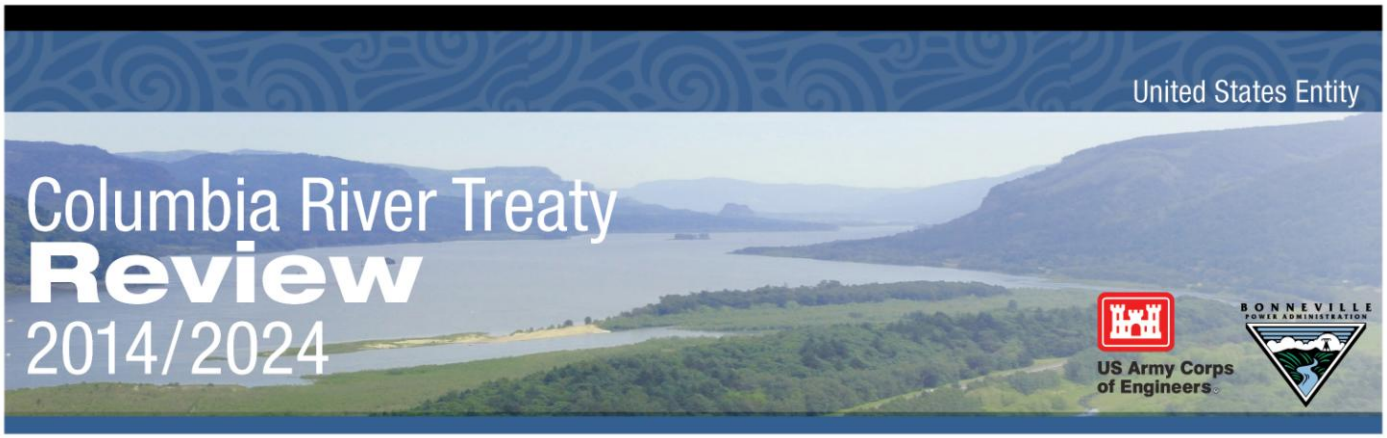

Overview of Iteration 2 Treaty Review Studies

Scope of Iteration 2 Studies:

- Develop future Treaty river management alternatives that strive to include the 3 primary driving purposes:
  - Hydropower
  - Flood risk management
  - Ecosystem-based function
- Analyze river management "components" to better understand the operation of the Columbia River system for a single purpose.
- Assess benefits & adverse impacts of the future Treaty alternatives
- Better understand sensitivity of future operation to Climate Change

> ***Alternative:*** A system of operational, structural and/or non-structural measures designed to include all three of the primary operational driving purposes: Ecosystem-based Function, Flood Risk Management and Hydropower.

Iteration 2 Alternatives:

- ***Current Condition (RC-CC):*** Uses the current operation of the Columbia River System following pre-2024 operating protocols and procedures under the Columbia River Treaty. This is the "Reference Case" used for comparison to modeled future alternatives and components.
- ***Treaty Continues, Called Upon (2A-TC):*** Assesses the Treaty Continues operation after 2024 using a procedure to "Call Upon" Canadian storage for flood risk management. Power operations are coordinated with Canada. This alternative uses current storage reservation diagrams for U.S. reservoirs to attempt to manage flows to 450 thousand cubic feet per second (kcfs) below at The Dalles.
- ***Treaty Terminates, Called Upon (2A-TT):*** Assesses the Treaty Terminates operation using a called upon procedure to access storage in Canada after 2024. This alternative does not have coordinated power operations with Canada. Knowledge of Canadian operations are uncertain, and uncertainty was accounted for in flood risk operations. Five potential Treaty Terminates Canadian operations were evaluated; the most likely Canadian operations were used to assess impacts.
- ***Treaty Continues, Called Upon with reduced Flood Risk Drafts (2B-TC):*** Assesses the impacts and benefits of reducing the amount of system authorized flood storage in certain U.S. reservoirs while implementing Called Upon procedures and coordinated power operation with Canada. This alternative uses modified storage reservation diagrams at Grand Coulee, Dworshak and Brownlee in attempt to manage flows at The Dalles to below 600 kcfs.

Iteration 2 Components:

> ***Component:*** A system of operational, structural and/or non-structural measures designed to focus on only one of the operational driving purposes: Ecosystem-based Function, Flood Risk or Hydropower. Components are not meant to be stand-alone alternatives that could realistically be implemented, but are meant to better understand the operation of the Columbia River system for a single purpose. Based on what is learned during Iteration #2, components may be combined during Iteration #3 to form comprehensive alternatives.

Ecosystem Components

- ***Natural Hydrograph (E1):*** Simulates water volume and timing across the Canadian border from Canadian Treaty storage reservoirs and U.S. storage reservoirs needed to emulate a normative spring hydrograph All power, flood control and fisheries operations for endangered species required under existing biological opinions (BiOp) are eliminated—all operations are focused on achieving the more-normative hydrograph.
- ***Natural Lakes & Rivers (E2):*** Simulates a more natural condition of river flows and reservoir levels. All reservoirs are kept as full as possible and inflows to projects or dams are passed through to achieve lake-like conditions. All power, system flood control and BiOp operations are eliminated from this component—all operations are focused on achieving full lakes and reservoirs.
- ***Summer Flows for Anadromous Fish Migration (E3):*** Assesses changes to the volume and timing of water across the border to supply summer flows to improve anadromous fish migration. This component attempts to achieve the BiOp objective of 200 kcfs flows at McNary Dam through the summer using Canadian storage. This component uses Treaty Continues, Called Upon alternative (2A-TC) flood risk, power and BiOp operations.
- ***Dry Year Strategy Spring Flows (E5):*** Assesses changes to timing and volume across the border to improve mainstem Columbia River ecosystem during the driest water years. This component seeks to improve flows mid-April through early June for migration. This component uses flood risk, power and BiOp operations from the Treaty Continues, Called Upon with reduced Flood Risk Drafts (2B-TC) alternative.

Flood Risk Management Components

- ***Full Use of Authorized Storage (F1):*** Assesses and estimates the level of flood risk that can be achieved by maximizing use of authorized storage beyond what is assumed for U.S. Operations in the Treaty Continues, Called Upon alternative (2A-TC). This component results in a calculation of flood risk for the U.S. system.
- ***No Called Upon Flood Storage (F2):*** Assesses the value of Called Upon storage in Canada in terms of economic consequence accrued if Canadian Storage is not accessed for flood risk management as allowed by the Treaty after 2024. This component models the operation of the Treaty Continues (2A-TC) alternative without Called Upon and evaluates the flood consequences that could occur due to the lack of Canadian Storage.
- ***Modify US Levees to Perform Authorized Levels (F3):*** Assesses the economic consequences that could be reduced if the U.S. levees were improved to perform at an authorized level of protection. This component assumes all levees are built and maintained to their authorized level—to achieve this levees would need to be rehabilitated, repaired and in some cases built higher. Operations are based on Treaty Continues, Called Upon alternative (2A-TC).

Hydropower Components

- ***Optimize Joint Canadian & US Hydropower Operations (H1):*** Assesses whether the joint U.S. and Canadian optimization for power generation as defined under the Columbia River Treaty is a true reflection of the joint system capability based on today's hydropower system using modern modeling tools and methods.
- ***Optimize Joint Canadian & US Hydropower Operations Subject to Meeting Biological Requirements (H2):*** Assesses the change in hydropower generation when the joint U.S. and Canadian Columbia Basin hydro-systems are optimized for power while also operating for U.S. biological opinion objectives and Canadian Fisheries operations.

Iteration 2 Assessments:
Iteration 2 used results of hydroregulation models expressed as changes in timing and volume of river flows and changes in reservoir storage and elevation to conduct a high level comparison of the Treaty alternatives and components. Numeric models and qualitative evaluations were used to assess their relative benefits and impacts to river purposes and outputs compared against the Reference Condition (RC-CC).

Ecosystem-based Function Assessments:

- ***Anadromous Fish Assessments:*** Using Comparative Survival Study (CSS), COMPASS and Habitat models, alternatives and components were assessed for changes in Fall Chinook rearing habitat and in-river survival, smolt-to-adult return, and travel time for Chinook and steelhead. A qualitative assessment was also done by NOAA Fisheries for adult fallback.
- ***Estuary Assessments:*** Using CMOP-SELFE and Delft3D models, alternatives and components were assessed for changes in Salinity Intrusion Length, Plume Volume and Salmon Habitat Opportunity. Additional analysis is being conducted on sedimentation and erosion impacts.
- ***Resident Fish Assessments:*** Using habitat models, sturgeon spawning habitat was evaluated for the alternatives and components. A qualitative analysis was done for Snake River resident fish on the alternatives. More iteration 2 analyses on resident fish will be released in late spring.
- ***Water Quality Assessments:*** Using HEC-RAS, CE-QUAL-W2 and SYSTDG models, alternatives and components were assessed for changes in water temperature and total dissolved gas (TDG).

Flood Risk Assessment:

- The flood risk analysis is a systematic, evidence-based approach for quantifying and describing the nature, likelihood and magnitude of risk associated with the current condition and the same values resulting from a changed condition due to future action.
- ***Uncertainty:*** The Columbia River System does not have enough storage to account for the runoff produced, thus operators depend heavily on forecasts to predict timing and quantity of the runoff. Sudden changes in the runoff patterns due to warm weather or rain events have the potential to produce devastating consequences similar to the Vanport Flood in 1948. The Flood Risk Team is analyzing the uncertainty and unpredictability of the system.
- ***Flood Risk:*** Flood risk is calculated by multiplying consequences of a flood event by the probability of that event. Increases in flood flows correlate to an increase in risk. This analysis considers economic, social and hydrologic factors.

Hydropower Assessments:

- ***Power Revenue Effects:*** Using AURORA model, market prices were estimated with the industry standard for alternatives and components. The value of capacity was also evaluated
- ***Power Generation Effects:*** Using HydSim model, changes in hydropower generation was evaluated for alternatives and components.
- ***Power System Reliability:*** Using the HYDSIM and HOSS Models, alternatives and components were assessed for loss of load probability (LOLP.) Loss of load is a condition where the load is greater than the ability of the resources to serve it. This assessment evaluates the reliability of the system. Several other reliability metrics were assessed such as the 10^{th} percentile generation capability, critical period (1937) generation capability, and Super Peak generation capability of the Federal Columbia Power System (FCRPS).
- ***Carbon Emission Equivalents:*** Using "Marginal Carbon Dioxide Production Rates of the Northwest Power System" (Northwest Power and Conservation Council, August 2008), assessed alternatives and components for marginal carbon dioxide production in the U.S. and Canadian hydropower systems. This information was translated to compare increases from RC-CC with respect to passenger car and power plant equivalents.
- ***Wind Integration Analysis:*** Using a spreadsheet tool, analyzed the ability of the hydropower system to carry reserves needed to balance the moment-to-moment variations between loads and generation created by the fluctuations of wind generation.

Other Assessments:

- ***Navigation Assessment:*** Using a spreadsheet model with thresholds that impact commercial navigation, assessed the alternatives and components for their impact to navigation. Specifically identified reservoir levels in Lake Roosevelt that adversely affect the Gifford Inchelium Ferry; flows on the Lower Snake, Mid- and Lower Columbia Rivers; and flows that affect sediment deposition in the Columbia River.
- ***Recreation Assessment:*** Using a spreadsheet model with thresholds that impact recreation availability, assessed the alternatives and components for their impact on reservoir and river recreation. Specifically, identified reservoir levels necessary to provide boat ramp access/usability and outflows and reservoirs that provide for optimal river recreation opportunity.
- ***Water Supply Assessment:*** Using a spreadsheet model, evaluated the pumping costs for the Columbia Basin Project (formed by Grand Coulee Dam) and Lake Umatilla (formed by John Day Dam) for alternatives.

Iteration 2 Assessment Summary by Alternative and Component

	RC-CC	2A-TC	2A-TT	2B-TC	E1	E2	E3	E5	F1	F2	F3	H1	H2
Anadromous Fish	X	X	X	X	X	X	X	X					
Estuary	X	X	X	X	X	X	X	X					
Resident Fish	X	X	X	X	X	X		X					
Water Quality	X	X	X	X	X	X	X**	X**					
Hydropower	X	X	X	X	X	X	X	X				X	X
Flood Risk	X	X	X	X	X*	X*	X*	X*	X	X	X		
Navigation	X	X	X	X	X	X	X	X					
Recreation	X	X	X	X	X	X	X	X					
Water Supply	X	X	X	X	X	X							

**Qualitative Assessment*
***Temperature Only*