2014 Fish Passage Plan

Section 7 – Lower Monumental Dam

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Project Acronym*	LMN
River Mile (RM)	Snake River RM 41.6
Reservoir	Lake Herbert G. West
Minimum Instantaneous Flow (kcfs)	Dec–Feb: 0 kcfs \ Mar–Nov: 11.5 kcfs
Forebay Normal Operating Range (ft)	537' – 540'
Tailrace Rate of Change Limit (ft/hr)	1.5'/hr
Powerhouse Length (ft)	656'
Powerhouse Hydraulic Capacity (kcfs)	130 kcfs
Turbine Units (#)	6 (Units 1-3 BLH Kaplan; Units 4-6 Allis Chalmers Kaplan)
Turbine Unit Generating Capacity (MW)	Rated: 810 MW (Units 1-6 @135 MW) \ Maximum: 930 MW (Units 1-6 @155 MW)
Gatewell Orifice Diameter	12"
Spillway Length (ft)	498'
Spillway Hydraulic Capacity (kcfs)	850 kcfs
Spillbays (#)	8
Spillway Weirs (#)	1 Removable Spillway Weir (RSW) in Bay 8
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)	1969 (1st Generation) / 1991 (current)
Submersible Traveling Screens (STS)	1992
Juvenile Fish Transportation Program - Corps	1993
Removable Spillway Weir (RSW)	2008
Bypass Outfall Flume Relocation	2012
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, this acronym may differ from other acronyms used in the region. For example, a common acronym for Lower Monumental is LMO. However, that acronym is assigned to another NWD project, thus the official Corps NWD acronym is LMN.

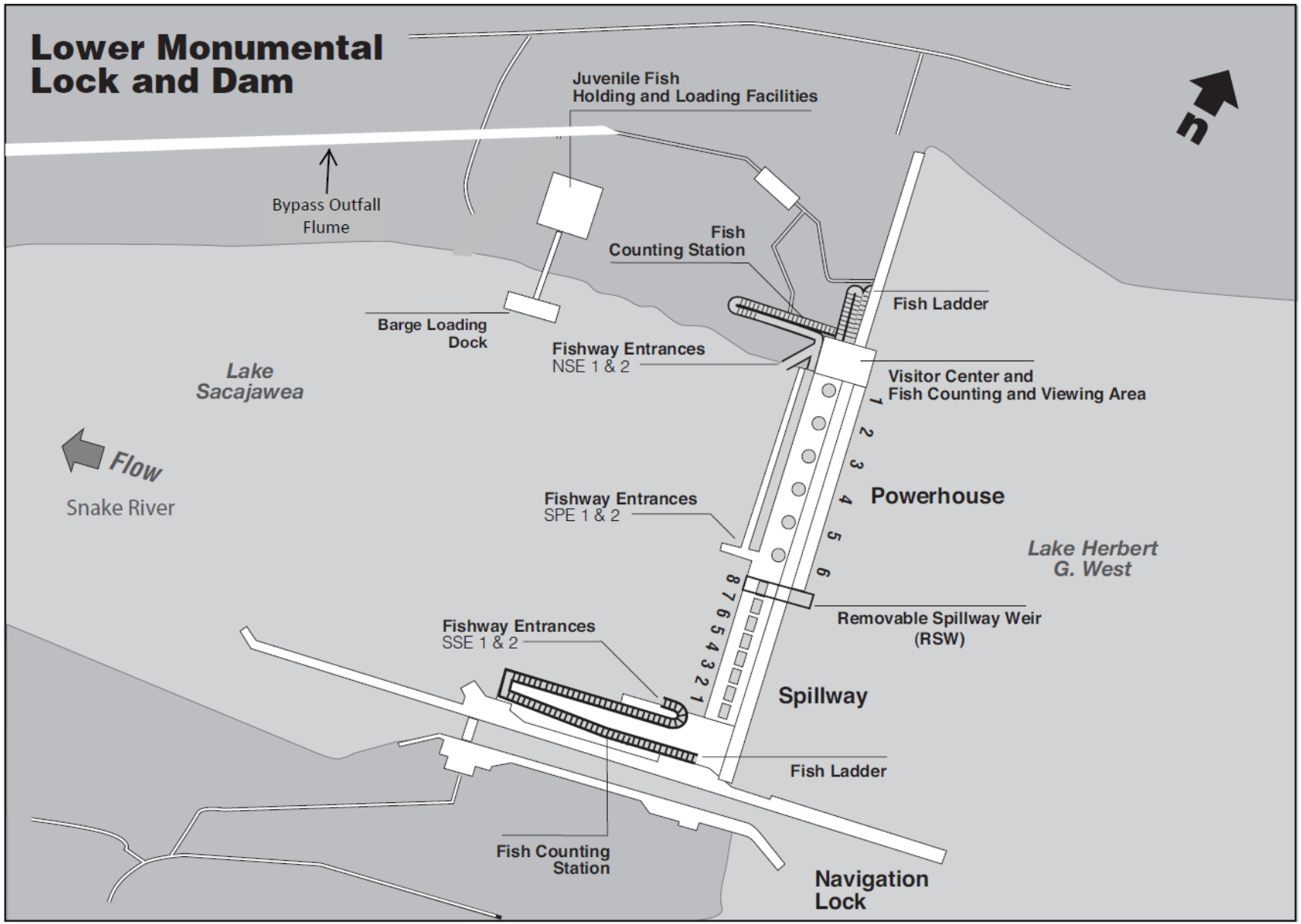
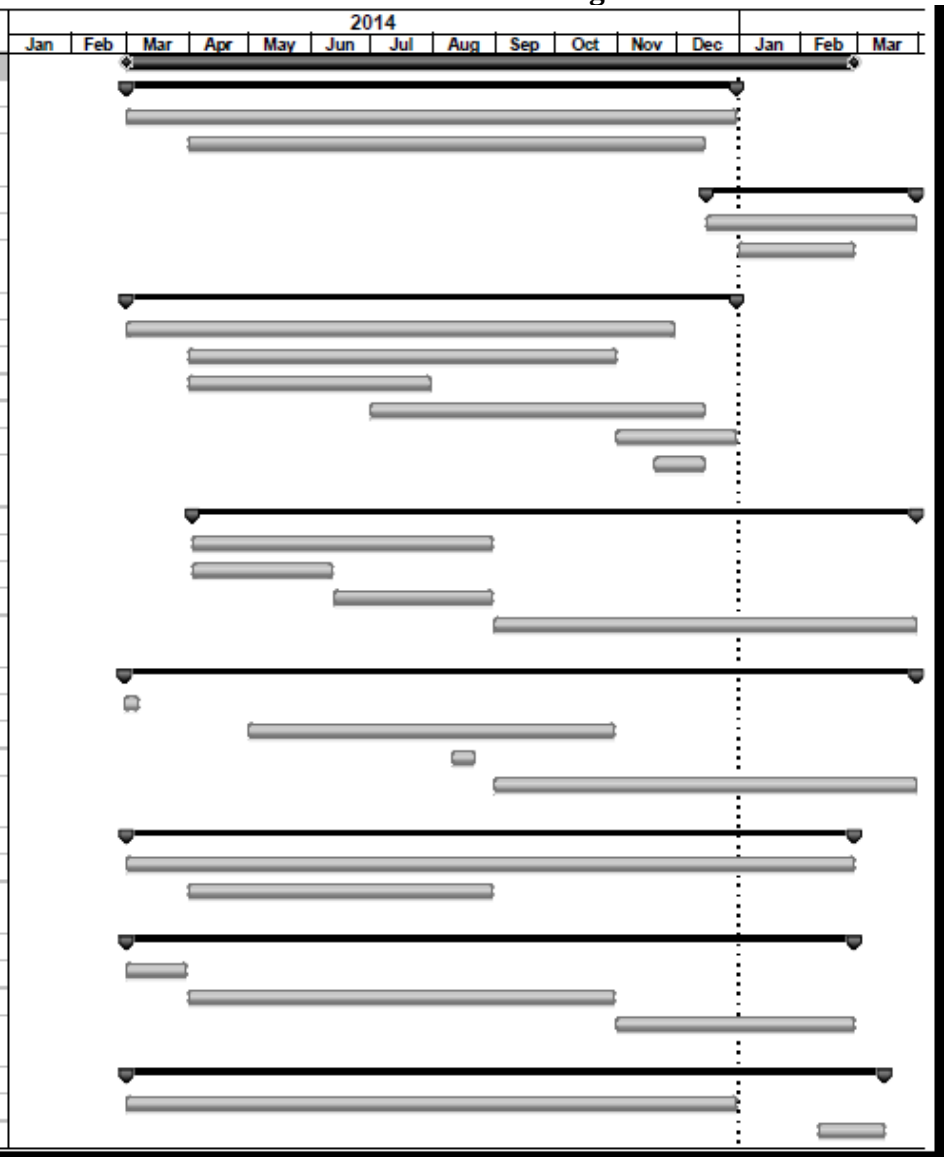


Figure LMN-1. Lower Monumental Lock & Dam General Site Plan.

Table LMN-1. Lower Monumental Dam Schedule of Operations and Actions Defined in the 2014 Fish Passage Plan.

Task Name	Start Date	End Date	FPP Reference
2014 FPP Operations & Actions - Lower Monumental	**3/1/14**	**2/28/15**	**LMN**
Fish Passage Facilities Operation	**3/1/14**	**12/31/14**	**2.3.**
Adult Fish Facilities	3/1/14	12/31/14	2.3.2.2
Juvenile Fish Facilities	4/1/14	12/15/14	2.3.1
Fish Passage Facilities Maintenance	**12/16/14**	**3/31/15**	**2.3**
Juvenile Fish Facilities Winter Maintenance	12/16/14	3/31/15	2.3.1.1
Adult Fish Facilities Winter Maintenance	1/1/15	2/28/15	2.3.2.1
Turbine Operations for Fish Passage	**3/1/14**	**12/31/14**	**4.1., 2.3.1.**
Turbine operating priority order	3/1/14	11/30/14	4.1.
1% operating range - hard constraint	4/1/14	10/31/14	4.1.1.
Backflush orifices ≥ once per 8-hrs	4/1/14	7/31/14	2.3.1.2.c.6.
One unit may operate w/ head gates in standard	7/1/14	12/15/14	4.3.2.
Priority turbine unit maintenance	11/1/14	12/31/14	4.3.1.
STS removal if cold-weather criteria apply	11/20/14	12/15/14	2.3.1.2.b.10
Spill Operations for Fish Passage	**4/3/14**	**3/31/15**	**2.3.1.2., App E**
Spillway Weir in service (end date approx)	4/3/14	8/31/14	2.3.1.2.g.
Spring Spill Operations (end date approx)	4/3/14	6/12/14	FOP
Summer Spill Operations (dates approx)	6/13/14	8/31/14	FOP
Spillway Weir Maintenance	9/1/14	3/31/15	2.3.1.2.h.
Special Operations & Studies (dates approximate)	**2/28/14**	**3/31/15**	**App A**
Units 4-6 Exciter Re-Commissioning	2/28/14	3/7/14	7.1.3.
Adult Lamprey Passage Studies	5/1/14	10/31/14	7.2.1.-2.
Transformer Maintenance	8/11/14	8/22/14	7.1.5.
Steady State Model Validation Testing	9/1/14	3/31/15	7.1.6.
TDG Monitoring	**3/1/14**	**2/28/15**	**2.2.**
TDG Monitoring - Tailrace (year-round)	3/1/14	2/28/15	station LMNW
TDG Monitoring - Forebay	4/1/14	8/31/14	station LMNA
Adult Fish Counting	**3/1/14**	**2/28/15**	**Table LMN-3**
Daytime Video 0400-2000 PST	3/1/14	3/31/14	
Daytime Visual 0400-2000 PST	4/1/14	10/31/14	
Daytime Video 0400-2000 PST	11/1/14	2/28/15	
Reports	**3/1/14**	**3/15/15**	**2.3.3.**
Weekly Reports	3/1/14	12/31/14	
Annual Report	2/10/15	3/15/15	



1. FISH PASSAGE INFORMATION

The locations of fish passage facilities and other dam structures at Lower Monumental Lock and Dam are illustrated in **Figure LMN-1**. Dates for fish operations, research and other special operations are shown in **Table LMN-1**.

1.1. Juvenile Fish Passage.

1.1.1. Facilities Description. The Lower Monumental juvenile facilities consist of standard-length submersible traveling screens (STSs), vertical barrier screens (VBSs), 12" orifices, collection gallery, dewatering structure, and a bypass flume to the tailrace. Transportation facilities consist of a separator to sort juvenile fish by size and to separate them from adult fish, sampling facilities, raceways, office and sampling building, truck and barge loading facilities, and PIT-tag detection and deflector systems.

1.1.2. Juvenile Migration Timing. Juvenile migration timing at Lower Monumental Dam (**Table LMN-2**) is based on juvenile fish collection numbers for the most recent 10-year period and do not reflect fish guidance efficiency (FGE) or passage via the RSW or spillway. Salmon, steelhead, bull trout, lamprey, and other species are routinely counted. Maintenance of juvenile fish passage facilities that may impact juvenile fish passage or facility operations should be conducted during the winter maintenance season.

Table LMN-2. Juvenile Salmonid Passage Timing at Lower Monumental Dam for the Most Recent 10-Year Period (2004-2013) Based on Daily & Yearly Collection Data.

Year	10%	50%	90%	# Days	10%	50%	90%	# Days
	Yearling Chinook				Subyearling Chinook			
2004	16-Apr	22-Apr	18-May	32	16-May	26-Jun	13-Jul	58
2005	18-Apr	8-May	17-May	29	2-Jun	12-Jun	30-Jun	28
2006	1-May	10-May	20-May	19	26-May	8-Jun	1-Jul	36
2007	12-May	15-May	20-May	8	30-May	11-Jun	8-Jul	39
2008	18-May	21-May	28-May	10	5-Jun	14-Jun	5-Jul	30
2009	10-May	20-May	27-May	17	2-Jun	9-Jun	3-Jul	31
2010	18-May	21-May	8-Jun	21	8-Jun	12-Jun	7-Jul	29
2011	10-May	15-May	21-May	11	31-May	23-Jun	24-Jul	54
2012	6-May	12-May	24-May	18	6-Jun	19-Jun	6-Jul	30
2013	9-May	13-May	16-May	7	5-Jun	12-Jun	13-Jul	38
MEDIAN	**9-May**	**14-May**	**20-May**	**18**	**2-Jun**	**12-Jun**	**6-Jul**	**34**
MIN	**16-Apr**	**22-Apr**	**16-May**	**7**	**16-May**	**8-Jun**	**30-Jun**	**28**
MAX	**18-May**	**21-May**	**8-Jun**	**32**	**8-Jun**	**26-Jun**	**24-Jul**	**58**
	Unclipped Steelhead				Clipped Steelhead			
2004	17-Apr	16-May	1-Jun	45	23-Apr	15-May	4-Jun	42
2005	6-May	14-May	24-May	18	20-Apr	13-May	20-May	30
2006	2-May	16-May	25-May	23	29-Apr	9-May	22-May	23
2007	12-May	15-May	23-May	11	12-May	15-May	21-May	9
2008	20-May	21-May	31-May	11	18-May	21-May	28-May	10
2009	10-May	22-May	6-Jun	27	10-May	20-May	1-Jun	22
2010	18-May	26-May	11-Jun	24	8-May	23-May	9-Jun	32
2011	14-May	20-May	1-Jun	18	11-May	16-May	29-May	18
2012	8-May	19-May	2-Jun	25	7-May	15-May	27-May	20
2013	9-May	14-May	21-May	12	8-May	14-May	19-May	11
MEDIAN	**9-May**	**20-May**	**31-May**	**2121**	**8-May**	**15-May**	**27-May**	**2121**
MIN	**17-Apr**	**14-May**	**21-May**	**11**	**20-Apr**	**9-May**	**19-May**	**9**
MAX	**20-May**	**26-May**	**11-Jun**	**45**	**18-May**	**23-May**	**9-Jun**	**42**
	Coho				Sockeye (Wild & Hatchery)			
2004	15-May	29-May	8-Jun	24	16-May	25-May	3-Jun	18
2005	11-May	16-May	23-May	12	30-Apr	24-May	5-Jun	36
2006	14-May	22-May	31-May	17	4-May	21-May	29-May	25
2007	14-May	16-May	23-May	9	14-May	19-May	26-May	12
2008	20-May	20-May	24-May	4	21-May	22-May	3-Jun	13
2009	18-May	26-May	30-Jun	43	20-May	23-May	2-Jun	13
2010	19-May	5-Jun	14-Jun	26	23-May	3-Jun	16-Jun	24
2011	13-May	21-May	3-Jun	21	13-May	30-May	12-Jun	30
2012	9-May	22-May	5-Jun	27	9-May	22-May	3-Jun	25
2013	10-May	14-May	22-May	12	18-May	20-May	23-May	5
MEDIAN	**14-May**	**21-May**	**1-Jun**	**19**	**15-May**	**22-May**	**3-Jun**	**21**
MIN	**9-May**	**14-May**	**22-May**	**4**	**30-Apr**	**19-May**	**23-May**	**5**
MAX	**20-May**	**5-Jun**	**30-Jun**	**43**	**23-May**	**3-Jun**	**16-Jun**	**36**

1.2. Adult Fish Passage.

1.2.1. Facilities Description. Lower Monumental adult fish passage facilities are comprised of north and south shore ladders and collection systems with a common auxiliary water supply. The north shore ladder connects to 2 north shore entrances and the powerhouse collection system. The powerhouse collection system has 2 downstream entrances at the south end of the powerhouse (a former side entrance has been permanently closed) and a common transportation channel. Two north shore entrances, two downstream south powerhouse entrances, and none of the floating orifices will be used during the fish passage season. The south shore ladder has 2 downstream entrances (a former side entrance has been permanently closed). Three turbine-driven pumps provide auxiliary water from the north side of the powerhouse to the powerhouse diffusers via a supply conduit under the powerhouse collection channel, and to the south shore collection system diffuser via a supply conduit under the spillway. Excess water from the juvenile bypass system (approximately 200-240 cfs) is added to the auxiliary water supply for the powerhouse collection system.

1.2.2. Adult Migration Timing and Counting. Upstream migrants are present at the project throughout the year and adult passage facilities are operated year-round. Maintenance of adult facilities occurs in January–February, typically one shore at a time, to minimize impacts on upstream migrants. Adult salmon, steelhead, shad and lamprey are counted (**Table LMN-3**) and daily data are posted online at: http://www.nwp.usace.army.mil/Missions/Environment/Fishdata.aspx. Yearly fish counts are used to determine peak adult migration timing (**Table LMN-4**). Sturgeon and bull trout are relatively infrequent and counts are posted online periodically during the passage season in *Miscellaneous Fish Counts* and summarized in the *Annual Fish Passage Report*.

Table LMN-3. Adult Fish Counting Schedule at Lower Monumental Dam (3/1/14-2/28/15).

Count Period	Counting Method and Hours *
March 1–31, 2014	Video 0400–2000 hours (PST)
April 1, 2014 – October 31, 2014	Visual 0400–2000 hours (PST)
November 1, 2014 – February 28, 2015	Video 0400-2000 hours (PST)

*All count hours are shown in Pacific Standard Time (PST). Note that during Daylight Saving Time (DST) from Mar 9–Nov 2, 2014, count hours will be one hour later (DST = PST+1).

Table LMN-4. Adult Fish Count Period and Peak Passage Timing at Lower Monumental Dam (based on yearly counts since 1969).

Species	Count Period	Earliest Peak	Latest Peak
Spring Chinook	Apr 1 – Jun 13	Apr 20	May 27
Summer Chinook	Jun 14 – Aug 13	Jun 14	Jul 12
Fall Chinook	Aug 14 – Oct 31	Sep 4	Sep 30
Steelhead	Apr 1 – Oct 31	Sep 13	Oct 13
Sockeye	Apr 1 – Oct 31	Jun 24	Jul 25
Lamprey	Apr 1 – Oct 31	Jul 20	Jul 27

1.2.2.1. Time-of-day (diel) distributions of adult salmonid activity at fishway entrances and exits are summarized in **Figure LMN-2** (see *Keefer & Caudill 2008* at: http://www.nwd-wc.usace.army.mil/tmt/documents/FPOM/2010/2013_FPOM_MEET/2013_JUN/).

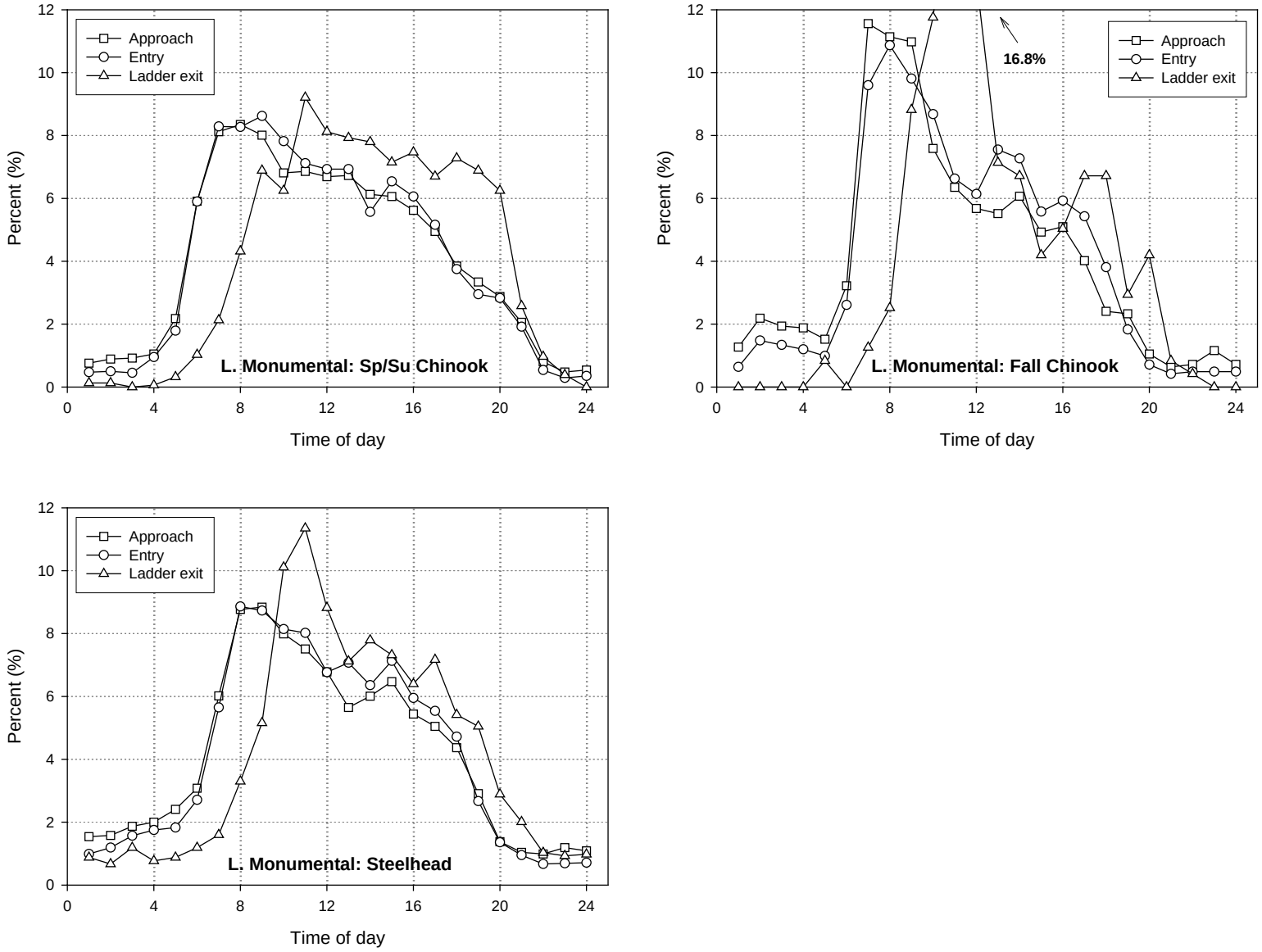


Figure LMN-2. Diel Distribution of Adult Salmonids at Lower Monumental Fishway Entrances and Exits (*Keefer & Caudill 2008*).

2. PROJECT OPERATIONS

2.1. Spill Management.

See the Fish Operations Plan (**Appendix E**) for more information.

2.1.1. Involuntary Spill. Involuntary spill at Lower Monumental 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 Lower Monumental shall be distributed in accordance with the spill patterns included at the end of this section (**Tables LMN-9** and **LMN-10)**.

2.1.2. Spill for Fish Passage. To improve tailrace juvenile egress conditions and minimize eddies, it is recommended that the Lower Monumental project be operated as shown in **Table LMN-5** while spilling for fish passage. If possible, involuntary spill under the flow levels shown should follow these project operations.

2.2. Total Dissolved Gas (TDG) Management.

2.2.1. TDG levels at all projects are monitored in accordance with the *TDG Monitoring Plan,* included in the *Water Management Plan* as Appendix 4 and available online at: http://www.nwd-wc.usace.army.mil/tmt/documents/wmp/.

2.3. Operating Criteria.

2.3.1. Juvenile Fish Passage Facilities. Operate from April 1–September 30 for juvenile fish bypass, collection and transportation, and from October 1–December 15 for bypassing adult fallbacks. Operate the juvenile facilities according to the criteria listed below and in the *Juvenile Fish Transportation Program* (**Appendix B**) for bypass, collection, and transport. The transportation program may be revised in accordance with ESA Section 10 permit and the NOAA Fisheries Biological Opinion.

2.3.1.1. Winter Maintenance Period (December 16–March 31). Check and perform maintenance as required on the items listed below.

2.3.1.1.a. Forebay Area and Intakes.

a.1. Remove debris from forebay and gatewell slots.

a.2. Rake trashracks just prior to the operating season.

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

a.4. Inspect and repair gatewell dip net as needed.

2.3.1.1.b. Submersible Traveling Screens (STS) and Vertical Barrier Screens (VBS).

b.1. Maintenance completed on all screens.

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

b.3. Log results of trial run.

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

2.3.1.1.c. Collection Channel.

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

c.2. Orifice lights are operational.

c.3. Orifices clean and valves operating correctly.

c.4. Orifice air backflush system works correctly.

2.3.1.1.d. Dewatering Structure and Flume.

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

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

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

d.4. All valves should be operating correctly.

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

2.3.1.1.e. Transportation Facilities.

e.1. Primary bypass flume switch gate maintained and in good operating condition.

e.2. Flume interior smooth with no rough edges.

e.3. Perforated plate edges smooth with no rough edges.

e.4. Wet separator and fish distribution system should be maintained and ready for operation as designed.

e.5. Brushes and screens on crowders in good condition with no holes in screens or rough edges.

e.6. Crowders maintained, tested, and operating correctly.

e.7. All valves, slide gates, and switch gates maintained and in good operating condition.

e.8. Retainer screens in place with no holes in screens or sharp wires protruding.

e.9. Barge and truck loading pipes should be free of debris, cracks, or blockages. Truck and barge loading hose couplings should have no rough edges and barge loading boom should be maintained and tested.

e.10. All sampling equipment should be maintained and in good operating condition prior to watering up the facilities.

e.11. Maintain juvenile PIT-tag system as required (see "*Columbia Basin PIT-tag Information System, General Gate Maintenance and Inspection, Walla Walla District*", February 2003). Coordinate with PSMFC.

e.12. Mini- and midi-tanks maintained and in good operating condition.

2.3.1.1.f. Avian Predation Areas (Forebay and Tailrace). Inspect bird wires, avian deterrent devices, 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.

2.3.1.1.g. Maintenance Records. Record all maintenance and inspections.

2.3.1.2. Juvenile Fish Passage Period (April 1–December 15). Check and perform maintenance as required on the items listed below.

2.3.1.2.a. Forebay Area and Intakes.

a.1. Remove debris from forebay.

a.2. Log gatewell drawdown differentials in bulkhead slots at least once a week.

a.3. Remove debris from forebay and 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.

a.4. Inspect gatewell slots daily (preferably early in day shift) 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 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.

a.5. 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 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 the 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.

a.6. Coordinate cleaning efforts with personnel operating juvenile collection facilities.

a.7. Dip bulkhead gatewell slots to remove fish prior to installing bulkhead for dewatering bulkhead slot.

2.3.1.2.b. STSs, VBSs and Head Gates.

b.1. Operate STSs in cycle mode when average fork length of sub-yearling Chinook or sockeye is greater than 120 mm.

b.2. Operate STSs in continuous run mode when average fork length of sub-yearling chinook or sockeye is less than 120 mm or if fish condition deteriorates. Return to cycle mode after one week has passed and re-evaluate.

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

b.4. Record STS amp readings daily.

b.5. If an STS 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.

b.6. Half of the STSs may be pulled after October 1 for maintenance as long as unscreened turbine units are not operated.

b.7. Make formal determination at end of season as to adequacy of STS mesh and any replacement needs.

b.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.

b.9. Turbine units are to be operated with *raised* head gates to improve fish guidance efficiency when STSs are installed (April 1 through December 15), except as provided for in **Section 4.3**., Turbine Unit Maintenance.

b.10. When extreme cold weather is forecasted (temperatures below 20^{o}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.

2.3.1.2.c. Collection Channel.

c.1. Assure that orifices are clean and operable. 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).

c.2. Assure that orifice lights are functional and operating in open orifices. Orifice lights and area lights may be turned off the evening before the channel is dewatered at the end of the season to encourage fish to exit the channel volitionally (dewatering occurs December 16 or later). Area lights can be turned on briefly for personnel access if necessary.

c.3. Replace all burned out orifice lights within 24 hours of notification. Orifice lights shall remain lighted 24 hours/day.

c.4. Orifice jets must hit no closer than 3' from the back wall with the collection channel full.

c.5. Orifice valves must be either fully open or fully closed.

c.6. Backflush orifices at least once per day and more frequently if required. During periods of high debris volumes and fish numbers, 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.

c.7. Water-up valve capable of operating when needed.

2.3.1.2.d. Dewatering Structure.

d.1. Assure the trash sweep is operating correctly. The frequency of the sweep should be set as necessary to maintain a clean screen, with a minimum operation of at least once per hour. Operate the air flush as specified by the project biologist to maintain a clean screen.

d.2. Hand clean trapezoidal section once a day or as often as needed to maintain a clean condition.

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

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

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

2.3.1.2.e. Transportation Facilities.

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

e.2. Crowder screen brushes should be maintained in good operating condition, with no holes or sharp edges on crowder screens.

e.3. Inspect raceway and tank retainer screens to make sure they are clean with no holes or protruding wires.

e.4. Operate wet separator and fish distribution system as designed.

e.5. Truck and barge loading facilities in good operating condition.

e.6. Inform PSMFC, in advance if possible, of situations that will require 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. bypassing fish from raceways to the river, operating in primary bypass mode without an operational full-flow detector, emergency dewaterings).

2.3.1.2.f. Avian Predation Areas (Forebay and Tailrace).

f.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.

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

f.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.

2.3.1.2.g. Removable Spillway Weir[1] (RSW) Operation.

g.1. The RSW in spillbay 8 will be in the raised position and operational on the first day of spill for fish passage.

g.2. When the RSW is in operation, the spillgate shall be raised to where it does not touch flow passing down the RSW.

g.3. When the National Weather Service forecasts Lower Monumental inflows to exceed 200,000 cfs, initiate aggressive forebay debris removal so that RSW operation will not be impeded and coordinate with RCC and CENWW-OD-T.

g.4. Complete RSW stow (complete rotation to the landing pad) when inflows exceed 260,000 cfs, upstream river gage flows are increasing, and the NWS forecasts Lower Monumental inflow to exceed 300,000 cfs.

g.5. When the project is not spilling, the RSW may be operated for short periods of time upon request by the Project Biologist through CENWW if it appears the juvenile fish transportation facility and barge holding capacities will be exceeded, as described in the *Juvenile Fish Transportation Plan* (**Appendix B section 4.4.4**).

2.3.1.2.h. RSW Maintenance (September 1 – April 1).

h.1. Forebay debris removal: Prior to inspections listed below, if a debris raft is present in the forebay and will interfere with the defined operations, a debris spill will be coordinated in accordance with paragraph **5.1**. Debris in the RSW seals or between the transition plate and ogee will adversely affect the operation of the RSW.

h.2. Transition Plate inspection will be performed annually to validate that the transition from the RSW to the ogee is intact. The primary means of inspection will be done with divers or an ROV:

i. If divers are used, turbine units 5&6 and spillbays 7&8 will be removed from service. Units 5&6 outages will require a deviation from FPP priority order (**Table LMN-5**). Coordination of unit outages will follow normal outage notification guidelines. Up to a week before the inspection, bay 8 will need to be opened 1 or 2 stops to facilitate clearing of debris and silt from the transition plates. Spilling through bay 8 will be coordinated with RCC following normal guidelines.

ii. If an ROV is used, spillbay 8 will be out of service for the inspection. The morning of the inspection, bay 8 will need to be opened 1 or 2 stops to facilitate

[1] 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.

clearing of debris and silt from the transition plates. Spilling water through bay 8 will be coordinated with RCC following normal guidelines.

h.3. Transition Plate bolts, umbilical and seal inspection will be performed by divers and will require the RSW to be disengaged from the face of the dam and tipped back to the pierce point. Prior to moving the RSW, bay 8 will need to be opened 1 or 2 stops to remove debris or silt that has accumulated on the transition plates or beak region that would slide off onto the ogee and cause problems when the RSW is stowed. Spill through bay 8 will occur up to a week before the inspection and will be coordinated with RCC through normal guidelines. This inspection will also require units 5&6 and bays 7&8 out of service. Units 5&6 outages will require a deviation from FPP priority order. Coordination of the unit outages will follow normal outage notification guidelines. Upon completion of the dive, prior to stowing the RSW, bay 8 will need to be opened up to 3 stops to clean any debris from the ogee. The anticipated duration of this inspection is 1 to 3 days. Reports of the inspection will be submitted to the CENWW biological staff.

h.4. Loss of Transition Plate(s) or seals will render the RSW out of service until repaired. The level of inspection will initialize with a diver or ROV inspection as defined above for Transition Plate Inspection. The repair and replacement effort will be similar to Transition Plate Bolt, Umbilical and seal inspection above. The timeframe will be longer to repair and or install a new plate(s) or seals. Required outages will be coordinated as listed above for the necessary actions.

2.3.1.2.i. Inspection and Record Keeping.

i.1. Inspect fish facilities at least once every 8 hours. Inspect all facilities according to fish facilities monitoring program.

i.2. Record all maintenance and inspections.

2.3.2. Adult Fish Passage Facilities. Operate adult fish passage facilities according to the following criteria.

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

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

2.3.2.1.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.

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

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

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

2.3.2.1.f. Fish pumps maintained and ready for operation.

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

2.3.2.2. Adult Fish Passage Period (March 1–December 31).

Note: Ice Harbor pool may be operated at minimum operating pool (MOP) elevation range 437'–438' msl as part of the Corps' efforts to improve migration conditions for juvenile salmonids. This may result in some of the Lower Monumental adult fishway entrances bottoming out on their sills prior to reaching criteria depths. Continuous operation at MOP may also result in increased pumping head on the auxiliary water supply pumps, decreasing the amount of water pumped.

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

2.3.2.2.b. Counting Windows. All counting slots at Lower Monumental Dam are fixed at a width of 19". All equipment should be maintained and in good condition. The counting window and backboard should be cleaned as needed to maintain good visibility.

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

2.3.2.2.d. North Shore Entrances (NSE 1&2). Top of gate elevation on sill = 429'.

d.1. Operate both gates.

d.2. Weir depth: 8' or greater below tailwater.

2.3.2.2.e. Floating Orifice Gates. No floating orifice gates will be operated.

2.3.2.2.f. South Powerhouse Entrances (SPE 1&2). Top of gate elev. on sill =432'.

f.1. Operate both downstream gates.

f.2. Weir depth: 8' or greater below tailwater. At tailwaters below elevation 440', weirs should be on sill.

2.3.2.2.g. South Shore Entrances (SSE 1&2). Top of gate elev. on sill = 431'.

g.1. Operate both downstream gates.

g.2. Weir depth: SSE 1 operate 8' or greater below tailwater. SSE 2 raised 6' above sill. At tailwaters below elevation 439', SSE 1 weir should be on sill.

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

h.1. A permanently installed "RED LION PLC with DETEC sensor" type 3020-1002, 4-20 milliamp unit was installed (by Leopold Stevens Inc., Gresham, OR) in the collection channel at the unit 1 / unit 2 transition. The unit is located in the channel's length and width to avoid the non-characteristic high readings that would occur on the slope near an entrance or the non-characteristic low reading that would occur in the turbulent zone on the curve from the pump discharge supply conduit. The location of the sending unit typifies the velocity conditions throughout the length of the channel.

i. To read the meter, the toggle switch is positioned in the "ON" position. As the unit warms up the velocity reading output shows the numerical readout increasing. When it stabilizes and repeats a number the reading is recorded.

ii. The velocity reading is a part of the ladder inspections that are done 3 times per week at Lower Monumental; additionally the reading will be added to the state biologists daily inspection form so that daily readings are documented.

2.3.2.2.i. Head on Trashracks.

i.1. Maximum head of 0.5' on ladder exits.

i.2. Maximum head on south shore picketed leads shall be 0.3'. Maximum head on north shore picketed leads shall be 0.4'.

i.3. Trashracks and picketed leads installed correctly.

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

2.3.2.2.k. Facility Inspections.

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

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

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

k.4. Project personnel shall check fishway control system twice per month to ensure that it is within calibration. This may be done as part of routine fishway inspections.

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

k.6. Record all inspections.

2.3.3. Juvenile & Adult Fish Facility Monitoring and Reporting.

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

2.3.3.2. Weekly Reports. March 1–December 31, Project Biologists shall prepare weekly reports summarizing project operations. The weekly reports 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 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. The reports shall include:

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

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

iii. Adult fishway control calibrations;

iv. STS and VBS inspections;

v. Any unusual activities at the project that may have affected fish passage.

2.3.3.3. 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.

2.3.3.4. 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.

2.4. Navigation Spill Operations.

Short-term adjustments in spill are required for navigation safety. Types of adjustments may include: reductions in spill discharge rates, adjustments in spill patterns, and/or spill stoppages that result in exceedances of the MOP operating range. Actual operations will vary due to conditions such as spill patterns, turbine unit operations, wind, experience of boat captains, etc. The Corps will make short-term adjustment in spill as appropriate in real-time to provide safe navigation conditions. Additional information regarding specific spill operations associated with navigation may be found in the Fish Operations Plan (FOP), included in the FPP as **Appendix E**.

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 and guidelines (**Appendix F**). When river temperatures reach 70°F or greater, all adult fish handling will be coordinated through CENWW-OD-T. Dewatering and fish handling plans were reviewed and revised in 2011 to ensure that they comply with guidelines.

3.1. Juvenile Fish Passage Facilities Maintenance.

3.1.1. Scheduled Maintenance. Scheduled maintenance of juvenile facilities is conducted throughout the year. Long-term maintenance or modifications that require facilities to be out of service for 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.

3.1.2. 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:

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.

3.1.2.1. 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, 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 backflushed at least once per day,

and more frequently if required by heavy debris loads. If an air-valve fails, 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. During any closure event of orifices in an operating turbine unit, gatewells will be checked hourly. During times of high fish passage or if there is evidence of any difficulty in holding fish in gatewells, fish are to be dipped from the gatewells at a more frequent interval.

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 transportation facilities. The dewatering structure contains a trash sweep and air burst system for cleaning the inclined screen of impinged debris. If the cleaning systems break and interfere with juvenile fish passage through the structure or if the inclined screen is damaged, an emergency bypass system at the upstream end of the dewatering structure will be used to bypass juveniles while repairs are made. Operation of the emergency bypass system requires the juvenile bypass system to be dewatered and stoplogs inserted at the upstream end of the inclined screen. The emergency bypass is then opened and the bypass system operated with 6 gatewell orifices open. Orifices will then need to be routinely rotated, every three hours, in order to let juveniles emigrate from all of the gatewells. While the facilities are in emergency bypass operation, project personnel shall monitor gatewells for signs of fish problems or mortality. Spill may be provided as an alternative avenue for fish passage during a collection channel outage.

3.1.2.4. Bypass Flume. The corrugated metal flume transports juveniles to either the transportation facilities or to the river below the project (primary bypass). If there is a problem with the flume that interferes with its operation, the emergency bypass system at the upper end of the flume can be opened and all of the fish in the bypass system diverted to the river below the project through the secondary emergency bypass system while repairs are made. Since the piping to the river for secondary emergency bypass is also part of the raw water supply for the load and hold facility, the load and hold must be evacuated of fish and dewatered before going into secondary emergency bypass.

3.1.2.5. Transportation Facilities. The transportation facilities can be operated to collect and hold juveniles for the transportation program or to bypass them back to the river (secondary bypass). If part of the facility malfunctions or is damaged, efforts will first be made to bypass the fish around the damaged area. If this is not possible, the fish will be bypassed to the river via the primary bypass pipe.

3.2. Adult Fish Passage Facilities Maintenance.

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–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.

3.2.1.1. Auxiliary Water Supply System. The auxiliary water for the ladders and collection systems is supplied by three turbine-driven pumps on the north shore, with at least two pumps being required for normal operation. On a monthly basis, each pump, one pump at a time, may be taken out of service for up to two days for maintenance. The maintenance performed during this outage is routine monthly and quarterly maintenance as defined within the COE maintenance program. This maintenance will not be performed when river conditions will not allow the ladder to remain in criteria using only a two-pump operation.

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. 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. Auxiliary Water Supply System. The auxiliary water for the fish ladders and the collection systems is supplied by three turbine-driven pumps on the north shore, with at least two pumps being required for normal operation. If one, two, or all three pumps fail, the fishway will be adjusted in the following manner until repairs can be made: SPE 2 and/or SSE 2 will be closed and SPE 1 raised to provide the required 1' to 2' head differential in the system. If the desired head differential cannot be reached by the time SPE 1 reaches 5' below tailwater, SPE 1 should be closed, the collection channel bulkheaded off at the junction pool, and NSE 1 and 2 and SSE 1 operated as deep as possible to maintain the head. If it cannot be maintained at a depth greater than 6', the weirs should be maintained at 6' regardless of the head differential.

3.2.2.3. Fishway Entrances. The fishway entrances consist of main entrance weirs with hoists and automatic controls. 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 an entrance from being operated manually, the weirs can usually be left in a lowered position while repairs are being conducted or the entrance may be closed and the water redistributed to other entrances while repairs are made.

3.2.2.4. Diffuser Gratings. Diffuser chambers for adding auxiliary water to fish ladders and collection channels are covered by gratings attached by several different methods. Diffuser gratings are normally checked during the winter maintenance period to make sure they are in place. These inspections are done by either dewatering 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 should begin immediately through the established unscheduled maintenance coordination procedures (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 & 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 LMN-5**. 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 on the priority list shall be operated. Also see **Section 2.1, Spill Management**.

Turbine Unit 1 was the Fish Priority unit prior to the failure of blade linkages. Temporary repairs included blades being welded in fixed positions. Operating turbine unit 1 improves juvenile fish passage by eliminating the eddy at the fish loading dock. Turbine unit 1 operation is also preferred as operation attracts adult fish to the North fish ladder. Since this turbine unit has fixed blades and a narrow operation window, starts and stops can cause excessive wear and tear. Unit 1 run priority is last-on/first-off for all flow conditions until blade link pin repairs are completed (currently scheduled for 2015–2016). Turbine unit 1 may be turned off at the power plant operator's discretion, when the flows are between 55kcfs-70kcfs.

Table LMN-5. Turbine Unit Operating Priority for Lower Monumental Dam.

Season	Unit Priority
Fish Passage Season March 1 – November 30	2, 3, 4, 5, 6 then 1*

* If no spill is occurring, U1 may be operated at any priority level at the discretion of project personnel. **NOTE**: U1 has fixed-pitch blades and can operate only at about 130 megawatts. *This unit priority sequence will remain in effect until unit 1 blade link pin repairs are completed in 2015 or 2016.*

4.1.1. Turbine Unit Operating Ranges. From April 1–October 31, turbine units will be operated within ±1% of peak turbine efficiency (1% range), as specified in *BPA's Load Shaping Guidelines* (**Appendix C**). Turbine unit output and discharge at the lower and upper 1% limits (with and without STSs) for various heads are defined in **Tables LMN-6** (unit 1), **LMN-7** (units 2-3) and **LMN-8** (units 4-6). If operation outside the 1% range is necessary, Project personnel shall record the information and provide to BPA on a weekly basis according to the load shaping guidelines. Operation outside of the 1% range may be necessary to:

i. Meet BPA load requirements. Load requests will be made in accordance with BPA's policy, statutory requirements and load shaping guidelines (**Appendix C**);

ii. If the draft tube is to be dewatered, the unit will be operated at full load (>1%) for a minimum of 15 minutes prior to installing tail logs. If not possible to load, the unit will be run at speed-no-load (<1%) for a minimum of 15 minutes. This is to reduce the number of fish in the scrollcase prior to installing stop logs;

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

iv. Comply with other coordinated fish measures.

4.1.1.1.a. From November 1–March 31, turbine units will continue to be operated within the 1% range except when BPA load requests require the units to be operated outside the 1% range.

4.1.2. Minimum Generation / Power System Reliability. All of the lower Snake River powerhouses may be required to keep one generating turbine unit on line at all times to maintain power system reliability. During low flows, there may not be enough inflow to meet this generation requirement and required minimum spill. Under these circumstances the power generation requirement will take precedence over the minimum spill requirement. At Lower Monumental Dam, minimum generation requirements are: 16.5–19.5 kcfs, for turbine unit 1 (blades are fixed); 11.3–13.1 kcfs, for turbine units 2-3, and; 13.5–14.5 kcfs, for turbine units 4-6. Actual attainable minimum generation levels may vary depending on project conditions.

Table LMN-6. Lower Monumental Dam Turbine Unit 1 Output (MW) and Discharge (cfs) at Upper and Lower Limits of the 1% Efficiency Range with and without STSs. [1]

Project Head (feet)	Turbine Unit 1							
	With STS				No STS			
	1% Lower Limit		1% Upper Limit		1% Lower Limit		1% Upper Limit	
	MW	cfs	MW	cfs	MW	cfs	MW	cfs
85	**106.9**	**18,185**	**113.8**	**19,346**	**108.5**	**18,234**	**115.3**	**19,383**
86	108.6	18,222	115.4	19,361	110.1	18,268	116.9	19,395
87	110.2	18,258	116.9	19,375	111.8	18,301	118.5	19,406
88	111.8	18,292	118.5	19,388	113.4	18,332	120.1	19,416
89	113.5	18,325	120.1	19,400	115.1	18,361	121.7	19,425
90	**115.0**	**18,338**	**121.6**	**19,394**	**116.7**	**18,390**	**123.3**	**19,433**
91	116.4	18,335	123.1	19,390	118.1	18,384	124.8	19,426
92	117.8	18,331	124.6	19,385	119.5	18,377	126.3	19,418
93	119.2	18,328	126.0	19,381	120.9	18,370	127.7	19,411
94	120.6	18,323	127.5	19,375	122.3	18,364	129.2	19,403
95	**121.9**	**18,304**	**128.9**	**19,354**	**123.7**	**18,356**	**130.7**	**19,394**
96	123.3	18,310	130.4	19,367	125.1	18,360	132.2	19,404
97	124.7	18,315	131.9	19,379	126.5	18,362	133.7	19,413
98	126.1	18,321	133.5	19,390	127.9	18,365	135.3	19,421
99	127.5	18,326	135.0	19,401	129.3	18,367	136.8	19,430
100	**128.8**	**18,316**	**136.4**	**19,396**	**130.7**	**18,369**	**138.3**	**19,437**
101	130.3	18,322	138.1	19,430	132.2	18,373	140.0	19,468
102	131.7	18,328	139.8	19,463	133.6	18,376	141.7	19,498
103	133.1	18,334	141.5	19,494	135.0	18,380	143.4	19,526
104	134.5	18,340	143.2	19,525	136.4	18,382	145.1	19,554
105	**135.9**	**18,331**	**144.8**	**19,539**	**137.9**	**18,385**	**146.8**	**19,581**

1. Unit 1 has fixed-pitch blades. Tables based on 1962 model test and 2005 U1 abbreviated index test.

Table LMN-7. Lower Monumental Dam Turbine Units 2 and 3 Output (MW) and Discharge (cfs) Per Unit at Upper and Lower Limits of the 1% Efficiency Range with and without STSs. [1]

Project Head (feet)	Turbine Units 2 and 3							
	With STS				No STS			
	1% Lower Limit		1% Upper Limit		1% Lower Limit		1% Upper Limit	
	MW	cfs	MW	cfs	MW	cfs	MW	cfs
80	**62.2**	**10,817**	**114.4**	**19,891**	**62.8**	**10,772**	**112.1**	**19,234**
81	63.5	10,892	117.2	20,106	64.1	10,846	114.8	19,442
82	64.8	10,964	120.0	20,314	65.4	10,919	117.6	19,644
83	66.1	11,035	122.8	20,517	66.6	10,989	120.3	19,840
84	67.3	11,103	125.6	20,714	67.9	11,057	123.1	20,031
85	**68.6**	**11,169**	**128.5**	**20,905**	**69.2**	**11,123**	**125.8**	**20,216**
86	69.4	11,154	131.0	21,056	70.0	11,109	128.3	20,363
87	70.2	11,140	133.5	21,204	70.8	11,094	130.8	20,506
88	70.9	11,125	136.1	21,348	71.6	11,080	133.3	20,645
89	71.7	11,111	138.6	21,488	72.3	11,066	135.8	20,781
90	**72.4**	**11,097**	**141.2**	**21,625**	**73.1**	**11,052**	**138.3**	**20,913**
91	73.3	11,088	141.6	21,418	74.0	11,043	138.7	20,714
92	74.1	11,079	142.0	21,216	74.8	11,035	139.1	20,518
93	75.0	11,071	142.4	21,018	75.7	11,026	139.5	20,327
94	75.8	11,061	142.8	20,824	76.5	11,017	139.9	20,140
95	**76.7**	**11,052**	**143.2**	**20,634**	**77.4**	**11,009**	**140.3**	**19,956**
96	77.7	11,071	143.3	20,416	78.4	11,027	140.4	19,746
97	78.8	11,088	143.5	20,203	79.5	11,044	140.6	19,540
98	79.8	11,105	143.6	19,994	80.5	11,061	140.7	19,338
99	80.8	11,121	143.8	19,789	81.5	11,078	140.9	19,141
100	**81.8**	**11,137**	**144.0**	**19,589**	**82.6**	**11,093**	**141.0**	**18,947**
101	82.7	11,138	145.9	19,641	83.5	11,095	142.9	18,998
102	83.6	11,140	147.8	19,692	84.3	11,096	144.8	19,047
103	84.5	11,141	149.7	19,741	85.2	11,098	146.7	19,095
104	85.4	11,142	151.6	19,789	86.1	11,099	148.5	19,142
105	**86.2**	**11,143**	**153.5**	**19,837**	**87.0**	**11,100**	**150.4**	**19,188**
106	86.9	11,122	154.9	19,822	87.7	11,079	151.8	19,173
107	87.6	11,101	155.2	19,632	88.4	11,059	153.2	19,159
108	88.4	11,081	155.2	19,420	89.1	11,038	154.6	19,145
109	89.1	11,061	155.2	19,221	89.9	11,019	155.2	19,016
110	**89.8**	**11,041**	**155.2**	**19,007**	**90.6**	**10,999**	**155.2**	**18,818**

1. Tables revised to reflect new information using 2002 index test and original 1975 turbine model test. Table based on information provided by HDC in letter to NWW dated August 20, 2003 (Table revised 2005).

Table LMN-8. Lower Monumental Dam Turbine Units 4, 5 and 6 Output (MW) and Discharge (cfs) Per Unit at Upper and Lower Limits of the 1% Efficiency Range with and without STSs. [1]

Project Head (feet)	Turbine Units 4, 5, 6							
	With STS				Without STS			
	1% Lower Limit		1% Upper Limit		1% Lower Limit		1% Upper Limit	
	MW	cfs	MW	cfs	MW	cfs	MW	cfs
80	**84.3**	**14,189**	**115.1**	**19,364**	**84.0**	**13,999**	**113.9**	**18,975**
81	85.4	14,181	116.8	19,392	85.1	13,992	115.6	19,002
82	86.5	14,174	118.5	19,419	86.2	13,985	117.3	19,029
83	87.6	14,166	120.3	19,445	87.3	13,977	119.1	19,054
84	88.7	14,158	122.0	19,469	88.4	13,969	120.8	19,079
85	**89.8**	**14,150**	**123.8**	**19,493**	**89.5**	**13,962**	**122.5**	**19,102**
86	91.0	14,160	125.5	19,519	90.7	13,971	124.2	19,128
87	92.2	14,169	127.2	19,545	91.9	13,981	125.9	19,153
88	93.4	14,178	128.9	19,569	93.1	13,990	127.6	19,177
89	94.6	14,187	130.6	19,593	94.2	13,998	129.3	19,201
90	**95.7**	**14,195**	**132.3**	**19,616**	**95.4**	**14,006**	**131.0**	**19,224**
91	96.9	14,196	133.9	19,613	96.5	14,007	132.5	19,221
92	98.0	14,197	135.4	19,610	97.7	14,008	134.0	19,218
93	99.2	14,197	136.9	19,607	98.8	14,009	135.5	19,215
94	100.3	14,198	138.5	19,603	99.9	14,010	137.1	19,211
95	**101.4**	**14,198**	**140.0**	**19,600**	**101.1**	**14,010**	**138.6**	**19,208**
96	102.3	14,170	140.5	19,456	102.0	13,982	139.1	19,067
97	103.2	14,142	141.0	19,315	102.9	13,954	139.6	18,929
98	104.1	14,114	141.5	19,177	103.8	13,928	140.1	18,794
99	105.1	14,087	142.0	19,042	104.7	13,901	140.5	18,662
100	**106.0**	**14,061**	**142.5**	**18,909**	**105.6**	**13,875**	**141.0**	**18,532**
101	107.3	14,091	143.9	18,909	106.9	13,904	142.5	18,532
102	108.5	14,120	145.4	18,909	108.2	13,933	143.9	18,532
103	109.8	14,149	146.8	18,909	109.4	13,962	145.3	18,532
104	111.1	14,177	148.2	18,909	110.7	13,989	146.7	18,532
105	**112.4**	**14,204**	**149.6**	**18,909**	**112.0**	**14,017**	**148.1**	**18,532**
106	113.5	14,203	151.6	18,981	113.1	14,015	150.1	18,602
107	114.5	14,202	153.6	19,051	114.1	14,014	152.0	18,670
108	115.6	14,200	155.2	19,099	115.2	14,013	154.0	18,738
109	116.6	14,199	155.2	18,894	116.2	14,011	155.2	18,725
110	**117.7**	**14,198**	**155.2**	**18,694**	**117.3**	**14,010**	**155.2**	**18,531**

1. Tables revised to reflect new information using 2002 index test and original 1975 turbine model test. Table based on information provided by HDC in letter to NWW dated August 20, 2003 (Table revised 2005).

4.2. Turbine Unit Outages during High River Flows.

During high spring flows, turbine unit outages for inspecting fish screens, repairing research equipment (e.g., hydroacoustic or radio-telemetry), 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 Lower Monumental, this special operation shall take place when river flows are above 120 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.

4.3. Turbine Unit Maintenance.

4.3.1. The 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 from mid-July through late November. Maintenance of priority units for adult passage is normally completed in November–December but can be completed in mid-August. Impacts to migrating adults should be minimized. 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% peak efficiency range. This work will be scheduled in compliance with BPA load shaping guidelines (**Appendix C**) to minimize impacts on juvenile fish. Transformers are Doble tested every three years, or more frequently if there is a known problem with a transformer, and normally take 2–3 workdays. To conduct the testing, the distribution lines must be disconnected from the transformers and normal generation stopped. One turbine unit will operate at speed-no-load to provide project power and operation of fish passage facilities. Spill may be provided to meet minimum required project discharges during the testing hours. Doble tests are normally scheduled for August or early September to minimize impacts on adult and juvenile fish passage. If Doble testing impacts priority units for fish passage, adult passage timing should be considered to minimize impacts to migrating adults.

4.3.2. Head Gates.[2] Turbine units are to be operated with raised head gates to improve fish passage conditions when STSs are installed, except as provided below. To facilitate annual maintenance, head gates are used to dewater the turbine units. To minimize turbine outage periods to the actual time required for maintenance (from July 1–December 15), head gates in one turbine unit may be lowered to the standard operating position and connected to hydraulic cylinders on the afternoon of the last regular workday (normally Thursday) prior to the start of the maintenance. With the head gates in the standard operating position, the turbine unit may be operated until 0700 hours of the next regular workday (normally Monday). Once maintenance is

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

completed, the turbine unit can be operated with the head gates in the standard operating position until 1200 hours of the first regular workday. If turbine maintenance or the raising of the head gates to the raised operating position is delayed after the time periods stated above, the turbine unit shall be immediately taken out of service until the work can be accomplished. Operation of turbine units with head gates in the standard operating position shall be restricted to July 1–December 15, and shall not occur unless at least four other turbine units are available for service. No more than one turbine unit at a time shall be operated with head gates in the standard operating position and the turbine unit will be operated on last-on, first-off priority.

4.3.3. Unwatering turbine units should be accomplished in accordance with project dewatering plans. If the turbine unit draft tube is to be dewatered, operate unit with full load for a minimum of 15 minutes prior to installing tail logs. 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 scrollcase 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. Units may be operationally tested for up to 30 minutes before going into maintenance status by running the unit at speed no load and various loads within the 1% criteria to allow pre-maintenance measurements and testing AND TO ALLOW ALL FISH TO MOVE THROUGH THE UNIT. Units may be operationally tested after maintenance or repair while remaining in maintenance or forced outage status. Operational testing may consist of running the unit for up to a cumulative time of 30 minutes (within 1% criteria) before it is returned to operational status. Operational testing OF UNIT UNDER MAINTENANCE is in addition to a unit in run status (E.G. MINIMUM GENERATION) required for power plant reliability. Operational testing may deviate from fish priority units and may require water that would otherwise be used for spill if the running unit for reliability is at its 1% minimum load. Water will be used from the powerhouse allocation if possible, and water diverted from spill for operational testing will be minimized to that necessary to maintain and assure generation system reliability.

4.3.5. 6-Year Overhaul. One unit per year is selected for a 6-year overhaul at Lower Monumental. A 6-year maintenance outage requires unwatering the unit so that more in-depth maintenance other than annual checks can be performed. This level of maintenance requires additional consideration before the outage (pre-outage) and after the work is complete (post-outage). During the course of this work, many systems and sub-systems of the unit may be disassembled, replaced or repaired.

> **4.3.5.1.a. Scheduling:** The outage for the overhaul unit will be scheduled during a period which minimizes impacts to fish. The work will start as recommended in **4.3** above.
>
> **4.3.5.1.b. Pre-Outage Run Time:** Prior to a unit coming out-of-service (OOS) for 6-year overhaul, the unit may need to be run continuously for 48 hours, which may require a deviation from unit priority in **Table LMN-5**. Scheduling the unit first in line for maintenance should allow for ample water to accommodate a 48-hour run time to finalize pre-maintenance checks. More water (kcfs) will be required if unit 4, 5 or 6 is selected. This will require a deviation from Minimum Generation section in the Fish Operations Plan (FOP), included in the FPP as **Appendix E**.

4.3.5.1.c. Post-Outage Run Time: Following a 6-year overhaul, the unit must be run continuous for 48 hours to ensure unit is ready for service. Following 48 hours of continuous run time, a second period of 48 hours of intermittent testing may be required to fix minor items detected in the continuous run time. This post-outage run will require a deviation from the unit priority table in LMN-5. The post-outage run will require a deviation from paragraph 4.3.1 to allow the unit to run with the headgate cylinder in place and the headgate in the lower position. If the unit selected for 6-year overhaul is unit 4, 5 or 6, a deviation from minimum generation as defined in the FOP will be necessary as units 4-6 require an additional 2-3 kcfs at lower ranges of operation. The constraint of running the unit within the 1% efficiency guideline will remain in place.

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. 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. Debris Spill Coordination.

All special spills (other than normal patterns for ongoing spill operations) and project operations for passing debris will be coordinated prior to operations taking place. Each project shall contact CENWW-OD-T at least two workdays prior to the day of the requested special project debris spill operation. 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.

5.2. Emergency Spills.

Emergency spills may be implemented if necessary to pass woody debris accumulating in front of the spillbay weir and compromising the safe unobstructed fish passage. The project will immediately spill the woody debris obstructing fish passage and will notify CENWW-OD-T of the emergency spill as soon as possible to notify RCC, NOAA Fisheries, and FPOM.

Table LMN-9. [pg *1 of 3*] Lower Monumental Dam Bulk Spill Patterns with RSW. [a]

Total Spill (kcfs)	LMN Bulk Spill Patterns w/RSW [a] # Gate Stops per Spillbay								Total Stops (#)
	Bay 1	Bay 2	Bay 3	Bay 4	Bay 5	Bay 6	Bay 7	Bay 8 (RSW) [b]	
8.6		1						4.5	**5.5**
10.1		2						4.5	**6.5**
11.9		2				1		4.5	**7.5**
13.4		2				2		4.5	**8.5**
14.9		2				3		4.5	**9.5**
16.3		2				4		4.5	**10.5**
17.8		3				4		4.5	**11.5**
19.6		3			1	4		4.5	**12.5**
21.3		3			1	5		4.5	**13.5**
23.1	1	3			1	5		4.5	**14.5**
25.4	1	1	1	1	1	6		4.5	**15.5**
26.9	1	1	1	1	2	6		4.5	**16.5**
28.4	1	1	1	2	2	6		4.5	**17.5**
29.6	1	1	1	2	4	5		4.5	**18.5**
31.3	1	1	1	2	5	5		4.5	**19.5**
32.8	2	1	1	2	5	5		4.5	**20.5**
34.3	2	1	2	2	5	5		4.5	**21.5**
35.8	2	2	2	2	5	5		4.5	**22.5**
37.3	3	2	2	2	5	5		4.5	**23.5**
38.8	3	3	2	2	5	5		4.5	**24.5**
40.6	3	3	2	2	5	5	1	4.5	**25.5**
42.1	3	3	2	2	5	5	2	4.5	**26.5**
43.6	3	3	2	3	5	5	2	4.5	**27.5**
45.1	3	3	3	3	5	5	2	4.5	**28.5**
46.8	3	3	3	3	5	6	2	4.5	**29.5**
48.5	3	3	3	3	6	6	2	4.5	**30.5**
50.0	3	3	3	3	6	6	3	4.5	**31.5**
51.4	3	3	3	3	6	6	4	4.5	**32.5**
53.1	3	3	3	3	6	6	5	4.5	**33.5**
54.8	3	3	3	3	6	6	6	4.5	**34.5**
56.2	3	3	3	4	6	6	6	4.5	**35.5**
57.6	3	3	4	4	6	6	6	4.5	**36.5**
59.0	3	4	4	4	6	6	6	4.5	**37.5**
60.4	4	4	4	4	6	6	6	4.5	**38.5**
62.1	4	4	4	5	6	6	6	4.5	**39.5**
63.8	4	4	5	5	6	6	6	4.5	**40.5**
65.5	4	5	5	5	6	6	6	4.5	**41.5**
67.2	5	5	5	5	6	6	6	4.5	**42.5**
68.9	5	5	5	6	6	6	6	4.5	**43.5**

Total Spill	LMN Bulk Spill Patterns w/RSW [a] # Gate Stops per Spillbay								Total Stops
(kcfs)	Bay 1	Bay 2	Bay 3	Bay 4	Bay 5	Bay 6	Bay 7	Bay 8 (RSW) [b]	(#)
70.6	5	5	6	6	6	6	6	4.5	**44.5**
72.3	5	6	6	6	6	6	6	4.5	**45.5**
74.0	6	6	6	6	6	6	6	4.5	**46.5**
75.6	6	6	6	6	6	7	6	4.5	**47.5**
77.2	6	7	6	6	6	7	6	4.5	**48.5**
78.8	6	7	6	6	7	7	6	4.5	**49.5**
80.4	6	7	7	6	7	7	6	4.5	**50.5**
82.0	6	7	7	7	7	7	6	4.5	**51.5**
83.6	7	7	7	7	7	7	6	4.5	**52.5**
85.2	7	7	7	7	7	7	7	4.5	**53.5**
87.0	7	7	7	7	7	8	7	4.5	**54.5**
88.8	7	8	7	7	7	8	7	4.5	**55.5**
90.6	7	8	7	7	8	8	7	4.5	**56.5**
92.4	7	8	8	7	8	8	7	4.5	**57.5**
94.2	7	8	8	8	8	8	7	4.5	**58.5**
96.0	8	8	8	8	8	8	7	4.5	**59.5**
97.8	8	8	8	8	8	8	8	4.5	**60.5**
99.4	8	8	8	8	8	9	8	4.5	**61.5**
101.0	8	9	8	8	8	9	8	4.5	**62.5**
102.6	8	9	8	8	9	9	8	4.5	**63.5**
104.2	8	9	9	8	9	9	8	4.5	**64.5**
105.8	8	9	9	9	9	9	8	4.5	**65.5**
107.4	9	9	9	9	9	9	8	4.5	**66.5**
109.0	9	9	9	9	9	9	9	4.5	**67.5**
110.8	9	9	9	9	9	10	9	4.5	**68.5**
112.6	9	10	9	9	9	10	9	4.5	**69.5**
114.4	9	10	9	9	10	10	9	4.5	**70.5**
116.2	9	10	10	9	10	10	9	4.5	**71.5**
118.0	9	10	10	10	10	10	9	4.5	**72.5**
119.8	10	10	10	10	10	10	9	4.5	**73.5**
121.6	10	10	10	10	10	10	10	4.5	**74.5**
123.3	10	10	10	10	10	11	10	4.5	**75.5**
125.0	10	11	10	10	10	11	10	4.5	**76.5**
126.7	10	11	10	10	11	11	10	4.5	**77.5**
128.4	10	11	11	10	11	11	10	4.5	**78.5**
130.1	10	11	11	11	11	11	10	4.5	**79.5**
131.8	11	11	11	11	11	11	10	4.5	**80.5**
133.5	11	11	11	11	11	11	11	4.5	**81.5**
135.2	11	11	11	11	11	12	11	4.5	**82.5**
136.9	11	12	11	11	11	12	11	4.5	**83.5**

Total Spill	LMN Bulk Spill Patterns w/RSW [a] # Gate Stops per Spillbay								Total Stops
(kcfs)	Bay 1	Bay 2	Bay 3	Bay 4	Bay 5	Bay 6	Bay 7	Bay 8 (RSW) [b]	(#)
138.6	11	12	11	11	12	12	11	4.5	**84.5**
140.3	11	12	12	11	12	12	11	4.5	**85.5**
142.0	11	12	12	12	12	12	11	4.5	**86.5**
143.7	12	12	12	12	12	12	11	4.5	**87.5**
145.4	12	12	12	12	12	12	12	4.5	**88.5**
147.1	12	12	12	12	12	13	12	4.5	**89.5**
148.8	12	13	12	12	12	13	12	4.5	**90.5**
150.5	12	13	12	12	13	13	12	4.5	**91.5**
152.2	12	13	13	12	13	13	12	4.5	**92.5**
153.9	12	13	13	13	13	13	12	4.5	**93.5**
155.6	13	13	13	13	13	13	12	4.5	**94.5**
157.3	13	13	13	13	13	13	13	4.5	**95.5**
159.0	13	13	13	13	13	14	13	4.5	**96.5**
160.7	13	14	13	13	13	14	13	4.5	**97.5**
162.4	13	14	13	13	14	14	13	4.5	**98.5**
164.1	13	14	14	13	14	14	13	4.5	**99.5**
165.8	13	14	14	14	14	14	13	4.5	**100.5**
167.5	14	14	14	14	14	14	13	4.5	**101.5**
169.2	14	14	14	14	14	14	14	4.5	**102.5**
171.0	14	14	14	14	14	15	14	4.5	**103.5**
172.8	14	15	14	14	14	15	14	4.5	**104.5**
174.6	14	15	14	14	15	15	14	4.5	**105.5**
176.4	14	15	15	14	15	15	14	4.5	**106.5**
178.2	14	15	15	15	15	15	14	4.5	**107.5**
180.0	15	15	15	15	15	15	14	4.5	**108.5**
181.8	15	15	15	15	15	15	15	4.5	**109.5**

a. "Total Spill" calculated at forebay elevation 537.0 ft based on interim spillway rating table dated 2 Apr 2009. Patterns expanded February 2014 for lower spill <8.6 kcfs when the RSW cannot be operated.

b. Bay 8 with RSW equivalent to ~4.5 stops at forebay elevation 537.0 ft. Raise Bay 8 tainter gate above stop 9 for RSW to ensure free surface and debris passage.

Table LMN-10. [*pg 1 of 3*] Lower Monumental Dam Uniform Spill Patterns with RSW. [a]

Total Spill (kcfs)	LMN Uniform Spill Patterns w/RSW [a] # Gate Stops per Spillbay								Total Stops (#)
	Bay 1	Bay 2	Bay 3	Bay 4	Bay 5	Bay 6	Bay 7	Bay 8 (RSW) [b]	
8.6						1		4.5	**5.5**
10.4		1				1		4.5	**6.5**
12.2		1			1	1		4.5	**7.5**
14		1	1		1	1		4.5	**8.5**
15.8		1	1	1	1	1		4.5	**9.5**
17.6	1	1	1	1	1	1		4.5	**10.5**
19.4	1	1	1	1	1	1	1	4.5	**11.5**
20.9	1	1	1	1	1	2	1	4.5	**12.5**
22.4	1	2	1	1	1	2	1	4.5	**13.5**
23.9	1	2	1	1	2	2	1	4.5	**14.5**
25.4	1	2	2	1	2	2	1	4.5	**15.5**
26.9	1	2	2	2	2	2	1	4.5	**16.5**
28.4	2	2	2	2	2	2	1	4.5	**17.5**
29.9	2	2	2	2	2	2	2	4.5	**18.5**
31.4	2	2	2	2	2	3	2	4.5	**19.5**
32.9	2	3	2	2	2	3	2	4.5	**20.5**
34.4	2	3	2	2	3	3	2	4.5	**21.5**
35.9	2	3	3	2	3	3	2	4.5	**22.5**
37.4	2	3	3	3	3	3	2	4.5	**23.5**
38.9	3	3	3	3	3	3	2	4.5	**24.5**
40.4	3	3	3	3	3	3	3	4.5	**25.5**
41.8	3	3	3	3	3	4	3	4.5	**26.5**
43.2	3	4	3	3	3	4	3	4.5	**27.5**
44.6	3	4	3	3	4	4	3	4.5	**28.5**
46	3	4	4	3	4	4	3	4.5	**29.5**
47.4	3	4	4	4	4	4	3	4.5	**30.5**
48.8	4	4	4	4	4	4	3	4.5	**31.5**
50.2	4	4	4	4	4	4	4	4.5	**32.5**
51.9	4	4	4	4	4	5	4	4.5	**33.5**
53.6	4	5	4	4	4	5	4	4.5	**34.5**
55.3	4	5	4	4	5	5	4	4.5	**35.5**
57	4	5	5	4	5	5	4	4.5	**36.5**
58.7	4	5	5	5	5	5	4	4.5	**37.5**
60.4	5	5	5	5	5	5	4	4.5	**38.5**
62.1	5	5	5	5	5	5	5	4.5	**39.5**
63.8	5	5	5	5	5	6	5	4.5	**40.5**
65.5	5	6	5	5	5	6	5	4.5	**41.5**
67.2	5	6	5	5	6	6	5	4.5	**42.5**
68.9	5	6	6	5	6	6	5	4.5	**43.5**
70.6	5	6	6	6	6	6	5	4.5	**44.5**
72.3	6	6	6	6	6	6	5	4.5	**45.5**
74	6	6	6	6	6	6	6	4.5	**46.5**

Total Spill	LMN Uniform Spill Patterns w/RSW [a] # Gate Stops per Spillbay								Total Stops
(kcfs)	Bay 1	Bay 2	Bay 3	Bay 4	Bay 5	Bay 6	Bay 7	Bay 8 (RSW) [b]	(#)
75.6	6	6	6	6	6	7	6	4.5	**47.5**
77.2	6	7	6	6	6	7	6	4.5	**48.5**
78.8	6	7	6	6	7	7	6	4.5	**49.5**
80.4	6	7	7	6	7	7	6	4.5	**50.5**
82	6	7	7	7	7	7	6	4.5	**51.5**
83.6	7	7	7	7	7	7	6	4.5	**52.5**
85.2	7	7	7	7	7	7	7	4.5	**53.5**
87	7	7	7	7	7	8	7	4.5	**54.5**
88.8	7	8	7	7	7	8	7	4.5	**55.5**
90.6	7	8	7	7	8	8	7	4.5	**56.5**
92.4	7	8	8	7	8	8	7	4.5	**57.5**
94.2	7	8	8	8	8	8	7	4.5	**58.5**
96	8	8	8	8	8	8	7	4.5	**59.5**
97.8	8	8	8	8	8	8	8	4.5	**60.5**
99.4	8	8	8	8	8	9	8	4.5	**61.5**
101	8	9	8	8	8	9	8	4.5	**62.5**
102.6	8	9	8	8	9	9	8	4.5	**63.5**
104.2	8	9	9	8	9	9	8	4.5	**64.5**
105.8	8	9	9	9	9	9	8	4.5	**65.5**
107.4	9	9	9	9	9	9	8	4.5	**66.5**
109	9	9	9	9	9	9	9	4.5	**67.5**
110.8	9	9	9	9	9	10	9	4.5	**68.5**
112.6	9	10	9	9	9	10	9	4.5	**69.5**
114.4	9	10	9	9	10	10	9	4.5	**70.5**
116.2	9	10	10	9	10	10	9	4.5	**71.5**
118	9	10	10	10	10	10	9	4.5	**72.5**
119.8	10	10	10	10	10	10	9	4.5	**73.5**
121.6	10	10	10	10	10	10	10	4.5	**74.5**
123.3	10	10	10	10	10	11	10	4.5	**75.5**
125	10	11	10	10	10	11	10	4.5	**76.5**
126.7	10	11	10	10	11	11	10	4.5	**77.5**
128.4	10	11	11	10	11	11	10	4.5	**78.5**
130.1	10	11	11	11	11	11	10	4.5	**79.5**
131.8	11	11	11	11	11	11	10	4.5	**80.5**
133.5	11	11	11	11	11	11	11	4.5	**81.5**
135.2	11	11	11	11	11	12	11	4.5	**82.5**
136.9	11	12	11	11	11	12	11	4.5	**83.5**
138.6	11	12	11	11	12	12	11	4.5	**84.5**
140.3	11	12	12	11	12	12	11	4.5	**85.5**
142	11	12	12	12	12	12	11	4.5	**86.5**
143.7	12	12	12	12	12	12	11	4.5	**87.5**
145.4	12	12	12	12	12	12	12	4.5	**88.5**
147.1	12	12	12	12	12	13	12	4.5	**89.5**

Total Spill	LMN Uniform Spill Patterns w/RSW [a] # Gate Stops per Spillbay								Total Stops
(kcfs)	Bay 1	Bay 2	Bay 3	Bay 4	Bay 5	Bay 6	Bay 7	Bay 8 (RSW) [b]	(#)
148.8	12	13	12	12	12	13	12	4.5	**90.5**
150.5	12	13	12	12	13	13	12	4.5	**91.5**
152.2	12	13	13	12	13	13	12	4.5	**92.5**
153.9	12	13	13	13	13	13	12	4.5	**93.5**
155.6	13	13	13	13	13	13	12	4.5	**94.5**
157.3	13	13	13	13	13	13	13	4.5	**95.5**
159	13	13	13	13	13	14	13	4.5	**96.5**
160.7	13	14	13	13	13	14	13	4.5	**97.5**
162.4	13	14	13	13	14	14	13	4.5	**98.5**
164.1	13	14	14	13	14	14	13	4.5	**99.5**
165.8	13	14	14	14	14	14	13	4.5	**100.5**
167.5	14	14	14	14	14	14	13	4.5	**101.5**
169.2	14	14	14	14	14	14	14	4.5	**102.5**
171	14	14	14	14	14	15	14	4.5	**103.5**
172.8	14	15	14	14	14	15	14	4.5	**104.5**
174.6	14	15	14	14	15	15	14	4.5	**105.5**
176.4	14	15	15	14	15	15	14	4.5	**106.5**
178.2	14	15	15	15	15	15	14	4.5	**107.5**
180	15	15	15	15	15	15	14	4.5	**108.5**
181.8	15	15	15	15	15	15	15	4.5	**109.5**

a. "Total Spill" calculated at forebay elevation 537.0 ft based on interim spillway rating table dated 2 Apr 2009.

b. Bay 8 with RSW equivalent to ~4.5 stops at forebay elevation 537.0 ft. Raise Bay 8 tainter gate above stop 9 for RSW to ensure free surface and debris passage.