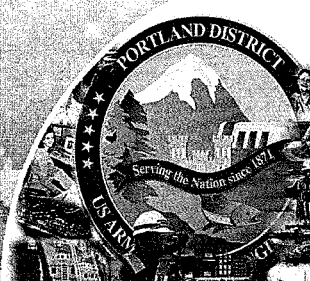



Bonneville Second Powerhouse – Orifice Improvements


Karen Kuhn
Hydraulic Engineer
Portland District
2 June 2011

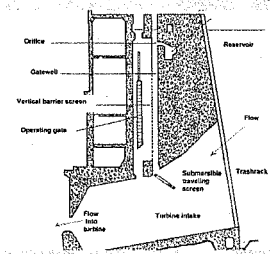
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B2 Orifice Improvements Overview


- History
- Where we are now
- Letter Report
- Alternatives
 - ▶ Category 1
 - ▶ Category 2
- Alternative Comparison Factors & Ranking
- Homework



PORTLAND DISTRICT 2 BUILDING STRONG



Generic Fish Guidance System




PORTLAND DISTRICT 3 BUILDING STRONG



Existing B2 Orifice
Photo Taken From Gatewell Side

Attraction Lighting tube terminates near orifice entrance.



PORTLAND DISTRICT 4 BUILDING STRONG




Original Gate Assembly on North Orifices 11-18
Photo Taken at Collection Channel

Some orifices appear to be closer to wall due to removal of concrete.




PORTLAND DISTRICT 5 BUILDING STRONG

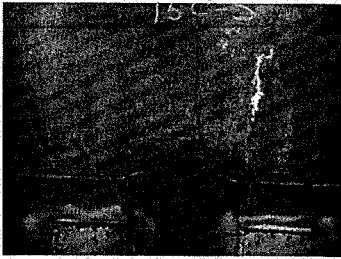


Gate Assembly to South Orifices 11-14
Added in 1999 Modifications

Cylinder is larger creating longer travel distance for jet



PORTLAND DISTRICT 6 BUILDING STRONG



Sealed South Orifices Units 15-18
 Addition of Gates and Actuators would make these orifices usable.

PORTLAND DISTRICT 7 BUILDING STRONG

B2 Orifice Improvements History

- DSM Construction 1982
 - ▶ Twenty eight 12" diameter orifice rings operating with clean jets (8.9-12.6 cfs each or 250-350 cfs range)
 - ▶ Disturbances indicator of debris blockage
- FGE Studies 1983-1991
- DSM Improvements 1999
 - ▶ Added 12 more orifices (total 40), replaced 12" orifice plates with 13" for more flow to channel
 - ▶ Modified DSM Collection Channel, Control Weir, Dewatering Facility to improve channel & wall screen velocities (10.4-14.7 cfs each or 456-486 cfs range)

PORTLAND DISTRICT 8 BUILDING STRONG

B2 Orifice Improvements History

- Post DSM Improvements 1999+
 - ▶ Forty 13" diameter orifice rings operating with disturbed jets when there is no debris blockage
 - ▶ Newly 'opened' orifices striking gate housing
 - ▶ Too much flow for DSM criteria
- Field Testing/Construction 2000-2002
 - ▶ Replaced 13" with 12 5/8" orifice rings
 - ▶ DSM criteria met (reduced flow) but jets still disturbed

PORTLAND DISTRICT 9 BUILDING STRONG


B2 Orifice Improvements History

- Field Testing 2006
 - ▶ Decided air demand for jet the primary problem for higher Forebay Elevations
 - ▶ Tested orifice ring sizes, 11" to 12 1/4"
 - ▶ 11" ring on north orifices best separation between jet and tube (more space/air to maintain clean jet)
 - ▶ South orifices have larger cylinders increasing length
 - Jets consistently disturbed and striking gate housing especially for lower Forebay Elevations
 - ▶ Recommendation
 - Increase tube size from 15" to 17.75" to allow more air
 - Increase orifice ring diameter 12 5/8" to 13" (1999 design)

PORTLAND DISTRICT 10 BUILDING STRONG

B2 Orifice Improvements Field Testing 2006 FB EL=73.6 ft.

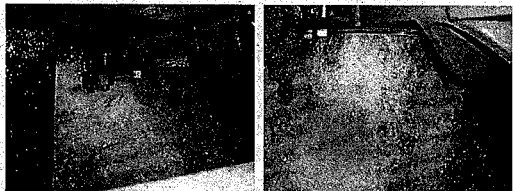
12C-N Orifice Ring=11" 12A-N Orifice Ring=12"



PORTLAND DISTRICT 11 BUILDING STRONG

B2 Orifice Improvements Field Testing 2006 FB EL=73.6 ft.

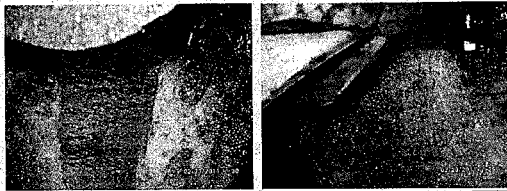
Best North Orifice – 12C Best South Orifice – 12C



PORTLAND DISTRICT 12 BUILDING STRONG

B2 Orifice Improvements Site Visit 2011 FB EL=71.9 ft

North Orifice - 11A South Orifice - 11A



PORTLAND DISTRICT 13 BUILDING STRONG[®]

B2 Orifice Improvements History

- Improvements Study begins 2008
 - ▶ Suggested 2006 recommendations – Increase tube diameter and decrease orifice ring diameter
 - ▶ Resulting design would interfere with current attraction lighting
 - ▶ PNNL study indicates that with the current light tube configuration "...light sources produced light levels below effective minimum luminance values noted in the literature."
 - ▶ Recommend alternate light source – light ring

PORTLAND DISTRICT 14 BUILDING STRONG[®]

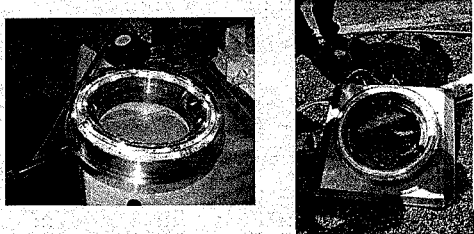
B2 Orifice Improvements McNary Lighting Study

- Prototype Light Ring installed at McNary Gatewell 2010
- PIT Tagged fish released and analyzed passage times via PIT Trap
- Found increased OPE with Higher Lux lighting tests
- Passage benefits all species but effect was greater on Sockeye and CH1's
- No impacts with Increased Turbidity

PORTLAND DISTRICT 15 BUILDING STRONG[®]

B2 Orifice Improvements McNary Lighting Study


Light Ring in Lab Light Ring Water Test



PORTLAND DISTRICT 16 BUILDING STRONG[®]

B2 Orifice Improvements McNary Lighting Study

Installing Apparatus Light Visible From Deck



PORTLAND DISTRICT 17 BUILDING STRONG[®]


B2 Orifice Improvements Current Study

- Letter Report Objectives
 - ▶ Determine Purpose/Scope of Work
 - ▶ Define Problem and Design Criteria
 - ▶ Suggest Reasonable Alternatives
 - ▶ Come up With Evaluation Criteria and Rank by Importance
 - ▶ Select Best Alternative Based on Evaluation Criteria
 - ▶ Provide Design for Chosen Alternative
- Plans and Specifications Phase 2012
 - ▶ Detailed Design

PORTLAND DISTRICT 18 BUILDING STRONG[®]

B2 Orifice Improvements Letter Report - Scope


- Identify and recommend modifications to the DSM gatewell orifice, vent tube, and gate assembly to provide hydraulically and biologically acceptable passage to the DSM channel as part of the overall operation of the DSM system.



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B2 Orifice Improvements Letter Report – Problem Statement


- Existing orifices operate as disturbed jets preventing necessary detection of debris blockage at intake known to be harmful to fish.
- Lighting study at Bonneville has indicated that current attraction lighting is less than ideal.



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B2 Orifice Improvements Letter Report – Design Criteria


- Provide safe fish passage for range of forebay elevations 71.5 to 76.5 ft.
- Maintain appropriate hydraulic criteria for the operation of the DSM to include discharge, velocities, and jet trajectory for orifices, collection channel, dewatering facility and exit section for range of forebay elevations 71.5 to 76.5 ft.



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B2 Orifice Improvements Letter Report - Alternatives


- Category 1: Address need for additional air to supply air demand at higher forebay elevations
- Category 2: Provide alternative means for monitoring orifice entrance for potential debris blockage
- Category 3: Provide relief from jet impingement especially during low forebay elevations
- Category 4: Address insufficient light attraction in conjunction with Category 1, 2 or 3 alternatives



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B2 Orifice Improvements Letter Report – Alternative Category 1 (1 of 2)


- Category 1: Provide additional air supply
 - ▶ Alternative 1.1: Add compressed air to jet and return orifice ring diameter to 13" (existing 12 5/8")
 - ▶ Alternative 1.2: Vent orifice tube through existing light tubes and return orifice ring diameter to 13" (existing 12 5/8")
 - ▶ Alternative 1.3: Recore orifices from 16" to >= 19", increase tube size 15" to >= 17.75" and return orifice ring diameter to 13" (existing 12 5/8")



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B2 Orifice Improvements Letter Report – Alternative Category 1 2 of 2

- Alternative 1.4: Reduce orifice ring diameter <= 12" and open additional orifices @ Units 15-18
 - Would require modification of screen criteria from fry to smolt for latter part of passage season when fry have passed
 - Assumes that dewatering system can be modified to function as designed with additional flow (roughly 150 cfs)



PORTLAND DISTRICT 24 BUILDING STRONG_®

B2 Orifice Improvements Letter Report – Alternative Category 2

- Category 2: Alternative debris monitoring
 - ▶ Alternative 2.1: Add cameras in gatewell for visual inspection
 - ▶ Alternative 2.2: Add pressure sensors across orifice openings
 - ▶ Alternative 2.3: Add sonic (acoustic) sensors across orifice openings



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B2 Orifice Improvements Letter Report – Alternative Category 3

- Category 3: Reduce jet impingement
 - ▶ Alternative 3.1: Partially support jet at bottom through tube using insert with rounded entrance to allow jet to exit without impacting gate housing or end of orifice tube
 - ▶ Alternative 3.2: Fully support jet (full pipe flow) using insert with rounded entrance to allow jet to exit without impacting gate housing or end of orifice tube
 - ▶ Alternative 3.3: Offset orifice ring vertically up at upstream end and offset gate housing down at exit so that jet trajectory will not impact gate housing or end of orifice tube



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B2 Orifice Improvements Letter Report – Alternative Category 4

- Category 4: Address insufficient light attraction in conjunction with Category 1, 2 or 3 alternatives
 - ▶ Alternative 4.1: Provide light attraction at orifice entrance flush mounted with orifice ring



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B2 Orifice Improvements Letter Report – Alternative Evaluation Criteria (in order of importance)

- Clean Observable Passage
- Fish Condition with Modification
- Alignment with DSM Criteria
- Technical Viability
- O & M Cost
- Ease of Testing Proof of Concept
- Construction Cost
- Other?



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B2 Orifice Improvements Homework

- Resource Agencies:
 - ▶ Review Alternatives and provide comments or additions by Thursday 9 June 2011
 - ▶ Review Evaluation Criteria and Ranking and provide comments or additions by Thursday 9 June 2011
- Portland District:
 - ▶ Prepare 60% Letter Report with Agency Input



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Bonneville Second Powerhouse – Orifice Improvements

- Questions?
- Concerns?
- Feedback?

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