

Calculating Hydro Peak Capability

TRAP

- Trapezoidal approximation of sustained peaking capability of the regional hydro system
- Maximizes an input sustained peak period (e.g. 2, 4, 6, 10 hours)
- Linear Program with sustained peak and off sustained peak turbine flow and spill as random variables
- Models 5 days of repeated operation

TRAP Update

- Changed to use external linear solver
- Added output files to explicitly show linear systems being solved and optimal solution outputs for each period solved
 - There are 80 (Water Years) * 14 (Periods) * 4 (Outage Scenarios) = 4480 linear systems that are solved by TRAP
- Reorganized code for readability
- Updated Storage Logic

Inputs

- BPA Monthly Regulated Flows
- Modeled Projects and Zones
- Project Type
 - Reservoirs
 - Limited Pond
- Minimum Flow by Period
- Dec Flow Requirements
- Forced Outage Rates and Maintenance min and max by Period
- HK Curves
- Sustained Peak Length

Key Assumptions

- 4 hour ramps, modeled as adding 4 hours to sustained peak period
- 110% of monthly flows are weekday flows
- BiOp Spill as either minimum spill or percentage of flow as spill – percentage flow spill not optimized
- Independent outages constrain maximum generation
- 50% of projects not modeled follow load and 50% have flat generation

Basic Formulation

- Linear system equations take the general form
$$\text{Storage Water} + \text{Project Water} - \text{Upstream Water} = \text{Side Flows}$$
- Objective function maximizes turbine flows multiplied by the HK with a penalty of $10 * \text{spill flows}$ for extra spill

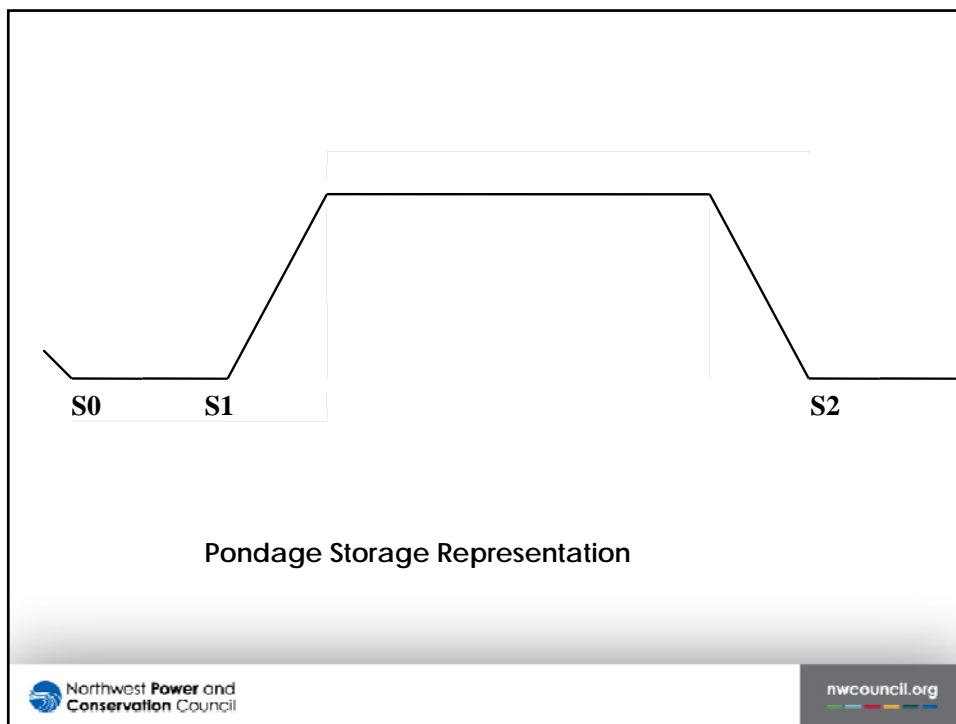
Storage Logic

- For large reservoirs, e.g. Grand Coulee, storage within the week is unlimited
- For smaller ponds, storage is limited by input kcfs-hrs limit

Pondage Treatment

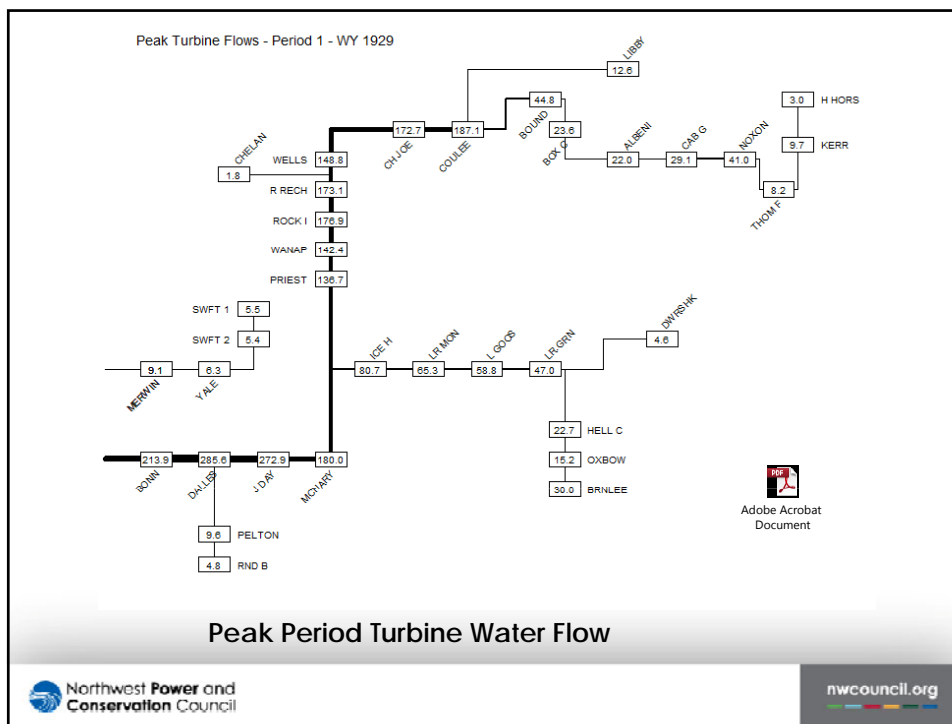
- Revised from previous logic, three points of storage measured:
 - S0 represents pond content at the beginning of the off-sustained-peak period
 - S1 represents pond content at the end of the off-sustained-peak period
 - S2 represents pond content after the sustained-peak period
- Revised so off-sustained-peak storage/draft ($S1 - S0$) is limited to 50% change of pond content and total storage/draft is limited to 20% change of pond content ($S2 - S0$)





Output Visualization

At the bottom of the slide, there is a logo for "Northwest Power and Conservation Council" on the left and the website "nwcouncil.org" on the right.



Applications to Flexibility

- Current Flexibility Assessment Methods Work
- What is the maximum/minimum dispatch of the hydro system?
- Within scheduling period flexibility versus between scheduling period flexibility

Public Release of TRAP

- **TRAP is now publicly available code**
 - Fortran code base
 - Available on GitHub, can be easily forked to experiment with different inputs/logic
 - Enhancement Requests and Bug Tracking
- <https://github.com/NWCouncil/trap2>