Integrated Watershed Water Quality Modeling with HEC-WAT

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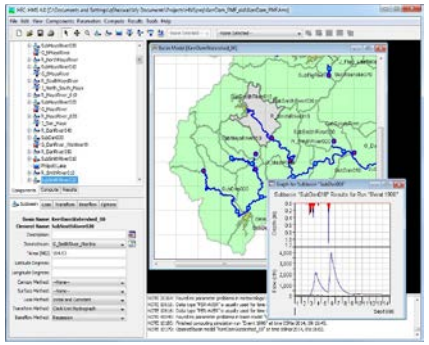
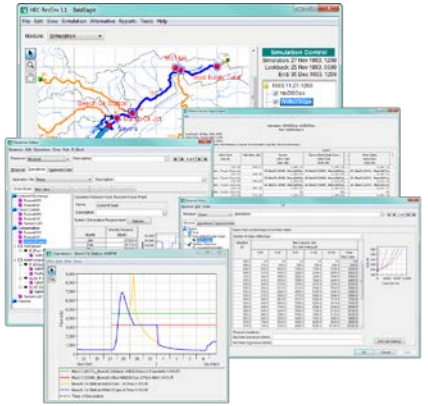
Integrated Watershed Water Quality Modeling

HEC-HMS
Runoff

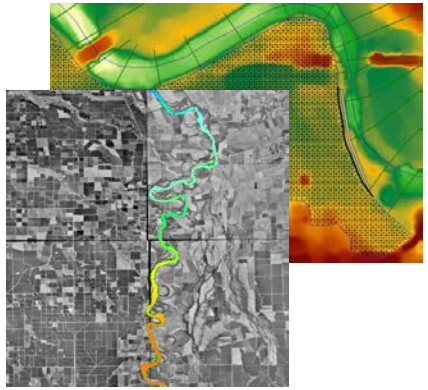


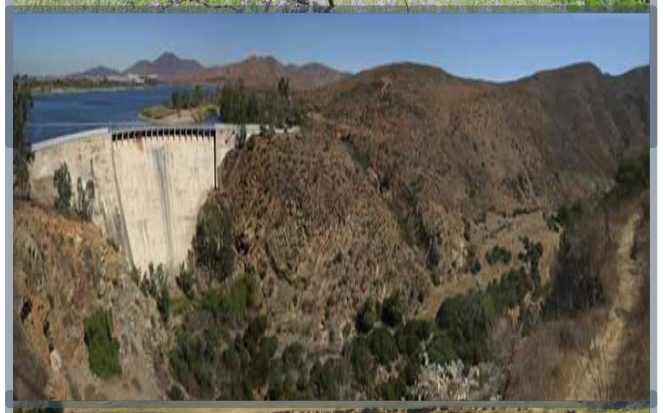
HEC-ResSim
Reservoir release decisions

CE-QUAL-W2
2D Reservoir WQ

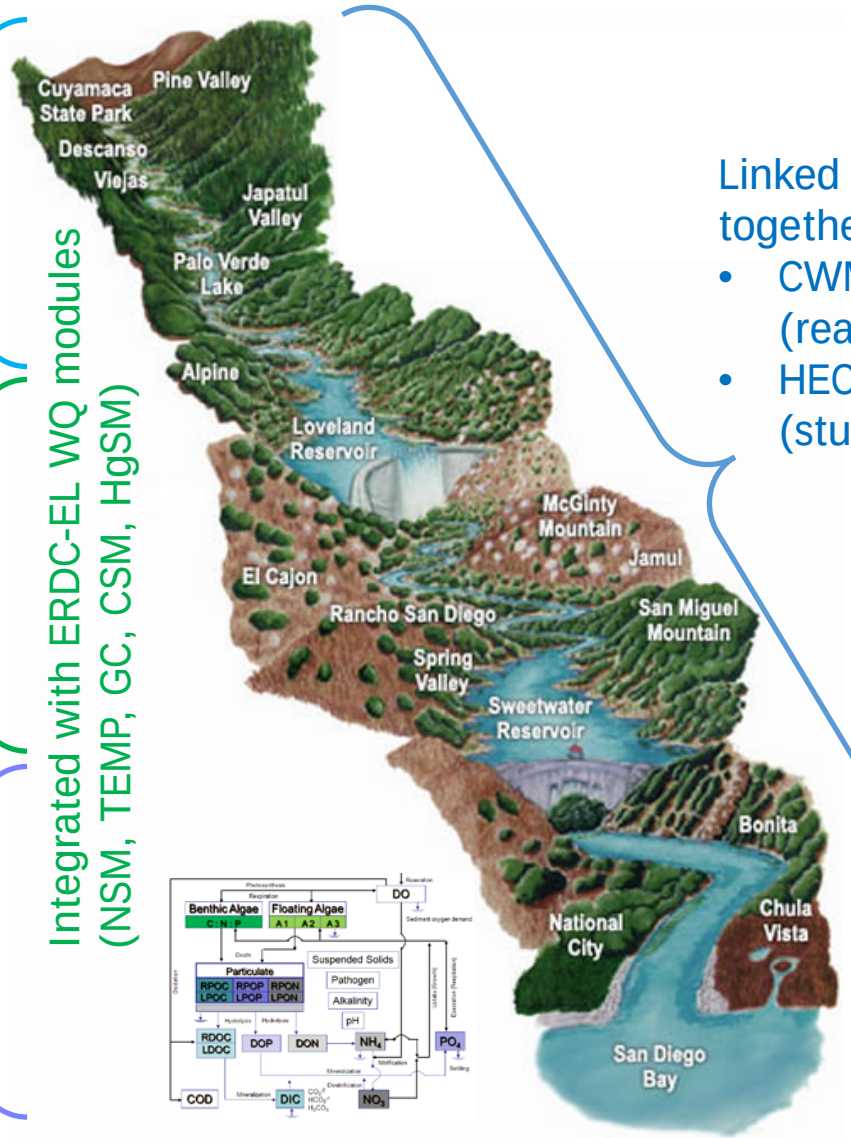


HEC-RAS
River hydraulics





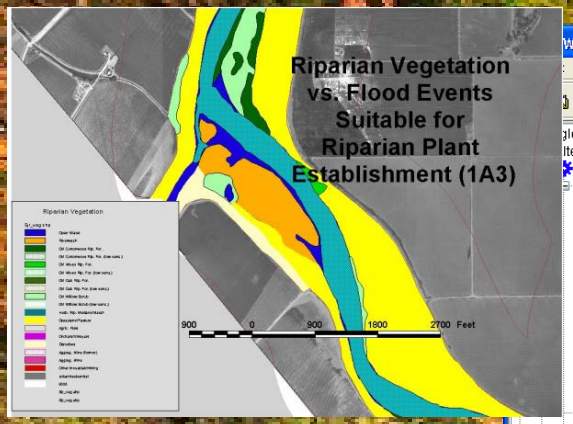
Integrated with ERDC-EL WQ modules
(NSM, TEMP, GC, CSM, HgSM)



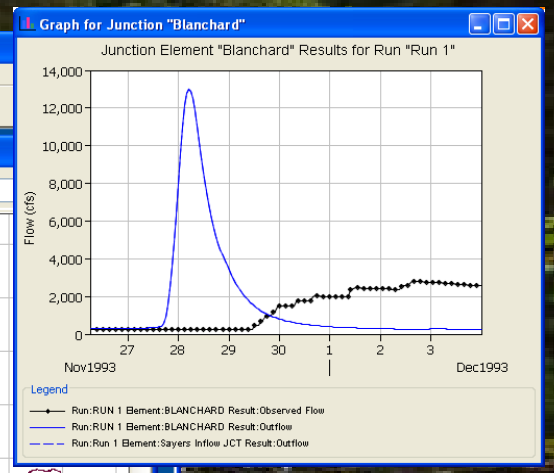
Linked together with
- CWMS (real-time)
- HEC-WAT (studies)

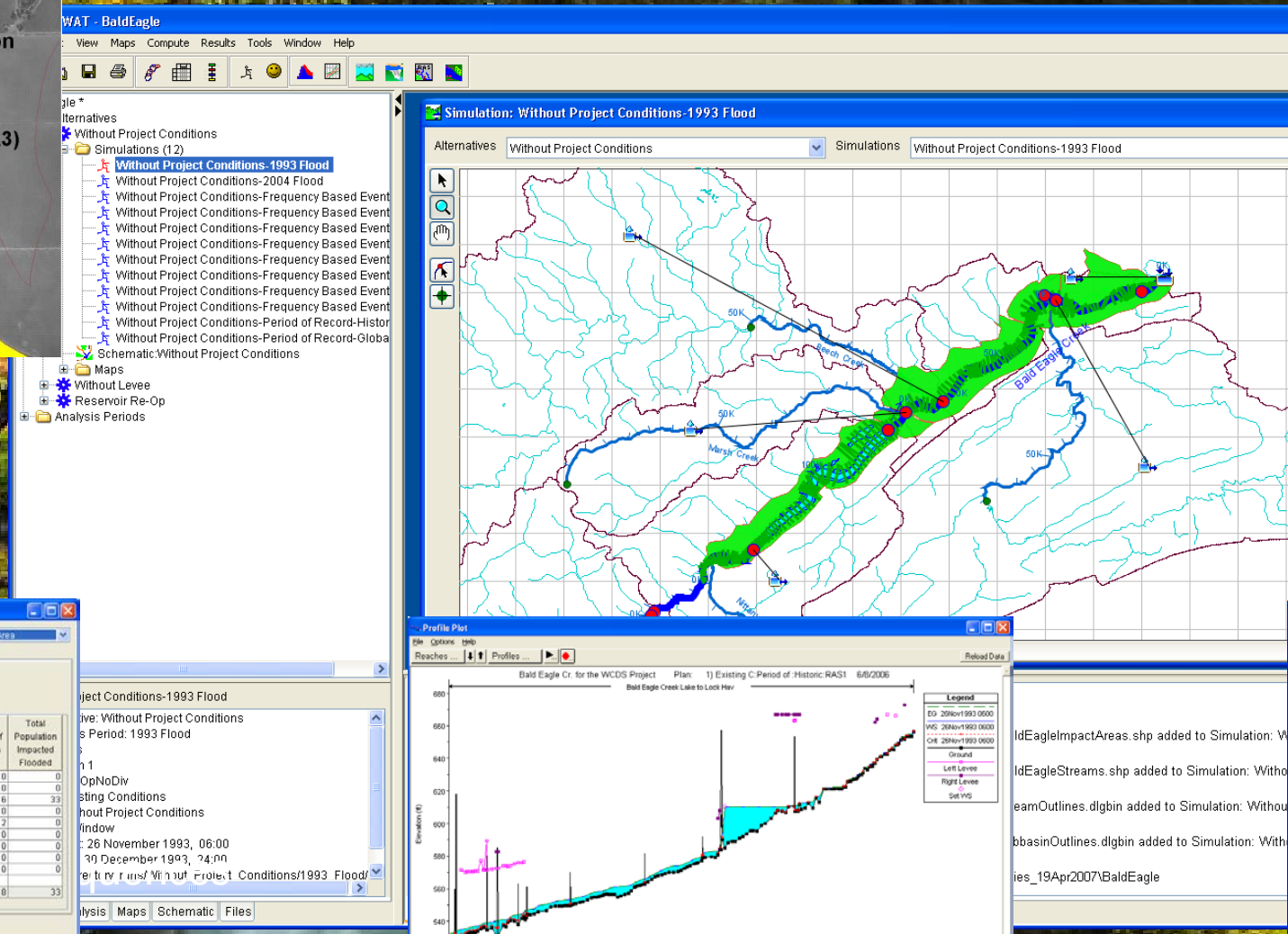
HEC-WAT (Watershed Analysis Tool)

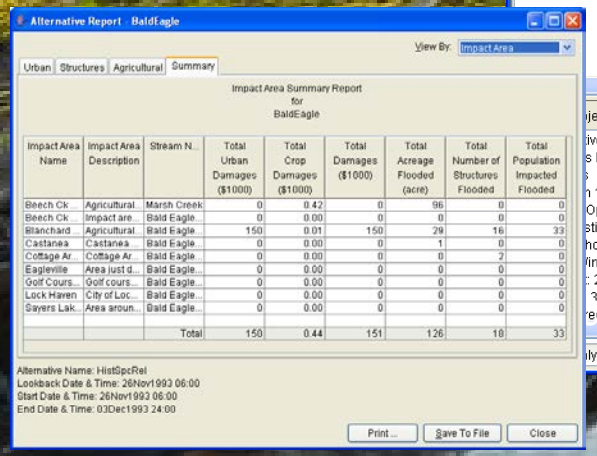
Environmental

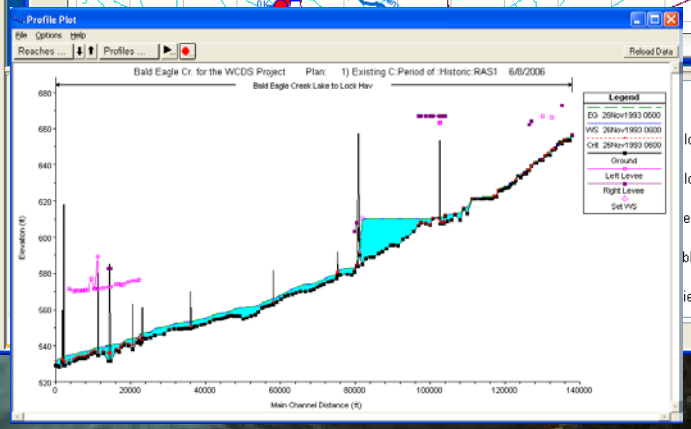


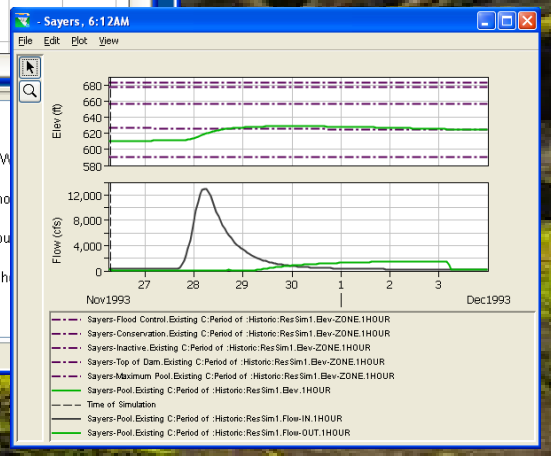
Hydrology











Consequences

Hydraulics

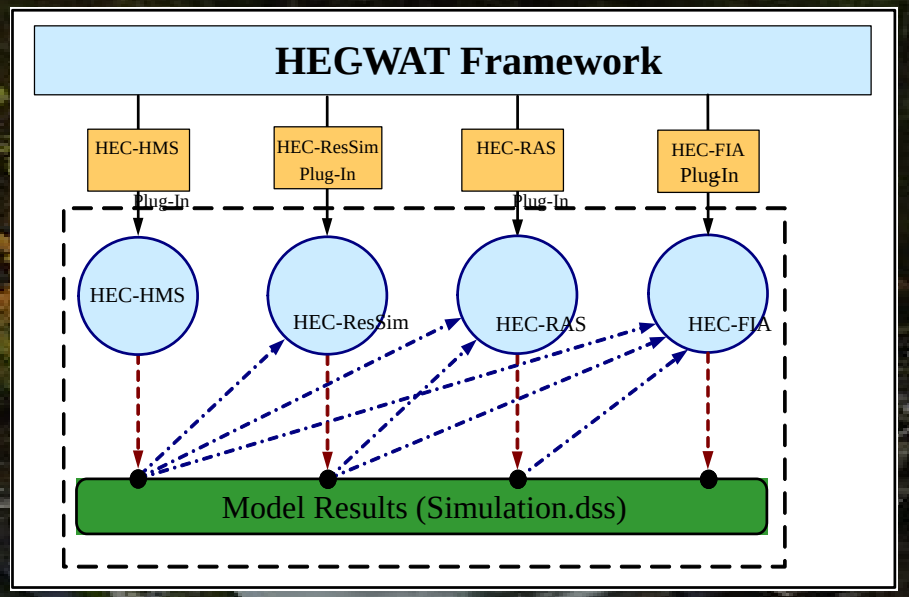
Reservoir

HEC-WAT Capabilities

- Planning tool
- An overarching interface and model integrator for building, editing and running models commonly applied by multi-disciplinary teams and saving and displaying data and results in a coordinated fashion
- Meets the needs of performing water resources studies in a collaborative, comprehensive, systems based approach
- Integrates analytical processes
  - Includes: hydrologic, hydraulic, economic, environmental, and social impact assessments
- Provide an effective way to communicate risk to study team and public
- Flexible, can be used to perform a large comprehensive study or a small CAP (Continuing Authorities Program) study

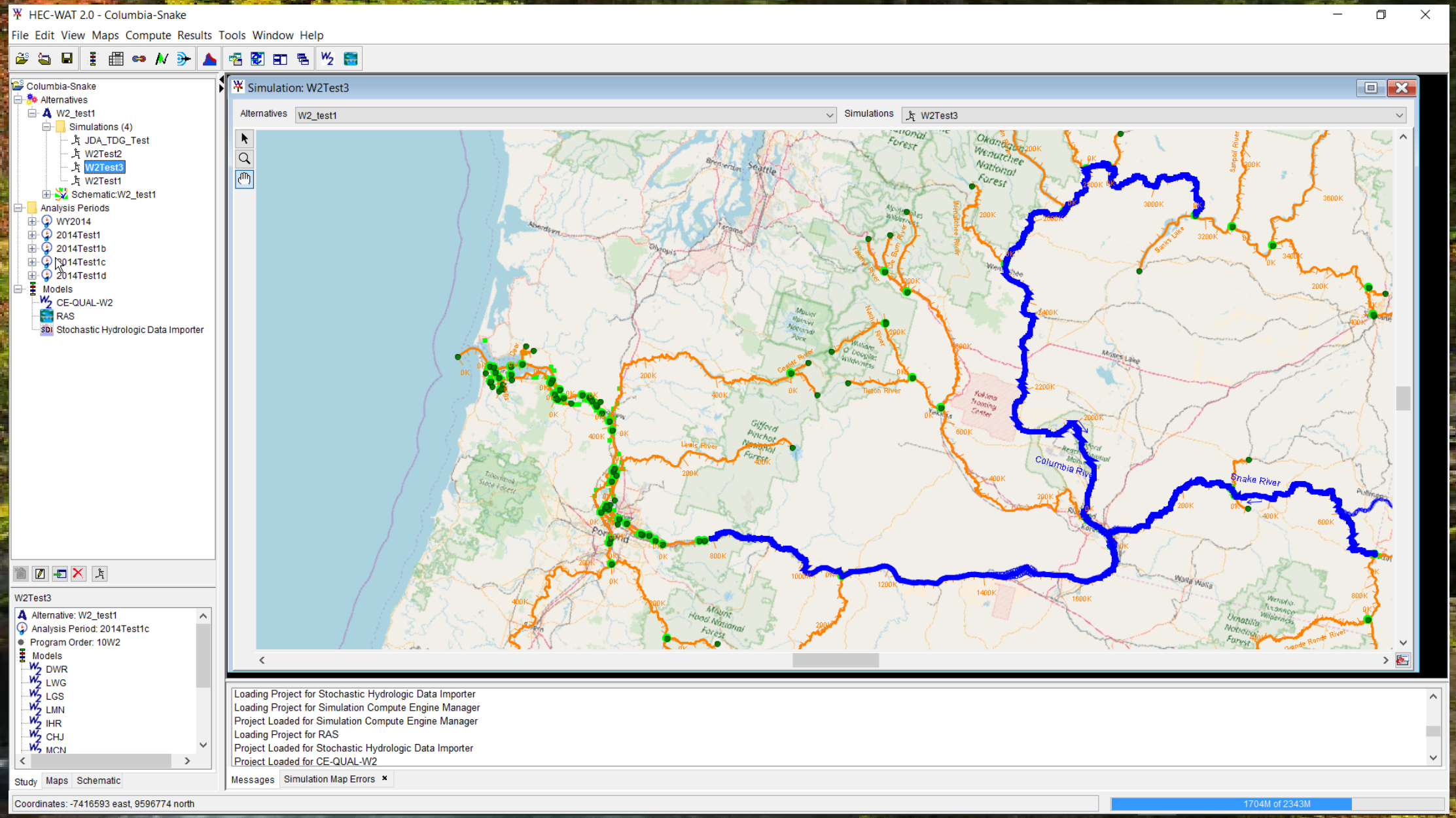
HEC-WAT Capabilities

- Models and tools used during the analytical process
- Hydrology - HEC-HMS, GeoHMS
- Reservoirs - HEC-ResSim
- Hydraulics - HEC-RAS, GeoRAS
- Economics - HEC-FIA
- Environmental - HEC-EFM
- Statistical - HEC-SSP
- Other software - GSSHA, FLO-2D,
- ADH & RiverWare
- Share data across models with
- a common HEC-DSS file
- Involve modelers early in the study process; encourages a team approach
- Communication is provided with plug-ins
- Essentially an event or period-of-record simulation



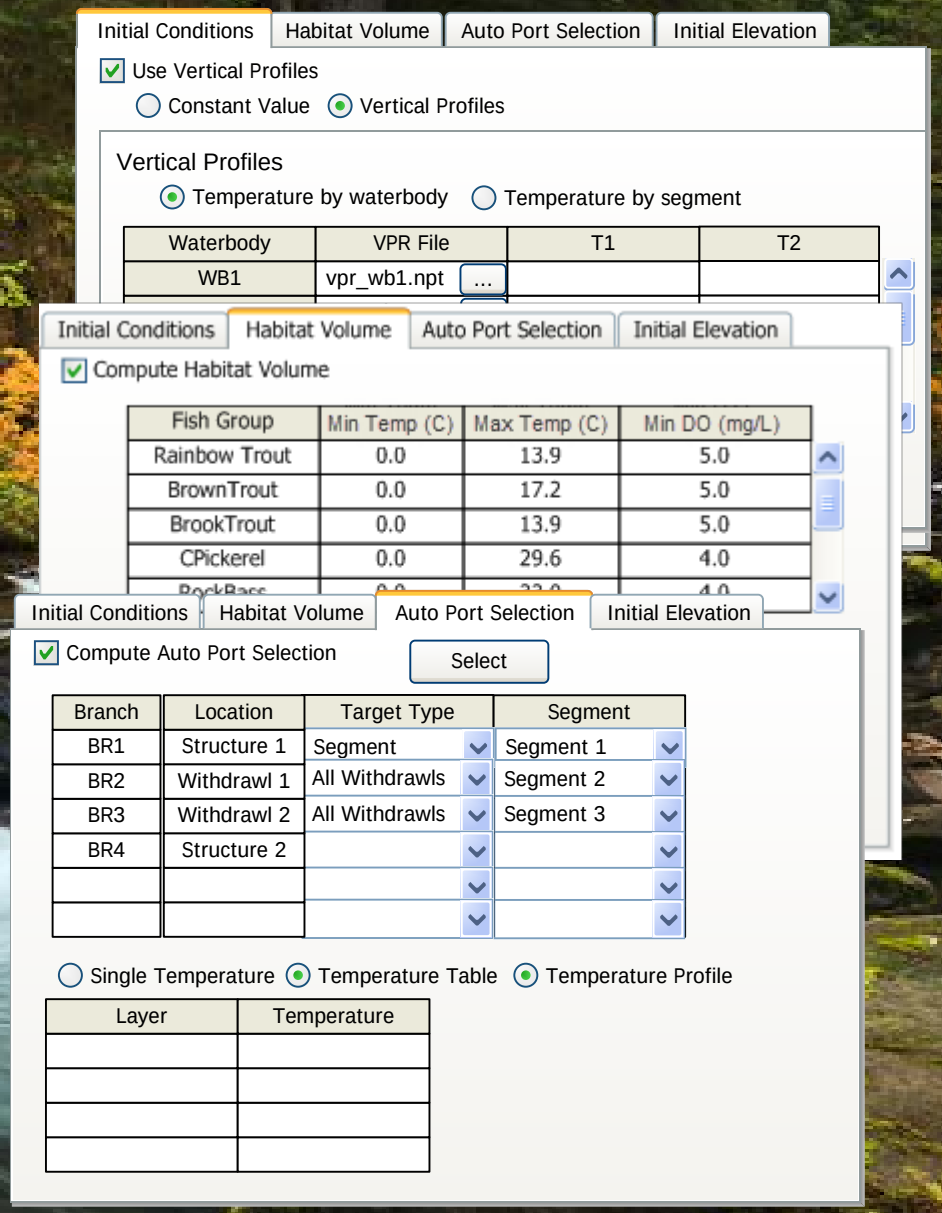
Watershed-Scale Water Quality Modeling

CE-QUAL-W2 Plug-In for HEC-WAT



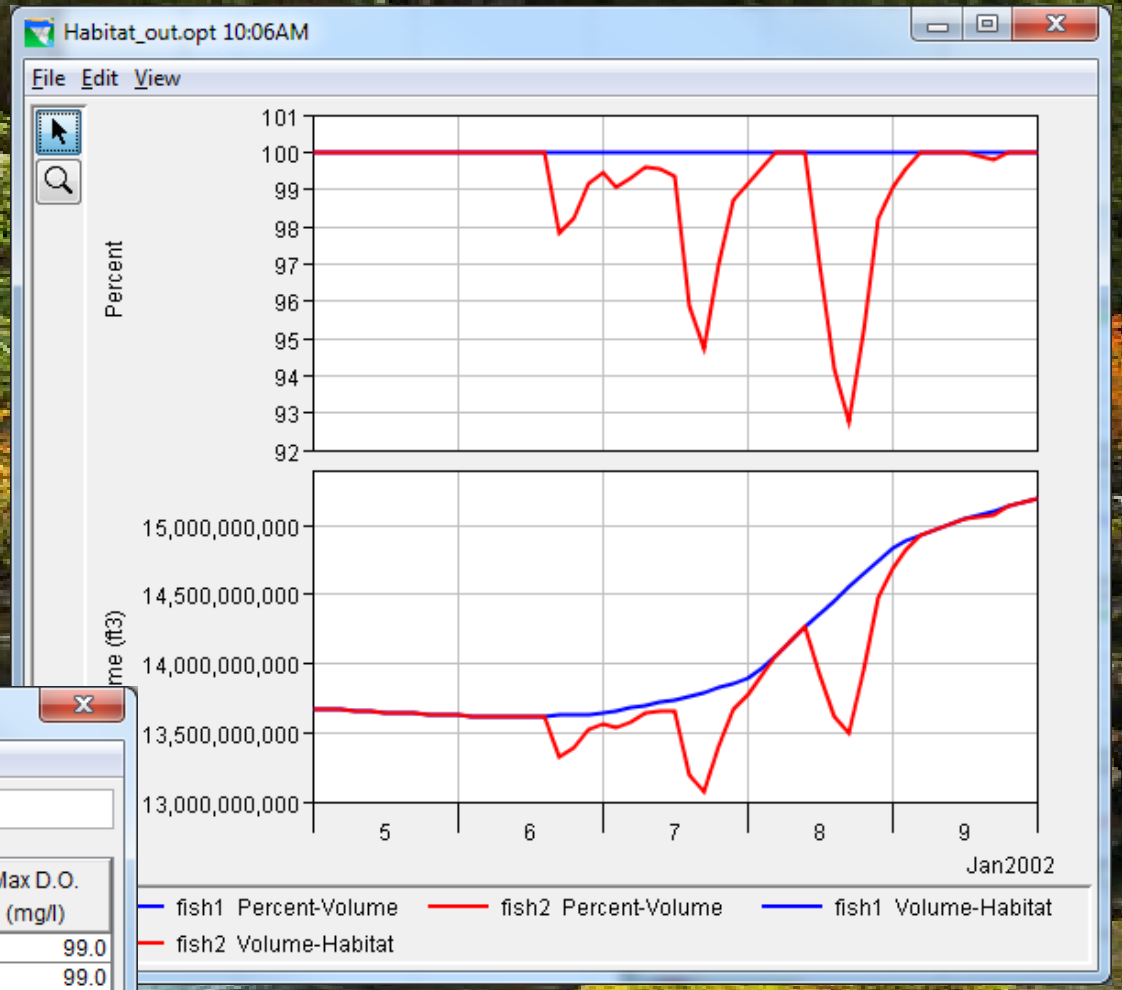
CE-QUAL-W2 Plug-In for HEC-WAT

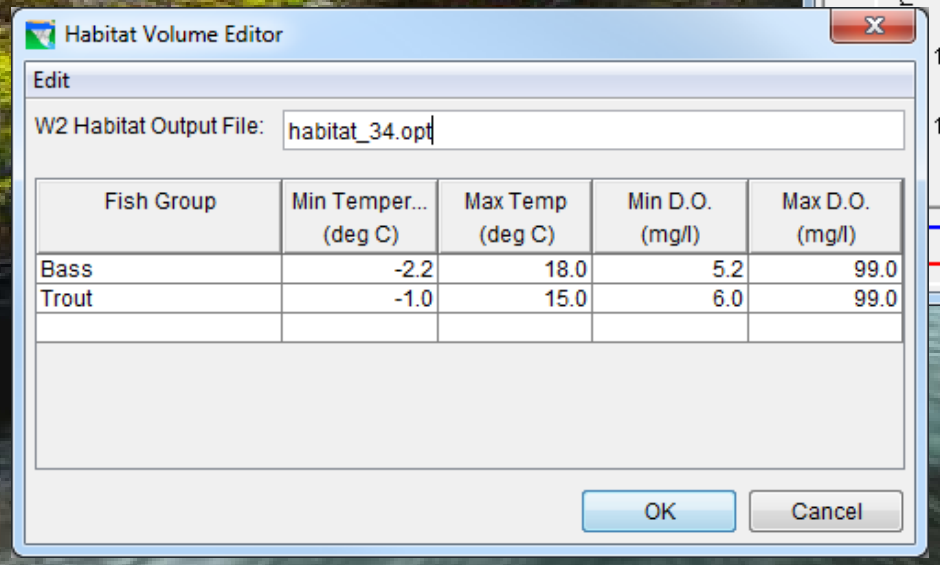
- Features:
  - Watershed-scale water quality modeling capability
    - Link one or more CE-QUAL-W2 models with other models
  - Specify initial and boundary conditions
    - Constant
    - Vertical profiles
  - Auto-Port Selection (Selective Withdrawal)
  - Habitat Volume
  - Restart Capability
  - Plots and Reports
- Application:
  - Columbia-Snake River System (Northwestern U.S.)



Habitat Volume

- Compute habitat volume for any number of fish species
  - Total Volume
  - Percent of Total
- Criteria
  - Temperature range
  - Dissolved oxygen





Fish Group	Min Temper... (deg C)	Max Temp (deg C)	Min D.O. (mg/l)	Max D.O. (mg/l)
Bass	-2.2	18.0	5.2	99.0
Trout	-1.0	15.0	6.0	99.0

Model Linking

Model Linking Editor

File Edit View

Simulation: W2Test3

Model To Link: CE-QUAL-W2-LWG

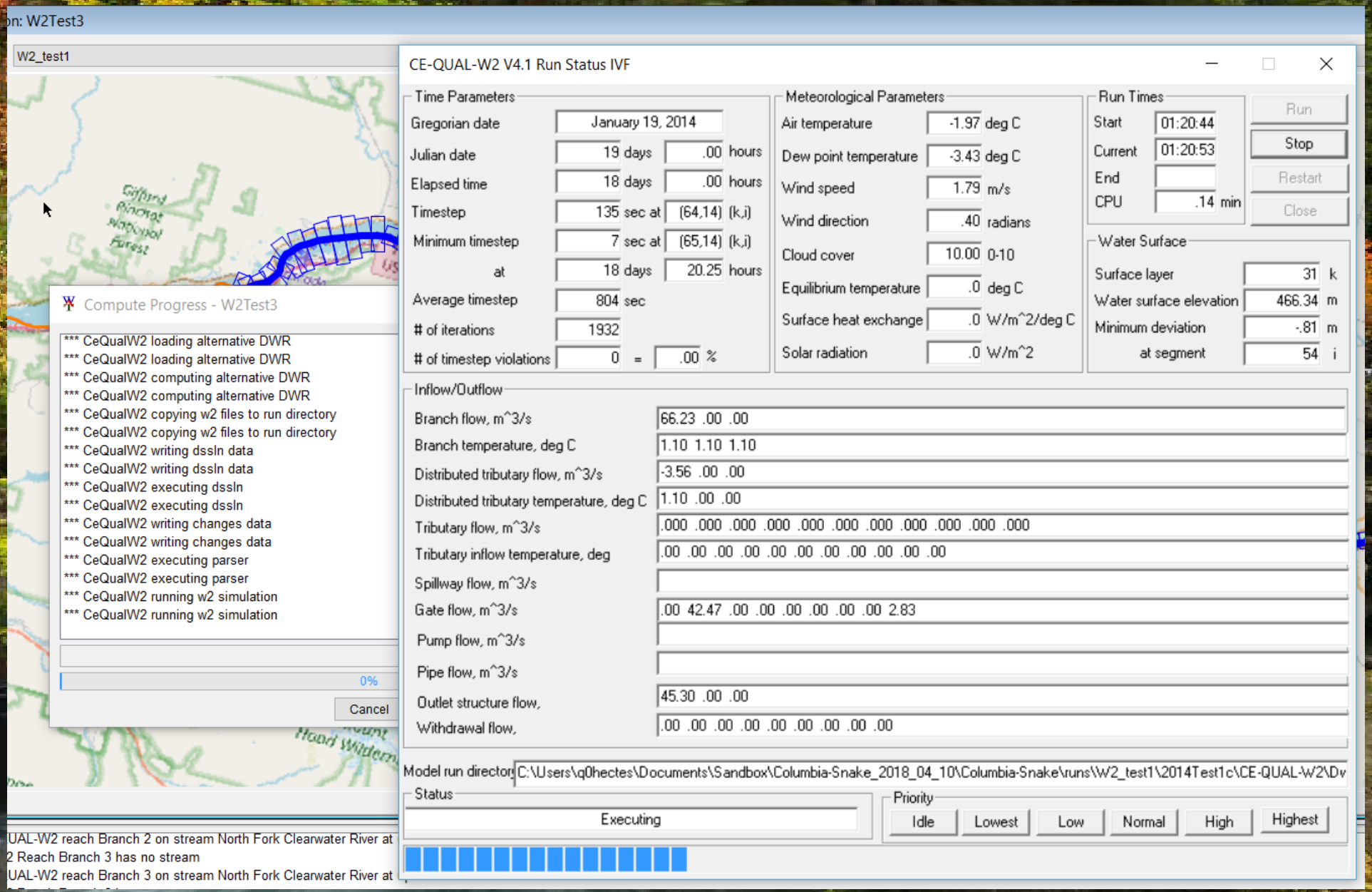
Default Model To Link:

Location	Parameter	Input From Model	Location/Parameter	Dynamically Linked
qin_br1	flow			
qin_br2	flow			
qdt_br1	flow			
met_wb1	air temperature			
met_wb1	dew point temperature			
met_wb1	wind speed			
met_wb1	wind direction			
met_wb1	cloud cover			
tin_br1	temperature	CE-QUAL-W2-DWR	Segment 45 Withdrawal Temperature - T	
tin_br2	temperature			
tdt_br1	temperature			

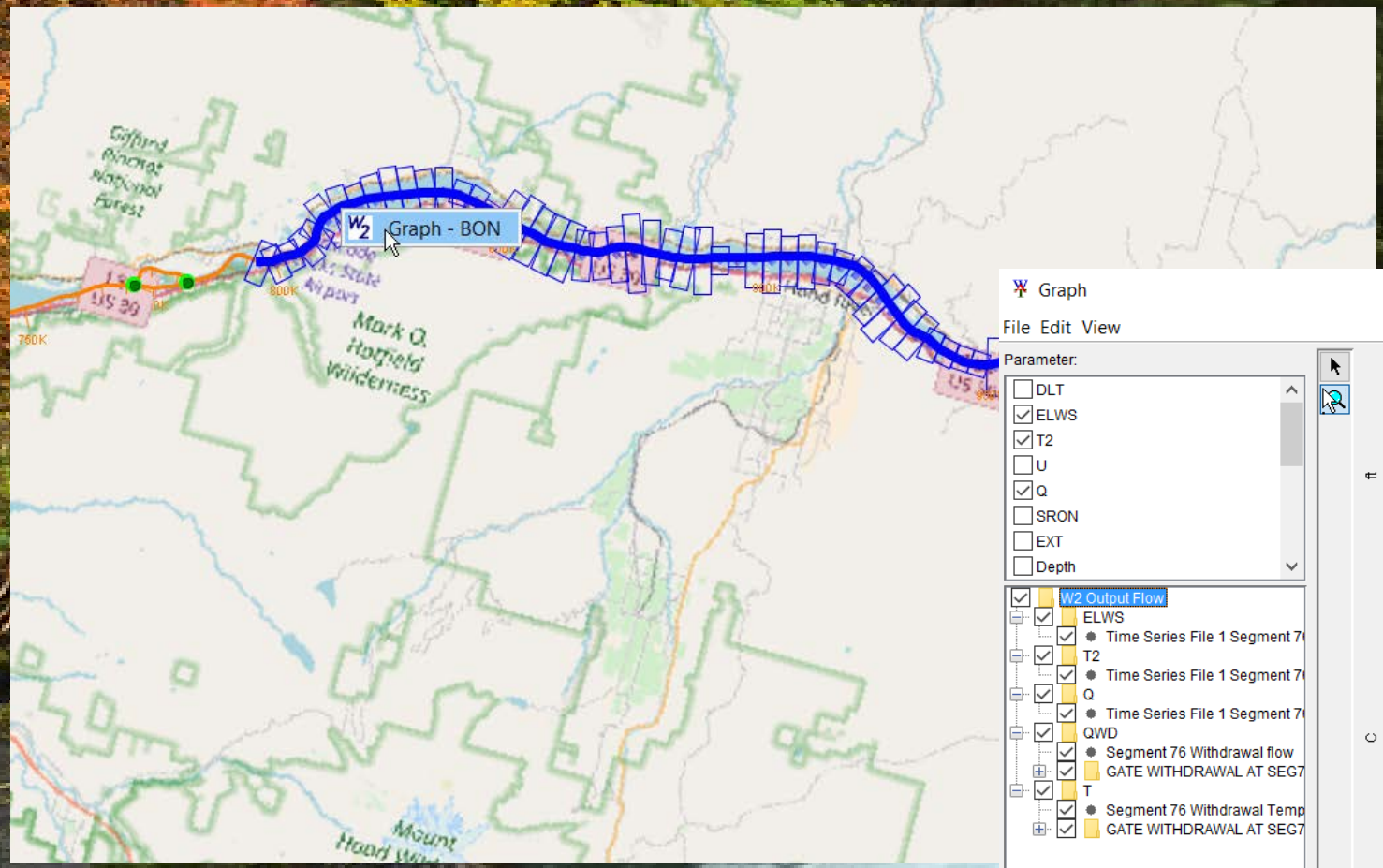
Select Source Data...

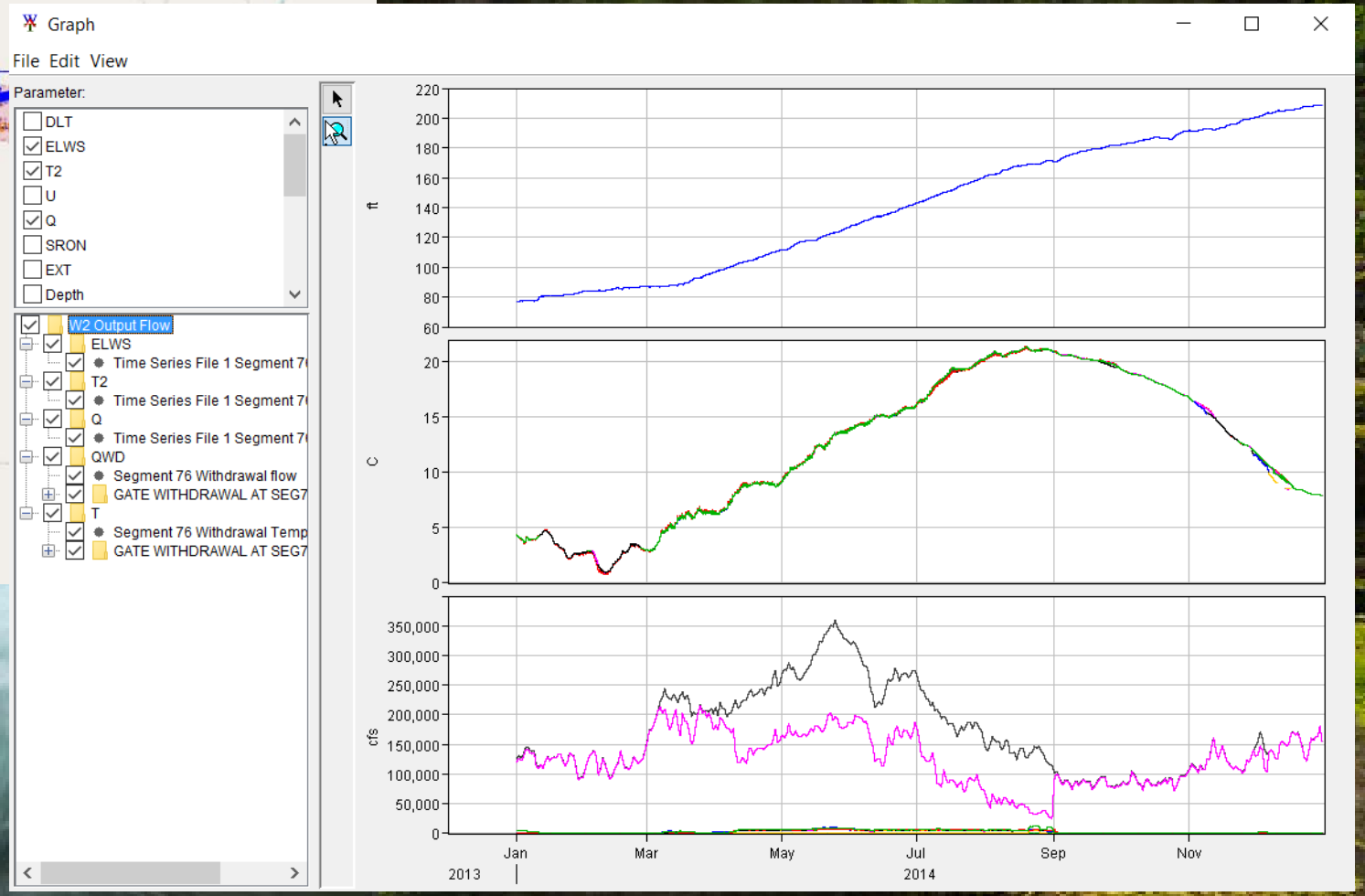
Dynamically Linked Locations Linked In Different Simulation

Running a Simulation



CE-QUAL-W2 Results





Columbia-Snake-Clearwater Watershed

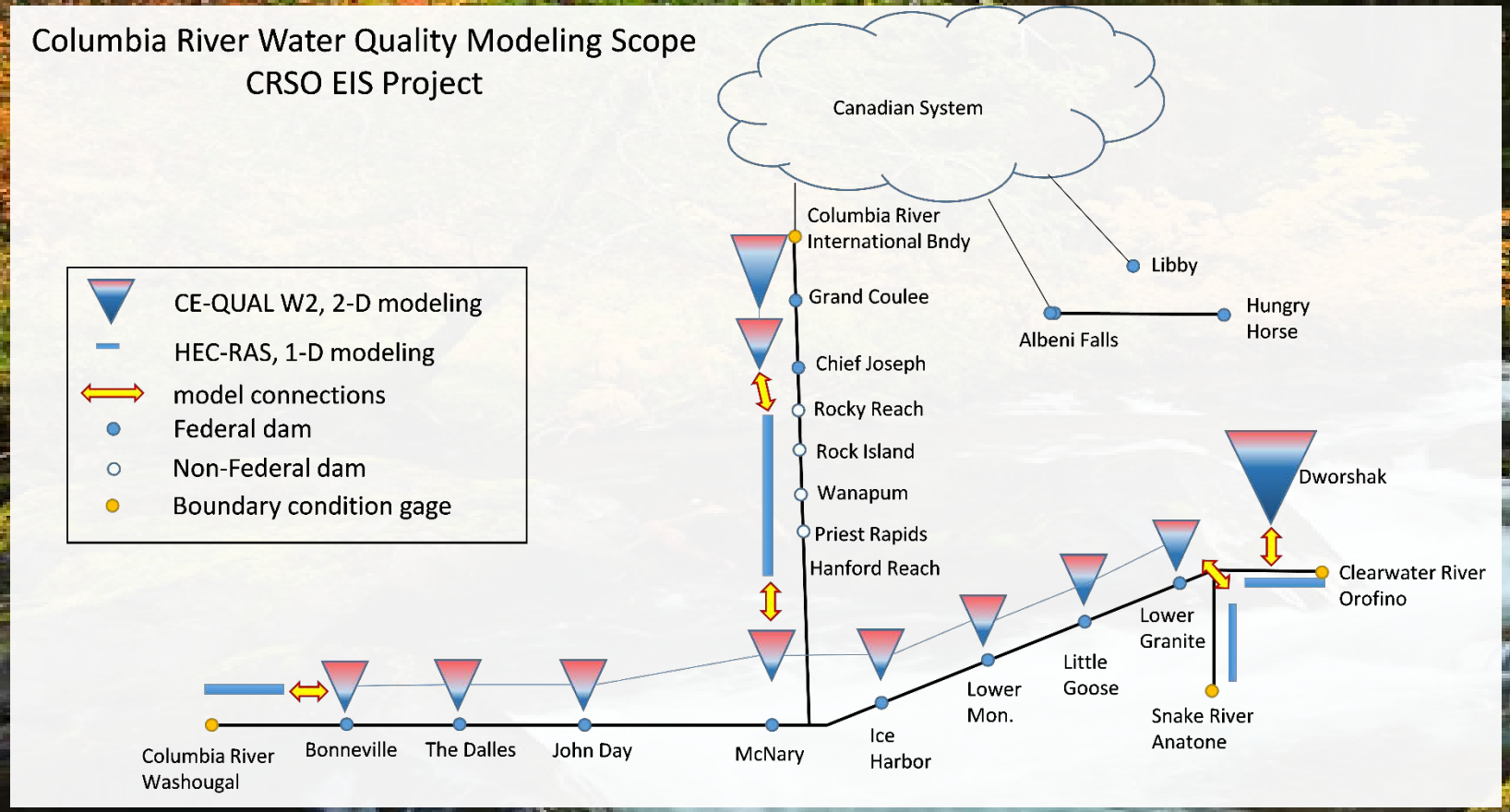
Water Quality Modeling

HEC-WAT for the Columbia River Watershed

- 258,000 sq. mile watershed
- 2 countries
- 7 states
- 1,214 river miles
- 125 tributaries
- Approximately 176,000 structures
- 51 projects
- 100 fragility curve locations
- 43 consequence areas
- 128 levee systems (449 miles)

Columbia-Snake-Clearwater Watershed

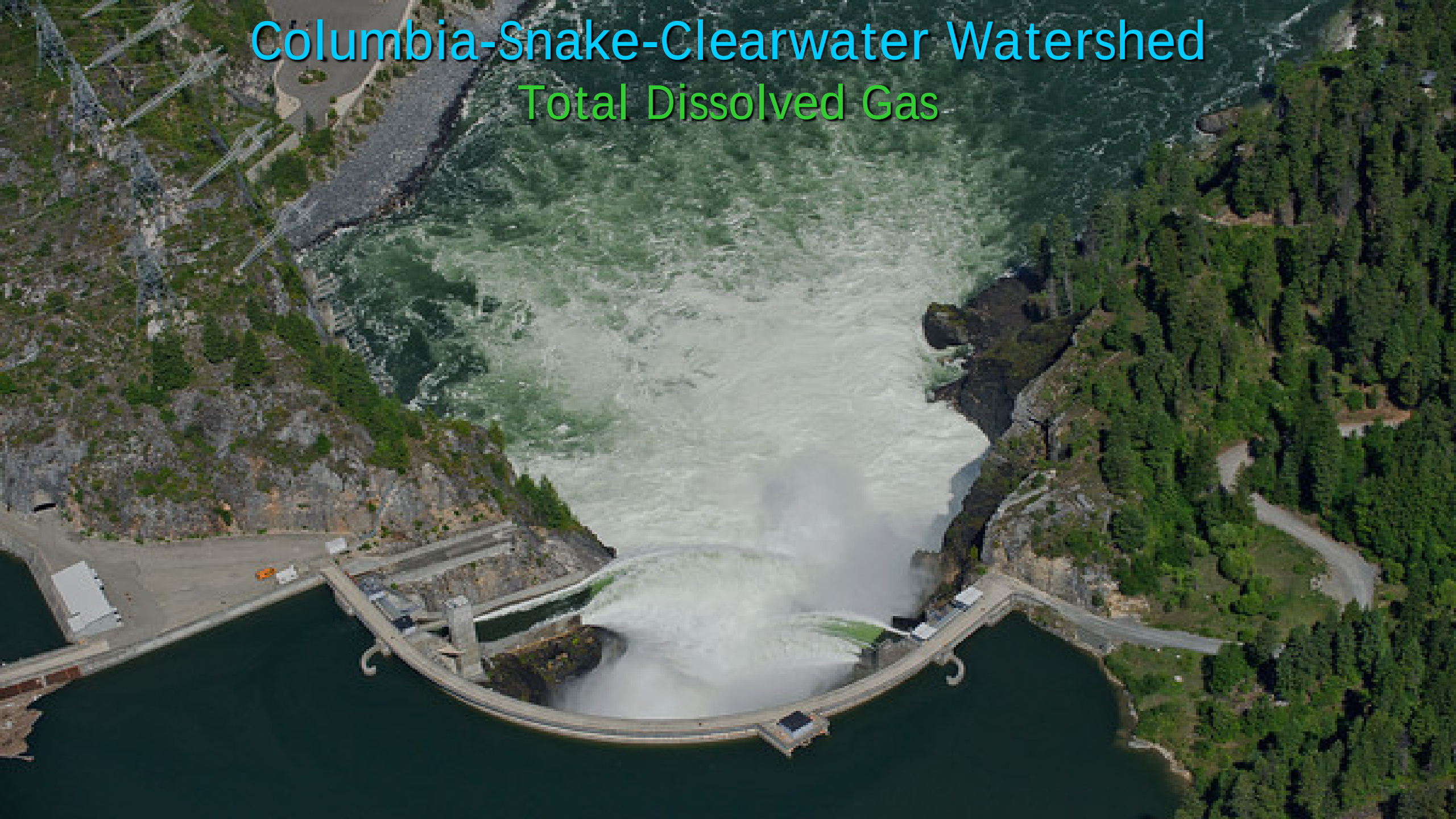
Water Quality Modeling



- Watershed-scale WQ model in HEC-WAT:
  - Rivers: HEC-RAS
  - Reservoirs: CE-QUAL-W2
  - Parameters:
    - Temperature
    - Total Dissolved Gas (TDG)

Columbia-Snake-Clearwater Watershed

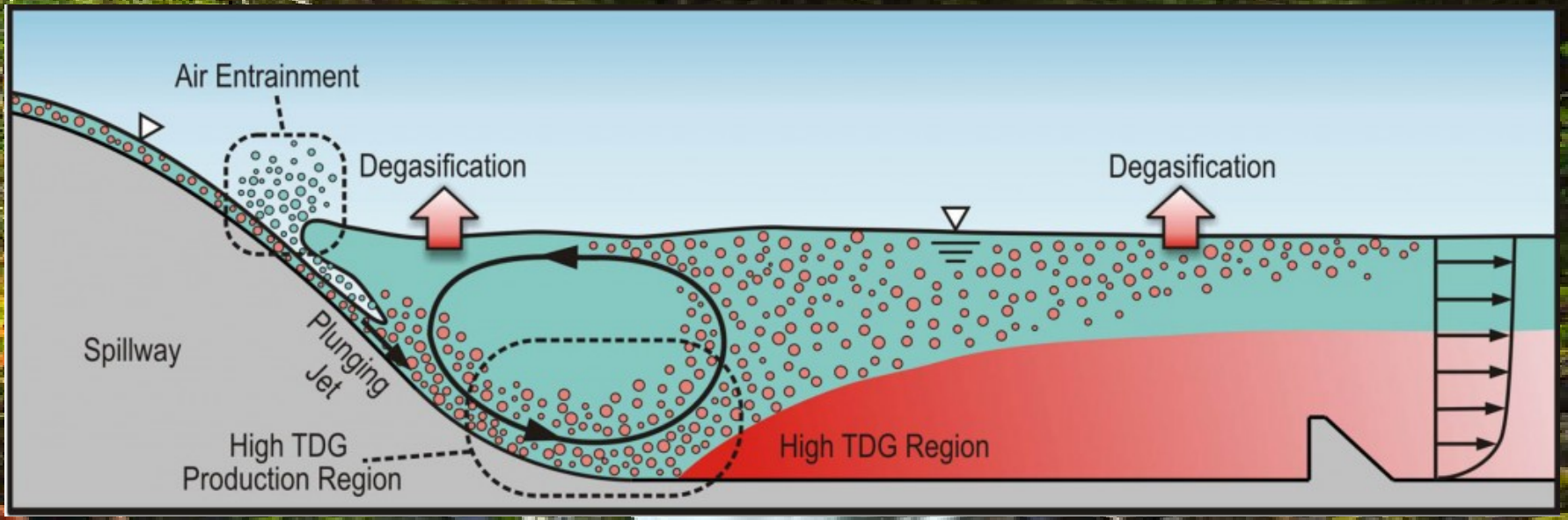
Total Dissolved Gas



Columbia-Snake-Clearwater Watershed

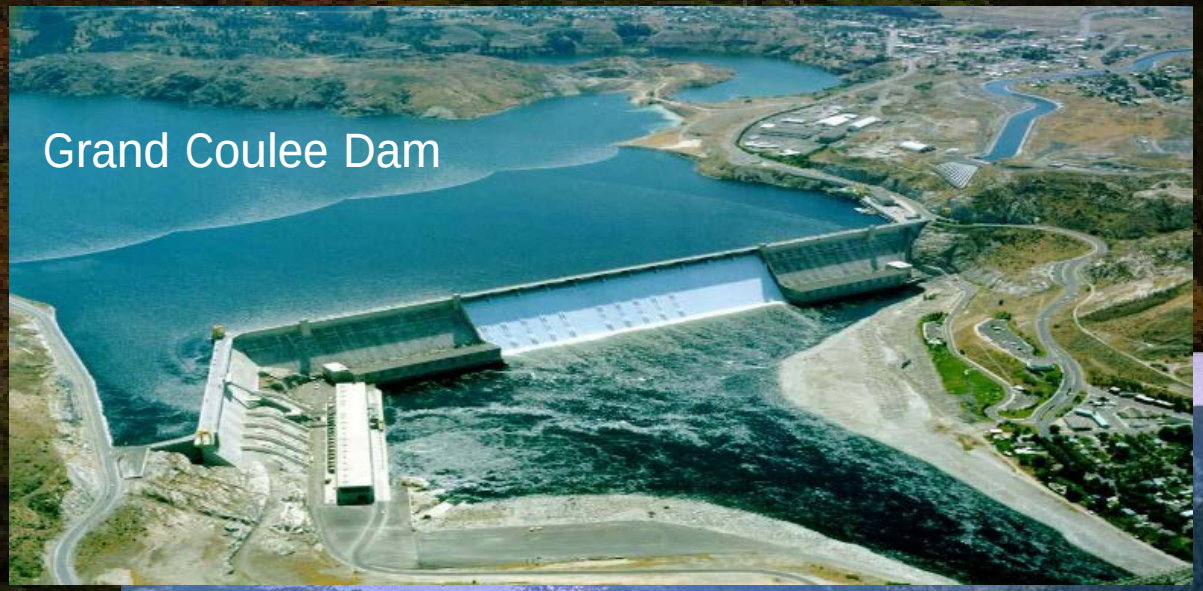
Total Dissolved Gas

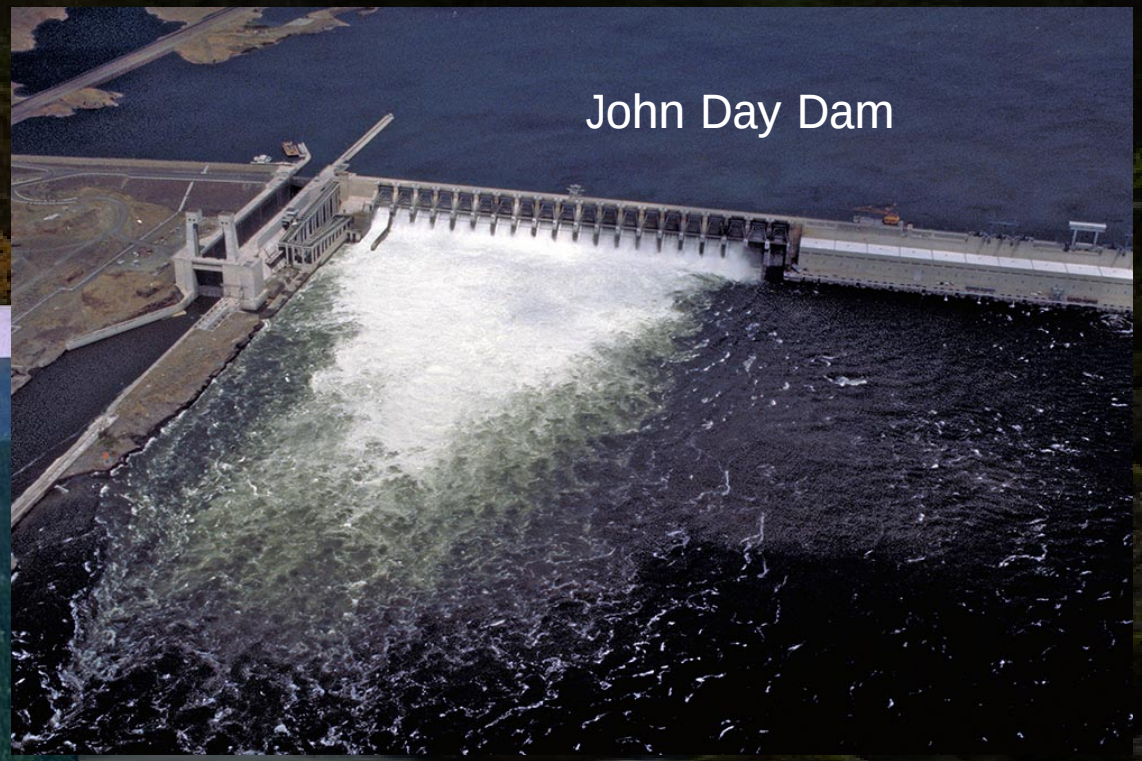
- Source:
  - High flows plunging to great depths
- Problem:
  - Gas bubble trauma in fish
    - Increased predation
    - Injury
    - Infection



Columbia-Snake-Clearwater Watershed

Total Dissolved Gas





Columbia-Snake-Clearwater Watershed

Total Dissolved Gas

- TDG Modeling:
  - NEPA analysis for 2017 Environmental Impact Statement (EIS)
    - HEC-WAT:
      - CE-QUAL-W2 (SYSTDG equations)
      - HEC-RAS (Physically based)
  - Real-time modeling
    - Corps Water Management System (CWMS):
      - HEC-RAS
      - HEC-ResSim (future)

Missouri River Recovery Program (MRRP)

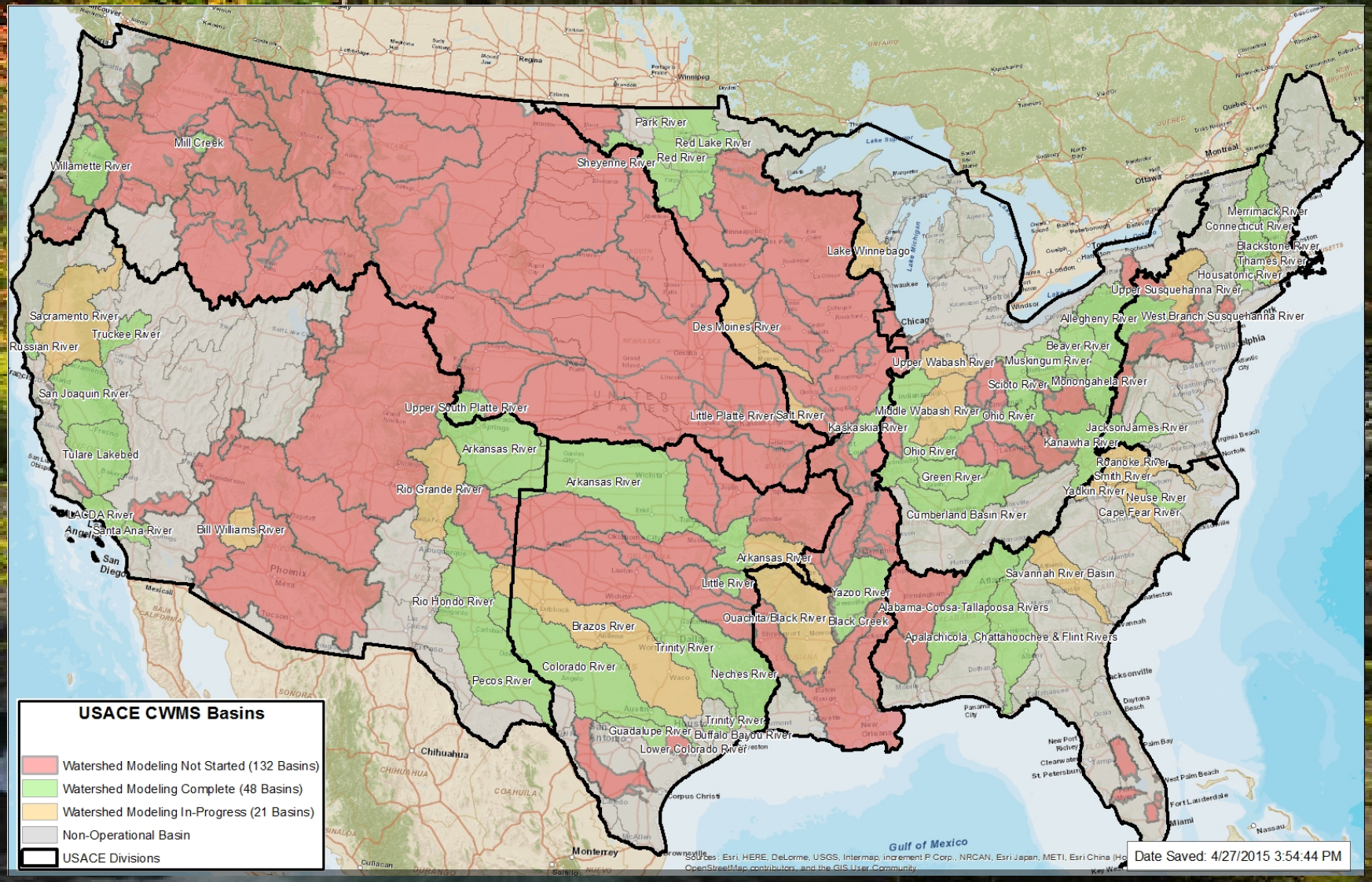
- Effort to replace lost habitat & avoid jeopardy to endangered species (pallid sturgeon, least tern, piping plover)
- Based on BiOP 2000 (amended in 2003)
- Models being developed include basic reservoir management, hydraulics, sediment/geomorphology, water quality, species response models, impacts on economic & other social interests
- HEC-WAT will manage model analysis & track data flow & output

Past and Present Collaborators
(Alphabetical)

- Lea Adams, USACE-HEC
- Mark Ackerman, RMA
- Steve Andrews, RMA
- Chris Berger, PSU
- Gary Brunner, USACE-HEC
- Barry Bunch, USACE-ERDC-EL
- Ben Chacon, RMA
- John DeGeorge, RMA
- Mark Dortch, ERDC-EL
- Scott English, USACE-NWD
- Paul Ely, RMA
- Alex Kennedy, USACE-HEC
- Joan Klipsch, USACE-HEC
- Mark Jensen, USACE-HEC
- Billy Johnson, USACE-ERDC-EL
- Steve Juul, USACE-NWW
- Cindy Lowney, RMA
- Ryan Miles, RMA
- Chan Modini, USACE-HEC
- Jay Pak, USACE-HEC
- Steve Piper, RMA
- Alex Sanchez, USACE-HEC
- Bill Scharffenberg, USACE-HEC
- Don Smith, RMA
- Todd Steissberg, USACE-HEC
- Tammy Threadgill, USACE-ERDC-EL
- Dottie Tillman, USACE-ERDC-EL
- Scott Wells, PSU
- Brian Zettle, USACE-SAM
- Zhonglong Zhang, LimnoTech

Questions?

Corps Water Management System (CWMS) Implementation



- Goal: 201 watersheds implemented by 2022