Case Study: Simulating Sediment Transport in the Lower Susquehanna River – Lake Clarke and Lake Aldred

Preliminary Data – Subject to Revision

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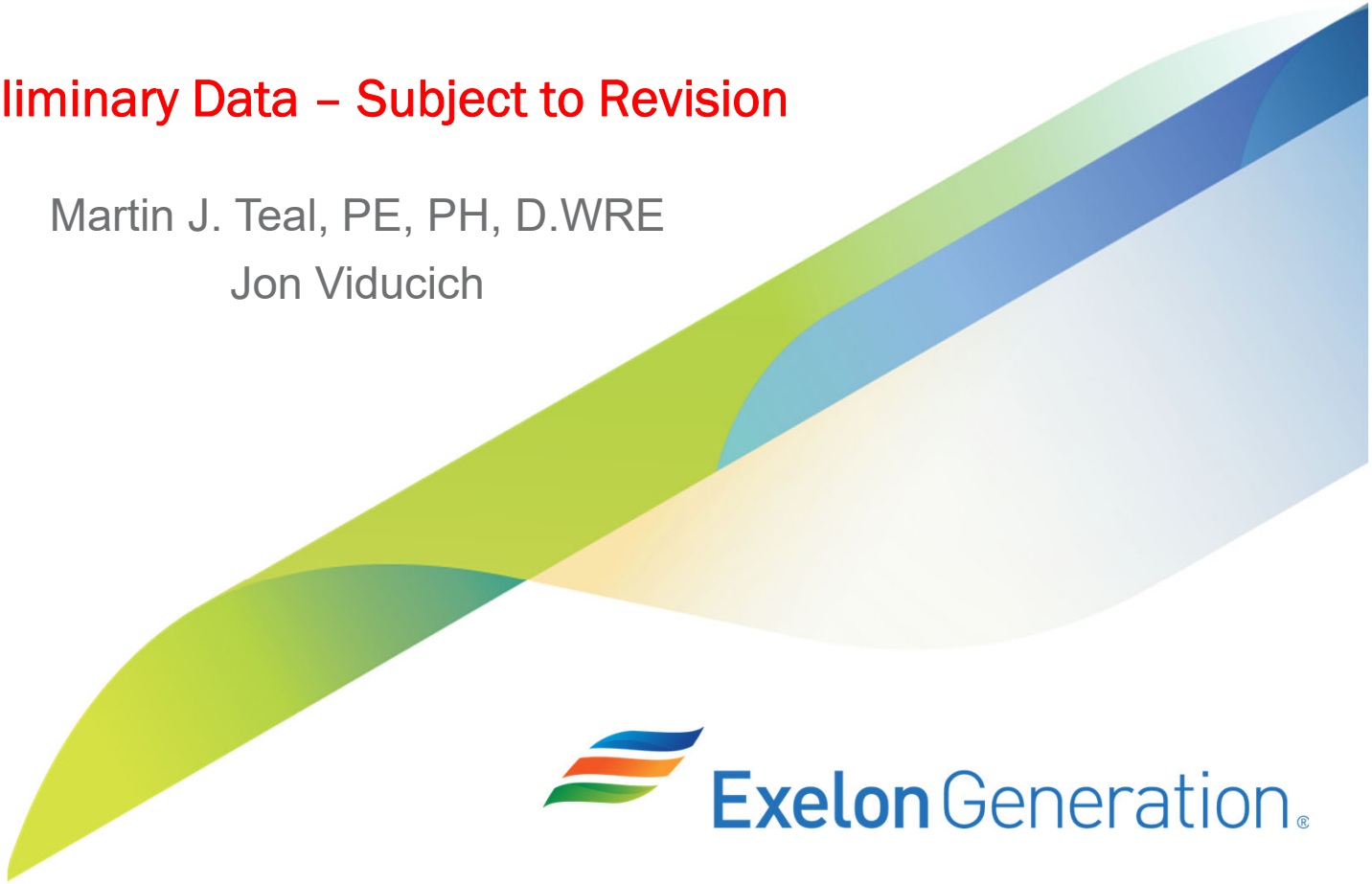

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Introduction and Background

- Recent Interest in the Lower Susquehanna River Reservoirs
  - ✓ Dynamic equilibrium
  - ✓ Potential impacts on Chesapeake Bay water quality
  - ✓ Past studies

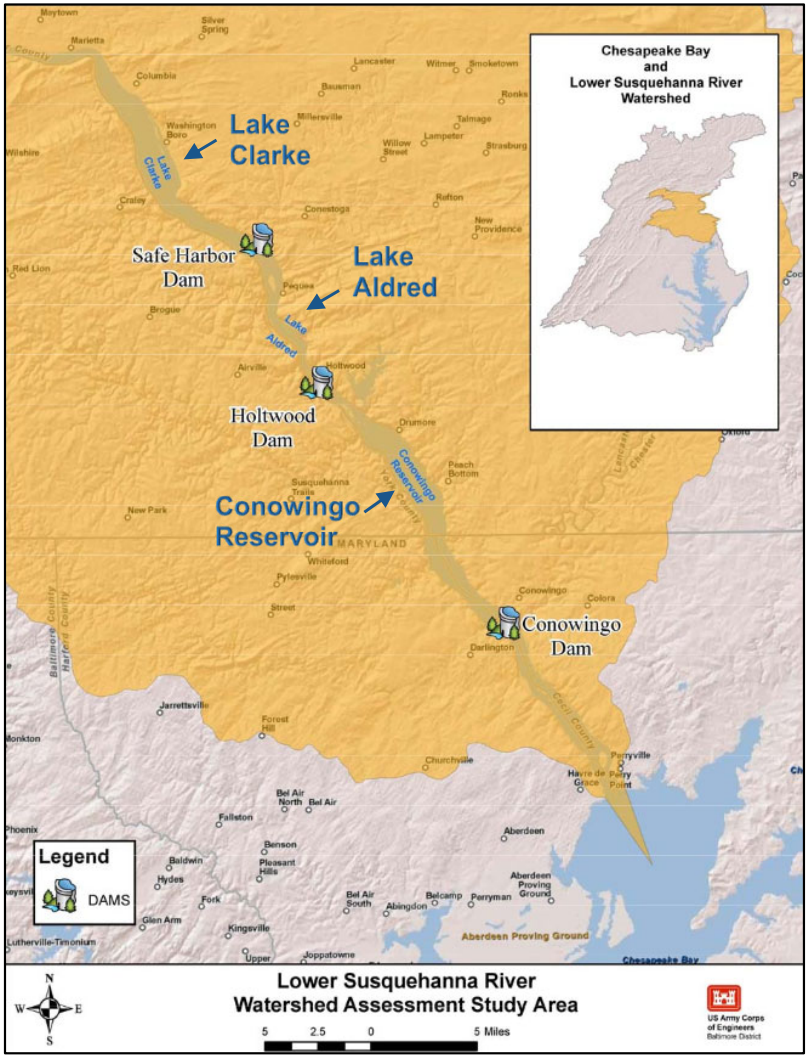

Figure 1-2 from Lower Susquehanna River Watershed Assessment (2015)

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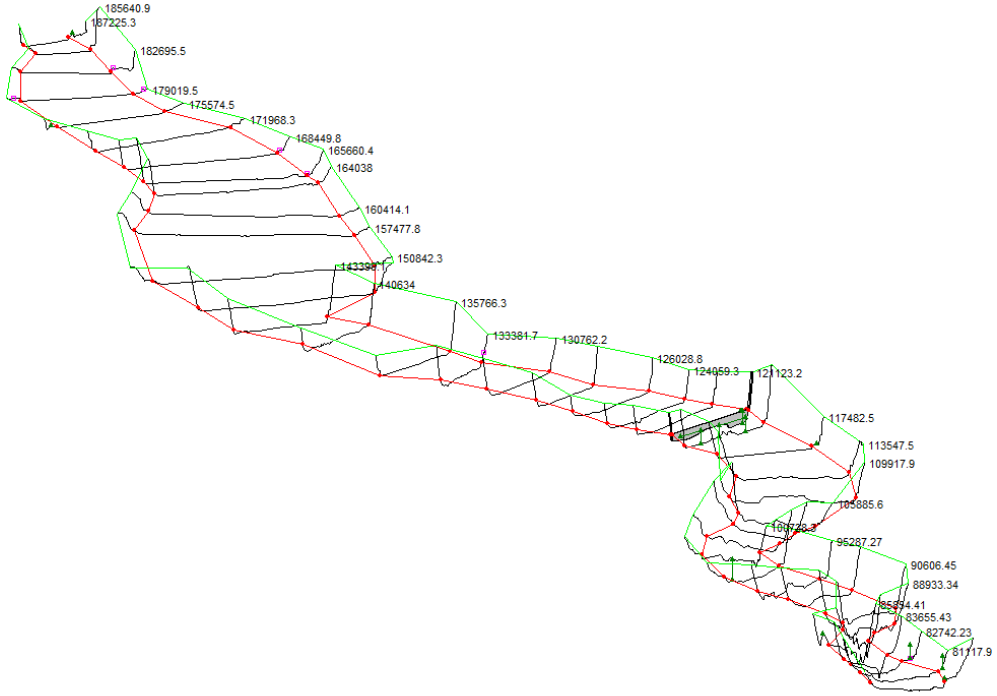
Background – Previous Sediment Transport Studies

- Hainly, Reed, Flippo & Barton (USGS WRIR 95-4122, 1995)
  - ✓ U.S. Army Corps of Engineers HEC-6 Model (quasi-unsteady)
  - ✓ Marietta, PA to Conowingo Dam
  - ✓ Cohesive & non-cohesive sediments
  - ✓ Calibrated to calendar year 1987 flows, verified with 1988-1989 events
  - ✓ Computed trap efficiency was **low** compared to measured trap efficiency over entire system, coarsened inflow sediment sizes to compensate
- Langland & Koerkle (USGS, 2014)
  - ✓ U.S. Army Corps of Engineers HEC-RAS Model (quasi-unsteady)
  - ✓ Marietta, PA to Conowingo Dam, cross sections based on 2008/1996 bathymetry
  - ✓ Calibrated to computed volume changes 2008-2011 and measured sediment outflows at Conowingo Dam
  - ✓ **Two** models: 2008-2011 (net deposition), September 7-13 2011 (TS Lee, net scour)

Study Goals

- Develop unsteady, 1D sediment transport model
  - ✓ Marietta, PA to Holtwood Dam (20.4 miles)
- Aid in parameterization of Chesapeake Bay Watershed Model
- Input for HDR model of Conowingo Pond



Study Goals – Model Improvements

- Improve upon past studies using U.S. Army Corps of Engineers HEC-RAS 5.0 Model (unsteady)
  - ✓ Solves the unsteady flow equation, routing flow and explicitly accounting for storage and travel time
  - ✓ Conserves volume, important in reservoir systems
  - ✓ Cohesive and non-cohesive sediments

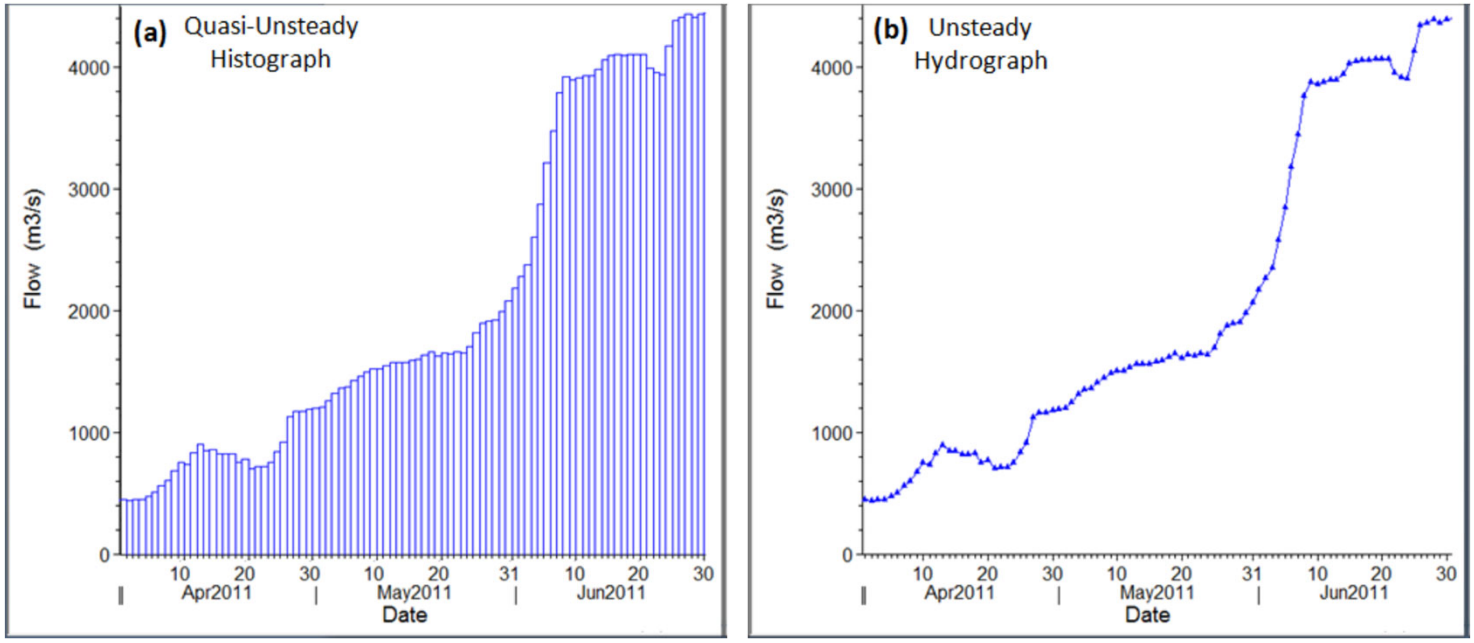
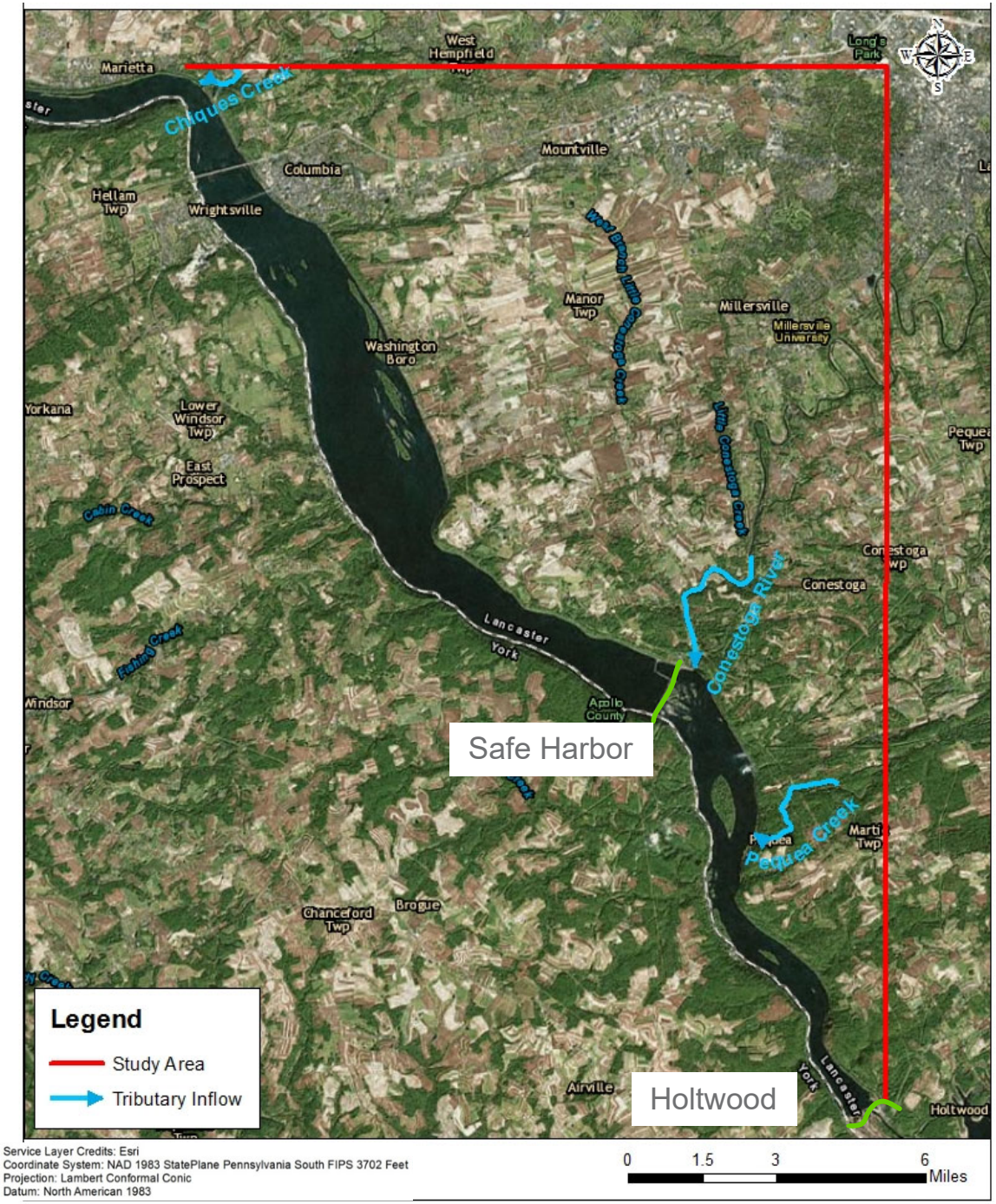


Figure 17-1 HEC-RAS Version 5.0 User's Manual (2016)

Current Study (cont'd)

HEC-RAS Model Study Area



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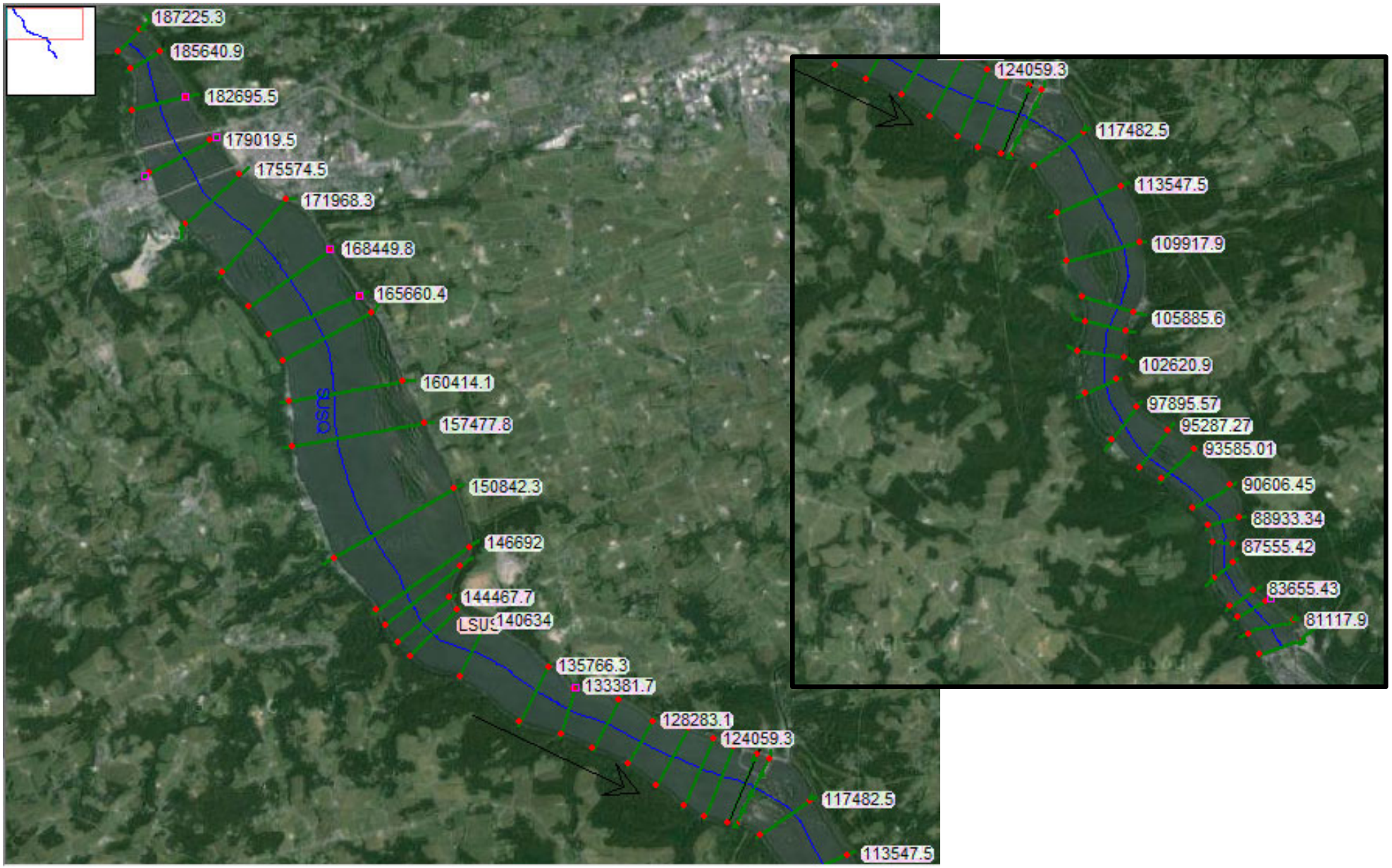
Current Study (cont'd)



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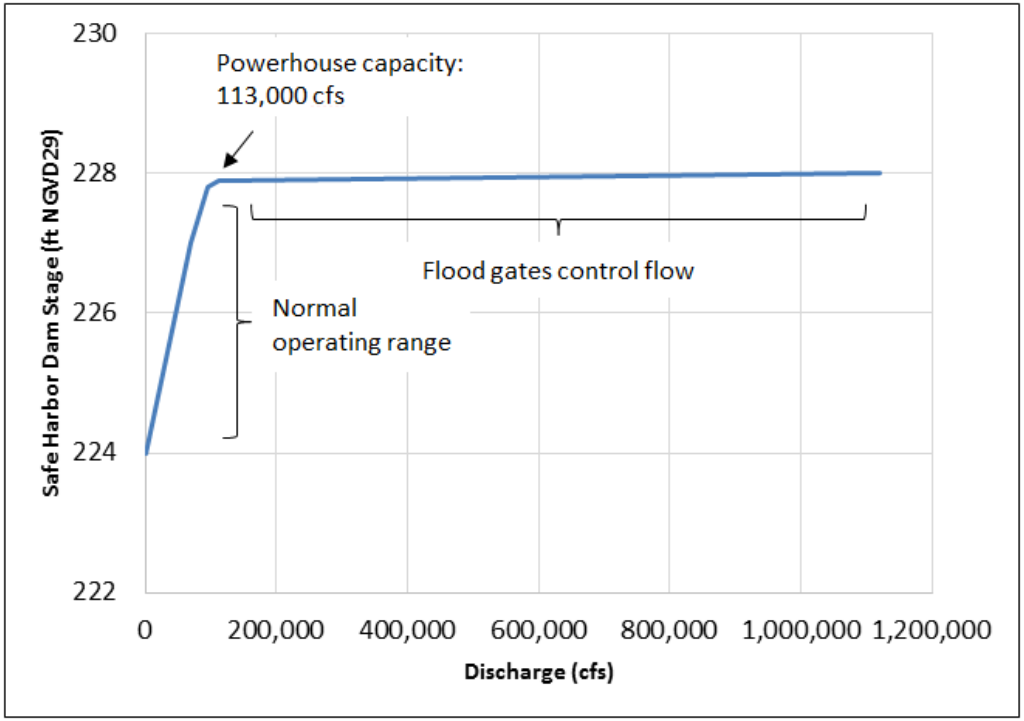
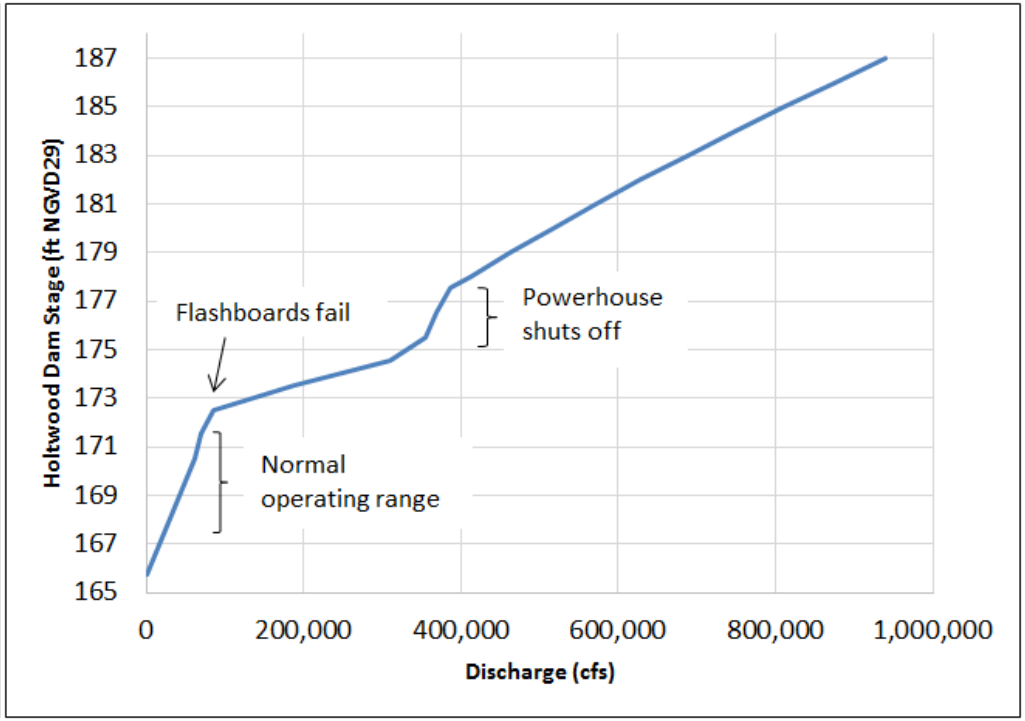
Current Study (cont'd)

- Boundary Conditions
  - ✓ Flow, inflowing sediment load at Marietta (USGS gage)
    - ✓ 24-hr time series combining gage data when available and rating curve-generated data when not
  - ✓ Tributary flows and sediment loading from Conestoga River and Pequea Creek only (USGS gages)
    - ✓ No accounting for other tributary water or sediment inflows – accounts for 99.5% of drainage area at Holtwood Dam
  - ✓ *Stage at Holtwood – water surface elevation versus discharge rating curve*
  - ✓ *Gate operations at Safe Harbor*



Safe Harbor Dam Interior Boundary Rating Curve



Holtwood Dam Boundary Rating Curve

Current Study (cont'd)

- Boundary Conditions
  - ✓ Flow, inflowing sediment load at Marietta (USGS gage)
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  - ✓ Tributary flows and sediment loading from Conestoga River and Pequea Creek only (USGS gages)
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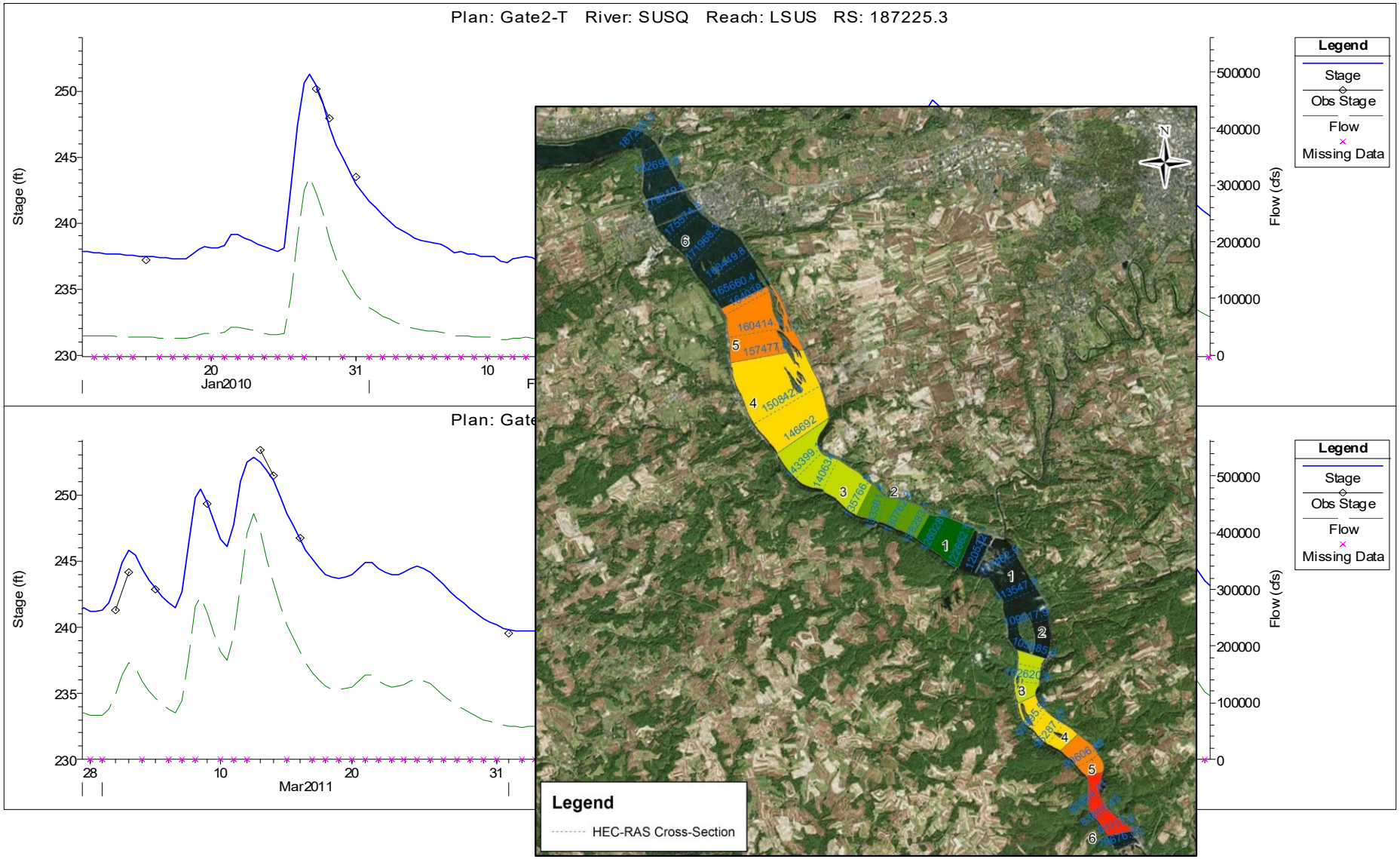
  - ✓ *Stage at Holtwood – water surface elevation versus discharge rating curve*
  - ✓ *Gate operations at Safe Harbor*
- Hydraulics
  - ✓ Used cross sections from Langland RAS model (2008/1996 bathymetry), adjusted hydraulic property tables, minor XS properties
  - ✓ Preserved roughness, but adjusted via factors during calibration
  - ✓ Calibrated computed water surface elevations (WSELs) to measured WSELs at Marietta via blanket roughness multiplication factors by flow rate and season 2008-2011
  - ✓ Unsteady flow simulation conserves volume in the system

Model Calibration and Verification

- Hydraulic Calibration at Marietta, PA



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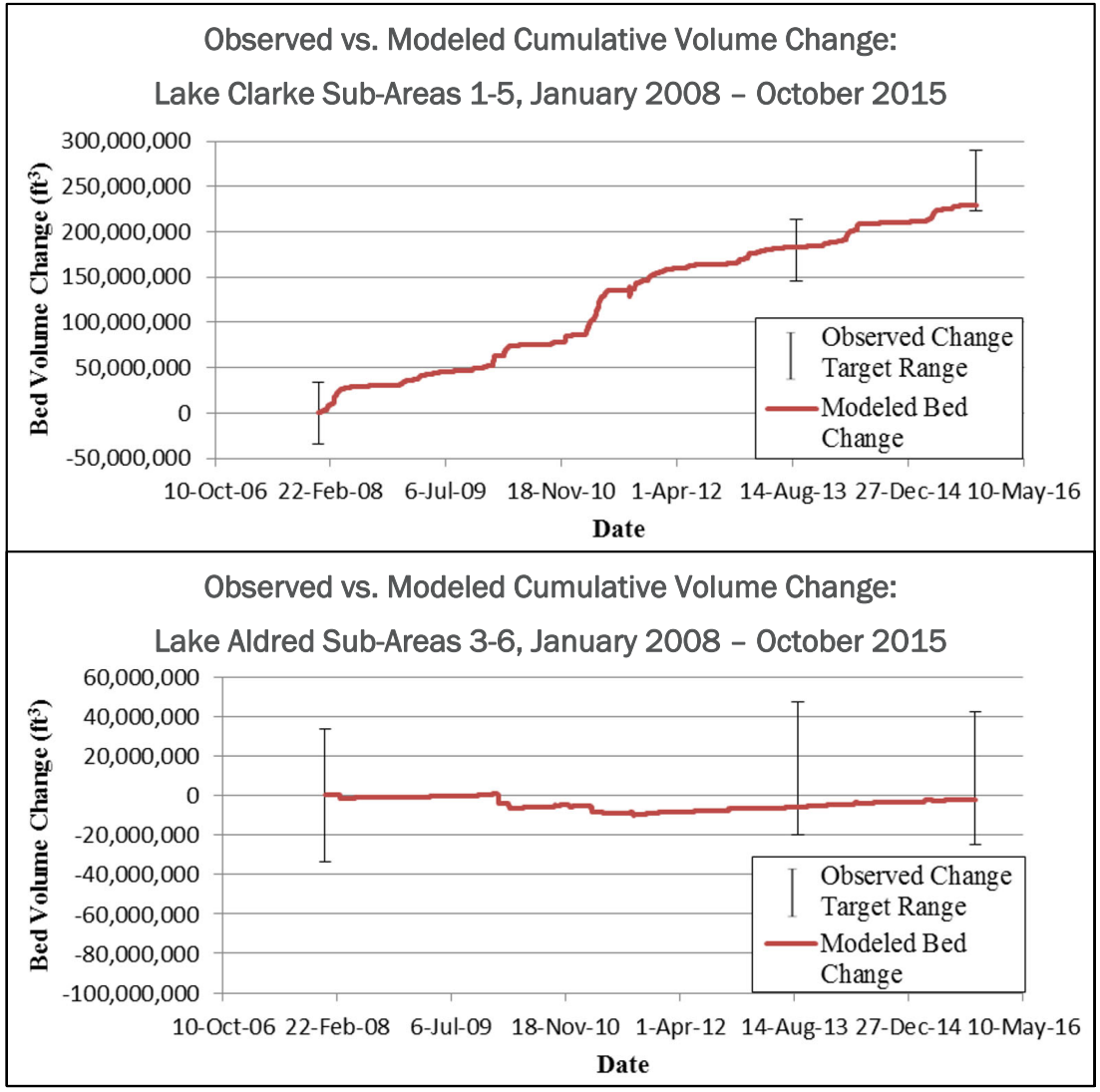
Model Calibration and Verification (2)

- Sediment Transport Calibration
  - ✓ January 2008 – August 2013
  - ✓ Several large events, including Tropical Storm Lee
- Sediment Transport Verification
  - ✓ August 2013 - October 2015
  - ✓ Unusually low flows



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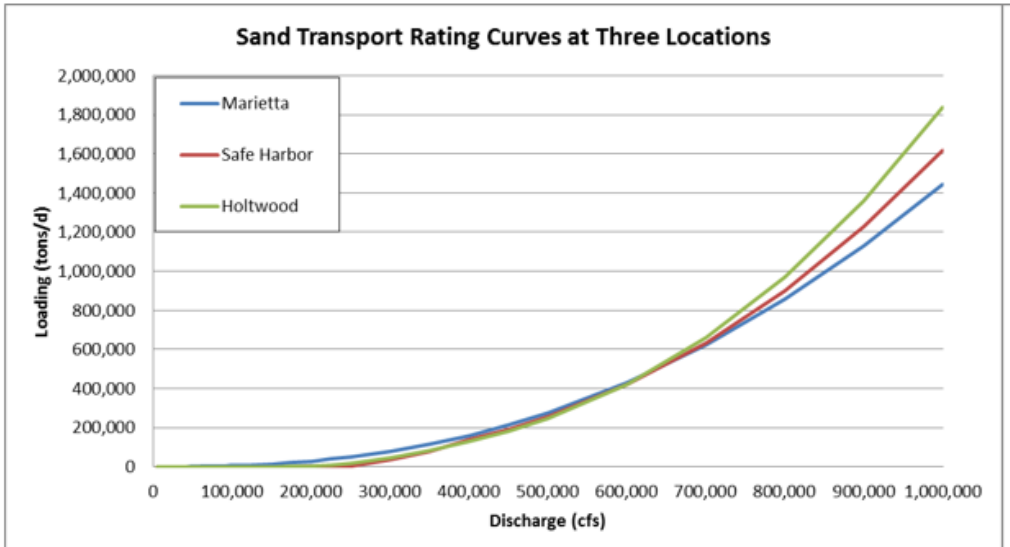
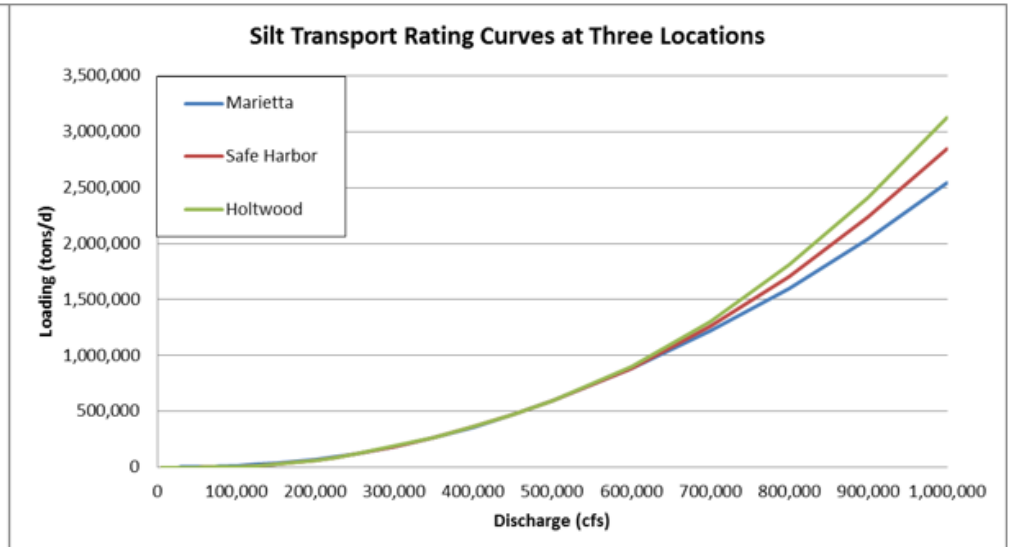
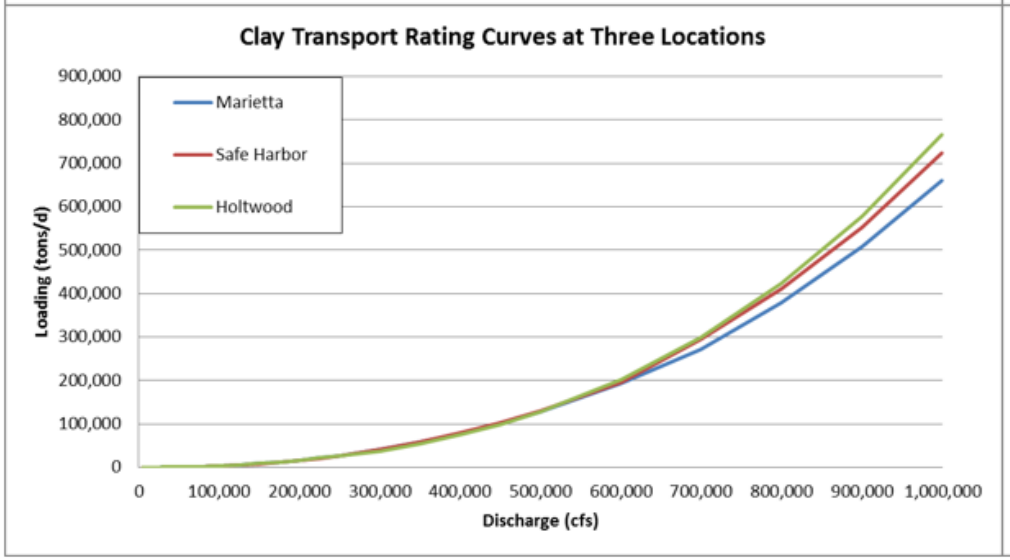
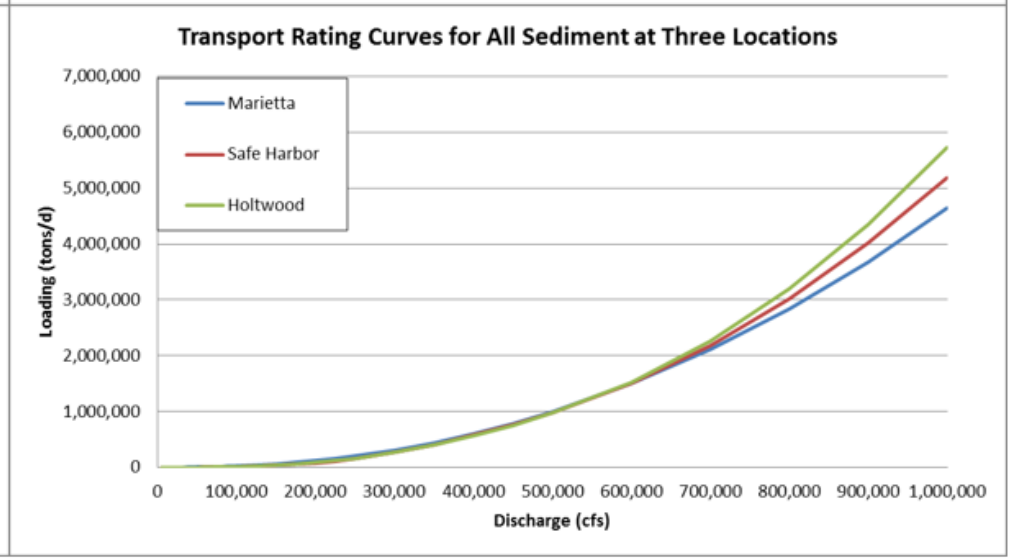
Sediment Rating Curves









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Questions?