Overview of Unsteady Flow Modeling

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Hydrologic Engineering Center

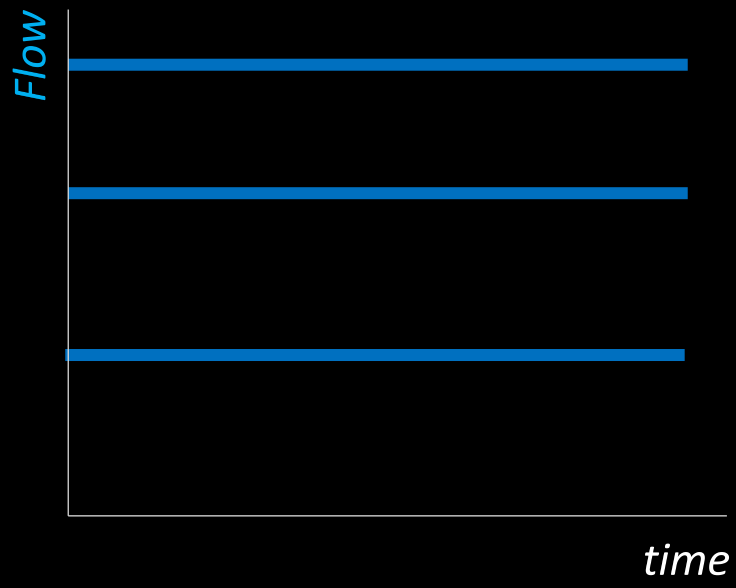
Overview:

1. What is Unsteady Flow?
2. How is it different than Steady Flow?
3. Why would you use it?
4. Examples?

1. What is Unsteady Flow?

Steady Flow

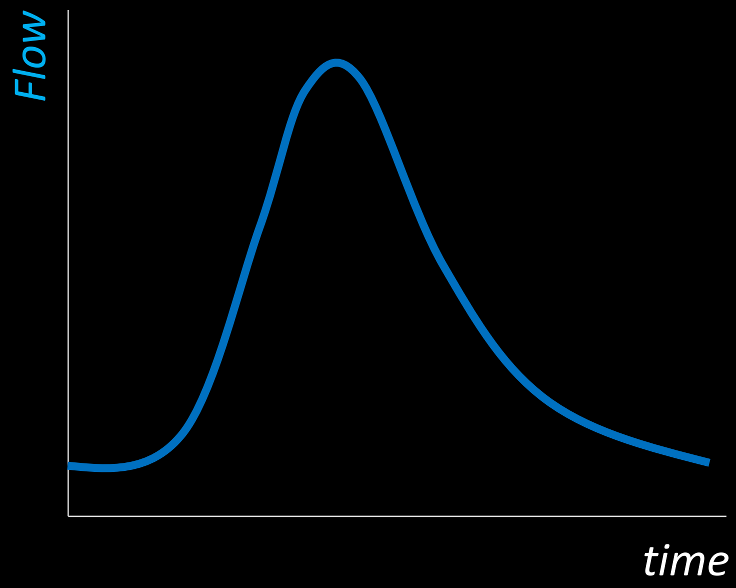
Q(~~t~~)



changes gradually
Flow ~~does not change~~ with time

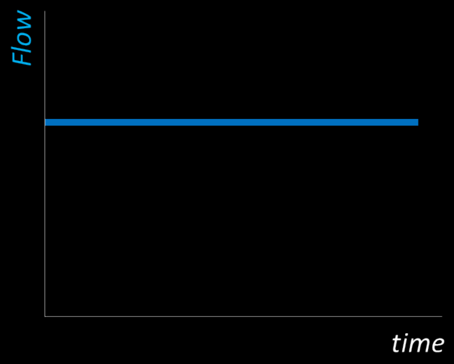
Unsteady Flow

Q(t)



Flow changes with time

1. What is Unsteady Flow?

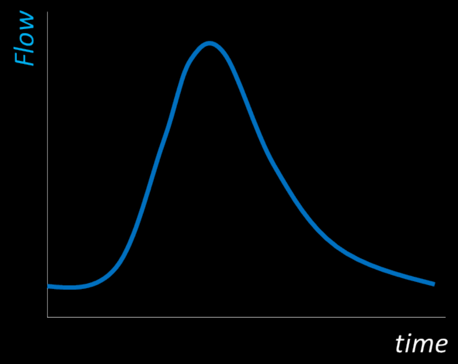


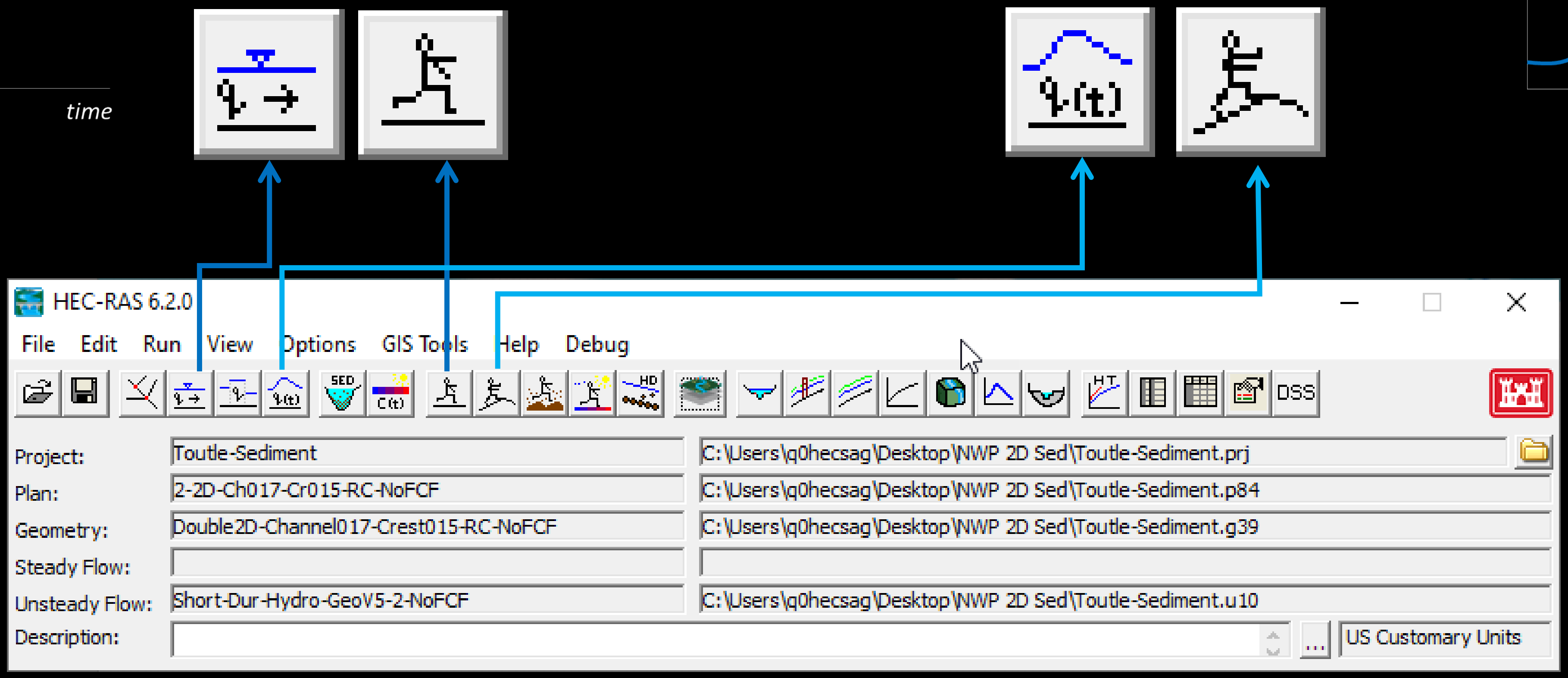
Steady Flow

Q(~~t~~)

Unsteady Flow

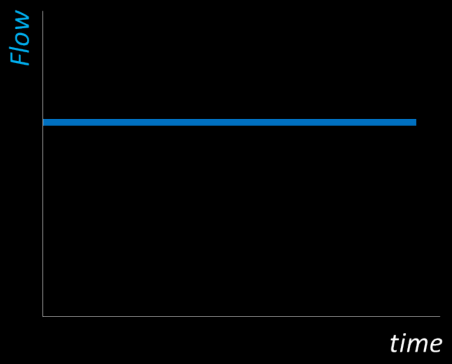
$Q(t)$



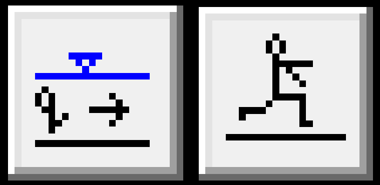


1. What is Unsteady Flow?

Steady Flow

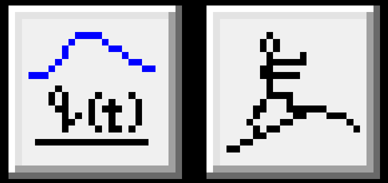


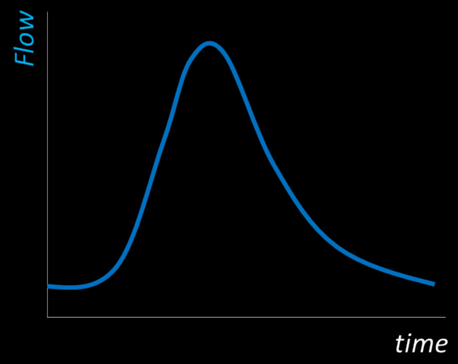
Q(~~*t*~~)



Unsteady Flow

Q(t)





Overview:

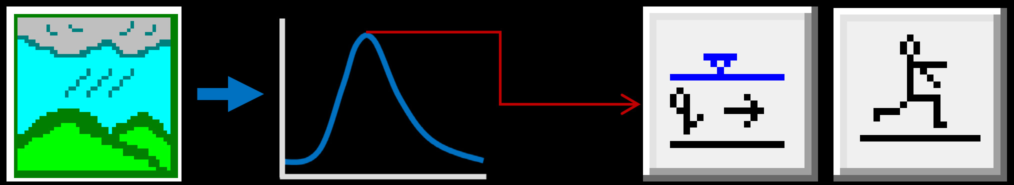
1. What is Unsteady Flow?

2. How is it different than Steady Flow?
    i. Boundary Conditions
    ii. Calibration
    iii. Applications

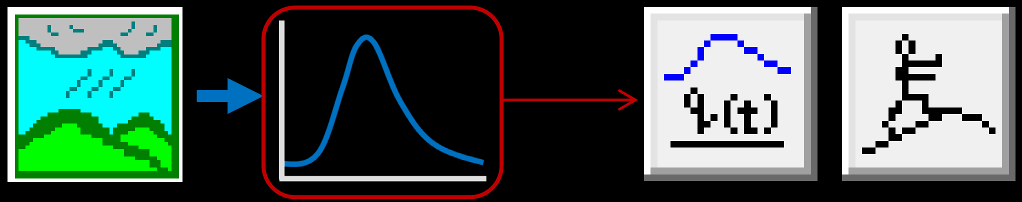
2. How is it different than Steady Flow?

Boundary Conditions

Hydrologic Routing



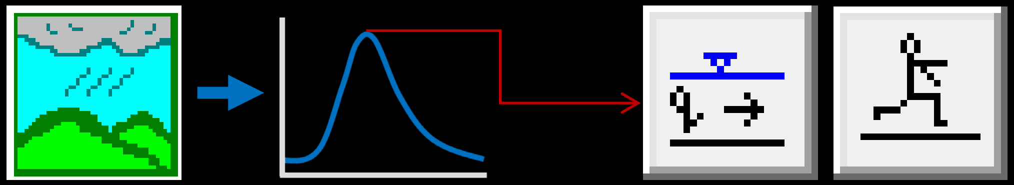
Hydraulic Routing



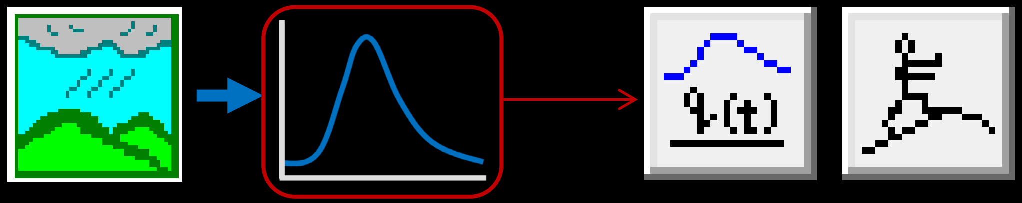
2. How is it different than Steady Flow?

Boundary Conditions

Hydrologic Routing

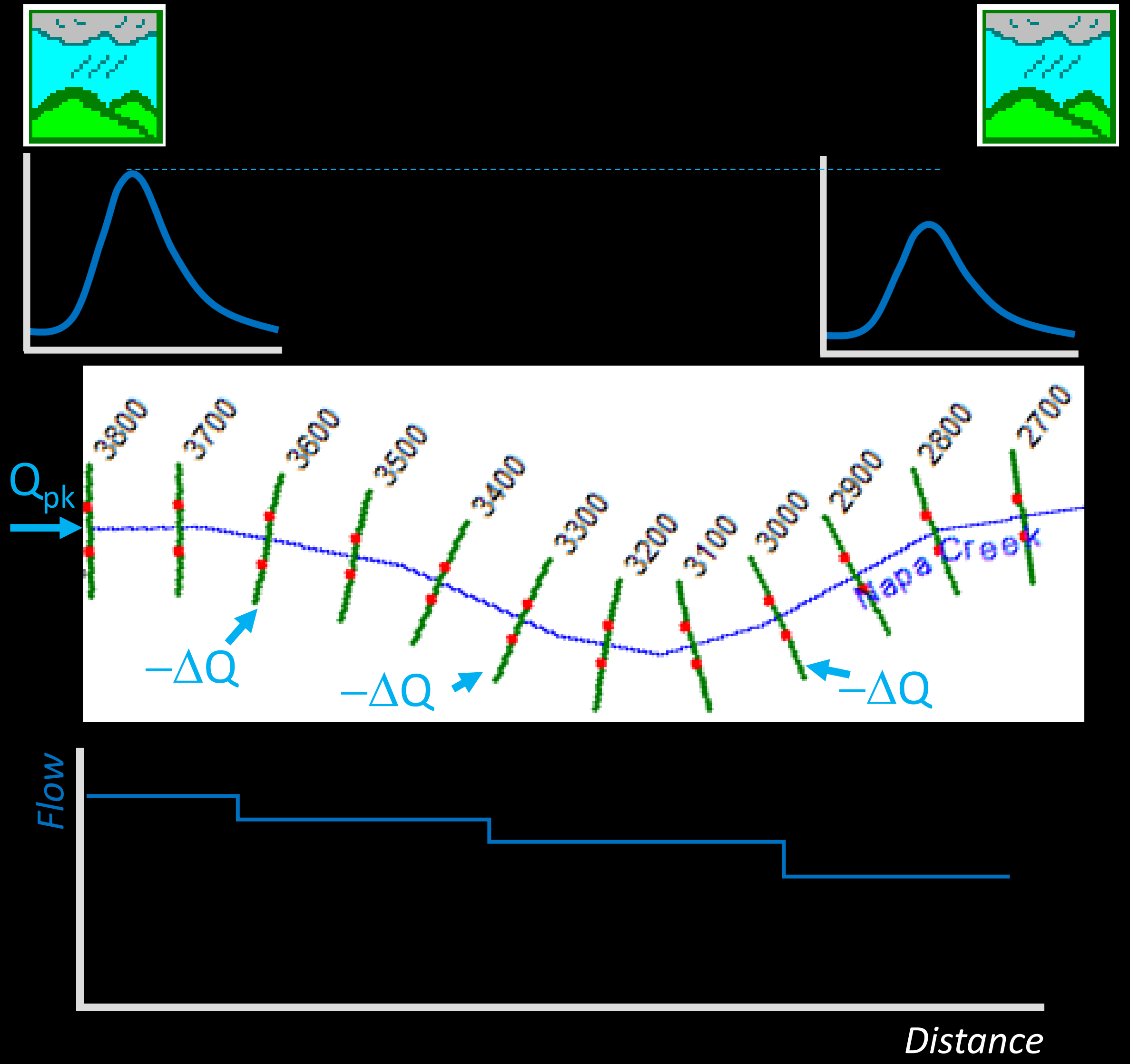


Hydraulic Routing

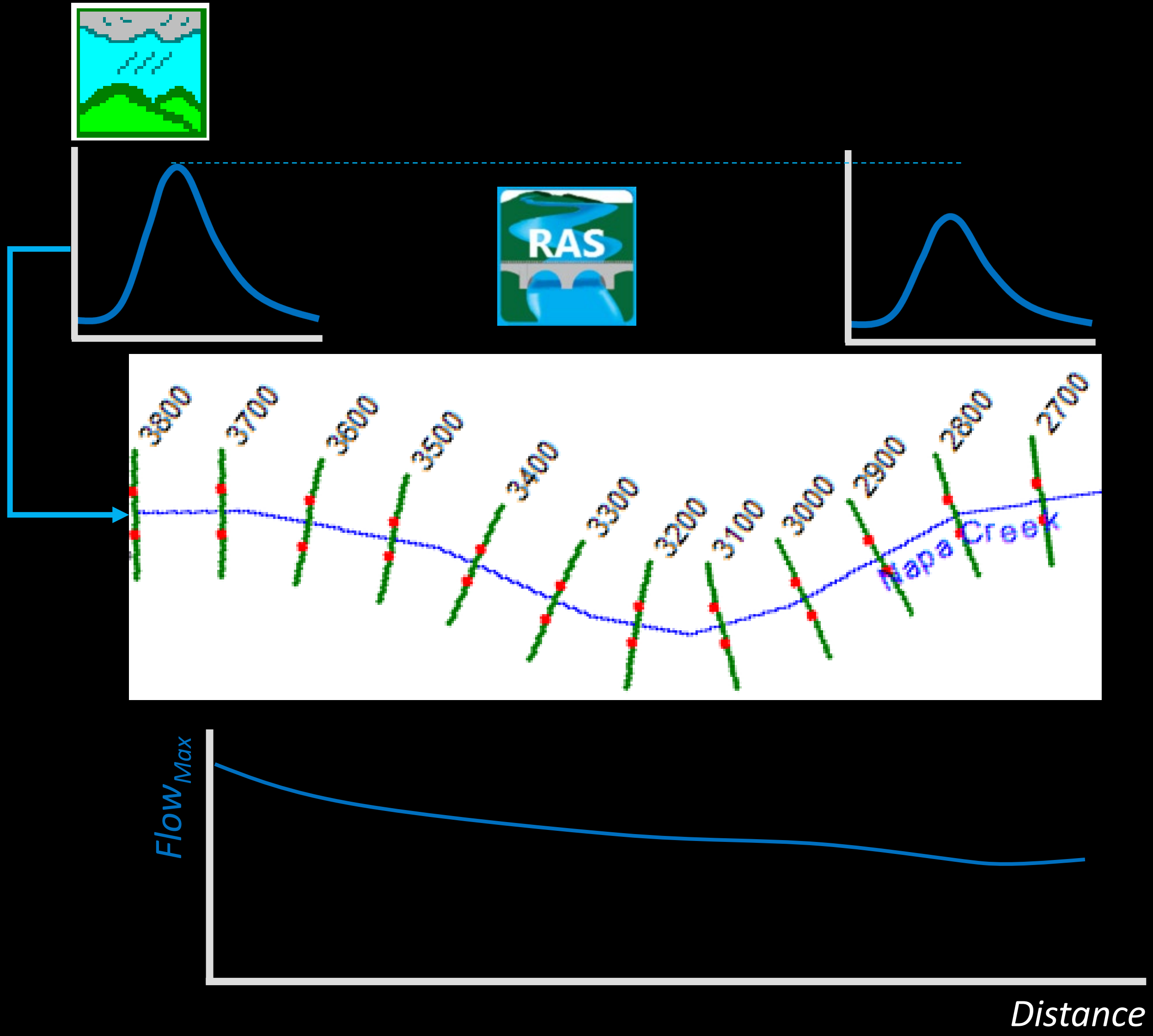


Example 1: Flood Attenuation

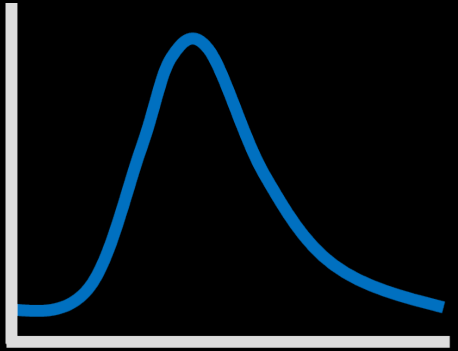
Hydrologic Routing
Steady Flow

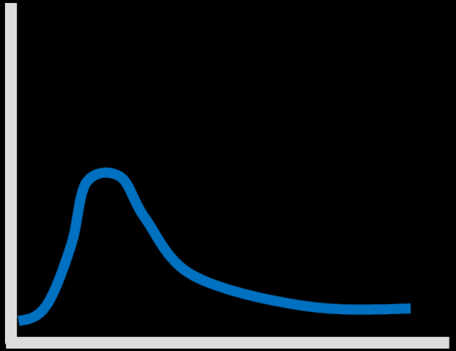


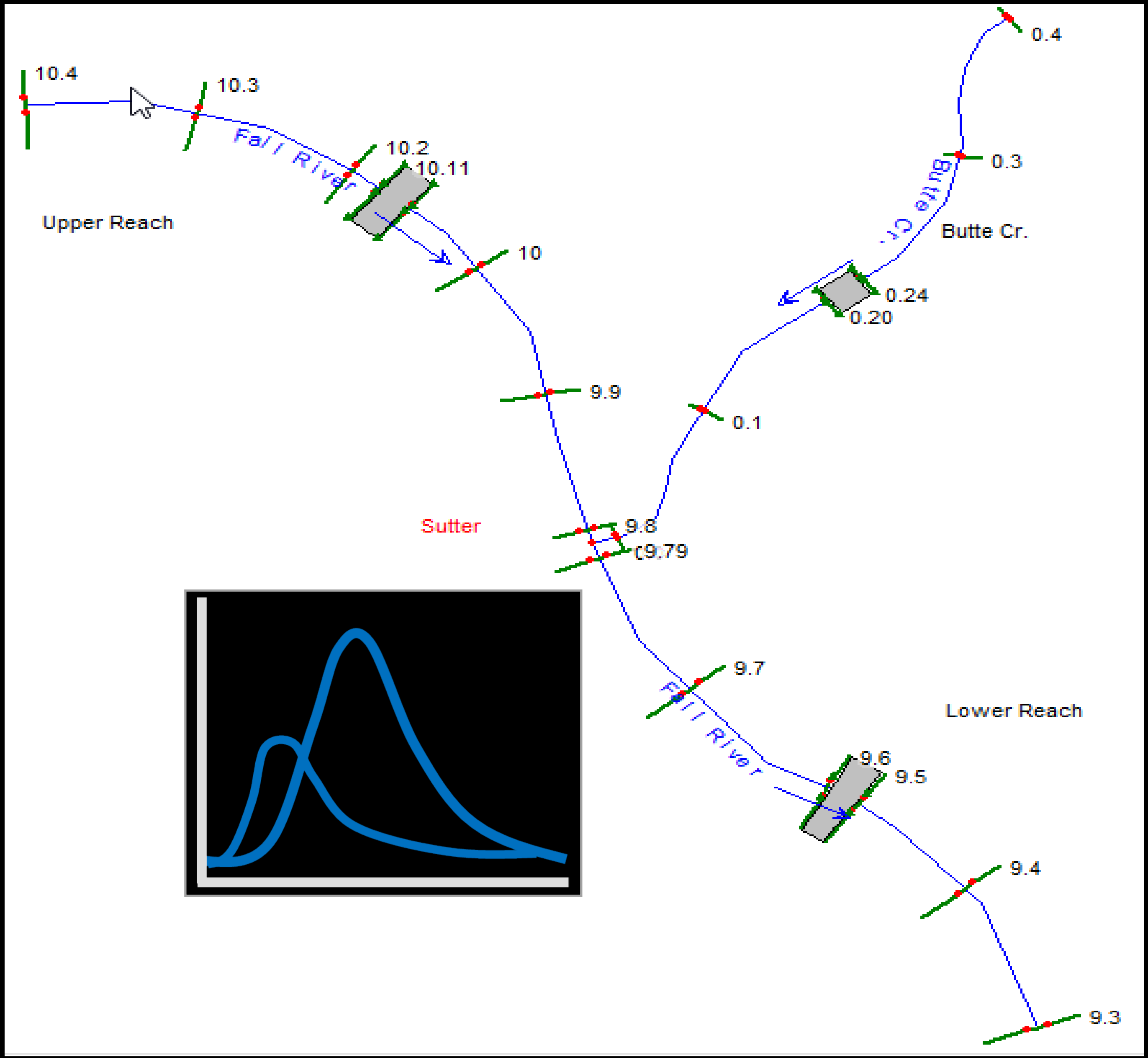
Hydraulic Routing
Unsteady Flow



Example 2: Tributary Timing



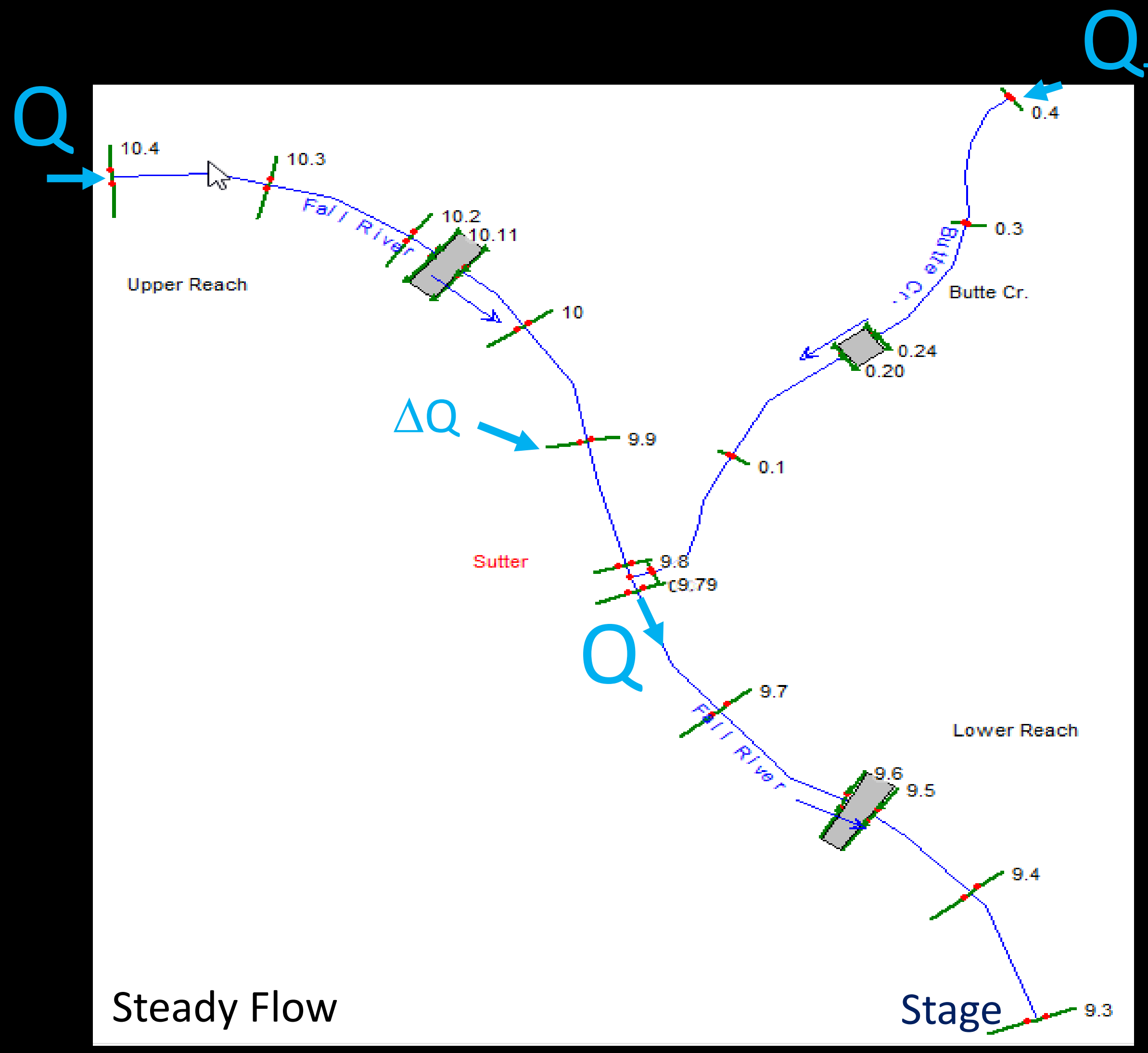


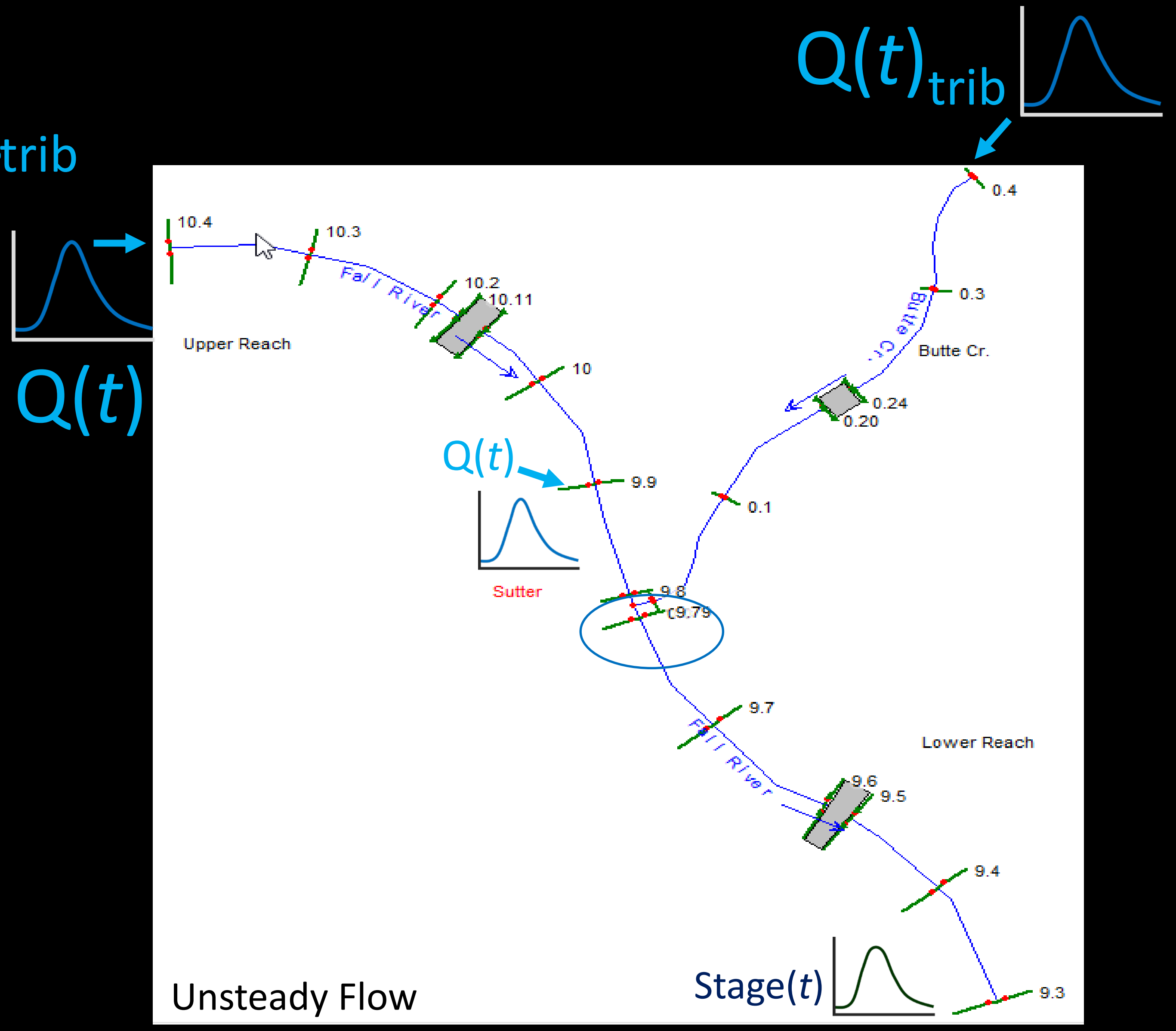


Example 2: Tributary Timing

Hydrologic Routing
Steady Flow

Hydraulic Routing
Unsteady Flow

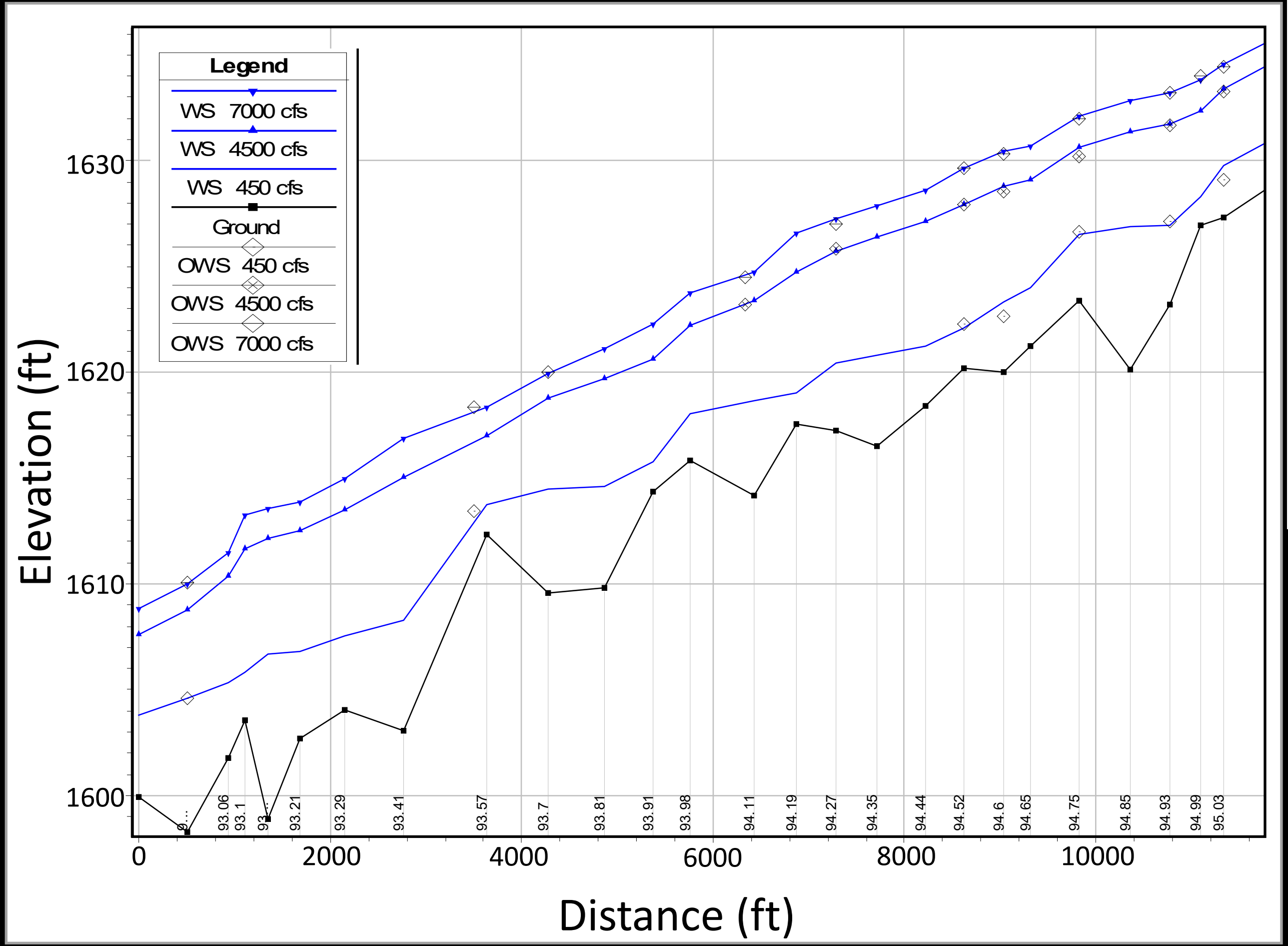




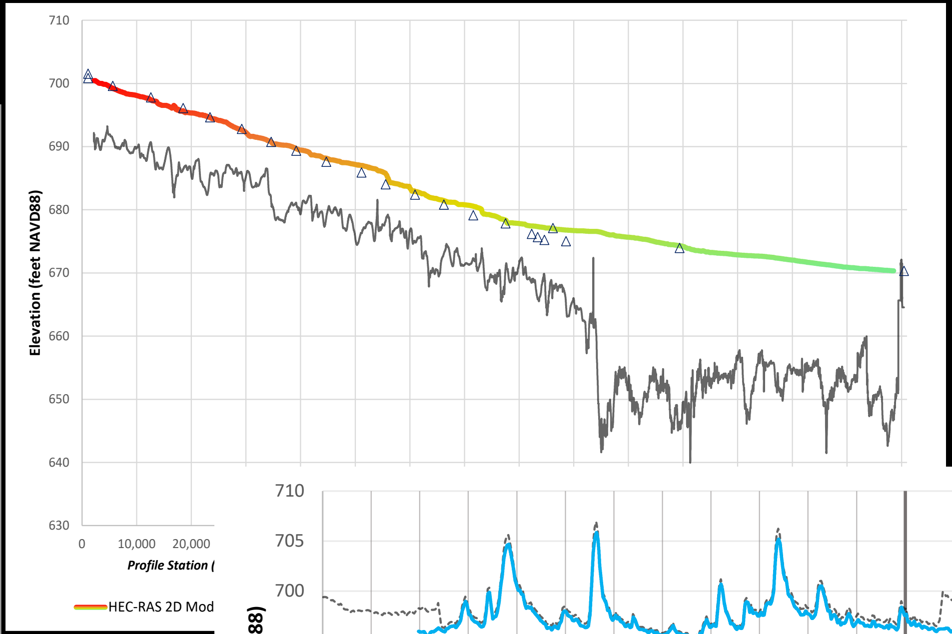
2. How is it different than Steady Flow?

Calibration

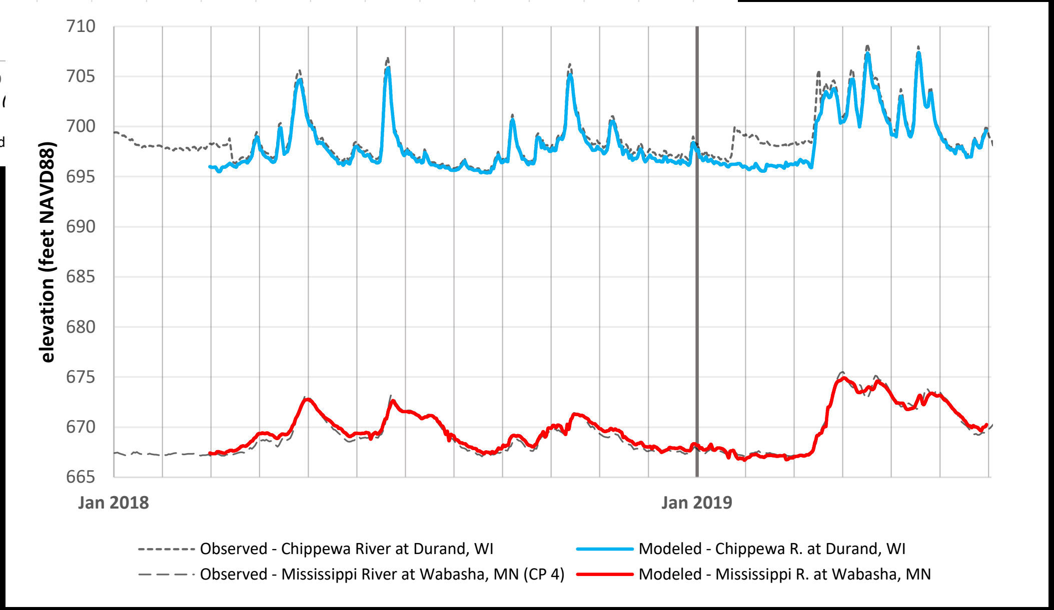
Steady Flow



Unsteady Flow



By: Alex Nelson (MVP)

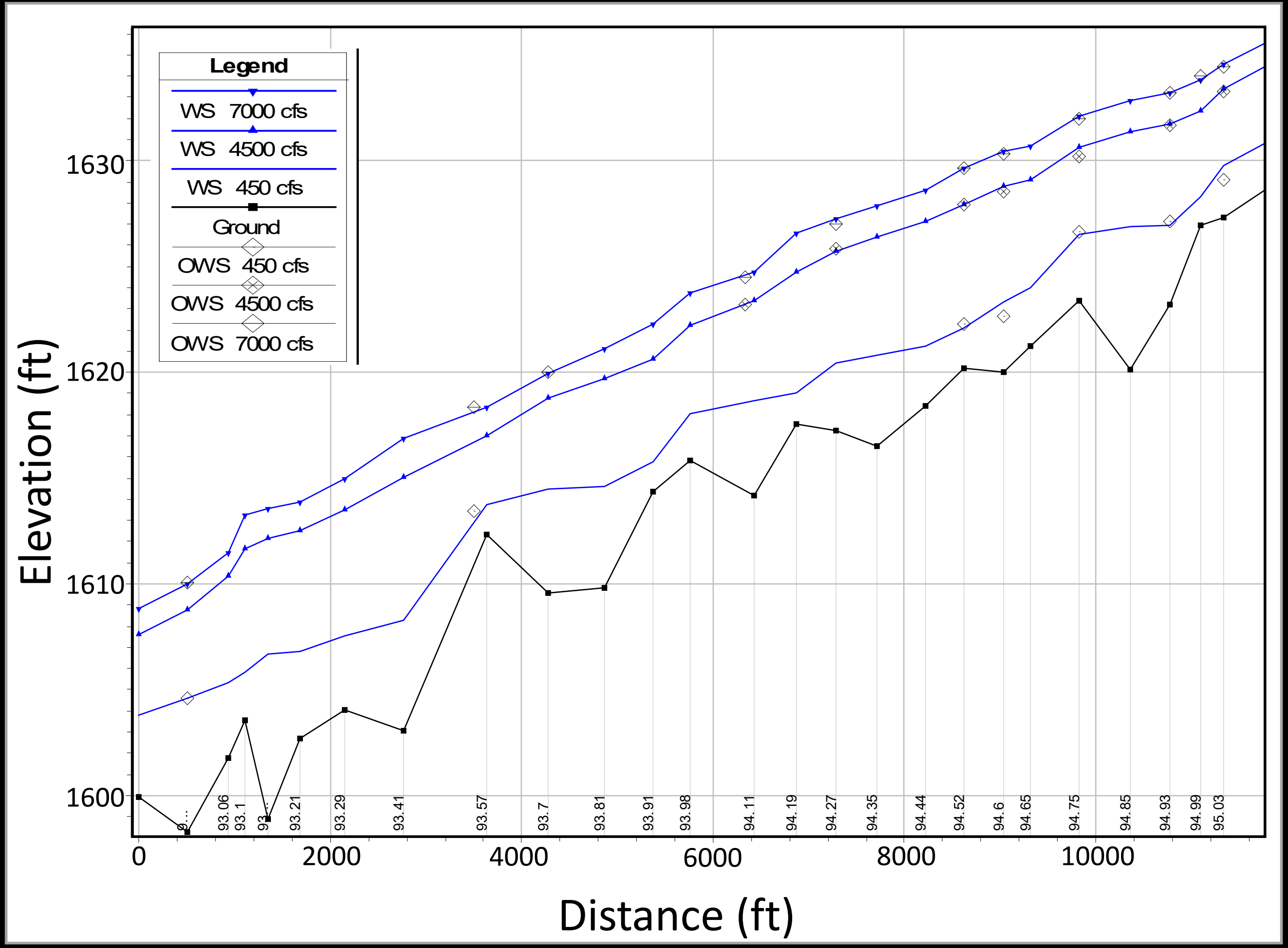


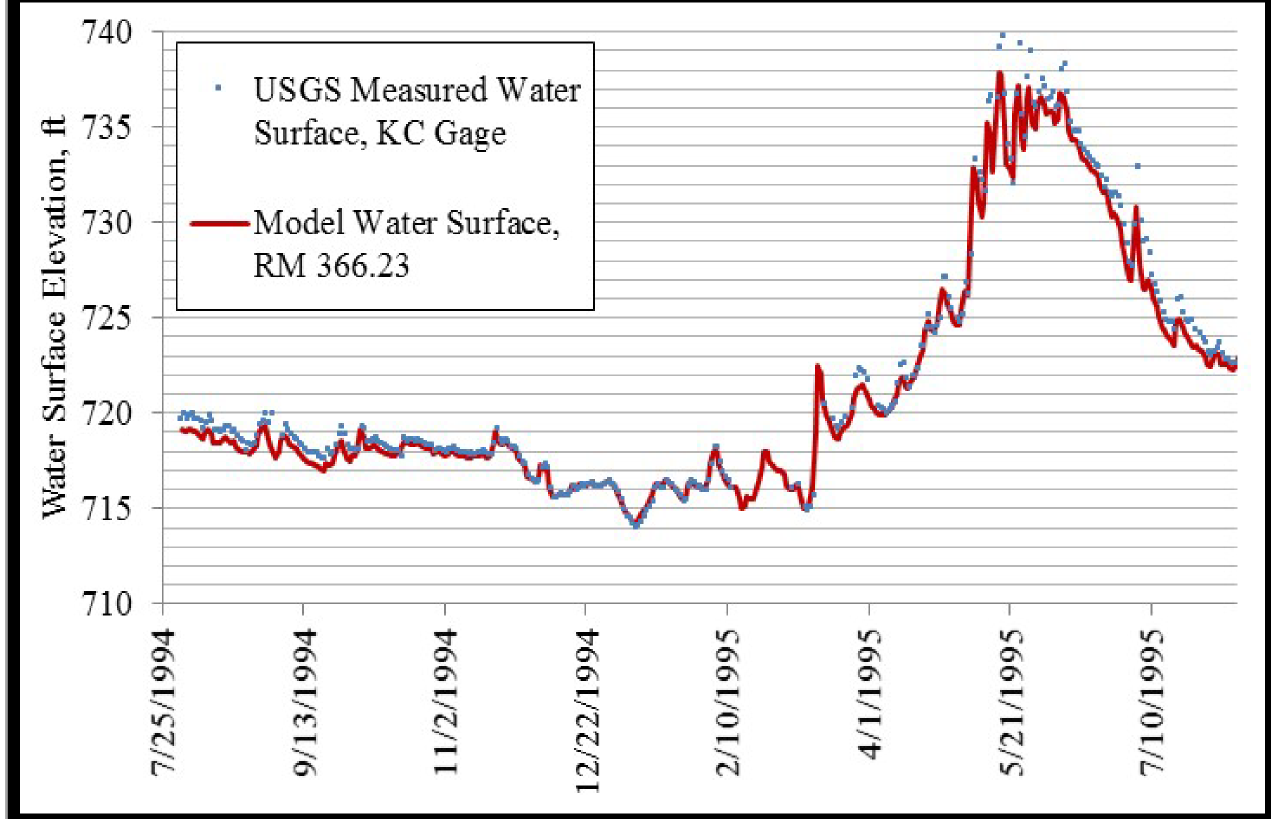
2. How is it different than Steady Flow?

Calibration

Steady Flow

Unsteady Flow

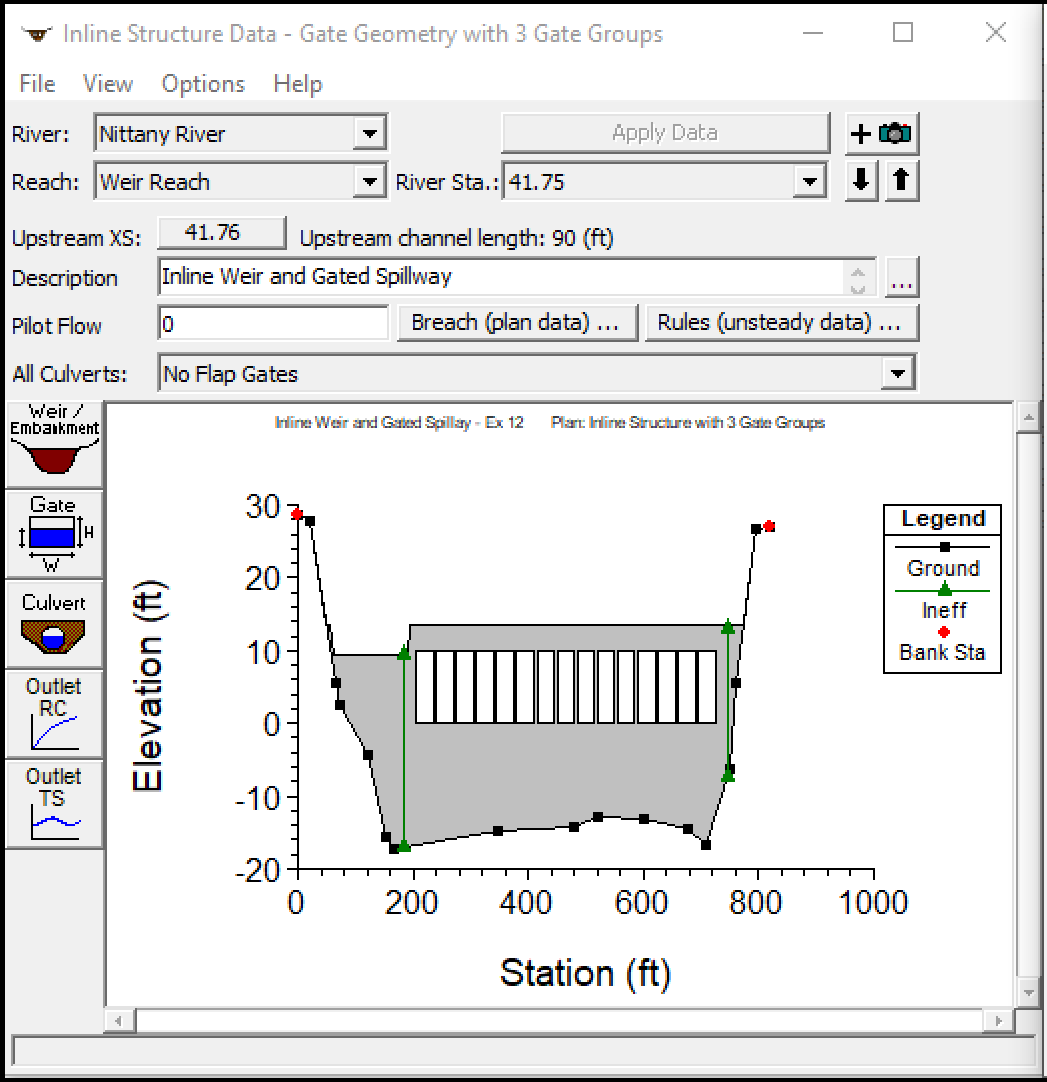


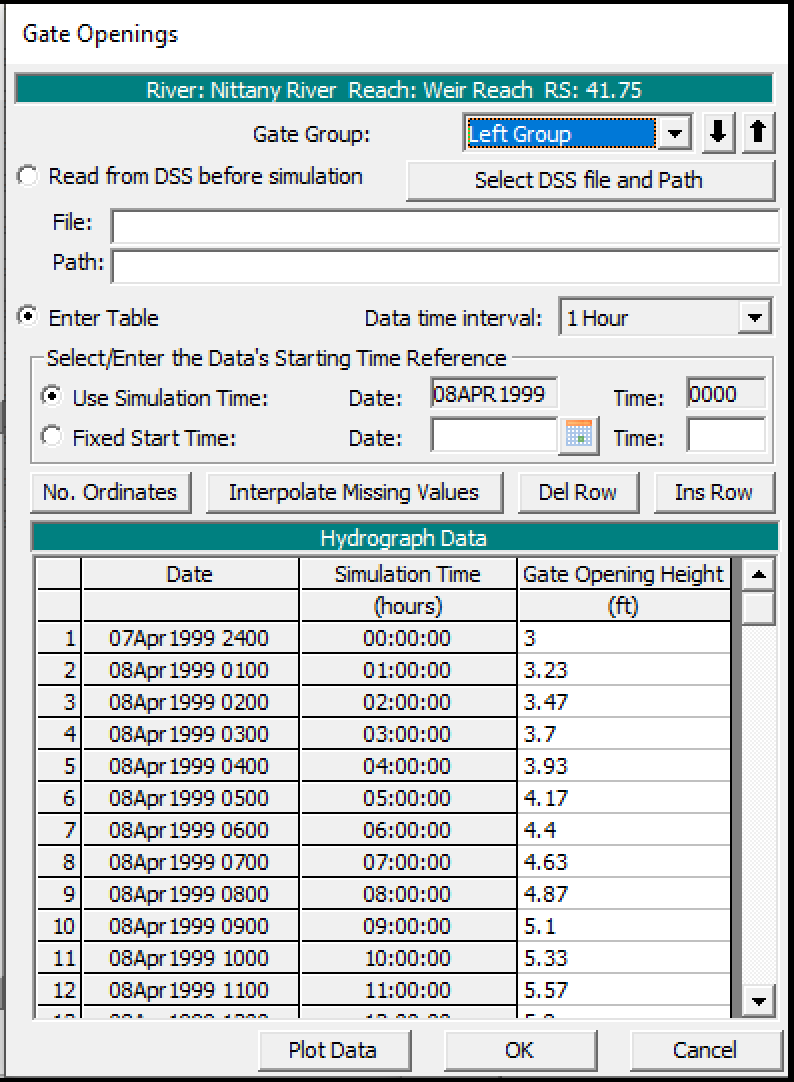


By: John Shelley, PhD (NWK)
From: Missouri River Bed Degradation Feasibility Study. USACE (2017).

2. How is it different than Steady Flow?

Applications



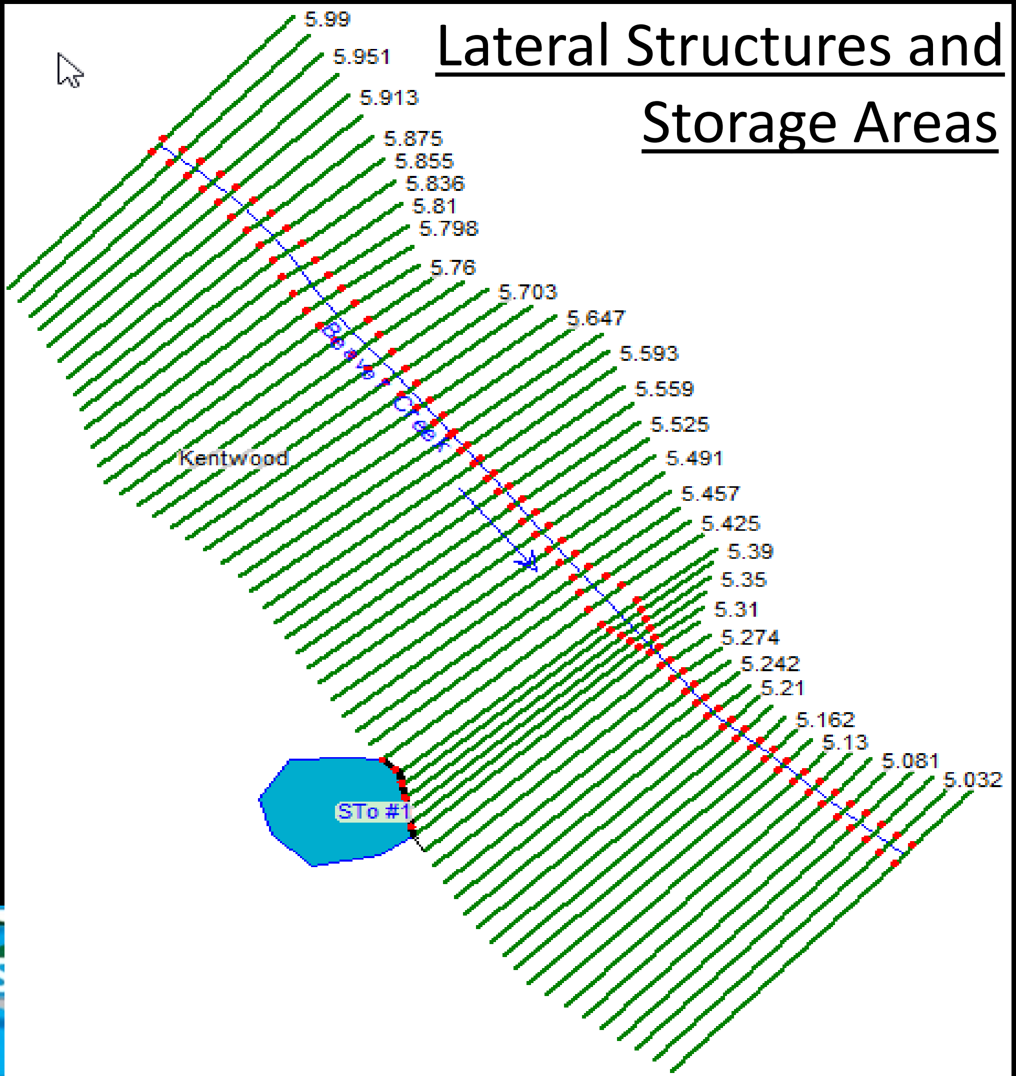


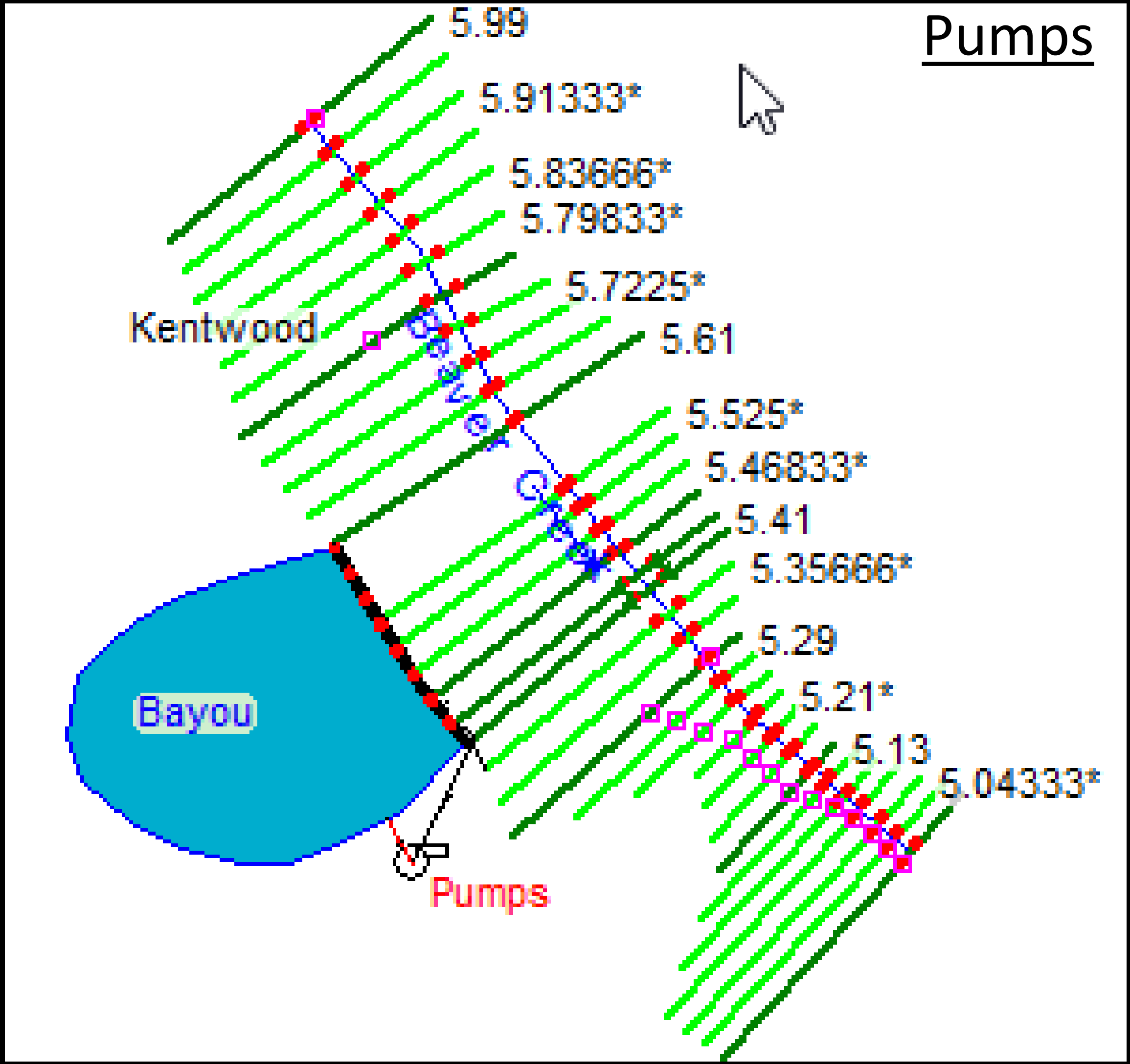
Dams and Reservoirs:

- All – Volume Matters
- Operations –*f(t)*
  - Specified
  - Rules
- Dam Breach

2. How is it different than Steady Flow?

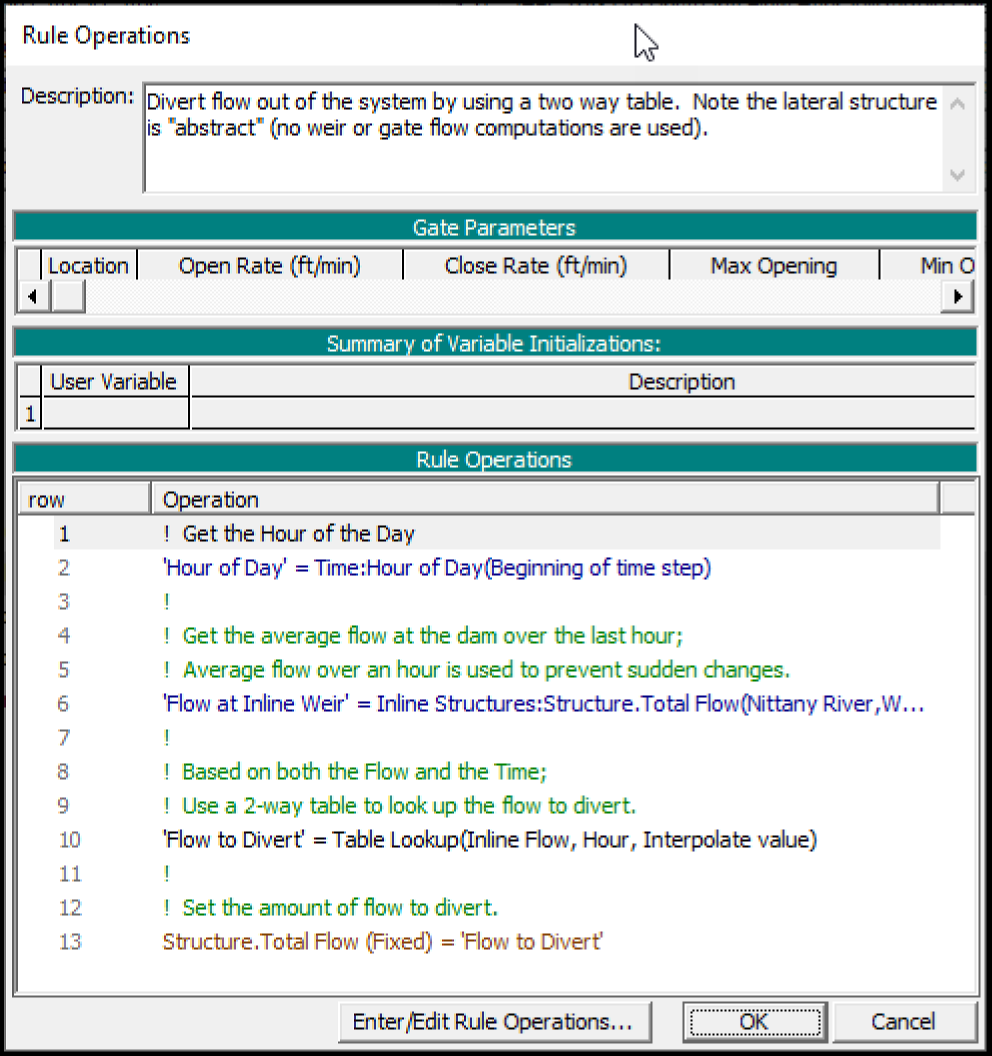
Applications





2. How is it different than Steady Flow?

Applications



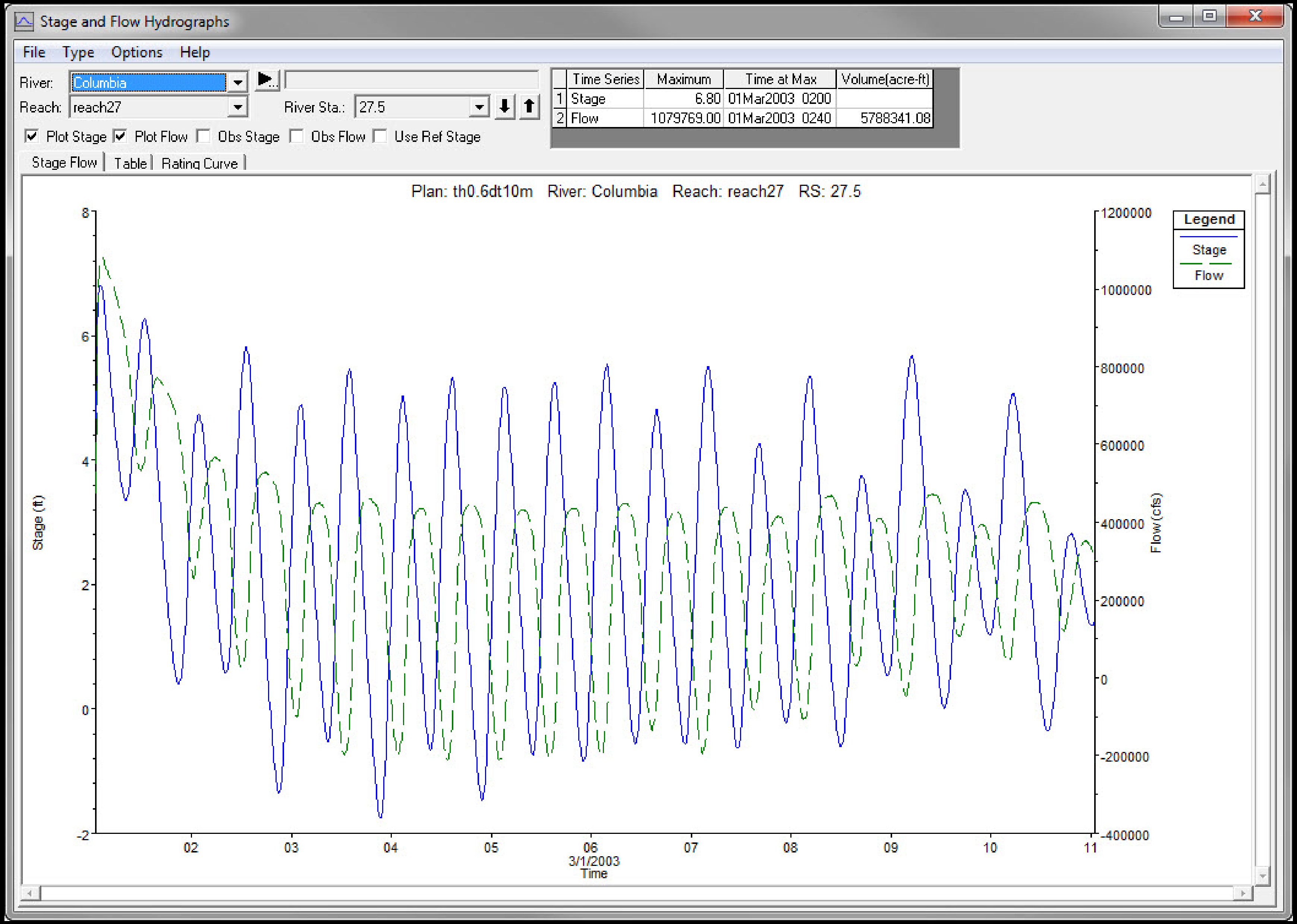
Operational Rules:

- Dam Operations
- Lateral Gates
- Pumps
- Sediment

Unsteady Flow Examples

- Navigation Dam
- Lower Columbia River Tidal Flow
- Russian River Dambreak Model
- Allegheny/Ohio River Real Time Forecasting Model
- Operational Rules and Reservoir Flushing

Lower Columbia River Tidal Flow

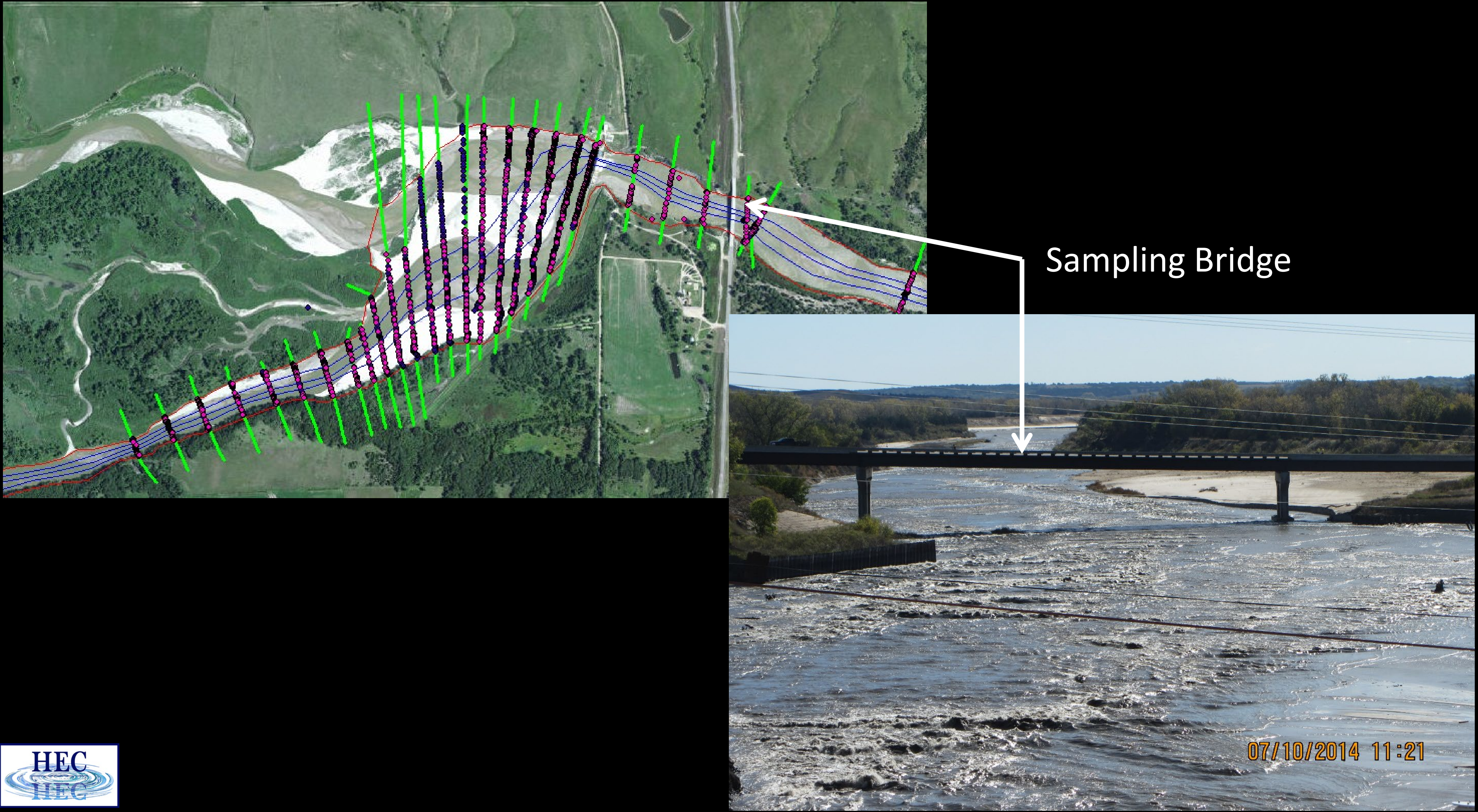


Russian River Dam Breach Model

HEC
HEC
RAS

Spencer Dam Reservoir Flushing Model

Reservoir 97% Full of Sediment – Flushed 2X per year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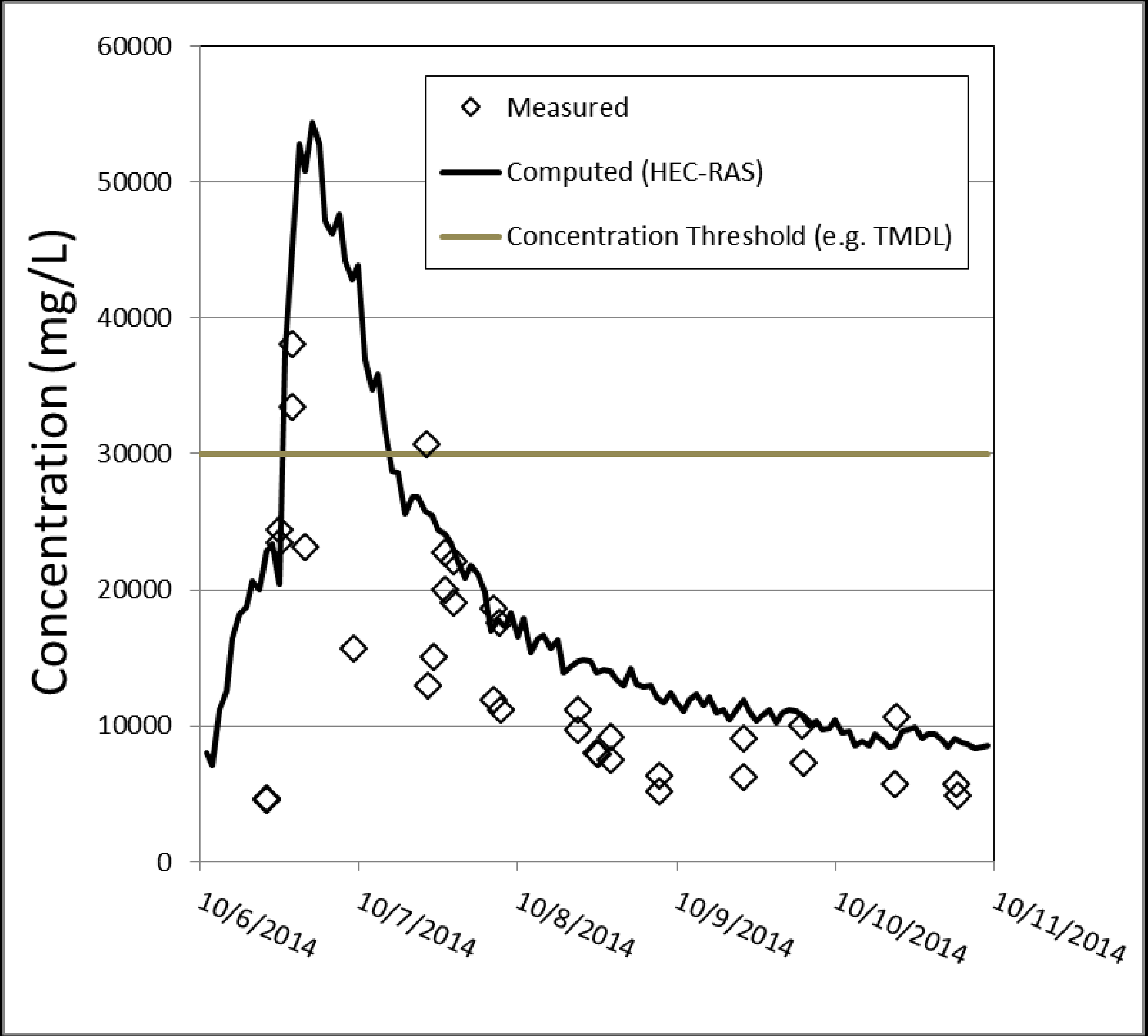

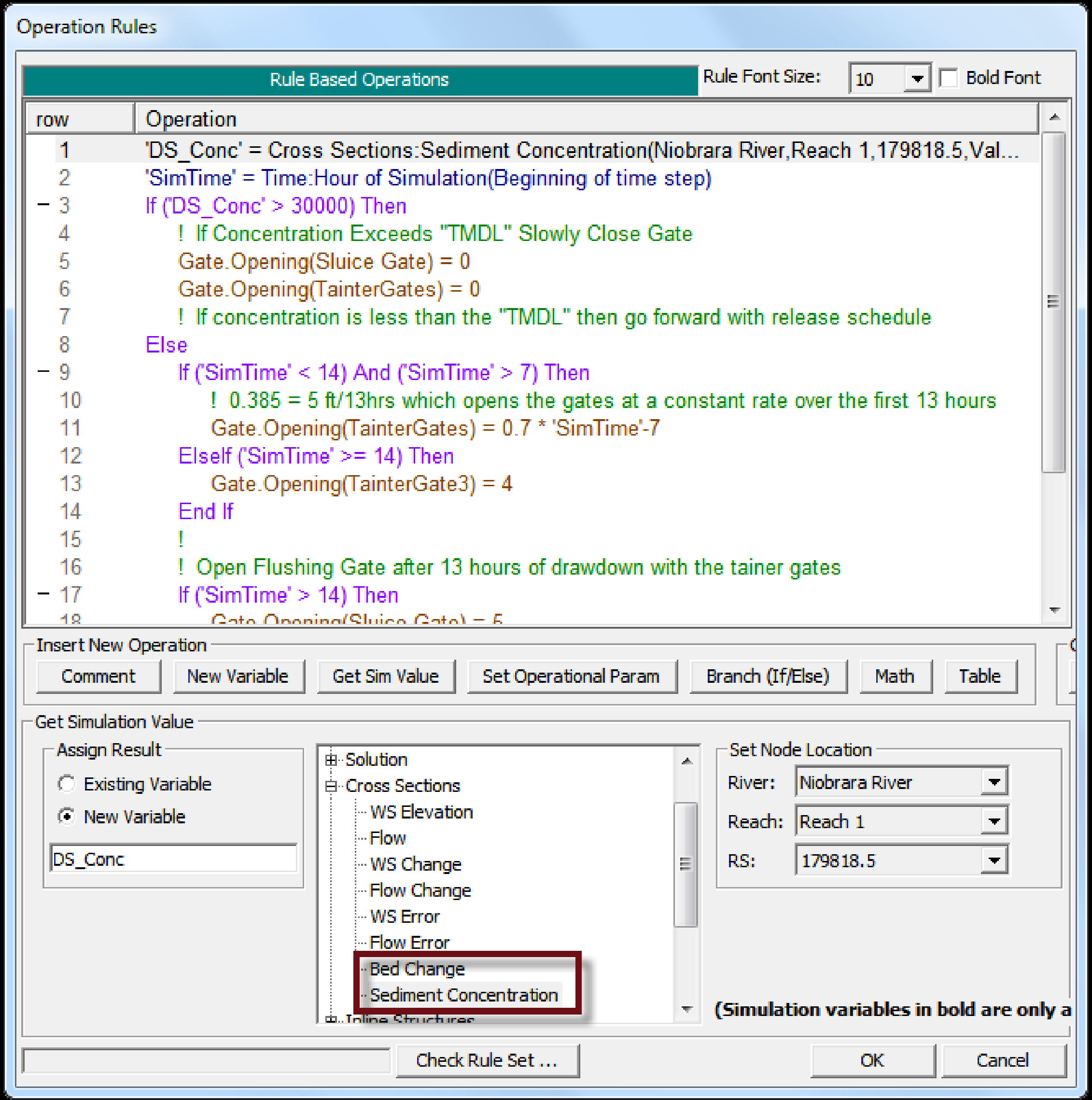

Gibson, S. and Boyd, P. (2016) "Designing Reservoir Sediment Management Alternatives with Automated Concentration Constraints in a 1D Sediment Model," River Sedimentation: Proceedings of the 13th International Symposium onon River Sedimentation, ed edited by S. Wieprecht, *et al*.

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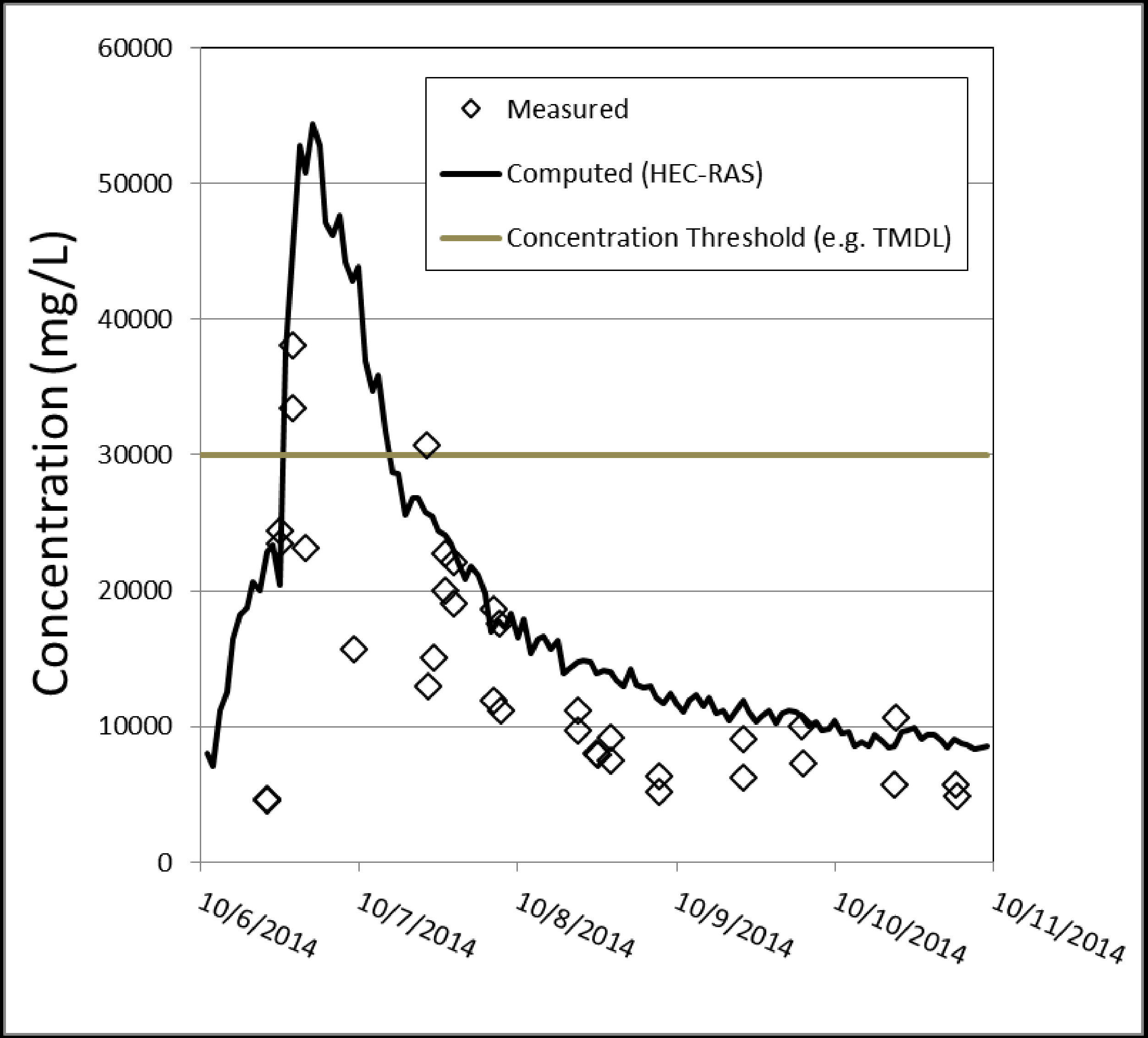

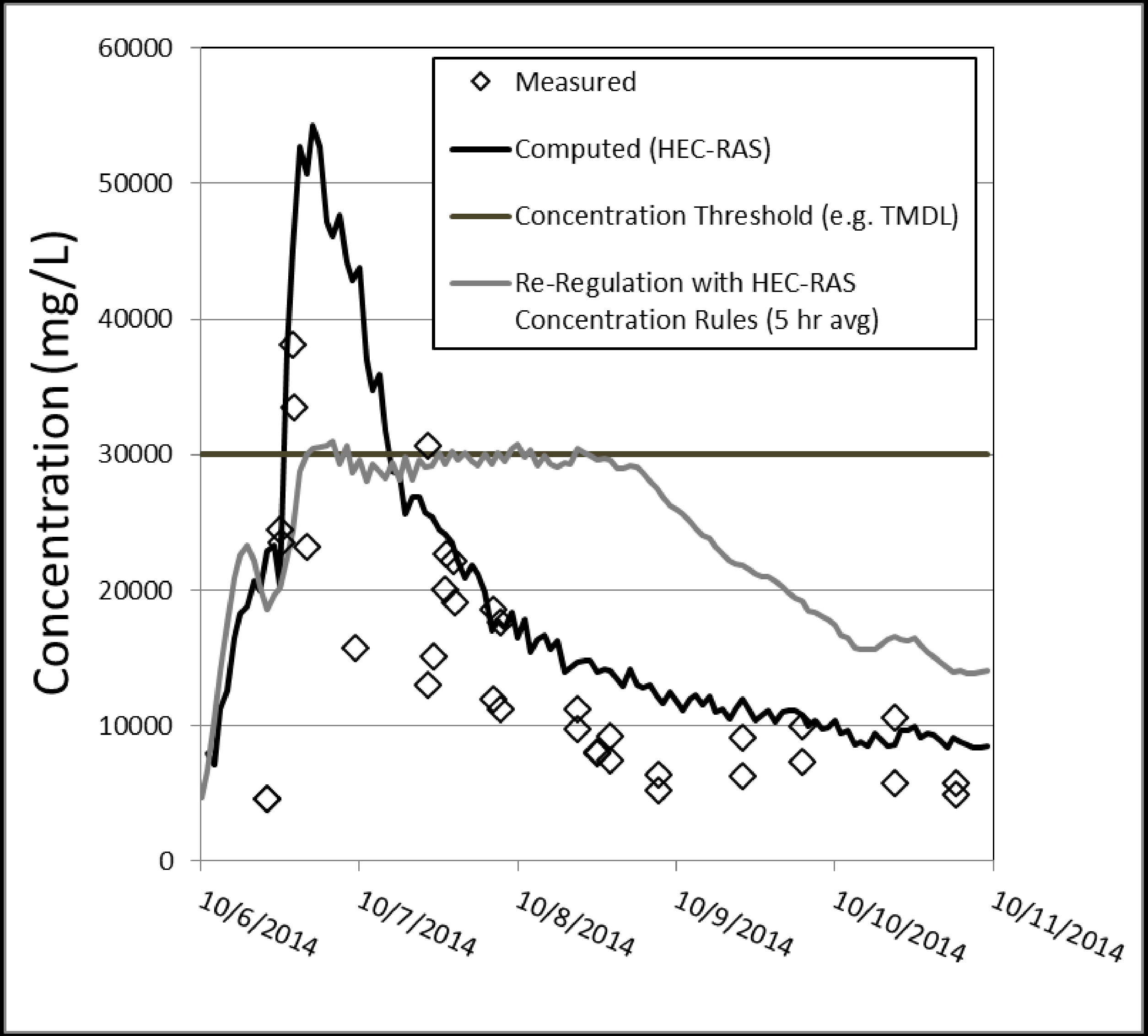

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