**DRAFT 2017 Fish Passage Plan**

**Chapter 2 – Bonneville Dam**

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**Bonneville Dam**

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

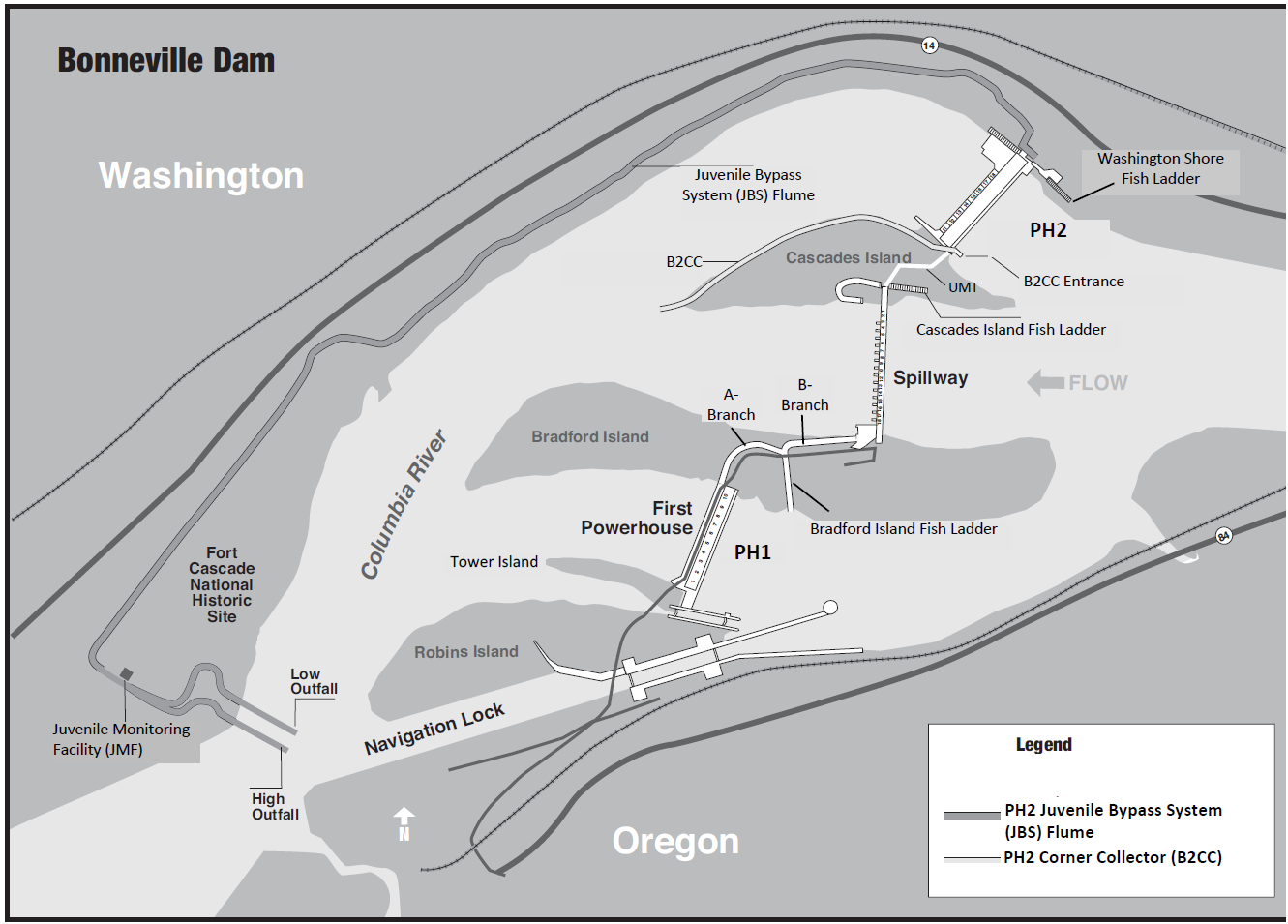
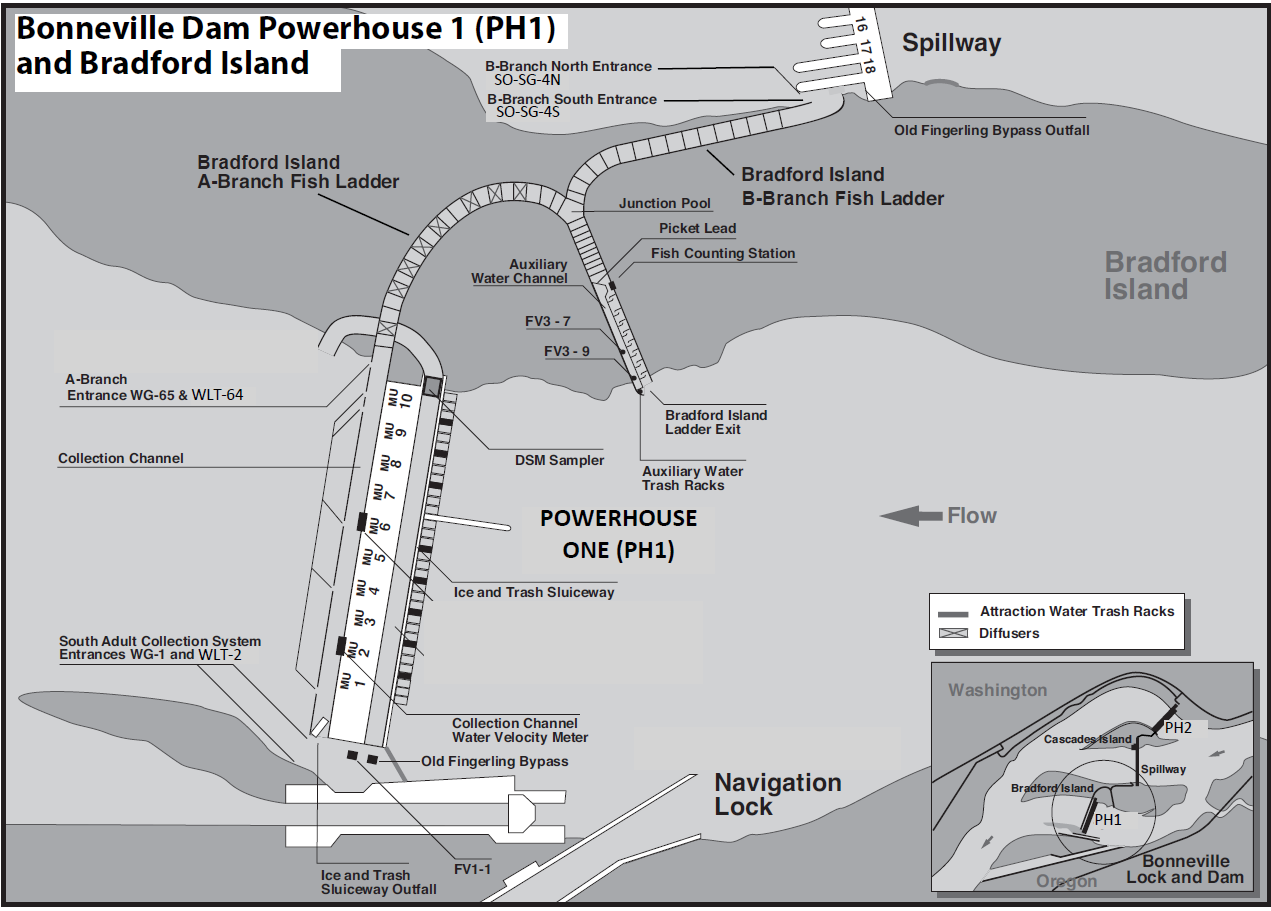
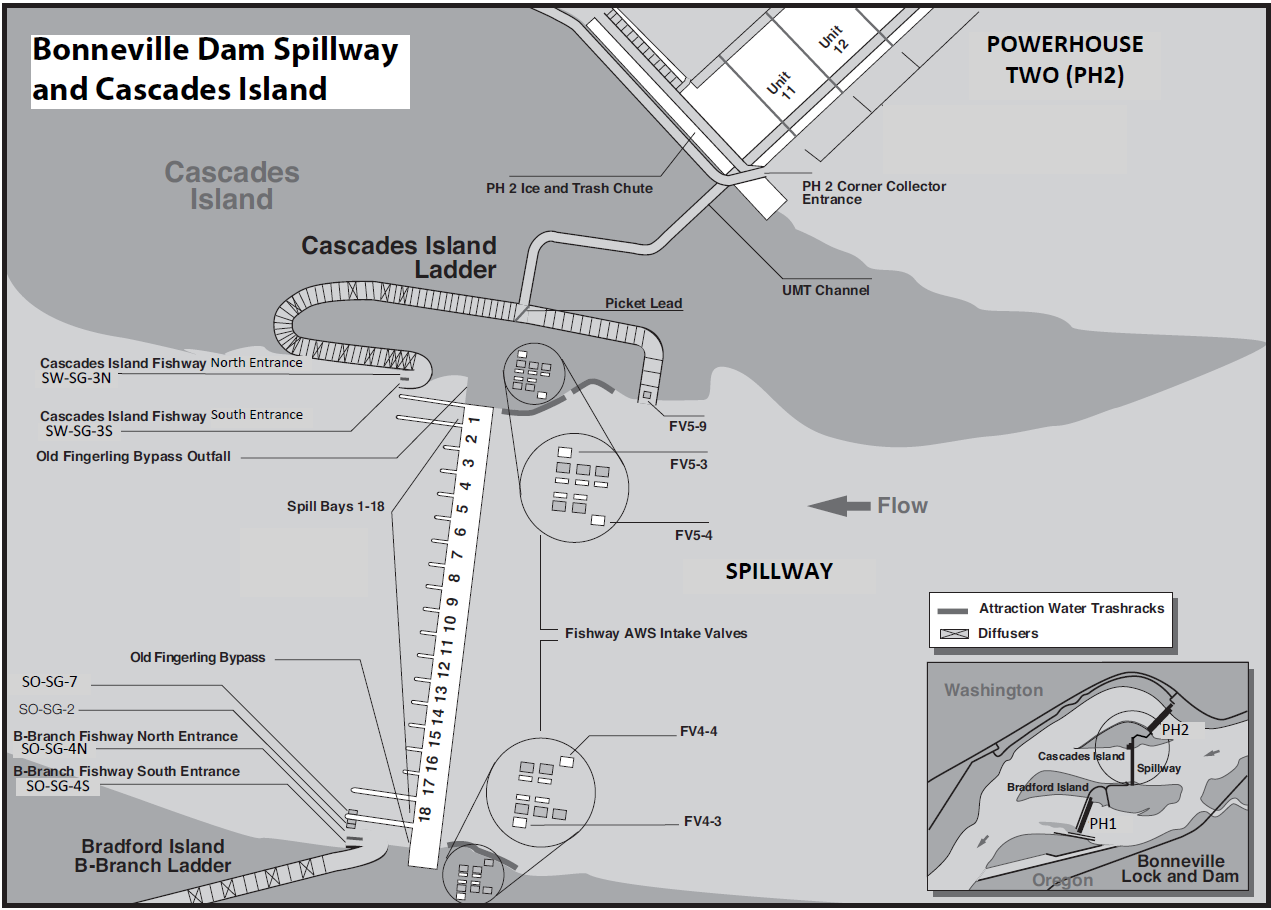


Figure BON-. Bonneville Dam Overview, including Powerhouse 1 (PH1), Powerhouse 2 (PH2), Spillway, Adult Fish Ladders, PH2 Juvenile Bypass System (JBS), Corner Collector (B2CC), Juvenile Monitoring Facility (JMF) and JBS Outfall.



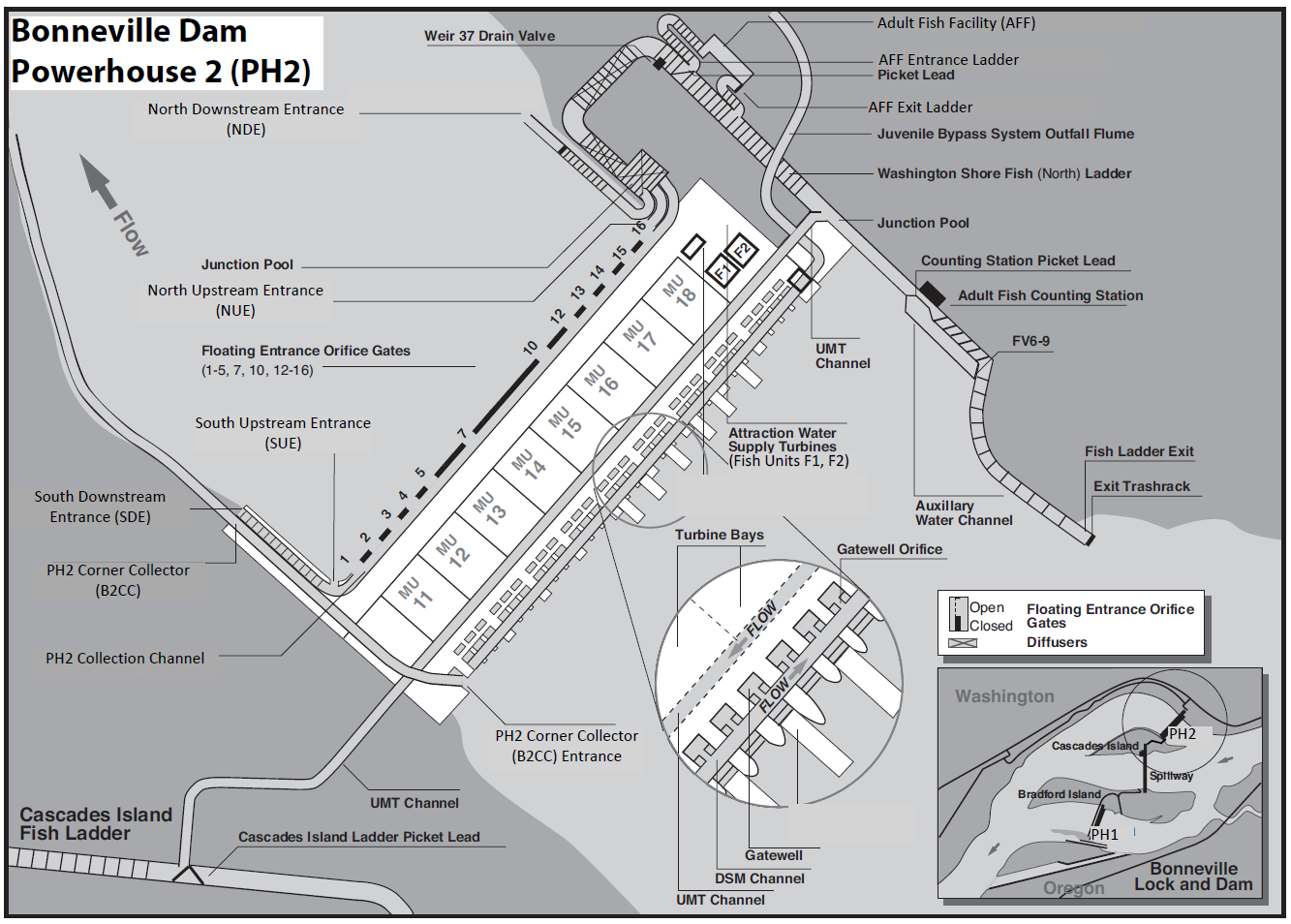
**= Ladder Temperature Monitors (3)**

Figure BON-. Bonneville Dam Powerhouse 1 (PH1) and Bradford Island Adult Fish Ladder A-Branch and B-Branch.



**= Ladder Temperature Monitors (2)**

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



**= Ladder Temperature Monitors (4)**

Figure BON-. Bonneville Dam Powerhouse 2 (PH2) and Washington Shore (WS) North Fish Ladder.

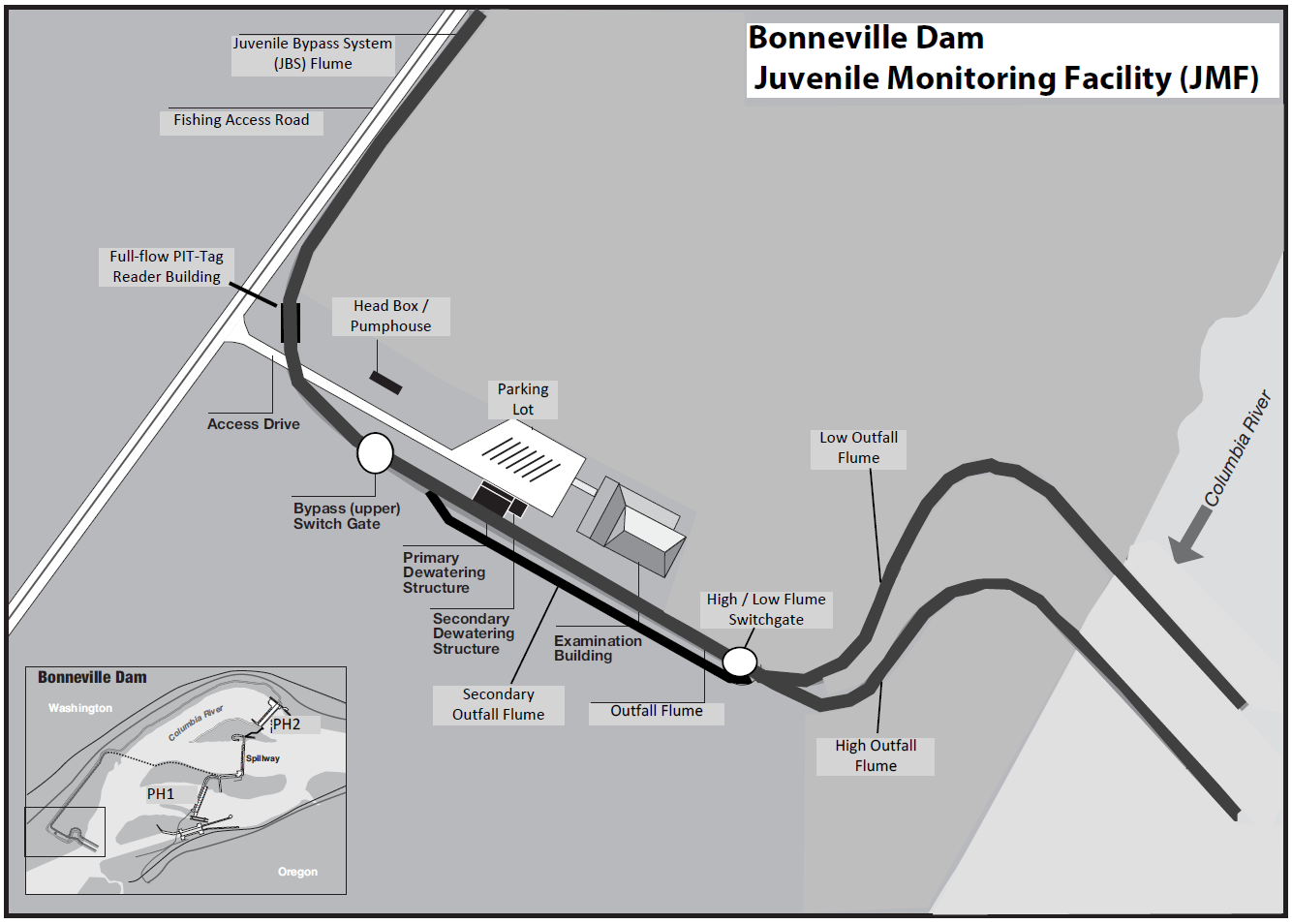


Figure BON-. Bonneville Dam Juvenile (Smolt) Monitoring Facility (JMF) and Outfall Flumes.

Table BON-. Bonneville Dam Schedule of Operations and Actions Defined in the 2017 Fish Passage Plan.



1. FISH PASSAGE INFORMATION

Fish passage facilities at Bonneville Lock & Dam are shown in **Figure BON-1** through **BON-5** and described below. The schedule for project operations described in the Fish Passage Plan (FPP) and Appendices is included in **Table BON-1**.

* 1. Juvenile Fish Passage.
     1. **Juvenile Fish Facilities - Powerhouse One (PH1).** Juvenile fish passage routes at the Bonneville Dam Powerhouse One (PH1) consist of an ice and trash sluiceway (ITS) and minimum gap runner (MGR) turbines.
     2. **Juvenile Fish Facilities - Powerhouse Two (PH2).** Juvenile fish passage facilities at Bonneville Dam Powerhouse Two (PH2) consist of: streamlined trash racks; submersible traveling screens (STS); vertical bar screens (VBS); two 12.5" orifices per gatewell in main units 11-14 and fish unit 2; one 12.5" orifice in all other gatewells flowing into the bypass channel; an excess water elimination facility; and a 48" fish transport pipe which connects the bypass channel to the downstream Juvenile Monitoring Facility (JMF) and the tailrace via 48" and 42" transport pipes (high and low outfall location, respectively).
        1. All eight PH2 main turbine units have STSs, VBSs, and streamlined trashracks.
        2. Two smaller turbines (fish units) supply adult fishway auxiliary water and do not have STSs or streamlined trashracks, and have a fine trashrack with 0.75" clear opening.
        3. The PH2 corner collector (B2CC) on the south side of the PH2 tailrace extends several hundred feet west and empties at the tip of Cascades Island.
     3. **Juvenile Fish Migration Timing.** The juvenile fish migration season occurs March 1–November 30. **Table BON-2** shows the primary passage periods for each species. Bull trout, lamprey, juvenile sturgeon, and other listed salmonids shall be recorded in the by-catch of the Juvenile Monitoring Facility (JMF). Maintenance of juvenile fish facilities is scheduled for December 16 through the end of February to minimize the impact on downstream migrants. These activities will be coordinated to minimize potential impacts on juvenile migrants that may be present at that time.

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

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Year** | **10%** | **50%** | **90%** | **# Days** | **10%** | **50%** | **90%** | **# Days** |
| **Yearling Chinook** | | | | **Subyearling Chinook \* (Brights only\*\*)** | | | |
| **2007** | 20-Apr | 11-May | 23-May | 34 | 19-Jun | 8-Jul | 22-Jul | 34 |
| **2008** | 20-Apr | 12-May | 27-May | 38 | 22-Jun | 6-Jul | 23-Jul | 32 |
| **2009** | 19-Apr | 11-May | 26-May | 38 | 20-Jun | 30-Jun | 19-Jul | 30 |
| **2010** | 27-Apr | 13-May | 1-Jun | 36 | 19-Jun | 5-Jul | 20-Jul | 32 |
| **2011** | 17-Apr | 10-May | 18-May | 32 | 24-Jun | 14-Jul | 2-Aug | 40 |
| **2012** | 24-Apr | 12-May | 23-May | 30 | 23-Jun | 9-Jul | 26-Jul | 34 |
| **2013** | 28-Apr | 12-May | 21-May | 24 | 29-Jun | 9-Jul | 16-Jul | 18 |
| **2014** | 22-Apr | 9-May | 24-May | 33 | 28-Jun | 9-Jul | 25-Jul | 28 |
| **2015** | 23-Apr | 8-May | 22-May | 30 | 16-Jun | 4-Jul | 14-Jul | 29 |
| **2016** | 18-Apr | 2-May | 13-May | 26 | 24-Jun | 7-Jul | 24-Jul | 31 |
| **10-Yr MEDIAN** | **21-Apr** | **11-May** | **23-May** | **33** | **15-Jun\*** | **29-Jun\*** | **19-Jul\*** | **35\*** |
| **10-Yr MIN** | **17-Apr** | **2-May** | **13-May** | **24** | **6-Jun\*** | **22-Jun\*** | **14-Jul\*** | **30\*** |
| **10-Yr MAX** | **28-Apr** | **13-May** | **1-Jun** | **38** | **21-Jun\*** | **9-Jul\*** | **15-Aug\*** | **70\*** |
|  | **Unclipped Steelhead** | | | | **Clipped Steelhead** | | | |
| **2007** | 29-Apr | 16-May | 3-Jun | 36 | 8-May | 17-May | 4-Jun | 28 |
| **2008** | 5-May | 14-May | 30-May | 26 | 7-May | 13-May | 25-May | 19 |
| **2009** | 30-Apr | 13-May | 29-May | 30 | 4-May | 13-May | 26-May | 23 |
| **2010** | 1-May | 14-May | 1-Jun | 32 | 6-May | 14-May | 7-Jun | 33 |
| **2011** | 23-Apr | 15-May | 31-May | 39 | 24-Apr | 12-May | 29-May | 36 |
| **2012** | 26-Apr | 11-May | 29-May | 34 | 29-Apr | 10-May | 28-May | 30 |
| **2013** | 22-Apr | 12-May | 3-Jun | 43 | 28-Apr | 9-May | 28-May | 31 |
| **2014** | 22-Apr | 10-May | 28-May | 37 | 2-May | 12-May | 23-May | 22 |
| **2015** | 30-Apr | 18-May | 29-May | 30 | 4-May | 11-May | 25-May | 22 |
| **2016** | 18-Apr | 5-May | 22-May | 35 | 29-Apr | 5-May | 19-May | 21 |
| **10-Yr MEDIAN** | **27-Apr** | **13-May** | **29-May** | **33** | **3-May** | **12-May** | **27-May** | **25** |
| **10-Yr MIN** | **18-Apr** | **5-May** | **22-May** | **26** | **24-Apr** | **5-May** | **19-May** | **19** |
| **10-Yr MAX** | **5-May** | **18-May** | **3-Jun** | **43** | **8-May** | **17-May** | **7-Jun** | **36** |
|  | **Coho** | | | | **Sockeye (Wild & Hatchery)** | | | |
| **2007** | 26-Apr | 13-May | 31-May | 36 | 16-May | 25-May | 7-Jun | 23 |
| **2008** | 1-May | 18-May | 30-May | 30 | 24-May | 29-May | 8-Jun | 16 |
| **2009** | 29-Apr | 22-May | 1-Jun | 35 | 15-May | 26-May | 5-Jun | 22 |
| **2010** | 24-Apr | 14-May | 5-Jun | 43 | 19-May | 1-Jun | 10-Jun | 23 |
| **2011** | 11-Apr | 14-May | 24-May | 44 | 4-May | 17-May | 4-Jun | 32 |
| **2012** | 26-Apr | 18-May | 7-Jun | 43 | 9-May | 14-May | 23-May | 15 |
| **2013** | 16-Apr | 14-May | 1-Jun | 47 | 14-May | 20-May | 26-May | 13 |
| **2014** | 25-Apr | 12-May | 28-May | 34 | 15-May | 22-May | 30-May | 16 |
| **2015** | 15-Apr | 9-May | 28-May | 44 | 14-May | 22-May | 29-May | 16 |
| **2016** | 13-Apr | 2-May | 19-May | 37 | 5-May | 11-May | 20-May | 16 |
| **10-Yr MEDIAN** | **24-Apr** | **14-May** | **30-May** | **37** | **14-May** | **22-May** | **1-Jun** | **19** |
| **10-Yr MIN** | **11-Apr** | **2-May** | **19-May** | **30** | **4-May** | **11-May** | **20-May** | **13** |
| **10-Yr MAX** | **1-May** | **22-May** | **7-Jun** | **47** | **24-May** | **1-Jun** | **10-Jun** | **32** |

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

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

* 1. Adult Fish Passage.
     1. **Adult Fish Facilities.** Bonneville Dam adult fish passage facilities consist of two main fishway segments:

**Bradford Island (Figure BON-2)** is formed by the PH1 collection channel and Bradford Island A-branch ladder that join the B-branch (south spillway) ladder at the Bradford Island junction pool. The PH1 ice & trash sluiceway (ITS) is also used for adult passage year-round (**section 2.4.1**). The Bradford Island fishway has a counting station and auxiliary water supplies for attraction flow.

**Washington Shore (Figure BON-3, BON-4)** is formed by the PH2 collection channel, and north and south monoliths that join the Washington Shore (North) ladder and Cascades Island (north spillway) ladder at the upstream migrant transportation (UMT) channel. The Washington Shore and Cascades Island fishways have counting stations. The Washington Shore ladder also has an Adult Fish Facility (AFF). All collection systems have auxiliary water supplies for attraction flow.

* + 1. Annual maintenance of adult fish facilities (**section 4.3**) is scheduled December 1 through the end of February (winter maintenance period) to minimize impacts on upstream migrants and to minimize fallback of adult fall Chinook and steelhead.
    2. **Adult Fish Migration Timing & Counting.** Upstream migrants are present throughout the year and adult passage facilities are operated year-round.
       1. Adult salmon, steelhead, lamprey, and shad are typically counted year-round (**Table BON-3**) and data are posted daily at: <http://www.fpc.org/adultsalmon_home.html>. Fish passage is relatively light November 1–March 31 and counting is done by video, primarily to monitor ESA-listed winter steelhead, and posted online every three days. Sturgeon and bull trout are relatively infrequent and counts are reported in *Miscellaneous Fish Counts* and summarized in the *Annual Fish Passage Report*.
       2. Yearly counts through the most recent passage year are used to determine the earliest and latest dates of peak adult fish passage (**Table BON-4)**. Time-of-day (diel) distributions of adult salmonid activity at Bonneville Dam fishway entrances and exits are shown in **Figure BON-6**.

Table BON-. Bonneville Dam Adult Fish Count Schedule, 3/1/2017–2/28/2018.

|  |  |
| --- | --- |
| **Count Period** | **Counting Method and Hours \*** |
| March 1–31 | Day Video 0400–2000 hours (PST) |
| April 1 – November 30 | Day Visual 0500–2100 hours (DST) |
| May 15 – September 30 | Night Video 2100–0500 hours (DST) |
| December 1 – end of February | Video 0400–2000 hours (PST) |

**\***In 2017, Daylight Saving Time (DST) is in effect March 12 – November 5 and hours are adjusted forward 1 hour from Pacific Standard Time (PST). DST = PST+1.

Table BON-. Bonneville Dam Adult Count Period and Peak Passage Timing (based on yearly counts since 1938, except winter steelhead since 1999 and lamprey since 2001).

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



Figure BON-. Diel Distribution of Adult Salmonids at Bonneville Dam Fishway Entrances and Exits (*Keefer & Caudill 2008*). [www.nwd-wc.usace.army.mil/tmt/documents/FPOM/2010/2013\_FPOM\_MEET/2013\_JUN/](http://www.nwd-wc.usace.army.mil/tmt/documents/FPOM/2010/2013_FPOM_MEET/2013_JUN/)

1. fish facilities Operation
   1. General.
      1. Yearling Chinook salmon and most other juvenile salmonids migrate downstream in the spring, whereas sub-yearling Chinook salmon predominantly migrate in the summer after mid-June. Studies specific to Bonneville Dam indicate that juvenile fish survival through various passage routes differ between spring and summer.
      2. **Powerhouse Unit Priority.** Turbine unit operating priority is defined in **Table BON-13**. If a unit is out of service, the next available unit in the priority order will be operated.
      3. **Split Flows.** 
         * 1. Before August 31, if adult and jack salmonid counts equal or exceed 30,000 fish/day, Project Fisheries will initiate coordination with the Fish Passage Operations & Maintenance (FPOM) to discuss options for splitting flow between powerhouses to balance attraction flow and adult passage among the project’s fishways.
           2. After August 31, when adult and jack salmonid counts equal or exceed 25,000 fish/day, the Project will operate two or more priority turbines at PH1 in an attempt to balance adult passage between both powerhouses (assuming no PH1 units are already operating). While PH2 is still priority, project fisheries, at their discretion, may shift additional unit flow up to half the combined powerhouse flow, to PH1 as necessary to alleviate adult fishway crowding. This operation will continue until adult and jack salmonid counts fall below 20,000 fish.
           3. See **section** **5** for unit priority order during split flows and for unit operating ranges at PH1 and PH2.
      4. Research, non-routine maintenance, fish-related activities, and construction will not be conducted within 100' of any fishway entrance or exit, within 50' of any other part of the adult fishway, or directly in, above, or adjacent to any fishway, unless coordinated with FPOM or FFDRWG by the Project, District Operations and/or Planning or Construction office. Alternate actions will be considered by District and Project biologists in conjunction with the Regional fish agencies on a case-by-case basis.
      5. Currently coordinated special operations related to research are described in **Appendix A - Special Project Operations & Studies**.
      6. Emergency situations should be dealt with immediately by the Project in coordination with the Project and/or District biologist. If unavailable, the biologists will be informed immediately following the incident of steps taken to correct the situation. On a monthly basis, as necessary, the project biologist will provide FPOM a summary of any emergency actions undertaken.
      7. All activities within boat restricted zones (BRZ) will be coordinated with the Project at least two weeks in advance, unless it is deemed an emergency (see coordination guidancein **Chapter 1 - Overview**).
   2. Spill Management.
      1. Spring and summer spill operations for juvenile fish passage are defined in the *Fish Operations Plan* (FOP), included in the FPP as **Appendix E**. Spill patterns are defined in **Table BON-16**. Spill changes will be made through regional coordination at TMT.
      2. Night spill is limited as necessary to control total dissolved gas (TDG) super-saturation. Adjustments of night spill may be granted on a case-by-case basis by the Corps Reservoir Control Center (RCC), dependent upon TDG monitoring at stations downstream of the dam, biological monitoring, and fish movement.
      3. “Day” and “Night” spill hours are defined in **Table BON-5**. The transition from day to night spill and vice versa will normally take 15–20 minutes due to the time required to start, synchronize, and load multiple generators. The transition to day spill should not start until after the night period. Frequently, a change in total river discharge will occur concurrently with these spill transitions. The transition to night spill should begin early enough to minimize the chance of violating the established night spill maximum.

Table BON-. Day/Night Spill Schedule for Bonneville Dam.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Date Range** | **Day Start Hour** | **Day End Hour\*** | **Night Start Hour \*** | **Night End Hour** |
| Jan 1–19 | 0700 | 1730 | 1730 | 0700 |
| Jan 20–Feb 14 | 0630 | 1800 | 1800 | 0630 |
| Feb 15–Mar 1 | 0600 | 1830 | 1830 | 0600 |
| Mar 2–Apr 2 | 0600 | 1930 | 1930 | 0600 |
| Apr 3–20 | 0500 | 2030 | 2030 | 0500 |
| Apr 21–May 16 | 0500 | 2100 | 2100 | 0500 |
| May 17–31 | 0430 | 2130 | 2130 | 0430 |
| Jun 1–30 | 0430 | 2130 | 2130 | 0430 |
| Jul 1–31 | 0430 | 2200 | 2200 | 0430 |
| Aug 1–15 | 0500 | 2145 | 2145 | 0500 |
| Aug 16–31 | 0500 | 2030 | 2030 | 0500 |
| Sep 1–16 | 0530 | 2000 | 2000 | 0530 |
| Sep 17–Oct 4 | 0600 | 1930 | 1930 | 0600 |
| Oct 5–19 | 0630 | 1900 | 1900 | 0630 |
| Oct 20–29 | 0630 | 1830 | 1830 | 0630 |
| Oct 30–Nov 30 | 0600 | 1700 | 1700 | 0600 |
| Dec 1–31 | 0630 | 1700 | 1700 | 0630 |

\* Transition to night spill begins 15-20 minutes before the Night Start Hour.

* + 1. **Minimum Spill.** From April 10–August 31, minimum spill is 50 kcfs to provide acceptable tailrace conditions for juvenile fish egress. However, during extreme low flow conditions, lower spill levels may be considered and coordinated through TMT. There is no minimum spill level September 1–April 9. See the FOP (**Appendix E**) for more information.
    2. **Adult Fallback.** From June 16 through August, when PH1 is in operation, day spill will be limited to not exceed 100 kcfs to minimize adult fallback. Normally, this will apply 1 hour before sunrise to ½ hour after sunset (**Table BON-5**). During the portion of the sockeye run that occurs June 16–July 15, this spill limit will apply until 1 hour after sunset only when PH1 is operating.
    3. **Ladder Attraction Flow.** From September 1 through April 9, during day hours (**Table BON-5**), spill will occur from bays 1 and 18 each open 6" (1 stop) to provide attraction flow to the Cascades Island and Bradford Island B-Branch ladders, respectively. From December 1 through the end of February, spill will only occur from the bay(s) adjacent to an operating ladder entrance.
    4. **Powerhouse 2 Corner Collector (B2CC).** During spill that occurs September 1–April 9 (outside of fish passage spill season), the B2CC will be operated if available to provide a surface passage route.
    5. **Total Dissolved Gas (TDG).** TDG is monitored at Bonneville Dam as defined in **Table BON-1**, in accordance with the annual *TDG Monitoring Plan***[[1]](#footnote-1)** and the *Dissolved Gas Monitoring Plan of Action 2015-2018*.**[[2]](#footnote-2)** Starting March 1, TDG at Cascades Island will be reported every 4 hours, as well as the spill rate and total project outflow. Excessive TDG may harm fish and will be controlled to the extent possible, subject to river conditions. Management tools include system-wide spill distribution through the Spill Priority List issued by the Corps Northwestern Division Reservoir Control Center (RCC), night and/or day spill limits, and shaping of spill.
  1. Operating Criteria - Juvenile Fish Facilities.
     1. **Juvenile Facilities - Winter Maintenance (December 1 – end of February).** 
        1. Remove debris from forebay, trash racks, and gatewell slots at both powerhouses as necessary to maintain these areas debris-free.
        2. See **section 2.4.1** for PH1 ice & trash sluiceway (ITS) operations for adult passage after November 30**.**
        3. **Avian Lines.** See *Avian Monitoring & Deterrence Action Plans* in **Appendix L**. From September through March, there will be no avian abatement measures other than avian lines. Avian lines will be repaired and/or reinstalled as soon as possible following damage or removal. New avian lines will be installed and maintained in locations determined to have significant avian predation. Avian abatement measures shall be in place by March 1 unless delayed by weather, in which case work will be completed as soon as weather permits.
        4. **Powerhouse Two (PH2).**
           1. STSs will remain in service through December 15 to prevent adult salmonids from falling back through turbine units, thereby shortening some aspects of the winter maintenance period by two weeks. Unscreened units will be operated on a last-on, first-off basis. Beginning December 16, all STSs may be removed.
           2. 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.
           3. 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.
           4. The PH2 Downstream Migrant (DSM2) channel may be dewatered only when required for maintenance and will be minimized to the extent practicable.
           5. Inspect all gatewell orifices, orifice lighting and flushing systems, and clean and/or repair as necessary so that orifices and associated systems are fully functional.
           6. Inspect dewatering screens and associated equipment. Clean and/or repair as necessary.
           7. Inspect and correct any deficiencies in DSM channel, conduit outfall walls and floor.
           8. **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.
           9. **Powerhouse 2 Corner Collector (B2CC).** During spill that occurs September 1–April 9 (outside of fish passage spill season), the B2CC will be operated if available to provide a surface passage route.
        5. **Spillway.**
           1. Inspect and repair where necessary spill gates and control systems. The spillway, except for coordinated exceptions, must be able to achieve spill patterns on the first day of the juvenile fish passage season.
           2. As per *Bonneville Operating Order 14*, raise and lower each spill gate to test for operability and check calibration prior to start of spill season, usually in March.
           3. Spill guidance during the winter maintenance period is defined in **section 2.2** and the FOP (**Appendix E**).
     2. **Juvenile Fish Passage Season (March 1 – November 30).**
        1. Main unit gatewell drawdown will be measured a minimum of once per week. Remove debris from forebay and trashracks as required to maintain less than 1.5' of total drawdown in gatewells.
        2. A slight oily sheen is commonly found in many gatewells, from sources such as lubricated lifting beams, etc. Unusual accumulations of oil (e.g., oil slick) in gate slots will be removed within 24 hours. Appropriate procedures to remove fish during this situation will be determined in coordination with FPOM. Regardless of unit operating status, oil accumulations will be dealt with promptly.
        3. **Avian Deterrence.** See the *Avian Monitoring & Deterrence Action Plans* in **Appendix L**. From April through August, avian abatement measures other than avian lines will be implemented as necessary. Avian lines will be repaired and/or reinstalled as soon as possible following damage or removal. New avian lines will be installed and maintained in locations determined to have significant avian predation. From September through March, there will be no avian abatement measures other than avian lines.
        4. Set PH1 ITS chain gates 1A and 1B at 70' msl. Ensure gates 3B, 6C and 10B are operating according to **Table BON-6**.
           1. If chain gates for Unit 1 are OOS, set chain gates 2A and 2B at 70' msl. Ensure gates 3B, 6C, and 10B are operating according to **Table BON-6.**

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

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

* + - 1. **Powerhouse Two (PH2).**
         1. Juvenile fish protection devices (STS, etc.) will be in place prior to the juvenile fish passage season. Screens (STSs, VBSs) will remain in operation through December 15 to prevent adult salmonids from falling back through turbine units.
         2. Main unit gatewell drawdown will be measured a minimum of once per week. Check more often during times of overwhelming debris, as described in **section 2.3.2.5.p**.
         3. Remove debris from forebay and trash racks as required to maintain ≤ 1.5' gatewell drawdown, or as indicated by fish condition (e.g., higher than expected descaling), or as determined by the Project Biologist. STSs in units being raked will run continuously during raking. Gatewell orifices of the unit being raked must be closed during the procedure.
         4. Operate STSs at 60o angle from vertical.
         5. Turbines without a full complement of STSs will not operate except when in compliance with other coordinated fish measures.
         6. Observe each STS watt and/or amp gauge and record reading at least once per day. If an STS failure occurs, then follow procedures in *Fish Facility Maintenance*.
         7. 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 1,440 hours run time). Frequency of monthly inspections may be based on individual turbine unit run time.
         8. No STS inspections will be scheduled when it may cause excessive TDG due to increased forced spill.
         9. VBS inspections will occur immediately prior to peaks in juvenile fish migrations, which begin about May 1, mid-July and September 1.
         10. More frequent inspections may be required by the Project Biologist or under the following conditions: deteriorating fish condition, increased debris in bypass system, and/or other indications of STS or VBS malfunctions or failure.
         11. If manually inspecting VBSs, shut off units and dip gatewells prior to pulling VBS. It is not necessary to dip gatewells of units that have been off for 48 hours or longer.
         12. VBSs will be cleaned when drawdowns read 1.1' on any day (including weekends) and when drawdowns reach 0.9' on Thursdays.
         13. If a screen has reached the cleaning threshold, clean all 3 screens in that unit.
         14. Unit will be shut down if VBS drawdown equals or exceeds 1.5' in 12-hours.
         15. Rake trashracks at Units 11, 12 prior to March 1 and at least once/month throughout fish passage season.
         16. If STS or VBS damage or plugging is detected, follow procedures in *Fish Facilities Maintenance* (**section 4**). In the event of overwhelming debris (as defined below) follow the procedures as follows. Monitor gatewell drawdown daily.

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

If the TIE crane is out of service, the Gantry Crane will be used to pull the main VBS and the spare VBS will not be installed in the back slot.

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

If the VBS drawdown criteria of <1.5' over 12-hours CANNOT be maintained due to debris even after performing the above operations, then STSs will be pulled out until the screen re-installation criteria have been met (**p.6** below).

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

**Screen Re-Installation Criteria.** At the discretion of the Project Biologist and in consultation with FPOM, the Project will install STSs in the highest priority unit available. When VBS drawdown for that unit remains below 1.1' for 24 hours, the Project will re-install the remaining STSs.

* + - * 1. **Gatewell Orifice Systems**. All gatewell orifice systems should be operational.

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

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

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.

* + - * 1. **Orifice Lights.** Replace all non-operational orifice lights within 24 hours. Orifice lights shall remain lighted 24 hours/day. DSM gallery lights should be off except when there are personnel in the gallery.
        2. **Gatewell Cleaning.** The project will clean gatewells before the water surface becomes 50% covered with debris. If due to the volume of debris, it is not possible to keep the gatewell surfaces 50% clear, they will be cleaned at least once daily.

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.

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.

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

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

* + - * 1. **Powerhouse Two Corner Collector (B2CC).**

March 1–April 10 (Kelt Trigger): the B2CC will be open for downstream migrating steelhead kelts if the following criteria are achieved based on kelt counts at the JMF adult/debris separator. If 2 kelts/day are counted on 2 consecutive days, and the total cumulative count since March 1 is ≥ 20 kelts, JMF personnel will notify Project Fisheries and the Control Room to open the B2CC within 1 hour.

April 10–August 31 (Spring & Summer Spill): the B2CC will be open during spring and summer spill for fish passage, as defined in the FOP (**Appendix E**). The B2CC will be opened within one hour of the start of spring spill on April 10 (unless already open for kelt, as defined above in **t.1**) and closed within one hour of the end of summer spill on August 31.

September 1–April 9: During spill that occurs outside of fish passage spill season, the B2CC will be opened if available to provide a surface passage route.

* + - * 1. **DSM2 Channel.**

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

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

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

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

Project biologists shall have the discretion to modify the cleaning system program at any time to maintain FPP criteria.

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

**Operation.** Maintain the channel elevation between 64.2'–64.4' as measured at the staff gauge in front of the ERG. DSM channel elevation is maintained by a combination of add-in water, 30 non-regulating orifices and 12 regulating orifices (units 11-14). The add-in water provides a fixed input of 60 cfs and the non-regulating orifices are open at all forebay elevations. If the channel elevation exceeds the range of 64.2-64.4', the regulating orifices will open one at a time from south to north (starting at Unit 11) until proper channel elevation is achieved.

* + - 1. **Juvenile Monitoring Facility (JMF).**
         1. Project Biologists orJMF personnel will operate the upper switchgate as necessary for sampling requirements.
         2. The lower switchgate is in automatic control. JMF personnel (PSMFC) will monitor and report any problems with the lower switchgate to Project Biologists.
         3. On seasonal ascending tailwater elevations, the transition from low to high outfall should be between tailwater elevations at the upper end of 16'–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 16'–18' range.
         5. Operate the outfall avian hydrocannons March 1–November 1. The cannons will be operated 24 hours/day during fish passage season.
         6. For specific monitoring facility guidance, see *Protocols for Juvenile Monitoring Facility Operations at Bonneville Dam* (**Appendix J**).
  1. Operating Criteria - Adult Fish Facilities.
     1. **Adult Facilities - Winter Maintenance (December 1 – end of February).**
        1. Operate adult fish passage facilities according to fish passage season standards (**section 2.4.2**). Systems may be dewatered or operated out of criteria for repair and maintenance.
        2. Outage periods will be minimized to the extent practicable.
        3. Only one ladder servicing the powerhouses and the associated powerhouse collection system (including auxiliary water supply system) may be out of service or out of standard operating criteria at one time, unless specifically coordinated.
        4. One of the two ladders servicing the spillway will be in full operation at all times unless otherwise coordinated.
        5. Operate spillbays 1 and/or 18 for adult attraction (**section** **2.2.6**).
        6. Adjust fish counting stations crowders to fully open if videotaping is temporarily discontinued due to unscheduled events or during winter maintenance (dewatering) period.
        7. Sea Lion Exclusion Devices (SLEDs) will be installed at all adult fishway entrances and all floating orifice gates (FOGs).
        8. Inspect and calibrate all staff gauges and water level indicators. Repair and/or clean where necessary.
        9. 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.
        10. Inspect for and clear debris in the ladder exits.
        11. Reinstall counting station picket leads prior to watering up ladders during maintenance.
        12. **PH1 ITS.** Except when closed to facilitate maintenance activities, the PH1 ITS gates 1A, 1B, 3B, 6C, and 10B should remain open from December 1 through the end of February for steelhead kelt passage.
            1. Set chain gate 1A and 1B at 70' msl. Ensure gates 3B, 6C, and 10B are operating according to **Table BON-6**.
            2. From December 15 through end of February, the Project may close the ITS endgate or ITS gates for winter maintenance (including researcher equipment O&M). Closures may not exceed six hours per day unless otherwise coordinated with FPOM.
        13. In the appropriate year (when fishway is out of service for winter maintenance), dredge AWS intakes to maintain the following elevations:

PH2 Fish Unit intake: -22' to -24'msl;

BI exit, FV3-7, FV3-9: +63' msl.

* + 1. **Adult Fish Passage Season (March 1 – November 30).**
       1. Water depths will be measured at the Bradford Island A- and B-branch staff gauges, at the Washington Shore weirs 37 and 38, and at the UMT staff gauge in the Cascades Island fishway. Maintain water depth over fish ladder weirs at 1.0' ±0.1' during non-shad passage season (< 5,000 shad/day/count station) and at 1.3' ±0.1' during shad passage season (≥ 5,000 shad/day/count station).
       2. **Temperature Monitoring.**
          1. Water temperature will be measured in an adult fishway at each powerhouse. When water temperature reaches 70°F, all fish handling activities will be coordinated through FPOM prior to any action to verify protocols that will be followed. Fish handling activities in the Adult Fish Facility (AFF) will implement protocols in **Appendix G**.
          2. From June 1 through September 30, water temperature will be monitored at adult fishway entrances and exits (**Figure BON-2, BON-4**).

Temperature monitors shall be placed within 10 meters of all shore-oriented entrances and exits.

If possible, the entrance monitor shall be within 1 meter above the ladder floor and at least 10 meters downstream of ladder diffusers to allow for sufficient mixing with surface water.

The exit monitor shall be within 1 meter above the ladder floor and above all diffusers to allow for sufficient mixing with surface water.

If an existing temperature monitoring location is proposed for either the exit or entrance, it shall be verified that the site accurately reflects water temperature within 10 meters of the entrance or exit.

Project Fisheries will submit temperature data to the Fish Passage Center (FPC) on a weekly basis for posting online at: <http://www.fpc.org/river/Q_ladderwatertempgraph.php>.

* + - 1. Head on all entrances should be 1'–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'–2' at the NUE entrance is indicated by a 1.2'–2.2' (1.7' preferred) entrance head calculated using the fishway and tailwater staff gauges closest to NUE. Refer to **Table BON-12** when unable to achieve head criterion.
      2. Water velocity shall be maintained between 1.5 feet per second (fps) and 4 fps (2 fps preferred) 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.
      3. Maximum head of 0.5' will be allowed on the PH1 attraction water intakes and trash racks at all the ladder exits, with 4" maximum head on all picket leads. Debris shall be removed when significant amounts accumulate.
      4. Staff gauges and water level indicators will be readable at all water levels encountered during the fish passage season, including: PH1 south collection channel, PH1 north collection channel, PH1 north tailwater, PH1 south forebay, BI A- and B-branch ladders, BI weir, B-branch entrance, CI entrance, CI ladder below UMT entrance, NUE/NDE/SUE/SDE collection channel, NUE/SUE tailwater, and PH2 north forebay.
      5. Stillwells used in lieu of staff gauges will be checked for calibration once/week.
      6. **Fish Counting.** The current fish counting program is in **Table BON-3**. Count station crowders shall remain in operating position while visual counting and/or videotaping is being conducted. All equipment should be maintained and in good condition. The counting window and backboard should be cleaned as needed to maintain good visibility.
         1. The crowder shall be opened to full count slot width when not counting. During counting, the crowder shall be open as far as possible to allow accurate counting and shall not be closed to less than 18". This will usually occur during high turbidity conditions to maintain count accuracy. All equipment will be maintained in good condition. The counting window and backboard will be cleaned as needed to maintain good visibility. The crowder ranges are as follows:

Washington Shore = 22.8" – 38.4"

Cascades Island = currently out of service (max. opening approximately 36")

Bradford Island = 20.4" – 36.0"

* + - * 1. 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.
        2. Project biologists, FFU, and the fish count supervisor shall coordinate to achieve optimum count slot passage and/or count accuracy conditions.
        3. If counting is temporarily discontinued due to unscheduled events, the crowder shall be fully opened.
        4. The crowder may remain in operating position during the counters’ hourly 10-minute break period.
        5. The fish passage slot lights shall remain on overnight.
        6. Upstream light banks in both count stations shall remain off to facilitate fish passage through the count slot and to 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 with FPOM.
        7. Inspect and ensure that optimum passage conditions are maintained at fishway entrances, exits, and in the count slots.
      1. When spilling exclusively for adult attraction, spillbays 1 and/or 18 shall be open 6" during day hours only if adjacent to operating fishway entrances (**section** **2.2.6**).
      2. Ladder entrances at Cascades Island are labeled “SW-SG” (Washington Sluice Gate) and entrances at Bradford Island are “SO-SG” (Oregon Sluice Gate).
         1. Side entrances SW-SG-5 and SO-SG-7 shall remain closed.
         2. Downstream entrances SW-SG-1 and SO-SG-2 shall operate as continuously-open, free-flowing vertical slots.
         3. Downstream entrances SW-SG-3 and SO-SG-4, adjacent to shorelines, consist of pairs of sluice gates (north and south):

At Cascades Island, -3N and -3S shall be closed at all tailwater elevations.

At B-Branch, when tailwater exceeds 17', -4N and -4S shall be closed. When tailwater is between 9' and 17', sluice gate -4N shall be open. When the tailwater is below 9', both sluice gates -4N and -4S shall be open.

* + - 1. **SLEDs.** Sea Lion Exclusion Devices (SLEDs) will be at all adult fishway entrances and all floating orifice gates (FOGs).

FOG SLEDs can be left in year-round.

Either the B-Branch or Cascades Island entrance SLED (dependent on crane location) may be left in year-round due to the inability to move the 65-ton crane across the spillway.

All other entrance SLEDs will be raised by June 1 for adult sockeye passage and lowered by July 20, or as soon as possible if a sea lion is observed in the fishway.

* + - 1. **Powerhouse One (PH1).**
         1. **Weir Gates.** PH1 weir gates will be operated as shown in **Table BON-10.**

**Gate Pairing.** The four weir gates will be operated in two pairs. Only one gate pair will be allowed to operate at a 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'.

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

* + - * 1. **Fish Valve FV1-1.**

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

**Differential.** Low: collection channel/tailwater differential <1'. High: collection channel/tailwater differential >2.0'.

* + - * 1. **Fish Valve FV3-7.** Maintain the opening concurrent with the charts for valve opening, as set by the forebay and tailwater elevations.
        2. **Bradford Island A-Branch.** Bradford Island A-branch diffuser gates FG3-3 through FG3-9 are open according to patterns in **Table BON-7**.
        3. **PH1 Collection Channel Diffusers.** Diffuser valves are operated according to patterns in **Table BON-11.**

Table BON-. Bradford Island A-branch Fish Ladder Diffuser Operating Ranges.

|  |  |  |
| --- | --- | --- |
| **Diffuser** | **Operating Setpoint – Tailwater Elevation (ft)** | **Position** |
| FG3-3 | >8.2 | Open |
| FG3-4 | >13.7 | Open |
| FG3-5 | >16.7 | Open |
| FG3-6 | >19.7 | Open |
| FG3-7 | >25.2 | Open |
| FG3-8 | >28.2 | Open |
| FG3-9 | > 31.2 | Open |

Table BON-. Bradford Island B-Branch Fish Ladder Diffuser Operating Ranges.

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

Table BON-. Cascades Island Fish Ladder Diffuser Operating Ranges.

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

Table BON-. Bonneville Dam Powerhouse One (PH1) Weir Gate Requirements.

|  |  |  |  |
| --- | --- | --- | --- |
| **Weir Gate** | **Submergence Requirement (ft)** | **Differential Requirement (ft)** | **Sill Elevation (ft)** |
| 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 |

Table BON-. Bonneville Dam Powerhouse One (PH1) Collection Channel Diffuser Valve Operation. \**Any diffusers not listed should be CLOSED.\**

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

* + - 1. **Powerhouse Two (PH2).**
         1. During day spill (**Table BON-5**), operate all north (NUE, NDE) and south (SUE, SDE) entrances. Operate weir crests at elevation 1' (fully lowered) at tailwater elevation ≤ 14'. At tailwater elevation > 14', operate weir crest ≥ 13' below tailwater.
         2. Operate all 12 active PH2 floating gate fishway entrances.
         3. **Lamprey Operations June 1–August 31:** During night spill (**Table BON-5**), reduce fish unit output to operate all north (NUE, NDE) and south (SUE, SDE) entrances at 0.5' of entrance head. To ensure proper function of fish units, B2 fish unit output can be further reduced or placed on standby to float debris as necessary from 2200-0400 hours.
         4. Measure fish unit gatewell drawdown at least once per week. When head across trash racks exceeds 1.5', the trash racks will be cleaned that day (may be done by raking late in the workday). However, if 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.
         5. Take soundings annually at the PH2 Fish Unit intake and the BI exit/AWS intake to determine sediment accumulation and plan for the appropriate dredging need. Fish Unit intake dredging is a key component to maintaining a reliable AWS system and should be prioritized during winter maintenance (**section 2.4.1**).

1. fish Facilities Monitoring & Reporting
   1. Inspections.
      1. The results of all inspections and the readiness of the facilities for operation will be reported to the FPOM at the meeting immediately prior to the fish passage season.
      2. During fish passage season, fish passage facilities will be inspected at least three times/day, seven days/week to assure operation according to established criteria. Daily inspections will include at least one by Project Fisheries, one by Project Operators and one modified (PLC check).
      3. During winter maintenance season, fish passage facilities will be inspected at least once/day, seven days/week, with at least three inspections per week performed by Project Fisheries.
      4. More frequent inspections will occur as noted throughout the text.
      5. Project fish biologists and biological staff will conduct at least three inspections per week.
   2. Zebra Mussel Monitoring.
      1. 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. Reporting.
      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:

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

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

Adult fishway control calibrations;

STS and VBS inspections;

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

When trapping is occurring in the AFF;

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

* + 1. **Weekly Reports** shall cover Sunday–Saturday and e-mailed to CENWP-OD, CENWD-PDW-R (RCC) and other interested parties as soon as possible the following week.
    2. ***Memorandum for the Record* (MFR)** shall be prepared by Project biologists for any adverse or negative impact to fish or fishways (see MFR template included in **FPP Chapter 1 – Overview**). The MFR will be sent to FPOM by the next working day and added to the next FPOM agenda for review. Items that shall be included in the memo are:

Time and date of incident;

Nature of activity that led to fish impact;

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

Number of fish affected, species, origin, discernible injuries, tags, photos, etc.;

Future actions to avoid a similar impact;

Regional coordination and responses/comments.

* + 1. **Annual Reports** shall be prepared by Project biologists by January 31 summarizing the operation of the project fish passage facilities for the previous year.
       1. The annual report will cover from the beginning of one adult fish facility winter maintenance period to the beginning of the next.
       2. The annual report also will include a description of all actions taken to discourage avian predation at the project, with an overview of the effectiveness of the activities.
       3. The annual report will be provided to CENWP-OD in time for distribution to FPOM members at the February meeting.

1. Fish Facilities Maintenance
   1. General.
      1. **Routine Maintenance.**
         1. Staff gauges and other water-level sensors will be installed, cleaned, and/or repaired as required.
         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.
         3. Maintenance activities that occur during the fish passage period and that may affect fish passage will be reported in the weekly reports.
   2. Maintenance - Juvenile Fish Facilities.
      1. **Routine Maintenance.**
         1. **Submersible Traveling Screens (STS).** The STS system will receive preventive maintenance or repair at all times of the year, including the winter maintenance period. Whenever a generator malfunctions or is scheduled for maintenance, the three STSs in that turbine may be maintained, repaired, or exchanged for other STSs needing maintenance or repair. One third of the STSs at Bonneville are scheduled for complete overhaul each year resulting in a three-year maintenance cycle unless future developments indicate that longer life expectancy is possible.
         2. **Juvenile Bypass Systems (JBS).** The JBS will receive preventive maintenance throughout the year. During the juvenile fish passage season, this will normally be above-water work such as maintenance of automatic systems, air lines, electrical systems, and monitoring equipment. During the winter maintenance period, the systems may be dewatered downstream of the gatewell orifices. The systems will then be visually inspected in all accessible areas for damaged equipment and in areas that may cause problems to the juvenile fish. Any problem areas identified are to be repaired if the project is able. In extreme cases, the work will be contracted as soon as possible or repaired during the next winter maintenance period. Channel modifications and general maintenance also should be completed at this time.
            1. 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.
         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.
            1. 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.
            2. Certain turbine and spillway flows at the projects are secondarily used to attract adult fish to fishway entrances, to keep predator fish from accumulating near juvenile release sites, and/or to move juveniles downstream away from the project. During fish passage season, do not take units F1, F2, 1, 3, 11, and 18 out of service, when practicable.
            3. Whenever practicable, except during split flows operation, do not take any other PH2 units out of service June 21–September 15, to minimize PH1 operation.
            4. 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.
            5. 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.
      2. **Non-Routine Maintenance.** Maintenance of facilities that sometimes break down during fish passage season (e.g., fish screens) will be carried out as described below.
         1. Unscheduled maintenance that will have a significant impact on juvenile fish passage shall be coordinated with the Regional fish agencies through FPOM and with RCC on a case-by-case basis by CENWP-OD biologists. See **FPP Chapter 1 - Overview** for the Memo of Coordination (MOC) instructions and template. The CENWP-OD biologists will be notified by the project as soon as possible after it becomes apparent that maintenance repairs are required. The Project Operations Manager has the authority to initiate work prior to notifying CENWP-OD when delay of the work will result in an unsafe situation for people, property, or fish.
         2. **Screens.** If an STS or VBS is found to be damaged or inoperative in an operating unit, the unit will be regarded as an unscreened unit. The screen will be repaired or replaced before returning the unit to normal service.
         3. **Juvenile Bypass Systems (JBS).** 
            1. The JBS is controlled automatically (PLC). When an automatic system fails, it can usually be operated manually. This allows either facility to operate according to criteria while repair of the automatic system is completed.
            2. 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.
            3. If automatic systems fail and the system is operated manually, facility inspections should increase to a frequency to ensure systems operate within criteria.
            4. All STS gatewells will be inspected daily and cleaned before they become 50% covered with debris. If due to volume of debris it is not possible to keep the gatewell surfaces at least 50% clear, they will be cleaned at least once daily. Turbines with a gatewell fully covered with debris will not be operated, except on a last-on/first-off basis, if required to be in compliance with other coordinated fish measures. This is to maintain clean orifices and minimize fish injury. The gatewell orifices will be closed during the cleaning operation. Check gatewell drawdown and clean trashracks if necessary.
            5. **Powerhouse One (PH1).** PH1 juvenile passage routes consist of the ITS and MGR turbines. The DSM is no longer in service.
            6. **Powerhouse Two (PH2).** If the bypass system fails in the dewatering section or release pipe, fish may be released through the emergency relief conduit. This operation will continue until repairs are accomplished or until the end of the fish passage season. Any decision on whether or not to shut this system down for dewatering and repairs will be made in coordination with the FPOM. During this emergency operating mode, power generation will be minimized at the PH2. Repairs will receive high priority.
            7. During fishway inspections, VBSs may be found plugged, damaged or not properly seated. In these cases, the associated unit will be taken out of service as if unscreened and repairs will be made before returning the unit to normal service. If screens are pulled and replaced, the underwater video inspection camera will be deployed to check the screens for proper seating.
         4. **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.
   3. Maintenance - Adult Fish Facilities.
      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.
         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.
         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.
            1. An underwater video system or diver may be used for underwater inspections. This scheduled inspection and any associated maintenance will occur during winter maintenance period and once during fish passage season unless specially coordinated. Any non-routine maintenance and fishway modifications will be handled individually.
            2. A Project Biologist will attend all dewatering activities potentially involving fish, as well as inspections, to provide fish related input.
         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.
            1. Daily inspections of fish ladders and collection systems should include looking for any flow changes that may indicate problems with diffuser gratings.
            2. 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.
            3. If possible, a video inspection should be made ASAP to determine the extent of the problem. If diffusers gratings are found to be missing or displaced, creating openings into the diffuser chambers, a method of repair shall be developed and coordinated with the fish agencies and tribes through the established FPOM coordination procedure.
            4. Repairs shall be made as quickly as possible unless coordinated differently.
         4. **Adult Fish Ladders & Counting Stations.** Also see *Adult Fish Trapping Protocols* (**Appendix G**).Adult fish ladders will be dewatered once each year during winter maintenance. During this time, the ladders will be inspected for blocked orifices, projections into the fishway that may injure fish, weir stability, damaged picket leads, exit gate problems, loose diffusion gratings, unreadable or damaged staff gauges, defective diffusion valves, malfunctioning operating equipment at the counting stations, as well as other potential problems. Problems identified throughout the passage year that do not affect fish passage, as well as those identified during the dewatered period, may then be repaired. Trash racks at the ladder exits will be raked when criteria is approached or exceeded. When practicable, rake trash racks during the time of day when fish passage is least affected, usually late morning (**Figure BON-6**). Fish count station windows, light panels, and crowder panels will be cleaned as needed to achieve accurate counts and, when practicable, during the time of day when fish passage is least affected, usually late morning.
      2. **Non-Routine Maintenance.** Maintenance activities that occur during the fish passage period that may affect fish passage will be reported in the weekly reports. Non-routine maintenance that will significantly affect the operation of a facility, such as repair of displaced diffuser gratings, will be coordinated with RCC and Regional fish agencies through FPOM. Coordination procedures for non-routine maintenance of adult and juvenile facilities are the same. Any non-routine maintenance and fishway modifications will be handled individually.
         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.
            1. **Powerhouse One (PH1).** If any valves or other part of the system fails, the project shall attempt to maintain criteria by adjusting functioning valves. Conduit pressure must be monitored and not allowed to exceed the established limits.
            2. **Spillway.** Two separate fishway auxiliary water valves add water to each spillway ladder (Cascades Island and B-branch ladders). If one of these valves or any other part of the system malfunctions, the functioning parts of the system are to be adjusted to compensate. If repairs cannot be made in 24 hours, close the sluice gate entrance, if open. This will divert the reduced available water to the entrance slots. If a head of 1' is still not achieved, stop logs are to be added to the entrance slots until the desired head or a weir depth of not less than 6' below the tailwater surface is reached. At this point maintain the gate positions until the auxiliary water system is repaired.
            3. **Powerhouse Two (PH2).**

If either or both fishway auxiliary water turbines do not provide sufficient water to meet full criteria, the adult facilities will be operated according to *Emergency Operations for Bonneville PH2 AWS Systems Operations* (**Table BON-12**) or until a fishway head of 1' is achieved.

When one of the fish turbines has failed or been taken out of service, refer to **Table BON-12** for turbine operations, floating orifices, diffuser gates, and main gates during emergency situations. **Table BON-12** 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.

From September 1–March 31, if both fish unit turbines fail and repairs cannot be made within 8 hours, coordination with FPOM will occur to develop operational guidelines that may include modified powerhouse priority operations.

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

Table BON-. Bonneville Dam PH2 Auxiliary Water Supply Emergency Operations.

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

* + - 1. **Powerhouse & 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.
      2. **Adult Fish Ladders & Counting Stations.** Ladder components include picket leads, counting stations, fishway exits, and overflow weirs with orifices. Pickets with excessive spacing (greater than 1"), concrete erosion around the leads, or missing pickets can allow fish into areas where escape is difficult. In some instances of picket lead failure, spare leads and spare installation slots are available. In these cases the spare leads are installed and the damaged leads are removed and repaired. In the remaining instances of picket lead failure or concrete erosion, the timing and method of repair will depend upon the severity of the problem. The decision of whether or not to dewater the fishway and repair any problems will be made in coordination with the Regional fish agencies through FPOM.
      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.
         1. Daily inspections of fish ladders and collection systems should include looking for any flow changes that may indicate problems with diffuser gratings.
         2. 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.
         3. If possible, a video inspection should be made as soon as possible to determine the extent of the problem. If diffuser gratings are found to be missing or displaced, creating openings into the diffuser chambers, a method of repair shall be developed and coordinated with the Regional fish agencies through FPOM.
         4. Repairs shall be made as quickly as possible unless coordinated differently.

1. Turbine Unit Operation & Maintenance
   1. Turbine Unit Priority Order.
      1. Powerhouse and turbine unit priority orders are defined in **Table BON-13**.
      2. When splitting flows (**section 2.1.3**), the top two available PH1 priority units will be operated first, followed by normal PH2 unit priority. If there is need for more units after all available PH2 units are operating, proceed with normal PH1 unit priority.
      3. During high head events (e.g., higher than normal forebay), the top priority unit at PH1 may be operated when necessary to keep PH2 units within the 1% range.

Table BON-. Bonneville Dam Turbine Unit Operating Priority Order.

|  |  |
| --- | --- |
| PERIOD / OPERATION | PRIORITY \* |
| Year-Round:  Fish Ladders in service; PH1 Ladder out of service | **PH2**: 11, 18, 12, 17, 13, 14, 15, 16,  **Then** **PH1**: 1, 10, 3, 6, 2, 4, 5, 8, 7, 9 |
| PH2 Fish Ladder out of service | **PH1**: 1, 10, 3, 6, 2, 4, 5, 8, 7, 9,  **Then** **PH2**: 11, 18, 12, 17, 13, 14, 15, 16 |
| Split Flows  (**section 2.1.3**) | **PH1**: 1, 10 (or top two available PH1 priority units),  **Then PH2**: 11, 18, 12, 17, 13, 14, 15, 16,  **Then** **PH1:** 3, 6, 2, 4, 5, 8, 7, 9 |
| PH1 Unit Priority | 1, 10, 3, 6, 2, 4, 5, 8, 7, 9 |
| PH2 Unit Priority | 11, 18, 12, 17, 13, 14, 15, 16 |

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

* 1. Turbine Unit Operating Range.
     1. From April 1 through October 31, turbine units will be operated within ±1% of peak efficiency (1% range), as specified in *BPA Load Shaping Guidelines* (**Appendix C**). Turbine units at PH1 may be operated up to the Best Operating Point (BOP). Lower and upper limits of the operating ranges at PH1 and PH2 are defined in **Tables BON-14** and **BON-15**, respectively.
        1. From April 10 through June 15, as a soft constraint, PH2 units should not be operated below the 1% mid-range (<13 kcfs) to minimize turbulence that may impact fish that pass through the turbines.
     2. While not required to do so in the off-season, November 1–March 31, units will normally be operated within the 1% range since it is the optimum point for maximizing energy output of a given unit of water over time. Operation outside the 1% range is allowed if needed for power generation or other needs.
  2. Turbine Unit Maintenance.
     1. **Maintenance Schedules**.
        1. Turbine unit maintenance schedules will be reviewed by Project and District Operations biologists for fish impacts.
        2. Priority unit maintenance will be scheduled for the winter maintenance period or when there are few fish passing the project, to the extent possible. Priority units 1, 3, 11, and 18 will be scheduled for any necessary extended outages between December 1 and April 30. Non-priority units should not be scheduled for routine or extended outages during this time if it will delay or conflict with priority unit maintenance. To maintain the priority importance of Unit 1 when PH1 must be used, long-term outages will be avoided after the beginning of the juvenile fish passage season until after the adult fall Chinook and coho migration ends in late October. Unit 1 provides important attraction flow for adult fish and helps pass juvenile fish downstream when PH1 is operating.
     2. **Operational Testing.** 
        1. Pre-Maintenance: Before units go into maintenance status, units may be operationally tested for up to 60 minutes by running at various loads within and outside of the 1% range for pre-maintenance measurements and testing. Units will be run for a minimum of 3 hours to flush fish prior to installing tail logs.
        2. Post-Maintenance: After maintenance or repair, units may be operationally tested while remaining in maintenance or forced outage status by running for up to a cumulative time of 60 minutes within and outside of the 1% range before returning to operational status.
        3. Units may be operated outside of the 1% range for up to 20 minutes during testing. Unit operations below the 1% range will be minimized to the extent practicable.
        4. Operational testing may deviate from priority units and may require water that would otherwise be used for spill if the units operating for reliability are at the 1% lower limit (minimum generation). Water for operational testing will be used from powerhouse allocation when possible, and diverted from spill only to the extent necessary to maintain generation system reliability.
     3. **Idle Units.** When a unit is idle, wicket gates will remain in a closed position unless tail logs are installed and fish salvage has been done in the draft tube, or the project is holding a safety pool below the level of the wicket gates.
     4. **Slow Roll.** Turbines that have been idle/out-of-service will be started by slow rolling the unit after tipping turbine blades from flat to steep and back to flat.
     5. **Long-Term Outages.** In the event of long-term powerhouse outages, affected units will be exercised periodically. Each unit will be operated for 4-8 hours every 2 weeks to exercise governor components and clean wetted surfaces of corrosion so that if the unit is needed, fish injury will be minimized and the units will be in good operating condition. Actual runtime will be minimum necessary to keep the unit in good working condition and may be performed at night, day or whenever unit cycling will have the minimum effect on fish as determined by the Project Biologist.
     6. Head gates**[[3]](#footnote-5)** at Units 11-18 have been dogged off and the system depressurized. Oil leaks develop frequently when the system operates with normal pressure. Further related instructions are described in a memo from the Project Chief of Operations (*Memorandum for All Operations, dated September 23, 1993. Subject: Powerhouse 2 Hydraulic Head Gate Operation*).

1. Dewatering Plans
   1. General.
      1. *Guidelines for Dewatering and Fish Handling Plans* (**Appendix F**) have been developed by the projects and approved by FPOM, and are followed for most project facility dewaterings. The plans include consideration for fish safety and are consistent with the following general guidance. The appropriate plans are reviewed by participants before each salvage operation. Dewatering Plans are also available online.[[4]](#footnote-6)
      2. Whether pumps or drain valves are used, automatic pump shut off devices will be utilized to prevent stranding fish. If automatic pump shut off devices and low water alarms are not used, the dewatering process must be continuously monitored to prevent stranding.
      3. Project Biologist(s) and/or alternate Corps fish personnel will attend all project activities involving fish handling.
      4. The fish agencies and tribes will be notified of any dewaterings and may be invited if additional help is deemed necessary and all safety considerations can be met.
      5. Adult salmonids will be released into the forebay and juvenile salmonids will be released into the tailrace, depending on the age composition of fish in the tank. If a ladder is dewatered in the spring or summer, steelhead kelts will be released into the tailrace. If large numbers of sturgeon are present, it may be necessary to release them into either the forebay or tailrace, depending on the location of the recovery operation.
   2. Dewatering - Juvenile Bypass Systems (JBS).
      1. See *Guidelines for Dewatering and Fish Handling Plans* (**Appendix F**) and *Dewatering Plans*.**6**
   3. Dewatering - Adult Fish Ladder.
      1. **Routine Maintenance.**
         1. When possible, operate the ladder to be dewatered at orifice flow for at least 24 hours, and up to 96 hours, prior to dewatering. This operation shall not be initiated prior to 1800 hours on November 30 if a ladder outage is scheduled for December 1.
         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.
         3. A Project Biologist will assure that fish rescue equipment is available and will coordinate to ensure adequate numbers of personnel will be available to move fish out of the dewatered ladder.
         4. Project personnel will install head gates to shut down ladder flow. Where possible, a minimum depth of 1"-2" will be maintained in the ladder until fish are rescued.
         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.
      2. **Non-Routine Maintenance.**
         1. Follow steps in **section** **6.3.1** above. When possible, discontinue fishway auxiliary water and operate the ladder at orifice flow as long as possible (prefer 3-24 hours) prior to dewatering.
   4. Dewatering - Powerhouse Fish Collection System.
      1. **Routine Maintenance.**
         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.
         2. Project Fisheries will directly assist fish rescue operations, provide technical guidance, ensure fish safety and ensure rescue equipment/personnel are available if needed.
   5. Dewatering - Turbine Units.
      1. Immediately before setting the head gates, remove juvenile fish from gatewell(s) that will be drained by use of a special dipping basket. Typically, at least one gatewell is drained to allow ventilation into the draft tube.
      2. If the draft tube is to be dewatered, place head gates and tail logs immediately after the turbine unit is shut down when possible. Bottom tail logs should be placed first. This is necessary for both scheduled and unscheduled outages.
      3. If a turbine unit has been idle and the draft tube is to be dewatered, it will be operated when possible at full load for a minimum of 1 hour, 4 hours preferred. Stop logs will then be placed immediately. It is recommended adjacent units also be operated for a minimum of 1 hour, 4 hours preferred, to flush fish prior to placing tail logs in the unit to be OOS. It is also recommended that units adjacent to OOS units not be voluntarily taken OOS until the adjacent units return to service.
      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.
      5. Fish rescue personnel will inspect dewatered turbine draft tubes, scroll cases, and intakes as soon as water levels reach a depth permitting visual inspection and the hatch cover is opened.
      6. A Project Biologist will provide technical guidance for fish safety and will directly participate in fish salvage.
      7. A Project Biologist will invite FPOM members to participate in the dewatering, and will assure that rescue equipment is available if needed.
      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.
   6. Dewatering - Navigation Lock.
      1. The navigation lock is frequently dewatered for routine maintenance in late February/early March, in conjunction with navigation lock outages at The Dalles and John Day dams.
      2. The area between the upstream bulkhead and the upstream gate is surveyed for fish as water levels allow. The lateral and pool areas on the floor of the lock are surveyed for fish from above. Most of these areas remain full of water, precluding the ability to implement successful fish salvage operations. Areas where water levels slowly decrease are accessed via crane when pool levels reach a depth of approximately 3 feet. The fill conduits are accessed and checked for fish only if needed and can be done safely. All salvaged fish are removed, transported via bag or tank and released to the river.
2. Forebay Debris Removal
   * 1. Debris can impact fish passage conditions in several ways. It can plug or block trash racks, VBSs, gatewell orifices, dewatering screens, and facility piping, resulting in impingement, injuries, and descaling of fish.
     2. Debris is removed by operating the PH1 ITS, B2CC, or passing it through the spillway with a special spill gate operation.
     3. Special spill operations that don’t follow the normal spill schedule or volume limits will be coordinated prior to their execution. Normally, the project shall contact CENWP-OD at least two workdays prior to the day the special operation is required. Using information provided by the project, CENWP-OD will coordinate with FPOM and with RCC, as necessary. Once the coordination is complete, RCC will issue a Teletype detailing the special operations.
3. Response to Hazardous Materials Spills
   * 1. Bonneville Project’s guidance for responding to hazardous substance spills is contained in its Emergency Spill Response Plan.
     2. In the event of a hazardous materials spill, the Project Biologist has the authority to make fishway adjustments outside of operating criteria as necessary to prevent contamination of the ladder until unified command is formed and consultation is established with FPOM. NOAA Fisheries will be notified within 24 hours of a ladder closure.
     3. Project Fisheries will be contacted as soon as possible after a hazardous material release and prior to any modification to fishway operations. Project biologist(s) will in turn contact the CENWP-OD biologist and FPOM. Attempts should be made to first contact the Project Biologist on duty. During fish passage season, there is a Project Biologist on duty seven days a week. If a Project Biologist cannot be reached by radio or in the office, attempts to contact Project Fisheries will occur in the following order (contact information available in Control Room):

Ben Hausmann, Supervisory Fishery Biologist

Ida Royer, Fishery Biologist

Brian Bissell, Fishery Biologist

Andrew Derugin, Fishery Biologist

Tammy Mackey, Fisheries Supervisor

Table BON-. Bonneville Dam Powerhouse One Turbine Units 1–10 Power (MW) and Flow (cfs) at Lower and Upper Limits of the ±1% Peak Efficiency Operating Range and Best Operating Point (BOP). 1

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Project** | **Powerhouse One (Units 1–10)** | | | | | |
| **Head** | **1% Lower Limit** | | **1% Upper Limit** | | **Best Operating Point (BOP)** | |
| **(ft)** | **(MW/unit)** | **(cfs/unit)** | **(MW/unit)** | **(cfs/unit)** | **(MW/unit)** | **(cfs/unit)** |
| **35** | 18.9 | 7,203 | 23.6 | 9,019 | 27.3 | 10,527 |
| **36** | 19.5 | 7,205 | 24.3 | 8,985 | 28.3 | 10,564 |
| **37** | 20.1 | 7,205 | 25 | 8,951 | 29.2 | 10,598 |
| **38** | 20.7 | 7,204 | 25.6 | 8,918 | 30.2 | 10,627 |
| **39** | 21.3 | 7,202 | 26.3 | 8,886 | 31.2 | 10,654 |
| **40** | 21.9 | 7,199 | 26.9 | 8,854 | 32.1 | 10,677 |
| **41** | 22.5 | 7,201 | 28 | 8,969 | 33.2 | 10,759 |
| **42** | 23.1 | 7,202 | 29.1 | 9,077 | 34.3 | 10,837 |
| **43** | 23.6 | 7,203 | 30.1 | 9,180 | 35.4 | 10,910 |
| **44** | 24.2 | 7,203 | 31.2 | 9,278 | 36.5 | 10,979 |
| **45** | 24.8 | 7,203 | 32.3 | 9,370 | 37.6 | 11,045 |
| **46** | 25.4 | 7,210 | 33.2 | 9,416 | 38.8 | 11,109 |
| **47** | 26 | 7,217 | 34.1 | 9,459 | 39.9 | 11,170 |
| **48** | 26.6 | 7,223 | 35 | 9,500 | 41 | 11,227 |
| **49** | 27.3 | 7,229 | 36 | 9,539 | 42.1 | 11,282 |
| **50** | 27.9 | 7,234 | 36.9 | 9,575 | 43.2 | 11,333 |
| **51** | 28.5 | 7,241 | 37.8 | 9,618 | 44.2 | 11,356 |
| **52** | 29.1 | 7,248 | 38.4 | 9,577 | 45.2 | 11,378 |
| **53** | 29.7 | 7,254 | 39 | 9,537 | 46.2 | 11,398 |
| **54** | 30.3 | 7,260 | 39.7 | 9,499 | 47.2 | 11,418 |
| **55** | 30.9 | 7,266 | 41.6 | 9,768 | 48.2 | 11,465 |
| **56** | 31.5 | 7,269 | 42.5 | 9,808 | 49.2 | 11,478 |
| **57** | 32.1 | 7,272 | 43.4 | 9,846 | 50.3 | 11,518 |
| **58** | 32.7 | 7,274 | 44.4 | 9,883 | 51.4 | 11,557 |
| **59** | 33.3 | 7,277 | 45.3 | 9,918 | 52.4 | 11,594 |
| **60** | 33.8 | 7,279 | 46.3 | 9,952 | 53.5 | 11,630 |
| **61** | 34.5 | 7,296 | 46.9 | 9,930 | 54.3 | 11,610 |
| **62** | 35.1 | 7,311 | 47.6 | 9,909 | 55.1 | 11,591 |
| **63** | 35.8 | 7,326 | 48.3 | 9,889 | 56 | 11,572 |
| **64** | 36.5 | 7,340 | 49 | 9,868 | 56.6 | 11,519 |
| **65** | 37.1 | 7,354 | 49.7 | 9,849 |
| **66** | 37.6 | 7,341 | 50.6 | 9,876 |
| **67** | 38.1 | 7,329 | 51.4 | 9,902 |
| **68** | 38.6 | 7,317 | 52.3 | 9,928 |
| **69** | 39 | 7,305 | 53.2 | 9,954 |
| **70** | 39.5 | 7,294 | 54.1 | 9,979 |

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

Table BON-. Bonneville Dam Powerhouse Two Turbine Units 11–18 Power (MW) and Flow (cfs) at Lower, Mid-Range and Upper Limits of the ±1% Peak Efficiency Operating Range. 1

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

**1.** Table based on January 2001 data (HDC). Updated 2006. Added “Mid-Range” 2014.

Table BON-. [*pg 1 of 8*] Bonneville Dam Spill Patterns in Vertical Gate Opening (ft) per Spillbay (0.5 ft = 1 gate stop). [[5]](#footnote-7)

| **BON Spill Patterns - Vertical Gate Opening (ft) per Spillbay** | | | | | | | | | | | | | | | | | | **Total Open** | **Spill 4** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** | **16** | **17** | **18** | **(ft)** | **(kcfs)** |
| 0.5 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 0.5 | **1** | **2.3** |
| 0.5 | 0.5 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 0.5 | **1.5** | **3.4** |
| 0.5 | 0.5 |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 0.5 | 0.5 | **2** | **4.6** |
| 0.5 | 0.5 |  |  |  |  |  |  |  |  |  |  |  |  |  | 0.5 | 0.5 | 0.5 | **2.5** | **5.7** |
| 0.5 | 0.5 |  | 0.5 |  |  |  |  |  |  |  |  |  |  |  | 0.5 | 0.5 | 0.5 | **3** | **6.9** |
| 0.5 | 0.5 |  | 0.5 | 0.5 |  |  |  |  |  |  |  |  |  |  | 0.5 | 0.5 | 0.5 | **3.5** | **8** |
| 0.5 | 0.5 |  | 0.5 | 0.5 |  |  |  |  |  |  |  |  | 0.5 |  | 0.5 | 0.5 | 0.5 | **4** | **9.2** |
| 0.5 | 0.5 |  | 0.5 | 0.5 |  |  |  |  |  |  | 0.5 |  | 0.5 |  | 0.5 | 0.5 | 0.5 | **4.5** | **10.3** |
| 0.5 | 0.5 |  | 0.5 | 0.5 |  |  |  |  | 0.5 |  | 0.5 |  | 0.5 |  | 0.5 | 0.5 | 0.5 | **5** | **11.5** |
| 0.5 | 0.5 |  | 0.5 | 0.5 |  |  | 0.5 |  | 0.5 |  | 0.5 |  | 0.5 |  | 0.5 | 0.5 | 0.5 | **5.5** | **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 | **6** | **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 | **6.5** | **14.9** |
| 0.5 | 1 | 0.5 | 0.5 | 0.5 |  |  | 0.5 |  | 0.5 |  | 0.5 |  | 0.5 |  | 0.5 | 1 | 0.5 | **7** | **16** |
| 0.5 | 1 | 0.5 | 0.5 | 0.5 | 0.5 |  | 0.5 |  | 0.5 |  | 0.5 |  | 0.5 |  | 0.5 | 1 | 0.5 | **7.5** | **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 | **8** | **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 | **8.5** | **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 | **9** | **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 | **9.5** | **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 | **10** | **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 | **10.5** | **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 | **11** | **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 | **11.5** | **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 | **12** | **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 | **12.5** | **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 | **13** | **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 | **13.5** | **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 | **14** | **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 | **14.5** | **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 | **15** | **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 | **15.5** | **35.3** |
| 1 | 1 | 1 | 1 | 0.5 | 1 | 1 | 0.5 | 1 | 1 | 0.5 | 1 | 1 | 0.5 | 1 | 1 | 1 | 1 | **16** | **36.4** |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0.5 | 1 | 1 | 0.5 | 1 | 1 | 0.5 | 1 | 1 | 1 | 1 | **16.5** | **37.6** |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0.5 | 1 | 1 | 0.5 | 1 | 1 | 1 | 1 | **17** | **38.7** |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0.5 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | **17.5** | **39.8** |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | **18** | **40.9** |
| 1 | 1.5 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | **18.5** | **42** |
| 1 | 1.5 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1.5 | 1 | **19** | **43.2** |
| 1 | 1.5 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1.5 | 1.5 | 1 | **19.5** | **44.3** |
| 1 | 1.5 | 1.5 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1.5 | 1.5 | 1 | **20** | **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 | **20.5** | **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 | **21** | **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 | **21.5** | **48.6** |
| 2 | 2 | 2 | 0 | 2 | 0 | 0 | 2 | 0 | 2 | 0 | 0 | 2 | 2 | 0 | 2 | 2 | 2 | **22** | **49.0** |
| 2 | 2 | 2 | 0 | 2 | 0 | 0 | 2 | 0 | 2 | 0 | 0 | 2 | 2 | 0 | 2 | 2.5 | 2 | **22.5** | **50.1** |
| 2 | 2.5 | 2 | 0 | 2 | 0 | 0 | 2 | 0 | 2 | 0 | 0 | 2 | 2 | 0 | 2 | 2.5 | 2 | **23** | **51.1** |
| 2 | 2.5 | 2 | 0 | 2 | 0 | 0 | 2 | 0 | 2 | 0 | 0 | 2 | 2 | 0 | 2.5 | 2.5 | 2 | **23.5** | **52.2** |
| 2 | 2 | 2 | 0 | 2 | 0 | 2 | 2 | 0 | 2 | 0 | 0 | 2 | 2 | 0 | 2 | 2 | 2 | **24** | **53.5** |
| 2 | 2 | 2 | 0 | 2 | 0 | 2 | 2 | 0 | 2 | 0 | 0 | 2 | 2 | 0 | 2 | 2.5 | 2 | **24.5** | **54.5** |
| 2 | 2.5 | 2 | 0 | 2 | 0 | 2 | 2 | 0 | 2 | 0 | 0 | 2 | 2 | 0 | 2 | 2.5 | 2 | **25** | **55.6** |
| 2 | 2.5 | 2 | 0 | 2 | 0 | 2 | 2 | 0 | 2 | 0 | 0 | 2 | 2 | 0 | 2.5 | 2.5 | 2 | **25.5** | **56.6** |
| 2 | 2 | 2 | 0 | 2 | 0 | 2 | 2 | 0 | 2 | 2 | 0 | 2 | 2 | 0 | 2 | 2 | 2 | **26** | **57.9** |
| 2 | 2 | 2 | 0 | 2 | 0 | 2 | 2 | 0 | 2 | 2 | 0 | 2 | 2 | 0 | 2 | 2.5 | 2 | **26.5** | **59.0** |
| 2 | 2.5 | 2 | 0 | 2 | 0 | 2 | 2 | 0 | 2 | 2 | 0 | 2 | 2 | 0 | 2 | 2.5 | 2 | **27** | **60.0** |
| 2 | 2.5 | 2 | 0 | 2 | 0 | 2 | 2 | 0 | 2 | 2 | 0 | 2 | 2 | 0 | 2.5 | 2.5 | 2 | **27.5** | **61.1** |
| 2 | 2 | 2 | 2 | 2 | 0 | 2 | 2 | 0 | 2 | 2 | 0 | 2 | 2 | 0 | 2 | 2 | 2 | **28** | **62.4** |
| 2 | 2 | 2 | 2 | 2 | 0 | 2 | 2 | 0 | 2 | 2 | 0 | 2 | 2 | 0 | 2 | 2.5 | 2 | **28.5** | **63.4** |
| 2 | 2.5 | 2 | 2 | 2 | 0 | 2 | 2 | 0 | 2 | 2 | 0 | 2 | 2 | 0 | 2 | 2.5 | 2 | **29** | **64.5** |
| 2 | 2.5 | 2 | 2 | 2 | 0 | 2 | 2 | 0 | 2 | 2 | 0 | 2 | 2 | 0 | 2.5 | 2.5 | 2 | **29.5** | **65.6** |
| 2 | 2 | 2 | 2 | 2 | 0 | 2 | 2 | 0 | 2 | 2 | 0 | 2 | 2 | 2 | 2 | 2 | 2 | **30** | **66.8** |
| 2 | 2 | 2 | 2 | 2 | 0 | 2 | 2 | 0 | 2 | 2 | 0 | 2 | 2 | 2 | 2 | 2.5 | 2 | **30.5** | **67.9** |
| 2 | 2.5 | 2 | 2 | 2 | 0 | 2 | 2 | 0 | 2 | 2 | 0 | 2 | 2 | 2 | 2 | 2.5 | 2 | **31** | **69.0** |
| 2 | 2.5 | 2 | 2 | 2 | 0 | 2 | 2 | 0 | 2 | 2 | 0 | 2 | 2 | 2 | 2.5 | 2.5 | 2 | **31.5** | **70.0** |
| 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 0 | 2 | 2 | 0 | 2 | 2 | 2 | 2 | 2 | 2 | **32** | **71.3** |
| 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 0 | 2 | 2 | 0 | 2 | 2 | 2 | 2 | 2.5 | 2 | **32.5** | **72.4** |
| 2 | 2.5 | 2 | 2 | 2 | 2 | 2 | 2 | 0 | 2 | 2 | 0 | 2 | 2 | 2 | 2 | 2.5 | 2 | **33** | **73.4** |
| 2 | 2.5 | 2 | 2 | 2 | 2 | 2 | 2 | 0 | 2 | 2 | 0 | 2 | 2 | 2 | 2.5 | 2.5 | 2 | **33.5** | **74.5** |
| 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 0 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | **34** | **75.8** |
| 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 0 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2.5 | 2 | **34.5** | **76.8** |
| 2 | 2.5 | 2 | 2 | 2 | 2 | 2 | 2 | 0 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2.5 | 2 | **35** | **77.9** |
| 2 | 2.5 | 2 | 2 | 2 | 2 | 2 | 2 | 0 | 2 | 2 | 2 | 2 | 2 | 2 | 2.5 | 2.5 | 2 | **35.5** | **78.9** |
| 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | **36** | **80.2** |
| 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2.5 | 2 | **36.5** | **81.3** |
| 2 | 2.5 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2.5 | 2 | **37** | **82.3** |
| 2 | 2.5 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2.5 | 2.5 | 2 | **37.5** | **83.4** |
| 2 | 2.5 | 2.5 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2.5 | 2.5 | 2 | **38** | **84.4** |
| 2 | 2.5 | 2.5 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2.5 | 2.5 | 2.5 | **38.5** | **85.5** |
| 2.5 | 2.5 | 2.5 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2.5 | 2.5 | 2.5 | **39** | **86.6** |
| 2.5 | 2.5 | 2.5 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2.5 | 3 | 2.5 | **39.5** | **87.6** |
| 2.5 | 3 | 2.5 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2.5 | 3 | 2.5 | **40** | **88.6** |
| 2.5 | 3 | 2.5 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2.5 | 3 | 3 | **40.5** | **89.7** |
| 3 | 3 | 2.5 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2.5 | 3 | 3 | **41** | **90.7** |
| 3 | 3 | 2.5 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | **41.5** | **91.7** |
| 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | **42** | **92.8** |
| 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2.5 | 3 | 3 | 3 | **42.5** | **93.8** |
| 3 | 3 | 3 | 2.5 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2.5 | 3 | 3 | 3 | **43** | **94.9** |
| 3 | 3 | 3 | 2.5 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2.5 | 2.5 | 3 | 3 | 3 | **43.5** | **96.0** |
| 3 | 3 | 3 | 2.5 | 2.5 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2.5 | 2.5 | 3 | 3 | 3 | **44** | **97.0** |
| 3 | 3 | 3 | 2.5 | 2.5 | 2 | 2 | 2 | 2 | 2 | 2 | 2.5 | 2 | 2.5 | 2.5 | 3 | 3 | 3 | **44.5** | **98.1** |
| 3 | 3 | 3 | 2.5 | 2.5 | 2 | 2 | 2 | 2.5 | 2 | 2 | 2.5 | 2 | 2.5 | 2.5 | 3 | 3 | 3 | **45** | **99.1** |
| 3 | 3 | 3 | 2.5 | 2.5 | 2.5 | 2 | 2 | 2.5 | 2 | 2 | 2.5 | 2 | 2.5 | 2.5 | 3 | 3 | 3 | **45.5** | **100.2** |
| 3 | 3 | 3 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2 | 2 | 2 | 2.5 | 2.5 | 2.5 | 2.5 | 3 | 3 | 3 | **46.5** | **102.3** |
| 3 | 3 | 3 | 2.5 | 3 | 2.5 | 2.5 | 2.5 | 2 | 2 | 2 | 2.5 | 2.5 | 2.5 | 3 | 3 | 3 | 3 | **47.5** | **104.4** |
| 3 | 3 | 3 | 3 | 3 | 2.5 | 2.5 | 2.5 | 2 | 2 | 2 | 2.5 | 2.5 | 2.5 | 3 | 3.5 | 3 | 3 | **48.5** | **106.4** |
| 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 | **50** | **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 | **50.5** | **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 | **51** | **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 | **51.5** | **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 | **52** | **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 | **52.5** | **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 | **53** | **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 | **53.5** | **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 | **54** | **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 | **54.5** | **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 | **55** | **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 | **55.5** | **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 | **56** | **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 | **56.5** | **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 | **57** | **124** |
| 3.5 | 3.5 | 3.5 | 3.5 | 3 | 3 | 3 | 3 | 2.5 | 2.5 | 3 | 3 | 3 | 3 | 3 | 3.5 | 4 | 4 | **57.5** | **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 | **58** | **126** |
| 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 | **58.5** | **127** |
| 3.5 | 3.5 | 3.5 | 3.5 | 3 | 3 | 3 | 3 | 2.5 | 3 | 3 | 3 | 3 | 3 | 3.5 | 4 | 4 | 4 | **59** | **128** |
| 3.5 | 3.5 | 3.5 | 3.5 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3.5 | 4 | 4 | 4 | **59.5** | **129** |
| 3.5 | 4 | 3.5 | 3.5 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3.5 | 4 | 4 | 4 | **60** | **130** |
| 3.5 | 4 | 4 | 3.5 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3.5 | 4 | 4 | 4 | **60.5** | **131** |
| 4 | 4 | 4 | 3.5 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3.5 | 4 | 4 | 4 | **61** | **132** |
| 4 | 4 | 4 | 4 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3.5 | 4 | 4 | 4 | **61.5** | **133** |
| 4 | 4 | 4 | 4 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 4 | **62** | **134** |
| 4 | 4 | 4 | 4 | 3 | 3.5 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 4 | **62.5** | **135** |
| 4 | 4 | 4 | 4 | 3.5 | 3.5 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 4 | **63** | **136.1** |
| 4 | 4 | 4 | 4 | 3.5 | 3.5 | 3 | 3 | 3 | 3 | 3 | 3 | 3.5 | 3 | 4 | 4 | 4 | 4 | **63.5** | **137.1** |
| 4 | 4 | 4 | 4 | 3.5 | 3.5 | 3 | 3 | 3 | 3 | 3 | 3 | 3.5 | 3.5 | 4 | 4 | 4 | 4 | **64** | **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 | **64.5** | **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 | **65** | **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 | **65.5** | **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 | **66** | **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 | **66.5** | **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 | **67** | **144** |
| 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 | **67.5** | **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 | **68** | **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 | **68.5** | **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 | **69** | **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 | **69.5** | **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 | **70** | **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 | **70.5** | **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 | **71** | **152.1** |
| 4 | 4.5 | 4.5 | 4 | 4 | 4 | 4 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 4 | 4 | 4 | 4.5 | 4.5 | 4 | **71.5** | **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 | **72** | **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 | **72.5** | **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 | **73** | **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 | **73.5** | **157.1** |
| 4 | 4.5 | 4.5 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4.5 | 4.5 | 4 | **74** | **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 | **74.5** | **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 | **75** | **160** |
| 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 | **75.5** | **161** |
| 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 | **76** | **162** |
| 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 | **76.5** | **163** |
| 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 | **77** | **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 | **77.5** | **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 | **78** | **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 | **78.5** | **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 | **79** | **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 | **79.5** | **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 | **80** | **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 | **80.5** | **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 | **81** | **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 | **81.5** | **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 | **82** | **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 | **82.5** | **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 | **83** | **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 | **83.5** | **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 | **84** | **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 | **84.5** | **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 | **85** | **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 | **85.5** | **180.4** |
| 4 | 5 | 5 | 5 | 5 | 5 | 4.5 | 5 | 4.5 | 4.5 | 4.5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | **86** | **181.3** |
| 4 | 5 | 5 | 5 | 5 | 5 | 4.5 | 5 | 4.5 | 5 | 4.5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | **86.5** | **182.3** |
| 4 | 5 | 5 | 5 | 5 | 5 | 4.5 | 5 | 5 | 5 | 4.5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | **87** | **183.3** |
| 4 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4.5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | **87.5** | **184.2** |
| 4 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | **88** | **185.2** |
| 4 | 5.5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | **88.5** | **186.1** |
| 4 | 5.5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5.5 | 4 | **89** | **187.1** |
| 4 | 5.5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5.5 | 5.5 | 4 | **89.5** | **188** |
| 4 | 5.5 | 5.5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5.5 | 5.5 | 4 | **90** | **189** |
| 4 | 5.5 | 5.5 | 5 | 5.5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5.5 | 5.5 | 4 | **90.5** | **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 | **91** | **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 | **91.5** | **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 | **92** | **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 | **92.5** | **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 | **93** | **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 | **93.5** | **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 | **94** | **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 | **94.5** | **197.5** |
| 4 | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 | 5 | 5.5 | 5.5 | 5.5 | 5 | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 | 4 | **95** | **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 | **95.5** | **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 | **96** | **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 | **96.5** | **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 | **97** | **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 | **97.5** | **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 | **98** | **204** |
| 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 | **98.5** | **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 | **99** | **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 | **99.5** | **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 | **100** | **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 | **100.5** | **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 | **101** | **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 | **101.5** | **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 | **102** | **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 | **102.5** | **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 | **103** | **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 | **103.5** | **214.3** |
| 4.5 | 6 | 6 | 6 | 6 | 6 | 5.5 | 6 | 6 | 6 | 5.5 | 6 | 6 | 6 | 6 | 6 | 6 | 4.5 | **104** | **215.2** |
| 4.5 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 5.5 | 6 | 6 | 6 | 6 | 6 | 6 | 4.5 | **104.5** | **216.2** |
| 4.5 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 4.5 | **105** | **217.1** |
| 4.5 | 6 | 6 | 6 | 6.5 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 4.5 | **105.5** | **218** |
| 4.5 | 6 | 6 | 6 | 6.5 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6.5 | 6 | 6 | 6 | 6 | 4.5 | **106** | **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 | **106.5** | **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 | **107** | **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 | **107.5** | **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 | **108** | **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 | **108.5** | **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 | **109** | **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 | **109.5** | **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 | **110** | **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 | **110.5** | **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 | **111** | **228** |
| 4.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6 | 6.5 | 6 | 6.5 | 6 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 4.5 | **111.5** | **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 | **112** | **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 | **112.5** | **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 | **113** | **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 | **113.5** | **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 | **114** | **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 | **114.5** | **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 | **115** | **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 | **115.5** | **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 | **116** | **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 | **116.5** | **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 | **117** | **239** |
| 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 | **117.5** | **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 | **118** | **240.8** |
| 5 | 7 | 7 | 6.5 | 7 | 7 | 6.5 | 7 | 6.5 | 6.5 | 6.5 | 7 | 7 | 6.5 | 6.5 | 7 | 7 | 5 | **118.5** | **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 | **119** | **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 | **119.5** | **243.5** |
| 5 | 7 | 7 | 7 | 7 | 7 | 6.5 | 7 | 6.5 | 7 | 6.5 | 7 | 7 | 6.5 | 7 | 7 | 7 | 5 | **120** | **244.4** |
| 5 | 7 | 7 | 7 | 7 | 7 | 6.5 | 7 | 6.5 | 7 | 6.5 | 7 | 7 | 7 | 7 | 7 | 7 | 5 | **120.5** | **245.3** |
| 5 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 6.5 | 7 | 6.5 | 7 | 7 | 7 | 7 | 7 | 7 | 5 | **121** | **246.2** |
| 5 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 6.5 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 5 | **121.5** | **247.1** |
| 5 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 5 | **122** | **248** |
| 5 | 7 | 7 | 7 | 7.5 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 5 | **122.5** | **248.8** |
| 5 | 7 | 7 | 7 | 7.5 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7.5 | 7 | 7 | 7 | 7 | 5 | **123** | **249.7** |
| 5 | 7 | 7 | 7 | 7.5 | 7 | 7 | 7 | 7 | 7 | 7 | 7.5 | 7.5 | 7 | 7 | 7 | 7 | 5 | **123.5** | **250.6** |
| 5 | 7 | 7 | 7 | 7.5 | 7.5 | 7 | 7 | 7 | 7 | 7 | 7.5 | 7.5 | 7 | 7 | 7 | 7 | 5 | **124** | **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 | **124.5** | **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 | **125** | **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 | **125.5** | **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 | **126** | **255** |
| 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 | **126.5** | **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 | **127** | **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 | **127.5** | **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 | **128** | **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 | **128.5** | **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 | **129** | **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 | **129.5** | **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 | **130** | **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 | **130.5** | **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 | **131** | **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 | **131.5** | **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 | **132** | **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 | **132.5** | **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 | **133** | **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 | **133.5** | **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 | **134** | **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 | **134.5** | **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 | **135** | **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 | **135.5** | **271.7** |
| 5 | 7.5 | 8 | 8 | 8 | 8 | 8 | 8 | 7.5 | 8 | 7.5 | 8 | 8 | 8 | 8 | 8 | 7.5 | 5 | **136** | **272.5** |
| 5 | 7.5 | 8 | 8 | 8 | 8 | 8 | 8 | 7.5 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 7.5 | 5 | **136.5** | **273.4** |
| 5 | 7.5 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 7.5 | 5 | **137** | **274.3** |
| 5 | 7.5 | 8 | 8 | 8.5 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 7.5 | 5 | **137.5** | **275.1** |
| 5 | 7.5 | 8 | 8 | 8.5 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8.5 | 8 | 8 | 8 | 7.5 | 5 | **138** | **276** |
| 5 | 7.5 | 8 | 8 | 8.5 | 8 | 8 | 8 | 8 | 8 | 8 | 8.5 | 8.5 | 8 | 8 | 8 | 7.5 | 5 | **138.5** | **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 | **139** | **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 | **139.5** | **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 | **140** | **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 | **140.5** | **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 | **141** | **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 | **141.5** | **282** |
| 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 | **142** | **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 | **142.5** | **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 | **143** | **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 | **143.5** | **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 | **144** | **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 | **144.5** | **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 | **145** | **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 | **145.5** | **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 | **146** | **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 | **146.5** | **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 | **147** | **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 | **147.5** | **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 | **148** | **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 | **148.5** | **294** |
| 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 | **149** | **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 | **149.5** | **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 | **150** | **296.5** |

1. Annual TDG Monitoring Plan (Appendix 4 of the WMP): [www.nwd-wc.usace.army.mil/tmt/documents/wmp/](http://www.nwd-wc.usace.army.mil/tmt/documents/wmp/) [↑](#footnote-ref-1)
2. 2015-2018 TDG Monitoring Plan: [www.nwd-wc.usace.army.mil/tmt/wqnew/tdg\_monitoring/2015-18.pdf](http://www.nwd-wc.usace.army.mil/tmt/wqnew/tdg_monitoring/2015-18.pdf) [↑](#footnote-ref-2)
3. Head gates may also be referred to as “operating” gates at some projects. The terms are interchangeable. [↑](#footnote-ref-5)
4. Dewatering Plans are available on the FPOM website: [www.nwd-wc.usace.army.mil/tmt/documents/FPOM/2010/](http://www.nwd-wc.usace.army.mil/tmt/documents/FPOM/2010/) [↑](#footnote-ref-6)
5. This table defines spill patterns in increments of ½ ft total gate opening (1 stop) per row. Spill (kcfs) is calculated as a function of total gate opening (ft) at forebay elevation 74.0 ft (updated 2007). [↑](#footnote-ref-7)