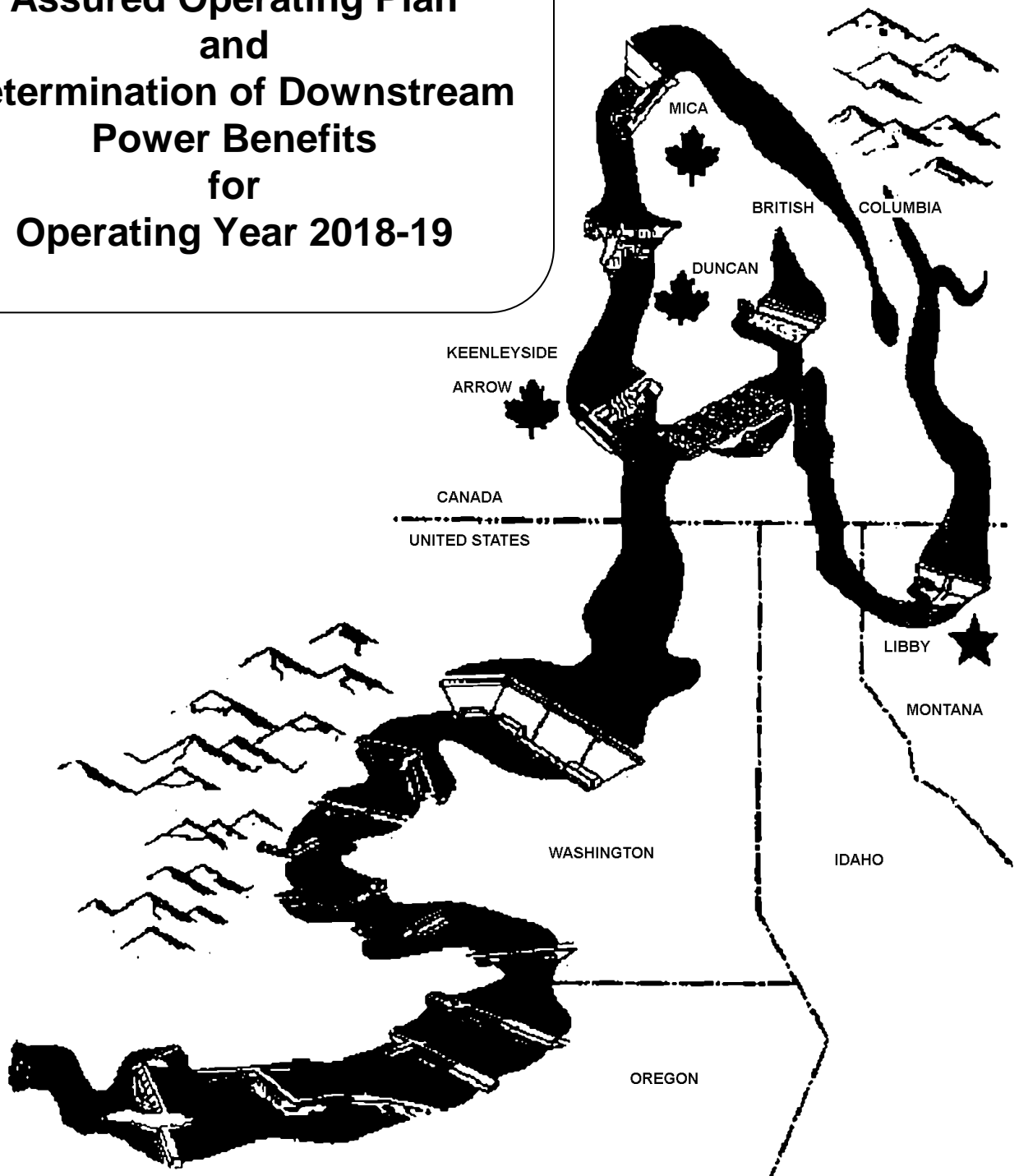


**COLUMBIA RIVER TREATY
Assured Operating Plan
and
Determination of Downstream
Power Benefits
for
Operating Year 2018-19**



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**COLUMBIA RIVER TREATY ENTITY AGREEMENT ON THE
ASSURED OPERATING PLAN AND
DETERMINATION OF DOWNSTREAM POWER BENEFITS
FOR OPERATING YEAR 2018-19**

The Columbia River Treaty between Canada and the United States of America requires that the Entities agree annually on an assured plan of operation for Canadian Treaty Storage and the resulting downstream power benefits for the sixth succeeding year.

The Entities agree that the attached reports entitled "Columbia River Treaty Hydroelectric Operating Plan: Assured Operating Plan for Operating Year 2018-19" and "Columbia River Treaty Determination of Downstream Power Benefits for the Assured Operating Plan for Operating Year 2018-19," both dated December 2013, shall be the Assured Operating Plan and Determination of Downstream Power Benefits for the 2018-19 Operating Year.

In witness thereof, the Entities have caused this Agreement to be executed.

Executed for the Canadian Entity this 16th day of December, 2013.

By: _____

Chris K. O'Riley
Chair

Executed for the United States Entity this 4th day of December, 2013.

By: _____

Elliot E. Mainzer
Acting Chairman

By: _____

Brigadier General John S. Kem
Member

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ERRATA for
COLUMBIA RIVER TREATY
DETERMINATION OF DOWNSTREAM POWER BENEFITS
for the ASSURED OPERATING PLAN
for OPERATING YEAR 2015-16

October 2013

The following page shows a correction to the table, Determination of Step I Firm Peak Hydro Loads, published as Table 1B on page 9 of the document, Determination of Downstream Power Benefits (DDPB) for the Assured Operating Plan (AOP) for Operating Year (OY) 2015-16, dated September 2011.

Originally, Table 1B was published with a sizable error on line 2(d). This error, in turn, led to errors on lines 2(k), 5, 7, 9, 10(a) and 10(c).

Because this error was discovered during the development of AOP19, the U.S. and Canadian Entity Operating Committee Chairs determined that posting an errata statement in this AOP 19 document would be appropriate, as well as in the upcoming Detailed Operating Plan for Canadian Storage that will be developed for the period of OY 2015-16.

TABLE 1B
DETERMINATION OF STEP I FIRM PEAK HYDRO LOADS
FOR 2015-16 ASSURED OPERATING PLAN
(MW)

| | Aug15 | Aug31 | Sept | Oct | Nov | Dec | Jan | Feb | March | Apr15 | Apr30 | May | June | July |
|---|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|
| 1. Pacific Northwest Area (PNWA) Firm Load | | | | | | | | | | | | | | |
| a) White Book Regional Firm Load | 29828 | 29828 | 27762 | 28901 | 32594 | 35154 | 35278 | 33675 | 30799 | 28910 | 28910 | 28382 | 29497 | 31072 |
| b) Exclude 99% of UPL's Idaho load | -463 | -463 | -432 | -431 | -431 | -461 | -439 | -452 | -423 | -400 | -400 | -446 | -517 | -570 |
| c) Adj.for Federal Peak Diversity 1/ | -445 | -478 | -507 | -320 | -293 | -507 | -302 | -306 | -349 | -467 | -481 | -476 | -471 | -385 |
| d) Updates to Coulee pumping forec. | 321 | 302 | 293 | 387 | 257 | 337 | 170 | 189 | 325 | 183 | 155 | 257 | 290 | 293 |
| e) ...Total PNWA Firm Loads | 29240 | 29188 | 27116 | 28537 | 32127 | 34522 | 34707 | 33106 | 30352 | 28226 | 28184 | 27715 | 28799 | 30409 |
| f) Monthly Load Factors in Percent | 75.40 | 75.39 | 76.29 | 72.67 | 72.04 | 73.05 | 72.89 | 72.40 | 73.56 | 75.09 | 75.38 | 74.54 | 74.96 | 75.16 |
| 2. Flows-Out of firm power from PNWA | | | | | | | | | | | | | | |
| a) White Book Exports | 2488 | 2488 | 2486 | 2125 | 1991 | 1990 | 1988 | 1989 | 1991 | 2020 | 2027 | 1870 | 2374 | 2364 |
| b) Remove WB Canadian Entitlement | -1350 | -1350 | -1350 | -1350 | -1350 | -1350 | -1350 | -1350 | -1350 | -1350 | -1350 | -1350 | -1350 | -1350 |
| c) Add estimated Can.Entitle. exported | 1367 | 1367 | 1367 | 1367 | 1367 | 1367 | 1367 | 1367 | 1367 | 1367 | 1367 | 1367 | 1367 | 1367 |
| d) Added export for WB surplus | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| e) Add Seasonal Exch. WB Export | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| f) Add Seasonal Exch. Shape Export | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| g) Thermal Inst. used outside region 2 | 258 | 258 | 279 | 152 | 117 | 10 | 77 | 55 | 39 | 15 | 140 | 256 | 249 | 249 |
| h) ...Subtotal for Table 2 | 2763 | 2763 | 2782 | 2293 | 2125 | 2017 | 2005 | 2082 | 2063 | 2076 | 2059 | 2027 | 2647 | 2630 |
| i) Remove Plant Sales | -563 | -563 | -563 | -563 | -555 | -552 | -552 | -552 | -555 | -555 | -563 | -419 | -563 | -563 |
| j) Remove Flow-through-transfer | -75 | -75 | -75 | -45 | -45 | -45 | -45 | -45 | -45 | -75 | -75 | -75 | -75 | -75 |
| k) ...Total | 2125 | 2125 | 2144 | 1686 | 1525 | 1419 | 1408 | 1485 | 1463 | 1446 | 1422 | 1533 | 2009 | 1992 |
| 3. Flows-In of firm power to PNWA, except from coordinated thermal installations | | | | | | | | | | | | | | |
| a) White Book Imports | -1073 | -1073 | -1010 | -1113 | -1438 | -1613 | -1625 | -1593 | -1278 | -1171 | -1171 | -1059 | -1130 | -1206 |
| b) Remove UP&L imports for | 542 | 542 | 498 | 498 | 505 | 528 | 498 | 511 | 476 | 451 | 451 | 525 | 630 | 666 |
| c) Remove Eastern Thermal Instal | 309 | 309 | 291 | 423 | 462 | 571 | 581 | 503 | 498 | 486 | 486 | 313 | 279 | 319 |
| d) Added SeEx for WB Surplus | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| e) Added Can.Import for WB deficits | 0 | -1367 | -1367 | 0 | 0 | -1367 | -1367 | -1367 | -1367 | 0 | 0 | 0 | 0 | -1367 |
| f) Added Calif.Import for WB deficits | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| g) Added Seas.Exch. for Aop hydro | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| h) Remove Flow-Through-Xfers | 75 | 75 | 75 | 45 | 45 | 45 | 45 | 45 | 45 | 75 | 75 | 75 | 75 | 75 |
| i) ...Total | -146 | -1513 | -1513 | -147 | -427 | -1837 | -1868 | -1901 | -1626 | -159 | -159 | -147 | -146 | -1513 |
| 4. PNWA Non-Step I Hydro and Non-thermal Resources | | | | | | | | | | | | | | |
| a) Hydro Independents (1932) | -1569 | -1554 | -1582 | -1342 | -1584 | -1497 | -1568 | -1395 | -1789 | -1775 | -1818 | -1968 | -2005 | -1749 |
| b) Non-Step I Coord. Hydro (1932) | -1821 | -1980 | -2006 | -2075 | -2142 | -2114 | -2019 | -1867 | -1752 | -1711 | -1811 | -2012 | -2361 | -2440 |
| c) WB Regional Hydro NUGs | -371 | -369 | -297 | -214 | -156 | -143 | -135 | -146 | -183 | -297 | -306 | -433 | -454 | -444 |
| d) WB Renewable NUGs | -76 | -76 | -76 | -76 | -76 | -76 | -76 | -76 | -76 | -76 | -76 | -76 | -76 | -76 |
| e) WB Renewables | -29 | -29 | -29 | -29 | -29 | -29 | -29 | -29 | -29 | -29 | -29 | -29 | -29 | -29 |
| f) Total (1932) | -3866 | -4008 | -3990 | -3737 | -3987 | -3860 | -3828 | -3513 | -3829 | -3888 | -4040 | -4519 | -4925 | -4738 |
| 5. Step I System Load 3/ (1932) | 27353 | 25791 | 23757 | 26338 | 29238 | 30245 | 30419 | 29177 | 26360 | 25625 | 25407 | 24582 | 25737 | 26149 |
| 6. Coordinated Thermal Installations | | | | | | | | | | | | | | |
| a) Columbia Generating Station (CGS) | 1140 | 1140 | 1140 | 1140 | 1140 | 1140 | 1140 | 1140 | 1140 | 1140 | 1140 | 565 | 565 | 1140 |
| b) Generic Thermal Installations | 10738 | 10738 | 10794 | 10889 | 10953 | 10997 | 11007 | 10978 | 10468 | 9955 | 9489 | 8581 | 10125 | 10741 |
| c) ...Total | 11878 | 11878 | 11934 | 12029 | 12093 | 12137 | 12147 | 12118 | 11608 | 11095 | 10629 | 9146 | 10690 | 11881 |
| 7. Step I Hydro Resc. Needed (1932) 4/ | 25798 | 23865 | 21569 | 23492 | 26169 | 26376 | 26009 | 25152 | 22918 | 22814 | 22830 | 23405 | 23381 | 24125 |
| 8. Step I Resource Adjustments | | | | | | | | | | | | | | |
| a) Hydro Maintenance 5/ | -4595 | -4032 | -3787 | -3208 | -2935 | -2037 | -1561 | -2286 | -2626 | -2751 | -2483 | -2360 | -2202 | -3720 |
| b) Transmission System Losses 6/ | -1196 | -1271 | -1273 | -1248 | -1279 | -1344 | -1334 | -1258 | -1195 | -1156 | -1164 | -1172 | -1281 | -1316 |
| c) Reserves (assume 11%) 7/ | -4532 | -4648 | -4685 | -4727 | -4811 | -4886 | -4842 | -4550 | -4344 | -4376 | -4405 | -4437 | -4852 | -4819 |
| d) ...Total maint., losses, & reserves | ##### | -9952 | -9745 | -9183 | -9024 | -8268 | -7737 | -8094 | -8166 | -8283 | -8052 | -7969 | -8334 | -9856 |
| e) Hydro maint. as %reg. hydro cap.= | 15.3% | 13.3% | 12.4% | 10.5% | 9.6% | 6.7% | 5.3% | 8.2% | 9.8% | 10.0% | 8.9% | 8.1% | 7.2% | 12.0% |
| f) Peak Resv. as % resources | 11.0% | 11.0% | 11.0% | 11.0% | 11.0% | 11.0% | 11.0% | 11.0% | 11.0% | 11.0% | 11.0% | 11.0% | 11.0% | 11.0% |
| | Aug15 | Aug31 | Sept | Oct | Nov | Dec | Jan | Feb | March | Apr15 | Apr30 | May | June | July |
| 9. Required Step I Resources | 27353 | 25791 | 23757 | 26338 | 29238 | 30245 | 30419 | 29177 | 26360 | 25625 | 25407 | 24582 | 25737 | 26149 |
| 10. Coordinated Hydro load and Surplus/Deficit (1932) | | | | | | | | | | | | | | |
| a) Coordinated Hydro Load (1932) 8/ | 27619 | 25844 | 23574 | 25568 | 28311 | 28490 | 28029 | 27019 | 24670 | 24525 | 24640 | 25417 | 25742 | 26564 |
| b) Actual Coord. Hydro Gen (1932) 9/ | 30052 | 30403 | 30451 | 30416 | 30590 | 30463 | 29605 | 28019 | 26684 | 27550 | 27864 | 29035 | 30694 | 30914 |
| c) ...Surplus/Deficit (1932) | 2433 | 4559 | 6877 | 4848 | 2279 | 1973 | 1576 | 1000 | 2014 | 3025 | 3224 | 3618 | 4952 | 4350 |

Notes:

- 1/ Federal peak diversity is a reduction in peak load due to peak loads not all being coincidental.
- 2/ Export or import to balance difference between excluded thermal imports and generic thermal installation.
- 3/ Total Step I Firm Peak Load is the sum of lines 1(e) + 2(k) + 3(i) + 4(f)
- 4/ Step I hydro resources needed to meet the load = line 5 - line 6(c) - line 8(d). Actual resource capability is higher. Used 1932 because has lowest surplus.
- 5/ From WB, based on 5-year PNCA average as a MW reduction from installed capacity. May need to revise next year as a reduction from 1937 capability.
- 6/ Transmission losses are 3.25% of all resources including imports, net of reserves and maintenance.
- 7/ Reserves are 11% of resources, i.e. 4(f), 6(c), 10(b) - 8(a)
- 8/ Lines 4b and 7
- 9/ System Instantaneous Peak (1932)

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**COLUMBIA RIVER TREATY
HYDROELECTRIC OPERATING PLAN**

**ASSURED OPERATING PLAN
FOR OPERATING YEAR 2018-19**

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TABLE OF CONTENTS

| <u>Section</u> | <u>Page</u> |
|---|--------------------|
| 1. Introduction | 1 |
| 2. Development of the Assured Operating Plan | 1 |
| a) Procedures | 1 |
| b) System Regulation Studies | 3 |
| c) Evaluation of the Joint Optimum Study | 4 |
| (1) Determination of Optimum Generation in Canada and the USA | 4 |
| (2) Maximum Permitted Reduction in Downstream Power Benefits | 4 |
| 3. Rule Curves | 5 |
| a) Critical Rule Curves | 5 |
| b) Refill Curves | 5 |
| (1) Assured Refill Curves | 6 |
| (2) Variable Refill Curves | 6 |
| c) Operating Rule Curve Lower Limits (ORCLLs)..... | 6 |
| d) Upper Rule Curves (Flood Risk Management)..... | 6 |
| e) Operating Rule Curves..... | 7 |
| 4. Operating Rules | 7 |
| a) Operation at or above ORC | 7 |
| b) Operation below ORC | 8 |
| c) Canadian Treaty Project Operating Criteria | 8 |
| (1) Mica Project Operating Criteria..... | 8 |
| (2) Arrow Project Operating Criteria (APOC) | 8 |
| d) Other Canadian Project Operation | 9 |
| 5. Preparation of the Detailed Operating Plan | 9 |
| 6. Canadian Entitlement | 10 |
| 7. Summary of Changes Compared to the 2017-18 AOP and Notable Assumptions | 10 |
| a) Pacific Northwest Area (PNWA) Firm Load..... | 10 |
| b) Flows of Power at Points of Interconnection | 11 |
| c) Non-Step I Hydro and Other Non-Thermal Resources | 12 |
| d) Thermal Installations..... | 12 |
| e) Hydro Project Modified Streamflows | 12 |
| f) Hydro Project Rule Curves..... | 13 |
| g) Other Hydro Project Operating Procedures, Constraints, and Plant Data | 13 |

| | |
|--|----|
| End Notes | 13 |
| Table 1 - Mica Project Operating Criteria (English Units) | 14 |
| Table 1.1a - Arrow Project Operating Criteria: Definition (English Units)..... | 15 |
| Table 1.1b - Arrow Project Operating Criteria: 30-Year Operating Data (English Units)..... | 16 |
| Table 1.1c - Arrow Project Operating Criteria: Implementation Distribution Factors | 17 |
| Table 2 - Comparison of Assured Operating Plan Study Results | 18 |
| Table 3 - Critical Rule Curves End of Period Treaty Storage Contents (English Units) | 19 |
| Table 4 - Mica Assured and Variable Refill Curves (English Units) | 20 |
| Table 5 - Arrow Assured and Variable Refill Curves (English Units) | 21 |
| Table 6 - Duncan Assured and Variable Refill Curves (English Units)..... | 22 |
| Table 7 - Mica Upper Rule Curves (Flood Risk Management) (English Units) | 23 |
| Table 8 - Arrow Upper Rule Curves (Flood Risk Management) (English Units)..... | 24 |
| Table 9 - Duncan Upper Rule Curves (Flood Risk Management) (English Units)..... | 25 |
| Table 10 - Composite ORCs for the Whole of Canadian Treaty Storage (English Units) | 26 |
| Table 11 - Composite Canadian Treaty Storage Operation (English Units)..... | 27 |
| Table 12 - Comparison of Recent Assured Operating Plan Studies (English Units) | 28 |
| Table 1M - Mica Project Operating Criteria (Metric Units) | 29 |
| Table 1.1aM - Arrow Project Operating Criteria: Definition (Metric Units)..... | 30 |
| Table 1.1bM - Arrow Project Operating Criteria: 30-Year Operating Data (Metric Units).... | 31 |
| Table 3M - Critical Rule Curves End of Period Treaty Storage Contents (Metric Units) | 32 |
| Table 4M - Mica Assured and Variable Refill Curves (Metric Units) | 33 |
| Table 5M - Arrow Assured and Variable Refill Curves (Metric Units)..... | 34 |
| Table 6M - Duncan Assured and Variable Refill Curves (Metric Units)..... | 35 |
| Table 7M - Mica Upper Rule Curves (Flood Risk Management) (Metric Units) | 36 |
| Table 8M - Arrow Upper Rule Curves (Flood Risk Management) (Metric Units)..... | 37 |
| Table 9M - Duncan Upper Rule Curves (Flood Risk Management) (Metric Units)..... | 38 |
| Table 10M - Composite ORCs for the Whole of Canadian Treaty Storage (Metric Units) ... | 39 |
| Table 11M - Composite Canadian Treaty Storage Operation (Metric Units)..... | 40 |
| Table 12M - Comparison of Recent Assured Operating Plan Studies (Metric Units) | 41 |
| Appendix A - Project Operating Procedures for the 2018-19 AOP/DDPB | 42 |

HYDROELECTRIC OPERATING PLAN ASSURED OPERATING PLAN FOR OPERATING YEAR 2018-19

December 2013

1. Introduction

The “Treaty between Canada and the United States of America relating to the cooperative development of the water resources of the Columbia River Basin” (Treaty), dated 17 January 1961, requires that each year the Entities designated by the two governments will formulate and carry out operating arrangements necessary to implement the Treaty and will agree on an Assured Operating Plan (AOP) for the Treaty storage in Canada (Canadian Treaty Storage) and resulting downstream power benefits for the sixth succeeding operating year. This AOP for operating year 2018-19 (AOP19) provides the Entities with an operating plan for Canadian Treaty Storage and information for planning the power systems that are dependent on or coordinated with the operation of the Canadian Treaty Storage projects.

2. Development of the Assured Operating Plan

a) Procedures

This AOP was prepared in accordance with the Treaty, the “Protocol - Annex to Exchange of Notes, Dated January 22, 1964 Between the Governments of Canada and the United States Regarding the Columbia River Treaty” (Protocol), and the following Entity Agreements:

- The Entity Agreements, signed 28 July and 12 August 1988, on “Principles for the Preparation of the AOP and Determination of Downstream Power Benefit (DDPB) Studies” and “Changes to Procedures for the Preparation of the AOP and DDPB Studies” (1988 Entity Agreements);
- The “Columbia River Treaty Entity Agreement on Resolving the Dispute on Critical Period Determination, the Capacity Entitlement, for the 1998-99, 1999-00, and 2000-01 AOP/DDPBs, and Operating Procedures for the 2001-02 and Future AOPs,” signed 29 August 1996 (29 August 1996 Entity Agreement); and
- Except for the changes noted below, the “Columbia River Treaty Entity Agreement on the Principles and Procedures for Preparing and Implementing Hydroelectric Operating Plans For Operation of Canadian Treaty Storage” (POP), dated October 2003 and signed 16 December 2003, including the September 2011 update to Appendix 1 - Refill Curves; the November 2004 addition of Appendix 6 - Streamline Procedures; the addition of Appendix 7 – Table of Median Flows based on the 2010 Level Modified Streamflows; and the September 2007 addition of Appendix 8 concerning Water Supply Forecasts along with the

February 2012 revision of Appendix 8, Table 1, concerning the Summary of Errors and Hedges.

Special terms used in this document, but not defined herein, have the meanings defined in the Treaty, Protocol, or the above Entity Agreements. The POP is based on criteria contained in Annex A and Annex B of the Treaty, the Protocol, and the Columbia River Treaty Flood Control Operating Plan (FCOP), dated May 2003.

For the AOP19, the Entities have agreed to use all three streamline procedures defined in Appendix 6 of the POP. These streamline procedures include “Forecasting Loads and Resources” for determining the thermal installations, as described in Subsection 7(d) of this document, the “Multi-Year Use of Same Operating Criteria for Canadian Treaty Storage” based on the AOP18 Joint Optimum Step I system regulation study, as explained in Subsection 2(b) of this document, and the “Monthly Hydro Energy Reshaping for Step II and III 30-year System Regulation Studies” for determining the energy entitlement, as described in Subsection 7(f) of the accompanying document, Columbia River Treaty Determination of Downstream Power Benefits for the Assured Operating Plan for Operating Year 2018-19 (DDPB19).

In addition, the Entities have agreed to add to or modify certain procedures defined in POP as follows:

- Allocate available uncommitted PNWA resources and available uncommitted imports from Canada and California to balance the White Book (WB) firm load/resource deficit, as was done since the AOP/DDPB13, as described in Subsections 7(b) and 7(d), and include the allocated Canadian import into the load/resource balance
- Exclude seasonal exchanges for balancing WB loads and resources (the same as was done since AOP16);
- Shape generic thermal installations based on the full amount of WB large thermal, co-generation and combustion turbines and 30% of unreported CT energy capability that are estimated to be needed to meet the WB load, as described in Subsection 7(d); and

In accordance with Protocol VII(2), this AOP provides a reservoir-balance relationship for each month for the whole of the Canadian Treaty Storage. This relationship is determined from the following:

- The Critical Rule Curves (CRCs), Upper Rule Curves (URCs), and the related rule curves and data for each project used to compute the individual project Operating Rule Curves (ORCs);
- Operating rules and criteria for operation of the Canadian Treaty Storage in accordance with the principles contained in the above references; and
- The supporting data and model used to simulate the 30-year operation for the Step I Joint Optimum (AOP18-41) system regulation study^[1].

This AOP includes both metric (International Standard) and English units^[2]. The system regulation studies and supporting data were based on English units. The metric units are approximations derived by rounding conversions from English units. Metric values are displayed with either one or two decimal places to assure consistency with English units and do not imply that level of precision. The inclusion of metric units complies with USA Federal statutory requirements. Tables referred to in the text are in English units. Metric tables use the same numbering system as the English tables with the letter “M” after the table number.

b) System Regulation Studies

This AOP was prepared in accordance with Annex A, paragraph 7, of the Treaty, which requires Canadian Treaty Storage operation for joint optimum power generation in both Canada and the USA. Downstream power benefits were computed with the Canadian Treaty Storage operation based on the same criteria for joint optimum power generation used in the Step I study.

Step I system regulation studies for the AOP19 are based on 2018-19 operating year estimated loads and resources in the USA PNWA including estimated flows of power from and to adjacent areas and hydro resources in the Columbia River Basin in British Columbia. In accordance with the Streamline Procedure “Multi-Year Use of Same Operating Criteria for Canadian Treaty Storage”, the Entities have agreed to add seasonal exchange imports and exports to adjust the Step I system regulated hydro energy load to be the same as in the AOP18. With the same regulated hydro energy load and no change in hydro system capability, the AOP18 Step I system regulation study can serve as the basis for the AOP19.

In accordance with Protocol VIII, the AOP19 is based on a 30-year stream flow period and the Entities have agreed to use an operating year of 1 August through 31 July. The studies used historical flows for the period August 1928 through July 1958, modified by estimated irrigation depletions for the 2010 level^[3] and including updated estimates of Grand Coulee net pumping requirements.

The CRCs were determined from critical period studies of optimum power generation in both Canada and the USA. The study indicated a continuous 42.5 calendar-month critical period for the USA Step I system resulting from flows during the period from 16 August 1928 through 29 February 1932. With the exception of Brownlee and Dworshak, it was assumed that all reservoirs, both in the USA and Canada, were full at the beginning of the critical period except where minimum release requirements made this impossible.

The Corps of Engineers has transitioned to new terminology, from “Flood Control” to “Flood Risk Management” (FRM). Historic documents that use the term “flood control” will not be changed. The Flood Risk Management operation at Canadian projects was based on individual project flood risk criteria instead of a composite curve. The Canadian Entity selected a 5.03/4.44 cubic kilometer (km³) (4.08/3.6 million acre-feet (Maf)) Mica/Arrow flood risk allocation in accordance with Section 6 of the FCOP. Flood Risk Management and Variable Refill Curves are based on historical inflow volumes. Although only 19.12 km³ (15.5 Maf) of usable

storage is committed for power operation purposes under the Treaty, the FCOP provides for the full draft of the total 25.29 km³ (20.5 Maf) of usable storage for on-call flood risk management purposes. Flood Risk Management Rule Curves are implemented in the system regulation studies as upper rule curves.

c) Evaluation of the Joint Optimum Study

In accordance with Subsections 3.2.A and 3.3.A(3) of the POP, the changes in Canadian Treaty Storage operation for an optimum power generation at-site in Canada and downstream in Canada and the USA (Joint Optimum), compared to an operation for optimum power only in the USA (USA Optimum), were evaluated as required by Annex A, paragraph 7 of the Treaty using the two criteria described below:

(1) Determination of Optimum Generation in Canada and the USA

To determine whether optimum power generation in both Canada and the USA was achieved in the system regulation studies, the annual firm energy capability, dependable peaking capability, and average annual usable secondary energy were computed for both the Canadian and USA systems.

In order to measure optimum power generation for the AOP19, the Columbia River Treaty Operating Committee agreed that the three quantities would be assigned the following relative values:

| <u>Quantity</u> | <u>Relative Value</u> |
|---|-----------------------|
| Annual firm energy capability (average megawatts (aMW)) | 3 |
| Dependable peaking capability (MW) | 1 |
| Average annual usable secondary energy (aMW) | 2 |

For the AOP19, in accordance with the second streamline procedure (as described in Subsection 2(b)), these quantities were based on the AOP18 studies. It should also be noted that the period for the dependable peaking capability (i.e. the period with the least surplus firm peak capability over the thirty water years) changed from 15 August 1931 (in AOP18) to January 1932 (in AOP19) due to changes in the peak load shape.

The sum of the three weighted quantities showed a net gain in the Joint Optimum Study compared to the USA Optimum Study. The Entities agree that this result is in accordance with Subsection 3.2.A of the POP. The results of these calculations are shown in Table 2.

(2) Maximum Permitted Reduction in Downstream Power Benefits

Annex A, paragraph 7 of the Treaty defines the limits to any reduction in the downstream power benefits in the USA resulting from a change in Canadian Treaty Storage operation to achieve a joint optimum operation.

In accordance with the third streamline procedure (as described in the DDPB19, Subsection 7(f)), and using the re-shaped DDPB18 storage

operation for the optimum generation in both Canada and the USA, there was a 1.3 aMW increase in the Canadian Entitlement for average annual usable energy, as compared to the re-shaped USA optimum operation. There was no change in the dependable capacity compared to the operation for optimum generation in the USA alone. (See Table 5 of DDPB19, columns A and B.)

Since there is no reduction in entitlement, the Entities have determined in Section 4 of the DDPB19 that the calculation of maximum permitted reduction in downstream power benefits is not necessary.

3. Rule Curves

The operation of Canadian Treaty Storage during the 2018-19 Operating Year shall be guided by the ORCs and CRCs for the whole of Canadian Treaty Storage, Flood Risk Management Curves for the individual projects, and project operating criteria for Mica and Arrow. The ORCs and CRCs are first determined for the individual Canadian projects and then summed to yield the Composite ORC for the whole of Canadian Treaty Storage, in accordance with paragraph VII-(2) of the Protocol. The ORCs are derived from the various curves described below.

a) Critical Rule Curves

The CRC is defined by the end-of-period storage content of Canadian Treaty Storage during the critical period. It is used to determine proportional draft below the ORCs as defined in Subsection 4(b) of this document. Generally, CRCs are adjusted for crossovers by the hydro regulation model as defined in Section 2.3.A of the POP. CRC crossovers occur when the second, third, or fourth year CRCs are higher than any of the lower numbered CRCs. Past practice was for the hydro regulation model to lower the storage amounts in the higher numbered CRCs at all projects as needed to eliminate the crossover. For the Canadian Treaty projects, this adjustment is applied only if the sum of Mica + Arrow + Duncan Treaty storage has a composite CRC crossover. The adjustment is made to Arrow first unless or until Arrow is empty, then the adjustment is made to Duncan. The CRCs for Duncan, Arrow, Mica, and the Composite CRCs for the whole of Canadian Treaty Storage are tabulated in Table 3.

b) Refill Curves

There are two types of refill curves, Assured Refill Curves (ARCs) and Variable Refill Curves (VRCs), which are discussed in the following subsections. Tabulations of the ARCs and VRCs, and supporting data used in determining the ARCs and VRCs for Mica, Arrow, and Duncan are provided in Tables 4, 5, and 6, respectively. Under the second streamline procedure, all distribution factors, forecast errors, Power Discharge Requirements (PDRs), and Operating Rule Curve Lower Limits (ORCLLs) are the same as used in the AOP18.

(1) Assured Refill Curves

The ARCs indicate the minimum August through June end-of-period storage contents required to meet firm load and refill the Coordinated System storage by 31 July, based on the 1930-31 inflows. The upstream storage requirements and the PDR are determined in accordance with Section 2.3.B and Appendix 1 as modified in the POP. The 1930-31 inflows are the second lowest January through July unregulated streamflows at The Dalles, Oregon, during the 30-year (1928-58) stream flow period, which has approximately a 95% probability of exceedance.

(2) Variable Refill Curves

The VRCs indicate the minimum January through June end-of-period storage contents required to refill the Coordinated System storage by 31 July based on the 95% confidence forecasted inflow volume. The upstream storage refill requirements and PDRs are determined in accordance with Section 2.3.B and Appendix 1 as modified in the POP. In the system regulation studies, historical volume inflows, adjusted for the 95% confidence forecast error, were used instead of forecast inflows. The PDRs are a function of the unregulated January through July runoff volume at The Dalles, Oregon. In those years when the January through July runoff volume at The Dalles is between 98.68 km^3 (80 Maf) and 135.69 km^3 (110 Maf), the PDRs are interpolated linearly between the values shown in Tables 4-6. In those years when the January through July runoff volume at The Dalles is less than 98.68 km^3 (80 Maf), or greater than 135.69 km^3 (110 Maf), the PDR values for 98.68 km^3 and 135.69 km^3 (80 Maf and 110 Maf), respectively, are used. For AOP19, as was used since AOP12, the VRC Lower Limit (VRCLL) was applied as a set rule curve lower limit for Grand Coulee's VRC only.

Tables 4-6 illustrate the range of VRCs for Mica, Arrow, and Duncan for the 30-year stream flow period. In actual operation in 2018-19, the PDRs and VRCLLs will be based on the forecast of unregulated runoff at The Dalles.

c) Operating Rule Curve Lower Limits

The ORCLLs indicate the minimum 31 January through 15 April end-of-period storage contents that must be maintained to protect the ability of the system to meet firm load during the period 1 January through 30 April. The ORCLLs protect the system's ability to meet firm load in the event that the VRCs permit storage to be emptied and sufficient natural flow is not available to carry the load prior to the start of the freshet. Such rule curves shall limit the ORC to be no lower than the ORCLLs. The ORCLLs are developed for 1936-37 water conditions which include the lowest January through April unregulated streamflows at The Dalles during the 30-year stream flow period. The ORCLLs for Mica, Arrow, and Duncan are shown in Tables 4, 5, and 6, respectively.

d) Upper Rule Curves (Flood Risk Management)

The URCs indicate the maximum end-of-period storage contents to which each

individual Canadian Treaty Storage project shall be evacuated for Flood Risk Management. The URCs used in the studies were based upon Flood Control Storage Reservation Diagrams contained in the FCOP and analysis of system flood risk simulations. URCs for Mica, Arrow, and Duncan for the 30-year stream flow period are shown in Tables 7, 8, and 9, respectively. Tables 7 and 8 reflect an agreed transfer of flood management space in Mica and Arrow to maximum drafts of 5.03 km^3 and 4.44 km^3 (4.08 Maf and 3.6 Maf), respectively. In actual operation for 2018-19, the URCs will be computed as outlined in the FCOP using the latest forecast of runoff available at that time.

e) Operating Rule Curves

The ORCs define the normal limit of storage draft to produce secondary energy and provide a high probability of refilling the reservoirs. In general, the Operating Plan does not permit serving secondary loads at the risk of failing to refill storage and thereby jeopardizing the firm load carrying capability of the USA or Canadian systems during subsequent years.

During the period 1 August through 31 December, the ORC is defined as the CRC for the first year of the critical period (CRC1) or the ARC, whichever is higher. During the period 1 January through 31 July, the ORC is defined as the higher of the CRC1 and the ARC, unless the VRC (limited by the VRCLL) is lower, then the VRC defines the ORC. During the period 1 January through 15 April, the ORC will not be lower than the ORCLL. The ORC shall be less than or equal to the URC at each individual project in all periods. The composite ORCs for the whole of Canadian Treaty Storage for the 30-year streamflow period are included in Table 10 to illustrate the probable future range of these curves based on historical water conditions.

4. Operating Rules

As described in Subsection 2(b) of this document, the AOP19 system regulation study is based on the AOP18-41 system regulation study. The storage operation results for the whole of Canadian Treaty Storage for the 30-year streamflow period are shown in Table 11. The study contains the agreed-upon ORCs and CRCs, and operating procedures and constraints, such as maximum and minimum project elevations, discharges, and draft rates. These constraints are included as part of this operating plan and are listed in Appendix A of this document.

The following rules and other operating criteria included in the AOP18-41 system regulation study will apply to the operation of Canadian Treaty Storage during the 2018-19 Operating Year, subject to the provisions under Section 5 of this document.

a) Operation at or above ORC

The whole of Canadian Treaty Storage will be drafted to its ORC as required to produce optimum generation in Canada and the USA in accordance with Annex A, paragraph 7, of the Treaty, subject to project physical characteristics and operating constraints.

b) Operation below ORC

The whole of Canadian Treaty Storage will be drafted below its ORC as required to produce optimum power generation, to the extent that a system regulation study determines that proportional draft below the ORC is required to produce the hydro firm energy load carrying capability (FELCC) of the USA system. FELCC is determined by the applicable Critical Period regulation study. Proportional draft between rule curves will be determined as described in Section 2.4.C of the POP.

c) Canadian Treaty Project Operating Criteria

Mica and Arrow reservoirs will be operated in accordance with project operating criteria listed in Tables 1 and 1.1, respectively, so as to optimize generation at Mica, Revelstoke, and Arrow, and downstream in the USA. Under these operating criteria, outflows will be increased as required to avoid storage above the URC at each reservoir.

(1) Mica Project Operating Criteria

In general, the Mica operation in each period is either a target flow or target content, as listed in Table 1 and is determined by Arrow's storage content at the end of the previous period. In the event that Mica's operation to the Table 1 operating criteria results in more or less than the project's share of draft from the whole of Canadian Treaty Storage as described in Subsections 4(a) or 4(b) above, compensating changes will be made at Arrow to the extent possible.

Mica storage releases in excess of 8.63 km^3 (7.0 Maf) that are required to maintain the Mica outflows specified under this plan will be retained in the Arrow reservoir, subject to flood risk management and other project operating criteria at Arrow. The total combined storage draft from Mica and Arrow will not exceed 17.39 km^3 (14.1 Maf), unless flood risk management or minimum flow criteria will not permit the excess Mica storage releases to be retained at Arrow. Based on this AOP, the probability of a combined Mica + Arrow storage release in excess of 17.39 km^3 (14.1 Maf) occurring has been judged to be negligible; however, in actual operations, should Treaty specified constraints require combined Mica + Arrow storage draft in excess of 17.39 km^3 (14.1 Maf), it is mutually agreed for the sole purpose of this AOP that such releases may occur. If such a release should occur, the target Mica operation will remain as specified in Table 1, and the excess release will be returned as soon as the operating criteria permit.

The adoption of the above described procedure for addressing total combined storage draft from Mica and Arrow in this AOP19 is not intended to set a precedent for future AOPs and is subject to change in future AOPs.

(2) Arrow Project Operating Criteria (APOC)

In general, Arrow reservoir will be operated to provide the balance of the required Canadian Treaty Storage as described in Subsections 4(a) or 4(b)

above, subject to physical and operating constraints. These constraints include, but are not limited to, the URC, rate-of-draft and minimum flows limits, and the Arrow Project Operating Criteria (APOC).

The APOC are shown in Table 1.1(a) and consists of maximum storage limits, maximum outflow limits and minimum outflow limits at Arrow. The maximum storage limits apply from February to June depending on the forecast for The Dalles residual unregulated runoff for the current month through July. The maximum and minimum outflow limits apply under all water conditions, subject to flood risk management requirements and a maximum combined draft of 17.39 km³ (14.1 Maf) at Mica + Arrow, respectively. In no circumstance shall the minimum outflow be reduced below the Treaty specified minimum of 142 m³/s (5,000 cfs).

Implementation of the APOC storage limits in the Detailed Operating Plan will use the distribution factors shown in Table 1.1(c). These distribution factors are multiplied by the current month through July forecast volumes at The Dalles, to calculate future month through July volume forecasts. The resulting residual month-July volumes are then used to determine the maximum storage levels from the criteria provided in Table 1.1(a). To assist implementation of this procedure, an example is shown at the bottom of Table 1.1(c).

d) Other Canadian Project Operation

Revelstoke, Upper Bonnington, Lower Bonnington, South Slocan, Brilliant, Seven Mile, and Waneta are included in the AOP19 as run-of-river projects. Generation at Arrow is modeled in the studies. Corra Linn and Kootenay Canal are included and operated in accordance with criteria utilized in the AOP18.

5. Preparation of the Detailed Operating Plan

The Entities have to this date agreed that each year a Detailed Operating Plan (DOP) will be prepared for the immediately succeeding operating year. Such DOPs are made under authority of Article XIV.2 of the Columbia River Treaty, which states in part:

" . . . the powers and the duties of the entities include: . . .

"(k) preparation and implementation of detailed operating plans that may produce results more advantageous to both countries than those that would arise from operation under the plans referred to in Annexes A and B."

The 2018-19 DOP (DOP19) will reflect the latest available load, resource, and other pertinent data to the extent the Entities agree that this data should be included in the plan. The data and criteria contained herein may be reviewed and updated as agreed by the Entities to form the basis for a DOP19. Failing agreement on updating the data and/or criteria, the DOP19 for Canadian Treaty Storage shall include the rule curves, Mica and Arrow operating criteria, and other data and criteria provided in this AOP. Actual operation of Canadian Treaty Storage during the 2018-19 Operating Year shall be guided by the DOP19.

In AOP studies the values used to define the various rule curves are period-end values only. In actual operation, it is necessary to operate in such a manner during the course of each period that these period-end values can be achieved in accordance with the operating rules. Due to the normal variation of power load and streamflow during any period, straight-line interpolation between the period-end points should not be assumed. During the storage drawdown season, Canadian Treaty Storage should not be drafted below its period-end point at any time during the period unless it can be conservatively demonstrated that sufficient inflow is available, in excess of the minimum outflow required to serve power demand, to refill the reservoir to its end-of-period value as required.

During the storage evacuation and refill season, operation will be consistent with the FCOP. When refill of Canadian Treaty Storage is being guided by Flood Risk Management Refill Curves, such curves will be computed on a day-by-day basis using the residual volume-of-inflow forecasts depleted by the volume required for minimum outflow, unless higher flows are required to meet firm load, for each day through the end of the refill season.

6. Canadian Entitlement

The amount of Canadian Entitlement is defined in the companion document “Determination of Downstream Power Benefits for the Assured Operating Plan for Operating Year 2018-19.”

The Treaty specifies return of the Canadian Entitlement at a point near Oliver, British Columbia, unless otherwise agreed by the Entities. Because no cross-border transmission exists near Oliver, the Entities completed an agreement on Aspects of the Delivery of the Canadian Entitlement for 1 April 1998 through 15 September 2024, dated 29 March 1999^[4]. This Agreement covers the full 1 August 2018 through 31 July 2019 period covered by this AOP, and includes transmission losses and scheduling guidelines for delivery of the Canadian Entitlement.

7. Summary of Changes Compared to the 2017-18 AOP and Notable Assumptions

Data from the recent AOPs are compared and summarized in Table 12. An explanation of the more important changes and notable assumptions follows.

a) Pacific Northwest Area (PNWA) Firm Load

Loads for the AOP19 are based on Bonneville Power Administration’s (BPA) October 2012 White Book (WB12)^[5] expected load forecast. The WB12 forecast for the 2018-19 regional firm load is 23,548 annual aMW, which is 275 aMW higher than the AOP18. There were minor changes to the Idaho portion of the Utah Power & Light load and to the Coulee pumping requirements, leading to an increase in the net PNWA firm load by 270 annual aMW from the AOP18 to AOP19.

The average critical period load factor increased from 74.60% in AOP18 to 75.08% in AOP19. This was mainly due to changes in the energy and peak load forecast.

b) Flows of Power at Points of Interconnection

The Step I System Load includes the net effect of flows of power at points of interconnection which are all imports and exports, except those classified as thermal installations, plant sales, and flow-through-transfers.

- For the AOP19, the estimate of the amount of Canadian Entitlement energy and other uncommitted imports that would be assumed to serve load in the PNWA were based on a similar procedure being used since AOP13, except that since AOP16, the use of added seasonal exchanges to balance firm WB loads and resources has been eliminated. This procedure assumes all of the Canadian Entitlement is returned to Canada, but is then available as an uncommitted import for the PNWA. The procedure determines the WB12 firm energy deficit without uncommitted thermal resources and then uses an allocation procedure of uncommitted resources to eliminate the deficit. The first step eliminates monthly deficits by proportionally allocating uncommitted PNWA resources (without unreported CT capability) and Canadian imports based on their availability. For the AOP19, this procedure resulted in 36% (171 annual aMW) of the available Canadian import being used for serving PNWA load. The allocated amount of uncommitted PNWA resources (without unreported CT capability) is used in the determination of the shape of the generic thermal installation, as discussed in Subsection 7(d). Any remaining deficits are then allocated based on the proportion of available unreported CT capability and assumed available California imports. The resulting amount of allocated imports are included in the Step I load/resource balance. Compared to AOP18, this procedure results in a 41 annual aMW increase in Entitlement energy serving load in the U.S.
- The estimated Canadian Entitlement included in export loads was 470 annual aMW of energy and 1295 MW of capacity. The amount computed for the DDPB19 is 472.5 annual aMW of energy and 1284.0 MW of capacity. Iterative studies to update the Canadian Entitlement assumed in the load estimate (see DDPB Table 1) were not performed because the effect on the amount of thermal installations would not noticeably impact the results of the studies.
- For the AOP19, as was the case since AOP15, a seasonal exchange to reshape the residual hydro load to reflect differences between AOP and WB hydro capabilities was not used. In addition, as was the case since AOP16, the AOP19 did not use seasonal exchanges to balance the firm WB loads and resources. However, in accordance with the Streamline Procedure “Multi-Year Use of Same Operating Criteria for Canadian Treaty Storage” and as described in Subsection 2(b), a seasonal exchange was added to the AOP19 to adjust the Step I system regulated hydro load to be the same as the AOP18.
- Compared to the AOP18, power flows-out (exports that are mostly to the southwest but also include the Entitlement) increased by 69 annual aMW, and power flows-in (imports) increased by 196 annual aMW.
- The difference in total exports can be accounted for due to the net effect of a large increase in WB exports and the use of a Seasonal Exchange to match the AOP19 Step I system regulated hydro load with that from the AOP18 (second

streamline procedure), offset by a large decrease in plant sales as well as a reduction in exported thermal.

- The difference in total imports can be accounted for due primarily to the use of Seasonal Exchanges to match the AOP19 Step I system regulated hydro load with that from the AOP18 (second streamline procedure) and, to a lesser extent, with the increased use of Canadian Imports for WB deficits.

c) Non-Step I Hydro and Other Non-Thermal Resources

The Step I System Load is reduced by hydro-independent generation, non-Step I coordinated hydro, and miscellaneous non-thermal resources. For the AOP19, these resources have increased by 165 annual aMW over the AOP18. This is primarily due to an increase of renewables in AOP19.

Firm wind is included in AOP19 resources from the WB12, as in AOP18. In the WB12, firm wind is the monthly wind generation that occurred in the operating year with the lowest total PNWA wind generation.

d) Thermal Installations

Because of increasing difficulty in forecasting Thermal Installations, the Entities again used the Streamline Procedure for “Loads and Resources” for determining Thermal Installations, as used since AOP07. The procedure includes the Columbia Generating Station (CGS) plus one generic Thermal Installation, sized as needed to balance loads and resources in the critical period. In this AOP, an average of the two year (2017-18 and 2018-19) maintenance cycle at CGS was used.

For the AOP19, as was the case since AOP16, it was agreed that the coordinated thermal installations used to determine the shape of the generic thermal installation for the AOP load and resource balance are the full amount of WB12 large thermal, co-generation, and combustion turbines and 30% of unreported CT energy capability that are estimated to be needed to meet the WB12 load.

The total thermal installations decreased by 22 annual aMW from AOP18 to AOP19, as shown in DDPB19, Subsection 7(b), due to a combination of all changes in loads and resources as explained above. However, changes in thermal maintenance resulted in decreased thermal generation September-November and February-April, and increased generation May-July.

e) Hydro Project Modified Streamflows

The unregulated base streamflows used in the system regulation studies were the same as those used in the AOP18 studies, which were based on the 2010 Modified Streamflow update, published by BPA in August 2011. Modified Streamflows are determined from historic observed streamflows, adjusted to remove the historic storage regulation effect at modeled upstream projects, and modified to a common level of irrigation depletions (2010 level) and reservoir evaporation. As in the AOP18, these flows were further adjusted to include net Grand Coulee pumping updates from the PNCA 1 February 2012 data submittal.

f) Hydro Project Rule Curves

In accordance with the Streamline procedure “Multi-Year Use of Same Operating Criteria for Canadian Treaty Storage”, and as described in Subsection 2(b) of this document, the AOP19 system regulation studies use the same hydro project rule curves as the AOP18. Please refer to the document, Columbia River Treaty Hydroelectric Operating Plan Assured Operating Plan for Operating Year 2017-18 (AOP18) for notable assumptions affecting hydro project rule curves.

g) Other Hydro Project Operating Procedures, Constraints, and Plant Data

In accordance with the Streamline procedure “Multi-Year Use of Same Operating Criteria for Canadian Treaty Storage”, and as described in Subsection 2(b) of this document, the AOP19 system regulation studies use the same hydro project operating procedures, constraints and plant data as the AOP18. Please refer to the AOP18 document for notable assumptions affecting operating procedures, constraints, and plant data.

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- [1] “BPA Hydroelectric Power Planning Program, Assured Operating Plan 30-year System Regulation Study 18-41,” dated 22 January 2013.
- [2] The conversion factors used are:
- (a) million acre-feet (Maf) times 1.2335 equals cubic kilometers (km^3);
 - (b) thousand second-foot-days (ksfd) times 2.4466 equals cubic hectometers (hm^3);
 - (c) cubic feet per second (cfs) divided by 35.3147 equals cubic meters per second (m^3/s);
 - and
 - (d) feet (ft) times 0.3048 equals meters (m).
- [3] ‘2010 Level Modified Streamflow, 1928-2008’ (document DOE/BP-4352) published by Bonneville Power Administration (BPA), Portland, Oregon (dated August 2011).
- [4] “Columbia River Treaty Entity Agreement on Aspects of the Delivery of the Canadian Entitlement for April 1, 1998 Through September 15, 2024” between the Canadian Entity and the United States Entity, dated 29 March 1999.
- [5] October 2012 Final Study #S104-WB-20121129-173308 of the “2012 Pacific Northwest Loads & Resources Study, Operating Years 2014 through 2023”.

TABLE 1
(English Units)
MICA PROJECT OPERATING CRITERIA
2018-19 ASSURED OPERATING PLAN

| Period | End of Previous Period Arrow Storage Content (ksfd) | Target Operation | | Target Operation Limits | | |
|--------------|---|------------------------------------|--|--|--------------------------------|-----------------------------|
| | | Period Average Outflow (cfs) | End-of-Period Treaty Storage Content 1/ (ksfd) | Minimum Treaty Storage Content 2/ (ksfd) | Maximum Outflow 1/ (cfs) | Minimum Outflow (cfs) |
| August 1-15 | 3,300 - FULL | - | 3,494.1 | - | 34,000 | 15,000 |
| | 2,490 - 3,300 | 28,000 | - | 0 | - | 15,000 |
| | 0 - 2,490 | 32,000 | - | 0 | - | 15,000 |
| | 0 - 0 | 32,000 | - | 0 | - | 15,000 |
| August 16-31 | 3,400 - FULL | - | 3,529.20 | - | 34,000 | 15,000 |
| | 2,600 - 3,400 | 24,000 | - | 0 | - | 15,000 |
| | 2,000 - 2,600 | 29,000 | - | 0 | - | 15,000 |
| | 0 - 2,000 | 32,000 | - | 0 | - | 15,000 |
| September | 3,000 - FULL | - | 3,529.2 | - | 34,000 | 10,000 |
| | 1,600 - 3,000 | 27,000 | - | 0 | - | 10,000 |
| | 0 - 1,600 | 32,000 | - | 0 | - | 10,000 |
| | 0 - 0 | 32,000 | - | 0 | - | 10,000 |
| October | 3,000 - FULL | - | 3,404.1 | - | 34,000 | 10,000 |
| | 1,600 - 3,000 | 23,000 | - | 0 | - | 10,000 |
| | 1,080 - 1,600 | 24,000 | - | 0 | - | 10,000 |
| | 0 - 1,080 | 32,000 | - | 0 | - | 10,000 |
| November | 3,100 - FULL | 19,000 | - | 0 | - | 10,000 |
| | 2,770 - 3,100 | 21,000 | - | 0 | - | 10,000 |
| | 1,000 - 2,770 | 26,000 | - | 0 | - | 10,000 |
| | 0 - 1,000 | 32,000 | - | 0 | - | 10,000 |
| December | 2,510 - FULL | 23,000 | - | 204.1 | - | 10,000 |
| | 2,460 - 2,510 | 28,000 | - | 204.1 | - | 10,000 |
| | 400 - 2,460 | 29,000 | - | 204.1 | - | 10,000 |
| | 0 - 400 | 32,000 | - | 204.1 | - | 10,000 |
| January | 2,170 - FULL | 24,000 | - | 204.1 | - | 12,000 |
| | 1,950 - 2,170 | 21,000 | - | 204.1 | - | 12,000 |
| | 1,870 - 1,950 | 27,000 | - | 204.1 | - | 12,000 |
| | 0 - 1,870 | 29,000 | - | 204.1 | - | 12,000 |
| February | 1,350 - FULL | 23,000 | - | 0 | - | 12,000 |
| | 920 - 1,350 | 25,000 | - | 0 | - | 12,000 |
| | 350 - 920 | 27,000 | - | 0 | - | 12,000 |
| | 0 - 350 | 29,000 | - | 0 | - | 12,000 |
| March | 500 - FULL | 10,000 | - | 0 | - | 12,000 |
| | 340 - 500 | 17,000 | - | 0 | - | 12,000 |
| | 170 - 340 | 23,000 | - | 0 | - | 12,000 |
| | 0 - 170 | 26,000 | - | 0 | - | 12,000 |
| April 1-15 | 650 - FULL | 15,000 | - | 0 | - | 12,000 |
| | 340 - 650 | 12,000 | - | 0 | - | 12,000 |
| | 170 - 340 | 20,000 | - | 0 | - | 12,000 |
| | 0 - 170 | 26,000 | - | 0 | - | 12,000 |
| April 16-30 | 720 - FULL | 10,000 | - | 0 | - | 10,000 |
| | 570 - 720 | 15,000 | - | 0 | - | 10,000 |
| | 0 - 570 | 10,000 | - | 0 | - | 10,000 |
| | 0 - 0 | 10,000 | - | 0 | - | 10,000 |
| May | 580 - FULL | 8,000 | - | 0 | - | 8,000 |
| | 550 - 580 | 10,000 | - | 0 | - | 8,000 |
| | 250 - 550 | 8,000 | - | 0 | - | 8,000 |
| | 0 - 250 | 10,000 | - | 0 | - | 8,000 |
| June | 1,350 - FULL | 8,000 | - | 0 | - | 8,000 |
| | 1,130 - 1,350 | 10,000 | - | 0 | - | 8,000 |
| | 0 - 1,130 | 16,000 | - | 0 | - | 8,000 |
| | 0 - 0 | 16,000 | - | 0 | - | 8,000 |
| July | 2,900 - FULL | - | 3,436.20 | - | 34,000 | 10,000 |
| | 2,300 - 2,900 | 17,000 | - | 0 | - | 10,000 |
| | 0 - 2,300 | 32,000 | - | 0 | - | 10,000 |
| | 0 - 0 | 32,000 | - | 0 | - | 10,000 |

Notes:

1/ If the Mica target end-of-period storage content is less than 3,529.2 ksfd, then a maximum outflow of 34,000 cfs will apply.

2/ Mica outflow s will be reduced to minimum to maintain the reservoir above the minimum Treaty storage content.

This will override any flow target.

TABLE 1.1a
(English Units)
ARROW PROJECT OPERATING CRITERIA
DEFINITION
2018-19 ASSURED OPERATING PLAN

| Period | Volume Runoff Period | The Dalles Volume Runoff (Maf) | Maximum Storage Limit 1/ 2/ (ksfd) | Maximum Outflow Limit 3/ (cfs) | Minimum Outflow Limit 4/ (cfs) |
|----------------------|----------------------|--------------------------------|------------------------------------|--------------------------------|--------------------------------|
| August 15 - December | - | | URC | - | 10,000 |
| January | - | | URC | 70,000 | 10,000 |
| February | 1 Feb - 31 Jul | ≤ 70 to >70 | URC to 1,500 | 60,000 | 20,000 |
| March | 1 Mar - 31 Jul | ≥ 80 to >65 | 1,500 to 900 | - | 20,000 |
| April 15 | 1 Apr - 31 Jul | ≤ 65 to >60 | URC to 900 | - | 15,000 |
| April 30 | 1 Apr - 31 Jul | ≥ 75 to >60 | 900 to 800 | - | 12,000 |
| May | 1 May - 31 Jul | ≤ 65 to >65 | URC to 2,200 | - | 5,000 |
| June | 1 Jun - 31 Jul | ≥ 70 to >37 | 2,200 to 3,300 | - | 5,000 |
| July | - | ≥ 40 | 3,300 URC | - | 10,000 |

Notes:

- 1/ If the Maximum Storage Limit is computed to be above the URC, then the URC will apply.
- 2/ Interpolate when there are two values. For example, if the February-July volume runoff is between 70 Maf and 80 Maf, then the Maximum Storage Limit is interpolated between February's URC and 1,500 ksfd.
- 3/ The Maximum Average Monthly Outflow Limit takes precedence over the Maximum Storage Limit. However, the Maximum Outflow Limit may be exceeded to avoid storage above the URC.
- 4/ The Minimum Average Monthly Outflow Limit is an operating limit and may be reduced to as low as 5,000 cfs (Treaty minimum) to avoid drafting Mica+Arrow storage beyond 14.1 Maf.

TABLE 1.1b
(English Units)
ARROW PROJECT OPERATING CRITERIA
30 YEAR OPERATING DATA
FOR 2018-19 ASSURED OPERATING PLAN

| | AUG15-DEC | JAN | FEB | MAR | APR15 | APR30 | MAY | JUN | JUL |
|--|------------------|------------|------------|------------|--------------|--------------|------------|------------|------------|
| Maximum Average Monthly Flow Limits (cfs) | - | 70,000 | 60,000 | - | - | - | - | - | - |
| Minimum Average Monthly Flow Limits (cfs) | 10,000 | 10,000 | 20,000 | 20,000 | 15,000 | 12,000 | 5,000 | 5,000 | 10,000 |
| End-of-Period Maximum Storage Limits (ksfd) | | | | | | | | | |
| 1928-29 | - | - | URC | URC | URC | URC | URC | URC | - |
| 1929-30 | - | - | URC | URC | URC | URC | URC | URC | - |
| 1930-31 | - | - | URC | URC | URC | URC | URC | URC | - |
| 1931-32 | - | - | 1500.0 | 900.0 | 900.0 | 800.0 | URC | 3300.0 | - |
| 1932-33 | - | - | 1500.0 | 900.0 | 900.0 | 800.0 | URC | URC | - |
| 1933-34 | - | - | 1500.0 | 900.0 | 900.0 | 800.0 | URC | URC | - |
| 1934-35 | - | - | 1500.0 | 900.0 | 900.0 | 800.0 | URC | 3300.0 | - |
| 1935-36 | - | - | 1500.0 | 900.0 | 900.0 | 800.0 | URC | URC | - |
| 1936-37 | - | - | URC | URC | URC | URC | URC | URC | - |
| 1937-38 | - | - | 1500.0 | 900.0 | 900.0 | 800.0 | URC | 3300.0 | - |
| 1938-39 | - | - | 1914.5 | 1185.2 | 900.0 | 800.0 | URC | URC | - |
| 1939-40 | - | - | 2032.0 | 1584.1 | 1864.3 | 1821.2 | URC | URC | - |
| 1940-41 | - | - | URC | URC | URC | URC | URC | URC | - |
| 1941-42 | - | - | 1500.0 | 900.0 | 900.0 | 800.0 | URC | URC | - |
| 1942-43 | - | - | 1500.0 | 900.0 | 900.0 | 800.0 | 2200.0 | 3300.0 | - |
| 1943-44 | - | - | URC | URC | URC | URC | URC | URC | - |
| 1944-45 | - | - | 1792.2 | 1217.1 | 900.0 | 800.0 | URC | 3507.1 | - |
| 1945-46 | - | - | 1500.0 | 900.0 | 900.0 | 800.0 | URC | 3300.0 | - |
| 1946-47 | - | - | 1500.0 | 900.0 | 900.0 | 800.0 | 2200.0 | 3343.7 | - |
| 1947-48 | - | - | 1500.0 | 900.0 | 900.0 | 800.0 | URC | 3300.0 | - |
| 1948-49 | - | - | 1500.0 | 900.0 | 900.0 | 800.0 | 2666.6 | URC | - |
| 1949-50 | - | - | 1500.0 | 900.0 | 900.0 | 800.0 | URC | URC | - |
| 1950-51 | - | - | 1500.0 | 900.0 | 900.0 | 800.0 | URC | 3300.0 | - |
| 1951-52 | - | - | 1500.0 | 900.0 | 900.0 | 800.0 | 2200.0 | 3335.8 | - |
| 1952-53 | - | - | 1500.0 | 900.0 | 900.0 | 800.0 | URC | 3300.0 | - |
| 1953-54 | - | - | 1500.0 | 900.0 | 900.0 | 800.0 | URC | URC | - |
| 1954-55 | - | - | 1500.0 | 900.0 | 900.0 | 800.0 | URC | 3300.0 | - |
| 1955-56 | - | - | 1500.0 | 900.0 | 900.0 | 800.0 | 2200.0 | 3300.0 | - |
| 1956-57 | - | - | 1500.0 | 900.0 | 900.0 | 800.0 | 2200.0 | 3336.7 | - |
| 1957-58 | - | - | 1500.0 | 900.0 | 900.0 | 800.0 | 2200.0 | 3568.7 | - |

TABLE 1.1c
APOC IMPLEMENTATION
DISTRIBUTION FACTORS FOR THE DALLES
2018-19 ASSURED OPERATING PLAN

| Forecast Date | Forecast Period | The Dalles Distribution Factors <u>1/</u> | | | | | |
|---------------|-----------------|---|---------|---------|---------|---------|---------|
| | | Jan-Jul | Feb-Jul | Mar-Jul | Apr-Jul | May-Jul | Jun-Jul |
| 1-Jan | 1 Jan - 31 Jul | 1.0000 | 0.9440 | 0.8860 | 0.8080 | 0.6800 | 0.4270 |
| 1-Feb | 1 Feb - 31 Jul | | 1.0000 | 0.9390 | 0.8560 | 0.7200 | 0.4520 |
| 1-Mar | 1 Mar - 31 Jul | | | 1.0000 | 0.9120 | 0.7670 | 0.4810 |
| 1-Apr | 1 Apr - 31 Jul | | | | 1.0000 | 0.8410 | 0.5280 |
| 1-May | 1 May - 31 Jul | | | | | 1.0000 | 0.6280 |
| 1-Jun | 1 Jun - 31 Jul | | | | | | 1.0000 |

Notes:

1/ Unless otherwise agreed, the DOP19 will apply these distribution factors to the monthly volume forecast at The Dalles for computing the Month - July runoff volumes required by the APOC. These distribution factors are calculated from the 2010 Modified Flows mean 80 year Jan - Jul, Feb - Jul, etc., volumes.

For Example, in the month of May:

| 1 May Forecast Forecast Volume = 64 Maf (May-Jul) | From Table 1.1c | | | Look up Table 1.1a | | | |
|---|--------------------------------------|--|--------------------|---|--------------------|---------------------------------------|--------------------|
| | The Dalles Distribution Factor | Month-Jul Volume Runoff (Maf) | (km ³) | The Dalles Volume Runoff (Maf) | (km ³) | Maximum Storage Limit (ksfd) | (hm ³) |
| May | 1.0000 | 64.0 | 78.9 | ≤ 65 | ≤ 80.2 | URC | URC |
| June | 0.6280 | 40.2 | 49.6 | ≥ 40 | ≥ 49.3 | 3300 | 8073.7 |

TABLE 2
COMPARISON OF 2018-19 ASSURED OPERATING PLAN
STUDY RESULTS (BASED ON THE 2017-18 ASSURED OPERATING PLAN)

Study 19-41 provides Optimum Generation in Canada and in the United States.

Study 19-11 provides Optimum Generation in the United States only.

| | Study No. 19-41 | Study No. 19-11 | Net Gain | Weight | Value |
|---|--------------------|--------------------|-------------|--------|-------|
| 1. Firm Energy Capability (aMW) | | | | | |
| U.S. System 1/ | 11821.4 | 11821.9 | -0.5 | | |
| Canada 2/, 3/ | 3028.6 | 3010.1 | 18.6 | | |
| Total | 14850.0 | 14832.0 | 18.0 | 3 | 54.0 |
| 2. Dependable Peaking Capacity (MW) | | | | | |
| U.S. System 4/ | 29546.6 | 29511.3 | 35.3 | | |
| Canada 2/, 5/ | 6432.9 | 6395.7 | 37.2 | | |
| Total | 35979.5 | 35907.0 | 72.5 | 1 | 72.5 |
| 3. Average Annual Usable Secondary Energy (aMW) | | | | | |
| U.S. System 6/ | 3315.0 | 3292.3 | 22.7 | | |
| Canada 2/, 7/ | 289.0 | 313.1 | -24.1 | | |
| Total | 3604.0 | 3605.4 | -1.4 | 2 | -2.8 |
| Net Change in Value = | | | | | 123.7 |

1/ U.S. system firm energy capability was determined over the U.S. system critical period beginning 16 August 1928 and ending 29 February 1932.

2/ Canadian system includes Mica, Arrow, Revelstoke, Kootenay Canal, Corra Linn, Upper Bonnington, Lower Bonnington, South Slocan, Brilliant, Seven Mile and Waneta.

3/ Canadian system firm energy capability was determined over the Canadian system critical period beginning 1 October 1940 and ending 30 April 1946.

4/ U.S. system dependable peaking capability was updated to be from January 1932.

5/ Canadian system dependable peaking capability was determined from December 1944.

6/ U.S. system 30-year average secondary energy limited to secondary market.

7/ Canadian system 30-year average generation minus firm energy capability.

TABLE 3
(English Units)
CRITICAL RULE CURVES
END OF PERIOD TREATY STORAGE CONTENTS (KSFD)
2018 - 19 ASSURED OPERATING PLAN

| <u>YEAR</u> | <u>AUG15</u> | <u>AUG31</u> | <u>SEP</u> | <u>OCT</u> | <u>NOV</u> | <u>DEC</u> | <u>JAN</u> | <u>FEB</u> | <u>MAR</u> | <u>APR15</u> | <u>APR30</u> | <u>MAY</u> | <u>JUN</u> | <u>JUL</u> |
|----------------|--------------|--------------|------------|------------|------------|------------|------------|------------|------------|--------------|--------------|------------|------------|------------|
| MICA | | | | | | | | | | | | | | |
| 1928-29 | 3529.2 | 3529.2 | 3361.5 | 3067.0 | 2614.2 | 1489.2 | 958.8 | 783.8 | 788.1 | 775.8 | 384.1 | 685.5 | 2332.8 | 3429.1 |
| 1929-30 | 3529.2 | 3520.6 | 3275.7 | 2984.9 | 2358.8 | 1775.8 | 607.2 | 40.8 | 0.0 | 0.0 | 219.4 | 870.4 | 2371.2 | 3324.1 |
| 1930-31 | 3529.2 | 3529.2 | 3369.1 | 3057.5 | 2496.6 | 1665.1 | 770.2 | 187.1 | 0.0 | 0.0 | 0.0 | 673.2 | 2034.2 | 2553.7 |
| 1931-32 | 2582.1 | 2536.1 | 2089.1 | 1648.9 | 1121.9 | 253.7 | 0.0 | 0.0 | | | | | | |
| ARROW | | | | | | | | | | | | | | |
| 1928-29 | 3579.6 | 3579.6 | 3513.0 | 3571.7 | 3484.4 | 3497.7 | 2190.0 | 831.7 | 410.7 | 315.2 | 746.8 | 1824.6 | 3363.4 | 3522.7 |
| 1929-30 | 3579.1 | 3499.9 | 2950.2 | 2296.8 | 1756.8 | 1283.9 | 513.5 | 88.8 | 0.0 | 104.9 | 453.6 | 1551.2 | 2653.4 | 3258.1 |
| 1930-31 | 3378.9 | 3466.4 | 3179.6 | 2686.6 | 1981.7 | 1450.4 | 679.6 | 114.2 | 0.0 | 0.0 | 0.1 | 768.8 | 1837.0 | 2133.4 |
| 1931-32 | 1821.1 | 1627.8 | 1414.4 | 1114.9 | 318.4 | 0.0 | 0.0 | 0.0 | | | | | | |
| DUNCAN | | | | | | | | | | | | | | |
| 1928-29 | 705.8 | 705.8 | 625.0 | 600.0 | 550.0 | 450.0 | 250.0 | 93.0 | 102.0 | 107.5 | 118.8 | 236.3 | 511.1 | 698.0 |
| 1929-30 | 700.0 | 675.0 | 550.0 | 500.0 | 450.0 | 300.0 | 100.0 | 75.0 | 0.0 | 13.4 | 46.5 | 161.5 | 381.1 | 550.0 |
| 1930-31 | 600.0 | 600.0 | 525.0 | 450.0 | 400.0 | 200.0 | 75.0 | 25.0 | 0.0 | 4.8 | 0.0 | 157.2 | 395.1 | 500.0 |
| 1931-32 | 550.0 | 550.0 | 450.0 | 350.0 | 150.0 | 0.0 | 0.0 | 0.0 | | | | | | |
| COMPOSITE | | | | | | | | | | | | | | |
| 1928-29 | 7814.6 | 7814.6 | 7499.5 | 7238.7 | 6648.6 | 5436.9 | 3398.8 | 1708.5 | 1300.8 | 1198.5 | 1249.7 | 2746.4 | 6207.3 | 7649.8 |
| 1929-30 | 7808.3 | 7695.5 | 6775.9 | 5781.7 | 4565.6 | 3359.7 | 1220.7 | 204.6 | 0.0 | 118.3 | 719.5 | 2583.1 | 5405.7 | 7132.2 |
| 1930-31 | 7508.1 | 7595.6 | 7073.7 | 6194.1 | 4878.3 | 3315.5 | 1524.8 | 326.3 | 0.0 | 4.8 | 0.1 | 1599.2 | 4266.3 | 5187.1 |
| 1931-32 | 4953.2 | 4713.9 | 3953.5 | 3113.8 | 1590.3 | 253.7 | 0.0 | 0.0 | | | | | | |

Note: Individual project rule curves are input to the AOP19 Step 1 study and adjusted to eliminate any Canadian composite crossovers according to Subsection 3(a) of this AOP19 document.

TABLE 4
(English Units)
MICA

ASSURED AND VARIABLE REFILL CURVES
DISTRIBUTION FACTORS AND FORECAST ERRORS
POWER DISCHARGE REQUIREMENTS, AND OPERATING RULE CURVE LOWER LIMITS
2018 - 19 ASSURED OPERATING PLAN

| | <u>AUG15</u> | <u>AUG31</u> | <u>SEP</u> | <u>OCT</u> | <u>NOV</u> | <u>DEC</u> | <u>JAN</u> | <u>FEB</u> | <u>MAR</u> | <u>APR15</u> | <u>APR30</u> | <u>MAY</u> | <u>JUN</u> | <u>JUL</u> |
|---|--------------|--------------|------------|------------|------------|------------|------------|------------|------------|--------------|--------------|------------|------------|------------|
| <u>ASSURED REFILL CURVE (KSF)</u> | 0.0 | 0.0 | 589.3 | 767.7 | 832.7 | 848.9 | 843.6 | 832.0 | 838.6 | 863.7 | 927.0 | 1500.4 | 2706.0 | 3529.2 |
| <u>VARIABLE REFILL CURVES (KSF)</u> | | | | | | | | | | | | | | |
| 1928-29 | | | | | | | 2057.0 | 1875.8 | 1818.8 | 1811.0 | 1854.8 | 2366.8 | 2986.3 | 3529.2 |
| 1929-30 | | | | | | | 1033.6 | 812.1 | 746.6 | 757.0 | 917.1 | 1763.0 | 2696.2 | " |
| 1930-31 | | | | | | | 1291.8 | 1079.5 | 1009.1 | 997.8 | 1091.6 | 1781.9 | 2772.5 | " |
| 1931-32 | | | | | | | 474.2 | 268.6 | 205.4 | 194.9 | 316.0 | 1118.6 | 2520.1 | " |
| 1932-33 | | | | | | | 380.6 | 210.5 | 164.6 | 152.0 | 233.5 | 1017.9 | 2353.9 | " |
| 1933-34 | | | | | | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 764.9 | 2611.0 | " |
| 1934-35 | | | | | | | 724.1 | 535.4 | 501.5 | 508.9 | 582.7 | 1296.7 | 2459.8 | " |
| 1935-36 | | | | | | | 546.5 | 358.1 | 313.1 | 300.1 | 399.0 | 1283.4 | 2739.4 | " |
| 1936-37 | | | | | | | 2043.8 | 1841.9 | 1770.1 | 1751.4 | 1843.3 | 2379.0 | 3018.6 | " |
| 1937-38 | | | | | | | 753.4 | 564.9 | 501.4 | 495.4 | 592.0 | 1341.9 | 2613.9 | " |
| 1938-39 | | | | | | | 1048.3 | 904.2 | 847.9 | 862.5 | 977.2 | 1756.8 | 2993.0 | " |
| 1939-40 | | | | | | | 829.8 | 648.8 | 610.1 | 618.7 | 751.9 | 1554.4 | 2748.2 | " |
| 1940-41 | | | | | | | 1477.1 | 1285.6 | 1234.5 | 1242.5 | 1422.8 | 2158.8 | 3000.3 | " |
| 1941-42 | | | | | | | 1223.8 | 1036.2 | 976.9 | 961.7 | 1041.1 | 1712.0 | 2795.5 | " |
| 1942-43 | | | | | | | 1391.0 | 1180.9 | 1118.4 | 1103.0 | 1258.4 | 1967.1 | 2857.4 | " |
| 1943-44 | | | | | | | 2149.6 | 1932.1 | 1873.8 | 1864.2 | 1935.5 | 2488.2 | 3161.3 | " |
| 1944-45 | | | | | | | 1992.7 | 1812.2 | 1767.8 | 1768.9 | 1821.3 | 2330.7 | 3049.1 | " |
| 1945-46 | | | | | | | 174.2 | 0.0 | 0.0 | 0.0 | 0.0 | 818.0 | 2515.9 | " |
| 1946-47 | | | | | | | 288.1 | 122.5 | 86.6 | 85.4 | 206.1 | 1077.7 | 2585.6 | " |
| 1947-48 | | | | | | | 236.9 | 50.7 | 0.0 | 0.0 | 56.6 | 874.0 | 2469.8 | " |
| 1948-49 | | | | | | | 1935.2 | 1725.2 | 1645.5 | 1629.6 | 1709.7 | 2244.7 | 3258.6 | " |
| 1949-50 | | | | | | | 592.8 | 367.4 | 292.3 | 269.8 | 358.3 | 1094.3 | 2277.0 | " |
| 1950-51 | | | | | | | 584.1 | 406.4 | 363.4 | 358.6 | 476.1 | 1213.0 | 2646.5 | " |
| 1951-52 | | | | | | | 991.2 | 771.3 | 702.4 | 674.1 | 759.2 | 1507.2 | 2797.1 | " |
| 1952-53 | | | | | | | 1272.7 | 1071.0 | 1011.3 | 995.7 | 1058.6 | 1661.8 | 2763.3 | " |
| 1953-54 | | | | | | | 147.4 | 0.0 | 0.0 | 0.0 | 1.5 | 790.5 | 2248.5 | " |
| 1954-55 | | | | | | | 908.0 | 734.1 | 691.2 | 688.4 | 778.3 | 1433.8 | 2447.2 | " |
| 1955-56 | | | | | | | 455.9 | 263.9 | 200.8 | 180.8 | 273.4 | 1111.3 | 2559.2 | " |
| 1956-57 | | | | | | | 624.7 | 425.5 | 376.9 | 369.1 | 462.1 | 1197.1 | 2897.1 | " |
| 1957-58 | | | | | | | 458.2 | 271.9 | 229.9 | 227.5 | 336.6 | 1094.3 | 2654.3 | " |
| <u>DISTRIBUTION FACTORS</u> | | | | | | | 0.9760 | 0.9790 | 0.9750 | 0.9820 | 0.9650 | 0.7920 | 0.5060 | N/A |
| <u>FORECAST ERRORS (KSF)</u> | | | | | | | 727.9 | 521.8 | 455.2 | 420.2 | 420.2 | 401.4 | 397.0 | N/A |
| <u>POWER DISCHARGE REQUIREMENTS (CFS):</u> | | | | | | | | | | | | | | |
| ASSURED REFILL CURVE | | | | | | | | | | | | | | |
| 3000 | 3000 | 3000 | 3000 | 3000 | 3000 | 3000 | 3000 | 3000 | 3000 | 3000 | 3000 | 9600 | 20000 | 30000 |
| VARIABLE REFILL CURVES | | | | | | | 80 | MAF | 3000 | 3000 | 3000 | 3000 | 3000 | 27200 |
| (BY VOLUME RUNOFF AT THE DALLES) | | | | | | | 95 | MAF | 3000 | 3000 | 3000 | 3000 | 3000 | 23000 |
| | | | | | | | 110 | MAF | 3000 | 3000 | 3000 | 3000 | 3000 | 23000 |
| <u>VARIABLE REFILL CURVE LOWER LIMITS (KSF)</u> | | | | | | | 80 | MAF | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| (BY VOLUME RUNOFF AT THE DALLES) | | | | | | | 95 | MAF | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | | | | | | | 110 | MAF | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| <u>OPERATING RULE CURVE LOWER LIMITS (KSF)</u> | | | | | | | 421.6 | 22.5 | 0.0 | 0.0 | | | | |

TABLE 5
(English Units)
ARROW
ASSURED AND VARIABLE REFILL CURVES
DISTRIBUTION FACTORS AND FORECAST ERRORS
POWER DISCHARGE REQUIREMENTS, AND OPERATING RULE CURVE LOWER LIMITS
2018 - 19 ASSURED OPERATING PLAN

| | <u>AUG15</u> | <u>AUG31</u> | <u>SEP</u> | <u>OCT</u> | <u>NOV</u> | <u>DEC</u> | <u>JAN</u> | <u>FEB</u> | <u>MAR</u> | <u>APR15</u> | <u>APR30</u> | <u>MAY</u> | <u>JUN</u> | <u>JUL</u> |
|--|--------------|--------------|------------|------------|------------|------------|------------|------------|------------|--------------|--------------|------------|------------|------------|
| <u>ASSURED REFILL CURVE (KSFD)</u> | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 514.0 | 661.8 | 743.3 | 824.0 | 992.8 | 2267.6 | 3507.2 | 3579.6 |
| <u>VARIABLE REFILL CURVES (KSFD)</u> | | | | | | | | | | | | | | |
| 1928-29 | | | | | | | 2683.4 | 2461.2 | 2346.6 | 2276.2 | 2406.9 | 3197.5 | 3570.7 | 3579.6 |
| 1929-30 | | | | | | | 999.9 | 826.2 | 868.8 | 873.7 | 1145.6 | 2586.4 | 3368.3 | " |
| 1930-31 | | | | | | | 1504.2 | 1281.7 | 1188.2 | 1151.8 | 1369.6 | 2441.5 | 3379.0 | " |
| 1931-32 | | | | | | | 0.0 | 0.0 | 0.0 | 0.0 | 227.2 | 1660.1 | 3065.5 | " |
| 1932-33 | | | | | | | 375.4 | 326.5 | 338.6 | 335.0 | 551.4 | 1804.4 | 3000.0 | " |
| 1933-34 | | | | | | | 0.0 | 0.0 | 0.0 | 0.0 | 158.0 | 2270.7 | 3494.5 | " |
| 1934-35 | | | | | | | 637.6 | 577.6 | 686.1 | 710.2 | 898.5 | 2019.1 | 3113.4 | " |
| 1935-36 | | | | | | | 697.0 | 540.5 | 493.6 | 461.5 | 633.5 | 2007.9 | 3412.6 | " |
| 1936-37 | | | | | | | 2992.4 | 2725.7 | 2600.5 | 2501.4 | 2653.4 | 3371.6 | 3579.6 | " |
| 1937-38 | | | | | | | 988.8 | 897.3 | 913.6 | 946.0 | 1173.8 | 2304.5 | 3311.0 | " |
| 1938-39 | | | | | | | 1230.9 | 1058.0 | 975.8 | 940.6 | 1235.0 | 2531.2 | 3579.6 | " |
| 1939-40 | | | | | | | 882.0 | 786.4 | 834.4 | 921.9 | 1202.4 | 2310.5 | 3448.8 | " |
| 1940-41 | | | | | | | 2139.1 | 1965.9 | 1909.8 | 1995.1 | 2436.1 | 3482.1 | 3579.6 | " |
| 1941-42 | | | | | | | 2110.4 | 1941.9 | 1879.1 | 1810.0 | 2016.4 | 2984.6 | " | " |
| 1942-43 | | | | | | | 2570.9 | 2333.9 | 2245.3 | 2160.9 | 2460.0 | 3479.7 | " | " |
| 1943-44 | | | | | | | 3504.1 | 3291.3 | 3189.3 | 3093.1 | 3264.1 | 3579.6 | " | " |
| 1944-45 | | | | | | | 2862.1 | 2694.6 | 2617.9 | 2575.7 | 2701.7 | 3389.2 | " | " |
| 1945-46 | | | | | | | 99.2 | 153.9 | 117.5 | 96.6 | 431.7 | 1784.6 | 3203.5 | " |
| 1946-47 | | | | | | | 720.4 | 679.7 | 682.8 | 705.2 | 960.4 | 2204.4 | 3302.6 | " |
| 1947-48 | | | | | | | 500.3 | 551.7 | 547.5 | 487.1 | 688.5 | 1899.2 | 3230.8 | " |
| 1948-49 | | | | | | | 2245.8 | 2041.5 | 1974.9 | 1916.6 | 2153.0 | 3214.3 | 3579.6 | " |
| 1949-50 | | | | | | | 573.6 | 457.6 | 473.4 | 474.0 | 678.5 | 1820.6 | 2876.1 | " |
| 1950-51 | | | | | | | 877.0 | 794.4 | 835.4 | 800.5 | 1048.1 | 2173.6 | 3373.5 | " |
| 1951-52 | | | | | | | 942.4 | 786.9 | 806.2 | 779.4 | 968.1 | 2226.6 | 3433.7 | " |
| 1952-53 | | | | | | | 1602.1 | 1409.8 | 1356.2 | 1298.6 | 1452.0 | 2490.6 | 3380.7 | " |
| 1953-54 | | | | | | | 0.0 | 0.0 | 5.1 | 10.6 | 302.9 | 1526.9 | 2885.2 | " |
| 1954-55 | | | | | | | 652.3 | 591.8 | 630.6 | 606.0 | 821.9 | 1894.3 | 2855.5 | " |
| 1955-56 | | | | | | | 355.9 | 253.0 | 271.4 | 266.3 | 502.6 | 1894.2 | 3233.3 | " |
| 1956-57 | | | | | | | 424.6 | 302.9 | 313.3 | 296.7 | 526.0 | 1751.1 | 3552.3 | " |
| 1957-58 | | | | | | | 223.5 | 116.5 | 172.7 | 239.8 | 535.7 | 1780.7 | 3269.7 | " |
| <u>DISTRIBUTION FACTORS</u> | | | | | | | 0.9730 | 0.9760 | 0.9700 | 0.9740 | 0.9510 | 0.7420 | 0.4670 | N/A |
| <u>FORECAST ERRORS (KSFD)</u> | | | | | | | 1485.1 | 1095.3 | 954.2 | 809.7 | 809.7 | 723.2 | 679.4 | N/A |
| <u>POWER DISCHARGE REQUIREMENTS (CFS):</u> | | | | | | | | | | | | | | |
| ASSURED REFILL CURVE | 5000 | 5000 | 5000 | 5000 | 5000 | 5000 | 5000 | 5000 | 5000 | 5000 | 5000 | 9500 | 33000 | 60000 |
| VARIABLE REFILL CURVES | | | | | 80 | MAF | 5000 | 5000 | 5000 | 5000 | 5000 | 5000 | 31000 | 50000 |
| (BY VOLUME RUNOFF AT THE DALLES) | | | | | 95 | MAF | 5000 | 5000 | 5000 | 5000 | 5000 | 5000 | 31000 | 50000 |
| | | | | | 110 | MAF | 5000 | 5000 | 5000 | 5000 | 5000 | 5000 | 31000 | 50000 |
| <u>VARIABLE REFILL CURVE LOWER LIMITS (KSFD)</u> | | | | | 80 | MAF | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| (BY VOLUME RUNOFF AT THE DALLES) | | | | | 95 | MAF | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | | | | | 110 | MAF | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| <u>OPERATING RULE CURVE LOWER LIMITS (KSFD)</u> | | | | | | | 411.3 | 37.5 | 0.0 | 0.0 | | | | |

TABLE 6
(English Units)
DUNCAN

ASSURED AND VARIABLE REFILL CURVES
DISTRIBUTION FACTORS AND FORECAST ERRORS
POWER DISCHARGE REQUIREMENTS, AND OPERATING RULE CURVE LOWER LIMITS
2018 - 19 ASSURED OPERATING PLAN

| | <u>AUG15</u> | <u>AUG31</u> | <u>SEP</u> | <u>OCT</u> | <u>NOV</u> | <u>DEC</u> | <u>JAN</u> | <u>FEB</u> | <u>MAR</u> | <u>APR15</u> | <u>APR30</u> | <u>MAY</u> | <u>JUN</u> | <u>JUL</u> |
|--|--------------|--------------|------------|------------|------------|------------|------------|------------|------------|--------------|--------------|------------|------------|------------|
| <u>ASSURED REFILL CURVE (KSFD)</u> | 0.0 | 0.0 | 1.3 | 32.0 | 49.5 | 60.7 | 70.9 | 80.1 | 94.2 | 105.0 | 120.6 | 277.8 | 503.7 | 705.8 |
| <u>VARIABLE REFILL CURVES (KSFD)</u> | | | | | | | | | | | | | | |
| 1928-29 | | | | | | | 349.0 | 332.0 | 340.3 | 338.2 | 354.8 | 460.7 | 595.8 | 705.8 |
| 1929-30 | | | | | | | 347.4 | 330.0 | 338.1 | 335.6 | 359.8 | 480.9 | 607.6 | " |
| 1930-31 | | | | | | | 291.8 | 275.7 | 287.4 | 290.0 | 312.7 | 430.9 | 595.8 | " |
| 1931-32 | | | | | | | 16.8 | 2.3 | 21.1 | 29.2 | 64.5 | 249.0 | 505.6 | " |
| 1932-33 | | | | | | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 75.0 | 367.5 | " |
| 1933-34 | | | | | | | 33.4 | 36.2 | 60.2 | 74.4 | 120.7 | 328.3 | 578.1 | " |
| 1934-35 | | | | | | | 82.2 | 72.9 | 95.8 | 97.6 | 121.8 | 286.5 | 500.7 | " |
| 1935-36 | | | | | | | 58.5 | 43.4 | 55.0 | 55.5 | 83.0 | 283.2 | 557.3 | " |
| 1936-37 | | | | | | | 284.7 | 266.8 | 277.1 | 275.0 | 296.0 | 416.0 | 577.1 | " |
| 1937-38 | | | | | | | 76.9 | 68.7 | 84.8 | 93.3 | 123.5 | 297.9 | 534.3 | " |
| 1938-39 | | | | | | | 129.4 | 118.9 | 131.7 | 135.2 | 166.9 | 338.1 | 581.0 | " |
| 1939-40 | | | | | | | 116.3 | 110.7 | 131.2 | 144.2 | 178.6 | 341.0 | 567.1 | " |
| 1940-41 | | | | | | | 200.5 | 192.1 | 208.5 | 223.2 | 268.7 | 420.3 | 590.3 | " |
| 1941-42 | | | | | | | 194.6 | 188.6 | 204.8 | 208.4 | 237.7 | 383.8 | 570.9 | " |
| 1942-43 | | | | | | | 206.8 | 193.5 | 208.4 | 210.4 | 249.2 | 405.5 | 563.5 | " |
| 1943-44 | | | | | | | 355.1 | 342.7 | 355.7 | 355.5 | 379.1 | 487.6 | 626.9 | " |
| 1944-45 | | | | | | | 277.7 | 265.6 | 279.7 | 280.1 | 298.3 | 416.7 | 585.2 | " |
| 1945-46 | | | | | | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 190.6 | 503.3 | " |
| 1946-47 | | | | | | | " | " | " | " | 30.6 | 234.6 | 513.0 | " |
| 1947-48 | | | | | | | 39.8 | 28.6 | 46.4 | 47.0 | 71.9 | 251.9 | 527.9 | " |
| 1948-49 | | | | | | | 266.1 | 249.8 | 261.4 | 260.2 | 285.5 | 422.6 | 630.1 | " |
| 1949-50 | | | | | | | 66.2 | 50.4 | 64.6 | 64.0 | 90.5 | 255.7 | 463.2 | " |
| 1950-51 | | | | | | | 0.0 | 0.0 | 0.0 | 0.0 | 31.9 | 220.3 | 495.4 | " |
| 1951-52 | | | | | | | 97.0 | 83.3 | 100.8 | 101.2 | 127.1 | 312.8 | 546.3 | " |
| 1952-53 | | | | | | | 94.2 | 83.2 | 98.7 | 100.6 | 123.6 | 287.4 | 508.7 | " |
| 1953-54 | | | | | | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 150.2 | 438.2 | " |
| 1954-55 | | | | | | | 30.1 | 18.6 | 34.1 | 37.0 | 65.1 | 232.4 | 438.0 | " |
| 1955-56 | | | | | | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 200.9 | 496.2 | " |
| 1956-57 | | | | | | | 50.0 | 32.3 | 45.9 | 48.2 | 77.4 | 250.5 | 564.6 | " |
| 1957-58 | | | | | | | 0.0 | 0.0 | 0.0 | 0.0 | 2.6 | 190.5 | 516.4 | " |
| <u>DISTRIBUTION FACTORS</u> | | | | | | | 0.9740 | 0.9800 | 0.9760 | 0.9790 | 0.9570 | 0.7510 | 0.4810 | N/A |
| <u>FORECAST ERRORS (KSFD)</u> | | | | | | | 127.6 | 104.3 | 105.0 | 93.8 | 93.8 | 86.9 | 78.0 | N/A |
| <u>POWER DISCHARGE REQUIREMENTS (CFS):</u> | | | | | | | | | | | | | | |
| ASSURED REFILL CURVE | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 500 | 800 |
| VARIABLE REFILL CURVES | | | | | 80 MAF | | 100 | 100 | 100 | 100 | 100 | 100 | 1800 | 2500 |
| (BY VOLUME RUNOFF AT THE DALLES) | | | | | 95 MAF | | 100 | 100 | 100 | 100 | 100 | 100 | 1800 | 2500 |
| | | | | | 110 MAF | | 100 | 100 | 100 | 100 | 100 | 100 | 1800 | 2500 |
| <u>VARIABLE REFILL CURVE LOWER LIMITS (KSFD)</u> | | | | | 80 MAF | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| (BY VOLUME RUNOFF AT THE DALLES) | | | | | 95 MAF | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | | | | | 110 MAF | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| <u>OPERATING RULE CURVE LOWER LIMITS (KSFD)</u> | | | | | | | 11.8 | 6.3 | 0.0 | 0.0 | | | | |

TABLE 7
(English Units)
MICA
UPPER RULE CURVES (FLOOD CONTROL)
END OF PERIOD TREATY STORAGE CONTENTS (KSFD)
2018 - 19 ASSURED OPERATING PLAN

| <u>YEAR</u> | <u>AUG15</u> | <u>AUG31</u> | <u>SEP</u> | <u>OCT</u> | <u>NOV</u> | <u>DEC</u> | <u>JAN</u> | <u>FEB</u> | <u>MAR</u> | <u>APR15</u> | <u>APR30</u> | <u>MAY</u> | <u>JUN</u> | <u>JUL</u> |
|-------------|--------------|--------------|------------|------------|------------|------------|------------|------------|------------|--------------|--------------|------------|------------|------------|
| 1928-29 | 3529.2 | 3529.2 | 3529.2 | 3428.4 | 3428.4 | 3331.6 | 3207.0 | 3094.5 | 2969.9 | 2969.9 | 2969.9 | 3311.0 | 3529.2 | 3529.2 |
| 1929-30 | " | " | " | " | " | " | 3155.2 | 2996.1 | 2819.7 | 2819.7 | 2819.7 | 2903.4 | 3283.0 | " |
| 1930-31 | " | " | " | " | " | " | 3331.6 | 3331.6 | 3331.6 | 3331.6 | 3331.6 | 3331.6 | 3529.2 | " |
| 1931-32 | " | " | " | " | " | " | 2698.3 | 2105.4 | 1472.2 | 1472.2 | 1472.2 | 2313.5 | 3451.1 | " |
| 1932-33 | " | " | " | " | " | " | 2691.3 | 2112.5 | " | " | " | 1661.5 | 3282.4 | " |
| 1933-34 | " | " | " | " | " | " | " | " | " | 1519.5 | 1984.4 | 3370.8 | 3529.2 | " |
| 1934-35 | " | " | " | " | " | " | " | " | " | 1472.2 | 1472.2 | 1918.6 | 3333.8 | " |
| 1935-36 | " | " | " | " | " | " | 2698.3 | 2105.4 | " | " | 1665.5 | 2827.7 | 3529.2 | " |
| 1936-37 | " | " | " | " | " | " | 3141.9 | 2970.8 | 2781.2 | 2781.2 | 2781.2 | 3001.8 | " | " |
| 1937-38 | " | " | " | " | " | " | 2691.3 | 2112.5 | 1472.2 | 1472.2 | 1472.2 | 1984.4 | " | " |
| 1938-39 | " | " | " | " | " | " | 2854.7 | 2423.4 | 1946.5 | 1946.5 | 2014.6 | 3214.2 | 3420.0 | " |
| 1939-40 | " | " | " | " | " | " | 3013.4 | 2715.7 | 2397.6 | 2397.6 | 2397.6 | 3306.3 | 3429.6 | " |
| 1940-41 | " | " | " | " | " | " | 3331.6 | 3331.6 | 3331.6 | 3331.6 | 3331.6 | 3516.5 | 3529.2 | " |
| 1941-42 | " | " | " | " | " | " | 2691.3 | 2112.5 | 1472.2 | 1472.2 | 1472.2 | 1955.6 | 3280.3 | " |
| 1942-43 | " | " | " | " | " | " | " | " | " | 1505.1 | 1712.9 | 2206.6 | 3284.4 | " |
| 1943-44 | " | " | " | " | " | " | 3331.6 | 3331.6 | 3331.6 | 3331.6 | 3331.6 | 3521.5 | 3529.2 | " |
| 1944-45 | " | " | " | " | " | " | 2839.7 | 2395.0 | 1903.2 | 1903.2 | 1903.2 | 2217.0 | " | " |
| 1945-46 | " | " | " | " | " | " | 2691.3 | 2112.5 | 1472.2 | 1472.2 | 1472.2 | 2712.5 | " | " |
| 1946-47 | " | " | " | " | " | " | " | " | " | " | 1503.0 | 2578.8 | " | " |
| 1947-48 | " | " | " | " | " | " | 2698.3 | 2105.4 | " | " | 1472.2 | 2327.9 | " | " |
| 1948-49 | " | " | " | " | " | " | 2691.3 | 2112.5 | " | " | 1498.9 | 2430.8 | 3527.1 | " |
| 1949-50 | " | " | " | " | " | " | " | " | " | " | 1472.2 | 1546.2 | 3126.0 | " |
| 1950-51 | " | " | " | " | " | " | " | " | " | " | " | 2457.5 | 3529.2 | " |
| 1951-52 | " | " | " | " | " | " | 2698.3 | 2105.4 | " | " | 1577.1 | 2531.5 | " | " |
| 1952-53 | " | " | " | " | " | " | 2691.3 | 2112.5 | " | " | 1472.2 | 1932.9 | 3391.4 | " |
| 1953-54 | " | " | " | " | " | " | " | " | " | " | " | 2144.8 | 2772.2 | " |
| 1954-55 | " | " | " | " | " | " | " | " | " | " | " | 1472.2 | 3052.0 | " |
| 1955-56 | " | " | " | " | " | " | 2698.3 | 2105.4 | " | " | " | 2284.7 | 3529.2 | " |
| 1956-57 | " | " | " | " | " | " | 2691.3 | 2112.5 | " | " | " | 2984.1 | " | " |
| 1957-58 | " | " | " | " | " | " | " | " | " | " | " | 2613.8 | " | " |

TABLE 8
(English Units)
ARROW
UPPER RULE CURVES (FLOOD CONTROL)
END OF PERIOD TREATY STORAGE CONTENTS (KSFD)
2018 - 19 ASSURED OPERATING PLAN

| <u>YEAR</u> | <u>AUG15</u> | <u>AUG31</u> | <u>SEP</u> | <u>OCT</u> | <u>NOV</u> | <u>DEC</u> | <u>JAN</u> | <u>FEB</u> | <u>MAR</u> | <u>APR15</u> | <u>APR30</u> | <u>MAY</u> | <u>JUN</u> | <u>JUL</u> |
|-------------|--------------|--------------|------------|------------|------------|------------|------------|------------|------------|--------------|--------------|------------|------------|------------|
| 1928-29 | 3579.6 | 3579.6 | 3579.6 | 3453.6 | 3453.6 | 3223.7 | 3191.1 | 3161.6 | 3129.1 | 3129.1 | 3129.1 | 3208.8 | 3579.6 | 3579.6 |
| 1929-30 | " | " | " | " | " | " | 3143.1 | 3070.3 | 2989.7 | 2989.7 | 2989.7 | 2990.3 | " | " |
| 1930-31 | " | " | " | " | " | " | 3223.7 | 3223.7 | 3223.7 | 3223.7 | 3223.7 | 3579.6 | " | " |
| 1931-32 | " | " | " | " | " | " | 2726.5 | 2261.7 | 1764.6 | 1764.6 | 1764.6 | 2042.3 | " | " |
| 1932-33 | " | " | " | " | " | " | 2721.0 | 2267.2 | " | " | " | 1764.6 | 3211.2 | " |
| 1933-34 | " | " | " | " | " | " | " | " | " | 1779.1 | 2271.0 | 2436.1 | 3579.6 | " |
| 1934-35 | " | " | " | " | " | " | " | " | " | 1764.6 | 1764.6 | 2053.2 | " | " |
| 1935-36 | " | " | " | " | " | " | 2726.5 | 2261.7 | " | " | 1878.9 | 3113.1 | " | " |
| 1936-37 | " | " | " | " | " | " | 3130.6 | 3046.7 | 2953.7 | 2953.7 | 2953.7 | 2953.7 | " | " |
| 1937-38 | " | " | " | " | " | " | 2721.0 | 2267.2 | 1764.6 | 1764.6 | 1764.6 | 1986.0 | " | " |
| 1938-39 | " | " | " | " | " | " | 2862.2 | 2535.6 | 2174.1 | 2174.1 | 2185.4 | 2396.2 | " | " |
| 1939-40 | " | " | " | " | " | " | 3009.3 | 2809.1 | 2594.8 | 2594.8 | 2594.8 | 3140.4 | " | " |
| 1940-41 | " | " | " | " | " | " | 3223.7 | 3223.7 | 3223.7 | 3223.7 | 3223.7 | 3416.6 | " | " |
| 1941-42 | " | " | " | " | " | " | 2721.0 | 2267.2 | 1764.6 | 1764.6 | 1764.6 | 1969.7 | 2918.9 | " |
| 1942-43 | " | " | " | " | " | " | " | " | " | " | 2033.2 | 2494.2 | 3579.6 | " |
| 1943-44 | " | " | " | " | " | " | 3223.7 | 3223.7 | 3223.7 | 3223.7 | 3223.7 | 3223.7 | " | " |
| 1944-45 | " | " | " | " | " | " | 2849.3 | 2511.1 | 2136.7 | 2136.7 | 2136.7 | 2169.9 | " | " |
| 1945-46 | " | " | " | " | " | " | 2721.0 | 2267.2 | 1764.6 | 1764.6 | 1764.6 | 1878.9 | " | " |
| 1946-47 | " | " | " | " | " | " | " | " | " | " | " | 2211.1 | " | " |
| 1947-48 | " | " | " | " | " | " | 2726.5 | 2261.7 | " | " | " | 1880.7 | " | " |
| 1948-49 | " | " | " | " | " | " | 2721.0 | 2267.2 | " | " | 1771.8 | 2915.3 | " | " |
| 1949-50 | " | " | " | " | " | " | " | " | " | " | 1764.6 | 1764.6 | 2997.0 | " |
| 1950-51 | " | " | " | " | " | " | " | " | " | " | " | 2138.5 | 3579.6 | " |
| 1951-52 | " | " | " | " | " | " | 2726.5 | 2261.7 | " | " | 1866.2 | 2830.0 | " | " |
| 1952-53 | " | " | " | " | " | " | 2721.0 | 2267.2 | " | " | 1764.6 | 2007.8 | " | " |
| 1953-54 | " | " | " | " | " | " | " | " | " | " | " | 2111.3 | 2900.8 | " |
| 1954-55 | " | " | " | " | " | " | " | " | " | " | " | 1764.6 | 3314.6 | " |
| 1955-56 | " | " | " | " | " | " | 2726.5 | 2261.7 | " | " | " | 2383.5 | 3579.6 | " |
| 1956-57 | " | " | " | " | " | " | 2721.0 | 2267.2 | " | " | " | 2646.7 | " | " |
| 1957-58 | " | " | " | " | " | " | " | " | " | " | " | 2652.1 | " | " |

TABLE 9
(English Units)
DUNCAN
UPPER RULE CURVES (FLOOD CONTROL)
END OF PERIOD TREATY STORAGE CONTENTS (KSFD)
2018 - 19 ASSURED OPERATING PLAN

| <u>YEAR</u> | <u>AUG15</u> | <u>AUG31</u> | <u>SEP</u> | <u>OCT</u> | <u>NOV</u> | <u>DEC</u> | <u>JAN</u> | <u>FEB</u> | <u>MAR</u> | <u>APR15</u> | <u>APR30</u> | <u>MAY</u> | <u>JUN</u> | <u>JUL</u> |
|-------------|--------------|--------------|------------|------------|------------|------------|------------|------------|------------|--------------|--------------|------------|------------|------------|
| 1928-29 | 705.8 | 705.8 | 705.8 | 705.8 | 705.8 | 504.1 | 418.0 | 340.3 | 340.3 | 340.3 | 340.3 | 429.1 | 704.3 | 705.8 |
| 1929-30 | " | " | " | " | " | " | 408.7 | 322.6 | 322.6 | 322.6 | 322.6 | 357.1 | 577.0 | " |
| 1930-31 | " | " | " | " | " | " | 390.7 | 288.3 | 288.3 | 288.3 | 288.3 | 426.5 | 664.5 | " |
| 1931-32 | " | " | " | " | " | " | 277.3 | 93.2 | 65.7 | 65.7 | 66.9 | 277.0 | 626.8 | " |
| 1932-33 | " | " | " | " | " | " | 273.7 | " | " | " | 65.7 | 130.6 | 558.8 | " |
| 1933-34 | " | " | " | " | " | " | " | " | " | 90.2 | 168.0 | 422.2 | 657.4 | " |
| 1934-35 | " | " | " | " | " | " | " | " | " | 65.7 | 65.7 | 180.2 | 504.9 | " |
| 1935-36 | " | " | " | " | " | " | 277.3 | " | " | 69.3 | 127.5 | 390.9 | 697.8 | " |
| 1936-37 | " | " | " | " | " | " | 374.8 | 258.1 | 258.1 | 258.1 | 258.1 | 334.6 | 583.1 | " |
| 1937-38 | " | " | " | " | " | " | 290.1 | 115.9 | 97.0 | 97.0 | 97.0 | 250.4 | 584.8 | " |
| 1938-39 | " | " | " | " | " | " | 285.1 | 109.0 | 87.5 | 87.5 | 119.7 | 368.0 | 576.9 | " |
| 1939-40 | " | " | " | " | " | " | 301.1 | 126.5 | 111.4 | 111.4 | 111.4 | 321.7 | 596.3 | " |
| 1940-41 | " | " | " | " | " | " | 344.4 | 200.1 | 200.1 | 200.1 | 200.1 | 327.1 | 579.4 | " |
| 1941-42 | " | " | " | " | " | " | 326.1 | 165.6 | 165.1 | 165.1 | 165.1 | 278.5 | 501.6 | " |
| 1942-43 | " | " | " | " | " | " | 329.3 | 171.4 | 171.4 | 190.1 | 239.8 | 361.7 | 564.7 | " |
| 1943-44 | " | " | " | " | " | " | 412.5 | 327.2 | 327.2 | 327.2 | 327.2 | 386.6 | 617.6 | " |
| 1944-45 | " | " | " | " | " | " | 381.5 | 270.7 | 270.7 | 270.7 | 270.7 | 364.2 | 622.7 | " |
| 1945-46 | " | " | " | " | " | " | 273.7 | 93.2 | 65.7 | 65.7 | 79.2 | 360.9 | 698.4 | " |
| 1946-47 | " | " | " | " | " | " | " | " | " | " | 90.8 | 335.2 | 654.3 | " |
| 1947-48 | " | " | " | " | " | " | 277.3 | " | " | " | 65.7 | 281.3 | 673.3 | " |
| 1948-49 | " | " | " | " | " | " | 368.0 | 245.0 | 245.0 | 245.0 | 266.2 | 503.0 | 705.8 | " |
| 1949-50 | " | " | " | " | " | " | 273.7 | 93.2 | 65.7 | 65.7 | 65.7 | 105.5 | 476.7 | " |
| 1950-51 | " | " | " | " | " | " | " | " | " | " | " | 291.7 | 560.6 | " |
| 1951-52 | " | " | " | " | " | " | 277.3 | " | " | " | 114.1 | 323.5 | 623.7 | " |
| 1952-53 | " | " | " | " | " | " | 273.7 | " | " | " | 65.7 | 188.8 | 493.2 | " |
| 1953-54 | " | " | " | " | " | " | " | " | " | " | " | 252.5 | 539.2 | " |
| 1954-55 | " | " | " | " | " | " | " | " | " | " | " | 65.5 | 462.6 | " |
| 1955-56 | " | " | " | " | " | " | 277.3 | " | " | " | " | 295.4 | 659.3 | " |
| 1956-57 | " | " | " | " | " | " | 273.7 | " | " | " | 71.2 | 399.5 | 705.8 | " |
| 1957-58 | " | " | " | " | " | " | " | " | " | " | 66.3 | 371.9 | " | " |

TABLE 10
(English Units)
COMPOSITE OPERATING RULE CURVES
FOR THE WHOLE OF CANADIAN TREATY STORAGE
END OF PERIOD TREATY STORAGE CONTENTS (KSFD)
2018 - 19 ASSURED OPERATING PLAN

| <u>YEAR</u> | <u>AUG15</u> | <u>AUG31</u> | <u>SEP</u> | <u>OCT</u> | <u>NOV</u> | <u>DEC</u> | <u>JAN</u> | <u>FEB</u> | <u>MAR</u> | <u>APR15</u> | <u>APR30</u> | <u>MAY</u> | <u>JUN</u> | <u>JUL</u> |
|-------------|--------------|--------------|------------|------------|------------|------------|------------|------------|------------|--------------|--------------|------------|------------|------------|
| 1928-29 | 7814.6 | 7814.6 | 7499.5 | 7120.6 | 6617.8 | 5162.9 | 3398.8 | 1756.7 | 1683.9 | 1795.2 | 2040.4 | 4045.8 | 6724.3 | 7814.6 |
| 1929-30 | " | " | " | " | " | " | 2208.7 | 1731.3 | 1591.9 | 1688.5 | 2030.5 | " | 6575.6 | " |
| 1930-31 | " | " | " | " | " | " | 2713.0 | 1756.7 | 1683.9 | 1795.2 | 2040.4 | " | 6596.1 | " |
| 1931-32 | " | " | " | " | " | " | 902.3 | 312.4 | 226.5 | 224.1 | 607.7 | 3027.7 | 6091.2 | " |
| 1932-33 | " | " | " | " | " | " | 844.7 | 543.3 | 503.2 | 487.0 | 784.9 | 2857.5 | 5721.4 | " |
| 1933-34 | " | " | " | " | " | " | 866.3 | 96.2 | 60.2 | 74.4 | 278.6 | 3310.3 | 6616.6 | " |
| 1934-35 | " | " | " | " | " | " | 1443.9 | 1185.9 | 1253.3 | 1284.8 | 1546.9 | 3496.0 | 6073.9 | " |
| 1935-36 | " | " | " | " | " | " | 1302.0 | 942.0 | 861.7 | 817.1 | 1115.5 | 3569.1 | 6629.7 | " |
| 1936-37 | " | " | " | " | " | " | 3398.8 | 1756.7 | 1683.9 | 1795.2 | 2040.4 | 4045.8 | 6724.3 | " |
| 1937-38 | " | " | " | " | " | " | 1819.1 | 1465.3 | 1329.5 | 1412.7 | 1681.8 | 3578.3 | 6436.0 | " |
| 1938-39 | " | " | " | " | " | " | 2319.1 | 1756.7 | 1669.4 | 1774.0 | 2039.5 | 4045.8 | 6724.3 | " |
| 1939-40 | " | " | " | " | " | " | 1828.1 | 1528.2 | 1455.4 | 1550.2 | 1856.1 | " | 6665.9 | " |
| 1940-41 | " | " | " | " | " | " | 3298.4 | 1756.7 | 1683.9 | 1795.2 | 2040.4 | " | 6724.3 | " |
| 1941-42 | " | " | " | " | " | " | 3263.8 | " | " | " | " | 3747.9 | 6126.5 | " |
| 1942-43 | " | " | " | " | " | " | 3355.6 | " | " | " | " | 4045.8 | 6724.3 | " |
| 1943-44 | " | " | " | " | " | " | 3398.8 | " | " | " | " | " | " | " |
| 1944-45 | " | " | " | " | " | " | " | " | " | " | " | 3948.1 | " | " |
| 1945-46 | " | " | " | " | " | " | 844.7 | 182.7 | 117.5 | 96.6 | 431.7 | 2793.2 | 6222.7 | " |
| 1946-47 | " | " | " | " | " | " | 1153.8 | 808.5 | 769.4 | 790.6 | 1197.1 | 3516.7 | 6399.3 | " |
| 1947-48 | " | " | " | " | " | " | 961.7 | 631.0 | 593.9 | 534.1 | 810.8 | 3006.6 | 6211.7 | " |
| 1948-49 | " | " | " | " | " | " | 3398.8 | 1756.7 | 1683.9 | 1795.2 | 2040.4 | 4045.8 | 6724.3 | " |
| 1949-50 | " | " | " | " | " | " | 1232.6 | 875.4 | 830.3 | 807.8 | 1102.5 | 2964.4 | 5616.3 | " |
| 1950-51 | " | " | " | " | " | " | 1472.9 | 1207.1 | 1106.7 | 1159.1 | 1500.8 | 3571.8 | 6515.4 | " |
| 1951-52 | " | " | " | " | " | " | 1998.2 | 1641.5 | 1511.4 | 1519.2 | 1841.4 | 4004.8 | 6650.8 | " |
| 1952-53 | " | " | " | " | " | " | 2655.1 | 1746.9 | 1647.6 | 1753.4 | 1985.5 | 3697.0 | 6579.9 | " |
| 1953-54 | " | " | " | " | " | " | 844.7 | 66.3 | 5.1 | 10.6 | 304.4 | 2467.6 | 5571.9 | " |
| 1954-55 | " | " | " | " | " | " | 1590.4 | 1344.5 | 1355.9 | 1331.4 | 1665.3 | 3263.9 | 5740.7 | " |
| 1955-56 | " | " | " | " | " | " | 879.0 | 523.2 | 472.2 | 447.1 | 776.0 | 3206.4 | 6288.7 | " |
| 1956-57 | " | " | " | " | " | " | 1099.3 | 760.7 | 736.1 | 714.0 | 1059.3 | 3198.7 | 6724.3 | " |
| 1957-58 | " | " | " | " | " | " | 881.3 | 394.7 | 402.6 | 467.3 | 874.9 | 3065.5 | 6435.1 | " |

TABLE 11
(English Units)
COMPOSITE END STORAGE
FOR THE WHOLE OF CANADIAN TREATY STORAGE
END OF PERIOD TREATY STORAGE CONTENTS (KSFD)
2018 - 19 ASSURED OPERATING PLAN

| YEAR | AUG15 | AUG31 | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR15 | APR30 | MAY | JUN | JUL |
|---------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| 1928-29 | 7814.6 | 7814.6 | 7499.5 | 7238.7 | 6648.7 | 5436.9 | 3398.8 | 1708.5 | 1300.9 | 1198.4 | 1249.7 | 2746.4 | 6207.3 | 7649.8 |
| 1929-30 | 7808.3 | 7695.5 | 6726.0 | 5781.7 | 4565.6 | 3359.7 | 1220.7 | 204.6 | 0.0 | 118.3 | 719.5 | 2583.1 | 5405.7 | 7132.2 |
| 1930-31 | 7508.1 | 7595.6 | 7048.7 | 6194.1 | 4878.3 | 3315.4 | 1524.8 | 326.3 | 0.0 | 4.8 | 0.1 | 1599.2 | 4266.3 | 5187.1 |
| 1931-32 | 4953.2 | 4713.9 | 3953.5 | 3113.8 | 1590.3 | 253.7 | 0.0 | 0.0 | 1.7 | 121.6 | 460.8 | 2385.4 | 5823.9 | 7614.8 |
| 1932-33 | 7746.4 | 7814.6 | 6937.1 | 6351.7 | 6374.5 | 5162.9 | 3053.5 | 1405.5 | 503.2 | 438.5 | 646.2 | 2396.1 | 5721.4 | 7721.6 |
| 1933-34 | 7814.6 | 7814.6 | 7499.5 | 7120.6 | 6617.8 | 5162.9 | 3129.7 | 1546.7 | 769.8 | 606.1 | 1227.7 | 3310.3 | 6211.6 | 7615.2 |
| 1934-35 | 7772.5 | 7691.8 | 6775.9 | 6146.8 | 6501.5 | 5162.9 | 3063.5 | 1563.3 | 1226.9 | 1104.1 | 1244.8 | 3095.1 | 6073.9 | 7814.6 |
| 1935-36 | 7814.6 | 7793.4 | 7398.0 | 6657.0 | 5661.7 | 4163.5 | 1981.7 | 900.2 | 505.5 | 417.2 | 874.4 | 3569.1 | 6629.7 | 7721.6 |
| 1936-37 | 7795.2 | 7690.4 | 6775.9 | 5899.7 | 4678.3 | 3252.3 | 1194.8 | 185.2 | 0.0 | 8.7 | 52.7 | 1545.4 | 4547.7 | 5979.7 |
| 1937-38 | 5972.0 | 5836.0 | 5133.1 | 4501.8 | 3885.5 | 3073.1 | 1819.1 | 1448.7 | 780.8 | 679.9 | 587.9 | 2582.3 | 5756.2 | 7696.2 |
| 1938-39 | 7673.3 | 7640.6 | 7053.2 | 6609.9 | 5699.6 | 4675.0 | 2525.5 | 1731.2 | 1349.8 | 1382.0 | 1415.8 | 4045.8 | 6034.1 | 7721.6 |
| 1939-40 | 7808.6 | 7704.0 | 6834.1 | 6331.8 | 5784.8 | 5162.9 | 3038.8 | 1528.2 | 1273.0 | 1361.9 | 1676.2 | 4045.8 | 6052.9 | 7236.0 |
| 1940-41 | 7325.3 | 7246.9 | 6775.9 | 6702.5 | 5709.7 | 4460.2 | 2853.4 | 1546.4 | 1302.4 | 1519.2 | 1940.4 | 3064.3 | 4799.5 | 5714.6 |
| 1941-42 | 5559.1 | 5422.2 | 5075.4 | 5540.0 | 5102.0 | 5162.9 | 3283.4 | 1756.7 | 1091.6 | 976.8 | 879.5 | 2783.7 | 5144.0 | 7589.6 |
| 1942-43 | 7779.5 | 7771.0 | 7090.2 | 6420.0 | 6177.7 | 5162.9 | 3363.0 | 1756.7 | 1335.1 | 1406.8 | 1444.1 | 2807.0 | 5210.1 | 7721.6 |
| 1943-44 | 7814.6 | 7814.6 | 7431.8 | 7120.6 | 6503.2 | 5162.2 | 3382.6 | 1720.1 | 1208.1 | 1155.3 | 1174.2 | 2408.6 | 4571.9 | 5340.5 |
| 1944-45 | 5189.6 | 4985.9 | 4258.6 | 3657.8 | 2363.6 | 1010.7 | 204.1 | 0.0 | 0.0 | 0.8 | 0.0 | 1829.4 | 4796.5 | 6425.4 |
| 1945-46 | 6254.1 | 6066.9 | 5331.2 | 4656.0 | 3833.2 | 2974.5 | 844.7 | 182.7 | 0.0 | 0.0 | 283.0 | 2729.8 | 6200.2 | 7721.6 |
| 1946-47 | 7814.6 | 7799.3 | 7499.5 | 7120.6 | 6617.8 | 5162.9 | 2970.8 | 1325.3 | 769.4 | 790.6 | 1197.1 | 3516.7 | 6399.3 | 7814.6 |
| 1947-48 | 7814.6 | 7791.6 | 7499.5 | 7120.6 | 6617.8 | 5162.9 | 2997.3 | 1262.8 | 593.9 | 487.9 | 689.9 | 3006.6 | 6211.7 | 7814.6 |
| 1948-49 | 7814.6 | 7814.6 | 7499.5 | 7120.6 | 6617.8 | 5162.9 | 3398.8 | 1756.7 | 1363.1 | 1362.8 | 1505.7 | 4045.8 | 6373.8 | 7413.0 |
| 1949-50 | 7715.9 | 7674.4 | 6836.4 | 6325.3 | 6399.5 | 5162.9 | 2969.1 | 1306.7 | 827.6 | 766.4 | 835.7 | 2252.0 | 5616.3 | 7814.6 |
| 1950-51 | 7814.6 | 7814.6 | 7499.5 | 7120.6 | 6617.8 | 5162.9 | 3051.2 | 1440.1 | 997.4 | 1020.2 | 1157.8 | 3570.1 | 6194.3 | 7753.3 |
| 1951-52 | 7814.6 | 7814.6 | 7499.5 | 7120.6 | 6617.8 | 5162.9 | 2970.2 | 1641.5 | 1204.3 | 1138.4 | 1458.8 | 3830.8 | 6543.2 | 7721.6 |
| 1952-53 | 7814.6 | 7779.9 | 7208.8 | 6530.9 | 5541.6 | 4263.2 | 2720.2 | 1746.9 | 1330.0 | 1171.0 | 995.6 | 2872.8 | 5824.8 | 7721.6 |
| 1953-54 | 7805.1 | 7814.6 | 7499.5 | 7120.6 | 6617.8 | 5162.9 | 3029.5 | 1439.4 | 554.0 | 215.2 | 247.7 | 2467.6 | 5571.9 | 7814.6 |
| 1954-55 | 7814.6 | 7814.6 | 7499.5 | 7120.6 | 6617.8 | 5162.9 | 3077.4 | 1464.9 | 1068.4 | 1035.0 | 913.6 | 2071.9 | 5740.7 | 7721.6 |
| 1955-56 | 7814.6 | 7814.6 | 7499.5 | 7120.6 | 6617.8 | 5162.9 | 3023.0 | 1298.3 | 472.2 | 439.2 | 776.0 | 3206.4 | 6288.7 | 7721.6 |
| 1956-57 | 7779.5 | 7814.6 | 7499.5 | 7120.6 | 6617.8 | 5162.9 | 2990.4 | 1338.9 | 736.1 | 703.9 | 889.0 | 3198.7 | 6712.0 | 7721.6 |
| 1957-58 | 7769.6 | 7685.9 | 6924.2 | 6612.8 | 6063.6 | 5162.9 | 3019.8 | 1420.2 | 492.9 | 467.3 | 656.7 | 3065.5 | 6435.1 | 7721.6 |
| Max | 7814.6 | 7814.6 | 7499.5 | 7238.7 | 6648.7 | 5436.9 | 3398.8 | 1756.7 | 1363.1 | 1519.2 | 1940.4 | 4045.8 | 6712.0 | 7814.6 |
| Median | 7800.2 | 7775.5 | 7071.7 | 6611.4 | 6276.1 | 5162.9 | 2993.9 | 1439.8 | 775.3 | 735.2 | 884.3 | 2839.9 | 5929.5 | 7721.6 |
| Average | 7399.7 | 7351.5 | 6802.1 | 6320.0 | 5671.4 | 4439.0 | 2536.7 | 1231.8 | 768.6 | 736.6 | 906.7 | 2887.7 | 5778.8 | 7345.3 |
| Min | 4953.2 | 4713.9 | 3953.5 | 3113.8 | 1590.3 | 253.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1545.4 | 4266.3 | 5187.1 |

TABLE 12
(English Units)
COMPARISON OF RECENT ASSURED OPERATING PLAN STUDIES

| | 2010-11 | 2011-12 through 2013-14 1/ | 2014-15 | 2015-16 through 2016-17 3/ | 2017-18 through 2018-19 4/ |
|--|--------------|----------------------------------|--------------|----------------------------------|----------------------------------|
| MICA TARGET OPERATION (ksfd or cfs) | | | | | |
| AUG 15 | 3439.2 | 3364.2 | 3379.2 | 3379.2 | 3494.1 |
| AUG 31 | FULL | FULL | FULL | FULL | FULL |
| SEP | FULL | FULL | FULL | FULL | FULL |
| OCT | 3428.4 | 3428.4 | 3428.4 | 3404.1 | 3404.1 |
| NOV | 21000 | 21000 | 22000 | 21000 | 19000 |
| DEC | 25000 | 25000 | 22000 | 17000 | 23000 |
| JAN | 27000 | 24000 | 24000 | 24000 | 24000 |
| FEB | 21000 | 21000 | 21000 | 26000 | 23000 |
| MAR | 21000 | 17000 | 25000 | 25000 | 10000 |
| APR 15 | 22000 | 20000 | 17000 | 21000 | 15000 |
| APR 30 | 10000 | 10000 | 10000 | 10000 | 10000 |
| MAY | 8000 | 8000 | 8000 | 8000 | 8000 |
| JUN | 8000 | 8000 | 10000 | 8000 | 8000 |
| JUL | 3467.2 | 3467.2 | 3467.2 | 3436.2 | 3436.2 |
| COMPOSITE CRC1 CANADIAN TREATY STORAGE CONTENT (ksfd) | | | | | |
| 1928 AUG 31 | 7794.1 | 7814.4 | 7814.6 | 7814.6 | 7814.6 |
| 1928 DEC | 5086 | 5204 | 5282.1 | 5092.5 | 5436.9 |
| 1929 APR15 | 1048.2 | 1084.4 | 1078.2 | 1024.5 | 1198.4 |
| 1929 JUL | 7233.2 | 7329.8 | 7500.9 | 7585.9 | 7649.8 |
| COMPOSITE CANADIAN TREATY STORAGE CONTENT (ksfd) 2/ | | | | | |
| AUG 31 | 7438.0 | 7362.8 | 7406.8 | 7415.3 | 7385.9 |
| DEC | 4612.9 | 4630.0 | 4644.6 | 4490.1 | 4524.4 |
| APR15 | 842.6 | 908.6 | 889.3 | 716.3 | 811.0 |
| JUL | 7268.9 | 7147.1 | 7279.9 | 7303.8 | 7388.7 |
| STEP 1 GAINS AND LOSSES DUE TO REOPERATION (MW) | | | | | |
| U.S. Firm Energy | -0.3 | 0.1 | 0.0 | 0.0 | -0.5 |
| U.S. Dependable Peaking Capacity 5/ | -19.1 | -22.9 | -3.9 | -2.1 | 6.9 / 35.3 |
| U.S. Average Annual Usable Secondary Energy | 16.0 | 21.6 | 21.3 | 17.6 | 22.7 |
| BCH Firm Energy | 34.4 | 43.6 | 44.0 | 24.0 | 18.6 |
| BCH Dependable Peaking Capacity | 43.8 | 41.7 | 47.8 | 28.2 | 37.2 |
| BCH Average Annual Usable Secondary Energy | -20.8 | -13.9 | -33.4 | -16.2 | -24.1 |
| COORDINATED HYDRO LOAD (MW) | | | | | |
| AUG 15 | 11138 | 10969 | 11187 | 11367 | 12028 |
| AUG 31 | 11167 | 11104 | 10971 | 10944 | 11399 |
| SEP | 11025 | 11081 | 9756 | 9822 | 10207 |
| OCT | 9958 | 9920 | 9758 | 10051 | 9233 |
| NOV | 11333 | 11458 | 11821 | 12152 | 11434 |
| DEC | 13369 | 13316 | 13836 | 13744 | 13523 |
| JAN | 13076 | 12878 | 13323 | 13933 | 13862 |
| FEB | 11902 | 11721 | 13179 | 12876 | 13006 |
| MAR | 10967 | 10501 | 12022 | 11269 | 11264 |
| APR 15 | 10241 | 9786 | 10476 | 10894 | 9583 |
| APR 30 | 12475 | 11502 | 11012 | 11600 | 10684 |
| MAY | 13493 | 13287 | 12198 | 12166 | 12344 |
| JUN | 14080 | 13867 | 12208 | 11291 | 11314 |
| JUL | <u>12725</u> | <u>12531</u> | <u>11954</u> | <u>11812</u> | <u>12256</u> |
| ANNUAL AVERAGE | 12039 | 11856 | 11819 | 11794 | 11689 |

1/ The AOP 2013-14 and 2012-13 utilize the same system regulation study as the 2011-12.

2/ Prior to AOP15, average content based on 60 years of modified flow s. AOP15 through AOP17 averages based on 70 years of modified flow s. AOP18 and AOP19 averages based on 80 years of modified flow s.

3/ The AOP 2016-17 utilizes the same Step 1 system regulation studies as used in the AOP 2015-16, so these coordinated hydro loads will be used for the DOP17 TSR unless otherwise agreed.

4/ The AOP 2018-19 utilizes the same Step 1 system regulation studies as used in the AOP 2017-18, so these coordinated hydro loads will be used for the DOP19 TSR unless otherwise agreed.

5/ Due to changes between the AOP 2017-18 and the AOP 2018-19 peak load shape, the period in which the U.S. system dependable peaking capability was determined changed from 15 August 1931 to January 1932.

TABLE 1M
(Metric Units)
MICA PROJECT OPERATING CRITERIA
2018-19 ASSURED OPERATING PLAN

| Period | End of Previous Period Arrow Storage Content (hm ³) | Target Operation | | Target Operation Limits | | |
|--------------|---|--|--|--|--|---|
| | | Period Average Outflow (m ³ /s) | End-of-Period Treaty Storage Content 1/ (hm ³) | Minimum Treaty Storage Content 2/ (hm ³) | Maximum Outflow 1/ (m ³ /s) | Minimum Outflow (m ³ /s) |
| August 1-15 | 8,073.8 - FULL 6,092.0 - 8,073.8 0.0 - 6,092.0 | - 792.87 906.14 | 8,548.7 - - | - 0.0 0.0 | 962.77 - - | 424.75 424.75 424.75 |
| August 16-31 | 8,318.4 - FULL 6,361.2 - 8,318.4 4,893.2 - 6,361.2 0.0 - 4,893.2 | - 679.60 821.19 906.14 | 8,634.5 - - - | - 0.0 0.0 0.0 | 962.77 - - - | 424.75 424.75 424.75 424.75 |
| September | 7,339.8 - FULL 3,914.6 - 7,339.8 0.0 - 3,914.6 | - 764.55 906.14 | 8,634.5 - - | - 0.0 0.0 | 962.77 - - | 283.17 283.17 283.17 |
| October | 7,339.8 - FULL 3,914.6 - 7,339.8 2,642.3 - 3,914.6 0.0 - 2,642.3 | - 651.29 679.60 906.14 | 8,328.5 - - - | - 0.0 0.0 0.0 | 962.77 - - - | 283.17 283.17 283.17 283.17 |
| November | 7,584.5 - FULL 6,777.1 - 7,584.5 2,446.6 - 6,777.1 0.0 - 2,446.6 | 538.02 594.65 736.24 906.14 | - - - - | 0.0 0.0 0.0 0.0 | - - - - | 283.17 283.17 283.17 283.17 |
| December | 6,141.0 - FULL 6,018.6 - 6,141.0 978.6 - 6,018.6 0.0 - 978.6 | 651.29 792.87 821.19 906.14 | - - - - | 499.4 499.4 499.4 499.4 | - - - - | 283.17 283.17 283.17 283.17 |
| January | 5,309.1 - FULL 4,770.9 - 5,309.1 4,575.1 - 4,770.9 0.0 - 4,575.1 | 679.60 594.65 764.55 821.19 | - - - - | 499.4 499.4 499.4 499.4 | - - - - | 339.80 339.80 339.80 339.80 |
| February | 3,302.9 - FULL 2,250.9 - 3,302.9 856.3 - 2,250.9 0.0 - 856.3 | 651.29 707.92 764.55 821.19 | - - - - | 0.0 0.0 0.0 0.0 | - - - - | 339.80 339.80 339.80 339.80 |
| March | 1,223.3 - FULL 831.8 - 1,223.3 415.9 - 831.8 0.0 - 415.9 | 283.17 481.39 651.29 736.24 | - - - - | 0.0 0.0 0.0 0.0 | - - - - | 339.80 339.80 339.80 339.80 |
| April 1-15 | 1,590.3 - FULL 831.8 - 1,590.3 415.9 - 831.8 0.0 - 415.9 | 424.75 339.80 566.34 736.24 | - - - - | 0.0 0.0 0.0 0.0 | - - - - | 339.80 339.80 339.80 339.80 |
| April 16-30 | 1,761.6 - FULL 1,394.6 - 1,761.6 0.0 - 1,394.6 | 283.17 424.75 283.17 | - - - | 0.0 0.0 0.0 | - - - | 283.17 283.17 283.17 |
| May | 1,419.0 - FULL 1,345.6 - 1,419.0 611.7 - 1,345.6 0.0 - 611.7 | 226.53 283.17 226.53 283.17 | - - - - | 0.0 0.0 0.0 0.0 | - - - - | 226.53 226.53 226.53 226.53 |
| June | 3,302.9 - FULL 2,764.7 - 3,302.9 0.0 - 2,764.7 | 226.53 283.17 453.07 | - - - | 0.0 0.0 0.0 | - - - | 226.53 226.53 226.53 |
| July | 7,095.1 - FULL 5,627.2 - 7,095.1 0.0 - 5,627.2 | - 481.39 906.14 | 8,407.0 - - | - 0.0 0.0 | 962.77 - - | 283.17 283.17 283.17 |

Notes:

1/ If the Mica target end-of-period storage content is less than 8,634.5 hm³, then a maximum outflow of 962.77 m³/s will apply.

2/ Mica outflow s will be reduced to minimum to maintain the reservoir above the minimum Treaty storage content.

This will override any flow target.

TABLE 1.1aM
(Metric Units)
ARROW PROJECT OPERATING CRITERIA
DEFINITION
2018-19 ASSURED OPERATING PLAN

| Period | Volume Runoff Period | The Dalles Volume Runoff (km ³) | Maximum Storage Limit 1/ 2/ (hm ³) | Maximum Outflow Limit 3/ (m ³ /s) | Minimum Outflow Limit 4/ (m ³ /s) |
|----------------------|----------------------|---|--|--|--|
| August 15 - December | - | | URC | - | 283.2 |
| January | - | | URC | 1,982 | 283.2 |
| February | 1 Feb - 31 Jul | ≤ 86 >86 to <99 | URC URC to 3,670 | 1,699 | 566.3 |
| March | 1 Mar - 31 Jul | ≥ 99 ≤ 80 >80 to <93 | 3,670 URC URC to 2,202 | - | 566.3 |
| April 15 | 1 Apr - 31 Jul | ≥ 93 ≤ 74 >74 to <80 | 2,202 URC URC to 2,202 | - | 424.8 |
| April 30 | 1 Apr - 31 Jul | ≥ 80 ≤ 74 >74 to <80 | 2,202 URC URC to 1,957 | - | 339.8 |
| May | 1 May - 31 Jul | ≥ 86 ≤ 80 >80 to <86 | 1,957 URC URC to 5,382 | - | 141.6 |
| June | 1 Jun - 31 Jul | ≥ 86 ≤ 46 >46 to <49 | 5,382 URC URC to 8,074 | - | 141.6 |
| July | - | ≥ 49 | 8,074 URC | - | 283.2 |

Notes:

- 1/ If the Maximum Storage Limit is computed to be above the URC, then the URC will apply.
- 2/ Interpolate when there are two values. For example, if the February-July volume runoff is between 86 km³ and 99 km³, then the Maximum Storage Limit is interpolated between February's URC and 3,670 hm³.
- 3/ The Maximum Average Monthly Outflow Limit takes precedence over the Maximum Storage Limit. However, the Maximum Outflow Limit may be exceeded to avoid storage above the URC.
- 4/ The Minimum Average Monthly Outflow Limit is an operating limit and may be reduced to as low as 141.6 m³/s (Treaty minimum) to avoid drafting Mica+Arrow storage beyond 17.0 km³.

**TABLE 1.1bM
(Metric Units)
ARROW PROJECT OPERATING CRITERIA
30 YEAR OPERATING DATA
FOR 2018-19 ASSURED OPERATING PLAN**

| | AUG15-DEC | JAN | FEB | MAR | APR15 | APR30 | MAY | JUN | JUL |
|--|-----------|-------|--------|--------|--------|--------|--------|--------|-------|
| Maximum Average Monthly Flow Limits (m³/s) | - | 1,982 | 1,699 | - | - | - | - | - | - |
| Minimum Average Monthly Flow Limits (m³/s) | 283.2 | 283.2 | 566.3 | 566.3 | 424.8 | 339.8 | 141.6 | 141.6 | 283.2 |
| End-of-Period Maximum Storage Limits (hm³) | | | | | | | | | |
| 1928-29 | - | - | URC | URC | URC | URC | URC | URC | - |
| 1929-30 | - | - | URC | URC | URC | URC | URC | URC | - |
| 1930-31 | - | - | URC | URC | URC | URC | URC | URC | - |
| 1931-32 | - | - | 3669.9 | 2201.9 | 2201.9 | 1957.3 | URC | 8073.7 | - |
| 1932-33 | - | - | 3669.9 | 2201.9 | 2201.9 | 1957.3 | URC | URC | - |
| 1933-34 | - | - | 3669.9 | 2201.9 | 2201.9 | 1957.3 | URC | URC | - |
| 1934-35 | - | - | 3669.9 | 2201.9 | 2201.9 | 1957.3 | URC | 8073.7 | - |
| 1935-36 | - | - | 3669.9 | 2201.9 | 2201.9 | 1957.3 | URC | URC | - |
| 1936-37 | - | - | URC | URC | URC | URC | URC | URC | - |
| 1937-38 | - | - | 3669.9 | 2201.9 | 2201.9 | 1957.3 | URC | 8073.7 | - |
| 1938-39 | - | - | 4684.0 | 2899.7 | 2201.9 | 1957.3 | URC | URC | - |
| 1939-40 | - | - | 4971.4 | 3875.6 | 4561.2 | 4455.7 | URC | URC | - |
| 1940-41 | - | - | URC | URC | URC | URC | URC | URC | - |
| 1941-42 | - | - | 3669.9 | 2201.9 | 2201.9 | 1957.3 | URC | URC | - |
| 1942-43 | - | - | 3669.9 | 2201.9 | 2201.9 | 1957.3 | 5382.5 | 8073.7 | - |
| 1943-44 | - | - | URC | URC | URC | URC | URC | URC | - |
| 1944-45 | - | - | 4384.8 | 2977.7 | 2201.9 | 1957.3 | URC | 8580.4 | - |
| 1945-46 | - | - | 3669.9 | 2201.9 | 2201.9 | 1957.3 | URC | 8073.7 | - |
| 1946-47 | - | - | 3669.9 | 2201.9 | 2201.9 | 1957.3 | 5382.5 | 8180.6 | - |
| 1947-48 | - | - | 3669.9 | 2201.9 | 2201.9 | 1957.3 | URC | 8073.7 | - |
| 1948-49 | - | - | 3669.9 | 2201.9 | 2201.9 | 1957.3 | 6524.0 | URC | - |
| 1949-50 | - | - | 3669.9 | 2201.9 | 2201.9 | 1957.3 | URC | URC | - |
| 1950-51 | - | - | 3669.9 | 2201.9 | 2201.9 | 1957.3 | URC | 8073.7 | - |
| 1951-52 | - | - | 3669.9 | 2201.9 | 2201.9 | 1957.3 | 5382.5 | 8161.3 | - |
| 1952-53 | - | - | 3669.9 | 2201.9 | 2201.9 | 1957.3 | URC | 8073.7 | - |
| 1953-54 | - | - | 3669.9 | 2201.9 | 2201.9 | 1957.3 | URC | URC | - |
| 1954-55 | - | - | 3669.9 | 2201.9 | 2201.9 | 1957.3 | URC | 8073.7 | - |
| 1955-56 | - | - | 3669.9 | 2201.9 | 2201.9 | 1957.3 | 5382.5 | 8073.7 | - |
| 1956-57 | - | - | 3669.9 | 2201.9 | 2201.9 | 1957.3 | 5382.5 | 8163.5 | - |
| 1957-58 | - | - | 3669.9 | 2201.9 | 2201.9 | 1957.3 | 5382.5 | 8731.1 | - |

TABLE 3M
(Metric Units)
CRITICAL RULE CURVES
END OF PERIOD TREATY STORAGE CONTENTS (hm³)
2018 - 19 ASSURED OPERATING PLAN

| <u>YEAR</u> | <u>AUG15</u> | <u>AUG31</u> | <u>SEP</u> | <u>OCT</u> | <u>NOV</u> | <u>DEC</u> | <u>JAN</u> | <u>FEB</u> | <u>MAR</u> | <u>APR15</u> | <u>APR30</u> | <u>MAY</u> | <u>JUN</u> | <u>JUL</u> |
|-------------|--------------|--------------|------------|------------|------------|------------|------------|------------|------------|--------------|--------------|------------|------------|------------|
| MICA | | | | | | | | | | | | | | |
| 1928-29 | 8634.5 | 8634.5 | 8224.2 | 7503.7 | 6395.9 | 3643.5 | 2345.8 | 1917.6 | 1928.2 | 1898.1 | 939.7 | 1677.1 | 5707.4 | 8389.6 |
| 1929-30 | 8634.5 | 8613.5 | 8014.3 | 7302.9 | 5771.0 | 4344.7 | 1485.6 | 99.8 | 0.0 | 0.0 | 536.8 | 2129.5 | 5801.4 | 8132.7 |
| 1930-31 | 8634.5 | 8634.5 | 8242.8 | 7480.5 | 6108.2 | 4073.8 | 1884.4 | 457.8 | 0.0 | 0.0 | 0.0 | 1647.1 | 4976.9 | 6247.9 |
| 1931-32 | 6317.4 | 6204.8 | 5111.2 | 4034.2 | 2744.8 | 620.7 | 0.0 | 0.0 | | | | | | |
| ARROW | | | | | | | | | | | | | | |
| 1928-29 | 8757.8 | 8757.8 | 8594.9 | 8738.5 | 8524.9 | 8557.5 | 5358.1 | 2034.8 | 1004.8 | 771.2 | 1827.1 | 4464.1 | 8228.9 | 8618.6 |
| 1929-30 | 8756.6 | 8562.9 | 7218.0 | 5619.4 | 4298.2 | 3141.2 | 1256.3 | 217.3 | 0.0 | 256.6 | 1109.8 | 3795.2 | 6491.8 | 7971.3 |
| 1930-31 | 8266.8 | 8480.9 | 7779.2 | 6573.0 | 4848.4 | 3548.5 | 1662.7 | 279.4 | 0.0 | 0.0 | 0.2 | 1880.9 | 4494.4 | 5219.6 |
| 1931-32 | 4455.5 | 3982.6 | 3460.5 | 2727.7 | 779.0 | 0.0 | 0.0 | 0.0 | | | | | | |
| DUNCAN | | | | | | | | | | | | | | |
| 1928-29 | 1726.8 | 1726.8 | 1529.1 | 1468.0 | 1345.6 | 1101.0 | 611.6 | 227.5 | 249.6 | 263.0 | 290.7 | 578.1 | 1250.5 | 1707.7 |
| 1929-30 | 1712.6 | 1651.5 | 1345.6 | 1223.3 | 1101.0 | 734.0 | 244.7 | 183.5 | 0.0 | 32.8 | 113.8 | 395.1 | 932.4 | 1345.6 |
| 1930-31 | 1468.0 | 1468.0 | 1284.5 | 1101.0 | 978.6 | 489.3 | 183.5 | 61.2 | 0.0 | 11.7 | 0.0 | 384.6 | 966.7 | 1223.3 |
| 1931-32 | 1345.6 | 1345.6 | 1101.0 | 856.3 | 367.0 | 0.0 | 0.0 | 0.0 | | | | | | |
| COMPOSITE | | | | | | | | | | | | | | |
| 1928-29 | 19119.2 | 19119.2 | 18348.3 | 17710.2 | 16266.5 | 13301.9 | 8315.5 | 4180.0 | 3182.5 | 2932.2 | 3057.5 | 6719.3 | 15186.8 | 18716.0 |
| 1929-30 | 19103.8 | 18827.8 | 16577.9 | 14145.5 | 11170.2 | 8219.8 | 2986.6 | 500.6 | 0.0 | 289.4 | 1760.3 | 6319.8 | 13225.6 | 17449.6 |
| 1930-31 | 18369.3 | 18583.4 | 17306.5 | 15154.5 | 11935.2 | 8111.7 | 3730.6 | 798.3 | 0.0 | 11.7 | 0.2 | 3912.6 | 10437.9 | 12690.8 |
| 1931-32 | 12118.5 | 11533.0 | 9672.6 | 7618.2 | 3890.8 | 620.7 | 0.0 | 0.0 | | | | | | |

| TABLE 4M (Metric Units) MICA ASSURED AND VARIABLE REFILL CURVES, DISTRIBUTION FACTORS AND FORECAST ERRORS, POWER DISCHARGE REQUIREMENTS, AND OPERATING RULE CURVE LOWER LIMITS 2018 - 19 ASSURED OPERATING PLAN | | | | | | | | | | | | | | |
|---|-------|-------|--------|--------|--------|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|
| | AUG15 | AUG31 | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR15 | APR30 | MAY | JUN | JUL |
| ASSURED REFILL CURVE (hm ³) | 0.0 | 0.0 | 1441.8 | 1878.3 | 2037.3 | 2076.9 | 2064.0 | 2035.6 | 2051.7 | 2113.1 | 2268.0 | 3670.9 | 6620.5 | 8634.5 |
| VARIABLE REFILL CURVES (hm ³) | | | | | | | | | | | | | | |
| 1928-29 | | | | | | | 5032.7 | 4589.3 | 4449.9 | 4430.8 | 4538.0 | 5790.6 | 7306.3 | 8634.5 |
| 1929-30 | | | | | | | 2528.8 | 1986.9 | 1826.6 | 1852.1 | 2243.8 | 4313.4 | 6596.5 | " |
| 1930-31 | | | | | | | 3160.5 | 2641.1 | 2468.9 | 2441.2 | 2670.7 | 4359.6 | 6783.2 | " |
| 1931-32 | | | | | | | 1160.2 | 657.2 | 502.5 | 476.8 | 773.1 | 2736.8 | 6165.7 | " |
| 1932-33 | | | | | | | 931.2 | 515.0 | 402.7 | 371.9 | 571.3 | 2490.4 | 5759.1 | " |
| 1933-34 | | | | | | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1871.4 | 6388.1 | " |
| 1934-35 | | | | | | | 1771.6 | 1309.9 | 1227.0 | 1245.1 | 1425.6 | 3172.5 | 6018.1 | " |
| 1935-36 | | | | | | | 1337.1 | 876.1 | 766.0 | 734.2 | 976.2 | 3140.0 | 6702.2 | " |
| 1936-37 | | | | | | | 5000.4 | 4506.4 | 4330.7 | 4285.0 | 4509.8 | 5820.5 | 7385.3 | " |
| 1937-38 | | | | | | | 1843.3 | 1382.1 | 1226.7 | 1212.0 | 1448.4 | 3283.1 | 6395.2 | " |
| 1938-39 | | | | | | | 2564.8 | 2212.2 | 2074.5 | 2110.2 | 2390.8 | 4298.2 | 7322.7 | " |
| 1939-40 | | | | | | | 2030.2 | 1587.4 | 1492.7 | 1513.7 | 1839.6 | 3803.0 | 6723.7 | " |
| 1940-41 | | | | | | | 3613.9 | 3145.3 | 3020.3 | 3039.9 | 3481.0 | 5281.7 | 7340.5 | " |
| 1941-42 | | | | | | | 2994.1 | 2535.2 | 2390.1 | 2352.9 | 2547.2 | 4188.6 | 6839.5 | " |
| 1942-43 | | | | | | | 3403.2 | 2889.2 | 2736.3 | 2698.6 | 3078.8 | 4812.7 | 6990.9 | " |
| 1943-44 | | | | | | | 5259.2 | 4727.1 | 4584.4 | 4561.0 | 4735.4 | 6087.6 | 7734.4 | " |
| 1944-45 | | | | | | | 4875.3 | 4433.7 | 4325.1 | 4327.8 | 4456.0 | 5702.3 | 7459.9 | " |
| 1945-46 | | | | | | | 426.2 | 0.0 | 0.0 | 0.0 | 0.0 | 2001.3 | 6155.4 | " |
| 1946-47 | | | | | | | 704.9 | 299.7 | 211.9 | 208.9 | 504.2 | 2636.7 | 6325.9 | " |
| 1947-48 | | | | | | | 579.6 | 124.0 | 0.0 | 0.0 | 138.5 | 2138.3 | 6042.6 | " |
| 1948-49 | | | | | | | 4734.7 | 4220.9 | 4025.9 | 3987.0 | 4183.0 | 5491.9 | 7972.5 | " |
| 1949-50 | | | | | | | 1450.3 | 898.9 | 715.1 | 660.1 | 876.6 | 2677.3 | 5570.9 | " |
| 1950-51 | | | | | | | 1429.1 | 994.3 | 889.1 | 877.4 | 1164.8 | 2967.7 | 6474.9 | " |
| 1951-52 | | | | | | | 2425.1 | 1887.1 | 1718.5 | 1649.3 | 1857.5 | 3687.5 | 6843.4 | " |
| 1952-53 | | | | | | | 3113.8 | 2620.3 | 2474.2 | 2436.1 | 2590.0 | 4065.8 | 6760.7 | " |
| 1953-54 | | | | | | | 360.6 | 0.0 | 0.0 | 0.0 | 3.7 | 1934.0 | 5501.2 | " |
| 1954-55 | | | | | | | 2221.5 | 1796.0 | 1691.1 | 1684.2 | 1904.2 | 3507.9 | 5987.3 | " |
| 1955-56 | | | | | | | 1115.4 | 645.7 | 491.3 | 442.3 | 668.9 | 2718.9 | 6261.3 | " |
| 1956-57 | | | | | | | 1528.4 | 1041.0 | 922.1 | 903.0 | 1130.6 | 2928.8 | 7088.0 | " |
| 1957-58 | | | | | | | 1121.0 | 665.2 | 562.5 | 556.6 | 823.5 | 2677.3 | 6494.0 | " |
| DISTRIBUTION FACTORS | | | | | | | 0.9760 | 0.9790 | 0.9750 | 0.9820 | 0.9650 | 0.7920 | 0.5060 | N/A |
| FORECAST ERRORS (hm ³) | | | | | | | 1780.9 | 1276.6 | 1113.7 | 1028.1 | 1028.1 | 982.1 | 971.3 | N/A |
| POWER DISCHARGE REQUIREMENTS (m ³ /s): | | | | | | | | | | | | | | |
| ASSURED REFILL CURVE | | | | | | | | | | | | | | |
| | 84.95 | 84.95 | 84.95 | 84.95 | 84.95 | 84.95 | 84.95 | 84.95 | 84.95 | 84.95 | 84.95 | 271.84 | 566.34 | 849.50 |
| VARIABLE REFILL CURVES | | | | | 98.68 | km ³ | 85.0 | 85.0 | 85.0 | 85.0 | 85.0 | 85.0 | 566.3 | 770.2 |
| (BY VOLUME RUNOFF AT THE DALLES) | | | | | 117.18 | km ³ | 85.0 | 85.0 | 85.0 | 85.0 | 85.0 | 85.0 | 339.8 | 651.3 |
| | | | | | 135.69 | km ³ | 85.0 | 85.0 | 85.0 | 85.0 | 85.0 | 85.0 | 339.8 | 651.3 |
| VARIABLE REFILL CURVE LOWER LIMITS (hm ³) | | | | | 98.68 | km ³ | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| (BY VOLUME RUNOFF AT THE DALLES) | | | | | 117.18 | km ³ | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | | | | | 135.69 | km ³ | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| OPERATING RULE CURVE LOWER LIMITS (hm ³) | | | | | | | 1031.5 | 55.0 | 0.0 | 0.0 | | | | |

TABLE 5M
(Metric Units)
ARROW

**ASSURED AND VARIABLE REFILL CURVES,
 DISTRIBUTION FACTORS AND FORECAST ERRORS,
 POWER DISCHARGE REQUIREMENTS, AND OPERATING RULE CURVE LOWER LIMITS
 2018 - 19 ASSURED OPERATING PLAN**

| | <u>AUG15</u> | <u>AUG31</u> | <u>SEP</u> | <u>OCT</u> | <u>NOV</u> | <u>DEC</u> | <u>JAN</u> | <u>FEB</u> | <u>MAR</u> | <u>APR15</u> | <u>APR30</u> | <u>MAY</u> | <u>JUN</u> | <u>JUL</u> |
|--|--------------|--------------|------------|------------|------------|-----------------|------------|------------|------------|--------------|--------------|------------|------------|------------|
| <u>ASSURED REFILL CURVE (hm³)</u> | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1257.6 | 1619.2 | 1818.6 | 2016.0 | 2429.0 | 5547.9 | 8580.7 | 8757.8 |
| <u>VARIABLE REFILL CURVES (hm³)</u> | | | | | | | | | | | | | | |
| 1928-29 | | | | | | | 6565.2 | 6021.6 | 5741.2 | 5569.0 | 5888.7 | 7823.0 | 8736.1 | 8757.8 |
| 1929-30 | | | | | | | 2446.4 | 2021.4 | 2125.6 | 2137.6 | 2802.8 | 6327.9 | 8240.9 | " |
| 1930-31 | | | | | | | 3680.2 | 3135.8 | 2907.1 | 2818.0 | 3350.9 | 5973.4 | 8267.1 | " |
| 1931-32 | | | | | | | 0.0 | 0.0 | 0.0 | 0.0 | 555.9 | 4061.6 | 7500.1 | " |
| 1932-33 | | | | | | | 918.5 | 798.8 | 828.4 | 819.6 | 1349.1 | 4414.6 | 7339.8 | " |
| 1933-34 | | | | | | | 0.0 | 0.0 | 0.0 | 0.0 | 386.6 | 5555.5 | 8549.6 | " |
| 1934-35 | | | | | | | 1560.0 | 1413.2 | 1678.6 | 1737.6 | 2198.3 | 4939.9 | 7617.2 | " |
| 1935-36 | | | | | | | 1705.3 | 1322.4 | 1207.6 | 1129.1 | 1549.9 | 4912.5 | 8349.3 | " |
| 1936-37 | | | | | | | 7321.2 | 6668.7 | 6362.4 | 6119.9 | 6491.8 | 8249.0 | 8757.8 | " |
| 1937-38 | | | | | | | 2419.2 | 2195.3 | 2235.2 | 2314.5 | 2871.8 | 5638.2 | 8100.7 | " |
| 1938-39 | | | | | | | 3011.5 | 2588.5 | 2387.4 | 2301.3 | 3021.6 | 6192.8 | 8757.8 | " |
| 1939-40 | | | | | | | 2157.9 | 1924.0 | 2041.4 | 2255.5 | 2941.8 | 5652.9 | 8437.8 | " |
| 1940-41 | | | | | | | 5233.5 | 4809.8 | 4672.5 | 4881.2 | 5960.2 | 8519.3 | 8757.8 | " |
| 1941-42 | | | | | | | 5163.3 | 4751.1 | 4597.4 | 4428.3 | 4933.3 | 7302.1 | " | " |
| 1942-43 | | | | | | | 6290.0 | 5710.1 | 5493.4 | 5286.9 | 6018.6 | 8513.4 | " | " |
| 1943-44 | | | | | | | 8573.1 | 8052.5 | 7802.9 | 7567.6 | 7985.9 | 8757.8 | " | " |
| 1944-45 | | | | | | | 7002.4 | 6592.6 | 6405.0 | 6301.7 | 6610.0 | 8292.0 | " | " |
| 1945-46 | | | | | | | 242.7 | 376.5 | 287.5 | 236.3 | 1056.2 | 4366.2 | 7837.7 | " |
| 1946-47 | | | | | | | 1762.5 | 1663.0 | 1670.5 | 1725.3 | 2349.7 | 5393.3 | 8080.1 | " |
| 1947-48 | | | | | | | 1224.0 | 1349.8 | 1339.5 | 1191.7 | 1684.5 | 4646.6 | 7904.5 | " |
| 1948-49 | | | | | | | 5494.6 | 4994.7 | 4831.8 | 4689.2 | 5267.5 | 7864.1 | 8757.8 | " |
| 1949-50 | | | | | | | 1403.4 | 1119.6 | 1158.2 | 1159.7 | 1660.0 | 4454.3 | 7036.7 | " |
| 1950-51 | | | | | | | 2145.7 | 1943.6 | 2043.9 | 1958.5 | 2564.3 | 5317.9 | 8253.6 | " |
| 1951-52 | | | | | | | 2305.7 | 1925.2 | 1972.4 | 1906.9 | 2368.6 | 5447.6 | 8400.9 | " |
| 1952-53 | | | | | | | 3919.7 | 3449.2 | 3318.1 | 3177.2 | 3552.5 | 6093.5 | 8271.2 | " |
| 1953-54 | | | | | | | 0.0 | 0.0 | 12.5 | 25.9 | 741.1 | 3735.7 | 7058.9 | " |
| 1954-55 | | | | | | | 1595.9 | 1447.9 | 1542.8 | 1482.6 | 2010.9 | 4634.6 | 6986.3 | " |
| 1955-56 | | | | | | | 870.7 | 619.0 | 664.0 | 651.5 | 1229.7 | 4634.3 | 7910.6 | " |
| 1956-57 | | | | | | | 1038.8 | 741.1 | 766.5 | 725.9 | 1286.9 | 4284.2 | 8691.1 | " |
| 1957-58 | | | | | | | 546.8 | 285.0 | 422.5 | 586.7 | 1310.6 | 4356.7 | 7999.6 | " |
| <u>DISTRIBUTION FACTORS</u> | | | | | | | 0.9730 | 0.9760 | 0.9700 | 0.9740 | 0.9510 | 0.7420 | 0.4670 | N/A |
| <u>FORECAST ERRORS (hm³)</u> | | | | | | | 3633.4 | 2679.8 | 2334.5 | 1981.0 | 1981.0 | 1769.4 | 1662.2 | N/A |
| <u>POWER DISCHARGE REQUIREMENTS (m³/s):</u> | | | | | | | | | | | | | | |
| ASSURED REFILL CURVE | 141.58 | 141.58 | 141.58 | 141.58 | 141.58 | 141.58 | 141.58 | 141.58 | 141.58 | 141.58 | 141.58 | 269.01 | 934.46 | 1699.01 |
| VARIABLE REFILL CURVES | | | | | 98.68 | km ³ | 141.58 | 141.58 | 141.58 | 141.58 | 141.58 | 141.58 | 877.82 | 1415.84 |
| (BY VOLUME RUNOFF AT THE DALLES) | | | | | 117.18 | km ³ | 141.58 | 141.58 | 141.58 | 141.58 | 141.58 | 141.58 | 877.82 | 1415.84 |
| | | | | | 135.69 | km ³ | 141.58 | 141.58 | 141.58 | 141.58 | 141.58 | 141.58 | 877.82 | 1415.84 |
| <u>VARIABLE REFILL CURVE LOWER LIMITS (hm³)</u> | | | | | 98.68 | km ³ | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| (BY VOLUME RUNOFF AT THE DALLES) | | | | | 117.18 | km ³ | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | | | | | 135.69 | km ³ | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| <u>OPERATING RULE CURVE LOWER LIMITS (hm³)</u> | | | | | | | 1006.3 | 91.7 | 0.0 | 0.0 | | | | |

TABLE 6M
(Metric Units)
DUNCAN
ASSURED AND VARIABLE REFILL CURVES,
DISTRIBUTION FACTORS AND FORECAST ERRORS,
POWER DISCHARGE REQUIREMENTS, AND OPERATING RULE CURVE LOWER LIMITS
2018 - 19 ASSURED OPERATING PLAN

| | <u>AUG15</u> | <u>AUG31</u> | <u>SEP</u> | <u>OCT</u> | <u>NOV</u> | <u>DEC</u> | <u>JAN</u> | <u>FEB</u> | <u>MAR</u> | <u>APR15</u> | <u>APR30</u> | <u>MAY</u> | <u>JUN</u> | <u>JUL</u> |
|--|--------------|--------------|------------|------------|------------------------|------------|------------|------------|------------|--------------|--------------|------------|------------|------------|
| <u>ASSURED REFILL CURVE (hm³)</u> | 0.0 | 0.0 | 3.2 | 78.3 | 121.1 | 148.5 | 173.5 | 196.0 | 230.5 | 256.9 | 295.1 | 679.7 | 1232.4 | 1726.8 |
| <u>VARIABLE REFILL CURVES (hm³)</u> | | | | | | | | | | | | | | |
| 1928-29 | | | | | | | 853.9 | 812.3 | 832.6 | 827.4 | 868.1 | 1127.1 | 1457.7 | 1726.8 |
| 1929-30 | | | | | | | 849.9 | 807.4 | 827.2 | 821.1 | 880.3 | 1176.6 | 1486.6 | " |
| 1930-31 | | | | | | | 713.9 | 674.5 | 703.2 | 709.5 | 765.1 | 1054.2 | 1457.7 | " |
| 1931-32 | | | | | | | 41.1 | 5.6 | 51.6 | 71.4 | 157.8 | 609.2 | 1237.0 | " |
| 1932-33 | | | | | | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 183.5 | 899.1 | " |
| 1933-34 | | | | | | | 81.7 | 88.6 | 147.3 | 182.0 | 295.3 | 803.2 | 1414.4 | " |
| 1934-35 | | | | | | | 201.1 | 178.4 | 234.4 | 238.8 | 298.0 | 701.0 | 1225.0 | " |
| 1935-36 | | | | | | | 143.1 | 106.2 | 134.6 | 135.8 | 203.1 | 692.9 | 1363.5 | " |
| 1936-37 | | | | | | | 696.5 | 652.8 | 678.0 | 672.8 | 724.2 | 1017.8 | 1411.9 | " |
| 1937-38 | | | | | | | 188.1 | 168.1 | 207.5 | 228.3 | 302.2 | 728.8 | 1307.2 | " |
| 1938-39 | | | | | | | 316.6 | 290.9 | 322.2 | 330.8 | 408.3 | 827.2 | 1421.5 | " |
| 1939-40 | | | | | | | 284.5 | 270.8 | 321.0 | 352.8 | 437.0 | 834.3 | 1387.5 | " |
| 1940-41 | | | | | | | 490.5 | 470.0 | 510.1 | 546.1 | 657.4 | 1028.3 | 1444.2 | " |
| 1941-42 | | | | | | | 476.1 | 461.4 | 501.1 | 509.9 | 581.6 | 939.0 | 1396.8 | " |
| 1942-43 | | | | | | | 506.0 | 473.4 | 509.9 | 514.8 | 609.7 | 992.1 | 1378.7 | " |
| 1943-44 | | | | | | | 868.8 | 838.4 | 870.3 | 869.8 | 927.5 | 1193.0 | 1533.8 | " |
| 1944-45 | | | | | | | 679.4 | 649.8 | 684.3 | 685.3 | 729.8 | 1019.5 | 1431.8 | " |
| 1945-46 | | | | | | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 466.3 | 1231.4 | " |
| 1946-47 | | | | | | | " | " | " | " | 74.9 | 574.0 | 1255.1 | " |
| 1947-48 | | | | | | | 97.4 | 70.0 | 113.5 | 115.0 | 175.9 | 616.3 | 1291.6 | " |
| 1948-49 | | | | | | | 651.0 | 611.2 | 639.5 | 636.6 | 698.5 | 1033.9 | 1541.6 | " |
| 1949-50 | | | | | | | 162.0 | 123.3 | 158.1 | 156.6 | 221.4 | 625.6 | 1133.3 | " |
| 1950-51 | | | | | | | 0.0 | 0.0 | 0.0 | 0.0 | 78.0 | 539.0 | 1212.0 | " |
| 1951-52 | | | | | | | 237.3 | 203.8 | 246.6 | 247.6 | 311.0 | 765.3 | 1336.6 | " |
| 1952-53 | | | | | | | 230.5 | 203.6 | 241.5 | 246.1 | 302.4 | 703.2 | 1244.6 | " |
| 1953-54 | | | | | | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 367.5 | 1072.1 | " |
| 1954-55 | | | | | | | 73.6 | 45.5 | 83.4 | 90.5 | 159.3 | 568.6 | 1071.6 | " |
| 1955-56 | | | | | | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 491.5 | 1214.0 | " |
| 1956-57 | | | | | | | 122.3 | 79.0 | 112.3 | 117.9 | 189.4 | 612.9 | 1381.4 | " |
| 1957-58 | | | | | | | 0.0 | 0.0 | 0.0 | 0.0 | 6.4 | 466.1 | 1263.4 | " |
| <u>DISTRIBUTION FACTORS</u> | | | | | | | 0.9740 | 0.9800 | 0.9760 | 0.9790 | 0.9570 | 0.7510 | 0.4810 | N/A |
| <u>FORECAST ERRORS (hm³)</u> | | | | | | | 312.2 | 255.2 | 256.9 | 229.5 | 229.5 | 212.6 | 190.8 | N/A |
| <u>POWER DISCHARGE REQUIREMENTS (m³/s):</u> | | | | | | | | | | | | | | |
| ASSURED REFILL CURVE | 2.83 | 2.83 | 2.83 | 2.83 | 2.83 | 2.83 | 2.83 | 2.83 | 2.83 | 2.83 | 2.83 | 2.83 | 14.16 | 22.65 |
| VARIABLE REFILL CURVES | | | | | 98.68 km ³ | | 2.83 | 2.83 | 2.83 | 2.83 | 2.83 | 2.83 | 50.97 | 70.79 |
| (BY VOLUME RUNOFF AT THE DALLES) | | | | | 117.18 km ³ | | 2.83 | 2.83 | 2.83 | 2.83 | 2.83 | 2.83 | 50.97 | 70.79 |
| | | | | | 135.69 km ³ | | 2.83 | 2.83 | 2.83 | 2.83 | 2.83 | 2.83 | 50.97 | 70.79 |
| <u>VARIABLE REFILL CURVE LOWER LIMITS (hm³)</u> | | | | | 98.68 km ³ | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| (BY VOLUME RUNOFF AT THE DALLES) | | | | | 117.18 km ³ | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | | | | | 135.69 km ³ | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| <u>OPERATING RULE CURVE LOWER LIMITS (hm³)</u> | | | | | | | 28.9 | 15.4 | 0.0 | 0.0 | | | | |

TABLE 7M
(Metric Units)
MICA
UPPER RULE CURVES (FLOOD CONTROL)
END OF PERIOD TREATY STORAGE CONTENTS (hm³)
2018 - 19 ASSURED OPERATING PLAN

| <u>YEAR</u> | <u>AUG15</u> | <u>AUG31</u> | <u>SEP</u> | <u>OCT</u> | <u>NOV</u> | <u>DEC</u> | <u>JAN</u> | <u>FEB</u> | <u>MAR</u> | <u>APR15</u> | <u>APR30</u> | <u>MAY</u> | <u>JUN</u> | <u>JUL</u> |
|-------------|--------------|--------------|------------|------------|------------|------------|------------|------------|------------|--------------|--------------|------------|------------|------------|
| 1928-29 | 8634.5 | 8634.5 | 8634.5 | 8387.9 | 8387.9 | 8151.1 | 7846.2 | 7571.0 | 7266.2 | 7266.2 | 7266.2 | 8100.7 | 8634.5 | 8634.5 |
| 1929-30 | " | " | " | " | " | " | 7719.5 | 7330.3 | 6898.7 | 6898.7 | 6898.7 | 7103.5 | 8032.2 | " |
| 1930-31 | " | " | " | " | " | " | 8151.1 | 8151.1 | 8151.1 | 8151.1 | 8151.1 | 8151.1 | 8634.5 | " |
| 1931-32 | " | " | " | " | " | " | 6601.7 | 5151.1 | 3601.9 | 3601.9 | 3601.9 | 5660.2 | 8443.5 | " |
| 1932-33 | " | " | " | " | " | " | 6584.5 | 5168.4 | " | " | " | 4065.0 | 8030.7 | " |
| 1933-34 | " | " | " | " | " | " | " | " | " | 3717.6 | 4855.0 | 8247.0 | 8634.5 | " |
| 1934-35 | " | " | " | " | " | " | " | " | " | 3601.9 | 3601.9 | 4694.0 | 8156.5 | " |
| 1935-36 | " | " | " | " | " | " | 6601.7 | 5151.1 | " | " | 4074.8 | 6918.3 | 8634.5 | " |
| 1936-37 | " | " | " | " | " | " | 7687.0 | 7268.4 | 6804.5 | 6804.5 | 6804.5 | 7344.2 | " | " |
| 1937-38 | " | " | " | " | " | " | 6584.5 | 5168.4 | 3601.9 | 3601.9 | 3601.9 | 4855.0 | " | " |
| 1938-39 | " | " | " | " | " | " | 6984.3 | 5929.1 | 4762.3 | 4762.3 | 4928.9 | 7863.9 | 8367.4 | " |
| 1939-40 | " | " | " | " | " | " | 7372.6 | 6644.2 | 5866.0 | 5866.0 | 5866.0 | 8089.2 | 8390.9 | " |
| 1940-41 | " | " | " | " | " | " | 8151.1 | 8151.1 | 8151.1 | 8151.1 | 8151.1 | 8603.5 | 8634.5 | " |
| 1941-42 | " | " | " | " | " | " | 6584.5 | 5168.4 | 3601.9 | 3601.9 | 3601.9 | 4784.6 | 8025.6 | " |
| 1942-43 | " | " | " | " | " | " | " | " | " | 3682.4 | 4190.8 | 5398.7 | 8035.6 | " |
| 1943-44 | " | " | " | " | " | " | 8151.1 | 8151.1 | 8151.1 | 8151.1 | 8151.1 | 8615.7 | 8634.5 | " |
| 1944-45 | " | " | " | " | " | " | 6947.6 | 5859.6 | 4656.4 | 4656.4 | 4656.4 | 5424.1 | " | " |
| 1945-46 | " | " | " | " | " | " | 6584.5 | 5168.4 | 3601.9 | 3601.9 | 3601.9 | 6636.4 | " | " |
| 1946-47 | " | " | " | " | " | " | " | " | " | " | 3677.2 | 6309.3 | " | " |
| 1947-48 | " | " | " | " | " | " | 6601.7 | 5151.1 | " | " | 3601.9 | 5695.4 | " | " |
| 1948-49 | " | " | " | " | " | " | 6584.5 | 5168.4 | " | " | 3667.2 | 5947.2 | 8629.4 | " |
| 1949-50 | " | " | " | " | " | " | " | " | " | " | 3601.9 | 3782.9 | 7648.1 | " |
| 1950-51 | " | " | " | " | " | " | " | " | " | " | " | 6012.5 | 8634.5 | " |
| 1951-52 | " | " | " | " | " | " | 6601.7 | 5151.1 | " | " | 3858.5 | 6193.6 | " | " |
| 1952-53 | " | " | " | " | " | " | 6584.5 | 5168.4 | " | " | 3601.9 | 4729.0 | 8297.4 | " |
| 1953-54 | " | " | " | " | " | " | " | " | " | " | " | 5247.5 | 6782.5 | " |
| 1954-55 | " | " | " | " | " | " | " | " | " | " | " | 3601.9 | 7467.0 | " |
| 1955-56 | " | " | " | " | " | " | 6601.7 | 5151.1 | " | " | " | 5589.7 | 8634.5 | " |
| 1956-57 | " | " | " | " | " | " | 6584.5 | 5168.4 | " | " | " | 7300.9 | " | " |
| 1957-58 | " | " | " | " | " | " | " | " | " | " | " | 6394.9 | " | " |

TABLE 8M
(Metric Units)
ARROW
UPPER RULE CURVES (FLOOD CONTROL)
END OF PERIOD TREATY STORAGE CONTENTS (hm³)
2018 - 19 ASSURED OPERATING PLAN

| <u>YEAR</u> | <u>AUG15</u> | <u>AUG31</u> | <u>SEP</u> | <u>OCT</u> | <u>NOV</u> | <u>DEC</u> | <u>JAN</u> | <u>FEB</u> | <u>MAR</u> | <u>APR15</u> | <u>APR30</u> | <u>MAY</u> | <u>JUN</u> | <u>JUL</u> |
|-------------|--------------|--------------|------------|------------|------------|------------|------------|------------|------------|--------------|--------------|------------|------------|------------|
| 1928-29 | 8757.8 | 8757.8 | 8757.8 | 8449.6 | 8449.6 | 7887.1 | 7807.3 | 7735.2 | 7655.7 | 7655.7 | 7655.7 | 7850.6 | 8757.8 | 8757.8 |
| 1929-30 | " | " | " | " | " | " | 7689.9 | 7511.8 | 7314.6 | 7314.6 | 7314.6 | 7316.1 | " | " |
| 1930-31 | " | " | " | " | " | " | 7887.1 | 7887.1 | 7887.1 | 7887.1 | 7887.1 | 8757.8 | " | " |
| 1931-32 | " | " | " | " | " | " | 6670.7 | 5533.5 | 4317.3 | 4317.3 | 4317.3 | 4996.7 | " | " |
| 1932-33 | " | " | " | " | " | " | 6657.2 | 5546.9 | " | " | " | 4317.3 | 7856.5 | " |
| 1933-34 | " | " | " | " | " | " | " | " | " | 4352.7 | 5556.2 | 5960.2 | 8757.8 | " |
| 1934-35 | " | " | " | " | " | " | " | " | " | 4317.3 | 4317.3 | 5023.4 | " | " |
| 1935-36 | " | " | " | " | " | " | 6670.7 | 5533.5 | " | " | 4596.9 | 7616.5 | " | " |
| 1936-37 | " | " | " | " | " | " | 7659.3 | 7454.1 | 7226.5 | 7226.5 | 7226.5 | 7226.5 | " | " |
| 1937-38 | " | " | " | " | " | " | 6657.2 | 5546.9 | 4317.3 | 4317.3 | 4317.3 | 4858.9 | " | " |
| 1938-39 | " | " | " | " | " | " | 7002.7 | 6203.6 | 5319.2 | 5319.2 | 5346.8 | 5862.5 | " | " |
| 1939-40 | " | " | " | " | " | " | 7362.6 | 6872.7 | 6348.4 | 6348.4 | 6348.4 | 7683.3 | " | " |
| 1940-41 | " | " | " | " | " | " | 7887.1 | 7887.1 | 7887.1 | 7887.1 | 7887.1 | 8359.1 | " | " |
| 1941-42 | " | " | " | " | " | " | 6657.2 | 5546.9 | 4317.3 | 4317.3 | 4317.3 | 4819.1 | 7141.4 | " |
| 1942-43 | " | " | " | " | " | " | " | " | " | " | 4974.4 | 6102.3 | 8757.8 | " |
| 1943-44 | " | " | " | " | " | " | 7887.1 | 7887.1 | 7887.1 | 7887.1 | 7887.1 | 7887.1 | " | " |
| 1944-45 | " | " | " | " | " | " | 6971.1 | 6143.7 | 5227.6 | 5227.6 | 5227.6 | 5308.9 | " | " |
| 1945-46 | " | " | " | " | " | " | 6657.2 | 5546.9 | 4317.3 | 4317.3 | 4317.3 | 4596.9 | " | " |
| 1946-47 | " | " | " | " | " | " | " | " | " | " | " | 5409.7 | " | " |
| 1947-48 | " | " | " | " | " | " | 6670.7 | 5533.5 | " | " | " | 4601.3 | " | " |
| 1948-49 | " | " | " | " | " | " | 6657.2 | 5546.9 | " | " | 4334.9 | 7132.6 | " | " |
| 1949-50 | " | " | " | " | " | " | " | " | " | " | 4317.3 | 4317.3 | 7332.5 | " |
| 1950-51 | " | " | " | " | " | " | " | " | " | " | " | 5232.1 | 8757.8 | " |
| 1951-52 | " | " | " | " | " | " | 6670.7 | 5533.5 | " | " | 4565.8 | 6923.9 | " | " |
| 1952-53 | " | " | " | " | " | " | 6657.2 | 5546.9 | " | " | 4317.3 | 4912.3 | " | " |
| 1953-54 | " | " | " | " | " | " | " | " | " | " | " | 5165.5 | 7097.1 | " |
| 1954-55 | " | " | " | " | " | " | " | " | " | " | " | 4317.3 | 8109.5 | " |
| 1955-56 | " | " | " | " | " | " | 6670.7 | 5533.5 | " | " | " | 5831.5 | 8757.8 | " |
| 1956-57 | " | " | " | " | " | " | 6657.2 | 5546.9 | " | " | " | 6475.4 | " | " |
| 1957-58 | " | " | " | " | " | " | " | " | " | " | " | 6488.6 | " | " |

TABLE 9M
(Metric Units)
DUNCAN
UPPER RULE CURVES (FLOOD CONTROL)
END OF PERIOD TREATY STORAGE CONTENTS (hm³)
2018 - 19 ASSURED OPERATING PLAN

| <u>YEAR</u> | <u>AUG15</u> | <u>AUG31</u> | <u>SEP</u> | <u>OCT</u> | <u>NOV</u> | <u>DEC</u> | <u>JAN</u> | <u>FEB</u> | <u>MAR</u> | <u>APR15</u> | <u>APR30</u> | <u>MAY</u> | <u>JUN</u> | <u>JUL</u> |
|-------------|--------------|--------------|------------|------------|------------|------------|------------|------------|------------|--------------|--------------|------------|------------|------------|
| 1928-29 | 1726.8 | 1726.8 | 1726.8 | 1726.8 | 1726.8 | 1233.3 | 1022.7 | 832.6 | 832.6 | 832.6 | 832.6 | 1049.8 | 1723.1 | 1726.8 |
| 1929-30 | " | " | " | " | " | " | 999.9 | 789.3 | 789.3 | 789.3 | 789.3 | 873.7 | 1411.7 | " |
| 1930-31 | " | " | " | " | " | " | 955.9 | 705.4 | 705.4 | 705.4 | 705.4 | 1043.5 | 1625.8 | " |
| 1931-32 | " | " | " | " | " | " | 678.4 | 228.0 | 160.7 | 160.7 | 163.7 | 677.7 | 1533.5 | " |
| 1932-33 | " | " | " | " | " | " | 669.6 | " | " | " | 160.7 | 319.5 | 1367.2 | " |
| 1933-34 | " | " | " | " | " | " | " | " | " | 220.7 | 411.0 | 1033.0 | 1608.4 | " |
| 1934-35 | " | " | " | " | " | " | " | " | " | 160.7 | 160.7 | 440.9 | 1235.3 | " |
| 1935-36 | " | " | " | " | " | " | 678.4 | " | " | 169.5 | 311.9 | 956.4 | 1707.2 | " |
| 1936-37 | " | " | " | " | " | " | 917.0 | 631.5 | 631.5 | 631.5 | 631.5 | 818.6 | 1426.6 | " |
| 1937-38 | " | " | " | " | " | " | 709.8 | 283.6 | 237.3 | 237.3 | 237.3 | 612.6 | 1430.8 | " |
| 1938-39 | " | " | " | " | " | " | 697.5 | 266.7 | 214.1 | 214.1 | 292.9 | 900.3 | 1411.4 | " |
| 1939-40 | " | " | " | " | " | " | 736.7 | 309.5 | 272.6 | 272.6 | 272.6 | 787.1 | 1458.9 | " |
| 1940-41 | " | " | " | " | " | " | 842.6 | 489.6 | 489.6 | 489.6 | 489.6 | 800.3 | 1417.6 | " |
| 1941-42 | " | " | " | " | " | " | 797.8 | 405.2 | 403.9 | 403.9 | 403.9 | 681.4 | 1227.2 | " |
| 1942-43 | " | " | " | " | " | " | 805.7 | 419.3 | 419.3 | 465.1 | 586.7 | 884.9 | 1381.6 | " |
| 1943-44 | " | " | " | " | " | " | 1009.2 | 800.5 | 800.5 | 800.5 | 800.5 | 945.9 | 1511.0 | " |
| 1944-45 | " | " | " | " | " | " | 933.4 | 662.3 | 662.3 | 662.3 | 662.3 | 891.1 | 1523.5 | " |
| 1945-46 | " | " | " | " | " | " | 669.6 | 228.0 | 160.7 | 160.7 | 193.8 | 883.0 | 1708.7 | " |
| 1946-47 | " | " | " | " | " | " | " | " | " | " | 222.2 | 820.1 | 1600.8 | " |
| 1947-48 | " | " | " | " | " | " | 678.4 | " | " | " | 160.7 | 688.2 | 1647.3 | " |
| 1948-49 | " | " | " | " | " | " | 900.3 | 599.4 | 599.4 | 599.4 | 651.3 | 1230.6 | 1726.8 | " |
| 1949-50 | " | " | " | " | " | " | 669.6 | 228.0 | 160.7 | 160.7 | 160.7 | 258.1 | 1166.3 | " |
| 1950-51 | " | " | " | " | " | " | " | " | " | " | " | 713.7 | 1371.6 | " |
| 1951-52 | " | " | " | " | " | " | 678.4 | " | " | " | 279.2 | 791.5 | 1525.9 | " |
| 1952-53 | " | " | " | " | " | " | 669.6 | " | " | " | 160.7 | 461.9 | 1206.7 | " |
| 1953-54 | " | " | " | " | " | " | " | " | " | " | " | 617.8 | 1319.2 | " |
| 1954-55 | " | " | " | " | " | " | " | " | " | " | " | 160.3 | 1131.8 | " |
| 1955-56 | " | " | " | " | " | " | 678.4 | " | " | " | " | 722.7 | 1613.0 | " |
| 1956-57 | " | " | " | " | " | " | 669.6 | " | " | " | 174.2 | 977.4 | 1726.8 | " |
| 1957-58 | " | " | " | " | " | " | " | " | " | " | 162.2 | 909.9 | " | " |

TABLE 10M
(Metric Units)
COMPOSITE OPERATING RULE CURVES
FOR THE WHOLE OF CANADIAN TREATY STORAGE
END OF PERIOD TREATY STORAGE CONTENTS (hm³)
2018 - 19 ASSURED OPERATING PLAN

| <u>YEAR</u> | <u>AUG15</u> | <u>AUG31</u> | <u>SEP</u> | <u>OCT</u> | <u>NOV</u> | <u>DEC</u> | <u>JAN</u> | <u>FEB</u> | <u>MAR</u> | <u>APR15</u> | <u>APR30</u> | <u>MAY</u> | <u>JUN</u> | <u>JUL</u> |
|-------------|--------------|--------------|------------|------------|------------|------------|------------|------------|------------|--------------|--------------|------------|------------|------------|
| 1928-29 | 19119.2 | 19119.2 | 18348.3 | 17421.3 | 16191.1 | 12631.6 | 8315.5 | 4297.9 | 4119.8 | 4392.1 | 4992.0 | 9898.5 | 16451.7 | 19119.2 |
| 1929-30 | " | " | " | " | " | " | 5403.8 | 4235.8 | 3894.7 | 4131.1 | 4967.8 | " | 16087.9 | " |
| 1930-31 | " | " | " | " | " | " | 6637.6 | 4297.9 | 4119.8 | 4392.1 | 4992.0 | " | 16138.0 | " |
| 1931-32 | " | " | " | " | " | " | 2207.6 | 764.3 | 554.2 | 548.3 | 1486.8 | 7407.6 | 14902.7 | " |
| 1932-33 | " | " | " | " | " | " | 2066.6 | 1329.2 | 1231.1 | 1191.5 | 1920.3 | 6991.2 | 13998.0 | " |
| 1933-34 | " | " | " | " | " | " | 2119.5 | 235.4 | 147.3 | 182.0 | 681.6 | 8099.0 | 16188.2 | " |
| 1934-35 | " | " | " | " | " | " | 3532.6 | 2901.4 | 3066.3 | 3143.4 | 3784.6 | 8553.3 | 14860.4 | " |
| 1935-36 | " | " | " | " | " | " | 3185.5 | 2304.7 | 2108.2 | 1999.1 | 2729.2 | 8732.2 | 16220.2 | " |
| 1936-37 | " | " | " | " | " | " | 8315.5 | 4297.9 | 4119.8 | 4392.1 | 4992.0 | 9898.5 | 16451.7 | " |
| 1937-38 | " | " | " | " | " | " | 4450.6 | 3585.0 | 3252.8 | 3456.3 | 4114.7 | 8754.7 | 15746.3 | " |
| 1938-39 | " | " | " | " | " | " | 5673.9 | 4297.9 | 4084.4 | 4340.3 | 4989.8 | 9898.5 | 16451.7 | " |
| 1939-40 | " | " | " | " | " | " | 4472.6 | 3738.9 | 3560.8 | 3792.7 | 4541.1 | " | 16308.8 | " |
| 1940-41 | " | " | " | " | " | " | 8069.9 | 4297.9 | 4119.8 | 4392.1 | 4992.0 | " | 16451.7 | " |
| 1941-42 | " | " | " | " | " | " | 7985.2 | " | " | " | " | 9169.6 | 14989.1 | " |
| 1942-43 | " | " | " | " | " | " | 8209.8 | " | " | " | " | 9898.5 | 16451.7 | " |
| 1943-44 | " | " | " | " | " | " | 8315.5 | " | " | " | " | " | " | " |
| 1944-45 | " | " | " | " | " | " | " | " | " | " | " | 9659.4 | " | " |
| 1945-46 | " | " | " | " | " | " | 2066.6 | 447.0 | 287.5 | 236.3 | 1056.2 | 6833.8 | 15224.5 | " |
| 1946-47 | " | " | " | " | " | " | 2822.9 | 1978.1 | 1882.4 | 1934.3 | 2928.8 | 8604.0 | 15656.5 | " |
| 1947-48 | " | " | " | " | " | " | 2352.9 | 1543.8 | 1453.0 | 1306.7 | 1983.7 | 7355.9 | 15197.5 | " |
| 1948-49 | " | " | " | " | " | " | 8315.5 | 4297.9 | 4119.8 | 4392.1 | 4992.0 | 9898.5 | 16451.7 | " |
| 1949-50 | " | " | " | " | " | " | 3015.7 | 2141.8 | 2031.4 | 1976.4 | 2697.4 | 7252.7 | 13740.8 | " |
| 1950-51 | " | " | " | " | " | " | 3603.6 | 2953.3 | 2707.7 | 2835.9 | 3671.9 | 8738.8 | 15940.6 | " |
| 1951-52 | " | " | " | " | " | " | 4888.8 | 4016.1 | 3697.8 | 3716.9 | 4505.2 | 9798.1 | 16271.8 | " |
| 1952-53 | " | " | " | " | " | " | 6496.0 | 4274.0 | 4031.0 | 4289.9 | 4857.7 | 9045.1 | 16098.4 | " |
| 1953-54 | " | " | " | " | " | " | 2066.6 | 162.2 | 12.5 | 25.9 | 744.7 | 6037.2 | 13632.2 | " |
| 1954-55 | " | " | " | " | " | " | 3891.1 | 3289.5 | 3317.3 | 3257.4 | 4074.3 | 7985.5 | 14045.2 | " |
| 1955-56 | " | " | " | " | " | " | 2150.6 | 1280.1 | 1155.3 | 1093.9 | 1898.6 | 7844.8 | 15385.9 | " |
| 1956-57 | " | " | " | " | " | " | 2689.5 | 1861.1 | 1800.9 | 1746.9 | 2591.7 | 7825.9 | 16451.7 | " |
| 1957-58 | " | " | " | " | " | " | 2156.2 | 965.7 | 985.0 | 1143.3 | 2140.5 | 7500.1 | 15744.1 | " |

TABLE 11M
(Metric Units)
COMPOSITE END STORAGE
FOR THE WHOLE OF CANADIAN STORAGE
END OF PERIOD TREATY STORAGE CONTENTS (hm³)
2018 - 19 ASSURED OPERATING PLAN

| YEAR | AUG15 | AUG31 | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR15 | APR30 | MAY | JUN | JUL |
|---------|---------|---------|---------|---------|---------|---------|--------|--------|--------|--------|--------|--------|---------|---------|
| 1928-29 | 19119.2 | 19119.2 | 18348.3 | 17710.2 | 16266.7 | 13301.9 | 8315.5 | 4180.0 | 3182.8 | 2932.0 | 3057.5 | 6719.3 | 15186.8 | 18716.0 |
| 1929-30 | 19103.8 | 18827.8 | 16455.8 | 14145.5 | 11170.2 | 8219.8 | 2986.6 | 500.6 | 0.0 | 289.4 | 1760.3 | 6319.8 | 13225.6 | 17449.6 |
| 1930-31 | 18369.3 | 18583.4 | 17245.3 | 15154.5 | 11935.2 | 8111.5 | 3730.6 | 798.3 | 0.0 | 11.7 | 0.2 | 3912.6 | 10437.9 | 12690.8 |
| 1931-32 | 12118.5 | 11533.0 | 9672.6 | 7618.2 | 3890.8 | 620.7 | 0.0 | 0.0 | 4.2 | 297.5 | 1127.4 | 5836.1 | 14248.8 | 18630.4 |
| 1932-33 | 18952.3 | 19119.2 | 16972.3 | 15540.1 | 15595.9 | 12631.6 | 7470.7 | 3438.7 | 1231.1 | 1072.8 | 1581.0 | 5862.3 | 13998.0 | 18891.7 |
| 1933-34 | 19119.2 | 19119.2 | 18348.3 | 17421.3 | 16191.1 | 12631.6 | 7657.1 | 3784.2 | 1883.4 | 1482.9 | 3003.7 | 8099.0 | 15197.3 | 18631.3 |
| 1934-35 | 19016.2 | 18818.8 | 16577.9 | 15038.8 | 15906.6 | 12631.6 | 7495.2 | 3824.8 | 3001.7 | 2701.3 | 3045.5 | 7572.5 | 14860.4 | 19119.2 |
| 1935-36 | 19119.2 | 19067.3 | 18099.9 | 16287.0 | 13851.9 | 10186.4 | 4848.4 | 2202.4 | 1236.8 | 1020.7 | 2139.3 | 8732.2 | 16220.2 | 18891.7 |
| 1936-37 | 19071.7 | 18815.3 | 16577.9 | 14434.2 | 11445.9 | 7957.1 | 2923.2 | 453.1 | 0.0 | 21.3 | 128.9 | 3781.0 | 11126.4 | 14629.9 |
| 1937-38 | 14611.1 | 14278.4 | 12558.6 | 11014.1 | 9506.3 | 7518.6 | 4450.6 | 3544.4 | 1910.3 | 1663.4 | 1438.4 | 6317.9 | 14083.1 | 18829.5 |
| 1938-39 | 18773.5 | 18693.5 | 17256.4 | 16171.8 | 13944.6 | 11437.9 | 6178.9 | 4235.6 | 3302.4 | 3381.2 | 3463.9 | 9898.5 | 14763.0 | 18891.7 |
| 1939-40 | 19104.5 | 18848.6 | 16720.3 | 15491.4 | 14153.1 | 12631.6 | 7434.7 | 3738.9 | 3114.5 | 3332.0 | 4101.0 | 9898.5 | 14809.0 | 17703.6 |
| 1940-41 | 17922.1 | 17730.3 | 16577.9 | 16398.3 | 13969.4 | 10912.3 | 6981.1 | 3783.4 | 3186.5 | 3716.9 | 4747.4 | 7497.1 | 11742.5 | 13981.3 |
| 1941-42 | 13600.9 | 13266.0 | 12417.5 | 13554.2 | 12482.6 | 12631.6 | 8033.2 | 4297.9 | 2670.7 | 2389.8 | 2151.8 | 6810.6 | 12585.3 | 18568.7 |
| 1942-43 | 19033.3 | 19012.5 | 17346.9 | 15707.2 | 15114.4 | 12631.6 | 8227.9 | 4297.9 | 3266.5 | 3441.9 | 3533.1 | 6867.6 | 12747.0 | 18891.7 |
| 1943-44 | 19119.2 | 19119.2 | 18182.6 | 17421.3 | 15910.7 | 12629.8 | 8275.9 | 4208.4 | 2955.7 | 2826.6 | 2872.8 | 5892.9 | 11185.6 | 13066.1 |
| 1944-45 | 12696.9 | 12198.5 | 10419.1 | 8949.2 | 5782.8 | 2472.8 | 499.4 | 0.0 | 0.0 | 2.0 | 0.0 | 4475.8 | 11735.1 | 15720.4 |
| 1945-46 | 15301.3 | 14843.3 | 13043.3 | 11391.4 | 9378.3 | 7277.4 | 2066.6 | 447.0 | 0.0 | 0.0 | 692.4 | 6678.7 | 15169.4 | 18891.7 |
| 1946-47 | 19119.2 | 19081.8 | 18348.3 | 17421.3 | 16191.1 | 12631.6 | 7268.4 | 3242.5 | 1882.4 | 1934.3 | 2928.8 | 8604.0 | 15656.5 | 19119.2 |
| 1947-48 | 19119.2 | 19062.9 | 18348.3 | 17421.3 | 16191.1 | 12631.6 | 7333.2 | 3089.6 | 1453.0 | 1193.7 | 1687.9 | 7355.9 | 15197.5 | 19119.2 |
| 1948-49 | 19119.2 | 19119.2 | 18348.3 | 17421.3 | 16191.1 | 12631.6 | 8315.5 | 4297.9 | 3335.0 | 3334.2 | 3683.8 | 9898.5 | 15594.1 | 18136.6 |
| 1949-50 | 18877.7 | 18776.2 | 16725.9 | 15475.5 | 15657.0 | 12631.6 | 7264.2 | 3197.0 | 2024.8 | 1875.1 | 2044.6 | 5509.7 | 13740.8 | 19119.2 |
| 1950-51 | 19119.2 | 19119.2 | 18348.3 | 17421.3 | 16191.1 | 12631.6 | 7465.1 | 3523.3 | 2440.2 | 2496.0 | 2832.7 | 8734.6 | 15155.0 | 18969.2 |
| 1951-52 | 19119.2 | 19119.2 | 18348.3 | 17421.3 | 16191.1 | 12631.6 | 7266.9 | 4016.1 | 2946.4 | 2785.2 | 3569.1 | 9372.4 | 16008.6 | 18891.7 |
| 1952-53 | 19119.2 | 19034.3 | 17637.1 | 15978.5 | 13558.1 | 10430.3 | 6655.2 | 4274.0 | 3254.0 | 2865.0 | 2435.8 | 7028.6 | 14251.0 | 18891.7 |
| 1953-54 | 19096.0 | 19119.2 | 18348.3 | 17421.3 | 16191.1 | 12631.6 | 7412.0 | 3521.6 | 1355.4 | 526.5 | 606.0 | 6037.2 | 13632.2 | 19119.2 |
| 1954-55 | 19119.2 | 19119.2 | 18348.3 | 17421.3 | 16191.1 | 12631.6 | 7529.2 | 3584.0 | 2613.9 | 2532.2 | 2235.2 | 5069.1 | 14045.2 | 18891.7 |
| 1955-56 | 19119.2 | 19119.2 | 18348.3 | 17421.3 | 16191.1 | 12631.6 | 7396.1 | 3176.4 | 1155.3 | 1074.5 | 1898.6 | 7844.8 | 15385.9 | 18891.7 |
| 1956-57 | 19033.3 | 19119.2 | 18348.3 | 17421.3 | 16191.1 | 12631.6 | 7316.3 | 3275.8 | 1800.9 | 1722.2 | 2175.0 | 7825.9 | 16421.6 | 18891.7 |
| 1957-58 | 19009.1 | 18804.3 | 16940.7 | 16178.9 | 14835.2 | 12631.6 | 7388.2 | 3474.7 | 1205.9 | 1143.3 | 1606.7 | 7500.1 | 15744.1 | 18891.7 |
| Max | 19119.2 | 19119.2 | 18348.3 | 17710.2 | 16266.7 | 13301.9 | 8315.5 | 4297.9 | 3335.0 | 3716.9 | 4747.4 | 9898.5 | 16421.6 | 19119.2 |
| Median | 19083.8 | 19023.4 | 17301.6 | 16175.3 | 15355.1 | 12631.6 | 7324.8 | 3522.5 | 1896.8 | 1798.6 | 2163.4 | 6948.1 | 14507.0 | 18891.7 |
| Average | 18104.1 | 17986.2 | 16642.0 | 15462.4 | 13875.6 | 10860.4 | 6206.2 | 3013.6 | 1880.5 | 1802.2 | 2218.3 | 7065.1 | 14138.5 | 17970.9 |
| Min | 12118.5 | 11533.0 | 9672.6 | 7618.2 | 3890.8 | 620.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3781.0 | 10437.9 | 12690.8 |

TABLE 12M
(Metric Units)
COMPARISON OF RECENT ASSURED OPERATING PLAN STUDIES

| | 2010-11 | 2011-12 through 2013-14 1/ | 2014-15 | 2015-16 through 2016-17 3/ | 2017-18 through 2018-19 4/ |
|--|--------------|----------------------------------|--------------|----------------------------------|----------------------------------|
| MICA TARGET OPERATION (hm³ or m³/s) | | | | | |
| AUG 15 | 8414.3 | 8230.9 | 8267.6 | 8267.6 | 8548.7 |
| AUG 31 | FULL | FULL | FULL | FULL | FULL |
| SEP | FULL | FULL | FULL | FULL | FULL |
| OCT | 8387.9 | 8387.9 | 8387.9 | 8328.5 | 8328.5 |
| NOV | 594.7 | 594.7 | 623.0 | 594.7 | 538.0 |
| DEC | 707.9 | 707.9 | 623.0 | 481.4 | 651.3 |
| JAN | 764.6 | 679.6 | 679.6 | 679.6 | 679.6 |
| FEB | 594.7 | 594.7 | 594.7 | 736.2 | 651.3 |
| MAR | 594.7 | 481.4 | 707.9 | 707.9 | 283.2 |
| APR 15 | 623.0 | 566.3 | 481.4 | 594.7 | 424.8 |
| APR 30 | 283.2 | 283.2 | 283.2 | 283.2 | 283.2 |
| MAY | 226.5 | 226.5 | 226.5 | 226.5 | 226.5 |
| JUN | 226.5 | 226.5 | 283.2 | 226.5 | 226.5 |
| JUL | 8482.9 | 8482.9 | 8482.9 | 8407.0 | 8407.0 |
| COMPOSITE CRC1 CANADIAN TREATY STORAGE CONTENT (hm³) | | | | | |
| 1928 AUG 31 | 19069.0 | 19118.7 | 19119.2 | 19119.2 | 19119.2 |
| 1928 DEC | 12443.4 | 12732.1 | 12923.2 | 12459.3 | 13301.9 |
| 1929 APR15 | 2564.5 | 2653.1 | 2637.9 | 2506.5 | 2932.0 |
| 1929 JUL | 17696.7 | 17933.1 | 18351.7 | 18559.7 | 18716.0 |
| COMPOSITE CANADIAN TREATY STORAGE CONTENT (hm³) 2/ | | | | | |
| AUG 31 | 18197.7 | 18013.8 | 18121.4 | 18142.3 | 18070.3 |
| DEC | 11286.0 | 11327.8 | 11363.5 | 10985.5 | 11069.5 |
| APR15 | 2061.6 | 2222.9 | 2175.9 | 1752.5 | 1984.2 |
| JUL | 17784.1 | 17486.1 | 17811.0 | 17869.5 | 18077.2 |
| STEP I GAINS AND LOSSES DUE TO REOPERATION (MW) | | | | | |
| U.S. Firm Energy | -0.3 | 0.1 | 0.0 | 0.0 | -0.5 |
| U.S. Dependable Peaking Capacity 5/ | -19.1 | -22.9 | -3.9 | -2.1 | 6.9 / 35.3 |
| U.S. Average Annual Usable Secondary Energy | 16.0 | 21.6 | 21.3 | 17.6 | 22.7 |
| BCH Firm Energy | 34.4 | 43.6 | 44.0 | 24.0 | 18.6 |
| BCH Dependable Peaking Capacity | 43.8 | 41.7 | 47.8 | 28.2 | 37.2 |
| BCH Average Annual Usable Secondary Energy | -20.8 | -13.9 | -33.4 | -16.2 | -24.1 |
| COORDINATED HYDRO LOAD (MW) | | | | | |
| AUG 15 | 11138 | 10969 | 11187 | 11367 | 12028 |
| AUG 31 | 11167 | 11104 | 10971 | 10944 | 11399 |
| SEP | 11025 | 11081 | 9756 | 9822 | 10207 |
| OCT | 9958 | 9920 | 9758 | 10051 | 9233 |
| NOV | 11333 | 11458 | 11821 | 12152 | 11434 |
| DEC | 13369 | 13316 | 13836 | 13744 | 13523 |
| JAN | 13076 | 12878 | 13323 | 13933 | 13862 |
| FEB | 11902 | 11721 | 13179 | 12876 | 13006 |
| MAR | 10967 | 10501 | 12022 | 11269 | 11264 |
| APR 15 | 10241 | 9786 | 10476 | 10894 | 9583 |
| APR 30 | 12475 | 11502 | 11012 | 11600 | 10684 |
| MAY | 13493 | 13287 | 12198 | 12166 | 12344 |
| JUN | 14080 | 13867 | 12208 | 11291 | 11314 |
| JUL | <u>12725</u> | <u>12531</u> | <u>11954</u> | <u>11812</u> | <u>12256</u> |
| ANNUAL AVERAGE | 12039 | 11856 | 11819 | 11794 | 11689 |

1/ The AOP 2013-14 and 2012-13 utilize the same system regulation study as the 2011-12.

2/ Prior to AOP15, average content based on 60 years of modified flow s. AOP15 through AOP17 averages based on 70 years of modified flow s. AOP18 and AOP19 averages based on 80 years of modified flow s.

3/ The AOP 2016-17 utilizes the same Step 1 system regulation studies as used in the AOP 2015-16, so these coordinated hydro loads will be used for the DOP17 TSR unless otherwise agreed.

4/ The AOP 2018-19 utilizes the same Step 1 system regulation studies as used in the AOP 2017-18, so these coordinated hydro loads will be used for the DOP19 TSR unless otherwise agreed.

5/ Due to changes between the AOP 2017-18 and the AOP 2018-19 peak load shape, the period in which the U.S. system dependable peaking capability was determined changed from 15 August 1931 to January 1932.

Appendix A
Project Operating Procedures for the 2018-19
Assured Operating Plan and Determination of Downstream Power Benefits

Definition of split months: Apr=Apr.1-30, Apr.15=Apr.1-Apr.15, Apr30=Apr.15-Apr.30; Aug=Aug.1-31, Aug.15=Aug.1-15, Aug.31=Aug.16-31.

| <u>Project</u> | <u>Requirements</u> | | | | |
|--------------------------|------------------------|----------------|---------------|--|--|
| <u>Name (Number)</u> | <u>Constraint Type</u> | <u>English</u> | <u>Metric</u> | <u>Explanation</u> | <u>Source</u> |
| <u>Canadian Projects</u> | | | | | |
| Mica (1890) | Minimum Flow | 3000 cfs | 85.0 m³/s | | In place in AOP79, AOP80, AOP84. |
| Arrow (1831) | Minimum Flow | 5000 cfs | 141.6 m³/s | | In place in AOP79, AOP80, AOP84. |
| Duncan (1681) | Draft Rate Limit | 1.0 ft/day | 0.30 m/day | | |
| | Minimum Flow | 100 cfs | 2.8 m³/s | | In place in AOP79, AOP80, AOP84. |
| | Maximum Flow | 10000 cfs | 283.2 m³/s | | |
| | Draft Rate Limit | 1.0 ft/day | 0.30 m/day | | |
| | Other | | | Remove 5-step logic of Operate to meet IJC orders for Corra Linn. | CRTOC agreement on to remove 5-step logic procedures to implement 1938 IJC order. 2012 |
| <u>Base System</u> | | | | | |
| Hungry Horse (1530) | Minimum Flow | 400 cfs | 11.3 m³/s | Minimum project discharge. | In place in AOP79, AOP80, AOP84. |
| | Maximum Flow | 9500 cfs | 269.0 m³/s | Step 1 only | |
| | Minimum Content | | | None | |
| | Other | | | No VECC limit. | VECC limit not in place in AOP79. |
| Kerr (1510) | Minimum Flow | 1500 cfs | 42.5 m³/s | All periods | In place in AOP80, AOP84. |
| | Maximum Flow | | | None | |
| | Minimum Content | 614.7 ksfd | 1503.9 hm³ | Jun - Sep | MPC 2-1-92, PNCA submittal similar operation, Jun-Aug 15, in AOP80. |
| | | 2893.0 ft | 881.79 m | | |
| | | 426.3 ksfd | 1043 hm³ | May | |
| | | 2890.0 ft | 880.9 m | | |
| | | 0.0 ksfd | 0 hm³ | Empty Apr 15 | FERC, AOP80. |
| | | 2883.0 ft | 878.74 m | | |
| | Maximum Content | 58.6 ksfd | 143.37 hm³ | March | In place in AOP80, AOP84. |
| | | 2884.0 ft | 879.04 m | (Included to help meet the Apr 15 FERC requirement.) | |
| | Other | 0.0 ksfd | 0 hm³ | Conditions permitted, should be on or about, empty Mar and Apr 15. | FERC, AOP80. |
| | | 2883.0 ft | 878.74 m | | |
| Thompson Falls (1490) | | | | None Noted | |

Appendix A
Project Operating Procedures for the 2018-19
Assured Operating Plan and Determination of Downstream Power Benefits

| <u>Project</u> <u>Name (Number)</u> | <u>Constraint Type</u> | <u>Requirements</u> | | <u>Explanation</u> | <u>Source</u> |
|--|--|--|-------------------------|--|--|
| | | <u>English</u> | <u>Metric</u> | | |
| Noxon Rapids (1480) | Minimum Content For Step I: | 116.3 ksfd | 284.54 hm ³ | May - Aug 31, | In place in AOP84, similar operation in AOP80. |
| | | 2331.0 ft | 710.49 m | | |
| | | 112.3 ksfd | 274.75 hm ³ | Sep - Jan, | |
| | | 2330.0 ft | 710.18 m | | |
| | | 78.7 ksfd | 192.55 hm ³ | Feb, | |
| | | 2321.0 ft | 707.44 m | | |
| | | 26.5 ksfd | 64.834 hm ³ | Mar, | |
| | | 2305.0 ft | 702.56 m | | |
| | | 0.0 ksfd | 0 hm ³ | Empty Apr 15, Apr 30, and for end of CP. | |
| | | 2295.0 ft | 699.52 m | | |
| | Minimum & Maximum Content For Steps II & III: | 116.3 ksfd | 284.54 hm ³ | All periods | In place in AOP79, AOP84. |
| | | 2331.0 ft | 710.49 m | | |
| Cabinet Gorge (1475) | | | | None Noted | |
| Albeni Falls (1465) | Minimum Flow | 4000 cfs | 113.3 m ³ /s | All periods | In place in AOP80, AOP84. |
| | Minimum Content | (Dec may fill on restriction, note below) | | | In place in AOP80, AOP84. |
| | | 582.4 ksfd | 1424.9 hm ³ | Jun - Aug 31 | |
| | | 2062.5 ft | 628.65 m | | |
| | | 465.7 ksfd | 1139.4 hm ³ | Sep | |
| | | 2060.0 ft | 627.89 m | | |
| | | 190.4 ksfd | 465.83 hm ³ | Oct | |
| | | 2054.0 ft | 626.06 m | | |
| | | 57.6 ksfd | 140.92 hm ³ | Nov-Apr 15 (empty at end of CP) | |
| | | 2051.0 ft | 625.14 m | | |
| | | 190.4 ksfd | 465.83 hm ³ | Apr 30 | |
| | | 2054.0 ft | 626.06 m | | |
| | | 279.0 ksfd | 682.59 hm ³ | May | |
| | | 2056.0 ft | 626.67 m | | |
| | For Steps I & II: | Optimum to run CP & LT to Jun-Oct SMINs. | | | |
| | For Step III: | Keep full at beginning of CP. Often (not always) optimum to run higher than SMIN in CP & LT (except when occasionally drafting below SMIN to meet load). | | | |
| | | 57.6 ksfd | 140.9 hm ³ | Nov - Mar | |
| | | 2051.0 ft | 625.14 m | | |
| | | 458.4 ksfd | 1121.5 hm ³ | May | |
| | | 2059.8 ft | 627.8 m | | |
| | | 582.4 ksfd | 1424.9 hm ³ | Sep | |
| | | 2062.5 ft | 628.7 m | | |
| | | 465.7 ksfd | 1139.4 hm ³ | Oct | |
| | | 2060.0 ft | 627.89 m | | |

Appendix A
Project Operating Procedures for the 2018-19
Assured Operating Plan and Determination of Downstream Power Benefits

| Project | Requirements | | | | |
|------------------------------------|----------------------|-------------|---|---|--|
| Name (Number) | Constraint Type | English | Metric | Explanation | Source |
| Albeni Falls (1465) (Continued) | Kokanee Spawning | 1.0 ft | 0.30 m | Draft limit below Nov. 20th Elevation through Dec. 31st. | In place before AOP80 and supported by minimum contents noted above. |
| | | 0.5 ft | 0.15 m | If project fills, draft no more than this amount. | |
| | | | Dec. 31 - Mar 31, operate between SMIN and URC within above noted draft limits. | | |
| | Other Spill | 50 cfs | 1.4 m³/s | All periods None Noted | |
| Grand Coulee (1280) | Minimum Flow | 30000 cfs | 849.5 m³/s | All periods | In place in AOP79, AOP80, AOP84. |
| | Minimum Content | 0.0 ksfd | 0.0 hm³ | Empty at end of CP. | |
| | Step I only: | 1208.0 ft | 368.20 m | May and June | Retain as a power operation (for pumping). |
| | | 843.7 ksfd | 2064.2 hm³ | | |
| | Steps II & III only: | 1240.0 ft | 377.95 m | May and June | |
| | | 868.8 ksfd | 2125.6 hm³ | | |
| | | 1240.0 ft | 378.0 m | | |
| | Maximum Content | | | | |
| | Step I only: | 2.0 ft | 0.61 m | Operating room Sep - Nov | In place in AOP89 Retain as a power operation. |
| | | 3.0 ft | 0.91 m | Operating room Dec - Feb | |
| | Steps II & III only: | 2557.1 ksfd | 6256.1 hm³ | Aug-Nov | |
| | | 1288.0 ft | 392.58 m | Dec-Feb | |
| 2518.3 ksfd | | 6161.2 hm³ | | | |
| 1287.0 ft | | 392.28 m | | | |
| Draft Rate Limit | 1.3 ft/day | 0.40 m/day | (bank sloughage) | | |
| | 1.5 ft/day | 0.46 m/day | (Constraint submitted as 1.5 ft/day interpreted as 1.3 ft/day mo.ave.) | | |
| Chief Joseph (1270) | Other Spill | 500 cfs | 14.2 m³/s | All periods | |
| Wells (1220) | Other Spill | 1000 cfs | 28.3 m³/s | All periods | 2/1/05 C. Wagers, Douglas With fish ladder |
| | Fish Spill | | | None | |
| Rocky Reach (1200) | Fish Spill/Bypass | | | None | |
| | Other Spill | 200 cfs | 5.7 m³/s | Aug 31 - Apr 15 (leakage) | |
| Rock Island (1170) | Fish Spill/Bypass | | | None | |
| Wanapum (1165) | Fish Spill/Bypass | | | None | |
| | Other Spill | 2200 cfs | 62.3 m³/s | All periods | With fish ladder |

Appendix A
Project Operating Procedures for the 2018-19
Assured Operating Plan and Determination of Downstream Power Benefits

| <u>Project</u> <u>Name (Number)</u> | <u>Constraint Type</u> | <u>Requirements</u> | | <u>Explanation</u> | <u>Source</u> |
|--|-------------------------|------------------------|---|---|------------------------------------|
| | | <u>English</u> | <u>Metric</u> | | |
| Priest Rapids (1160) | Minimum Flow | | | Limit removed | |
| | Fish Spill/Bypass | | | None | |
| | Other Spill | 2200 cfs | 62.3 m ³ /s | All periods | With fish ladder |
| Brownlee (767) | Minimum Flow | 0 cfs | 0.0 m ³ /s | All years, all periods in CP & LT studies. | 4-04 C. Henriksen |
| | Downstream Minimum Flow | 6500 cfs | 184.1 m ³ /s | All periods for navigation requirement downstream at Hells Canyon (project #762). Draft Brownlee to help meet this requirement in CP and LT studies. | |
| | Power Operation | | | Agree to use similar "historic" power operation (rule curves) provided by IPC and used in AOP since AOP97 for CP. | 2-1-91 PNCA submittal |
| | | | | Optimizer was used in the Step I critical period study to get a starting point for Brownlee operations. Results were then modified to follow the general shape of the "historic" shape for power with the exception of going empty at the end of the critical period. To the extent possible, CRC1 is used in every year. Step II/III studies will use the same operation, except as needed to start critical periods full and end empty. | 5-12 P. Kingsbury, T. Downen (BPA) |
| Oxbow (765) | Other Spill | 100 cfs | 2.8 m ³ /s | All periods | |
| Ice Harbor (502) | Fish Spill/Bypass | | | None | |
| | Other Spill | 740 cfs | 21.0 m ³ /s | All periods | |
| | Incremental Spill | | | None | |
| | Minimum Flow | | | None | |
| | Other | 204.8 ksf 440.0 ft | 83.7 hm ³ 134.11 m | Run at all periods | |
| McNary (488) | Other Spill | 3475 cfs | 98.4 m ³ /s | All periods | |
| | Incremental Spill | | | None | |
| John Day (440) | Fish Spill/Bypass | | | None | |
| | Other Spill | 800 cfs | 22.7 m ³ /s | All periods | |
| | Incremental Spill | | | None | |
| | Minimum Flow | 50000 cfs 12500 cfs | 1415.8 m ³ /s 354.0 m ³ /s | Mar - Nov Dec - Feb | |

Appendix A
Project Operating Procedures for the 2018-19
Assured Operating Plan and Determination of Downstream Power Benefits

| <u>Project</u> <u>Name (Number)</u> | <u>Constraint Type</u> | <u>Requirements</u> | | <u>Explanation</u> | <u>Source</u> |
|--|------------------------|------------------------|----------------------------------|---|---|
| | | <u>English</u> | <u>Metric</u> | | |
| John Day (440) (Continued) | Other Step I: | 269.7 ksf | 659.8 hm ³ | June - Aug 15 | In place AOP80 |
| | | 268.0 ft | 81.69 m | | |
| | | 242.5 ksf | 593.3 hm ³ | Aug 31 - Sep | |
| | | 267.0 ft | 81.38 m | | |
| | | 153.7 ksf | 376.0 hm ³ | Oct - Mar | |
| | | 263.6 ft | 80.35 m | | |
| | | 114.9 ksf | 281.1 hm ³ | Apr - May | |
| | | 262.0 ft | 79.86 m | | |
| | Steps II & III: | 190.0 ksf | 464.8 hm ³ | Use JDA as run-of-river plant. | |
| | | 265.0 ft | 80.77 m | | |
| The Dalles (365) | Fish Spill/Bypass | | | None | |
| | Other Spill | 1300 cfs | 36.8 m ³ /s | All periods | |
| | Incremental Spill | | | None | |
| | Minimum Flow | 50000 cfs | 1415.8 m ³ /s | Mar - Nov | |
| | | 12500 cfs | 354.0 m ³ /s | Dec - Feb | |
| Bonneville (320) | Fish Spill/Bypass | | | None | |
| | Other Spill | 8040 cfs | 227.7 m ³ /s | All periods | |
| | Incremental Spill | | | None | |
| Kootenay Lake (Corra Linn (1665)) | Minimum Flow | 5000 cfs | 141.6 m ³ /s | All periods | BCHydro agreements 1969. |
| | Other | | | Remove 5-step logic of Operate to meet IJC orders for Corra Linn. | CRTOC agreement on to remove 5-step logic procedures to implement 1938 IJC order. |
| Chelan (1210) | Minimum Flow | 50 cfs | 1.4 m ³ /s | All periods | In place in AOP79, AOP80, AOP84 |
| | Minimum Content | 308.5 ksf | 126.1 hm ³ | Jul - Sep (except as needed to empty at end of critical period). | In place in AOP79, AOP80, AOP84 |
| | | 1098.0 ft | 334.7 m | | |
| Coeur d'Alene L (1341) | Minimum Flow | 50 cfs | 1.4 m ³ /s | All periods | In place in AOP79. |
| | Minimum Content | 112.5 ksf 2128.0 ft | 275.2 hm ³ 648.6 m | May - Aug Flood control may override these minimum contents. | 2-1-00 PNCA submittal |
| Post Falls (1340) | Minimum Flow | 50 cfs | 1.4 m ³ /s | All periods | In place in AOP79, AOP80, AOP84. |
| <u>Other Major Step I Projects</u> | | | | | |
| Libby (1760) | Minimum Flow | 4000 cfs | 113.3 m ³ /s | All periods | |
| | Other Spill | 200 cfs | 5.7 m ³ /s | All periods | |

Appendix A
Project Operating Procedures for the 2018-19
Assured Operating Plan and Determination of Downstream Power Benefits

| Project | | Requirements | | | |
|-----------------------------|-----------------|----------------------------------|------------------------|---|--|
| Name (Number) | Constraint Type | English | Metric | Explanation | Source |
| Libby (1760) (Continued) | Minimum Content | By | | | |
| | | 776.9 ksfd | 1900.7 hm ³ | 1929 Dec | 2-1-93 PNCA submittal, in plac in AOP99. |
| | | 2363.0 ft | 720.24 m | | |
| | | 676.5 ksfd | 1655.1 hm ³ | 1929 Jan | |
| | | 2355.0 ft | 717.80 m | | |
| | | 603.6 ksfd | 1476.8 hm ³ | 1929 Feb | |
| | | 2349.0 ft | 715.98 m | | |
| | | 2147.7 ksfd | 5254.5 hm ³ | 1929 Jul | |
| | | 2443.0 ft | 744.63 m | | |
| | | 652.0 ksfd | 1595.2 hm ³ | 1930 Dec | |
| | | 2353.0 ft | 717.19 m | | |
| | | 433.2 ksfd | 1059.9 hm ³ | 1930 Jan | |
| | | 2334.0 ft | 711.40 m | | |
| | | 389.3 ksfd | 952.5 hm ³ | 1930 Feb | |
| | | 2330.0 ft | 710.18 m | | |
| | | 348.5 ksfd | 852.6 hm ³ | 1930 Mar | |
| | | 2326.0 ft | 708.96 m | | |
| | | 297.4 ksfd | 727.6 hm ³ | 1930 Apr 15 | |
| | | 2321.0 ft | 707.44 m | | |
| | | 444.2 ksfd | 1086.8 hm ³ | 1930 Apr 30 | |
| | | 2335.0 ft | 711.71 m | | |
| | | 499.1 ksfd | 1221.1 hm ³ | 1930 May | |
| | | 2340.0 ft | 713.23 m | | |
| | | 1344.6 ksfd | 3289.7 hm ³ | 1930 Jun | |
| | | 2402.0 ft | 732.13 m | | |
| | | 1771.9 ksfd | 4335.1 hm ³ | 1930 Jul | |
| | | 2425.0 ft | 739.14 m | | |
| | | 317.8 ksfd | 777.5 hm ³ | 1931 Dec | |
| | | 2323.0 ft | 708.05 m | | |
| | | 192.2 ksfd | 470.2 hm ³ | 1931 Jan | |
| | | 2310.0 ft | 704.09 m | | |
| | | 103.1 ksfd | 252.2 hm ³ | 1931 Feb-Apr 30 | |
| | | 2300.0 ft | 701.04 m | | |
| | | 192.2 ksfd | 470.2 hm ³ | 1931 May | |
| | | 2310.0 ft | 704.09 m | | |
| | | 676.5 ksfd | 1655.1 hm ³ | 1931 Jun | |
| | | 2355.0 ft | 717.80 m | | |
| | | 868.0 ksfd | 2123.6 hm ³ | 1931 Jul | |
| | | 2370.0 ft | 722.38 m | | |
| | | 174.4 ksfd | 426.7 hm ³ | 1932 Dec | |
| | | 2308.0 ft | 703.48 m | | |
| | | 103.1 ksfd | 252.2 hm ³ | 1932 Jan | |
| | | 2300.0 ft | 701.04 m | | |
| | | 0.0 ksfd | 0.0 hm ³ | Empty at end of CP*** | |
| | | 2287.0 ft | 697.08 m | | |
| | | 776.9 ksfd | 1900.7 hm ³ | All Dec | |
| | | 2363.0 ft | 720.24 m | | |
| | | 373.1 ksfd | 152.5 hm ³ | July 1930 - No more than this amount lower than July 1929. | 2-1-94 PNCA submittal, in place in AOP00 and AOP01. |
| | | 857.1 ksfd | 350.3 hm ³ | July 1931 - No more than this amount lower than July 1930. | |
| | | March - Implement PNCA 6(c)2(c). | | | |

Appendix A
Project Operating Procedures for the 2018-19
Assured Operating Plan and Determination of Downstream Power Benefits

| <u>Project</u> <u>Name (Number)</u> | <u>Constraint Type</u> | <u>Requirements</u> | | <u>Explanation</u> | <u>Source</u> |
|---|------------------------|--|-------------------------|--|--|
| | | <u>English</u> | <u>Metric</u> | | |
| Libby (1760) (Continued) | Max Summer Draft | 5 ft | 1.5 m | | |
| | Other | | | Remove 5-step logic of Operate to meet IJC orders for Corra Linn. | CRTOC agreement on to remove 5-step logic procedures to implement 1938 IJC order. 2012 |
| Dworshak (535) | Minimum Flow | 1600 cfs | 45.3 m ³ /s | All periods | 2-1-12 PNCA submittal (1500 cfs powerhouse/100 cfs hatchery water supply) |
| | Maximum Flow | 14000 cfs | 396.4 m ³ /s | All periods (model includes maximum 14000 cfs for all periods, but URC may override.) | 2-1-02 PNCA submittal |
| | | 25000 cfs | 707.9 m ³ /s | Up to 25 kcfs for flood control all periods. | |
| | Start CP at: | 497 ksfd | 1215.9 hm ³ | Aug 15 | |
| | End CP at: | 218.4 ksfd | 534.3 hm ³ | Feb | |
| | Other | Run on minimum flow or flood control observing maximum & minimum flow requirements Oct-May and meets target operation Jun-Sep to obtain uniform outflows Jul-Aug | | | 2-1-05 PNCA submittal |
| | Target Operation: | | | | Target Elev based on 2010 modified flows and new 80 yr Flood Control data |
| | | 780.9 ksfd | 1910.5 hm ³ | Jul | |
| | | 1573.4 ft | 479.57 m | | |
| | | 652.6 ksfd | 1596.6 hm ³ | Aug 15 | |
| | | 1556.8 ft | 474.51 m | | for Jul-Aug 15 and Sep based use 80-yr Median May 2012 |
| | | 497 ksfd | 1215.9 hm ³ | Aug 31 | |
| | | 1535 ft | 467.87 m | | |
| | | 389.4 ksfd | 952.7 hm ³ | Sep | |
| | | 1519 ft | 462.99 m | | |
| | | 1016 ksfd | 2485.7 hm ³ | Jun | |
| | | 1600 ft | 487.68 m | | |
| | Other Spill | 100 cfs | 2.8 m ³ /s | All periods | |
| Lower Granite (520) | Bypass Date | | | None | |
| | Other Spill | 450 cfs | 12.7 m ³ /s | Jul | 2-1-09 PNCA submittal |
| | | 510 cfs | 14.4 m ³ /s | 15-Aug | |
| | | 470 cfs | 13.3 m ³ /s | 30-Aug | |
| | | 480 cfs | 13.6 m ³ /s | Sep | |
| | | 530 cfs | 15.0 m ³ /s | Oct | |
| | | 410 cfs | 11.6 m ³ /s | Nov | |
| | | 340 cfs | 9.6 m ³ /s | Dec | |
| | | 100 cfs | 2.8 m ³ /s | Jan | |
| | | 130 cfs | 3.7 m ³ /s | Feb | |
| | | 230 cfs | 6.5 m ³ /s | Mar | |
| | | 420 cfs | 11.9 m ³ /s | 15-Apr | |
| | | 440 cfs | 12.5 m ³ /s | Apr 30 - May | |
| | | 460 cfs | 13.0 m ³ /s | Jun | |

Appendix A
Project Operating Procedures for the 2018-19
Assured Operating Plan and Determination of Downstream Power Benefits

| <u>Project</u> <u>Name (Number)</u> | <u>Constraint Type</u> | <u>Requirements</u> | | <u>Explanation</u> | <u>Source</u> |
|--|---------------------------------|---------------------|--------------------------|---|-----------------------|
| | | <u>English</u> | <u>Metric</u> | | |
| Lower Granite (520) (Continued) | Incremental Spill Fish Spill | | | Removed | |
| | | 17333 cfs | 490.8 m ³ /s | Apr 15 [20 kcfs for 13 days] | 2-1-12 PNCA submittal |
| | | 20000 cfs | 566.3 m ³ /s | Apr 30 - May [20 kcfs] | 2-1-12 PNCA submittal |
| | | 19333 cfs | 547.4 m ³ /s | June [20 kcfs through June 21 then 18 kcfs] | 2-1-12 PNCA submittal |
| | Maximum Fish Spill | 18000 cfs | 509.7 m ³ /s | Jul - Aug | 2-1-12 PNCA submittal |
| | | 40000 cfs | 1132.7 m ³ /s | Apr 15 - Jun 21 | |
| | | 40000 cfs | 1132.7 m ³ /s | Jun - Aug 15 | |
| | | | | | |
| | Minimum Flow | 11500 cfs | 325.6 m ³ /s | All periods | |
| | Other | 224.9 ksf | 550.2 hm ³ | On MOP Apr - Oct 31. | |
| | | 733 ft | 223.42 m | On MOP Apr - Oct 31. | |
| | | 245.7 ksf | 601.1 hm ³ | On full pool Nov 30 - Mar 31. | |
| | | 738 ft | 224.94 m | On full pool Nov 30 - Mar 31. | |
| Little Goose (518) | Bypass Date | | | None | |
| | Other Spill | 590 cfs | 16.7 m ³ /s | Jul | 2-1-09 PNCA submittal |
| | | 620 cfs | 17.6 m ³ /s | 15-Aug | |
| | | 500 cfs | 14.2 m ³ /s | 30-Aug | |
| | | 750 cfs | 21.2 m ³ /s | Sep | |
| | | 640 cfs | 18.1 m ³ /s | Oct | |
| | | 500 cfs | 14.2 m ³ /s | Nov | |
| | | 460 cfs | 13.0 m ³ /s | Dec | |
| | | 120 cfs | 3.4 m ³ /s | Jan | |
| | | 240 cfs | 6.8 m ³ /s | Feb | |
| | | 380 cfs | 10.8 m ³ /s | Mar | |
| | | 530 cfs | 15.0 m ³ /s | 15-Apr | |
| | | 580 cfs | 16.4 m ³ /s | Apr 30 - May | |
| | | 660 cfs | 18.7 m ³ /s | May | |
| | | 590 cfs | 16.7 m ³ /s | Jun | |
| | Incremental Spill | | | Removed | |
| | Fish Spill (% of outflow) | 26% | | Apr 15 [30%*13/15] | 2012 data submittal |
| | | 30% | | Apr 30 | 2012 data submittal |
| | | 30% | | May | 2012 data submittal |
| | | 30% | | Jun - Aug 31 | 2012 data submittal |
| | Maximum Fish Spill | 30000 cfs | 849.5 m ³ /s | Apr 15 - Apr 31 | |
| | | 28000 cfs | 792.9 m ³ /s | May | |
| | | 30000 cfs | 849.5 m ³ /s | Jun | |
| | | 28000 cfs | 792.9 m ³ /s | Jul - Aug 31 | |
| | Minimum Flow | 11500 cfs | 325.6 m ³ /s | All periods | |
| | Other | 260.5 ksf | 106.5 hm ³ | On MOP Apr - Aug 31. | |
| | | 633 ft | 192.94 m | | |
| | | 285.0 ksf | 697.3 hm ³ | On full pool Sep 30 - Mar 31. | |
| | | 638 ft | 194.46 m | | |

Appendix A
Project Operating Procedures for the 2018-19
Assured Operating Plan and Determination of Downstream Power Benefits

| Project | Requirements | | | | | |
|------------------------|--------------------|------------|-------------------------|------------------------------------|-----------------------|--|
| Name (Number) | Constraint Type | English | Metric | Explanation | Source | |
| Lower Monumental (504) | Bypass Date | | | A bypass date of 2010 was assumed. | | |
| | Other Spill | 790 cfs | 22.4 m ³ /s | Jul | 2-1-09 PNCA submittal | |
| | | 860 cfs | 24.4 m ³ /s | 15-Aug | | |
| | | 770 cfs | 21.8 m ³ /s | 30-Aug | | |
| | | 780 cfs | 22.1 m ³ /s | Sep | | |
| | | 840 cfs | 23.8 m ³ /s | Oct | | |
| | | 750 cfs | 21.2 m ³ /s | Nov | | |
| | | 720 cfs | 20.4 m ³ /s | Dec | | |
| | | 450 cfs | 12.7 m ³ /s | Jan | | |
| | | 410 cfs | 11.6 m ³ /s | Feb | | |
| | | 560 cfs | 15.9 m ³ /s | Mar | | |
| | | 770 cfs | 21.8 m ³ /s | 15-Apr | | |
| | | 780 cfs | 22.1 m ³ /s | Apr 30 - May | | |
| | | 840 cfs | 23.8 m ³ /s | May | | |
| | | 780 cfs | 22.1 m ³ /s | Jun | | |
| | Fish Spill | 22533 cfs | 638.1 m ³ /s | Apr 15 [26000*(13/15)] | 2-1-12 PNCA submittal | |
| | | 25000 cfs | 707.9 m ³ /s | Apr 31 | | |
| | | 22000 cfs | 623.0 m ³ /s | May | 2012 data submittal | |
| | | 18333 cfs | 519.1 m ³ /s | June | 2012 data submittal | |
| | | 17000 cfs | 481.4 m ³ /s | Jul - Aug 31 | | |
| | Maximum Fish Spill | 26000 cfs | 736.2 m ³ /s | Apr 15 | | |
| | | 25000 cfs | 707.9 m ³ /s | Apr 30 | | |
| | | 22000 cfs | 623.0 m ³ /s | May | | |
| | | 19000 cfs | 538.0 m ³ /s | Jun | | |
| | | 24000 cfs | 679.6 m ³ /s | Jul - Aug 31 | | |
| | Minimum Flow | 11500 cfs | 325.6 m ³ /s | All period | | |
| | Other | 180.5 ksfd | 441.6 hm ³ | On MOP Apr - Aug 31. | | |
| | | 537 ft | 163.68 m | | | |
| | | 190.1 ksfd | 465.1 hm ³ | On full pool Sep 30 - Mar 31. | | |
| | | 540 ft | 164.59 m | | | |
| Cushman (2206) | Other Spill | 240 cfs | 6.8 m ³ /s | All periods | 2-1-09 PNCA submittal | |
| LaGrande (2188) | Other Spill | 30 cfs | 0.8 m ³ /s | All periods | Submittal | |
| Lower Baker (2025) | Max Storage Limits | 67.0 ksfd | 163.9 hm ³ | Jul - Aug 31 | 2-1-12 PNCA submittal | |
| | | 442.4 ft | 134.84 m | | | |
| | | 40.1 ksfd | 98.1 hm ³ | Sep | | |
| | | 415.9 ft | 126.77 m | Oct - Dec | | |
| | | 34.7 ksfd | 84.9 hm ³ | | | |
| | | 409.8 ft | 124.91 m | Jan - Mar | | |
| | | 45.2 ksfd | 110.6 hm ³ | | | |
| | | 421.4 ft | 128.44 m | Apr 15 | | |
| | | 46.7 ksfd | 114.3 hm ³ | | | |
| | | 423.0 ft | 128.93 m | Apr 30 - Jun | | |
| | | 67.0 ksfd | 163.9 hm ³ | | | |
| | | 442.4 ft | 134.84 m | | | |
| | Min Storage Limit | 30.4 ksfd | 74.4 hm ³ | Jun - Sep | | |
| | | 404.8 ft | 123.38 m | | | |
| | | 18.0 ksfd | 44.0 hm ³ | Oct - May | | |
| | | 389.0 ft | 118.57 m | | | |

Appendix A
Project Operating Procedures for the 2018-19
Assured Operating Plan and Determination of Downstream Power Benefits

| <u>Project</u> <u>Name (Number)</u> | <u>Constraint Type</u> | <u>Requirements</u> | | <u>Explanation</u> | <u>Source</u> |
|--|------------------------|---------------------|-----------------------|---|-----------------------|
| | | <u>English</u> | <u>Metric</u> | | |
| Upper Baker (2028) | Max Storage Limits | 107.4 ksfd | 262.8 hm ³ | May - Sep | 2-1-12 PNCA submittal |
| | | 727.8 ft | 221.83 m | | |
| | | 103.5 ksfd | 253.2 hm ³ | Oct | |
| | | 726.1 ft | 221.32 m | | |
| | | 70.9 ksfd | 173.5 hm ³ | Nov - Feb | |
| | | 711.7 ft | 216.93 m | | |
| | | 84.6 ksfd | 207.0 hm ³ | Mar - Apr 30 | |
| | | 718.0 ft | 218.85 m | | |
| | Min Storage Limits | 100.5 ksfd | 245.9 hm ³ | Jun - Aug 31 | |
| | | 724.8 ft | 220.92 m | | |
| | | 91.1 ksfd | 222.9 hm ³ | Sep | |
| | | 720.8 ft | 219.70 m | | |
| | | 40.6 ksfd | 99.3 hm ³ | Oct | |
| | | 695.2 ft | 211.90 m | | |
| | | 25.5 ksfd | 62.4 hm ³ | Nov - Apr 30 | |
| | | 685.0 ft | 208.79 m | | |
| Timothy (117) | Minimum Content | 24.5 ksfd | 59.9 hm ³ | Oct - May | 3-6-01 PNCA submittal |
| | | 3180.0 ft | 969.26 m | | |
| | | 31.1 ksfd | 76.1 hm ³ | Jun - Aug 31 | |
| | | 3190.0 ft | 972.31 m | | |
| | | 27.8 ksfd | 68.0 hm ³ | Sep | |
| | | 3185.0 ft | 970.79 m | | |
| Long Lake (1305) | Minimum Content | 50.1 ksfd | 122.6 hm ³ | Apr - Nov | 2-5-02 PNCA submittal |
| | | 1535.0 ft | 467.87 m | | |
| | | 19.7 ksfd | 48.2 hm ³ | Dec - Mar | |
| | Draft Rate Limit | 1522.0 ft | 463.9 m | | 2-1-03 PNCA submittal |
| | | 1.0 ft/day | 0.30 m/day | | |
| Priest Lake (1470) | Maximum Content | 0.0 ksfd | 0.0 hm ³ | Oct | 2-1-03 PNCA submittal |
| | | 0.0 ft | 0.00 m | | |
| | Max/Min Content | 35.5 ksfd | 86.9 hm ³ | Maintain at or near after runoff through Sep. | |
| | | | | | |
| | | 3.0 ft | 0.91 m | | |
| Ross (2070) | Minimum Content/ | | | Dependent on Skagit Fisheries. | 2-1-06 PNCA submittal |
| | | Fixed ARCs and VRCs | | | |
| Gorge (2065) | Minimum Flow | | | Settlement; monthly data, varies by water year. | 2-1-12 PNCA submittal |

**COLUMBIA RIVER TREATY
DETERMINATION OF DOWNSTREAM POWER BENEFITS
FOR THE ASSURED OPERATING PLAN
FOR OPERATING YEAR 2018-19**

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TABLE OF CONTENTS

| <u>Section</u> | <u>Page</u> |
|--|-------------|
| 1. Introduction | 1 |
| 2. Procedures..... | 1 |
| 3. Results of Canadian Entitlement Computations | 3 |
| 4. Computation of Maximum Allowable Reduction in Downstream Power Benefits | 3 |
| 5. Delivery of the Canadian Entitlement | 3 |
| 6. Summary of Information Used for Canadian Entitlement Computations..... | 3 |
| 7. Summary of Changes Compared to the 2017-18 DDPB and Notable Assumptions | 5 |
| a) Steps II and III Firm Loads | 5 |
| b) Thermal Installations..... | 6 |
| c) Hydro Project Modified Stream Flows | 6 |
| d) Hydro Project Rule Curves..... | 7 |
| e) Other Hydro Project Operating Procedures, Constraints, and Plant Data | 7 |
| f) Steps II and III Critical Period and 30-year System Regulation Studies | 7 |
| g) Downstream Power Benefits | 7 |
| TABLE 1A Determination of Step I Firm Energy Hydro Loads..... | 9 |
| TABLE 1B Determination of Step I Firm Peak Hydro Loads..... | 10 |
| TABLE 2 Determination of Thermal Displacement Market | 11 |
| TABLE 3 Determination of Loads for Step II and Step III Studies..... | 12 |
| TABLE 4 Summary of Steps I, II, & III Power Regulations | 13 |
| TABLE 5 Computation of Canadian Entitlement..... | 14 |
| TABLE 6 Comparison of Recent DDPB Studies..... | 15 |
| CHART 1 Duration Curves of 30-Year Monthly Hydro Generation | 17 |

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**DETERMINATION OF DOWNSTREAM POWER BENEFITS (DDPB)
FOR THE ASSURED OPERATING PLAN
FOR OPERATING YEAR 2018-19**

December 2013

1. Introduction

The “Treaty between Canada and The United States of America relating to Cooperative Development of The Water Resources of The Columbia River Basin” (Treaty), dated 17 January 1961, requires that downstream power benefits from the operation of the Treaty storage in Canada (Canadian Treaty Storage) to be determined in advance by the two Entities created by the Treaty. The purpose of this document is to describe the results of the Determination of Downstream Power Benefits for operating year 2018-19 (DDPB19).

2. Procedures

The procedures followed in the benefit studies are those provided in Article VII; Annex A, paragraph 7, and Annex B of the Treaty; in paragraphs VIII, IX, and X of the “Protocol - Annex to Exchange of Notes, Dated January 22, 1964 Between the Governments of Canada And the United States Regarding the Columbia River Treaty” (Protocol), and in the following Entity agreements:

- The Entity agreements, signed 28 July and 12 August 1988, on “Principles for the Preparation of the AOP and Determination of Downstream Power Benefit (DDPB) Studies” and “Changes to Procedures for the Preparation of the AOP and DDPB Studies” (1988 Entity Agreements);
- The “Columbia River Treaty Entity Agreement on Resolving the Dispute on Critical Period Determination, the Capacity Entitlement for the 1998-99, 1999-00, and 2000-01 AOP/DDPBs, and Operating Procedures for the 2001-02 and Future AOPs,” signed 29 August 1996 (1996 Entity Agreement); and
- Except for the changes noted below, the “Columbia River Treaty Entity Agreement on the Principles and Procedures for Preparing and Implementing Hydroelectric Operating Plans For Operation of Canadian Treaty Storage” (POP), dated October 2003 and signed 16 December 2003, including the September 2011 update to Appendix 1 - Refill Curves; the November 2004 addition of Appendix 6 - Streamline Procedures; the addition of Appendix 7 – Table of Median Flows based on the 2010 Level Modified Streamflows; and the September 2007 addition of Appendix 8 concerning Water Supply Forecasts along with the February 2012 revision of Appendix 8, Table 1, concerning the Summary of Errors and Hedges.

Special terms used in this document, but not defined herein, have the meanings defined in the Treaty, Protocol, or the above Entity agreements. The POP is based on criteria contained in Annex A and Annex B of the Treaty, the Protocol, and the “Columbia River Treaty Flood Control Operating Plan” (FCOP) dated May 2003.

For the DDPB19, the Entities have agreed to use all three streamline procedures defined in Appendix 6 of the POP. These streamline procedures include “Forecasting Loads and Resources” for determining the thermal installations, as described in Subsection 7(d) of the accompanying document, Columbia River Treaty Hydroelectric Operating Plan of the Assured Operating Plan for Operating Year 2018-19 (AOP19), the “Multi-Year Use of Same Operating Criteria for Canadian Treaty Storage” based on the AOP18 Joint Optimum Step I system regulation study, as explained in Subsection 2(b) of the AOP19, and the “Monthly Hydro Energy Reshaping for Step II and III 30-year System Regulation Studies” for determining the energy entitlement, as described in Subsection 7(f) of this document.

In addition to the changes discussed in Subsection 2(a) of the AOP19 document, the Entities have agreed to modify the DDPB19 Table 2 calculation of Thermal Displacement Market (TDM), as was done since DDPB13, to use thermal imports (e.g. market purchases of power from California, but not Canadian Entitlement (CE) or Skagit Treaty power) to support exports (not including CE, plant sales, flow-through-transfers (FTT), seasonal exchanges (SE) or excess extra-regional thermal installations), on an annual basis, as either FTTs or SEs.

The Canadian Entitlement Benefits were computed from the following studies:

- Step I -- Operation of the total United States of America (USA) Columbia Basin hydro and thermal system, with 19.12 cubic kilometers¹ (km³) (15.5 million acre-feet (Maf)) of Canadian Treaty Storage operated for flood control and optimum power generation in both countries including coordination with other generation in Canada and the USA;
- Step II -- Operation of the Step I thermal system, the base hydro system, and 19.12 km³ (15.5 Maf) of Canadian Treaty Storage operated for flood control and optimum power generation in both countries; and
- Step III -- Operation of the Step I thermal system and the base hydro system operated for flood control and optimum power generation in the United States.

As part of the DDPB, separate determinations may be carried out relating to the limit of year-to-year reduction in benefits attributable to the operation of Canadian Treaty Storage in operating plans designed to achieve optimum power generation at-site in Canada and downstream in Canada and the USA (Joint Optimum). However, as indicated in Section 4 below, the calculations were not needed for the 2018-19 operating year.

3. **Results of Canadian Entitlement Computations**

The Canadian Entitlement to the downstream power benefits in the USA attributable to operation in accordance with Treaty Annex A, paragraph 7, for optimum power generation in Canada and the USA, which is one-half the total downstream power benefits, was determined to be (see Joint Optimum results in Table 5):

$$\begin{array}{ll} \text{Dependable Capacity} & = 1284.0 \text{ megawatts (MW)} \\ \text{Average Annual Usable Energy} & = 472.5 \text{ average annual MW} \end{array}$$

All downstream power benefit computations are rounded to the nearest tenth of a MW.

4. **Computation of Maximum Allowable Reduction in Downstream Power Benefits**

Treaty Annex A, paragraph 7, states in part that:

“ . . . Any reduction in the downstream power benefits in the United States of America resulting from that change in operation of the Canadian storage shall not exceed in any one year the reduction in downstream power benefits in the United States of America which would result from reducing by 500,000 acre-feet the Canadian storage operated to achieve optimum power generation in the United States of America and shall not exceed at any time during the period of the Treaty the reduction in downstream power benefits in the United States of America which would result from similarly reducing the Canadian storage by 3,000,000 acre-feet.”

Step II studies based on the assumption of optimum power generation in Canada and the USA resulted in a 1.3 average annual megawatt (aMW) increase in the Energy Entitlement and no change in the Capacity Entitlement compared to the Step II study based on optimum power generation only in the USA (see Table 5, columns A and B). Since there was no reduction in the downstream power benefits for the Joint Optimum Study, the computation of the maximum allowable reduction in downstream power benefits, as defined in Section 3.3.A(3) of the POP, was not necessary.

5. **Delivery of the Canadian Entitlement**

See Section 6 of the AOP19.

6. **Summary of Information Used for Canadian Entitlement Computations**

The following tables and chart summarize the study results:

| | |
|----------|--|
| Table 1A | <u>Determination of Step I Firm Energy Hydro Loads</u> |
| and | |
| Table 1B | <u>Determination of Step I Firm Peak Hydro Loads</u> |

These tables follow the definition of Step I loads and resources defined by Treaty Annex B, paragraph 7, and clarified by the 1988 Entity Agreements and modified according to the Streamline Procedures noted in Section 2 of this DDPB and described in Section 7 of the AOP19. Table 1A shows the Step I energy loads and resources while Table 1B shows the Step I peak loads and resources.

Table 2 Determination of Thermal Displacement Market

This table shows the computation of the TDM for the downstream power benefit determination of average annual usable energy. The TDM is calculated as the thermal installations shown in Table 1A with subsequent reductions for estimated minimum thermal generation and system sales. System sales are all exports except for Canadian Entitlement, plant sales, seasonal exchanges, and flow-through-transfers, as defined in POP and modified in Section 2 of this DDPB.

Table 3 Determination of Loads for Step II and Step III Studies

This table shows the computation of the Step II and III loads. The monthly loads for Steps II and III studies have the same ratios between each month and the annual average as the PNWA load (to maintain the same annual load shape). The PNWA firm loads were based on the Bonneville Power Administration (BPA) 2012 White Book (WB12) load forecast as described in Subsection 7(a) of the AOP19. The Grand Coulee net pumping load is included in this estimate. The method for computing the firm load for the Steps II and III studies is described in the 1988 Entity Agreements and in the POP.

Table 4 Summary of Steps I, II, and III Power Regulations

This table summarizes the results of the Steps I, II, and III power regulation studies for each project and the total system. The determination of the Steps I, II, and III loads and thermal installations is shown in Tables 1 to 3.

Hydro maintenance, transmission losses and peaking reserves (for capacity balance) are summed together in the Step I load-resource balance as a resource adjustment. The Steps II and III capacity balance includes the hydro maintenance and the peaking reserves based on the same percentage as the Step I system.

The firm energy load carrying capability for the Steps I, II, and III systems is based on the same critical periods as recent studies. The firm peak load carrying capability for each system is based on the period with the lowest surplus firm peak capability over the thirty water years. For the AOP/DDPB19, these periods are January 1932 for the Steps I and II systems and January 1930 for the Step III system.

Table 5 Computation of Canadian Entitlement

- A. Joint Optimum Generation in Canada and the USA
 B. Optimum Generation in the USA Only

The essential elements used in the computation of the Canadian Entitlement arising from the downstream power benefits under the Joint Optimum and USA Optimum are shown under Columns A and B, respectively. These elements are derived from (1) Steps II and III USA Optimum critical period studies based on loads determined in Table 3; (2) the Thermal Displacement Market from Table 2; and (3) the Step II Joint Optimum and Step III USA Optimum 30-year hydro regulation studies based on the DDPB18 with revisions to reshape generation to the 2018-19 Steps II and III loads as described in Subsection 7(f).

As explained in Section 4 of this document, the computation of maximum allowable reduction in downstream power benefits are not shown in this table because the calculation was not necessary.

Table 6 Comparison of Recent DDPB Studies

Chart 1 Duration Curves of 30 Years Monthly Hydro Generation

This chart shows duration curves of the hydro generation in aMW from the Joint Optimum Step II and the USA Optimum Step III system regulation studies² which graphically illustrate the change in average annual usable hydro energy.

Usable hydro energy consists of firm energy plus usable nonfirm energy. Firm energy, as shown in Table 5, is equal to the firm hydro loads. Nonfirm energy is the monthly hydro energy capability in excess of the firm hydro loads. The usable nonfirm energy is computed in accordance with Annex B, paragraphs 3(b) and 3(c), as the portion of nonfirm energy that can be used to displace thermal installations designated to meet PNWA firm loads, plus the remaining usable energy. The Entities agree that remaining usable energy is computed on the basis of 40% of the nonfirm energy remaining after thermal displacement.

7. Summary of Changes Compared to the 2017-18 DDPB and Notable Assumptions

Data from recent DDPBs are summarized in Table 6. The following is an explanation of changes and notable assumptions that impact computation of the Entitlement compared to the DDPB18 studies.

a) Steps II and III Firm Loads

The Steps II and III hydro firm load shape shown on Table 3 is somewhat different from the DDPB18. For DDPB19, the 2018-19 loads trend higher in April and August and lower in October, December through February, and again in May

and June. This is mainly due to the change in PNWA load shape and thermal maintenance schedules, as explained in Subsection 7(b).

Differences between DDPB19 and DDPB18 Table 3 Hydro Loads

| | <u>Aug1</u> | <u>Aug2</u> | <u>Sept</u> | <u>Oct</u> | <u>Nov</u> | <u>Dec</u> | <u>Jan</u> | <u>Feb</u> | <u>Mar</u> | <u>Apr1</u> | <u>Apr2</u> | <u>May</u> | <u>June</u> | <u>July</u> | <u>Avg.</u> | <u>CPavg</u> |
|-------------------|-------------|-------------|-------------|------------|------------|------------|------------|------------|------------|-------------|-------------|------------|-------------|-------------|-------------|--------------|
| DDPB19 S2 | 8741 | 8734 | 7407 | 6670 | 8595 | 10244 | 10529 | 9631 | 8737 | 8306 | 8848 | 10025 | 9097 | 9468 | 8977 | 8906 |
| DDPB18 S2 | 8659 | 8641 | 7393 | 6738 | 8586 | 10414 | 10605 | 9686 | 8745 | 7494 | 8268 | 10534 | 9300 | 9431 | 8999 | 8903 |
| Difference | 82 | 93 | 15 | -67 | 8 | -170 | -76 | -56 | -8 | 812 | 579 | -510 | -203 | 38 | -22 | 3 |
| DDPB19 S3 | 6353 | 6346 | 5199 | 4546 | 6219 | 7636 | 7891 | 7123 | 6434 | 6104 | 6641 | 7883 | 6782 | 7001 | 6621 | 6978 |
| DDPB18 S3 | 6288 | 6272 | 5188 | 4608 | 6214 | 7793 | 7965 | 7176 | 6435 | 5304 | 6058 | 8392 | 6986 | 6979 | 6644 | 6957 |
| Difference | 65 | 74 | 11 | -62 | 5 | -157 | -74 | -52 | -1 | 800 | 583 | -508 | -205 | 21 | -23 | 21 |

The average critical period load factor increased from 74.60% in AOP18 (WB11) to 75.08% in AOP19 (WB12).

b) Thermal Installations

The total thermal installation energy capability shown in Tables 1 to 3 decreased by 22 annual aMW compared to the DDPB18. This is due to the combined effects of increases in PNWA firm load (270 aMW), exports (69 aMW), imports (196 aMW), and renewable resources (165 aMW), most of which is wind.

Beginning with AOP06, Columbia Generating Station changed from an annual maintenance cycle to a 24 month cycle. This created a circumstance where this maintenance was included only in alternate years of the AOP with a resulting effect of swings in Energy Entitlement. Beginning with AOP/DDPB14 and continuing with this AOP/DDPB, the Entities have agreed to use the average of the two year maintenance schedule, thereby eliminating the year to year Energy Entitlement variability and effect on the AOP storage operations.

In addition, the thermal installation shape has changed due to changes in thermal maintenance schedules (mostly coal but also combustion turbines and co-generation).

The TDM increased by 67 annual aMW, due to changes in system sales. Both the thermal installation and TDM changes are shown in the following table.

DDPB19 minus DDPB18 Table 2 Thermal Installations and Thermal Displacement Market

| | <u>Aug1</u> | <u>Aug2</u> | <u>Sept</u> | <u>Oct</u> | <u>Nov</u> | <u>Dec</u> | <u>Jan</u> | <u>Feb</u> | <u>Mar</u> | <u>Apr1</u> | <u>Apr2</u> | <u>May</u> | <u>June</u> | <u>July</u> | <u>Avg.</u> | <u>CP avg</u> |
|--------------------|-------------|-------------|-------------|------------|------------|------------|------------|------------|------------|-------------|-------------|------------|-------------|-------------|-------------|---------------|
| DDPB19 T.I. | 10381 | 10380 | 10271 | 10335 | 10428 | 10637 | 10590 | 10442 | 9700 | 9326 | 8815 | 7116 | 9437 | 10287 | 9888 | 9973 |
| DDPB18 T.I. | 10381 | 10379 | 10305 | 10357 | 10461 | 10633 | 10593 | 10471 | 9797 | 10087 | 9476 | 6667 | 9276 | 10251 | 9909 | 9994 |
| Difference | 1 | 1 | -34 | -22 | -33 | 4 | -3 | -29 | -97 | -762 | -661 | 449 | 161 | 36 | -22 | -21 |
| TDM 19 | 10041 | 10040 | 9933 | 9996 | 10087 | 10291 | 10245 | 10100 | 9376 | 9012 | 8513 | 6848 | 9108 | 9948 | 9558 | 9641 |
| TDM 18 | 9952 | 9951 | 9878 | 9929 | 10030 | 10198 | 10159 | 10040 | 9383 | 9666 | 9070 | 6323 | 8862 | 9824 | 9491 | 9574 |
| Difference | 89 | 89 | 55 | 67 | 56 | 93 | 86 | 60 | -7 | -654 | -556 | 525 | 246 | 124 | 67 | 68 |

c) Hydro Project Modified Stream Flows

The unregulated base stream flows used in the Steps II and III system regulation studies are the same as those used in the Step I studies (see Subsection 7(e) of AOP19), which were the 2010 Modified Streamflows published by BPA in August

2011, except for adjustments to add the effect of natural lake regulation and remove reservoir evaporation at projects not included in Steps II or III.

d) Hydro Project Rule Curves

As explained in Subsection 7(f) of the AOP19 document, critical rule curves and refill curves are the same as the AOP18.

e) Other Hydro Project Operating Procedures, Constraints, and Plant Data

As explained in Subsection 7(g) of the AOP19 document, operating procedures, constraints, and plant data are the same as used in the AOP18, and are described in Subsection 7(g) of the AOP18 document.

f) Steps II and III Critical Period and 30-year System Regulation Studies

Critical period studies are performed to establish the length of the critical stream flow period and the hydro firm load carrying capability. The Entities conducted Step II and Step III critical period system regulation studies for the 2018-19 operating year in accordance with procedures described in Section 3.3 of the POP.

The Step II and Step III critical stream flow periods are unchanged from the DDPB18 studies. The Step II critical period comprises the 20 calendar-months from 1 September 1943 through 30 April 1945, and the Step III critical period consists of the 5.5 calendar-months from 1 November 1936 through 15 April 1937. The Step II critical period generation, as compared to DDPB18, increased by 3.3 aMW, while the average annual firm energy decreased by 21.8 aMW. The Step III critical period generation increased by 20.9 aMW, but the average annual firm energy decreased by 23.2 aMW. These changes to critical period generation and average annual firm energy are primarily due to changes in the Steps II and III load shapes.

For the 30-year System Regulation Studies, the Entities agreed to use the Streamline procedure “Monthly Hydro Energy Reshaping for Step II and III 30-year System Regulation Studies”, based on the DDPB18, along with a month-to-month generation reshaping procedure, to estimate Steps II and III 30-year average annual usable hydro energy for this DDPB. The procedure reshapes the monthly hydro generation from the DDPB18 30-year hydro system regulation study by borrowing surplus energy from future months to meet any deficits under the DDPB19 Steps II and III firm hydro loads.

g) Downstream Power Benefits

The Canadian Capacity Entitlement decreased from 1304.1 MW in the DDPB18 to 1284.0 MW in the DDPB19, a decrease of 20.1 MW. This is caused by a slight increase in the critical period load factor as well as a smaller increase in the Step II critical period generation relative to the Step III critical period generation.

The Canadian Energy Entitlement decreased from 475.0 annual aMW in the

DDPB18 to 472.5 annual aMW in the DDPB19, a decrease of 2.5 annual aMW. This decrease is caused mainly by a combination of changes in the shape of the Thermal Displacement Market as well as the Steps II and III loads.

End Notes:

¹ The Treaty defines the Canadian Treaty Storage in English units. The metric conversion is a rounded approximation.

² The Steps II and III DDPB19 hydro system generation estimates, dated 25 September 2013, were determined by applying the third streamline procedure to reshape the DDPB18 system regulation studies.

TABLE 1A
DETERMINATION OF STEP I FIRM ENERGY HYDRO LOADS
FOR 2018-19 ASSURED OPERATING PLAN
(Average MW)

| | Aug15 | Aug31 | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr15 | Apr30 | May | Jun | Jul | Ann. Avg. | CP Avg. 1/ |
|---|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|
| 1. Pacific Northwest Area (PNWA) Firm Load | | | | | | | | | | | | | | | | |
| a) White Book Regional Firm Load 2/ | 23893 | 23915 | 22077 | 21227 | 23686 | 26000 | 26245 | 24987 | 22965 | 21993 | 21993 | 21434 | 23268 | 24828 | 23548 | 23622 |
| b) Exclude 99% of UPL's Idaho load 3/ | -525 | -525 | -474 | -441 | -433 | -467 | -439 | -453 | -427 | -407 | -407 | -455 | -580 | -640 | -479 | -475 |
| c) Update Coulee pumping 4/ | -7 | -39 | -7 | -12 | -14 | -24 | -6 | -13 | -15 | -46 | -9 | -40 | -46 | -54 | -24 | -22 |
| d) ...Total PNWA Firm Loads | 23360 | 23350 | 21596 | 20774 | 23239 | 25509 | 25800 | 24521 | 22522 | 21540 | 21577 | 20939 | 22642 | 24134 | 23046 | 23124 |
| e) Annual Load Shape in Percent | 101.4 | 101.3 | 93.7 | 90.1 | 100.8 | 110.7 | 112.0 | 106.4 | 97.7 | 93.5 | 93.6 | 90.9 | 98.2 | 104.7 | 100.0 | 100.3 |
| 2. Flows-Out of firm power from PNWA | | | | | | | | | | | | | | | | |
| a) White Book Exports, incl firm sp 5/ | 1691 | 1762 | 1478 | 1493 | 1238 | 1121 | 1090 | 1157 | 1445 | 1496 | 1477 | 1312 | 1650 | 1616 | 1403 | 1387 |
| b) Remove WB Canadian Entitlement | -464 | -464 | -464 | -464 | -464 | -464 | -464 | -464 | -464 | -464 | -464 | -464 | -464 | -464 | -464 | -464 |
| c) Add est. Can. Entitle. Exported 6/ | 470 | 470 | 470 | 470 | 470 | 470 | 470 | 470 | 470 | 470 | 470 | 470 | 470 | 470 | 470 | 470 |
| d) Added export for WB surplus | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| e) Added SeEx for WB Surplus | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| f) Added SeEx for AOP Hydro 7/ | 0 | 0 | 279 | 0 | 0 | 204 | 0 | 0 | 0 | 0 | 0 | 601 | 389 | 145 | 136 | 126 |
| g) Imp. Thermal used out of region 8/ | 95 | 95 | 113 | 121 | 88 | 50 | 52 | 48 | 51 | 76 | 54 | 0 | 80 | 70 | 69 | 71 |
| h) ...Subtotal for Table 2 | 1792 | 1863 | 1877 | 1620 | 1332 | 1381 | 1148 | 1211 | 1503 | 1578 | 1538 | 1919 | 2125 | 1838 | 1614 | 1591 |
| i) Remove Plant Sales | -878 | -909 | -810 | -767 | -748 | -636 | -605 | -549 | -859 | -1025 | -1007 | -841 | -1133 | -952 | -818 | -801 |
| j) Remove Flow-through-transfer | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| k) ...Total | 914 | 953 | 1067 | 853 | 584 | 745 | 543 | 663 | 644 | 553 | 531 | 1078 | 992 | 886 | 795 | 790 |
| 3. Flows-In of firm power to PNWA, except from coordinated thermal installations | | | | | | | | | | | | | | | | |
| a) White Book Imports 9/ | -981 | -973 | -776 | -738 | -946 | -1326 | -985 | -965 | -815 | -719 | -719 | -761 | -923 | -994 | -911 | -918 |
| b) Remove UP&L imports for 1(b) 3/ | 526 | 525 | 474 | 441 | 433 | 467 | 439 | 453 | 427 | 407 | 407 | 455 | 580 | 640 | 479 | 475 |
| c) Remove Eastern Thermal Instal 10/ | 304 | 304 | 281 | 276 | 313 | 360 | 355 | 353 | 318 | 278 | 278 | 275 | 300 | 326 | 311 | 313 |
| d) Added SeEx for WB Surplus | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| e) Added Can.Import for WB deficits 11/ | 0 | -18 | -207 | 0 | -5 | -264 | -470 | -421 | -331 | -179 | -36 | 0 | 0 | -252 | -171 | -177 |
| f) Added Calif.Import for WB deficits 12/ | 0 | 0 | 0 | 0 | 0 | 0 | -22 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -2 | -2 |
| g) Added SeEx for AOP Hydro 7/ | -128 | -253 | 0 | -177 | -148 | 0 | -129 | -187 | -201 | -655 | -555 | 0 | 0 | 0 | -136 | -133 |
| h) Remove Flow-Through-Xfers | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| i) ...Total | -279 | -415 | -228 | -199 | -353 | -763 | -812 | -767 | -601 | -869 | -625 | -32 | -42 | -280 | -429 | -442 |
| 4. PNWA Non-Step I Hydro and Non-Thermal Resources | | | | | | | | | | | | | | | | |
| a) Hydro Independents (1929 water) | -1004 | -986 | -983 | -1084 | -1104 | -995 | -1013 | -842 | -952 | -1121 | -1151 | -1426 | -1375 | -1111 | -1086 | -963 |
| b) Non-Step I Coordinated Hydro (1929) | -495 | -458 | -551 | -925 | -934 | -945 | -1245 | -673 | -715 | -810 | -705 | -641 | -1054 | -658 | -798 | -808 |
| c) WB Regional Hydro NUGs | -322 | -321 | -241 | -163 | -130 | -123 | -115 | -123 | -154 | -273 | -278 | -398 | -419 | -418 | -241 | -229 |
| d) WB Renewable NUGs | -62 | -62 | -62 | -62 | -62 | -62 | -62 | -62 | -61 | -62 | -61 | -61 | -61 | -61 | -62 | -62 |
| e) WB Renewables | -872 | -1415 | -1299 | -1151 | -973 | -880 | -621 | -642 | -1077 | -1472 | -1108 | -1252 | -1640 | -1300 | -1108 | -1087 |
| f) ...Total (1929) | -2754 | -3242 | -3136 | -3384 | -3202 | -3005 | -3055 | -2342 | -2960 | -3737 | -3303 | -3778 | -4550 | -3549 | -3295 | -3149 |
| 5. Step I System Load (1929) 13/ | 21241 | 20647 | 19299 | 18045 | 20267 | 22486 | 22475 | 22075 | 19606 | 17486 | 18179 | 18206 | 19041 | 21191 | 20116 | 20323 |
| 6. Coordinated Thermal Installations 14/ | | | | | | | | | | | | | | | | |
| a) Columbia Generation Station (WNP2) | 1030 | 1030 | 1030 | 1030 | 1030 | 1030 | 1030 | 1030 | 1030 | 1030 | 1030 | 681 | 515 | 980 | 954 | 965 |
| b) Generic Thermal Installations | 9351 | 9350 | 9241 | 9305 | 9398 | 9607 | 9560 | 9412 | 8670 | 8296 | 7785 | 6435 | 8922 | 9307 | 8934 | 9008 |
| c) ...Total | 10381 | 10380 | 10271 | 10335 | 10428 | 10637 | 10590 | 10442 | 9700 | 9326 | 8815 | 7116 | 9437 | 10287 | 9888 | 9973 |
| 7. Step I Hydro Resources (1929) 15/ | 11533 | 10941 | 9656 | 8309 | 10500 | 12578 | 12617 | 12333 | 10550 | 8774 | 9979 | 11703 | 10260 | 11598 | 10891 | 11014 |
| 8. Step I Resource Adjustments | | | | | | | | | | | | | | | | |
| a) Hydro Maintenance | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| b) Transmission System Losses 16/ | -674 | -674 | -628 | -599 | -661 | -730 | -732 | -700 | -644 | -613 | -614 | -613 | -656 | -695 | -662 | -664 |
| 9. Total Step I System Resources (1929) | 21241 | 20647 | 19299 | 18045 | 20267 | 22486 | 22475 | 22075 | 19606 | 17486 | 18179 | 18206 | 19041 | 21191 | 20116 | 20323 |
| 10. Coordinated Hydro Load (1929) 17/ | 12028 | 11399 | 10207 | 9233 | 11434 | 13523 | 13862 | 13006 | 11264 | 9583 | 10684 | 12344 | 11314 | 12256 | 11689 | 11822 |
| a) Coord. Hydro Load Shape (1929) 18/ | 102.9% | 97.5% | 87.3% | 79.0% | 97.8% | 115.7% | 118.6% | 111.3% | 96.4% | 82.0% | 91.4% | 105.6% | 96.8% | 104.9% | 100.0% | |

Notes:

- 1/ The Step I critical period is the 42.5 months beginning 16 August 1928 and ending 29 February 1932.
- 2/ BPA Final 2012 White Book (WB12) total regional firm load estimate, which includes estimated Coulee pumping and Idaho loads served by Utah P&L.
- 3/ Annex B requires exclusion of Idaho load from area served by Utah Power Light in 1964. We exclude import that supports that, but include the import for the 1% within the region.
- 4/ Coulee pumping loads were updated to the 2012 PNCA data submittal to be consistent with the pumping flows in the Base Flows.
- 5/ WB12 exports include Firm Seasonal Exchanges, Flow-Through Transfers, Plant Sales, and an estimate of the Canadian Entitlement.
- 6/ Assumes 470 MW Energy Entitlement exported to Canada.
- 7/ Seasonal Exchanges were employed in this AOP to make the Coordinated Hydro Load in Line 10 match the AOP18 Coordinated Hydro Load.
- 8/ Added thermal export to balance difference between thermal import and equivalent thermal installation based on generic annual shape.
- 9/ White Book Imports include coordinated thermal installations, seasonal & capacity exchanges, flow-through-transfers, and Skagit Treaty power.
- 10/ Imports identified as coordinated thermal installations are excluded, to be replaced by a portion of the Generic Thermal Installations.
- 11/ Added Canadian import as a portion of the resources needed to balance WB deficits, based on 36% of estimated 470 aMW of Energy Entitlement.
- 12/ Added Calif. import as a portion of the resources needed to balance WB deficits, based on the pro rata procedure.
- 13/ Lines 1d + 2k + 3i + 4f, based on 1929 hydro independent capability.
- 14/ Thermal installations are CGS, plus a generic thermal installation that is sized to meet the Step 1 System load minus Step I Hydro.
- 15/ Step I Hydro (US hydro projects at and upstream of Bonneville Dam) critical period capability shaped to 1929 load, line 5 minus lines 6c, 8a, & 8b.
- 16/ Transmission losses are 2.71% of all resources including imports.
- 17/ The Coordinated Hydro Load is the Step I Hydro Resources plus Non-Step I Coordinated Hydro, lines 7 - 4b.
- 18/ The Coordinated Hydro Load Shape shows the net effect of loads and nonhydro resources on the coordinated system hydro resources.

TABLE 1B
DETERMINATION OF STEP I FIRM PEAK HYDRO LOADS
FOR 2018-19 ASSURED OPERATING PLAN
(MW)

| | Aug15 | Aug31 | Sept | Oct | Nov | Dec | Jan | Feb | March | Apr15 | Apr30 | May | June | July |
|---|--------------|--------------|---------------|---------------|---------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|
| 1. Pacific Northwest Area (PNWA) Firm Load | | | | | | | | | | | | | | |
| a) White Book Regional Firm Load | 32254 | 32254 | 28768 | 29359 | 32515 | 35861 | 35783 | 33881 | 31057 | 29462 | 29462 | 27840 | 31017 | 33286 |
| b) Exclude 99% of UPL's Idaho load | -740 | -740 | -622 | -563 | -560 | -641 | -584 | -583 | -559 | -531 | -531 | -572 | -809 | -884 |
| c) Adj. for Federal Peak Diversity 1/ | -499 | -536 | -565 | -364 | -311 | -570 | -315 | -336 | -391 | -501 | -516 | -524 | -527 | -429 |
| d) Updates to Coulee pumping forec. | -65 | -65 | -28 | -76 | 126 | 126 | 251 | -21 | 0 | -18 | -28 | -2 | -7 | -72 |
| e) ...Total PNWA Firm Loads | 30951 | 30913 | 27553 | 28356 | 31769 | 34777 | 35135 | 32941 | 30106 | 28413 | 28388 | 26741 | 29675 | 31901 |
| f) Monthly Load Factors in Percent | 75.48 | 75.54 | 78.38 | 73.26 | 73.15 | 73.35 | 73.43 | 74.44 | 74.81 | 75.81 | 76.01 | 78.30 | 76.30 | 75.65 |
| 2. Flows-Out of firm power from PNWA | | | | | | | | | | | | | | |
| a) White Book Exports | 2011 | 2052 | 1898 | 1799 | 1530 | 1530 | 1530 | 1659 | 1646 | 1530 | 1538 | 1394 | 1838 | 1870 |
| b) Remove WB Canadian Entitlement | -1324 | -1324 | -1324 | -1324 | -1324 | -1324 | -1324 | -1324 | -1324 | -1324 | -1324 | -1324 | -1324 | -1324 |
| c) Add estimated Can. Entitle. exported | 1295 | 1295 | 1295 | 1295 | 1295 | 1295 | 1295 | 1295 | 1295 | 1295 | 1295 | 1295 | 1295 | 1295 |
| d) Added export for WB surplus | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| e) Add Seasonal Exch. WB Export | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| f) Add Seasonal Exch. Shape Export | 0 | 0 | 279 | 0 | 0 | 204 | 0 | 0 | 0 | 0 | 0 | 601 | 389 | 145 |
| g) Thermal Inst. used outside region 2/ | 71 | 71 | 95 | 103 | 64 | 0 | 12 | 12 | 37 | 69 | 69 | 16 | 49 | 53 |
| h) ...Subtotal for Table 2 | 2053 | 2094 | 2243 | 1873 | 1565 | 1704 | 1512 | 1641 | 1654 | 1569 | 1577 | 1982 | 2247 | 2039 |
| i) Remove Plant Sales | -199 | -199 | -199 | -199 | -199 | -199 | -199 | -199 | -199 | -199 | -199 | -55 | -199 | -199 |
| j) Remove Flow-through-transfer | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| k) ...Total | 1854 | 1896 | 2044 | 1674 | 1366 | 1505 | 1313 | 1443 | 1455 | 1370 | 1378 | 1927 | 2048 | 1840 |
| 3. Flows-In of firm power to PNWA, except from coordinated thermal installations | | | | | | | | | | | | | | |
| a) White Book Imports | -1415 | -1408 | -1154 | -1095 | -1415 | -1831 | -1568 | -1598 | -1251 | -1064 | -1064 | -1096 | -1369 | -1459 |
| b) Remove UP&L imports for SW Idaho | 740 | 740 | 622 | 563 | 560 | 641 | 584 | 583 | 559 | 531 | 531 | 572 | 809 | 884 |
| c) Remove Eastern Thermal Instal | 401 | 401 | 380 | 379 | 422 | 483 | 477 | 475 | 426 | 369 | 369 | 371 | 406 | 420 |
| d) Added SeEx for WB Surplus | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| e) Added Can. Import for WB deficits | 0 | -1295 | -1295 | 0 | -1295 | -1295 | -1295 | -1295 | -1295 | -1295 | -1295 | 0 | 0 | -1295 |
| f) Added Calif. Import for WB deficits | 0 | 0 | 0 | 0 | 0 | 0 | -22 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| g) Added Seas. Exch. for Aop hydro | -128 | -253 | 0 | -177 | -148 | 0 | -129 | -187 | -201 | -655 | -555 | 0 | 0 | 0 |
| h) Remove Flow-Through-Xfers | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| i) ...Total | -401 | -1815 | -1448 | -330 | -1875 | -2003 | -1954 | -2022 | -1761 | -2115 | -2014 | -152 | -154 | -1450 |
| 4. PNWA Non-Step I Hydro and Non-thermal Resources | | | | | | | | | | | | | | |
| a) Hydro Independents (1932) | -1282 | -1272 | -1232 | -1124 | -1257 | -1386 | -1561 | -1264 | -1633 | -1633 | -1647 | -1895 | -1779 | -1529 |
| b) Non-Step I Coord. Hydro (1932) | -1503 | -1577 | -1930 | -2015 | -2161 | -2134 | -2050 | -1911 | -1822 | -1788 | -2020 | -2026 | -2376 | -2439 |
| c) WB Regional Hydro NUGs | -401 | -399 | -327 | -244 | -185 | -174 | -166 | -177 | -216 | -326 | -340 | -464 | -481 | -471 |
| d) WB Renewable NUGs | -77 | -77 | -77 | -77 | -77 | -77 | -77 | -77 | -76 | -76 | -76 | -76 | -76 | -76 |
| e) WB Renewables | -38 | -38 | -38 | -38 | -38 | -38 | -38 | -38 | -38 | -38 | -38 | -38 | -38 | -38 |
| f) ... Total (1932) | -3300 | -3362 | -3603 | -3498 | -3718 | -3809 | -3892 | -3468 | -3784 | -3862 | -4121 | -4499 | -4749 | -4554 |
| 5. Step I System Load 3/ (1932) | 29104 | 27632 | 24546 | 26202 | 27542 | 30471 | 30603 | 28894 | 26016 | 23807 | 23630 | 24017 | 26820 | 27738 |
| 6. Coordinated Thermal Installations | | | | | | | | | | | | | | |
| a) Columbia Generating Station (cgs) | 1130 | 1130 | 1130 | 1130 | 1130 | 1130 | 1130 | 1130 | 1130 | 1130 | 1130 | 565 | 565 | 1130 |
| b) Generic Thermal Installations | 11089 | 11089 | 11135 | 11312 | 11398 | 11459 | 11467 | 11426 | 10871 | 10256 | 10256 | 9094 | 10681 | 11091 |
| c) ...Total | 12219 | 12219 | 12265 | 12442 | 12528 | 12589 | 12597 | 12556 | 12001 | 11386 | 11386 | 9659 | 11246 | 12221 |
| 7. Step I Hydro Resc. Needed (1932) 4/ | 26752 | 25288 | 22798 | 24717 | 25168 | 27322 | 26876 | 24874 | 22651 | 21099 | 20483 | 21937 | 23659 | 24603 |
| 8. Step I Resource Adjustments | | | | | | | | | | | | | | |
| a) Hydro Maintenance 5/ | -4445 | -4397 | -5075 | -5614 | -4590 | -3707 | -3136 | -3042 | -3385 | -3374 | -2787 | -2185 | -2265 | -3240 |
| b) ...Hydro maint. as % reg. hydro capa | 14.5% | 14.3% | 16.2% | 18.0% | 14.6% | 11.7% | 10.1% | 10.4% | 11.9% | 11.5% | 9.4% | 7.1% | 7.0% | 10.1% |
| c) Transmission System Losses 6/ | -1135 | -1183 | -1165 | -1116 | -1202 | -1242 | -1241 | -1193 | -1135 | -1154 | -1182 | -1124 | -1211 | -1250 |
| d) Reserves (11% of resources) 7/ | -4288 | -4296 | -4276 | -4228 | -4362 | -4491 | -4493 | -4301 | -4117 | -4150 | -4269 | -4270 | -4608 | -4596 |
| e) ...Peak reserves as % resources | 11.0% | 11.0% | 11.0% | 11.0% | 11.0% | 11.0% | 11.0% | 11.0% | 11.0% | 11.0% | 11.0% | 11.0% | 11.0% | 11.0% |
| f) ...Total Adjustments | -9868 | -9875 | -10517 | -10958 | -10154 | -9440 | -8870 | -8536 | -8636 | -8678 | -8239 | -7578 | -8085 | -9086 |
| 9. Required Step I Resources | 29104 | 27632 | 24546 | 26202 | 27542 | 30471 | 30603 | 28894 | 26016 | 23807 | 23630 | 24017 | 26820 | 27738 |
| 10. Coordinated Hydro load and Surplus/Deficit (1932) | | | | | | | | | | | | | | |
| a) Coordinated Hydro Load (1932) 8/ | 28255 | 26865 | 24728 | 26732 | 27329 | 29456 | 28926 | 26786 | 24473 | 22887 | 22502 | 23962 | 26034 | 27042 |
| b) Actual Coord. Hydro Gen (1932) 9/ | 29410 | 29446 | 30014 | 30124 | 30158 | 30269 | 29547 | 28034 | 26844 | 27645 | 28109 | 28870 | 30540 | 30686 |
| c) ...Surplus/Deficit (1932) | 1155 | 2581 | 5286 | 3392 | 2829 | 813 | 621 | 1248 | 2371 | 4758 | 5607 | 4908 | 4506 | 3644 |

Notes:

- 1/ Federal peak diversity is a reduction in peak load due to peak loads not all being coincidental.
- 2/ Export or import to balance difference between excluded thermal imports and generic thermal installation.
- 3/ Total Step I Firm Peak Load is the sum of lines 1e + 2k + 3i + 4f.
- 4/ Step I hydro resources needed to meet the load = line 5 minus lines 6c and 8f. Actual resource capability is higher. Used 1932 because has lowest surplus.
- 5/ Maintenance factors from WB 1937 (but identified in WB as maintenance for 1929).
- 6/ Transmission losses are 3.35% of all resources including imports, net of reserves and maintenance.
- 7/ Assumed value.
- 8/ Lines 4b and 7.
- 9/ System Instantaneous Peak (1932).

TABLE 2
DETERMINATION OF THERMAL DISPLACEMENT MARKET
FOR 2018-19 AOP/DDPB STEPS II AND III STUDIES
(Average MW)

| | Aug15 | Aug31 | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr15 | Apr30 | May | Jun | Jul | Annual Average | CP Avg (42.5 mon) |
|--|-------|-------|-------|-------|-------|-------|-------|-------|------|-------|-------|------|-------|-------|----------------|-------------------|
| 1. STEP I THERMAL INSTALLATIONS | | | | | | | | | | | | | | | | |
| a) From Table 1A, line 6(c) | 10381 | 10380 | 10271 | 10335 | 10428 | 10637 | 10590 | 10442 | 9700 | 9326 | 8815 | 7116 | 9437 | 10287 | 9887.7 | 9973.2 |
| 2. DISPLACEABLE THERMAL RESOURCES | | | | | | | | | | | | | | | | |
| a) Minimum Gen. from % of Thermal | 233 | 233 | 230 | 232 | 234 | 239 | 238 | 234 | 216 | 207 | 194 | 160 | 222 | 232 | 222.5 | 224.3 |
| b) Net Displaceable Thermal Resources | 10148 | 10148 | 10041 | 10104 | 10194 | 10398 | 10352 | 10207 | 9484 | 9119 | 8621 | 6956 | 9215 | 10056 | 9665.3 | 9748.9 |
| 3. SYSTEM SALES (i.e. Amount of Coordinated Thermal Installation Power Used Outside PNWA) | | | | | | | | | | | | | | | | |
| a) Flow s-Out (Table 1A, line 2(h)) | 1792 | 1863 | 1877 | 1620 | 1332 | 1381 | 1148 | 1211 | 1503 | 1578 | 1538 | 1919 | 2125 | 1838 | 1613.6 | 1590.7 |
| b) ...Exclude Can.Entitlement Exported | -470 | -470 | -470 | -470 | -470 | -470 | -470 | -470 | -470 | -470 | -470 | -470 | -470 | -470 | -470.0 | -470.0 |
| c) ...Exclude Plant Sales | -878 | -909 | -810 | -767 | -748 | -636 | -605 | -549 | -859 | -1025 | -1007 | -841 | -1133 | -952 | -818.4 | -800.9 |
| d) ...Exclude WB Flow -Through-Transfer | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 | 0.0 |
| e) ...Exclude WB. Seasonal Exchange | -187 | -187 | -168 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -46 | -160 | -47.1 | -46.1 |
| f) ...Exclude SeEx for WB Surp/Def | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 | 0.0 |
| g) ...Exclude SeEx for AOP Hydro Diff. | 0 | 0 | -279 | 0 | 0 | -204 | 0 | 0 | 0 | 0 | 0 | -601 | -389 | -145 | -135.7 | -126.3 |
| h) ...Exclude Other Flow -ThruTransfer | -123 | -116 | -3 | -3 | -4 | -71 | -27 | -4 | -4 | -3 | -3 | -3 | -3 | -3 | -20.8 | -21.7 |
| i) ...Exclude Other Seasonal Exchange | -15 | -21 | -17 | -44 | -13 | 0 | -5 | -22 | -20 | -9 | -7 | 0 | -10 | -12 | -14.1 | -14.5 |
| j) ...Total System Sales | 118 | 159 | 130 | 336 | 97 | 0 | 41 | 167 | 151 | 70 | 51 | 3 | 74 | 94 | 107.5 | 111.1 |
| k) Uniform Average Ann.System Sales | 108 | 108 | 108 | 108 | 108 | 108 | 108 | 108 | 108 | 108 | 108 | 108 | 108 | 108 | 107.5 | 107.5 |
| 4 THERMAL DISPLACEMENT MARKET | | | | | | | | | | | | | | | | |
| a) Line 2b minus line 3k | 10041 | 10040 | 9933 | 9996 | 10087 | 10291 | 10245 | 10100 | 9376 | 9012 | 8513 | 6848 | 9108 | 9948 | 9557.7 | 9641.4 |

Notes:

- 2a Minimum generation is 0.0249 times the monthly average Step I thermal, without CGS; based on 2006 AOP data.
- 3b Canadian Entitlement exports are assumed to be supported by hydro instead of thermal.
- 3c Plant sales include Longview Fibre and approximately 25 percent of Boardman; line 2i, Table 1A.
- 3d Flow-through-transfers from the White Book.
- 3e Seasonal Exchanges from the White Book.
- 3f f Seasonal exchange added to White Book value to export WB surplus.
- 3g Seasonal Exchanges were employed in this AOP to make the Coordinated Hydro Load in Line 10 match the AOP18 Coordinated Hydro Load.
- 3h Other flow through transfers are remaining flows-out supported by remaining thermal imports in the same period.
- 3i Other Seasonal Exchanges are remaining exports supported by thermal imports greater than imports on an annual basis.
- 3j Total System Sales are total exports excluding exchanges, plant sales, flow-thru-xfers, and the Canadian Entitlement. The sum of Lines 3a through 3i.
- 3k Average Annual System Sales shaped uniformly per 1988 Entity Agreement assumption that shaping is supported by hydro system.
- 4 PNW Area Thermal Displacement Market is the Total Displaceable Thermal Resources used to meet PNW Area firm loads. Lines 2b minus 3k.

TABLE 3
DETERMINATION OF LOADS FOR STEP II AND STEP III STUDIES
FOR 2018-19 AOP/DDPB STUDIES

| Period | PACIFIC NORTHWEST AREA LOADS | | | | THERMAL INSTALLATIONS | | | |
|-------------------------------------|--------------------------------------|--|--------------------------------------|-----------------------------|--------------------------------------|--------------------------------------|--------------------------------------|-------------------------------|
| | Area Energy Load 1/ aMW | Annual Energy Load Shape Percent | Peak Load MW | Load Factor Percent | Energy Capability 2/ aMW | Annual Energy Shape Percent | Peak Capability MW | Capacity Factor Percent |
| | | | | | | | | |
| August 1-15 | 23360 | 101.37 | 30951 | 75.48 | 10381 | 105.0% | 12219 | 85.0% |
| August 16-31 | 23350 | 101.32 | 30913 | 75.54 | 10380 | 105.0% | 12219 | 85.0% |
| September | 21596 | 93.71 | 27553 | 78.38 | 10271 | 103.9% | 12265 | 83.7% |
| October | 20774 | 90.14 | 28356 | 73.26 | 10335 | 104.5% | 12442 | 83.1% |
| November | 23239 | 100.84 | 31769 | 73.15 | 10428 | 105.5% | 12528 | 83.2% |
| December | 25509 | 110.69 | 34777 | 73.35 | 10637 | 107.6% | 12589 | 84.5% |
| January | 25800 | 111.95 | 35135 | 73.43 | 10590 | 107.1% | 12597 | 84.1% |
| February | 24521 | 106.40 | 32941 | 74.44 | 10442 | 105.6% | 12556 | 83.2% |
| March | 22522 | 97.73 | 30106 | 74.81 | 9700 | 98.1% | 12001 | 80.8% |
| April 1-15 | 21540 | 93.47 | 28413 | 75.81 | 9326 | 94.3% | 11386 | 81.9% |
| April 16-30 | 21577 | 93.63 | 28388 | 76.01 | 8815 | 89.1% | 11386 | 77.4% |
| May | 20939 | 90.86 | 26741 | 78.30 | 7116 | 72.0% | 9659 | 73.7% |
| June | 22642 | 98.25 | 29675 | 76.30 | 9437 | 95.4% | 11246 | 83.9% |
| July | 24134 | 104.72 | 31901 | 75.65 | 10287 | 104.0% | 12221 | 84.2% |
| Annual Avg. Z/ | 23045.6 | 100.00 | | 75.21 | 9887.7 | 100.0% | | 82.4% |
| S1 CP Avg(42.5mon) | 23123.9 | | | 75.08 | 9973.2 | | | |
| S2 CP Avg(20mon) | 23104.0 | | | | 10006.7 | | | |
| S3 CP Avg(5.5mon) | 24069.8 | AvgAnnEn/MaxPeak= 65.6% | | | 10264.1 | AvgAnnEn/MaxPeak= 78.5% | | |
| Period | STEP II SYSTEM | | | | STEP III SYSTEM | | | |
| | Total Energy Load 3/ aMW | Total Peak Load MW | Hydro Energy Load 4/ aMW | Hydro Peak Load MW | Total Energy Load 3/ aMW | Total Peak Load MW | Hydro Energy Load 4/ aMW | Hydro Peak Load MW |
| | | | | | | | | |
| August 1-15 | 19122.5 | 25336 | 8741.4 | 13117 | 16733.9 | 22171 | 6352.7 | 9952 |
| August 16-31 | 19114.5 | 25305 | 8734.1 | 13086 | 16726.8 | 22144 | 6346.4 | 9925 |
| September | 17678.1 | 22555 | 7407.3 | 10289 | 15469.9 | 19737 | 5199.0 | 7472 |
| October | 17005.7 | 23212 | 6670.2 | 10769 | 14881.4 | 20312 | 4546.0 | 7870 |
| November | 19022.9 | 26006 | 8594.8 | 13478 | 16646.7 | 22757 | 6218.6 | 10230 |
| December | 20881.6 | 28469 | 10244.3 | 15880 | 18273.3 | 24912 | 7636.0 | 12324 |
| January | 21119.3 | 28761 | 10529.2 | 16164 | 18481.2 | 25168 | 7891.1 | 12571 |
| February | 20072.3 | 26965 | 9630.5 | 14409 | 17565.0 | 23597 | 7123.2 | 11041 |
| March | 18436.4 | 24645 | 8736.6 | 12644 | 16133.4 | 21566 | 6433.7 | 9565 |
| April 1-15 | 17632.1 | 23259 | 8306.2 | 11872 | 15429.6 | 20353 | 6103.8 | 8967 |
| April 16-30 | 17662.4 | 23238 | 8847.5 | 11851 | 15456.1 | 20335 | 6641.3 | 8949 |
| May | 17140.3 | 21890 | 10024.5 | 12231 | 14999.3 | 19156 | 7883.5 | 9497 |
| June | 18534.3 | 24292 | 9096.9 | 13046 | 16219.1 | 21257 | 6781.7 | 10012 |
| July | 19755.8 | 26114 | 9468.4 | 13893 | 17288.0 | 22852 | 7000.6 | 10631 |
| Annual Avg. Z/ | 18864.9 | | 8977.2 | | 16508.4 | | 6620.7 | |
| S2 CP Avg(20mon) | 18912.8 | | 8906.1 | | | | | |
| S3 CP Avg(5.5mon) | | | | | 17242.1 | | 6978.0 | |
| Joint Optimum S2 CP capability 5/ = | | | | 8906.11 | S3 CP capability 6/ = 6978.00 | | | |

Notes:

1/ The PNW Area load does not include the exports, but does include pumping.

2/ The thermal installations include all thermal used to meet the Step I system load. (Table 2, line 1(a)).

3/ The total firm load for the Step II and III studies is computed to have the same shape as the load of the PNW Area.

4/ The hydro load is equal to the total load minus the Step I study thermal installations for each period.

5/ Input is the assumed critical period average generation for the Step II hydro studies and is used to calculate the residual hydro loads.

6/ Input is the assumed critical period average generation for the Step III hydro studies and is used to calculate the residual hydro loads.

7/ The Annual Average is for the operating year. The Critical Period (CP) averages are for the historic water years.

TABLE 4
SUMMARY OF STEPS I, II, & III POWER REGULATIONS
FOR 2018-19 ASSURED OPERATING PLAN

| | BASIC DATA | | STEP I | | | | STEP II | | | | STEP III | | | | | |
|--|--------------|---|-------------------|----------------------|--------------------|-------------------|----------------------|--------------------|--------------------|-------------------|----------------------|--------------------|--------------------|-------|--------|-------|
| | NUMBER OF | MAXIMUM INSTALLED PEAKING CAPACITY | USABLE STORAGE | CRITICAL CAPACITY | CRITICAL ENERGY | USABLE STORAGE | CRITICAL CAPACITY | CRITICAL PERIOD | 30 YEAR AVERAGE | USABLE STORAGE | CRITICAL CAPACITY | CRITICAL PERIOD | 30 YEAR AVERAGE | | | |
| | | Jan 1932 | | FELCC Avg.Gen | Jan 1932 | | FELCC Avg.Gen | Jan 1930 | FELCC Avg.Gen | | ANNUAL GEN. | | | | | |
| | UNITS | MW | kaf | hm ³ | MW | MW | kaf | hm ³ | MW | MW | MW | kaf | hm ³ | MW | MW | MW |
| 1. HYDRO RESOURCES | | | | | | | | | | | | | | | | |
| a) CANADIAN STORAGE | | | | | | | | | | | | | | | | |
| Mica | | | 7000 | 8634 | | | 7000 | 8634 | | | | | | | | |
| Arrow | | | 7100 | 8758 | | | 7100 | 8758 | | | | | | | | |
| Duncan | | | 1400 | 1727 | | | 1400 | 1727 | | | | | | | | |
| Subtotal | | | 15500 | 19119 | | | 15500 | 19119 | | | | | | | | |
| b) BASE SYSTEM | | | | | | | | | | | | | | | | |
| Hungry Horse | 4 | 428 | 3072 | 3789 | 134 | 93 | 3008 | 3710 | 144 | 108 | 98 | 3008 | 3710 | 330 | 235 | 96 |
| Kerr | 3 | 160 | 1219 | 1504 | 168 | 122 | 1219 | 1504 | 175 | 112 | 129 | 1219 | 1504 | 175 | 155 | 125 |
| Thompson Falls | 6 | 85 | 0 | 0 | 85 | 56 | 0 | 0 | 85 | 53 | 58 | 0 | 0 | 85 | 66 | 58 |
| Noxon Rapids | 5 | 554 | 231 | 285 | 490 | 151 | 0 | 0 | 528 | 132 | 201 | 0 | 0 | 528 | 176 | 201 |
| Cabinet Gorge | 4 | 239 | 0 | 0 | 262 | 104 | 0 | 0 | 262 | 91 | 125 | 0 | 0 | 262 | 117 | 126 |
| Albeni Falls | 3 | 50 | 1155 | 1425 | 21 | 22 | 1155 | 1425 | 20 | 22 | 21 | 1155 | 1425 | 20 | 21 | 19 |
| Box Canyon | 4 | 74 | 0 | 0 | 71 | 46 | 0 | 0 | 71 | 44 | 48 | 0 | 0 | 71 | 57 | 47 |
| Grand Coulee | 24+3SS | 6684 | 5185 | 6396 | 5911 | 2022 | 5072 | 6256 | 6020 | 1821 | 2396 | 5072 | 6256 | 5195 | 1225 | 2305 |
| Chief Joseph | 27 | 2535 | 0 | 0 | 2535 | 1075 | 0 | 0 | 2535 | 977 | 1314 | 0 | 0 | 2535 | 709 | 1239 |
| Wells | 10 | 840 | 0 | 0 | 840 | 421 | 0 | 0 | 840 | 390 | 491 | 0 | 0 | 840 | 288 | 444 |
| Chelan | 2 | 54 | 677 | 835 | 50 | 38 | 676 | 834 | 51 | 38 | 44 | 676 | 834 | 52 | 51 | 43 |
| Rocky Reach | 11 | 1267 | 0 | 0 | 1274 | 609 | 0 | 0 | 1274 | 563 | 732 | 0 | 0 | 1274 | 409 | 671 |
| Rock Island | 18 | 513 | 0 | 0 | 529 | 276 | 0 | 0 | 529 | 259 | 322 | 0 | 0 | 529 | 191 | 295 |
| Wanapum | 10 | 986 | 0 | 0 | 825 | 503 | 0 | 0 | 825 | 466 | 590 | 0 | 0 | 825 | 330 | 523 |
| Priest Rapids | 10 | 912 | 0 | 0 | 770 | 489 | 0 | 0 | 770 | 456 | 561 | 0 | 0 | 770 | 331 | 494 |
| Brownlee | 5 | 675 | 975 | 1203 | 675 | 198 | 974 | 1201 | 675 | 257 | 285 | 974 | 1201 | 662 | 243 | 286 |
| Oxbow | 4 | 220 | 0 | 0 | 220 | 83 | 0 | 0 | 220 | 107 | 116 | 0 | 0 | 220 | 105 | 116 |
| Ice Harbor | 6 | 693 | 0 | 0 | 693 | 206 | 0 | 0 | 693 | 221 | 297 | 0 | 0 | 693 | 162 | 297 |
| McNary | 14 | 1127 | 0 | 0 | 1127 | 615 | 0 | 0 | 1127 | 590 | 762 | 0 | 0 | 1127 | 438 | 708 |
| John Day | 16 | 2484 | 535 | 660 | 2484 | 943 | 0 | 0 | 2484 | 917 | 1264 | 0 | 0 | 2484 | 688 | 1220 |
| The Dalles | 22+2F | 2074 | 0 | 0 | 1875 | 767 | 0 | 0 | 1875 | 744 | 1001 | 0 | 0 | 1875 | 563 | 957 |
| Bonneville | 18+2F | 1088 | 0 | 0 | 1065 | 554 | 0 | 0 | 1065 | 537 | 677 | 0 | 0 | 1065 | 419 | 634 |
| Kootenay Lake | 0 | 0 | 673 | 830 | 0 | 0 | 673 | 830 | 0 | 0 | 0 | 673 | 830 | 0 | 0 | 0 |
| Coeur d'Alene Lake | 0 | 0 | 223 | 275 | 0 | 0 | 223 | 275 | 0 | 0 | 0 | 223 | 275 | 0 | 0 | 0 |
| Total Base System 1/ | | 23742 | 29445 | 36320 | 22104 | 9393 | 28500 | 35154 | 22268 | 8906 | 11535 | 13000 | 16035 | 21618 | 6977.9 | 10906 |
| c) ADDITIONAL STEP I PROJECTS | | | | | | | | | | | | | | | | |
| Libby | 5 | 600 | 4980 | 6143 | 352 | 202 | | | | | | | | | | |
| Boundary | 6 | 1055 | 0 | 0 | 855 | 368 | | | | | | | | | | |
| Spokane Rivr Pnts 2/ | 24 | 173 | 104 | 128 | 161 | 98 | | | | | | | | | | |
| Hells Canyon | 3 | 450 | 0 | 0 | 370 | 165 | | | | | | | | | | |
| Dworshak | 3 | 450 | 2015 | 2485 | 444 | 154 | | | | | | | | | | |
| Lower Granite | 6 | 932 | 0 | 0 | 932 | 160 | | | | | | | | | | |
| Little Goose | 6 | 932 | 0 | 0 | 932 | 169 | | | | | | | | | | |
| Lower Monumental | 6 | 932 | 0 | 0 | 928 | 165 | | | | | | | | | | |
| Pelton, Rereg.& RB | 7 | 423 | 274 | 338 | 419 | 139 | | | | | | | | | | |
| Total added Step I | | 5947 | 7373 | 9094 | 5393 | 1620 | | | | | | | | | | |
| d) Total Hydro | | 29689 | 52318 | 64533 | 27497 | 11013 | 44000 | 54273 | 22268 | 8906 | 11535 | 13000 | 16035 | 21618 | 6978 | 10906 |
| 2. THERMAL INSTALLATIONS 3/ | | | | | | | | | | | | | | | | |
| | | | CpEn/AnnPk=79% | 12597 | 9973 | | CpEn/AnnPk=79% | 12597 | 10007 | 9888 | | CpEn/AnnPk=81% | 12597 | 10264 | 9888 | |
| 3. RESOURCE ADJUSTMENTS | | | | | | | | | | | | | | | | |
| a) Hydro maintenance 4/ | | | | | -3136 | 0 | -10.1% of hydro | -2245 | n.a. | n.a. | | -10.1% of hydro | -2179 | n.a. | n.a. | |
| b) Peaking reserves 5/ | | | | | -4493 | n.a. | -11% of resc. | -3835 | n.a. | n.a. | | -11% of resc. | -3764 | n.a. | n.a. | |
| c) Transmission losses 6/ | | | | | -1241 | -664 | | n.a. | n.a. | n.a. | | | n.a. | n.a. | n.a. | |
| 4. TOTAL RESOURCES 7/ | | | | | | | | | | | | | | | | |
| | | | CpEn/AnnPk=65% | 31223 | 20322 | | CpEn/AnnPk=66% | 28785 | 18913 | 21422 | | CpEn/AnnPk=61% | 28272 | 17242 | 20794 | |
| 5. Steps I, II, & III System Loads | | | | | | | | | | | | | | | | |
| a) PNW Area firm load | | | CpEn/AnnPk=66% | 35135 | 23124 | | | | | | | | | | | |
| b) Net of Exports + Imports | | | | -640 | 348 | | | | | | | | | | | |
| c) Non-Step I resources | | | | -2050 | -808 | | | | | | | | | | | |
| d) Hydro Independents | | | | -1561 | -963 | | | | | | | | | | | |
| e) Miscellaneous resources | | | | -281 | -1377 | | | | | | | | | | | |
| f) ...Net Step I,II,III System Load 8/ | | | CpEn/AnnPk=66% | 30603 | 20323 | | CpEn/AnnPk=66% | 28761 | 18913 | 18865 | | CpEn/AnnPk=69% | 25168 | 17242 | 16508 | |
| 6. SURPLUS (Line 4 - 5 (f)) | | | | | | | | | | | | | | | | |
| | | | | | 620 | 0 | | | | | | | | 3104 | 0 | 4286 |
| CRITICAL PERIOD | | | | | | | | | | | | | | | | |
| Starts | | | | August 16, 1928 | | | September 1, 1943 | | | | | November 1, 1936 | | | | |
| Ends | | | | February 29, 1932 | | | April 30, 1945 | | | | | April 15, 1937 | | | | |
| Length (Months) | | | | 42.5 Months | | | 20 Months | | | | | 5.5 Months | | | | |
| Study Identification | | | | 19-41 | | | 19-12 9/ | | | | | 19-13 9/ | | | | |

Notes

1/ The above totals may not exactly equal the sum of the above values due to rounding. The total Base System Storage for Steps I & II includes Canadian storage.

2/ Spokane River Plants include: Little Falls, Long Lake, Nine Mile, Monroe, Upper Falls, and Post Falls.

3/ From Tables 1a, 1b and 3.

4/ Step I hydro maintenance from Tables 1a and 1b. Steps II/III peak hydro maintenance is the same percent as Step I coordinated Hydro; no energy maintenance loss was included because impact is negligible. Hydro maintenance energy losses are not included in Steps II & III.

5/ Steps I, II, and III peak reserves are 11% of resources.

6/ Step I transmission losses from Table 1a and 1b. Steps II & III transmission losses are not included, since it would change the energy load by the same amount. Total Resources is the sum total of lines 1b + 2 + 3a + 3b + 3c. For Step I, this does not include non-Step I coordinated hydro or hydro-independents.

7/ Step I energy load from Table 1a, line 5, and January peak load from Table 1b, line 5. Steps II & III energy load from Table 3. Steps II & III peak loads are equal to Steps II and III January energy load divided by the PNWA January load factor.

8/ Steps II and III FPLCC and 30 Year Average Annual Gen are from 1842 and 1813 studies, respectively. FELCCs are from 1912 and 1913 Critical Period studies.

TABLE 5
COMPUTATION OF CANADIAN ENTITLEMENT
FOR 2018-19 ASSURED OPERATING PLAN

- A. Joint Optimum Power Generation in Canada and the U.S.**
 (from agreement in place of the 19-42 and 19-13 30-yr studies)
- B. Optimum Power Generation in the U.S. Only**
 (from agreement in place of the 19-12 and 19-13 30-yr studies)

| Determination of Dependable Capacity Credited to Canadian Storage (MW) | | |
|---|---------------|---------------|
| | <u>(A)</u> | <u>(B)</u> |
| Step II - Critical Period Average Generation <u>1/</u> | 8906.1 | 8906.1 |
| Step III - Critical Period Average Generation <u>2/</u> | 6978.0 | 6978.0 |
| Gain Due to Canadian Storage | 1928.1 | 1928.1 |
| Average Critical Period Load Factor in percent <u>3/</u> | 75.08 | 75.08 |
| Dependable Capacity Gain <u>4/</u> | 2567.9 | 2567.9 |
| Dependable Capacity Limit (from Table 4) <u>5/</u> | 3592.6 | 3592.6 |
| Canadian Share of Dependable Capacity <u>6/</u> | 1284.0 | 1284.0 |
| Determination of Increase in Average Annual Usable Hydro Energy (aMW) | | |
| Step II (with Canadian Storage) <u>1/</u> | <u>(A)</u> | <u>(B)</u> |
| Firm Energy <u>7/</u> | 8977.6 | 8977.6 |
| Thermal Displacement Energy <u>8/</u> | 2432.6 | 2429.1 |
| Remaining Usable Energy <u>9/</u> | 49.9 | 50.7 |
| System Average Annual Usable Energy | 11460.1 | 11457.4 |
| Step III (without Canadian Storage) <u>2/</u> | | |
| Firm Energy <u>7/</u> | 6621.0 | 6621.0 |
| Thermal Displacement Energy <u>8/</u> | 3633.4 | 3633.4 |
| Remaining Usable Energy <u>9/</u> | 260.7 | 260.7 |
| System Average Annual Usable Energy | 10515.1 | 10515.1 |
| Average Annual Usable Energy Gain <u>10/</u> | 945.0 | 942.3 |
| Canadian Share of Average Annual Energy Gain <u>5/</u> | 472.5 | 471.2 |

- 1/ Step II values were obtained from the 19-12 Critical Period study for Capacity Entitlement, and the Streamline Method using 18-12 and 18-42 30-year studies for Energy Entitlement.
- 2/ Step III values were obtained from the 19-13 Critical Period study for Capacity Entitlement, and the Streamline Method using 18-13 30-year study for Energy Entitlement.
- 3/ Critical period load factor from Table 3.
- 4/ Dependable Capacity Gain credited to Canadian storage equals gain in critical period average generation divided by the average critical period load factor.
- 5/ From Table 4. Does not set a precedent or necessarily imply agreement on calculation of this value.
- 6/ One-half Dependable Capacity or Usable Energy Gain, as limited by Capacity Credit Limit.
- 7/ From 30-year average firm load served, which includes 7 leap years (29 days in February), so slightly different than Table 3.
- 8/ Average secondary generation limited to Potential Thermal Displacement Market.
- 9/ Forty percent (40%) of the remaining secondary energy.
- 10/ Difference between Step II and Step III Average Annual Usable Energy.

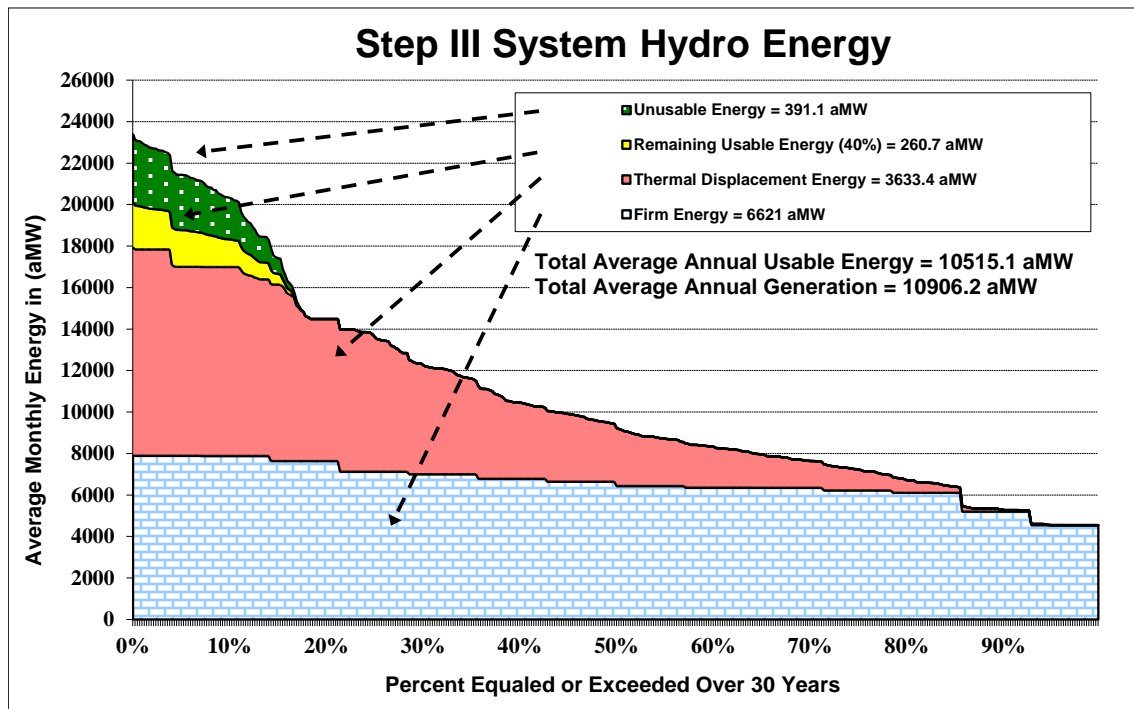
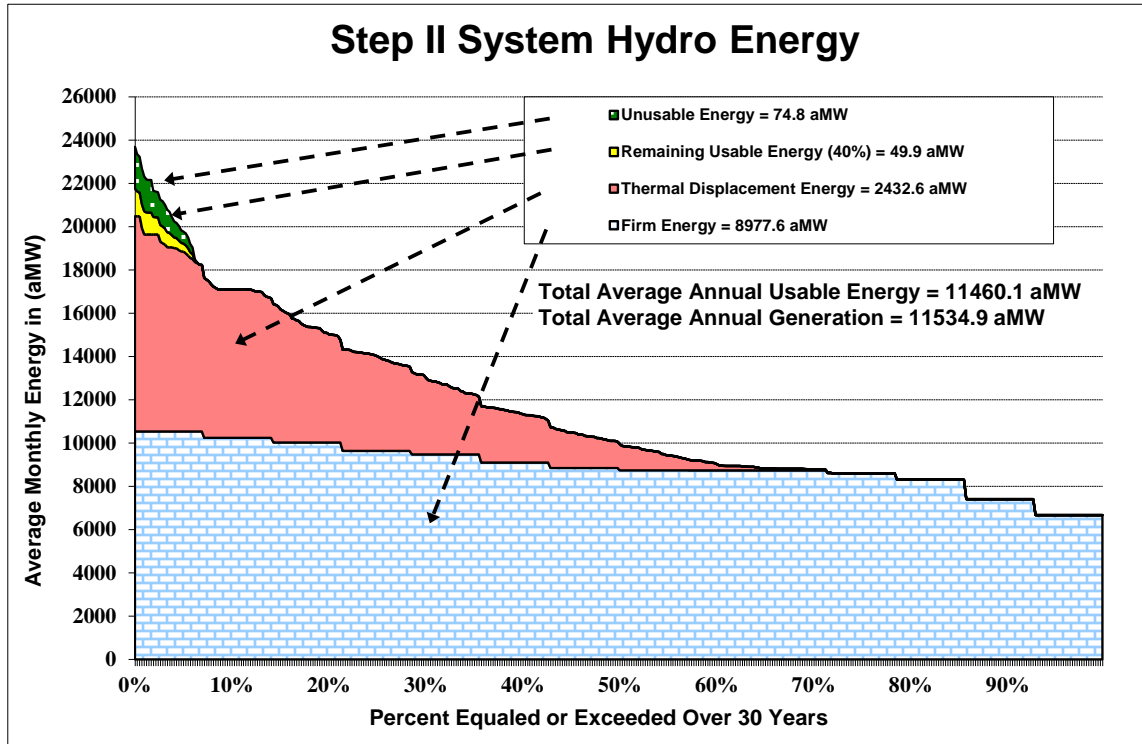
TABLE 6
COMPARISON OF RECENT DDPB STUDIES
 (English and Metric units)

| | 2014-15 | 2015-16 | 2016-17 | 2017-18 | 2018-19 |
|--|---------------|---------------|---------------|---------------|---------------|
| AVERAGE PNWA ENERGY LOAD | | | | | |
| Annual Load (MW) | 23013.7 | 22478.2 | 22801.8 | 22775.6 | 23045.6 |
| January Load Factor (%) 1/ | 112.8 | 112.5 | 112.6 | 112.1 | 112.0 |
| Critical Period (CP) Avg. Load Factor (%) | 74.8 | 73.9 | 74.0 | 74.6 | 75.1 |
| Annual Firm Exports 2/ | 833.0 | 832.3 | 841.9 | 725.6 | 795.2 |
| Annual Firm Imports 3/ | 467.0 | 378.6 | 400.4 | 233.1 | 429.3 |
| Annual Non-Step 1 Hydro & Misc Rsrc 4/ | 2919.0 | 3022.4 | 3012.8 | 3130.5 | 3295.1 |
| Total Annual Step 1 Load 5/ | 20462.0 | 19909.5 | 20230.6 | 20137.6 | 20116.4 |
| THERMAL INSTALLATIONS (MW) 6/ | | | | | |
| January Peak Capability | 13734.6 | 12146.7 | 12533.5 | 12367.5 | 12596.8 |
| CP Energy | 10215.7 | 9662.4 | 9995.3 | 9994.3 | 9973.2 |
| CP Minimum Generation | 230.3 | 216.6 | 224.8 | 224.8 | 224.3 |
| Average Annual System Export Sales | 180.5 | 252.6 | 239.3 | 195.9 | 107.5 |
| Average Annual Displaceable Market | 9708.5 | 9111.5 | 9448.2 | 9490.6 | 9557.7 |
| Average Annual Energy 7/ | 10117.0 | 9578.8 | 9910.5 | 9909.4 | 9887.7 |
| HYDRO RESOURCES (aMW) | | | | | |
| Average Annual Step 1 Hydro Resources 8/ | 11021.0 | 10994.7 | 10991.3 | 10890.9 | 10890.9 |
| Average Annual Step 1 Coord Hydro Load 9/ | 11819.0 | 11793.9 | 11790.9 | 11689.3 | 11689.3 |
| STEP I/II/III CP (MONTHS) | 42.5/20/5.5 | 42.5/20/5.5 | 42.5/20/5.5 | 42.5/20/5.5 | 42.5/20/5.5 |
| BASE STREAMFLOWS AT THE DALLES 10/ | | | | | |
| Step I 30-yr Avg Streamflow, cfs and m ³ /s | 175120 4959 | 175084 4958 | 175084 4958 | 173390 4910 | 173390 4910 |
| Step I CP Average, cfs and m ³ /s | 114518 3243 | 114487 3242 | 114487 3242 | 112665 3190 | 112665 3190 |
| Step II CP Average, cfs and m ³ /s | 101396 2871 | 101376 2871 | 101376 2871 | 99211 2809 | 99211 2809 |
| Step III CP Average, cfs and m ³ /s | 56034 1587 | 56088 1588 | 56088 1588 | 54698 1549 | 54698 1549 |
| CAPACITY BENEFITS (MW) | | | | | |
| Step II CP Generation | 8944.9 | 8951.5 | 8948.4 | 8902.8 | 8906.1 |
| Step III CP Generation | 6898.7 | 6981.7 | 6974.5 | 6957.1 | 6978.0 |
| Step II Gain over Step III | 2046.2 | 1969.9 | 1973.9 | 1945.7 | 1928.1 |
| CANADIAN ENTITLEMENT | 1368.6 | 1332.3 | 1333.2 | 1304.1 | 1284.0 |
| Change due to Mica Reoperation | 1.5 | 1.2 | 0.0 | 1.3 | 0.0 |
| ENERGY BENEFITS (aMW) | | | | | |
| Step II Annual Firm | 8961.8 | 8960.1 | 8944.7 | 8999.4 | 8977.6 |
| Step II Thermal Displacement | 2423.9 | 2383.9 | 2422.6 | 2407.8 | 2432.6 |
| Step II Remaining Usable Secondary | 49.1 | 68.1 | 58.6 | 51.0 | 49.9 |
| Step II System Average Annual Usable | 11434.8 | 11412.0 | 11425.8 | 11458.2 | 11460.1 |
| Step III Annual Firm | 6300.7 | 6422.8 | 6354.9 | 6644.2 | 6621.0 |
| Step III Thermal Displacement | 3879.6 | 3681.8 | 3800.3 | 3598.5 | 3633.4 |
| Step III Remaining Usable Secondary | 294.7 | 330.0 | 309.8 | 265.4 | 260.7 |
| Step III System Average Annual Average | 10475.1 | 10434.6 | 10465.1 | 10508.2 | 10515.1 |
| CANADIAN ENTITLEMENT 11/ | 479.9 | 488.7 | 484.0 | 475.0 | 472.5 |
| Change due to Mica Reoperation | 9.9 | 3.7 | 3.7 | 1.3 | 1.3 |
| STEP II PEAK CAPABILITY (MW) | 30944 | 28367 | 30163 | 29649 | 28785 |
| STEP II PEAK LOAD (MW) | 29236 | 27306 | 29051 | 29014 | 28761 |
| STEP III PEAK CAPABILITY (MW) | 30063 | 27703 | 28035 | 29105 | 28272 |
| STEP III PEAK LOAD (MW) | 25158 | 23568 | 23992 | 25400 | 25168 |

FOOTNOTES FOR TABLE 6

1. $100\% \times (\text{January}) / (\text{average annual PNWA})$ firm loads (Table 1A, row 1(d)).
2. Average annual total firm exports (Table 1A, row 2(k)).
3. Absolute value of average annual total firm imports (Table 1A, row 3(i)).
4. Absolute value of average annual PNWA Non-Step I Hydro and Non-Thermal Resources (Table 1A, row 4(f)).
5. Average annual total Step I load (Table 1A, row 5).
6. Beginning with the 2006-07 DDPB, thermal installations include Columbia Generating Station and a generic thermal installation sized as needed to meet the Step I load. January thermal peak capability is shown (Table 1B, row 6(c)), which corresponds with the actual minimum peak surplus month (Table 1B, row 10(c)).
7. Average annual Energy from the thermal installations (Table 1A, row 6(c)).
8. Average annual Step I Hydro Resources (Table 1A, row 7).
9. Average annual Step I Coordinated Hydro load (Table 1A, row 10).
10. The 2010 level modified streamflows were used beginning with the 2017-18 DDPB with adjustments for the Grand Coulee net pumping flows. The 2014-15, 2015-16 and 2016-17 DDPBs, based upon 2000 level modified streamflows, all include updated adjustments for the Grand Coulee gross pumping flows.
11. The energy benefits for 2014-15, 2015-16, and 2017-18 are all based upon Step II Joint Optimum and Step III U.S. Optimum 30-year hydro regulation studies. The energy benefits for 2016-17 are based upon 30-Year U.S. Optimum hydro regulation studies, which includes an adjustment (+3.7 aMW) to estimate the increase in the energy entitlement that would result from a Joint Optimum operation of the Step II study. The energy benefits for 2018-19 are estimated using the third streamline procedure based on the 2017-18 Step II Joint Optimum and Step III U.S. Optimum 30-year hydro regulation studies.

CHART 1
DURATION CURVES OF 30-YEAR MONTHLY HYDRO GENERATION
From the 19-42 and 19-13 Studies (Average monthly MW)



Values on chart above may differ from the values on Table 5 by as much as 0.1 aMW due to rounding error.