Jun 24th, 4:45 PM - 5:00 PM

Session C9: Priest Rapids Fish Bypass: A Case Study from Start to Finish

Curtis Dotson
Grant County Public Utility District

Fish Passage Conference

June 22 – 24, 2015

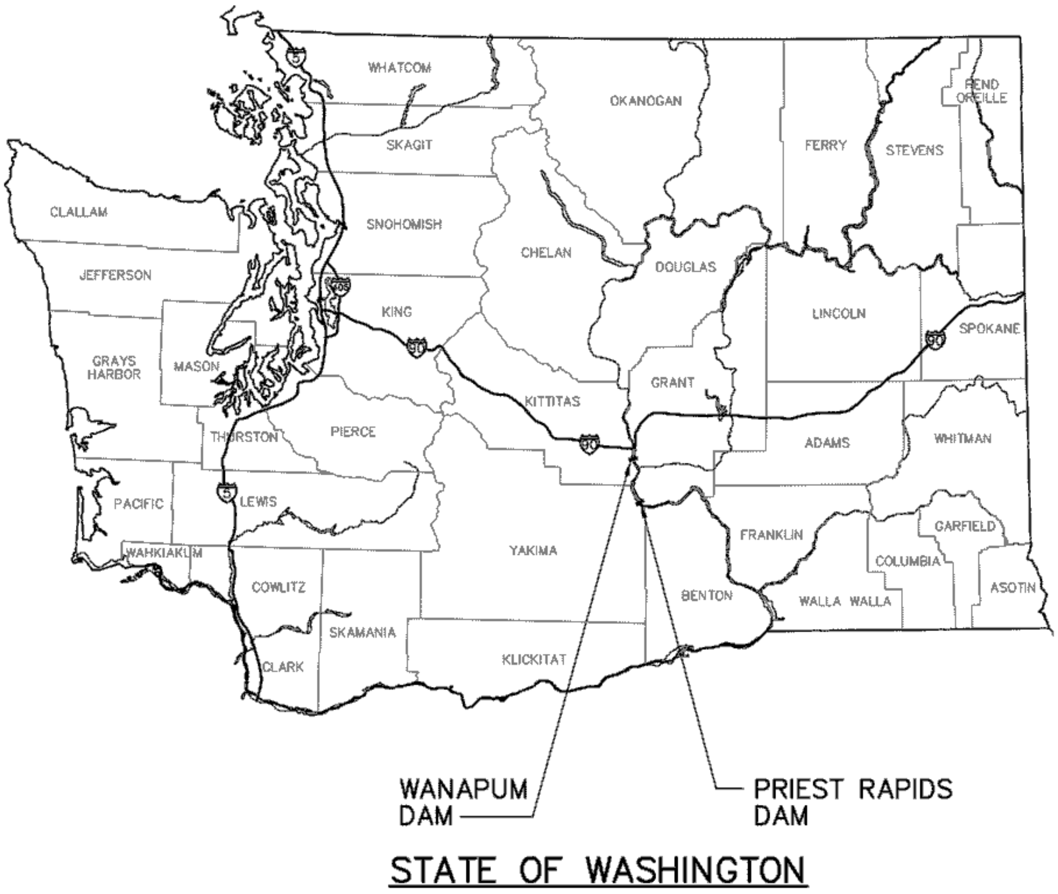
Priest Rapids Fish Bypass: A Case Study from Start to Finish

Grant County
PUBLIC UTILITY DISTRICT
Excellence in Service and Leadership

Project Location

Grant County
PUBLIC UTILITY DISTRICT
Excellence in Service and Leadership

- Priest Rapids Dam
- One of two dams owned and operated by Grant PUD in Central Washington



Priest Rapids Dam MOA Spill for fish passage

61% of total daily river flow (spring spill)

39% of total daily river flow (summer spill)

MOA Spill vs. Bypass

Overview – Developing Downstream Passage Options

- For successful passage, a design must:
  - Identify and utilize location of migration corridor
  - Consider behavior and biomechanical ability of species to pass
  - Match hydraulic cues from passage device to migration corridor, behavior and ability
  - Integrate project operations and hydrology
  - Avoid passing through dangerous routes

Work Plan for Design and Implementation

- *Implement a plan for developing a design for a non-turbine fish passage route*

  - Design guidelines
  - Concept development, modeling and assessment
  - Selection and advancement of preferred design
  - Prototype testing and evaluation
  - Final design and implementation
  - Field testing and evaluation

“TOOLS” USED IN DESIGN AND EVALUATION PROCESS

Acoustic tagged fish

- Fish passage routes and survival
- Fish behavioral characteristics

CFD models of forebay and tailrace

- Flow patterns
- Velocities and accelerations
- Zones of influence

Physical hydraulic models of forebay, tailrace and bypass

- Flow observations and characteristics

Numerical fish surrogate (NFS) model

- Estimate of fish passage routes

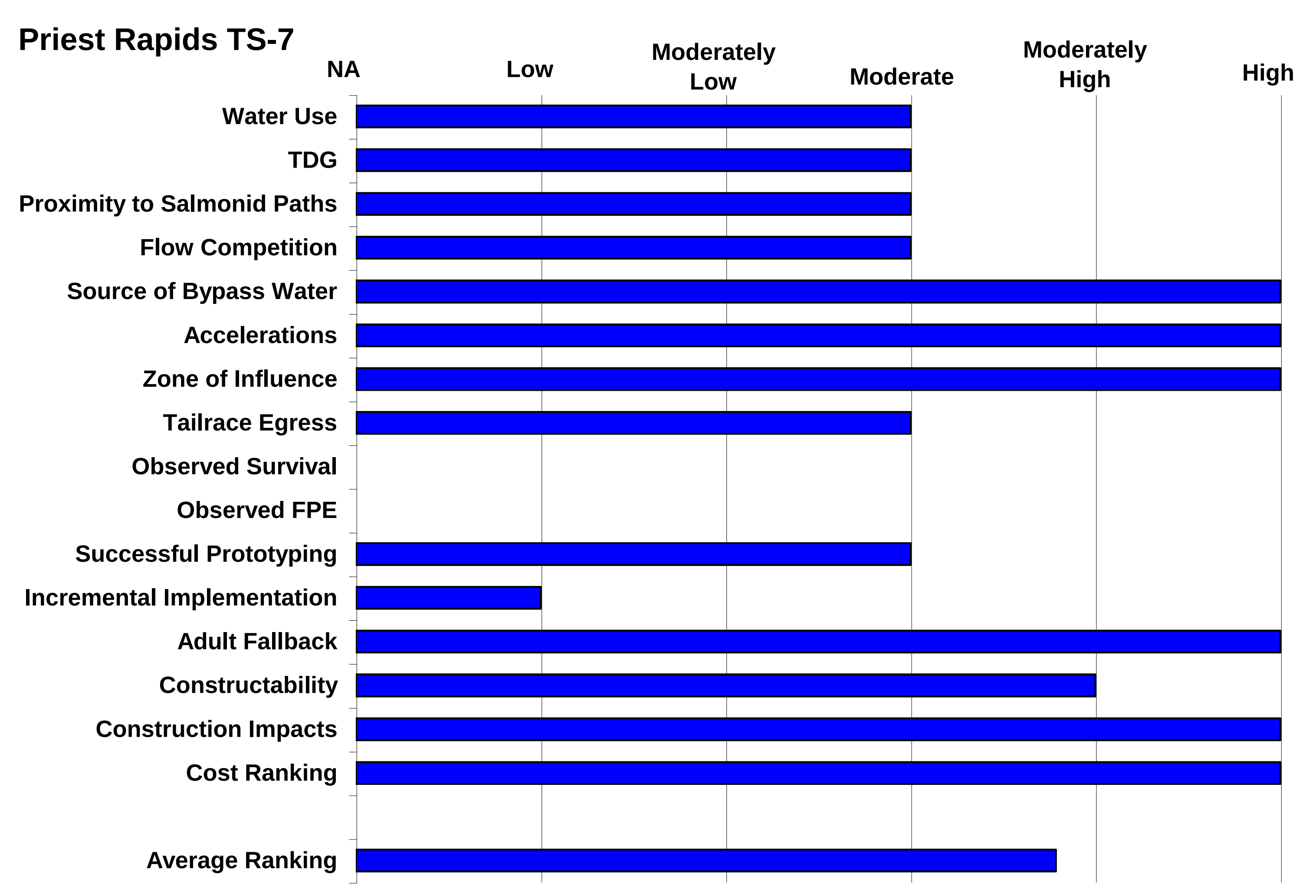
“Team Approach”

HISTORY OF WORK AT PRIEST RAPIDS DAM

2002

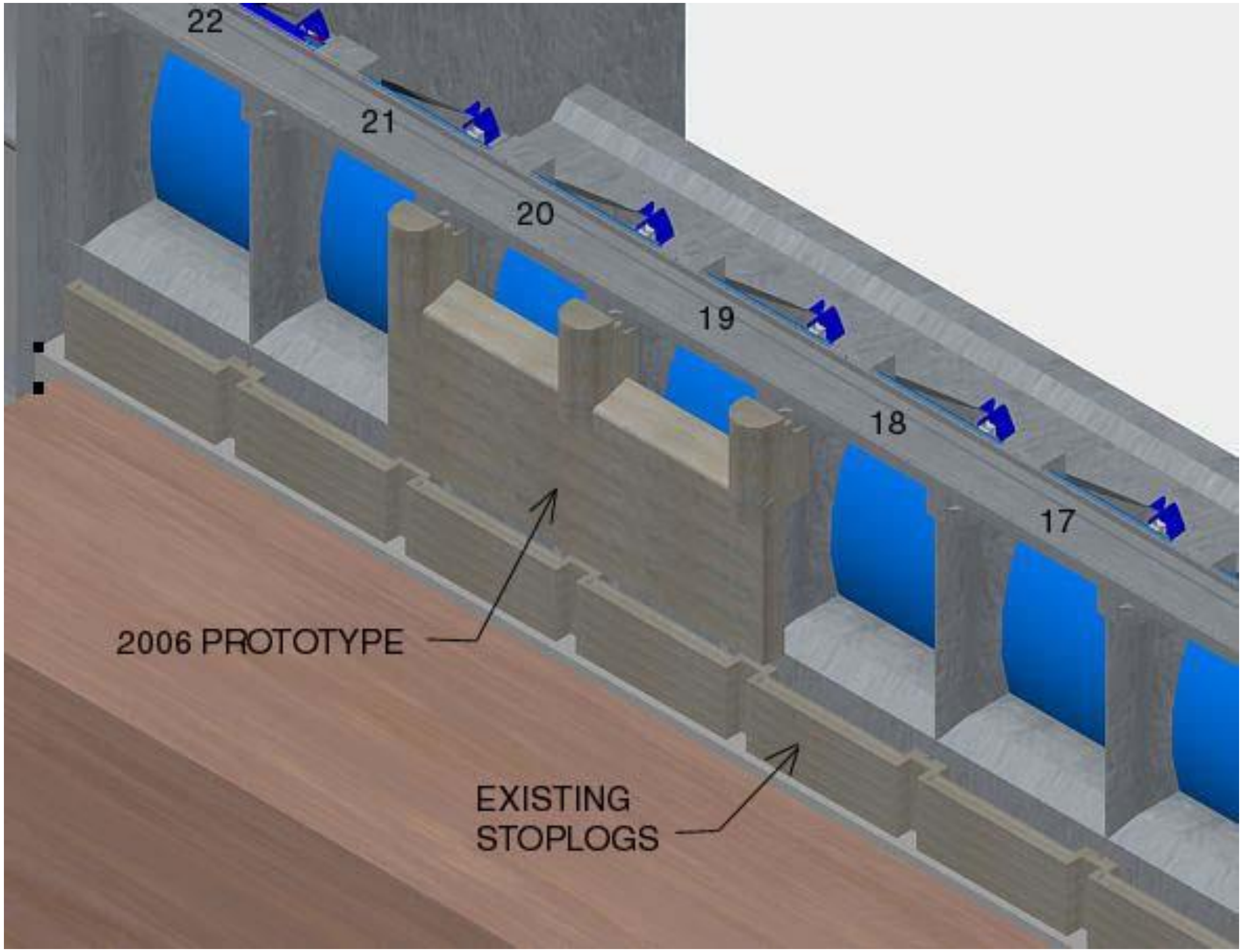
- Commenced study of fish passage alternatives for both Wanapum and Priest Rapids dams
- Prototype test of spillway gate 17 full open

SUMMARY OF 2003 FISH PASSAGE ALTERNATIVES STUDY REPORT



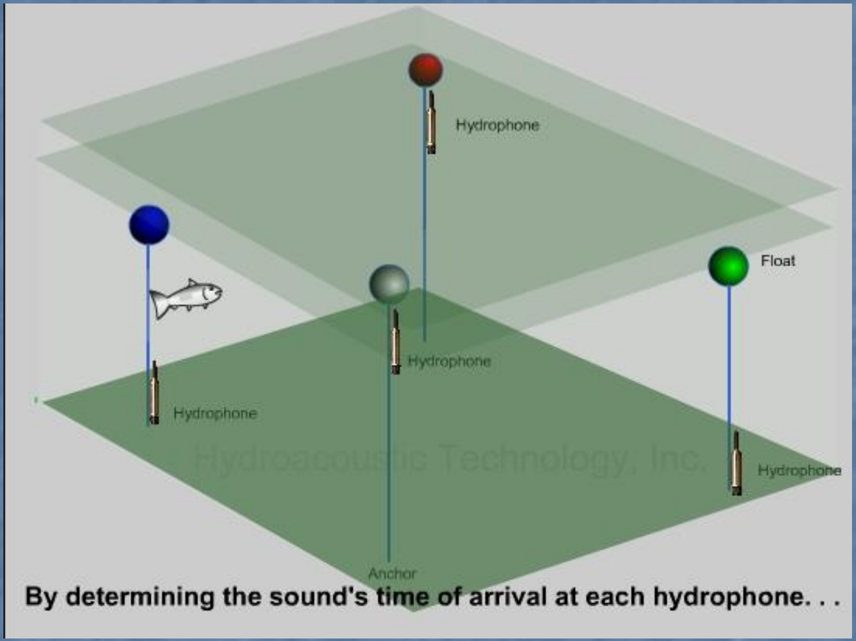
HISTORY OF WORK TO DATE AT PRIEST RAPIDS DAM

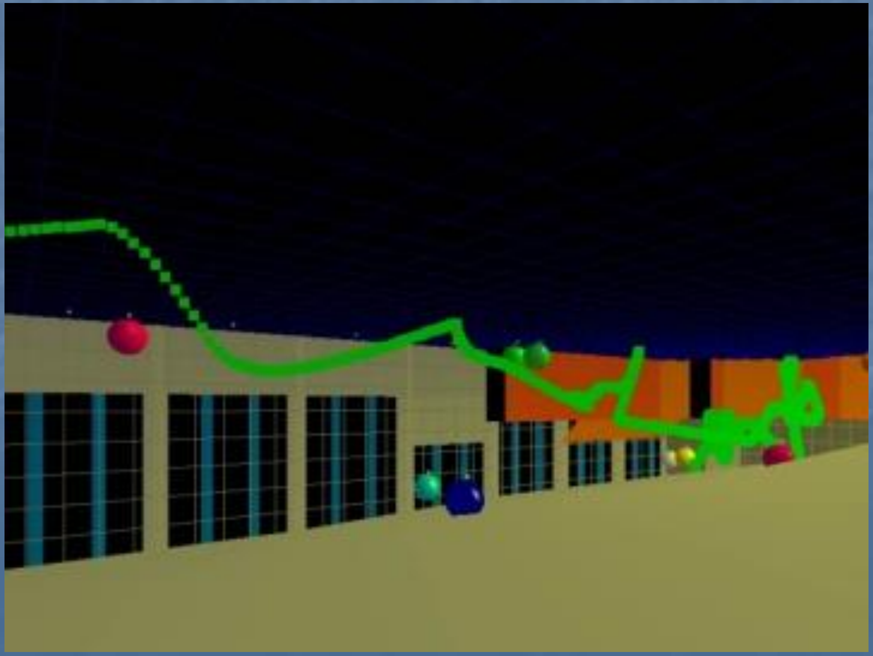
2006 - Prototype test of topspill in spillbays 19/20



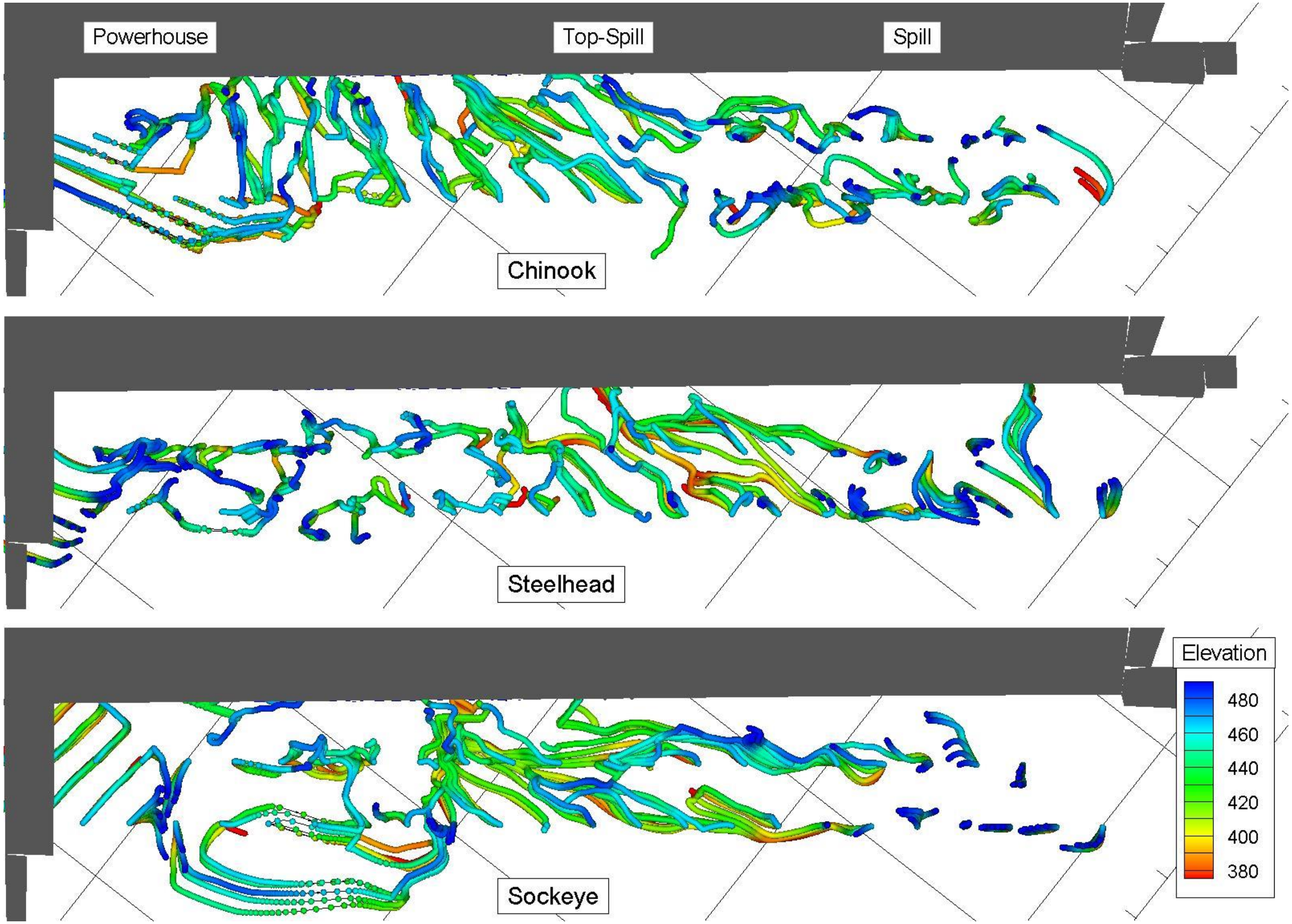
TOP-SPILL BULKHEAD AT PRIEST RAPIDS DAM

Acoustic Tags for Tracking



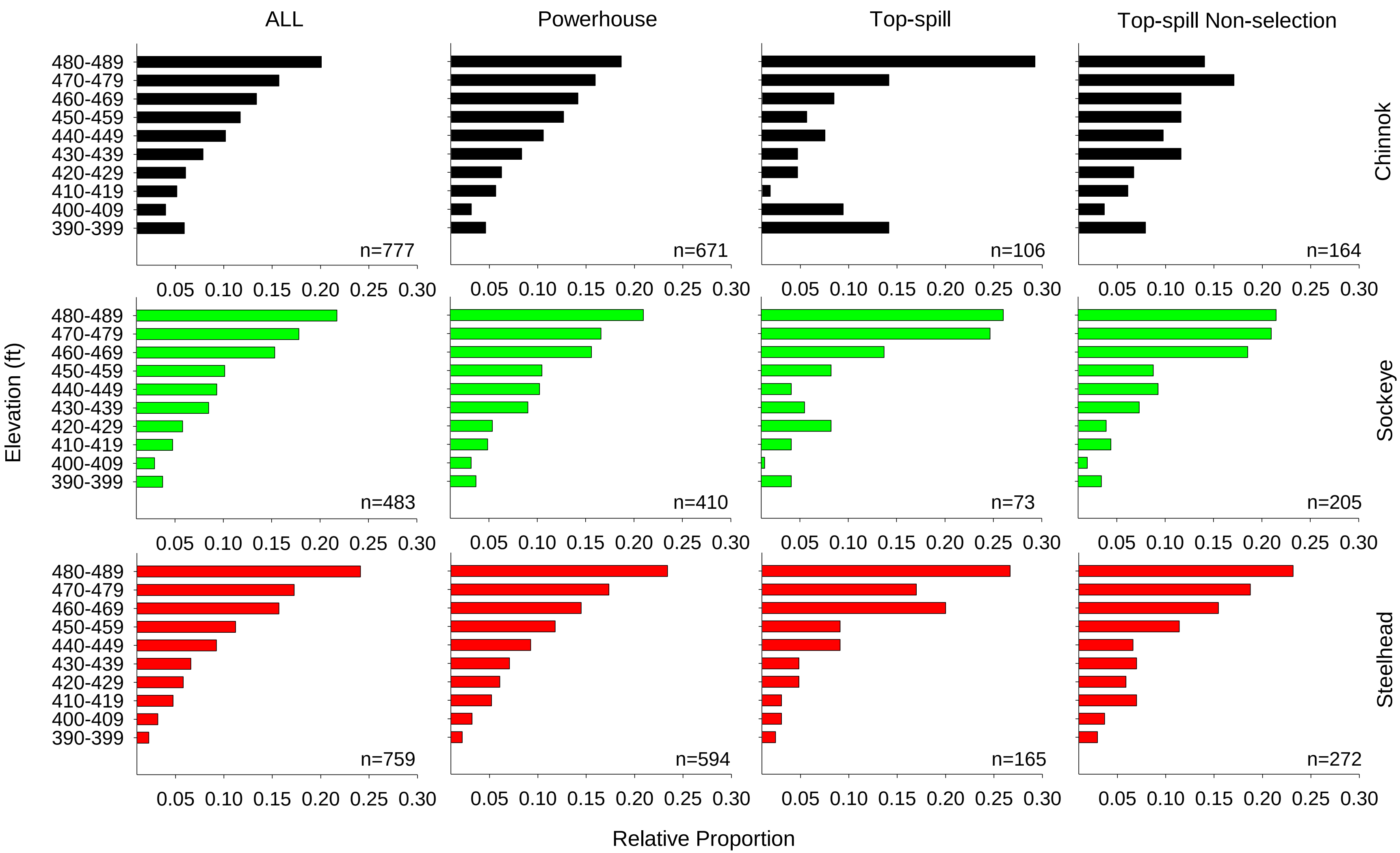


2007



Streamtraces are based on the net vector fields which are represented for Chinook, steelhead and sockeye. Streamtraces represent net fish movement under steady state conditions and illustrate overall fish behavior in the forebay of Priest Rapids Dam.

2007



Histograms of approach in elevation (ft) by species and exit route at Priest Rapids Dam. Few fish used the spillway as a passage route, therefore, fish that chose not to select the op-spill as a passage route has been displayed The approach of each species (Chinook, steelhead and sockeye) is displayed from top to bottom and by exit route from left to right

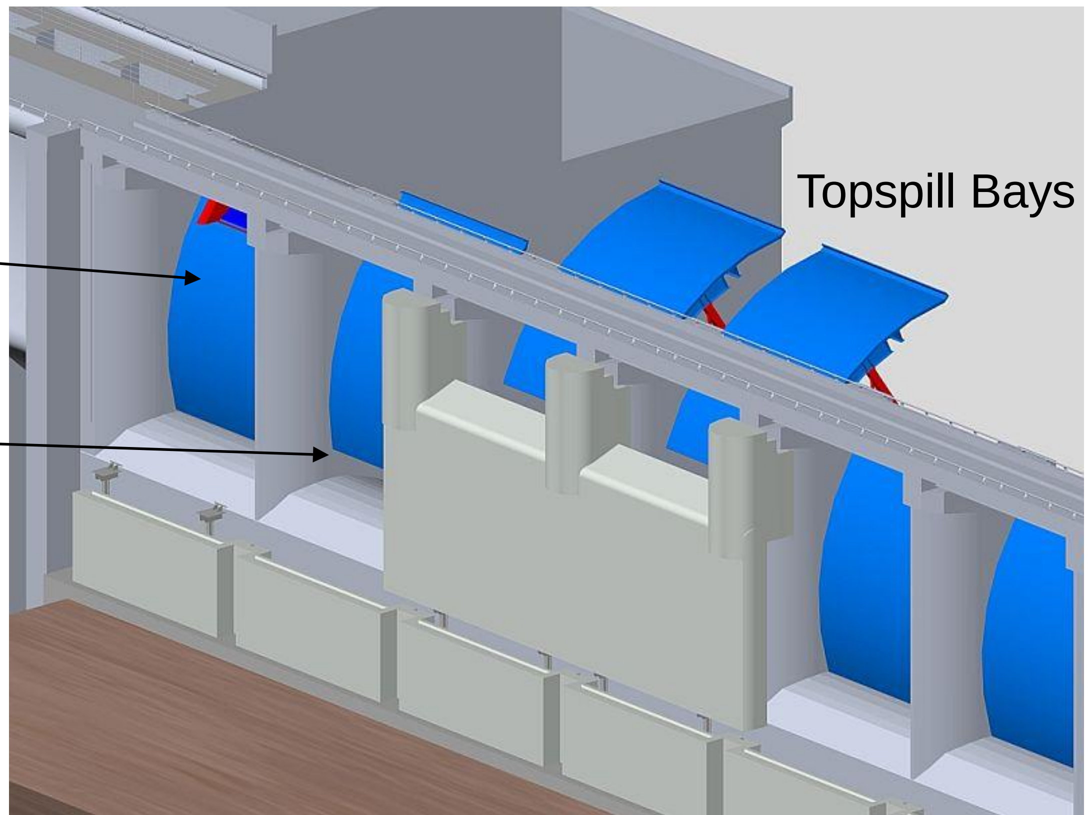
Top-Spill Bulkhead Percent Fish Passage

Date	**Chinook**	**Steelhead**	**Sockeye**
2006	12%	15%	20%
2007	13%	19%	12%

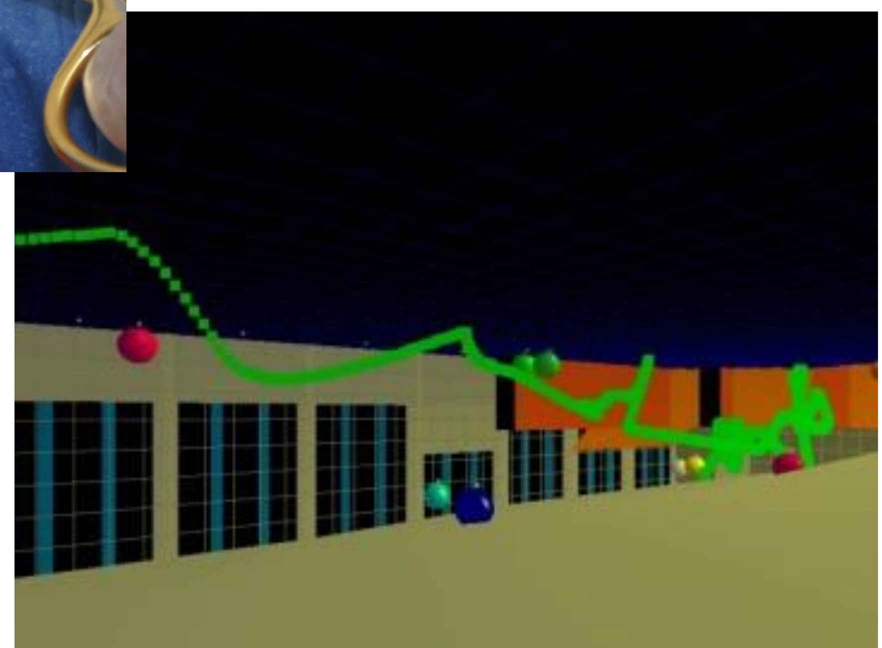
HISTORY OF WORK TO DATE AT PRIEST RAPIDS DAM

2008

Decision to prototype test topspill in spillbays 19, 20, 22 and bottom spill in 21 and modify powerhouse operations



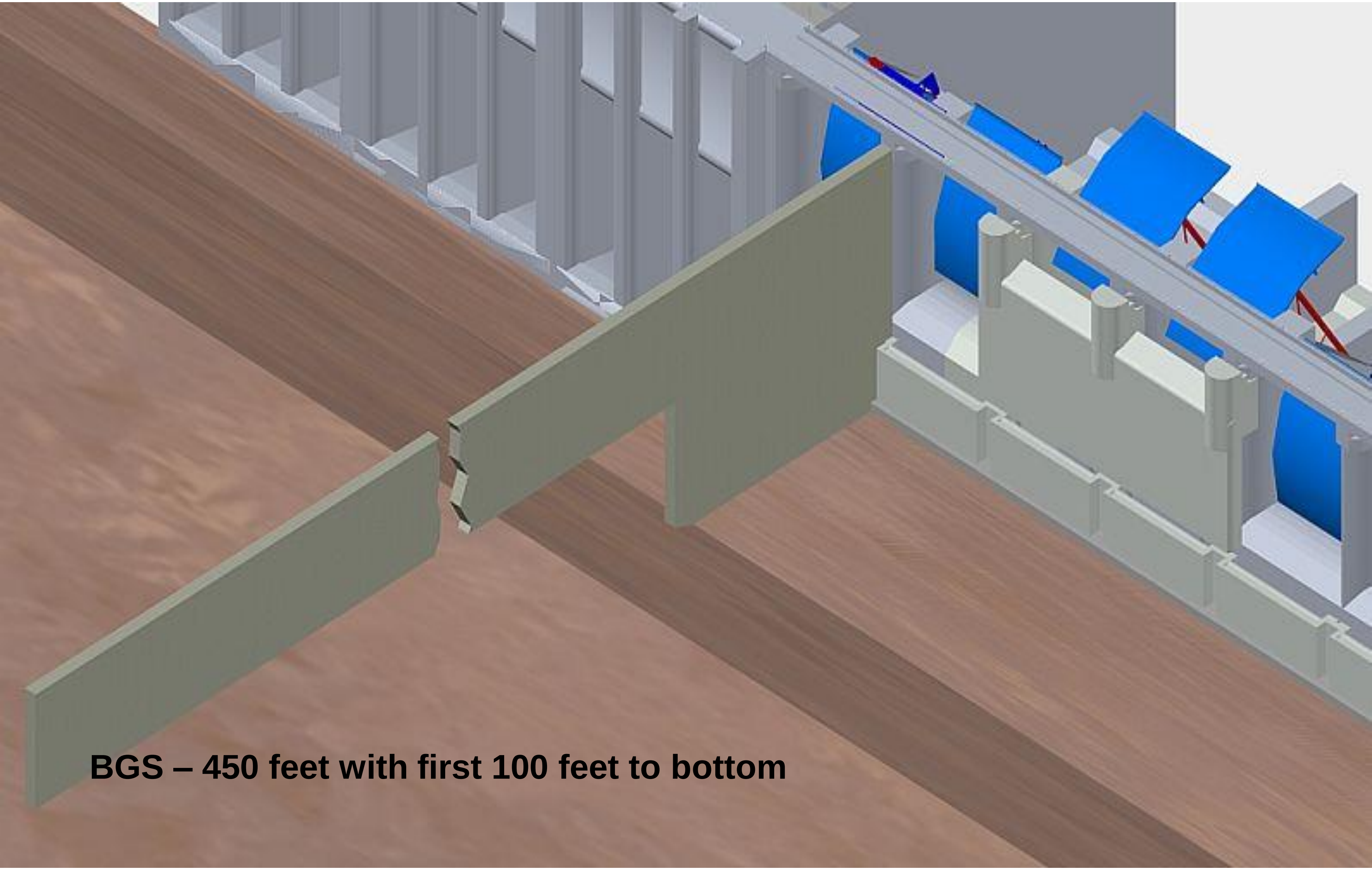
Acoustic Tags for Tracking



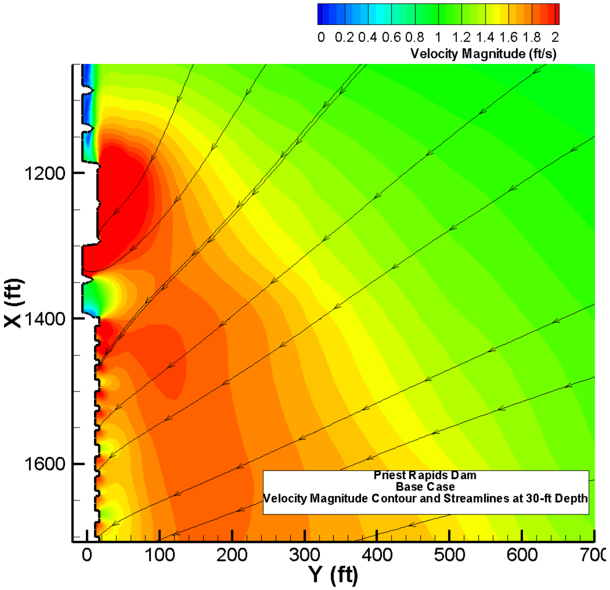
Top-Spill Bulkhead Percent Fish Passage

Date	**Chinook**	**Steelhead**	**Sockeye**
2006	12%	15%	20%
2007	13%	19%	12%
2008	**24%**	**30%**	**26%**

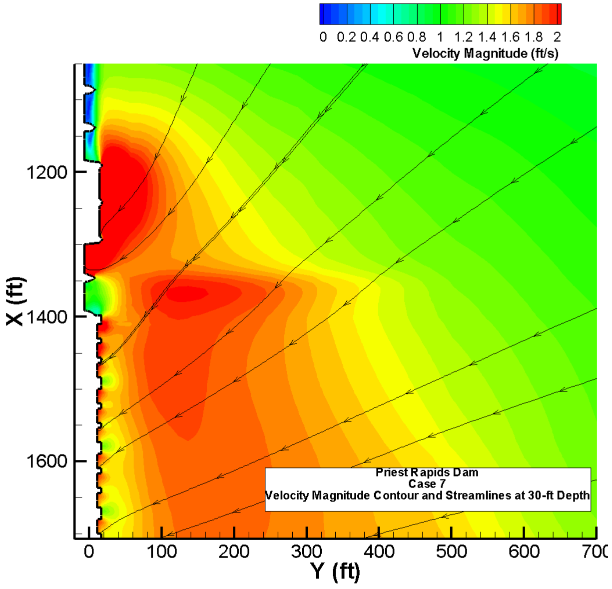
Forebay Guidance Screen at Priest Rapids



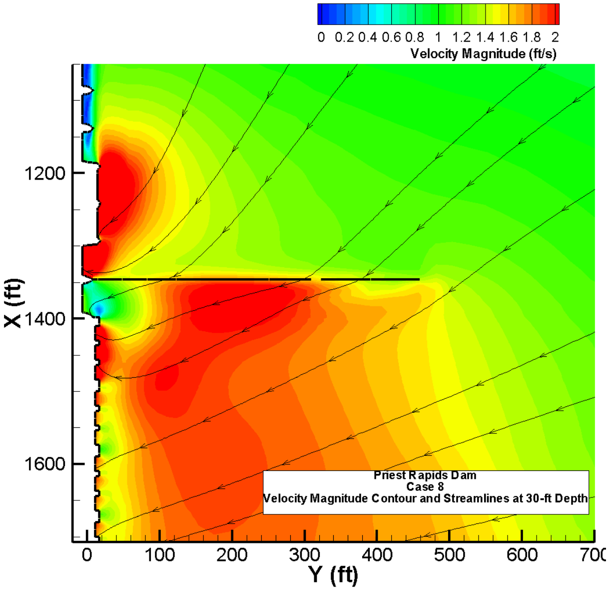
BGS – 450 feet with first 100 feet to bottom



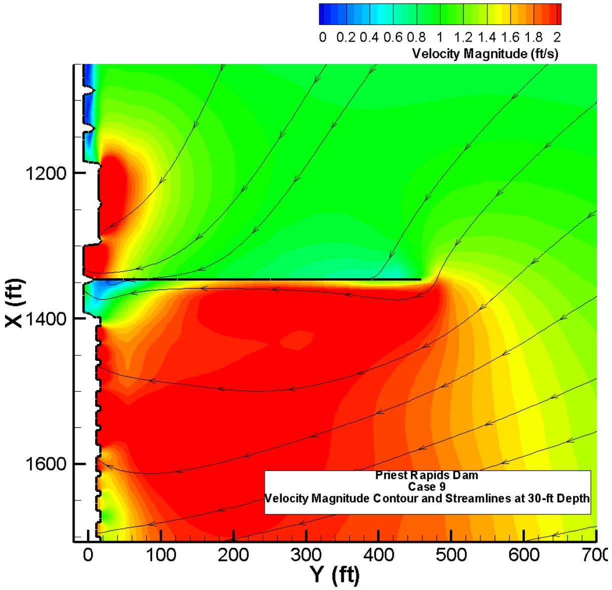
Base Case – Section at 30 ft depth



450 ft Training Wall – 10 ft deep

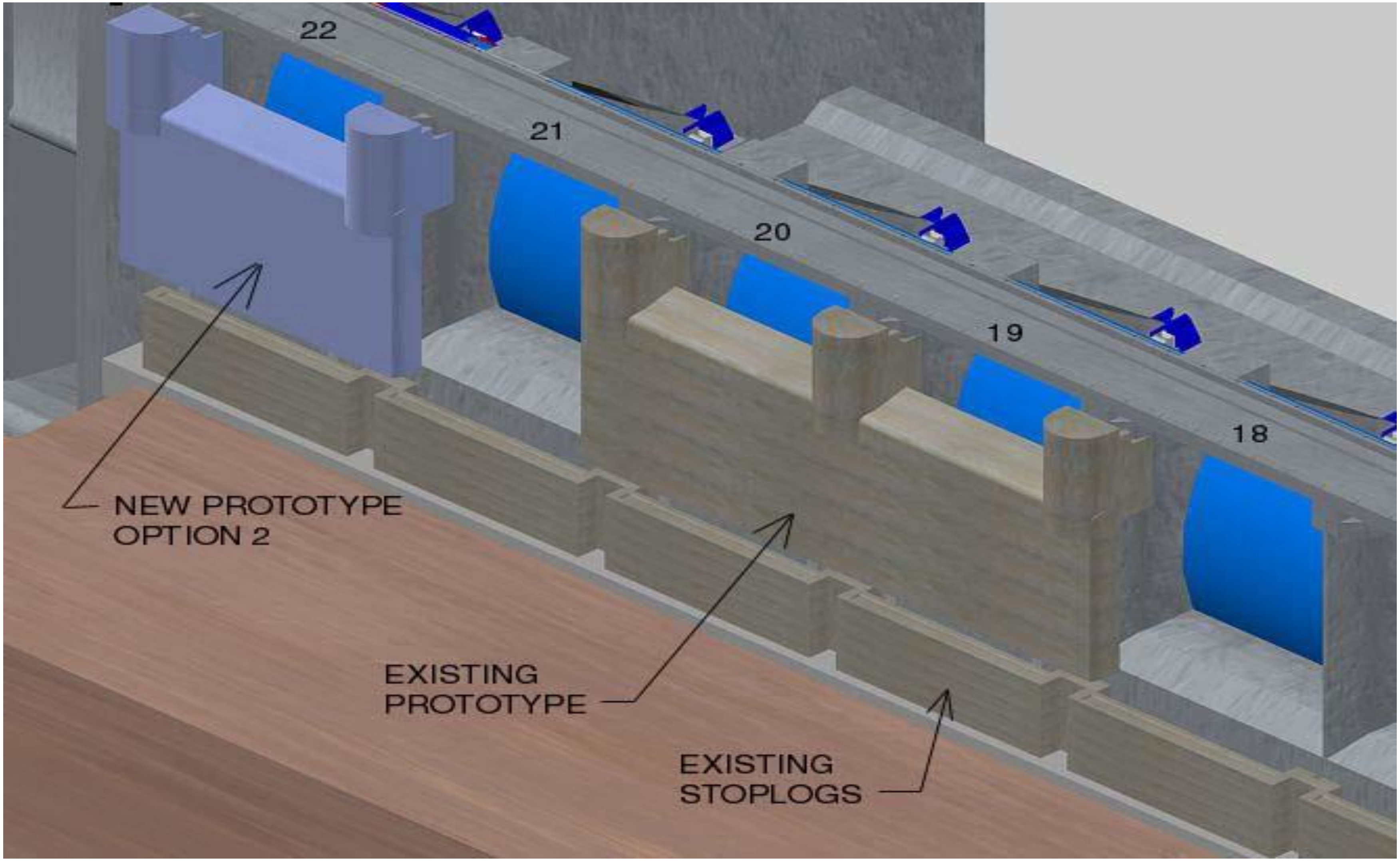


450 ft Training Wall – 30 ft deep

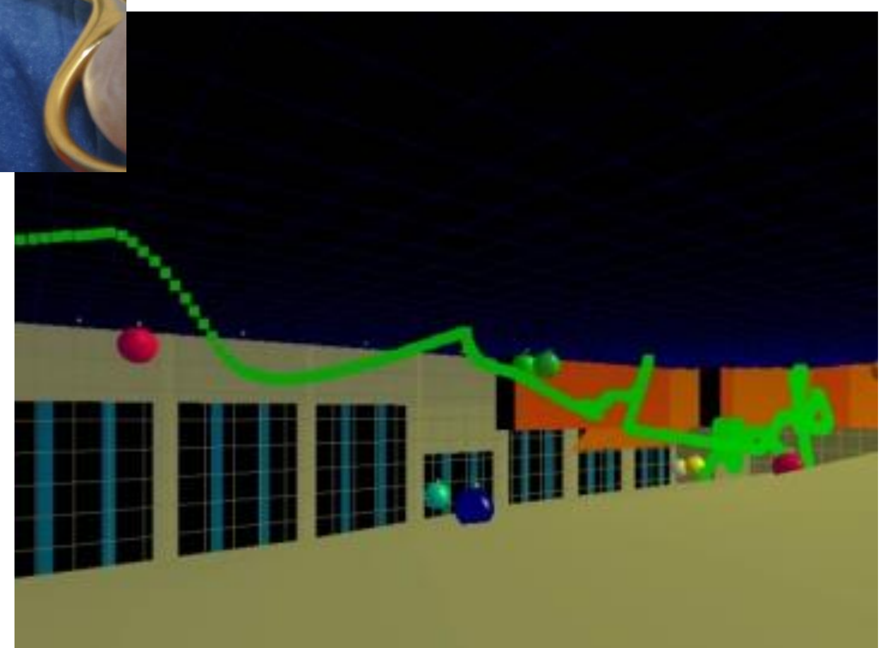


450 ft Training Wall – 50 ft deep

Top-Spill moved to new location:



Acoustic Tags for Tracking

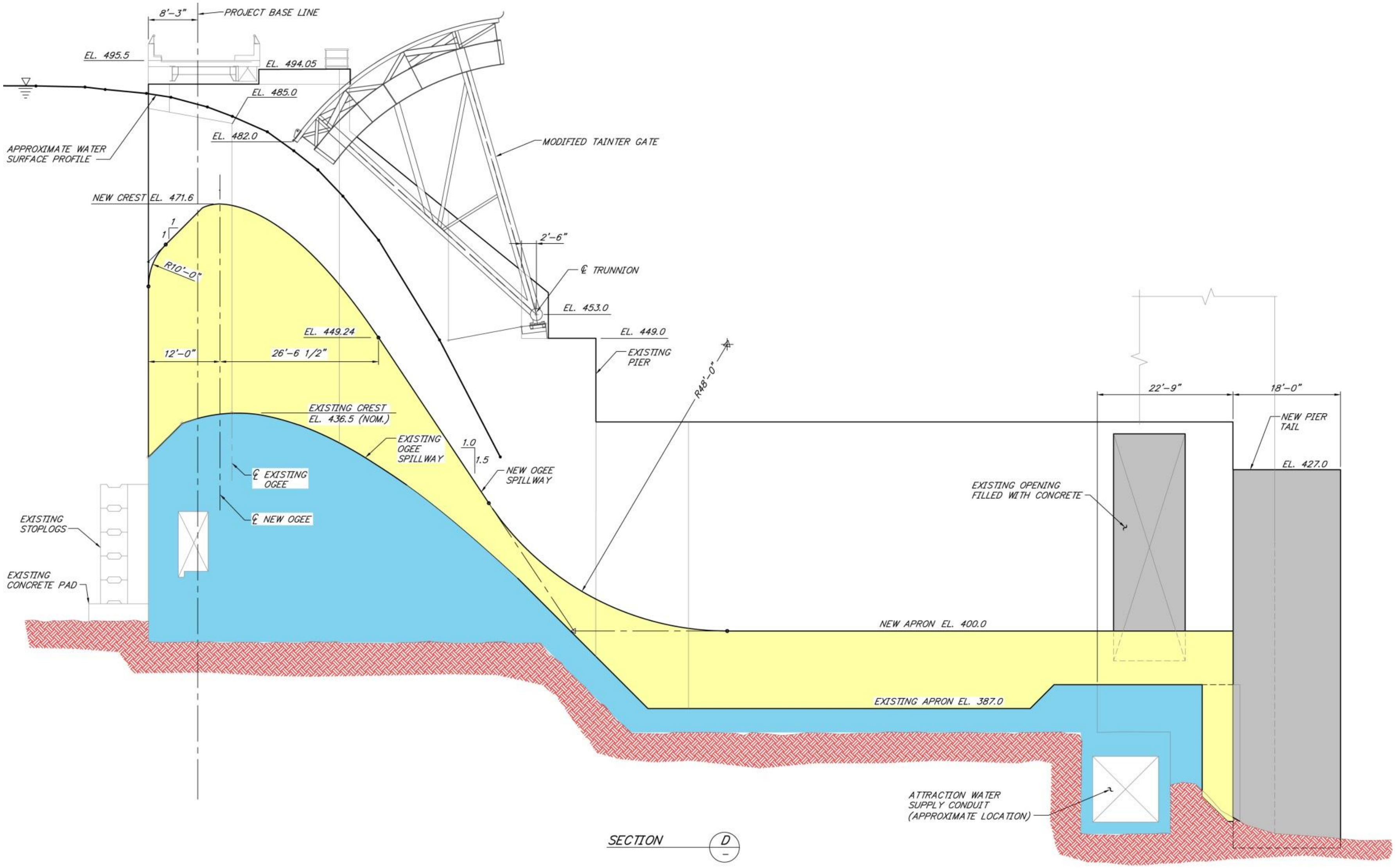


Top-Spill Bulkhead Percent Fish Passage

Date	Chinook	Steelhead	Sockeye
2006	12%	15%	20%
2007	13%	19%	12%
2008	23%	33%	22%
2009	n/a	50%	39%
2010	n/a	64%	52%

Priest Rapids Fish Bypass

Grant County PUBLIC UTILITY DISTRICT



Priest Rapids Fish Bypass Project (PRFB)

Modeling Work

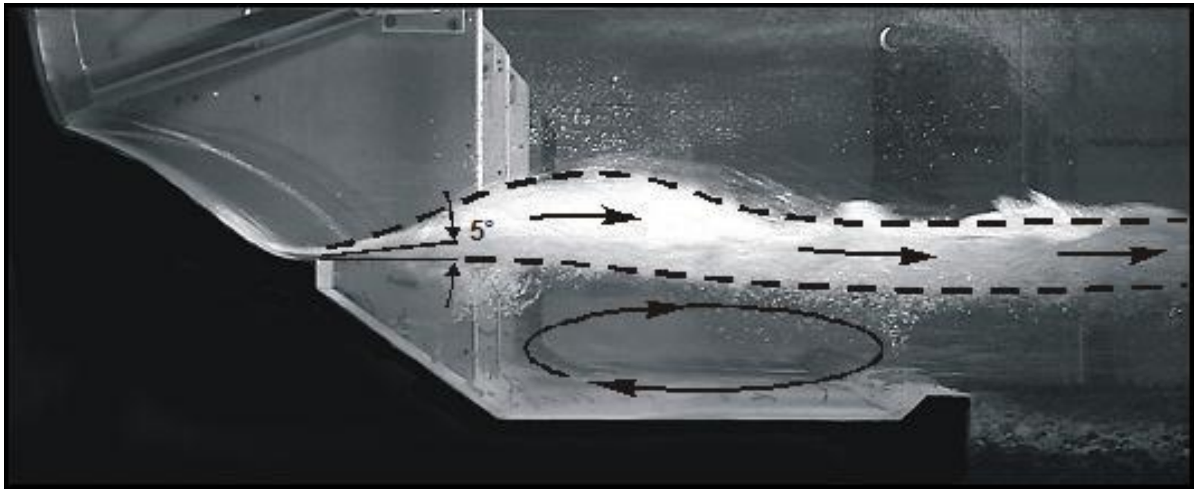
Grant County PUBLIC UTILITY DISTRICT Excellence in Service and Leadership

Agencies & Tribes (PRCC) in Iowa

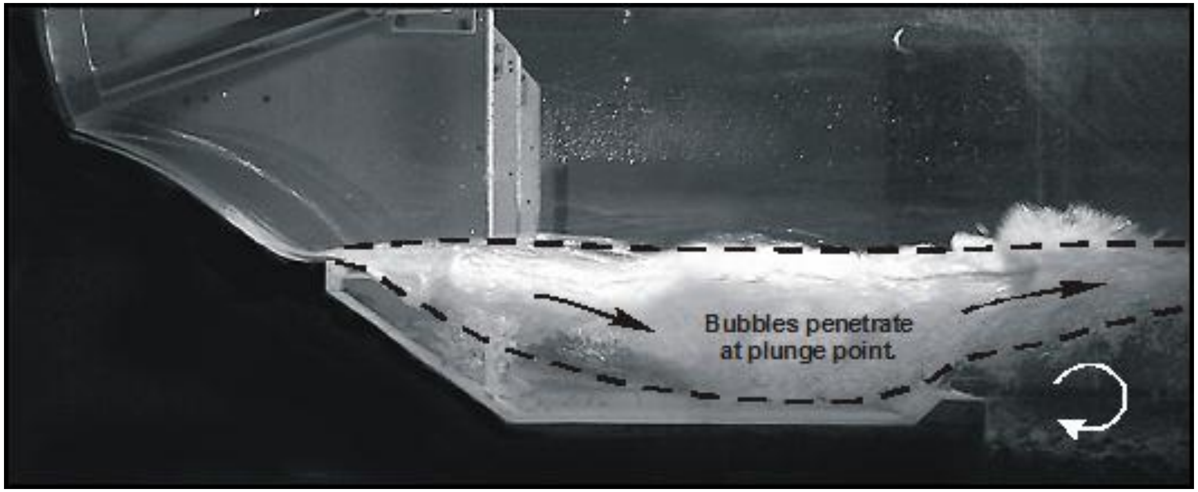
1:20 Physical Model

Priest Rapids Fish Bypass

Grant County
PUBLIC UTILITY DISTRICT



Skimming surface jet



Plunging jet

Priest Rapids Dam

Factors in Development of Production Design

Bypass Location

- entrance near high concentration of fish which is adjacent to the powerhouse
- exit near additional flow and away from areas of high concentrations of predators
- bypass located at spillbays 20 to 22

Entrance

- no deceleration or upwelling
- based on prototype data no need for special control of accelerations

Priest Rapids Dam

Factors in Development of Production Design

Bypass Flow

- **select a value to achieve required survival goal through top spill or combination of top and bottom spill**
- **single spillbay limited to 10 Kcfs to minimize TDG and maximize tailrace survival**
- **crest elevation of 471.4 ft +/- passes 9 kcfs at a forebay elevation of 486.6 ft**

Priest Rapids Dam

Factors in Development of Production Design

Exit

- no adverse impacts or shear to minimize mortality
- no plunging of flow to minimize uptake of dissolved gas - apron elevation set to keep flow near the surface

Dam Safety

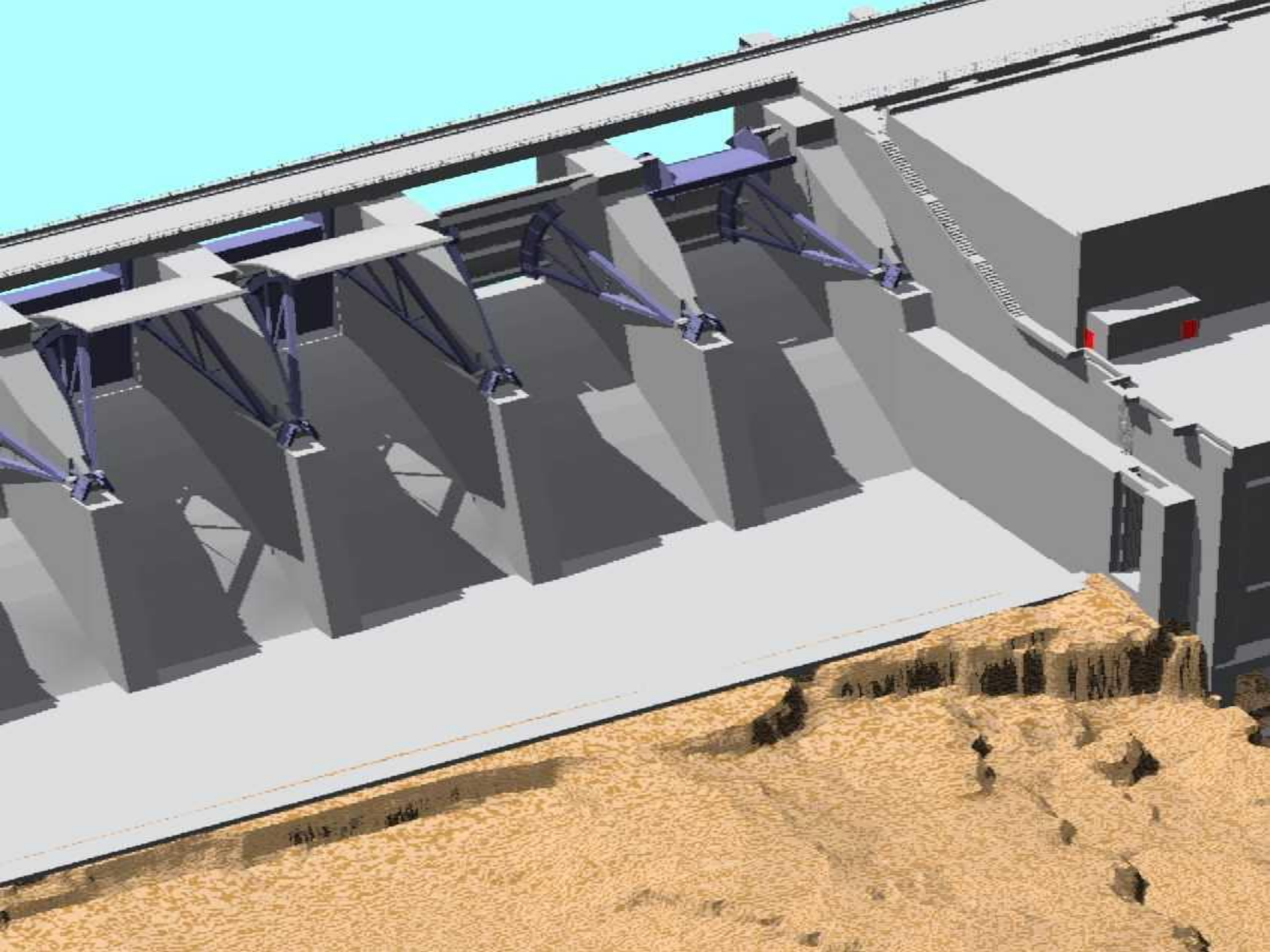
- must be able to pass Probable Maximum Flood (PMF) of 1400 Kcfs at a forebay elevation of 491.5 ft

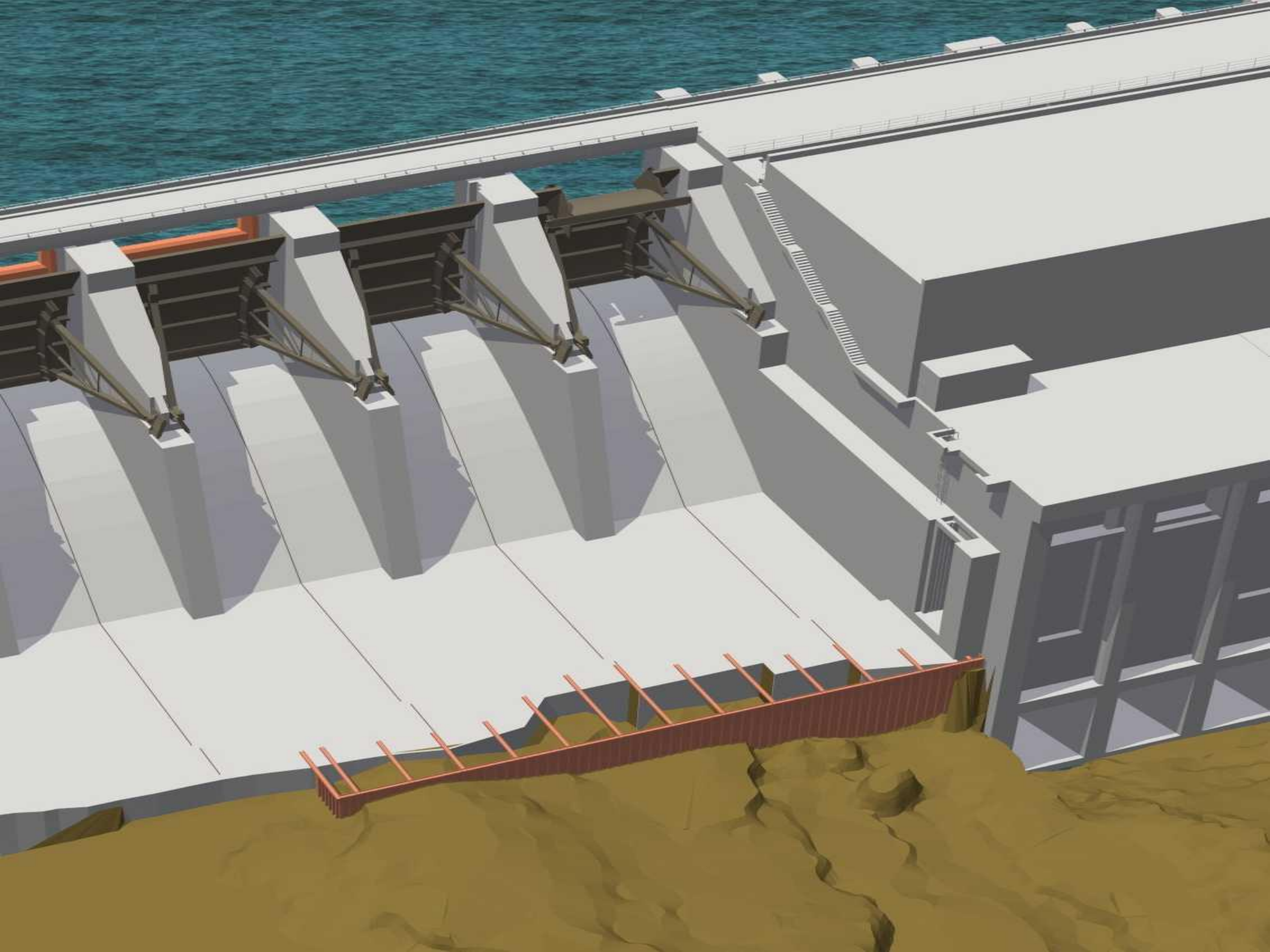
- could likely dedicate three topspill bays to pass target fish bypass flow and also pass the PMF through the entire spillway

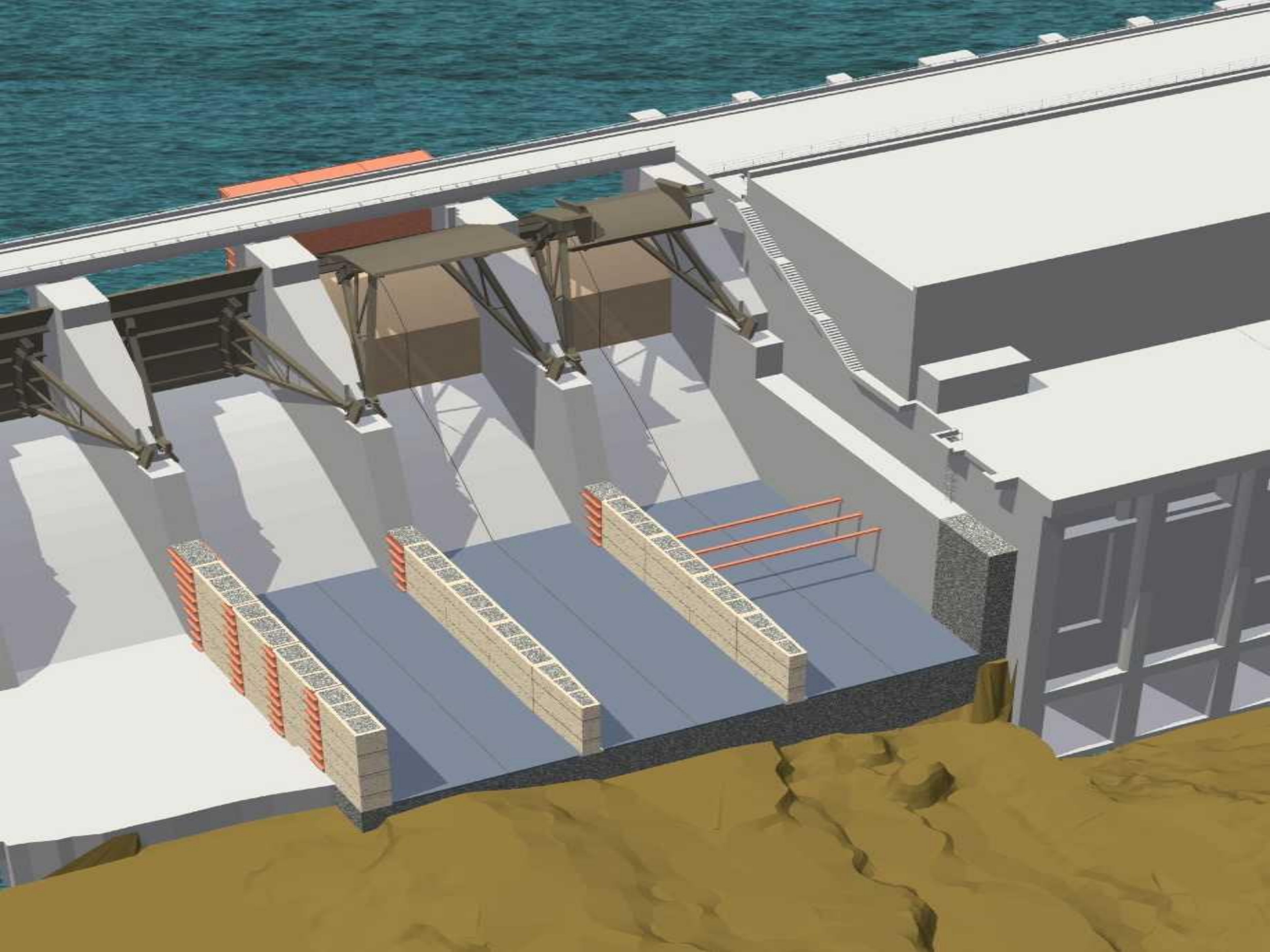
- must not result in reduction of dam stability

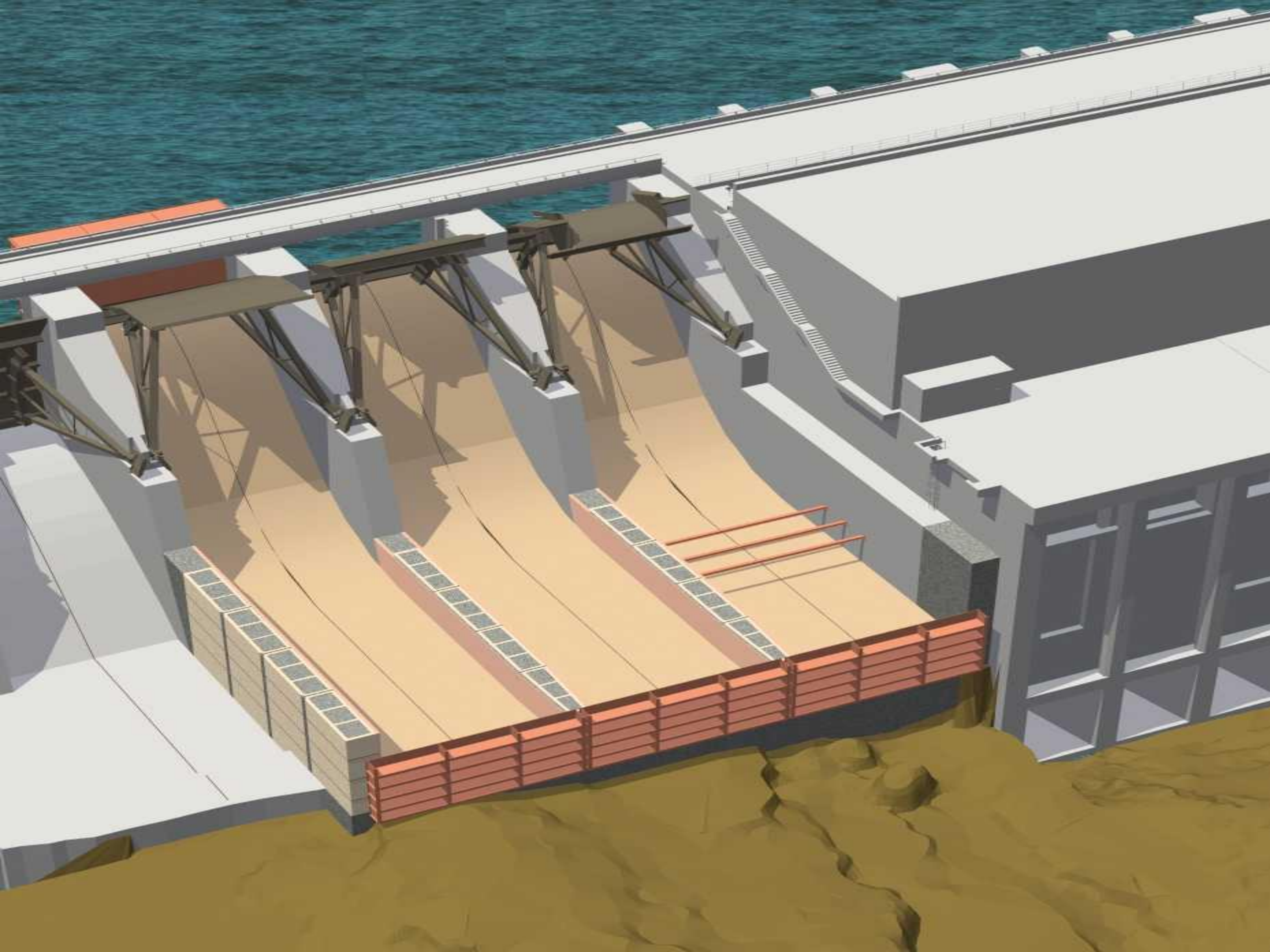
Operations

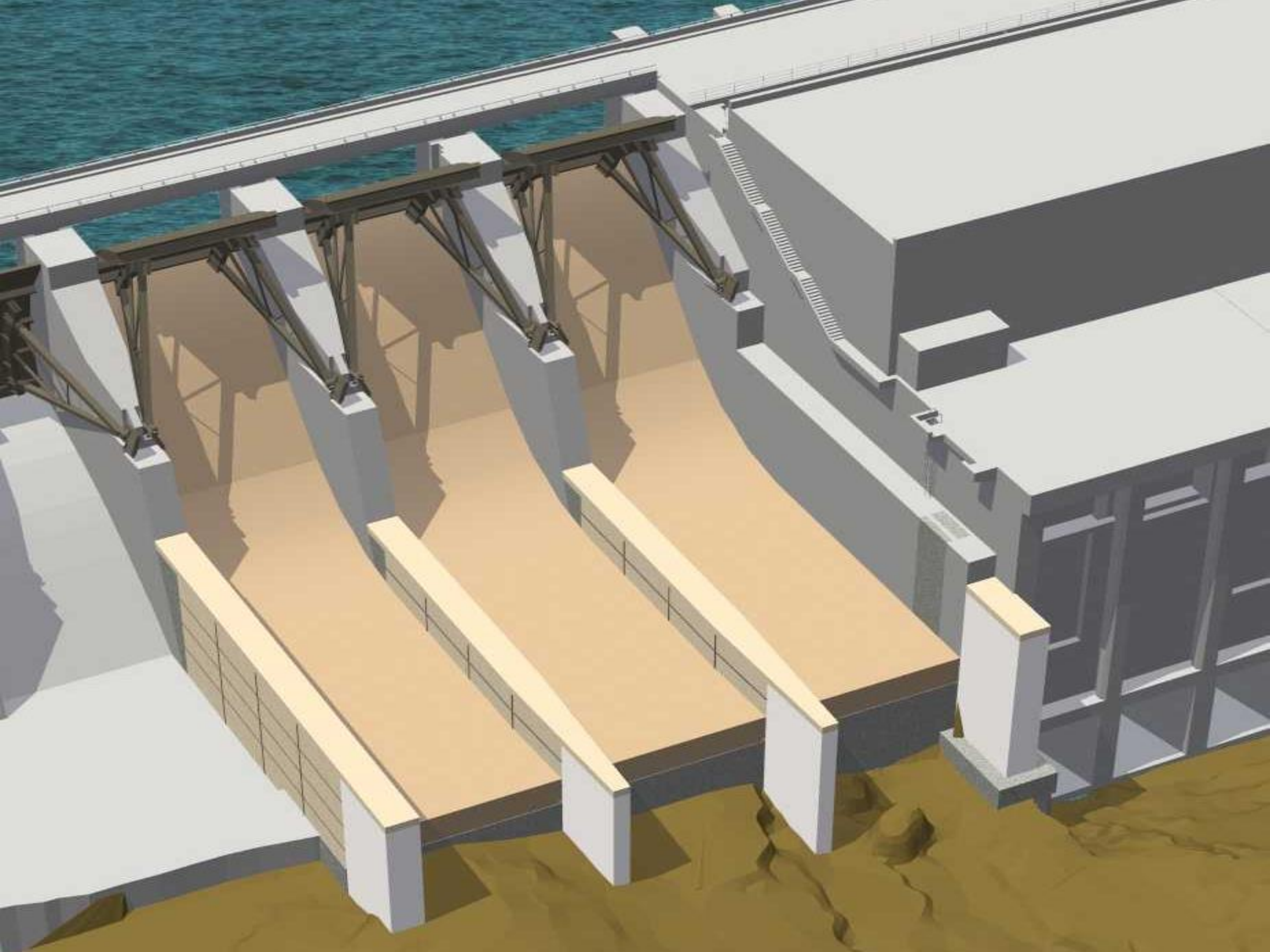
- gate design











Upstream View without Water

Grant County
PUBLIC UTILITY DISTRICT
Excellence in Service and Leadership

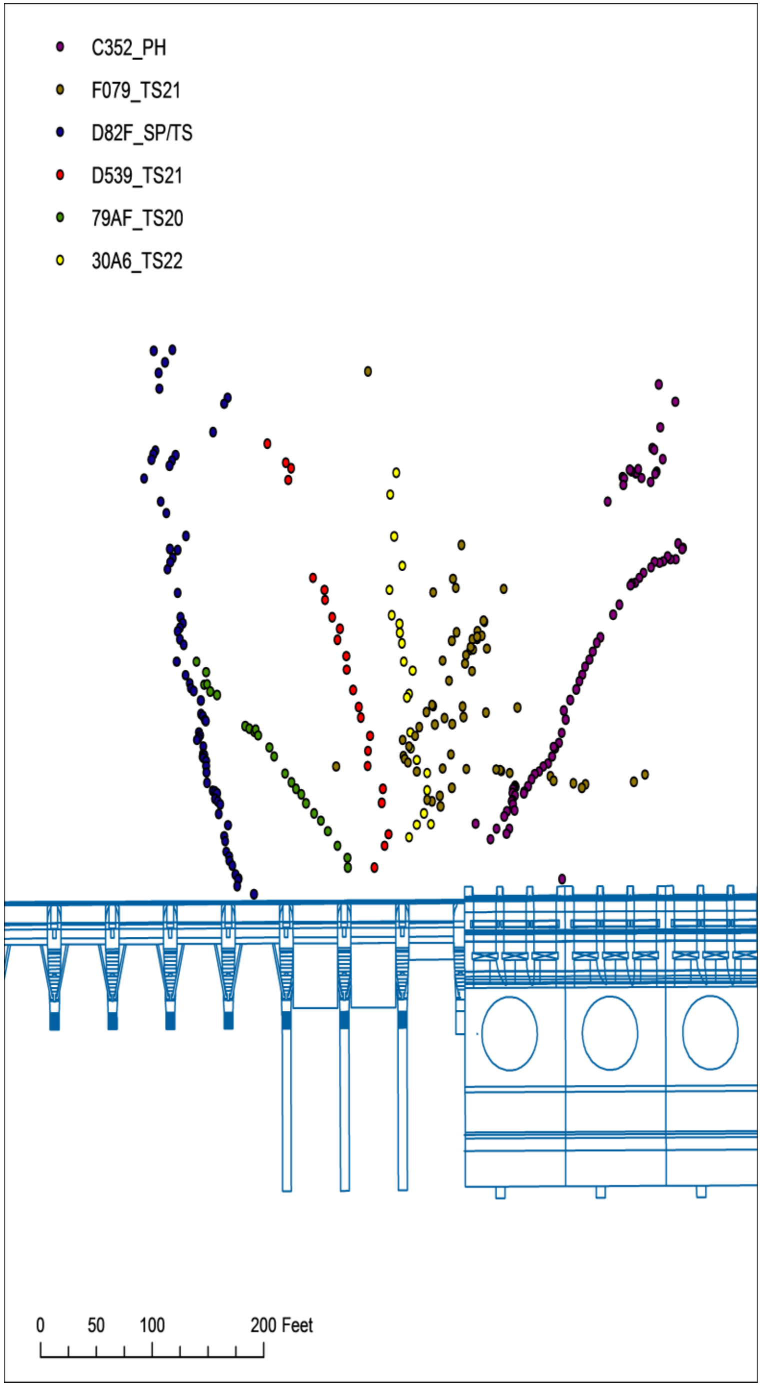
Project Features

Grant County
PUBLIC UTILITY DISTRICT
Excellence in Service and Leadership

- Nominal full bypass flow of 27,000 cfs from 3 bays at 9,000 cfs each.
- On/Off operation in each bay using modified existing tainter gates.
- Length of 204.75 feet from upstream to downstream end of pier tails.
- Nominal exit chute width of 44 feet for each bay.
- Discharge flow elevated to minimize total dissolved gas (TDG) and tailrace scour.

3D Positions

in progress

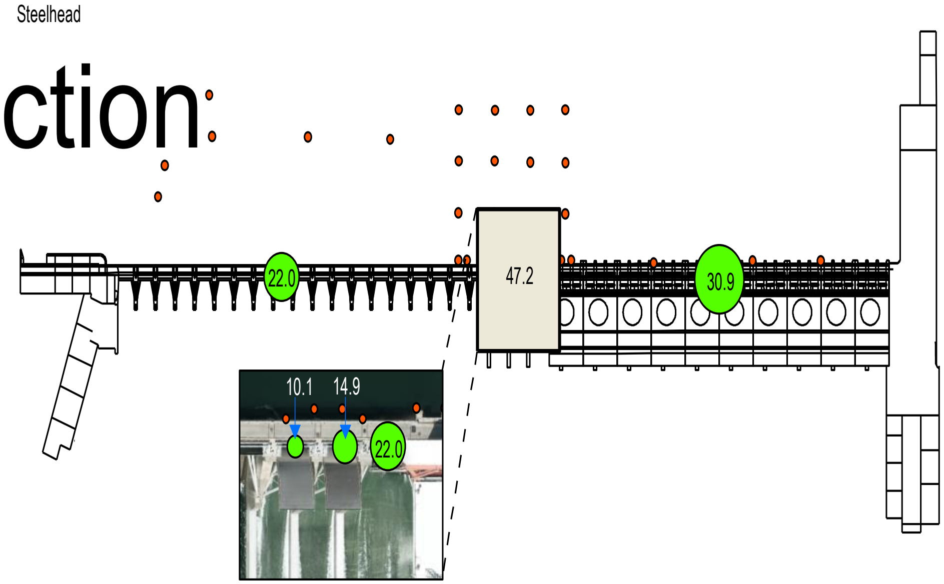


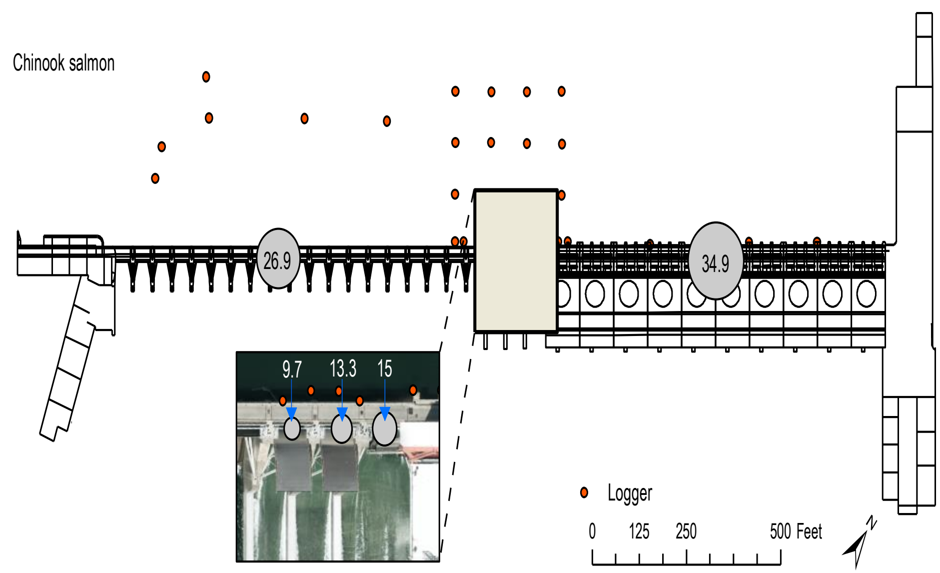
Passage Route Selection

Priest Rapids Dam - 2014

- Steelhead: Non-Turbine FPE 69%
  - **47.2% top-spill,** 22.0% spillway
  - 30.9% powerhouse

- Yearling Chinook: Non-Turbine FPE 65%
  - **38.1% top-spill**, 26.9% spillway
  - 34.9% powerhouse





FPE = Fish Passage Efficiency

Survival by Passage Route

Passage Route	Wanapum Qty Passed	Wanapum Detected Downstream	Priest Rapids Qty Passed	Priest Rapids Detected Downstream
Steelhead				
WFB/PRFB	36	1.000	507	**0.996**
Spillway	164	0.994	236	0.970
Powerhouse	152	0.941	276	0.938
Yearling Chinook				
WFB/PRFB	27	0.963	415	**0.998**
Spillway	99	0.970	293	0.980
Powerhouse	225	0.982	352	0.926

Point estimates are based on proportions of fish detected downstream at one or more locations that passed

Generation Benefits from the Priest Rapids Bypass

Construction Cost of PR Fish Bypass
$44,630,000

Generation Difference with New Bypass
456,480 MWh

Value of Increased Generation
$8,216,640 (based on $18 MWh power)

Conclusion - New Bypass would pay for itself in less than 6 years

Questions ?