2022 Fish Passage Plan

Chapter 7 – Lower Monumental Dam

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Lower Monumental Dam

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’/hour
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, so the official Corps NWD acronym is **LMN**.

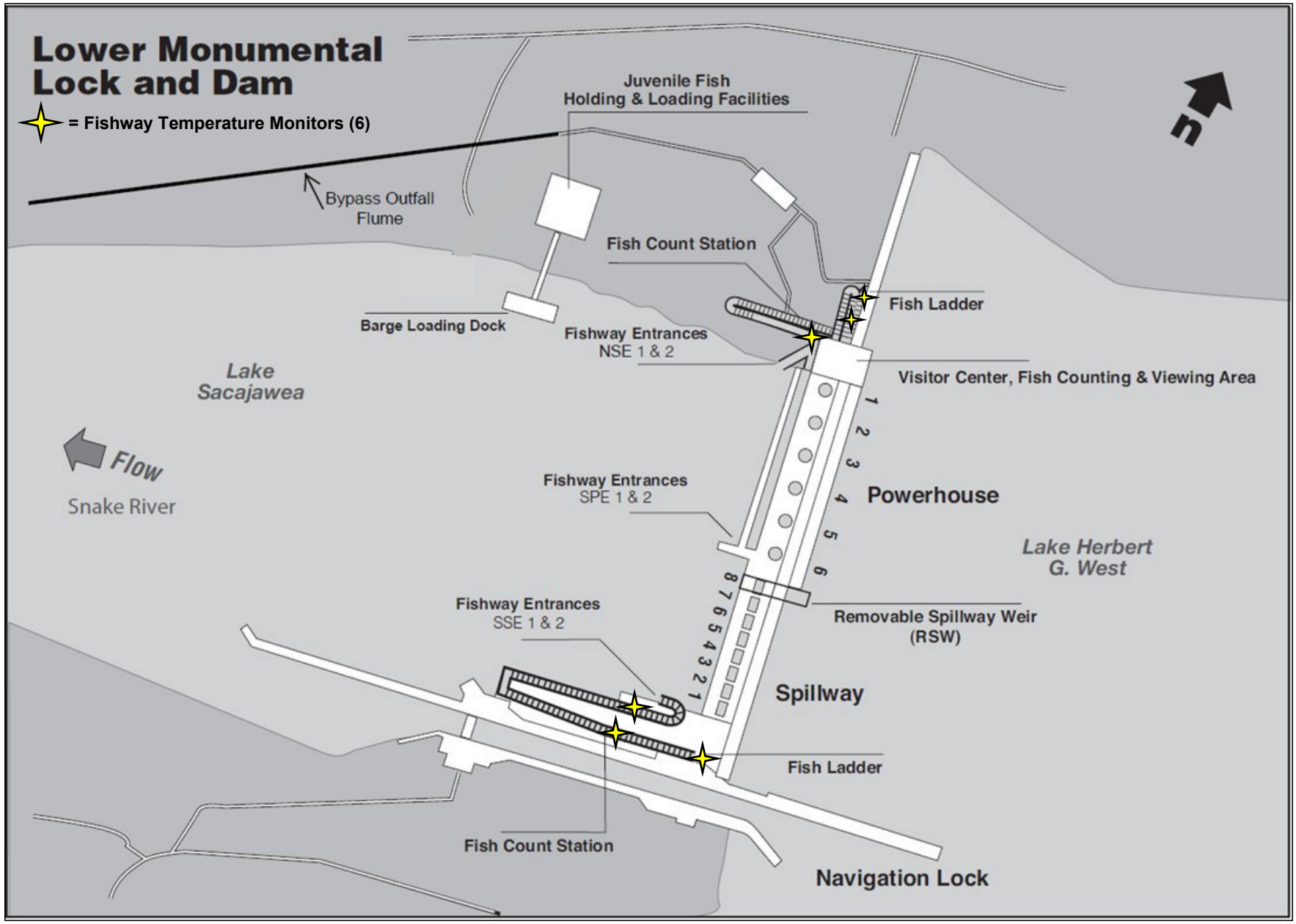
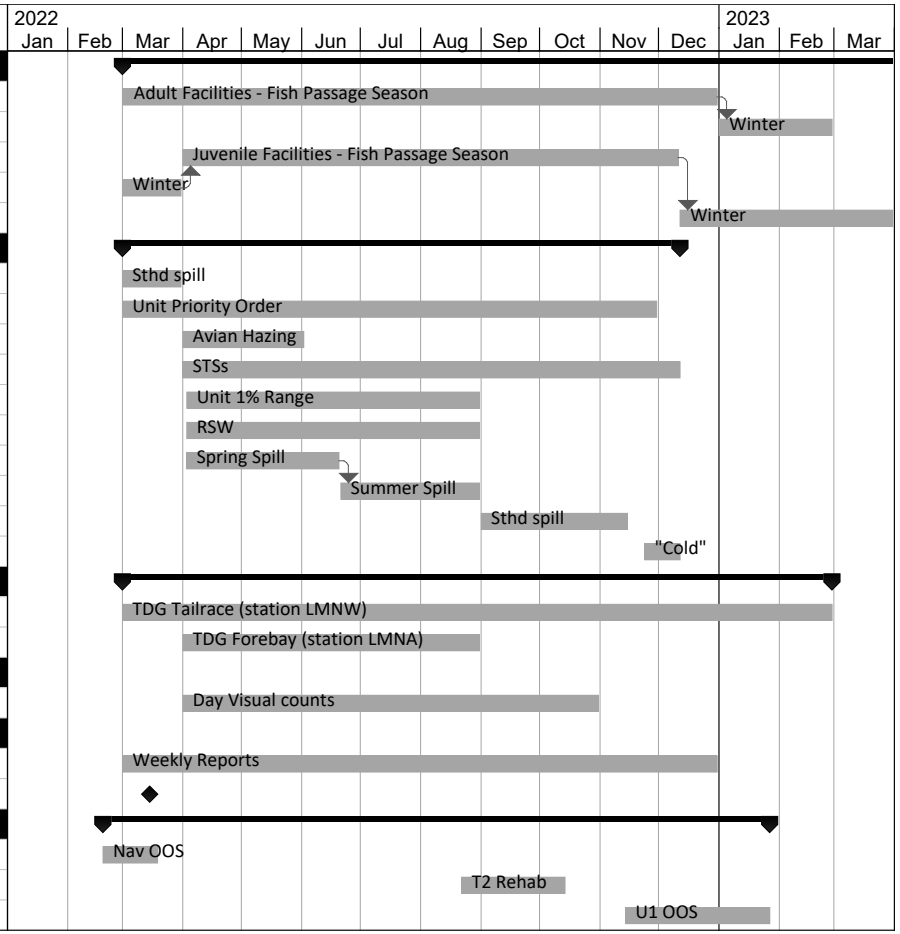


Figure LMN-1. Lower Monumental Lock & Dam General Site Plan.

Table LMN-1. Lower Monumental Dam Schedule of Operations and Actions Defined in the 2022 Fish Passage Plan.

Task Name	Start	End	FPP Section
FISH PASSAGE FACILITIES	**Tue 3/1/22**	**Fri 3/31/23**	
Adult Facilities - Fish Passage Season	Tue 3/1/22	Sat 12/31/22	2.4.2
Adult Facilities - Winter Maintenance	Sun 1/1/23	Tue 2/28/23	2.4.1
Juvenile Facilities - Fish Passage Season	Fri 4/1/22	Sun 12/11/22	2.3.2
Juvenile Facilities - Winter Maintenance	Tue 3/1/22	Thu 3/31/22	2.3.1
	Mon 12/12/22	Fri 3/31/23	
PROJECT OPERATIONS FOR FISH PASSAGE	**Tue 3/1/22**	**Mon 12/12/22**	
RSW Spill for Adult Steelhead	Tue 3/1/22	Thu 3/31/22	2.2.2
Turbine unit priority order	Tue 3/1/22	Wed 11/30/22	4.1
Avian hazing	Fri 4/1/22	Thu 6/2/22	Appendix L
STSs	Fri 4/1/22	Mon 12/12/22	2.3.2
Turbine unit 1% operating range	Sun 4/3/22	Wed 8/31/22	4.2
RSW open (end date approx)	Sun 4/3/22	Wed 8/31/22	2.3.2.6
Spring Spill	Sun 4/3/22	Mon 6/20/22	App E (FOP)
Summer Spill	Tue 6/21/22	Wed 8/31/22	App E (FOP)
RSW Spill for Adult Steelhead	Thu 9/1/22	Tue 11/15/22	2.2.2
STS removal during cold weather	Thu 11/24/22	Mon 12/12/22	2.3.2.2
TDG MONITORING	**Tue 3/1/22**	**Tue 2/28/23**	
TDG Monitoring - Tailrace (year-round)	Tue 3/1/22	Tue 2/28/23	2.2
TDG Monitoring - Forebay	Fri 4/1/22	Wed 8/31/22	2.2
ADULT FISH COUNTING	**Fri 4/1/22**	**Mon 10/31/22**	
Day Visual 0500-2100 PDT	Fri 4/1/22	Mon 10/31/22	1.2.2
REPORTS	**Tue 3/1/22**	**Sat 12/31/22**	
Weekly Reports	Tue 3/1/22	Sat 12/31/22	2.5.2
Annual Report due (for previous year)	Tue 3/15/22	Tue 3/15/22	2.5.2
SPECIAL OPS & STUDIES (Appendix A)	**Sat 2/19/22**	**Fri 1/27/23**	
Navigation Lock annual outage	Sat 2/19/22	Sat 3/19/22	App A 1.4
T2 Rehabilitation	Mon 8/22/22	Fri 10/14/22	App A 7.1
U1 Maintenance	Mon 11/14/22	Fri 1/27/23	App A 7.1



1. FISH PASSAGE INFORMATION

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

1.1. Juvenile Fish Facilities and Migration Timing.

1.1.1. Juvenile Fish Facilities.

1.1.1.1. The Lower Monumental Dam juvenile fish facilities consist of:

i. standard-length submersible traveling screens (STS),

ii. vertical barrier screens (VBS),

iii. 12" orifices,

iv. collection gallery,

v. dewatering structure,

vi. and a bypass flume to the tailrace.

1.1.1.2. Transportation facilities consist of:

i. a separator to sort by size and separate from adult fish,

ii. sampling facilities,

iii. raceways,

iv. office and sampling building,

v. truck and barge loading facilities,

vi. and PIT-tag detection and deflector systems.

1.1.1.3. Maintenance of juvenile fish facilities that may impact fish or facility operations should be conducted during the winter maintenance period.

1.1.2. Juvenile Fish Migration Timing. Juvenile fish passage timing at Lower Monumental Dam is shown in **Table LMN-2** based on collection data from the most recent 10-year period (does not reflect fish guidance efficiency [FGE] or passage via the RSW or spillway). Salmon, steelhead, bull trout, lamprey, and other species are routinely counted.

Table LMN-2. Juvenile Salmonid Passage Timing at Lower Monumental Dam for Most Recent 10 Years Based on Daily & Yearly Collection Data.

Year	10%	50%	90%	# Days	10%	50%	90%	# Days
	Yearling Chinook (wild & hatchery)				Subyearling Chinook (wild & hatchery)			
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
2014	3-May	8-May	21-May	18	3-Jun	11-Jun	11-Jul	38
2015	2-May	8-May	14-May	12	30-May	8-Jun	30-Jun	31
2016	22-Apr	5-May	11-May	19	5-Jun	11-Jun	5-Jul	30
2017	18-Apr	6-May	14-May	26	18-Apr	6-May	17-Jun	60
2018	18-Apr	4-May	15-May	27	29-May	2-Jun	5-Jul	37
2019*	3-Apr	30-Apr	18-May	45	28-May	2-Jun	28-Jun	31
2020	28-Apr	14-May	22-May	24	19-May	25-Jun	22-Jul	64
2021	11-Apr	8-May	19-May	38	29-May	29-Jun	3-Jul	35
10-Yr MEDIAN	**25-Apr**	**8-May**	**17-May**	**22**	**29-May**	**11-Jun**	**5-Jul**	**36**
10-Yr MIN	**3-Apr**	**30-Apr**	**11-May**	**7**	**18-Apr**	**6-May**	**17-Jun**	**30**
10-Yr MAX	**9-May**	**14-May**	**24-May**	**45**	**6-Jun**	**29-Jun**	**22-Jul**	**64**
	Unclipped Steelhead				Clipped Steelhead			
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
2014	3-May	15-May	28-May	25	2-May	8-May	25-May	23
2015	3-May	12-May	22-May	19	1-May	8-May	20-May	19
2016	20-Apr	6-May	16-May	26	22-Apr	30-Apr	11-May	19
2017	22-Apr	9-May	23-May	31	20-Apr	2-May	13-May	23
2018	20-Apr	5-May	23-May	33	16-Apr	30-Apr	13-May	27
2019*	17-Apr	25-Apr	19-May	32	13-Apr	25-Apr	13-May	30
2020	30-Apr	10-May	26-May	26	25-Apr	3-May	24-May	29
2021	24-Apr	9-May	23-May	29	20-Apr	29-Apr	20-May	30
10-Yr MEDIAN	**27-Apr**	**9-May**	**23-May**	**26**	**23-Apr**	**2-May**	**19-May**	**23**
10-Yr MIN	**17-Apr**	**25-Apr**	**16-May**	**12**	**13-Apr**	**25-Apr**	**11-May**	**11**
10-Yr MAX	**9-May**	**19-May**	**2-Jun**	**33**	**8-May**	**15-May**	**27-May**	**30**
	Coho (wild & hatchery)				Sockeye (wild & hatchery)			
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
2014	7-May	21-May	29-May	22	3-May	14-May	25-May	22
2015	10-May	18-May	29-May	19	16-May	19-May	21-May	5
2016	2-May	9-May	19-May	17	21-May	22-May	26-May	5
2017	9-May	15-May	29-May	20	20-Apr	14-May	26-May	36
2018	29-Apr	20-May	26-May	27	1-May	13-May	3-Jun	33
2019*	23-Apr	19-May	4-Jun	42	18-May	20-May	22-May	4
2020	3-May	19-May	13-May	10	16-May	19-May	22-May	6
2021	6-May	18-May	9-Jun	34	3-May	13-May	19-May	16
10-Yr MEDIAN	**6-May**	**18-May**	**29-May**	**21**	**12-May**	**19-May**	**24-May**	**11**
10-Yr MIN	**23-Apr**	**9-May**	**13-May**	**10**	**20-Apr**	**13-May**	**19-May**	**4**
10-Yr MAX	**10-May**	**22-May**	**9-Jun**	**42**	**21-May**	**22-May**	**3-Jun**	**36**

*2019 passage data include the early start of Lower Monumental sampling on March 1st.

1.2. Adult Fish Facilities and Migration Timing.

1.2.1. Adult Fish Facilities. Lower Monumental adult fish facilities are comprised of north and south shore ladders and collection systems with a common auxiliary water supply. Maintenance occurs in Jan–Feb, typically one shore at a time to minimize impacts on upstream migrants.

1.2.1.1. The north shore ladder connects to two north shore entrances and the powerhouse collection system. The powerhouse collection system has two entrances at the downstream south end of the powerhouse (a former side entrance is 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 fish passage season.

1.2.1.2. The south shore ladder has two downstream entrances (a former side entrance is 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 Fish Migration Timing & Counting.

1.2.2.1. Upstream migrants are present throughout the year and adult facilities are operated year-round. Adult salmon, steelhead, bull trout, shad, and lamprey are counted per the schedule in **Table LMN-3** and data are posted daily at: www.fpc.org. The presence of other species (i.e., sturgeon, grass carp, Atlantic salmon, etc.) are recorded as comments and reported in the *Annual Fish Passage Report*. Relatively few fish pass the south ladder so one person can count both ladders from the north shore counting room by direct observation of the north viewing window and by video monitor of the south shore counting room.

1.2.2.2. Yearly counts through the most recent passage year are used to determine the earliest and latest dates of peak adult fish passage defined in **Table LMN-4**. Time-of-day (diel) distributions of adult salmonids at fishway entrances and exits are shown in **Figure LMN-2**.

Table LMN-3. Lower Monumental Adult Fish Counting Schedule Mar 2022-Feb 2023.

Count Period	Counting Method and Hours *
April 1 – October 31	Day Visual 0500–2100 hours (PDT)

*PST = Pacific Standard Time; PDT = Pacific Daylight Time, in effect during daylight saving time 3/13/22–11/6/22.

Table LMN-4. Lower Monumental Dam Adult Fish Count Period and Peak Passage Timing (based on yearly counts from 1969 through most recent count year).

Species	Count Period	Earliest Peak	Latest Peak
Spring Chinook	Apr 1 – Jun 13	Apr 20	June 9
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 7	Aug 17

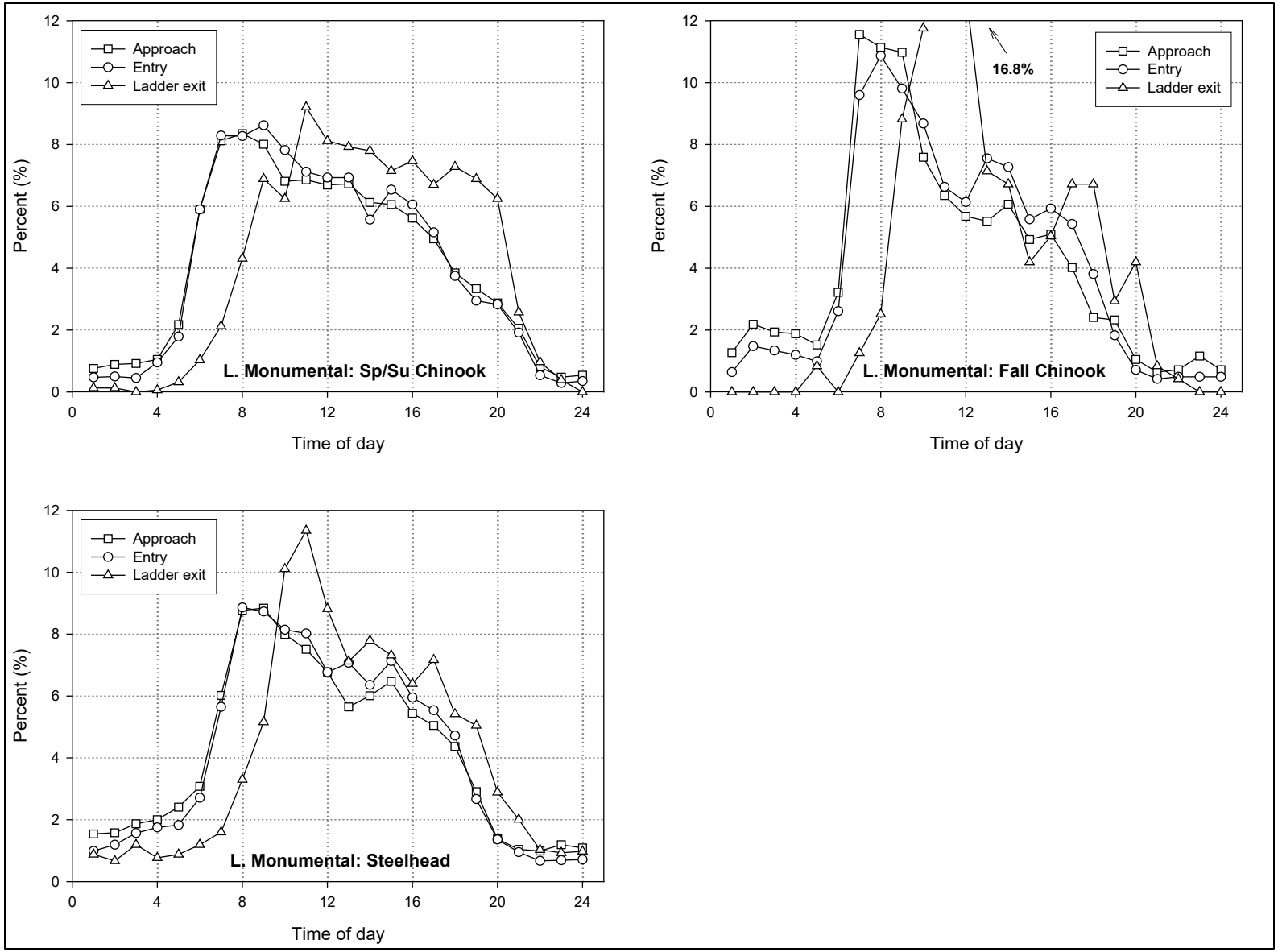


Figure LMN-2. Diel Distribution of Adult Salmonids at Lower Monumental Fishway Entrances and Exits (*Keefer & Caudill 2008*). Report and summary letter available online at: pweb.crohms.org/tmt/documents/FPOM/2010/2013_FPOM_MEET/2013_JUN/

2. FISH FACILITIES OPERATIONS

2.1. General.

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

2.1.2. Research, non-routine maintenance activities, and construction will not be conducted within 100' of any fishway entrance or exit, within 50' of any other part of the adult fishway, or directly in, above, or adjacent to any fishway, unless coordinated with FPOM or FFDRWG by the Project, District Operations and/or Planning or Construction office. These distances are approximate and will be updated after data are collected and analyzed to determine the threshold for adverse impacts to adult fish behavior. Alternate actions will be considered by District and Project biologists in conjunction with the Regional fish agencies on a case-by-case basis.

2.1.3. Emergency situations should be dealt with immediately by the Project in coordination with the Project and/or District biologist. If unavailable, the biologists will be informed immediately following the incident of steps taken to correct the situation. On a monthly basis, as necessary, the Project biologist will provide FPOM a summary of any emergency actions undertaken.

2.1.4. All activities within boat restricted zones (BRZ) will be coordinated with the Project at least two weeks in advance, unless it is deemed an emergency (see also **FPP Chapter 1 - Overview** for coordination guidance).

2.2. Spill Management.

2.2.1. Spring and summer spill operations for juvenile fish passage are defined in the *Fish Operations Plan* (FOP), included in the Fish Passage Plan as **Appendix E**. Spill at Lower Monumental will be distributed in patterns defined in **Table LMN-7 through LMN-9**.

2.2.2. Surface spill will be implemented at McNary and the four lower Snake River dams as a means of providing non-powerhouse downstream passage for adult steelhead that overshoot natal tributaries prior to spawning or that strive to repeat a subsequent reproduction cycle (iteroparity). This operation is pursuant to non-discretionary terms and conditions in the 2020 NOAA Fisheries Columbia River System (CRS) Biological Opinion[1], which calls for surface spill via the spillway weir at each of the five projects from March 1 through March 30 and from October 1 through November 15, three times each week on non-consecutive days for four hours in the morning (generally between 05:00 and 11:00). This operation is also considered in the 2020 USFWS CRS Biological Opinion[2] as a means of providing safe and effective downstream passage for adult steelhead and other fish.

i. In 2022, surface spill in the fall will begin September 1 (instead of October 1) to comply with the Agreement for short-term operations of the Columbia River

[1] NOAA CRS BiOp, section 2.17.4.G, "*Reduce Take of Overshoot Adult Steelhead*": https://www.fisheries.noaa.gov/webdam/download/109136871

[2] USFWS CRS BiOp, section 5.7.4, "*Off-season Surface Spill for Downstream Passage of Adult Steelhead*": https://ecos.fws.gov/tails/pub/document/17101031

System (CRS).[3] As such, in 2022, surface spill for adult steelhead will occur March 1–30 and September 1–November 15.

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

2.2.4. Total dissolved gas (TDG) is monitored at Lower Monumental Dam during the periods defined in **Table LMN-1**, pursuant to the Corps' annual *TDG Management Plan* and current *Dissolved Gas Monitoring Plan of Action*.[4]

2.2.5. To ensure navigation safety, short-term spill adjustments may be required, including spill reduction, spill pattern adjustments, and/or spill stoppages that result in forebay exceedances of the Minimum Operating Pool (MOP) range. The Corps will make short-term spill adjustments in real-time as appropriate to maintain safe navigation conditions. Actual operations will vary depending on spill patterns, turbine operations, experience of boat captains, etc. See the FOP (**Appendix E**) for more information.

2.3. Operating Criteria – Juvenile Fish Facilities.

2.3.1. Juvenile Facilities - Winter Maintenance Period (3rd week of December – March 31).

2.3.1.1. Forebay Area and Intakes.

i. Remove debris from forebay and gatewell slots.

ii. Rake trashracks just prior to the operating season.

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

iv. Inspect and repair gatewell dip net as needed.

2.3.1.2. Submersible Traveling Screens (STS) and Vertical Barrier Screens (VBS).

i. Removal of STSs may begin on the Monday of the 3rd week of December.

ii. Maintenance completed on all screens.

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

[3] See Term Sheet, section B (PDF page 7): http://pweb.crohms.org/tmt/JointMotion_TermSheet_CourtOrder_OCT2021.pdf

[4] TDG Management Plan (Appendix 4 of the WMP): pweb.crohms.org/tmt/documents/wmp/.
TDG Monitoring Plan of Action: www.nwd.usace.army.mil/Missions/Water/Columbia/Water-Quality/

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

2.3.1.3. Collection Channel.

i. Maintain water-up valve capable of operating when needed.

ii. Maintain orifice lights operational.

iii. Maintain orifices clean and valves operating correctly.

iv. Maintain orifice air backflush system working correctly.

2.3.1.4. Transportation Facilities.

i. Maintain primary bypass flume switch gate in good operating condition.

ii. Maintain flume interior smooth with no rough edges.

iii. Maintain perforated plate edges smooth with no rough edges.

iv. Maintain the wet separator and fish distribution system ready for operation.

v. Maintain brushes and screens on crowders in good condition with no holes in screens or rough edges.

vi. Maintain and test crowders to ensure operating correctly.

vii. Maintain all valves, slide gates, and switch gates in good operating condition.

viii. Maintain retainer screens in place with no holes or sharp wires protruding.

ix. Maintain barge and truck loading pipes free of debris, cracks, or blockages. Truck and barge loading hose couplings should have no rough edges. Test and maintain barge loading boom.

x. Maintain all sampling equipment in good operating condition prior to watering up the facilities.

xi. 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.

xii. Maintain mini- and midi-tanks in good operating condition.

2.3.1.5. Dewatering Structure and Flume.

i. Clean and maintain inclined screen in good condition with no gaps between screen panels, damaged panels, or missing silicone.

ii. Maintain screen cleaning system (brush and air flush) operating correctly.

iii. Test and maintain overflow weirs in good operating condition.

iv. Maintain all valves operating correctly.

v. Maintain flume interior smooth with no rough edges.

2.3.1.6. Record all maintenance and inspections.

2.3.1.7. Perform RSW inspections and maintenance as described below in **section 2.3.2.7**.

2.3.1.8. Inspect bird wires, avian deterrent devices, and other deterrents, and repair or replace as needed. Where possible, install additional bird wires or other deterrents to cover areas of known avian predation. Prepare avian abatement contract as needed. For information on avian management at Lower Monumental Dam, see the *Predation Monitoring and Deterrence Action Plans* in **Appendix L** (Table 2 and section 8).

2.3.2. Juvenile Facilities – Fish Passage Season (April 1 – 3rd week of December).

Operate in accordance with criteria defined below for juvenile fish bypass, collection, and transport April 1–September 30, and for adult fallbacks October 1 until Monday of the third week of December. Also operate according to criteria in the Corps of Engineers Juvenile Fish Transportation Plan (**Appendix B**). The transportation program may be revised in accordance with the ESA Section 10 permit and the NOAA Fisheries Biological Opinion.

2.3.2.1. Forebay Area and Intakes.

i. Remove debris from forebay.

ii. Inspect gatewell slots daily (preferably early in day shift) for debris, fish buildup, and contaminating substances (particularly oil). Clean gatewells before they become 50% covered with debris. If the volume of debris precludes the ability to keep the gatewell at least 50% clear, clean at least once daily. If flows through an orifice or fish conditions give indications that an orifice may be partially obstructed with debris, close and backflush the orifice to remove the obstruction. If the obstruction cannot be removed, close the orifice and operate the alternate orifice for that gatewell slot. If both orifices become obstructed or plugged with debris, do not operate the turbine unit until the gatewell and orifices are cleared of debris.

iii. If a visible accumulation of contaminating substances (e.g., oil) is detected in a gatewell and cannot be removed within 24 hours, immediately close the gatewell orifices and shut down the turbine unit 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, and tie off with a rope for later disposal. Take action

as soon as possible to remove oil from the gatewell so the orifice can be reopened to allow fish to exit the gatewell. Do not close orifices for longer than 48 hours.

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

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

vi. Coordinate cleaning efforts with personnel operating juvenile collection facilities.

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

2.3.2.2. STSs and VBSs.

i. Operate STSs in cycle mode when average fork length of subyearling Chinook or sockeye is greater than 120 mm.

ii. Operate STSs in continuous-run mode when average fork length of sub-yearling Chinook salmon or sockeye is less than 120 mm or if fish condition deteriorates.

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

iv. Record STS amp readings daily.

v. If an STS is damaged or fails during the juvenile fish passage season, follow procedures defined for unscheduled maintenance in **section 3.2.2**. In no case should a turbine unit be operated with a missing or a known non-operating or damaged STS.

vi. Between spring and summer, inspect at least two VBSs in two different turbine units that were operated frequently in the spring. If a debris accumulation is noted, inspect other VBSs and clean debris as necessary.

vii. After October 1, up to half of the STSs may be pulled for maintenance as long as unscreened turbine units are not operated.

viii. Between Thanksgiving and the Monday of the 3rd week of December , if the National Weather Service forecast for Lower Monumental Dam[5] is below 20°F

[5] NWS weather forecast for Lower Monumental Dam:
forecast.weather.gov/MapClick.php?lat=46.56353885200048&lon=-118.53924714099969

for the 24 hours or longer, the STSs may be removed. Prior to removing screens, request special permission from CENWW-OD-T, who will then inform NOAA Fisheries and FPOM.

ix. At the end of the season, make a formal determination as to the adequacy of STS mesh and any replacement needs.

2.3.2.3. Collection Channel.

i. Ensure orifices are clean and operating. Operate at least one orifice per gatewell slot (preferably the north orifice). If the project is operating within MOP, additional orifices may be operated to maintain a full collection channel. If orifices must be closed to repair any part of the facility, see **section 3.2.2.4** to determine if the turbine unit must be shut down and if fish must be dipped from the gatewell(s).

ii. Ensure orifice lights are functioning and operating in open orifices 24 hrs/day. Replace all burned out orifice lights within 24 hours of notification. Orifice lights and area lights may be turned off the evening before dewatering the channel at the end of the season (the Monday of the 3rd week of December or later) to encourage fish to exit the channel volitionally. Area lights can be turned on briefly for personnel access if necessary.

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

iv. Orifice valves must be either fully open or fully closed.

v. Backflush orifices at least once per day and more frequently if required. During periods of high debris volumes and fish numbers, from April 1 through July 31, inspect and backflush orifices once per 8-hour shift or more frequently as determined by the Project biologist, to keep orifices clean.

vi. Ensure the water-up valve is capable of operating when needed.

2.3.2.4. Dewatering Structure.

i. Ensure 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.

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

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

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

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

2.3.2.5. Transportation Facilities.

i. Inspect all screens to make sure there are no holes or sharp edges.

ii. Maintain crowder screen brushes in good operating condition with no holes or sharp edges on crowder screens.

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

iv. Operate wet separator and fish distribution system as designed.

v. Maintain truck and barge loading facilities in good operating condition.

vi. Inform PSMFC, in advance if possible, of situations that will require the PIT-tag system to be 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).

2.3.2.6. Removable Spillway Weir (RSW).

i. Lower Monumental Dam has one removable spillway weir (RSW) in spillbay 8 that, when open, provides a surface route for fish passage. The RSW can be opened and closed from the control room.

ii. The spill rate through the RSW is a function of the forebay elevation – as the pool elevation increases, more water is spilled over the RSW:

LMN Forebay Elevation (ft)	RSW Spill Rate (kcfs)
537	6.7
537.5	7.1
538	7.5
538.5	8.0
539	8.5
539.5	9.0
540	9.5

iii. The RSW will be in the raised position and operational during spill for juvenile passage (**Appendix E**) and spill for adult steelhead (**section 2.2.2**):

- Raise the spill gate to where it does not touch flow passing down the RSW.

- During high flows, if the Northwest River Forecast Center (NWRFC) inflow forecast for Lower Monumental[6] is above 200 kcfs, initiate aggressive forebay debris removal to avoid impeding RSW operation. Coordinate with RCC and CENWW-OD-T. If inflow exceeds 260 kcfs, the upstream river gauge flow is increasing, and the NWRFC inflow forecast for Lower Monumental is above 300 kcfs, stow the RSW (complete rotation to the landing pad).

- During summer spill (June 21-August 31), when daily average total project outflow is less than 30 kcfs and inflow is forecasted to remain below 30 kcfs for at least three days on a declining hydrograph, close the RSW and spill according to patterns with no RSW in **Table LMN-10**. If daily average project outflow subsequently increases above 30 kcfs and inflow is forecasted to remain above 30 kcfs for at least three days, re-open the RSW. Continue to open and close the RSW according to these criteria throughout summer spill.

iv. Outside of spill season when transport is occurring, the RSW may be operated for short periods upon request by the Project Biologist through CENWW if it appears the juvenile transportation facility and barge holding capacities will be exceeded, as defined in the *Juvenile Fish Transportation Plan* (**Appendix B**).

2.3.2.7. RSW Inspections and Maintenance (September 1 – March 31).

i. Prior to the inspections listed below, if a debris raft is present in the forebay and will interfere with defined operations, coordinate a debris spill in accordance with **section 5**. Debris in the RSW seals or between the transition plate and ogee will adversely impact operation of the RSW.

ii. Annually inspect the Transition Plate to validate that transition from the RSW to the ogee is intact. The primary means of inspection will be done with divers or an ROV. (1) If divers are used, Units 5&6 and spillbays 7&8 must be removed from service. Coordinate unit outages following normal outage notification guidelines. Coordinate with RCC to open bay 8 one or two stops for up to one week before the inspection to facilitate clearing of debris and silt from the Transition Plates. (2) If an ROV is used, bay 8 will be removed from service. Coordinate with RCC to open bay 8 one or two stops on the morning of the inspection to facilitate clearing of debris and silt from the Transition Plates.

iii. Transition Plate bolts, umbilical and seal inspection will be done by divers and requires the RSW to be disengaged from the face of the dam and tipped back to the pierce point. Coordinate with RCC to open bay 8 one or two stops for up to a week before the inspection in order 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. For the dive inspection, coordinate with RCC to remove Units 5&6 and spillbays 7&8 from service. Upon completion of the dive, prior to stowing the RSW, open bay 8 up to three stops to clean any

[6] NWRFC inflow forecast for Lower Monumental Dam:
www.nwrfc.noaa.gov/river/station/flowplot/flowplot.cgi?id=LMNW1

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.

iv. 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 the annual inspection (**ii**). The repair and replacement effort will be similar to Transition Plate Bolt, Umbilical and seal inspection above (**iii**). The timeframe will be longer to repair and/or install new plate(s) or seals. Required outages will be coordinated as listed above for the necessary actions.

2.3.2.8. Inspect fish facilities at least once every 8 hours. Inspect all facilities according to fish facilities monitoring program. Record all maintenance and inspections.

2.3.2.9. Avian Predation Management. Operate in accordance with *Predation Monitoring and Deterrence Action Plans* for Lower Monumental Dam in **Appendix** L (Table 2 and section 8). Monitor bird wires and other avian deterrent devices to ensure good condition and replace any broken wires or devices as soon as possible. Implement harassment program to deter avian predation in areas actively used by birds and not covered by bird wires or other devices. 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.

2.4. Operating Criteria - Adult Fish Facilities.

2.4.1. Adult Fish Facilities – Winter Maintenance Period (January 1 – end of February).

2.4.1.1. Inspect all staff gauges and water level indicators. Repair and/or clean where necessary. Calibrate all water level measuring devices as necessary for proper operations.

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

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

2.4.1.4. Inspect all spill gates and ensure they are operable.

2.4.1.5. Maintain fish pumps ready for operation.

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

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

Note: Operating the Ice Harbor forebay within the Minimum Operating Pool (MOP) for juvenile salmonids may result in some of the Lower Monumental adult fishway entrances bottoming out on their sills prior to reaching criteria depths. Continuous operation within MOP may also result in increased pumping head on the auxiliary water supply pumps, decreasing the amount of water pumped.

2.4.2.1. Maintain all staff gauges in readable condition at all water levels encountered during fish passage period. Repair or clean as necessary.

2.4.2.2. Maintain water depth over fishway ladder weirs in the range of 1.0'–1.3'.

2.4.2.3. Maintain head on all fishway entrances in the range of 1' to 2'.

2.4.2.4. North Shore Entrances (NSE 1&2).

i. Operate both gates.

ii. Top of gate elevation on sill = 429'.

iii. Weir depth ≥ 8' below tailwater.

2.4.2.5. South Powerhouse Entrances (SPE 1&2).

i. Operate both downstream gates.

ii. Top of gate elevation on sill = 432'.

iii. Weir depth ≥ 8' below tailwater. At tailwater below elevation 440', weirs should be on sill.

2.4.2.6. South Shore Entrances (SSE 1&2).

i. Operate both downstream gates.

ii. Top of gate elevation on sill = 431'.

iii. Operate SSE 1 at ≥ 8' below tailwater. Raise SSE 2 above sill 6'. At tailwater below elevation 439', SSE 1 weir should be on sill.

2.4.2.7. Channel Velocity. Maintain water velocities in the range of 1.5–4.0 feet per second (fps). At Lower Monumental, a "*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. 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. The velocity reading is a part of the ladder inspections that are done three 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.

2.4.2.8. No floating orifice gates will be operated.

2.4.2.9. Correctly install trashracks and picketed leads. Maximum head on ladder exits is 0.5'. Maximum head on south shore picketed leads is 0.3'. Maximum head on north shore picketed leads is 0.4'.

2.4.2.10. All counting slots at Lower Monumental Dam are fixed at a width of 19". Maintain all equipment in good condition. Clean the counting window and backboard as needed to maintain good visibility.

2.4.2.11. Facility Inspections.

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

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

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

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

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

vi. Record all inspections.

2.4.2.12. Fishway Temperature Monitoring. From June 1 through September 30, measure water temperature at adult fishway entrances and exits and submit data to the Fish Passage Center (FPC) weekly for posting online.[7] Ensure the location of the monitors meets the following criteria:

i. Within 10 meters of all shore-oriented entrances and exits.

ii. Entrance monitor within 1 meter above the ladder floor and at least 10 meters downstream of ladder diffusers, if possible, to allow for sufficient mixing with surface water.

[7] FPC ladder temperature data website: www.fpc.org/smolt/smolt_queries/Q_ladderwatertempgraphv2.php

iii. Exit monitor within 1 meter above the ladder floor and above all diffusers to allow for sufficient mixing with surface water.

iv. If an existing temperature monitoring location is proposed to be used for either the exit or entrance, verify that the site accurately reflects water temperature within 10 meters of the entrance or exit.

2.5. Fish Facility Monitoring and Reporting.

2.5.1. Monitoring.

2.5.1.1. Project biologists shall inspect fish passage facilities at the frequencies described above in the juvenile and adult fish facilities operating criteria, **sections 2.3 and 2.4**.

2.5.1.2. 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.

2.5.2. Reporting.

2.5.2.1. Weekly Reports. Project Biologists shall prepare weekly reports March 1–December 31 summarizing project and fish facility operations for each week (Friday through Thursday), along with an evaluation of resulting fish passage conditions. The reports will be e-mailed CENWW-OD-T by noon the following Monday. The weekly reports will include:

i. Out-of-criteria situations and subsequent corrective actions taken.

ii. Equipment malfunctions, breakdowns, or damage, with a summary of resulting repairs.

iii. Adult fishway control calibrations.

iv. STS and VBS inspections.

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

2.5.2.2. In-Season. Any adverse or negative impact to fish or fishways shall be reported in a *Memorandum for the Record* (MFR) prepared by Project biologists and sent to FPOM by the next working day, pursuant to the coordination process and template in **FPP Chapter 1 – Overview** (section 2.3.2).

2.5.2.3. 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.

3. FISH FACILITIES MAINTENANCE

3.1. Dewatering & Fish Handling.

3.1.1. All dewatering (also referred to as "unwatering") shall be accomplished in accordance with approved *Dewatering Guidelines and Fish Salvage Plans* in **Appendix F**. *Dewatering Plans*[8] were reviewed and revised in 2011 to ensure that they comply with **Appendix F**.

3.1.2. Project biologists should be present to provide technical guidance at all project activities that may involve fish handling. When river temperatures reach 70°F or greater, all adult fish handling will be coordinated through CENWW-OD-T.

3.2. Maintenance - Juvenile Fish Facilities.

3.2.1. Scheduled Maintenance.

3.2.1.1. Scheduled maintenance of juvenile facilities is conducted throughout the year.

3.2.1.2. Long-term maintenance or modifications that require facilities out of service for extended periods of time are conducted during the winter maintenance period, beginning as early as the Monday of the 3rd week of December through March 31.

3.2.1.3. During fish passage season, parts of the facilities are maintained on a daily, weekly, or longer interval to keep them in proper operating condition.

3.2.2. Unscheduled Maintenance.

3.2.2.1. Unscheduled maintenance is to correct any situation that prevents facilities from operating according to criteria or that will impact fish passage or survival.

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

i. Description of the problem.

ii. Type of outage required.

iii. Impact on facility operation.

iv. Length of time for repairs.

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

[8] Project Dewatering Plans: pweb.crohms.org/tmt/documents/FPOM/2010/

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

3.2.2.4. 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 that operates the orifice fails, the orifice should be closed and the alternate orifice for that gatewell operated until repairs can be made. If both air-valves that operate the orifices in a gatewell fail and the orifice cannot be fully operated, or must be kept closed, the turbine unit will normally be taken out of service until repairs can be made. At the discretion of the Project Biologist, both orifices in a gatewell may be closed for up to 5 hours in an operating turbine unit with STSs in place, but orifice closure times may need to be less depending on fish numbers and condition. Reduce turbine unit loading to the lower end of the 1% efficiency range if deemed necessary by the Project Biologist. If both orifices remain closed after 5 hours, the turbine unit will be taken out of service. During any orifice closure, gatewells shall be monitored hourly (unit is operating) or at least every two hours (unit is not operating) by project personnel for signs of fish problems or mortality. If repairs are to take longer than 48 hours and both orifices in a gatewell need to remain closed, juvenile fish will be dipped from the gatewell with a gatewell dip basket in accordance with the project dewatering and fish-handling plan. 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 prior to the 48 hours.

3.2.2.5. 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.

3.2.2.6. 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.

3.2.2.7. 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.

3.3. Maintenance - Adult Fish Facilities.

3.3.1. Scheduled Maintenance.

3.3.1.1. Scheduled maintenance that will have no effect on fish passage may be conducted at any time.

3.3.1.2. Scheduled maintenance of a facility that must be dewatered, or maintenance that will have a significant effect on fish passage, will be done during the January–February winter maintenance period. Winter maintenance is normally conducted one fish ladder at a time to maintain fish passage.

3.3.1.3. When facilities are not being worked on during the winter maintenance period, they will be operated according to normal criteria unless otherwise coordinated with NOAA Fisheries and FPOM.

3.3.1.4. Auxiliary water for 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.

3.3.2. Unscheduled Maintenance.

3.3.2.1. 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 in **section 3.2.2**. If part of a facility malfunctions or is damaged during the fish passage season and the facility can still be operated within criteria without any detrimental effects on fish passage, repairs may not be conducted until the winter maintenance period or until fewer

numbers of fish are passing the project. If part of a facility is damaged or malfunctions that may significantly impact fish passage, it will be repaired as soon as possible.

3.3.2.2. Fish Ladders and Counting Stations. The fish ladders contain fixed weirs, counting stations with picket leads, and fish exits with trashracks. If any part of the ladder fails or is blocked with debris during 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.

3.3.2.3. Hazardous Materials Spill. In the event of a hazardous materials spill, the Project Biologist has the authority to make fishway adjustments outside of operating criteria as necessary to prevent contamination of the ladder until unified command is formed and consultation is established with FPOM. NOAA Fisheries will be notified within 24 hours of a ladder closure.

3.3.2.4. Auxiliary Water Supply (AWS). The auxiliary water for fish ladders and collection systems is supplied by three turbine-driven pumps on the north shore, with at least two pumps 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:

i. SPE 2 and/or SSE 2 will be closed and SPE 1 raised to provide the required 1-2' head differential in the system.

ii. If the desired 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.

iii. If it cannot be maintained at a depth greater than 6', the weirs should be maintained at 6' regardless of head differential.

3.3.2.5. 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.

3.3.2.6. Diffuser Gratings. Diffuser chambers for adding auxiliary water to fish ladders and collection channels are covered by gratings attached by several different methods. Diffuser gratings are normally checked during winter maintenance to ensure they are in place, either by 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 in **section 3.2.2**. If possible, a video inspection should be done 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 Priority Order.

4.1.1. From March 1 through November 30, turbine units will be operated in the order of priority defined in **Table LMN-5** in order to enhance adult and juvenile fish passage. If a turbine unit is out of service for maintenance or repair, the next unit in the priority order shall be operated. Unit priority order may be coordinated differently to allow for fish research, construction, or project maintenance activities.

4.1.2. Unit 1 provides the best fish passage conditions by eliminating the eddy at the juvenile fish loading dock and providing attraction flow to the North adult fish ladder. Therefore, the default priority order for fish passage starts with Unit 1, then proceeds in order from north to south. However, due to blade seal failures on Unit 5, the runner blades are hydraulically locked at a set angle which restricts the unit to a narrower operating range (**Table LMN-6-A**). To avoid excessive wear and tear from repeated starts/stops, Unit 5 is operated last-on/first-off in the priority order for all flow conditions until the unit is repaired.

Table LMN-5. Lower Monumental Dam Turbine Unit Priority Order.

Season	Unit Priority Order
March 1 – November 30 Fish Passage Season	DEFAULT = 1, 2, 3, 4, 5, 6 MODIFIED ORDER for Unit 5 w/ Locked Blades* Start-up: 1, 2, 3, 4, 6, 5* Shutdown: 5*, 6, 4, 3, 2, 1
December 1 – End of February Winter Maintenance Period	Any Order

* Unit 5 has hydraulically locked blades and is operated in the "MODIFIED ORDER" to minimize starts/stops. When the blade seals are replaced, the unit will resume operating in the "DEFAULT" priority order.

4.2. Turbine Unit Operating Range.

4.2.1. Turbine unit flow and power output at the lower and upper limits of the ±1% peak efficiency range, and at the operating limit, are defined in **Table LMN-6**, except Unit 5 with locked-blades in in **Table LMN-6-A**. Turbine units will be operated within these ranges according to *BPA's Load Shaping Guidelines* (**Appendix C**), as summarized below.

4.2.2. In-Season: April 3–August 31 (Spring/Summer Spill for Juvenile Fish Passage).

4.2.2.1. Turbine units will be operated within ±1% of peak turbine efficiency (1% range), except under limited conditions and durations when turbines may be operated above the 1% range for the use of reserves or for TDG management during high flows (refer to **Appendix C** for more information). All required fish passage spill operations will be met prior to operating turbines above the 1% range. If in-season operation outside the 1% range is necessary, Project personnel shall record the information to provide to BPA on a weekly basis according to the *Guidelines*. Operation outside the 1% range may be necessary to:

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

ii. If the draft tube is to be dewatered (**section 4.3.9**), the unit will be operated at full load >1% (or at speed no load <1% if not possible to load) for a minimum of 15 minutes prior to installing tail logs to flush fish from the unit.

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

iv. Comply with other coordinated fish measures.

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

4.2.3. Off-Season: September 1–April 2. While not required to do so in the off-season, turbines will normally run within the 1% range since it is the optimum point for maximizing energy output of a given unit of water over time. Operation outside the 1% range is allowed if needed for power generation or other needs.

4.3. Turbine Unit Maintenance.

4.3.1. Turbine unit maintenance schedules will be reviewed annually by Project and Operations Division biologists for fish impacts. If the maintenance requires operating outside of FPP criteria, the work will be coordinated with regional salmon managers via FPOM, per the coordination process in **FPP Chapter 1 – Overview** (section 2.3).

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

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

4.3.4. Turbine units may occasionally require overhauls to repair major problems with the turbine or generator. Overhauls may take over one year to accomplish.

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

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

i. Pre-Maintenance: Units may be operationally tested for up to 30 minutes by running the unit at speed-no-load and various loads within the 1% range for measurements and testing, and to allow all fish to move through the unit.

ii. Post-Maintenance: Units may be operationally tested while remaining in maintenance or forced outage status by running the unit for up to a cumulative time of 30 minutes (within 1% range) before returning to operational status.

4.3.7. Six-Year Overhaul. One unit per year is scheduled for a 6-year overhaul that requires unwatering the unit to perform more in-depth maintenance other than annual checks. This level of maintenance requires additional consideration before the outage (pre-outage) and after the work is complete (post-outage). During the work, many systems and sub-systems of the unit may be disassembled, replaced or repaired. The overhaul unit outage will be scheduled during a period that minimizes impacts to fish. The work will start as recommended in **section 4.3.1**.

i. Pre-Outage: Prior to going out-of-service for a 6-year overhaul, the unit may need to be run continuously for 48 hours, which may require a deviation from FPP unit priority in **Table LMN-5**. Scheduling the unit first in line for maintenance should allow for ample water to accomplish a 48-hour run time for pre-maintenance checks. More water will be required for Unit 4, 5, or 6, as these units require an additional 2-3 kcfs at lower operating points.

ii. Post-Outage: Following a 6-year overhaul, the unit must be run continuously for 48 hours to ensure it is ready for service. A second period of 48 hours of intermittent testing may be required to fix minor items detected in the first continuous run. This post-outage run will require a deviation from FPP unit priority in **Table LMN-5** and from **section 4.3.6** to allow the unit to run with the head gate cylinder in place and the head gate in the lower position. More water will be required for Unit 4, 5, or 6, as these units require an additional 2-3 kcfs at lower operating points. The 1% range constraint will remain in place.

4.3.8. Head Gates.[9] Turbine units may be operated with head gates either in the *raised or stored* position. Once all new cylinders have been acquired, turbine units will operate with all head gates in the original design stored position to ensure the safety of Project personnel and facilities.

4.3.9. Dewatering Units. Dewatering (also referred to as "unwatering") should be accomplished in accordance with project *Dewatering Plans*.[8] 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.

4.3.10. Doble Testing. The yearly outage schedule is defined in **Appendix A**. Transformer Doble testing is required every three years, or more frequently if there is a known problem with a transformer, and requires the associated turbine units to be out of service for 2–3 workdays. Doble testing is normally scheduled for August or early September in conjunction with other scheduled unit maintenance to minimize impacts on fish passage. To conduct testing, the distribution lines must be disconnected from the transformers and normal generation stopped. One turbine unit will operate at speed-no-load (approximately 7 kcfs) to provide project power and operation of fish passage facilities (station service). Spill may be provided to meet minimum required project discharge during testing. If Doble testing will impact priority units for fish passage, adult passage timing should be considered to minimize impacts to migrating adults. Available units will be operated in accordance with FPP priority order and within the 1% range.

4.3.11. Turbine Unit Outages during High Flows. During high spring flows, turbine unit outages for inspecting fish screens, repairing research equipment (e.g., hydroacoustic or radiotelemetry), and/or other fish items may cause increased spill in order to maintain reservoir levels within operating ranges. This may result in TDG exceeding standards. It is important that this work be conducted when scheduled to ensure that facilities are working correctly and not injuring migrating fish, and that important fish research data are collected. To facilitate this work, reservoir storage may be utilized to minimize impacts from taking turbine units out of service and increasing spill. At Lower Monumental, this special operation shall take place when flow is above 120 kcfs or when increased spill will result in TDG exceeding standards. The activities covered under these operations will be coordinated with TMT whenever possible.

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

Table LMN-6. Lower Monumental Dam Turbine Unit Power (MW) and Flow (cfs) at ±1% of Peak Turbine Efficiency (Lower and Upper Limits of 1% Range) and Operating Limits. [a, b]

Project Head (feet)	LMN Units 1, 2, and 3 – with STS						LMN Units 1, 2, and 3 – No STS					
	1% Lower Limit		1% Upper Limit		Operating Limit		1% Lower Limit		1% Upper Limit		Operating Limit	
	MW	cfs	MW	cfs	MW	cfs	MW	cfs	MW	cfs	MW	cfs
85	72.0	11,693	112.0	18,173	130.9	22,028	71.2	11,499	115.4	18,636	134.3	22,368
86	73.0	11,706	114.4	18,332	133.2	22,163	71.9	11,471	117.9	18,805	136.8	22,503
87	74.0	11,717	116.6	18,458	135.7	22,324	72.7	11,447	120.3	18,937	139.3	22,621
88	75.0	11,727	118.7	18,554	136.8	22,146	73.4	11,417	122.6	19,061	140.6	22,460
89	76.0	11,739	120.5	18,611	138.0	21,996	74.2	11,392	124.6	19,136	141.8	22,279
90	77.0	11,750	122.4	18,681	139.4	21,901	74.9	11,369	126.4	19,179	142.9	22,114
91	78.0	11,764	124.1	18,715	140.7	21,803	75.6	11,344	128.0	19,200	143.9	21,961
92	79.0	11,772	126.0	18,782	141.6	21,646	76.4	11,321	129.3	19,168	145.0	21,827
93	80.0	11,780	128.1	18,864	142.5	21,463	77.1	11,294	130.6	19,132	146.0	21,676
94	81.0	11,793	129.9	18,922	143.4	21,266	77.8	11,268	131.8	19,091	146.8	21,487
95	82.0	11,809	132.0	19,003	144.3	21,079	78.6	11,251	132.8	19,009	147.4	21,298
96	83.1	11,831	134.2	19,101	144.9	20,880	79.4	11,240	133.8	18,926	148.0	21,121
97	84.3	11,862	136.3	19,176	145.5	20,689	80.3	11,233	134.9	18,860	148.5	20,945
98	85.5	11,896	138.6	19,272	146.1	20,509	81.2	11,230	136.0	18,806	149.0	20,763
99	86.7	11,929	141.0	19,387	146.6	20,314	82.2	11,229	137.4	18,782	149.4	20,575
100	88.0	11,963	143.3	19,487	147.1	20,101	83.0	11,224	139.1	18,800	149.8	20,387
101	88.8	11,941	142.7	19,195	147.6	19,973	84.1	11,238	138.9	18,573	150.1	20,224
102	89.6	11,920	142.1	18,904	148.0	19,841	85.1	11,255	138.6	18,332	150.5	20,064
103	90.4	11,898	141.5	18,626	148.3	19,707	86.1	11,269	138.4	18,111	150.9	19,901
104	91.2	11,876	141.0	18,373	148.7	19,567	87.1	11,281	138.5	17,933	151.2	19,735
105	91.8	11,835	140.9	18,172	149.1	19,419	88.0	11,279	138.9	17,803	151.4	19,566
	LMN Units 4 and 6 – with STS						LMN Units 4 and 6 – No STS					
85	86.7	13,771	108.3	17,190	126.7	20,417	90.5	14,545	120.9	19,416	125.8	20,379
86	88.0	13,802	109.7	17,206	128.2	20,417	91.6	14,534	121.3	19,251	127.2	20,380
87	89.2	13,826	111.3	17,252	129.8	20,416	92.6	14,521	121.9	19,103	128.7	20,380
88	90.4	13,844	113.0	17,312	131.3	20,415	93.7	14,511	122.8	19,020	130.2	20,380
89	91.6	13,864	114.7	17,363	132.9	20,415	94.7	14,506	124.3	19,034	131.8	20,380
90	92.8	13,888	116.3	17,402	134.4	20,414	95.9	14,505	126.4	19,126	133.4	20,380
91	94.0	13,908	117.9	17,445	136.0	20,415	97.0	14,507	128.5	19,223	135.0	20,380
92	95.1	13,923	119.4	17,473	137.5	20,414	98.2	14,514	130.3	19,268	136.6	20,380
93	96.3	13,936	120.8	17,491	139.1	20,414	99.3	14,524	131.8	19,266	138.1	20,380
94	97.4	13,945	122.6	17,556	140.7	20,414	100.5	14,539	133.0	19,232	139.6	20,380
95	98.5	13,956	124.5	17,643	142.2	20,414	101.8	14,565	134.0	19,168	141.0	20,380
96	99.6	13,974	126.8	17,780	143.7	20,415	103.1	14,596	134.7	19,068	142.4	20,380
97	100.8	13,995	129.3	17,947	145.2	20,416	104.4	14,620	135.2	18,938	143.8	20,380
98	102.0	14,014	131.4	18,064	146.7	20,416	105.6	14,625	135.7	18,793	145.2	20,380
99	103.1	14,031	133.2	18,120	148.2	20,417	106.6	14,610	136.1	18,649	146.7	20,379
100	104.2	14,039	134.7	18,143	149.7	20,417	107.5	14,581	136.6	18,528	148.3	20,382
101	105.2	14,026	136.0	18,134	151.2	20,421	108.4	14,545	138.1	18,539	149.9	20,379
102	106.4	14,042	137.1	18,106	152.6	20,422	109.2	14,515	139.7	18,558	151.6	20,379
103	107.6	14,058	138.1	18,047	154.1	20,424	110.2	14,496	141.1	18,564	153.1	20,380
104	108.6	14,051	138.8	17,968	155.5	20,426	111.2	14,483	142.5	18,568	154.7	20,380
105	109.3	14,006	139.3	17,844	157.4	20,531	112.2	14,476	143.8	18,561	156.0	20,356

a. Values provided by HDC (May 2022). Flow (cfs) was calculated based on turbine efficiency, project head, and power output (MW). "Operating Limit" is the maximum safe operating point based on cavitation or generator limit (added Feb 2018).

b. Unit 5 has hydraulically locked runner blades and a restricted operating range, as defined in **Table LMN-6-A**.

Table LMN-6-A. Temporary Restricted Operating Range for Lower Monumental Unit 5 with Locked Runner Blades (Non-Adjustable).[a]

Project Head (feet)	LMN Unit 5 (blades locked @ 25°) – with STS						LMN Unit 5 (blades locked @ 25°) – No STS					
	Lower Limit		Peak Efficiency		Upper Limit		Lower Limit		Peak Efficiency		Upper Limit	
	MW	cfs	MW	cfs	MW	cfs	MW	cfs	MW	cfs	MW	cfs
85	110.4	17,810	112.2	18,000	113.8	18,362	110.6	17,761	113.1	18,052	114.2	18,336
86	112.1	17,859	114.3	18,102	115.4	18,391	112.4	17,814	114.7	18,089	115.9	18,376
87	113.8	17,906	115.8	18,125	117.1	18,420	114.1	17,865	116.4	18,123	117.6	18,415
88	115.4	17,943	117.4	18,150	118.7	18,453	115.8	17,907	118.1	18,158	119.3	18,458
89	116.9	17,964	119.0	18,174	120.4	18,488	117.4	17,935	119.7	18,194	121.1	18,503
90	118.3	17,957	120.6	18,197	122.0	18,521	118.8	17,936	121.4	18,227	122.8	18,547
91	120.3	18,047	122.2	18,224	123.7	18,556	120.8	18,026	123.6	18,336	124.6	18,592
92	122.1	18,113	124.2	18,316	125.3	18,582	122.7	18,092	125.3	18,368	126.3	18,629
93	123.9	18,158	125.8	18,341	127.0	18,616	124.4	18,139	126.9	18,404	128.1	18,672
94	125.6	18,200	127.4	18,363	128.6	18,644	126.2	18,185	128.6	18,437	129.8	18,712
95	127.2	18,237	129.0	18,387	130.3	18,676	127.9	18,225	130.3	18,471	131.6	18,754
96	128.6	18,236	130.6	18,415	131.9	18,707	129.3	18,231	132.1	18,511	133.3	18,795
97	130.0	18,240	132.2	18,444	133.6	18,739	130.8	18,241	133.8	18,550	135.1	18,837
98	131.4	18,245	133.8	18,474	135.2	18,771	132.3	18,252	135.5	18,591	136.8	18,880
99	132.9	18,256	135.4	18,501	136.9	18,811	133.8	18,269	137.2	18,629	138.7	18,931
100	134.3	18,265	137.1	18,531	138.8	18,878	135.3	18,284	138.9	18,670	140.7	19,010
101	135.6	18,257	138.3	18,520	140.3	18,884	136.6	18,270	140.6	18,709	142.0	19,001
102	136.9	18,247	140.1	18,572	141.7	18,887	137.8	18,253	141.8	18,682	143.4	18,991
103	138.1	18,234	141.4	18,560	143.1	18,889	139.0	18,234	143.0	18,656	144.7	18,980
104	139.3	18,219	142.7	18,547	144.5	18,889	140.2	18,211	144.2	18,629	146.0	18,966
105	140.5	18,198	143.9	18,534	145.9	18,888	141.4	18,185	145.4	18,602	147.3	18,952

a. Unit 5 has hydraulically locked (non-adjustable) runner blades due to leaking blade seals and is restricted to a smaller operating range until the blade seals are repaired or replaced. Values provided by HDC based on the 1962 Model Test and Feb 2020 U5 Index Test, as updated in May 2022.

5. FOREBAY DEBRIS REMOVAL

5.1.1. 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.

5.1.2. 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.

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

Table LMN-7. [page *1 of 3*] Lower Monumental Dam Bulk Spill Patterns with RSW. [a]

LMN Bulk Spill Patterns - # Gate Stops per Spillbay								Total Stops	Spill [a]
Bay 1	Bay 2	Bay 3	Bay 4	Bay 5	Bay 6	Bay 7	Bay 8 [b]	(#)	(kcfs)
	2				4		RSW	**6**	**16.3**
	3				4		RSW	**7**	**17.8**
	3			1	4		RSW	**8**	**19.6**
	3			1	5		RSW	**9**	**21.3**
1	3			1	5		RSW	**10**	**23.1**
1	1	1	1	1	6		RSW	**11**	**25.4**
1	1	1	1	2	6		RSW	**12**	**26.9**
1	1	1	2	2	6		RSW	**13**	**28.4**
1	1	1	2	4	5		RSW	**14**	**29.6**
1	1	1	2	5	5		RSW	**15**	**31.3**
2	1	1	2	5	5		RSW	**16**	**32.8**
2	1	2	2	5	5		RSW	**17**	**34.3**
2	2	2	2	5	5		RSW	**18**	**35.8**
3	2	2	2	5	5		RSW	**19**	**37.3**
3	3	2	2	5	5		RSW	**20**	**38.8**
3	3	2	2	5	5	1	RSW	**21**	**40.6**
3	3	2	2	5	5	2	RSW	**22**	**42.1**
3	3	2	3	5	5	2	RSW	**23**	**43.6**
3	3	3	3	5	5	2	RSW	**24**	**45.1**
3	3	3	3	5	6	2	RSW	**25**	**46.8**
3	3	3	3	6	6	2	RSW	**26**	**48.5**
3	3	3	3	6	6	3	RSW	**27**	**50.0**
3	3	3	3	6	6	4	RSW	**28**	**51.4**
3	3	3	3	6	6	5	RSW	**29**	**53.1**
3	3	3	3	6	6	6	RSW	**30**	**54.8**
3	3	3	4	6	6	6	RSW	**31**	**56.2**
3	3	4	4	6	6	6	RSW	**32**	**57.6**
3	4	4	4	6	6	6	RSW	**33**	**59.0**
4	4	4	4	6	6	6	RSW	**34**	**60.4**
4	4	4	5	6	6	6	RSW	**35**	**62.1**
4	4	5	5	6	6	6	RSW	**36**	**63.8**
4	5	5	5	6	6	6	RSW	**37**	**65.5**
5	5	5	5	6	6	6	RSW	**38**	**67.2**
5	5	5	6	6	6	6	RSW	**39**	**68.9**
5	5	6	6	6	6	6	RSW	**40**	**70.6**
5	6	6	6	6	6	6	RSW	**41**	**72.3**
6	6	6	6	6	6	6	RSW	**42**	**74.0**
6	6	6	6	6	7	6	RSW	**43**	**75.6**
6	7	6	6	6	7	6	RSW	**44**	**77.2**
6	7	6	6	7	7	6	RSW	**45**	**78.8**
6	7	7	6	7	7	6	RSW	**46**	**80.4**
6	7	7	7	7	7	6	RSW	**47**	**82.0**
7	7	7	7	7	7	6	RSW	**48**	**83.6**
7	7	7	7	7	7	7	RSW	**49**	**85.2**
7	7	7	7	7	8	7	RSW	**50**	**87.0**
7	8	7	7	7	8	7	RSW	**51**	**88.8**

LMN Bulk Spill Patterns - # Gate Stops per Spillbay								Total Stops	Spill [a]
Bay 1	Bay 2	Bay 3	Bay 4	Bay 5	Bay 6	Bay 7	Bay 8 [b]	(#)	(kcfs)
7	8	7	7	8	8	7	RSW	**52**	**90.6**
7	8	8	7	8	8	7	RSW	**53**	**92.4**
7	8	8	8	8	8	7	RSW	**54**	**94.2**
8	8	8	8	8	8	7	RSW	**55**	**96.0**
8	8	8	8	8	8	8	RSW	**56**	**97.8**
8	8	8	8	8	9	8	RSW	**57**	**99.4**
8	9	8	8	8	9	8	RSW	**58**	**101.0**
8	9	8	8	9	9	8	RSW	**59**	**102.6**
8	9	9	8	9	9	8	RSW	**60**	**104.2**
8	9	9	9	9	9	8	RSW	**61**	**105.8**
9	9	9	9	9	9	8	RSW	**62**	**107.4**
9	9	9	9	9	9	9	RSW	**63**	**109.0**
9	9	9	9	9	10	9	RSW	**64**	**110.8**
9	10	9	9	9	10	9	RSW	**65**	**112.6**
9	10	9	9	10	10	9	RSW	**66**	**114.4**
9	10	10	9	10	10	9	RSW	**67**	**116.2**
9	10	10	10	10	10	9	RSW	**68**	**118.0**
10	10	10	10	10	10	9	RSW	**69**	**119.8**
10	10	10	10	10	10	10	RSW	**70**	**121.6**
10	10	10	10	10	11	10	RSW	**71**	**123.3**
10	11	10	10	10	11	10	RSW	**72**	**125.0**
10	11	10	10	11	11	10	RSW	**73**	**126.7**
10	11	11	10	11	11	10	RSW	**74**	**128.4**
10	11	11	11	11	11	10	RSW	**75**	**130.1**
11	11	11	11	11	11	10	RSW	**76**	**131.8**
11	11	11	11	11	11	11	RSW	**77**	**133.5**
11	11	11	11	11	12	11	RSW	**78**	**135.2**
11	12	11	11	11	12	11	RSW	**79**	**136.9**
11	12	11	11	12	12	11	RSW	**80**	**138.6**
11	12	12	11	12	12	11	RSW	**81**	**140.3**
11	12	12	12	12	12	11	RSW	**82**	**142.0**
12	12	12	12	12	12	11	RSW	**83**	**143.7**
12	12	12	12	12	12	12	RSW	**84**	**145.4**
12	12	12	12	12	13	12	RSW	**85**	**147.1**
12	13	12	12	12	13	12	RSW	**86**	**148.8**
12	13	12	12	13	13	12	RSW	**87**	**150.5**
12	13	13	12	13	13	12	RSW	**88**	**152.2**
12	13	13	13	13	13	12	RSW	**89**	**153.9**
13	13	13	13	13	13	12	RSW	**90**	**155.6**
13	13	13	13	13	13	13	RSW	**91**	**157.3**
13	13	13	13	13	14	13	RSW	**92**	**159.0**
13	14	13	13	13	14	13	RSW	**93**	**160.7**
13	14	13	13	14	14	13	RSW	**94**	**162.4**
13	14	14	13	14	14	13	RSW	**95**	**164.1**
13	14	14	14	14	14	13	RSW	**96**	**165.8**
14	14	14	14	14	14	13	RSW	**97**	**167.5**
14	14	14	14	14	14	14	RSW	**98**	**169.2**
14	14	14	14	14	15	14	RSW	**99**	**171.0**

LMN Bulk Spill Patterns - # Gate Stops per Spillbay								Total Stops (#)	Spill [a] (kcfs)
Bay 1	Bay 2	Bay 3	Bay 4	Bay 5	Bay 6	Bay 7	Bay 8 [b]		
14	15	14	14	14	15	14	RSW	**100**	**172.8**
14	15	14	14	15	15	14	RSW	**101**	**174.6**
14	15	15	14	15	15	14	RSW	**102**	**176.4**
14	15	15	15	15	15	14	RSW	**103**	**178.2**
15	15	15	15	15	15	14	RSW	**104**	**180.0**
15	15	15	15	15	15	15	RSW	**105**	**181.8**

a. Spill (kcfs) is calculated as a function of total stops + RSW spill at forebay elevation 537.0 ft.

b. Bay 8 w/ RSW = 6.7 kcfs spill at forebay 537.0 ft. Raise Bay 8 tainter gate above stop 9 to ensure free surface and debris passage. When low flow criteria are met (< 30 kcfs, per **section 2.3.2.6**), the RSW will be closed and spill distributed in patterns defined in **Table LMN-10**.

Table LMN-8. Lower Monumental Uniform Spill Patterns with RSW. [a, b]

NOTE: While spillbay 3 is out of service (OOS), refer to MODIFED UNIFORM patterns in **Table LMN-9** below, starting on page LMN-37.

LMN Uniform Spill Patterns - # Gate Stops per Spillbay								Total Stops	Total Spill [a]
Bay 1	Bay 2	Bay 3	Bay 4	Bay 5	Bay 6	Bay 7	Bay 8 [b]	(#)	(kcfs)
	1	1	1	1	1		RSW	5	15.8
1	1	1	1	1	1		RSW	6	17.6
1	1	1	1	1	1	1	RSW	7	19.4
1	1	1	1	1	2	1	RSW	8	20.9
1	2	1	1	1	2	1	RSW	9	22.4
1	2	1	1	2	2	1	RSW	10	23.9
1	2	2	1	2	2	1	RSW	11	25.4
1	2	2	2	2	2	1	RSW	12	26.9
2	2	2	2	2	2	1	RSW	13	28.4
2	2	2	2	2	2	2	RSW	14	29.9
2	2	2	2	2	3	2	RSW	15	31.4
2	3	2	2	2	3	2	RSW	16	32.9
2	3	2	2	3	3	2	RSW	17	34.4
2	3	3	2	3	3	2	RSW	18	35.9
2	3	3	3	3	3	2	RSW	19	37.4
3	3	3	3	3	3	2	RSW	20	38.9
3	3	3	3	3	3	3	RSW	21	40.4
3	3	3	3	3	4	3	RSW	22	41.8
3	4	3	3	3	4	3	RSW	23	43.2
3	4	3	3	4	4	3	RSW	24	44.6
3	4	4	3	4	4	3	RSW	25	46.0
3	4	4	4	4	4	3	RSW	26	47.4
4	4	4	4	4	4	3	RSW	27	48.8
4	4	4	4	4	4	4	RSW	28	50.2
4	4	4	4	4	5	4	RSW	29	51.9
4	5	4	4	4	5	4	RSW	30	53.6
4	5	4	4	5	5	4	RSW	31	55.3
4	5	5	4	5	5	4	RSW	32	57.0
4	5	5	5	5	5	4	RSW	33	58.7
5	5	5	5	5	5	4	RSW	34	60.4
5	5	5	5	5	5	5	RSW	35	62.1
5	5	5	5	5	6	5	RSW	36	63.8
5	6	5	5	5	6	5	RSW	37	65.5
5	6	5	5	6	6	5	RSW	38	67.2
5	6	6	5	6	6	5	RSW	39	68.9
5	6	6	6	6	6	5	RSW	40	70.6
6	6	6	6	6	6	5	RSW	41	72.3
6	6	6	6	6	6	6	RSW	42	74.0
6	6	6	6	6	7	6	RSW	43	75.6
6	7	6	6	6	7	6	RSW	44	77.2

6	7	6	6	7	7	6	RSW	**45**	**78.8**
6	7	7	6	7	7	6	RSW	**46**	**80.4**
6	7	7	7	7	7	6	RSW	**47**	**82.0**
7	7	7	7	7	7	6	RSW	**48**	**83.6**
7	7	7	7	7	7	7	RSW	**49**	**85.2**
7	7	7	7	7	8	7	RSW	**50**	**87.0**
7	8	7	7	7	8	7	RSW	**51**	**88.8**
7	8	7	7	8	8	7	RSW	**52**	**90.6**
7	8	8	7	8	8	7	RSW	**53**	**92.4**
7	8	8	8	8	8	7	RSW	**54**	**94.2**
8	8	8	8	8	8	7	RSW	**55**	**96.0**
8	8	8	8	8	8	8	RSW	**56**	**97.8**
8	8	8	8	8	9	8	RSW	**57**	**99.4**
8	9	8	8	8	9	8	RSW	**58**	**101.0**
8	9	8	8	9	9	8	RSW	**59**	**102.6**
8	9	9	8	9	9	8	RSW	**60**	**104.2**
8	9	9	9	9	9	8	RSW	**61**	**105.8**
9	9	9	9	9	9	8	RSW	**62**	**107.4**
9	9	9	9	9	9	9	RSW	**63**	**109.0**
9	9	9	9	9	10	9	RSW	**64**	**110.8**
9	10	9	9	9	10	9	RSW	**65**	**112.6**
9	10	9	9	10	10	9	RSW	**66**	**114.4**
9	10	10	9	10	10	9	RSW	**67**	**116.2**
9	10	10	10	10	10	9	RSW	**68**	**118.0**
10	10	10	10	10	10	9	RSW	**69**	**119.8**
10	10	10	10	10	10	10	RSW	**70**	**121.6**
10	10	10	10	10	11	10	RSW	**71**	**123.3**
10	11	10	10	10	11	10	RSW	**72**	**125.0**
10	11	10	10	11	11	10	RSW	**73**	**126.7**
10	11	11	10	11	11	10	RSW	**74**	**128.4**
10	11	11	11	11	11	10	RSW	**75**	**130.1**
11	11	11	11	11	11	10	RSW	**76**	**131.8**
11	11	11	11	11	11	11	RSW	**77**	**133.5**
11	11	11	11	11	12	11	RSW	**78**	**135.2**
11	12	11	11	11	12	11	RSW	**79**	**136.9**
11	12	11	11	12	12	11	RSW	**80**	**138.6**
11	12	12	11	12	12	11	RSW	**81**	**140.3**
11	12	12	12	12	12	11	RSW	**82**	**142.0**
12	12	12	12	12	12	11	RSW	**83**	**143.7**
12	12	12	12	12	12	12	RSW	**84**	**145.4**
12	12	12	12	12	13	12	RSW	**85**	**147.1**
12	13	12	12	12	13	12	RSW	**86**	**148.8**
12	13	12	12	13	13	12	RSW	**87**	**150.5**
12	13	13	12	13	13	12	RSW	**88**	**152.2**
12	13	13	13	13	13	12	RSW	**89**	**153.9**
13	13	13	13	13	13	12	RSW	**90**	**155.6**

13	13	13	13	13	13	13	RSW	**91**	**157.3**
13	13	13	13	13	14	13	RSW	**92**	**159.0**
13	14	13	13	13	14	13	RSW	**93**	**160.7**
13	14	13	13	14	14	13	RSW	**94**	**162.4**
13	14	14	13	14	14	13	RSW	**95**	**164.1**
13	14	14	14	14	14	13	RSW	**96**	**165.8**
14	14	14	14	14	14	13	RSW	**97**	**167.5**
14	14	14	14	14	14	14	RSW	**98**	**169.2**
14	14	14	14	14	15	14	RSW	**99**	**171.0**
14	15	14	14	14	15	14	RSW	**100**	**172.8**
14	15	14	14	15	15	14	RSW	**101**	**174.6**
14	15	15	14	15	15	14	RSW	**102**	**176.4**
14	15	15	15	15	15	14	RSW	**103**	**178.2**
15	15	15	15	15	15	14	RSW	**104**	**180.0**
15	15	15	15	15	15	15	RSW	**105**	**181.8**

a. Spill (kcfs) is calculated as a function of total stops + RSW spill at forebay elevation 537.0 ft (based on interim spillway rating table 2-Apr-2009).

b. Bay 8 w/ RSW = 7.5 kcfs spill at forebay 538.0 ft. Raise Bay 8 tainter gate above stop 9 to ensure free surface and debris passage. When low flow criteria are met (< 30 kcfs, per **section 2.3.2.6**), the RSW will be closed and spill distributed in patterns defined in **Table LMN-10.**

Table LMN-9. [MODIFIED FOR BAY 3 OOS]. Lower Monumental MODIFED Uniform Spill Patterns with RSW and Spillbay 3 Out of Service. [a, b]

LMN Uniform Spill Patterns - # Gate Stops per Spillbay (BAY 3 OOS)								Total Stops	Total Spill
Bay 1	Bay 2	Bay 3	Bay 4	Bay 5	Bay 6	Bay 7	Bay 8	(#)	(Kcfs)
0	0		0	0	0	0	RSW	**0**	7.5
0	0		0	0	1	0	RSW	**1**	9.3
0	1		0	0	1	0	RSW	**2**	11.1
0	1		0	1	1	0	RSW	**3**	12.9
0	1		1	1	1	0	RSW	**4**	14.7
1	1		1	1	1	0	RSW	**5**	16.5
1	1		1	1	1	1	RSW	**6**	18.3
1	1		1	1	2	1	RSW	**7**	19.8
1	2		1	1	2	1	RSW	**8**	21.3
1	2		2	1	2	1	RSW	**9**	22.8
1	2		2	2	2	1	RSW	**10**	24.3
2	2		2	2	2	1	RSW	**11**	25.8
2	2		2	2	2	2	RSW	**12**	27.3
2	2		2	2	3	2	RSW	**13**	28.8
2	3		2	2	3	2	RSW	**14**	30.3
2	3		3	2	3	2	RSW	**15**	31.8
2	3		3	3	3	2	RSW	**16**	33.3
3	3		3	3	3	2	RSW	**17**	34.8
3	3		3	3	3	3	RSW	**18**	36.3
3	3		3	3	4	3	RSW	**19**	37.7
3	4		3	3	4	3	RSW	**20**	39.1
3	4		4	3	4	3	RSW	**21**	40.5
3	4		4	4	4	3	RSW	**22**	41.9
4	4		4	4	4	3	RSW	**23**	43.3
4	4		4	4	4	4	RSW	**24**	44.7
4	4		4	4	5	4	RSW	**25**	46.4
4	5		4	4	5	4	RSW	**26**	48.1
4	5		5	4	5	4	RSW	**27**	49.8
4	5		5	5	5	4	RSW	**28**	51.5
5	5		5	5	5	4	RSW	**29**	53.2
5	5		5	5	5	5	RSW	**30**	54.9
5	5		5	5	6	5	RSW	**31**	56.6
5	6		5	5	6	5	RSW	**32**	58.3
5	6		6	5	6	5	RSW	**33**	60.0
5	6		6	6	6	5	RSW	**34**	61.7
6	6		6	6	6	5	RSW	**35**	63.4
6	6		6	6	6	6	RSW	**36**	65.1
6	6		6	6	7	6	RSW	**37**	66.8
6	7		6	6	7	6	RSW	**38**	68.5
6	7		7	6	7	6	RSW	**39**	70.2
6	7		7	7	7	6	RSW	**40**	71.9
7	7		7	7	7	6	RSW	**41**	73.6
7	7		7	7	7	7	RSW	**42**	75.3
7	7		7	7	8	7	RSW	**43**	77.1

LMN Uniform Spill Patterns - # Gate Stops per Spillbay (BAY 3 OOS)								Total Stops	Total Spill
Bay 1	Bay 2	Bay 3	Bay 4	Bay 5	Bay 6	Bay 7	Bay 8	(#)	(Kcfs)
7	8		7	7	8	7	RSW	**44**	78.9
7	8		8	7	8	7	RSW	**45**	80.7
7	8		8	8	8	7	RSW	**46**	82.5
8	8		8	8	8	7	RSW	**47**	84.3
8	8		8	8	8	8	RSW	**48**	86.1
8	8		8	8	9	8	RSW	**49**	87.8
8	9		8	8	9	8	RSW	**50**	89.5
8	9		9	8	9	8	RSW	**51**	91.2
8	9		9	9	9	8	RSW	**52**	92.9
9	9		9	9	9	8	RSW	**53**	94.6
9	9		9	9	9	9	RSW	**54**	96.3
9	9		9	9	10	9	RSW	**55**	98.0
9	10		9	9	10	9	RSW	**56**	99.7
9	10		10	9	10	9	RSW	**57**	101.4
9	10		10	10	10	9	RSW	**58**	103.1
10	10		10	10	10	9	RSW	**59**	104.8
10	10		10	10	10	10	RSW	**60**	106.5
10	10		10	10	11	10	RSW	**61**	108.1
10	11		10	10	11	10	RSW	**62**	109.7
10	11		11	10	11	10	RSW	**63**	111.3
10	11		11	11	11	10	RSW	**64**	112.9
11	11		11	11	11	10	RSW	**65**	114.5
11	11		11	11	11	11	RSW	**66**	116.1
11	11		11	11	12	11	RSW	**67**	118.0
11	12		11	11	12	11	RSW	**68**	119.9
11	12		12	11	12	11	RSW	**69**	121.8
11	12		12	12	12	11	RSW	**70**	123.7
12	12		12	12	12	11	RSW	**71**	125.6
12	12		12	12	12	12	RSW	**72**	127.5
12	12		12	12	13	12	RSW	**73**	129.2
12	13		12	12	13	12	RSW	**74**	130.9
12	13		13	12	13	12	RSW	**75**	132.6
12	13		13	13	13	12	RSW	**76**	134.3
13	13		13	13	13	12	RSW	**77**	136.0
13	13		13	13	13	13	RSW	**78**	137.7
13	13		13	13	14	13	RSW	**79**	139.4
13	14		13	13	14	13	RSW	**80**	141.1
13	14		14	13	14	13	RSW	**81**	142.8
13	14		14	14	14	13	RSW	**82**	144.5
14	14		14	14	14	13	RSW	**83**	146.2
14	14		14	14	14	14	RSW	**84**	147.9
14	14		14	14	15	14	RSW	**85**	149.7
14	15		14	14	15	14	RSW	**86**	151.5
14	15		15	14	15	14	RSW	**87**	153.3
14	15		15	15	15	14	RSW	**88**	155.1
15	15		15	15	15	14	RSW	**89**	156.9

LMN Uniform Spill Patterns - # Gate Stops per Spillbay (BAY 3 OOS)								Total Stops	Total Spill
Bay 1	Bay 2	Bay 3	Bay 4	Bay 5	Bay 6	Bay 7	Bay 8	(#)	(Kcfs)
15	15		15	15	15	15	RSW	**90**	158.7
15	15		15	15	16	15	RSW	**91**	160.4
15	16		15	15	16	15	RSW	**92**	162.1
15	16		16	15	16	15	RSW	**93**	163.8
15	16		16	16	16	15	RSW	**94**	165.5
16	16		16	16	16	15	RSW	**95**	167.2
16	16		16	16	16	16	RSW	**96**	168.9
16	16		16	16	17	16	RSW	**97**	170.7
16	17		16	16	17	16	RSW	**98**	172.5
16	17		17	16	17	16	RSW	**99**	174.3
16	17		17	17	17	16	RSW	**100**	176.1
17	17		17	17	17	16	RSW	**101**	177.9
17	17		17	17	17	17	RSW	**102**	179.7
17	17		17	17	18	17	RSW	**103**	181.5
17	18		17	17	18	17	RSW	**104**	183.3
17	18		18	17	18	17	RSW	**105**	185.1

c. Spill (kcfs) is calculated as a function of total stops + RSW spill at forebay elevation 537.0 ft (based on interim spillway rating table 2-Apr-2009).

d. Bay 8 w/ RSW = 7.5 kcfs spill at forebay 538.0 ft. Raise Bay 8 tainter gate above stop 9 to ensure free surface and debris passage. When low flow criteria are met (< 30 kcfs, per **section 2.3.2.6**), the RSW will be closed and spill distributed in patterns defined in **Table LMN-10.**

Table LMN-10. Lower Monumental Dam Spill Patterns with No RSW (Bay 8 Closed). [a, b]

LMN Spill Patterns w/ NO RSW - # Gate Stops per Spillbay								Total Stops	Spill [a]
Bay 1	Bay 2	Bay 3	Bay 4	Bay 5	Bay 6	Bay 7	Bay 8 [b]	(#)	(kcfs)
	1						CLOSE	**1**	**1.8**
	1					1	CLOSE	**2**	**3.6**
	1			1		1	CLOSE	**3**	**5.4**
	2			1		1	CLOSE	**4**	**6.9**
	2			1		2	CLOSE	**5**	**8.4**
	2			2		2	CLOSE	**6**	**9.9**
	2			2		3	CLOSE	**7**	**11.4**
	2			3		3	CLOSE	**8**	**12.9**
	2			3		4	CLOSE	**9**	**14.3**
	2			3		5	CLOSE	**10**	**16.0**
	2			4		5	CLOSE	**11**	**17.4**

a. Spill (kcfs) is calculated as a function of total stops at forebay elevation 537.0 ft.

b. When low flow criteria are met (< 30 kcfs, per **section 2.3.2.6**), the RSW will be closed and spill distributed in patterns defined in this table.