
2021 WATER MANAGEMENT PLAN



North Fork Clearwater Watershed Snowline
June 1st, 2020
Photo by the U.S. Army Corps of Engineers

Bonneville Power Administration
U.S. Bureau of Reclamation
U.S. Army Corps of Engineers

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1. Introduction

The U.S. Army Corps of Engineers (Corps), Bureau of Reclamation (Reclamation), and Bonneville Power Administration (BPA), collectively referred to as the Action Agencies (AAs), have consulted with the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS), collectively referred to as the Services, on the effects of operating the 14 Federal multi-purpose projects in the Columbia River System (CRS) on species listed as endangered or threatened under the Endangered Species Act (ESA). These consultations resulted in biological opinions (2020 CRS BiOps) from the Services that concluded that operations and maintenance of the CRS as proposed by the AAs in the Biological Assessment of Effects of the Operations and Maintenance of the Federal Columbia River System (January 2020) (2020 CRS BA) and the Clarification and Additional Information to the Biological Assessment of Effects of the Operations and Maintenance of the Columbia River System on ESA-listed Species transmitted to the Services on January 23, 2020 (April 1, 2020) (2020 BA Clarification Letter), as well as actions in the Incidental Take Statements in the 2020 CRS BiOps are not likely to jeopardize the continued existence or adversely modify designated critical habitat of ESA-listed species. The AAs are currently operating in accordance with the 2020 CRS BiOps from the Services as well as other governing documents that are described below in greater detail in Section 2.

The 2021 Water Management Plan (WMP) describes the AAs' plan for the 2021 water year (October 1, 2020 through September 30, 2021) for implementing the specific storage project and reservoir operations as detailed in the Proposed Action in the AAs' 2020 CRS BA and 2020 BA Clarification Letter and analyzed in the 2020 NMFS CRS BiOp (2020 NMFS BiOp) and the 2020 USFWS CRS BiOp (2020 USFWS BiOp). The AAs selected the Preferred Alternative from the 2020 Columbia River System Operations Environmental Impact Statement (CRSO EIS), which was the basis of the Proposed Action in the 2020 CRS BA, as the Selected Alternative for implementation in the Record of Decision (ROD), dated September 28, 2020. The ROD also incorporated the requirements outlined in the Incidental Take Statements contained in the 2020 CRS BiOps.

The AAs are the final authorities on the content of the WMP after coordination with the sovereign inter-agency Technical Management Team (TMT) to solicit their review, comment, and recommendations for consideration during preparation of the WMP. The WMP is consistent with the adaptive management provisions considered in the CRSO EIS and ROD, as well as the 2020 CRS BiOps. System operations contained in the WMP may be adjusted in-season in coordination with the TMT. The AAs prepare seasonal updates to the 2021 WMP in coordination with the TMT and will post any updates on the following website: <http://pweb.crohms.org/tmt/documents/wmp/>

2. Governing Documents

Information regarding operations described in the WMP may be found in the following governing documents.

2.1 Biological Assessments (BA)

2007 BA on the Upper Snake (Reclamation)

Reclamation submitted a BA to NMFS in August 2007 that described actions involving operations and routine maintenance at 12 Federal projects located upstream of Brownlee Reservoir and evaluated the effects of those actions on ESA-listed fish species. The BA is available on the following website:

<http://www.usbr.gov/pn/programs/esa/uppersnake/index.html>

2020 CRS BA (BPA, Reclamation, and Corps)

The Corps, on behalf of the AAs, submitted a BA to the Services on January 23, 2020, titled, “Biological Assessment of Effects of the Operations and Maintenance of the Federal Columbia River System on ESA-Listed Species” (2020 CRS BA). The 2020 CRS BA described the operation and maintenance of the 14 Federal multiple use dam and reservoir projects in the CRS for formal consultation under Section 7 of the ESA and Essential Fish Habitat consultation under the Magnuson-Stevens Fishery Conservation and Management Act. The 2020 CRS BA described the operations and maintenance of the 14 CRS dams and associated effects of those actions on ESA-listed species. The 2020 CRS BA citation throughout this WMP incorporates by reference the April 1, 2020, letter from the Corps to the Services titled, “Clarification and Additional Information to the Biological Assessment of Effects of the Operations and Maintenance of the Columbia River System on ESA-listed Species Transmitted to the Services on January 23, 2020” (2020 BA Clarification Letter). The BA may be found in Appendix V, Part 1, on the following website:

<https://www.nwd.usace.army.mil/CRSO/Final-EIS/#top>

2.2 BiOps

2008 NMFS Upper Snake BiOp

The 2008 NMFS Upper Snake BiOp titled, “Consultation for the Operation and Maintenance of 10 U.S. Bureau of Reclamation Projects and 2 Related Actions in the Upper Snake River above Brownlee Reservoir (Revised and Reissued Pursuant to court order, *American Rivers v. NOAA Fisheries*, CV 04-0061-RE (D. Or. Feb. 27, 2006,)),” and dated May 5, 2008. The document may be found on the following website:

http://www.westcoast.fisheries.noaa.gov/fish_passage/fcrps_opinion/federal_columbia_river_power_system.html

2020 USFWS BiOp

The 2020 USFWS BiOp titled, “Endangered Species Act - Section 7 Consultation Biological Opinion U.S. Fish and Wildlife Service Reference: 01EWF00-2017-F-1650, Columbia River System Operations and Maintenance of 14 Federal Dams and Reservoirs,” dated July 24, 2020, replaced the 2000 and 2006 USFWS BiOps. The 2020 USFWS BiOp analyzed the effects of the Proposed Action as described in the AAs’ 2020 CRS BA. The 2020 USFWS BiOp and related documents may be found on the following website:

<http://www.salmonrecovery.gov/BiologicalOpinions/FCRPSBiOp.aspx>

2020 NMFS BiOp

The 2020 NMFS BiOp titled, “Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response, Continued Operation and Maintenance of the Columbia River System,” dated July 24, 2020, replaced the 2019 NMFS BiOp. The 2020 NMFS BiOp analyzed the effects of the Proposed Action as described in the AAs’ 2020 CRS BA. The 2020 NMFS BiOp and related documents may be found on the following website:

<http://www.salmonrecovery.gov/BiologicalOpinions/FCRPSBiOp.aspx>

2.3 Additional Governing Documents

1987 Snake River Basin Adjudication (SRBA)

The 1987 SRBA was an administrative and legal process that began in 1987 to determine the water rights in the Snake River Basin drainage. The Final Unified Decree for the SRBA was signed on August 25, 2014. Documentation associated with the SRBA may found on the following website:

<https://idwr.idaho.gov/water-rights/adjudication/SRBA/>

2003 Corps Columbia River Treaty Flood Control Operating Plan (FCOP)

The Columbia River Treaty between Canada and the United States of America provides that the powers and duties of the United States Entity include the preparation of a Flood Control Operation Plan (FCOP) for Canadian storage in the Upper Columbia River Basin. The purpose of the FCOP for Canadian storage is to prescribe criteria and procedures by which the Canadian Entity will operate Mica, Duncan, and Arrow Reservoirs to achieve flood risk management (FRM) objectives in the United States and Canada. Because Canadian storage is an integral part of the overall Columbia River reservoir system, the FCOP for this storage must be related to the flood control plan of the Columbia River as a whole. The principles of the Columbia River System operation are therefore contained in the FCOP, which may be found on the following website:

<http://www.nwd-wc.usace.army.mil/cafe/forecast/FCOP/FCOP2003.pdf>

2.4 Other Key Documents

Columbia River System Operations Environmental Impact Statement and Record of Decision

The Final CRSO EIS dated July 2020 addresses the ongoing operations, maintenance, and configuration of the 14 Federal Columbia River System (CRS) projects on the Columbia and Snake rivers. As part of the CRSO EIS, the agencies considered six alternatives to Columbia River System operations, maintenance, and configuration. The agencies analyzed the effects of these alternatives on the human environment, including environmental, economic, and social impacts. On February 28, 2020, the co-lead agencies released for public comment the Draft CRSO EIS describing the effects of these alternatives and identifying the agencies’ Preferred

Alternative. The co-lead agencies released the Final EIS on July 28, 2020, and the agencies issued the joint Record of Decision on September 28, 2020. The co-lead agencies identified the Preferred Alternative, as described in detail in Chapter 7 of the Final EIS, as the Selected Alternative in the Record of Decision (ROD). The Draft and Final CRSO EIS and the Record of Decision may be found on the following website:

<https://www.nwd.usace.army.mil/CRSO/Final-EIS/#top>

Columbia Basin Fish Accords

States, tribes and the AAs continue to work side by side for the good of endangered salmon and steelhead through the Columbia Basin Fish Accords. The original agreements, signed in 2008, provided states and tribes more than \$900 million to implement projects benefiting salmon, steelhead, and other fish and wildlife, and \$50 million for Pacific lamprey passage improvements at Federal dams on the Columbia and Snake rivers. Accord agreements were extended in 2018 with the Shoshone Bannock Tribes, the Columbia River Inter-Tribal Fish Commission, the Confederated Tribes and Bands of the Yakama Nation, the Confederated Tribes of the Colville Reservation, the Confederated Tribes of the Umatilla Indian Reservation, the Confederated Tribes of the Warm Springs Reservation of Oregon, the states of Idaho and Montana, and the AAs. Additionally, there is an Accord agreement with the AAs and the Kalispel Tribe of Indians effective until September 30, 2022. The State of Washington has signed a Memorandum of Understanding with BPA.

Albeni Falls Dam Flexible Winter Power Operations Final Environmental Assessment

The Albeni Falls Dam Flexible Winter Power Operations Final Environmental Assessment (FWPO EA), dated October 2011, evaluates the effects of a BPA proposal that the Corps operate Albeni Falls Dam (AFD) during the winter months to utilize a larger portion of the authorized operating range. The proposal includes storing and discharging water behind AFD for power purposes during the winter months, potentially fluctuating the surface elevation of Lake Pend Oreille between the annual minimum control elevation (MCE) and 2056 feet from about mid-December until March 31 every year. The FWPO EA analysis found that preparation of a new or supplemental EIS was not warranted to implement the FWPO, and resulted in the adoption of FWPO as a winter operation at AFD.

This document may found on the following website:

<https://www.nws.usace.army.mil/Portals/27/docs/environmental/resources/OlderEnvironmentalDocuments/AFD%20FWPO%20Final%20EA%2011-04-11%20signed%20all.pdf>

3. WMP Implementation Process

3.1 Technical Management Team (TMT)

The TMT is an inter-agency technical group comprised of sovereign representatives responsible for making in-season recommendations to the AAs on dam and reservoir operations in an effort to meet the expectations of the applicable BiOps (listed above) and accommodate changing conditions, such as water supply, fish migration, water quality, new information, and

maintenance issues. The TMT consists of representatives from: the tribes of Nez Perce, Kootenai, Colville, Umatilla, Spokane, and Warm Springs; the states of Oregon, Washington, Idaho, and Montana; NMFS; USFWS; and the AAs.

3.2 Preparation of the WMP

Each fall, the AAs prepare an annual WMP (draft by October 1 and final by December 31). The AAs prepared this WMP for the 2021 water year consistent with the CRSO EIS ROD, as detailed in the Final CRSO EIS, 2020 CRS BiOps, 2020 CRS BA, and 2020 BA Clarification Letter. This WMP describes the planned operations of the CRS dams and reservoirs for the 2021 water year (October 1, 2020, through September 30, 2021)¹. The operations are designed to:

1. Implement the actions identified in the CRSO EIS ROD, as detailed in the Final CRSO EIS, 2020 CRS BA, and 2020 CRS BiOps.
2. Implement the requirements outlined in the Incidental Take Statements contained in the 2020 CRS BiOps.
3. Meet other CRS project requirements and purposes such as FRM, hydropower generation, irrigation, navigation, recreation, and conservation of fish and wildlife. Additional information regarding Columbia River FRM may be found on the following website: <http://www.nwd.usace.army.mil/Missions/Water/Columbia/Flood-Control/>
4. Take into account recommendations contained in the applicable Northwest Power and Conservation Council's Fish and Wildlife Program and amendments.

The WMP also includes special operations planned for the year (e.g., tests, maintenance, construction activities, etc.) known at the time the WMP is developed. Throughout the season, the AAs will utilize the TMT forum to provide the region with seasonal updates on water supply forecasts and specific project operations. These will be available on the following website: <http://pweb.crohms.org/tmt/documents/wmp/>

3.3 Fish Passage Plan (FPP)

The Corps coordinates with regional agencies to prepare an annual Fish Passage Plan (FPP) that provides detailed operating criteria for project fish passage facilities, powerhouses, and spillways to facilitate the safe and efficient passage of migratory fish. The FPP contains appendices that describe special operations for fish research studies, the juvenile fish transportation program, operation of turbine units with respect to 1% of peak efficiency, spill for fish passage, total dissolved gas (TDG) monitoring, and dewatering procedures. The FPP is coordinated through the inter-agency Fish Passage Operations and Maintenance (FPOM) Coordination Team and is available on the following website:

<http://pweb.crohms.org/tmt/documents/fpp/>

¹ In the preparation of the draft WMP, very little information is available about the upcoming year's water supply; therefore, the draft provides a general description of planned operations for that water year.

3.4 Non-ESA-Listed Fish and Wildlife Conservation Operations

Each year the AAs implement water management actions to achieve other project purposes in addition to those required under the ESA, including: FRM, hydropower generation, irrigation, navigation, recreation, and conservation of fish and wildlife. Table 1 defines non-ESA listed fish and wildlife conservation related water management actions that may be implemented and the time of year such actions typically occur, and are further described below.

Table 1. Location and Timing of Water Management Actions Related to non-ESA listed Fish and Wildlife Species.

Project	Water Management Actions for:	Time of Year
Keenleyside (Arrow)	Mountain whitefish	December – January
Keenleyside (Arrow)	Rainbow trout	April – June
Duncan	Whitefish	March – May
Libby	Burbot (temperature)	October - February
Dworshak	Hatchery rearing and release (TDG management and increased flow)	March-April
Grand Coulee	Refill for resident fish	September-October
Hanford Reach Fall Chinook Protection Program Agreement	Fall Chinook	October – June
McNary	Waterfowl Nesting	March – May
Bonneville	Fall Chinook	October - May

4. Columbia River System Operations

4.1 Priorities

The 2020 CRS BiOps considered the following strategies for flow management:

1. Provide minimum project flows in the fall and winter to support fisheries below the storage projects (e.g., Hungry Horse, Dworshak, Albeni Falls, and Libby). Limit the winter/spring drawdown of storage reservoirs to increase spring flows and the probability of reservoir refill.
2. Draft from storage reservoirs in the summer to increase summer flows.

3. Provide adequate flows in the fall and winter to support mainstem chum spawning and incubation below Bonneville Dam.

To implement these strategies, the AAs have developed the following priorities (in order) for flow management and individual reservoir operations after ensuring adequate FRM is provided:

1. Operate storage projects to meet minimum flow and ramp rate criteria for resident fish.
2. Attempt to refill the storage projects by the end of June/early July (exact date to be determined during in season management) to provide summer flow augmentation consistent with available water supply, spring operations, and FRM requirements (2020 NMFS BiOp, page 52). For example, a late snowmelt runoff may result in a later refill in order to avoid excessive spill. Target refill dates for the storage projects are listed below in Table 5.
3. Operate storage projects to be at their FRM elevation in early April (the exact date to be determined during in-season management) to maximize flows for the spring out-migration of juvenile salmon (2020 NMFS BiOp, page 52²).
4. Operate Grand Coulee to balance the needs of chum flow augmentation and spring flow augmentation from the start of chum spawning in November through the end of chum emergence (approximately April) to maintain sufficient water depth to protect chum spawning and incubation habitat at the Ives Island complex below Bonneville Dam.

Operations are intended to benefit ESA-listed anadromous fish and to benefit ESA-listed resident fish (e.g., bull trout, Kootenai River white sturgeon) that may be affected by CRS operations. Projects are also operated to meet minimum outflows; avoid involuntary spill and resulting elevated TDG; avoid fluctuations in outflow that may strand fish and degrade fish habitat; and to provide specific releases from storage projects in order to improve downstream flows and water temperatures for fish. These operations are generally the highest priority because of the direct linkage between a particular operation and impacts on fish near the dam.

Because the water year begins on October 1, the flow objectives described in the 2020 CRS BA, (page 2-33) are not encountered in the same order as various operations described in the 2020 NMFS BiOp (e.g., chum spawning flows will be determined prior to spring and summer migration flows, even though chum flows are a lower priority (2020 NMFS BiOp, page 986)). However, the AAs will make every effort to follow flow priorities while implementing operations as they occur chronologically during the year. Objectives include:

1. Drafting storage projects to their August 31 or September 30 elevation targets (2020 NMFS BiOp, page 52) are a higher priority than the summer flow objectives (2020 CRS BA, page 2-33) in order to meet other project uses and reserve water in storage for the following year.
2. Operate storage projects to be at their FRM elevation in early April (the exact date to be determined during in-season management) (2020 NMFS BiOp, page 31). These levels will vary with the runoff forecast. The ability to meet this objective is affected by the quantity of

² The citations provided herein refer to the description of the Proposed Action as summarized in the relevant BiOp(s). For a full description of the Proposed Action, see the 2020 CRS BA.

water released for FRM, changes in runoff volume forecasts, power generation and unit availability, planned and unplanned pool restrictions, draft rate restrictions, water quality, and fishery flows to support both lower Columbia River chum and Hanford Reach fall Chinook spawning, as well as minimum flow requirements below the projects.

3. Attempt to refill the storage projects by the end of June/early July (exact date to be determined during in season management) to provide summer flow augmentation consistent with available water supply, spring operations, and FRM requirements (2020 NMFS BiOp, page 31). Through TMT and in-season management, priority for spring flow may be adjusted with a recognition that summer refill may be compromised.
4. Manage the available storage to augment summer (July and August) flows in the lower Columbia River and lower Snake River in an attempt to meet flow objectives and to minimize increases in water temperature, as described below in the project-specific sections (Section 6).

These objectives are intended as general guidelines. Consistent with actions considered in the current BiOps, the AAs adaptively manage to adjust CRS operations based on best available science, and knowledge about current conditions in the system and effects due to management actions. Conditions that are continually changing include: information on fish migration, stock status, biological requirements, biological effectiveness, and hydrologic and environmental conditions.

4.2 Conflicts

System managers recognize that water supply conditions are variable and unpredictable and there is often insufficient water to accomplish all the objectives addressed in the current BiOps for the benefit of listed fish. This may be further complicated by responsibilities to provide for other authorized purposes such as FRM, hydropower generation, irrigation, recreation, and navigation needs. Management of water resources for any one fish species may conflict with the availability of water for other fish species or project purposes. The AAs, in coordination with regional sovereign representatives through the TMT, consider the multiple uses of the system, while prioritizing measures to benefit listed species. Below are some of the typical conflicts that may occur.

4.2.1 FRM Draft versus Project Refill

The 2020 CRS BiOps specify operation of storage projects at their FRM elevation targets in early April (the exact date to be determined during in-season management) (2020 NMFS BiOp, page 31). This is designed to increase the likelihood of refill and to maximize both spring flow management and summer flow augmentation.

FRM procedures specify the amount of storage needed to provide flood damage reduction. In furtherance of the flood damage reduction objective, storage space is provided to minimize the risk due to forecast and runoff uncertainty. In an effort to reduce forecast error and to better anticipate the runoff timing or water supply, the AAs and the Northwest River Forecast Center (NWRFC) use the best available science to compute water supply forecasts.

4.2.2 Spring Flow Management versus Project Refill and Summer Flow Augmentation

FRM elevations are determined based on water supply, runoff and hydrologic model forecasts and can change significantly from one forecast to the next. Changes in forecasts throughout the FRM season can make it difficult to achieve spring flow and project refill objectives. The summer flow objective at McNary is supported by various flow augmentation measures. There is a limited amount of water available for flow augmentation and summer flow objectives are provided as a biological guideline.

4.2.3 Chum Flow versus Project Refill and Spring Flow Management

Providing a Bonneville Dam tailwater elevation level conducive to chum spawning, incubation, and emergence in the Ives Island complex typically requires flow augmentation from storage reservoirs before reliable flow forecast information becomes available. The proposed continuation of operations for chum spawning, incubation, and egress will improve chum productivity; however, maintaining chum flow augmentation throughout the winter and early spring has the potential to jeopardize spring refill objectives at Grand Coulee Dam during low water years. When this scenario arises, the TMT may recommend dewatering chum redds in the mainstem Ives/Pierce Island area. Tailwater elevations for the spawning operation are set in November through December in coordination with the TMT. The tailwater for incubation and emergence is held as a minimum.

Early water supply forecasts are available starting in December, however the forecast errors are very large. Water supply forecasts become incrementally more reliable as time between the forecast and the forecast period decreases. If the tailwater elevation level selected during the spawning season is too high (requiring higher flows and potentially requiring deeper reservoir drafts), there is an increased risk of missing refill to the April 10 elevation objective at Grand Coulee thereby reducing spring flow augmentation if the higher flows are maintained throughout the chum incubation and emergence period. If the flows must be reduced during the incubation period to target refill, then there is the risk of dewatering chum redds. During the emergence period, the TMT will discuss balancing project refill and spring flows that benefit multiple ESUs that have priority over maintaining the protection tailwater elevation set in December.

4.2.4 Libby Dam Sturgeon Flow versus Summer Flow Augmentation hum Flow

Water released from Libby Dam for spring sturgeon spawning flows (pulse) during May, June, and into July can reduce the probability of reservoir refill, and consequently the amount of the water available for summer flow augmentation from Libby. Although an effort will be made to balance sturgeon flows and reservoir refill, water released for sturgeon spawning flows will take a higher priority than refilling by early July.

4.2.5 Fish Operations versus Other Project Uses

In addition to FRM operations, there are other project purposes that may conflict with operations for the benefit of fish. For example, operations for irrigation and reservoir recreation may conflict with releases of water for flow augmentation. TMT will discuss these issues when they

arise and may make recommendations to the AAs with responsibility for the operational decisions.

4.2.6 Conflicts and Priorities Summary

The conflicts described above pose many challenges to the AAs in meeting the multiple uses of the CRS. The priorities for flow management and individual reservoir operations outlined in Section 4.1 will assist the AAs in operational decision-making.

Discussion of conflicts between operational requirements and alternatives for addressing such conflicts will occur in TMT. Ultimately, the AA with the authority and responsibility for the operation to meet authorized project purposes will make the decision.

4.3 Emergencies

The WMP, the 2020 CRS BiOps, and the current FPP acknowledge that emergencies and other unexpected events occur and may cause interruptions or adjustments of fish protection measures. Such deviations may be short in duration, such as a response to an unexpected unit outage or power line failure, or a search and rescue operation, or longer in duration, such as what was experienced in 2001 in response to the low water conditions. Emergency operations will be managed in accordance with the TMT Emergency Protocols (included in the WMP as Appendix 1), the FPP and other appropriate AA emergency procedures.

4.3.1 Operational Emergencies

The AAs will manage interruptions or adjustments in water management actions, which may occur due to unforeseen power system, FRM, navigation, dam safety, or other emergencies. Such emergency actions will be viewed by the AAs as a last resort and will only be used in place of operations outlined in the annual WMP if necessary. Emergency operations will be managed in accordance with TMT Emergency Protocols, the FPP and other appropriate AA emergency procedures and coordinated through TMT when practicable. The AAs will take all reasonable steps to limit the duration of any interruption in fish protection measures. Emergency Action Plans for generation and transmission emergencies are provided in the Attachments to the TMT Emergency Protocols.

4.3.2 Fish Emergencies

The AAs will manage operations for fish passage and protection at CRS facilities. The intended operation may be modified for brief periods of time due to unexpected equipment failures or other conditions. These events can result in short periods when projects are operating outside normal specifications due to unexpected or emergency events. Where there are significant biological effects of more than short duration emergencies impacting fish, the AAs will coordinate with the Regional Forum (2020 CRS BA, page 2-71) to develop and implement appropriate adaptive management actions to address the situation. The AAs will take all reasonable steps to limit the duration of any fish emergency. The AAs will operate in accordance with the TMT Emergency Protocols identified in Appendix 1 of the WMP.

4.3.3 Emergency Operations for Non-ESA listed Fish

The AAs agree to take reasonable actions to aid non-ESA listed fish during brief periods of time due to unexpected equipment failures or other conditions and when significant detrimental biological effects are anticipated or likely to have occurred. When there is a conflict in such operations, operations for ESA-listed fish will take priority.

4.4 Fish Research

Research studies may require special operations that differ from routine operations otherwise considered in the 2020 CRS BiOps, and described in the current FPP. These studies are generally developed through technical workgroups of the Regional Forum (e.g., the Corps' Anadromous Fish Evaluation Program, Fish Facilities Design Review Work Group, and Studies Review Work Group). Specific research operations are further described in the Corps' FPP (Appendix A) and the AAs' seasonal updates to the WMP. In most cases, operations associated with research entail relatively minor changes from routine operations and are coordinated in regional technical forums (e.g., TMT and/or FPOM). In some cases, the nature or magnitude of operational changes for research may require further coordination and review in policy forums [e.g., Hydro Coordination Senior Technical Team (HCT) or Regional Implementation and Oversight Group (RIOG)]. Generally, research planning and coordination occurs throughout the late fall and winter, with final research plans established by late winter/early spring. If extraordinary events occur, such as extreme runoff conditions (high or low) or a system emergency, planned research may be modified prior to implementation to accommodate anticipated unique circumstances and/or to reallocate resources to obtain the greatest value given the circumstances.

4.5 FRM Shifts

The AAs will look for opportunities to shift system FRM requirements from Brownlee and Dworshak to Grand Coulee periodically from January through April to provide more water for flow augmentation in the lower Snake River during the spring migration. The shift will be based upon end-of-month FRM elevations as stated in the official water supply forecasts produced early each month during this time period. Consideration of these FRM shifts by the Corps will include an analysis of impacts to FRM and will not be implemented if FRM would be compromised. These shifts may be implemented after coordination with TMT to discuss tradeoffs and impacts. The reservoirs must be back to their specific upper rule curve (URC) by April 30.

5. Decision Points and Water Supply Forecasts

5.1 Water Management Decisions and Actions

Table 2 below lists times associated with key water management decisions/actions. Some decision points, such as setting flow objectives, are described in the 2020 CRS BA. Other decision points, such as setting weekly flow augmentation levels, require thorough discussion and coordination. The decision points given below are spelled out in the 2020 CRS BA or are

based on best professional judgment and expertise. These decisions are made by the AAs in consideration of actions analyzed in the BiOps, and input received through the Regional Forums (TMT, RIOG, and Regional Executives).

Table 2. Water Management Decision Points/Actions.

August	September	Early October	November	Winter (December–March)	Early April	Early May	June	Early July
<ul style="list-style-type: none"> • <u>Lower Granite:</u> Variable MOP operation in August or as necessary based on flows (see section 6.10.1). • <u>Dworshak:</u> Coordinate project outflows in order to achieve Lower Granite tailwater temperatures at or below 68°F (see section 6.8.2). 	<ul style="list-style-type: none"> • <u>Albeni Falls:</u> Lake Pend Oreille will be drafted mid to late Sep from the summer operating range. • <u>Libby:</u> Stable flows to protect bull trout and other resident fish while targeting 5 to 20 feet from full by end of Sep. • <u>Hungry Horse:</u> Stable flows to protect bull trout and other resident fish while targeting 10 to 20 feet from full by end of Sep. • <u>Dworshak:</u> Draft to 1520 feet (80 feet from full) by end of Sep, unless modified per the Agreement between U.S. and Nez Perce Tribe for water use in the Dworshak Reservoir. 	<ul style="list-style-type: none"> • <u>Albeni Falls:</u> draft to 2051 feet by mid-Nov unless otherwise requested. • <u>Bonneville:</u> Assess potential tailwater elevations to support chum spawning. • Storage Projects: Preliminary discussions of FRM/project refill strategy. • Support for Hanford Reach fall Chinook protection operations. • <u>Libby:</u> Consider Kootenai burbot temperature operation. 	<ul style="list-style-type: none"> • Early season WSF using SOI. • Hanford Reach fall Chinook redd protection level set. • <u>Bonneville:</u> Set Tailwater elevations to support chum spawning. 	<ul style="list-style-type: none"> • <u>Bonneville:</u> Determine winter/spring chum redd protection tailwater elevation. • Storage Projects: Determine FRM and refill strategies, including any available FRM shifts. • Determine final spring refill objectives based on FCEs and WSFs. • <u>Hungry Horse, Columbia Falls:</u> Min flows set by Jan, Feb, Mar WSF for Apr-Aug. • <u>Dworshak:</u> Determine flexibility to operate above min flow and still reach spring refill targets. • <u>Libby:</u> Monthly Corps WSF determines end of month FRM elevations. • <u>Grand Coulee:</u> Use March WSF at The Dalles Apr-Sep to determine if Lake Roosevelt Inc. Storage draft is 82.5 KAF or 132.5 KAF. 	<ul style="list-style-type: none"> • Spring flow objectives set by April WSFs. • Determine spring flow management strategy including priority for refill. • <u>Lower Snake Projects:</u> Apr 3 begin MOP. • <u>John Day:</u> Apr 10 begin predator disruption operations for Blalock Island Caspian terns (264.5-266.5 feet) to June 1 (may extend to June 15) • Storage Projects: Determine refill start date based on streamflow forecast to exceed ICF at The Dalles. • <u>Libby, Hungry Horse:</u> If required, use April WSF to determine VARQ refill flows. • <u>Storage Projects:</u> When not at min flows, operate to spring refill objectives determined by in-season management. 	<ul style="list-style-type: none"> • <u>Libby:</u> Evaluate likely tier for sturgeon volume using May WSF. Regional technical team recommends shape, timing of sturgeon pulse. • <u>Libby:</u> Minimum outflow 6 kcfs for bull trout from May 15 until sturgeon op begins. • <u>Libby:</u> Use May WSF to calculate tiered bull trout flow for post-sturgeon flow through Aug. • Storage Projects: Determine refill start date based on streamflow forecast to exceed ICF at The Dalles (if not in April). • <u>Libby/Hungry Horse:</u> Use May WSF to determine VARQ refill flows. • <u>Libby:</u> Use local seasonal water supply forecast (Apr-Aug) to determine the draft limit. • <u>Hungry Horse:</u> Use local May WSF for Apr-Aug to determine Sep draft limit. 	<ul style="list-style-type: none"> • <u>Lower Granite:</u> Summer flow objective determined by June WSF. • <u>Libby, Hungry Horse:</u> Use June WSF to determine VARQ refill flows. • Determine summer flow augmentation strategy (early June). • <u>Dworshak:</u> Refill by about June 30. • Begin Dworshak temperature modeling. • <u>John Day:</u> Begin MIP operation June 1 (may be as late as June 15) through Aug 31. 	<ul style="list-style-type: none"> • <u>Grand Coulee:</u> summer draft limit determined by July WSF for The Dalles Apr-Aug. • <u>Libby, Hungry Horse:</u> Estimate stable flows that will draft for salmon. • <u>Libby:</u> Refill probability is likely later in July (exact date determined in-season). • <u>Dworshak:</u> Begin summer flow augmentation and temperature moderation.

5.2 Water Supply Forecasts (WSF)

Water supply forecasts (WSF) serve as a guide to how much water may be available for fish and other operations. Flow projections are provided to the TMT regularly during the fish passage season (April 3 – August 31).

The NWRFC, Corps, Reclamation, and others prepare water supply forecasts to manage the Columbia and Snake rivers, and implement actions considered in the 2020 CRS BiOps (Tables 3 and 4 below).

In 2021, the NWRFC 50% exceedance value for the 10-day initialized ESP forecast (ESP10) for The Dalles and Lower Granite, released closest to or prior to the 3rd working day of the month will be used as the official forecast for each month will be the default forecast for calculating system FRM.

Table 3. Forecast Designations.

Date	Forecast Designation
6 January 2021	January
3 February 2021	February
3 March 2021	March
5 April 2021	April
5 May 2021	May
3 June 2021	June
6 July 2021	July

Table 4. Water Supply Forecasts Used to Implement BiOp Actions. See Table 5 for project-specific operations.

Forecast Point	Forecast period	Forecast	BiOp Actions to be Determined
Hungry Horse	April – August Provided by Reclamation	January, February, March	Sets min. flows at Hungry Horse and Columbia Falls
	May – September Provided by Reclamation	January, February, March	Sets VARQ FRM targets
		April	Sets VARQ FRM targets and VARQ refill flows
		May,	Sets VARQ refill flows Sets end of September draft target
		June	Sets VARQ refill flows
The Dalles	April – September Provided by NWRFC	March	Sets CRWMP adjustments at Grand Coulee
	April – August Provided by NWRFC	April	Sets spring flow objective at McNary Dam
		July	Sets end of August draft limit at Grand Coulee
Lower Granite	April – July Provided by NWRFC	April	Sets spring flow objective at Lower Granite
		June	Sets summer flow objective at Lower Granite
Libby	April – August Provided by Corps Seattle District	December	Sets end of December variable draft target
		January, February, March	Sets VARQ FRM targets
		April	Sets VARQ FRM targets and VARQ refill flows
		May	Sets Libby min. sturgeon flow volume and min. bull trout flows for after sturgeon pulse through Sept. Sets VARQ FRM targets and VARQ refill flows Sets end of September draft limit.
		June	VARQ refill flows
Dworshak	April – July Provided by Corps Walla Walla District	January to March	Manage for reservoir FRM and VDL
		April to June	Manage for reservoir FRM and refill

6. Project Operations

Table 5 summarizes the major fish-related reservoir and flow operations by project, consistent with the proposed action considered in the 2020 CRS BiOps. More detailed descriptions of each of these operations by project follow the table.

Table 5. Project Operations for ESA-listed Fish Species.

Project	FRM & Project Refill	Kootenai River White Sturgeon	Bull Trout	Spring Anadromous	Summer Anadromous	Chum
Libby (section 0)	<p><u>Winter:</u> Operate to VARQ FRM rule curve and achieve target elevation by April 10 if possible.</p> <p><u>Spring:</u> Adhere to VARQ Operating Procedures, supply tiered volume for sturgeon and minimum flow for bull trout.</p> <p><u>Summer:</u> Provide summer flow augmentation, refill. Exact date determined in-season dependent on available water supply, shape, and spring flow operations, while avoiding involuntary spill and meeting FRM objectives.</p>	<p><u>May–July:</u> Provide sturgeon tiered volume to augment flow at Bonners Ferry.</p>	<p><u>Year -Round:</u> Maintain project minimum flow requirements. Operate using ramping rates to minimize adverse effects of flow fluctuations.</p> <p><u>May 15–Sep 30:</u> Operate to bull trout minimum flow requirements. Maintain steady outflow if possible Jul–Sep while targeting draft to end of Sep sliding scale elevation, between 2439 and 2454, based on May final forecast for April-August runoff at Libby Dam. Full is 2459 feet.</p>	<p>Operate to meet refill and support flow objectives if possible without jeopardizing FRM, meeting sturgeon volume goals and not exceeding TDG limits.</p>	<p><u>September:</u> Target draft to end of Sep sliding scale elevation, between 2439 and 2454, based on May final forecast for April-August runoff at Libby Dam. Full is 2459 feet.</p>	<p>Fall/winter storage may be used to support chum flows.</p>
Hungry Horse (section 0)	<p><u>Winter:</u> Operate to VARQ FRM rule curves and to 75% probability of meeting April upper rule curve in April elevation objective.</p>	N/A	<p><u>Year-Round:</u> Maintain Columbia Falls and project minimum flow requirements. Operate using ramping rates to minimize adverse effects of flow fluctuations and maintain steady outflow if possible Jul–Sep.</p> <p>Draft during Jul-Sep to a target elevation of 3550 feet (10 feet from full) by Sep 30, except in dry water years³ when the draft target is 3540 feet (20 feet from full). Full is 3560 feet.</p>	<p>Refill by about June 30 if possible without excessive spill and operate to help meet flow objectives without exceeding TDG limits.</p>	<p><u>September:</u> Draft during Jul-Sep to a target elevation of 3550 feet (10 feet from full) by Sep 30, except in dry water years³ when the draft target elevation is 3540 feet (20 feet from full).</p>	N/A

Project	FRM & Project Refill	Kootenai River White Sturgeon	Bull Trout	Spring Anadromous	Summer Anadromous	Chum
Albeni Falls (section 0)	<u>Winter:</u> Operate within standard FRM criteria. <u>Spring:</u> Refill by June 30.	N/A	<u>Fall/Winter:</u> Winter minimum control elevation will be 2051 feet by mid-Nov. Maintain 2051 feet until stable lake elevation is no longer required to support kokanee spawning as coordinated with IDFG. After end of stable lake operation to support kokanee spawning, operate not to exceed FRM rule curve but not below minimum control elevation.	N/A	N/A	<u>Fall/Winter:</u> Storage may be used to support chum flows.
Grand Coulee (section 0)	<u>Winter:</u> Operate for FRM no lower than the VDL. <u>Spring:</u> Refill after the Fourth of July holiday each year (exact date to be determined during in-season management).	N/A	N/A	Operate to help support Spring flow objectives below Priest Rapids and McNary. Jan-Apr maintain 85% confidence of achieving spring refill objectives.	<u>July-August:</u> Draft to support salmon flow objectives during Jul-Aug with variable draft limit of 1278 to 1280 feet by Aug 31 based on the WSF. ³ <u>August:</u> Reduce pumping into Banks Lake and allow Banks Lake to operate up to 5 feet from full (1565 feet) to help meet salmon flow objectives when needed.	<u>Fall/Winter:</u> Storage may be used to support chum flows.
Dworshak (section 0)	<u>Winter:</u> Operate for FRM and VDL through March 31st <u>Spring:</u> Operate for FRM, flow objectives for hatchery releases, and refill by about June 30. Grand Coulee/Dworshak shift.	N/A	N/A	N/A	Summer draft no lower than 1535 feet by end of Aug and draft to 1520 feet (80 feet from full) by end of Sep, unless modified per the Agreement between U.S. and Nez Perce Tribe for water use in the Dworshak Reservoir.	<u>Fall/Winter:</u> Storage may be used to support chum flows, if 95% refill can be maintained.

³ These draft limits will be modified by the *Lake Roosevelt Incremental Storage Release Project* (Section 0).

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Project	FRM & Project Refill	Kootenai River White Sturgeon	Bull Trout	Spring Anadromous	Summer Anadromous	Chum
Lower Granite (section Error! Reference source not found.)	Pool can be drafted as low as 724 feet to protect levees during high flows.	N/A	N/A	Flow objective of 85-100 kcfs Operate within 1.5 foot MOP range.	Flow objective of 50-55 kcfs. Operate within 1.5 foot MOP range.	N/A
Little Goose (section Error! Reference source not found.)	N/A	N/A	N/A	Operate within 1.5 foot MOP range.	Operate within 1.5 foot MOP range.	N/A
Lower Monumental (section Error! Reference source not found.)	N/A	N/A	N/A	Operate within 1.5 foot MOP range.	Operate within 1.5 foot MOP range.	N/A
Ice Harbor (section Error! Reference source not found.)	N/A	N/A	N/A	Operate within 1.5 foot MOP range.	Operate within 1.5 foot MOP range.	N/A
McNary (section 0)	N/A	N/A	N/A	Flow objective of 220-260 kcfs.	Flow objective of 200 kcfs.	N/A
John Day (section 0)	Reservoir may be operated between 257 and 268 feet for FRM objectives	N/A	N/A	Operate from 264.5 to 266.5 feet, April 10 to June 1 (may be as late as June 15), to decrease avian predation on ESA-listed juvenile salmon and steelhead in the lower Columbia River.	Operate within 2.0 feet of minimum level that maintains irrigation pumping (262.5-264.5 feet), from early June through August 31.	When storage space allows and not in conflict with FRM, the use of John Day storage space will contribute maintaining chum tailwater criteria.
The Dalles (section 0)	N/A	N/A	N/A	Operate turbines as described in the FPP.	Operate turbines as described in the FPP.	N/A

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Project	FRM & Project Refill	Kootenai River White Sturgeon	Bull Trout	Spring Anadromous	Summer Anadromous	Chum
Bonneville (section 0)	N/A	N/A	N/A	Operate turbines as described in the FPP.	Operate turbines as described in the FPP.	Operate discharge to manage the project tailwater (Tanner Creek) to provide access to spawning habitat for protection through emergence for chum spawning at Ives Island immediately downstream on the Oregon shore 0.9 miles downstream of PH1

6.1 Hugh Keenleyside Dam (Arrow Canadian Project)

6.1.1 Mountain Whitefish Flows

Canada has been testing Arrow flow regimes for mountain whitefish spawning over the last several years. Desirable spawning flow levels are defined by Canada and may be modified annually. The historically desired operation is an Arrow outflow between 45-55 kcfs beginning the third week in December and continuing through mid-January. Egg protection flows are generally about 19 kcfs lower than the spawning flow from mid-January through the end of March. For 2021, Canada has indicated that the level of white fish protection will be determined by BC Hydro in consultation with Canadian regulators. The negotiation of annual agreements under the Treaty will reflect the outcome of BC Hydro discussions on flow objectives for whitefish.

6.1.2 Rainbow Trout Flows

Rainbow trout spawning typically begins in April. The Canadian objective is to provide stable or increasing river levels downstream of Arrow between April 1 and June 30. Provision of these flows is negotiated through annual agreements under the Treaty. Canada has indicated that research suggest the current operating regime has resulted in smaller, less healthy fish. The level of trout spawning protection for 2021 will be determined by BC Hydro in consultation with Canadian regulators.

6.2 Hungry Horse Dam

Hungry Horse Dam is operated for multiple purposes including fish and wildlife, FRM, power, and recreation. Specific operations for flow management to aid anadromous and resident fish are listed in the following sections.

6.2.1 Winter/Spring Operations

During the winter and early spring Hungry Horse will operate to meet minimum downstream flow requirements, operate to meet FRM objectives and provide power/operational flexibility to achieve a 75% probability of reaching its upper rule curve in April or as decided in-season to provide more water for spring flows. This is achieved by operating between the Upper Rule Curve (URC) as an upper limit and the Variable Draft Limits (VDL) as a lower operating limit for the reservoir and will continue to target April 10th for the calculation. Stream flows, in season forecasts and real time conditions the exact date that the upper rule curve will be reached in coordination with TMT. The URC is the maximum elevation allowed for FRM and is calculated by using the Storage Reservation Diagram (SRD) developed for VARQ FRM. A description of VDL is provided in Section 7.4. Reclamation computes Hungry Horse Dam's April 10 elevation by linear interpolation between the March 31 and April 15 forecasted FRM elevations based on the Reclamation March Final for the May - September Water Supply Forecast (WSF).

Refill at Hungry Horse usually begins approximately ten days prior to when streamflow forecasts of unregulated flow is projected to exceed the Initial Control Flow (ICF) at The Dalles, Oregon. During refill, discharges from Hungry Horse are determined using inflow volume forecasts, streamflow forecasts, weather forecasts, and the VARQ Operating Procedures. Other factors such as local FRM are also considered when determining refill operations. During the latter part of the FRM season (April) and the refill season (typically May through June), Hungry Horse discharges may be reduced for local flood protection in the Flathead Valley. In 2014 the official flood stage for the Flathead River at Columbia Falls, Montana was modified to 13 feet (approximate flow 44000 cubic feet per second (cfs)) when Flathead Lake elevation is in the top 1 foot (2892-2893 feet). The flood stage is 14 feet (approximately 51000 cfs) when Flathead Lake's elevation is more than 1 foot below full (2892 feet or lower). These criteria were developed to minimize flooding on the Flathead River above Flathead Lake. With these criteria, Reclamation will adjust outflows from Hungry Horse Dam as necessary (down to a minimum discharge of 300 cfs) as long as there is enough space in the reservoir to manage the remaining runoff. Hungry Horse generally starts reducing discharges when the stage at Columbia Falls hits and begins to exceed 12.5 feet when the flood stage criteria is 13 feet, and 13 feet when the flood stage criteria is 14 feet. However, depending on remaining runoff volume and available reservoir space, Hungry Horse may not start reducing discharges until Columbia Falls reaches levels higher than these criteria.

Often during the spring, changes in FRM, transmission limitations and generation unit availability will require adaptive management actions for real-time operations in order to control refill and to avoid spill.

6.2.2 Selective Withdrawal System Maintenance

Maintenance of Hungry Horses Selective Withdrawal System (SWS) has not happened in the last 3 years and needs to be performed in 2021. The maintenance would require Hungry Horse to be at elevation 3525 feet the first part of April for 2 to 3 weeks, regardless of the required FRM elevation for that year. The SWS is used to control the temperature of the releases in the summer that are critical to the fishery below Hungry Horse.

More information and coordination on the drawdown will occur in-season.

6.2.3 Summer Operations

Hungry Horse will operate to refill by about June 30 to provide summer flow augmentation, except as specifically provided by the TMT. However, the timing and shape of the spring runoff may result in reservoir refill before or after June 30. For example, a late snowmelt runoff may delay refill to sometime after June 30 in order to avoid excessive spill.

During the summer, Hungry Horse is drafted within the 2020 CRS BA specified draft limits. The flow levels are set to meet the end of September target elevation based on the best information available and are coordinated with TMT. A number of factors are considered in setting the flows including the status of fish migration, attainment of flow objectives, water quality, and the effects that reservoir operations will have on other listed and resident fish

populations. Hungry Horse discharges during the summer months should be even or gradually declining in order to minimize a double peak on the Flathead River.

The summer operation will target the reservoir elevation of 3540 feet to 3550 feet (20 feet to 10 feet from full) by September 30 and this will be based on the water supply forecast. Table 6 shows the end of September Targets based of the Hungry Horse May water supply forecast. However, if the project fails to refill, especially during drought years, minimum flow requirements (see Section 0) may draft the reservoir below the end of September target elevation.

Table 6. Hungry Horse End of September Elevation Targets

Hungry Horse May-September inflow forecast (KAF)	Hungry Horse forebay target on Sept 30 (ft)
< 1410	3540
1410 – 1580	Interpolate between 3540-3550
> 1580	3550

Operations in September are primarily focused on benefiting listed resident bull trout and other fish species below the project. The intent is to maintain steady or gradually declining flows below the project. Hungry Horse may draft slightly above or below the end of September draft limit depending on inflows and minimum flow requirements. Hungry Horse may end the month at an elevation above the end of September draft limit if inflows are higher than were forecasted in the planned operation. Hungry Horse may end the month at an elevation below the end of September draft limit due to minimum flow requirements and if inflows are lower than were forecasted in the planned operation.

6.2.5 Minimum Flows and Ramp Rates

The following minimum flows and ramp rates help guide project operations to meet various purposes, including power production. Minimum flows and ramp rates were identified in the 2020 USFWS BiOp for Hungry Horse Dam to protect resident fish and their food organisms in the Flathead River.

There are two minimum flow requirements for Hungry Horse Dam. One is for the South Fork of the Flathead River below the project, the second is for Columbia Falls on the mainstem Flathead River located just downstream from the confluence of the South Fork with the mainstem. The minimum flows for both sites are determined monthly based on the Reclamation WSF for the inflows to Hungry Horse for the period April 1 through August 31. These minimum flows are determined monthly starting with the January forecast, and then set for the remainder of the year based on the March final runoff forecast. Table 6 shows how the minimum flows are calculated⁴. The minimum flow requirements generally govern Hungry Horse discharges in the

⁴ 2000 USFWS BiOp, Section 3.A.1, Page 6.

fall unless the static FRM levels require discharges greater than the minimum flow to maintain the required space in the reservoir through the end of December.

Table 7. Minimum Flows at Hungry Horse and Columbia Falls.

Hungry Horse Apr–Aug inflow forecast (KAF)	Hungry Horse min flow ^a (CFS)	Columbia Falls min flow (CFS)
< 1190	400	3200
1190 - 1790	Interpolate between 400-900	Interpolate between 3200-3500
> 1790	900	3500

a. To prevent or minimize flooding on the Flathead River above Flathead Lake, Hungry Horse discharges can be reduced to a minimum flow of 300 cfs when the stage at Columbia Falls exceeds 13 feet.

The maximum ramp up and ramp down rates are detailed in Table 7. The daily and hourly ramping rates may be exceeded during flood emergencies to protect health and public safety and in association with power or transmission emergencies. The ramp rates will be followed except when they would cause a unit(s) to operate in a zone that could result in premature wear or failure of the units. In this case the project will utilize a ramp rate which allows all units to operate outside the rough zone. The AAs will provide additional information to the USFWS describing operations outside the “rough zone.”

Table 8. Hungry Horse Dam Ramping Rates.

Daily and Hourly Maximum Ramp Up Rates for Hungry Horse Dam (as measured by daily flows, not daily averages, restricted by hourly rates)		
Flow Range (measured at Columbia Falls)	Ramp Up Unit Limit (daily max)	Ramp Up Unit Limit (hourly max)
3200 - 6000 cfs	1800 cfs/day	1000 cfs/hour
>6000 - 8000 cfs	1800 cfs/day	1000 cfs/hour
>8000 - 10000 cfs	3600 cfs/day	1800 cfs/hour
>10000 cfs	No limit	1800 cfs/hour

Daily and Hourly Maximum Ramp Down Rates for Hungry Horse Dam (as measured by daily flows, not daily averages, restricted by hourly rates)		
Flow Range (measured at Columbia Falls)	Ramp Down Unit Limit (daily max)	Ramp Down Unit Limit (hourly max)
3200 - 6000 cfs	600 cfs/day	600 cfs/hour
>6000 - 8000 cfs	1000 cfs/day	600 cfs/hour
>8000 - 12000 cfs	2000 cfs/day	1000 cfs/hour
>12000 cfs	5000 cfs/day	1800 cfs/hour

6.2.6 Spill Operations

Hungry Horse will be operated to avoid spill if practicable. Spill at Hungry Horse is defined as any release through the dam that does not pass through the power plant. Full capacity of the

power plant is around 408 MW (~12000 cfs) at full pool, however current transmission restrictions limit generation to 310 MW (~9000 cfs). Large amounts of spill can cause TDG levels in the South Fork of the Flathead River to exceed the state of Montana's standard of 110%. Empirical data and estimates show that limiting spill to a maximum of 15% of total outflow will facilitate operations consistent with the Montana State TDG standard of 110%.

6.3 Albeni Falls Dam

6.3.1 Albeni Falls Dam Fall and Winter Operations

The Corps received a letter from the USFWS dated October 21, 2013, regarding the 2013-2014 Minimum Control Elevation (MCE) for Lake Pend Oreille, Idaho (FWS Ref: 01EIFW00-2014-TA-0005 (COMM-110)). The letter indicated the USFWS would not be providing a System Operations Request (SOR) for the 2013-2014 MCE due to IDFG's re-evaluation of kokanee egg-to-fry survival data. Subsequent to this letter IDFG concluded survival data do not exist at this time to justify a USFWS request for a specific MCE and accordingly the USFWS deferred to the AAs for determining the MCE.

For the winter of 2021, the Albeni Falls planned target is an MCE of 2051 feet. The lake will stay within a half-foot of the MCE during kokanee spawning. Albeni Falls may be operated to begin implementation of the Flexible Winter Power Operation (FWPO) if requested by BPA as early as after spawning is declared over or December 31, whichever occurs first. Lake Pend Oreille may be fluctuated under FWPO from the MCE to elevation 2056 feet.

6.3.2 Coordination

The Action Agencies will continue to coordinate with the Region on Albeni Falls operations.

6.3.3 FRM Draft

Albeni Falls Dam will be operated during the winter season using standard FRM criteria.

6.3.4 Refill Operations

During the spring, Albeni Falls Dam will be operated to fill Lake Pend Oreille in accordance with standard FRM criteria.

6.3.5 Summer Operations

During the summer, Albeni Falls Dam will be operated to maintain Lake Pend Oreille elevation at Hope, Idaho, between elevation 2062.0 and 2062.5 feet. The Lake will be held above elevation 2062.0 feet through the third Sunday in September, or September 18, whichever date is later. The Corps will try to keep the water surface elevation above 2061.0 feet through the fourth Sunday in September, or September 25, whichever is later. The latter elevations may change in the event of biological and/or operational needs of the coordinated system. Starting on October 1, the Lake will begin the draft to elevation 2051.0 feet by mid-November.

6.4 Libby Dam

Libby Dam flows will be regulated consistent with existing treaties, Libby Project authorization for public safety, and other laws to achieve water volumes, water velocities, water depths, and water temperature at a time to maximize the probability of allowing significant sturgeon recruitment and to provide a year-round thermograph that approximates normative conditions, while also meeting flood damage reduction objectives. The year-round project minimum outflow is 4.0 kcfs.

6.4.1 Coordination

The AAs will continue to coordinate Libby Dam BiOp operations at TMT.

6.4.2 Burbot

The selective withdrawal system at Libby Dam will be utilized each fall to provide the coolest discharge temperatures possible, October through February, to aid burbot migration and spawning in the Kootenai River near Bonners Ferry, Idaho. An interagency Memorandum of Agreement for this species was completed in June 2005. Use of VARQ FRM procedure and implementation of the variable end-of-December FRM target elevation may aid this operation in years with below average runoff forecasts.

6.4.3 Ramp Rates and Daily Shaping

The purpose of the following actions is to provide better conditions for resident fish by limiting the flow fluctuations and setting minimum flow levels. In addition, ramping rates protect varial zone productivity by emulating a normative hydrograph. These ramp rates for Libby Dam were included in the 2020 CRS BA to minimize impacts to bull trout and were considered in the 2020 USFWS BiOp. The following ramp rates (Table 8) will guide project operations to meet various purposes, including power production.

Daily and hourly ramping rates may be exceeded during flood emergencies to protect health and public safety and in association with power or transmission emergencies. Variances to these ramping rates during years when water supply forecasting errors overestimate actual runoff, or variances are necessary to provide augmentation water for other listed species or other purposes, will be coordinated through the TMT process. This is expected only in dry water years^{Error!} Bookmark not defined. At the project, the ramp rates will be followed except when they would cause a unit(s) to operate in the rough zone, a zone of chaotic flow in which all parts of a unit are subject to increased vibration and cavitation that could result in premature wear or failure of the units. In this case, the project will utilize a ramp rate which allows all units to operate outside the rough zone.

Table 8: Daily and hourly maximum ramping rates for Libby Dam^a

	Starting Flow	Hourly	Daily
Summer (May 1–September 30)			
Ramp Up	4–6,000 cfs	2,500 cfs	1 unit

	6–9,000 cfs	2,500 cfs	1 unit
	9–16,000 cfs	2,500 cfs	2 units
	16,000 cfs- Q_{PHC}^b	5,000 cfs	2 units
Ramp Down	4–6,000 cfs	500 cfs	500 cfs
	6–9,000 cfs	500 cfs	1,000 cfs
	9–16,000 cfs	1,000 cfs	2,000 cfs
	16,000 cfs- Q_{PHC}^b	3,500 cfs	1 unit
Winter (October 1–April 30)			
Ramp Up	4–6,000 cfs	2,000 cfs	1 unit
	6–9,000 cfs	2,000 cfs	1 unit
	9–16,000 cfs	3,500 cfs	2 units
	16,000 cfs- Q_{PHC}^b	7,000 cfs	2 units
Ramp Down	4–6,000 cfs	500 cfs	1,000 cfs
	6–9,000 cfs	500 cfs	2,500 cfs
	9–16,000 cfs	1,000 cfs	1 unit
	16,000 cfs- Q_{PHC}^b	3,500 cfs	1 unit
^a As measured by cumulative daily flow changes within the 24-hour period (mid-night to mid-night, not daily averages), restricted by hourly rates. ^b Q = discharge or flow; PHC = powerhouse capacity.			

(2020 CRS Biological Assessment, page 2-40, Table 2.4)

(2006 USFWS BiOp at Description of the proposed action, page 7, Table 1.)

6.4.4 FRM

The Corps will continue to use its forecast procedure in December to determine the December 31 FRM elevation. In water years where the December forecast for the period April through August is less than 5900 KAF based on the Corps' forecast procedures, the end-of-December draft elevation will be higher than 2411 feet. If the December forecast for April-August is 5500 KAF or less, the end-of-December target elevation would be 2426.7 feet. The end-of-December elevation is a sliding scale between elevation 2426.7 feet and 2411 feet when the forecast is between 5500 and 5900 KAF.

Libby Dam will be operated during January through March (into April if the start of refill has not been declared) to the VARQ FRM storage reservation diagram (SRD). During the refill period from about April through June, Libby Dam will release flow in accordance with VARQ FRM Operating Procedures at Libby Dam. Refill at Libby Dam will begin on May 1 for Libby April-August WSF of less than 6.9 MAF, and will begin on May 1 or 10 days prior to when the forecasted unregulated flow at The Dalles is expected to exceed the ICF, whichever is earlier, for forecast of 6.9 MAF or above. Once refill begins, Libby Dam outflow will be no lower than the computed VARQ flow (or inflow, if that is lower than the VARQ flow), unless otherwise allowed by the VARQ Operating Procedures. For example, changes to reduce the VARQ flow

can occur to protect human life and safety, during the final stages of refill, or through a deviation request.

The VARQ flow will be recalculated with each new Corps water supply forecast and outflows will be adjusted accordingly. The VARQ flow will also be recalculated at a daily to weekly frequency to adjust VARQ outflows for prior releases during refill. If the VARQ operating procedures require discharges above powerhouse capacity, spill from Libby Dam may occur. The intent is to adjust Libby Dam discharge to maximize reservoir refill probability and minimize the potential for spill.

6.4.5 Spring Operations

The purpose of the following actions are to refill Libby Dam in order to provide the flow for Kootenai River white sturgeon, bull trout minimum flows, and anadromous fish flow augmentation water. Libby Dam will provide flows for sturgeon, bull trout, and salmon during spring; for salmon and bull trout during summer and for bull trout and resident fish in September while attempting to minimize a double peak or large flow fluctuations in the June–September period. The AAs will operate Libby Dam to provide for summer flow augmentation, exact refill date to be determined in-season by available water supply and shape and spring flow operations, while also avoiding involuntary spill and meeting FRM objectives. During the spring, the AAs will operate Libby Dam to meet its flow and refill objectives. If both of these objectives cannot be achieved, VARQ and sturgeon flow operations are a higher priority over summer refill.

When not operating to minimum flows, the project will be operated to achieve a 75% chance of the upper FRM rule curve on or about April 10 (the exact date to be determined during in-season management) to increase flows for spring flow management.

6.4.6 Bull Trout Flows

From May 15 to June 30 and during the month of September, a minimum flow of 6000 cfs will be discharged and minimum flows of 4000 cfs will be provided for the rest of the year. Volume to sustain the basal flow of 6000 cfs from May 15 through May 31 will be accounted for with sturgeon volumes, and in the fall should be drawn from the autumn FRM draft. Table 9 shows how the bull trout minimum flow is determined during this period.

Table 9. Minimum bull trout releases from Libby Dam July 1–August 31, based on May final Libby water supply forecast for April-August period (May 15–June 30 and all of September minimum is 6 kcfs).

Libby Forecast Runoff Volume (MAF*)	Minimum bull trout flows between sturgeon and salmon flows (kcfs)
0.00 < forecast < 4.80	6 kcfs
4.80 < forecast < 6.00	7 kcfs
6.00 < forecast < 6.70	8 kcfs
6.70 < forecast < 8.10	9 kcfs
8.10 < forecast < 8.90	9 kcfs
8.90 < forecast	9 kcfs

*MAF = million acre-feet

6.4.7 Sturgeon Operation

The purpose of the actions below is to provide water for sturgeon spawning and egg incubation. Libby Dam will provide the tiered volume for sturgeon flows as described in the 2020 CRS BA, and considered in the 2020 USFWS BiOp, and as summarized in Figure 1. The outflow during sturgeon augmentation period will be equal to or greater than the VARQ flow. The release operation will be developed prior to commencement of the sturgeon tiered flow release. Water temperature profiles will be monitored near the dam starting in April and continue through July to provide information necessary for timing of sturgeon spawning/rearing flow augmentation. Also, water temperature profiles in the forebay are used to determine when warmer temperatures may be provided to assist sturgeon spawning. Reservoir temperature data collection is occurring and is intended to allow better planning for temperature management of water releases.

This sturgeon water will be in addition to needs for listed bull trout and salmon, and will be measured above the 4000 cfs minimum releases from Libby Dam. Accounting for these tiered volumes will begin when the regional team of biologists determine that benefits to conservation of sturgeon are most likely to occur. Sturgeon volume accounting will also occur when additional flow above FRM flow is needed to sustain a base flow of 6000 cfs from May 15 to May 31 (minimum bull trout flow), regardless of sturgeon augmentation commencement. Sturgeon flows will generally be initiated between mid-May and the end of June to augment lower basin runoff entering the Kootenai River below Libby Dam, consistent with the current version of the Kootenai River Ecosystem Function Restoration Flow Plan Implementation Protocol and the 2020 CRS BA.

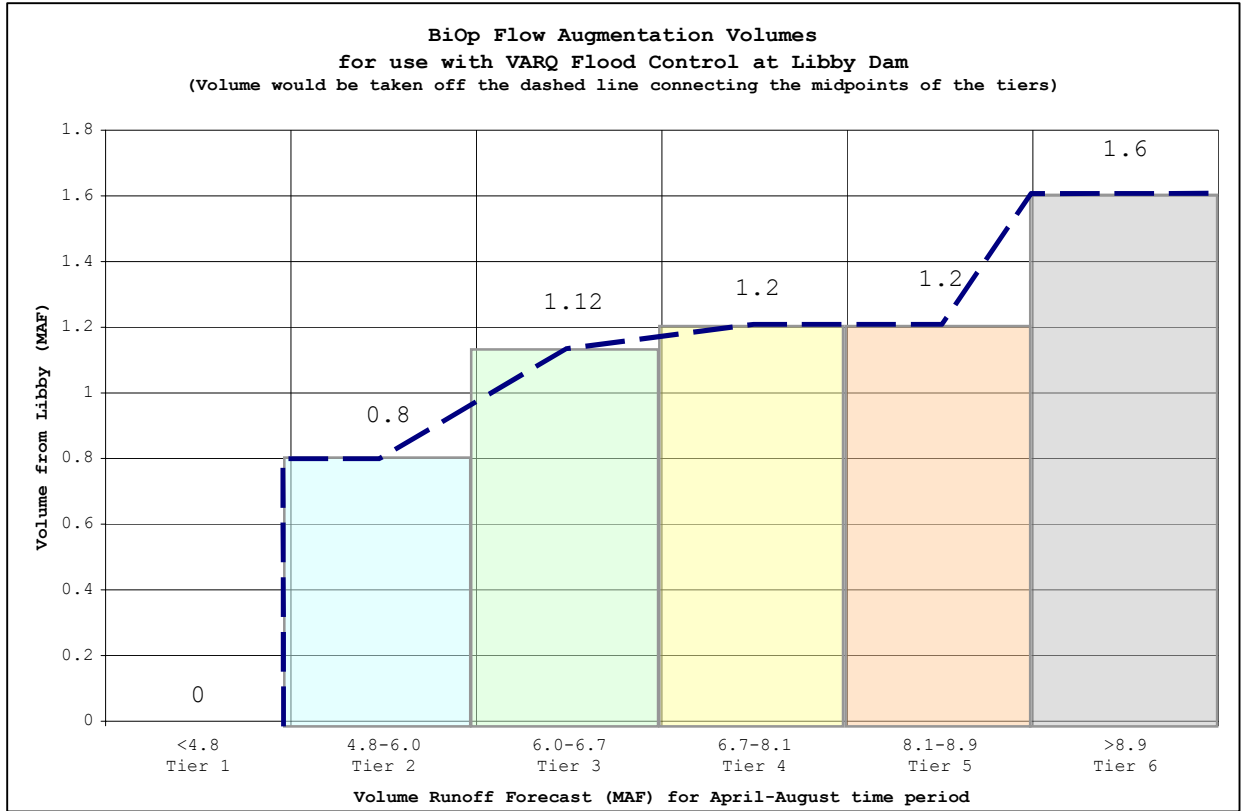


Figure 1. “Tiered” volumes of water for sturgeon flow enhancement to be released from Libby Dam according to the Libby May final forecast of April–August volume. Actual flow releases would be shaped according to seasonal requests from the USFWS and in-season management of water actually available.

6.4.8 Post-Sturgeon Operation

After the sturgeon operation, flows will be planned to be stable or slowly declining over the summer and to achieve refill, if possible, in July or early August, while trying to minimize a double peak in outflows. Summer operations will be coordinated through TMT in-season management. Libby Dam releases will follow ramp rates listed in the 2020 CRS BA and shown on Table 8.

6.4.9 Summer Operations

During the summer, the AAs draft Libby Dam within the specified draft limits in the 2020 CRS BA based on flow recommendations coordinated at TMT. The AAs consider a number of factors when developing flow recommendations for TMT to review, such as: the impact of flow fluctuations on bull trout and other resident fish below the project, the status of juvenile salmon outmigration in the lower Columbia River, attainment of flow objectives, water quality, and the effects that reservoir operations will have on other listed and resident fish populations.

During the months of July through September, the AAs will operate Libby Dam to augment flows for juvenile salmon out-migration in the Columbia River and to help meet local resident fish needs. In the summer, the AAs will operate to target by the end of September the reservoir

elevation designated by the Libby sliding scale (Table 10). However, if the project fails to refill to above these target elevations, then the project will be operated during the summer months to release inflows or to meet minimum flow requirements and minimum bull trout flows.

Table 10. Libby Sliding Scale for End of September Target Elevation. Draft targets are interpolated from this table. August targets are 2.5 feet higher than interpolated September targets.

Libby final May forecast for Apr–Aug inflow (percentile)	Libby final May forecast for Apr–Aug inflow (MAF*)	End of September Lake Koocanusa Elevation Target (ft-NGVD29)*
≤ 15 th percentile	4.66	2439
25 th percentile	5.01	2449
75 th percentile	6.78	2449
≥85 th percentile	7.33	2454

**MAF = million acre-feet. Values here based on the current official 30-year period of 1981 to 2010. These values will be updated based on the next official 30-year period from 1991 to 2020.*

***Targets are interpolated between 15th and 25th percentile, and between 75th and 85th percentile.*

Arrangements for retention of July-September water in Lake Koocanusa are possible through a Libby-Canadian storage water exchange under the current Libby Coordination Agreement, which was signed February 16, 2000. However, this operation cannot be guaranteed in any given year because it must be mutually beneficial to the Canadian Entity and the U.S. Entity. Information needed for such a determination such as the volume of the water year, is not available until well into the migration season. This operation, if any, for a given water year is generally not finalized until June or July of that year. The Coordination Agreement reduces the draft of Lake Koocanusa and provides an equivalent amount of water from Canada.

The Corps will use the best available forecast at the end of each month for July and August to set an outflow that will gradually draft Libby to the target elevation by the end of September as defined in the 2020 CRS BA. The objective of this operation is to maintain a stable or gradually declining outflow for the period from July through September. If this calculated flow is greater than the bull trout minimum, then the discharge will be maintained until updated at the end of each month.

The following limits to flow fluctuation during summer and fall at Libby Dam shall be implemented after the tiered flow volume for Kootenai River white sturgeon has been released, and releases for salmon flow augmentation are ramping down through September:

- Outflows at or below 9 kcfs
 - Maintain existing instream flow requirement for bull trout. Minimize fluctuation.
- Flows between 9 kcfs and 16 kcfs
 - Maximum increase of 2000 cfs (corresponds to daily maximum ramp down rate for this period).

- Flows between 16 kcfs and Power House Capacity
 - Maximum increase of 5000 cfs or one unit (corresponds to daily maximum ramp down rate for this period)
- Maximum of one allowable increase within the above flow bands after the sturgeon volume has been expended and through September 30.

6.5 Grand Coulee Dam

Grand Coulee Dam is operated for multiple purposes including fish and wildlife, FRM, irrigation, hydropower generation, and recreation. Specific operations for flow management to aid anadromous and resident fish are listed in the following sections.

6.5.1 Winter/Spring Operations

Grand Coulee will be operated for FRM from January through April using Grand Coulee's FRM SRD as coordinated through adaptive management between the Corps and Reclamation in season. Grand Coulee is also operated during this period to support chum operations (described in detail in Section 7.3) and to maintain an 85% probability of reaching the April 10 elevation objective in order to provide more water for spring flows.

Maintaining an 85% probability of reaching the April 10 elevation objective is achieved by operating between the URC as an upper elevation limit and the VDL as a lower elevation limit for the reservoir from January through March. A description of VDL is provided in Section 7.4.

Reclamation computes Grand Coulee Dam's April 10 elevation objective by linear interpolation between the March 31 and April 15 forecasted FRM elevations based on the NWRFC March Final April-August WSF at The Dalles. The March forecast is chosen for the calculation of the April 10 elevation objective in order to allow enough time to react and to plan Grand Coulee operations accordingly. The April final forecast is typically released on the 3rd working day of the month, after which the Corps calculates FRM elevations. This usually means that final April 15 and April 30 FRM elevations are released around the 5th working day of April at the earliest. It is notable that even modest changes in The Dalles water supply forecast can produce significant changes in the forecasted FRM elevations for Grand Coulee. In order to achieve final April FRM targets, actual Grand Coulee elevations on April 10 may be below or above the April 10 objective depending on draft rates and water supply conditions and will be coordinated in-season.

The operation to be at Grand Coulee's upper rule curve has changed in the 2020 CRS BA. The calculation of the VDL, described above, will still use the April 10 date for the calculation but the timing of the reaching the upper rule curve during the month of April will be coordinated in-season with TMT. April 10 will still be the default target date but operations for FRM, balancing fishery needs, and power operations may necessitate being above or below the target with coordination with TMT.

An additional factor that needs to be considered during spring operations is the on-going Third Power Plant (TPP) overhaul at Grand Coulee. The TPP overhaul will result in one TPP unit being out of service at any given time during the overhaul period. This is in addition to other

units being out of service for routine scheduled maintenance. A TPP unit has a hydraulic capacity of 25 kcfs – 35 kcfs depending on unit and head. Every effort is made to schedule annual and other routine maintenance outside of the “normal” spring FRM/refill period when possible but heavy runoff years, early or delayed runoff timing, and/or unscheduled maintenance in conjunction with the TPP overhaul will increase the probability of spill and excessive TDG production. Adaptive management operations at Grand Coulee may need to be considered during the TPP overhaul period in order to minimize spill and TDG production. The TPP overhaul is currently forecasted to be completed in 2030. Grand Coulee operations will be discussed and coordinated with the TMT.

Opportunities to shift system FRM requirements from Brownlee to Grand Coulee will also be considered. The deepest reservoir draft typically occurs around April 30. Refill at Grand Coulee normally begins approximately one day prior to when streamflow forecasts of unregulated flow is projected to exceed the ICF at The Dalles Dam.

During the spring, the AAs will operate the CRS to help meet the flow objectives, to meet system FRM requirements and to refill the projects. If all of the objectives cannot be achieved, the TMT will make an in-season recommendation, weighing considerations unique to each particular year and project. System FRM requirements during refill, especially during above average years, may result in significant spill below Grand Coulee Dam to control refill, meet downstream FRM flow objectives, and limit downstream flooding. High levels of spill below Grand Coulee result in high TDG levels. A more detailed discussion of spill operations is discussed in Section 6.5.9.

6.5.2 Summer Operations

Grand Coulee will operate to refill after the Fourth of July holiday each year to provide summer flow augmentation, except as specifically provided by the TMT. Grand Coulee will be operated during the summer (July and August) to help meet the flow objectives for juvenile salmon out-migration. Grand Coulee will draft to support salmon flow objectives during July-August with variable draft limit of 1278 to 1280 feet by August 31 based on the water supply forecast. If the July Final April through August forecast for The Dalles is equal to or greater than 92 MAF then Lake Roosevelt’s draft limit will be 1280 feet. If the forecast is less than 92 MAF, the draft limit will be 1278 feet. These draft limits will be modified to implement the Lake Roosevelt Incremental Storage Release Project (see Section 6.5.6).

6.5.3 Banks Lake Summer Operation

Banks Lake will be allowed to draft to elevation 1565 feet by the end of August to provide more water for summer flow augmentation. Pumping to Banks Lake will be reduced and irrigation for the Columbia Basin Project will be met by drafting the reservoir up to 5 feet from full (elevation 1570 feet) by the end of August.

6.5.4 Project Maintenance

The drum gates are an extremely important dam safety feature and must be maintained. Drum gate maintenance is planned to occur annually during March, April, and May. The reservoir must be at or below elevation 1255 feet for 8 weeks in order to complete a drum gate

maintenance cycle. At a minimum, drum gate maintenance must be completed at least one time in a 3-year period, two times in a 5-year period, and three times in a 7-year period. The in-season criteria for accomplishing drum gate maintenance will be based on the FRM requirement for the April 30 maximum Grand Coulee elevation as determined by the February final April-August water supply forecast. The February forecast is used to allow sufficient time to draft the reservoir below 1255 feet by March 15. These criteria are summarized in Table 11 and described in greater detail below.

If the February forecast sets the Grand Coulee April 30 FRM elevation at or below 1255 feet, Grand Coulee will be drafted to perform drum gate maintenance. When the February forecast sets the April 30 FRM requirement above 1265 feet, drum gate maintenance will be “forced” only if needed to meet the requirements of the 1 in 3, 2 in 5, and 3 in 7 criteria. If the April 30 FRM requirement is between 1255 and 1265 feet, then maintenance will only be done if the following year would be a “forced” drum gate maintenance year. For example, if maintenance is deferred in year “one” due to dry conditions and the forecasted FRM elevation is between 1255 feet and 1265 feet in year “two”, then drum gate maintenance would be accomplished in year “two” in order to avoid “forced” drum gate maintenance in year “three” regardless of water supply conditions. The example above illustrates the 1 in 3 criteria but the 2 in 5 and 3 in 7 criteria would also need to be checked.

Table 11. Grand Coulee Dam Criteria for Drum Gate Maintenance.

February FRM Requirement for Maximum April 30 GCL Elevation (feet) ¹	Drum Gate Maintenance ²
≤ 1255 feet	YES
1255 – 1265 feet	If following year would be a “forced” drum gate maintenance year: Yes If following year would not be a “forced” drum gate maintenance year: No
> 1265 feet	If in “forced” drum gate maintenance year: Yes If not in “forced” drum gate maintenance year: No

1. Maximum April 30 GCL Elevation based on the February official April-August water supply forecast for The Dalles using the 10-day QPF median values published by the NWRFC on the third working day of February, adjusted for available storage capacity upstream of The Dalles other than Grand Coulee Dam. Monthly FRM requirements are available online at: http://www.nwd-wc.usace.army.mil/report/flood_risk/
2. Drum Gate Maintenance is required to meet the 1 in 3, 2 in 5, and 3 in 7 criteria

Drum gate maintenance was not done in 2019 but was completed in the spring of 2015, 2016, 2017, 2018, and 2020. Therefore, based on the 1 in 3, 2 in 5, and 3 in 7 criteria, drum gate maintenance will be performed in 2021 if the Grand Coulee April 30 FRM requirement based on the February final water supply forecast is at or below elevation 1255 feet. If drum gate maintenance is not completed in 2021, the criteria requires maintenance completion in 2023.

In addition to the annual Drum Gate Maintenance, an inspection and maintenance activity is planned for the 57” Butterfly Drum Gate Intake Valves. Some inspection and maintenance on these valves can occur regardless of water levels, but some maintenance requires water levels at or below 1219 feet. The external inspection and maintenance that requires water levels at or

below 1219 feet, for a week duration, must occur once every ten years. This inspection takes advantage of spring drafts for FRM, but in some years may require an additional draft below FRM requirements to conduct this maintenance. This could result in additional outflow, a longer duration of ferry outage, and elevated spill and TDG. The decision to inspect the valves will be an in-season decision depending on if the project is required to draft to elevation 1,222 feet, if refill is not triggered to be refilled in the next few weeks, and if the project can reasonably draft without violating TDG requirements.

6.5.5 Fall Refill

Reclamation attempts to operate Grand Coulee Dam and Lake Roosevelt to refill to an elevation of 1,283 feet by September 30 at the request of tribes to aid resident fish, including access to shoreline and tributary habitat. To maintain power generation flexibility, the Lake Roosevelt elevation objective of 1,283 feet or higher by the end of September may be delayed to no later than the end of October. Delaying refilling to an elevation of 1,283 feet allows more operational flexibility for hydropower generation by relaxing restrictions on seasonal pool elevations at Grand Coulee Dam. In most years, meeting the targeted elevation of 1,283 feet by the end of September is anticipated, but in drier years when the summer flow augmentation objective is 1,278 feet (at the end of August) refilling to 1,283 feet affects hydropower generational flexibility. In these years, the requirement is not until the end of October, but the project will be operated to refill to an elevation of 1,283 feet as soon as practical.

6.5.6 Lake Roosevelt Incremental Storage Release Project

The Lake Roosevelt Incremental Storage Release Project is a component of the Columbia River Water Management Program (CRWMP) and is intended to improve municipal and industrial water supply, provide water to replace some ground water use in the Odessa Subarea, enhance stream flows in the Columbia River to benefit fish, and to provide water to interruptible water right holders in drought years. A Memorandum of Understanding (MOU) regarding the Lake Roosevelt Incremental Storage Release Project was signed by the State of Washington, Reclamation, and the Columbia Basin Irrigation Districts in December 2004. In December 2007, Water Resource Management Agreements in support of the incremental storage releases from Lake Roosevelt were signed by the State of Washington, the Confederated Tribes of the Colville Reservation, and the Spokane Tribe of Indians.

The Lake Roosevelt Incremental Storage Release Project will not reduce flows during the salmon flow objective period (April - August). A third of this water will go to in-stream flows. A more detailed description of this item is provided in Section 7.5 and in the 2020 CRS BA (page 2-45).

6.5.7 Chum Flows

Grand Coulee may be used to help meet tailwater elevations below Bonneville Dam to support chum spawning and incubation. The chum operation is described in more detail in Section 7.3.

6.5.8 Priest Rapids Flow Objective

Grand Coulee will be operated to help meet the flow objective at Priest Rapids Dam as coordinated with the TMT (see Section 6.7 for objectives).

6.5.9 Spill Operations

Forced spill at Grand Coulee, as the result of system FRM requirements, may result in high levels of TDG below Grand Coulee Dam. There will be times that Grand Coulee has to spill any required discharge that is in excess of power plant capacity to control refill, meet downstream FRM flow objectives, and to limit downstream flooding. If Lake Roosevelt is above elevation 1265.5 feet, Grand Coulee can spill water over the drum gates. However, if Lake Roosevelt is below elevation 1265.5 feet, then all spill must be through the outlet tubes which can result in high levels of TDG below the project. Another factor that can cause elevated TDG levels downstream of the dam include elevated TDG levels in the forebay resulting from high TDG levels coming into Lake Roosevelt from Canada. High TDG levels resulting from outlet tube spill and/or from high forebay TDG generally affects the river reach between Grand Coulee and Chief Joseph dams and beyond. The spillway flow deflectors at Chief Joseph Dam are very efficient at stripping TDG and reducing TDG traveling further downstream when operating. During forced spill events, Grand Coulee will be operated to minimize TDG production to the extent practicable. Involuntary spill at Grand Coulee Dam will be managed in coordination with Chief Joseph Dam operations.

6.6 Chief Joseph Dam

Chief Joseph will spill according to the spill priority list and TDG production estimates to assist in systemwide TDG management.

6.7 Priest Rapids Dam

6.7.1 Spring Operations

The spring flow objective at Priest Rapids Dam is 135 kcfs from April 10 to June 30.

6.7.2 Hanford Reach Protection Flows

Grant County PUD manages the discharge from Priest Rapids Dam at the following intervals during the year to provide protection for the spawning, incubation and rearing of fall Chinook salmon.

- October-November, reverse loading (low flows during daylight hours, spill excess at night) to reduce the formation of redds at high river elevations on Vernita Bar
- November-May, maintain "Critical Elevation" in the Hanford Reach (minimum flow restriction to prevent dewatering of redds)
- March-June, reduce daily flow fluctuations to decrease mortality to juvenile fall Chinook from stranding and entrapment

6.8 Dworshak Dam

6.8.1 Winter/Spring Operations

Winter flow releases from Dworshak will be made to meet end of month FRM targets based on the official water supply forecast. From the period of January 1 to March 31, slightly deeper reservoir drafts will be calculated in-season to improve FRM operations, reduce spring spill at Dworshak Dam, and increase hydropower generation consistent with meeting a 95% refill probability by about June 30 and are no lower than the in-season projected March 31 FRM elevation. The spring flow operation is to maintain a 95% probability of refilling Dworshak while also providing a minimum of 125 KAF of additional releases above the minimum flow of 1.6 kcfs of stored water from Dworshak reservoir in order to maximize the chance of meeting the lower Snake River spring flow objective and aid out-migrating salmon and steelhead. During the spring, the AAs will operate Dworshak Dam to improve the probability of meeting the flow and refill objectives, refilling by about June 30. The reservoir is deemed to be “full” at elevations of 1599 feet or above. If both these objectives cannot be achieved, the TMT will make an in-season recommendation, weighing considerations unique to each particular year. Opportunities to shift system FRM requirements from Dworshak to Grand Coulee will be considered periodically from January through April. Shift of system space will not occur in high water years (with a Dworshak water supply forecast greater than 2.9 MAF April to July runoff). In coordination with the TMT, the Corps may adjust project outflows, if necessary, in order to move juvenile fish into the mainstem Clearwater River during the spring hatchery releases.

6.8.2 Summer Operations

Summer flow augmentation is provided from Dworshak to increase fish survival by moderating river temperatures (improved water quality), and increasing flows in the lower Snake River.

The summer temperature moderation and flow augmentation releases from Dworshak will be shaped with the intent to maintain water temperatures at the Lower Granite tailrace fixed monitoring site at or below 68°F. The Corps maintains and operates a water quality analysis model (CE-QUAL-W2), which is used in-season to forecast downstream water temperatures and inform Dworshak release decisions. The model extends from Dworshak (Clearwater River) and Hells Canyon (Snake River) dams downstream through Ice Harbor Dam. Dworshak releases generally are sufficient to provide effective water temperature management in the Lower Granite tailrace but these efforts can be overwhelmed by extremely hot weather, high discharges of warm water from Hells Canyon Dam, changes in spill operations, or high wind events that disrupt (due to mixing) the thermal stratification in the Lower Granite reservoir.

During the summer (July and August) the AAs will operate Dworshak to help meet flow/temperature objectives in coordination with the TMT. The AAs plan to draft no lower than 1535 feet by the end of August, and draft to 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 (Dworshak Board Operational Plan) for water use in the Dworshak Reservoir. The extension of the draft limit into September assures that water will be released consistent with the Nez Perce Tribe (NPT) Agreement. Releases under the NPT Agreement will be determined in the annual

plan prepared by the Corps, NMFS, Nez Perce Tribe, Idaho, and BPA and presented to the TMT for implementation.

6.8.3 Fall Operations

After summer fish operations are completed (including the NPT Agreement operations in September), flows from Dworshak will be limited to minimum discharge (one small turbine operating above the cavitation zone and within 110% TDG, approximately 1600 cfs) unless higher flows are required for FRM, emergencies, or other project uses. The purpose of these actions is to manage the filling of Dworshak reservoir while operating the project for multiple uses. Flows from Dworshak also may be maintained above minimum flow if Corps analysis determines there is flexibility to release a volume of water above minimum flow and still maintain a 95% reliability of meeting spring refill objectives.

6.8.4 Project Maintenance

As described in the 2020 FPP (see Appendix I), the annual maintenance period is September 15 through the end of February. Special procedures developed to avoid fish impacts during unit testing and start-up will be followed in accordance with the FPP (see Appendix I). Changes to the dates associated with project maintenance will be coordinated with the FPOM via the Fish Passage Plan change form process.

6.9 Brownlee Dam

Opportunities to shift system FRM requirements from Brownlee to Grand Coulee will be considered. See section 4.5 on FRM Shifts for more details. The shifts could occur from January through April. The reservoirs need to be back to their specific URC by April 30. The purpose of this shift is to allow Brownlee to be at higher elevations to increase the probability for increased spring flows in the Snake River. These shifts may be implemented after coordination with the TMT.

6.10 Lower Snake River Dams (Lower Granite, Little Goose, Lower Monumental, Ice Harbor)

6.10.1 Reservoir Operations

The four lower Snake River CRS projects (Lower Granite, Little Goose, Lower Monumental, and Ice Harbor) are operated for multiple purposes including fish and wildlife conservation, irrigation, navigation, hydropower generation, recreation, and limited FRM. The AAs will operate Lower Granite, Little Goose, Lower Monumental, and Ice Harbor Dams at minimum operating pool (MOP) with a 1.5-foot operating range from April 3 until August 14, unless adjusted due to (rare) low flow occurrences in the Snake River to meet authorized project purposes (2020 CRS BA, page 2-51; 2020 NMFS BiOp, page 58, and; 2020 USFWS BiOp, page 18). The Corps conducts a bathymetric survey of the federal navigation channel annually to assure a 14 foot depth is maintained in the federal navigation channel. The survey conducted in the fall of 2017 demonstrated impairment of the federal navigation channel in the Lower Granite

pool. In accordance with the 2020 CRS BA, until sediment accumulation is addressed to provide required channel depths for safe navigation, the Corps will continue use of the variable MOP operation implemented during the 2020 fish passage season to maintain a safe navigation channel. The AAs will coordinate this operation and any other changes in MOP operations with TMT. Additional information regarding turbine operations ($\pm 1\%$ from peak efficiency), spill operations, and juvenile transportation may be found in the most current Fish Operations Plan and Fish Passage Plan.

6.10.2 Snake River Zero Generation

The four lower Snake River projects may cease hydropower generation during the dates and times defined below when power market conditions warrant and when river conditions make it feasible to store water during low demand periods for use during higher demand periods:

October 15 – November 30	Nighttime hours, end no later than 2 hours before dawn
December 1-14	Nighttime hours
December 15 – February 28	Nighttime hours + up to 3 daytime hours

This operation is pursuant to the AAs’ Proposed Action in the 2020 CRS BA, page 2-64, and analyzed in the 2020 NMFS BiOp, page 944, and the 2020 USFWS BiOp, page 212. Based on previous operations between December 15 and February 28 and during nighttime hours only, BPA estimates that the use of this operation may occur 1 out of every 3 to 5 days at each project (2020 NMFS BiOp, page 64).

The timing of “*nighttime*” and “*dawn*” changes throughout the year. Based on the hours of actual Civil Twilight at Lower Granite Dam, the following hour ranges were coordinated during the October 21, 2020, TMT meeting to be consistent with the criteria identified in the 2020 CRS BA:

DATES	“NIGHTTIME” HOURS FOR ZERO GEN
October 15-31	1900-0400 (ending 2 hours < dawn)
November 1-30	1800-0400 (ending 2 hours < dawn)
December 1-14	1800-0600
December 15 - January 31	1800-0600 + up to 3 daytime hours
February 1-28	1900-0600 + up to 3 daytime hours

Sources for definitions and computation of nighttime hours:
<https://www.esrl.noaa.gov/gmd/grad/solcalc/glossary.html>
<https://www.esrl.noaa.gov/gmd/grad/solcalc/calcdetails.html>

6.10.3 Lower Granite Dam Flow Objectives

6.10.3.1 Spring Flow Objectives

The April final runoff volume forecast at Lower Granite Dam for April to July determines the spring flow objective at Lower Granite Dam. When the forecast is less than 16 million acre-feet (MAF), the flow objective will be 85 kcfs. If the forecast is between 16 and 20 MAF, the flow objective will be linearly interpolated between 85 and 100 kcfs. If the forecast is greater than 20 MAF, the flow objective will be 100 kcfs. The flow objective is measured as the season average of the discharge at Lower Granite between the planning dates of April 3 to June 20. These flow objectives are provided as a biological guideline and will likely not be met throughout the entire migration season in all years because the flow in the Snake River primarily depends on the volume and shape of the natural runoff, while the augmentation volumes available are small in comparison to the overall objective. Flow in the Snake River during this period is supported by drafting Dworshak Dam and flow augmentation water from the upper Snake River. During spill operations associated with FRM operations (e.g. February through May) the Corps will make best efforts to minimize TDG effects in the North Fork Clearwater. With the new added power flexibility identified in the 2020 CRS BA the Corps will be able to more effectively minimize any adverse impacts associated with TDG in the North Fork Clearwater River.

6.10.3.2 Summer Flow Objectives

The June final runoff volume forecast at Lower Granite Dam for April to July determines the summer flow objective at Lower Granite Dam. When the forecast is less than 16 MAF, the flow objective will be 50 kcfs. If the forecast is between 16 and 28 MAF, the flow objective will be linearly interpolated between 50 and 55 kcfs. If the forecast is greater than 28 MAF, the flow objective will be 55 kcfs. The summer flow objective is measured as the season average of the discharge at Lower Granite between the planning dates of June 21 to August 31. The summer flow in the Snake River is augmented by the release of stored water upstream of Lower Granite Dam. The summer flow objectives are provided as a biological guideline and will likely not be met throughout the entire migration season in all years because there is a limited amount of stored water available for flow augmentation and the natural shape of the runoff generally produces decreasing streamflows from July to the end of August.

6.11 Lower Columbia River Dams (McNary, John Day, The Dalles, Bonneville)

6.11.1 Reservoir Operations

The four lower Columbia River CRS projects (McNary, John Day, The Dalles, and Bonneville) are operated for multiple purposes including fish and wildlife, irrigation, navigation, hydropower generation, recreation, and limited FRM. The AAs will operate the lower Columbia River reservoirs within their normal operating ranges. Additional information regarding turbine operations ($\pm 1\%$ from peak efficiency), and spill operations, may be found in the most current Fish Operations Plan and Fish Passage Plan.

6.11.1.1 Tribal Treaty Fishing

To accommodate tribal treaty fishing in the lower Columbia River, the AAs will operate The Dalles and Bonneville Dams within a 1.5-foot range and John Day Dam within a 2.0 foot operating range during tribal fishing seasons.

6.11.1.2 McNary Waterfowl Nesting

From March through May, McNary Dam will be operated in the top 1 foot of the normal forebay operating range for several hours every 4 days to improve waterfowl nesting conditions in the McNary pool (Lake Wallula).

6.11.1.3 Blalock Island Operation

As described in the 2020 CRS BA (page 2-57), from April 10 – June 1 (or as feasible based on river flows), the John Day reservoir elevation will be held between 264.5 feet and 266.5 feet (an average of 265.5 feet) to deter Caspian terns from nesting in the Blalock Islands Complex. The Action Agencies intend to begin increasing the forebay elevation prior to initiation of nesting by Caspian terns to avoid take of tern eggs; operations may begin earlier than April 10 (when the reservoir is typically operated between 262.0 to 266.5 feet). The operation may be adaptively managed due to changing run timing; however, the intent of the operation is to begin returning to reservoir elevations of 262.5–264.5 feet on June 1, but no later than June 15, which generally captures 95% of the annual juvenile steelhead migration. The results of this action would be monitored and communicated with USFWS and NMFS. During the operation, safety-related restrictions would continue, including but not be limited to maintaining ramp rates for minimizing project erosion and maintaining power grid reliability. Following this operation, the John Day reservoir elevation would return to MIP + 2 ft operation through August 31.

6.11.1.4 John Day Dam Minimum Irrigation Pool (MIP)

From June 1 through August 31, John Day Dam will be operated to minimize water travel time for downstream-migrating juvenile salmon by operating the forebay within the minimum irrigation pool (MIP) range of 262.5 to 264.5 feet, which is the lowest pool elevation that allows irrigation withdrawals.

6.11.2 McNary Dam Flow Objectives

6.11.2.1 Spring Flow Objectives

The spring flow objective at McNary Dam is set according to the April final runoff volume forecast at The Dalles Dam for April to August. When the forecast is less than 80 MAF the flow objective will be 220 kcfs. If the forecast is between 80 MAF and 92 MAF the flow objective will be linearly interpolated between 220 kcfs and 260 kcfs. If the forecast is greater than 92 MAF the flow objective will be 260 kcfs. The spring flow objective is measured as the season average discharge at McNary Dam between the planning dates of April 10 to June 30. The flow objective is provided as a biological guideline and will not be met throughout the migration season in all years due to variability in volume and shape of the natural runoff.

6.11.2.2 Summer Flow Objectives

The summer flow objective at McNary Dam is 200 kcfs. The summer flow objective is measured as the season average of the discharge at McNary Dam between the planning dates of July 1 to August 31. The flow in the summer at McNary is augmented by the release of stored water upstream of McNary Dam. The summer flow objective cannot be met in all years as there is a limited amount of stored water available for flow augmentation and the natural shape of the runoff generally produces decreasing streamflows from July to the end of August.

6.11.2.3 Weekend Flows

Weekend flows are often lower than weekday flows due to less electrical load demand in the region. During the spring and summer migration period (April through August), the AAs will strive to maintain McNary flows during the weekend at a level which is at least 80% of the previous weekday average.

6.11.3 Chum Operation

See section 7.3 for a detailed discussion on the chum operation.

7. Specific Operations

7.1 Canadian Storage for Flow Augmentation

7.1.1 Columbia River Treaty (Treaty) Storage

The entities can prepare and implement supplemental operating agreements. One such agreement is the annually-developed Non-Power Uses Agreement.

The U.S. Section of the Columbia River Treaty Operating Committee will seek a Non-Power Uses Agreement with Canada that will allow storage of 1 MAF of water in Canadian Treaty space for release during the migration season for the benefit of U.S. fisheries. These supplemental operating agreements must be mutually agreed upon and provide benefits for both entities.

Annual agreements between the U.S. and Canadian entities to provide flow augmentation storage in Canada for U.S. fisheries will seek to include provisions that allow flexibility for the release of any stored water to provide U.S. fisheries benefits to the extent possible by:

- Providing the greatest flexibility possible for releasing water to benefit U.S. fisheries April through July;
- Giving preference to meeting April 10 elevation objectives or achieving refill at Grand Coulee Dam over flow augmentation storage in Canada in lower water supply conditions; and

- Releasing flow augmentation storage to avoid causing damaging flow or excessive TDG in the U.S. or Canada.

The traditional Non-Power Uses Agreement is designed to provide non-power benefits in the U.S. (1 MAF of flow augmentation water stored in Canada) in exchange for non-power benefits in Canada (whitefish (Section 6.1.1) and trout (Section 6.1.2)). Each year discussions begin in the fall with Canada on a Non-Power Uses Agreement the storage and release of the 1 MAF of flow augmentation. Canadian objectives for whitefish and trout protection will be determined by BC Hydro in consultation with Canadian regulators.

In-season management under the Non-Power Uses Agreement is coordinated on a continuing basis by the Operating Committee to try to meet the objectives of both countries and may require mutual agreement.

In addition to the Non-Power Uses Agreement, other supplemental operating agreements may be in place or may be developed during the operating year. Historically, those agreements are developed and implemented in accordance with their terms so as to not reduce the benefits of the Non-Power Uses Agreement.

BPA and the Corps will continue to coordinate with Federal agencies, States and Tribes on Treaty operations and operating plans.

7.1.2 Non-Treaty Storage (NTS) Long Term Agreement

BPA and BC Hydro executed a Long Term Non-Treaty Storage (NTS) agreement effective 10 April 2012 through 15 September 2024. The U.S. and Canadian Entities are satisfied that mutual benefits can be achieved without adversely affecting the operation of Treaty storage in Canadian projects in accordance with the Columbia River Treaty or delivery of the Canadian Entitlement. This agreement provides 5 MAF of NTS for both power and non-power benefits for BC Hydro, BPA, and Canadian and U.S. interests, including the opportunity to provide benefits for ESA-listed fish. BPA has the right to release 0.5 MAF of storage from its account in the spring to benefit ESA-listed fish during the lowest 20th percentile of water years based on the May, April-August volume forecast at The Dalles, provided such a release was not made in the prior year (see also Section 9 below).

In addition, to the extent that Non-Treaty storage use can provide benefits to fish by storing some water in the spring for release in the summer (by the end of August), BPA will coordinate such operations with Federal agencies, States and Tribes.

7.2 Upper Snake River Reservoir Operation for Flow Augmentation

Reclamation will attempt to provide 487 KAF annually of flow augmentation from the Reclamation projects in the upper Snake River basin consistent with its Proposed Action as described in the November 2007 Biological Assessment for O&M of its projects in the Snake River basin above Brownlee Reservoir. Reclamation's flow augmentation program is dependent on willing sellers and must be consistent with Idaho State law.

7.3 Bonneville Chum Operations

As described in the 2020 NMFS BiOp (page 1015), the AAs will provide a tailwater elevation below Bonneville Dam of approximately 11.5 feet beginning the first week of November (or when chum arrive) and ending by December 31, if reservoir elevations and climate forecasts indicate this operation can be maintained through incubation and emergence. The Columbia River chum salmon Evolutionarily Significant Unit (ESU) includes all naturally spawning populations and three hatchery programs of chum salmon in the Columbia River and its tributaries in Washington and Oregon. The hatchery programs include the Grays River Program and the Washougal River Hatchery/Duncan Creek Program, in Washington and the Big Creek Hatchery Program in Oregon. There are three major population groups (MPG) on the Columbia River, with each MPG consisting of multiple sub-populations: Coast, Cascade and Gorge (NMFS, Lower Columbia River Recovery Plan, June 2013). The Ives/Pierce Islands spawning area is part of the Gorge MPG (Lower Gorge sub-population) and is the focus of the Bonneville chum operations described below.

The AAs plan to operate the CRS to provide flows to support chum salmon spawning, incubation and egress from, and through the Ives/Pierce Islands spawning areas. The Ives/Pierce Island complex represents a small but important spawning area and provides access to tributary spawning areas for the segment of the population that spawns in the mainstem and tributaries of the Columbia River between the Glenn-Jackson Bridge and Bonneville Dam. Listed Lower Columbia River Tule fall Chinook salmon and non-listed up-river bright fall Chinook salmon are also known to spawn in the Ives/Pierce Islands area. The 2020 NMFS BiOp recognizes that access to spawning habitat in the Ives/Pierce area is primarily a function of the Bonneville Dam tailwater. When the Bonneville Dam tailwater elevation is greater than 11.3 feet above mean sea level (msl) salmon begin to have access to the Ives/Pierce Islands spawning area. Chum access to spawning habitat in Hamilton, Hardy and Duncan creeks is also a function of sufficient tailwater elevation and fall rain events to recharge the aquifer and water up the spawning areas within the creeks.

Chum access and use of the available spawning area in the Ives/Pierce Island complex is driven by Bonneville Dam tailwater elevations as measured at the Tanner Creek gage. Tailwater elevations below Bonneville Dam are directly correlated with the amount of chum spawning habitat available in the Ives/Pierce Island complex. Bonneville Dam discharges have the most direct effect on tailwater elevations. However, the daily and hourly variability of tides, wind and tributary flow downstream of Bonneville Dam directly affect the required outflow from Bonneville Dam to achieve a particular tailwater elevation on a daily and hourly basis.

The tailwater operating range used over the last several years have restricted access to spawning habitat in the Ives/Pierce Island area between tailwater elevations of 11.0 and 13.0 feet. During this period most redds have been set such that Bonneville Dam tailwater elevations in the range of 11.3 to 12.5 feet would provide adequate protection. As the tailwater elevations increase above 11.3 chum typically use habitat available at the lower elevations first. Some chum salmon may spawn at elevations between 12.0 and 13.0 feet, however this habitat area is generally considered less desirable for chum spawning. As tailwater elevations increase beyond 13.0 feet, new habitat is wetted and becomes available for chum spawning. However, as tailwater

elevations increase above 13.5 feet some habitat between 11.3 and 12.0 feet becomes unsuitable for chum due to higher water velocities. At a tailwater of 16.0 feet and greater, chum are forced out of suitable habitat zones. Common spawning areas at lower and higher elevations are mostly spatially distinct but there is some significant overlap. In years of high escapement and adequate water supply, it may be possible to maximize the available habitat by first managing the tailwater for the lower elevations to benefit early arrivals, and then as conditions allow, increase the tailwater elevation to allow later arriving adults access to additional spawning habitat.

Tributary flow from Hamilton Creek can affect the access to the Ives Island habitat below 12.0 feet but has reduced impact at tailwater elevations above 12.0 feet. Chum salmon may have restricted access to Hamilton Creek at tailwater elevations less than 11.3 feet depending the flow in Hamilton Creek. With recent modifications to the fish ladder at Duncan Creek Dam, chum can now access the creek at 11.5 foot tailwater elevations. Since the year 2000, when the tailwater regulation for chum began, protection levels for incubation and emergence have not been set at elevations higher than 14 feet even when tailwater elevations during the spawning period (November-December) have exceeded 14 feet extended periods of time. The additional amount of flow augmentation required to support such a high tailwater elevation and potential number of redds affected is typically weighed against the likely consequence to the ability to refill Grand Coulee to its April 10 elevation objective.

These impacts were addressed in the 2020 NMFS BiOp which outlined, chum salmon spawning operations as having lower priority than achieving spring flow objectives or summer refill. If all of the BiOp objectives cannot be met, the AAs will work with NMFS and the regional salmon managers to identify operations that would best benefit salmon while maintaining other fish protection measures.

There are two phases of the Ives/Pierce area chum operations: spawning (typically from early November through late December) and incubation and egress (typically from late December through early April).

7.3.1 Chum Spawning Phase

In the first week of November or when fish arrive (as coordinated with the TMT), Bonneville Dam will start operating to provide a tailwater elevation (TWE) range of 11.3-13.0 feet until spawning ends or December 31. The official project TWE gauge is located 0.9 mile downstream of Bonneville Dam's powerhouse 1 on the Oregon shore, 50 feet upstream of Tanner Creek at river mile 144.5. Generally, the range of outflow from Bonneville Dam required to maintain this TWE can vary from less than the project minimum discharge (58 kcfs) up to 135 kcfs. This range demonstrates the profound effect of natural conditions downstream of Bonneville Dam on the water elevation. Tides, wind, wave and unregulated inflows to the Columbia River all have an influence on the ability to regulate the TWE below Bonneville Dam with the outflow from Bonneville Dam.

In addition to the uncertainty and variability of downstream conditions that affect TWE at Bonneville Dam, there are many upstream variables as well. Generally, the flow at Bonneville Dam is augmented by storage releases from Grand Coulee Dam which can take 1 - 2 days to arrive at Bonneville Dam depending on how the water is passed through several non-federal

dams which can alter the shape and timing of the flow. Further, the volume of unregulated flow into the Columbia River upstream of Bonneville Dam is difficult to predict but is critical in meeting the spawning elevations. The ability to operate Bonneville Dam to a particular TWE constraint is contingent on the ability of the hydrosystem to forecast and manage all of these variables and conditions. Reservoir operations upstream of Bonneville may provide additional water to help support the chum operation.

The Columbia River System is often unable to maintain the TWE within the range of 11.3-13.0 feet during daylight hours throughout the entire spawning period. Significant seasonal rain events commonly require that the operation must be modified in order to manage the additional water. Research to assess the impacts of higher flows (day and night) on chum salmon redd development indicated that increased flows nightly up to 175 kcfs delayed spawning by temporarily displacing fish until flows decreased to base levels, but did not force fish to abandon their redds and search for new locations (Tiffan et al. 2009).

7.3.2 Chum Spawning Operational Steps

The spawning operation should utilize the considerations below to minimize the establishment of high elevation redds. Managing the spawning operation to minimize the required protection level increases the probability that the protection level can be maintained through egress in the early spring.

- Early season forecasts can be used by TMT to determine a level of caution when choosing the spawning elevations to provide below Bonneville. A general apprehension to provide tailwater elevations which will achieve a protection level above 11.3 feet is prudent in most years. Fall precipitation can lead to chum spawning at higher elevations than intended. It may be difficult to commit to providing those elevations without a solid water supply forecast.
- If water supply forecasts indicate it is unlikely a higher protection elevation (for example: daytime tailwater > 17 feet) can be maintained through emergence TMT will consider an operation that shapes flows during the spawning phase in order to discourage spawning at higher elevations in the Ives/Pierce Island area as a potential tool to keep redds below high risk elevations.

Steps 1-7 below describe an example of a transition from a controlled operation to an uncontrolled operation when conditions are such that the daytime TWE range cannot be maintained. The steps are reversed if it is possible to return to a controlled operation and high elevation redds have not been established. There may be changes made to these steps based on the TMT discussion. The following tailwater operation was coordinated with the TMT during the October 29, 2014 meeting.

- 1) Bonneville Dam tailwater will be operated within a range of 11.3–13.0 feet during all hours.
- 2) If necessary to pass additional flow, Bonneville Dam tailwater will be operated up to 16.5 feet during nighttime hours (1700-0600). Highest tailwater elevations will be concentrated around midnight.

- 3) If necessary to pass additional flow, Bonneville Dam tailwater will be operated up to 18.5 feet during nighttime hours (1700-0600). Highest tailwater elevations will be concentrated around midnight.
- 4) If necessary to pass additional flow, Bonneville Dam tailwater operating range will become 13.0–16.5 feet during daytime hours (0600-1700) with no upper limit during nighttime hours. Highest tailwater elevations will be concentrated around midnight. The Action Agencies will notify the TMT of this occurrence and coordinate further operations if necessary.

There are several conditions that typically preclude the chum spawning operation for multiple days. These events are usually forecasted well in advance, and an appropriate course of action is coordinated through TMT. Below are some examples of the conditions where the chum operation cannot be managed within the above constraints:

- 1) Conditions downstream of Bonneville (e.g., high tides, high inflows) result in high TWE regardless of project discharge. Even at minimum discharge, these conditions could raise the TWE above the target range.
- 2) Heavy precipitation events increase inflow to the Columbia River both upstream and downstream of Bonneville Dam. The combination of low required flow at Bonneville Dam, unregulated inflows to the Columbia River upstream of Bonneville Dam, and the lack of storage capacity behind the lower Columbia River dams, result in little to no control over the resulting TWE below Bonneville Dam.

7.3.3 Chum Incubation and Egress

Washington Department of Fish and Wildlife (WDFW) will inform the TMT when they establish chum salmon spawning is complete at the Ives/Pierce Island area; this usually occurs in late December but will not extend past December 31. Following the completion of spawning, the operation is shifted to provide a minimum tailwater elevation (as coordinated with TMT). In most years an elevation between 11.3 and 11.7 is adequate. Redds established at higher elevations may not be fully protected. The end of the chum protection operation is coordinated with the TMT after it is determined that completion of emergence and egress has occurred or if the volume of flow augmentation required to maintain the protection level jeopardizes spring refill objectives.

The protection operation typically ends between mid-March and April 10. In some years emergence and egress may not be complete by April 10 and TMT may be asked to extend the tailwater protection elevation through emergency and egress. TMT will then discuss the impacts of TDG associated with spill and/or operation of the corner collector for fish passage at Bonneville Dam and its potential for negatively affecting fry in the gravel. However, typically spring flow augmentation volumes generally provide sufficient flows to maintain the protection elevations. Bonneville starts its spring spill around April 10, but a delay in the start of spill may be needed. The chum protection level decision will be revisited at least monthly through the TMT process to assure it is consistent with the need to provide spring flows for listed Columbia and Snake River stocks.

7.3.4 Considerations for Dewatering Chum Redds

While a conservative approach to managing tailwater elevations during spawning reduces the risk of dewatering redds, it does not eliminate dewatering as a possibility. The conditions in each year vary too dramatically to allow for the development of set criteria for whether or not to dewater redds, therefore the decision is made in-season conditions with the TMT. Factors considered in making a dewatering decision include:

- Number of redds that would be affected and the percentage they represent of:
 - the overall Ives/Pierce Islands and Hamilton Springs complex;
 - the total population spawning above the I-205 Bridge;
 - the entire ESU.
- Emergence timing based on available temperature data;
- Status of the CRS storage reservoir elevations;
- Expected benefit to reservoir levels and river operations which would be provided by the dewatering decision;
- Precipitation and runoff forecasts;
- Expected river operations due to power market environment;
- Status of the upriver spring Chinook, steelhead and sockeye listed stocks;
- Existence and status of a brood contingency plan.

7.3.5 Chum Redd Dewatering and Alternative Maintenance Options

If water supply conditions indicate that it is not possible to maintain the minimum tailwater elevation established in December for Bonneville Dam, the protection level may be reduced to a level that can be maintained. If chum redds are dewatered as a result of diminished water supply conditions a “rewetting operation” once a day for ~1 hour has been utilized as an interim measure to provide some level of protection in the event that water supply conditions improve sufficiently to restore the full protection level. However, rewetting is only effective under some conditions.

If protection for all redds has been suspended the TMT will consider an operation to provide egress for chum migrating from habitat in Hamilton, Hardy and Duncan creeks. The potential impact to spring flows as a result of this operation would be evaluated through coordination with the TMT.

7.4 Description of Variable Draft Limits

Variable Draft Limits (VDLs) are period-by-period draft limits at Grand Coulee and Hungry Horse from January-March 31. These are planned limits to Firm Energy Load Carrying Capability (FELCC) generation to protect the ability to refill Grand Coulee and Hungry Horse to their April 10 elevation objectives with an 85% and 75% confidence respectively.

The VDLs are based on: (1) The April 10 elevation objective which is calculated from the forecasted March 31 and April 15 FRM elevations (2) statistical inflow volumes (85% exceedance for Grand Coulee and 75% exceedance for Hungry Horse), and (3) actual downstream flow objectives.

VDLs are calculated monthly from January through March after updated volume forecasts and FRM elevations have been issued. The VDL at the end of a period (e.g., January 31) is computed to determine the lowest elevation where the outflow requirements and the April 10 elevation objective can be achieved using a 75%/85% probable inflow volume. For example, Hungry Horse's January VDL is computed as:

- The expected April 10 elevation objective based on January forecast.
- Minus February 1 to April 10 inflow volume of 165.7 ksf (75% statistical inflow volume).
- Plus February 1 to April 10 minimum discharge requirement for Columbia Falls.

The VDL is not a mandatory draft elevation and operation above the VDL is acceptable as long as it is not a higher elevation than FRM curve, FELCC is already being met, and at-site and downstream flow objectives are also being served. Also, VDLs at Grand Coulee are further limited by VDL lower limits of 1260 feet in January, 1250 feet in February and 1240 feet in March.

The statistical inflow volumes for Hungry Horse and Grand Coulee are derived as follows:

- Hungry Horse – The inflow volumes used are the 75% probable inflow into Hungry Horse reservoir plus the 75% probable incremental at Columbia Falls. The data used to compute these inflow volumes for Hungry Horse are from the 2010 80 WY Modified Streamflows.
- Grand Coulee – The inflow volumes used are the 85% probable regulated inflow volume into Grand Coulee and the 75% probable regulated incremental to Priest Rapids Dam. The data used to compute these inflow volumes will be taken from the results of an in-season ESP hydroregulation study that reflects the most current operational assumptions streamflow forecast.

The slightly deeper draft for winter hydropower flexibility at Dworshak Dam (also referred to as a VDL), will be available January through the end of February, is based on the following:

- The expected March FRM elevation.
- The expected releases at Dworshak Dam for hatchery and maintenance flows while still maintaining a 95% confidence of refill.
- The anticipated refill date based on the start of summer flow augmentation.

7.5 Lake Roosevelt Incremental Storage Release Project of the Washington State Department of Ecology, Columbia River Water Management Program

7.5.1 Lake Roosevelt Incremental Storage Releases

The Lake Roosevelt Incremental Storage Releases portion of Washington State's Columbia River Water Management Program (CRWMP) result in additional water withdrawals from Lake

Roosevelt for both out-of-stream use and instream flows. For every two acre-feet of water put to out-of-stream use, one acre-foot of water will go to instream flows (“*no net loss plus one-third*”). The Incremental draft, when fully developed, would result in a release of 82,500 acre-feet in most years, or about 1.0 foot of draft at Lake Roosevelt. In years when the March 1 final forecast of April through September runoff at The Dalles is less than 60 million acre-feet, an additional draft of 50,000 acre-feet for interruptible water users and instream flow will occur, for a total draft of 132,500 acre-feet or about 1.8 feet of draft.

7.5.2 Release Framework and Accounting for Lake Roosevelt Incremental Draft

The only way to demonstrate that the water came from Lake Roosevelt and not stream flows during the juvenile fish migration period is to draft Lake Roosevelt. As described in the 2020 CRS BiOp (page 50), there are two elevation objectives during the juvenile fish migration period: (1) end of June (early July) refill, and (2) August 31 draft, the latter of which is forecast based. When water is released in the April-through-June spring period from the Lake Roosevelt incremental draft water account, then Lake Roosevelt would need to miss refill by that amount. Lake Roosevelt would draft below the end of August draft limit by the amount released in both the spring and July-August summer flow augmentation periods.

7.5.3 2021 Operations

The amount and timing of water to be released in 2020 will not be determined until the March final WSF for April – September at The Dalles is completed. Estimates of 2021 incremental storage releases will be included in the 2021 seasonal update.

7.6 Public Coordination

Actions in the WMP will be coordinated with NMFS, USFWS, and the states and tribes in pre-season planning and in-season management of flow and spill operations. This coordination will occur in the TMT process and will utilize the best available science. The WMP and associated documents are posted to the web and available to the public on the TMT website (<http://pweb.crohms.org/tmt/>). TMT meetings also have conference call information and WebEx web-meeting services that are available to the public.

At all appropriate decision points, the AAs will routinely seek timely input and concurrence from the USFWS on all matters affecting ESA-listed fish within the jurisdiction of USFWS through the Columbia River Treaty, International Joint Commission (International Kootenay Lake Board of Control), and all other decision making processes involving trans-boundary waters in the Columbia River basin. This will include notification of all meetings and decision points and provision of opportunities to advise the AAs during meetings and in writing, as appropriate.

8. Water Quality

8.1 Water Quality Plans

The Corps has completed a comprehensive 2014 Water Quality Plan (WQP) outlining the physical and operational changes that could be used to improve the overall water quality in the

mainstem waters of the Clearwater, Snake, and Columbia rivers. The plan is available on the following website:

http://pweb.crohms.org/tmt/wq/studies/wq_plan/wq2014.pdf

8.2 Total Dissolved Gas (TDG) Monitoring

Exposure to high levels of TDG over long periods of time can be harmful or lethal to fish. Monitoring in the waters impacted by operations at the dams is necessary where voluntary spill is employed for juvenile fish passage to ensure that gas levels do not exceed TDG thresholds established in applicable state water quality criteria and waivers. The Corps TDG monitoring program is described in the TDG Monitoring Plan of Action, which included data quality criteria for fixed monitoring stations, goals related to the accuracy, precision, and completeness of data at each fixed monitoring station and the methodologies that are used in the attempt to achieve those goals, calibration protocols (data quality control), data review and corrections (data quality assurance), and completeness of data. The TDG Monitoring Plan of Action can be found on the following website:

https://pweb.crohms.org/tmt/documents/ops/201903_TDG_Monitoring_Plan.pdf

The Reservoir Control Center is responsible for monitoring the TDG and water temperature conditions in waters impacted by Corps projects on the Columbia and Snake rivers. To assess water quality conditions in these waters, the Corps operates TDG and temperature monitors in the forebays and the tailwaters of the lower Columbia River/lower Snake River dams, and other selected river sites. The Corps prepares a Total Dissolved Gas Management Plan (TDG Management Plan) each year (see Appendix 4). This TDG Management Plan provides information addressing voluntary and involuntary spill, use of the spill priority list, the process for setting spill caps, TDG management policies, and the TDG monitoring program. Spill caps for individual projects can be found on the following website:

<http://www.nwd-wc.usace.army.mil/tmt/documents/ops/spill/caps/>

9. Dry Water Year Operations

A dry year is defined as a year when the NWRFC May final forecast for April-August runoff at The Dalles Dam is below the 20th percentile for the NWRFC statistical period of record. The statistical 30-year period of record is currently 1981 to 2010, for which the 20th percentile value is 72.5 MAF. Consistent with prior recommendations from NMFS, the AAs propose the following system management actions, where practicable, to benefit migrating salmon and steelhead in dry water years:

- Within the defined draft limits for flow augmentation (i.e., the reservoir elevations described for storage projects above), flexibility will be exercised in a dry water year to distribute available water across the expected migration season to optimize biological benefits and anadromous fish survival. The AAs will coordinate use of this flexibility with the Regional Forum through the TMT.

- In dry water years, operating plans developed under the Treaty may result in Treaty reservoirs being operated below their normal refill levels in the late spring and summer, increasing flows during that period relative to a standard refill operation.
- Annual agreements between the U.S. and Canadian entities to provide flow augmentation from Treaty storage in Canada will include provisions that allow flexibility for the release of any stored water to provide U.S. fisheries benefits in dry water years, to the extent possible.
- The non-Treaty storage agreement is in place for an additional 0.5 MAF of non-Treaty storage for use in dry water years (but not in consecutive years).
- Bonneville will implement, as appropriate, measures recommended in the *Guide to Tools and Principles for a Dry Year Strategy* (2020 CRS BA, page 2-62) to reduce the effect that energy requirements may pose to ESA-listed species.
- Transport operations will be adaptively managed in dry years for low-flow conditions and coordinated through the Regional Forum process.