Section 6 - Ice Harbor Dam

1. Fish Passage Information. . . . . IHR– 1
1.1. Juvenile Fish Passage. . . . . IHR- 1
1.2. Adult Fish Passage. . . . . IHR- 1
2. Project Operation. . . . . IHR- 5
2.1 Spill Management. . . . . IHR- 5
2.2 Dissolved Gas Management and Control. . . . . IHR- 6
2.3. Operating Criteria. . . . . IHR- 6
3. Project Maintenance. IHR-17
3.1. Juvenile Fish Passage Facilities. IHR-18
3.2. Adult Fish Passage Facilities. IHR-21
4. Turbine Unit Operation and Maintenance. IHR-23
4.1. Turbine Unit Operation. IHR-23
4.2. Turbine Unit Outages During High River Flow Periods. IHR-29
4.3. Turbine Unit Maintenance. IHR-30
5. Forebay Debris Removal. IHR-31

Ice Harbor Dam

1. Fish Passage Information.

The locations of fish passage facilities at Ice Harbor Lock and Dam are shown in Figure IHR-1. Dates of project operations for fish purposes and special operations are listed in Table IHR-1.

1.1. Juvenile Fish Passage.

1.1.1. Facilities Description.

The juvenile fish passage facilities at Ice Harbor consist of standard length submersible traveling screens, vertical barrier screens, 12" orifices, collection channel and dewatering structure, sampling facilities, transportation flume/pipe to the tailrace below the project, and a full-flow PIT tag detection system.

1.1.2. Juvenile Migration Timing.

Juvenile passage timing at Ice Harbor Dam corresponds closely with juvenile passage at Lower Monumental Dam (Table LMN-2). Salmon, steelhead, bull trout, lamprey, and other species are routinely counted when sampling occurs at Ice Harbor. Maintenance of juvenile fish passage facilities that may impact juvenile fish passage or facility operations should be conducted during the winter maintenance season.

1.2. Adult Fish Passage.

1.2.1. Facilities Description.

The adult fish passage facilities at Ice Harbor are made up of separate north and south shore facilities. The 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 three electric pumps with two pumps normally operated. The 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, seven operating floating orifices, and a common transportation channel. One of the downstream north powerhouse entrances and seven 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 from six to eight are normally used to provide the required flows. The 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.

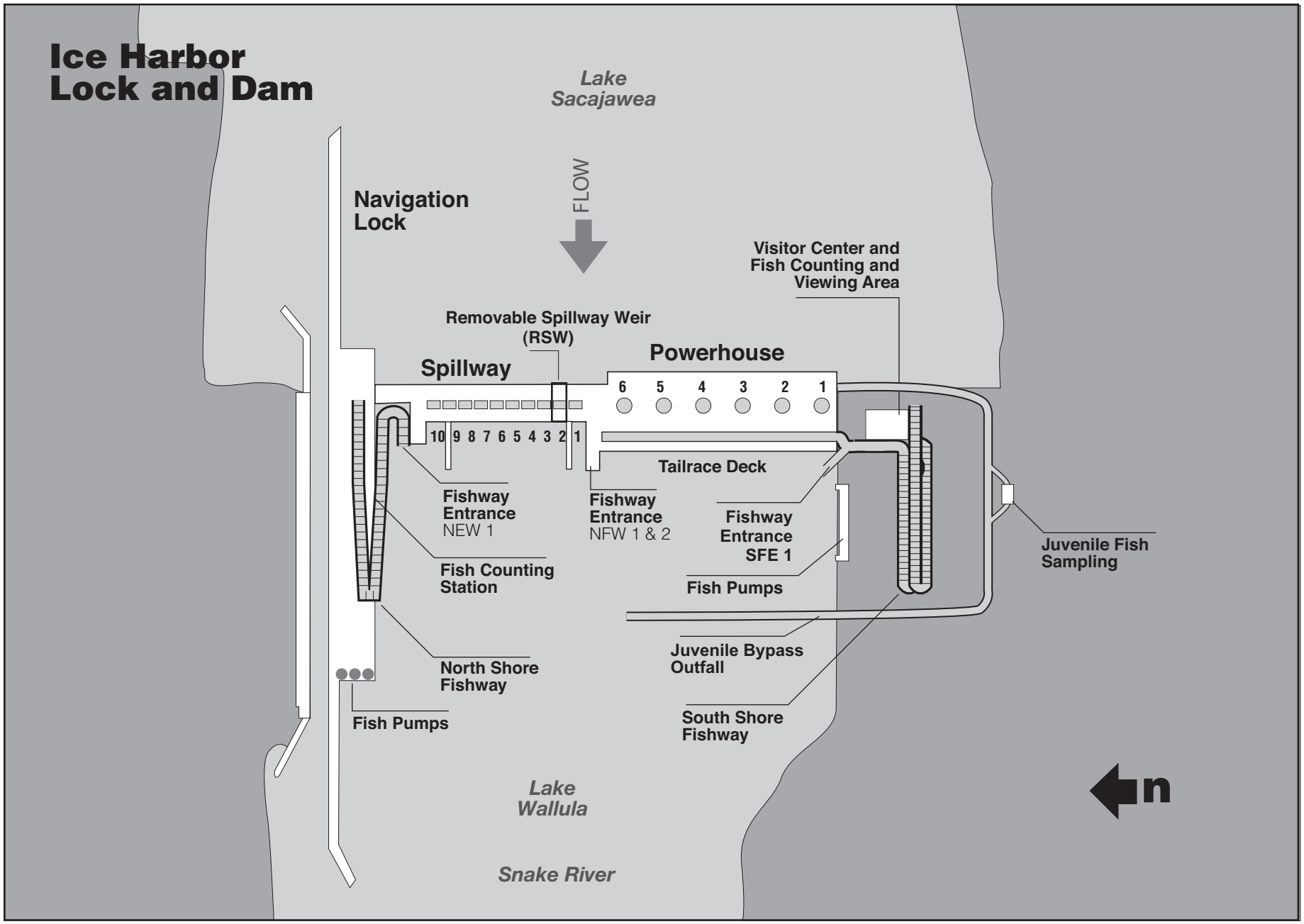
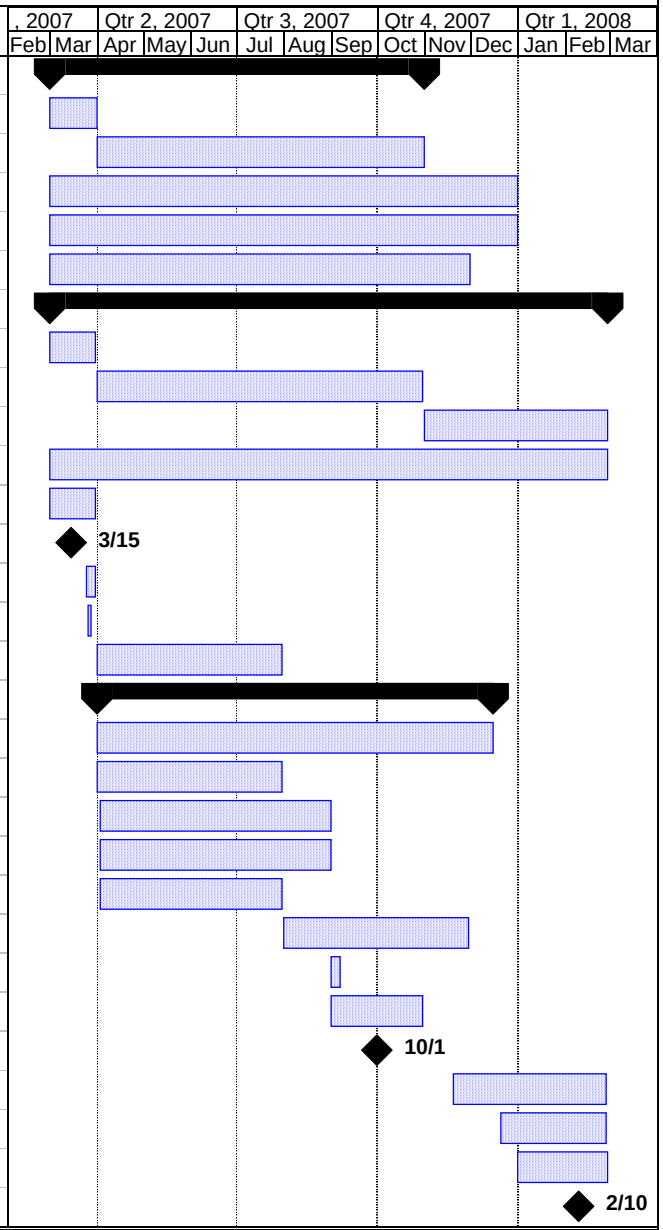


Figure IHR-1 Ice Harbor Lock and Dam General Site Plan

Table IHR-1. Dates of project operations for fish purposes at Ice Harbor, 2007 March 2007

Task Name	Start	Finish	FPP Reference
Adult Fish counting	**3/1/07**	**10/31/07**	**Ihr 1.2.2**
0600 - 1600 PST	3/1/07	3/31/07	Ihr 1.2.2
0400 - 2000 PST	4/1/07	10/31/07	Ihr 1.2.2
Adult Fish Passage Period	3/1/07	12/31/07	Ihr 2.3.2.2
Weekly Reports	3/1/07	12/31/07	Ihr 2.3.3
Operate Turbines for Fish Passage	3/1/07	11/30/07	Ihr 4.1
1% limitations	**3/1/07**	**2/28/08**	**Ihr 4.1**
1% Soft	3/1/07	3/31/07	Ihr 4.1
1% Hard	4/1/07	10/31/07	Ihr 4.1
1% Soft	11/1/07	2/28/08	Ihr 4.1
TDG Monitoring	3/1/07	2/28/08	App D Table 4
Winter Maintenance Period Juvenile	3/1/07	3/31/07	Ihr 2.3.1.1.
Final Report	3/15/07	3/15/07	Ihr 2.3.3
Ice Boat Barrier Installation	3/25/07	3/31/07	App A Ihr 1.3
Turbine Direct Injury and 48-hour Survival Evaluation	3/26/07	3/28/07	App A Ihr 2.2
Back flush orifices once per shift	4/1/07	7/31/07	Ihr 2.3.1.2.c.5
Operate juvenile facilities	**4/1/07**	**12/15/07**	**Ihr 2.3.1**
Juvenile Passage Period	4/1/07	12/15/07	Ihr 2.3.1.2
Approach patterns of juvenile salmonids	4/1/07	7/31/07	App A Ihr 2.4
RSW passage and survival evaluation	4/3/07	8/31/07	App A Ihr 2.1
Spill for Fish	4/3/07	8/31/07	App E
Impacts of Avian Predation on Salmonid Smolts	4/3/07	7/31/07	App A Ihr 2.3
Unit 2 Welding Blades	8/1/07	11/30/07	App A Ihr 1.5
Ice Boat Barrier Installation	9/1/07	9/7/07	App A Ihr 1.3
Replacement of Turbine Unit Fire Protection System	9/1/07	10/31/07	App A Ihr 1.4
1/2 STS May Be Pulled after this date	10/1/07	10/1/07	Ihr 2.3.1.2.b.6
Units 1-6 Protective Relays	11/20/07	2/28/08	App A Ihr 1.6
Winter Maintenance Period Juvenile	12/21/07	2/28/08	Ihr 2.3.1.1.
Maintenance of Adult Facilities	1/1/08	2/28/08	Ihr 1.2.2
Draft Final Report	2/10/08	2/10/08	Ihr 2.3.3



1.2.2. Adult Migration Timing.

Upstream migrants are present at Ice Harbor Dam all year. Maintenance of adult fish facilities is scheduled for January and February to minimize impacts on upstream migrants. Facilities are usually shut down one shore at a time for maintenance. Table IHR-2 lists primary passage periods by species and the earliest and latest dates of peak passage based on fish count data compiled by the Corps of Engineers. Adult fish (salmon, steelhead, bull trout, and lamprey) are normally counted from April 1 through October 31, 16 hours per day (0400 to 2000 hours Pacific Standard Time). Additional 10 hour per day counting will take place in March (0600 to 1600 hours PST) to gather information for setting non-routine maintenance schedules.

Table IHR-2. Adult migration timing at Ice Harbor Dam from 1962-2006 based on fish counts.

Species	Counting Period	Date of Peak Passage	
		Earliest	Latest
Spring Chinook	4/1 - 6/11	4/22	5/26
Summer Chinook	6/12 - 8/11	6/12	7/23
Fall Chinook	8/12- 12/15	9/5	9/30
Steelhead	4/1 – 12/15	9/15	10/12
Sockeye	4/1 – 12/15	7/1	9/22

2. Project Operation.

2.1 Spill Management.

Involuntary spill at Ice Harbor is the result of river flow exceeding powerhouse capacity, insufficient generation loads to pass the river flow, turbine unit outages (forced or scheduled), or the failure of a key component of the juvenile fish passage facility which forces the project to spill to provide juvenile fish passage. Spill at Ice Harbor will be distributed in accordance with the spill patterns listed in Tables IHR-8,IHR-9, and IHR-10. Special spills for juvenile fish passage will be provided as detailed in Appendixes A and E.

2.2. Dissolved Gas Management and Control.

Total dissolved gas TDG) levels at Ice Harbor are monitored in accordance with the Dissolved Gas Monitoring Program, Appendix D. The TDG will be monitored in the Ice Harbor forebay and tailrace. The TDG data will be collected every half-hour and transmitted hourly via computer year-round. Related data collected at the same time will be spill volume and total project flow. Implementation of requests for spill will be based in part upon TDG monitoring data along with juvenile migration data. Requests for spill will be coordinated through the Technical Management Team (TMT).

2.3. Operating Criteria.

2.3.1. Juvenile Fish Passage Facilities.

Operate from April 1 through October 31 for juvenile fish passage and from November 1 through December 15 for protecting adult fallbacks. The facilities should be operated according to the following criteria:

2.3.1.1. Winter Maintenance Period (December 16 through March 31).

Check and perform maintenance as required on the items listed below.

a. Forebay Area and Intakes.

1. Remove debris from forebay and gatewell slots.

2. Rake trashracks just prior to the operating season.

3. Measure drawdown in gatewell slots after cleaning trashracks and with STSs in place.

4. Inspect and repair gatewell dip net as needed.

b. Submersible Traveling Screens and Vertical Barrier Screens.

1. Maintenance completed on all screens.

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

3. Log trial Run.

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

c. Collection Channel.

1. Water-up valve capable of operating when needed.

2. Orifice lights are operational.

3. Orifices clean and valves operating correctly.

4. Orifice air backflush system works correctly.

5. Netting along handrails maintained and in good condition.

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

d. Dewatering Structure and Flume.

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

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

3. Overflow weirs should be maintained, tested, and operating correctly.

4. All valves should be operating correctly.

5. Flume interior should be smooth with no rough edges.

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

e. Sampling Facilities.

1. Flume dewatering structure should be maintained and in good operating condition with no holes or gaps between dewatering screen panels. Silicone sealer should be in good condition.

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

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

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

5. All valves and switch gates maintained and in good operating condition.

6. All sampling equipment maintained and in good operating condition.

7. Maintain juvenile PIT tag system as required. Coordinate with PSMFC.

f. 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.

g. Maintenance Records. Record all maintenance and inspections.

2.3.1.2. Fish Passage Period (April 1 through December 15).

a. Forebay Area and Intakes.

1. Remove debris from forebay.

2. Remove debris from trashracks as required to maintain less than 1' of additional drawdown in gate slots. 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.

3. Inspect gatewell slots daily for debris, fish buildup, and contaminating substances (particularly oil). Clean gatewells before they become half covered with debris. If, due to the volume of the debris, it is not possible to keep the gatewell surfaces at least half clear, they should be cleaned at least once daily. If flows through an orifice 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 can not 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 shall not be operated until the gatewell and orifices are cleared of debris.

4. If a visible accumulation of contaminating substances (such as oil) is detected in a gatewell and it 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 absorbent (not adsorbent) 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 the oil from the gatewell so the orifice can be reopened to allow the fish to exit the gatewell. Orifices shall not be closed for longer than 48 hours.

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

b. Submersible Traveling Screens and Vertical Barrier Screens.

1. Operate STSs in cycling mode when average fork length of sub-yearling chinook or sockeye is greater than 120 mm at Lower Monumental collection facility.

2. Operate STSs in continuous operational mode when average fork length of sub-yearling chinook or sockeye is less than 120 mm at Lower Monumental collection facility, or if there is other evidence that smaller juvenile fish are present at the project. Return to cycling mode after one week has passed and re-evaluate.

3. Inspect each STS once per month by means of underwater video. Spot check VBSs at the same time.

4. Record STS amp readings daily.

5. 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.

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

7. Make formal determination at end of season as to adequacy of STS screen mesh and replacement if necessary.

8. Inspect at least 2 VBSs in 2 different turbine units between the spring and summer migration periods. Both turbine units should have been operated frequently during the spring. If a debris accumulation is noted, inspect other VBSs and clean debris as necessary.

c. Collection Channel.

1. Orifices clean and operating. Operate at least one orifice per gatewell slot (preferably the north orifice). If the project is operating at 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. Also see section 3.1.2.2. to determine if the turbine unit must be shut down and if fish must be dipped from the gatewell(s).

2. 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.

3. Orifice jets hitting no closer than 3’ from back wall, collection channel full.

4. Orifice valves are either fully open or closed.

5. Backflush orifices at least once per day and more frequently if required. 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.

6. Water-up valve capable of operating when needed.

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

8. Netting or covers over orifice chutes in good condition.

d. Dewatering Structure.

1. Trash sweep operating correctly. The frequency of sweep should be set as necessary to maintain a clean screen, with a minimum operation of at least once per hour. If automated cleaning system problems occur, operate manually at least once per work shift, or more as necessary, to maintain a clean screen.

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

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

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

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

e. Sampling Facilities.

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

2. Operate wet separator and fish distribution system as designed. Sample fish twice per week during the main juvenile bypass season to monitor juvenile fish descaling and other fish condition parameters. Sampling is not recommended when water temperatures exceed 70° F unless authorized by an ESA permit. Provide information in project weekly report.

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

4. Operate preanesthetic system as designed.

5. 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).

f. Avian Predation Areas (Forebay and Tailrace).

1. Bird wires and other avian deterrent devices should be monitored to assure they are in good condition. Any broken wires or devices should be replaced as soon as possible.

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

3. 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 activities.

g. Removable Spillway Weir (RSW).

1. Operational criteria for the new RSW are not available at this time (November 2005). Criteria will be provided later by amending the Fish Passage Plan.

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

2.3.2. Adult Fish Passage Facilities.

Operate the adult fish passage facilities according to the following criteria.

2.3.2.1. Winter Maintenance Period (January 1 through February 28).

a. Inspect all staff gages and water level indicators. Repair and/or clean where necessary.

b. 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.

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

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

e. Inspect all spill gates and ensure that they are operable.

f. Fish pumps maintained and ready for operation.

g. Maintain adult PIT tag system as required. Coordinate with PSMFC.

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

2.3.2.2. Fish Passage Period (March 1 through December 31).

Note: During extremely high flow periods when tailwater level exceeds elevation 353' msl, the fish pumps may have to be turned off so that the head differential on the auxiliary water supply conduit ceiling slab does not exceed structural design criteria.

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

b. Counting Windows. The minimum counting slot width should be 18". All equipment should be maintained and in good condition. The counting window and backboard should be cleaned as needed to maintain good visibility.

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

d. North Shore Entrance (NEW 1). Elevation of top of gate when on sill = 332.25'.

1. Operate downstream gate closest to shore.

2. Weir depth: 8' or greater below tailwater. At tailwaters less than elevation 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.

3. North Shore Lower Diffuser Gates: If the tailwater is below elevation 344', the diffuser gates should be fully open. If the tailwater is above elevation 344', the diffuser gates should be one-half open.

e. North Powerhouse Entrance (NFE 1 and 2). Elevation of top of gate when on sill = 332.25'.

1. Operate 1 downstream gate.

2. 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.]

f. Floating Orifice Gates. Operate 7 floating orifices (O.G. numbers 1, 2, 4, 6, 8, 10, and 12).

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

1. Operate entrance closest to powerhouse.

2. 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.]

h. Channel Velocity. 1.5' to 4' per second.

i. Head on Trashracks.

1. Maximum head of 0.5' on ladder exits.

2. Maximum head on picketed leads shall be 0.3'.

3. Trashracks and picketed leads installed correctly.

j. Staff Gages and Water Level Indicators. All staff gages should be readable at all water levels encountered during the fish passage period. Repair or clean as necessary.

k. 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).

l. Facility Inspections.

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

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

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

4. 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.

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

6. Record all inspections.

2.3.2. Facility Monitoring and Reporting.

Project biologists shall inspect fish passage facilities at the frequencies listed in the juvenile and adult fish facilities operating criteria sections. Project biologists shall prepare weekly reports, from March 1 through December 31, summarizing project operations. The weekly reports should provide an overview of how the project and the fish passage facilities operated during the week and an evaluation of resulting fish passage conditions. The reports shall include: any out of criteria situations observed and subsequent corrective actions taken; any equipment malfunctions, breakdowns, or damage along with a summary of resulting repair activities; adult fishway control calibrations; STS and VBS inspections; and any unusual activities that occurred at the project that may affect fish passage. The weekly reports shall cover a Friday through Thursday time period and shall be sent to CENWW-OD-T by noon the following Monday via electronic mail. 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 all actions taken to discourage avian predation at the project, with an overview of the effectiveness of the activities in discouraging avian predation. Project biologists also inspect project facilities once per month and during dewaterings for the presence of zebra mussels. Biologists shall provide a report to CENWW-OD-T on a monthly basis summarizing zebra mussel inspections.

3. Project Maintenance.

Project biologists should be present to provide technical guidance at all project activities that may involve fish handling. All dewaterings shall be accomplished in accordance with approved project dewatering and fish handling plans. **When river temperatures reach 70 degrees Fahrenheit or greater, all adult fish handling will be coordinated through CENWW-OD-T**. Dewatering and fish handling plans were reviewed and revised in 2000 to ensure that they comply with Appendix F, Guidelines for Dewatering and Fish Handling Plans.

3.1. Juvenile Fish Passage Facilities.

3.1.1. Scheduled Maintenance.

Scheduled maintenance of the juvenile facilities is conducted during the entire year. Long-term maintenance or modifications of facilities that require them to be out of service for extended periods of time are conducted during the winter maintenance period from December 16 through 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.

3.1.2. Unscheduled Maintenance.

Unscheduled maintenance is the correction of any situation that prevents the facilities from operating according to criteria or that will impact fish passage or survival. Maintenance of facilities such as STSs, which sometimes break down during the fish passage season, will be carried out as described below. In these cases, repairs will be made as prescribed and CENWW-OD-T notified for further coordination. Unscheduled maintenance that will have a significant impact on juvenile fish passage shall be coordinated with NOAA Fisheries and other FPOM participants on a case-by-case basis by CENWW-OD-T. CENWW-OD-T will be notified as soon as possible after it becomes apparent that maintenance repairs are required. The Operations Manager has the authority to initiate work prior to notifying CENWW-OD-T when in his opinion delay of the work will result in an unsafe situation for people, property, or fish. Information required by CENWW-OD-T includes:

a. Description of the problem.

b. Type of outage required.

c. Impact on facility operation.

d. Length of time for repairs.

e. Expected impacts on fish passage and proposed measures to mitigate them.

3.1.2.1. Submersible Traveling Screens.

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.

3.1.2.2. 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.

3.1.2.3. 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 foot differential it initiates continuous screen cleaning. If the sensors detect a differential of .30 foot 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.

3.1.2.4. Bypass Flume/Pipe.

The bypass flume/pipe transports fish to the sampling facilities and to the tailrace below the project. If there is a problem with the flume/pipe that requires it to be dewatered, procedures will be taken similar to section 3.1.2.3.

3.1.2.5. 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.

3.2. Adult Fish Passage Facilities.

3.2.1. Scheduled Maintenance.

Scheduled maintenance of a facility that must be dewatered to work on or whose maintenance will have a significant effect on fish passage will be done during the January and 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 the project 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 other FPOM participants.

3.2.2. Unscheduled Maintenance.

Unscheduled maintenance that will significantly affect the operation of a facility 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 (see section 3.1.2.). 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.

3.2.2.1. 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 the 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.

3.2.2.2. 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. If a pump fails during two-pump operation, the pump on standby will be operated to provide the necessary flows. If two or all three pumps fail, the NEW1 weir will be maintained at a level of 6' below tailwater until repairs are made.

3.2.2.3. South Shore Auxiliary Water Supply System.

The south shore auxiliary water is supplied by eight electric pumps and 150 to 180 cfs of excess water from the juvenile fish passage facilities. Fluctuating tailwater levels require from six to eight pumps to be operated to provide the auxiliary water. 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. If criteria cannot be met, the floating orifices should be closed in the following order: OG-12, OG-10, OG-8, and OG-6. 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, OG-1, and OG-2. 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.

3.2.2.4. Fishway Entrances.

The fishway entrances consist of main entrance weirs with hoists and automatic controls, and floating orifices which regulate themselves with tailwater fluctuations. If any of the automatic controls malfunction, the weirs can be operated manually by project personnel and kept within criteria. If there is a further failure which prevents the

entrance from being operated manually, an alternate entrance will be opened until repairs can be made. If a floating orifice fails, it will be pulled out of the water and the entrance bulkheaded off until the floating orifice is repaired.

3.2.2.5. Diffuser Gratings.

Diffuser chambers for adding auxiliary water to fish ladders and collection channels are covered by gratings attached by several different methods. Diffuser gratings are normally checked during the winter maintenance period to make sure they are in place. These inspections are done by either dewatering and physically inspecting the diffuser gratings, or by using underwater video cameras, divers, or other methods. Diffuser gratings may come loose during the fish passage season due to a variety of reasons. Daily inspections of fish ladders and collection systems should include looking for any flow changes that may indicate problems with diffuser gratings. If a diffuser 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 in the fishway. Coordination of the problems should begin immediately through the established unscheduled maintenance coordination procedure (see section 3.1.2). If possible, a video inspection should be made as soon as possible to determine the extent of the problem. If diffuser gratings are found to be missing or displaced, creating openings into the diffuser chambers, a method of repair shall be developed and coordinated with the fish agencies and tribes through the established coordination procedure. Repairs shall be made as quickly as possible unless coordinated differently.

4. Turbine Unit Operation and Maintenance.

4.1. Turbine Unit Operation.

When in operation, turbine units will be operated to enhance adult and juvenile fish passage from March 1 through November 30. During this time period turbine units will be operated as needed to meet generation requirements in the priority order shown in Table IHR-3. Model studies of Ice Harbor Dam show that spilling at lower river flows can cause eddying in front of the powerhouse. To provide the best fish passage conditions during periods of spill,

it is extremely important that the turbine units operate in a specific operating order to minimize eddying conditions. Results from the model studies and preferred operations to reduce eddying are reflected in Table IHR-3.

Table IHR-3. Turbine unit operating priority for Ice Harbor Dam.

Season	Time of Day	Unit Priority*
March 1 – November 30 (Project NOT Spilling)	24 hours	1, 3, 4, then 5 and 6 (any order), 2
March 1 – November 30 (Project IS Spilling)	24 hours	1, 3, 6, 4, 5, and 2
December 1 – February 28	24 hours	Any Order

Note: If unit 3 is out of service, operate unit 4 in place of unit 3. Unit 2 will be operated on a last on/first off basis until an oil leakage problem can be corrected.

The hours of operations may be coordinated and adjusted in-season by CENWW-OD-T (through coordination with TMT) if fish passage or other conditions at the project require it. Unit operating priority may be coordinated differently to allow for fish research, construction, or project maintenance activities. If a turbine unit is taken out of service for maintenance or repair, the next unit in the priority list shall be operated.

Turbine units will be operated within 1% of best efficiency from April 1 through October 31 (as specified in BPA's load shaping guidelines, Appendix C) unless operation outside of that range is necessary to: 1) meet the load requirements of the BPA Administrator whose load requests will be made in accordance with BPA's policy, statutory requirements, and load shaping guidelines (Appendix C); or 2) be in compliance with other coordinated fish measures. Project personnel shall record when turbine units are operated outside the 1% efficiency range and shall provide the information to BPA on a weekly basis according to the load shaping guidelines. Between November 1 and March 31, turbine units will continue to be operated within the 1% turbine efficiency range except when BPA load requests require the units to be operated outside the 1% range. Guidelines for operation of the turbine units within the 1% efficiency range at various heads are shown in Tables IHR-4 through IHR-7.

Table IHR-4. The 1% best efficiency ranges for turbine units 1-3 with standard length submersible traveling screens installed.

Head (Ft)	Lower Generator Limits (MW)	Lower Generator Limits (CFS)	Upper Generator Limits (MW)	Upper Generator Limits (CFS)
85	**51**	**8,029**	**88**	**13,850**
86	52	8,055	89	13,845
87	53	8,079	90	13,840
88	53	8,103	91	13,834
89	54	8,127	92	13,829
90	**55**	**8,149**	**93**	**13,824**
91	56	8,155	94	13,846
92	56	8,161	96	13,869
93	57	8,166	97	13,890
94	58	8,172	98	13,912
95	**58**	**8,177**	**99**	**13,932**
96	59	8,194	100	13,925
97	60	8,212	101	13,918
98	61	8,228	102	13,911
99	61	8,245	103	13,904
100	**62**	**8,261**	**104**	**13,921**
101	63	8,308	104	13,774
102	64	8,354	104	13,630
103	65	8,400	104	13,488
104	66	8,444	104	13,350
105	**67**	**8,488**	**104**	**13,214**

NOTE: Table is based on the 1956 model test and 1994 unit 3 index test (Table IHR-4 revised, 2005).

Table IHR-5. The 1% best efficiency ranges for turbine units 1-3 without standard length submersible traveling screens installed.

Head (Ft)	Lower Generator Limits (MW)	Lower Generator Limits (CFS)	Upper Generator Limits (MW)	Upper Generator Limits (CFS)
85	**51**	**7,907**	**79**	**12,331**
86	51	7,932	80	12,326
87	52	7,956	81	12,322
88	53	7,980	82	12,317
89	54	8,003	83	12,313
90	**55**	**8,025**	**84**	**12,308**
91	55	8,031	85	12,328
92	56	8,037	86	12,348
93	56	8,042	87	12,367
94	57	8,047	88	12,386
95	**58**	**8,052**	**89**	**12,405**
96	59	8,070	90	12,398
97	59	8,087	91	12,392
98	60	8,103	92	12,386
99	61	8,119	93	12,380
100	**62**	**8,135**	**94**	**12,374**
101	62	8,182	94	12,334
102	63	8,227	95	12,295
103	64	8,272	95	12,256
104	65	8,316	96	12,219
105	**66**	**8,359**	**97**	**12,182**

NOTE: Table is based on the 1956 model test and 1994 unit 3 index test.

Table IHR-6. The 1% best efficiency ranges for turbine units 4-6 with standard length submersible traveling screens installed.

Head (Ft)	Lower Generator Limits (MW)	Lower Generator Limits (CFS)	Upper Generator Limits (MW)	Upper Generator Limits (CFS)
85	**58**	**9,065**	**108**	**16,787**
86	59	9,076	110	16,804
87	60	9,086	111	16,820
88	61	9,096	113	16,835
89	62	9,105	114	16,850
90	**63**	**9,114**	**116**	**16,864**
91	63	9,112	117	16,875
92	64	9,110	119	16,886
93	65	9,107	120	16,896
94	65	9,105	121	16,906
95	**66**	**9,102**	**123**	**16,916**
96	67	9,112	124	16,884
97	68	9,121	125	16,852
98	69	9,130	126	16,821
99	69	9,138	127	16,787
100	**70**	**9,146**	**127**	**16,581**
101	71	9,141	127	16,398
102	71	9,137	127	16,218
103	72	9,132	127	16,041
104	73	9,127	127	15,868
105	**73**	**9,123**	**127**	**15,698**

NOTE: Table is based on the 1978 model test and 1993 unit 6 index test (Table IHR-6 revised, 2005).

Table IHR-7. The 1% best efficiency ranges for turbine units 4-6 without standard length submersible traveling screens installed.

Head (Ft)	Lower Generator Limits (MW)	Lower Generator Limits (CFS)	Upper Generator Limits (MW)	Upper Generator Limits (CFS)
85	**61**	**9,350**	**103**	**15,934**
86	62	9,361	105	15,950
87	62	9,371	106	15,966
88	63	9,381	108	15,980
89	64	9,391	109	15,994
90	**65**	**9,400**	**111**	**16,007**
91	66	9,398	112	16,018
92	66	9,396	113	16,029
93	67	9,393	115	16,039
94	68	9,391	116	16,048
95	**69**	**9,389**	**117**	**16,057**
96	70	9,398	119	16,027
97	70	9,408	120	15,997
98	71	9,417	121	15,967
99	72	9,426	122	15,938
100	**73**	**9,434**	**123**	**15,909**
101	74	9,429	125	16,078
102	74	9,424	127	16,164
103	75	9,419	127	15,991
104	76	9,414	127	15,822
105	**76**	**9,410**	**127**	**15,656**

NOTE: Table is based on the 1978 model test and 1993 unit 6 index test (Table IHR-7 revised 2005).

4.2. Turbine Unit Outages During High River Flow Periods.

During high spring flows, turbine unit outages for inspecting fish screens, repairing research equipment such as hydroacoustic or radio telemetry equipment, and other fish items may cause increased spill at a project in order to maintain reservoir levels within operating levels. This may result in TDG levels exceeding standards. It is important that this work be conducted when scheduled to ensure that facilities are working correctly and not injuring migrating fish, and that important fish research data is collected. To facilitate this work, reservoir storage may be utilized to minimize impacts from taking turbine units out of service and increasing spill. At Ice Harbor, this special operation may take place when river flows are above 100 kcfs or when increasing spill levels will result in TDG levels exceeding standards. The activities covered under these operations will be coordinated with and approved by the TMT whenever possible.

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

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

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

c. The RCC will coordinate the work activities through the TMT.

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

e. Spill will be increased by one spill bay 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.

f. 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 the normal MOP range (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.)

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

h. If work, such as screen inspections, is not finished, project personnel shall schedule another turbine unit outage for a date where it can be implemented again.

If the work that needs to be done is of an emergency nature that does not normally require the turbine unit to be taken out of service (such as a failed hydroacoustic transducer versus a failed fish screen), and can not 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 approval to do the work is given, the turbine unit shall be taken out of service and the reservoir level allowed to increase until it reaches 1' above the MOP operating range. At this point, the turbine unit must be returned to service and the reservoir will be drafted back to the MOP range using one spill bay stop setting above passing inflows.

4.3. Turbine Unit Maintenance.

The project turbine unit maintenance schedule will be reviewed annually by project and Operations Division biologists for fish impacts. If possible, maintenance of priority units will be scheduled for non-fish passage periods, or when there are low numbers of fish passing the project. Each turbine unit requires annual maintenance that may take from several days to two weeks. Annual maintenance of all turbine units is normally scheduled during the mid-July to late November time frame. The maintenance of priority units for adult passage is normally conducted in mid-August, when fewer adults are migrating,

to minimize impacts on migrating adults. Turbine units may occasionally require overhauls to repair major problems with the turbine or generator. Overhauls may take over one year to accomplish. Turbine units, governors, exciters, and control systems require periodic maintenance, calibration, and
testing which may take them outside of the 1% turbine efficiency range. This work will be scheduled in compliance with BPA load shaping guidelines (Appendix C) to minimize impacts on juvenile fish.

Unwatering turbine units should be accomplished in accordance with project dewatering plans. Prior to dewatering a turbine unit for maintenance, the turbine unit should be spun at speed-no-load, if possible, immediately before installing tailrace stoplogs and headgates to minimize the number of fish in the draft tube and scroll case. 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 before hand.

5. Forebay Debris Removal.

Debris at projects can impact fish passage conditions. Debris can plug or block trashracks, VBSs, gatewell orifices, dewatering screens, separators, and facility piping resulting in impingement, injuries, and descaling of fish. 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. This is not always possible at each project, as some projects do not have forebay debris removal capability. In this case, the only viable alternative is to spill the debris.

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. CENWW-OD-T shall coordinate the special operations with RCC, NOAA Fisheries, and other FPOM participants. Project personnel shall provide CENWW-OD-T the reason for the debris spill request, including an explanation of project facilities being impacted by the debris, the date and time of the requested spill, and any special powerhouse or other operations required to move the debris to the spillway. When a debris spill is coordinated and approved, RCC shall issue a teletype detailing the specifics of the special operations.

Table IHR-8. Ice Harbor high gate spill pattern with deflectors in all spill bays. RSW not operating.

Spill Bay										Total Stops	Total Spill (kcfs)
1	2	3	4	5	6	7	8	9	10		
		5								5	8.5
		5							1	6	10.2
		5						1	1	7	11.9
		5						1.5	1.5	8	13.6
		5						2	2	9	15.4
		5		5						10	17.0
		5		5					1	11	18.7
		5.5		5.5					1	12	20.4
		5.5		5.5				1	1	13	22.1
		5.5		5.5				1.5	1.5	14	23.8
		5		5		5				15	25.5
		5		5		5			1	16	27.2
		5.5		5.5		5			1	17	28.9
		5.5		5.5		5.5			1.5	18	30.5
		6		6		6			1	19	32.0
		5		5		5		5		20	34.0
		5		5		5		5	1	21	35.7
		5.5		5		5		5.5	1	22	37.3
		5.5		5.5		5.5		5.5	1	23	39.0
		6		5.5		5.5		6	1	24	40.6
		6		6		6		6	1	25	42.1
		5	5	5		5		5	1	26	44.2
		5.5	5	5		5		5.5	1	27	45.8
		5.5	5	5.5		5.5		5.5	1	28	47.5
		5.5	5.5	5.5		5.5		6	1	29	49.1
		5.5	5.5	6		6		6	1	30	50.7
		6	6	6		6		6	1	31	52.2
		6	6	6.5		6.5		6	1	32	54.0
		6.5	6.5	6.5		6.5		6	1	33	55.8
		6	6	5	5	5		6	1	34	57.5
		6	6	5	5	6		6	1	35	59.1
		6	6	6	5	6		6	1	36	60.7
		6	6	6	6	6		6	1	37	62.3
		6	6	6	6	7		6	1	38	64.1
		6	6	6	6	7		7	1	39	65.7
		6	6	6	7	7		7	1	40	67.4
		6	6	7	7	7		7	1	41	69.1
		6	7	7	7	7		7	1	42	70.8
		7	7	7	7	7		7	1	43	72.5

Table IHR-8. Ice Harbor high gate spill pattern with deflectors in all spill bays. RSW not operating. (continued).

Spill Bay										Total Stops	Total Spill (kcfs)
1	2	3	4	5	6	7	8	9	10		
6		6	6	6	6	7		6	1	44	74.1
6		6	6	6	7	7		6	1	45	75.8
6		6	6	7	7	7		6	1	46	77.5
6		6	7	7	7	7		6	1	47	79.2
6		7	7	7	7	7		6	1	48	80.9
6		6	6	6	6	6	6	6	1	49	82.5
6		6	6	6	6	7	6	6	1	50	84.2
6		6	6	6	7	7	6	6	1	51	85.9
6		6	6	6	7	7	6	7	1	52	87.6
6		6	6	7	7	7	6	7	1	53	89.3
6		6	7	7	7	7	6	7	1	54	91.0
6		7	7	7	7	7	6	7	1	55	92.7

Table IHR-9. Ice Harbor RSW 30% spill pattern

Spill Bay												
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Total Stops**	**Total Spill (kcfs)**	**Total River (kcfs)**
0	rsw	0	0	0	0	0	0	0	0	0	8.4	28.0
0	rsw	0	0	0	0	0	0	0	1	1	10.1	33.7
0	rsw	0	0	0	0	0	0	1	1	2	11.8	39.4
0	rsw	0	0	0	0	0	1	1	1	3	13.5	45.1
0	rsw	0	0	0	0	1	1	1	1	4	15.2	50.8
0	**rsw**	**0**	**0**	**0**	**1**	**1**	**1**	**1**	**1**	**5**	**17.0**	**56.5**
0	rsw	5	0	0	0	0	0	0	1	6	18.6	61.8
0	rsw	5	0	0	0	0	0	1	1	7	20.3	67.5
0	rsw	5	0	0	0	0	1	1	1	8	22.0	73.2
0	rsw	5	0	0	0	1	1	1	1	9	23.7	78.9
0	**rsw**	**5**	**0**	**0**	**1**	**1**	**1**	**1**	**1**	**10**	**25.4**	**84.6**
0	rsw	5	0	5	0	0	0	0	1	11	27.0	90.0
0	rsw	5	0	5	0	0	0	1	1	12	28.7	95.7
0	rsw	5	0	5	0	0	1	1	1	13	30.4	101.4
0	rsw	5	0	5	0	0	1	1	2	14	32.1	107.0
0	**rsw**	**5**	**0**	**5**	**0**	**0**	**1**	**2**	**2**	**15**	**33.8**	**112.7**
0	rsw	5	0	5	0	0	2	2	2	16	35.5	118.4
0	rsw	6	0	5	0	0	2	2	2	17	37.2	123.9
0	rsw	6	0	6	0	0	2	2	2	18	38.8	129.4
0	rsw	6	0	6	0	1	2	2	2	19	40.5	135.1
0	**rsw**	**6**	**0**	**6**	**0**	**2**	**2**	**2**	**2**	**20**	**42.2**	**140.8**
0	rsw	5	0	5	0	5	2	2	2	21	44.0	146.5
0	rsw	5	0	5	0	6	2	2	2	22	45.6	152.0
0	rsw	5	0	6	0	6	2	2	2	23	47.3	157.6
0	rsw	6	0	6	0	6	2	2	2	24	48.9	163.1
0	**rsw**	**6**	**0**	**6**	**0**	**6**	**2**	**3**	**2**	**25**	**50.6**	**168.7**
0	rsw	6	0	6	0	6	2	4	2	26	52.3	174.3
0	rsw	6	0	6	0	6	2	5	2	27	54.0	179.9
0	rsw	6	0	6	0	6	2	6	2	28	55.6	185.4
0	rsw	6	0	6	1	6	2	6	2	29	57.3	191.1
0	**rsw**	**6**	**0**	**6**	**2**	**6**	**2**	**6**	**2**	**30**	**59.0**	**196.8**
0	rsw	6	0	6	3	6	2	6	2	31	60.7	202.4
0	rsw	6	0	6	4	6	2	6	2	32	62.4	208.0
0	rsw	6	0	6	5	6	2	6	2	33	64.1	213.5
0	rsw	6	0	6	6	6	2	6	2	34	65.7	219.1

Table IHR-10. Ice Harbor RSW 45 kcfs/Spill Cap spill pattern.

Spill Bay											
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Total Stops**	**Total Spill (kcfs)**
0	rsw	0	0	0	0	0	0	0	0	0	8.4
0	rsw	0	0	0	0	0	0	0	1	1	10.1
0	rsw	0	0	0	0	0	0	1	1	2	11.8
0	rsw	0	0	0	0	0	1	1	1	3	13.5
0	rsw	0	0	0	0	1	1	1	1	4	15.2
0	**rsw**	**0**	**0**	**0**	**1**	**1**	**1**	**1**	**1**	**5**	**17.0**
0	rsw	0	5	0	0	0	0	0	1	6	18.6
0	rsw	0	5	0	0	0	0	1	1	7	20.3
0	rsw	0	5	0	0	0	1	1	1	8	22.0
0	rsw	0	5	0	0	1	1	1	1	9	23.7
0	**rsw**	**0**	**5**	**0**	**5**	**0**	**0**	**0**	**0**	**10**	**25.3**
0	rsw	0	5	0	5	0	0	0	1	11	27.0
0	rsw	0	5	0	5	0	0	1	1	12	28.7
0	rsw	0	5	0	5	0	1	1	1	13	30.4
0	rsw	0	5	0	5	1	1	1	1	14	32.1
0	**rsw**	**0**	**5**	**0**	**5**	**1**	**1**	**1**	**2**	**15**	**33.8**
0	rsw	0	5	0	5	1	1	2	2	16	35.5
0	rsw	0	5	0	5	1	2	2	2	17	37.2
0	rsw	0	5	0	5	2	2	2	2	18	38.9
0	rsw	0	5	0	5	2	2	2	3	19	40.6
0	**rsw**	**0**	**5**	**0**	**5**	**2**	**2**	**3**	**3**	**20**	**42.3**
0	rsw	0	5	0	5	5	2	2	2	21	44.0
0	rsw	0	6	0	5	5	2	2	2	22	45.6
0	rsw	0	6	0	6	5	2	2	2	23	47.3
0	rsw	0	6	0	6	6	2	2	2	24	48.9
0	**rsw**	**0**	**6**	**5**	**5**	**5**	**1**	**1**	**2**	**25**	**50.7**
0	rsw	0	6	5	5	5	1	2	2	26	52.4
0	rsw	0	6	5	5	5	2	2	2	27	54.1
0	rsw	0	6	6	5	5	2	2	2	28	55.7
0	rsw	0	6	6	5	5	2	3	2	29	57.4
0	**rsw**	**0**	**6**	**6**	**5**	**5**	**2**	**4**	**2**	**30**	**59.1**
0	rsw	0	6	6	5	5	2	5	2	31	60.7
0	rsw	0	6	6	5	5	3	5	2	32	62.4
0	rsw	0	6	6	5	5	4	5	2	33	64.1
0	rsw	0	6	6	5	5	5	5	2	34	65.8
0	**rsw**	**1**	**6**	**6**	**5**	**5**	**5**	**5**	**2**	**35**	**67.5**
0	rsw	2	6	6	5	5	5	5	2	36	69.2
0	rsw	3	6	6	5	5	5	5	2	37	70.9
0	rsw	4	6	6	5	5	5	5	2	38	72.6
0	rsw	5	6	6	5	5	5	5	2	39	74.2
0	**rsw**	**6**	**6**	**6**	**5**	**5**	**5**	**5**	**2**	**40**	**75.9**

Note: The normal minimum spill level is 15.2 kcfs.

Table IHR-10. Ice Harbor RSW 45 kcfs/Spill Cap spill pattern (continued).

Spill Bay											
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Total Stops**	**Total Spill (kcfs)**
0	rsw	6	6	6	6	5	5	5	2	41	77.5
0	rsw	6	6	6	6	6	5	5	2	42	79.2
0	rsw	6	6	6	6	6	6	5	2	43	80.9
0	rsw	6	6	6	6	6	6	6	2	44	82.5
0	**rsw**	**7**	**6**	**6**	**6**	**6**	**6**	**6**	**2**	**45**	**84.1**
0	rsw	7	7	6	6	6	6	6	2	46	85.7
0	rsw	7	7	7	6	6	6	6	2	47	87.3
0	rsw	7	7	7	7	6	6	6	2	48	88.9
0	rsw	7	7	7	7	7	6	6	2	49	90.5
0	**rsw**	**7**	**7**	**7**	**7**	**7**	**7**	**6**	**2**	**50**	**92.1**
0	rsw	7	7	7	7	7	7	7	2	51	93.7
0	rsw	8	7	7	7	7	7	7	2	52	95.3
0	rsw	8	8	7	7	7	7	7	2	53	96.9
0	rsw	8	8	8	7	7	7	7	2	54	98.5
0	**rsw**	**8**	**8**	**8**	**8**	**7**	**7**	**7**	**2**	**55**	**100.1**
0	rsw	8	8	8	8	8	7	7	2	56	101.7
0	rsw	8	8	8	8	8	8	7	2	57	103.3
0	rsw	8	8	8	8	8	8	8	2	58	104.9
0	rsw	9	8	8	8	8	8	8	2	59	106.6
0	**rsw**	**9**	**9**	**8**	**8**	**8**	**8**	**8**	**2**	**60**	**108.3**
0	rsw	9	9	9	8	8	8	8	2	61	110.0
0	rsw	9	9	9	9	8	8	8	2	62	111.7
0	rsw	9	9	9	9	9	8	8	2	63	113.4