2013 Fish Passage Plan
Section 2 – Bonneville Dam

Table of Contents

1. Fish Passage Information BON-01
    1.1. Juvenile Fish Passage BON-01
    1.2. Adult Fish Passage BON-09
2. Project Operation BON-10
    2.1. General BON-10
    2.2. Spill Management BON-11
    2.3. Total Dissolved Gas Management and Control BON-13
    2.4. Juvenile Fish Passage Facilities BON-13
    2.5. Adult Fish Passage Facilities BON-20
3. Facility Monitoring and Reporting BON-26
    3.1. Inspections.....BON-26
    3.2. Zebra Mussel Monitoring.....BON-26
    3.3. Reporting.....BON-26
4. Fish Facilities Maintenance BON-27
    4.1. General BON-27
    4.2. Juvenile Fish Passage Facilities BON-28
    4.3. Adult Fish Passage Facilities BON-30
5. Turbine Unit Operation and Maintenance.. .....BON-34
6. Dewatering Plans BON-36
    6.1. Guidelines for Any Dewatering.....BON-36
    6.2. Juvenile Bypass Systems BON-37
    6.3. Adult Fish Ladder.....BON-37
    6.4. Powerhouse Fish Collection System BON-37
    6.5. Turbines.....BON-38
7. Forebay Debris Removal BON-39
8. Response to Hazardous Materials Spills.....BON-39
9. Endnotes.....BON-39

Section 2 Bonneville Dam

1. FISH PASSAGE INFORMATION

The locations of fish passage facilities are shown on the following general site plans for Bonneville Lock and Dam (**Figures BON-1** through **BON-5**). Dates for project operations for fish purposes and special operations are listed in **Table BON-1**.

1.1. Juvenile Fish Passage.

1.1.1. Facilities Description - Powerhouse One (PH1). Juvenile fish passage routes at the Bonneville Dam Powerhouse One (PH1) consist of an ice and trash sluiceway (ITS) and minimum gap runner (MGR) turbines.

1.1.2. Facilities Description - Powerhouse Two (PH2). Juvenile fish passage facilities at Bonneville Dam Powerhouse Two (PH2) consist of: turbine intake extensions (TIEs); streamlined trash racks; submersible traveling screens (STSs); vertical bar screens (VBSs); two 12.5” orifices per gatewell in units 11-14 and fish unit 2; one 12.5” orifice in all other gatewells flowing into a fish bypass channel; an excess water elimination facility; and a 48" fish transport pipe which connects the bypass channel to the tailrace. A 48” and 42” transport pipe, at the high and low outfalls respectively, transport fish to the tailrace at the outfall location. The Juvenile Monitoring Facility (JMF) is included in the bypass.

1.1.2.1. All eight PH2 main turbine units have STSs, VBSs, and streamlined trashracks. Units 15-18 also have TIEs.

1.1.2.2. Two smaller turbines that supply adult fishway auxiliary water do not have STSs, TIEs, or streamlined trashracks; however, they have a fine trashrack with a 0.75” clear opening.

1.1.2.3. The Corner Collector (B2CC) is located on the south side of PH2. The B2CC flume extends several hundred feet west on the south side of the PH2 tailrace and empties at the tip of Cascades Island.

1.1.3. Juvenile Migration Timing. The juvenile fish migration season occurs from March 1–November 30. **Table BON-2** shows the primary passage periods for each species. Bull trout, lamprey, juvenile sturgeon, and other listed salmonids shall be recorded in the by-catch of the Juvenile Monitoring Facility (JMF). Maintenance of juvenile fish facilities is scheduled for the period December 16 through the end of February to minimize the impact on downstream migrants. These activities will be coordinated to minimize potential impacts on juvenile migrants that may be present at that time.

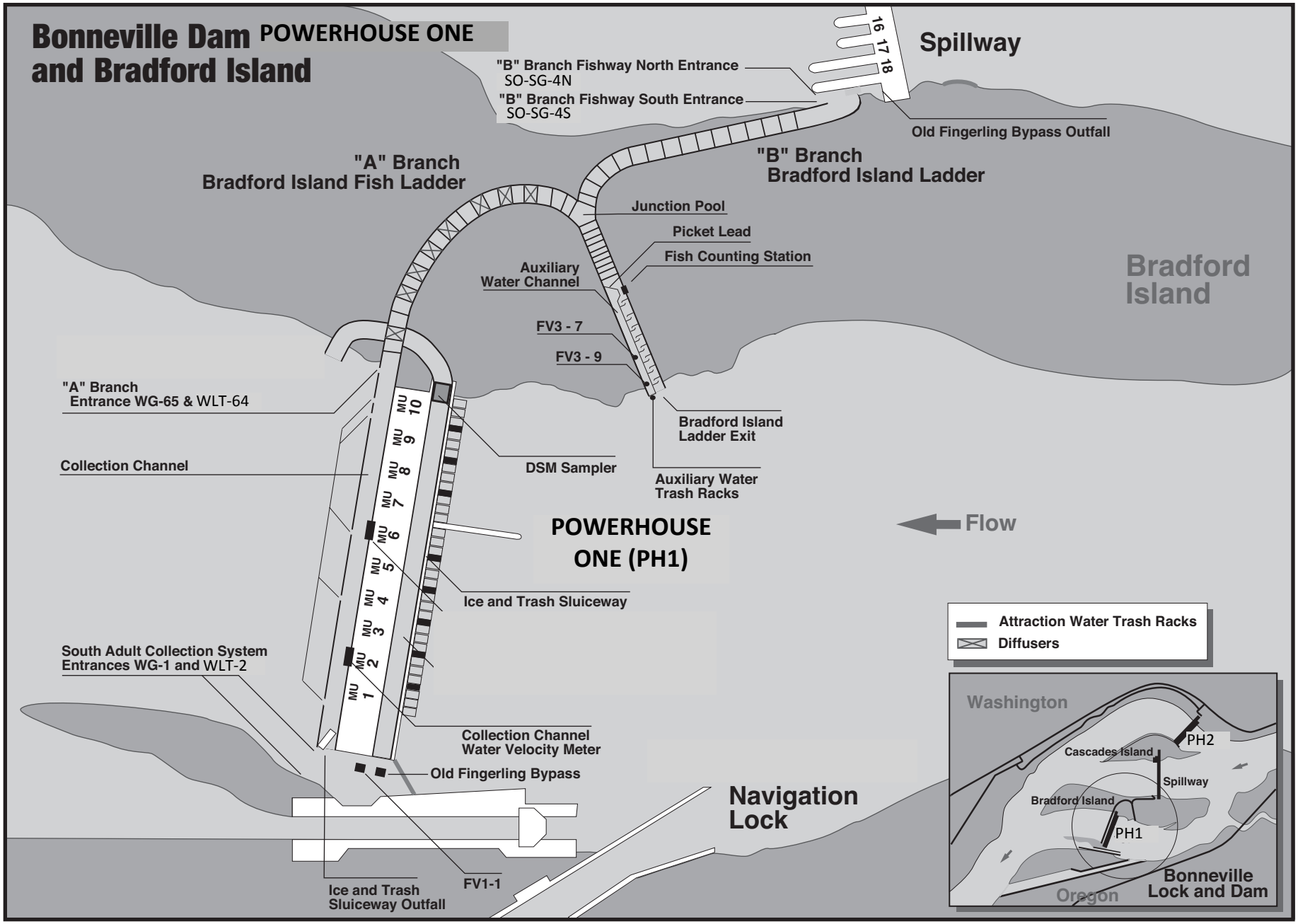

Figure BON-1. Bonneville Dam Powerhouse One and Bradford Island Fish Ladder.

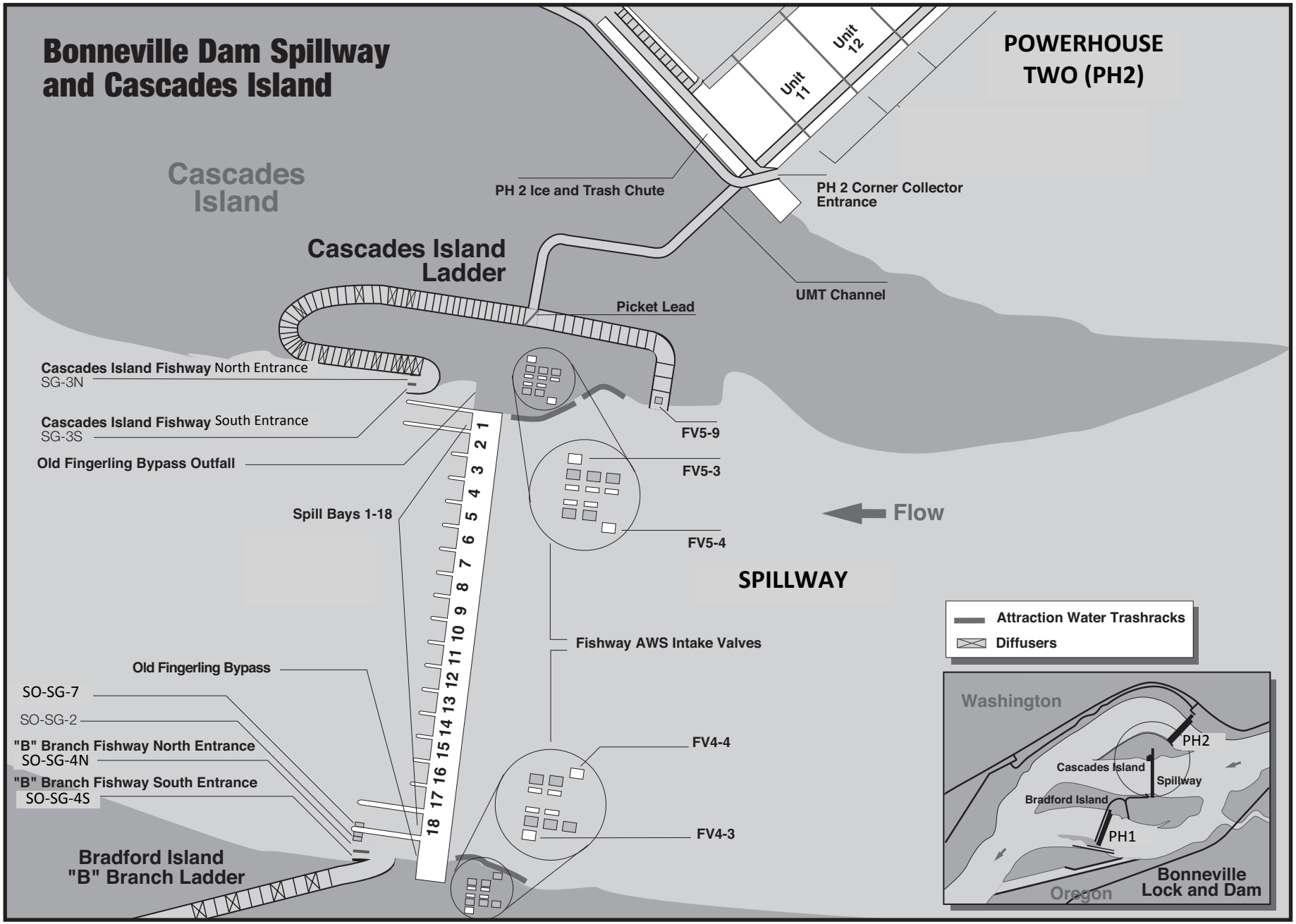

Figure BON-2. Bonneville Dam Spillway, Cascades Island Fish Ladder and Upstream Migrant Transportation (UMT) Channel.

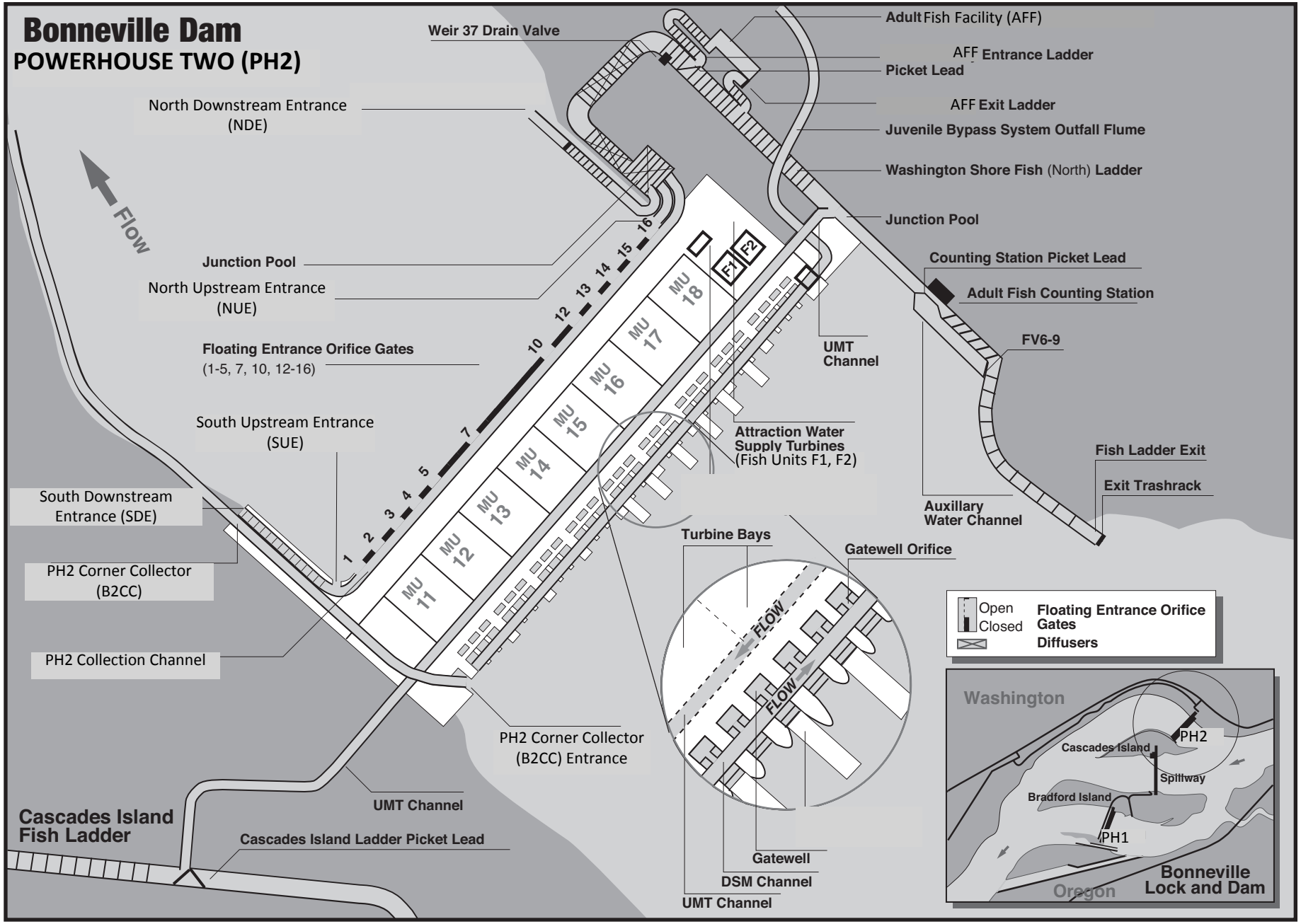

Figure BON-3. Bonneville Dam Powerhouse Two and Washington Shore (WS) North Fish Ladder.

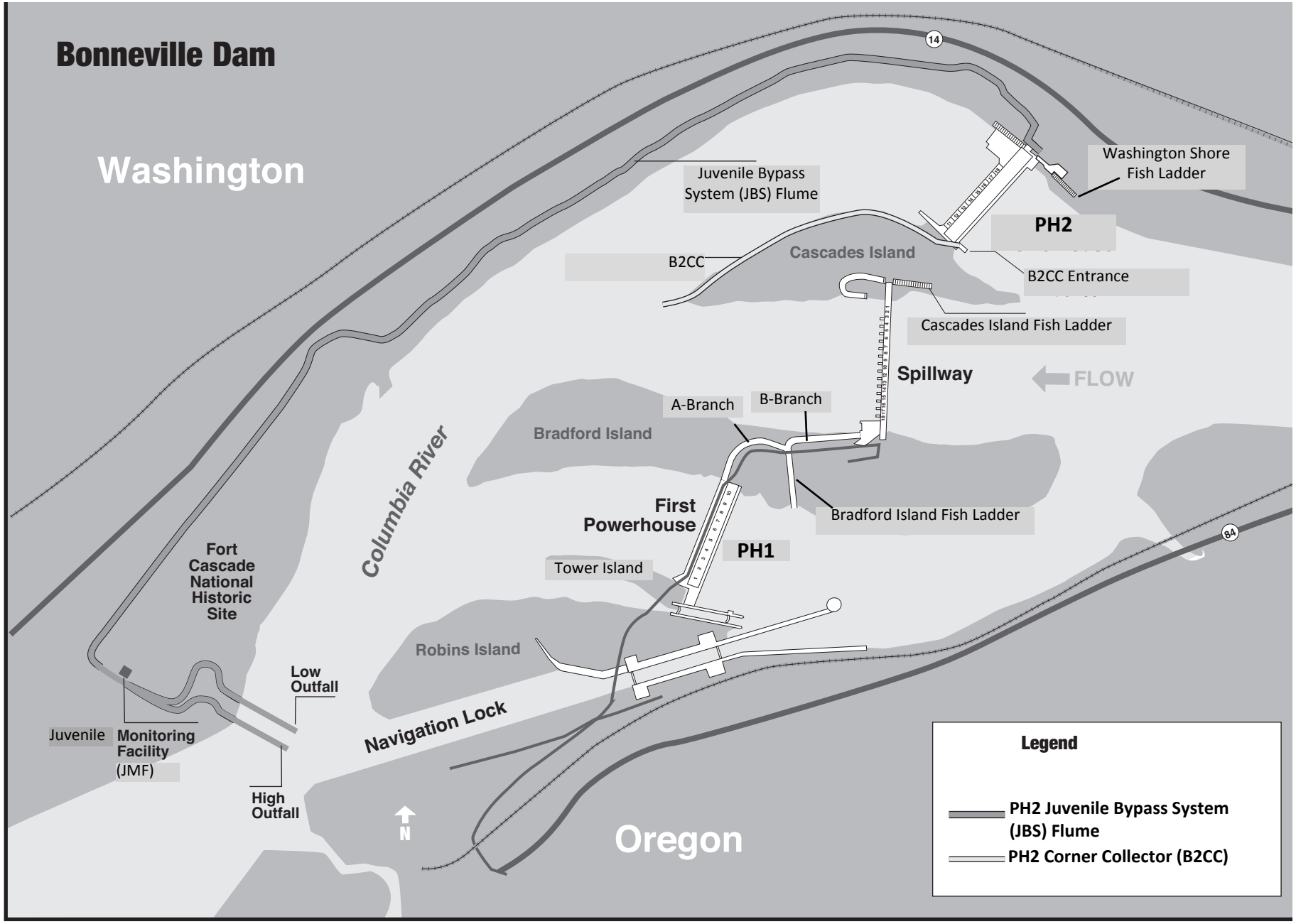

Figure BON-4. Bonneville Dam Juvenile Bypass System (JBS), including Powerhouse Two Bypass Flume, Juvenile Monitoring Facility (JMF), JBS Outfall, and Corner Collector (B2CC).

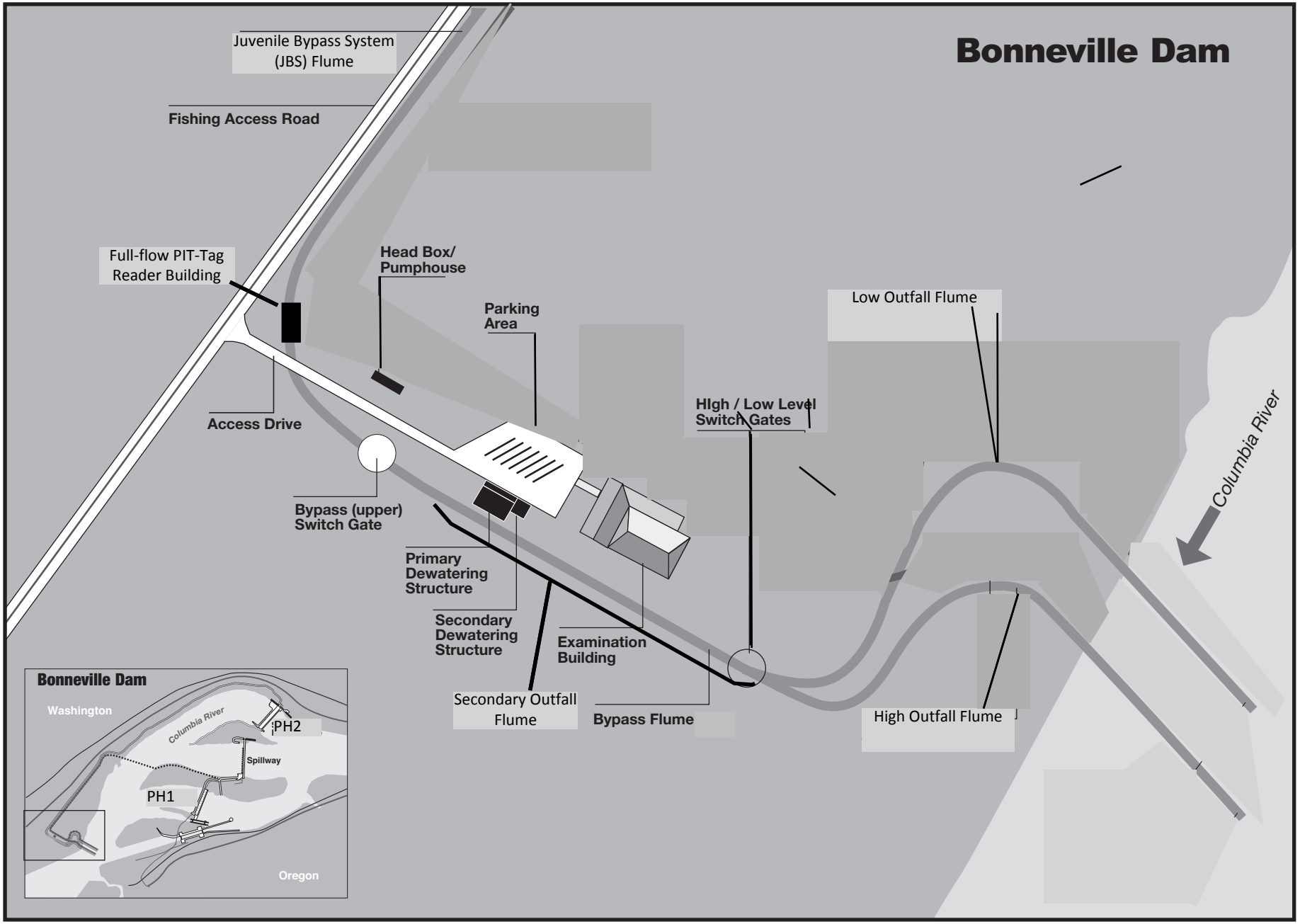

Figure BON-5. Bonneville Dam Powerhouse Two (PH2) Juvenile Bypass System (JBS) -- Juvenile Monitoring Facility (JMF) and Outfall Flumes.

Table BON-1. Bonneville Dam Dates of Fish-Related Operations for 2013 Fish Passage Season and 2013/14 Winter Maintenance Period.

Task Name	Start	Finish	Reference
2013 FISH PASSAGE SEASON	**3/1/13**	**11/30/13**	**BON 2.4.**
Juvenile Fish Passage Season	3/1/13	11/30/13	BON 2.4.1.2
Adult Fish Passage Season	3/1/13	11/30/13	BON 2.4.2.2
Lamprey Passage Season	6/1/13	8/31/13	BON 2.5.4.c
2013-2014 WINTER MAINTENANCE PERIOD	**12/1/13**	**2/28/14**	**BON 2.4.**
Juvenile Fish Facilities Winter Maintenance	12/1/13	2/28/14	BON 2.4.1.1
Adult Fish Facilities Winter Maintenance	12/1/13	2/28/14	BON 2.4.2.1
ADULT FISH COUNTING (YEAR-ROUND)	**3/1/13**	**2/28/14**	**Table BON-3**
Video 0400 - 2000 PST	3/1/13	3/31/13	
Visual 0500 - 2100 DST	4/1/13	10/31/13	
Video Night 2100 - 0500 DST	6/15/13	9/30/13	
Video 0400 - 2000 PST	11/1/13	2/28/14	
1% CONSTRAINTS (YEAR-ROUND)	**3/1/13**	**2/28/14**	**BON 5.3**
1% soft constraint	3/1/13	3/31/13	
1% hard constraint	4/1/13	10/31/13	
1% soft constraint	11/1/13	2/28/14	
TDG MONITORING (YEAR-ROUND)	**3/1/13**	**2/28/14**	**BON 2.3**
TDG Monitoring - Tailrace (year-round)	3/1/13	2/28/14	WRNO
TDG Monitoring - Tailrace	4/1/13	8/31/13	CCIW, CWMW
TDG Monitoring - Forebay	4/1/13	8/31/13	BON
Operation of Ice & Trash Sluiceway (year-round)	**3/1/13**	**2/28/14**	**BON 1.2.1.1**
PH2 Screens Installed	**3/1/13**	**12/15/13**	**BON 2.4.2.2.a**
AVIAN ABATEMENT MEASURES	**3/1/13**	**12/1/13**	**BON 2.4**
Avian Predator Control Lines	3/1/13	12/1/13	BON 2.4.1.1.c.
JMF Outfall Avian Cannons	3/1/13	11/1/13	BON 2.4.2.5.a.5
Avian Hazing	4/1/13	8/31/13	BON 2.4.1.2 c
SPECIAL OPERATIONS & STUDIES	**3/1/13**	**10/31/13**	**Appendix A**
Sea Lion Predation Study	3/1/13	5/31/13	App A BON 2.4
PH2 FGE Test of Turbulence Reduction Device	3/6/13	7/31/13	App A BON 2.1
Adult Salmon Studies	3/20/13	10/15/13	App A BON 2.2
Lamprey Passage Evaluations	6/3/13	10/31/13	App A BON 2.3
Spillbays 1 & 18 - Gates Open 6"	**3/1/13**	**4/10/13**	**BON 2.2.3.1**
Operate PH2 Corner Collector (B2CC)	**4/10/13**	**8/31/13**	**BON 2.4.2.3**
SPILL FOR FISH PASSAGE	**4/10/13**	**8/31/13**	
Spring Spill - 100 kcfs	4/10/13	6/15/13	
Summer Spill - 85 kcfs/121 kcfs	6/16/13	7/20/13	
Summer Spill - 75 kcfs/TDG cap	7/21/13	8/31/13	
Spillbays 1 & 18 - Gates Open 6"	**9/1/13**	**11/30/13**	**BON 2.2.3.1**
Weekly Reports (year-round)	**3/1/13**	**2/28/14**	**BON 3.3.1**
Annual Report (for Dec 1, 2012 - Nov 30, 2013)	**1/31/14**	**1/31/14**	**BON 3.3.4**

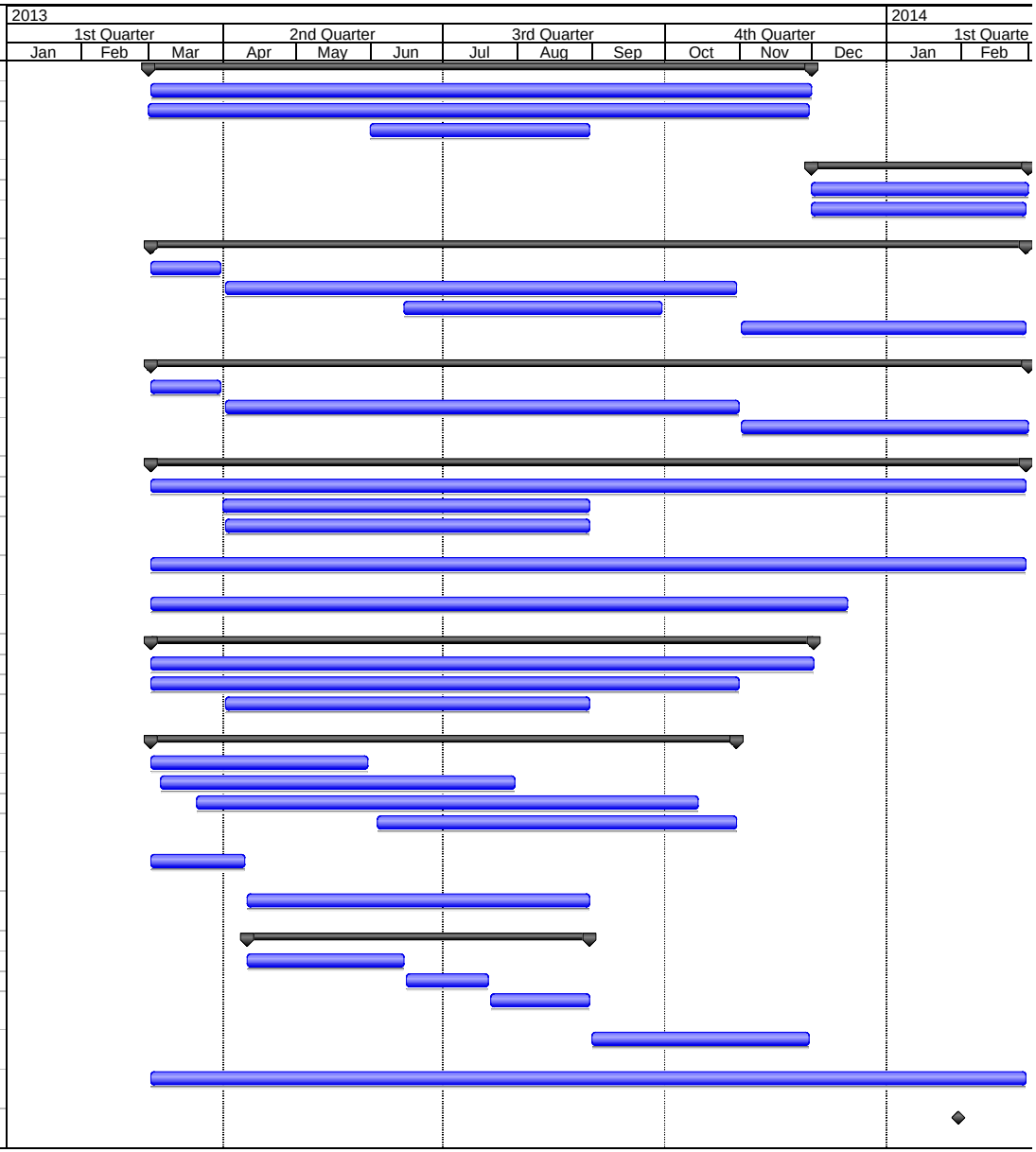

Table BON-2. Bonneville Dam 10-Year Juvenile Salmonid Passage Data (2003-2012).

Yearling Chinook	10 %	50%	90 %	# of Days
2003	Apr 22	May 14	May 31	40
2004	Apr 17	May 04	May 30	44
2005	Apr 19	May 07	May 25	37
2006	Apr 16	May 9	May 21	36
2007	Apr 20	May 11	May 23	34
2008	Apr 20	May 12	May 27	38
2009	Apr 19	May 11	May 26	38
2010	Apr 27	May 13	Jun 01	36
2011	Apr 17	May 10	May 18	32
2012	Apr 24	May 12	May 23	30
MEDIAN	**Apr 19**	**May 11**	**May 25**	**37**
MIN	**Apr 16**	**May 04**	**May 18**	**30**
MAX	**Apr 27**	**May 14**	**Jun 01**	**44**

Subyearling Chinook ("Brights" only*)	10 %	50%	90 %	# of Days
2003	Jun 15	Jul 01	Jul 19	35
2004	Jun 10	Jun 28	Jul 14	35
2005	Jun 15	Jun 28	Jul 20	36
2006	Jun 16	Jun 29	Jul 15	30
2007	Jun 19	Jul 08	Jul 22	34
2008	Jun 22	Jul 06	Jul 23	32
2009	Jun 20	Jun 30	Jul 19	30
2010	Jun 19	Jul 05	Jul 20	32
2011	Jun 24	Jul 14	Aug 02	40
2012	Jun 23	Jul 09	Jul 26	34
MEDIAN	**Jun 19**	**Jul 03**	**Jul 20**	**32**
MIN	**Jun 10**	**Jun 28**	**Jul 14**	**30**
MAX	**Jun 24**	**Jul 14**	**Aug 02**	**70**

Unclipped Steelhead	10 %	50%	90 %	# of Days
2003	May 03	May 27	Jun 09	38
2004	Apr 17	May 16	May 31	45
2005	Apr 23	May 11	May 29	37
2006	Apr 24	May 07	May 29	36
2007	Apr 29	May 16	Jun 03	36
2008	May 5	May 14	May 30	26
2009	Apr 30	May 13	May 29	30
2010	May 01	May 14	Jun 01	32
2011	Apr 23	May 15	May 31	39
2012	Apr 26	May 11	May 29	34
MEDIAN	**Apr 27**	**May 14**	**May 30**	**34**
MIN	**Apr 17**	**May 07**	**May 29**	**26**
MAX	**May 05**	**May 27**	**Jun 09**	**45**

Clipped Steelhead	10 %	50%	90 %	# of Days
2003	May 07	May 30	Jun 11	36
2004	Apr 30	May 16	May 27	28
2005	Apr 26	May 15	May 30	35
2006	Apr 27	May 08	May 29	33
2007	May 08	May 17	Jun 04	28
2008	May 07	May 13	May 25	19
2009	May 04	May 13	May 26	23
2010	May 06	May 14	Jun 07	33
2011	Apr 24	May 12	May 29	36
2012	Apr 29	May 10	May 28	30
MEDIAN	**May 02**	**May 13**	**May 29**	**28**
MIN	**Apr 24**	**May 08**	**May 25**	**19**
MAX	**May 08**	**May 30**	**Jun 11**	**41**

Coho	10 %	50%	90 %	# of Days
2003	Apr 29	May 16	Jun 09	42
2004	Apr 18	May 05	May 27	40
2005	Apr 22	May 9	May 27	36
2006	Apr 27	May 17	May 27	31
2007	Apr 26	May 13	May 31	36
2008	May 01	May 18	May 30	30
2009	Apr 29	May 22	Jun 01	35
2010	Apr 24	May 14	Jun 05	43
2011	Apr 11	May 14	May 24	44
2012	Apr 26	May 18	Jun 07	43
MEDIAN	**Apr 26**	**May 15**	**May 30**	**35**
MIN	**Apr 11**	**May 05**	**May 24**	**20**
MAX	**Apr 26**	**May 18**	**Jun 07**	**44**

Sockeye (Wild & Hatchery)	10 %	50%	90 %	# of Days
2003	May 12	May 20	Jun 05	25
2004	May 21	Jun 01	Jun 15	26
2005	May 15	May 23	Jun 01	18
2006	May 10	May 19	May 31	22
2007	May 16	May 25	Jun 07	23
2008	May 24	May 29	Jun 08	16
2009	May 15	May 26	Jun 05	22
2010	May 19	Jun 01	Jun 10	23
2011	May 04	May 17	Jun 04	32
2012	May 9	May 14	May 23	15
MEDIAN	**May 15**	**May 24**	**Jun 05**	**22**
MIN	**May 04**	**May 14**	**May 23**	**15**
MAX	**May 24**	**Jun 01**	**Jun 15**	**34**

* Includes upriver brights only in order to exclude influence by Spring Creek NFH Tules.

1.2. Adult Fish Passage.

1.2.1. Facilities Description. Adult fish passage facilities at Bonneville Dam consist of two main fishway segments:

1.2.1.1. Bradford Island Fishway (Figure BON-1) is formed by the PH1 collection channel and Bradford Island A-branch ladder that join the south spillway ladder entrance and B-branch ladder at the Bradford Island ladder junction pool. The ice and trash sluiceway (ITS) is also used for adult passage throughout the year. The system consists of 3 automated chain gates and 27 manual chain gates.

1.2.1.2. Washington Shore Fishway (Figure BON-2) is formed by the PH2 collection channel and the north and south monoliths that join the Washington Shore (North) ladder and the Cascades Island (north spillway) ladder at the upstream migrant transportation (UMT) channel.

1.2.1.3. The Bradford Island, Cascades Island and Washington Shore fishways have counting stations. The Washington Shore ladder also has an adult fish facility (AFF). All four collection systems have auxiliary water supplies for fish attraction.

1.2.2. Adult Migration Timing and Counting. Upstream migrants are present at Bonneville Dam throughout the year and adult passage facilities are operated year-round. Adult salmon, steelhead, shad, and lamprey are normally counted year-round (**Table BON-3**), and these data appear daily (or every three days during video counting periods) on the Corps' adult fish count website (http://www.nwp.usace.army.mil/Missions/Environment/Fishdata.aspx). Migration timing data for these species, except shad, appear in **Table BON-4**. Sturgeon and bull trout are also counted and recorded on the fish counters' daily summary sheet comments section, but do not appear on the Corps daily website total due to relative infrequency of passage. These data are posted periodically during the passage season in the Miscellaneous Fish Counts report on the Corps' website, and summarized in the Annual Fish Passage Report.

1.2.2.1. The adult fish counting schedule is shown in **Table BON-3**. Fish passage from November through March is relatively light; therefore, fish counting is done by video, primarily to monitor winter steelhead passage, especially ESA-listed winter steelhead.

Table BON-3. Adult Fish Counting Schedule at Bonneville Dam.

Count Period	Counting Method and Hours [1]
March 01, 2013 – March 31, 2013	Video 0400–2000 hours (PST)
April 01, 2013 – October 31, 2013	Visual 0500–2100 hours (DST)
June 15, 2013 – September 30, 2013	Night Video 2100–0500 hours (DST)
November 01, 2013 – February 28, 2014	Video 0400–2000 hours (PST)

1. In 2013, daylight saving time (DST) is in effect from March 10–November 3, and hours are adjusted forward one hour from Pacific Standard Time (PST). DST = PST+1.

1.2.2.2. Annual winter maintenance of adult fish facilities is scheduled from December 1 through February (in-water work period) to minimize the impact on upstream migrants and to minimize adult fall Chinook and steelhead fallback.

1.2.2.3. Adult fish migration timing has been calculated for Bonneville Dam from count data collected by the Corps since 1938. **Table BON-4** summarizes count periods and peak adult fish passage timing through 2012, and includes count periods and the earliest and latest peaks of migration for each species (except shad) at Bonneville Dam. Steelhead are counted by video at Bonneville Dam from November 01 through March 31 as described in **Table BON-3**, but the ESA-listed winter steelhead population passage period is considered to be from November 16 through March 31 as described in **Table BON-4**. Peak migration timing is based on yearly data beginning in 1999 for winter steelhead, and in 2001 for lamprey.

Table BON-4. Adult Count Periods and Peak Migration Timing at Bonneville Dam (based on 1938-2012 fish count data*).

Species	Count Period	Earliest Peak	Latest Peak
Spring Chinook	3/14 – 5/31	4/15	5/27
Summer Chinook	6/1 – 7/31	6/3	7/31
Fall Chinook	8/1 – 11/15	8/30	9/17
Sockeye	6/1 – 8/15	6/20	7/13
Steelhead	4/1 – 3/31	7/16	9/22
Winter steelhead*	11/16 – 3/31	3/1	3/28
Coho	7/15 – 11/15	8/29	10/11
Lamprey*	3/15 – 11/15	6/20	7/18

*Peak migration timing based on yearly data beginning in 1999 for winter steelhead, and in 2001 for lamprey.

2. PROJECT OPERATION

2.1. General. Yearling Chinook and most other juvenile salmonids migrate downstream in the spring, whereas during the summer, after mid-June, sub-yearling Chinook dominate. Studies specific to Bonneville Dam indicate that fish survival rates for passage through various routes differ between spring and summer.

2.1.1. Powerhouse Flow Distribution. Bonneville turbine operating priority is established as outlined in **Table BON-14**. If a turbine is out of service, use the next turbine in the priority list.

2.1.2. When adult and jack salmonid counts equal or exceed 30,000 fish per day before August 31, project fisheries will initiate Fish Passage Operations and Maintenance Team (FPOM) coordination to discuss options for powerhouse flow-splitting to provide additional flow attraction areas to help balance adult passage among the project's fishways. When adult and jack salmonid counts equal or exceed 25,000 fish per day after August 31, the Project will operate two priority turbines at PH1 in an attempt to balance adult passage between both powerhouses

(assuming there was no prior unit operation at PH1). This operation will continue until Project adult and jack salmon counts fall below 20,000 fish.

2.1.2.1. Turbine units at PH1 should be operated at the mid or upper 1% range whenever possible during the split flows operation.

2.1.2.2. Turbine units at PH2 should be operated at the mid to lower 1% range whenever possible during the split flows operation.

2.1.2.3. Split flow operations, prior to the end of summer spill, may only occur if flows exceed 120 kcfs.

2.1.3. Other Activities. Research, non-routine maintenance, other fish-related activities, and construction activities will not be conducted within 100' of any fishway entrance or exit or within 50' of the rest of the fishway, or directly in, above, or adjacent to any fishway, unless coordinated by the Project, Portland District Operations and/or Planning, the Dive operation coordinator, or CEWNP Construction office through FPOM and FFDRWG with the Region. Currently coordinated special operations related to research are described in **Appendix A**. Alternate actions will be considered by district and project biologists in coordination with the Regional fish agencies on a case-by-case basis. Emergency situations should be dealt with immediately by the project in consultation with the project or district biologist. If unavailable, the biologists will be informed of steps taken to correct the situation immediately following the incident. All activities within boat-restricted zones (BRZ) will be coordinated at least two weeks in advance with the project, unless it is deemed an emergency (see also Overview for coordination guidance).

2.2. Spill Management. See the Fish Operations Plan (**Appendix E**) for more information.

2.2.1. General. Only one spill schedule will be used at Bonneville Dam (**Table BON-17**).

2.2.1.1. Decisions regarding spill changes will be made through regional agreement at TMT.

2.2.1.2. Nighttime spill is limited as necessary to control total dissolved gas (TDG) super-saturation. Adjustments of the nighttime spill level may be granted on a case-by-case basis by the Reservoir Control Center (RCC), dependent upon TDG monitoring at stations downstream of the dam, biological monitoring, and fish movement.

2.2.1.3. The hours of nighttime spill are the daily complements of the periods of daytime spill (**Table BON-5**). The transition from daytime spill cap to nighttime spill cap and vice versa will normally take 15 to 20 minutes due to the time required to start, synchronize, and load multiple generators. The transition to the daytime spill period should not start until after the nighttime cap period is over.

2.2.1.4. Frequently, a total river discharge change will occur concurrently with these spill transitions. The transition to the nighttime cap should begin early enough to minimize chances of violating the defined nighttime spill maximum.

2.2.2. Juvenile Fish. Minimum spill level is 50 kcfs from April 10 through August 31 to provide acceptable conditions for juvenile fish tailrace egress. However, under extreme low flow conditions, lower spill levels may be considered and coordinated through the TMT. There is no minimum spill level from September 1 through April 9. For spill specific information see Appendix E: Operations Related to Project Spill for Fish Passage.

2.2.3. Adult Fish. To reduce adult fallback from June 16 through August, whenever PH1 is in operation, daytime spill will be limited to 100 kcfs or less (**see also 2.2.2**). Normally, this restriction will be from 1 hour before sunrise to ½ hour after sunset (**Table BON-5**). During that portion of the sockeye run that occurs from June 16 through July 15, the cap will apply until 1 hour after sunset only when PH1 is in operation.

2.2.3.1. From September 1 through November 30 and from March 1 through April 10 (beginning of spill for juvenile fish passage), provide spill from bays 1 and 18 with each gate open 6" (one stop) during daylight hours as defined in **Table BON-5**. From December 1 through February 28, spill only from the bay(s) that are adjacent to an operating fishway entrance with each spill gate open 6" (one stop).

Table BON-5. Daytime Spill Schedule for Bonneville Dam.

Date Range	Daytime Spill Hours	
	Begin	End
Jan 01 – Jan 19	0700	1730
Jan 20 – Feb 14	0630	1800
Feb 15 – Mar 01	0600	1830
Mar 02 – Apr 02	0600	1930
Apr 03 – Apr 20	0500	2030
Apr 21 – May 16	0500	2100
May 17 – May 31	0430	2130
Jun 01 – Jun 30	0430	2130
Jul 01 – Jul 31	0430	2200
Aug 01 – Aug 15	0500	2145
Aug 16 – Aug 31	0500	2030
Sep 01 – Sep 16	0530	2000
Sep 17 – Oct 04	0600	1930
Oct 05 – Oct 19	0630	1900
Oct 20 – Oct 29	0630	1830
Oct 30 – Nov 30	0600	1700
Dec 01 – Dec 31	0630	1700

2.3. Total Dissolved Gas (TDG) Management and Control. Total dissolved gas (TDG) levels at all projects are monitored in accordance with the TDG Monitoring Plan, included in the Water Management Plan as Appendix 4, and available online at: http://www.nwd-wc.usace.army.mil/tmt/documents/wmp/2013/**.**

2.3.1. The TDG data will be reported every four hours starting March 1 for Cascades Island station at Bonneville. Spill volume and total project flow will be reported at the same time.

2.3.2. Excessive TDG levels may harm fish and will be controlled to the extent possible, subject to river flow conditions. Control measures will include system spill allocation through the spill priority list issued by RCC, nighttime or daytime spill limits, and shaping of spill discharge.

2.4. Juvenile Fish Passage Facilities.

2.4.1. Powerhouse One (PH1) Operating Criteria.

2.4.1.1. December 01 through February 28 (Winter Maintenance Period).

a. Remove debris from forebay, trash racks, and gatewell slots to maintain these areas debris-free.

b. Ice and trash sluiceway (ITS) operations after November 30 are detailed in section **2.5.1.1.m.**

c. Avian Abatement Measures. Reinstall or repair avian predator control lines as soon as possible following damage or removal. Install and maintain new avian predator control lines in locations determined to be significantly impacted by avian predators. Avian abatement measures shall be in place by March 01 unless this work is delayed because of inclement weather. If this occurs, the work will be completed as soon as the weather permits after that date. However, there will be no avian abatement measures, other than avian lines, performed from September through March each year.

2.4.1.2. March 01 through November 30 (Juvenile Fish Passage Season).

a. Main unit gatewell drawdown will be measured a minimum of once per week. Remove debris from forebay and trashracks as required to maintain less than 1.5' of total drawdown in gatewells.

b. A slight oily sheen is commonly found in many gatewells. This may come from sources such as lubricated lifting beams, etc. When unusual accumulations of oil (e.g., oil slick) occur in gate slots, they will be removed within 24 hours. Appropriate procedures to remove fish during this situation will be determined in coordination with FPOM. Regardless of unit operating status, oil accumulations will be dealt with promptly.

c. Reinstall or repair avian predator control lines as soon as possible following significant damage or removal. Install and maintain new avian predator control lines in locations determined to be significantly impacted by avian predators. Implement other avian abatement measures as necessary from April through August only.

d. At the ITS, set chain gate 1A and 1B at 70' msl. Ensure gates 3B, 6C, and 10B are operating according to **Table BON-6**.

Table BON-6. Chain Gate Elevations (feet) at Bonneville Dam Powerhouse 1 (PH1) Ice and Trash Sluiceway (ITS).

Forebay Elevation (ft)	PH1 ITS Chain Gates 3B	6C	10B		Forebay Elevation (ft)	PH1 ITS Chain Gates 3B	6C	10B
<72	70.00	70.00	70.00		**75**	71.75	72.25	73.00
72	70.00	70.00	70.00		**76**	73.50	73.50	74.00
73	70.00	70.25	70.75		**77**	75.00	75.00	75.00
74	70.75	71.50	71.75		**>77**	75.00	75.00	75.00

2.4.2. Powerhouse Two (PH2) Operating Criteria.

2.4.2.1. December 01 through February 28 (Winter Maintenance Period).

a. STSs will remain in place through December 15 to prevent adult salmonids from falling back through turbine units, thereby shortening some aspects of the winter maintenance period by two weeks. Unscreened units will be operated on a last-on, first-off basis. Beginning December 16, all STSs may be removed.

b. Video or manually inspect VBSs for damage, holes, debris accumulations, protrusions, and proper seating. Clean and repair, as necessary, such that all VBSs in operable units are functional.

c. Inspect each STS and operate on trial run (dogged off at deck level). Install STS in each intake of operational units by the end of February.

d. The PH2 Downstream Migrant (DSM2) channel may be dewatered only when required for maintenance. The maintenance period will be minimized to the extent practicable.

e. Remove debris from forebay, trash racks and gatewell slots to maintain these areas debris-free.

f. Inspect and where necessary clean and/or repair all gatewell orifices, orifice lighting systems and flushing systems so that orifices and associated systems are fully functional.

g. Inspect and where necessary clean and/or repair dewatering screens and associated equipment.

h. Inspect and correct any deficiencies in DSM channel, conduit outfall walls and floor.

j. Flume Pipe (from exit of DSM to outfall). Visually inspect outfall flume pipe and associated switch gates once per year from the transition section leaving the powerhouse to the outfall return to the river for obstructions, protrusions, or structural deficiencies that may affect fish passage.

k. Avian Predation Lines. Reinstall or repair avian predator control lines as soon as possible following significant damage or removal. Install and maintain new avian predator control lines in locations determined to be significantly impacted by avian predators. Avian abatement measures shall be in place by March 01 unless this work is delayed because of inclement weather. If this occurs, the work will be completed as soon as possible after that date. However, there will be no avian abatement measures, other than avian lines, performed from September through March each year.

2.4.2.2. March 01 through November 30 (Juvenile Fish Passage Season).

a. Juvenile fish protection devices (STS, etc.) will be in place prior to the juvenile fish passage season. Screens (STSs and VBSs) will remain in operation through December 15 to prevent adult salmonids from falling back through turbine units.

b. Main unit gatewell drawdown will be measured a minimum of once per week. Check more often during times of overwhelming debris, as described in **section 2.4.2.2.j.**

c. Remove debris from the forebay and trash racks as required to maintain less than 1.5' of drawdown in gatewells, or as indicated by fish condition (e.g., higher than expected descaling), or as determined by the project biologist. The STSs in units being raked will be run continuously during raking operations. Gatewell orifices of the unit being raked must be closed during the procedure.

d. Measure fish unit gatewell drawdown at least once per week. When the head across trash racks exceeds 1.5', the trash racks will be cleaned that day. This may be done by raking late in the workday or by turning the unit off at night and letting the debris float off the racks. However, if the head exceeds 3' or if the adult fishway head is reduced, the unit's racks will be raked immediately, even if it is early in the day. When debris accumulation is persistent, unit 18 may be operated while the fish unit is off at night to help draw loosened debris away.

e. Operate STSs at angle of 60° from vertical.

f. Turbines without a full complement of STSs will not operate except when in compliance with other coordinated fish measures.

g. Observe each STS watt and/or amp gauge and record reading at least once per day. If an STS failure occurs, then follow procedures in Fish Facility Maintenance.

h. Video or manually inspect each STS once per month (or 720 hours run time) and each VBS a minimum of once every two months (or 1440 hours run time). Frequency of monthly inspections may be based on individual turbine unit run time.

1. No STS inspections will be scheduled when they will cause excessive TDG due to increased forced spill.

2. VBS inspections will occur immediately prior to peaks in juvenile fish migrations, which begin about May 01, mid-July, and September 01.

3. More frequent inspections may be required by the project biologist or under the following conditions: deterioration of fish conditions, increased debris load in bypass system, and other indications of STS or VBS malfunctions or failure.

4. If manually inspecting VBSs, prior to pulling VBSs for inspections, shut off units and dip gatewells. It is not necessary to dip gatewells of units that have been off for 48 hours or longer.

5. VBSs will be cleaned when drawdowns read 1.1' on any day (including weekends) and when drawdowns reach 0.9' on Thursdays.

6. If a screen has reached the cleaning threshold, all three screens in that unit will be cleaned.

7. A unit will be shutdown if VBS drawdown equals or exceeds 1.5' in a 12-hour period.

i. Rake unit 11 and unit 12 trashracks prior to March 1 and at least once a month throughout fish passage season.

j. If STS or VBS damage or plugging is detected, follow procedures in Section 4 Fish Facilities Maintenance. In the event of overwhelming debris (as defined below) follow the procedures outlined below. Monitor gatewell drawdown daily.

1. TIE Crane in service:

A. VBSs will be cleaned by installing the spare VBS in the back slot, pulling the main VBS up and spray it off with a fire hose, then replace back in slot and pull spare (reverse order).

B. If the VBS drawdown criteria of <1.1' CANNOT be maintained during the day due to debris, the spare VBS will not be installed in the back slot and the gatewells will not be dipped. The Project will pull the main screen, spray it off with a fire hose, and then re-install.

C. If the VBS drawdown criteria of <1.5' over a 12-hour period CANNOT be maintained due to debris, even after performing the above operations, then the STSs will be pulled out until the screen re-installation criteria (see **2.4.2.2.j.3**) have been met.

D. Once the screens have been removed, these units should operate only as necessary to maintain TDG levels below dissolved gas cap limits.

2. TIE Crane OOS = use Gantry Crane:

A. If the Gantry Crane is used to pull the main VBS, the spare VBS will not be installed in the back slot.

B. If the VBS drawdown criteria of <1.5' over a 12 hour period CANNOT be maintained due to debris, even after performing the above operations, then the STSs will be pulled out until the screen re-installation criteria (see **2.4.2.2.j.3**) have been met.

C. Once the screens have been removed, these units should be operated only as necessary to maintain TDG levels below dissolved gas cap limits.

3. SCREEN RE-INSTALLATION CRITERIA: Once flows drop below 300 kcfs and water clarity is 4' or greater, the Project will install STSs in the highest priority unit available. When VBS drawdown for that unit remains below 1.1' for 24 hours, the Project will re-install the remaining STSs. The reinstallation process may occur before or after the above criteria are reached at the discretion of the Project Biologist followed by a discussion with FPOM.

k. All gatewell orifice systems should be operational.

1. Orifices automatically flush 3 times per day, one orifice every 10 minutes. Orifices with less than a clear flow jet will be flushed manually during the inspection.

2. Manually flush orifices known to have recurring plugging or other problems.

3. Orifice jets will be observed through the light tubes during the inspection. Light tubes and orifice tube lenses shall be replaced and kept clean as required so that visual observations of orifice jets are possible during fishway inspections.

l. Replace all non-operational orifice lights within 24 hours. Orifice lights shall remain lighted 24 hours/day.

1. The DSM gallery lights should be left off except when project or other staff is in the gallery.

m. The project will clean gatewells before the water surface becomes 50% covered with debris. If due to the volume of debris, it is not possible to keep the gatewell surfaces 50% clear, they will be cleaned at least once daily.

1. Turbines with a gatewell fully covered with debris will not be operated except to be in compliance with other coordinated fish measures, and then only on a last-on/first-off basis.

2. Gatewell orifices will be closed during the cleaning operations. After cleaning a gatewell, inspect and, if necessary, clean the orifice in that gatewell and then check gatewell drawdown.

3. Coordinate gatewell cleaning with JMF personnel operating downstream juvenile sampling facilities.

n. A slight oily sheen is commonly found in many gatewells. When unusual accumulations of oil occur in gate slots, it will be removed within 24 hours. When this is not possible, the gatewell orifice will be closed and the turbine unit will be shut down until cleaning is accomplished. Appropriate procedures to remove fish during this situation will be determined in coordination with FPOM. Regardless of unit operating status, oil accumulations will be dealt with promptly.

o. Reinstall or repair avian predator control lines in present locations as soon as possible following significant damage or removal. Install and maintain new avian predator control lines in locations determined to be significantly impacted by avian predators. Implement other avian abatement measures as necessary from April through August only.

2.4.2.3. Powerhouse Two Corner Collector (B2CC) Operation. Operate the B2CC during spill season. Open and close the B2CC within one hour of the start and end of spill season, respectively.

a. Beginning on March 01, JMF personnel will enumerate steelhead kelt at the JMF adult/debris separator. If 2 kelts per day are observed at the JMF separators for 2 consecutive days for a cumulative total of 20 kelts, JMF personnel will notify the Control Room and Project Fisheries, and the B2CC will be opened within 1 hour.

2.4.2.4. DSM2 Channel Operation.

a. Screen cleaners. The primary screen cleaner will be the airburst system. The system may be set to cycle every 20, 60, or 180 minutes, depending on debris loads.

1. In the event that the air system is unable to maintain the desired water elevation at the dewatering area, then the duration of the cleaning cycle will be increased as necessary.

2. If the system is still unable to accommodate the debris load, then the mechanical brush system will be activated in conjunction with the airburst system to maintain the desired water elevation. The systems will continue to work in tandem until debris loads lessen and the airburst system can maintain a correct water elevation.

3. Once water elevations can be maintained, the mechanical system will be returned to standby and the airburst system cleaning will be the primary system once again.

4. The Project biologists shall have the discretion to modify the cleaning system program at anytime to maintain FPP criteria.

5. The mechanical screen cleaners will be run once a week to exercise the equipment.

b. **Operation**. Maintain the channel elevation between 64.2'–64.4' as measured at the staff gauge in front of the ERG.

Table BON-7. Regulating Orifice Control at Bonneville Dam DSM2.

Orifice	FB ≤ 71.5'	FB ≤ 72.5'	FB ≤ 73.5'	FB ≤ 74.5'	FB ≤ 75.5'	FB ≤ 76.5'
11A-S	Open	Open	Open	Open	Open	
11B-S	Open	Open	Open	Open		
11C-S	Open	Open	Open	Open		
12A-S	Open	Open	Open			
12B-S	Open	Open	Open			
12C-S	Open	Open				
13A-S	Open	Open				
13B-S	Open	Open				
13C-S	Open					
14A-S	Open					
14B-S	Open					
14C-S	Open					

2.4.2.5. Juvenile Monitoring Facility (JMF).

a. Operation.

1. Project Biologists or JMF personnel will operate the upper switchgate as necessary for sampling requirements.

2. The lower switchgate is in automatic control. JMF personnel (PSMFC) will monitor and report to Project Biologists any problems with the lower switchgate.

3. On seasonal ascending tailwater elevations, the transition from low to high outfall should be between tailwater elevations at the upper end of 16' to 18' range.

4. On seasonal descending tailwater elevations, the transition from high to low outfall should be between tailwater elevations at the lower end of 18' to 16' range.

5. Operate the outfall avian cannons from March 1 through November 1. The cannons will be operated 24 hours/day during fish passage season.

6. For specific monitoring facility guidance, see also **Appendix J** *Protocols for Juvenile Monitoring Facility Operations at Bonneville Dam*.

2.4.3. Spillway Operating Criteria.

2.4.3.1. December 01 through February 28 (Winter Maintenance Period).

a. Inspect and repair where necessary spill gates and control systems. The spillway, except for coordinated exceptions, must be able to achieve spill patterns on the first day of the juvenile fish passage season.

b. As per procedures in *Bonneville Operating Order 14*, each spill gate will be raised and lowered to test for operability and check calibration prior to start of spill season, usually in March.

c. For spill guidance during winter maintenance periods, see **Appendix E** or section **2.2**.

2.4.3.2. March 01 through November 30 (Juvenile Fish Passage Season). Spill will be provided according to the guidance in **Appendix E** and section **2.2**.

2.5. Adult Fish Passage Facilities.

2.5.1. All Adult Fish Passage Facilities Operating Criteria.

2.5.1.1. December 01 through end of February (Winter Maintenance Period).

a. Operate adult fish passage facilities according to fish passage season standards. Systems may be dewatered or operated out of criteria for repair and maintenance.

b. Only one ladder servicing the powerhouses and the associated powerhouse collection system (including the auxiliary water supply system) may be out of service or operating out of standard operating criteria at any one time, unless specifically coordinated.

c. Turbines will be operated in the priority order in **Table BON-14**.

d. One of the two ladders servicing the spillway channel will be in full operation at all times unless otherwise coordinated.

e. Outage periods will be minimized to the extent practicable.

f. Operate spillbays 1 and 18 as described in section **2.2.3.1** and **Table BON-5**.

g. Adjust fish counting stations crowders to fully open if videotaping is temporarily discontinued due to unscheduled events or during winter maintenance (dewatering) period only.

h. Sea Lion Exclusion Devices (SLEDs) will be installed at all 8 main fishway entrances and B2 FOGs on or before February 1 and removed by June 15 each season. SLEDs may be installed earlier or kept in place later if significant numbers of pinnipeds are present at Bonneville outside of these dates.

i. Inspect and calibrate all staff gauges and water level indicators. Repair and/or clean where necessary.

j. Unless specially coordinated, dewater all ladders and inspect all dewatered sections of fish facilities for projections, debris, or plugged orifices that could injure fish or slow their progress up the ladder. Repair deficiencies.

k. Inspect for and clear debris in the ladder exits.

l. Reinstall counting station picket leads prior to watering up ladders during maintenance.

m. Except when closed to facilitate maintenance activities, the PH1 ITS gates 1A, 1B, 3B, 6C, and 10B should remain open from December 01 through the end of February to provide steelhead kelt passage.

1. Set chain gate 1A and 1B at 70’ msl. Ensure gates 3B, 6C, and 10B are operating according to **Table BON-6**.

2. From December 15 through the end of February the Project may close the ITS endgate or ITS gates to facilitate winter maintenance (including researcher equipment O&M) in the PH1 forebay. Closures may not exceed six hours per day unless otherwise coordinated with FPOM.

n. In the appropriate year (when the fishway is out of service for winter maintenance), dredge AWS intakes to maintain the following elevations:

1. -22’ to -24’msl at PH2 Fish Unit intake;
2. +63’ msl at BI exit, FV3-7 and FV3-9.

2.5.1.2. March 01 through November 30 (Adult Fish Passage Season).

a. Maintain water depth over fish ladder weirs at 1.0’ ±0.1’ during non-shad passage season (<5,000 shad per day/per count station) and 1.3’ ±0.1’ during shad passage season (≥ 5,000 shad per day/per count station). Water depths will be measured at the A- and B-branch staff gages in the Bradford Island fishway, at weirs 37 and 38 in the Washington shore fishway, and at the UMT staff gage in the Cascades Island fishway.

b. Water temperature will be measured in an adult fishway at each powerhouse. When water temperature reaches 70°F, all fish handling activities will be coordinated through FPOM prior to any action to verify protocols that will be followed. Fish handling activities in the Adult Fish Facility (AFF) will implement protocols in **Appendix G**.

c. Head on all entrances should be: 1' to 2' (1.5' preferred). Head at the NUE is calculated differently because the collection channel staff gage is in the junction pool. A head of approximately 1' to 2' at the NUE entrance is indicated by a 1.2' to 2.2' (1.7' preferred) entrance head calculated using the fishway and tailwater staff gages closest to NUE. Refer to **Table BON-13** when unable to achieve head criterion.

d. A water velocity of 1.5 to 4 fps (2 fps preferred) shall be maintained for the full length of the powerhouse collection channel, and the lower ends of the fish ladders that are below the tailwater. Water velocities will be measured directly, and monitored during fishway inspections to verify channels are operating between 1.5 and 4 fps.

e. A maximum of 0.5' head will be allowed on the PH1 attraction water intakes and trash racks at all the ladder exits, with 4" maximum head on all picket leads. Debris shall be removed when significant amounts accumulate.

f. Staff gages and water level indicators will be readable at all water levels encountered during the fish passage period. These include: PH1 south collection channel, PH1 north collection channel, PH1 north tailwater, PH1 south forebay, BI A- and B-branch ladders, BI weir, B-branch entrance, CI entrance, CI ladder below the UMT entrance, NUE/NDE/SUE/SDE collection channel, NUE/SUE tailwater, and PH2 north forebay.

g. Stillwells used in lieu of staff gages will be checked for calibration once per week.

h. The current fish counting program is conducted 16 hours per day, year around (see **Table BON-3**). Count station crowders shall remain in the operating position while visual counting and/or videotaping is being conducted. All equipment should be maintained and in good condition. The counting window and backboard should be cleaned as needed to maintain good visibility.

1. The crowder shall be opened to full count slot width when not counting. The crowder shall be open as far as possible to allow accurate counting and shall not be closed to less than 18” while counting. This will usually occur during high turbidity conditions to maintain count accuracy. All equipment will be maintained in good condition. The counting window and backboard will be cleaned as needed to maintain good visibility. The crowder ranges are as follows:

- Washington Shore = 22.8”–38.4”;
- Cascades Island = currently out of service (max. opening approximately 36”);
- Bradford Island = 20.4”–36”.

2. If passage is impaired by this condition, the count slot may be widened until proper passage conditions are achieved, even though count accuracy may be compromised to some degree.

3. Project biologists, FFU, and the fish count supervisor shall coordinate to achieve optimum count slot passage and/or count accuracy conditions.

4. If counting is temporarily discontinued due to unscheduled events, the crowder shall be fully opened.

5. The crowder may remain in operating position during the counters' hourly ten-minute break period.

6. Leave the fish passage slot lighted overnight.

i. Upstream light banks in both count stations shall remain off to facilitate fish passage through the count slot and help reduce the number of fish impacting the count window framework, unless other passage problems result, or count accuracy is compromised as determined by the fish count supervisor and coordinated through FPOM.

j. Inspect and ensure that optimum passage conditions are maintained at fishway entrances, exits, and in the count slots.

k. Take soundings annually at the PH2 Fish Unit intake and the BI exit/AWS intake to determine sediment accumulation and plan for the appropriate dredging need.

2.5.2. Main Dam Ladders.

2.5.2.1. When spilling exclusively for adult attraction, spill only during the daylight hours (see **Table BON-5**). Spill Bays 1 and/or 18 shall be open 6" only if adjacent to operating fishway entrances (see section **2.2.3.1**).

2.5.2.2. Side entrances SW-SG-5 and SO-SG-7 shall remain closed. Downstream entrances SW-SG-1 and SO-SG-2 shall operate as continuously open free-flowing vertical slots. Downstream entrances SW-SG-3 and SO-SG-4 (adjacent to shore) consist of pairs of sluice gates. SO-SG-4N and SO-SG-4S shall be closed at all tailwater elevations. When the tailwater is below 9', sluice gates SW-SG-3N, SW-SG-3S, shall be open. When the tailwater is between 9' and 17', sluice gate SW-SG-3N shall close. When the tailwater exceeds 17', sluice gates SW-SG-3N and SW-SG-3S shall be closed.

Table BON-8. Diffuser Operating Ranges at Bonneville Dam Bradford Island B-Branch.

Diffuser	Operating Range (feet)	Diffuser	Operating Range (feet)	Diffuser	Operating Range (feet)
FG3-18	>34	FG3-23	>19	FG3-28	<25
FG3-19	>31	FG3-24	>16	FG3-29	Manual open
FG3-20	>28	FG3-25	13'-34	FG3-30	Manual open
FG3-21	>25	FG3-26	12'-31	FG3-31	>25
FG3-22	>22	FG3-27	10.5-28	FG3-32	>26
				FG3-33	>27

Table BON-9. Diffuser Operating Ranges at Bonneville Dam Cascades Island.

Diffuser	Operating Range (feet)	Diffuser	Operating Range (feet)	Diffuser	Operating Range (feet)
FG6-5	>31	FG6-10	>17	FG6-15	Manual open
FG6-6	>29	FG6-11	>14	FG6-16	Manual open
FG6-7	>25	FG6-12	>11	FG6-17	Manual open
FG6-8	>23	FG6-13	>10	FG6-18	>12
FG6-9	>20	FG6-14	>9	FG6-19	>15
				FG6-20	>19

2.5.3. Powerhouse One (PH1).

2.5.3.1. Weir Gates. The PH1 weir gates will be operated as shown in **Table BON-10.**

a. Gate Pairing. The four weir gates will be operated in two pairs. Only one gate pair will be allowed to operate at any given time. Gates 1 and 65 will operate together as the active pair for tailwater elevations greater than 23' msl, while gates 2 and 64 will operate together as the active pair for tailwater elevations less than 26' msl. For tailwater elevations between 23' and 26', the designated active pair will depend on whether the tailwater elevation has been rising or falling with a "dead band" of 1.5'.

b. **Transition Positioning.** During a transition, the former active pair is closed and the new active pair is positioned according to tailwater.

Table BON-10. Weir Gate Requirements at Bonneville Dam Powerhouse One.

Weir Gate	Submergence Requirement (feet)	Differential Requirement (feet)	Sill Elevation (feet)
1	>8'	1'-2'	8.5'
2	>8'	1'-2'	2'
64	8'-8.4'	1'-2'	2'
65	8'-8.4'	1'-2'	8.5'

2.5.3.2. Control of Fish Valve FV1-1.

a. Emergency Closure. If the collection channel/tailwater differential is greater than 2.5', or if the pressure differential between the auxiliary water supply conduit and the collection channel becomes excessive, as determined by operators, close FV1-1.

b. Differential. Low: if the collection channel/tailwater differential is less than 1'. High: if the collection channel/tailwater differential is more than 2.0'.

2.5.3.3. Control of Fish Valve FV3-7. Maintain the opening concurrent with the charts for valve opening, as set by the forebay and tailwater elevations.

2.5.3.4. Control of A-Branch Diffusion Gates FG3-3 through FG3-9. Bradford Island A-branch diffusers are open according to the pattern in **Table BON-11**.

Table BON-11. Diffuser Operating Ranges at Bonneville Dam Bradford Island A-branch.

Diffuser	Operating Range – Tailwater Elevation (feet)	Dead Bands (feet)
FG3-3	8.2 – 13.3	7.8 – 8.2
FG3-4	13.7 – 16.3	13.3 – 13.7
FG3-5	16.7 – 19.3	16.3 – 16.7
FG3-6	19.7 – 24.8	19.3 – 19.7
FG3-7	25.2 – 27.8	24.8 – 25.2
FG3-8	28.2 – 30.8	27.8 – 28.2
FG3-9	> 31.2	30.8 - 31.2

2.5.3.5. Powerhouse One Collection Channel Diffusers. Diffuser valves are operated according to the pattern in **Table BON-12**.

Table BON-12. Open Adult Fish Collection Channel Diffuser Valves at Bonneville Dam Powerhouse One. ***Any diffusers not listed should be Closed.***

Valve	Setting		Valve	Setting
FG2-4	Open		FG2-20	Open
FG2-8	Open		FG2-21	Open
FG2-12	Open		FG2-22A	Open
FG2-19	Open		FG2-22B	Open

2.5.4. Powerhouse Two (PH2).

a. During daytime spill hours (**Table BON-5**), operate all north (NUE and NDE) and south (SUE and SDE) entrances. Operate weir crests at elevation 1' (fully lowered) for tailwater elevations up to 14'. For tailwater elevations greater than 14', operate weir crest 13' or greater below tailwater.

b. Operate all 12 active PH2 floating gate fishway entrances.

c. Lamprey Operations, June 1–August 31: During nighttime spill hours (**Table BON-5**), reduce fish unit output to operate all north (NUE and NDE) and south (SUE and SDE) entrances at 0.5' of entrance head. To ensure proper function of the fish units, B2 fish unit output can be further reduced or placed on standby to float debris as necessary from 2200-0400 hours.

3. FACILITY MONITORING AND REPORTING

3.1. Inspections.

3.1.1. The results of all inspections and the readiness of the facilities for operation will be reported to the FPOM at the meeting immediately prior to the fish passage season.

3.1.2. During fish passage season, fish passage facilities will be inspected at least three times per day/seven days a week to assure operation according to established criteria.

3.1.3. During winter maintenance season, fish passage facilities will be inspected three times per day/at least three days a week.

3.1.4. More frequent inspections will occur as noted throughout the text.

3.1.5. The project fish biologists and fish biological staff will conduct at least three inspections per week though additional fishway inspections may be performed by FFU and fish agencies.

3.2. Zebra Mussel Monitoring. A zebra mussel monitoring program will continue. These organisms have become a serious problem elsewhere in the country and may become introduced into the Columbia River basin. Inspections should also be made when dewatering all project facilities.

3.3. Reporting.

3.3.1. Project biologists shall prepare weekly reports throughout the year summarizing project operations. The weekly reports will provide an overview of how the project and the fish passage facilities operated during the week and an evaluation of resulting fish passage conditions. The reports shall include:

a. Any out-of-criteria situations observed and subsequent corrective actions taken.
b. Any equipment malfunctions, breakdowns, or damage along with a summary of resulting repair activities.
c. Adult fishway control calibrations.
d. STS and VBS inspections.
e. AWS closures (i.e. cleaning times).
f. When trapping is occurring in the AFF.
g. Any unusual activities which occurred at the project which may affect fish passage.

3.3.2. The weekly reports shall cover a Sunday through Saturday period and they shall be e-mailed to CENWP-OD and other interested parties as soon as possible the following week, with a copy to CENWD-PDW-R (RCC).

3.3.3. The project biologists shall prepare a memo for the record for any negative impact to fish or fishways. This memo will be sent to FPOM by the next working day. Items that shall be included in the memo are:

a. Time and date.
b. Nature of activity that leads to fish impact.
c. Agency responsible for the impact, or the name of the reporter if no responsible party can be identified.
d. Fish numbers, species, origin, discernible external injuries, tags, etc.
e. Future actions to avoid a similar impact.
f. Any relevant photos.

3.3.4. The project biologists shall prepare an annual report by January 31, summarizing the operation of the project fish passage facilities for the previous year.

3.3.4.1. The report will cover from the beginning of one adult fish facility winter maintenance period to the beginning of the next.

3.3.4.2. The annual report also will include a description of all actions taken to discourage avian predation at the project, with an overview of the effectiveness of the activities in discouraging avian predation.

3.3.4.3. The annual report will be provided to CENWP-OD in time for distribution to FPOM members at the February meeting.

4. FISH FACILITIES MAINTENANCE

4.1. General.

4.1.1. Routine Maintenance.

4.1.1.1. Staff gages and other water-level sensors will be installed, cleaned, and/or repaired as required.

4.1.1.2. Scheduled fishway maintenance, to the extent practicable, will be conducted during periods when passage has been documented to be at its lowest during the regular scheduled workday, to minimize impacts to migrating salmonids.

4.1.1.3. Maintenance activities that occur during the fish passage period and that may affect fish passage will be reported in the weekly reports.

4.2. Juvenile Fish Passage Facilities.

4.2.1. Routine Maintenance.

4.2.1.1. Submersible Traveling Screens. The STS system will receive preventive maintenance or repair at all times of the year, including the winter maintenance period. Whenever a generator malfunctions or is scheduled for maintenance, the three STSs in that turbine may be maintained, repaired, or exchanged for other STSs needing maintenance or repair. One third of the STSs at Bonneville are scheduled for complete overhaul each year resulting in a three-year maintenance cycle unless future developments indicate that longer life expectancy is possible.

4.2.1.2. Juvenile Bypass Systems (JBS). The JBS will receive preventive maintenance throughout the year. During the juvenile fish passage season, this will normally be above-water work such as maintenance of automatic systems, air lines, electrical systems, and monitoring equipment. During the winter maintenance period, the systems may be dewatered downstream of the gatewell orifices. The systems will then be visually inspected in all accessible areas for damaged equipment and in areas that may cause problems to the juvenile fish. Any problem areas identified are to be repaired if the project is able. In extreme cases, the work will be contracted as soon as possible or repaired during the next winter maintenance period. Channel modifications and general maintenance also should be completed at this time.

a. The trash racks are to be raked just prior to the juvenile fish passage season and whenever trash accumulations are suspected because of increased head across the trash racks (>1.5') or increased juvenile fish descaling. Additional trash rack raking may be necessary when a storm brings large quantities of debris down river to the project. Gatewell orifices in the unit being raked will be closed during the procedure.

4.2.1.3. Turbines and Spillways. Maintenance and routine repair of project turbines and spillways is a regular and recurring process which requires units to be shut down for extended periods of time

a. The maintenance schedules for turbines and spillways will reflect equal weighting given to fish, power, and water management and will be coordinated with the appropriate fish and resource agencies through FPOM.

b. Certain turbine and spillway discharges at the projects are secondarily used to attract adult fish to fishway entrances, to keep predator fish from accumulating near juvenile release sites, and to move juveniles downstream away from the project. During the fish passage season, do not take units F1, F2, 1, 3, 11, and 18 out of service, when practicable.

c. Whenever practicable, except during split flows operation, do not take any other PH2 units out of service from June 21 through September 15, to minimize PH1 operation.

d. Fish units may be taken out of service to facilitate cleaning of the fish unit brush rigging. Through trial and error, it has been determined that the rigging should be cleaned twice during the passage season. One cleaning operation is performed in conjunction with the mid-year collection channel diffuser grating inspection, and the second stands alone on the outage schedule.

e. Some types of turbine maintenance will require testing the turbine throughout its full operating range before returning it to normal service. These operations will be coordinated with the appropriate resource agencies.

4.2.2. Non-Routine Maintenance. Maintenance of facilities such as fish screens, which sometimes break down during the fish passage season, will be carried out as described below.

4.2.2.1. Unscheduled maintenance that will have a significant impact on juvenile fish passage shall be coordinated with the Regional fish agencies through FPOM and with RCC on a case-by-case basis by CENWP-OD biologists. The CENWP-OD biologists will be notified by the project as soon as possible after it becomes apparent that maintenance repairs are required. The Project Operations Manager has the authority to initiate work prior to notifying CENWP-OD when delay of the work will result in an unsafe situation for people, property, or fish. Information required by CENWP-OD includes (see **Overview** for coordination form):

1. Description of the problem.
2. Type of outage required.
3. Impact on facility operation.
4. Length of time for repairs.
5. Expected impacts on fish passage.

4.2.2.2. Submersible Traveling Screens. If an STS or VBS is found to be damaged or inoperative in an operating unit, the unit will be regarded as an unscreened unit. The screen will be repaired or replaced before returning the unit to normal service.

4.2.2.3. Juvenile Bypass Systems (JBS).

a. The JBS is controlled automatically (PLC). When an automatic system fails, it can usually be operated manually. This allows either facility to operate according to criteria while repair of the automatic system is completed.

b. Orifices allow fish out of the gatewells into a bypass channel. If an orifice valve system becomes inoperative, it will be repaired expeditiously. When the orifices become plugged with debris they are pneumatically flushed.

c. If automatic systems fail and the system is operated manually, facility inspections should increase to a frequency that ensures systems continue to operate within criteria.

d. All STS gatewells will be inspected daily and cleaned before they become 50% covered with debris. If due to volume of debris it is not possible to keep the gatewell

surfaces at least 50% clear, they will be cleaned at least once daily. Turbines with a gatewell fully covered with debris will not be operated, except on a last-on/first-off basis, if required to be in compliance with other coordinated fish measures. This is to maintain clean orifices and minimize fish injury. The gatewell orifices will be closed during the cleaning operation. Check gatewell drawdown and clean trashracks if necessary.

e. Powerhouse One (PH1). PH1 juvenile passage routes consist of the ITS and MGR turbines. The DSM is no longer in service.

f. Powerhouse Two (PH2). If the bypass system fails in the dewatering section or release pipe, fish may be released through the emergency relief conduit. This operation will continue until repairs are accomplished or until the end of the fish passage season. Any decision on whether or not to shut this system down for dewatering and repairs will be made in coordination with the FPOM. During this emergency operating mode, power generation will be minimized at the PH2. Repairs will receive high priority.

g. During fishway inspections the VBSs may be found plugged, damaged, or not properly seated. In these cases, the associated unit will be taken out of service as if unscreened and repairs will be made before returning the unit to normal service. If screens are pulled and replaced, the underwater video inspection camera will be deployed to check the screens for proper seating.

4.2.2.4. Turbines and Spillways. If a spill gate becomes inoperable, the operator will make the changes necessary to accommodate the spill and then immediately notify the operations supervisor and project biologist to determine the best pattern to follow until repairs are completed. This interim operation shall be coordinated with the FPOM through the district biologist who will provide additional guidance to the project.

4.3. Adult Fish Passage Facilities.

4.3.1. Routine Maintenance. Maintenance activities that occur during the fish passage period and that may affect fish passage will be reported in the weekly reports.

4.3.1.1. Fishway Auxiliary Water Systems. Bonneville Project auxiliary water systems consist of gravity flow and hydroelectric generating systems. Preventive maintenance and normal repair are carried out as needed throughout the year. Trash racks for the AWS intakes will be raked when drawdown exceeds criteria. When practicable, rake trash racks during the time of day when fish passage is least affected.

4.3.1.2. Powerhouse and Spillway Adult Fish Collection Systems. Preventive maintenance and repair occurs throughout the year. During the primary adult fish passage season this maintenance will not involve any operations which will cause failure to comply with the adult fishway criteria except as specially coordinated or as needed for semi-annual maintenance. Inspection of those parts of the adult collection channel systems which require dewatering, such as diffusion gratings, leads, and entrance gates, will be scheduled once per

year during the winter maintenance season while the system is dewatered, with one additional inspection during the fish passage season, unless a channel must be dewatered for fishway modifications or to correct observed problems.

a. An underwater video system or diver may be used for underwater inspections. This scheduled inspection and any associated maintenance will occur during winter maintenance period and once during fish passage season unless specially coordinated. Any non-routine maintenance and fishway modifications will be handled individually.

b. A project biologist will attend all dewatering activities potentially involving fish, as well as inspections, to provide fish related input.

4.3.1.3. Diffuser Gratings: Diffuser chambers for adding auxiliary water to fish ladders and collection channels are covered by gratings attached by several different methods. Diffuser gratings are normally checked during the winter maintenance period to make sure they are in place. These inspections are done by either dewatering the fish passage way and physically inspecting the diffuser gratings, or by using other methods to inspect the gratings. Diffuser gratings may come loose during the fish passage season.

a. Daily inspections of fish ladders and collection systems should include looking for any flow changes that may indicate problems with diffuser gratings.

b. If a diffuser grating is known to or suspected of having moved, creating an opening into a diffuser chamber, efforts must immediately be taken to correct the situation and minimize impacts on adult fish in the fishway.

c. If possible, a video inspection should be made ASAP to determine the extent of the problem. If diffusers gratings are found to be missing or displaced, creating openings into the diffuser chambers, a method of repair shall be developed and coordinated with the fish agencies and tribes through the established FPOM coordination procedure.

d. Repairs shall be made as quickly as possible unless coordinated differently.

4.3.1.4. Adult Fish Ladders and Counting Stations. (Also see **Appendix G** *Adult Fish Trapping Protocols*.) The adult fish ladders will be dewatered once each year during the winter maintenance period. During this time, the ladders will be inspected for blocked orifices, projections into the fishway that may injure fish, stability of the weirs, damaged picket leads, exit gate problems, loose diffusion gratings, unreadable or damaged staff gauges, defective diffusion valves, and malfunctioning operating equipment at the counting stations, as well as other potential problems. Problems identified throughout the passage year that do not affect fish passage, as well as those identified during the dewatered period, may then be repaired. Trash racks at the ladder exits will be raked when criteria is approached or exceeded. When practicable, rake trash racks during the time of day when fish passage is least affected, usually late morning fish count station windows, light panels, and crowder

panels will be cleaned as needed to achieve accurate counts and, when practicable, during the time of day when fish passage is least affected, usually late morning.

4.3.2. Non-Routine Maintenance. Maintenance activities that occur during the fish passage period and that may affect fish passage will be reported in the weekly reports. Non-routine maintenance that will significantly affect the operation of a facility, such as repair of displaced diffuser gratings, will be coordinated with the Regional fish agencies through FPOM and with RCC. Coordination procedures for non-routine maintenance of adult facilities are the same as for juvenile facilities. Any non-routine maintenance and fishway modifications will be handled on an individual basis.

4.3.2.1. Fishway Auxiliary Water Systems. Most fishway auxiliary water systems are operated automatically. If the automatic system fails, then the system will be manually operated by project personnel to maintain criteria while repair of the automatic system is carried out. When this operation becomes necessary, project personnel will increase the surveillance of the adult system to ensure that criteria are being met. In the event of AWS failure, FPOM will be used in an advisory capacity to assist the project as needed.

a. Powerhouse One (PH1). If any valves or any other part of the system fails, the project shall attempt to maintain criteria by adjusting those valves which continue to function. Conduit pressure must be monitored and not allowed to exceed the established limits.

b. Spillway. Two separate fishway auxiliary water valves add water to each spillway ladder (Cascades Island and B-branch ladders). If one of these valves or any other part of the system malfunctions, the functioning parts of the system are to be adjusted to compensate. If repairs cannot be made in 24 hours, close the sluice gate entrance, if open. This will divert the reduced available water to the entrance slots. If a head of 1' is still not achieved, stop logs are to be added to the entrance slots until the desired head or a weir depth of not less than 6' below the tailwater surface is reached. At this point maintain the gate positions until the auxiliary water system is repaired.

c. Powerhouse Two (PH2).

1. If either or both of the fishway auxiliary water turbines is unable to provide water sufficient to meet full criteria, the adult facilities will be operated according to **Table Bon-13**, Emergency Operations for Bonneville PH2 AWS Systems Operations or until a fishway head of 1’ is achieved.

2. Table Bon-13 is a guide for configuring turbine flows, floating orifices, diffuser gates, and main gates during emergency situations when one of the fish turbines has failed or been taken out of service. **Table BON-13** guidance should be followed to the extent practicable, and shore entrance weirs should be raised in increments or closed as needed to maintain the proper fishway head.

3. If both fish unit turbines fail between September 01 and March 31 and repairs cannot be made within 8 hours, coordination with FPOM will occur to develop operational guidelines that may include modified powerhouse priority operations.

4. PH2 adult fishway diffusion system valves A3 and A4 were found damaged and have been removed. These valves were designed to be closed when tailwater drops below 11' and 9', respectively. Even though the valves cannot be closed, velocity in the channel has remained in criteria.

Table BON-13. Emergency Operations for Bonneville Dam Powerhouse Two Auxiliary Water Supply.

Tailwater Elevation (ft)	Turbine (MW)	Turbine Q (cfs)	**********CLOSED**********			
			Floating Orifices	South "B" Diffusers	PH "C" Diffusers	Main Entrances
8	13.90	2,950	All	B3-8	C1-5	None
9	13.95	3,010	All	B3-8	C1-5	None
10	14.05	3,090	All	B3-8	C1-5	None
11	14.15	3,165	All	B3-8	C1-5	None
12	14.20	3,230	All	B3-8	C1-5	None
13	14.40	3,340	All	B3-8	C1-5	None
14	14.40	3,400	All	B3-8	C1-5	None
15	14.60	3,520	All	B3-8	C1-5	None
16	14.30	3,515	All	B3-8	C1-5	None
17	14.20	3,560	All	B3-8	C1-5	None
18	14.00	3,575	All	B5-8	None	NU-E
19	13.60	3,535	All	B5-8	None	NU-E
20	13.30	3,520	All	B4-8	None	NU-E
21	13.00	3,510	All	B4-8	None	NU-E
22	12.70	3,505	All	B4-8	None	NU-E
23	12.40	3,505	All	B4-8	None	NU-E
24	12.20	3,535	All	B4-8	None	NU-E
25	11.60	3,535	All	B4-8	None	NU-E
26	11.10	3,365	All	B4-8	None	NU-E
27	10.60	3,285	All	B4-8	None	NU-E
28	10.00	3,160	All	B3-8	None	NU-E

4.3.2.2. Powerhouse and Spillway Adult Fish Collection Systems. Bonneville Project contains several types of fishway entrances. In most cases, if failures occur, the entrance can and will be operated manually by project personnel until repairs are made. If this operation becomes necessary, project personnel will increase the surveillance of the adult system to ensure that criteria are being met. In those cases in which the failure will not allow the entrance to be operated manually, the gate will be maintained, to the extent possible, in an operational position. If this is not possible, the entrance will be repaired expediently and returned to manual or automatic control at the earliest possible date.

4.3.2.3. Adult Fish Ladders and Counting Stations. Ladder components include picket leads, counting stations, fishway exits, and overflow weirs with orifices. Pickets with

excessive spacing (greater than 1"), concrete erosion around the leads, or missing pickets can allow fish into areas where escape is difficult. In some instances of picket lead failure, spare leads and spare installation slots are available. In these cases the spare leads are installed and the damaged leads are removed and repaired. In the remaining instances of picket lead failure or concrete erosion, the timing and method of repair will depend upon the severity of the problem. The decision of whether or not to dewater the fishway and repair any problems will be made in coordination with the Regional fish agencies through FPOM.

4.3.2.4. Diffuser Gratings. Diffuser chambers for adding auxiliary water to fish ladders and collection channels are covered by gratings attached by several different methods. Diffuser gratings are normally checked during the winter maintenance period to make sure they are in place. These inspections are done by either dewatering the fish passage way and physically inspecting the diffuser gratings, or by using other methods to inspect the gratings. Diffuser gratings may come loose during the fish passage season.

a. Daily inspections of fish ladders and collection systems should include looking for any flow changes that may indicate problems with diffuser gratings.

b. If a diffuser grating is known to or suspected of having moved, creating an opening into a diffuser chamber, efforts must immediately be taken to correct the situation and minimize impacts on adult fish in the fishway.

c. If possible, a video inspection should be made as soon as possible to determine the extent of the problem. If diffuser gratings are found to be missing or displaced, creating openings into the diffuser chambers, a method of repair shall be developed and coordinated with the Regional fish agencies through FPOM.

d. Repairs shall be made as quickly as possible unless coordinated differently.

5. TURBINE UNIT OPERATION AND MAINTENANCE

5.1. Powerhouse priority is detailed in **Table BON-14.** When splitting flows, as directed in section **2.1.2,** the top two available priority units for PH1 will be operated first followed by normal unit priority at PH2. If there is a need for more units, and all available units at PH2 are in operation, proceed with the normal unit priority for PH1**.**

5.2. Turbine units at PH1 will operate within 1% of best efficiency and within cavitation limits at various head ranges as shown in **Table BON-15**.

5.2.1. Turbine units at PH2 will operate at the mid to lower 1% range (unless total dissolved gas waivers are exceeded in the tailrace) of best efficiency and within cavitation limits at various head ranges as shown in **Table BON-16**.

5.3. Turbines will be operated within ±1% of best turbine efficiency from April 1 through October 31 (as specified in the BPA load shaping guidelines), except as outlined in **Appendix C**.

5.4. The project turbine unit maintenance schedules will be reviewed by Project and Operations Division biologists for fish impacts. If possible, maintenance of priority units will be scheduled for winter maintenance periods, or when there are low numbers of fish passing the project.

Table BON-14. Turbine Unit Operating Priorities at Bonneville Dam (Units 1-18).

PERIOD	PRIORITY *
Year-Round; Adult Fish Ladders in service	PH2 Priority: 11,18,12,17,13,14,15,16, 1,10,3,6,2,4,5,8,7,9
PH1 Adult Fish Ladder out of service	
PH2 Adult Fish Ladder out of service	PH1 Priority: 1,10,3,6,2,4,5,8,7,9 11,18,12,17,13,14,15,16,
Split Flows (all units available)	1,10,11,18,12,17,13,14,15,16,3,6,2,4,5,8,7,9
PH1 Unit priority	1,10,3,6,2,4,5,8,7,9
PH2 Unit priority	11,18,12,17,13,14,15,16

* Changes in unit priorities may occur and will be authorized in RCC teletypes as needed.

5.4.1. When PH1 is operating, Unit 1 provides important attraction flow for adult fish and helps move juvenile fish downstream. To maintain the priority importance of Unit 1 when PH1 must be used, long-term outages will be avoided after the beginning of the juvenile fish passage season until after the adult fall Chinook and coho runs at the end of October.

5.4.2. In the event of long-term powerhouse outages, affected units will be exercised periodically. Each unit will be operated 4-8 hours every two weeks to exercise governor components and clean wetted surfaces of corrosion, so that if needed, fish injury will be minimized and the units will be in good operating condition. Actual runtime will be the minimum amount needed to keep the unit in good working condition. This may be performed at night, daytime, or whenever unit cycling will have the least effect on fish passage as determined by the project biologist.

5.4.3. Units may be operationally tested for up to 30 minutes before going into maintenance status by running the unit at speed-no-load and various loads within the 1% range to allow pre-maintenance measurements and testing, AND TO ALLOW ALL FISH TO MOVE THROUGH THE UNIT. Units may be operationally tested after maintenance or repair while remaining in maintenance or forced outage status. Operational testing may consist of running the unit for up to a cumulative time of 30 minutes (within 1% range) before it is returned to operational status. Operational testing OF UNIT UNDER MAINTENANCE is in addition to a unit in run status (e.g., MINIMUM GENERATION) required for power plant reliability. Operational testing may deviate from fish priority units and may require water that would otherwise be used for spill if the running unit for reliability is at its 1% minimum load. Water will be used from powerhouse

allocation if possible, and water diverted from spill for operational testing will be minimized to that necessary to maintain and assure generation system reliability.

5.5. The headgates at units 11 through 18 have been dogged off and the system has been depressurized. Oil leaks develop frequently when the system operates with normal pressure. Further related instructions are described in a memorandum from the project operations superintendent. (*Memorandum for All Operations, from BON Chief of Operations, dated September 23, 1993. Subject: Powerhouse 2 Hydraulic Head Gate Operation*).

5.6. From December 1 through April 30, priority units 1, 3, 11, and 18 will be scheduled for any necessary extended outages. During this time, non-priority units should not be scheduled for routine or extended outages if the outage will delay or conflict with priority unit maintenance.

5.7. Turbines which have been idle/out of service for more than 12 hours will be started by slow rolling the unit after manually tipping turbine blades from flat to steep and back to flat.

5.8. During high head events (such as a higher than normal forebay) the top priority unit at PH1 may be operated, when necessary, to keep PH2 units within the 1% efficiency range.

6. DEWATERING PLANS

6.1. Guidelines for any dewatering. *Guidelines for Dewatering and Fish Handling Plans* (**Appendix F**) have been developed and are followed for most project facilities dewaterings. These plans include consideration for fish safety and are consistent with the following general guidance. The appropriate plans are reviewed by participants before each salvage operation. Dewatering Plans are also available online at: http://www.nwd-wc.usace.army.mil/tmt/documents/FPOM/2010/

6.1.2. Whether pumps or drain valves are used, automatic pump shut off devices will be utilized to prevent stranding fish. If automatic pump shut off devices and low water alarms are not used, the dewatering process must be continuously monitored to prevent stranding.

6.1.3. Project Biologist and/or alternate Corps fish personnel will attend all project activities involving fish handling.

6.1.4. The fish agencies and tribes will be notified of any dewaterings and may be invited if additional help is deemed necessary, and all safety considerations can be met.

6.1.5. Adult salmonids will be released into the forebay and juvenile salmonids will be released into the tailrace, depending on the age composition of fish in the tank. If a ladder is dewatered in the spring or summer, steelhead kelts will be released into the tailrace. If large numbers of sturgeon are present, it may be necessary to release them into either the forebay or tailrace, depending on the location of the recovery operation.

6.2. Juvenile Bypass Systems (JBS). *Guidelines for Dewatering and Fish Handling Plans* (**Appendix F**) and the Dewatering Plans are available online at: http://www.nwd-wc.usace.army.mil/tmt/documents/FPOM/2010/.

6.3. Adult Fish Ladder.

6.3.1. Routine Maintenance.

6.3.1.1. When possible, operate the ladder to be dewatered at orifice flow for at least 24 hours, and up to 96 hours, prior to dewatering. This operation shall not be initiated prior to 1800 hours on November 30 if a ladder outage is scheduled for December 1.

6.3.1.2. Discontinue all fishway auxiliary water supplies at least 24 hours, but no more than 96 hours, prior to dewatering. This operation shall not be initiated until 1800 hours on November 30 if a ladder outage is scheduled for December 1.

6.3.1.3. A project biologist will assure that fish rescue equipment is available and will coordinate to ensure adequate numbers of personnel will be available to move fish out of the dewatered ladder.

6.3.1.4. Project personnel will install head gates to shut down ladder flow. Where possible, a minimum depth of 1" - 2" will be maintained in ladder until fish are rescued.

6.3.1.5. Orifice blocking devices that are placed in the lower-most weirs to prevent fish from re-ascending the dewatered portion of the adult fishway shall have ropes placed on them to be tied to fishway railings. The orifice blocks shall be removed just before the fishway is returned to service. The ropes will help identify and prevent the orifice blocks from being accidentally left in place after fishway water-up. The orifice blocking devices will appear on the pre-water-up checklist maintained by the project biologist.

6.3.2. Non-Routine Maintenance.

6.3.2.1. When possible discontinue fishway auxiliary water and operate the ladder at orifice flow as long as possible (prefer 3-24 hours) prior to dewatering.

6.3.2.2. Follow **6.3.1.3 - 6.3.1.5** above.

6.4. Powerhouse Fish Collection System.

6.4.1. Routine Maintenance.

6.4.1.1. During the pumping or draining operation to dewater a portion or the entire collection channel, the water level will not be allowed to drop to a level which strands fish. Personnel shall remain onsite during pumping operations to ensure stranding does not occur, or a water-level sensor that deactivates the dewatering process will be used.

6.4.1.2. Project Fisheries will directly assist fish rescue operations, provide technical guidance, ensure fish safety and ensure rescue equipment/personnel are available if needed.

6.5. Turbines.

6.5.1. From December 1 through April 30, priority units 1, 3, 11, and 18 will be scheduled for any necessary extended outages. During this time, non-priority units should not be scheduled for routine or extended outages if the outage will delay or conflict with priority unit maintenance.

6.5.2. Turbines which have been idle/out of service will be started by slow rolling the unit after manually tipping turbine blades from flat to steep and back to flat.

6.5.3. Immediately before setting the head gates, remove juvenile fish from the gatewell(s) that will be drained. This is done by use of a special dipping basket. Typically, at least one gatewell is drained to allow ventilation into the draft tube.

6.5.4. When possible place head gates and tail logs immediately after a turbine unit is shut down if the draft tube is to be dewatered. This is necessary for both scheduled and unscheduled outages. Bottom tail logs should be placed first.

6.5.5. If a turbine unit draft tube is to be dewatered and the turbine unit has been idle, it will be operated when possible at full load for a minimum of one hour, four hours preferred. Stop logs will then be placed immediately. It is recommended adjacent units be operated a minimum of one hour, four hours preferred, to flush fish prior to placing tail logs in the unit to be OOS. It is also recommended that units located adjacent to OOS units not be voluntarily taken out of service until the adjacent units return to service.

6.5.6. Water levels in the draft tube will not be allowed to drop to a level that strands fish. Adequate inspections will be conducted to ensure that stranding does not occur.

6.5.7. Fish rescue personnel will inspect dewatered turbine draft tubes, scroll cases, and intakes as soon as water levels reach a depth permitting visual inspection and the hatch cover is opened.

6.5.8. A project biologist and/or alternate Corps fish personnel will provide technical guidance for fish safety and will directly participate in fish salvage.

6.5.9. A project biologist will invite FPOM members to participate in the dewatering, and will assure that rescue equipment is available if needed.

6.5.10. If the unit is planned to be out of service and partially drained for less than 4 days and low numbers of fish are trapped, then it will not be necessary to remove fish from draft tubes as long as an adequate safety pool is maintained. Adequate inspections will be conducted to ensure the safety pool is maintained and fish are in good condition.

7. FOREBAY DEBRIS REMOVAL

Debris can impact fish passage conditions in several ways. It can plug or block trash racks, VBSs, gatewell orifices, dewatering screens, and facility piping, resulting in impingement, injuries, and descaling of fish.

7.1. Debris is removed by operating the PH1 ITS, the B2CC, or passing it through the spillway with a special spill gate operation.

7.2. Special spill operations that don't follow the normal spill schedule or volume limits will be coordinated prior to their execution. Normally, the project shall contact CENWP-OD at least two workdays prior to the day the special operation is required. Using information provided by the project, CENWP-OD will coordinate with FPOM and with RCC, as necessary. Once the coordination is complete, RCC will issue a Teletype detailing the special operations.

8. RESPONSE TO HAZARDOUS MATERIALS SPILLS

Bonneville Project's guidance for responding to hazardous substance spills is contained in its Emergency Spill Response Plan. This guidance will be followed in case of a spill.

8.1. Project Fisheries will be contacted as soon as possible after a hazardous material release and prior to any modification to fishway operations. The project biologist will in turn contact the CENWP-OD biologist and FPOM. Attempts should be made to first contact the project biologist on duty. During fish passage season there is a project biologist on duty seven days a week. If a project biologist cannot be reached by radio or in the office, attempts to contact Project Fisheries will occur in the following order (contact information is available in the Control Room):

1. Ben Hausmann, Supervisory Fishery Biologist
2. Andrew Traylor, Fishery Biologist
3. Ida Royer, Fishery Biologist
4. Bern Klatte, Fisheries Section Supervisor, or Tammy Mackey, Fishery Biologist

9. ENDNOTES

Not applicable to this Project.

Table BON-15. Bonneville Dam Powerhouse One Turbine Units 1-10 Output (MW) and Discharge (cfs) at the Upper and Lower Limits of the 1% of Peak Efficiency Operating Range and at the Best Operating Point for Head Elevations of 35-70 feet. [i]

Head (ft)	Powerhouse One (Units 1-10)					
	Lower 1% Limit		Upper 1% Limit		Best Operating Point [ii]	
	(MW)	(cfs)	(MW)	(cfs)	(MW)	(cfs)
35	18.9	7,203	23.6	9,019	27.3	10,527
36	19.5	7,205	24.3	8,985	28.3	10,564
37	20.1	7,205	25.0	8,951	29.2	10,598
38	20.7	7,204	25.6	8,918	30.2	10,627
39	21.3	7,202	26.3	8,886	31.2	10,654
40	21.9	7,199	26.9	8,854	32.1	10,677
41	22.5	7,201	28.0	8,969	33.2	10,759
42	23.1	7,202	29.1	9,077	34.3	10,837
43	23.6	7,203	30.1	9,180	35.4	10,910
44	24.2	7,203	31.2	9,278	36.5	10,979
45	24.8	7,203	32.3	9,370	37.6	11,045
46	25.4	7,210	33.2	9,416	38.8	11,109
47	26.0	7,217	34.1	9,459	39.9	11,170
48	26.6	7,223	35.0	9,500	41.0	11,227
49	27.3	7,229	36.0	9,539	42.1	11,282
50	27.9	7,234	36.9	9,575	43.2	11,333
51	28.5	7,241	37.8	9,618	44.2	11,356
52	29.1	7,248	38.4	9,577	45.2	11,378
53	29.7	7,254	39.0	9,537	46.2	11,398
54	30.3	7,260	39.7	9,499	47.2	11,418
55	30.9	7,266	41.6	9,768	48.2	11,465
56	31.5	7,269	42.5	9,808	49.2	11,478
57	32.1	7,272	43.4	9,846	50.3	11,518
58	32.7	7,274	44.4	9,883	51.4	11,557
59	33.3	7,277	45.3	9,918	52.4	11,594
60	33.8	7,279	46.3	9,952	53.5	11,630
61	34.5	7,296	46.9	9,930	54.3	11,610
62	35.1	7,311	47.6	9,909	55.1	11,591
63	35.8	7,326	48.3	9,889	56.0	11,572
64	36.5	7,340	49.0	9,868	56.6	11,519
65	37.1	7,354	49.7	9,849		
66	37.6	7,341	50.6	9,876		
67	38.1	7,329	51.4	9,902		
68	38.6	7,317	52.3	9,928		
69	39.0	7,305	53.2	9,954		
70	39.5	7,294	54.1	9,979		

i. Table based on June 2000 data provided by HDC; 2009–removed STS reference; 2013–added "Best Operating Point" columns.

ii. **Best Operating Point** (also referred to as best geometry): when turbine wicket gates and stay vanes align for maximum water discharge at any operating head (i.e., flow entering turbine runner encounters least amount of cross-sectional area of combined wicket gate and stay vane profiles). The best operating point of PH1 turbines is above the existing upper 1% limit and below the cavitation limit. **From April 01–October 31, turbines will operate within 1% limits as a hard constraint, unless otherwise coordinated with the region as a special operation for fish passage.**

Table BON-16. Bonneville Dam Powerhouse Two Turbine Units 11-18 (with and without STSs) Output (MW) and Discharge (cfs) at the Upper and Lower Limits of the 1% of Peak Efficiency Operating Range.

Head (feet)	Powerhouse Two (units 11-18)							
	With STS				Without STS			
	Lower 1% Limit		Upper 1% Limit		Lower 1% Limit		Upper 1% Limit	
	(MW)	(cfs)	(MW)	(cfs)	(MW)	(cfs)	(MW)	(cfs)
35	27.6	11,259	44.3	18,068	28.2	11,444	45.1	18,277
36	28.5	11,271	45.8	18,097	29.2	11,455	46.6	18,306
37	29.4	11,279	47.3	18,121	30.1	11,464	48.1	18,331
38	30.3	11,284	48.8	18,139	31.0	11,470	49.7	18,350
39	31.3	11,287	50.3	18,153	32.0	11,473	51.2	18,364
40	32.2	11,288	51.8	18,162	32.9	11,474	52.7	18,374
41	33.0	11,259	53.3	18,197	33.7	11,445	54.3	18,409
42	33.8	11,230	54.9	18,228	34.6	11,415	55.8	18,441
43	34.6	11,201	56.4	18,255	35.4	11,386	57.4	18,468
44	35.4	11,172	57.9	18,278	36.2	11,357	58.9	18,493
45	36.2	11,144	59.4	18,299	37.0	11,328	60.5	18,514
46	37.0	11,139	61.0	18,366	37.9	11,324	62.1	18,581
47	37.8	11,135	61.9	18,200	38.7	11,319	63.0	18,415
48	38.7	11,129	62.7	18,040	39.6	11,314	63.8	18,255
49	39.5	11,124	63.5	17,887	40.4	11,308	64.7	18,101
50	40.3	11,118	67.5	18,598	41.3	11,303	68.7	18,817
51	41.3	11,154	69.8	18,850	42.2	11,339	71.1	19,072
52	42.3	11,187	72.1	19,091	43.2	11,373	73.4	19,316
53	43.2	11,219	74.5	19,323	44.2	11,405	75.8	19,551
54	44.2	11,249	76.5	19,536	45.2	11,436	76.5	19,431
55	45.2	11,278	76.5	19,115	46.2	11,466	76.5	18,975
56	46.4	11,343	76.5	18,718	47.4	11,531	76.5	18,581
57	47.6	11,404	76.5	18,336	48.6	11,593	76.5	18,202
58	48.8	11,461	76.5	17,967	49.9	11,652	76.5	17,836
59	50.0	11,515	76.5	17,611	51.1	11,707	76.5	17,483
60	51.2	11,567	76.5	17,267	52.3	11,760	76.5	17,142
61	51.8	11,532	76.5	16,978	53.0	11,724	76.5	16,857
62	52.5	11,498	76.5	16,699	53.7	11,690	76.5	16,582
63	53.1	11,466	76.5	16,428	54.3	11,657	76.5	16,315
64	53.7	11,434	76.5	16,166	55.0	11,625	76.5	16,056
65	54.4	11,405	76.5	15,912	55.6	11,595	76.5	15,806
66	55.4	11,448	76.5	15,671	56.7	11,639	76.5	15,570
67	56.5	11,490	76.5	15,437	57.8	11,682	76.5	15,341
68	57.5	11,532	76.5	15,210	58.9	11,724	76.5	15,119
69	58.6	11,571	76.5	14,990	59.9	11,764	76.5	14,903
70	59.6	11,610	76.5	14,775	61.0	11,803	76.5	14,693

* Table based on data provided by HDC, January 2001 (Table BON-16 revised 2006).

Table BON-17 (page 1 of 9). Spill Patterns for Bonneville Dam. (Flow calculations updated in 2007.)

Bonneville Dam Spillway Bay Number																		1 Stop = ½ ft	FB = 74.0 ft
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18		
Spill Gate Vertical Opening (feet)																		# Gate Stops	Total Spill (kcfs)
0.5																	0.5	2	2.3
0.5	0.5																0.5	3	3.4
0.5	0.5															0.5	0.5	4	4.6
0.5	0.5														0.5	0.5	0.5	5	5.7
0.5	0.5		0.5												0.5	0.5	0.5	6	6.9
0.5	0.5		0.5	0.5											0.5	0.5	0.5	7	8.0
0.5	0.5		0.5	0.5									0.5		0.5	0.5	0.5	8	9.2
0.5	0.5		0.5	0.5							0.5		0.5		0.5	0.5	0.5	9	10.3
0.5	0.5		0.5	0.5					0.5		0.5		0.5		0.5	0.5	0.5	10	11.5
0.5	0.5		0.5	0.5			0.5		0.5		0.5		0.5		0.5	0.5	0.5	11	12.6
0.5	0.5	0.5	0.5	0.5			0.5		0.5		0.5		0.5		0.5	0.5	0.5	12	13.8
0.5	0.5	0.5	0.5	0.5			0.5		0.5		0.5		0.5		0.5	1	0.5	13	14.9
0.5	1	0.5	0.5	0.5			0.5		0.5		0.5		0.5		0.5	1	0.5	14	16.0
0.5	1	0.5	0.5	0.5	0.5		0.5		0.5		0.5		0.5		0.5	1	0.5	15	17.2
0.5	1	0.5	0.5	0.5	0.5		0.5		0.5		0.5		0.5	0.5	0.5	1	0.5	16	18.3
0.5	1	0.5	0.5	0.5	0.5	0.5	0.5		0.5		0.5		0.5	0.5	0.5	1	0.5	17	19.5
0.5	1	0.5	0.5	0.5	0.5	0.5	0.5		0.5		0.5	0.5	0.5	0.5	0.5	1	0.5	18	20.6
0.5	1	0.5	0.5	0.5	0.5	0.5	0.5		0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	0.5	19	21.8
0.5	1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	0.5	20	22.9
0.5	1	1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	0.5	21	24.1
0.5	1	1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	1	22	25.2
1	1	1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	1	23	26.3
1	1	1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	1	1	24	27.4
1	1	1	1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	1	1	25	28.6
1	1	1	1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	1	1	1	26	29.7
1	1	1	1	0.5	0.5	0.5	0.5	1	0.5	0.5	0.5	0.5	0.5	1	1	1	1	27	30.8
1	1	1	1	0.5	0.5	1	0.5	1	0.5	0.5	0.5	0.5	0.5	1	1	1	1	28	31.9
1	1	1	1	0.5	0.5	1	0.5	1	0.5	0.5	1	0.5	0.5	1	1	1	1	29	33.1
1	1	1	1	0.5	1	1	0.5	1	0.5	0.5	1	0.5	0.5	1	1	1	1	30	34.2
1	1	1	1	0.5	1	1	0.5	1	0.5	0.5	1	1	0.5	1	1	1	1	31	35.3
1	1	1	1	0.5	1	1	0.5	1	1	0.5	1	1	0.5	1	1	1	1	32	36.4
1	1	1	1	1	1	1	0.5	1	1	0.5	1	1	0.5	1	1	1	1	33	37.6
1	1	1	1	1	1	1	1	1	1	0.5	1	1	0.5	1	1	1	1	34	38.7
1	1	1	1	1	1	1	1	1	1	0.5	1	1	1	1	1	1	1	35	39.8

Bonneville Dam Spillway Bay Number																		1 Stop = ½ ft	FB = 74.0 ft
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18		
Spill Gate Vertical Opening (feet)																		# Gate Stops	Total Spill (kcfs)
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	36	40.9
1	1.5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	37	42.0
1	1.5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1.5	1	38	43.2
1	1.5	1	1	1	1	1	1	1	1	1	1	1	1	1	1.5	1.5	1	39	44.3
1	1.5	1.5	1	1	1	1	1	1	1	1	1	1	1	1	1.5	1.5	1	40	45.4
1.5	1.5	1.5	1	1	1	1	1	1	1	1	1	1	1	1	1.5	1.5	1	41	46.5
1.5	1.5	1.5	1	1	1	1	1	1	1	1	1	1	1	1	1.5	1.5	1.5	42	47.6
1.5	1.5	1.5	1	1	1	1	1	1	1	1	1	1	1	1	1.5	2	1.5	43	48.6
2	2	2	0	2	0	0	2	0	2	0	0	2	2	0	2	2	2	44	49
2	2	2	0	2	0	0	2	0	2	0	0	2	2	0	2	2.5	2	45	50
2	2.5	2	0	2	0	0	2	0	2	0	0	2	2	0	2	2.5	2	46	52
2	2.5	2	0	2	0	0	2	0	2	0	0	2	2	0	2.5	2.5	2	47	53
2	2	2	0	2	0	2	2	0	2	0	0	2	2	0	2	2	2	48	54
2	2	2	0	2	0	2	2	0	2	0	0	2	2	0	2	2.5	2	49	55
2	2.5	2	0	2	0	2	2	0	2	0	0	2	2	0	2	2.5	2	50	56
2	2.5	2	0	2	0	2	2	0	2	0	0	2	2	0	2.5	2.5	2	51	57
2	2	2	0	2	0	2	2	0	2	2	0	2	2	0	2	2	2	52	58
2	2	2	0	2	0	2	2	0	2	2	0	2	2	0	2	2.5	2	53	59
2	2.5	2	0	2	0	2	2	0	2	2	0	2	2	0	2	2.5	2	54	61
2	2.5	2	0	2	0	2	2	0	2	2	0	2	2	0	2.5	2.5	2	55	62
2	2	2	2	2	0	2	2	0	2	2	0	2	2	0	2	2	2	56	63
2	2	2	2	2	0	2	2	0	2	2	0	2	2	0	2	2.5	2	57	64
2	2.5	2	2	2	0	2	2	0	2	2	0	2	2	0	2	2.5	2	58	65
2	2.5	2	2	2	0	2	2	0	2	2	0	2	2	0	2.5	2.5	2	59	66
2	2	2	2	2	0	2	2	0	2	2	0	2	2	2	2	2	2	60	67
2	2	2	2	2	0	2	2	0	2	2	0	2	2	2	2	2.5	2	61	68
2	2.5	2	2	2	0	2	2	0	2	2	0	2	2	2	2	2.5	2	62	70
2	2.5	2	2	2	0	2	2	0	2	2	0	2	2	2	2.5	2.5	2	63	71
2	2	2	2	2	2	2	2	0	2	2	0	2	2	2	2	2	2	64	72
2	2	2	2	2	2	2	2	0	2	2	0	2	2	2	2	2.5	2	65	73
2	2.5	2	2	2	2	2	2	0	2	2	0	2	2	2	2	2.5	2	66	74
2	2.5	2	2	2	2	2	2	0	2	2	0	2	2	2	2.5	2.5	2	67	75
2	2	2	2	2	2	2	2	0	2	2	2	2	2	2	2	2	2	68	76
2	2	2	2	2	2	2	2	0	2	2	2	2	2	2	2	2.5	2	69	77
2	2.5	2	2	2	2	2	2	0	2	2	2	2	2	2	2	2.5	2	70	78

Bonneville Dam Spillway Bay Number																		1 Stop = ½ ft	FB = 74.0 ft
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18		
Spill Gate Vertical Opening (feet)																		# Gate Stops	Total Spill (kcfs)
2	2.5	2	2	2	2	2	2	0	2	2	2	2	2	2	2.5	2.5	2	71	80
2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	72	81
2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2.5	2	73	82
2	2.5	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2.5	2	74	83
2	2.5	2	2	2	2	2	2	2	2	2	2	2	2	2	2.5	2.5	2	75	84
2	2.5	2.5	2	2	2	2	2	2	2	2	2	2	2	2	2.5	2.5	2	76	85
2	2.5	2.5	2	2	2	2	2	2	2	2	2	2	2	2	2.5	2.5	2.5	77	86
2.5	2.5	2.5	2	2	2	2	2	2	2	2	2	2	2	2	2.5	2.5	2.5	78	87
2.5	2.5	2.5	2	2	2	2	2	2	2	2	2	2	2	2	2.5	3	2.5	79	88
2.5	3	2.5	2	2	2	2	2	2	2	2	2	2	2	2	2.5	3	2.5	80	89
2.5	3	2.5	2	2	2	2	2	2	2	2	2	2	2	2	2.5	3	3	81	90
3	3	2.5	2	2	2	2	2	2	2	2	2	2	2	2	2.5	3	3	82	91
3	3	2.5	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	83	92
3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	84	94
3	3	3	2	2	2	2	2	2	2	2	2	2	2	2.5	3	3	3	85	95
3	3	3	2.5	2	2	2	2	2	2	2	2	2	2	2.5	3	3	3	86	96
3	3	3	2.5	2	2	2	2	2	2	2	2	2	2.5	2.5	3	3	3	87	97
3	3	3	2.5	2.5	2	2	2	2	2	2	2	2	2.5	2.5	3	3	3	88	98
3	3	3	2.5	2.5	2	2	2	2	2	2	2.5	2	2.5	2.5	3	3	3	89	99
3	3	3	2.5	2.5	2	2	2	2.5	2	2	2.5	2	2.5	2.5	3	3	3	90	100
3	3	3	2.5	2.5	2.5	2	2	2.5	2	2	2.5	2	2.5	2.5	3	3	3	91	101
3	3	3	2.5	2.5	2.5	2.5	2.5	2	2	2	2.5	2.5	2.5	2.5	3	3	3	93	103
3	3	3	2.5	3	2.5	2.5	2.5	2	2	2	2.5	2.5	2.5	3	3	3	3	95	105
3	3	3	3	3	2.5	2.5	2.5	2	2	2	2.5	2.5	2.5	3	3.5	3	3	97	107
3	3.5	3	3	3	2.5	2.5	2.5	2	2.5	2	2.5	2.5	2.5	3	3.5	3.5	3	100	110
3	3.5	3.5	3	3	2.5	2.5	2.5	2	2.5	2	2.5	2.5	2.5	3	3.5	3.5	3	101	110.5
3	3.5	3.5	3	3	2.5	2.5	2.5	2	2.5	2.5	2.5	2.5	2.5	3	3.5	3.5	3	102	111.6
3	3.5	3.5	3	3	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	3	3.5	3.5	3	103	112.6
3	3.5	3.5	3	3	3	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	3	3.5	3.5	3	104	113.7
3	3.5	3.5	3	3	3	3	2.5	2.5	2.5	2.5	2.5	2.5	2.5	3	3.5	3.5	3	105	114.7
3	3.5	3.5	3	3	3	3	2.5	2.5	2.5	2.5	2.5	2.5	2.5	3	3.5	3.5	3.5	106	115.7
3	3.5	3.5	3	3	3	3	2.5	2.5	2.5	2.5	2.5	2.5	2.5	3	3.5	4	3.5	107	116.7
3	3.5	3.5	3	3	3	3	3	2.5	2.5	2.5	2.5	2.5	2.5	3	3.5	4	3.5	108	117.8
3	3.5	3.5	3	3	3	3	3	2.5	2.5	2.5	2.5	2.5	3	3	3.5	4	3.5	109	118.8

Bonneville Dam Spillway Bay Number																		1 Stop = ½ ft	FB = 74.0 ft
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18		
Spill Gate Vertical Opening (feet)																		# Gate Stops	Total Spill (kcfs)
3	3.5	3.5	3	3	3	3	3	2.5	2.5	2.5	2.5	3	3	3	3.5	4	3.5	110	119.8
3	3.5	3.5	3	3	3	3	3	2.5	2.5	3	2.5	3	3	3	3.5	4	3.5	111	120.9
3	3.5	3.5	3	3	3	3	3	2.5	2.5	3	3	3	3	3	3.5	4	3.5	112	121.9
3.5	3.5	3.5	3	3	3	3	3	2.5	2.5	3	3	3	3	3	3.5	4	3.5	113	122.9
3.5	3.5	3.5	3.5	3	3	3	3	2.5	2.5	3	3	3	3	3	3.5	4	3.5	114	124.0
3.5	3.5	3.5	3.5	3	3	3	3	2.5	2.5	3	3	3	3	3	3.5	4	4	115	124.9
3.5	3.5	3.5	3.5	3	3	3	3	2.5	2.5	3	3	3	3	3.5	3.5	4	4	116	126.0
3.5	3.5	3.5	3.5	3	3	3	3	2.5	2.5	3	3	3	3	3.5	4	4	4	117	127.0
3.5	3.5	3.5	3.5	3	3	3	3	2.5	3	3	3	3	3	3.5	4	4	4	118	128.0
3.5	3.5	3.5	3.5	3	3	3	3	3	3	3	3	3	3	3.5	4	4	4	119	129.0
3.5	4	3.5	3.5	3	3	3	3	3	3	3	3	3	3	3.5	4	4	4	120	130.0
3.5	4	4	3.5	3	3	3	3	3	3	3	3	3	3	3.5	4	4	4	121	131.0
4	4	4	3.5	3	3	3	3	3	3	3	3	3	3	3.5	4	4	4	122	132.0
4	4	4	4	3	3	3	3	3	3	3	3	3	3	3.5	4	4	4	123	133.0
4	4	4	4	3	3	3	3	3	3	3	3	3	3	4	4	4	4	124	134.0
4	4	4	4	3	3.5	3	3	3	3	3	3	3	3	4	4	4	4	125	135.0
4	4	4	4	3.5	3.5	3	3	3	3	3	3	3	3	4	4	4	4	126	136.1
4	4	4	4	3.5	3.5	3	3	3	3	3	3	3.5	3	4	4	4	4	127	137.1
4	4	4	4	3.5	3.5	3	3	3	3	3	3	3.5	3.5	4	4	4	4	128	138.1
4	4	4	4	3.5	3.5	3	3	3	3	3	3	3.5	3.5	4	4	4.5	4	129	139.1
4	4	4	4	3.5	3.5	3.5	3	3	3	3	3	3.5	3.5	4	4	4.5	4	130	140.1
4	4	4	4	3.5	3.5	3.5	3	3	3	3	3.5	3.5	3.5	4	4	4.5	4	131	141.1
4	4	4	4	3.5	3.5	3.5	3	3	3	3	3.5	3.5	3.5	4	4.5	4.5	4	132	142.1
4	4.5	4	4	3.5	3.5	3.5	3	3	3	3	3.5	3.5	3.5	4	4.5	4.5	4	133	143.1
4	4.5	4.5	4	3.5	3.5	3.5	3	3	3	3	3.5	3.5	3.5	4	4.5	4.5	4	134	144.0
4	4.5	4.5	4	3.5	3.5	3.5	3	3	3.5	3	3.5	3.5	3.5	4	4.5	4.5	4	135	145.1
4	4.5	4.5	4	3.5	3.5	3.5	3.5	3	3.5	3	3.5	3.5	3.5	4	4.5	4.5	4	136	146.1
4	4.5	4.5	4	3.5	3.5	3.5	3.5	3	3.5	3.5	3.5	3.5	3.5	4	4.5	4.5	4	137	147.1
4	4.5	4.5	4	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	4	4.5	4.5	4	138	148.1
4	4.5	4.5	4	4	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	4	4.5	4.5	4	139	149.1
4	4.5	4.5	4	4	4	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	4	4.5	4.5	4	140	150.1
4	4.5	4.5	4	4	4	3.5	3.5	3.5	3.5	3.5	3.5	3.5	4	4	4.5	4.5	4	141	151.1
4	4.5	4.5	4	4	4	4	3.5	3.5	3.5	3.5	3.5	3.5	4	4	4.5	4.5	4	142	152.1
4	4.5	4.5	4	4	4	4	3.5	3.5	3.5	3.5	3.5	4	4	4	4.5	4.5	4	143	153.1

Bonneville Dam Spillway Bay Number																		1 Stop = ½ ft	FB = 74.0 ft
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18		
Spill Gate Vertical Opening (feet)																		# Gate Stops	Total Spill (kcfs)
4	4.5	4.5	4	4	4	4	3.5	3.5	3.5	3.5	4	4	4	4	4.5	4.5	4	144	154.1
4	4.5	4.5	4	4	4	4	4	3.5	3.5	3.5	4	4	4	4	4.5	4.5	4	145	155.1
4	4.5	4.5	4	4	4	4	4	3.5	3.5	4	4	4	4	4	4.5	4.5	4	146	156.1
4	4.5	4.5	4	4	4	4	4	4	3.5	4	4	4	4	4	4.5	4.5	4	147	157.1
4	4.5	4.5	4	4	4	4	4	4	4	4	4	4	4	4	4.5	4.5	4	148	158.1
4	4.5	4.5	4.5	4	4	4	4	4	4	4	4	4	4	4	4.5	4.5	4	149	159.1
4	4.5	4.5	4.5	4	4	4	4	4	4	4	4	4	4	4.5	4.5	4.5	4	150	160.0
4	4.5	4.5	4.5	4.5	4	4	4	4	4	4	4	4	4	4.5	4.5	4.5	4	151	161.0
4	4.5	4.5	4.5	4.5	4	4	4	4	4	4	4	4	4.5	4.5	4.5	4.5	4	152	162.0
4	4.5	4.5	4.5	4.5	4.5	4	4	4	4	4	4	4	4.5	4.5	4.5	4.5	4	153	163.0
4	4.5	4.5	4.5	4.5	4.5	4	4	4	4	4	4	4.5	4.5	4.5	4.5	4.5	4	154	163.9
4	4.5	4.5	4.5	4.5	4.5	4	4	4	4	4	4	4.5	4.5	4.5	4.5	5	4	155	164.9
4	5	4.5	4.5	4.5	4.5	4	4	4	4	4	4	4.5	4.5	4.5	4.5	5	4	156	165.9
4	5	4.5	4.5	4.5	4.5	4	4	4	4	4	4.5	4.5	4.5	4.5	4.5	5	4	157	166.8
4	5	4.5	4.5	4.5	4.5	4.5	4	4	4	4	4.5	4.5	4.5	4.5	4.5	5	4	158	167.8
4	5	4.5	4.5	4.5	4.5	4.5	4	4	4	4	4.5	4.5	4.5	4.5	5	5	4	159	168.8
4	5	4.5	4.5	4.5	4.5	4.5	4	4	4	4.5	4.5	4.5	4.5	4.5	5	5	4	160	169.8
4	5	5	4.5	4.5	4.5	4.5	4	4	4	4.5	4.5	4.5	4.5	4.5	5	5	4	161	170.7
4	5	5	4.5	4.5	4.5	4.5	4	4	4	4.5	4.5	4.5	4.5	5	5	5	4	162	171.7
4	5	5	5	4.5	4.5	4.5	4	4	4	4.5	4.5	4.5	4.5	5	5	5	4	163	172.6
4	5	5	5	4.5	4.5	4.5	4	4.5	4	4.5	4.5	4.5	4.5	5	5	5	4	164	173.6
4	5	5	5	4.5	4.5	4.5	4	4.5	4	4.5	4.5	4.5	5	5	5	5	4	165	174.6
4	5	5	5	4.5	4.5	4.5	4.5	4.5	4	4.5	4.5	4.5	5	5	5	5	4	166	175.6
4	5	5	5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	5	5	5	5	4	167	176.5
4	5	5	5	4.5	5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	5	5	5	5	4	168	177.5
4	5	5	5	4.5	5	4.5	4.5	4.5	4.5	4.5	5	4.5	5	5	5	5	4	169	178.5
4	5	5	5	4.5	5	4.5	4.5	4.5	4.5	4.5	5	5	5	5	5	5	4	170	179.4
4	5	5	5	5	5	4.5	4.5	4.5	4.5	4.5	5	5	5	5	5	5	4	171	180.4
4	5	5	5	5	5	4.5	5	4.5	4.5	4.5	5	5	5	5	5	5	4	172	181.3
4	5	5	5	5	5	4.5	5	4.5	5	4.5	5	5	5	5	5	5	4	173	182.3
4	5	5	5	5	5	4.5	5	5	5	4.5	5	5	5	5	5	5	4	174	183.3
4	5	5	5	5	5	5	5	5	5	4.5	5	5	5	5	5	5	4	175	184.2
4	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	4	176	185.2
4	5.5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	4	177	186.1

Bonneville Dam Spillway Bay Number																		1 Stop = ½ ft	FB = 74.0 ft
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18		
Spill Gate Vertical Opening (feet)																		# Gate Stops	Total Spill (kcfs)
4	5.5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5.5	4	178	187.1
4	5.5	5	5	5	5	5	5	5	5	5	5	5	5	5	5.5	5.5	4	179	188.0
4	5.5	5.5	5	5	5	5	5	5	5	5	5	5	5	5	5.5	5.5	4	180	189.0
4	5.5	5.5	5	5.5	5	5	5	5	5	5	5	5	5	5	5.5	5.5	4	181	189.9
4	5.5	5.5	5	5.5	5	5	5	5	5	5	5	5	5	5.5	5.5	5.5	4	182	190.8
4	5.5	5.5	5.5	5.5	5	5	5	5	5	5	5	5	5	5.5	5.5	5.5	4	183	191.8
4	5.5	5.5	5.5	5.5	5	5	5	5	5.5	5	5	5	5	5.5	5.5	5.5	4	184	192.7
4	5.5	5.5	5.5	5.5	5	5	5.5	5	5.5	5	5	5	5	5.5	5.5	5.5	4	185	193.7
4	5.5	5.5	5.5	5.5	5	5	5.5	5	5.5	5	5	5.5	5	5.5	5.5	5.5	4	186	194.6
4	5.5	5.5	5.5	5.5	5	5	5.5	5.5	5.5	5	5	5.5	5	5.5	5.5	5.5	4	187	195.6
4	5.5	5.5	5.5	5.5	5.5	5	5.5	5.5	5.5	5	5	5.5	5	5.5	5.5	5.5	4	188	196.5
4	5.5	5.5	5.5	5.5	5.5	5	5.5	5.5	5.5	5	5.5	5.5	5	5.5	5.5	5.5	4	189	197.5
4	5.5	5.5	5.5	5.5	5.5	5	5.5	5.5	5.5	5	5.5	5.5	5.5	5.5	5.5	5.5	4	190	198.4
4	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5	5.5	5.5	5.5	5.5	5.5	5.5	4	191	199.3
4	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	4	192	200.3
4	5.5	5.5	5.5	6	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	4	193	201.2
4	5.5	5.5	5.5	6	5.5	5.5	5.5	5.5	5.5	5.5	5.5	6	5.5	5.5	5.5	5.5	4	194	202.1
4	5.5	5.5	5.5	6	5.5	5.5	5.5	5.5	5.5	5.5	6	6	5.5	5.5	5.5	5.5	4	195	203.1
4	5.5	5.5	5.5	6	6	5.5	5.5	5.5	5.5	5.5	6	6	5.5	5.5	5.5	5.5	4	196	204.0
4	5.5	5.5	5.5	6	6	5.5	6	5.5	5.5	5.5	6	6	5.5	5.5	5.5	5.5	4	197	204.9
4	5.5	5.5	5.5	6	6	5.5	6	5.5	6	5.5	6	6	5.5	5.5	5.5	5.5	4	198	205.9
4	6	5.5	5.5	6	6	5.5	6	5.5	6	5.5	6	6	5.5	5.5	5.5	5.5	4	199	206.8
4	6	5.5	5.5	6	6	5.5	6	5.5	6	5.5	6	6	5.5	5.5	5.5	6	4	200	207.7
4	6	5.5	5.5	6	6	5.5	6	5.5	6	5.5	6	6	5.5	5.5	6	6	4	201	208.6
4	6	6	5.5	6	6	5.5	6	5.5	6	5.5	6	6	5.5	5.5	6	6	4	202	209.6
4	6	6	5.5	6	6	5.5	6	5.5	6	5.5	6	6	6	5.5	6	6	4	203	210.5
4	6	6	5.5	6	6	5.5	6	5.5	6	5.5	6	6	6	5.5	6	6	4.5	204	211.5
4.5	6	6	5.5	6	6	5.5	6	5.5	6	5.5	6	6	6	5.5	6	6	4.5	205	212.4
4.5	6	6	6	6	6	5.5	6	5.5	6	5.5	6	6	6	5.5	6	6	4.5	206	213.4
4.5	6	6	6	6	6	5.5	6	5.5	6	5.5	6	6	6	6	6	6	4.5	207	214.3
4.5	6	6	6	6	6	5.5	6	6	6	5.5	6	6	6	6	6	6	4.5	208	215.2
4.5	6	6	6	6	6	6	6	6	6	5.5	6	6	6	6	6	6	4.5	209	216.2
4.5	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	4.5	210	217.1
4.5	6	6	6	6.5	6	6	6	6	6	6	6	6	6	6	6	6	4.5	211	218.0

Bonneville Dam Spillway Bay Number																		1 Stop = ½ ft	FB = 74.0 ft
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18		
Spill Gate Vertical Opening (feet)																		# Gate Stops	Total Spill (kcfs)
4.5	6	6	6	6.5	6	6	6	6	6	6	6	6.5	6	6	6	6	4.5	212	218.9
4.5	6	6	6	6.5	6	6	6	6	6	6	6.5	6.5	6	6	6	6	4.5	213	219.8
4.5	6	6	6	6.5	6.5	6	6	6	6	6	6.5	6.5	6	6	6	6	4.5	214	220.7
4.5	6	6	6	6.5	6.5	6	6.5	6	6	6	6.5	6.5	6	6	6	6	4.5	215	221.6
4.5	6	6	6	6.5	6.5	6	6.5	6	6	6	6.5	6.5	6	6	6	6.5	4.5	216	222.6
4.5	6.5	6	6	6.5	6.5	6	6.5	6	6	6	6.5	6.5	6	6	6	6.5	4.5	217	223.5
4.5	6.5	6	6	6.5	6.5	6	6.5	6	6	6	6.5	6.5	6	6	6.5	6.5	4.5	218	224.4
4.5	6.5	6.5	6	6.5	6.5	6	6.5	6	6	6	6.5	6.5	6	6	6.5	6.5	4.5	219	225.3
4.5	6.5	6.5	6	6.5	6.5	6	6.5	6	6.5	6	6.5	6.5	6	6	6.5	6.5	4.5	220	226.2
4.5	6.5	6.5	6	6.5	6.5	6	6.5	6	6.5	6	6.5	6.5	6	6.5	6.5	6.5	4.5	221	227.1
4.5	6.5	6.5	6.5	6.5	6.5	6	6.5	6	6.5	6	6.5	6.5	6	6.5	6.5	6.5	4.5	222	228.0
4.5	6.5	6.5	6.5	6.5	6.5	6	6.5	6	6.5	6	6.5	6.5	6.5	6.5	6.5	6.5	4.5	223	228.9
4.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6	6.5	6	6.5	6.5	6.5	6.5	6.5	6.5	4.5	224	229.9
4.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	4.5	225	230.8
4.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	4.5	226	231.7
4.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	5	227	232.6
5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	5	228	233.6
5	6.5	6.5	6.5	7	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	5	229	234.5
5	6.5	6.5	6.5	7	6.5	6.5	6.5	6.5	6.5	6.5	6.5	7	6.5	6.5	6.5	6.5	5	230	235.4
5	6.5	6.5	6.5	7	6.5	6.5	6.5	6.5	6.5	6.5	7	7	6.5	6.5	6.5	6.5	5	231	236.3
5	6.5	6.5	6.5	7	7	6.5	6.5	6.5	6.5	6.5	7	7	6.5	6.5	6.5	6.5	5	232	237.2
5	6.5	6.5	6.5	7	7	6.5	7	6.5	6.5	6.5	7	7	6.5	6.5	6.5	6.5	5	233	238.1
5	6.5	6.5	6.5	7	7	6.5	7	6.5	6.5	6.5	7	7	6.5	6.5	6.5	7	5	234	239.0
5	7	6.5	6.5	7	7	6.5	7	6.5	6.5	6.5	7	7	6.5	6.5	6.5	7	5	235	239.9
5	7	6.5	6.5	7	7	6.5	7	6.5	6.5	6.5	7	7	6.5	6.5	7	7	5	236	240.8
5	7	7	6.5	7	7	6.5	7	6.5	6.5	6.5	7	7	6.5	6.5	7	7	5	237	241.7
5	7	7	6.5	7	7	6.5	7	6.5	7	6.5	7	7	6.5	6.5	7	7	5	238	242.6
5	7	7	6.5	7	7	6.5	7	6.5	7	6.5	7	7	6.5	7	7	7	5	239	243.5
5	7	7	7	7	7	6.5	7	6.5	7	6.5	7	7	6.5	7	7	7	5	240	244.4
5	7	7	7	7	7	6.5	7	6.5	7	6.5	7	7	7	7	7	7	5	241	245.3
5	7	7	7	7	7	7	7	6.5	7	6.5	7	7	7	7	7	7	5	242	246.2
5	7	7	7	7	7	7	7	6.5	7	7	7	7	7	7	7	7	5	243	247.1
5	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	5	244	248.0
5	7	7	7	7.5	7	7	7	7	7	7	7	7	7	7	7	7	5	245	248.8

Bonneville Dam Spillway Bay Number																		1 Stop = ½ ft	FB = 74.0 ft
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18		
Spill Gate Vertical Opening (feet)																		# Gate Stops	Total Spill (kcfs)
5	7	7	7	7.5	7	7	7	7	7	7	7	7.5	7	7	7	7	5	246	249.7
5	7	7	7	7.5	7	7	7	7	7	7	7.5	7.5	7	7	7	7	5	247	250.6
5	7	7	7	7.5	7.5	7	7	7	7	7	7.5	7.5	7	7	7	7	5	248	251.5
5	7	7	7	7.5	7.5	7	7.5	7	7	7	7.5	7.5	7	7	7	7	5	249	252.4
5	7	7	7	7.5	7.5	7	7.5	7	7	7	7.5	7.5	7	7	7.5	7	5	250	253.3
5	7	7.5	7	7.5	7.5	7	7.5	7	7	7	7.5	7.5	7	7	7.5	7	5	251	254.1
5	7	7.5	7	7.5	7.5	7	7.5	7	7.5	7	7.5	7.5	7	7	7.5	7	5	252	255.0
5	7	7.5	7	7.5	7.5	7	7.5	7	7.5	7	7.5	7.5	7	7.5	7.5	7	5	253	255.9
5	7	7.5	7.5	7.5	7.5	7	7.5	7	7.5	7	7.5	7.5	7	7.5	7.5	7	5	254	256.8
5	7	7.5	7.5	7.5	7.5	7	7.5	7	7.5	7	7.5	7.5	7.5	7.5	7.5	7	5	255	257.7
5	7	7.5	7.5	7.5	7.5	7.5	7.5	7	7.5	7	7.5	7.5	7.5	7.5	7.5	7	5	256	258.6
5	7	7.5	7.5	7.5	7.5	7.5	7.5	7	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7	5	257	259.5
5	7	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7	5	258	260.3
5	7	7.5	7.5	8	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7	5	259	261.2
5	7	7.5	7.5	8	7.5	7.5	7.5	7.5	7.5	7.5	7.5	8	7.5	7.5	7.5	7	5	260	262.1
5	7	7.5	7.5	8	7.5	7.5	7.5	7.5	7.5	7.5	8	8	7.5	7.5	7.5	7	5	261	262.9
5	7	7.5	7.5	8	8	7.5	7.5	7.5	7.5	7.5	8	8	7.5	7.5	7.5	7	5	262	263.8
5	7	7.5	7.5	8	8	7.5	8	7.5	7.5	7.5	8	8	7.5	7.5	7.5	7	5	263	264.7
5	7	7.5	7.5	8	8	7.5	8	7.5	7.5	7.5	8	8	7.5	7.5	7.5	7.5	5	264	265.6
5	7.5	7.5	7.5	8	8	7.5	8	7.5	7.5	7.5	8	8	7.5	7.5	7.5	7.5	5	265	266.5
5	7.5	7.5	7.5	8	8	7.5	8	7.5	7.5	7.5	8	8	7.5	7.5	8	7.5	5	266	267.3
5	7.5	8	7.5	8	8	7.5	8	7.5	7.5	7.5	8	8	7.5	7.5	8	7.5	5	267	268.2
5	7.5	8	7.5	8	8	7.5	8	7.5	8	7.5	8	8	7.5	7.5	8	7.5	5	268	269.1
5	7.5	8	7.5	8	8	7.5	8	7.5	8	7.5	8	8	7.5	8	8	7.5	5	269	269.9
5	7.5	8	8	8	8	7.5	8	7.5	8	7.5	8	8	7.5	8	8	7.5	5	270	270.8
5	7.5	8	8	8	8	7.5	8	7.5	8	7.5	8	8	8	8	8	7.5	5	271	271.7
5	7.5	8	8	8	8	8	8	7.5	8	7.5	8	8	8	8	8	7.5	5	272	272.5
5	7.5	8	8	8	8	8	8	7.5	8	8	8	8	8	8	8	7.5	5	273	273.4
5	7.5	8	8	8	8	8	8	8	8	8	8	8	8	8	8	7.5	5	274	274.3
5	7.5	8	8	8.5	8	8	8	8	8	8	8	8	8	8	8	7.5	5	275	275.1
5	7.5	8	8	8.5	8	8	8	8	8	8	8	8.5	8	8	8	7.5	5	276	276.0
5	7.5	8	8	8.5	8	8	8	8	8	8	8.5	8.5	8	8	8	7.5	5	277	276.9
5	7.5	8	8	8.5	8.5	8	8	8	8	8	8.5	8.5	8	8	8	7.5	5	278	277.7
5	7.5	8	8	8.5	8.5	8	8.5	8	8	8	8.5	8.5	8	8	8	7.5	5	279	278.6

Bonneville Dam Spillway Bay Number																		1 Stop = ½ ft	FB = 74.0 ft
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18		
Spill Gate Vertical Opening (feet)																		# Gate Stops	Total Spill (kcfs)
5	7.5	8	8	8.5	8.5	8	8.5	8	8	8	8.5	8.5	8	8	8	8	5	280	279.5
5	8	8	8	8.5	8.5	8	8.5	8	8	8	8.5	8.5	8	8	8	8	5	281	280.3
5	8	8	8	8.5	8.5	8	8.5	8	8	8	8.5	8.5	8	8	8.5	8	5	282	281.2
5	8	8.5	8	8.5	8.5	8	8.5	8	8	8	8.5	8.5	8	8	8.5	8	5	283	282.0
5	8	8.5	8	8.5	8.5	8	8.5	8	8.5	8	8.5	8.5	8	8	8.5	8	5	284	282.9
5	8	8.5	8	8.5	8.5	8	8.5	8	8.5	8	8.5	8.5	8	8.5	8.5	8	5	285	283.8
5	8	8.5	8.5	8.5	8.5	8	8.5	8	8.5	8	8.5	8.5	8	8.5	8.5	8	5	286	284.6
5	8	8.5	8.5	8.5	8.5	8	8.5	8	8.5	8	8.5	8.5	8.5	8.5	8.5	8	5	287	285.5
5	8	8.5	8.5	8.5	8.5	8.5	8.5	8	8.5	8	8.5	8.5	8.5	8.5	8.5	8	5	288	286.3
5	8	8.5	8.5	8.5	8.5	8.5	8.5	8	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8	5	289	287.2
5	8	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8	5	290	288.1
5	8	8.5	8.5	9	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8	5	291	288.9
5	8	8.5	8.5	9	8.5	8.5	8.5	8.5	8.5	8.5	8.5	9	8.5	8.5	8.5	8	5	292	289.7
5	8	8.5	8.5	9	8.5	8.5	8.5	8.5	8.5	8.5	9	9	8.5	8.5	8.5	8	5	293	290.6
5	8	8.5	8.5	9	9	8.5	8.5	8.5	8.5	8.5	9	9	8.5	8.5	8.5	8	5	294	291.4
5	8	8.5	8.5	9	9	8.5	9	8.5	8.5	8.5	9	9	8.5	8.5	8.5	8	5	295	292.3
5	8	8.5	8.5	9	9	8.5	9	8.5	8.5	8.5	9	9	8.5	8.5	8.5	8.5	5	296	293.1
5	8	8.5	8.5	9	9	8.5	9	8.5	8.5	8.5	9	9	8.5	8.5	9	8.5	5	297	294.0
5	8	9	8.5	9	9	8.5	9	8.5	8.5	8.5	9	9	8.5	8.5	9	8.5	5	298	294.8
5	8	9	8.5	9	9	8.5	9	8.5	9	8.5	9	9	8.5	8.5	9	8.5	5	299	295.7
5	8	9	8.5	9	9	8.5	9	8.5	9	8.5	9	9	8.5	9	9	8.5	5	300	296.5