Utilizing Hydropower to Respond to VER Fluctuations

ESIG Workshop

Kevin Howard

Executive VP and Chief Operating Officer

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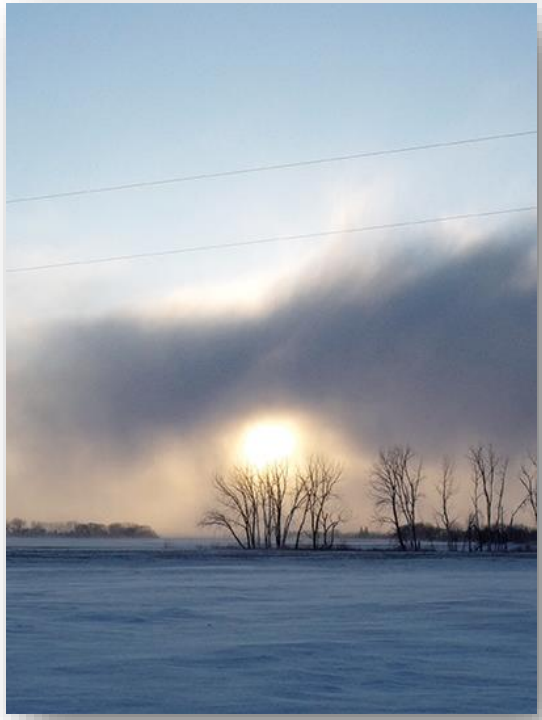
Western Area Power Administration

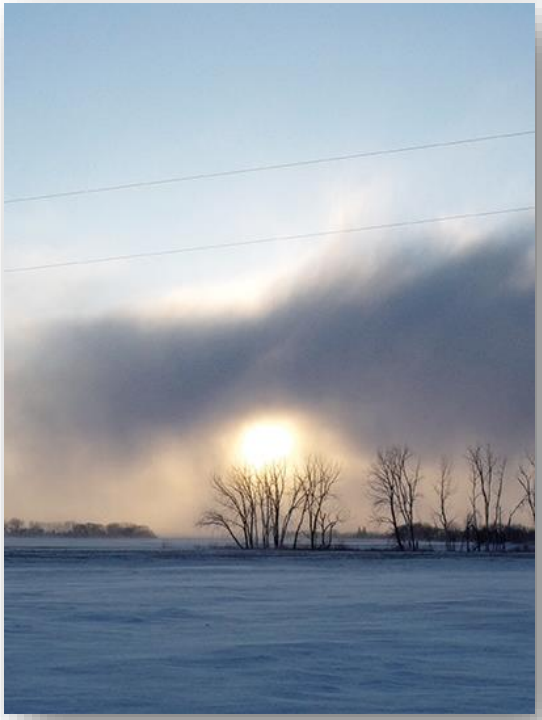
Hydropower for Variable Energy Resources Following

- Recent peak load event and associated wind challenges
- WAPA overview and role in the west
- Hydropower for renewables integration
  - Capabilities
  - Challenges
    - Water limitations
    - Environmental
  - Example operational restrictions for hydro



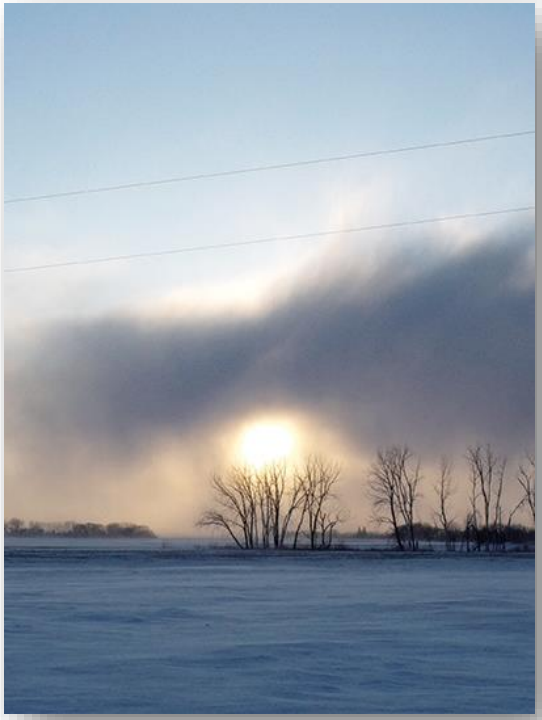
Midwest Generation events: Jan. 25–31

- Jan. 25, 2019
  - "Cold Weather Alert" issued for 1/29 to 2/1
- Jan. 30, 2019
  - Issued "Maximum Generation Event" Jan. 30 into Jan. 31
  - Mandatory emergency order
    - Risk of not having enough generation and transmission resources to serve load – avoid brown-outs or black-outs.



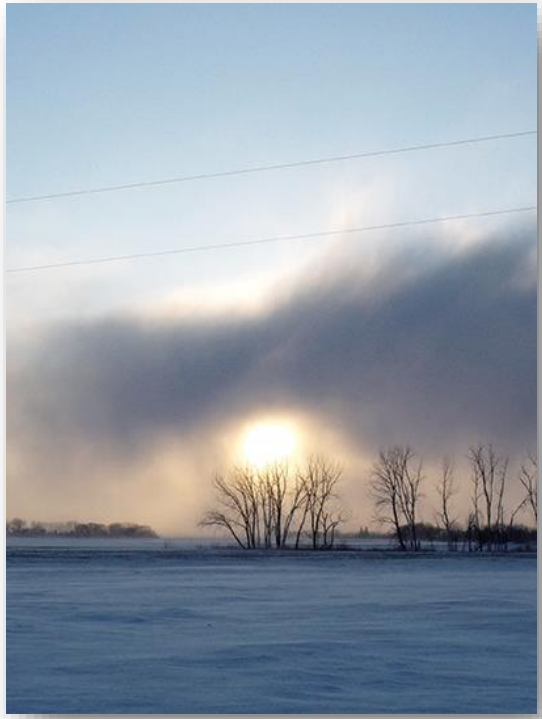
What was the area facing?

- Temps -30 degrees and colder in upper Midwest.
- Near-record demand for energy in Midwest.
- Baseload coal, natural gas and nuclear plants had some issues with cold, but mostly delivered.
- Reduced wind generation
  - Total wind generation of 17,000 MW
  - Originally planned/scheduled for 14,000 MW
  - Adjusted to 11,000 MW
  - Received only 4,000 MW
- Why reduced wind power
  - Wind not as strong as predicted
  - Wind turbines stop operating at -20 to -25 degrees

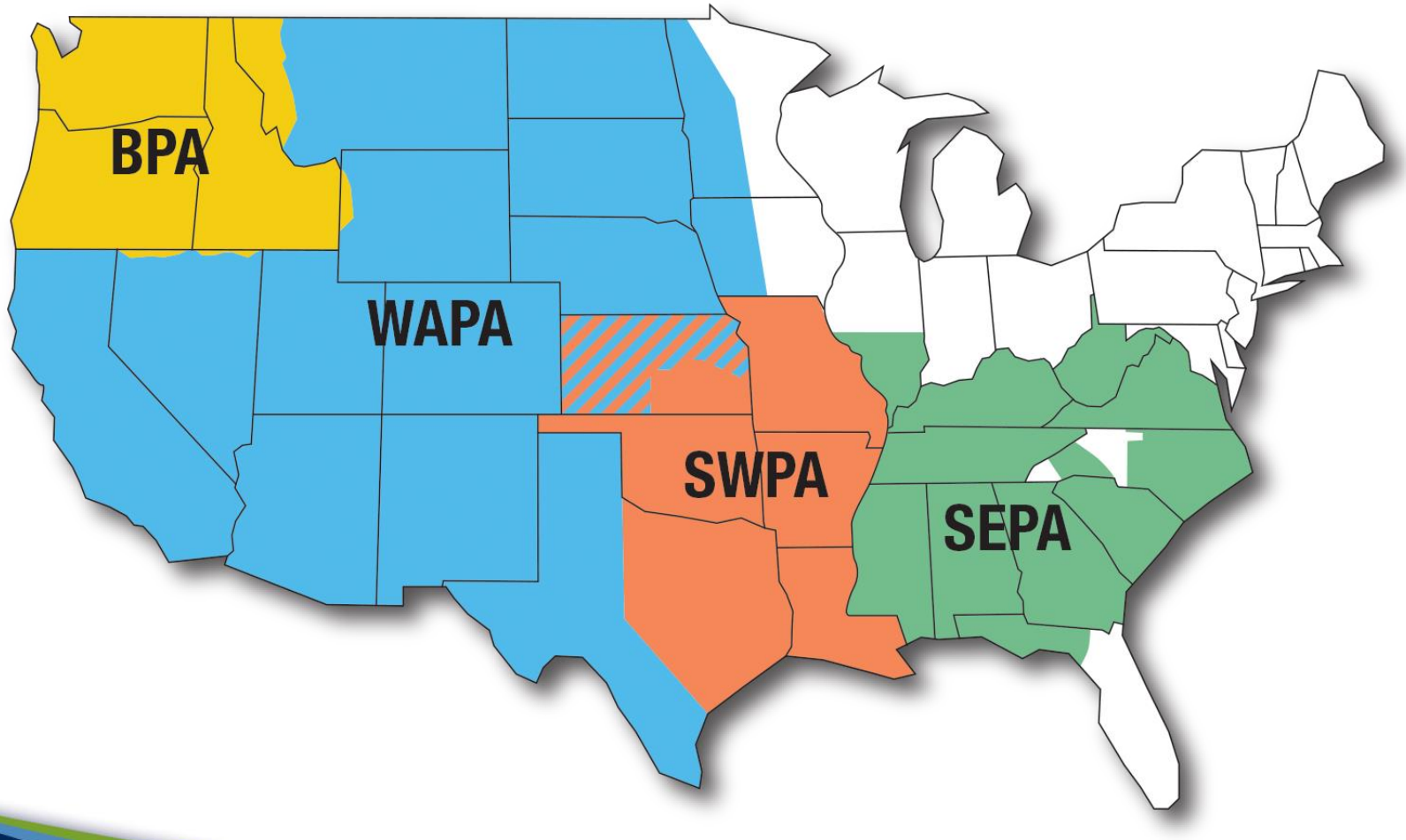


How energy needs were met

- Baseload coal, natural gas and nuclear
- Demand Response load control
- Imported power from adjacent areas:
  - 7,500 MW

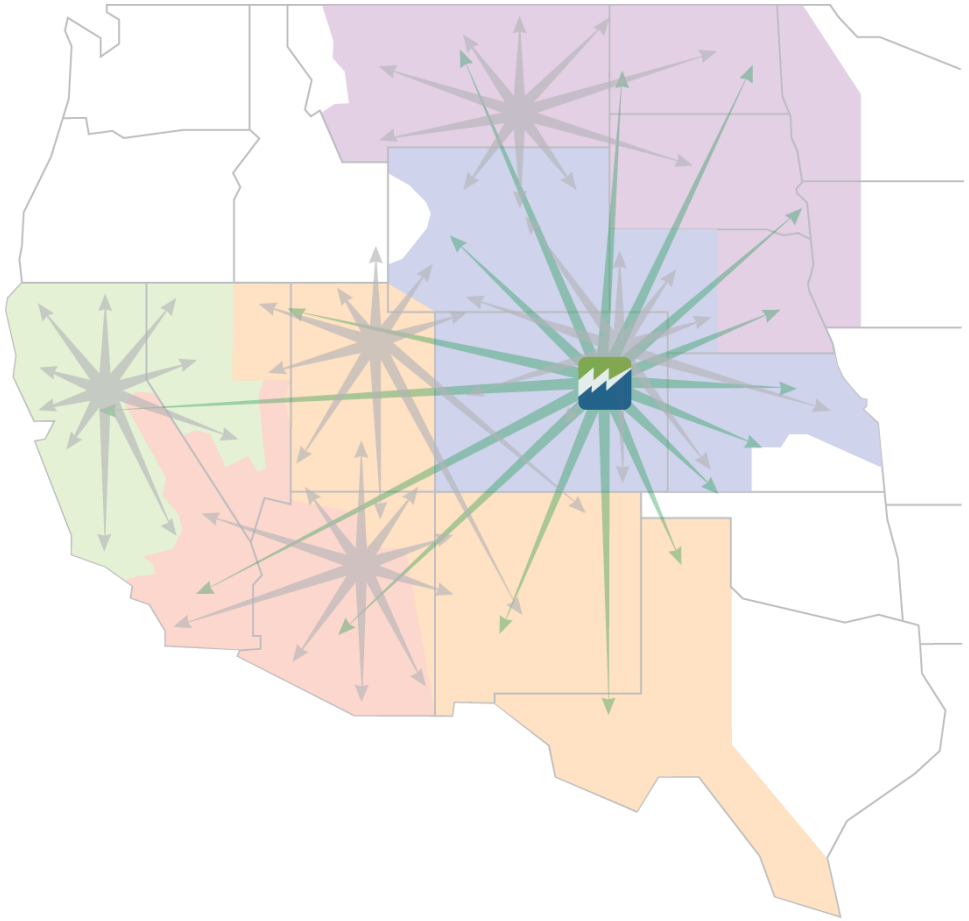


Power Marketing Administrations



In the West

- Balancing distributed and broad system
- 4 regions
- 1 management center
- 15-state footprint
- Top 10 largest transmission utility in country



Customer-focused

- Nearly 700 customers
  - Cities and towns
  - Rural electric cooperatives
  - Irrigation districts
  - Public power districts
  - Federal and state agencies
  - Native American tribes
- Preference entities under the 1939 Reclamation Reform Act

Our power comes from

- Hydroelectric energy produced at federal generating agencies
- Multipurpose projects
- Variable water availability

Hydropower for Variable Energy Resources Following

- **Capabilities**
  - **Availability**
    - Hydro isn't scheduled at maximum or minimum output capability for much of the year, resulting in available generation to respond to fluctuating VER output.
  - **Speed of Response**
    - Typical ramping up from an OFF state to full power output in approximately 10 minutes.
    - Can be backed down to no output in the same amount of time.
    - For even faster response, hydro units can be placed in a "speed-no-load" state for spinning reserves or for use as regulation within the balancing authority area.

Hydropower for Variable Energy Resources Following

- **Challenges**
  - **Spring Runoff**
    - Hydro often running at maximum output at all hours of the day for extended periods - eliminates use for VER following.
  - **Winter Conditions**
    - River flows near minimum - responses to fluctuations in VER output significantly reduced.
  - **Non-Variable Hydro Plants**
    - Many hydro plants are operated as constant output units for prevention of flooding or environmental issues.
    - Unavailable for VER following.

Hydropower for Variable Energy Resources Following

- **Challenges**
  - **Environmental Restrictions Example (Glen Canyon Dam)**
    - Recreational users, sport fish populations, native fish populations, other wildlife and ecosystem impacts, sandbar creation and Native American archeological and spiritual sites.
    - **Minimum and Maximum Release Rates**
      - Minimum flow rate – 5,000 cfs off peak and 8,000 cfs on peak.
      - The maximum scheduling release is 25,000 cfs.
  - **Hourly Ramping Limitations**
    - The maximum upward ramp rate – 4,000 cfs.
    - The maximum downward ramp rate – 2,500 cfs.

Hydropower for Variable Energy Resources Following

- **Challenges (Glen Canyon Dam)**
  - **Total Daily Release Fluctuation** – Difference between minimum and maximum release rate per day limited to 5,000 – 8,000 cfs depending on the time of year.
  - **Monthly Total Release**
    - Varies depending on season and amount of water in the system.
    - Limits ability to respond to VER fluctuations, especially near the end of the month.

Hydropower for Variable Energy Resources Following

- **Challenges (Glen Canyon Dam)**

  Wildlife Special Operations

  - Targets preservation or recovery of aquatic wildlife.
  - Annual high-flow events
    - Simulate spring runoff conditions to transport sediment for beach building and to aid the development of aquatic species.
    - Plant running at maximum output with no variation, limiting the ability to respond to VER fluctuations.
      - Low steady flows without variation designed for aquatic insects that preclude the use of the facility for VER following.

Hydropower for Variable Energy Resources Following

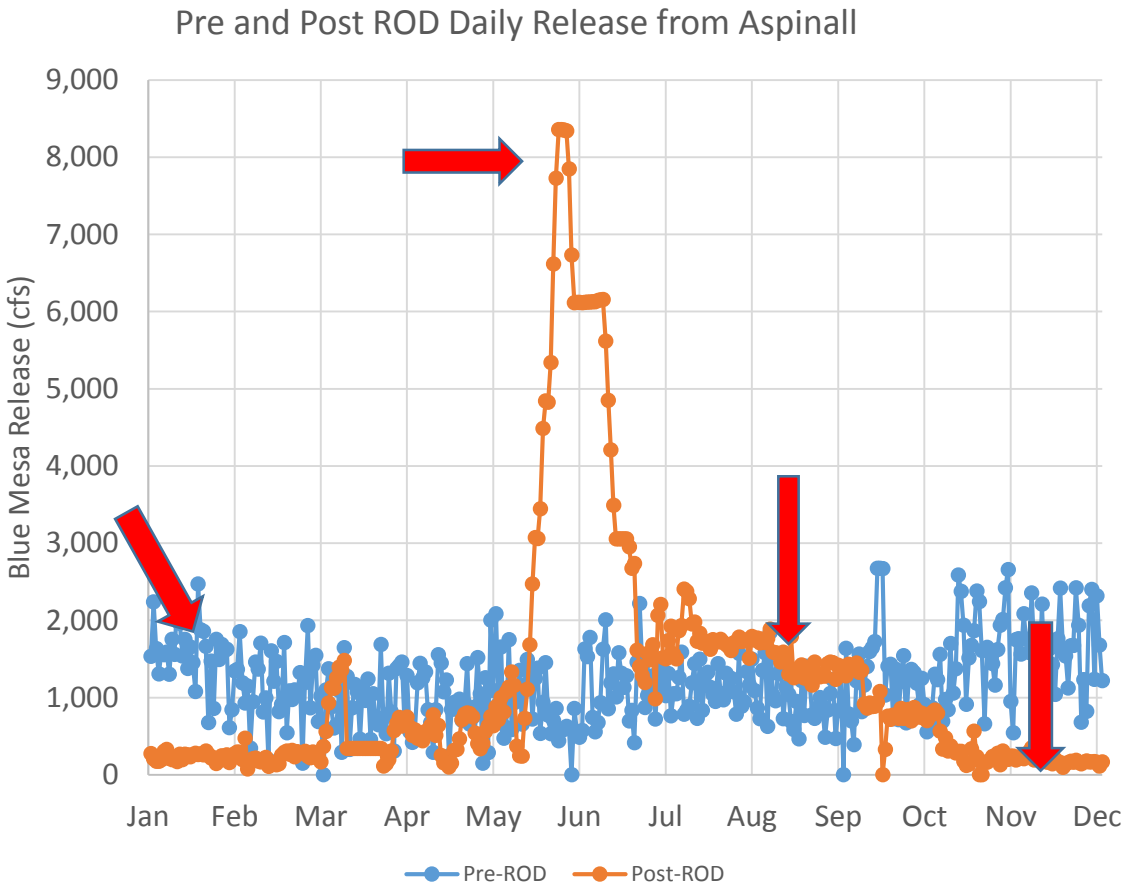
- **Glen Canyon Dam**

  Emergency Exception Criteria

  - Glen Canyon is used for spinning reserves and regulation
  - In most cases, emergency activations of reserves and/or the use of the plant for other reliability emergencies is exempt from limitations imposed during normal operations.
  - Nevertheless, system operators attempt to work within the environmental restrictions whenever possible.

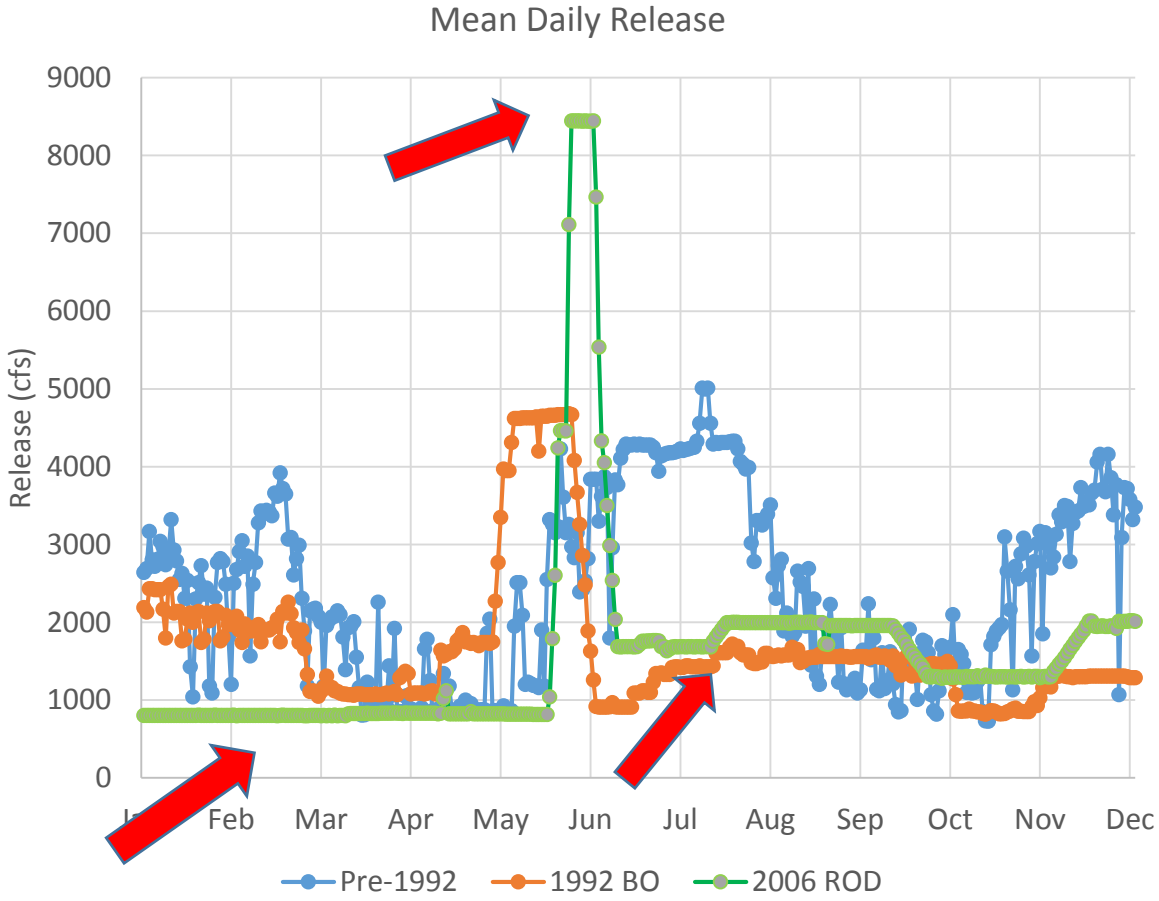
Aspinall Release

- Pre-2012 ROD
  - Operations dictated primarily by hydropower needs and flood management.
- 2012 ROD
  - Dictated releases mimic “natural” flow.
  - Releases increase for spring peak.
  - Prescribed base flows for each month.
    - Base flows must also provide sufficient water for downstream water rights.



Flaming Gorge Release

- 2006 ROD
  - Spring releases up to full bypass to achieve target at Jensen.
  - Release is determined by May 1 forecast of April – July inflow forecast into Flaming Gorge.
  - Summer and winter releases made to achieve targeted base flow at Jensen (900-3,000 cfs dependent on hydrology).



Hydropower for Variable Energy Resources Following

Plants with an after bay

- Some facilities are equipped with an after bay downstream of the main power plant.
  - Regulates river release to smooth flow
  - Increases plants operational ability to ramp for response to VER
- **Crystal Dam** in Colorado is the after bay of Morrow Point Dam. Crystal Dam releases a constant flow of water into the Black Canyon National Park even though Morrow Point Dam may be peaking heavily.
- **Yellowtail Dam after bay** in Montana regulates the Big Horn River flow while Yellowtail Dam is peaking and also regulates water flow into the Big Horn Canal.

Contact/follow us

Kevin Howard
720-962-7080
Howard@wapa.gov

wapa.gov

@westernareapowr

western-area-power-administration

WesternAreaPower1

westernareapower

wapa.gov