Appendix I

Dworshak Operations

I. Introduction

The NOAA Fisheries 2008 Biological Opinion (2008 BiOp) requires annual progress reports that describe actions taken to implement certain reasonable and prudent actions (RPA) for the Endangered Species Act (ESA) commitments. This annual progress reporting requirement applies to RPAs 4 and 15 which include Dworshak Dam operations. This appendix is to provide the information needed for completion of the annual progress report and to provide the regional Technical Management Team (TMT) with a summary on the Dworshak Dam summer operation.

II. 2008 Biological Opinion, RPA Actions

The NOAA Fisheries 2008 BiOp, RPAs 4 and 15 calls for several actions associated with Dworshak Project operations:

RPA 4 – Storage Project Operations:

1. Operate to standard flood control criteria; shift system flood control to Grand Coulee when possible, unless modified by Hydro Strategy 1, Action 14 (Dry Water Year Operations).
2. When not operating to minimum flows, operate to reaching the upper flood control rule curve on or about April 10 (the exact date to be determined during in-season management) to increase flows for spring flow management.
3. Provide minimum flows while not exceeding Idaho State Total Dissolved Gas (TDG) water quality standard of 110%.
4. Refill the reservoir by about June 30 to 1600 ft.
5. Draft the reservoir to elevation 1535 feet by the end of August and elevation 1520 feet (80 feet from full) by the end of September unless modified per the Agreement between the U.S. and the Nez Perce Tribe for water use in the Dworshak Reservoir.
6. Regulate outflow temperatures to attempt to maintain water temperatures at Lower Granite tailwater at or below the water quality standard of 68° F.
7. Maximum project discharge for salmon flow augmentation to be within state of Idaho TDG water quality standards of 110% (There will be expansion of a water temperature modeling program with CE-QUAL-W2).

RPA 15 – Water Quality Plan:

8. Continued development of the CE-QUAL-W2 model for estimating river temperatures from Dworshak Dam on the Clearwater, Middle Snake River near the confluence with the Grand Ronde River (USGS Anatone gauge) and through the lower Snake River (all four Corps lower Snake River projects). The model results are used to assist in real-time decision making for Dworshak Dam operations.

III. Actual Operations

a. Hydrologic Summary

The total inflow to Dworshak Reservoir during water year 2010 was approximately 2.7 million acre-feet (maf). The April through July runoff totaled 1.9 maf, which is 72 percent of average based on the period 1971-2000. The peak inflow

occurred on June 3rd at 21.4 thousand cubic-feet per second (kcfs) and the reservoir reached full pool (1600.00 feet) on June 24th. The peak discharge from Dworshak Dam was 13.7 kcfs on June 21st. Based on the 72 percent of normal runoff in the North Fork Clearwater above Dworshak, the inflow to Dworshak represents a dry year with operations consistent with RPA-14. Discharge from Dworshak was minimized to the extent possible during the winter and spring in effort to maximize the chance of refill.

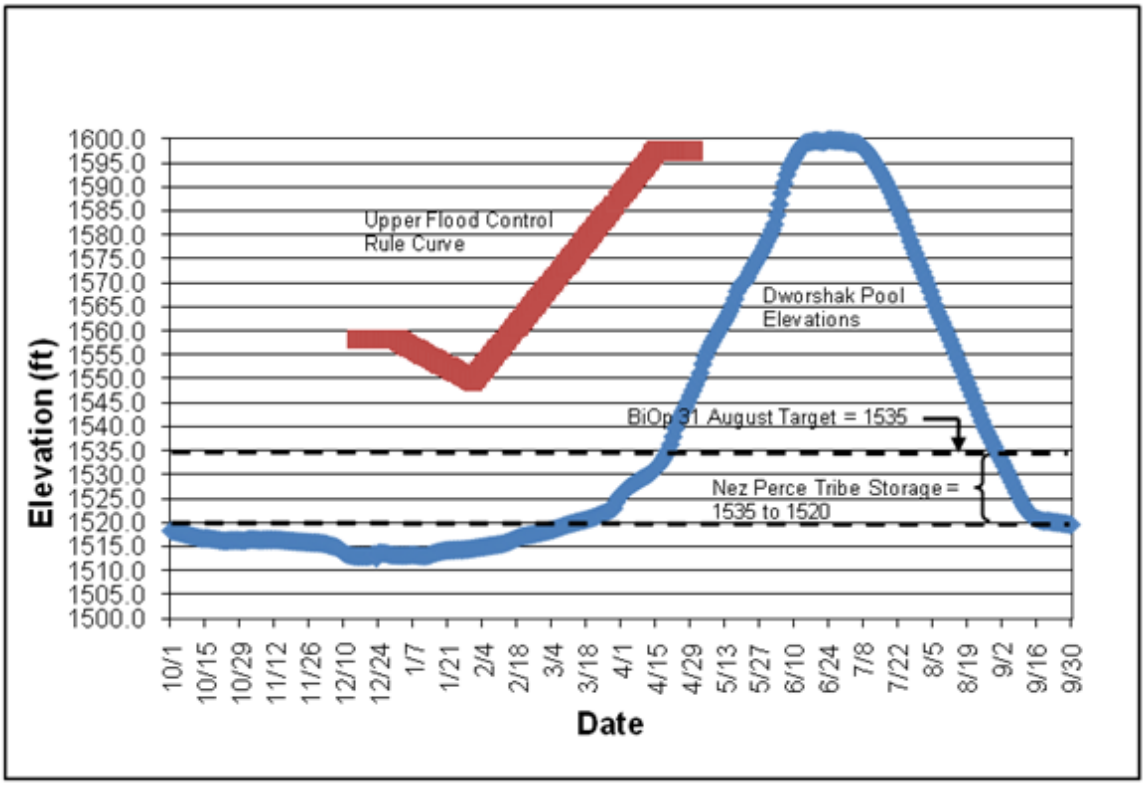
b. Dworshak Dam Elevation Summary

The reservoir elevation targets as outlined in the 2008 BiOp, RPA 4, specific actions #1, #2, #4 and #5 as listed in section II were satisfied during 2010. Refill of the reservoir began in January and continued through June, reaching full on June 24th. A visual inspection of the snow pack in the basin was conducted on June 14th by helicopter, and found approximately 5 percent snow covered area with a ripe snowpack (actively melting). Final refill was timed to intersect the falling limb of the inflow hydrograph as it receded below Dworshak powerhouse discharge capacity. The reservoir maintained near full pool until July 6th at which time temperature moderation and flow augmentation began for the lower Snake River (Figure 1). The reservoir was drafted to elevation 1535 ft by August 31st and subsequently drafted an additional 15 ft to elevation 1520 ft by September 23rd. This effort was to release the 200 thousand acre-feet (kaf) of the Nez Perce Tribe adjudicated water. Discharges were set to minimum levels beginning September 23rd. Figure I-1 shows the elevation of the reservoir during water year 2010.

c. Grand Coulee Dam/Dworshak Dam Flood Control Shift

During water year 2010, the potential shift was computed based on the upper flood control curve for Dworshak Reservoir. Due to the abnormally dry fall and winter, Dworshak Dam was operated throughout the fall, winter and spring until mid May on minimum discharge, and the pool did not fill enough to reach the upper flood control rule curve. As a result, there was more space in Dworshak Reservoir than was required for flood control, so no space could be shifted to the Grand Coulee Project. The highlighted area in Figure I-1 reflects the low pool elevation with respect to the upper flood control curve. A Grand Coulee/Dworshak flood control shift was not physically possible in 2010. Discharge from Dworshak was kept at minimum discharge (except for required unit testing after annual maintenance) from the end of September to the middle of May. From February to April (flood control shift season) Dworshak was at least 35 feet below the upper flood control rule curve. To have a shift of flood control space, Dworshak must have sufficient inflow to fill above the upper flood control rule curve and Grand Coulee must be able to draft below its upper rule curve. The operation satisfied the 2008 BiOp action requirement #2. Starting in late January the minimum discharge from Dworshak Dam was reduced to 1.2 kcfs and held there until June 8th (in spite of cavitation damage) in an effort to conserve water and refill Dworshak Reservoir except for a small fish augmentation flush from May 19th to 21st.

Figure I-1:
Dworshak Dam Elevation
Water Year 2010



d. Significant In-season Issues (e.g., gate failures, oil spills, unit outages, etc.)

During 2010 there were a few concerns with the operability of Dworshak Dam. There were no TDG or temperature exceedances during, or as a result of, in-season equipment operational issues at Dworshak Dam.

e. System Operations Request (SOR) Summary

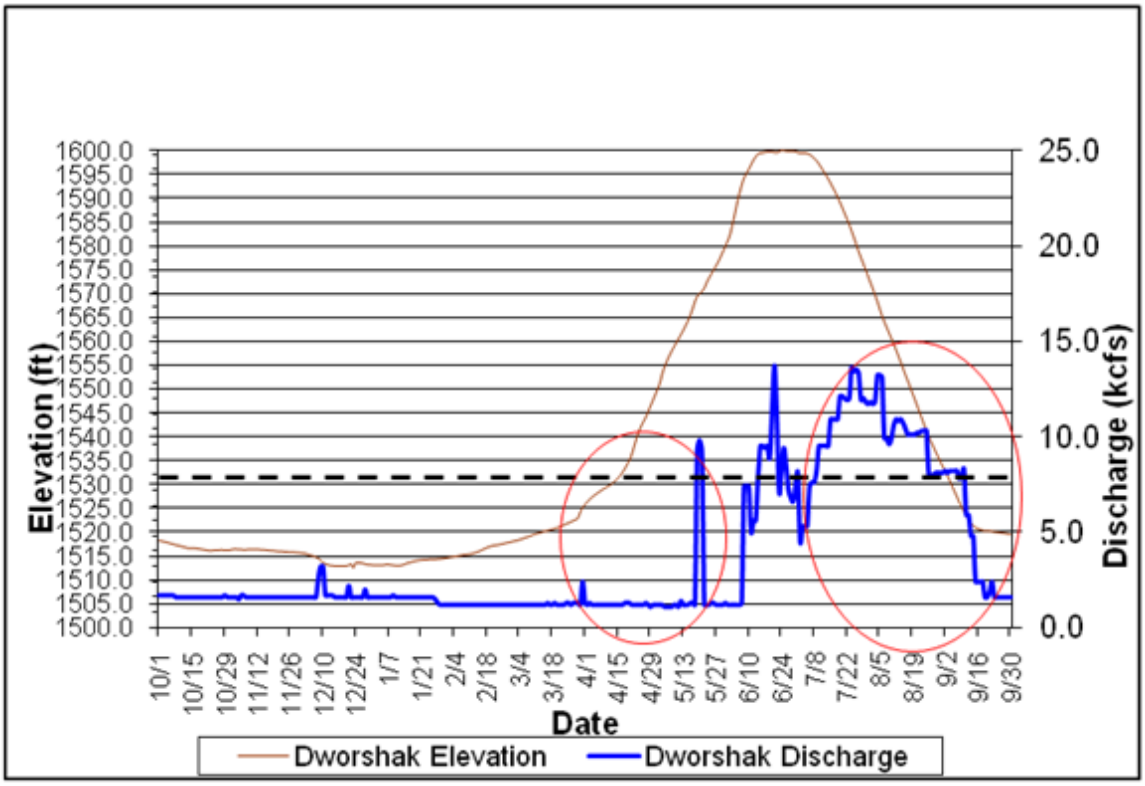
There was one SOR for Dworshak Project during the 2010 water year. The SOR requested increased flows up to powerhouse capacity (10 to 10.5 kcfs) for three consecutive days during the week of May 17th. During this period in the season, the snowmelt runoff volume is still subject to considerable change. Based on 15 historical years with similar runoff volume compared to the forecasted water supply volume, there was about a 50% chance of the reservoir missing refill. Supplying the flows requested by the SOR could have potentially adversely impacted refill by as much as 3 feet. The SOR was discussed on May 12th and 17th with the TMT representatives expressing the significance of the need for the flow pulse. The Corps of Engineers (COE) implemented the SOR as requested starting the full powerhouse discharge at 0:00 hours on May 19th and continuing through 24:00 hours on May 21st.

f. Flow Augmentation Summary

Water for flow augmentation and temperature moderation was supplied for both spring migration as well as summer temperature control on the lower Snake River.

Figure I-2 highlights the discharge made during both of those time periods. The spring flow augmentation resulted in a peak discharge of 2.4 kcfs and a total volume of 0.09 maf released from March 31 through May 6. The summer flow augmentation and temperature moderation resulted in a peak discharge of 13.6 kcfs and a total volume of 1.43 maf released from July 7 through September 23. The average discharge rates for both the spring and summer augmentation periods were 1.2 kcfs and 9.1 kcfs, respectively. Again, these operations satisfied RPA 4, specific actions #1 and #2 as listed in section II. The Corps provided minimum flows during the winter and spring which fulfilled the requirement in RPA 4, specific action #3 as listed in section II.

Figure I-2:
Dworshak Dam Elevation and Discharge Relationship
Water Year 2010



g. Dworshak Dam Water Temperature Summary

During WY 2010, the seasonal average discharge for flow augmentation and temperature moderation was much lower than most of the previous water years. By maximizing the use of the powerhouse intake selector gate in conjunction with the forebay temperature data (Figure I-3) the discharge temperatures were maintained near 45°F from early May to late August. In addition, using this information allowed seasonal discharge temperatures to be below the values observed during the last 10 years of flow augmentation (Figure I-4). This provided the necessary cool water to meet the RPA 4, specific action #6 listed in section II at Lower Granite Dam.

Figure I-3:
Dworshak Reservoir Forebay Temperature
(Data from Floating Temperature String DWR_S1 @ 0600 hr)

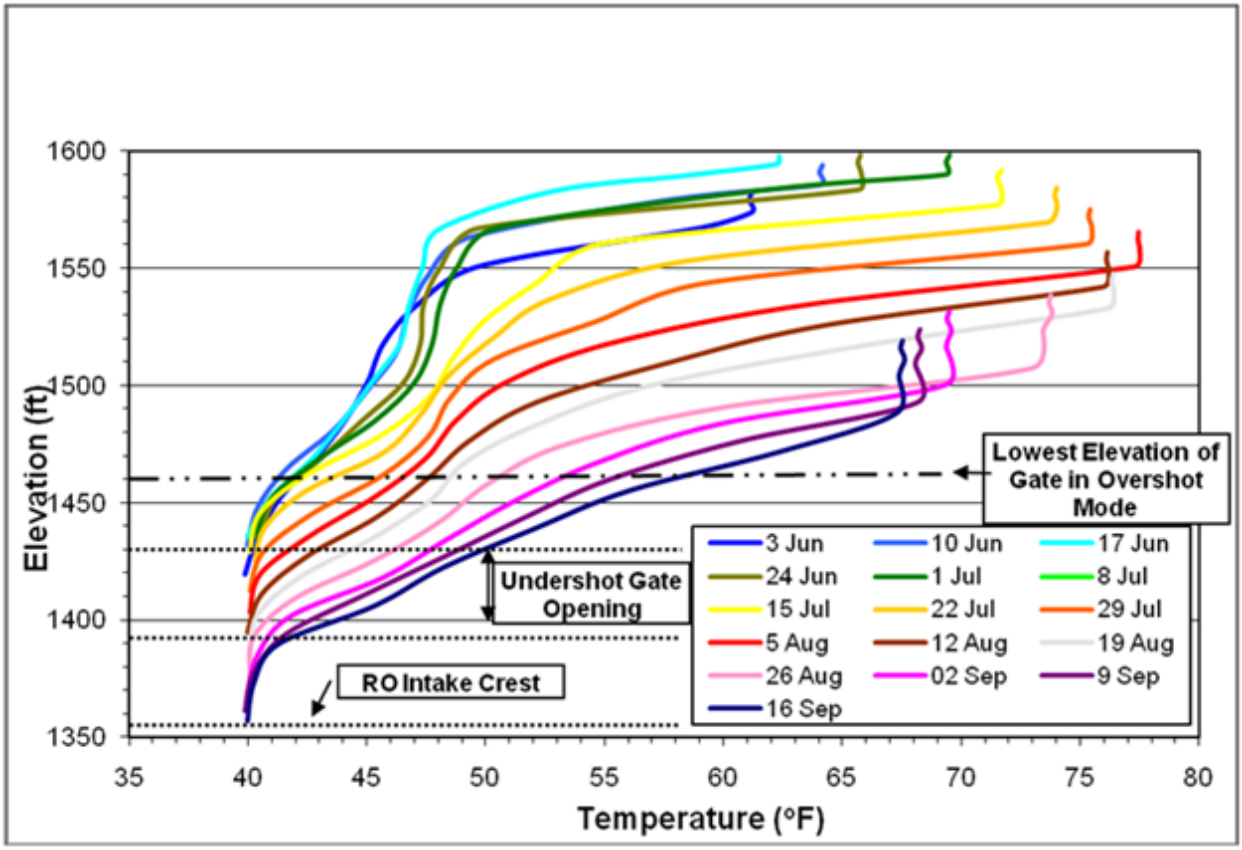
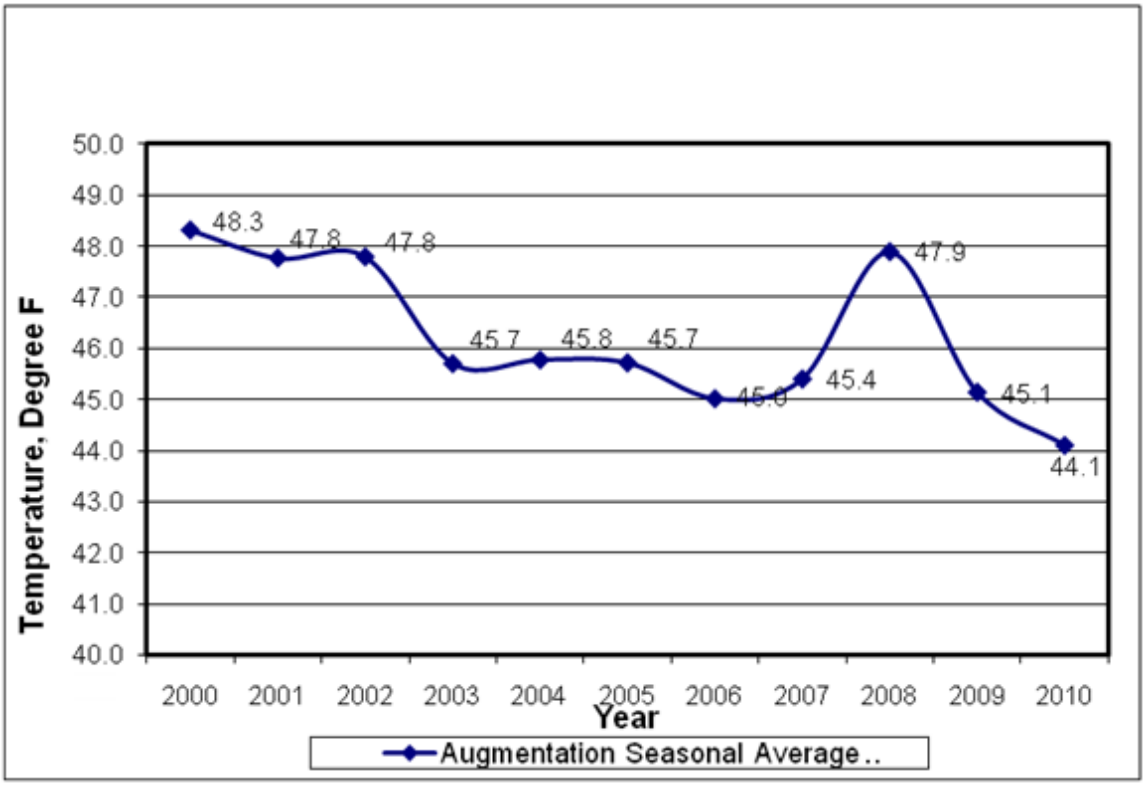


Figure I-4:
Dworshak Dam Seasonal Average Discharge Temperature
2000-2008

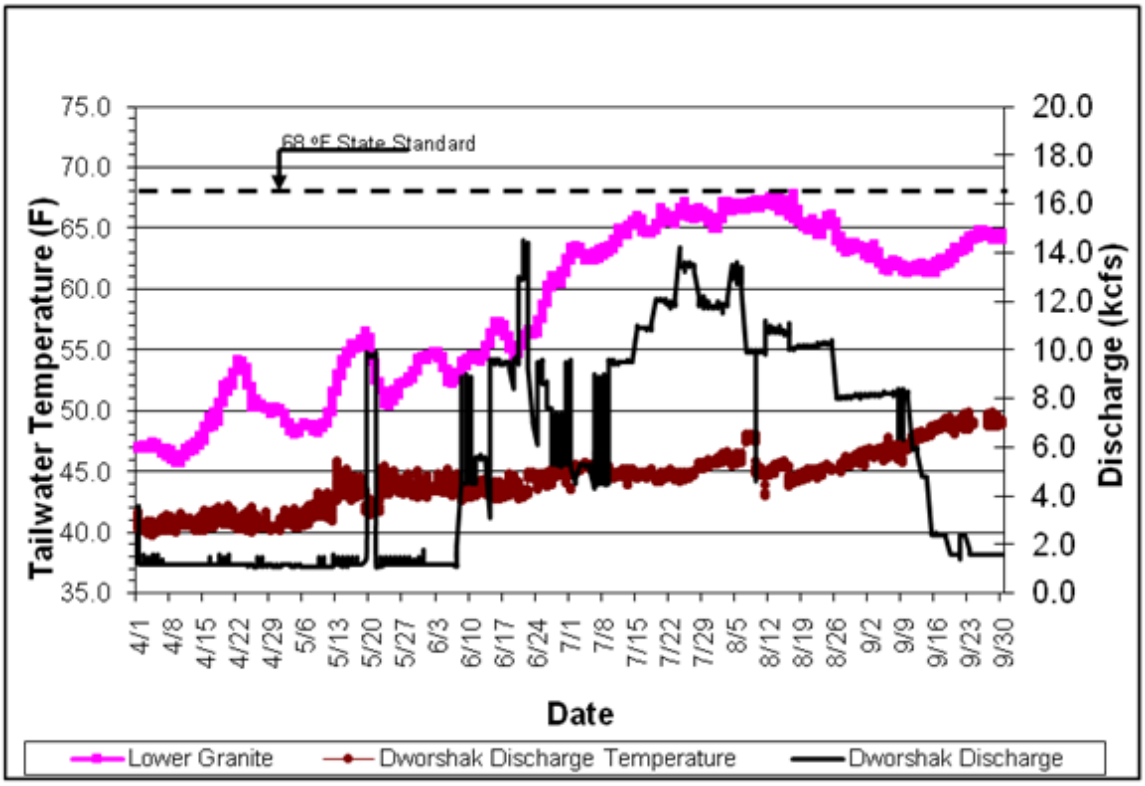


IV. Effects of Cold Water Releases on Lower Granite Dam Tailwater Temperature.

a. Lower Granite Dam Temperature Summary

The tailwater temperatures at Lower Granite Dam through the augmentation season did not exceed 68°F. This was the result of cooler late spring and early summer temperatures due to above average precipitation in June, and Dworshak cool water releases throughout the summer. Without the very cool (45°F) water released from Dworshak Dam, there would have been many temperature exceedances, especially in August. The 2010 Dworshak Dam summer flow augmentation and temperature moderation operations to provide a cooling effect on the lower Snake River were successful 100% of the time and fulfilled the requirements of RPA 4, specific action #6 listed in section II. The weather during the summer of 2010 in Lewiston, ID was relatively normal with a couple weeks of 100+ °F temperatures. Therefore, Dworshak Dam releases prevented significant increases in Snake River temperatures below Lower Granite Dam. Figure I-5 demonstrates how Dworshak Dam discharges affected Lower Granite tailwater temperatures during water year 2010.

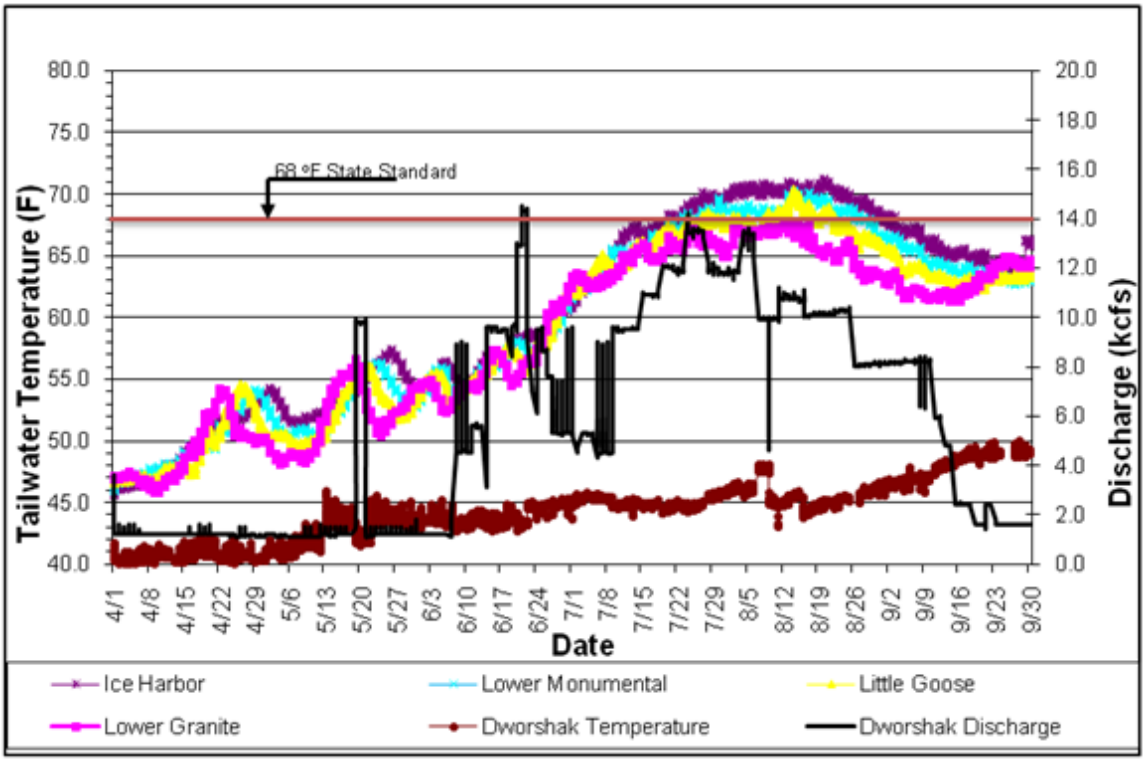
Figure I-5:
Lower Granite Tailwater Temperature
April 1- September 30, 2010



b. In-Season Decisions Results

In addition to meeting the target for temperature at Lower Granite Dam, Figure I-6 shows the tailwater temperatures for all the Lower Snake River projects. The only extended periods that exceed the Washington temperature standard were much further downstream at Lower Monumental and Ice Harbor dams where Dworshak Dam discharge has significantly less influence.

Figure I-6:
Lower Snake River Temperatures and Dworshak Outflows
April 1-September 30, 2010



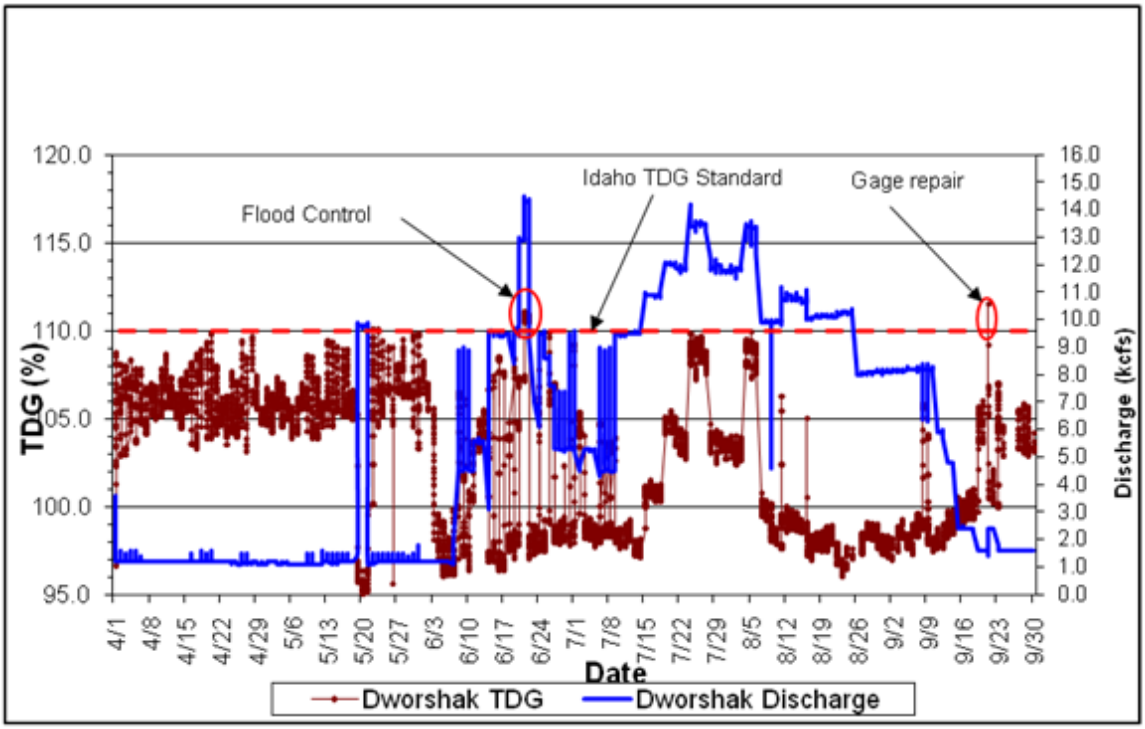
V. TDG Levels in Dworshak Dam Tailwater

a. Dworshak Dam TDG Levels Summary

The discharge from Dworshak Dam exceeded the Idaho state total dissolved gas standard only a few hours during the summer flow augmentation period. As a result, the RPA 4, specific action #7 as listed in section II requirement to keep TDG levels at or below 110percent, were satisfied approximately 99.5 percent of the time for TDG in the north fork Clearwater River. The isolated occurrences for exceeding 110 percent TDG level were unavoidable due to high discharge, and during a repair of the TDG gauge just below Dworshak Dam.. The period of high discharges occurred during the late spring when late rain caused higher than forecasted inflows when the pool was nearly full (mid June). Discharge was increased to 14.5 kcfs to offset the higher inflow, resulting in a short period of high TDG. The 110% TDG limit was exceeded later in September, however, this exceedance occurred during a repair and extension of the TDG gauge deployment pipe. The increase in TDG coincided with an increase in discharge from 1.4 to 2.2 kcfs which does not normally result in elevated TDG. The high TDG may have been due to the location of the temporary TDG monitoring equipment.

Figure I-7 shows the TDG levels relative to the total Dworshak Project discharge. There were no TDG values during the winter and early spring that exceeded 110% while maintaining minimum stream flows below Dworshak Dam.

Figure I-7:
North Fork Clearwater below Dworshak Dam TDG Levels
April 1- September 30, 2010



VI. Water Temperature Modeling

a. CE-QUAL-W2 Model Summary

The CE-QUAL-W2 model was utilized extensively during the summer flow augmentation and temperature moderation of the lower Snake River. This model enabled the Corps, in conjunction with TMT members, to determine the best discharge sequences from Dworshak Dam to meet the temperature targets in the lower Snake River. The model results provided information to manage the discharge from Dworshak Dam more effectively during the flow augmentation season. The near real-time decision capability allowed for more flexibility to meet the RPA 15, specific action #7 as listed in section II. Table I-1 lists the dates of model runs during water year 2010.

Table I-1:
Dates of CE-QUAL-W2 Model Runs

Date	Run #
6/29/2010	1
7/7/2010	2
7/12/2010	3
7/13/2010	4
7/21/2010	5, 6
7/24/2010	7
7/26/2010	8, 9
7/27/2010	10, 11
7/29/2010	12
8/2/2010	13, 14, 15
8/3/2010	16, 17
8/4/2010	18, 19
8/5/2010	20, 21
8/9/2010	22, 23
8/10/2010	24, 25
8/11/2010	26
8/15/2010	27, 28
8/18/2010	29, 30
8/20/2010	31
8/23/2010	32
Total	32

The CE-QUAL-W2 modeling performed during the 2010 Dworshak Dam summer operations fulfilled the requirements of RPA 15, specific action #8 as listed in section II.

b. Water Quality Model Concerns

The input data to the model is often the most significant concern. The model calculations would likely be more accurate with improved data. This includes not only the forecasted air temperature and precipitation data, but also the observed air, water, and precipitation data. A major factor in the accuracy of the model is accurately predicting Idaho Power releases from Hells Canyon Dam.

c. Water Quality Model Improvements

During 2010, Walla Walla District (NWW) worked with a contractor and the model developer to make significant improvements to the model. Most of the improvements were made in the pre- and post-processing of the data required to run the model and display output. NWW is continuing to work with the contractor to

further enhance the CE-QUAL-W2 model by expanding the model calibration as well as upgrading to a new version of the model. These improvements will improve the capability of the model to be utilized as a nearly continuous simulation model, which will improve in-season decisions.

VII. Conclusion

Water year 2010 resulted in below average inflows to Dworshak Reservoir, similar to many other tributary basins in the Snake River watershed. The late spring precipitation significantly improved the amount of flexibility in providing flow augmentation and temperature moderation in the lower Snake River during spring and summer seasons. Overall, the requirements of the RPA Actions 4 and 15 of the 2008 BiOp were satisfied fully, except for when it was unavoidable as described in this appendix.