RECLAMATION

Managing Water in the West

Biological Assessment for Bureau of Reclamation Operations and Maintenance in the Snake River Basin above Brownlee Reservoir on Snake River Physa Snail (*Haitia [Physa] natricina)*

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

September 2014

U.S. DEPARTMENT OF THE INTERIOR

The mission of the Department of the Interior is to protect and provide access to our Nation's natural and cultural heritage and honor our trust responsibilities to Indian tribes and our commitments to island communities.

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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.

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Acronyms and Abbreviations

ADCP	Acoustic Doppler Current Profile
BA	Biological Assessment
BCSD	Bias Correction Spatial Disaggregation
BID	Burley Irrigation District
BiOp	Biological Opinion
BPA	Bonneville Power Administration
CFR	Code of Federal Regulations
cfs	cubic feet per second
Corps	U.S. Army Corps of Engineers
CWA	Clean Water Act
EA	Environmental Assessment
EFH	essential fish habitat
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
ESA	Endangered Species Act
FERC	Federal Energy Regulatory Commission
FONSI	Finding of No Significant Impact
FR	Federal Register
GCM	global climate (circulation) model
IDEQ	Idaho Department of Environmental Quality
ITS	Incidental Take Statement
LW/D	less warming and drier
LW/W	less warming and wetter

MC	minimal change
MID	Minidoka Irrigation District
MW	megawatt
MW/D	more warming and drier
MW/W	more warming and wetter
NEPA	National Environmental Policy Act
NOAA Fisheries	National Oceanic and Atmospheric Administration National Marine Fisheries Service
O&M	operation and maintenance
Reclamation	U.S. Bureau of Reclamation
RM	river mile
RMJOC	River Management Joint Operating Committee
ROD	Record of Decision
SCADA	Supervisory Control and Data Acquisition
Term Sheet	Nez Perce Term Sheet
TMDL	Total Maximum Daily Load
TP	Total Phosphorus
TSS	Total Suspended Solids
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UWCIG	University of Washington Climate Impact Group

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Chapter 1 OVERVIEW

1.1 Purpose of the Biological Assessment

The Endangered Species Act (ESA) sets out a comprehensive program for the protection of threatened and endangered species and their habitats. Section 7 (a)(2) of the ESA requires federal agencies to consult with either the U.S. Fish and Wildlife Service (USFWS) or National Marine Fisheries Service (NOAA Fisheries) on any federal action that may affect listed species (50 CFR § 402.12; 16 USC § 1536 (a)(2)). The U.S. Bureau of Reclamation (Reclamation) has prepared this Biological Assessment (BA) to assess the effects of the operation and maintenance (O&M) of Reclamation Projects in the upper Snake River basin above Brownlee Reservoir on Snake River physa (*Haitia (Physa) natricina*).

This BA is a companion document to the *Biological Assessment for Bureau of Reclamation Operation and Maintenance in the Snake River Basin above Brownlee Reservoir* (2004 Upper Snake BA) and addresses impacts to the Snake River physa due to long-term O&M of 11 federal actions in the upper Snake River basin above Brownlee Reservoir. Generally, these operations remain unchanged from those considered in the 2004 Upper Snake BA.

Further, this BA provides analysis of changes to the operations of the Minidoka Dam spillway and powerplant that will occur after the construction of the new spillway is complete in March 2015.

The new spillway will provide greater flexibility in how water passes through Minidoka Dam, but will not alter overall operations in the Snake River above Milner Dam. This document provides a detailed description of these operations in Chapter 2. Minidoka Dam is located on the Snake River in south-central Idaho (Figure 1-1).

This BA fulfills the requirements of 50 CFR 402.14(c), and the *Endangered Species Consultation Handbook: Procedures for Conducting Consultation and Conference Activities under Section 7 of the Endangered Species Act* (USFWS and NOAA Fisheries 1998).

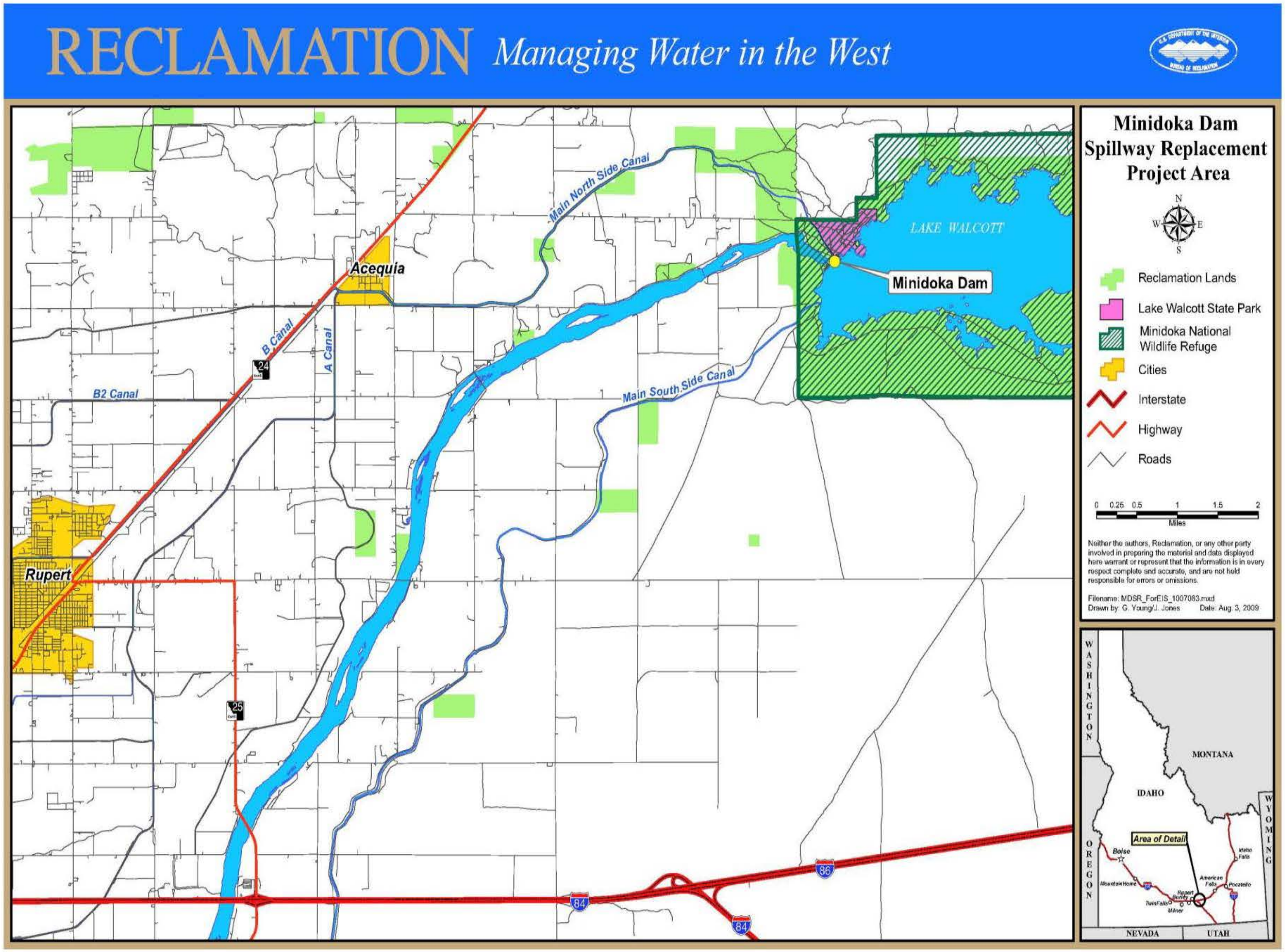

Figure 1-1. Minidoka BA project area.

1.2 Background and Consultation History

In March 2005, Reclamation received a biological opinion (2005 BiOp) from USFWS (USFWS 2005) that concluded that Reclamation's proposed actions in the upper Snake River basin were not likely to jeopardize the continued existence of bald eagles, Utah Valvata snail, Snake River physa snail, Bliss Rapids snail, bull trout, and the Ute ladies'-tresses.

The Incidental Take Statement in the 2005 BiOp did not quantify take of Snake River physa because "inadequate information exist[ed] about whether and where the species presently occurs in the Minidoka reach to accurately predict specific impacts of the action to the Snake River physa" and "[w]ithout that information it is not possible to anticipate whether or what incidental take is reasonably certain to result from the actions" (USFWS 2005, p. 162).

To resolve this uncertainty, Reclamation proposed to survey the Snake River below Minidoka Dam. The purpose of these surveys was twofold: 1) to determine if snails matching the species description (Taylor 2003) existed within the Minidoka reach of the Snake River (river mile [RM] 663 to RM 675); and 2) if found, to determine if the Snake River physa is a distinct species or a phenotypic variant of another species in the family Physidae. Following additional surveys from 2006 through 2008, Reclamation positively identified Snake River physa in the Minidoka reach as well as the Minidoka Dam spillway area and determined the species to be distinct.

After completion of the survey effort, Reclamation entered into consultation with the USFWS for the Minidoka Dam spillway replacement project. This project proposed to replace the existing spillway structure with one that allowed greater operational flexibility between the spillway and power generation facilities of Minidoka Dam. Reclamation is currently in the process of replacing the spillway portion of Minidoka Dam and anticipates project completion on March 31, 2015.

Reclamation reinitiates formal consultation due to new information confirming the presence of the ESA-listed Snake River physa in the Minidoka Dam spillway, the Snake River below Minidoka Dam, and the Snake River below Swan Falls Dam, as well as the operational flexibility now provided by the new spillway structure. Therefore, Reclamation has prepared this BA to address the long-term O&M of its facilities located above Brownlee Reservoir, including potentially new operations at Minidoka Dam and spillway. The proposed long-term O&M of the new structure is being addressed separately to better align with ongoing actions associated with the long-term O&M of the current USFWS 2005 BiOp.

1.2.1 Relationship to Existing Biological Opinions

In November 2004, Reclamation initiated consultation with USFWS and NOAA Fisheries on the effects of routine O&M of the Reclamation projects in the Snake River basin above

Brownlee Reservoir (Reclamation 2004a), in part to address changes in operations resulting from Reclamation's salmon flow augmentation commitments under the Nez Perce Water Rights Settlement. Reclamation received a BiOp from NOAA Fisheries and USFWS in March, 2005. After litigation, the 2005 NOAA Fisheries BiOp was remanded for additional analysis. After preparation of a second BA, (2007 Upper Snake BA) Reclamation received a BiOp from NOAA Fisheries in May 2008. Each BiOp provided ESA coverage on Reclamation's upper Snake River operations through 2034, the duration of the Nez Perce Water Rights Settlement.

This current BA is a companion document to Reclamation's 2004 Upper Snake BA. Total system operations will be consistent with the 2004 and 2007 Upper Snake BAs and as described in the respective BiOps (USFWS 2005; NOAA Fisheries 2008). The general descriptions of the proposed actions in Chapter 2 of the 2004 Upper Snake BA also remain the same and are herein incorporated by reference (Reclamation 2004a, p 11-28.)

1.3 Proposed Actions

The 2004 Upper Snake BA documented 11 proposed actions, comprising the O&M of 12 federal Reclamation projects in the upper Snake River basin: the Baker, Boise, Burnt River, Little Wood River, Lucky Peak, Mann Creek, Michaud Flats, Minidoka, Owyhee, Palisades, Ririe, and Vale Projects (Reclamation 2004, p.2). Some of these projects consist of multiple divisions on separate rivers. Reclamation does not coordinate operation among all 12 projects, but rather operates divisions, projects or groups of projects independently of each other. Therefore, some actions reflect the operations of only a single project and other actions encompass the integrated operation of multiple divisions of a project or multiple projects.

Because Snake River physa occur in the Snake River at multiple locations, this BA addresses the effects of all 11 proposed actions, collectively referred to as the Future O&M of facilities above Brownlee Reservoir. However, not all actions may affect the same areas of the Snake River. Accordingly, this document breaks these proposed actions into the following actions:

- Future O&M in the Snake River system above Milner Dam. This includes the long-term operation of the features and facilities of the Michaud Flats, Minidoka, Palisades, and Ririe Projects.
- Future O&M of all projects above Brownlee Reservoir, including those in the Little Wood River, Owyhee, Boise, Payette, Malheur, Mann Creek, Burnt River, and Powder River systems.
- Future provision of salmon flow augmentation from rental or acquisition of natural flow rights.

As part of the operations of the Minidoka spillway, Reclamation also proposes to change the way it partitions flow between the powerplant and spillway at Minidoka Dam. Using the iterative adaptive management approach identified in Reclamation's *Final Environmental Impact Statement (EIS), Minidoka Dam Spillway Replacement, Minidoka Project, Idaho* (Reclamation 2010a), Reclamation will adjust flow partitioning at Minidoka Dam and spillway and identify impacts to the Snake River physa located within the spillway area. These changes only affect conditions in the immediate vicinity of Minidoka Dam.

The only changes from Reclamation's 2004 Upper Snake BA identified in this 2014 BA are specific to how water will pass through the newly constructed facilities at Minidoka Dam. These changes only affect conditions in the spillway area. Overall system management and accounting will stay consistent with Reclamation's current operations, as described in both the 2004 and 2007 Upper Snake BAs.

1.4 Action Area

The analysis contained in this BA will be broken into 3 distinct segments based on Reclamation's operational impacts to each specific reach of the Snake River, and the amount and type of relevant data available to Reclamation for analysis. Reclamation now has enough information to complete the following analyses for Snake River physa in the three segments of the Snake River above Brownlee Reservoir listed below:

1. Conduct a detailed analysis of Reclamation's impacts to Snake River physa in the 11.5-mile reach starting at Minidoka Dam and extending downstream to the I-84 Bridge (RM 663) (Figure 1-2);
2. Conduct a detailed analysis of Reclamation's impacts to Snake River physa in the spillway area located below the spillway structure of Minidoka Dam (Figure 1-3);
3. Prepare a general, qualitative discussion of Reclamation's hydrologic impacts to physa in the Snake River from Milner Dam downstream to above Brownlee Reservoir (Figure 1-4).

Milner pool, the portion of the Snake River between I-84 Bridge and Milner Dam, was excluded from the analysis due to lack of suitable habitat.

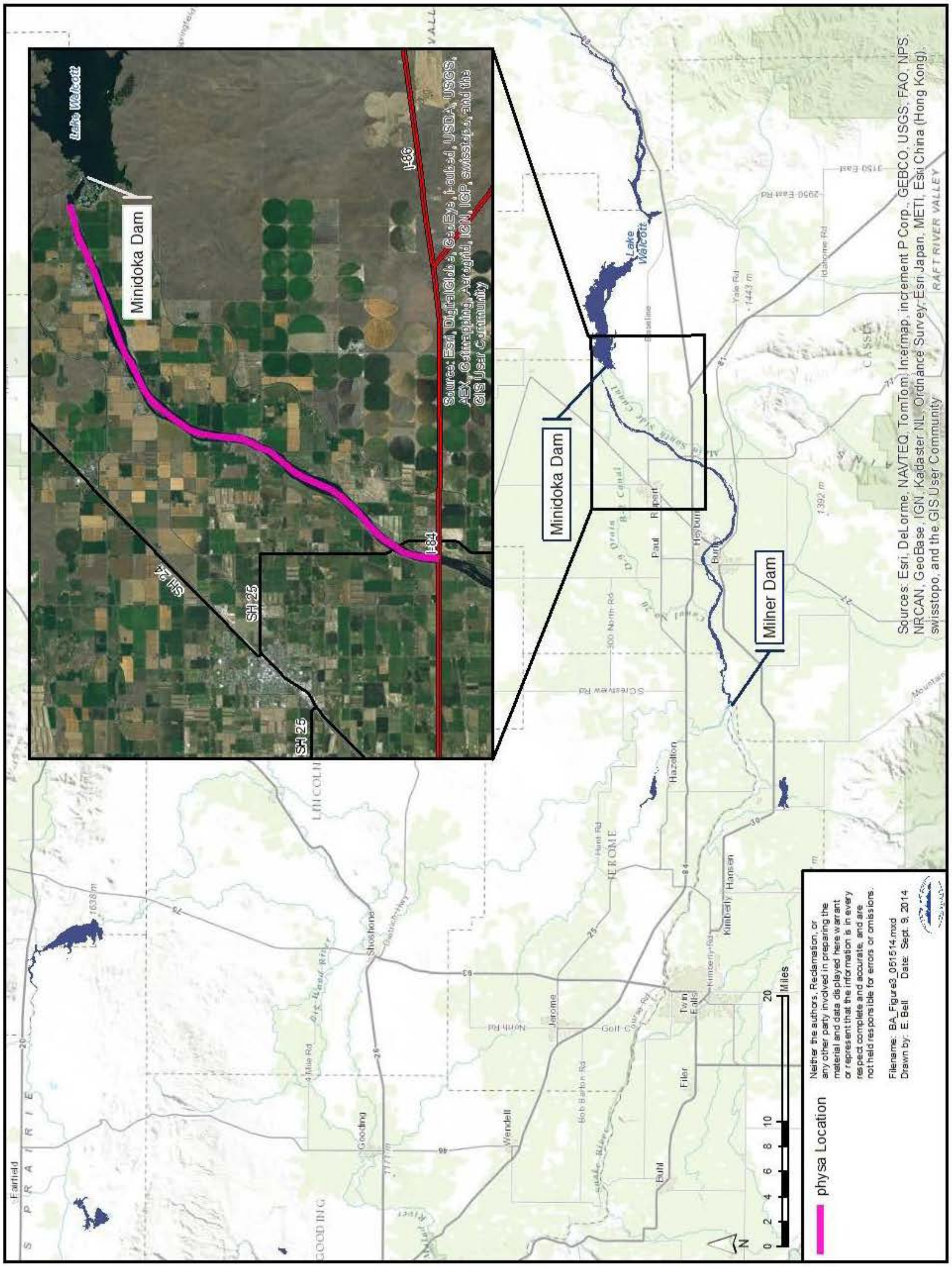

Figure 1-2. Reclamation's Snake River physa Segment 1 analysis area (11.6-mile reach starting at Minidoka Dam and extending downstream to the I-84 Bridge).

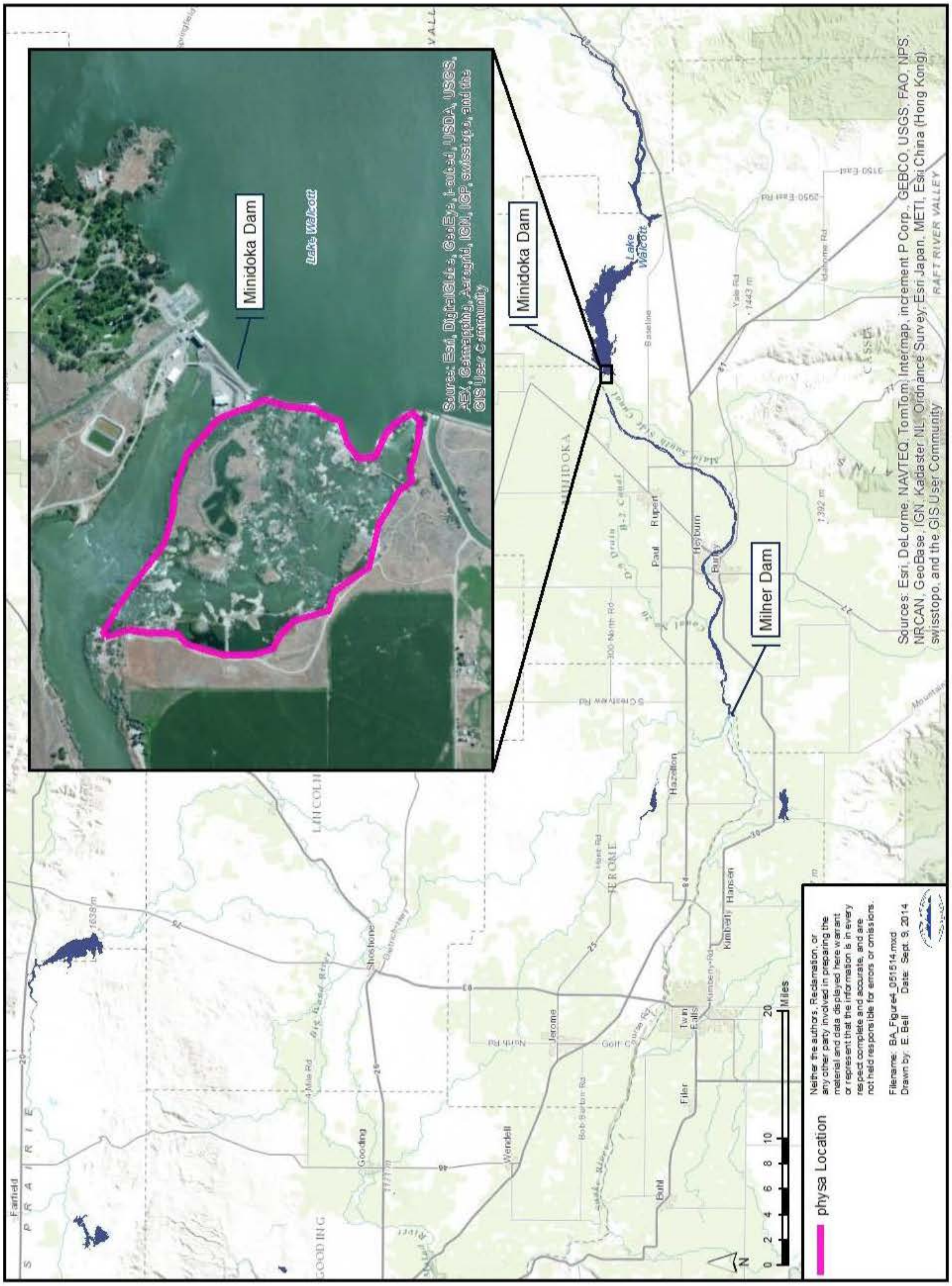

Figure 1-3. Reclamation's Snake River physa Segment 2 analysis area (spillway area located below Minidoka Dam).

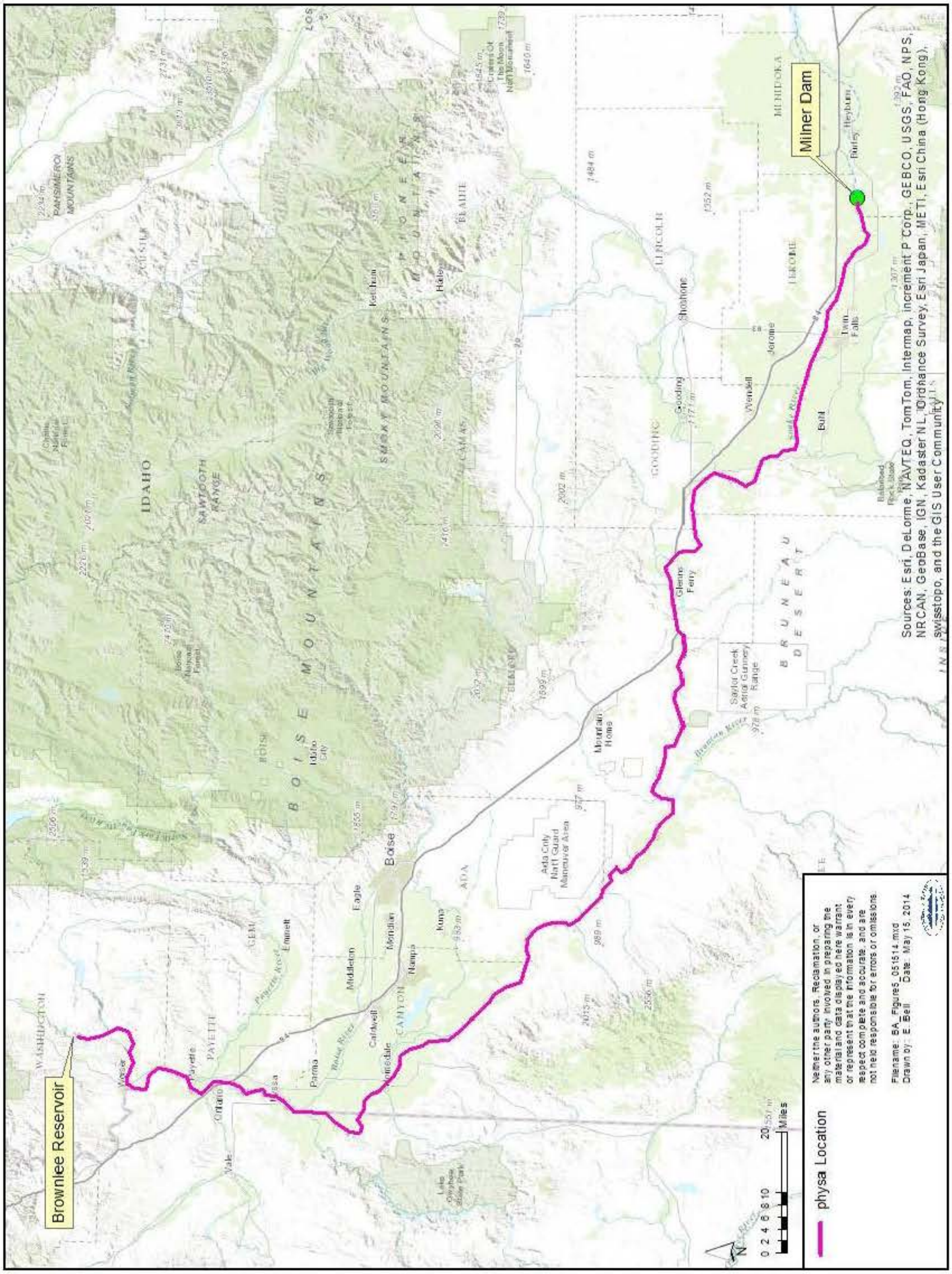

Figure 1-4. Reclamation's Snake River physa Segment 3 analysis area (Snake River from Milner Dam downstream to above Brownlee Reservoir).

1.5 Duration of the Proposed Action

The duration of the proposed action is 20 years (2015 through December 31, 2034). This is the period contemplated by Section III (the Snake River Flow Component) of the April 2004 Nez Perce Term Sheet (Term Sheet) for the proposed settlement of the federal water right claims of the Nez Perce Tribe in the Snake River Basin Adjudication (Nez Perce Tribe et al. 2004). The Term Sheet applies, in part, to those actions involving the operation of the Reclamation projects located in Idaho.

1.6 Effect Determinations for Snake River physa

This BA analyzes the effects of its proposed actions on Snake River physa, taking into account new information available since the 2004 Upper Snake BA and operational changes at the Minidoka Dam spillway.

In accordance with the provisions of the ESA-implementing regulations and the USFWS and NMFS Section 7 Handbook (USFWS and NOAA Fisheries 1998), Reclamation used the following definitions to make its effects determinations:

> **May affect –** The appropriate conclusion if the federal agency determines its proposed action may pose effects on listed species or designated critical habitat. The federal agency must also determine whether the effects constitute an adverse effect as defined below.
>
> **Not likely to adversely affect (NLAA) –** The appropriate conclusion when effects on listed species are expected to be discountable, insignificant, or completely beneficial. Beneficial effects are contemporaneous positive effects without any adverse effects to the species. Insignificant effects relate to the size of the impact and should never reach the scale where take occurs. Discountable effects are those extremely unlikely to occur. Based on best judgment, a reasonably informed person would not: (1) be able to meaningfully measure, detect, or evaluate insignificant effects; or (2) expect effects to occur.
>
> **Likely to adversely affect (LAA) –** The appropriate conclusion if any adverse effect to listed species that may occur as a direct or indirect result of the proposed action or its interrelated or interdependent actions, and the effect is not discountable, insignificant, or beneficial. In the event the overall effect of the proposed action is beneficial to the listed species, but is also likely to cause some adverse effects, then the proposed action "is likely to adversely affect" the listed species. If incidental take is anticipated to occur as a result of the proposed action, an "is likely to adversely affect" determination should

be made. This determination of "is likely to adversely affect" would require the initiation of formal Section 7 consultation.

In summary, Future O&M in the Snake River System above Milner Dam **may affect and is likely to adversely affect** Snake River physa in Minidoka Spillway and the Snake River from Minidoka Dam downstream to the I-84 Bridge. Below the I-84 Bridge, effects of this action will be insignificant and not likely to adversely affect Snake River physa in the Snake River between Milner Dam and Brownlee Reservoir.

The remaining 10 actions in the Snake River basin above Brownlee Reservoir and the provision of salmon flow augmentation **may affect, but are not likely to adversely affect** Snake River physa anywhere in the action area.

Table 1-1. Effects summary for Snake River physa in the three segments of the Snake River above Brownlee Reservoir.

	Minidoka Dam to I-84 Bridge	Minidoka Spillway	Milner Dam to Brownlee Reservoir
O&M in Snake River Above Milner	**LAA**	**LAA**	NLAA
O&M above Brownlee (remaining 10 proposed actions)	No Effect	No Effect	NLAA
Salmon Flow Augmentation	NLAA	No Effect	NLAA

1.7 How to Read This Document

This BA has been written to:

- Document analysis of the effects of the proposed actions on ESA-listed species and designated critical habitat.
- Request formal consultation for "likely to adversely affect" conclusions.
- This document does not present the effects on essential fish habitat (EFH) as required under the Magnuson-Stevens Fishery Conservation and Management Act, as no EFH exists in the action area.

The introductory section contains a list of acronyms and abbreviations, the frontispiece, and the table of contents.

Chapter 1 provides the preliminary information and background on this ESA Section 7 consultation.

Chapter 2 describes the proposed actions and action areas.

Chapter 3 covers the current hydrologic and water quality conditions in the Snake River from Minidoka Dam downstream to above Brownlee Reservoir, including the operation of the newly constructed Minidoka Dam spillway and the hydrologic and water quality conditions within the spillway area. In addition, it contains the baseline information for the Snake River physa analysis.

Chapter 4 provides baseline information and analysis on Snake River physa within the action area. It also summarizes the effects of the action on Snake River physa.

Chapter 5 contains a list of literature cited for this BA.

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Chapter 2
DESCRIPTION OF THE PROPOSED ACTION

2.1 Introduction

Reclamation's proposed action for the upper Snake River operations as described in the 2004 Upper Snake BA will remain largely unchanged with one potential modification. The operations specific to seasonal partitioning of flows between Minidoka Dam powerplants and spillway, as described in previous consultations, will be altered through an iterative adaptive management approach (Reclamation 2010a) where Reclamation will seek lower irrigation season flows within the spillway through implementing adjustments in current flow partitioning and identify subsequent impacts to the Snake River physa located within the spillway area. As the proposed action associated with Minidoka Dam and spillway will involve incremental deviations from current operations, this chapter will include descriptions of current operations at Minidoka Dam and spillway.

2.2 Current System Management

2.2.1 Overview

For the purposes of this document, the upper Snake River basin is the Snake River basin located above Brownlee Dam as described in the *Bureau of Reclamation Operations and Maintenance in the Snake River Basin above Brownlee Reservoir Biological Opinion* (USFWS 2005). Reclamation facilities located in the upper Snake River basin are shown on Figure 2-1. These features and facilities are part of 12 federal projects which include Baker (upper and lower divisions), Boise, Burnt River, Little Wood River, Lucky Peak, Mann Creek, Michaud Flats, Minidoka, Owyhee, Palisades, Ririe, and Vale Projects. Management of these projects is consistent with operations described in Reclamation 2004a, Reclamation 2007, and USFWS 2005. An extensive discussion of the historical flow conditions as it relates to the upper Snake River project facilities and action area can be found in the 2004 Upper Snake BA (Reclamation 2004a).

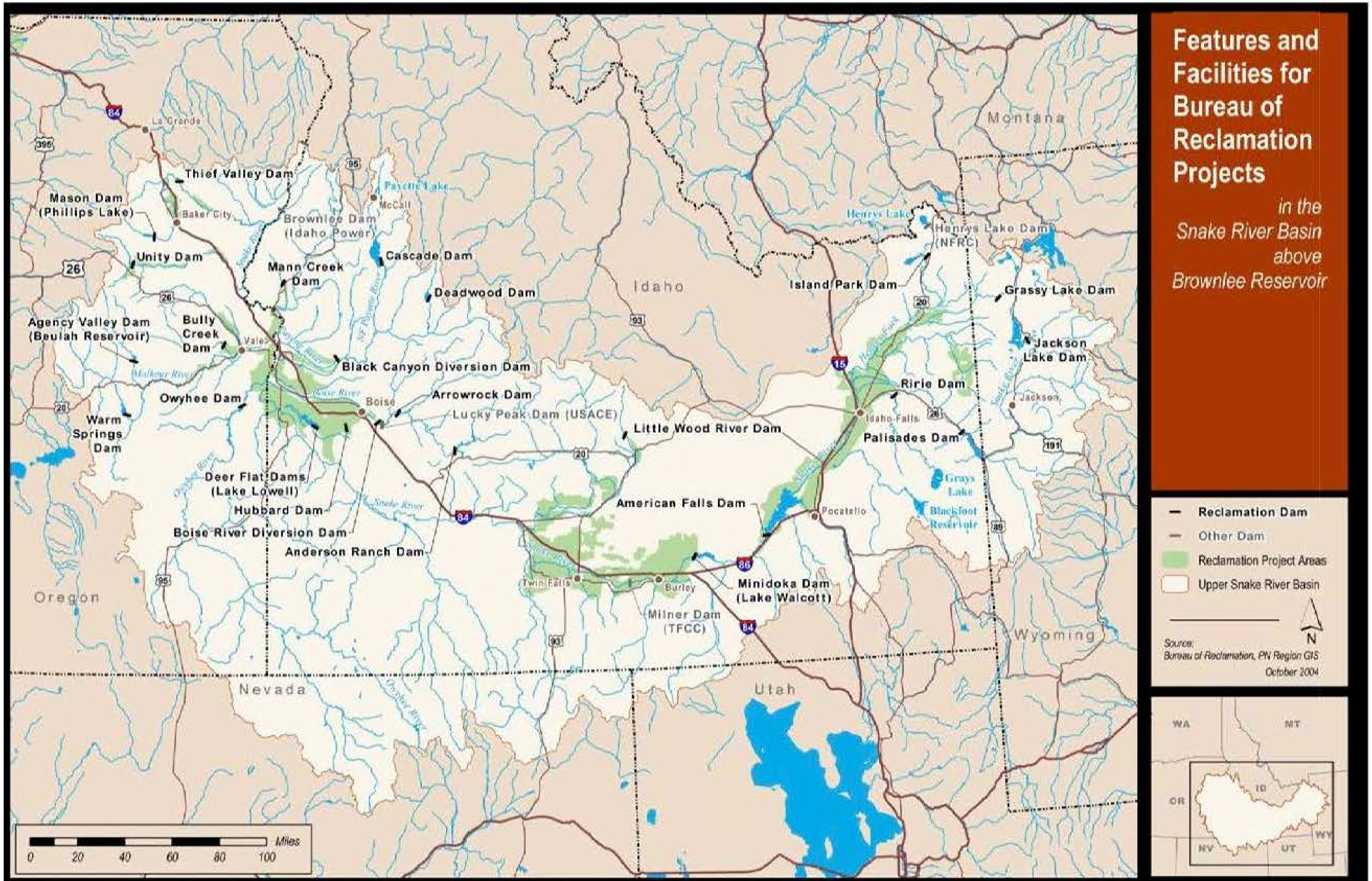

Figure 2-1. Reclamation facilities located in the upper Snake River basin.

2.3 Future O&M in the Snake River System above Milner Dam

As previously stated, future Snake River system, above Milner Dam, flow conditions associated with Reclamation facilities are consistent with those modeled for the 2004 Upper Snake BA and identified in USFWS 2005 BiOp. Overall, upper Snake River system management is anticipated to remain consistent with operations descriptions identified in Reclamation 2004b and USFWS 2005. Changes in flow conditions associated with the new spillway structure located at Minidoka Dam will be specific to the partitioning of flows between the powerhouse and spillway structure only. Flows past Minidoka Dam will continue to be a product of outflow from American Falls Reservoir plus small reach gains (approximately 135 to 190 cfs) and are measured at the U.S. Geological Survey (USGS) gage (USGS 13081500 Snake River near Minidoka Idaho, at Howells Ferry) located less than ½-mile below Minidoka Dam (Figure 2-2).

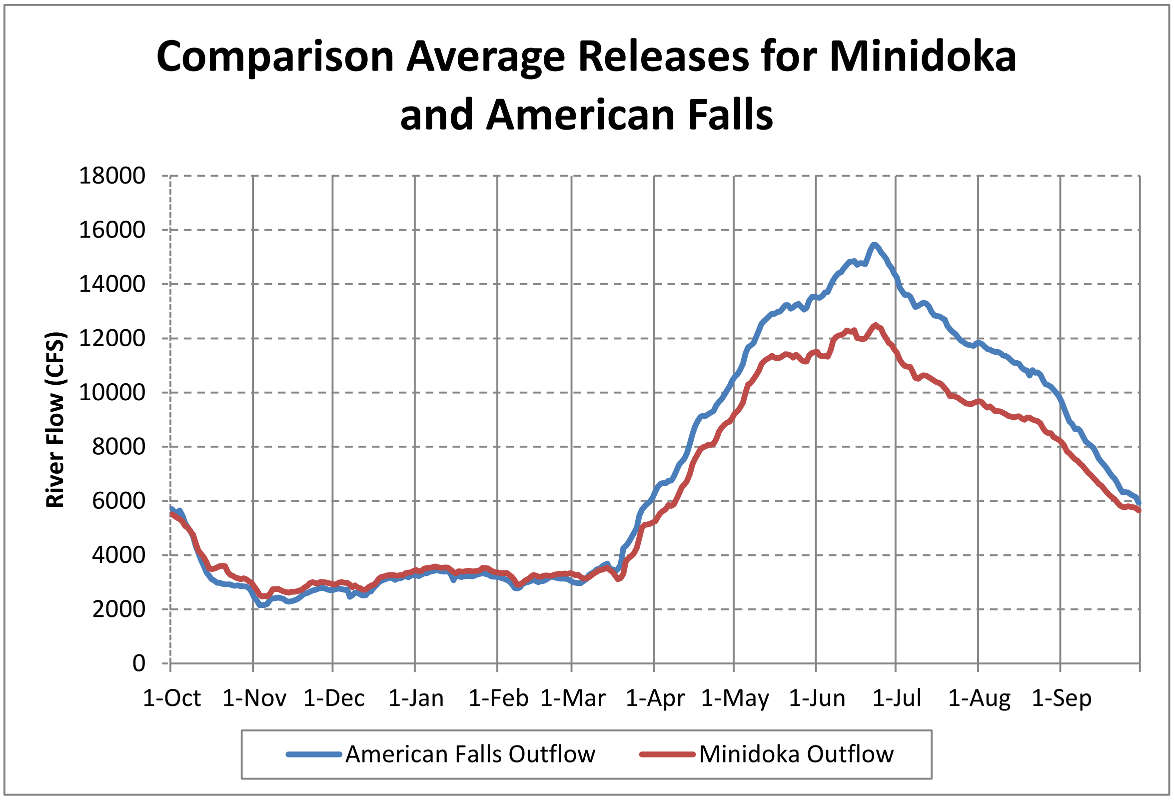

Figure 2-2. Comparison of average outflow from Minidoka and American Falls dams. Note how Minidoka Dam outflow matches American Fall Dam outflow. The reduction in outflow from Minidoka Dam relative to American Falls Dam from April 1 through October 1 is due to diversions into the Northside and Southside canals located at Minidoka Dam.

2.3.1 The New Spillway

Reclamation is currently replacing the spillway and canal headworks at Minidoka Dam to correct structural deficiencies. Reclamation is currently correcting these structural problems, by:

- Replacing the entire spillway portion of Minidoka Dam with a new spillway structure containing an overflow spillway and new radial gates and additional release gates for better control of water releases;
- Installing a new service road below the spillway;
- Installing new embankments along the South Side Canal;
- Replacing both the North Side and South Side canal headworks.

The new structure is a concrete overflow structure. Flows will be controlled through the use of the existing 3 radial-style gates as well as 12 newly constructed radial-style gates located on the southern portion of the spillway structure. The spillway now has four water release points at locations along the spillway to provide flows to the downstream wetlands area. Operation of the new radial gates in the spillway is consistent with the current range of operations and also includes:

- Releases for downstream deliveries beyond the capacity of the powerplants, including flow augmentation for salmon;
- Releases resulting from flood operations;
- Flow passage during load rejection at the powerplants if the existing radial gates become disabled or go off-line for maintenance;
- Biological releases, as determined through the adaptive management process.

The new structure will provide Reclamation with greater flexibility in its management of Minidoka Dam and spillway. Future flows past the facility are described below.

2.3.2 Operation of Spillway

With the new spillway structure, current operational constraints necessary to prevent ice damage will be eliminated. Consequently, Reclamation generally intends to maintain Lake Walcott at its full operational elevation of 4245.0 feet throughout the year. However, in 25 to 50 percent of years, it is expected that irrigation demand, facility maintenance needs, and environmental concerns will require that the reservoir be drafted to elevation 4240.0 feet during the winter months.

The drafting of Lake Walcott will usually be prompted when water deliveries from American Falls Reservoir create a low pool condition (about 100,000 acre-feet of storage) at American

Falls. When low pool conditions exist or appear imminent at American Falls, the Minidoka pool may be drawn down to meet irrigation demands below American Falls. When required, the drafting of Lake Walcott will occur late in the irrigation season (beginning as early as mid-August and lasting through the end of October) by making deliveries to Burley Irrigation District (BID) and Minidoka Irrigation District (MID) and other irrigation deliveries below Minidoka Dam. Once Lake Walcott has been drafted, it will typically remain at the reduced level until mid-March, or as soon as upstream flood operations begin. Refill of Lake Walcott will be accomplished by increased releases from American Falls Reservoir.

Minidoka Dam will continue to be operated as a run-of-the river project. However, during irrigation season, Reclamation will seek to adjust the existing minimum spillway flow. The intent is to increase power generation while continuing to meet the intent of the mitigation requirement for the Inman Powerplant and minimize impacts to Snake River physa located within the spillway area (Reclamation 2010a). Reclamation proposes releases through the spillway be a minimum of 500 cfs during much of the irrigation season as identified in Table 2-1. Releases will be as follows:

- Approximately 50 cfs through each of the four northern-most release points (points labeled 1 and 3 on Figure 2-3).
- At least 300 cfs through one of the radial gates located in the new gated spillway portion of the new structure (Figure 2-3).

Spillway flows would be increased during the irrigation season, when sufficient water is available after powerplant hydraulic capacity is met. It is expected that in most years, Reclamation would have flow greater than 500 cfs in the spillway at some time in the water year due to downstream demand exceeding powerplant hydraulic capacity. Over the last 10 years, all years except 2004 would have had spillway flows exceeding 500 cfs for the entire irrigation season due to downstream demands; 2004 would have had the 500 cfs minimum flow for much of the irrigation season.

Figure 2-3. Minidoka Dam spillway release points.

2.3.3 Adaptive Management

An adaptive management approach is proposed to adjust the minimum flow down to a consistent 500 cfs through the spillway area during much of the entire irrigation season (Table 2-1). Adjustment to the proposed 500 cfs minimum spillway flow will occur over a period of 4 years following construction. This will allow potential impacts to the biological resources within the spillway area to be assessed. The proposed incremental reduction in spillway flows is shown in Table 2-1. Water not being routed through the spillway would be routed through the powerplant. Reclamation will monitor biological resources and collect water quality information at each incremental decrease of flow in order to assess potential impacts associated with the reduction in flow (Reclamation 2010a). While increased power generation is the intent of this change in spillway operations, the new minimum spillway flow will ultimately be established by Reclamation, based on the results of the adaptive management process.

Table 2-1. Current operations and proposed incremental reduction schedule at Minidoka Dam.

	Spillway Flow (cfs)					Powerplant Flow (cfs)				
	2013 current	**2014**	**2015**	**2016**	**2017**	**2013**	**2014**	**2015**	**2016**	**2017**
Nov. 01	<1	<1	<1	<100	<100	400	400	525	525	525
Dec. 01	<1	<1	<1	<100	<100	400	400	525	525	525
Jan. 01	<1	<1	<1	<100	<100	400	400	525	525	525
Feb. 01	<1	<1	<1	<100	<100	400	400	525	525	525
Mar. 01	<1	<1	<1	<100	<100	400	400	525	525	525
Apr. 01	<1,300	<1,300	<1,300	<1,000	<500	<5,035	<5,035	<5,035	<5,335	<5,835
Apr. 15	1,300	1,300	1,300	1,000	500	<8,850*	<8,850	<8,850	<8,850	<8,850
May 01	1,300	1,300	1,300	1,000	500	<8,850	<8,850	<8,850	<8,850	<8,850
June 01	1,300	1,300	1,300	1,000	500	<8,850	<8,850	<8,850	<8,850	<8,850
July 01	1,900	1,900	1,500	1,000	500	<8,850	<8,850	<8,850	<8,850	<8,850
Aug. 01	1,900	1,900	1,500	1,000	500	<8,850	<8,850	<8,850	<8,850	<8,850
Sep. 01	1,300	1,300	1,300	1,000	500	<8,850	<8,850	<8,850	<8,850	<8,850
Sep. 15	<1,300	<1,300	<1,300	<1,000	<500	<5,035	<5,035	<5,035	<5,335	<5,835
Oct. 01	<1,300	<1,300	<1,300	<1,000	<500	400	400	525	525	525

* Irrigation season powerplant flows are highly variable within and among years and are dependent upon several factors. Accurate monthly flows cannot be precisely expressed in a single table. The maximum powerplant capacity at Minidoka Dam is 8,850 cfs.

To replace leakage which currently exists along the existing structure outside of irrigation season, Reclamation may provide seasonally adjusted flows through the new spillway structure at one of the water release points (possibly release point 3, Figure 2-3). A non-irrigation season flow from 1 to 100 cfs may be maintained in the spillway. The non-irrigation season flows would consist of a combination of possible structural leakage and controlled releases. Flows through the spillway would be measured by subtracting powerplant flows from flow data measured at the immediately downstream USGS gage at Howells Ferry (USGS 13081500) as well as conducting physical measurements.

2.3.4 Interagency Technical Team

In anticipation of the Minidoka Dam spillway replacement project, Reclamation convened a Natural Resource Working Group in 2004, comprised of various state and federal agencies with jurisdiction and/or interests in the Minidoka Dam and spillway area. The group met at Minidoka Dam on March 25, 2005 to discuss the spillway replacement project and gather input from resource professionals regarding resource needs and concerns related to the project. The group met annually from 2005 through 2008, at which time Reclamation initiated the environmental analysis for the Minidoka Dam Spillway Replacement project (Final Environmental Impact Statement [EIS]) (73 FR 67206). Although the group did not formally meet after 2008, members were formally involved in project planning and discussions through the National Environmental Policy Act (NEPA). Reclamation held scoping meetings in December of 2008. In December of 2009, the Draft EIS was provided to 95 individuals, organizations, agencies and congressional delegates for review and comment. Public meetings were again held in January 2010.

Reclamation formally established the interagency Technical Team in early 2011, shortly after the Record of Decision (ROD) for the *Minidoka Spillway Replacement Final EIS* was signed, based on commitments made by Reclamation in the EIS. The Technical Team was established to determine monitoring protocols, impact thresholds, and critical minimum-flow criteria for the spillway area for the Snake River physa. The Technical Team has been collecting baseline information, in varying capacities, since 2011 (Reclamation 2012, 2013a, and 2014a). The team consists of representatives from state and federal agencies as well as academia. All data pertaining to ecological resources associated with this project have been, and will continue to be, provided to this team until final spillway flows have been established.

In the *Minidoka Dam Spillway Replacement Project Final EIS*, Reclamation proposed to reduce irrigation season spillway flows to 500 cfs in order to boost power production for much of the season; however, this flow will be ultimately determined by Reclamation managers utilizing guidance and information provided by the Technical Team. The Technical Team provides a forum so natural resource professionals can evaluate the Minidoka spillway area, determine baseline conditions, and identify indicators or thresholds relative to the respective biotic resources within the area. The Technical Team designed the adaptive management approach to identify the current status of the spillway area and will develop indicators or thresholds, as well as continue collecting information throughout the duration of the incremental flow reduction sequence. The new spillway flow will be established based on the flow requirements of the Snake River physa as well as impacts to other resources. Reclamation will operate the facility to maximize power production while minimizing impacts to biotic resources within the spillway area.

In the Final EIS, Reclamation proposed an adaptive management approach to arrive at the desired target minimum flow of 500 cfs. Based on this approach, Reclamation will gradually reduce irrigation season flows over a 4-year period while monitoring for adverse effects to the biological community in the spillway area. Reclamation proposes the incremental reduction in spillway flows as follows:

- Year 1 – 1,900 cfs
- Year 2 – 1,500 cfs
- Year 3 – 1,000 cfs
- Year 4 – 500 cfs

During the 4-year evaluation period, the Technical Team will have the ability to determine subsequent year spillway flows based upon previous year's data. For example, in the event that unfavorable conditions for the Snake River physa are identified during the 1,000 cfs operation in year 3, the Technical Team could identify a different flow (such as 1,250 cfs) for the year 4 evaluation. This will allow the Technical Team to identify the minimum spillway flow necessary to maintain the biotic resources within the spillway area. If hydrologic events preclude Reclamation from achieving the annual target minimums during one of the four evaluation years, Reclamation will postpone the respective flow evaluation until regular hydrologic conditions occur. Should monitoring data indicate negative impacts to biological communities in the spillway, Reclamation will revert to a higher minimum spillway discharge, up to the existing levels shown on Table 2-1.

The Technical Team was formalized in 2011 and initiated data collection in that year. Data was again collected in 2012, 2013, and 2014. The results from each annual data-collection activity have been discussed each fall at the annual Technical Team meeting. Reclamation proposes to continue this through the duration of the incremental flow-reduction sequence until which time a preferred operation is identified. Data collected by the Technical Team in 2012, 2013, and 2014 as well as data previously collected by Reclamation will provide the baseline for the incremental flow reduction analysis.

There is no planned release of water through the spillway outside of irrigation season. However, due to the presence of Snake River physa inhabiting the spillway area and the unknown potential reductions in leakage past the new spillway structure, limited releases may be necessary to avoid impacts to Snake River physa. Similar to the adaptive management approach proposed for spillway flows during irrigation season, Reclamation will, in cooperation with the Technical Team, establish monitoring protocols and criteria which will determine what flows, if any, are needed to avoid impacts to the snails in the spillway area outside of irrigation season. If it is determined that non-irrigation season flows are required, Reclamation will provide flows of up to 100 cfs through the new spillway structure, possibly at release point 3, as shown on Figure 2-3.

2.3.5 Summary of Proposed Snake River Operations above Milner Dam

Reclamation's operational flexibility is regulated and constrained by federal water delivery contracts, state water rights law, timing of irrigation demand, facility maintenance needs, flood control operations, and environmental requirements and concerns. Reclamation will have the physical flexibility to adjust the normal reservoir water surface between elevations 4245.0 feet (full pool) and 4240.0 feet as conditions warrant. Controlled irrigation season spillway releases at Minidoka Dam will range from 500 cfs to 1,900 cfs. Non-irrigation season spillway flows will range from 0 cfs up to 100 cfs as determined necessary to meet biological requirements.

Following construction, the minimum flow past Minidoka Dam outside of irrigation season will be approximately 525 cfs (24-hour average). This minimum flow is necessary to provide power to heat and light the powerplants to prevent damage to equipment and to maintain control. These flows are typically experienced during the winter months and are comprised of both powerplant and spillway releases measured at the downstream USGS gage (USGS 13081500 Snake River near Minidoka Idaho, at Howells Ferry). It should be noted however, due to fluctuating weather conditions, gage icing, gage error, as well as other factors influencing gage readings, false readings can occur for multiple days, thereby requiring manual data correction to identify actual flow conditions.

2.4 Future O&M in the Snake River above Brownlee Reservoir

Reclamation's operations within the Snake River basin upstream from Brownlee Reservoir to Milner Dam will remain unchanged from those considered in the 2004 Upper Snake BA. Total system operations will be consistent with the 2004 and 2007 Upper Snake BAs and as described in the respective BiOps (USFWS 2005; NOAA Fisheries 2008). The general descriptions of the proposed actions in Chapter 2 of the 2004 BA also remain the same and are herein incorporated by reference (Reclamation 2004a, p 11-28.)

2.5 Future Provision of Salmon Flow Augmentation

Reclamation annually provides up to 487,000 acre-feet of water from the Snake River above Brownlee Reservoir, intended to benefit ESA-listed anadromous fish species in the lower Snake and Columbia Rivers. Reclamation's delivery and timing of flow augmentation water is described in the 2007 Upper Snake BA and incorporated in the 2008 NOAA Fisheries BiOp and Incidental Take Statement for O&M of Bureau of Reclamation Projects in the Snake River Basin above Brownlee Reservoir (NOAA Fisheries 2008). Reclamation described these changes in an August 2007 BA (2007 Upper Snake BA) (Reclamation 2007) for the 2008 NOAA Fisheries BiOp. The proposed action description in this BA is consistent with Reclamation's 2007 Upper Snake BA and thereby incorporated by reference.

2.6 Snake River System Maintenance Activities

In general, all maintenance activities within the Snake River system are handled on a case-by-case basis. Annual maintenance activities typically occur within existing structures and outside of irrigation season, thereby resulting in no affect to ESA-listed species. Maintenance activities are typically scheduled to not coincide with annual water-delivery or flood operations. Reclamation O&M and natural resources personnel coordinate prior to scheduling major maintenance activities to identify timing, sequencing, and other alternatives to avoid or minimize potential impacts to biological resources, including ESA-listed snails. Reclamation will confer with the USFWS to determine the appropriate level of consultation necessary if maintenance activities arise that may affect ESA-listed species.

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Chapter 3
HYDROLOGIC AND WATER QUALITY CONDITIONS

Reclamation's 2004 Upper Snake BA describes historical hydrologic environmental baseline conditions and changes that occurred as a result of Reclamation's past operations as well as private upstream water development activities. As discussed, Reclamation's proposed actions for upper Snake River operations will be consistent with the 2004 Upper Snake BA, except for the partition of flows between Minidoka Dam's power facility and spillway. The proposed action will not alter the current system management, including the volume or shape of water past Milner Dam.

This chapter covers the current hydrologic and water quality conditions in the Snake River from Minidoka Dam downstream to above Brownlee Reservoir. This chapter also describes the operation of the newly constructed Minidoka Dam spillway and the hydrologic and water quality conditions within the spillway area. Section 3.1 focuses on the mainstem of the Snake River from RM 674.5 to RM 351.3, which includes the known distribution of Snake River physa. Tributaries within this segment of the Snake River, where the Snake River physa is not known to exist, were not analyzed as they were assessed in Reclamation's 2004 Upper Snake BA and no operational changes will be made in these tributaries. However, the gages in the Snake River will be used to examine the effects of these tributaries on the Snake River flow regime.

3.1 Upper Snake River Current Hydrologic Conditions

3.1.1 Hydrologic Data Analysis Background

Hydrology affects every physical or biological feature essential to the conservation of the Snake River physa. Flow rates such as minimum flows or irrigation demand interactions are discussed in terms of limiting factors for Snake River physa distribution and abundance. System management and changes in flows past Minidoka Dam are described in both the historical (observed record) and future climate change record (simulated record). The hydrologic information used in this BA comes primarily from current data generated from observed records. Simulated records were acquired from MODSIM hydrologic model outputs that generate monthly data.

MODSIM is a general purpose river and reservoir operation computer simulations model that includes the river system features of storage, irrigation demand, operational flow objectives, and reservoir content. The 2010 MODSIM model simulates current hydrologic conditions and future hydrologic conditions and analyzes both the naturalized and the modified flows on the mainstem Snake River to Brownlee Reservoir as well as the Boise and Payette River systems. The historical data utilized in the model consisted of modified flows from 1928 to 2008. Future simulations were provided for the time period of 2010 to 2039, referred to as the "2020s" because the period of record analyzed is generally centered on that future window. This model has also been used to generate results for the River Management Joint Operating Committee (RMJOC) Climate Change Study. Current flow conditions are consistent with those modeled for the 2004 Upper Snake BA and are extensively discussed in Chapter 3 of that document (Reclamation 2004a).

As in the 2005 analyses, the model output data for this BA were sorted and categorized into wet (10 percent exceedance), average (50 percent exceedance), and dry (90 percent exceedance) water year types based on the modeled total annual volume into Brownlee Reservoir for the MODSIM proposed action scenario. The wet and dry water year types each constitute 10 percent of the years, whereas the average group of water year types comprises the remaining 80 percent. For each of these categories, the data were averaged for use in the analyses within the action area considered in this BA.

The current known distribution of the Snake River physa is from Minidoka Dam at RM 674.5 downstream to RM 368 in Ontario, Oregon. The action area for this consultation for the Snake River physa, and the hydrologic conditions described herein, will include the Snake River from Minidoka Dam down to the Snake River gage near Weiser, ID (USGS gage #1326900) at RM 351.3, which is the nearest gage to the downstream distribution point.

The USGS river gages provide the hydrologic data with the exception of the Snake River at Milner gage, which combines data from Idaho Power and Reclamation gages. The period of record used in this analysis and subsequent discussion is the 1981 through 2010 water years for all gages, using a daily time step. All gages had complete periods of record with the exception of the Snake River at Nyssa gage, which has missing data in water years 1987 through 1989. Summary hydrographs displayed in this chapter illustrate the maximum, 10 percent, 50 percent, 90 percent, and minimum daily exceedance values for the respective water year.

3.1.2 Snake River above Milner Dam

The Snake River above Milner Dam is operated primarily to satisfy irrigation demands in the Snake River plain. The Snake River immediately above Milner Dam is operated with a control point at Milner Dam, where system storage and flood control operations are balanced to maximize storage in the system above this point. Minidoka Dam is operated with a minimum flow in the winter months (non-irrigation season) of approximately 525 cfs. During the irrigation season, Minidoka Dam is operated as a run-of-the-river dam to meet downstream demands, primarily irrigation demands but also to deliver storage water leased or rented for use below Milner Dam. This operation typically results in zero flow being delivered to the river below Milner Dam when operated for irrigation demand only. A summary hydrograph of the current river flow, below Minidoka Dam at RM 674.5 is shown on Figure 3-1, USGS Gage #13081500 Snake River near Minidoka, ID. The summary hydrograph shows that the maximum and 10 percent exceedance years are typically reflective of flood control operations. The minimum, 50 percent, and 90 percent exceedance flows display little variation because they reflect dry and average conditions which are highly influenced by irrigation diversions and therefore consistent. Only in the larger runoff years will releases typically exceed irrigation demand, therefore, in the majority of years releases are made for irrigation only and do not vary much despite the water year type. In 50 percent of the years, Minidoka outflow is above 5,000 cfs throughout much of the irrigation season (May 1 through September 30).

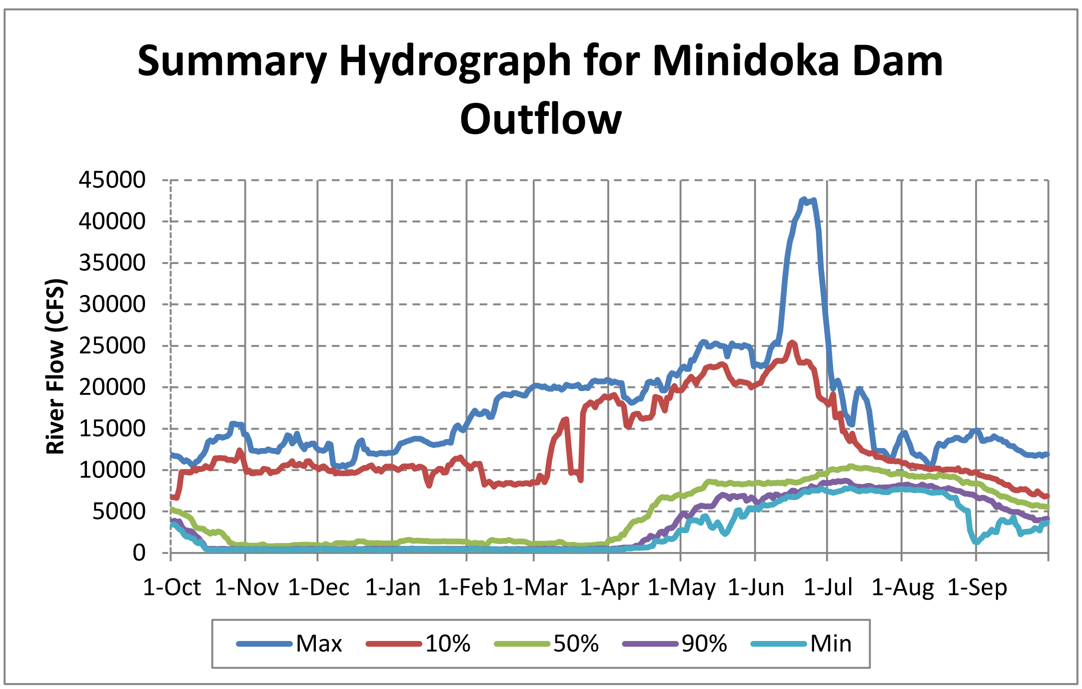

Figure 3-1. Summary hydrograph for flows below Minidoka Dam.

Figure 3-2 shows the resultant flows in the river below Milner Dam at RM 638.7. This flow is a combination of releases through the Idaho Power Hydropower Facility and releases to the river in the canyon directly below the dam. The flows are represented together because they combine approximately 1-mile downstream from the dam and form the total discharge in the downstream section of the Snake River.

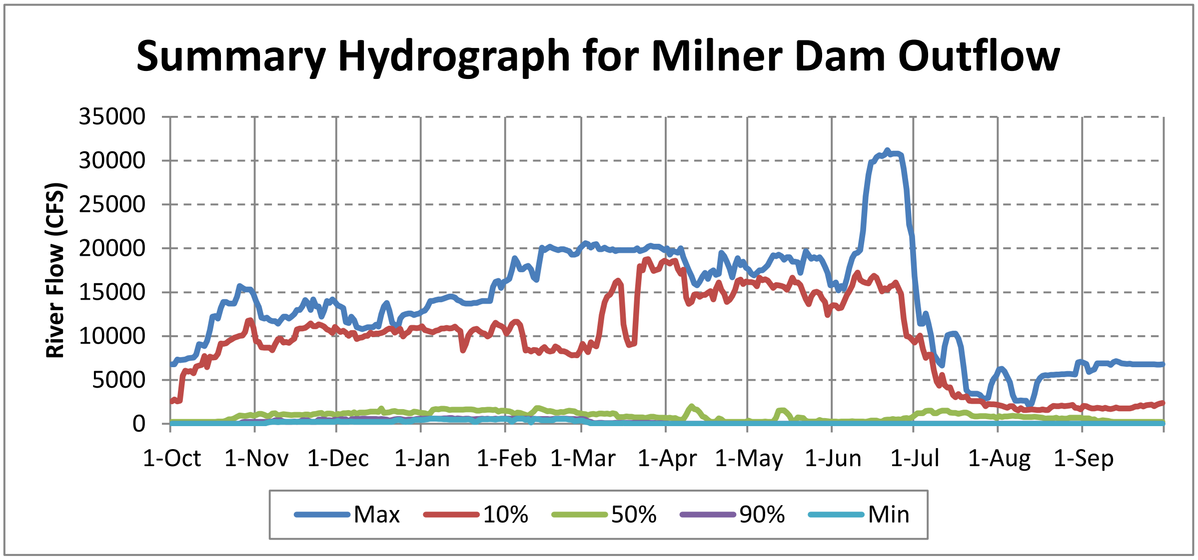

Figure 3-2. Summary hydrograph for flows below Milner Dam.

3.1.3 Minidoka Dam Spillway

Spillway Construction History

The Minidoka Dam spillway was originally designed as an overflow structure without means of regulation of surplus discharge to the river. Due to difficulties experienced in the 1908 water year, the spillway was raised 5 feet in 1909. This new spillway structure consisted of piers on 7-foot centers which were grooved to receive flashboards. The new spillway was very successful but considerable labor was required to operate the flashboards to control river flow. In 1912, Reclamation constructed 4 radial gates to allow operators to regulate the river below the dam without having to manipulate the flashboards. The gates were fully operational in 1913. In 1989, the radial gates were replaced since they had largely surpassed their design life and showed visible damage resulting from regular operations.

Reclamation is currently in the process of replacing the spillway portion of Minidoka Dam with an anticipated project-completion date of March 31, 2015. The new spillway structure will provide greater operational flexibility at the Minidoka Dam site.

Current Conditions

Minidoka Dam is on the Snake River at RM 674.5 in Rupert, Idaho, downstream of American Falls Dam and upstream of Milner Dam. The dam is operated as a run-of-the-river dam, passing inflow from American Falls to facilitate irrigation deliveries and other downstream demands to Milner Dam. The dam forms Lake Walcott, with a capacity greater than 210,200 acre-feet, which includes an unidentified quantity of dead pool, 115,000 acre-feet of inactive storage and 95,200 acre-feet of active storage. The Minidoka Powerplant was completed in 1909; the Inman Powerplant, a two-unit powerplant, was added in 1997, making the total power generation capacity 28.5 MW, with a combined turbine capacity of approximately 8,850 cfs. Water is routed through turbines in the two powerplants, through the existing radial gates, and over the spillway. The partitioning of flows between the powerplant and spillway depends on the time of year, total inflow, and associated demands.

As a result of adding the Inman Powerplant in 1997, Reclamation entered into several environmental commitments as part of the Environmental Assessment and Finding of No Significant Impact, including the following spillway operation:

- Minimum spillway flows during irrigation season:
  - April 15 through June 30: 1,300 cfs
  - July 1 through August 31: flow increased to 1,900 cfs
  - September 1 through September 15: 1,300 cfs
  - April 1 through April 14 and September 16 through October 31:
    - First 5,035 cfs through the powerplant
    - Next available 1,300 cfs over existing spillway
    - Flows in excess of 6,335 cfs routed through the powerplant up to plant capacity
    - Additional flow above plant capacity is discharged over existing spillway

A portion of the spillway flow originates from seepage through the spillway structure. Additionally, a pipeline from the Inman Powerplant headworks feeds a wetland that was constructed as mitigation for the powerplant.

After irrigation season, Lake Walcott is held between elevation 4239.5 feet and 4240.0 feet because of the deteriorated structural condition of the old spillway, thus bringing the water surface elevation below the overflow structure. Prior to the onset of irrigation season each year, Lake Walcott is returned to full-pool elevation. No controlled releases are currently provided through the spillway structure outside of irrigation season, although water does seep through cracks in the structure year-around, as well as through the stop logs during irrigation season. Reclamation attempted to quantify flows as a result of structural leakage in 2010 and 2011 by visually observing, tracking, and measuring flows through the spillway during the winter months outside of irrigation season. Flows did not appear to seep into the spillway area from any location with the exception of cracks in the structure and total cumulative recorded flows were always less than 1 cfs.

The physical condition of the existing spillway constrains winter operations because the ogee crest is not capable of resisting the loads imposed by ice on the reservoir surface. Additionally, if water was stored above the crest, leakage through the joints of hundreds of boards would cause an unmanageable accumulation of ice immediately below the structure. In the winter, the radial gates are the only path for water releases from the spillway structure because the reservoir is drawn down 5 feet to an elevation below the base of the stoplogs. In dry winters, no water is spilled through the radial gates. Occasionally, during wet winters, powerplants alone cannot accommodate all of the flow, thereby requiring the use of the radial gates.

Figure 3-3 shows a summary hydrograph of Reclamation operations at Minidoka Dam and Lake Walcott. The target refill date for Lake Walcott is April 1 or the beginning of the irrigation season. Lake Walcott is filled by moving water from American Falls to prepare Lake Walcott for irrigation deliveries to the Minidoka North and South Side canals. The lake is filled to an elevation of 4245 feet and is held throughout the irrigation season at this level by passing inflows from American Falls into the Minidoka North and South side canals or downstream into the river to meet Milner demands. This 4245 foot elevation corresponds to holding the full 95,200 acre-feet of active storage in the reservoir during the irrigation season. At the end of the irrigation season, Reclamation lowers the level of Lake Walcott to 4240 feet elevation to avoid ice damage to the structure. This drawdown occurs every year under current conditions. When the winter level is reached, the irrigation season has ended and flows over the Minidoka spillway are shut off. During dry years, Reclamation may draw down Minidoka Reservoir early to use the storage for irrigation deliveries to the Milner canals.

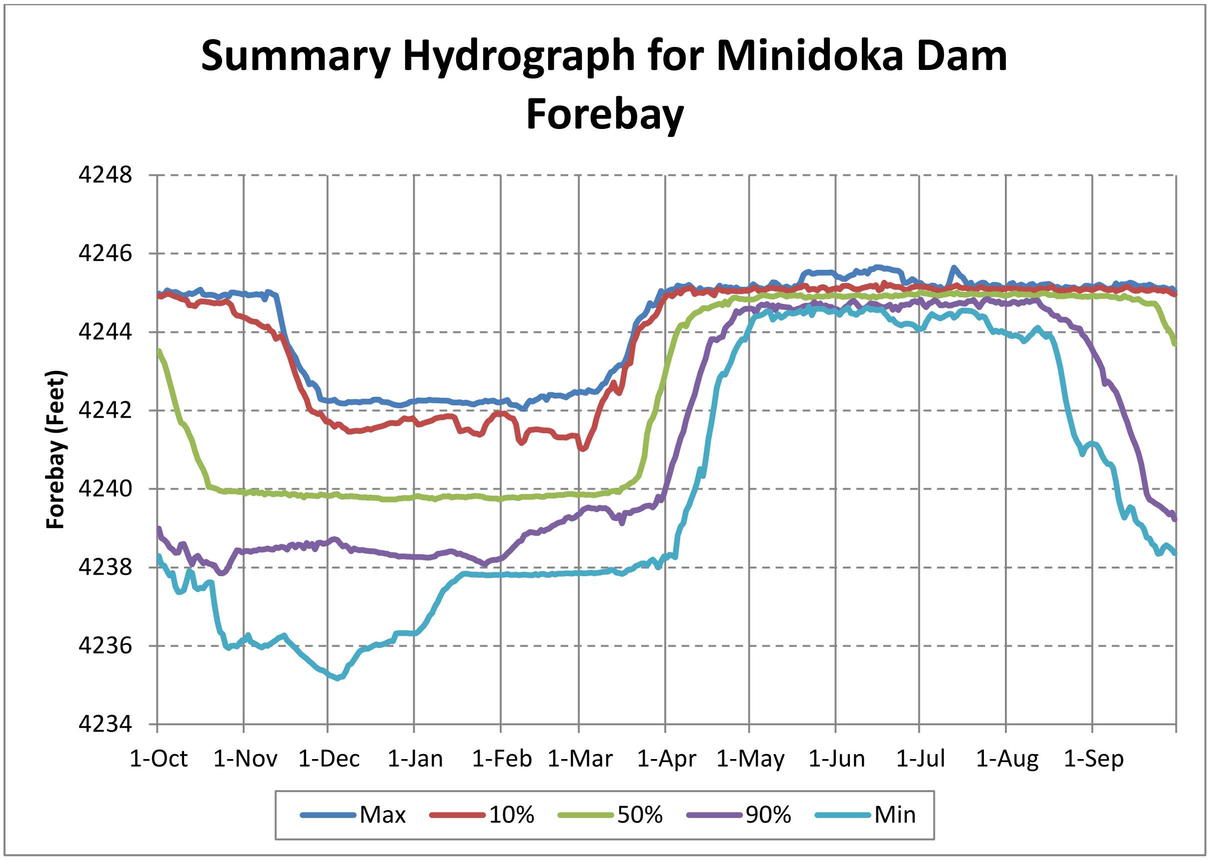

Figure 3-3. Summary hydrograph for Lake Walcott operations.

As observed in Figure 3-1, June through September releases from Minidoka Dam to the river exceed 7,000 cfs in about 80 percent of the years. During the winter months, Reclamation passes inflow from American Falls. American Falls has a winter minimum flow established at 350 cfs and the typical winter reach gain from American Falls to Lake Walcott is 150 to 175 cfs, resulting in a typical winter release of at least 500 cfs. However, releases from Minidoka Dam have historically been as low as 400 cfs in 10 percent of the years. This recorded minimum flow is comprised of both powerplant and spillway flows as well as subsurface seepage. The minimum flow of 400 cfs through Minidoka Dam is required to provide for the electrical requirements within the Minidoka Dam facility.

3.1.4 Snake River above Brownlee Reservoir

The 92.1-mile reach downstream of Milner Dam to the King Hill gage (USGS gage #13154500, Snake River at King Hill, ID at RM 546.6) experiences a large increase in flow as a result of groundwater and irrigation return flow and is minimally impacted by Milner Dam operations, with the exception of flood control releases, which can be seen in the maximum and 10 percent exceedance plots (Figure 3-4). Because flows at King Hill are comprised almost entirely of aquifer discharges and irrigation returns, flows at the Snake River at King Hill remain relatively stable throughout the year, resulting in little change to stage or inundated area with the exception of flood conditions. A comparison of the Milner Dam and King Hill hydrographs show that for 50 percent of the years, operations at Milner Dam are relatively small compared to the Snake River flows at King Hill, and do not have a major impact on the flow in the lower section of the Snake River. The only exception, outside of flood operations, to this observation is during the release of water for flow augmentation (discussed in Section 3.1.5) from the Snake River above Milner Dam.

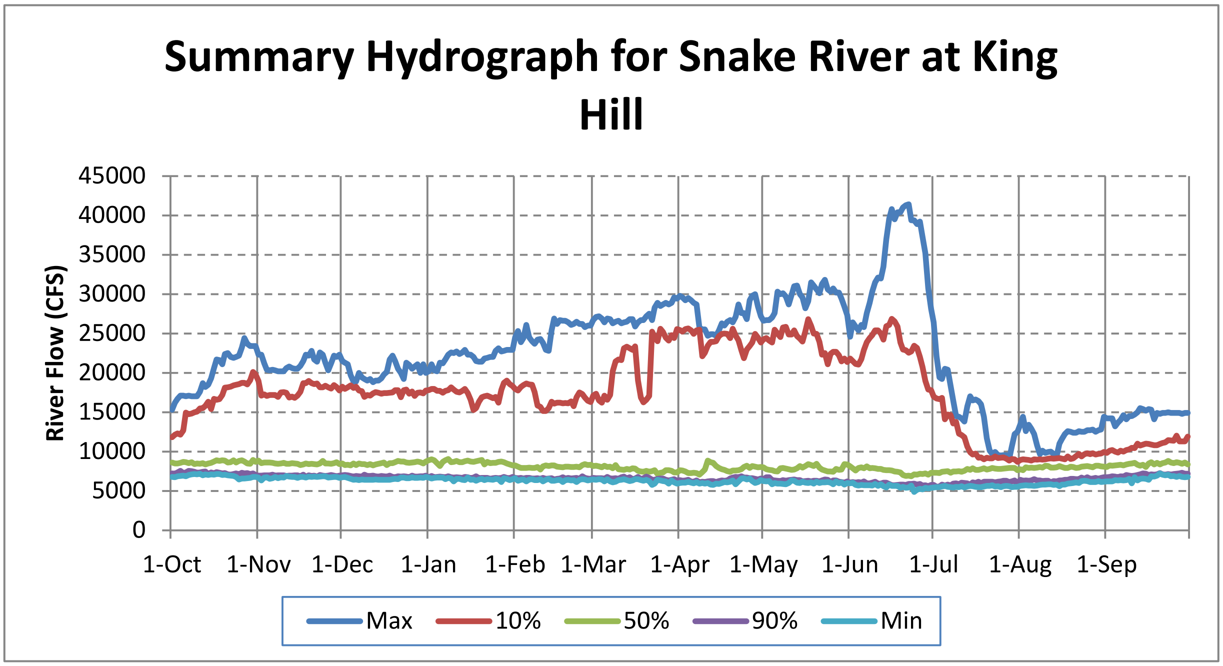

Figure 3-4. Summary hydrograph for flows at King Hill.

Reclamation maintains no water-control facilities in the Snake River below the privately-owned and operated Milner Dam; however, there are numerous private facilities between Milner Dam and Brownlee Reservoir that have varying degrees of impact to the river. To determine the effects of flow in these reaches, and to isolate Reclamation operations, the USGS Snake River at Murphy, ID gage #13172500 (RM 452.5) is used to determine the flow in the Snake River above the confluence with the Owyhee and Boise Rivers (Figure 3-5). The Murphy gage is located approximately 60 miles upstream of the confluence with the Owyhee River (RM 392.6) and the Boise River (RM 392.3). A relatively minor reduction in mainstem flow occurs in the King Hill to Murphy reach as a result of irrigation diversions.

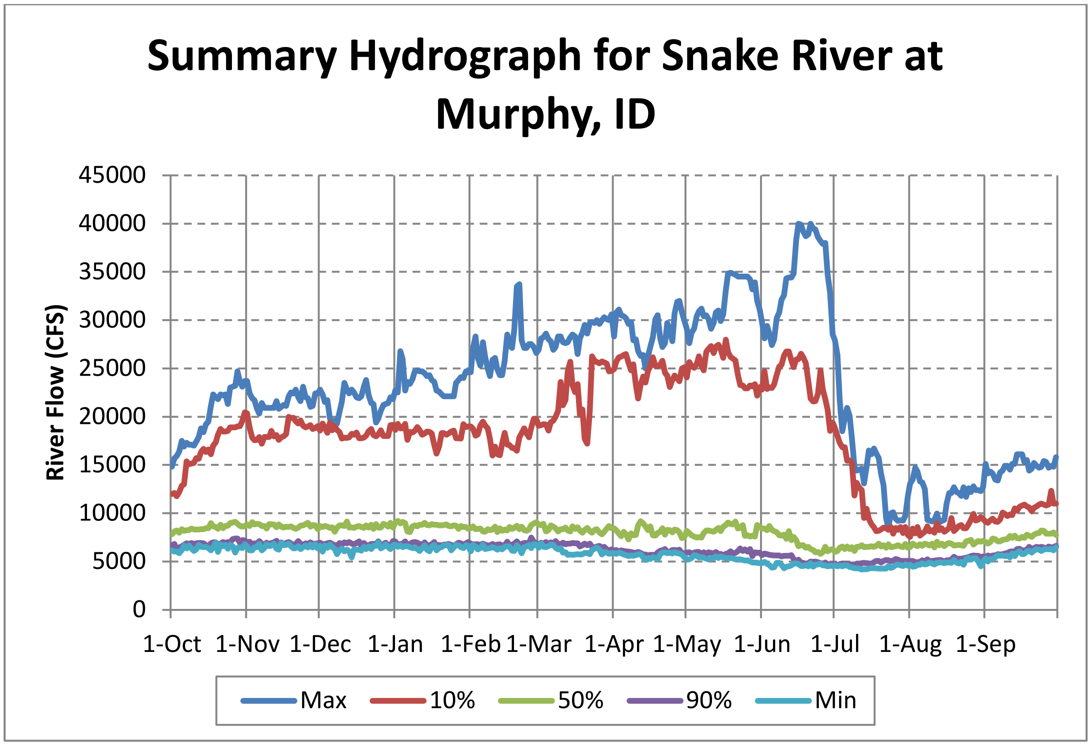

Figure 3-5. Summary hydrograph for flows at Murphy.

Below the confluence with the Boise and Owyhee river systems is the USGS gage #13213100 Snake River at Nyssa, OR at RM 385.6 (Figure 3-6). The Snake River at Nyssa hydrograph displays the influence of flood control releases from these tributary river systems. However, the overall low flow regime is very similar to the reach above the confluences with the Owyhee and Boise Rivers due to the low flows these rivers contribute outside of flood control operations.

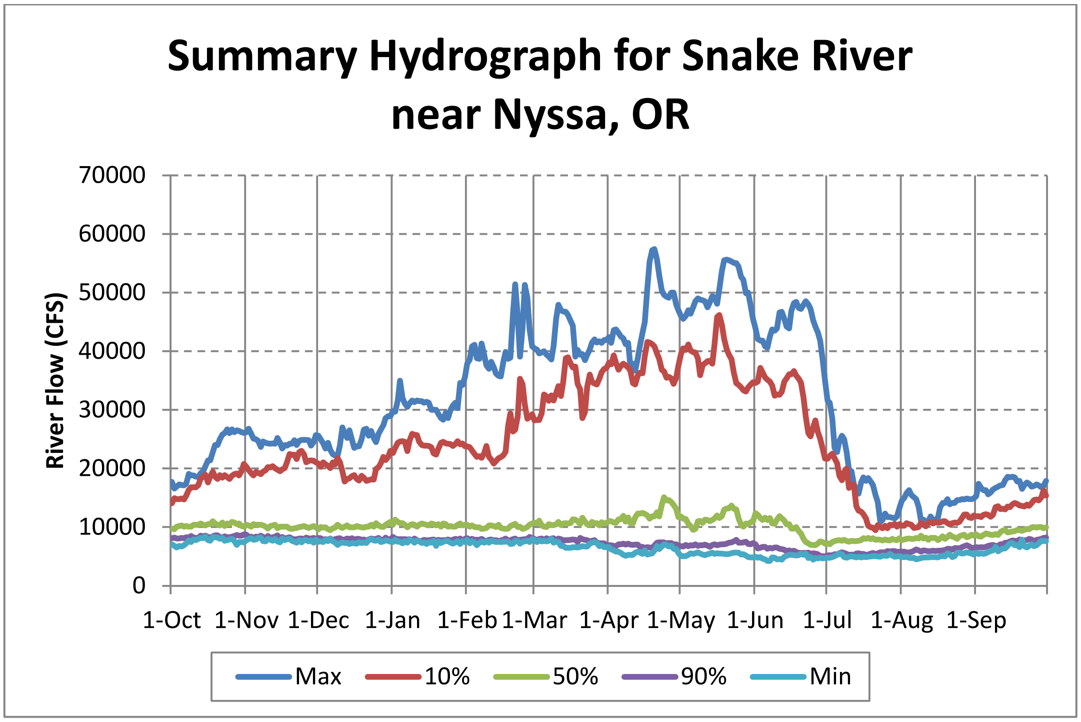

Figure 3-6. Summary hydrograph for flows at Nyssa, Oregon.

Moving downstream, the next major confluences are the Malheur River from the west at RM 368.2, and the Payette River from the east at RM 365. The next gage below these tributary confluences is the Snake River at Weiser at RM 351.3 (USGS gage #13269000 Snake River at Weiser, ID; Figure 3-7), representing the downstream extent of Reclamation influence as it relates to currently known Snake River physa distribution (Brownlee Reservoir, an Idaho Power project, influences the Snake River below this point). The Weiser gage shows how the cumulative flows, both naturally occurring and regulated, from multiple tributary basins can result in very large flows at Weiser, and in turn cause large flows into Brownlee Reservoir. The median (50 percent exceedance) hydrograph shows how flows increase from mid-April through June as a result of the tributary inflow. Much of this is attributed to the Payette basin, which more closely mimics the natural hydrograph due to the amount of the basin runoff (roughly 50 percent) that is not controlled by storage facilities. Natural flows from the Bruneau basin and unregulated portions of the Malheur basin, along with regulated flow from the Boise basin, also add to this spring freshet, although typically to a smaller degree than the Payette.

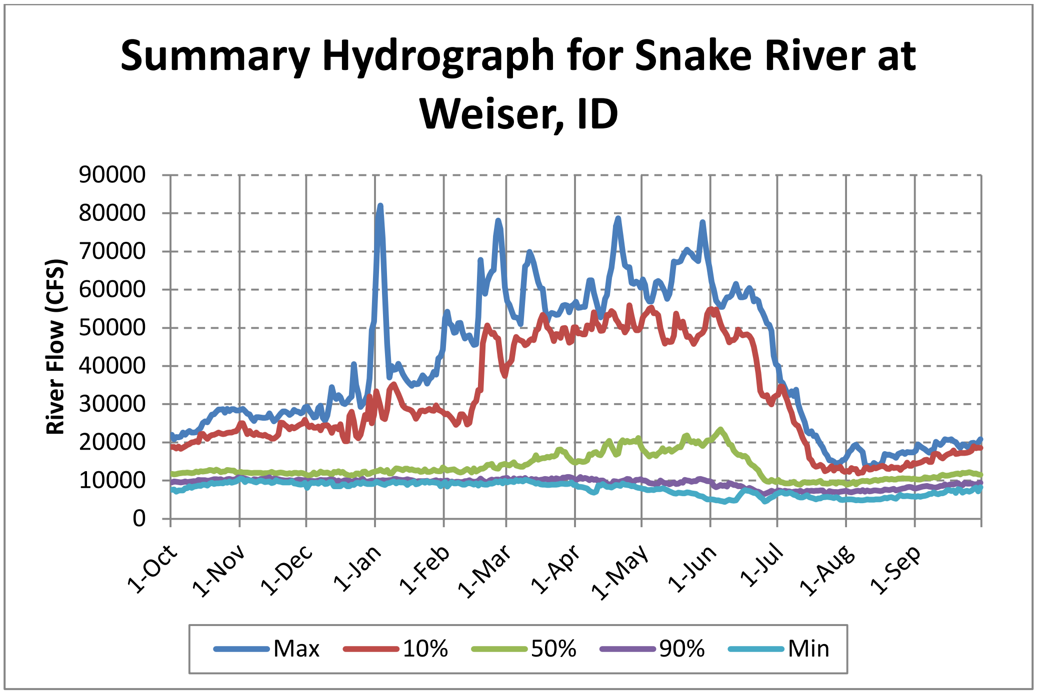

Figure 3-7. Summary hydrograph for flows at Weiser, Idaho.

Figure 3-8 displays the monthly unregulated flow and regulated flow in the USGS gage #13247500 Payette River near Horseshoe Bend, ID, denoting the similar shape and magnitude of these monthly values due to the unregulated portion of the basin.

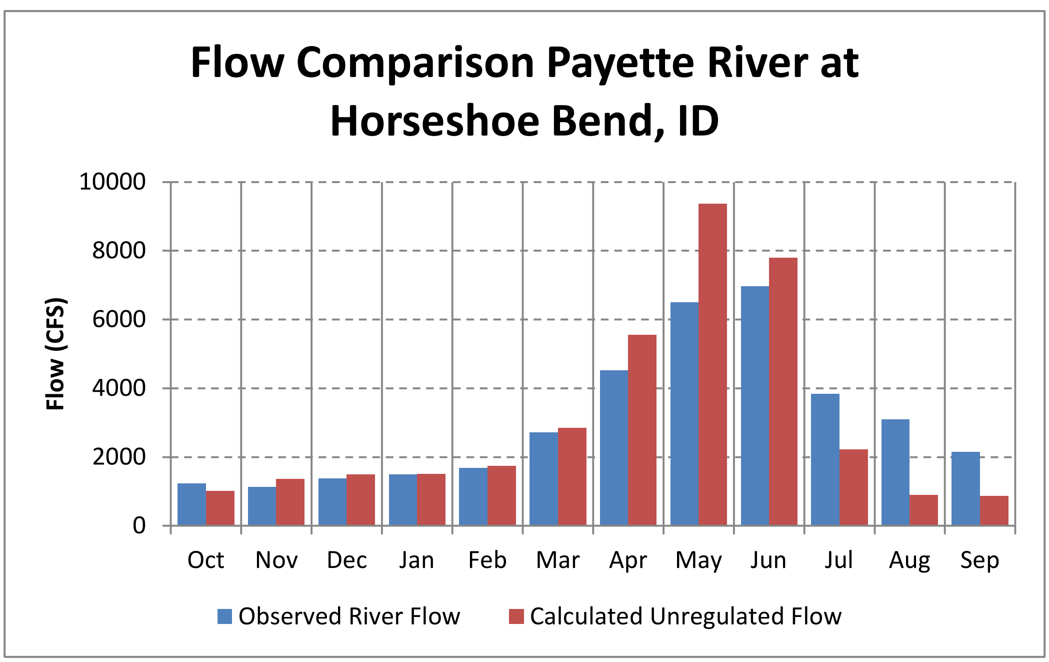

Figure 3-8. Comparative hydrograph for the Payette River flows at Horseshoe Bend.

3.1.5 Flow Augmentation

Reclamation annually provides up to 487,000 acre-feet of water from the Snake River above Brownlee Reservoir, intended to benefit ESA-listed anadromous fish species in the lower Snake and Columbia Rivers. The amount that is provided from above Milner Dam is variable each year depending on water year type, amounts available from the Water District 1 rental pool, and hydrologic conditions in other source basins. Reclamation's delivery and timing of flow augmentation water is described in the 2007 Upper Snake BA and incorporated in the 2008 NOAA Fisheries BiOp and Incidental Take Statement for O&M of Bureau of Reclamation Projects in the Snake River basin above Brownlee Reservoir (NOAA Fisheries 2008). Reclamation described these changes in the 2007 Upper Snake BA (Reclamation 2007) for the 2008 NOAA Fisheries BiOp.

In its 2007 Upper Snake BA, Reclamation committed to shifting releases to earlier in the migration season when Snake River flows are more beneficial to listed fish. The primary goals of the earlier releases are to more closely coincide with fish migration and to minimize the amount of warmer water provided in August, shifting releases to July or earlier. The opportunity and ability to shift the releases varies depending on the water year type, total augmentation volume available, and the basin the augmentation originates from.

The primary strategy for shifting augmentation releases in the upper Snake River basin above Milner involves higher release rates and a relaxation of down-ramping criteria at the conclusion of augmentation. Formerly, the down-ramping rate of 100 cfs per day was very restrictive and forced lower release rates to avoid a protracted down-ramping period. With the restrictive rate, it was necessary to extend augmentation releases past Milner Dam into mid to late August in most years. The 2008 BiOp anticipated that augmentation releases can be provided in May or June in most average or lower water years, and by the end of July in most wet years. Table 3-1 lists the approximate volumes, flow rates, and timing of flow augmentation releases past Milner Dam since implementation of the 2008 BiOp.

Table 3-1. Approximate volumes, flow rates, and timing of flow augmentation releases past Milner Dam since implementation of the 2008 BiOp.

Year	Volume (acre-feet)	Rate (cfs)	Timing
2009	199,758	3,450 – 4,200	July 5 through July 31
2010	198,966	3,200 1,600	May 3 through May 31 June 30 through July 14
2011	207,500	3,500	July 28 through August 26
2012	190,179	3,500 – 4,500	June 8 through July 8
2013	154,885	2,250 – 2,400	May 1 through June 4

3.2 Future Hydrologic Conditions

The potential impacts of climate change for this BA were evaluated using climate change and hydrology datasets that were adopted by Bonneville Power Administration (BPA), U.S. Army Corps of Engineers (Corps), and Reclamation in 2011. These agencies collaborated to develop climate change and hydrology datasets to be used in their longer-term planning activities in the Columbia Snake River Basin. The datasets development was coordinated through the RMJOC.

Climate change simulations were conducted using global climate (circulation) models (GCMs) selected under the direction of the RMJOC. During this process, future climate change and hydrologic datasets were selected based on GCM type, emission forcing scenario, area of interest, and timescale. In addition, both the Hybrid-Delta (step change) and Transient (time evolving) techniques were used.[1] The data were downscaled from a large coarse-scale GCM resolution to a finer resolution scale that was better representative of the geographic area of study (i.e., the Columbia Basin) and bias-corrected (a process in which each GCM's tendencies to simulate past conditions that are statistically different from historical observations {e.g., too wet, too warm} are adjusted). This process is referred to as Bias Correction Spatial Disaggregation (BCSD).

For the RMJOC Climate Change Study, future climate change Hybrid-Delta datasets were selected for two future periods, from 2010 through 2039 and 2030 to 2059. These 30-year periods are also referred to as "centered around" the 2020s and 2040s, respectively. Six ranges of future temperature and precipitation conditions were selected to be evaluated relative to a simulated historical period from 1950 to 1999.[2] The ranges selected included:

- Central (C) or the future projection closest to the 50th percentile temperature and 50th percentile precipitation;
- Minimal change (MC) roughly targeting less warming and 50th percentile precipitation;
- More warming and wetter (MW/W) or the future projection closest to the 90th percentile temperature and 90th percentile precipitation;
- Less warming and wetter (LW/W) or the future projection closest to the 10th percentile temperature and 90th percentile precipitation;

[1] U.S. Bureau of Reclamation, U.S. Army Corps of Engineers, and Bonneville Power Administration, 2010. Climate and Hydrology Datasets for use in the RMJOC Agencies' Longer-term Planning Studies: Part 1 – Future Climate and Hydrology Datasets.

[2] The ranges were developed by selecting the scenario that was closest to the 90th, 50th, and 10th percentile coordinates for change in mean annual temperature and mean annual precipitation over the Columbia River Basin. This enabled "bracketing" the ranges so a broad range of future projections could be analyzed.

- More warming and drier (MW/D) or the future projection closest to the 90th percentile temperature and 10th percentile precipitation;
- Less warming and drier (LW/D) or the future projection closest to the 10th percentile temperature and 10th percentile precipitation.

These ranges of temperature and precipitation were generated using two of several future emission forcings available. Emission forcings make assumptions about future emissions based on different economic, technical, environmental, and social developments. The selected emission forcings included A1B, which assumes an average or medium emissions future and B1, which assumes a low emissions future. A more detailed description of the emission forcings can be found in the Special Report on Emissions Scenarios.[3]

Only the data results from the Hybrid-Delta 2020s were selected and incorporated for this BA because the period extends through 2039 (extent of the BA timeframe). In addition, rather than choosing all six ranges of temperature of precipitation, only three that provided the broadest range of results were used in this analysis and include:

- Less Warming and Wetter (LW/W) with lower emissions (IPSL_CM4 and emissions scenario AB1);
- Central Change (C) and lower emissions (HADCM with emissions scenario B1);
- More Warming and Drier (MW/D) with higher emissions than the B1 (CCSM3 with emission scenario B1.

The resulting hydrology datasets from these three scenarios were obtained from the Reclamation MODSIM-DSS water resource model.

In general, the results showed higher winter-early spring flows and reduced late summer flows. The higher winter flows resulted in higher spring outflows and higher reservoir elevations compared to historical operations. The RMJOC Climate Change Study did not address changes in evaporation, irrigation demand, cropping patterns, evapotranspiration, or return flows in the Columbia Basin; it only studied the changes to water supply and the impact of that supply change on reservoir operations. The study recommended further investigations including using a daily model to evaluate the effects that the changing shape of the natural hydrographs would have on water use and flood management. This work is scheduled to begin in Fiscal Year 2015.

[3] IPCC (2000). IPCC Special Report on Emissions Scenarios (Nakicenovic, N., and R. Swart, Eds.). Print version: Cambridge University Press, UK. This version: IPCC website. http://www.ipcc.ch/ipcreports/sres/emission/index.php?idp=27#anc1. Retrieved August 18, 2011.

3.2.1 MODSIM-DSS Water Resource Model

The hydrologic information used to evaluate future conditions in this BA comes primarily from modeled data in monthly time steps. Modeled data is from the 2010 version of MODSIM, a general purpose river and reservoir operation computer simulations model that includes the river system features of storage, irrigation demand, operational flow objectives, and reservoir content. The MODSIM model was updated in 2010 to simulate current hydrologic conditions and future hydrologic conditions and analyze both the naturalized and the modified flows on the mainstem Snake River to Brownlee Reservoir as well as the Boise and Payette River systems. The historical results reported using the modified flows model range from 1928 to 2008. Future simulations were provided for the time period of 2010 to 2039, referred to as the “2020s” because the period of record analyzed is generally centered on that future window.

The modified flows calculated in the 2010 MODSIM version are different from the 2000 modified flows dataset and are described in a technical memorandum titled "Modified and Naturalized Flow of the Snake River Basin above Brownlee Reservoir" (Reclamation 2010b). The 2010 modified flows incorporate the current level of irrigation development, which reflects the effects of groundwater pumping in the system. The dataset is considered a more accurate estimation of 2010 conditions because all years reflect the same current level of groundwater impacts. The annual flow volumes for the 2000 dataset are 6 percent larger than the 2010 dataset on average. The difference between these datasets was the assumption of groundwater pumping depletions above King Hill; therefore, the results between the two datasets are not directly comparable. The total effect to the Snake River as a result of the additional pumping is still less than the 2.0 million acre-feet representing steady state conditions. The methodologies used in the data infill process, definition of irrigation demand patterns, and calibration efforts were more consistent between basins for the 2010 Modified Flow model than for the 2000 model development. The variations in procedures between the datasets account for some of the differences; however, the majority of the differences are a result of accounting or additional groundwater pumping.

In 2010 and 2011, the MODSIM model was used again (Version 8.1) to generate results for the RMJOC Climate Change Study. In addition to the previously mentioned revisions, the historical record used in the RMJOC Climate Change Study for studying the effects of the 2010 level operations (the "modified flow model") was generated by the University of Washington’s Climate Impacts Group (UWCIG) instead of Reclamation as was done in both the 2004 and the 2007 Upper Snake BAs. The UWCIG historical flow record was used because the same procedure used to model that flow was used to model future flows and using these data maintains consistency in reporting the results between future and historical changes. A comparison of Reclamation's historical record and UWCIG's historical record using the naturalized model showed that UWCIG flows were less than 0.2 percent higher than Reclamation flow over the entire period of record (Reclamation 2011a, Table 10, page 130).

Reclamation used results from the RMJOC Climate Change Study model so that a direct comparison between future flows and historical flows can be made in this BA. Reclamation completed the RMJOC Climate Change Study in which the hydrology in the upper Snake River basin above Brownlee Reservoir was analyzed. Reclamation, the Corps, and the BPA completed a four-part series of reports:

1. *Climate and Hydrology Datasets for Use in the River Management Joint Operating Committee (RMJOC) Climate Agencies' Longer-Term Planning Studies: Part I - Future Climate and Hydrology Datasets* (December 2010)
2. *Climate and Hydrology Datasets for Use in the RMJOC Climate Agencies' Longer-Term Planning Studies: Part II - Reservoir Operations Assessments for Reclamation Tributary Basins* (January 2011)
3. *Climate and Hydrology Datasets for Use in the RMJOC Climate Agencies' Longer-Term Planning Studies: Part III - Reservoir Operations Assessment: Columbia Basin Flood Control and Hydropower* (May 2011)
4. *Climate and Hydrology Datasets for Use in the RMJOC Climate Agencies' Longer-Term Planning Studies: Part IV - Summary* (May 2011)

A summary of the results from these reports as they pertain to Minidoka Dam are provided below.

3.2.2 Analysis from the RMJOC Climate Change Study

Results from the RMJOC Climate Change Study were used in this BA to analyze potential impacts of climate change on Snake River physa snail habitat in the upper Snake River basin at Minidoka Dam and Lake Walcott (the reservoir behind Minidoka Dam). This MODSIM model is a monthly time step model, limiting results reporting to monthly averages. Also, note that the volumes shown are cumulative volumes to Lake Walcott, not volumes specific to the dam and reservoir.

Modeled Climate Change Effects on Inflows to Minidoka Dam from the RMJOC Climate Change Study

Figure 3-9 shows the simulated historical inflow to Minidoka Dam in relation to the three future climate change projections representing the range of future climate through 2039. As shown, in the higher flow events, almost all of the climate change projections indicate an increase in inflow volume when compared to historical inflow. This is true throughout the full range of exceedances.

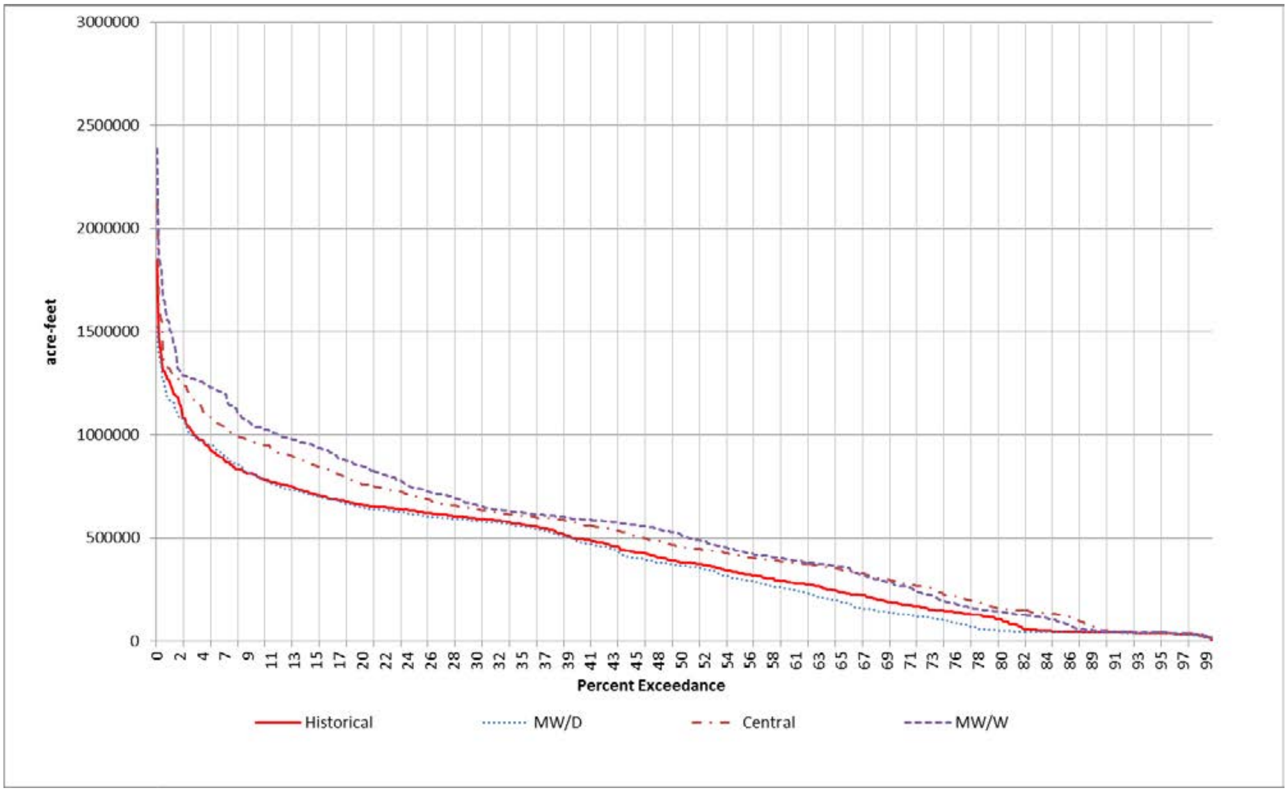

Figure 3-9. Percent exceedance plot of inflow to Minidoka Dam for modeled climate scenarios.

Figure 3-10 depicts the inflows for the three future climate change projections and historical inflow in a summary hydrograph. Historically, the peak inflow has occurred in June, but in the MW/W and MW/D future conditions there appears to be a shift in inflow timing to one month earlier. In all three future conditions, there is an increase in peak volume when compared to simulated historical inflow.

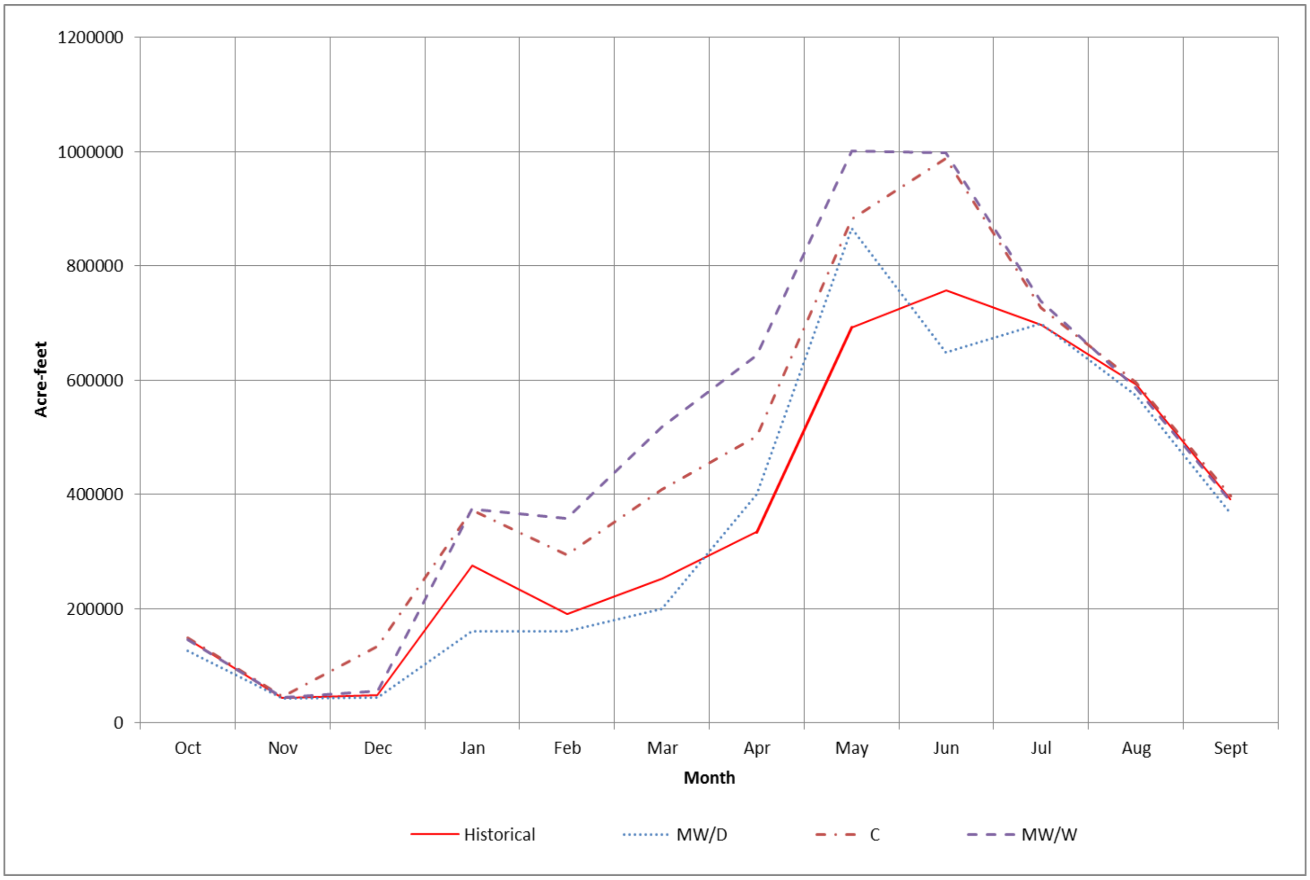

Figure 3-10. Summary hydrograph of inflow to Minidoka Dam for modeled climate scenarios.

However, as shown in Figure 3-11, due to the way in which Minidoka Dam and Lake Walcott are operated, minimal changes are projected in the total storage volume regardless of inflow volume. Minor changes are observed around the 10 percent exceedance volume, but in general, storage volume remains unchanged.

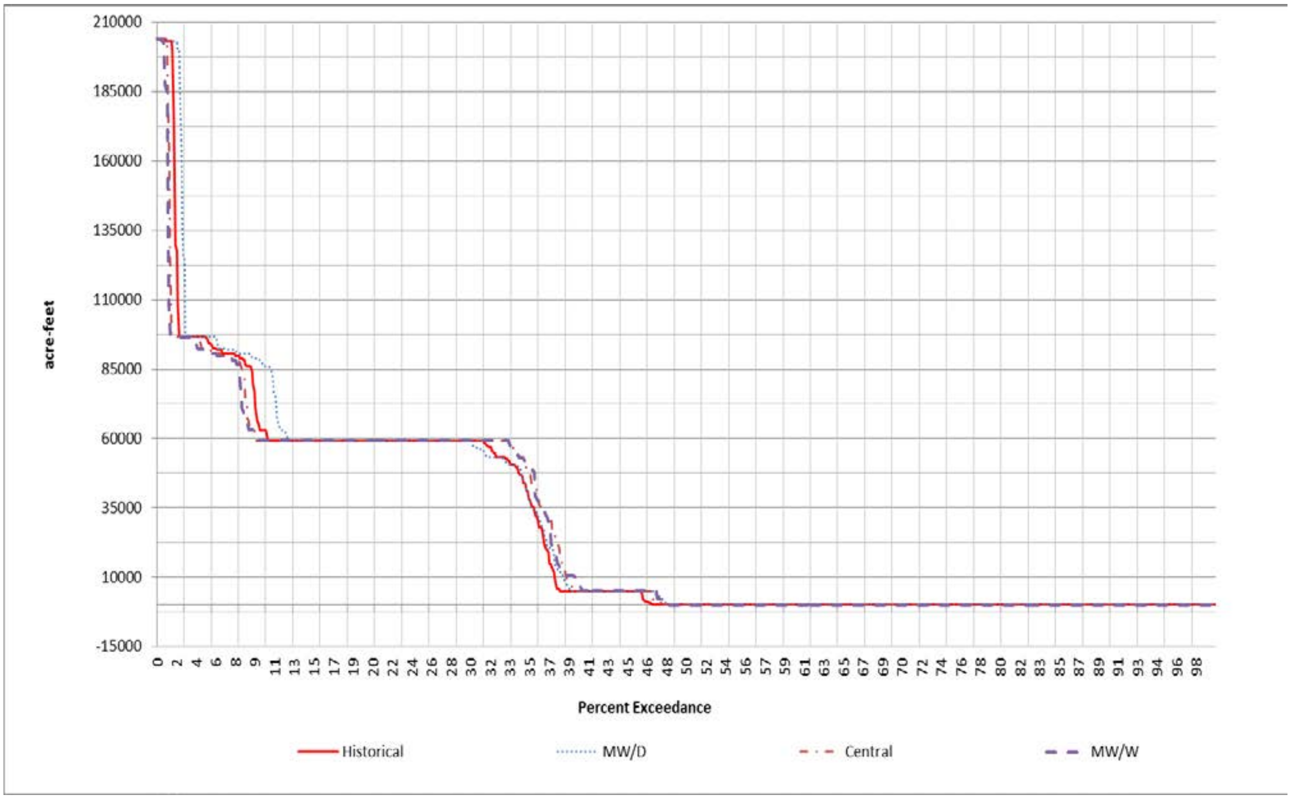

Figure 3-11. Percent exceedance of storage volume in Lake Walcott.

Figure 3-12 shows an exceedance curve for outflow from Minidoka Dam. As shown in the previous plots, some future climate change projections will result in more inflow to Lake Walcott. However, because water-delivery operations are generally static regardless of inflow, the outflow from the reservoir is projected to be higher than historical outflow in the central and MW/W climate change projections.

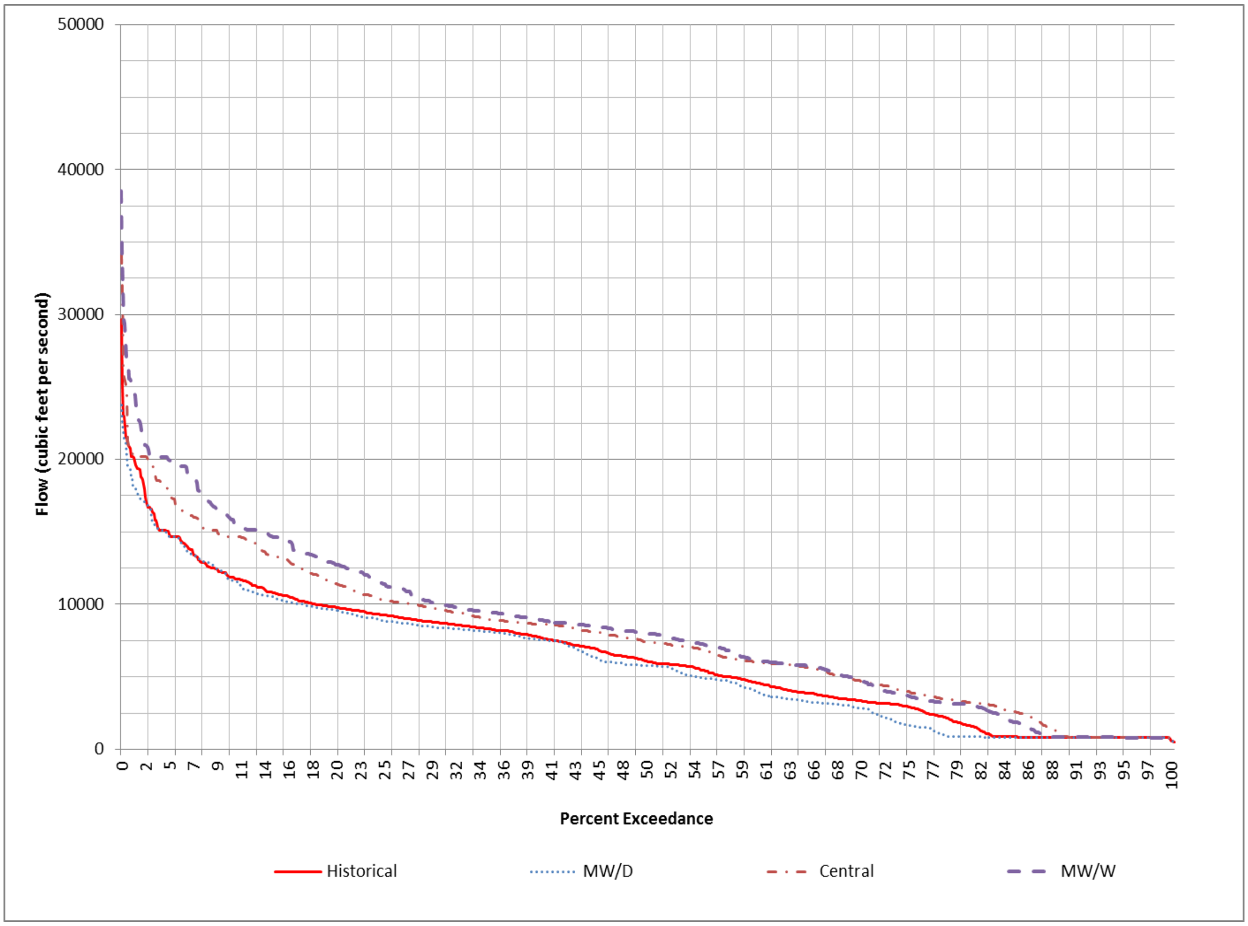

Figure 3-12. Percent exceedance of outflow from Lake Walcott.

Outflow from Minidoka Dam is also depicted as a summary hydrograph in Figure 3-13. This summary hydrograph illustrates that the increase from the annual minimum outflow from Minidoka Dam occurs on average, earlier in both the MW/D and MW/W climate change projections. All three future climate change projections suggest unregulated outflow rates from Minidoka Dam will be higher than historical rates. In addition, the MW/D climate change projection reflects lower outflow from February to April, when compared to historical outflow.

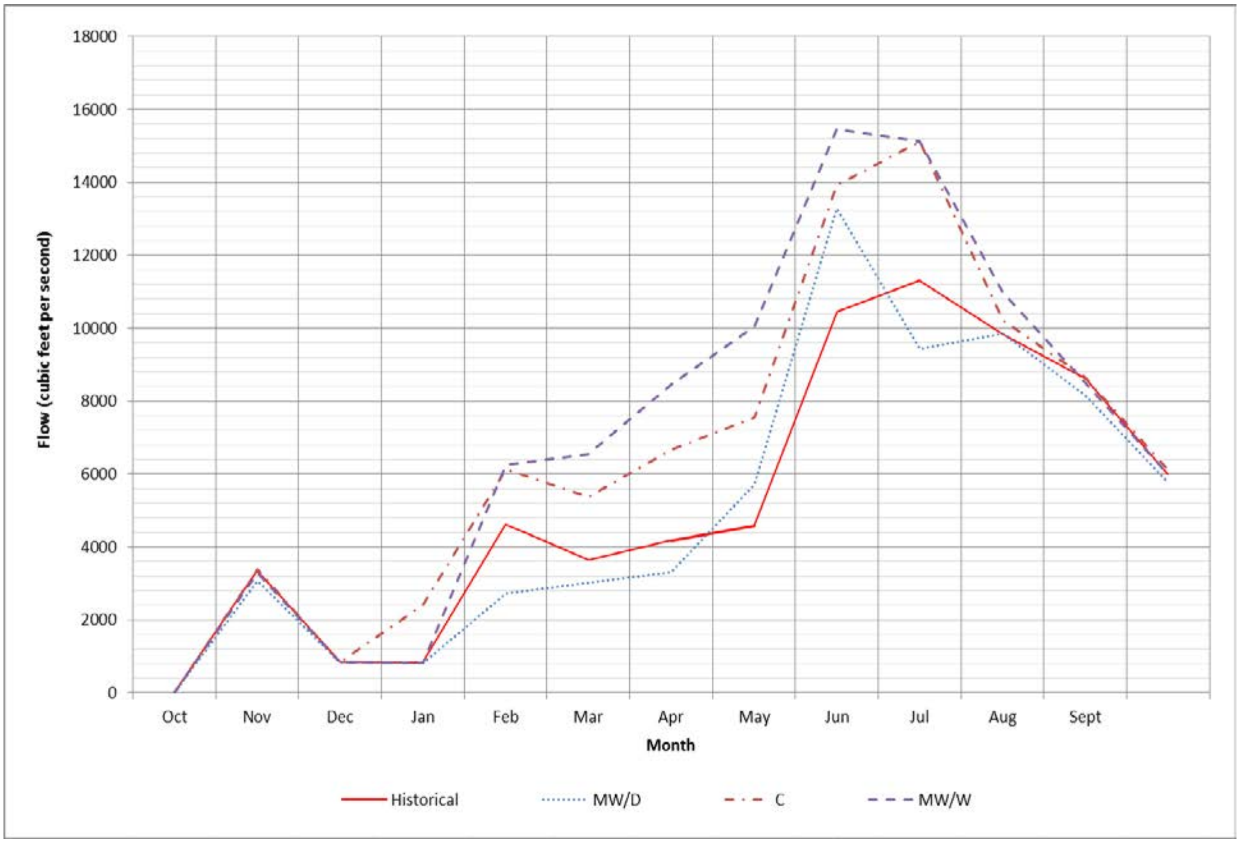

Figure 3-13. Summary hydrograph of outflow from Minidoka Dam. Note: Minidoka Dam outflows are not 0 cfs in mid-October. Rather, flows outside of irrigation season are typically at or below 500 cfs, which is not reflected in the model output.

3.3 Possible Effects of Future Climate Change

Climate change has the potential to profoundly alter the aquatic habitat through both direct and indirect effects. Direct effects would be evident in alterations of water yield, runoff timing, peak flows, and stream temperature. Future projections suggest that the Pacific Northwest may gradually become wetter than historical conditions. This is also significantly different from projections in the southern United States. Warming trends may lead to a shift in cool season precipitation, resulting in more rain and less snow, which would cause increased rainfall-runoff volume during the cool season accompanied by less snowpack accumulation (Reclamation 2011b). Future climate projections based on hydrologic analyses suggest that warming and associated loss of snowpack will persist over much of the western United States.

Warming is expected to diminish the accumulation of snow during the cool season (i.e., late autumn through early spring) and the availability of snowmelt to sustain runoff during the warm season (i.e., late spring through early autumn). Decreased snowpack volume also could result in decreased groundwater infiltration, runoff, and ultimately decreased contribution to summer base flow in rivers.

Warming is expected to lead to more rainfall-runoff during the cool season than snowpack accumulation. This would lead to increases in the December to March runoff and decrease the April to July runoff. As an example of how this may affect aquatic species, for cold-water associated salmonids in mountainous regions, where the upper distribution is often limited by impassable barriers, an upward thermal shift in suitable habitat can result in a reduction in size of suitable habitat patches and loss of connectivity among patches, which in turn can lead to a population decline (USFWS 2011).

It currently is not known how projected changes in runoff associated with future climate change will impact Snake River physa. Environmental reproductive cues are not known for this species, therefore, whether an earlier spring pulse has the potential to impact Snake River physa reproduction and recruitment is not known. However, based on information from other species within the family Physidae, generally, if water temperatures warm earlier in the year and cool later, it is possible the reproductive period for Snake River physa could be extended. Modeled projections of future flow conditions will likely have little to no impact on flow or suitable substrate availability for Snake River physa located within the spillway area or in the Minidoka reach. Earlier runoff as a result of increased winter precipitation and snowpack changes is not projected to interrupt Reclamation's ability to provide irrigation flows from American Falls Reservoir. Irrigation season flows will likely continue consistent with current operations during the period for which this analysis was conducted. If the suggested reductions to aquifer infiltration occur, the potential exists to impact Snake River physa within the Snake River downstream from Milner Dam via reductions in river flow resulting from reduced groundwater influence within this reach.

3.4 Current Upper Snake River Water Quality Conditions

Section 303(d) of the Clean Water Act (CWA) requires that states and tribes restore and maintain the chemical, physical, and biological integrity of the nation's waters. States and tribes must adopt water quality standards necessary to protect fish, shellfish, and wildlife while providing for recreation in and on the waters whenever possible. Part of the state responsibilities include requirements to identify and prioritize water bodies that are water quality limited (i.e., water bodies that do not meet water quality standards).

States and tribes must periodically publish a priority list of impaired waters every 2 years. For waters identified on this list, states and tribes must develop water quality improvement plans known as TMDLs that establish thresholds for pollutant loads set at levels to achieve water quality standards. The most recent approved Section 303 (d) list for the State of Idaho is the 2010 Integrated Report (IDEQ 2011).

The Section 303(d) listing process and subsequent TMDL development is initiated when beneficial uses are not being supported, which is generally identified through exceedance of criteria or through biological assessment of the existing or designated beneficial uses. Primary water quality problems identified in the action area includes water temperature, sediment, excess total phosphorus, low dissolved oxygen, and unknown pollutants (IDEQ 2011). Unknown pollutants are generally listed as a result of the biological assessment process used by the Idaho Department of Environmental Quality (IDEQ).

In 2000, the state developed the TMDL for the Lake Walcott Subbasin (Lay 2000) that includes the area below Minidoka Dam and the spillway. In this TMDL the primary constituents that received load and waste load allocations were sediment, oil and grease, and total phosphorus. Sediment targets were established at a monthly average of 25 mg/L and a daily maximum of 40 mg/L. Oil and Grease targets were established at no more than 5 mg/L at any time. Total phosphorus targets were established at 0.08 mg/L yearly average, with a daily maximum of no more than 0.128 mg/L (Lay 2000).

The next downstream TMDL that covers the lower action area is the Upper Snake-Rock Subbasin Assessment and TMDL which was originally completed in 1997, modified in 2000 and 2005, and had a 5-year status review completed in 2010 (IDEQ 2010). This assessment covers the Snake River from Milner Dam to King Hill. Pollutant targets for these Snake River segments are 0.075 mg/L total phosphorus, total suspended sediment concentrations of less than 52 mg/L, and bacteria concentrations of less than 406 cfu/100 ml.

After the Upper Snake-Rock Subbasin, the next downstream TMDL is the Snake River King Hill C.J. Strike Subbasin Assessment and TMDL (IDEQ 2006). This assessment covers the Snake River from King Hill to C.J. Strike Dam. Pollutant targets for these Snake River segments are 0.075 mg/L total phosphorus and a geometric mean of total suspended sediment concentrations less than 50 mg/L for no more than 60 consecutive days.

Mid Snake Succor Subbasin Assessment and TMDL covers the Snake River from C.J. Strike to the confluence with the Boise River. This TMDL was approved in 2003. The segments below C.J. Strike Reservoir were originally listed for sediment impairment. However, the assessment process determined that sediment was not impairing the beneficial uses, but that total dissolved gas was. Pollutant targets for the Snake River segments below Swan Falls Dam to the Boise River were set at 0.070 mg/L total phosphorus. It was determined that the total phosphorus reductions and TMDL would address the low dissolved oxygen and pH issues noted on the Section 303(d) list. Idaho also elected to add temperature as a pollutant, but no load and waste load allocations have been developed yet for this pollutant.

The final TMDL in the action area is the Snake River Hells Canyon TMDL (IDEQ and ODEQ 2004). This multi-basin TMDL was approved by the Environmental Protection Agency (EPA) in 2004. The TMDL covers the Snake River from RM 409 near Adrian, Oregon to just upstream of the confluence with the Salmon River. This TMDL covers the lower portion of the action area for this BA. Pollutant targets for these Snake River segments are 0.070 mg/L total phosphorus. It was determined that the total phosphorus reductions and TMDL would alleviate the low dissolved oxygen and pH issues noted on the Section 303(d) list. Bacteria contamination was found to not occur, and as a result that contamination was removed from consideration. However, it was determined that mercury contaminant was occurring, but no data was available to assess the impacts or to develop a TMDL. Action on the mercury issues has been postponed until appropriate data can be collected.

3.5 Minidoka Dam Spillway Water Quality Conditions

3.5.1 Current Conditions

As discussed in Chapter 2, flows into Lake Walcott are controlled by American Falls Dam to meet the downstream demands of irrigation and other water rights. Sediment carried into Lake Walcott by the Snake River and other tributary streams generally deposits in the upstream portions of the reservoir where it transitions from river-like to lake-like. This transitional area begins approximately 4 river miles downstream from the confluence with Raft River. Sediment deposited in this area may be redistributed to lower areas of Lake Walcott each year when the reservoir is drawn down in the winter for spillway protection. In addition, Lake Walcott also retains much of the nutrient load passing through from American Falls Reservoir as well as the nutrient loads from tributary streams and other point and nonpoint sources located upstream from the reservoir.

As a result, water quality conditions in the spillway area and the river segment below the dam can be quite different from the water quality seen below American Falls Dam and even through much of Lake Walcott. Furthermore, Lake Walcott currently supports the designated and existing beneficial uses. These beneficial uses are domestic water supply, cold water aquatic life, and primary contact recreation. As part of an ongoing reservoir monitoring program for operating projects, Reclamation collects water quality data every 3 years from Lake Walcott. These samples are analyzed for chemical, physical, biological, and trace metal parameters. Reclamation also collects data from temperature recording loggers throughout the spillway area. These data have been collected in 2005 and 2010. In other years, the temperature loggers were placed mainly in the snail pool[4] to assess the local temperature of that feature. In addition, the State of Idaho collected water quality data from the reservoir in 2007 to review the status of the Lake Walcott Subbasin Assessment and TMDL.

Minidoka Dam Spillway

Due to the sediment and nutrient retention in Lake Walcott, the water passing Minidoka Dam is typically of excellent quality. Water quality begins to degrade several miles downstream due to several large point sources as well as many smaller agricultural drains and tributaries which carry nonpoint source loads of nutrients. However, this does not occur within the reach between Minidoka Dam and upper Milner Pool. As a result, the Snake River downstream of Lake Walcott does not currently support the designated and existing beneficial uses. Waste load and load allocations for total phosphorus were developed by the State and are prescribed in the Lake Walcott Subbasin Assessment and TMDL. This segment of the Snake River was also assigned load allocations for sediment as well as oil and grease in anti-degradation TMDLs (Lay 2000). Total phosphorus (TP) targets for the Snake River downstream from Minidoka Dam were set at an average annual concentration of 0.08 mg/L of TP and a 0.128 mg/L TP daily maximum concentration to allow for natural variability. TP concentrations passing Minidoka Dam typically average 0.06 mg/L. However, this data is collected at Jackson Bridge, approximately 5 miles downstream from Minidoka Dam. Jackson Bridge is located just upstream of the pool created by Milner Dam.

Lake Walcott effectively retains most sediment delivered to the reservoir from upstream locations. Monthly annual TSS concentrations below Lake Walcott range from 4.2 to 14.3 mg/L. These values are well below the 25 mg/l concentration target used in the Lake Walcott TMDL to develop load and waste load allocations for Milner Pool. The proposed action should maintain the current levels of sediment and nutrient transport from Lake Walcott into the spillway and the Snake River segment below Minidoka Dam.

Under current conditions, a slight seasonal effect can be seen in the TSS data below Minidoka Dam. In March and April, sediment transport from the reservoir increases slightly, which corresponds with the annual spring freshet and flood control releases from upstream storage reservoirs. Additionally, in the months of September, October, and November, TSS also increases above the annual average of 9.2 mg/L. Also, in these months there are occasional spikes in TSS above the water quality targets. These spikes and monthly average concentration increases may be the result of the reservoir level changes, or they may simply be a reflection of the natural increase in TSS due to the die-off of aquatic plants or wind events mixing bottom sediments, leading to higher export of sediment coinciding with reservoir

[4] The "snail pool" is an area within the Minidoka spillway where live Snake River physa have been identified in successive years (Reclamation 2010a).

drawdown. In general, these spikes account for less than 10 percent of the overall TSS concentration in the Snake River on an annual basis.

The average daily maximum water temperature in the spillway is nearly uniform. There appears to be little difference between the temperature of water discharge over the spillway and at the end of the spillway. Furthermore, there does not appear to be any difference between the spillway temperatures and the reservoir surface temperatures. The results of the 2005 and 2010 temperature logger placements clearly illustrate these points. Plots were generated using an Inverse Distance Weighting (IDW) technique to model the temperature on a spatial basis. This was done using the R statistical software program and the default IDW function within the "GSTAT" package. Data in 15-minute increments were aggregated into daily maximums and input into the IDW function along with each data point's spatial coordinates as projected in the "IDTM83" coordinate system. The plots show a polygon shape, which is the rough outline of the Minidoka Dam spillway area, as shown in Figure 1-3. The area outside of the polygon shape is model overlap and is not the actual temperature of that area.

The various temperature logger data were synthesized into daily relative temperature charts that animate the spillway temperature regime by month. The plots shown herein are the first day of May, June, July, August, and September of both years. For example, in Figure 3-14, on May 1, 2005, most of the spillway is at 54.44°F while two areas of the spillway were slightly cooler and slightly warmer. There does not appear to be any correlation of temperatures with features in the spillway as each summer progresses. In later dates, the upstream portion of the spillway can be approximately 1°F cooler than the end of the spillway, as seen in Figure 3-16. Yet in the following months the upstream portion of the spillway is warmer than the downstream portion as shown in Figure 3-17. Very little variation of within-spillway temperature exists, although seasonal temperature variation exists as expected. See Figure 3-14 through Figure 3-23 for summer relative spillway temperatures.

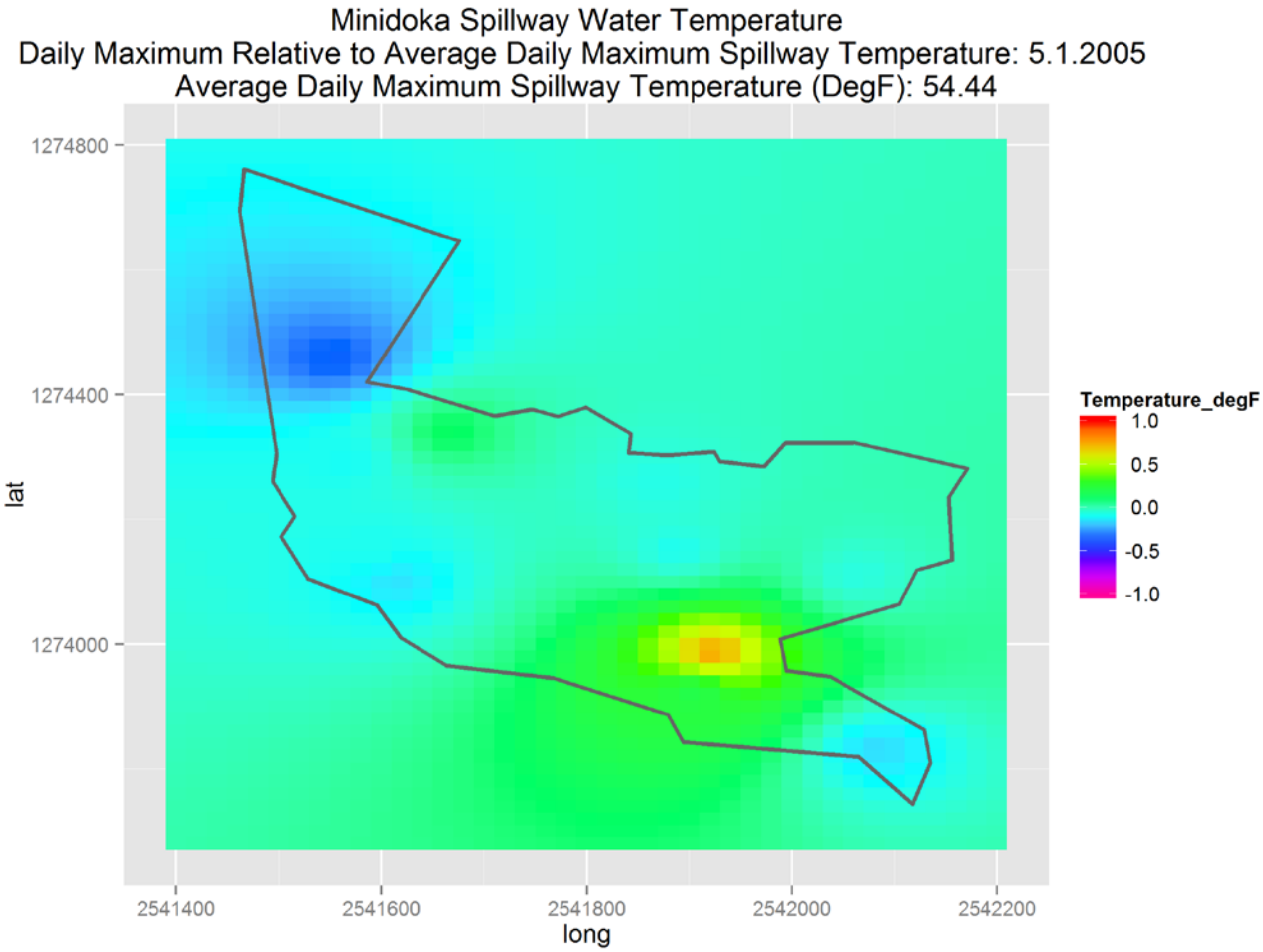

Figure 3-14. May 1, 2005 spatial variation of maximum spillway temperatures.

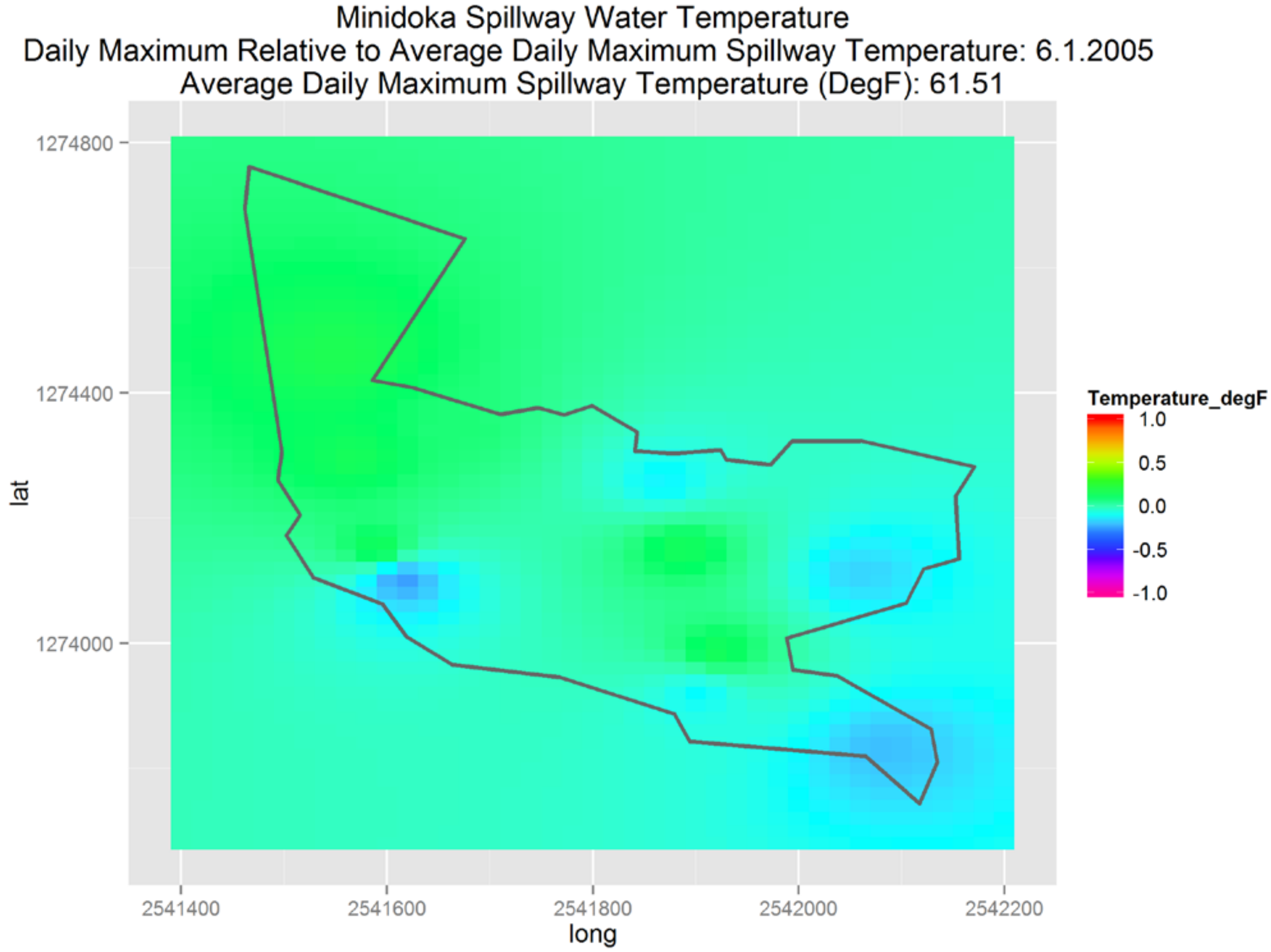

Figure 3-15. June 1, 2005 spatial variation of maximum spillway temperatures.

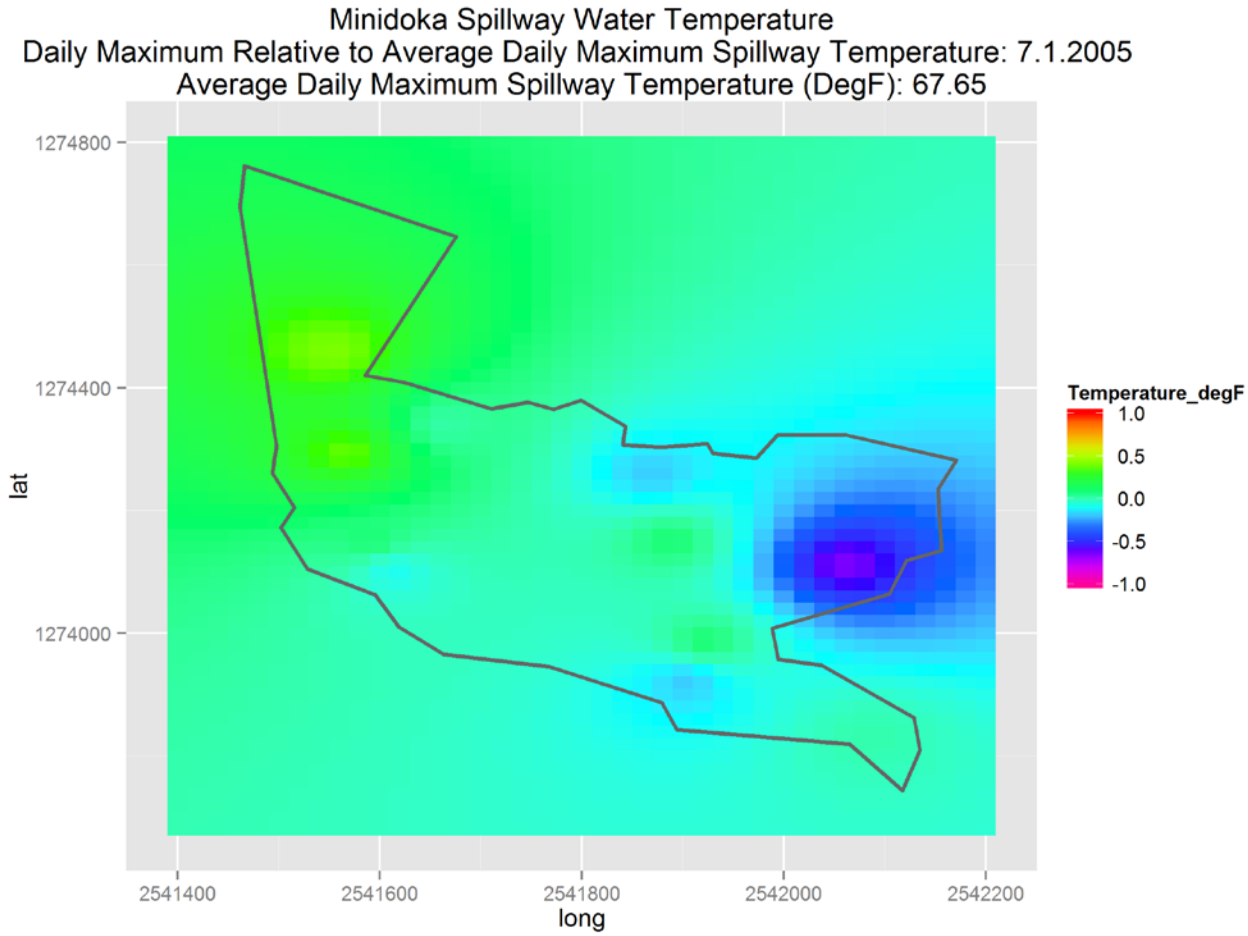

Figure 3-16. July 1, 2005 spatial variation of maximum spillway temperatures.

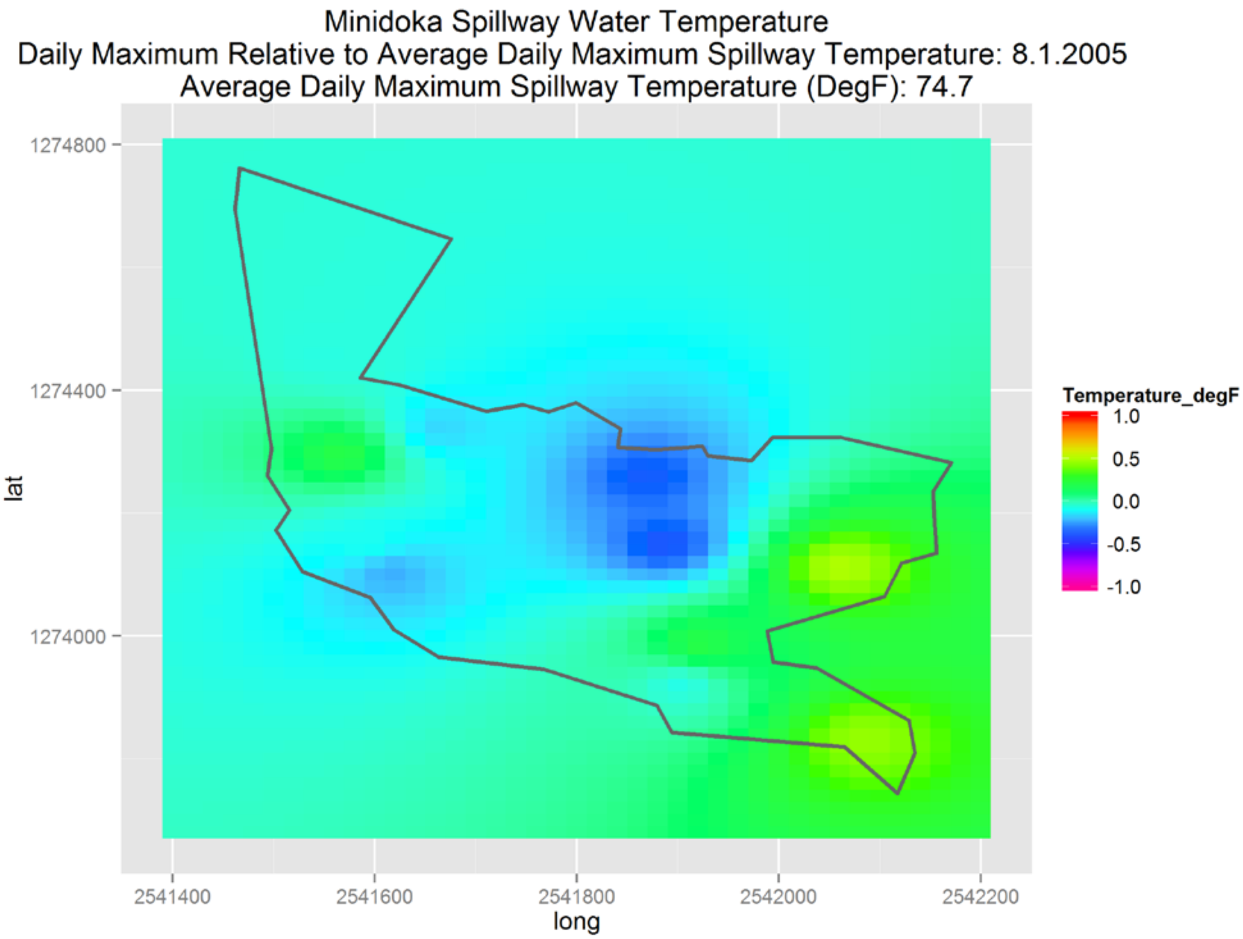

Figure 3-17. August 1, 2005 spatial variation of maximum spillway temperatures.

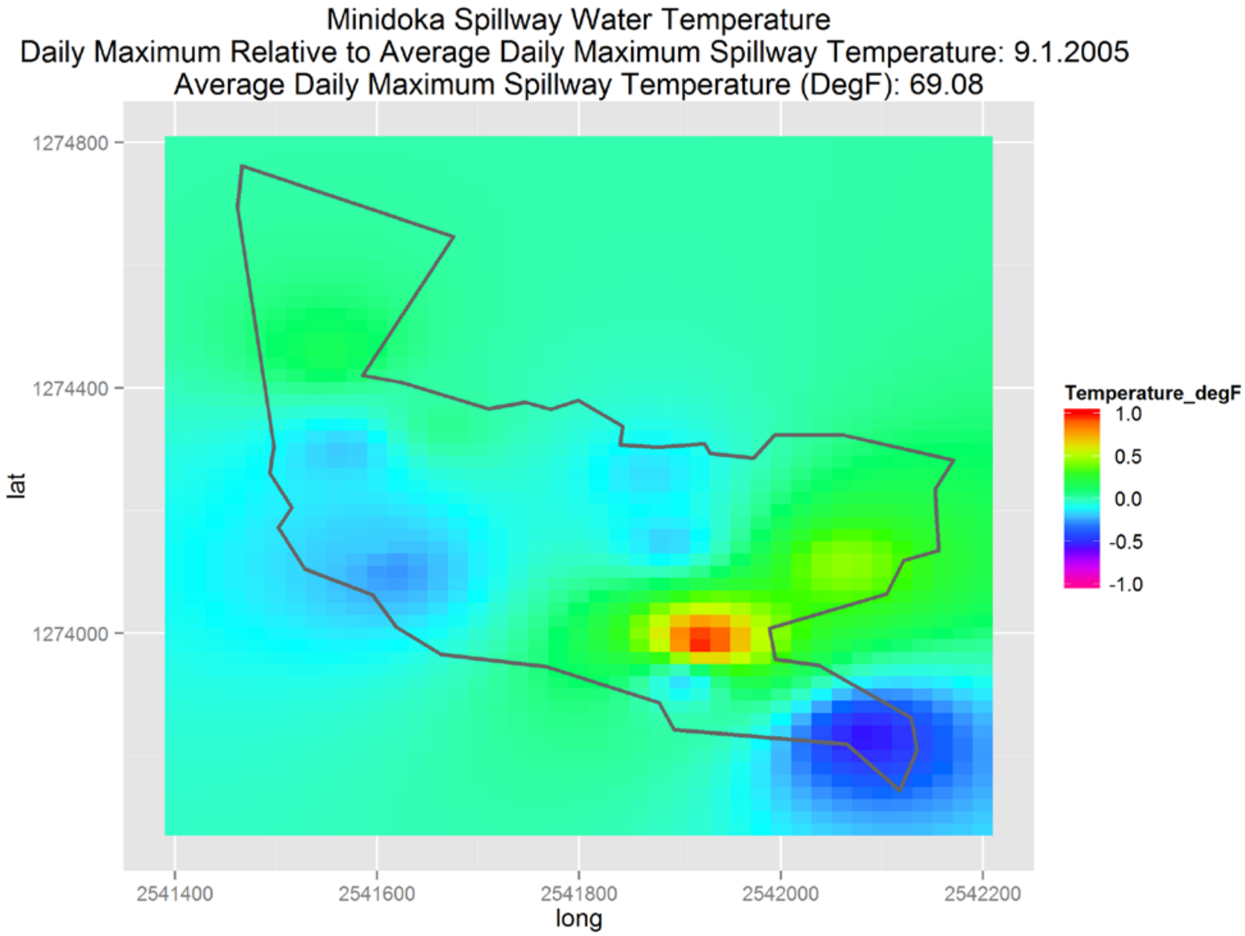

Figure 3-18. September 1, 2005 spatial variation of maximum spillway temperatures.

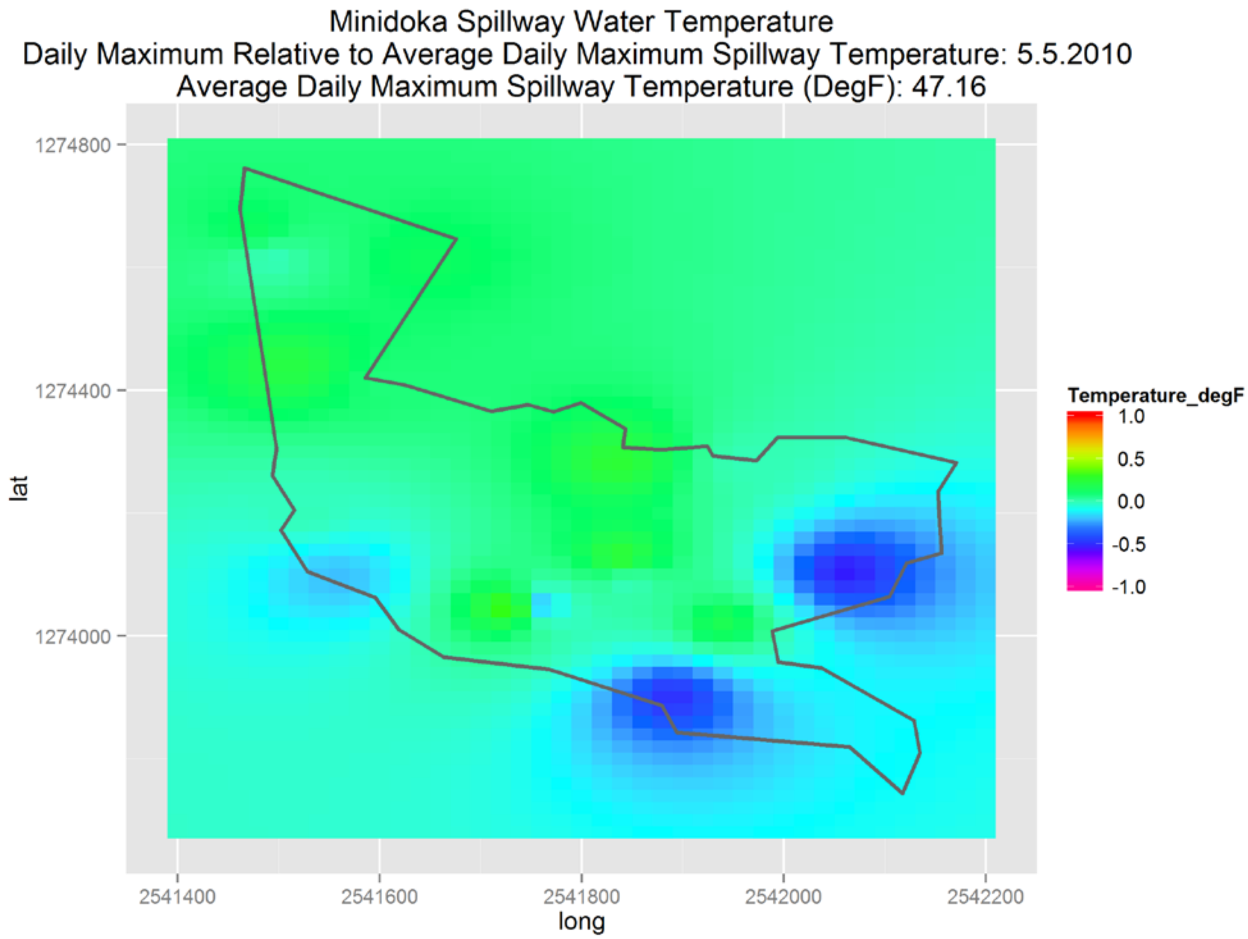

Figure 3-19. May 5, 2010 spatial variation of maximum spillway temperatures.

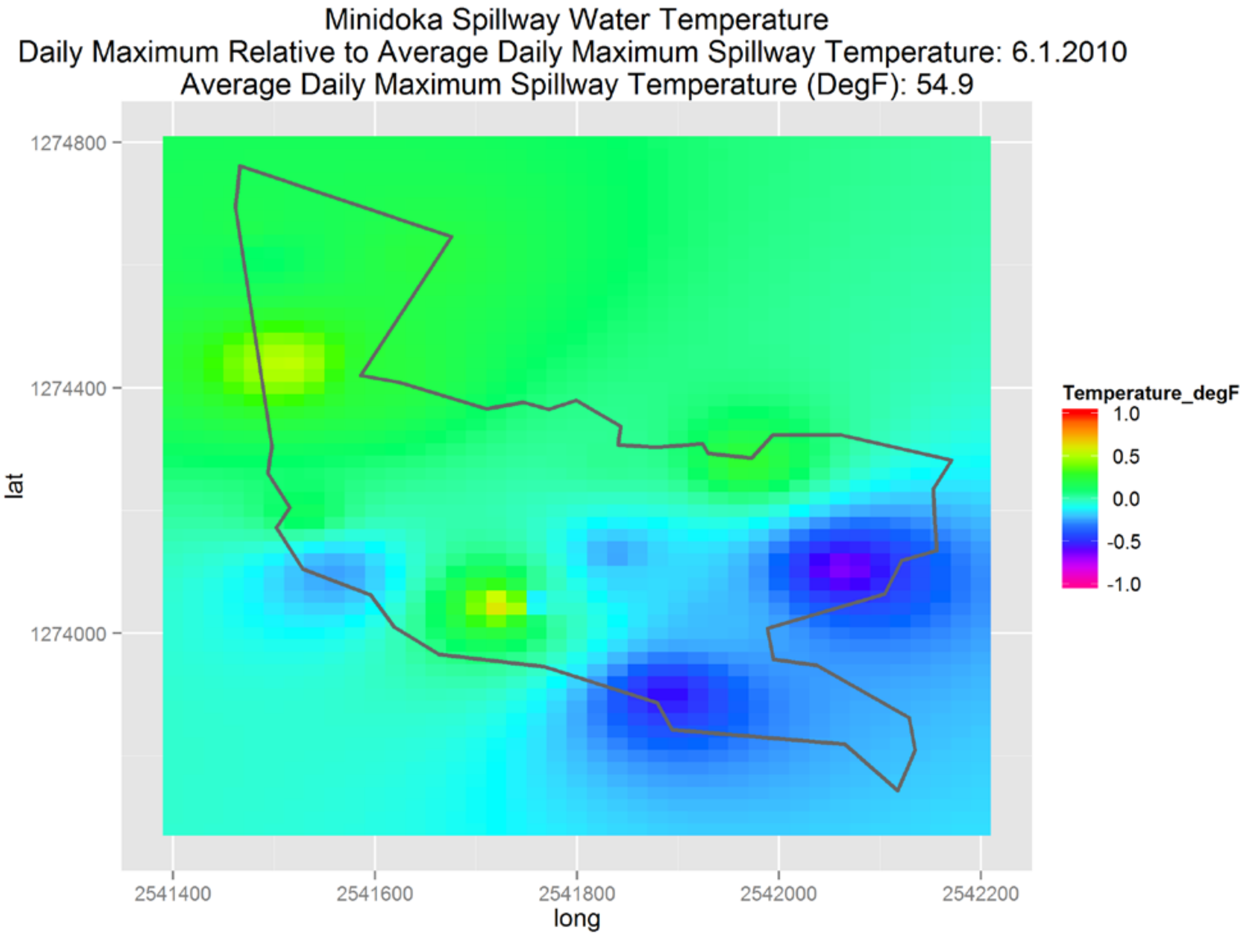

Figure 3-20. June 1, 2010 spatial variation of maximum spillway temperatures.

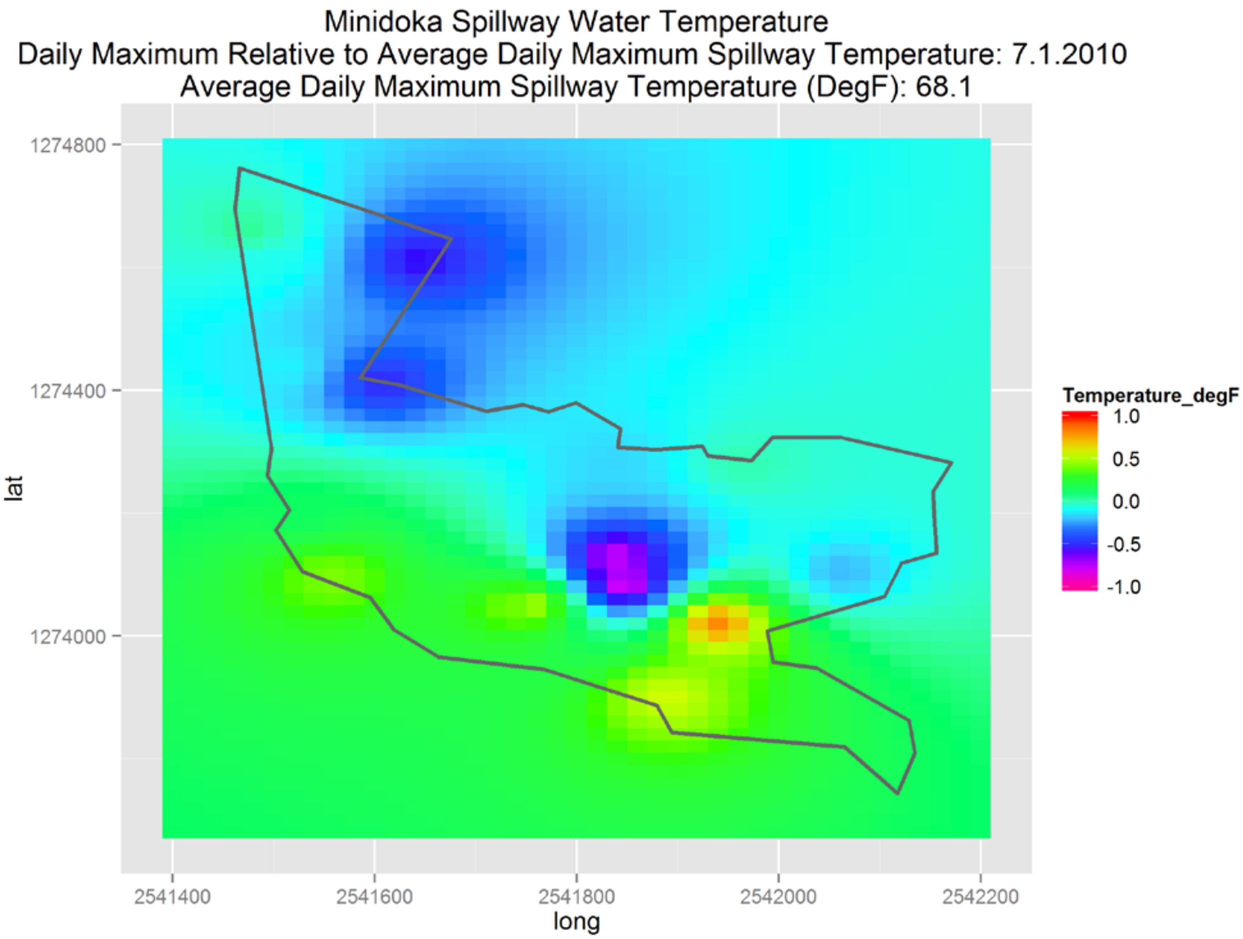

Figure 3-21. July 1, 2010 spatial variation of maximum spillway temperatures.

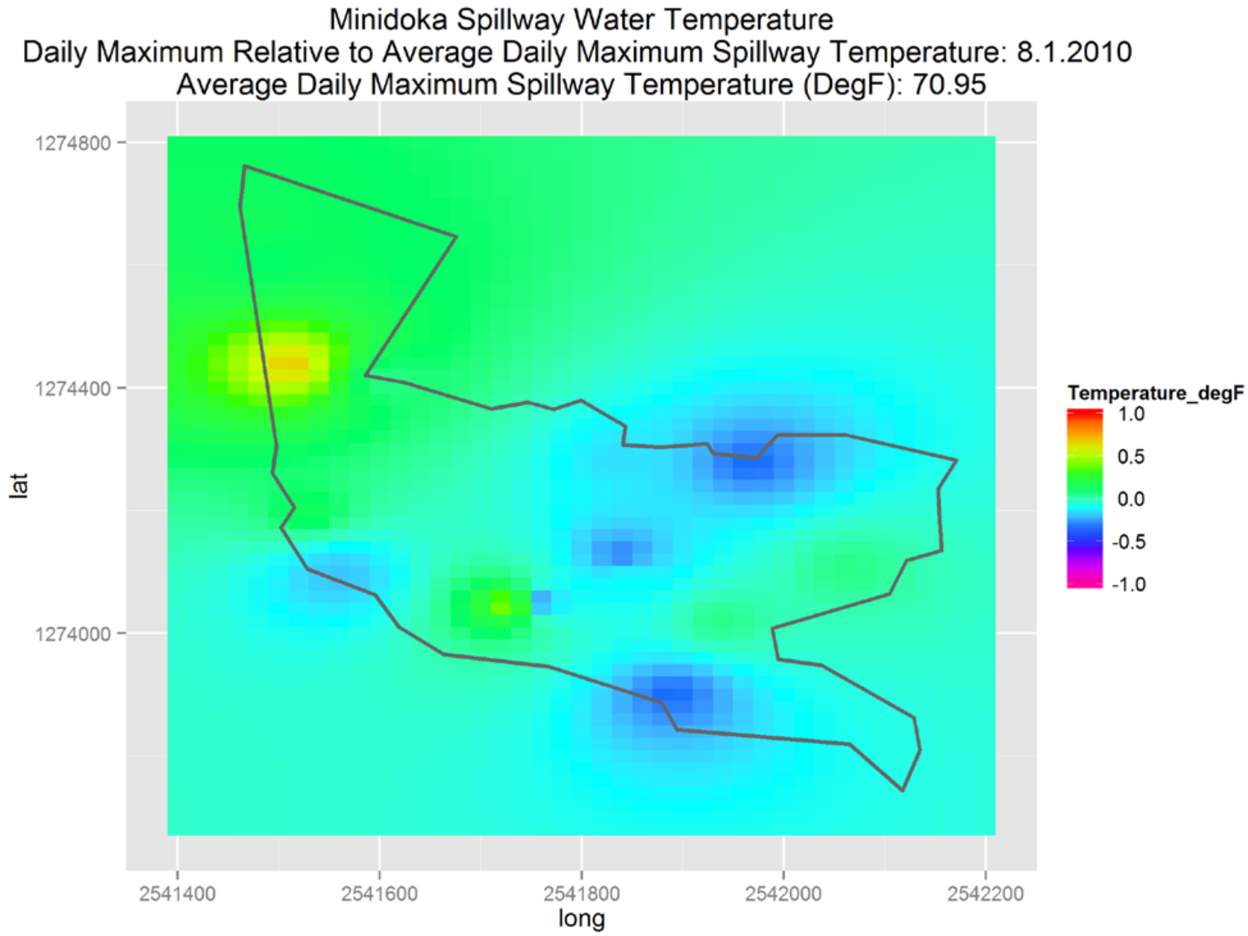

Figure 3-22. August 1, 2010 spatial variation of maximum spillway temperatures.

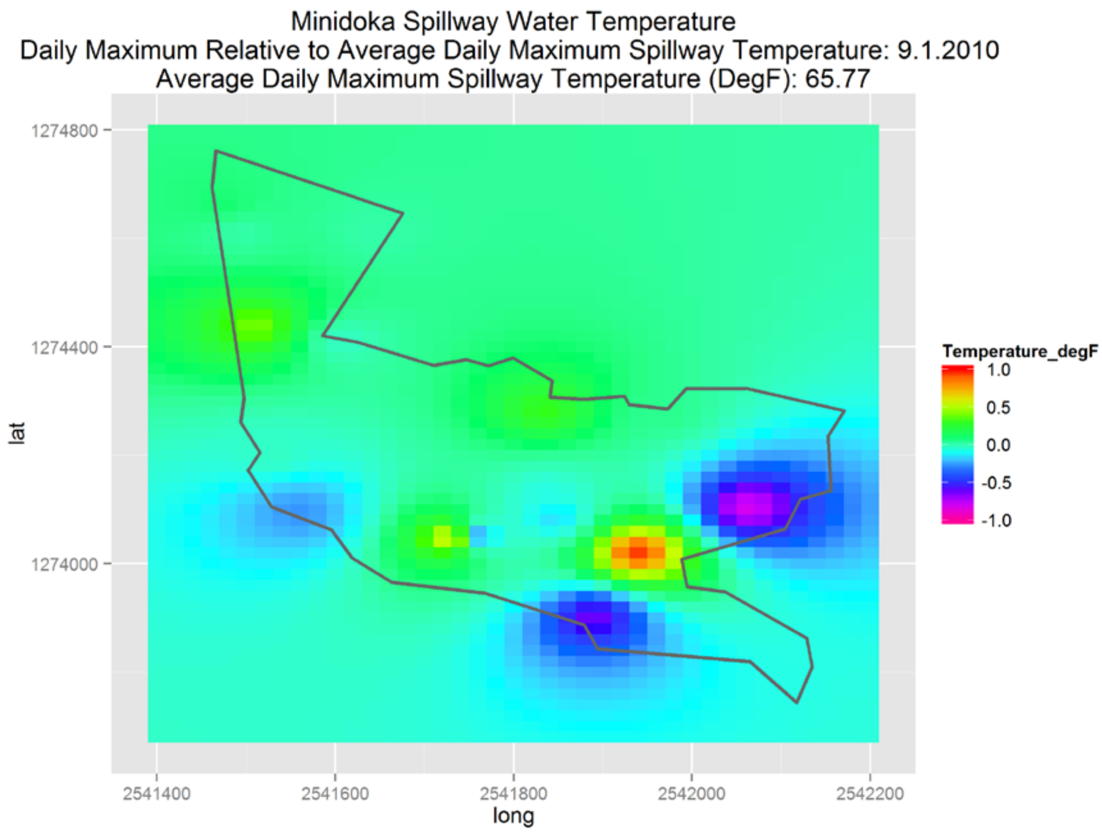

Figure 3-23. September 1, 2010 spatial variation of maximum spillway temperatures.

3.5.2 Adaptive Management Spillway Release Analysis

As stated previously, Lake Walcott effectively retains most of the sediment that flows into the reservoir from upstream locations, with very little being passed downstream from Minidoka Dam. Seasonally, the amount passed downstream increases slightly, potentially as a result of the reservoir being drawn down or wind events on the reservoir entraining sediment into the upper water column. With the frequency the reservoir is drawn down being reduced to approximately 25 to 50 percent of future years for the proposed action, this seasonal increase in sediment concentration associated with drawdown would be reduced or eliminated. In the drier type years when the reservoir is drawn down in response to storage depletion at American Falls Reservoir, we would also expect slight delivery of sediment and nutrients into the spillway and river reach below Minidoka Dam. These deliveries would be similar to the sediment and nutrient loads prior to the operational changes in the spillway. However, from a cumulative standpoint, the less frequent drawdowns associated with the proposed new operation of Minidoka Dam spillway will result in a decrease in seasonal sediment transport.

The proposed action should have similar effects on the river temperature. Currently, a minimum of 1,900 cfs is delivered across the existing spillway during the summer months of

July and August (typically the warmest period). The proposed action seeks to reduce this to a minimum of 500 cfs over a period of 4 years, thus effectively reducing the spillway delivery by at least 60 percent. As a result, the width-to-depth ratio of the spillway area would change and the potential exists for a decrease in velocity across the length of the spillway area, however, this may be offset by the new spillway structural design. The consequences of these changes would be an increase in the total solar loading which will result in a warming of the waters discharged across the spillway area in comparison with the historic operations. Travel time across the area below the spillway to the Snake River will also increase slightly due to the reduction in flow. Both changes allow for increased solar loading and warming of the discharged waters. However, the magnitude of this change on average temperature in the spillway area is likely less than a few tenths of a degree Celsius, and the change in the Snake River below the spillway area would be even less due to the thermal mass of the Snake River being much greater than the spillway water.

To understand the potential changes in travel time and temperature, Reclamation conducted a qualitative examination using a SSTEMP water quality model. The model was neither validated nor calibrated to the existing conditions of the spillway. However, the general nature of the spillway was modeled to determine if there would be significant changes in travel time or daily maximum temperature variations. Parameters from the spillway, such as channel roughness and shade were estimated. Actual background temperatures from the reservoir were used in the qualitative analysis. Discharge was varied from 1,300 cfs to 500 cfs. The resulting temperature and travel time changes for this qualitative review indicated that travel time would increase only slightly, by less than a few minutes, and that daily maximum temperature increases of less than a few tenths of a degree Celsius may occur. This is a result of the relatively short distance along the length of the spillway, spillway slope, and the velocity of the water flowing the length of the spillway.

As a result of this qualitative analysis no further temperature modeling was conducted. Reclamation anticipates little to no changes in irrigation season water temperature within the spillway area, although this will be quantified through the adaptive management process. The Technical Team will identify changes to temperature and velocity within the spillway area during the 4-year post construction evaluation period and make recommendations accordingly.

Smaller temperature changes are anticipated for the river segment below Minidoka Dam. Discharge through the power plant make up a significant portion of the flow in this section of the river regardless of the operational changes in the spillway. As a result, the background temperatures of the reservoir will remain the driving factor in the temperature of the river segment from Minidoka Dam downstream to the Milner Pool. Additionally, the reservoir only weakly stratifies and is prone to wind events that can mix the reservoir throughout the water column. As a result, there is no vertical temperature gradient that can be taken advantage of to change the river temperature through changes in withdrawal depth. The reservoir temperatures routinely reach 22 to 25°C during the summer months.

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Chapter 4
SNAKE RIVER PHYSA ANALYSIS

4.1 Introduction

Five species of aquatic mollusks in the middle Snake River were listed as endangered or threatened in 1992 (57 FR 59244). The Banbury Springs lanx (*Lanx sp.*), the Idaho springsnail (*Pyrgulopsis idahoensis*), the Snake River physa (*Physa natricina*), and the Utah valvata (*Valvata utahensis*) were listed as endangered. The Bliss Rapids snail (*Taylorconcha serpenticola*) was listed as threatened. The Federal Register notice provided summary information for the species. All five species are endemic to the Snake River and/or some springs and tributaries, and are thought to be generally intolerant of pollution. These species were listed due to declining distribution within the Snake River, adverse habitat modification and deteriorating water quality from hydroelectric development, peak-loading effects from water and power operations, water withdrawal and storage, water pollution, and inadequate government regulatory mechanisms.

The USFWS (1995) recovery plan for these species includes short- and long-term multi-agency objectives to restore viable, self-reproducing colonies of the listed snails. Downlisting or delisting originally depended on the detection of increasing, self-reproducing colonies at monitoring sites within each species' recovery area for at least a 5-year period; however, delisting has occurred for the Idaho springsnail based on new scientific information resulting in reclassification of a species and for the Utah valvata based on identification of errors in the original listing. Although addressed in previous Reclamation BAs, the Utah valvata (*Valvata utahensis*) is not addressed in this assessment due to the delisting of the species in 2010.

One of the five original-listed species is known to occur within the assessment area: Snake River physa. This assessment will focus on this species.

4.2 Background

4.2.1 Snake River Physa and Action Area

The USFWS listed the Snake River physa as endangered effective January 13, 1993 (57 FR 59244), although no critical habitat has been designated for this species. A recovery plan for the Snake River physa was published by USFWS as part of the *Snake River Aquatic Species Recovery Plan* (USFWS 1995). The target recovery area for this species is from the Snake River RM 553 to RM 675, which includes the river reach downstream of Minidoka Dam and includes the spillway area.

Existing populations of the Snake River physa are known only from the Snake River in central and south-southwest Idaho, with the exception of two (live-when-collected) specimens recovered in 2002 from the Bruneau River arm of C.J. Strike Reservoir (Keebaugh 2009). Fossil evidence indicates this species existed in the Pleistocene-Holocene lakes and rivers of northern Utah and southeastern Idaho, and as such, is a relict species from Lake Bonneville, Lake Thatcher, the Bear River, and other lakes and watersheds connected to these water bodies (Frest 1991; Link, Kaufman, and Thackray 1999).

The USFWS (1995) reported the Snake River physa's "modern" range extended from Grandview (RM 487) to the Hagerman Reach (RM 573). Surveys conducted by Idaho Power Company between 1995 and 2003 (Keebaugh 2009) and Reclamation from 2006 through 2008 (Gates and Kerans 2010) confirm its current distribution, based on live-when-collected specimens, from RM 368 near Ontario, Oregon (128 miles downstream from its previously recognized downstream range), upstream to Minidoka Dam (RM 675). Within this range (RM 675-368), Snake River physa have been recovered live from the reach below Lower Salmon Falls Dam (RM 573) downstream to RM 368 (and including the Bruneau Arm of C.J. Strike Reservoir) and in the Minidoka reach (RM 675 to RM 663.5). They have not been found in the reaches between Lower Salmon Falls Dam and the Minidoka reach (RM 573-663.5). While the presence of the species in this area cannot be ruled out, the occupied range of Snake River physa consists of the Minidoka reach and the reach between Lower Salmon Falls Dam to RM 368.

Reclamation's action area includes the entire known distribution of Snake River physa within the Snake River system.

4.2.2 Species Description and Needs

The Snake River physa was first formally described by Taylor (Taylor 1988; 2003). The shells of adult Snake River physa may reach 7 mm in length with 3 to 3.5 whorls, and are amber to brown in color and ovoid in overall shape. The aperture whorl is inflated compared to other Physidae in the Snake River, with the aperture whorl being greater than or equal to one half of the entire shell width. The growth rings are oblique to the axis of coil at about 40° and relatively course, appearing as raised threads. The soft tissues have been described from limited specimens and greater variation in these characteristics may be present upon detailed inspection of more specimens. The body is nearly colorless, but tentacles have a dense black core of melanin in the distal half. Penal complex lacks pigmentation although the penal sheath may be opaque. The tip of the penis is simple (not ornamented). The preputal gland is nearly as long as the penal sheath.

The Snake River physa is a pulmonate species, in the family Physidae, order Basommatophora (Taylor 1988; 2003). Recent collections of specimens closely resembling Taylor's (1988; 2003) descriptions of Snake River physa have been used to assess morphological, anatomical, and molecular uniqueness. Live snails resembling Snake River physa collected by Reclamation below Minidoka Dam as part of monitoring required in the USFWS 2005 BiOp (USFWS 2005) began to be recovered in numbers sufficient to provide specimens for morphological review and genetic analysis. Burch (2008; 2010) and Gates and Kerans (2010) identified snails collected by Reclamation as Snake River physa using Taylor's (1988; 2003) shell and soft tissue characters. Their genetic analysis also found these specimens to be a species distinct from P. acuta.

In 2004, Keebaugh (2004) at the Orma J. Smith Museum of Natural History discovered 4 Snake River physa (alive when sampled) and 12 empty Snake River physa shells in stored Reclamation samples. The Orma J. Smith Museum of Natural History, located at Albertsons College in Caldwell, Idaho, is the federal depository for federal Snake River snail collections. Reclamation consultants collected the potential Snake River physa specimens during a shoreline survey conducted in 1996 below Minidoka Dam. The specimens were verified as Snake River physa by the late Dr. Terrance Frest, a regional malacologist.

In 2005, Reclamation concluded Section 7 ESA consultation with the USFWS for future Reclamation operations on 12 federal projects located in the Snake River basin above Brownlee Reservoir (Reclamation 2004b; USFWS 2005). One of Reclamation's proposed actions was to conduct 3 years (during a 5-year period) of Snake River physa surveys from below Minidoka Dam downstream to above Milner Pool. Data collection for the study began in 2006 and was completed in 2008 (Gates and Kerans 2010).

Gates and Kerans' (2010) detailed study, which sampled cross sections of the river profile, characterized Snake River physa habitat below Minidoka Dam as occurring in run, glide, and pool habitats with moderate mean velocity (0.57 m/s). Mean depth of samples containing Snake River physa was 1.74 m. Live specimens were most frequently recovered from depths of 1.5 to 2.5 m, similar to that described by Taylor. Depths in which all specimens were recovered ranged from less than 0.5 m to over 3.0 m, and abundances of three or more Snake River physa per sample were found at depths greater than 1.5 m. Eighty percent of samples containing live Snake River physa were located in the middle 50 percent of the river channel (Gates and Kerans 2010). This evidence may be suggestive of habitat requirements related primarily to velocity and depth as they influence substrate deposition, and possibly other factors. Conditions present at the location of established colonies are used to define the "modern" habitat required by this species, which includes relatively large, relatively contiguous areas with the following attributes: higher water velocities; small and medium gravels, sometimes intermixed with course sand, free of fines; and higher dissolved oxygen.

Gates and Kerans (2010) also collected Snake River physa from the Minidoka Dam spillway area. The spillway area was dry ground prior to completion of the dam and spillway in 1906. Despite multiple survey efforts, to date no Snake River physa have been confirmed from surveys conducted upstream of Minidoka Dam. The colonies below Minidoka Dam and spillway are currently considered the upstream-most extent of the species' current range. Since 2010, Snake River physa have been collected within the Minidoka Dam spillway area, but, occurrence has been intermittent and at very low densities, with no live Snake River physa encountered in 2012 and 2014 and two collected in 2013 as part of Reclamation's current Snake River physa flow analysis study.

Gates and Kerans (2011) performed similar analyses on 15 of 51 live-when-collected specimens identified as Snake River physa (Keebaugh 2009), and collected by Idaho Power Company between 1998 and 2001 in the Snake River reaches from Bliss Dam (RM 560) downstream to RM 368. Gates and Kerans (2011) found that these specimens were not genetically distinct from Snake River physa collected below Minidoka Dam (but were genetically distinct from P. acuta), and provided additional support that Taylor's (1988) shell description of Snake River physa is diagnostic (Gates and Kerans 2011).

4.3 Effects of the Proposed Action

As discussed earlier in Chapter 1, the effects analysis for Reclamation's proposed actions to continue water operations on the Snake River above Brownlee Reservoir and assess flow partitioning past Minidoka Dam and spillway will be separated into three distinct segments. Each segment is a function of Reclamations ability to impact flow conditions as a result of annual water-management operations. The three segments are as follows: Minidoka Dam spillway area, Snake River from Minidoka Dam downstream to the I-84 Bridge, and the Snake River from Milner Dam downstream to above Brownlee Reservoir. Maps for each respective section are included in Chapter 1.

Minidoka Dam Spillway

As discussed earlier in Chapters 1 and 2, Minidoka Dam is a run-of-the-river facility primarily utilized to divert water into two canals and generate power. Flows at the facility are partitioned between the spillway area and powerplant during irrigation season. This annual flow partitioning has resulted in the establishment of a variety of habitat types within the spillway area supporting a wide variety of aquatic and terrestrial life. Aquatic snail surveys were initiated in the spillway area in 2000 when a survey was conducted by Reclamation for Utah valvata. Since then, the spillway area has been sampled multiple times (2000, 2003, 2004, 2006, 2007, 2012, 2013, and 2014) for ESA-listed snails, with live Snake River physa being encountered in 2006, 2007 and 2013 (Figure 4-1).

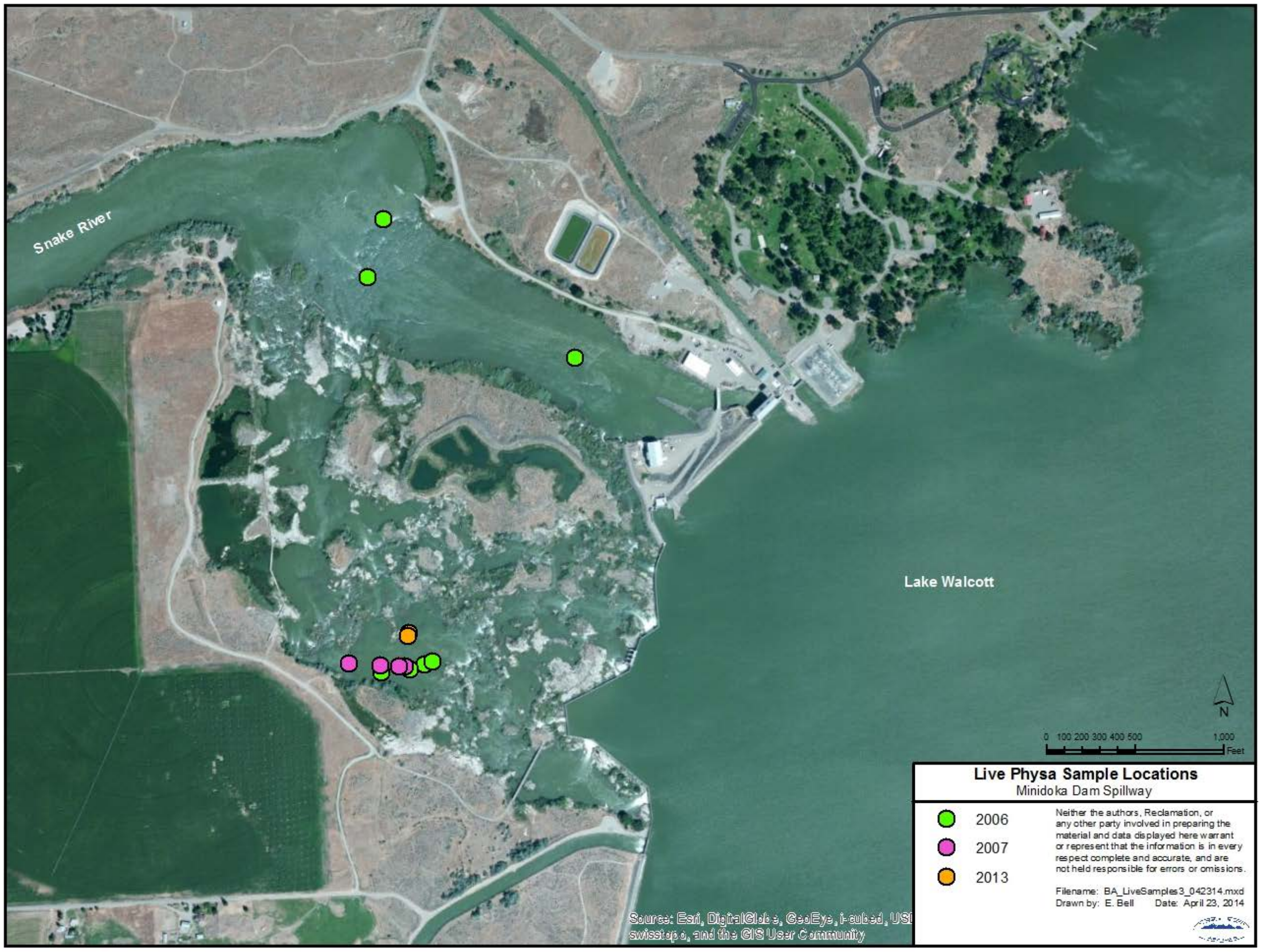

Figure 4-1. Live Snake River physa collected within the spillway area since 2006. Snake River physa were specifically targeted for collection beginning in 2006. Live specimens were collected in 2006, 2007, and 2013. No live Snake River physa were encountered in 2008, 2012, and 2014.

Occurrence of the species within the spillway area has been marginal, with detection ranging widely (15 per 0.25 m^2 in 2006 and zero in 2012). Although live Snake River physa were collected in the spillway pool during surveys conducted in 2006, 2007, and 2013, it is unknown whether Snake River physa colonized the spillway from upstream or downstream, by avian dispersal, how long they persisted in the spillway area, or whether they are ephemeral in this non-native habitat. Of particular interest is the one live Snake River physa specimen collected by Reclamation in the mitigation wetland in 2006. This wetland is an artificial wetland constructed by Reclamation as a mitigation commitment resulting from the construction of the Inman Powerplant at Minidoka Dam in 1997. The substrate of this wetland is composed entirely of fine materials with rooted macrophytes; habitat not suitable for Snake River physa colonization. Flows are provided to the wetland via a small pipe located on the face of the powerplant intake. Snake River physa distribution into this area is only possible via avian transport, human transport (highly unlikely), or veliger drift. Further studies need to be conducted to determine the dispersal mechanism for this species. Table 4-1 provides a summary of Snake River physa surveys conducted by Reclamation within the spillway area.

Table 4-1. Number of live Snake River physa collected from the spillway area during each survey effort. Note: 2014 data was not available for use at the time this document was prepared.

	2006	2007	2012	2013
Number Samples Collected	8	17	40	40
Number Live Snake River physa encountered	19	1	0	2

The Minidoka Dam spillway is situated in a gently undulating basalt surface with frequent rock outcroppings. The immediate vicinity of the spillway consists of broad, relatively undissected plain formed by Quaternary fluid basalt lava flows. Interlayed within the basalt flows are discontinuous inferflow zones comprised of both naturally occurring sediments resulting from deposition at the time of the lava flow as well as sediments transported via current system operations. The consolidated basalt substrate of the spillway area does not possess the physical attributes typically associated with Snake River physa colonization. Unconsolidated material located within the discontinuous interflow zones provides the appropriate substrate of gravels with intermittent cobbles and pebbles. This substrate, however, only provides suitable habitat in the presence of flows sufficient to provide the conditions necessary for Snake River physa colonization (conditions described in Section 4.2.2). Due to the bathemetry of the spillway area (Figure 4-2), much of the habitat is pool habitat, with higher velocities occurring at elevation breaks where one pool empties into the next. Much of the higher velocity locations occur within the solid basalt substrate. The portions of the spillway area where higher velocities intersect the unconsolidated materials (small gravels to medium cobbles) within the interflow zones produce the habitat requirements thought to be necessary for Snake River physa colonization. The availability of this habitat type is very limited within the spillway area; however, it remains watered year-round.

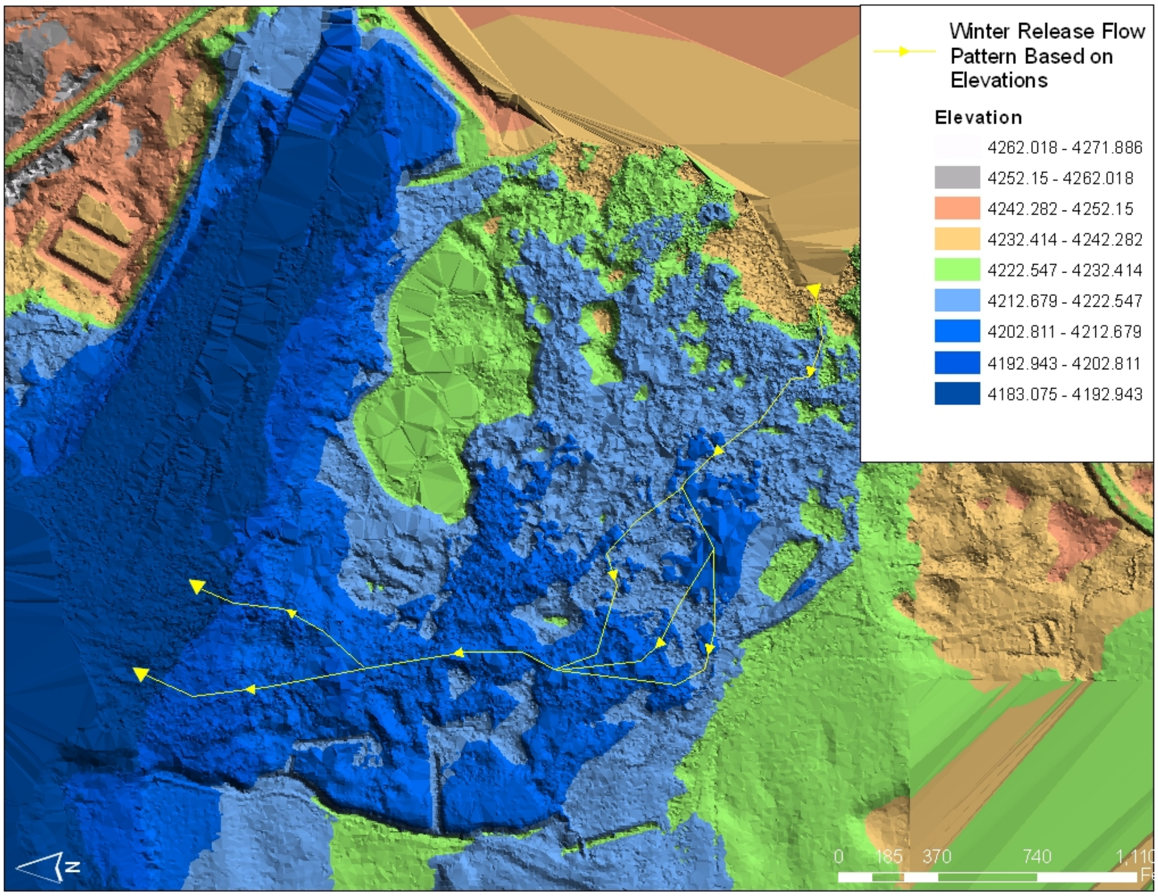

Figure 4-2. A 3-D image of the spillway area utilizing physical survey and LiDAR data. The winter release flow pattern is displayed for the purpose of illustrating flow direction through the spillway area utilizing a single release point.

The pool known as the 'snail pool' (Figure 4-3) is where deposits of unconsolidated materials can be found. The substrate of this pool consists of unconsolidated gravels with intermittent basalt outcrops in the upstream end and transitions to smaller gravels and fines with intermittent basalt outcrops on the lower end. The elevation of the snail pool is lower than the adjacent upstream spillway pools, resulting in higher velocity flow conditions in the upper portions of this pool. Additionally, specific features of this point in the spillway area result in turbulent flow conditions. The culmination of higher velocities, adequate substrate and higher dissolved oxygen associated with turbulent conditions creates conditions conducive to Snake River physa colonization. However, the small size (approximately 1 acre) supports low numbers of this diffusely dispersed species, thereby, making detection difficult and inconsistent.

Figure 4-3. The pool within the Minidoka spillway area known as the 'snail pool' is delineated by the yellow line. This is the location within the spillway area where live Snake River physa have been identified in successive years.

As previously discussed, Reclamation is utilizing an adaptive management approach with the assistance of a multi-agency Technical Team to arrive at an operational flow that will optimize power production without resulting in adverse effects to the Snake River physa known to occur within the spillway area. As a result of this process, Reclamation entered into an agreement with the USGS to collect velocity and water quality data at each snail collection quadrat. Data is collected by the USGS simultaneous with Reclamation snail surveys. The intent of the data collection is to determine flow and water quality conditions within the spillway area and assess site-specific conditions for locations where Snake River physa occur. Figure 4-4 shows one of the cross sections surveyed by USGS and Reclamation in 2013. The points on the flow graph are where live Snake River physa were encountered. Consistent with Gates and Kerans (2010), live Snake River physa were associated with velocities greater than 0.5 m/s and depths greater than 1.3 meters.

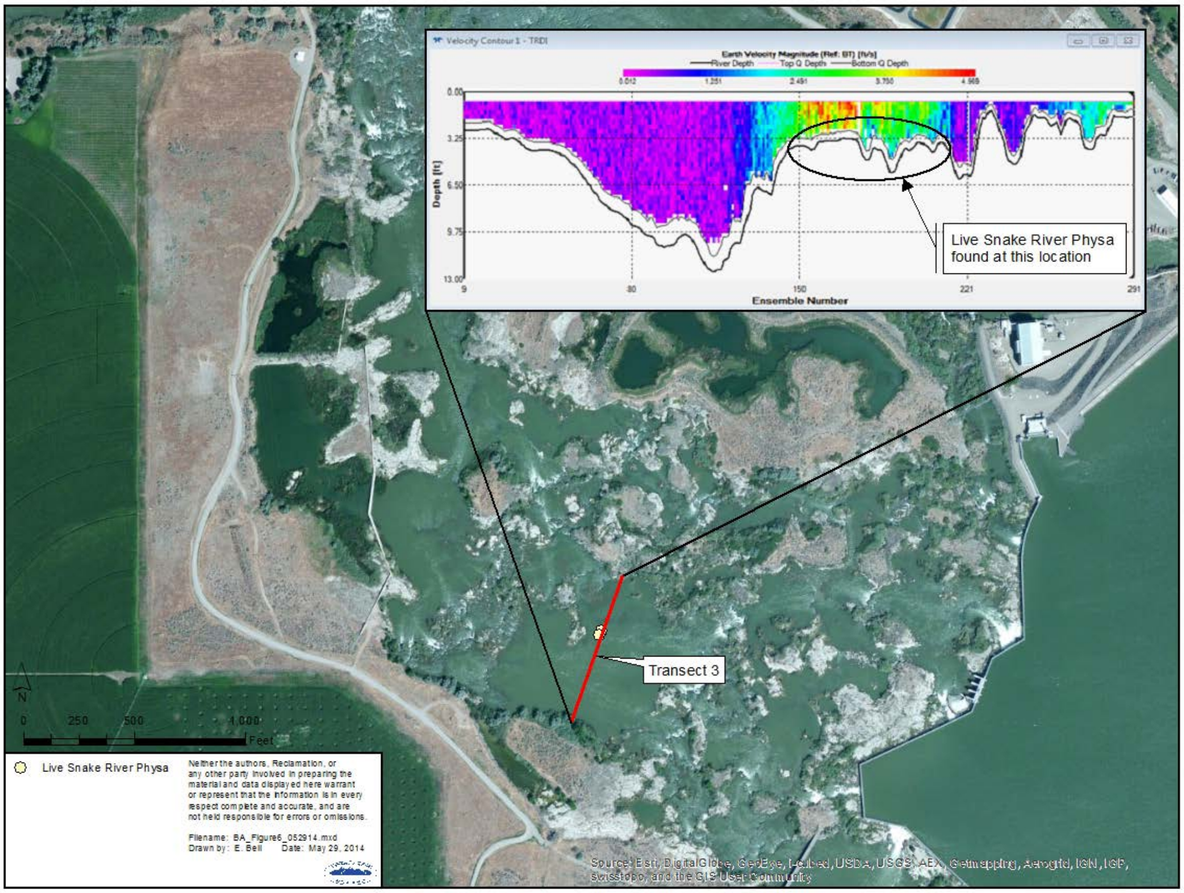

Figure 4-4. The USGS ADCP cross-sectional profile with location of live-when-collected Snake River physa shown on the aerial photo as well as the profile inset. Note the location of live Snake River physa relative to higher water velocities within the profile.

The USGS and Reclamation, in conjunction with the Technical Team, will continue to collect data following construction of the new spillway structure, assessing flow and water quality conditions at each previously identified flow. It is anticipated water velocities will increase throughout the snail pool as a result of the new structure. The previous overflow spillway structure was located approximately 1,300 feet upstream of the snail pool. Water coming over the spillway dropped into a large pool which ultimately flowed into the snail pool. The new structure is located approximately half the distance from the snail pool as the previous structure, thereby decreasing flow time to the snail pool. Additionally, the new structure consists of a radial-style gate which is a bottom release as opposed to a surface release like before. Water releases associated with the new structure will be subject to substantially higher pressure, resulting in much higher velocities at the point of release. Although not known, it is likely the increased velocity at the point of release coupled with the shortened flow distance will result in higher velocity conditions through the snail pool, possibly creating more usable habitat within this area. By continuing to collect Acoustic Doppler Current Profiles (ADCP) and water quality data along each snail survey transect, the Technical Team will be able to evaluate a range of operations following completion of the spillway in March, 2015. This will provide the Technical Team data necessary to make informed flow recommendations to Reclamation decision makers.

Water quality conditions identified within the spillway area since 2012 are consistent with Gates and Kerans (2010) and with nearby (6 miles downstream) locations where Snake River physa are known to consistently occur at relatively high numbers (Jackson Bridge site), with the exception of velocity, which is typically lower (Table 4-2). Therefore, it is not likely water quality is the limiting factor affecting Snake River physa distribution within the spillway area. Snake River physa distribution is likely a factor of habitat availability. During the 2006 through 2008 and ongoing 2012 through 2014 studies, Snake River physa have been found to occur throughout the Minidoka reach (RM 675 to RM 663.5) in a diffusely distributed population, suggesting the species rarely exhibits high density colony behavior. This characteristic decreases the detectability of the species and suggests larger expanses of habitat may be necessary for colonization. To date, water depth and velocity have been the best indicators of Snake River physa presence within the Minidoka reach and Minidoka spillway area.

Table 4-2. Range and mean of physical habitat parameters measured during the 2012 and 2013 Snake River physa surveys. Mean (ẋ) given in parenthesis. Significant differences (a=0.05) are shaded.

Site	Current Velocity (m/s)	pH	Temperature (°C)	Dissolved Oxygen (mg/L)	Turbidity (NTU)
Jackson Bridge 2012	0.13-0.52 (0.33)	8.2-8.6 (8.4)	20.0-23.3 (21.9)	7.9-11.2 (10.1)	17.9-27.4 (21.8)
Spillway Pool 2012	0.01-0.39 (0.12)	8.1-8.3 (8.2)	20.2-21.0 (20.6)	8.0-9.0 (8.4)	18.7-25.5 (22.0)
Jackson Bridge 2013	0.18-0.83 (0.45)	8.6-8.8 (8.7)	21.2-24.2 (22.6)	6.5-9.2 (7.7)	5.4-7.7 (6.7)
Spillway Pool 2013	0.01-0.4 (0.10)	8.6-8.8 (8.7)	22.4-23.3 (22.8)	7.5-8.6 (7.9)	4.4-32.5 (6.8)

As previously discussed, annual Reclamation operations do not completely dewater the spillway area. Pools within the spillway area remain filled outside of irrigation season. Although no controlled releases are provided outside of irrigation season, structural leakage (<1 cfs) provides flows through the spillway area, including the snail pool. Once irrigation deliveries cease, spillway pool water surface elevations drop to the point where they no longer spill, and remain at this level until the next irrigation season. This suggests flows are not lost from the spillway area via seepage and the small flows into the spillway area are sufficient to maintain pool elevation outside of irrigation season. Currently, only wetted footprint and water temperature information are collected from the spillway area outside of irrigation season. This information is made available to the Technical Team for evaluation. The Technical Team will continue to monitor spillway conditions outside of irrigation season to determine what managed releases, if any, are necessary to maintain the Snake River physa populations.

It is anticipated structural leakage will occur with the new structure. This leakage will need to be assessed to ensure adequate flows are provided through the spillway area to maintain the species. If it is ultimately determined controlled releases will be required outside of irrigation season, one of the release points identified in Figure 1-2 will be utilized for this operation. Currently, water release point 2 is preferred (Figure 1-2). Water released from this point in the structure flows directly to and through the snail pool.

The reproductive period for Snake River physa is not known, but might be expected to generally follow that of other Snake River gastropods, with juveniles appearing in mid to late spring and numbers peaking in mid to late summer. Although the dispersal mechanism for Snake River physa is not known, it is possible for juveniles to disperse into portions of the spillway area or Snake River downstream, subject to dewatering as a result of non-irrigation season operations. Although the wetted footprint of the spillway area changes little under a full range of operational elevations (Figure 4-5), the dispersal of Snake River physa into the annual fluctuation zone will result in take. Reclamation does not anticipate annual take within the spillway area will be very high due to the fact the wetted footprint changes little annually, and only basalt outcrops which are not utilized by Snake River physa, become dewatered outside of irrigation season.

Currently, Reclamation does not possess adequate data to present annual estimated take within the spillway area as a result of current spillway operations. In an effort to provide additional baseline data for the flow-evaluation component of the Minidoka Dam spillway adaptive management process, Reclamation began collecting data from one location (Jackson Bridge site) identified by Gates and Kerans (2010) as having adequate numbers of live Snake River physa to serve as a reference site from which to compare spillway data. Reclamation began data collection at the Jackson Bridge site and the Minidoka spillway area in 2012 as part of the adaptive management process in conjunction with the Technical Team. Data collection will continue at the two locations through the flow-evaluation period, at which point final spillway operations will be determined. The intent is to establish a flow designed to meet Reclamation's needs, while minimizing, to the greatest extent possible, impacts to the Snake River physa within the spillway area.

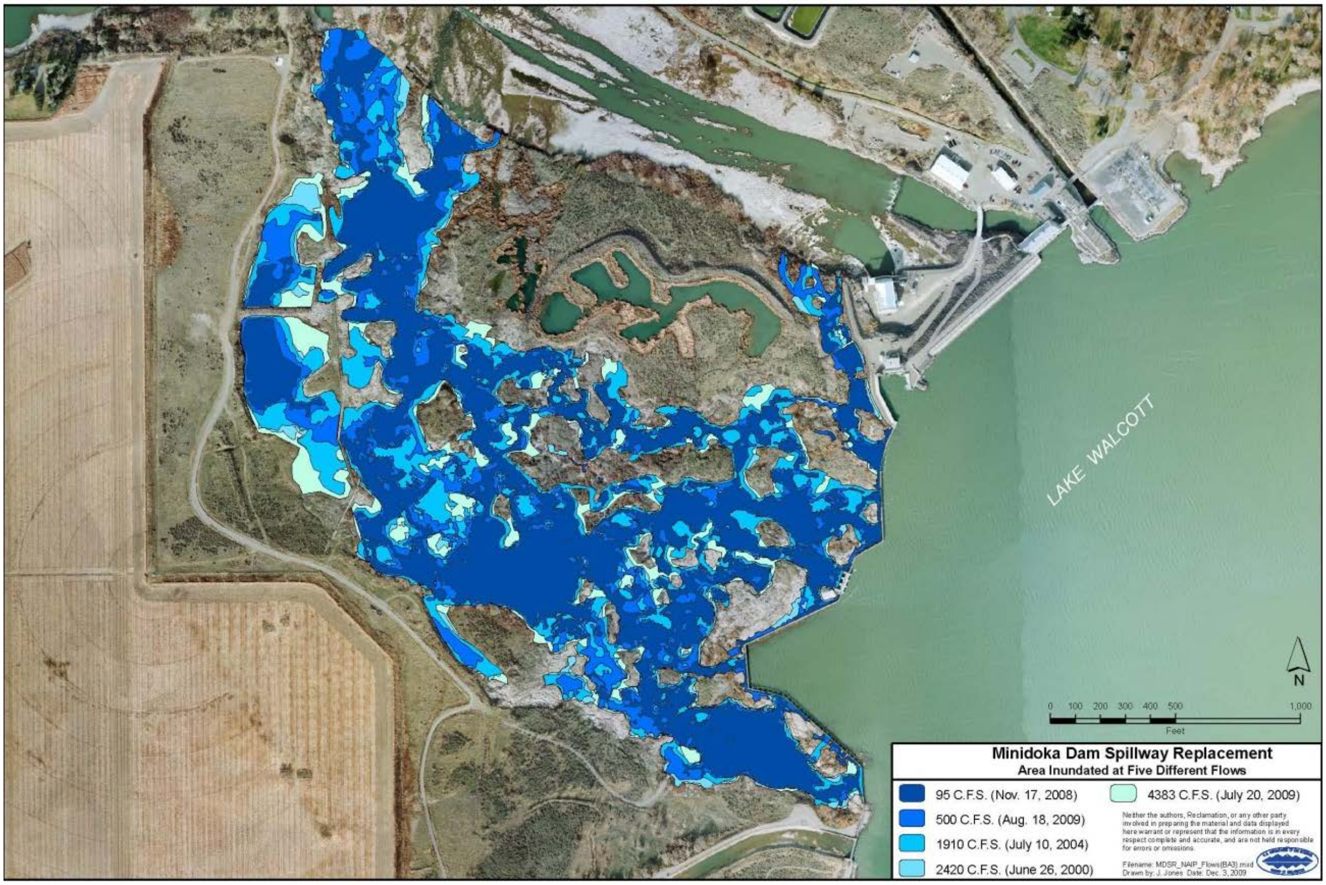

Figure 4-5. Minidoka spillway area wetted footprint at five different flows. Each successively higher flow includes the shaded area depicted for the next lower flow. For example, the wetted footprint at 500 cfs includes the area depicted by the two darker shades of blue (95 cfs and 500 cfs in legend).

Snake River from Minidoka Dam Downstream to I-84 Bridge

Flows below Minidoka Dam range from a daily average of 12,500 cfs to meet peak irrigation deliveries to as low as 400 cfs during the storage season of dry years. During the winter, Minidoka Dam passes inflow that comes from American Falls Reservoir releases and from reach gains (which vary but are typically between 150 and 175 cfs). Outflow as low as 60 cfs is possible during the spring immediately prior to the irrigation season when Minidoka Dam is being raised to full pool. It should be noted, however, that the 60 cfs operation results from analysis of historic data but does not reflect commitments made for the Inman Powerplant at Minidoka Dam and structural modifications made at American Falls Dam. Flow below Minidoka Dam has not been less than 100 cfs since 1978 and not less than 75 cfs since 1964. All of the flows less than 75 cfs occurred between 1962 and 1964, the first three years of no winter diversions at Milner Dam. Due to structural limitations at American Falls Dam, as well as the need to provide power to the Minidoka Dam facility, minimum flows below Minidoka Dam will continue to be greater than 400 cfs (approximately 525 cfs; see Section 1.3). The channel's shape from Minidoka Dam downstream to Milner Pool keeps much of the channel watered, even during flows below 400 cfs. Reclamation predicts flows below 400 cfs approximately 5 percent of the time.

Snake River physa presence within this reach of the Snake River is well documented (Gates and Kerans 2010; Reclamation 2013b; Reclamation 2014b). Snake River physa are distributed throughout the reach with greatest concentrations being found at the old Jackson Bridge site (RM 669.7). The consistent presence and high relative density suggest this reach of the Snake River consistently possesses the attributes necessary to maintain a seemingly robust population. Research has shown Snake River physa within the Minidoka reach prefer small and medium gravels, sometimes intermixed with course sand, free of fines. Results from Gates' data suggest that relatively large, relatively contiguous areas of preferred habitat may be one factor resulting in comparatively high densities (generally less than or equal to 32 individuals per square mile ($m^{2)}$, but up to 40 to 64 per m^2 in three samples) and abundance of Snake River physa within this reach. These results are relative, however. While the species has been found in the Minidoka reach in the highest numbers and densities so far recorded, Snake River physa occur throughout this reach in a diffusely distributed population, again suggesting the species rarely exhibits high density colony behavior.

The Minidoka reach of the Snake River is dominated by the preferred habitat of the Snake River physa. This reach is characterized by low fines, primarily because of its relative location within the upper Snake River system. American Falls Reservoir and Lake Walcott, located immediately upstream of the Minidoka reach, act as sediment traps, resulting in nearly sediment-free water passing Minidoka Dam and the spillway. This is further supported by the near absence of aquatic macrophytes within this reach. Fine materials located within this reach are typically found in shallower water near the shore line where velocities are lower. The thalweg, where higher seasonal velocities occur, is relative free of fine materials. Much of the suitable habitat within this reach is associated with higher velocities. The lower velocities associated with shallower water within this reach typically do not support Snake River physa.

Snake River physa are generally found in the deeper portions of this reach, within the thalweg where their preferred habitat is located. Figure 4-6 and Figure 4-7 show ADCP data collected during Reclamation's 2013 survey period. Snake River physa are generally associated with these deeper habitats where higher velocities prevent fine materials from settling within the gravel and pebble substrate. Due to the shape of the channel throughout this reach, this portion of the river stays wetted at the full range of Reclamation operations. Flows associated with flood operations and seasonal irrigation releases result in higher water velocities and flushing flows, preventing the deposition of fine materials within these deeper habitats.

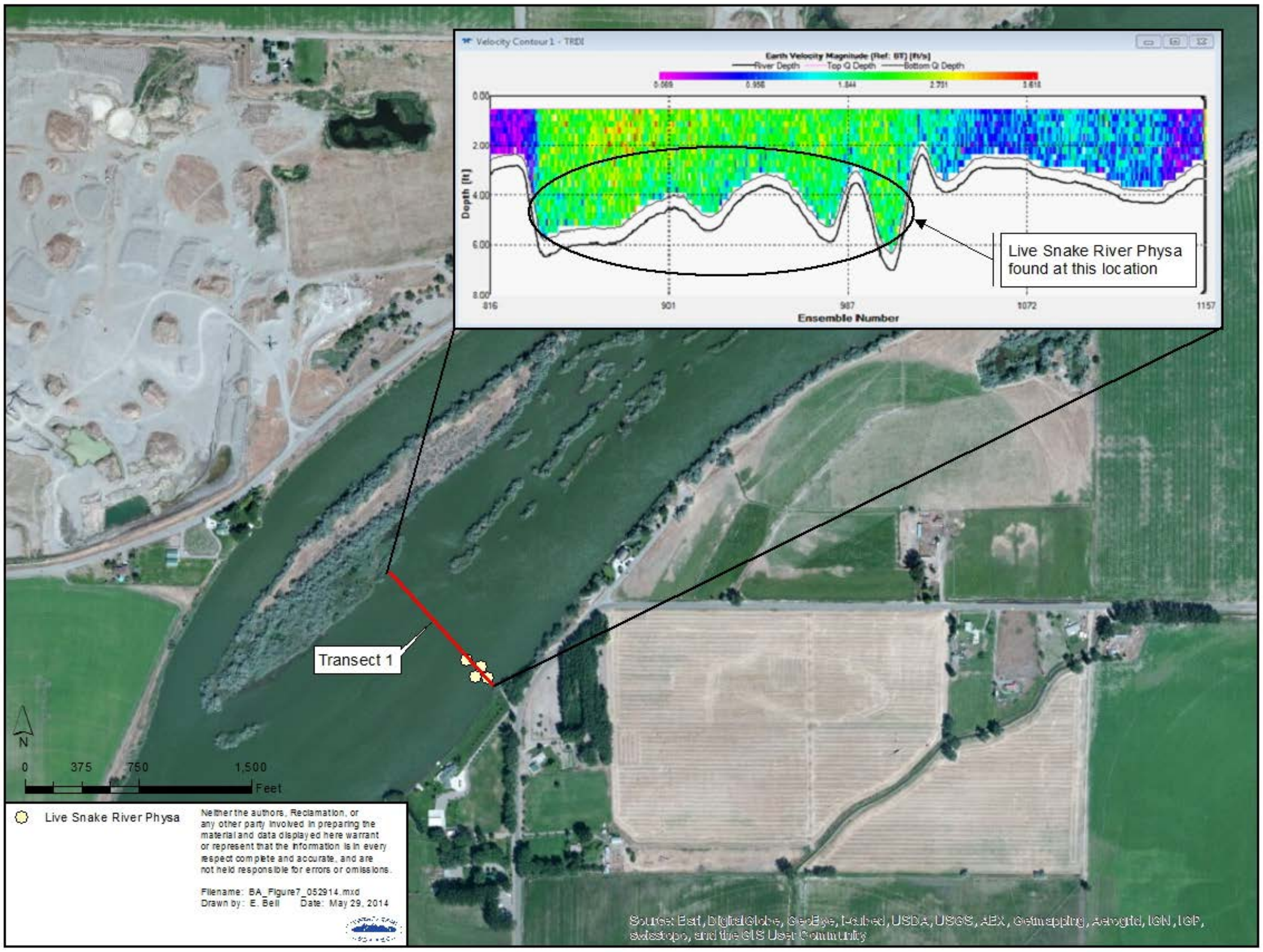

Figure 4-6. The USGS ADCP cross-sectional profile with locations of live-when-collected Snake River physa shown on the aerial photo as well as the profile inset. Note the location of live Snake River physa relative to higher water velocities within the profile.

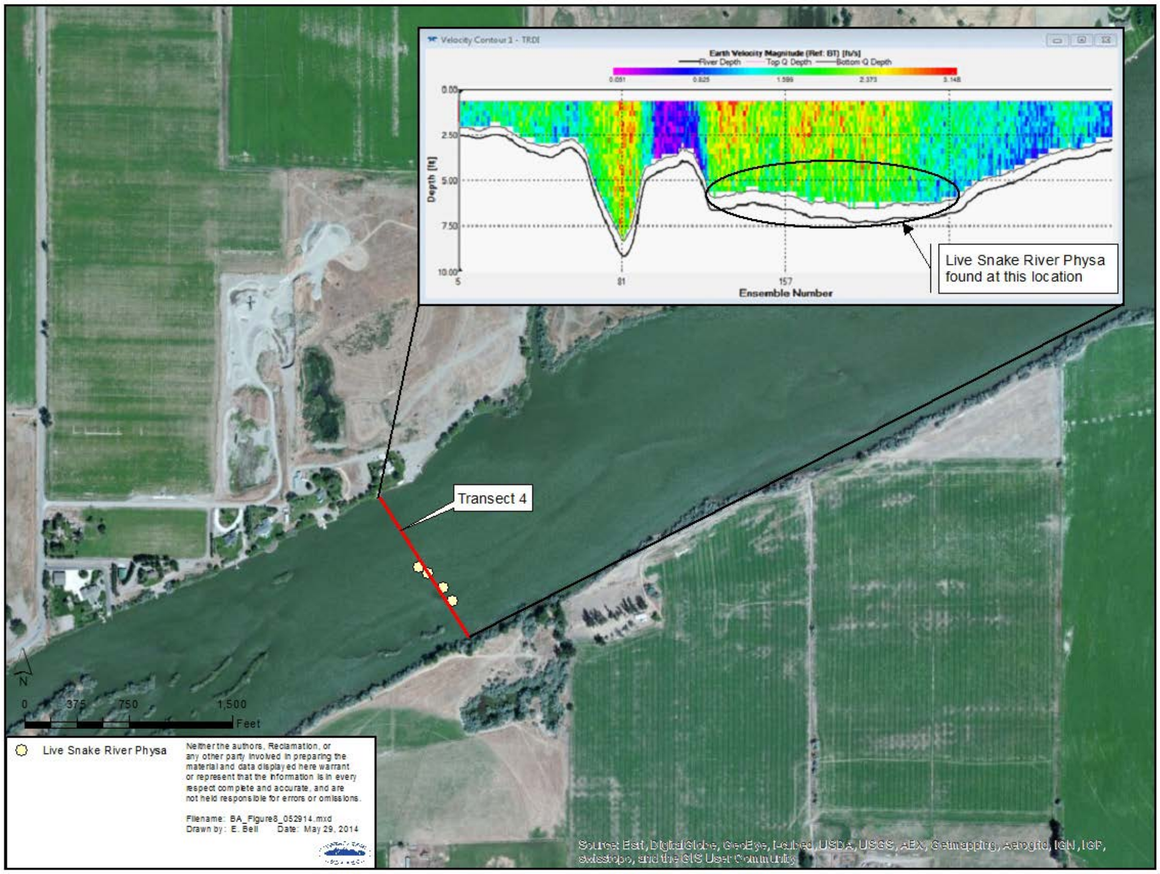

Figure 4-7. The USGS ADCP cross-sectional profile with locations of live-when-collected Snake River physa shown on the aerial photo as well as the profile inset. Note the location of live Snake River physa relative to higher water velocities within the profile.

Dissolved oxygen data collected by Reclamation since 2005 indicated dissolved oxygen is not a limiting factor, with concentrations ranging from 6.2 to 10 mg/l. Although the preferred range of dissolve oxygen concentration is not known for Snake River physa, recorded concentrations in the Minidoka reach of the Snake River are considered adequate to support aquatic life (i.e., >6 mg/l). Additionally, the near absence of fine materials and aquatic macrophytes along with oxygenation as a result of agitation through the upstream spillway area, further reduce the likelihood of impacts to Snake River physa as a result of low dissolved oxygen concentrations.

As previously discussed, Reclamation generally intends to hold Lake Walcott at full-pool elevation throughout the year in many years, as opposed to the current annual 5-foot drawdown. The current operation of drafting the reservoir each year following irrigation season has the potential to transport sediments deposited in the upper portions of the reservoir further downstream into the reservoir. Although this is likely a small change in sediment movement, over time it has the potential to result in short-term increases in Total Suspended Solids (TSS) past Minidoka Dam. However, by maintaining a steady full-pool elevation at

Lake Walcott following completion of the new spillway structure, this potential for sediment movement will be reduced. The maintenance of a full-pool elevation at Lake Walcott, year-round, will serve to maintain Snake River physa habitat in the Minidoka reach of the Snake River.

As discussed in the USFWS 2005 BiOp (USFWS 2005), the operation and maintenance of Reclamation's upper Snake River facilities has altered the annual hydrograph of the mainstem Snake River (Figure 4-8). Flows in the Minidoka reach were typically much higher during the winter months than current operations, averaging approximately 6,500 to 7,000 cfs. Figure 4-8 illustrates a general comparison of Reclamation's current operations and calculated natural flows. The calculated natural flow in Figure 4-8 takes into account current diversions and provides a better indicator of the true flow that would be in the river without current human effects. The time period used is water years 1988 to 2013 using monthly averages, and is calculated at the Howells Ferry Gage. Reclamation's operations have reduced the wetted footprint of the Snake River in the Minidoka reach outside of irrigation season, likely resulting in take. Although annual operations result in a reduction in annual flow and associated wetted footprint, due to the shape of the channel through this reach, the net change in wetted footprint is low when compared to other channel shapes. The general 'box' shape of the channel results in reductions in water depths with little reduction in wetted footprint. Further, the preferred habitat of Snake River physa within this reach of the river occurs at greater depths where higher velocities occur. This further reduces the extent of take expected to occur as a result of annual operations. However, take is anticipated to occur on an annual basis as a result of flow reductions outside of irrigation season. Juvenile Snake River physa distributing into the annual fluctuation zone will likely dessicate following flow reductions, resulting in take. Further, annual reductions in flow potentially reduce the availability of year-round usable habitat for Snake River physa. Although the overall reduction is likely very low due to channel morphology, it does exist to some extent. The degree to which an overall reduction in habitat availability resulting from Reclamation's operations exists is currently unknown due to the lack of bathymetric data for this reach of the Snake River.

Gates and Kerans (2010) found a majority of mollusc species within this reach, including Snake River physa, were found more frequently and more abundantly in the permanently watered habitat than the seasonally dewatered littoral zone. *Gyraulus parvus* and *Pisidium casertanum* were the only mollusc species to colonize the littoral zone suggesting better dispersal abilities and/or different habitat requirements. Of particular interest was the lack of invasive *P. antipodarum* populations in the littoral zone, a species known for rapid colonization and population expansion. These results differ from those in other reaches of the Snake River. Sampling below American Falls Dam (RM 714) in areas that experience less littoral zone dewatering than Minidoka Dam (5 to 7 m exposed littoral zone as opposed to 10 to 20 m) showed recolonization of the littoral zone all the way to the shoreline in August by many of the mollusc species found only in deeper water below Minidoka (Gates and Kerans 2010). This contrast suggests that differences in flow regime or littoral habitat may prevent molluscs from recolonizing the seasonally available littoral zone below Minidoka Dam. Consistent with Reclamation's findings, Gates and Kerans (2010) data indicated that silt was more common in dewatered habitats than watered habitats which likely contributed to decreased mollusc abundance in this zone.

Reclamation is currently constructing a 2-dimensional model of the Minidoka reach of the Snake River. Pressure transducers were installed throughout the Minidoka reach in 2011 to collect real-time depth data. Cross-sectional survey data was collected in 2011 and 2012 and will be collected again in 2014. This data will allow Reclamation to construct a model identifying Snake River physa habitat availability at a range of flows. The goal is to have the model calibrated and operational prior to completion of the Minidoka Dam spillway structure. Reclamation will use this model to identify potential impacts to Snake River physa habitat availability resulting from annual water operations. The model will quantify overall reduction in usable habitat and the subsequent reduction in overall habitat available to the species for annual occupation. This data will be useful to Reclamation operators in evaluating current and future flow conditions below Minidoka Dam as a result of upper Snake River operations. Additionally, this data will be useful in monitoring and quantifying potential annual impacts to Snake River physa habitat resulting from operations.

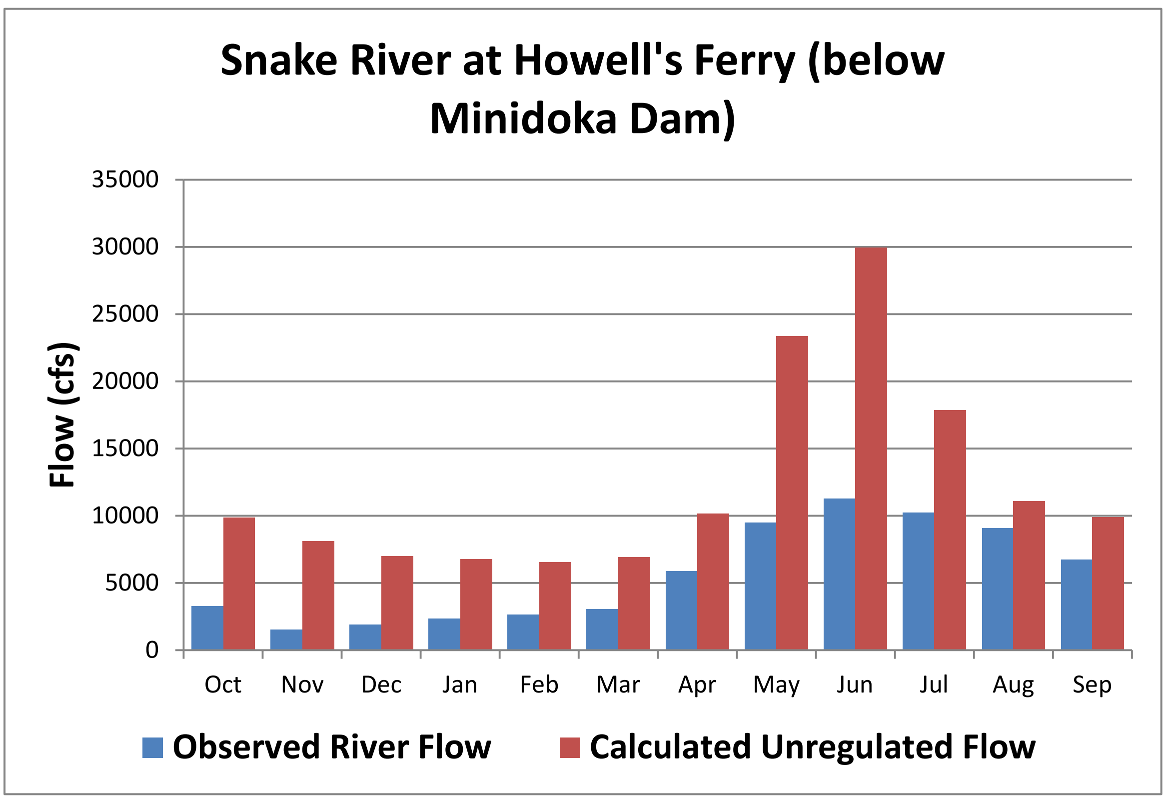

Figure 4-8. Observed versus calculated unregulated flow in the Snake River at Howell's Ferry gage.

Snake River from Milner Dam Downstream to Brownlee Reservoir

Downstream from Minidoka Dam, private dams alter the water operations, water quality, and river habitat. These dams include Milner Dam and the Idaho Power dams (Idaho Power's Mid-Snake Projects, C.J. Strike, and Swan Falls Dams) that are subject to ESA consultation through the Federal Energy Regulatory Commission (FERC) relicensing process. The Idaho Power dams are operated to optimize power generation and meet customer demand. Irrigation activities store or remove much of the surface water in the river upstream from Milner Dam. Streamflow is restored by tributaries, return flows, and springs (including those in the Thousand Springs area). The only Reclamation facilities located below Milner Dam on the Snake River are four irrigation pumps located near Marsing, Idaho. Reclamation's influence on physa and physa habitat downstream of Milner Dam is negligible due to the influence of water management by non-Reclamation entities.

Little snail information exists for the reach beginning immediately below Milner Dam downstream to the first Idaho Power facility. Milner Dam is generally considered to be the lowest control point in Reclamation's O&M in the Snake River system above Milner Dam, and downstream activities are conducted independent of those activities upstream from Milner Dam (Reclamation 2004b). The upstream storage reservoirs do not supply irrigation water to entities that divert water from the Snake River downstream from Milner Dam, and there are no Reclamation reservoirs on the mainstem downstream from Milner Dam within the action area (Reclamation 2004b). The exercise of water rights, including private water rights, above Milner Dam has reduced flow at the dam to zero, though large flows do pass the dam in years of high runoff and when salmon flow augmentation water is delivered.

Idaho Power's FERC license requires Idaho Power to maintain, within its capability, a minimum release of 200 cfs immediately downstream from Milner Dam. However, there is no water right for this minimum release, so water must come from natural flow (spill water) between irrigation seasons or from storage or rental pools. This water may not always be available. During the past 95 years, flows have been reduced to between 50 and 0 cfs below Milner Dam 131 times for periods greater than 4 days (when flows below Milner Dam are reduced to, or very near, 0 cfs, the Snake River at Milner gage sometimes gives falsely inflated readings; many times recorded flows up to 50 cfs are false readings). Discharge of the Snake River Plain Aquifer from Bancroft Springs (RM 553) upstream to Briggs Springs (RM 590.5) provides most of the inflow to the Snake River in the reach from Milner Dam to King Hill.

Although operational effects below Milner Dam may not be as direct as they are above Milner Dam, Reclamation's operations do affect the Snake River below Milner Dam. The analysis below Milner Dam is separated from upstream operations analysis based on localized impacts. Immediately below Milner Dam, future O&M in the Snake River system above Milner Dam is partially responsible for occasionally dewatering the Snake River through the storage and diversion of project water. Between Milner Dam and Shoshone Falls, limited spring input adds water to the channel although, Snake River physa are currently not known to exist within this reach. From Shoshone Falls to above Brownlee Reservoir, combined effects associated with the proposed actions become increasingly difficult to distinguish from other localized factors. In this reach, river flows are increased via spring recharge, localized runoff, irrigation return flows, and municipal and industrial effluent. Water quality is also altered by urbanization, effluent from dairies, fish culture facilities, and irrigation returns. Any potential effects resulting from Reclamation's proposed actions become further attenuated by Idaho Power's localized operations.

Within the species' range (RM 675 to RM 368), Snake River physa have been recovered live from the reach below Lower Salmon Falls Dam (RM 573) downstream to RM 368 (and including the Bruneau Arm of C.J. Strike Reservoir) (Figure 4-9) and in the Minidoka reach (RM 675 to RM 663.5). They have not been found in the reaches between Lower Salmon Falls Dam and Milner Dam (RM 573 to RM 639.1), although surveys in this area have been sporadic. While the presence of the species in this area cannot be ruled out, the occupied range of Snake River physa consists of the Minidoka reach and the reach between Lower Salmon Falls Dam to RM 368.

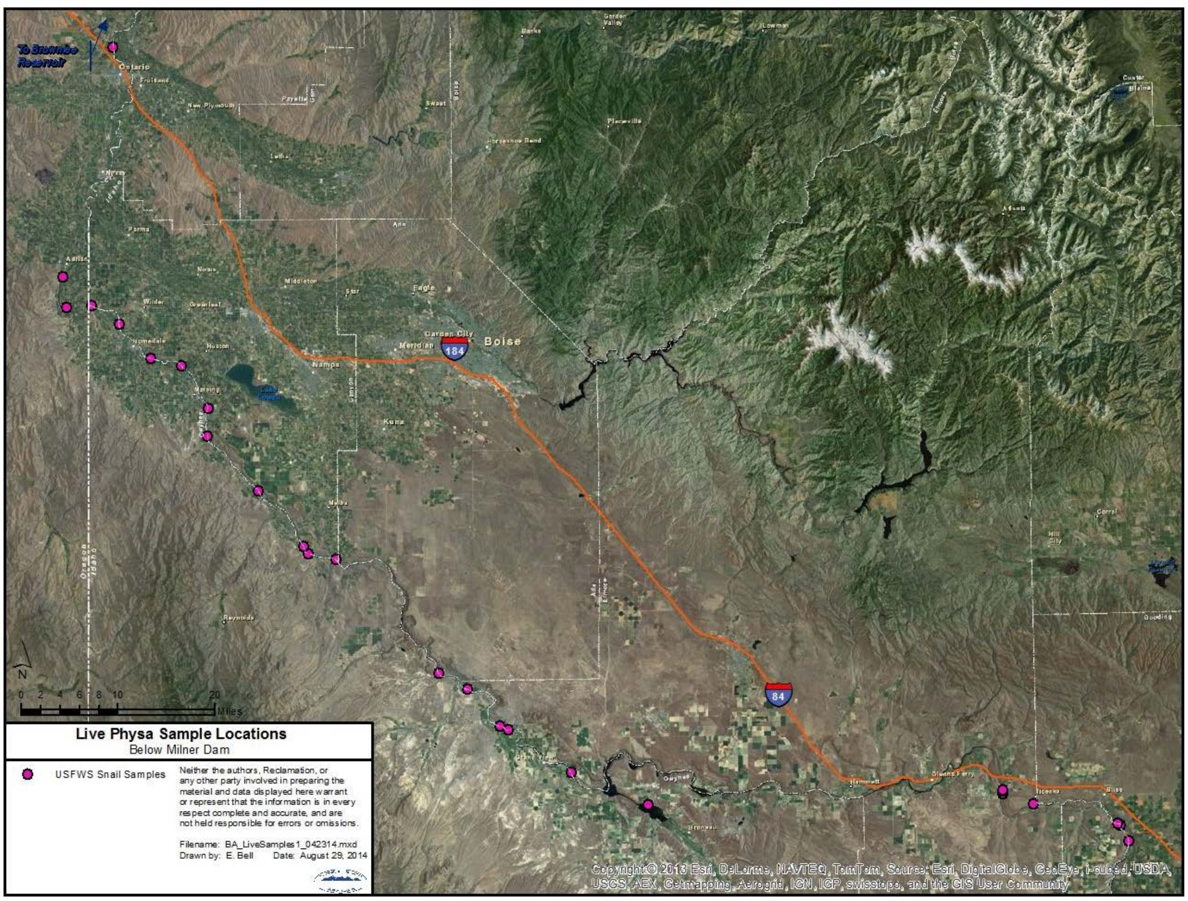

Figure 4-9. Live Snake River physa collection points from the Snake River from Milner Dam downstream to Brownlee Reservoir.

Reclamation's operational impacts within this reach of the Snake River as a result of salmon flow augmentation releases are described in Chapter 3 of this document. Under the proposed actions described in the 2004 Upper Snake BA, salmon flow augmentation during average to dry water years may slightly increase flows in this reach from current operations (Reclamation 2004a). The model predicts an increase from current operations of 147 cfs in minimum annual discharge at the Snake River near Murphy, Idaho. The effects of Reclamation's proposed actions will be attenuated and negligible in this reach of the river. The effects of Reclamation water releases in the past seem to have had a negligible impact on river stage at the Idaho Power facilities below Twin Falls (Reclamation 1996). An increase in salmon flow augmentation from 1,500 cfs to 3,000 cfs (release shape is dependent upon water year, see Chapter 3) will have a negligible impact on Snake River physa in this reach due to the timing of the flow events and the volume relative to existing base flows.

Reclamation is unable to distinguish any likely effects to Snake River physa attributable to the proposed actions within this reach. Flow augmentation releases at Milner Dam will result in less than a 0.5-foot increase in river stage at King Hill (RM 546.6). This event typically occurs in June and July and is relatively short in duration. It is anticipated that no Snake River physa mortality will be attributable to this short-term fluctuation. Due to the magnitude of this flow event and its relative impact to river stage within this reach of the Snake River, it is unlikely Snake River physa will distribute into the short-term fluctuation zone during flow augmentation releases.

In addition to the larger structures described above, numerous pumps and diversions affect flows and habitat in the action areas, including Reclamation's irrigation pumps located near Marsing, Idaho (RM 424.5). The past effects of these diversions on Snake River physa are unknown. Collectively, the reduction of flow does reduce the amount of snail habitat available; however, this change has not been quantified. In addition, reductions in flow can be generally related to reductions in water quality. This, too, has not been quantified.

Reclamation did conduct a snail survey in a small area adjacent to the pumps near Marsing, Idaho, on September 28, 2004, prior to a proposed construction project. No physa were found during this effort. Although no snails were found, again, no data exists regarding the life history of Snake River physa. Further, little is known regarding snail entrainment. Currently, it is not known specifically how the species disperses, outside of physical movement across the substrate. Some species of snail disperse by clinging to water surface tension and drifting or by simply altering their specific gravity and drifting (Pennak 1989). In addition, snail eggs or juveniles that become dislodged from the substrate may disperse by drifting in the water column. It is possible for Snake River physa adults, juveniles, and eggs to become entrained in water diversion structures on the Snake River. However, without knowing the dispersal mechanism, dispersal rates, and dispersing snail concentrations per unit volume of water, it is not possible to make any inferences regarding snail entrainment under current conditions.

In conclusion, the effects from future O&M in the Snake River system above Milner Dam, provision of salmon flow augmentation from the rental or acquisition of natural flow rights, and future operations in the Little Wood, Owyhee, Boise, Payette, and Malheur river systems become attenuated and insignificant in this reach of the Snake River, relative to other local factors. However, impacts to Snake River physa may occur within this reach as a result of juvenile and/or adult dispersal, still Reclamation is unable to reach any conclusion regarding its extent due to the lack of life history information for this species.

4.4 Cumulative Effects

Cumulative effects include the effects of future state, tribal, local, or private actions that are reasonably certain to occur in the action area considered in this BA. Future federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to Section 7 of the ESA.

Cumulative effects from a variety of activities are likely to continue to affect Snake River physa within the action area. These actions include, but are not limited to, industrial and residential development, agricultural and grazing activities, continued depletion of regional aquifers, and various construction and maintenance projects associated with water-management structures within this reach of the Snake River. Continued O&M of non-federal Idaho Power dams will continue to impacts flows within this reach of the Snake River as well.

Water discharge and temperatures are impacted by changes and variability in regional climate across the Snake River basin. Seasonal variation in the Snake River discharge is impacted by winter precipitation amounts, snowpack depths at higher elevations and variability in winter precipitation type (rain vs. snow). Possible future climate changes across the Snake River basin have the potential to impact snowpack, seasonal water volume, runoff timing, and runoff patterns.

4.5 Effects Conclusion

Reclamation has determined that future O&M in the Snake River system above Milner Dam including the segment from Minidoka Dam downstream to the I-84 Bridge and the Minidoka Dam spillway area may affect and is likely to adversely affect Snake River physa in this reach of the Snake River.

Adverse effects to Snake River physa in this reach of the Snake River include unquantified effects due to stranding and mortality from annual flow fluctuations. Adverse effects to Snake River physa below Minidoka Dam include stranding and mortality in the spillway area during the annual dewatering period, and stranding and mortality when flows in the mainstem Snake River are less than 400 cfs, approximately 5 percent of the time.

Reclamation has determined that future O&M of all projects above Brownlee Reservoir, including those in the Little Wood River, Owyhee, Boise, Payette, Malheur, Mann Creek, Burnt River, and Powder River systems; the segment of the Snake River from Milner Dam upstream to the I-84 Bridge; and the management of flow augmentation releases, may affect but are not likely to adversely affect the Snake River physa downstream from Milner Dam.

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