3/10/14 –Table BON-17 revised format;
5/8/14 - Section 5.2.1 revised per change form 14BON001;
5/21/14 –Table BON-16 corrected data typo at 70' head w/ no STS

2014 Fish Passage Plan

Section 2 – Bonneville Dam

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Bonneville Dam

River Mile (RM)	Columbia River – RM 146.1
Reservoir	Lake Bonneville
Minimum Instantaneous Flow (kcfs)	80 kcfs
Forebay Normal Operating Range (ft)	71.5’ – 76.5’
Tailrace Rate of Change Limit (ft)	Apr-Sep: 1.5’/hr, 4’/day Oct-Mar: 3’/hr, 7’/day
Powerhouse Length (ft)	PH1: 1,027’ PH2: 986’
Powerhouse Hydraulic Capacity (kcfs)	PH1: 136 kcfs PH2: 152 kcfs
Turbine Units (#)	PH1: 10 Main Units (1-10 S. Morgan Smith Kaplan) PH2: 8 Main Units (11-18 Allis-Chalmers Kaplan) + 2 Fish Units (Sulzer/Escher-Wyss Kaplan)
Turbine Generating Capacity (MW)	Rated: 1,093 MW (PH1: 535 MW + PH2: 558 MW) Maximum: 1,238 MW (PH1: 600 MW + PH2: 638 MW)
Gatewell Orifice Diameter (in)	12.5” orifices – 2/gatewell at Units 11-14 and F2; 1/gatewell at Units 15-18 and F1
Spillway Length (ft)	1,450’
Spillway Hydraulic Capacity (kcfs)	1,600 kcfs
Spillbays (#)	18
Spillway Weirs (#)	0
Navigation Lock Length x Width (ft)	675’ x 86’
Navigation Lock Max. Lift (ft)	70’

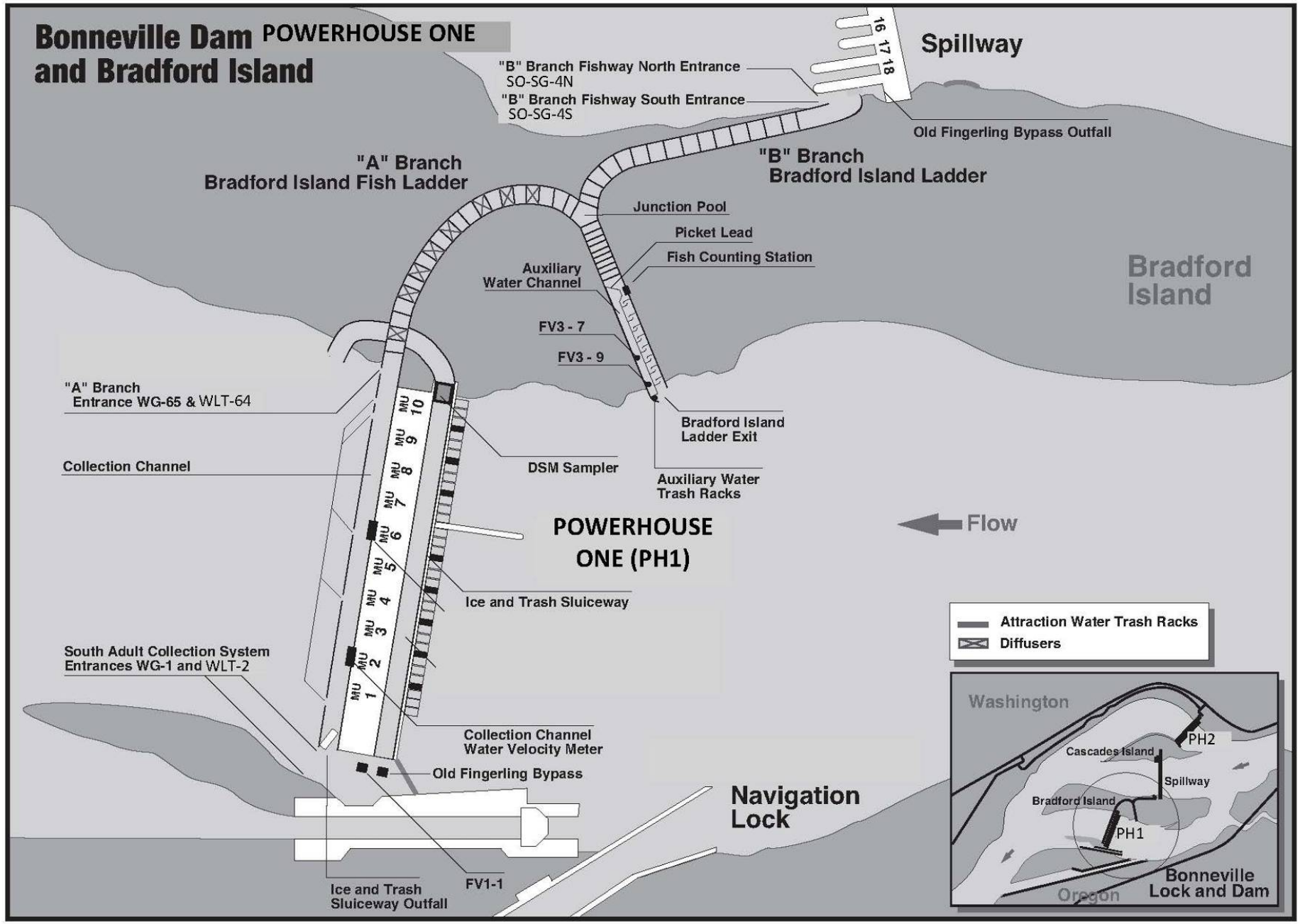


Figure BON-1. Bonneville Dam Powerhouse One and Bradford Island Fish Ladder.

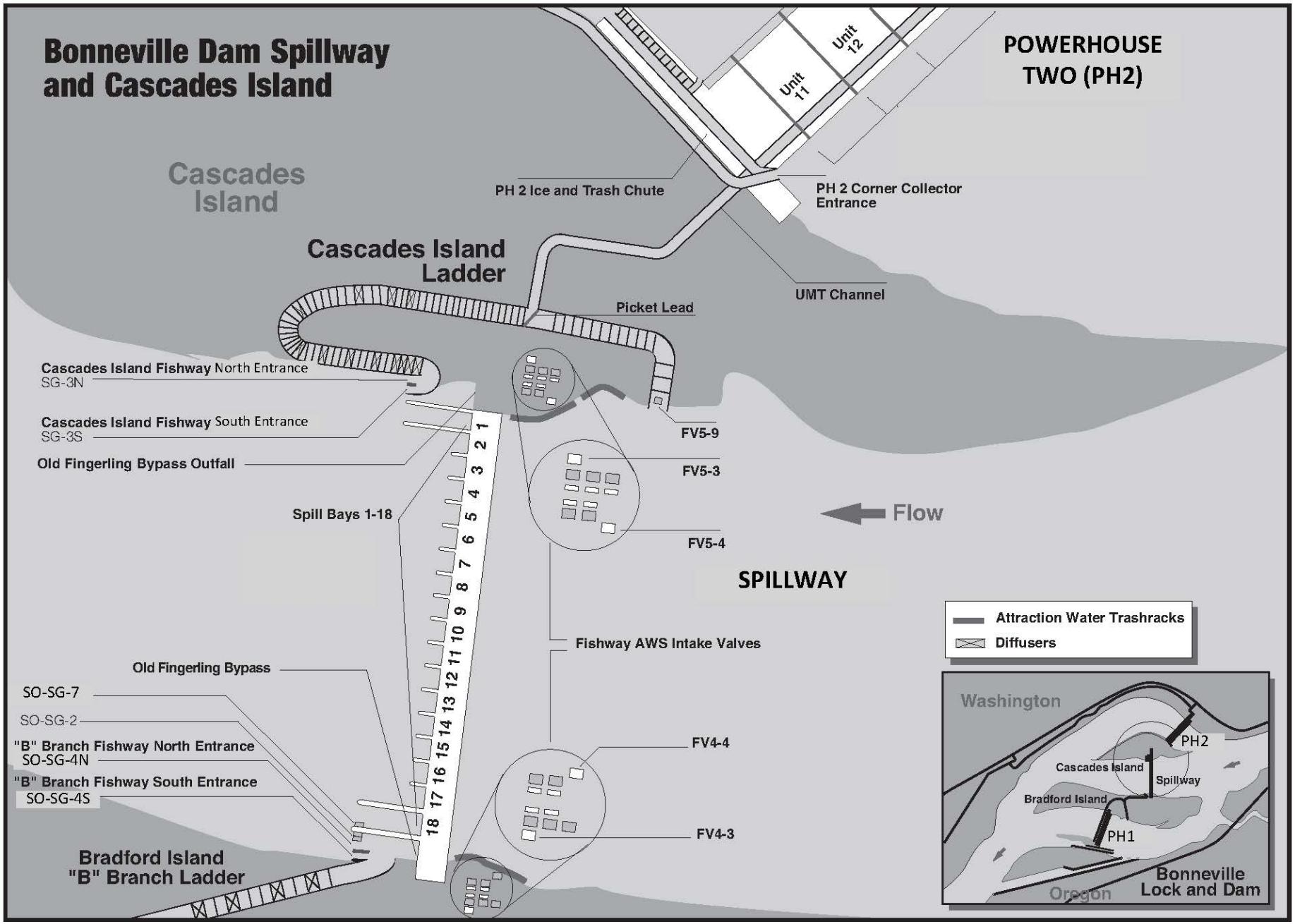


Figure BON-2. Bonneville Dam Spillway, Cascades Island Fish Ladder and Upstream Migrant Transportation Channel (UMT).

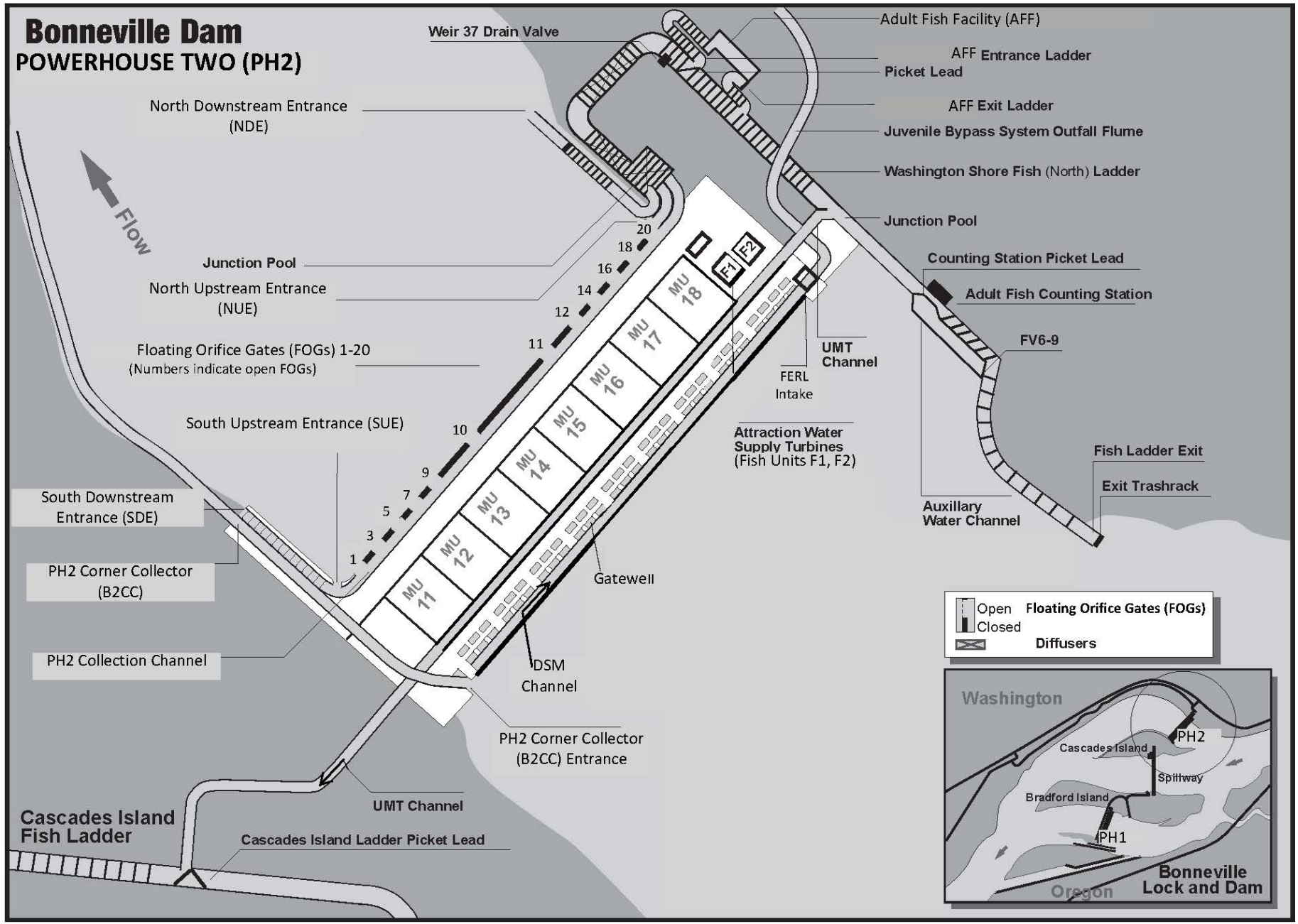


Figure BON-3. Bonneville Dam Powerhouse Two and Washington (North) Shore Fish Ladder.

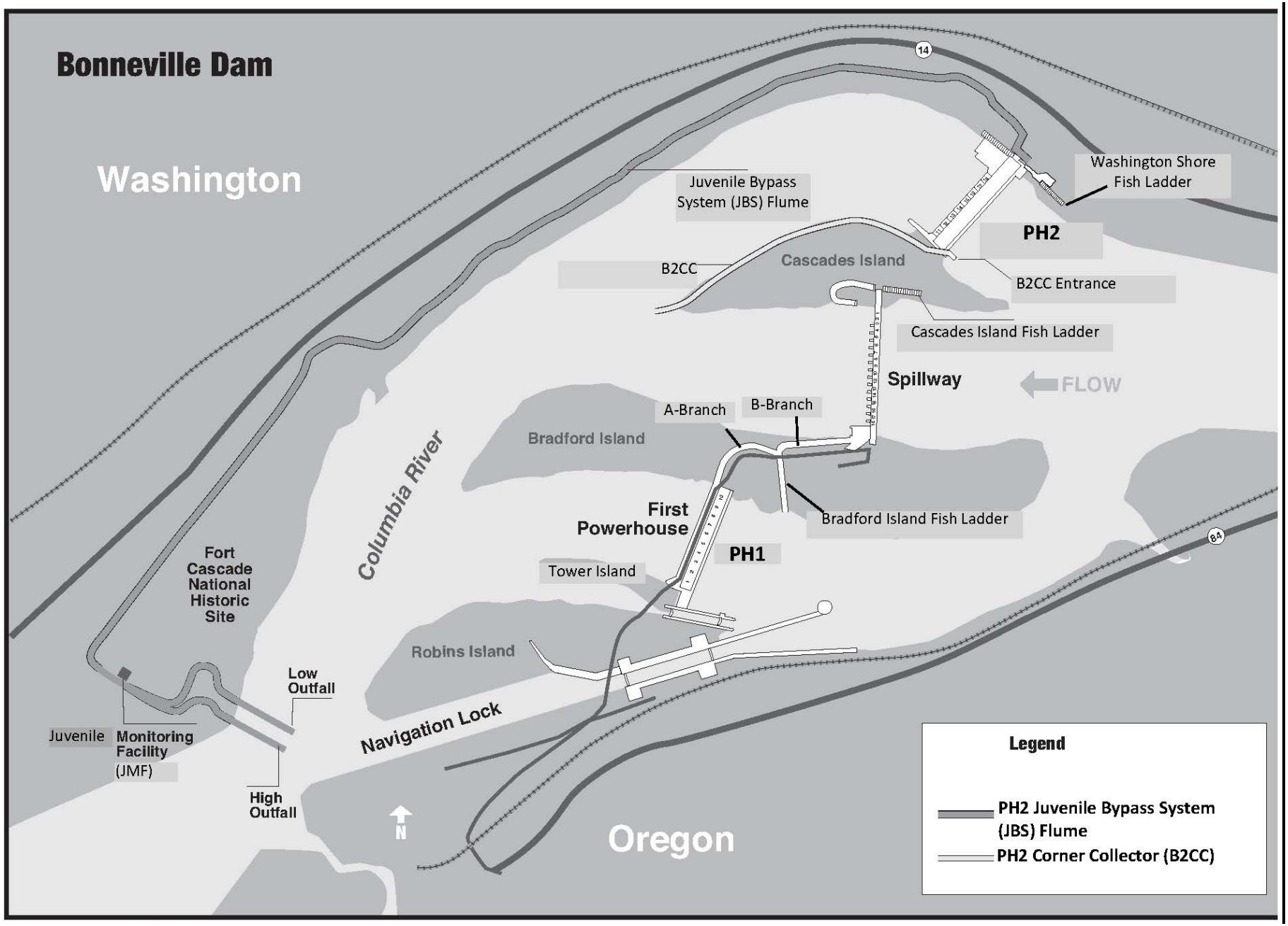


Figure BON-4. Bonneville Dam Juvenile Fish Bypass System (JBS).

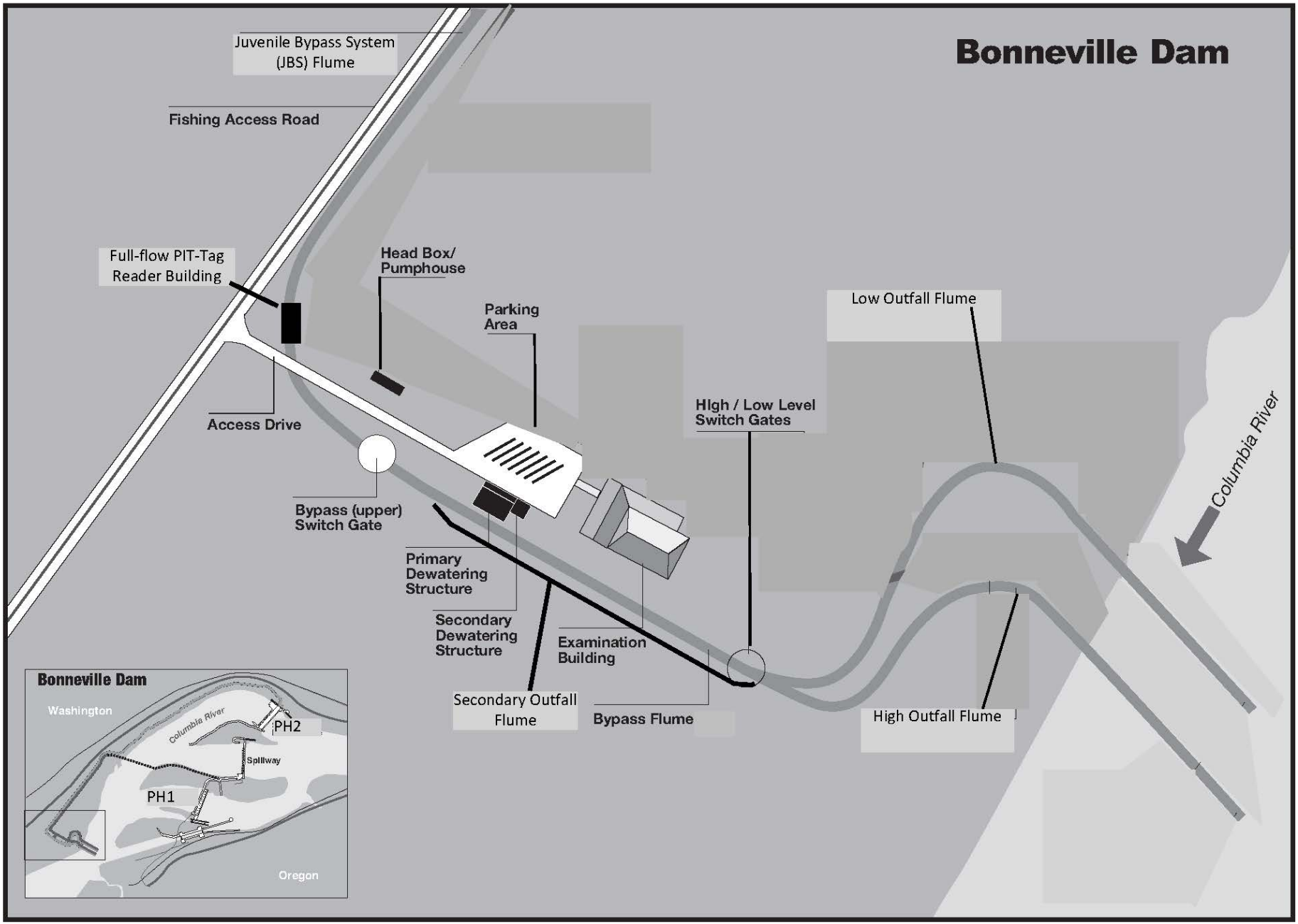
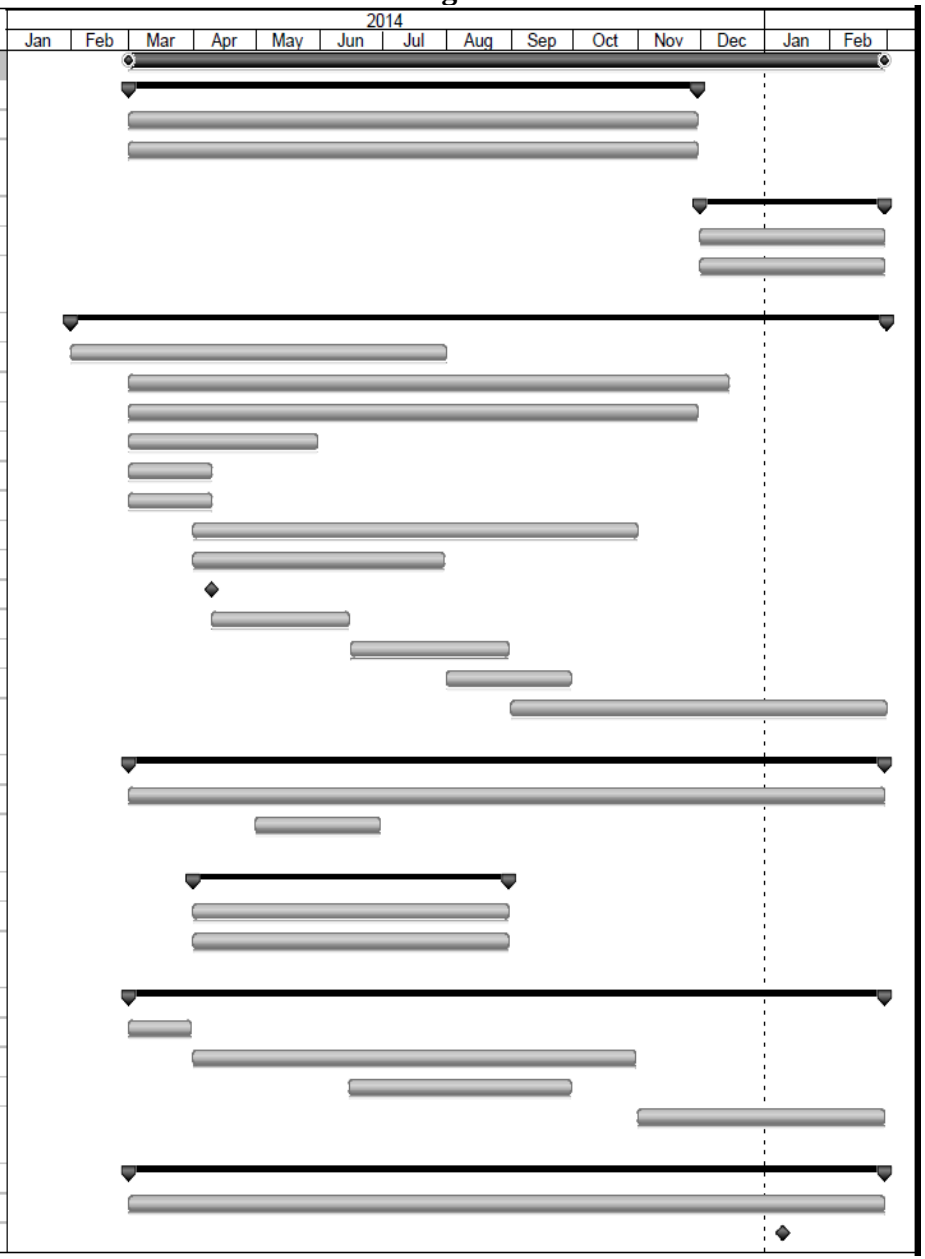


Figure BON-5. Bonneville Dam Juvenile Fish (Smolt) Monitoring Facility and Outfall Flumes.

Table BON-1. Bonneville Dam Schedule of Operations and Actions Defined in the 2014 Fish Passage Plan.

Task Name	Start Date	End Date	FPP Reference
2014 FPP Operations & Actions - Bonneville	**3/1/14**	**2/28/15**	**BON**
Fish Passage Facilities Operation	**3/1/14**	**11/30/14**	**2.4. and 2.5.**
Adult Fish Facilities	3/1/14	11/30/14	2.5.1.2.
Juvenile Fish Facilities	3/1/14	11/30/14	2.4.1.2.
Fish Passage Facilities Maintenance	**12/1/14**	**2/28/15**	**2.4. and 2.5.**
Juvenile Fish Facilities Winter Maintenance	12/1/14	2/28/15	2.4.1.1.
Adult Fish Facilities Winter Maintenance	12/1/14	2/28/15	2.5.1.1.
Project Operations for Fish Passage	**2/1/14**	**3/1/15**	
SLEDs at adult entrances (install ≤ Feb 1)	2/1/14	8/1/14	2.5.1.1.h.
STS operation	3/1/14	12/15/14	2.4.2.2.a.
Turbine operating priority order	3/1/14	11/30/14	Table BON-14
Pinniped Hazing	3/1/14	5/31/14	9.2.1.
Spill Bays 1 and 18 for adult attraction	3/1/14	4/10/14	2.2.4.1.
Kelt enumeration at JMF for B2CC trigger	3/1/14	4/10/14	2.4.2.3.
Turbine 1% operating range - hard constraint	4/1/14	10/31/14	5.2.
Avian Hazing	4/1/14	7/31/14	9.1.1.
Avian Wires installed no later than April 10	4/10/14	4/10/14	9.1.2.
Spring Spill Operations	4/10/14	6/15/14	FOP
Summer Spill Operations	6/16/14	8/31/14	FOP
No SLEDs at adult entrances (install ≥ Oct 1)	8/1/14	9/30/14	2.5.1.1.h.
Spill Bays 1 and/or 18 for adult attraction	9/1/14	3/1/15	2.2.4.1.
Special Operations & Studies (dates approx)	**3/1/14**	**2/28/15**	**Appendix A**
Adult Salmon Studies	3/1/14	2/28/15	2.2.1.
PH2 FGE Gatewell Velocity Testing	5/1/14	6/30/14	2.2.2.
TDG Monitoring	**4/1/14**	**8/31/14**	**2.3.1.**
TDG Monitoring - Tailrace	4/1/14	8/31/14	station CCIW
TDG Monitoring - Forebay	4/1/14	8/31/14	station BON
Adult Fish Counting	**3/1/14**	**2/28/15**	**Table BON-3**
Daytime Video 0400-2000 PST	3/1/14	3/31/14	
Daytime Visual 0500-2100 DST	4/1/14	10/31/14	
Night Video 2100-0500 DST	6/15/14	9/30/14	
Daytime Video 0400-2000 PST	11/1/14	2/28/15	
Reports	**3/1/14**	**2/28/15**	**3.3.**
Weekly Reports	3/1/14	2/28/15	
Annual Report	1/10/15	1/10/15	



1. FISH PASSAGE INFORMATION

The locations of fish passage facilities at Bonneville Lock & Dam are shown on the general site plan in **Figures BON-1** through **BON-5**. The schedule for project operations described in the Fish Passage Plan (FPP) and appendices is included 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: 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.

1.1.2.2. Two smaller turbines (fish units) supply adult fishway auxiliary water and do not have STSs or streamlined trashracks, and have a fine trashrack with 0.75" clear opening.

1.1.2.3. The PH2 corner collector (B2CC) on the south side of the PH2 tailrace extends several hundred feet west 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 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.

Table BON-2. Juvenile Salmonid Passage Timing at Bonneville Dam for Most Recent 10-Years (2004-2013) Based on Daily & Yearly Collection Data.*

Year	10%	50%	90%	# Days	10%	50%	90%	# Days
	Yearling Chinook				Subyearling Chinook * (Brights only**)			
2004	17-Apr	4-May	30-May	44	10-Jun	28-Jun	14-Jul	35
2005	19-Apr	7-May	25-May	37	15-Jun	28-Jun	20-Jul	36
2006	16-Apr	9-May	21-May	36	16-Jun	29-Jun	15-Jul	30
2007	20-Apr	11-May	23-May	34	19-Jun	8-Jul	22-Jul	34
2008	20-Apr	12-May	27-May	38	22-Jun	6-Jul	23-Jul	32
2009	19-Apr	11-May	26-May	38	20-Jun	30-Jun	19-Jul	30
2010	27-Apr	13-May	1-Jun	36	19-Jun	5-Jul	20-Jul	32
2011	17-Apr	10-May	18-May	32	24-Jun	14-Jul	2-Aug	40
2012	24-Apr	12-May	23-May	30	23-Jun	9-Jul	26-Jul	34
2013	28-Apr	12-May	21-May	24	29-Jun	9-Jul	16-Jul	18
MEDIAN	**19-Apr**	**11-May**	**24-May**	**36**	**15-Jun**	**29-Jun**	**19-Jul**	**35**
MIN	**16-Apr**	**4-May**	**18-May**	**24**	**6-Jun**	**22-Jun**	**14-Jul**	**30**
MAX	**28-Apr**	**13-May**	**1-Jun**	**44**	**21-Jun**	**9-Jul**	**15-Aug**	**70**
	Unclipped Steelhead				Clipped Steelhead			
2004	17-Apr	16-May	31-May	45	30-Apr	16-May	27-May	28
2005	23-Apr	11-May	29-May	37	26-Apr	15-May	30-May	35
2006	24-Apr	7-May	29-May	36	27-Apr	8-May	29-May	33
2007	29-Apr	16-May	3-Jun	36	8-May	17-May	4-Jun	28
2008	5-May	14-May	30-May	26	7-May	13-May	25-May	19
2009	30-Apr	13-May	29-May	30	4-May	13-May	26-May	23
2010	1-May	14-May	1-Jun	32	6-May	14-May	7-Jun	33
2011	23-Apr	15-May	31-May	39	24-Apr	12-May	29-May	36
2012	26-Apr	11-May	29-May	34	29-Apr	10-May	28-May	30
2013	22-Apr	12-May	3-Jun	43	28-Apr	9-May	28-May	31
MEDIAN	**2-Apr**	**13-May**	**30-May**	**37**	**29-Apr**	**13-May**	**28-May**	**30**
MIN	**17-Apr**	**7-May**	**29-May**	**26**	**24-Apr**	**8-May**	**25-May**	**19**
MAX	**5-May**	**16-May**	**3-Jun**	**45**	**8-May**	**17-May**	**7-Jun**	**36**
	Coho				Sockeye (Wild & Hatchery)			
2004	18-Apr	5-May	27-May	40	21-May	1-Jun	15-Jun	26
2005	22-Apr	9-May	27-May	36	15-May	23-May	1-Jun	18
2006	27-Apr	17-May	27-May	31	10-May	19-May	31-May	22
2007	26-Apr	13-May	31-May	36	16-May	25-May	7-Jun	23
2008	1-May	18-May	30-May	30	24-May	29-May	8-Jun	16
2009	29-Apr	22-May	1-Jun	35	15-May	26-May	5-Jun	22
2010	24-Apr	14-May	5-Jun	43	19-May	1-Jun	10-Jun	23
2011	11-Apr	14-May	24-May	44	4-May	17-May	4-Jun	32
2012	26-Apr	18-May	7-Jun	43	9-May	14-May	23-May	15
2013	16-Apr	14-May	1-Jun	47	14-May	20-May	26-May	13
MEDIAN	**25-Apr**	**14-May**	**30-May**	**37**	**15-May**	**24-May**	**4-Jun**	**22**
MIN	**11-Apr**	**5-May**	**24-May**	**30**	**4-May**	**14-May**	**23-May**	**13**
MAX	**1-May**	**22-May**	**7-Jun**	**47**	**24-May**	**1-Jun**	**15-Jun**	**32**

* Subyearling Chinook MEDIAN, MIN, MAX based on 1998-2006 data. Data 2007-present not included due to potential bias from missed sample days during high water temperature sampling protocols (**Appendix K**).

** 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 PH2 collection channel and the north and south monoliths that join Washington Shore (North) ladder and 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 Fish Migration Timing and Count Schedule. Upstream migrants are present throughout the year and adult passage facilities are operated year-round. Adult salmon, steelhead, lamprey and shad are typically counted year-round (**Table BON-3**) and daily data are posted online at: http://www.nwp.usace.army.mil/Missions/Environment/Fishdata.aspx. Fish passage November 1–March 31 is relatively light and counting is done by video, primarily to monitor ESA-listed winter steelhead, and posted online every three days. Sturgeon and bull trout are relatively infrequent and counts are posted online periodically during the passage season in *Miscellaneous Fish Count*s and summarized in the *Annual Fish Passage Report*.

1.2.2.1. Peak timing of adult fish passage at Bonneville Dam is determined based on yearly counts through the most recent passage year, beginning in 1938 for adult salmon and steelhead, in 1999 for winter steelhead, and in 2001 for lamprey (**Table BON-4**).

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

Table BON-3. Adult Fish Count Schedule at Bonneville Dam (3/1/2014 – 2/28/2015).

Count Period	Counting Method and Hours *
March 1–31, 2014	Video 0400–2000 hours (PST)
April 1, 2014 – October 31, 2014	Visual 0500–2100 hours (DST)
June 15, 2014 – September 30, 2014	Night Video 2100–0500 hours (DST)
November 1, 2014 – February 28, 2015	Video 0400–2000 hours (PST)

*****In 2014, Daylight Saving Time (DST) is in effect from March 9 – November 2, and hours are adjusted forward one hour from Pacific Standard Time (PST). DST = PST+1.

Table BON-4. Adult Count Period and Peak Passage Timing at Bonneville Dam Based on Yearly Counts Since 1938 (except winter steelhead since 1999 and lamprey since 2001).

Species	Count Period	Earliest Peak	Latest Peak
Spring Chinook	Mar 14 – May 31	Apr 15	May 27
Summer Chinook	Jun 1 – Jul 31	Jun 3	Jul 31
Fall Chinook	Aug 1 – Nov 15	Aug 30	Sep 17
Sockeye	Jun 1 – Aug 15	Jun 20	Jul 13
Steelhead	Apr 1 – Mar 31	Jul 16	Sep 22
Winter Steelhead	Nov 16 – Mar 31	Mar 1	Mar 28
Coho	Jul 15 – Nov 15	Aug 29	Oct 11
Lamprey	Mar 15 – Nov 15	Jun 20	Jul 18

1.2.2.1. Time-of-day (diel) distributions of adult salmonid activity at Bonneville Dam fishway entrances and exits are summarized in **Figure BON-6** (see *Keefer & Caudill 2008* at: http://www.nwd-wc.usace.army.mil/tmt/documents/FPOM/2010/2013_FPOM_MEET/2013_JUN/).

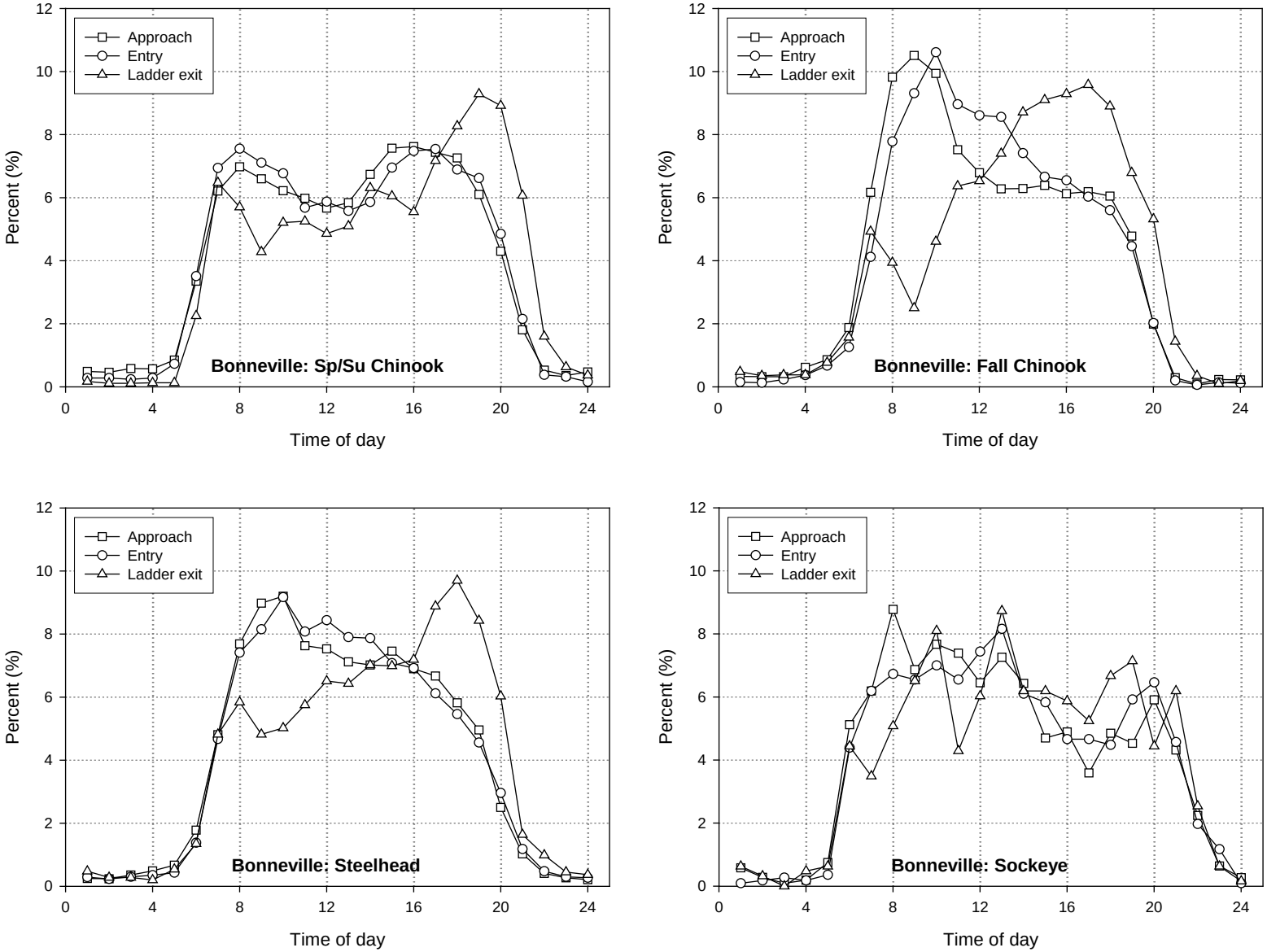


Figure BON-6. Diel Distribution of Adult Salmonids at Bonneville Dam Fishway Entrances and Exits (*Keefer & Caudill 2008*).

2. PROJECT OPERATION

2.1. General.

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

2.1.1. Powerhouse Unit Priority. Turbine operating priority is defined in **Table BON-14**. If a turbine is out of service, use the next turbine in the priority list.

2.1.1.1. Unit Priority during Split Flows. Before August 31, if adult and jack salmonid counts equal or exceed 30,000 fish/day, Project Fisheries will initiate coordination with the Fish Passage Operations & Maintenance (FPOM) team to discuss options for splitting flow between powerhouses to balance attraction flow and adult passage among the project's fishways. After August 31, when adult and jack salmonid counts equal or exceed 25,000 fish/day, the Project will operate two priority turbines at PH1 in an attempt to balance adult passage between both powerhouses (assuming no PH1 units are already operating). This operation will continue until adult and jack salmonid counts fall below 20,000 fish.

2.1.1.1.a. Turbine units at PH1 should be operated at the mid or upper 1% range whenever possible during split flow operations.

2.1.1.1.b. Turbine units at PH2 should be operated at the mid to lower 1% range whenever possible during split flow operations.

2.1.1.1.c. Split flow operations during summer spill may only occur if flow is > 120 kcfs.

2.1.2. 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 *Special Project Operations & Studies* (**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 **FPP Overview** for coordination protocols).

2.2. Spill Management.

2.2.1. See the *Fish Operations Plan* (FOP; **Appendix E**). Bonneville Dam spill patterns are defined in **Table BON-17**. Spill changes will be made through regional coordination at TMT.

2.2.2. 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 Corps Reservoir Control Center (RCC), dependent upon TDG monitoring at stations downstream of the dam, biological monitoring, and fish movement.

2.2.2.1. Nighttime spill hours are the daily complements of daytime spill hours defined in **Table BON-5**. The transition from daytime spill cap to nighttime spill cap and vice versa will normally take 15–20 minutes due to time required to start, synchronize and load multiple generators. The transition to daytime spill should not start until after the nighttime period.

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

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

Date Range	Daytime Spill Hours	
	Start Hour	End Hour
Jan 1 – Jan 19	0700	1730
Jan 20 – Feb 14	0630	1800
Feb 15 – Mar 01	0600	1830
Mar 2 – Apr 02	0600	1930
Apr 3 – Apr 20	0500	2030
Apr 21 – May 16	0500	2100
May 17 – May 31	0430	2130
Jun 1 – Jun 30	0430	2130
Jul 1 – Jul 31	0430	2200
Aug 1 – Aug 15	0500	2145
Aug 16 – Aug 31	0500	2030
Sep 1 – Sep 16	0530	2000
Sep 17 – Oct 04	0600	1930
Oct 5 – Oct 19	0630	1900
Oct 20 – Oct 29	0630	1830
Oct 30 – Nov 30	0600	1700
Dec 1 – Dec 31	0630	1700

2.2.3. Juvenile Fish. From April 10–August 31, the minimum spill level is 50 kcfs to provide acceptable tailrace conditions for juvenile fish egress. However, during extreme low flow conditions, lower spill levels may be considered and coordinated through TMT. There is no minimum spill level September 1–April 9. See the *FOP* (**Appendix E**) for more information.

2.2.4. Adult Fish. To reduce adult fallback whenever PH1 is in operation from June 16 through August, daytime spill will be limited to 100 kcfs or less (**see section 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.

2.2.4.1. Attraction Flow. From September 1–November 30 and March 1–April 10 (beginning of spill for juvenile fish passage), spill from Bays 1 and 18 with each gate open 6" (1 stop) during daylight hours (**Table BON-5**). From December 1–February 28, spill only from the bay(s) adjacent to an operating fishway entrance with each spill gate open 6".

2.3. Total Dissolved Gas (TDG) Management.

2.3.1. 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/.

2.3.2. 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.

2.3.3. 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 1 – February 28 (Winter Maintenance Period).

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

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

2.4.1.1.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 1 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 1 – November 30 (Juvenile Fish Passage Season).

2.4.1.2.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.

2.4.1.2.b. A slight oily sheen is commonly found in many gatewells, from sources such as lubricated lifting beams, etc. Unusual accumulations of oil (e.g., oil slick) in gate slots 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.

2.4.1.2.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.

2.4.1.2.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**.

d.1. If chain gates for Unit 1 are OOS, set chain gates 2A and 2B at 70' msl. Ensure gates 3B, 6C, and 10B are operating according to **Table BON-6.**

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

Forebay Elevation (ft)	PH1 ITS Chain Gates			Forebay Elevation (ft)	PH1 ITS Chain Gates		
	3B	6C	10B		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 1 – February 28 (Winter Maintenance Period).

2.4.2.1.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.

2.4.2.1.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.

2.4.2.1.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.

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

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

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

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

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

2.4.2.1.i. 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.

2.4.2.1.j. Avian 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 1 – November 30 (Juvenile Fish Passage Season).

2.4.2.2.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.

2.4.2.2.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**.

2.4.2.2.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.

2.4.2.2.d. Operate STSs at angle of 60^{o} from vertical.

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

2.4.2.2.f. 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*.

2.4.2.2.g. 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.

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

g.2. VBS inspections will occur immediately prior to peaks in juvenile fish migrations, which begin about May 1, mid-July, and September 1.

g.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.

g.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.

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

g.6. If a screen has reached the cleaning threshold, all 3 screens in that unit will be cleaned.

g.7. Unit will be shutdown if VBS drawdown equals or exceeds 1.5' in 12-hour period.

2.4.2.2.h. Rake trashracks at Units 11 and 12 prior to March 1 and at least once/month throughout fish passage season.

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

i.1. TIE Crane in service:

i. 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).

ii. 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.

iii. 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.

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

i.2. TIE Crane OOS = use Gantry Crane:

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

ii. 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.

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

i.3. Screen Re-Installation Criteria: At the discretion of the Project Biologist and in consultation with FPOM, 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.

2.4.2.2.j. Gatewell Orifice Systems. All gatewell orifice systems should be operational.

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

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

j.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.

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

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

2.4.2.2.l. Gatewell Cleaning. 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.

l.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.

l.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.

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

l.4. 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.

2.4.2.2.m. Avian Lines. Reinstall or repair avian 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 April–August only.

2.4.2.3. Powerhouse Two Corner Collector (B2CC). Operate B2CC during spill season. Open and close the B2CC within 1 hour of the start and end of spill season, respectively.

a.1. Beginning March 1, 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.

2.4.2.4.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.

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

a.2. If the system is still unable to accommodate debris loads, 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.

a.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.

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

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

2.4.2.4.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**).

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) Operation.

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

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

2.4.2.5.c. 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.

2.4.2.5.d. 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.

2.4.2.5.e. Operate the outfall avian cannons March 1–November 1. The cannons will be operated 24 hours/day during fish passage season.

2.4.2.5.f. For specific monitoring facility guidance, see *Protocols for Juvenile Monitoring Facility Operations at Bonneville Dam* (**Appendix J**).

2.4.3. Spillway Operating Criteria.

2.4.3.1. December 1 –February 28 (Winter Maintenance Period).

2.4.3.1.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.

2.4.3.1.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.

2.4.3.1.c. For spill guidance during winter maintenance periods, see the *FOP* (**Appendix E**) or **section 2.2**.

2.4.3.2. March 1 – November 30 (Juvenile Fish Passage Season). Spill will be provided according to guidance in the *FOP* (**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 1 – end of February (Winter Maintenance Period).

2.5.1.1.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.

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

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

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

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

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

2.5.1.1.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.

2.5.1.1.h. Sea Lion Exclusion Devices (SLEDs) will be installed at all adult fishway entrances no earlier than October 1 and no later than February 1, and will be removed by August 1 each year. All floating orifice gates (FOGs) can be left installed year-round.

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

2.5.1.1.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.

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

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

2.5.1.1.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.

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

m.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.

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

i. -22' to -24'msl at PH2 Fish Unit intake;

ii. +63' msl at BI exit, FV3-7 and FV3-9.

2.5.1.2. March 1 – November 30 (Adult Fish Passage Season).

2.5.1.2.a. Maintain water depth over fish ladder weirs at 1.0' ±0.1' during non-shad passage season (< 5,000 shad/day/count station) and 1.3' ±0.1' during shad passage season (≥ 5,000 shad/day/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.

2.5.1.2.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**.

2.5.1.2.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.

2.5.1.2.d. 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.

2.5.1.2.e. Maximum head of 0.5' 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.

2.5.1.2.f. Staff gages and water level indicators will be readable at all water levels encountered during the fish passage season, including: 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 UMT entrance, NUE/NDE/SUE/SDE collection channel, NUE/SUE tailwater, and PH2 north forebay.

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

2.5.1.2.h. The current fish counting program is conducted 16 hours per day, year-round (**Table BON-3**). Count station crowders shall remain in 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.

h.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:

i. Washington Shore = 22.8–38.4”;

ii. Cascades Island = currently out of service (max. opening approximately 36”);

iii. Bradford Island = 20.4–36.0”.

h.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.

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

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

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

h.6. Leave the fish passage slot lighted overnight.

2.5.1.2.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.

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

2.5.2. Main Dam Fish Ladders.

2.5.2.1. When spilling exclusively for adult attraction, spill only during daylight hours (**Table BON-5**). Spillbays 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 Fish Ladder.

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 Fish Ladder.

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.**

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'

2.5.3.1.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'.

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

2.5.3.2. Control of Fish Valve FV1-1.

2.5.3.2.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.

2.5.3.2.b. Differential. Low: collection channel/tailwater differential <1'.
High: collection channel/tailwater differential >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 Bradford Island 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. PH1 Collection Channel Diffusers. Diffuser valves are operated according to the pattern in **Table BON-12**.

Table BON-12. Collection Channel Diffuser Valve Operation 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).

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

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

2.5.4.3. 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.

2.5.4.4. 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. 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.

2.5.4.5. 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. Fish Unit intake dredging is a key component to maintaining a reliable AWS system and should be prioritized during winter maintenance season (see **section 2.5.1.1.n**).

3. FACILITY MONITORING & 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/day, seven days/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/week.

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

3.1.5. 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:

i. Any out-of-criteria situations observed and subsequent corrective actions taken;

ii. Any equipment malfunctions, breakdowns, or damage along with a summary of resulting repair activities;

iii. Adult fishway control calibrations;

iv. STS and VBS inspections;

v. AWS closures (i.e., cleaning times);

vi. When trapping is occurring in the AFF;

vii. Any unusual activities at the project that may affect fish passage.

3.3.2. Weekly Reports shall cover Sunday–Saturday and e-mailed to CENWP-OD, CENWD-PDW-R (RCC) and other interested parties as soon as possible the following week.

3.3.3. ***Memorandum for the Record*** **(MFR)** shall be prepared by Project biologists for any adverse or negative impact to fish or fishways. The MFR will be sent to FPOM by the next working day. Items that shall be included in the memo are:

i. Time and date of incident;

ii. Nature of activity that lead to fish impact;

iii. Agency responsible for the impact, or the name of the reporter if no responsible party can be identified;

iv. Fish numbers, species, origin, discernible external injuries, tags, etc.;

v. Future actions to avoid a similar impact;

vi. Any relevant photos.

3.3.4. Annual reports shall be prepared by Project biologists 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.

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 (STS). 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.

4.2.1.2.a. 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.

4.2.1.3.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.

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

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

4.2.1.3.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.

4.2.1.3.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 that sometimes break down during fish passage season (e.g., fish screens) 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):

i. Description of the problem;

ii. Type of outage required;

iii. Impact on facility operation;

iv. Length of time for repairs;

v. Expected impacts on fish passage.

4.2.2.2. 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).

4.2.2.3.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.

4.2.2.3.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.

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

4.2.2.3.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.

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

4.2.2.3.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.

4.2.2.3.g. During fishway inspections, 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.

4.3.1.2.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.

4.3.1.2.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.

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

4.3.1.3.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.

4.3.1.3.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.

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

4.3.1.4. Adult Fish Ladders and Counting Stations. Also see *Adult Fish Trapping Protocols* (**Appendix G**). Adult fish ladders will be dewatered once each year during winter maintenance. During this time, the ladders will be inspected for blocked orifices, projections into the fishway that may injure fish, weir stability, damaged picket leads, exit gate problems, loose diffusion gratings, unreadable or damaged staff gauges, defective diffusion valves, 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 (**Figure BON-6**). 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 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 RCC and Regional fish agencies through FPOM. Coordination procedures for non-routine maintenance of adult and juvenile facilities are the same. Any non-routine maintenance and fishway modifications will be handled individually.

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.

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

4.3.2.1.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.

4.3.2.1.c. Powerhouse Two (PH2).

c.1. If either or both fishway auxiliary water turbines do not provide sufficient water to meet full criteria, the adult facilities will be operated according to *Emergency Operations for Bonneville PH2 AWS Systems Operations* (**Table Bon-13**) or until a fishway head of 1’ is achieved.

c.2. When one of the fish turbines has failed or been taken out of service, refer to **Table Bon-13** for turbine operations, floating orifices, diffuser gates, and main gates during emergency situations. **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.

c.3. If both fish unit turbines fail from September 1–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.

c.4. PH2 adult fishway diffusion system valves A3 and A4 have been removed due to damage. 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 PH2 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.

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

4.3.2.4.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.

4.3.2.4.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.

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

5. TURBINE UNIT OPERATION & MAINTENANCE

5.1. Turbine Unit Priority.

Powerhouse and turbine unit priority throughout the year is defined 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.

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

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

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

5.2. Turbine Unit Operating Range.

5.2.1. Turbine unit operations within ±1% of peak turbine efficiency (1% range) are specified in the *BPA Load Shaping Guidelines* (**Appendix C**) for implementation during the period of April 1 through October 31. Through regional coordination with FPOM and TMT, the 1% range guidelines during this period have been modified as defined below in **5.2.1.1** to minimize PH2 gatewell turbulence for bypassed juvenile salmonids until structural and/or other solutions are implemented. Turbine unit operating range limits are defined in **Tables BON-15 (PH1)** and **BON-16 (PH2)**.

5.2.1.1. From April 1 through October 31, turbine units will operate sequentially in the following order of operating ranges to pass increasing levels of flow:

5.2.1.1.a. PH2 units within 1% mid-range;

5.2.1.1.b. Then, PH1 units up to 1% upper limit;

5.2.1.1.c. Then, PH1 units up to BOP;

5.2.1.1.d. Then, additional flow in excess of what can be passed in the steps above will be passed in one of the three following ways, or as otherwise determined by Project Fisheries based on observed conditions:

d.1. April 1–April 9: PH2 units up to 1% upper limit.

d.2. April 10–June 15 (Spring Spill) w/ Juvenile Trigger[1]: When juvenile spring Chinook collection counts at BON JMF are greater than adult spring Chinook (excluding jacks) total passage counts for three consecutive days (juvenile trigger), Project Fisheries will notify the control room to maintain PH2 units within 1% mid-range as a hard constraint and pass additional flow as spill.

d.3. April 10–June 15 (Spring Spill) w/ Adult Trigger[2]: When adult spring Chinook total passage counts (excluding jacks) are greater than juvenile spring Chinook collection counts at BON JMF for two consecutive days (adult trigger), Project Fisheries will notify the control room to operate PH2 up to 1% upper limit in priority order from north to south: 18, 17, 16, 15, 14, 13, 12, 11.

d.4. June 16–October 31: PH2 units up to 1% upper limit.

[1] **Juvenile spring Chinook:** reported as "CollCount" in SMP Smolt Data (query: current year, BO2, Combined Chinook Yearling), available online at: http://www.fpc.org/smolt/smpsubmitdataquery_2014v7.html

[2] **Adult spring Chinook:** reported as "Adult Chinook daily" in Corps Adult Fish Count Running Sum Report for Bonneville, available online at: http://www.nwp.usace.army.mil/Missions/Environment/Fish/Data.aspx

5.3. Turbine Unit Maintenance.

5.3.1. 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 few fish passing the project.

5.3.2. 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.

5.3.3. In the event of long-term powerhouse outages, affected units will be exercised periodically. Each unit will be operated 4-8 hours every 2 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 minimum necessary to keep the unit in good working condition and may be performed at night, day or whenever unit cycling will have the least effect on fish as determined by the project biologist.

5.3.4. 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.

5.3.5. The head gates 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*).

5.3.6. 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.

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

5.3.8. 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% range.

5.3.9. When a unit is idle, wicket gates will remain in a closed position unless tail logs are installed and fish salvage has been done in the draft tube or the project is holding a safety pool below the level of the wicket gates.

6. DEWATERING PLANS

6.1. Guidelines for All Dewaterings.

6.1.1. *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).

See the *Guidelines for Dewatering and Fish Handling Plans* (**Appendix F**) and *Dewatering Plans*, 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.[3] 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 steps in **Routine Maintenance (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.

[3] Head gates may also be referred to as "operating" gates at some projects. The terms are interchangeable.

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.

6.6. Navigation Lock.

6.6.1. The navigation lock is frequently dewatered for routine maintenance in late February/early March, in conjunction with navigation lock outages at The Dalles and John Day dams.

6.6.2. The area between the upstream bulkhead and the upstream gate is surveyed for fish as water levels allow. The lateral and pool areas on the floor of the lock are surveyed for fish from above. Most of these areas remain full of water, precluding the ability to implement successful fish salvage operations. Areas where water levels slowly decrease are accessed via crane when pool levels reach a depth of approximately 3 feet. The fill conduits are accessed and checked for fish only if needed and can be done safely. All salvaged fish are removed, transported via bag or tank and released to the river.

7. FOREBAY DEBRIS REMOVAL

7.1.1. 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.

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

7.1.3. 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

8.1.1. 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.

8.1.2. Project Fisheries will be contacted as soon as possible after a hazardous material release and prior to any modification to fishway operations. Project biologist(s) 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 available in Control Room):

i. Ben Hausmann, Supervisory Fishery Biologist

ii. Andrew Traylor, Fishery Biologist

iii. Ida Royer, Fishery Biologist

iv. Brian Bissell, Fishery Biologist

v. Bern Klatte, Fisheries Section Supervisor, or Tammy Mackey, Fishery Biologist

9. HAZING ACTIVITIES

9.1. Avian Hazing (Piscivorous Birds).

9.1.1. From April 1 through July 31, piscivorous birds shall be hazed at Bonneville Dam 7 days/week for 8 hours/day between the hours of 0600-2000. Hours of hazing should vary so that birds do not acclimate to long periods without hazing.

9.1.2. Avian Wires. Avian wires shall be installed prior to 10 April each year.

9.1.3. Hazing techniques are detailed in the approved Operating Plan. The objective of the program is to reduce avian predation of migrating juvenile salmonids and lamprey by hazing or harassing piscivorous birds in a manner that impedes their ability to successfully forage on fish or forces them to leave the area.

9.1.4. Avian hazing shall occur primarily near dam locations where predation risk is high (e.g., tailrace areas where fish may be disoriented after passing the project or forebay areas where fish may be delayed from passing the project).

9.1.5. Birds shall be hazed near the spillway and powerhouse discharge areas, the juvenile bypass outfall(s), and where birds congregate or feed, ranging up to approximately 2,000 feet downstream of the dam and outfall site. Roosting and actively foraging birds shall also be hazed within the forebay boat restricted zones (BRZ).

9.1.6. During juvenile lamprey outmigration, Wildlife Service specialists may be requested to focus hazing at specific areas of the project where juvenile lamprey are known to pass.

9.2. Pinniped Hazing.

9.2.1. From March 1 through May 31, pinnipeds (primarily California sea lions and Steller sea lions) shall be hazed at Bonneville Dam 7 days/week for 8 hours/day between the hours of 0600-2000. Hours of hazing should vary so that pinnipeds do not acclimate to long periods without hazing, unless otherwise coordinated with the POC.

9.2.2. Hazing techniques are defined in the approved *Operating Plan* and in accordance with the *Marine Mammal Protection Act of 1972, Section 109 h.1.c*. The program objective is to reduce pinniped predation on adult salmonids, sturgeon and lamprey by hazing or harassing pinnipeds in a manner that impedes their ability to forage successfully or forces them to leave the area.

9.2.3. Pinnipeds hazing shall occur in the tailrace areas of the dam and spillway, Tanner Creek, and areas where pinnipeds haul out (except when otherwise coordinated for trapping efforts), ranging to approximately 1,500 feet downstream of the dam and outfall site.

9.2.4. Special activities will be coordinated each year with Federal, State and Tribal agencies in their hazing efforts from boats as needed, efforts to trap/take, and for special evaluations or tests.

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

Project Head (ft)	Powerhouse One (Units 1–10)					
	1% Lower Limit		1% Upper Limit		Best Operating Point (BOP)	
	(MW/unit)	(cfs/unit)	(MW/unit)	(cfs/unit)	(MW/unit)	(cfs/unit)
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	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	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	7,217	34.1	9,459	39.9	11,170
48	26.6	7,223	35	9,500	41	11,227
49	27.3	7,229	36	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	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	11,572
64	36.5	7,340	49	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	7,305	53.2	9,954		
70	39.5	7,294	54.1	9,979		

1. Table based on June 2000 data (HDC). Updated 2009 (removed STSs) and 2013 (added BOP).

Table BON-16. Bonneville Dam Powerhouse Two Turbine Units 11–18 Output (MW) and Discharge (cfs) Per Unit at the Lower, Mid-Range and Upper Limits of the 1% Peak Efficiency Operating Range. [1]

Project Head (ft)	Powerhouse Two (Units 11-18)											
	With STS						No STS					
	1% Lower Limit		1% Mid-Range		1% Upper Limit		1% Lower Limit		1% Mid-Range		1% Upper Limit	
			13kcfs	15kcfs					13kcfs	15kcfs		
	(MW)	(cfs)	(MW)	(MW)	(MW)	(cfs)	(MW)	(cfs)	(MW)	(MW)	(MW)	(cfs)
35	27.6	11,259	31.9	36.8	44.3	18,068	28.2	11,444	32.1	37.0	45.1	18,277
36	28.5	11,271	32.9	37.9	45.8	18,097	29.2	11,455	33.1	38.2	46.6	18,306
37	29.4	11,279	33.9	39.1	47.3	18,121	30.1	11,464	34.1	39.4	48.1	18,331
38	30.3	11,284	34.9	40.3	48.8	18,139	31.0	11,470	35.2	40.6	49.7	18,350
39	31.3	11,287	36.0	41.6	50.3	18,153	32.0	11,473	36.3	41.8	51.2	18,364
40	32.2	11,288	37.1	42.8	51.8	18,162	32.9	11,474	37.3	43.0	52.7	18,374
41	33.0	11,259	38.1	44.0	53.3	18,197	33.7	11,445	38.3	44.2	54.3	18,409
42	33.8	11,230	39.1	45.2	54.9	18,228	34.6	11,415	39.4	45.4	55.8	18,441
43	34.6	11,201	40.2	46.3	56.4	18,255	35.4	11,386	40.4	46.6	57.4	18,468
44	35.4	11,172	41.2	47.5	57.9	18,278	36.2	11,357	41.4	47.8	58.9	18,493
45	36.2	11,144	42.2	48.7	59.4	18,299	37.0	11,328	42.5	49.0	60.5	18,514
46	37.0	11,139	43.2	49.8	61.0	18,366	37.9	11,324	43.5	50.2	62.1	18,581
47	37.8	11,135	44.2	51.0	61.9	18,200	38.7	11,319	44.5	51.3	63.0	18,415
48	38.7	11,129	45.2	52.1	62.7	18,040	39.6	11,314	45.5	52.5	63.8	18,255
49	39.5	11,124	46.2	53.3	63.5	17,887	40.4	11,308	46.5	53.6	64.7	18,101
50	40.3	11,118	47.2	54.4	67.5	18,598	41.3	11,303	47.5	54.8	68.7	18,817
51	41.3	11,154	48.1	55.5	69.8	18,850	42.2	11,339	48.4	55.9	71.1	19,072
52	42.3	11,187	49.1	56.7	72.1	19,091	43.2	11,373	49.4	57.0	73.4	19,316
53	43.2	11,219	50.1	57.8	74.5	19,323	44.2	11,405	50.4	58.1	75.8	19,551
54	44.2	11,249	51.0	58.8	76.5	19,536	45.2	11,436	51.3	59.2	76.5	19,431
55	45.2	11,278	52.1	60.1	76.5	19,115	46.2	11,466	52.4	60.5	76.5	18,975
56	46.4	11,343	53.2	61.3	76.5	18,718	47.4	11,531	53.5	61.7	76.5	18,581
57	47.6	11,404	54.2	62.6	76.5	18,336	48.6	11,593	54.6	63.0	76.5	18,202
58	48.8	11,461	55.4	63.9	76.5	17,967	49.9	11,652	55.7	64.3	76.5	17,836
59	50.0	11,515	56.5	65.1	76.5	17,611	51.1	11,707	56.8	65.6	76.5	17,483
60	51.2	11,567	57.6	66.4	76.5	17,267	52.3	11,760	57.9	66.8	76.5	17,142
61	51.8	11,532	58.5	67.5	76.5	16,978	53.0	11,724	58.9	67.9	76.5	16,857
62	52.5	11,498	59.5	68.6	76.5	16,699	53.7	11,690	59.8	69.1	76.5	16,582
63	53.1	11,466	60.4	69.7	76.5	16,428	54.3	11,657	60.8	70.1	76.5	16,315
64	53.7	11,434	61.3	70.7	76.5	16,166	55.0	11,625	61.7	71.2	76.5	16,056
65	54.4	11,405	62.3	71.8	76.5	15,912	55.6	11,595	62.6	72.3	76.5	15,806
66	55.4	11,448	63.2	72.9	76.5	15,671	56.7	11,639	63.6	73.4	76.5	15,570
67	56.5	11,490	64.2	74.0	76.5	15,437	57.8	11,682	64.6	74.5	76.5	15,341
68	57.5	11,532	65.1	75.1	76.5	15,210	58.9	11,724	65.5	75.6	76.5	15,119
69	58.6	11,571	66.1	76.3	76.5	14,990	59.9	11,764	66.5	76.5	76.5	14,903
70	59.6	11,610	67.0	77.3	76.5	14,775	61.0	11,803	67.5	76.5	76.5	14,693

1. Table based on January 2001 data (HDC). Updated 2006 and 2014 (added Mid-Range).

Table BON-17. [*pg 1 of 9*] Bonneville Dam Spill Patterns in Vertical Gate Opening (ft) per Spill Bay (0.5 ft per 1 gate stop). [4] [5]

Total Spill	BON Spill Patterns – Vertical Gate Opening (ft) per Spill Bay (0.5 ft = 1 Gate Stop)																		Total Stops
(kcfs)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	(1 stop= 0.5')
2.3	0.5																	0.5	**2**
3.4	0.5	0.5																0.5	**3**
4.6	0.5	0.5															0.5	0.5	**4**
5.7	0.5	0.5														0.5	0.5	0.5	**5**
6.9	0.5	0.5		0.5												0.5	0.5	0.5	**6**
8	0.5	0.5		0.5	0.5											0.5	0.5	0.5	**7**
9.2	0.5	0.5		0.5	0.5									0.5		0.5	0.5	0.5	**8**
10.3	0.5	0.5		0.5	0.5							0.5		0.5		0.5	0.5	0.5	**9**
11.5	0.5	0.5		0.5	0.5					0.5		0.5		0.5		0.5	0.5	0.5	**10**
12.6	0.5	0.5		0.5	0.5			0.5		0.5		0.5		0.5		0.5	0.5	0.5	**11**
13.8	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**
14.9	0.5	0.5	0.5	0.5	0.5			0.5		0.5		0.5		0.5		0.5	1	0.5	**13**
16	0.5	1	0.5	0.5	0.5			0.5		0.5		0.5		0.5		0.5	1	0.5	**14**
17.2	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**
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	1	0.5	**16**
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	1	0.5	**17**
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	1	0.5	**18**
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	1	0.5	**19**
22.9	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**
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	0.5	**21**
25.2	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**
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	0.5	1	1	**23**
27.4	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**
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	0.5	1	1	1	**25**
29.7	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**
30.8	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**
31.9	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**
33.1	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**
34.2	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**

[4] "Total Spill" calculated based on forebay elevation 74.0 ft (updated 2007)..
[5] 3/10/2014 – Patterns changed to vertical feet per bay rather than # of gate stops per bay.

Total Spill	BON Spill Patterns – Vertical Gate Opening (ft) per Spill Bay (0.5 ft = 1 Gate Stop)																		Total Stops
(kcfs)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	(1 stop= 0.5')
35.3	1	1	1	1	0.5	1	1	0.5	1	0.5	0.5	1	1	0.5	1	1	1	1	**31**
36.4	1	1	1	1	0.5	1	1	0.5	1	1	0.5	1	1	0.5	1	1	1	1	**32**
37.6	1	1	1	1	1	1	1	0.5	1	1	0.5	1	1	0.5	1	1	1	1	**33**
38.7	1	1	1	1	1	1	1	1	1	1	0.5	1	1	0.5	1	1	1	1	**34**
39.8	1	1	1	1	1	1	1	1	1	1	0.5	1	1	1	1	1	1	1	**35**
40.9	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	**36**
42	1	1.5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	**37**
43.2	1	1.5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1.5	1	**38**
44.3	1	1.5	1	1	1	1	1	1	1	1	1	1	1	1	1	1.5	1.5	1	**39**
45.4	1	1.5	1.5	1	1	1	1	1	1	1	1	1	1	1	1	1.5	1.5	1	**40**
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	**41**
47.6	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**
48.6	1.5	1.5	1.5	1	1	1	1	1	1	1	1	1	1	1	1	1.5	2	1.5	**43**
49	2	2	2	0	2	0	0	2	0	2	0	0	2	2	0	2	2	2	**44**
50	2	2	2	0	2	0	0	2	0	2	0	0	2	2	0	2	2.5	2	**45**
52	2	2.5	2	0	2	0	0	2	0	2	0	0	2	2	0	2	2.5	2	**46**
53	2	2.5	2	0	2	0	0	2	0	2	0	0	2	2	0	2.5	2.5	2	**47**
54	2	2	2	0	2	0	2	2	0	2	0	0	2	2	0	2	2	2	**48**
55	2	2	2	0	2	0	2	2	0	2	0	0	2	2	0	2	2.5	2	**49**
56	2	2.5	2	0	2	0	2	2	0	2	0	0	2	2	0	2	2.5	2	**50**
57	2	2.5	2	0	2	0	2	2	0	2	0	0	2	2	0	2.5	2.5	2	**51**
58	2	2	2	0	2	0	2	2	0	2	2	0	2	2	0	2	2	2	**52**
59	2	2	2	0	2	0	2	2	0	2	2	0	2	2	0	2	2.5	2	**53**
61	2	2.5	2	0	2	0	2	2	0	2	2	0	2	2	0	2	2.5	2	**54**
62	2	2.5	2	0	2	0	2	2	0	2	2	0	2	2	0	2.5	2.5	2	**55**
63	2	2	2	2	2	0	2	2	0	2	2	0	2	2	0	2	2	2	**56**
64	2	2	2	2	2	0	2	2	0	2	2	0	2	2	0	2	2.5	2	**57**
65	2	2.5	2	2	2	0	2	2	0	2	2	0	2	2	0	2	2.5	2	**58**
66	2	2.5	2	2	2	0	2	2	0	2	2	0	2	2	0	2.5	2.5	2	**59**
67	2	2	2	2	2	0	2	2	0	2	2	0	2	2	2	2	2	2	**60**
68	2	2	2	2	2	0	2	2	0	2	2	0	2	2	2	2	2.5	2	**61**
70	2	2.5	2	2	2	0	2	2	0	2	2	0	2	2	2	2	2.5	2	**62**
71	2	2.5	2	2	2	0	2	2	0	2	2	0	2	2	2	2.5	2.5	2	**63**
72	2	2	2	2	2	2	2	2	0	2	2	0	2	2	2	2	2	2	**64**

Total Spill	BON Spill Patterns – Vertical Gate Opening (ft) per Spill Bay (0.5 ft = 1 Gate Stop)																		Total Stops
(kcfs)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	(1 stop= 0.5')
73	2	2	2	2	2	2	2	2	0	2	2	0	2	2	2	2	2.5	2	**65**
74	2	2.5	2	2	2	2	2	2	0	2	2	0	2	2	2	2	2.5	2	**66**
75	2	2.5	2	2	2	2	2	2	0	2	2	0	2	2	2	2.5	2.5	2	**67**
76	2	2	2	2	2	2	2	2	0	2	2	2	2	2	2	2	2	2	**68**
77	2	2	2	2	2	2	2	2	0	2	2	2	2	2	2	2	2.5	2	**69**
78	2	2.5	2	2	2	2	2	2	0	2	2	2	2	2	2	2	2.5	2	**70**
80	2	2.5	2	2	2	2	2	2	0	2	2	2	2	2	2	2.5	2.5	2	**71**
81	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	**72**
82	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2.5	2	**73**
83	2	2.5	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2.5	2	**74**
84	2	2.5	2	2	2	2	2	2	2	2	2	2	2	2	2	2.5	2.5	2	**75**
85	2	2.5	2.5	2	2	2	2	2	2	2	2	2	2	2	2	2.5	2.5	2	**76**
86	2	2.5	2.5	2	2	2	2	2	2	2	2	2	2	2	2	2.5	2.5	2.5	**77**
87	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**
88	2.5	2.5	2.5	2	2	2	2	2	2	2	2	2	2	2	2	2.5	3	2.5	**79**
89	2.5	3	2.5	2	2	2	2	2	2	2	2	2	2	2	2	2.5	3	2.5	**80**
90	2.5	3	2.5	2	2	2	2	2	2	2	2	2	2	2	2	2.5	3	3	**81**
91	3	3	2.5	2	2	2	2	2	2	2	2	2	2	2	2	2.5	3	3	**82**
92	3	3	2.5	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	**83**
94	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	**84**
95	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2.5	3	3	3	**85**
96	3	3	3	2.5	2	2	2	2	2	2	2	2	2	2	2.5	3	3	3	**86**
97	3	3	3	2.5	2	2	2	2	2	2	2	2	2	2.5	2.5	3	3	3	**87**
98	3	3	3	2.5	2.5	2	2	2	2	2	2	2	2	2.5	2.5	3	3	3	**88**
99	3	3	3	2.5	2.5	2	2	2	2	2	2	2.5	2	2.5	2.5	3	3	3	**89**
100	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**
101	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**
103	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**
105	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**
107	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**
110	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**
110.5	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**
111.6	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**
112.6	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**

Total Spill	BON Spill Patterns – Vertical Gate Opening (ft) per Spill Bay (0.5 ft = 1 Gate Stop)																		Total Stops
(kcfs)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	(1 stop= 0.5')
113.7	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**
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	**105**
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	3.5	3.5	**106**
116.7	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**
117.8	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**
118.8	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**
119.8	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**
120.9	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**
121.9	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**
122.9	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**
124	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**
124.9	3.5	3.5	3.5	3.5	3	3	3	3	2.5	2.5	3	3	3	3	3	3.5	4	4	**115**
126	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**
127	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**
128	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**
129	3.5	3.5	3.5	3.5	3	3	3	3	3	3	3	3	3	3	3.5	4	4	4	**119**
130	3.5	4	3.5	3.5	3	3	3	3	3	3	3	3	3	3	3.5	4	4	4	**120**
131	3.5	4	4	3.5	3	3	3	3	3	3	3	3	3	3	3.5	4	4	4	**121**
132	4	4	4	3.5	3	3	3	3	3	3	3	3	3	3	3.5	4	4	4	**122**
133	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3.5	4	4	4	**123**
134	4	4	4	4	3	3	3	3	3	3	3	3	3	3	4	4	4	4	**124**
135	4	4	4	4	3	3.5	3	3	3	3	3	3	3	3	4	4	4	4	**125**
136.1	4	4	4	4	3.5	3.5	3	3	3	3	3	3	3	3	4	4	4	4	**126**
137.1	4	4	4	4	3.5	3.5	3	3	3	3	3	3	3.5	3	4	4	4	4	**127**
138.1	4	4	4	4	3.5	3.5	3	3	3	3	3	3	3.5	3.5	4	4	4	4	**128**
139.1	4	4	4	4	3.5	3.5	3	3	3	3	3	3	3.5	3.5	4	4	4.5	4	**129**
140.1	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**
141.1	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**
142.1	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**
143.1	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**
144	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**
145.1	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**
146.1	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**
147.1	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**

Total Spill	BON Spill Patterns – Vertical Gate Opening (ft) per Spill Bay (0.5 ft = 1 Gate Stop)																		Total Stops
(kcfs)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	(1 stop= 0.5')
148.1	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**
149.1	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**
150.1	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**
151.1	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**
152.1	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**
153.1	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**
154.1	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**
155.1	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**
156.1	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**
157.1	4	4.5	4.5	4	4	4	4	4	4	3.5	4	4	4	4	4	4.5	4.5	4	**147**
158.1	4	4.5	4.5	4	4	4	4	4	4	4	4	4	4	4	4	4.5	4.5	4	**148**
159.1	4	4.5	4.5	4.5	4	4	4	4	4	4	4	4	4	4	4	4.5	4.5	4	**149**
160	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**
161	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**
162	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**
163	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**
163.9	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	4.5	4	**154**
164.9	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**
165.9	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**
166.8	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**
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	4.5	5	4	**158**
168.8	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**
169.8	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**
170.7	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**
171.7	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**
172.6	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**
173.6	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**
174.6	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**
175.6	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**
176.5	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**
177.5	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**
178.5	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**
179.4	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**
180.4	4	5	5	5	5	5	4.5	4.5	4.5	4.5	4.5	5	5	5	5	5	5	4	**171**

Total Spill	BON Spill Patterns – Vertical Gate Opening (ft) per Spill Bay (0.5 ft = 1 Gate Stop)																		Total Stops
(kcfs)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	(1 stop= 0.5')
181.3	4	5	5	5	5	5	4.5	5	4.5	4.5	4.5	5	5	5	5	5	5	4	**172**
182.3	4	5	5	5	5	5	4.5	5	4.5	5	4.5	5	5	5	5	5	5	4	**173**
183.3	4	5	5	5	5	5	4.5	5	5	5	4.5	5	5	5	5	5	5	4	**174**
184.2	4	5	5	5	5	5	5	5	5	5	4.5	5	5	5	5	5	5	4	**175**
185.2	4	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	4	**176**
186.1	4	5.5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	4	**177**
187.1	4	5.5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5.5	4	**178**
188	4	5.5	5	5	5	5	5	5	5	5	5	5	5	5	5	5.5	5.5	4	**179**
189	4	5.5	5.5	5	5	5	5	5	5	5	5	5	5	5	5	5.5	5.5	4	**180**
189.9	4	5.5	5.5	5	5.5	5	5	5	5	5	5	5	5	5	5	5.5	5.5	4	**181**
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	4	**182**
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	4	**183**
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	4	**184**
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	4	**185**
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	4	**186**
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	4	**187**
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	4	**188**
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	4	**189**
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	4	**190**
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	4	**191**
200.3	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**
201.2	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**
202.1	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**
203.1	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**
204	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**
204.9	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**
205.9	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**
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	5.5	4	**199**
207.7	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**
208.6	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**
209.6	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**
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	**203**
211.5	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**
212.4	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**

Total Spill	BON Spill Patterns – Vertical Gate Opening (ft) per Spill Bay (0.5 ft = 1 Gate Stop)																		Total Stops
(kcfs)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	(1 stop= 0.5')
213.4	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**
214.3	4.5	6	6	6	6	6	5.5	6	5.5	6	5.5	6	6	6	6	6	6	4.5	**207**
215.2	4.5	6	6	6	6	6	5.5	6	6	6	5.5	6	6	6	6	6	6	4.5	**208**
216.2	4.5	6	6	6	6	6	6	6	6	6	5.5	6	6	6	6	6	6	4.5	**209**
217.1	4.5	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	4.5	**210**
218	4.5	6	6	6	6.5	6	6	6	6	6	6	6	6	6	6	6	6	4.5	**211**
218.9	4.5	6	6	6	6.5	6	6	6	6	6	6	6	6.5	6	6	6	6	4.5	**212**
219.8	4.5	6	6	6	6.5	6	6	6	6	6	6	6.5	6.5	6	6	6	6	4.5	**213**
220.7	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**
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	4.5	**215**
222.6	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**
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	6.5	4.5	**217**
224.4	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**
225.3	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**
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	6.5	6.5	4.5	**220**
227.1	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**
228	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**
228.9	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**
229.9	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**
230.8	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**
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	4.5	**226**
232.6	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**
233.6	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**
234.5	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**
235.4	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**
236.3	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**
237.2	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**
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	6.5	5	**233**
239	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**
239.9	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**
240.8	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**
241.7	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**
242.6	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**
243.5	5	7	7	6.5	7	7	6.5	7	6.5	7	6.5	7	7	6.5	7	7	7	5	**239**

Total Spill	BON Spill Patterns – Vertical Gate Opening (ft) per Spill Bay (0.5 ft = 1 Gate Stop)																		Total Stops
(kcfs)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	(1 stop= 0.5')
244.4	5	7	7	7	7	7	6.5	7	6.5	7	6.5	7	7	6.5	7	7	7	5	**240**
245.3	5	7	7	7	7	7	6.5	7	6.5	7	6.5	7	7	7	7	7	7	5	**241**
246.2	5	7	7	7	7	7	7	7	6.5	7	6.5	7	7	7	7	7	7	5	**242**
247.1	5	7	7	7	7	7	7	7	6.5	7	7	7	7	7	7	7	7	5	**243**
248	5	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	5	**244**
248.8	5	7	7	7	7.5	7	7	7	7	7	7	7	7	7	7	7	7	5	**245**
249.7	5	7	7	7	7.5	7	7	7	7	7	7	7	7.5	7	7	7	7	5	**246**
250.6	5	7	7	7	7.5	7	7	7	7	7	7	7.5	7.5	7	7	7	7	5	**247**
251.5	5	7	7	7	7.5	7.5	7	7	7	7	7	7.5	7.5	7	7	7	7	5	**248**
252.4	5	7	7	7	7.5	7.5	7	7.5	7	7	7	7.5	7.5	7	7	7	7	5	**249**
253.3	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**
254.1	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**
255	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**
255.9	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**
256.8	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**
257.7	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**
258.6	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**
259.5	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**
260.3	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**
261.2	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**
262.1	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**
262.9	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**
263.8	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**
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	**263**
265.6	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**
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	7.5	7.5	5	**265**
267.3	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**
268.2	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**
269.1	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**
269.9	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**
270.8	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**
271.7	5	7.5	8	8	8	8	7.5	8	7.5	8	7.5	8	8	8	8	8	7.5	5	**271**
272.5	5	7.5	8	8	8	8	8	8	7.5	8	7.5	8	8	8	8	8	7.5	5	**272**
273.4	5	7.5	8	8	8	8	8	8	7.5	8	8	8	8	8	8	8	7.5	5	**273**

Total Spill	BON Spill Patterns – Vertical Gate Opening (ft) per Spill Bay (0.5 ft = 1 Gate Stop)																		Total Stops
(kcfs)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	(1 stop= 0.5')
274.3	5	7.5	8	8	8	8	8	8	8	8	8	8	8	8	8	8	7.5	5	**274**
275.1	5	7.5	8	8	8.5	8	8	8	8	8	8	8	8	8	8	8	7.5	5	**275**
276	5	7.5	8	8	8.5	8	8	8	8	8	8	8	8.5	8	8	8	7.5	5	**276**
276.9	5	7.5	8	8	8.5	8	8	8	8	8	8	8.5	8.5	8	8	8	7.5	5	**277**
277.7	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**
278.6	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**
279.5	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**
280.3	5	8	8	8	8.5	8.5	8	8.5	8	8	8	8.5	8.5	8	8	8	8	5	**281**
281.2	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**
282	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**
282.9	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**
283.8	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**
284.6	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**
285.5	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**
286.3	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**
287.2	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**
288.1	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**
288.9	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**
289.7	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**
290.6	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**
291.4	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**
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	**295**
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	8.5	8.5	5	**296**
294	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**
294.8	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**
295.7	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**
296.5	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**