

Sediment Management for Dam Removal: An HEC-6 Approach



Overview



- **What is HEC-6?**
- **Why use HEC-6 for Dam Removal Studies?**
- **Applicability of HEC-6 for Dam Removal Studies**
- **Unique Issues to Dam Removal and Sediment Management using HEC-6**
- **Conclusions**

HEC-6. What is it?



- **One-Dimensional Moveable Boundary Open Channel Flow Numerical Model.**
- **Time-Series of Steady Flow Profiles.**
- **Can Simulate Changes in River Profiles due to Scour and/or Deposition over Moderate Time Periods (years +).**
- **Simulates Bed Sediment Sorting and Armoring.**

Why use HEC-6???



● Time-series Sediment Concentrations

■ Fisheries

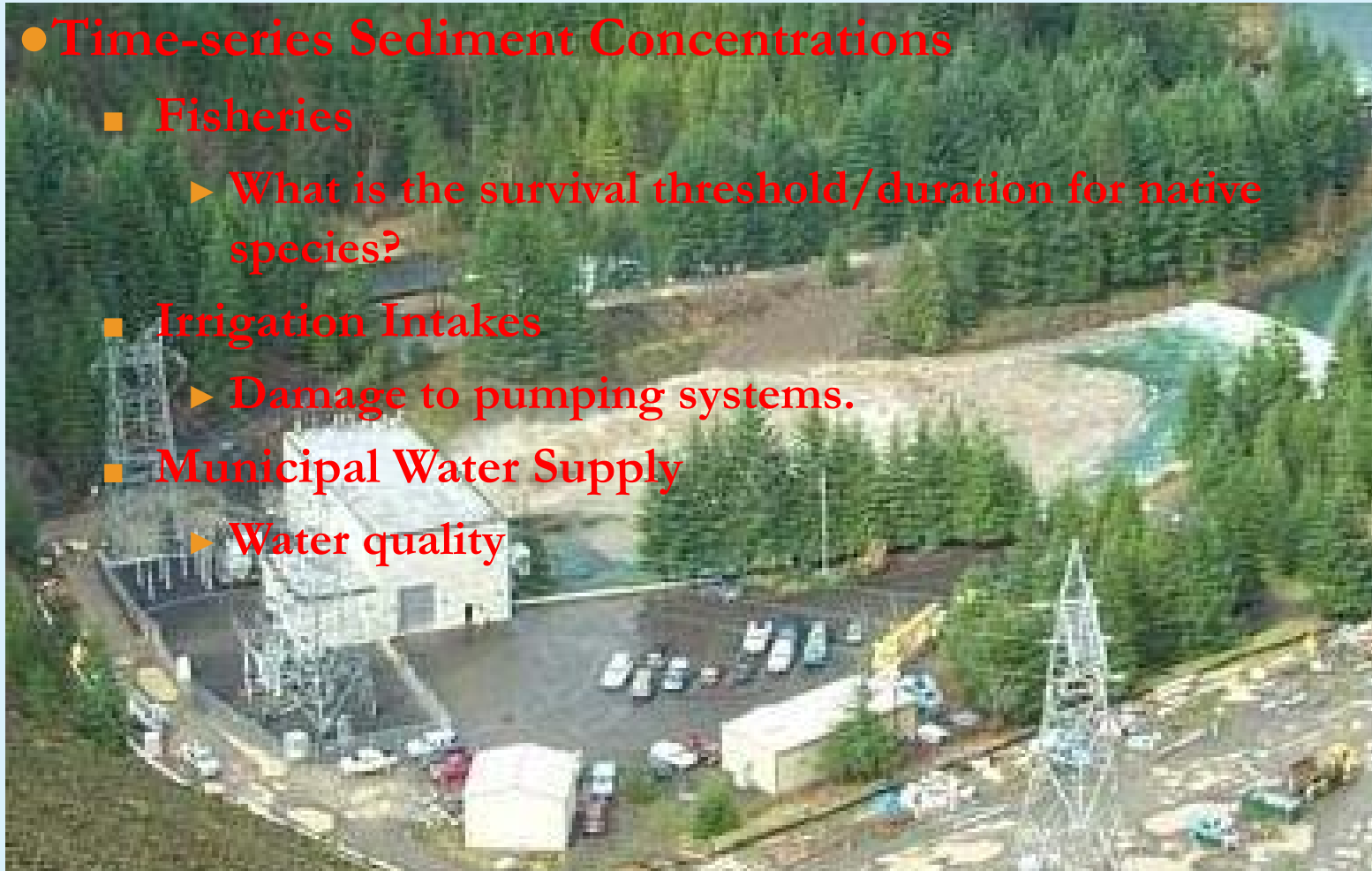
- ▶ What is the survival threshold/duration for native species?

■ Irrigation Intakes

- ▶ Damage to pumping systems.

■ Municipal Water Supply

- ▶ Water quality



Why use HEC-6???



- **Volumes**

- **Quantities of sediment removed from the reservoir.**
- **Sources of Sediment Scoured**
 - ▶ **Are there contaminated sites within the reservoir?**
 - ▶ **What areas need to be targeted for scour/non-scour**

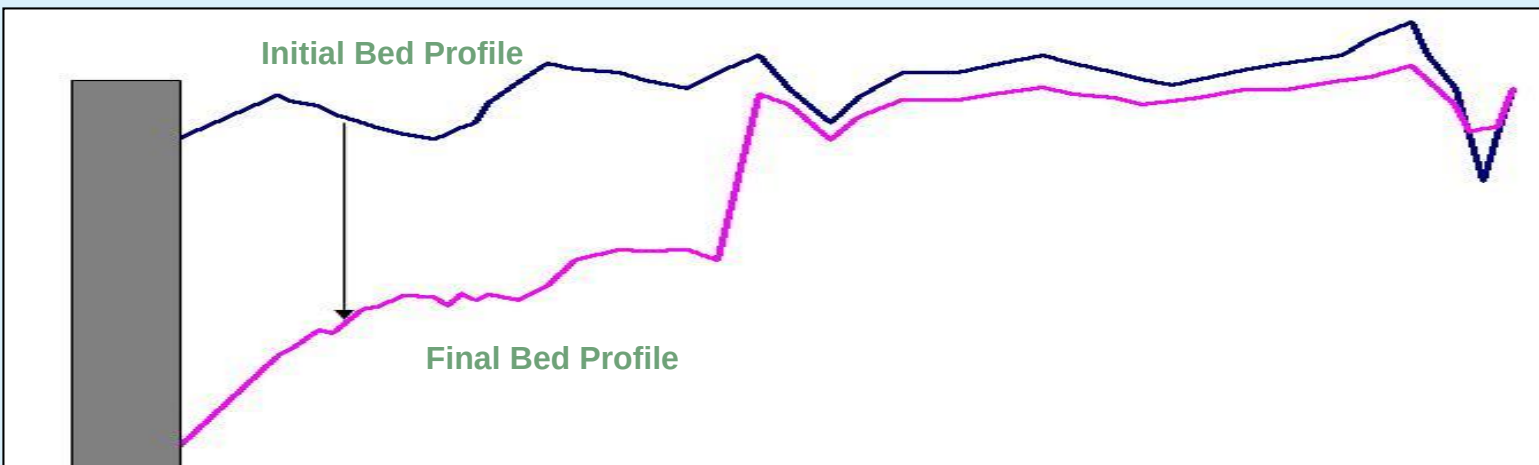
Why use HEC-6???



- **Downstream Depositional Zones**

- Bridge Constrictions
- Overbank Areas
- Pump/Canal Intakes

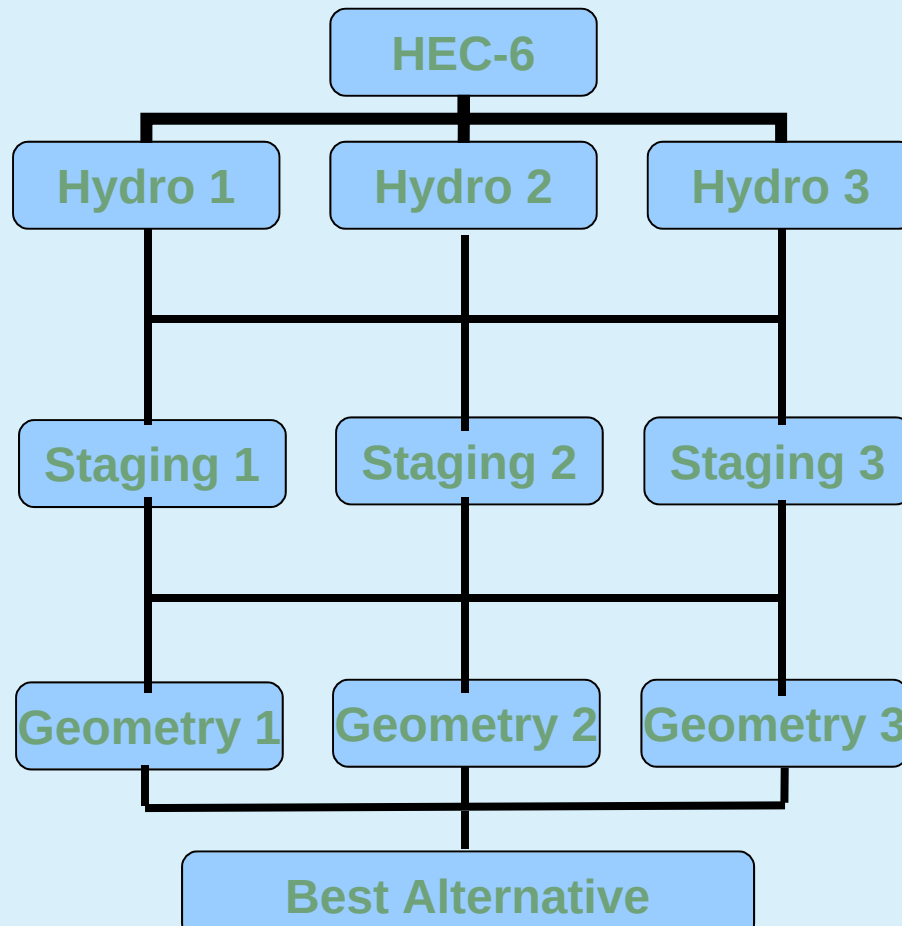
- **Final Bed Profiles**



Why use HEC-6???



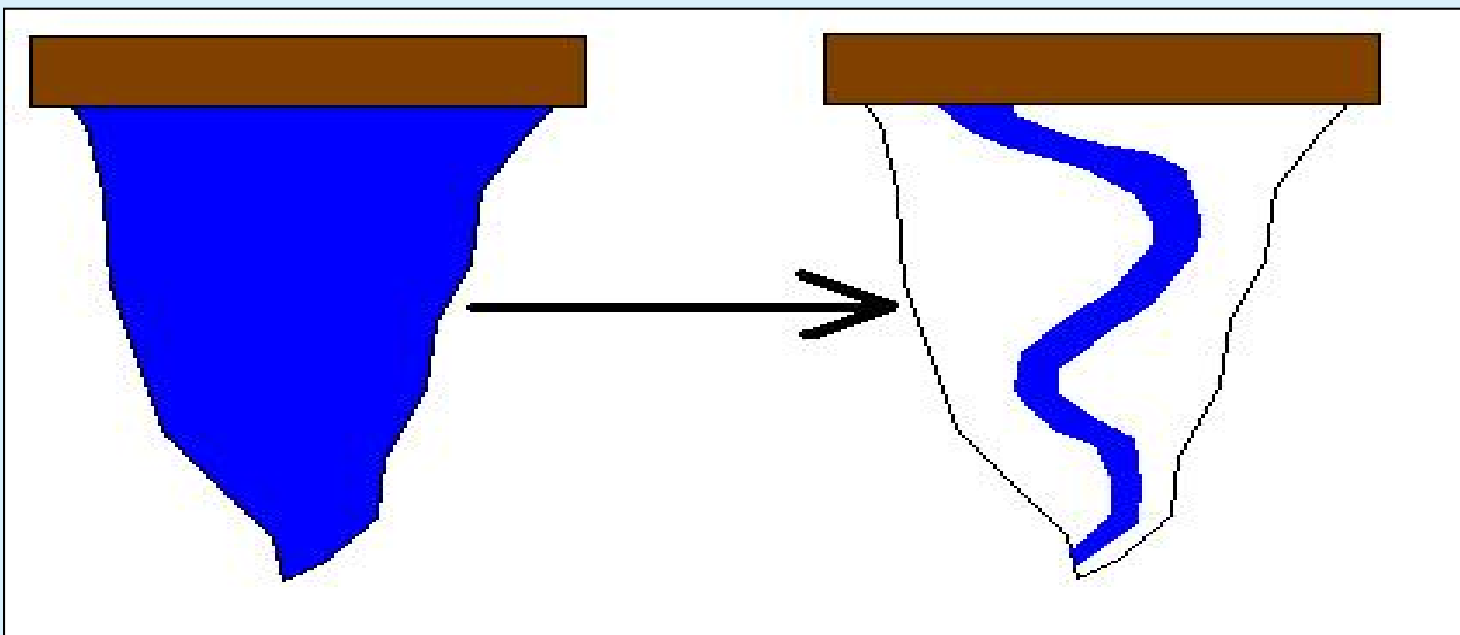
- Good Tool to Evaluate a Variety of Dam Removal Alternatives.



Applicability of HEC-6 to Dam Removal



- *Dynamic Equilibrium* (Calibration)
- Represented by 1-D Assumption
 - *Final Thalweg already present or can be logically assumed.*



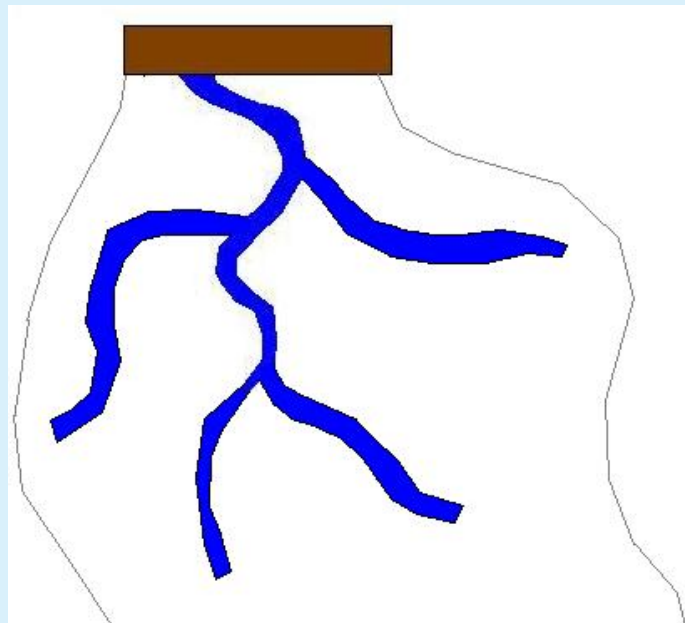
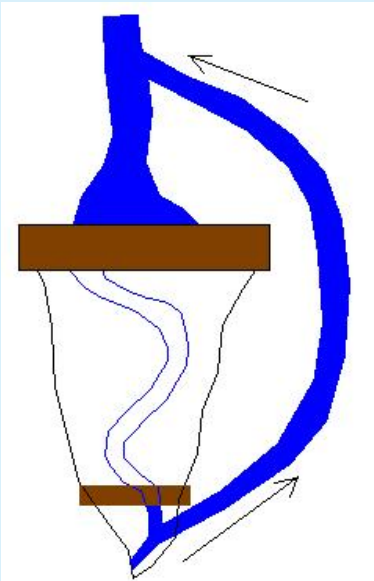
Applicability of HEC-6 to Dam Removal



- Full Drawdown is Relatively Gradual
 - Months or Years...*not* Days

- Bypass Channels

Multiple Reaches



Unique Issues for Dam Removal



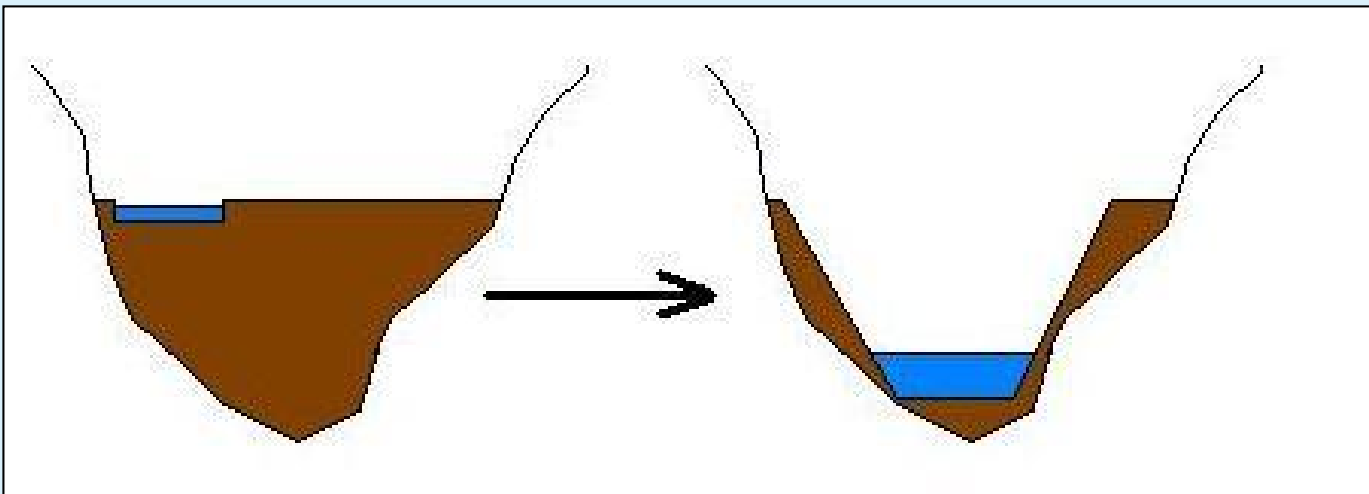
- **Internal Boundary at Dam**
 - Gradual Drawdown can be simulated by designating the Dam cross section as an internal boundary
 - Water surface elevations are specified for each time step.

Unique Issues for Dam Removal



● Staging

- HEC-6 can simulate the removal of part or all of the dam by using the DREDGE card.
- The DREDGE card allows for a portion of the cross section to be removed *during* the simulation.
- The DREDGE template must be a trapezoidal shape.



Unique Issues for Dam Removal

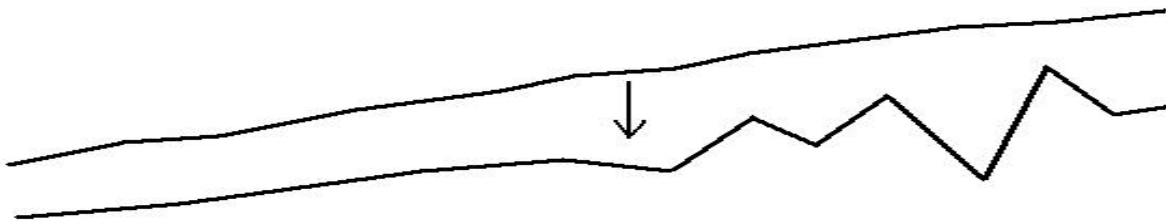


- Staging (cont.)
 - Only one DREDGE card per cross section. If the dam is removed in stages, use the DREDGE card to simulate the final staged removal.
 - Previous stages must be lumped in to the initial cross section shape.
 - May overestimate localized scour.

Unique Issues for Dam Removal



- Cross Section Spacing
 - Close. Less than 200 ft for moderate drawdown periods. Useful to cut cross sections from GIS
 - Refined Cross Section Spacing can:
 - ▶ Improve numerical stability. Be mindful of time step!
– *Explicit Solution Scheme*
 - ▶ Eliminate “Sawtooth” profile pattern



Unique Issues for Dam Removal



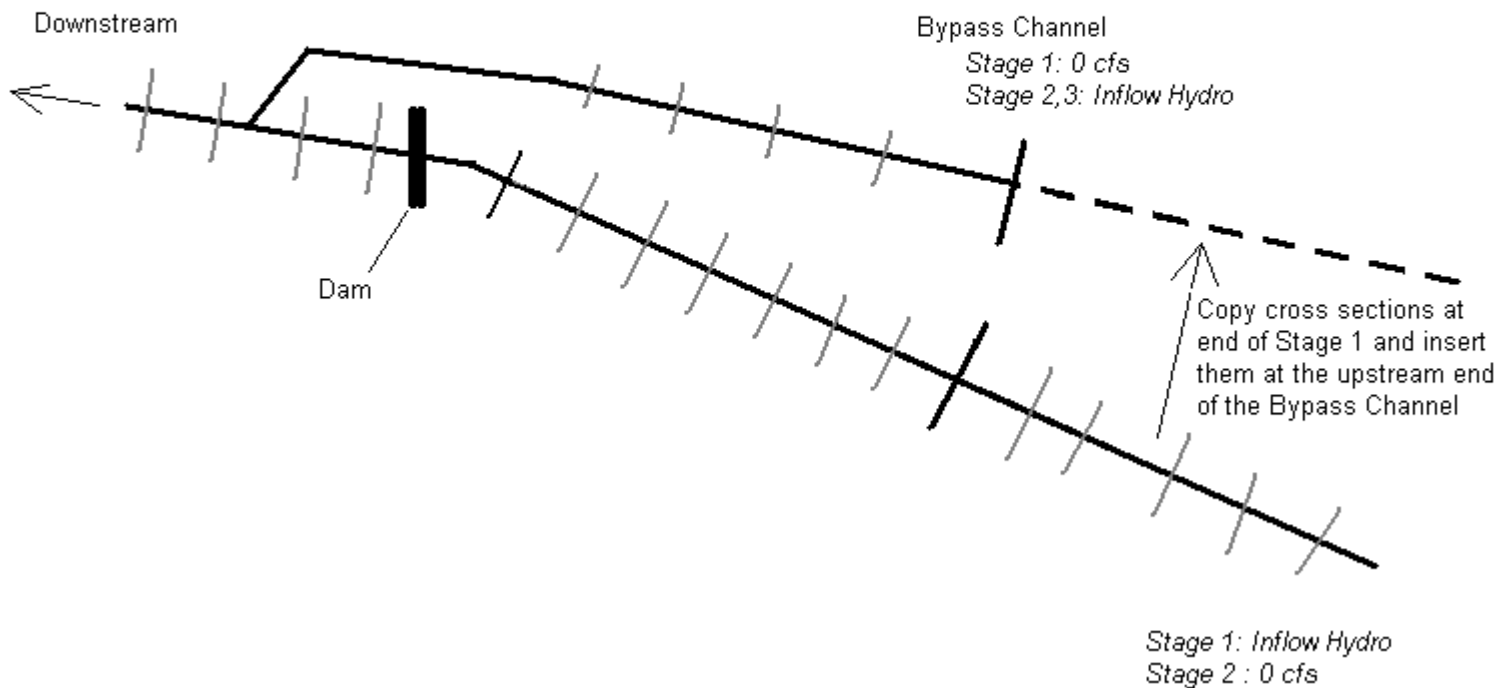
- Time Steps
 - 1 day or less throughout the simulation.
 - 1/10 or 1/20 day for active drawdown periods.
 - May have to reduce to 1/100 day at times throughout the simulation to achieve numerical stability.

Unique Issues for Dam Removal



- **Bypass Channels**
 - Some dam removal scenarios involve bypassing reservoir sediments with a constructed channel.
 - HEC-6 cannot handle looped networks.
 - Must use a common upstream reach for the reservoir and the bypass channel. Copy the sediment and geometry properties from the upstream reach above the reservoir at the time step in which flow is bypassed. Then transfer those properties to the “pseudo” reach above the bypass channel.

Unique Issues for Dam Removal



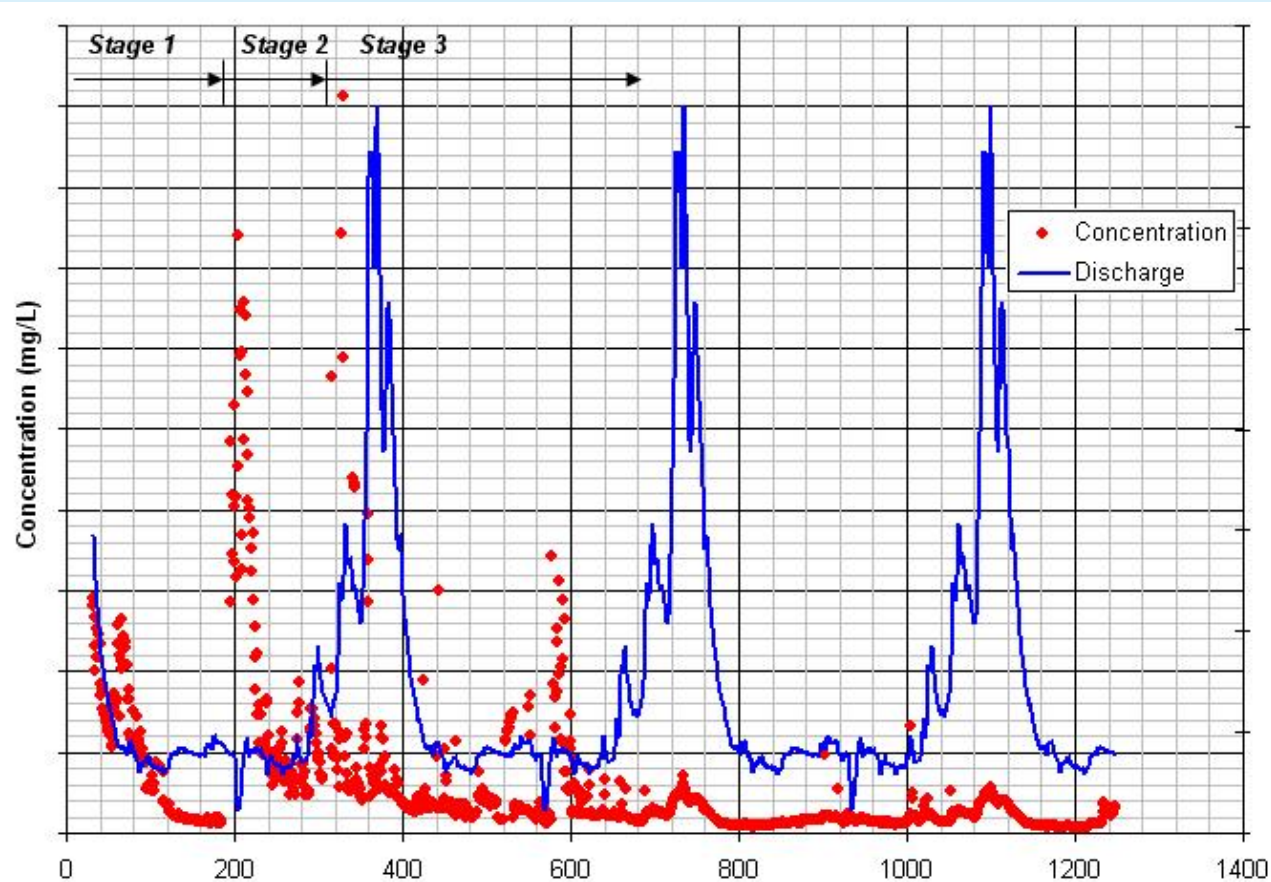
Conclusions



- **HEC-6 is a Useful Tool for Evaluating Alternative Dam Removal Scenarios**
 - Should be used for a comparison of alternatives, not for coming up with hard numbers.
 - Can be used to evaluate different staging and inflow hydrograph timings.
 - Can be used to evaluate staging durations (i.e. How fast should the dam be removed?)

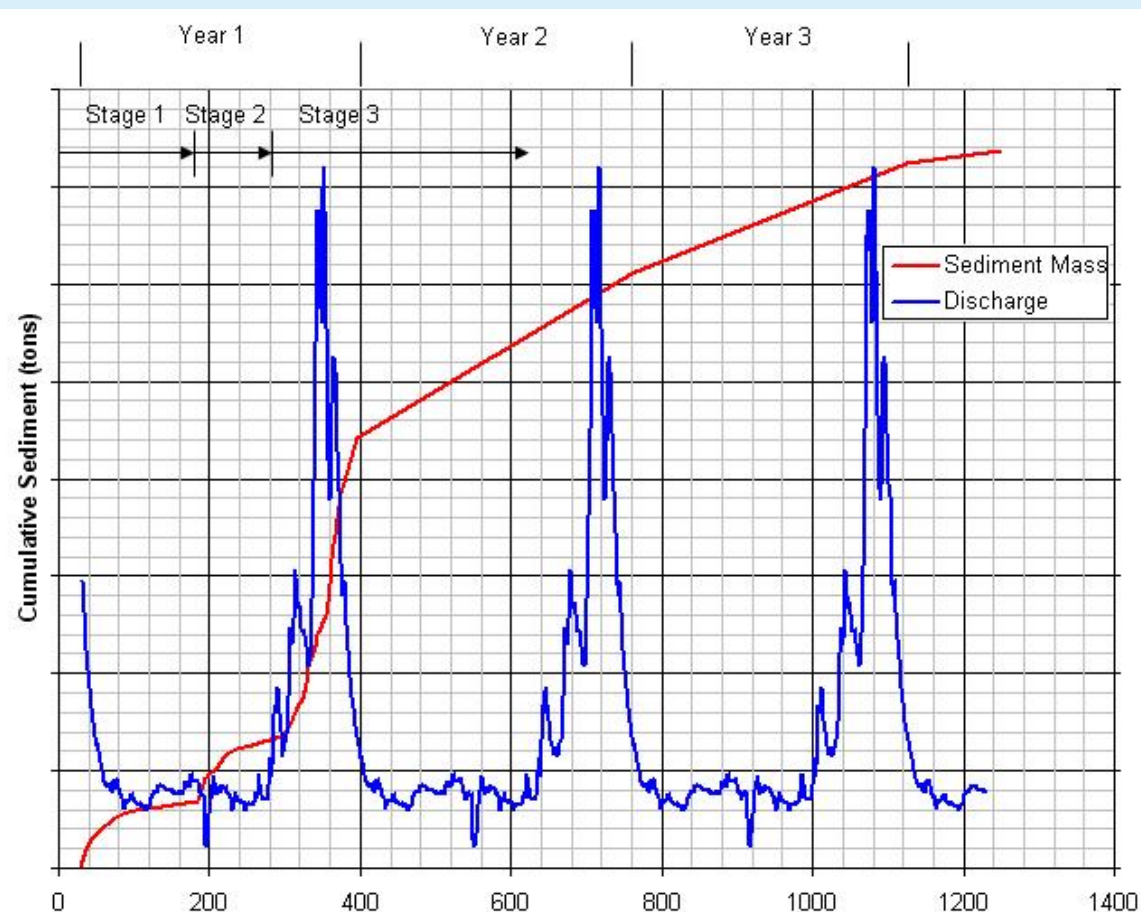
Conclusions

Sediment Concentrations



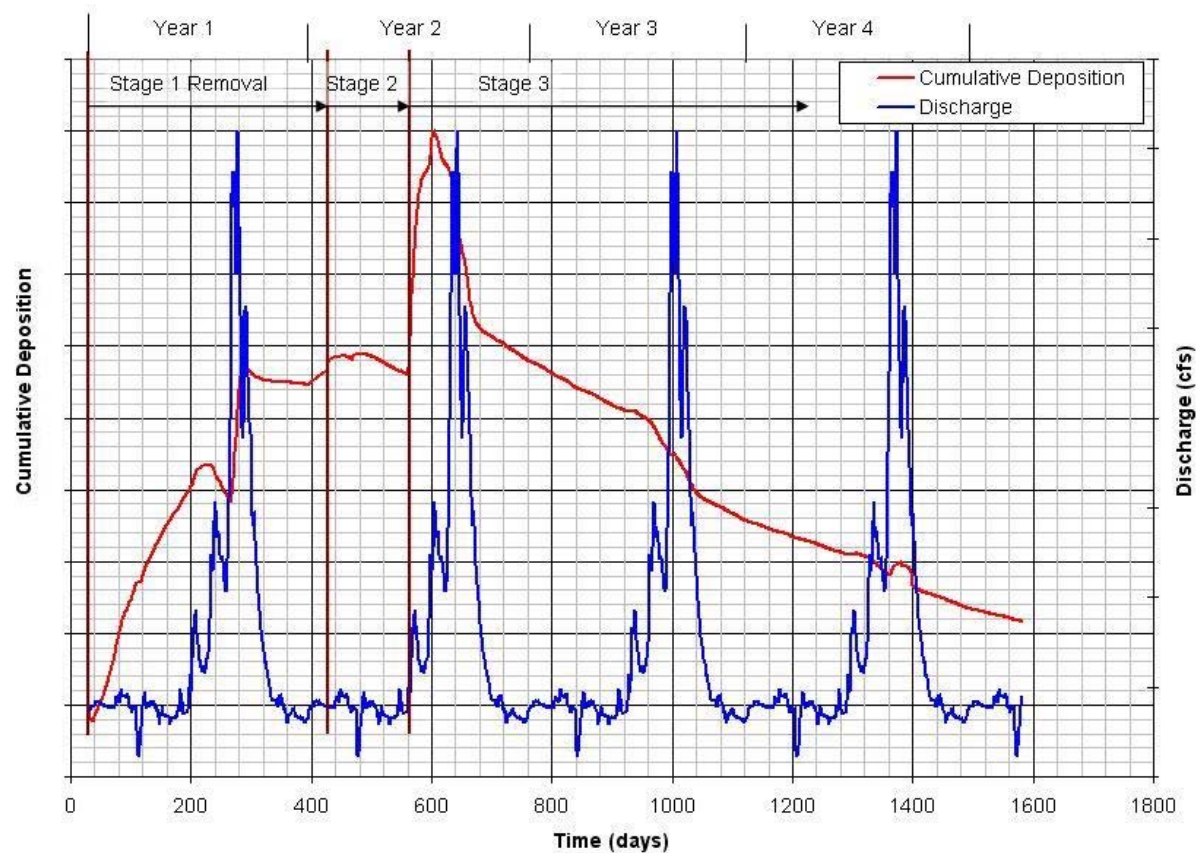
Conclusions

Cumulative Sediment Through Dam



Conclusions

Cumulative Sediment Deposition Downstream



Conclusions

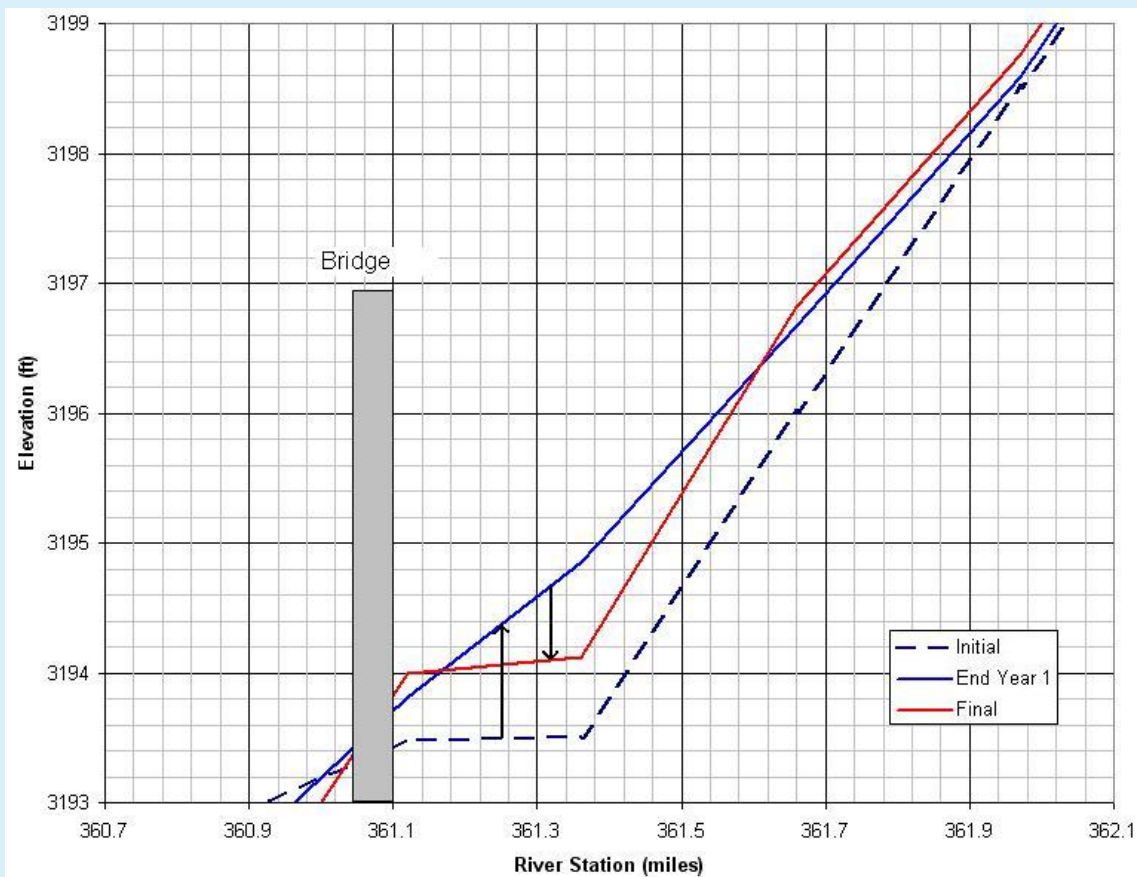


- Can evaluate grade control structures and their effectiveness.
- Can pinpoint potential deposition zones in downstream reaches.
 - ▶ Bridges
 - ▶ Natural grade breaks
 - ▶ Areas of low velocity

Conclusions



Local Sedimentation at Downstream Bridge



Questions???

