AGENDA

Fish Passage O&M Coordination (FPOM) Team
NOAA Fisheries Office 1201 NE Lloyd Blvd (Lloyd Center MAX stop)
St. Helens Room (10TH Floor)
February 14, 2008 (900-1200)
Call in number- 503-808-5199 passcode- 2580

1. Review/Approve Agenda and Minutes (B. Klatte)

2. Action Items (B. Klatte)

2.1 [long time ago] Switch Gate Seal at BON: **ACTION**: JDA and BON will collaborate on new seals. ***STATUS:*** *This item will be carried over to future meetings while JDA continues to work on air bladder seals.*

2.2 Discussion of JDA SMF future operations. **ACTION:** D. Schwartz will set up a meeting for all the necessary participants to really, thoroughly discuss the future monitoring needs at the JDA SMF. ***STATUS:*** *Waiting for FPAC to discuss. It was recommended a message be sent to Paul Wagner to get the discussion on the FPAC agenda.*

2.3 [Nov 07] TDA stub weir removal. ***STATUS:*** **Currently on hold, but will be kept in Action Items for now.**

2.4 [Jan 08] Fish counter check in and out procedures. **ACTION:** Mackey and Bailey will collect proper protocols for check in and out for each Project. This information will be sent to G. Moody. ***STATUS:*** *Generic language is best for the contract. Each Project will ensure that the check-in procedures are detailed at annual safety talks.*

2.5 [Jan 08] Late season counting ended around 20 December at Lower Granite. **ACTION:** WDFW will send counts to Moody and let FPOM know when the counts are posted.

2.6 [Jan 08] Sea lion deterrent presentation by ACTIX. **ACTION:** G. Fredricks will take info to G. Griffin.

2.7 [Jan 08] Sea lion task group. **ACTION:** S. Bettin is the chairperson. First task- literature search for the sensitivities of our native fishes.

2.8 [Jan 08] FPP hard copies. **ACTION:** Get copy requests to S. Boyd at Feb. FPOM.

2.9 [Jan 08] Avian lethal take. **ACTION:** Cordie will take the lead in further pursuit of filing the application and lethal take. ***To be discussed under Agenda Item #9***

2.10 [Jan 08] Altered spill operations for navigation. **ACTION:** B. Klatte will contact R. Wertheimer, K. Hanson, A. Setter and L. Ebner about getting the tug operators to ERDC during the 28 Jan-1 Feb trip. ***To be discussed under Agenda Item #10.***

3. Updates. (B. Klatte)

3.1 Pinnipeds at Bonneville.

3.2 Bonneville BI fishway. Need to prioritize funds for repairing/replacing Bradford Is. fishway. It appears the Ambursen (old navlock) section may be moving downstream, thus causing issues with installing fish valve bulkheads.

3.3 BON ROV inspection update. Need to take Bay 1 OOS during fishway inspection to look at 15’ debris pile downstream of the bay. Inspection to be on 2/19-20.

3.4 B2CC closing date. August 29, 31 or September 2? Rigging crew cost is $700-1000, but getting volunteers may be difficult on a holiday weekend.
3.5 Little Goose cormorant take research.

4. Bonneville trolley pipe installation. (Schwartz)
According to our dive schedule for the installation of the pier nose trolley pipes we will be diving at or around units 17, 18 & F1&F2 starting on either late Tuesday the 4th of March or all day on Wednesday the 5th. To have divers in the water at the pier area requires not only the main unit they are working on off but units on either side of them off-line and cleared out. The dive scheduled to install the last (3) three pipes at the north end of PH2 will require the fish units being shutdown during our dive. This will require a full day outage of F1 & F2 on or around Tuesday the 4th or Wednesday the 5th. The region has been in support of the unit outages needed to facilitate the dives but turning off the fish units goes above this original agreement.

5. Lamprey lighting at the viewing windows. (Clugston)
Lamprey counters would like additional lighting outside the count station at BON.

6. Painting the JDA north count station fishway floor. (Cordie)

7. Development of VBS drawdown criteria. (Cordie)

8. Development of the fishway velocity task group. (Cordie)

9. Avian hazing/lethal take. (Klatte)

10. Results from the January JDA ERDC trip- unit priority.
10.1 FPP Table JDA-5
10.2 FPP JDA 4.2.1.3
10.3 tow boaters update
10.4 spill volume (60 v 55) from 10-21 April.

11. FPP finalization.
12.1Bonneville PH1 unit priority (**see attachment**)
12.2Bonneville VBS criteria
12.3McNary 2.3.1.2.d language for drawdown over dewatering screens.
12.4Appendix G- increased sampling, fish in the recovery tank, and temperatures.
12.5Appendix K sampling hours
12.6Appendix J temperature protocols.

12. Water forecast. (RCC)

13. Other

14. Shad task group meeting following FPOM **(Moved to March)**.

U.S. ARMY CORPS OF ENGINEERS
PORTLAND DISTRICT

Hydraulic Study of Bonneville First Powerhouse Turbine Unit Priorities and Ice and Trash Sluiceway Operations for Spring and Summer 2004 Biological Test Program

100% DRAFT

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APPENDICES (not included in this draft)

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Introduction

The Bonneville Project is located on the Columbia River, 42 miles east of Portland, Oregon at river mile 146. The Bonneville 1st Powerhouse (B1) is located at the south end of the project spanning the river between Bradford and Robin Islands (see Figure 1). Due to the discontinuation of the use of the screen system at Bonneville, the passage of juvenile salmonids through the ice and trash sluiceway is the primary means of bypassing fish safely around B1. The ice and trash sluiceway extends across the B1 forebay immediately above the turbine intakes and adjacent to the gate wells (see Figure 2). The sluiceway has 30 adjustable chain gates (3 labeled a, b, or c above each turbine intake 1 through 10). This series of forebay openings, each separated by a pier, causes the sluiceway channel geometry to be very non-uniform. The channel is also transversely sloped so that it is tied into the geometry of the turbine intake below, overall creating a complicated hydraulic structure to model (see Figure 3). The sluiceway transports fish entering the chain gates through the upper sluiceway channel; over a sill at the south end; to a channel passing perpendicular through the dam; and finally exiting to the B1 tailrace at the south end of the powerhouse in the form of a jet (submerged or unsubmerged depending on tailrace elevation).

Study Objectives

The purpose of this study is to determine optimal B1 operations for juvenile salmon passing through the B1 ice and trash sluice during the 2004 spring and summer biological study seasons. To achieve this goal, three objectives were set. (1) Determine a turbine unit priority for optimum juvenile egress from the B1 tailrace for a range of spring and summer flow conditions. (2) Based on the turbine unit operations established in objective 1, determine the optimal forebay entrance locations for the ice and trash sluiceway for the spring and summer biological testing programs. (3) Determine the optimal gates settings to provide for best attraction and then passage through the system once the juvenile are captured, as well as to allow for instrument placement for the biological evaluation of the study.

Modeling Efforts

The study used a number of hydraulic tools to meet the objectives described above. The first was a 3-dimensional computation fluid dynamics (CFD) model of the B1 tailrace. The third was a CFD model of the B1 forebay. The second a 1:100 scale model of the entire Bonneville project. Lastly, a 1-dimensional (1D) model of the ice and trash sluiceway developed by the Northwest Hydraulic Consultants (NHC) in 1997 was used to simulate conditions in the ice and trash sluiceway. Each tool and how it fits into the overall study is described in more detail below.

Tailrace Modeling

Two models were used to evaluate B1 turbine unit priorities for the 2004 biological test program. The first, a CFD model of the B1 tailrace and the second 1:100 scale physical model. Various operational scenarios were run in both tailrace models to provide information on the egress conditions at B1.

Tailrace CFD Modeling

The tailrace CFD model was developed for the Bonneville Second Powerhouse Corner Collector. The model was documented in “Development and Application of a 3D CFD Model for the Bonneville Project Tailrace for Proposed High Flow Outfall Structures” by Rakowski, Serkowski, Richmond and Guensch, September 2001. The tailrace model was calibrated using

Happy valentine’s day Happy valentine’s day Happy valentine’s Day data collected in the Bonneville Second Powerhouse tailrace channel. A prototype data set was collected in the B1 tailrace channel in 2003 to further verify the CFD tailrace model. The verification results will be presented in the next section of this report. Numerous operational scenarios were run to determine unit priorities to optimize tailrace egress. The numerical model results were used in conjunction with the 1:100 scale physical model observations (described later) to determine the unit priorities summarized in the Recommended Operations Section.

Tailrace CFD Model Verification Results

Stationary and moving transect Acoustic Doppler Current Profiler (ADCP) and point velocity data were collected in the tailrace of B1. These data were collected to calibrate and verify numerical and physical models of the B1 tailrace. The data collection effort is summarized in Acoustic Doppler Current Profiler and Point Velocity Measurement Field Data Collection, Lower Columbia River Projects” by ENSR, July 2003. The field data was collected on April 8th 2003. Figure 4 summarizes the stationary ADCP data set. Figure 5 summarizes the moving transects data. Table 1 provides hourly readings of project operations. Total river flows as suggested by the moving transects (Figure 5) and the hourly data (Table 1) differ by about 10,000 cfs, thus two CFD runs were made. Table 2 summarizes the project flow conditions and the two CFD model runs. The actual boundary conditions applied to the model for the verification runs is provided in Appendix C of this report along with the boundary conditions of all runs for this study.

Results for the two different CFD runs are shown in Figures 6 and 7. Generally, all transects show a better match under the higher total river flow scenario (Figure 7), Transect 1 is the worst match and is also the transect closest to the turbine draft tubes. In addition, the old navigation channel appears to create a larger shadow than appears in the CFD model as shown at transect locations 3-3, 3-1, 4-2 and 4-1.

Figures 8, 9 and 10 show the depth profiles of velocity magnitude of the measured data versus the velocity magnitude of the model data for a specific transect location. Included in Figures 8 through 10 is the measured data plus and minus two standard deviations. The numerical data easily falls within the “range” of measured data. The fact that the CFD velocity magnitudes profile is consistently less than the measurement profile, especially at the shallower depths, suggests that the grid could be refined to provide a profile more representative of the measured profile. The need to further refine the grid is also demonstrated in Figures 11 and 12. Figures 11 and 12 are for a total river discharge of 270 Kcfs, 140 Kcfs through B2, 100 Kcfs through the spillway and 30 Kcfs through B1 (units 2, 3 and 5). Nine massless particles were released in the B1 Ice and Trash outfall and the disposition of those particles are traced in Figures 11 and 12. In Figure 11 several traces stop on the south shore. Figure 12 is an enlargement of this area. The cell size is not sufficient (small enough) to allow the particles to re-circulate back to the powerhouse. But stopping at the shore or re-circulating back to the powerhouse are both poor egress conditions and in that regard the model is effective in capturing poor egress conditions. Additional grid refinement would most likely improve the ability of the model to reproduce the prototype data but it is not critical to evaluating unit priorities where general flow patterns are required over the B1 tailrace.

Tailrace CFD Model Study

The tailrace study was patterned to identify turbine unit priorities that provided best egress for a 1, 2, 3, and 4 unit scenario. In the end the overall turbine unit priority study considered that a unit, once turned on, would remain in the pattern as more and more turbines were brought online

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but this was not initially done in the preliminary CFD modeling because at this point we wanted individual optimal operations for each scenario. The numerical model runs did prioritize Units 1, 3, 4, and 6 because they have newer and more fish friendly minimum gap runners (MGR). Table A-1 of Appendix A lists the project operations that were run in the CFD tailrace model. To identify unit priorities that would maximize tailrace egress conditions, several runs were first made with different single turbine units operating. After the optimal first turbine was established, a number of different combinations of two turbine unit operations were tried. Again, these did not all necessarily include the optimum single turbine option because the thought was to find optimal conditions at each scenario (1 turbine, 2 turbine etc.). This was continued for combinations of three turbine and four turbine units operations. All of the turbine unit priority runs were made with the tailwater at 21.0 feet National Geodetic Vertical Datum of 1929 (NGVD29). The spillway was operated at 100,000 cfs and a full load at the Bonneville Second Powerhouse (B2), 138,600 cfs. The operating turbine units at B1 were loaded at 10,000 cfs. For all of the CFD tailrace runs the B1 Ice and Trash Sluiceway was operated at 500 cfs. Figure 13 shows the extent of the tailrace model and the blow up in the left hand side shows the velocity vectors in the B1 tailrace.

Tailwater sensitivity was checked with no result (general flow patterns are not highly variable with tailwater changes and therefore the conditions observed for these unit priority are fairly robust.

Tailrace CFD Study Results

To understand egress from the B1 Ice and Trash Sluiceway nine massless particles were released in the sluiceway outfall. The massless particles do not represent a juvenile fish but represent the path the water in the outfall takes. Figures 14 through 18 show the distribution of the nine particles for the five single turbine unit flow conditions (Units 1, 2, 3, 4, and 6 respectively). Good egress conditions occur when the massless particles move out of the B1 tailrace in the most expeditious manner and ideally towards the center of the channel. Unfortunately, the location of the outfall at the south side of B1 makes a particle path towards the center of the channel unlikely. Figure 14 shows a good egress conditions with just Unit 1 operating. The nine particles all head directly out, although the particles are close to the shoreline. The Unit 2 single turbine operation is similar to the Unit 1 single turbine scenario except the Unit 2 jet stays further off shore than for the Unit 1 operation. Particle tracks for this scenario show that flow leaving the outfall does not move into this jet (Figure 15) therefore the outfall egress along the north shore would be slower with just unit 2 operating than with just unit 1 operating. Figure 16 shows a good egress condition with just unit 3 operating. The nine particles head directly out and the particles move toward the center of the channel. When comparing Figures 14 and 16, the velocities for the Unit 1 case are higher (2 to 3 feet per second) than the Unit 3 case (approximately 1 fps). When Unit 4 is operated (Figure 17) all particles get out of the tailrace but they spend time in a re-circulation cell south of Unit 4. Figure 18 shows results for Unit 6 with the particles appearing trapped in a re-circulation cell south of Unit 6. Results for 2 units, 3 units and 4 units are shown in Appendix A but in general once the single unit scenario was optimized increasing the number of turbines tended to improve egress conditions as long as a large space wasn’t left between operating units. More discussion of the tailrace egress conditions, along with recommended unit priorities, is provided in the physical model section.

1:100 Scale Physical Model

The Bonneville Locks and Dam 1:100 General Model, along with other scale models of the Columbia River, are used extensively to determine fish egress patterns based on operations of

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the powerhouses and spillway. For the purposes of this study the general model was used to corroborate CFD model results and visually confirm and document the proposed unit priorities. Because the B1 structure was replaced in 2000 the model needed to be verified prior to it’s use in this study.

1:100 Model Verification

At the time the newer B1 model was constructed and installed in the 1:100 scale general model at Engineering Research and Development Center (ERDC) no data was available for verification. In 2003 tailrace velocities were measured at various locations with an ADCP and, as with the CFD tailrace model, that data set was used to verify the accuracy of the 1:100 scale general model’s simulation of the B1 tailrace. The details of the B1 model verification are detailed in Appendix B of this report. A summary of the findings and the relevance to this study are provided below.

The first data check was to use the average velocities along Transect 2 to compute discharge coming from the B1 Powerhouse. The reported discharge through the B1 powerhouse during 8 April 2003 was 59,800 cfs. The powerhouse units and miscellaneous flows of the model were set to match project conditions on 8 April. The computed discharge in the B1 model tailrace was 60,846 cfs, a difference of 1.75 percent. This would tend to verify that the discharge being passed through the B1 is correct and that the velocities obtained in the B1 tailrace along Transect 2 are reasonable.

A comparison of model and prototype component velocities, standard deviations of each component velocity, resultant velocity magnitude and direction for the stations, and depths along each transect are shown in Tables 3 through 5. Figure 19 provides a direct comparison of the velocity vectors in the B1 tailrace. The east and north component velocities for Transect 1 (Table 3) tended to be slightly higher in the prototype than in the model therefore the resultant velocity is also higher. The prototype headings for Station 1-2 are approximately the same as the model. The prototype headings at Station 1-4 are from 20 to over 100 degrees less than the model. The prototype headings for Station 1-6 are from 4 to 8 degrees less in than the model. Standard deviations for the east component flow are greater for the model than the prototype at Station 1-2 with the north component approximately the same. Standard deviations for both the east and north components were greater for the prototype than the model at Station 1-4 and at Station 1-6 the standard deviations for the prototype were slightly greater than the model.

For Transect 2 the east component velocities are higher for the prototype than the model for Stations 2-1 and 2-2, lower for Station 2-3, and very nearly the same for Stations 2-4 through 2-7. The north component is consistently larger for the prototype than the model for all stations. This makes the resultant magnitude higher for the prototype at most stations than the model, even though there are several magnitudes almost equal and a few were the model exceeds the prototype. All of the headings for the model are from 2 to 8 degrees further clockwise than the prototype, except at Station 2-2 at 20 ft depth, which was 12 degrees greater. Standard deviations for many of the data points are not extremely different for model or prototype.

For Transect 3 the east component velocities, except for a few points, are larger in the prototype than the model. The north values, except for a couple of points, are much larger in the prototype than the model. This generally makes the resultant magnitudes, except for a few points, considerably higher for the prototype than the model. The headings, except for Stations 3-1 and 3-3, are generally 6-17 degrees further clockwise for the model than the prototype. Velocities

Happy valentine's day Happy valentine's day Happy valentine's Day taken at Stations 3-1 and 3-3 in both the model and prototype were relatively slow with high standard deviations. Standard deviations for the east and north component velocities tend to be considerably higher for the prototype than the model.

Overall the physical model agreed fairly well with the ADCP measurements at the project as well as the CFD model results for the same stations and depths. There is a little concern over the heading of the vectors along the south shore of Bradford Island but for the purposes of this study the model appears to be accurately simulating the B1 tailrace conditions measured on 8 April 2003. More details of the model verification can be found in the ERDC verification report in Appendix B of the report.

Physical Model Study

The 1:100 scale general model of Bonneville Lock and Dam was used to evaluate current direction and velocity (CD&V) conditions in the tailrace below the B1 powerhouse for documentation of flow conditions and powerhouse unit operations. The physical modeling included a variety of operational setups (changes in operations at the B1 and B2 powerhouses and the spillway) and were initially documented with dye release video.

The forebay elevation was maintained at elevation 74.5 ft NGVD2929 for all tests. The tailwater varied from elevation 21.0 ft NGVD29 with a total river discharge of 260,000 cfs, and 17.5 ft NGVD29 with a total river discharge of 200,000 cfs. Operational details for each of the conditions are listed on the individual current direction and velocity figures found in the ERDC data report found in Appendix B of this report.

CD&V data was collected by tracking the path of lighted cylindrical floats submerged to a depth of 9 ft (prototype) as the currents through the test section of the model moved them. The data were collected using the video tracking system (VTS) that records the path of the floats by storing the time stamp and pixel coordinate position of each lighted float moving through the camera view. The data in this file is then post-processed to provide the time stamp and state plane coordinate for each light and converted to velocity vectors throughout the tailrace.

Physical Model Results

Figure 20 shows the set of CD&Vs taken representing the spring flows with the total river discharge set at 260,000 cfs, and B1 Unit 4 operating to a capacity of 10,000 cfs with the remainder of the total river discharge divided through the other structures. The tracks indicated the flow immediately below the operating unit moves out toward the center of the channel, following the angle of the island on the left bank line. The pattern spreads across the channel until exiting at the end of the B1 tailrace, where it is picked up by the flow from the spillway and the B2 powerhouse discharges. The flow just below the B1 Powerhouse on the right descending bank is caught in a clockwise eddy that spreads about half a mile below the structure and returns current back toward the powerhouse. Toward the end of the island on the right, but closer to the waterline, the eddy is smaller, but here also the flow is brought back toward the structure. The flow below the island on the left descending bank is also caught up in a clockwise eddy that spins back into the main B1 channel.

Figure 21 shows the 260,000 cfs flow with units 2 and 4 operation to a capacity of 10,000 cfs each, and the rest of the total river flow dispersed as indicated on the plate. There is a larger flow discharged from the B1 powerhouse that follows the island, and this increases in velocity in the tailrace. Below the structure on the left bank line, the flow distribution is carried to the end of the

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tailrace. The eddy below the structure on the right still exists, but is not as large as with one unit operating. The eddy effect toward the end of the island on the right is present and extends further downstream, and is further to the center in the tailrace.

With units 2, 3, and 4 operational (Figure 22), the flow pattern appears to follow the channel all the way to the end of the tailrace. There is still an eddy below the structure on the right bank, but this is smaller and does not extend as far downstream as in both previous conditions. The condition seems to eliminate the eddy on the right bank toward the end of the island on the right.

The next series of CD&Vs are of the total river discharge of 200,000 cfs, with the first having Unit 1 in the B1 Powerhouse opened to pass 10,000 cfs (Figure 23). In this pattern, the main volume of flow follows the island on the left descending bank, all the way to the exit of the B1 channel. The clockwise eddy on the right bank is pronounced and affects the flow all the way to the end of the island on the right and has its affect out to the center of the channel. The eddy flow is brought all the way back to the structure and then divides, moving in both a clockwise and counter clockwise pattern just below the structure. Below the island on the left bank, there is a small counter clockwise eddy that forces the flow into the main channel.

The next figure is the same total river flow, but with units 1 and 3 open on the B1 Powerhouse (Figure 24). The flow pattern on the left bank follows the island to the end on the tailrace, but the eddy below the island on the left is more pronounced and closer to the end of the island. On the right, the clockwise eddy toward the end of the island is eliminated, but below the structure to about half a mile below the structure the clockwise eddy still exists, bring flow back toward the powerhouse.

The next figure (Figure 25) has units 1, 3 and 4 operating at 10,000 cfs each. The flow follows the channel and carries all the way to the exit of the tailrace, showing a pattern that crosses to the right bank. There is a small counter clockwise eddy below the end of the island on the left and a large clockwise eddy below the structure to about half way across the channel and extending downstream for a distance.

The last figure (Figure 26) shows a total river of 200,000 cfs with units 1, 3, 4, and 5 opened to 10,000 cfs each. The pattern follows the channel below the unit discharges, and extends to the end of the tailrace. Eddies close to the end of the islands on the left and right are eliminated. There is still a clockwise eddy below the structure on the right where there is no unit discharge, which is similar to the pattern with three units open. The eddy seems to be tighter here but still pronounced.

Turbine Unit Priorities

These results in conjunction with the tailrace CFD results lead the following operations for spring and summer testing. The best unit priority appears to start with Unit 4 and then proceed to units 2,6, and 5 so that operating units are spaced out (one dead unit between operating units) to avoid the south to north eddy that hit the north shore and split, some returning to powerhouse and some exiting to the tailrace. After units 4, 2, 6, 5, are brought on-line, 7 and 10 were compared as a fifth unit with 7 appearing to be a better condition because running 10 created a dead spot in the center of the powerhouse into which flow from units 10 and part of 6 flowed. Unit 7 operation eliminated this and actually helped to train Unit 6 a little better. If additional B1 units are needed the recommended priority is 10, 9, and 8. These last units in the sequence were chosen, without modeling, to help with adult attraction.

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Forebay Modeling

The forebay model consists of the B1, B2, and the Spillway and was developed for Prototype Surface Collector at B1 and for fish guidance efficiency (FGE) improvements at B2. The model was calibrated using a variety of data sets and is documented in “Development and Application of a 3D CFD Model for the Bonneville Project Powerhouse 1 and Powerhouse 2” by Rakowski, Serkowski, Richmond and Recknagle, September 2001. A limited number of runs were made in the forebay model to determine how turbine priorities would impact fish guidance into the Ice and Trash Sluiceway.

Forebay CFD Model Study

The biological focus in 2004 is to measure B1 tailrace survival under the best egress conditions. The focus is not to maximize the collection efficiency of the B1 Ice and Trash Sluiceway. Thus forebay hydraulics were not considered in setting unit priorities in 2004. The forebay hydraulics were considered, along with unit priority in establishing which chain gates were to be opened to allow entry into the ice and trash sluiceway. The operating conditions used in the CFD model runs made for this purpose are summarized in Table A-2 in Appendix A of this report.

Forebay CFD Model Results

Figures 27-31 show the velocity magnitude contours and stream traces at Elevation 74 (½ foot below the water surface) for 5 operating conditions. The main thing to note in the forebay model runs is that a re-circulation cell tends to form at the north end of B1 when units 3 and 6 and unit 6 are operated (Figures 27 and 30). It is possible that the re-circulation cell could delay juvenile fish and provide additional opportunity for predation. A recirculation cell also forms in simulations of the units 1 and 3 operation and the Unit 3 only operation but this cell splits off at the edge of the navigation lock exit approximately 200 ft upstream of the face of the powerhouse and therefore is less likely to divert any fish milling in front of the powerhouse. Because the 2004 biological study is not focused on maximizing collection efficiency but maximizing tailrace egress conditions this is noted but not used in determining unit priorities.

In addition to the recirculation cell, the CFD modeling also suggests that, as long as only units south of the training, wall located between units 6 and 7 are operated, the streamlines approaching B1 stay south of the training wall (Figures 27-31). This suggests that chain gates that have been left open north of the training wall in the past to capture fish in that area could be closed if we assume the majority of fish will end up south of the training wall based on the streamlines. Opening gates north of the training wall tend to create poor conditions in the ice and trash sluiceway and should be avoided if possible. For this year’s biological program, no chain gates were opened north of the training wall.

1 Dimensional Numerical Modeling

The final step in investigating optimal operations for the ice and trash sluiceway involved the use of the TRASH model. TRASH is a 1D model of the ice and trash sluiceway developed by NHC in 1997. The 1D model provides a tool for determining the discharge, water surface elevations, and average velocities in the ice and trash sluice. The TRASH model was used to find gate settings for the chain gates that provide flow over the weirs and through the channel at velocities greater than 3 feet per second (fps). Ideally, this would have been achievable with single gate settings for forebays ranging from 74 ft to 76.5 ft NGVD29. For the given turbine unit operating (as set through the physical and numerical tailrace modeling described above, only the chain gates above those operating units will be opened in order to optimize attraction into the sluiceway. Therefore, based on the unit priorities, chain gates 2c, 4c, and 6c, were operated so

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as to offer a sluiceway entrance over each of the first three turbines to be brought on line (units 4, 2, and 6) and to be placed adjacent to units operated later in the unit priority (units 5 and 7). An entrance under this setup will not cover units 10, 9, and 8 but operation of these units is unlikely and therefore it is deemed acceptable.

1 Dimensional Model Verification

The initial TRASH model calibration was done in 1997 using discharge measurements from the 1:40 scale B1 model at the ERDC lab located in Vicksburg, MS. Unfortunately, the sluiceway portion of the 1:40 model had never been calibrated to prototype data and consequently the TRASH model was not verified against prototype data until 2000 when it was verified against water surface measurements taken over two days (November 28, 2000 and December 17, 2000. As a result of those verification efforts, it was found that the TRASH model, as initially calibrated, significantly underestimated the water surface in the ice and trash sluice. This would also cause the model to over estimate flows when the channel gates become submerged because at that point the flow becomes a function of the channel water surface elevation as well as the head over the gate.

As a result of the 2000 data, the initial model calibration was discarded and the model was recalibrated to the 2000 data. Unfortunately, since the 2000 data only included water surface elevations and not sluiceway flows this data set was little more appropriate for calibrating the model, which is meant to provide flow as an output, than that used for the original calibration. The model calibrated with the 2000 data predicted approximately half the flow predicted by the original model calibration.

The two very different model calibrations described above made it necessary to recalibrate the ice and trash sluice model yet again. In order for the TRASH model to simulate the performance of the ice and trash sluiceway with regards to biological criteria, including water surface elevations and flows, it needs to be calibrated to a data set that contains actual water surface elevations and flows for a given operational setup (ideally multiple operations). Therefore, in March 2004 flow measurements and water surface measurements were collected at the ice and trash sluice with the intent of using that data to recalibrate the model to at least one complete calibration data set (flow and water surface). The data collection and calibration are described in more detail in appendix c of this report.

The model, as presently calibrated, is an accurate predictor of flow through the ice and trash sluice until the weirs become submerged. When the weirs become submerged the water surface in the channel impacts the flow through the weir. Any error in the water surface (averaging 0.35 ft lower than prototype as currently calibrated but can be as much as 1 foot on the low side) will act to over predict the flow by as much as 30 % for a single gate operating. The model can function when the gates become submerged but this needs to be accounted for in the modeled results. The second option is to ensure the submerged condition is avoided when using the model by operating the sluiceway to not allow the water surface inside the channel to come equal with the chain gate crest. Limiting model operations to this range could over predict the flow by as much as 8%. Since one of the primary biological criteria for sluiceway operations at the moment is to maintain unsubmerged flow over the chain gates, so that fish aren’t likely to return to the forebay once they’ve entered the sluiceway, this is a viable use of the model. Therefore for the purposes of this study the use of the model is limited to conditions where the water surface in the sluice way is at least one foot lower than the chain gate.

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1 Dimensional Model Study

The one dimensional modeled study was conducted to find optimal operating conditions within the ice and trash sluice. There are two constraints set on the chain gate left open for the sluiceway operation. The first is that the biological study only has equipment for a maximum of three chain gates and second that those three gates are to be opened over operating turbines so that the turbine flows will help in attracting juveniles to the chain gate entrances. Since the unit priority, established by the physical and numerical tailrace model study are units 4,2,6,5,7,10,9,8, chain gates 2c, 4c, and 6c were set open to allow for maximum coverage of the forebay under those priorities. As stated in the CFD forebay modeling section, because the turbine unit priority won’t likely include running units north of the training wall, no chain gates are operated north of the training wall. With the chain gates chosen the 1D model was used to establish gate elevations to optimize conditions in the ice and trash sluiceway with the following criteria:

Design Criteria:

- Minimum of 3 fps over weirs and throughout channel
- Unsubmerged flow over chain gate entrances
- No gate controls (set and leave operations)
- Maximize flow through the system for better forebay attraction
- Design for Forebay range of 74.5 ft to 76.5

In addition to the design criteria listed above, the equipment used for the biological study requires a minimum of 3 ft of depth over the chain gates at all times to allow for complete detection coverage of the entrances. To allow the head over a gate to drop below 3 ft would compromise the results of the biological study. This criteria turns out to be the overriding criteria for setting gate elevation. Because of this, the ice and trash sluice optimization was conducted with two approaches. The first was to disregard the biological study constraint on head over the weir but accept the constraint on the number of gates and get an optimum operation with three gates. The second approach was to document conditions with the head constraint. This gave an actual and baseline operation to compare to (to see how far off optimal operations we are with the current biological study).

1 Dimensional Model Results

Table 6 summarizes the performance of the ice and trash sluice for all the 1 D model simulations. The table is basically a schematic of the ice and trash sluice for a given operation scenario with the channel velocity provided at each gate. Gates that are open have two additional values the first being the approximate entrance velocity and the lower value being the gate elevation. Velocities highlighted red are below the 3 fps criteria and velocities shaded blue are above the criteria. Gate elevations that are red are submerged by the channel water surface and the gate elevations that are blue are unsubmerged by the channel water surface.

A number of approaches can be taken in setting the gate elevations for chain gate 2c, 4c, and 6c to their optimal elevation for the design forebay elevation. The choice of approach depends on how the criteria are prioritized because not all criteria can be met over the entire range of forebay elevations without some form of gate controls to track the forebay elevation. For the optimum three gate performance scenario it is assumed that a 3 fps velocity over the weir and unsubmerged weir flow are the primary performance criteria to provide a maximum velocity for a given flow scenario and to ensure that fish entering the system can’t leave the system if the gate is unsubmerged. In order to achieve this, the maximum gate elevation is set so that at the

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lowest design forebay the minimum 3 fps entrance velocity is met. This under this scenario the optimal gate elevation is 73.2 ft NGVD29. This elevation provides entrance velocities above 3 fps and unsubmerged weir flow for the design forebay range. The ice and trash sluice channel velocities are above 3 fps downstream of gate 4c except at forebay 74.5 ft NGVD29 where it doesn’t reach 3 fps until it gets downstream of gate 2c. Trials 1, 2, and 3 in Table 6 provide optimal 3 gate conditions under this approach for forebays 74.5, 75.5, and 76.5 ft NGVD29 respectively.

As stated before the instruments used in the biological study require a minimum of 3 ft of submergence at all times in order to function properly throughout the biological study. This would require that the gates be set 3 ft below the lowest design forebay (74.5 ft NGVD29), or at elevation 71.5 ft NGVD29. Trial 4, 5, and 6 in Table 6 provide ice and trash sluice conditions for these gate elevations for forebays 74.5, 75.5, and 76.5 ft NGVD29 respectively. Operated like this the ice and trash sluiceway does provide for higher channel velocities and entrance velocities above 3 fps throughout the operating but gates 4c and 6c become submerged at a forebay elevation of 75.5 ft NGVD29. All gates become submerged at the maximum forebay of 76.5 NGVD29.

Recommended Operations

The recommended operations for optimal ice and trash sluice performance with three chain gates open are as follows:

- B1 unit priority (first on to last on) should be 4,2,6,5,7,10,9, and 8.
- Chain gates 2c, 4c, and 6c should be operated to provide a sluiceway entrance over each of the first 3 operating units and adjacent to the next two units in the unit priority.
- The chain gates should be set at an elevation of 73.2ft NGVD29 to provide maximum entrance velocities without submerging any of the opened gates.

Since the instruments that are being used to track fish for this study preclude the last of these recommendations the three gates should be set to provide the minimum submergence required for the instruments (71.5 ft NGVD29) at the minimum design forebay (74.5 ft NGVD29).

It is also recommended that hydraulic data be collected as part of future biological study to evaluate the performance of the ice and trash sluice over a range of forebays and operational scenarios so that the best conditions can be achieved with regards to forebay attraction, ice and trash sluice passage, and tailrace egress. Hydraulic data would allow for improved performance of the 1D model so that it can be expected to give reasonable simulation for submerged flow conditions, which is an important operating range if maximum flow through the system and channel velocities becoming the primary criteria in evaluating performance.

If all criteria are to be met with the ice and trash sluice a larger number of gate openings should be considered in future evaluations as well as automating the gates to track the forebay and provide constant optimal performance throughout the design forebay ranges.

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February 2008

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
					1	2
3	4	5	6	7	8 Revised Draft FPP Due to NWD Happy Birthday	9
10	11	12 TDAN dewater	13 TDAN dewater	14 FPOM Meeting-NOAA	15	16
17	18 President's Day	19 JDAN dewater	20 JDAN dewater	21	22	23
24	25	26	27	28	29 Annual FPP Issued Adult fish facility maintenance ends	

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March 2008

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
						1 Adult Passage Season Begins – Start counting at Lower Granite Dam
2	3	4	5	6	7	8
9	10	11	12	13 FPOM - NOAA Shad task group.	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

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April 2008

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
		1 Adult Fish Counting Starts all Dams. Juvenile Bypass Season Begins	2	3 Juvenile Spill Starts Snake River Dams – Pools to MOP	4	5
6	7	8	9	10 FPOM Meeting-NOAA	11	12
13	14	15	16	17	18	19
20	21 Snake River Juvenile Transport Begins	22	23	24	25	26
27 Happy Birthday	28	29	30