

LOWER SNAKE TAILWATER IMPACTS

Technical Management Team

May 10, 2023



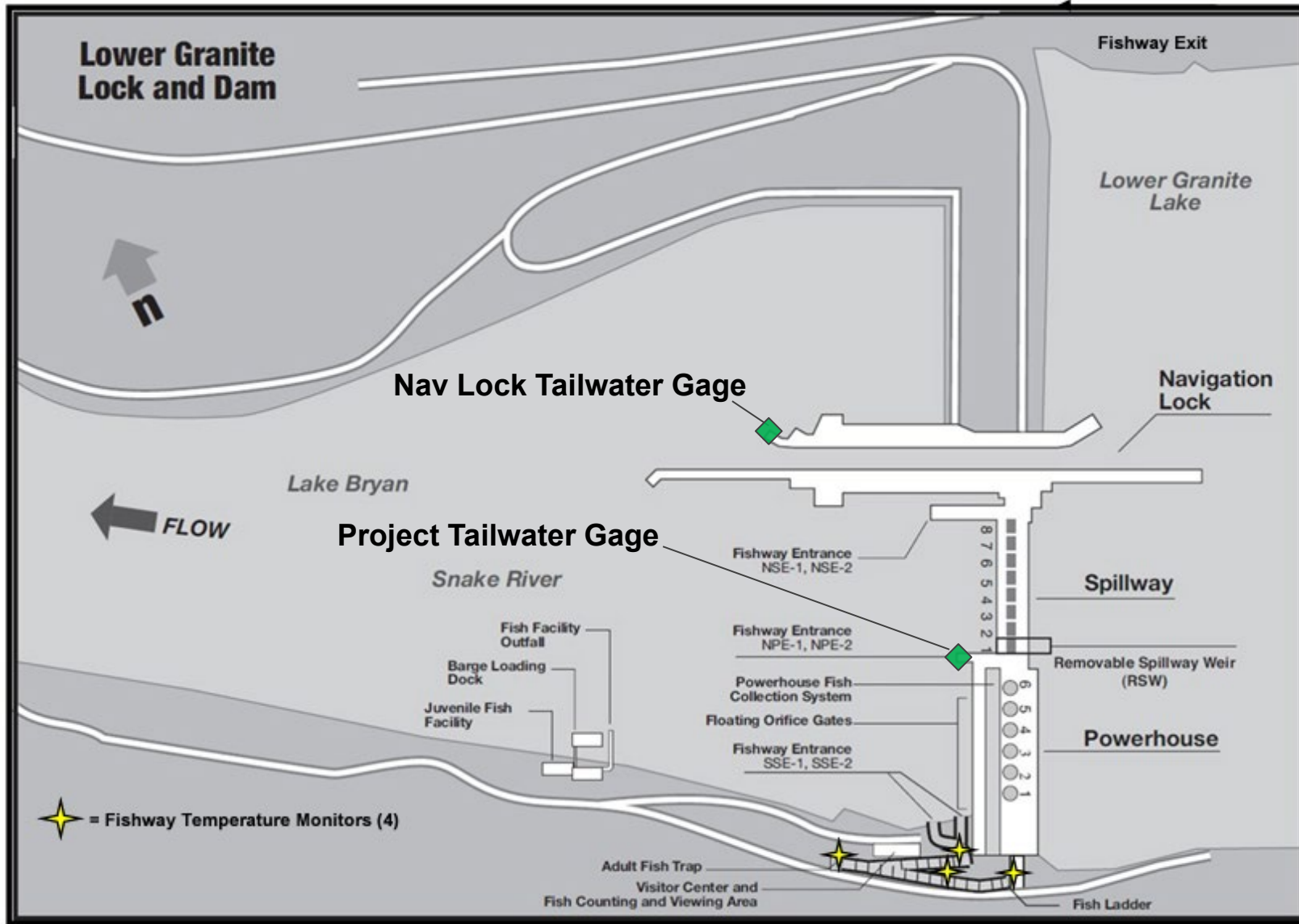
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LOWER GRANITE



Things impacted by tailwater elevations:

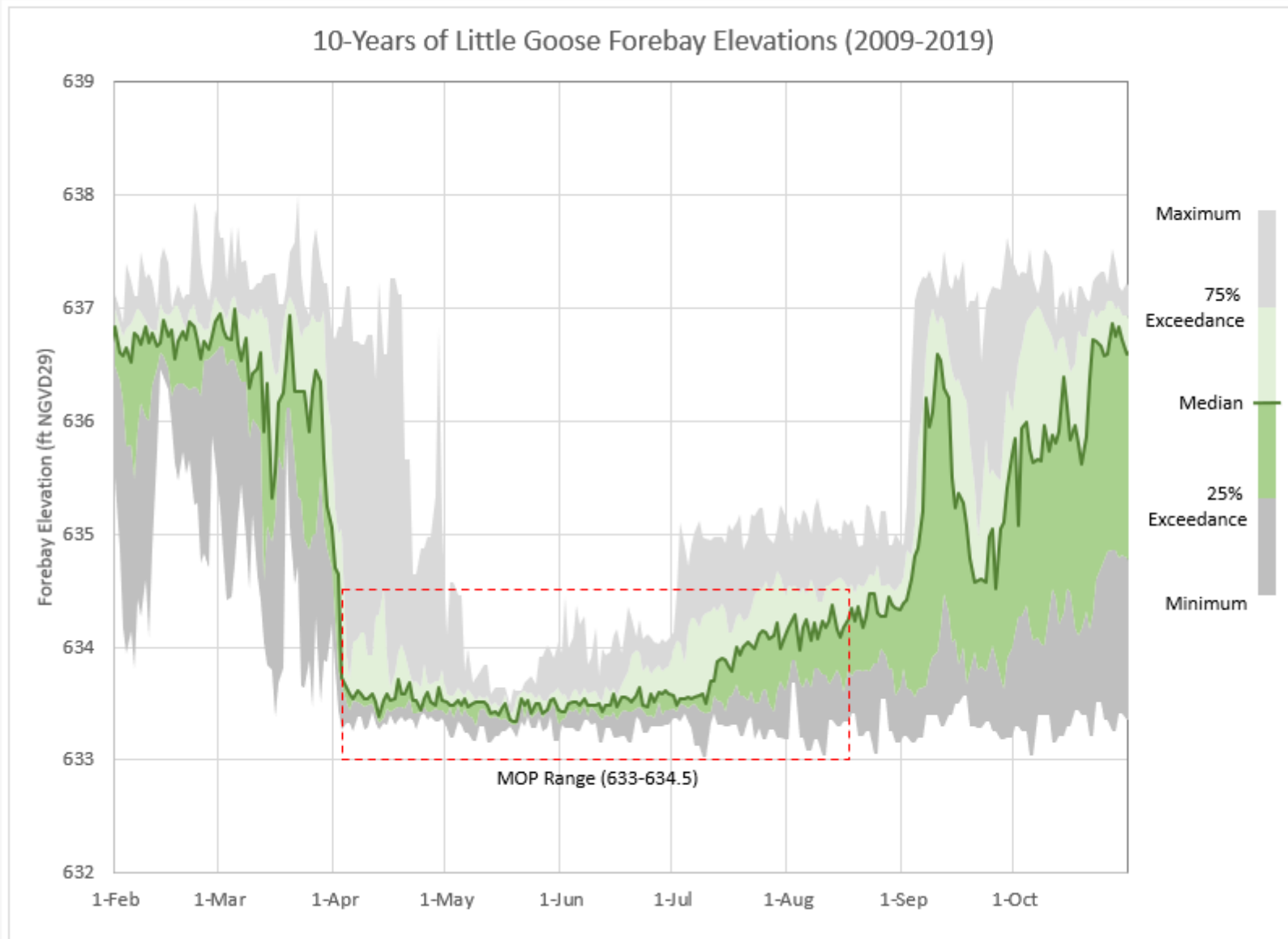
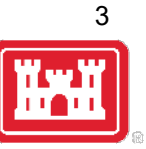
- Adult fishway entrances
- Fishway pumps
- Turbine Units
- Nav lock exits
- Federal navigation channel
- Flow deflectors

Tailwater gage trends:

- The 2 gages are similar when:
 - There's no spill
 - Flows are high
- When spill percentages are high (and flow are below 50k), the nav lock gage is generally higher.



HISTORIC OPERATION (LITTLE GOOSE FOREBAY)



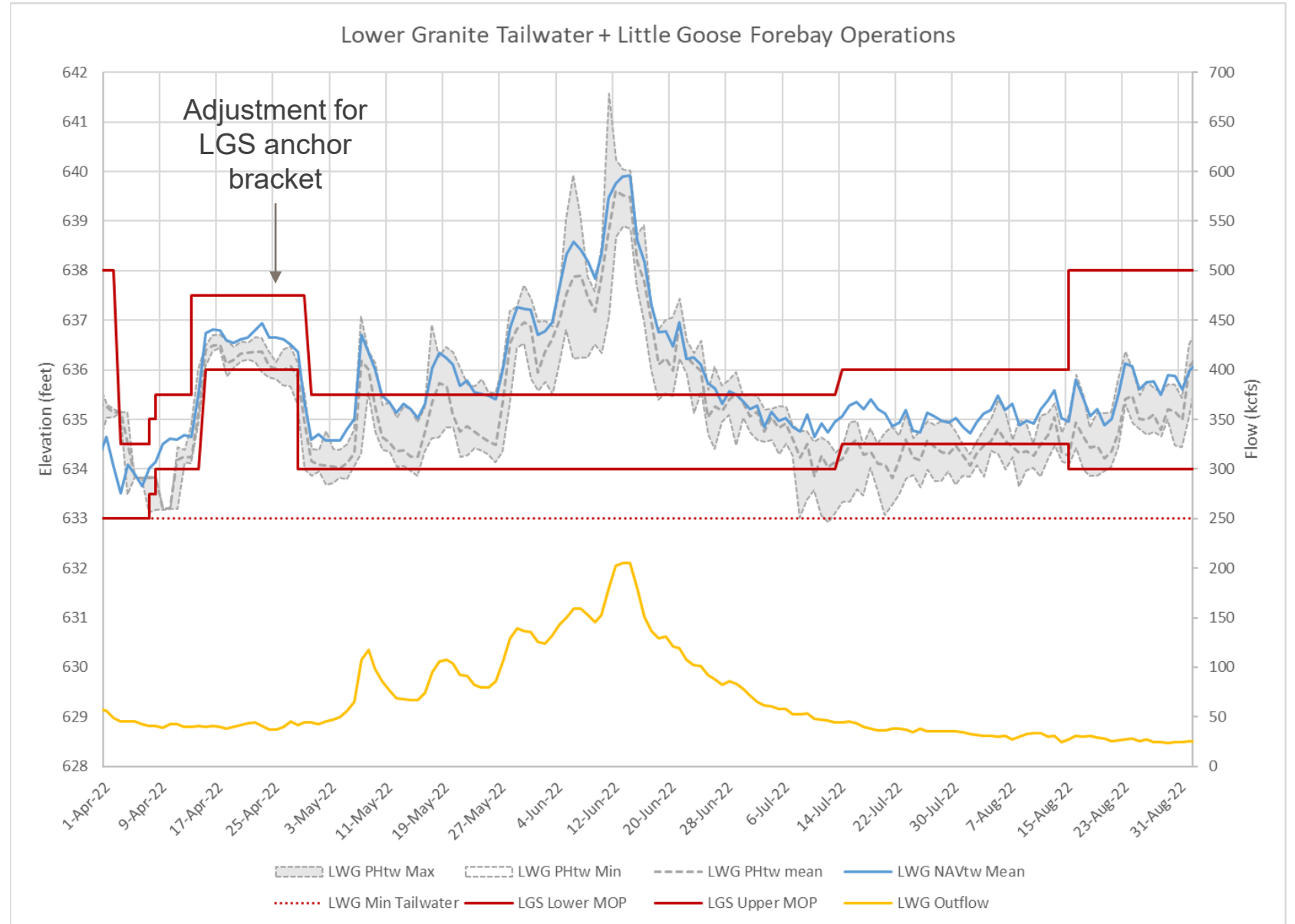
- The FOP included language referencing raising MOP beginning in 2009 citing navigation sill needs below Lower Granite, and later below Little Goose
- Little Goose forebay rises were common in the summer when flows decreased



LOWER GRANITE 2022



- Spill operations change tailrace hydraulics creating more turbulence and wave action
- When outflows are less than ~75 kcfs, the nav lock gage typically reads higher than powerhouse gage and Little Goose forebay
- Under these conditions, the powerhouse tailwater gage can drop below the minimum tailwater elevation and the Corps must raise the forebay at Little Goose to help maintain the minimum tailwater at Lower Granite

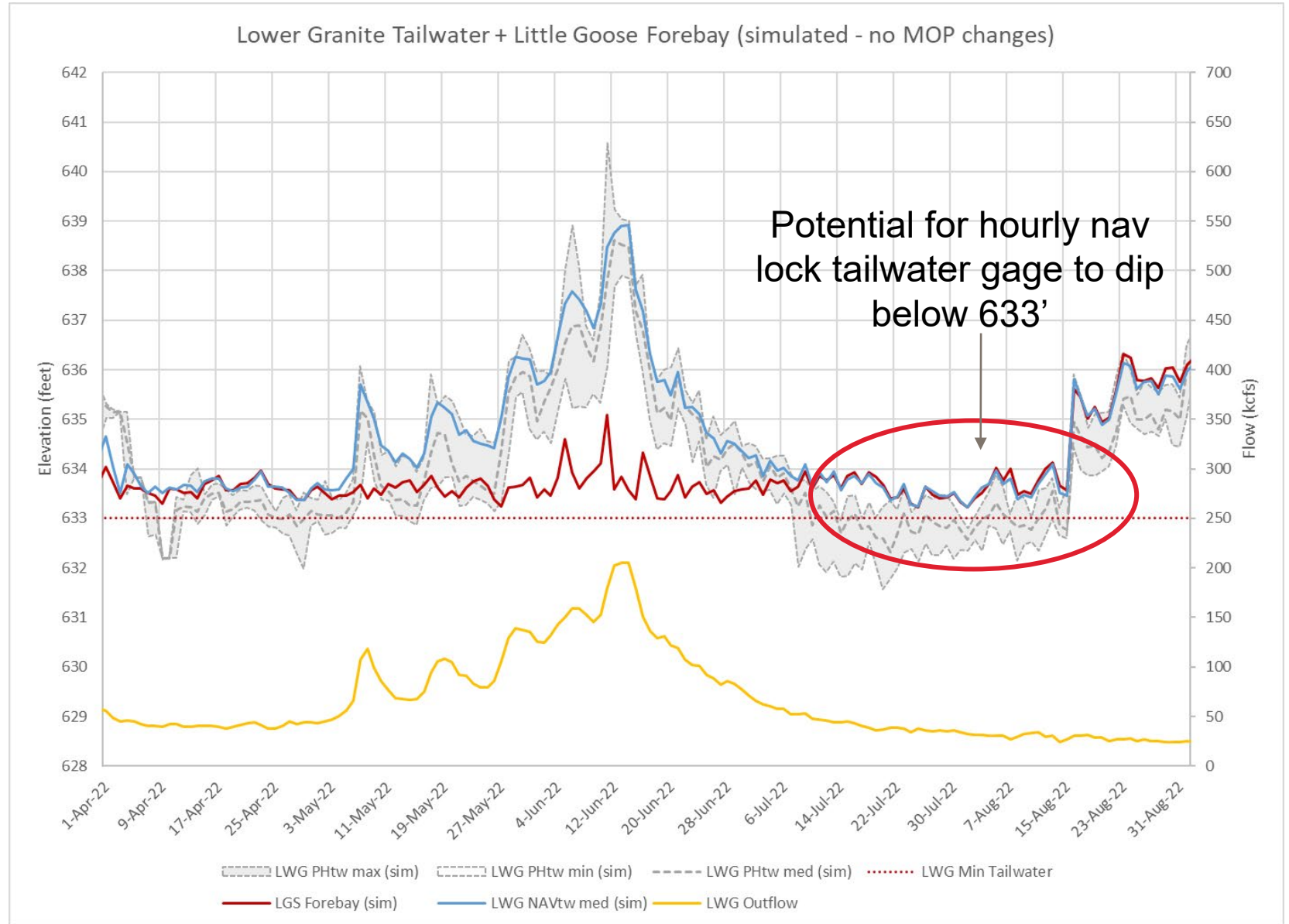




HYPOTHETICAL OPERATION – NO RAISED MOP

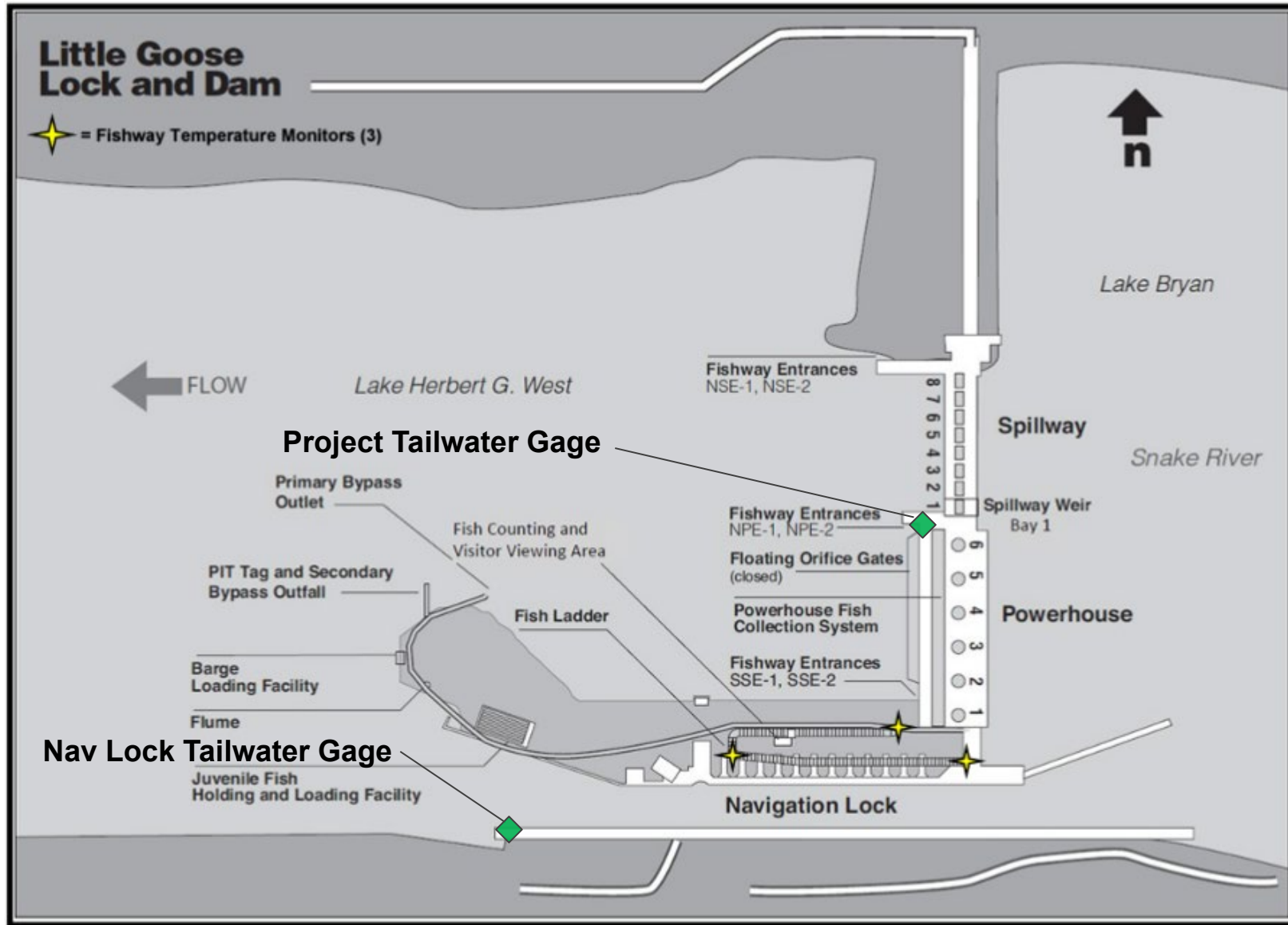


- Used 2022 operation
- Plot shows simulated Lower Granite tailwater and Little Goose forebay elevations
- Removed the effects of raised MOP adjustments
- Powerhouse tailwater elevations estimated to be up to 1.5 feet below the minimum tailwater requirement
- Potential for nav lock tailwater elevation to dip below 633' in summer (day average elev shown but hourly min and max range can be 1-1.5')





LITTLE GOOSE

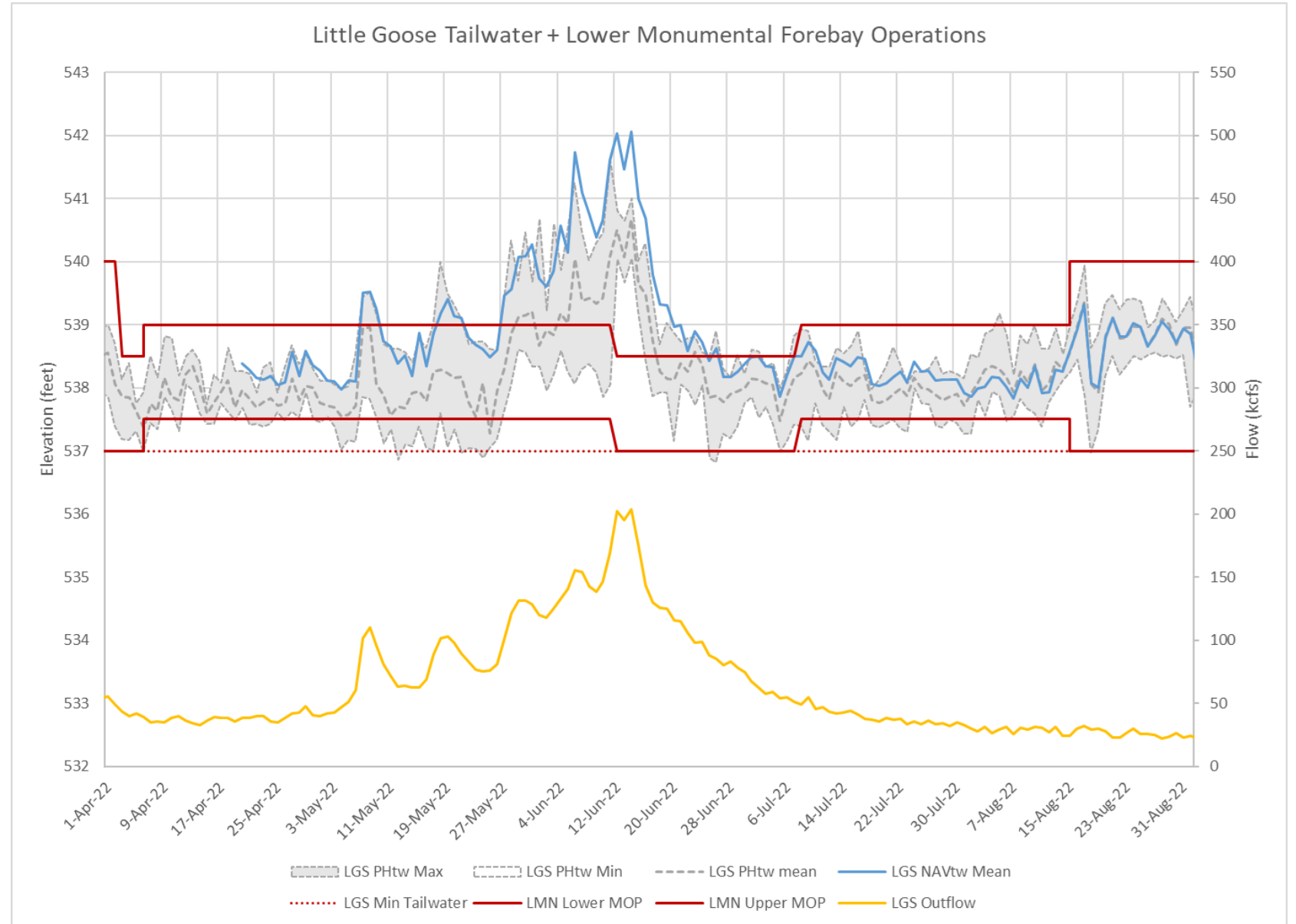




LITTLE GOOSE 2022



- During spill operations and when outflows are less than ~100 kcfs, tailwater elevations fluctuate near the project minimum and Lower Monumental usually needs a raised MOP operation
- When outflows exceed ~100 kcfs, tailwater elevations increase and Lower Monumental can usually operate in MOP

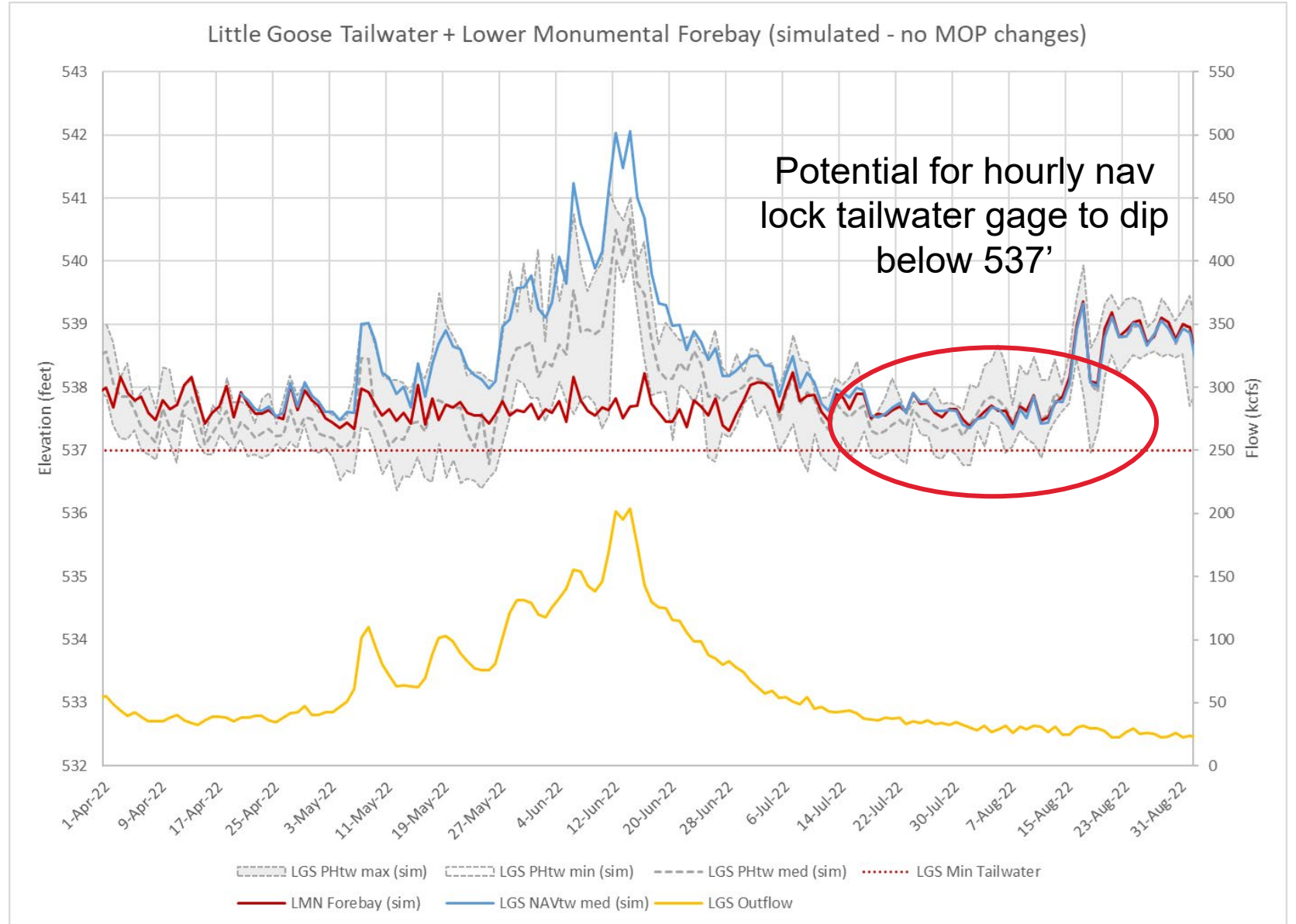




HYPOTHETICAL OPERATION – NO RAISED MOP

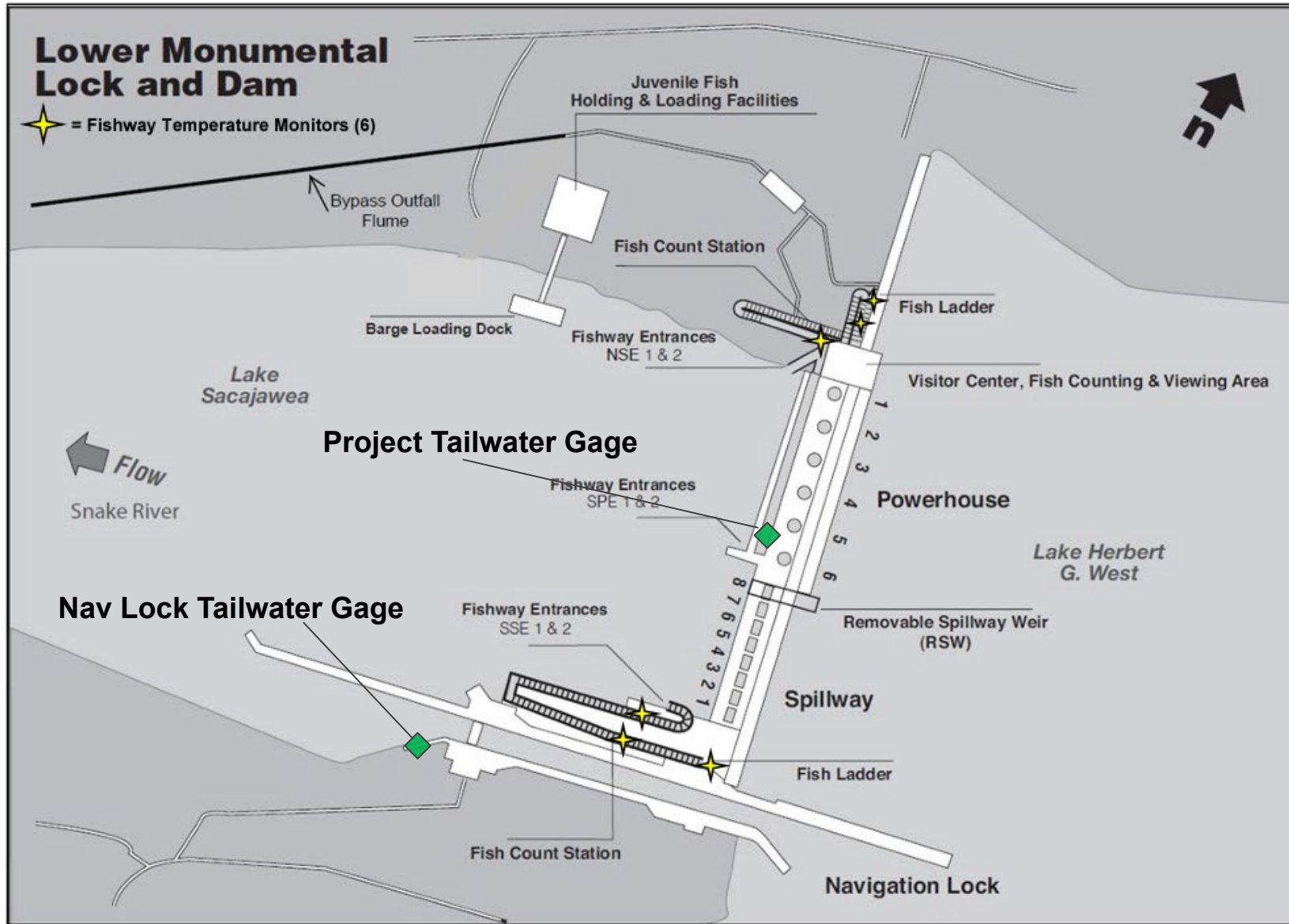


- Plot shows simulated Little Goose tailwater and Lower Monumental forebay elevations
- Removed the effects of raised MOP adjustments
- Powerhouse tailwater ~0.5' low in spring and late summer
- Potential for nav lock tailwater gage to dip below 537' in summer (day average elev shown but hourly min and max range can be 1-1.5')





LOWER MONUMENTAL



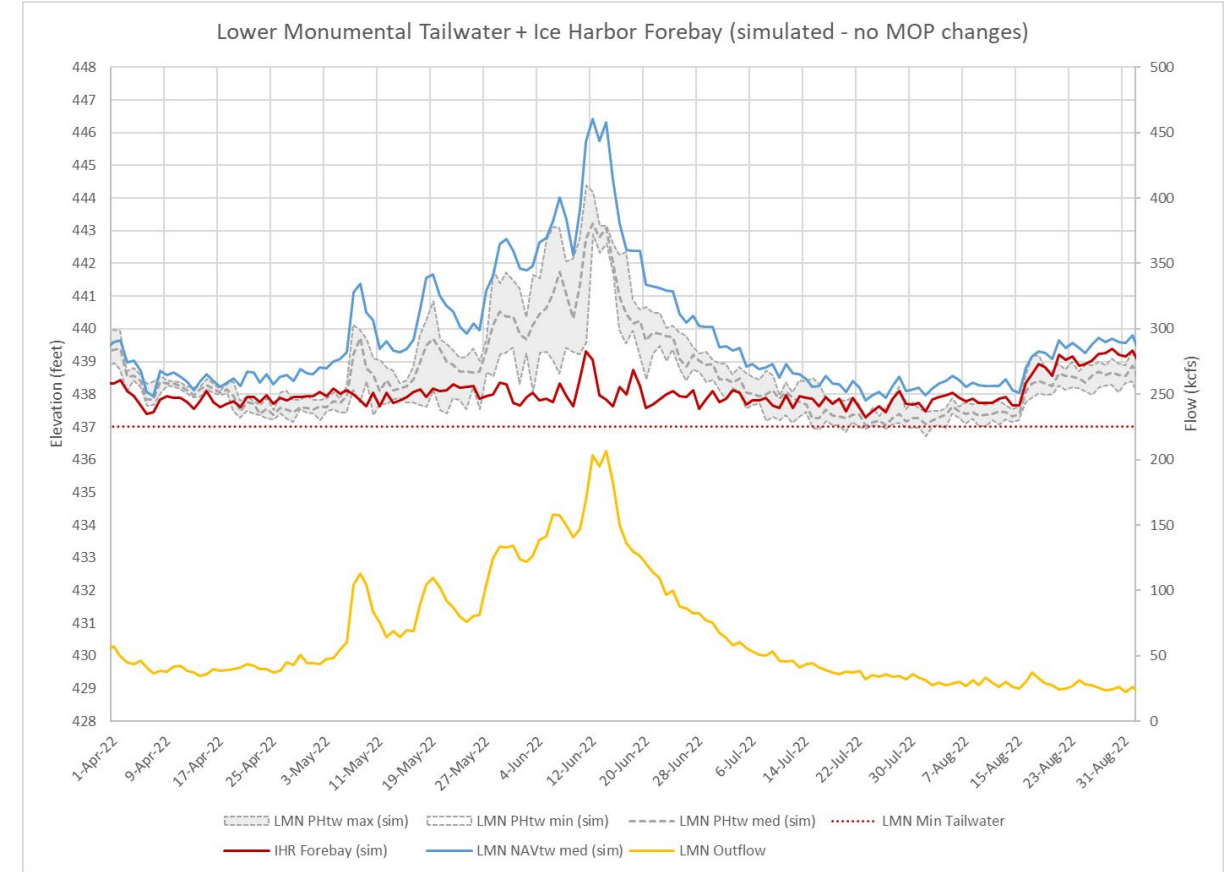
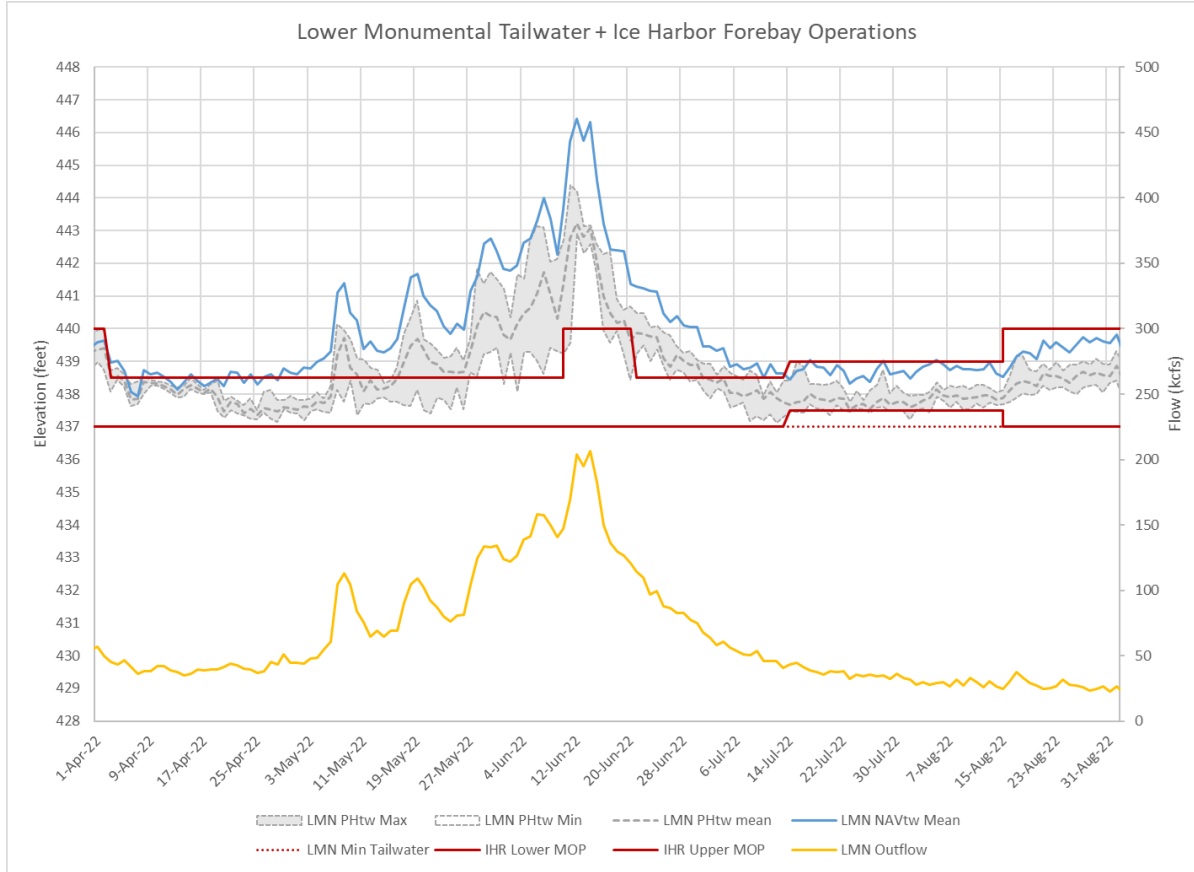


LOWER MONUMENTAL

2022 OPERATIONS



HYPOTHETICAL OPERATION – NO RAISED MOP



During summer spill operations, when outflows were less than ~50 kcfs, tailwater elevations dropped near project minimum and the Ice Harbor forebay was raised

Small dips below minimum tailwater may occur when outflows are less than ~50 kcfs

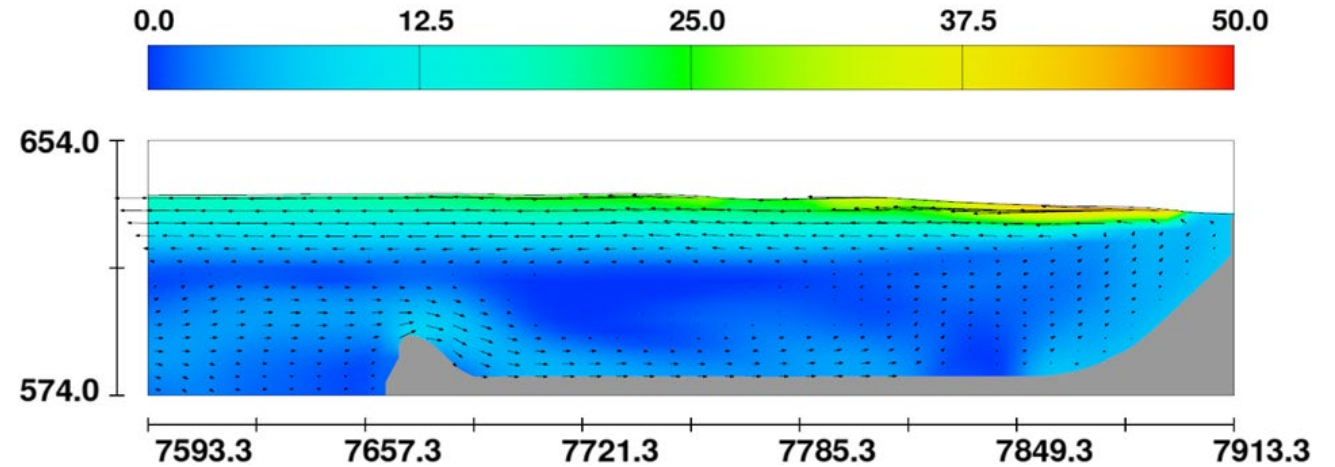


FLOW DEFLECTORS & EROSION

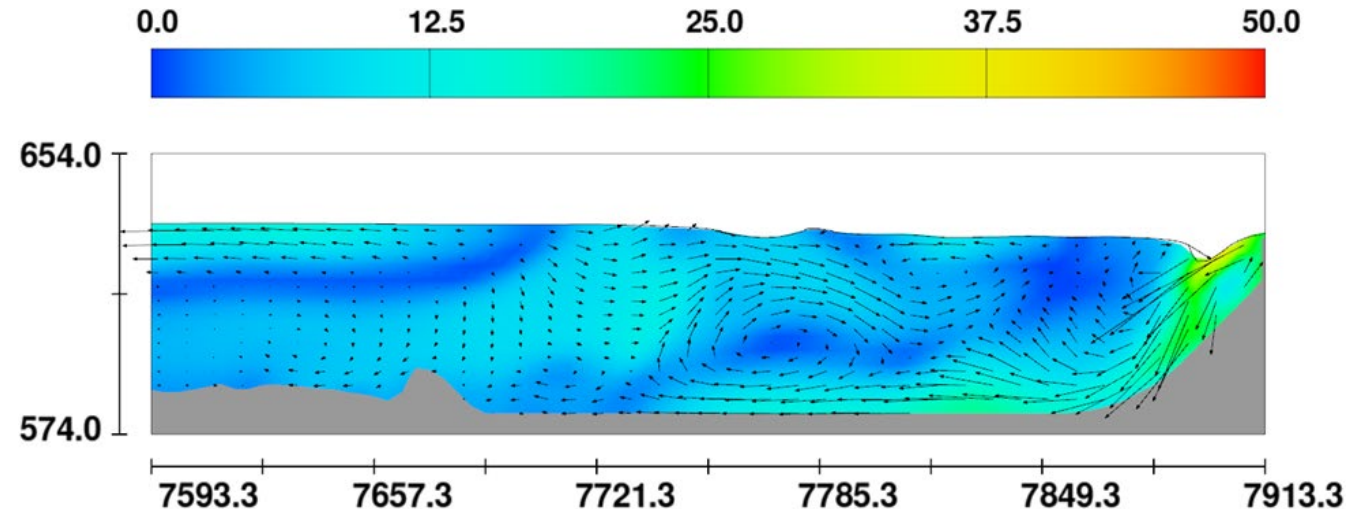


- Flow deflectors were designed from the 1970's to 1990's for a normal range of flows and tailwater elevations generally targeting forced spill operations during higher flows scenarios
- Skimming flow is the design flow condition to reduce downstream TDG
- Plunging flow occurs when the tailwater is too low or when the spill volume is too high
- Lowering tailwater elevation can cause spill to transition from undular/skimming to plunging
- Plunging flows can raise TDG and increase velocities at the stilling basin floor therefore increasing ball milling erosion

**CFD 3.8 Kcfs – 56 kcfs river at Normal Tailwater
Skimming Flow**



**CFD 8.2 Kcfs – 56 kcfs river at Normal Tailwater
Severe Plunging Flow**



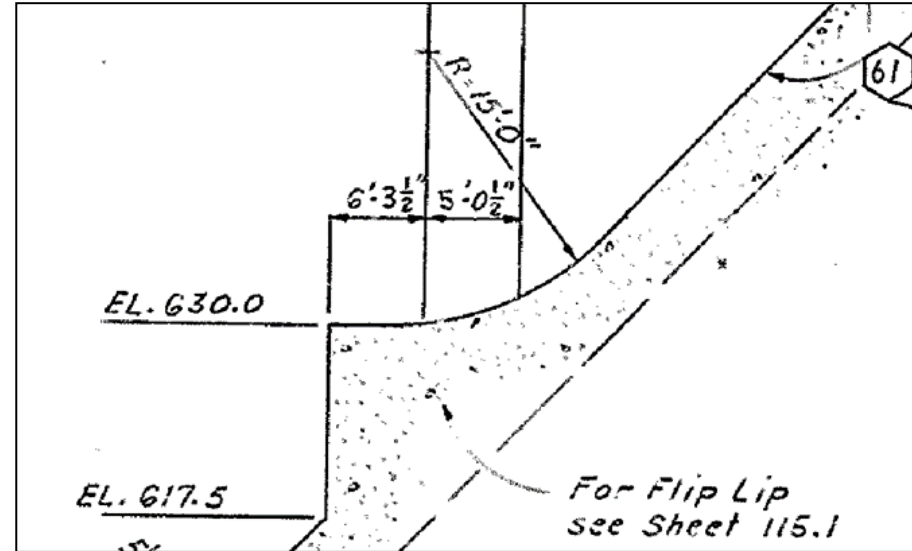


FLOW DEFLECTOR IMPACT SUMMARY



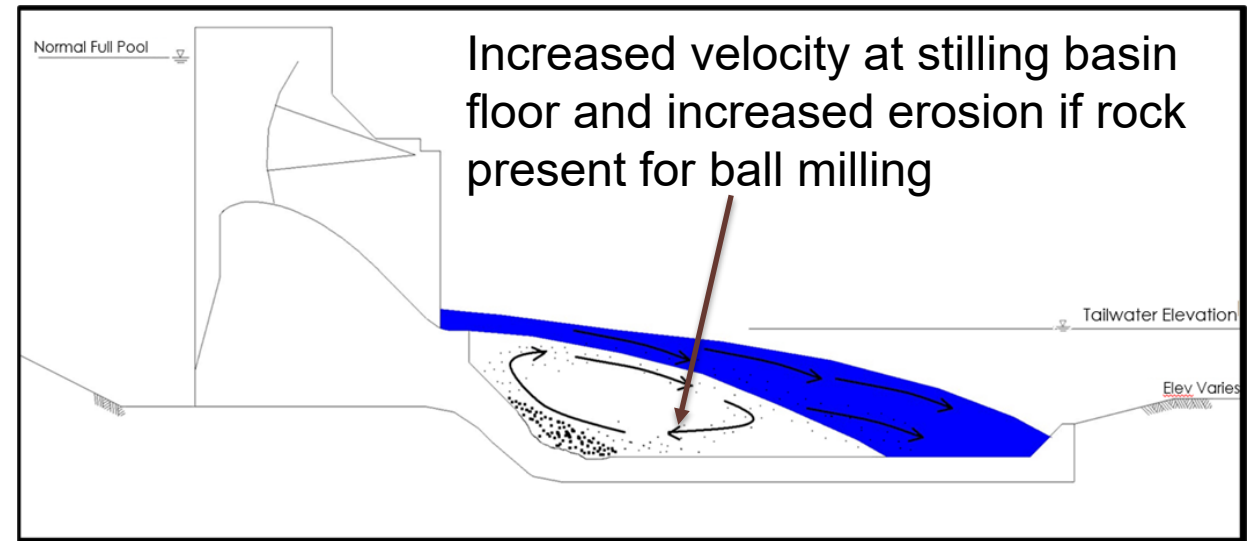
The increased frequency of unstable or plunging jets is likely to have the following negative impacts:

- Increased stilling basin erosion, primarily through ball milling
- Higher fish injury potential for spill passed juvenile salmon



Lower Granite Interior Bay Deflector Design

	Stilling Basin Erosion Potential	Potential for Fish Injury
Lower Monumental	Minor	Minor to Moderate
Little Goose	Minor	Minor to Moderate
Lower Granite	Moderate	Moderate



Plunging Flow Depiction



ADULT FISH FACILITIES



The Corps operates adult fish facilities in accordance with the following 3 adult fishway criteria identified in the 2023 Fish Passage Plan:

- Entrance Differentials should be 1-2 ft and create attraction flow
- Entrance Depths should be ≥ 8 ft (or ≥ 7 ft at some ladder entrances)
- Channel Velocities should be 1.5-4 fps

Operating to meet all criteria can be a challenge to balance fishway velocities, entrance depths and differentials.

- At the minimum tailwater, all fishway entrances are at or near sill. Decreasing the tailwater further reduces entrance depths, decreases the head differential and thus reduces attraction velocity and discharge.
- At low tailwater elevations, fishway pumps operate at a higher pumped head, causing overheating and forced trips resulting in O&M issues and potential for failure of the pumps.
- Spill at low tailwater creates even lower local tailwater at some main entrances, adding to the challenge in meeting all fishway criteria.

Lower Granite Fish Ladder





SUMMARY OF IMPACTS



- Dropping below minimum tailwater elevations (e.g. not raising downstream forebay elevations) is anticipated to have negative impacts at Lower Granite, Little Goose and Lower Monumental.
- Impacts at adult fishways, especially at Lower Granite, is most concerning for the Corps
- Risks of pump failure due to added strain on aging equipment is not acceptable

	Stilling Basin Erosion Potential	Potential for Fish Injury	Potential to Violate Fish Ladder Criteria*	Increased Risk of Pump Failure
Lower Monumental	Minor	Minor to Moderate	Minor	Minor
Little Goose	Minor	Minor to Moderate	Moderate	Moderate
Lower Granite	Moderate	Moderate	Severe	Severe

* Maintaining fishway criteria is currently a challenge to keep things balanced even while meeting min tailwater



OPERATIONS FOR 2023



New criteria for MOP adjustments:

- Nav lock tailwater gage must remain above the minimum elevation at all times
 - e.g. Lower Granite min Nav lock gage = 633.0 ft
- Powerhouse tailwater gage will still be maintained above the minimum tailwater but more flexibility will be allowed for occasional small fluctuations below minimum tailwater
- Forebay elevations will be raised as necessary to meet new criteria but is expected to shorten time of MOP adjustments
- Corps will monitor this new criteria for adverse effects and may adjust if needed using best engineering judgement. Corps will provide MOP adjustment updates at TMT during Ops Review.

Key questions for MOP adjustments:

- Is the upstream tailwater currently lower than the downstream forebay?
 - If so, by how much?
 - Is the maximum daily difference greater than a half-foot, 1-foot, 1.5-feet?
- Is the inflow forecast rising or falling?
 - Does the forecast support a change to the current operation?



IN SUMMARY



- Corps will operate to ensure Nav Lock tailwater gage meets min tailwater elevations at all times to avoid barge collisions with nav sill protecting infrastructure and human health and safety
- Corps will adjust operations to meet minimum powerhouse tailwater elevations but more flexibility will be allowed for occasional small fluctuations below minimum tailwater to:
 - Ensure adult fishways remain within criteria (as much as possible)
 - Minimize risk to fishway pumps
 - Reduce duration flow deflectors are in plunging flow regime in order to minimize additional erosion & potential juvenile fish injury
 - Minimize time above MOP on the Lower Snake
- Corps will continue to look for opportunities (such as reaching flow thresholds) to return projects to MOP
- Corps will report MOP adjustment updates to TMT during Operations Review

