RECLAMATION

Managing Water in the West

Reclamation's Implementation Measures for Operating Deadwood Dam – Addressing Terms and Conditions from U.S. Fish and Wildlife Service 2005 Biological Opinion for Operation and Maintenance of the Bureau of Reclamation Projects in the Snake River Basin above Brownlee Reservoir

U.S. Department of the Interior
Bureau of Reclamation
Pacific Northwest Region
Snake River Area Office
Boise, Idaho

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U.S. DEPARTMENT OF THE INTERIOR

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MISSION OF THE BUREAU OF RECLAMATION

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

Acknowledgements: Special thanks to Allyn Meuleman for her contributions on the holistic study approach and guidance to the team throughout the Flexibility Study.

Cover Image: Deadwood Reservoir, Deadwood Dam with water releases over the spillway, and Deadwood River downstream of the dam.

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ACRONYMS AND ABBREVIATIONS

2005 Opinion	U.S. Fish and Wildlife Service 2005 Biological Opinion for *Bureau of Reclamation Operations and Maintenance in the Snake River Basin above Brownlee Reservoir*
2014 Opinion	U.S. Fish and Wildlife Service 2014 Biological Opinion for *Bureau of Reclamation Operations and Maintenance in the Snake River Basin above Brownlee Reservoir*
Assessment	Biological Assessment
Benefits	Actions that improve known levels of incidental take
CFR	Code of Federal Regulations
cfs	cubic feet per second
DO	dissolved oxygen
ESA	Endangered Species Act
Flexibility Study	Final Deadwood Reservoir Operations Flexibility Evaluation
FMO	Foraging/Migration/Overwintering
FR	Federal Register
IM	Reclamation's implementation measures for operational changes for Deadwood Dam to address Terms and Conditions from the USFWS 2005 Biological Opinion for Bull Trout
km	kilometer
NOAA Fisheries	National Oceanic and Atmospheric Administration National Marine Fisheries Service
O&M	operation and maintenance
Opinion	Biological Opinion
PCE	Primary Constituent Elements
Reclamation	U.S. Bureau of Reclamation
SOP	Standing Operating Procedure
USFWS	U.S. Fish and Wildlife Service

1 INTRODUCTION

This document is an addendum to the U.S. Bureau of Reclamation's (Reclamation) 2004 Upper Snake Biological Assessment (2004 Assessment) and its 2004 Operation Description of Bureau of Reclamation Projects in the Snake River Above Brownlee Reservoir (2004 Operation Description). Both the 2004 Assessment and the 2004 Operation Description are cited in this document and should be referenced for more details, as needed (Reclamation 2004a and Reclamation 2004b, respectively). The purpose of this addendum is to present Reclamation's implementation measures (IMs) for operational changes for Deadwood Dam to meet the terms and conditions of the U.S. Fish and Wildlife Service's (USFWS) 2005 *Biological Opinion for Bureau of Reclamation Operations and Maintenance in the Snake River Basin above Brownlee Reservoir* for bull trout (2005 Opinion). This addendum also presents IMs to meet the conservation recommendations in the USFWS's 2014 *Biological Opinion for Bureau of Reclamation Operations and Maintenance in the Snake River Basin above Brownlee Reservoir* focused on bull trout critical habitat (2014 Opinion) (USFWS 2005 and USFWS 2014, respectively).

Reclamation conducted a study reported in the *Final Deadwood Reservoir Operations Flexibility Evaluation* (Flexibility Study) to address terms and conditions from the 2005 Opinion for the operations of Deadwood Dam (Reclamation 2016 revised). The Flexibility Study was conducted from 2006 to 2015 and represents the most recent and comprehensive analysis of the effects of operations at Deadwood Dam on bull trout and their habitat. The Flexibility Study was a multi-disciplinary and multi-agency project. The study evaluated the use of different flows, ramping rates, and the spillway to benefit bull trout and bull trout critical habitat in the following six areas:

- Reservoir productivity
- River productivity
- Bull trout behavior in the reservoir
- Bull trout behavior in the river
- Bull trout biomass in the reservoir
- Bull trout biomass in the river

The study examined operational flexibility to minimize incidental take[1] and balance benefits to bull trout and bull trout critical habitat in both the reservoir and river. Beneficial effects (benefits) refer to actions that improve known levels of incidental take. A summary of the Flexibility Study is presented in Chapter 3 of this document.

[1] "Incidental Take refers to takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency . . . ." 50 C.F.R. § 402.02.. Incidental take is not prohibited if it complies with the terms and conditions specified in an incidental take statement (16 U.S.C. § 1536(o)(2)).

Data resulting from the Flexibility Study, along with other available data from site-specific monitoring and investigative studies, was used to develop Reclamation's IMs provided in this document. The IMs are anticipated to provide benefits to baseline conditions that have been described for both bull trout and bull trout critical habitat (Reclamation 2004a and Reclamation 2013), while balancing interactions between the reservoir and river. Reclamation's four IMs for managing Deadwood Dam operations are outlined below. A full description of the IMs and their effects on bull trout and bull trout critical habitat can be found in Chapter 4.

Spring Ramp Up

Follow existing Standing Operating Procedures (SOPs) and operate within flood control requirements. When spill occurs, modulate water temperature in the river using a combination of discharge from outlet valves and spillway.

Fall Ramp Down

Follow existing SOPs to complete ramp down over a period of 24 to 48 hours with hourly flow adjustments made from dusk until dawn.

Non-irrigation Season Stable Discharge Flows

For the period between completion of irrigation flows to the start of spring ramp up, limit releases to 2.3 cubic feet per second (i.e., only outflow from the hydropower generator). Ramp up is associated with increased runoff and is weather dependent. Natural flow increase due to snow melt generally occurs in the "spring," but conditions that cause discharge to increase from the non-irrigation season stable discharge could occur at any time.

Discretionary Spill

Use discretionary spill when reservoir conditions allow. Modulate river water temperature using a combination of discharge from the outlet valves and spillway.

The IMs relate to each of the 2005 Opinion terms and conditions as follows:

1. Ramp up in the spring (Term and Condition (T&C) 3.c. and 3.d.)
2. Ramp down in the fall (T&C 3.c.)
3. Non-irrigation season stable flows (T&C 3.a. and 3.b.)
4. Discretionary spill (T&C 3.e.)

The IMs work in unison to address the terms and conditions of the 2005 Opinion. It is important to note that, due to the interrelated nature of effects from each separate dam operation, developing holistic operating IMs to address multiple terms and conditions and effects to bull trout critical habitat Primary Constituent Elements (PCEs)[2] is complex. For example, winter discharge (T&C 3.a.) will influence conditions in the river throughout the winter, but may also

[2] Since completion of the 2014 bull trout critical habitat consultation, reference to Primary Constituent Elements has been changed to Principle and Biological Features (PBF). However, for continuity with the 2014 biological opinion, reference to PCEs is used in this document.

allow operational flexibility that could affect reservoir elevations (T&C 3.d.), use of the spillway (T&C 3.e.), and water temperature in the river downstream of the dam (T&C 3.b.). Maximizing beneficial effects for bull trout in the Deadwood River Basin involves recognizing the interaction between individual operations and balancing operational flexibility between all IMs rather than focusing on individual terms and conditions.

Figure 1-1 graphically shows the complex, interrelated nature of effects from each separate dam operation. It speaks to the relationship between Reclamation's IMs, the 2005 Opinion terms and conditions, and bull trout critical habitat PCEs. PCEs are identified habitat features that are essential to the conservation of the species (USFWS and NOAA 1998). Note that this figure is not meant to be a comprehensive depiction, but rather to demonstrate the complexity of interactions considered in the development of individual IMs that collectively frame Reclamation's holistic operational approach.

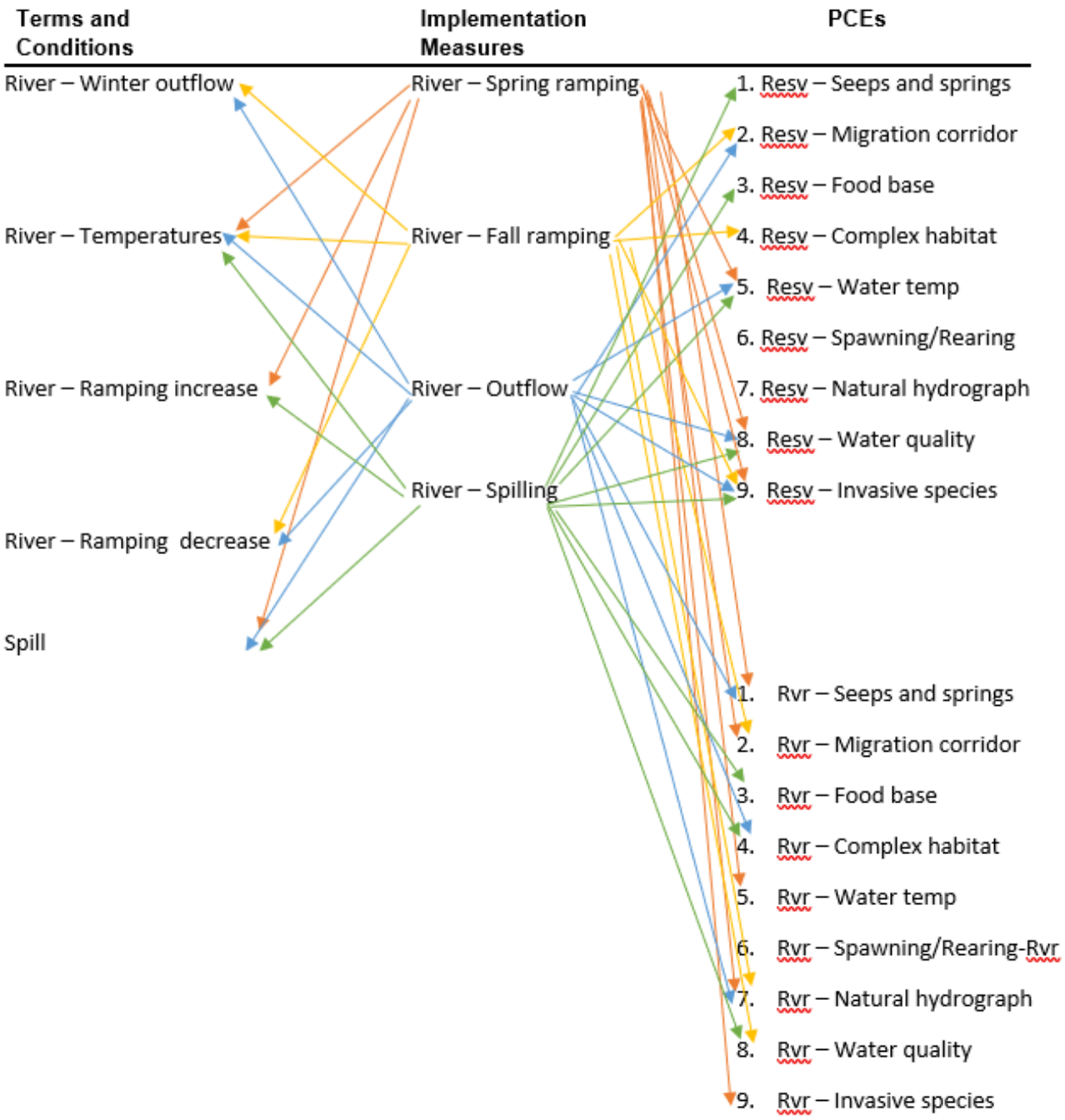

Figure 1-1. Relationship between Reclamation's IMs, the 2005 Opinion terms and conditions, and bull trout critical habitat Primary Constituent Elements (PCEs).

Arrows link each IM (center column) to specific terms and conditions that are addressed by the respective IM (at left) and the PCEs affected (at right). The effect of these relationships on bull trout critical habitat is labeled for reservoir and river.

Note: PCEs for the Reservoir (Resv) are not present for Spawning/Rearing and Natural Hydrograph and PCEs for the River (Rvr) are not present for Spawning/Rearing (Reclamation 2013); therefore, no interactions of these PCEs are depicted in Figure 1-1. Terms and Conditions and PCEs for the South Fork Payette or Boise Project are not listed because there are insignificant or no effects, respectively, caused by the IMs.

Reclamation has concluded that the measures recommended in this document will minimize the effect and/or amount of incidental take associated with operation of Deadwood Dam, representing the best operational plan for bull trout. Reclamation's implementation measures include actions that are outside the range or frequency that was analyzed in the 2005 biological opinion. These actions include:

1. Rate of down ramping;
2. Reduced volume of discharge from Deadwood Dam during the stable non-irrigation season; and
3. River water temperature adjustments using spillway discharge.

Reclamation intends to reinitiate formal consultation with respect to those aspects of the implementation measures not fully considered in the 2005 biological opinion. This document will serve as the foundation for an amendment to the biological assessment, which Reclamation will prepare and submit to USFWS as part of its reinitiation package.

1.1 Action Area

The 2005 Opinion analyzed all Reclamation Projects in the Snake River above Brownlee Reservoir. One of the Reclamation Projects analyzed was the Boise Project, made up of the Payette and Arrowrock Divisions. Deadwood Dam, Cascade Dam, and Black Canyon Diversion Dam make up the Payette Division (Reclamation 2004b). In the Payette Division, only the Deadwood watershed includes bull trout and/or bull trout critical habitat that are influenced by the operation of a Reclamation dam. Therefore, the 2005 Opinion analyzed Deadwood Dam separately from other action areas included in the consultation.

The Deadwood Dam effects analysis from the 2014 Opinion includes three river reaches "that may be directly or indirectly affected by [these IMs] and not merely the immediate area involved in the action (USFWS and NOAA 1998)." Each portion of the action area begins at the action's furthest upstream effect (e.g., the uppermost extent of the storage reservoir) and ends at the location of its farthest downstream effect (e.g., confluence with the Middle Fork of the Payette River). The three reaches include the following:

1. Deadwood Reservoir
2. Deadwood River downstream of the dam to the confluence with the South Fork Payette River
3. South Fork Payette River from the confluence with the Deadwood River downstream to the confluence with the Middle Fork of the Payette River (USFWS 2014)

Reclamation's IMs encompass both bull trout and bull trout critical habitat influenced from operation of Deadwood Dam. Therefore, in this document, the action areas from both the 2005 and 2014 Opinions were combined due to the interconnectivity between the two previous consultations. In this document, Reclamation will refer only to this defined Deadwood IMs action area, unless otherwise noted.

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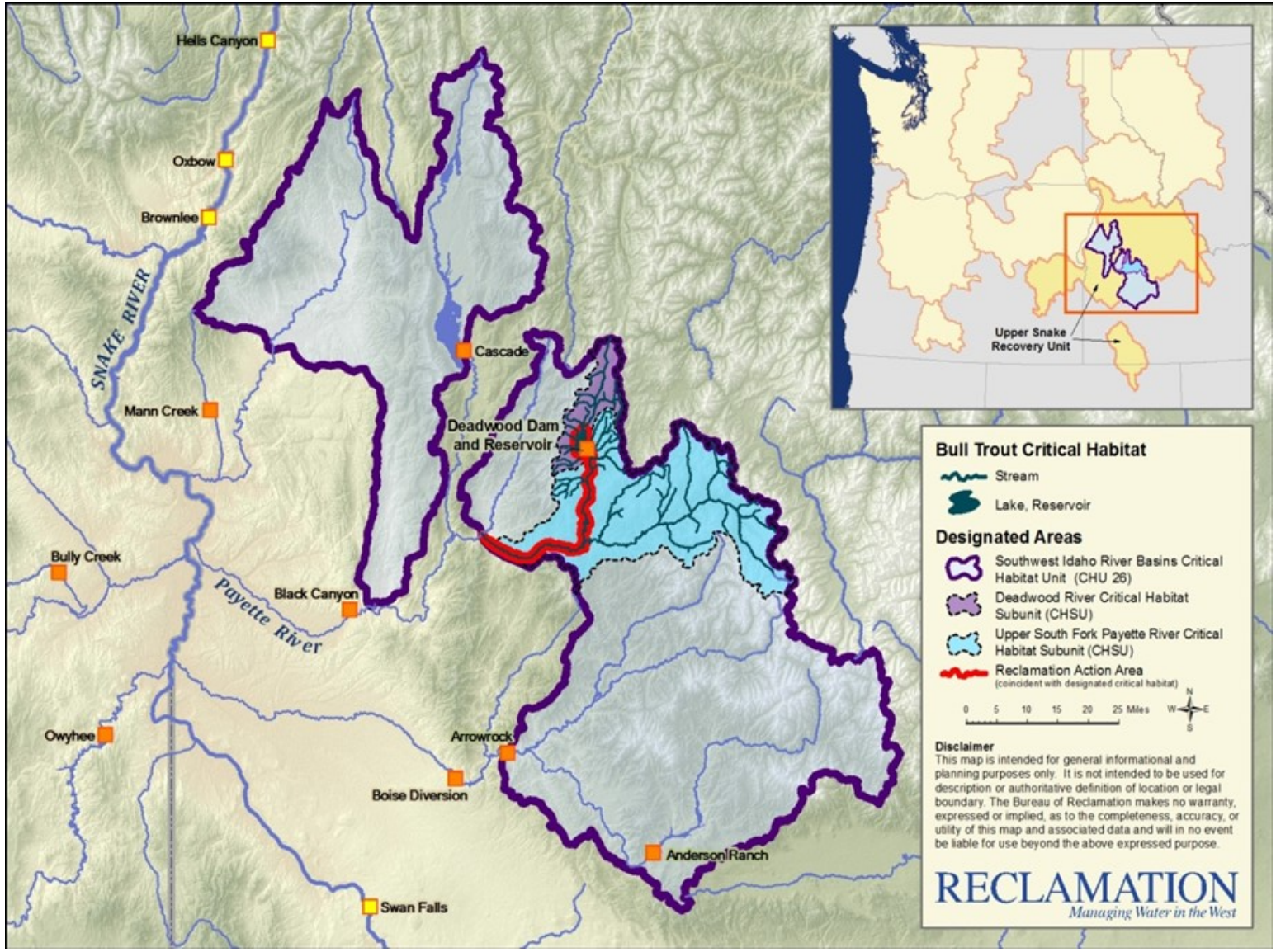

Figure 1-2. Action area analyzed for Reclamation's IMs, highlighted in red. The Southwest Idaho River Basin Critical Habitat Unit 26 boundary is highlighted in purple.

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1.2 Definitions

Two terms used throughout this addendum, discretionary and baseline, are important to meet the purpose of this document and are defined below for clarification.

1.2.1 Discretionary Actions

Discretionary operations are actions that are voluntarily performed, versus non-discretionary operations that are mandated to occur. In this document, the potential range of operations where Reclamation has discretion were investigated in relation to effects to bull trout and bull trout critical habitat. Reclamation conducted this analysis in a holistic, ecosystem-wide approach to fully understand any potential tradeoffs of operational effects between the reservoir and river systems.

For this document, non-discretionary operations are those required by the Endangered Species Act (ESA), flood control, or public safety. For the 2005 Opinion, USFWS used Reclamation's analysis of the range of operations to develop thresholds and operational indicators. USFWS determined that, if Deadwood Dam was managed within the proposed operational indicators, incidental take of bull trout would be minimized.

When consultation is reinitiated, operational indicators will be updated to reflect the beneficial effects resulting from implementation of recommended operations defined in this document. However, the distinction of discretionary and non-discretionary actions is still relevant. Since flood control and public safety actions are considered non-discretionary, they may occur outside the range of the operational indicators. Flood control operations are authorized through U.S. Code Title 33, Chapter II, Part 208, Section 208.10 and specified for each facility through coordination with the U.S. Army Corps of Engineers. During certain conditions, flood control operations require use of the spillway.

1.2.2 Baseline

Baseline conditions are defined in the 2005 Opinion and in Reclamation's bull trout critical habitat Biological Assessment (2013 Assessment) (Reclamation 2013). Operations that are part of the baseline conditions, but are not considered in these IMs, include deep water releases from the reservoir and irrigation releases to fulfill water right deliveries. These conditions are part of the required components of the December 19, 1935 project authorization approved by the President (Reclamation 2004b) and are cost-prohibitive to change.

2 CONSULTATION BACKGROUND

2.1 Overview

In November 2004, Reclamation consulted concurrently with the USFWS and National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NOAA Fisheries) on the effects of operations and maintenance of Reclamation's facilities in the Snake River basin above Brownlee Reservoir (proposed action) under Section 7 of the ESA (Reclamation 2004a). The 2004 Biological Assessment (Assessment) Reclamation submitted to USFWS addressed impacts to bull trout and other resident ESA-listed species present in the project area, but did not explicitly address impacts to bull trout critical habitat as none was designated in the affected area at that time.

Reclamation received a Biological Opinion (Opinion) from USFWS in March 2005 concluding that Reclamation's proposed actions were not likely to jeopardize the continued existence of bull trout (USFWS 2005). The USFWS 2005 Opinion contained reasonable and prudent measures with associated terms and conditions aimed at reducing incidental take of bull trout at Federal facilities in the Boise, Payette, and Malheur river systems. Reclamation also received an Opinion from NOAA Fisheries in March 2005. The NOAA Fisheries 2005 Opinion was superseded by its 2008 ESA Section 7(a)(2) Consultation Opinion (NOAA Fisheries 2008).

In 2007, Reclamation proposed amendments to its 2004 Assessment regarding salmon flow augmentation actions and revised its assessment on impacts to salmon and steelhead and designated critical habitat downstream of Brownlee Dam (Reclamation 2007). These amendments satisfied requirements of a September 2006 U.S. District Court Opinion and Order of Remand. Reclamation concluded that the salmon flow augmentation refinements described in the 2007 Assessment would not cause new effects to ESA-listed resident species not previously considered in the 2005 Opinion. Reclamation provided this conclusion in a letter to USFWS dated September 6, 2007.

In October 2010, *Endangered and Threatened Wildlife and Plants; Revised Designation of Critical Habitat for Bull Trout in the Coterminous United States: Final Rule* was published in the Federal Register by USFWS. This final rule designated bull trout critical habitat. The area designated included portions of the Boise, Payette, Malheur, and Powder Rivers, and the main stems of the Snake and Columbia Rivers. All these rivers are hydrologically influenced in varying degrees by operation of Reclamation facilities in the Snake River above Brownlee Reservoir (USFWS 2014).

Subsequently, Reclamation initiated consultation with the USFWS on bull trout critical habitat (Reclamation 2013). This consultation was completed in June 2014. The USFWS concluded that the operations of Deadwood Dam are not likely to destroy or adversely modify designated critical habitat for bull trout (USFWS 2014). Reclamation's 2013 Assessment and USFWS's corresponding 2014 Opinion are considered companion documents to the 2004 Assessment and

2005 Opinion, which are incorporated by reference and include details not repeated in this document.

2.2 Background Specific to Deadwood Dam

The 2005 Opinion identified reasonable and prudent measures to satisfy compliance with the ESA. The reasonable and prudent measures for Deadwood Dam operations identified that Reclamation is to "implement measures to minimize the effect and/or amount of [incidental] take associated with operation of Deadwood Dam." Components associated with the reasonable and prudent measures include the following and are discussed in more depth in this section:

- Operational Indicators – Operational thresholds that are monitored for compliance with the incidental take statement. If thresholds are exceeded, additional take is determined.
- Terms and Conditions – A requirement of the 2005 Opinion used to minimize impact of incidental take that may occur from the operation of Deadwood Dam.
- Monitoring and Reporting – Guidelines to track population trends, review critical habitat conditions, and report monitoring actions and associated findings.

2.2.1 Operational Indicators

For the 2005 Opinion, USFWS used Reclamation's analysis of the range of operations to develop thresholds and four operational indicators to monitor incidental take. Every year, Reclamation sends a report to USFWS documenting the status of these indicators (Reclamation 2018). These operational indicators are summarized in Table 2-1, which relates to reservoir pool elevation, use of the spillway, and discharge. Table 2-1 identifies the current conditions for Deadwood Dam. Operational indicators and sources of take may be revised during future consultation.

Table 2-1. Operational Indicators and associated incidental take for Deadwood Dam as listed in the 2005 Opinion (USFWS 2005). Relevant citations from the Flexibility Study pertaining to the original terms and conditions can be found in individual chapters of this report.

Incidental Take	Operational Indicators	Critical Season	Percent of Expected Occurrence
Up to 2 to 4 percent of bull trout in Deadwood Reservoir are entrained into the Deadwood River downstream of the dam.	Water discharged over the spillway.	Spring	37% (11 of 30 years)
Up to 2 to 4 percent of bull trout in Deadwood Reservoir are affected by degraded water quality.	Reservoir storage volume falls below 50,000 acre-feet.	August through October	7% (2 of 30 years)

Incidental Take	Operational Indicators	Critical Season	Percent of Expected Occurrence
All bull trout in the Deadwood River downstream of the dam are affected by spillway discharges that disrupt timing of migration and spawning, and that alter metabolic rates.	Water is discharged over the spillway.	May through July	35% (11 of 30 years)
All bull trout in the Deadwood River downstream from the dam are affected by low winter streamflows and temperatures that affect bull trout movement and growth and reproduction of bull trout and the prey base.	Deep water releases at Deadwood Dam and low flows downstream of the dam.	Seasonal effects to water temperature and discharge.	100 percent (30 of 30 years)

2.2.2 Terms and Conditions

The operations of Deadwood Dam have five terms and conditions from the 2005 Opinion that were developed to minimize incidental take that could occur from operation of the facility. These five terms and conditions are cited below and followed by a brief description of the effects encompassed by each Term and Condition and Reclamation's approach at that time.

Term and Condition 3.a. – "Determine whether there is flexibility within the action as proposed to operate Deadwood Dam to reduce the effects to bull trout when winter streamflows in the Deadwood River below Deadwood Dam are less than inflows to Deadwood Reservoir upstream. Cooperate with the Service [USFWS] to identify and implement any actions that can be taken to facilitate winter flows that more closely approximate reservoir inflows to reduce effects to bull trout."

Since 1994, Reclamation has targeted a winter non-irrigation season stable discharge of 50 cubic feet per second (cfs) from Deadwood Dam. The estimated unregulated inflow (daily average) to the reservoir often drops below 50 cfs and Reclamation has documented it as low as 45 cfs on a monthly average. The median of monthly average inflows between 1994 and 2016 for October through February ranges from 70 to 80 cfs. The variability of season inflows suggests that a non-irrigation season stable discharge of 50 cfs is not limiting bull trout critical habitat in the Deadwood River downstream of the dam (USFWS 2014).

Reclamation has taken the following actions to address Term and Condition 3.a.:

Identify a winter discharge that provides benefits to bull trout and minimizes adverse effects to bull trout critical habitat (see Section 4.3). Next, consider the effects of winter discharges cumulatively with other IMs to provide a benefit to both bull trout and bull trout critical habitat holistically (see Figure 1-1) within the action area.

Term and Condition 3.b. – "Determine whether there is flexibility within the action as proposed to operate Deadwood Dam to reduce harm and harassment of bull trout associated with extreme low temperatures in the river below the dam. Cooperate with the Service [USFWS] to identify and implement any actions that can be taken to increase water temperatures from their present range of 3 to 7°C to a range that better supports an adequate and diverse prey base for bull trout."

Reclamation's Flexibility Study (Reclamation 2016 revised) provided a better understanding of the influence discharge has on water temperature and the influence of water temperature on the aquatic life downstream of Deadwood Dam (Reclamation 2016 revised, Chapter 3). Reclamation documented the range of water temperatures with current operations to be much wider than previously thought (Reclamation 2016 revised, Chapter 5). Documentation shows that a single change to timing and volume of discharge can affect downstream water temperatures for several seasons (Reclamation 2016 revised, Chapter 2).

Deadwood River water temperatures are heavily influenced by water conditions in the lower water layer of the reservoir. During the winter, water at its maximum density (4°C) is found in this lower water layer and is typically released through the outlet valves directly into the river. Reservoir discharge remains at 4°C until the 4°C water is depleted, typically in February or March, at which time the remaining water throughout the reservoir mixes. As the reservoir fills and surface temperatures increase, the coldest water again fills the deepest portion of the reservoir. During the summer, the coldest water in the reservoir occupies the deepest water layer and is discharged until it is either all released, or the reservoir naturally cools again in the fall. The rate of fall refill and spring spill have a strong influence on the interactions between the upper and lower water layers and the temperatures of the water discharged into the river (Reclamation 2016 revised, Chapter 2).

Reclamation has taken the following actions to address Term and Condition 3.b.:

Identify operations that can provide water temperatures in the river downstream of the dam that more closely resemble unregulated conditions (see Sections 4.2, 4.3 and 4.4). Next, consider the effects of these operations cumulatively with other IMs to provide a benefit to both bull trout and bull trout critical habitat holistically within the action area (Figure 1-1).

Term and Condition 3.c. – "Determine and implement ramping rates for both increases and decreases of flow that reduce harassment and harm of bull trout in the Deadwood River below Deadwood Dam. Cooperate with the Service [USFWS] to develop a strategy for ramping rates associated with the action as proposed."

Ramping rates follow Reclamation's SOPs for each facility (Reclamation 2004b) and account for safe operating limits of the equipment, flood control requirements and public safety. Recent studies have examined the effects of ramping rates on aquatic life in both the reservoir and downstream river (Reclamation 2016 revised, Chapter 4.2 pages 45 and 54).

Reclamation has taken the following actions to address Term and Condition 3.c.:

Identify ramping rates that minimize incidental take of bull trout and protect bull trout critical habitat (Sections 4.1 and 4.2). Next, consider the effects of these operations cumulatively with other IMs to provide a benefit to both bull trout and bull trout critical habitat holistically within the action area (Figure 1-1).

Term and Condition 3.d. – "Determine whether there is flexibility within the action as proposed to manage flows from Deadwood Dam particularly during the spring, to minimize take (harassment) associated with disruption of bull trout biological processes, particularly migratory cues. Cooperate with the Service [USFWS] to identify and implement any actions that can be taken to associate with this term and condition."

The regulated hydrograph of the Deadwood River is significantly altered from the unregulated flow regime (Reclamation 2013). This is due to reductions of normal spring runoff and storage of water that is discharged in the summer months for irrigation demand (Reclamation 2016 revised, Section 3.1.1, pages 4-5). The managed hydrograph at Deadwood Dam has been part of the baseline since the completion of construction in 1931.

Reclamation has taken the following actions to address Term and Condition 3.d.:

Identify operations that are most likely to minimize disturbance to the biological processes of bull trout (Sections 4.1 to 4.4). Next, consider the effects of those operations cumulatively with other IMs to provide a benefit to both bull trout and bull trout critical habitat holistically within the action area (Figure 1-1).

Term and Condition 3.e. – "Minimize the frequency, duration, and extent of discharge of water over the spillway at Deadwood Dam to avoid and reduce the effects of entraining bull trout. If, in implementing actions for terms and conditions 3a through 3d, the risk of entrainment changes, coordinate with the Service [USFWS] to determine the feasibility of this term and condition."

The spillway at Deadwood Dam is an open design. When the pool elevation reaches the crest of the spillway, water flows over the spillway. Adjusting discharge through the outlet valves can limit the probability of spillway use; however, during high water conditions, water flowing over the spillway cannot be avoided. Water vacated from the reservoir over the spillway is warmer than water discharged through the outlet valves. However, the volume of water discharged from the outlet valves can be adjusted, which allows for discharge from the two sources to be mixed to provide water temperatures in the river that more closely follow unregulated conditions.

Reclamation has taken the following actions to address Term and Condition 3.e.:

Identify operations that minimize the risk of bull trout entrainment (i.e., fish being displaced from the reservoir thorough either the spillway or outlet works) (Section 4.4.1.2).

Next, consider the effects of those operations cumulatively with other IMs to provide a benefit to both bull trout and bull trout critical habitat holistically within the action area (Figure 1-1).

2.2.3 Monitoring and Reporting

Monitoring

General guidelines for future monitoring of bull trout and bull trout critical habitat in the action area are identified in Chapter 6 of this document and will supersede previous monitoring defined in Reclamation's 2006 Monitoring and Implementation Plan (Reclamation 2006). Specific details for monitoring will be defined in a forthcoming Monitoring Study Plan that will be developed prior to implementation of the actions (expected implementation fall of 2020). As outlined in Reclamation's 2006 Monitoring and Implementation Plan, monitoring currently involves the following:

- Conducting investigative studies aimed at the terms and conditions, such as the efforts completed with the Flexibility Study.
- Tracking to ensure Deadwood Dam is operating within the bounds of the four operational indicators.
- Reporting on findings of investigative studies and adherence of operations to bounds of operational indicators.

This document outlines the continued monitoring of incidental take and documentation of additional means of take.

Reporting

Reclamation satisfies reporting requirements for effects to bull trout and bull trout critical habitat by annual reporting and investigative study completion reports. Annual reporting is submitted to the USFWS by March 31 of each year and includes results of monitoring throughout the reporting period and the status of ongoing investigative studies. Investigative studies that focus on specific terms and conditions may take multiple years to complete and final results are typically reported in a completion report that is submitted to the USFWS. Reclamation's Flexibility Study (Reclamation 2016 revised) is an example of the most recent and comprehensive investigative study.

3 SUMMARY OF THE FLEXIBILITY STUDY

Reclamation conducted the Flexibility Study with the assistance of external subject matter experts to specifically address terms and conditions from the 2005 Opinion (Reclamation 2016 revised). The Flexibility Study was a multi-disciplinary project that examined operational flexibility to minimize incidental take and balance benefits to bull trout and bull trout critical

habitat in both the reservoir and river. The study was conducted from 2006 to 2015. Results from the Flexibility Study, along with other available data, were integral to the development of Reclamation's IMs provided in this document.

Operational scenarios examining reservoir storage and timing/amount of discharge in dry, wet, and average climatic conditions were modeled for Deadwood Reservoir and the Deadwood River downstream of Deadwood Dam to identify effects to bull trout and bull trout critical habitat (Reclamation 2016 revised, Chapter 1). Within the range of operations defined in the 2005 Opinion, Reclamation has flexibility to operate Deadwood Dam during three operational scenarios:

1. Discharging from outlet valves and/or hydropower generator during non-irrigation season.

2. Ramp up or down of flow in the spring and fall.

3. Discharge from the spillway.

Sources of discharge and volume of discharge determine the extent of flexibility during the three operational scenarios.

Deadwood Dam has three sources of discharge:

1. Two outlet valves with a maximum combined discharge of 1,800 cfs (900 cfs each).

2. A small hydropower generator capable of releasing a maximum of 2.3 cfs.

3. A spillway that allows, at a maximum, 10,500 cfs to flow through. The spillway is an open design with a crest elevation of 5334.0 feet above sea level, allowing water to spill when the reservoir is above that elevation.

Volume of discharge during the irrigation season is closely regulated to deliver water from the reservoir to downstream water users in accordance with state water rights. Outside of the irrigation season there is some flexibility in how releases are made. Reclamation has followed different strategies historically. From 1931 to 1994, non-irrigation season stable flows varied annually with an emphasis on flood control and water storage. From 1994 to 2009, non-irrigation season stable flows were set at 50 cfs, the estimated unregulated inflow to the reservoir. From 2009 to 2015, Reclamation varied post-irrigation season discharge as part of the Flexibility Study to analyze effects of different flows, ramping rates, and use of the spillway to benefit bull trout and bull trout critical habitat.

In addition, the Flexibility Study included intensive data collection that was used to develop, calibrate and validate hydrologic, water temperature, water chemistry and primary production models for the study area. Short-term study flows (reduced discharge) were tested in 2009, 2010, 2014, and 2015 to facilitate data collection of physical habitat and other stream channel

variables. Bull trout were monitored with various tagging technologies from 2006 to 2011, with most data generated between 2006 and 2009.

3.1 Flexibility Study Results

The Flexibility Study evaluated the use of different flows, ramping rates, and the spillway to benefit bull trout and bull trout critical habitat in the following six areas:

- Reservoir productivity
- River productivity
- Bull trout behavior in the reservoir
- Bull trout behavior in the river
- Bull trout biomass in the reservoir
- Bull trout biomass in the river

The results of this analysis are summarized below.

3.1.1 Productivity in the Reservoir

The Flexibility Study identified that Deadwood Dam operations had little influence on net productivity (i.e., the bull trout food chain) in the reservoir, including algal growth. Conversely, hydrologic conditions (e.g., inflow, weather patterns, snow pack) had a strong influence on productivity. The Flexibility Study identified that higher than expected algal growth commonly occurs in the upper water layer of the reservoir during the late fall (Reclamation 2016 revised, Chapter 2). When the abundant algal community dies, it settles to the reservoir bottom where, during the winter, it decays causing the available dissolved oxygen (DO) in this water layer of the reservoir to be depleted. The environment of algal decay and little-to-no DO allows certain minerals (phosphorus, iron and manganese) to be absorbed (bio-available) in the water column. This water layer returns to an oxygenated equilibrium once the reservoir water layers mix in the spring or the water is released into the river and exposed to oxygen.

In terms of hydrologic conditions, the Flexibility Study determined wet years have 134 to 156 percent greater productivity than dry years. The greatest difference was found between wet years and dry years (with non-irrigation season stable flows of 50 cfs), due to the lower reservoir volume in the spring of dry years when productivity rates are greatest. Reservoir productivity was about 15 percent higher when implementing the low (0 and 2.3 cfs) post-irrigation stable flows in comparison to the status quo 50 cfs post-irrigation season stable flows.

3.1.2 Productivity in Deadwood River Downstream of the Dam

The Flexibility Study results identified that water operations influence productivity in the river primarily in the first 3.7 kilometers (km) downstream of the dam. Beyond that point, the effects of water operations decrease and more closely resemble unregulated conditions. Increased nutrients and organic matter discharged from the reservoir are a likely cause for the

macroinvertebrate (aquatic insects herein referred to as “insects”) community and their prey base (periphyton) to differ from unregulated sites (Reclamation 2016 revised, Chapter 3).

For example, in unregulated sites there were higher proportions of insects that collect and process organic matter compared to the section immediately downstream of the dam where there were proportionally more filter feeding insects. Additionally, in this 3.7 km reach, insect drift was lower. Farther downstream on the Deadwood River, there were no measurable effects of operations on insect movement, density, biomass, or production in comparison to unregulated sites.

Based on the study results and observed data, predicted effects of a 2.3 cfs post-irrigation discharge support the most biomass of bull trout and insect species during dry and wet climatic conditions. Comparatively, average climatic conditions had little difference among the potential biomass supported by different operational scenarios. Ramping rate also had no effect on biomass of prey. Insect production was not a concern during any of the operational scenarios considered because of the fast growth and expansion of insects during periods of increased discharge.

3.1.3 Bull Trout Behavior in the Reservoir

The Flexibility Study results show that bull trout that use the reservoir for rearing habitat exhibited different behaviors between years and associated reservoir conditions (Reclamation 2016 revised, Chapter 4). In 2007 (dry conditions), as the reservoir level declined and water temperatures approached 20^{o} C, bull trout left the reservoir and reared in tributaries. Yet, average growth was not affected by this shift in habitat use. In 2011 (wet conditions), when the reservoir level was higher, bull trout remained in the reservoir throughout the year, only migrating to spawn in tributaries during the fall. Acoustic and radio telemetry tag data indicated that bull trout used the shallower areas of the reservoir (< 2 meters depth) and were often located near tributaries.

Although bull trout appear to adjust to reservoir levels and shift habitat use, the study analyses indicate that higher summertime reservoir levels benefit bull trout and associated prey in the reservoir. Quick reservoir refilling following the irrigation season creates better rearing and migration conditions for bull trout that use reservoir habitat. A lower post-irrigation season discharge (i.e., 2.3 or 0 cfs) and fast ramp down of releases are both operations that contribute to a quick reservoir refill. Higher post-irrigation season reservoir levels also help to maintain colder water temperatures in the lower water layer of the reservoir throughout the year. When reservoir storage allows the spillway to be used, releasing warmer surface water from the reservoir can provide a buffer allowing maintenance of the cooler water in the lower water layer longer into the summer/fall.

3.1.4 Bull Trout Behavior in Deadwood River Downstream of the Dam

The Flexibility Study results found that bull trout were not widely distributed downstream of the dam. Individuals were only captured in the stilling basin immediately downstream of the dam

(Reclamation 2016 revised, Chapter 4). Resident populations were present in nearby tributaries and in South Fork Payette River tributaries. Habitat in the Deadwood River downstream of the dam should be considered accessible for bull trout with no known barriers to migration. Bull trout captured in the stilling basin were genetically assigned to source populations sampled upstream of the dam. When reservoir storage allows the spillway to be used, mixing cooler water released from the outlet valves with warmer water released from the spillway allows water temperatures in the river to be more like unregulated conditions.

3.1.5 Bull Trout Biomass in the Reservoir

Study results indicated that reservoir operations had little effect on the potential biomass of bull trout and other fishes during average and wet climatic conditions in the reservoir. However, in dry climatic conditions, the potential for bull trout production was about 15 percent higher under the low post-irrigation discharge scenarios as compared to the 50 cfs discharge scenario (Reclamation 2016 revised, Chapter 2). Bull trout growth in the reservoir is high—nearly double—the measured growth in the tributaries downstream of the dam. These analyses indicate that the production of bull trout in the reservoir is not limited by food. The food base can support more bull trout than are present in the reservoir/stream populations upstream of the dam. Therefore, other factors likely limit population size, such as spawning habitat quality or quantity, water temperatures, or DO.

3.1.6 Bull Trout Biomass in Deadwood River Downstream of the Dam

The study found that reservoir operations had varied effects on the potential biomass of bull trout and other fishes in the river downstream of the dam (Reclamation 2016 revised, Chapter 3). Multiple reasons likely contribute to a lack of use (potential biomass) by bull trout in this area, including climatic conditions, spawning habitat quantity and quality, and/or loss of anadromous fishes and associated production. These factors were not examined in the Flexibility Study.

Distribution studies indicate that Deadwood Dam may be on the edge of suitable bull trout habitat within the Payette River basin. The analyses of ramp down found that fast ramp down resulted in water temperatures closer to unregulated conditions in the river downstream of the dam. The study also found that the rate of ramp up at the beginning of the irrigation season did not result in measurable differences. Fast ramp down was also analyzed for effects of stranding fish in the river downstream of the dam. No bull trout were observed during stranding surveys; however, fast ramp down appeared to result in higher rates of stranding for other fishes in the river downstream of the dam. The ramp down guidelines described in section 4.2 balance the benefits of ramping down across both the reservoir and the river while minimizing the potential for take of bull trout.

The study analyses found overall trade-offs between optimal reservoir habitat conditions and optimal downstream river conditions for bull trout and other aquatic species (Reclamation 2016 revised, Chapter 7). For example, maintaining cold water habitat in the reservoir throughout the

year will result in water temperatures in the downstream river that are colder than unregulated water temperatures throughout the irrigation season and warmer than unregulated water temperatures during the winter. The situations in which Reclamation has flexibility in operations (i.e., volume of winter discharge, ramping, and use of the spillway for discharge) could be used as tools, in most scenarios, to improve conditions for bull trout in both the reservoir and the river.

4 RECLAMATION'S IMPLEMENTATION MEASURES AND EFFECTS OF IMPLEMENTATION MEASURES ON BULL TROUT AND BULL TROUT CRITICAL HABITAT

This chapter presents Reclamation's IMs for operational changes at Deadwood Dam to minimize incidental take of bull trout. Bull trout Terms and Conditions and bull trout critical habitat PCEs are addressed by the IMs as compared to the environmental baseline (Section 1.2.2). Effects anticipated to occur as a result of implementing the IMs for the Deadwood Reservoir and Deadwood River Downstream of the Dam are discussed in detail in this chapter. Effects of IMs for the South Fork Payette River and Boise Project are not mentioned because there are insignificant or no effects, respectively, caused by the IMs. Each section of this chapter describes how the IMs will affect each environmental condition. IMs are discussed for the following four operations:

1. Ramp Up in the Spring (IM1)
2. Ramp Down in the Fall (IM2)
3. Non-irrigation Season Stable Discharge (IM3)
4. Discretionary Spill (IM4)

As noted in Section 1.2, baseline conditions are defined in the 2005 Opinion and in Reclamation's bull trout critical habitat Biological Assessment (2013 Assessment) (Reclamation 2013). Operations that are part of the baseline conditions, but are not considered in these IMs, include deep water releases from the reservoir and irrigation season releases to fulfill water right deliveries. These conditions are part of the required components of the December 19, 1935, project authorization approved by the President (Reclamation 2004b) and are cost-prohibitive to change.

Operations not listed above will continue to be within the range analyzed in the 2005 Opinion. These operations include, but are not limited to, irrigation season flows. Public safety and flood control operations are non-discretionary and determine the timing and volume of spring discharges; however, ramping rates identified in this document will be followed as closely as possible during non-discretionary operations.

4.1 Implementation Measure 1: Recommended Operation for Ramp Up in the Spring

To ramp up flows in the spring, Reclamation recommends the following guidelines:

- Follow all existing SOPs, including flood control requirements.
- In cases of discretionary spill, use existing water temperature gages located in both the forebay (measured in the reservoir at the dam) and immediately downstream of the dam to adjust water temperatures to resemble unregulated conditions. Modulate river water temperature to the extent possible by adjusting the volume of cooler water from the outlet valves to reach the desired water temperature in the river. The combination of release locations will allow water temperature to more closely resemble unregulated conditions. Mix the two water sources to minimize water temperature changes greater than 5°C per 12-hour period and aim to not exceed a maximum water temperature of 15°C.
- Use the following protocol to make flow increases:

  For releases of 0 – 1,000 cfs

  - Maximum 100 cfs the first day of ramp up
  - Maximum 200 cfs on days 2 and 3 of ramp up
  - Maximum 250 cfs on days 4 and 5 of ramp up

  For releases greater than 1,000 cfs

  - Maximum increase of 250 cfs per 3 hour period
- Changes to outflow could occur at any time (especially if the dam is operating under flood control operations). However, for the safety of recreationists, whenever possible, flow changes will be avoided on weekends and made between 8:30 p.m. and 10:00 pm.

4.1.1 Effects of Implementation Measure

Spring ramp up is the period when discharge is increased from winter discharge to irrigation flows or flood control. Conditions primarily influenced during this period include change of flow and water temperature in the river. The potential for these variables to affect bull trout is primarily associated with behavioral cues of prey fishes and displacement of fish. These effects are discussed below.

4.1.1.1 Effects on the Reservoir

Following the recommended ramp up rate, in conjunction with the other IMs, will provide holistic benefits to the reservoir.

4.1.1.2 Effects on River Hydrology and Temperatures in Deadwood River Downstream of the Dam

Yearly ramp up at Deadwood Dam is generally initiated on or around April 20. However, pre-irrigation season ramp up may occur earlier in high water years when flood control dictates the need for earlier season water releases from Deadwood Reservoir. Other than flood control releases, ramp up rates follow the SOPs for Deadwood Dam.

Discharge from the reservoir during the irrigation season and some periods of flood control is greater than the combined flow of the upstream tributaries (Reclamation 2016 revised; pages 3-4 to 3-7). Discharge from the reservoir during the non-irrigation season stable flows (see Section 4.3) is less than the combined flow of upstream tributaries. The ramp up period allows the river water temperature and hydrograph to transition to irrigation season conditions. The extent of effects during this transition was analyzed for the Flexibility Study. Varying the rate of ramp up at the beginning of the irrigation season did not result in measurable differences in the water temperatures downstream of the dam (Reclamation 2016 revised, Section 3.1.7 pages 3-9), even though the discharged water temperature was cooler than temperatures in the tributaries. The incremental (gradual) changes will allow fish to voluntarily relocate to seasonal habitat, which will minimize the potential for displacement. Following the recommended ramp up rate—in conjunction with the other IMs—will provide holistic benefits to the river.

4.1.1.3 Effects on Prey Base (Migratory and Spawning Cues) in Deadwood River Downstream of the Dam

Ramp up has the potential to affect the migratory/spawning cues for fish present in the Deadwood River downstream of the dam. The fish community in this section of the Deadwood River is dominated by rainbow trout, sculpin species, dace species, and mountain whitefish, all of which comprise the prey base for bull trout. Small-sized fishes of any species are prey for bull trout. Yet, even the largest individuals of the species present in this section of the Deadwood River are not large enough to prey upon most bull trout that would be present downstream of the dam (Reclamation 2013). The prey base also includes insects. None of the operational scenarios had a measurable effect on movement, density, biomass, or production of insects in comparison to unregulated sites (Reclamation 2016 revised, Chapter 3).

The timing and success of spawning for all fish is influenced by water temperatures before, during, and after spawning. In the Deadwood River, spring spawning fishes include: rainbow trout, cutthroat trout, sculpin species, and dace species. Ramp up operations will affect the volume of water in the river downstream of the dam, but the water temperature will remain unchanged compared to previous discharge rates. The only opportunity to modify the constant 4°C discharge from Deadwood Dam is when the reservoir water level allows the spillway to be used. When this occurs, water released from the outlet valves is mixed with warmer water released from the spillway and water temperatures in the river become more like unregulated conditions (see Section 4.4).

Sculpin species spawn from mid-May through June when water temperatures reach 7.8°C to 17.2°C, resulting in an egg incubation period of 21 to 28 days (Bailey 1952). Dace species tend to spawn later in the spring and into the summer when water temperatures are warmer. Cold water temperatures in the Deadwood River downstream of the dam likely preclude successful spawning of these species except when use of the spillway allows for discharge of warmer surface water from Deadwood Dam. Therefore, spring ramp up prior to this timeframe is unlikely to affect the migratory or spawning cues of these fish.

Native rainbow trout, also referred to as redband rainbow trout, inhabit a wide range of water temperatures (EPA 2001; Cassinelli 2007). However, distribution, growth, and feeding of native rainbow trout are all maximized at water temperatures greater than those observed in the Deadwood River downstream of the dam most of the year (under the current operations). The favorable range of temperatures for rainbow trout spawning and egg incubation is 2.2°C to 20°C. Yet, optimal survival requires water temperatures during incubation of eggs that do not prolong juvenile emergence (hatching). Incubation times are influenced by water temperatures, with warmer temperatures leading to accelerated incubation and earlier emergence. There may be a survival advantage for early spawning/emergence, which allows for greater offspring growth before winter (Bjornn and Reiser 1991).

In the Deadwood River downstream of the dam, the constant winter and spring water temperature of 4°C correlates with a 79-day incubation period for rainbow trout. The earliest observations of sexually mature rainbow trout entering downstream tributaries to spawn occurred at Wilson Creek in early June (Dare and Rose 2006). June is later than the April/May period observed with most rainbow trout in southwestern Idaho (Miller et al. 2014). Historic timing of spring ramp up or flood control flow increases do not likely interfere with rainbow trout spawning migration in the Deadwood River downstream of the dam, although releases at cooler temperatures in this timeframe may be associated with delayed spawning.

The Deadwood River is identified as bull trout critical habitat and described as Foraging/Migration/Overwintering (FMO) habitat (75 FR 63898). The Deadwood River below the dam is not described as spawning or rearing habitat for bull trout. However, bull trout are affected indirectly by the effect of temperature and flow on the spawning behavior of other fishes that are prey for bull trout. The gradual ramp up followed in the baseline continues to provide conditions that are most similar to unregulated areas. Spring ramp up (IM1) and the effect on water temperature (PCE 5) will have an insignificant effect on bull trout in the Deadwood River downstream of the dam (T&C 3.c and 3.d.) and their prey base including fish and insects (PCE 3) Following the recommended ramp up rate, in conjunction with the other IMs, will provide holistic benefits to the river.

4.2 Implementation Measure 2: Recommended Operation for Ramp Down in the Fall

To ramp down flows in the fall, Reclamation recommends the guidelines below:

- Follow all existing SOPs.
- Ramp down to 2.3 cfs immediately following irrigation flows.
- To the extent operationally possible, complete ramp down (over a period of 24 to 48 hours) with hourly flow changes from dusk till dawn.
- When possible, avoid ramp down on the weekends and early morning hours when periods of river-related recreation are mostly likely to occur.
- Target flow reductions to create a change in downstream water depth of 4 inches per hour (10 centimeters per hour). This rate corresponds to conditions that minimize stranding risks for fish (Bradford 1997; Halleraker et al. 2003). Outlet valve adjustments to ramp down to winter discharge levels should follow the guidelines below:
    1. When several flow reductions are anticipated, the first adjustment should not exceed 50 cfs and should be followed in 60 minutes by a second reduction.
    2. To reduce discharge from any level down to 250 cfs, reduction increments should not exceed 100 cfs with no more than one adjustment every 60 minutes.
    3. To reduce discharge below approximately 250 cfs, reduction increments should not exceed 50 cfs with no more than one adjustment every 60 minutes.

4.2.1 Effects of Implementation Measure

Fall ramp down is the period when discharge from Deadwood Dam is decreased from higher irrigation flows to lower winter flows. Conditions primarily influenced during this period include the rate of reservoir refill and the change of river flow and temperature. The potential for these variables to affect bull trout in the reservoir and the river are discussed below.

4.2.1.1 Effects on the Reservoir

The effects of fall ramp down on reservoir storage levels, productivity, varial zones and barriers to bull trout migration is discussed below.

4.2.1.1.1 Storage Levels

Fall ramp down of discharge from the dam affects rate of refill and carryover storage of the reservoir. A slower ramping down rate corresponds to a slower refill and a lower fall and winter reservoir storage volume. Lower reservoir storage volumes lead to lower storage carryover and lower early spring reservoir levels. Rapid ramp down operations will increase the rate of refill for the reservoir (PCE 8). They will also increase the potential for spring fill and the ability to use

discretionary spill (Section 4.4), both of which have beneficial effects to bull trout and bull trout critical habitat.

4.2.1.1.2 Productivity

Reservoir productivity has not been shown to cause population level effects to bull trout in Deadwood Reservoir. Bull trout growth in the reservoir is generally high and not limited by reservoir productivity (Reclamation 2016 revised, Section 2.3). Rapid ramp down operations are not expected to have a direct effect on reservoir productivity.

4.2.1.1.3 Varial Zones and Barriers to Migration

The portion of a reservoir where tributaries enter is called the varial zone. The varial zone is the transition between a reservoir environment and a river environment. Varial zones are more similar to river environments but are comparatively shallower and have less cover than unregulated river locations. In Deadwood Reservoir, habitat quality in the varial zone is greatly reduced during the lowest seasonal reservoir elevation when fine material from each tributary creates a delta in the reservoir that may limit the ability for fish to safely migrate (USFWS 2014).

The rate of initial reservoir refill has the most impact on improving habitat quality in the varial zone. Lower fall reservoir levels prior to the initiation of reservoir refill can contribute to longer varial zones that result in an increased risk of predation for bull trout. Bull trout migration to or from the reservoir can occur at any time during the year, but is most prevalent during the spawning season, which coincides with the end of irrigation releases. The topic of physical barriers to migration posed by varial zones is discussed in more detail in Section 4.3.1.1. Rapid ramp down operations will reduce negative impacts of the varial zone delta effect by allowing a more rapid initial rate of refill and inundating the shallowest delta habitat earlier in the bull trout migration season. A more rapid initial rate of refill will reduce the current seasonal adverse effect to bull trout created by varial zone deltas that reduce habitat diversity (T&C 3.b.) (USFWS 2014).

If sustained above 15°C, water temperature can also be a barrier to migration. This condition may occur in the reservoir during the summer/fall as a result of climate variability and is exacerbated by low reservoir storage. Rapid ramp down operations and the ability to use discretionary spill (Section 4.4), will have a beneficial effect by increasing the rate of refill for the reservoir and minimizing the potential of reservoir water temperature exceeding 15°C in the fall (PCE 2 and PCE 5).

4.2.1.2 Effects on the Deadwood River Downstream of the Dam

Fall ramp down typically occurs in a few days and, compared to the non-irrigation season stable flows, has less effect on the Deadwood River downstream of the dam. During the Flexibility Study (Reclamation 2016 revised), three ramping rates—slow, average, and fast—were analyzed. The effects of these different ramping rates on bull trout stranding (physical barriers) and the prey base in the Deadwood River downstream of the dam are summarized below.

4.2.1.2.1 Stranding (Physical Barriers)

Ramp down operations have the potential to affect bull trout as well as bull trout critical habitat. This is due to the potential for flow reductions to rapidly dewater the formerly-wetted channel and strand fish or insects in disconnected pools. Studies of stranding rates have shown that the susceptibility of fish to stranding is a function of behavioral responses to changing flows. These behavioral responses are influenced by variables including species, fish body size, water temperature, time of day of flow changes and rates of stage change (Bradford 1997; Halleraker et al. 2003; and Irvine et al. 2009 as cited in Reclamation 2016 revised, Section 4.2.4, page 55). While site-specific habitat characteristics play a role in stranding potential, studies suggest that, in general, incorporating the following two measures will reduce the risk of stranding:

1. Operational conditioning reductions (i.e., temporary reductions of flows followed by increases, prior to the final operational reduction).

2. Moderated ramping rates, particularly rates that result in water depth reductions of less than 4 inches per hour (10 centimeters per hour) (Bradford 1997; Halleraker et al. 2003; Irvine et al. 2009 as cited in Reclamation 2016 revised, Section 4.2.4, page 55; and Flodmark 2004).

To a lesser degree, ramp down rates also have the potential to affect insect production by stranding insects that were using habitat along the stream margin during periods of higher flow. Due to tributary inflows, most of the effects caused by water operations on the insect community and their prey base dissipate by 3.7 kilometers downstream of the dam. Farther downstream, no measurable effects of the dam or operations were observed on insect movement, density, biomass, or production in comparison to unregulated sites (Reclamation 2016 revised, Section 6.6, pages 6-9).

Streamflows change seasonally due to natural events, and both habitat dewatering and stranding of fish and insects occur naturally. The extent and severity of stranding, and its impacts to survival, is likely dependent on climatic and environmental conditions that vary spatially and temporally. Bull trout were not detected in any stranding event during the Flexibility Study evaluation (including field surveys during ramping to and stabilization of winter releases of 50 cfs, 2 cfs, and 0 cfs) (Reclamation 2016 revised, Section 4.2.4, pages 54-56). The analysis for the stranding portion of the study assumed stranded fish were not able to migrate to other habitat rather than selecting for the stranding pools. Habitat that fish may be stranded in can also provide favorable rearing conditions that fish may select for, such as side channels or disconnected pools that are fed by ground water or springs (Reclamation 2016 revised, Section 4.2.4, pages 54-56).

While following the recommended operations during the flexibility study, no bull trout were observed stranded. The risk of stranding will be reduced by following the implementation measures that provide a small initial adjustment change and define the time between adjustments (PCE 2 and T&C 3.c.). The possibility of stranding still exists; however, the reduced risk of

stranding due to IM2 will provide holistic benefits to the Deadwood River downstream of the dam.

4.2.1.2.2 Prey Base

Delivery of stored water for irrigation generally ends between late August and mid-September. The discharges from the dam are then ramped down for winter. Ramp down can affect the prey base by dewatering seasonally important habitat and/or causing water temperatures to vary from unregulated conditions. Seasonally important habitat includes migration corridors to winter habitat (discussed in previous section) and spawning habitat for fall-spawning fishes.

Ramp down rates have the potential to affect spawning habitat and reproductive success of fall-spawning prey fishes in the Deadwood River downstream of the dam. The mountain whitefish, a native salmonid, is particularly vulnerable. Mountain whitefish spawn from mid-September to mid-November when water temperatures range from 0°C to 11°C (EPA 1974); they generally spawn along shallow river margins.

The spawning and incubation period for whitefish (up to 14 weeks) overlaps with ramp down operations at Deadwood Dam. This overlap causes eggs deposited in shallow water to suffer increased mortality due to dewatering. Also, fall ramp down may cause water temperature fluctuations. Under current operations, the temperature of water released from Deadwood Dam may be over 11^{o}C until mid-to-late October. The Flexibility Study analyzed fast, average and slow ramp down rates and determined that fast ramp down provides water temperatures closest to unregulated water temperatures (PCE 5) (Reclamation 2016 revised, Section 6.1, page 2). Therefore, fast ramp down is less likely to affect the incubation of eggs from fall-spawning fishes.

Average daily water temperatures in the Deadwood River where it enters the reservoir range from 7.5°C to 2.3°C during October and reflect the unregulated thermal regime. The rapid ramp down proposed in this IM has a beneficial effect on the prey base by providing a longer fall timeframe that water temperatures can more closely mimic unregulated temperature conditions (T&C 3.b.).

4.3 Implementation Measure 3: Recommended Operation for Non-Irrigation Season Stable Discharge

To manage non-irrigation flow operations, Reclamation recommends the guidelines below:

- Limit outflow to the hydropower generator (approximately 2.3 cfs) once ramp down from irrigation flows has concluded.
- Stop releasing flow through the outlet valves until ramp up begins in the spring, unless it is necessary for flood control, public safety, or ESA considerations.

- If a flow of approximately 2.3 cfs is not able to be maintained, use discharge through the valve(s) to maintain water quality criteria, if needed.

4.3.1 Effects of Implementation Measure

Non-irrigation stable flows refer to anytime that irrigation flows are not being released from the dam. This is typically between October and May. For this document, non-irrigation season begins with fall ramp down and ends with spring ramp up. Discharge during this period can affect bull trout in the Deadwood River downstream of the dam and the migratory population in Deadwood Reservoir, as well as critical habitat for both populations.

The rate of stable non-irrigation season flows recommended in this document are less than the current flows. Reclamation did not take actions to directly reduce effects of low flows because effects did not limit the ability of bull trout to access critical habitat (PCE 2 and PCE 8) and the operations are expected to provide holistic benefits to the reservoir and river as described below. The Flexibility Study found that, while the amount of habitat provided at the recommended non-irrigation season stable flow of 2.3 cfs compared to 50 cfs is reduced, it is not expected to limit the ability of bull trout to use critical habitat (Reclamation 2016 revised, Section 4.2.4) or move between habitats (connectivity). Other effects resulting from this IM vary between the fall and winter and are described separately below.

Environmental conditions most likely to be influenced during the fall period include the following:

- Water temperature downstream of the dam
- Connectivity downstream of the dam
- Stilling basin water quality downstream of the dam
- Habitat quality in the migration corridor of the reservoir

Environmental conditions most likely to be influenced during the winter period include the following:

- Water temperature and ice conditions downstream of the dam
- Connectivity downstream of the dam
- Stilling basin water quality downstream of the dam
- Water levels in the reservoir

4.3.1.1 Fall: End of Irrigation Season through October 15

The condition of water released from the dam during the fall varies depending on the rate of release. Water quality constituents that are most susceptible to flow rate include: temperature,

DO, and concentrations of metals.[3] While a discharge of 50 cfs is close to the rate of a typical winter inflow into the reservoir from the Deadwood River (Reclamation 2016 revised, Section 3.1, pages 26-53), the temperature of water discharged from the dam in the fall is warmer than the unregulated temperatures measured above the reservoir.

The date that irrigation season ends varies depending on local weather-driven irrigation demand and volume remaining in the reservoir. Timing of the end of irrigation flows has ranged from August 23 to September 16 over the last 25 years and typically occurs September 3. During years with higher than average water supplies, the end of irrigation flow tends to be later than in low water years. The dam is typically winterized around October 15 and flows remain stable until flood control or irrigation demand requires changes, typically the following spring.

Releases from the dam can be finely adjusted at volumes above 50 cfs. However, mechanical limitations of the release valves preclude the ability to safely make incremental changes at volumes less than 50 cfs without causing damage to the equipment. Therefore, a flow of 50 cfs is the minimum that can be released from the main valves. When releases from both valves are closed, an alternative discharge can come from diverting up to 2.3 cfs through a hydropower generator that draws water from the same intake as the release valves.

Prior to water year 1994, there were frequently no releases from the dam outside of flood control and irrigation releases. Starting in 1994, Reclamation generally maintained non-irrigation season stable flows above 50 cfs. This decision was based, in part, on a previous informal agreement between Reclamation and Idaho Department of Fish and Game (Reclamation 1984). Reclamation's only exceptions to the 50 cfs agreement were for maintenance and interim operations of 2.3 cfs in 2013 and 2014 (provided through the hydropower generator) to study the impacts of lower flows.

4.3.1.1.1 Effects on the Reservoir

Fall ramp down typically begins around September 3. This timing corresponds with the time when bull trout migrate back to the reservoir following tributary spawning and when the reservoir volume is at the lowest level of the season. The recommended non-irrigation season stable discharge of 2.3 cfs would have immediate impacts on the rate of refill in the reservoir and benefit fish migrating through the shallow tributary deltas (Prisciandaro 2015). Habitat benefits are gained throughout the period of refill, but the greatest benefits are gained during the first 2 weeks following ramp down as the shallowest water in the tributary deltas are inundated. Within 2 weeks following ramp down to the recommended non-irrigation season stable discharge (2.3 cfs), reservoir volume would increase approximately 4,000 acre-feet more than occurs at the current fall release of 50 cfs. This is equivalent to 3.8 percent of the total active storage of the reservoir and would be a higher percentage in dry years since ramp down occurs earlier when less water is available.

[3] DO and metal concentrations immediately below the dam are a result of reservoir processes and vary at different water levels and seasons. Reclamation only has the ability to directly change flows.

Increased storage of this amount would improve habitat diversity in this portion of the migration corridor for bull trout moving through this area (Prisciandaro 2015). The non-irrigation season discharge and the ability to use discretionary spill (Section 4.4) will have a beneficial effect by increasing the rate of refill for the reservoir and minimizing the potential of reservoir water temperature exceeding 15 °C in the fall (PCE 2, PCE 5 and T&C 3.e.). Both actions would help to maintain beneficial water temperatures in the reservoir (PCE 5). These IMs provide conditions that, when modeled, provide benefits to bull trout habitat in the reservoir during a wider range of climatic conditions than do current conditions (Weigel et al. 2017). A greater frequency of complete refill would provide benefits to water quality and quantity (PCE 8) and FMO habitat in the reservoir and river, particularly during the following summer and fall periods.

4.3.1.1.2 Effects on the Deadwood River Downstream of the Dam

Water Temperature

Water temperature during the fall can influence migration timing, spawning, and foraging behavior of all fish. Water temperatures aligned with unregulated conditions provide a metabolic advantage to fish, contributing to increased overwinter survival. The IMs allow for operational flexibility to manage water temperatures to resemble reservoir inflow conditions both in terms of daily average and daily variation (Reclamation 2016 revised, Section 3.1, pages 4-6). This IMs will provide a benefit to water temperatures in the river downstream of the dam (PCE 5 and T&C 3.b.).

Connectivity

Temporary seasonal effects of lowered non-irrigation stable discharges will result in increased potential for shallow conditions (depths < 5 cm). These conditions could potentially limit fish movement in the 300 meters of the Deadwood River between the dam and the inflow of Wilson Creek. However, Reclamation has documented both bull trout and rainbow trout successfully moving through this area at a discharge of 2.3 cfs.

This IMs will have a seasonal adverse effect to bull trout critical habitat in the first 300 meters downstream of the dam caused by reduced migration habitat diversity (PCE 2). The recommended operations will not affect connectivity or availability to FMO habitat throughout the rest of the action area.

Stilling Basin Water Quality

The stilling basin contains FMO habitat that is used by all species of fish present in the river downstream of the dam. The transitional effects to water quality in the stilling basin caused by discharge and reservoir conditions are described in this section. When warm summer and cool residual winter water are mixed in the reservoir in the fall, the biochemical oxygen demand of microbes in the sediments (algal decay) leads to oxygen depletion in the lower water layer of the reservoir. In turn, the oxygen depletion results in reduced water quality (as described in section 3.1.1). When this water is released into the river, the minerals in the stilling basin water are in a temporary reduced state that allows some minerals to become bio-available in the river.

When reservoir mixing coincides with discharges of 50 cfs, the discharge turbulence re-oxygenates the water within the stilling basin and improves water quality by oxidizing and decreasing the bio-availability of some of the minerals in the water. Conversely, when reservoir mixing coincides with discharges of less than 50 cfs, low DO levels are expected to occur in the stilling basin and some minerals in the stilling basin water would have an increased bio-availability in the water column (PCE 8). However, these conditions would be limited in duration and distance; water would be re-oxygenated within 0.5 km distance downstream of the dam (Reclamation 2016 revised, Section 5.2.5).

This IM will result in limited adverse seasonal effects to water quality in the stilling basin (PCE 8), but no expected effects to bull trout in this area. Reclamation has documented bull trout and rainbow trout residing in the stilling basin during periods of reduced water quality by relying on seeps and springs and connectivity in/out of the stilling basin.

4.3.1.2 Winter Discharge: October 15 to Ramp up the Following Spring

The volume of water discharged from the dam during the winter discharge period directly and indirectly impacts the reservoir and the river. Winter discharge is the period after winterization of the dam (typically around October 15) until flood control or irrigation releases require changes the following spring. Operational flexibility after October 15 is limited because access to the facility is difficult during the winter season and the system cannot be winterized remotely. If a valve is closed for winter operations (discharge less than 50 cfs), it must be properly winterized or the cold temperatures could damage equipment and cause a public safety concern.

Winter discharges influence river conditions by affecting water temperature and ice as described below, connectivity, and stilling basin water quality. However, unlike fall flows that affect bull trout during their migration to winter habitat, winter discharges affect the quality and quantity of winter habitat. In addition, winter discharges influence reservoir conditions by directly affecting the rate of refill. Increasing the reservoir refill rate due to lower winter discharges increases the potential for discretionary spill the following spring (Section 4.4) and, in some conditions, creates additional storage the following summer. These physical changes have the potential to influence primary productivity and temperature regimes in the reservoir and river (Reclamation 2016 revised, sections 2.2.6 and 3.3 respectively).

4.3.1.2.1 Effects on the Reservoir

This IM will result in benefits to reservoir storage and potential timing and duration of spill in the spring (see Section 4.4). A winter discharge of 2.3 cfs would refill reservoir storage more quickly than the current 50 cfs and increase the likelihood of the reservoir reaching full pool. A greater frequency of complete refill would provide benefits to water quality, primary productivity, and FMO habitat in both the reservoir and river, particularly during the summer and fall periods. These IMs allow conditions that, when modeled, provide bull trout habitat in the reservoir during a wider range of climatic conditions than do current conditions (Weigel et al. 2017). A greater frequency of complete refill would provide benefits to water quality and

quantity (PCE 8) and FMO habitat in the reservoir and river, particularly during the following summer and fall periods.

4.3.1.2.2 Effects on Deadwood River Downstream of the Dam

Water Temperature and Ice Conditions

The volume of water released from the dam, geomorphic variables, and weather patterns influence the naturally unstable nature of ice in this reach. Ice conditions naturally vary throughout the winter season and include periods without ice cover or with ice found on top of the water, on the bottom of the channel, in suspension above the bottom of the channel resembling slush, and in ice dams (Reclamation 2016 revised, Section 3.1.5, pages 60-73; Tranmer et al. 2017). The recommended winter discharge of 2.3 cfs will help to stabilize ice conditions in the river downstream of the dam (Tranmer et al. 2017). Stable conditions include the persistence of surface ice that insulates the underlying habitat from severe weather fluctuations that are common in this area.

Variable ice conditions in the river downstream of the dam are due in part to the temperature and volume of water being discharged from the dam. Water released from the valves or hydropower generator during this time vary in temperature early in the season. But, once the reservoir water layers mix, the reservoir temperatures are consistently close to 4^{o}C. The temperature of 4^{o}C is warmer than the unregulated conditions in the basin. The period of consistent 4^{o}C water temperature typically starts in early December and continues through early May. The recommended winter stable discharge of 2.3 cfs will allow the reduced volume of discharged water to more quickly cool to a constant temperature, which creates a more natural and stable condition for ice (Tranmer et al. 2017). Therefore, this IM will result in benefits to the quality of FMO habitat in the Deadwood River downstream of the dam (PCE2, PCE 4, PCE 5 and T&C 3.b.).

Connectivity

Fish will typically migrate from summer/fall season habitat to overwintering habitat prior to the onset of winter conditions. Once in overwintering habitat, fish are not typically observed migrating between winter habitats unless conditions dramatically change (i.e., formation of ice in suspension above the bottom of the channel and/or on the bottom of the channel). While migrating to winter habitat, the fish could encounter shallow conditions (PCE 8), but those habitats are not expected to limit migration. The recommended winter discharge of 2.3 cfs would allow more natural water temperatures and stable ice conditions than those observed at the current winter discharge of 50 cfs and minimize the likelihood of fish displacement due to ice (PCE 2). As a result of more stable ice conditions that would allow migration between overwintering habitats (T&C 3.a.), this IM will result in benefits to the quality of FMO habitat in the Deadwood River downstream of the dam.

Stilling Basin Water Quality

Water quality conditions in the stilling basin during this period will be like those described in section 4.3.1.1.1. Reclamation has documented bull trout and rainbow trout residing in the stilling basin during periods of reduced water quality, relying on seeps, springs, and connectivity in/out of the stilling basin when needed. This IM will result in limited adverse seasonal effects to water quality in the stilling basin (PCE 8), but no expected effects to bull trout in this area. The recommended operations will not affect connectivity or availability to FMO habitat.

4.4 Implementation Measure 3: Recommended Operation for Discretionary Spill

To manage discretionary spill operations, Reclamation recommends the guidelines below:

- Use the spillway for discharge when conditions allow.
- If spill occurs, modulate river water temperature using a combination of water released from the outlet valves and spillway. A combination of release locations will allow water temperature to more closely resemble unregulated conditions. Mix the two water sources to minimize water temperature changes greater than 5°C per 12-hour period and aim to not exceed a maximum water temperature of 15°C.

4.4.1 Effects of Implementation Measure

Discretionary spill is the period when reservoir elevation reaches the spillway and when releases through the outlet valves are managed so that water flows over the spillway. Water management that allows discretionary spill is one of only two measures that can be taken to manage water temperature for the benefit of bull trout and their prey base. The period of discretionary spill is most likely to result in river water temperatures more closely aligned with unregulated conditions; cooler reservoir water temperatures during the summer and fall; and entrainment in the fall through the outlet valves at the dam.

4.4.1.1 Water Temperature in Reservoir

Warm weather patterns during the irrigation season can result in reservoir temperatures increasing to a level that causes bull trout to migrate from the reservoir. Reservoir water temperature warming occurs because the coldest water (located in the lower water layer) is discharged during the irrigation season. This leaves the warmer upper water layer to continue to warm until the entire water column exceeds Idaho Department of Environmental Quality standards for cold water life.

Reclamation has identified that filling the reservoir to the level that allows warm water to be released over the spillway (in the spring) will increase the layer of cold water in the reservoir and minimize the occurrences of all cold water being discharged from the reservoir during the summer or fall. Spillway discharge has been limited to non-discretionary use because of the potential for bull trout to be entrained. However, data from the Flexibility Study show that total

annual entrainment could be reduced by spillway use (T&C 3.e.). In turn, increased spillway use could result in more cool water habitat in the reservoir to benefit bull trout during warm weather patterns (Reclamation 2016 revised, Section 6.2).

Reclamation has shown that entrainment can occur with either spillway or outlet valve releases. These IMs will not change the possibility of entrainment, but, entrainment frequency is expected to be reduced due to overall benefits to the reservoir water temperature. Entrainment was previously thought to be limited to periods when water flows over the spillway. Yet, sampling since 2005 suggests that entrainment is likely to also occur through the outlet valves. Reclamation's analyses were not able to distinguish seasonal entrainment patterns and no tagged fish were documented being entrained.

This IM is expected to result in cooler water temperatures, which are beneficial to bull trout in the summer and fall (PCE 5). Cooler water temperatures allow bull trout to use more habitat throughout the reservoir (PCE 4). Warmer water temperatures, when present, may limit the distribution of bull trout to isolated areas of cooler, deeper water, like the forebay, where the potential for entrainment is increased.

4.4.1.2 Water Temperatures in Deadwood River Downstream of the Dam

Water temperatures in the Deadwood River downstream of the dam vary from what would be expected in an unregulated system. Water temperature influences multiple parameters that directly and indirectly affect bull trout, such as migratory behavior, thermal refuge, prey availability, and water quality, among others. Stream temperatures change seasonally due to solar radiation, tributary inputs and other weather related variables, as well as discharge from the dam (Reclamation 2016 revised). Deadwood Dam has three sources of discharge described in Chapter 3 of this report.

The spillway is one of the three sources of discharge at Deadwood Dam, but use of the spillway is dependent on reservoir volume and is not possible every year. Use of the spillway has ranged from 16 to 64 days (Reclamation 2016 revised) prior to restricted use as directed by T&C 3.e of the 2005 Opinion and required flood control. When flood control regulations require the spillway to be used (non-discretionary), the outlet valves are typically also used. The use of both sources of discharge simultaneously allows reservoir volume to be quickly reduced and spillway use minimized. Discretionary use of the spillway would provide an opportunity for warmer, well-oxygenated water from the upper water layer of the reservoir to be mixed with cooler deep-water releases from the outlet valves. The mix of spillway flows and outlet valve releases can be adjusted to produce water temperatures that resemble unregulated conditions. This IM, when in practice, helps to maintain a beneficial water temperature (PCE 5, T&C 3.b. and T&C 3.d.) by managing flows to provide a more unregulated water temperature profile during the time of spillway flows. This beneficial water temperature profile provides a metabolic advantage and increased fitness for bull trout and their prey base. Additionally, the ability to use discretionary spill (Section 4.4), will have a beneficial effect in the summer and fall by reducing the volume of warm water in the reservoir and the possibility of discharge into the river exceeding 15 °C in the fall (PCE 5).

5 SUMMARY OF EFFECTS OF RECLAMATION'S IMPLEMENTATION MEASURES

Reclamation has considered results from the Flexibility Study to provide more precise detail and data than was previously available and used to develop the IMs. However, not all the IMs are expected to have an effect of a different degree or nature than was previously considered in the 2005 and 2014 Opinions. Effects of the IMs are summarized in Table 5-1 and Table 5-2 and describe effects that differ from those described in the 2005 and 2014 Opinions.

5.1 Summary of Effects on Bull Trout Critical Habitat Primary Constituent Elements

In 2010, the USFWS designated bull trout critical habitat in the project area per the Endangered Species Act and regulations at 50 CFR 424.12(b). Since bull trout as a species were designated prior to bull trout critical habitat, Reclamation conducted separate consultations with the USFWS for each (USFWS 2005 and USFWS 2014). Despite the two separate consultations, effects of the IMs outlined in this document affect both bull trout and bull trout critical habitat.

USFWS identified nine bull trout critical habitat PCEs determined to be essential to bull trout survival and which may require special management considerations or protection. The effects of Reclamation's IMs on each bull trout critical habitat PCE as compared to the environmental baseline are summarized in Table 5-1. Reclamation's IMs are analyzed for the three locations where the critical habitat action area overlaps with the Southwest Idaho River Basin Critical Habitat Unit 26 (Figure 1-2). This analysis is similar to the approach in the 2013 Assessment (Reclamation 2013).

Table 5-1. Effects of Reclamation's IMs for operations of Deadwood Dam on each bull trout critical habitat Primary Constituent Element (PCE) compared to the environmental baseline. IMs are defined as follows: Implementation Measure 1 (IM1) = Ramp Up in the Spring; Implementation Measure 2 (IM2) = Ramp Down in the Fall; Implementation Measure 3 (IM3) = Non-irrigation Season Stable Discharge; Implementation Measure 4 (IM4) = Discretionary Spill.[1]

PCE No.	PCE Description (Abbreviated)	Effects of the IMs			Boise Project
		Deadwood Reservoir	Deadwood River Downstream of the Dam	South Fork Payette River	
PCE 1	Springs, seeps, groundwater sources	Insignificant[2]	Insignificant	Insignificant	No effect
PCE 2	Migration habitats with minimal impediments	IM2: Beneficial IM3: Beneficial	IM3: Seasonally adverse	Insignificant	No effect
PCE 3	Abundant food base	IMs collectively beneficial[3]	IM2: Beneficial	Insignificant	No effect
PCE 4	Complex river, stream, lake, and reservoir aquatic environments and process	IM3: Beneficial IM4: Beneficial	Insignificant	Insignificant	No effect
PCE 5	Water temperatures ranging from 2°-15°C with adequate thermal refuge	IM2: Beneficial IM3: Beneficial IM4: Beneficial	IM3: Beneficial	Insignificant	No effect
PCE 6	Spawning/rearing substrate	Not present	Not present	Not present	Not present
PCE 7	A natural (unregulated) hydrograph or, if flows are controlled, minimal flow departure from a natural hydrograph	Not present	Insignificant	Insignificant	No effect
PCE 8	Sufficient water quality and quantity	IM2: Beneficial IM3: Beneficial	IM3: Seasonally adverse	Insignificant	No effect
PCE 9	Sufficiently low levels of non-native predatory, interbreeding, or competing species	Insignificant	IMs collectively beneficial	Insignificant	No effect

[1] For definitions of key terms in Table 5-1, reference 50 CFR 424.12(b).

[2] In Reclamation's 2013 Biological Assessment, "Insignificant" is defined as, "Where a proposed action influences, but does not alter the function of a PCE" (Reclamation 2013).

[3] "Collectively beneficial" is cited if holistic benefits are observed when the IMs are collectively implemented.

5.2 Summary of Effects on Bull Trout Terms and Conditions

The 2005 Opinion has five terms and conditions for the operations of Deadwood Dam that were developed to minimize incidental take. The effects of Reclamation's IMs on each bull trout critical habitat term and condition, as compared to the environmental baseline, are summarized in Table 5-2.

Table 5-2. Effects of Reclamation's IMs for operations of Deadwood Dam on each bull trout Term and Condition (T&C) compared to the environmental baseline. IMs are defined as follows: Implementation Measure 1 (IM1) = Ramp Up in the Spring; Implementation Measure 2 (IM2) = Ramp Down in the Fall; Implementation Measure 3 (IM3) = Non-irrigation Season Stable Discharge; Implementation Measure 4 (IM4) = Discretionary Spill.

T&C No.	T&C Description (Abbreviated)	Effects of the IMs			Boise Project
		Deadwood Reservoir	Deadwood River Downstream of the Dam	South Fork Payette River	
3.a.	Determine whether there is flexibility within the action as proposed to operate Deadwood Dam to reduce the effects to bull trout when winter streamflows in the Deadwood River below Deadwood Dam are less than inflows to Deadwood Reservoir upstream.	IMs collectively beneficial[1]	IM3: Beneficial	Insignificant	No effect
3.b.	Determine whether there is flexibility within the action as proposed to operate Deadwood Dam to reduce harm and harassment of bull trout associated with extreme low temperatures in the river below the dam.	IMs collectively beneficial	IM2: Beneficial IM3: Beneficial IM4: Beneficial	Insignificant	No effect
3.c.	Determine and implement ramping rates for both increases and decreases of flow that reduce harassment and harm of bull trout in the Deadwood River below Deadwood Dam.	IMs collectively beneficial	IM2: Beneficial	Insignificant	No effect

T&C No.	T&C Description (Abbreviated)	Effects of the IMs			Boise Project
		Deadwood Reservoir	Deadwood River Downstream of the Dam	South Fork Payette River	
3.d.	Determine whether there is flexibility within the action as proposed to manage flows from Deadwood Dam, particularly during the spring, to minimize take associated with disruption of bull trout biological processes, particularly migratory cues.	IMs collectively benefit	IM3: Beneficial IM4: Beneficial	Insignificant	No effect
3.e.	Minimize the frequency, duration, and extent of discharge of water over the spillway at Deadwood Dam.	IM3: Beneficial IM4: Beneficial	IM3: Beneficial IM4: Beneficial	Insignificant	No effect

[1] "Collectively beneficial" is cited if holistic benefits are observed when the IMs are collectively implemented.

6 CONCLUSIONS OF THE EFFECTS OF RECLAMATION'S IMPLEMENTATION MEASURES ON BULL TROUT AND BULL TROUT CRITICAL HABITAT

The interrelated nature of effects from individual dam operations and multiple terms and conditions makes it complex to develop IMs that operate holistically (Figure 1-1). Individually, many IMs have an insignificant effect on the PCEs or terms and conditions; however, when implemented collectively, the IMs provide holistic benefits to each of the action areas.

Baseline conditions (current reservoir operations) support a stable, and at times increasing, population of migratory bull trout. Under Reclamation's IMs, the operations of Deadwood Dam will, to the extent possible, maximize conditions (PCEs) that are essential to the conservation of the species (Terms and Conditions) as defined by the USFWS. These IMs balance the interactions between the reservoir and river and result in benefits for both bull trout and bull trout critical habitat as compared to baseline conditions, even with the uncertainty of variable climate conditions.

Reclamation has concluded that the measures recommended in this document will minimize the effect and/or amount of incidental take associated with operation of Deadwood Dam, representing the best operational plan for bull trout. Reclamation recognizes that implementation of these measures will require additional consultation with the USFWS to update the Incidental Take Statement through the duration of the 2005 Opinion.

7 MONITORING AND REPORTING PLANS

7.1 Monitoring Plan through Year 2034

Reclamation will develop a Monitoring Study Plan prior to implementing these IMs. The Monitoring Study Plan will provide specific guidance to satisfy monitoring requirements in the 2005 Opinion and the 2014 Opinion and will supersede previous monitoring guidelines outlined in the 2006 Monitoring and Implementation Plan (Reclamation 2006).

7.1.1 Monitoring of Deadwood Reservoir

Monitoring guidance for the Deadwood Reservoir will incorporate measures to monitor IMs provided in this document and may include the parameters outlined in Table 7-1.

Table 7-1. Possible monitoring guidance for Reclamation's IMs for the Deadwood Reservoir.

Implementation Measures	Possible Monitoring Guidance
Spring Ramp Up	Monitor water temperature in the forebay. Collaborate with local natural resource agencies to monitor the fish community and/or habitat.
Fall Ramp Down	Monitor depth and length of varial zones. Collaborate with local natural resource agencies to monitor the fish community and/or habitat.
Non-irrigation Season Stable Discharge Flows	Compare the size and age class of bull trout captured during trap and transport efforts to records of previously captured bull trout.
Discretionary Spill	Monitor water temperature in the forebay and tailrace downstream of the mixing zone. Collaborate with local natural resource agencies to monitor the fish community and/or habitat.

7.1.2 Monitoring of the Deadwood River Downstream of the Dam

Monitoring guidance for the Deadwood River downstream of the dam will incorporate measures to monitor IMs provided in this document and may include the parameters and frequency of data collection outlined in Table 7-2.

Table 7-2. Possible monitoring guidance for Reclamation's IMs for the Deadwood River downstream of the dam.

Implementation Measures	Possible Monitoring Guidance
Spring Ramp Up	Monitor water temperature at gage locations. Collaborate with local natural resource agencies.
Fall Ramp Down	Monitor water temperature at gage locations. Collaborate with local natural resource agencies.
Non-irrigation Season Stable Discharge Flows	Compare the size and age class of bull trout captured during trap and transport efforts to records of previously captured bull trout. Monitor ice conditions downstream of the dam. Monitor water quality conditions in the stilling basin. Collaborate with local natural resource agencies.
Discretionary Spill	Monitor water temperature at gauge locations. For up to 5 years following IM implementation, trap and transport bull trout to assess dam operation effects on entrainment.

7.2 Reporting Plan through Year 2034

Reporting for the Deadwood Dam operations will continue to follow the reporting schedule through 2034 specified in the 2005 Opinion.

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