



Columbia River System Operations Draft Environmental Impact Statement

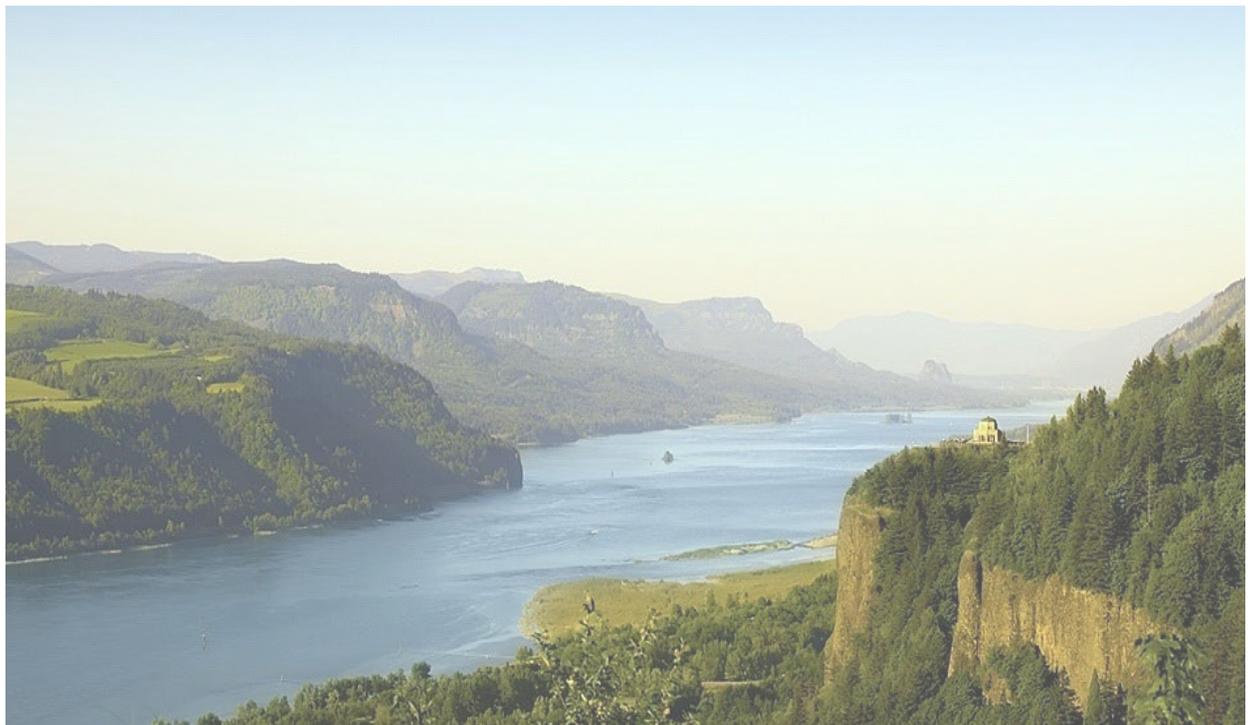
February 2020

Co-Lead Agencies:

U.S. Army Corps of Engineers – Northwestern Division

Bureau of Reclamation – Pacific Northwest Region

Bonneville Power Administration (DOE/EIS-0529)



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of Engineers®**



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Columbia River System Operations

Draft Environmental Impact Statement

Co-Lead Agencies: U.S. Department of the Army, U.S. Army Corps of Engineers – Northwestern Division; Bureau of Reclamation – Pacific Northwest Region; U.S. Department of Energy, Bonneville Power Administration (DOE/EIS – 0529)

Cooperating Agencies: U.S. Coast Guard; U.S. Environmental Protection Agency; U.S. Department of Interior, Bureau of Indian Affairs; State of Idaho; State of Montana; State of Oregon; State of Washington; Lake County, Montana; Confederated Salish Kootenai and Tribes of the Flathead Reservation; Confederated Tribes of the Colville Reservation; Confederated Tribes of Grand Ronde Community of Oregon; Confederated Tribes of the Umatilla Indian Reservation; Confederated Tribes and Bands of the Yakama Nation; Cowlitz Indian Tribe; Kootenai Tribe of Idaho; Nez Perce Tribe; Burns Paiute Tribe; Fort McDermitt Paiute and Shoshone Tribes of the Fort McDermitt Indian Reservation; Shoshone-Paiute Tribes of Duck Valley Reservation; Shoshone-Bannock Tribes of the Fort Hall Reservation; and Spokane Tribe of Indians.¹

Title of Proposed Project: Columbia River System Operations

States Involved: Idaho, Montana, Oregon, and Washington

Abstract: The U.S. Army Corps of Engineers, Bureau of Reclamation, and Bonneville Power Administration, as co-lead agencies, have prepared this Columbia River System Operations Draft Environmental Impact Statement (EIS) in accordance with the National Environmental Policy Act (NEPA). The co-lead agencies requested Federal, state, and local agencies, and tribes to participate as cooperating agencies based on their jurisdiction by law, or their special expertise. More than 30 entities from across the region agreed to be cooperating agencies in this NEPA process. In addition, co-lead agencies gathered input from the public, tribes, local, state, and Federal governments, and water resource users— including utility customers, commercial navigation and port entities, irrigation users, fishing and commercial fishers, and other public interest groups during the scoping process.

The EIS identifies and evaluates a No Action Alternative and five alternatives for operations, maintenance, and configuration of the Columbia River System (CRS). The alternatives are based on scoping input and expertise from cooperating and co-lead agencies. The alternatives include different system operations and additional structural modifications to existing projects, such as breaching the embankments at the Lower Granite, Little Goose, Lower Monumental, and Ice Harbor Projects; modifying fish ladders; or adjusting storage operations to affect the timing of flows for various purposes. The alternatives explore a range of spill levels to support juvenile fish passage, varying levels of hydropower generation by seasonal changes in flows, and differing actions to support the needs of Endangered Species Act (ESA)-listed anadromous and resident fish. Some alternatives evaluate additional future water supply for irrigation purposes

¹ Continued discussions concerning the Spokane Tribe of Indian's cooperating agency status are ongoing.

and increased water management flexibility to react to unexpected river flow changes and increase the likelihood of achieving refill of storage reservoirs. After evaluating the potential effects of the five alternatives on resources, such as flood risk management, water supply, hydropower generation, fish, vegetation, wildlife, wetlands, floodplains, climate, navigation, cultural resources, tribal interests, recreation, and other environmental, social, and economic resources, the co-lead agencies identified a Preferred Alternative that balances multiple, sometimes competing, river resource needs and co-lead agency mission requirements. The co-lead agencies expect that the suite of operational, maintenance, and structural measures included in the Preferred Alternative would allow them to meet the EIS intent as expressed in the Purpose and Need and the EIS objectives, including those to benefit ESA-listed species, while also continuing to meet the congressionally authorized purposes of the system. The EIS also documents measures to avoid, offset, or minimize impacts to resources affected by system operations, maintenance, and configuration where feasible.

Comments Due: April 13, 2020

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Compact Disc and Hard Copies* – Call the automated recording line at 1-800-290-5033 and leave your name and mailing address.

*A limited number of hard copies will be available upon request due to the size of the document (over 4,000 pages in multiple volumes).

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U.S. Army Corps of Engineers, Northwestern Division, Attention: CRSO EIS, PO Box 2870, Portland, OR 97208-2870



EXECUTIVE SUMMARY

Columbia River System Operations Draft Environmental Impact Statement



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Bonneville
POWER ADMINISTRATION





The U.S. Army Corps of Engineers, Bureau of Reclamation and Bonneville Power Administration, as co-lead agencies, have prepared this Columbia River System Operations Environmental Impact Statement (EIS) in accordance with the National Environmental Policy Act (NEPA). NEPA requires federal agencies to review and disclose the environmental effects of taking an action. The action referred to in this EIS is not one specific act, but is rather a multi-faceted approach to system operations, maintenance, and configuration of the 14 Federal dam and reservoir projects in Idaho, Montana, Oregon and Washington, called the Columbia River System (CRS). We prepared this document in response to the need to review and update management of the CRS, including evaluating impacts to resources in the context of new information and changed conditions in the Columbia River basin. Information and insights from this process has enabled the development of a comprehensive approach to management of the CRS that meets multiple statutory authorities and complies with all applicable laws and regulations.

More than 30 entities from across the region, consisting of tribes, Federal agencies, and state and local governments, agreed to participate as cooperating agencies in this NEPA process. We greatly appreciate their technical expertise and input on early versions of this document. We are especially grateful to our tribal partners for helping ensure that the document reflects tribal perspectives on the Columbia River System.

The EIS identifies and evaluates six alternatives for operations, maintenance, and configuration of the CRS. After evaluating the potential effects of the six alternatives on flood risk management, water supply, hydropower generation, fish and wildlife, navigation, cultural resources, recreation and other environmental and socioeconomic resources, the co-lead agencies identified a Preferred Alternative that sought to achieve a reasonable balance of multiple river resource needs and co-lead agency mission requirements. The Preferred Alternative is comprised of a suite of operational and structural measures that allow us to meet the congressionally authorized purposes of the System, the Purpose and Need Statement and objectives of the EIS, including those to benefit species listed as threatened and endangered under the Endangered Species Act. Detailed descriptions of the alternatives are presented in Chapter 2 (No Action and Multi-objective Alternatives) and Chapter 7 (Preferred Alternative) of the EIS.

We recognize that the operation and maintenance of the Columbia River System affects threatened and endangered fish populations within the region, and the co-lead agencies are committed to mitigating these effects. Additional regional actions are needed, though, to address other effects that are beyond the co-lead agencies' responsibilities.

It was very important to us to seek input from a wide variety of stakeholders in the region as we developed this EIS. Not surprisingly, there is a wide range of views and opinions about the best approaches to managing the Columbia River System. However, it was also apparent that people throughout the Northwest share many common values and interests. Our goal has been to develop an approach to river management that balances these multiple perspectives and can serve as a springboard to continued progress in the region on recovery and mitigation for fish and wildlife, reliable and affordable clean electricity, and economic vitality for the many communities that depend on the CRS for their livelihoods. Our understanding of the Columbia River System will continue to improve, and the perspectives of the people living in the region will continue to evolve as well. We look forward to working with our many partners throughout the region on these important and timely issues.

Sincerely,

D. Peter Helmlinger, P.E.
Brigadier General
U.S. Army
Division Commander

Lorri Gray
Regional Director
Columbia-Pacific Northwest
Bureau of Reclamation
U.S. Department of the Interior

Elliot Mainzer
Administrator and CEO
Bonneville Power Administration
U.S. Department of Energy



PREFACE

The Columbia River basin is one of the greatest natural resources in the western United States, and the rivers and their tributaries form the dominant water system in the Northwest. The headwaters of the Columbia River begin at Columbia Lake, on the west slope of the Rocky Mountain Range in Canada, and the river follows a circuitous path for more than 1,200 miles before emptying into the Pacific Ocean near Astoria, Oregon. As its largest tributary, the Snake River originates in Western Wyoming and travels 1,078 miles before merging with the Columbia near Tri-Cities, Washington. The rivers influence the lives of people, fish and wildlife throughout the Northwest. The Columbia River and its tributaries, including both those in the upper and lower river and the Snake River, impact nearly every resident of the Northwest in some way, by providing hydroelectric power, recreation, navigation, water supply, flood risk management, and more.

Indigenous peoples have depended on the river and its resources for spiritual and economic well-being since time immemorial. These resources are central to tribal culture, ceremony, and subsistence within the interior Columbia River basin and its tributaries. Salmon, steelhead, Pacific lamprey, sturgeon, bull trout, and other native species found in the river are essential to many tribes' identities. Tribal populations also depended on the river for transportation, trade, fishing, and water supply.

As Euroamericans began arriving in the region in the 1800s, the Columbia River and its tributaries became an important resource for them as well. They too depended on the river for transportation, trade, commercial fishing, and irrigation water. By the 1920s, plans were being developed for the construction of multipurpose dams in the Columbia River to manage the river in new ways. With Congress' approval and funding, numerous dams were built along the Columbia River and its tributaries to provide for flood risk management, navigation, hydropower generation, irrigation, recreation, and water supply. The federal dams that are a part of the Columbia River System (CRS) were built and put into service between 1938 and 1976.

Today, the CRS continues to provide valuable social and economic benefits to the region. Operation of the CRS for flood risk management is an important purpose of the system, one that has reduced the risk to lives, property, and infrastructure in the basin. Large floods have occurred in the Columbia River basin throughout history

with catastrophic consequences. For example, in 1948, a flood destroyed Vanport, Oregon. Dozens of people lost their lives. Today, the CRS provides flood risk management for communities along the river.

The Columbia-Snake Navigation System is an important component of the regional economy. Between 50 and 60 million tons of cargo are transported each year on barges that can navigate the lower Snake River beginning near Lewiston, Idaho, and Clarkston, Washington, to its confluence with the Columbia River near Pasco, Washington, and then on the Columbia River to its confluence with the Pacific Ocean near Astoria, Oregon. The river system allows farmers to export grain and other crops grown in interior parts of the United States to overseas markets. Cruise line operators also use the system for tourism, which is a growing business on the Columbia and Snake rivers.

The CRS is the source of economical, reliable, and clean power generation, providing the region with some of the least greenhouse gas (GHG) intensive electricity in the United States. On average, the CRS produces 8,500 average megawatts of carbon-free power (equivalent to the power needs of eight cities the size of Seattle) reducing the need to use other carbon-emitting resources, like gas and coal plants. The flexibility of the CRS also helps integrate variable renewable resources like wind and solar by stabilizing the system when these resources are unavailable. In power grid operations, the amount of power produced must match the amount being consumed, second by second. Maintaining this balance requires flexible generating resources. Flexible resources are always available and can be ramped up and down as needed to manage normal fluctuations in supply and demand, as well as to help balance the variable output of renewable resources such as wind and solar. Hydropower is an example of a flexible resource that helps manage the moment-to-moment variability of these renewable generators' output. With 2,500 average megawatts or more of coal capacity expected to be retired in the 2020s, the hydropower system can continue to provide reliable power while helping to decarbonize the regional economy.

The Columbia River and its tributaries provide water for millions of people throughout the Columbia River basin. Farmers depend on water from the system to irrigate crops that contribute to the national economy. These crops include grains, alfalfa, and fruits and vegetables, including the wine grapes that form the foundation of the Northwest wine industry. Water from within the study area irrigates about 1,393,000 acres of land, with the potential for more.

While the region has derived many benefits from the CRS, there have also been adverse effects, particularly to populations of native fish. In addition to the initial construction and ongoing operations of the CRS, over the past century the development of the Columbia River basin has brought with it many stressors which have collectively contributed to population declines of native fish species, including urbanization and development in wetlands and floodplains, overfishing, water diversions, water pollution, invasive species introduction, mining, farming, ranching practices, logging and riparian erosion, hatchery-produced fish and competition, and adverse ocean conditions. It is estimated that before the late 1800s, a range of five to 16 million salmon and steelhead returned to the Columbia River basin each year. Numbers of anadromous fish began to decline in the late 1800s and continued to drop into the late 1900s. Bull trout, sturgeon, and other resident fish species have also experienced significant declines.

An **ANADROMOUS FISH** is born in fresh water, migrates out to the ocean where it spends most of its life, then returns to fresh water to spawn. Salmon, steelhead, and lamprey are all anadromous fish.

Construction of the CRS directly impacted many of the region's tribal communities. Tribal homes, villages, and resource gathering locations and traditional fishing sites were inundated. Some of the most well-known of these are Celilo Falls near The Dalles, Oregon, and Kettle Falls along Lake Roosevelt in Washington. After initial construction, the dams restricted the movement

MEGAWATT (MW) is the standard term of measurement for bulk electricity. One megawatt is 1 million watts. The total possible output of a generating plant is expressed in megawatts. For example, Grand Coulee, the largest dam in the Columbia River Basin and one of the largest in the world, has a maximum capacity of 6,735 megawatts. However, power plants are not operated at full capacity year-round. A generating plant's energy output over a certain period of time (often a year) is expressed in **AVERAGE MEGAWATTS**. One average megawatt is equivalent to one megawatt delivered continuously over a year. Grand Coulee's annual energy output is 2,382 average megawatts.



An elder from the Confederated Tribes of the Colville Reservation points to an inundated home site and fishing station on the north bank of the Snake River.

of resident and anadromous fish, contributing to their population declines. These population declines were devastating to many tribes. As noted previously, fish are central to the identity of tribes. In 1994, Donald Sampson, then Chair of the Confederated Tribes of the Umatilla Indian Reservation Board of Trustees, stated:

“Salmon are the centerpiece of our culture, religion, spirit, and indeed, our very existence. As Indians, we speak solely for the salmon. We have no hidden agenda. We do not make decisions to appease special interest groups. We do not bow to the will of powerful economic interests. Our people’s desire is simple—to preserve the fish, to preserve our way of life, now and for future generations.”

Tribal Circumstances and Impacts of the Lower Snake River Project on the Nez Perce, Yakama, Umatilla, Warm Springs and Shoshone Bannock Tribes Meyer Resources, Inc., 1999.

Today, the annual runs of salmon and steelhead average just over two million fish, of which 40 percent are naturally produced. The rest come from hatchery programs developed for conservation or safety-net purposes, or as mitigation for the construction of the dams. Since 1992, more than half of Columbia River salmon and steelhead species have been listed under the Endangered Species Act (ESA). Regional debate continues about the relative importance of the different factors that cumulatively led to this decline, but there is little debate that the construction and operation of the CRS has had a sizable impact on fish. Tremendous effort and billions of dollars have been invested in infrastructure, hatcheries, and other projects to improve passage and habitat for fish in the basin over the last 50 years.



The fish ladder at John Day Lock and Dam that allows adult fish to migrate upstream of the dam.

The co-lead agencies have made substantial improvements for resident and anadromous (both adult and juvenile) fish passage at the lower Snake River and lower Columbia River dams. The co-lead agencies have undertaken large-scale efforts to improve fish and wildlife habitat in tributaries and the estuary. In addition to the habitat restoration actions that have been taken to address direct impacts where they occur from operations, these actions typically enhance fish and wildlife habitat not directly impacted by the operation and maintenance of the CRS, but help mitigate for the effects of the CRS. The co-lead agencies have funded an extensive hatchery program that includes conservation hatcheries for

ESA-listed fish and other hatcheries to mitigate for the construction and operation of the dams. Many of these hatchery fish support tribal, commercial, and sport harvest. While not inclusive of all actions that have been taken to benefit salmon, steelhead, Pacific lamprey, bull trout, sturgeon, and other native fish species, these examples help provide context for the level of effort that has gone into improving conditions for fish within the basin.

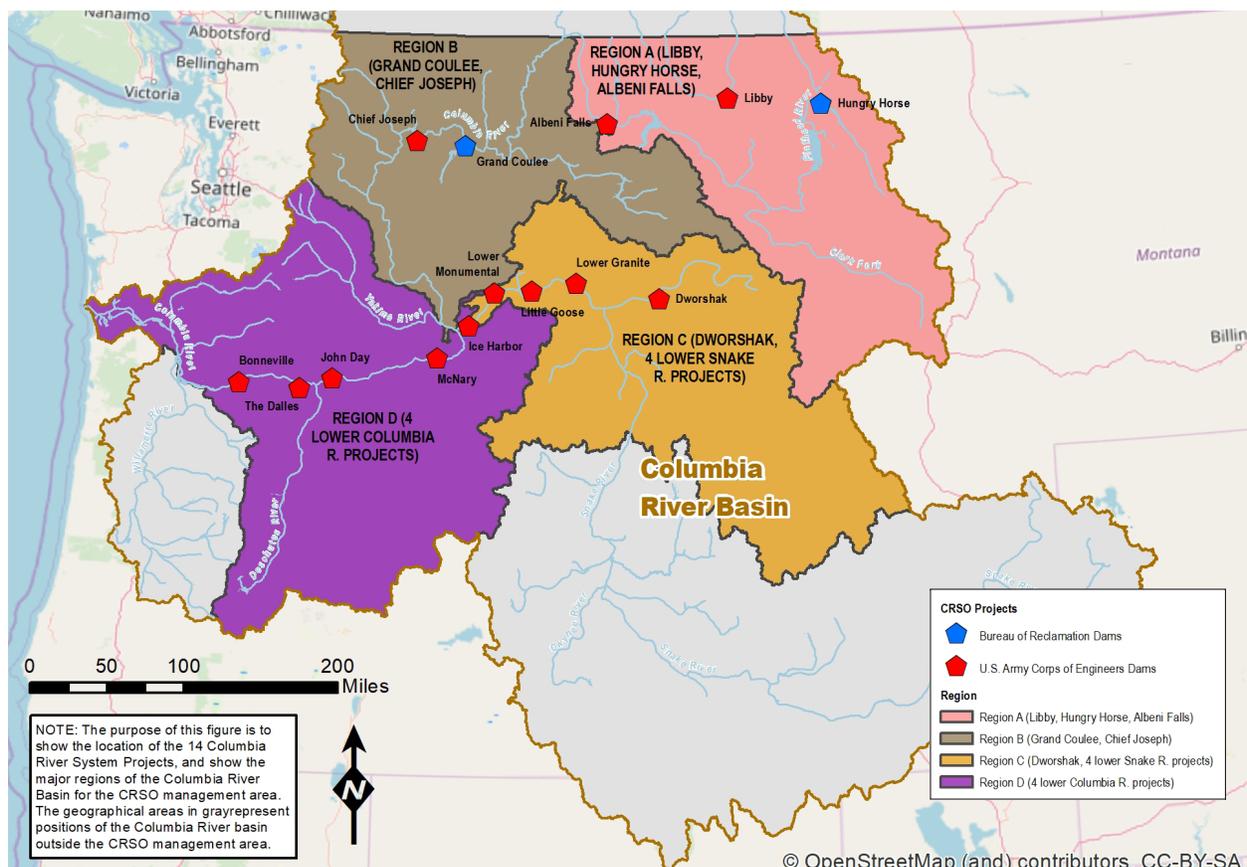
The co-lead agencies are committed to working with the region to continue to improve conditions for fish and wildlife affected by operations of the CRS.

1 INTRODUCTION

The U.S. Army Corps of Engineers (Corps), Bureau of Reclamation (Reclamation) and Bonneville Power Administration (Bonneville), as co-lead agencies, have developed the Columbia River System Operations (CRSO) Environmental Impact Statement (EIS) in accordance with the National Environmental Policy Act (NEPA). The co-lead agencies prepared this EIS in response to the need to review and update operations, maintenance, and configuration of the 14 CRS multiple purpose dams

and related facilities (“projects”). These projects include Libby, Hungry Horse, Albeni Falls, Grand Coulee, Chief Joseph, Dworshak, Lower Granite, Little Goose, Lower Monumental, Ice Harbor, McNary, John Day, The Dalles, and Bonneville (Figure ES-1). The United States Congress authorized the Corps and Reclamation to construct, operate, and maintain the CRS projects to meet multiple specified purposes, including flood risk management (FRM), navigation, hydropower generation, irrigation,

Figure ES-1: Columbia River System Projects



Uses of the Columbia River System

- | | | | |
|---|-----------------------|---|-----------------|
|  | Flood Risk Management |  | Fish & Wildlife |
|  | Recreation |  | Navigation |
|  | Irrigation |  | Water Supply |
|  | Power | | |
|  | Fish Migration | | |
|  | Water Quality | | |



Figure ES-2: Uses of the Columbia River System

fish and wildlife conservation, recreation, and municipal and industrial (M&I) water supply (Figure ES-2). Bonneville is authorized to market and transmit the power generated by these coordinated system operations. Although the CRS has many purposes, it is operated as one interconnected system.

To meet the many uses of the Columbia River System, the co-lead agencies manage a complex operation that includes storing and releasing water at just the right times and in just the right amounts to meet various needs throughout the year. Often, actions to meet one need make it more challenging to meet another. For example, in January, operators begin drafting reservoirs to make room for spring runoff and provide flood risk management space, but sufficient water must still be available in early April to help propel juvenile salmon and steelhead in their migration to the ocean. All of the system's purposes are important and must be carefully choreographed.

As part of the CRSO EIS, the co-lead agencies analyzed the environmental, economic, and social impacts of the No Action and Action Alternatives, reviewing new scientific information, where applicable, and responding to the Opinion and Order from the U.S. District Court for the District of Oregon.¹ The Opinion and Order states the EIS should evaluate how to ensure that the prospective management of the CRS is not likely to jeopardize the continued existence of any endangered or threatened species, or result in the destruction or adverse modification of designated critical habitat. It also ordered the co-lead agencies to complete the Final EIS and records of decision by June 2021 and September 2021 respectively.

This executive summary provides an overview of the draft EIS, which is a much larger document that contains highly detailed analysis and results. This executive summary also provides an overview of the major environmental effects of the Preferred Alternative, but it is not intended to be a substitute for the broader CRSO EIS

¹ *National Wildlife Federation, et al. v. National Marine Fisheries Service (NMFS), et al.*, 184 F. Supp. 3d 861 (D Or. 2016).

document, which provides a comprehensive and detailed description of the environmental effects and mitigation for the Preferred Alternative. The table of contents below identifies the major topics and chapters of the EIS. Where possible, the executive summary points to the EIS chapter and section where the reader can find further details on a topic. Here is a link to the EIS website: www.crsso.info.

Chapter 1	Introduction
Chapter 2	Alternatives
Chapter 3	Affected Environment and Environmental Consequences
Chapter 4	Climate
Chapter 5	Mitigation
Chapter 6	Cumulative Effects
Chapter 7	Preferred Alternative
Chapter 8	Compliance with Environmental Statutes
Chapter 9	Coordination and Public Involvement
Chapter 10	List of Preparers
Chapter 11	References
Chapter 12	List of Appendices

The geographic scope of the EIS encompasses the 14 federal projects on the Columbia River, Snake River, and some of its major tributaries. Other federal projects located across the Columbia River basin (e.g., the Willamette Valley projects, the Yakima Valley projects, and other federal projects in the Snake River basin), are not included in the specific geographic scope for the effects analysis in this EIS. Those projects are separate

from CRS operations and are carried out under different legal authorities.² Additionally, non-federal projects in the geographic scope were included in the modeling of hydrology and outflows of operations into the system, cumulative effects considerations, and considerations for how our operations may cause impacts to non-federal projects. However, these were not included in this CRS analysis to scope new measures of how they could operate differently. Non-federal projects are subject to different regulations, and requirements for operations are outlined in FERC licensing. In addition, three projects in the Canadian portion of the basin are partially coordinated with the CRS under the Columbia River Treaty (CRT). These other projects may be included in the cumulative effects analysis, as appropriate.

The temporal scope of the EIS is assumed to be 25 years from the signing of the records of decision (RODs) in order to have a similar period of analysis for comparison of effects across resources for all multiple objective alternatives. However, the socioeconomic analysis uses a 50-year period to capture the full array of changing costs and investments, and to evaluate the total costs, benefits, consequences and tradeoffs of the alternatives considered. The 50-year period of analysis provides a long-term perspective that enables the co-lead agencies to distinguish between short-term socioeconomic impacts that may occur during the implementation of alternatives and long-term effects that would occur after implementation is completed. The range of activities and effects evaluated in this EIS provide the co-lead agencies the ability to learn and adapt to changing conditions and new information over time. Adaptive management will continue to be an important approach to managing the CRS moving forward.

The October 19, 2018 *Presidential Memorandum on Promoting the Reliable Supply and Delivery of Water in the West* directed the co-lead agencies to shorten the timeline to prepare the EIS a year ahead of the original schedule adopted in the Opinion and Order. The schedule was primarily compressed between the completion of the Draft EIS and signing the records of decision. Publication of the Draft EIS represents the noteworthy contributions of numerous entities within the region working to analyze complicated issues.

² For example, the Willamette Basin System, operated by the Corps, is authorized in part by several of the same Flood Control Acts as some of the CRS projects. However, as outlined in these authorizations, the Willamette System was designed as a comprehensive plan of development specific to the Willamette Basin, which would be operated as a separate system from the CRS.

2 REGIONAL INPUT

The co-lead agencies (Corps, Reclamation, and Bonneville) share responsibility and legal authority for managing the CRS and worked together to develop the EIS. While developing the EIS, the co-lead agencies understood the importance of seeking broad input from the region. The co-lead agencies gathered input from the public; tribes; local, state, and federal governments; water resource users, including utility customers, commercial navigation and port entities, irrigation users, fishing and commercial fishers; and other public interest groups during the scoping process.

2.1 PUBLIC SCOPING

The co-lead agencies implemented a robust public scoping process to provide an opportunity for the public to help identify significant issues that should be evaluated in the EIS. The public scoping period extended from September 30, 2016, through February 7, 2017. Also during this time, the co-lead agencies conducted 16 public meetings and two webinars.

More than 400,000 comments were provided by members of the public, tribes, local and state governmental agencies, non-governmental organizations, and other stakeholders during the public scoping period. The scoping comments are summarized in the Public Scoping Report for the Columbia River System Operations Environmental Impact Statement, October 2017, which can be found at www.crsso.info.

2.2 COOPERATING AGENCIES

The co-lead agencies requested federal, state, and local agencies, and tribes to participate as cooperating agencies based on their jurisdiction by law, or their special expertise. More than 30 entities from across the region agreed to be cooperating agencies in this NEPA process. The current cooperating agencies are listed in Table ES-1. These cooperating agencies contributed to the EIS by providing information, participating on technical teams, and reviewing draft materials. The cooperating agencies retain the right to comment on the Draft and Final EISs during the public review and comment processes. As the federal agencies responsible for complying with NEPA, the co-lead agencies retained decision making authority over the content of the Draft and Final EIS, as well as the ultimate content of the Records of Decision. Due to this, the cooperating agencies may or may not agree with or fully support all of the content of these documents.

TABLE ES-1 - COOPERATING AGENCIES

FEDERAL AGENCIES
U.S. Environmental Protection Agency, Region 10
U.S. Coast Guard, 13th Coast Guard District
U.S. Department of the Interior, Bureau of Indian Affairs
STATE AGENCIES
<i>IDAHO</i>
Governor's Office of Species Conservation
Governor's Office of Energy and Mineral Resources
Department of Fish and Game
Department of Agriculture
Department of Lands
Department of Environmental Quality
Historic Preservation Office
Department of Parks and Recreation
Department of Water Resources
Idaho Department of Transportation
<i>OREGON</i>
Department of Fish and Wildlife
Department of Energy
Water Resources Department
Department of Agriculture
Department of Environmental Quality
<i>MONTANA</i>
Montana Office of the Governor
Montana Fish, Wildlife and Parks
<i>WASHINGTON</i>
Department of Ecology
Department of Fish and Wildlife
Department of Agriculture
COUNTY AGENCIES
Lake County, Montana
TRIBES
Confederated Salish and Kootenai Tribes of the Flathead Reservation
Confederated Tribes of the Colville Reservation
Confederated Tribes of Grand Ronde
Confederated Tribes of the Umatilla Indian Reservation
Confederated Tribes and Bands of the Yakama Nation
Cowlitz Indian Tribe
Kootenai Tribe of Idaho
Nez Perce Tribe
Burns Paiute Tribe
Fort McDermitt Paiute and Shoshone Tribes of the Fort McDermitt Indian Reservation
Shoshone-Paiute Tribes of the Duck Valley Reservation
Shoshone-Bannock Tribes of the Fort Hall Reservation
INTERTRIBAL ORGANIZATION
Upper Snake River Tribes Foundation on behalf of: Burns Paiute Tribe, Fort McDermitt Paiute-Shoshone Tribe, and Shoshone-Paiute Tribes of the Duck Valley Reservation

2.3 TRIBAL COORDINATION AND PERSPECTIVE

Since time immemorial, the Columbia River Basin has been inhabited by Native American peoples, who successfully subsisted on the abundant natural resources of the region. They built thriving communities that relied on the lands to sustain their way of life. Through treaties, executive orders, judicial decisions, and legislation, the tribes ceded most of their territory to the United States while retaining smaller portions of land for their reservations. Some tribes, through treaties, retained the right to hunt, fish, and gather in their usual and accustomed locations, including areas outside of their reservations. The potentially affected area of the CRS includes portions of tribal reservations, trust lands, and ceded lands of 19 federally recognized tribes. Reservoirs that are part of the CRS system inundate parts of three existing Indian reservations: the Colville and Spokane reservations, which are partially inundated by Lake Roosevelt; and the Nez Perce Reservation, which is partially inundated by Dworshak Reservoir. In some cases, the U.S. Government has entered into special agreements with these tribes regarding management of the reservoirs because of their location within reservations.

In its relations with tribes, the United States “has charged itself with moral obligations of the highest responsibility and trust” (Seminole Nation v. United States, 1942). These trust responsibilities derive from the historical relationship between the federal government and tribes as expressed in Treaties, Statutes, Executive Orders, and Federal Indian case law. The co-lead agencies are committed to a government-to-government relationship with the tribal governments and recognize the unique character of each tribe. Tribal governments have the primary authority and responsibility for many reservation affairs, and may be co-managers of natural resources within their respective ceded, treaty, or usual and accustomed areas. As a result, the co-lead agencies have sought to involve the tribes from the beginning of this process to gain their perspective on the planning and management activities of water resources, fish and wildlife resources and other natural resources in order to achieve mutually beneficial results. The co-lead agencies engaged with tribes during the development of the EIS by inviting them to be cooperating agencies, participating in formal government-to-government consultations, and engaging with them through other existing processes, such as the Columbia Basin Fish Accords. The co-lead agencies initiated government-to-government engagement with the tribes in Table ES-2.

TABLE ES-2 - ENGAGEMENT WITH FEDERALLY RECOGNIZED TRIBES

Burns Paiute Tribe
Coeur D'Alene Tribe of Indians
Confederated Salish and Kootenai Tribes of the Flathead Reservation
Confederated Tribes of the Chehalis Reservation
Confederated Tribes of Grand Ronde
Confederated Tribes of Siletz Indians of Oregon
Confederated Tribes of the Colville Reservation
Confederated Tribes of the Umatilla Indian Reservation
Confederated Tribes of Warm Springs Reservation
Confederated Tribes and Bands of the Yakama Nation
Cowlitz Indian Tribe
Fort McDermitt Paiute and Shoshone Tribes of the Fort McDermitt Indian Reservation
Kalispel Tribe of Indians
Kootenai Tribe of Idaho
Nez Perce Tribe
Shoalwater Bay Indian Tribe
Shoshone-Bannock Tribes of the Fort Hall Reservation
Shoshone-Paiute Tribes of the Duck Valley Reservation
Spokane Tribe of Indians

The tribes of the Columbia River basin represent diverse and distinct cultures, each different from the next. There is one theme, however, that the tribes all have in common: Their association with the natural resources of the region permeates every aspect of their cultures. This association results in a strong sense of stewardship for the land.

It is difficult to overstate the effects the CRS has had on tribal culture, way of life, and traditions. These effects have been explicit—as in the loss of celebrated fishing sites of regional importance such as Celilo and Kettle Falls; and implicit—including the loss of the innumerable and unquantifiable intra- and inter-tribal interactions that occurred at these locations, such as loci-focused ceremonies, traditions, languages and customs, dances and song. The losses of these areas have adversely affected how tribal communities define themselves, interact with each other, and live full spiritual lives; and in the process has undermined the processes through which living cultures are nourished, maintained, and perpetuated. The Confederated Tribes of the Colville Reservation (CTCR) stated:

“The dams’ effect on tribal culture is far-reaching. Youth in Keller are losing their traditional ways, the tainted river and loss of salmon damaged the CTCR way of life. Parents do not have the same opportunities to pass down their customs and traditions. Few know all the words to the different ceremonies anymore. No one person still remembers the names of all the fish. No one person remembers all the different names used for some species of fish, as they are called by different names as they move through the stages of their life ... when sweats are not conducted, the language is not spoken as often, legends are not told, family history is forgotten, ritual practices are lost, and the status and role of the elders are diminished.”

(See Appendix P)



Celilo Falls before and after construction of The Dalles Dam inundated the area, putting the falls underwater. For thousands of years, Celilo Falls served as a culturally significant fishing site for tribes.



Kettle Falls, before and after inundation. This area served as a major fishing location and focal point for tribal interactions, for millennia.

Many of the tribes have not only lost access to traditional places, but have lost access to the one thing that all these places on the river had in common, which bound them together- the salmon. The loss of these foundational aspects of tribal culture has manifested itself across tribal communities in very tangible ways. The tribes cope with levels of poverty, ill health, and unemployment at significantly higher proportional rates than any other ethnic group in the country, which in turn leads to significantly higher mortality rates in comparison to non-native communities.

Many of the facilities and much of the infrastructure that make up the CRS were put in place before legislation or enactment of executive orders that required the U.S. government to consider the effects these actions would have on the natural and cultural environment, and tribes. When the tribes did raise their concerns, they were often ignored or minimized:

“Present tribal suffering stems, in large part, from the cumulative stripping away of tribal Treaty-protected resources to create wealth for non-Indians of the region ... In earlier decades, bureaucrats working to convert the river to produce electricity, irrigate agriculture, carry commodities by river barge, and accommodate deposit of waste, asserted that ‘uncertainty regarding impacts on salmon could be managed’ as the conversion of the river moved forward.”

Tribal Circumstances and Impacts of the Lower Snake River Project on the Nez Perce, Yakama, Umatilla, Warm Springs and Shoshone Bannock Tribes, Meyer Resources, Inc., 1999.

Given the co-lead agencies’ trust responsibilities, and their relationships with tribes that have deepened over the years through collaboration in the Columbia River basin, it is important that tribal perspectives have a prominent place in this document, as well as in the management of the Columbia River System.

2.4 AREAS OF CONTROVERSY

Lower Snake River Dam Breach

The co-lead agencies received important feedback from tribal engagement, cooperating agencies, and through public scoping pertaining to breaching the four lower Snake River dams. Breaching the four lower Snake River dams has been a topic of public discourse for decades. This EIS provides an updated analysis of the many biological and sociological variables and the costs and benefits of retaining or breaching the lower Snake River dams. In combination with other sources of information and analysis available in the public domain, this document can help inform the regional conversation on this complex and often polarizing issue. New congressional authority and associated funding would be required to implement the dam breaching measures evaluated in the EIS. However, the measures are carried forward in the analysis to align with the District Court’s Opinion and Order, as well as in response to comments received during public scoping.

Fish Modeling

The EIS analysis uses two different approaches to estimate how the changes to CRS operations that were developed as part of this EIS will change the rates of adult salmon and steelhead returning to the Columbia and Snake Rivers. These models are the National Oceanic and Atmospheric Administration’s National Marine Fisheries Service (NMFS) Life Cycle Model (LCM), which includes the Comparative Passage (COMPASS) model; and the Comparative Survival Study (CSS) model, which has been collaboratively developed by federal and state agencies and tribal sovereigns. Both models were used to estimate the magnitude of effects on spring Chinook salmon and steelhead, and where applicable, the model results were considered and applied to other species.

The models apply different assumptions and predict survival using different combinations of environmental variables, which are described in more detail in Chapter 3, Section 5. In general, the CSS model predicts that for juvenile salmon and steelhead on their way downstream, additional increases in spring spill would reduce the number of powerhouses these young fish would swim through and increase the number of returning adults in subsequent years. The NMFS LCM does not predict the same magnitude of increases in adult returns due

to increases in spill levels beyond performance standard spill, but instead predicts that variables such as ocean conditions or the number of fish transported past the dams have a bigger impact on how many adult fish return.

One element, delayed mortality, stands out as particularly important in explaining the models' different predictions. Delayed or "latent" mortality is mortality attributed to the CRS, but not experienced by juvenile salmon and steelhead until after they pass through the freshwater CRS. The CSS model attributes the majority of recent declines in returning adult salmon and steelhead to decreased ocean survival (delayed mortality) directly associated with passage past the dams, but the CSS models also consider numerous other factors including ocean conditions. NMFS's LCM attributes the majority of recent declines to the arrival time of juveniles entering the ocean (e.g., fish that enter the ocean later in their migration run-timing tend to have lower survival), and deteriorating ocean conditions (decadal scale cycles in ocean productivity and warming water in the Northeast Pacific).

SPILL The co-lead agencies release (or spill) water through the federal dams in the spring and summer to help juvenile salmon and steelhead migrate safely to the ocean. With spill, fish go past the dams in water that flows through spillway openings, rather than traveling through turbines or bypass systems. Spillway weirs allow juvenile salmon and steelhead to pass a dam near the water surface, under lower accelerations and lower pressures, providing a more efficient and less stressful dam passage route (see Figure ES-3).

Given the ongoing regional and scientific debate over these two models, the co-lead agencies decided to use both models to evaluate the range of potential impacts in the CRSO EIS. This approach allows for a transparent examination of the results and assumptions embedded in the two primary analytical models and allows the co-lead agencies to share the assumptions and results of both models to inform decision making. The differences in the two models illustrate the complexity of predicting how anadromous fish would respond to different management actions and highlight the uncertainty that future research and management decisions will need to address.

Many of the scoping comments expressed a desire to have the EIS include the CSS model. The CSS model is an important part of the broader anadromous fish analysis in the CRSO EIS. Information generated by the CSS model was considered alongside other quantitative and qualitative lines of evidence and played an important role

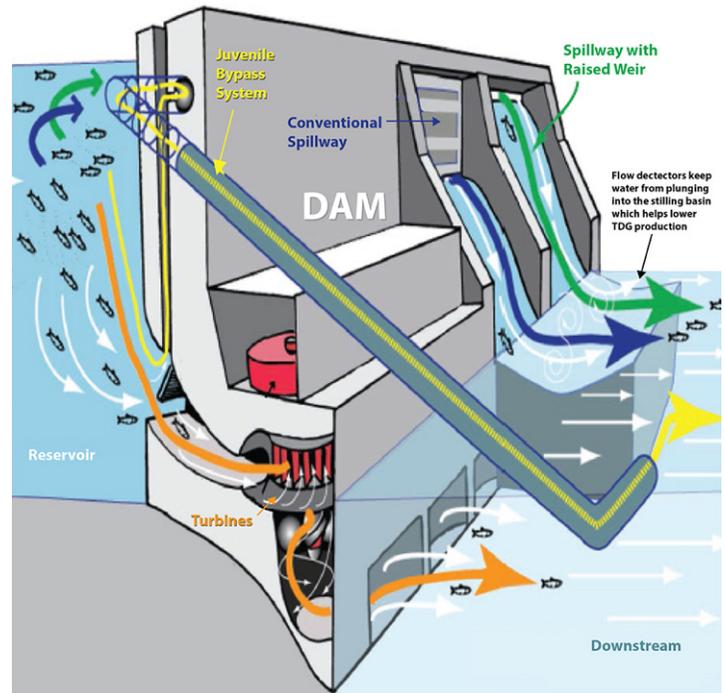


Figure ES-3: Juvenile fish passage routes on Columbia River System dams

in shaping the preferred alternative. Through the Flexible Spill Agreement signed in 2018 (*2019–2021 Spill Operation Agreement*), the co-lead agencies have also sought to develop more collaborative and constructive working relationships with the proponents of the CSS model. Through this EIS, the co-lead agencies are creating an additional opportunity to test the assumptions about the potential for significantly increased salmon survival embedded in the CSS model through the adaptive implementation of a flexible spill operation. This adaptive implementation framework includes careful monitoring and evaluation to ensure there are not adverse impacts on aquatic species or other unintended consequences.

Reintroduction

Reintroduction of salmon above Grand Coulee Dam and installation of fish passage at Grand Coulee and Chief Joseph Dams is an important and complex, large-scale concept. Its consideration, evaluation, and implementation should involve multiple tribal, federal, state, and other entities. A coordinated approach among water users, tribes, states, multiple federal agencies, and others would be necessary. To allow so many differing interests to coordinate on such a complex topic, which may include international considerations, a decision-making



framework and a series of regional workshops would be necessary just to approach the first step of defining reintroduction objectives. Given the incompatibility of such a wildlife management decision-making framework with an analysis of the operation of the CRS, it is not feasible to proceed with a detailed consideration of reintroduction in this EIS. Moreover, to meaningfully analyze reintroduction as a measure, the details of the proposal would need to be understood well enough to include in hydrologic, water quality, and fish models. That information is not currently available, and development of those details was not possible in the timeframe of this NEPA process. Nevertheless, the agencies and interested regional sovereigns are developing a framework to address critical information gaps.

Water Quality

The EIS analysis predicted water temperature and total dissolved gas (TDG) effects under various dam configurations and operations as specified in the EIS alternatives.

Temperature

There are elevated water temperatures in the Columbia River Basin due to regular climatic events and climate variability. There is also regional controversy over the role the federal projects may play in contributing to higher water temperatures. Due to this controversy, the co-lead agencies developed a model that could distinguish operational changes and water quality. While other water quality models for the Columbia River Basin exist (e.g. EPA's RBM-10 model), the co-lead agencies used CE-QUAL W2 due to its ability to simulate two-dimensional reservoir stratification (temperature differences at depth) that occurs in the CRS. This was particularly of interest for analyzing changes in Dworshak operations and the effects on water temperatures in the lower Snake River.

Elevated water temperature, above state water quality criteria of 20 °C (68 °F), within much of the Columbia and Snake Rivers is a concern. Water management operations at the projects are able to provide more beneficial water temperatures than have historically been observed. Nonetheless, water temperatures in many locations of the Columbia River Basin are too warm. Concern about water temperatures increasing in the future and contributing to decline of water quality was expressed by cooperating agencies. The co-lead agencies used regionally developed climate and hydrology projections from the River Management Joint Operating Committee (RMJOC-II) study to qualitatively assess potential effects to resources, including water temperatures. This approach was used due to the uncertainty of results in the rapidly evolving science of climate change impacts on water temperature and the role of the CRS.

TOTAL DISSOLVED GAS (TDG) is the amount of gas present in water. Supersaturation of gasses in water released at hydropower dams can cause gas bubble trauma that can lead to mortality if fish are exposed to harmful levels for extended periods of time. Similar risks occur for SCUBA divers when dissolved gasses (mainly nitrogen) come out of solution in bubbles when returning to the surface too quickly and can lead to decompression sickness through temporary injury, paralysis, or death, often referred to as “the bends.”

Columbia and Lower Snake River Temperature Total Maximum Daily Load (TMDL)

Over the past two years, EPA has updated the RBM-10 one-dimensional temperature model to assess Columbia and Snake River water temperatures and evaluate the effects from the federal and non-federal dams as part of the re-initiation of the TMDL project. Preliminary results have been shared across the region, which has led some stakeholders to compare the scenarios analyzed in the TMDL effort against CRSO EIS results. There are similarities in the RBM-10 and CE-QUAL W2/HEC-RAS modeling assessments of the lower Snake River, and both project teams have evaluated the similarities and differences in the models as part of an uncertainty assessment. At the same time, direct comparisons are not appropriate given the differences between scenarios and assumptions made between the two projects. These differences are described in Appendix D, Section 2.2.2.

2.5 ISSUES TO BE RESOLVED

Water Quality Standards

Implementation of the Juvenile Fish Passage Spill operations measure in the Preferred Alternative is constrained by the Washington and Oregon total dissolved gas (TDG) standards. The national TDG water quality standard is 110 percent saturation. Before 2019, the states of Oregon and Washington changed their TDG standards to allow for 120 percent TDG in the tailrace (below the dam) and 115 percent TDG in the forebay (above the dam) in Washington, and 120 percent TDG in the tailrace in Oregon, to enable juvenile fish passage on the lower Columbia and Snake rivers during the spring and summer. Beginning in April 2019, the Corps agreed to implement spill for juvenile fish passage as outlined in the 2019–2021 Spill Operation Agreement (Agreement). The second year of flexible spill operations is on track to begin in April 2020. To facilitate higher juvenile fish passage spill in the spring, Oregon and Washington agreed to consider changing their TDG water quality standard. The Agreement called for spring spill up to 120 percent in 2019, a level allowed by Oregon but above the state of Washington’s standard at that time. In 2019, Washington temporarily changed their TDG standard to 120 percent TDG in the tailrace and removed the 115 percent TDG forebay limit for a one year duration, allowing for the successful implementation of the first year of the Agreement.

Implementation of the second year of the Agreement requires Oregon and Washington to increase the TDG standard up to 125 percent TDG to allow the Corps to provide 16 hours per day of 125 percent TDG spill in the spring. In Oregon, the Environmental Quality Commission approved a spring TDG standard of 125 percent at its January 2020 hearing. The Oregon modification went into

effect on February 11, 2020, once it was signed by the Oregon Department of Environmental Quality Director. In Washington, a permanent rule change to facilitate the 125 percent TDG spring spill for juvenile fish passage as detailed in the Flex Spill Agreement requires approval from the U.S. Environmental Protection Agency. The Washington rule is currently awaiting approval by the U.S. Environmental Protection Agency as of February 14, 2020.

3 DEVELOPMENT AND COMPARISON OF ALTERNATIVES

Alternatives were developed to meet the Purpose and Need Statement and eight study objectives developed for the EIS, and to review and update the operations and management of the 14 CRS projects and the associated analysis of impacts since the last system analysis conducted in the 1990s (System Operation Review EIS, 1997). The three co-lead agencies convened technical subject matter experts from their agencies, as well as the cooperating agencies, to support developing the measures and alternatives.

The EIS contains a “purpose and need” statement to briefly specify the underlying purpose and need to which the agency is responding in proposing the alternatives including the proposed action. This discussion, typically one or two paragraphs long, is important for general context and understanding as well as to provide the framework in which reasonable alternatives to the proposed action will be identified.



PURPOSE AND NEED FOR ACTION

The U.S. Army Corps of Engineers (Corps), the U.S. Bureau of Reclamation (Reclamation), and the Bonneville Power Administration (BPA) are co-leads in preparing this Environmental Impact Statement (EIS) under NEPA on the coordinated water management functions for the operation, maintenance, and configuration (“management”) of the 14 federal dam and reservoir projects that comprise the Columbia River System (System). The U.S. Congress authorized the Corps and Reclamation to construct, operate and maintain the System projects to meet multiple specified purposes, including flood control (also referred to as flood risk management), navigation, hydropower production, irrigation, fish and wildlife conservation, recreation, municipal and industrial water supply, and water quality, though not every project is authorized for every one of these purposes. BPA is authorized to market and transmit the power generated by these coordinated System operations.

The on-going action that requires evaluation under NEPA is the long-term coordinated management of the System projects for the multiple purposes identified above. An underlying need to which the co-lead agencies are responding is reviewing and updating the management of the System, including evaluating measures to avoid, offset, or minimize impacts to resources affected by the management of the System in the context of new information and changed conditions in the Columbia River basin. In addition, the co-lead agencies are responding to the Opinion and Order issued by the U.S. District Court for the District of Oregon³ such that this EIS will evaluate how to insure that the prospective management of the System is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of designated critical habitat, including evaluating mitigation measures to address impacts to listed species. The EIS will evaluate actions within the co-lead agencies’ current authorities, as well as certain actions that are not within the co-lead agencies’ authorities, based on the District Court’s observations about alternatives that could be considered and comments received during the scoping process. The EIS will also allow the co-lead agencies and the region to evaluate the costs, benefits and tradeoffs of various alternatives as part of reviewing and updating the management of the System.

The co-lead agencies will use the information garnered through this process to inform future decisions and allow for a flexible approach to meeting multiple responsibilities including resource, legal, and institutional purposes.

Resource Purposes

- Provide for a reliable level of flood risk by managing the System to afford safeguards for public safety, infrastructure, and property
- Provide an adequate, efficient, economical and reliable power supply that supports the integrated Columbia River Power system
- Provide water supply for irrigation, municipal, and industrial uses
- Provide for waterway transportation capability
- Provide for the conservation of fish and wildlife resources, including threatened, endangered, and sensitive species throughout the environment affected by System operations
- Consider and plan for climate change impacts on resources and on the management of the System
- Provide opportunities for recreation at System lakes and reservoirs
- Protect and preserve cultural resources

Legal and Institutional Purposes

- Act within the authorities granted to the agencies under existing statutes; and when applicable, identify where new statutory authority may be needed
- Comply with environmental laws and regulations and all other applicable federal statutory and regulatory requirements, including those specifically addressing the System such as requirements under the Northwest Power Act “to adequately protect, mitigate, and enhance fish and wildlife, including related spawning grounds and habitat, affected by such projects or facilities in a manner that provides equitable treatment for such fish and wildlife with the other purposes for which such system and facilities are managed and operated.” 16 U.S.C.A. § 839b(11)(A)
- Protect Native American treaty and reserved rights and trust obligations for natural and cultural resources throughout the environment affected by System operations
- Continue to utilize a collaborative Regional Forum framework to allow for flexibility and adaptive management of the System
- Ensure project Water Control Manuals adequately reflect the management of the System

³ NWF v. NMFS, 184 F. Supp. 3d 861 (D. Or. 2016).



Terminology

Objectives are what the federal agencies are trying to accomplish (the “why”). They are statements of the desired outcome of the EIS, as identified by the federal agencies and from scoping comments. An example of an objective is to improve ESA-listed anadromous salmonid adult fish migration within the project area.

A **measure** is the action the agencies would take to achieve an objective (the “how”). It describes an action, usually in a precise location, that meets an objective, in whole or in part. Using the objective mentioned above, a measure could be to provide structural enhancements for fish passage, such as improving fish ladders.

An **alternative** is a combination of one or more measures that, together, would address one or more of the objectives. In this EIS, the co-lead agencies designed the action alternatives to address several objectives, and are therefore calling them Multiple Objective Alternatives (MOs).

The co-lead agencies, working with the cooperating agencies, developed eight objectives for operating the system, using the Purpose and Need Statement and input from tribal coordination, cooperating agencies, and the public. Several of the objectives relate to key tribal resources and treaty reserved rights—an important consideration for decision makers.

COLUMBIA RIVER SYSTEM OPERATIONS OBJECTIVES

- Improve ESA-listed anadromous salmonid juvenile fish rearing, passage, and survival within the CRS through actions including but not limited to project configuration, flow management, spill operations, and water quality management. (**Improve Juvenile Salmon**)
- Improve ESA-listed anadromous salmonid adult fish migration within the CRS through actions including but not limited to project configuration, flow management, spill operations, and water quality management. (**Improve Adult Salmon**)
- Improve ESA-listed resident fish survival and spawning success at CRS projects through actions including but not limited to project configuration, flow management, improving connectivity, project operations, and water quality management. (**Improve Resident Fish**)
- Provide an adequate, efficient, economical, and reliable power supply that supports the integrated FCRPS. (**Provide a Reliable and Economic Power Supply**)
- Minimize greenhouse gas (GHG) emissions from power production in the Pacific Northwest by generating carbon-free power through a combination of hydropower and integration of other renewable energy sources. (**Minimize GHG Emissions**)
- Maximize operating flexibility by implementing updated, adaptable water management strategies to be responsive to changing conditions, including hydrology, climate, and the environment. (**Maximize Adaptable Water Management**)
- Meet existing contractual water supply obligations and provide for authorized additional regional water supply. (**Provide Water Supply**)
- Improve conditions for lamprey within the CRS through actions potentially including but not limited to project configurations, flow management, spill operations, and water quality management. (**Improve Lamprey**)

Using the Purpose and Need Statement and the objectives, the co-lead and cooperating agencies developed suites of measures and finally, combined measures into a reasonable range of alternatives representing alternatives for long-term system operations. The alternatives consist of the No Action Alternative and four Multiple Objective Alternatives (MOs). The No Action Alternative describes the “status quo” when the Notice of Intent to Prepare the EIS was issued (September 2016) and provides a baseline to which the other alternatives are compared. The MOs include a range of spill levels for juvenile fish passage, varying levels of hydropower production, and differing actions to support the needs of Endangered Species Act (ESA)-listed salmonids and resident fish. The MOs include proposed means to support the future supply of water for irrigation and municipal and industrial purposes. The MOs also include increased water management flexibility that will allow water managers to react to unanticipated changes in river flow, climate variability, and increase the likelihood of achieving refill of storage reservoirs. After evaluating the potential effects of the alternatives on the environmental, social, and economic resources, the ability to meet objectives and fulfil the Purpose and Need Statement, and effects to flood risk management, water supply, hydropower generation, navigation, fish and wildlife conservation, cultural resources, recreation and other purposes, the

co-lead agencies developed a Preferred Alternative designed to achieve a reasonable balance of competing river resource needs and co-lead agency mission requirements. Detailed descriptions of the alternatives are presented in Chapter 2 and Chapter 7 of the EIS.

Definition of Effects

- **No Effect:** The action would result in no effect as compared to the No Action Alternative.
- **Negligible Effect:** The effect would not change the resource character in a perceptible way. Negligible is defined as of such little consequences as to not require additional consideration or mitigation.
- **Minor Effect:** The effect to the resource would be perceptible; however, it may result in a small overall change in resource character.
- **Moderate Effect:** The effect to the resource would be perceptible and may result in an overall change in resource character.
- **Major Effect:** The effect to the resource would likely result in a large overall change in resource character.

4 NO ACTION ALTERNATIVE

Overview

The No Action Alternative includes all operations, maintenance, fish and wildlife programs, and mitigation efforts in effect when the EIS was initiated in September 2016. Juvenile fish passage spill operations at the four lower Columbia River and four lower Snake River dams would follow the 2016 Fish Operations Plan developed by the Corps. This plan used performance standard spill developed under previous Endangered Species Act biological opinions.

PERFORMANCE STANDARD SPILL Spill levels from the 2008-2010 Federal Columbia River Power System Biological Opinion that were tailored to meet the BiOp standards of 96 percent average per-dam survival for spring migrants and 93 percent for summer migrating fish (see Figure ES-4).

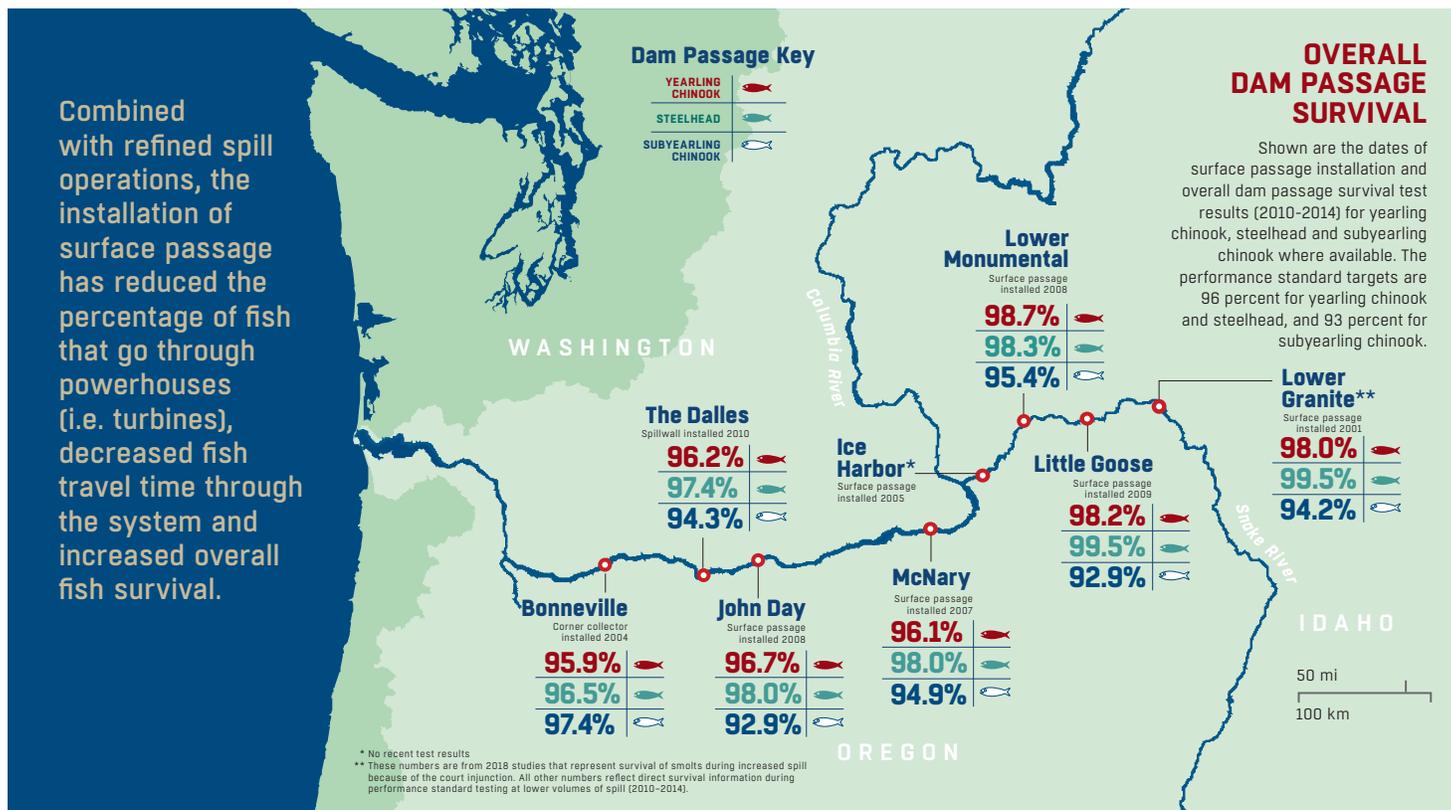


Figure ES-4: Overall Dam Passage Survival

Under the No Action Alternative, the co-lead agencies would also implement structural measures that were already budgeted for and scheduled as of September 2016. The majority of these structural measures are dam modifications to improve conditions for fish listed as threatened and endangered under the ESA. For example, installation of improved fish passage turbines planned for Ice Harbor and McNary Dams would occur as planned. Other ongoing habitat and mitigation programs would continue as planned when the EIS process started. A detailed description of measures included in the No Action Alternative is included in Chapter 2 of the EIS.

Does the No Action Alternative address the EIS Objectives?

The No Action Alternative met the Purpose and Need of the EIS, but it did not meet all of the objectives developed for the EIS.

The No Action Alternative did not provide adequate improvements to meet the **Improve Juvenile Salmon, Improve Adult Salmon, Improve Resident Fish, and Improve Lamprey** objectives. As outlined in this alternative, improvements to fish survival and abundance would be achieved through construction of additional

fish passage structural measures at the lower Columbia River and lower Snake River projects that were completed or planned as of 2016. The No Action Alternative also considered previous efforts in offsite improvements from actions such as habitat restoration and hatchery programs and assumed those programs would continue. Additional measures that could be adopted to improve fish survival to meet these objectives were considered but only resulted in small, incremental improvements and did not meet the EIS objectives for larger, more substantial improvements for fish.

The No Action Alternative generally satisfied the **Provide a Reliable and Economic Power Supply** objective as it resulted in no additional upward power rate pressure or potential regional reliability issues. However, it only partially meets the objectives to **Provide Water Supply** and **Maximize Adaptable Water Management** because it would not provide the additional authorized regional water supply. Further, the No Action Alternative does not include a measure to reflect operational restrictions that may be the result from important maintenance activities at Grand Coulee in the near-term. (The multi-objective alternatives all include a measure for additional maintenance at Grand Coulee to assess the impact on operations.)

Additional Effects of the No Action Alternative

It is not expected that there would be any new moderate or major impacts to environmental, economic, or social resources as a result of continuing the No Action Alternative. Information gained from evaluating this alternative was used to inform the development of the Preferred Alternative that seeks to balance managing the system for all authorized purposes while providing additional benefits to fish.



Lamprey

5 MULTIPLE OBJECTIVE ALTERNATIVE 1 (MO1)

Overview of the Alternative

MO1 was developed to meet all objectives while prioritizing benefits to lamprey and ESA-listed fish species relative to the No Action Alternative. MO1 differs from the other alternatives by carrying out a juvenile fish passage spill operation referred to as a block spill design. The block spill design alternates between two operations: a base operation that provides spill over the spillways using tailored spill levels at each project based on historical survival tests; and a fixed higher spill target at all projects. During the high spill block that uses the same target at all projects, the operators would release water through the spillways up to a target of no more than 120 percent total dissolved gas (TDG) in the tailrace (below the dam) of projects and 115 percent TDG in the forebay (above the dam) of those projects. In addition, MO1 sets the duration of juvenile fish passage spill to end based on a fish count trigger, rather than a predetermined date. MO1 proposes to initiate transport operations (barging) for juvenile fish approximately two weeks earlier than under the No Action Alternative. MO1 also includes two predator disruption measures, fluctuating elevations in the John Day pool, to limit both predator fish and birds from reducing ESA-listed juvenile fish populations during the spring migration.

MO1 also incorporated measures to increase hydropower generation flexibility in the lower basin projects and alters the use of stored water at Dworshak for downstream water temperature control in the summer. MO1 includes a number of measures similar to the other action alternatives, including increased water management flexibility and water supply, and using local forecasts in whole-basin planning. Detailed descriptions of the measures that are included in MO1 are described in Chapter 2 of the EIS.

Does MO1 Address EIS Objectives?

MO1 is predicted to provide benefits, although minor, as measured in both models, to most ESA-listed anadromous salmonid fish species, both juvenile and adult. MO1 also includes structural modifications to infrastructure at the dams to benefit passage of adult salmon, steelhead, and Pacific lamprey. MO1 is thus expected to meet the objectives to **Improve Juvenile Salmon, Improve Adult Salmon, Improve Resident Fish, and Improve Lamprey**. The expected degree of these benefits varied depending on specific species, location, and the outputs from the two separate models (Fish Passage Center's CSS and NMFS's LCM). The CSS model generally predicted minor improvements for the species modeled, while the LCM generally predicted

negligible decreases to minor improvements to anadromous species that were modeled. Overall, the expected degree of improvements to ESA-listed salmonids was predicted to be less than was desired by the co-lead agencies. MO1 results in both beneficial and adverse effects on resident fish. Cumulatively these effects are expected to be negligible, minor, or in some cases localized moderately adverse, as compared to the No Action Alternative. MO1 proposes mitigation for resident fish, as appropriate.

MO1 marginally could meet the **Provide a Reliable and Economic Power Supply** objective. MO1 reduces hydropower generation by approximately 130 average megawatts (aMW) a year under average water conditions, and 300 aMW under low water conditions. A number of measures contributed to the decrease in hydropower production, including spring spill at higher levels than in the No Action Alternative and additional irrigation withdrawals. Hydropower reliability was impacted by these two measures and several others, including a measure to alter the timing of flows from Dworshak in late summer (a measure that was intended to but did not result in the improvement in lower Snake River water temperatures). An earlier end to summer spill partially moderated the power impact on generation and reliability. The alternative has roughly twice the risk of power shortages (blackouts or emergency conditions) compared to the No Action Alternative and more than twice the risk compared to the Northwest Power and Conservation Council's target for regional reliability.

To maintain regional reliability at the same level as the No Action Alternative, additional resources would have to be built, at a cost of between \$34 million a year (for fossil-fuel based replacement resources) and \$161 million a year (for variable renewable resources like wind and solar). For Bonneville's wholesale power rates, MO1 places upward base rate pressure of 4.5 percent to 8.6 percent over the No Action Alternative, depending upon the type of resources acquired and the source of funding for those resources. (Compared to Bonneville financing new resources, if public utilities acquire the new generation then the impact to Bonneville's wholesale power rate is generally lower, though the impact to retail customers of the public utilities is similar.) The base rate analysis only considered the costs of resources necessary to return regional reliability to the levels of the No Action Alternative and an estimate for the related structural plus fish and wildlife cost impacts. As such, it did not address other potential cost uncertainties under MO1, such as the cost of integrating new renewable resources, potentially shorter financing timeframes, and the costs and availability of firm demand response. These effects (and others) are captured in a rate sensitivity analysis performed on Bonneville's wholesale

power rate. As discussed in section 3.7.3, including the rate sensitivities, MO1 could increase the wholesale rate pressure on Bonneville's power rate by up to 14.4 percent. Section 3.7.3.3 of the EIS discusses the hydropower impacts including retail rate impacts of MO1 in more detail.

Regarding the objective to **Minimize GHG Emissions**, the reduction in hydropower generation under MO1 could slightly increase GHG emissions if there is an offsetting increase in generation from fossil fuel resources. However, if the reduction in hydropower is replaced with zero-carbon resources, GHG emissions from power generation may be slightly reduced relative to the No Action Alternative.

MO1 also met the objectives to **Maximize Adaptable Water Management** and **Provide Water Supply**.

Additional Effects of MO1

Under MO1, there would likely be moderate adverse effects to water quality in the lower Snake River and resident fish in the upper Columbia River basin. This is due to the modified Dworshak flow regime that would result in a moderate increase in water temperatures to above Washington State water quality standards (68 °F) downstream. The Dworshak reservoir could be at a lower elevation in June and July (and at a higher elevation in August) compared to the No Action Alternative, resulting a moderate increase in water temperatures in the lower Snake River during August.

For cultural resources, there could be additional major effects at Hungry Horse, Lake Roosevelt, and Dworshak reservoirs due to increasing the frequency of elevation changes. Increased frequency in elevation changes typically correlates with increased erosion in reservoirs and exposure, which can displace or destroy cultural resources. An increased number of high draft events at Dworshak could also lead to major adverse effects. The Dworshak reservoir would also be at a lower elevation in June and July compared to the No Action Alternative. Changes in reservoir elevations could result in effects to the Kettle Falls sacred site due to increases in the potential for looting.

There would likely be no major or moderate economic effects above and beyond the potential electricity rate impacts described above. The co-lead agencies used the analysis in MO1 to inform the development of the Preferred Alternative that seeks to balance managing the system for all purposes while providing additional benefits for fish and other study objectives.

6 MULTIPLE OBJECTIVE ALTERNATIVE 2 (MO2)

Overview of the Alternative

MO2 was developed to prioritize hydropower production and flexibility and reduce regional GHG emissions, benefit lamprey and ESA-listed salmon through structural measures, and benefit ESA-listed salmon through increased transport, while meeting the other study objectives and avoiding or minimizing adverse impacts to other resources. It would slightly relax the No Action Alternative's restrictions on operating ranges and generation ramping rates to evaluate the potential to increase hydropower production efficiency. This would also increase operators' flexibility to respond to changes in power demand and changes in generation of other renewable resources. The measures within MO2 would increase the ability to meet power demand with hydropower production during the most valuable periods (e.g., winter, summer, and daily peak demands). The upper basin storage projects would be allowed to draft slightly deeper, allowing more hydropower generation in the winter and less during the spring.

MO2 evaluates an expanded juvenile fish transportation operation season. This alternative proposes to transport all collected ESA-listed juvenile fish for release downstream of the Bonneville project, by barge or truck. It would also reduce juvenile fish passage spill operations to a target of up to 110 percent TDG, providing the lowest end of the range of juvenile fish passage spill operations evaluated in this EIS.

Structural measures in MO2 are aimed at producing benefits for ESA-listed fish and lamprey. These measures are similar to other alternatives and include making improvements to adult fish ladders, upgrading spillway weirs, adding powerhouse surface passage, and turbine upgrades at John Day.

Chapter 2 of the EIS provides a detailed description of the measures that are included in MO2.

Does MO2 Address the EIS Objectives?

In general, MO2 is less effective than the other MOs at meeting the **Improve Juvenile Salmon**, **Improve Adult Salmon**, and **Improve Resident Fish** objectives. However, the expected effects of MO2 on anadromous species varied depending on the species, location, and by the outputs from the two distinct models (CSS and LCM) used in this analysis.

Based on the NMFS LCM, MO2 was less effective at meeting the **Improve Juvenile Salmon** and **Improve Adult Salmon** objectives for upper Columbia River Chinook salmon and steelhead. The LCM predicts

SMOLT-TO-ADULT RETURN RATIO (SAR)

is the rate at which a group of fish survive from their smolt life stage (typically measured at the first dam in their migration such as Lower Granite Dam but can also be from their fresh-water tributary or hatchery of origin) to an ending point as an adult (usually back to a dam in the CRS such as Bonneville—the first dam adults encounter—or Lower Granite Dam which is the last dam that Snake River fish can pass).

a 1 to 4 percent relative reduction in in-river survival as well as a 1 percent relative reduction in the smolt-to-adult (SAR) estimate for upper Columbia River spring Chinook. The CSS models were not available for upper Columbia fish.

For Snake River spring Chinook and steelhead, the CSS model generally predicted adverse effects, a 30 percent relative reduction in SARs for spring Chinook, while the LCM generally predicted negligible to minor beneficial effects relative to anadromous species that were modeled in the No Action Alternative. The minor beneficial effects result from increases in fish transportation rates.

MO2 also includes structural modifications at the dams to benefit passage of adult salmon, steelhead, and Pacific lamprey. While structural modifications may provide some benefit to lamprey passage, the overall shift to more powerhouse flow and passage makes this alternative less effective at meeting the **Improve Lamprey** objective than the other MOs. Greater numbers of lamprey would likely pass near fish bypass screens and would be at a higher risk of injury or impingement compared to the No Action Alternative.

MO2 is expected to have a major adverse effect to resident fish in the upper Columbia basin due to changes in reservoir operations and elevation for hydropower water storage. MO2 proposes mitigation, as appropriate, to minimize adverse effects to negligible and to meet the **Improve Resident Fish** objectives.

Compared to the other MOs, MO2 resulted in the greatest benefits to the **Provide a Reliable and Economic Power Supply** and **Minimize GHG Emissions** objectives. The additional hydropower generation produced by MO2 would increase hydropower generation by 450 average megawatts (averaged over 80 historical water years). In the most adverse water year studied, generation would also increase, leading to an additional 380 average megawatts that Bonneville would be able to offer its preference customers (primarily public power utilities) under long-term, firm power-sales contracts. Three measures had the largest impact on these increases: limiting fish passage spill to 110 percent TDG, ending fish passage spill in August, and allowing storage projects to draft slightly deeper for hydropower.



With the increase in hydropower generation, MO2 would improve regional reliability compared to the No Action Alternative. Regional generating resource costs would also likely decrease, as additional hydropower generated under MO2 could partially eliminate the need to build additional resources for reliability purposes as the region retires coal plants. For Bonneville's wholesale power rate, MO2 would cause downward rate pressure by approximately 0.8 percent. As noted above, the base rate analysis includes the costs of resources necessary to return regional reliability to the levels of the No Action Alternative as well as related structural measures and fish and wildlife improvement costs. Rate impacts resulting from any other effects of MO2 were addressed in a rate sensitivity analysis. The high end of the rate sensitivity analysis identified rate pressure of up to 1.9 percent due to a potential increase in Fish and Wildlife Program spending of up to \$53 million a year. This increased funding would be used to mitigate the possible impacts of MO2 on fish and wildlife. The low end of the sensitivity analysis found that by excluding one structural measure for fish collection at the McNary project (fish collection there could be accomplished more cost-effectively through other means), power rates could experience downward rate pressure of about 4 percent compared to the No Action Alternative. Section 3.7.3.4 of the EIS discusses the hydropower impacts of MO2 in more detail.

The increase in hydropower generation under MO2 would displace fossil fuel generation (such as natural gas or coal-based generation) in the current resource mix, thus reducing electricity sector GHG emissions. Section 3.8.3.4 discusses the GHG emissions impacts in further detail. Furthermore, as the region seeks to rely less on fossil fuel resources, the additional hydropower capability from MO2 would also support the integration of more variable renewable resources, which rely on balancing services provided by flexible generating plants. Currently, hydropower and natural gas power plants provide the

majority of integration services for variable renewable resources. As the Northwest increases its reliance on new variable renewable resources, increasing hydropower production and flexibility in MO2 would help reduce the reliance on natural-gas generation. In addition to hydropower flexibility, technical advances in storage and other options may become viable to help integrate the variable renewable generation.

MO2 met the objectives for **Maximize Adaptable Water Management**. However, MO2 only partially met the **Provide Water Supply** objective. Specifically, MO2 met the existing contractual water supply obligations, but did not provide for authorized additional regional water supply. MO2 did not include the additional water supply because the co-lead agencies wanted to analyze a range of alternatives, including one without the additional water supply. Because water withdrawal for irrigation decreases hydropower production, exclusion of the water supply measure from MO2 was consistent with the broader theme of the measure.

Additional Effects of MO2

MO2 would have major beneficial economic effects to power if the measure for powerhouse surface passage with fish collection at the McNary project is excluded. The McNary project was not carried forward into the preferred alternative because the final estimated cost for the structure was over \$850 million yet only provided negligible biological benefits for salmon and steelhead. Those same biological benefits could be obtained at much lower costs using alternate measures.

There would be ongoing major adverse social effects to cultural resources and tribal interests at Lake Roosevelt and Dworshak Dam due to changes in reservoir elevations. There could also be major adverse effects to the Kettle Falls sacred site if changed reservoir elevations results in looting.



Information gained from the analysis of this alternative was used by the co-lead agencies to inform and improve the development of the Preferred Alternative that seeks to balance managing the system for all purposes while providing additional benefits for fish and other study objectives.

7 MULTIPLE OBJECTIVE ALTERNATIVE 3 (MO3)

Overview of the Alternative

MO3 was developed to evaluate the effects of breaching the four lower Snake River dams (Lower Granite, Little Goose, Lower Monumental, and Ice Harbor) along with actions for water management flexibility, limited increases in hydropower generation in certain areas of the basin at specific times, and altered water supply (small increases in volume and small change in timing). In addition to breaching these four projects, MO3 differs from the other alternatives by carrying out a spring juvenile fish passage spill operation that sets flow through the spillways up to a target of 120 percent TDG in the tailrace of the four lower Columbia River projects (McNary, John Day, The Dalles, and Bonneville). This alternative also proposes an earlier end to summer juvenile fish passage spill operations than the No Action Alternative. Instead, reduced spill levels would allow for increased hydropower production during August when low numbers of juvenile fish are typically present.

Structural measures in this alternative include breaching the four lower Snake River dams by removing the earthen embankment at each dam, resulting in a controlled drawdown.

Operational measures in MO3 are intended to improve juvenile and adult fish travel times, improve conditions for resident fish in the upper basin, increase hydropower generation flexibility in certain portions of the basin in order to begin to offset the lost generation from dam

breaching, provide more flexibility to water managers, and provide additional water supply. A detailed description of measures that are included in MO3 is provided in Chapter 2 of the EIS.

MO3 would only partially meet the Purpose and Need and some of the objectives for the EIS to various levels. Additionally, breaching the dams would not allow the co-lead agencies to operate and maintain the dams for their congressionally authorized purposes of navigation, hydropower, envisioned recreational benefits, and water supply for irrigation purposes. It also has the highest adverse impacts to other resources, especially social and economic effects. However, it predicts the highest benefits for several of the ESA-listed juvenile and adult salmon and provides additional riverine type recreational opportunities. It also returns access and opportunities to some of the traditional cultural resources and properties for tribal purposes.

Many tribes have commented that the economic impacts of implementing this alternative must be viewed in the context of the ongoing and disproportionate social, cultural, and socioeconomic effects to Indian tribes and tribal communities from present and cumulative effects of the current System. They note that these effects, along with impairment of Indian treaty-reserved rights, would be reduced under MO3.

MO3 was carried forward in the analysis to align with the District of Oregon's Opinion and Order, and in response to comments received during public scoping that requested this alternative be evaluated. Breaching the four lower Snake River dams also received substantial interest by several tribes who believe that this alternative is the best option to offset some of the substantial adverse impacts of the CRS. New congressional authority and funding would be required to implement the dam breaching measures in MO3.

Does MO3 Address the EIS Objectives?

MO3 would meet the objectives of **Improve Juvenile Salmon, Improve Adult Salmon, Improve Resident Fish, and Improve Lamprey.**

Model estimates for MO3 showed the highest predicted potential smolt-to-adult returns (SARs) for Snake River salmon and steelhead among the alternatives. Quantitative model results from both the CSS and LCM were available and indicated a range of potential long-term benefits largely due to how the models address latent mortality, the delayed death of salmon following passage through the CRS. The CSS model predicts that outmigrants from Lower Granite that return to Lower Granite (SARs) would increase by 170 percent relative to the No Action Alternative. The NMFS LCM predicted that SARs from Lower Granite to Bonneville would improve by 14 percent relative to the No Action Alternative. The LCM also assessed SARs under several levels of assumed latent mortality reductions (10, 25, and 50 percent). For these scenarios, the LCM also predicted that if latent mortality were further reduced, additional improvement in SARs would be expected. These results highlight the importance of how latent mortality is considered in the analysis and the strong effect it has on the predicted results. The degree to which latent mortality is affecting salmon and steelhead is one of the critical uncertainties in this EIS analysis. The CSS model also predicted similar improvements for Snake River steelhead to those described for Snake River Chinook. The LCM was not available for use on Snake River steelhead in this EIS.

Results from the NMFS LCM indicate that the level of improvement to upper Columbia Chinook SARs is dependent on the level to which latent mortality affects this stock. If increased spill in the lower Columbia River does not improve ocean survival, (i.e. reduce latent mortality) the LCM model predicts negligible to minor improvements in SARs (one percent relative increase). Larger reductions in latent mortality would result in larger predicted increases in both SARs and abundance for Upper Columbia stocks (4 to 147 percent relative increase in abundance).

These changes are primarily due to increased spill levels (120 percent TDG) in the lower Columbia River. The CSS model was not available for use on upper Columbia River species in this EIS.

MO3 is also expected to provide a long-term benefit to species that spawn or rear in the mainstem Snake River habitats, such as fall Chinook. By breaching the four lower Snake River dams, major short-term adverse impacts to fish, riparian and wetland habitat in the Snake River and confluence of the Columbia River would occur. These impacts would be associated with the initial breaching

of the dams, drawing down the reservoirs, and the time required for the river to move sediment and stabilize. These effects are expected to diminish over time. MO3 also includes structural modifications to infrastructure at the dams to benefit passage of adult salmon, steelhead, and Pacific lamprey.

Breaching of the lower Snake River projects would have major long-term beneficial effects to resident fish in the Snake River due to improved rearing and migration conditions. During the breaching, major short-term adverse effects would occur as described above for anadromous fish. In general, effects outside of the Snake River would be similar to MO1.

MO3 would not meet the objective to **Provide a Reliable and Economic Power Supply.** Under MO3, hydropower generation would decrease by 1,100 aMW under average water conditions, and 730 aMW under low water conditions compared to the No Action Alternative.

The lower Snake River projects provide more than 2,000 MW of sustained peaking capabilities during the winter, and a quarter of the federal power system's current reserves holding capability. The dams play an important role in maintaining reliability, and their flexibility and dispatchability are valuable components of the CRS. MO3 would more than double the region's risk of power shortages compared to the No Action Alternative—from 6.6 percent risk of a year having power shortages in the No Action Alternative (roughly one year in 15) to 13.9 percent in MO3 (or nearly one year in 7) for the base case (current operation of coal-fired power plants). The loss of power generation at the lower Snake River dams accounts for most of this decrease. Increases in spring spill for juvenile fish passage at the lower Columbia River projects and increases in water withdrawal for irrigation included in the alternative further reduce hydropower generation while the end of summer spill in August increases generation in that month.

Significant quantities of replacement resources would have to be built to maintain regional power reliability at the No Action Alternative levels. As referenced above, without such a resource build-out, the region would face the likelihood of a loss of load event, e.g. a power blackout, nearly one in every seven years in MO3 for the base case including the current fleet of regional coal plants. Two potential resource replacement portfolios were developed for this approach. The first was a conventional least-cost portfolio. Based on co-lead agency analysis (including a review of other publicly available information), the conventional, least-cost resource replacement would include 1,120 megawatts (MW) of combined cycle natural gas turbines at an overall cost of about \$200 million a year. For Bonneville's wholesale power rate, MO3's conventional least-cost resource

portfolio, along with related structural and fish and wildlife spending adjustments, places upward rate pressure of between 8.2 percent and 9.6 percent over the No Action Alternative, depending upon the source of funding for those resources. The second resource portfolio was a zero-carbon replacement portfolio. Understanding the development of the zero-carbon portfolio requires some additional context about the rapidly evolving energy policy environment in the western U.S. as well as how renewable energy resources interact with the broader power system.

Several states in the western U.S. have passed, or are likely to pass, legislation directed at decarbonizing the electric grid. California began implementing an economy-wide cap-and-trade program in 2013. In 2018, the California legislature passed a law seeking to achieve 100 percent carbon-free electricity by 2045 (Senate Bill 100). Washington enacted the Clean Energy Transformation Act (CETA) in 2019, requiring that Washington utilities eliminate coal costs from their retail rates by 2025. CETA also directs Washington retail utilities to serve loads with 100 percent carbon-neutral power by 2030, and 100 percent carbon-free power by 2045 (RCW 19.405). Oregon has been considering a cap-and-trade program similar to California's program. Additionally, Nevada (Senate Bill 358, 2019) and New Mexico (Senate Bill 489, 2019) both adopted 100 percent carbon-free goals for the electricity sector. The province of British Columbia has had a carbon tax in place since 2008.

In light of this legislative and policy trend, the co-lead agencies assumed that no new gas-fired generation would be built to replace the lost generation from the lower Snake River dams in developing the least-carbon replacement portfolio; only zero-carbon resources could be selected. At the utility-scale, the current zero-carbon options are solar and wind resources, batteries, and demand response programs. For MO3, the EIS analysis started with an effort to restore the loss of load probability to the No Action Alternative level of 6.6 percent. This analysis identified a potential zero-carbon replacement portfolio consisting of 2,550 MW of solar resources and 600 MW of demand response to restore the LOLP. This portfolio relies on using the existing regional system to help make up for some of the lost capabilities of the lower Snake River projects—primarily by operating thermal plants more frequently to meet regional load.

These initial modeling results were based on assumptions embedded in the No Action Alternative and raised two important additional considerations. First of all, the models used to determine this initial zero-carbon replacement portfolio do not adequately capture the flexibility and dispatchable peaking capabilities that the lower Snake River dams bring to the regional power system. In order to partially reflect the permanent loss of sustained

dispatchable hydropower peaking capacity, reserve capability and flexibility at the lower Snake River projects, an additional 1,275 MW of battery storage were added to the zero-carbon portfolio for the base case analysis (in addition to 2,550 MW of solar and 600 MW of demand response). The estimated cost of this base case portfolio was \$419 million per year. For Bonneville's wholesale power rate, MO3's zero-carbon resource portfolio, along with related structural and fish and wildlife spending adjustments, place upward rate pressure of between 9.5 percent and 19.3 percent over the No Action Alternative, depending upon the source of funding for those resources. (If public utilities acquire the new generation directly, the impact to Bonneville's wholesale power rate is generally lower than if Bonneville acquires the resources. In either case, though, the impact to retail customers of the public utilities is fairly similar.) While this portfolio with the addition of batteries continues to rely on regional thermal resources to make up for lost energy, capacity and reserves, it lessens that reliance. This portfolio is captured in the Base Case section of the rate analysis described in Section 3.7.3.5 together with retail rate impacts.

The second issue concerning the base case zero-carbon replacement portfolio is that the composition of the regional power system is undergoing rapid change, and will continue to do so over the coming years with increased coal plant retirements and restrictions on the use of natural gas generation. The base case portfolio implicitly assumes that other regional resources would be used to make up for any deficiencies in the power system's sustained peaking, storage, and dispatchable capability caused by the loss of generation from the lower Snake River dams. As a result, given the expected coal plant retirements and restrictions on natural gas generation, replacing the full flexibility and capability of the lower Snake River dams with zero-carbon resources would require substantially more resources, such as additional dispatchable battery technology, than estimated in the base case analysis. To reflect these additional costs, a rate sensitivity analysis was performed for MO3 to estimate the rate pressure effect of an expanded zero-carbon resource portfolio on Bonneville's wholesale power rate. As described in Section 3.7.3.5, this expanded zero-carbon resource portfolio would include power capabilities similar to those lost with the breaching of the lower Snake River projects.

The costs of an expanded zero-carbon resource portfolio designed to replace the full capability of the lower Snake River dams would be significant: up to \$527 million a year above the resource costs assumed in the base case analysis. Additional variables such as resource financing uncertainties and the uncertainty in the cost and availability of demand response add to this rate

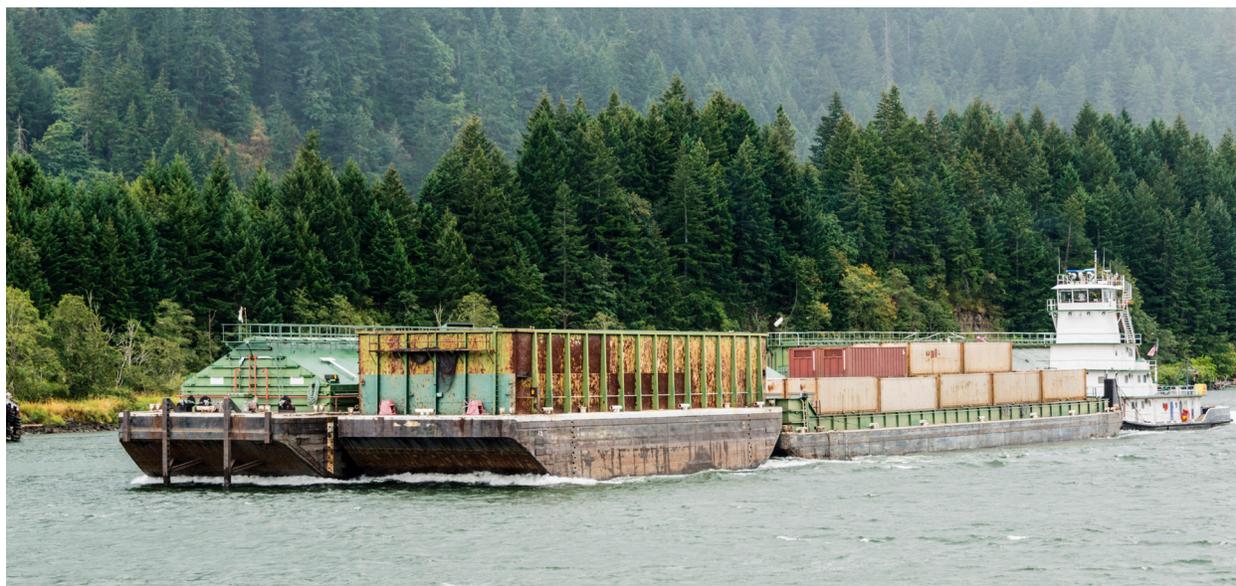
sensitivity. Selecting this portfolio would represent a very large investment in the regional power system, equal to roughly a billion dollars a year or one-third of Bonneville's power revenues. If Bonneville had to replace the lower Snake River projects' full capability with zero-carbon resources, the rate pressure could be up to 50 percent on wholesale power rates. Before making such an investment, Bonneville and its regional partners would need to collaborate on identifying other viable options that could maintain reliability and meet regional carbon objectives, while also ensuring federal power remains competitively priced for Bonneville's power customers.

MO3 would also not meet the objective to **Minimize GHG Emissions**. GHG emissions were analyzed for the base case hydropower impacts discussed above without the effect of the additional coal-plant retirements. GHG emissions would increase the most if the hydropower were replaced with natural gas. This would lead to an additional 3.3 million metric tons (MMT) of CO₂, a 10 percent increase in power-related emissions across the Northwest. However, even assuming the new replacement resources are variable renewables (the base case of solar with batteries), some increase in fossil fuel-based generation from existing power plants would occur to maintain system reliability. This is because the magnitude and timing of the reduction in hydropower generation would occur in particular times seasonally or daily (e.g., during peak demand) during which flexible resources would need to increase generation in order to maintain reliability (i.e., to meet the demand for power and avoid blackouts). As discussed above, based on currently available technology, other renewable resources (e.g., solar and wind) are variable; that is, they cannot always

be dispatched on demand because they are reliant on external factors, such as sun exposure or wind speed. Therefore, these sources of renewable generation must be used alongside other flexible (dispatchable) resources to maintain system reliability. With less clean hydropower to provide this flexible resource, the region would likely rely more on fossil-fuel-based resources, such as coal and natural gas, to balance renewable generation. This increased reliance on fossil-fuel-based resources is estimated to increase power-related emissions by 2.7 percent (1 MMT of CO₂) across the region even assuming the new replacement resources are other renewables. In the future, technical advances in storage and other low-carbon options may become increasingly viable to help integrate variable renewable generation. With the expanded portfolio that is intended as a full replacement of the capabilities of the lost generation from the lower Snake River dams, the GHG emissions impact would probably be lower.

The loss of hydropower generation at Ice Harbor would require that a transmission reinforcement project be in place prior to breaching of the dams. The transmission reinforcement project would cost about \$94 million.

In addition, MO3 would result in shipping activities shifting from barge to road and rail transport as described below. As barge transportation is a relatively low source of GHG emissions per ton-mile of freight compared with truck or train transportation, MO3 would also increase transportation-related emissions for wheat that is currently transported along the lower Snake River by up to 53 percent (an increase of 0.056 MMT of CO₂). Section 3.8.3.5 discusses the transportation sector GHG impacts in further detail.



MO3 would meet the objectives to **Maximize Adaptable Water Management** and **Provide Water Supply**, but there would be adverse impacts to irrigation in the lower Snake River borne by other public and private entities due to dam breaching. Assuming 47,926 acres were no longer irrigated, the present value of the lost social welfare benefit under the MO3 alternative is \$458 million (annual equivalent value is \$17 million). Further information can be found in Chapter 3.12.

Additional Effects of MO3

MO3 would have multiple adverse and beneficial effects on environmental, socioeconomic, cultural, and river operations as described below.

Transportation

Major adverse effects would be anticipated under MO3. The lower Snake River shallow draft navigation channel would no longer be available, eliminating commercial navigation to multiple port facilities on the lower Snake River, include the four primary commercial navigation ports—the Port of Lewiston, the Port of Clarkston, the Port of Whitman County (Wilma, Almota, Central Ferry), and the Port of Garfield. As a result, the cost to transport goods to market would increase. For example, the cost to transport wheat, which accounted for 87 percent of the downbound tonnage on the lower Snake River in 2018, is estimated to increase by \$0.07–\$0.24/bushel. This is equivalent to an increase of 10 to 33 percent in average transportation costs. Cost increases for specific shippers would depend upon location and would vary throughout the region, depending on transportation options at each location. Farmers could also experience increased production costs associated with higher transportation costs for upriver movements (i.e., fertilizer, crops). There would be additional demands on existing road and rail infrastructure as well as at barging facilities near the Tri-Cities, Washington, increasing traffic and air pollution. Additional capacity and infrastructure improvements would likely be required, borne by public and private entities, and would vary depending on how the rail industry adjusted its rates with reduced competition from the barge industry.

If increased rail rates are low or non-existent, then significant increased demand on rail infrastructure would occur that would likely exceed current capacities (which could also cause rail rates to increase), as tonnage demand for rail would increase by 86 percent. Assuming new facilities would be required to accommodate the increase in capacity, costs could range from a total of \$25 million to \$50 million. In addition, upgrades to existing shortline rail lines of approximately \$30 million to \$36 million, or approximately \$2 million annually may be needed.

If rail rates increase by 25 percent, there would be a 22 percent increase in average transportation costs. With a 25 percent rail rate increase, increased rail demands would likely exceed current shortline rail capacity, but somewhat less than if rail rates did not increase. Costs to increase capacity could be as high as \$25 million under this scenario. Truck use would increase moderately, which would increase wear and tear on roadways and could result in additional road repair costs of up to \$4 million annually.

If rail rates increase by 50 percent following dam breach, average transportation costs would increase by 33 percent. Under this scenario, rail infrastructure demand increases would not be anticipated. Instead, a substantial increase in truck use would occur (an increase of 84 percent compared to the No Action Alternative). Under this scenario, increases in vehicular accident rates, highway traffic and congestion would occur. In addition, additional wear and tear on roadways could result in additional road repair costs of up to \$10 million annually.

Adverse regional economic effects would occur as the jobs and income provided by the four primary commercial navigation ports would be curtailed, including the Port of Lewiston, the Port of Clarkston, the Port of Whitman County (Wilma, Almota, Central Ferry), and the Port of Garfield. Commercial cruise lines that operate on the lower Columbia and lower Snake River, providing voyage to approximately 18,000 cruise line passengers per year, would be adversely affected by reduced numbers and distance of trips, with adverse effects to tourism revenues and associated jobs and income. Communities affected, such as Clarkston, Lewiston and Asotin, would lose their ‘river port’ community identity. Some port facilities within Lake Wallula, the reservoir behind McNary Dam, would require additional dredging to maintain access to the navigation channel following dam breach.

Environmental

Major adverse short-term effects to other environmental resources along the lower Snake River and confluence of the Columbia River and lower Snake River would occur from the initial dam breaching and river drawing down, but there are anticipated to be major long-term beneficial effects to vegetation, wildlife, wetlands, and floodplains in the lower Snake River. For water quality, water temperatures would be warmer in the summer (during the day) that may exceed water quality standards, but spring and fall water temperature improvements are anticipated.

Cultural resources

In the lower Snake River, MO3 could result in additional major adverse effects to archaeological sites due to potential exposure of 14,000 acres that are currently inundated. Following the drawdown, the long-term goal



would be for the river to return to as natural a condition as possible which is expected to have a beneficial effect to traditional cultural practices such as fishing, gathering, and occupation. Conversion to a more natural riverine system would allow improved access for tribal communities to areas currently inundated. There is also the potential for additional major adverse effects to archaeological sites at Hungry Horse Reservoir due to the increased frequency and size of draw-downs to compensate for the removal of the Lower Snake River dams.

Recreation

In terms of economic effects, major long-term adverse effects to lower Snake River barge navigation and reservoir-based recreation in the lower Snake River would occur. Major adverse effects would occur to reservoir-based recreation because these reservoirs and associated boat ramp access would cease to exist. However, there would likely be major long-term beneficial effects to river-based recreation, and improved recreational and tribal fishing.

Despite the major benefits to fish expected from MO3, this alternative was not identified as the Preferred Alternative due to the adverse impacts to other resources such as transportation, power reliability and affordability, and greenhouse gas emissions. The region's understanding of the impacts, both beneficial and adverse, of the Columbia River System will improve over time just as the perspectives and values of the people living in the Columbia Basin will continue to change as well. This EIS is not expected to end the regional debate on the future of the four lower Snake River dams. On the contrary, this EIS provides information and analysis to inform that future dialogue.

The co-lead agencies used the analysis in MO3 to inform and improve the development of the Preferred Alternative that seeks to balance managing the system for all purposes while providing additional benefits for fish and other study objectives.

8 MULTIPLE OBJECTIVE ALTERNATIVE 4 (MO4)

Overview of the Alternative

MO4 was developed with a primary focus on measures to benefit ESA-listed fish, integrated with measures for water management flexibility, hydropower production, and additional water supply. This alternative includes the highest level of spill in the range considered in this EIS, dry-year augmentation of spring flow with water stored in upper basin reservoirs, and annually drawing down the lower Snake River and Columbia River reservoirs to their minimum operating pools. This alternative also includes changes to juvenile fish transportation operations, operations to help establish riparian vegetation in the Upper Basin, and improved surface passage spill for adult steelhead. The structural measures in this alternative are primarily focused on improving passage conditions for ESA-listed salmonids and Pacific lamprey. The inclusion of a measure for spillway weir notch inserts for adult steelhead downstream passage is unique to the MO4 alternative; the rest of the structural measures are variations of other measures described in the other MOs, including structural measures for Pacific lamprey.

The operational measures would make improvements to meet project objectives. In MO4, Juvenile fish passage spill is set up to 125 percent TDG during the spring and summer, which is the highest volume and longest duration of spill included in any of the alternatives. This is intended to decrease travel time and improve juvenile downstream fish passage. The juvenile fish transport program would operate primarily in the spring and fall. This alternative also contains a measure for restricting winter flows from the Libby project to protect newly established downstream riparian vegetation, and to improve conditions for ESA-listed resident fish, bull trout, and Kootenai River White Sturgeon in the upper Columbia River basin. Chapter 2 of the EIS describes the measures that are included in MO4 in more detail.

Does MO4 Address the EIS Objectives?

Similar to MO3, the potential benefits of MO4 for **Improve Juvenile Salmon and Improve Adult Salmon** varies greatly depending on which model is used (see Fish Modeling discussion above). The CSS model predicts large increases in all salmon and steelhead returns, to both the Columbia and Snake Rivers. These increases are predicted based on increased spill levels that would increase the number of fish passing via the spillways and avoiding powerhouses, which the CSS models predicts would reduce latent mortality associated with CRS passage. Snake River spring Chinook and steelhead SARs are predicted to improve by 70 to 75 percent relative to the No Action Alternative.

The LCM predicts minor benefits to Upper Columbia spring Chinook and steelhead, with 2 percent relative increases in SARs and downstream survival. However, for Snake River Chinook, the model predicts that unless changes in passage through the CRS can increase ocean survival by 10 percent (i.e. latent mortality effects are decreased by 10 percent), the net impact to Snake River Chinook salmon would be adverse, a relative decrease in SARs of 12 percent. This potential decrease in overall adult returns is primarily driven by reductions in fish transport rates due to high spill, a relationship that could be similar for Snake River steelhead. MO4 also includes structural modifications to infrastructure at the dams to benefit passage of adult salmon, steelhead, and Pacific lamprey.

MO4 causes minor to major adverse effects to resident fish due to deep drafts of the upper basin storage projects. Resident fish in the lower basin would also be exposed to elevated TDG levels in the lower basin. MO4 proposes mitigation to reduce resident fish adverse effects to negligible, as appropriate, and the objective for **Improving Resident Fish** would be met.

MO4 would not meet the **Provide a Reliable and Economic Power Supply** objective. Under MO4, hydro-

power generation decreases by 1,300 aMW under average water conditions, and 870 aMW under low water conditions compared to the No Action Alternative, the largest impacts on hydropower generation of any of the alternatives. The reason for the reduced generation is the increase in juvenile fish passage spill, up to 125 percent total dissolved gas levels 7 days a week, 24 hours a day from March 1 to August 31, with most lower Snake and lower Columbia River projects operating at minimum generation levels in the majority of water conditions. This increase in spill, together with a measure that provides dry-year augmentation of spring flow with water stored in upper basin reservoirs, contributes to MO4 having the highest probability of power shortages of any of the MOs, with blackouts or emergency conditions in roughly one in three years.

Substantial additional resources would be needed to maintain regional reliability at the No Action Alternative levels. The conventional least-cost resource replacement portfolio would include 3,240 MW of simple cycle natural gas turbines at an annual cost of \$156 million (excluding fuel). Replacing the lost hydropower generation with variable renewable resources would require around 5,000 MW of solar (occupying nearly 47 square miles of land) and 600 MW of demand response at an estimated annual cost of \$350 million. For Bonneville's wholesale power rates, MO4 places upward base rate pressure of 23.5 percent to 25.3 percent over the No Action Alternative, depending upon the type of resources acquired and the source of funding for those resources. Additional rate sensitivities around this base analysis, discussed in Chapter 3.7.3.6, could lead to upward rate pressure as high as 41 percent in the Bonneville wholesale power rate. Chapter 3 also provides additional sensitivity analyses of impacts of MO4 on reliability and cost given the higher expectations of coal plant retirements and restrictions on natural gas generation resulting from recent policy and planning changes. Retail rate impacts are also discussed in Chapter 3.7.3.6.



MO4 would not meet the **Minimize GHG Emissions** objective. GHG emissions would increase the most if the hydropower is replaced with natural gas (an 8.4 percent, or 3.1 MMT of CO₂ increase in power-related emissions across the Pacific Northwest). However, as with MO3, even assuming the new replacement resources are variable renewables (solar with demand response), some increase in fossil-fuel-based generation from existing power plants would occur to maintain system reliability. This seems counter-intuitive, but adding wind and solar, which are variable resources (not always available) requires a base source of dispatchable capacity to maintain reliability when they are not available. The region currently relies on the CRS to provide much of this back-up source of generation. If a significant amount of hydroelectric generation is reduced, given the region's current resource portfolio, additional generation from coal and gas would likely be used to balance for the variable nature of renewable resources. Consequently, replacing lost hydropower generation with variable renewable resources would still increase power-related GHG emissions by 0.8 percent (0.31 MMT of CO₂) across the region. Section 3.8.3.6 discusses the GHG impacts of MO4 in further detail.

This analysis is based largely on existing technology and the region's existing resource portfolio. Future technology developments—such as advances in utility-scale storage, demand management, adding voltage support capabilities to wind or solar, other emerging renewable options like tidal or wave power, small modular nuclear reactors, pumped storage, and technologies not yet in the public eye—may reduce the need to rely on fossil-fuel power for integrating variable renewable resources.

MO4 would meet the objectives to **Maximize Adaptable Water Management** and **Provide Water Supply** because the CRS would be operated to meet the flood risk management measures and does not remove authorized water supply.

Additional Effects of MO4

Overall, major adverse economic effects would occur under MO4. For irrigation on the lower Columbia River, particularly at John Day, reservoir levels may be lowered to the point where pumping could no longer be possible. Additionally, in low water years, major adverse effects to water-based recreational access at Lake Pend Oreille could occur.

MO4 would result in major adverse effects to resident fish in the Upper Basin that could require mitigation.

Finally, major social effects to cultural resources at Lake Roosevelt, John Day, and Hungry Horse reservoirs could occur. Lake Roosevelt would be at a lower elevation primarily in the spring and summer in dry years due to

providing spring flow augmentation downstream. Hungry Horse reservoir would provide dry-year flow augmentation in the summer, and may not recover to the No Action elevation in some of the years. The overall result would be increased exposure and erosion of cultural resources. At John Day, the elevation of the reservoir is drawn down to minimum navigation pool during the juvenile fish passage season. There would be additional moderate effects to cultural resources at the remaining lower Columbia River Projects due to additional drawdown. There could be major effects to Kettle Falls (sacred site) if changes in reservoir elevations lead to increased potential for looting. Changes in reservoir elevation at Albeni Falls may result in reduced access to Bear Paw Rock (sacred site), which may result in less tribal visitation.

As with the other alternatives, the co-lead agencies used this analysis to inform and improve the Preferred Alternative that seeks to balance managing the system for all purposes while providing additional benefits to fish and other study objectives.

9 ALTERNATIVES CONSIDERED BUT NOT EVALUATED IN DETAIL

Initially, several important issues were identified during scoping for consideration in this EIS. This included the reintroduction of salmon above Chief Joseph and Grand Coulee Dams into the upper Columbia Basin, where passage is currently blocked. Additionally, the co-lead agencies received requests to integrate the ongoing Columbia River Treaty negotiations between the United States and Canada into the analysis. Following the CRT Sovereign Review process, the CRT Regional Recommendation stated that Pacific Northwest states and tribes support the pursuit of a comprehensive flood risk management study to re-evaluate usage of flood plains and potential changes to current levels of protection. All of these concerns or measures were considered but removed from further analysis in the EIS for the reasons detailed in Section 2.5.

In addition, a preliminary suite of single objective focused alternatives were developed to maximize certain project purposes or benefit specific resources without attempting to minimize adverse effects on other resources. As information on how suites of measures from these alternatives preformed became better understood, they were used to develop the MOs in order to meet the objectives in a more comprehensive manner. None of the single objective alternatives were retained for detailed analysis in the EIS. Additional information on these alternatives can be found in Appendix A—Alternative Development.

10 PREFERRED ALTERNATIVE

Overview of the Preferred Alternative

The Preferred Alternative provides flexibility to adapt to changing conditions in the Columbia River Basin, ensures that human life and safety can be protected through flood risk management, protects valuable fish and wildlife resources, supplies water to farmers and cities, and ensures adequate, affordable, and reliable power. Throughout this process, the co-lead agencies endeavored to identify a way to best meet the multiple purposes and objectives of the Columbia River System, and build on recent progress in establishing a more collaborative, creative approach to river operations and salmon protection. Each co-lead agency has different criteria for the outcome of the EIS, but worked together to select one alternative that seeks to balance the multiple purposes of the federal projects, while complying with the relevant environmental laws and regulations.

The five multiple purpose alternatives met the study's Purpose and Need Statement and objectives to varying degrees and with varying levels of beneficial and adverse effects. Because of this, the co-lead agencies selected a combination of suites of measures from the alternatives to develop the Preferred Alternative based on how well the measures met the Purpose and Need Statement and EIS objectives, with consideration of environmental, economic, and social effects. Developing the Preferred Alternative allowed the co-lead agencies to refine several measures based on information learned during the process of modeling and evaluating the alternatives.

After the alternatives were initially developed, the implementation of spring spill operations in 2018 and the development of the fish operations plan for 2019 led to new information regarding spill for juvenile fish passage to benefit downstream migration of juvenile anadromous fish. With this information, the co-lead agencies modified the juvenile fish spill operation for the Preferred Alternative using the analysis from the range of spill levels evaluated in the MOs. The intent was to create an opportunity for a major potential benefit to salmon and steelhead through increased spill, as indicated by the CSS model, while avoiding many of the adverse effects to power generation and reliability associated with juvenile spill operations analyzed in MO4. The primary method to accomplish this in the Preferred Alternative is a flexible spill operation that spills more for fish passage when power generation is less valuable and spills less when power generation is more valuable. The Preferred Alternative also acknowledges the range of potential outcomes predicted by the models used to estimate impacts to anadromous fish, and therefore includes a study to evaluate the potential benefits and unintended consequences of significantly higher spill levels. The

underlying principles and model of constructive collaboration established through the 2018 flexible spill agreement have been carried forward in the Preferred Alternative.

All measures included in the Preferred Alternative are either carried forward from the No Action Alternative, or are original measures or refined measures that were evaluated in MOs 1 through 4. The exceptions are an added measure for lamprey passage (closeable floating orifice gates) and measures identified as part of the associated CRS ESA consultation processes. This led to a Preferred Alternative that seeks a balanced approach to enable the co-lead agencies to meet the multiple purposes of the System and requirements for fish and wildlife including ESA-listed species. Following the initial development of the Preferred Alternative, the co-lead agencies shared it with the National Marine Fisheries Service, U.S. Fish and Wildlife Service, tribes, and cooperating agencies to solicit feedback and further input. The feedback received from the Services and the Cooperating Agencies was highly valuable and despite the sizable volume of comments, the co-lead agencies addressed and incorporated this feedback wherever possible.

Tribal partners provided valuable input and expertise throughout the development of the EIS and tribal interests and perspectives played an important role in how the co-lead agencies shaped the Preferred Alternative. The importance of healthy salmon and steelhead populations to tribal cultures and economies are a central part of the rationale for selecting fish passage spill measures that have the potential to provide major improvements in SARs. Continued investment in structural improvements for lamprey passage also reflects consistent feedback received from numerous tribes. The affirmation and refinement of the Montana Operation, measures designed to carefully balance resident fish needs with other projects purposes, is the result of close coordination with tribal partners in the Upper Basin.

Does the Preferred Alternative Address the Objectives?

The Preferred Alternative meets the Purpose and Need Statement and objectives developed for the EIS for operation of the CRS. Where appropriate, mitigation measures have been incorporated into the Preferred Alternative to address adverse impacts when compared to the No Action Alternative. For example, the Preferred Alternative includes a mitigation measure to address the potential for access to blocked tributaries for bull trout due to operations at Libby dam. Ongoing programs and operation and maintenance activities would continue from the time this EIS was initiated in 2016 unless otherwise described. Preliminary measures proposed



by the co-lead agencies for compliance with the ESA are also included. These may be modified or added to as the ESA consultation process is still underway. Many of the measures in the Preferred Alternative are intended to improve conditions for ESA-listed fish and lamprey. Other measures are intended to provide more flexible ways for the co-lead agencies to meet water needs for fish and wildlife, flood risk management, water supply, and hydropower in the Columbia Basin. A detailed description of the measures included in the Preferred Alternative is included in Chapter 7 of the EIS.

The Preferred Alternative would meet the **Improve Juvenile Salmon, Improve Adult Salmon, and Improve Lamprey objectives**. According to the CCS model, Snake River Chinook and steelhead are expected to see relative improvements in SARs of 35 and 28 percent respectively. If latent mortality effects are reduced, the LCM models also predict that levels of SARs would increase. However, if latent mortality effects are not reduced, the LCM predicts that SARs for Snake River spring Chinook may also be lower than the No Action Alternative (range of minus 7.5 to plus 28 percent change relative to the No Action Alternative) due to reduced rates of transportation. Results for upper Columbia River stocks are beneficial based on LCM estimates. In-river survival and SARs are anticipated to increase. The ranges in potential effects are due to the different assumptions made by each of the fish models.

The Preferred Alternative is expected to address the adult migration delay caused by high spill predicted in MO4 analysis through the inclusion of periods of reduced spill. The Preferred Alternative is anticipated to, and is specifically designed to, test and evaluate whether increased spill will ultimately lead to an increase in adult fish. Spill operations would be managed adaptively, building off of the established Regional Forum processes, to address unexpected challenges, such as potential

delays to adult migration, effects to navigation, and other challenges or opportunities that may require either a temporary or permanent change. As noted above, anadromous fish from regions other than the Snake River are expected to have minor improvements or similar effects compared to the No Action Alternative.

The Preferred Alternative includes modification of the John Day Reservoir for predator disruption. Reservoir levels would be increased before Caspian tern nesting season to dissuade nesting on islands in John Day's reservoir, and then dropped back down to the minimum operating pool range in June as is normal during the juvenile fish migration season. Ramp rates at John Day Dam limit the rate of change in reservoir elevations and would be similar to the No Action Alternative. The effect of the John Day Reservoir Predation Disruption measure would have negligible effects on larval lamprey (such as stranding) compared to the No Action Alternative.

The Preferred Alternative is expected to have similar effects as the No Action Alternative on water temperature. TDG levels in the lower Snake and lower Columbia in the spring are expected to increase relative to the No Action Alternative due to increased spill intended for juvenile fish passage. These TDG levels are expected to be lower than MO4 spill in the spring due to the inclusion of periods of reduced spill for hydropower generation under a flexible spill operation.

The Preferred Alternative would also meet the **Improve Resident Fish** objective. Effects to resident fish vary by region and by species but are generally minor relative to the No Action Alternative. For example, at Libby Dam, effects to resident fish are expected to have both minor adverse effects due to higher river elevations during the winter and minor beneficial effects due to the changes in reservoir elevation, downstream water temperatures, and restoration of native riparian vegetation. Effects at

Hungry Horse are expected to be minor beneficial due to higher reservoir levels in late summer. Resident fish in Lake Roosevelt at Grand Coulee are expected to experience minor adverse effects because of changes in reservoir levels, but this would be mitigated for by augmenting spawning habitat. The slightly deeper drafts at Dworshak resulting from a more formal calculation of winter drawdown are expected to have minor adverse effects to bull trout and kokanee because of increased entrainment risk and increased drawdown that may isolate fish from tributaries. In the lower Columbia River and lower Snake River, the Preferred Alternative could have minor adverse effects on resident fish due to the higher TDG levels and minor beneficial effects from increased fish passage spill resulting in decreased powerhouse passage at dams.

The Preferred Alternative would meet the **Provide a Reliable and Economic Power Supply** objective. Hydropower generation decreases under the Preferred Alternative by 160 aMW assuming average water, and 300 aMW assuming low water, in large part due to the increased spring spill for juvenile fish passage. While overall hydropower generation would decrease under the Preferred Alternative, reliability is comparable to that of the No Action Alternative because other measures increase hydropower generation slightly in the winter, and more substantially in late August, and increase hydropower flexibility in some locations and periods. Therefore, no additional resources are needed to maintain regional reliability at the No Action Alternative level.

For Bonneville's wholesale power rates, the Preferred Alternative places additional rate pressure of 2.7 percent relative to the No Action Alternative. Additional rate sensitivities not included in the base analysis could lower the rate pressure to 0.4 percent. This rate pressure is within a range that may be offset by cost reductions. For instance, over the past two years, Bonneville and its partners took steps to offset the costs of reduced hydropower generation resulting from the Opinion and Order from the U.S. District Court for the District of Oregon. The spill operations contained in the Preferred Alternative are designed to test the potential biological benefits of increased spill while maintaining cost neutrality for regional electricity ratepayers relative to the 2018 spill injunction.

The Preferred Alternative marginally meets the **Minimize GHG Emissions** objective. Due to the reduction in hydropower generation, air quality would most likely be degraded slightly and greenhouse gas emissions in the Northwest would likely increase by an estimated 0.26 MMT (or 0.70 percent) compared to the No Action Alternative. Other emissions sources (e.g., navigation,

construction, fugitive dust) are most likely to have a negligible effect on air quality and greenhouse gas emissions relative to the No Action Alternative across the basin.

The Preferred Alternative also meets the **Maximize Adaptable Water Management** and **Meet Water Obligations** objectives.

Additional Effects of the Preferred Alternative

Many of the tribal cooperating agencies provided valuable input on the broader historical context of cultural resource impacts resulting from the construction and operation of the CRS prior to 2016. Relative to the No Action Alternative, the effects of the Preferred Alternative generally have negligible effects on cultural resources. The current FCRPS Cultural Resource Program would continue under the Preferred Alternative.

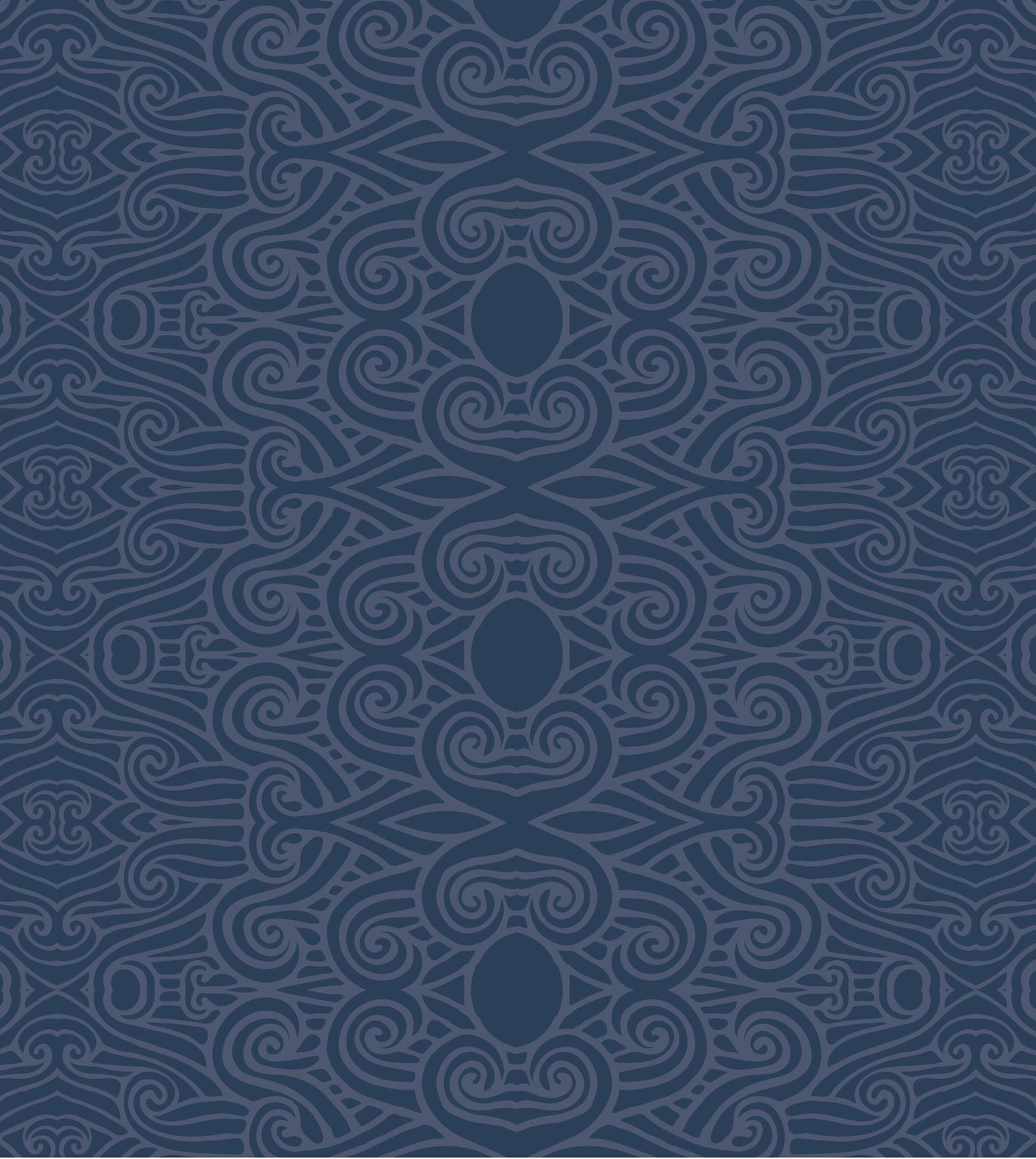
Overall, the Preferred Alternative would result in less adverse effects to archaeological resources than the other action alternatives. Except for Lake Koochanusa, the Preferred Alternative is neutral or even slightly better than the No Action Alternative. This does not mean that the Preferred Alternative would eliminate the ongoing adverse effects of operating the reservoirs, but there may be a slight reduction in the rate at which archaeological sites decay. The adverse effects at Libby to archaeological resources resulting from the Preferred Alternative are minor.

As with the other alternatives, and similar to archaeological resources, traditional cultural properties would continue to experience major adverse effects associated with the operations and maintenance of the CRS. These effects that have occurred and would continue to occur under the Preferred Alternative are summarized in Chapter 3.16 and listed in Table 3-299. However, based on available information, and with reference to the assumptions and constraints previously described for traditional cultural properties, the Preferred Alternative would likely not result in an appreciable increase in adverse effects relative to the No Action Alternative.

Consistent with the sacred sites identified for Chapter 3, the Preferred Alternative evaluates effects to two sacred sites. Operational changes at Grand Coulee and Albeni Falls as described for the Preferred Alternative would be negligible when compared to the No Action Alternative. The quantitative analysis discussed above shows that the period of site exposure at Kettle Falls and Bear Paw Rock would not increase. Based on the similarity between the Preferred Alternative and the No Action Alternative, the effects to sacred sites under the Preferred Alternative are expected to be negligible.

MAJOR CONCLUSIONS

The co-lead agencies developed the Preferred Alternative as part of an iterative process. The Preferred Alternative is a combination of measures included in the five multiple objective alternatives using the information that was learned during their evaluation. In some instances, measures were modified to improve their ability to meet the Purpose and Need or objectives, or refined to avoid, reduce or minimize adverse environmental, economic, and social impacts. The co-lead agencies expect that the Preferred Alternative would allow them to meet the EIS intent as expressed in the Purpose and Need and the EIS objectives, including those to benefit ESA-listed species, while also continuing to meet the congressionally authorized purposes of the system. In conclusion, the Preferred Alternative seeks to balance the multiple purposes of the federal projects, while complying with the applicable federal environmental laws, implementing regulations, and executive orders. The applicable environmental statutes, regulations, and executive orders are summarized and a status of compliance is detailed in Chapter 8.1.



FEBRUARY 2020

EXECUTIVE SUMMARY: COLUMBIA RIVER SYSTEM OPERATIONS DRAFT ENVIRONMENTAL IMPACT STATEMENT

U.S. Army Corps of Engineers

Bureau of Reclamation

Bonneville Power Administration

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ACRONYMS AND ABBREVIATIONS

ACS	U.S. Census Bureau American Community Survey
ADFG	Alaska Department of Fish and Game
AEP	annual exceedance probability
AF/AT	average flow/average temperature
AF/LT	average inflow/low temperature
amsl	above mean sea level
aMW	average megawatt
AQI	Air Quality Index
AR	atmospheric river
ASW	adjustable spillway weir
BA	balancing authority
BiOp	biological opinion
BMP	best management practice
Bonneville	Bonneville Power Administration
BP-18	Current (2018) Bonneville Power Administration rate case
CAA	Clean Air Act
Census	U.S. Census Bureau
Census of Agriculture	U.S. Department of Agriculture Census of Agriculture
CEM	conceptual ecological models
CEQ	Council on Environmental Quality
C.F.R.	Code of Federal Regulations
cfs	cubic feet per second
CH ₄	methane
CIAA	Cumulative Impact Analysis Area
cm	centimeters
CO	carbon monoxide
CO ₂	carbon dioxide
CO ₂ e	carbon dioxide equivalents
COMPASS	Comparative Passage model
Corps	U.S. Army Corps of Engineers
CRITFC	Columbia River Inter-Tribal Fish Commission
CRS	Columbia River System
CRSO	Columbia River System Operations
CRT	Columbia River Treaty
CRWMP	Columbia River Water Management Program
CSKT	Confederated Salish and Kootenai Tribes
CSNS	Columbia-Snake Navigation System

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CSS	Comparative Survival Study model
CTCR	Confederated Tribes of the Colville Reservation
Cultural Resources Program	Federal Columbia River Power System Cultural Resources Program
CWA	Clean Water Act
CYE	Cabinet-Yaak Ecosystem
dba	decibels on the A-weighted scale
DM	Departmental Manual
DMMP	Dredged Material Management Plan
DO	dissolved oxygen
DOD	U.S. Department of Defense
DOE	U.S. Department of Energy
DOI	U.S. Department of the Interior
DPS	distinct population segment
DSI	direct service industry
Ecology	Washington State Department of Ecology
EIA	U.S. Energy Information Administration
EIS	environmental impact statement
EJSCREEN	Environmental Justice Mapping and Screening Tool
EO	Executive Order
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
ESU	evolutionarily significant unit
F&W Program	Bonneville Power Administration's Fish and Wildlife Program
FCRPS	Federal Columbia River Power System
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
FONSI	Finding of No Significant Impact
FOP	fish operations plan
FR	Federal Register
FRM	flood risk management
ft/s	feet per second
FY	fiscal year
GAP	Gap Analysis Program
GBT	gas bubble trauma
GHG	greenhouse gas
GIS	geographic information system
GWP	global warming potential
H&H	hydrology and hydraulics

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Acronyms and Abbreviations*

HAP	hazardous air pollutant
HCNRA	Hells Canyon National Recreation Area
H. Doc.	U.S. Congress House Document
HEC-RAS	Hydraulic Engineering Center River Analysis System
HF/LT	high inflow/low temperature
HMU	Habitat Management Unit
Hydsim	Hydro System Simulator
IAPMP	Inland Avian Predator Management Plan
IBA	Important Bird Area
IDAPA	Idaho Administrative Procedures Act
IDEQ	Idaho Department of Environmental Quality
IDFG	Idaho Department of Fish and Game
IDPR	Idaho Department of Parks and Recreation
IFP	improved fish passage
IOU	investor-owned utility
IPCC	Intergovernmental Panel on Climate Change
ISAB	Independent Scientific Advisory Board
ITA	Indian Trust Asset
IWG	Interagency Working Group
kaf	thousand acre-feet
kcfs	thousand cubic feet per second
kg	kilogram
km	kilometers
KTOI	Kootenai Tribe of Idaho
kW	kilowatt
kWh	kilowatt hour
Lakes Commission	Lakes Commission
LCM	Life Cycle Model
LCR FNC	Lower Columbia River Federal Navigation Channel
LF/AT	low flow/average temperature
LOLP	loss of load probability
LRFEP	Lake Roosevelt Fishery Enhancement Program
m	meters
M&I	municipal and industrial
Maf	million acre-feet
Mcy	million cubic cards
MDEQ	Montana Department of Environmental Quality
MFWP	Montana Fish, Wildlife and Parks

*Columbia River System Operations Environmental Impact Statement
Acronyms and Abbreviations*

mg/L	milligrams per liter
MIP	minimum irrigation pool
MMPA	Marine Mammal Protection Act
MMT	Million metric tons
MO	Multiple Objective Alternative
MOP	minimum operating pool
MOU	memorandum of understanding
MPG	major population group
MW	megawatt
MWh	megawatt per hour
N ₂ O	nitrous oxide
NAAQS	National Ambient Air Quality Standards
NASS	National Agricultural Statistics Service
NAVD88	North American Vertical Datum of 1988
NCDE	Northern Continental Divide Ecosystem
NCE	Northern Cascades Ecosystem
nDPS	northern distinct population segment of green sturgeon
NEI	National Emissions Inventory
NEPA	National Environmental Policy Act
NERC	North American Electric Reliability Corporation
NGO	non-governmental organization
NGVD29	National Geodetic Vertical Datum of 1929
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NO ₂	nitrogen dioxide
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
Northwest Power Act	Pacific Northwest Electric Power Planning and Conservation Act
NO _x	nitrogen oxides
NPDES	National Pollutant Discharge Elimination System
NPS	National Park Service
NPV	net present value
NRC	Nuclear Research Council
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
NT	network integration
NTDE	National Tidal Datum Epoch
NW Council	Northwest Power and Conservation Council

*Columbia River System Operations Environmental Impact Statement
Acronyms and Abbreviations*

NWFSC	Northwest Fisheries Science Center
NWHI	Northwest Habitat Institute
NWI	National Wetlands Inventory
NWR	National Wildlife Refuge
NWRFC	Northwest River Forecast Center
O ₃	ozone
OAR	Oregon Administrative Rule
ODA	Oregon Department of Agriculture
ODEQ	Oregon Department of Environmental Quality
ODFW	Oregon Department of Fish and Wildlife
OPRD	Oregon Parks and Recreation Department
ORS	Oregon Revised Statute
PAD-US	Protected Areas Database of the United States
PCBs	polychlorinated biphenyls
PFMC	Pacific Fishery Management Council
PIT	passive integrated transponder
PITPH	probability of passing powerhouses
PM	particulate matter
ppm	parts per million
PSC	Pacific Salmon Commission
PSMP	Lower Snake River Programmatic Sediment Management Plan
PTP	point-to-point
PUD	public utility district
RCP	Resource Concentration Pathway
REC	renewable energy certificate
Reclamation	U.S. Bureau of Reclamation
ResSim	Hydrologic Engineering Center Reservoir System Simulation
RF	radiative forcing
RFFA	reasonably foreseeable future actions
RHWM	rate period high water mark
RM	river mile
RM&E	research, monitoring, and evaluation
RMJOC	River Management Joint Operating Committee
ROD	Record of Decision
RPA	reasonable and prudent alternative
RPS	Renewable Portfolio Standard
RSLC	relative sea level change
RUVD	Recreation Use Valuation Database

*Columbia River System Operations Environmental Impact Statement
Acronyms and Abbreviations*

SAR	smolt to adult return rate
SCC	social cost of carbon
SCENT	Snake Columbia Economic Navigation Tool
sDPS	southern distinct population segment of green sturgeon
SIP	state implementation plan
SKQ	Seli'š Ksanka Qlispe'
SO ₂	sulfur dioxide
SOR	Columbia River System Operation Review
SRD	storage reservation diagram
SWS	selective withdrawal system
Systemwide PA	2009 Systemwide Programmatic Agreement for the Management of Historic Properties Affected by the Multipurpose Operations of Fourteen Projects of the Federal Columbia River Power System
TCL	traditional cultural landscape
TCP	traditional cultural property
TDG	total dissolved gas
TEV	total economic value
TIR	transport to in-river SAR ratio
TMDL	total maximum daily load
TMT	Technical Management Team
TRM	tiered rate methodology
UDV	unit day value
URC	upper rule curve
USC	United States Code
USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGCRP	U.S. Global Change Research Program
USGS	U.S. Geological Survey
VarQ	variable discharge storage regulation procedure
VOC	volatile organic compound
W/D	width to depth
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife
WECC	Western Electricity Coordination Council
WQS	water quality standard
WMA	Wildlife Management Area
WNWCB	Washington Noxious Weed Control Board

*Columbia River System Operations Environmental Impact Statement
Acronyms and Abbreviations*

WSE	water surface elevation
WSPRC	Washington State Parks and Recreation Commission
WTP	willingness-to-pay

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GLOSSARY

Access point: A place where people access a site for recreation. An access point might include a boat launch, a campground, a parking area, etc. A recreation area may contain one or more access points.

Acre-foot: The volume of water that will cover an area of 1 acre to a depth of 1 foot.

Ambient air: Ambient air is the air surrounding a particular spot, such as a powerplant.

Anadromous fish: Fish, such as salmon or steelhead trout, that hatch in fresh water, migrate to and mature in the ocean, and return to fresh water as adults to spawn.

Annual operating plan: A yearly plan for operating projects on the Columbia River. Such a plan is specifically required by the Columbia River Treaty and by the Pacific Northwest Coordination Agreement.

Aquifer: Any geological formation containing water, especially one that supplies water to wells, springs, etc.

Artifact: An object of any type made by human hands. Tools, weapons, pottery, and sculptured and engraved objects are artifacts.

Augment: Increase; in this application, to increase river flows above levels that would occur under normal operation by releasing more water from storage reservoirs.

Average megawatt (aMW): A unit of energy that represents 1 megawatt of electric power capacity continuously over a year. One aMW is equal to 8,760 megawatts per hour.

British Columbia Hydro and Power Authority: This Canadian Crown corporation was formed in 1962 following the merger of an expropriated private utility and the B.C. Power Commission.

Balancing authority: The responsible entity that integrates resource plans ahead of time, maintains load interchange-generation balance within a balancing authority area, and supports interconnection frequency in real time.

Balancing authority area: The collection of generation, transmission, and loads within the metered boundaries of the balancing authority. The balancing authority maintains load-resource balance within this area.

Baseload: In a demand sense, a load that varies only slightly over a specified time period. In a supply sense, a plant that operates most efficiently at a relatively constant level of generation.

Bypass system: Structure in a dam that provides a route for fish to move through or around the dam without going through the turbines.

35 **Capacity:** The maximum load that a generator, piece of equipment, substation, transmission
36 line, or system can carry under existing service conditions. Baseload capacity is the power
37 output that can be continuously produced to run at least 70 percent of the time. Firm capacity
38 is the capacity whose availability is ensured to the purchaser.

39 **Columbia River Treaty (CRT):** A treaty signed by the United States and Canada on September
40 16, 1964, for joint development of the Columbia River. Under the treaty Canada built three
41 large storage dams (Duncan, Keenleyside, and Mica) on the upper reaches of the Columbia
42 River, which originates in Canada. It is a U.S.-Canadian agreement for bilateral development
43 and management of the Columbia River to achieve flood control and increased power
44 production.

45 **Consumer surplus:** Economic value received by the consumer of a good, service, or resource
46 (e.g., by a recreational user) that is above the price actually paid.

47 **Cubic feet per second (cfs):** A unit of measurement pertaining to flow or discharge of water.
48 One cfs is equal to 449 gallons (1.7 cubic meters) per minute.

49 **Cultural resources:** The non-renewable evidence of human occupation or activity as seen in any
50 district, site, building, structure, artifact, ruin, object, work of art, architecture, or natural
51 feature that was part of human history at the national, state, or local level.

52 **Demand:** For electrical energy, the rate at which it is used, whether at a given instant or
53 averaged over any designated period of time.

54 **Depletion:** Withdrawal of water from a stream, thereby reducing the volume of instream flow.

55 **Discharge:** Volume of water flowing at a given time, usually expressed in cubic feet per second.

56 **Dissolved gas concentrations:** The amount of chemicals normally occurring as gases, such as
57 nitrogen and oxygen, which are held in solution in water, expressed in units such as milligrams
58 of the gas per liter of liquid.

59 **Draft:** Release of water from a storage reservoir.

60 **Draft rate:** The rate at which water, released from storage behind a dam, reduces the elevation
61 of the reservoir.

62 **Drawdown:** The distance that the water surface of a reservoir is lowered from a given elevation
63 as water is released from the reservoir. Also refers to the act of lowering reservoir levels.

64 **Economic value:** The difference between the maximum amount a recreationist would be willing
65 to pay to participate in a recreational activity and the actual cost of participating in that activity.
66 This is referred to by economists as consumer surplus or net economic value.

67 **Electricity:** Electric current used or regarded as a source of power.

- 68 **Endangered:** A plant or animal species which is in danger of extinction throughout all or a
69 significant portion of its range because its habitat is threatened with destruction, drastic
70 modification, or severe curtailment, or because of overexploitation, disease, predation, or
71 other factors; federally endangered species are officially designated by the U.S. Fish and
72 Wildlife Service or the National Marine Fisheries Service and published in the *Federal Register*.
- 73 **Endemic:** Native or limited to a certain region.
- 74 **Energy:** As commonly used in the electric utility industry, electric energy means kilowatt-hours,
75 or joules (the level of power delivered multiplied by the amount of time that the level of power
76 is delivered). Used interchangeably with, although technically not a synonym of, power.
- 77 **Entrainment:** The drawing of fish and other aquatic organisms into tubes or tunnels carrying
78 water for cooling purposes into thermal plants, or for power generating purposes into
79 hydroelectric plants. Entrainment increases mortality rates for those organisms.
- 80 **Firm energy:** Energy considered ensurable to the customer to meet all agreed-upon portions of
81 the customer's load requirements over a defined period. As defined in Bonneville Power
82 Administration's system, electric energy produced under critical water conditions.
- 83 **Fishery:** Generally defined as a group of individuals or vessels that catch finfish or harvest
84 shellfish, with specific commonalities in activity, including the fish species or stock targeted, the
85 gear used, the location of activity, and the season of activity.
- 86 **Fish hatchery:** A facility in which fish eggs are incubated and hatched and juvenile fish are
87 reared for release to rivers or lakes.
- 88 **Fish ladders:** A series of ascending pools constructed to enable salmon or other fish to swim
89 upstream around or over a dam.
- 90 **Fish passage facilities:** Features of a dam that enable fish to move around, through, or over
91 without harm. Generally an upstream fish ladder or a downstream bypass system.
- 92 **Flow:** The volume of water passing a given point per unit of time.
- 93 **Flowgates:** Flowgates are points along a transmission system through which the power flow is
94 measured.
- 95 **Forebay:** The portion of the reservoir at a hydroelectric plant which is immediately upstream of
96 the generating station.
- 97 **Freshet:** A rapid temporary rise in streamflow caused by heavy rains or rapid snowmelt.
- 98 **Full pool:** The maximum level of a reservoir under its established normal operating range.

- 99 **Generation:** The act of producing electricity from other forms of energy or the amount of
100 electrical energy produced.
- 101 **Historical streamflow record:** The unregulated streamflow database of the 50 years beginning
102 in July 1928; data is modified to adjust for factors such as irrigation depletions and evaporations
103 for the particular operating year being studied.
- 104 **Hydraulic head:** The vertical distance between the surface of the reservoir and the surface of
105 the river immediately downstream from the turbines and dam.
- 106 **Hydroelectric:** The production of electric power through use of the gravitational force of falling
107 water.
- 108 **Hydrology:** The science of dealing with the continuous cycle of evapotranspiration,
109 precipitation, and runoff.
- 110 **Hydroregulation model:** A computer-based mathematical model that simulates the regulation
111 of water in the coordinated operation of a river system.
- 112 **Inflow:** Water that flows into a reservoir or forebay during a specified period.
- 113 **Intake:** The entrance to a conduit through a dam or water facility.
- 114 **Interruptible:** A supply of power which, by agreement, can be shut off on relatively short notice
115 (from minutes to a few days).
- 116 **Intertie:** A transmission line or system of transmission lines permitting a flow of energy
117 between major power systems. The Bonneville Power Administration transmission grid has
118 interties to British Columbia, Canada; California; and eastern Montana.
- 119 **Jobs:** Combined full- and part-time jobs on an annualized basis.
- 120 **Juvenile:** The early stage in the life cycle of anadromous fish when they migrate downstream to
121 the ocean.
- 122 **kcfs:** Thousand cubic feet per second; a measurement of water flow equivalent to 1,000 cubic
123 feet of water passing a given point in one second.
- 124 **Labor income:** includes employee compensation and proprietary income. Employee
125 compensation consists of wage and salary payments as well as benefits (e.g., health and
126 retirement benefits) and employer paid payroll taxes (e.g., employer social security
127 contributions and unemployment taxes). Proprietary income consists of payments received by
128 self-employed individuals (such as doctors and lawyers) and unincorporated business owners.
- 129 **Levee:** An embankment constructed to prevent a river from overflowing.

- 130 **Littoral zone:** The shallower waters near the shore of a reservoir or lake.
- 131 **Load:** The amount of electric power or energy delivered or required at any specified point or
132 points on a system. Load originates primarily at the energy-consuming equipment of customers.
- 133 **Load shaping:** The adjustment of storage releases so that generation and load are continuously
134 in balance.
- 135 **Lock:** A chambered structure on a waterway closed off with gates for the purpose of raising or
136 lowering the water level within the lock chamber so ships can move from one elevation to
137 another along the waterway.
- 138 **Low pool:** At or near the minimum level of a reservoir under its established normal operating
139 range.
- 140 **Macrophytes:** Aquatic plants that are macroscopic, or large enough to be seen with the naked
141 eye.
- 142 **Mainstem:** The principal river in a basin, as opposed to the tributary streams and smaller rivers
143 that feed into it.
- 144 **Megawatt (MW) and kilowatt (kW):** A watt is a measure of a unit of power. One megawatt
145 represents 1,000 kilowatts or 1 million watts. MW is a standard metric describing electric
146 power generating capacity.
- 147 **Megawatt hours (MWh) and kilowatt hours (kWh):** MWh and kWh are energy measurements
148 denoting electricity production or consumption. One MWh equals 1,000 kWh. In the electricity
149 context, power (MW) is the rate of producing, transferring, or using energy, and energy (MWh)
150 is power used over a period of time.
- 151 **Middle Columbia:** The section of the Columbia River from the U.S.-Canada border to its
152 confluence with the Snake River.
- 153 **Model:** A mathematical function with parameters that can be adjusted so that the function
154 closely describes a set of empirical data. A “mathematical” or “mechanistic” model is usually
155 based on biological or physical mechanisms and has model parameters that have real-world
156 interpretations. In contrast, “statistical” or “empirical” models involve curve-fitting to data
157 where the math function used is selected for its numerical properties. Extrapolation from
158 mechanistic models (e.g., pharmacokinetic equations) usually carries higher confidence than
159 extrapolation using empirical models (e.g., logic).
- 160 **Minimum operating pool (MOP):** The minimum elevation of the established normal operating
161 range of a reservoir.
- 162 **Operating limits:** Limits or requirements that must be factored into the planning process for
163 operating reservoirs and generating projects. (Also see operating requirements, below.)

- 164 **Operating requirements:** Guidelines and limits that must be followed in the operation of a
165 reservoir or generating project. These requirements may originate in authorizing legislation,
166 physical plant limitations, or other sources. Non-power operating requirements pertain to
167 navigation, flood control, recreation, irrigation, and other non-power uses of a river.
- 168 **Operating rule curve:** A curve, or family of curves, indicating how a reservoir is to be operated
169 under specific conditions and for specific purposes.
- 170 **Operating year:** The 12-month period from August 1 through July 31.
- 171 **Outages:** Periods, both planned and unexpected, during which the transmission of power stops
172 or a particular power-producing facility ceases to provide generation.
- 173 **Outflow:** The volume of water per unit of time discharged at a hydroelectric project.
- 174 **Pacific Northwest Coordination Agreement:** A binding agreement among Bonneville Power
175 Administration, the U.S. Army Corps of Engineers, U.S. Bureau of Reclamation, and the major
176 generating utilities in the Pacific Northwest that stemmed from the Columbia River Treaty. The
177 agreement specifies a multitude of operating rules, criteria, and procedures for coordinating
178 operation of the system for power production. It directs operation of major generation facilities
179 as though they belonged to a single owner.
- 180 **Pacific Northwest Electric Power Planning and Conservation Act:** In December 1980, Congress
181 passed this Act, Public Law 96-501 (referred to as the Northwest Power Act). This act
182 authorized the four Pacific Northwest States— Idaho, Montana, Oregon, and Washington—to
183 enter into an interstate compact for long-range planning and protection of shared resources. As
184 a result of the act, each of the four states passed enabling legislation to create the Northwest
185 Power Planning Council in April 1981.
- 186 **Particulates:** Substances that consist of minute separate particles, such as dust or soot.
- 187 **Peak load:** The maximum load in a stated period of time. It may be the maximum load at a
188 given instant in the stated period or the maximum average load within a designated interval of
189 the stated period of time. Peak can also be used to refer to the maximum capacity or energy.
- 190 **Peaking or peaking capacity:** The generating capacity available to assist in meeting that portion
191 of the load that is above baseload. Alternatively, the maximum output of a generating plant or
192 plants during a specified peak-load period.
- 193 **Phytoplankton:** The plant portion of floating or weakly swimming organisms, often microscopic
194 in size, in a body of water.
- 195 **Pool:** Reservoir; a body of water impounded by a dam.

- 196 **Power:** The rate of energy production or transfer. Power is expressed in watts and used
197 interchangeably with energy, although it is technically not a synonym of energy. Power
198 delivered to a load is also called demand.
- 199 **Project outflow:** The volume of water per unit of time discharged from a project.
- 200 **Record of Decision (ROD):** A document notifying the public of a decision made, together with
201 the reasons for making that decision. Records of Decision are published in the *Federal Register*.
- 202 **Recreation area:** A reservoir, river reach between reservoirs, or the Pacific Ocean off the coast
203 of Oregon and Washington, used for recreation. A recreation area may have one or more access
204 points.
- 205 **Redds:** Salmon spawning nests in gravel.
- 206 **Refill:** The point at which the hydro system is considered “full” from the seasonal snowmelt
207 runoff. Also refers to the annual process of filling a reservoir.
- 208 **Regional economic contributions:** These reflect economic activity within a specific geographic
209 region supported by expenditures for a particular economic sector (e.g., recreational visitation).
210 Contributions are often measured in terms of sales (spending), jobs, income, and value added,
211 though other measures may be used.
- 212 **Reliability:** For a power system, a measure of the degree of certainty that the system will
213 continue to meet load for a specified period of time.
- 214 **Reservoir elevations:** The levels of the water stored behind dams.
- 215 **Reservoir storage:** The volume of water in a reservoir at a given time.
- 216 **Resident fish:** Fish species that reside in fresh water throughout their lives.
- 217 **Residualize:** When migrating juvenile salmonid smolts lose their urge to migrate, physiologically
218 revert to their freshwater life form, and remain in fresh water rather than migrate to sea.
- 219 **Riprap:** Broken rock, cobbles, or boulders placed on the bank of a stream or river for protection
220 against the erosive action of water.
- 221 **Rule curves:** Water levels, represented graphically as curves, that guide reservoir operations.
- 222 **Run-of-river dams:** Hydroelectric generating plants that operate based only on available
223 streamflow and some short-term storage (hourly, daily, or weekly).
- 224 **Run-of-river reservoirs:** The pools or impoundments formed behind run-of-river dams.
- 225 **Salmonids:** Fish of the family Salmonidae, such as salmon, trout (including steelhead), char, and
226 whitefish.

- 227 **Scoping:** The process of defining the scope of a study, primarily with respect to the issues,
228 geographic area, and alternatives to be considered. The term is typically used in association
229 with environmental documents prepared under the National Environmental Policy Act.
- 230 **Secondary energy:** Hydroelectric energy in excess of firm energy, often used to displace
231 thermal resources. Sometimes called non-firm energy.
- 232 **Sedimentation:** The settling of material (such as dust or other particles) into water and
233 eventual deposition on the bottoms of streams and rivers.
- 234 **Shaping:** The scheduling and operating of generating resources to meet changing load levels.
235 Load shaping on a hydro system usually involves the adjustment of reservoir releases so that
236 generation and load are continuously in balance.
- 237 **Simulation:** The representation of an actual system by analogous characteristics of a device
238 that is easier to construct, modify, or understand, or by mathematical equations.
- 239 **Smolt:** A juvenile salmon or steelhead migrating to the ocean and undergoing physiological
240 changes to adapt its body from a freshwater to a saltwater environment.
- 241 **Spawning:** The releasing and fertilizing of eggs by fish.
- 242 **Spending:** Equivalent to the sales by firms in the region. This can be expressed in terms of (1)
243 recreation expenditures, and/or (2) final demand, which is the total sales by firms in the region
244 from all buyers, including recreationists, as well as businesses and households in subsequent
245 rounds of spending.
- 246 **Spill:** Water passed over a spillway without going through turbines to produce electricity. Spill
247 can be forced, when there is no storage capability and flows exceed turbine capacity, or
248 planned, for example, when water is spilled to enhance juvenile fish passage.
- 249 **Spillway:** Overflow structure of a dam
- 250 **Stochastic:** Involving chance or probability.
- 251 **Storage reservoirs:** Reservoirs that have space for retaining water from springtime snowmelts.
252 Retained water is released as necessary for multiple uses: power production, fish passage,
253 irrigation, and navigation.
- 254 **Streamflow:** The rate at which water passes a given point in a stream, usually expressed in
255 cubic feet per second.
- 256 **Subyearlings:** Juvenile fish less than 1 year old.
- 257 **Surplus energy:** Energy generated that is beyond the immediate needs of the producing
258 system. This energy may be sold on an interruptible basis or as firm power.

259 **System flood control:** Flood protection for the Portland, Oregon, and Vancouver, Washington,
260 metropolitan area that is coordinated among all of the storage reservoirs in the Columbia River
261 system.

262 **Tailrace:** The canal or channel that carries water away from a dam.

263 **Tailwater:** The water surface immediately downstream from a dam or hydroelectric
264 powerplant.

265 **Threatened:** Legal status afforded to plant or animal species that are likely to become
266 endangered within the foreseeable future throughout all or a significant portion of their range,
267 as determined by the U.S. Fish and Wildlife Service or the National Marine Fisheries Service.

268 **Transmission path:** A path refers to a route over which the power flows from one point to
269 another (i.e., the direction power flows across a transmission line).

270 **Tules:** The name commonly applied to fall chinook salmon originating on the lower Columbia
271 River.

272 **Turbidity:** A measure of the optical clarity of water, which depends on the light scattering and
273 absorption characteristics of suspended and dissolved material in the water.

274 **Turbine:** Machinery that converts kinetic energy of a moving fluid, such as falling water, to
275 mechanical or electrical power.

276 **Upper rule curve (URC):** The flood control rule curve for a storage reservoir which typically is
277 the uppermost of the family of rule curves used to guide reservoir operations.

278 **Upriver brights:** The name commonly applied to fall chinook salmon originating on the middle
279 Columbia River, primarily in the area below Priest Rapids Dam.

280 **Velocity:** Speed; the rate of linear motion in a given direction.

281 **Water conditions:** The overall supply of water to operate the Pacific Northwest hydroelectric
282 generating system at any given time, taking into account reservoir levels, snowpack, any needs
283 to provide water or retain water to meet various operating constraints (such as the water
284 budget, flood control, flow constraints, etc.), weather conditions, and other factors.

285 **Water particle travel time:** The theoretical time that a water particle would take to travel
286 through a given reservoir or river reach. It is calculated by dividing the flow (volume of water
287 per unit time) by the cross-sectional area of the channel.

288 **Water retention time:** The length of time that a particle of water is resident in a lake or
289 reservoir, based on rates of inflow, outflow, and circulation within the waterbody.

290 **Water rights:** Priority claims to water. In Western states, water rights are based on the principle
291 “first in time, first in right,” meaning older claims take precedence over newer ones.

292 **Water year:** One hydrologic cycle corresponding to Bonneville Power Administration’s fiscal
293 year, October 1 through September 30. Depending on streamflows a water year may be
294 defined as high, low, or average, or *critical*. The **critical water year** is a sequence of streamflows
295 under which the regional hydro system could produce an amount of power equal to that which
296 could have been produced during the historical critical period, given today’s generating
297 facilities and constraints.

298 **Yearlings:** One-year-old juvenile salmon and steelhead.

299 **Zooplankton:** Aquatic animals that cannot actively swim against the current and cannot make
300 their own food by photosynthesis.

301

DATUM CONVERSION

302 This table shows the vertical datum adjustment from NGVD29 to NAVD88 for the fourteen CRS
303 projects.

304 Vertical Datum Adjustment

Location	Datum Adjustment (feet)
Albeni Falls Dam	3.9
Bonneville Dam	3.3
Chief Joseph Dam	4.0
Dworshak Dam	3.3
Grand Coulee Dam	3.9
Hungry Horse Dam	3.9
Ice Harbor Dam	3.4
John Day Dam	3.2
Libby Dam	3.9
Little Goose Dam	3.2
Lower Granite Dam	3.4
Lower Monumental Dam	3.3
McNary Dam	3.3
The Dalles Dam	3.3

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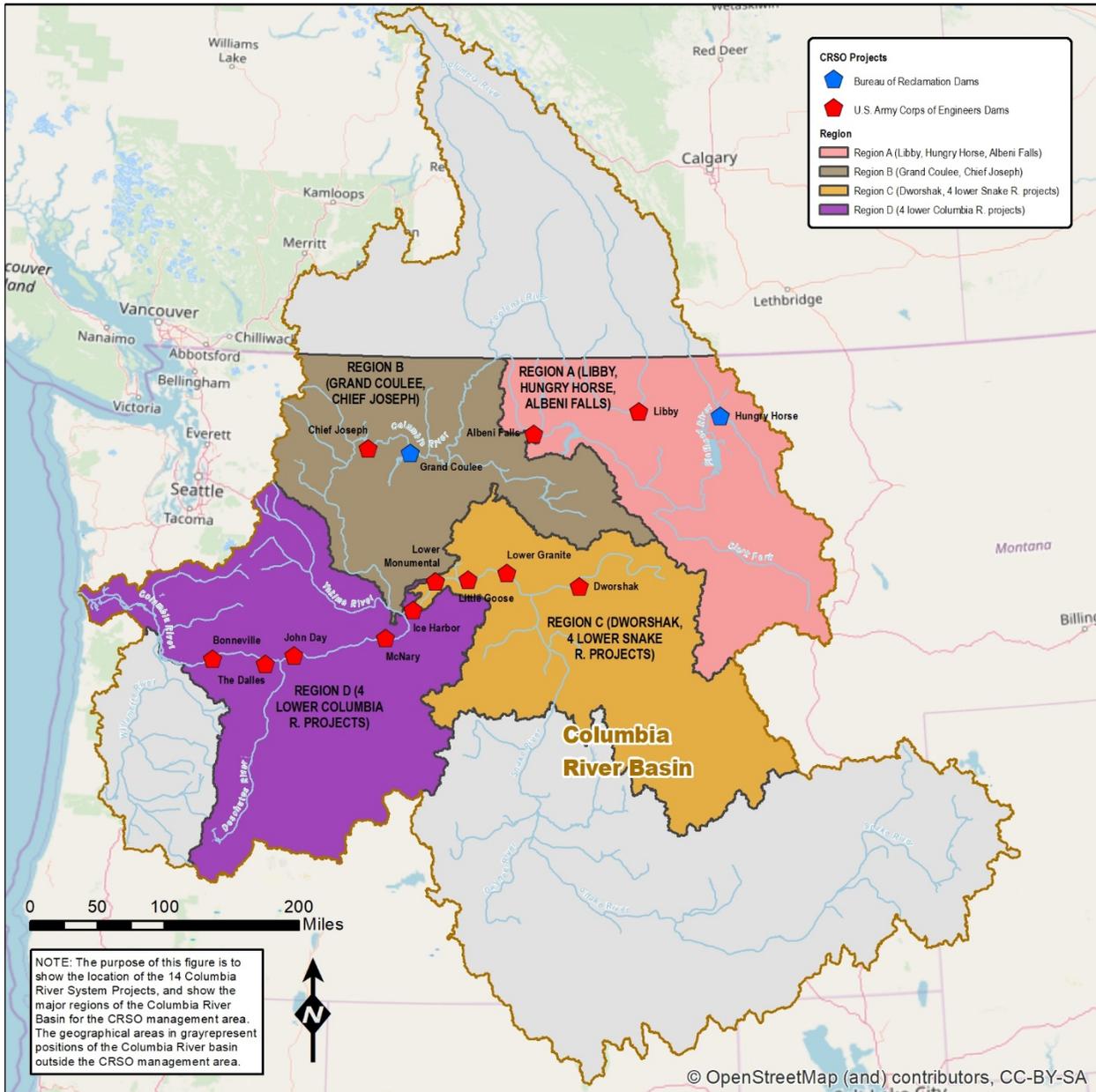
CHAPTER 1 - INTRODUCTION

2 1.1 BACKGROUND

3 The Columbia River is one the greatest natural resources in the western United States. The river
4 and its tributaries impact nearly every resident of the Northwest in some way, by providing
5 hydroelectric power, recreation opportunities, navigation, irrigation for crops, and more. The
6 Columbia River System’s Federal and non-Federal dams also provide hydroelectric energy
7 production for about half of regional demands. For thousands of tribal members whose
8 societies have been shaped over millennia by their proximity to and relationship with the
9 Columbia River and its tributaries, these water bodies are also an essential source of life and a
10 foundation of tribal spiritual and cultural connections. Many tribes have not only lost access to
11 traditional places on the river, but have lost access to the one thing that all these places had in
12 common, which bound them together—the salmon.

13 Today, a variety of projects in The Northwest waterways are operated for hydropower and
14 other purposes. There are approximately 375 major projects; 141 are owned by Federal
15 agencies, and 221 are owned by non-Federal entities. Of the 141 Federal projects, 31 generate
16 hydropower in addition to serving other purposes. These 31 multi-purpose dam and reservoir
17 projects make up the Federal Columbia River Power System (FCRPS), constructed and operated
18 by the U.S. Army Corps of Engineers (Corps) and the U.S. Bureau of Reclamation (Reclamation).
19 The Bonneville Power Administration (Bonneville) markets and delivers electric power from the
20 FCRPS. Each project within the FCRPS is operated to meet various congressionally authorized
21 purposes and other system-wide purposes.

22 Fourteen of the FCRPS projects are operated as a coordinated system known as the Columbia
23 River System within the interior Columbia River Basin in the states of Idaho, Montana, Oregon,
24 and Washington. The 14 CRS projects (“project” is used to collectively refer to a dam and its
25 associated reservoir) are Libby, Hungry Horse, Albeni Falls, Grand Coulee, Chief Joseph,
26 Dworshak, Lower Granite, Little Goose, Lower Monumental, Ice Harbor, McNary, John Day, The
27 Dalles, and Bonneville. Projects in the upper Snake, Willamette, and Rogue River Basins are
28 excluded from the CRS because these are coordinated and operated separately. Projects in
29 Canada are not operated by the co-lead agencies. Figure 1-1 shows the geographic locations of
30 the 14 CRS projects. The CRS consists of subbasins, each having distinct topographic,
31 meteorological, and/or hydrologic characteristics. These subbasins are grouped into four
32 regions, A to D, shown in Figure 1-1, that are referred to throughout this environmental impact
33 statement (EIS). The Corps, Reclamation, and Bonneville are preparing this EIS, as co-lead
34 agencies, under the requirements of the National Environmental Policy Act (NEPA), to identify
35 the environmental impacts associated with the operation, maintenance, and configuration
36 (management) of the CRS.



37
38 **Figure 1-1. Geographic Locations of the Columbia River System Projects**

39 The U.S. Congress authorized the Corps and Reclamation to construct, operate, and maintain
40 the CRS projects to meet multiple specified purposes, including flood risk management (FRM),
41 navigation, hydropower production, irrigation, fish and wildlife conservation, recreation, and
42 municipal and industrial (M&I) water supply. However, not every project is authorized for all of
43 these purposes. Bonneville is authorized to market and transmit the power generated by these
44 coordinated system operations. The following list provides more detail about these purposes:

- 45 • Flood Risk Management (FRM). Storage projects allow water managers to store water in
46 times of high flow volume to reduce the likelihood of flooding throughout the system.
- 47 • Water Supply/Irrigation. Some projects are operated for the storage and delivery of
48 irrigation and municipal and industrial (M&I) water. For example, water pumped from Lake
49 Roosevelt behind Grand Coulee Dam is delivered downstream to Banks Lake for irrigation
50 and M&I. John Day is operated to meet elevation requirements to allow for pumping water
51 for irrigation. Other projects, such as the lower Snake River projects, provide the incidental
52 benefit of pumping by maintaining elevations for other purposes, such as navigation.
- 53 • Hydroelectric Power Generation. The Federal dams in the Northwest supply about 27
54 percent of the region’s power under average water conditions (Bonneville 2019c).
- 55 • Navigation. The four lower Columbia River dams and four lower Snake River dams have
56 navigation locks that allow passage for boats and barges to facilitate the transport of goods
57 to and from the Pacific Ocean and inland ports as far upstream as Lewiston, Idaho.
- 58 • Recreation. The reservoir and adjacent public (or park) lands provide recreational
59 opportunities for boaters, anglers, swimmers, wind and kite surfers, hunters, hikers, and
60 campers throughout the year.
- 61 • Fish and Wildlife. The Corps and Reclamation operate the system to support the protection
62 and conservation of fish and wildlife species in the Columbia River Basin. Bonneville
63 supports efforts to mitigate for the effects of development and operation of the FCRPS. This
64 includes the impacts of the CRS on fish and wildlife in the mainstem Columbia River and its
65 tributaries, pursuant to the Pacific Northwest Power Act, in a manner consistent with the
66 Northwest Power and Conservation Council’s Fish and Wildlife Program.¹

67 An overview of the CRS is provided in Section 1.9, *Introduction to Columbia River System*
68 *Operations*.

69 In the 1990s, the co-lead agencies analyzed the environmental impacts of operating the system
70 in the Columbia River System Operation Review (SOR) EIS, and issued respective records of
71 decision (RODs) in 1997 that adopted a system operation strategy. This strategy included
72 operations supporting fish listed under the Endangered Species Act (ESA), while fulfilling all
73 other congressionally authorized purposes. Operational changes have been adopted under
74 subsequent ESA consultations and project-specific NEPA documents. Changed environmental
75 conditions in the Columbia River Basin, and new scientific information since the release of the
76 SOR EIS, have triggered a reevaluation of the coordinated CRSO. In preparing this EIS, the co-
77 lead agencies are also responding to the Opinion and Order issued by the U.S. District Court for
78 the District of Oregon² (see Section 1.2 for more information).

¹ Pacific Northwest Electric Power Planning and Conservation Act of 1980 (Northwest Power Act) (16 U.S.C § 839b (h)(10)(A)).

² *National Wildlife Federation, et al. v. National Marine Fisheries Service, et al.*, 184 F. Supp. 3d 861 (D. Or. 2016).

79 **1.2 PURPOSE AND NEED FOR ACTION**

80 The ongoing action that requires evaluation under NEPA is the long-term coordinated operation
81 and management of the CRS projects for the multiple purposes identified above. An underlying
82 need to which the co-lead agencies are responding, is to review and update the management of
83 the CRS, including evaluating measures to avoid, offset, or minimize impacts to resources
84 affected by managing the CRS in the context of new information and changed conditions in the
85 Columbia River Basin since the SOR EIS was released. In addition, the co-lead agencies are
86 responding to the Opinion and Order issued by the U.S. District Court for the District of Oregon
87 (District Court) which states that the EIS should evaluate how to ensure that the prospective
88 management of the CRS is not likely to jeopardize the continued existence of any endangered
89 or threatened species, or result in the destruction or adverse modification of designated critical
90 habitat. This includes evaluating mitigation measures to address impacts to listed species from
91 CRS operations. The EIS evaluates actions within the current authorities of the co-lead agencies,
92 as well as certain actions that are not within their authorities, based on the District Court's
93 observations about alternatives that could be considered and comments received during the
94 scoping process. The EIS also allows the co-lead agencies and the region to evaluate the costs,
95 benefits, and tradeoffs of various alternatives as part of reviewing and updating the
96 management of the CRS.

97 The co-lead agencies will use the information garnered through this process to guide future
98 decisions, and allow for a flexible approach to meeting multiple responsibilities including
99 resource, legal, and institutional purposes of the action.

100 • Resource Purposes:

- 101 ○ Provide for a reliable level of FRM by operating the CRS to afford safeguards for public
102 safety, infrastructure, and property
- 103 ○ Provide an adequate, efficient, economical, and reliable power supply that supports the
104 integrated Columbia River Power System
- 105 ○ Provide water supply for irrigation, municipal, and industrial uses
- 106 ○ Provide for waterway transportation capability
- 107 ○ Provide for the conservation of fish and wildlife resources, including threatened,
108 endangered, and sensitive species throughout the environment affected by CRS
109 operations
- 110 ○ Consider and plan for climate change impacts on resources, and on the management of
111 the CRS
- 112 ○ Provide opportunities for recreation at CRS lakes and reservoirs
- 113 ○ Protect and preserve cultural resources

- 114 • Legal and Institutional Purposes:
 - 115 ○ Act within the authorities granted to the agencies under existing statutes, and when
 - 116 applicable, identify where new statutory authority may be needed
 - 117 ○ Comply with environmental laws and regulations and all other applicable Federal
 - 118 statutory and regulatory requirements, including those specifically addressing the CRS
 - 119 such as requirements under the Northwest Power Act “to adequately protect, mitigate,
 - 120 and enhance fish and wildlife, including related spawning grounds and habitat, affected
 - 121 by such projects or facilities in a manner that provides equitable treatment for such fish
 - 122 and wildlife with the other purposes for which such system and facilities are managed
 - 123 and operated.” (16 United States Code [U.S.C.] § 839b(11)(A))
 - 124 ○ Protect Native American treaty and reserved rights and fulfill trust obligations for
 - 125 natural and cultural resources throughout the environment affected by CRS operations
 - 126 ○ Continue to use a collaborative Regional Forum framework to allow for flexibility and
 - 127 adaptive management of the CRS
 - 128 ○ Ensure project Water Control Manuals adequately reflect the management of the CRS

129 **1.3 SCOPE OF THE PROJECT**

130 **1.3.1 Geographic and Temporal Scope**

131 The Columbia River is one of the largest rivers in North America. With its tributaries, it forms
132 the dominant water system in the Northwest Region. It is the fourth largest river in the United
133 States, as measured by average annual flow. The Columbia River originates in British Columbia,
134 at Columbia Lake on the west slope of the Rocky Mountains. The river enters the United States
135 in the northeastern corner of the state of Washington. It then flows south and west, then
136 southeasterly to its confluence with the Snake River near Pasco, Washington. It turns westward,
137 forming the Washington-Oregon border before flowing into the Pacific Ocean near Astoria,
138 Oregon. Four of the major tributaries to the Columbia River in the United States are the
139 Kootenai, Clark Fork, Pend Oreille, and Snake rivers.

140 The specific geographic scope of the CRS proposed alternatives encompasses the 14 Federal
141 projects on the Columbia River and its major tributaries (Figure 1-1). The other Federal projects
142 in the Columbia River Basin (e.g., the Willamette Valley projects, the Yakima Valley projects,
143 and other Federal projects on the Snake River) and non-Federal projects in the basin, are not
144 included in the specific geographic scope for the effects analysis because operation of those
145 other projects are separate actions carried out under different legal authorities.³ In addition,
146 three Canadian projects in the Canadian portion of the basin are partially coordinated with the
147 CRS under the Columbia River Treaty (CRT). These other projects may be included in the

³ For example, the Willamette Basin System, operated by the Corps, is authorized in part by several of the same Flood Control Acts as some of the CRS projects. However, as outlined in these authorizations, the Willamette System was designed as a comprehensive plan of development specific to the Willamette Basin, which would be operated as a separate system from the CRS.

148 cumulative effects analysis, as appropriate (refer to Chapter 6, *Cumulative Effects*). The
149 potential for any significant effects of the alternatives that could arise in Canadian portions of
150 the basin were reviewed in general as a matter of policy.

151 The temporal scope of this analysis is assumed to be 25 years from the signing of the Records of
152 Decision (RODs), with the exception of the socioeconomic-related resource analysis. For the
153 socioeconomic analysis, a 50-year period of analysis is used to better capture the full array of
154 costs, benefits, and tradeoffs being evaluated in the alternatives. The 50-year period of analysis
155 provides a long-term perspective, and enables the socioeconomic analysis to distinguish
156 between short-term impacts that may occur during the implementation of alternatives and
157 long-term effects that would occur after implementation is completed. The assumption for
158 analysis in the draft EIS is that any alternative would be implemented immediately after the
159 ROD is signed. Recognizing the uncertainty around particular structural and mitigation
160 measures and the time required for implementation, a sensitivity analysis was completed to
161 determine the effect of construction timing on costs and is provided in the cost analysis.

162 **1.4 COLUMBIA RIVER SYSTEM OPERATIONS INTERAGENCY TEAM**

163 **1.4.1 Co-Lead Agencies**

164 The co-lead agencies (the Corps, Reclamation, and Bonneville) share responsibility and legal
165 authority for managing the Federal elements of the CRS. These three co-lead agencies
166 coordinate the operation of the CRS and have worked together to develop this EIS.

167 The Corps and Reclamation develop operating requirements for their projects. These are the
168 limits within which a reservoir or dam must be operated. Some requirements are established by
169 Congress when a project is authorized, while others are established by the agencies based on
170 operating experience. Within these operating limits, Bonneville schedules and dispatches
171 power. This process requires continuous communication and coordination among the three
172 agencies.

173 **1.4.1.1 *The U.S. Army Corps of Engineers***

174 The Corps operates and maintains 12 of the 14 projects being evaluated as part of the CRSO EIS.
175 Nine of these projects are operated on the lower Snake and Columbia rivers, while three
176 provide storage in the upper reaches of the Columbia River Basin. The Corps has a major role in
177 coordinating multiple uses in the system. It is responsible for system FRM in the basin,
178 maintaining navigation locks and channels to accommodate river passage, producing
179 hydropower, maintaining recreation facilities, and operating fish passage facilities.

180 **1.4.1.2 *The U.S. Bureau of Reclamation***

181 Reclamation operates two CRS storage projects: Grand Coulee and Hungry Horse. Grand Coulee
182 Dam Project plays a prominent role in the coordinated CRS because of its size (approximately
183 5.4 million acre-feet [Maf] of storage in Lake Roosevelt) and key location. Grand Coulee is the

184 largest CRS project used for FRM and is a key generator and regulator for hydropower.
185 Additionally, Grand Coulee Dam serves as the primary water diversion facility for the Columbia
186 Basin Project and its irrigation system. Storage at Hungry Horse is very valuable because of its
187 headwaters location. The water released from Hungry Horse passes through many downstream
188 dam and reservoir projects—both Federal and non-Federal. Hungry Horse provides local and
189 system FRM and hydropower. Additionally, flow augmentation delivered from Hungry Horse
190 benefits both resident and anadromous fish as it passes downstream.

191 **1.4.1.3 Bonneville Power Administration**

192 Bonneville markets and distributes power generated at the Federal dams on the Columbia River
193 and its tributaries. The not-for-profit agency sells power from the dams and other generating
194 plants to public and private utilities and large industries. The agency also owns and operates
195 over 15,000 miles of high voltage transmission lines to deliver the electricity. Federal law
196 requires Bonneville, when providing electricity produced at the Federal dams, to give
197 preference to publicly owned utilities and entities in the Northwest.

198 **1.4.2 Co-Lead Agency Framework**

199 The co-lead agencies established a project organizational structure to analyze the broad range
200 of alternatives for this EIS. Multiple interagency technical teams, consisting of co-lead agency
201 staff and cooperating agencies, represented the resources analyzed. The technical teams
202 provided subject matter expertise in the preparation of the draft EIS and interacted with the
203 other technical teams.

204 **1.4.3 Cooperating Agency Involvement**

205 The co-lead agencies asked tribes and Federal, state, and local agencies to participate as
206 cooperating agencies based on their jurisdiction by law, or their special expertise with respect
207 to any environmental issue evaluated in this EIS. The agencies and tribes listed in Table 1-1
208 accepted the request and are cooperating agencies for this project. These cooperating agencies
209 contributed to the draft EIS by providing information, participating on technical teams, and
210 reviewing draft documents. A more in-depth discussion is located in Chapter 9, *Coordination
211 and Public Involvement Process*.

212 **Table 1-1. Columbia River System Operations Environmental Impact Statement Cooperating**
213 **Agencies**

Cooperating Agencies
Federal Agencies
U.S. Environmental Protection Agency, Region 10
U.S. Coast Guard, 13th Coast Guard District
U.S. Department of the Interior, Bureau of Indian Affairs
State Agencies
<i>Idaho</i>
Governor's Office of Species Conservation ^{1/}

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Cooperating Agencies
Governor's Office of Energy and Mineral Resources
Department of Fish and Game
Department of Agriculture
Department of Lands
Department of Environmental Quality
Historic Preservation Office
Department of Parks and Recreation
Department of Water Resources
Idaho Department of Transportation
<i>Oregon</i>
Department of Fish and Wildlife ^{1/}
Department of Energy
Water Resources Department
Department of Agriculture
Department of Environmental Quality
<i>Montana</i>
Montana Office of the Governor ^{1/}
Montana Fish, Wildlife and Parks
<i>Washington</i>
Department of Ecology
Department of Fish and Wildlife ^{1/}
Department of Agriculture
County Agencies
Lake County, Montana
Tribes
Confederated Salish and Kootenai Tribes of the Flathead Reservation
Confederated Tribes of the Colville Reservation
Confederated Tribes of the Grand Ronde
Confederated Tribes of the Umatilla Indian Reservation
Confederated Tribes and Bands of the Yakama Nation
Cowlitz Indian Tribe
Kootenai Tribe of Idaho
Nez Perce Tribe
Burns Paiute Tribe
Fort McDermitt Paiute and Shoshone Tribes of the Fort McDermitt Indian Reservation
Shoshone-Paiute Tribes of the Duck Valley Reservation
Shoshone-Bannock Tribes of the Fort Hall Reservation
Spokane Tribe of Indians ^{2/}
Intertribal Organization
Upper Snake River Tribes Foundation on behalf of Burns Paiute Tribe, Fort McDermitt Paiute-Shoshone Tribe, and Shoshone-Paiute Tribes of the Duck Valley Reservation.

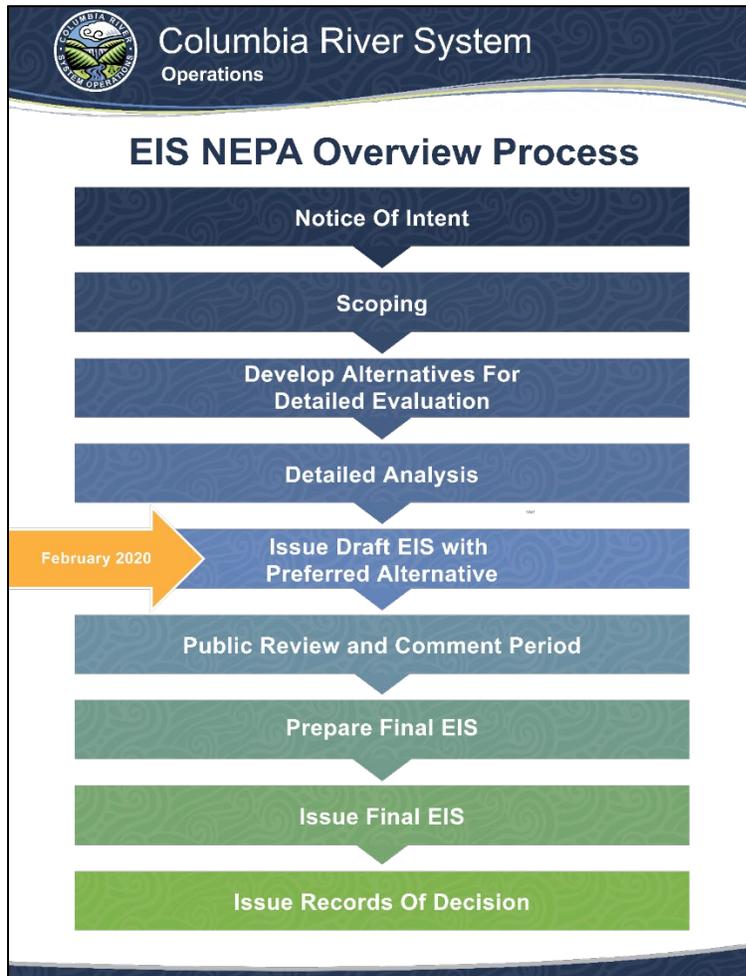
214 1/ Lead for that state's Memorandum of Understanding.

215 2/ Continued discussions concerning the Spokane Tribe of Indian's cooperating agency status are ongoing.

215 **1.5 NATIONAL ENVIRONMENTAL POLICY ACT PROCESS AND PUBLIC INVOLVEMENT**

216 **1.5.1 Overview of the National Environmental Policy Act Process**

217 Two major purposes of the NEPA process are better-informed decisions and public
218 involvement. This EIS provides information necessary for decision-makers to fully evaluate a
219 range of alternatives and adopt a long-term operation strategy for the CRS. It fully addresses
220 the potential impacts of alternatives, as required under the NEPA of 1969, as amended (42
221 U.S.C. § 4321 et seq.); Council on Environmental Quality (CEQ) regulations (40 Code of Federal
222 Regulations [C.F.R.] §§ 1500–1508); Corps Engineer Regulation (ER) 200-2-2 (33 C.F.R. § 230);
223 Department of Energy's NEPA Implementing Procedures (10 C.F.R. § 1021); Department of the
224 Interior (DOI) NEPA Regulations (43 C.F.R. § 46); and the DOI Departmental Manual Chapter
225 516. A brief description of public involvement can be seen in Section 1.5.2, while a more in-
226 depth discussion is located in Chapter 9, *Coordination and Public Involvement Process*.
227 Figure 1-2 illustrates the EIS NEPA Overview Process and where the co-lead agencies are in the
228 process.



229 **Figure 1-2. The Environmental Impact Statement National Environmental Policy Act Overview**
230 **Process**
231

232 **1.5.2 Public Involvement**

233 Public involvement is required by NEPA before a Federal agency undertakes an action affecting
234 the environment. The purpose of public involvement is to support informed decision-making.
235 This section gives an overview of the public involvement process for this project, including
236 public scoping and tribal coordination. Chapter 9, *Coordination and Public Involvement Process*,
237 provides a more in-depth discussion.

238 **1.5.2.1 Public Scoping**

239 One of the first steps in the NEPA process is to establish the scope of the project, and one
240 component of accomplishing this step is the public scoping process. The co-lead agencies
241 implemented a robust public scoping process intended to provide ample opportunity for the
242 public to engage. The public was invited to provide assistance in defining the issues, concerns,
243 and scope of alternatives to be addressed. The Notice of Intent (NOI) was published in the
244 *Federal Register* on September 30, 2016 (81 Federal Register [FR] 67382). The public comment
245 period was scheduled to end January 17, 2017, and a schedule was announced for 15 public
246 meetings and two webinars. In addition, a public scoping letter was sent to interested parties
247 on September 30, 2016. On November 4, 2016, the co-lead agencies issued a *Federal Register*
248 notice of an additional public meeting to be held in Pasco, Washington (81 FR 76962). On
249 January 3, 2017, the comment period was extended to February 7, 2017 (82 FR 137).

250 In addition, the co-lead agencies issued a series of press releases and newspaper
251 advertisements announcing the public meetings. A public website (www.crsso.info) was
252 established at the time of the NOI to communicate and share information about the CRSO EIS.
253 The 16 open-house public meetings were held across the region (Figure 1-3). Two webinars
254 were held on December 13, 2016.

255 The co-lead agencies received more than 400,000 comments during the scoping period and
256 these were summarized into the *Public Scoping Report for the Columbia River System*
257 *Operations Environmental Impact Statement*, October 2017, which can be found at
258 www.crsso.info and is incorporated by reference herein. Members of the public, tribes, local and
259 state governmental agencies, non-governmental organizations, and other stakeholders
260 provided these comments.



261
262 **Figure 1-3. Map of Public Scoping Meeting Locations**

263 **1.5.2.2 Public Involvement on the Draft Environmental Impact Statement**

264 The public comment period, during which any person or organization may comment on the
 265 draft EIS, is mandated by Federal laws. For the CRSO Draft EIS, the public comment period will
 266 be open for 45 days. The purpose of this review is to seek input on the alternatives considered,
 267 effects of the alternatives, and associated mitigation. The co-lead agencies will consider all
 268 comments received during the comment period. The complete list of comments regarding the
 269 draft EIS and co-lead agencies' responses will be included as an appendix to the CRSO Final EIS.
 270 The co-lead agencies will host multiple public meetings throughout the region during the public
 271 comment period. In addition to accepting comments during the public meetings, comments will
 272 be accepted via mail or the CRSO website.

273 **1.5.2.3 Tribal Coordination and Government-to-Government Consultation**

274 Since time immemorial, Native American tribes have inhabited the Columbia River Basin. These
 275 tribes successfully subsisted on the abundant natural resources of the area, and built thriving
 276 communities that relied on the lands to sustain their way of life. Through treaties, executive
 277 orders, judicial decisions, and legislation, tribes ceded most of their aboriginal territory to the

278 United States. Tribes retained smaller portions of land for their reservations. Many tribes,
279 through treaties, retained the right to hunt, fish, and gather in their usual and accustomed
280 locations, including areas outside of their reservations. The potentially affected area of the CRS
281 includes portions of tribal reservations, trust lands, and ceded lands of 19 federally recognized
282 tribes. Reservoirs that are part of the CRS system inundate parts of three existing Indian
283 reservations: the Colville and Spokane reservations, which are partially inundated by Lake
284 Roosevelt, and the Nez Perce Reservation, which is partially inundated by Dworshak Reservoir.
285 In fact, half of Grand Coulee Dam’s reservoir, Lake Roosevelt, lies within the Colville
286 Reservation. In some cases, the U.S. Government has entered into special agreements with
287 these tribes regarding management of the reservoirs because of their location within
288 reservations.

289 The co-lead agencies have a unique legal and political relationship with tribal governments as
290 sovereigns. This Federal trust responsibility is established through, and confirmed by, the U.S.
291 Constitution, treaties, statutes, executive orders, and judicial decisions. The co-lead agencies
292 have regulations and tribal policies regarding the trust responsibility (refer to Chapters 8 and 9).
293 In recognition of the Federal government’s trust responsibility, the co-lead agencies engage in
294 regular and meaningful government-to-government consultation and collaboration with tribal
295 governments when a proposed action may affect a tribe or its resources. In an effort to ensure
296 regular engagement and participation in the CRSO EIS, multiple avenues were identified for
297 tribal engagement:

- 298 • Participation in the NEPA process as a Cooperating Agency (see Section 1.4.3, *Cooperating*
299 *Agency Involvement*).
- 300 • Tribal engagement and consultation on a government-to-government level.
- 301 • Through existing processes developed under the Columbia Basin Fish Accords.

302 Before the public scoping notice was published in the *Federal Register* on September 30, 2016,
303 the co-lead agencies initiated an engagement and consultation process with the 19 federally
304 recognized Native American tribes and three tribal organizations in the Columbia River Basin
305 that are potentially impacted by proposed actions being evaluated in the EIS. The co-lead
306 agencies took a three-tiered approach to ensure successful tribal engagement and consultation
307 throughout the development of the CRSO EIS. The co-lead agencies also indicated that, upon
308 request, one-on-one, government-to-government consultation with any individual tribe was
309 available at any time throughout the CRSO EIS process.

310 The three-tiered strategic approach to tribal engagement and government-to-government
311 consultation was intended to emphasize information sharing and communication with tribal
312 technical staff to ensure policy staff and leadership were regularly and sufficiently informed
313 throughout the CRSO EIS process. At the first tier, technical issues were raised by technical or
314 policy tribal staff and resolved, whenever possible. Unresolved issues were then raised to the
315 second tier—Deputy Level Meetings. The third tier, Executive Level Meetings, was intended to
316 ensure tribal leadership were informed of the EIS development and to address any issues not

317 resolved at the Technical or Deputy level, as well as to consult on major decision points in the
318 CRSO EIS process directly with the co-lead agency Executives.

319 *Tier 1 – Technical Level Meetings:* Attended by the technical staff of the three co-lead agencies
320 and key subject matter experts. These meetings were held quarterly at a staff level throughout
321 the NEPA process or more frequently to meet the needs of tribal participants. These meetings
322 provided tribal staff with information critical to preparing tribal leadership for Deputy and
323 Executive level meetings. The co-lead agencies conducted technical level meetings in person
324 and via webinars and conference calls.

325 *Tier 2 – Deputy Level Meetings:* Attended by deputies and appropriate support staff from the
326 three co-lead agencies. A morning session was held to provide meaningful dialog and updates
327 on the project, with time set aside in the afternoon for consultation sessions with individual
328 tribes. The co-lead agencies held the Deputy level meetings in various locations around the
329 region to make it as convenient as possible to tribal participants to attend; the locations usually
330 included Boise, Idaho; Spokane, Washington; and Portland, Oregon. These regional meetings
331 were held in person at appropriate intervals, prior to Executive level meetings, or as requested
332 by tribal leaders.

333 *Tier 3 – Executive Level Meetings:* These sessions were attended by executives and appropriate
334 support staff from the three co-lead agencies. Time was set aside in the afternoon for
335 consultation sessions with individual tribes. As with the Deputy level meetings, the co-lead
336 agencies held Executive level meetings in multiple locations around the region to make it as
337 convenient as possible for tribal leaders to participate. These regional meetings were held in
338 person when significant project milestones were achieved. Executive level meetings occurred
339 once a year, or as requested by tribal leaders.

340 Individual tribes were also afforded consultation meetings with appropriate co-lead agency
341 staff or Executives when requested. Additionally, co-lead agency staff and tribal liaisons
342 contacted each tribe’s designated points of contact.

343 **1.5.2.4 Tribal Perspectives**

344 The co-lead agencies have included a “Tribal Perspectives” section in the CRSO EIS to provide an
345 opportunity for tribes to offer their unique perspective on the impacts of the CRS specific to
346 their respective tribe. This section can be found in Chapter 3.17, *Indian Trust Assets, Tribal
347 Perspectives, and Tribal Interests*. This Tribal Perspectives narrative is intended to convey
348 impacts to non-property based cultural resources. Each of the 19 tribes had an opportunity to
349 provide their narrative to address the Tribal Perspectives section in a holistic manner. Eleven
350 tribes provided tribal perspectives.

351 The evaluation of CRSO EIS alternatives and impacts on many of the resources important to
352 tribes throughout the Columbia River Basin (e.g., salmon, resident fish, and lamprey, as well as
353 cultural resources) were analyzed in the alternatives of the CRSO EIS. For example, many tribes
354 share overlapping interests in the Columbia River Basin. However, potential CRS impacts may

355 be unique to individual tribes based on many factors, including where they were historically
356 located, where they are currently located, and which resources are impacted in those locations.
357 In most instances, the CRSO EIS analysis focused on impacts to specific resources affected by a
358 proposed alternative.

359 **1.6 KEY ISSUES AND RESOURCE CONCERNS**

360 During the NEPA public scoping process, the cooperating agencies, tribes, the public, and
361 stakeholders identified issues and concerns to the co-lead agencies. Section 1.6.1, *Issues*
362 *Identified during Scoping*, points out three issues that repeatedly were brought up during the
363 scoping process. Section 1.6.2, *Resource Concerns*, provides an overview of various public
364 concerns, presented by resource, which arose in the scoping process.

365 **1.6.1 Issues Identified During Scoping**

366 During scoping, much of the discussion focused on the specific needs of individual river issues
367 or resources. For a more in-depth discussion, refer to Chapter 9, *Coordination and Public*
368 *Involvement Process*. Several key issues identified were ESA-listed fish, climate change, and
369 socioeconomics.

370 Many comments regarding ESA-listed fish were received. These comments were specifically
371 directed at the relationship between ESA-listed fish species (e.g., salmon, steelhead, bull trout,
372 and white sturgeon) and dam configuration and operations. The effects of the CRS on both
373 anadromous and resident ESA-listed fish, as well as non-ESA-listed fish, have been debated in
374 the region over the last several decades. The implementation of fish improvement technologies
375 and structures, and ways to optimize the system for fish is an ongoing discussion for Federal,
376 state, local, and tribal entities in the Columbia River Basin. In addition to ESA-listed fish, many
377 scoping comments were received regarding ESA-listed Southern resident killer whales and how
378 they will be addressed through this process when assessing impacts to salmon populations.

379 Another key issue expressed in scoping comments was the need for climate change to be
380 addressed in the EIS, particularly with respect to how the system would be affected by a
381 changing environment, as well as water quantity and quality (particularly stream and reservoir
382 temperatures), salmonid survival and recovery, hydropower production, and groundwater
383 recharge. Increasing temperatures, reduced snowpack, altered amounts and timing of runoff,
384 drought, and low water conditions were of specific concern, as were how factors contributing
385 to climate change (e.g., greenhouse gas emissions) could potentially be affected by actions in
386 the Columbia River Basin.

387 Socioeconomic scoping comments were directed primarily at the positive and negative effects
388 of the proposed action to tourism, recreation, fisheries, hydropower generation, flood control,
389 industry, transportation, and agriculture. Potential impacts to the existing Columbia and Snake
390 river navigation system are of concern to many in the Columbia River Basin. In addition, the
391 scoping comments expressed concerns regarding potential effects to recreation (boating,
392 fishing, etc.) as a result of actions impacting fish and wildlife.

393 *Tribal Issues Identified During Scoping*

394 During scoping for the CRSO EIS, tribes expressed concerns about the impacts the system has
395 had on natural resources, cultural resources and ways of life. The tribes in the Basin expressed
396 concerns about impacts on tribal economics with regards to fishing, hunting, and their culture,
397 such as preserving their language and tribal way of life. In addition, some tribes had comments
398 about how they cope with levels of poverty, ill health, and unemployment at significantly higher
399 proportional rates than any other ethnic group in the country, which in turn leads to
400 significantly higher mortality rates in comparison to non-native communities. Throughout the
401 document, the co-lead agencies have considered effects to tribal interests that were provided
402 in their Tribal Perspectives.

403 **1.6.2 Resource Concerns**

404 A variety of interests are represented throughout the Columbia River Basin, and not all of those
405 interests are compatible; thus, tradeoffs between resources must occur. The following is a short
406 description of each major resource and a summary of concerns about each expressed during
407 scoping.

408 **1.6.2.1 Navigation**

409 The key navigation interests on the CRS are those people and businesses with economic ties to
410 ships, barges, and port facilities that rely on Federal facilities in the CRS to provide the
411 waterway infrastructure. People concerned about the ability to navigate the waters of the CRS
412 emphasized the importance of waterborne commerce as an element of the regional economy
413 and the need to maintain adequate channel depths for navigation.

414 **1.6.2.2 Flood Risk Management**

415 People in flood-prone areas have an interest in FRM in the Northwest. Maintaining existing
416 FRM levels is important to those interests, as are accurate flood forecasting efforts for efficient
417 reservoir storage and water releases. Some have expressed concerns regarding impacts
418 experienced in the upper Columbia River Basin from reservoir FRM operations aimed at
419 protecting flood-prone areas along the lower Columbia River.

420 **1.6.2.3 Water Supply and Irrigation**

421 The primary irrigation customers of the system are those farmers who divert or pump water
422 from rivers and reservoir pools to irrigate their crops. These customers emphasize the
423 economic benefits of agriculture to the region, and are concerned with maintaining adequate
424 reservoir elevations to accommodate irrigation pumps and ensure the continued availability of
425 stored water for irrigation.

426 **1.6.2.4 Power Generation**

427 Hydropower provides low cost electricity, helps meet state and local carbon emission goals,
428 provides resiliency to the interconnected power system and, when available, is a low-cost
429 flexible resource that can be used to integrate alternative energy resources into the power grid.
430 At times both Federal CRS dams and non-Federal dams produce large quantities of excess
431 electricity that is surplus to meeting regional firm power load demands. Such surplus power is
432 regularly offered for sale to purchasers throughout the western United States and Canada.
433 Many parties stressed how vitally important hydropower is to the regional economy. Numerous
434 commenters expressed concern that clean, historically affordable hydropower might be
435 replaced with other energy resources like fossil-fuel powered generation such as natural gas
436 power or small modular nuclear reactors. These other types of energy may be more expensive,
437 unproven, or more ecologically damaging. Commenters expressed concern that this EIS process
438 may result in decisions that would compromise the region's historic hydropower resource base.
439 Other power-related concerns included energy conservation, increased generating efficiency,
440 and keeping electricity rates low.

441 **1.6.2.5 Anadromous Fish**

442 Tribes, states, the public, commercial and sport fishing groups, and Federal fishery
443 management agencies are concerned about how the projects affect, and will continue to affect,
444 anadromous fish survival and recovery. Many expressed the importance of the salmon and
445 lamprey contribution to the environment, regional economy, and ecosystem of the Pacific
446 Northwest.

447 **1.6.2.6 Resident Fish and Resident Fish Habitat**

448 The primary interests related to resident fish and their habitat includes the tribes, state and
449 Federal fishery management agencies, anglers, and businesses that serve the anglers. These
450 interests believe resident fish should be considered just as important as anadromous fish in CRS
451 operations. They would like to see storage reservoirs operated to benefit resident fish or limit
452 the effects of storage operations on resident fish.

453 **1.6.2.7 Wildlife and Wildlife Habitat**

454 Tribes, resource managers, hunters, and sightseers are important interest groups for wildlife
455 and wildlife habitat. For the tribes, wildlife is important to cultural and ecological integrity. They
456 seek to place more emphasis on wildlife in system operations by preserving and restoring
457 habitat and wetlands, improving water quality, and changing river flows to benefit wildlife.
458 During scoping, many people expressed how much they value orcas, including ESA-listed
459 Southern resident killer whales.

460 **1.6.2.8 Recreation**

461 CRS projects provide recreational opportunities for the public in a variety of ways. Outfitters,
462 guides, boaters, marina owners, and tribal, local, state, and Federal agencies providing
463 recreation-related services, represent these interests. They emphasize the economic and social
464 impacts reservoir operations have on regions and communities dependent on recreation and
465 tourism. Some river recreational interests would like more opportunities for whitewater
466 recreation. In addition, recreational fishing groups have concerns about effects on fish and
467 what improvements have been or could be made.

468 **1.6.2.9 Cultural Resources**

469 The Columbia River Basin has been home to humans for over 12,000 years. Many of the tribes
470 trace the history of the region back to time immemorial. Many, if not all, of the region's tribes
471 have oral traditions telling of their creation in the places where they were and are along the
472 Columbia River. The pre-contact and historic-period artifacts and sites along the river are an
473 important source of information about the past, and they supplement other sources of
474 information, such as written records and oral history. Traditional cultural properties (defined in
475 Chapter 3.16), highly valued by Native Americans, include fishing sites at usual and accustomed
476 places, hunting and traditional hunting sites, and natural resources important to contemporary
477 tribal life. Native Americans, archaeologists, historians, members of the general public, and
478 state and Federal agencies are interested in protecting the cultural resources of the region.
479 These interests would like to minimize damage to cultural resources from the effects of
480 reservoir operations, which include but are not limited to water level fluctuations, wave and
481 wind action, inundation, irrigation, transportation, and recreation, among others. In addition,
482 there is a concern about losses caused by vandalism and looting.

483 **1.6.2.10 Water Quality**

484 The primary water quality issues related to reservoir operations are total dissolved gas (TDG),
485 water temperature, and sediment. TDG is a concern at dams that provide juvenile fish passage
486 spill at many locations in the Columbia River Basin. Elevated water temperature, above state
487 water quality criteria of 20 °C (68 °F) exist within much of the Columbia River Basin. Sediment
488 transport through many of the reservoirs is also a concern; dams disrupt the longitudinal
489 continuity of the river system, which often results in armoring riverbeds, which are less suitable
490 for spawning. These concerns are represented through actions brought by environmental
491 groups, regulations, and policy actions by Federal, state, and local agencies, and tribes.

492 **1.6.2.11 Economics**

493 Virtually everyone in the Northwest has an economic stake in the CRS. Low-cost, affordable
494 hydropower is an important element in the economic life of the region. Comments expressed
495 concern about the economic effects of changes to recreation, navigation, irrigation, and water
496 supply as a result of changes to river operations.

497 **1.6.3 Climate Change Consideration for the Columbia River System Operations**

498 Based on recent research, increasing temperatures due to climate change will likely lead to
499 declining snowpack and earlier peak seasonal snowmelt. Though less certain, there is also
500 potential for increased fall and summer streamflows and longer periods of low summer flows
501 (RMJOC 2018). Many comments received during the scoping process reflected concerns about
502 how these changes may impact individual resources, air quality and greenhouse gasses. The
503 basis for the climate assessment in this EIS includes findings on projected regional temperature,
504 precipitation, snowpack, and streamflow changes resulting from a 4-year research project
505 completed by the University of Washington and Oregon State University for the River
506 Management Joint Operating Committee, and in collaboration with regional stakeholders. The
507 discussion in Chapter 3 of the environmental consequences to resources from the measures
508 and alternatives reflect modeling and analysis based on observed climate in the region over the
509 80-year period of 1929 to 2008. Chapter 4 builds on that analysis by providing a discussion of
510 how the projected changes in regional climate through 2050 may impact the resources and
511 effectiveness of alternatives for the CRS.

512 **1.7 RELATIONSHIP TO OTHER FEDERAL NATIONAL ENVIRONMENTAL POLICY ACT EFFORTS,**
513 **AND OTHER FEDERAL STUDIES, DOCUMENTS, AND REPORTS**

514 The following projects and programs occur within the Columbia River Basin and are interrelated
515 with, but independent from, this EIS.

- 516 • Final Environmental Impact Statement to Inform Columbia River Basin Hatchery Operations
517 and the Funding of Mitchell Act Hatchery Programs, September 2014, National Marine
518 Fisheries Service (NMFS). This EIS examines alternatives designed to reduce or minimize the
519 adverse effects, or increase the benefits, of hatchery operations on natural-origin salmon
520 and steelhead populations. Hatchery operators would continue to pursue not only the
521 conservation or harvest goals that currently apply to each hatchery program, but also
522 different or additional conservation and harvest goals.
- 523 • Lower Snake River Programmatic Sediment Management Plan (PSMP) Final EIS, August
524 2014, Corps. The PSMP provides a programmatic framework to evaluate and implement
525 sediment management measures to address the accumulation of sediment that interferes
526 with existing authorized project purposes in the lower Snake River projects. The PSMP
527 process includes triggers, actions for long-term and short-term planning, actions to address
528 sediment, as well as monitoring and regional engagement.
- 529 • The Double-Crested Cormorant Management Plan to Reduce Predation of Juvenile
530 Salmonids in the Columbia River Estuary, Final Environmental Impact Statement, 2015. This
531 plan had two phases: Phase 1: Reduce colony size to baseline population (as identified in
532 NMFS Biological Opinion [BiOp] Reasonable and Prudent Action 46) to between 5,380 and
533 5,939 breeding pairs on East Sand Island. Phase 2: Modify terrain at East Sand Island to limit
534 breeding habitat to maintain colony size in the long term; support with hazing and egg take
535 as needed to ensure colony does not exceed 5,380 to 5,939 breeding pairs. The Corps
536 reduced the colony below the 5,380 to 5,939 threshold, and then moved into early

537 implementation of Phase 2 in 2018. The Corps has implemented the terrain modification at
538 East Sand Island during winter of 2018 and will monitor population at East Sand Island for 3
539 years (2019 is year 1) to determine success of the project. The Corps will use hazing as
540 needed to maintain population size.

541 • Caspian Tern Management Plan to Reduce Predation of Juvenile Salmonids in the Columbia
542 River Estuary, Final Environmental Impact Statement, 2005, U.S. Fish and Wildlife Service
543 (USFWS). Management has reduced habitat on East Sand Island to a minimum of 1 acre,
544 while enhancing or creating habitat out of the Columbia River Basin (southern
545 Oregon/northern California) to support breeding pairs, creating 2 acres for every 1 acre
546 reduced on East Sand Island. It was assumed that reducing habitat at East Sand Island to 1
547 acre would support 3,125 to 4,375 breeding pairs, which would support a population
548 growth rate. The Corps created approximately 8 acres of alternative nesting habitat and
549 reduced the breeding habitat at East Sand Island to 1 acre. However, there are still a greater
550 number of birds because they nested in densities higher than anticipated. The Corps will
551 continue to maintain 1 acre of habitat at East Sand Island and use hazing to prevent birds
552 from establishing satellite colonies on the beaches.

553 • Columbia Basin Project (CBP). Grand Coulee, operated by Reclamation, stores water for the
554 CBP. The water is pumped approximately 300 feet from Lake Roosevelt to Banks Lake where
555 it is distributed by canal to irrigators within the CBP. The CBP currently has water rights and
556 previous NEPA compliance to deliver 3.318 Maf of water for irrigation of 720,000 acres and
557 for M&I purposes. Water for the Odessa Subarea and Lake Roosevelt Incremental Storage
558 agreement are included in the 3.318 Maf.

559 • Lower Columbia River Dredged Material Maintenance Plan. The most recent dredged
560 material management plan (DMMP) is from 1998 for the continued operation and
561 maintenance of the federally authorized Lower Columbia River Federal Navigation Channel
562 (43 feet deep with 5 feet of advanced maintenance dredging, by 600 feet wide with 100
563 feet advanced maintenance dredging) with minimized draft restriction days. Currently, an
564 integrated DMMP EIS is being developed for a 20-year DMMP for the lower Columbia River
565 from river mile 105.5 to 3 for the continued maintenance of the congressionally authorized
566 Federal navigation channel (Water Resources Development Act of 1999, Consolidated
567 Appropriations Act of 2004).

568 • John Day Mitigation Program. The John Day Mitigation program was originally authorized to
569 offset mainstem fall Chinook salmon production losses that resulted from construction of
570 The Dalles and John Day Dams and is implemented by the Corps. Mitigation for these losses
571 is particularly important to regional tribes that historically depended on these salmon for
572 ceremonial, subsistence and economic support. The scope of this mitigation program
573 consists of a combination of adult (broodstock) collection, adult egg take (spawning), egg
574 incubation, juvenile rearing and acclimation, and release of hatchery fall Chinook salmon
575 using a combination of hatchery facilities on the mid-Columbia River. The purpose of this
576 mitigation program is to identify facilities for the production and release of hatchery smolts
577 in numbers sufficient to achieve in-kind mitigation: that is, a total adult production of
578 107,000 adult fall Chinook salmon at a ratio of 25 percent tule fall Chinook salmon and

- 579 75 percent upper river fall Chinook salmon. Upriver brights should be released from sites
580 above the Bonneville Project to achieve in-place mitigation.
- 581 • Bonneville’s Fish and Wildlife Program. Bonneville provides funding to multiple local, state,
582 tribal and Federal entities as part of its Fish and Wildlife Program to implement offsite
583 mitigation actions listed in various biological opinions for ESA-listed species. The Bonneville
584 Fish and Wildlife Program also funds efforts to protect, mitigate, and enhance fish and
585 wildlife, including non-listed species, affected by the development and operation of the
586 FCRPS, which includes the CRS under the Pacific Northwest Electric Power Planning and
587 Conservation Act of 1980 (Northwest Power Act) (16 U.S.C. § 839b (h)(10)(A)). These efforts
588 are consistent with the recommendations developed through the Northwest Power and
589 Conservation Council’s Fish and Wildlife Program. These projects would continue to
590 undergo site-specific environmental compliance prior to implementation. This analysis
591 includes review under applicable laws and regulations, such as NEPA.
 - 592 • Odessa Subarea Special Study Project. The need to address declining groundwater supply in
593 the Odessa Subarea and avoid economic loss to the region’s agricultural sector led
594 Reclamation and Washington Department of Ecology (Ecology) to conduct the Odessa
595 Subarea Special Study. The purpose identified by Reclamation and Ecology to guide the
596 proposed action is: “. . . to maintain economic viability by providing surface water from the
597 CBP to replace groundwater from declining wells currently used for irrigation in the Odessa
598 Subarea.” This purpose is consistent with the intent of the CBP Act by encouraging
599 “settlement and development of the project, and for other purposes.” Surface water would
600 be provided as part of the continued, phased development of the CBP, and would come
601 from existing CBP diversion and storage water rights from the Columbia River. The Odessa
602 Subarea Special Study was completed in 2012 and the ROD signed in 2013 (Reclamation
603 2012 and 2013).
 - 604 • 2019 to 2021 Flexible Spill Operation Agreement. The 2019 to 2021 Flexible Spill Operation
605 Agreement outlines implementation of the spring flexible spill operations in 2019 and 2020
606 at the lower Snake River projects and lower Columbia River projects. Spill operations in
607 2019 included spill up to the 120 percent TDG cap under the applicable state water quality
608 standards. The Spill Operation Agreement also identified a spring flexible spill scenario for
609 implementation in 2020 to 2021 up to the 125 percent TDG cap at most of the dams, which
610 the parties later collaboratively worked to finalize. The state processes necessary to modify
611 the state water quality standards are ongoing. Flexible spill refers to a 24-hour variable spill
612 operation for juvenile fish passage at the four lower Snake River and four lower Columbia
613 River projects. The flexible spill operation takes advantage of peak and off-peak load hours
614 throughout the day to vary juvenile fish passage spill to complement periods of power
615 demand. During peak load hours, spill for juvenile fish passage is provided at Performance
616 Standard spill levels for up to 8 hours per day. Performance Standard spill is juvenile fish
617 passage spill at the eight fish passage dams (initially developed under the NOAA 2008 BiOp
618 and implemented under the NOAA 2008, 2010 and 2014 BiOps to achieve 96 percent
619 juvenile dam passage survival for spring migrants and 93 percent juvenile dam passage
620 survival for summer migrants. During the remaining 16 hours throughout the day, spill for

621 juvenile fish passage is provided up to the TDG cap, defined as spill to the maximum level
622 that meets, but does not exceed, the TDG criteria allowed under the applicable state water
623 quality standard. The 2019 flexible spill operation was implemented.

624 • ESA Section 7(a)(2) 2019 BiOp, Consultation for Continued Operation and Maintenance of
625 the CRS, conducted by NMFS for the Corps, Bonneville, and Reclamation, March 29, 2019.
626 This BiOp addresses the continued operation and maintenance of the CRS with the inclusion
627 of the 2019 to 2021 Flexible Spill Operation Agreement for spill and hydropower operations.

628 • Lower Snake River Fish and Wildlife Compensation Program. This program was initiated to
629 provide fish and wildlife compensation for construction of the four lower Snake River
630 projects (Ice Harbor, Lower Monumental, Little Goose, and Lower Granite). The program
631 was first described in a 1975 report, Special Report, Lower Snake River Fish and Wildlife
632 Compensation Plan, Lower Snake River, Washington and Idaho. This report was developed
633 by the Corps, in consultation with the USFWS, to assure compliance with the Fish and
634 Wildlife Coordination Act. With the exception of riparian habitat development, the Lower
635 Snake River Fish and Wildlife Compensation Program mitigation requirements for both
636 fisheries and terrestrial wildlife, as laid out in the authorizations and subsequent clarifying
637 reports, are complete. The construction of fish hatcheries and hatchery facility transfers are
638 complete, but operating and maintaining a number of hatcheries continues. The terrestrial
639 wildlife mitigation program, including the development of lands along the lower Snake
640 River, acquisition of new lands for hunting opportunity, and the game farm alternative, is
641 also complete. The Corps will continue to maintain and enhance wildlife habitat developed
642 under the Lower Snake Compensation Plan into the foreseeable future through the Natural
643 Resource Management program.

644 • Sovereign Review Process during the Treaty Review. *While the following process is not*
645 *related to the CRSO process and has been officially concluded, it is noted here for historical*
646 *informational purposes only.* The purpose of the Columbia River Treaty 2014/2024 Review
647 (Treaty Review) was to enable the United States Entity, working in collaboration with
648 regional sovereigns and stakeholders, to make an informed recommendation to the U.S.
649 Department of State as to whether it is in the best interest of the U.S. to continue the
650 Treaty, terminate the Treaty, or seek to negotiate with Canada to amend or modify the
651 Treaty. The Treaty Review included extensive engagement within the region. Regional
652 sovereigns participated through the Sovereign Review Team (SRT) and included
653 representatives from four northwestern states (Oregon, Washington, Montana, and Idaho),
654 15 Native American tribes, and representatives from 10 Federal agencies with
655 responsibilities related to the Columbia River. The SRT's primary responsibility was in the
656 policy and recommendation development arena. The Sovereign Technical Team (STT),
657 composed of technical experts representing the sovereigns, provided expertise to design
658 the analytical work with STT workgroups providing more specialized technical expertise in
659 specific areas. Non-sovereign stakeholders in the region participated through listening
660 sessions, workshops, and other public meetings. Non-sovereigns included electric utilities,
661 irrigators, commercial navigation interests, recreation interests, and others. Government-
662 to-government level sessions were also held with regional tribal leadership and

663 congressional and national leaders and committees. The Sovereign Review process resulted
664 in a Regional Recommendation that was delivered to the U.S. Department of State in
665 December 2013.

666 **1.8 RELEVANT NATIONAL ENVIRONMENTAL POLICY ACT AND ENDANGERED SPECIES ACT**
667 **DOCUMENTS AND REPORTS**

668 Key relevant documents used in this EIS are listed below:

- 669 • Columbia River System Operations Review Final EIS, November 1995. Preparations for this
670 EIS began to take shape as soon as the first petition was made for Columbia River salmonids
671 to be listed under the ESA. It was a joint project between Reclamation, the Corps, and
672 Bonneville to consider changes in the operation of the FCRPS to benefit salmon runs.
- 673 • Biological Opinion: Effects to Listed Species from Operation of the Federal Columbia River
674 Power System, consultation conducted by USFWS, December 20, 2000. The BiOp came in
675 response to a draft feasibility report/environmental impact statement (FR/EIS) on operation
676 of the FCRPS by Bonneville, Reclamation, and the Corps. It essentially addressed three non-
677 breaching alternatives: major system improvements, existing conditions, and maximum
678 transport of juvenile salmon. A fourth alternative, breaching the lower Snake River dams or
679 natural river drawdown, was not analyzed in the BiOp, but would be addressed if the
680 implementation of this alternative came to fruition.
- 681 • Lower Snake River Juvenile Salmon Migration Feasibility Report and Final EIS, Corps, Walla
682 Walla District, February 2002. This FR/EIS examines only the four dams on the lower Snake
683 River: Lower Granite, Little Goose, Lower Monumental, and Ice Harbor. It comes in response
684 to the 2000 National Oceanic and Atmospheric Administration (NOAA) NMFS BiOp on
685 operation of the FCRPS. It addresses four alternatives: major system improvements, existing
686 conditions, maximum transport of juvenile salmon, and natural river drawdown. Major
687 system improvements, with adaptive management, were the preferred alternative of the
688 study.
- 689 • Endangered Species Act Section 7(a)(2) 2008 Biological Opinion, Consultation for Operation
690 of the Federal Columbia River Power System, conducted by NMFS for the Corps, Bonneville,
691 and Reclamation, May 5, 2008. This BiOp was later supplemented, May 20, 2010, to
692 incorporate the Adaptive Management Implementation Plan and January 17, 2014 to: (1)
693 address specific issues raised by the District Court for the District of Oregon; (2) consider
694 effects to newly designated critical habitat for eulachon and green sturgeon, and to
695 proposed critical habitat for lower Columbia River coho salmon; and (3) address updated
696 scientific information in 2010 and 2014.
- 697 • Upper Columbia Alternative Flood Control and Fish Operations Final EIS, April 2006 and
698 Corps and Reclamation Records of Decisions, June 2008, and September 2009, respectively;
699 the Corps as lead and Reclamation as cooperating agency. This EIS examined the
700 implementation of alternative flood operations at Libby Dam on the Kootenai River and
701 Hungry Horse Dam on the South Fork Flathead River, with an operation known as “variable

702 discharge storage regulation procedure,” or VARQ, and flow augmentation for ESA-listed
703 fish populations in the Kootenai River, the Flathead River, and mainstem Columbia River.
704 Flow augmentation (i.e., fish flows) includes release of water for bull trout, salmon, and, at
705 Libby Dam, white sturgeon. The actions addressed in this EIS are in direct response to
706 reasonable and prudent actions contained in the 2000 USFWS FCRPS BiOp; the 2006 USFWS
707 BiOp regarding the Effects of Libby Dam Operations on the Kootenai River White Sturgeon,
708 Bull Trout and Kootenai Sturgeon Critical Habitat, and in the 2004 Updated Proposed
709 Action; and the 2004 NMFS FCRPS BiOp.

- 710 • Biological Opinion regarding the Effects of Libby Dam Operations on the Kootenai River
711 White Sturgeon, Bull Trout, and Kootenai Sturgeon Critical Habitat. Consultation conducted
712 by USFWS, February 18, 2006, with a 2008 clarified RPA. This BiOp addressed
713 implementation of VARQ, ramping rates and daily shaping, minimum flows, and flow
714 augmentation for fish.
- 715 • Albeni Falls Flexible Winter Power Operations Final Environmental Assessment October
716 2011, and Finding of No Significant Impact, November 2011, Corps and Bonneville. This is a
717 winter management operation at Albeni Falls Dam that more actively uses storage behind
718 Albeni Falls Dam for power generation.

719 **1.9 INTRODUCTION TO COLUMBIA RIVER SYSTEM OPERATIONS**

720 Dam development in the Columbia River Basin began in the 1800s. Mainstem dam
721 development began with Rock Island Dam (a non-Federal project) on the Columbia River in
722 1933, and continued through 1975 with the completion of Lower Granite Dam on the Snake
723 River. Most of the dams were constructed from the 1950s through the 1970s. This section
724 provides brief descriptions of Federal projects and non-Federal projects, and an overview of
725 how the CRS is operated.

726 **1.9.1 Federal Dams and Reservoirs**

727 Federal agencies operate a series of 31 multipurpose dams known as the Federal Columbia
728 River Power System on the Columbia River and its tributaries, 14 of which are operated as a
729 coordinated system, referred to as the Columbia River System. The 14 CRS projects are
730 described below. The other FCRPS projects, such as those in the Willamette subbasin, the
731 Yakima subbasin, or the Boise River Basin, operate more independently. The output at the
732 projects with hydropower facilities is used in meeting the region’s electricity demand. However,
733 the multi-purpose operation of these other FCRPS projects is generally not factored into the
734 coordinated planning scenarios of the CRS.

735 Project features of the CRS include dams and reservoirs, navigation channels and locks,
736 hydroelectric powerhouses, associated transmission infrastructure , spillways, sluiceways, fish
737 ladders and bypass facilities, irrigation diversions and pumps, parks and recreation facilities,
738 boat launches, lands dedicated to the projects, and areas set aside for mitigation of wildlife
739 habitat losses.

740 Bonneville, the Corps, and Reclamation each have a role in coordinating the CRS. The Corps
741 operates 12 of the 14 projects, and has responsibilities for FRM, recreation, fish and wildlife
742 conservation, navigation, power production, irrigation and M&I water supply at these 12
743 reservoirs (although responsibilities for several resources, , such as fish and wildlife
744 conservation and power generation, are shared with other agencies). The Corps also maintains
745 navigation channels and has FRM responsibilities throughout the Columbia River Basin.
746 Reclamation operates Grand Coulee and Hungry Horse projects, and has responsibility for
747 federally financed water development and irrigation programs, hydropower, and water quality
748 at these two projects. Bonneville Power Administration markets and distributes the power
749 generated at all Federal projects in the Columbia River Basin, and builds and operates
750 transmission lines to deliver the electricity. Bonneville also mitigates the impacts on fish and
751 wildlife from the federally owned hydroelectric projects from which Bonneville markets power.
752 The Corps and Reclamation develop multiple purpose operating requirements for their projects
753 and, within these limits, Bonneville schedules and dispatches power. The CRS alternatives
754 (referred to in this EIS as No Action Alternative and Multiple Objective Alternatives 1 through 4
755 and the Preferred Alternative) only include specific actions at these 14 Federal projects, and do
756 not include any actions at the other FCRPS or non-Federal projects.

757 The general characteristics of each of these 14 Federal projects are summarized in Table 1-2,
758 and more detailed descriptions of these projects can be found at www.CRSO.info.

759 **Table 1-2. General Characteristics of the Columbia River System Projects**

Project	Reservoir / Lake	Project Type	Approximate Normal Operating Range NGVD29	Number of Turbine Units (Nameplate Capacity-MW) ^{3/}	Number of Spillbays and Other Tubes	Navigation Locks	Fish Passage
Libby	Koocanusa	Storage	2,287–2,459 feet ^{1/}	5 (605)	2 spillbays	N/A	N/A
Hungry Horse	Hungry Horse	Storage	3,336–3,560 feet ^{1/}	4 (428)	1 ring gate (spillbay) 3 outlet tubes	N/A	N/A
Albeni Falls	Pend Oreille	Storage	2,051–2,062.5 feet ^{1/}	3 (49)	10 spillbays	N/A	N/A
Grand Coulee	Roosevelt	Storage	1,208–1,290 feet ^{1/}	33 (6,735 + pumped storage)	11 spillbays 40 outlet tubes	N/A	N/A
Chief Joseph	Rufus Woods	Run-of-river	950–956 feet	27 (2,614)	19 spillbays	N/A	N/A
Dworshak	Dworshak	Storage	1,445–1,600 feet ^{1/}	3 (465)	2 spillbays	N/A	N/A
Lower Granite	Lower Granite	Run-of-river	733–738 feet	6 (930)	8 spillbays	Yes	Yes
Little Goose	Bryan	Run-of-river	633–638 feet	6 (930)	8 spillbays	Yes	Yes
Lower Monumental	Herbert G. West	Run-of-river	537–540 feet	6 (930)	8 spillbays	Yes	Yes
Ice Harbor	Sacajawea	Run-of-river	437–440 feet	6 (693)	10 spillbays	Yes	Yes
McNary	Wallula	Run-of-river	337–340 feet	14 (1,120)	22 spillbays	Yes	Yes
John Day ^{2/}	Umatilla	Storage	January 1–March 14: 262.0–265.0 feet March 15–April 9: 262.5–265.0 feet April 10–September 30: 262.5–264.0 feet October 1–31: 262.5–265.0 feet November 1–December 31: 262.0–266.5 feet	16 (2,480)	20 spillbays	Yes	Yes

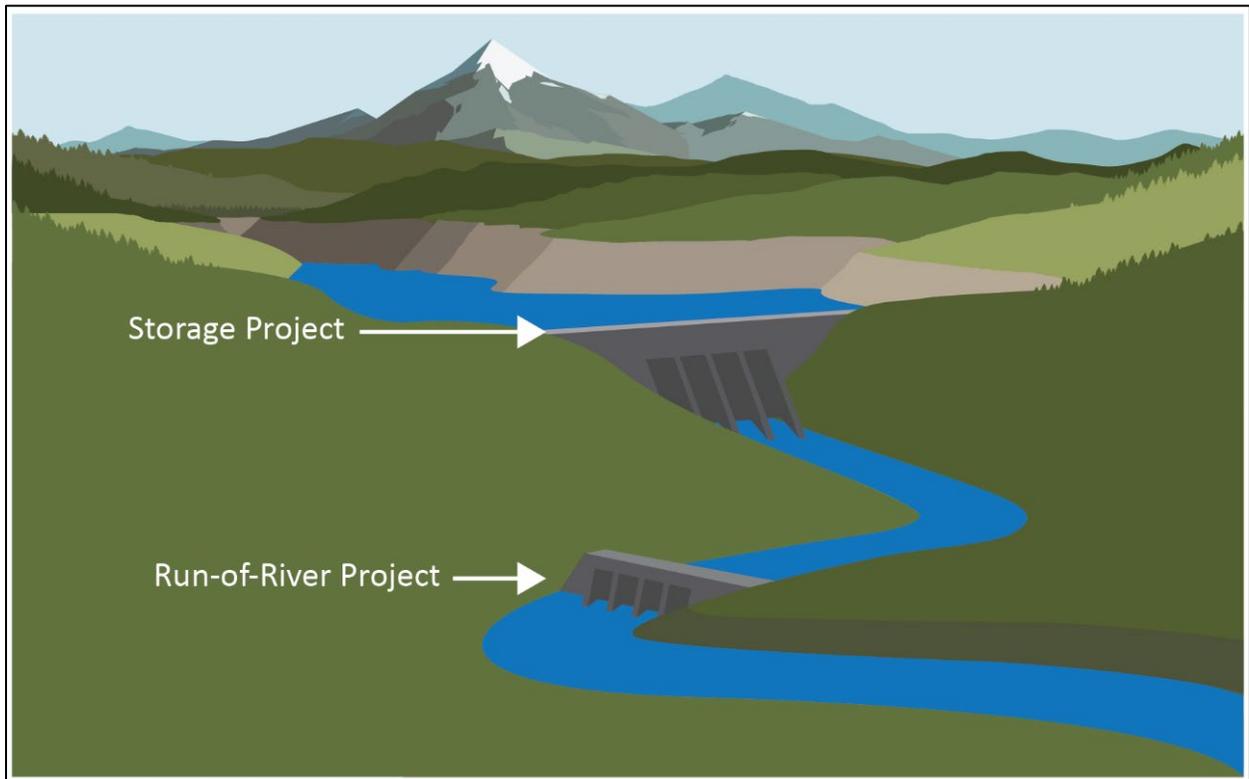
*Columbia River System Operations Environmental Impact Statement
Chapter 1, Introduction*

Project	Reservoir / Lake	Project Type	Approximate Normal Operating Range NGVD29	Number of Turbine Units (Nameplate Capacity-MW)^{3/}	Number of Spillbays and Other Tubes	Navigation Locks	Fish Passage
The Dalles	Celilo	Run-of-river	155–160 feet	22 (2,052), plus 2 fish units	23 spillbays	Yes	Yes
Bonneville	Bonneville	Run-of-river	71.5–76.5 feet	PH1: 10 PH2: 8 (1,195) plus 2 fish units	18 spillbays	Yes	Yes

760 Note: N/A = not applicable; NGVD29 = National Geodetic Vertical Datum of 1929.
761 1/ For storage reservoirs, the minimum possible elevation is based on location of the project intakes. Actual reservoir levels may reach these elevations only
762 rarely.
763 2/ The normal operating range for John Day varies seasonally to support multiple objectives including irrigation, navigation, ESA-listed fish recovery,
764 hydropower, and FRM.
765 3/ <https://www.bpa.gov/p/Generation/White-Book/wb/2018-WBK-Loads-and-Resources-Summary-20190403.pdf>.

766 **1.9.2 Storage and Run-of-River Projects**

767 The 14 Federal projects examined in detail in the CRS fall into two major categories: storage
768 and run-of-river projects. It is important to understand the difference between the two, which
769 is graphically illustrated in Figure 1-4, and explained in the following paragraphs. The six Federal
770 projects classified as storage projects in the CRS are Libby, Hungry Horse, Albeni Falls, Grand
771 Coulee, Dworshak, and John Day. The eight Federal projects considered to be run-of-river
772 projects in the CRS are Chief Joseph, Lower Granite, Little Goose, Lower Monumental, Ice
773 Harbor, McNary, The Dalles, and Bonneville. While John Day may be characterized as a storage
774 project and is authorized for FRM, it has limited storage capacity and is operated more like a
775 run-of-river project where the project does not store incoming flow.



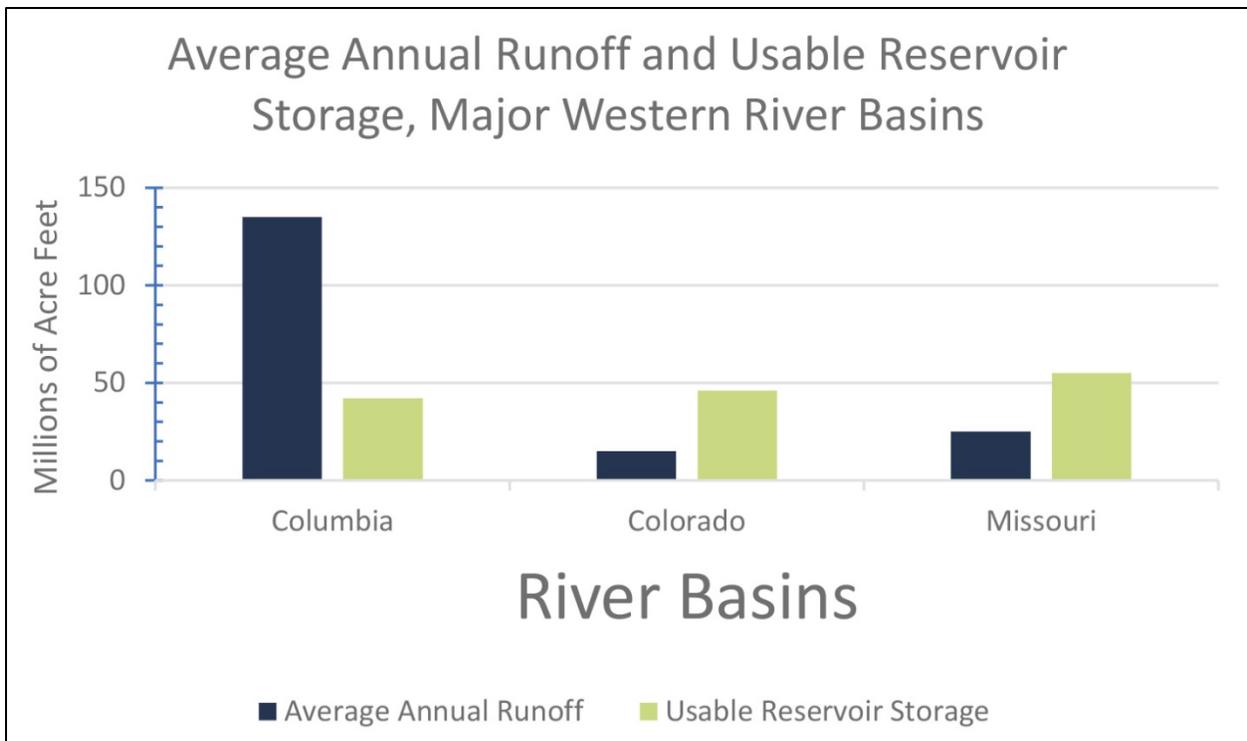
776
777 **Figure 1-4. Graphic Representation of Storage and Run-of-River Projects**

778 **1.9.2.1 Storage Projects**

779 Storage is the key to operation of the multiple-use river system. The storage reservoirs adjust
780 the river's natural flow patterns to conform more closely to water use patterns, storing water
781 from rain and snowmelt to reduce flood risk and generate power when needed. Water in
782 storage reservoirs is also called upon throughout the year to support flows for fish. More water
783 enters the river system during the spring snowmelt than is required at the time for power
784 production, irrigation, and other uses. Reservoirs capture some of this runoff and store it until
785 the late summer, fall, and winter, when it is released.

786 The system storage capacity represents the system's capability to “shape” flows for a variety of
787 purposes. Shaping refers to the operating agencies' ability to control river flow by timing the
788 storage and release of water from the storage reservoirs to meet specific purposes. Water is
789 held in storage and released for multiple authorized purposes, including hydropower and for
790 fish. In addition, shaping helps reduce downstream flows during the flooding season. Balancing
791 the various uses of system storage can be challenging as demands increase because only a finite
792 amount of water and storage space is available in the system to meet competing needs.

793 The total system storage capacity in the Columbia Basin is approximately 55 million acre-feet
794 (Maf) of which approximately 20 Maf is in Canada, approximately 17 Maf in the CRS, and
795 approximately 18 Maf in other Federal and non-Federal reservoirs. Of the total storage
796 capacity, approximately 40 Maf is available for system FRM. This is an enormous amount of
797 water, but it is only about 30 percent of an average year's runoff, as measured at The Dalles.
798 While there is a large amount of storage on the Columbia River, there is a relatively low degree
799 of control on the Columbia compared to other large river systems in the United States (e.g., the
800 Missouri and Colorado River systems). Figure 1-5 illustrates the average annual and usable
801 reservoir storage in the Columbia, Colorado, and Missouri River basins.



802
803 **Figure 1-5. Comparison of Major Western River Basins**

804 The combined storage in the reservoirs of the five Federal storage projects considered in the
805 CRSO EIS is approximately 17 Maf. Active storage capacity of the five storage projects ranges
806 from about 1.2 Maf at Albeni Falls to nearly 5.4 Maf at Grand Coulee (Table 1-3). While John
807 Day is authorized for FRM, it has limited storage capacity and is operated primarily like a run-of-
808 river project where the project does not store incoming flow. Three Canadian dams, Mica,

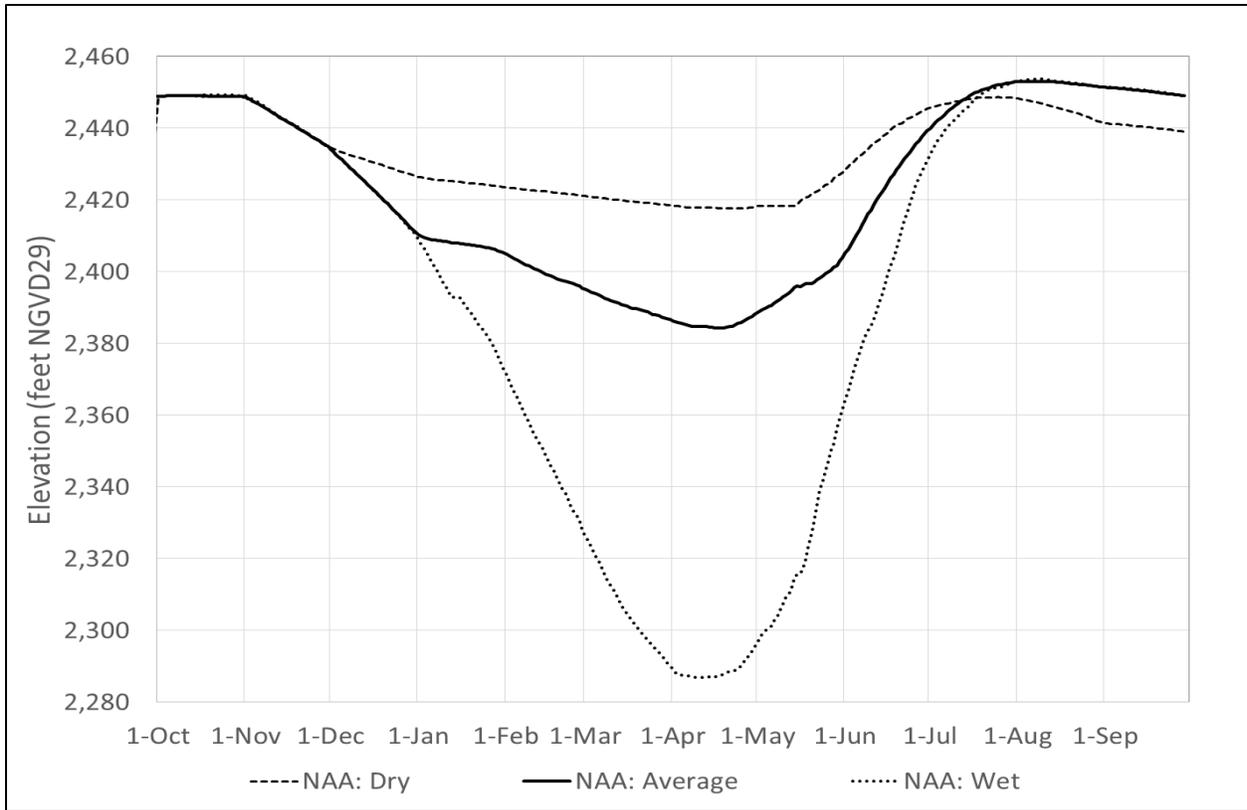
809 Duncan, and Arrow, add up to another 20.5 Maf of storage. These eight projects are
810 strategically located in the throughout the Columbia River Basin to capture runoff for later
811 release.

812 **Table 1-3. Active Storage Capacity at Columbia River System Storage Projects**

Project	River	Operator	Active Storage Approximate (Maf)	Authorized System FRM (Maf)
Projects Authorized and Operated for System Flood Control			17.0	16.5
Libby	Kootenai	Corps	5.0	5.0
Hungry Horse	South Fork Flathead	Reclamation	3.0	3.0
Albeni Falls	Pend Oreille	Corps	1.2	0.6
Dworshak	North Fork Clearwater	Corps	2.0	2.0
Grand Coulee	Columbia	Reclamation	5.4	5.4
John Day	Columbia	Corps	0.5	0.5

813 Note: Maf = the volume of water that would cover 1 million acres to a depth of 1 foot.

814 Reservoir levels at storage projects typically vary greatly during normal operations and with
815 changes in year-to-year water conditions. Libby operates over a range of 172 feet; Hungry
816 Horse, 224 feet; Albeni Falls, 11.5 feet; Grand Coulee, 82 feet; and Dworshak, 155 feet.
817 Although Albeni Falls operates over a relatively small range, it controls a large volume of stored
818 water because of the large surface area of Lake Pend Oreille. Variations between full pools and
819 lowered pools tend to occur seasonally. Just prior to the spring snowmelt, pools are generally
820 kept low to provide enough space for increasing flows and FRM. When possible, operators try
821 to operate pools near full during the summer, when recreation demand is the highest.
822 Figure 1-6 illustrates elevation patterns for Libby under median hydrographs of dry, average,
823 and wet years. The figure groups years into “dry,” “average,” and “wet” years based on the May
824 water supply forecast for the April to August runoff period into Libby, and then calculates the
825 median elevation for each day within the group. The dry grouping represents the lowest 20
826 percent of forecasted years, the average grouping represents years in the middle 60 percent of
827 forecasted years, and wet grouping represents the highest 20 percent of forecasted years. This
828 type of figure is explained further in Chapter 3, but is shown here to demonstrate how reservoir
829 levels at storage projects can vary depending on water year type.



830
831 **Figure 1-6. Median Hydrographs of Dry, Average, and Wet Years at Libby Project**
832 Note: NAA = No Action Alternative.

833 **1.9.2.2 Run-of-River Projects**

834 The Chief Joseph, Lower Granite, Little Goose, Lower Monumental, Ice Harbor, McNary, The
835 Dalles, and Bonneville projects are run-of-river projects with limited storage capacity. They
836 were developed primarily for navigation and/or hydropower generation. All run-of-river
837 projects provide hydraulic head for power generation. The eight Federal projects on the lower
838 Snake and Columbia rivers also form enough channel depth to permit barge navigation. Run-of-
839 river projects pass water at the dam at nearly the same rate it enters. The water that backs up
840 behind run-of-river projects is referred to as pondage. The pondage at these projects is
841 sufficient to control flows on only a daily or weekly basis, and use of the pondage causes
842 frequent, small fluctuations in water levels. Reservoir levels behind these projects typically vary
843 only 3 to 5 feet in normal operations (see Table 1-2). Maintaining the reservoir within the
844 normal operating range in the pool allows the facilities at the dams (e.g., navigation locks,
845 hydropower turbines, fish ladders, and juvenile fish bypass facilities) to function properly, in
846 accordance with the engineering design. Irrigation has developed in the run-of-river projects
847 utilizing the pool elevations that exist due to hydropower and navigation operations.

848 **1.9.3 Non-Federal Dams and Reservoirs**

849 In addition to the 14 Federal projects described above, there are numerous other dam and
850 reservoir projects in the Columbia River and its tributaries that are operated by Federal and
851 non-Federal entities in the United States and Canada. Major dams in the Columbia Basin are
852 shown in Figure 1-7. A brief description of these non-Federal facilities and how they relate to
853 the CRS is contained in the following paragraphs.



854
855 **Figure 1-7 Columbia River Watershed System**

856 **1.9.3.1 Canadian Projects**

857 Projects located in the Canadian portion of the Columbia River watershed play a key role in
858 overall system operation and coordination, although the co-lead agencies do not operate these
859 Canadian projects. There is a total of 11 major dams in the Canadian portion of the basin,
860 shown in Figure 1-7. Of the 11 dams, 7 are downstream of CRS projects, including Libby or
861 Hungry Horse and Albeni Falls; the Kootenai River below Libby and the Pend Oreille River below
862 Albeni Falls and two non-Federal US dams both flow north into Canada. Three Canadian
863 projects (Mica, Duncan, and Arrow Lakes) are Columbia River Treaty (CRT) storage projects
864 located in the headwaters of the Columbia and Kootenay River system and are particularly
865 important to overall system storage coordination. The CRT, ratified in 1964, cleared the way for
866 the construction of storage capacity at these three Canadian storage projects and at Libby Dam.
867 This more than doubled the storage capacity of the CRS. The CRT provides for coordination of
868 operations of the three CRT Canadian storage projects with U.S. projects for power production,
869 FRM, and other purposes as mutually agreed upon.

870 In evaluating CRSO alternatives, the CRT projects in Canada (Mica, Duncan, and Arrow Lakes)
871 are assumed to operate consistent with practices in effect at the time the CRSO NOI was
872 published in the *Federal Register* on September 30, 2016 (81 FR 67382). Assumptions about CRT
873 storage are necessary to analyze CRS operations, and the best available information is the
874 current operations. This assumption, and any other assumptions, procedures, or methodologies
875 in this EIS regarding the Canadian projects or the effect of Canadian projects and their
876 operations are for EIS analytical purposes only and does not establish, create, or imply any
877 position or interpretation of the CRT. This EIS evaluated the effects in the four NEPA sub regions
878 in the United States, while recognizing the CRS projects operate within a transboundary basin.
879 The potential for any significant effects of the alternatives that could arise in Canadian portions
880 of the basin were reviewed in general as a matter of policy.

881 **1.9.3.2 Mid-Columbia River Projects**

882 After Rock Island Dam was completed in 1933, four more run-of-river dams were constructed
883 on the middle Columbia River (Region B in Figure 1-7) in Washington during the 1950s and
884 1960s by three different Public Utility Districts (PUDs). These projects are operated under
885 licenses from the Federal Energy Regulatory Commission (FERC). They include:

- 886 • Wells, operated by Douglas County PUD
- 887 • Rocky Reach and Rock Island, operated by Chelan County PUD
- 888 • Wanapum and Priest Rapids, operated by Grant County PUD

889 Flow patterns at the mid-Columbia River projects are influenced by operations at the Canadian
890 and Federal projects upstream, particularly Grand Coulee Dam. While releases from Grand
891 Coulee Dam are regulated by Chief Joseph Dam, the Federal project located upstream from
892 Wells Dam, Federal storage project operations still affect the size and timing of flows at the five

893 PUD dams. The CRSO alternatives do not include any specific actions that would require the
894 mid-Columbia River projects to operate outside their normal ranges.

895 **1.9.3.3 Middle Snake River Dams**

896 Idaho Power Company operates three FERC-licensed dams, collectively known as the Hells
897 Canyon Complex, located on the middle Snake River between Oregon and Idaho. The Hells
898 Canyon, Oxbow, and Brownlee Projects are hydropower facilities that affect flows into the
899 lower Snake River. Hells Canyon and Oxbow are run-of-river projects downstream of Brownlee
900 Dam. Brownlee Dam is the most significant project for FRM in the Hells Canyon Complex with
901 an active storage capacity of 980,000 acre-feet that is used jointly for FRM and power
902 production. Operations at Brownlee Dam control inflows to Oxbow and Hells Canyon, which
903 operate as run-of-river dams passing flows through to the lower Snake River projects. The Hells
904 Canyon Complex has a significant effect on flows in the lower Snake River, especially in the
905 vicinity of Lewiston, Idaho, with Brownlee Reservoir helping to reduce flooding in the lower
906 Columbia River Basin. The CRS alternatives do not include any specific actions that would
907 require the Hells Canyon Complex to operate outside its normal ranges.

908 **1.9.3.4 Pend Oreille, Clark Fork, and Flathead River Dams**

909 Major non-Federal projects in the U.S. on the Pend Oreille and Clark Fork River systems are
910 shown on Figure 1-7 in Region A. All of these dams are downstream of Hungry Horse Dam, and
911 two are downstream of Albeni Falls Dam. The CRSO EIS alternatives do not include any specific
912 actions that would require these non-Federal projects to operate outside their normal ranges.
913 These projects are operated under licenses from the Federal Energy Regulatory Commission
914 (FERC).

- 915 • Pend Oreille River Dams:
 - 916 ○ Box Canyon, operated by Pend Oreille County PUD
 - 917 ○ Boundary, operated by Seattle City Light
- 918 • Clark Fork River Dams:
 - 919 ○ Thompson Falls, operated by Northwestern Corporation
 - 920 ○ Noxon Rapids and Cabinet Gorge, operated by Avista Corporation
- 921 • Flathead River Dams:
 - 922 ○ Seli's Ksanka Qlispe' (SKQ), operated by operated by Energy Keepers, Inc.

923 **1.9.3.5 Other Tributary Dams**

924 There are many other dams located on tributaries of the Columbia River and upstream of CRS
925 projects and outside of the study area. Major dams are shown in Figure 1-7 and include dams in
926 the following sub-basins.

- 927 • The Middle Snake River includes 3 non-Federal dams.
- 928 • The Upper Snake River Basin includes 23 Federal and non-Federal dams.
- 929 • The Yakima River Basin includes 6 Federal dams.
- 930 • The Spokane River Basin includes 5 non-Federal dams.
- 931 • The Wenatchee River Basin includes Chelan Dam, a non-Federal dam.
- 932 • The Priest River Basin includes Priest Lake Dam, a non-Federal dam.
- 933 • Tributaries of the Lower Columbia River include 34 Federal and non-Federal dams.

934 **1.9.4 System Planning and Operations**

935 Each Federal project within the scope of the CRSO EIS was constructed under specific
936 congressionally authorized legislation identifying the major intended uses. All of the projects
937 were specifically authorized for hydropower production, most were authorized for navigation,
938 and some were also authorized for FRM and irrigation. The seasonal abundance of water, and
939 the predictability of its use, allows a project to support other uses as well, but only incidentally.
940 General congressional authorization allows for such uses as fish and wildlife conservation,
941 recreation, and M&I water supply.

942 While the authorizing legislation stipulated intended use, it seldom contained explicit provisions
943 for operating the individual projects or for their coordinated operation within the total system.
944 The Corps and Reclamation are largely responsible for deciding how to operate their projects
945 based on the principles of multiple-use operation, agency statutes, operations experience, and
946 public input. Project operations are guided by water control manuals prepared for most
947 projects.

948 Congressional authorization, multiple-use operating principles, water control manuals, and
949 public interest provide overall guidance for system planning and management. Within this
950 overall framework, planning is needed to guide system operations in response to actual
951 hydrologic conditions. As a result, several annual planning processes guide system operations
952 from year to year.

953 **1.9.5 Annual Planning**

954 The Corps, Reclamation and non-Federal utilities update their operating plans throughout the
955 year to optimize power operations within the constraints for FRM, fish operations, navigation,
956 and other constraints (specified in their FERC licenses for non-Federal utilities; specified by the
957 Corps and Reclamation for Bonneville power operations).

958 The annual planning process starts each February and incorporates non-power considerations.
959 Each reservoir owner submits multiple-use operating requirements (e.g., required minimum
960 outflows) that must be accommodated in the resulting plan. Utility parties also submit forecasts
961 of their electricity loads, the output of their non-hydro generating resources, and planned

962 maintenance outages for their resources. Studies are conducted to determine how much power
963 can be produced from the whole system and by each Pacific Northwest Coordination
964 Agreement (PNCA) party. The PNCA is an agreement involving 16 entities in the Northwest,
965 including Federal water and power agencies and electric utilities. Through the PNCA, major
966 hydroelectric generating plants and electric systems that serve the Pacific Northwest, including
967 dams on the Columbia River in the United States, operations are planned as if they are
968 controlled by a single entity. This is important because the power generation benefits of the
969 Columbia River Treaty are based on an assumption that the operation of the Columbia River
970 dams will be coordinated between the United States and Canada. The PNCA studies are
971 updated throughout the operating year and guide reservoir operations that produce the
972 planned power capability while meeting numerous other operating requirements. Although
973 reservoirs are not required to operate in accordance with the plan, rights and obligations under
974 the PNCA provide for exchanges of power between utilities to assure each utility can achieve
975 the benefits of a coordinated plan.

976 Annual planning processes are also developed for purposes other than power. The Technical
977 Management Team (TMT) is an inter-agency technical group comprised of sovereign
978 representatives responsible for making in-season recommendations to the co-lead agencies
979 (Corps, Bonneville, and Reclamation) on dam and reservoir operations in an effort to meet the
980 expectations of the applicable BiOps and accommodate changing conditions, such as water
981 supply, fish migration, water quality, new information, and maintenance issues. The TMT
982 consists of representatives from the co-lead agencies, NMFS, USFWS, the states of Oregon,
983 Washington, Idaho, and Montana, and tribal sovereigns.

984 Each fall, the co-lead agencies prepare an annual Water Management Plan (WMP) consistent
985 with applicable BiOps that describes the planned operations of the CRS dams and reservoirs for
986 the water year (October 1 through September 30). The WMP is designed by the co-lead
987 agencies to meet specific purposes:

- 988 • Implement water management measures consistent with actions considered in their
989 respective BiOps.
- 990 • Assist in meeting the biological performance standards specified in the BiOps in
991 combination with other actions or operations identified in the BiOps.
- 992 • Meet other CRS project requirements and purposes such as FRM, hydropower generation,
993 irrigation, navigation, recreation, and conservation of fish and wildlife.
- 994 • Take into account recommendations contained in the applicable Northwest Power and
995 Conservation Council's Fish and Wildlife Program and amendments.

996 The WMP also includes special operations planned for the year (e.g., special tests,
997 maintenance, construction activities, etc.) known at the time the WMP is developed.
998 Throughout the season, the co-lead agencies use the TMT forum to provide the region with
999 seasonal updates on water supply forecasts and specific project operations.

1000 The Corps coordinates with regional agencies to prepare an annual Fish Passage Plan (FPP) that
1001 provides detailed operating criteria for project fish passage facilities, powerhouses, and
1002 spillways to facilitate the safe and efficient passage of migratory fish. The FPP contains
1003 appendices that describe special operations for fish research studies, the juvenile fish
1004 transportation program, operation of turbine units within operational constraints, spill for fish
1005 passage, TDG monitoring, and dewatering procedures. The FPP is coordinated through the
1006 inter-agency Fish Passage Operations and Maintenance Coordination Team.

1007 **1.9.6 Annual and Short-Term Operation**

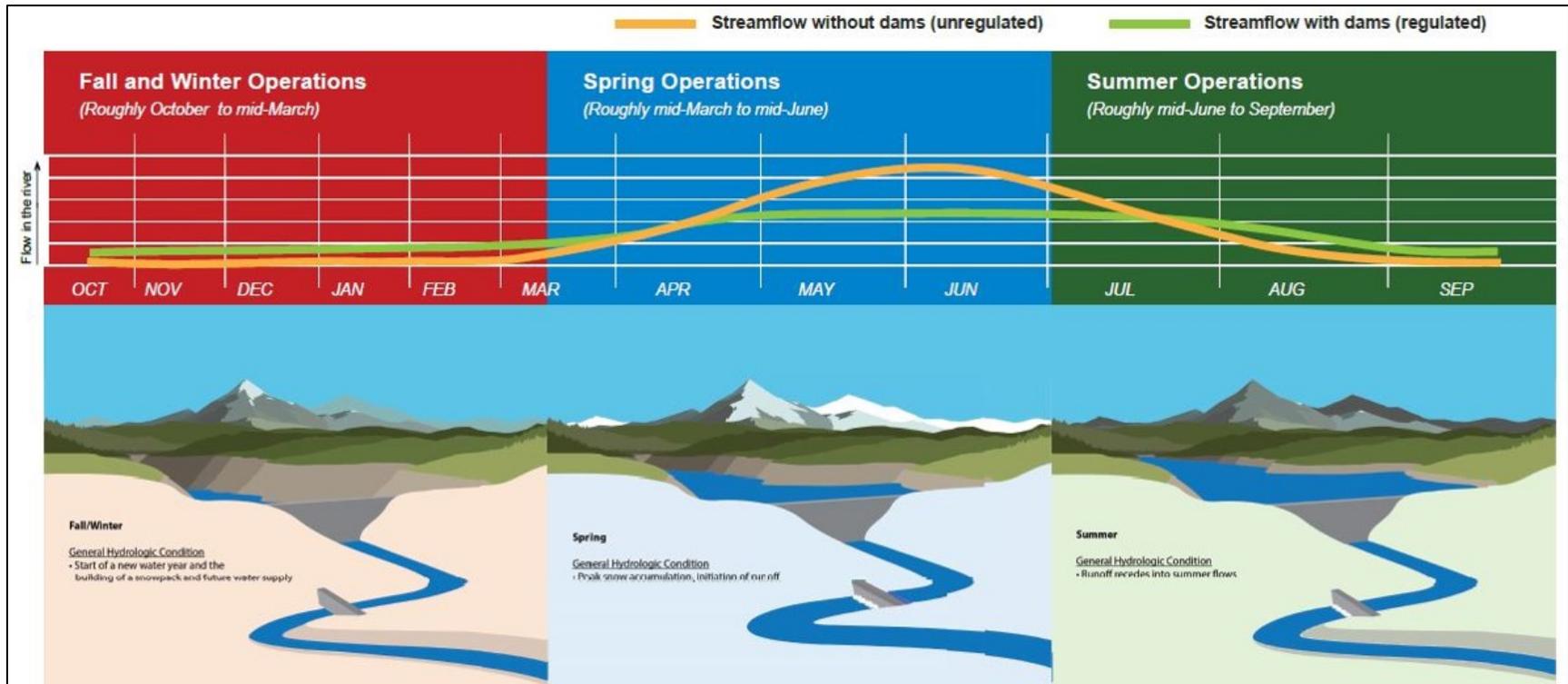
1008 Current operation of the Federal system throughout the year is based on meeting several
1009 related, but sometimes conflicting, objectives. These include providing adequate flood storage
1010 space for controlling spring runoff; providing sufficient water levels for navigation, recreation,
1011 and fish and wildlife; maintaining an acceptable probability that reservoirs will refill to provide
1012 water for next year's operation; providing adequate water supply for irrigation; providing flows
1013 to aid the downstream migration of anadromous juvenile fish; and maximizing power
1014 generation, within the requirements imposed by other objectives.

1015 Annual operation of the Federal system follows a three-season cycle (fall/winter, spring, and
1016 summer) graphically represented in Figure 1-8.

1017 • For the fall/winter season, approximately October to mid-March, the general hydrologic
1018 condition is the start of the new water year, and the building of a snowpack and future
1019 water supply. In the fall and winter months, storage projects in the Columbia River Basin are
1020 preparing for the following spring's runoff (snowmelt and rain). Storage projects are
1021 operated to reduce flooding downstream. As snow accumulates in the mountains,
1022 reservoirs are lowered (drawn down) so high flows in the spring can be captured. During
1023 this fall/winter season, operators must also provide a safe navigation corridor, generate
1024 power, and protect wildlife habitat.

1025 In the fall and winter, rivers are flowing at low, base-flow levels. Little is known at this
1026 time of year about how much snow will accumulate throughout the winter and how
1027 much water will come down the river in the upcoming spring. Winter storms may also
1028 bring rises in the river during this season.

1029



1030

1031 **Figure 1-8. Seasonal Operations of Columbia River System**

1032

1033 • During the spring season, the general hydrologic condition is peak snow accumulation
1034 sometime between mid-March and mid-May, depending on location in the Columbia River
1035 Basin and elevation. Water supply forecasts provide context to the type of runoff
1036 anticipated in the spring and provide information about the space required for FRM
1037 operations. Runoff can occur earlier in lower elevation subbasins because of earlier
1038 snowmelt and low elevation rains. Once runoff begins, the storage projects reduce outflow
1039 and begin refilling the reservoirs. The co-lead agencies balance FRM requirements and refill
1040 by attempting to operate no lower than the FRM elevation as of April 10th.

1041 The CRS is operated in the spring primarily to manage spring runoff for FRM to the
1042 extent possible, store water for irrigation use later in the season, and provide conditions
1043 to aid juvenile and adult fish migration. During this time, operators must also provide a
1044 safe navigation corridor, generate power, and protect wildlife habitat.

1045 • For the summer season, which runs from approximately mid-June through September,
1046 spring runoff recedes into lower summer flows. Storage reservoirs reach their highest
1047 elevation in the summer months, often reaching full pool. Water stored during the spring is
1048 then released to augment flows for fish in the lower Columbia and lower Snake Rivers.
1049 Flows also provide water for irrigation, recreation, and power production. By summer, the
1050 peak flows from spring runoff transition to lower summer flows.

1051 In the summer months, the system is operated to balance additional flow for
1052 augmentation downstream to aid juvenile and adult fish migration, provide water for
1053 irrigation use, and generate power. During this time, operators must also provide a safe
1054 navigation corridor, support recreation interests, and protect wildlife habitat.

1055 The co-lead agencies have some flexibility in CRS operations as they attempt to meet the
1056 diverse and changing needs of the region based on information that becomes available over the
1057 course of the operating year. Many factors cause short-term operational adjustments. For
1058 example, sometimes periods of heavy rain causes higher flows in the fall. This water can be
1059 used to produce additional or surplus energy, which can be offered and sold into the wholesale
1060 electricity market. Alternatively, depending on conditions at the dams, water can be stored for
1061 future use if storage space is available. In a poor snowpack year, minimum fish flows,
1062 navigation, and other constraints dictate how much water the projects must discharge, allowing
1063 as much water as possible to be used to fill the reservoir. In a poor snowpack year, there may
1064 not be enough water to provide power to meet firm energy demand in the region, and
1065 Bonneville might need to purchase power on the wholesale market to meet its obligations.

1066 The actual operations take place in what is described as “real time,” that is, decisions must be
1067 made in a few minutes, days, or at most, a few weeks. Operators regulate the system in an
1068 effort to satisfy all the various purposes contained in the annual operating plan. They may need
1069 to respond to in-stream conditions for fish or navigation, or take advantage of an opportunity
1070 to generate extra power to sell as surplus when economically beneficial. Boating accidents,
1071 generator outages, the weather, and even the timing of recreational events can influence
1072 operational decisions. From time to time, there are also periodic maintenance activities that

1073 drive reservoir levels. For example, Reclamation has established a periodic maintenance
1074 schedule for the drum gates that regulate flow into the spillway at Grand Coulee Dam, and this
1075 requires the reservoir to be drawn down to elevation 1255 feet National Geodetic Vertical
1076 Datum of 1929 (NGVD29).⁴ Please see Chapter 2 for more details on maintenance-driven
1077 elevation changes.

1078 **1.9.7 Operational Strategies to Meet Other System Uses, Planning and Operations**

1079 Preceding sections summarized key operational strategies to effectively manage and plan CRS
1080 operations, including but not limited to water supply, hydropower generation, and FRM. The
1081 following sections summarize key operational strategies to effectively manage other resources
1082 including navigation, water quality, and fish resources.

1083 **1.9.7.1 Navigation**

1084 Navigation in the Columbia River Basin is both commercial and recreational. Section 3.10
1085 provides detailed information on navigation. Commercial use takes place primarily along the
1086 Columbia-Snake Navigation System (CSNS). The CSNS covers the entire 470-mile-long water
1087 highway formed by the eight mainstem dams and lock facilities on the lower Columbia and
1088 Snake rivers. The CSNS follows the navigable reaches of the lower Snake River beginning near
1089 Lewiston, Idaho, and Clarkston, Washington, to its confluence with the Columbia River near
1090 Pasco, Washington, and then down another 330 miles on the Columbia River to its junction
1091 with the Pacific Ocean near Astoria, Oregon. The CSNS consists of three primary segments: (1) a
1092 43-foot-deep draft segment between the Pacific Ocean and Portland, Oregon, and Vancouver,
1093 Washington (river mile (RM) 106); (2) a 28-foot segment (maintained at 17 feet) of the
1094 Columbia River between Vancouver, Washington and The Dalles, Oregon; and (3) a 14-foot
1095 shallow draft section of the Columbia River, which stretches from The Dalles to Pasco,
1096 Washington to the Snake River RM 140 at Lewiston, Idaho, and Clarkston, Washington.
1097 Traditionally, locks are taken out of service for approximately two weeks each year for
1098 maintenance, which generally occurs in the spring. The shallow draft channel accommodates
1099 Corps and U.S. Coast Guard vessels, shallow-draft tugs, barges, and recreational boats; and
1100 connects the interior of the Columbia River Basin with deep-water ports on the lower Columbia
1101 River.

1102 Commercial barges and other river traffic need minimum water depths to navigate successfully.
1103 Unlike other river uses, navigation has depth requirements that do not vary seasonally. Dam
1104 operators must regulate water releases and maintain reservoir levels to provide minimum
1105 navigation depths throughout the year. Operating requirements for navigation differ between
1106 the waterway's deep draft and shallow draft segments.

1107 From the Pacific Ocean to The Dalles, Oregon, navigation requirements can usually be met by
1108 natural river flows, without any special releases of water from the CRS projects. Periodic
1109 dredging maintains this channel's depth to support navigation even at normal low flows, most

⁴ More information on NGVD29 can be found in Chapter 3, Hydrology and Hydraulics, Section 3.2.4.1.

1110 notably near Pillar Rock, which is located in the middle of the channel at Columbia RM 27 near
1111 Brookfield, Washington.

1112 In the portion of the shallow-draft channel from Pasco, Washington, to Lewiston, Idaho,
1113 maximum and minimum reservoir elevations have been established to maintain an authorized
1114 14-foot channel depth. The authorized channel depth can be maintained physically, by
1115 dredging, most notably in Lower Granite Reservoir at the confluence of the Snake and
1116 Clearwater Rivers, or operationally by raising reservoir levels. At times, the navigation channel
1117 is controlled operationally for specific purposes. For example, the McNary Reservoir needs to
1118 be above a minimum of 338 feet and held within a half-foot range and Priest Rapids Dam
1119 discharges need to be held within a specified range to facilitate periodic shipments of nuclear
1120 reactor compartment disposal packages to the Port of Benton by the U.S. Navy. Thus,
1121 navigation requirements are fully met within the flexibility provided under normal CRS
1122 operations.

1123 Between 1996 and 2016, an average of 54.1 million tons of freight per year was moved on the
1124 CSNS, of which 4.8 million tons of freight was moved on the lower Snake River (Corps
1125 Waterborne Commerce Statistics 2018). The top ten commodities transported are wheat,
1126 soybeans, corn, wood, sodium carbonate, pebbles and gravel, potassium chloride fertilizers,
1127 gasoline, other light oils, and scrap metal (Corps Waterborne Commerce Statistics 2018).

1128 Many types of recreational motorized and non-motorized pleasure crafts are used throughout
1129 the Columbia River Basin. Commercial tour guide and transportation services also exist in some
1130 locations. Several cruise companies offer cruises along the lower Columbia River and on the
1131 lower Snake River to Clarkston, Washington.

1132 Two ferries operate on Lake Roosevelt, the reservoir behind Grand Coulee Dam. The Keller
1133 Ferry is operated by the Washington Department of Transportation as a link on rural State
1134 Route 21 and provides access to the Colville Indian Reservation. It can run throughout the
1135 entire operating range of the reservoir, from elevation 1,208 to 1,290 feet. The Inchelium-
1136 Gifford Ferry provides access to the Colville Indian Reservation from Washington State Highway
1137 25. This ferry cannot operate below elevation 1,229 feet. Both ferries carry normal highway
1138 traffic.

1139 **1.9.7.2 Fish**

1140 Prior to dam construction, some populations of salmon, steelhead, lamprey, and other
1141 anadromous species migrated as far as 1,200 miles up the Columbia River to Lake Windermere,
1142 Canada, and 600 miles up the Snake River to Shoshone Falls, near Twin Falls, Idaho. As part of
1143 the Independent Science Advisory Board (ISAB) review of density dependence, the ISAB
1144 estimated that a range of 5 to 9 million salmon and steelhead once returned to the Columbia
1145 River Basin in the pre-development era (prior to 1850) with the primary evidence (i.e., probable
1146 harvest rates) supporting an estimate of around 6 million fish per year (ISAB 2015). Other
1147 published estimates of pre-development abundance range from 7.5 to 8.9 million fish
1148 (Chapman 1986) or 10 to 16 million fish (NW Council 1986), assuming that all species could

1149 reach maximum abundance in the same year. Current returns of salmon and steelhead are well
1150 below the pre-development estimates of abundance. NMFS' 2016 5-year status review notes
1151 that:

1152 "Many West Coast salmon and steelhead (*Oncorhynchus* spp.) stocks have declined
1153 substantially from their historical numbers and now are at a fraction of their historical
1154 abundance. Several factors contribute to these declines, including: overfishing, loss and
1155 degradation of freshwater and estuarine habitat, hydropower development, poor ocean
1156 conditions, and hatchery practices. These factors collectively led to the National Marine
1157 Fisheries Service's (NMFS) listing of 28 salmon and steelhead stocks in California, Idaho,
1158 Oregon, and Washington under the Federal Endangered Species Act (ESA)." (NOAA
1159 2016)

1160 Dams without fish passage block anadromous fish access to much of the upstream portions of
1161 the Columbia and Snake rivers and their tributaries. As juveniles, anadromous fish migrate from
1162 fresh water to marine environments and then return to fresh water as adults to spawn. Over
1163 550 miles of mainstem Columbia River habitat (and many more miles of tributaries) have no
1164 returning anadromous fish above Chief Joseph Dam, which is the current upstream limit of
1165 salmon and steelhead in the Columbia River. Over 50 percent of the originally inhabited
1166 mainstem of the Snake River is no longer accessible to anadromous fish, as the Hells Canyon
1167 Complex limits access to the upper 247 miles of this river, plus access to tributaries. Dworshak
1168 Dam blocks upstream migration on the North Fork of the Clearwater River. Additional historical
1169 background information is included in Section 3.5.

1170 The kinds and numbers of resident fish vary considerably across the Columbia River Basin.
1171 Many species interact with each other and their habitats to form local/regional fish
1172 communities. Some of these species are important for cultural, recreational, and commercial
1173 harvest. Some resident fish populations, including bull trout and Kootenai River white sturgeon
1174 are listed under the ESA. Others, such as burbot, westslope cutthroat trout, and kokanee, are
1175 not listed. Many habitats in the Columbia River Basin are fragmented by Federal and non-
1176 Federal dams for native resident fish. Dams and associated reservoirs have created more
1177 opportunities for the expansion of non-native game fish introduced into the basin.

1178 Within the Columbia River Basin, various actions, plans, agreements, and programs have been
1179 implemented by Federal, state, local, and tribal entities to contribute to the survival and
1180 recovery of ESA-listed species and to the maintenance of other stocks. These actions, plans, and
1181 programs aim to improve water quality, habitat, up- and down-stream migrations, and address
1182 predation, among other goals.

1183 Water quality improvements include the installation of flow deflectors to reduce the amount of
1184 TDG at Chief Joseph, all four lower Snake projects (Ice Harbor, Lower Monumental, Little
1185 Goose, and Lower Granite dams), McNary, John Day, and Bonneville dams, and multilevel
1186 outlets to release water at certain temperatures at some projects, including Libby, Hungry
1187 Horse, and Dworshak dams.

1188 Throughout the Columbia River Basin, fish and wildlife habitat protection, mitigation, and
1189 enhancement projects have been constructed with funding from a wide variety of programs,
1190 including programs implemented through by the state agencies like the Washington Salmon
1191 Recovery Funding Board and the Oregon Watershed Enhancement Board as well as Federal
1192 programs such as Bonneville’s Fish and Wildlife Program, Corps’ authorities like the section 536
1193 program, BOR’s ESA Recovery Program, NOAA’s Pacific Coastal Salmon Recovery Fund, USFWS
1194 Partners for Fish and Wildlife Program, NRCS Conservation Easement Recovery Program, North
1195 American Wetlands Conservation Act. These interagency groups work collaboratively to better
1196 integrate, organize, and coordinate fish recovery and water quality efforts in support of
1197 protecting and restoring the Columbia River Basin aquatic ecosystem.

1198 **HABITAT ACTIONS**

1199 Bonneville works with states, tribes and watershed groups to protect, mitigate, and enhance
1200 spawning and rearing habitat, targeting factors that limit fish survival throughout the Columbia
1201 River Basin. Bonneville has funded hundreds of actions across the basin to restore natural
1202 stream channels, reconnect estuarine tidal channels, enhance flow volume and timing, expand
1203 cold water refuges and open access to habitat (www.cbfish.org). These habitat improvement
1204 actions provide both near-term and long-term benefits, including those that will help address
1205 the effects of climate change. Actions that improve connectivity and stream flow will provide a
1206 buffer against the effects of climate change.

1207 In addition to habitat improvement actions, Bonneville works with willing landowners to
1208 protect land and water by putting it under permanent conservation easement to further
1209 support habitat and fish conservation in the short and long term.

1210 All eight Federal projects on the lower Columbia and lower Snake Rivers provide fish passage to
1211 accommodate anadromous fish migration. Some fish facilities were included in the initial design
1212 of the projects, while others were added at a later date. Facilities and operations designed to
1213 benefit fish include ladders for adults and diversion screens for juveniles; a transportation
1214 program consisting of collection facilities, barges, and trucks for juvenile migration; hatcheries
1215 to supplement harvest and wild stocks; and in-stream flow management for both juveniles and
1216 adults. Actions to address predation on salmon and steelhead have ranged from lethal removal
1217 to non-lethal dissuasion and hazing. Avian wires at the CRS projects and higher water levels
1218 during nesting seasons are techniques to deter birds from using a particular area. For seals and
1219 sea lions (pinnipeds), exclusion devices have been installed at the projects as a dissuasion
1220 method. Hazing has been carried out to deter both birds and pinnipeds from preying on
1221 migrating salmonids.

1222 **UPSTREAM FISH PASSAGE**

1223 Fish ladders, which allow adult salmon and other fish species including lamprey to migrate
1224 upstream, were built during the original construction of all eight Federal run-of-river projects
1225 on the lower Columbia and Snake rivers. (The five PUD dams on the middle Columbia River also
1226 have fish ladders to maintain anadromous fish access to the Wenatchee, Methow, Entiat, and

1227 Okanogan rivers.) Each of these projects has one to three ladders operating continuously,
 1228 except during winter maintenance outages. Even though the fish ladders were not originally
 1229 designed for lamprey passage, several ladder modifications have been made since the early
 1230 2000s and more are expected in the future to improve lamprey passage. Resident fish passage
 1231 is blocked by Libby, Hungry Horse, and Albeni Falls dams. The Grand Coulee, Chief Joseph, and
 1232 Dworshak dams effectively block the upstream migration of anadromous fish. All six of these
 1233 projects were not designed with fish passage facilities and so effectively block the upstream
 1234 access for both resident and anadromous fish.

1235 The Bonneville Dam has three fish ladders; The Dalles, John Day, McNary, Ice Harbor, and
 1236 Lower Monumental Dams each have two fish ladders; and the Little Goose and Lower Granite
 1237 Dams each have one fish ladder. Adult fish enter a ladder through collection systems that run
 1238 along the entire front of a dam's powerhouse, as well as at other key locations. Specific flow
 1239 conditions near the ladder entrances are needed to attract adult fish into the ladders. The
 1240 attraction water is provided by pumps, small turbines, or gravity flow from the reservoir behind
 1241 the dam, depending on the design of the individual system. The fish swim upstream to the base
 1242 of the fish ladder, where they migrate up the ladder and exit into the reservoir above the dam.
 1243 Each ladder contains a fish-counting station where the fish pass an underwater viewing
 1244 window, allowing them to be counted and identified by species.

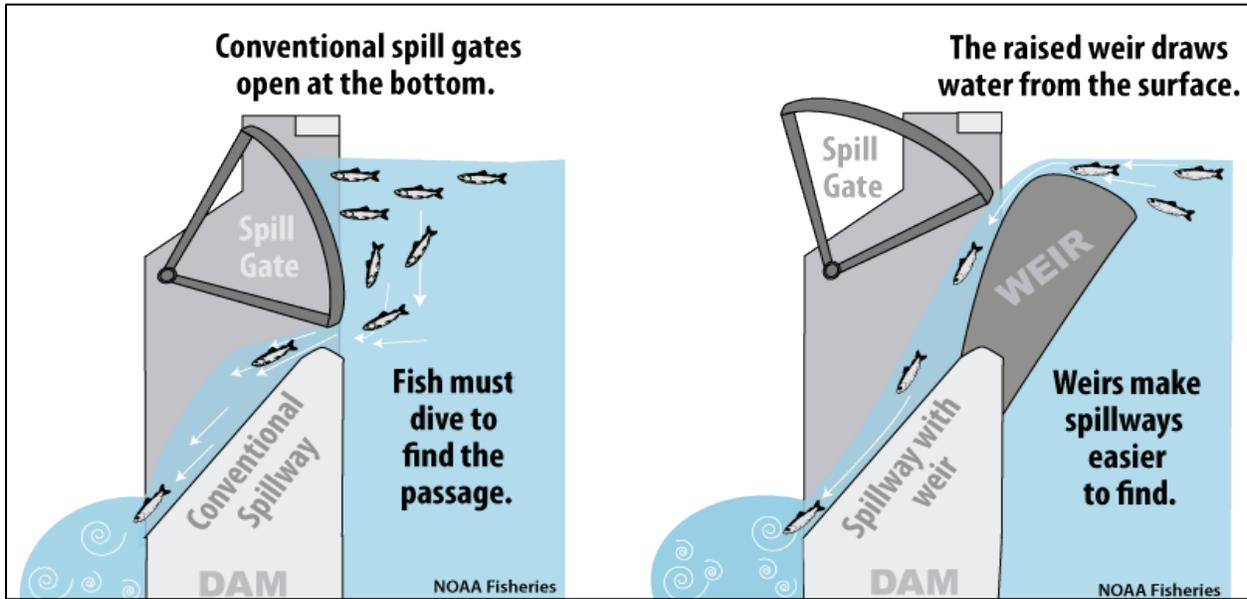
1245 **DOWNSTREAM FISH PASSAGE**

1246 Currently, juvenile fish can migrate past the dams via several routes: over the spillway, through
 1247 the turbines, or through the juvenile fish bypass systems, sluiceways or corner collector
 1248 (Table 1-4). In addition, some fish are transported past the dams by barge or truck.

1249 **Table 1-4. Types of Downstream Fish Passage**

Project	Type of Downstream Fish Passage
Lower Granite	spillway, spillway weir, juvenile bypass system, turbines, barges, and trucks
Little Goose	spillway, spillway weir, juvenile bypass system, turbines, barges, and trucks
Lower Monumental	spillway, spillway weir, juvenile bypass system, turbines, barges, and trucks
Ice Harbor	spillway, spillway weir, juvenile bypass system, and turbines
McNary	spillway, two spillway weirs, juvenile bypass system, turbines, and improved fish passage turbines
John Day	spillway, two spillway weirs, juvenile bypass system, and turbines
The Dalles	spillway, sluiceway, and turbines
Bonneville	corner collector, spillway, sluiceway, juvenile bypass system, turbines, and improved fish passage turbines

1250 Spillway passage occurs through either conventional spill or spillway weirs (Figure 1-9).
1251 Conventional spill requires juvenile fish, which generally travel near the surface of the river, to
1252 dive to find passage at the bottom of the spill gates, while spillway weirs provide conditions
1253 that are more favorable and more effective surface passage. Spillway weirs are mounted onto
1254 the face of a dam and use surface flows to draw fish toward the structure. This route allows
1255 juvenile salmon and steelhead to pass the dam near the water surface under lower
1256 accelerations and lower pressures, providing a more efficient and faster dam passage route.



1257
1258 **Figure 1-9. Passage Routes of Juvenile Salmon for Conventional Spill and Spillway Weir**
1259 **Routes**

1260 Powerhouse passage for juvenile salmonids is also broken into multiple routes, including
1261 turbines, juvenile bypass, sluiceways, and corner collector passage. Juvenile bypass systems
1262 divert juvenile anadromous fish away from the turbine intakes and through a bypass system to
1263 raceways, where they are collected for transport or bypassed directly back into the river. The
1264 juvenile bypass system guides 60 to 90 percent of juvenile salmon and steelhead that enter the
1265 powerhouse away from the turbines and into the bypass. Fish collected for transport are placed
1266 in either barges or trucks and transported around multiple dams and released downstream of
1267 Bonneville Dam.

1268 At The Dalles Dam, turbine units are not screened. As a result, powerhouse fish passage
1269 consists of turbines or the ice-and-trash sluiceway, a rectangular channel extending along the
1270 upstream side of the powerhouse. When the sluiceway gates are open, water and juvenile
1271 migrants are skimmed from the forebay into the sluiceway, and bypassed to the tailrace.

1272 At Bonneville Dam, turbine units are only screened at the second powerhouse because juvenile
1273 fish turbine passage was found to be better without screens at the first powerhouse. The first
1274 powerhouse also has an ice-and-trash sluiceway. The corner collector at Bonneville Dam was

1275 the ice and trash sluiceway at the second powerhouse that was transformed into a juvenile
1276 bypass route that was extended to release the fish back into the river further downstream.

1277 **1.9.7.3 Water Quality**

1278 State water quality standards are developed to ensure the protection of the water's beneficial
1279 uses. Minimum outflow requirements, which generally vary by season, are specified for each
1280 project to help maintain desired downstream conditions. The co-lead agencies recognize
1281 Federal, state, and EPA-approved tribal water quality standards, and manage a variety of
1282 programs and facilities intended to maintain water quality throughout the Columbia River
1283 Basin. Two main water quality parameters affected by CRS operations are water temperature
1284 and TDG. See Section 3.4 for detailed water quality information.

1285 **TEMPERATURE**

1286 It is understood that the creation of reservoirs can cause a change in the natural thermal
1287 regime of a river. Reservoirs tend to create thermal responses that lag behind that found in
1288 unregulated rivers, creating outflow temperatures that are cooler in the spring and warmer in
1289 the fall compared to natural or pre-dam thermal conditions. Dams and reservoirs tend to
1290 reduce the within-day warming and cooling processes typically observed in free-flowing rivers.
1291 For more information, refer to Chapter 3.4, Water Quality.

1292 The CRS storage projects, which include Hungry Horse, Libby, and Dworshak dams are deep
1293 storage reservoirs that retain water for several months, allowing for temperature stratification
1294 (water arranged in layers that vary in temperature). This stratification provides the ability to
1295 operate these dams, through selective withdrawal, to meet downstream water temperature
1296 objectives. Cold-water releases from Dworshak Dam have been used successfully to reduce
1297 water temperatures at Lower Granite Dam. However, the cooling effects of the Dworshak
1298 releases are attenuated, as the Snake River flows toward the confluence with the Columbia
1299 River. Water temperatures in the lower Snake River are primarily determined by a combination
1300 of the temperature of the water originating from the middle Snake River and the Clearwater
1301 River. Lower and middle Snake River maximum summer temperatures exceeded the current 68
1302 °F (20 °C) Washington standard before the dams were constructed (Corps 2002, Peery et al.
1303 2003). Grand Coulee is also considered a storage project, but it is unique in the fact that it has
1304 relatively low retention times due to the large amount of flow through the project. This short
1305 retention time results in very weak thermal stratification, and homogenous temperatures at
1306 penstock intake depths. The lack of strong thermal stratification results in Grand Coulee Dam
1307 releasing the coolest water possible during hot summer months. The other CRS dams are run-
1308 of-river projects with short retention times (only a few days or weeks) with more uniform water
1309 temperatures from the surface to the bottom (not stratified); selective withdrawal is not
1310 possible at these dams.

1311 **TOTAL DISSOLVED GAS**

1312 Spilling water at a dam results in increased TDG levels in downstream waters when aerated
1313 water plunges to depths where pressure increases the solubility of atmospheric gases. Water

1314 that contains high levels of dissolved gases (e.g., nitrogen and oxygen) can be harmful to fish.
1315 The TDG saturation in water below CRS dams often exceed state and tribal water quality
1316 standards of 110 percent during the juvenile fish passage season, generally April to August;
1317 however, this criterion does not apply to flows above the 7-day, 10-year frequency flow (7Q10)
1318 flood flow. In addition, special waiver or rule modifications from Oregon Department of
1319 Environmental Quality and a criteria adjustment from the Washington Department of Ecology
1320 have been established as a special condition during the juvenile fish passage periods of spill for
1321 downstream fish migration (April 1 to August 31), allowing for the exceedance of the 110
1322 percent TDG water quality standard at the lower Columbia River and lower Snake River dams
1323 up to a specified tailwater or forebay percent TDG maximum. The co-lead agencies have made
1324 major efforts to reduce TDG generation during the juvenile fish passage season by regulating
1325 flow and installing structures such as flow deflectors to reduce the plunge of water that reduces
1326 the amount of entrained air. Although the co-lead agencies have made major efforts to reduce
1327 TDG generation during high-flow years, there are situations where TDG water quality criteria
1328 are exceeded. For example, TDG can be in excess of 120 percent in the Columbia River at the
1329 International Boundary. Spillway releases can improve downstream juvenile fish migration, so
1330 balancing these releases and TDG production is important.

1331 TDG and water temperature data are monitored in real time through a network of fixed
1332 monitoring stations operated by the Corps, Reclamation, and Grant and Douglas County PUD to
1333 provide information about dam operations during the juvenile fish passage and migration
1334 season. These monitors are used to measure compliance with state and tribal water quality
1335 standards.⁵ The data collected through this monitoring network provides information used to
1336 adjust spill on a real-time basis through the system.

⁵ Tribal water quality standards exist for the mainstem Columbia River and tributaries per each tribe's jurisdiction. Certain tribes in the basin have water quality standards that have been approved by EPA.

1 **CHAPTER 2 - ALTERNATIVES**

2 **2.1 INTRODUCTION**

3 This chapter describes the No Action Alternative and the four Multi-Objective (MO) alternatives
4 which make up the initial range of alternatives considered in the Columbia River System
5 Operations (CRSO) Environmental Impact Statement (EIS). A sixth alternative, the Preferred
6 Alternative, includes many of the measures described in this chapter. The Preferred Alternative
7 is described and evaluated in Chapter 7.

8 The U.S. Army Corps of Engineers (Corps), U.S. Bureau of Reclamation (Reclamation), and
9 Bonneville Power Administration (Bonneville), co-lead agencies for the EIS, developed a range
10 of alternatives for the future physical configuration, operation, and maintenance of the 14
11 projects of the Columbia River System (CRS) to achieve a reasonable balance of competing
12 resource demands for the available water and meet the purpose and need for this EIS.

13 The co-lead agencies defined eight objectives (section 2.2.1) to meet the purpose and need
14 statement for the EIS and to direct the development of the alternatives. A suite of eight
15 preliminary draft alternatives were developed to focus on individual resources. These Single
16 Objective Alternatives (SOs) provided information regarding how well measures might perform
17 when combined, and helped identify any conflicts between resources, actions, or locations.
18 These SO Alternatives informed the next iteration of alternatives development. The resulting
19 range of alternatives consists of the No Action Alternative and four Multiple Objective
20 Alternatives (MOs). The No Action Alternative is a description of continuing current practices,
21 whereas the MOs modify one or more aspects of the operation, maintenance, and
22 configuration of the projects.

23 The MOs include a range of spill levels for juvenile fish passage, varying levels of hydropower
24 production, and differing actions to support the needs of Endangered Species Act (ESA)-listed
25 anadromous and resident fish. The MOs also include proposed means to support future
26 delivery of water for irrigation and municipal and industrial purposes as well as increased water
27 management flexibility to react to unanticipated changes in river flow and increase the
28 likelihood of achieving refill of storage reservoirs. After evaluating the potential effects of the
29 alternatives on flood risk management (FRM), irrigation, hydropower generation, navigation,
30 fish and wildlife conservation, cultural resources, recreation and other environmental and
31 socioeconomic resources, the Preferred Alternative was developed to achieve a reasonable
32 balance of competing resource needs (Chapter 7, Preferred Alternative) while meeting the
33 purpose and need statement (Section 1.2). This chapter describes the five alternatives and the
34 process used to develop and evaluate them.

35 **2.2 OVERVIEW OF ALTERNATIVES DEVELOPMENT PROCESS**

36 The three co-lead agencies developed alternatives for the CRSO EIS to focus on changes to
37 operations, maintenance, and configuration of the 14 identified projects in the CRS. Several
38 other scopes that include regional efforts for consideration were suggested for the EIS which

39 the co-lead agencies did not develop alternatives to address. These are identified in Section 2.4.
40 Alternatives were developed to meet the purpose and need statement, identified objectives,
41 and congressionally authorized purposes of the projects within the CRS. The process used to
42 develop the No Action Alternative and MOs is summarized in this chapter, and fully detailed in
43 Appendix A, *Alternatives Development*.

44 The co-lead agencies used an iterative process to build alternatives. They began by identifying
45 objectives for future management of the CRS. Actions that could be taken to meet those
46 objectives, called measures, were then identified. Finally, the measures were combined into
47 alternatives and refined over time to produce a reasonable range of alternatives for analysis. In
48 support of the alternatives development process, technical subject matter experts were
49 convened from the three co-lead agencies, cooperating agency staffs, and multiple Native
50 American tribes. These subject matter experts were assigned to technical teams based on their
51 respective area of expertise. Many in-person workshops and web-based meetings were
52 conducted by the technical teams to ensure a collaborative alternatives development process.
53 Reviews of early draft alternatives, comment resolution, and refinement of alternatives were
54 also conducted via web-based meetings to include large numbers of team members across the
55 geographic region. The co-lead agencies used the input from the scoping process, technical
56 teams, cooperating agencies, and tribes as the alternatives were developed. They also
57 considered the Purpose and Need Statement and objectives. While there were broad efforts to
58 collaboratively build and evaluate the alternatives, the co-lead agencies are ultimately
59 responsible for the decisions made in the EIS process, including decisions on scope of the
60 analysis. The co-lead agencies retain final responsibility for the analysis in the draft and final
61 EISs and the decision made in each agency's respective Records of Decision (ROD). The
62 participation of the cooperating agencies and their collaboration with the lead agencies does
63 not infer that they agree with the conclusions in the analysis or that they are waiving any rights
64 to review and comment on the draft and final EIS during the public comment period.

Multiple Objective Alternatives Terminology

Objectives are what the Federal agencies are trying to accomplish (the "why"). They are statements of the desired outcome of the EIS, as identified by the Federal agencies and scoping comments. An example of an objective is to improve ESA-listed anadromous salmonid adult fish migration within the project area.

A **measure** is the action the agencies would take to achieve an objective (the "how"). It describes an action, usually in a precise location, that meets an objective, in whole or in part. Using the objective mentioned above, a measure could be to provide structural enhancements for fish passage, such as improving fish ladders.

An **alternative** is a combination of one or more measures that, together, would address one or more of the objectives. In this EIS, the co-lead agencies designed the action alternatives to address several objectives and are therefore calling them Multiple Objective Alternatives (MOs).

65 **2.2.1 Objectives**

66 Objectives are statements of the desired outcome of various resource conditions that are
67 expected to result by taking Federal action(s). The eight objectives presented below, along with
68 the EIS Purpose and need statement (Section 1.2), guided the development of a reasonable
69 range of alternatives:

- 70 • Objective 1: Improve ESA-listed anadromous salmonid juvenile fish rearing, passage, and
71 survival within the CRSO project area through actions including but not limited to project
72 configuration, flow management, spill operations, and water quality management.
- 73 • Objective 2: Improve ESA-listed anadromous salmonid adult fish migration within the CRSO
74 project area through actions including but not limited to project configuration, flow
75 management, spill operations, and water quality management.
- 76 • Objective 3: Improve ESA-listed resident fish survival and spawning success at CRSO projects
77 through actions including but not limited to project configuration, flow management,
78 improving connectivity, project operations, and water quality management.
- 79 • Objective 4: Provide an adequate, efficient, economical, and reliable power supply that
80 supports the integrated Columbia River Power System.
- 81 • Objective 5: Minimize greenhouse gas emissions from power production in the Northwest
82 by generating carbon-free power through a combination of hydropower and integration of
83 other renewable energy sources.
- 84 • Objective 6: Maximize operating flexibility by implementing updated, adaptable water
85 management strategies to be responsive to changing conditions, including hydrology,
86 climate, and the environment.
- 87 • Objective 7: Meet existing contractual water supply obligations and provide for authorized
88 additional regional water supply.
- 89 • Objective 8: Improve conditions for lamprey within the CRSO project area through actions
90 potentially including but not limited to project configurations, flow management, spill
91 operations, and water quality management.

92 **2.2.2 Measures**

93 As stated previously, a measure describes an action that could be taken to meet one or more
94 objectives. Measures are typically specific to a discrete action in a precise location. For
95 example, a measure could be to improve adult ladder passage through modification of the adult
96 trap at the Lower Granite Project. An alternative is usually constructed of a number of
97 measures that are combined to meet the objectives.

98 Many measures were considered to address objectives and build a reasonable range of
99 alternatives during the development of this EIS. Potential measures were submitted by the
100 public, stakeholders, and tribes during the scoping process. Additional measures were

101 developed by technical team members from co-lead and cooperating agencies. Before
102 combining measures into alternatives, they were evaluated to determine if they met the EIS
103 purpose and need statement and at least one objective. Those measures that did not meet at
104 least one objective were eliminated from further consideration. Remaining measures were
105 further evaluated to determine whether the measures were technically feasible, or whether
106 they constituted a risk to human life and safety (including increasing flood risk). Additional
107 detail of this process can be found in Appendix A, *Alternatives Development*.

108 Measures remaining after screening fall under two categories: structural or operational.
109 Structural measures are those involving a physical change to the project such as installation of a
110 feature in the spillway or modifying fish ladders. Operational measures are those involving a
111 change in how water is stored or released at the projects or how juvenile fish are transported
112 around the projects. Examples of operational measures include a change in timing of drawdown
113 or refill of a water storage reservoir and a change in how much water is released through the
114 spillway versus the powerhouse. Further, the operational measures of each alternative are
115 categorized as follows:

- 116 • **Fish Passage Spill** – Fish passage spill refers to the use of flow released through spillway
117 gates to allow juvenile fish to migrate downstream from the forebay of a reservoir to the
118 tailrace of the dam.
- 119 • **Juvenile Fish Transportation** – Juvenile fish transportation refers to the collection of ESA-
120 listed juvenile fish at collector projects for relocation downstream of the Bonneville project
121 via barges or trucks.
- 122 • **Water Management** – Water management refers to the planned release of flow from the
123 projects to either draft or refill reservoirs. Water management also refers to operations to
124 meet project purposes such as FRM, hydropower production, and irrigation as well as fish
125 and wildlife purposes.
- 126 • **Water Supply** – Water supply refers to the withdrawal of water for the purpose of irrigation
127 and municipal and industrial use.
- 128 • **Other Operational** – Other operational measures include actions taken to support fish and
129 wildlife. For example, the drawdown of reservoirs to reduce juvenile salmon outmigration
130 time.

131 **2.3 ALTERNATIVE SCREENING**

132 To achieve a broad range of alternatives, the co-lead agencies collaborated with cooperating
133 agencies in teams of technical experts through several iterations to create 12 alternatives that
134 could meet the CRSO EIS purpose and need statement: first, eight single objective alternatives,
135 and then four MOs. After completing the effort to develop the single and MO alternatives, the
136 co-lead agencies evaluated all 12 alternatives against screening criteria of completeness and
137 efficiency.

- 138 • **Completeness** was used to evaluate the extent to which a given alternative provides and
139 accounts for all actions to meet most or all objectives, and thereby satisfying the purpose
140 and need statement.
- 141 • **Efficiency** was considered as how well (without duplication of effort) an alternative would
142 meet objectives. Usually, cost effectiveness is part of this consideration, but costs were not
143 available at the early screening of alternatives. In this case, efficiency was based on
144 efficiency of analysis of measures and the elimination of duplication of effort.

145 The evaluation of the 12 alternatives against these two criteria found that the MOs were more
146 complete than the single objective alternatives. The MOs were also determined to be more
147 efficient, as MOs were composed of combinations of measures from the single objective
148 alternatives. Retaining the single objective alternatives would have resulted in duplication of
149 analyses which otherwise are included in the MOs. This resulted in the finding that the four
150 MOs presented the most complete and efficient way to achieve identified objectives, and these
151 represented a reasonable range of alternatives that included the suites of measures the
152 technical teams identified. The single objective alternatives were eliminated from further
153 consideration. The complete detailed descriptions of the single objective alternatives and their
154 measures are located in Appendix A, *Alternatives Development*. A brief description of the
155 alternatives removed from further consideration is in Section 2.5.

156 **2.4 RANGE OF ALTERNATIVES**

157 **2.4.1 Introduction**

158 The analysis in this chapter focuses on five alternatives, which include the No Action
159 Alternative, Multiple Objective Alternative 1 (MO1), Multiple Objective Alternative 2 (MO2),
160 Multiple Objective Alternative 3 (MO3), and Multiple Objective Alternative 4 (MO4). An
161 important note is that the descriptions of the MOs only include how they differ from the No
162 Action Alternative. For example, under the No Action Alternative, Libby and Hungry Horse Dams
163 operate to daily and hourly ramping up and down restrictions as per the 2006 USFWS BiOp.
164 Two MOs include ramping rate measures that would allow project operators to increase or
165 decrease the rate of flow released from the dam more quickly than under the No Action
166 Alternative. The other two MOs would continue to adhere to the No Action Alternative ramping
167 rates and their descriptions do not restate the No Action Alternative operation for the sake of
168 brevity.

169 MOs are so named in that they attempt to incorporate measures that would address more than
170 one of the eight CRSO objectives. However, these alternatives do not attempt to balance all of
171 the objectives equally. Rather, the MOs explore a range of structural and operational changes
172 in order to determine impacts of potential new solutions and analyze the trade-offs of
173 combining ideas under one alternative.

174 The sections below provide summarized descriptions of the five alternatives, which include an
175 explanation of the measures within the alternative. The descriptions begin with an overall

176 summary of the alternative and include the distinction amongst the four MOs. The structural
177 measures of each alternative are characterized first, followed by the operational measures. The
178 complete detailed descriptions of the alternatives and their measures are located in Appendix
179 A, *Alternatives Development*.

180 **2.4.2 No Action Alternative**

181 For this EIS, the No Action Alternative describes the operation, maintenance, and configuration
182 of the CRS, from September 30, 2016, the date the Notice of Intent to complete the CRSO EIS
183 was published in the Federal Register. The No Action Alternative is required by the National
184 Environmental Policy Act (NEPA), in accordance with the Council on Environmental Quality
185 regulations (40 Code of Federal Regulations [CFR] 1502.14). The No Action Alternative considers
186 what would happen if the CRS continued to be operated, maintained, and configured with no
187 change. The EIS assumes that, to the extent possible, all ongoing, scheduled, and routine
188 maintenance activities for the Federal infrastructure and all structural features, including those
189 recently constructed or reasonably foreseeable, are included in the No Action Alternative.

190 The No Action Alternative provides a baseline condition for comparing environmental effects of
191 the MOs. The No Action Alternative assumes the CRS will continue to be operated for all
192 congressionally authorized purposes, requiring a balancing of operations across the 14 projects
193 within the CRS. Current operations include actions agreed to in previous ESA consultations
194 among the co-lead agencies, National Marine Fisheries Service (NMFS), and U.S. Fish and
195 Wildlife Service (USFWS).

196 The No Action Alternative also assumes structural measures already budgeted and scheduled
197 would be implemented. The majority of these structural/construction projects are
198 modifications to the dams intended to improve conditions for ESA-listed fish or improve safety
199 for operators and the public. A general description of the No Action Alternative is located in
200 Section 2.4.2. Additional discussion of the No Action Alternative is contained in Appendix A,
201 *Alternatives Development*.

202 As described in Chapter 1, Introduction, the CRS is operated to meet multiple authorized
203 purposes, and consider other regional priorities. The volume of water in the CRS in any given
204 year is variable and finite, and not all operations to benefit various resources may be achieved
205 in a given year. In coordinating system water management, the co-lead agencies generally
206 prioritize FRM and environmental responsibilities, such as conservation actions for ESA-listed
207 fish species and other species of concern, before Bonneville shapes any remaining flexibility to
208 manage water flow for hydropower generation to meet daily and seasonal power demands.

209 Information described in the No Action Alternative is drawn from a number of documents,
210 including the Fish Operations Plan (Corps 2016a), Fish Passage Plan (Corps 2016b), biological
211 opinions (BiOps) from NMFS and USFWS (NMFS 2008b; USFWS 2006), Water Management
212 Plans (Corps 1992), and other sources.

213 **2.4.2.1 No Action Alternative Description of Measures**

214 This section provides a brief description of the way the CRS is operated, and would be
215 expected to operate, if no other changes are implemented. A more comprehensive description
216 of current system operations is contained in Appendix A, *Alternatives Development*.

217 **STRUCTURAL MEASURES**

218 In addition to investments that meet the structural measures criteria described in Section 2.4.2,
219 the co-lead agencies will continue to invest in power-related capital improvements, additions,
220 replacements, and non-routine extraordinary maintenance/expense as needed to meet
221 reliability standards, availability requirements, regional adequacy guidelines, efficiency needs,
222 environmental requirements, safety and security standards, and other requirements.

223 **Hungry Horse Project Power Plant Modernization**

224 The power plant at Hungry Horse Project began an extensive modernization effort in Fiscal Year
225 (FY) 2018. This work will bring the facilities to current industry standards. It will include the full
226 overhaul or replacement of governors, exciters, fixed-wheel gates, and turbines; a generator
227 rewind; overhaul of the selective withdrawal system; and recoating the penstocks. In addition,
228 cranes that service the power plant will be refurbished or replaced, and the power plant will be
229 brought up to modern fire protection standards. For one of the years of the project, the power
230 plant overhaul would limit the number of turbines available to generate power during the
231 overhaul. This would not affect the amount of water released from the dam because outlets
232 will be used. The full effort is expected to take 10 years to complete.

233 **Third Powerplant Overhaul Project**

234 Third Powerplant Overhaul Project includes work on the six generating units, turbines, shafts,
235 and auxiliary equipment at the Grand Coulee Dam Third Powerplant. The main portion of the
236 overhaul work is being completed within the confines of the third powerplant.

237 **John W. Keys III Pump-Generating Plant Modernization Project**

238 John W. Keys III Pump-Generating Plant Modernization Project at Grand Coulee Dam includes
239 pump-generating and auxiliary equipment. Work will be within the confines of the plant and
240 completed in 2034.

241 **Lower Granite Project Juvenile Facility Bypass Improvements**

242 This action modified the existing bypass system to construct an open channel with increased
243 orifice size, intended to move fish from the collection channel to the existing juvenile fish
244 collection facility. The work is intended to reduce the time fish spend in the system, moving
245 them more quickly and reducing stress and delays. The project includes an enlarged collection
246 channel, flow reduction through the transport channel, improved water supply to the location
247 downstream of the collection channel, and a relocation of the primary outfall to reduce
248 predation. Construction was complete and the system became fully operational in FY 2019.

249 **Lower Granite Project Spillway Passive Integrated Transponder Monitoring System**

250 A passive integrated transponder (PIT)-tag monitoring system was installed over spillbay 1, the
251 location of the removable spillway weir. The system includes a set of antennas mounted in the
252 surface of the spillway and connected to an electrical transceiver located on the tailrace deck.
253 These antennas support collection of data so numbers of juvenile fish migrating over the
254 spillway can be compared with using the bypass system or other routes. This system was
255 installed in FY 2020.

256 **Little Goose Project Adjustable Spillway Weir Closure**

257 An adjustable spillway weir (ASW) was fabricated and installed in spillbay 1 at Little Goose Dam.
258 The project included a mechanical system to adjust the crest elevation of the spillway to allow
259 juvenile salmon and steelhead to pass the dam near the water surface. This allows operators to
260 adjust quickly to changing conditions, thus increasing the likelihood of juvenile salmon and
261 steelhead survival under the No Action Alternative spill operation.

262 **Little Goose Project Adult Ladder Temperature Improvements**

263 This structural measure includes a 90-foot-deep chimney attached to the face of the dam to
264 pull cool water from lower reservoir elevations and release it into the fish ladder. In the ladder,
265 the cold water mixes with surface water from the forebay to lower water temperatures. The
266 cold water is also sprayed onto the surface water in the forebay to cool water at the ladder exit.
267 This project is intended to keep ladder water temperatures within an acceptable range and
268 prevent delays in fish passage during periods of high water and air temperatures. Construction
269 was completed in FY 2018.

270 **Little Goose Project Boat Barrier**

271 This structure is comprised of a set of anchors and lines holding a string of booms and cables in
272 the forebay of the Little Goose Project. It is a safety measure intended to keep boats from
273 approaching the spillway. The cables have bird spikes to keep fish-eating birds off the structure
274 in an attempt to reduce predation in the forebay. Construction was completed in FY 2018.

275 **Little Goose Project Trash Shear Boom Repair**

276 This is a repair of an existing boom. The action included replacement of longitudinal cable to
277 reconnect 20 concrete floats. The floats are 40 feet long and 8 inches wide. This boom is
278 intended to direct debris away from the powerhouse to protect powerhouse infrastructure.

279 **Ice Harbor Project Turbines 1 to 3 Replacement and Generator Rewind¹**

280 The Ice Harbor turbine replacement and rewind will replace existing turbine runner blades on
281 units 1, 2, and 3, with state-of-the-art improved fish passage runners. The project will also
282 rewind the electrical components and replace the distributors. Collectively, these changes will
283 improve hydraulic conditions for fish and increase hydropower generating efficiency. Units 1
284 and 3 will be replaced with adjustable blades for increased operating flexibility to adjust to
285 changing river conditions. Unit 2 will remain a fixed-blade unit. The turbine replacement is
286 scheduled to be completed in FY 2021, with some turbines being installed sooner than FY 2021.

287 **McNary Project Turbine Replacement**

288 This action includes full replacement of all 14 turbines at McNary with new turbines. This
289 includes replacement of runners, discharge rings, windings, wicket gates, and potential draft
290 tube modifications, pending final design. The replacement will increase reliability, increase
291 generating efficiency, increase hydraulic capacity, and improve hydraulic conditions for fish.
292 The turbine replacement project is presently in its design phase. Construction is expected to be
293 completed within FY 2033.

294 **Adult Passive Integrated Transponder Tag Monitoring System at John Day Project**

295 PIT antennas were installed in both the north and south adult fish ladders during the 2016/2017
296 winter maintenance period. A PIT detection system at John Day Project will allow biologists to
297 track and monitor adult upstream migration and assist in development of more accurate
298 estimates of adult salmon survival through the CRS.

299 **Bonneville Project Gatewell Orifice Modifications**

300 Biological testing in 2008, 2009, and 2013 showed elevated mortality for juvenile salmon in the
301 gatewells when the units are operating at the upper end of the peak efficiency range (>15

¹ As part of ongoing litigation on the Columbia River System, the Corps, in coordination with Bonneville, is providing information to National Wildlife Federation on certain planned projects at the four lower Snake River dam and reservoir projects through the end of the CRSO EIS process. The four lower Snake River dam and reservoir projects are Ice Harbor, Lower Monumental, Little Goose and Lower Granite. The Corps, in coordination with Bonneville, is providing information on three categories: (1) Capital Hydropower Improvement Projects; (2) Columbia River Fish Mitigation Projects; and (3) Other Non-Power Capital Projects (e.g., navigation). The Capital Hydropower Improvement Project information provided to National Wildlife Federation is available here:

<https://www.bpa.gov/Finance/AssetMgmt/lsrdp/Pages/Lower-Snake-River-Dam-Projects.aspx>.

The Corps' Engineering Regulations (ER) provide that the evaluation of alternatives does not include past costs (or benefits) (ER 1105-2-100 Section 2-4). The Corps considers any expenditures, including capital, at any of its dam and reservoir projects that occur prior to completion of the EIS as "sunk" costs, and therefore, these expenditures would not be relevant to a recommendation on whether the dam and reservoir projects should be breached or not. Sunk costs have already been expended and are not material in the evaluation of alternatives that will be implemented after those expenditures have been made. Rather, in evaluating alternatives for the CRSO EIS, the co-lead agencies are evaluating future benefits and costs.

302 thousand cubic feet per second [kcfs]). This project is to improve juvenile salmon survival in the
303 gatewells at the Bonneville Project's second powerhouse.

304 **OPERATIONS**

305 The CRS is operated for a number of purposes: to reduce flood risk, generate hydropower,
306 provide water for irrigation and water supply, to provide navigation, for recreation, and to meet
307 fish and wildlife purposes. The current operations are described below.

308 **OPERATIONS FOR FLOOD RISK MANAGEMENT**

309 The CRS is authorized to provide FRM in the Columbia River Basin. It is the responsibility of the
310 Corps and Reclamation to protect the general safety and welfare of the public by managing
311 risks and consequences associated with flooding. The CRS operates storage dams and reservoirs
312 to balance inflow and outflow and meet the authorized purposes. All CRS storage projects
313 generally operate in a coordinated manner to minimize flood consequences in local areas and
314 in the lower Columbia River below Bonneville Project. Operations are developed collaboratively
315 by co-lead agency water managers and are described in the Water Control Manual for each
316 project. Operations may vary from year to year based on forecasted water conditions and are
317 adjusted throughout the year to meet changing conditions caused by weather. A gage located
318 at The Dalles, Oregon, is the reference gage for the Columbia River Basin.

319 Water managers from the co-lead agencies operate the system to make the best use of flood
320 space (capacity in the reservoirs to store inflows) and flood storage (the actual volume of water
321 stored in a reservoir for future use) across the FRM season. The FRM season includes three
322 operational regimes developed to provide flood protections throughout the Columbia River
323 Basin. These regimes are described in the following paragraphs:

324

325 • **Fall Operations: September through December.** Minimal system FRM operations occur
326 during this period, although specific projects have maximum reservoir elevations to meet
327 FRM objectives or other goals and agreements. For example, Albeni Falls meets maximum
328 reservoir elevation in mid-November to provide power generation flexibility, manage winter
329 floods and to protect kokanee spawning incubation. Maximum reservoir elevations are set
330 for the Libby, Hungry Horse, and Dworshak Projects for December.

331 • **Storage Evacuation Operations: January through April.** During storage evacuation
332 operations, the storage projects are drafted based on precipitation and snow accumulation
333 in the basin in order to prepare for high spring flows and reduce the potential for flooding.
334 The projects operate to a storage reservoir diagram (SRD) that is specific to each reservoir.
335 The SRD describes the minimum flood space requirement for each project and is adjusted
336 monthly based on current water supply conditions.

337 • **Refill Operations: May through August.** Although CRS reservoir operations generally
338 achieve refill by June 30, the actual refill date may vary depending on the timing and shape
339 of the spring runoff. For example, a late snowmelt runoff may result in a later refill in order

340 to avoid excessive spill. During the refill period, outflow from the reservoir is kept lower
341 than inflow, allowing the water level in the reservoir to increase and refill. In this manner,
342 the reservoir eventually reaches its refill elevation when flood risk has significantly
343 decreased. FRM refill at Hungry Horse and Libby dams are operated based on variable flow
344 operating criteria. This criterion provides a more normal spring flow regime that benefits
345 listed species and increases the likelihood of full reservoirs and water supplies for summer
346 flow needs.

347 ***Fall Operations at the Libby Project***

348 Libby Project typically releases the minimum outflow (4 kcfs) through the month of October in
349 order to maintain the reservoir elevation prior to the start of the FRM draft in November. The
350 maximum elevation requirement for November 30 is elevation 2,448 feet National Geodetic
351 Vertical Datum of 1929 (NGVD29), which allows 0.5 million acre-feet (Maf) of space. However,
352 Libby is often drafted as low as 2,435 feet NGVD29 in November to ensure that the December
353 31 flood space elevation requirements can be achieved without exceeding the powerhouse
354 capacity at Libby Project.

355 ***Downstream Control Points at the Hungry Horse Project***

356 Columbia Falls, Montana, serves as the control point for local FRM operations at the Hungry
357 Horse Project. In 2014, the official flood stage for the Flathead River at Columbia Falls was
358 modified to 13 feet (an approximate flow of 44 kcfs) when the Flathead Lake elevation is in the
359 top 1 foot (elevation 2,892 to 2,893 feet NGVD29). The flood stage is 14 feet (approximately 51
360 kcfs) when the elevation of Flathead Lake is more than 1 foot below full pool (elevation 2,892
361 feet NGVD29 or lower).

362 When the Flathead River at Columbia Falls is at or above flood stage or forecasted to be at or
363 above flood stage, outflows from the Hungry Horse Project will be adjusted as necessary (to a
364 minimum discharge of 300 cfs) as long as enough space exists in the reservoir to manage
365 remaining runoff. The Hungry Horse Project generally starts reducing discharges when flood
366 stage at Columbia Falls begins to exceed 12.5 feet when flood stage criteria is 13 feet, and 13
367 feet when flood stage criteria is 14 feet. Depending on the remaining runoff volume and
368 available reservoir space, however, the project may not begin reducing discharges until
369 Columbia Falls reaches levels higher than these criteria.

370 ***Allowable Rate of Change of Release at the John Day Project***

371 Safety precautions prohibit sudden changes in flow from the John Day Reservoir during normal
372 operating conditions. However, unusual or emergency conditions may require rapid evacuation
373 of stored water to achieve maximum flood storage space (between 257.0 feet and 268.0 feet
374 NGVD29). The maximum permissible rate of change in tailwater elevation is 3 feet per hour,
375 which corresponds to a change of approximately 200 kcfs per hour. This restriction is necessary
376 to provide navigation safety at the downstream approach to the navigation lock. The maximum

377 rate of change will not be used on a routine basis due to potentially severe effects on
378 navigation, recreation, and fish, including ESA-listed salmonids.

379 **OPERATIONS TO BENEFIT ANADROMOUS FISH**

380 ***Fish and Wildlife Operations***

381 The CRS is authorized to operate in a manner that provides benefits to fish and wildlife. The co-
382 lead agencies coordinate fish and wildlife management with a number of other Federal, State,
383 and tribal entities. In addition to operations intended to benefit ESA-listed anadromous fish and
384 their designated critical habitat, the co-lead agencies operate the CRS projects to benefit ESA-
385 listed resident fish (e.g., bull trout [*Salvelinus confluentus*] and Kootenai River White Sturgeon
386 [*Acipenser transmontanus*]) and their designated critical habitat. The co-lead agencies, in
387 coordination with NMFS and USFWS, make adjustments in CRS operations based on the best
388 available science, knowledge about current conditions in the system, and any effects from
389 management actions. Under the No Action Alternative, the analysis assumes that the system
390 will continue to be operated for fish and wildlife purposes per the terms of the 2016 Fish
391 Passage Plan and the Fish Operations Plan, both of which are developed annually by the Corps,
392 in coordination with Bonneville, regional Federal, State, and tribal fish agencies, and other
393 partners from the Fish Passage Operations and Maintenance work group. Operations to benefit
394 ESA-listed resident fish are also described. Specific operations for fish and wildlife are
395 designated in the following paragraphs and would continue as described under the No Action
396 Alternative.

397 ***Total Dissolved Gas Management***

398 The co-lead agencies use several different methods to manage total dissolved gas (TDG) across
399 the basin, including monitoring, structures, and operations, which are described here. Specific
400 actions are further described in future sections related to operations for fish benefits.

401 The co-lead agencies implement a TDG monitoring program, with monitoring locations at all 14
402 CRS projects, as well as the middle Columbia River dams (Wells Dam, Rocky Reach, Rock Island,
403 and Priest Rapids), and other locations on the Snake and Columbia Rivers. The monitoring
404 stations are operated by the Corps, Reclamation, and the Grant and Douglas County Public
405 Utility Districts. Data collected at these locations is used to inform project operations and adjust
406 spill on a real-time basis during fish migration season, and to monitor compliance with state
407 and tribal water quality standards.

408 Spillway flow deflectors have been installed at all of the 14 CRS projects except at The Dalles
409 and Grand Coulee (see Chapter 3, Affected Environment and Environmental Consequences, for
410 further discussion). Flow deflectors are structures that are installed at the base of the spillway.
411 They deflect spillway flows horizontally at the water surface, away from the dam, rather than
412 allowing the water discharged over the spillway to plunge vertically in the stilling basin and
413 increase concentrations of TDG. In addition to flow deflectors, the Corps has installed a training
414 wall at The Dalles to increase survival of juvenile fish that pass over the spillways and limit TDG.

415 The Corps develops and implements specific spill patterns for each of the lower Snake and
416 lower Columbia projects. These patterns dictate how much water is discharged through each
417 spillway during fish passage season, and are defined in the Fish Passage Plan, developed
418 annually. The spill patterns are developed to respond to the unique configuration of fish
419 passage facilities, spillways, flow deflectors, and downstream bathymetry at each project. Spill
420 patterns are managed to adapt to changing conditions, such as flow volumes, in the river (see
421 Spill Operations Section).

422 ***Flow Augmentation***

423 The Libby, Hungry Horse, Dworshak, and Grand Coulee Projects are managed to provide water
424 for downstream flow augmentation to benefit ESA-listed fish in spring and summer. Spring flow
425 augmentation generally begins in April, after the storage reservoirs have filled to the spring
426 elevation objectives per the annual Water Management Plan for that year² (FRM refill generally
427 runs from December through April.). Specific operations and elevations for are outlined in the
428 Water Control Manual for each project. Dworshak operations are described below. These
429 operations would continue under the No Action Alternative.

430 Storage projects provide summer flow augmentation after refilling to their maximum elevation,
431 usually around the end of June or July. Libby and Hungry Horse summer flow augmentation
432 draft benefits anadromous fish but is also shaped to benefit ESA-listed resident bull trout and
433 other sensitive, native fish species downstream of the projects. The intent is to maintain steady
434 or gradually declining flows until they reach the end of September elevation objectives. Grand
435 Coulee is also drafted to provide summer flow augmentation to benefit ESA-listed salmonids in
436 the Columbia River. Drafts for flow augmentation from Grand Coulee typically begin in July,
437 while summer flow augmentation at the other projects generally begins in either June or July,
438 depending on water supply and stream flow conditions.

439 ***Spring and Summer Flow Objectives***

440 The co-lead agencies, in collaboration with NMFS, USFWS, and state and tribal fish and wildlife
441 agencies across the Columbia River Basin, have developed flow objectives for the spring and
442 summer fish passage seasons on the lower Snake and lower Columbia Rivers. These flow
443 objectives are intended to benefit ESA-listed fish. In some years, the flow objectives may not be
444 met throughout the entire migration season because flows in the lower Snake and Columbia
445 Rivers depend on the volume and shape of natural runoff, combined with the flow
446 augmentation volumes. Due to annual water year variability, these volumes may not meet the
447 flow objectives in spite of water managers' efforts to meet them as much as possible.

448 For the lower Snake River, the spring flow objective is determined by the final April water
449 forecast for Lower Granite Dam; the summer flow objective is determined by the June water

² The water management plan for each year is available at <https://pweb.crohms.org/tmt/>.

450 forecast. In the lower Columbia River, the flow objectives are determined by the April and June
451 forecasts at The Dalles.

452 ***Spring and Summer Operations at Dworshak Project***

453 Dworshak Project is operated in the spring to maximize the probability of refilling the reservoir
454 to support summer flow augmentation, and also to provide the flows needed to meet spring
455 objectives in the lower Snake River during the downstream migration of juvenile salmon and
456 steelhead. If both these objectives cannot be achieved, the (TMT) will make an in-season
457 recommendation, weighing considerations unique to each particular year. During the spring,
458 Dworshak releases approximately 4 to 6 kcfs, if necessary, to help move fish from the Dworshak
459 and Clearwater fish hatcheries, located directly downstream, into the mainstem of the
460 Clearwater River.

461 Summer flow augmentation provided from Dworshak increases the survival of ESA-listed fish by
462 moderating river temperatures and increasing water velocities in the lower Snake River. During
463 the summer (July and August), the co-lead agencies operate Dworshak to help meet the
464 flow/temperature objectives identified, in coordination with the TMT. The co-lead agencies
465 plan to draft to elevation 1,535 feet NGVD29 by the end of August and elevation 1,520 feet
466 NGVD29 by the end of September each year, unless modified per the agreement between the
467 United States government and the Nez Perce Tribe for water use in the Dworshak Reservoir.
468 Portions of Dworshak Reservoir lie within the exterior boundaries of the Nez Perce Reservation.
469 The extension of the draft limit into September assures water will be released consistent with
470 the Snake River Basin Adjudication Agreement.

471 ***Flood Risk Management Shift***

472 Periodically, the co-lead agencies look for opportunities to shift system FRM space
473 requirements from Brownlee Reservoir (owned by Idaho Power) and Dworshak to Grand Coulee
474 from January through April in order to provide more water for flow augmentation in the lower
475 Snake River during spring migration of anadromous fish. The shift allows operators to draft
476 Grand Coulee deeper in the winter in order to keep the Brownlee and Dworshak reservoirs at
477 higher levels. The reservoirs must be back to their specific upper rule curve (URC) by April 30.
478 These shifts are implemented only after coordination with the TMT and are intended to
479 increase the probability for increased spring flows in the lower Snake River. Consideration of
480 these FRM shifts by the Corps and Reclamation will include an analysis of impacts to FRM, and
481 the shift would not occur if FRM would be compromised.

482 ***Spill Operations***

483 Planned annual spring and summer spill operations at the lower Snake and lower Columbia
484 River projects are designed to improve downstream fish passage for juvenile salmonids. Spill
485 levels and patterns of spill across the spillways are defined by regional fish managers and
486 agencies in the annual Fish Operations Plan . State agencies, such as Oregon Department of
487 Environmental Quality and Washington Department of Ecology, each set TDG water quality

standards for their respective areas of jurisdiction . The co-lead agencies are required to comply with state water quality standards . In 2016, the co-lead agencies implemented performance standard spill levels for fish passage that did not exceed 120 percent TDG in project tailraces, and 115 percent TDG in the forebay of the next project downstream. At the lower Snake River projects, spring spill is implemented from April 3 to June 20, and summer spill occurs from June 21 to August 31. At the lower Columbia River projects, spring spill is implemented from April 10 to June 15, and summer spill occurs from June 16 to August 31. Spill would continue at the same levels and timing under the No Action Alternative.

Under certain circumstances, such as during high flow events, the CRS projects may need to release water using the spillways to maintain sufficient storage capacity in the reservoirs for FRM . When this occurs, it is referred to as involuntary spill . When an involuntary spill operation is implemented, the co-lead agencies utilize the Spill Priority List that establishes the order and amount of spill to be released by the CRS projects . The Spill Priority List is developed in a regional forum and published in each year’s Water Management Plan . Table 2-1 provides the order and cap for spill above the Fish Operation Plan spill levels . The Spill Priority List defines the project priority order for lack-of-load spill in order to manage TDG on a system-wide basis . If necessary, to spill above Fish Operation Plan rates due to lack-of-load, spill will be allocated to projects in the following priority order.

Table 2-1. Spill Priority List

Priority Order	Project	TDG Cap (%)	Example Spill Caps (kcfs)
Level 1 (State TDG Standards^{1/})			
1	LWG	120% / 115%	41
2	LGS	120% / 115%	40
3	LMN (bulk)	120% / 115%	28
4	LMN (uniform)	120% / 115%	36
5	IHR (night)	120% ^{2/}	95 ^{3/}
6	IHR (day)	120% ^{2/}	75 ^{3/}
7	MCN	120% / 115%	146
8	JDA	120% / 115%	90
9	TDA	120% / 115%	135
10	BON	120% ^{2/}	130
11	CHJ	110%	20
12	GCL ^{4/}	110%	OT = 0; DG = 5
13	DWR	110%	30%
Level 2			
14	LWG	120%	45
15	LGS	120%	52
16	LMN (uniform)	120%	44
17	MCN	120%	146
18	JDA	120%	146
19	TDA	120%	135
20	CHJ	120% / 115% ^{5/}	60

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Priority Order	Project	TDG Cap (%)	Example Spill Caps (kcfs)
21	GCL ^{4/}	115%	OT = 5; DG = 15
Level 3 (Levels 4–7: same order as Level 3)			
22	LWG	122%	52
23	LGS	122%	59
24	LMN (uniform)	122%	60
25	IHR (night)	122%	95 ^{3/}
26	IHR (day)	122%	85 ^{3/}
27	MCN	122%	152
28	JDA	122%	177
29	TDA	122%	160
30	BON	122%	160
31	CHJ	120%	100
32	GCL ^{4/}	120%	OT = 15; DG = 40

507 Note: This priority list was effective April 1, 2016, until further notice (no later than August 31, 2016). BON =
508 Bonneville; IHR = Ice Harbor; JDA = John Day; LGS = Little Goose; LMN = Lower Monumental; LWG = Lower Granite;
509 MCN = McNary; TDA = The Dalles.

510 1/ Apr 1-Aug 31 (FOP Spring and Summer Spill) TDG standards are in effect at LWG, LGS, LMN, IHR, MCN, JDA, TDA,
511 BON for ≤120% in the tailrace (Oregon, Washington) and ≤115% in next downstream forebay (Washington), except
512 BON which does not have a downstream forebay standard. Current spill caps are online: [http://www.nwd-
513 wc.usace.army.mil/tmt/documents/ops/spill/caps/](http://www.nwd-wc.usace.army.mil/tmt/documents/ops/spill/caps/).

514 2/ No downstream forebay standard.

515 3/ IHR spill caps based on: Night 1800–0500 (11 hours) = FOP spill; Day 0500–1800 (13 hours) = lack of load spill
516 (>FOP Day 45 kcfs).

517 4/ GCL spill is via outlet tubes (OT) or drumgates (DG). Transition to DG at forebay elevation 1,267–1,270 feet.

518 5/ Assumes spill duration ≤6 hrs.

519 Over-capacity spill is another type of involuntary spill and occurs when flows exceed the
520 hydraulic capacity of the available power generation facilities at a specific dam. Over-capacity
521 spill can be affected by high river flows, planned and unplanned unit outages, planned and
522 unplanned transmission outages, and other transmission constraints. Any of these conditions
523 physically limit the potential for hydropower production. Over-capacity spill will generally be
524 the amount of project outflow in excess of the maximum amount that can be released through
525 all available generators and other outlet structures (e.g., sluiceways and fish ladders). In
526 general, when this condition occurs, the affected project will be operating at maximum
527 generation, but within the Fish Passage Plan turbine operating criteria capability to minimize
528 the amount of spill.

529 **Temperature Control**

530 Operations to improve water temperatures to benefit ESA-listed fish are conducted at 11 of the
531 14 CRS projects. Temperature control operations are conducted to benefit both anadromous
532 and resident fish. Temperature control operations described here benefit anadromous fish and
533 bull trout. Temperature operations to benefit resident fish are described later in this chapter.

534 During late spring and summer, water is released from lower levels of the Dworshak Reservoir
535 using selective withdrawal gates. The water is used to help cool water temperatures in the
536 lower Snake River downstream of the confluence of the Clearwater and Snake Rivers. These
537 cooler waters improve thermal conditions for bull trout, salmon, and steelhead in the lower
538 Snake River (Cook and Richmond 2004). At the Lower Granite and Little Goose Projects, the
539 cooler water is supplied to fish ladders at the dams to allow upstream migration for adult
540 salmonids.

541 At the Lower Granite and Little Goose Projects, the forebay tends to stratify, with warm water
542 near the surface and cool water from the Dworshak Project deeper in the water column. When
543 temperatures in the fish ladders are equal to or greater than 68 degrees Fahrenheit (°F), the
544 Corps operates pumps to supply the fish ladders with cool water pumped from deep in the
545 reservoir. The pumps are typically operated from mid- to late summer, depending on climatic
546 conditions.

547 From June 1 to September 30, water temperature data is collected at adult ladder entrances
548 and exits at each Corps project in the lower Snake and lower Columbia Rivers. This serves to
549 monitor for temperature differentials in the ladder that could act to block adult fish from
550 ascending the fish ladders to migrate upstream of each dam.

551 ***Variable Draft Limits***

552 The variable draft limits (VDL) are end of period draft limits at Grand Coulee and Hungry Horse
553 in January through March. The VDL is not a mandatory draft elevation but rather provides lower
554 limit for hydropower generation flexibility. The VDL defines the lower operating limit based on
555 an inflow probability that would be sufficient to refill Grand Coulee and Hungry Horse to the
556 April 10 elevation objective with 85% and 75% confidence respectively, pursuant to the 2008
557 NMFS BiOp³ and the Hanford Reach Fall Chinook Protection Program. The VDL elevation
558 calculation does not guarantee 85% and 75% chance of refill but provides flexibility while
559 considering the spring flow objective-based April 10 elevation. Operation above the VDL is
560 desirable but must also not exceed the maximum elevation allowed for FRM.

561 ***Minimum Flows and Draft Limitations at Grand Coulee Project***

562 The minimum daily average flow from the Grand Coulee Project is related to the minimum
563 discharge below Priest Rapids Dam, which is owned by Grant County Public Utility District and
564 located on the middle Columbia River. Generally, minimum outflow from Grand Coulee, 30 kcfs,
565 is enough to provide the 36 kcfs minimum discharge required below Priest Rapids Dam.

566 The current operational draft rate limit for Lake Roosevelt is 1.5 feet per 24 hours, a rate
567 intended to help protect against potential landslides and the erosion caused by rapidly drawing

³ NMFS, 2008. Remand of 2004 Biological Opinion on the Federal Columbia River Power System; NMFS, 2010. Supplemental Consultation on Remand for Operation of the Federal Columbia River Power System; NMFS, 2014. Supplemental Consultation on Remand for Operation of the Federal Columbia River Power System.

568 down the reservoir. Bonneville may request an exceedance to this draft rate in order to meet
569 increased power demand (e.g., during a winter cold snap), or the Corps may make a request to
570 meet FRM requirements. In all cases, draft rate exceedance requests must be approved by
571 Reclamation, and additional monitoring for erosion and landslides is required. Draft rates
572 should not exceed 2 feet per 24 hours even if a draft rate exceedance is granted. Additional
573 monitoring, including aerial surveillance is required when the reservoir is drafting more than
574 1.5 feet per 24 hours. Monitoring at more frequent intervals is required as the reservoir
575 elevation drops. Below 1,240 feet NGVD29, no draft greater than 1.5 feet in 24 hours should be
576 considered and all other reasonable actions should be exhausted prior to requesting approval
577 from Reclamation for exceedance.

578 ***Lake Roosevelt Incremental Storage Release Project***

579 The Lake Roosevelt Incremental Storage Release Project is a component of the Columbia River
580 Water Management Program (CRWMP). It is intended to improve municipal and industrial
581 water supply, provide water to replace some groundwater use in the Odessa Subarea, enhance
582 stream flows in the Columbia River to benefit fish, and provide water to interruptible water
583 right holders in drought years. A memorandum of understanding regarding the Lake Roosevelt
584 Incremental Storage Release Project was signed by the State of Washington, Reclamation, and
585 the Columbia Basin Irrigation Districts in December 2004. In December 2007, Water Resource
586 Management Agreements supporting the incremental storage releases from Lake Roosevelt
587 were signed by the State of Washington, the Confederated Tribes of the Colville Reservation,
588 and the Spokane Tribe of Indians.

589 The Lake Roosevelt Incremental Storage Release Project does not reduce flows during the
590 salmon flow objective period (April through August). This project provides for Lake Roosevelt to
591 be drafted an additional 1.0 foot in non-drought years and up to 1.8 feet in drought years by
592 the end of August. One-third of this water will go to instream flows.

593 ***Hanford Reach Fall Chinook Protection Program***

594 Naturally spawning fall Chinook salmon in the Hanford Reach of the Columbia River, which are
595 not listed under the ESA, spawn from October through the third week in November. Similar to
596 the chum operations described below, a minimum flow is set during the spawning period and
597 must be maintained to avoid dewatering redds. Though not listed under the ESA, these fish are
598 an important resource to the region. During spawning, the Hanford Reach Fall Chinook
599 Protection Program Agreement requires that Priest Rapid outflows are not higher than 70 kcfs
600 and not lower than 55 kcfs for a continuous period of at least 12 hours of each day. Grand
601 Coulee is operated to help support the minimum flow required below Priest Rapids Dam.
602 Emergence occurs at the point where the eggs in the redds have accumulated 800 to 1000
603 degree-day C temperature units after the initiation of spawning, this typically occurs over a
604 four-week period beginning in April and ending in early May.

605 ***Chum Flows and Operations***

606 The Grand Coulee and Bonneville Projects are operated to support chum spawning and
607 protections at the Ives Island complex below the Bonneville Project. There are two phases of
608 the chum operations: spawning (typically in early November to late December) and
609 incubation/egress (typically from late December to early April). The yearly operation is
610 coordinated through the TMT and described in the annual Water Management Plan and
611 seasonal updates, using the process described in Section 1.9.5, *Annual Planning*.

612 Grand Coulee is generally operated to refill to elevations between 1,285 and 1,288 feet
613 NGVD29 by the end of October to provide sufficient storage to support the chum spawning
614 operation and winter power generation.

615 Beginning in November, the Bonneville Project operates to maintain the tailwater elevation in
616 the range of 11.5 feet to 13.0 feet until chum spawning ends in late December. If it becomes
617 necessary to operate the tailwater at elevations above 13.0 feet because of precipitation
618 events, tidal influences, etc.), chum still have the ability to spawn at higher elevations.
619 However, as tailwater elevations increase above 13.5 feet, some habitat in the lower elevations
620 (11.3 feet to 12.0 feet) becomes unsuitable for chum due to higher water velocities. In addition,
621 eggs spawned at higher elevations may risk being dewatered later in the year if there is an
622 insufficient water supply.

623 After chum spawning is complete in late December, the co-lead agencies coordinate with the
624 TMT to establish the minimum tailwater elevation necessary to protect the incubating eggs
625 until fry have emerged from the gravel, or by April 10, whichever comes first.

626 ***Priest Rapids Spring Flow Objective***

627 The Grand Coulee Project is operated from April 10 to June 30 to help meet the spring flow
628 objective at Priest Rapids Dam, a public utility dam in the middle Columbia River. Grand Coulee
629 provides flow to help meet the 135 kcfs flow objective for anadromous salmon and steelhead. If
630 water year conditions do not allow operators to meet the 135 kcfs objective, a flow lower than
631 the objective is used and gradually increased when possible. During dry years, the initial flow
632 typically begins at around 90 kcfs and ramps up incrementally based on the water supply
633 forecast, the timing of the juvenile fish migration, and streamflow conditions.

634 ***Turbine Operations***

635 To potentially improve the survival of fish that pass through the powerhouse at a project,
636 turbines at all projects on the lower Snake and lower Columbia Rivers target an operation
637 within ± 1 percent of peak turbine efficiency (referred to as the "1 percent range") during the
638 juvenile and adult migration seasons, from April 1 to October 31 (Corps 2016a, Chapters 2–9
639 and Appendix C). This ability to adjust unit operations for optimal performance potentially helps
640 reduce fish injury and cavitation damage to the turbines.

641 **Minimum Operating Pool**

642 The four lower Snake River projects operate to minimize water travel time for juvenile fish
643 migration by operating the forebays in the minimum operating pool (MOP) 1-foot range from
644 April 3 until approximately September 1. Elevations may be adjusted to meet other authorized
645 project purposes (primarily navigation), however.

646 **Minimum Irrigation Pool**

647 From April 10 to September 30, John Day Project is operated to minimize water travel time for
648 downstream-migrating juvenile salmon by operating the forebay within the minimum irrigation
649 pool (MIP) range (262.5 to 264.0 feet). The MIP is the lowest pool elevation that allows
650 irrigation withdrawals. Irrigation withdrawals from the John Day pool typically begin in early
651 March and extend through mid-November.

652 The normal operating ranges, MOP elevation ranges, and MIP elevation ranges for the four
653 lower Snake River and four lower Columbia River projects are included here for reference
654 (Table 2-2).

655 **Table 2-2. Operating Range Elevations for the Lower Snake River and Lower Columbia River**
656 **Projects**

Location	Normal Operating Elevation Range (NGVD29) Minimum–Maximum	MOP/MIP Elevation Range (NGVD29) Minimum–Maximum
Lower Granite	733.0–738.0	733.0–734.0
Little Goose	633.0–638.0	633.0–634.0
Lower Monumental	537.0–540.0	537.0–538.0
Ice Harbor	437.0–440.0	437.0–438.0
McNary	337.0–340.0	N/A ^{1/}
John Day	262.0–266.5	262.5–264.0 ^{2/}
The Dalles	155.0–160.0	N/A ^{1/}
Bonneville	71.5–76.5	N/A ^{1/}

657 Note: N/A = not applicable.

658 1/ McNary, The Dalles, and Bonneville Projects have no MOP or MIP restriction and operate within Normal
659 Elevation Range.

660 2/ John Day is restricted by a MIP rather than a MOP.

661 **Juvenile Fish Transportation Program**

662 The Juvenile Fish Transportation Program is implemented by the Corps. Juvenile fish are
663 collected at the Lower Granite, Little Goose, and Lower Monumental Projects for transport via
664 barge or truck. They are moved downriver to a location below Bonneville Project, where they
665 are released to continue their migration to the ocean. Juvenile fish collection starts no later
666 than May 1, and barging begins the day after collection begins. Fish are transported daily or
667 every other day throughout the migration season. Transportation operations may be adjusted
668 due to research, conditions at fish collection facilities (e.g., overcrowding or temperature

669 extremes), or through the adaptive management process with the Fish Passage Operations and
670 Maintenance work group and/or the TMT (e.g., as a response to expected environmental
671 conditions, or recent transport vs. in-river research results). Timing and operations are
672 coordinated with regional fish managers.

673 **OPERATIONS TO BENEFIT RESIDENT FISH**

674 ***Flow Augmentation***

675 Libby is drafted in the summer to benefit resident fish in the Kootenai River and salmonids in
676 the Columbia River. To meet the needs of Kootenai River white sturgeon and bull trout,
677 operations ensure minimum flows in the rivers downstream to support both species and these
678 flows are prioritized over summer refill for recreation. The Hungry Horse Project maintains
679 minimum flows for resident fish. To the extent possible, the intent is to maintain steady or
680 gradually declining summer flows below the project in consideration of resident fish needs.

681 ***Temperature Control***

682 At Libby, discharge temperatures are adjusted using a selective withdrawal system to provide
683 thermal conditions in the Kootenai River to promote spawning, migration, and egg and larval
684 development for Kootenai River white sturgeon and burbot, a popular game fish. To the extent
685 possible, natural river conditions for biological productivity are provided.

686 At the Hungry Horse Project, per an agreement with Montana Fish, Wildlife & Parks, selective
687 withdrawal gates are required to be operated from June to the end of September, but are
688 typically operated into November when the reservoir temperatures become uniform and
689 isothermal, and the benefits of the selective withdrawal system operations are negated. The
690 goal is to provide water temperatures to the river to improve productivity for native fish species
691 and prevent non-native lake trout from moving upstream from Flathead Lake.

692 ***Sturgeon Operations at the Libby Project***

693 Operations at the Libby Project include the release of flows to benefit Kootenai River white
694 sturgeon. These operations are developed annually by regional biologists (led by USFWS), based
695 on May water supply forecasts described in the 2006 Libby BiOp (as clarified in 2008) (USFWS
696 2006). Release of this water falls within FRM authorities and is equal to or greater than VarQ
697 (variable discharge) flow.

698 Libby operates to release tiered Kootenai River white sturgeon flow augmentation volumes to
699 provide for the habitat needs during spawning and recruitment in April, May, June, and July.
700 The intent of sturgeon flow augmentation is to augment lower basin runoff from tributaries of
701 the Kootenai River downstream of the Libby Project. Sturgeon flow augmentation operations
702 are consistent with the current version of the *Kootenai River Ecosystem Function Restoration
703 Flow Plan Implementation Protocol* (Bonneville 2007) and USFWS's 2006 BiOp for the Libby
704 Project (as clarified in 2008) (USFWS 2006).

705 **Lake Pend Oreille Elevations for Kokanee and Bull Trout**

706 Lake elevations at the Albeni Falls Project are managed to support the survival of kokanee, a
707 critical food source for ESA-listed bull trout. During the spring, the project is operated to fill
708 Lake Pend Oreille in accordance with FRM criteria. During the summer, the project is operated
709 to maintain Lake Pend Oreille at a minimum elevation of 2,062.0 feet NGVD29 for recreation
710 through Labor Day. In recent years, the start of drawdown has been delayed to the third
711 Sunday in September, or September 18, whichever is later. Starting October 1, the project
712 begins drafting to an elevation within a half-foot of 2,051.0 feet NGVD29 by mid-November,
713 prior to when kokanee is expected to begin spawning. Flows released during the draft also
714 support ESA-listed salmon in the Columbia River, particularly chum salmon downstream of
715 Bonneville Project.

716 **Operations to Limit TDG Production at the Hungry Horse and Chief Joseph Projects**

717 The Hungry Horse Project is operated to minimize spill and the resultant generation of TDG.
718 Although the generation capacity of Hungry Horse Project is about 428 megawatts (MW), there
719 is a transmission limit at the Hungry Horse Project of 310 MW (about 9,000 cfs). Releases in
720 excess of approximately 9,000 cfs must be put through the hollow jet flow valves, which can
721 generate TDG. Empirical data and estimates show that limiting spill to a maximum of 15 percent
722 of total outflow will help avoid exceeding the Montana State TDG standard of 110 percent
723 saturation. When spill is anticipated to exceed 15 percent of total outflow, Reclamation
724 attempts, to the extent possible, to pre-draft or reshape drawdown and refill operations to
725 minimize spill and excess TDG generation.

726 In 2008, the Chief Joseph Project was fitted with spillway flow deflectors to reduce levels of
727 TDG downstream of the project when water passes over the spillway. Throughout the year, spill
728 is allocated to the Chief Joseph Project as needed to manage TDG on a system-wide basis to
729 reduce TDG effects to aquatic species, including ESA-listed fish species (see Table 2-1 for the
730 Spill Priority List relative to system-wide TDG management).

731 **HYDROPOWER GENERATION**

732 The CRS projects are authorized to generate hydropower for electricity using large turbines at
733 each of the projects. While the generation of hydropower does not consume water, water must
734 be positioned to enable generation. When power is generated that water is passed from one
735 project to the next or downstream to the ocean. The coordinated water management of the
736 CRS therefore includes managing the amount of water used for hydropower generation. In
737 conjunction with the Corps and Reclamation carrying out project-specific requirements,
738 Bonneville plans system operations to meet both power and non-power objectives and shapes
739 any remaining flexibility to manage water flow for power generation. These plans prioritize
740 BiOps commitments over hydropower. However, in emergency situations or when managing
741 the system to avoid an impending emergency, power system operations can be prioritized to
742 protect human health and safety as well as the safety and reliability of the power grid.

743 Hydropower generation is based on a variety of factors at each project: the type of project
744 (storage vs. run-of-river), and generator and reservoir capacity at each project. In addition, the
745 future CRS objectives and constraints must be accounted for in determining the distribution of
746 generation in a current period. Storage projects typically release water based on non-power
747 objectives, such as fish objectives or flood control. When there is flexibility for hydropower,
748 storage projects may hold water until there is a need to generate electricity, whether for a
749 week, a month, or even another season. The amount of electricity generated depends on
750 available storage capacity and overall system flexibility, given other constraints.

751 The run-of-river projects generate electricity based on inflows, with minimal ability to store
752 water to shape flows. Therefore, these projects also have minimal ability to control the timing
753 of electrical generation. Some generation can be adjusted from one hour to the next, and
754 perhaps to the subsequent day, but long-term storage for later generation is limited.

755 Both the lower Snake and lower Columbia River projects have minimum generation
756 requirements to support power system reliability. The Corps has identified minimum
757 generation powerhouse outflow values derived from actual generation records when turbines
758 were operating within ± 1 percent of best efficiency. Varying pool elevations or system
759 disturbances may result in minor variations.

760 All lower Snake and lower Columbia River powerhouses may be required to keep one or more
761 generating units online at all times for power system reliability under low river flow conditions.
762 Low flow operations at lower Snake and lower Columbia River projects are triggered when
763 inflow is not sufficient to meet both minimum generation requirements and planned
764 operations to benefit ESA-listed fish. Under low flow conditions, the lower Snake River projects
765 will operate one turbine at minimum generation and spill the remaining outflow. Minimum
766 generation at the lower Columbia River projects is determined by grid reliability needs and
767 generally require more than one turbine to be operating.

768 ***Power System Operation***

769 The amount of electricity generated at the 14 CRS projects depends on a variety of factors,
770 including operational constraints, ESA obligations, regional load,⁴ and river flows. Seasonally,
771 river flow determines when power is generated. For example, peak hydroelectric generation
772 typically coincides with spring runoff, while low flows and low generation generally occur in late
773 summer and fall. Energy supply (including generation, imports, and exports) must equal
774 demand (load) at all times. Bonneville participates in the wholesale electricity market, where
775 they buy and sell electricity to ensure demand and supply on the Federal system are always
776 balanced. Bonneville is a North American Electric Reliability Corporation (NERC)-registered
777 balancing authority.⁵ As such, Bonneville is responsible for maintaining the balance between

⁴ *Load, or demand*, refers to electricity being consumed in the region.

⁵ A balancing authority is the entity responsible for scheduling generation on transmission paths ahead of time, maintaining a load-interchange-generation balance within a balancing authority area, and supporting

778 generation and load within the Bonneville Balancing Authority Area, which includes portions of
779 the states of Washington, Oregon, Idaho, Montana, and California.

780 Bonneville conducts daily load shaping which means that generation is adjusted to meet load.
781 These adjustments take place day-to-day, hour-to-hour, and even second-to-second. Bonneville
782 uses various CRS projects (when and where there is flexibility within the FRM, environmental
783 responsibilities, and other constraints) to increase and decrease generation to match that
784 demand. Often, if there is not enough flexibility to meet changes in demand, Bonneville
785 augments its generation flexibility with purchases or sales in the wholesale power market for
786 optimized power production, while providing protection for resident fish and maintaining FRM.
787 In some conditions, most often but not exclusively during spring runoff in high-water years,
788 there may be more water flowing through the system than would be ideal for environmental
789 and power needs. In these situations, even after setting some water aside for juvenile fish spill,
790 the generation from that water supply may exceed both the regional demand and the ability to
791 export (sell) the power to other regions like California. This excess power cannot be generated
792 or sold, and some water is spilled for lack of market.

793 To ensure adequate supply to meet demand, Bonneville sets aside a certain portion of
794 hydropower generation capability to meet its reserves obligation for unexpected increases or
795 decreases in generation or load in the Bonneville Balancing Authority Area. These unexpected
796 changes in generation can come from variable sources such as wind power, sudden generation
797 outages, or transmission constraints.

798 Bonneville also maintains the transmission grid for safety and reliability. The ability of the
799 transmission system to reliably accommodate generation from the projects may impact water
800 management functions at the projects (e.g., the location and amount of power generation
801 required to maintain system reliability, and the best location to generate to meet the need).
802 Transmission facilities owned and operated by Bonneville interconnect and integrate electric
803 power generated at the Federal projects to the regional transmission grid. Certain transmission
804 system needs can impact water management functions at the projects. For example,
805 Bonneville's management of its transmission system in response to a transmission line outage
806 can influence the location and amount of power generation required to maintain system
807 reliability, which impacts when, where, and through which outlets the co-lead agencies pass
808 river flows at the dams.

809 At times, the combined output of generation at Libby and Hungry Horse exceeds the ability of
810 the local transmission system to reliably deliver the output of these projects to the wider
811 transmission system. Bonneville has implemented maximum generation limits to maintain
812 stability and meet required standards. Bonneville sets the allowable generation from Libby and
813 Hungry Horse to balance the amount of generation that can be used to both serve load within

interconnection frequency in real time. A balancing authority area is the collection of generation, transmission, and loads within the metered boundaries of the designated balancing authority. The balancing authority maintains load-resource balance within this area.

814 the Flathead Valley and transfer generation to the wider transmission system at the same time.
815 There could be ongoing variations in allowable generation based on loads in the Flathead Valley
816 that changes throughout the day. Currently, the combined maximum generation limit is 920
817 MW for heavy load hours and 860 MW for light load hours for the Libby and Hungry Horse
818 Projects.

819 **IRRIGATION AND WATER SUPPLY**

820 Irrigation accounts for most surface water withdrawals in the Columbia River Basin, which is
821 about 5 percent of total river flow.⁶ Annually, about 13 Maf of water, 7 Maf from the rivers
822 considered in this EIS, is supplied for irrigation, drinking water, and other municipal and
823 industrial needs. The total acreage in the United States portion of the basin irrigated by
824 Reclamation projects (including the Columbia Basin Project, Chief Joseph Dam Project, and
825 Yakima, Umatilla, The Dalles, Deschutes, upper Snake River, and Crooked River facilities) is
826 about 4.3 million acres. Of this, about 680,000 acres are irrigated from river reaches potentially
827 impacted by changes in operations evaluated in this EIS.

828 Of the 14 Federal projects included in this EIS, only Grand Coulee (Lake Roosevelt) and John Day
829 have operations specific to water supply purposes. Other CRS projects do supply water for
830 irrigation or municipal and industrial purposes, but the other projects are not operated
831 explicitly to provide that water. The irrigation season generally extends from mid-March to
832 November 1, but some water is also pumped through the winter months.

833 Grand Coulee is the largest water supply provider within the study area. Each year the John W.
834 Keys Pumping Plant can pump up to 3,318 thousand acre-feet (kaf) of water to Banks Lake for
835 use on 720,000 acres within the Columbia Basin Project (CBP), based on water rights and
836 completed NEPA analyses (Reclamation 2009, 2012). Under current operations, water is
837 pumped through six pump/generators and six pumps from Lake Roosevelt (behind the Grand
838 Coulee Project), to Banks Lake through the John W. Keys Pumping Plant, located at the left
839 abutment of Grand Coulee Project. Banks Lake then delivers water to the Columbia Basin
840 Project for irrigation and municipal and industrial water use.

841 The Columbia Basin Project Act (57 Statute 14) authorized the Secretary of Interior to construct,
842 operate, and maintain the CBP pursuant to the Reclamation Project Act of 1939. The Secretary
843 subsequently directed Reclamation to construct, operate, and maintain the project in House
844 Document 172 (October 30, 1944), according to the terms of the 1939 Reclamation Project Act.
845 In that report, the Secretary directed Reclamation to provide water for irrigation of up to
846 1,029,000 acres. Grand Coulee, operated by Reclamation, stores water for the CBP. The water is
847 pumped approximately 300 feet from Lake Roosevelt to Banks Lake where it is distributed by
848 canal to irrigators within the CBP. The CBP currently has water rights and previous NEPA
849 compliance to deliver 3.318 Maf of water for irrigation of 720,000 acres and for M&I purposes.

⁶ Calculated using a 30-year average (1981 to 2010) inflow to The Dalles of 133 Maf (Northwest River Forecast Center 2018) and 7.1 Maf of diversion (Bonneville 2011b).

850 Water for the Odessa Subarea and Lake Roosevelt Incremental Storage agreement are included
851 in the 3.318 Maf.

852 Odessa Subarea Special Study Project. The need to address declining groundwater supply in the
853 Odessa Subarea, and avoid economic loss to the region’s agricultural sector led Reclamation
854 and Washington Department of Ecology (Ecology) to conduct the Odessa Subarea Special Study.
855 The purpose identified by Reclamation and Ecology to guide the proposed action is: “. . . to
856 maintain economic viability by providing surface water from the CBP to replace groundwater
857 from declining wells currently used for irrigation in the Odessa Subarea.” This purpose is
858 consistent with the intent of the CBP Act by encouraging “settlement and development of the
859 project, and for other purposes.” Surface water would be provided as part of the continued,
860 phased development of the CBP, and would come from existing CBP diversion and storage
861 water rights from the Columbia River. The Odessa Subarea Special Study was completed in 2012
862 and the ROD signed in (Reclamation 2012 and 2013).

863 The lower Snake and lower Columbia River projects also provide water to support irrigation and
864 municipal and industrial water supply, which is delivered via a number of pumping stations. This
865 is an incidental use and these reservoirs are not operated specifically to provide water supply of
866 this sort. Operations at John Day on the lower Columbia River are operated specifically to
867 maintain elevations for the operation of water supply pumps.

868 **MAINTENANCE OPERATIONS**

869 ***Routine Maintenance***

870 The co-lead agencies will continue to implement a maintenance program at each CRS project,
871 consisting of routine inspection and maintenance of both power and non-power assets. The co-
872 lead agencies conduct annual routine maintenance at all projects. Preventive and corrective
873 maintenance coordinated and planned to occur at regular intervals is referred to as scheduled,
874 or routine, maintenance. This type of routine maintenance would continue to be performed on
875 all fish facilities, spillway components, navigation locks, generating units, and supporting
876 systems to ensure project safety and reliability and to comply with North American Electric
877 Reliability Corporation (NERC)/Western Electricity Coordinating Council (WECC) regulatory
878 requirements.

879 ***Unscheduled and Non-Routine Maintenance***

880 Unplanned maintenance is referred to as unscheduled maintenance. It may occur any time a
881 problem, unforeseen maintenance issue, or emergency requires a project feature (e.g., a
882 generating unit), be taken offline in order to resolve. Unscheduled maintenance, if it occurs in
883 combination with ongoing scheduled maintenance, may significantly reduce the generating
884 capability and hydraulic capacity of a project. The timing, duration, and extent of these events
885 cannot be forecasted, however. The co-lead agencies inform regional water managers and fish
886 managers when changes to regular operations are required for unscheduled and/or emergency
887 non-routine maintenance.

888 Maintenance that is planned but not performed at regular intervals (e.g., turbine unit
889 overhauls, major structural modifications, or rehabilitations) is referred to as non-routine
890 maintenance. Non-routine maintenance is not performed at regular, pre-determined
891 frequency, and includes tasks more significant in nature than routine scheduled maintenance.
892 These Federal actions would be evaluated under a separate NEPA document. Non-routine
893 maintenance examples include power plant modernization and major rehabilitation of CRS
894 project features. Additionally, any work conducted either by the project operator or Bonneville
895 that takes a powerhouse line out of service will generally affect several generators at one time.
896 These types of outages, planned and coordinated in advance where possible, would continue
897 under the No Action Alternative.

898 ***Drum Gate Maintenance at Grand Coulee Project***

899 Reclamation's Operations and Maintenance Program requires annual inspections and dam
900 safety maintenance for the 11 drum gates at Grand Coulee Project. A drum gate is a hinged
901 overflow spill gate at the top of the dam, consisting of a horizontal cylindrical section that can
902 be raised from its compartment to increase the spillway height. Each drum gate is 135 feet long
903 and 30 feet high. Lake Roosevelt must be at or below elevation 1,255 feet NGVD29 for a
904 minimum of 8 weeks in order to complete drum gate maintenance. Drum gate maintenance is
905 scheduled annually during March, April, and May to take advantage of the FRM draft. However,
906 the water conditions in the basin (dry, average, wet), and in-season conditions may affect or
907 delay maintenance activities. To adjust for this uncertainty, and to ensure that the drum gates
908 are maintained, Reclamation requires that, at a minimum, drum gate maintenance must be
909 completed at least one time in a 3-year period, two times in a 5-year period, and three times in
910 a 7-year period. The in-season criteria for accomplishing drum gate maintenance is based on
911 the FRM requirement for the April 30 maximum Grand Coulee elevation as determined by
912 water supply forecasts produced in February.

913 The February forecast is used to allow sufficient time to draft the reservoir below 1,255 feet
914 NGVD29 by March 15. If the February forecast sets the Grand Coulee April 30 FRM elevation at
915 or below 1,255 feet NGVD29, Grand Coulee will be drafted to perform drum gate maintenance.
916 When the February forecast sets the April 30 FRM requirement above 1,265 feet NGVD29,
917 drum gate maintenance will require a "forced" draft only if needed to meet the requirements
918 of the criteria described in the previous paragraph. If the April 30 FRM requirement is between
919 1,255 and 1,265 feet NGVD29, maintenance will only be done if the following year would be a
920 "forced" drum gate maintenance year. For example, if maintenance is deferred in one year due
921 to dry conditions and the forecasted FRM elevation is between 1,255 feet and 1,265 feet
922 NGVD29 the next year, drum gate maintenance would be accomplished in the second year in
923 order to avoid "forced" drum gate maintenance in the third year.

924 In addition to the annual drum gate maintenance, an annual inspection and maintenance
925 activity is planned for the 57-inch butterfly drum gate intake valves. Some inspection and
926 maintenance on these valves can occur regardless of water levels, but some maintenance
927 requires water levels at or below 1,219 feet NGVD29. The external inspection and maintenance

928 that requires water levels at or below 1,219 feet NGVD29, for a week’s duration, is scheduled to
929 occur once every 10 years. This inspection takes advantage of spring drafts for FRM, but in
930 some years may require an additional draft below FRM requirements to conduct this
931 maintenance.

932 ***Third Powerplant Overhaul Project***

933 On April 28, 2010, a FONSI was signed authorizing the third powerplant overhaul and
934 modernization, which includes work on the six generating units, turbines, shafts, and auxiliary
935 equipment at the Grand Coulee Third Powerplant. The main portion of the overhaul work is
936 being completed within the confines of the third powerplant. The Third Power Plant Overhaul
937 Project was updated with a second EIS and FONSI in February 2019. Documents and
938 information regarding the Third Powerplant Overhaul Project are available online (Reclamation
939 2019e).

940 ***John W. Keys III Pump-Generating Plant Modernization Project***

941 On March 12, 2012, a FONSI was signed authorizing the overhaul and modernization of the
942 John W. Keys III Pump-Generating Plant. The main portion of the overhaul work will be
943 completed within the confines of the John W. Keys III Pump-Generating Plant. The overhaul and
944 modernization are scheduled for completion in 2034. Documents and information regarding the
945 modernization are available online (Reclamation 2017).

946 ***Grand Coulee G1 through G18 Modernization and Overhaul Project***

947 Reclamation is implementing this project to modernize and overhaul the power-generating
948 units G1 through G18 in the left and right power houses at Grand Coulee Dam, by refurbishing
949 or replacing key components. Reclamation would maintain current operations for FRM to
950 protect communities and generate hydropower while the project is being implemented. Under
951 the G1 through G18 Modernization and Overhaul Project, current hydrologic operations would
952 be maintained, and, therefore, the project is not expected to have any impacts on water, or
953 fisheries resources in the Columbia River or Lake Roosevelt. Reclamation completed an EA and
954 FONSI in August 2018 for the Grand Coulee G1 through G18 modernization and overhaul
955 (Reclamation 2018b).

956 **FISH RESEARCH**

957 Research studies may require special operations that differ from the routine operations
958 otherwise described in the applicable and the current Fish Passage Plan. Variations in normal
959 operations for research actions are coordinated with the TMT.

960 **COORDINATION WITH REGIONAL TRIBES**

961 Regional tribes participate in the development of fish-related plans such as the Fish Passage
962 Plan and the Fish Operations Plan, and the co-lead agencies coordinate the operation of CRS
963 reservoirs with these tribes. In addition to operations to support anadromous and resident fish

964 and other resources important to the tribes, the co-lead agencies coordinate when CRS
965 operations may directly impact resources or operations of tribally owned or operated facilities
966 (e.g., at the Dworshak or Grand Coulee Projects). In some cases, the co-lead agencies operate
967 specifically to support tribal activities, such as holding the reservoirs at certain elevations to
968 support tribal fishing in the summer and fall. This is regularly done at the John Day, The Dalles,
969 and Bonneville Projects.

970 **NAVIGATION**

971 The Corps maintains a shallow-draft navigation channel for barge transport, with a minimum
972 depth of 14 feet, on the lower Snake and lower Columbia Rivers. For these projects, water
973 managers in the Columbia River Basin adjust reservoir levels and spill patterns, reduce spill, or
974 implement short-term spill curtailment, as needed to maintain safe navigation on the lower
975 Snake River and lower Columbia River. Annual maintenance of the navigation facilities at the
976 projects takes place in March. Major maintenance of the navigation system, including activities
977 that may cause a temporary outage of barge traffic (e.g., gate maintenance or dredging) is
978 conducted as needed and scheduled based on risk. These extended outages are coordinated
979 regionally to reduce impacts to shippers and minimize economic disruption. Under the No
980 Action Alternative, navigation operations and maintenance and operations for safety will
981 continue.

982 **RECREATION**

983 The co-lead agencies operate projects to support recreation in various ways. In some instances,
984 the change in operation might involve holding a specific reservoir at a specific elevation to
985 support a short-term activity (e.g., boat races or weekend festivals). In other locations (Albeni
986 Falls, Dworshak, and Grand Coulee), operations may plan to achieve refill elevations and hold
987 them to support recreation pools over a longer season. Recreation is an authorized purpose of
988 the CRS projects, and the co-lead agencies would continue current operational adjustments to
989 support recreation, as needed, as long as operations do not negatively impact higher priority
990 operations (e.g., FRM or fish and wildlife purposes).

991 **MEASURES PREVIOUSLY COMMITTED TO BY THE CO-LEAD AGENCIES TO BENEFIT**

992 **ENDANGERED SPECIES ACT–LISTED FISH**

993 The co-lead agencies have coordinated with regional stakeholders to design and implement
994 several measures to benefit ESA-listed fish species. The majority of these measures originate
995 from USFWS or NMFS BiOp reasonable and prudent alternatives (RPAs). Measures include
996 construction of habitat projects and are often coupled with research, monitoring, and
997 evaluation (RM&E) efforts to inform trends, successful achievement of benefits and/or next-
998 phase project details. Operational measures include guidelines for extensive regional
999 stakeholder coordination such as annual water management plans and fish passage plans.
1000 Measures to benefit ESA-listed fish also include hatchery programs, predator management
1001 programs, and nutrient enhancement. Table 2-3 provides specific measures to benefit ESA-

1002 listed fish implemented under the No Action Alternative and lists the source of the measure
1003 (e.g., RPA).

1004 **Table 2-3. No Action Alternative Measures to Benefit Endangered Species Act–Listed Fish**
1005 **Species**

Measure	Measure Name	Description
Habitat Measures	Tributary Habitat Implementation 2010–2018 for both Chinook salmon and steelhead	Specified construction projects, Research Monitoring and Evaluation (RM&E) actions, and species status and trend data collection habitat and survival improvement
	Kootenai White Sturgeon Habitat Restoration	Implementation of habitat project at a Tier 1 habitat restoration location
	Estuary Habitat Implementation 2010–2019	Specified construction projects, RM&E actions, and species status and trend data collection habitat and survival improvement
	Kootenai River White Sturgeon Nutrient Enhancement	Continued BPA support of nutrient enhancement in the Kootenai River through FY 2025
	Dworshak Reservoir Long-Term Nutrient Supplementation Program	Continued nutrient enhancement in the Dworshak Reservoir to enhance biological productivity of the reservoir for kokanee and reduction of algal blooms.
Operational Measures	Storage Project Operations (Upper Columbia Basin)	Develop Annual Water Management Plan and Fish Operations Plan for flow to aid juvenile fish passage
	Lower Columbia and Snake River Operations	Develop Annual Water Management Plan and Fish Operations Plan for flow to aid juvenile fish passage
	Sturgeon Operations at the Libby Project	Ongoing, seasonal flow augmentation from Libby Dam for Kootenai River white sturgeon, consistent with the Flow Plan Implementation Protocol; Real-Time Management
	Kootenai River Operations for Bull Trout	Libby Dam minimum flow to aid bull trout
	In-Season Water Management	Seasonal updates to the Annual Water Management Plan
	Operational Emergencies	Real-Time Management for unforeseen events
	Fish Emergencies	Real-Time Management for unforeseen events coordinated with Regional Forum
	Dry Year Operations	Real-Time Management when a dry water year is declared
	Water Quality Plan for TDG and Water Temperature	Maintain Water Quality Plan for TDG and water temperature in the mainstem Columbia and Snake Rivers
	Chum Spawning Flow	Coordination of operations via the TMT; Real-Time Management
	Turbine Unit Operations	Operate turbine units to achieve best fish passage survival (operate within 1 percent of best efficiency)
	Spill Operations to Improve Juvenile Passage	Define, and adjust within season, juvenile fish passage spill within the Annual Fish Operations Plan and Fish Passage Plan; Real-Time Management
	Juvenile Fish Transportation in the Columbia and Snake Rivers	Collect and transport juvenile fish from three Snake River dams to below Bonneville Dam per Annual Fish Operations Plan and Fish Passage Plan; Real-Time Management
	Fish Passage Plan	The Corps develops an Annual Fish Passage Plan

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Measure	Measure Name	Description
Hatcheries	Federal Columbia River Power System (FCRPS) Mitigation Hatcheries – Programmatic	Continue support of hatcheries and adopt programmatic criteria for funding decisions on mitigation programs for the FCRPS that incorporate best management practices
	Kootenai River White Sturgeon Conservation Aquaculture	Continued BPA support of hatchery-raised Kootenai River white sturgeon for supplementation of lack of wild, natural recruitment
	Implement Safety Net Programs	Continue to identify and plan for ongoing “safety net” programs to provide benefits to ESA-listed stocks at high risk of extinction
	Conservation Programs to Build Genetic Resources	Continue to fund conservation programs that assist in recovery
Predator Management Measures	Northern Pikeminnow Management Program	Ongoing base program and general increase in northern pikeminnow sport-reward fishery reward structure
	Reduce Caspian Terns on East Sand Island in the Columbia River Estuary	Annual site preparations and hazing/dissuasion to maintain 1.0 acre of suitable habitat at East Sand Island and prevent birds from establishing satellite colonies outside of 1.0-acre colony site
	Double-Crested Cormorant	Plan implementation completed March 2019. Annual hazing ongoing with limited egg-take to maintain colony size objectives, as necessary.
	Inland Avian Predation	Plan implementation concluded in 2018. Ongoing monitoring of tern colony during nesting season through 2021 breeding season.
	Other Avian Deterrent Actions	Monitor avian predator activity, continue avian deterrent programs at all lower Snake and Columbia River dams. Part of annual Fish Passage Plan .
	Marine Mammal Control Measures	Install and improve, as needed, sea lion excluder gates at all main adult fish ladder entrances at Bonneville Dam annually

Measure	Measure Name	Description
Habitat Program	Lower Snake River Fish & Wildlife Compensation Plan	Congress authorized the Lower Snake River Compensation Plan (LSRCP) as part of the Water Resources Development Act of 1976 (90 Stat.2917) to offset fish and wildlife losses caused by construction and operation of the four lower Snake River dams. A major component of the authorized plan was the design and construction of fish hatcheries and satellite facilities. Administered through the USFWS, the 25 LSRCP hatcheries and satellite facilities are operated by Idaho Department of Fish and Game (IDFG), Washington Department of Fish and Wildlife (WDFW), Oregon Department of Fish and Wildlife (ODFW), USFWS, the Nez Perce Tribe (NPT), Confederated Tribes of the Umatilla River (CTUIR), and Shoshone-Bannock Tribes (SBT). The LSRCP hatcheries and satellite facilities produce and release more than 19 million salmon and steelhead as part of the program's mitigation responsibility. Bonneville directly funds USFWS for the annual operation and maintenance of these LSRCP facilities. Corps also provides annual funding to implement other components of the LSRCP such as the management units for upland and riparian habitat (woody riparian initiative), a game bird farm, and other ongoing habitat management at locations across the lower Snake River basin.

1006 **BONNEVILLE’S FISH AND WILDLIFE PROGRAM AND DIRECT FUNDING AGREEMENTS WITH THE**
1007 **CORPS AND RECLAMATION**

1008 Bonneville’s Fish and Wildlife Program funds hundreds of projects each year to mitigate the
1009 impacts of the development and operation of the Federal hydropower system on fish and
1010 wildlife. Bonneville began this program to fulfill mandates set by Congress in the Pacific
1011 Northwest Electric Power Planning and Conservation Act of 1980 (Northwest Power Act), 16
1012 U.S.C. § 839b(h)(10)(A), to protect, mitigate, and enhance fish and wildlife affected by the
1013 development and operation of the FCRPS. Each year Bonneville funds projects with many local,
1014 state, tribal, and Federal entities to fulfill its Northwest Power Act fish and wildlife
1015 responsibilities and to implement offsite mitigation actions listed in various BiOps for ESA-listed
1016 species. Offsite protection and mitigation actions typically address impacts to fish and wildlife
1017 not caused directly by the CRS, but they are actions that can improve the overall conditions for
1018 fish to help address uncertainty related to any residual adverse effects of CRS management and
1019 climate variability on fish and wildlife. For example, Fish and Wildlife Program funding improves
1020 habitat in the mainstem as well as tributaries and the estuary, builds hatcheries and boosts
1021 hatchery fish production, evaluates the success of these efforts, and improves scientific
1022 knowledge through research. This work is implemented through annual contracts, many of
1023 which are associated with multi-year agreements like the Columbia River Basin Fish Accords,
1024 the Accord extensions, or wildlife settlements.

1025 In their management and operation of the CRS, Bonneville, the Corps, and Reclamation have
1026 together fulfilled the other primary fish and wildlife mitigation mandate in the Northwest
1027 Power Act, providing fish and wildlife “equitable treatment” with the other congressionally

1028 authorized purposes of the FCRPS (16 U.S.C. § 839b(h)(11)(A)(i)). Since the 1990s, the Federal
1029 agencies have overhauled the system, achieving juvenile dam passage survival that meets or
1030 exceeds performance standards of 96 and 93 percent for spring and summer migrants,
1031 respectively,⁷ a marked improvement as compared to when Congress passed the Act and the
1032 estimated average juvenile mortality at each mainstem dam and reservoir project was 15 to 20
1033 percent, with losses recorded as high as 30 percent.⁸ Travel time also improved for yearling
1034 Chinook and juvenile steelhead through the system, even in low flow years such as 2015.⁹ And,
1035 total in-river survival has improved for migrating juvenile salmon and steelhead. Comparing
1036 two time periods reported in the National Oceanic and Atmospheric Administration’s (NOAA)
1037 reach study, (1997–2007 and 2008–2016; Faulkner et al. 2017), there has been a 10 percent
1038 survival increase for hatchery and wild sockeye salmon, a 2 percent increase in hatchery and
1039 wild Chinook (4 percent for wild), and a 25 percent survival increase for hatchery and wild
1040 steelhead (13 percent for wild).

1041 The Federal agencies achieved these results by installing turbine intake screens and bypass
1042 systems, modifying spillways (e.g., flow deflectors, surface spill weirs, and modified surface spill
1043 structures), and installing improved fish passage turbines while also experimenting with and
1044 adjusting flow and spill regimes to benefit salmon, steelhead, and sturgeon. Additional
1045 modifications to fish ladders have also been underway to increase passage of adult lamprey,
1046 including the installation of specialized lamprey passage structures at Bonneville, The Dalles
1047 and McNary Dams. These structural and operational improvements help fulfill ESA and Clean
1048 Water Act mandates while also harkening back to one of the original purposes of the Northwest
1049 Power Act—to mitigate for fish by providing suitable environmental conditions that are
1050 substantially obtainable from the management, operation, and configuration of the system (16
1051 U.S.C. § 839(6)).

1052 ***Habitat actions***

1053 Bonneville works with states, tribes, and watershed groups to protect, mitigate, and enhance
1054 spawning and rearing habitat, targeting factors that limit fish survival throughout the Columbia
1055 River Basin. Bonneville has funded hundreds of projects across the basin to restore natural
1056 stream channels, reconnect estuarine tidal channels, enhance flow volume and timing, and
1057 expand cold water refuges and open access to habitat (www.cbfish.org). These habitat
1058 improvement actions provide both near-term and long-term benefits, including those that will
1059 help address the effects of climate change. Actions that improve connectivity and streamflow
1060 will provide a buffer against the effects of climate change.

⁷ See Endangered Species Act Federal Columbia River Power System 2016 Comprehensive Evaluation – Section 1, at 17, t.2 (Jan. 2017).

⁸ See *Nw. Res. Info. Ctr. v. Nw. Power Planning Council*, 35 F.3d 1371, 1374 (9th Cir. 1994) (citing the U.S. General Accounting Office, *Impacts and Implications of the Pacific Northwest Power Bill*, at 22 (Sept. 4, 1979)).

⁹ 2016 Comprehensive Evaluation at page 20.

1061 In addition to habitat improvement actions, Bonneville works with willing landowners to
1062 protect land by putting it under permanent conservation easement to further support habitat
1063 and fish conservation in the short and long term.

1064 ***Hatchery actions***

1065 Bonneville constructed and now funds the operation and maintenance of over 20
1066 compensation, conservation, and supplementation hatchery programs throughout the
1067 Columbia and Snake River basins to preserve, rebuild, and reduce extinction risk for ESA-listed
1068 fish species as well as to meet Northwest Power Act objectives to protect, mitigate, and
1069 enhance fish and wildlife affected by the FCRPS. The conservation hatchery programs help
1070 rebuild and enhance the naturally reproducing ESA-listed fish in their native habitats using
1071 locally adapted broodstock, while maintaining genetic and ecologic integrity, and supporting
1072 harvest where and when consistent with conservation objectives. These hatchery programs
1073 include captive propagation for critically endangered Snake River sockeye, Snake River
1074 spring/summer Chinook supplementation, Snake River fall Chinook supplementation,
1075 reintroduction of spring Chinook in the Okanagan Basin, coho salmon reintroduction and
1076 supplementation in the middle and upper Columbia basins, reconditioning of middle and upper
1077 Columbia and Snake River steelhead kelts, Kootenai River white sturgeon, burbot, and
1078 westslope cutthroat trout.

1079 ***Predation***

1080 Bonneville's Fish and Wildlife Program funds efforts to address the mortality of ESA-listed and
1081 non-listed fish caused by predators including birds, fish, and mammals. Certain types of fish in
1082 rivers are voracious consumers of juvenile salmon and steelhead. Predation by introduced fish
1083 species in reservoirs is also a concern. Other predators are known to consume substantial
1084 numbers of adult spring Chinook salmon and winter steelhead below Bonneville Dam, and
1085 injure adult fish that migrate upstream. Bonneville funds projects to reduce the impact of these
1086 predator species on native fish.

1087 ***Lamprey***

1088 Several lamprey species, both anadromous and resident, are native to the Columbia River
1089 Basin, which historically supported productive populations. Much of the research and
1090 mitigation effort in the basin is currently focused on the anadromous Pacific lamprey due to its
1091 cultural importance to tribes and vital role in the ecosystem. At present, Bonneville funds six
1092 lamprey projects to improve understanding of Pacific lamprey status and limiting factors,
1093 implement high-priority habitat restoration actions, increase populations through
1094 reintroduction and translocation efforts, and conduct artificial propagation research with plans
1095 to release hatchery juveniles in select areas pending an environmental assessment.

1096 **Wildlife Mitigation for Construction, Inundation, and Operations**

1097 When the CRS dams were built and the reservoirs behind them filled, they inundated about
1098 308,996 acres, much of it important fish and wildlife habitat. To calculate the area affected by
1099 CRS development—dam construction and inundation by the reservoirs behind them—
1100 Bonneville relied on either the amounts agreed upon in negotiated mitigation agreements with
1101 state and tribal entities or the loss assessments prepared by Federal, state, and tribal wildlife
1102 managers.¹⁰

1103 To date, Bonneville has implemented numerous wildlife habitat projects to address the impact
1104 of the development of the FCRPS, many of which included acquisition and permanent
1105 protection of wildlife habitat. Bonneville also provides operations and maintenance funding for
1106 these projects.

1107 The loss assessments relating to dam construction and inundation considered all habitat losses
1108 up to and including full reservoir pool levels. As such, mitigation for those losses can also serve
1109 to address the effects of reservoir operations on wildlife habitat, to the extent that such
1110 operational impacts occur below full pool level.

1111 While much of the mitigation work was implemented through annual contracts, Bonneville and
1112 its partners negotiated “settlement agreements” to complete the wildlife mitigation for
1113 construction and inundation impacts, and some operational impacts, for Dworshak, Libby,
1114 Hungry Horse and part of the impacts from the Albeni Falls Dams. These settlements allowed
1115 Bonneville and the affected states or tribes to agree on an appropriate amount of mitigation to
1116 be done and the funding or other consideration Bonneville would provide.

1117 • **Albeni Falls Dam.** In the 2018 Albeni Falls Dam Wildlife Mitigation Agreement, Bonneville
1118 and the State of Idaho established that 14,087 acres had been mitigated through the efforts
1119 of the state and three tribes to address wildlife impacts from the construction and
1120 inundation of the dam (6,617 acres were impacted as a result of the construction and
1121 inundation of Albeni Falls Dam).¹¹ In addition, Bonneville agreed to fund the State of Idaho
1122 to protect and enhance 1,279 acres of wetland habitat at the Clark Fork Delta and an
1123 additional 99 acres at the Priest River Delta to address the upriver effects of Albeni Falls
1124 operations. This is in addition to the 624 acres of wetland protected and enhanced on the
1125 Clark Fork Delta by IDFG, which was funded by Bonneville through a letter agreement in
1126 2012.

¹⁰ Bonneville funded but did not control the production of wildlife habitat loss assessments by wildlife managers in the mid-1980s and early 1990s. These documents, also called “Brown Books,” are on file with Bonneville. The Brown Books generally reflect the acres inundated by the FCRPS as determined by the surface area of the reservoirs created behind each dam (e.g., USFWS 1990).

¹¹ Northern Idaho Memorandum of Agreement Between the State of Idaho and the Bonneville Power Administration for Wildlife Habitat Stewardship and Restoration section II.C, page 5 (2018) (on file with Bonneville).

- 1127 • **Dworshak Dam.** The 1992 Dworshak Wildlife Mitigation Agreement with the State of Idaho
1128 and the Nez Perce Tribe, frequently referred to as the “Dworshak Settlement,” fully
1129 mitigated the impacts to wildlife from the construction and inundation of Dworshak Dam
1130 estimated at 16,970 acres.¹² To determine this acreage, Bonneville relied on the Dworshak
1131 Wildlife Agreement reports from the tribe. The tribe’s 2018 annual report indicates it has
1132 purchased 7,576 acres and still has over \$9.5 million remaining in its mitigation fund
1133 established under the agreement (Nez Perce Tribe 2018). The State of Idaho also has a \$3
1134 million fund provided by Bonneville to manage the 60,000-acre Peter T. Johnson Unit of the
1135 Craig Mountain Wildlife Management Area (formerly known as Craig Mountain), which
1136 Bonneville purchased and transferred to the State of Idaho (IDFG 2014). All told, Bonneville
1137 has already funded 67,576 acres of mitigation for Dworshak Dam.
- 1138 • **Montana Dams.** As with Dworshak, Bonneville fully addressed the construction and
1139 inundation mitigation for wildlife occurring around Libby and Hungry Horse dams using a
1140 comprehensive long-term agreement. To determine acreage protected, Bonneville relied on
1141 reports from Montana Fish, Wildlife, and Parks. Under the 1989 Montana Wildlife
1142 Mitigation Trust Agreement (MFWP 2013), Montana has protected or enhanced 272,104
1143 acres (the Northwest Power Planning Council’s program called for a total of 55,837 acres for
1144 Libby and Hungry Horse Dams split between 29,171 acres of enhancement and 26,666 acres
1145 of protection; MFWP 2019).¹³

1146 **DIRECT FUNDING AGREEMENTS WITH THE CORPS AND RECLAMATION**

1147 In addition to Bonneville’s fish and wildlife mitigation described above, there are also fish and
1148 wildlife mitigation costs that are direct funded by Bonneville to the Corps and Reclamation for
1149 mitigation activities, such as hatchery operations, fish stocking, elk habitat maintenance, and
1150 others. The specifics of these programs are described below.

1151 **Lower Snake River Compensation Plan**

1152 In addition to the hatchery operations that are funded through the Fish and Wildlife Program,
1153 Bonneville directly funds the annual operations and maintenance of the Lower Snake River
1154 Compensation Plan (LSRCP). Congress authorized the LSRCP as part of the Water Resources
1155 Development Act of 1976 (90 Stat. 2917) to offset fish and wildlife losses caused by
1156 construction and operation of the four lower Snake River dams. A major component of the
1157 authorized plan was the design and construction of fish hatcheries and satellite facilities. The
1158 LSRCP is administered through the USFWS. The LSRCP hatcheries and satellite facilities produce
1159 and release more than 19 million salmon and steelhead as part of the program’s mitigation

¹² Crediting Forum, Final Report 3.

¹³ See Northwest Power Planning Council, 1987 Columbia River Basin Fish and Wildlife Program § 1000 138–39 tbl.4, <https://www.nwcouncil.org/media/6843101/1987Program.PDF>; see also, Montana Fish, Wildlife and Parks, Program for Mitigating Wildlife Impacts Caused by construction of Libby and Hungry Horse Dams: Five-Year Operating Plan 3 (July 1, 2009) (citing Yde and Olsen (1984)), <http://fwp.mt.gov/fwpDoc.html?id=53780> [hereinafter Program for Libby and Hungry Horse].

1160 responsibility. Corps also provides annual funding to implement other components of the LSRCP
1161 such as the management units for upland and riparian habitat (woody riparian initiative), a
1162 game bird farm, and other ongoing habitat management at locations across the lower Snake
1163 River basin. LSRCP would be continued, consistent with the No Action Alternative, under all of
1164 the Multiple Objective Alternatives except for MO3.

1165 **2.4.3 Multiple Objective Alternative 1**

1166 MO1 was developed to integrate actions that would benefit both juvenile and adult life stages
1167 of ESA-listed anadromous fish, as well as measures to benefit ESA-listed resident fish. At the
1168 same time, this alternative incorporates measures for water management flexibility,
1169 hydropower production, and additional water supply.

1170 MO1 differs from the other alternatives by carrying out a juvenile fish passage spill operation
1171 referred to as a block spill design. The block spill design alternates between a base operation
1172 that releases surface flow, where juvenile fish are most present, over the spillways using
1173 different flows at each project versus the same target at all projects. For the block that uses the
1174 same target at all projects, the operators would release flow through the spillways up to a
1175 target of no more than 120 percent TDG in the tailrace of projects and 115 percent TDG in the
1176 forebay of those projects. In addition, MO1 sets the duration of this juvenile fish passage spill to
1177 end based upon a fish count trigger rather than a predetermined date. MO1 proposes to
1178 initiate transport operations for juvenile fish approximately 2 weeks earlier than under the No
1179 Action Alternative.

1180 After establishing the juvenile fish passage spill measure, MO1 incorporated measures to
1181 increase hydropower generation flexibility in the lower basin projects and use stored water at
1182 Dworshak for downstream water temperature control in the summer. MO1 then includes
1183 measures similar to the other action alternatives, which include increased water management
1184 flexibility, water supply, opportunities for disruption of ESA-listed fish predators, and optimize
1185 inclusion of local forecasts for upper basin projects into whole-basin planning.

1186 All measures included in MO1 are listed in Table 2-4, and a brief description of those measures
1187 is contained in the following section.

1188 **Table 2-4. Measures of Multiple Objective Alternative 1**

Measure Description	Abbreviated Measure Name
Structural Measures	
Construct additional powerhouse surface passage routes at McNary and Ice Harbor Dams	Additional Powerhouse Surface Passage
Upgrade spillway weirs to ASWs	Upgrade to Adjustable Spillway Weirs
Improve adult ladder passage through modification of adult trap at Lower Granite Dam	Lower Granite Trap Modifications
Modify the upper ladder serpentine flow control ladder sections at Bonneville Dam	Modify Bonneville Ladder Serpentine Weir

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Measure Description	Abbreviated Measure Name
Install pumping systems to provide deeper, cooler water in adult fish ladders at Lower Monumental and Ice Harbor Dams	Lower Snake Ladder Pumps
Expand network of LPSs to bypass impediments	Lamprey Passage Structures
Modify turbine cooling water strainer systems to safely exclude Pacific lamprey	Turbine Strainer Lamprey Exclusion
Modify turbine intake bypass screens that cause juvenile lamprey impingement	Bypass Screen Modifications for Lamprey
Modify existing fish ladders, incorporating lamprey passage features and criteria	Lamprey Passage Ladder Modifications
Install improved-fish passage turbines at John Day	Improved Fish Passage Turbines
Operational Measures	
<i>Fish Passage</i>	
Operate spill to evaluate latent mortality hypothesis; alternate base spill and spill cap 120/115 percent TDG	Block Spill Test (Base + 120/115%)
Modify summer juvenile fish passage spill operations to end based on fish collection numbers	Summer Spill Stop Trigger
Change start of juvenile fish transportation during spring juvenile fish passage spill operations	Early Start Transport
Allow contingency reserves to be carried within juvenile fish passage spill	Contingency Reserves Within Juvenile Fish Passage Spill
<i>Water Management</i>	
Modify Libby draft and refill operations when water supply forecast is 6.9 Maf or less	Modified Draft at Libby
Eliminate end-of-December variable draft at Libby and replace with single draft target	December Libby Target Elevation
Update the upstream Storage Corrections Method as applied to the Grand Coulee SRD	Update System FRM Calculation
Decrease the Grand Coulee Dam draft rate used in planning drawdown	Planned Draft Rate at Grand Coulee
Operational constraints for ongoing Grand Coulee maintenance of power plants	Grand Coulee Maintenance Operations
Develop draft requirements/assessment approach to protect against rain-induced flooding	Winter System FRM Space
<i>Water Supply</i>	
Increase volume of water pumped from Lake Roosevelt during annual irrigation season	Lake Roosevelt Additional Water Supply
Increase water managers' flexibility to store and release water from Hungry Horse Reservoir	Hungry Horse Additional Water Supply
Increase water diversion from the Columbia River for the Chief Joseph Dam Project	Chief Joseph Dam Project Additional Water Supply
<i>Hydropower</i>	
Increase forebay operating range flexibility at the lower Snake River and John Day projects for hydropower generation flexibility.	Increased Forebay Range Flexibility

Measure Description	Abbreviated Measure Name
<i>Other Operational</i>	
Implement modified timing of Lower Snake Basin reservoir draft for additional cooler water	Modified Dworshak Summer Draft
Implement sliding scale summer draft at Libby and Hungry Horse	Sliding Scale at Libby and Hungry Horse
Manipulate lower Columbia reservoir elevations to disrupt juvenile salmonid predator reproduction	Predator Disruption Operations

1189 **2.4.3.1 Multiple Objective Alternative 1 Description of Measures**

1190 **STRUCTURAL MEASURES**

1191 **Construct additional powerhouse surface passage routes at Ice Harbor and McNary Dams**

1192 **This measure will be referred to as “Additional Powerhouse Surface Passage” throughout the**
 1193 **remainder of this EIS.** This measure would reestablish the operation of existing ice and trash
 1194 sluiceways for fish passage, which had been ceased to accommodate updated fish collection
 1195 procedures. To implement this measure, existing bulkheads would be replaced with telescoping
 1196 weirs. This would also require modifications to the existing juvenile fish facility and to the floor
 1197 elevation at McNary Project. Operation of these sluiceways would divert 8 kcfs from the
 1198 powerhouse at McNary. The diversion at Ice Harbor would amount to 4 kcfs from the
 1199 powerhouse. The surface passage would be used March 1 to August 31.

1200 **Upgrade existing spillway weirs to adjustable spillway weirs**

1201 **This measure will be referred to as “Upgrade to Adjustable Spillway Weirs” throughout the**
 1202 **remainder of this EIS.** This measure would replace those existing spillway weirs that are not
 1203 adjustable with adjustable spillway weirs, which will provide better operational flexibility based
 1204 on river flows. Two dams, McNary and John Day, would receive the upgrades. One weir would
 1205 be upgraded at McNary and two weirs would be upgraded at John Day. This measure would
 1206 contribute to meeting objective 1 to improve passage for ESA-listed juvenile anadromous fish.

1207 **Improve adult ladder passage through modification of adult trap and adult trap bypass loop**
 1208 **at Lower Granite Dam**

1209 **This measure will be referred to as “Lower Granite Trap Modifications” throughout the**
 1210 **remainder of this EIS.** This measure would reconfigure the existing adult trap bypass at the
 1211 Lower Granite Project to reduce the height that adult fish must ascend, reduce deployment of
 1212 the main fish ladder diversion gate, and to use a vacuum tube to move adult fish that are
 1213 handled for monitoring and research at the trap. This measure would contribute to meeting
 1214 objective 2 to improve passage for adult ESA-listed anadromous fish.

1215 **Modify the upper ladder serpentine flow control ladder sections at Bonneville Project**

1216 **This measure will be referred to as “Modify Bonneville Ladder Serpentine Weir” throughout**
1217 **the remainder of this EIS.** This measure would modify the upper serpentine flow control fish
1218 ladder sections at the Bonneville Project, converting them to a vertical slot style fishway. The
1219 existing baffles at the project’s Bradford Island and Washington Shore fish ladders would be
1220 replaced with baffles that have vertical slot orifices for fish passage. This measure is intended to
1221 benefit adult fish passage and would contribute to meeting objective 2 for adult ESA-listed
1222 anadromous fish.

1223 **Install pumping systems to provide deeper, cooler water in adult fish ladders at Lower**
1224 **Monumental and Ice Harbor Projects**

1225 **This measure will be referred to as “Lower Snake Ladder Pumps” throughout the remainder**
1226 **of this EIS.** This measure would install pumping systems for the fish ladders at Lower
1227 Monumental and Ice Harbor projects. The pumps would pull water from elevations deep in the
1228 reservoir to provide cooling water to fish ladders and at fish ladder entrances to reduce thermal
1229 barriers to adult fish passage for adult salmon migrating upstream. This measure would
1230 contribute to meeting objective 2 to improve adult ESA-listed anadromous fish migration.

1231 **Expand network of lamprey passage structures to bypass impediments in existing fish ladders**

1232 **This measure will be referred to as “Lamprey Passage Structures” throughout the remainder**
1233 **of this EIS.** Existing fish ladders at the John Day and Bonneville Projects would be modified with
1234 additional structures to make upstream passage easier for lamprey. The structures may be an
1235 aluminum slot or tunnel that lamprey would use to travel an alternate but parallel route along
1236 the existing fish ladder. The lamprey passage structures would use an independent water
1237 source and employ flow velocities that attract lamprey to the alternative route. These
1238 structures would be constructed as follows:

1239 At the Bonneville Project, additional lamprey passage structures would be installed in two
1240 locations: on the Bradford Island ladder (south ladder) and at the Washington Shore fish ladder
1241 (north ladder).

1242 At the John Day Project, a lamprey passage structures would be constructed on the south fish
1243 ladder and the existing lamprey passage structures on the north ladder would be extended
1244 from the tailrace deck to the forebay.

1245 This measure would contribute to meeting the objective to improve conditions for Pacific
1246 lamprey.

1247 **Modify turbine cooling water strainer systems to safely exclude Pacific lamprey**

1248 **This measure will be referred to as “Turbine Strainer Lamprey Exclusion” throughout the**
1249 **remainder of this EIS.** This measure would install structures to prevent juvenile lamprey and all
1250 other fish from being entrained into the turbine unit cooling water source. A hood would be

1251 installed over the existing intake grating and allow sweeping flows to move fish past the
1252 opening, making entrainment unlikely, and keeping all fish out of the cooling water piping. This
1253 measure would contribute to meeting the objective to improve conditions for Pacific lamprey.

1254 **Modify turbine intake bypass screens that cause juvenile lamprey impingement**

1255 **This measure will be referred to as “Bypass Screen Modifications for Lamprey” throughout**
1256 **the remainder of this EIS.** This measure would replace existing fish screens used to divert fish
1257 into the collection channel of the juvenile bypass system. The co-lead agencies would replace
1258 existing extended-length bar screens with submerged traveling screens to reduce juvenile
1259 lamprey entanglement at the McNary, Little Goose, and Lower Granite Projects. This measure
1260 would contribute to meeting the objective to improve conditions for Pacific lamprey.

1261 **Modify existing fish ladders, incorporating lamprey passage features and criteria**

1262 **This measure will be referred to as “Lamprey Passage Ladder Modifications” throughout the**
1263 **remainder of this EIS.** This measure would modify existing fish ladders at the lower Snake and
1264 lower Columbia River projects as follows:

- 1265 • **Install ramps to salmon orifices at Bonneville Project** Install concrete or aluminum ramps in
1266 the fish ladder to make salmon orifices elevated above the fish ladder floor more accessible
1267 to lamprey. A ramp would enable adult lamprey to more easily and directly access the
1268 salmon passage openings by removing right angles at the approach.
- 1269 • **Install diffuser grating plating at Bonneville Project (south and Cascade Island ladders),**
1270 **The Dalles (north ladder), and Lower Monumental (north and south ladders)** Install a solid
1271 stainless-steel plate over the floor diffuser grating within the existing fish ladder. The
1272 diffuser adds water to the fish ladder to increase flows in the ladder, but existing grating
1273 and water velocities make it difficult for lamprey to pass through the wall passage orifices.
1274 This plating would provide an attachment surface for lamprey to attach and rest as they
1275 swim upstream through the fish ladder.
- 1276 • **Install additional refuge boxes at Bonneville Project** Construct metal refuge boxes on the
1277 floor of the fish ladder to provide a protected resting environment for lamprey migrating
1278 upstream. Additional refuge boxes would be installed in the Washington shore and Bradford
1279 Island fish ladders.
- 1280 • **Install a wetted wall in the fish ladder at Bonneville Project** Install a metal wall in the
1281 serpentine section of the Washington shore fish ladder at Bonneville Project (similar to that
1282 already installed in the Bradford Island ladder). This would provide an alternate upstream
1283 passage route for migrating adult lamprey and allow the lamprey to escape the higher
1284 water velocities in the fish ladder.
- 1285 • **Install entrance weir caps at McNary, Ice Harbor, Lower Monumental, Little Goose, and**
1286 **Lower Granite** Round edges at fish ladder entrance weirs to eliminate 90-degree surfaces,
1287 which hinder lamprey from entering fish ladders on the lower Snake projects and at
1288 McNary. Rounding these edges would provide lamprey a constant attachment surface to

1289 overcome the high water velocities encountered at the entrance of the fish ladders. This
1290 measure would contribute to meeting the objective to improve conditions for Pacific
1291 lamprey.

1292 **Install improved fish passage turbines at John Day**

1293 **This measure will be referred to as “Improved Fish Passage Turbines” throughout the**
1294 **remainder of this EIS.** This measure would install improved fish passage (IFP) turbines at the
1295 John Day Project to improve hydraulic conditions for fish passing through the turbines. These
1296 IFP turbines are designed to improve hydropower turbine efficiency and hydraulic conditions
1297 for fish passing through the turbines, similar to the IFP turbines at the Ice Harbor Project. The
1298 existing 16 turbines would be replaced two at a time over a period of approximately 8 to 12
1299 years. This measure would contribute to meeting objectives 4 and 5 by installing new turbines
1300 for an efficient and reliable power supply that minimizes greenhouse gas emissions, indirectly
1301 improve water quality by reducing total dissolved gas (TDG). Because the turbines are designed
1302 to minimize negative impacts to fish passing through the powerhouse, it would also contribute
1303 to meeting objective 1, which strives to improve passage and survival for ESA juvenile
1304 anadromous fish.

1305 **OPERATIONAL MEASURES**

1306 **Operate spill test to evaluate latent mortality hypothesis; alternate base spill and spill cap**
1307 **120/115 percent TDG**

1308 **This measure will be referred to as “Block Spill Test (Base + 120/115%)” throughout the**
1309 **remainder of this EIS.** This measure is to operate the lower Snake River and lower Columbia
1310 River projects in a manner that allows comparison of two different fish passage spill operations
1311 by alternating between a base spill operation and a test spill operation. The details of the two
1312 spill operations are contained in Table 2-5. The base spill would be implemented first in year
1313 one, and the test block operations implemented first the following year. These operations
1314 would be implemented annually from April 3 to June 20 for the lower Snake River projects and
1315 from April 10 to June 15 for the lower Columbia River projects. The block spill operations would
1316 exchange specific dates biannually while holding overall spill dates constant. This measure
1317 would contribute to meeting objective 1, as it is intended to improve passage for ESA-listed
1318 anadromous fish.

1319 **Table 2-5. Juvenile Fish Passage Spill Measure for Multiple Objective Alternative 1**

Location	Spring Base Spill Operation: (Volume/Percent of Total Flow Routed to Spillway)	Spring Test Spill Operation: (Volume/Percent of Total Flow Routed to Spillway)
Lower Granite	20 kcfs	120/115% Gas Cap ^{1/}
Little Goose	30%	120/115% Gas Cap ^{1/}
Lower Monumental	120/115% Gas Cap ^{1/}	120/115% Gas Cap ^{1/}
Ice Harbor	30%	120/115% Gas Cap ^{1/}
McNary	48%	120/115% Gas Cap ^{1/}

Location	Spring Base Spill Operation: (Volume/Percent of Total Flow Routed to Spillway)	Spring Test Spill Operation: (Volume/Percent of Total Flow Routed to Spillway)
John Day	32%	120/115% Gas Cap ^{1/}
The Dalles	40%	120/115% Gas Cap ^{1/}
Bonneville	100 kcfs	120/115% Gas Cap ^{1/}

1320 1/ 120/115% Gas Cap spill is spill to the maximum level that meets, but does not exceed, the TDG criteria allowed
 1321 under state law in 2017. Co-lead agencies would manage juvenile fish passage spill on a daily 24-hour basis.
 1322 Implementation of the daily spill averaging would facilitate integration of renewable power, including solar and
 1323 wind power.

1324 Modify summer juvenile fish passage spill operations to end based on fish collection numbers

1325 **This measure will be referred to as “Summer Spill Stop Trigger” throughout the remainder of**
 1326 **this EIS.** The existing spill regime at the lower Snake and lower Columbia River projects would
 1327 be modified to curtail fish passage spill when fish collection numbers at the projects remain
 1328 below 300 juvenile fish for four consecutive days. This has potential to end summer spill at one
 1329 or more of the lower Snake River projects as early as August 1, and all spill operations would
 1330 cease by August 31. This operation would begin annually June 21, and end when the criteria
 1331 described here is met. This measure would modify current spill operations, which are
 1332 undertaken to improve ESA-listed juvenile fish passage . Thus, it contributes to meeting
 1333 objective 1.

1334 Change start of juvenile fish transportation during spring juvenile fish passage spill operations

1335 **This measure will be referred to as “Early Start Transport” throughout the remainder of this**
 1336 **EIS.** The transport of juvenile salmon collected at the Lower Granite, Little Goose, and Lower
 1337 Monumental Projects would begin on April 15, approximately two weeks earlier than current
 1338 fish transport operations described in the No Action Alternative, to potentially increase the
 1339 total number of juvenile fish transported. Transport operations would end September 30 at
 1340 Lower Monumental and October 31 at Lower Granite and Little Goose. Collected juvenile fish
 1341 would be transported to a location below the Bonneville Project via barge or truck on a daily or
 1342 every-other-day schedule, depending on the numbers of fish collected at the collector projects.
 1343 This measure was developed to contribute to meet objective 1, which is intended to improve
 1344 survival and passage of ESA-listed juvenile anadromous fish.

1345 Allow contingency reserves to be carried within juvenile fish passage spill

1346 **This measure will be referred to as “Contingency Reserves Within Juvenile Fish Passage Spill”**
 1347 **throughout the remainder of this EIS.** This measure would allow operations to change fish spill
 1348 for short durations during fish passage spill season. The change would be implemented to meet
 1349 energy demands that are caused by unexpected events such as transmission interruption or the
 1350 failure of a generator. These events are rare and, when they occur, the co-lead agencies may be
 1351 able to cover the contingencies without temporarily reducing spill. This measure would provide
 1352 operating flexibility to allow Bonneville to carry required reserves on the turbines to ensure grid
 1353 reliability. This measure would be implemented at all lower Snake River and lower Columbia

1354 River projects during the fish spill season. This measure would contribute to meeting objective
1355 4 to provide an adequate, efficient, and reliable power supply.

1356 **Modify Libby draft and refill operations when water supply forecast is 6.9 Maf or less**

1357 **This measure will be referred to as “Modified Draft at Libby” throughout the remainder of**
1358 **this EIS.** This measure would base the date for initiation of refill of Lake Kootcanusa on the local
1359 forecast of water volume in the Kootenai River Basin of the CRS during lower water years,
1360 rather than on the No Action Alternative practice of initiating refill based upon water volume
1361 forecast in the lower Columbia River at The Dalles. This would modify water operations at Libby
1362 to provide water managers more flexibility to respond to local conditions in the upper basin.
1363 The measure would change flow management so that local flood durations and the start of refill
1364 operations are tied to Kootenai Basin runoff. The new procedure will also take into
1365 consideration other planned releases for resources such as resident fish.

1366 This measure would provide more flood space for local high spring flow, and lower the risk of
1367 filling the reservoir early, which can result in a need to spill to create more flood space before
1368 the end of the FRM operations season. This measure was developed to contribute to meet
1369 objective 6, which would maximize operating flexibility by implementing adaptable water
1370 management strategies in order to be responsive to changing conditions.

1371
1372
1373

1374 **Eliminate end-of-December variable draft at Libby and replace with single draft target**

1375 **This measure will be referred to as “December Libby Target Elevation” throughout the**
1376 **remainder of this EIS.** This measure would change current operations at Libby from a variable
1377 draft implemented at the end of December to a fixed draft target of elevation 2,420 feet
1378 NGVD29 to prevent over-drafting of the reservoir in years that have less precipitation than
1379 forecasted. In most years, this operation would allow the reservoir draft to be shifted from
1380 November/December to January/February, holding more water in the reservoir longer to meet
1381 demand in drier years, and providing flexibility for water managers to adapt to a wide range of
1382 runoff conditions throughout the water year. It would support delivery of nutrients and water
1383 temperatures that support sturgeon during the sturgeon flow augmentation operation. This
1384 measure was developed to contribute to meet objective 6, which would maximize operating
1385 flexibility by implementing adaptable water management strategies in order to be responsive
1386 to changing conditions.

1387 **Update the upstream Storage Corrections Method as applied to the Grand Coulee Storage**
1388 **Reservoir Diagram**

1389 **This measure will be referred to as “Update System FRM Calculation” throughout the**
1390 **remainder of this EIS.** This measure would change the end-of-month maximum flood space
1391 elevation of Lake Roosevelt at Grand Coulee based on whether the storage reservoirs upstream

1392 of Grand Coulee had drafted to reach their required flood space elevations at the end of the
1393 months of January, February, March, and April. If one or more upstream storage reservoirs
1394 were unable to draft down to their required flood space elevations at the end of each of those
1395 months, then Lake Roosevelt would be used to provide additional flood storage space for the
1396 CRS. This measure differs from the No Action Alternative by allowing the Grand Coulee Project
1397 to better respond to changing conditions in the upstream storage reservoirs. There would be no
1398 change to the current level of FRM, but rather, a shift in where flood space is held. This
1399 measure was developed to contribute to meeting objective 6, which would maximize operating
1400 flexibility by implementing adaptable water management strategies in order to be responsive
1401 to changing conditions.

1402 **Decrease the Grand Coulee Project draft rate used in planning drawdown**

1403 **This measure will be referred to as “Planned Draft Rate at Grand Coulee” throughout the**
1404 **remainder of this EIS.** This measure would change the way that Lake Roosevelt is drawn down
1405 to reach flood space elevations in winter and spring at Grand Coulee. Under the proposed
1406 operation, the reservoir drawdown would begin earlier, and the reservoir elevations would be
1407 lowered more slowly in order to reduce the risk of landslides along the shoreline. The current
1408 rate would be reduced in the Planned Draft Rate at Grand Coulee from 1 ft/day to 0.8 ft/day.
1409 Ultimately, the deepest lake elevations for system FRM are not changed by this measure, but
1410 the timing and rate for reaching those lower reservoir elevations would change. This measure
1411 was developed to contribute to meeting objective 6, which would maximize operating flexibility
1412 by implementing adaptable water management strategies in order to be responsive to changing
1413 conditions.

1414 **Operational constraints for ongoing Grand Coulee maintenance of power plants**

1415 **This measure will be referred to as “Grand Coulee Maintenance Operations” throughout the**
1416 **remainder of this EIS.** This measure would expedite the maintenance schedule for the power
1417 plants and spillways of the Grand Coulee Project relative to the No Action Alternative schedule.
1418 The maintenance on the power plants would reduce the number of units available, requiring
1419 additional spill in some situations. The project would keep 27 of the 40 regulating gates and/or
1420 eight drum gates in service and take the others out of service to perform spillway maintenance
1421 activities at an accelerated rate. The expedited maintenance schedule has the potential to
1422 complete maintenance activities sooner; this could increase reliability and hydraulic capacity
1423 through powerplants while decreasing the risk of unplanned maintenance that often leads to
1424 non-fish passage spill. This measure was developed to contribute to meeting objective 6, which
1425 would maximize operating flexibility by implementing adaptable water management strategies
1426 in order to be responsive to changing conditions. This measure would also contribute to
1427 meeting objective 4 to provide a reliable power supply by supporting maintenance of the
1428 turbines at Grand Coulee.

1429 **Develop draft requirements/assessment approach to protect against rain-induced flooding**

1430 **This measure will be referred to as “Winter System FRM Space” throughout the remainder of**
1431 **this EIS.** This measure would increase flood space in Grand Coulee by 650,000 acre-feet to
1432 protect against rain-induced flooding downstream. In order to provide the necessary space,
1433 Grand Coulee would be drafted more deeply from mid-December through March. All other
1434 existing winter operations described in the No Action Alternative would remain the same. This
1435 measure is intended to increase operational flexibility to maintain flood risk protection for the
1436 lower Columbia River. This measure was developed to contribute to meeting objective 6, which
1437 would maximize operating flexibility by implementing adaptable water management strategies
1438 in order to be responsive to changing conditions.

1439 **Increase volume of water pumped from Lake Roosevelt during annual irrigation season**

1440 **This measure will be referred to as “Lake Roosevelt Additional Water Supply” throughout the**
1441 **remainder of this EIS.** This measure would deliver 4,472,138 acre-feet of water, the amount of
1442 water required to irrigate the full number of authorized acres for the CBP, by increasing the
1443 amount of water pumped from Lake Roosevelt for irrigation and municipal and industrial water
1444 supply. This is an increase of 1,154,138 acre-feet over current withdrawals. This water volume
1445 could be delivered annually, generally during the irrigation season (April through October),
1446 from Lake Roosevelt at Grand Coulee, as the demand arises. Additionally, this measure would
1447 change the timing of delivery of recently developed water supplies for the Odessa Subarea of
1448 the CBP (164,000 acre-feet for irrigation and 15,000 acre-feet for M&I of the current supplies)
1449 from September and October to when the water is needed, on demand. This measure would
1450 contribute to meeting objective 7 to meet existing water supply obligations and provide for
1451 additional authorized regional water supply.

1452 **Increase water managers’ flexibility to store and release water from Hungry Horse Reservoir**

1453 **This measure will be referred to as “Hungry Horse Additional Water Supply” throughout the**
1454 **remainder of this EIS.** This measure would change water management operations at Hungry
1455 Horse to ensure that an additional 90,000 acre-feet of water is available for delivery annually to
1456 fulfill the water rights settlement with the Confederated Salish and Kootenai Tribes. Operations
1457 would prioritize maintaining enough water to meet flow augmentation requirements and the
1458 delivery of 90,000 acre-feet of water to the Confederated Salish and Kootenai Tribes for
1459 irrigation and municipal and industrial purposes, as outlined in the settlement. This measure
1460 would contribute to meeting objective 7 to meet existing water supply obligations and provide
1461 for additional authorized regional water supply.

1462 **Increase water diversion from the Columbia River for the Chief Joseph Dam Project**

1463 **This measure will be referred to as “Chief Joseph Dam Project Additional Water Supply”**
1464 **throughout the remainder of this EIS.** This measure would prioritize annual delivery of 9,600
1465 acre-feet of irrigation water to the Chief Joseph Dam Project. Deliver the full congressionally
1466 authorized amount of water for the irrigation of lands downstream of Chief Joseph Dam using

1467 water from the Chief Joseph Project. This measure would contribute to meeting objective 7 to
1468 meet existing water supply obligations and provide for additional authorized regional water
1469 supply.

1470 **Increase forebay operating range flexibility at the lower Snake River and John Day Projects**
1471 **for hydropower generation flexibility**

1472 **This measure will be referred to as “Increased Forebay Range Flexibility” throughout the**
1473 **remainder of this EIS.** This measure would provide operating flexibility during the fish passage
1474 season (April 3 to August 31) by changing the operating elevation range restriction at the lower
1475 Snake and John Day projects. The lower Snake projects would operate within a 1.5-foot MOP
1476 range, and John Day would operate within a 2-foot MIP range (262.5 to 264.5 feet NGVD29),
1477 except from April 1 to May 31 when the John Day forebay operating range would remain
1478 between elevations 263.5 and 265 feet NGVD29. This operating range restriction would end
1479 when spill is reduced or ends. Safety-related restrictions would continue, including, but not
1480 limited to, maintaining ramp rates to minimize shoreline erosion and maintain power grid
1481 reliability. This measure is intended to increase flexibility for water management, shaping
1482 hydropower production to meet energy demand and maintain power grid reliability. This
1483 measure would contribute to meeting objective 4, with the goal of providing an adequate,
1484 efficient, economical, and reliable power supply that supports the Columbia River power
1485 system.

1486 **Implement modified timing of the lower Snake Basin reservoir draft for additional cooler**
1487 **water**

1488 **This measure will be referred to as “Modified Dworshak Summer Draft” throughout the**
1489 **remainder of this EIS.** This measure would alter the current draft schedule at Dworshak to
1490 provide more cooling water in the lower Snake River to benefit migrating adult salmonids at
1491 different times than described in the No Action Alternative. The draft would be tied to water
1492 temperatures from year to year, but generally, drafting from Dworshak Reservoir would begin
1493 June 21 to August 1 for migrating sockeye salmon and summer Chinook. The later draft
1494 (September 1 to September 30) would provide cooling water for fall Chinook and steelhead.
1495 This measure would contribute to meeting objective 2, which is intended to improve passage
1496 and migration for adult ESA-listed anadromous fish.

1497 **Implement a sliding-scale summer draft at Libby and Hungry Horse**

1498 **This measure will be referred to as “Sliding Scale at Libby and Hungry Horse” throughout the**
1499 **remainder of this EIS.** The trigger for summer draft from the Libby and Hungry Horse Projects
1500 for downstream fish will be changed from a system forecast point to a local forecast point. The
1501 Libby and Hungry Horse Projects would be operated based on local water supply conditions to
1502 allow water managers more flexibility to balance local resident fish priorities in the upper basin
1503 with downstream flow augmentation for the middle and lower basin. In addition, the change in
1504 draft elevation would occur over a range, a “sliding scale,” rather than an abrupt point when

1505 the water supply forecast changes. This measure would contribute to meeting objective 3 to
1506 improve resident fish survival and spawning success at CRS projects.

1507 **Manipulate lower Columbia River reservoir elevations to disrupt juvenile salmonid predator**
1508 **reproduction**

1509 **This measure will be referred to as “Predator Disruption Operations” throughout the**
1510 **remainder of this EIS.** This measure would manipulate reservoir elevations on the John Day
1511 Reservoir to disrupt avian nesting on islands in the reservoir. The action would dissuade
1512 colonies of species known to consume high numbers of outmigrating juvenile salmon and
1513 steelhead from nesting. The measure would allow water managers to fluctuate pool elevations
1514 between 263.5 and 265 feet NGVD29, a 1.5-foot operating range, during the months of April
1515 and May. This measure would contribute to meeting objective 1, intended to improve the
1516 survival and passage of ESA-listed juvenile anadromous fish.

1517 **2.4.4 Multiple Objective Alternative 2**

1518 MO2 was developed to increase hydropower production and reduce regional greenhouse gas
1519 emissions while avoiding or minimizing negative impacts to other authorized project purposes
1520 and co-lead agency missions. It would slightly relax the No Action Alternative's restrictions on
1521 operating ranges and ramping rates to evaluate the potential to increase hydropower
1522 production efficiency and increase operators' flexibility to respond to changes in power
1523 demand and changes in generation of other renewable resources. The measures within MO2
1524 would increase the ability to meet power demand with hydropower production during the most
1525 valuable periods (e.g., winter, summer, and daytime peak demands). The upper basin storage
1526 projects would be allowed to draft slightly deeper, up to 10 feet below Upper Rule Curve (URC)
1527 values (Appendix I, *Hydroregulation*, modeling data sheets), allowing more hydropower
1528 generation in the winter and less during the spring.

1529 MO2 also differs from the other alternatives by excluding the water supply measures and
1530 evaluating an expanded juvenile fish transportation operation season. This alternative proposes
1531 to transport all collected ESA-listed juvenile fish for release downstream of the Bonneville
1532 Project by barge or truck and reducing juvenile fish passage spill operations to a target of near
1533 110 percent TDG. Inclusion of the target near 110 percent TDG spill operation provides the
1534 lowest end of the range of juvenile fish passage spill operations evaluated in this EIS.

1535 Structural measures of MO2 are aimed at benefits for ESA-listed fish and lamprey. These
1536 measures are similar to other alternatives and include making improvements to adult fish
1537 ladders, upgrading spillway weirs, adding powerhouse surface passage, and turbine upgrades at
1538 John Day. A brief description of the measures contained in MO2 are provided in Table 2-6 and
1539 listed below.

1540 **Table 2-6. Measures of Multiple Objective Alternative 2**

Measure Descriptions	Abbreviated Measure Name
Structural Measures	
Install improved fish passage turbines at John Day	Improved Fish Passage Turbines
Construct powerhouse and/or spill surface passage routes at John Day, McNary and Ice Harbor Dams	Additional Powerhouse Surface Passage
Cease installation of fish screens at Ice Harbor, McNary and John Day Projects	Fewer Fish Screens
Upgrade spillway weirs to ASWs	Upgrade to Adjustable Spillway Weirs
Install pumping systems to provide deeper, cooler water in adult fish ladders at Lower Monumental and Ice Harbor Dams	Lower Snake Ladder Pumps
Expand network of LPSs to bypass impediments	Lamprey Passage Structures
Modify turbine cooling water strainer systems to safely exclude Pacific lamprey	Turbine Strainer Lamprey Exclusion
Modify turbine intake bypass screens that cause juvenile lamprey impingement	Bypass Screen Modifications for Lamprey
Modify existing fish ladders, incorporating lamprey passage features and criteria	Lamprey Passage Ladder Modifications
Operational Measures	
<i>Fish Passage</i>	
Limit fish passage spill to near 110 percent TDG	Spill to 110% TDG
Juvenile fish transportation at Lower Granite, Little Goose, Lower Monumental, and McNary down to Bonneville Dam April 25 to August 31	Increase Juvenile Fish Transportation
Allow contingency reserves to be carried within juvenile fish passage spill	Contingency Reserves Within Juvenile Fish Passage Spill
<i>Water Management</i>	
Modify Libby draft and refill operations when water supply forecast is 6.9 Maf or less	Modified Draft at Libby
Eliminate end-of-December variable draft at Libby and replace with single draft target	December Libby Target Elevation
Update the upstream Storage Corrections Method as applied to the Grand Coulee SRD	Update System FRM Calculation
Decrease the Grand Coulee Dam draft rate used in planning drawdown	Planned Draft Rate at Grand Coulee
Operational constraints for ongoing Grand Coulee maintenance of power plants	Grand Coulee Maintenance Operations
Develop draft requirements/assessment approach to protect against rain-induced flooding	Winter System FRM Space
<i>Hydropower</i>	
Ramping rate limitations at all projects will be defined only for safety or engineering	Ramping Rates for Safety
At the four lower Snake River projects, operate within the full reservoir operating range year-round	Full Range Reservoir Operations
At John Day, allow project to operate up to full pool except as needed for FRM	John Day Full Pool

Measure Descriptions	Abbreviated Measure Name
The storage projects may be drafted slightly deeper for hydropower	Slightly Deeper Draft for Hydropower
Operate turbines across their full range of capacity year-round	Full Range Turbine Operations
Zero generation operations may occur on lower Snake River projects November through February	Zero Generation Operations
<i>Other Operational</i>	
Implement sliding scale summer draft at Libby and Hungry Horse Dams	Sliding Scale at Libby and Hungry Horse

1541 **2.4.4.1 Multiple Objective Alternative 2 Description of Measures**

1542 **STRUCTURAL MEASURES**

1543 **Improved Fish Passage Turbines**

1544 This measure is the same as described in MO1. This measure would contribute to meeting
 1545 objectives 4 and 5 by installing new turbines for an efficient and reliable power supply that
 1546 minimizes greenhouse gas emissions. Because the turbines are designed to minimize negative
 1547 impacts to fish passing through the powerhouse, it would also contribute to meeting objective
 1548 1, which strives to improve passage and survival for ESA juvenile anadromous fish.

1549 **Additional Powerhouse Surface Passage**

1550 This measure is the same as described in MO1, though it also includes the John Day Project.
 1551 This measure would contribute to meeting objective 1 to improve passage for ESA-listed
 1552 juvenile anadromous fish.

1553 **Cease installation of fish screens at Ice Harbor, McNary, and John Day Projects**

1554 **This measure will be referred to as “Fewer Fish Screens” throughout the remainder of this**
 1555 **EIS.** This measure would potentially cease installation of fish screens to increase the efficiency
 1556 of hydropower turbines at the Ice Harbor, McNary, and John Day Dams once IFP turbines are
 1557 installed. This measure is intended to consider running the new IFP turbines unscreened if
 1558 warranted biologically similar to the process implemented once turbines were replaced at the
 1559 first powerhouse at Bonneville Dam. The co-lead agencies would collaborate with NMFS and
 1560 USFWS to develop a Turbine Intake Bypass Screen Management and Future Strategy process to
 1561 monitor success of the improved fish passage turbines and determine when best to remove fish
 1562 screens at these projects.

1563 **Upgrade to Adjustable Spillway Weirs**

1564 Removal of fish screens would make hydropower production more efficient . Thus, this
 1565 measure would contribute to meeting objective 4 to provide an adequate, efficient,
 1566 economical, and reliable power supply.

1567 **Lower Snake Ladder Pumps**

1568 This measure is the same as described in MO1. This measure would contribute to meeting
1569 objective 2 to improve adult ESA-listed anadromous fish migration.

1570 **Lamprey Passage Structures**

1571 This measure is the same as described in MO1. This measure would contribute to meeting the
1572 objective to improve conditions for pacific lamprey.

1573 **Turbine Strainer Lamprey Exclusion**

1574 This measure is the same as described in MO1. This measure would contribute to meeting the
1575 objective to improve conditions for pacific lamprey.

1576 **Bypass Screen Modifications for Lamprey**

1577 This measure is the same as described in MO1. This measure would contribute to meeting the
1578 objective to improve conditions for pacific lamprey.

1579 **Lamprey Passage Ladder Modifications**

1580 This measure is the same as described in MO1. This measure would contribute to meeting the
1581 objective to improve conditions for pacific lamprey.

1582 **OPERATIONAL MEASURES**

1583 **Limit fish passage spill to 110 percent TDG**

1584 **This measure will be referred to as “Spill to 110% TDG” throughout the remainder of this EIS.**
1585 This measure would decrease spill for juvenile fish passage from the current operational levels,
1586 and limit fish passage spill to near the 110 percent TDG levels, as measured in-river (including
1587 tailraces and downstream forebays), except when minimum spill levels are higher, including
1588 spill needed for the powerhouse surface passage routes, for the spillway weirs, and/or for adult
1589 attraction to fish ladders. These operations would be implemented at the four lower Snake
1590 River and the four lower Columbia River projects. Spill during high flow and flood events would
1591 not be constrained to a cap of 110 percent TDG, but would be set to levels necessary to ensure
1592 public safety. Lack of market spill would follow the spill priority list set by TMT. These spill
1593 operations would be implemented annually beginning April 3 at the lower Snake River projects
1594 and April 10 at the lower Columbia River projects. Juvenile fish passage spill at all projects
1595 would cease at midnight July 31 each year. This measure would improve hydropower
1596 production, and thus, contribute to meeting objective 4 to provide an adequate, efficient,
1597 economical, and reliable power supply.

1598 **Juvenile fish transportation at Lower Granite, Little Goose, Lower Monumental, and McNary**
1599 **Dams down to Bonneville Dam April 25 to August 31**

1600 **This measure will be referred to as “Increase Juvenile Fish Transportation” throughout the**
1601 **remainder of this EIS.** This measure would transport all juvenile fish that enter juvenile fish
1602 bypasses at Lower Granite, Little Goose, Lower Monumental, and at the powerhouse surface
1603 passage facility at McNary for release below Bonneville Dam. Juvenile salmon would be
1604 transported by barge or by truck, and transport would be conducted from April 25 to August
1605 31. This would extend the current juvenile transport season, starting slightly earlier than the No
1606 Action Alternative, and ending at a fixed end date, which is later in the summer than current
1607 transport operations. This measure would contribute to meeting objective 1 and is intended to
1608 benefit ESA-listed juvenile anadromous fish.

1609 **Contingency Reserves Within Juvenile Fish Passage Spill**

1610 This measure is the same as described in MO1. This measure would contribute to meeting
1611 objective 4 to provide an adequate, efficient, and reliable power supply.

1612 **Modified Draft at Libby**

1613 This measure is the same as described in MO1. This measure was developed to meet objective
1614 6, which would maximize operating flexibility by implementing adaptable water management
1615 strategies in order to be responsive to changing conditions.

1616 **December Libby Target Elevation**

1617 This measure is the same as described in MO1, but the target elevation is 2,400 feet, not 2,420
1618 feet NGVD29. feet NGVD29. This measure was developed to contribute to meeting objective 6,
1619 which would maximize operating flexibility by implementing adaptable water management
1620 strategies in order to be responsive to changing conditions.

1621 **Update System FRM Calculation**

1622 This measure is the same as described in MO1. This measure was developed to contribute to
1623 meeting objective 6, which would maximize operating flexibility by implementing adaptable
1624 water management strategies in order to be responsive to changing conditions.

1625 **Planned Draft Rate at Grand Coulee**

1626 This measure is the same as described in MO1. This measure was developed to contribute to
1627 meeting objective 6, which would maximize operating flexibility by implementing adaptable
1628 water management strategies in order to be responsive to changing conditions.

1629 **Grand Coulee Maintenance Operations**

1630 This measure is the same as described in MO1. This measure was developed to contribute to
1631 meeting t objective 6, which would maximize operating flexibility by implementing adaptable
1632 water management strategies in order to be responsive to changing conditions. This measure
1633 would also contribute to meeting objective 4 to provide a reliable power supply by supporting
1634 maintenance of the turbines at Grand Coulee.

1635 **Winter System FRM Space**

1636 This measure is the same as described in MO1. This measure was developed to contribute to
1637 meeting objective 6, which would maximize operating flexibility by implementing adaptable
1638 water management strategies in order to be responsive to changing conditions.

1639 **Ramping rate limitations at all projects will be defined only for safety or engineering**

1640 **This measure will be referred to as “Ramping Rates for Safety” throughout the remainder of**
1641 **this EIS.** This measure would provide operational flexibility for hydropower generation by
1642 applying ramping rates only for safety or engineering purposes (e.g., erosion in the tailrace),
1643 relaxing all other ramping rate constraints such as those implemented to benefit fish and
1644 wildlife. This would allow operators to change flow operations within a 24-hour period to meet
1645 changes in hydropower demand. The measure would apply at all 14 CRS projects. This measure
1646 would contribute to meeting objective 4 to provide an adequate, efficient, economical and
1647 reliable power supply, by allowing additional flexibility to generate hydropower.

1648 **At all four lower Snake River projects, operate within the full reservoir operating range year-**
1649 **round**

1650 **This measure will be referred to as “Full Range Reservoir Operations” throughout the**
1651 **remainder of this EIS.** This measure would allow the four lower Snake River projects (Lower
1652 Granite, Little Goose, Lower Monumental, and Ice Harbor) to operate within their full normal
1653 operating range to provide greater flexibility to meet demand for hydropower generation. This
1654 would remove the current requirement that the projects operate within a 1-foot MOP range
1655 during fish passage season (April through August). This measure would contribute to meeting
1656 objective 4 to provide an adequate, efficient, economical, and reliable power supply that
1657 supports the integrated Columbia River power system.

1658 **At John Day, allow project to operate up to full pool, except as needed for flood risk**
1659 **management**

1660 **This measure will be referred to as “John Day Full Pool” throughout the remainder of this EIS.**
1661 This measure would remove current restrictions on seasonal pool elevations at the John Day
1662 Project, allowing more operating flexibility for hourly and daily shaping of hydropower
1663 generation. The measure would allow for operation of the reservoir across the full range
1664 possible, between 262.5 and 266.5 feet NGVD29 all year, except as needed for FRM. By

1665 providing additional operating flexibility this measure would contribute to meeting objective 4
1666 for an adequate, efficient, economical, and reliable power supply.

1667 **The storage projects may be drafted slightly deeper for hydropower**

1668 **This measure will be referred to as “Slightly Deeper Draft for Hydropower” throughout the**
1669 **remainder of this EIS.** This measure would provide slightly more operational flexibility (up to 10
1670 feet below URC values [Appendix I, *Hydroregulation*]) for hydropower generation by relaxing
1671 restrictions on seasonal pool elevations at the storage projects (Libby, Hungry Horse, Albeni
1672 Falls, Grand Coulee, and Dworshak). The operations in this measure would allow deeper
1673 drafting of the FRM pool to meet hydropower demand. This measure would contribute to
1674 meeting objective 4 to provide an adequate, efficient, economical, and reliable power supply
1675 that supports the integrated Columbia River power system.

1676 **Operate turbines across their full range of capacity year-round**

1677 **This measure will be referred to as “Full Range Turbine Operations” throughout the**
1678 **remainder of this EIS.** This measure would lift the requirement to operate hydropower turbines
1679 within 1 percent of peak efficiency during fish passage season at the lower Snake and lower
1680 Columbia projects: Lower Granite, Little Goose, Lower Monumental, Ice Harbor, McNary, John
1681 Day, The Dalles, and Bonneville. This would allow the turbines to operate across the full range
1682 of their generating capacity and provide more flexibility to generate hydropower to meet
1683 demand. Removing the limitation would allow more water to pass through the turbines during
1684 periods of high flow, potentially reducing TDG levels in the river. This measure would contribute
1685 to meeting objective 4 to provide an adequate, efficient, economical, and reliable power supply
1686 that supports the integrated Columbia River power system.

1687 **Zero generation operations may occur on lower Snake River projects November through**
1688 **February**

1689 **This measure will be referred to as “Zero Generation Operations” throughout the remainder**
1690 **of this EIS.** This measure would allow the lower Snake River projects to cease hydropower
1691 generation when there is little demand, unless limited by grid stability requirements. Currently,
1692 these projects are allowed to operate at zero generation mid-December through mid-February.
1693 This measure would extend that period to begin in September and extend through March. This
1694 would allow operators to save water in low-demand periods to use during high-demand periods
1695 in order to meet demand for hydropower. This measure would contribute to meeting objective
1696 4 to provide an adequate, efficient, economical, and reliable power supply that supports the
1697 integrated Columbia River power system.

1698 **Sliding Scale at Libby and Hungry Horse**

1699 This measure is the same as described in MO1. This measure would contribute to meeting
1700 objective 3 to improve resident fish survival and spawning success at CRS projects.

1701 **2.4.5 Multiple Objective Alternative 3**

1702 MO3 was developed to integrate actions for water management flexibility, hydropower
1703 production, and water supply with measures that would breach the four lower Snake River
1704 dams (Lower Granite, Little Goose, Lower Monumental, and Ice Harbor). In addition to
1705 breaching these four projects, MO3 differs from the other alternatives by carrying out a juvenile
1706 fish passage spill operation that sets flow through the spillways up to a target of no more than
1707 120 percent TDG in the tailrace of the four lower Columbia River projects (McNary, John Day,
1708 The Dalles, and Bonneville). The alternative also proposes an earlier end to summer juvenile
1709 fish passage spill operations than the No Action Alternative. Instead, flows would transition to
1710 increased hydropower production when low numbers of juvenile fish are anticipated.

1711 Structural measures in this alternative include breaching the four lower Snake River dams by
1712 removing the earthen embankment at each dam location, resulting in a controlled drawdown.

1713 Operational measures in MO3 are intended to improve juvenile fish travel times, improve
1714 conditions for resident fish in the upper basin, increase hydropower generation flexibility,
1715 provide more flexibility to water managers, and provide additional water supply.

1716 A brief description of the measures contained in MO3 is listed in Table 2-7 and the following
1717 paragraphs.

1718 **Table 2-7. Measures of Multiple Objective Alternative 3**

Measure Descriptions	Abbreviated Measure Name
Structural Measures	
Construct additional powerhouse and/or spill surface passage routes at McNary Dam	Additional Powerhouse Surface Passage
Cease installation of fish screens at McNary Dam and John Day	Fewer Fish Screens
Upgrade spillway weirs to ASWs	Upgrade to Adjustable Spillway Weirs
Modify the upper ladder serpentine flow control ladder sections at Bonneville Dam	Modify Bonneville Ladder Serpentine Weir
Expand network of LPSs to bypass impediments	Lamprey Passage Structures
Modify turbine cooling water strainer systems to safely exclude Pacific lamprey	Turbine Strainer Lamprey Exclusion
Modify turbine intake bypass screens that cause juvenile lamprey impingement	Bypass Screen Modifications for Lamprey
Modify existing fish ladders, incorporating lamprey passage features and criteria	Lamprey Passage Ladder Modifications
Install improved fish passage turbines at John Day	Improved Fish Passage Turbines
Dam Breach	
Remove earthen embankments and adjacent structures, as required, at each lower Snake River dam	Breach Snake Embankments
Modify equipment and infrastructure to adjust to drawdown conditions at each lower Snake River dam	Lower Snake Infrastructure Drawdown

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Measure Descriptions	Abbreviated Measure Name
Operational Measures	
<i>Dam Breach</i>	
Develop procedures to operate existing equipment during reservoir drawdown	Drawdown Operating Procedures
Develop contingency plans to address unexpected issues with drawdown operations	Drawdown Contingency Plans
<i>Fish Passage</i>	
Limit fish passage spill to 120 percent TDG at McNary, John Day, The Dalles, and Bonneville Dams	Spring Spill to 120% TDG
Reduce the duration of summer juvenile fish passage spill	Reduced Summer Spill
Allow contingency reserves to be carried within juvenile fish passage spill	Contingency Reserves Within Juvenile Fish Passage Spill
<i>Water Management</i>	
Modify Libby draft and refill operations when water supply forecast is 6.9 Maf or less	Modified Draft at Libby
Eliminate end-of-December variable draft at Libby and replace with single draft target	December Libby Target Elevation
Update the upstream Storage Corrections Method as applied to the Grand Coulee SRD with flat spot retained	Update System FRM Calculation
Decrease the Grand Coulee Dam draft rate used in planning drawdown	Planned Draft Rate at Grand Coulee
Operational constraints for ongoing Grand Coulee maintenance of power plants	Grand Coulee Maintenance Operations
<i>Water Supply</i>	
Increase volume of water pumped from Lake Roosevelt during annual irrigation season	Lake Roosevelt Additional Water Supply
Increase water managers' flexibility to store and release water from Hungry Horse Reservoir	Hungry Horse Additional Water Supply
Increase water diversion from the Columbia River for the Chief Joseph Dam Project	Chief Joseph Dam Project Additional Water Supply
<i>Hydropower</i>	
Ramping rate limitations at all projects will be defined only for safety or engineering	Ramping Rates for Safety
At John Day, allow project to operate up to full pool except as needed for FRM	John Day Full Pool
Operate turbines within and above 1 percent peak efficiency in juvenile fish passage season	Above 1% Turbine Operations
<i>Other Operational</i>	
Implement sliding scale summer draft at Libby and Hungry Horse Dams	Sliding Scale at Libby and Hungry Horse

1719 **2.4.5.1 Multiple Objective Alternative 3 Description of Measures**

1720 **STRUCTURAL MEASURES**

1721 **Remove earthen embankments and adjacent structures, as required, at each lower Snake**
1722 **River dam**

1723 **This measure will be referred to as “Breach Snake Embankments” throughout the remainder**
1724 **of this EIS.** This measure would breach the lower Snake River dams. The demolition would
1725 remove the earthen embankments, abutments, and portions of existing structures at the dams
1726 to eliminate the reservoirs behind the Lower Granite, Little Goose, Lower Monumental, and Ice
1727 Harbor Projects. In order to minimize impacts to migrating salmon and ensure safety, the
1728 removal of the embankments would be conducted in two phases during the low water period in
1729 the river. Drawdown would begin in August, with the removal of structures during October,
1730 months when few ESA-listed salmon would be present in the Snake River. To do this, the north
1731 embankments at the Lower Granite and Little Goose Projects would be removed the first year,
1732 and the south embankment at Lower Monumental and north embankment at Ice Harbor would
1733 be removed the second year. The co-lead agencies would implement a controlled drawdown, at
1734 a rate of 2 feet per day, beginning in August and continuing through December, in order to
1735 safely evacuate the reservoir and minimize damages to infrastructure (highways, bridges,
1736 railroads) adjacent to the reservoirs. In-water structures such as anchored concrete blocks
1737 would be installed at Ice Harbor to produce resting pools and hydraulic conditions needed for
1738 fish passage. This measure was developed to contribute to meeting objective 1 for
1739 improvements to ESA-listed juvenile salmonid rearing, passage, and survival.

1740 **Modify equipment and infrastructure to adjust to drawdown conditions at each lower Snake**
1741 **River dam**

1742 **This measure will be referred to as “Lower Snake Infrastructure Drawdown” throughout the**
1743 **remainder of this EIS.** In order to implement breaching, the reservoirs would be drawn down to
1744 spillway elevations. In order to evacuate the reservoirs below this level, three turbines at each
1745 of the four lower Snake River dams would be modified so that they could be used as low-level
1746 water outlets to support a controlled drawdown of the reservoirs. The turbines would be
1747 modified to operate over a range of low head conditions, requiring modification to the cooling
1748 water systems, and removal of the turbine blades. This would allow maximum discharge of
1749 water through the turbine passages at low head. These actions would be taken several months
1750 in advance of initiation of drawdown. This measure was developed to contribute to meeting
1751 objective 1 for improvements to ESA-listed juvenile salmonid rearing, passage, and survival.

1752 **Additional Powerhouse Surface Passage**

1753 This measure is the same as described in MO1, but without inclusion of the Ice Harbor Project
1754 on the lower Snake River. This measure would contribute to meeting objective 1 to improve
1755 passage for ESA-listed juvenile anadromous fish.

1756 **Fewer Fish Screens**

1757 This measure is the same as described in MO2, but without inclusion of the Ice Harbor Project
1758 on the lower Snake River. Removal of fish screens would make hydropower production more
1759 efficient . Thus, this measure would contribute to meeting objective 4 to provide an adequate,
1760 efficient, economical, and reliable power supply.

1761 **Upgrade to Adjustable Spillway Weirs**

1762 This measure is the same as described in MO1 but applies only to the lower Columbia River
1763 projects and does not include the lower Snake River projects. This measure was developed to
1764 contribute to meeting objective 1 for improvements to ESA-listed juvenile salmonid rearing,
1765 passage, and survival.

1766 **Modify Bonneville Ladder Serpentine Weir**

1767 This measure is the same as described in MO1. This measure is intended to benefit adult fish
1768 passage and would contribute to meeting objective 2 for adult ESA-listed anadromous fish.

1769 **Lamprey Passage Structures**

1770 This measure is the same as described in MO1. This measure would contribute to meeting the
1771 objective to improve conditions for Pacific lamprey.

1772 **Turbine Strainer Lamprey Exclusion**

1773 This measure is the same as described in MO1. This measure would contribute to meeting the
1774 objective to improve conditions for Pacific lamprey.

1775 **Bypass Screen Modifications for Lamprey**

1776 This measure is the same as described in MO1 but would only be implemented at McNary. This
1777 measure would contribute to meeting the objective to improve conditions for Pacific lamprey.

1778 **Lamprey Passage Ladder Modifications**

1779 This measure is the same as described in MO1 but would not be implemented at the lower
1780 Snake River projects. This measure would contribute to meeting the objective to improve
1781 conditions for Pacific lamprey.

1782 **Improved Fish Passage Turbines**

1783 This measure is the same as described in MO1. This measure would contribute to meeting
1784 objectives 4 and 5 by installing new turbines for an efficient and reliable power supply that
1785 minimizes greenhouse gas emissions. Because the turbines are designed to minimize negative

1786 impacts to fish passing through the powerhouse, it would also contribute to meeting objective
1787 1, which strives to improve passage and survival for ESA juvenile anadromous fish.

1788 **OPERATIONAL MEASURES**

1789 **Develop procedures to operate existing equipment during reservoir drawdown**

1790 **This measure will be referred to as “Drawdown Operating Procedures” throughout the**
1791 **remainder of this EIS.** This measure would be implemented in conjunction with the structural
1792 measures described above. Under this measure, equipment at the dams to be used for
1793 drawdown would be tested and calibrated to establish operational limits. Engineers, and
1794 powerhouse and transmission operators would establish manual operations and procedures
1795 using the modified equipment to facilitate a controlled and safe reservoir evacuation to support
1796 dam breaching. This measure was developed to contribute to meeting objective 1 for
1797 improvements to ESA-listed juvenile salmonid rearing, passage, and survival.

1798 **Develop contingency plans to address unexpected issues with drawdown operations**

1799 **This measure will be referred to as “Drawdown Contingency Plans” throughout the remainder**
1800 **of this EIS.** Corps staff that operate the dams would develop plans for unexpected operations
1801 or emergency shutdown during reservoir drawdown. To address the risks of breaching such
1802 large dams, training would be provided to dam and transmission system operators to
1803 implement emergency actions during unanticipated circumstances to ensure the safety of the
1804 general public and construction and dam personnel during reservoir drawdown. This measure
1805 was developed to contribute to meeting objective 1 for improvements to ESA-listed juvenile
1806 salmonid rearing, passage, and survival.

1807 **Limit fish passage spill to 120 percent TDG at McNary, John Day, The Dalles, and Bonneville**
1808 **Dams**

1809 **This measure will be referred to as “Spring Spill to 120 Percent TDG” throughout the**
1810 **remainder of this EIS.** This measure would modify spring juvenile fish passage spill to allow spill
1811 up to 120 percent tailrace gas cap. Juvenile fish passage spill to 120 percent TDG would be
1812 implemented annually at the McNary, John Day, The Dalles, and Bonneville Projects from April
1813 10 to June 15. McNary, John Day, and The Dalles would spill to 120 percent in the tailrace, while
1814 Bonneville would spill to 120 percent in the tailrace not to exceed a 150 kcfs spill constraint.
1815 The juvenile fish spill volumes at each project are described in Table 2-8. This measure is
1816 intended to contribute to meeting objective 1 to improve the passage and survival of juvenile
1817 ESA-listed salmonids.

1818 **Table 2-8. Juvenile Fish Passage Spill Measure for Multiple Objective Alternative 3**

Location	Spill Regime
McNary	120% tailrace Spill Cap ^{1/}
John Day	120% tailrace Spill Cap ^{1/}
The Dalles	120% tailrace Spill Cap ^{1/}
Bonneville	120% tailrace Spill Cap ^{1/} , not to exceed 150 kcfs spill

1819 1/ The term “spill cap” refers to the maximum spill level at each project that is estimated to meet, but not exceed,
 1820 the gas cap in the tailrace unless the spill cap is constrained (e.g.,150 kcfs maximum spill for Bonneville Dam). In
 1821 this measure, spill caps will be set to meet, but not exceed, the gas cap of 120% TDG as measured at the tailrace
 1822 fixed monitoring stations. This gas cap is consistent with the current Oregon TDG water quality standard
 1823 modification and with Washington State’s current short-term modification to its TDG water quality standard
 1824 (2019), which removed the 115% TDG criteria.

1825 **Reduce the duration of summer juvenile fish passage spill**

1826 **This measure will be referred to as “Reduced Summer Spill” throughout the remainder of this**
 1827 **EIS.** This measure would reduce the period of fish passage spill in the summer, ending all
 1828 summer spill operations at midnight July 31 at McNary, John Day, The Dalles, and Bonneville
 1829 Dams to allow for an increase in hydropower production during periods when low numbers of
 1830 juvenile fish are migrating. This measure would contribute to meeting objective 4, and is
 1831 intended to provide an adequate, efficient, economical, and reliable power supply that
 1832 supports the integrated Columbia River power system.

1833 **Ramping Rates for Safety**

1834 This measure is the same as described in MO2. This measure would contribute to meeting
 1835 objective 4 to provide an adequate, efficient, economical, and reliable power supply, by
 1836 allowing additional flexibility to generate hydropower.

1837 **John Day Full Pool**

1838 This measure is the same as described in MO2. By providing additional operating flexibility this
 1839 measure would continue to meet objective 4 for an adequate, efficient, economical, and
 1840 reliable power supply.

1841 **Operate turbines within and above 1 percent peak efficiency during juvenile fish passage**
 1842 **season**

1843 **This measure will be referred to as “Above 1 Percent Turbine Operations” throughout the**
 1844 **remainder of this EIS.** This measure would lift the requirement to operate hydropower turbines
 1845 only within a 1 percent peak efficiency during the fish passage season at McNary, John Day, The
 1846 Dalles, and Bonneville Dams. This would allow turbine operation within and above the current 1
 1847 percent peak efficiency limit to increase flexibility for hydropower generation to meet demand
 1848 during high flow periods. This measure would contribute to meeting objective 4 to provide an
 1849 adequate, efficient, economical, and reliable power supply that supports the integrated
 1850 Columbia River power system.

1851 **Sliding Scale at Libby and Hungry Horse**

1852 This measure is the same as described in MO1. This measure would contribute to meeting
1853 objective 3 to improve resident fish survival and spawning success at CRS projects.

1854 **Contingency Reserves Within Juvenile Fish Passage Spill**

1855 This measure is the same as described in MO1. This measure would contribute to meeting
1856 objective 4 to provide an adequate, efficient, and reliable power supply.

1857 **Modified Draft at Libby**

1858 This measure is the same as described in MO1. This measure was developed to contribute to
1859 meeting objective 6, which would maximize operating flexibility by implementing adaptable
1860 water management strategies in order to be responsive to changing conditions.

1861 **December Libby Target Elevation**

1862 This measure is the same as described in MO1, but with a target elevation of 2,400 feet
1863 NGVD29. This measure was developed to contribute to meeting objective 6, which would
1864 maximize operating flexibility by implementing adaptable water management strategies in
1865 order to be responsive to changing conditions.

1866 **Update System FRM Calculation**

1867 This measure is the same as described in MO1, except that the SRD maintains what is known as
1868 the “flat spot” from the No Action Alternative. The flat spot is a range of water supply
1869 conditions that doesn’t require additional draft, but rather requires a consistent draft (“flat”) of
1870 1,222.7 feet NGVD29 over those conditions. This slight adjustment to the flood risk draft
1871 elevation reduces impacts to water supply operations. This measure was developed to
1872 contribute to meeting objective 6, which would maximize operating flexibility by implementing
1873 adaptable water management strategies in order to be responsive to changing conditions.

1874 **Planned Draft Rate at Grand Coulee**

1875 This measure is the same as described in MO1. This measure was developed to contribute to
1876 meeting objective 6, which would maximize operating flexibility by implementing adaptable
1877 water management strategies in order to be responsive to changing conditions.

1878 **Grand Coulee Maintenance Operations**

1879 This measure was developed to contribute to meeting objective 6, which would maximize
1880 operating flexibility by implementing adaptable water management strategies in order to be
1881 responsive to changing conditions. This measure would also contribute to meeting objective 4
1882 to provide a reliable power supply by supporting maintenance of the turbines at Grand Coulee.

1883 **Lake Roosevelt Additional Water Supply**

1884 This measure is the same as described in MO1. This measure would contribute to meeting
1885 objective 7 to meet existing water supply obligations and provide for additional authorized
1886 regional water supply.

1887 **Hungry Horse Additional Water Supply**

1888 This measure is the same as described in MO1. This measure would contribute to meeting
1889 objective 7 to meet existing water supply obligations and provide for additional authorized
1890 regional water supply.

1891 **Chief Joseph Dam Project Additional Water Supply**

1892 This measure is the same as described in MO1. This measure would contribute to meeting
1893 objective 7 to meet existing water supply obligations and provide for additional authorized
1894 regional water supply.

1895 **2.4.6 Multiple Objective Alternative 4**

1896 MO4 was developed to examine an additional combination of measures to benefit ESA-listed
1897 fish integrated with measures for water management flexibility, hydropower production, and
1898 additional water supply. The additional combination of fish measures that differ from the other
1899 alternatives include proposing spillway weir notch inserts, changes to the juvenile fish
1900 transportation operations, the highest spill target in the range considered in this EIS. Annually
1901 drawing down the lower Snake River and Columbia River reservoirs to their minimum operating
1902 pools, a measure for establishment of riparian vegetation, dry-year augmentation of spring flow
1903 with water stored in upper basin reservoirs, and increased powerhouse surface passage for kelt
1904 and overshoots.

1905 The structural measures in this alternative are primarily focused on improving passage
1906 conditions for ESA-listed salmonids and Pacific lamprey. The inclusion of spillway weir notch
1907 inserts is the only structural measure difference from the other action alternatives. The
1908 operational measures are focused on making improvements and providing flexibility across
1909 authorized project purposes. In MO4, the juvenile fish transport program is proposed to
1910 operate only in the spring and fall, while juvenile fish passage spill is set to a target of no more
1911 than 125 percent TDG during the spring and summer spill season. The alternative also contains
1912 a measure for flows from the Libby Project targeted for downstream riparian vegetation
1913 establishment that is intended to improve conditions for ESA-listed resident fish, bull trout, and
1914 Kootenai River white sturgeon in the upper Columbia River Basin.

1915 A brief description of the measures contained in MO4 is listed in Table 2-9 and the following
1916 paragraphs.

1917 **Table 2-9. Measures of Multiple Objective Alternative 4**

Measure Descriptions	Abbreviated Measure Name
Structural Measures	
Construct additional powerhouse surface passage routes to meet system-wide PITPH target	Additional Powerhouse Surface Passage
Improve adult ladder passage through modification of adult trap at Lower Granite Dam	Lower Granite Trap Modifications
Install pumping systems to provide deeper, cooler water in adult fish ladders at Lower Monumental and Ice Harbor Dams	Lower Snake Ladder Pumps
Install improved fish passage turbines at John Day	Improved Fish Passage Turbines
Expand network of LPSs to bypass impediments	Lamprey Passage Structures
Modify turbine intake bypass screens that cause juvenile lamprey impingement	Bypass Screen Modifications for Lamprey
Modify existing fish ladders, incorporating lamprey passage features and criteria	Lamprey Passage Ladder Modifications
Addition of spillway weir notch gate inserts	Spillway Weir Notch Inserts
Modify turbine cooling water strainer systems to safely exclude Pacific lamprey	Turbine Strainer Lamprey Exclusion
Operational Measures	
<i>Fish Passage</i>	
Spill through surface passage structures for steelhead overshoots, overwintering steelhead, and kelt	Spill for Adult Steelhead
Set juvenile fish passage spill to not exceed 125 percent TDG	Spill to 125% TDG
Allow contingency reserves to be carried within juvenile fish passage spill	Contingency Reserves Within Juvenile Fish Passage Spill
Implement juvenile fish transportation during spring and fall periods at Lower Granite, Little Goose, and Lower Monumental Dams	Spring & Fall Transport
Cease juvenile transport during portions of summer spill period at Lower Granite, Little Goose, and Lower Monumental Dams	No Summer Transport
<i>Water Management</i>	
Modify Libby draft and refill operations when water supply forecast is 6.9 Maf or less	Modified Draft at Libby
Eliminate end-of-December variable draft at Libby and replace with single draft target	December Libby Target Elevation
Update the upstream Storage Corrections Method as applied to the Grand Coulee SRD	Update System FRM Calculation
Decrease the Grand Coulee Dam draft rate used in planning drawdown	Planned Draft Rate at Grand Coulee
Operational constraints for ongoing Grand Coulee maintenance of power plants and spillways	Grand Coulee Maintenance Operations
Develop draft requirements/assessment approach to protect against rain-induced flooding	Winter System FRM Space
<i>Water Supply</i>	
Increase volume of water pumped from Lake Roosevelt during annual irrigation season	Lake Roosevelt Additional Water Supply

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Measure Descriptions	Abbreviated Measure Name
Increase water managers' flexibility to store and release water from Hungry Horse Reservoir	Hungry Horse Additional Water Supply
Increase water diversion from the Columbia River for the Chief Joseph Dam Project	Chief Joseph Dam Project Additional Water Supply
Operate turbines within and above 1 percent peak efficiency in juvenile fish passage season	Above 1% Turbine Operations
<i>Other Operational Measures</i>	
Strive to hold minimum 220 kcfs spring flow/200 kcfs summer flow at McNary Dam using upstream storage	McNary Flow Objective
Reservoir drawdown to Minimum Operating Pool to reduce outmigration travel time	Drawdown to MOP
Implement sliding scale summer draft at Libby and Hungry Horse	Sliding Scale at Libby and Hungry Horse
Support establishment of vegetation at Libby Dam by limiting Bonners Ferry stage height November through March	Winter Stage for Riparian

1918 **2.4.6.1 Multiple Objective Alternative 4 Description of Measures**

1919 **STRUCTURAL MEASURES**

1920 **Additional Powerhouse Surface Passage**

1921 This measure is the same as described in MO1, but under MO4, the additional powerhouse
 1922 surface passage route would be used to measure probability of passing powerhouses (PITPH).
 1923 As stated in the May 13, 2019 Fish Passage Center Memorandum, "PITPH is an index that
 1924 describes the probability that an average juvenile fish will experience powerhouse passage
 1925 under specific project operations. PITPH is an index used to characterize the effects of spill in
 1926 CSS analyses. CSS analyses have shown that the probability of passing powerhouses (PITPH)
 1927 influences juvenile travel time, juvenile survival, and smolt-to-adult return rates" (Fish Passage
 1928 Center 2019). This measure would contribute to meeting objective 1 to improve passage for
 1929 ESA-listed juvenile anadromous fish.

1930 **Lower Granite Trap Modifications**

1931 This measure is the same as described in MO1. This measure would contribute to meeting
 1932 objective 2 to improve passage for adult ESA-listed anadromous fish.

1933 **Lower Snake Ladder Pumps**

1934 This measure is the same as described in MO1. This measure would contribute to meeting
 1935 objective 2 to improve adult ESA-listed anadromous fish migration.

1936 **Improved Fish Passage Turbines**

1937 This measure is the same as described in MO1. This measure would contribute to meeting
 1938 objectives 4 and 5 by installing new turbines for an efficient and reliable power supply that

1939 minimizes greenhouse gas emissions. Because the turbines are designed to minimize negative
1940 impacts to fish passing through the powerhouse, it would also contribute to meeting objective
1941 1, which strives to improve passage and survival for ESA juvenile anadromous fish.

1942 **Lamprey Passage Structures**

1943 This measure is the same as described in MO1. This measure would contribute to meeting the
1944 objective to improve conditions for Pacific lamprey.

1945 **Bypass Screen Modifications for Lamprey**

1946 This measure is the same as described in MO1. This measure would contribute to meeting the
1947 objective to improve conditions for Pacific lamprey.

1948 **Lamprey Passage Ladder Modifications**

1949 This measure is the same as described in MO1. This measure would contribute to meeting the
1950 objective to improve conditions for Pacific lamprey.

1951 **Turbine Strainer Lamprey Exclusion**

1952 This measure is the same as described in MO1. This measure would contribute to meeting the
1953 objective to improve conditions for Pacific lamprey.

1954 **Add spillway weir notch gate inserts.**

1955 **This measure will be referred to as “Spillway Weir Notch Inserts” throughout the remainder**
1956 **of this EIS.** Modify existing spillway weirs at Lower Granite, Little Goose, Lower Monumental,
1957 Ice Harbor, McNary, and John Day Dams. A notch gate would be installed in one spillway weir at
1958 each dam to create a smaller opening in the weir and enable reduced spill flow velocities. The
1959 notched weirs would be operated October 1 to November 31 at all dams. This measure would
1960 contribute to meeting objective 1 and is intended to improve the passage and survival of ESA-
1961 listed juvenile anadromous fish.

1962 **OPERATIONAL MEASURES**

1963 **Spill through surface passage structures for steelhead overshoots, overwintering steelhead**
1964 **and kelt**

1965 **This measure will be referred to as “Spill for Adult Steelhead” throughout the remainder of**
1966 **this EIS.** Implementation of this measure would require modification of the spillway weirs as
1967 described above for the Spillway Weir Notch Inserts measure to facilitate downstream passage
1968 of adult salmon, steelhead, and kelt. Flows would be directed through the weirs at the Lower
1969 Granite, Little Goose, Lower Monumental, Ice Harbor, McNary and John Day Projects from
1970 October 1 to November 31. The measure is intended to increase adult salmon and steelhead

1971 survival by decreasing passage mortality of adult steelhead. This measure would contribute to
1972 meeting objective 2, intended to benefit adult ESA-listed anadromous fish.

1973 **Set juvenile fish passage spill to not exceed 125 percent TDG**

1974 **This measure will be referred to as “Spill to 125 Percent TDG” throughout the remainder of**
1975 **this EIS.** This measure would set the target for juvenile fish passage spill up to 125 percent TDG,
1976 as measured in the tailrace, at the four lower Snake River and four lower Columbia River
1977 projects. Juvenile fish passage spill to this level would be dependent upon availability of
1978 sufficient flow to meet minimum generation requirements for hydropower. Upstream storage
1979 reservoirs would not be drafted specifically to reach 125 percent TDG spill levels. This juvenile
1980 fish passage spill regime would be implemented March 1 to August 31 at Lower Granite, Little
1981 Goose, Lower Monumental, Ice Harbor, McNary, John Day, The Dalles, and Bonneville Dams.
1982 This measure is intended to improve passage for juvenile ESA-listed salmonids, and as such,
1983 would contribute to meeting objective 1.

1984 **Allow contingency reserves to be carried within juvenile fish passage spill**

1985 This measure will be referred to as “Contingency Reserves Within Juvenile Fish Passage Spill”
1986 throughout the remainder of this EIS. This measure is the same as described in MO1. This
1987 measure would contribute to meeting objective 4 to provide an adequate, efficient, and reliable
1988 power supply.

1989 **Implement juvenile fish transportation during spring and fall periods at Lower Granite, Little**
1990 **Goose, and Lower Monumental Dams**

1991 **This measure will be referred to as “Spring & Fall Transport” throughout the remainder of this**
1992 **EIS.** Juvenile fish transportation on barges and trucks would be implemented in two
1993 timeframes, April 25 to June 14, and August 16 to November 15, rather than transport
1994 beginning no later than May 1 through the migration season. During these two transport
1995 seasons, all juvenile salmonids that enter the juvenile fish bypass systems at Lower Granite,
1996 Little Goose, and Lower Monumental Dams would be collected and transported to a location
1997 downstream of Bonneville Dam for release. This measure would contribute to meeting
1998 objective 1 to improve passage and survival of juvenile ESA-listed salmonids.

1999 **Cease juvenile transport during portions of summer spill period at Lower Granite, Little**
2000 **Goose, and Lower Monumental Dams**

2001 **This measure will be referred to as “No Summer Transport” throughout the remainder of this**
2002 **EIS.** The juvenile transport program at Lower Granite, Little Goose, and Lower Monumental
2003 Dams would be suspended during the full summer timeframe (June 15 to August 15). Instead of
2004 collection for transport, all juvenile fish entering the fish bypasses at these projects would be
2005 returned to the river to migrate during the June 15 to August 15 window. This measure is a
2006 variation of the current and proposed transport program, which is intended to improve passage

2007 and survival of juvenile ESA-listed salmonids . As such, it would contribute to meeting objective
2008 1.

2009 **Modified Draft at Libby**

2010 This measure is the same as described in MO1. This measure was developed to contribute to
2011 meeting objective 6, which would maximize operating flexibility by implementing adaptable
2012 water management strategies in order to be responsive to changing conditions

2013 **December Libby Target Elevation**

2014 This measure is the same as described in MO1, with a target elevation of 2,420 feet NGVD29.
2015 This measure was developed to contribute to meeting objective 6, which would maximize
2016 operating flexibility by implementing adaptable water management strategies in order to be
2017 responsive to changing conditions.

2018 **Update System FRM Calculation**

2019 This measure is the same as described in MO1. This measure was developed to contribute to
2020 meeting objective 6, which would maximize operating flexibility by implementing adaptable
2021 water management strategies in order to be responsive to changing conditions.

2022 **Planned Draft Rate at Grand Coulee**

2023 This measure is the same as described in MO1. This measure was developed to contribute to
2024 meeting objective 6, which would maximize operating flexibility by implementing adaptable
2025 water management strategies in order to be responsive to changing conditions.

2026 **Grand Coulee Maintenance Operations**

2027 This measure is the same as described in MO1. This measure was developed to contribute to
2028 meeting objective 6, which would maximize operating flexibility by implementing adaptable
2029 water management strategies in order to be responsive to changing conditions . This measure
2030 would also contribute to meeting objective 4 to provide a reliable power supply by supporting
2031 maintenance of the turbines at Grand Coulee.

2032 **Winter System FRM Space**

2033 This measure is the same as described in MO1. This measure was developed to contribute to
2034 meeting objective 6, which would maximize operating flexibility by implementing adaptable
2035 water management strategies in order to be responsive to changing conditions.

2036 **Lake Roosevelt Additional Water Supply**

2037 This measure is the same as described in MO1. This measure would contribute to meeting
2038 objective 7 to meet existing water supply obligations and provide for additional authorized
2039 regional water supply.

2040 **Hungry Horse Additional Water Supply**

2041 This measure is the same as described in MO1. This measure would contribute to meeting
2042 objective 7 to meet existing water supply obligations and provide for additional authorized
2043 regional water supply.

2044 **Chief Joseph Dam Project Additional Water Supply**

2045 This measure is the same as described in MO1. This measure would contribute to meeting
2046 objective 7 to meet existing water supply obligations and provide for additional authorized
2047 regional water supply.

2048 **Above 1 Percent Turbine Operations**

2049 This measure is the same as described in MO3, but would include the Lower Granite, Little
2050 Goose, Lower Monumental, and Ice Harbor Projects. This measure would contribute to meeting
2051 objective 4 to provide an adequate, efficient, economical, and reliable power supply that
2052 supports the integrated Columbia River power system.

2053 **Strive to hold minimum 220 kcfs spring flow/200 kcfs summer flow at McNary using upstream
2054 storage**

2055 **This measure will be referred to as “McNary Flow Target” throughout the remainder of this**
2056 **EIS.** This measure would augment flows in the lower Columbia River during the juvenile salmon
2057 outmigration period in low water years. The summer flow objective at McNary is supported by
2058 various flow augmentation measures in the No Action Alternative that would continue,
2059 however, this measure would provide additional flow augmentation. Even with this additional
2060 water, there is a limited amount of water available for flow augmentation and flow objectives
2061 are provided as a biological guideline. To meet this minimum flow objective for the lower
2062 Columbia River, up to 2.0 Maf of storage water from the Hungry Horse, Libby, Albeni Falls, and
2063 Grand Coulee Projects would be provided above that provided currently, in order to meet
2064 spring or summer flow objectives established for the McNary Project. Grand Coulee would be
2065 drafted from first to meet the flow objective, with no more than 40 kcfs being released in a
2066 single day and drafting the reservoir to no more than the minimum pool elevation. Then,
2067 Hungry Horse, Libby, and Albeni Falls reservoirs would be drafted to support the augmented
2068 flow target as well as to refill Grand Coulee’s reservoir, but to a reduced refill elevation. Local
2069 resident fish operations in the upper basin, such as minimum flows for resident fish, would be
2070 maintained. In the event that all 2.0 Maf of water has not been used by June 15, then the
2071 remaining volume of water would be released to meet a reduced minimum flow objective of

2072 200 kcfs at McNary through to July 31. This measure is not anticipated be implemented every
2073 year, but rather only when the system-wide April to August water supply forecast is below 87.5
2074 Maf, the current 30-year average for the period 1981 to 2008, which will be updated after
2075 2020. This measure is intended to benefit ESA-listed juvenile anadromous fish migration, and as
2076 such, would contribute to meeting objective 1.

2077 **Reservoir drawdown to Minimum Operating Pool to reduce outmigration travel time**

2078 **This measure will be referred to as “Drawdown to MOP” throughout the remainder of this**
2079 **EIS.** The lower Snake River and lower Columbia River projects would be operated at lower
2080 elevations to reduce travel times for juvenile fish out-migration while providing slightly
2081 increased operating range flexibility at the lower Snake River projects. These operations would
2082 be implemented at the lower Snake River projects from March 15 to August 15, and at the
2083 lower Columbia projects from March 25 to August 15. The projects would be drafted down to
2084 the following reservoir elevations (Table 2-10).

2085 **Table 2-10. Drawdown to MOP Measure for Multiple Objective Alternative 4**

Location	MO4 MOP Forebay Elevation
Lower Granite	733.0 + 1.5 ft range
Little Goose	633.0 + 1.5 ft range
Lower Monumental	537 + 1.5 ft range
Ice Harbor	437 + 1.5 ft range
McNary	337.0 + 1.0 ft range
John Day	261.0 + 1.5 ft range
The Dalles	155.0 + 1.5 ft range
Bonneville	71.5 + 1.5 ft range

2086 This measure is intended to benefit ESA-listed juvenile anadromous fish migration, and as such,
2087 would contribute to meeting objective 1.

2088 **Sliding Scale at Libby and Hungry Horse**

2089 This measure is the same as described in MO1. This measure would contribute to meeting
2090 objective 3 to improve resident fish survival and spawning success at CRS projects.

2091 **Support establishment of vegetation at Libby Dam by limiting Bonners Ferry stage height**
2092 **November through March**

2093 **This measure will be referred to as “Winter Stage for Riparian” throughout the remainder of**
2094 **this EIS.** Operate to limit the Bonners Ferry river elevations to a maximum of 1,753 feet
2095 NGVD29 from November through March to create conditions that would increase survival of
2096 riparian vegetation downstream of Libby Dam. The riparian vegetation is considered an
2097 important factor in creating good conditions for Kootenai white sturgeon and bull trout
2098 (Table 2-9). This measure would contribute to meeting objective 3 to improve resident fish
2099 survival and spawning success at CRS projects.

2100 **2.5 ALTERNATIVES CONSIDERED BUT REMOVED FROM FURTHER CONSIDERATION**

2101 Initially, eight single objective-focused alternatives were developed to maximize certain project
 2102 purposes and emphasize specific resources, in a hypothetical condition where other purposes
 2103 do not constrain the possibility of actions that could be taken. These single objective
 2104 alternatives provided the framework for the exchange of expertise across technical disciplines
 2105 throughout the Columbia River Basin. The technical teams collaborated to determine where
 2106 measures would be most effective and if they were compatible across the 14 projects in the
 2107 CRS. If measures were determined to be conflicting, or experts felt one measure would perform
 2108 better at accomplishing the objective as compared to a similar measure, the team decided
 2109 which measure to retain or modify to meet the intended single objective. In some cases,
 2110 measures were suggested, either through scoping or by technical team members, but were not
 2111 selected for further consideration. This unrestrained development of single objective-focused
 2112 alternatives helped the co-lead agencies understand which measures the technical teams
 2113 prioritized and understood to be most effective and formed the basis for framing the MO
 2114 process with a manageable suite of measures.

2115 As information was exchanged, redundancies between alternatives and conflicts between
 2116 proposed measures became more clearly understood, leading to refinement of the draft
 2117 alternatives. The MOs were then developed to meet a blend of actions and benefits across
 2118 project authorities.

2119 The single objective-focused alternatives (Table 2-11) are summarized in the following sections,
 2120 with additional detail in Appendix A, *Alternatives Development*.

2121 **Table 2-11. List of Draft Single Objective-Focused Alternatives**

Single Objective Alternatives
Spill to 125% TDG with Extended Duration
Juvenile Anadromous Fish Survival
Adult Anadromous Fish Survival
ESA-Listed Resident Fish Survival
Hydropower Generation
Water Management
Water Supply
Lower Snake River Dam Breach

2122 **2.5.1 Single Objective Focus Alternative for Increased Spill to 125 Percent TDG with**
 2123 **Extended Duration**

2124 The Single Focus Alternative for Increased Spill to 125 Percent TDG with Extended Duration was
 2125 not an objective-focused alternative. Rather, it was developed based on scoping comments
 2126 specifically requesting analysis of an increased juvenile fish passage spill target level. This
 2127 alternative is comprised of two operational measures but has no associated structural
 2128 measures. The first operational measure involves increasing the proportion of flow released
 2129 over the spillway (referred to as “spill”), relative to the No Action Alternative, at the lower

2130 Snake and lower Columbia River dams. Juvenile fish passage spill levels would be increased to a
2131 target not to exceed 125 percent TDG, as measured in the tailrace of each project. The second
2132 operational measure to cease summer transportation was added because flows associated with
2133 this level of spill results in very few fish entering the fish collection facilities at the Lower
2134 Granite, Little Goose, and Lower Monumental Projects. The Single Focus Alternative for
2135 Increased Spill to 125 Percent TDG with Extended Duration was intended to benefit juvenile fish
2136 migration during the March 1 to August 31 timeframe each year.

2137 This alternative was refined and became part of MO4 for analysis.

2138 **2.5.2 Single Objective Focus Juvenile Anadromous Fish Survival Alternative**

2139 The Single Objective Focus Juvenile Anadromous Fish Survival Alternative was designed to
2140 maximize juvenile salmonid survival through the CRS by prioritizing juvenile-focused actions
2141 above some of the other congressionally authorized project purposes and above other
2142 salmonid life stages. Although juvenile anadromous fish do not experience the CRS separately
2143 from their adult counterparts, this alternative emphasizes how actions to benefit the survival of
2144 juvenile salmonids affects both the adult life stage and other co-lead agency missions (e.g.,
2145 FRM, hydropower production, and water quality).

2146 The measures from this alternative were refined and became part of the MOs.

2147 **2.5.3 Single Objective Focus Adult Anadromous Fish Survival Alternative**

2148 The Single Objective Focus Adult Anadromous Fish Survival Alternative contains a mix of
2149 structural and operational measures intended to improve the migration and survival of
2150 anadromous adult steelhead and salmon. Structural measures are focused on improving
2151 conditions for adult salmon migrating upstream through the fish ladders. Under this alternative,
2152 the adult fish trap and bypass loop at Lower Granite Dam would be modified to shorten the
2153 time it takes an adult salmon to travel through the bypass. Pumps would be installed at Lower
2154 Monumental and Ice Harbor Dams to provide cooling water for the fish ladders. The
2155 Washington shore and Bradford Island fish ladders at Bonneville Dam would be modified to a
2156 vertical slot fishway to reduce upstream travel times for adult salmon and steelhead. In
2157 addition, the alternative includes a measure to transport all juvenile salmonids from the
2158 collector projects, which includes Lower Granite, Little Goose, Lower Monumental, and McNary
2159 Dams. Juvenile salmonids collected at these projects would be transported downstream via
2160 barge or truck for release below Bonneville Project. Spill would be reduced to provide only fish
2161 attraction spill and spill for steelhead overshoots, overwintering steelhead, and downstream
2162 passage for kelt.

2163 The majority of measures from this alternative were refined and became part of the MOs.

2164 **2.5.4 Single Objective Focus ESA-Listed Resident Fish Survival Alternative**

2165 The Single Objective Focus ESA-Listed Resident Fish Survival Alternative was intended to
2166 improve river and reservoir habitat conditions for the two ESA-listed resident fish in the
2167 Columbia River Basin, bull trout and Kootenai River white sturgeon, through improving water
2168 temperature management, creating conditions for higher reservoir productivity during the
2169 summer months, and improving the likelihood of releasing instream flow objectives for resident
2170 fish in the CRS. This alternative focused on the upper Columbia River dams and did not include
2171 changes to the lower Columbia or Snake River operations. The Single Objective Focus ESA-Listed
2172 Resident Fish Survival Alternative emphasized the survival of resident fish juveniles and adults
2173 in CRS reservoirs through measures developed for improving condition for spawning, egg-
2174 hatching success, and food resource availability.

2175 The measures from this alternative were refined and became part of the MOs.

2176 **2.5.5 Single Objective Focus on Hydropower Generation Alternative**

2177 The Single Objective Focus on Hydropower Generation Alternative describes action that would
2178 maximize hydropower generation at CRS projects. The proposed measures would create
2179 circumstances similar to conditions that existed prior to implementation of the Northwest
2180 Power Act and actions implemented for BiOps and other agreements. Restrictions on ramping
2181 rates, turbine operating ranges, reservoir operating ranges, and similar measures have reduced
2182 the flexibility needed for enough hydropower generation to serve hourly, daily, and seasonal
2183 power demands. The Single Objective Focus on Hydropower Generation Alternative includes
2184 relaxing current restrictions on operating ranges and ramping rates found in the No Action
2185 Alternative in order to evaluate the potential to increase hydropower production efficiency and
2186 increase flexibility to respond to changing power demands. This alternative does not provide
2187 spill for juvenile fish passage.

2188 Most of the measures from this alternative were modified or refined and became part of the
2189 MOs. The majority of the measures became part of MO2.

2190 **2.5.6 Single Objective Focus Water Management Alternative**

2191 The Single Objective Focus Water Management Alternative would provide water managers with
2192 the increased flexibility to react to unanticipated changes in river flow and forecast runoff
2193 volume, as well as prepare for the operational constraints of implementing ongoing
2194 maintenance at Grand Coulee Project. This alternative does not include any structural measures
2195 or operational changes to the lower Columbia and Snake River dams. The operational measures
2196 at Grand Coulee, Libby, Hungry Horse, and Dworshak Projects included in this alternative are
2197 intended to update FRM and improve the likelihood of achieving storage project refill. This, in
2198 turn, would provide downstream flow augmentation and recreational benefits, faster turnover
2199 of the Libby reservoir to support downstream nutrient delivery, and better management of
2200 outflow temperature during Kootenai River white sturgeon spawning.

2201 As storage reservoirs are drafted for FRM, situations can occur where rapid and large water
2202 releases are required in the March to April timeframe to achieve FRM draft goals (e.g., high
2203 runoff during late winter/early spring or years with rapidly increasing water supply forecasts).
2204 Drafting large volumes in a short timeframe can require increased spill (lack of market/lack of
2205 turbine) to achieve the maximum FRM elevation or a deviation from FRM draft requirements,
2206 which could result in high TDG levels or slight increases in flood risk in a given year. In addition,
2207 heavy rain often results in near-term high runoff that cannot be forecasted in the same way as
2208 longer-term, snowmelt-induced runoff. Water management operating procedures that more
2209 explicitly account for the rain component of runoff would afford greater flexibility and
2210 adaptability in reservoir operations. The Single Objective Focus Water Management Alternative
2211 is expected to maintain the current level of flood risk, meet contractual water supply
2212 obligations, maintain infrastructure to ensure safe and reliable operations, and maintain
2213 commercial navigation.

2214 The measures from this alternative were refined and became part of the MOs.

2215 **2.5.7 Single Objective Focus Water Supply Alternative**

2216 The Single Objective Focus Water Supply Alternative was formulated to assess providing
2217 additional water to authorized, but not yet developed, lands within the Columbia Basin Project
2218 and the Chief Joseph Dam Project. In addition, the alternative assesses delivering 90,000 acre-
2219 feet of water from Hungry Horse Dam for currently undefined use by the Confederated Salish
2220 and Kootenai Tribes. The scope for this alternative is limited to the diversion of water from the
2221 Columbia and South Fork Flathead Rivers and does not describe how that water is used or
2222 where. To clarify, the scope of this alternative as related to the Columbia Basin Project is
2223 limited to the diversion of water from Grand Coulee's Lake Roosevelt into Banks Lake using the
2224 John W. Keys Pumping Plant and does not include pumping that water from Banks Lake to the
2225 additional acres of land.

2226 The Single Objective Focus Water Supply Alternative is focused on upper basin dams and river
2227 segments, including Lake Roosevelt and the Columbia River above Grand Coulee Dam, Hungry
2228 Horse Dam and reservoir on the Flathead River, and Chief Joseph Dam on the Columbia River
2229 and proposes to maintain the No Action Alternative's configuration and general operations.
2230 This alternative was developed with the assumption that there would be a warranted, future
2231 demand to irrigate the remaining authorized acreage within the Columbia River Basin, which
2232 would require delivery of the total authorized volume of water.

2233 The Single Objective Focus Water Supply Alternative included only operational measures. These
2234 measures were focused on water diversion from Grand Coulee's Lake Roosevelt via the John W.
2235 Keys Pumping Plant, delivery of water from Hungry Horse, and diversion of water for the Chief
2236 Joseph Dam Project. At Lake Roosevelt, water diverted to Banks Lake would be increased to
2237 supply an additional 1,154,138 acre-feet of water to irrigate an additional 256,475 acres of land
2238 as authorized under the Columbia Basin Project. Presently, only 772,525 acres have been
2239 developed for delivery. Hungry Horse Reservoir was originally authorized for irrigation but has
2240 never been used for that purpose. The release of 90,000 acre-feet for the Confederated Salish

2241 and Kootenai Tribes could be used for irrigation, municipal and industrial, or in-stream uses.
2242 Since the use of the water is not currently defined, the entire 90,000 acre-feet of water is
2243 assumed to be diverted from the river at Flathead Lake so as to evaluate the most extreme
2244 impact of using this water. Finally, 9,600 acre-feet of water would be diverted from the
2245 Columbia River into the Chief Joseph Dam Project (a Reclamation irrigation project not to be
2246 confused by the Corps' dam of the same name). However, the John W. Keys Pumping Plant
2247 would not be reconfigured under this alternative, because the existing design is capable of
2248 pumping the increased volume proposed. Instead, monthly volumes of diversion flow from Lake
2249 Roosevelt would be reshaped to prevent substantial drafting of Banks Lake as an operational
2250 measure.

2251 The measures from this alternative were refined and became part of MO1, MO3, and MO4.

2252 **2.5.8 Single Objective Focus Lower Snake River Dam Breaching Alternative**

2253 The Single Objective Focus Lower Snake River Dam Breaching Alternative was not an objective-
2254 focused alternative. It was developed based on formal scoping comments specifically
2255 requesting analysis of this action. The hypothesis for this alternative was that habitat conditions
2256 for 4 of the 13 listed anadromous species in the Columbia River Basin could potentially be
2257 restored. The alternative proposed breaching the four lower Snake River dams (Lower Granite,
2258 Little Goose, Lower Monumental, and Ice Harbor) by removing the earthen embankments at
2259 each location. The reservoirs behind the dams would be drawn down slowly to avoid damage to
2260 adjacent infrastructure (e.g., roads, bridges, and railroads) and ensure life safety of
2261 downstream populations. The concrete portions of the dams would remain in place, but the
2262 powerhouses would be mothballed. The generators would be modified for use as outlets during
2263 a controlled reservoir drawdown. The breaching would occur over a 2-year period, with the two
2264 upstream dams (Lower Granite and Little Goose) breached first and followed the next year by
2265 Lower Monumental and Ice Harbor. Spreading the breaching over 2 years allows the work to
2266 occur during the in-water work window, when very few ESA-listed fish are present in the
2267 reservoirs and inflows are relatively small.

2268 This alternative was refined and included in MO3 for analysis in this EIS.

2269 **2.5.9 Multiple Objective Alternative Crosswalk**

2270 Table 2-12 represents how the measures of the Single Objective Focus Alternatives were
2271 distributed in the MOs.

2272 **Table 2-12. Multiple Objective Alternative Crosswalk**

CRSO Measure Name	Spill to 125% TDG	Juvenile Anadrom. Focus	Adult Anadromous Focus	Resident Fish Focus	Hydropower Focus	Water Management	Water Supply Focus	LSR Dam Breach Focus	MO1	MO2	MO3	MO4	Measure source from Alternatives
Structural Measures													
Additional Powerhouse Surface Passage	-	Juv	-	-	-	-	-	-	Juv	Juv	Juv	Juv	Juvenile
Upgrade to Adjustable Spillway Weirs	-	Juv	-	-	-	-	-	-	Juv	Juv	Juv	-	Juvenile
Lower Granite Trap Modifications	-	-	Adu	-	-	-	-	-	Adu	-	-	Adu	Adult
Modify Bonneville Ladder Serpentine Weir	-	-	Adu	-	-	-	-	-	Adu	-	Adu	-	Adult
Lower Snake Ladder Pumps	-	-	Adu	-	-	-	-	-	Adu	Adu	-	Adu	Adult
Spillway Weir Notch Inserts	-	-	-	-	-	-	-	-	-	-	-	X	MO4
Fewer Fish Screens	-	-	-	-	Hyd	-	-	-	-	Hyd	Hyd	-	Hydropower
Improved Fish Passage Turbines	-	-	-	-	-	-	-	-	X	X	X	X	MO1,2,3,4
Lamprey Passage Structures	-	-	-	-	-	-	-	-	X	X	X	X	MO1,2,3,4
Turbine Strainer Lamprey Exclusion	-	-	-	-	-	-	-	-	X	X	X	X	MO1,2,3,4
Bypass Screen Modifications for Lamprey	-	-	-	-	-	-	-	-	X	X	X	X	MO1,2,3,4
Lamprey Passage Ladder Modifications	-	-	-	-	-	-	-	-	X	X	X	X	MO1,2,3,4

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CRSO Measure Name	Spill to 125% TDG	Juvenile Anadrom. Focus	Adult Anadromous Focus	Resident Fish Focus	Hydropower Focus	Water Management	Water Supply Focus	LSR Dam Breach Focus	MO1	MO2	MO3	MO4	Measure source from Alternatives
<i>Dam Breach</i>													
Breach Snake Embankments	-	-	-	-	-	-	-	LSR	-	-	LSR	-	LSR Breach
Lower Snake Infrastructure Drawdown	-	-	-	-	-	-	-	LSR	-	-	LSR	-	LSR Breach
Operational Measures													
<i>Dam Breach</i>													
Drawdown Operating Procedures	-	-	-	-	-	-	-	LSR	-	-	LSR	-	LSR Breach
Drawdown Contingency Plans	-	-	-	-	-	-	-	LSR	-	-	LSR	-	LSR Breach
<i>Fish Passage</i>													
Block Spill Test (Base + 120/115%)	-	-	-	-	-	-	-	-	X	-	-	-	MO1
Summer Spill Stop Trigger	-	-	-	-	-	-	-	-	X	-	-	-	MO1
Early Start Transport	-	-	-	-	-	-	-	-	X	-	-	-	MO1
Contingency Reserves Within Juvenile Fish Passage Spill	-	-	-	-	-	-	-	-	X	X	X	X	MO1,2,3,4
Spill to 110% TDG	-	-	-	-	-	-	-	-	-	X	-	-	MO2
Spring & Fall Transport	-	-	-	-	-	-	-	-	-	-	-	X	MO4
No Summer Transport	-	-	-	-	-	-	-	-	-	-	-	X	MO4
Reduced Summer Spill	-	-	-	-	-	-	-	-	-	-	X	-	MO3
Spill to 125% TDG	125	-	-	-	-	-	-	-	-	-	-	125	125%
Spring Spill to 120% TDG	-	Juv	-	-	-	-	-	-	-	-	Juv	-	Juvenile
Spill for Adult Steelhead	-	-	Adu	-	-	-	-	-	-	-	-	Adu	Adult

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CRSO Measure Name	Spill to 125% TDG	Juvenile Anadrom. Focus	Adult Anadromous Focus	Resident Fish Focus	Hydropower Focus	Water Management	Water Supply Focus	LSR Dam Breach Focus	MO1	MO2	MO3	MO4	Measure source from Alternatives
Increase Juvenile Fish Transportation	-	-	Adu	-	-	-	-	-	-	Adu	-	-	Adult
<i>Water Management</i>													
Modified Draft at Libby	-	-	-	-	-	WM	-	-	WM	WM	WM	WM	Water Mgmt
December Libby Target Elevation	-	-	-	Res	-	WM	-	-	WM	WM	WM	WM	Water Mgmt
Update System FRM Calculation	-	-	-	-	-	WM	-	-	WM	WM	WM	WM	Water Mgmt
Planned Draft Rate at Grand Coulee	-	-	-	-	-	WM	-	-	WM	WM	WM	WM	Water Mgmt
Grand Coulee Maintenance Operations	-	-	-	-	-	WM	-	-	WM	WM	WM	WM	Water Mgmt
Winter System FRM Space	-	-	-	-	-	WM	-	-	WM	WM	-	WM	Water Mgmt
<i>Water Supply</i>													
Lake Roosevelt Additional Water Supply	-	-	-	-	-	-	WS	-	WS	-	WS	WS	Water Supply
Hungry Horse Additional Water Supply	-	-	-	-	-	-	WS	-	WS	-	WS	WS	Water Supply
Chief Joseph Dam Project Add'l Water Supply	-	-	-	-	-	-	WS	-	WS	-	WS	WS	Water Supply
<i>Hydropower</i>													
Increased Forebay Range Flexibility	-	-	-	-	Hyd	-	-	-	Hyd	-	-	-	Hydropower
Slightly Deeper Draft for Hydropower	-	-	-	-	Hyd	-	-	-	-	Hyd	-	-	Hydropower

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Ramping Rates for Safety	-	-	-	-	Hyd	-	-	-	-	Hyd	Hyd	-	Hydropower
John Day Full Pool	-	-	-	-	Hyd	-	-	-	-	Hyd	Hyd	-	Hydropower
Full Range Reservoir Operations	-	-	-	-	Hyd	-	-	-	-	Hyd	-	-	Hydropower
Full Range Turbine Operations	-	-	-	-	Hyd	-	-	-	-	Hyd	-	-	Hydropower
Above 1% Turbine Operations	-	-	-	-	Hyd	-	-	-	-	-	Hyd	Hyd	Hydropower
Zero Generation Operations	-	-	-	-	Hyd	-	-	-	-	Hyd	-	-	Hydropower
<i>Other Operational Measures</i>													
McNary Flow Target	-	Juv	-	-	-	-	-	-	-	-	-	Juv	Juvenile
Drawdown to MOP	-	Juv	-	-	-	-	-	-	-	-	-	Juv	Juvenile
Predator Disruption Operations	-	Juv	-	-	-	-	-	-	Juv	-	-	-	Juvenile
Modified Dworshak Summer Draft	-	-	Adu	-	-	-	-	-	Adu	-	-	-	Adult
Sliding Scale at Libby and Hungry Horse	-	-	-	Res	-	-	-	-	Res	Res	Res	Res	Resident
Winter Stage for Riparian	-	-	-	Res	-	-	-	-	-	-	-	Res	Resident

2273 Note: -- = not applicable; LSR = lower Snake River.

2274

2275 **2.5.10 Other Proposals and Measures Considered but Removed from Further Consideration**

2276 Within this EIS, other proposals and measures were considered but removed from
2277 consideration early in the alternative development process. These measures were removed
2278 from further consideration for several reasons: because they had been previously studied or
2279 considered and found to be ineffective; because the measures were already being examined
2280 under a separate NEPA effort; or because they were outside of the scope of this EIS. Examples
2281 and brief rationale of specific measures considered but removed from further consideration
2282 include:

- 2283 • Reintroduction of salmon above Grand Coulee Dam and installation of fish passage at Grand
2284 Coulee and Chief Joseph Dams. Reintroduction is an important and complex, large-scale
2285 concept. Its consideration, evaluation, and implementation should involve multiple tribal,
2286 federal, state, and other entities. A coordinated approach among water users, tribes, states,
2287 multiple federal agencies, and others would be necessary. To allow so many differing
2288 interests to coordinate on such a complex topic, which may include international
2289 considerations, a decision-making framework and a series of regional workshops would be
2290 necessary just to approach the first step of defining reintroduction objectives. Given the
2291 incompatibility of such a wildlife management decision-making framework with an analysis
2292 of the operation of the CRS, it is not feasible to proceed with a detailed consideration of
2293 reintroduction in this EIS. Moreover, to meaningfully analyze reintroduction as a measure,
2294 the details of the proposal would need to be understood well enough to include in
2295 hydrologic, water quality, and fish models. That information is not presently available, and
2296 development of those details was not possible in the timeframe of this NEPA process.
2297 Nevertheless, the agencies and interested regional sovereigns are developing a framework
2298 to address critical information gaps.
- 2299 • Creation of “natural rivers” to mimic pre-dam construction conditions, which was previously
2300 studied and found to be infeasible. The co-lead agencies concluded that breaching all 14
2301 dams would be unreasonable for several reasons, including that this action would either
2302 preclude or significantly alter the co-lead agencies’ ability to meet their congressionally
2303 authorized purposes in the system and it would likely result in significant human health and
2304 safety concerns. In addition, the co-lead agencies have no existing data for breaching the
2305 remaining dams such that completion of necessary analysis would take years to gather data
2306 and develop a model.
- 2307 • A comprehensive FRM study for the Columbia River Basin. The scope of analysis of this EIS is
2308 limited to analyzing those measures that are part of the water management operations,
2309 associated maintenance, and structural configuration of the 14 Federal dam and reservoir
2310 projects. The Purpose and Need Statement includes a necessary constraint on the
2311 alternatives development to provide for a reliable level of flood risk by operating the
2312 Columbia River System to afford safeguards for public safety, infrastructure, and property.
2313 This screened out re-evaluating system flood risk management from further consideration
2314 in this EIS. However, FRM is an authorized project purpose and is assessed for each
2315 alternative in this EIS. Interest from states and tribes in a process to assess potential

2316 changes to the current level of flood risk protection was identified during the Columbia
2317 River Treaty (CRT) Sovereign Review Process completed in December 2013. The Regional
2318 Recommendation stated that the Pacific Northwest states and tribes support the pursuit of
2319 Congressional authorization and appropriations for a region-wide public process to assess
2320 potential changes to the current level of flood risk protection in the Columbia River Basin to
2321 enhance spring and summer flows. However, no such authorization or appropriation was
2322 provided and, as such, a study for this purpose was determined to be outside of the scope
2323 of this EIS.

2324 • The Columbia Basin spans the United States and Canada. The Columbia River's flow at the
2325 U.S.-Canada border is affected in part by how the Columbia River Treaty operations in
2326 Canada are managed. The 2016 CRT-related operations, were applied in the EIS analysis, as
2327 the best-available information. If CRT-related operations change in a manner that presents
2328 new information or circumstances resulting in significant changes that were not previously
2329 addressed, those changes will be addressed by this NEPA process if they are identified in
2330 time or subsequently in another NEPA process, if necessary.