
2011 WATER MANAGEMENT PLAN



Bonneville Dam
(Photo courtesy of Dennis Schwartz)

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

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2011 Water Management Plan

2 Introduction

The Water Management Plan (WMP) describes the Action Agencies' annual plan for implementing specific operations identified in the NMFS 2008 Biological Opinion and NMFS 2010 Supplemental Biological Opinion (NMFS 2010 Supplemental BiOp), and the USFWS 2000 and 2006 BiOps on the operation of the FCRPS during the current water year (October 2010 – September 2011). The AAs are the final authorities on the content of 2011 WMP, although review, comment, and recommendations are solicited from the Technical Management Team (TMT) and NMFS for consideration during preparation of the WMP. Seasonal operation summary updates to the WMP (spring/summer & fall/winter updates) will be prepared by the AAs and distributed to the region through the TMT. The system operations contained herein may be adjusted according to water year conditions based on recommendations from the TMT and pending review and coordination with NMFS and/or USFWS, whichever is appropriate.

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), undergo Endangered Species Act (ESA) consultations on the effects of the operation of 14 Federal multi-purpose hydropower projects in the Federal Columbia River Power System (FCRPS)¹ on listed species² with the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS). Biological opinions produced in response to these consultations contain operations that are addressed in this WMP. The applicable biological assessments and biological opinions are as follows:

- The AAs' 2007 FCRPS Biological Assessment (BA) and the Comprehensive Analysis of the FCRPS and Mainstem Effects of Upper Snake and Other Tributary Actions (Comprehensive Analysis) (USACE *et al.* 2007) (BA) were submitted to NMFS in August 2007 and can be found at:

<http://www.nwr.noaa.gov/Salmon-Hydropower/Columbia-Snake-Basin/final-BOs.cfm>

- Reclamation's 2007 Upper Snake BA and BiOp

The BA can be found at:

<http://www.usbr.gov/pn/programs/UpperSnake/>.

The BiOp can be found at:

<http://www.nwr.noaa.gov/Salmon-Hydropower/Columbia-Snake-Basin/final-BOs.cfm>

¹ The FCRPS comprises 14 Federal multipurpose hydropower projects. The 12 projects operated and maintained by the Corps are: Bonneville, The Dalles, John Day, McNary, Chief Joseph, Albeni Falls, Libby, Ice Harbor, Lower Monumental, Little Goose, Lower Granite and Dworshak dams. Reclamation operates and maintains the following FCRPS projects: Hungry Horse Project and the Columbia Basin Project, which includes Grand Coulee Dam.

² Species listed as endangered or threatened under the Endangered Species Act (ESA).

- NMFS's 2008 FCRPS BiOp

The current WMP reflects provisions contained in the NMFS 2008 FCRPS BiOp (NMFS BiOp) issued May 5th, 2008, and titled "Consultation on Remand for Operation of the Federal Columbia River Power System, 11 Bureau of Reclamation Projects in the Columbia Basin and ESA Section 10(a)(1)(A) Permit for Juvenile Fish Transportation Program (Revised and reissued pursuant to court order, *NWF v. NMFS*, Civ. No. CV 01-640-RE (D. Oregon))." The Corps prepared a Record of Consultation and Statement of Decision (ROCASOD) relative to the NMFS BiOp on August 1, 2008, BPA signed a Record of Decision (ROD) on August 13, 2008 and Reclamation signed a Decision Document on September 3, 2008. The NMFS BiOp, the Upper Snake BiOp, the Corps' ROCASOD, and Reclamation's Decision Document can be found at:

<http://www.nwr.noaa.gov/Salmon-Hydropower/Columbia-Snake-Basin/Final-BOs.cfm>

- NMFS 2010 Supplemental FCRPS Biological Opinion

After the Obama Administration reviewed the BiOp in 2009, NOAA and the Action Agencies jointly developed an Adaptive Management Implementation Plan (AMIP). In February 2010, the federal agencies entered into a voluntary remand to formally integrate the AMIP developed during the fall of 2009 into the 2008 BiOp and its RPA.

In addition to consideration of new information, the 2010 Supplemental BiOp incorporated the 2008 BiOp and added the amended AMIP to the 2008 BiOp RPA. The Action Agencies amended their respective Records of Decision on June 11, 2010. The amended ROD's may be found at the following website:

<http://www.bpa.gov/corporate/pubs/RODS/2010/>

The Supplemental FCRPS BiOp may be found at the following website:

<http://www.nwr.noaa.gov/Salmon-Hydropower/Columbia-Snake-Basin/final-BOs.cfm>

- USFWS's 2000 FCRPS BiOp, the 2006 Libby Dam BiOp

The USFWS 2000 FCRPS BiOp, "Effects to Listed Species from Operation of the Federal Columbia River Power System" is operative for all the FCRPS projects except for Libby Dam and can be found at: <http://www.fws.gov/pacific/finalbiop/BiOp.html>.

The USFWS issued the 2006 Libby BiOp, which amended and supplemented the USFWS 2000 BiOp with respect to the effects of the operations of Libby Dam on the Kootenai sturgeon and the bull trout in the Kootenai River. That document can be found at: <http://kootenaifwlibrary.org/PDFs/26S%20Final%20Libby%20Dam%20BiOp%202-18-06lr3.pdf>

3 Additional Governing Documents

- Corps 2003 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 Canadian and United States Entities include the preparation of a flood control operation plan (FCOP) for the Canadian storage. 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

desired flood control objectives in the United States and Canada. The purpose of including Libby Reservoir in the FCOP is to meet the Treaty requirement to coordinate its operation for flood control protection in 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. A copy of the FCOP may be found online at the following website:
<http://www.nwd-wc.usace.army.mil/cafe/forecast/FCOP/FCOP2003.pdf>

4 WMP Implementation Process

- Technical Management Team

The TMT is an inter-agency technical group comprised of sovereign representatives responsible for making recommendations to the AA's on dam and reservoir operations in an effort to meet the expectations of the applicable BiOps (NMFS 2010 Supplemental; USFWS 2000 FCRPS, USFWS 2006 Libby; BOR 2007 Upper Snake). The Corps' representative is the TMT chair; and, the TMT consists of representatives from: NMFS, USFWS, BOR, Corps, BPA; the states of Oregon, Washington, Idaho, Montana; and, tribal sovereigns.

- Preparation of the WMP

Each fall, the AAs prepare an annual WMP (draft by October 1st and the final by January 1st). The AAs have prepared this WMP for the 2011 water year consistent with the NMFS 2010 Supplemental BiOp and the USFWS 2000 and 2006 BiOps. This WMP describes the planned operations of the FCRPS dams and reservoirs for the 2011 water year (October 1, 2010 through September 30, 2011)³. The operations are designed to:

- implement water management measures in a manner consistent with actions considered in their respective BiOps.
- assist in meeting the biological performance standards specified in the BiOps in combination with other actions or operations identified in the NMFS 2010 Supplemental BiOp.
- meet non-BiOp related requirements and purposes such as flood control, hydropower, irrigation, navigation, recreation, and fish and wildlife not listed under the ESA. For a detailed description of flood control see <http://www.nwd-wc.usace.army.mil/report/colriverflood.htm>.
- take into consideration recommendations contained in the applicable Northwest Power and Conservation Council Fish and Wildlife Program and amendments.

³ When the draft WMP is prepared, very little information is available about the future year's water supply; therefore, the draft provides only a general description of how the FCRPS will be operated during the upcoming water year.

The WMP will also include any special operations (such as any special tests, required maintenance, construction activities, flood control procedures planned for the year, etc.) that are known at the time the WMP is developed. These action plans will take into account changes in the operations due to water supply or other factors. As the water supply forecasts become available, the AAs will develop more detailed in-season action plans for the proposed FCRPS project operations that describe planned hydro system fish operations for the upcoming fall and winter (draft by November 1 and final by January 1) and for the spring, and summer (draft by March 1 and final by May 15).

- The Corps also prepares a Fish Passage Plan (FPP) each year that provides detailed operating criteria for project fish passage facilities, powerhouses, and spillways to allow for the efficient passage of migratory fish. The FPP contains appendices that describe special operations for fish research studies, the juvenile fish transportation program, operation of units within 1% of best efficiency, spill for fish passage, total dissolved gas (TDG) monitoring, and dewatering procedures. The FPP is coordinated through the Fish Passage Operations and Maintenance Coordination Team (FPOM) and is available on the web at <http://www.nwd-wc.usace.army.mil/tmt/>.

- **NMFS 2010 Supplemental BiOp Strategies**

This WMP addresses strategies to enhance juvenile and adult fish survival through a coordinated set of hydro project management actions to achieve performance standards, and to provide benefits to resident fish. The plan is structured to address water management actions associated with the following strategies and sub-strategies, as defined in the NMFS 2010 Supplemental BiOp.

- Hydropower Strategy 1—Operate the FCRPS to provide flows and water quality to improve juvenile and adult fish survival.
- Hydropower Strategy 2—Modify Columbia and Snake River dams to maximize juvenile and adult fish survival.
- Hydropower Strategy 3—Implement spill and juvenile transportation improvements at Columbia River and Snake River dams.
- Hydropower Strategy 4—Operate and maintain facilities at Corps mainstem projects to maintain biological performance.

4.1 Non ESA Operations

Each year the AAs implement water management actions that are not part of our ESA obligations, but are aimed at meeting other project requirements and purposes such as flood control, power generation, irrigation, navigation, recreation, and fish and wildlife not listed under the ESA. Table 1 includes fish and wildlife related non-ESA water management actions that may be implemented and the time of year such actions typically occur. These actions are further described below.

Table 1. Non-ESA listed species and period of impact.

Action	Time of Year
Keenleyside Dam (Arrow) mountain whitefish actions	December – January
Keenleyside Dam (Arrow) rainbow trout actions	April – June
Libby - burbot actions	October - February
Dworshak – flow increase for hatchery release	March
Grand Coulee – kokanee	September – Mid November
Hanford Reach Fall Chinook Protection Program Agreement	October – June
McNary - waterfowl nesting	March – May
McNary - waterfowl hunting enhancement	October – January
John Day - goose nesting	March – May
Bonneville - Tribal fishing	April – September
Bonneville - Spring Creek Hatchery release	April – May
Ice Harbor - waterfowl hunting enhancement	October – January
Little Goose – waterfowl hunting enhancement	October – January
Duncan - whitefish flows	March – May

4.2 Lamprey Passage

The Fish Accords signed in May 2008 address actions to protect Pacific lamprey. The goals of the Pacific lamprey passage program are to improve both juvenile and adult lamprey passage through the FCRPS. Guidance for project operations to improve passage conditions for adult and juvenile lamprey are addressed in FPOM and specific 2011 operations for juvenile and adult lamprey will be defined in the appropriate project sections of the 2011 FPP. In-season conflicts between operations for listed species and Pacific lamprey not covered in the FPP will be reviewed by TMT and TMT may provide management recommendations on these issues.

5 Hydro System Operation

- Priorities

The NMFS 2010 Supplemental BiOp and USFWS 2000 and 2006 BiOps list the following strategies for flow management:

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

Provide minimum flows in the fall and winter to support mainstem chum spawning and incubation flow below Bonneville Dam. The Action Agencies have reviewed these strategies and other actions called for in the NMFS 2010 Supplemental BiOp, and USFWS 2000 and 2006 BiOps and developed the following priorities (in order) for flow management and individual reservoir operations after ensuring adequate flood damage reduction is provided:

1. Operate storage reservoirs (Hungry Horse and Libby) to meet minimum flow and ramp rate criteria for resident fish.
2. Refill the storage projects to provide summer flow augmentation. The timing and shape of the spring runoff may result in reservoir refill a few days before or after the target refill date. For example, a late snowmelt runoff may delay refill in order to avoid excessive spill.
 - Hungry Horse refill by about June 30 to provide summer flow augmentation.
 - Dworshak refill by about June 30 to provide summer flow augmentation.
 - Grand Coulee refill by about June 30 to provide summer flow augmentation.
 - Operate Libby Dam in accordance with VARQ Operating Procedures combined with the tiered sturgeon volume shaped as recommended in the USFWS 2006 BiOp, as clarified. These operating assumptions provide an approximate 12% probability of Libby refill to within one ft. of full by July 31.

3. Operate storage projects to be at their April 10 elevation objectives, if possible, to provide spring flow augmentation.
4. Provide flow augmentation, from the start of chum spawning in November through the end of chum emergence (approximately April), to maintain sufficient water surface to protect Ives/Pierce Island chum salmon spawning and incubation.

In addition to operations for anadromous fish, the AAs operate the FCRPS projects to benefit listed fish at or near each project or in its reservoir. Reservoirs operate to meet project minimum outflows, to avoid involuntary spill and resulting elevated TDG, to reduce outflow fluctuations to avoid stranding fish and degrading fish habitat and productivity, to reduce cross sectional area of run-of river mainstem projects to speed juvenile passage and reduce reservoir surface area to moderate temperatures, and to make specific temperature releases from storage projects to improve 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.

As the operating year begins on October 1, the flow objectives are not encountered in the same order as the NMFS 2010 Supplemental BiOp flow priorities (e.g. decisions need to be made on chum spawning flows first despite the fact that they have a lower priority than spring or summer migration flows). However, the AAs will operate chronologically during the year while attempting to meet the flow priorities as they are outlined in the NMFS 2010 Supplemental BiOp. Objectives include:

- Operate the storage reservoirs (Dworshak, Hungry Horse, Libby, and Grand Coulee) to achieve the April 10 refill objectives with a high probability. These levels vary with the runoff forecast. The ability to reach these objectives is affected by how much water was released for flood control, changes in runoff volume forecasts, power generation, and fishery flows to support both lower Columbia chum and Hanford reach fall Chinook spawning, as well as minimum flow requirements below the projects.
- Refill the storage reservoirs by about June 30⁴ while minimizing spill (except as needed to maintain flood control), in order to maximize available storage of water for the benefit of summer migrants. Although the June 30 refill objective generally has priority over spring flow (April, May, June) objectives, the AAs attempt to refill as well as meet the spring flow objectives and other fish needs.
- Manage the available storage to augment summer (July and August) flows in an attempt to meet flow objectives and to moderate water temperature. When

⁴ Libby Dam refill probability is likely to be later into July as defined in the VARQ Flood Control Operating Procedures and supporting effects analysis. *See*, Upper Columbia Alternative Flood Control and Fish Operations (VARQ) Environmental Impact Statement.
<http://www.usbr.gov/pn/programs/fcrps/varq/index.html>

necessary for summer flow augmentation, Libby and Hungry Horse will be drafted to no lower than their specified draft limits by September 30, Grand Coulee and Banks Lake will be drafted to no lower than their specified draft limits by August 31. Dworshak will reach its summer draft limit in September to augment summer flows and to moderate river temperatures. Draft limits are a higher priority than the summer flow objectives in order to meet other project uses and reserve water in storage for the following year.

- These objectives are intended as general guidelines. The NMFS 2010 Supplemental BiOp and the USFWS 2000 and 2006 BiOps embrace the concept of adaptive management. Adaptive management is the concept that the operation of the system should be adjusted based on best available science and acquired knowledge about current conditions in the system and effects due to management actions, as opposed to following a rigid set of rules. Conditions that are continually changing include information on fish migration, stock status, biological requirements, biological effectiveness, and hydrologic and environmental conditions.
- Conflicts

System managers recognize that water supply conditions are variable and unpredictable and there is typically insufficient water to accomplish all the objectives addressed in the NMFS 2010 Supplemental BiOp, and USFWS 2000 and 2006 BiOps for the benefit of listed fish. This may be further complicated by responsibilities to provide for other authorized purposes such as flood protection, power system reliability, 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 parties through the TMT, consider the multiple uses of the system, while placing a high priority on measures to benefit listed species. Below are some of the typical conflicts that may occur.

5.1 Flood Control Draft versus Project Refill

The NMFS 2010 Supplemental BiOp, and USFWS 2000 and 2006 BiOps specify that the storage projects be as full as possible on April 10 to increase the likelihood of refill and to maximize both spring flow management and summer flow augmentation.

Flood control 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 reduce the risk of 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 River Forecast Center (RFC) use the best available science to compute water supply forecasts. An annual forecast review will occur each fall by the Columbia River Forecast Group (CRFG) to evaluate the performance of the current forecast procedures. The CRFG will evaluate new forecasting techniques for potential implementation.

5.2 Provision of Spring Flows versus Project Refill and Summer Flow Augmentation

Flood control elevations are determined based on water supply and runoff forecasts and can change significantly from one forecast to the next. Changes in forecasts throughout the flood control season can make it difficult to achieve both flow and project refill objectives.

5.3 Chum Tailwater Elevations versus Refill/Spring Flows

Providing a Bonneville Dam tailwater elevation level for chum spawning and incubation in the Ives Island complex typically requires flow augmentation from storage reservoirs when reliable flow forecast information is unavailable. Project refill and spring flows have priority over flow augmentation to provide chum tailwater elevations which have to be set in November/December. Although there is an early season Southern Oscillation Index (SOI) based forecast and other early season climate indices that can provide an indication of the upcoming year's water supply, the more reliable water supply forecasts don't start until January. If the tailwater elevation level selected during the spawning season is too high (requiring higher flows and requiring deeper reservoir drafts), there is a risk of drafting below the April 10 elevation objective thereby reducing spring flows if the higher flows are maintained throughout the incubation period. On the other hand, if the flows are reduced during the incubation period in order to refill, then there is the risk of dewatering chum redds. When this conflict arises, project refill and spring flows that benefit multiple ESUs have priority over maintaining the chum tailwater elevations set in December.

5.4 Sturgeon Pulse below Libby Dam versus Summer Flow Augmentation

Water released from Libby Dam for spring sturgeon spawning flows (pulse) during May and into July impact the project's ability to refill, thus reducing the reservoir refill level, and consequently the amount of the water available for summer flow augmentation from Libby. Water released for sturgeon spawning flows will take a higher priority than refilling by early July to meet salmon summer flow targets.

5.5 Fish Operations versus Other Project Uses

In addition to flood control operation, there are other project purposes that may conflict with operations for the benefit of fish. For example; (1) a particular spill pattern at a project may impact the ability of commercial barges to access and enter navigation locks safely. Additionally, in some cases, spill must be curtailed temporarily to allow fish barges to safely moor and load fish at fish loading facilities; (2) spilling water for juvenile fish passage reduces the amount of power that can be generated to meet demand; and, (3) timing of releases for flow augmentation during fish migration periods may conflict with the shape or timing of power demand. In addition to power generation, operations for irrigation and reservoir recreation may conflict with releases of water for flow augmentation.

5.6 Conflicts and Priorities

The conflicts described above pose many challenges to the AAs in meeting the multiple uses of the hydrosystem. The priorities for flow management and individual reservoir operations outlined in section 4.1 will assist the AAs in their operational decision-making. Discussion of conflicts between operational requirements and alternatives for addressing such conflicts will occur in TMT.

- **Emergencies**

The WMP, the NMFS 2010 Supplemental BiOp, 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, the FPP and other appropriate AA emergency procedures. The TMT Emergency Protocols can be found Appendix 1: Emergency Protocols.

5.7 Operational Emergencies

The AAs will manage interruptions or adjustments in water management actions, which may occur due to unforeseen power system, flood control, 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. 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 1 and 2 of the TMT Emergency Protocols.

5.8 Fish Emergencies

The AAs will manage operations for fish passage and protection at FCRPS 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 develop (in coordination with the in-season management Regional Forum (see BA Appendix B.2.1) and implement appropriate adaptive management actions to address the situation. The AA's will take all reasonable steps to limit the duration of any fish emergency. The AA's will operate in accordance with the TMT Emergency Protocols identified in Appendix 1 of the WMP.

5.9 Emergency Operations for Non-ESA listed Fish

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

- **Fish Research**

Research studies sometimes require special operations that differ from routine operations otherwise described in the NMFS 2010 Supplemental BiOp, the USFWS 2000 and 2006 BiOps, and 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 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 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. In the event extraordinary events occur, such as extreme low runoff conditions or a hydrosystem 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.

- **Flood Control Shifts**

The AA will look for opportunities to shift system flood control requirements from Brownlee and Dworshak to Grand Coulee periodically between January 31 and April 15 to provide more water for flow augmentation in the lower Snake River during the spring migration. Consideration of these flood control shifts by the Corps will include an analysis of impacts to flood risk management and will not be implemented if flood control would be compromised. These shifts may be implemented after coordination with TMT to discuss tradeoffs and impacts.

6 Decision Points and Water Supply Forecasts

Table 2 below lists the key water management decisions/actions and when they need to be made. Some decision points, such as setting flow objectives, are clearly articulated in the NMFS 2010 Supplemental BiOp and the USFWS 2000 and 2006 BiOps. 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 BiOps, or are based on best professional judgment and expertise. These decisions are made by the AAs in consideration of actions called for in the BiOps, and input received through the Regional Forum (TMT, RIOG, and Regional Executives).

Table 2. Water Management Decision Points/Actions.

	September	Early October	November	Winter (December – March)	Early April	Early May	June	Early July
Operations	<ul style="list-style-type: none"> Albeni Falls fall/winter minimum control elevation discussion to support kokanee spawning and incubation Establish stable flows from Libby to protect bull trout and other resident fish while meeting end of September draft limit 	<ul style="list-style-type: none"> Assess potential tailwater elevations to support chum spawning below Bonneville Dam Preliminary discussions of flood control/project refill strategy Support for Hanford Reach fall chinook protection operations begins. <i>(Non-Bi Op Action)</i> Consider Kootenai burbot temperature operation 	<ul style="list-style-type: none"> Early season water supply forecast using SOI 	<ul style="list-style-type: none"> Determine winter/spring chum flow tailwater elevations below Bonneville Dam Determine flood control and refill strategies, including any available flood control shifts Determine final April 10 objective base on FCE's from March Final WSF. Minimum flows from Hungry Horse Dam and minimum Columbia Falls flows are set by April-August 	<ul style="list-style-type: none"> Spring flow objectives are set by the April final volume forecasts Determine spring flow management strategy including priority for refill Determine Juvenile Fish Transport Operations for Lower Snake Projects and McNary Determine start dates and levels by project for spring spill Determine start date for Minimum 	<ul style="list-style-type: none"> Evaluate likely tier for sturgeon water volume Determine refill start date based on streamflow forecast to exceed Initial Control Flow (ICF) at The Dalles (if this does not occur in April) Use May forecast to determine VARQ refill flows for Libby and Hungry Horse Use May final forecast to calculate the appropriate 	<ul style="list-style-type: none"> Summer flow objective at Lower Granite determined by June final volume forecast Use June forecast to determine VARQ refill flows for Libby and Hungry Horse Regional technical team recommends shape and timing of Libby Dam sturgeon pulse Determine summer flow augmentation strategy (early June) 	<ul style="list-style-type: none"> Grand Coulee summer reservoir draft limit determined by July Final April – August volume forecast at The Dalles Salmon Draft at Libby and Hungry Horse

	September	Early October	November	Winter (December – March)	Early April	Early May	June	Early July
				forecast <ul style="list-style-type: none"> • Begin discussing spring operations • Begin spring transport discussions • Hanford Reach operations (<i>non-BiOp action</i>) discussed, beginning in January • Perform analysis to determine amount of flexibility Dworshak has to operate above minimum flow and still reach spring refill targets • Prepare outlook for meeting flow objectives • Determine end of 	Operating Pool (MOP) at Lower Snake River projects <ul style="list-style-type: none"> • Determine John Day forebay elevations • Determine refill start date based on streamflow forecast to exceed Initial Control Flow at The Dalles • If required, use April forecast to determine VARQ refill flows for Libby and Hungry Horse 	volume of the bull trout flow release from Libby for after the sturgeon pulse through August <ul style="list-style-type: none"> • Use May final forecast to calculate the appropriate volume of the sturgeon tiered flow release from Libby • Regional technical team recommends shape and timing of Libby Dam sturgeon pulse • May 15 until sturgeon flow begins Libby minimum outflow is 6 	<ul style="list-style-type: none"> • Complete Dworshak temperature modeling and determine release strategy • Decision on McNary juvenile fish transportation (late June) 	

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	September	Early October	November	Winter (December – March)	Early April	Early May	June	Early July
				December flood control elevation at Libby, using the Corps' December forecast		kcfs for bull trout.		
Plans		Develop fall/winter update to the annual WMP		Preliminary work on spring/summer update to the annual WMP	Start operational plans for Libby and Hungry Horse Dams	Libby and Hungry Horse operational plans due		
Forecasts				January, February, and March volume forecasts released by the NWRFC	April final forecast released by NWRFC	May final forecast released by NWRFC	June final forecast released by NWRFC	

6.1 Water Supply Forecasts

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

The RFC, Corps Northwestern Division Hydrologic Engineering Branch, Reclamation, and others prepare water supply forecasts to manage the Columbia River. Table 3 below lists the forecasts used to implement actions referenced in the BiOps. Table 4 summarizes the major fish-related reservoir and flow operations by project. More detailed descriptions of each of these operations follow.

Table 3. Water Supply Forecasts Used to Implement BiOp Actions.

Forecast Point	Forecast period	Forecast	BiOp Actions to be Determined
Hungry Horse	April – August Provided by Reclamation	January, February, and March Final	Columbia Falls and Hungry Horse minimum flows
	May – September Provided by Reclamation	January, February and March Final	Sets VARQ flood control targets
		April Final	Sets VARQ flood control targets and VARQ refill flows
		May and June Final	VARQ refill flows
The Dalles	April – August Provided by NWRFC	April Final	Spring flow objective at McNary Dam Juvenile Fish Transport operations at McNary
		May Final	Libby Summer Draft Limit (2,449 ft. by the end of September except for the lowest 20 percent of years, then 2,439 ft. by the end of September). Hungry Horse Summer Draft Limit (3,550 ft. by the end of September except for the lowest 20 percent of years, then 3,540 ft. by the end of September).
		July Final	Summer draft elevation for Grand Coulee (August 31 elevation of 1,280 ft. or 1,278 ft.)
Lower Granite	April – July Provided by NWRFC	April Final	Spring flow objective at Lower Granite Juvenile Fish Transport operations at Lower Snake Projects

Lower Granite	April – July Provided by	June Final	Summer flow objective at Lower Granite
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	NWRFC		
Libby	April – August Provided by Seattle District	December Final	Sets end of December variable draft target
		January, February and March Final	Sets VARQ flood control targets
		April Final	Sets VARQ flood control targets and VARQ refill flows
		May Final	Volume of water to provide for sturgeon and minimum bull trout flows to begin after sturgeon pulse through August. VARQ refill flows
		June Final	VARQ refill flows
Dworshak	April – August Provided by Walla Walla District	October to June	Draft for summer flow augmentation and water temperature reduction, not to exceed reservoir draft limit of 1,520 ft. in September

Table 4. Reservoir and Flow Operations for ESA-listed fish species.

Project	Flood Control & Refill	Sturgeon	Bull Trout	Spring Anadromous	Summer Anadromous	Chum
Libby	<p><u>Winter:</u> Operate to VARQ flood control rule curve and achieve appropriate elevation by April 10 if possible</p> <p><u>Spring:</u> Adhere to VARQ Operating Procedures at Libby Dam, supply the appropriate tiered volume for sturgeon, supply appropriate minimum bull trout flow</p>	<p><u>May – July</u> Provide USFWS sturgeon volume to augment flows at Bonners Ferry.</p>	<p><u>Year Round:</u> Observe project ramping rates to minimize adverse affects of flow fluctuations</p> <p>May 15 – Sep 30: Operate to Bull Trout Minimum Flows and maintain a steady outflow if possible for July — September while meeting end of September draft limit.</p>	<p>Operate to meet flow objectives and refill if possible without jeopardizing flood control</p>	<p><u>September</u> Draft 10 ft. from full by the end of September (except in lowest 20th percentile water years, as measured by The Dalles May water supply forecast, when draft will increase to 20 ft. from full by end of September)</p>	<p>Fall/winter storage may be used to support chum flows</p>
Hungry Horse	<p><u>Winter:</u> Operate to VARQ flood control rule curves with a 75% confidence of meeting the April 10 elevation objective</p> <p><u>Spring:</u> Refill by about June 30 if possible without excessive spill and operate to help meet flow objectives</p>		<p><u>Year Round:</u> Operate in order to maintain Columbia Falls and project minimum flow requirements. Operate using ramping rates to minimize adverse affects of flow fluctuations and maintain a steady outflow if possible for July — September while meeting end of September draft limit.</p>	<p>Operate to meet flow objectives and June 30 refill if possible without exceeding TDG limits</p>	<p><u>September</u> Draft 10 ft. from full (elevation 3,550 ft.) by the end of September except in lowest 20th percentile water years, as measured at The Dalles when draft will increase to 20 ft. from full (elevation 3,540 ft.) by the end of September</p>	

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Project	Flood Control & Refill	Sturgeon	Bull Trout	Spring Anadromous	Summer Anadromous	Chum
Albeni Falls	<p><u>Winter</u>: Operate to standard flood control criteria</p> <p><u>Spring</u>: Refill by June 30 and operate to help meet flow objectives</p>		<p><u>Fall/Winter</u>: Determine winter minimum control elevation after annual meeting with AAs, IDFG, NMFS, USFWS and interested parties. This year's winter minimum control elevation will be 2,055 ft. Reach 2,055 ft. msl by mid-November and maintain this elevation until the end of kokanee spawning as determined by IDFG survey.</p> <p>After the end of spawning, operate not to exceed flood control rule curve but not to fall below the winter control elevation.</p>			Fall/winter storage may be used to support chum flows

Project	Flood Control & Refill	Sturgeon	Bull Trout	Spring Anadromous	Summer Anadromous	Chum
Grand Coulee	<p><u>Winter:</u> Operate to 85% confidence of meeting April 10 elevation objective</p> <p><u>Spring:</u> Refill by about June 30 and operate to help meet flow objectives</p>			<p>Operate to 85% confidence of meeting April 10 elevation objectives to increase spring flows in the Lower Columbia river.</p> <p>Operate to help meet the Spring flow objective at Priest Rapids Dam</p>	<p><u>July-August:</u> Draft to support salmon flow objectives, not to exceed reservoir draft limit of 1,280 ft (\geq 92 MAF July Final forecast at The Dalles) or 1,278 ft. ($<$92 MAF forecast at The Dalles)⁵</p> <p><u>August:</u> Operate Banks Lake to draft to elevation 1,565 ft. by August 31 to provide more water for summer flow augmentation</p>	<p>Fall/winter storage may be used to support chum flows</p>
Dworshak	<p><u>Winter:</u> Operate to achieve April 10 refill objective</p> <p><u>Spring:</u> Refill by about June 30 and operate to help meet flow objectives</p>				<p>Draft for summer flow augmentation and water temperature reduction, not to exceed reservoir draft limit of 1,520 ft. in September</p>	<p>Fall/winter storage may be used to support chum flows</p>
Lower Granite				<p>Flow objective of 85-100 kcfs</p> <p>Operate within 1 ft. of MOP to reduce juvenile travel time</p> <p>Operate within 1% of best efficiency</p>	<p>Flow objective of 50-55 kcfs</p> <p>Operate within 1 ft. of MOP to reduce juvenile travel time</p> <p>Operate within 1% of best efficiency</p>	

⁵ These draft limits will be modified as the Lake Roosevelt Incremental Storage Release Project is implemented (see Section 6.5.6).

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Project	Flood Control & Refill	Sturgeon	Bull Trout	Spring Anadromous	Summer Anadromous	Chum
Little Goose				Operate within 1 ft. of MOP to reduce juvenile travel time Operate within 1% of best efficiency Manually set Unit 1 lower operating limit	Operate within 1 ft. of MOP to reduce juvenile travel time Operate within 1% of best efficiency Manually set Unit 1 lower operating limit	
Lower Monumental				Operate within 1 ft. of MOP to reduce juvenile travel time Operate within 1% of best efficiency	Operate within 1 ft. of MOP to reduce juvenile travel time Operate within 1% of best efficiency	
Ice Harbor				Operate within 1 ft. of MOP to reduce juvenile travel time Operate within 1% of best efficiency	Operate within 1 ft. of MOP to reduce juvenile travel time Operate within 1% of best efficiency	
McNary				Flow objective of 220-260 kcfs Operate within 1% of best efficiency	Flow objective of 200 kcfs Operate within 1% of best efficiency	
John Day				Operate within 1.5 ft. of minimum level that provides irrigation pumping to reduce juvenile travel time Operate within 1% of best efficiency	Operate within 1% of best efficiency	
The Dalles				Operate within 1% of best efficiency	Operate within 1% of best efficiency	

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Project	Flood Control & Refill	Sturgeon	Bull Trout	Spring Anadromous	Summer Anadromous	Chum
Bonneville				Operate within 1% of best efficiency	Operate within 1% of best efficiency	Provide support to chum if hydrologic conditions indicate system can likely maintain minimum project tailwater elevation (on Oregon shore 0.9 miles downstream of first powerhouse and 50 ft. upstream of Tanner Creek) during spawning and incubation

7 Project Operations

7.1 Hugh Keenlyside Dam (Arrow Canadian Project)

7.1.1 Mountain Whitefish

Spawning flow levels are set between 45-55 kcfs beginning the third week in December and continuing through mid-January. Egg protection flows are set 5-15 kcfs lower than the spawning flow from mid-January through the end of March.

7.1.2 Rainbow Trout

Rainbow trout spawning begins in April. Protection levels begin somewhere between 15 and 25 kcfs. The goal is to have stable flows or ever-increasing flows through June.

7.2 Hungry Horse Dam

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

7.2.1 Winter/Spring Operations

Hungry Horse will be operated for flood control from January through April using the Storage Reservation Diagram (SRD) developed for VARQ flood control. Hungry Horse began operating using VARQ Flood Control rule curves on an interim basis starting January 1, 2001, based on an Environmental Assessment Finding of No Significant Impact. Reclamation in coordination with the Corps, completed the Upper Columbia EIS in 2006. A ROD was prepared and signed by Reclamation in September 2009.

Hungry Horse will be operated during the winter and early spring to achieve a 75% probability of reaching the April 10 elevation objective in order to provide more water for spring flows. This is achieved by operating between Upper Rule Curve (URC) as an upper limit and the Variable Draft Limits (VDL's) as a lower operating limit for the reservoir from January through March. A description of VDL's is provided in Section 7.5. In many years, typically dry years, the previous year's summer draft for flow augmentation and year-round required minimum discharges for resident fisheries will prevent Hungry Horse from reaching the April 10 elevation objective. Reclamation computes Hungry Horse Dam's April 10 elevation objective by linear interpolation between the March 31 and April 15 forecasted flood control elevations based on the Reclamation March Final 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 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 flood control are also considered when determining refill operations. During the latter part of the flood control season (April) and the refill season (typically May through June), Hungry Horse discharges may be reduced for local flood

protection in the Flathead Valley. The official flood stage for the Flathead River at Columbia Falls, Montana is 14 ft. (an approximate flow of 51,000 cubic feet per second (cfs)). In order to prevent or minimize flooding on the Flathead River above Flathead Lake, Reclamation will adjust outflows from Hungry Horse Dam as necessary (down to a minimum discharge of 300 cfs) in order to maintain the Flathead River at Columbia Falls below 14 ft. if possible. Hungry Horse generally starts reducing discharges when the stage at Columbia Falls begins to exceed 13 ft. (approximately 44,000 cfs).

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

7.2.2 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 a few days before or after the June 30 target date. 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 NOAA Fisheries BiOp's specified draft limits based on flow recommendations provided by TMT. TMT considers a number of factors when developing its flow recommendations, such as: the status of the migration, attainment of flow objectives, water quality, and the effects that reservoir operations will have on other listed and resident fish populations. Flows during the summer months should be even or gradually declining in order to minimize a double peak on the Flathead River. The summer reservoir draft limit at Hungry Horse is 3,550 ft. (10 ft. from full) by September 30 except in the lowest 20th percentile⁶ of water years (The Dalles April-August <71.8 maf) when the draft limit is elevation 3,540 ft. (20 ft. from full) by September 30. If the project fails to refill, especially during drought years, minimum flow requirements (see Section 6.2.4) may draft the reservoir below these draft limits. 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 flows below the project. Inflows increasing above the planned operation could result in an elevation above the end of September draft limit.

7.2.3 Reporting

Reclamation will fulfill the USFWS Reasonable and Prudent Measure (RPM) from the 2000 USFWS BiOp for annual and monthly reporting by contributing to the annual WMP and presenting weekly and biweekly reports of Hungry Horse operations through the TMT process. Reclamation will also fulfill the USFWS RPM recommendation for reporting actual operations by making available pertinent historic elevations and flows as related to Hungry Horse Dam through its current website at:

<http://www.usbr.gov/pn/hydromet/esatea.html>.

⁶ The lowest 20th percentile as measured at The Dalles (RPA 4 in RPA Table, pg 6 of 98) based on RFC's statistical period, currently 1971-2000, using May final for The Dalles Apr-Aug (RPA 14 in RPA table, pg 15 of 98)

7.2.4 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 2000 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 Columbia Falls on the mainstem Flathead River located just downstream from the confluence of the South Fork with the mainstem. This flow requirement generally governs Hungry Horse outflows during the fall and winter. The second minimum flow requirement is for the South Fork Flathead River just below Hungry Horse Dam. This minimum flow typically comes into play during refill of the project in spring when the minimum flows at Columbia Falls are met by the North and Middle Fork flows. The minimum outflow for Hungry Horse Dam and the minimum flow for Columbia Falls will be determined monthly based on the Reclamation WSF for the inflows into Hungry Horse for the period April 1 to August 31. Both 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 5 shows how the minimum flows are calculated⁷. Reclamation Water Supply Forecasts will be provided to the TMT.

Table 5. Minimum Flows at Hungry Horse and Columbia Falls.

April – August inflow forecast (KAF)	Hungry Horse min flow⁸ (CFS)	Columbia Falls min flow (CFS)
<1190	400	3,200
1,790 > forecast > 1,190	Interpolate between 400 and 900	Interpolate between 3,200 and 3,500
>1,790	900	3,500

The maximum ramp up and ramp down rates are detailed in Table 6. 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 (Note: 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.”

⁷ USFWS BiOp at Section 3.A.1 Page 6

⁸ 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 ft.

Table 6. 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 (Daily max)	Ramp Up Unit (Hourly max)
3,200 - 6,000 cfs	Limit ramp up 1,800 cfs per day	1,000 cfs/hour
>6,000 - 8,000 cfs	Limit ramp up 1,800 cfs per day	1,000 cfs/hour
>8,000 - 10,000 cfs	Limit ramp up 3,600 cfs per day	1,800 cfs/hour
>10,000 cfs	No limit	1,800 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 (Daily max)	Ramp Down Unit (Hourly max)
3,200 - 6,000 cfs	Limit ramp down to 600 cfs per day	600 cfs/hour
>6,000 - 8,000 cfs	Limit ramp down to 1,000 cfs per day	600 cfs/hour
>8,000 - 12,000 cfs	Limit ramp down to 2,000 cfs per day	1,000 cfs/hour
>12,000 cfs	Limit ramp down to 5,000 cfs per day	1,800 cfs/hour

7.2.5 Spill

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. 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 help to avoid exceeding the Montana State TDG standard of 110%.

7.3 Albeni Falls Dam

7.3.1 Albeni Falls Dam Fall and Winter Coordination

The AAs, the USFWS, NOAA Fisheries, and IDFG will meet annually (per the 2000 USFWS BiOp and the USFWS letter of September 28, 2007 to the Corps and BPA on “Lake Pend Oreille Winter Lake Elevations.”), along with the Kalispel Tribe and other interested parties, to evaluate Lake Pend Oreille female kokanee spawner numbers, the winter climate (precipitation) forecast, spawning and incubation success for threatened lower Columbia River chum salmon the previous winter, and recent history of winter

elevations for Lake Pend Oreille (hereafter referred to as the “interagency meeting”). One of the purposes of this meeting is to recommend the winter minimum control elevation (MCE) to ensure winter lake operation addresses the needs of kokanee spawning and hence, threatened bull trout, which feed on kokanee, while also taking into consideration spawning and incubation needs for lower Columbia River chum salmon. A decision support tree has been developed by the parties to evaluate these factors in a stepwise decision process to provide recommendations on minimum winter lake elevations.

Generally, sufficient information is available in September to develop a sound recommendation. TMT members will consider recommendations made at the interagency meeting. If the decision support tree is sensitive to and there is likely volatility in specific parameters (e.g. November through January precipitation outlook) participants in the interagency meeting may elect to defer making a recommendation on the MCE until updated information is available in October and recommend interim operations until such data are available.

TMT members will review recommendations from the interagency meeting and develop a recommendation for the proposed Lake Pend Oreille fall and winter operations to the Action Agencies for final decision.

7.3.2 Flood Control Draft

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

7.3.3 Refill

During the spring, Albeni Falls Dam will be operated to fill Lake Pend Oreille in accordance with standard flood control criteria. The AAs will operate Albeni Falls Dam to meet the flow objectives and refill by approximately June 30.

7.3.4 Summer Operations

During the summer, Albeni Falls Dam will be operated to maintain Lake Pend Oreille elevation at Hope, Idaho, between elevation 2,062 ft. and 2,062.5 ft. The annual fall drawdown to the winter minimum control elevation begins soon after Labor Day.

7.4 Libby Dam

7.4.1 Libby Dam General Operations

Libby Dam flows will be regulated consistent with existing treaties, Libby Project authorization for public safety, other laws, and the 1938 International Joint Commission order on Kootenay Lake 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.

7.4.1.1 Coordination

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

7.4.1.2 Burbot

Providing low temperatures, if possible, from Libby Dam to aid upstream migration of burbot to spawning areas in the Kootenai River in Idaho will occur each winter. These low temperatures may be called for over an extended period from October through February. Specific details of this operation for the current year will be developed and will be included in the fall/winter update. An interagency Memorandum of Agreement for this species was completed in June 2005. Use of VARQ flood control procedure and implementation of the variable end-of-December flood control target elevation may aid this operation in years with below average runoff forecasts.

7.4.1.3 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 proposed in the BA supplement to minimize impacts to bull trout and are included in the USFWS 2006 BiOp. The following ramp rates will guide project operations to meet various purposes, including power production.

Table 8. Prescribed maximum ramp rates to protect resident fish and prey organisms in the Kootenai River in addition to minimizing levee erosion along the river. Rate of change may be less than stated limits.

		<u>Summer</u> (05/01 - 09/31)	
		<u>Hourly</u>	<u>Daily</u>
Ramp Up	4-6 kcfs	2500 cfs	1 unit
	6-9 kcfs	2500 cfs	1 unit
	9-16 kcfs	2500 cfs	2 units
	16-QPHC	5000 cfs	2 units
Ramp Down	4-6 kcfs	500 cfs	500 cfs
	6-9 kcfs	500 cfs	1000 cfs
	9-16 kcfs	1000 cfs	2000 cfs
	16-QPHC	3500 cfs	1 unit
		<u>Winter</u> (10/01 - 04/30)	
		<u>Hourly</u>	<u>Daily</u>
Ramp Up	4-6 kcfs	2000 cfs	1 unit
	6-9 kcfs	2000 cfs	1 unit
	9-16 kcfs	3500 cfs	2 units
	16-QPHC	7000 cfs	2 units
Ramp Down	4-6 kcfs	500 cfs	1000 cfs
	6-9 kcfs	500 cfs	2500 cfs
	9-16 kcfs	1000 cfs	1 unit
	16-QPHC	3500 cfs	1 unit

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

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 in only the lowest 20th percentile water years (Note: 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).

7.4.2 Flood Control

The Corps will continue to use its forecast procedure in December to determine the December 31 flood control elevation. In water years where the forecast for the period April through August is less than 5,900 KAF based on the Corps' forecast procedures, the end-of-December draft elevation will be higher than 2,411 ft. If the early forecast for

April-August is 5,500 KAF or less, the end-of-December target elevation would be 2,426.7 ft. The end-of-December elevation is a sliding scale between elevation 2,426.7 ft. and 2,411 ft. when the forecast is between 5,500 and 5,900 KAF.

Libby Dam will be operated during January through March to the VARQ flood control storage reservation diagram (SRD). During the refill period from about April through June, Libby Dam will release flow in accordance with VARQ Flood Control Operating Procedures at Libby Dam. Refill at Libby Dam will begin 10 days prior to when the forecasted unregulated flow at The Dalles is expected to exceed the ICF. 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. 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.

7.4.3 Spring Operations

The purpose of the following actions is to refill Libby Dam in order to provide the flow for Kootenai River white sturgeon, bull trout ramping rates, 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. After adhering to the VARQ flood control guidance and providing salmon flow augmentation and the sturgeon flow operation, Libby Dam refill may happen by July 31. During the spring, the AAs will operate Libby Dam to meet its flow and refill objectives. If both 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 reaching the April 10 elevation objective (the exact date to be determined during in-season management) to increase flows for spring flow management.

7.4.3.1 Bull Trout

From May 15 to June 30 and during the month of September, a minimum flow of 6,000 cfs will be provided and minimum flows of 4,000 cfs will be provided for the rest of the year. Volume to sustain the basal flow of 6,000 cfs from May 15 through May 31 will be accounted for with sturgeon volumes, and in the fall should be drawn from the autumn flood control draft.

Per the USFWS 2006 BiOp, the tiered bull trout minimum flow will be provided from 1 July through 31 August and the period between sturgeon and salmon flow augmentation

beginning in September. The bull trout minimum flow may be from 6,000 cfs to 9,000 cfs. Table 7 shows how to determine the bull trout minimum flow during this period.

Table 7. Minimum bull trout releases from Libby Dam July 1 through 31 August, based on the May final Libby water supply forecast for the April-August period (May 15 – June 30 and all of September the minimum is 6 kcfs).

Forecast runoff Volume (MAF*) at Libby	Min bull trout flows between sturgeon and salmon flows
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

7.4.3.2 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 USFWS 2006 BiOp, the Clarified 2008 RPA from USFWS and as summarized in Figure 2. 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, salmon, and will be measured above the 4,000 cfs minimum releases from Libby Dam. Accounting for these total tiered volumes will begin when the USFWS determines benefits to conservation of sturgeon are most likely to occur or when additional flow is needed to sustain basal flow of 6,000 cfs from May 15 through May 31. 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 USFWS 2006 BiOp and applicable clarifications.

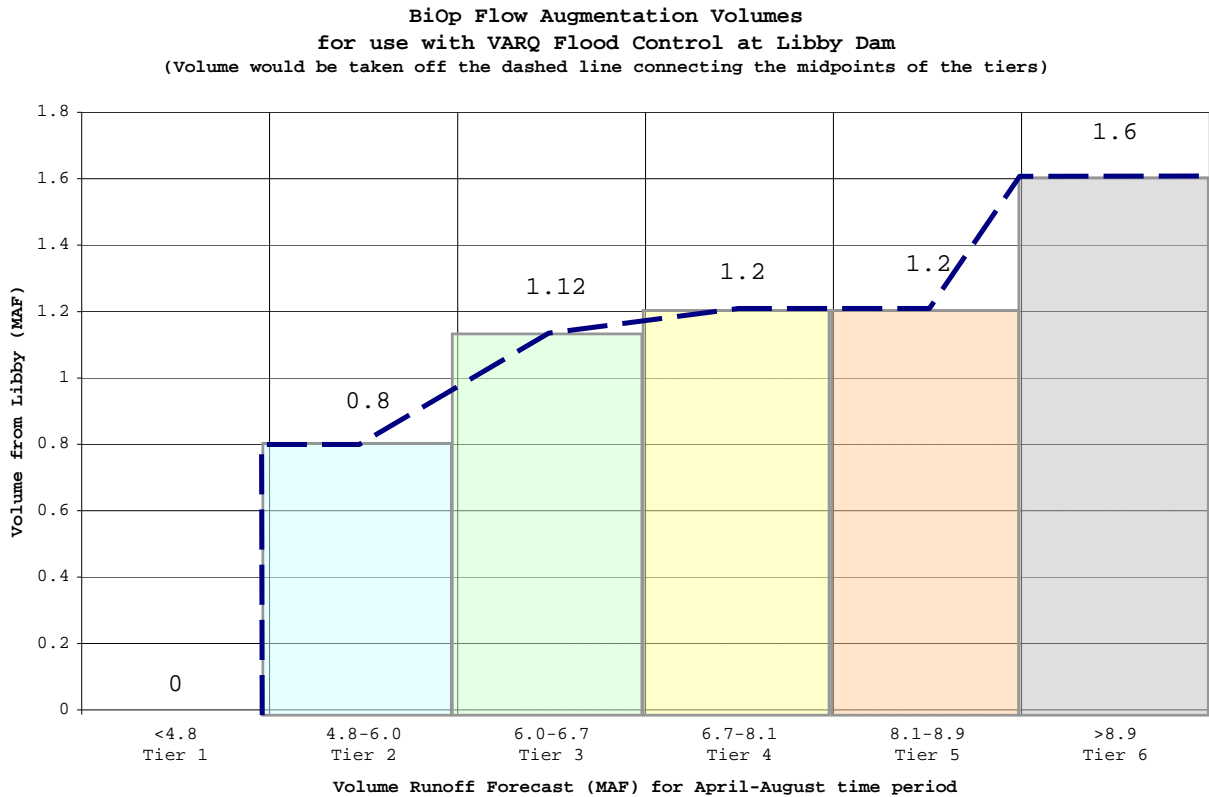


Figure 2. “Tiered” volumes of water for sturgeon flow enhancement to be released from Libby Dam according to the Libby May final forecast of April - August volume. Actual flow releases would be shaped according to seasonal requests from the USFWS and in-season management of water actually available.

7.4.3.3 Spill

The 2006 USFWS Clarified RPA, calls for the Corps to perform a spill operation, if conditions permit (e.g if a tier 1 year, this operation would not take place), in conjunction with the sturgeon pulse in 2011 taking into account other operational requirements. Spill that induces TDG in excess of 110% is not to exceed 7 days, water temperatures are to be maintained at or above 8° C, and spill will range between 5,000 cfs and 10,000 cfs. TDG shall never exceed 123%.

The spill will occur sometime between late May and late June, depending on water supply forecast, runoff projections, water temperature and reservoir elevation. The Corps will coordinate the timing and other details with the State of Montana, the USFWS, the Kootenai Tribe of Idaho, BPA, and other regional interests, assuring that conditions remain safe during the spill.

Otherwise, the Corps is to limit voluntary spill to avoid exceeding Montana State TDG standard of 110%, when possible, and in a manner consistent with the AAs’ responsibilities for ESA-listed resident fish and settlement agreement.

7.4.3.4 Post Sturgeon Operation

After the sturgeon operation flows will be set to try and refill by July 31, if possible, while trying to minimize double peak. Summer operations will be coordinated through TMT in-season management. A double peak is assumed to be a flow increase and decrease of more than 5,000 cfs within one month. Libby Dam releases will follow ramp rates in the 2006 USFWS BiOp.

7.4.4 Summer Operations

During the summer, the AAs draft Libby Dam within the NMFS 2010 Supplemental BiOp and USFWS BiOp's specified draft limits based on flow recommendations provided by TMT. TMT considers a number of factors when developing its flow recommendations, 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, attainment of flow objectives, water quality, and the effects that reservoir operations will have on other listed and resident fish populations.

During the summer (July and August), the AAs will operate Libby Dam to help meet the flow objectives for juvenile salmon out-migration in the Columbia River. The summer reservoir draft limit is 10 ft. from full by the end of September (except in lowest 20th percentile⁹ water years (The Dalles April-August <71.8 maf), when draft will increase to 20 ft. from full by end of September). If the project fails to refill, then release inflows or operate to meet minimum bull trout flows through the summer months. Rationale for the experimental draft was adopted by the Northwest Power and Conservation Council (Council) and further details of the evaluation can be found in the FCRPS 2008 Biological Opinion from NMFS (Appendix B.2.1).

Arrangements for retention of July-September water in Lake Koocanusa are possible under 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 exchange agreement reduces the draft of Lake Koocanusa and provides an equivalent amount of water from Canada.

For September, the Corps will use the best available forecast at the end of August to set a flow that will draft the remaining volume out of Libby. If this flow is greater than the bull trout minimum of 6 kcfs the discharge will be maintained until the draft target is met or the month ends, whichever comes first. Operating to this flow is consistent with Columbia River flow augmentation per the BiOp and a desire for stable flows immediately downstream of Libby.

⁹ The lowest 20th percentile as measured at The Dalles (RPA 4 in RPA Table, pg 6 of 98) based on RFC's statistical period, currently 1971-2000, using May final for The Dalles Apr-Aug (RPA 14 in RPA table, pg 15 of 98)

7.5 Grand Coulee Dam

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

7.5.1 Winter/Spring Operations

Grand Coulee will be operated for flood control from January through April using the NWRFC's forecast for unregulated runoff at The Dalles (adjusted for available storage capacity upstream of The Dalles other than at Grand Coulee Dam) and Grand Coulee's Flood Control SRD. Grand Coulee is also operated during this period to support chum operations (described in detail in Section 7.4) and to maintain an 85% probability of reaching the April 10 elevation objective.

The April 10 elevation objective purpose is to provide more water for spring flows and 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 7.5.

Reclamation computes Grand Coulee Dam's April 10 elevation objective by linear interpolation between the March 31 and April 15 forecasted flood control 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 not released until the 5th business day of the month, after which the Corps calculates flood control elevations. This usually means that final April 15 and April 30 flood control elevations are not released until around April 8 at the earliest. It is notable that even modest changes in The Dalles water supply forecast can produce significant changes in the forecasted flood control elevations for Grand Coulee. In order to achieve final April flood control targets, actual Grand Coulee elevations on April 10 may be slightly below or above the April 10 objective depending on draft rates and water supply conditions. Grand Coulee operations will be discussed and coordinated at TMT.

Opportunities to shift system flood control requirements from Brownlee and Dworshak to Grand Coulee will also be considered. See section 4.5 on Flood Control Shifts for more details. 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, Oregon.

During the spring, the AAs will operate the FCRPS to help meet the flow objectives and to refill the projects. If both of these objectives cannot be achieved, the TMT will make an in-season recommendation, weighing considerations unique to each particular year and project.

7.5.2 Summer Operations

Grand Coulee will operate to refill by about June 30 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 be drafted to a minimum elevation of either 1,280 ft. or 1,278 ft. by the end of August depending on the July Final forecast for April through August runoff produced by the NWRFC. 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 1,280 ft. If the forecast is less than 92 MAF, the draft limit will be 1,278 ft. These draft limits will be modified to implement the Lake Roosevelt Incremental Storage Release Project (see Section 6.5.6).

7.5.3 Banks Lake Summer Operation

Normally Banks Lake is drafted to elevation 1,565 feet (5 feet from full) by the end of August as part of the Action agencies summer flow augmentation program. In 2011 Banks Lake may be drafted deeper than elevation 1565 by the end of August. Required maintenance activities in the fall and winter on the Main Canal Outlet Structure and on the Feeder Canal near North Dam will require it to be drafted down nearly 30 feet by the end of October. In order to accomplish the desired elevation, pumping into Banks Lake will most likely end in July and irrigation withdrawals or generation back through the pump generators will drawdown the lake. As a result Banks Lake may be as much as 10-15 feet from full by August 31. After the maintenance activities have been completed, refilling of Banks Lake will begin in the late winter to early spring of 2012. More discussion of this maintenance activity is provided in the FCRPS BA (Appendix B, page B.1-4-8).

7.5.4 Project Maintenance

Drum gate maintenance is planned to occur during April and May annually. The reservoir must be at or below elevation 1,255 ft. to accomplish this work. Typically the flood control elevations during this time of year provide the required elevations and sufficient time to accomplish this work. However, during dry years flood control operations will not draft Lake Roosevelt low enough for a long enough period of time to perform necessary maintenance on the drum gates. Drum gate maintenance may be deferred in some dry water years; however drum gate maintenance must occur at a minimum one time in a 3-year period, two times in a 5-year period, and three times in a 7-year period. The drum gates are extremely important dam safety features and must be maintained at a satisfactory level. Drum gate maintenance was deferred in 2009 and 2010 because of low water supply forecasts and high flood control elevations. Since maintenance has been deferred the last 2 years, drum gate maintenance will be performed in the spring of 2011 regardless of water supply conditions. Lake Roosevelt will be at or below elevation 1255 feet for a minimum of 8 weeks during the spring of 2011 in order to accomplish the necessary maintenance. Reclamation will coordinate this operation with TMT.

7.5.5 Kokanee

Every attempt is made to refill Lake Roosevelt to 1,283 ft. by September 30 (coordination with tribe will determine actual date) and maintain an elevation 1,283 to 1,285 ft. or greater through the middle of November to aide in kokanee brood stock collection, improve spawning access to tributaries, and to increase retention time during a critical period for zooplankton production.

7.5.6 The Lake Roosevelt Incremental Storage Release Project

The Lake Roosevelt Incremental Storage Release Project will not reduce flows during the salmon flow objective period (April to August). This project provides that Lake Roosevelt will be drafted by an additional 1.0 ft. in non-drought years and by about 1.8 ft. in drought years by the end of August. A third of this water will go to in-stream flows. A more detailed description of this item is provided in Section 7.6 and in the FCRPS BA (Appendix B.2.1, pages 5-9).

7.5.7 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 7.4.

7.5.8 Priest Rapids Flow Objective

Grand Coulee will be operated to help meet Priest Rapids weekly flow objective to support fall Chinook salmon spawning and incubation.

7.5.9 Spill

Involuntary spill at Grand Coulee Dam will be managed in coordination with Chief Joseph Dam; see Sec. 6.5. Grand Coulee will be operated to minimize TDG production.

7.6 Chief Joseph Dam

Construction of spillway flow deflectors at Chief Joseph Dam was completed in October 2008. A spill test was conducted in April 2009 to characterize the performance of the flow deflectors in reducing TDG production. Spill amount and spill pattern configuration were varied during the test associated TDG levels were measured and recorded. A final report on the test results is expected in late 2010. Information from the report will aid in developing a spill swap plan between Chief Joseph and Grand Coulee dams to help minimize TDG production and reduce the TDG burden that carries downstream through the system.

7.7 Priest Rapids Dam

7.7.1 Spring Operations

The spring flow objective at Priest Rapids Dam is 135 kcfs from April 10 to June 30. There is no summer flow objective for Priest Rapids Dam.

7.7.2 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

7.8 Dworshak Dam

7.8.1 Spring Operations

The purpose of the spring flow augmentation, is to maintain a 95% probability of refilling Dworshak while also maximizing the releases of stored water from Dworshak reservoir in order to maximize the chance of meeting the Lower Snake 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 at "full" at elevations of 1,599 ft. or above. If both these objectives cannot be achieved, the TMT will make an in-season recommendation, weighing considerations unique to each particular year and project.

7.8.2 Flow Increase for Dworshak National Fish Hatchery Release.

Project will release 4-6 kcfs from Dworshak, if necessary, in order to move juvenile fish into the mainstem Clearwater River during the spring hatchery releases. Note: not in NMFS 2010 Supplemental BiOp.

7.8.3 Summer Operations

Summer flow augmentation is provided from Dworshak to increase listed fish survival by improving water quality (moderating river temperatures), and increasing water velocities 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 (CEQUAL-W2), which is used in-season to forecast 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 temperature management in the Lower Granite tailrace but can be overwhelmed by extremely hot weather or high discharges of warm water from Hells Canyon Dam.

During the summer, the AAs draft Dworshak within the NMFS 2010 Supplemental BiOp's specified draft limits based on flow recommendations provided by TMT. TMT considers a number of factors when developing its flow recommendations, such as: the status of the migration, attainment of flow objectives, water quality, and the effects that reservoir operations will have on other listed and resident fish populations.

During the summer (July and August) the AAs will operate Dworshak to help meet flow/temperature objectives. The AAs plan to draft Dworshak to 1,535 ft. by August 31 and draft to approximately 1,520 ft. in September. The extension of the draft limit into September assures that water will be released consistent with the Snake River Basin Adjudication Agreement (SRBA). Releases under the SRBA will be determined in the annual plan prepared by the Corps, NOAA, Nez Perce, and BPA and presented to TMT for implementation.

The maximum project discharge for salmon flow augmentation is limited to releases generating Total Dissolved Gas (TDG) within state of Idaho and Nez Perce Tribal water quality standards calling for of no greater than 110% TDG.

7.8.4 Fall/Winter Operations

After summer fish operations are completed (including the Nez Perce (SRBA) 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 1,600 cfs) unless higher flows are required for flood control, 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 high reliability of meeting spring refill objectives.

Dworshak will provide minimum flows, while not exceeding the Idaho State TDG water quality standard of 110%.

Opportunities to shift system flood control requirements from Brownlee and Dworshak to Grand Coulee will be considered periodically between January 31 and April 15. See section 4.5 on Flood Control Shifts for more details.

7.9 *Brownlee*

Opportunities to shift system flood control requirements from Brownlee to Grand Coulee will be considered. See section 4.5 on Flood Control Shifts for more details. The shifts could occur between January 31 and April 15. 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 TMT. The shifts typically occur in drier years when they will not compromise flood control.

7.10 Lower Granite Dam

7.10.1 Reservoir Operations

Lower Granite will operate within 1 ft. of Minimum Operating Pool (MOP) from approximately April 3 until small numbers of juvenile migrants are present (approximately September 1) unless adjusted to meet authorized project purposes, primarily navigation. TMT will provide a recommendation. The purpose of this action is to provide a smaller reservoir cross section to reduce juvenile salmon travel time and reduce flow fluctuations. Elevations may be modified to maintain the minimum navigation channel requirements. The purpose of this action is to provide a smaller reservoir cross section, believed to reduce juvenile salmon travel time, and reduce flow fluctuations.

7.10.2 Turbine Operations

To enhance juvenile passage survival, turbines at Lower Granite will be operated within 1% of peak efficiency during the juvenile and adult migration seasons (April 1 through October 31; see appendix C of the 2011 FPP).

7.10.3 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 planning dates for the spring flow objective are from April 3 to June 20. These flow objectives are provided as a biological guideline and will likely not be met through 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. Flow in the Snake River during this period is supported by drafting Dworshak Dam and flow augmentation water from the Upper Snake River. Dworshak storage is released from the April 10 elevation to the April 30 flood control elevation at a rate that does not exceed the State TDG water quality standards (110 % TDG) at the project.

7.10.4 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 planning dates for the summer flow objective are from June 21 to August 31. Summer flow objectives are provided as a biological guideline. Flow in the Snake River is supported by the summer draft, though tends to follow the natural hydrograph.

7.10.5 Spill Operations

Spill operations for fish passage are defined in appendix E of the 2011 FPP.

7.10.6 Juvenile Fish Transport Operations

Transport operations are defined in appendices B and E of the 2011 FPP.

7.11 Little Goose Dam

7.11.1 Reservoir Operations

Little Goose will operate within 1 ft. of MOP from approximately April 3 until small numbers of juvenile migrants are present (approximately September 1) unless adjusted to meet authorized project purposes, primarily navigation. This normally occurs in late August. The purpose of this action is to provide a smaller reservoir cross section to reduce juvenile salmon travel time and reduce flow fluctuations. Elevations may be modified to maintain the minimum navigation channel requirements. The navigation lock tailwater gage at Lower Granite Dam will be used to ensure minimum navigation channel requirements are met. The purpose of this action is to provide a smaller reservoir cross section, believed to reduce juvenile salmon travel time, and reduce flow fluctuations.

7.11.2 Turbine Operations

To enhance juvenile passage survival, turbines at Little Goose will be operated within 1% of peak efficiency during the juvenile and adult migration seasons (April 1 through October 31; see appendix C of the 2011 FPP).

Additionally, during the juvenile migration season, the lower operating limit of unit 1 will be manually re-set as indicated in Table 9.

Table 9. Operating limits for Little Goose turbine unit 1 during the 2011 spill season.

Lower Limit	Upper Limit	Condition
115 MW (~16,000 cfs)*	Varies w/Head	With extended-length submersible bar screens installed
125 MW (~17,500 cfs)*	Varies w/Head	Without extended-length submersible bar screens installed

* Discharges are approximate.

Unit operation control within the Generic Data Acquisition and Control System (GDACS) program tends to balance flows across available operating units. This alternative preferred operation will at times; result in an unbalanced operation where more flow is passing through unit 1 than other available operating units. A greater flow through unit 1 has been shown in the Little Goose general physical model to be very effective in disrupting an eddy that tends to form downstream of the powerhouse along the south shore. Disrupting the eddy optimizes the tailrace conditions for both adult passage and juvenile egress with the temporary spillway weir operating in spillbay 1.

7.11.3 Spill Operations

Spill operations for fish passage are defined in appendix E of the 2011 FPP.

7.11.4 Juvenile Fish Transport Operations

Transport operations are defined in appendices B and E of the 2011 FPP.

7.11.5 Waterfowl Hunting Enhancement

In order to enhance waterfowl hunting, the Little Goose pool is held constant several times a week from October to January.

7.12 Lower Monumental Dam

7.12.1 Reservoir Operations

Lower Monumental will operate within 1 ft. of MOP from approximately April 3 until small numbers of juvenile migrants are present (approximately September 1) unless adjusted to meet authorized project purposes, primarily navigation. The purpose of this action is to provide a smaller reservoir cross section to reduce juvenile salmon travel time and reduce flow fluctuations. Elevations may be modified to maintain the minimum navigation channel requirements. The purpose of this action is to provide a smaller reservoir cross section, believed to reduce juvenile salmon travel time, and reduce flow fluctuations.

7.12.2 Turbine Operations

To enhance juvenile passage survival, turbines at Lower Monumental will be operated within 1% of peak efficiency during the juvenile and adult migration seasons (April 1 through October 31; see appendix C of the 2011 FPP).

7.12.3 Spill Operations

Spill operations for fish passage are defined in appendix E of the 2011 FPP.

7.12.4 Juvenile Fish Transport Operations

Transport operations are defined in appendices B and E of the 2011 FPP.

7.13 Ice Harbor Dam

7.13.1 Reservoir Operations

Ice Harbor will operate within 1 ft. of MOP from approximately April 3 until small numbers of juvenile migrants are present (approximately September 1) unless adjusted to meet authorized project purposes, primarily navigation or if alternative reservoir operations are recommended and adopted as part of the Ice Harbor Dam Configuration and Operation Plan. The purpose of this action is to provide a smaller reservoir cross section to reduce juvenile salmon travel time and reduce flow fluctuations. The purpose of this action is to provide a smaller reservoir cross section, believed to reduce juvenile salmon travel time, and reduce flow fluctuations.

7.13.2 Turbine Operations

To enhance juvenile passage survival, turbines at Ice Harbor will be operated within 1% of peak efficiency during the juvenile and adult migration seasons (April 1 through October 31; see appendix C of the 2011 FPP).

7.13.3 Spill Operations

Spill operations for fish passage are defined in appendix E of the 2011 FPP.

7.13.4 Waterfowl Hunting Enhancement

In order to enhance waterfowl hunting, the Ice Harbor pool is held constant several times a week from October to January.

7.14 McNary

7.14.1 Turbine Operations

To enhance juvenile passage survival, turbines at McNary projects will be operated within 1% of peak efficiency during the juvenile and adult migration seasons (April 1 through October 31; see appendix C of the 2011 FPP).

7.14.2 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 planning dates for the spring flow objective will be from April 10 to June 30. The flow objective is provided as a biological guideline and will not be met through the migration season in all years due to variability in volume and shape of the natural runoff.

7.14.3 Summer Flow Objectives

The summer flow objective at McNary Dam is 200 kcfs. The planning dates for the summer flow objective will be from July 1 to August 31. The flow in the summer 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.

7.14.4 Weekend Flows

Weekend flows are often lower than weekday flows due to less electrical 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.

7.14.5 Spill Operations

Spill operations for fish passage are defined in appendix E of the 2011 FPP.

7.14.6 Waterfowl Nesting

To improve waterfowl nesting conditions in the McNary pool between March and May each year, the pool is operated in the top 1 ft. of the pool range for several hours every 4 days.

7.14.7 Waterfowl Hunting Enhancement

In order to enhance Waterfowl hunting, the McNary pool is held constant several times a week from October to January.

7.14.8 Juvenile Fish Transport Operations

Transport operations are defined in appendices B and E of the 2011 FPP.

7.14.9 Maintenance

Significant powerhouse outages will occur daily in August with the possibility of extending into September to allow for the construction of a section of new transmission line at the McNary substation. The exact details of this outage have been coordinated in the FPOM forum and included into the 2011 FPP. The outage will occur daily in August with potential to continue into September if flows or temperatures are too high requiring the work period to be extended.

7.15 John Day Dam

7.15.1 Navigation Lock Replacement

During December 2010 until February 2011, the John Day downstream navigation lock is scheduled for replacement. For a very limited time period, operations will require specified tailwater requirements at John Day that could, in turn, challenge system operations to meet chum tailwater limits below Bonneville Dam. To provide the appropriate flow for chum, and the requested John Day tailwater, The Dalles forebay would have to be operated as close to full as possible. Any unexpected, unplanned, system perturbations such as power or transmission issues, hydrologic or model forecast error, or other special operations coinciding with the lifts, could result in deviating from the preferred chum tailwater range below Bonneville.

7.15.2 Reservoir Operations

John Day pool will operate within a 1.5 ft. range of the minimum level that provides irrigation pumping from April 10 to September 30. The purpose of this action is to provide a smaller reservoir cross section to reduce juvenile salmon travel time.

7.15.3 Turbine Operations

To enhance juvenile passage survival, turbines at all the Lower Columbia projects will be operated within 1% of peak efficiency during the juvenile and adult migration seasons (April 1 through October 31; see appendix C of the 2011 FPP).

7.15.4 Spill Operations

Spill operations for fish passage are defined in appendix E of the 2011 FPP.

7.15.5 Goose Nesting

To encourage geese to nest in areas that are not typically inundated by frequent fluctuations in the John Day pool between March and May each year, the reservoir is operated in the top 1 ft. of the range for several hours every 4 days.

7.15.6 Tribal Fishing

To accommodate tribal fishing, the John Day pool may operate within a 1.5 ft. operation range during tribal fishing seasons.

7.16 The Dalles Dam

7.16.1 Turbine Operations

To enhance juvenile passage survival, turbines at all the Lower Columbia projects will be operated within 1% of peak efficiency during the juvenile and adult migration seasons (April 1 through October 31; see appendix C of the 2011 FPP).

7.16.2 Spill Operations

Spill operations for fish passage are defined in appendix E of the 2011 FPP.

7.17 Bonneville Dam

7.17.1 Turbine Operations

To enhance juvenile passage survival, turbines at all the Lower Columbia projects will be operated within 1% of peak efficiency during the juvenile and adult migration seasons (April 1 through October 31; see appendix C of the 2011 FPP).

7.17.2 Spill Operations

Spill operations for fish passage are defined in appendix E of the 2011 FPP.

7.17.3 Chum Operation

See section 7.4 for a detailed discussion on the chum operation.

7.17.4 Tribal Fishing

To accommodate tribal fishing, the Bonneville pool is normally held between elevation 75.0 and 76.5 ft. during tribal fishing times. Often the pool is held to a 1.5 ft. range.

7.17.5 Spring Creek Hatchery Release

Bonneville Dam turbine operations (i.e. reduced turbine loading) for the April and May releases of tule fall Chinook from the Spring Creek National Fish Hatchery will be determined at a later date with discussions at the TMT.

8 Specific Operations

8.1 Spill operations general

8.1.1 TDG Criteria

The Corps will continue to manage spring and summer spill for fish passage to the state of Oregon and Washington's TDG water quality criteria with all applicable waivers and exemptions. These levels are referred to as gas caps. The project maximum flow rate or spill discharge level that meets but does not exceed the gas cap, is referred to as the TDG spill cap. The gas caps are constant, whereas, spill caps may vary daily depending on flow, temperature, and other environmental conditions.

8.1.2 Adjustments to Spill

The TDG level is managed daily in response to changing conditions and adjustments in spill for fish passage will be made to manage the operation consistent with the states' TDG water quality criterion. Power system and other project emergencies, including unplanned/unanticipated facility maintenance or outages, may necessitate temporary adjustments in accordance with established protocols. A more detailed description of spill management operations are outlined in Appendix 4.

Power system and other project emergencies, including unplanned/unanticipated facility maintenance or outages, may necessitate temporary spill adjustments in accordance with established protocols.

The spill rates represented above assume average runoff conditions; however, actual conditions may require adjustments to these spill rates. Actual spill rates may increase above the specified rates resulting in instances where the TDG levels exceed water quality criterion. The Corps tracks these TDG instances and defines the instance types and attributes as summarized below in the following table.

Table 10: Type of TDG Instances

Types of Instance	
Type 1 Condition	TDG levels exceed the TDG standard due to exceeding powerhouse capacity at run-of-river projects resulting in spill above the BiOp fish spill levels. This condition type includes:
	<ul style="list-style-type: none"> • High runoff flows and flood control efforts. • BPA load requirements are lower than actual powerhouse capacity. • Involuntary spill at Mid Columbia River dams resulting in high TDG levels entering the lower Columbia River. • Involuntary spill at Snake River dams resulting in high TDG levels entering the lower Columbia River.
Type 1a Condition	Planned and unplanned outages of hydro power equipment including generation unit, intertie line, or powerhouse outages.
Type 2 Exceedance	TDG exceedances due to the operation or mechanical failure of non-generating equipment. This exceedance type includes:
	<ul style="list-style-type: none"> • Flow deflectors unable to function for TDG abatement with tailwater elevations above 19 - 26 feet at Bonneville Dam. • Spill gates stuck in open position or inadvertently left open. • Increased spill in a bulk spill operation to pass debris. • Communication errors, such as teletype were transmitted but change was not timely made or misinterpretation of intent of teletype by Project operator.
Type 2a Exceedance	Malfunctioning FMS gauge, resulting in fewer TDG or temperature measurements when setting TDG spill caps.
Type 3 Exceedance	TDG exceedances due to uncertainties when using best professional judgment, SYSTDG model and forecasts. This exceedance type includes:
	<ul style="list-style-type: none"> • Uncertainties when using best professional judgment to apply the spill guidance criteria, e.g., travel time, degassing, and spill patterns. • Uncertainties when using the SYSTDG model to predict the effects of various hydro system operations, temperature, degassing, and travel time. • Uncertainties when using forecasts for flows, temperature and wind. • Unanticipated sharp rise in water temperature (a 1.5 degree F. or greater change in a day). • Bulk spill pattern being used which generated more TDG than expected.

Spill below the specified rates could occur during low runoff conditions when meeting minimum generation levels at a project requires reducing spill rates. This would most likely occur in late July and August. Minimum generation and spill rates are specified in the 2011 FPP. Spill also may be reduced or curtailed to accommodate navigation safety issues or other critical unplanned needs (i.e. health and human safety, dam safety, prevent equipment failure, maintain transmission stability, etc.).

To make adjustments in response to changes in conditions, the Corps will utilize the existing Regional Forum committees. Changes in spill rates when flow conditions are higher or lower than anticipated will be coordinated through the TMT. This could include potential issues and adjustments to the juvenile fish transportation program, or fish passage emergency.

8.1.3 Spillway Operations

Actual hourly spill quantities at dams will be slightly greater or less than specified levels. The AAs will meet the requested spill levels to the extent possible, as described. However, actual spill levels depend on the precision of spill gate settings, flow variations in real time, varying project head (the elevation difference between a project's forebay and tailwater), automatic load following and other factors. Operations considerations are as follows:

Spill discharge levels: Due to limits in the precision of spill gates and control devices, short term flow variations, and head changes, it is not always possible to discharge the exact spill levels, or as stated in RCC spill requests (teletypes) to projects that call for discrete spill discharges. Therefore, spillway gates are opened to the gate settings identified in the FPP project spill pattern tables to provide spill discharge levels that are the closest to the prescribed spill discharge levels.

Spill percentages: Spill percentages are considered target spill levels. The project control room operator and BPA duty scheduler calculate spill levels to attempt to be within $\pm 1\%$ of the target percentage for the following hour. Prescribed or specified percentages may not always be attained due to low discharge conditions, periods of minimum generation, spill cap limitations, temporary spill curtailment for navigation safety, and other unavoidable circumstances. Operators and schedulers review the percentages achieved during the day and will attempt to adjust spill rates in later hours if necessary, with the objective of ending the day with a daily average spill percentage that achieves the specified spill percentage.

8.1.4 Minimum Generation

The Corps has identified minimum generation flows derived from FPP tables which specify turbine operation within the $\pm 1\%$ of best efficiency range. These minimum generation flows are approximations and do not account for varying head or other small adjustments that may result in variations in the reported minimum generation flow values and spill amount. Conditions that may result in minor variations include:

1. Varying pool elevation: as reservoirs fluctuate within the operating range, flow rates through the generating unit change.
2. Generating unit governor "dead band": the governor controls the number of megawatts the unit should generate and cannot precisely control a unit; variations can be $\pm 1\%$ to 2% of generation.
3. System disturbances: once the generator is online and connected to the grid, it responds to changes in system voltage and frequency. These changes may cause the unit to increase flow and generation slightly within an hour.
4. Individual units may behave slightly differently or have unit specific constraints.
5. Generation control systems regulate megawatts (MW) generation only, and not flow through turbines.

All of the lower Snake River powerhouses may be required to keep one generating unit on line at all times for power system reliability. During low flows, one generator is run at the bottom of the 1% of best efficiency range. All of the Snake River plants have 2 "families" of turbines with slightly different capacities. In most cases one of the smaller units, with somewhat less generation and flow, will be online during these times. At the Snake River dams, the smaller units are generally numbered 1 – 3 and are the first priority for operation during the fish passage season. However, if smaller units are unavailable, one of the larger units may be used. Further, at Lower Monumental, generating unit 1, which is the first priority unit during fish passage, is damaged and cannot operate at the low end of the design range. However, because this unit is a fish passage priority TMT may recommend use of this unit, which will result in higher turbine discharge rates than shown in the Lower Monumental Summer Operation Considerations section below. In addition, Ice Harbor units cannot be operated at the lower end of the 1% of best efficiency range. These units experience cavitation at a generation level somewhat higher than the lower 1% limit, which damages the turbine and can be detrimental to fish.

8.1.5 Low Flow Operations

Low flow operations on lower Snake and lower Columbia projects are triggered when inflow is not sufficient to provide for both minimum generation and the planned spill levels. In these situations, the projects will operate either one unit at minimum generation (Snake River projects) or at minimum powerhouse flow (Columbia River projects) and spill the remainder of flow coming into the project. As flows transition from higher flows to low flows, there may be situations when flows recede at a higher rate than forecasted. In addition, inflows provided by non-federal projects upstream are variable and uncertain. The combination of these factors may result in instances where unanticipated changes to inflow result in forebay elevations dropping to the low end of the MOP. Since these projects have limited operating flexibility, maintaining minimum generation and the target spill may not be possible on every hour.

Also during these low flow operations, additional flow that is passed through a dam as the result of navigational lockages becomes more apparent. This is because the volume of water needed to empty the navigation lock during periods of low flow is a greater percentage of the total flow than it had been earlier in the season. As a result, the official recorded spill percent through the spillway appears to be reduced since it does not include this volume of water needed to empty the navigation lock.

8.1.6 Operations for Transmission Stability

Because projects must be available to respond to within-hour load variability to satisfy North American Electric Reliability Council reserve requirements (“on response”), project operations may result in not meeting hourly spill requirements, mostly at McNary, John Day, and The Dalles dams. In addition to within-hour load variability, projects on response must be able to respond to within hour changes that result from intermittent generation (such as wind generation). During periods of rapidly changing loads and intermittent generation, projects on response may have significant changes in turbine discharge within the hour while the spill quantity remains the same within the hour. Under normal conditions, within-hour load changes occur mostly on hours immediately preceding and after the peak load hours, however, within-hour changes in intermittent generation can occur at any hour of the day. Sometimes, several hours after peak load hours, the project may be decreasing total outflow and generation faster than the corresponding spill decreases causing the percent spill to be slightly higher. Due to the high variability of within-hour load, these “Transmission Stability” hours may have a greater instance of reporting actual spill percentages that vary more than the +/- 1% requirement than other hours.

8.2 Canadian Storage for Flow Augmentation

8.2.1 Columbia River Treaty Storage

The purpose of the actions below is to see if more water from Canadian storage projects can be obtained for flow augmentation. One (1) MAF of Columbia River Treaty (Treaty) storage will be requested and negotiated when available with British Columbia (BC) Hydro to be provided and released during the migration season.

Annual agreements between the U.S. and Canadian entities to provide flow augmentation storage in Canada for U.S. fisheries needs 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:

- Providing the greatest flexibility possible for releasing water to benefit U.S. fisheries May 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.

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

8.2.2 Non-Treaty Storage (NTS)

BPA and BC Hydro have negotiated a non-Treaty storage agreement to provide for storage during the spring with subsequent release in July and August 2011, for flow enhancement as long as operations forecasts indicate that there is water available in spring to be stored and can be released in July and August.

8.2.3 Non-Treaty Long-Term Agreement

BPA will seek to negotiate a new long-term agreement on use of non-Treaty space in Canada so long as such an agreement provides both power and non-power benefits for BC Hydro, BPA, and Canadian and U.S. interests. As part of these negotiations, BPA will seek opportunities to provide benefits to ESA-listed fish, consistent with the Treaty. If a new long-term non-Treaty agreement is not in place, or does not address flows for fisheries purposes, BPA will approach BC Hydro about possibly negotiating an annual/seasonal agreement to provide U.S. fisheries benefits, consistent with the Treaty.

8.2.4 Non-Treaty Coordination with Federal Agencies, States, and Tribes

Prior to negotiations of new long-term or annual non-Treaty storage agreements, BPA will coordinate with Federal agencies, States, and Tribes to obtain ideas and information on possible points of negotiation, and will report on major developments during negotiations.

8.2.5 Non-Treaty Storage (NTS) Refill

BPA, in concert with BC Hydro, will refill the remaining non-Treaty storage space by June 30, 2011, as required under the 1990 non-Treaty storage agreement. Refill will be accomplished with minimal adverse impact to fisheries operations.

8.3 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.

8.4 Bonneville Chum Operations

The AAs plan to operate the FCRPS to provide flows to support chum salmon spawning, incubation and egress from the Ives/Pierce Islands spawning areas. The Bonneville chum spawning and incubation operation affects approximately 10% of the natural spawning area for the ESA listed Columbia River chum. Non-listed lower Columbia River fall Chinook also spawn in the area. The NMFS 2010 Supplemental BiOp recognizes that access to spawning habitat in the Ives/Pierce area is primarily a function of the water surface elevations greater than 11.2 ft. above mean sea level (msl). Managing the water surface elevation with the operation of Bonneville Dam has proven to be an effective means of protecting this spawning area. Providing spawning access to Hamilton Creek and Hardy Creek is similarly a function of sufficient tailwater elevation but must be coupled with sufficient rainfall events to get the creeks flowing sufficiently. As addressed in the NMFS 2010 Supplemental BiOp, chum salmon spawning operations have lower priority than spring flow objectives or summer refill. If all of the BiOp objectives cannot be met, the AAs will work with NOAA Fisheries and the regional salmon managers to identify operations that would best benefit salmon while maintaining other fish protection measures. There are two phases of chum operations; spawning which generally runs from late October through late December, and incubation and egress which runs from late December to early April.

8.4.1 Spawning Phase

In the first week of November (or when fish arrive) Bonneville Dam will begin operating to provide a tailwater (TW) range of 11.3 - 11.7 ft. until spawning ends or December 31. The official project tailwater gage is located on the Oregon side .9 miles downstream of Bonneville Dam First Powerhouse, 50 ft. upstream from Tanner Creek at river mile 144.5 ft. Generally, the range of outflow from Bonneville Dam required to maintain this tailwater elevation can vary from less than the project minimum discharge of 70 kcfs up to 135 kcfs. This range demonstrates the affect natural conditions downstream of Bonneville Dam have on the water surface. Tides, wind, wave and inflows to the Columbia River downstream of Bonneville Dam are all uncontrolled and difficult to predict.

In addition to the uncertainty of conditions downstream of Bonneville Dam there are just as many variables upstream. Generally, the flow at Bonneville Dam is augmented by storage releases from Grand Coulee Dam. This water takes approximately 24 hours to arrive at Bonneville Dam and must pass through several non-federal dams that can alter the shape of the flow. Also, the amount of unregulated flow into the Columbia River above Bonneville Dam is difficult to predict. The ability to operate Bonneville Dam to a

particular tailwater constraint is contingent on the ability of the hydrosystem to manage all of these variables.

The hydrosystem is rarely able to maintain the 11.3 - 11.7 ft. operation during day-light hours throughout the spawning period. Significant fall rain events will typically intervene; therefore the operation must be modified to accommodate these varied conditions. Research performed in 2005 to assess the impacts of higher flows (day and night) on chum salmon redd development indicated that increases in flows up to 175 kcfs delayed spawning until flows dropped back to base levels (125 kcfs) but did not force fish to abandon their redds and search for new locations. Extra chum spawning flows may be available from Lake Pend Oreille (Albeni Falls Dam) during fall drawdown when drafting to elevation 2051 as part of the planning process for winter draft for kokanee spawning. The SOR for Albeni Falls draft is formulated, usually in September, by the USFWS and IDFG in coordination with NMFS and other concerned parties. Through TMT, if water supply is deemed insufficient to provide adequate mainstem spawning or continuous tributary access, as appropriate, provide mainstem flow intermittently to allow fish access to tributary spawning sites if adequate spawning habitat is available in the tributaries. The following is a list of steps that generally captures the progression of the operation as river flow increases until the point where TMT typically convenes to discuss the options ahead.

8.4.1.1 Chum Spawning Operational Steps

The steps 1 through 6 below describe the transition from complete control of the operation to conditions where the daytime range cannot be managed.

1. Operate Bonneville tailwater elevation (TWE) between 11.3 - 11.7 ft. TWE all hours daily.
2. As needed, to pass water in excess of that needed to meet item 1, increase the TWE up to 18.5 ft. anytime between the hours 1700-0600.
3. If item 2 is insufficient to pass excess flow, increase TWE up to 12.5 ft. anytime between the hours of 0600 – 1700daily.
4. If items 2 and 3 are insufficient to pass excess flow, discuss options with TMT for passing additional water during daytime hours. Discussions typically include higher TWE, larger operating range (1 ft. vs. .4 ft.), daytime spikes in flow, multi-day increases in TWE, etc. Generally, the options will depend on weather and flow conditions and the number of actively spawning fish present.

There are several conditions that typically overwhelm the chum spawning operation for multiple days. These events are usually seen well in advance and the course of action to implement is discussed at TMT. Below are some examples of the conditions where the chum operation cannot be managed within the agreed constraints.

- Conditions downstream of Bonneville produce high TWE regardless of the discharge at Bonneville such as high tides and high inflows to the Columbia River downstream of Bonneville. Bonneville can be discharging the project minimum and still exceed the target TWE range.
- Heavy westside precipitation events increase inflow to the Columbia River both upstream and downstream of Bonneville. This condition combines a low required flow at Bonneville and uncontrolled inflows to the Columbia River above Bonneville. In the absence of storage capacity in the lower river, there is little control over the resulting TWE below Bonneville.

8.4.2 Incubation and Egress

Washington Department of Fish and Wildlife (WDFW) will determine when chum spawning is complete; this usually occurs no later than the end of December. Following the completion of spawning, the operation is shifted to provide a tailwater elevation (to be determined by TMT) equal to or greater than the elevation of the highest established redds. This elevation is typically around 11.3 ft. - 11.5 ft. msl during normal water years. Redds established due to conditions beyond the control of the action agency may not be protected. This operation continues until the completion of emergence and egress which can extend to the start of the spring flow management season around April 10. At that time, spring flow augmentation volumes generally provide sufficient flows to maintain the protection elevations necessary. If the emergence period extends beyond April 10 and the decision is made to maintain the tailwater, TMT will need to discuss the impacts of TDG associated with spill for fish passage at Bonneville Dam and its potential for negatively affecting fry in the gravel. Bonneville typically starts its spring spill around April 10, but a delay in the start of spill may be needed.

Revisit the chum protection level decision 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.

8.4.3 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 basis for a dewatering decision depends greatly on in-season conditions so are best made in TMT. Factors that should be considered in making a dewatering decision include:

- The number and percentage of the total redds which would be affected by the decision
- Emergence timing based on temperature units
- The percentage of the total chum population that spawned at other locations

- The component of the overall population that these redds represent
- Status of the FCRPS 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 listed stocks
- Existence and status of a brood contingency plan

8.4.4 Dewatering Options

Consideration of options to minimize the impacts should a decision be made to lower the protection level for the spawning, incubation and egress follow:

1. If water supply conditions indicate that it is not possible to maintain this minimum tailwater elevation at Bonneville Dam, flow will be provided at times during the chum- emergence season to allow juveniles to depart from Hamilton and Hardy Creeks. Details will be set through coordination in TMT.
2. 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 above 11.5 ft. 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.
3. Manage flows below what is necessary for mainstem spawning to discourage redds from being established in the area.
4. Shaping flows in a manner that would discourage redd development above a particular elevation. Reverse load factoring with nighttime discharges more than 75 kcfs over the daytime discharge level have occurred without impacting where chum redds were placed.
5. Shaping flows as low as possible during the day with one or two spikes of flow as short of duration as possible can also discourage redd development.

8.5 Description of Variable Draft Limits

Variable Draft Limits (VDL's) 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 VDL's are based on: (1) The April 10 elevation objective which is calculated from the forecasted March 31 and April 15 flood control elevations (2) statistical inflow volumes (85% exceedance for Grand Coulee and 75% exceedance for Hungry Horse), (3) actual downstream and project flow objectives, to meet at-site and Vernita Bar requirements, and (4) refill requirements at upstream projects and the flow forecasts which drive such upstream requirements.

VDL's are calculated monthly from January through March after updated volume forecasts and flood control elevations have been issued. The VDL at the end of a period (e.g., January 31) is computed as the carryover storage needed to meet the next periods' storage and outflow requirements with the goal of refilling to the elevation objective on April 10.

For example, Grand Coulee's January VDL is computed as:

- The expected April 10 Flood Control elevation based on January forecast.
- Minus February 1-April 10 inflow volume of 2,424 ksf (85% statistical inflow volume). This volume data is reduced by Banks Lake pumping
- Plus February 1 to April 10 minimum discharge requirement for Vernita Bar.
- Plus expected and realistic upstream refill requirement in February 1 to April 10 while observing the applicable upstream reservoir elevation limits.

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 flood control curve, FELCC is already being met, and at-site and downstream flow objectives are also being served. Also, VDL's at Grand Coulee are further limited by VDL lower limits of 1260 ft. in January, 1,250 ft. in February and 1,240 ft. in March.

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

8.6.1 Fish Flow Releases Advisory Group

The Fish Flow Releases Advisory Group (FFRAG) supplies a mechanism for fisheries comanagers to provide advice to Washington State Department of Ecology (Ecology) and Reclamation on the disposition of the one-third of active storage water that will be made available to augment instream flows ("fish water") through the development of new

storage facilities, pursuant to 90.90.020 RCW.¹⁰ At present, FFRAG has developed recommendations for the disposition of water to be released to offset permitted withdrawals related to the Lake Roosevelt Incremental Storage Releases project. Established in March 2009, FFRAG members include fish managers from Washington Department of Fish and Wildlife, National Marine Fisheries Service, U.S. Fish and Wildlife Service, Yakama Indian Nation, Confederated Tribes of the Umatilla Indian Reservation (represented by Columbia River Intertribal Fish Commission), and Confederated Tribes of the Colville Reservation. WDFW chairs the group, and the Director of Ecology’s Office of Columbia River and a representative of the U.S. Bureau of Reclamation also participate. The committee functions on the basis of consensus. Decisions of the group manifest in the form of recommendations/advice to Ecology and Reclamation.

8.6.2 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. The Incremental draft results in a release of 82,500 acre-feet in most years, or about 1.0 foot of draft at Lake Roosevelt. 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*”). 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. Releases are allocated as shown in Table 9.

Table 9. Lake Roosevelt Incremental Storage Release Allocations

Amount	Use	Description
30,000 acre-feet	Odessa Subarea (not shown in release distribution tables)	Water pumped to Banks Lake and delivered through the Columbia Basin Project to the Odessa Subarea, offsetting groundwater pumping.
25,000 acre-feet	Municipal / Industrial	Water released from Grand Coulee dam and withdrawn from the Columbia River at various sites downstream.
27,500 acre-feet	Instream flow (“fish”)	Water released to instream flow corresponding with the out-of-stream components above.

¹⁰ **90.90.020 Allocation and development of water supplies.** ... (1)(a) (ii) One-third of active storage shall be available to augment instream flows and shall be managed by the department of ecology. The timing of releases of this water shall be determined by the department of ecology, in cooperation with the department of fish and wildlife and fisheries comanagers, to maximize benefits to salmon and steelhead populations.

33,000 acre-feet	Interruptible water users (“drought”)	In drought years, offset withdrawals from some interruptible water right holders along the Columbia River at various sites downstream.
17,000 acre-feet	Instream flow (“drought fish”)	Water released to instream flow corresponding to the drought interruptible component.

8.6.3 Releases 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. Based on RPA 4 in the 2008 FCRPS BiOp, 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. Following (Table 10) is the FFRAG framework showing recommended distribution of incremental storage releases across months (Apr-Sep) under four water-year types: wet, average, dry, and drought. End-of-period accounting point elevations are also provided for each scenario.

Table 10 – Release of Lake Roosevelt Incremental Draft Water

Water Year Scenario	Purpose	Volume in acre-foot (Lake Roosevelt equivalent draft in feet)						
		Apr	May	June	July	Aug	Sept	Oct
A. “Wet”	Odessa	2,012	3,963	5,976	7,988	5,976	3,049 ¹	1,036
	M&I	2,000	3,988	4,875	4,694	4,944	4,500 ¹	
	Fish	0	4,950	5,500	5,775	5,775	5,500 ¹	
	Total	33,401 (0.4) ² (refill to 1289.6)			68,665 (0.9) ^{2,3} draft to 1279.1		12,799 ¹	1,036
B. “Average”	Odessa	2,012	3,963	5,976	7,988	5,976	3,049 ¹	1,036
	M&I	2,000	5,250	6,000	5,750	6,000		
	Fish	0	6,875	6,875	6,875	6,875		
	Total	38,951 (0.5) ² (refill to 1289.5)			78,415 (1.0) ^{2,3} (draft to 1277 or 1279) ⁴		3,049 ¹	1,036
C. “Dry”	Odessa	2,012	3,963	5,976	7,988	5,976	3,049 ¹	1,036
	M&I	3,700	8,850	5,700	3,250	3,500		
	Fish	4,675	16,775	6,050	0	0	0	
	Total	57,701 (0.7) ² (refill to 1289.3)			78,415 (1.0) ^{2,3} (draft to 1277)		3,049 ¹	1,036
D. “Drought”	Odessa	2,012	3,963	5,976	7,988	5,976	3,049 ¹	1,036
	M&I	4,200	8,350	5,700	3,250	3,500		
	Fish	6,050	15,400	6,050	0	0		

	Interruptible	4,620	7,590	3,960	6,930	9,900		
	Fish	3,740	9,520	3,740				
	Total	90,871 (1.1) ² (refill to 1288.9)			128,415 (1.7) ^{2,3} draft to 1276.3			4,085 ^{1,5}

¹ The FCRPS BiOp, RPA action 4 (Grand Coulee) says: “If the Lake Roosevelt drawdown component of Washington’s Columbia River Water Management Program (CRWMP) is implemented, it will not reduce flows during the salmon flow objective period (April to August). The metric for this is that Lake Roosevelt will be drafted by an additional 1.0 foot in non-drought years and by about 1.8 feet in drought years by the end of August.” Because of the way this RPA action is written, Reclamation cannot shift release of CRWMP water into September and still operate consistent with this RPA action; however, the volume of water shown here for September are so small that they cannot be measured.

² Additional draft at Lake Roosevelt in feet. Water surface elevation can only be measured to the nearest 10th.

³ To demonstrate that the water comes from Lake Roosevelt, the end of August draft includes both spring and summer releases.

⁴ August 31 draft to 1278 or 1280 is based on July final water supply forecast.

⁵ In drought years, irrigation water is drafted from Banks Lake in September, then refilled from Lake Roosevelt in October.

8.6.4 2011 Operations

The amount and timing of water to be released in 2011 won’t be determined until the March final Water Supply forecast for April – September at The Dalles is completed. Estimates of 2011 incremental storage releases will be included in the 2011 spring/summer update.

8.7 Public Coordination

Actions in the WMP will be coordinated with NOAA Fisheries, 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. At all appropriate decision points, the AAs will routinely seek timely input and concurrence from the USFWS on all matters affecting USFWS listed fish through the Columbia River Treaty, IJC, 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.

9 Water Quality

9.1 Water Quality Plans

The Corps has completed a comprehensive 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 was updated in January 2009 and can be found at http://www.nwd-wc.usace.army.mil/tmt/wq/studies/wq_plan/wq200814.pdf

9.1.1 Total Dissolved Gas Monitoring

Exposure to high levels of TDG over long periods of time can be harmful or lethal to fish. Environmental 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 NMFS BiOps, and applicable state water quality criteria. 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 Plan of Action can be found at http://www.nwd-wc.usace.army.mil/tmt/wqnew/tdg_and_temp/2010/app_b.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), which is a supporting document for the WMP. This TDG Management Plan provides detailed definitions of spill, spill conditions, TDG management measures, the rationale and process for setting spill caps, the TDG management policies, and the TDG monitoring program, and modeling. This plan is consistent with both the U.S. Fish and Wildlife Service and the National Marine Fisheries Service (NMFS) Federal Columbia River Power System (FCRPS) Biological Opinions (BiOps).

10 Dry Water Year Operations

Flow management during dry years is often critical to maintaining and improving habitat conditions for ESA-listed species. A dry water year is defined as the lowest 20th percentile years based on the NWRFC's averages for their statistical period of record (currently 1971 to 2000) using the May final water supply forecast for the April to August period as measured at The Dalles (71.8 maf). The AAs will complete the following activities to further the continuing efforts to address the dry flow years:

- Within the defined "buckets" of available water (reservoir draft limits identified in Reasonable and Prudent Alternative (RPA) Action 4), 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 in 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, therefore, increasing flows during that period relative to a standard refill operation.
- Annual agreements between the U.S. and Canadian entities to provide flow augmentation storage in Canada for U.S. fisheries needs 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.

- BPA will explore opportunities in future long-term NTS storage agreements to develop mutually beneficial in-season agreements with BC Hydro to shape water releases using NTS space within the year and between years to improve flows in the lowest 20th percentile water years to the benefit of ESA-listed Evolutionary Significant Units (ESUs), considering their status.
- Upon issuance of the FCRPS Biological Opinion, the AAs will convene a technical workgroup to scope and initiate investigations of alternative dry water year flow strategies to enhance flows in dry years for the benefit of ESA-listed ESUs.
- BPA will implement, as appropriate, its Guide to Tools and Principles for a Dry Year Strategy to reduce the effect energy requirements may pose to fish operations and other project purposes.
- Annual agreements between the U.S. and Canadian entities to provide flow augmentation storage in Canada for U.S. fisheries needs 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.

11 FCRPS Hydrosystem Performance Standards

The AAs will operate the FCRPS hydrosystem as described in this 2011 WMP, in an adaptive management framework, to make progress towards meeting biological performance goals. Those goals are contained in the 2008 NOAA Fisheries Biological Opinion as supplemented in the 2010 Supplemental BiOp. Adult and juvenile fish survival estimates from research, monitoring, and evaluation studies will be considered in annual planning as future plans are developed.

12 Conclusion

The 2011 WMP has been coordinated with and reviewed by the TMT. Seasonal action plans will be developed as described in the introduction to this plan. Additionally, operations may be adjusted in-season based on recommendations from the TMT.