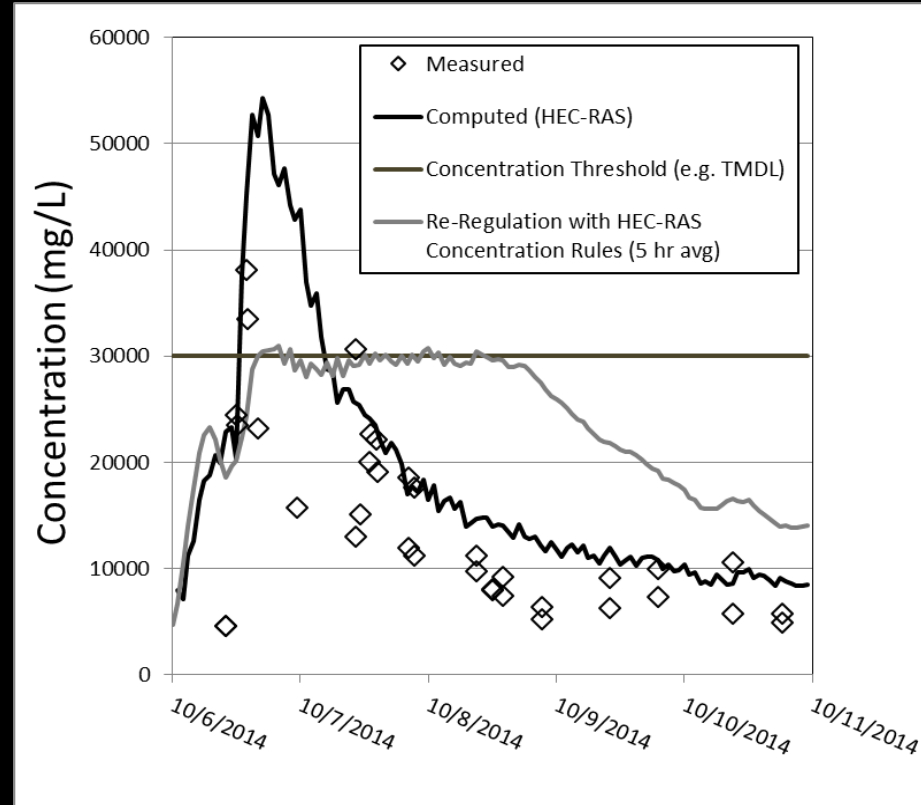
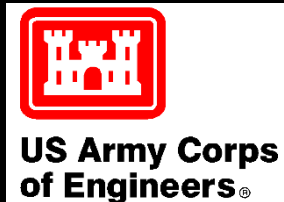


Monitoring and Modeling a Reservoir Flush:

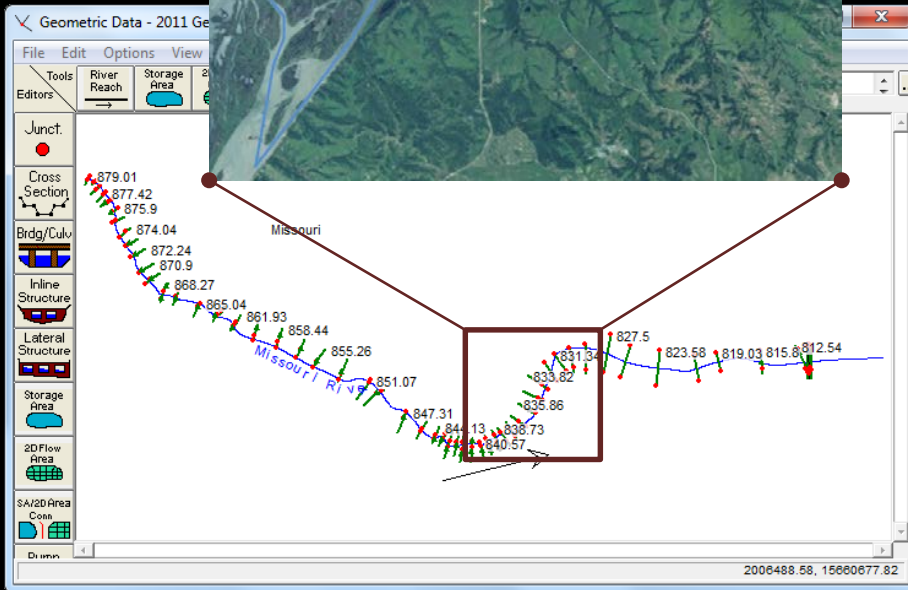
Simulating Sustainable Reservoir Management at Spencer Dam with an HEC-RAS Unsteady Sediment Model and New Sediment Operational Rules



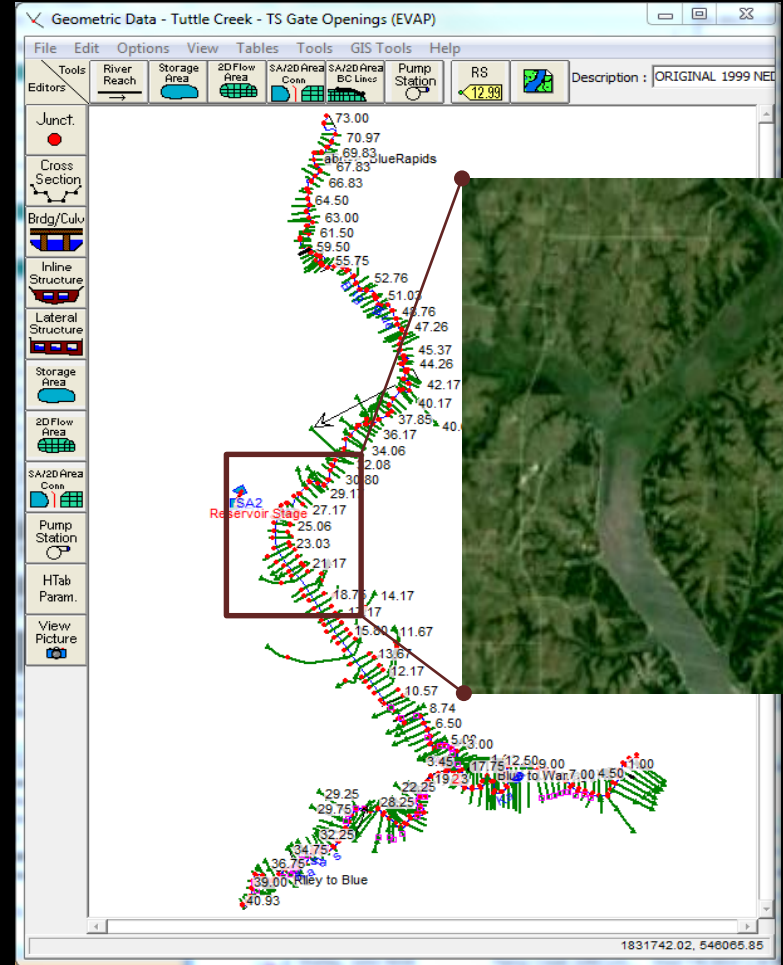
Stanford Gibson, PhD – US Army Corps of Engineers (HEC)
Paul Boyd, PhD, PE – US Army Corps of Engineers (Omaha)



Lewis and Clark Flushing Model



Tuttle Creek Sediment Routing Model

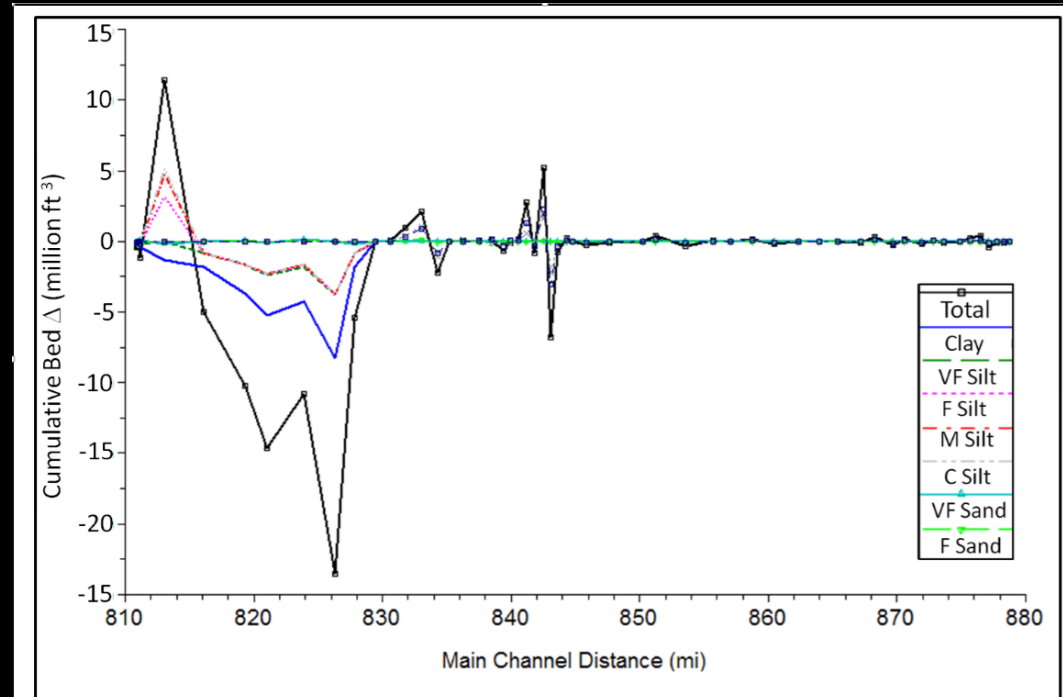
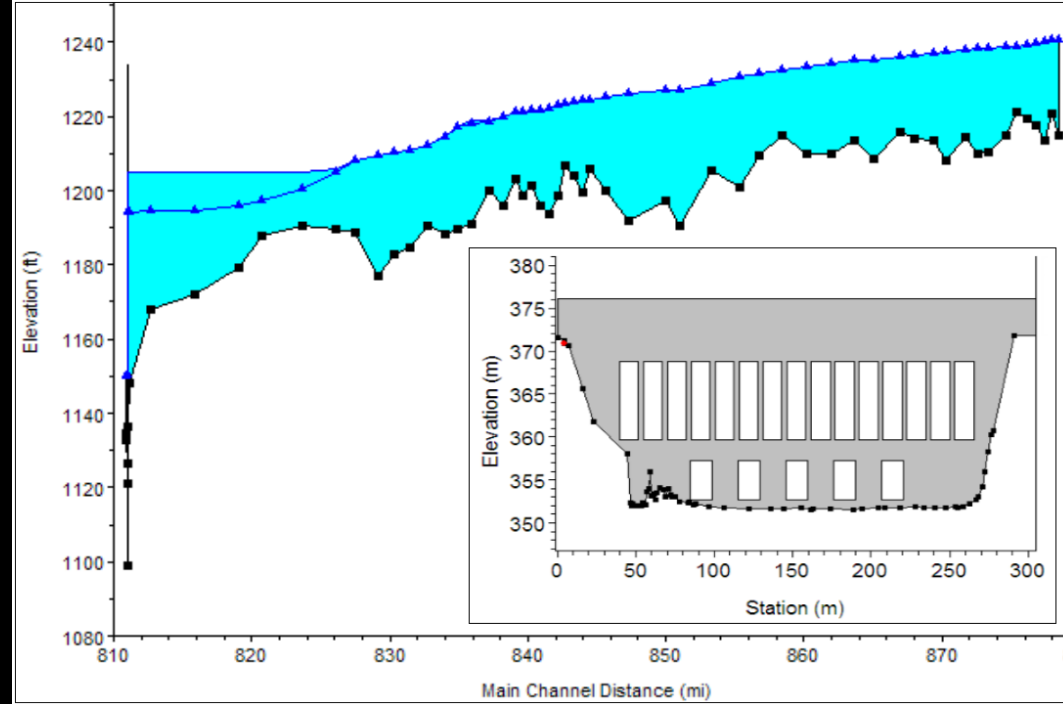


Gibson, S. and Boyd, P. (2014) "Modeling Long Term Alternatives for Sustainable Sediment Management Using Operational Sediment Transport Rules," *Reservoir Sedimentation* –Scheiss et al. (eds), 229-236.

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

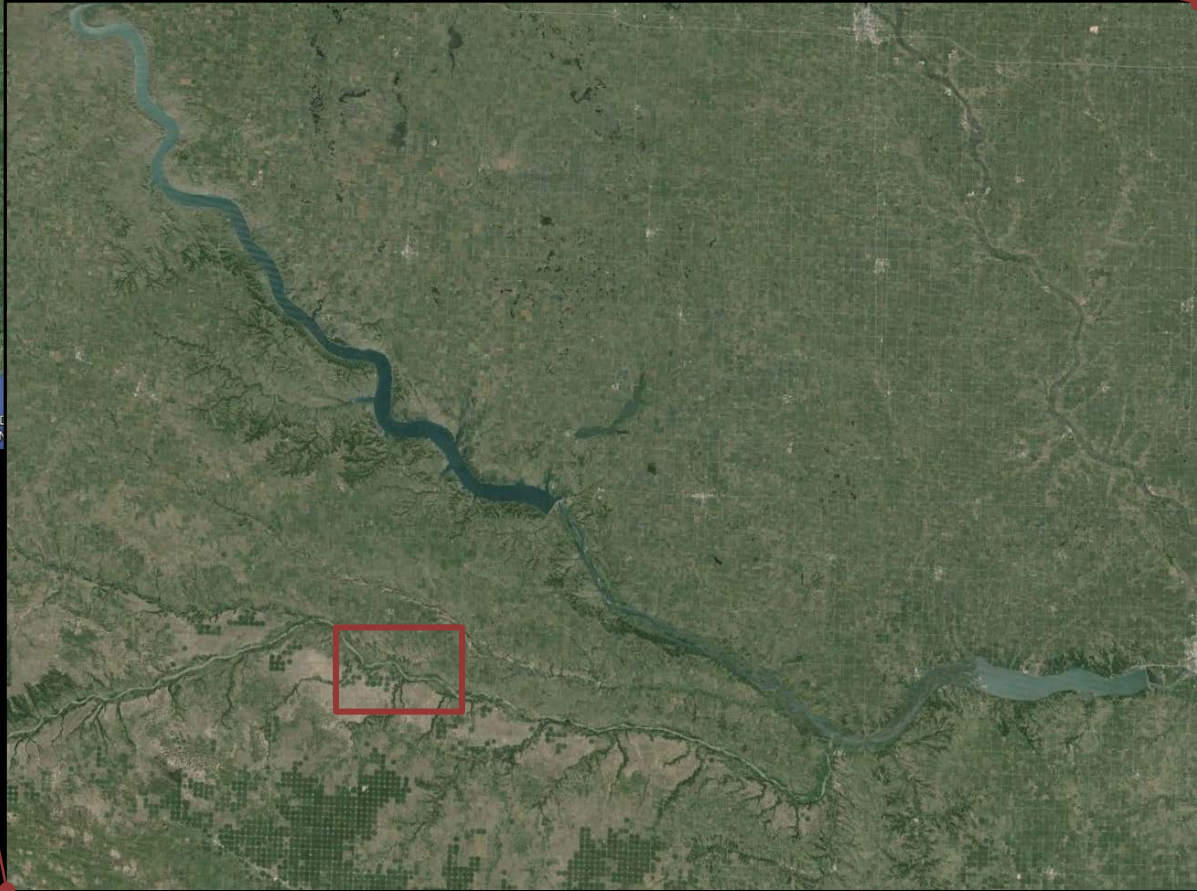
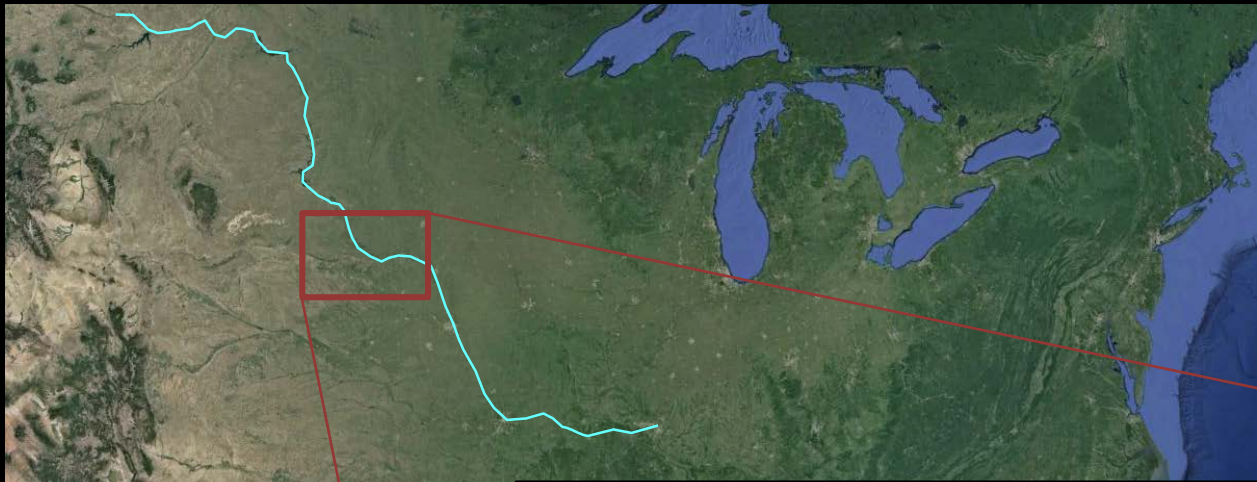


Spencer Dam on the Niobrara River

Spencer Dam Flushing Model



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



Data L
Data SIO, N



1925 – 10,400 acre-ft

1949 – 35 acre-ft

1950's – Flushing Gate Retrofit





The November 2015 Flush







t~8hrs



t~24hrs

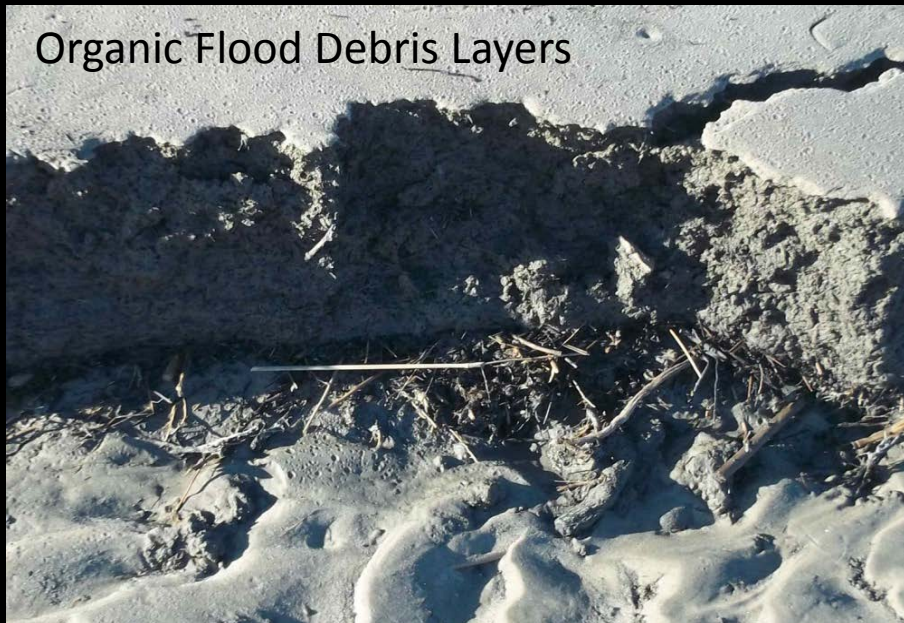
Reservoir Stratigraphy



Coarse Sand and Gravel Cross Bedding



Clay Seams



Organic Flood Debris Layers



Mud Flats

Qualitative Observations: Novel Bed Forms



Clay Rollers



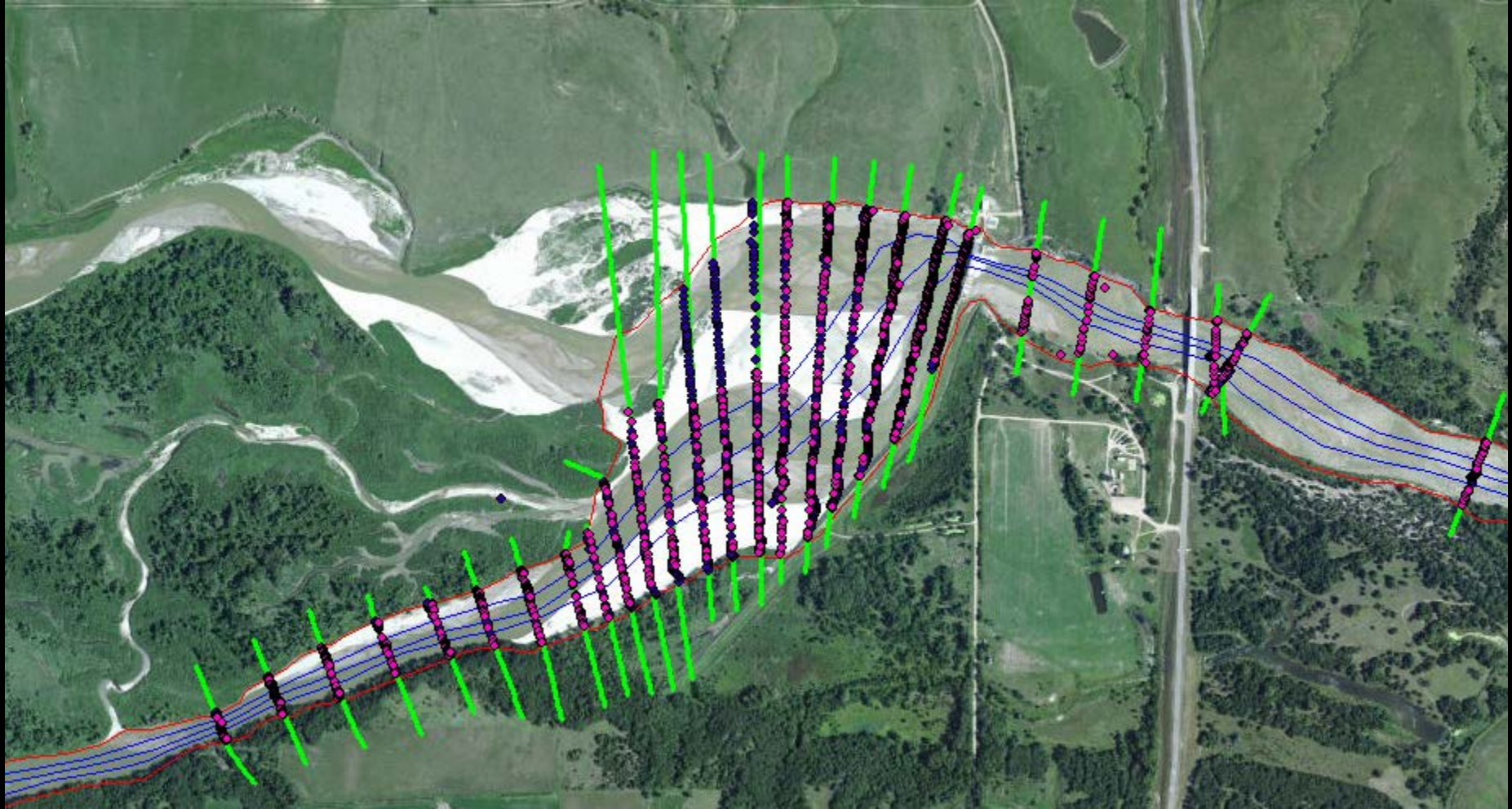
“Topographic” Bed Forms



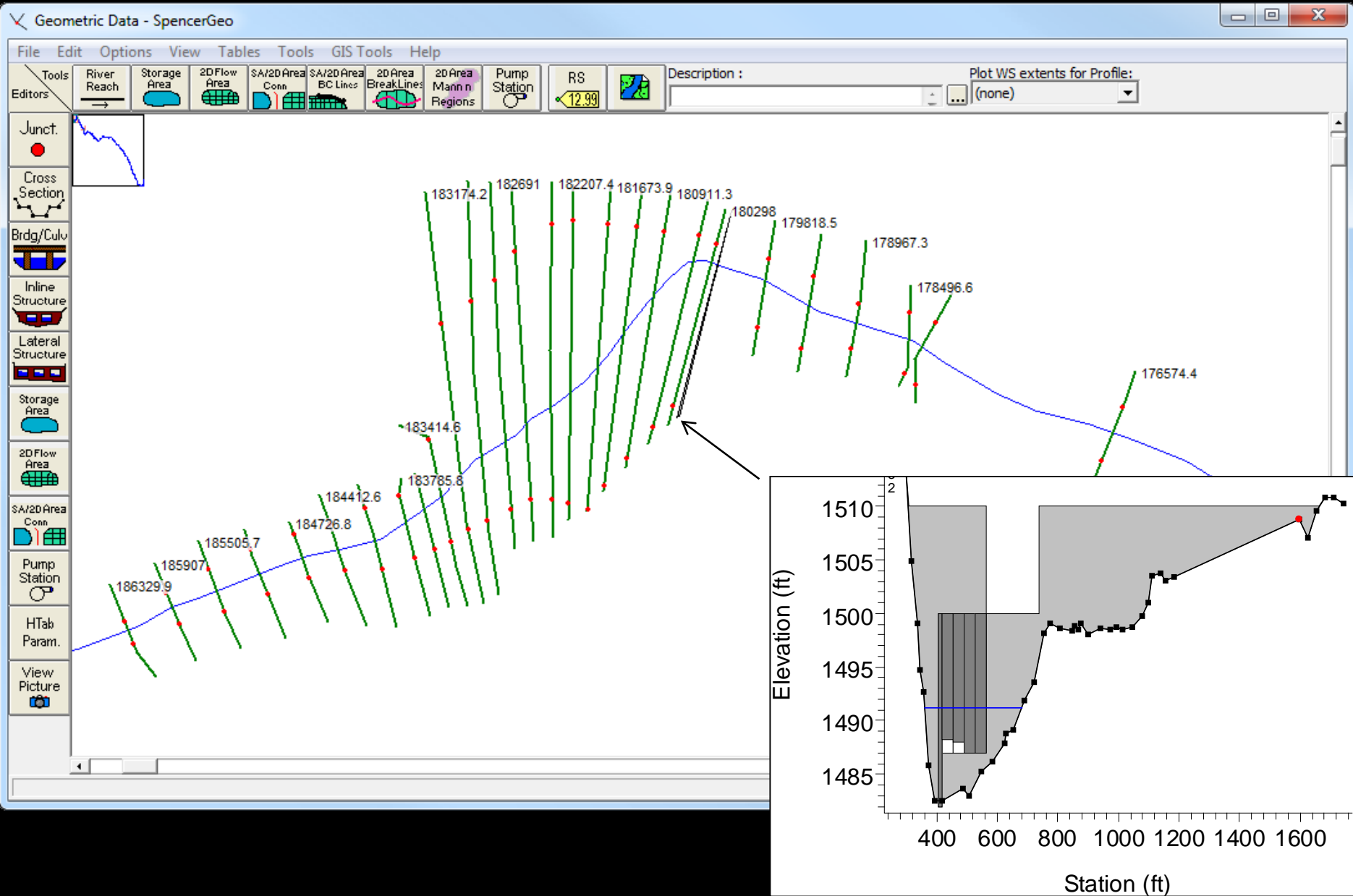
Periodic Antidunes - 90 s cycle

HEC-RAS Model and Calibration

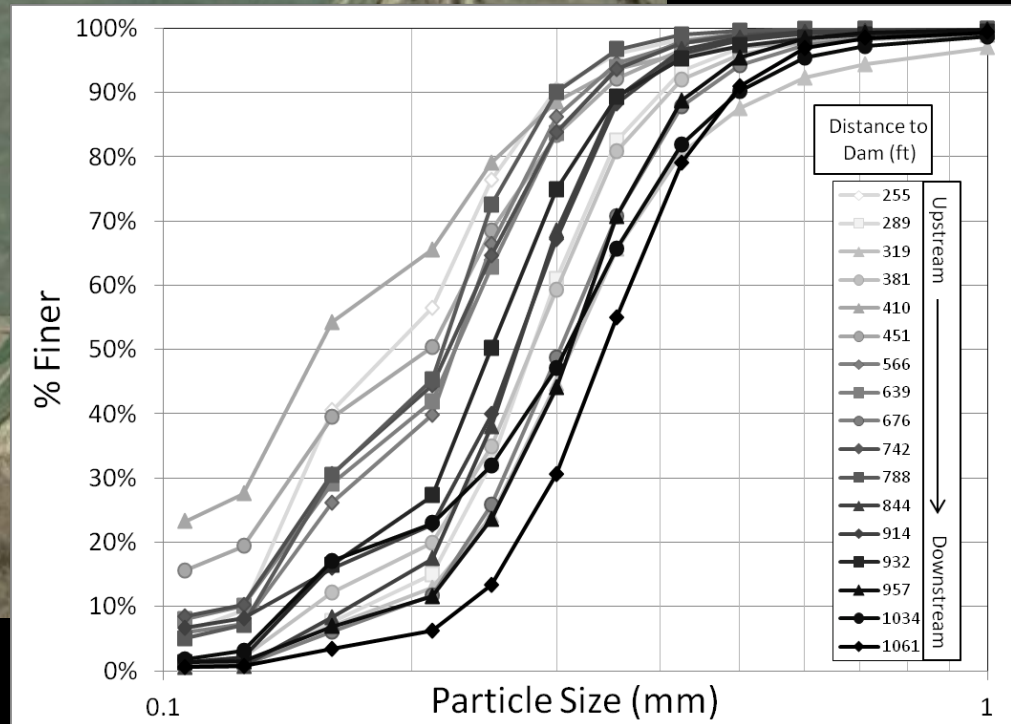
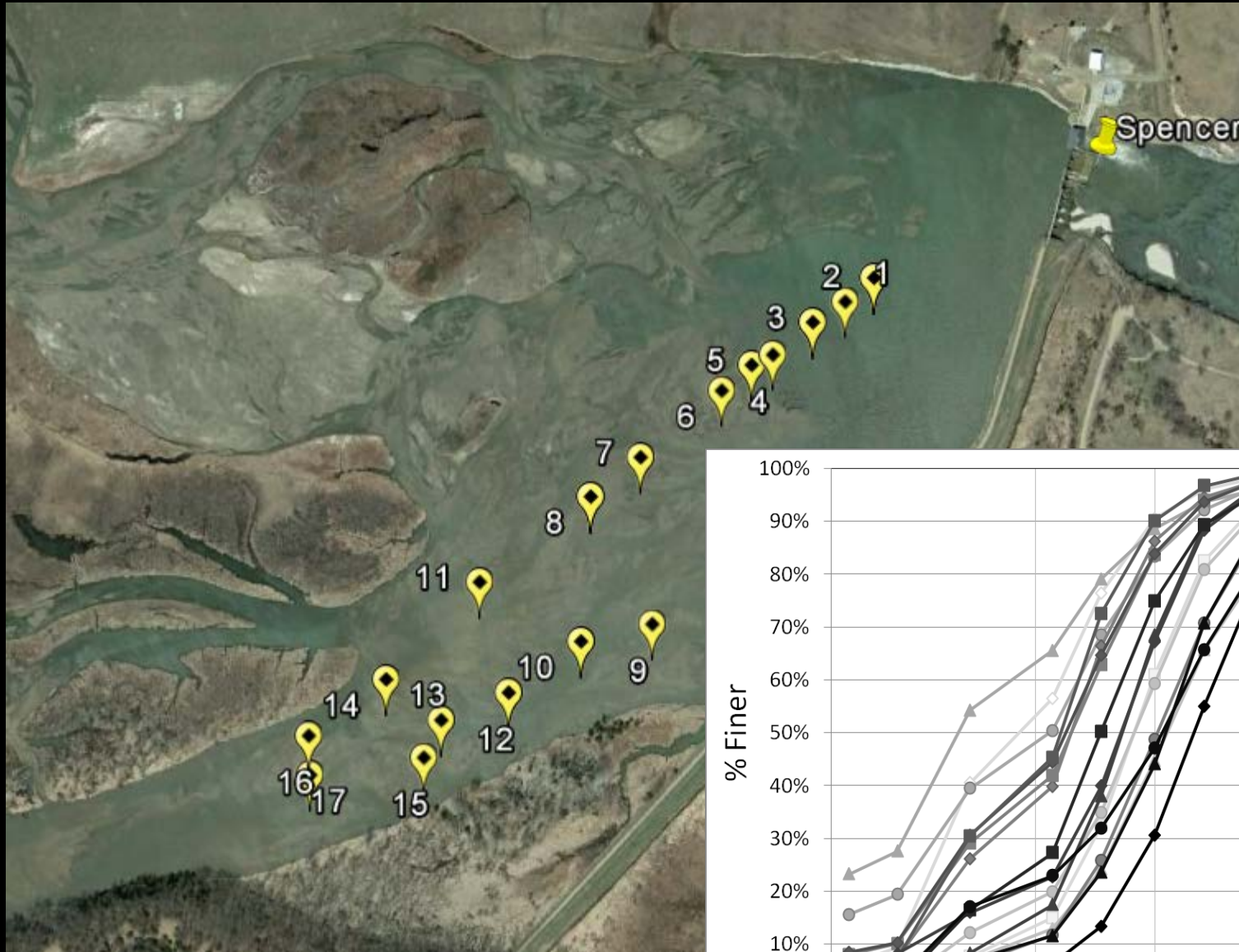
Survey and HEC-geoRAS Model



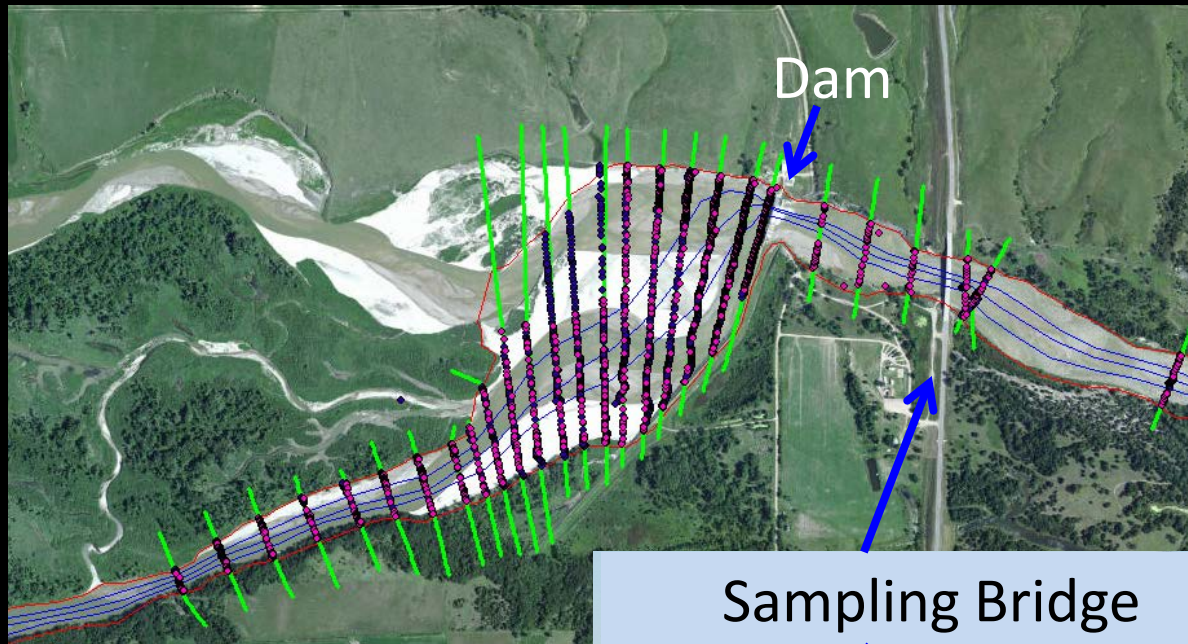
Spencer HEC-RAS Model



Pre-Flush Sediment Samples







Dam

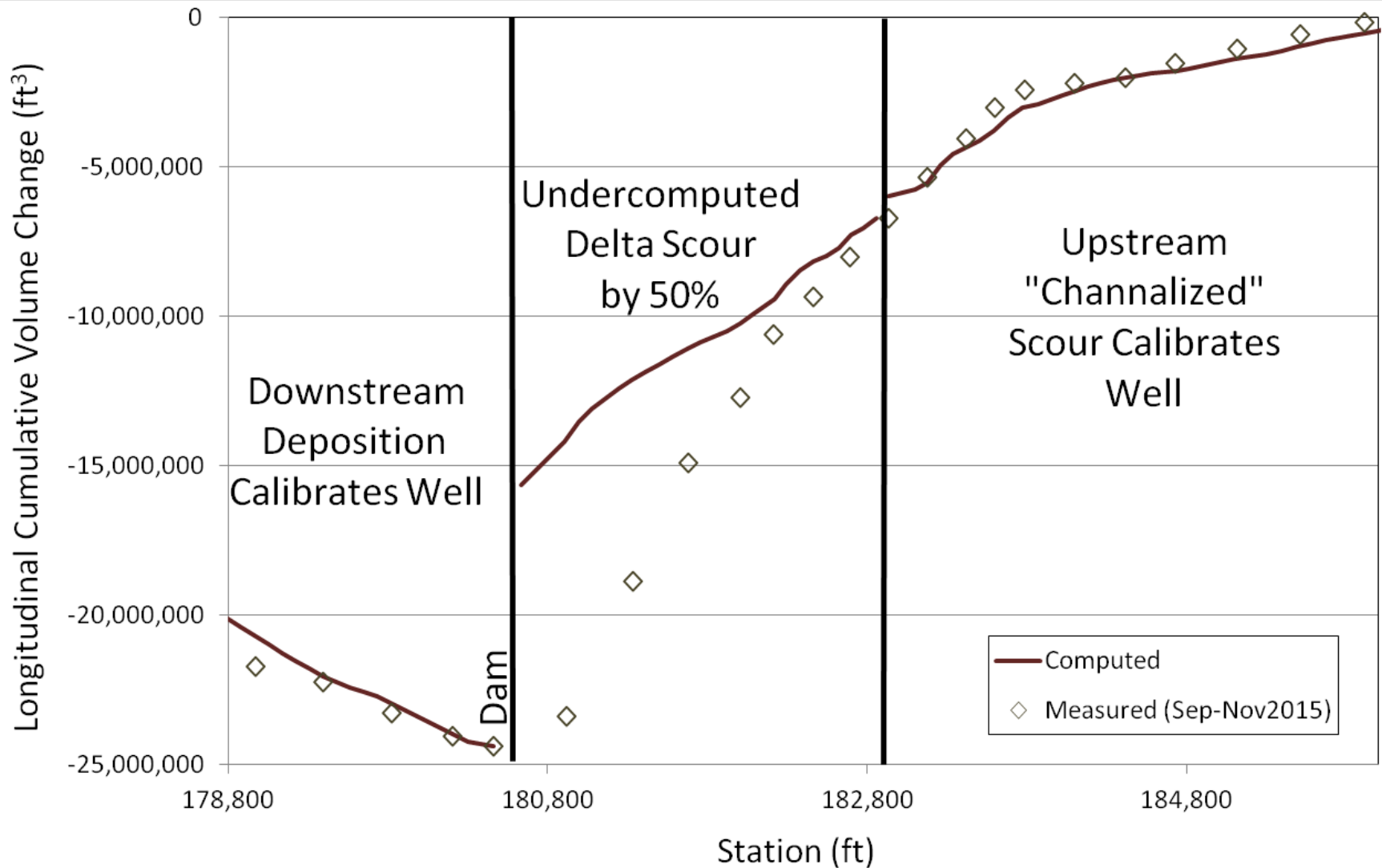
USGS Concentration Measurements



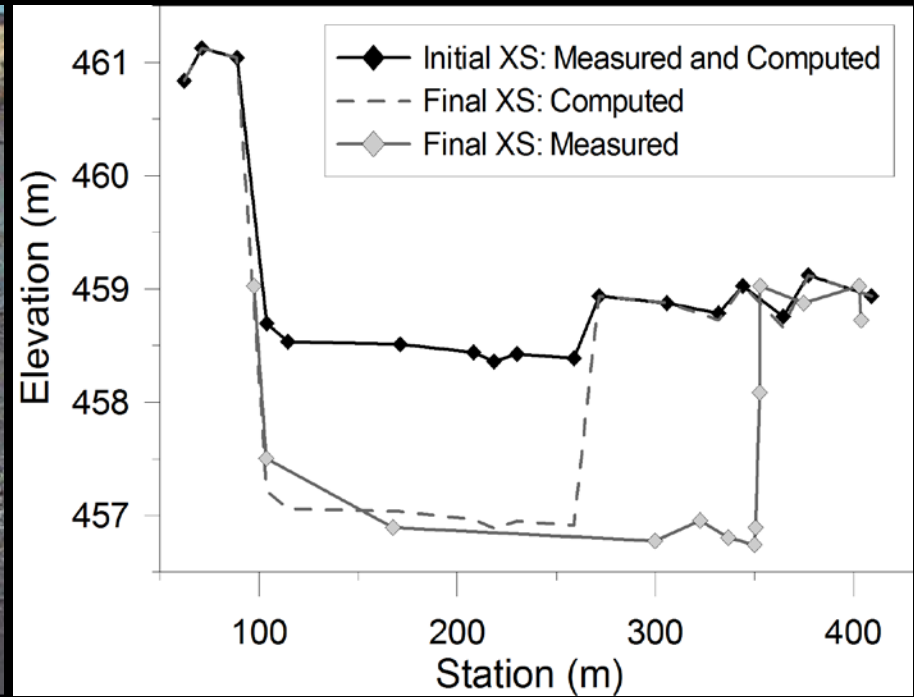
Sampling Bridge

07/10/2014 11:21

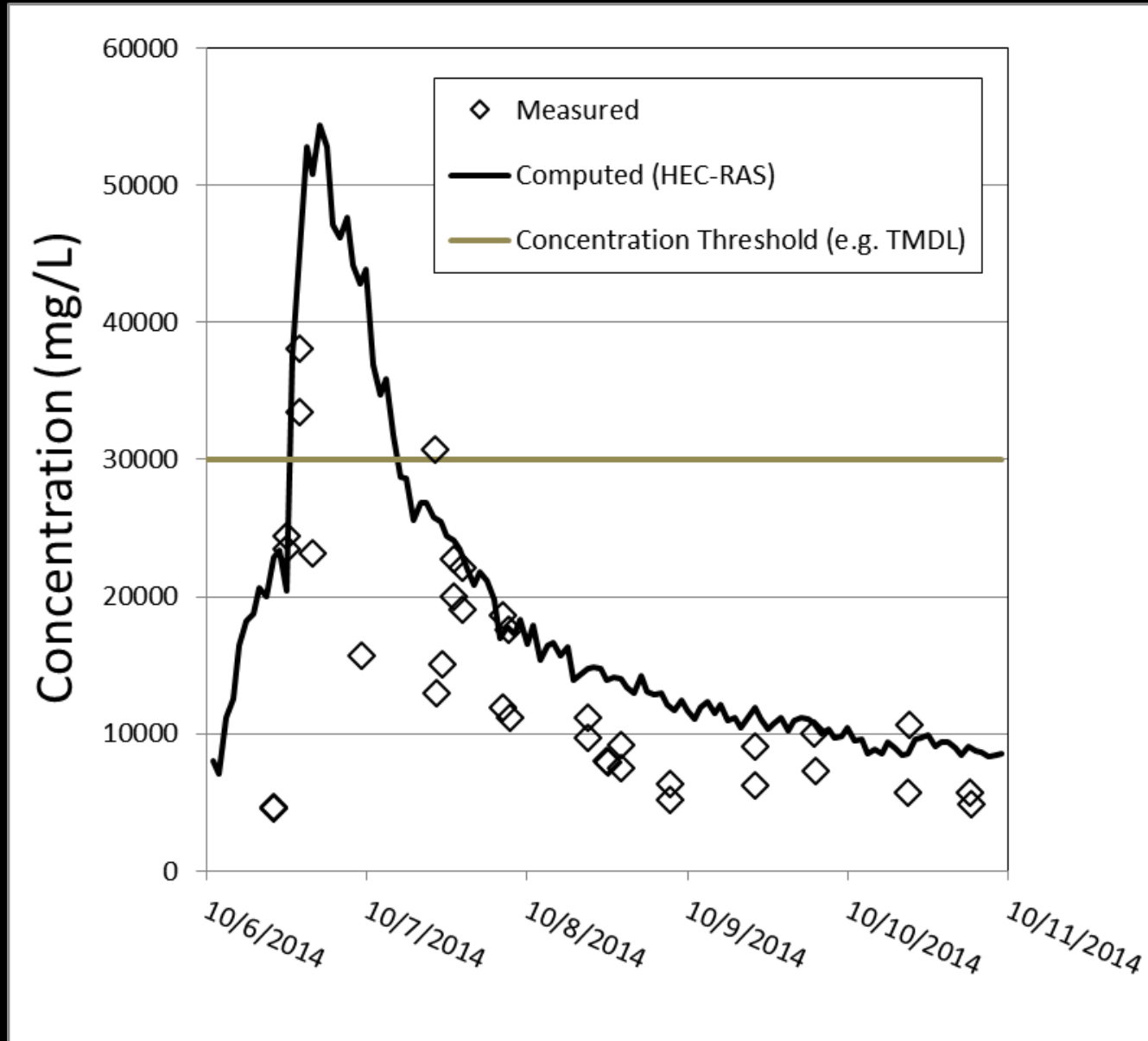
Spencer HEC-RAS Model



Lateral Processes Observed



Downstream Concentration Threshold



Operation Rules

Rule Based Operations

Rule Font Size: 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
18	Gate.Opening(Sluice Gate) = 5

Insert New Operation

Get Simulation Value

Assign Result

Existing Variable
 New Variable

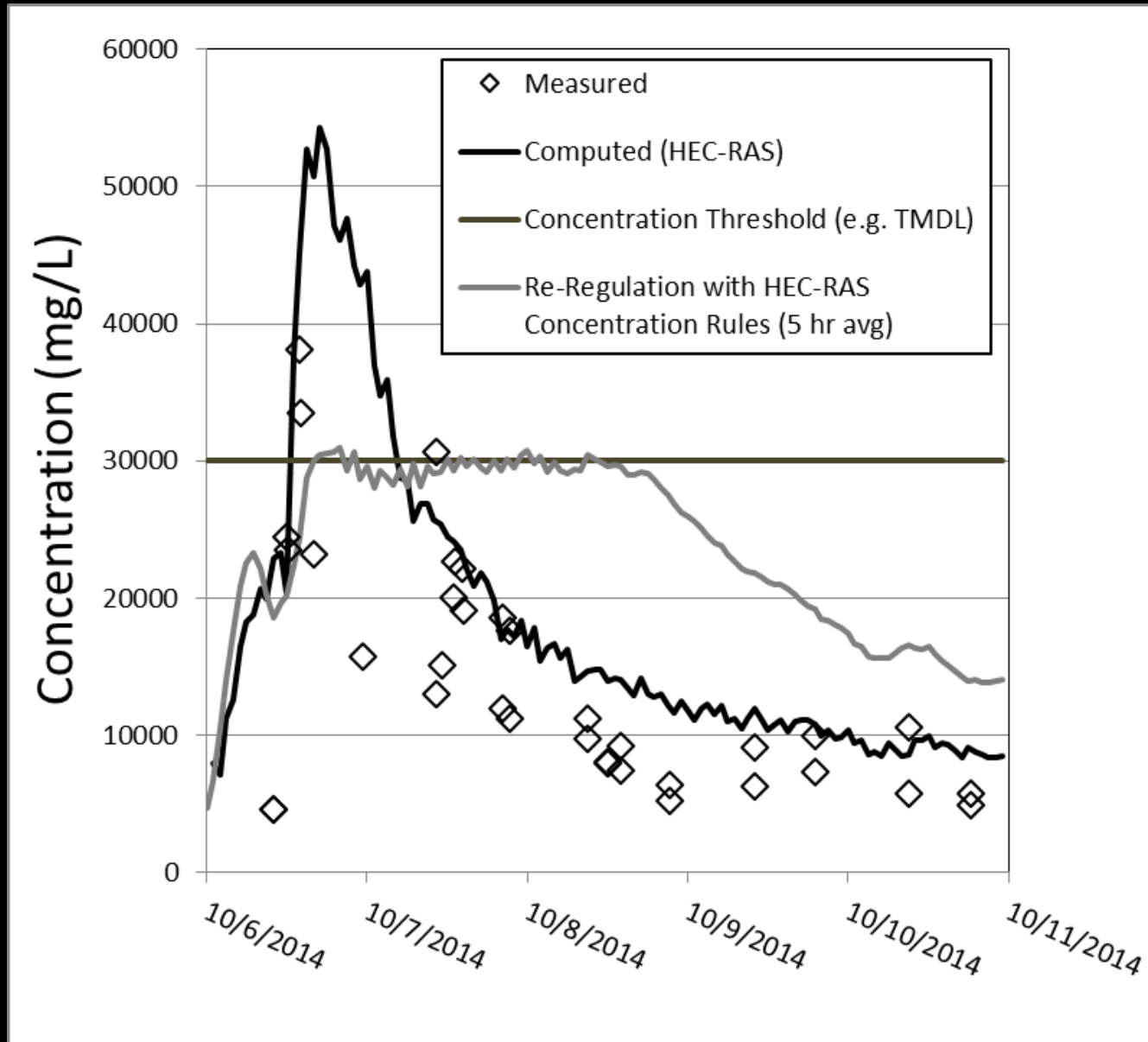
- ▢ Solution
- ▢ Cross Sections
 - ... WS Elevation
 - ... Flow
 - ... WS Change
 - ... Flow Change
 - ... WS Error
 - ... Flow Error
 - ... Bed Change**
 - ... Sediment Concentration**
- ▢ Inline Structures

Set Node Location

River:
 Reach:
 RS:

(Simulation variables in bold are only a

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