Summary Background Document for New Capital and Non-Routine Expense Hydropower Project

Project Title: Main Units 1-6 Discharge Ring Upgrade and Turbine Blade Cavitation Repair

Dam and Reservoir Project: Little Goose Lock and Dam

Estimated Total Cost: $3-7 Million Expense, Cavitation Repair/Seal Replacement per accounting guidelines
$12+ Million Capital, Discharge Ring Liner Upgrade per accounting guidelines

Estimated Schedule for Completion of the Project:

Phase 1a: FY21

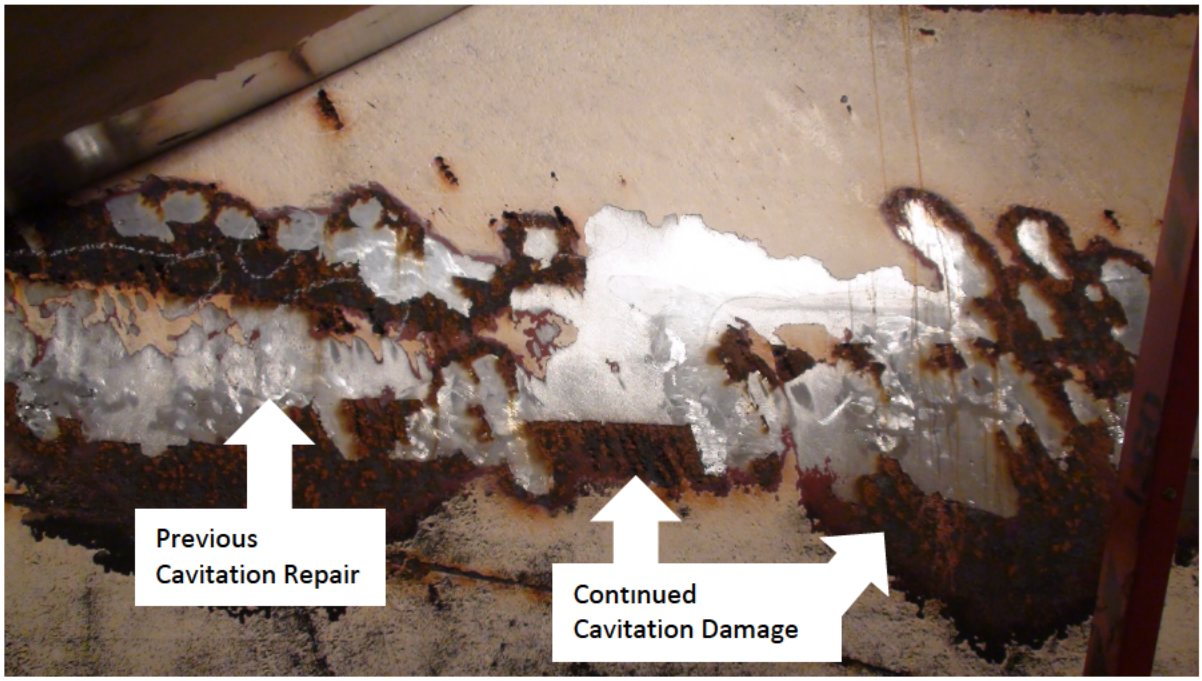
Phase 1: FY22-FY23

Phase 2: FY24-FY27

Expected Physical Completion: 30 Sep 2027

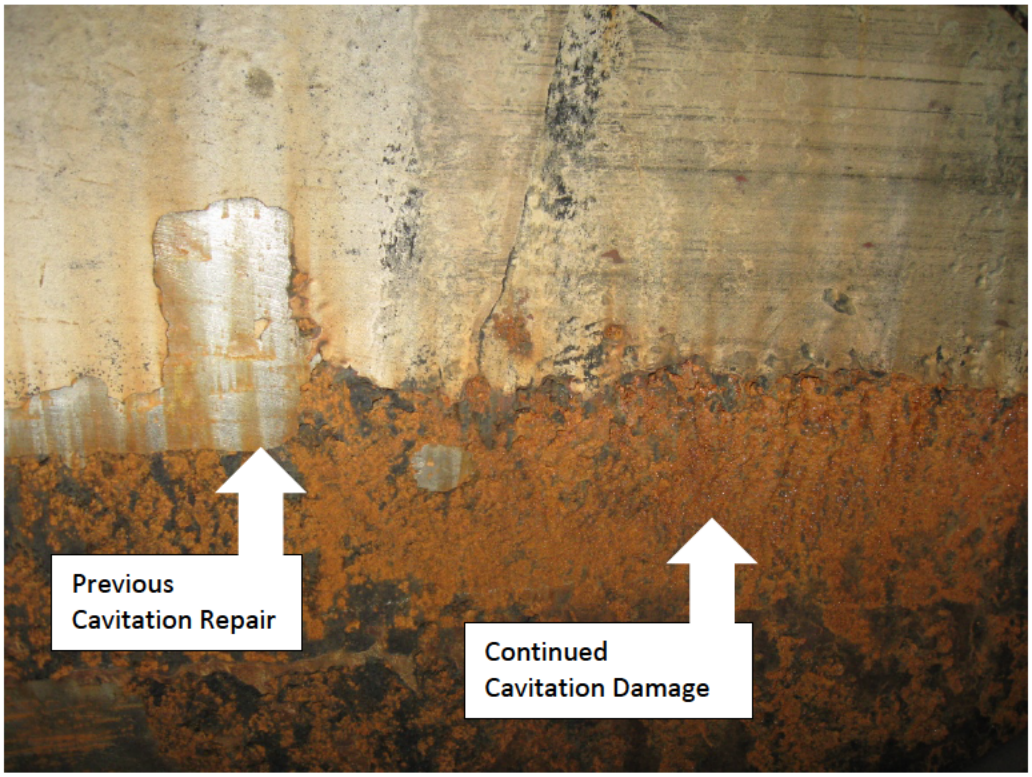
Project Background

There is extensive erosion damage to the discharge ring and turbine blades on all the main units (MUs) at Little Goose dam and reservoir project (project), due to cavitation (see Pictures 1 through 7). Cavitation erosion damage occurs during sudden pressure drops when liquid is changed to water vapor or bubbles. Cavitation generally occurs on the discharge ring at the level of operation of the end of turbine blades and underside of turbine blades. The discharge ring is defined as the area just below the wicket gates and walls opposite of the turbine blades. There have been several attempts to repair the cavitation damage during annual and overhaul unit outages by project staff; however, the extent of the cavitation damage has increased dramatically and requires additional funding and resources to make the repairs. At the completion of the cavitation work, while the MUs are unwatered, the Kaplan blade seals will be replaced with new seals to reduce the risk of oil loss to the river.



Picture 1: Typical Discharge Ring Damage and Repair
Previous Cavitation Repair with Stainless Steel Overlay:
Observed New or Continued Cavitation near Repaired Areas.

Picture 2: Typical Cavitation Damage on Discharge Ring and Previous Repairs:
Observed New or Continued Cavitation near Repaired Areas.



Picture 3: Close Up View of Discharge Ring:
Previous Repairs and Continued Cavitation Damage

Picture 4: Typical Turbine Blade Cavitation Damage at Blade End

Picture 5: Typical Cavitation Damage – Pitting and Corrosion Close Up

Pictures 6 & 7: Typical Discharge Ring and Blade Damage

Picture 8: Discharge Ring Stainless Steel Liner Upgrade – Final Stage of Installation
Replaces Portion of the Discharge Ring with a Stainless Steel Band
Typical of Work Performed at Lower Monumental 2016

Project Justification
The cavitation seen on the discharge rings and turbine blades is similar on all MUs. This cavitation, if not repaired, will continue to progress at an accelerated rate. Prior to major structural failure of the discharge ring, the unit efficiency will decrease. The efficiency decrease will reduce unit output and decrease power generation capabilities. Ultimately, the cavitation damage will cause the discharge ring to fail, which will result in unit failure and an extended forced outage. Additionally, the continued cavitation creates rough operation zones for the MUs by disrupting the flow of water and causing higher than normal levels of turbulence and increased vibration. This can result in operational changes to the unit, which result in sub-optimal generation and juvenile fish passage conditions. While most juvenile fish are routed away from the turbine passage route, continued operation of the MUs without repairs to the cavitation areas exposes fish to rough surfaces that can contribute to descaling, as well as introduce increased turbulence resulting in less favorable hydraulic conditions for turbine passage. This would impact threatened and endangered species listed under the Endangered Species (ESA).

Strategic Context
This investment is included in the current (2020) Federal Hydro System Asset Plan and included in the Non-Routine Expense plan.

Objective(s)
- Upgrade the discharge ring such that the MUs operate as originally designed.
- Repair turbine blade cavitation such that the MUs operate as originally designed to minimize or eliminate rough operation zones (or both).
- Replace turbine blade seals after the discharge ring and turbine blade cavitation work is complete.

Summary
This is a FY21 new start, and this project will have two funding sources. The discharge ring work, to install the stainless steel liner, is considered an upgrade and will be funded with capital dollars. The turbine blade cavitation repair and seal replacement work is considered maintenance, and will be funded with expense dollars. The discharge ring upgrade involves removing a band of damaged liner areas around the entire circumference of the discharge ring and replacing it with a new stainless steel liner. The new liner is then milled to design dimensions. The turbine blade cavitation (typically found on the underside of the blades) will be repaired by welding material over the prepped damaged area and then milling it to design dimensions. Replacement of the turbine blade seals is a routine maintenance activity that will be performed along with this cavitation work while the unit is unwatered.

Proposed Alternatives

Status Quo – Do Nothing, Repair as Fails: This alternative would not repair cavitation noted on the discharge ring or the turbine blades.

Rationale for why this alternative is unacceptable: The cavitation will continue to progress at an accelerating rate, causing inefficient operations of the MU and may result in turbine failure and an extended forced outage. Continued status quo operation of the MU exposes fish to rough surfaces that can contribute to descaling, as well as introduce increased turbulence resulting in less favorable hydraulic conditions for turbine passage, which could lead to increased impacts to ESA-listed species and power system reliability.

Alternative 1 – Discharge Ring Upgrade and Turbine Blade Repair for Main Units 1-6 (Recommended): This alternative would upgrade the discharge rings, by installing the stainless steel liner, restore the turbine blades to original dimensions for optimum operations, and replace the turbine blade seals.

Rationale for selecting this alternative: Minimizes rough operation zones and minimize risks of extended forced outages due to MU failure caused by cavitation. The upgrade to the discharge rings will increase life expectancy, reduce maintenance needs, and allow for efficient operations as well as decrease potential impacts to ESA-listed species and power system reliability.

Process
Phase 1a:

- Investigate and develop a list of recommended alternatives (repair/rehabilitation/replacement) for the discharge ring upgrade and turbine blade cavitation repair.
- Develop initial design resource needs, project schedule and budgetary cost.
- Phase 1a check-in at 60% completion at Capital Workgroup to review project alternatives.

Phase 1:

- Prepare Plans & Specification for 60% & 90% Design Reviews.
- Prepare contract documents to Biddability, Constructability, Operability, Environmental, Sustainability level.
- Revise/Update total project cost estimate.
- Advertise contract and pre-award acquisition activities.

Phase 2:

- Award and execute the contract.
- Contract administration, submittal reviews, and development of as-built drawings.
- Contract and subagreement closeout.