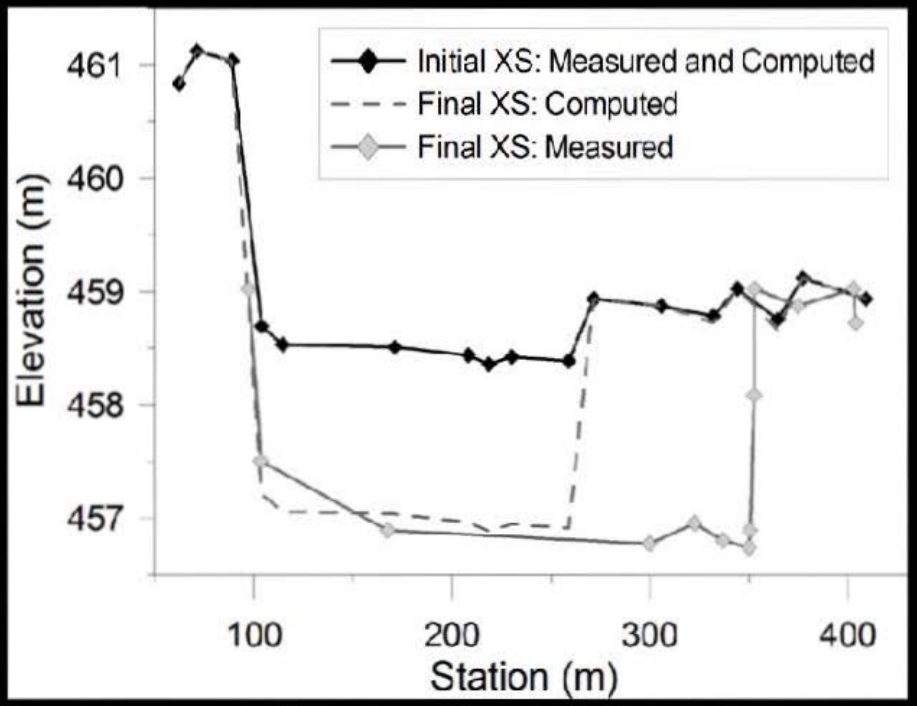
Downstream Concentration Calibration



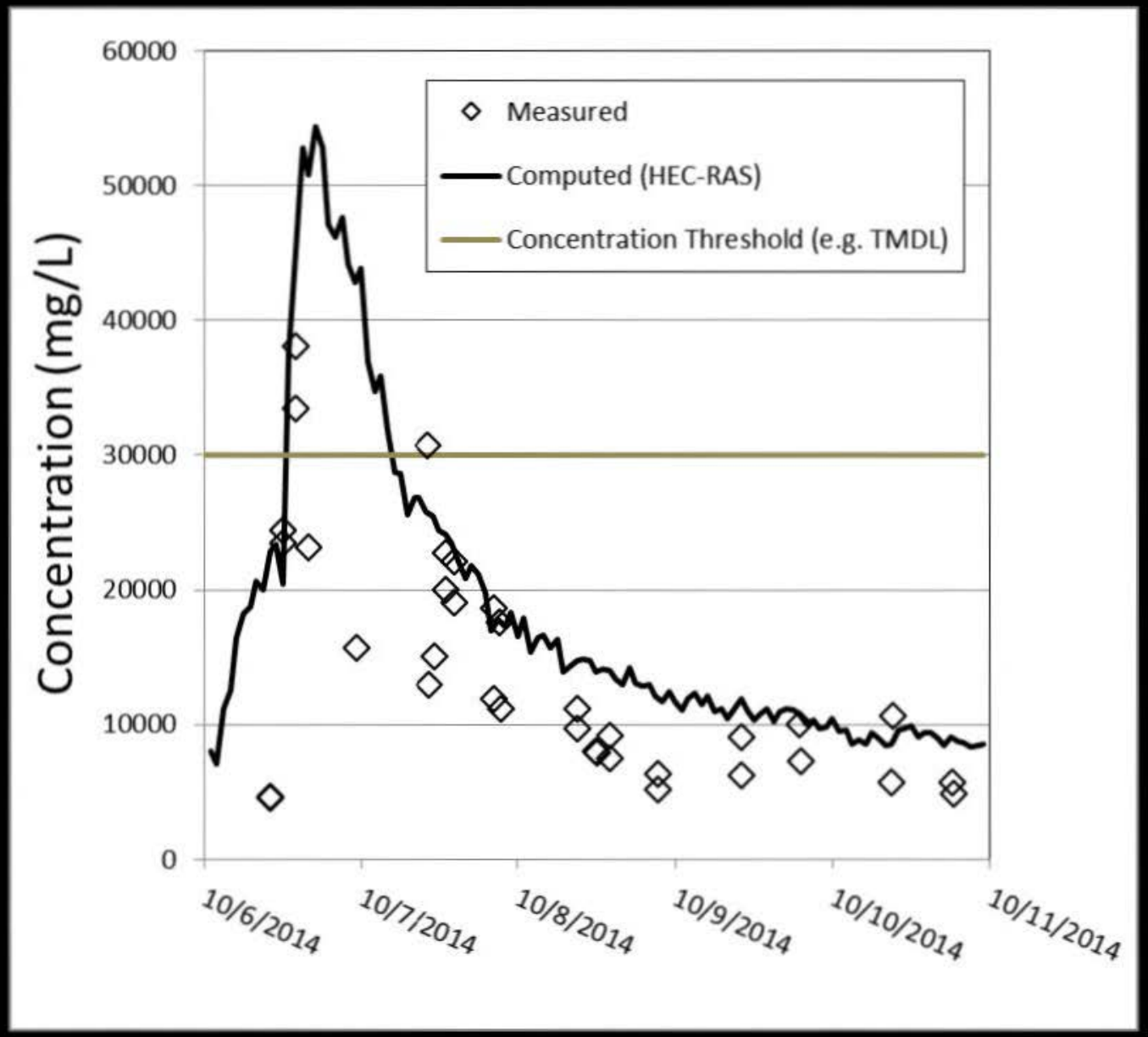
Spencer HEC-RAS Model

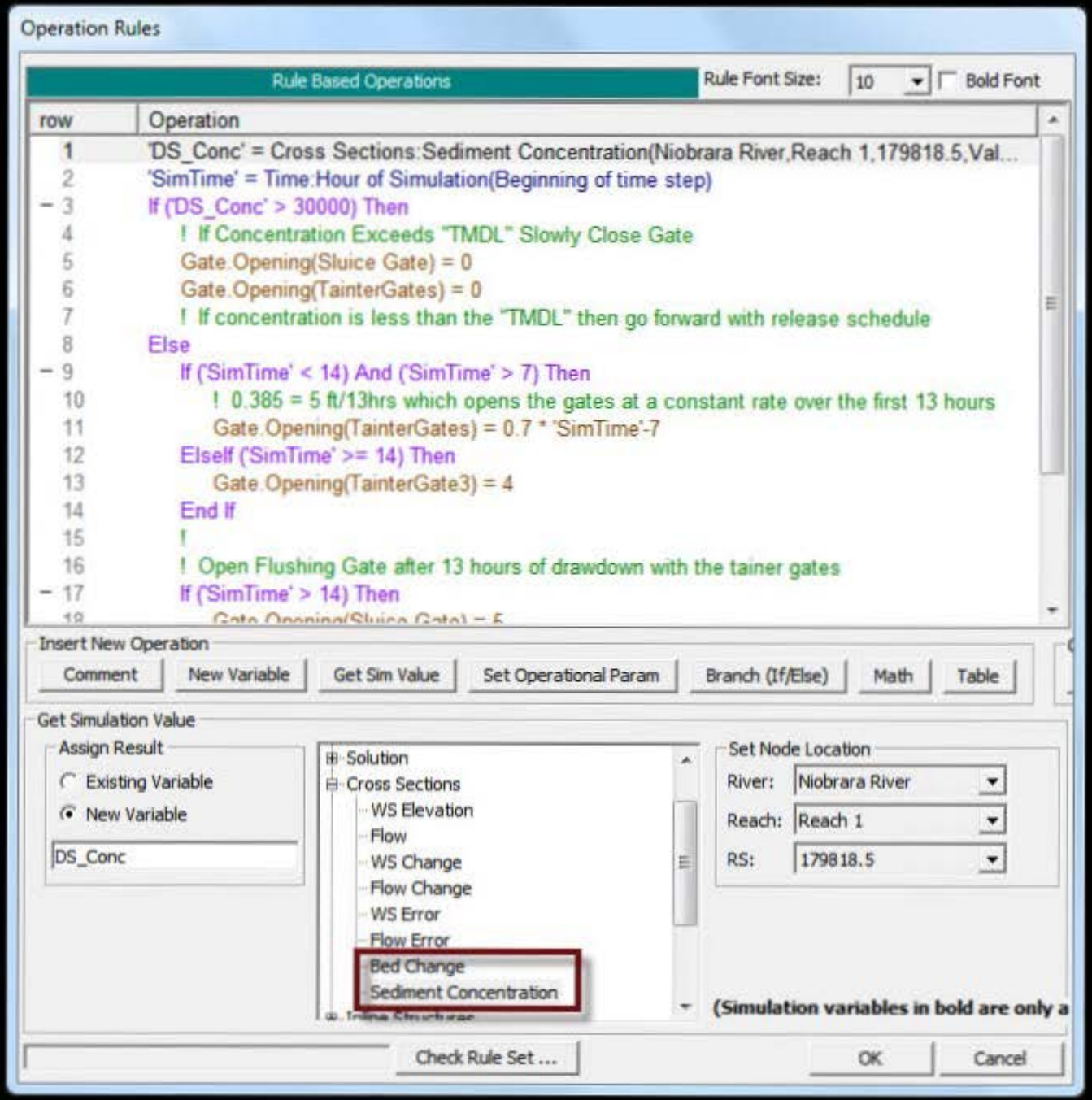


Lateral Processes Observed

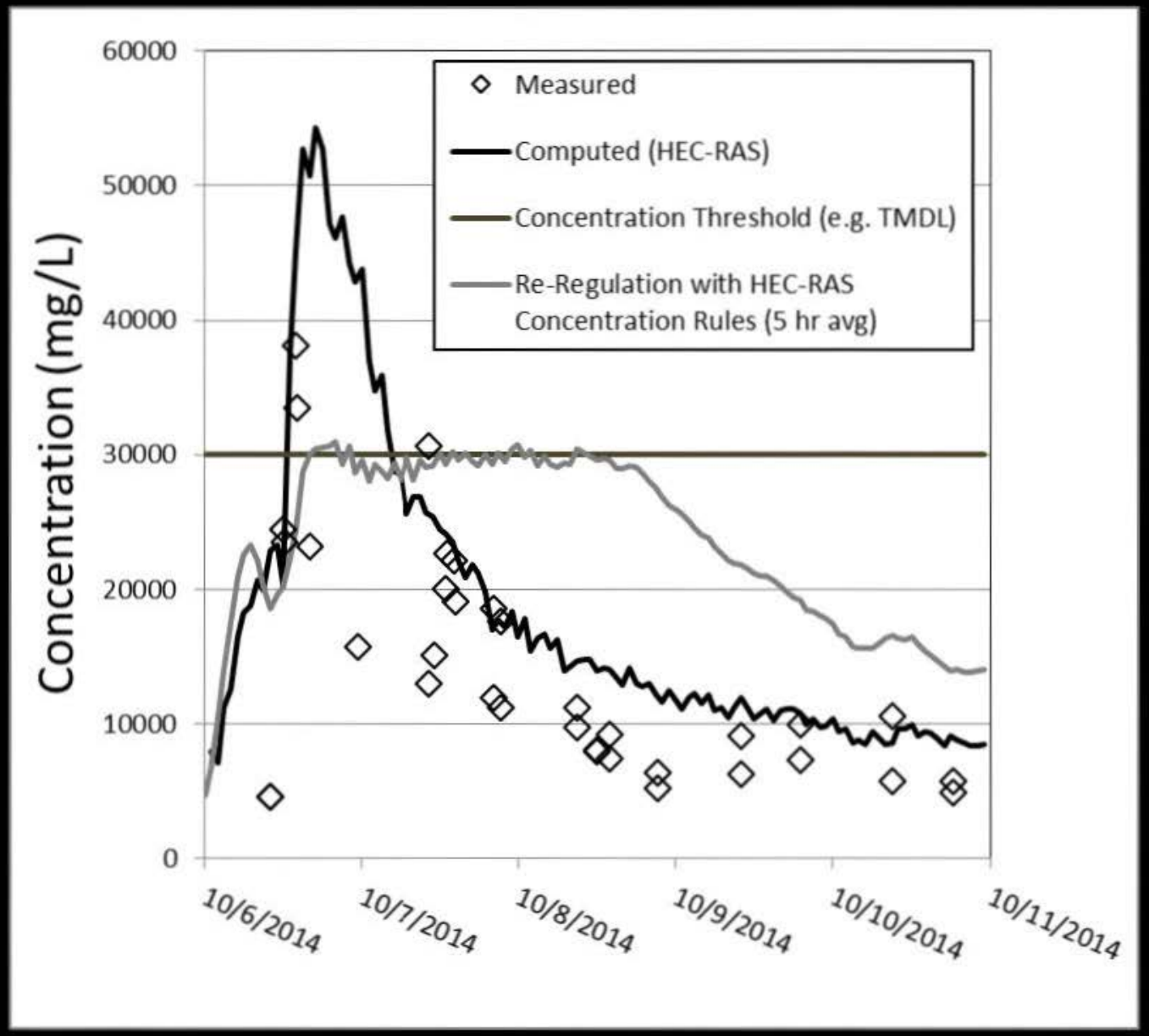


Downstream Concentration Threshold




Operation Rules
Rule Based Operations
Rule Font Size: 10
Bold Font
row
Operation
1 'DS_Conc' = Cross Sections:Sediment Concentration(Niobrara River,Reach 1,179818.5,Val...
2 'SimTime' = Time:Hour of Simulation(Beginning of time step)
3 If ('DS_Conc' > 30000) Then
4 ! If Concentration Exceeds "TMDL" Slowly Close Gate
5 Gate.Opening(Sluice Gate) = 0
6 Gate.Opening(TainterGates) = 0
7 ! If concentration is less than the "TMDL" then go forward with release schedule
8 Else
9 If ('SimTime' < 14) And ('SimTime' > 7) Then
10 ! 0.385 = 5 ft/13hrs which opens the gates at a constant rate over the first 13 hours
11 Gate.Opening(TainterGates) = 0.7 * 'SimTime'-7
12 ElseIf ('SimTime' >= 14) Then
13 Gate.Opening(TainterGate3) = 4
14 End If
15 !
16 ! Open Flushing Gate after 13 hours of drawdown with the tainer gates
17 If ('SimTime' > 14) Then
Insert New Operation
Comment
New Variable
Get Sim Value
Set Operational Param
Branch (If/Else)
Math
Table
Get Simulation Value
Assign Result
Existing Variable
New Variable
DS_Conc
Solution
Cross Sections
WS Elevation
Flow
WS Change
Flow Change
WS Error
Flow Error
Bed Change
Sediment Concentration
Set Node Location
River: Niobrara River
Reach: Reach 1
RS: 179818.5
(Simulation variables in bold are only a
Check Rule Set ...
OK
Cancel

HEC-RAS Concentration Threshold Model



Partners

Funding Partners:

Regional Sediment Management R&D Program (RSM)
Flood and Coastal Storm Damage Reduction R&D Program
Omaha District
USGS

HEC-RAS Team:

Gary Brunner, Mark Jensen, Steve Piper, Cam Ackerman, Alex Kennedy

District Partners:

Paul Boyd, PhD, PE – NWO
John Shelley, PhD – NWK

Niobrara River