

Columbia River Treaty

2014/2024 Review

United States Entity Supplemental Report

Appendix D

September 2010



United States Entity

APPENDIX D

PHASE 1 SUPPLEMENTAL STUDY RESULTS

CALLED UPON YEARS

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D.1 INTRODUCTION

In general, the planning and operation of the Canadian Treaty projects does not recognize operations not defined in the actual Treaty or Treaty Protocol. Since the Phase 1 studies were primarily focused on looking at the two fundamental river purposes defined under the Treaty, power and flood control, the studies did not include additional operations not considered under the Treaty. By approaching the Phase 1 studies from this Treaty standpoint, both the U.S. and Canadian Entities believed they created a baseline of information for comparison and to build from for future studies and for engagement with the sovereigns and stakeholders within their respective countries. However, since the Biological Opinions (BiOp) have such a strong influence on the U.S. operations, the U.S. Entity felt it was important to look at the Phase 1 study results with the fish operations included. The purpose of this appendix is to describe the modeling, methodology and criteria used in the U.S. Entity Phase 1 Supplemental studies that were done to assess the impacts to the U.S. system and fish operations when BiOp requirements were overlaid on the Phase 1 studies. The Phase 1 studies referred to in this appendix are:

1. Treaty continues post-2024 and Called Upon flood control is implemented (Study A);
2. Treaty is terminated in 2024 and Called Upon flood control is implemented (Study B); and
3. Treaty continues post-2024 with largely the same Treaty and flood control operations as today (Study C).

The purpose of this Appendix is to explore how system operations with Biological Opinion strategies performed in Called Upon years. In the Phase 1 studies, the Columbia River system was operated so as to not exceed two maximum flow objectives at The Dalles. One set of studies was performed to not exceed 450 kcfs as the maximum flood control flow objective at The Dalles. In these 450 kcfs studies, Called Upon flood control draft occurred in 52 of the 70 years being studied. The other studies where 600 kcfs was the maximum flood control flow objective at The Dalles, Called Upon draft occurred in 21 of the 70 years being studied.

Since reporting in Appendix B shows how the Phase 1 study results compared to these study result with the Biological Opinion across 70-years, and comparing the Biological Opinion studies to each other across seventy years in Appendix C, this section will examine results of the Supplemental studies in only the Called Upon years.

The C+BiOp studies are highlighted because they are being used to compare to the other studies. The C+BiOp studies do not include Called Upon flood control or effective use. They are most like the current studies being performed which incorporate the current Flood Control Operating Plan (FCOP) and current BiOp fish operations.

The following are the years for Called Upon was required for each maximum flood control flow objective:

600 kcfs Flood Control maximum flow objective: (21 Called Upon years) 1934, 38, 43, 47, 50-52, 56, 59, 65, 67, 69, 71, 72, 74, 76, 78, 81, 82, 85, 97

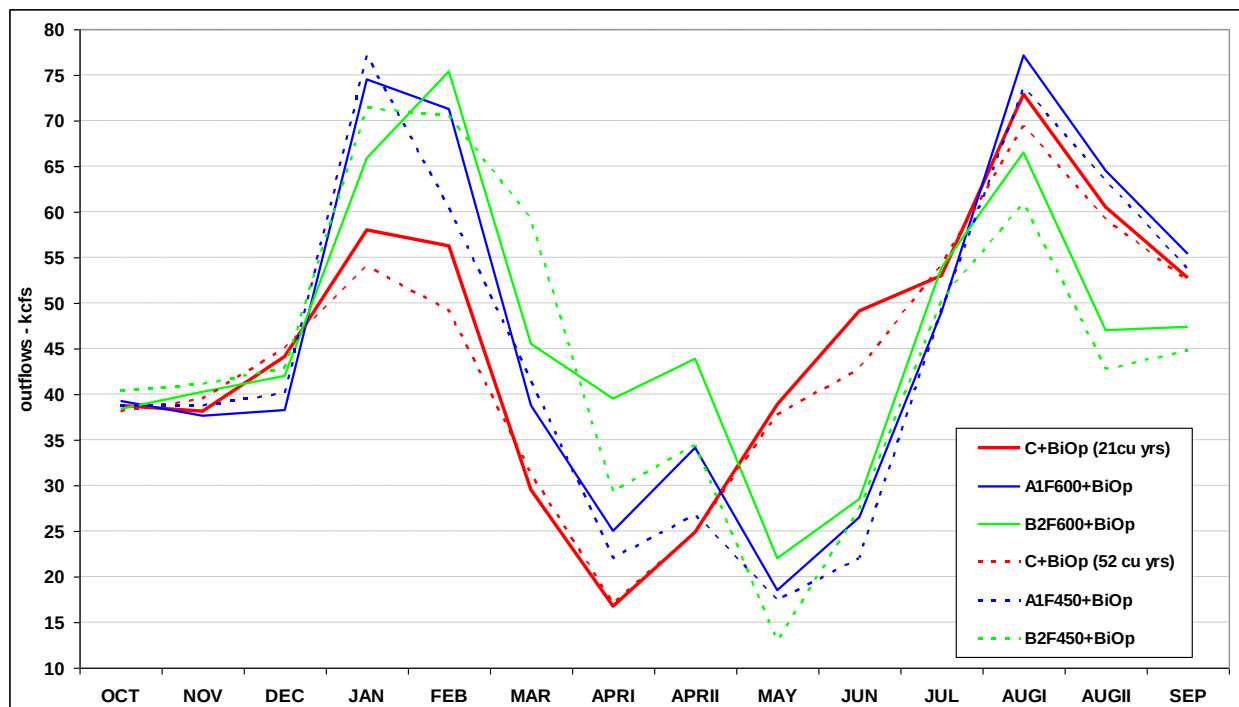
450 kcfs Flood Control maximum flow objective (52 Called upon years) 1932-35, 38, 39, 41-43,
46-54, 56-76, 78, 81-86, 89-91, 95-97

The following tables and graphs depict the relationship between Called Upon years only and the various fish operations modeled in the Supplemental studies.

D.2 ARROW PLUS DUNCAN OUTFLOWS

**Figure D-1 Arrow plus Duncan Outflows - Supplemental Studies
70-Year Studies – Average of Called Upon Years**

Outflows - kcfs	OCT	NOV	DEC	JAN	FEB	MAR	APRI	APRII	MAY	JUN	JUL	AUGI	AUGII	SEP
C+BiOp (21cu yrs)	39	38	44	58	56	30	17	25	39	49	53	73	61	53
A1F600+BiOp	39	38	38	74	71	39	25	34	19	26	49	77	65	55
B2F600+BiOp	38	40	42	66	75	45	39	44	22	29	54	67	47	47
C+BiOp (52 cu yrs)	38	39	45	54	49	31	17	25	38	43	54	69	59	52
A1F450+BiOp	39	39	40	77	60	41	22	27	17	22	49	74	63	54
B2F450+BiOp	40	41	43	71	70	59	29	34	13	27	50	61	43	45
A1F600 and B2F600	21 called upon yrs: 1934, 38, 43, 47, 50-52, 56, 59, 65, 67, 69, 71, 72, 74, 76, 78, 81, 82, 85, 97													
A1F450 and B2F450	52 called upon yrs: 1932-35, 38, 39, 41-43, 46-54, 56-76, 78, 81-86, 89-91, 95-97													



D.3 GENERATION

D.3.1 U.S. SYSTEM GENERATION

Figure D-2 U.S. System Generation - Supplemental Studies
70-Year Studies – Average of Called Upon Years

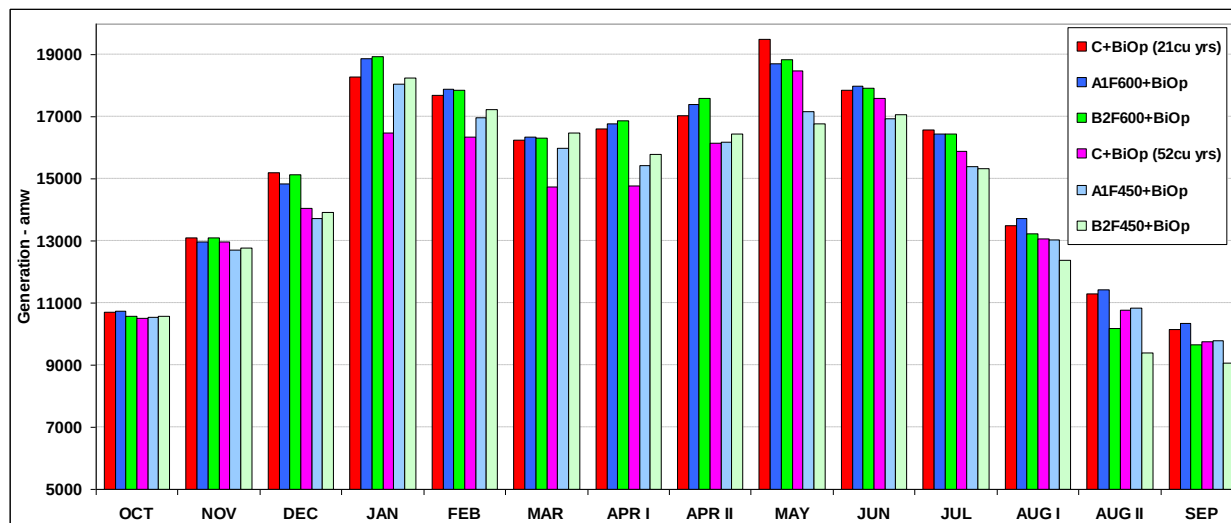
aMW	OCT	NOV	DEC	JAN	FEB	MAR	APR I	APR II	MAY	JUN	JUL	AUG I	AUG II	SEP	ANN AV
C+BiOp (21cu yrs)	10702	13105	15200	18286	17711	16270	16632	17051	19492	17882	16602	13503	11289	10159	15376
A1F600+BiOp	10750	12971	14844	18869	17905	16341	16798	17416	18730	18005	16441	13736	11423	10339	15393
B2F600+BiOp	10581	13094	15144	18941	17858	16310	16878	17612	18844	17933	16444	13231	10175	9677	15300
C+BiOp (52cu yrs)	10506	12962	14074	16494	16350	14760	14780	16171	18475	17597	15906	13063	10788	9750	14512
A1F450+BiOp	10544	12700	13719	18063	16986	15980	15441	16194	17193	16937	15405	13053	10848	9784	14577
B2F450+BiOp	10585	12786	13932	18246	17249	16473	15810	16462	16779	17074	15352	12382	9405	9065	14531

Diff = study minus C+BiOp **red** means study produced less generation than C+BiOp

aMW	OCT	NOV	DEC	JAN	FEB	MAR	APR I	APR II	MAY	JUN	JUL	AUG I	AUG II	SEP	ANN AV
A1F600+BiOp	48	-133	-356	583	194	71	166	365	-762	122	-160	233	133	180	17
B2F600+BiOp	-121	-10	-56	655	147	40	247	561	-648	51	-158	-272	-1114	-482	-76
A1F450+BiOp	38	-262	-355	1569	636	1220	661	23	-1282	-661	-501	-11	59	34	65
B2F450+BiOp	79	-176	-143	1752	900	1713	1031	291	-1696	-524	-554	-682	-1383	-685	19

A1F600 and B2F600 21 called upon yrs: 1934, 38, 43, 47, 50-52, 56, 59, 65, 67, 69, 71, 72, 74, 76, 78, 81, 82, 85, 97

A1F450 and B2F450 52 called upon yrs: 1932-35, 38, 39, 41-43, 46-54, 56-76, 78, 81-86, 89-91, 95-97



D.3.2 U.S. FEDERAL GENERATION

Figure D-3 U.S. Federal Generation - Supplemental Studies
70-Year Studies – Average of Called Upon Years

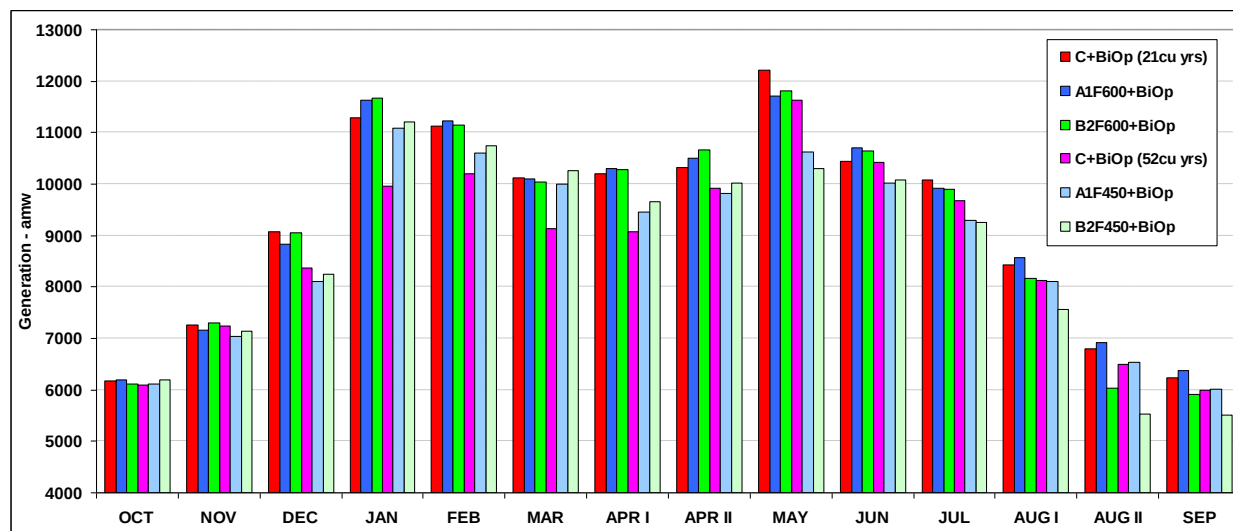
aMW	OCT	NOV	DEC	JAN	FEB	MAR	APR I	APR II	MAY	JUN	JUL	AUG I	AUG II	SEP	ANN AV
C+BiOp (21cu yrs)	6170	7265	9078	11294	11122	10114	10205	10313	12220	10452	10084	8430	6807	6235	9318
A1F600+BiOp	6204	7166	8827	11621	11225	10106	10298	10495	11718	10713	9915	8578	6915	6368	9325
B2F600+BiOp	6117	7299	9047	11664	11142	10032	10280	10662	11818	10642	9906	8165	6025	5910	9252
C+BiOp (52cu yrs)	6085	7244	8367	9959	10202	9141	9076	9911	11624	10419	9671	8131	6490	5994	8785
A1F450+BiOp	6119	7048	8099	11078	10602	9998	9450	9827	10618	10016	9285	8106	6536	6022	8811
B2F450+BiOp	6186	7143	8256	11217	10749	10265	9667	10016	10308	10083	9246	7572	5532	5512	8769

Diff = study minus C+BiOp red means study produced less generation than C+BiOp

aMW	OCT	NOV	DEC	JAN	FEB	MAR	APR I	APR II	MAY	JUN	JUL	AUG I	AUG II	SEP	ANN AV
A1F600+BiOp	34	-99	-251	327	103	-7	93	181	-502	261	-169	148	108	133	6
B2F600+BiOp	-53	34	-31	370	20	-82	75	348	-402	190	-178	-265	-782	-325	-66
A1F450+BiOp	34	-196	-268	1119	400	857	373	-84	-1007	-403	-386	-25	46	28	27
B2F450+BiOp	101	-101	-111	1258	547	1125	591	105	-1316	-335	-425	-559	-958	-481	-16

A1F600 and B2F600 21 called upon yrs: 1934, 38, 43, 47, 50-52, 56, 59, 65, 67, 69, 71, 72, 74, 76, 78, 81, 82, 85, 97

A1F450 and B2F450 52 called upon yrs: 1932-35, 38, 39, 41-43, 46-54, 56-76, 78, 81-86, 89-91, 95-97



D.3.3 MID-COLUMBIA GENERATION

**Figure D-4 Mid-Columbia Generation - Supplemental Studies
70-Year Studies – Average of Called Upon Years**

aMW	OCT	NOV	DEC	JAN	FEB	MAR	APR I	APR II	MAY	JUN	JUL	AUG I	AUG II	SEP	ANN AV
C+BiOp (21 cu yrs)	2001	2395	2688	3289	3196	2921	2845	2850	3265	3101	3000	2720	2368	1903	2761
A1F600+BiOp	2016	2363	2575	3528	3284	2990	2893	3003	3007	2966	3021	2783	2425	1962	2770
B2F600+BiOp	1980	2416	2662	3562	3323	3031	3003	3033	3022	2965	3023	2640	2021	1762	2755
C+BiOp (52cu yrs)	1972	2421	2565	3035	2975	2645	2499	2744	3033	2990	2924	2640	2253	1821	2619
A1F450+BiOp	1987	2366	2466	3479	3154	2940	2661	2754	2763	2742	2832	2665	2310	1841	2645
B2F450+BiOp	2014	2404	2536	3522	3274	3165	2810	2834	2665	2799	2821	2471	1829	1620	2646

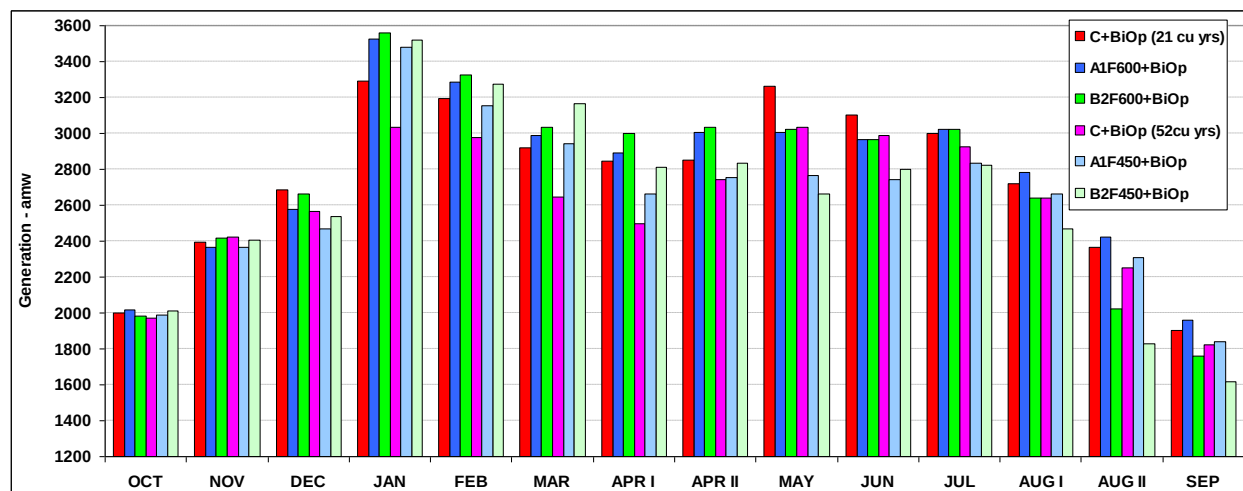
Mid-Columbia Generation from Wells, Chelan, Rocky Reach, Rock Island, Wanapum, and Priest Rapids

Diff = study minus C+BiOp **red** means study produced less generation than C+BiOp

aMW	OCT	NOV	DEC	JAN	FEB	MAR	APR I	APR II	MAY	JUN	JUL	AUG I	AUG II	SEP	ANN AV
A1F600+BiOp	15	-32	-113	239	88	69	48	154	-258	-135	21	63	56	59	9
B2F600+BiOp	-21	21	-26	272	128	111	157	184	-244	-136	23	-81	-348	-141	-6
A1F450+BiOp	15	-55	-99	444	178	296	162	10	-269	-248	-93	26	57	20	26
B2F450+BiOp	42	-17	-29	487	298	520	312	90	-367	-192	-103	-169	-424	-201	27

A1F600 and B2F600 21 called upon yrs: 1934, 38, 43, 47, 50-52, 56, 59, 65, 67, 69, 71, 72, 74, 76, 78, 81, 82, 85, 97

A1F450 and B2F450 52 called upon yrs: 1932-35, 38, 39, 41-43, 46-54, 56-76, 78, 81-86, 89-91, 95-97

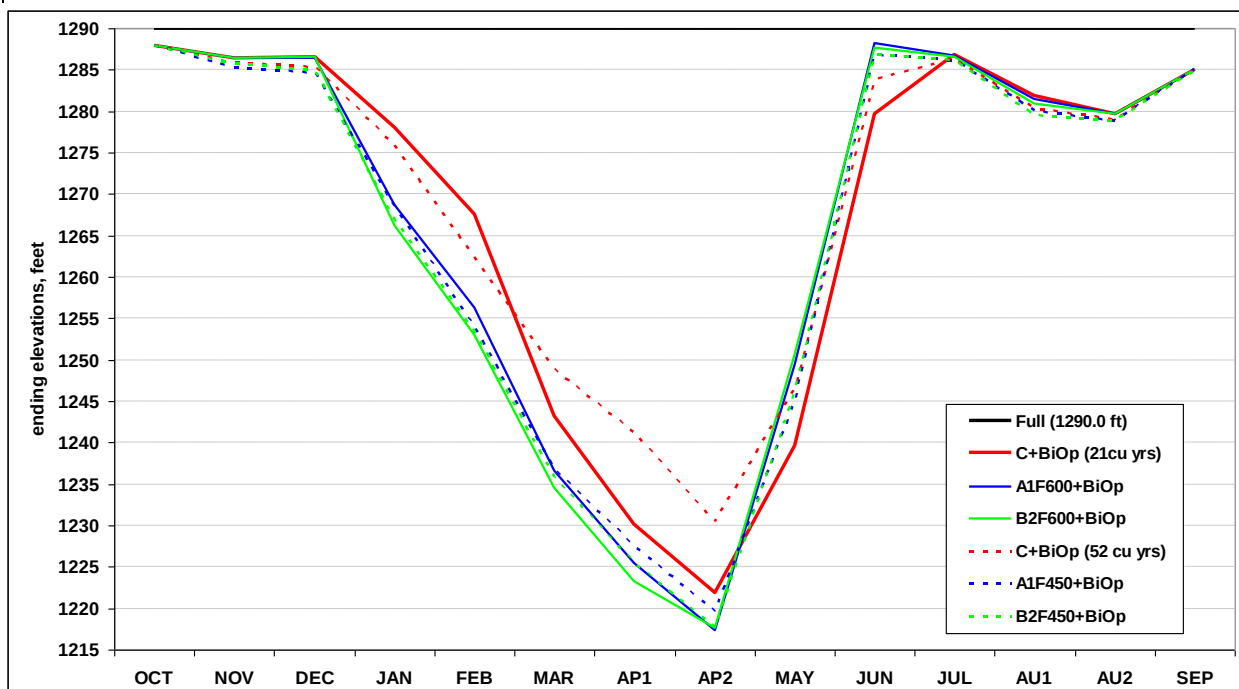


D.4 U.S. RESERVOIR ELEVATIONS

D.4.1 GRAND COULEE

**Figure D-5 Grand Coulee Elevations, feet - Supplemental Studies
70-Year Studies – Average of Called Upon Years**

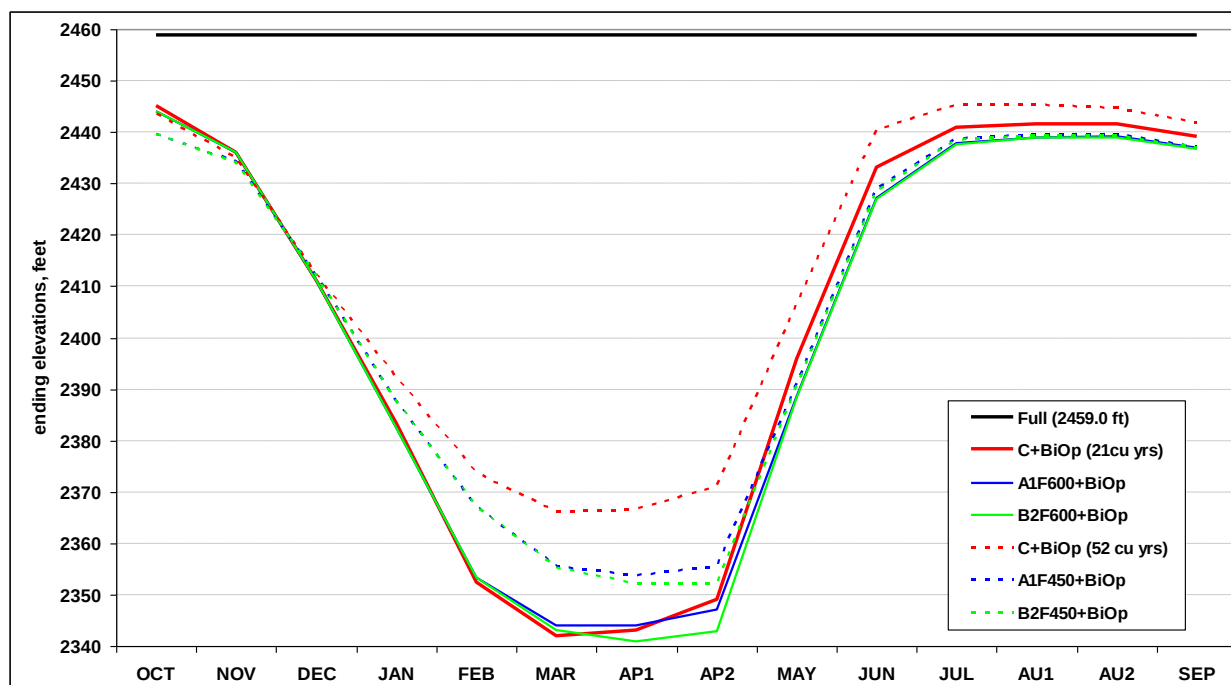
end of period elevations, ft	OCT	NOV	DEC	JAN	FEB	MAR	AP1	AP2	MAY	JUN	JUL	AU1	AU2	SEP
Full (1290.0 ft)	1290	1290	1290	1290	1290	1290	1290	1290	1290	1290	1290	1290	1290	1290
C+BiOp (21cu yrs)	1288	1286	1287	1278	1268	1243	1230	1222	1240	1280	1287	1282	1280	1285
A1F600+BiOp	1288	1286	1286	1269	1256	1237	1225	1217	1249	1288	1287	1281	1280	1285
B2F600+BiOp	1288	1286	1287	1266	1253	1235	1223	1218	1251	1288	1287	1281	1280	1285
C+BiOp (52 cu yrs)	1288	1286	1285	1276	1262	1249	1241	1230	1247	1284	1286	1280	1279	1285
A1F450+BiOp	1288	1285	1285	1269	1254	1237	1228	1219	1245	1287	1286	1280	1279	1285
B2F450+BiOp	1288	1286	1285	1267	1253	1236	1226	1218	1246	1287	1286	1280	1279	1285
A1F600 and B2F600	21 called upon yrs: 1934, 38, 43, 47, 50-52, 56, 59, 65, 67, 69, 71, 72, 74, 76, 78, 81, 82, 85, 97													
A1F450 and B2F450	52 called upon yrs: 1932-35, 38, 39, 41-43, 46-54, 56-76, 78, 81-86, 89-91, 95-97													



D.4.2 LIBBY DAM

Figure D-6 Libby Elevations, feet - Supplemental Studies
70-Year Studies – Average of Called Upon Years

end of period elevations, ft	OCT	NOV	DEC	JAN	FEB	MAR	AP1	AP2	MAY	JUN	JUL	AU1	AU2	SEP
Full (2459.0 ft)	2459	2459	2459	2459	2459	2459	2459	2459	2459	2459	2459	2459	2459	2459
C+BiOp (21cu yrs)	2445	2436	2411	2383	2353	2342	2343	2349	2396	2433	2441	2442	2442	2439
A1F600+BiOp	2444	2436	2411	2382	2353	2344	2344	2347	2389	2427	2438	2439	2439	2437
B2F600+BiOp	2444	2436	2411	2382	2353	2343	2341	2343	2388	2427	2438	2439	2439	2437
C+BiOp (52 cu yrs)	2444	2435	2412	2392	2374	2366	2367	2371	2407	2441	2445	2445	2445	2442
A1F450+BiOp	2440	2434	2412	2388	2367	2356	2354	2355	2391	2429	2439	2440	2440	2437
B2F450+BiOp	2440	2434	2412	2387	2367	2355	2352	2352	2391	2428	2439	2439	2439	2437
A1F600 and B2F600	21 called upon yrs: 1934, 38, 43, 47, 50-52, 56, 59, 65, 67, 69, 71, 72, 74, 76, 78, 81, 82, 85, 97													
A1F450 and B2F450	52 called upon yrs: 1932-35, 38, 39, 41-43, 46-54, 56-76, 78, 81-86, 89-91, 95-97													

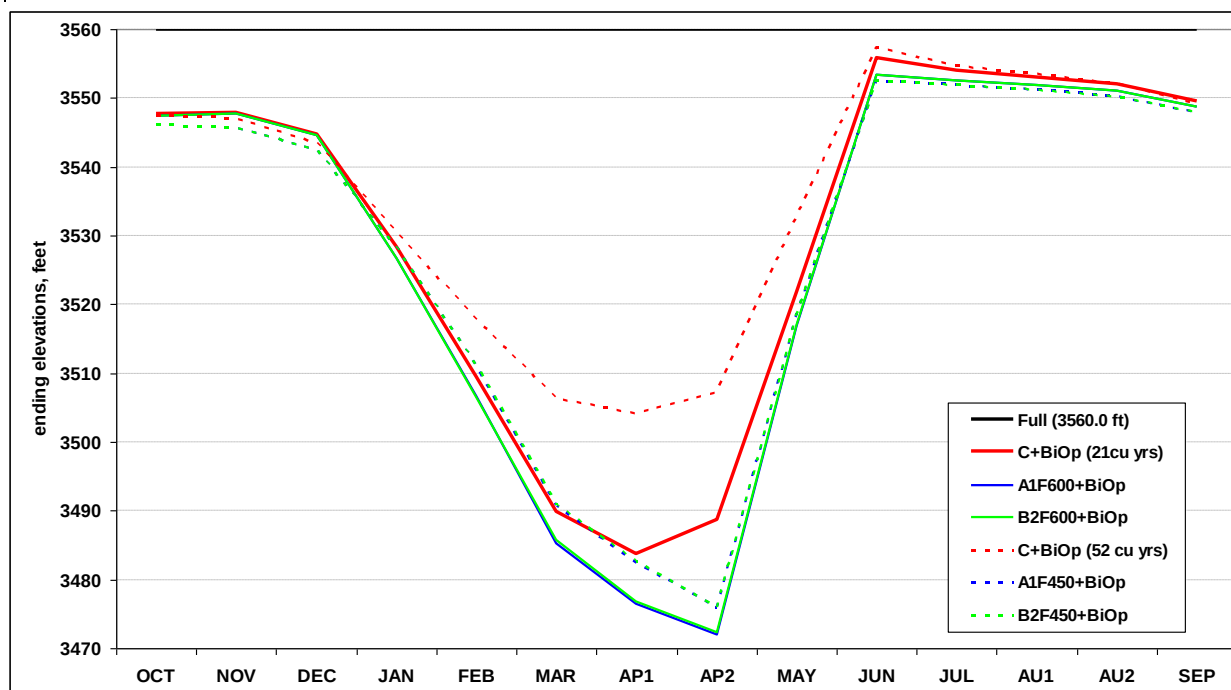


D.4.3 HUNGRY HORSE DAM

Figure D-7 Hungry Horse Elevations, feet - Supplemental Studies
70-Year Studies – Average of Called Upon Years

end of period elevations, ft	OCT	NOV	DEC	JAN	FEB	MAR	AP1	AP2	MAY	JUN	JUL	AU1	AU2	SEP
Full (3560.0 ft)	3560	3560	3560	3560	3560	3560	3560	3560	3560	3560	3560	3560	3560	3560
C+BiOp (21cu yrs)	3548	3548	3545	3528	3509	3490	3484	3489	3522	3556	3554	3553	3552	3550
A1F600+BiOp	3547	3548	3545	3527	3507	3485	3477	3472	3517	3553	3553	3552	3551	3549
B2F600+BiOp	3547	3548	3545	3527	3506	3486	3477	3472	3517	3553	3553	3552	3551	3549
C+BiOp (52 cu yrs)	3547	3547	3543	3530	3518	3506	3504	3507	3533	3557	3555	3553	3552	3549
A1F450+BiOp	3546	3546	3542	3528	3511	3491	3482	3476	3518	3553	3552	3551	3550	3548
B2F450+BiOp	3546	3546	3542	3528	3511	3491	3483	3476	3519	3553	3552	3551	3550	3548

A1F600 and B2F600 21 called upon yrs: 1934, 38, 43, 47, 50-52, 56, 59, 65, 67, 69, 71, 72, 74, 76, 78, 81, 82, 85, 97
A1F450 and B2F450 52 called upon yrs: 1932-35, 38, 39, 41-43, 46-54, 56-76, 78, 81-86, 89-91, 95-97

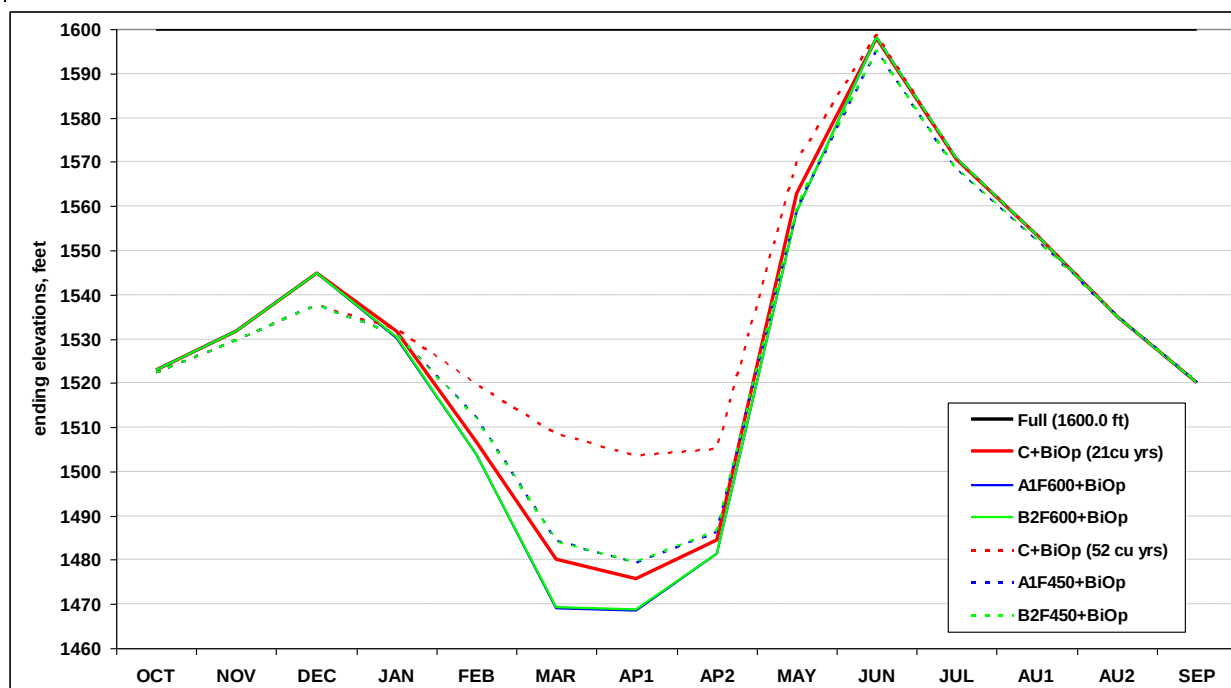


D.4.4 DWORSHAK

Figure D-8 Dworshak Elevations, feet - Supplemental Studies
70-Year Studies – Average of Called Upon Years

end of period elevations, ft	OCT	NOV	DEC	JAN	FEB	MAR	AP1	AP2	MAY	JUN	JUL	AU1	AU2	SEP
Full (1600.0 ft)	1600	1600	1600	1600	1600	1600	1600	1600	1600	1600	1600	1600	1600	1600
C+BiOp (21cu yrs)	1523	1532	1545	1532	1507	1480	1476	1485	1563	1598	1571	1554	1535	1520
A1F600+BiOp	1523	1532	1545	1530	1504	1469	1469	1481	1559	1598	1571	1554	1535	1520
B2F600+BiOp	1523	1532	1545	1530	1504	1469	1469	1481	1559	1598	1571	1554	1535	1520
C+BiOp (52 cu yrs)	1522	1530	1538	1532	1520	1509	1503	1505	1570	1599	1570	1554	1535	1520
A1F450+BiOp	1522	1530	1538	1531	1512	1484	1479	1486	1559	1595	1568	1552	1535	1520
B2F450+BiOp	1522	1530	1538	1531	1512	1484	1480	1486	1560	1595	1568	1552	1535	1520

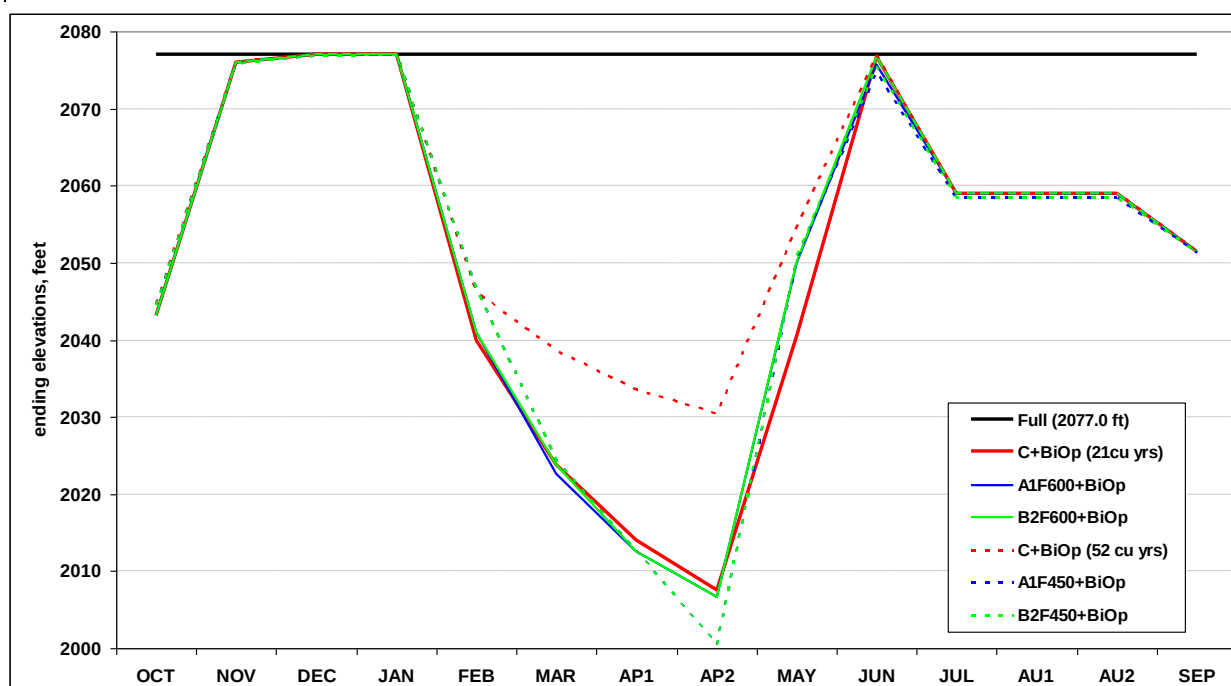
A1F600 and B2F600 21 called upon yrs: 1934, 38, 43, 47, 50-52, 56, 59, 65, 67, 69, 71, 72, 74, 76, 78, 81, 82, 85, 97
A1F450 and B2F450 52 called upon yrs: 1932-35, 38, 39, 41-43, 46-54, 56-76, 78, 81-86, 89-91, 95-97



D.4.5 BROWNLEE

Figure D-9 Brownlee Elevations, feet - Supplemental Studies
70-Year Studies – Average of Called Upon Years

end of period elevations, ft	OCT	NOV	DEC	JAN	FEB	MAR	AP1	AP2	MAY	JUN	JUL	AU1	AU2	SEP
Full (2077.0 ft)	2077	2077	2077	2077	2077	2077	2077	2077	2077	2077	2077	2077	2077	2077
C+BiOp (21cu yrs)	2043	2076	2077	2077	2040	2024	2014	2008	2041	2077	2059	2059	2059	2052
A1F600+BiOp	2043	2076	2077	2077	2041	2023	2013	2007	2050	2076	2059	2059	2059	2052
B2F600+BiOp	2043	2076	2077	2077	2041	2024	2013	2007	2050	2077	2059	2059	2059	2052
C+BiOp (52 cu yrs)	2045	2076	2077	2077	2046	2039	2034	2030	2055	2077	2059	2059	2059	2052
A1F450+BiOp	2044	2076	2077	2077	2047	2024	2013	2000	2050	2075	2058	2058	2058	2051
B2F450+BiOp	2044	2076	2077	2077	2047	2024	2013	2000	2051	2075	2058	2058	2058	2051
A1F600 and B2F600	21 called upon yrs: 1934, 38, 43, 47, 50-52, 56, 59, 65, 67, 69, 71, 72, 74, 76, 78, 81, 82, 85, 97													
A1F450 and B2F450	52 called upon yrs: 1932-35, 38, 39, 41-43, 46-54, 56-76, 78, 81-86, 89-91, 95-97													



D.5 MEETING FLOW OBJECTIVES IN CALLED UPON YEARS

Another objective of the Biological Opinions is to meet instream flow objectives at specified locations throughout the Columbia River system.

D.5.1 LOWER GRANITE

There was minimal difference in performance meeting the flow objectives at Lower Granite because Lower Granite is not downstream of Canada. Although the power operations and effective use operation has some impact at Lower Granite, it was not very noticeable in the Called Upon years.

D.5.2 PRIEST RAPIDS

**Figure D-10 Priest Rapids Outflows - Supplemental Studies
70-Year Studies – Average of Called Upon Years**

period average outflow - kcfs	OCT	NOV	DEC	JAN	FEB	MAR	AP1	AP2	MAY	JUN	JUL	AU1	AU2	SEP
C+BiOp (21cu yrs)	78	95	108	140	142	128	126	164	212	226	168	139	103	75
A1F600+BiOp	79	94	103	169	158	130	130	175	181	203	172	143	106	77
B2F600+BiOp	77	96	107	164	163	135	146	181	183	207	176	134	87	69
C+BiOp (52 cu yrs)	77	96	103	126	127	111	106	152	186	202	162	134	98	71
A1F450+BiOp	78	94	99	160	141	126	115	151	160	173	157	136	100	72
B2F450+BiOp	79	96	101	157	150	144	126	159	152	179	157	125	78	63

A1F600 and B2F600 21 called upon yrs: 1934, 38, 43, 47, 50-52, 56, 59, 65, 67, 69, 71, 72, 74, 76, 78, 81, 82, 85, 97

A1F450 and B2F450 52 called upon yrs: 1932-35, 38, 39, 41-43, 46-54, 56-76, 78, 81-86, 89-91, 95-97

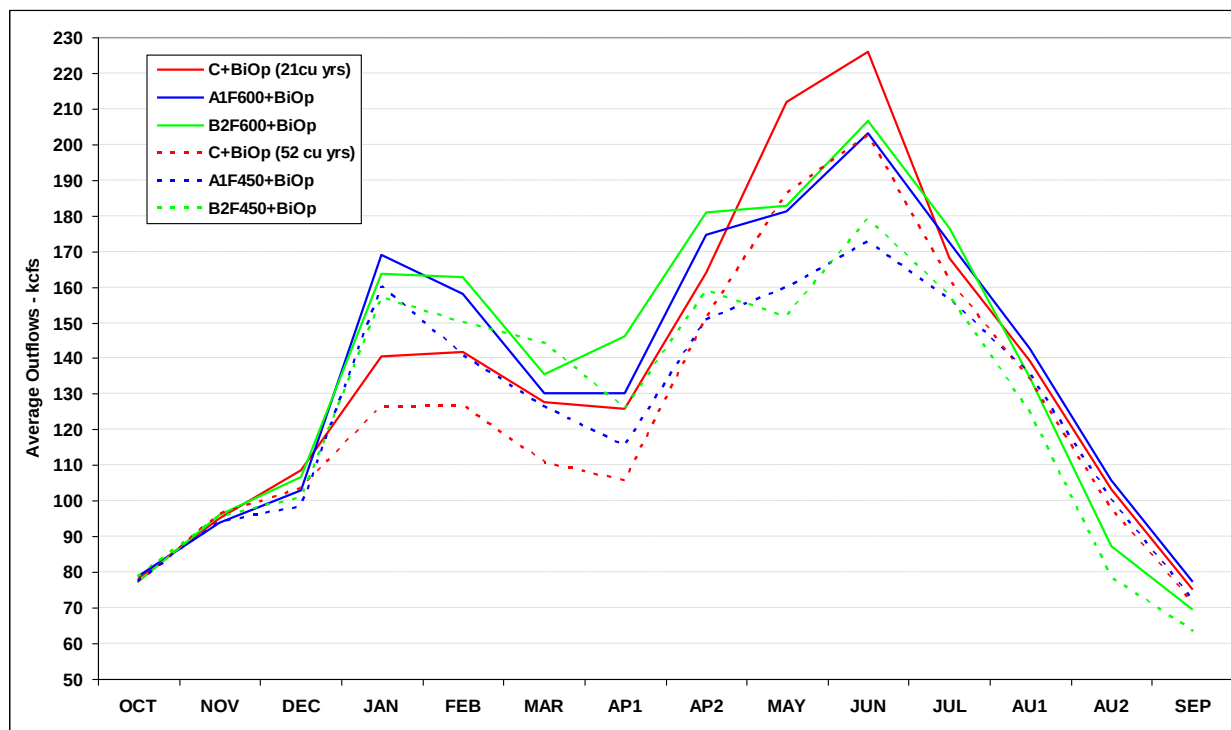


Figure D-11 Priest Rapids Flow Targets Met During Called Upon Years

+BiOp studies									
number of years target met +/- 1kcfs		50-70 kcfs				135 kcfs			
		DEC	JAN	FEB	MAR	APR I	APR II	MAY	JUN
C+BiOp no called upon	21cu yrs	21	21	21	21	20	18	21	20
A1F600+BiOp	21cu yrs	21	21	21	21	20	20	20	21
B2F600+BiOp	21cu yrs	21	21	21	21	21	20	20	21
C+BiOp no called upon	52cu yrs	52	52	52	52	35	34	50	49
A1F450+BiOp	52cu yrs	52	52	52	52	44	35	43	44
B2F450+BiOp	52cu yrs	52	52	52	52	46	42	39	44

Phase 1 Studies									
number of years target met +/- 1kcfs		50-70 kcfs				135 kcfs			
		DEC	JAN	FEB	MAR	APR I	APR II	MAY	JUN
C no called upon	21cu yrs	21	21	21	21	19	12	21	14
A1F600	21cu yrs	21	21	21	21	17	15	21	12
B2F600	21cu yrs	21	21	20	21	20	20	19	20
C no called upon	52cu yrs	52	52	52	51	33	19	40	28
A1F450	52cu yrs	52	52	51	51	32	25	33	26
B2F450	52cu yrs	51	52	51	52	45	35	36	41

difference in number of years targets met		DEC	JAN	FEB	MAR	APR I	APR II	MAY	JUN
A1F600+BiOp minus C+BiOp	21 cu yrs	0	0	0	0	0	2	-1	1
A1F600+BiOp minus A1F600	21 cu yrs	0	0	0	0	3	5	-1	9
A1F450+BiOp minus C+BiOp	52 cu yrs	0	0	0	0	9	1	-7	-5
A1F450+BiOp minus A1F450	52 cu yrs	0	0	1	1	12	10	10	18
B2F600+BiOp minus C+BiOp	21 cu yrs	0	0	0	0	1	2	-1	1
B2F600+BiOp minus B2F600	21 cu yrs	0	0	1	0	1	0	1	1
B2F450+BiOp minus C+BiOp	52 cu yrs	0	0	0	0	11	8	-11	-5
B2F450+BiOp minus B2F450	52 cu yrs	1	0	1	0	1	7	3	3

C studies: Current Treaty and Flood Control

A studies: Current Treaty and Called Upon Flood Control

B studies: Terminate Treaty and Called Upon Flood Control

Note: C+BiOp and A1F+BiOp studies assume SOA to store/release 1 Maf of
Flow Augmentation at Arrow

21 Called upon years: 1934, 38, 43, 47, 50-52, 56, 59, 65, 67, 69, 71, 72, 74, 76, 78, 81, 82, 85, 97

52 Called upon years: 1932-35, 38, 39, 41-43, 46-54, 56-76, 78, 81-86, 89-91, 95-97

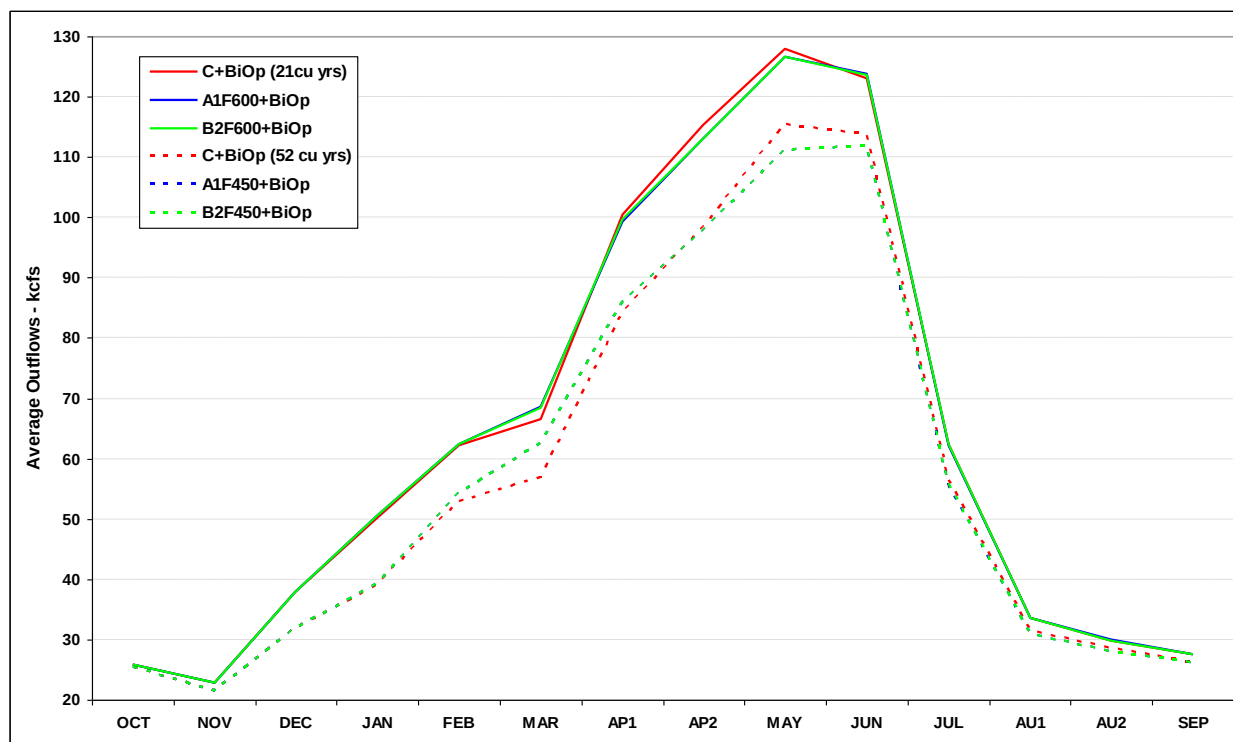
D.5.3 LOWER GRANITE

Figure D-12 Lower Granite Outflows - Supplemental Studies
70-Year Studies – Average of Called Upon Years

period average outflow - kcfs	OCT	NOV	DEC	JAN	FEB	MAR	AP1	AP2	MAY	JUN	JUL	AU1	AU2	SEP
C+BiOp (21cu yrs)	26	23	38	50	62	67	100	115	128	123	62	33	30	27
A1F600+BiOp	26	23	38	51	62	69	99	113	127	124	62	34	30	27
B2F600+BiOp	26	23	38	50	62	68	100	113	127	124	62	34	30	27
C+BiOp (52 cu yrs)	26	22	32	39	53	57	84	98	115	114	56	32	29	26
A1F450+BiOp	26	22	32	39	54	63	86	98	111	112	56	31	28	26
B2F450+BiOp	26	22	32	39	54	63	86	98	111	112	56	31	28	26

A1F600 and B2F600 21 called upon yrs: 1934, 38, 43, 47, 50-52, 56, 59, 65, 67, 69, 71, 72, 74, 76, 78, 81, 82, 85, 97

A1F450 and B2F450 52 called upon yrs: 1932-35, 38, 39, 41-43, 46-54, 56-76, 78, 81-86, 89-91, 95-97



Comparing the A1 and B2 450 studies to each other, and the A1 and B2 600 studies to each other, the flow objectives at Lower Granite are met the same number of years in years when Called Upon is triggered. As compared to the C+BiOp, flow objectives in the A1 and B2 studies were met less often in May. This is shown in the table below.

**Figure D-13 Lower Granite Flow Targets Met During Called Upon Years
70-Year Studies – Average of Called Upon Years**

+BiOp studies							
number of years target met +/- 1kcfs		85-100 kcfs				50-55 kcfs	
		APR I	APR II	MAY	JUN	JUL	AUG
C+BiOp no called upon	21cu yrs	13	14	19	19	15	0
A1F600+BiOp	21cu yrs	13	14	18	19	15	0
B2F600+BiOp	21cu yrs	13	14	18	19	15	0
C+BiOp no called upon	52cu yrs	23	27	39	43	28	0
A1F450+BiOp	52cu yrs	25	27	35	42	28	0
B2F450+BiOp	52cu yrs	25	27	35	42	28	0
Phase 1 Studies							
number of years target met +/- 1kcfs		85-100 kcfs				50-55 kcfs	
		APR I	APR II	MAY	JUN	JUL	AUG
C no called upon	21cu yrs	15	13	15	19	13	0
A1F600	21cu yrs	14	14	15	18	13	0
B2F600	21cu yrs	14	14	15	18	8	0
C no called upon	52cu yrs	23	24	33	43	23	0
A1F450	52cu yrs	25	27	31	39	23	0
B2F450	52cu yrs	25	27	31	40	15	0
difference in number of years targets met		APR I	APR II	MAY	JUN	JUL	AUG
A1F600+BiOp minus C+BiOp	21 cu yrs	0	0	-1	0	0	0
A1F600+BiOp minus A1F600	21 cu yrs	-1	0	3	1	2	0
A1F450+BiOp minus C+BiOp	52 cu yrs	2	0	-4	-1	0	0
A1F450+BiOp minus A1F450	52 cu yrs	0	0	4	3	5	0
B2F600+BiOp minus C+BiOp	21 cu yrs	0	0	-1	0	0	0
B2F600+BiOp minus B2F600	21 cu yrs	-1	0	3	1	7	0
B2F450+BiOp minus C+BiOp	52 cu yrs	2	0	-4	-1	0	0
B2F450+BiOp minus B2F450	52 cu yrs	0	0	4	2	13	0

C studies: Current Treaty and Flood Control

A studies: Current Treaty and Called Upon Flood Control

B studies: Terminate Treaty and Called Upon Flood Control

Note: C+BiOp and A1F+BiOp studies assume SOA to store/release 1 Maf of
Flow Augmentation at Arrow

21 Called upon years: 1934, 38, 43, 47, 50-52, 56, 59, 65, 67, 69, 71, 72, 74, 76, 78, 81, 82, 85,

52 Called upon years: 1932-35, 38, 39, 41-43, 46-54, 56-76, 78, 81-86, 89-91, 95-97

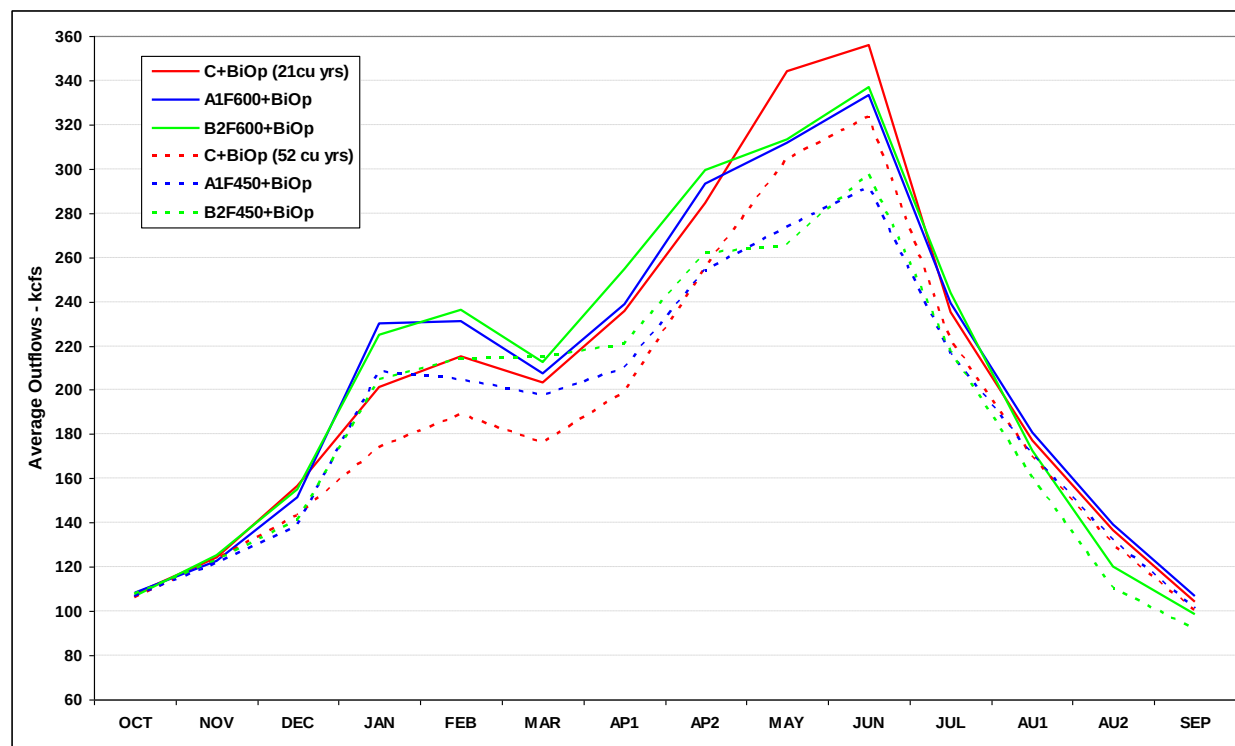
D.5.4 McNARY

**Figure D-14 McNary Outflows - Supplemental Studies
70-Year Studies – Average of Called Upon Years**

period average outflow - kcfs	OCT	NOV	DEC	JAN	FEB	MAR	AP1	AP2	MAY	JUN	JUL	AU1	AU2	SEP
C+BiOp (21cu yrs)	108	124	157	201	215	203	236	285	344	356	235	177	136	104
A1F600+BiOp	108	123	151	230	231	208	239	293	312	333	239	181	139	107
B2F600+BiOp	107	125	155	225	236	213	255	299	313	337	244	172	120	99
C+BiOp (52 cu yrs)	106	124	143	174	189	176	199	255	304	323	222	170	130	100
A1F450+BiOp	107	121	138	208	205	197	210	254	274	292	216	171	132	101
B2F450+BiOp	108	123	141	205	214	215	221	262	266	298	217	160	110	92

A1F600 and B2F600 21 called upon yrs: 1934, 38, 43, 47, 50-52, 56, 59, 65, 67, 69, 71, 72, 74, 76, 78, 81, 82, 85, 97

A1F450 and B2F450 52 called upon yrs: 1932-35, 38, 39, 41-43, 46-54, 56-76, 78, 81-86, 89-91, 95-97



**Figure D-15 McNary Flow Targets Met During Called Upon Years
70-Year Studies – Average of Called Upon Years**

+BiOp studies						
		220-260 kcfs			200 kcfs	
number of years target met +/- 1kcfs		APR II	MAY	JUN	JUL	AUG
C+BiOp <i>no called upon</i>	21cu yrs	14	21	19	18	2
A1F600+BiOp	21cu yrs	16	19	20	16	2
B2F600+BiOp	21cu yrs	18	20	19	15	2
C+BiOp <i>no called upon</i>	52cu yrs	26	43	42	35	3
A1F450+BiOp	52cu yrs	23	33	39	30	3
B2F450+BiOp	52cu yrs	29	29	39	30	3
Phase 1 studies						
		220-260 kcfs			200 kcfs	
number of years target met +/- 1kcfs		APR II	MAY	JUN	JUL	AUG
C <i>no called upon</i>	21cu yrs	11	19	12	15	1
A1F600	21cu yrs	11	18	11	12	1
B2F600	21cu yrs	16	18	18	14	1
C <i>no called upon</i>	52cu yrs	15	34	27	26	2
A1F450	52cu yrs	19	26	23	24	2
B2F450	52cu yrs	27	26	34	23	2
difference in number of years targets met		APR II	MAY	JUN	JUL	AUG
A1F600+BiOp minus C+BiOp	21 cu yrs	2	-2	1	-2	0
A1F600+BiOp minus A1F600	21 cu yrs	5	1	9	4	1
A1F450+BiOp minus C+BiOp	52 cu yrs	-3	-10	-3	-5	0
A1F450+BiOp minus A1F450	52 cu yrs	4	7	16	6	1
B2F600+BiOp minus C+BiOp	21 cu yrs	4	-1	0	-3	0
B2F600+BiOp minus B2F600	21 cu yrs	2	2	1	1	1
B2F450+BiOp minus C+BiOp	52 cu yrs	3	-14	-3	-5	0
B2F450+BiOp minus B2F450	52 cu yrs	2	3	5	7	1

C studies: Current Treaty and Flood Control

A studies: Current Treaty and Called Upon Flood Control

B studies: Terminate Treaty and Called Upon Flood Control

Note: C+BiOp and A1F+BiOp studies assume SOA to store/release 1 Maf of
Flow Augmentation at Arrow

21 Called upon years:

1934, 38, 43, 47, 50-52, 56, 59, 65, 67, 69, 71, 72, 74, 76, 78, 81, 82, 85, 97

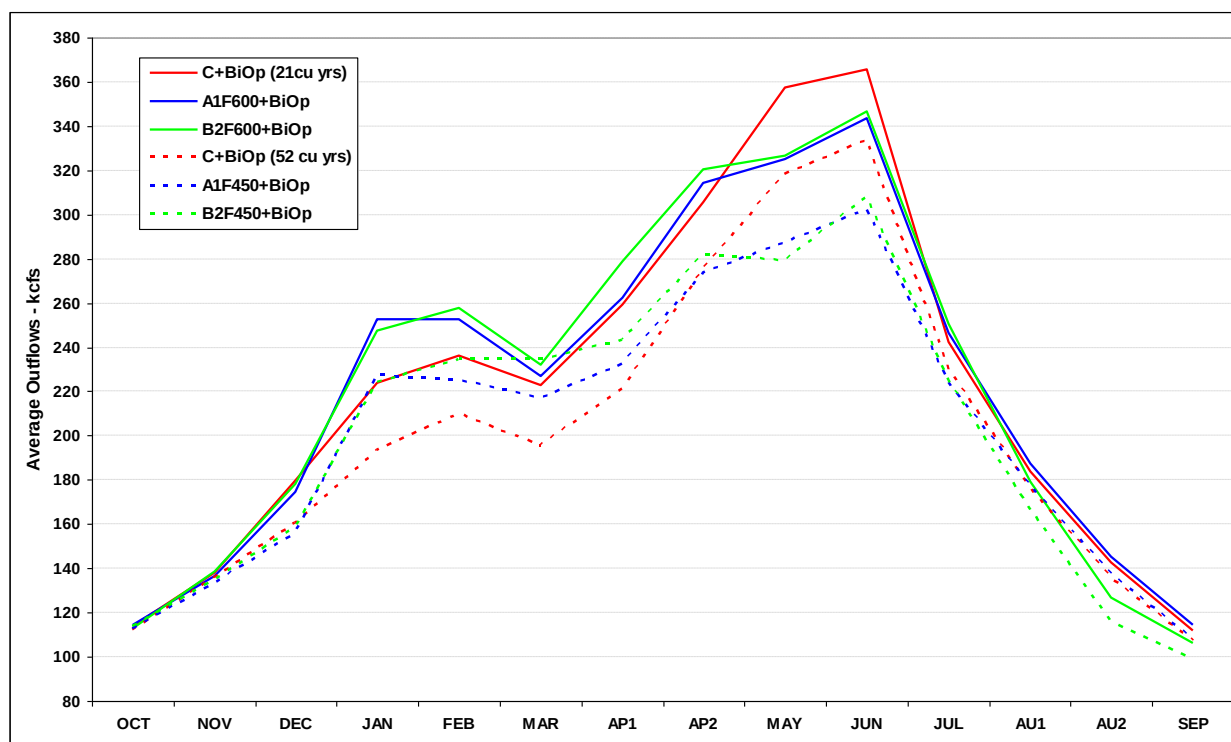
52 Called upon years: 1932-35, 38, 39, 41-43, 46-54, 56-76, 78, 81-86, 89-91, 95-97

D.5.5 BONNEVILLE DAM

**Figure D-16 Bonneville Outflows - Supplemental Studies
70-Year Studies – Average of Called Upon Years**

period average outflow - kcfs	OCT	NOV	DEC	JAN	FEB	MAR	AP1	AP2	MAY	JUN	JUL	AU1	AU2	SEP
C+BiOp (21cu yrs)	114	138	180	224	236	223	259	305	357	366	242	184	143	112
A1F600+BiOp	114	137	174	253	253	227	262	314	325	343	247	188	145	114
B2F600+BiOp	113	139	178	247	258	232	279	320	327	347	251	179	127	106
C+BiOp (52 cu yrs)	112	136	161	193	210	196	222	275	318	334	230	176	136	107
A1F450+BiOp	113	134	156	228	226	217	233	274	288	302	224	177	138	108
B2F450+BiOp	114	135	158	224	235	235	243	282	279	308	225	167	116	99

A1F600 and B2F600 21 called upon yrs: 1934, 38, 43, 47, 50-52, 56, 59, 65, 67, 69, 71, 72, 74, 76, 78, 81, 82, 85, 97
A1F450 and B2F450 52 called upon yrs: 1932-35, 38, 39, 41-43, 46-54, 56-76, 78, 81-86, 89-91, 95-97



**Figure D-17 Bonneville Flow Targets Met During Called Upon Years
70-Year Studies – Average of Called Upon Years**

+BiOp studies							
number of years target met +/- 1kcfs		125 kcfs					
		OCT	NOV	DEC	JAN	FEB	MAR
C+BiOp <i>no called upon</i>	21cu yrs	5	14	21	21	21	21
A1F600+BiOp	21cu yrs	5	12	21	21	20	21
B2F600+BiOp	21cu yrs	5	15	21	21	20	21
C+BiOp <i>no called upon</i>	52cu yrs	8	30	49	48	49	47
A1F450+BiOp	52cu yrs	8	27	46	50	50	47
B2F450+BiOp	52cu yrs	11	32	45	52	51	48
Phase 1 studies							
number of years target met +/- 1kcfs		125 kcfs					
		OCT	NOV	DEC	JAN	FEB	MAR
C <i>no called upon</i>	21cu yrs	6	15	21	21	21	21
A1F600	21cu yrs	6	15	21	21	21	21
B2F600	21cu yrs	6	21	21	21	21	21
C <i>no called upon</i>	52cu yrs	11	34	52	52	52	52
A1F450	52cu yrs	11	33	52	52	51	52
B2F450	52cu yrs	11	50	51	52	51	52
difference in number of years targets met		OCT	NOV	DEC	JAN	FEB	MAR
A1F600+BiOp minus C+BiOp	21 cu yrs	0	-2	0	0	-1	0
A1F600+BiOp minus A1F600	21 cu yrs	-1	-3	0	0	-1	0
A1F450+BiOp minus C+BiOp	52 cu yrs	0	-3	-3	2	1	0
A1F450+BiOp minus A1F450	52 cu yrs	-3	-6	-6	-2	-1	-5
B2F600+BiOp minus C+BiOp	21 cu yrs	0	1	0	0	-1	0
B2F600+BiOp minus B2F600	21 cu yrs	-1	-6	0	0	-1	0
B2F450+BiOp minus C+BiOp	52 cu yrs	3	2	-4	4	2	1
B2F450+BiOp minus B2F450	52 cu yrs	0	-18	-6	0	0	-4

C studies: Current Treaty and Flood Control

A studies: Current Treaty and Called Upon Flood Control

B studies: Terminate Treaty and Called Upon Flood Control

Note: C+BiOp and A1F+BiOp studies assume SOA to store/release 1 Maf of
Flow Augmentation at Arrow

21 Called upon years:

1934, 38, 43, 47, 50-52, 56, 59, 65, 67, 69, 71, 72, 74, 76, 78, 81, 82, 85, 97

52 Called upon years: 1932-35, 38, 39, 41-43, 46-54, 56-76, 78, 81-86, 89-91, 95-97