Model Development to Support Assessment of Flood Risk for the Columbia River Treaty Review

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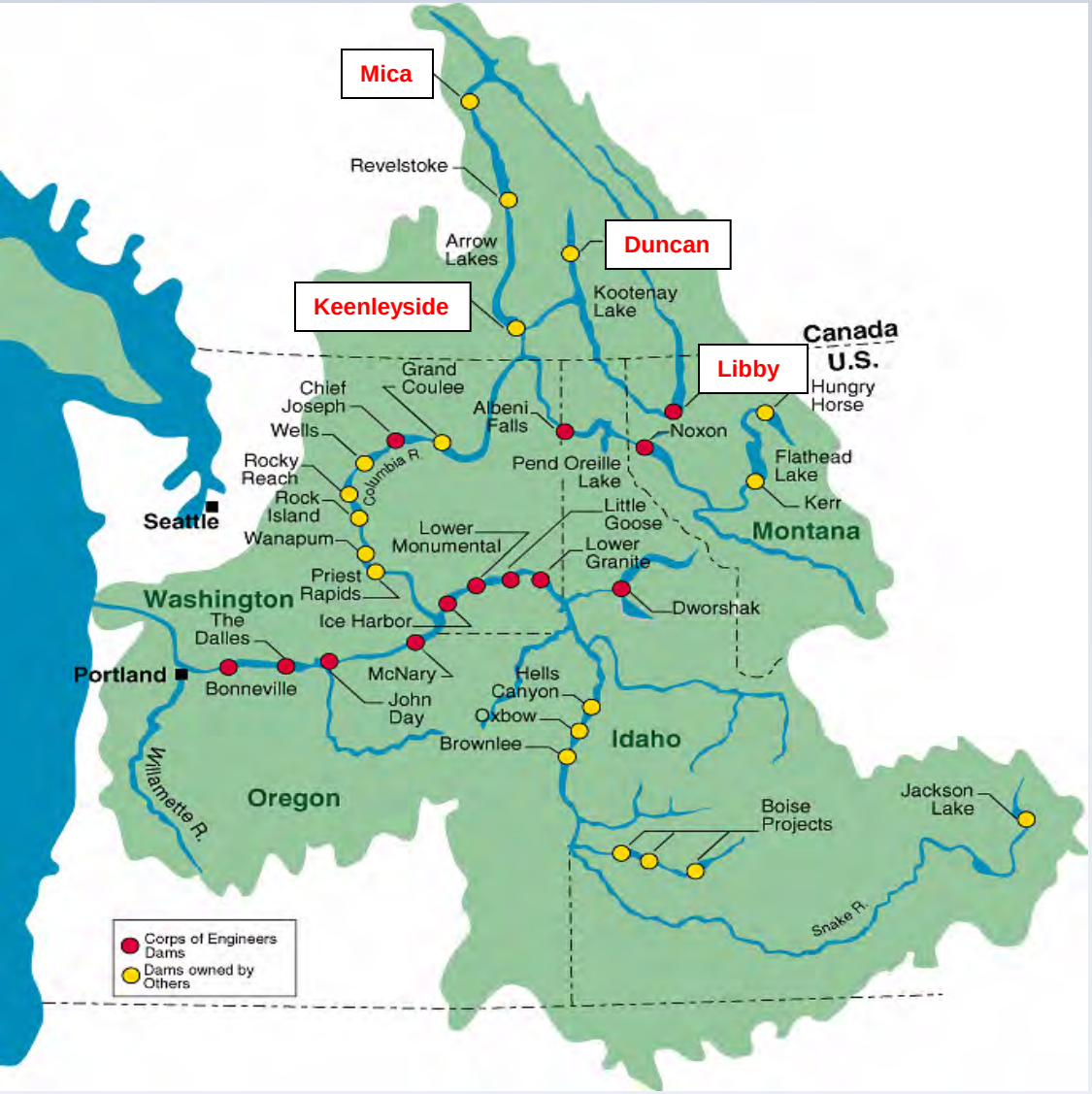
Presentation Outline

I. Modeling Goals and Approach
II. Data Collected
III. Data Developed
IV. Models built
V. Use in the Treaty Studies

The Columbia River System



Originates in Canada, Canada has 15% of the basin area, 30% of average annual flow is from Canada, 50% of worst Columbia flood flows (1894) came from Canada.

Flows 1,200 miles through 4 U.S. States, drainage area of 259,000 square miles

Over 60 large dams and reservoirs owned and operated by many different entities

Flood Risk Management

Task: Evaluate Flood Risk Under Current and Future Operating Scenarios

EM 1105-2-101: Requires Risk Analysis

- Expected Annual Damage
- Annual Exceedance Probability
- Long Term Risk
- Conditional Non-Exceedance
- Residual Risk

Goal: Provide Information to Support a Decision on Future of the Treaty

Modeling Goals

- Implement Flood Risk Management
- Models should be flexible, maintainable, adaptable
- Accurate geospatial economic data
- Integrate hydrologic/reservoir/river/economic
- Increase automation in the approach

What are we modeling?

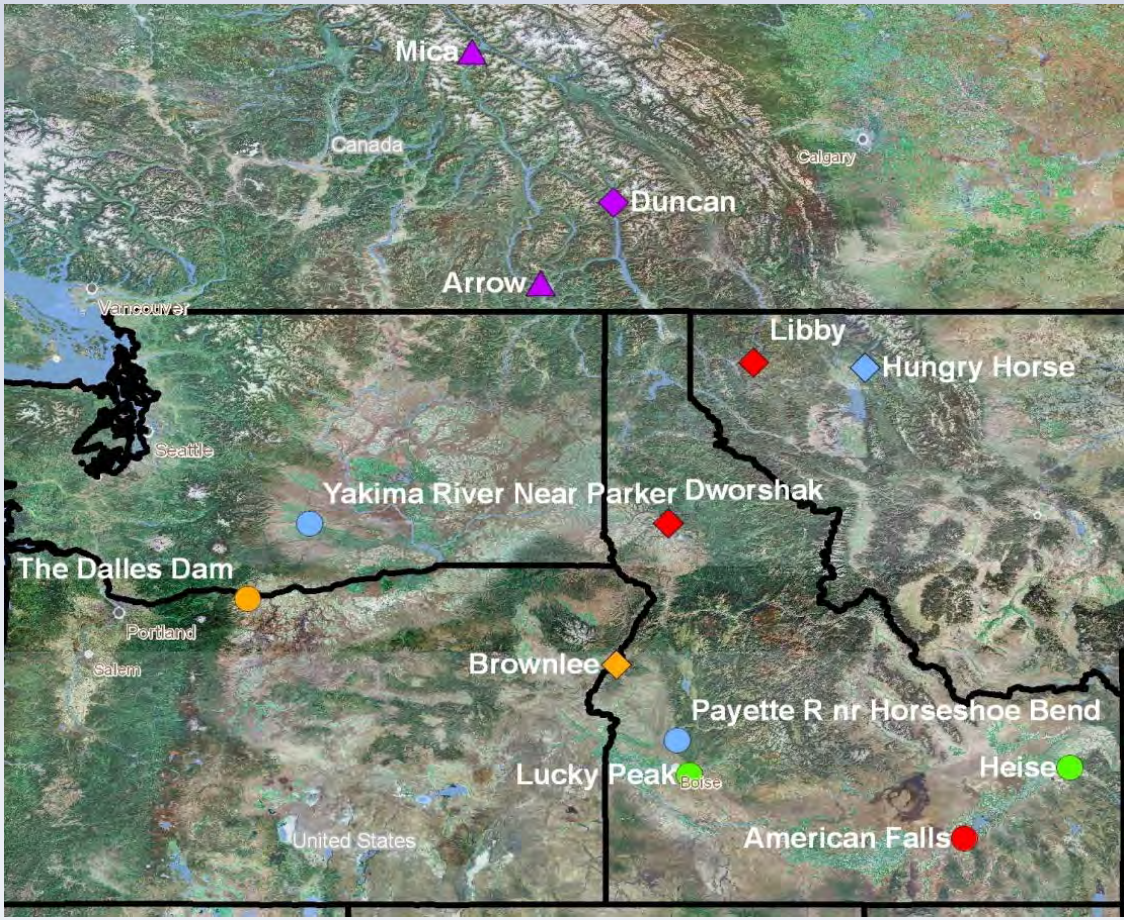
- There are 1,000 of dams in the basin
- Really only 8 of them have specific operations that are regularly used and manageable
- Historically there are 22 reservoirs that are modeled as part of “System” Flood Risk Management
- More than 60 dams are modeled for hydropower

Data Collected

1. LIDAR – 1600 river miles, 3000 square miles
2. Use of existing and collection of new river cross-sections/bathymetry
3. 3-D levee centerlines
4. structure inventory

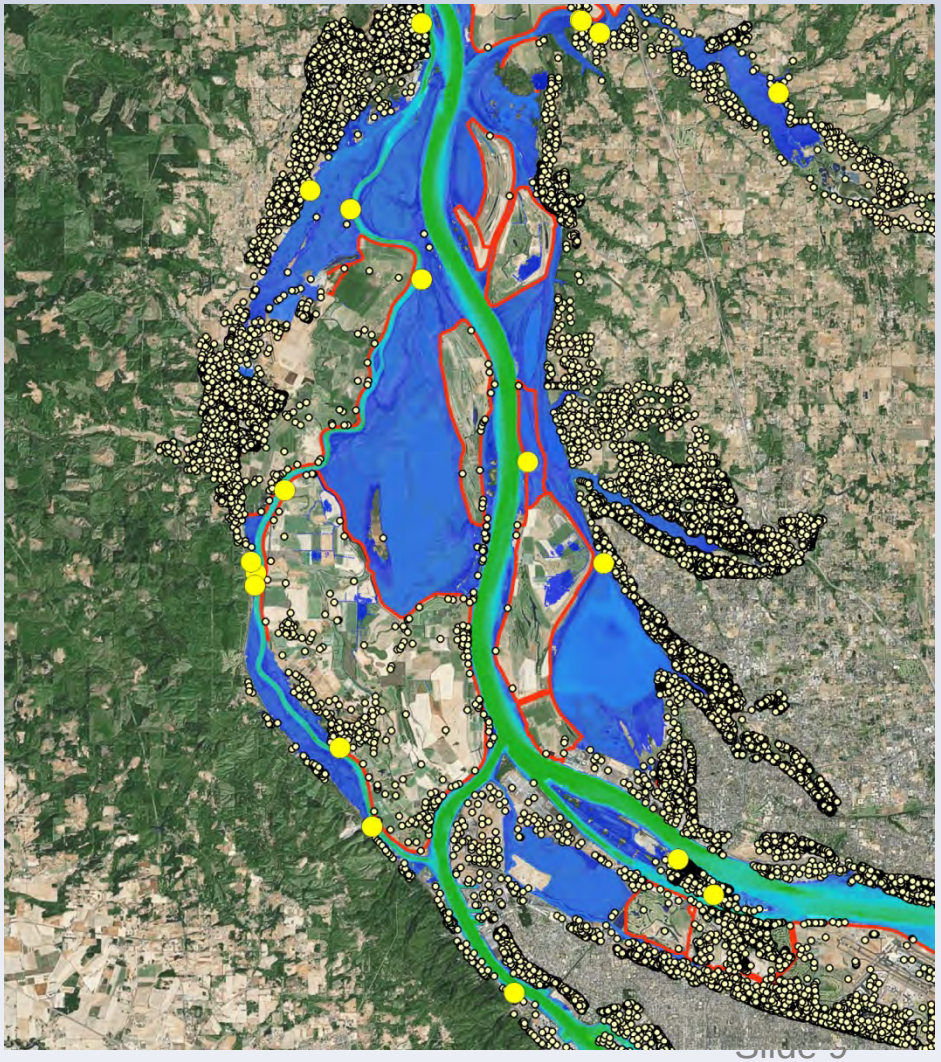
Data Developed

1. Hydrology
   - 2000 level modified flows dataset
   - “Synthetic” Low Probability Events
   - Climate Change
2. Standardized run-off volume forecasts
3. Levee fragility

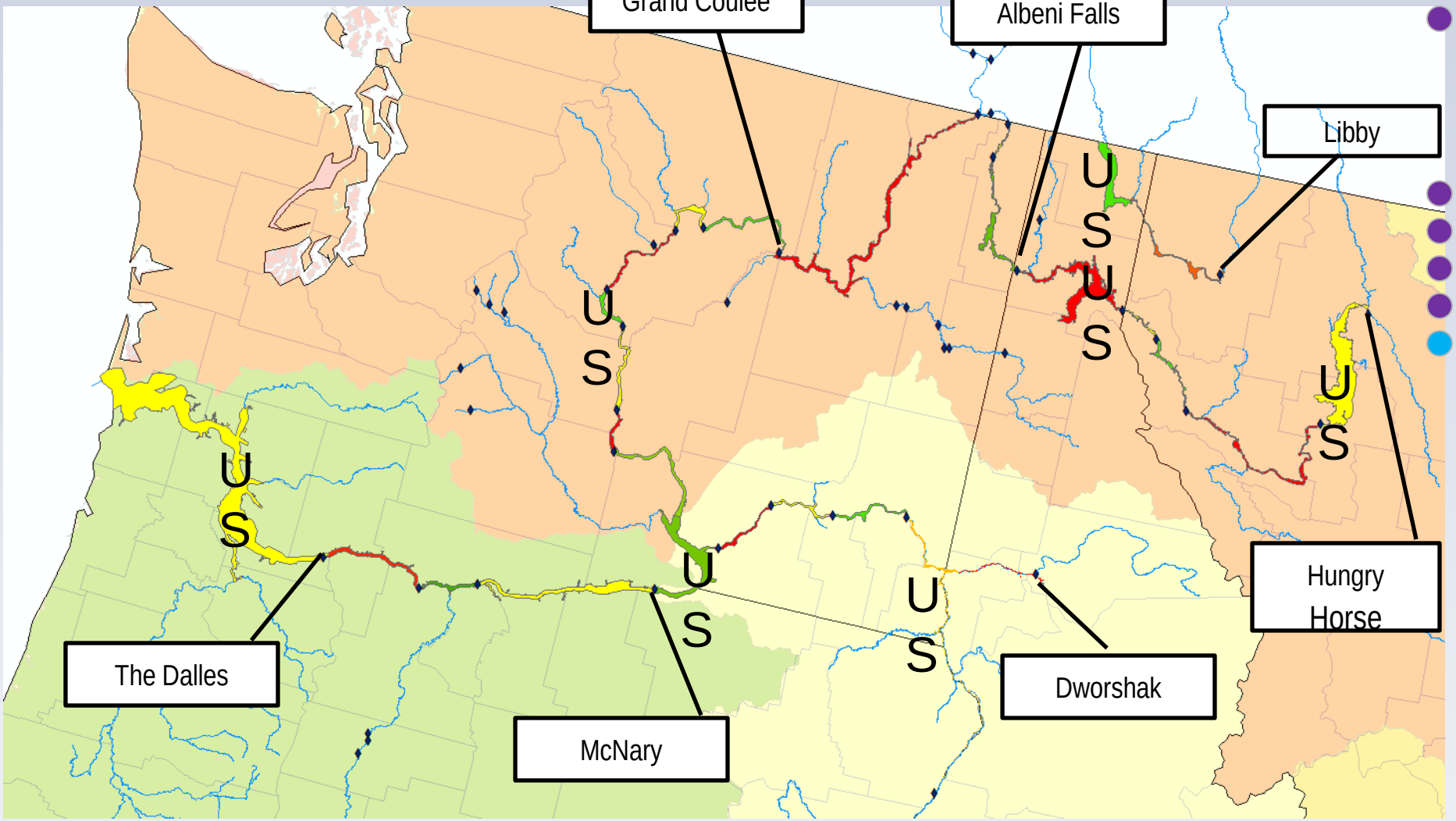


Models Developed

1. HEC-Ras
2. HEC-ResSim
3. HEC-FIA
4. HEC-WAT with FRA



Hydraulic Modeling



CRT System HEC-ResSim Model

- 67 projects in the model
- 36 with storage that can affect flood operations
- 8 which operate for “the system”

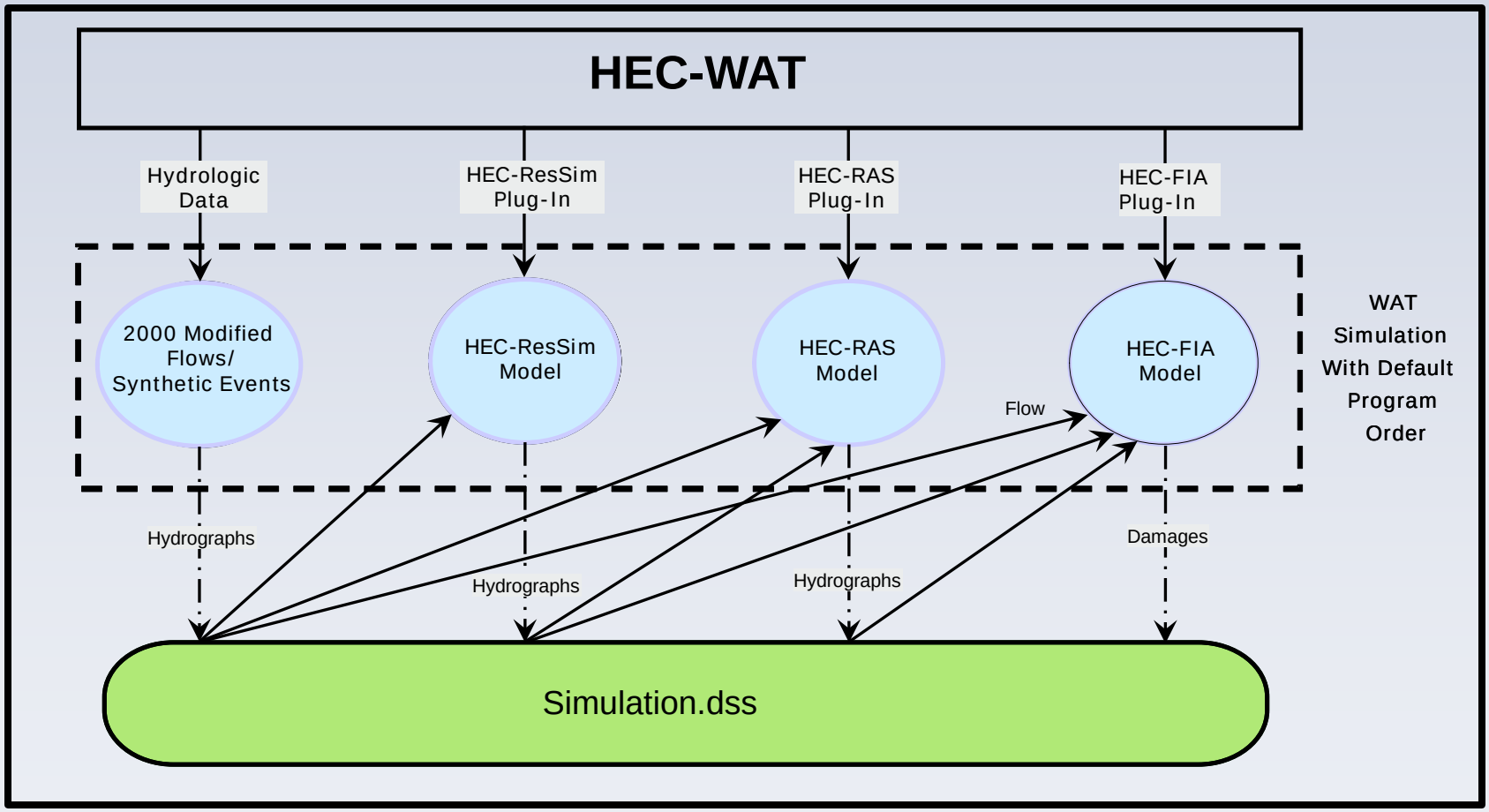
CRT System
HEC-ResSim Model

- Simulates reservoir operations at a planning level on a daily time-step.
  - Reservoirs were initially chosen for inclusion based primarily on volume, and whether they were included hydropower or flood studies.
  - Does not model ecosystem function (biop) operations
  - Simulates the majority of CRT Flood and Hydropower operations
  - Includes - flow routing, automated refill, continuous or refill based mode

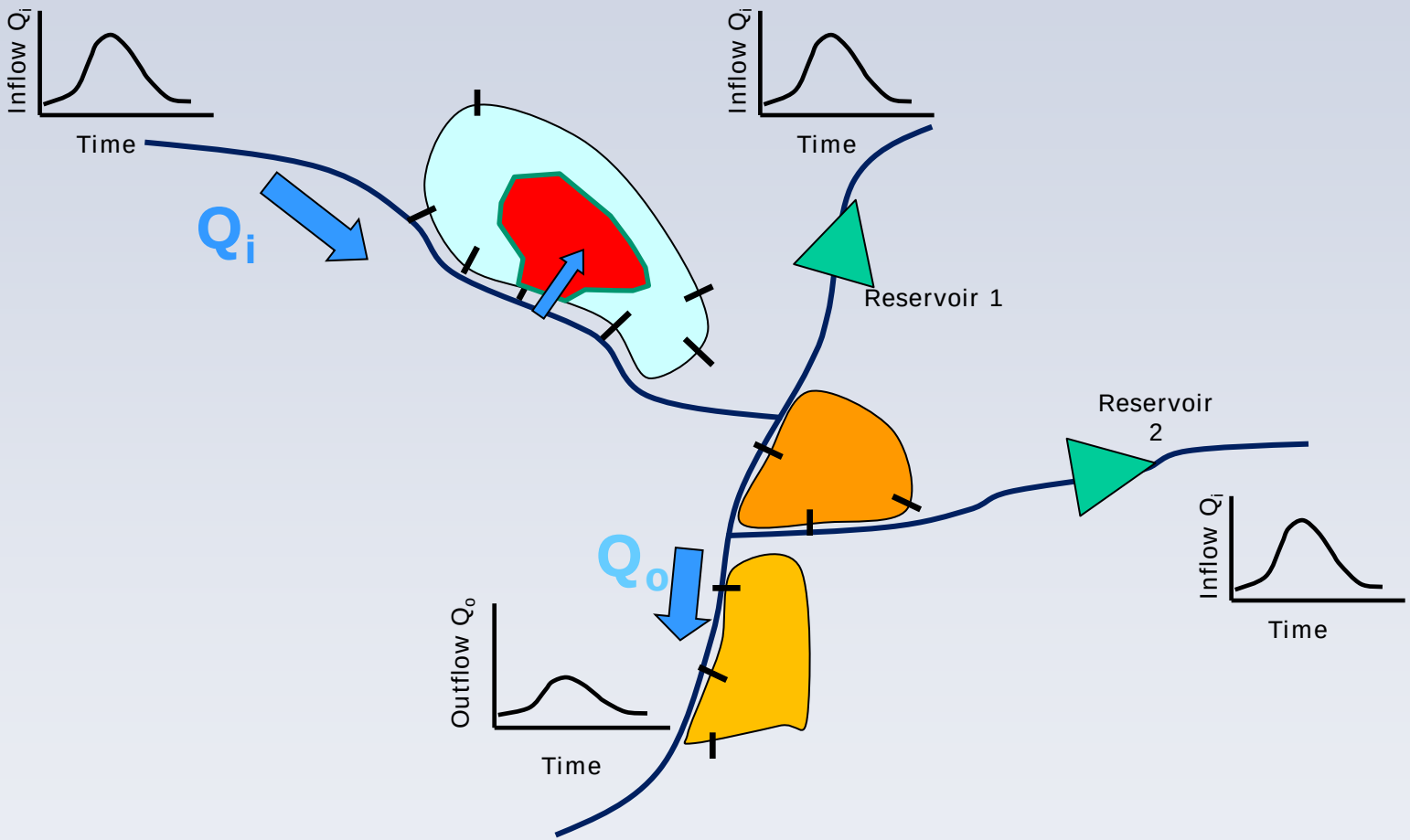
CRT System
HEC-ResSim Model

- Approach to developing post-2024 operations.
  - What will effective use and called upon look like?
  - How can they be designed to provide the same level of flood risk but meet the treaty description?
  - What does that mean for other users of the system?

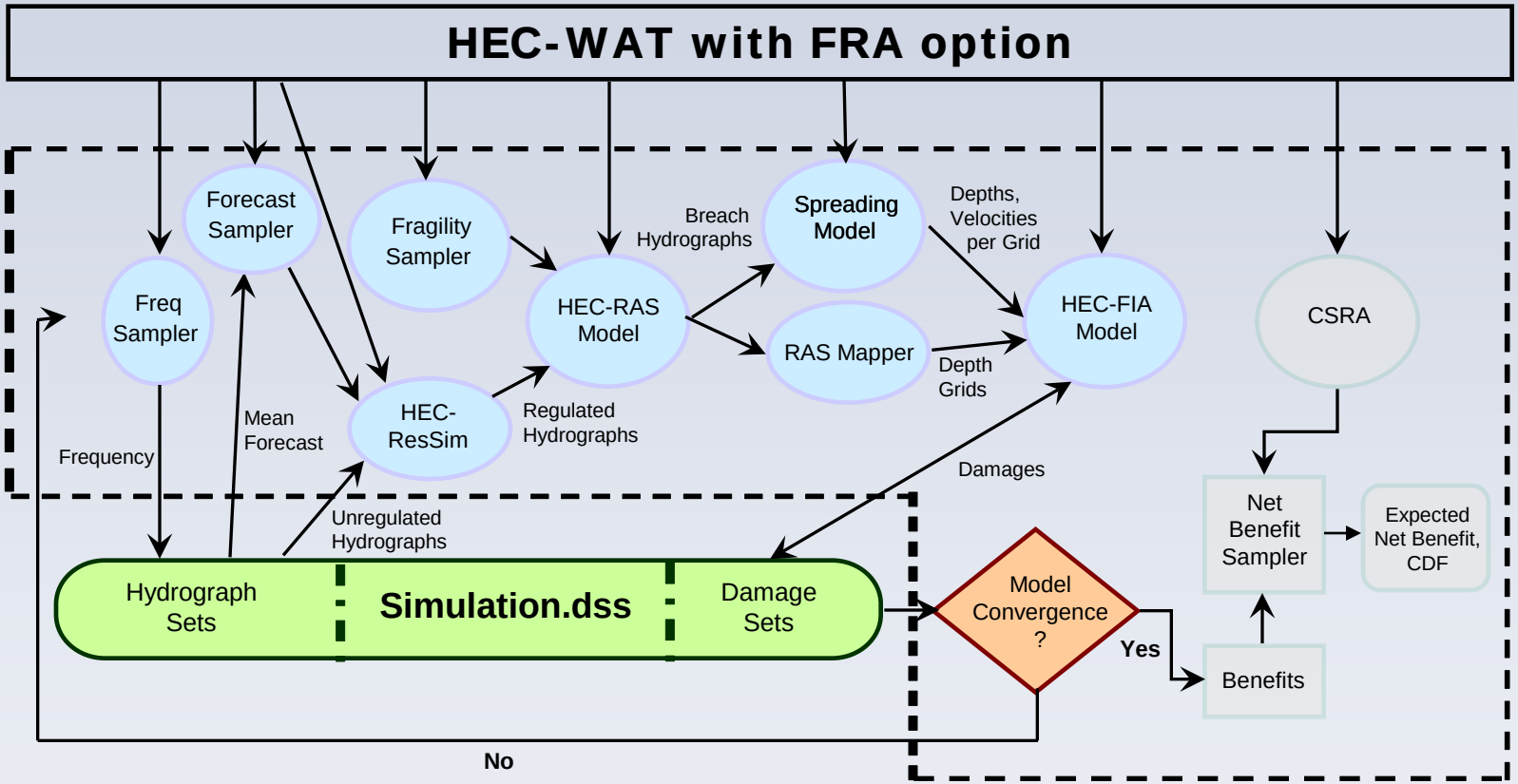
HEC-WAT Structure



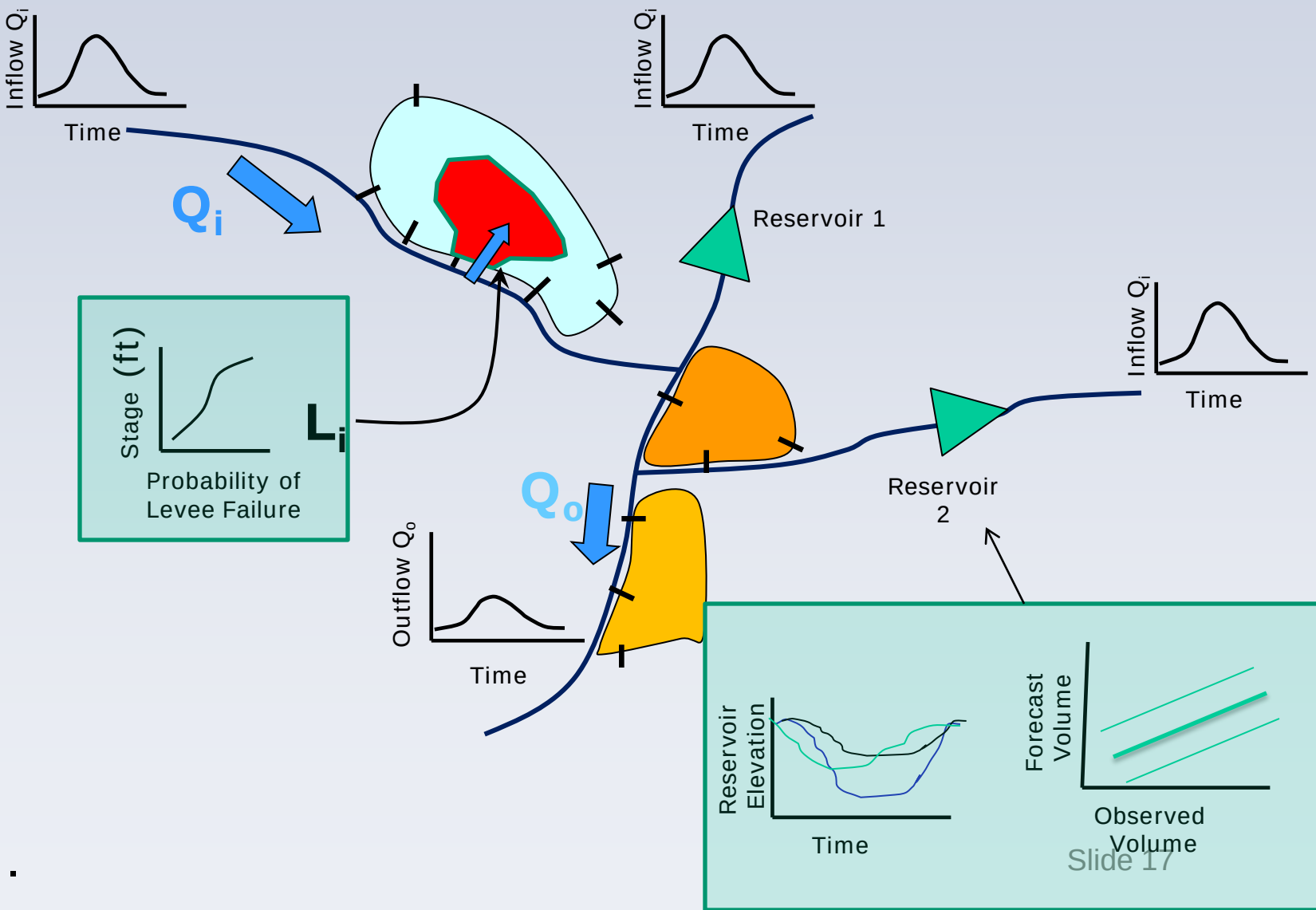
Flood Risk System



HEC-WAT Structure - FRA



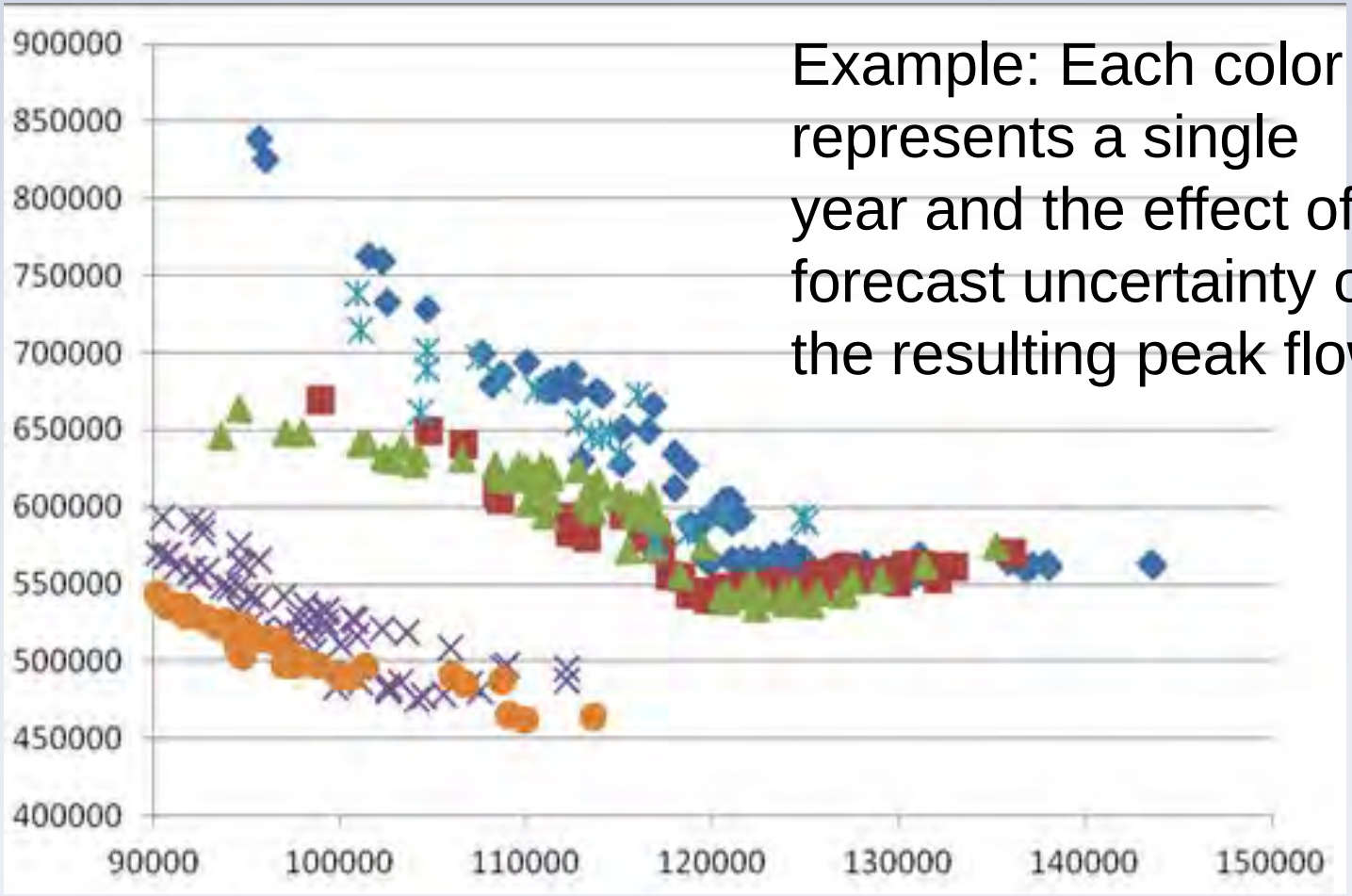
Flood Risk System



What does this mean for the Flood Risk Analysis

- Rather than this…..

What does this mean for Flood Risk Analysis



Example: Each color represents a single year and the effect of forecast uncertainty on the resulting peak flow

Uncertainties Incorporated in FRA (short-term)

- Forecast uncertainty
- Starting reservoir pool elevation
- Stage/flow rating curves
- Roughness coefficients
- Levee breaching parameters/fragility

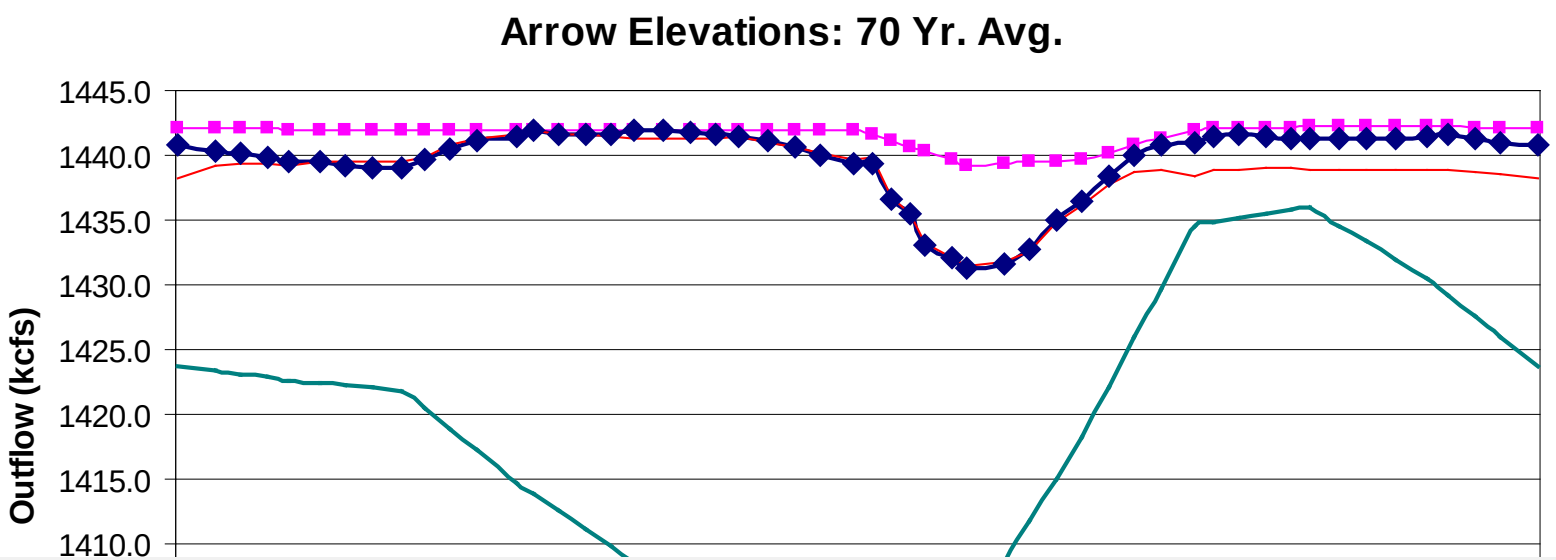
Uncertainties Incorporated in FRA (long-term)

HEC-ResSim	
Starting Storage/Elevation	Stream routing coefficients
Stage/flow Rating Curves	Reservoir physical data: storage/elevation, release capacity, etc.
Demands (water, power)	
Current Power Capacity (outages)	
Sedimentation changes	
HEC-RAS	
Roughness Coefficients	Weir Coefficients
Bridge Debris	Gate Coefficients
Ice thickness	Bridge/culvert coefficients
Dam/levee breeching parameters	Contraction/Expansion coefficients
	Boundary Conditions (normal depth slope, etc.)
	Terrain Data
HEC-FIA	
Foundation Height	Ground Elevation
Structure value	
Content Value	
Car Value	
Other Value	
Depth/Damage functions	
Population at Risk	

Many Other Uncertainties

- What will be an agreed upon called upon operation?
- What will be an agreed upon effective use operation?
- What could a CanadianTreaty Terminates operation look like?
- What Treaty operation will be agreed upon vs. what we assume?
- What biological operations will be desirable in U.S. and Canada?
- How will the basin change over time (people, places, demands)?
- How will the climate change over time?
- How will an operation change in real-time implementation, is it significant?…….

Example of using FRA to



Apply probability to the operations cases based on expert knowledge. Incorporate that into flood risk.

Case 1 – 50% chance of occurring
Case 4FB – 25% chance of occurring
Case 4C – 20% chance of occurring
Case NCS – 5% chance of occurring

What does this mean for the Treaty Studies

- We now have a tool in which operational changes in Canada or the U.S. can, relatively quickly, be evaluated for flood risk.
- This is only one piece of the puzzle that will be use to make a decision. Multiple studies through STT/SRT are ongoing:
  - How should called upon and effective use work operationally?
  - What is the impact of a less conservative flood risk operation?
  - What is the impact of trying to meet more normative flow levels in the mainstem?
  - What is the impact of more normative reservoir levels?
  - Can levees be improved o reduce flood risk?
  - Can levees be removed to reduce flood risk?
  - What is an appropriate system-based dry year operation?

Questions

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