Section 2

Bonneville Dam

Bonneville Dam

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

1.1. Juvenile Fish Passage.

1.1.1. Facilities Description, Powerhouse One. Juvenile fish passage facilities at the Bonneville Powerhouse One consist of chaingates and an ice and trash sluiceway.

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

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

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

1.1.2.3. The Powerhouse Two Corner Collector is located on the south side of the powerhouse. The associated flume extends several hundred feet west on the south side of the Powerhouse Two tailrace and empties at the tip of Cascades Island.

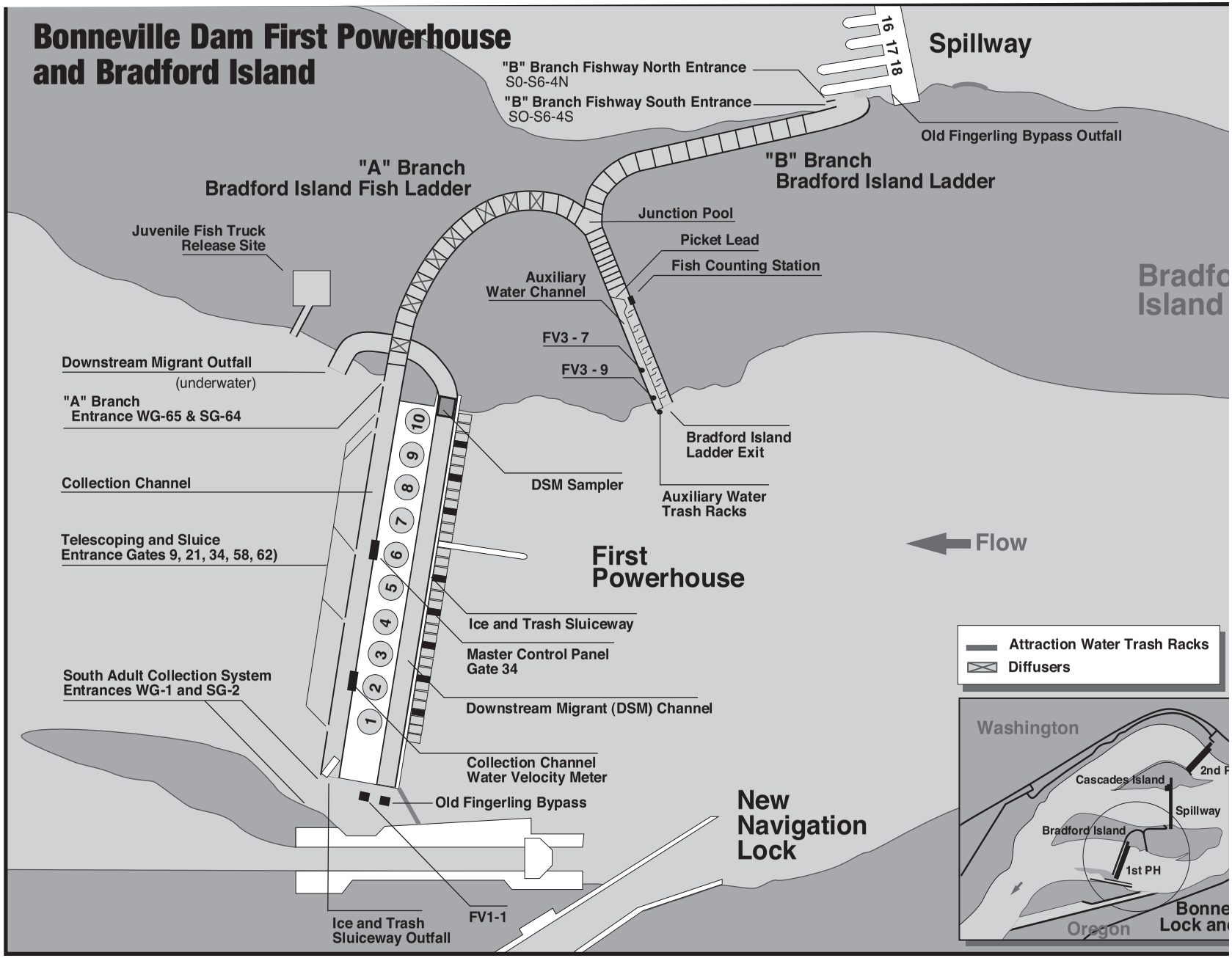


Figure BON-1 Bonneville Dam first powerhouse and Bradford Island fish ladder.

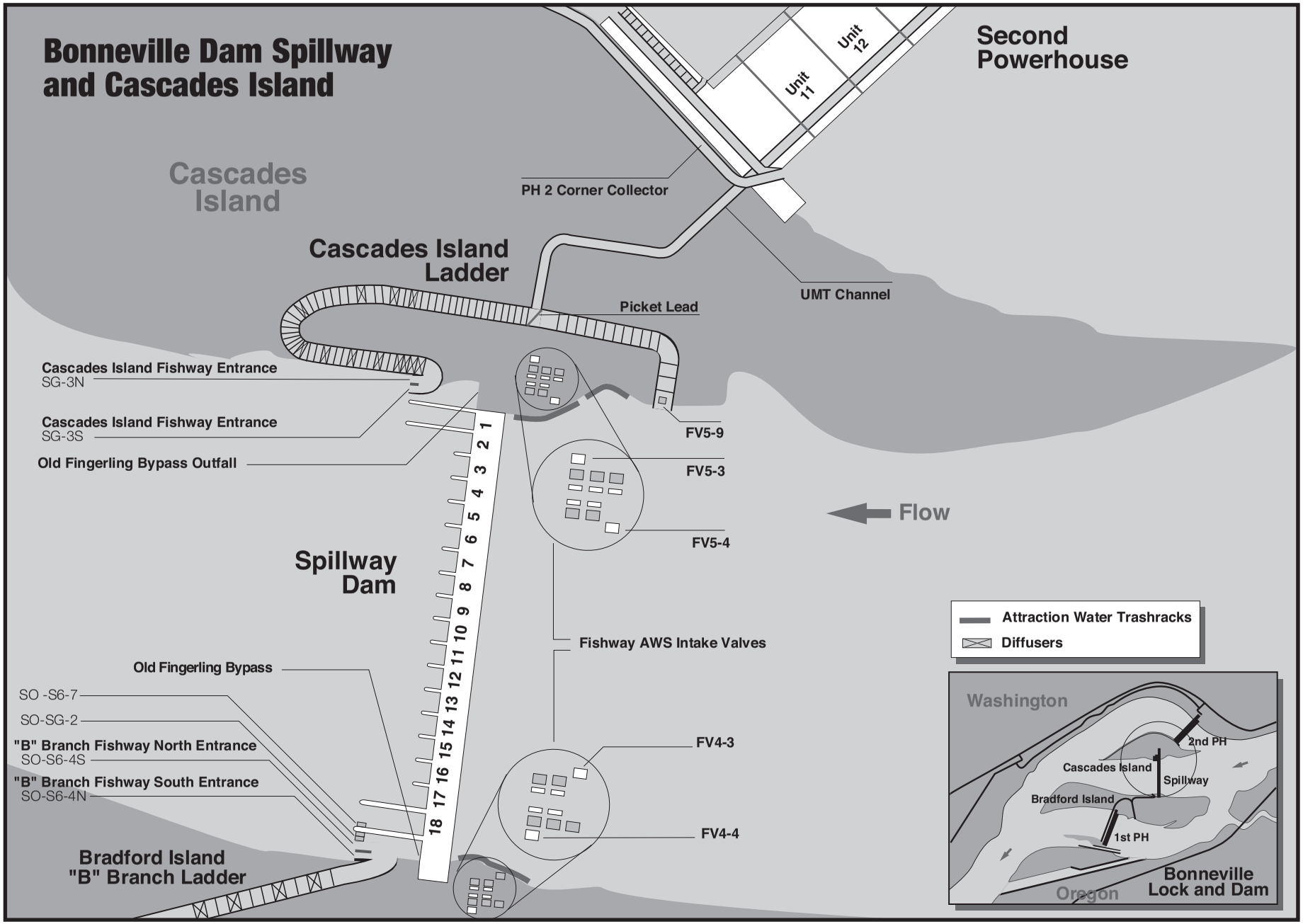


Figure BON-2 Bonneville Dam spillway, Cascades Island fish ladder and upstream migrant transportation channel (UMT).

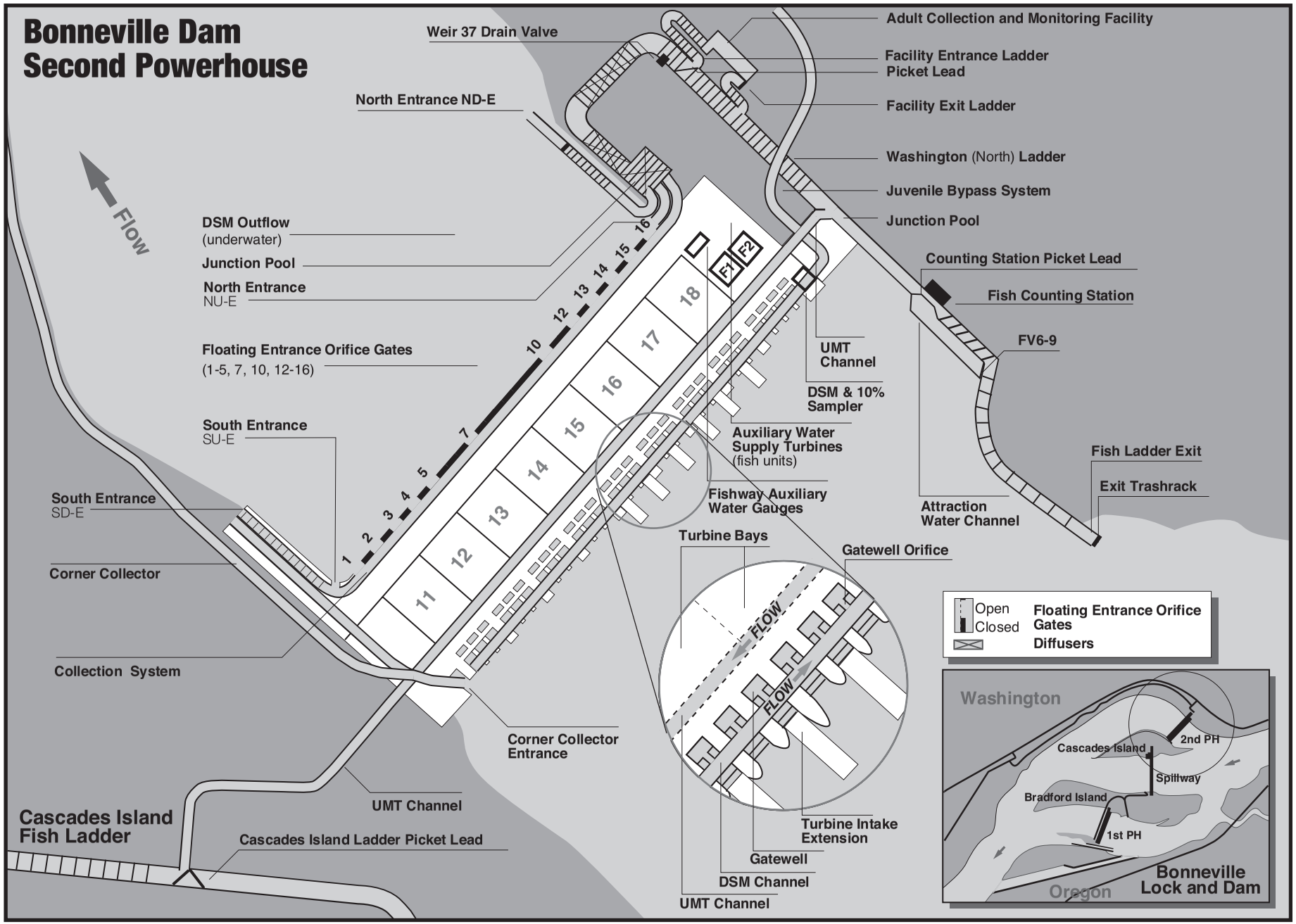


Figure BON-3 Bonneville Dam second powerhouse and Washington (north) fish ladder.

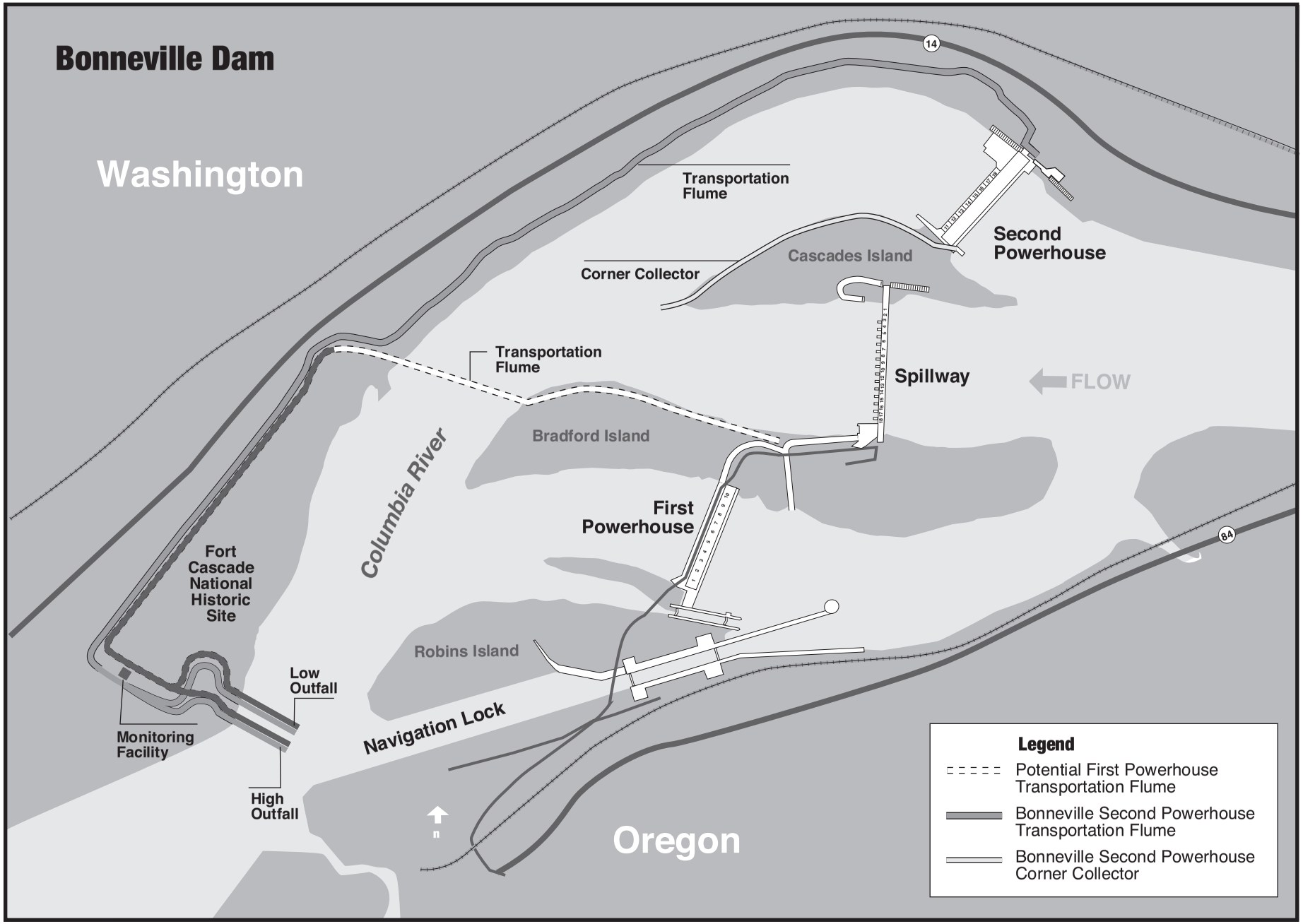


Figure BON-4 Bonneville juvenile fish passage system.

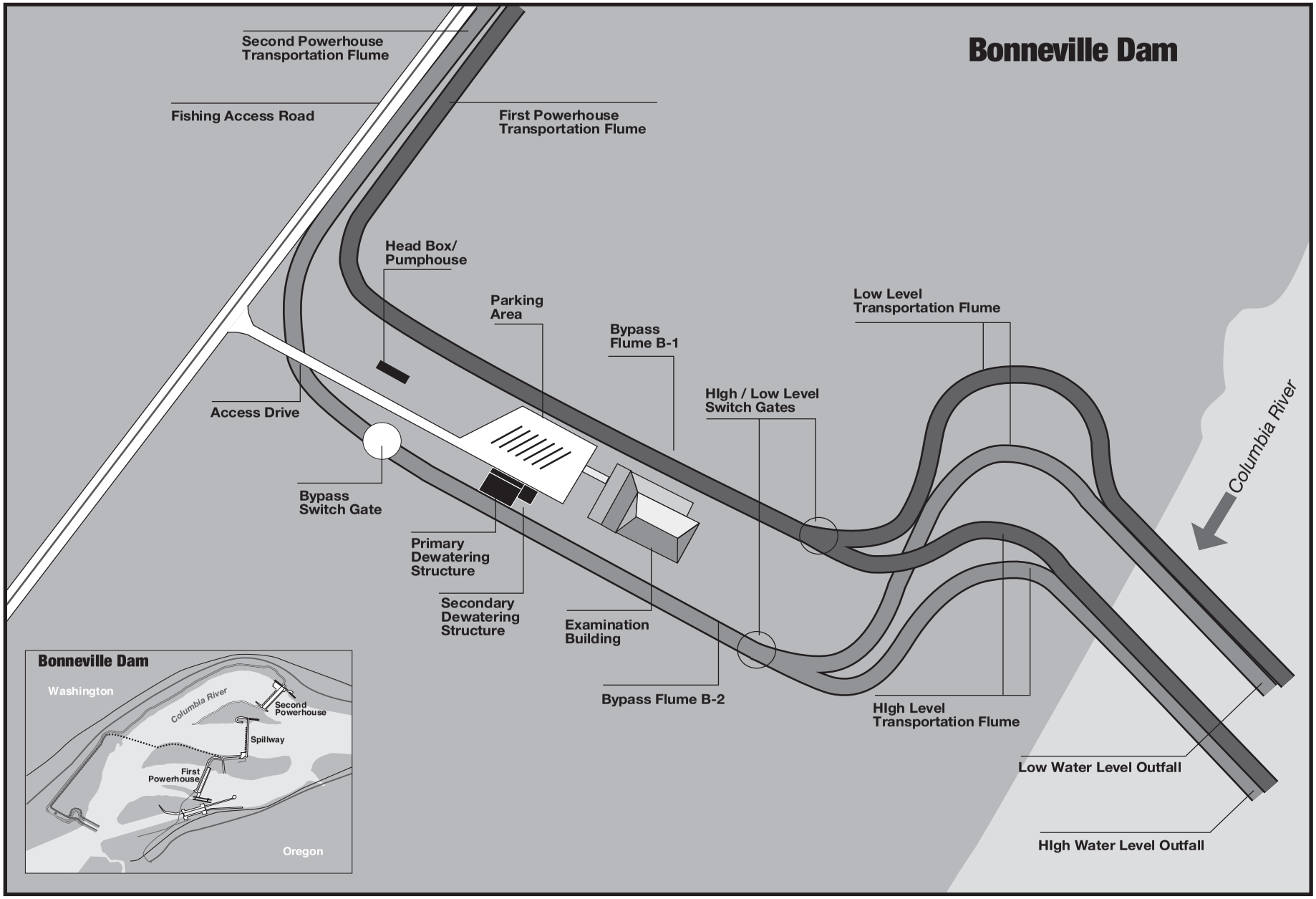
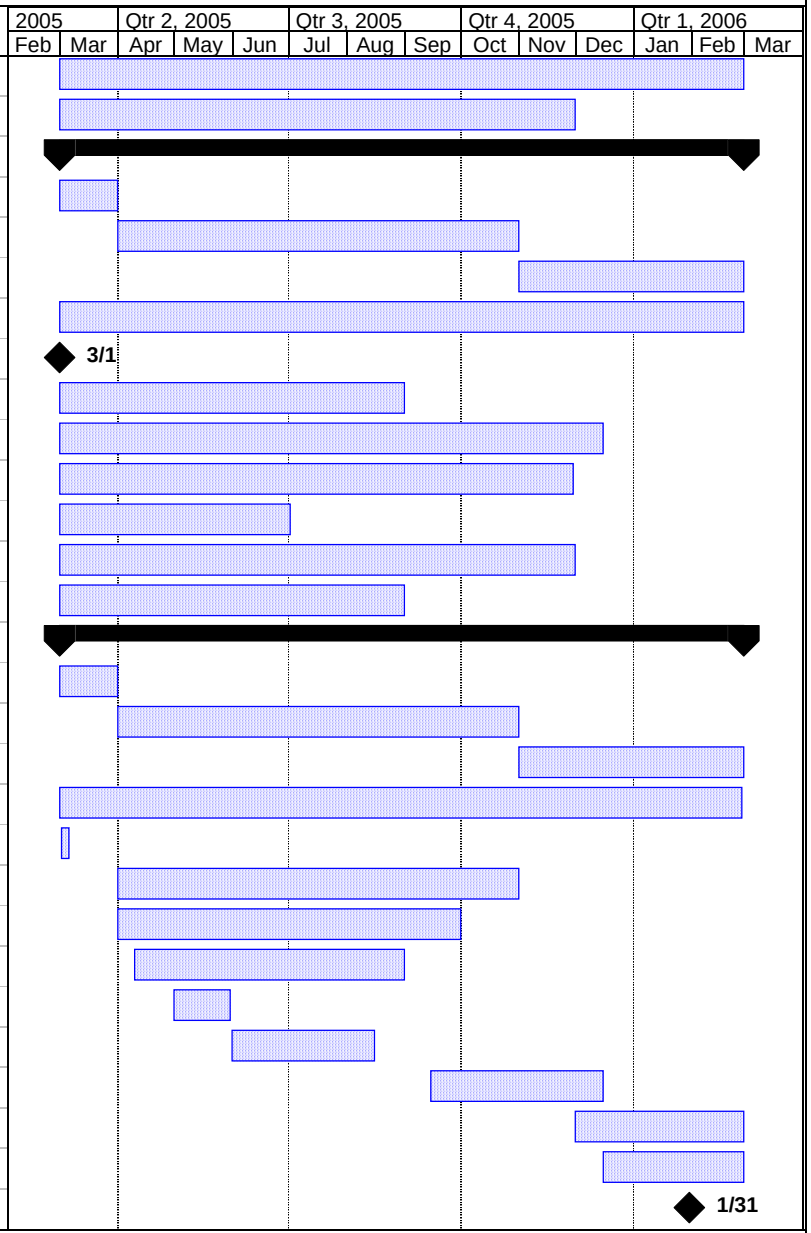


Figure BON-5 Bonnevillle Dam juvenile fish monitoring facility and outfall flumes.

Table BON-1. Dates of project operations for fish purposes at Bonneville Dam, 2005

Task Name	Start	Finish	FPP Reference
Weekly Reports	3/1/05	2/28/06	Bon 3.3.1
Juvenile Migration Timing	3/1/05	11/30/05	Bon 1.1.3
Adult Fish Counting	**3/1/05**	**2/28/06**	**Bon 1.2.2.2**
Video Count 0400 - 2000 PST	3/1/05	3/31/05	Bon 1.2.2.2
Visual Count 0400 - 2000 PST	4/1/05	10/31/05	Bon 1.2.2.2
Video Count 0400 - 2000 PST	11/1/05	2/28/06	Bon 1.2.2.2
TDG Monitoring	3/1/05	2/28/06	App D Phase 2
Avian Abatement in Place	3/1/05	3/1/05	Bon 2.4.1.1 e
Operate Avian Cannons	3/1/05	8/31/05	Bon 2.4.2.5.a.5
Screens in Place - PH2	3/1/05	12/15/05	Bon 2.4.2.2.a
Operation of Ice & Trash Chute	3/1/05	11/30/05	Bon 2.4.1.2.d
TIES in place	3/1/05	7/1/05	Bon 2.4.2.1.J & Bon 2.4.2.2.O
Adult Fish Passage Season	3/1/05	11/30/05	Bon 2.5.1.2
Spill Gates 1 and 18 Open 4"	3/1/05	8/31/05	Table Bon-6 & Bon 2.2.3.1
1% limitations	**3/1/05**	**2/28/06**	**Bon 5.3**
1% soft constraint	3/1/05	3/31/05	Bon 5.3
1% hard constraint	4/1/05	10/31/05	Bon 5.3
1% soft constraint	11/1/05	2/28/06	Bon 5.3
PH2 - priority	3/1/05	2/28/06	Table Bon-5
Spring Creek Hatchery Release Approx.	3/2/05	3/6/05	App A Bon 1.1 & Bon 2.4.2.3.a
Adult Salmon & Steelhead Eval	4/1/05	10/31/05	App A Bon 2.5
Eval of Gatewell Mods	4/1/05	9/30/05	App A Bon 2.6
Spill for Juvenile Fish	4/10/05	8/31/05	App A Bon 1.2
Bon Rehab Biological Testing	5/1/05	5/31/05	App A Bon 2.1
Special Spill Time for Sockeye	6/1/05	8/15/05	Bon 2.2.3
2 Screens in Place - PH1	9/15/05	12/15/05	Bon 2.4.1.1.1.a & Bon 2.5.3.f
Maintenance of Adult Fish Facilities	12/1/05	2/28/06	Bon 1.2.2.2
Maintenance of Juvenile Fish Facilities	12/16/05	2/28/06	Bon 1.1.3
Annual Report	1/31/06	1/31/06	Bon 3.3.3



1.1.3. Juvenile Migration Timing. The juvenile fish migration season occurs from March 1 through November 30. Tables BON-2a and BON-2b show the primary passage periods for each species. Maintenance of juvenile fish facilities is scheduled for the period December 16 through February to reduce 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-2a. PH1 10%, 50%, and 90% passage dates for 1995-1999

Yearling Chinook	10 %	50%	90 %	# of Days
1995	Apr 17	May 09	May 26	40
1996	Apr 19	May 02	May 27	39
1997	Apr 20	May 04	May 26	37
1998	Apr 23	May 05	May 23	31
1999	Apr 21	May 09	May 30	40
MEDIAN	Apr 20	May 05	May 26	39
MIN	Apr 17	May 02	May 23	31
MAX	Apr 23	May 09	May 30	40

Subyearling Chinook - "Brights" Only	10 %	50%	90 %	# of Days
1995	Jun 06	Jun 23	Jul 15	40
1996	Jun 09	Jun 29	Jul 18	40
1997	Jun 07	Jun 26	Jul 29	53
1998	Jun 03	Jun 16	Jul 20	48
1999	Jun 11	Jun 30	Jul 25	45
MEDIAN	Jun 07	Jun 26	Jul 20	45
MIN	Jun 03	Jun 16	Jul 15	40
MAX	Jun 11	Jun 30	Jul 29	53

Unclipped Steelhead	10 %	50%	90 %	# of Days
1995	Apr 28	May 12	May 27	30
1996	Apr 24	May 06	May 26	33
1997	Apr 23	May 08	May 25	33
1998	Apr 27	May 12	May 31	35
1999	Apr 24	May 13	Jun 01	39
MEDIAN	Apr 24	May 12	May 27	33
MIN	Apr 23	May 06	May 25	30
MAX	Apr 28	May 13	Jun 01	39

Clipped Steelhead	10 %	50%	90 %	# of Days
1995	May 04	May 17	May 29	26
1996	Apr 27	May 16	May 29	33
1997	Apr 29	May 13	May 28	30
1998	May 02	May 15	Jun 01	31
1999	Apr 27	May 19	Jun 05	40
MEDIAN	Apr 29	May 16	May 29	31
MIN	Apr 27	May 13	May 28	26
MAX	May 04	May 19	Jun 05	40

Coho	10 %	50%	90 %	# of Days
1995	Apr 28	May 13	May 29	32
1996	Apr 23	May 14	May 28	36
1997	Apr 29	May 18	Jun 04	37
1998	May 03	May 20	Jun 04	33
1999	Apr 28	May 23	Jun 07	41
MEDIAN	Apr 28	May 18	Jun 04	36
MIN	Apr 23	May 13	May 28	32
MAX	May 03	May 23	Jun 07	41

Sockeye (Wild + Hatchery)	10 %	50%	90 %	# of Days
1995	May 10	May 19	May 27	18
1996	May 04	May 18	Jun 02	30
1997	May 06	May 21	Jun 22	48
1998	May 10	May 15	May 29	20
1999	May 10	May 17	Jun 01	23
MEDIAN	May 10	May 18	Jun 01	23
MIN	May 04	May 15	May 27	18
MAX	May 10	May 21	Jun 22	48

Table BON-2b. PH2 10%, 50%, and 90% passage dates for 2000-2004.

Yearling Chinook	10 %	50%	90 %	# of Days
2000	Apr 23	May 17	Jun 01	40
2001	Apr 26	May 11	Jun 06	42
2002	Apr 25	May 18	Jun 01	38
2003	Apr 22	May 14	May 31	40
2004	Apr 17	May 04	May 30	44
MEDIAN	Apr 23	May 14	Jun 01	40
MIN	Apr 17	May 04	May 30	38
MAX	Apr 26	May 18	Jun 06	44

Subyearling Chinook[1]	10 %	50%	90 %	# of Days
2000	Jun 06	Jun 22	Jul 19	44
2001	Jun 07	Jul 09	Aug 15	70
2002	Jun 21	Jul 03	Jul 20	30
2003	Jun 15	Jul 01	Jul 19	35
2004	Jun 10	Jun 28	Jul 14	35
MEDIAN	Jun 10	Jul 01	Jul 19	40
MIN	Jun 06	Jun 22	Jul 14	30
MAX	Jun 21	Jul 09	Aug 15	70

Unclipped Steelhead	10 %	50%	90 %	# of Days
2000	Apr 23	May 16	Jun 01	40
2001	May 02	May 18	Jun 09	39
2002	May 01	May 27	Jun 09	40
2003	May 03	May 27	Jun 09	38
2004	Apr 17	May 16	May 31	45
MEDIAN	May 01	May 22	Jun 09	40
MIN	Apr 17	May 16	May31	38
MAX	May 03	May 27	Jun 09	45

Clipped Steelhead	10 %	50%	90 %	# of Days
2000	Apr 28	May 18	Jun 04	38
2001	May 07	May 20	Jun 12	37
2002	May 02	May 27	Jun 11	41
2003	May 07	May 30	Jun 11	36
2004	Apr 30	May 16	May 27	28
MEDIAN	May 24	May 20	Jun 11	41
MIN	Apr 28	May 16	May 27	28
MAX	May 07	May 30	Jun 12	41

Coho	10 %	50%	90 %	# of Days
2000	May 06	May 22	Jun 03	29
2001	May 15	May 24	Jun 03	20
2002	May 06	May 19	Jun 06	32
2003	Apr 29	May 16	Jun 09	42
2004	Apr 18	May 05	May 27	40
MEDIAN	May 18	May 19	Jun 03	29
MIN	Apr 29	May 05	May 27	20
MAX	May 15	May 24	Jun 09	42

Sockeye	10 %	50%	90 %	# of Days
2000	May 05	May 25	Jun 07	34
2001	Jun 03	Jun 10	Jun 25	23
2002	May 13	May 23	Jun 09	28
2003	May 12	May 20	Jun 05	25
2004	May 21	Jun 01	Jun 15	26
MEDIAN	May 13	May 25	Jun 09	28
MIN	May 05	May 20	Jun 05	23
MAX	Jun 03	Jun 10	Jun 25	34

[1] Includes upriver brights only (excludes 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. The Powerhouse One collection channel and A-branch ladder join the south spillway entrance and B-branch ladder at the junction pool at the Bradford Island ladder to form the Bradford Island fishway. The downstream migration channel (DSM) is also used for adult passage from September 15 through December 15. The system consists of 12″ orifices, six STSs and VBSs, and a migration channel that runs south and out the ice and trash sluiceway.

1.2.1.2. The Cascades Island ladder at the north side of the spillway is connected to the Washington shore ladder by the upstream migrant transportation (UMT) channel. The Powerhouse Two collection channel and north and south monoliths join the UMT to form the Washington shore fishway.

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

1.2.2. Adult Migration Timing. Upstream migrants are present at the project throughout the year and adult passage facilities are operated year round. Because passage through the winter months is relatively light, fish counting is by video rather than visual counting, primarily to monitor winter steelhead passage.

1.2.2.1. The adult fish count schedule is shown in Table BON-3.

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

Table BON-3. Adult fish counting schedule.

Period	Counting Method
January 1 – March 31	Video count 0400–2000 PST
April 1 – October 31	Visual count 0400-2000 PST
November 1 - December 31	Video count 0400–2000 PST

1.2.2.3. Adult migration count data for Bonneville Dam have been collected since 1938. Table BON-4 summarizes adult fish passage timing through 2004. The primary passage period and the earliest and latest peaks of migration recorded are listed for each species (from fish counts compiled by the Corps). Steelhead are counted by video at Bonneville Dam from November 01 through March 31 as described in Table BON-3, but the ESA-listed winter steelhead population passage period is considered to be from November 16 through March as described in Table BON-4. Peak winter steelhead migration timing for the years 1999-2004 appears in Table BON-4.

Table BON-4. Adult migration timing from fish counts, 1938-2004.

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

* = Lamprey data for 2000 – 2004

2. Project Operation.

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

2.1.1. Powerhouse Flow Distribution. Bonneville turbine operating priority is established as outlined in Table BON-5. If a turbine is out of service, use the next turbine in the priority list.

2.1.2. When adult salmonid counts equal or exceed 30,000 fish/day before August 31, project fisheries will initiate FPOM coordination to discuss options for powerhouse flow-splitting to provide additional flow attraction areas to help balance adult passage among the project’s fishways. When adult salmonid counts equal or exceed 25,000 fish/day after August 31, the Project will operate two priority turbines at PH1 in an attempt to balance adult passage between both powerhouses (assuming there was no prior unit operation at PH1). This operation will continue until Project fish counts fall below 20,000 fish.

2.1.3. Other Activities. Research, non-routine maintenance, other fish-related activities, and construction activities will not be conducted within 100' of any fishway entrance or exit or within 50' of the rest of the fishway, unless concurred with by regional fish managers through ESA and other fish passage forums. Currently approved special operations are described in Appendix A. Alternate actions will be considered by district and project biologists in coordination with the fish managers 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 in advance with the project.

Table BON-5. Turbine unit operating priorities, Bonneville Powerhouses One and Two.

PERIOD	PRIORITY
Year-round when adult fish ladders are in service	**11,18,15,12,17,14,13,16, 3,1,4,6,2,5,7,10,9,8**
First Powerhouse Adult Fish Ladder out of service	**11,18,15,12,17,14,13,16, 3,1,4,6,5,7,10,9,8**
Second Powerhouse Adult Fish Ladder out of service	**3,1,4,6,5,7,10,9,8 11,18,15,12,17,14,13,16**

See Appendix A, BON section, para. 3.0 for unit priorities during FGE and survival tests. Additional changes in unit priorities may occur and will be authorized in RCC teletypes as needed.

2.2. Spill Management.

2.2.1. General. Only one spill schedule will be used at Bonneville Dam (Table BON-15).

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

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

2.2.1.3. The hours of nighttime spill are the daily complements of the periods of daytime spill (Table BON-6). The transition from daytime spill cap to nighttime spill cap and vice versa will normally take 15 to 20 minutes due to the time required to start, synchronize, and load multiple generators. The transition to the daytime spill period should not start until after the nighttime cap period is over.

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

2.2.2. Juvenile Fish. Spill planning dates for juvenile fish passage have a start date of April 10 and end date of August 31.

These are planning dates and are flexible according to specific requirements relating to fish abundance. The daytime spill amount is 75 kcfs in order to reduce adult fallback. The NMFS 2004 BiOp sets a minimum spill level of 50 kcfs. At night, the spill amount will be up to the 120% gas cap.

2.2.3. Adult Fish. During the primary adult fish passage period, March 01 through November, daytime spill will be limited to 75 kcfs whenever possible. Normally, this restriction will be from one hour before sunrise to one half hour after sunset (Table BON-6). However, during the sockeye passage season, which begins when at least 10 adult sockeye pass the project per day, but no later than June 1 through August 15, the cap will apply until one hour after sunset.

2.2.3.1. From September 1 through November 30, and from March 1 to the beginning of spill for juvenile fish passage in early April, provide spill from bays 1 and 18 with each spill gate open 6″. From December 1 through February 28, provide spill for adult attraction from Spill Bay 1 by setting the spill gate open 6″. Spill for these periods will occur during daylight hours, as indicated in Table BON-6.

Table BON-6. Daytime spill schedule for Bonneville Project.

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

[1] Start date for sockeye passage varies.

2.3. Total Dissolved Gas (TDG) Management and Control. Implementation of spill requests will take into account TDG monitoring data and the observed condition of migrant juveniles and adults, along with juvenile migration monitoring data.

2.3.1. The Corps will monitor TDG from a station in the Bonneville forebay and from multiple stations located below Bonneville Dam.

2.3.2. The TDG data will be reported every four hours starting prior to the Spring Creek National Fish Hatchery (NFH) fish release, but not later than March 10 for all stations at Bonneville. Spill volume and total project flow will be reported at the same time.

2.3.3. The TDG data collection will continue year round at Bonneville forebay and Warrendale stations. The TDG monitoring plan is described in detail in Appendix D.

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

2.4. Juvenile Fish Passage Facilities.

2.4.1. Powerhouse One Operating Criteria

2.4.1.1. December 01 through February 28 (Winter maintenance period).

a. Screens (STS,VBS) in place in the two PH1 priority units will remain until December 15 to prevent adult salmonids from falling back through turbine units, thereby shortening some aspects of the winter maintenance period by two weeks.

b. Remove all STSs and VBSs after 15 December.

c. 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.

d. Remove debris from forebay, trash racks, and gatewell slots such that these areas are free of debris.

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

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

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

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

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

d. Open ice and trash sluiceway chain gate. Open chain gate 1C, 3C and 6C to 71.5’ msl.

e. The ice and trash sluiceway (ITS) operations after October 01 are detailed in section **2.5.3.g**

f. This authorization may be terminated at any time if problems arise that negatively impact fish migration or condition.

g. All gatewell orifices should be opened and DSM1 ran south from September 15 through December 15. This is to reduce the number of adults that fall back through the turbine units. Please refer to section **2.5.3.f**

2.4.2. Powerhouse Two Operating Criteria,

2.4.2.1. December 01 through February 28 (winter maintenance period).

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

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

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

d. DSM2 may be dewatered only when required for maintenance. The maintenance period will be minimized to the extent practicable.

e. Remove debris from forebay, trash racks and gatewell slots such that these areas are free of debris.

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

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

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

j. TIES for units 15-18 will be re-installed just prior to the start of the juvenile fish passage season, including, when practicable, prior to early fish releases from Spring Creek NFH.

k. 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.

l. Avian Predation Lines. Reinstall or repair avian

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

2.4.2.2. March 01 through November 30 (Fish passage season).

a. Juvenile fish protection devices (STS, etc.) will be in place prior to the juvenile fish passage season. (In the event that juvenile fish are released from Spring Creek NFH prior to March, the screens will be installed before the release occurs. The release for 2005 is 2 March.) Screens (STSs and VBSs) will remain in operation through December 15 to prevent adult salmonids from falling back through turbine units.

b. Main unit gatewell drawdown will be measured a minimum of once per week

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

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

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

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

g. Observe each STS watt and/or amp gauge at least once each day and record reading once per day. If an STS failure

occurs, then follow procedures in Fish Facility Maintenance.

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

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

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

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

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

i. If STS or VBS damage or plugging is detected, follow procedures in Fish Facilities Maintenance. Records of inspections or a summary of such records will be made available to FPOM by the February meeting, upon request.

j. All gatewell orifice systems should be operational.

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

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

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

k. Replace all burned out orifice lights within 24 hours. Orifice lights shall remain lighted 24 hours/day.

1. The DSM gallery lights should be left off except

when project or other staff is in the gallery.

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

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

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

m. A slight oily sheen is commonly found in many gatewells. This may come from sources such as lubricated lifting beams, etc. When unusual accumulations of oil (e.g., oil slick) occur in gate slots, they will be removed within 24 hours. 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 FPC and NOAA FISHERIES. Regardless of unit operating status, oil accumulations will be dealt with promptly.

1. Coordinate gatewell cleaning with personnel operating downstream sampling facilities.

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

o. TIES for units 15-18 will be removed following the spring juvenile yearling chinook out-migration period, usually in early July.

2.4.2.3. B2 Corner Collector Operation.

a. In 2005, operate the corner collector for the Spring Creek NFH fall Chinook release for an interagency-determined period of approximately 4 days beginning March 3. Operate the corner collector during spill season. Remove and install the headgate and bulkhead within 12 hours of the start and end of

spill season as possible.

2.4.2.4. DSM2 Channel Operation.

a. Screen cleaners. The primary screen cleaner will be the airburst system. The system is currently set to cycle every 60 minutes. The Project biological staff will coordinate with FPOM and other regional forum groups to develop a method to further evaluate the effectiveness of the airburst

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

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

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

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

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

b. Operation. Maintain the channel elevation between 64.2′ and 64.4′ as indicated by the staff gauge in front of the ERG. The system is designed to maintain the channel elevation at 64.3′ in automatic control. If the channel elevation increases or decreases, the PLC system will close or open orifices, respectively.

Table BON-7. DSM2 regulating orifice control (FB is forebay and "X" is open).

Orifice	FB <=71.5	FB <=72.5	FB <=73.5	FB <=74.5	FB <=75.5	FB <=76.5
11A-S	X	X	X	X	X	
11B-S	X	X	X	X		
11C-S	X	X	X	X		
12A-S	X	X	X			
12B-S	X	X	X			
12C-S	X	X				
13A-S	X	X				
13B-S	X	X				
13C-S	X					
14A-S	X					
14B-S	X					
14C-S	X					

2.4.2.5. Fish Transport Pipe and Flume.

a. Operation.

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

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

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

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

5. Operate the outfall avian cannons from March 1 through August 31. During August, avian cannons may be shut off if project observes no predatory birds at the outfall, and coordinates through FPOM. If birds reappear at the outfall, cannon operation will resume and FPOM will be informed. The cannons will be operated 24 hours/day during fish passage season.

2.4.2.6. Juvenile Monitoring Facility.

a. Background. The JMF is comprised of a transport flume,

Primary Dewatering Structure (PDS), adult transport flume, juvenile hopper, Secondary Dewatering Structure (SDS), 3-way diverter gate, 2-way diverter gate, sampling facility, and juvenile release transport flume.

b. Operation.

1. PSMFC personnel will operate the sampling facility as part of the smolt monitoring program and to collect fish for regionally approved research. Updated will go through the project biologist to the FPOM Coordination Team.

2. PSMFC personnel will monitor the facility 24/7 throughout the sampling season.

3. A PSMFC person on duty will perform a walk-through inspection of the entire facility (except the 2-mile transport flume) every two hours to ensure safe fish passage conditions. They will also observe video monitors at least every half hour or continually, and inspect manually every two hours or more frequently according to trash sweep operation or other debris potential. PSMFC shall monitor kelt passage over the separator.

4. Particular attention will be paid to the following: dewatering facilities including the PDS, SDS, PDS screen cleaner system, adult transport flume, juvenile hopper, all valves and auxiliary water systems, flushing water systems and their perforated plates, all gates including switch and diverter gates, PIT tag detectors, and all monitoring building systems including holding tanks, valves, and conduits to prevent injury and/or mortality to passing fish.

5. Monitor outfall avian cannons.

c. System Failures.

1. Any system failure will be reported to a project biologist as soon as possible. If a project biologist is unavailable, the control room will be contacted. The following actions should be taken in specific situations:

2. If a high or low water situation occurs in the PDS area, contact the control room immediately. If water level is uncontrollable, immediately switch the upper switchgate to bypass mode until the problem is corrected.

3. If a monitoring facility failure occurs, immediately switch the upper switchgate to bypass mode until repairs are made. Begin fish salvage operations immediately at

the monitoring facility.

4. If a lower switchgate failure occurs that results in releasing to the wrong high or low outfall and repairs can not be made within 24 hours, the special operation will be coordinated through FPOM.

5. If a problem with either the 2 way or 3 way rotating gates (e.g. stuck open or partially open) is discovered, the response protocol should be as follows:

a. Switch upper switchgate to bypass prior to following the sequence of directions below.

b. Immediately turn off the air to the rotating gate and manually rotate the half-round pipe section to the bypass position.

c. Inspect the affected areas for stranded fish and return them to the flume. Dead fish should be held in a bucket for processing by SMP personnel.

d. Immediately contact the project biologist, or if that is not possible, the control room operator. The operator will contact repair personnel.

e. Repairs should commence within 4 hours of discovering the problem.

f. Once all fish safety issues have been addressed and repair requests made, the problem should be thoroughly documented in writing and that information e-mailed to the SMP site biologist and other interested parties.

2.4.3. Spillway Operating Criteria.

2.4.3.1. December 01 through February 28 (winter maintenance).

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

b. Refer to Appendix E or section 2.2 for spill guidance during winter maintenance periods at Bonneville Project.

2.4.3.2. March 01 through November 30 (Fish Passage Season). Bonneville Dam uses a single spill schedule for both day and night. Spill will be provided according to the guidance in

section 2.2.

2.5. Adult Fish Passage Facilities.

2.5.1. All Adult Fish Passage Facilities Operating Criteria.

2.5.1.1. December 01 through end of February (winter maintenance period).

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

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

c. Turbines will be operated in the priority outlined in Table Bon 5 during the winter maintenance period.

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

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

f. Please see section **2.2.3.1.** and Table Bon-6 to determine spill bays 1 and 18 operating criteria

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

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

i. 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.

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

k. Reinstall picket leads at counting stations prior to watering up the ladders during maintenance.

l. Remove STSs and VBSs from PH1 turbine units the week of December 15.

2.5.1.2. March 01 through November 30 (fish passage season).

a. Maintain the water depth over fish ladder weirs at 1' +/- 0.1' during the non-shad passage season (August 16 through May 14) and 1.3' +/- 0.1' during the shad passage season (May 15 through August 15). 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 gauge in the Cascades Island fishway.

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

c. Head on all entrances should be: 1' to 2' (1.5' preferred). Head at the NUE is calculated differently because the collection channel staff gauge 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 gauges closest to NUE. Refer to Table BON-11 when unable to achieve head criterion.

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

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

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

g. Stillwells used in lieu of staff gauges will be checked

for calibration once per week.

h. The current fish counting program is conducted 16 hours per day, year around (See Table BON-3). Count station crowders shall remain in the operating position while visual counting and/or videotaping is being conducted.

1. The crowder shall be closed to allow the count slot width to be no less than 18 inches. This will usually occur during high turbidity conditions to allow count accuracy criteria to be achieved.

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

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

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

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

6. Leave the fish passage slot lighted overnight.

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

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

2.5.2. Main Dam Ladders.

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

b. 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. When the tailwater is below 9', sluice gates SW-SG-3N, SW-SG-3S, SO-SG-4N, and SO-SG-4S shall be open. When the tailwater is between 9' and 17', sluice gates SO-SG-4S and SW-SG-3N shall close. When the tailwater exceeds 17', sluice gates SW-SG-3N, SW-SG-3S, SO-SG-4N, and SO-SG-4S shall be closed.

2.5.3. Powerhouse One.

a. Weir Gates. The Powerhouse One weir gates will be operated as shown in Table BON-8.

1. 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'.

Table BON-8. Bonneville Dam first powerhouse weir gate requirements.

Weir Gate	Submergence Requirement	Differential Requirement	Sill Elevation
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'

* When tailwater is <13.5’, the 8’ submergence requirement can not be satisfied.

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

b. Control of Fish Valve FV1-1.

1. 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.

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

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

d. Control of A-Branch Diffusion Gates FG3-3 through FG3-9. First powerhouse A-branch diffusers are open according to the pattern in Table BON-9.

Table BON-9. Bonneville Dam A-branch diffuser operating ranges.

Diffusers	Operating Range (Tailwater Elevation)	Dead Bands
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'

e. Powerhouse One Collection Channel Diffusers. Diffuser valves are operated according to the pattern in Table BON-10.

Table BON-10. Bonneville Dam first powerhouse adult fish collection channel diffuser valve settings.

Valve	Setting	Valve	Setting
FG2-1	Closed	FG2-13	Closed
FG2-2	Closed	FG2-14	Closed
FG2-3	Closed	FG2-15	Closed
FG2-4	Open	FG2-16	Closed
FG2-5	Closed	FG2-17	Closed
FG2-6	Closed	FG2-18	Closed
FG2-7	Closed	FG2-19	Open
FG2-8	Open	FG2-20	Open
FG2-9	Closed	FG2-21	Open
FG2-10	Closed	FG2-22A	Open
FG2-11	Closed	FG2-22B	Open
FG2-12	Open		

f. STSs and VBSs will be installed in two PH1 priority units on September 15. This is to prevent adult fallbacks from going through the turbines. The two priority units will be screened through December 15, with a spare STS and VBS available.

1. The Powerhouse One DSM will be watered up on

September 15, with water flow to the south. The DSM will remain heading south until STSs and VBSs are removed mid-December.

2. All orifices will be opened to provide appropriate water flow.

3. All units with fish screens will have operating orifice lights. All non-screened units should have the orifice lights off.

4. Spare screens may be stored below the deck even with the orifices open. All but seven screens will be scrapped and removed in Spring 2005.

g. At least two adjacent chaingates should remain open from October 01 through the end of February. The two gates should be located over priority operating units and set to elevation 72.0’ msl. If possible, 10C should also be open about 1-2’ below forebay to provide flushing flow for the ITS. This operation is in consideration for steelhead kelt passage.

2.5.4. Second Powerhouse Two.

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

b. Operate all 12 powerhouse floating gate fishway entrances.

3. Facility Monitoring and Reporting.

3.1. Inspections.

3.1.1. The results of all inspections and the readiness of the facilities for operation will be reported to the Fish Passage Operations and Maintenance Coordination Team (FPOM) at the meeting immediately prior to the fish passage season.

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

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

3.1.4. More frequent inspections of some facility components

will occur as noted throughout the text.

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

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

3.3. Reporting.

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

a. any out-of-criteria situations observed and subsequent corrective actions taken;

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

c. adult fishway control calibrations;

d. STS and VBS inspections;

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

f. when trapping is occurring in the AFF;

g. any unusual activities which occurred at the project which may affect fish passage.

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

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

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

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

c. The annual report will be provided to CENWP-OP 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 gauges and other water-level sensors will be installed, cleaned, and/or repaired as required.

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

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

4.2. Juvenile Fish Passage Facilities.

4.2.1. Routine Maintenance.

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

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

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

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

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

b. Certain turbine and spillway discharges at the projects are secondarily used to attract adult fish to fishway entrances, to keep predator fish from accumulating near juvenile release sites, and to move juveniles downstream away from the project. During the fish passage season, do not take units F1, F2, 1, 2, 11, 17, and 18 out of service, when practicable.

c. When practicable, do not take any other Powerhouse Two units out of service during June 21 through September 15, to minimize Powerhouse One operation.

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

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

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

a. Unscheduled maintenance that will have a significant impact on juvenile fish passage shall be coordinated with FPOM

and NOAA FISHERIES on a case-by-case basis by project and CENWP-OP biologists. The CENWP-OP biologists will be notified 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-OP when delay of the work will result in an unsafe situation for people, property, or fish. Information required by CENWP-OP includes:

A. Description of the problem.
B. Type of outage required.
C. Impact on facility operation.
D. Length of time for repairs.
E. Expected impacts on fish passage.

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

4.2.2.3 Juvenile Bypass System.

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

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

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

d. All STS gatewells will be inspected daily and the project will clean them before they become half covered with debris. If, due to volume of debris, it is not possible to keep the gatewell surfaces at least half clear, they will be cleaned at least once daily. Turbines with a gatewell fully covered with debris will not be operated, except on a last on/first off basis, if required to be in compliance with other coordinated fish measures. This is to maintain clean orifices and minimize fish injury. The gatewell orifices will be closed during the cleaning operation. Check gatewell drawdown and clean trashracks if necessary.

e. Powerhouse One. PH1 juvenile passage facilities will

not be in service in 2005.

f. Powerhouse Two. 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 Powerhouse Two. Repairs will receive high priority.

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

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

4.3. Adult Fish Passage Facilities.

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

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

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

require dewatering, such as diffusion gratings, leads, and entrance gates, will be scheduled once per year during the winter maintenance season while the system is dewatered, with one additional inspection during the fish passage season, unless a channel must be dewatered for fishway modifications or to correct observed problems.

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

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

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

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

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

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

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

4.3.1.4. Adult Fish Ladders and Counting Stations. (Also see Appendix G for adult fish trapping protocols.) The adult fish

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

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

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

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

b. Spillway. Two separate fishway auxiliary water valves add water to each spillway ladder (Cascades Island and B-branch ladders). If one of these valves or any other part of the system malfunctions, the functioning parts of the system are to be

adjusted to compensate. If repairs cannot be made in 24 hours, close the sluice gate entrance, if open. This will divert the reduced available water to the entrance slots. If a head of 1' is still not achieved, stoplogs are to be added to the entrance slots until the desired head or a weir depth of not less than 6' below the tailwater surface is reached. At this point maintain the gate positions until the auxiliary water system is repaired.

c. Powerhouse Two.

1. If either of the fishway auxiliary water turbines is unable to provide water sufficient to meet full criteria, the adult facilities will be operated according to Table Bon-11, Emergency Operations for Bonneville Powerhouse Two AWS Systems Operations or until a fishway head of 1’ is achieved.

2. Table Bon-11 is a guide for configuring turbine flows, floating orifices, diffuser gates, and main gates during emergency situations when one of the fish turbines has failed or been taken out of service.

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

3. Table BON-11 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.

Table Bon-11. Emergency Operations Table for Bonneville Second Power House AWS Systems Operation.

TW (ft)	Turbine MW	Turbine Q (cfs)	Floating Orifice Gates Closed	South "B" Diffuser Gates Closed	Power-House Diffuser Gates Closed	Main Entrance Gates Closed
8	13.90	2950	All	B3-8	C1-5	None
9	13.95	3010	All	B3-8	C1-5	None
10	14.05	3090	All	B3-8	C1-5	None
11	14.15	3165	All	B3-8	C1-5	None
12	14.20	3230	All	B3-8	C1-5	None
13	14.40	3340	All	B3-8	C1-5	None
14	14.40	3400	All	B3-8	C1-5	None
15	14.60	3520	All	B3-8	C1-5	None
16	14.30	3515	All	B3-8	C1-5	None
17	14.20	3560	All	B3-8	C1-5	None
18	14.00	3575	All	B5-8	None	NU-E
19	13.60	3535	All	B5-8	None	NU-E
20	13.30	3520	All	B4-8	None	NU-E
21	13.00	3510	All	B4-8	None	NU-E
22	12.70	3505	All	B4-8	None	NU-E
23	12.40	3505	All	B4-8	None	NU-E
24	12.20	3535	All	B4-8	None	NU-E
25	11.60	3535	All	B4-8	None	NU-E
26	11.10	3365	All	B4-8	None	NU-E
27	10.60	3285	All	B4-8	None	NU-E
28	10.00	3160	All	B3-8	None	NU-E

4. If all auxiliary water systems fail or malfunction, close the NUE, SUE, and SDE and raise the NDE weir crest to 6' below tailwater with the floating orifice gates open. Maintain this configuration until the system is repaired. While under this configuration, power generation at Powerhouse Two will be minimized to the extent practicable to reduce fish attraction into this area unless Powerhouse One facilities are dewatered.

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

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. The components of the ladders 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 FPOM.

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

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

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

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

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

5. Turbine Unit Operation and Maintenance.

5.1. Unit operating priority throughout the year is shown in section 2.1.1, Powerhouse Flow Distribution. Operating the end units provides attraction flow for adult fish at both powerhouses and helps move juvenile fish out of the first powerhouse tailrace

5.2. Turbine units will operate within 1% of best efficiency and within cavitation limits at various head ranges as shown in Tables BON-12 through BON-14 for both powerhouses. Powerhouse One units 1 through 6 have different MW output requirements because they are minimum gap runner units and have a different MW versus discharge relationship.

5.3. To the extent technically feasible, turbines will be operated within +/-1% of best turbine efficiency from April 1 through October 31 (as specified in the BPA load shaping guidelines) to avoid excess daytime spill (during the time of year when the 75 kcfs spill cap applies), or to comply with other coordinated fish measures. However, during the rest of the year, the project will continue to operate units within the 1% turbine efficiency range, except as specifically requested by BPA to do otherwise as provided in Appendix C. New, separate 1% operating criteria are provided for MGR units 1 through 6 in Table BON-13).

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

5.4.1. Unit 1 provides important attraction flow for adult fish, and it helps move juvenile fish downstream. Long-term outages will be avoided after the beginning of the juvenile fish passage season, until after the adult fall chinook and coho runs at the end of October.

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

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

6. Dewatering Plans.

6.1. Guidelines for any dewatering

6.1.1. 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.

6.1.2. Whether pumps or drain valve 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. A 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 invited to assist in any dewatering and, at a minimum, are invited to participate in all ladder dewaterings.

6.1.5. Adult fish will be released into the forebay and juvenile fish will be released into the tailrace. If a ladder is dewatered in the spring or summer, steelhead kelts will be released into the tailrace.

6.2. Juvenile bypass systems. See Guidelines for Dewatering and Fish Handling Plans (Appendix F)

6.3. Adult Fish Ladder.

6.3.1. Routine Maintenance.

6.3.1.1. When possible operate the ladder to be dewatered at a reduced flow for at least 24 hours, and up to 96 hours, prior to dewatering. Reduced flow is defined as less than criterion operation, but more than orifice flow. 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 assure adequate numbers of personnel will be available to move fish out of the dewatered ladder.

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

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

6.3.2. Non-Routine Maintenance.

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

6.3.2.2. Follow **6.3.1.3.** through **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. A project biologist will assist directly in fish rescue operations, provide technical guidance to assure fish safety, and assure that rescue equipment and personnel are available if

needed.

6.5. Turbines.

6.5.1. 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.

6.5.2. 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.

6.5.3. If a turbine unit draft tube is to be dewatered and the turbine unit has been idle, it will be operated when possible at speed/no load and stop logs will then be placed immediately.

6.5.4. 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.

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

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

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

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

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

7.1. Debris is removed by operating the ice and trash sluiceway at Powerhouse One, the corner collector at Powerhouse Two, or

passing it through the spillway with special spill gate operation.

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

8. Response to Hazardous Materials Spills. Bonneville Project's guidance for responding to hazardous substance spills is contained in its Emergency Spill Response Plan. This guidance will be followed in case of a spill. The project biologist will be contacted as soon as possible after a hazardous material release. The project biologist will in turn contact the CENWP-OP biologist, NOAA FISHERIES, and FPC.

Table BON-12. Turbine operating ranges within the 1% turbine efficiency range for Bonneville First Powerhouse, units 7-10.

	First Powerhouse (units 7-10)							
	With STS				Without STS			
Head (feet)	Lower Limit (MW)	Lower Limit (cfs)	Upper Limit (MW)	Upper Limit (cfs)	Lower Limit (MW)	Lower Limit (cfs)	Upper Limit (MW)	Upper Limit (cfs)
35	12.7	5,285	29.2	12,107	13.2	5,385	31.0	12,620
36	13.3	5,345	30.3	12,212	13.7	5,409	32.3	12,716
37	13.8	5,401	31.5	12,310	14.2	5,431	33.5	12,803
38	14.4	5,453	32.7	12,401	14.7	5,450	34.8	12,882
39	14.9	5,501	33.8	12,486	15.2	5,466	36.0	12,954
40	15.1	5,377	35.1	12,485	15.7	5,481	37.3	13,020
41	15.6	5,422	36.2	12,557	16.3	5,528	38.5	13,095
42	16.2	5,464	37.4	12,623	16.8	5,571	39.8	13,165
43	16.7	5,504	38.6	12,685	17.4	5,612	41.0	13,230
44	17.3	5,541	39.7	12,743	18.0	5,650	42.3	13,291
45	17.8	5,576	40.9	12,796	18.5	5,685	43.5	13,347
46	18.4	5,633	41.8	12,769	19.2	5,743	44.4	13,319
47	19.1	5,687	42.7	12,742	19.8	5,798	45.4	13,292
48	19.7	5,738	43.6	12,716	20.4	5,851	46.3	13,265
49	20.3	5,786	44.5	12,690	21.1	5,900	47.3	13,238
50	20.9	5,832	45.4	12,664	21.7	5,947	48.2	13,211
51	21.7	5,923	46.1	12,587	22.5	6,041	49.0	13,131
52	22.5	6,011	46.8	12,512	23.3	6,130	49.8	13,075
53	23.2	6,095	47.4	12,440	24.2	6,216	50.6	13,020
54	24.0	6,174	48.1	12,370	25.0	6,297	51.4	12,966
55	24.8	6,251	48.8	12,302	25.8	6,376	51.9	12,836
56	25.3	6,262	50.1	12,400	26.3	6,387	53.3	12,938
57	25.8	6,273	51.3	12,495	26.8	6,398	54.6	13,036
58	26.3	6,284	52.6	12,587	27.3	6,409	55.9	13,132
59	26.7	6,294	53.8	12,676	27.8	6,420	57.2	13,225
60	27.2	6,305	55.1	12,762	28.3	6,430	58.6	13,315
61	27.6	6,298	56.2	12,810	28.7	6,423	59.7	13,365
62	28.0	6,292	57.2	12,857	29.1	6,417	60.0	12,961
63	28.4	6,286	58.3	12,903	29.5	6,411	59.8	12,696
64	28.4	6,281	59.4	12,947	29.9	6,405	59.5	12,425
65	29.2	6,275	59.2	12,495	30.4	6,399	59.2	12,148
66	29.9	6,328	59.7	12,418	31.0	6,453	59.7	12,076
67	30.5	6,379	60.1	12,337	31.7	6,505	60.1	12,000
68	31.2	6,429	60.5	12,253	32.4	6,556	60.5	11,921
69	31.8	6,478	60.9	12,165	33.1	6,606	60.9	11,838
70	32.5	6,526	61.3	12,073	33.8	6,654	61.3	11,751

Note: Table is based on information provided by HDC in 2000 and 2001 (Table BON-12 revised, 2005).

Table BON-13. Turbine operating ranges within the 1% turbine efficiency range for Bonneville First Powerhouse (rehabilitated) MGR, units 1-6.

	First Powerhouse (units 1-6)							
	With STS				Without STS			
Head (feet)	Lower Limit (MW)	Lower Limit (cfs)	Upper Limit (MW)	Upper Limit (cfs)	Lower Limit (MW)	Lower Limit (cfs)	Upper Limit (MW)	Upper Limit (cfs)
38	19.3	6,794	26.0	9,145	20.7	7,204	25.6	8,918
39	19.8	6,804	26.6	9,128	21.3	7,202	26.3	8,886
40	20.4	6,753	27.3	9,031	21.9	7,199	26.9	8,854
41	21.0	6,754	28.4	9,148	22.5	7,201	28.0	8,969
42	21.5	6,755	29.5	9,259	23.1	7,202	29.1	9,077
43	22.0	6,756	30.5	9,363	23.6	7,203	30.1	9,180
44	22.6	6,756	31.6	9,463	24.2	7,203	31.2	9,278
45	23.1	6,756	32.7	9,557	24.8	7,203	32.3	9,370
46	23.7	6,763	33.6	9,603	25.4	7,210	33.2	9,416
47	24.3	6,769	34.6	9,648	26.0	7,217	34.1	9,459
48	24.8	6,775	35.5	9,689	26.6	7,223	35.0	9,500
49	25.4	6,780	36.5	9,729	27.3	7,229	36.0	9,539
50	26.0	6,785	37.4	9,776	27.9	7,234	36.9	9,575
51	26.5	6,792	38.3	9,809	28.5	7,241	37.8	9,618
52	27.1	6,798	39.3	9,850	29.1	7,248	38.4	9,577
53	27.7	6,804	40.2	9,889	29.7	7,254	39.0	9,537
54	28.3	6,810	41.2	9,927	30.3	7,260	39.7	9,499
55	28.8	6,815	42.1	9,962	30.9	7,266	41.6	9,768
56	29.4	6,817	43.1	10,003	31.5	7,269	42.5	9,808
57	29.9	6,820	44.0	10,042	32.1	7,272	43.4	9,846
58	30.4	6,823	45.0	10,079	32.7	7,274	44.4	9,883
59	31.0	6,825	45.9	10,115	33.3	7,277	45.3	9,918
60	31.5	6,827	46.9	10,150	33.8	7,279	46.3	9,952
61	32.1	6,842	47.6	10,128	34.5	7,296	46.9	9,930
62	32.8	6,857	48.3	10,106	35.1	7,311	47.6	9,909
63	33.4	6,871	49.0	10,085	35.8	7,326	48.3	9,889
64	34.0	6,884	49.7	10,064	36.5	7,340	49.0	9,868
65	34.6	6,897	50.4	10,044	37.1	7,354	49.7	9,849
66	35.0	6,885	51.2	10,072	37.6	7,341	50.6	9,876
67	35.5	6,873	52.1	10,099	38.1	7,329	51.4	9,902
68	35.9	6,862	53.0	10,126	38.6	7,317	52.3	9,928
69	36.4	6,851	53.9	10,152	39.0	7,305	53.2	9,954
70	36.8	6,841	54.8	10,177	39.6	7,294	54.1	9,979

Note: Table is based on information provide by HDC in June 2000 (Table BON-13 revised-captions only,2005).

Table BON-14. Turbine operating ranges within the 1% turbine efficiency range for Bonneville second powerhouse (units 11-18), with or without STSs in place.

	Second Powerhouse (units 11-18)							
	With STS				Without STS			
Head (feet)	Lower Limit (MW)	Lower Limit (cfs)	Upper Limit (MW)	Upper Limit (cfs)	Lower Limit (MW)	Lower Limit (cfs)	Upper Limit (MW)	Upper Limit (cfs)
35	26.7	10,619	41.9	16,628	26.2	10,330	39.9	15,746
36	27.6	10,630	43.3	16,657	27.0	10,341	41.2	15,773
37	28.5	10,639	44.7	16,680	27.9	10,350	42.6	15,795
38	29.4	10,645	46.1	16,699	28.8	10,356	43.9	15,813
39	30.3	10,649	47.6	16,713	29.7	10,360	45.3	15,827
40	31.2	10,651	49.0	16,724	30.5	10,362	46.7	15,837
41	32.0	10,624	50.4	16,756	31.3	10,336	48.0	15,869
42	32.8	10,597	51.9	16,786	32.1	10,310	49.4	15,897
43	33.5	10,571	53.3	16,812	32.8	10,285	50.8	15,922
44	34.3	10,544	54.8	16,834	33.6	10,259	52.2	15,943
45	35.1	10,518	56.2	16,854	34.3	10,234	53.5	15,962
46	35.9	10,514	57.7	16,917	35.1	10,230	55.0	16,021
47	36.7	10,510	58.5	16,770	35.9	10,226	55.8	15,888
48	37.5	10,505	59.3	16,629	36.7	10,222	56.6	15,761
49	38.3	10,500	60.1	16,493	37.5	10,217	57.3	15,637
50	39.1	10,495	63.8	17,133	38.3	10,212	60.8	16,226
51	40.0	10,529	66.0	17,365	39.2	10,245	62.9	16,446
52	41.0	10,561	68.2	17,588	40.1	10,276	65.0	16,657
53	41.9	10,591	70.4	17,801	41.0	10,305	67.1	16,860
54	42.8	10,620	72.6	18,006	41.9	10,333	69.2	17,054
55	43.8	10,647	74.8	18,203	42.8	10,360	71.3	17,240
56	45.2	10,766	75.2	17,925	44.2	10,476	71.6	16,977
57	46.6	10,880	75.6	17,656	45.6	10,586	72.0	16,723
58	48.0	10,987	76.0	17,397	46.9	10,691	72.4	16,478
59	49.4	11,090	76.4	17,146	48.3	10,792	72.7	16,240
60	50.8	11,188	76.7	16,903	49.7	10,887	73.1	16,010
61	51.2	11,099	76.7	16,615	50.1	10,800	76.3	16,458
62	51.6	11,012	76.7	16,342	50.5	10,715	76.7	16,288
63	52.3	10,847	76.7	16,077	51.2	10,555	76.7	16,016
64	52.7	10,769	76.7	15,821	51.6	10,479	76.7	15,752
65	53.7	10,810	76.7	15,572	52.6	10,519	76.7	15,496
66	54.8	10,850	76.7	15,331	53.6	10,558	76.7	15,258
67	55.8	10,889	76.7	15,098	54.6	10,595	76.7	15,027
68	56.8	10,926	76.7	14,871	55.6	10,632	76.7	14,803
69	57.8	10,963	76.7	14,650	56.6	10,668	76.7	14,585

Note: Table 1 is based on information provided by HDC in January 2001(Table BON-14 revised, 2005).

Table BON-15. Spill patterns for Bonneville Dam.

Spillway Bay Number																		Stops	FB=74.0
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	ft.	Kcfs
vertical gate opening (ft.)																			
0.5																	0.5	2	2.3
0.5	0.5																0.5	3	3.4
0.5	0.5															0.5	0.5	4	4.6
0.5	0.5														0.5	0.5	0.5	5	5.7
0.5	0.5		0.5												0.5	0.5	0.5	6	6.9
0.5	0.5		0.5	0.5											0.5	0.5	0.5	7	8.0
0.5	0.5		0.5	0.5									0.5		0.5	0.5	0.5	8	9.2
0.5	0.5		0.5	0.5							0.5		0.5		0.5	0.5	0.5	9	10.3
0.5	0.5		0.5	0.5					0.5		0.5		0.5		0.5	0.5	0.5	10	11.5
0.5	0.5		0.5	0.5			0.5		0.5		0.5		0.5		0.5	0.5	0.5	11	12.6
0.5	0.5	0.5	0.5	0.5			0.5		0.5		0.5		0.5		0.5	0.5	0.5	12	13.8
0.5	0.5	0.5	0.5	0.5			0.5		0.5		0.5		0.5		0.5	1	0.5	13	14.9
0.5	1	0.5	0.5	0.5			0.5		0.5		0.5		0.5		0.5	1	0.5	14	16.0
0.5	1	0.5	0.5	0.5	0.5		0.5		0.5		0.5		0.5		0.5	1	0.5	15	17.2
0.5	1	0.5	0.5	0.5	0.5		0.5		0.5		0.5		0.5	0.5	0.5	1	0.5	16	18.3
0.5	1	0.5	0.5	0.5	0.5	0.5	0.5		0.5		0.5		0.5	0.5	0.5	1	0.5	17	19.5
0.5	1	0.5	0.5	0.5	0.5	0.5	0.5		0.5		0.5	0.5	0.5	0.5	0.5	1	0.5	18	20.6
0.5	1	0.5	0.5	0.5	0.5	0.5	0.5		0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	0.5	19	21.8
0.5	1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	0.5	20	22.9
0.5	1	1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	0.5	21	24.1
0.5	1	1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	1	22	25.2
1	1	1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	1	23	26.3
1	1	1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	1	1	24	27.4
1	1	1	1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	1	1	25	28.6
1	1	1	1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	1	1	1	26	29.7
1	1	1	1	0.5	0.5	0.5	0.5	1	0.5	0.5	0.5	0.5	0.5	1	1	1	1	27	30.8
1	1	1	1	0.5	0.5	1	0.5	1	0.5	0.5	0.5	0.5	0.5	1	1	1	1	28	31.9
1	1	1	1	0.5	0.5	1	0.5	1	0.5	0.5	1	0.5	0.5	1	1	1	1	29	33.1
1	1	1	1	0.5	1	1	0.5	1	0.5	0.5	1	0.5	0.5	1	1	1	1	30	34.2
1	1	1	1	0.5	1	1	0.5	1	0.5	0.5	1	1	0.5	1	1	1	1	31	35.3
1	1	1	1	0.5	1	1	0.5	1	1	0.5	1	1	0.5	1	1	1	1	32	36.4
1	1	1	1	1	1	1	0.5	1	1	0.5	1	1	0.5	1	1	1	1	33	37.6
1	1	1	1	1	1	1	1	1	1	0.5	1	1	0.5	1	1	1	1	34	38.7
1	1	1	1	1	1	1	1	1	1	0.5	1	1	1	1	1	1	1	35	39.8
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	36	40.9
1	1.5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	37	42.0
1	1.5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1.5	1	38	43.2
1	1.5	1	1	1	1	1	1	1	1	1	1	1	1	1	1.5	1.5	1	39	44.3
1	1.5	1.5	1	1	1	1	1	1	1	1	1	1	1	1	1.5	1.5	1	40	45.4
1.5	1.5	1.5	1	1	1	1	1	1	1	1	1	1	1	1	1.5	1.5	1	41	46.5
1.5	1.5	1.5	1	1	1	1	1	1	1	1	1	1	1	1	1.5	1.5	1.5	42	47.6
1.5	1.5	1.5	1	1	1	1	1	1	1	1	1	1	1	1	1.5	2	1.5	43	48.6
1.5	2	1.5	1	1	1	1	1	1	1	1	1	1	1	1	1.5	2	1.5	44	49.7
1.5	2	1.5	1	1	1	1	1	1	1	1	1	1	1	1	2	2	1.5	45	50.8
1.5	2	1.5	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	46	51.9
2	2	1.5	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	47	53.0
2	2	1.5	1	1	1	1	1	1.5	1	1	1	1	1	1	2	2	2	48	54.1

Flows calculations updated 3/21/2005

Table BON-15 (cont). Spill patterns for Bonneville Dam.

Spillway Bay Number																		Stops	FB=74.0
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	ft.	Kcfs
vertical gate opening (ft.)																			
2	2	2	1	1	1	1	1	1.5	1	1	1	1	1	1	2	2	2	49	55.1
2	2	2	1	1.5	1	1	1	1.5	1	1	1	1	1	1	2	2	2	50	56.2
2	2	2	1.5	1.5	1	1	1	1.5	1	1	1	1	1	1	2	2	2	51	57.3
2	2	2	1.5	1.5	1	1	1	1.5	1	1	1.5	1	1	1	2	2	2	52	58.4
2	2	2	1.5	1.5	1	1	1	1.5	1	1	1.5	1	1.5	1	2	2	2	53	59.5
2	2	2	1.5	1.5	1	1.5	1	1.5	1	1	1.5	1	1.5	1	2	2	2	54	60.6
2	2	2	1.5	1.5	1	1.5	1	1.5	1	1	1.5	1	1.5	1	2	2.5	2	55	61.7
2	2.5	2	1.5	1.5	1	1.5	1	1.5	1	1	1.5	1	1.5	1	2	2.5	2	56	62.8
2	2.5	2	1.5	1.5	1.5	1.5	1	1.5	1	1	1.5	1	1.5	1	2	2.5	2	57	63.9
2	2.5	2	1.5	1.5	1.5	1.5	1	1.5	1	1	1.5	1	1.5	1.5	2	2.5	2	58	65.0
2	2.5	2	1.5	1.5	1.5	1.5	1	1.5	1.5	1	1.5	1	1.5	1.5	2	2.5	2	59	66.1
2	2.5	2	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1	1.5	1	1.5	1.5	2	2.5	2	60	67.2
2	2.5	2	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1	1.5	1.5	1.5	1.5	2	2.5	2	61	68.3
2	2.5	2	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	2	2.5	2	62	69.4
2	2.5	2	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	2.5	2.5	2	63	70.4
2	2.5	2	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	2.5	3	2	64	71.5
2	2.5	2	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	2.5	3	2.5	65	72.5
2	3	2	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	2.5	3	2.5	66	73.6
2	3	2	1.5	2	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	2.5	3	2.5	67	74.6
2	3	2	1.5	2	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	2	2.5	3	2.5	68	75.7
2	3	2	2	2	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	2	2.5	3	2.5	69	76.8
2	3	2	2	2	1.5	1.5	1.5	1.5	1.5	1.5	1.5	2	1.5	2	2.5	3	2.5	70	77.9
2	3	2	2	2	1.5	1.5	2	1.5	1.5	1.5	1.5	2	1.5	2	2.5	3	2.5	71	79.0
2.5	3	2	2	2	1.5	1.5	2	1.5	1.5	1.5	1.5	2	1.5	2	2.5	3	2.5	72	80.0
2.5	3	2	2	2	1.5	1.5	2	1.5	2	1.5	1.5	2	1.5	2	2.5	3	2.5	73	81.1
2.5	3	2	2	2	1.5	1.5	2	1.5	2	1.5	1.5	2	1.5	2	3	3	2.5	74	82.1
2.5	3	2	2	2	2	1.5	2	1.5	2	1.5	1.5	2	1.5	2	3	3	2.5	75	83.2
2.5	3	2	2	2	2	1.5	2	1.5	2	1.5	1.5	2	2	2	3	3	2.5	76	84.3
2.5	3	2	2	2	2	1.5	2	1.5	2	1.5	1.5	2	2	2	3	3	3	77	85.3
2.5	3	2	2	2	2	1.5	2	1.5	2	1.5	2	2	2	2	3	3	3	78	86.4
3	3	2	2	2	2	1.5	2	1.5	2	1.5	2	2	2	2	3	3	3	79	87.4
3	3	2.5	2	2	2	1.5	2	1.5	2	1.5	2	2	2	2	3	3	3	80	88.5
3	3	2.5	2	2	2	2	2	1.5	2	1.5	2	2	2	2	3	3	3	81	89.6
3	3	2.5	2	2	2	2	2	2	2	1.5	2	2	2	2	3	3	3	82	90.7
3	3	2.5	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	83	91.7
3	3	2.5	2	2.5	2	2	2	2	2	2	2	2	2	2	3	3	3	84	92.8
3	3	2.5	2.5	2.5	2	2	2	2	2	2	2	2	2	2	3	3	3	85	93.9
3	3	2.5	2.5	2.5	2	2	2	2	2	2	2	2	2.5	2	3	3	3	86	94.9
3	3	2.5	2.5	2.5	2	2	2	2	2	2	2	2	2.5	2.5	3	3	3	87	96.0
3	3.5	2.5	2.5	2.5	2	2	2	2	2	2	2	2	2.5	2.5	3	3	3	88	97.0
3	3.5	3	2.5	2.5	2	2	2	2	2	2	2	2	2.5	2.5	3	3	3	89	98.0
3	3.5	3	2.5	2.5	2	2	2	2	2	2	2	2	2.5	2.5	3	3.5	3	90	99.0
3	3.5	3	2.5	2.5	2.5	2	2	2	2	2	2	2	2.5	2.5	3	3.5	3	91	100.1
3	3.5	3	2.5	2.5	2.5	2	2	2	2	2	2	2	2.5	2.5	3.5	3.5	3	92	101.1
3	3.5	3	2.5	2.5	2.5	2.5	2	2	2	2	2	2	2.5	2.5	3.5	3.5	3	93	102.2
3	3.5	3	2.5	2.5	2.5	2.5	2	2	2	2	2	2	2.5	3	3.5	3.5	3	94	103.2
3	3.5	3	2.5	3	2.5	2.5	2	2	2	2	2	2	2.5	3	3.5	3.5	3	95	104.2

Flows calculations updated 3/21/2005

Table BON-15 (cont). Spill patterns for Bonneville Dam.

Spillway Bay Number																		stops	FB=74.0
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	ft.	Kcfs
vertical gate opening (ft.)																			
3	3.5	3	3	3	2.5	2.5	2	2	2	2	2	2	2.5	3	3.5	3.5	3	96	105.3
3	3.5	3	3	3	2.5	2.5	2.5	2	2	2	2	2	2.5	3	3.5	3.5	3	97	106.3
3	3.5	3	3	3	2.5	2.5	2.5	2	2	2	2	2.5	2.5	3	3.5	3.5	3	98	107.4
3	3.5	3	3	3	2.5	2.5	2.5	2	2	2	2.5	2.5	2.5	3	3.5	3.5	3	99	108.5
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	109.5
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	110.5
3	3.5	3.5	3	3	2.5	2.5	2.5	2	2.5	2.5	2.5	2.5	2.5	3	3.5	3.5	3	102	111.6
3	3.5	3.5	3	3	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	3	3.5	3.5	3	103	112.6
3	3.5	3.5	3	3	3	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	3	3.5	3.5	3	104	113.7
3	3.5	3.5	3	3	3	3	2.5	2.5	2.5	2.5	2.5	2.5	2.5	3	3.5	3.5	3	105	114.7
3	3.5	3.5	3	3	3	3	2.5	2.5	2.5	2.5	2.5	2.5	2.5	3	3.5	3.5	3.5	106	115.7
3	3.5	3.5	3	3	3	3	2.5	2.5	2.5	2.5	2.5	2.5	2.5	3	3.5	4	3.5	107	116.7
3	3.5	3.5	3	3	3	3	3	2.5	2.5	2.5	2.5	2.5	2.5	3	3.5	4	3.5	108	117.8
3	3.5	3.5	3	3	3	3	3	2.5	2.5	2.5	2.5	2.5	3	3	3.5	4	3.5	109	118.8
3	3.5	3.5	3	3	3	3	3	2.5	2.5	2.5	2.5	3	3	3	3.5	4	3.5	110	119.8
3	3.5	3.5	3	3	3	3	3	2.5	2.5	3	2.5	3	3	3	3.5	4	3.5	111	120.9
3	3.5	3.5	3	3	3	3	3	2.5	2.5	3	3	3	3	3	3.5	4	3.5	112	121.9
3.5	3.5	3.5	3	3	3	3	3	2.5	2.5	3	3	3	3	3	3.5	4	3.5	113	122.9
3.5	3.5	3.5	3.5	3	3	3	3	2.5	2.5	3	3	3	3	3	3.5	4	3.5	114	124.0
3.5	3.5	3.5	3.5	3	3	3	3	2.5	2.5	3	3	3	3	3	3.5	4	4	115	124.9
3.5	3.5	3.5	3.5	3	3	3	3	2.5	2.5	3	3	3	3	3.5	3.5	4	4	116	126.0
3.5	3.5	3.5	3.5	3	3	3	3	2.5	2.5	3	3	3	3	3.5	4	4	4	117	127.0
3.5	3.5	3.5	3.5	3	3	3	3	2.5	3	3	3	3	3	3.5	4	4	4	118	128.0
3.5	3.5	3.5	3.5	3	3	3	3	3	3	3	3	3	3	3.5	4	4	4	119	129.0
3.5	4	3.5	3.5	3	3	3	3	3	3	3	3	3	3	3.5	4	4	4	120	130.0
3.5	4	4	3.5	3	3	3	3	3	3	3	3	3	3	3.5	4	4	4	121	131.0
4	4	4	3.5	3	3	3	3	3	3	3	3	3	3	3.5	4	4	4	122	132.0
4	4	4	4	3	3	3	3	3	3	3	3	3	3	3.5	4	4	4	123	133.0
4	4	4	4	3	3	3	3	3	3	3	3	3	3	4	4	4	4	124	134.0
4	4	4	4	3	3.5	3	3	3	3	3	3	3	3	4	4	4	4	125	135.0
4	4	4	4	3.5	3.5	3	3	3	3	3	3	3	3	4	4	4	4	126	136.1
4	4	4	4	3.5	3.5	3	3	3	3	3	3	3.5	3	4	4	4	4	127	137.1
4	4	4	4	3.5	3.5	3	3	3	3	3	3	3.5	3.5	4	4	4	4	128	138.1
4	4	4	4	3.5	3.5	3	3	3	3	3	3	3.5	3.5	4	4	4.5	4	129	139.1
4	4	4	4	3.5	3.5	3.5	3	3	3	3	3	3.5	3.5	4	4	4.5	4	130	140.1
4	4	4	4	3.5	3.5	3.5	3	3	3	3	3.5	3.5	3.5	4	4	4.5	4	131	141.1
4	4	4	4	3.5	3.5	3.5	3	3	3	3	3.5	3.5	3.5	4	4.5	4.5	4	132	142.1
4	4.5	4	4	3.5	3.5	3.5	3	3	3	3	3.5	3.5	3.5	4	4.5	4.5	4	133	143.1
4	4.5	4.5	4	3.5	3.5	3.5	3	3	3	3	3.5	3.5	3.5	4	4.5	4.5	4	134	144.0
4	4.5	4.5	4	3.5	3.5	3.5	3	3	3.5	3	3.5	3.5	3.5	4	4.5	4.5	4	135	145.1
4	4.5	4.5	4	3.5	3.5	3.5	3.5	3	3.5	3	3.5	3.5	3.5	4	4.5	4.5	4	136	146.1
4	4.5	4.5	4	3.5	3.5	3.5	3.5	3	3.5	3.5	3.5	3.5	3.5	4	4.5	4.5	4	137	147.1
4	4.5	4.5	4	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	4	4.5	4.5	4	138	148.1
4	4.5	4.5	4	4	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	4	4.5	4.5	4	139	149.1
4	4.5	4.5	4	4	4	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	4	4.5	4.5	4	140	150.1
4	4.5	4.5	4	4	4	3.5	3.5	3.5	3.5	3.5	3.5	3.5	4	4	4.5	4.5	4	141	151.1
4	4.5	4.5	4	4	4	4	3.5	3.5	3.5	3.5	3.5	3.5	4	4	4.5	4.5	4	142	152.1

Flows calculations updated 3/21/2005

Table BON-15 (cont). Spill patterns for Bonneville Dam.

Spillway Bay Number																		stops	FB=74.0
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	ft.	Kcfs
vertical gate opening (ft.)																			
4	4.5	4.5	4	4	4	4	3.5	3.5	3.5	3.5	3.5	4	4	4	4.5	4.5	4	143	153.1
4	4.5	4.5	4	4	4	4	3.5	3.5	3.5	3.5	4	4	4	4	4.5	4.5	4	144	154.1
4	4.5	4.5	4	4	4	4	4	3.5	3.5	3.5	4	4	4	4	4.5	4.5	4	145	155.1
4	4.5	4.5	4	4	4	4	4	3.5	3.5	4	4	4	4	4	4.5	4.5	4	146	156.1
4	4.5	4.5	4	4	4	4	4	4	3.5	4	4	4	4	4	4.5	4.5	4	147	157.1
4	4.5	4.5	4	4	4	4	4	4	4	4	4	4	4	4	4.5	4.5	4	148	158.1
4	4.5	4.5	4.5	4	4	4	4	4	4	4	4	4	4	4	4.5	4.5	4	149	159.1
4	4.5	4.5	4.5	4	4	4	4	4	4	4	4	4	4	4.5	4.5	4.5	4	150	160.0
4	4.5	4.5	4.5	4.5	4	4	4	4	4	4	4	4	4	4.5	4.5	4.5	4	151	161.0
4	4.5	4.5	4.5	4.5	4	4	4	4	4	4	4	4	4.5	4.5	4.5	4.5	4	152	162.0
4	4.5	4.5	4.5	4.5	4.5	4	4	4	4	4	4	4	4.5	4.5	4.5	4.5	4	153	163.0
4	4.5	4.5	4.5	4.5	4.5	4	4	4	4	4	4	4.5	4.5	4.5	4.5	4.5	4	154	163.9
4	4.5	4.5	4.5	4.5	4.5	4	4	4	4	4	4	4.5	4.5	4.5	4.5	5	4	155	164.9
4	5	4.5	4.5	4.5	4.5	4	4	4	4	4	4	4.5	4.5	4.5	4.5	5	4	156	165.9
4	5	4.5	4.5	4.5	4.5	4	4	4	4	4	4.5	4.5	4.5	4.5	4.5	5	4	157	166.8
4	5	4.5	4.5	4.5	4.5	4.5	4	4	4	4	4.5	4.5	4.5	4.5	4.5	5	4	158	167.8
4	5	4.5	4.5	4.5	4.5	4.5	4	4	4	4	4.5	4.5	4.5	4.5	5	5	4	159	168.8
4	5	4.5	4.5	4.5	4.5	4.5	4	4	4	4.5	4.5	4.5	4.5	4.5	5	5	4	160	169.8
4	5	5	4.5	4.5	4.5	4.5	4	4	4	4.5	4.5	4.5	4.5	4.5	5	5	4	161	170.7
4	5	5	4.5	4.5	4.5	4.5	4	4	4	4.5	4.5	4.5	4.5	5	5	5	4	162	171.7
4	5	5	5	4.5	4.5	4.5	4	4	4	4.5	4.5	4.5	4.5	5	5	5	4	163	172.6
4	5	5	5	4.5	4.5	4.5	4	4.5	4	4.5	4.5	4.5	4.5	5	5	5	4	164	173.6
4	5	5	5	4.5	4.5	4.5	4	4.5	4	4.5	4.5	4.5	5	5	5	5	4	165	174.6
4	5	5	5	4.5	4.5	4.5	4.5	4.5	4	4.5	4.5	4.5	5	5	5	5	4	166	175.6
4	5	5	5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	5	5	5	5	4	167	176.5
4	5	5	5	4.5	5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	5	5	5	5	4	168	177.5
4	5	5	5	4.5	5	4.5	4.5	4.5	4.5	4.5	5	4.5	5	5	5	5	4	169	178.5
4	5	5	5	4.5	5	4.5	4.5	4.5	4.5	4.5	5	5	5	5	5	5	4	170	179.4
4	5	5	5	5	5	4.5	4.5	4.5	4.5	4.5	5	5	5	5	5	5	4	171	180.4
4	5	5	5	5	5	4.5	5	4.5	4.5	4.5	5	5	5	5	5	5	4	172	181.3
4	5	5	5	5	5	4.5	5	4.5	5	4.5	5	5	5	5	5	5	4	173	182.3
4	5	5	5	5	5	4.5	5	5	5	4.5	5	5	5	5	5	5	4	174	183.3
4	5	5	5	5	5	5	5	5	5	4.5	5	5	5	5	5	5	4	175	184.2
4	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	4	176	185.2
4	5.5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	4	177	186.1
4	5.5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5.5	4	178	187.1
4	5.5	5	5	5	5	5	5	5	5	5	5	5	5	5	5.5	5.5	4	179	188.0
4	5.5	5.5	5	5	5	5	5	5	5	5	5	5	5	5	5.5	5.5	4	180	189.0
4	5.5	5.5	5	5.5	5	5	5	5	5	5	5	5	5	5	5.5	5.5	4	181	189.9
4	5.5	5.5	5	5.5	5	5	5	5	5	5	5	5	5	5.5	5.5	5.5	4	182	190.8
4	5.5	5.5	5.5	5.5	5	5	5	5	5	5	5	5	5	5.5	5.5	5.5	4	183	191.8
4	5.5	5.5	5.5	5.5	5	5	5	5	5.5	5	5	5	5	5.5	5.5	5.5	4	184	192.7
4	5.5	5.5	5.5	5.5	5	5	5.5	5	5.5	5	5	5	5	5.5	5.5	5.5	4	185	193.7
4	5.5	5.5	5.5	5.5	5	5	5.5	5	5.5	5	5	5.5	5	5.5	5.5	5.5	4	186	194.6
4	5.5	5.5	5.5	5.5	5	5	5.5	5.5	5.5	5	5	5.5	5	5.5	5.5	5.5	4	187	195.6
4	5.5	5.5	5.5	5.5	5.5	5	5.5	5.5	5.5	5	5	5.5	5	5.5	5.5	5.5	4	188	196.5
4	5.5	5.5	5.5	5.5	5.5	5	5.5	5.5	5.5	5	5.5	5.5	5	5.5	5.5	5.5	4	189	197.5

Flows calculations updated 3/21/2005

Table BON-15 (cont). Spill patterns for Bonneville Dam.

Spillway Bay Number																		stops	FB=74.0
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	ft.	Kcfs
vertical gate opening (ft.)																			
4	5.5	5.5	5.5	5.5	5.5	5	5.5	5.5	5.5	5	5.5	5.5	5.5	5.5	5.5	5.5	4	190	198.4
4	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5	5.5	5.5	5.5	5.5	5.5	5.5	4	191	199.3
4	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	4	192	200.3
4	5.5	5.5	5.5	6	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	4	193	201.2
4	5.5	5.5	5.5	6	5.5	5.5	5.5	5.5	5.5	5.5	5.5	6	5.5	5.5	5.5	5.5	4	194	202.1
4	5.5	5.5	5.5	6	5.5	5.5	5.5	5.5	5.5	5.5	6	6	5.5	5.5	5.5	5.5	4	195	203.1
4	5.5	5.5	5.5	6	6	5.5	5.5	5.5	5.5	5.5	6	6	5.5	5.5	5.5	5.5	4	196	204.0
4	5.5	5.5	5.5	6	6	5.5	6	5.5	5.5	5.5	6	6	5.5	5.5	5.5	5.5	4	197	204.9
4	5.5	5.5	5.5	6	6	5.5	6	5.5	6	5.5	6	6	5.5	5.5	5.5	5.5	4	198	205.9
4	6	5.5	5.5	6	6	5.5	6	5.5	6	5.5	6	6	5.5	5.5	5.5	5.5	4	199	206.8
4	6	5.5	5.5	6	6	5.5	6	5.5	6	5.5	6	6	5.5	5.5	5.5	6	4	200	207.7
4	6	5.5	5.5	6	6	5.5	6	5.5	6	5.5	6	6	5.5	5.5	6	6	4	201	208.6
4	6	6	5.5	6	6	5.5	6	5.5	6	5.5	6	6	5.5	5.5	6	6	4	202	209.6
4	6	6	5.5	6	6	5.5	6	5.5	6	5.5	6	6	6	5.5	6	6	4	203	210.5
4	6	6	5.5	6	6	5.5	6	5.5	6	5.5	6	6	6	5.5	6	6	4.5	204	211.5
4.5	6	6	5.5	6	6	5.5	6	5.5	6	5.5	6	6	6	5.5	6	6	4.5	205	212.4
4.5	6	6	6	6	6	5.5	6	5.5	6	5.5	6	6	6	5.5	6	6	4.5	206	213.4
4.5	6	6	6	6	6	5.5	6	5.5	6	5.5	6	6	6	6	6	6	4.5	207	214.3
4.5	6	6	6	6	6	5.5	6	6	6	5.5	6	6	6	6	6	6	4.5	208	215.2
4.5	6	6	6	6	6	6	6	6	6	5.5	6	6	6	6	6	6	4.5	209	216.2
4.5	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	4.5	210	217.1
4.5	6	6	6	6.5	6	6	6	6	6	6	6	6	6	6	6	6	4.5	211	218.0
4.5	6	6	6	6.5	6	6	6	6	6	6	6	6.5	6	6	6	6	4.5	212	218.9
4.5	6	6	6	6.5	6	6	6	6	6	6	6.5	6.5	6	6	6	6	4.5	213	219.8
4.5	6	6	6	6.5	6.5	6	6	6	6	6	6.5	6.5	6	6	6	6	4.5	214	220.7
4.5	6	6	6	6.5	6.5	6	6.5	6	6	6	6.5	6.5	6	6	6	6	4.5	215	221.6
4.5	6	6	6	6.5	6.5	6	6.5	6	6	6	6.5	6.5	6	6	6	6.5	4.5	216	222.6
4.5	6.5	6	6	6.5	6.5	6	6.5	6	6	6	6.5	6.5	6	6	6	6.5	4.5	217	223.5
4.5	6.5	6	6	6.5	6.5	6	6.5	6	6	6	6.5	6.5	6	6	6.5	6.5	4.5	218	224.4
4.5	6.5	6.5	6	6.5	6.5	6	6.5	6	6	6	6.5	6.5	6	6	6.5	6.5	4.5	219	225.3
4.5	6.5	6.5	6	6.5	6.5	6	6.5	6	6.5	6	6.5	6.5	6	6	6.5	6.5	4.5	220	226.2
4.5	6.5	6.5	6	6.5	6.5	6	6.5	6	6.5	6	6.5	6.5	6	6.5	6.5	6.5	4.5	221	227.1
4.5	6.5	6.5	6.5	6.5	6.5	6	6.5	6	6.5	6	6.5	6.5	6	6.5	6.5	6.5	4.5	222	228.0
4.5	6.5	6.5	6.5	6.5	6.5	6	6.5	6	6.5	6	6.5	6.5	6.5	6.5	6.5	6.5	4.5	223	228.9
4.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6	6.5	6	6.5	6.5	6.5	6.5	6.5	6.5	4.5	224	229.9
4.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	4.5	225	230.8
4.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	4.5	226	231.7
4.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	5	227	232.6
5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	5	228	233.6
5	6.5	6.5	6.5	7	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	5	229	234.5
5	6.5	6.5	6.5	7	6.5	6.5	6.5	6.5	6.5	6.5	6.5	7	6.5	6.5	6.5	6.5	5	230	235.4
5	6.5	6.5	6.5	7	6.5	6.5	6.5	6.5	6.5	6.5	7	7	6.5	6.5	6.5	6.5	5	231	236.3
5	6.5	6.5	6.5	7	7	6.5	6.5	6.5	6.5	6.5	7	7	6.5	6.5	6.5	6.5	5	232	237.2
5	6.5	6.5	6.5	7	7	6.5	7	6.5	6.5	6.5	7	7	6.5	6.5	6.5	6.5	5	233	238.1
5	6.5	6.5	6.5	7	7	6.5	7	6.5	6.5	6.5	7	7	6.5	6.5	6.5	7	5	234	239.0
5	7	6.5	6.5	7	7	6.5	7	6.5	6.5	6.5	7	7	6.5	6.5	6.5	7	5	235	239.9
5	7	6.5	6.5	7	7	6.5	7	6.5	6.5	6.5	7	7	6.5	6.5	7	7	5	236	240.8

Flows calculations updated 3/21/2005

Table BON-15 (cont). Spill patterns for Bonneville Dam.

Spillway Bay Number																		stops	FB=74.0
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	ft.	Kcfs
vertical gate opening (ft.)																			
5	7	7	6.5	7	7	6.5	7	6.5	6.5	6.5	7	7	6.5	6.5	7	7	5	237	241.7
5	7	7	6.5	7	7	6.5	7	6.5	7	6.5	7	7	6.5	6.5	7	7	5	238	242.6
5	7	7	6.5	7	7	6.5	7	6.5	7	6.5	7	7	6.5	7	7	7	5	239	243.5
5	7	7	7	7	7	6.5	7	6.5	7	6.5	7	7	6.5	7	7	7	5	240	244.4
5	7	7	7	7	7	6.5	7	6.5	7	6.5	7	7	7	7	7	7	5	241	245.3
5	7	7	7	7	7	7	7	6.5	7	6.5	7	7	7	7	7	7	5	242	246.2
5	7	7	7	7	7	7	7	6.5	7	7	7	7	7	7	7	7	5	243	247.1
5	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	5	244	248.0
5	7	7	7	7.5	7	7	7	7	7	7	7	7	7	7	7	7	5	245	248.8
5	7	7	7	7.5	7	7	7	7	7	7	7	7.5	7	7	7	7	5	246	249.7
5	7	7	7	7.5	7	7	7	7	7	7	7.5	7.5	7	7	7	7	5	247	250.6
5	7	7	7	7.5	7.5	7	7	7	7	7	7.5	7.5	7	7	7	7	5	248	251.5
5	7	7	7	7.5	7.5	7	7.5	7	7	7	7.5	7.5	7	7	7	7	5	249	252.4
5	7	7	7	7.5	7.5	7	7.5	7	7	7	7.5	7.5	7	7	7.5	7	5	250	253.3
5	7	7.5	7	7.5	7.5	7	7.5	7	7	7	7.5	7.5	7	7	7.5	7	5	251	254.1
5	7	7.5	7	7.5	7.5	7	7.5	7	7.5	7	7.5	7.5	7	7	7.5	7	5	252	255.0
5	7	7.5	7	7.5	7.5	7	7.5	7	7.5	7	7.5	7.5	7	7.5	7.5	7	5	253	255.9
5	7	7.5	7.5	7.5	7.5	7	7.5	7	7.5	7	7.5	7.5	7	7.5	7.5	7	5	254	256.8
5	7	7.5	7.5	7.5	7.5	7	7.5	7	7.5	7	7.5	7.5	7.5	7.5	7.5	7	5	255	257.7
5	7	7.5	7.5	7.5	7.5	7.5	7.5	7	7.5	7	7.5	7.5	7.5	7.5	7.5	7	5	256	258.6
5	7	7.5	7.5	7.5	7.5	7.5	7.5	7	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7	5	257	259.5
5	7	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7	5	258	260.3
5	7	7.5	7.5	8	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7	5	259	261.2
5	7	7.5	7.5	8	7.5	7.5	7.5	7.5	7.5	7.5	7.5	8	7.5	7.5	7.5	7	5	260	262.1
5	7	7.5	7.5	8	7.5	7.5	7.5	7.5	7.5	7.5	8	8	7.5	7.5	7.5	7	5	261	262.9
5	7	7.5	7.5	8	8	7.5	7.5	7.5	7.5	7.5	8	8	7.5	7.5	7.5	7	5	262	263.8
5	7	7.5	7.5	8	8	7.5	8	7.5	7.5	7.5	8	8	7.5	7.5	7.5	7	5	263	264.7
5	7	7.5	7.5	8	8	7.5	8	7.5	7.5	7.5	8	8	7.5	7.5	7.5	7.5	5	264	265.6
5	7.5	7.5	7.5	8	8	7.5	8	7.5	7.5	7.5	8	8	7.5	7.5	7.5	7.5	5	265	266.5
5	7.5	7.5	7.5	8	8	7.5	8	7.5	7.5	7.5	8	8	7.5	7.5	8	7.5	5	266	267.3
5	7.5	8	7.5	8	8	7.5	8	7.5	7.5	7.5	8	8	7.5	7.5	8	7.5	5	267	268.2
5	7.5	8	7.5	8	8	7.5	8	7.5	8	7.5	8	8	7.5	7.5	8	7.5	5	268	269.1
5	7.5	8	7.5	8	8	7.5	8	7.5	8	7.5	8	8	7.5	8	8	7.5	5	269	269.9
5	7.5	8	8	8	8	7.5	8	7.5	8	7.5	8	8	7.5	8	8	7.5	5	270	270.8
5	7.5	8	8	8	8	7.5	8	7.5	8	7.5	8	8	8	8	8	7.5	5	271	271.7
5	7.5	8	8	8	8	8	8	7.5	8	7.5	8	8	8	8	8	7.5	5	272	272.5
5	7.5	8	8	8	8	8	8	7.5	8	8	8	8	8	8	8	7.5	5	273	273.4
5	7.5	8	8	8	8	8	8	8	8	8	8	8	8	8	8	7.5	5	274	274.3
5	7.5	8	8	8.5	8	8	8	8	8	8	8	8	8	8	8	7.5	5	275	275.1
5	7.5	8	8	8.5	8	8	8	8	8	8	8	8.5	8	8	8	7.5	5	276	276.0
5	7.5	8	8	8.5	8	8	8	8	8	8	8.5	8.5	8	8	8	7.5	5	277	276.9
5	7.5	8	8	8.5	8.5	8	8	8	8	8	8.5	8.5	8	8	8	7.5	5	278	277.7
5	7.5	8	8	8.5	8.5	8	8.5	8	8	8	8.5	8.5	8	8	8	7.5	5	279	278.6
5	7.5	8	8	8.5	8.5	8	8.5	8	8	8	8.5	8.5	8	8	8	8	5	280	279.5
5	8	8	8	8.5	8.5	8	8.5	8	8	8	8.5	8.5	8	8	8	8	5	281	280.3
5	8	8	8	8.5	8.5	8	8.5	8	8	8	8.5	8.5	8	8	8.5	8	5	282	281.2
5	8	8.5	8	8.5	8.5	8	8.5	8	8	8	8.5	8.5	8	8	8.5	8	5	283	282.0

Flows calculations updated 3/21/2005

Table BON-15 (cont). Spill patterns for Bonneville Dam.

Spillway Bay Number																	stops	FB=74.0
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	ft.	Kcfs
vertical gate opening (ft.)																			
5	8	8.5	8	8.5	8.5	8	8.5	8	8.5	8	8.5	8.5	8	8	8.5	8	5	284	282.9
5	8	8.5	8	8.5	8.5	8	8.5	8	8.5	8	8.5	8.5	8	8.5	8.5	8	5	285	283.8
5	8	8.5	8.5	8.5	8.5	8	8.5	8	8.5	8	8.5	8.5	8	8.5	8.5	8	5	286	284.6
5	8	8.5	8.5	8.5	8.5	8	8.5	8	8.5	8	8.5	8.5	8.5	8.5	8.5	8	5	287	285.5
5	8	8.5	8.5	8.5	8.5	8.5	8.5	8	8.5	8	8.5	8.5	8.5	8.5	8.5	8	5	288	286.3
5	8	8.5	8.5	8.5	8.5	8.5	8.5	8	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8	5	289	287.2
5	8	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8	5	290	288.1
5	8	8.5	8.5	9	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8	5	291	288.9
5	8	8.5	8.5	9	8.5	8.5	8.5	8.5	8.5	8.5	8.5	9	8.5	8.5	8.5	8	5	292	289.7
5	8	8.5	8.5	9	8.5	8.5	8.5	8.5	8.5	8.5	9	9	8.5	8.5	8.5	8	5	293	290.6
5	8	8.5	8.5	9	9	8.5	8.5	8.5	8.5	8.5	9	9	8.5	8.5	8.5	8	5	294	291.4
5	8	8.5	8.5	9	9	8.5	9	8.5	8.5	8.5	9	9	8.5	8.5	8.5	8	5	295	292.3
5	8	8.5	8.5	9	9	8.5	9	8.5	8.5	8.5	9	9	8.5	8.5	8.5	8.5	5	296	293.1
5	8	8.5	8.5	9	9	8.5	9	8.5	8.5	8.5	9	9	8.5	8.5	9	8.5	5	297	294.0
5	8	9	8.5	9	9	8.5	9	8.5	8.5	8.5	9	9	8.5	8.5	9	8.5	5	298	294.8
5	8	9	8.5	9	9	8.5	9	8.5	9	8.5	9	9	8.5	8.5	9	8.5	5	299	295.7
5	8	9	8.5	9	9	8.5	9	8.5	9	8.5	9	9	8.5	9	9	8.5	5	300	296.5

Flows calculations updated 3/21/2005