# 2018 Fish Passage Plan

## Chapter 6 – Ice Harbor Dam

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# Ice Harbor Dam

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|---|---|
| **Project Acronym *** | IHR |
| **River Mile (RM)** | Snake River – RM 9.7 |
| **Reservoir** | Lake Sacajawea |
| **Minimum Instantaneous Flow (kcfs)** | Dec–Feb: 0 kcfs \ Mar–Jul: 9.5 kcfs \ Aug–Nov: 7.5 kcfs |
| **Forebay Normal Operating Range (ft)** | 437’ – 440’ |
| **Tailrace Rate of Change Limit (ft)** | 1.5’/hr |
| **Powerhouse Length (ft)** | 671’ |
| **Powerhouse Hydraulic Capacity (kcfs)** | 106 kcfs |
| **Turbine Units (#)** | 6 (Units 1-3 Smith Kaplan; Units 4-6 Allis Chalmers Kaplan) |
| **Turbine Unit Generating Capacity (MW)** | Rated: 603 MW (Units 1-3 @ 90 MW + Units 4-6 @ 111 MW)<br>Maximum: 693 MW (Units 1-3 @ 103 MW + Units 4-6 @ 128 MW) |
| **Spillway Length (ft)** | 590’ |
| **Spillway Hydraulic Capacity (kcfs)** | 850 kcfs |
| **Spillbays (#)** | 10 |
| **Spillway Weirs (#)** | 1 Removable Spillway Weir (RSW) in Bay 2 |
| **Navigation Lock Length x Width (ft)** | 650’ x 84’ (Usable Space) |
| **Navigation Lock Max. Lift (ft)** | 100’ |
| **FISH STRUCTURE/OPERATION START DATE** | |
| **Juvenile Bypass System (JBS)** | 1961 (1st Generation) |
| **Orifices (12” diameter)** | 1965 (2nd Generation) |
| **Transportation Research Program - NMFS** | 1965 |
| **Submersible Traveling Screens (STS)** | 1994 |
| **Juvenile Fish Transportation Program - Corps** | 1981 |
| **Removable Spillway Weir (RSW)** | 2005 |
| **Adult Fish Counts** | 1969 (South Shore & North Shore) |

*Project acronym designated by US Army Corps of Engineers, Northwestern Division, Columbia Basin Water Management Division. Due to the large number of projects managed by NWD, the acronym may differ from other commonly used acronyms. For example, Ice Harbor is often abbreviated as **ICE**. However, that acronym is assigned to another NWD project, so the official Corps NWD acronym for Ice Harbor is **IHR**.

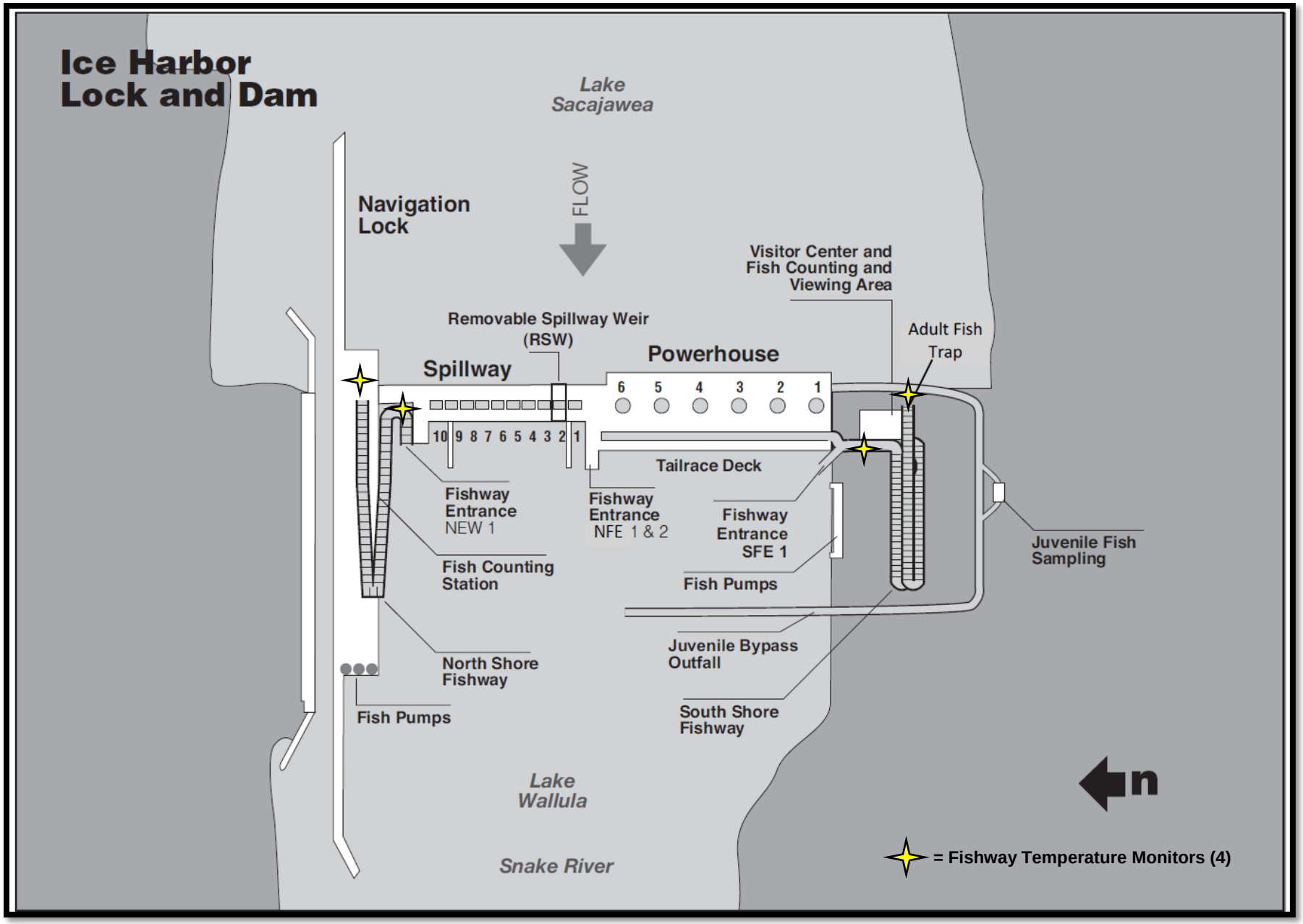
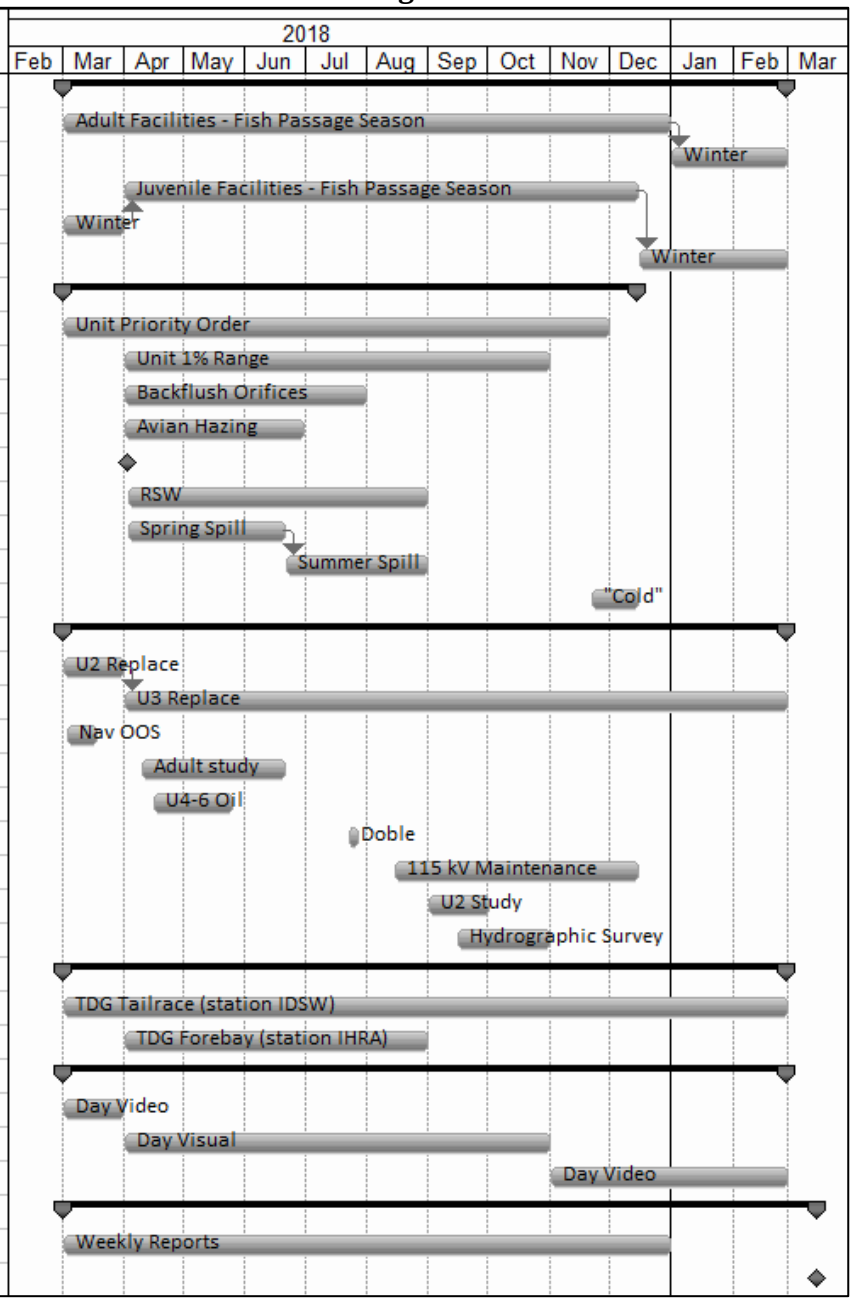



**Figure IHR-1. Ice Harbor Lock and Dam General Site Plan.**

**Table IHR-1. Ice Harbor Dam Schedule of Operations and Actions Defined in the 2018 Fish Passage Plan.**

| Task Name | Start | End | FPP Section |
|---|---|---|---|
| **FISH PASSAGE FACILITIES** | **3/1/18** | **2/28/19** | |
| Adult Facilities - Fish Passage Season | 3/1/18 | 12/31/18 | 2.4.2 |
| Adult Facilities - Winter Maintenance | 1/1/19 | 2/28/19 | 2.4.1 |
| Juvenile Facilities - Fish Passage Season | 4/1/18 | 12/15/18 | 2.3.2 |
| Juvenile Facilities - Winter Maintenance | 3/1/18 | 3/31/18 | 2.3.1 |
| | 12/16/18 | 2/28/19 | |
| **PROJECT OPERATIONS FOR FISH PASSAGE** | **3/1/18** | **12/15/18** | |
| Turbine unit priority order | 3/1/18 | 11/30/18 | Table IHR-4 |
| Turbine unit 1% operating range | 4/1/18 | 10/31/18 | 4.2 |
| Backflush orifices ≥ once per 8 hrs | 4/1/18 | 7/31/18 | 2.3.2.3.vi. |
| Avian hazing | 4/1/18 | 6/30/18 | App L 6.2 |
| Avian Wires installed NLT April 3 | 4/3/18 | 4/3/18 | App L 1.4 |
| Spillway weir in service (end date approx) | 4/3/18 | 8/31/18 | 2.3.2.7 |
| Spring Spill | 4/3/18 | 6/20/18 | App E (FOP) |
| Summer Spill | 6/21/18 | 8/31/18 | App E (FOP) |
| STS removal during cold weather | 11/22/18 | 12/15/18 | 2.3.2.2.ix |
| **SPECIAL OPS & STUDIES (Appendix A)** | **3/1/18** | **2/28/19** | |
| Unit 2 Replacement | 3/1/18 | 3/31/18 | App A 6.1 |
| Unit 3 Replacement | 4/1/18 | 2/28/19 | App A 6.1 |
| Navigation Lock annual outage | 3/3/18 | 3/18/18 | App A 1.4 |
| Adult Passage & Behavior | 4/10/18 | 6/20/18 | App A 6.2 |
| Units 4, 5, 6 Oil Replace | 4/16/18 | 5/25/18 | App A 6.1 |
| Doble testing | 7/23/18 | 7/27/18 | App A 1.5 |
| 115 kV Maintenance | 8/15/18 | 12/15/18 | App A 6.1 |
| Unit 2 Study | 9/1/18 | 10/1/18 | App A 6.2 |
| Stilling Basin Survey | 9/15/18 | 10/31/18 | App A 6.2 |
| **TDG MONITORING** | **3/1/18** | **2/28/19** | |
| TDG Monitoring - Tailrace (year-round) | 3/1/18 | 2/28/19 | 2.2 |
| TDG Monitoring - Forebay | 4/1/18 | 8/31/18 | 2.2 |
| **ADULT FISH COUNTING** | **3/1/18** | **2/28/19** | |
| Day Video 0400-2000 PST | 3/1/18 | 3/31/18 | Table IHR-2 |
| Day Visual 0500-2100 PDT | 4/1/18 | 10/31/18 | Table IHR-2 |
| Day Video 0400-2000 PST | 11/1/18 | 2/28/19 | Table IHR-2 |
| **REPORTS** | **3/1/18** | **3/15/19** | |
| Weekly Reports | 3/1/18 | 12/31/18 | 2.5.2 |
| Annual Report due | 3/15/19 | 3/15/19 | 2.5.3 |



# 1. FISH PASSAGE INFORMATION

Ice Harbor Lock & Dam fish passage facilities and other structures are shown in **Figure IHR-1**. The schedule of Ice Harbor Dam operations that are described in the Fish Passage Plan (FPP) and Appendices is in **Table IHR-1**.

## 1.1. Juvenile Fish Passage.

**1.1.1. Juvenile Fish Facilities.** The juvenile fish facilities at Ice Harbor Dam consist of standard length submersible traveling screens (STS), vertical barrier screens (VBS), 12" orifices, collection channel and dewatering structure, sampling facilities, transportation flume/pipe to the tailrace, and a full-flow PIT-tag detection system. Maintenance of juvenile fish facilities that may impact fish or facility operations should be conducted during the winter maintenance period.

**1.1.2. Juvenile Fish Migration Timing.** Juvenile fish passage timing at Ice Harbor Dam corresponds closely with juvenile passage at Lower Monumental Dam (**FPP Chapter 7 - Lower Monumental Dam, Table LMN-2**). Salmon, steelhead, bull trout, lamprey, and other species are routinely counted when sampling occurs at Ice Harbor Dam.

## 1.2. Adult Fish Passage.

**1.2.1. Adult Fish Facilities.** Ice Harbor Dam adult fish facilities are made up of separate north and south shore facilities, described below. Maintenance of adult facilities is scheduled for January–February, typically one shore at a time, to minimize impacts on upstream migrants.

**1.2.1.1.** North Shore facilities include a fish ladder with counting station, a small collection system, and a pumped auxiliary water supply system. The collection system includes two downstream entrances and one side entrance into the spillway basin. In normal operation, one downstream entrance is used and the other two entrances are closed. The auxiliary water is supplied by two electric pumps, with a third pump as a backup.

**1.2.1.2.** South Shore facilities are comprised of a fish ladder with counting station, two south shore entrances, a powerhouse collection system, and a pumped auxiliary water supply system. The powerhouse collection system includes two downstream entrances and one side entrance into the spillway basin at the north end of the powerhouse, four operating floating orifices, and a common transportation channel. One of the downstream north powerhouse entrances and four of the floating orifices are used during normal operation. At the south shore entrances, one entrance is normally used. The auxiliary water is supplied by eight electric pumps, of which between six and eight are normally used to provide the required flow. Excess water from the juvenile fish passage facilities is routed into the fish pump discharge chamber to provide additional attraction flow. The upper ends of both ladders have PIT-tag detectors.

**1.2.2. Adult Fish Migration Timing & Counting.**

**1.2.2.1.** Upstream migrants are present throughout the year and adult fish facilities are operated year-round. Adult salmon, steelhead, shad, and lamprey are counted per the schedule in **Table IHR-2** and data are posted daily at: www.fpc.org/adultsalmon_home.html.

Sturgeon and bull trout are relatively infrequent and are reported in *Miscellaneous Fish Counts* and in the *Annual Fish Passage Report*. Relatively few fish pass through the north ladder so one fish counter can effectively count both ladders simultaneously from the south shore counting room by direct observation of the south viewing window/slot and by video monitor connected to the north shore counting room.

**1.2.2.2.** Yearly counts through the most recent passage year are used to determine the earliest and latest dates of peak adult fish passage defined in **Table IHR-3**. Time-of-day (diel) distributions of adult salmonids at fishway entrances and exits are shown in **Figure IHR-2**.

**Table IHR-2. Ice Harbor Dam Adult Fish Counting Schedule, 3/1/2018 – 2/28/2019.**

| Count Period | Counting Method and Hours * |
|---|---|
| March 1 – 31 | Day Video 0400-2000 (PST) |
| April 1 – October 31 | Day Visual 0500–2100 hours (PDT) |
| November 1 – end of February | Day Video 0400-2000 (PST) |

*PST=Pacific Standard Time. PDT=Pacific Daylight Time (in effect during Daylight Saving Time 3/11/18-11/4/18).

**Table IHR-3. Ice Harbor Dam Adult Fish Count Period and Peak Passage Timing (based on yearly counts from 1962 through most recent count year).**

| Species | Count Period | Earliest Peak | Latest Peak |
|---|---|---|---|
| Spring Chinook | Apr 1 – Jun 11 | Apr 22 | Jun 11 |
| Summer Chinook | Jun 12 – Aug 11 | Jun 12 | Jul 23 |
| Fall Chinook | Aug 12 – Dec 31 | Sep 2 | Sep 30 |
| Steelhead | Apr 1 – Oct 31 | Sep 15 | Oct 12 |
| Sockeye | Apr 1 – Oct 31 | Jul 1 | Sep 22 |
| Lamprey | Apr 1 – Oct 31 | Jul 21 | Sep 3 |

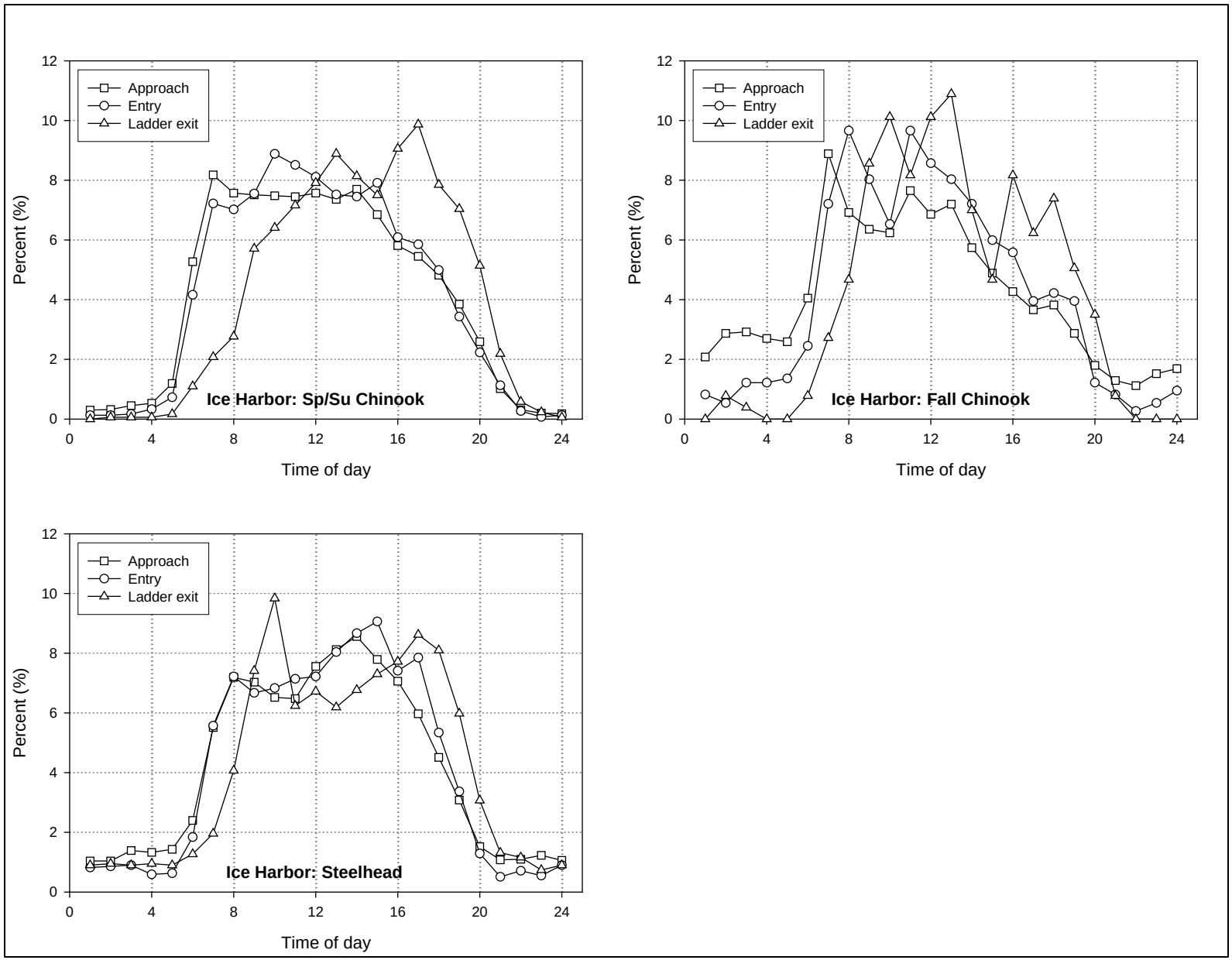



**Figure IHR-2. Diel Distribution of Adult Salmonids at Ice Harbor Dam Fishway Entrances and Exits (*Keefer & Caudill 2008*).**
pweb.crohms.org/tmt/documents/FPOM/2010/2013_FPOM_MEET/2013_JUN/

# 2. FISH FACILITIES OPERATIONS

## 2.1. General.

**2.1.1.** Yearly special operations related to research are described as currently coordinated in **Appendix A - Special Project Operations & Studies**.

**2.1.2.** Research, non-routine maintenance 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. These distances are approximate and will be updated after data are collected and analyzed to determine the threshold for adverse impacts to adult fish behavior. Alternate actions will be considered by District and Project biologists in conjunction with the Regional fish agencies on a case-by-case basis.

**2.1.3.** 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.

**2.1.4.** 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 also **FPP Chapter 1 - Overview** for coordination guidance).

## 2.2. Spill Management.

**2.2.1.** Spring and summer spill operations for juvenile fish passage are defined in the *Fish Operations Plan* (FOP), included in the Fish Passage Plan as **Appendix E**. Spill at Ice Harbor will be distributed in patterns defined in **Table IHR-6 through IHR-9**.

**2.2.2.** Involuntary spill is the result of river flow above powerhouse capacity, insufficient load (lack of load), turbine unit outages (forced or scheduled), or failure of a key component of the juvenile fish passage facility which forces spill to provide juvenile fish passage.

**2.2.3.** Total dissolved gas (TDG) is monitored at Ice Harbor Dam during the periods defined in **Table IHR-1**, pursuant to the Corps' annual *TDG Monitoring Plan* and *Dissolved Gas Monitoring Plan of Action 2015-2018*.[1]

[1] TDG Monitoring Plan (Appendix 4 of the WMP): pweb.crohms.org/tmt/documents/wmp/. TDG Monitoring Plan 2015-2018: pweb.crohms.org/tmt/wqnew/tdg_monitoring/2015-18.pdf

## 2.3. Operating Criteria – Juvenile Fish Facilities.

### 2.3.1. Juvenile Facilities - Winter Maintenance Period (December 16–March 31).

#### 2.3.1.1. Forebay Area and Intakes.

**i.** Remove debris from forebay and gatewell slots.

**ii.** Rake trashracks just prior to the operating season.

**iii.** Measure gatewell drawdown in slots after cleaning trashracks with STSs installed.

**iv.** Inspect and repair gatewell dip net as needed.

#### 2.3.1.2. Submersible Traveling Screens (STSs) and Vertical Barrier Screens (VBSs).

**i.** Maintenance completed on all screens.

**ii.** Inspect STSs prior to installation and operate one trial run (dogged off on deck) to ensure proper operation.

**iii.** Log trial run.

**iv.** Inspect all VBSs at least once per year with underwater video camera. Repair as needed.

#### 2.3.1.3. Collection Channel.

**i.** Water-up valve capable of operating when needed.

**ii.** Orifice lights are operational.

**iii.** Orifices clean and valves operating correctly.

**iv.** Orifice air backflush system works correctly.

**v.** Netting along handrails maintained and in good condition.

**vi.** Netting or covers over orifice chutes maintained and in good condition.

#### 2.3.1.4. Dewatering Structure and Flume.

**i.** Inclined screen should be clean and in good condition with no gaps between screen panels, damaged panels, or missing silicone.

**ii.** Screen cleaning system (brush and air flush) maintained and operating correctly.

**iii.** Overflow weirs should be maintained, tested, and operating correctly.

**iv.** All valves should be operating correctly.

**v.** Flume interior should be smooth with no rough edges.

**vi.** Maintain full-flow PIT-tag system as required. Coordinate with PSMFC.

**2.3.1.5. Sampling Facilities.**

**i.** Flume dewatering structure maintained in good operating condition with no holes or gaps between dewatering screen panels. Silicone sealer in good condition.

**ii.** Flume drop gate should be maintained and in good operating condition.

**iii.** The wet separator and fish distribution system should be maintained and ready for operation as designed.

**iv.** All dewatering screens and seals in separator and flume must be in good condition with no holes or gaps between panels, or sharp edges.

**v.** All valves and switch gates maintained and in good operating condition.

**vi.** All sampling equipment maintained and in good operating condition.

**vii.** Maintain juvenile PIT-tag system as required. Coordinate with PSMFC.

**2.3.1.6. Avian Predation Areas (Forebay and Tailrace).** Inspect bird wires, water cannon, and other deterrent devices and repair or replace as needed. Where possible, install additional bird wires or other deterrent devices to cover areas of known avian predation activity. Prepare avian abatement contract as needed.

**2.3.1.7. Maintenance Records.** Record all maintenance and inspections.

**2.3.2. Juvenile Fish Passage Season (April 1–December 15).** Operate in accordance with criteria below April 1–October 31 for juvenile fish passage and November 1–December 15 for adult fallbacks.

**2.3.2.1. Forebay Area and Intakes.**

**i.** Remove debris from forebay.

**ii.** Inspect gatewell slots daily (preferably early in day shift) for debris, fish buildup, and contaminating substances (particularly oil). Clean gatewells before they become 50% covered with debris. If the volume of debris precludes the ability to keep the gatewell at least 50% clear, they should be cleaned at least once daily. If flows through an orifice or fish conditions give indications that an orifice may be partially obstructed with debris, the orifice will be closed and backflushed

to remove the obstruction. If the obstruction cannot be removed, the orifice shall be closed and the alternate orifice for that gatewell slot shall be operated. If both orifices become obstructed or plugged with debris, the turbine unit will not be operated until the gatewell and orifices are cleared of debris.

**iii.** If a visible accumulation of contaminating substances (e.g., oil) is detected in a gatewell and cannot be removed within 24 hours, the gatewell orifices shall be closed immediately and the turbine unit shut down within one hour until the material has been removed and any problems corrected. A preferred method for removing oil from the water surface is to install lipophilic socks, booms, or pads capable of encapsulating the material, tied off with a rope for later disposal. Action should be taken as soon as possible to remove oil from the gatewell so the orifice can be reopened to allow fish to exit the gatewell. Orifices shall not be closed for longer than 48 hours.

**iv.** Remove debris from trashracks as necessary to maintain less than 1' of additional drawdown in gate slots (relative to drawdown with a clean screen). Additional raking may be required when heavy debris loads are present in the river. Coordinate turbine unit outages with other project work activities, if possible, to minimize turbine unit outages during the spring.

**v.** Dip bulkhead gatewell slots to remove fish prior to installing bulkhead for dewatering bulkhead slot.

#### 2.3.2.2. STSs and VBSs.

**i.** Operate STSs in cycling mode when average fork length of sub-yearling Chinook salmon or sockeye is greater than 120 mm at Lower Monumental Juvenile Fish Facility.

**ii.** Operate STSs in continuous-run mode when average fork length of sub-yearling Chinook salmon or sockeye is less than 120 mm at Lower Monumental Juvenile Fish Facility, or if there is evidence that smaller juvenile fish are present at Ice Harbor.

**iii.** Inspect each STS by underwater video once per month. Spot check VBSs at the same time.

**iv.** Record STS amp readings daily.

**v.** If an STS or VBS is damaged or fails during the juvenile fish passage season, follow procedures detailed under unscheduled maintenance of STSs. In no case should a turbine unit be operated with a missing or a known non-operating or damaged STS or VBS.

**vi.** Up to half of the STSs may be removed after October 1 for annual maintenance provided there is no operation of units without screens.

**vii.** Make a formal determination at the end of the season as to the adequacy of STS screen mesh and replacement if necessary.

**viii.** Inspect at least two VBSs in two different turbine units between spring and summer. Both turbine units should have been operated frequently in the spring. If debris accumulation is noted, inspect other VBSs and clean as necessary.

**ix.** If extreme cold weather is forecasted (< 20°F for ≥ 24 hours) between Thanksgiving and December 15, STSs may be removed. The project will first request special permission from CENWW-OD-T. CENWW-OD-T will inform NOAA Fisheries and FPOM of the action. NOAA's National Weather Service forecast for Ice Harbor Dam is available at: forecast.weather.gov/MapClick.php?lat=46.2469&lon=-118.8807

### 2.3.2.3. Collection Channel.

**i.** Orifices clean and operating. Operate at least one orifice per gatewell slot (preferably the north orifice). If the project is operating within the Minimum Operating Pool (MOP), additional orifices may be operated to maintain a full collection channel. If orifices must be closed to repair any part of the facility, monitor the gatewells hourly (unit is operating) or at least every two hours (unit is not operating) for fish condition and behavior. See **section 3.2.2.3** to determine if the unit must be shut down and if fish must be dipped from the gatewell(s).

**ii.** Orifice lights operational and operating on open orifices. Orifice lights and area lights may be turned off the evening before the channel is dewatered at the end of the season (dewatering occurs on December 16 or later) to encourage fish to exit the channel volitionally. Area lights can be turned on briefly for personnel access if necessary.

**iii.** Replace all burned out orifice lights within 24 hours of notification. Orifice lights shall remain lighted 24 hours/day.

**iv.** Orifice jets hitting no closer than 3' from back wall, collection channel full.

**v.** Orifice valves are either fully open or closed.

**vi.** Backflush orifices at least once per day. During periods of high fish and debris passage, April 1 through July 31, orifices should be inspected and backflushed once per 8-hour shift or more frequently as determined by the project biologist, to keep orifices clean.

**vii.** Water-up valve capable of operating when needed.

**viii.** The netting along handrails should be maintained in good condition with no holes or gaps in the netting.

**ix.** Netting or covers over orifice chutes in good condition.

### 2.3.2.4. Dewatering Structure.

**i.** Trash sweep operating correctly. Project Fisheries shall determine the sweep frequency of at least once every four hours, or shorter as necessary to maintain a clean screen. If automated cleaning system problems occur, operate manually at least once per work shift, or more as necessary to maintain a clean screen.

**ii.** Clean trapezoidal section at least once per day, and more frequently if required to maintain a clean condition.

**iii.** Check overflow weirs to make sure they are operating correctly, perform maintenance as required.

**iv.** There should be no gaps between screen panels in the inclined screen or holes in the screen panels.

**v.** Lights at the dewatering structure should be turned off at night, unless needed for personnel access, to encourage fish to move downstream volitionally.

### 2.3.2.5. Sampling Facilities.

**i.** All screens should be inspected to make sure there are no holes or sharp edges.

**ii.** Operate wet separator and fish distribution system as designed. Sample fish no less than twice per week with no more than three days between sample days during the main juvenile bypass season to monitor juvenile fish descaling and other fish condition parameters. The sample goal should be 100 fish of each of the predominant species of salmonids on each sample day, with no more than four hours of sampling. All fish collected during the sample will be examined and recorded. Increased frequency may be necessary during periods when injuries are noted or suspected (e.g., high debris periods). Sampling is not recommended when water temperatures exceed $70^0$ F unless authorized by an ESA permit. Fish condition reporting should follow the standardized SMP protocol and be sent to FPC within twelve hours after sampling.

**iii.** Crowder screen brushes should be maintained in good operating condition with no holes or sharp edges in the crowder screen.

**iv.** Operate pre-anesthetic system as designed.

**v.** Inform PSMFC, in advance if possible, of situations that cause the PIT-tag system to become inoperable (e.g. power outages) or that could result in confounding the interpretation of PIT-tag data (e.g. operating in primary bypass mode without an operational full-flow detector, emergency dewaterings).

### 2.3.2.6. Avian Predation Areas (Forebay and Tailrace).

**i.** Bird wires and other avian deterrent devices shall be monitored to ensure good condition. Any broken wires or devices shall be replaced as soon as possible.

**ii.** Harassment program in place to deter avian predation in areas actively used by birds and not covered by bird wires or other devices.

**iii.** Project biologists shall routinely monitor project areas to determine areas of active avian predation and, if possible, adjust harassment program to cover these areas or install bird wires or other deterrent devices to discourage avian predation.

### 2.3.2.7. Removable Spillway Weir (RSW).[2]

**i.** The RSW in spillbay 2 will be in the raised position and operational on the first day of spill for juvenile fish passage.

**ii.** When the RSW is in operation, spill through Bay 2 is fixed at approximately 8.4 kcfs. The spillgate shall be raised to where it does not touch flow passing down the RSW.

**iii.** When the National Weather Service forecasts Ice Harbor inflow to exceed 200 kcfs, initiate aggressive forebay debris removal so that RSW operation will not be impeded and coordinate with RCC and CENWW-OD-T.

**iv.** Complete RSW stow (complete rotation to the landing pad) when inflows exceed 260 kcfs, upstream river gauge flows are increasing, and the NWS forecasts Ice Harbor inflow to exceed 300 kcfs.

**v.** On or after June 21 (start of summer spill), when average daily total project outflow is less than 30 kcfs and forecasted to remain below 30 kcfs for three days or more on a declining hydrograph, the RSW will be closed and spill will be distributed in patterns for spill with no RSW in **Table IHR-6**. The RSW will be re-opened if average daily total project outflow increases above 30 kcfs and is forecasted to remain above 30 kcfs for three or more days. NWRFC inflow forecast for Ice Harbor Dam at:
www.nwrfc.noaa.gov/river/station/flowplot/flowplot.cgi?IHDW1

**2.3.2.8. Inspection and Record Keeping.** Inspect all facilities according to fish facilities monitoring plans. Record all maintenance and inspections.

[2] Spillway weirs provide surface passage routes via spillbay(s). Temporary, or Top, Spillway Weirs (*TSW*s) at Little Goose, McNary and John Day dams can be installed, uninstalled and moved between bays using the gantry crane. Removable Spillway Weirs (*RSW*s) at Lower Granite, Lower Monumental and Ice Harbor dams are "removed" by controlled descent to the bottom of the forebay.

## 2.4. Operating Criteria - Adult Fish Facilities.

### 2.4.1. Adult Facilities - Winter Maintenance (January 1–end of February).

**2.4.1.1.** Inspect all staff gauges and water level indicators. Repair and/or clean where necessary.

**2.4.1.2.** Dewater all ladders and inspect all dewatered sections of fish facilities for projections, debris, or plugged orifices which could injure fish or impede fish passage up the ladder. Fish ladder exit trashracks must have smooth surfaces where fish pass, and must have downstream edges that are adequately rounded or padded. Spare trashracks should be on hand for use as necessary. Inspect all diffuser gratings and chambers annually by dewatering or by using divers or video inspection techniques. All diffuser gratings and chambers are to be dewatered and physically inspected at least every 3 years. Repair deficiencies.

**2.4.1.3.** Inspect for and clean debris from the fish ladder exits. All trashracks and picketed leads must be clean and installed correctly.

**2.4.1.4.** Calibrate all water level measuring devices, as necessary, for proper facility operations.

**2.4.1.5.** Inspect all spill gates and ensure that they are operable.

**2.4.1.6.** Fish pumps maintained and ready for operation.

**2.4.1.7.** Maintain adult PIT-tag system as required. Coordinate with PSMFC.

**2.4.1.8.** Maintain the adult fish trap as required. This can also be done outside of the January-February period because the trap is removable.

### 2.4.2. Adult Fish Passage Season (March 1–December 31).

**Note**: During extremely high flows when tailwater level exceeds elevation 353' msl, project personnel will monitor for water seepage from the auxiliary water supply conduit into the powerhouse warehouse. If personnel determine that water seeping into the powerhouse could affect safety and equipment, the transverse bulkhead to the auxiliary water supply conduit will be installed and the number of AWS pumps in operation will be accordingly reduced until flooding is reduced to a manageable level.

**2.4.2.1. Fishway Ladders.** Water depth over weirs: 1' to 1.3'.

**2.4.2.2. Counting Windows.** The crowder shall be opened to full count slot width and the picketed leads shall be removed when not counting. The crowder shall be open as far as possible to allow accurate counting and shall not be closed to less than 18” while counting. This will usually occur during high turbidity conditions to allow count accuracy criteria to be achieved. All equipment should be maintained and in good condition. The counting window

and backboard should be cleaned as needed to maintain good visibility. Crowder ranges at IHR are as follows:

- North = 19.5” (fixed width)
- South = 19.5” (fixed width)

**2.4.2.3. Head on all Fishway Entrances.** Head range: 1' to 2'.

**2.4.2.4. North Shore Entrance (NEW 1).** Elevation at top of gate on sill = 332.25'.

**i.** Operate downstream gate closest to shore.

**ii.** Weir depth: 8' or greater below tailwater. At tailwaters less than 340.25', weirs should be on sill. Note that at low river flow and tailwater, some of the diffusers are above tailwater and project may only be able to maintain a 6' weir depth.

**iii.** North Shore Lower Diffuser Gates: If tailwater is below 344', diffuser gates should be fully open. If tailwater is above 344', diffuser gates should be ½ open.

**2.4.2.5. North Powerhouse Entrances (NFE 1&2).** Elevation at top of gate on sill=332.25'.

**i.** Operate one downstream gate.

**ii.** Weir depth: 8' or greater below tailwater. At tailwaters less than elevation 340.25', weirs should be on sill. [*Note: At low tailwater, weirs will bottom out and will be less than 8' below tailwater*.]

**2.4.2.6. Floating Orifice Gates.** Operate 4 floating orifices, OG1, 4, 10, and 12.

**2.4.2.7. South Shore Entrance (SFE-1).** Elevation of top of gate when on sill = 332.25'.

**i.** Operate entrance closest to powerhouse.

**ii.** Weir depth: 8' or greater below tailwater. At tailwaters less than elevation 340.25', weirs should be on sill. *[Note: At low tailwater, weirs will bottom out and will be less than 8' below tailwater.]*

**2.4.2.8. Channel Velocity.** 1.5 to 4.0 feet per second (fps). Ice Harbor Dam monitors water velocity at the junction pool in the lower south fish ladder. The current device utilizes Doppler Technology. Decision for placement was not only what was considered to be the single most representative position, but also the placement for maintenance and ease of installation. In addition, head is measured at the north, north powerhouse, and south fishway entrances.

**2.4.2.9. Head on Trashracks.**

**i.** Maximum head of 0.3’ on ladder exits.

**ii.** Maximum head on picketed leads shall be 0.3'.

**iii.** Trashracks and picketed leads installed correctly.

**2.4.2.10. Staff Gauges and Water Level Indicators.** All staff gauges should be readable at all water levels encountered during the fish passage period. Repair or clean as necessary.

**2.4.2.11.** Inform PSMFC, in advance if possible, of situations that cause the PIT-tag system to become inoperable (e.g. power outages) or that could result in confounding the interpretation of PIT-tag data (e.g. emergency dewaterings).

**2.4.2.12. Facility Inspections.**

**i.** Powerhouse operators shall inspect facilities once per day shift and check computer monitor information at least once during each back shift.

**ii.** Project biologists shall inspect facilities three times per week. Inspect all facilities according to fish facilities monitoring program.

**iii.** Picketed leads shall be inspected during all inspections to ensure they are clean and in the correct position (all the way down).

**iv.** Project personnel shall check calibration of fishway control system twice per month to ensure that it is kept within calibration. This may be done as part of routine fishway inspections.

**v.** Inspect fishways daily for foreign substances (particularly oil). If substances are found, corrective actions should be undertaken immediately.

**vi.** Record all inspections.

**2.4.2.13. Fishway Temperature Monitoring.** From June 1 through September 30, water temperature will be monitored at adult fishway entrances and exits.

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

**ii.** 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.

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

**iv.** If an existing temperature monitoring location is proposed to be used 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.

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

## 2.5. Fish Facility Monitoring & Reporting.

**2.5.1.** Project biologists shall inspect fish passage facilities at the frequencies listed in the juvenile and adult fish facilities operating criteria sections.

**2.5.2. Weekly Reports.** Project Biologists shall prepare weekly reports March 1–December 31, summarizing operations for Friday through Thursday, and email to CENWW-OD-T by noon the following Monday. Reports shall provide an overview of how the project and the fish passage facilities operated during the week and evaluate resulting fish passage conditions, and include:

**i.** Any out-of-criteria situations observed and subsequent corrective actions taken;
**ii.** Any equipment malfunctions, breakdowns, or damage along with a summary of resulting repair activities;
**iii.** Adult fishway control calibrations;
**iv.** STS and VBS inspections;
**v.** Any unusual activities at the project that may have affected fish passage.

**2.5.3. Annual Reports.** Project biologists shall prepare a draft annual report by February 10 and a final report by March 15 summarizing the operation of the project fish passage facilities for the previous year. The annual report shall also include a description of actions taken to discourage avian predation at the project, and an overview of the effectiveness of those activities in discouraging predation.

**2.5.4. Project Inspections.** Project biologists inspect project facilities once per month and during dewaterings for the presence of zebra and Quagga mussels. Biologists shall provide a report to CENWW-OD-T on a monthly basis summarizing mussel inspections.

# 3. FISH FACILITIES MAINTENANCE

## 3.1. Dewatering & Fish Handling.

**3.1.1.** Project biologists should be present to provide technical guidance at all project activities that may involve fish handling. All dewatering (also referred to as "unwatering") shall be accomplished in accordance with approved *Dewatering Guidelines and Fish Salvage Plans* (**Appendix F**). When river temperatures reach 70°F or greater, all adult fish handling will be coordinated through CENWW-OD-T. Project *Dewatering Plans*[3] were reviewed and revised in 2011 to ensure that they comply with **Appendix F**.

## 3.2. Maintenance - Juvenile Fish Facilities.

**3.2.1. Scheduled Maintenance.** Scheduled maintenance of juvenile facilities is conducted year-round. Long-term maintenance or modifications that require facilities to be out of service for

[3] Project Dewatering Plans are available on the FPOM website at: pweb.crohms.org/tmt/documents/FPOM/2010/

extended periods of time are conducted during the winter maintenance period December 16–March 31. During the fish passage season, parts of the facilities are maintained on a daily, weekly, or longer interval to keep them in proper operating condition.

**3.2.2. Unscheduled Maintenance.** Unscheduled maintenance is the correction of any situation that prevents facilities from operating within criteria or that will impact fish passage or survival.

**3.2.2.1. Notification/Reporting.** Maintenance of facilities such as STSs, which sometimes break down during fish passage season, will be carried out as described below. In these cases, repairs will be made as prescribed and CENWW-OD-T will be notified as soon as possible after it becomes apparent that repairs are required. The Operations Manager has the authority to initiate work prior to notifying CENWW-OD-T if a delay of the work will result in an unsafe situation for people, property, or fish. Unscheduled maintenance that will have a significant impact on fish passage shall be coordinated with NOAA Fisheries and FPOM on a case-by-case basis by CENWW-OD-T. Information required by CENWW-OD-T includes:

**i.** Description of the problem.
**ii.** Type of outage required.
**iii.** Impact on facility operation.
**iv.** Length of time for repairs.
**v.** Expected impacts on fish passage and proposed measures to mitigate them.

**3.2.2.2. STS.** The STSs are inspected periodically throughout the juvenile migration season with a video monitoring system. If a screen is found to be damaged it will be removed and either replaced with the spare STS or repaired and returned to service. A turbine unit shall not be operated with a known damaged or nonfunctioning STS or without a full complement of STSs. If an STS fails on a weekend or at night when maintenance crews are not available, the respective turbine unit will be shut down and generation switched to another fully screened unit. If all screened turbine units are in service, additional water may be spilled until the effected STS can be removed and repaired or replaced.

**3.2.2.3. Gatewell Orifices.** Each gatewell has two 12" orifices with air operated valves to allow fish to exit the gatewell. Under normal operation, one orifice per gatewell is operated. To minimize blockage from debris, orifices are cycled and back flushed at least once per day, and more frequently if required by heavy debris loads. If an air valve fails or is blocked with debris, the valve should be closed and the alternate orifice for that gatewell operated until repairs can be made. If both orifices are blocked with debris, damaged, or must be kept closed, the turbine unit will be taken out of service until repairs can be made. If repairs are to take longer than 48 hours, juvenile fish will be dipped from the gatewell with a gatewell dip basket in accordance with the project dewatering and fish-handling plan.

**3.2.2.4. Dewatering Structure.** The dewatering structure acts as a transition from the collection channel to the corrugated metal flume. An inclined screen allows excess water to be bled off, with all fish and remaining water transitioning into the corrugated metal flume. The excess water is discharged into the adult fish facility auxiliary water supply system and is also used as the water supply for the sampling facilities. The dewatering structure contains a trash sweep for cleaning the rectangular portion of the inclined screen, and an air blow back system for cleaning the transition (trapezoidal) section of the screen. The dewatering screen

has a set of differential pressure sensors for determining head differential across the screen. If the sensors detect a 0.15' differential it initiates continuous screen cleaning. If the sensors detect a differential of 0.30' it closes all but 3 orifices (Unit 1 orifices remain open) in the juvenile collection channel. Both conditions trigger an alarm at the control panel and in the control room. If the trash sweep breaks and interferes with juvenile fish passage through the structure or if the inclined screen or other component of the structure is damaged, the orifices may need be closed and the collection channel dewatered to allow repairs to be made. If the orifices are closed and the collection channel dewatered, the traveling screens will remain in operation. Fish will be allowed to accumulate in the gatewells for up to 2 days. If repairs are expected to take longer than 2 days, a salvage program will be initiated to remove fish from gatewells, with a gatewell dip basket, until repairs can be made and the system watered up again. While the collection channel is out of service, project personnel shall monitor gatewells for signs of fish problems or mortality. Spill may be provided as an alternative avenue for fish passage during the collection channel outage.

**3.2.2.5. Bypass Flume.** The bypass flume transports fish to the sampling facilities and to the tailrace below the project. If there is a problem with the flume that requires it to be dewatered, procedures will be taken similar to **section 3.1**.

**3.2.2.6. Sampling Facilities.** Under normal operation, juvenile fish are routed around the sampling facilities, except when sampling is being conducted. If there is a problem with the sampling facilities when it is in operation, the drop gate will be lowered to keep all juvenile fish in the bypass flume/pipe to bypass them directly to the river below the project. All fish in the sampling facility will then be released back to the river prior to sampling if there are any problems with holding them in the sample tank until they can be sampled.

## 3.3. Maintenance - Adult Fish Facilities.

**3.3.1. Scheduled Maintenance.** Scheduled maintenance of a facility that must be dewatered to work on or where maintenance will have a significant effect on fish passage will be done during the January–February winter maintenance period. Maintenance of facilities that will have no effect on fish passage may be conducted at any time. Maintenance is normally conducted on one fish ladder at a time during the winter to provide some fish passage at all times. When facilities are not being maintained during the winter maintenance period, they will be operated according to normal criteria unless otherwise coordinated with NOAA Fisheries and FPOM.

### 3.3.2. Unscheduled Maintenance.

**3.3.2.1. Notification/Reporting.** Unscheduled maintenance that will significantly affect facility operation will be coordinated with NOAA Fisheries and other FPOM participants. Coordination procedures for unscheduled maintenance of adult facilities are the same as for juvenile facilities (**section 3.2.2.**). If part of a facility malfunctions or is damaged during the fish passage season, and the facility can still be operated within criteria without any detrimental effects on fish passage, repairs may not be conducted until the winter maintenance period or until fewer numbers of fish are passing the project. If part of a facility is damaged or malfunctions that may significantly impact fish passage, it will be repaired as soon as possible.

**3.3.2.2. Fish Ladders and Counting Stations.** The fish ladders contain fixed weirs, counting stations with picket leads, and fish exits with trashracks. If any part of the ladder fails or is blocked with debris during fish passage season, efforts will first be made to correct the problem without dewatering the ladder. Trashracks, picket leads, and counting stations can sometimes be repaired or maintained without dewatering the ladder. The decision to dewater the ladder and make repairs during the fish passage season or wait until the winter maintenance period will be made after coordination with the fish agencies and tribes.

**3.3.2.2.a. Hazardous Materials Spill.** 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.

**3.3.2.3. North Shore Auxiliary Water Supply System.** The north shore facilities contain three electric pumps that provide auxiliary water to the diffusers at the bottom of the ladder and at the entrances. During normal operation two pumps are required to provide the necessary auxiliary water.

**3.3.2.3.a.** If a pump fails during 2-pump operation, the pump on standby will be operated to provide the necessary flows.

**3.3.2.3.b.** If two or all three pumps fail, the NEW1 weir will be maintained at a level of 6' below tailwater until repairs are made.

**3.3.2.4. South Shore Auxiliary Water Supply System.** The south shore auxiliary water is supplied by 8 electric pumps and 150-180 cfs of excess water from the juvenile fish facilities. Fluctuating water levels can require up to 8 pumps to be operated to provide the auxiliary water and meet criteria.

**3.3.2.4.a.** If one pump fails, a standby pump will be started to keep the fishway within criteria. If more pumps fail, this procedure will continue until all the standby pumps are in operation.

**3.3.2.4.b.** If criteria cannot be met within 24 hours, the floating orifices should be closed in the following order: OG-12 and OG-10.

**3.3.2.4.c.** If the required head differential of 1' to 2' cannot be reached when the floating orifices are closed, SSE 1 and NFE 2 will be closed equally at 1' intervals until it is reached or until the weirs are 5' below tailwater. Then the remaining floating orifices should be closed in the following order: OG-4 and OG-1.

**3.3.2.4.d.** If there is still not enough auxiliary water to maintain the head differential on the two main entrances, NFE 2 will be closed, the transportation channel bulkheaded off at the junction pool, and SSE 1 operated as deep as possible to maintain the head differential. If it cannot be maintained at a depth of 6' or greater, the weir will remain at 6' regardless of the head.

**3.3.2.5. Fishway Entrances.** The fishway entrances consist of main entrance weirs with hoists and automatic controls, and floating orifices which auto-regulate with tailwater fluctuations.

**3.3.2.5.a.** If any of the automatic controls malfunction, Project personnel will operate the weirs manually to maintain within criteria.

**3.3.2.5.b.** If there is a further failure that prevents the entrance from being operated manually, an alternate entrance will be opened until repairs can be made.

**3.3.2.5.c.** If a floating orifice fails, it will be pulled out of the water and the entrance bulkheaded off until the floating orifice is repaired.

**3.3.2.6. 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 winter maintenance to ensure they are in place. Inspections are done either by dewatering and physically inspecting the gratings, or by using underwater video cameras, divers, or other methods. Daily inspections of fish ladders and collection systems should include looking for any flow changes that may indicate problems with diffuser gratings.

**3.3.2.6.a.** Diffuser gratings may come loose during fish passage season due to a variety of reasons. If a grating is known or suspected to have moved, creating an opening into a diffuser chamber, efforts must immediately be taken to correct the situation and minimize impacts on adult fish. Coordination of issues should begin immediately through the established coordination procedure for Unscheduled Maintenance (**section 3.2.2.1.**). If possible, a video inspection should be made as soon as possible to determine the extent of the problem. If gratings are found to be missing or displaced, creating openings into the diffuser chambers, a repair plan shall be developed and coordinated with the fish agencies and tribes through the established coordination procedure. Repairs shall be made as quickly as possible unless otherwise coordinated.

# 4. TURBINE UNIT OPERATION & MAINTENANCE

## 4.1. Turbine Unit Priority Order.

**4.1.1.** From March 1 through November 30, turbine units will be operated in the order of priority defined in **Table IHR-4** to enhance adult and juvenile fish passage. Model studies of Ice Harbor Dam show that spill at low flows can cause eddying in front of the powerhouse. The unit priority order is defined to minimize eddying during spill and provide the best fish passage conditions. If a turbine unit is out of service for maintenance or repair, the next unit in the priority order shall be operated.

**4.1.2.** Unit priority order may be coordinated differently to allow for fish research, construction, or project maintenance activities. Hours of operations may be coordinated and adjusted in-season by CENWW-OD-T (through coordination with TMT) if necessary for fish passage or other conditions at the project.

**4.1.3. Single Unit Operation.** Ice Harbor should not operate a single unit on the *Ice Harbor-Franklin No.2 115kV* line. This line is connected to the *Sacajawea 500/115kV* transformer and the operation of a single unit on the line jeopardizes BPA system reliability. Therefore, IHR should not be run as a single or two-unit project with Unit(s) 3 and/or 4 without switching those units to the *Ice Harbor-Franklin No.3 115kV* line, disconnecting the *No.2 115kV* line from Ice Harbor, and disabling the transfer trip for the *No.2 115kV* line at Ice Harbor. This switching is necessary to prevent the loss of all Ice Harbor generation and the *Sacajawea* transformer if there is an outage of the *No.2 115kV* line. If single-unit operation is necessary and switching has not occurred in the yard, the project will operate Unit 1, 2, 6, or 5. Running Unit 3 or 4 alone on the *No. 2 115kV* line can only occur if the project operator can accomplish the needed switching.

**Table IHR-4. Ice Harbor Dam Turbine Unit Priority Order.**

| Season | Operation | Unit Priority Order |
|---|---|---|
| March 1 – November 30 Fish Passage Season | Single-Unit Operation w/ NO Line Switching | 1, 2, 6, 5 |
| | Single-Unit Operation AFTER Line Switching Or Multiple-Unit Operation | 1, 2, 3, 6, 4, 5 |
| December 1 – end of February Winter Maintenance | Single-Unit Operation w/ NO Line Switching | Any order for Units 1, 2, 5, 6 |
| | Single-Unit Operation AFTER Line Switching Or Multiple-Unit Operation | Any Order |

## 4.2. Turbine Unit Operating Range.

**4.2.1. In-Season (April 1–October 31).** As defined in the *BPA Load Shaping Guidelines* (**Appendix C**), all units will be operated within ±1% of peak turbine efficiency (1% range) to maximize survival of juvenile fish that pass through the turbines. Turbine unit flow and power output at the lower and upper limits of the 1% range are defined in **Table IHR-5**.

**4.2.1.1.** If operation outside the 1% range is necessary, Project personnel shall record the information to provide to BPA on a weekly basis according to the *Guidelines*. Operation outside the 1% range may be necessary to:

**i.** Meet BPA load requests made pursuant to BPA's policy, statutory requirements, and *Load Shaping Guidelines* (**Appendix C**);

**ii.** If the draft tube is to be dewatered (**section 4.3.3**), the unit will be operated at full load >1% (or at speed-no-load <1% if not possible to load) for a minimum of 15 minutes prior to installing tail logs in order to flush fish from the unit;

**iii.** Operate a turbine unit solely to provide station service; or

**iv.** Comply with other coordinated fish measures.

**4.2.1.2. Minimum Generation.** All of the lower Snake River projects may be required to keep one generating unit online at all times to maintain power system reliability. The minimum generation flow range for each unit is defined in the FOP Table 1 (**Appendix E**), as derived from the lower limits of the 1% range and actual unit operations. During low flow, there may not be enough river flow to meet this generation requirement and the FOP spill target. Under these circumstances, the project will operate the first available priority unit at minimum generation and spill the remainder of outflow. Actual attainable minimum generation may vary depending on real-time conditions.

**4.2.2. Off-Season (November 1–March 31).** While not required to do so in the off-season, turbines will normally run 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.

## Table IHR-5. Ice Harbor Dam Turbine Unit Power (MW) and Flow (cfs) at ±1% of Peak Turbine Efficiency (Lower and Upper Limits of 1% Range) and Operating Limits.[a]

| Project Head (feet) | IHR Unit 1 - With STS | | | | | | IHR Unit 1 - No STS | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1% Lower Limit | | 1% Upper Limit | | Operating Limit | | 1% Lower Limit | | 1% Upper Limit | | Operating Limit | |
| | MW | cfs | MW | cfs | MW | cfs | MW | cfs | MW | cfs | MW | cfs |
| **85** | 51.7 | 8,417 | 83.6 | 13,590 | 92.8 | 16,053 | 51.9 | 8,340 | 89.9 | 14,452 | 102.6 | 16,859 |
| **86** | 52.6 | 8,443 | 84.6 | 13,585 | 94.3 | 16,077 | 52.7 | 8,367 | 91.0 | 14,447 | 103.1 | 16,715 |
| **87** | 53.4 | 8,469 | 85.6 | 13,580 | 95.7 | 16,099 | 53.5 | 8,392 | 92.0 | 14,441 | 103.5 | 16,568 |
| **88** | 54.2 | 8,494 | 86.6 | 13,574 | 97.3 | 16,144 | 54.3 | 8,417 | 93.1 | 14,436 | 103.5 | 16,420 |
| **89** | 55.0 | 8,518 | 87.6 | 13,569 | 99.0 | 16,187 | 55.1 | 8,441 | 94.2 | 14,430 | 103.5 | 16,252 |
| **90** | 55.8 | 8,542 | 88.6 | 13,563 | 100.1 | 16,158 | 55.9 | 8,465 | 95.3 | 14,424 | 103.5 | 16,034 |
| **91** | 56.5 | 8,548 | 89.8 | 13,585 | 101.0 | 16,058 | 56.6 | 8,471 | 96.5 | 14,448 | 103.5 | 15,822 |
| **92** | 57.1 | 8,554 | 90.9 | 13,607 | 101.9 | 15,960 | 57.3 | 8,477 | 97.8 | 14,471 | 103.5 | 15,614 |
| **93** | 57.8 | 8,559 | 92.1 | 13,628 | 102.8 | 15,864 | 58.0 | 8,482 | 99.0 | 14,494 | 103.5 | 15,411 |
| **94** | 58.5 | 8,565 | 93.2 | 13,649 | 103.5 | 15,769 | 58.6 | 8,488 | 100.3 | 14,516 | 103.5 | 15,213 |
| **95** | 59.2 | 8,570 | 94.4 | 13,669 | 103.5 | 15,675 | 59.3 | 8,493 | 101.5 | 14,537 | 103.5 | 15,019 |
| **96** | 59.9 | 8,589 | 95.3 | 13,662 | 103.5 | 15,425 | 60.1 | 8,511 | 102.5 | 14,530 | 103.5 | 14,845 |
| **97** | 60.7 | 8,607 | 96.3 | 13,655 | 103.5 | 15,180 | 60.8 | 8,529 | 103.5 [b] | 14,676 | 103.5 | 14,676 |
| **98** | 61.5 | 8,624 | 97.3 | 13,648 | 103.5 | 14,941 | 61.6 | 8,546 | 103.5 [b] | 14,509 | 103.5 | 14,509 |
| **99** | 62.2 | 8,641 | 98.2 | 13,641 | 103.5 | 14,708 | 62.4 | 8,563 | 103.5 [b] | 14,347 | 103.5 | 14,347 |
| **100** | 63.0 | 8,658 | 99.2 | 13,634 | 103.5 | 14,481 | 63.1 | 8,580 | 103.5 [b] | 14,187 | 103.5 | 14,187 |
| **101** | 64.0 | 8,707 | 99.9 | 13,590 | 103.5 | 14,318 | 64.1 | 8,629 | 103.5 [b] | 14,037 | 103.5 | 14,037 |
| **102** | 65.0 | 8,756 | 100.6 | 13,547 | 103.5 | 14,158 | 65.2 | 8,677 | 103.5 [b] | 13,890 | 103.5 | 13,890 |
| **103** | 66.0 | 8,804 | 101.3 | 13,505 | 103.5 | 14,001 | 66.2 | 8,725 | 103.5 [b] | 13,746 | 103.5 | 13,746 |
| **104** | 67.0 | 8,850 | 102.0 | 13,463 | 103.5 | 13,847 | 67.2 | 8,771 | 103.5 [b] | 13,605 | 103.5 | 13,605 |
| **105** | 68.0 | 8,896 | 102.6 | 13,422 | 103.5 | 13,697 | 68.2 | 8,816 | 103.5 [b] | 13,466 | 103.5 | 13,466 |
| | IHR Unit 2 [c] - With STS | | | | | | IHR Unit 2 [c] - No STS | | | | | |
| **85** | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD |
| **86** | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD |
| **87** | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD |
| **88** | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD |
| **89** | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD |
| **90** | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD |
| **91** | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD |
| **92** | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD |
| **93** | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD |
| **94** | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD |
| **95** | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD |
| **96** | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD |
| **97** | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD |
| **98** | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD |
| **99** | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD |
| **100** | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD |
| **101** | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD |
| **102** | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD |
| **103** | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD |
| **104** | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD |
| **105** | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD | TBD |

**a.** Table values derived from HDC report (March 2007). Flow (cfs) calculated from turbine efficiency, head, and power output (MW). "Operating Limit" is the maximum safe operating point, based on cavitation or generator limit (added Feb 2018).

**b.** At project head ≥ 97 ft, Units 1, 4, 5, and 6 with No STS are restricted by the Operating Limit and cannot achieve the modeled upper limit of the 1% range. Power (MW) and flow (cfs) values shown are at Operating Limit.

**c.** Unit 2 is out of service through spring 2018 for turbine replacement. Table will be revised pending index tests.

| Project Head (feet) | IHR Unit 3 [d] - With STS | | | | | | IHR Unit 3 [d] - No STS | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1% Lower Limit | | 1% Upper Limit | | Operating Limit | | 1% Lower Limit | | 1% Upper Limit | | Operating Limit | |
| | MW | cfs | MW | cfs | MW | cfs | MW | cfs | MW | cfs | MW | cfs |
| **85** | 69.8 | 11,404 | 74.1 | 12,100 | n/a | n/a | 70.9 | 11,452 | 75.2 | 12,141 | n/a | n/a |
| **86** | 70.8 | 11,423 | 75.0 | 12,098 | n/a | n/a | 71.9 | 11,471 | 76.1 | 12,140 | n/a | n/a |
| **87** | 71.8 | 11,442 | 75.9 | 12,097 | n/a | n/a | 72.9 | 11,490 | 77.0 | 12,139 | n/a | n/a |
| **88** | 72.8 | 11,460 | 76.8 | 12,096 | n/a | n/a | 73.9 | 11,508 | 77.9 | 12,137 | n/a | n/a |
| **89** | 73.8 | 11,477 | 77.7 | 12,094 | n/a | n/a | 74.9 | 11,526 | 78.9 | 12,136 | n/a | n/a |
| **90** | 74.7 | 11,494 | 78.6 | 12,092 | n/a | n/a | 75.9 | 11,542 | 79.8 | 12,134 | n/a | n/a |
| **91** | 75.9 | 11,544 | 80.1 | 12,184 | n/a | n/a | 77.1 | 11,593 | 81.3 | 12,226 | n/a | n/a |
| **92** | 77.1 | 11,593 | 81.6 | 12,274 | n/a | n/a | 78.3 | 11,642 | 82.8 | 12,316 | n/a | n/a |
| **93** | 78.3 | 11,641 | 83.1 | 12,362 | n/a | n/a | 79.5 | 11,690 | 84.4 | 12,404 | n/a | n/a |
| **94** | 79.5 | 11,688 | 84.6 | 12,447 | n/a | n/a | 80.7 | 11,737 | 85.9 | 12,490 | n/a | n/a |
| **95** | 80.6 | 11,734 | 86.1 | 12,531 | n/a | n/a | 81.9 | 11,783 | 87.4 | 12,575 | n/a | n/a |
| **96** | 81.1 | 11,683 | 86.5 | 12,452 | n/a | n/a | 82.4 | 11,732 | 87.8 | 12,495 | n/a | n/a |
| **97** | 81.7 | 11,633 | 86.9 | 12,374 | n/a | n/a | 82.9 | 11,682 | 88.2 | 12,417 | n/a | n/a |
| **98** | 82.2 | 11,584 | 87.2 | 12,297 | n/a | n/a | 83.5 | 11,633 | 88.5 | 12,340 | n/a | n/a |
| **99** | 82.7 | 11,536 | 87.6 | 12,223 | n/a | n/a | 84.0 | 11,585 | 88.9 | 12,265 | n/a | n/a |
| **100** | 83.2 | 11,489 | 88.0 | 12,149 | n/a | n/a | 84.5 | 11,537 | 89.3 | 12,192 | n/a | n/a |
| **101** | 84.1 | 11,500 | 89.0 | 12,168 | n/a | n/a | 85.4 | 11,549 | 90.3 | 12,210 | n/a | n/a |
| **102** | 85.0 | 11,511 | 90.0 | 12,186 | n/a | n/a | 86.4 | 11,560 | 91.4 | 12,229 | n/a | n/a |
| **103** | 85.9 | 11,522 | 91.0 | 12,204 | n/a | n/a | 87.3 | 11,571 | 92.4 | 12,247 | n/a | n/a |
| **104** | 86.9 | 11,533 | 92.0 | 12,222 | n/a | n/a | 88.2 | 11,582 | 93.4 | 12,265 | n/a | n/a |
| **105** | 87.8 | 11,544 | 93.1 | 12,239 | n/a | n/a | 89.2 | 11,593 | 94.5 | 12,282 | n/a | n/a |
| | IHR Units 4, 5[e], 6 - With STS | | | | | | IHR Units 4, 5[e], 6 - No STS | | | | | |
| **85** | 58.9 | 9,369 | 93.1 | 14,810 | 121.8 | 20,745 | 62.0 | 9,745 | 110.7 | 17,413 | 121.8 | 19,401 |
| **86** | 59.7 | 9,380 | 94.4 | 14,824 | 122.7 | 20,569 | 62.8 | 9,756 | 112.3 | 17,430 | 122.7 | 19,283 |
| **87** | 60.6 | 9,390 | 95.7 | 14,838 | 123.4 | 20,392 | 63.7 | 9,767 | 113.8 | 17,447 | 123.4 | 19,162 |
| **88** | 61.4 | 9,400 | 97.0 | 14,851 | 124.2 | 20,212 | 64.5 | 9,777 | 115.3 | 17,462 | 124.2 | 19,039 |
| **89** | 62.2 | 9,410 | 98.2 | 14,864 | 124.9 | 20,034 | 65.4 | 9,787 | 116.8 | 17,477 | 124.9 | 18,905 |
| **90** | 63.0 | 9,419 | 99.5 | 14,876 | 125.6 | 19,747 | 66.3 | 9,797 | 118.3 | 17,492 | 125.6 | 18,752 |
| **91** | 63.7 | 9,416 | 100.7 | 14,885 | 126.2 | 19,569 | 67.0 | 9,794 | 119.8 | 17,503 | 126.2 | 18,599 |
| **92** | 64.5 | 9,414 | 102.0 | 14,895 | 126.9 | 19,389 | 67.8 | 9,792 | 121.3 | 17,515 | 126.9 | 18,445 |
| **93** | 65.2 | 9,411 | 103.2 | 14,904 | 127.2 | 19,159 | 68.6 | 9,789 | 122.7 | 17,525 | 127.2 | 18,242 |
| **94** | 65.9 | 9,409 | 104.5 | 14,912 | 127.2 | 18,893 | 69.3 | 9,787 | 124.2 | 17,535 | 127.2 | 18,004 |
| **95** | 66.6 | 9,406 | 105.7 | 14,921 | 127.2 | 18,633 | 70.1 | 9,784 | 125.7 | 17,545 | 127.2 | 17,771 |
| **96** | 67.5 | 9,416 | 106.7 | 14,892 | 127.2 | 18,396 | 70.9 | 9,794 | 126.8 | 17,512 | 127.2 | 17,560 |
| **97** | 68.3 | 9,425 | 107.7 | 14,864 | 127.2 | 18,165 | 71.8 | 9,804 | 127.2[b] | 17,353 | 127.2 | 17,353 |
| **98** | 69.1 | 9,434 | 108.6 | 14,836 | 127.2 | 17,938 | 72.7 | 9,813 | 127.2[b] | 17,150 | 127.2 | 17,150 |
| **99** | 69.9 | 9,442 | 109.6 | 14,809 | 127.2 | 17,717 | 73.5 | 9,822 | 127.2[b] | 16,952 | 127.2 | 16,952 |
| **100** | 70.7 | 9,451 | 110.6 | 14,782 | 127.2 | 17,499 | 74.4 | 9,831 | 127.2[b] | 16,757 | 127.2 | 16,757 |
| **101** | 71.4 | 9,446 | 112.9 | 14,939 | 127.2 | 17,251 | 75.1 | 9,825 | 127.2[b] | 16,573 | 127.2 | 16,573 |
| **102** | 72.0 | 9,441 | 115.1 | 15,093 | 127.2 | 17,009 | 75.7 | 9,820 | 127.2[b] | 16,393 | 127.2 | 16,393 |
| **103** | 72.7 | 9,436 | 117.4 | 15,244 | 127.2 | 16,771 | 76.4 | 9,815 | 127.2[b] | 16,216 | 127.2 | 16,216 |
| **104** | 73.3 | 9,431 | 119.7 | 15,392 | 127.2 | 16,539 | 77.1 | 9,810 | 127.2[b] | 16,042 | 127.2 | 16,042 |
| **105** | 74.0 | 9,426 | 121.9 | 15,538 | 127.2 | 16,312 | 77.8 | 9,805 | 127.2[b] | 15,872 | 127.2 | 15,872 |

**d.** Unit 3 has fixed blades and restricted operating range of approximately 11.4-12.5 kcfs (HDC report March 2015), but is scheduled to go out of service for turbine replacement starting in spring 2018 after Unit 2 returns to service. Table will be revised after completion of U3 turbine replacement and index testing.

**e.** Unit 5 has fixed blades and restricted operating range of approximately 13-14 kcfs (from 2017 U5 abbreviated index test).

## 4.3. Turbine Unit Maintenance.

### 4.3.1. Maintenance Schedule.

**4.3.1.1.** Turbine unit maintenance schedules will be reviewed annually by Project and Operations Division biologists for fish impacts.

**4.3.1.2.** Each turbine unit requires annual maintenance that may take from several days to two weeks, and is normally scheduled between mid-July and late November. Maintenance of priority units for adult passage is normally conducted in November or December, but can be completed in mid-August.

**4.3.1.3.** Priority unit maintenance will be scheduled for the winter maintenance period, or when there are few fish passing the project, to the extent possible. Impacts to migrating adults should be minimized.

**4.3.1.4.** Turbine units may occasionally require overhauls to repair major problems with the turbine or generator. Overhauls may take more than one year to accomplish.

**4.3.1.5.** Turbine units, governors, exciters, and control systems require periodic maintenance, calibration, and testing which may take them outside of the 1% range. This work will be scheduled in compliance with the *BPA Load Shaping Guidelines* (**Appendix C**) to minimize impacts on juvenile fish.

**4.3.2. Operational Testing.** Operational testing of a unit under maintenance is in addition to a unit in run status required for power plant reliability. Operational testing may deviate from FPP priority order and may require water that would otherwise be used for spill if the unit running for reliability is at its 1% lower limit (i.e., minimum generation). Water for operational testing will be used from the powerhouse allocation if possible, and will only be diverted from spill to the extent necessary to maintain power system reliability.

**4.3.2.1. Pre-Maintenance:** Before going into maintenance status, the unit may be operationally tested for up to 30 minutes (or up to 1 hour for 6-year overhaul) by running at full load, speed-no-load, and various loads within the 1% range for pre-maintenance measurements and testing, and to allow all fish to move through the unit. The unit will be run continuously during testing. Prior to installing stop logs for unwatering, the unit will be operated to flush fish, as described in **section 4.3.3. Unwatering Units**.

**4.3.2.2. Post-Maintenance:** After maintenance or repair while the unit remains in maintenance or forced outage status, the unit may be operationally tested for up to 30 minutes (or up to 2 hours for 6-year overhaul) by running the unit continuously within the 1% range in order to get the unit up to operational temperature.

**4.3.3. Unwatering Units.** Unwatering turbine units (also referred to as “dewatering”) should be accomplished in accordance with project *Dewatering Plans*[3]. If the turbine unit scroll case and/or draft tube is to be dewatered, operate unit with full load for a minimum of 15 minutes prior to

installing tail logs or lowering head gates.[4] If not possible to load, run unit at speed-no-load for minimum of 15 minutes. This is to reduce the number of fish in the scroll case prior to installing stop logs. If a turbine unit is out of service for maintenance for an extended period of time without tailrace stoplogs in place, efforts should be made to not open the wicket gates if the scroll case must be dewatered at a later date without the unit being spun beforehand.

**4.3.4. Doble Testing.** See **Appendix A** for yearly test schedule. Transformer Doble testing is required every three years, so one of the three lines is taken out of service every year to test two transformers. Doble testing is normally scheduled in the July/August timeframe in conjunction with scheduled unit maintenance. At Ice Harbor, the configuration of transmission lines requires two units along with the associated line to be out of service during testing (Line 1=Units 1-2, Line 2=Units 3-4, Line 3=Units 5-6). Since Ice Harbor has multiple transformer banks, transmission lines, and redundant switching capability, the remaining units will be available for operation during testing and will be operated in accordance with FPP priority order within the 1% range.

**4.3.5. Turbine Unit Outages during High Flows.** During high spring flows, turbine unit outages for NERC regulatory requirements, inspecting fish screens, repairing research equipment (e.g., hydroacoustic or radio telemetry equipment), and/or other fish items may cause increased spill in order to maintain reservoir levels within operating ranges. This may result in TDG exceeding standards. It is important that this work be conducted when scheduled to ensure facilities are working correctly and not injuring migrating fish, and that important fish research data are collected. To facilitate this work, reservoir storage may be utilized to minimize impacts from taking units out of service and increasing spill.

**4.3.5.1.** At Ice Harbor, this special operation may take place when flows are above 100 kcfs or when increased spill will result in TDG exceeding standards. The activities covered under these operations will be coordinated with TMT whenever possible.

**4.3.5.2.** For scheduled inspection or repair of research equipment, reservoirs shall be drafted to MOP and allowed to fill 1' above the MOP range as work is accomplished. After the work, reservoirs will slowly be drafted back to MOP. When inspection or repair work can be scheduled ahead of time, the following process will be followed:

**i.** Project personnel shall schedule unit outages through the approved outage scheduling procedure by noon Tuesday of the week prior to the outage.

**ii.** Project personnel shall also contact CENWW-OD-T and RCC by the same time period and inform them of the intended work.

**iii.** RCC will coordinate the work activities through TMT.

**iv.** After coordination with TMT, RCC shall issue a teletype issuing instructions to project and BPA personnel for the scheduled work.

[4] Head gates may also be referred to as “operating” gates at some projects. The terms are interchangeable.

**v.** Spill will be increased by one gate stop setting (about 1.7 kcfs) above passing inflow to slowly lower the level of Ice Harbor pool to MOP prior to the scheduled work taking place.

**vi.** When the work takes place, additional spill will not be provided and the reservoir will be allowed to refill until the reservoir is 1' above MOP (a 2' pondage from where the pool was when the work started). At this point, screen inspections shall stop. (At Snake River projects, this should allow about one normal workday for the scheduled work.)

**vii.** At the conclusion of the work, the reservoir shall be drafted back down to MOP utilizing a one spillbay stop increase in spill above passing inflow.

**viii.** If work, such as screen inspections, is incomplete, project personnel shall schedule another turbine unit outage for a date where it can be implemented.

**4.3.5.3.** If the required work is of an emergency nature that does not normally require the unit to be taken out of service (e.g., failed hydroacoustic transducer versus failed fish screen), and cannot wait for the above process to be implemented, project personnel shall notify CENWW-OD-T and RCC to get approval to do the work. If approved, the unit shall be taken out of service and the reservoir level may be operated up to 1' above MOP. At this point, the unit must be returned to service and the reservoir will be drafted back to MOP using one spillbay stop setting above passing inflows.

## 5. FOREBAY DEBRIS REMOVAL

**5.1.1.** Debris can impact fish passage conditions by plugging or blocking trashracks, VBSs, gatewell orifices, dewatering screens, separators, and/or facility piping, resulting in fish impingement, injuries, and descaling. Removing debris at its source in the forebay is sometimes necessary to maintain safe and efficient fish passage conditions, navigation, and other project activities. Debris can be removed from the forebay by: physically encircling the debris with log booms and pulling it to shore with boats where it can be removed with a crane; removing the debris from the top of the dam using a crane and scoop; or passing the debris through the spillway with special powerhouse operations and spill. The preferred option is to remove debris at each project when possible to avoid passing debris on to the next project downstream. However, some projects do not have forebay debris removal capability and the only viable alternative is to spill the debris.

**5.1.2.** Normally, the project shall contact CENWW-OD-T at least two workdays prior to the day the special operation is required. Using information provided by the project, CENWW-OD-T will notify FPOM and RCC will issue a teletype detailing the special operations.

**5.1.3.** All special spills (other than normal spill patterns for ongoing spill operations) and project operations for passing debris will be coordinated prior to the operations taking place. Each project shall contact CENWW-OD-T at least two workdays prior to the day they want the special project operations for spilling to pass debris. Project personnel shall provide CENWW-OD-T the reason for the debris spill request including an explanation of project facilities impacted by

debris, the date and time of the requested spill, and any special powerhouse or other operations required to move the debris to the spillway. Using information provided by the project, CENWW-OD-T shall coordinate the special operations with RCC, NOAA Fisheries and FPOM. When a debris spill is coordinated and approved, RCC shall issue a teletype detailing the specifics of the special operations.

**5.1.4. Emergency Spill**. Emergency spills may be implemented if necessary to pass woody debris that are accumulating in front of the spillbay weir(s), compromising the safe, unobstructed passage of fish. The operating project will immediately spill the woody debris to remove the obstructions to fish passage. The operating project will notify CENWW-OD-T of the emergency spill as soon as possible to provide notification to RCC, NOAA Fisheries, and other FPOM participants.

## Table IHR-6. Ice Harbor Dam Spill Patterns with No RSW (Bay 2 Closed). [a, b]

| IHR Spill Patterns with No RSW - # Gate Stops per Spillbay | | | | | | | | | | Total Stops | Spill [a] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Bay 1 | Bay 2 | Bay 3 | Bay 4 | Bay 5 | Bay 6 | Bay 7 | Bay 8 | Bay 9 | Bay 10 | (#) | (kcfs) |
| | CLOSE | | | | | | | | 1 | **1** | **1.7** |
| | CLOSE | 1 | | | | | | | 1 | **2** | **3.5** |
| | CLOSE | 1 | | | | | | 1 | 1 | **3** | **5.2** |
| | CLOSE | 1 | 1 | | | | | 1 | 1 | **4** | **6.9** |
| | CLOSE | 1 | 1 | | 1 | | | 1 | 1 | **5** | **8.7** |
| | CLOSE | 1 | 1 | | 1 | 1 | | 1 | 1 | **6** | **10.4** |
| | CLOSE | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | **7** | **12.1** |
| | CLOSE | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | **8** | **13.8** |
| | CLOSE | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | **9** | **15.6** |
| | CLOSE | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | **10** | **17.3** |
| | CLOSE | 2 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | **11** | **19** |
| | CLOSE | 2 | 2 | 1 | 1 | 1 | 1 | 2 | 2 | **12** | **20.7** |
| | CLOSE | 2 | 2 | 1 | 2 | 1 | 1 | 2 | 2 | **13** | **22.4** |
| | CLOSE | 5.5 | | 5.5 | | | | 1.5 | 1.5 | **14** | **23.8** |
| | CLOSE | 5 | | 5 | | 5 | | | | **15** | **25.5** |
| | CLOSE | 5 | | 5 | | 5 | | | 1 | **16** | **27.2** |
| | CLOSE | 5.5 | | 5.5 | | 5 | | | 1 | **17** | **28.9** |
| | CLOSE | 5.5 | | 5.5 | | 5.5 | | | 1.5 | **18** | **30.5** |
| | CLOSE | 6 | | 6 | | 6 | | | 1 | **19** | **32.0** |
| | CLOSE | 5 | | 5 | | 5 | | 5 | | **20** | **34.0** |
| | CLOSE | 5 | | 5 | | 5 | | 5 | 1 | **21** | **35.7** |
| | CLOSE | 5.5 | | 5 | | 5 | | 5.5 | 1 | **22** | **37.3** |
| | CLOSE | 5.5 | | 5.5 | | 5.5 | | 5.5 | 1 | **23** | **39.0** |
| | CLOSE | 6 | | 5.5 | | 5.5 | | 6 | 1 | **24** | **40.6** |
| | CLOSE | 6 | | 6 | | 6 | | 6 | 1 | **25** | **42.1** |
| | CLOSE | 5 | 5 | 5 | | 5 | | 5 | 1 | **26** | **44.2** |
| | CLOSE | 5.5 | 5 | 5 | | 5 | | 5.5 | 1 | **27** | **45.8** |
| | CLOSE | 5.5 | 5 | 5.5 | | 5.5 | | 5.5 | 1 | **28** | **47.5** |
| | CLOSE | 5.5 | 5.5 | 5.5 | | 5.5 | | 6 | 1 | **29** | **49.1** |
| | CLOSE | 5.5 | 5.5 | 6 | | 6 | | 6 | 1 | **30** | **50.7** |
| | CLOSE | 6 | 6 | 6 | | 6 | | 6 | 1 | **31** | **52.2** |
| | CLOSE | 6 | 6 | 6.5 | | 6.5 | | 6 | 1 | **32** | **54.0** |
| | CLOSE | 6.5 | 6.5 | 6.5 | | 6.5 | | 6 | 1 | **33** | **55.8** |
| | CLOSE | 6 | 6 | 5 | 5 | 5 | | 6 | 1 | **34** | **57.5** |
| | CLOSE | 6 | 6 | 5 | 5 | 6 | | 6 | 1 | **35** | **59.1** |
| | CLOSE | 6 | 6 | 6 | 5 | 6 | | 6 | 1 | **36** | **60.7** |
| | CLOSE | 6 | 6 | 6 | 6 | 6 | | 6 | 1 | **37** | **62.3** |
| | CLOSE | 6 | 6 | 6 | 6 | 7 | | 6 | 1 | **38** | **64.1** |
| | CLOSE | 6 | 6 | 6 | 6 | 7 | | 7 | 1 | **39** | **65.7** |
| | CLOSE | 6 | 6 | 6 | 7 | 7 | | 7 | 1 | **40** | **67.4** |
| | CLOSE | 6 | 6 | 7 | 7 | 7 | | 7 | 1 | **41** | **69.1** |
| | CLOSE | 6 | 7 | 7 | 7 | 7 | | 7 | 1 | **42** | **70.8** |
| | CLOSE | 7 | 7 | 7 | 7 | 7 | | 7 | 1 | **43** | **72.5** |
| 6 | CLOSE | 6 | 6 | 6 | 6 | 7 | | 6 | 1 | **44** | **74.1** |

| IHR Spill Patterns with No RSW - # Gate Stops per Spillbay | | | | | | | | | | Total Stops | Spill [a] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Bay 1 | Bay 2 | Bay 3 | Bay 4 | Bay 5 | Bay 6 | Bay 7 | Bay 8 | Bay 9 | Bay 10 | (#) | (kcfs) |
| 6 | CLOSE | 6 | 6 | 6 | 7 | 7 | | 6 | 1 | **45** | **75.8** |
| 6 | CLOSE | 6 | 6 | 7 | 7 | 7 | | 6 | 1 | **46** | **77.5** |
| 6 | CLOSE | 6 | 7 | 7 | 7 | 7 | | 6 | 1 | **47** | **79.2** |
| 6 | CLOSE | 7 | 7 | 7 | 7 | 7 | | 6 | 1 | **48** | **80.9** |
| 6 | CLOSE | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 1 | **49** | **82.5** |
| 6 | CLOSE | 6 | 6 | 6 | 6 | 7 | 6 | 6 | 1 | **50** | **84.2** |
| 6 | CLOSE | 6 | 6 | 6 | 7 | 7 | 6 | 6 | 1 | **51** | **85.9** |
| 6 | CLOSE | 6 | 6 | 6 | 7 | 7 | 6 | 7 | 1 | **52** | **87.6** |
| 6 | CLOSE | 6 | 6 | 7 | 7 | 7 | 6 | 7 | 1 | **53** | **89.3** |
| 6 | CLOSE | 6 | 7 | 7 | 7 | 7 | 6 | 7 | 1 | **54** | **91.0** |
| 6 | CLOSE | 7 | 7 | 7 | 7 | 7 | 6 | 7 | 1 | **55** | **92.7** |

**a.** Spill (kcfs) is calculated as a function of the total number of gate stops at forebay elevation 438.0 ft.

**b.** When total project outflow is < 30 kcfs, the RSW will be closed and spill distributed in patterns defined in this table (see **section 2.3.2.7**).

**Table IHR-7. [*pg 1 of 2*] Ice Harbor Dam Spill Patterns with RSW for 30% Spill.** [a, b, c]

| Total Outflow | Spill [a] | | IHR Spill Patterns for 30% Spill - # Gate Stops per Spillbay | | | | | | | | | | Total Stops |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (kcfs) | (kcfs) | (%) [b] | 1 | 2 [c] | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | (#) |
| **28.0** | **8.4** | **30.0%** | | RSW | | | | | | | | | **0** |
| **33.7** | **10.1** | **30.0%** | | RSW | | | | | | | | 1 | **1** |
| **39.3** | **11.8** | **30.0%** | | RSW | | | | | | | 1 | 1 | **2** |
| **45.0** | **13.5** | **30.0%** | | RSW | | | | | | 1 | 1 | 1 | **3** |
| **50.7** | **15.2** | **30.0%** | | RSW | | | | | 1 | 1 | 1 | 1 | **4** |
| **56.3** | **16.9** | **30.0%** | | RSW | | | | 1 | 1 | 1 | 1 | 1 | **5** |
| **62.0** | **18.6** | **30.0%** | | RSW | 5 | | | | | | | 1 | **6** |
| **67.7** | **20.3** | **30.0%** | | RSW | 5 | | | | | | 1 | 1 | **7** |
| **73.3** | **22.0** | **30.0%** | | RSW | 5 | | | | | 1 | 1 | 1 | **8** |
| **79.0** | **23.7** | **30.0%** | | RSW | 5 | | | | 1 | 1 | 1 | 1 | **9** |
| **84.7** | **25.4** | **30.0%** | | RSW | 5 | | | 1 | 1 | 1 | 1 | 1 | **10** |
| **90.3** | **27.1** | **30.0%** | | RSW | 5 | | 5 | | | | | 1 | **11** |
| **96.0** | **28.8** | **30.0%** | | RSW | 5 | | 5 | | | | 1 | 1 | **12** |
| **101.7** | **30.5** | **30.0%** | | RSW | 5 | | 5 | | | 1 | 1 | 1 | **13** |
| **107.3** | **32.2** | **30.0%** | | RSW | 5 | | 5 | | | 1 | 1 | 2 | **14** |
| **113.0** | **33.9** | **30.0%** | | RSW | 5 | | 5 | | | 1 | 2 | 2 | **15** |
| **118.7** | **35.6** | **30.0%** | | RSW | 5 | | 5 | | | 2 | 2 | 2 | **16** |
| **120.4** [b] | **37.3** | **31.0%** | | RSW | 6 | | 5 | | | 2 | 2 | 2 | **17** |
| **122.1** | **39.0** | **31.9%** | | RSW | 6 | | 6 | | | 2 | 2 | 2 | **18** |
| **123.8** | **40.7** | **32.9%** | | RSW | 6 | | 6 | | 1 | 2 | 2 | 2 | **19** |
| **125.5** | **42.4** | **33.8%** | | RSW | 6 | | 6 | | 2 | 2 | 2 | 2 | **20** |
| **127.2** | **44.1** | **34.7%** | | RSW | 5 | | 5 | | 5 | 2 | 2 | 2 | **21** |
| **128.9** | **45.8** | **35.5%** | | RSW | 5 | | 5 | | 6 | 2 | 2 | 2 | **22** |
| **130.6** | **47.5** | **36.4%** | | RSW | 5 | | 6 | | 6 | 2 | 2 | 2 | **23** |
| **132.3** | **49.2** | **37.2%** | | RSW | 6 | | 6 | | 6 | 2 | 2 | 2 | **24** |
| **134.0** | **50.9** | **38.0%** | | RSW | 6 | | 6 | | 6 | 2 | 3 | 2 | **25** |
| **135.7** | **52.6** | **38.8%** | | RSW | 6 | | 6 | | 6 | 2 | 4 | 2 | **26** |
| **137.4** | **54.3** | **39.5%** | | RSW | 6 | | 6 | | 6 | 2 | 5 | 2 | **27** |
| **139.1** | **56.0** | **40.3%** | | RSW | 6 | | 6 | | 6 | 2 | 6 | 2 | **28** |
| **140.8** | **57.7** | **41.0%** | | RSW | 6 | | 6 | 1 | 6 | 2 | 6 | 2 | **29** |
| **142.5** | **59.4** | **41.7%** | | RSW | 6 | | 6 | 2 | 6 | 2 | 6 | 2 | **30** |
| **144.2** | **61.1** | **42.4%** | | RSW | 6 | | 6 | 3 | 6 | 2 | 6 | 2 | **31** |
| **145.9** | **62.8** | **43.0%** | | RSW | 6 | | 6 | 4 | 6 | 2 | 6 | 2 | **32** |
| **147.6** | **64.5** | **43.7%** | | RSW | 6 | | 6 | 5 | 6 | 2 | 6 | 2 | **33** |
| **149.3** | **66.2** | **44.3%** | | RSW | 6 | | 6 | 6 | 6 | 2 | 6 | 2 | **34** |
| **151.0** | **67.9** | **45.0%** | | RSW | 6 | | 6 | 6 | 6 | 3 | 6 | 2 | **35** |
| **152.7** | **69.6** | **45.6%** | | RSW | 6 | | 6 | 6 | 6 | 4 | 6 | 2 | **36** |
| **154.4** | **71.3** | **46.2%** | | RSW | 6 | | 6 | 6 | 6 | 5 | 6 | 2 | **37** |
| **156.1** | **73.0** | **46.8%** | | RSW | 6 | | 6 | 6 | 6 | 6 | 6 | 2 | **38** |
| **157.8** | **74.7** | **47.3%** | | RSW | 6 | 1 | 6 | 6 | 6 | 6 | 6 | 2 | **39** |
| **159.5** | **76.4** | **47.9%** | | RSW | 6 | 2 | 6 | 6 | 6 | 6 | 6 | 2 | **40** |
| **161.2** | **78.1** | **48.4%** | | RSW | 6 | 3 | 6 | 6 | 6 | 6 | 6 | 2 | **41** |
| **162.9** | **79.8** | **49.0%** | | RSW | 6 | 4 | 6 | 6 | 6 | 6 | 6 | 2 | **42** |
| **164.6** | **81.5** | **49.5%** | | RSW | 6 | 5 | 6 | 6 | 6 | 6 | 6 | 2 | **43** |

| Total Outflow | Spill [a] | | IHR Spill Patterns for 30% Spill - # Gate Stops per Spillbay | | | | | | | | | | Total Stops |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (kcfs) | (kcfs) | (%) [b] | 1 | 2 [c] | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | (#) |
| **166.3** | **83.2** | **50.0%** | | RSW | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 2 | **44** |
| **168.0** | **84.9** | **50.5%** | | RSW | 7 | 6 | 6 | 6 | 6 | 6 | 6 | 2 | **45** |
| **169.7** | **86.6** | **51.0%** | | RSW | 7 | 7 | 6 | 6 | 6 | 6 | 6 | 2 | **46** |
| **171.4** | **88.3** | **51.5%** | | RSW | 7 | 7 | 7 | 6 | 6 | 6 | 6 | 2 | **47** |
| **173.1** | **90.0** | **52.0%** | | RSW | 7 | 7 | 7 | 7 | 6 | 6 | 6 | 2 | **48** |
| **174.8** | **91.7** | **52.5%** | | RSW | 7 | 7 | 7 | 7 | 7 | 6 | 6 | 2 | **49** |
| **176.5** | **93.4** | **52.9%** | | RSW | 7 | 7 | 7 | 7 | 7 | 7 | 6 | 2 | **50** |
| **178.2** | **95.1** | **53.4%** | | RSW | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 2 | **51** |
| **179.9** | **96.8** | **53.8%** | | RSW | 8 | 7 | 7 | 7 | 7 | 7 | 7 | 2 | **52** |
| **181.6** | **98.5** | **54.2%** | | RSW | 8 | 8 | 7 | 7 | 7 | 7 | 7 | 2 | **53** |
| **183.3** | **100.2** | **54.7%** | | RSW | 8 | 8 | 8 | 7 | 7 | 7 | 7 | 2 | **54** |
| **185.0** | **101.9** | **55.1%** | | RSW | 8 | 8 | 8 | 8 | 7 | 7 | 7 | 2 | **55** |
| **186.7** | **103.6** | **55.5%** | | RSW | 8 | 8 | 8 | 8 | 8 | 7 | 7 | 2 | **56** |
| **188.4** | **105.3** | **55.9%** | | RSW | 8 | 8 | 8 | 8 | 8 | 8 | 7 | 2 | **57** |
| **190.1** | **107.0** | **56.3%** | | RSW | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 2 | **58** |
| **191.8** | **108.7** | **56.7%** | | RSW | 9 | 8 | 8 | 8 | 8 | 8 | 8 | 2 | **59** |
| **193.5** | **110.4** | **57.1%** | | RSW | 9 | 9 | 8 | 8 | 8 | 8 | 8 | 2 | **60** |
| **195.2** | **112.1** | **57.4%** | | RSW | 9 | 9 | 9 | 8 | 8 | 8 | 8 | 2 | **61** |
| **196.9** | **113.8** | **57.8%** | | RSW | 9 | 9 | 9 | 9 | 8 | 8 | 8 | 2 | **62** |
| **198.6** | **115.5** | **58.2%** | | RSW | 9 | 9 | 9 | 9 | 9 | 8 | 8 | 2 | **63** |
| **200.3** | **117.2** | **58.5%** | | RSW | 9 | 9 | 9 | 9 | 9 | 9 | 8 | 2 | **64** |
| **202.0** | **118.9** | **58.9%** | | RSW | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 2 | **65** |
| **203.7** | **120.6** | **59.2%** | | RSW | 10 | 9 | 9 | 9 | 9 | 9 | 9 | 2 | **66** |
| **205.4** | **122.3** | **59.5%** | | RSW | 10 | 10 | 9 | 9 | 9 | 9 | 9 | 2 | **67** |
| **207.1** | **124.0** | **59.9%** | | RSW | 10 | 10 | 10 | 9 | 9 | 9 | 9 | 2 | **68** |
| **208.8** | **125.7** | **60.2%** | | RSW | 10 | 10 | 10 | 10 | 9 | 9 | 9 | 2 | **69** |
| **210.5** | **127.4** | **60.5%** | | RSW | 10 | 10 | 10 | 10 | 10 | 9 | 9 | 2 | **70** |
| **212.2** | **129.1** | **60.8%** | | RSW | 10 | 10 | 10 | 10 | 10 | 10 | 9 | 2 | **71** |
| **213.9** | **130.8** | **61.2%** | | RSW | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 2 | **72** |
| **215.6** | **132.5** | **61.5%** | | RSW | 11 | 10 | 10 | 10 | 10 | 10 | 10 | 2 | **73** |
| **217.3** | **134.2** | **61.8%** | | RSW | 11 | 11 | 10 | 10 | 10 | 10 | 10 | 2 | **74** |
| **219.0** | **135.9** | **62.1%** | | RSW | 11 | 11 | 11 | 10 | 10 | 10 | 10 | 2 | **75** |
| **220.7** | **137.6** | **62.3%** | | RSW | 11 | 11 | 11 | 11 | 10 | 10 | 10 | 2 | **76** |
| **222.4** | **139.3** | **62.6%** | | RSW | 11 | 11 | 11 | 11 | 11 | 10 | 10 | 2 | **77** |
| **224.1** | **141.0** | **62.9%** | | RSW | 11 | 11 | 11 | 11 | 11 | 11 | 10 | 2 | **78** |
| **225.8** | **142.7** | **63.2%** | | RSW | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 2 | **79** |
| **227.5** | **144.4** | **63.5%** | | RSW | 12 | 11 | 11 | 11 | 11 | 11 | 11 | 2 | **80** |
| **229.2** | **146.1** | **63.7%** | | RSW | 12 | 12 | 11 | 11 | 11 | 11 | 11 | 2 | **81** |
| **230.9** | **147.8** | **64.0%** | | RSW | 12 | 12 | 12 | 11 | 11 | 11 | 11 | 2 | **82** |
| **232.6** | **149.5** | **64.3%** | | RSW | 12 | 12 | 12 | 12 | 11 | 11 | 11 | 2 | **83** |

**a.** Spill (kcfs) is calculated as a function of the total number of gate stops plus RSW spill at forebay elevation 438.0 ft.

**b.** Spill will be > 30% when total outflow is > ~118.7 kcfs (project at max turbine capacity).

**c.** RSW in Bay 2 = fixed spill of ~8.4 kcfs at forebay 438.0 ft. When total project outflow is < 30 kcfs, the RSW will be closed and spill distributed in patterns defined in **Table IHR-6** (see **section 2.3.2.7**).

## Table IHR-8. [*pg 1 of 2*] Ice Harbor Dam Spill Patterns with RSW.[a, b]

| IHR Spill Patterns w/ RSW - # Gate Stops per Spillbay | | | | | | | | | | Total Stops | Spill [a] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Bay 1 | Bay 2 [b] | Bay 3 | Bay 4 | Bay 5 | Bay 6 | Bay 7 | Bay | Bay 9 | Bay 10 | (#) | (kcfs) |
| | RSW | | | | | | | | | **0** | **8.4** |
| | RSW | | | | | | | | 1 | **1** | **10.1** |
| | RSW | | | | | | | 1 | 1 | **2** | **11.8** |
| | RSW | | | | | | 1 | 1 | 1 | **3** | **13.5** |
| | RSW | | | | | 1 | 1 | 1 | 1 | **4** | **15.2** |
| | RSW | | | | 1 | 1 | 1 | 1 | 1 | **5** | **17.0** |
| | RSW | | 5 | | | | | | 1 | **6** | **18.6** |
| | RSW | | 5 | | | | | 1 | 1 | **7** | **20.3** |
| | RSW | | 5 | | | | 1 | 1 | 1 | **8** | **22.0** |
| | RSW | | 5 | | | 1 | 1 | 1 | 1 | **9** | **23.7** |
| | RSW | | 5 | | 5 | | | | | **10** | **25.3** |
| | RSW | | 5 | | 5 | | | | 1 | **11** | **27.0** |
| | RSW | | 5 | | 5 | | | 1 | 1 | **12** | **28.7** |
| | RSW | | 5 | | 5 | | 1 | 1 | 1 | **13** | **30.4** |
| | RSW | | 5 | | 5 | 1 | 1 | 1 | 1 | **14** | **32.1** |
| | RSW | | 5 | | 5 | 1 | 1 | 1 | 2 | **15** | **33.8** |
| | RSW | | 5 | | 5 | 1 | 1 | 2 | 2 | **16** | **35.5** |
| | RSW | | 5 | | 5 | 1 | 2 | 2 | 2 | **17** | **37.2** |
| | RSW | | 5 | | 5 | 2 | 2 | 2 | 2 | **18** | **38.9** |
| | RSW | | 5 | | 5 | 2 | 2 | 2 | 3 | **19** | **40.6** |
| | RSW | | 5 | | 5 | 2 | 2 | 3 | 3 | **20** | **42.3** |
| | RSW | | 5 | | 5 | 5 | 2 | 2 | 2 | **21** | **44.0** |
| | RSW | | 6 | | 5 | 5 | 2 | 2 | 2 | **22** | **45.6** |
| | RSW | | 6 | | 6 | 5 | 2 | 2 | 2 | **23** | **47.3** |
| | RSW | | 6 | | 6 | 6 | 2 | 2 | 2 | **24** | **48.9** |
| | RSW | | 6 | 5 | 5 | 5 | 1 | 1 | 2 | **25** | **50.7** |
| | RSW | | 6 | 5 | 5 | 5 | 1 | 2 | 2 | **26** | **52.4** |
| | RSW | | 6 | 5 | 5 | 5 | 2 | 2 | 2 | **27** | **54.1** |
| | RSW | | 6 | 6 | 5 | 5 | 2 | 2 | 2 | **28** | **55.7** |
| | RSW | | 6 | 6 | 5 | 5 | 2 | 3 | 2 | **29** | **57.4** |
| | RSW | | 6 | 6 | 5 | 5 | 2 | 4 | 2 | **30** | **59.1** |
| | RSW | | 6 | 6 | 5 | 5 | 2 | 5 | 2 | **31** | **60.7** |
| | RSW | | 6 | 6 | 5 | 5 | 3 | 5 | 2 | **32** | **62.4** |
| | RSW | | 6 | 6 | 5 | 5 | 4 | 5 | 2 | **33** | **64.1** |
| | RSW | | 6 | 6 | 5 | 5 | 5 | 5 | 2 | **34** | **65.8** |
| | RSW | 1 | 6 | 6 | 5 | 5 | 5 | 5 | 2 | **35** | **67.5** |
| | RSW | 2 | 6 | 6 | 5 | 5 | 5 | 5 | 2 | **36** | **69.2** |
| | RSW | 3 | 6 | 6 | 5 | 5 | 5 | 5 | 2 | **37** | **70.9** |
| | RSW | 4 | 6 | 6 | 5 | 5 | 5 | 5 | 2 | **38** | **72.6** |
| | RSW | 5 | 6 | 6 | 5 | 5 | 5 | 5 | 2 | **39** | **74.2** |
| | RSW | 6 | 6 | 6 | 5 | 5 | 5 | 5 | 2 | **40** | **75.9** |
| | RSW | 6 | 6 | 6 | 6 | 5 | 5 | 5 | 2 | **41** | **77.5** |
| | RSW | 6 | 6 | 6 | 6 | 6 | 5 | 5 | 2 | **42** | **79.2** |
| | RSW | 6 | 6 | 6 | 6 | 6 | 6 | 5 | 2 | **43** | **80.9** |
| | RSW | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 2 | **44** | **82.5** |
| | RSW | 7 | 6 | 6 | 6 | 6 | 6 | 6 | 2 | **45** | **84.1** |
| | RSW | 7 | 7 | 6 | 6 | 6 | 6 | 6 | 2 | **46** | **85.7** |
| | RSW | 7 | 7 | 7 | 6 | 6 | 6 | 6 | 2 | **47** | **87.3** |
| | RSW | 7 | 7 | 7 | 7 | 6 | 6 | 6 | 2 | **48** | **88.9** |
| | RSW | 7 | 7 | 7 | 7 | 7 | 6 | 6 | 2 | **49** | **90.5** |
| | RSW | 7 | 7 | 7 | 7 | 7 | 7 | 6 | 2 | **50** | **92.1** |
| | RSW | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 2 | **51** | **93.7** |
| | RSW | 8 | 7 | 7 | 7 | 7 | 7 | 7 | 2 | **52** | **95.3** |
| | RSW | 8 | 8 | 7 | 7 | 7 | 7 | 7 | 2 | **53** | **96.9** |
| | RSW | 8 | 8 | 8 | 7 | 7 | 7 | 7 | 2 | **54** | **98.5** |

| IHR Spill Patterns w/ RSW - # Gate Stops per Spillbay | | | | | | | | | | Total Stops | Spill [a] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Bay 1 | Bay 2 [b] | Bay 3 | Bay 4 | Bay 5 | Bay 6 | Bay 7 | Bay | Bay 9 | Bay 10 | (#) | (kcfs) |
| | RSW | 8 | 8 | 8 | 8 | 7 | 7 | 7 | 2 | **55** | **100.1** |
| | RSW | 8 | 8 | 8 | 8 | 8 | 7 | 7 | 2 | **56** | **101.7** |
| | RSW | 8 | 8 | 8 | 8 | 8 | 8 | 7 | 2 | **57** | **103.3** |
| | RSW | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 2 | **58** | **104.9** |
| | RSW | 9 | 8 | 8 | 8 | 8 | 8 | 8 | 2 | **59** | **106.6** |
| | RSW | 9 | 9 | 8 | 8 | 8 | 8 | 8 | 2 | **60** | **108.3** |
| | RSW | 9 | 9 | 9 | 8 | 8 | 8 | 8 | 2 | **61** | **110.0** |
| | RSW | 9 | 9 | 9 | 9 | 8 | 8 | 8 | 2 | **62** | **111.7** |
| | RSW | 9 | 9 | 9 | 9 | 9 | 8 | 8 | 2 | **63** | **113.4** |
| | RSW | 9 | 9 | 9 | 9 | 9 | 9 | 8 | 2 | **64** | **115.2** |
| | RSW | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 2 | **65** | **116.9** |
| | RSW | 10 | 9 | 9 | 9 | 9 | 9 | 9 | 2 | **66** | **118.4** |
| | RSW | 10 | 10 | 9 | 9 | 9 | 9 | 9 | 2 | **67** | **119.9** |
| | RSW | 10 | 10 | 10 | 9 | 9 | 9 | 9 | 2 | **68** | **121.4** |
| | RSW | 10 | 10 | 10 | 10 | 9 | 9 | 9 | 2 | **69** | **122.9** |
| | RSW | 10 | 10 | 10 | 10 | 10 | 9 | 9 | 2 | **70** | **124.4** |
| | RSW | 10 | 10 | 10 | 10 | 10 | 10 | 9 | 2 | **71** | **125.9** |
| | RSW | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 2 | **72** | **127.4** |
| | RSW | 11 | 10 | 10 | 10 | 10 | 10 | 10 | 2 | **73** | **129.1** |
| | RSW | 11 | 11 | 10 | 10 | 10 | 10 | 10 | 2 | **74** | **130.8** |
| | RSW | 11 | 11 | 11 | 10 | 10 | 10 | 10 | 2 | **75** | **132.5** |
| | RSW | 11 | 11 | 11 | 11 | 10 | 10 | 10 | 2 | **76** | **134.2** |
| | RSW | 11 | 11 | 11 | 11 | 11 | 10 | 10 | 2 | **77** | **135.9** |
| | RSW | 11 | 11 | 11 | 11 | 11 | 11 | 10 | 2 | **78** | **137.6** |
| | RSW | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 2 | **79** | **139.3** |
| | RSW | 12 | 11 | 11 | 11 | 11 | 11 | 11 | 2 | **80** | **140.8** |
| | RSW | 12 | 12 | 11 | 11 | 11 | 11 | 11 | 2 | **81** | **142.3** |
| | RSW | 12 | 12 | 12 | 11 | 11 | 11 | 11 | 2 | **82** | **143.8** |
| | RSW | 12 | 12 | 12 | 12 | 11 | 11 | 11 | 2 | **83** | **145.3** |
| | RSW | 12 | 12 | 12 | 12 | 12 | 11 | 11 | 2 | **84** | **146.8** |
| | RSW | 12 | 12 | 12 | 12 | 12 | 12 | 11 | 2 | **85** | **148.3** |
| | RSW | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 2 | **86** | **149.8** |
| | RSW | 13 | 12 | 12 | 12 | 12 | 12 | 12 | 2 | **87** | **151.4** |
| | RSW | 13 | 13 | 12 | 12 | 12 | 12 | 12 | 2 | **88** | **153.0** |
| | RSW | 13 | 13 | 13 | 12 | 12 | 12 | 12 | 2 | **89** | **154.6** |
| | RSW | 13 | 13 | 13 | 13 | 12 | 12 | 12 | 2 | **90** | **156.2** |
| | RSW | 13 | 13 | 13 | 13 | 13 | 12 | 12 | 2 | **91** | **157.8** |
| | RSW | 13 | 13 | 13 | 13 | 13 | 13 | 12 | 2 | **92** | **159.4** |
| | RSW | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 2 | **93** | **161.0** |
| | RSW | 14 | 13 | 13 | 13 | 13 | 13 | 13 | 2 | **94** | **162.6** |
| | RSW | 14 | 14 | 13 | 13 | 13 | 13 | 13 | 2 | **95** | **164.2** |
| | RSW | 14 | 14 | 14 | 13 | 13 | 13 | 13 | 2 | **96** | **165.8** |
| | RSW | 14 | 14 | 14 | 14 | 13 | 13 | 13 | 2 | **97** | **167.4** |
| | RSW | 14 | 14 | 14 | 14 | 14 | 13 | 13 | 2 | **98** | **169.0** |
| | RSW | 14 | 14 | 14 | 14 | 14 | 14 | 13 | 2 | **99** | **170.6** |
| | RSW | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 2 | **100** | **172.2** |

**a.** Spill (kcfs) is calculated as a function of the total number of gate stops plus RSW spill at forebay elevation 438.0 ft.

**b.** RSW in Bay 2 = fixed spill of ~8.4 kcfs at forebay 438.0 ft. When total project outflow is < 30 kcfs, the RSW will be closed and spill distributed in patterns defined in **Table IHR-6** (see **section 2.3.2.7**).