US Army Corps of Engineers®
Portland District

WILLAMETTE VALLEY SYSTEM OPERATIONS AND MAINTENANCE

DRAFT PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT

APPENDIX G: POWER AND TRANSMISSION

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACRONYMS

ALT	Alternative
aMW	Average **M**ega**w**atts
Bonneville	Bonneville Power Administration
CCS	Cross Cascades South
CRS	Columbia River System
CRSO	Columbia River System Operations
CWY	Critical Water Year
PEIS	Draft Environmental Impact Statement
EIS	Environmental Impact Statement
FCRPS	Federal Columbia River Power System
GEN	Generation
GENESYS	GENeration Evaluation SYStem
HYDSIM	**Hyd**ro System **Sim**ulation
IOU	Investor-Owned Utilities
IPR	Integrated Program Review
LCOG	Levelized Cost of Generation
LOLP	Loss of Load Probability
LT ATC	Long Term Available Transfer Capability
LTF	Long Term Firm
Mid-C	Mid-Columbia
MW	Megawatt
MWh	Megawatt hour
NAA	No Action Alternative
NPV	Net Present Value
NW Council	Northwest Power and Conservation Council
O&M	Operations and Maintenance
PA	Preferred Alternative
PF	Priority Firm Power
PNW	Pacific Northwest
PUD	Public utility districts
ResSim	Reservoir System Simulation
SAMP	Strategic Asset Management Plan
SOA	South of Allston
WVS	Willamette Valley System

CHAPTER 1 - INTRODUCTION

The Willamette Basin contains several Federal and non-Federal hydroelectric power-generating facilities used to generate electrical energy for local and regional consumption, as well as high-voltage transmission lines and other facilities that move this energy from the generating facilities to local and regional loads.

Regarding Federal hydropower generation, the Flood Control Act of 1948 (Pub. L. No. 80-858, 62 Stat. 1175) modified the Flood Control Act of 1938 to provide for the installation of hydroelectric power-generating facilities at eight Corps' multipurpose projects throughout the Willamette Basin: Detroit, Green Peter, Lookout Point, Cougar, Hills Creek, Big Cliff, Foster, and Dexter dams. These are a subset of the Federal Columbia River Power System (FCRPS) projects. The Corps dictates the parameters for dam operations to meet their statutory requirements, and power generation is subsequently scheduled within these parameters. The Cougar, Hills Creek, Big Cliff, Foster, and Dexter projects run a flat generation schedule each day based on the water available, and the generation schedule is determined solely by the Corps. For the Detroit, Green Peter, and Lookout Point projects, Bonneville is provided an opportunity to optimize the daily timing of power generation after the Corps determines their statutory requirement needs for other project purposes such as flood control and fish and water quality operations and identifies how many hours of generation would be available within a day, as well as any constraints (e.g., cannot be more than 10 continuous hours without generation).

Bonneville is a Federal power marketing administration designated by statute to sell power and transmission services throughout the Pacific Northwest region. Bonneville sells electric power from FCRPS projects, operated and maintained by other Federal agencies (i.e., Corps or Reclamation), to its regional firm power customers (wholesale power customers) across the Pacific Northwest, including municipalities, public utility districts (PUDs), cooperatives, Federal agencies, and investor-owned utilities (IOUs) and one direct service industry customer. These wholesale power customers, in turn, serve residential, commercial, and industrial retail customers (i.e., "end users").

Bonneville also operates and maintains about 15,000 circuit miles of the high-voltage transmission system within the Pacific Northwest region (Bonneville 2018a). This system integrates and transmits electric power within the Pacific Northwest region and interconnects with external transmission systems throughout the western United States and parts of Canada and Mexico. Separate from its power sales, Bonneville sells transmission services (for the delivery of electricity from generating resources to end users) and associated ancillary services (for maintaining transmission system reliability) to regional firm power customers, independent power producers, and power marketers.

1.1 FRAMEWORK FOR THE POWER AND TRANSMISSION ANALYSIS

This appendix details Bonneville's, in coordination with the Corps, analysis of the effects of the Willamette Valley System (WVS) Operations and Maintenance (O&M) Draft Environmental

Impact Statement (PEIS) Alternatives (Alternatives 1, 2A, 2B, 3A, 3B, 4, 5 and Preferred Alternative [PA]; hereinafter referred to collectively as Action Alternatives) on federal power and transmission resources, including the models, methods, and data sources employed, and a stepwise presentation of the results for each alternative. Figure 1-1 presents the framework for the analysis.

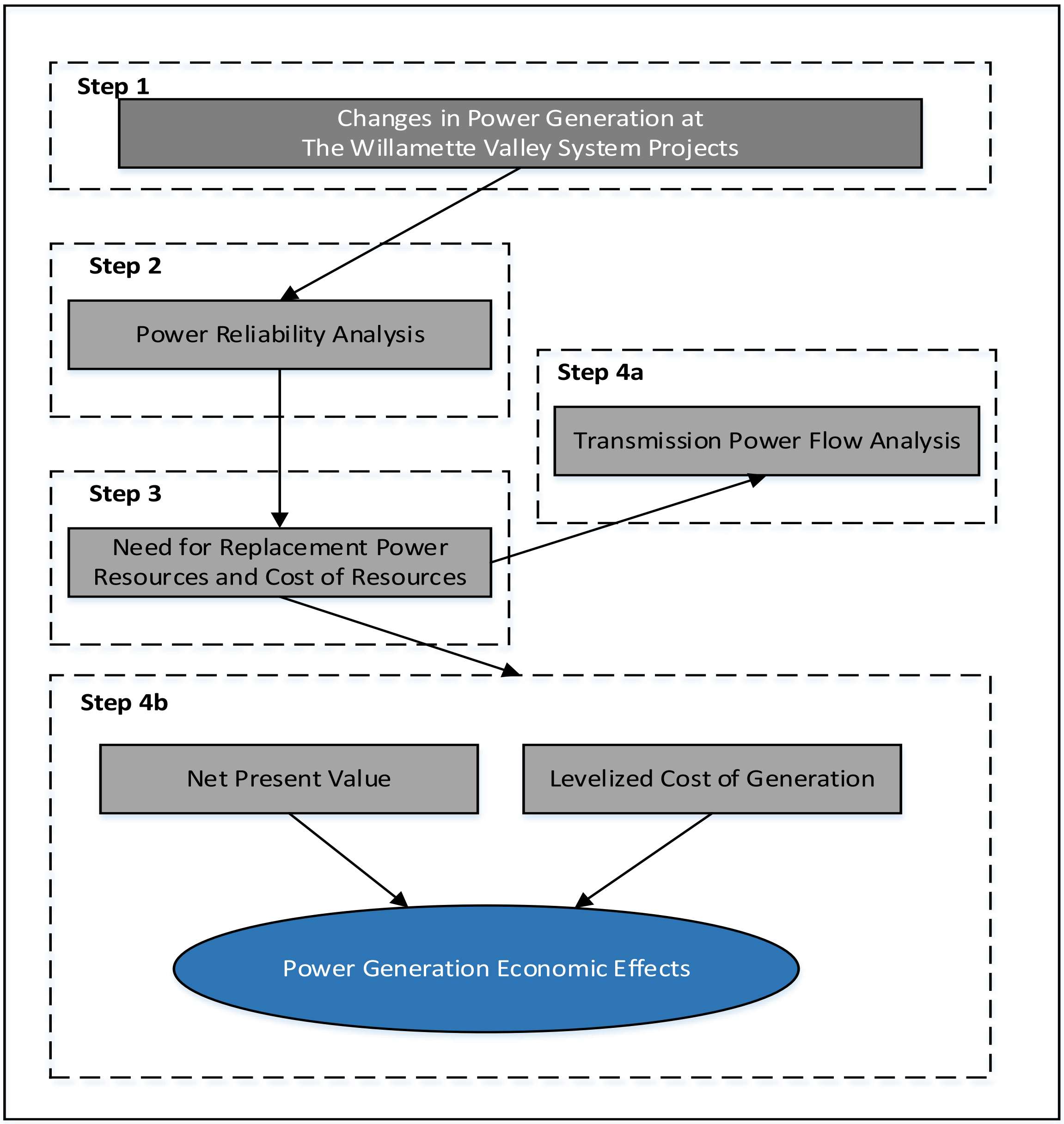


Figure 1-1. Analytical Approach for Evaluating Power and Transmission Effects of the WVS PEIS Action Alternatives.

Note: Additional power and transmission analysis occurs within each of the step boxes depicted.

Step 1 of the analysis assesses the effects of the Alternatives on hydropower generation based on average historical water conditions and for critical water conditions.[1] The amount of power generated by the system under each of the alternatives determines whether additional changes to, or investments in the system may be required to maintain Bonneville's ability to supply adequate and reliable power (both energy and capacity) to its firm power customers under 20-year contracts. Step 2 of the analysis evaluates the extent to which the alternatives would result in the need for Bonneville or other regional entities to acquire power from other resources (e.g., new or existing generating plants, wind, solar, etc.[2]) and construct new transmission infrastructure to replace the lost capability at Federal hydropower projects. To the extent Step 2 identifies a potential need to acquire resources or to build transmission infrastructure, Step 3 would identify potential replacement resources and associated costs[3]. Step 4a, the transmission analysis, estimates the incremental power flow change on Bonneville Transmission Network Paths between the No Action Alternative (NAA) and each of the other Alternatives during multiple seasons as a result of generation output changes at the federal WVS projects with hydropower facilities (Detroit, Big Cliff, Cougar, Green Peter, Foster, Hills Creek, Lookout Point, and Dexter dams).

Based on the inclusion of any new capital investments under each of the Alternatives, Step 4b of the analysis considers the Net Present Value (NPV) and Levelized Cost of Generation (LCOG) resulting from the increased costs of providing power. The NPV analysis compares the expected revenue produced by each WVS Project with hydropower facilities against their expected costs over a 30-year[4] study period for each of the Alternatives. A positive NPV indicates that power generation is economically justified while a negative NPV indicates that the costs of power production outweigh the benefits. The LCOG analysis evaluates the incremental cost of producing power, in $/MWh, for each project over the 30-year study period. This value provides a relative measure of cost-competitiveness when compared to other generating resources or market purchases.

The areas of analysis for the power and transmission resources differ as a function of Bonneville's products and services. Both the power and transmission studies focus on Bonneville's service area (Figure 1.1-2)**.** The Bonneville Service Area is defined by the Northwest Power Act as the Pacific Northwest, which includes Oregon, Washington, Idaho, the portion of

---

[1] The "critical water year" or "critical water conditions" represent the historic water year when the capability of the hydro system produces the least amount of dependable generation to serve the least amount of load while considering power and non-power operating constraints.

[2] In the context of power acquired from new resources, "existing" refers to currently operating generating plants or renewables (e.g., wind, solar, etc.) located outside of the Pacific Northwest region.

[3] To the extent Step 2 identifies potential needs to acquire power from new resources or construct transmission infrastructure, and if Bonneville proposes to take such action in the future, Bonneville would do so consistent with the Northwest Power Act and would complete additional site-specific planning and analysis in compliance with environmental laws, including the National Environmental Policy Act (NEPA).

[4] Bonneville's standard power generation economic analysis timeframe is 50 years. For consistency with other analyses in the EIS, a 30-year timeframe was used instead.

Montana west of the Continental Divide, and the portions of Nevada, Utah, and Wyoming within the Columbia River drainage basin. However, because Bonneville regularly markets its surplus power both within and outside the Pacific Northwest, the power evaluation additionally considers potential effects on power markets within the larger U.S. Portion of the Western Interconnection (Figure 1.1-2). The transmission analysis considers potential effects on multiple "paths," or routes over which power flowing from one point to another is monitored and managed (Figure 1.1-3).

1.2 ORGANIZATION OF THE APPENDIX

The following sections of this appendix are organized as follows:

Section 2 – Changes in Hydropower Generation (in aMW[5]): Section 2 focuses on Step 1 (Figure 1.1-1), describing the approach to modeling changes in power generation at the eight WVS projects with hydropower facilities[6].

Section 3 – Regional Power Supply and Replacement Resources: Section 3 focuses on Steps 2 and 3 (Figure 1.1-1), describing the approach to modeling the impacts of changes in power generation at the WVS projects on power supply (expressed in terms of loss of load probability [LOLP]), and, if needed, identifying any replacement resources and associated costs for maintaining an adequate and reliable supply of electricity.[7]

Section 4 – Transmission Paths Incremental Analysis: Section 4 describes Step 4a (Figure 1.1-1), linking changes in how and where power is generated to effects on the transmission system reliability.

Section 5 – Economic Viability of Power Generation: Section 5 describes Step 4b (Figure 1.1-1), evaluating how changes in power generation and costs affect the economic viability of WVS projects.

[5] The average electric power created from an energy source in megawatts (MW).
[6] The eight WVS projects with hydropower facilities are Cougar, Detroit, Big Cliff, Lookout Point, Dexter, Hills Creek, Green Peter, and Foster.
[7] Loss of Load Probability under the No Action Alternative is 6.5%. The NW Council target for LOLP is 5%. *See NW* Council Document Number 2011-14, Page 4, available at: https://www.nwcouncil.org/sites/default/files/2011_14_1.pdf.

Figure 1-2. Bonneville Service Area and U.S. Portion of the Western Interconnection.

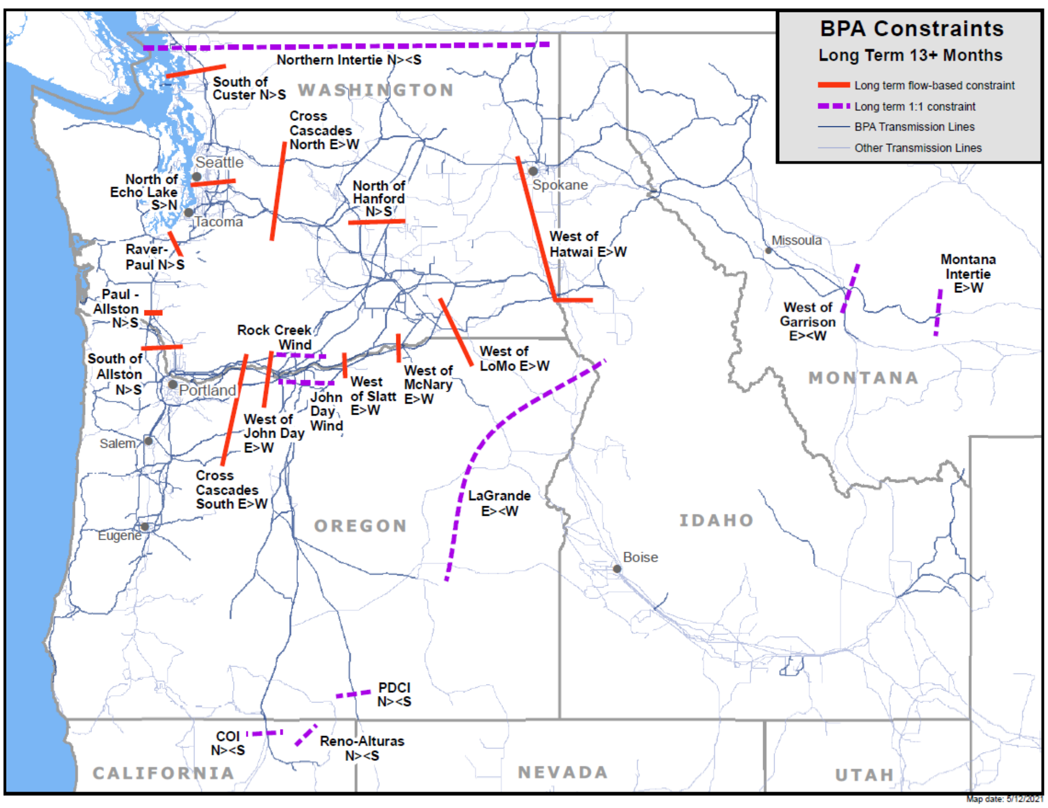


Figure 1-3. Northwest Transmission Paths.

Note: Red and purple dashed lines denote defined paths and interties (locations where power flows are monitored and analyzed).

Source: Bonneville (2021).

1.3 SUMMARY OF RESULTS FOR POWER AND TRANSMISSION ANALYSIS

Table 1.3-1 presents the summary of results for all alternatives. The following paragraphs describe results by topic for the Alternatives relative to the NAA.

1.3.1 Hydropower Generation

Under the NAA, annual average hydropower generation from the WVS projects was calculated to be 171 aMW[8] (roughly the amount of power used by 136,416 Northwest homes or used by residential customers in a city slightly more populated than Gresham, Oregon). Under Alternative 1 and 4, annual average hydropower generation from the WVS projects increased by 8 and 1.0 aMW, respectively, which reflect slight to indistinguishable increases (approximately 4.7 and 0.6 percent, respectively) relative to the NAA. Under Alternative 2A, annual average hydropower generation from the WVS projects decreased by approximately 4 aMW (-2.3 percent) relative to the NAA. Under Alternative 2B, annual average hydropower generation from the WVS projects decreased by approximately 18 aMW, or an approximate 10.6 percent decrease relative to the NAA. This annual average reduction reflects monthly reductions from November through May counterbalanced by increases in power from June through October. The annual average hydropower generation from the WVS projects under Alternative 3A and Alternative 3B decreased by 87 and 79 aMW, respectively, which are approximately 47.9 and 45.8% decreases relative to the NAA. These reductions reflect the numerous operational changes included in Alternative 3A and Alternative 3B resulting in reservoir elevations frequently being below the power pool; thereby, precluding hydropower generation for extended periods. Under Alternative 5, annual average hydropower generation from the WVS projects decreased by approximately 52 aMW, or an approximate 29.8 percent decrease relative to the NAA.

1.3.2 Regional Power Supply – Loss of Load Probability (LOLP)[9] and Replacement Resources

The best available regional hydroregulation data was used for this analysis, which includes 2021 hydroregulation data for the Willamette Valley System (WVS) projects generated by the Corps (see Appendix B), combined with 2020 hydroregulation data for all other FCRPS projects sourced from the Columbia River System Operations (CRSO) EIS' Preferred Alternative (Corps et al. 2020). Given the WVS projects represent a small subset of the FCRPS projects, the resulting NAA LOLP of 6.5 percent was indistinguishable from the CRSO EIS' Preferred Alternative LOLP of 6.4 percent (i.e., within the +/- 1 percent range of modeling accuracy).

---

[8] An average megawatt is one million watts delivered continuously 24 hours a day for one year.

[9] LOLP is expressed as a percentage that reflects the probability that the system will not be able to meet the demand for electricity in a particular year. Higher LOLPs reflect the increased likelihood that the power system would be unable to meet demand, and therefore, will result in power shortages or blackouts. A high LOLP is an indication of a less reliable power system. A low LOLP reflects a low likelihood that the power system will experience a power shortage. The LOLP is a measure of the frequency of outages but not a measure of their duration or magnitude.

Without replacement resources, regional LOLP would negligibly increase under Alt 2, Alt 3A and Alt 3B, and Alt 5 (+0.1 to +0.5 percentage points for each); would negligibly decrease under Alt 1 (-0.1 percentage points), and would not change under Alt 4 relative to the NAA. Since the LOLPs for each of the Alternatives are not materially different than the NAA (i.e., differences are within the +/- 1 percent range of modeling accuracy), the Alternatives would maintain essentially the same level of regional power system reliability as the NAA; therefore, replacement resources to return the LOLP to the NAA level would not be needed for any of the Alternatives.

1.3.3 Transmission Paths Incremental Analysis

The transmission flowgate incremental analysis identifies the potential changes in power flows that may occur under each of the Alternatives. Overall, results indicate that a reduction of the Willamette Valley System power generation and the location of replacement power generation either at Upper Columbia or Lower Snake generation facilities can decrease the transmission inventory available for commercial sales on constrained network flowgates. Constrained network flowgates for commercial planning have historically included South of Allston, Raver-Paul, North of Echo Lake, Cross Cascades South, and Cross Cascades North. Constraint definitions and total transfer capabilities can be subjected to change based on the future state of the transmission system and the evolving external market landscape.

1.3.4 Economic Viability of Power Generation

This analsis identifies the potential changes in the WVS projects' NPV and LCOG that may occur under each of the Alternatives. Overall, results indicate that power generation reductions and costs of structural measures under the Alternatives would result in large reductions in NPV and increases in the LCOG compared to the NAA. All of the Action Alternatives result in a negative median NPV for all WVS projects combined ranging from approximately -$196 million (NEAR-TERM OPERATIONS MEASURE) to -$937 million (ALT4)[10], which represent -$421 million and -$1.162 billion in reductions relative to the NAA, respectively. Under the Action Alternatives, costs of generation for the combined WVS projects would be expected to exceed both current Tier 1 rates and expected energy prices with increases in LCOG from the NAA ranging from $11.65/MWh (NEAR-TERM OPERATIONS MEASURE) to $37.61/MWh (ALT3A).

[10] Bonneville's share of basin-wide costs (e.g., RME) were not included in this analysis. With inclusion of those costs, the Net Present Value would be incrementally lower and the Levelized Costs of Generation would be incrementally higher. Additionally, structural cost estimates used in the analysis of Action Alternatives were at a conceptual design level with a 50% contingency. For other projects of similar size and complexity, the conceptual design cost estimates increased by 137% to 215% upon completion of the detailed design report. Post-construction, the complexity of these systems has typically resulted in further costs to improve performance. Higher implementation costs than currently estimated would result in additional reductions of the Net Present Value and increases in the levelized costs of generation.

Table 1-1. Summary of Hydropower and Transmission Effects for All WVS PEIS Alternatives.[6]

Effect[1/]	No Action Alternative (NAA)[1]	ALT 1 Relative to NAA	ALT 2A Relative to NAA	ALT 2B Relative to NAA	ALT 3A Relative to NAA	ALT 3B Relative to NAA	ALT 4 Relative to NAA	NEAR-TERM OPERATIONS MEASURE Relative to NAA	Preferred Alternative Relative to NAA
WVS Hydropower Generation (aMW)	171.3	+8	-4	-18	-87	-79	+1.0	-52	-18
Loss of Load Probability (LOLP; percent)	6.5	-0.1	0	+0.1	+0.5	+0.5	0	+0.3	+0.1
Replacement Resources/Costs to return LOLP to NAA level	——2	NA3	NA3	NA3	NA3	NA3	NA3	NA3	NA3
Transmission Flow Paths (seasonal MW changes on currently congested paths Cross Cascades South [CCS] and South of Allston [SOA])	W:6475.5 CCS; 1183 SOA Sp:4100.5 CCS;732.1 SOA Su: 5862.9 CCS;2525.1 SOA	All seasons: <+10 CCS & SOA	W:+18.4 CCS; +6.9 SOA Sp:+61.3 CCS; +11.8 SOA Su: <+10 CCS & SOA	W:+21.9 CCS; +8.3 SOA Sp:+25.1 CCS; 5.1 SOA Su: <+10 CCS & SOA	W:+37.2 CCS; +13.6 SOA Sp:+113.7 CCS;+22.3 SOA Su:+28.3 CCS	W:+41.4 CCS;+15.2 SOA Sp:+94.8 CCS; +18.7 SOA Su:+25.6 CCS	W/Su: <+10 CCS & SOA Sp: +15 CCS; +3.2 SOA	W:+47.0 CCS; +17.0 SOA Sp: +59.8 CCS; +11.4 SOA Su: <+10 CCS & SOA	W:+21.9 CCS; +8.3 SOA Sp:+25.1 CCS; 5.1 SOA Su: <+10 CCS & SOA
Transmission Reliability	Same/similar to affected environment	No change	No change	No regional change/locally comprised Blue River[4]	No regional change/locally comprised Oakridge & Blue River[4]	No regional change/locally comprised Oakridge & Blue River[4]	No change	No regional change/locally comprised Blue River[4]	No regional change/locally comprised Blue River[4]
Net Present Value5	$225M	-$1.159 B	-$863M	-$933M	-$853M	-$829M	-$1.162 B	-$421M	-$939
Levelized Cost of Generation ($/MWh)5	$26.70	+$27.14	+$20.75	+$23.96	+$37.61	+$32.72	+$27.84	+$11.65	+$24.11

Notes: The estimated Loss of Load Probability (LOLP) effects rely on the best available information regarding planned coal plant retirements as of 2017.

1/ The analysis of the NAA for these effect categories provides a baseline against which the Alternatives (ALT) are compared. Thus, the NAA results presented in this table describe the baseline magnitude of hydropower and transmission values and the ALT1 through ALT4 and PA results describe the change relative to No Action.

2/ A "——" indicates an effect category that is not relevant to the No Action Alternative because it only occurs as a result of implementing the ALTs (e.g., the need for new generation and transmission infrastructure and associated costs).

3/ The LOLP determined to be essentially the same as the NAA (within the +/- 1 percent range of modeling accuracy), so no replacement resources needed to return LOLP to the NAA level.

4/ Deep fall and spring drawdowns would compromise Hills Creek and/or Cougar dams' abilities to operate islanded and serve Oakridge and Blue River communities, respectively, under temporary storm or fire related outage conditions.
5/ Bonneville's share of basin-wide costs (e.g., RME) were not included in this analysis. With inclusion of those costs, the Net Present Value would be incrementally lower and the Levelized Costs of Generation would be incrementally higher. Additionally, structural cost estimates used in the analysis of Action Alternatives were at a conceptual design level with a 50% contingency. For other projects of similar size and complexity, the conceptual design cost estimates increased by 137% to 215% upon completion of the detailed design report. Post-construction, the complexity of these systems has typically resulted in further costs to improve performance. Higher implementation costs than currently estimated would result in additional reductions of the Net Present Value and increases in the levelized costs of generation.
6/ Alternative 5 effects are only inclusive of near-term operational measures and do not account for structural measures that have been proposed under the court order (e.g., Dexter Hatchery improvements), nor do they account for operational changes that could occur as a result of structural measure implementation.

CHAPTER 2 - HYDROPOWER GENERATION

This section provides the modeling analysis used to estimate the hydropower generation values (in aMW) resulting from the NAA and several alternatives with comparisons to the NAA. Hydropower generation results were calculated using HYDSIM (**Hyd**ro System **Sim**ulator) for the eight WVS projects with hydropower facilities including: Cougar, Detroit, Big Cliff, Lookout Point, Dexter, Hills Creek, Green Peter, and Foster dams. Two metrics were evaluated specifically for hydropower generation: average generation and critical water year (1937) average generation.

2.1 HYDROPOWER GENERATION METHODOLOGY

Bonneville and the Corps collaborated on modeling hydropower generation for the WVS PEIS alternatives. The Corps first used ResSim to model reservoir operations for the WVS PEIS alternatives (Appendix B). The resulting ResSim values for reservoir elevations, streamflows, and project spills were used as inputs for many different analyses performed for the WVS PEIS. Because ResSim does not include power drivers in operations and ResSim outputs did not provide hydropower production values for the alternatives, Bonneville produced the hydropower generation results using HYDSIM as described in section 3.1.2 below. The reservoir and streamflow conditions for each alternative over the 73-year study period in HYDSIM (Water Years 1935/36 through 2007/08) and the corresponding period in ResSim studies were closely coordinated with the Corps to minimize differences.

2.1.1 HYDSIM

HYDSIM has been in use at Bonneville for decades and is a well-calibrated hydropower generation model. HYDSIM is a monthly model, where April and August are split into half-months (e.g., April I and April II) giving 14 HYDSIM periods in each water year. The model has been used for years for hydropower planning at Bonneville and for Treaty coordination with Canada and regional utilities. Project inflows, outflows, powerhouse flows, and spills calculated by HYDSIM are period averages. Reservoir elevations and storage contents calculated by HYDSIM are end-of-period. Key study inputs include the measures listed in Chapter 2. Water Years 1935/36 through 2007/08 from the 2010 modified flows dataset spanning (BPA 2011) described in Appendix B were used as the baseline hydrology. Exhibit 1 provides additional information regarding the HYDSIM model.

Bonneville used the HYDSIM generation output to estimate and assess the impacts on two metrics, the average generation and critical water year generation, for each of the alternatives. These are standard metrics Bonneville uses in several types of studies involving the Federal Columbia River Power System (FCRPS) including Bonneville rate cases, system reliability studies, CRT planning studies, and planning studies such as the WVS EIS, and are as follows: **Average Generation (aMW)**: The average electric power created from an energy source in megawatts (MW). In this appendix, the average generation is reported either by year or by 14-period averages wherein April and August are split into two periods. It is calculated by HYDSIM as the annual average or the 14-period average for the 73 water-years studied.

Critical water-year average generation: The generation for water year 1937 (October 1, 1936 – September 30, 1937) is calculated in HYDSIM. This dry water year is one of the lowest average Columbia River System (CRS) power generation of all years in the 73-year study period and the least amount of load can be served by the hydro system during this period. Production of this amount of hydropower could reasonably be expected if the 1937 conditions repeated under modern system conditions. It is an important metric in determining the need for additional resources (power) to meet the Administrator's load supply obligations or replace aging and retired generating resources. Bonneville's long-term firm power sales to its regional power customers are tied to this metric.

2.2 ENERGY GENERATION RESULTS

Energy generation results for each of the WVS PEIS alternatives were produced for the WVS projects with hydropower facilities and the remainder of the FCRPS system was held constant since the operations of the U.S., CRS (Federal), Mid-Columbia, and Canadian systems are not influenced by WVS operations. Generation results for each alternative are driven primarily by storage reservoir objectives for downstream flow measures and specified project operational measures for fish passage Chapter 2 of the PEIS provide details about the measures in the alternatives.

This section also compares the energy generation results between the NAA and each alternative and provides explanations for generation changes from the NAA.

2.2.1 WVS Projects Energy Generation Summaries

Energy generation from results of HYDSIM outputs for combined WVS projects are provided for 73-Year Average Generation in Table 2.2-1 and Figure 2.2-1, and for Critical Water Year (1937) Average Generation in Table 2.2-2 and Figure 2.2-2.

Table 2-1. WVS Projects 73-Year Average Generation: Differences in Generation (aMW) compared to the NAA.[11]

	NAA	ALT1	ALT2A	ALT2B	ALT3A	ALT3B	ALT4	NTOM	ALT5
Oct	134	39	38	13	-83	-77	26	-5	15.5
Nov	230	46	-13	-41	-182	-187	20	-118	-49.2
Dec	231	-4	-53	-67	-148	-159	-8	-124	-69.5
Jan	235	-5	-30	-36	-60	-68	-7	-76	-37.8
Feb	147	-1	-7	-6	17	38	0	-20	-5.0
Mar	143	-11	-12	-22	-28	-11	-11	-43	-23.3
Apr I	177	-27	-26	-39	-81	-59	-26	-96	-33.8
Apr II	182	-29	-36	-50	-111	-100	-37	-110	-46.2
May	222	-9	-21	-39	-177	-154	-22	-89	-37.8
Jun	162	21	27	7	-119	-106	27	-10	7.3
Jul	106	30	20	9	-53	-44	19	5	8.1
Aug I	114	20	14	5	-56	-54	15	-16	4.7
Aug II	118	17	12	3	-52	-43	13	-18	2.9
Sep	151	-9	15	6	-59	-39	-14	-19	6.3
Annual Average	**171**	**8**	**-4**	**-18**	**-87**	**-79**	1	-52	**-18.6**

Table 2-2. WVS Projects Critical Water Year (1937) Average Generation: Differences in Generation (aMW) compared to the NAA.[7]

	NAA	ALT1	ALT2A	ALT2B	ALT3A	ALT3B	ALT4	NTOM	ALT5
Oct	119	8	17	-6	-83	-74	10	-11	32
Nov	156	52	7	-30	-144	-142	18	-82	-49
Dec	80	-9	-16	-14	-58	-63	-21	-45	-42
Jan	47	-6	-8	-14	-26	-32	-11	-27	-20
Feb	67	-10	-10	-17	-29	-37	-8	-40	-20
Mar	121	-7	-43	-54	-65	-52	-6	-43	-54
Apr I	188	-3	-6	-25	-63	-82	-12	-82	-30
Apr II	227	24	0	-43	-89	-124	0	-140	-44
May	356	5	-26	-50	-289	-251	-31	-145	-53
Jun	264	50	27	8	-197	-180	21	-14	8
Jul	111	20	25	12	-31	-23	23	20	14
Aug I	115	17	7	8	-46	-39	8	-8	1
Aug II	124	10	5	3	-58	-33	2	-22	2
Sep	155	-12	22	24	-30	-3	-18	4	18
Annual Average	**150**	**10**	**0**	**-14**	**-90**	**-83**	**-2**	**-42**	**-17**

[11] 1/ HYDSIM (**Hyd**ro System **Sim**ulation) uses a 14-period time step. April and August are split into two half-month periods because these months tend to have substantial natural flow differences between their first and second halves. Source: HYDSIM modeling results

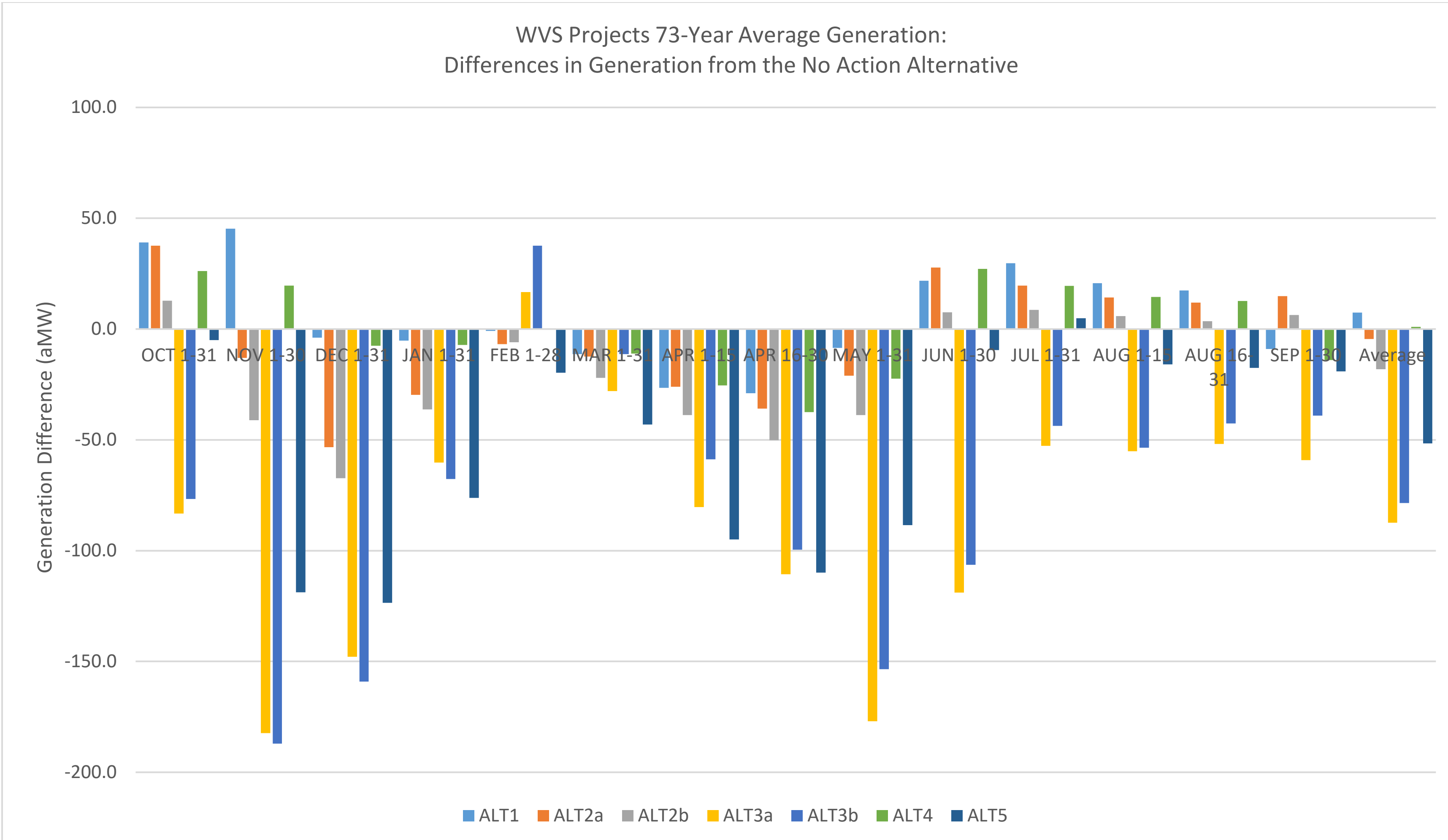


Figure 2-1. WVS Projects 73-Year Average Generation: Differences in Generation (aMW) from the No Action Alternative.

Note: HYDSIM uses a 14-period time step. April and August are split into two half-month periods because these months tend to have substantial natural flow differences between their first and second halves.

Source: HYDSIM modeling results.

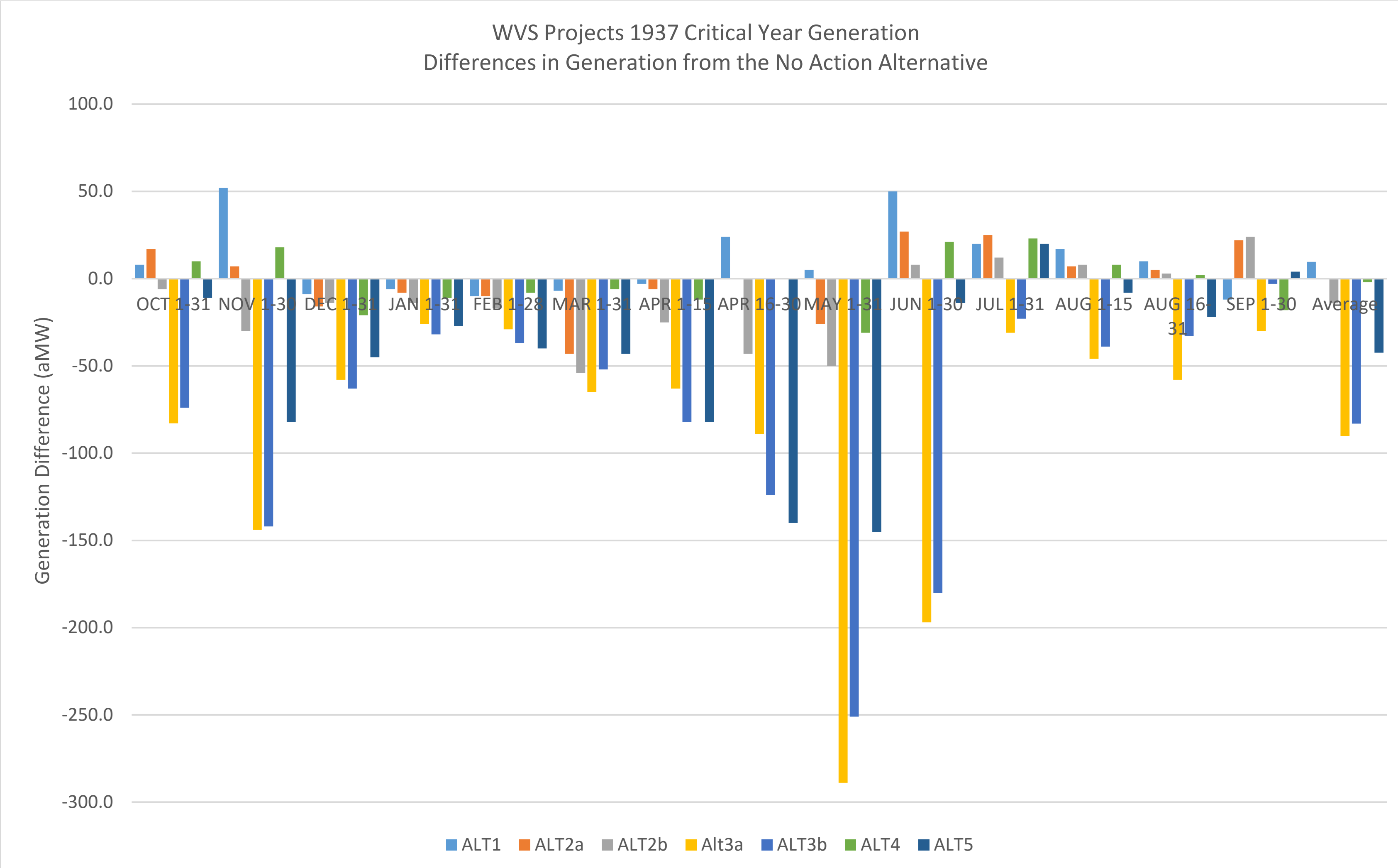


Figure 2-2. WVS Projects Critical Water Year (1937) Average Generation: Differences in Generation (aMW) from the No Action Alternative.

Note: HYDSIM uses a 14-period time step. April and August are split into two half-month periods because these months tend to have substantial natural flow differences between their first and second halves.

Source: HYDSIM modeling results.

2.2.2 WVS Projects Energy Generation (aMW): Alternative Comparisons to NAA

The following energy generation comparisons of Action Alternatives with the NAA are provided for the WVS projects with hydropower facilities (i.e. Dexter, Lookout Point, Hills Creek, Foster, Green Peter, Cougar, Big Cliff, and Detroit dams). Detailed information for individual project differences is provided in Exhibit 2.

Energy: No Action Alternative

Table 2.2-1 and Table 2.2-2 depicts the 73-Year Average Generation and Critical Water Year (1937) Average Generation of the combined WVS projects under the NAA, respectively. The annual average generation for the 73-year period is approximately 21 aMW higher than the critical water year (171 aMW versus 150 aMW). Generation varies seasonally with the lowest occurring in the months of July and August (106 to 118 aMW) over the 73-year period, and in December through February (47 to 80 aMW) during the critical water year. Highest generation occurs in November through January and again in May (222 to 235 aMW) over the 73-year period and from the latter half of April through June (227 to 356 aMW) during the critical water year.

Energy: ALT1 compared to NAA

Table 2.2-3 depicts the differences between ALT1 and the NAA for the 73-Year Average Generation and Critical Water Year (1937) Average Generation of the combined WVS projects. Positive differences indicate an increase, and negative differences indicate a decrease in average generation (aMW) from the NAA.

Figure 2.2-3 and Figure 2.2-4 illustrate the differences in generation of individual WVS projects between ALT1 and the NAA for the 73-Year Average Generation and Critical Water Year (1937) Average Generation, respectively. Individual project blocks indicate the amount of change in each project's monthly average generation (aMW) from the NAA. Project blocks above the zero line indicate a project under ALT1 measures generated more than the NAA; blocks below the zero line indicate less generation under ALT1 measures than the NAA. The total line indicates the difference in monthly average generation (aMW) for all WVS projects combined from the NAA.

ALT1: 73-YEAR AVERAGE GENERATION

Table 2.2-3 indicates an average annual increase of 8 aMW for the WVS projects combined under ALT 1 compared to the NAA. Differences in the 73-year Average Generation of the WVS projects between Alt 1 and the NAA primarily resulted from the following:

OCT - NOV: Higher average generation under ALT1 during this period was largely driven by increases in outflows through turbines at Detroit and Green Peter dams. In Alt 1, temperature control towers at Detroit and Green Peter dams replace operational spills for temperature management, which allows for increased flows through the turbines. Increased generation at these locations was somewhat offset by decreased generation at Lookout Point Dam.

Table 2-3. WVS Projects 73-Year Average Generation and Critical Water Year (CWY, 1937) Average Generation (aMW): ALT1 relative to NAA.[1]

	AVG GEN NAA	AVG GEN ALT1	AVG GEN Difference	CWY GEN NAA	CWY GEN ALT1	CWY GEN Difference
Oct	134	173	39	119	127	8
Nov	230	276	46	156	208	52
Dec	231	227	-4	80	71	-9
Jan	235	230	-5	47	41	-6
Feb	147	146	-1	67	57	-10
Mar	143	132	-11	121	114	-7
Apr I	177	150	-27	188	185	-3
Apr II	182	153	-29	227	251	24
May	222	213	-9	356	361	5
Jun	162	183	21	264	314	50
Jul	106	136	30	111	131	20
Aug I	114	134	20	115	132	17
Aug II	118	135	17	124	134	10
Sep	151	142	-9	155	143	-12
Annual Average[2]	**171**	**179**	**8**	**150**	**160**	**10**

1/ HYDSIM uses a 14-period time step. April and August are split into two half-month periods because these months tend to have substantial natural flow differences between their first and second halves.
2/ The Annual Average is a weighted average to account for the different number of days in the 14 periods.
Source: HYDSIM modeling results.

DEC – FEB: Slight reductions in average generation from the NAA during this period can be attributed to increases in spill, which were offset by some increased flows through turbines that moderated the reduction in average generation during this period. At Foster Dam, for example, the spill was typically greater than the change in turbine outflows. Hence, flow offsets helped explain the extent of generation reduction.

MAR – MAY: Reduced average generation under ALT1 during these months is primarily driven by reduced generation at Hills Creek (lower flows and higher end elevations result in reduced generation), Cougar, and Lookout Point dams.

JUN – AUG: Higher average generation under Alt1 in these months is driven by structural and/or operational changes at Detroit and Lookout Point dams. A temperature tower at Detroit Dam reduces the need for spill and results in increased flows through turbines with concomitant increases in generation. At Lookout Point Dam, increased flows through turbines contribute to increased generation.

SEPT: Reduced average generation under ALT1 in September can be attributed to decreased flows at Green Peter and Foster dams resulting in lower generation. These reductions are somewhat offset by increases in generation at Detroit Dam due to decreased spill at this location.

Figure 2-3. 73-Year Average Generation: Difference in Generation of ALT1 from the NAA.

Note: HYDSIM uses a 14-period time step. April and August are split into two half-month periods because these months tend to have substantial natural flow differences between their first and second halves.
Source: HYDSIM modeling results.

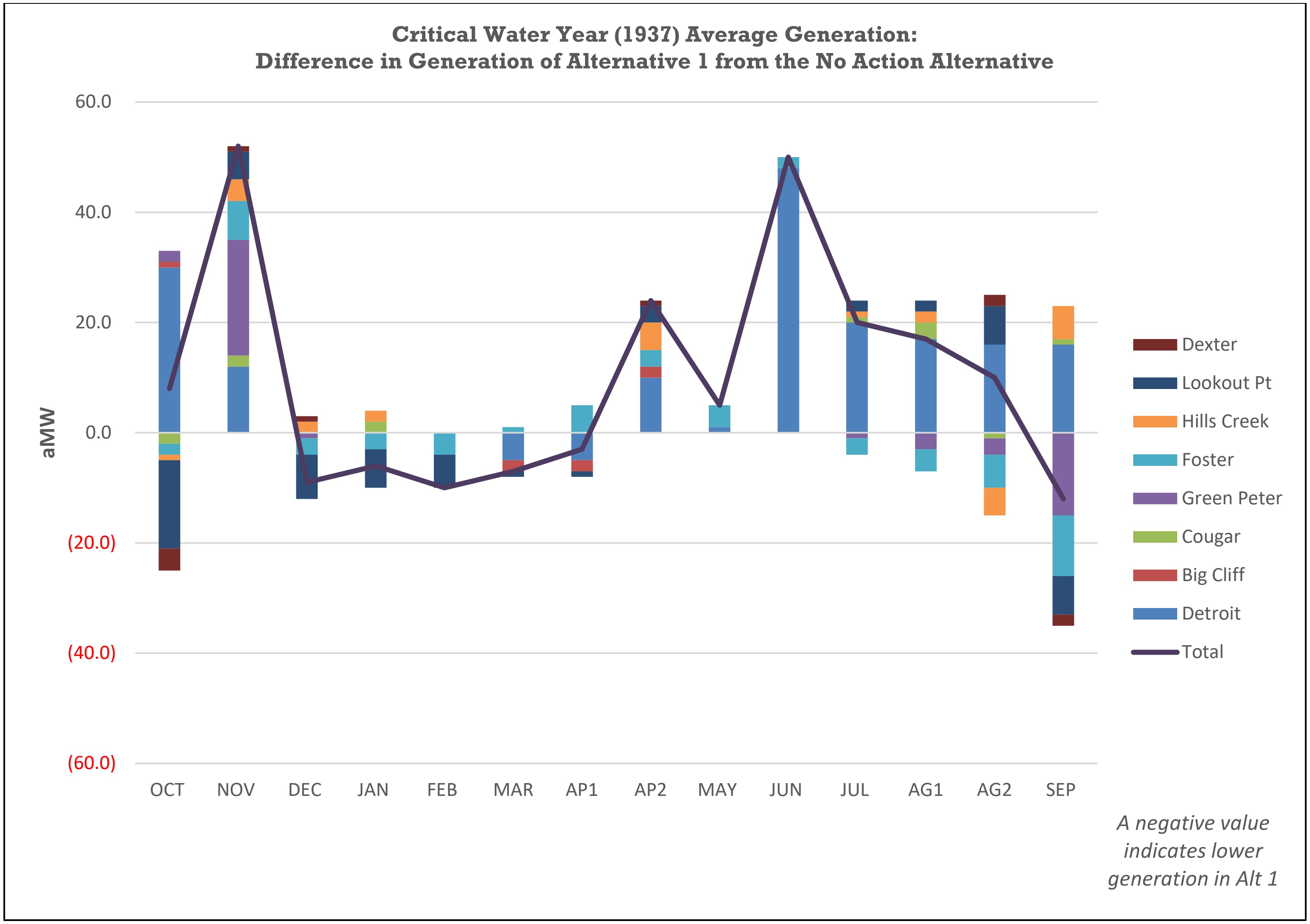


Figure 2-4. Critical Water Year (1937) Average Generation: Difference in Generation of ALT1 from the NAA.

Note: HYDSIM uses a 14-period time step. April and August are split into two half-month periods because these months tend to have substantial natural flow differences between their first and second halves.

Source: HYDSIM modeling results.

ALT1: CRITICAL WATER YEAR (1937) VS. 73-YEAR AVERAGE GENERATION

Overall, the annual average generation (aMW) for the combined WVS projects under ALT1 was higher than the NAA by approximately 6.7 and 4.7 percent in the Critical Water Year (1937) Average Generation and 73-Year Average Generation scenarios, respectively (Table 2.2-3). Decreases in generation occurred during the months of December through May and September, which were offset by increased generation during other months. A similar pattern of decreased generation was seen for the critical water year with the exception that there were generation increases in May and the latter half of April.

Energy: ALT2A compared to NAA

Table 2.2-4 depicts the differences between ALT2A and the NAA for the 73-Year Average Generation and Critical Water Year (1937) Average Generation of the combined WVS projects. Positive differences indicate an increase, and negative differences indicate a decrease in average generation (aMW) from the NAA.

Figure 2.2-5 and Figure 2.2-6 illustrate the differences in generation of individual WVS projects between ALT2A and the NAA for the 73-Year Average Generation and Critical Water Year (1937) Average Generation, respectively. Individual project blocks indicate the amount of change in each project's monthly average generation (aMW) from the NAA. Project blocks above the zero line indicate a project under ALT2A generated more than the NAA; blocks below the zero line indicate less generation under ALT2A than the NAA. The total line indicates the difference in monthly average generation (aMW) for all WVS projects combined from the NAA.

ALT2A: 73-YEAR AVERAGE GENERATION

Table 2.2-4 indicates an annual average decrease of 4 aMW for the WVS projects combined under ALT 2A compared to the NAA. Differences in average generation of the WVS projects between NAA and ALT2A primarily result from the following:

OCT: Higher ALT2A generation at Detroit, Foster, and Lookout Point dams offsets reduced generation at Green Peter Dam, resulting in an increase of 37.7 aMW of generation in this period. Unlike in ALT2B (below), Cougar Dam generation is largely unchanged between the NAA and ALT2A in this period since downstream fish passage is provided through a structural measure (i.e., FSS) instead of operationally.

NOV - MAY: ALT2A has lower generation compared to NAA. In the winter and later spring months, Green Peter Dam is the primary driver of the change, whereas in early spring decreased generation at Hills Creek Dam lowers the net generation. Detroit, Cougar, and Dexter exhibit smaller decreases in generation.

JUN – SEPT: Higher generation at Detroit Dam is the main driver for the increased generation in ALT2A compared to the NAA during this period.

Figure 2-5. 73-Year Average Generation and Critical Water Year (CWY, 1937) Average Generation at the WVS Projects: ALT2A relative to NAA, in aMW.[1]

	AVG GEN NAA	AVG GEN ALT2A	AVG GEN Difference	CWY GEN NAA	CWY GEN ALT2A	CWY GEN Difference
Oct	134	172	38	119	136	17
Nov	230	217	-13	156	163	7
Dec	231	178	-53	80	64	-16
Jan	235	205	-30	47	39	-8
Feb	147	140	-7	67	57	-10
Mar	143	131	-12	121	78	-43
Apr I	177	151	-26	188	182	-6
Apr II	182	146	-36	227	227	0
May	222	201	-21	356	330	-26
Jun	162	189	27	264	291	27
Jul	106	126	20	111	136	25
Aug I	114	128	14	115	122	7
Aug II	118	130	12	124	129	5
Sep	151	166	15	155	177	22
Annual Average[2]	**171**	**167**	**-4**	**150**	**150**	**0**

1/ HYDSIM uses a 14-period time step. April and August are split into two half-month periods because these months tend to have substantial natural flow differences between their first and second halves.
2/ The Annual Average is a weighted average to account for the different number of days in the 14 periods.
Source: HYDSIM modeling results.

ALT2A: CRITICAL WATER YEAR (1937) AVERAGE GENERATION VS. 73-YEAR AVERAGE GENERATION

Overall, the annual average generation (aMW) under ALT2A was lower than the NAA by approximately 2.3 percent in the 73-Year Average Generation scenario and there was no difference between the NAA and the Critical Water Year (1937) Average Generation (Table 2.2-4). Lower annual average generation in Alt2B was primarily driven by reduced generation at Green Peter Dam in the late fall through spring, especially in the winter months. Generation increases in summer and early fall months were primarily driven by increased outflows through turbines at Detroit Dam (associated with replacement of temperature management spills with a temperature control tower), which offset the extent of the annual average reduction.

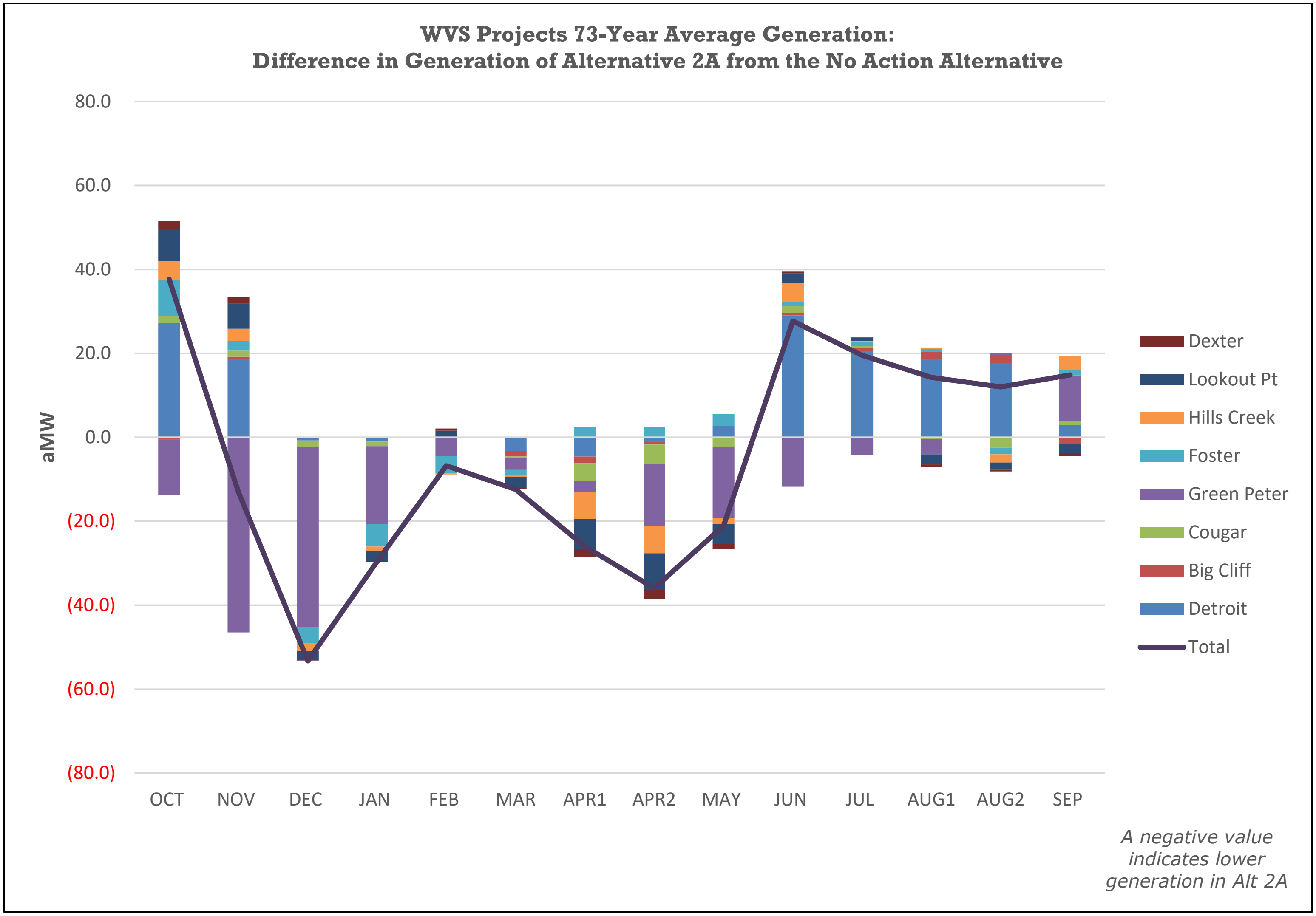


Figure 2-6. 73-Year Average Generation: Difference in Generation of ALT2A from the NAA.

Note: HYDSIM uses a 14-period time step. April and August are split into two half-month periods because these months tend to have substantial natural flow differences between their first and second halves.

Source: HYDSIM modeling results.

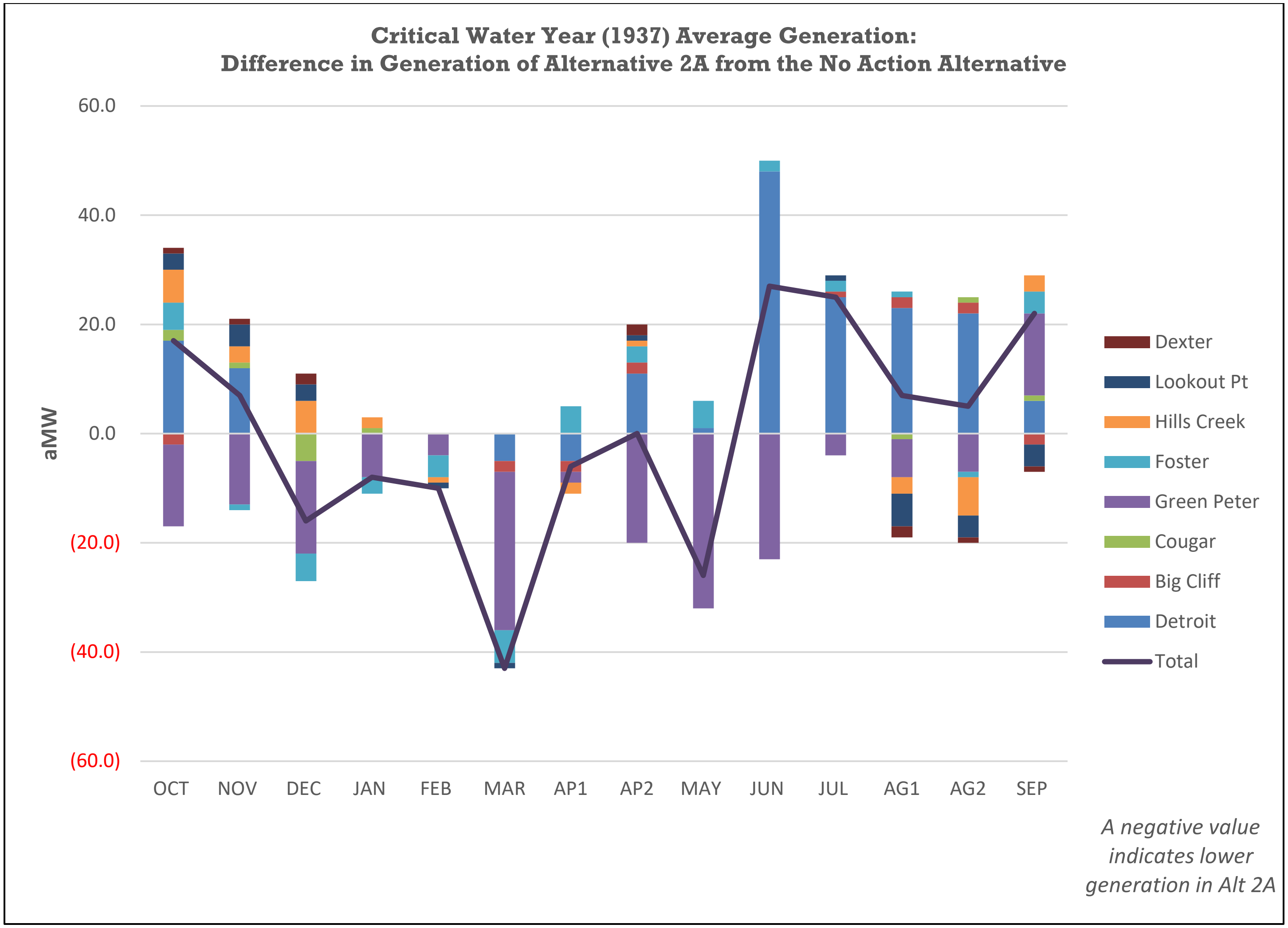


Figure 2-7. Critical Water Year (1937) Average Generation: Difference in Generation of ALT2A from the NAA.

Note: HYDSIM uses a 14-period time step. April and August are split into two half-month periods because these months tend to have substantial natural flow differences between their first and second halves.

Source: HYDSIM modeling results.

Energy: ALT2B compared to NAA

Table 2.2-5 depicts the differences between ALT2B and the NAA for the 73-Year Average Generation and Critical Water Year (1937) Average Generation for the WVS projects. Positive differences indicate an increase, and negative differences indicate a decrease in average generation (aMW) from the NAA.

Table 2-4. 73-Year Average Generation and Critical Water Year (CWY, 1937) Average Generation at the WVS Projects: ALT2B relative to NAA, in aMW.[1]

	AVG GEN NAA	AVG GEN ALT2B	AVG GEN Difference	CWY GEN NAA	CWY GEN ALT2B	CWY GEN Difference
Oct	134	147	13	119	113	-6
Nov	230	189	-41	156	126	-30
Dec	231	164	-67	80	66	-14
Jan	235	199	-36	47	33	-14
Feb	147	141	-6	67	50	-17
Mar	143	121	-22	121	67	-54
Apr I	177	138	-39	188	163	-25
Apr II	182	132	-50	227	184	-43
May	222	183	-39	356	306	-50
Jun	162	169	7	264	272	8
Jul	106	115	9	111	123	12
Aug I	114	119	5	115	123	8
Aug II	118	121	3	124	127	3
Sep	151	157	6	155	179	24
Annual Average[2]	171	153	-18	150	136	-14

1/ HYDSIM uses a 14-period time step. April and August are split into two half-month periods because these months tend to have substantial natural flow differences between their first and second halves.
2/ The Annual Average is a weighted average to account for the different number of days in the 14 periods.
Source: HYDSIM modeling results.

Figure 2.2-7 and Figure 2.2-8 illustrate the differences in generation of individual WVS projects between ALT2B and the NAA for the 73-Year Average Generation and Critical Water Year (1937) Average Generation, respectively. Individual project blocks indicate the amount of change in each project's monthly average generation (aMW) from the NAA. Project blocks above the zero line indicate a project under ALT2B generated more than the NAA; blocks below the zero line indicate less generation under ALT2B than the NAA. The total line indicates the difference in monthly average generation (aMW) for all WVS projects combined from the NAA.

ALT2B: 73-YEAR AVERAGE GENERATION

Table 2.2-5 indicates an annual average decrease of 18 aMW for the WVS projects combined under ALT2B compared to the NAA. Generation differences between NAA and ALT2B primarily result from the following:

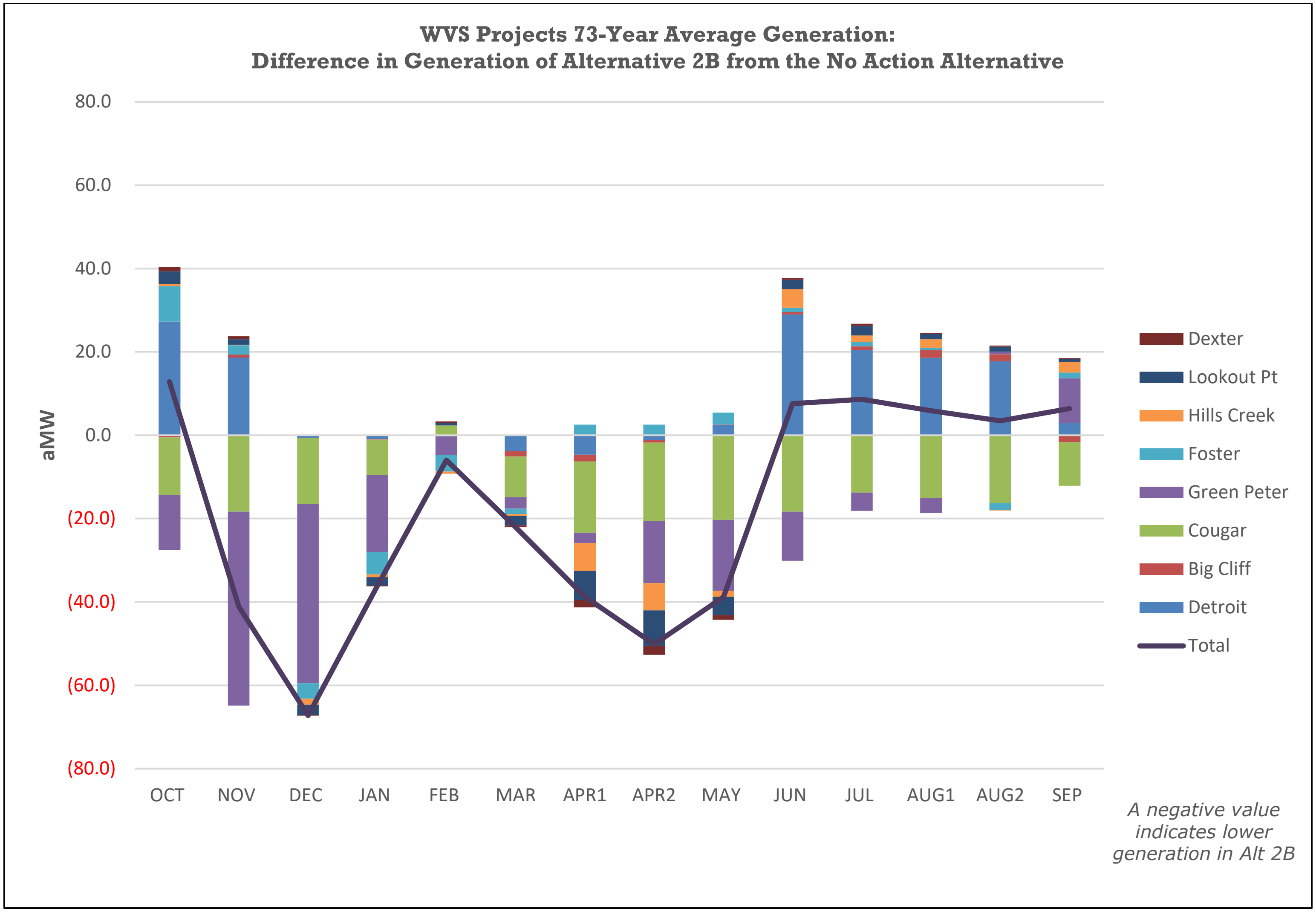


Figure 2-8. 73-Year Average Generation: Difference in Generation of ALT2B from the NAA.

Note: HYDSIM uses a 14-period time step. April and August are split into two half-month periods because these months tend to have substantial natural flow differences between their first and second halves.

Source: HYDSIM modeling results.

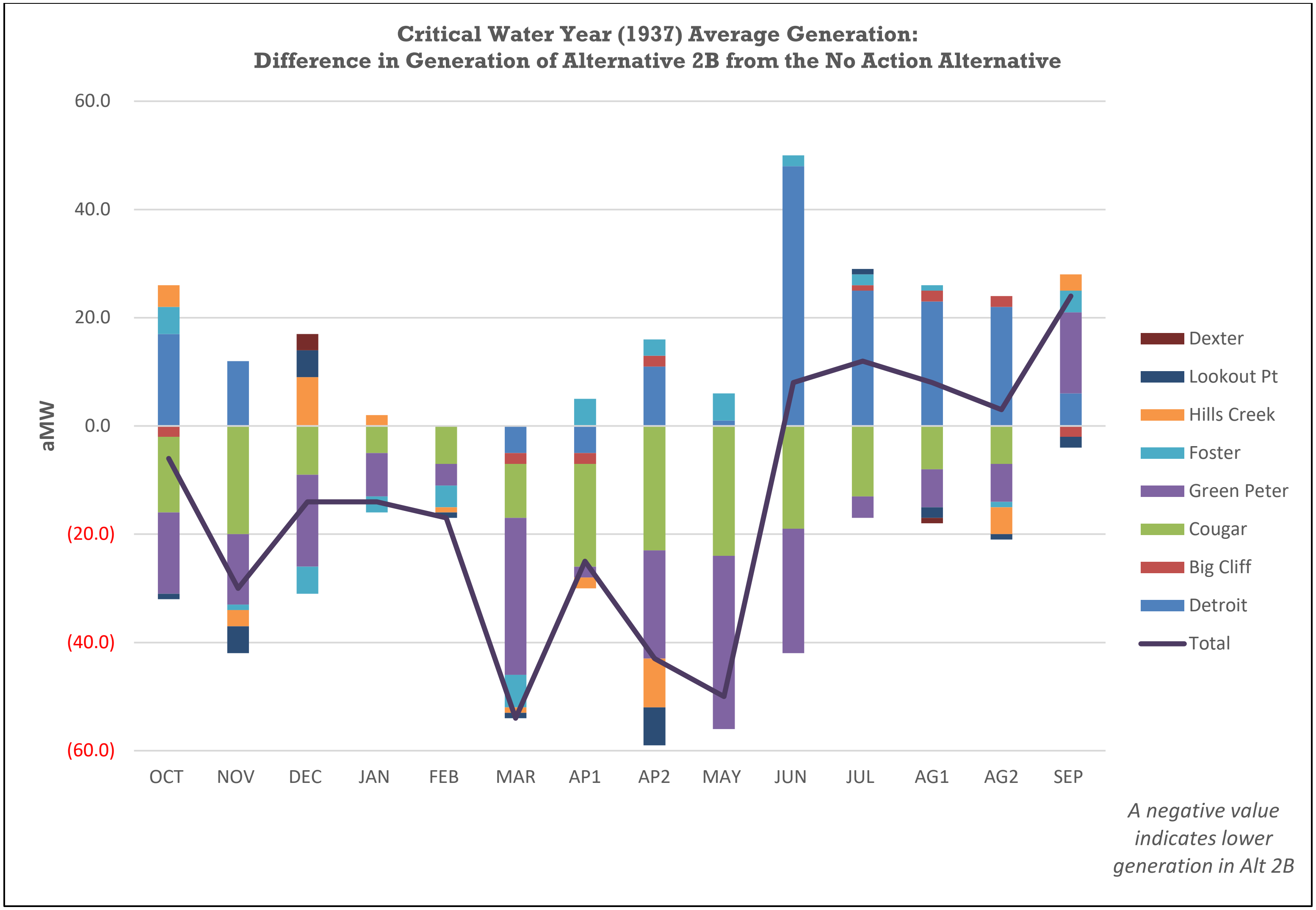


Figure 2-9. Critical Water Year (1937) Average Generation: Difference in Generation of ALT2B from the NAA.

Note: HYDSIM uses a 14-period time step. April and August are split into two half-month periods because these months tend to have substantial natural flow differences between their first and second halves.

Source: HYDSIM modeling results.

OCT: Higher average generation at Detroit and Foster dams under ALT2B offset reduced generation at Cougar and Green Peter, resulting in an increase of approximately 13 aMW of generation for all WVS projects combined in October.

NOV - MAY: ALT2B has lower average generation compared to the NAA for all WVS projects combined during these months. Cougar and Green Peter dams are the primary drivers of the difference. In fact, Cougar Dam has negligible generation in all months except January and February.

JUN – SEPT: ALT2B has higher average generation compared to the NAA for all WVS projects combined during these months. Higher ALT2B average generation at Detroit and Foster dams was the largest contributor to this increase. Reduced generation at Cougar Dam and other projects moderated the increase in average generation during this period.

ALT2B: CRITICAL WATER YEAR (1937) AVERAGE GENERATION VS. 73-YEAR AVERAGE GENERATION

Overall, the annual average generation (aMW) for the combined WVS projects under ALT2B was lower than the NAA by approximately 9.3 and 10.5 percent in the Critical Water Year (1937) Average Generation and 73-Year Average Generation scenarios, respectively (Table 2.2-3). Lower annual average generation in Alt2B was primarily driven by reduced generation at Cougar and Green Peter dams in the late fall through spring, especially in the winter months. Generation increases in summer and early fall months were primarily driven by increased outflows through turbines at Detroit Dam (associated with replacement of temperature management spills with a temperature control tower), which offset the extent of the annual average reduction.

Energy: ALT3A compared to NAA

Table 2.2-6 depicts the differences between ALT3A and the NAA for the 73-Year Average Generation and Critical Water Year (1937) Average Generation for the WVS projects. Positive differences indicate an increase, and negative differences indicate a decrease in average generation (aMW) from the NAA.

Figure 2.2-9 and Figure 2.2-10 illustrate the differences in generation of individual WVS projects between ALT3A and the NAA for the 73-Year Average Generation and Critical Water Year (1937) Average Generation, respectively. Individual project blocks indicate the amount of change in each project's monthly average generation (aMW) from the NAA. Project blocks above the zero line indicate a project under ALT3A generated more than the NAA; blocks below the zero line indicate less generation under ALT3A than the NAA. The total line indicates the difference in monthly average generation (aMW) for all WVS projects combined from the NAA.

Table 2-5. 73-Year Average Generation and Critical Water Year (CWY, 1937) Average Generation at the WVS Projects: ALT3A relative to NAA, in aMW.[1]

	AVG GEN NAA	AVG GEN ALT3A	AVG GEN Difference	CWY GEN NAA	CWY GEN ALT3A	CWY GEN Difference
Oct	134	51	-83	119	36	-83
Nov	230	48	-182	156	12	-144
Dec	231	83	-148	80	22	-58
Jan	235	175	-60	47	21	-26
Feb	147	164	17	67	38	-29
Mar	143	115	-28	121	56	-65
Apr I	177	96	-81	188	125	-63
Apr II	182	71	-111	227	138	-89
May	222	45	-177	356	67	-289
Jun	162	43	-119	264	67	-197
Jul	106	53	-53	111	80	-31
Aug I	114	58	-56	115	69	-46
Aug II	118	66	-52	124	66	-58
Sep	151	92	-59	155	125	-30
Annual Average[2]	**171**	**84**	**-87**	**150**	**60**	**-90**

1/ HYDSIM uses a 14-period time step. April and August are split into two half-month periods because these months tend to have substantial natural flow differences between their first and second halves.
2/ The Annual Average is a weighted average to account for the different number of days in the 14 periods.
Source: HYDSIM modeling results.

ALT3A: 73-YEAR AVERAGE GENERATION

Table 2.2-6 indicates an annual average decrease of 87 aMW for the WVS projects combined under ALT 3A compared to the NAA. Generation differences between NAA and ALT3A primarily result from the following:

SEPT – JAN: In the fall and early winter, ALT3A average generation is substantially reduced from the NAA at most projects except Foster (which had nearly double generation in October) and Dexter dams (which was unchanged). Fall deep reservoir drawdowns (Green Peter, Hills Creek, Cougar, Lookout Point, and Detroit dams) and spill operations conducted for fish passage (Green Peter, Foster, Hills Creek, Dexter, and Big Cliff dams) contribute to lower generation as a result of associated decreases in outflows through turbines.

FEB: This is the only month in which ALT3A average generation at all WVS projects combined is higher than the NAA. Higher outflows at Detroit, Big Cliff, and Cougar appear primarily responsible for the increase in generation. Spill and reservoir drawdown operations are not in effect during this period.

MAR – AUG2: In the spring and summer, ALT3A average generation is substantially reduced from the NAA at most projects. The impact is pronounced at Detroit, Cougar, Lookout Point, and Dexter dams. In May and June, several projects have average generation values of less than 1 aMW. Deep spring reservoir drawdowns and summer surface spill operations reduce generation as a result of associated decreases in outflows through turbines. Looking at Detroit Dam operations in May over several historical water years, for example, reveals that the combination of high spill values and lower reservoir elevations in the deep drawdown regime lead to less turbine flows and less corresponding generation.

ALT3A: CRITICAL WATER YEAR (1937) AVERAGE GENERATION VS. 73-YEAR AVERAGE GENERATION

Overall, the annual average generation (aMW) under ALT3A was less than the NAA by approximately 60.0 and 50.9 percent in the Critical Water Year (1937) Average Generation and 73-Year Average Generation scenarios, respectively (Table 2.2-6). Lower annual average generation in Alt3B was primarily driven by spill operations and deep fall and spring season reservoir drawdowns, which reduced generation at several projects as a result of associated decreases in outflows through turbines. It appears that deep spring drawdown and/or summer spills in the critical water year scenario would result in greater generation reductions compared to the NAA than over the 73 year average. It is also worth noting in the ALT3A critical water year, winter generation (NOV – JAN) is less than 20 aMW for the combined WVS projects.

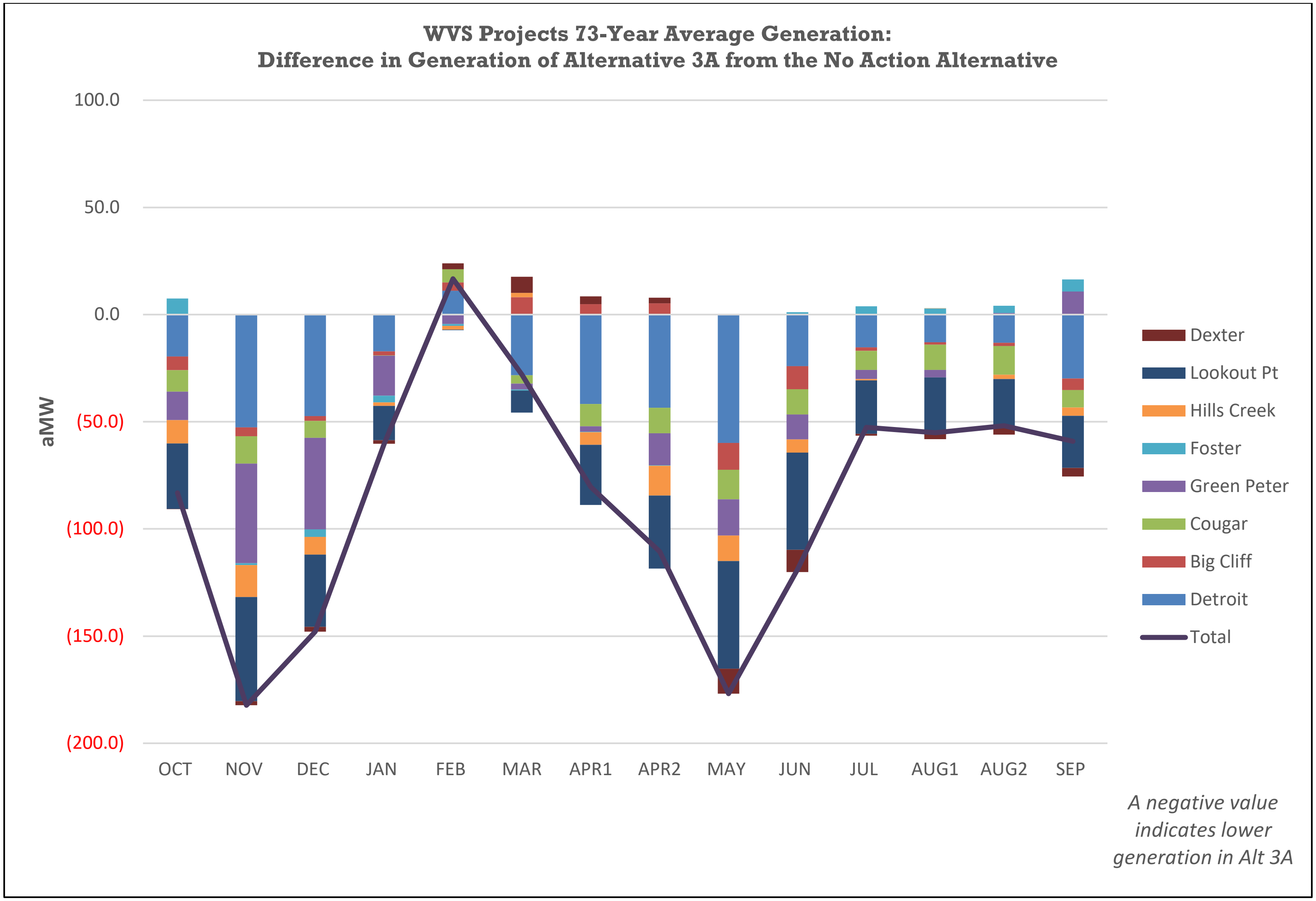


Figure 2-10. 73-Year Average Generation: Difference in Generation of ALT3A from the NAA.

Note: HYDSIM uses a 14-period time step. April and August are split into two half-month periods because these months tend to have substantial natural flow differences between their first and second halves.

Source: HYDSIM modeling results.

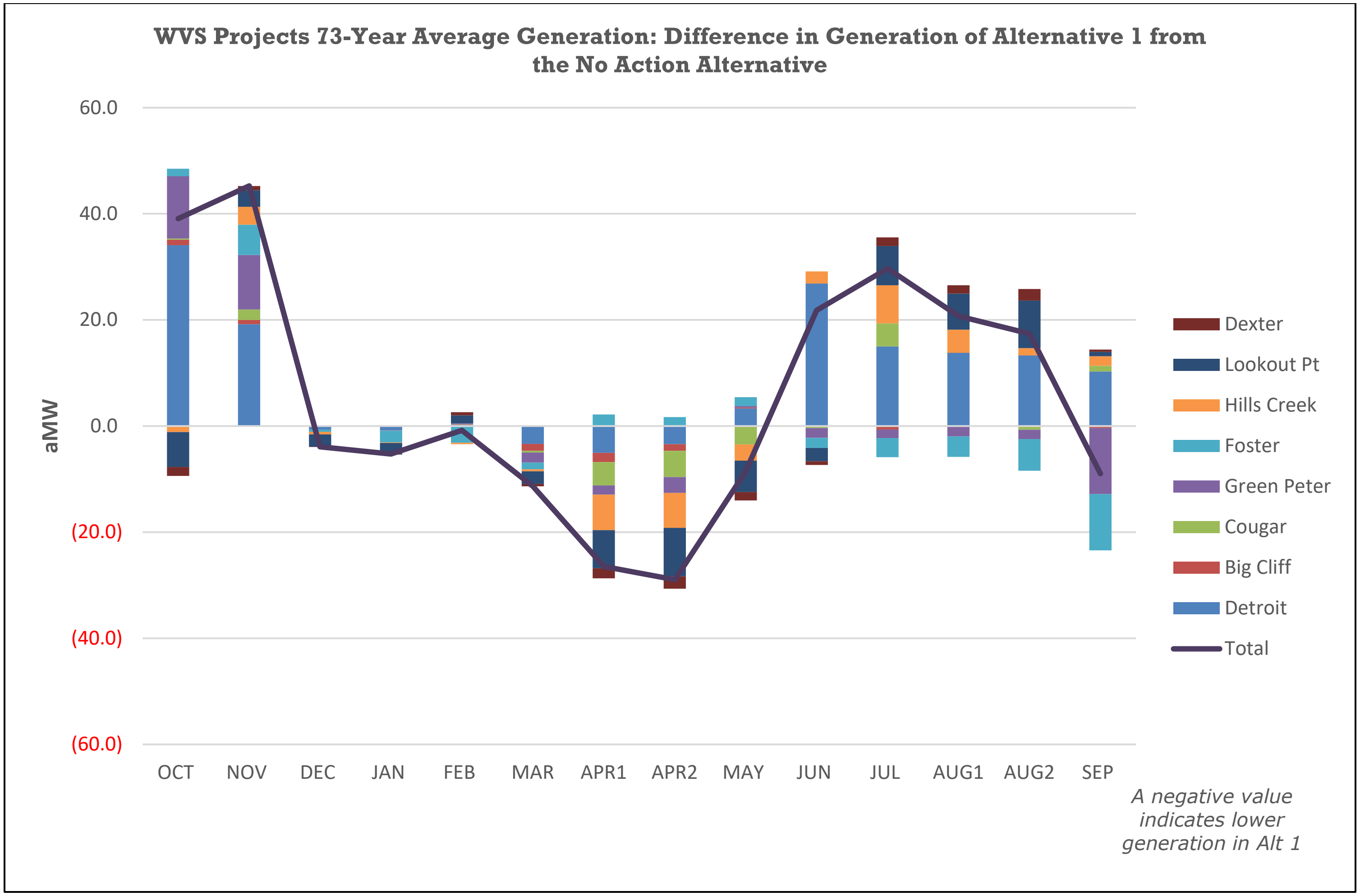


Figure 2.2-10. Critical Water Year (1937) Average Generation: Difference in Generation of ALT3A from the NAA.

Note: HYDSIM uses a 14-period time step. April and August are split into two half-month periods because these months tend to have substantial natural flow differences between their first and second halves.

Source: HYDSIM modeling results.

Energy: ALT3B compared to NAA

Table 2.2-7 depicts the differences between ALT3B and the NAA for the 73-Year Average Generation and Critical Water Year (1937) Average Generation for the WVS projects. Positive differences indicate an increase, and negative differences indicate a decrease in average generation (aMW) from the NAA.

Table 2-6. 73-Year Average Generation and Critical Water Year (CWY, 1937) Average Generation at the WVS Projects: ALT3B relative to NAA, in aMW.[1]

	AVG GEN NAA	AVG GEN ALT3B	AVG GEN Difference	CWY GEN NAA	CWY GEN ALT3B	CWY GEN Difference
Oct	134	57	-77	119	45	-74
Nov	230	43	-187	156	14	-142
Dec	231	72	-159	80	17	-63
Jan	235	167	-68	47	15	-32
Feb	147	185	38	67	30	-37
Mar	143	132	-11	121	69	-52
Apr I	177	118	-59	188	106	-82
Apr II	182	82	-100	227	103	-124
May	222	68	-154	356	105	-251
Jun	162	55	-106	264	84	-180
Jul	106	62	-44	111	88	-23
Aug I	114	60	-54	115	76	-39
Aug II	118	75	-43	124	91	-33
Sep	151	112	-39	155	152	-3
Annual Average[2]	**171**	**93**	**-79**	**150**	**67**	**-83**

1/ HYDSIM uses a 14-period time step. April and August are split into two half-month periods because these months tend to have substantial natural flow differences between their first and second halves.
2/ The Annual Average is a weighted average to account for the different number of days in the 14 periods.
Source: HYDSIM modeling results.

Figure 2.2-11 and Figure 2.2-12 illustrate the differences in generation of individual WVS projects between ALT3B and the NAA for the 73-Year Average Generation and Critical Water Year (1937) Average Generation, respectively. Individual project blocks indicate the amount of change in each project's monthly average generation (aMW) from the NAA. Project blocks above the zero line indicate a project under ALT3B generated more than the NAA; blocks below the zero line indicate less generation under ALT3B than the NAA. The total line indicates the difference in monthly average generation (aMW) for all WVS projects combined from the NAA.

ALT3B: 73-YEAR AVERAGE GENERATION

Table 2.2-7 indicates an annual average decrease of 79 aMW for the WVS projects

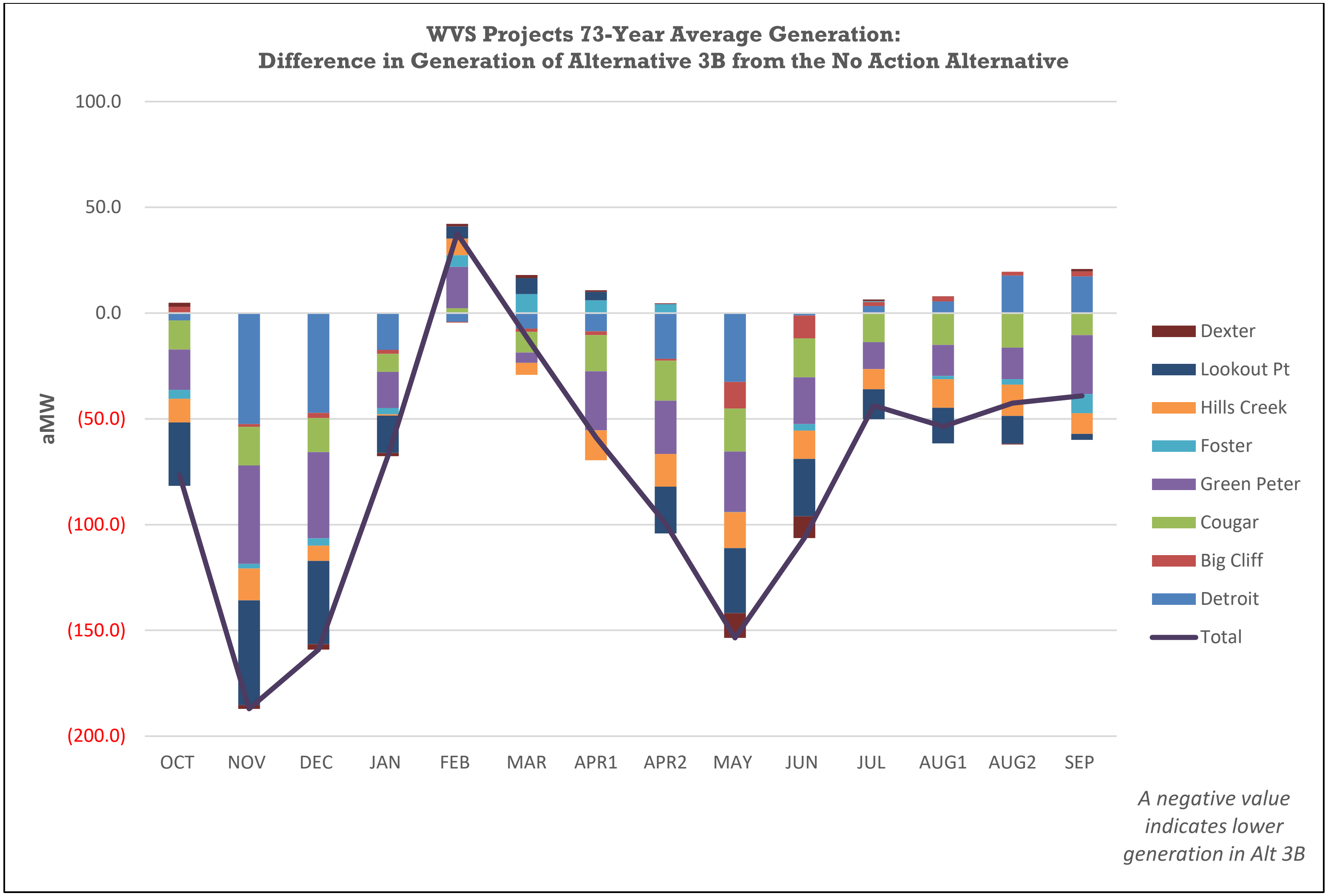


Figure 2-11. 73-Year Average Generation: Difference in Generation of ALT3B from the NAA.

Note: HYDSIM uses a 14-period time step. April and August are split into two half-month periods because these months tend to have substantial natural flow differences between their first and second halves.

Source: HYDSIM modeling results.

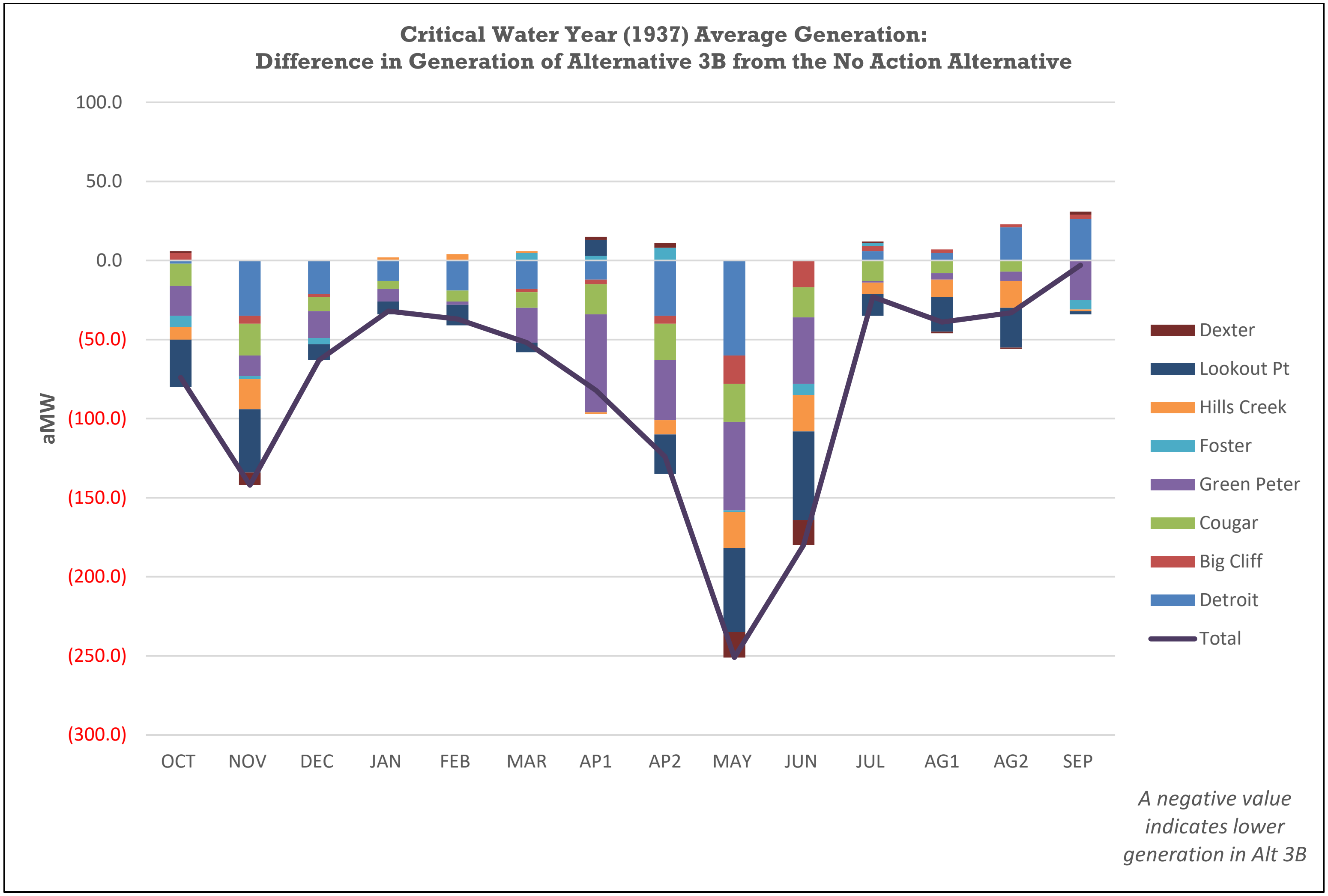


Figure 2-12. Critical Water Year (1937) Average Generation: Difference in Generation of ALT3B from NAA.

Note: HYDSIM uses a 14-period time step. April and August are split into two half-month periods because these months tend to have substantial natural flow differences between their first and second halves.

Source: HYDSIM modeling results.

combined under ALT3A compared to the NAA. Generation differences between NAA and ALT3B primarily result from the following:

SEPT – JAN: In the fall and early winter, ALT3B average generation is substantially reduced from the NAA at all projects. Fall deep reservoir drawdowns (Green Peter, Hills Creek, Cougar, Lookout Point, and Detroit dams) and spill operations conducted for fish passage (Green Peter, Foster, Hills Creek, Dexter, and Big Cliff dams) contribute to lower generation as a result of associated decreases in outflows through turbines.

FEB: This is the only period in which ALT3B generation at all WVS projects combined is higher than the NAA. Higher flows at Green Peter, Hills Creek, Foster, and Lookout Point appear primarily responsible for the increase in generation. Spill and drawdown operations are not in effect during this period.

MAR – AUG2: In the spring and summer, ALT3B average generation is substantially reduced from the NAA at most projects. The impact is most pronounced at Cougar associated with the deep spring reservoir drawdown to the diversion tunnel. There is higher spring/summer generation at Detroit and Big Cliff in the summer compared to the NAA. Deep spring drawdown at Hills Creek and Green Peter is allowed in ALT3B, which can be seen by the sharp reduction in generation at Green Peter from March to April. From April though June, several projects have average generation values of less than 1 aMW. Looking at the Green Peter operations in June over several historical water years, for example, reveals that the combination of high spill values, lower flows, and lower elevations in the deep drawdown regime lead to less turbine flows and less corresponding generation.

ALT3B: CRITICAL WATER YEAR (1937) AVERAGE GENERATION VS. 73-YEAR AVERAGE GENERATION

Overall, the annual average generation (aMW) under ALT3B was less than the NAA by approximately 55.3 and 45.6 percent in the Critical Water Year (1937) Average Generation and 73-Year Average Generation scenarios, respectively (Table 2.2-7). Lower annual average generation in Alt3B was primarily driven by spill operations and deep fall and spring season reservoir drawdowns, which reduced generation at several projects as a result of associated decreases in outflows through turbines. Decreases were particularly pronounced from April through June. It appears that deep spring drawdown and/or summer spills in the critical water year scenario would result in greater generation reductions compared to the NAA than over the 73 year average. It is also worth noting in the ALT3B critical water year, winter generation (NOV – JAN) is less than 20 aMW for the combined WVS projects.

Energy: ALT4 compared to NAA

Table 2.2-8 depicts the differences between ALT4 and the NAA for the 73-Year Average Generation and Critical Water Year (1937) Average Generation for the WVS projects. Positive differences indicate an increase, and negative differences indicate a decrease in average generation (aMW) from the NAA.

Table 2-7. 73-Year Average Generation and Critical Water Year (CWY, 1937) Average Generation at the WVS Projects: ALT4 relative to NAA, in aMW.[1]

	AVG GEN NAA	AVG GEN ALT4	AVG GEN Difference	CWY GEN NAA	CWY GEN ALT4	CWY GEN Difference
Oct	134	160	26	119	129	10
Nov	230	250	20	156	174	18
Dec	231	223	-8	80	59	-21
Jan	235	228	-7	47	36	-11
Feb	147	147	0	67	59	-8
Mar	143	132	-11	121	115	-6
Apr I	177	151	-26	188	176	-12
Apr II	182	145	-37	227	227	0
May	222	199	-22	356	325	-31
Jun	162	189	27	264	285	21
Jul	106	126	19	111	134	23
Aug I	114	128	15	115	123	8
Aug II	118	130	13	124	126	2
Sep	151	137	-14	155	137	-18
Annual Average[2]	171	172	1	150	148	-2

1/ HYDSIM uses a 14-period time step. April and August are split into two half-month periods because these months tend to have substantial natural flow differences between their first and second halves.
2/ The Annual Average is a weighted average to account for the different number of days in the 14 periods.
Source: HYDSIM modeling results.

Figure 2.2-13 and Figure 2.2-14 illustrate the differences in generation of individual WVS projects between ALT4 and the NAA for the 73-Year Average Generation and Critical Water Year (1937) Average Generation, respectively. Individual project blocks indicate the amount of change in each project's monthly average generation (aMW) from the NAA. Project blocks above the zero line indicate a project under ALT4 generated more than the NAA; blocks below the zero line indicate less generation under ALT4 than the NAA. The total line indicates the difference in monthly average generation (aMW) for all WVS projects combined from the NAA.

ALT4: 73-YEAR AVERAGE GENERATION

Table 2.2-8 indicates an annual average increase of 1 aMW for the WVS projects combined under ALT 4 compared to the NAA. Generation differences between NAA and ALT4 primarily result from the following:

OCT - NOV: Higher ALT4 generation at combined WVS projects during this period is largely driven by increases at Detroit, Lookout Point, and to a lesser degree, Hills Creek dams, which may be driven by water temperature control operations instead of NAA spill operations. Cold water regulating outlet discharge during this period may also contribute to reduction of generation at Green Peter Dam compared to the NAA.

DEC – MAY: During December through March, the ALT4 operations generally result in minor changes, typically reduction, in generation at all WVS projects without a main driver. In April and May, reduced generation at Green Peter Dam may be attributed to the start of surface spill measures.

JUN – AUG: Higher ALT4 generation at combined WVS projects during this period is largely driven by increases at Detroit Dam that are likely due to decreased temperature spill relative to the NAA. Conversely, Green Peter Dam has lower generation in this period, likely from the ALT4 surface spillway operation compared to the NAA.

SEPT: Lower ALT4 generation compared to NAA is driven by reductions at Green Peter and Foster dams during September. At Green Peter Dam, surface spill measures are still in effect, and at Foster Dam increased spill is accompanied by decreased flows.

ALT4: CRITICAL WATER YEAR (1937) AVERAGE GENERATION VS. 73-YEAR AVERAGE GENERATION

Overall, the annual average generation (aMW) for the combined WVS projects under ALT4 was similar to the NAA for both the Critical Water Year (1937) Average Generation and the 73-Year Average Generation scenarios with a 1.3 percent decrease and 0.6 percent increase, respectively (Table 2.2-8). Over the 73 year average, there were decreases in generation during the months of December through May and September, which were offset by increased generation during other months. A similar pattern of decreased generation was seen for the critical water year with the exception that there was no change in generation in the latter half of April.

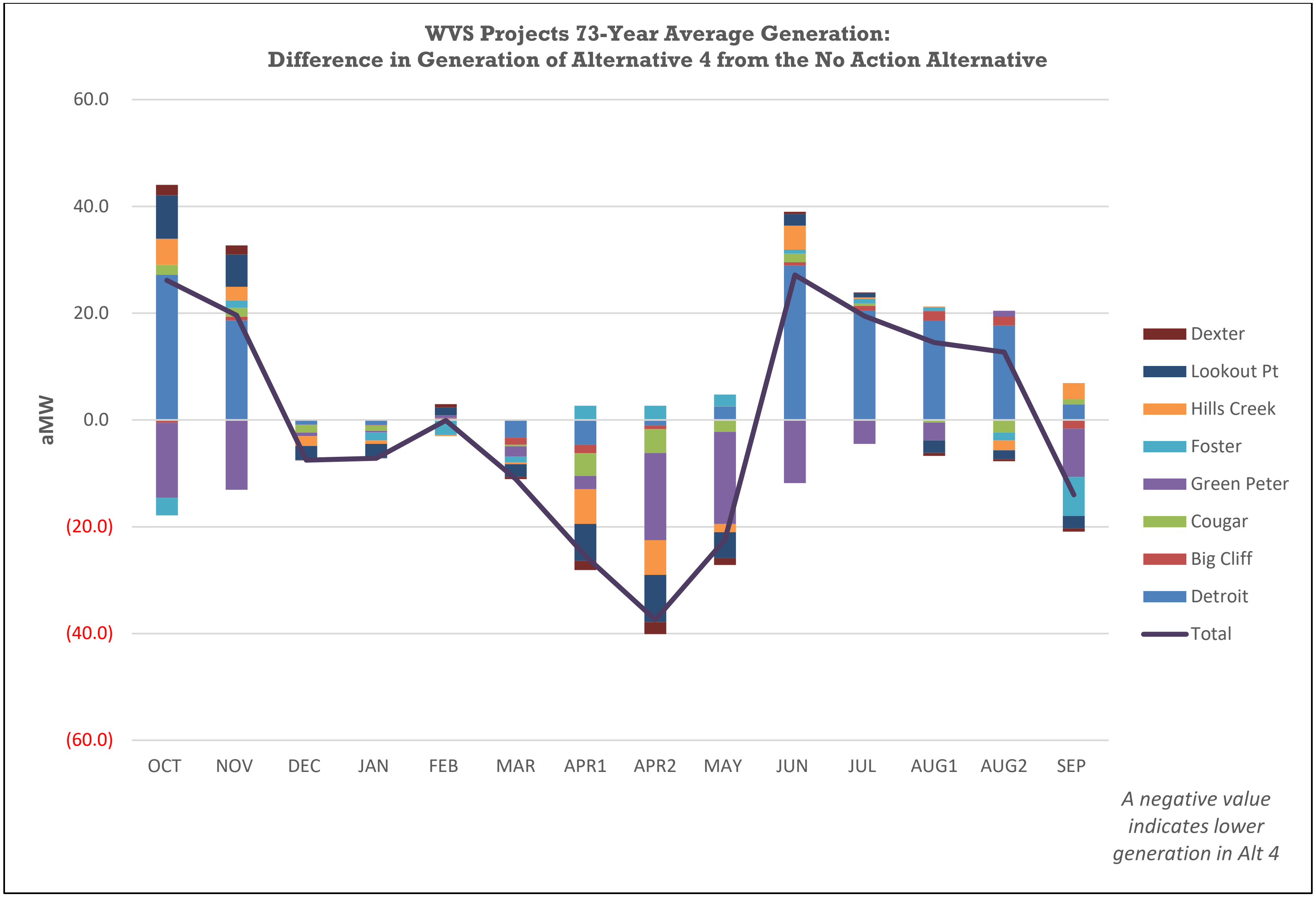


Figure 2-13. 73-Year Average Generation: Difference in Generation of ALT4 from the NAA.

Note: HYDSIM uses a 14-period time step. April and August are split into two half-month periods because these months tend to have substantial natural flow differences between their first and second halves.

Source: HYDSIM modeling results.

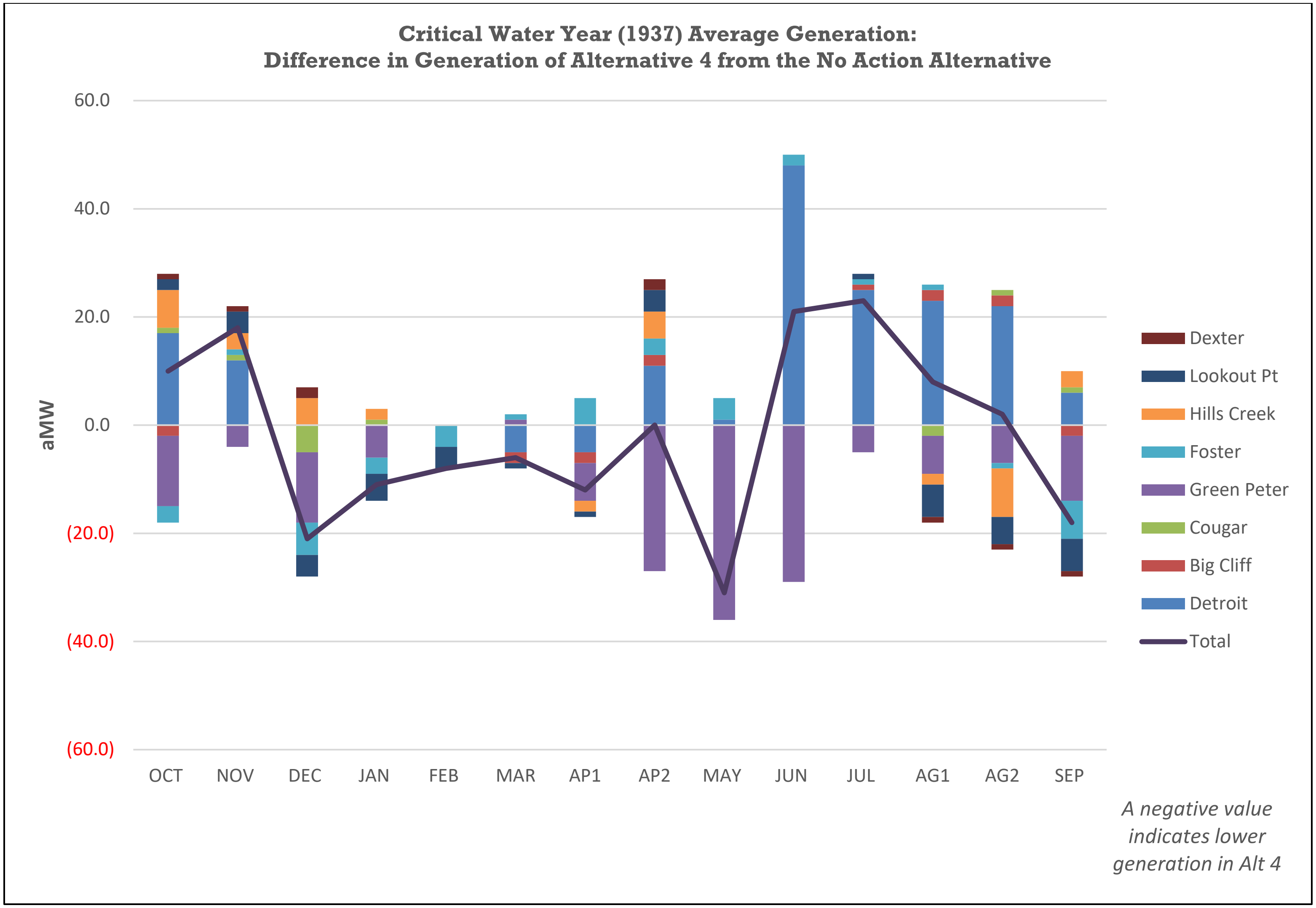


Figure 2-14. Critical Water Year (1937) Average Generation: Difference in Generation of ALT4 from the NAA.

Note: HYDSIM uses a 14-period time step. April and August are split into two half-month periods because these months tend to have substantial natural flow differences between their first and second halves.

Source: HYDSIM modeling results.

Energy: NEAR-TERM OPERATIONS compared to NAA

Table 2.2-9 depicts the differences between NEAR-TERM OPERATIONS MEASURENear-term Operations Measure and the NAA for the 73-Year Average Generation and Critical Water Year (1937) Average Generation for the WVS projects. Positive differences indicate an increase, and negative differences indicate a decrease in average generation (aMW) from the NAA.

Table 2-8. 73-Year Average Generation and Critical Water Year (CWY, 1937) Average Generation at the WVS Projects: NEAR-TERM OPERATIONS MEASURE relative to NAA, in aMW.[1]

	AVG GEN NAA	AVG GEN NEAR-TERM OPERATIONS MEASURE	AVG GEN Difference	CWY GEN NAA	CWY GEN NEAR-TERM OPERATIONS MEASURE	CWY GEN Difference
Oct	134	129	-5	119	108	-11
Nov	230	112	-118	156	74	-82
Dec	231	107	-124	80	35	-45
Jan	235	159	-76	47	20	-27
Feb	147	127	-20	67	27	-40
Mar	143	100	-43	121	78	-43
Apr I	177	81	-96	188	106	-82
Apr II	182	72	-110	227	87	-140
May	222	133	-89	356	211	-145
Jun	162	152	-10	264	250	-14
Jul	106	111	5	111	131	20
Aug I	114	98	-16	115	107	-8
Aug II	118	100	-18	124	102	-22
Sep	151	132	-19	155	159	4
Annual Average[2]	171	120	-52	150	108	-42

1/ HYDSIM uses a 14-period time step. April and August are split into two half-month periods because these months tend to have substantial natural flow differences between their first and second halves.
2/ The Annual Average is a weighted average to account for the different number of days in the 14 periods.
Source: HYDSIM modeling results.

Figure 2.2-15 and Figure 2.2-16 illustrate the differences in generation of individual WVS projects between NEAR-TERM OPERATIONS MEASURE and the NAA for the 73-Year Average Generation and Critical Water Year (1937) Average Generation, respectively. Individual project blocks indicate the amount of change in each project's monthly average generation (aMW) from the NAA. Project blocks above the zero line indicate a project under NEAR-TERM OPERATIONS MEASURE generated more than the NAA; blocks below the zero line indicate less generation under NEAR-TERM OPERATIONS MEASURE than the NAA. The total line indicates the difference in monthly average generation (aMW) for all WVS projects combined from the NAA.

Near-term Operations Measure: 73-YEAR AVERAGE GENERATION

Table 2.2-9 indicates an annual average decrease of 52 aMW for the WVS projects combined under ALT 5 compared to the NAA. Generation differences between NAA and NEAR-TERM OPERATIONS MEASURE primarily result from the following:

AUG 1 – OCT: In the late summer and early fall, overall generation for NEAR-TERM OPERATIONS MEASURE is lower than NAA, largely due to decreased generation at Lookout Point. At Lookout Point, summer and fall downstream passage operations include deep drawdowns, increased spill and limited use of turbines.

NOV - JAN: In the winter months, generation under NEAR-TERM OPERATIONS MEASURE is markedly lower than NAA. This change is driven by significantly decreased generation at Detroit, Green Peter, and Lookout Point, accompanied by moderately decreased generation at Foster and Cougar. At Detroit, NEAR-TERM OPERATIONS MEASURE measures for improved downstream fish passage includes modeling approximately 60% of daily flow going through the upper regulating outlet and approximately 40% through the penstock and turbines; the corresponding decrease in generation follows. NEAR-TERM OPERATIONS MEASURE contains a deep drawdown operation for improved fish passage at Green Peter which, as modeled, leads to a 73-year average generation of 0.5 aMW in NOV (67 of 73 years no generation) and 2.9 aMW (50 of 73 years no generation) in DEC.

FEB: Decreased generation at Detroit, and to a lesser extent Foster, drives the lowered NEAR-TERM OPERATIONS MEASURE generation compared to NAA. At Foster, a delayed refill measure keeps the reservoir at minimum conservation pool, the spillway is operated at night, and only one turbine unit will be operated.

MAR – MAY: All projects have decreased spring generation with the exception of Hills Creek in March and Green Peter and Big Cliff in May. At Detroit, spring downstream fish passage via strategic use of the spillway and turbines results in decreased generation as the operation calls for generation during the day and spill at night. Green Peter operations for improved juvenile fish passage with continuous spill in the spring lead to decreased generation through the beginning of May.

JUN – JUL: JUL is the only period in which the NEAR-TERM OPERATIONS MEASURE WVS has marginally higher total generation than the NAA, though the decrease in generation at Lookout Point largely offsets the increased generation at Green Peter.

NEAR-TERM OPERATIONS MEASURE: CRITICAL WATER YEAR (1937) AVERAGE GENERATION VS. 73-YEAR AVERAGE GENERATION

Overall, the annual average generation (aMW) for the combined WVS projects under NEAR-TERM OPERATIONS MEASURE was lower than the NAA for both the Critical Water Year (1937) Average Generation and the 73-Year Average Generation scenarios with a 28.2 percent decrease and 30.1 percent decrease, respectively (Table 2.2-9). Over the 73 year average, there were decreases in generation in all months except July. A similar pattern of decreased generation was seen for the critical water year with the exception that there was marginally more generation in September compared to NAA.

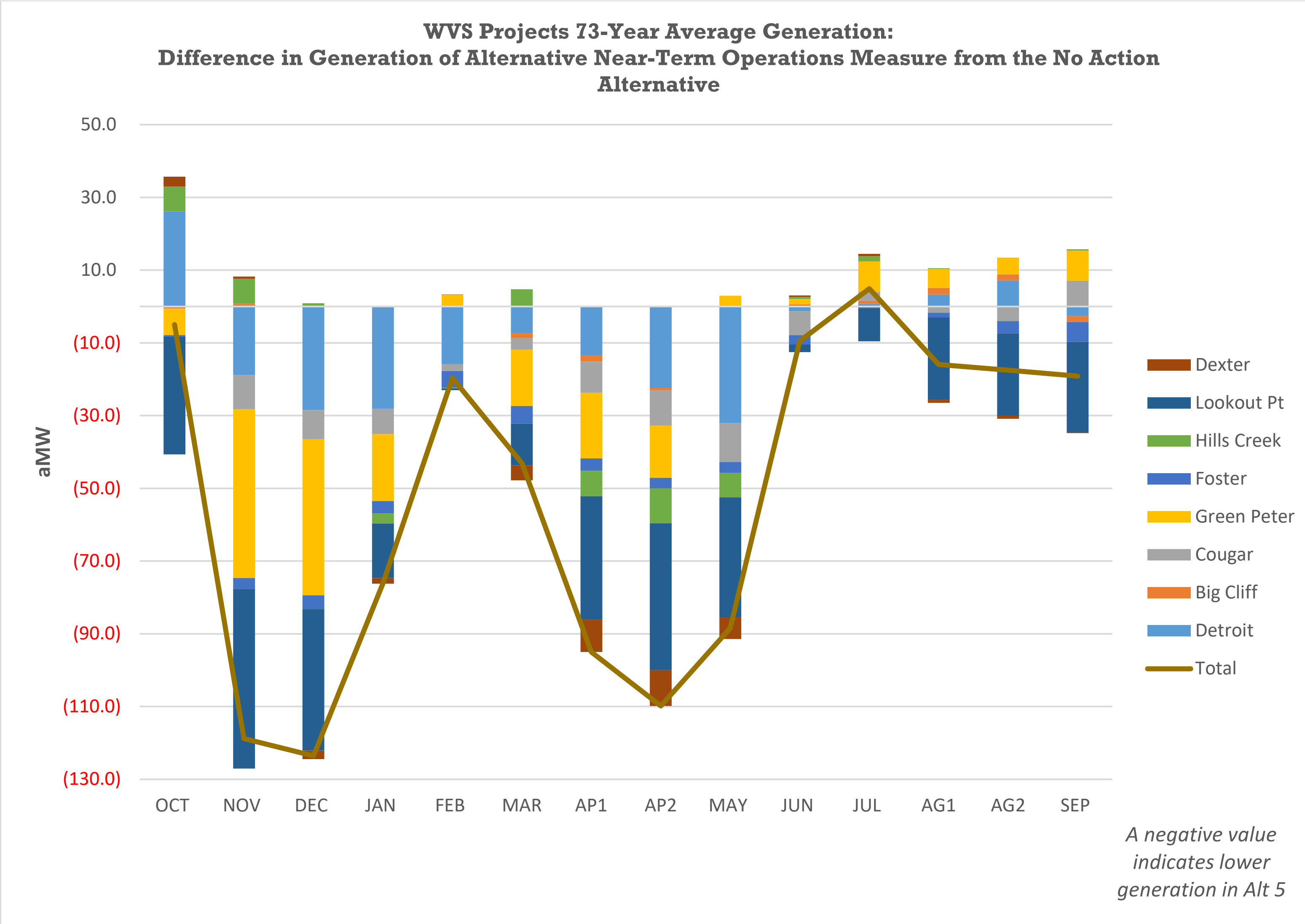


Figure 2-15. 73-Year Average Generation: Difference in Generation of NEAR-TERM OPERATIONS MEASURE from the NAA.

Note: HYDSIM uses a 14-period time step. April and August are split into two half-month periods because these months tend to have substantial natural flow differences between their first and second halves. Source: HYDSIM modeling results.

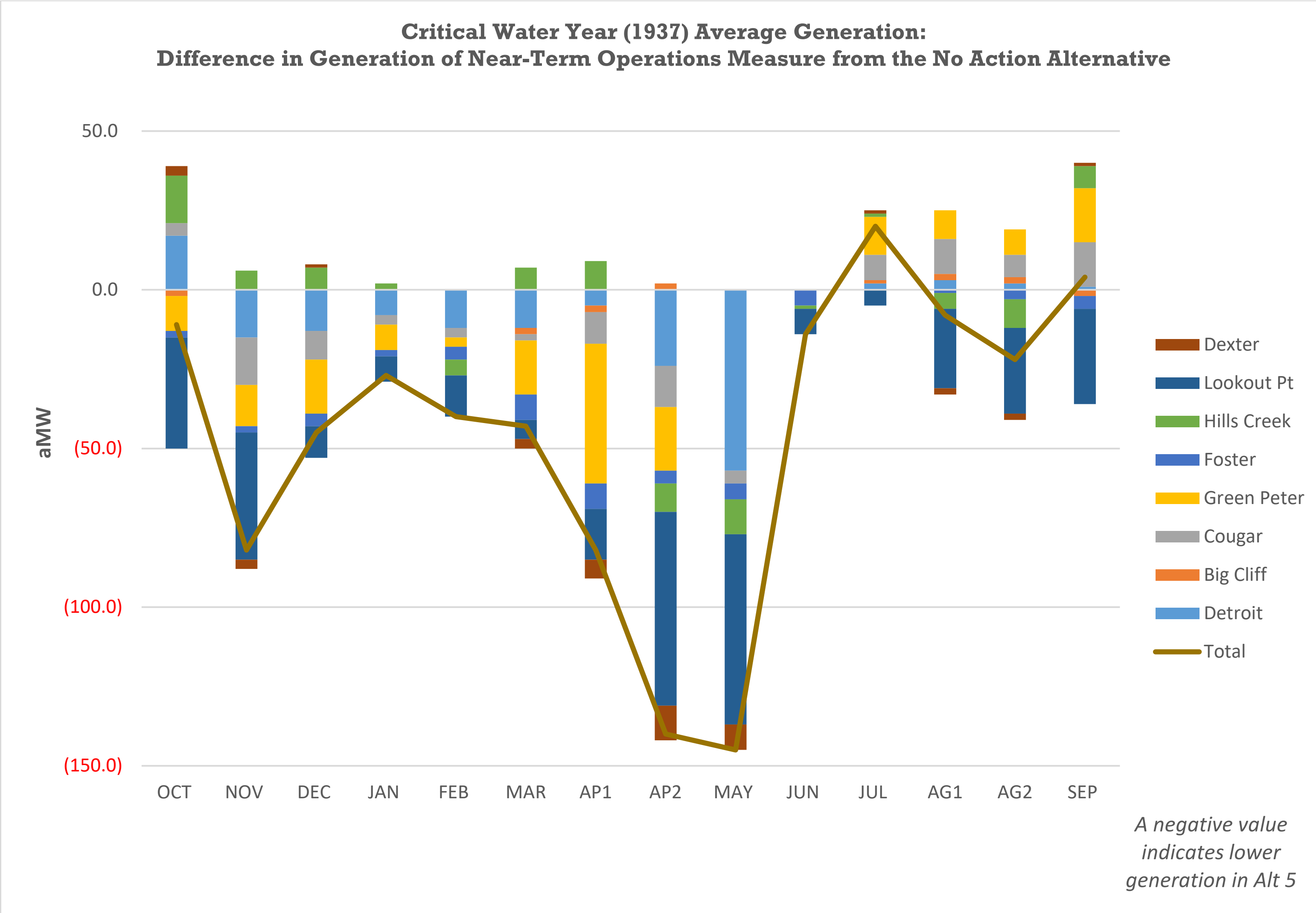


Figure 2-16. Critical Water Year (1937) Average Generation: Difference in Generation of NEAR-TERM OPERATIONS MEASURE from the NAA.

Note: HYDSIM uses a 14-period time step. April and August are split into two half-month periods because these months tend to have substantial natural flow differences between their first and second halves. Source: HYDSIM modeling results

Energy: ALT5 compared to NAA

Table 2.2-5 depicts the differences between Alt5 and the NAA for the 73-Year Average Generation and Critical Water Year (1937) Average Generation for the WVS projects. Positive differences indicate an increase, and negative differences indicate a decrease in average generation (aMW) from the NAA. The following sections show the results for Alternative 2B, which was chosen as the preferred alternative with some changes to flow. Models were not run for the preferred alternative, some potential qualitative differences due to the flow changes are described. Otherwise, specific results are shown for Alternative 2B and should be very similar.

At Green Peter and Foster, the minimum outflow target has shifted from 1,000 cfs under Alt 2B to 700 cfs under Alt 5. This could potentially lead to slightly lower generation than reported in the summary below.

At Hills Creek, the elevation reaches the top conservation storage less frequently under Alternative 5 than under Alt 2B. Additionally, the lower minimum elevation is met more frequently. This could potentially lead to slightly lower generation than reported in the summary below.

Table 2-9. 73-Year Average Generation and Critical Water Year (CWY, 1937) Average Generation at the WVS Projects: Alt5 relative to NAA, in aMW.[1]

	AVG GEN NAA	AVG GEN Alt5	AVG GEN Difference	CWY GEN NAA	CWY GEN Alt5	CWY GEN Difference
Oct	134	149	15	119	151	32
Nov	230	181	--49	156	107	-49
Dec	231	161	-69	80	38	-42
Jan	235	197	-38	47	27	-20
Feb	147	142	-5	67	47	-20
Mar	143	120	-23	121	67	-54
Apr I	177	143	-34	188	158	-30
Apr II	182	136	-46	227	183	-44
May	222	184	-38	356	303	-53
Jun	162	169	7	264	272	8
Jul	106	114	8	111	125	14
Aug I	114	118	5	115	116	1
Aug II	118	120	3	124	126	2
Sep	151	157	6	155	173	18
Annual Average[2]	**171**	**153**	**-19**	**150**	**134**	**--17**

1/ HYDSIM uses a 14-period time step. April and August are split into two half-month periods because these months tend to have substantial natural flow differences between their first and second halves.
2/ The Annual Average is a weighted average to account for the different number of days in the 14 periods.
Source: HYDSIM modeling results.

Figure 2.2-7 and Figure 2.2-8 illustrate the differences in generation of individual WVS projects between Alt5 and the NAA for the 73-Year Average Generation and Critical Water Year (1937) Average Generation, respectively. Individual project blocks indicate the amount of change in each project's monthly average generation (aMW) from the NAA. Project blocks above the zero line indicate a project under Alt5 generated more than the NAA; blocks below the zero line indicate less generation under Alt5 than the NAA. The total line indicates the difference in monthly average generation (aMW) for all WVS projects combined from the NAA.

Alt5: 73-YEAR AVERAGE GENERATION

Table 2.2-5 indicates an annual average decrease of 18 aMW for the WVS projects combined under Alt5 compared to the NAA. Generation differences between NAA and Alt5 primarily result from the following:

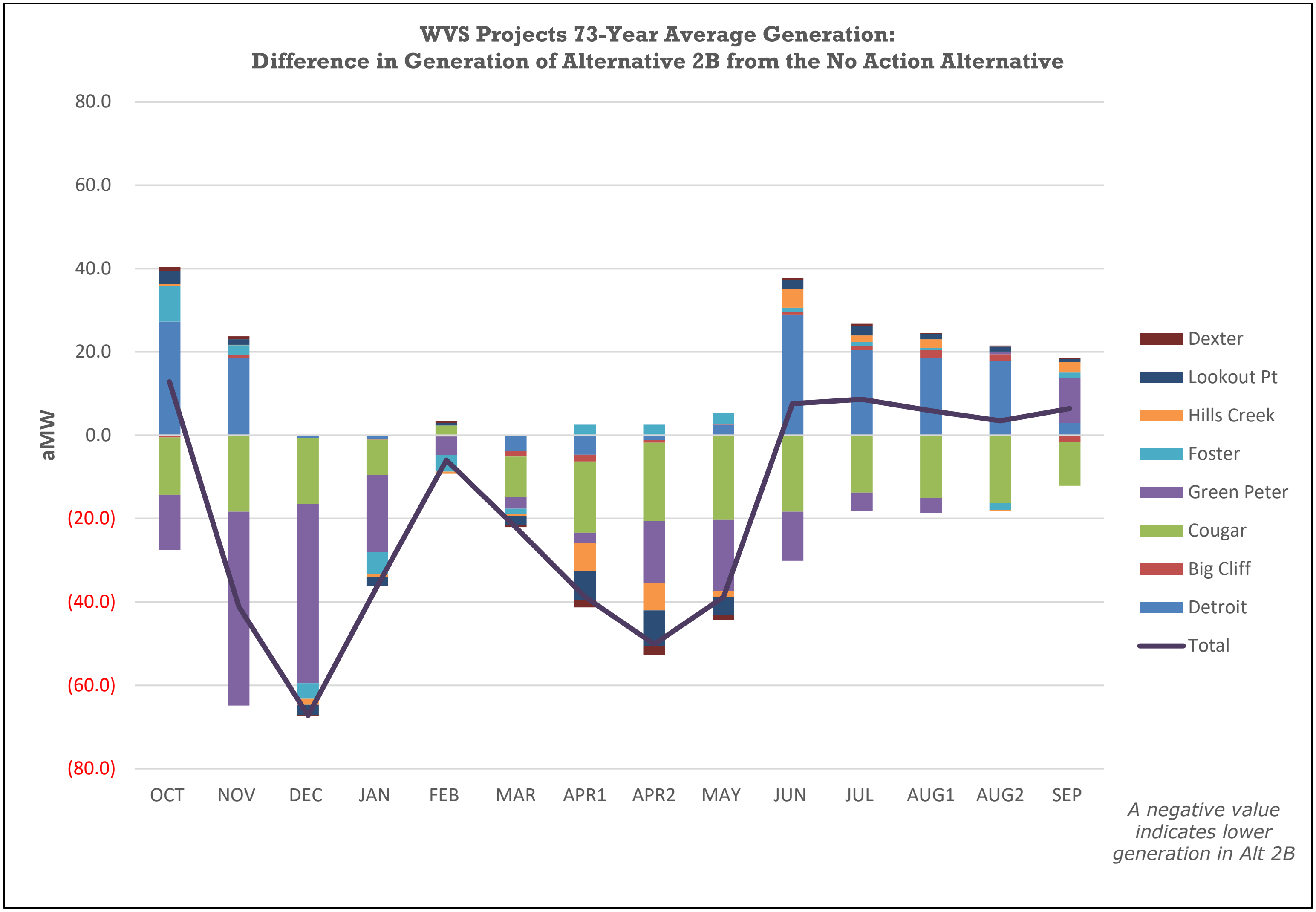


Figure 2-17. 73-Year Average Generation: Difference in Generation of Alt5 from the NAA.

Note: HYDSIM uses a 14-period time step. April and August are split into two half-month periods because these months tend to have substantial natural flow differences between their first and second halves.

Source: HYDSIM modeling results.

Figure 2-18. Critical Water Year (1937) Average Generation: Difference in Generation of Alt5 from the NAA.

Note: HYDSIM uses a 14-period time step. April and August are split into two half-month periods because these months tend to have substantial natural flow differences between their first and second halves.

Source: HYDSIM modeling results.

OCT: Higher average generation at Detroit and Foster dams under Alt5 offset reduced generation at Cougar and Green Peter, resulting in an increase of approximately 13 aMW of generation for all WVS projects combined in October.

NOV - MAY: Alt5 has lower average generation compared to the NAA for all WVS projects combined during these months. Cougar and Green Peter dams are the primary drivers of the difference. In fact, Cougar Dam has negligible generation in all months except January and February.

JUN – SEPT: Alt5 has higher average generation compared to the NAA for all WVS projects combined during these months. Higher Alt5 average generation at Detroit and Foster dams was the largest contributor to this increase. Reduced generation at Cougar Dam and other projects moderated the increase in average generation during this period.

Alt5: CRITICAL WATER YEAR (1937) AVERAGE GENERATION VS. 73-YEAR AVERAGE GENERATION

Overall, the annual average generation (aMW) for the combined WVS projects under Alt5 was lower than the NAA by approximately 9.3 and 10.5 percent in the Critical Water Year (1937) Average Generation and 73-Year Average Generation scenarios, respectively (Table 2.2-3). Lower annual average generation in Alt5 was primarily driven by reduced generation at Cougar and Green Peter dams in the late fall through spring, especially in the winter months. Generation increases in summer and early fall months were primarily driven by increased outflows through turbines at Detroit Dam (associated with replacement of temperature management spills with a temperature control tower), which offset the extent of the annual average reduction.

CHAPTER 3 - REGIONAL POWER SUPPLY AND REPLACEMENT RESOURCES

The operation, configuration, and maintenance changes described in the WVS ALTs would affect the magnitude of power generated from the eight WVS projects, as detailed in Chapter 3 of this appendix. The WVS projects are a subset of the FCRPS (31 Federal dams), and the associated transmission infrastructure. The WVS projects are operated independently from all other resources of the FCRPS. For all other FCRPS resources, they are all modeled consistently with the Preferred Alternative of the CRSO Preferred Alternative (i.e., their project storage operations, outflows, and generation are the same in each WVS alternative). The FCRPS and other resources acquired by Bonneville to meet its firm power supply obligations constitute what is known as the Federal Base System. Fluctuations in power generation at the WVS projects would therefore trigger adjustments in not only the Federal Base System but also the larger regional system of aggregated resources (e.g., incorporating additional generating capacity) to ensure the system is capable of supplying the demand for power, which fluctuates over the course of minutes, hours, days, months, and years.

This chapter describes the methods employed to identify how changes in generation at the WVS projects under the Alternatives would affect the adequacy and reliability of the regional power supply system absent any adjustments to existing resources. It then describes the approach used to identify and quantify the costs of "replacement resources," which are investments that would be needed to add capacity to maintain power system reliability at a level consistent with the No Action Alternative.

This stage of the analysis is scenario based. It evaluates the sensitivity of the results to assumptions regarding how the system would respond to changes stemming from the WVS Alternatives (i.e., changes in generation at the WVS projects).

3.1 REGIONAL POWER SYSTEM RELIABILITY METHODOLOGY

Bonneville modeled regional power system reliability for the WVS PEIS alternatives using the Northwest Power and Conservation Council's (NW Council) GENeration Evaluation SYStem (GENESYS) model as described in section 3.1.1 below. The analysis applies the GENESYS model to determine the LOLP metric (measures the likelihood of at least one power supply shortfall occurring in a future year) for the NAA and each of the Alternatives.

3.1.1 GENESYS

GENESYS is an economic dispatch model that uses Monte Carlo sampling to simulate short-term load uncertainty, and uncertainty in streamflows, wind, solar, and forced outages for thermal generation plants. The model performs a detailed constrained dispatch of the regulated hydropower projects in the Columbia River watershed and a simple dispatch of Pacific Northwest regional thermal plants against an extra-regional import market.

The model was developed by the NW Council, Bonneville, and other regional entities, and is used to perform studies requiring detailed hydropower dispatch for planning purposes.12 More specifically, NW Council uses GENESYS for annual adequacy assessments, periodic regulated hydropower flow studies and periodic analysis of lost revenue due to hydropower dispatch change. The adequacy of the regional power supply is assessed probabilistically in GENESYS by evaluating any regional shortfall against NW Council's adequacy standard (i.e., a LOLP of 5 percent or less). This standard was designed to assess whether the region has sufficient resources to meet growing demand for electricity in future years. Regulated hydropower flow studies have been performed for fish passage survival and life-cycle studies, and climate change scenarios.

For the WVS PEIS alternatives, datasets containing hydropower generation plant-specific parameters and constraints (inputs similar to those used in HYDSIM and ResSim models), thermal generation plant parameters and constraints, and other generation sources and constraints (i.e., wind and solar power plants) were input into the model. Additional inputs to the model include power demand (i.e., "loads") produced by the NW Council and assumptions regarding the availability of independent power producers and imports from outside the region.13 The NW Council's 2017 data set was used with specific parameters and constraints for the main stem hydroelectric system updated to reflect the recently completed CRSO EIS' Preferred Alternative conditions. The Willamette Projects are hydraulically independent of the main stem FCRPS Projects and are included as hydro independents in the GENESYS studies. For each of the WVS EIS Alternatives, the GENESYS model was updated to reflect the generation of the Willamette Projects of that particular alternative.

The GENESYS model relies on Monte Carlo simulations of the system to estimate LOLP based on weather-related load uncertainty, in addition to uncertainties in streamflows, wind, solar, and forced outages for thermal generation.14 The model performs a detailed dispatch of the regulated hydropower projects in the watershed of the Columbia River, Pacific Northwest regional thermal plants, wind, solar, along with other renewable energy resources, to determine the power imports that would be necessary to meet the load (demand) of the Pacific Northwest.

Bonneville used the GENESYS model to conduct the studies and ran 6,160 Monte Carlo simulations for each WVS PEIS alternative involving hydropower (i.e., HYDSIM results for WVS Projects), wind, and solar energy variability; forced outages on thermal plant generation; and hourly historical temperature variations (1936 to 2008). This provided the LOLP frequency (i.e., how many games out of 6,160 had instances of insufficient resources to meet the demand), but did not measure the magnitude or duration of an outage.

---

[12] The GENESYS model used for modeling is the classic version of GENESYS, which is available to Bonneville and the public by the Council as part of their 7th Power Plan (documentation in NW Council 2016). In the 8th Power Plan (in draft), the Council uses a new version of GENESYS which is not currently available to Bonneville or the public.
[13] Details for load descriptions are provided in NW Council 2017.
[14] In general, Monte Carlo simulation is a statistical technique that uses random events, or probability analysis, to simulate an outcome. Bonneville uses it to forecast potential regional load growth.

The reliability analyses were regional (NW-US) and were not performed for the CRS (Federal), Mid-Columbia, or Canadian systems. Because the utilities in the region can buy and sell power bilaterally with one another that is surplus to their retail load needs, the loss of generation by one entity can have adverse consequences to utilities relying on such generation. If the Federal system loses generation, BPA may be obligated to acquire resources to replace losses in the Federal Base System consistent with Bonneville's long-term firm power sales contracts or its customers may do so. Therefore, this analysis included identification of whether replacement resources would need to be acquired by Bonneville or its customers to serve Bonneville's firm power load obligations.

3.2 REGIONAL POWER SYSTEM RELIABILITY RESULTS

This section presents the LOLP results for the NAA and for the Alternatives with comparisons to the NAA. LOLP is expressed as a percentage that reflects the probability that the WVS and the larger regional power supply is adequate to meet the region's expected load demand for electricity in a year. Higher LOLPs reflect the increased likelihood that the power system would be unable to meet demand and lower LOLPs reflect a decreased likelihood that the power system would be unable to meet demand. The LOLP is a measure of the frequency of outages but not a measure of their duration or magnitude. While LOLP reflects the adequacy of the aggregated regional power supply, individual utilities within the Pacific Northwest, such as Bonneville, face a wide range of future resource needs that are unique to them which trigger actions and/or decisions to develop, add, or acquire resources to meet their obligations.

Achieving a higher level of power system reliability (a lower LOLP) requires the development of resources to meet either load growth or as replacement for losses in existing resources. Resources are developed by either individual utilities to meet their load serving obligations or by commercial/ independent power producers that assume the risk of building resources to meet forecasted supply needs.

In 2011, the NW Council set a regional standard for LOLP to be no higher than 5 percent. That is, in roughly one of every 20 years, the region would experience one or more energy shortages (potentially blackouts). The NW Council recommends investments in the power and transmission systems until the LOLP reaches 5 percent.

3.2.1 Regional Power System Reliability Summaries

Table 3.2-1 presents the LOLP results for each alternative. Based on the modeled changes in power generation, existing load forecasts, and coal plant retirements anticipated as of 2017, the NAA would result in an LOLP of 6.5 percent in 2022. This would exceed the current NW Council target of 5 percent.[15] However, because the NW Council's target is useful regional

[15] Note that LOLP is a probabilistic estimate and does not indicate magnitude or scale of potential power system outages and it is also not linear in effects, however, it is a useful metric of overall system reliability and

guidance, and 6.5 percent is within the range of the Pacific Northwest (PNW) Power System LOLP in recent years, this analysis considers the 6.5 percent NAA LOLP a reasonable benchmark level during the timeframe of this analysis.

Changes in power generation anticipated from structural and operational changes specified by the alternatives may affect the LOLP of the regional power system. As identified in Table 3.2-1, the differences between all of the Action Alternatives and the NOAA are indistinguishable (i.e., within the +/- 1 percent range of modeling accuracy) and the risk of blackouts or power shortages for all alternatives (including the NAA) is about once every 15 years. Since the WVS projects represent a small part of the overall PNW Power System and the LOLPs are not materially different from the NAA, no replacement resources are required to bring the LOLPs in alignment with the NAA.

Table 3-1. LOLP Results for WVS Alternatives.

Alternative	LOLP (%)	LOLP Difference from No Action	Blackout(s)/Power Shortage(s) Every x Years
No Action	6.5	N/A	1 year in every 15 years
ALT1	6.4	-0.1	1 year in every 15 years
ALT2A	6.5	0	1 year in every 15 years
Alt2B	6.6	+0.1	1 year in every 15 years
ALT3A	7.0	+0.5	1 year in every 15 years
ALT3B	7.0	+0.5	1 year in every 15 years
ALT4	6.5	0	1 year in every 15 years
NEAR-TERM OPERATIONS MEASURE	6.8	+0.3	1 year in every 15 years
Alt5	6.6		1 year in every 15 years

3.2.2 Regional Power System Reliability: Alternative Comparisons to NAA

3.2.2.1 No-Action Alternative

Bonneville's analysis of the LOLP for the NAA is 6.5 percent for the PNW, which means there was at least one blackout/power shortage in 6.5 percent of the simulation games. An LOLP of 6.5 percent means that the region could experience a significant power shortage (or recurring power shortages) in roughly one in every 15 years. These would be power shortages because loads would be greater than the power system's ability to generate electricity and would not be caused by power outages on the distribution system, such as when a tree hits a power line and

stability. *See* NW Council Document Number 2011-14, Page 4, available at: https://www.nwcouncil.org/sites/default/files/2011_14_1.pdf.

blacks out a neighborhood for a few hours. An LOLP event could result in rolling blackouts lasting up to several days.

The NAA LOLP does not meet the NW Council's 5 percent LOLP standard. Because the 6.5 percent NAA LOLP value is above the regional standard, regional utility planners (and potentially Bonneville is requested by its customers) should be building or acquiring new generating resources. However, the WVS Projects' NAA LOLP of 6.5 is not substantially different than the PNW Power System LOLP in recent years. The region has accepted this higher level of LOLP over the past 5 years in absence of replacement resources, and it has become the status quo. As such, the 6.5 percent LOLP of the NAA will serve as the measure of comparison for the effects of the other WVS PEIS alternatives.

3.2.2.2 Alt 1: Change from NAA

Bonneville estimates the LOLP for Alt1 is 6.4 percent for the PNW, which means there was a blackout/power shortage (or multiple blackouts) in 6.4 percent of the simulation games or approximately one every 15 years.

The LOLP changes from the NAA (6.5 percent) to Alt1 (6.4 percent) are indistinguishable (i.e., within the +/- 1 percent range of modeling accuracy); therefore, no replacement resources would be needed to return the LOLP to the NAA level.

3.2.2.3 Alt 2A: Change from NAA

Bonneville estimates the LOLP for Alt2A is 6.5 percent for the PNW, which means there was a blackout/power shortage (or multiple blackouts) in 6.5 percent of the simulation games or approximately one loss of load event or events (i.e., power shortages resulting in blackouts or emergency actions) every 15 years.

There is no difference between the LOLP of the NAA (6.5 percent) and Alt2A; therefore, no replacement resources would be needed to return the LOLP to the NAA level.

3.2.2.4 Alt 2B: Change from NAA

Bonneville estimates the LOLP for Alt2B is 6.6 percent for the PNW, which means there was a blackout/power shortage (or multiple blackouts) in 6.6 percent of the simulation games or approximately one loss of load event or events (i.e., power shortages resulting in blackouts or emergency actions) every 15 years.

The LOLP changes from the NAA (6.5 percent) to Alt2B (6.6 percent) are indistinguishable (i.e., within the +/- 1 percent range of modeling accuracy); therefore, no replacement resources would be needed to return the LOLP to the NAA level.

3.2.2.5 Alt 3A: Change from NAA

Bonneville estimates the LOLP for Alt3A is 7.0 percent for the PNW, which means there was an outage (or multiple outages) in 7.0 percent of the simulation games or approximately one loss of load event or events (i.e., power shortages resulting in blackouts or emergency actions) every 15 years.

The LOLP changes from the NAA (6.5 percent) to Alt3A (7.0 percent) are negligible and are indistinguishable (i.e., within the +/- 1 percent range of modeling accuracy); therefore, no replacement resources would be needed to return the LOLP to the NAA level.

3.2.2.6 Alt 3B: Change from NAA

Bonneville estimates the LOLP for Alt3B is 7.0 percent for the PNW, which means there was an outage (or multiple outages) in 7.0 percent of the simulation games or approximately one loss of load event or events (i.e., power shortages resulting in blackouts or emergency actions) every 15 years.

The LOLP changes from the NAA (6.5 percent) to Alt3B (7.0 percent) are indistinguishable (i.e., within the +/- 1 percent range of modeling accuracy); therefore, no replacement resources would be needed to return the LOLP to the NAA level.

3.2.2.7 Alt 4: Change from NAA

Bonneville estimates the LOLP for Alt4 is 6.5 percent for the PNW, which means there was an outage (or multiple outages) in 6.5 percent of the simulation games or approximately one loss of load event or events (i.e., power shortages resulting in blackouts or emergency actions) every 15 years.

There is no difference between the LOLP of the NAA (6.5 percent) and Alt4; therefore, no replacement resources would be needed to return the LOLP to the NAA level.

3.2.2.8 Near-Term Operations Measure: Change from NAA

Bonneville estimates the LOLP for Near-term operations measure is 6.8 percent for the PNW, which means there was an outage (or multiple outages) in 6.8 percent of the simulation games or approximately one loss of load event or events (i.e., power shortages resulting in blackouts or emergency actions) every 15 years.

The LOLP changes from the NAA (6.5 percent) to Near-term operations measure (6.8 percent) are indistinguishable (i.e., within the +/- 1 percent range of modeling accuracy); therefore, no replacement resources would be needed to return the LOLP to the NAA level.

3.2.2.9 Alt5: Change from NAA

Bonneville estimates the LOLP for Alt2B is 6.6 percent for the PNW, which means there was a blackout/power shortage (or multiple blackouts) in 6.6 percent of the simulation games or approximately one loss of load event or events (i.e., power shortages resulting in blackouts or emergency actions) every 15 years.

The LOLP changes from the NAA (6.5 percent) to Alt2B (6.6 percent) are indistinguishable (i.e., within the +/- 1 percent range of modeling accuracy); therefore, no replacement resources would be needed to return the LOLP to the NAA level.

For this, LOLP for Alt2B is assumed to be the same as Alt5.

CHAPTER 4 - TRANSMISSION PATHS INCREMENTAL ANALYSIS

This chapter describes the methodology, data, and results of the transmission paths incremental analysis that estimates the incremental power flow change on Bonneville Transmission Network Paths between the NAA and Alternatives during multiple seasons as a result of generation output changes at the Federal WVS projects with hydropower facilities (Detroit, Big Cliff, Cougar, Foster, Hills Creek, Lookout Point, and Dexter).

The purpose of the transmission paths incremental analysis was to evaluate expected changes in power flows that may occur under each of the Alternatives.

4.1 TRANSMISSION PATHS METHODOLOGY

Bonneville Transmission Services' most recent (September 2021) Long Term Available Transfer Capability (LT ATC) power flow base cases were used as the starting point for loads, resource dispatch, and transmission topology. These cases estimate utilization of Bonneville's Long Term Firm (LTF) transmission service commitments for a ten-year planning horizon under "All Lines in Service" conditions in selected seasonal conditions that may stress the transmission system. These cases simulate snapshots for 2031[16]. A single power flow case was used to represent each of the following seasonal conditions:

- Winter Peak (January), Upper Columbia stress zone;
- Spring Off-peak (May), Lower Snake stress zone; and
- Summer Peak (August), Upper Columbia stress zone.

NAA reference power flow cases were created by adjusting the output of each Willamette project to match the monthly average energy over 73 years of historical hydrology runoffs provided in the HYDSIM outputs for the three respective months listed above.

The LOLP analysis results (in Section 3 of this appendix) were also used as the basis for the assumptions to inform the case for the alternatives. In scenarios where development of new replacement resources would not be needed to return the LOLP to the NAA level, it was assumed that generation decreases at the Willamette projects would be balanced by increases at either the Upper Columbia or Lower Snake generation facilities.

The differences in power flows were calculated on Bonneville Transmission Network Paths between the NAA reference case and each EIS Alternative case for each of the three seasonal conditions (i.e., Winter Peak, Spring-Off-peak, and Summer Peak).

[16] WECC produces power flow models for the Western Interconnect power system for different planning horizons. A 10-year case is the farthest case WECC produces.

4.2 TRANSMISSION PATHS RESULTS

This section provides the transmission power flow results from the NAA and for the Alternatives with comparisons to the NAA.

4.2.1 Transmission Paths Summaries

Tables 4.2-1 through 4.2-3 represent the seasonal MW values for the WVS projects generation outputs and the Bonneville Transmission Network Paths and comparison of the changes in power flows between the NAA and the Alternatives.

With the NAA as the reference case, incremental power flow increases greater than 25 MW for Alt 3A and Alt 3B occurred on the Cross Cascades South path for all seasons. This results from the decreases in the Willamette Valley generation for those two alternatives with generation being replaced at either Upper Columbia (Winter and/or Summer peak cases) or Lower Snake (Spring Off-Peak case) generation facilities. Specific to only the Winter and Summer peak seasons for Alternatives 3A and 3B, incremental flow increases greater than 25 MW also occurred on North of Hanford due to the shift in generation from Willamette Valley to Upper Columbia. The Alt 3A and Alt 3B generation values for the Spring Off-peak season reflected the highest MW difference from the NAA; therefore, that season generally yielded the largest magnitude change in flows across Bonneville's network flow gates in comparison to the other two seasonal cases. For the Spring Off-Peak case, the largest change in flow of 118 MW occurred on the West of Lower Monumental path with other noticeable changes (greater than 25 MW) on Cross Cascades South, West of John Day, West of McNary, and West of Slatt due to the shift of generation from Willamette Valley to Lower Snake generation facilities. For Alt 3A and Alt 3B, the Summer Peak case resulted in the least amount of MW differences across Bonneville Transmission Network Paths.

Alt 2A for the Winter Peak case was the midpoint between Alt 3A and Alt 3B, and Alt 1 and Alt 4. For the Spring Off-Peak, the results were a bit higher than Alt 4 results, which had a slightly different generation output profile than Alt 2A. For the Summer Peak case, Alt 2A had the least amount of impacts on Bonneville Transmission Network Paths and Generation re-dispatch with respect to the NAA.

Generally, the network flow changes for all alternatives represent little to no impact for most paths. As discussed above, there is moderate impact on the congested Cross Cascades South path for some alternatives. This path supplies power from generators east of the Cascade Range to load centers in Portland and areas to the south. While some capacity on the path remains, decreases in generation for alternatives 2A, 2B, 3A, and 3B would have an incremental impact and may lead to minor cost increases for ratepayers and minor complications for meeting state climate goals.

Alt5 is shown to have the same results as Alt2B in the section below.

Table 4-1. Winter Peak Case (January); FCRPS Upper Columbia generation facilities replacement generation.

Generation Outputs (MW)	NAA	Alt 1	Alt 1 vs. NAA	Alt 2A	Alt 2A vs. NAA	Alt 2B	Alt 2B vs. NAA	Alt 3A	Alt 3A vs. NAA	Alt 3B	Alt 3B vs. NAA	Alt 4	Alt 4 vs. NAA	NTOM	NTOM vs. NAA	Alt5	Alt5 vs. NAA
Detroit	56.9	56.2	-0.7	56	-0.9	56	-0.9	39.8	-17.1	39.5	-17.4	56	-0.9	28.8	-28.1	56	-0.9
Big Cliff	12.9	12.8	-0.1	12.8	-0.1	12.8	-0.1	11	-1.9	10.9	-2	12.8	-0.1	12.8	-0.1	12.8	-0.1
Cougar	17.6	17.7	0.1	16.5	-1.1	9.2	-8.4	17.5	-0.1	9.1	-8.5	16.6	-1	10.7	-6.9	9.2	-8.4
Green Peter	45.5	45.5	0	27.0	-18.5	27	-18.5	26.9	-18.6	28.5	-17	45.3	-0.2	27.1	-18.4	27	-18.5
Foster	17.6	15.4	-2.2	12.2	-5.4	12.3	-5.3	14.4	-3.2	14.6	-3	16.1	-1.5	14.2	-3.4	12.3	-5.3
Hills Creek	22	21.9	-0.1	21.1	-0.9	21.3	-0.7	20.5	-1.5	21.3	-0.7	21.3	-0.7	19.2	-2.8	21.3	-0.7
Lookout Pt	49.5	47.3	-2.2	46.9	-2.6	47.5	-2	33.4	-16.1	31.8	-17.7	46.9	-2.6	34.5	-15.0	47.5	-2
Dexter	12.9	12.8	-0.1	12.8	-0.1	12.7	-0.2	11.3	-1.6	11.3	-1.6	12.8	-0.1	11.3	-1.6	12.7	-0.2
Combined WVS Projects	**234.9**	**229.6**	**-5.3**	**205.3**	**-29.6**	**198.8**	**-36.1**	**174.8**	**-60.1**	**167**	**-67.9**	**227.8**	**-7.1**	158.7	**-76.2**	**198.8**	**-36.1**
Bonneville Transmission Network Paths (MW)	**NAA**	**Alt 1**	**Alt 1 vs. NAA**	**Alt 2A**	**Alt 2A vs. NAA**	**Alt 2B**	**Alt 2B vs. NAA**	**Alt 3A**	**Alt 3A vs. NAA**	**Alt 3B**	**Alt 3B vs. NAA**	**Alt 4**	**Alt 4 vs. NAA**	**Alt 5**	**Alt 5 vs. NAA**	**PA**	**PA vs. NAA**
Cross Cascades North E>W	9445.7	9446.9	1.2	9452.8	7.1	9454.2	8.5	9459.8	14.1	9461.3	15.6	9447.2	1.5	9463.2	17.5	9454.2	8.5
Cross Cascades South E>W	6475.5	6478.7	3.2	6493.9	18.4	6497.4	21.9	6512.7	37.2	6516.9	41.4	6479.7	4.2	6522.5	47.0	6497.4	21.9
North of Echo Lake S>N	2362.6	2362.2	-0.4	2360.2	-2.4	2359.8	-2.8	2357.9	-4.7	2357.3	-5.3	2362.1	-0.5	2356.7	-5.9	2359.8	-2.8
North OF Hanford N>S	-1150.9	-1147.9	3	-1133.2	17.7	-1129.5	21.4	-1115	35.9	-1110.5	40.4	-1146.8	4.1	-1105.8	45.1	-1129.5	21.4
Paul to Allston N>S	245.6	246.5	0.9	251.3	5.7	252.4	6.8	256.9	11.3	258.2	12.6	246.8	1.2	259.7	14.1	252.4	6.8
Raver to Paul N>S	725.3	726	0.7	729.8	4.5	730.7	5.4	734.2	8.9	735.2	9.9	726.3	1	736.4	11.1	730.7	5.4
South of Allston N>S	1183	1184.2	1.2	1189.9	6.9	1191.3	8.3	1196.6	13.6	1198.2	15.2	1184.5	1.5	1200.0	17.0	1191.3	8.3
South of Custer N>S	-1371	-1371	0	-1370.8	0.2	-1370.8	0.2	-1370.7	0.3	-1370.7	0.3	-1370.9	0.1	-1370.7	0.3	-1370.8	0.2
West of Hatwai E>W	908.5	908.3	-0.2	907.1	-1.4	906.8	-1.7	905.6	-2.9	905.2	-3.3	908.2	-0.3	904.9	-3.6	906.8	-1.7
West of John Day E>W	3358.6	3359.3	0.7	3362.8	4.2	3363.4	4.8	3366.5	7.9	3367.2	8.6	3359.5	0.9	3368.6	10.0	3363.4	4.8
West of Lower Monumental E>W	2420.9	2421.2	0.3	2422.9	2.0	2423.3	2.4	2425	4.1	2425.4	4.5	2421.3	0.4	2426.0	5.1	2423.3	2.4
West of McNary E>W	2389.1	2389.9	0.8	2393.4	4.3	2394.3	5.2	2397.7	8.6	2398.8	9.7	2390.1	1	2399.9	10.8	2394.3	5.2
West of Slatt E>W	2679.7	2680.6	0.9	2685.1	5.4	2686.3	6.6	2690.8	11.1	2692.3	12.6	2681	1.3	2693.7	14.0	2686.3	6.6

Table 4-2. Spring Off-peak Case (May); FCRPS Lower Snake generation facilities are replacement generation.

Gen Outputs (MW)	NAA	Alt 1	Alt 1 vs. NAA	Alt 2A	Alt 2A vs. NAA	Alt 2B	Alt 2B vs. NAA	Alt 3A	Alt 3A vs. NAA	Alt 3B	Alt 3B vs. NAA	Alt 4	Alt 4 vs. NAA	Alt NTOM	Alt NTO M vs. NAA	ALT5	Alt5 vs. NAA
Detroit	59.8	63.2	3.4	34.1	-25.7	62.4	2.6	0	-59.8	27.5	-32.3	62.3	2.5	27.8	-32.0	62.4	2.6
Big Cliff	12.6	12.8	0.2	8.0	-4.6	12.7	0.1	0	-12.6	0	-12.6	12.7	0.1	12.7	0.1	12.7	0.1
Cougar	20.3	16.8	-3.5	10.8	-9.5	0	-20.3	18.4	-1.9	0	-20.3	18.1	-2.2	9.6	-10.7	0	-20.3
Green Peter	28.6	28.8	0.2	22.1	-6.5	11.6	-17	11.6	-17	0	-28.6	11.4	-17.2	31.5	2.9	11.6	-17
Foster	9.5	11.2	1.7	10.1	0.6	12.3	2.8	9.5	0	9.4	-0.1	11.6	2.1	6.4	-3.1	12.3	2.8
Hills Creek	24.1	21	-3.1	12.5	-11.6	22.6	-1.5	12.2	-11.9	21.1	-3	22.6	-1.5	17.4	-6.7	22.6	-1.5
Lookout Pt	54.9	49	-5.9	26.6	-28.3	50.6	-4.3	4.7	-50.2	24.2	-30.7	50.1	-4.8	21.9	-33.0	50.6	-4.3
Dexter	11.7	10.1	-1.6	6.5	-5.2	10.5	-1.2	0	-11.7	0	-11.7	10.4	-1.3	5.8	-5.9	10.5	-1.2
Combined WVS Projects	**221.5**	**212.9**	**-8.6**	**130.7**	**-90.8**	**182.7**	**-38.8**	**56.4**	**-165.1**	**82.2**	**-139.3**	**199.2**	**-22.3**	**133.1**	**-88.4**	**182.7**	**-38.8**

Bonneville Transmission Network Paths(MW)	NAA	Alt 1	Alt 1 vs. NAA	Alt 2A	Alt 2A vs. NAA	Alt 2B	Alt 2B vs. NAA	Alt 3A	Alt 3A vs. NAA	Alt 3B	Alt 3B vs. NAA	Alt 4	Alt 4 vs. NAA	Alt NTOM	Alt NTO M vs. NAA	Alt5	ALT5 vs. NAA
Cross Cascades North E>W	5652.7	5653.7	1	5666.9	14.2	5657.5	4.8	5676.9	24.2	5673.5	20.8	5655.7	3	5666.5	13.8	5657.5	4.8
Cross Cascades South E>W	4100.5	4105.7	5.2	4161.8	61.3	4125.6	25.1	4214.2	113.7	4195.3	94.8	4115.5	15	4160.3	59.8	4125.6	25.1
North of Echo Lake S>N	1297.0	1296.9	-0.1	1297.4	0.4	1296.5	-0.5	1296.4	-0.6	1296.7	-0.3	1296.7	-0.3	1297.4	0.4	1296.5	-0.5
North OF Hanford N>S	-333.8	-334.1	-0.3	-338.5	-4.7	-335.5	-1.7	-342.2	-8.4	-341	-7.2	-334.9	-1.1	-338.4	-4.6	-335.5	-1.7
Paul to Allston N>S	613.6	614.5	0.9	623.6	10.0	617.9	4.3	632.3	18.7	629.3	15.7	616.2	2.6	623.2	9.6	617.9	4.3
Raver to Paul N>S	881.3	882.0	0.7	889.4	8.1	884.8	3.5	896.5	15.2	894.1	12.8	883.5	2.2	889.1	7.8	884.8	3.5
South of Allston N>S	732.1	733.9	1.8	743.9	11.8	737.2	5.1	754.4	22.3	750.8	18.7	735.3	3.2	743.5	11.4	737.2	5.1
South of Custer N>S	-1368.3	-1368.2	0.1	-1370.2	-1.9	-1367.9	0.4	-1369.4	-1.1	-1369.7	-1.4	-1368.1	0.2	-1370.2	-1.9	-1367.9	0.4
West of Hatwai E>W	3088.1	3087.7	-0.4	3086.2	-1.9	3086.3	-1.8	3082.5	-5.6	3083.8	-4.3	3087	-1.1	3086.4	-1.7	3086.3	-1.8
West of John Day E>W	2997.4	2998.6	1.2	3014.3	16.9	3004.4	7	3029.1	31.7	3024	26.6	3001.7	4.3	3013.7	16.3	3004.4	7
West of Lower Monumental E>W	3728.5	3734.3	5.8	3793.0	64.5	3754.7	26.2	3846.7	118.2	3827.6	99.1	3744.3	15.8	3791.3	62.8	3754.7	26.2
West of McNary E>W	2305.9	2308.4	2.5	2334.3	28.4	2317.5	11.6	2358.2	52.3	2349.6	43.7	2312.9	7	2333.6	27.7	2317.5	11.6
West of Slatt E>W	2833.7	2836.0	2.3	2857.7	24.0	2843.6	9.9	2877.7	44	2870.5	36.8	2839.6	5.9	2857.1	23.4	2843.6	9.9

Table 4-3. Summer Peak Case (August); FCRPS Upper Columbia generation facilities replacement generation.

Gen Outputs (MW)	NAA	Alt 1	Alt 1 vs. NAA	Alt 2A	Alt 2A vs. NAA	Alt 2B	Alt 2B vs. NAA	Alt 3A	Alt 3A vs. NAA	Alt 3B	Alt 3B vs. NAA	Alt 4	Alt 4 vs. NAA	Alt NTOM	Alt NTOM vs. NAA	Alt5	Alt5 vs. NAA
Detroit	13.6	27.2	13.6	31.4	17.8	31.8	18.2	1.2	-12.4	25.3	11.7	31.8	18.2	18.9	5.3	31.8	18.2
Big Cliff	6	6	0	7.6	1.6	7.7	1.7	4.7	-1.3	8.1	2.1	7.7	1.7	7.7	1.7	7.7	1.7
Cougar	16.1	15.7	-0.4	14.4	-1.7	0.5	-15.6	5.7	-10.4	0.5	-15.6	14.7	-1.4	13.3	-2.8	0.5	-15.6
Green Peter	15.9	14.1	-1.8	16.5	0.6	14.5	-1.4	14.5	-1.4	1.1	-14.8	14.8	-1.1	20.8	4.9	14.5	-1.4
Foster	5.9	1	-4.9	5.3	-0.6	5.4	-0.5	9	3.1	3.9	-2	5.8	-0.1	3.5	-2.4	5.4	-0.5
Hills Creek	17	19.8	2.8	15.7	-1.3	17.9	0.9	19.2	2.2	6.4	-10.6	16.2	-0.8	17.1	0.1	17.9	0.9
Lookout Pt	33	40.8	7.8	31.0	-2.0	34.2	1.2	8.7	-24.3	17.8	-15.2	31	-2	10.4	-22.6	34.2	1.2
Dexter	8	9.9	1.9	7.6	-0.4	8.3	0.3	4.9	-3.1	8	0	7.5	-0.5	7.2	-0.8	8.3	0.3
Combined WVS Projects	**115.5**	**134.5**	**19**	**129.6**	**14.1**	**120.3**	**4.8**	**67.9**	**-47.6**	**71.1**	**-44.4**	**129.5**	**14**	**98.8**	**-16.7**	**120.3**	**4.8**
Bonneville Transmission Network Paths(MW)	**NAA**	**Alt 1**	**Alt 1 vs. NAA**	**Alt 2A**	**Alt 2A vs. NAA**	**Alt 2B**	**Alt 2B vs. NAA**	**Alt 3A**	**Alt 3A vs. NAA**	**Alt 3B**	**Alt 3B vs. NAA**	**Alt 4**	**Alt 4 vs. NAA**	**Alt NTOM**	**Alt NTOM vs. NAA**	**Alt5**	**Alt5 vs. NAA**
Cross Cascades North E>W	5327	5322.6	-4.4	5317.3	-9.7	5325.6	-1.4	5338.1	11.1	5337.6	10.6	5323.6	-3.4	5330.8	3.8	5325.6	-1.4
Cross Cascades South E>W	5862.9	5851.3	-11.6	5836.6	-26.3	5858.6	-4.3	5891.2	28.3	5888.5	25.6	5853.5	-9.4	5872.1	9.2	5858.6	-4.3
North of Echo Lake S>N	14.9	16.3	1.4	18.0	3.1	15.3	0.4	11.2	-3.7	11.4	-3.5	16	1.1	13.6	-1.3	15.3	0.4
North OF Hanford N>S	2478.8	2467.3	-11.5	2454.4	-24.4	2475.5	-3.3	2507.7	28.9	2505.9	27.1	2470.3	-8.5	2489.1	10.3	2475.5	-3.3
Paul to Allston N>S	1441.3	1437.9	-3.4	1433.8	-7.5	1440.2	-1.1	1450	8.7	1449.6	8.3	1438.7	-2.6	1444.3	3.0	1440.2	-1.1
Raver to Paul N>S	1270.8	1268.1	-2.7	1264.8	-6.0	1269.9	-0.9	1277.7	6.9	1277.4	6.6	1268.7	-2.1	1273.2	2.4	1269.9	-0.9
South of Allston N>S	2525.1	2521.9	-3.2	2516.1	-9.0	2523.8	-1.3	2535.4	10.3	2534	8.9	2522.4	-2.7	2528.7	3.6	2523.8	-1.3
South of Custer N>S	1088.4	1088.5	0.1	1088.5	0.1	1088.4	0	1088.4	0	1088.4	0	1088.5	0.1	1088.4	0.0	1088.4	0
West of Hatwai E>W	1100.2	1101	0.8	1101.8	1.6	1100.3	0.1	1098.1	-2.1	1098.2	-2	1100.7	0.5	1099.4	-0.8	1100.3	0.1
West of John Day E>W	2619.3	2617.1	-2.2	2613.4	-5.9	2618.2	-1.1	2624.9	5.6	2624.4	5.1	2617.2	-2.1	2620.8	1.5	2618.2	-1.1
West of Lower Monumental E>W	2108.1	2106.8	-1.3	2105.2	-2.9	2107.7	-0.4	2111.4	3.3	2111.2	3.1	2107.1	-1	2109.3	1.2	2107.7	-0.4
West of McNary E>W	2411.8	2409	-2.8	2405.8	-6.0	2410.9	-0.9	2418.6	6.8	2418.1	6.3	2409.6	-2.2	2414.1	2.3	2410.9	-0.9
West of Slatt E>W	3363.6	3360	-3.6	3356.3	-7.3	3362.7	-0.9	3372.7	9.1	3371.8	8.2	3361.1	-2.5	3367.0	3.4	3362.7	-0.9

4.2.2 Transmission Paths: Alternative Comparisons to NAA

4.2.2.1 No-Action Alternative

Generation outputs at WVS projects under the NAA vary seasonally ranging from a total of 234.9 MW in the Winter Peak, 221.5 MW in the Spring Off-peak, and 115.5 MW in the Summer Peak cases as shown in Table 4.2-1 through Table 4.2-3. These generation outputs contribute to varying power flows through Bonneville Network Paths ranging from -1371 MW and -1368.3 at South of Custer to 9445.7 and 5652.7 MW at Cross Cascades North during the Winter Peak and Spring Off-peak cases respectively; and from 14.9 MW at North of Echo Lake and 5862.9 MW at Cross Cascades South during the Summer Peak case.

4.2.2.2 Alt 1: Change from NAA

With the NAA as the reference case, most incremental changes on Bonneville Transmission Network Paths for Alternative 1 were less than +/-10 MW under all seasonal cases as shown in Table 4.2-1 through Table 4.2-3. The largest incremental changes on Bonneville Transmission Network Paths for Alternative 1 occurred under the Summer Peak case (Table 4.2-3), specifically Cross Cascades South and North of Hanford paths (-11.6 MW and -11.5 MW, respectively), which can be attributed to the 19 MW increase in Willamette Valley generation compared to the NAA.

4.2.2.3 Alt 2A: Change from NAA

With the NAA as the reference case, most incremental changes on Bonneville Transmission Network Paths for Alternative 2A under all seasonal cases were less than +/- 25 MW as shown in Table 4.2-1 through Table 4.2-3. The largest incremental changes on Bonneville Transmission Network Paths for Alternative 2B occurred under the Spring Off-peak case at the West of Lower Monumental (64.5 MW) and Cross Cascades South (61.3 MW) paths as shown in Table 4.2-2, which can be attributed to the 90.8 MW decrease in Willamette Valley generation in this seasonal case with generation being replaced at Lower Snake generation facilities.

4.2.2.4 Alt 2B: Change from NAA

With the NAA as the reference case, most incremental changes on Bonneville Transmission Network Paths for Alternative 2B under all seasonal cases were less than +/- 25 MW as shown in Table 4.2-1 through Table 4.2-3. The largest incremental changes on Bonneville Transmission Network Paths for Alternative 2B occurred under the Spring Off-peak case at the West of Lower Monumental (26.2 MW) and Cross Cascades South (25.1 MW) paths as shown in Table 4.2-2, which can be attributed to the 38.8 MW decrease in Willamette Valley generation in this seasonal case with generation being replaced at Lower Snake generation facilities.

4.2.2.5 Alt 3A: Change from NAA

With the NAA as the reference case, most incremental changes on Bonneville Transmission Network Paths for Alternative 3A under all seasonal cases were less than +/- 25 MW as shown in Table 4.2-1 through Table 4.2-3. The largest incremental changes on Bonneville Transmission Network Paths for Alternative 3A occurred under the Spring Off-peak case (Table 4.2-2), specifically Cross Cascades South and West of Lower Monumental paths (-113.7 MW and -118.2 MW, respectively). Other locations with greater than 25 MW differences from the NAA include West of John Day (31.7 MW), West of McNary (52.3 MW), and West of Slatt (44 MW) under the Spring Off-peak case and the Cross Cascades South (37.2 MW and 28.3 MW) and North of Hanford (25.2 MW and 28.9 MW) under the Winter and Summer Peak cases, respectively. These noted differences can be attributed to decreases in Willamette Valley generation under all seasonal cases (ranging between 47.6 MW and 165.1 MW) with generation being replaced at either Upper Columbia (Winter and/or Summer peak cases) or Lower Snake (Spring Off-Peak case) generation facilities.

4.2.2.6 Alt 3B: Change from NAA

With the NAA as the reference case, many incremental changes on Bonneville Transmission Network Paths for Alternative 3A under all seasonal cases were less than +/- 25 MW as shown in Table 4.2-1 through Table 4.2-3. The largest incremental changes on Bonneville Transmission Network Paths for Alternative 3B occurred under the Spring Off-peak case as shown in Table 4.2-2, specifically Cross Cascades South and West of Lower Monumental paths (-94.8 MW and -99.1 MW, respectively). Other locations with greater than 25 MW differences from the NAA include West of John Day (26.6 MW), West of McNary (43.7 MW), and West of Slatt (36.8 MW) under the Spring Off-peak case and Cross Cascades South (41.4) and North of Hanford (40.4 MW) under the Winter Peak case as shown in Table 4.2.2 and Table 4.2.1, respectively. These noted differences can be attributed to the decreases in the Willamette Valley generation under all seasonal cases (ranging between 47.6 MW and 165.1 MW) with generation being replaced at either Upper Columbia (Winter and/or Summer peak cases) or Lower Snake (Spring Off-Peak case) generation facilities.

4.2.2.7 Alt 4: Change from NAA

With the NAA as the reference case, most incremental changes on Bonneville Transmission Network Paths for Alternative 4 were less than +/-10 MW as shown in Table 4.2-1 through Table 4.2-3. The largest incremental changes on Bonneville Transmission Network Paths for Alternative 4 occurred under the Spring Off-peak case (Table 4.2-23), specifically Cross Cascades South and West of Lower Monumental paths (15 MW and 15.8 MW, respectively), which can be attributed to the 14 MW increase in Willamette Valley generation compared to the NAA.

4.2.2.8 Alt Near-Term Operations Measure: Change from NAA

With the NAA as the reference case, many incremental changes on Bonneville Transmission Network Paths for Alternative 5 under all seasonal cases were less than +/- 25 MW as shown in Table 4.2-1 through Table 4.2-3. The largest incremental changes on Bonneville Transmission Network Paths for Alternative 5 occurred under the Spring Off-peak case as shown in Table 4.2-2, specifically Cross Cascades South and West of Lower Monumental paths (59.8 MW and 62.8 MW, respectively). Other locations with greater than 25 MW differences from the NAA include

West of McNary (27.7 MW) under the Spring Off-peak case and Cross Cascades South (47.0) and North of Hanford (45.1 MW) under the Winter Peak case as shown in Table 4.2.2 and Table 4.2.1, respectively. These noted differences can be attributed to the decreases in the Willamette Valley generation under all seasonal cases (ranging between 16.7 MW and 88.4 MW) with generation being replaced at either Upper Columbia (Winter and/or Summer peak cases) or Lower Snake (Spring Off-Peak case) generation facilities.

4.2.2.9 Alt5: Change from NAA

With the NAA as the reference case, most incremental changes on Bonneville Transmission Network Paths for Alternative 2B under all seasonal cases were less than +/- 25 MW as shown in Table 4.2-1 through Table 4.2-3. The largest incremental changes on Bonneville Transmission Network Paths for Alternative 2B occurred under the Spring Off-peak case at the West of Lower Monumental (26.2 MW) and Cross Cascades South (25.1 MW) paths as shown in Table 4.2-2, which can be attributed to the 38.8 MW decrease in Willamette Valley generation in this seasonal case with generation being replaced at Lower Snake generation facilities.

CHAPTER 5 - ECONOMIC VIABILITY OF POWER GENERATION

To determine the long-term financial viability of power operations at Willamette Valley projects, the NPV and LCOG are analyzed under each Action Alternative. The analysis considers the Bonneville direct funded capital, operations, and maintenance programs as well as the structural and operational measures identified in the Action Alternatives. Costs and generation are forecast over a 30-year study period, consistent with typical economic analyses for investments in the FCRPS.

5.1 POWER GENERATION ECONOMIC ANALYSES METHODOLOGIES

Bonneville is obligated to first provide contracted preference customers the opportunity to purchase power generation at the Tier 1 preference rate. Once Bonneville's Tier 1 obligations are fulfilled, Bonneville can then sell surplus energy in secondary markets. Through the end of Bonneville's current contract period with its customers in 2028, a reasonable estimate of the revenue produced by the WVS projects under each Alternative during this period can be based on the assumption that power generation at critical water is valued at Tier 1 rates and generation in excess of critical water is valued at Mid-Columbia (Mid-C) market price forecasts. Since post-2028 contractual conditions are not yet clear, Tier 1 rates were not applied during this period and instead all energy was valued at the forecasted Mid-Columbia market price from 2029 through the end of the 30-year study period. Given the LOLP analysis in Section 3 indicates replacement resources would not be needed to return the LOLP to the NAA level under any of the Alternatives, the forecasted market value of generation from the facilities was considered a reasonable assumption to use for post-2028 revenue estimates. The assumption is that differences in generation under the Alternatives would result in either lost secondary sales opportunities or forced market purchases but no long-term acquisitions would be required. As a result, the Mid-Columbia market price is the most representative value available for post-2028.

Figure 5.1-1 presents the framework for the economic analyses. Bonneville uses HYDSIM (Section 2.1.1) and AURORA (Section 5.1.1) models to produce a range of outputs for generation and energy pricing, respectively, that vary by water year. The AURORA model employs a Monte Carlo simulation to generate a robust distribution of potential future states governing the wholesale energy market in the Pacific Northwest. Joining the generation and wholesale market price forecasts on common water years allows for the construction of a distribution of revenue streams associated with each Willamette Valley project.

Estimated revenue at each project was then compared with the long-term cost to sustain the projects identified in the 2022 FCRPS Strategic Asset Management Plan (SAMP) plus any structural measures contained within the Action Alternatives. Finally, these net revenues were discounted to arrive at a distribution of NPVs and Levelized Costs of Generation.

5.1.1 Aurora

AURORA is a production cost model, developed by Energy Exemplar, Ltd Pty., used by hundreds of utilities globally to forecast short- and long-term electricity prices. Given model inputs (resource build, load forecast, fuel cost, etc.), AURORA produces a price forecast by calculating the least cost solution of meeting system-wide load on

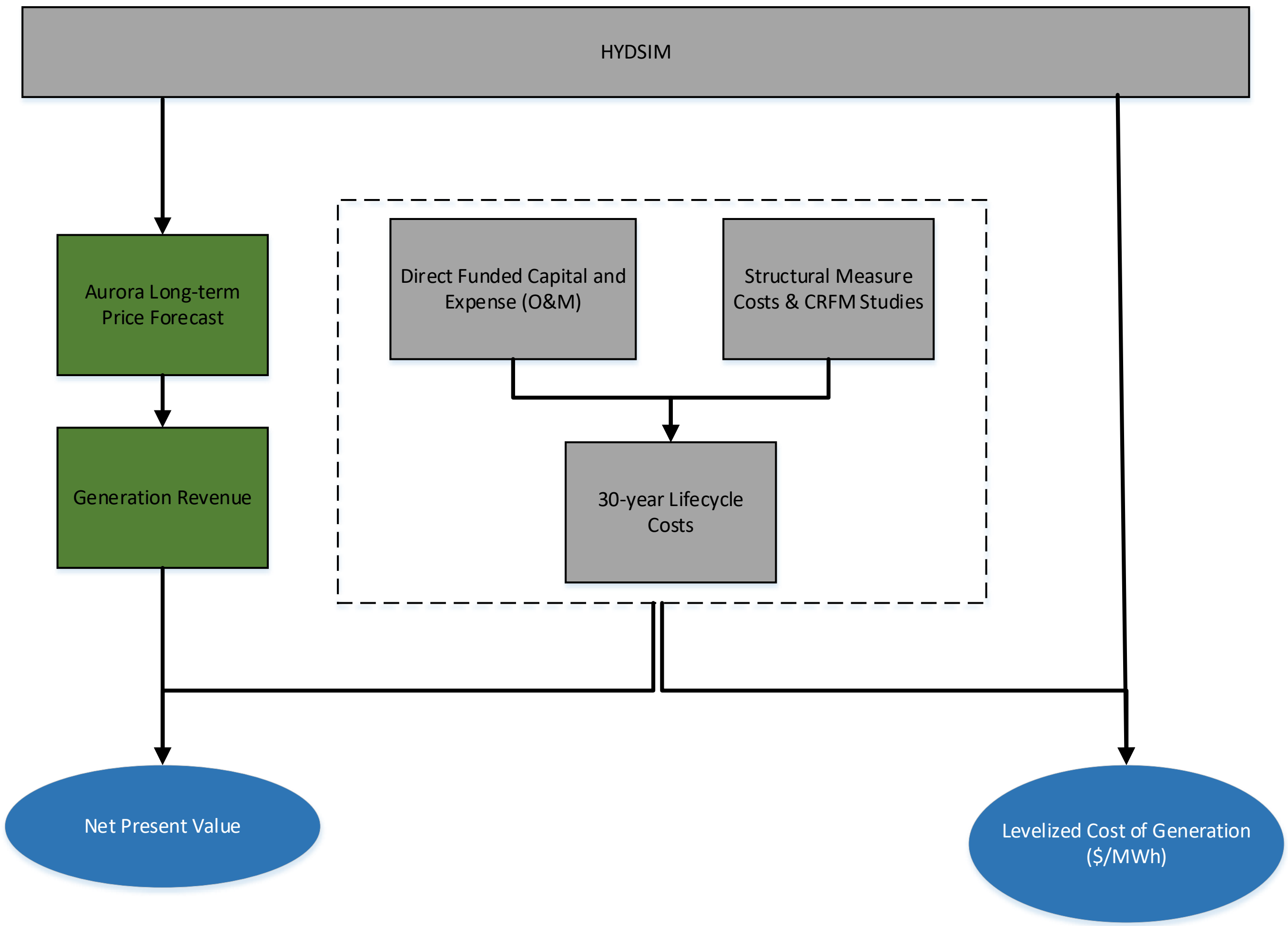


Figure 5-1. Analytical Approach for Evaluating Power Generation Economic Effects of the WVS Action Alternatives.

Notes: HYDSIM (Generation by month, 73 Water Years); Aurora Long-term Price Forecast (1600 games correlated with 73 Water Years); Direct Funded Capital and Expense (O&M) Forecasts (2022 SAMP and Corps' budget submissions used in support of the BP-24 Integrated Program Review); and Generation Revenue, NPV, and LCOG (1600 games each).

an hourly basis, subject to a number of operating constraints. The cost of producing and delivering an additional unit of energy to a location in the system is assumed to approximate the price at that location. Bonneville uses AURORA to create price distributions by using Monte Carlo sampling of projected loads, hydro generation, gas prices, transmission capacity, wind generation, and Columbia Generating Station (CGS) capability. Bonneville uses the AURORA model to produce a range of price forecasts by year, month, and water year. Standard AURORA runs consist of 3200 iterations (80 Water Years and 40 iterations per Water Year) that vary loads, hydro generation, gas prices, transmission capability, wind generation, and Columbia Generating Station availability to produce a distribution of price forecasts. However, the most recent long term forecast had 1600 iterations (80 Water Years and 20 iterations per Water Year) due to modeling changes that resulted in longer run times.

5.1.2 Generation Revenue

Section 2.2.1 describes how generation for each Action Alternative was modeled using HYDSIM to produce expected monthly generation for each facility across 73 water years from 1936 to 2008. To calculate generation revenue, the HYDSIM modeling results were correlated with forward looking energy prices that relate to each of the 73 water year conditions. Energy prices were modeled from 2024 through 2033 with subsequent years escalated at the rate of inflation (2022 inflation forecast averaging 2.4%).

Before pricing was applied, generation was split between generation under critical water year and surplus generation conditions. This was performed by comparing the monthly generation from each water year to the monthly generation from 1937 critical water for each generation facility, respectively. Monthly generation less than or equal to the monthly generation from 1937 was valued at Tier 1 Priority Firm Power (PF) rates. Incremental generation in excess of 1937 generation was assumed to be valued at the Mid-C market price forecast. After 2028, the year in which Bonneville's current long-term contracts with its customer expire, all generation was valued at the Mid-C market price forecast. **Error! Reference source not found.** shows an example of how the generation split was determined.

Table 5-1. Example - Generation Pricing Methodology.

Plant	Water Year	October Generation (MWh)	Critical Year Generation (MWh)	Generation at Tier 1 (MWh)	Surplus Generation at Mid C (MWh)
Big Cliff	1937	7440	7440	7440	0
Big Cliff	1938	9672	7440	7440	2232
Big Cliff	1941	6696	7440	6696	0

5.1.3 30-year Lifecycle Costs[17]

5.1.3.1 Direct Funded Capital and Expense (Operations and Maintenance) Costs

Direct funded capital forecasts were sourced from the 2022 FCRPS Strategic Asset Management Plan (SAMP; Bonneville 2022). The SAMP is produced every two years in support of BPA's Integrated Program Review (IPR) process to set capital and expense budgets. The SAMP analysis produces a 50-year capital forecast for equipment replacement need based on equipment condition, criticality, and risk; the first 30-years was used for this analysis. The Corps' budget submissions used in support of the BP-24 Integrated Program Review were used as a source for expense (operations and maintenance) values.

5.1.3.2 Structural Measure Costs

Structural Measure costs (capital and operations and maintenance) were estimated by the Corps at the Class 5 level for each Action Alternative with structural measures (see Appendix M). Class 5 estimates (commonly referred to as "Rough Order of Magnitude") inherently have considerable risk and uncertainty resulting in high contingencies. For purposes of this analysis, it is assumed that contingencies are 50%, capital costs are incurred in Year 1 (2024), and operations and maintenance of the structural measures are escalated at the rate of inflation (2022 inflation forecast averaging 2.4%) for the 30-year study period.

5.1.4 Net Present Value Calculation

The NPV compares the present value of benefits to the present value of costs. It considers the direct funded capital and expense (operations, routine and non-routine maintenance) forecasts, as well as the capital, operations and maintenances cost associated with structural measures. System-wide costs, such as Bonneville's fish and wildlife program, are not included in the NPV. The NPV is calculated as:

$$NPV = \sum_{t=1}^{n} \frac{B_t - C_t}{(1+i)^t}$$

$$B = Benefits\ (generation\ revenue)$$
$$C = Costs\ (direct\ funded\ capital, expense, structural\ measures)$$
$$i = Discount\ Rate$$
$$n = Study\ period\ (30\ years)$$

Benefits and costs are forecast over the 30-year study period for each of the 1600 iterations. These cash flows are discounted using Bonneville's Risk Free 2022 discount rate of 2.81%. The

[17] Bonneville's share of basin-wide costs (e.g., RME) were not included in analysis. With inclusion of those costs, the Net Present Value estimates would be incrementally lower and the Levelized Costs of Generation estimates would be incrementally higher.

Bonneville's Official Agency Discount Rate was determined to be the best applicable rate in this power specific NPV evaluation. A positive NPV indicates that power generation at the dams is economically justified, while a negative NPV indicates that costs outweigh the benefits.

5.1.5 Levelized Cost of Generation Calculation

The LCOG evaluates the incremental cost of producing power at a facility. It considers the direct funded capital and expense (operations, routine and non-routine maintenance) forecasts, as well as the capital, operations and maintenances costs associated with structural measures. System-wide costs, such as Bonneville's fish and wildlife program, are not included in LCOG. The LCOG is calculated as:

$$Levelized\ Cost\ of\ Generation = \frac{\sum_{t=1}^{n} \frac{C_t + E_t}{(1+i)^t}}{\sum_{t=1}^{n} \frac{G}{(1+i)^t}}$$

$$C = Direct\ funded\ capital + Structural\ measure\ costs$$
$$E = Expense\ (operations\ and\ maintenance)$$
$$G = Average\ annual\ generation$$
$$i = Discount\ rate$$
$$n = Study\ period\ (50\ years)$$

The LCOG takes the stream of forecasted costs over the 30-year study period and "levelizes" them to produce an annualized cost of power production. This measure, in $/MWh, is then compared to the levelized cost of alternative resources to understand the relative competitiveness and affordability of each dam.

5.2 POWER GENERATION ECONOMIC RESULTS

5.2.1 Power Generation Economics Summaries

5.2.1.1 Net Present Value

Median NPVs from the 1600 iterations are shown in Table 5.2-1. The combined WVS projects with hydropower facilities have a positive median Net Present Value of $225 million over the 30-year study period under the NAA.

All of the Action Alternatives result in a negative median NPV for all WVS projects combined ranging from approximately -$196 million to -$933 million. For individual WVS projects, only Hills Creek and Detroit/Big Cliff have a positive NPV under one or more alternatives. Hills Creek has a positive median NPV in the No Action Alternative, Alternative 1, Alternative 2A, Alternative 2B, and Alternative 5. It's NPV ranges from $37 million in Alternative 5 to $49 million under the near-term operations measure[18]. Detroit/Big Cliff also have a positive NPV of $5 million under the near-term operations measure.

Table 5.2-2 provides the percentage of the 1600 iterations that resulted in a positive NPV under each alternative. Approximately 77.7 percent of iterations for the No Action Alternative resulted in a positive NPV for the Willamette Valley system. Across the Action Alternatives, between 0.3 and 20.9 percent of the iterations resulted in a positive NPV for the combined WVS projects.

5.2.1.2 Levelized Cost of Generation

Median LCOG are shown in Table 5.2-3 for each alternative. Under the NAA, median levelized costs for the combined WVS projects are estimated to be $26.70, which is $8.23 less than current average Tier 1 rates ($34.93[19]) and within the range of recent

[18] The near term operations measure includes near term operational measures only and does not consider the effects of near term structural measures identified under the court order, nor does it account for operational changes that may occur as a result of implementing the near term structural measures.
[19] Bonneville. 2021. BP-22 Rate Proceeding, Administrator's Final Record of Decision, BP-22-A-02, July 2021. https://www.bpa.gov/Finance/RateCases/BP-22-Rate-Case/Documents/BP-22 Final Proposal/BP-22-A-02 BP-22 Final ROD.pdf

Table 5-2. 30-year Net Present Value by Alternative in Millions of 2024 Dollars (Median of 1600 iterations, 2.81 % Risk Free Bonneville Discount Rate).[3,4]

Project	NAA	ALT1	ALT2A	ALT2B	ALT3A	ALT3B	ALT4	ALT5	Near-term Operations Measure
Detroit/Big Cliff[1]	84	-351	-353	-354	-189	-73	-356	-354	5
Green Peter/Foster[1]	-3	-296	-208	-207	-172	-231	-134	-209	-123
Lookout Point/Dexter[1]	109	-309	-28	-30	-144	-83	-304	-33	-94
Cougar	-3	-22	-90	-152	-86	-152	-76	-153	-32
Hills Creek	39	45	43	39	-41	-68	-67	37	49
Combined WVS Projects[2]	**225**	**-934**	**-638**	**-708**	**-628**	**-604**	**-937**	**-714**	**-196**

1/ Cougar and Hills Creek dams are operated as individual projects. Additionally, peaking dams and their respective re-regulating dams are functionally operated together as individual projects; therefore, the combined peaking/reregulating dams (Detroit/Big Cliff, Green Peter/Foster, and Lookout Point/Dexter) are treated as individual projects.

2/ Net Present Values for combined WVS projects are calculated from the sum of benefits and costs across each project for 1600 iterations. The median result may not equal the sum of median results for individual plants.

3/Bonneville's share of basin-wide costs (e.g., RME) were not included in this analysis. With inclusion of those costs, the Net Present Value would be incrementally lower and the Levelized Costs of Generation would be incrementally higher. Additionally, structural cost estimates used in the analysis of Action Alternatives were at a conceptual design level with a 50% contingency. For other projects of similar size and complexity, the conceptual design cost estimates increased by 137% to 215% upon completion of the detailed design report. Post-construction, the complexity of these systems has typically resulted in further costs to improve performance. Higher implementation costs than currently estimated would result in additional reductions of the Net Present Value and increases in the levelized costs of generation.

4/ Alternative 5 effects are only inclusive of near-term operational measures and do not account for structural measures that have been proposed under the court order (e.g., upgrades to the Dexter adult fish facility), nor do they account for operational changes that could occur as a result of structural measure implementation.

Table 5-3. Percent of 1600 Iterations with a Positive NPV by Alternative.

Project	NAA	ALT1	ALT2A	ALT2B	ALT3A	ALT3B	ALT4	ALT5	Near-term Operations Measure
Detroit/Big Cliff1	84.7	0.2	0.2	0.2	0.4	12.7	0.2	0.2	52.8
Green Peter/Foster1	48.6	0.2	0.1	0.1	0.3	0.2	2.1	0.1	1.4
Lookout Point/Dexter1	89.6	0.4	38.8	38.2	0.8	11.2	0.4	36.6	7.1
Cougar	46.3	25.6	0.4	0.0	0.3	0.0	0.9	0.0	14.4
Hills Creek	89.8	92.3	91.4	89.8	6.6	0.6	3.9	88.6	94.1
Combined WVS Projects1	77.8	0.7	3.0	1.3	0.3	0.5	0.6	1.3	20.9

1/ Cougar and Hills Creek dams are operated as individual projects. Additionally, peaking dams and their respective re-regulating dams are functionally operated together as individual projects; therefore, the combined peaking/reregulating dams (Detroit/Big Cliff, Green Peter/Foster, and Lookout Point/Dexter) are treated as individual projects.

2/Net Present Values for combined WVS projects are calculated from the sum of benefits and costs across each project for 1600 iterations. The Combined WVS project value is not an average of the individual plants.

Table 5-4. 2024 Cost of Generation ($/MWh) by Alternative (Median of 1600 iterations).[3,4]

Project	NAA	ALT1	ALT2A	ALT2B	ALT3A	ALT3B	ALT4	ALT5	Near-term Operations Measure
Detroit/Big Cliff[1]	$25.24	$57.50	$57.50	$57.52	$81.57	$41.25	$57.71	$57.52	$31.97
Green Peter/Foster[1]	$33.86	$66.01	$64.74	$64.68	$58.85	$86.99	$52.03	$64.90	$50.40
Lookout Point/Dexter[1]	$22.96	$57.87	$34.52	$34.52	$64.14	$42.92	$57.17	$34.52	$44.93
Cougar	$32.49	$38.22	$56.24	$340.57	$80.53	$346.18	$52.34	$363.99	$42.76
Hills Creek	$21.85	$21.26	$21.54	$21.95	$44.79	$67.13	$46.48	$22.20	$21.57
Combined WVS Projects[2]	**$26.70**	**$53.84**	**$47.45**	**$50.66**	**$64.32**	**$59.42**	**$54.54**	**$50.81**	**$38.35**

1/ Cougar and Hills Creek dams are operated as individual projects. Additionally, peaking dams and their respective re-regulating dams are functionally operated together as individual projects; therefore, the combined peaking/reregulating dams (Detroit/Big Cliff, Green Peter/Foster, and Lookout Point/Dexter) are treated as individual projects.

2/ Cost of Generation for combined WVS projects are calculated from the sum of costs and generation across each project for 1600 iterations. The median result from the 1600 iterations is displayed. Combined WVS project Cost of Generation is not an average across the individual projects as each project contributes a different amount of generation per year.

3/Bonneville's share of basin-wide costs (e.g., RME) were not included in this analysis. With inclusion of those costs, the Net Present Value would be incrementally lower and the Levelized Costs of Generation would be incrementally higher. Additionally, structural cost estimates used in the analysis of Action Alternatives were at a conceptual design level with a 50% contingency. For other projects of similar size and complexity, the conceptual design cost estimates increased by 137% to 215% upon completion of the detailed design report. Post-construction, the complexity of these systems has typically resulted in further costs to improve performance. Higher implementation costs than currently estimated would result in additional reductions of the Net Present Value and increases in the levelized costs of generation. Additionally, 4/Alternative 5 effects are only inclusive of near-term operational measures and do not account for structural measures that have been proposed under the court order (e.g., Dexter Hatchery improvements), nor do they account for operational changes that could occur as a result of structural measure implementation.

average Mid-C market energy prices. Under the Action Alternatives, costs of generation for the combined WVS projects would be expected to exceed both current Tier 1 rates and expected energy prices. For individual WVS projects, the costs of generation at Hills Creek, Lookout Point, and Detroit/Big Cliff under some Action Alternatives are estimated to be below current average Tier 1 rates ranging from approximately $21.54/MWh (Hills Creek under Alternative 2A) to $34.52/MWh (Lookout Point/Dexter under Alternative 2A, 2B and 5).

5.2.2 Power Generation Economics: Alternative Comparisons to NAA

5.2.2.1 No-Action Alternative

Over the 30-year study period, the median Net Present Value for the combined WVS projects under the No Action Alternative is about $225 million and the median Levelized Cost of Generation is estimated to be $26.70/MWh[20].

As Table 5.2-1 and Table 5.2-3 indicate, only three individual projects[21] have positive median NPVs including Hills Creek ($39 million), Detroit/Big Cliff ($84 million), and Lookout Point/Dexter ($109 million); and their levelized costs range from $21.85/MWh (Hills Creek) and $25.24/MWh (Detroit/Big Cliff). As shown in Table 5.2-2, these same three projects are the only ones having a positive Net Present Value in more than 50% of the 1,600 iterations. Cougar and Green Peter/Foster, respectively, have negative median Net Present Values of -$3 million; levelized costs of generation of $32.49/MWh and $33.86/MWh; and proportion of 1,600 iterations resulting in a positive Net Present Value at 46.3 percent and 48.6 percent.

5.2.2.2 Alt 1: Change from NAA

Over the 30-year study period, power operations are estimated to have a median Net Present Value of -$934 million under Alternative 1[22]. This is a $1.159 billion, or 515 percent, reduction in Net Present Value compared to the No Action Alternative. Across the 1,600 iterations that varied energy prices and water conditions, only 0.7 percent resulted in a positive Net Present Value for the combined WVS projects. The median Levelized Cost of Generation for the

---

[20] Bonneville's share of basin-wide costs (e.g., RME) were not included in this analysis. With inclusion of those costs, the Net Present Value would be incrementally lower and the levelized costs of generation would be incrementally higher.

[21] Cougar and Hills Creek dams are operated as individual projects. Additionally, peaking dams and their respective re-regulating dams are functionally operated together as individual projects; therefore, the combined peaking/reregulating dams (Detroit/Big Cliff, Green Peter/Foster, and Lookout Point/Dexter) are treated as individual projects.

[22] Bonneville's share of basin-wide costs (e.g., RME) were not included in this analysis. With inclusion of those costs, the Net Present Value would be incrementally lower and the Levelized Costs of Generation would be incrementally higher. Additionally, structural cost estimates used in the analysis were at a conceptual design level with a 50% contingency. For other projects of similar size and complexity, the conceptual design cost estimates increased by 137% to 215% upon completion of the detailed design report. Post-construction, the complexity of these systems has typically resulted in further costs to improve performance. Higher implementation costs than currently estimated would result in additional reductions of the Net Present Value and increases in the levelized costs of generation.

combined WVS projects is estimated to rise from $26.70/MWh under the No Action Alternative to $53.84/MWh under Alternative 1[20], which is a $27.14, or 102 percent, increase.

As Table 5.2-1 through Table 5.2-3 indicate, all WVS projects except Hills Creek have negative median Net Present Values ranging from -$22 million (Cougar) to -$351 million (Detroit/Big Cliff); levelized costs of generation ranging from $38.22/MWh (Cougar) to $66.01/MWh (Green Peter/Foster); and proportion of 1,600 iterations resulting in a positive Net Present Value ranging from 0.2 percent (Detroit/Big Cliff and Green Peter/Foster) to 25.6 percent (Cougar). Hills Creek has the only positive Net Present Value at $45 million. It had a positive Net Present Value in 92.3 percent of the 1600 iterations and has a median levelized cost of generation of $21.26.

5.2.2.3 Alt 2A: Change from NAA

Over the 30-year study period, power operations are estimated to have a median Net Present Value of -$638 million under Alternative 2A[20]. This is a $863 million, or 384 percent, reduction in Net Present Value compared to the No Action Alternative. Across the 1,600 iterations that varied energy prices and water conditions, only 3.0 percent resulted in a positive Net Present Value. The median Levelized Cost of Generation for the combined WVS projects is estimated to rise from $26.70/MWh under the No Action Alternative to $47.45/MWh under Alternative 2A[20], which is a $20.75, or 78 percent, increase.

As Table 5.2-1 and Table 5.2-3 indicate, Hills Creek is the only WVS project that has a positive median Net Present Value at $43 million under Alternative 2A. It's levelized cost of generation is $21.54/MWh. Hills Creek is the only project that has a positive Net Present Value in more than 50% of the 1600 iterations from the economic analysis. Other projects have negative median Net Present Values ranging from -$28 million (Lookout Point/Dexter) to -$353 million (Detroit/Big Cliff); levelized costs of generation ranging from $34.52/MWh (Lookout Point/Dexter) to $64.74/MWh (Green Peter/Foster); and a proportion of 1,600 iterations resulting in a positive Net Present Value ranging from 0.1 percent (Green Peter/Foster) to 38.81 percent (Lookout Point/Dexter).

5.2.2.4 Alt 2B: Change from NAA

Over the 30-year study period, power operations are estimated to have a median Net Present Value of -$-708 million under Alternative 2B[20]. This is a $933 million, or 415 percent, reduction in Net Present Value compared to the No Action Alternative. Across the 1,600 iterations that varied energy prices and water conditions, only 1.3 percent resulted in a positive Net Present Value. The median Levelized Cost of Generation for the combined WVS projects is estimated to rise from $26.70/MWh under the No Action Alternative to $50.66/MWh under Alternative 2B[20], which is a $23.96, or 90 percent, increase. This is substantially greater than expected market prices and less competitive compared to other renewable resources that are expected to become more affordable in the future.

As Table 5.2-1 and Table 5.2-3 indicate, Hills Creek is the only WVS project under Alternative 2B that has a positive median Net Present Value at $39 million. Its levelized cost of generation is $21.95/MWh. Hills Creek is the only project that has a positive Net Present Value in more than 50% of the 1600 iterations from the economic analysis. Other projects have negative median Net Present Values ranging from -$30 million (Lookout Point/Dexter) to -$354 million (Detroit/Big Cliff); levelized costs of generation ranging from $34.52/MWh (Lookout Point/Dexter) to $340.57 MWh (Cougar); and proportion of 1,600 iterations resulting in a positive Net Present Value ranging from 0 percent (Cougar) to 38.19 percent (Lookout Point/Dexter).

5.2.2.5 Alt 3A: Change from NAA

Over the 30-year study period, power operations are estimated to have a median Net Present Value of -$628 million under Alternative 3A[20]. This is a $853 million, or 379 percent, reduction in Net Present Value compared to the No Action Alternative. Across the 1,600 iterations that varied energy prices and water conditions, only 0.3 percent resulted in a positive Net Present Value. The median Levelized Cost of Generation for the combined WVS projects is estimated to rise from $26.70/MWh under the No Action Alternative to $64.32/MWh under Alternative 3A[20], which is a $37.61, or 141 percent, increase. This is substantially greater than expected market prices and less competitive compared to other renewable resources that are expected to become more affordable in the future.

As Table 5.2-1 and Table 5.2-3 indicate, all of the WVS projects under Alternative 3A have negative median Net Present Values ranging from -$41 million (Hills Creek) to -$189 million (Detroit/Big Cliff) and levelized costs of generation ranging from $44.79/MWh (Hills Creek) to $81.57/MWh (Detroit/Big Cliff); and a proportion of 1,600 iterations resulting in a positive Net Present Value ranging from 0.25 percent (Cougar) to 6.7 percent (Hills Creek).

5.2.2.6 Alt 3B: Change from NAA

Over the 30-year study period, power operations are estimated to have a median Net Present Value of -$604 million under Alternative 3B[20]. This is a $829 million, or 369 percent, reduction in Net Present Value compared to the No Action Alternative. Across the 1,600 iterations that varied energy prices and water conditions, only 0.5 percent resulted in a positive Net Present Value. The median Levelized Cost of Generation for the combined WVS projects is estimated to rise from $26.70/MWh under the No Action Alternative to $59.42/MWh under Alternative 3B[20], which is a $32.72, or 123 percent, increase). This is substantially greater than expected market prices and less competitive compared to other renewable resources that are expected to become more affordable in the future.

As Table 5.2-1 and Table 5.2-3 indicate, all of the WVS projects have negative median Net Present Values ranging from -$68 million (Hills Creek) to -$231 million (Green Peter/Foster) and their levelized costs of generation range from $41.25/MWh (Detroit/Big Cliff) to $346.18/MWh (Cougar). None of the projects had a positive Net Present Value in more than 50% of the iterations, with the proportion of 1,600 iterations resulting in a positive Net Present Value ranging from 0 percent (Cougar) to 12.69 percent (Detroit/Big Cliff).

5.2.2.7 Alt 4: Change from NAA

Over the 30-year study period, power operations are estimated to have a median Net Present Value of -$937 million under Alternative 4[20]. This is a $1.162 billion, or 517%, reduction in Net Present Value compared to the No Action Alternative. Across the 1,600 iterations that varied energy prices and water conditions, only 0.6 percent resulted in a positive Net Present Value. The median Levelized Cost of Generation for the combined WVS projects is estimated to rise from $26.70/MWh under the No Action Alternative to $54.54/MWh under Alternative 4[20], which is a $27.84 , or 104 percent, increase). This is substantially greater than expected market prices and less competitive compared to other renewable resources that are expected to become more affordable in the future.

As Table 5.2-1 and Table 5.2-3 indicate, all of the WVS projects under Alternative 4 have negative median Net Present Values ranging from -$67 million (Hills Creek) to -$356 million (Detroit/Big Cliff) and their levelized costs of generation range from $46.48/MWh (Hills Creek) to $57.71/MWh (Detroit/Big Cliff). None of the projects had a positive Net Present Value in more than 50% of the iterations, with the proportion of 1,600 iterations resulting in a positive Net Present Value ranging from 0.2 percent (Detroit/Big Cliff) to 3.9 percent (Hills Creek).

5.2.2.8 Near-term Operations Measure: Change from NAA

Over the 30-year study period, power operations are estimated to have a median Net Present Value of -$196 million under Alternative 5[20]. This is a $421 million, or 187%, reduction in Net Present Value compared to the No Action Alternative[20]. Across the 1,600 iterations that varied energy prices and water conditions, only 20.9 percent resulted in a positive Net Present Value. The median Levelized Cost of Generation for the combined WVS projects is estimated to rise from $26.70/MWh under the No Action Alternative to $38.35/MWh under Alternative 4[20], which is an $11.65, or 44 percent, increase). This is substantially greater than expected market prices and less competitive compared to other renewable resources that are expected to become more affordable in the future.

As Table 5.2-1 and Table 5.2-3 indicate, Detroit/Big Cliff and Hills Creek are the only WVS projects having positive median Net Present Values of $5 million and $49 million, respectively; and their levelized costs of generation are $31.97/MWh and $21.57/MWh, respectively. They are also the only projects having a positive Net Present Value in more than 50% of the iterations. Other projects have negative median Net Present Values ranging from -$32 million (Cougar) to -$123 million (Green Peter/Foster) and levelized costs of generation ranging from $42.76/MWh (Cougar) to $50.40/MWh (Green Peter/Foster); and a proportion of 1,600 iterations resulting in a positive Net Present Value ranging from 1.4 percent (Green Peter/Foster) to 14.4 percent (Cougar).

5.2.2.9 Alt5: Change from NAA

Over the 30-year study period, power operations are estimated to have a median Net Present Value of -$714 million under Alternative 5[20]. This is a $939 million, or 417 percent, reduction in Net Present Value compared to the No Action Alternative. Across the 1,600 iterations that varied energy prices and water conditions, only 1.31 percent resulted in a positive Net Present Value. The median Levelized Cost of Generation for the combined WVS projects is estimated to rise from $26.70/MWh under the No Action Alternative to $50.81/MWh under Alternative 5[20], which is a $24.11, or 90 percent, increase. This is substantially greater than expected market prices and less competitive compared to other renewable resources that are expected to become more affordable in the future.

As Table 5.2-1 and Table 5.2-3 indicate, Hills Creek is the only WVS project under Alternative 5 that has a positive median Net Present Value at $37 million. Its levelized cost of generation is $22.20/MWh. Hills Creek is also the only projects that has a positive Net Present Value in more than 50% of the 1600 iterations from the economic analysis. Other projects have negative median Net Present Values ranging from -$33 million (Lookout Point/Dexter) to -$354 million (Detroit/Big Cliff); levelized costs of generation ranging from $34.52/MWh (Lookout Point/Dexter) to $363.99/MWh (Cougar); and proportion of 1,600 iterations resulting in a positive Net Present Value ranging from 0 percent (Cougar) to 33.63 percent (Lookout Point/Dexter).

REFERENCES

Bonneville (Bonneville Power Administration). 2011. 2010 Level Modified Streamflow, 1928-2008. DOE/BP-4352.

______. 2022. FCRPS Program Strategy. Available at: https://www.bpa.gov/-/media/Aep/finance/asset-management/management-plans/2022-fcrps-samp.pdf

______. 2021. Bonneville ATC long-term constraints map. Available at https://www.bpa.gov/transmission/Doing%20Business/ATCMethodology/Documents/atc-long-term-constraints.pdf

Corps (U.S. Army Corps of Engineers), U.S. Bureau of Reclamation, and Bonneville Power Administration. 2020. Columbia River System Operation EIS. Available at https://www.nwd.usace.army.mil/CRSO/

NW Council. 2016. GENESYS Documentation. Available at https://www.nwcouncil.org/sites/default/files/genesys_techdocumentation_20161011_0.pdf

NW Council. 2017. Pacific Northwest Power Supply Adequacy Assessment for 2022, Document 2017-5 (July 11, 2017). Available at https://www.nwcouncil.org/sites/default/files/2017-5.pdf.

EXHIBIT 1. HYDSIM MODELING BACKGROUND

The Willamette Basin is primarily rain based, and the projects are operated to flood control fall through spring. Flood risk management in the Willamette basin is accomplished by drafting the reservoirs behind the dams to low levels in the late fall before the rains start in order to provide storage space to retain inflow during downstream flood events. The release of any retained water during the flood season is regulated by the flow levels at downstream control points such as Albany and Salem whenever possible. After the flood season has passed, the reservoirs are filled with the spring inflows to their maximum conservation season level. Summer is climatically very dry, and the outflows are set for recreation, flow objectives for fish and wildlife, and irrigation. There are eight projects that generate hydropower and they have minimal capability to shape generation to load. This cycle of drafting and filling is guided by a “Conservation Curve” at each storage project that specifies the timing of each of these phases of regulation. The Conservation Curve is the pool elevation that the reservoir is managed to stay at or below when possible, with pool levels above the curve when operating for flood risk management, and pool levels below the curve when inflows are low and the stored water is released to meet the various, mostly BiOp related, needs of the system.

The objective of the Willamette EIS is to assess the impacts of proposed changes to the Willamette Valley reservoir operations. Simulating reservoir operations over a wide variety of hydrologic conditions provides a quantitative tool to assess impacts and compare different alternative operations. Several existing datasets that extend to 2009 are already available to provide the inflow, evaporation, and irrigation data. ResSim models are used to model the system on a daily basis, which is better suited to simulate intra-month reservoir elevations, dam outflows, and evaluate potential flooding events (flood risk management). The NAA and alternatives were first modeled in ResSim by USACE before HYDSIM models the system in 14 periods, monthly with two split months, April and August. The outputs are end of period project elevations, period average turbine outflow, spillway outflows, and period average generation.

The general hydroregulation simulation process is for Bonneville staff to develop inputs for HYDSIM from inflow data provided by USACE, the 2010 Modified Flow dataset (80 water years, 2008 levels of irrigation depletion), the run-off forecast at The Dalles (1929 – 2009), upper rule curves from the HYSSR and HEC5 models, plant data from Pacific Northwest Coordination Agreement submissions by the USACE, and other requirements and flow priorities. Input quality control is provided by modeling staff before the HYDSIM model is run. Outputs are reviewed by multiple modeling staff to ensure the model is implementing the conditions as desired, and no conflicting requirements cause the model to not satisfy a desired operating condition. Further, all the hydroregulation of the alternatives were run through both the HYDSIM and ResSim models, and the outputs, specifically end of month elevation at projects, was compared by a group of hydro modelers for quality control.

The modeling approach for the WVS EIS aligned different model approaches and types to provide similar representations of key operations for all impact assessments. The three primary steps of the modeling approach: input, modeling (or study/task), and output. This section describes the steps applied to achieve outputs for each alternative. Results from the hydroregulation modeling were used in subsequent modeling steps to provide results for different impact assessments. The results from the Bonneville hydropower simulation model (HYDSIM) portion of the hydroregulation studies were detailed sets of 73-year by 14-period (April and August being split months, Water Years 1935/36 – 2007/08) project outflows, reservoir elevations, reservoir contents, spillway flows at 11 projects and power generation data at the 8 power generating projects in the WVS. Specifically, the WVS HYSDIM model includes the hydroindependent Portland General Electric projects on the Clackamas River: Timothy, Oak Grove, North Fork, Faraday, and River Mill as well as the USACE projects on the Santiam River: Detroit, Big Cliff, Green Peter, Foster; the McKenzie River project Cougar; and Upper Willamette River projects Hills Creek, Lookout Point, Dexter, and the Lost Creek on the Rogue River. These projects were not connected as a complete system in HYDSIM, rather each tributary's projects were connected as individual system.

Five non-generating projects and three control points were added to the HYDSIM plant file during WVS EIS development. New project numbers and control point numbers were created from downstream to upstream in ascending order and are Fern Ridge, Cottage Grove, Dorena, Fall Creek and Blue River. The new control points Albany, Salem, and TW Sullivan. The control points are connected to the upstream projects as like actual physical location. For each project, the storage-elevation, maximum discharge, and project limits are from the HYSSR model and are verified by the HEC5 model from the USACE, Portland District. These tables are also used for calculating average generation at each project. Period average generation is calculated in HYDSIM based on run of river vs. reservoir project type. For reservoir type projects, average generation is determined mathematically by taking the product of turbine flow and H/K at a project, limited by a maximum generation constraint that is project dependent. Generation at Detroit, Cougar, Green Peter, Foster, Hills Creek, and Lookout Point is modeled in this way. H/K ("H over K") tables are from the Columbia HYDSIM model used in the CRSO and cross-checked against the HEC5 and HYSSR models. These tables relate H/K to head where "head" refers to the forebay elevation minus the tailwater elevation. The forebay elevation is the elevation that corresponds to the *average* storage for the project during the period of interest, not the difference between initial and ending elevation. Storage-elevation tables are provided and validated for each project by USACE, Portland District. Tailwater is constant for the Willamette projects. The re-regulation projects Dexter and Big Cliff are modeled as run of river, and in this case the average generation can be found by interpolating on the generation-discharge table using turbine flow.

The WVS EIS consists of several alternative operations that incorporate structural, flow, fish spill, and temperature control measures as well as a No-Action Alterative (NAA). The NAA is intended to reflect the current operations with minimum flow objectives from the 2008 BiOp and maximum flow constraints from both project water control manuals as well as the 2008 BiOp. Additionally, the NAA includes measures at Detroit for temperature spill and at Foster for temperature/fish weir spill, which are detailed below. In HYDSIM, Biop fish minimum flows at projects are used as project minimum flows. These fish flow requirements vary based on deficit years and surplus years. The deficit years were determined based on May 31st storage content of all projects. If the storage content is less than 1.2 MAF (604.8 ksfd) then that year is assumed to be a deficit year and will follow a corresponding flow guideline. Additionally there are minimum flow targets for Albany and Salem for certain months. The Willamette River operation was defined in the model as a list of priorities.

Priorities are in the order of:

1. Project minimum storage or elevation on Dec. 31st
2. Tributary or Project minimum flow
3. Mainstem Flow augmentation at Salem and Albany
4. Interim draft limits on the projects year around

The Action Alternatives contain different combinations of operational and structural measures. Measures are only modeled in ResSim if reservoir elevations, total outflow, or outlet specific flow are affected. For each alternative, the regulated flows, maximum flows, minimum flows, and spill for each project is sent to BPA for power analysis. The new flows, spill, and operational changes such as deeper draft limits are incorporated into a HYDSIM study and ultimately produce the average generation values for projects in the WVS.

EXHIBIT 2. AVERAGE AND CRITICAL WATER GENERATION EFFECTS ON U.S. PROJECTS

This exhibit provides 73 year average (Water Years 1935/36 through 2007/08) and critical water (1937) average generation HYDSIM data by Willamette Valley System project. The tabular generation details supplement the graphs in Section 3.1. HYDSIM uses a 14-period time step with April and August split into two half-month periods because these months tend to have substantial natural flow differences between their first and second halves. Negative numbers indicate an alternative produced less hydropower than the NAA.

73 Year Average Generation (Water Years 1935/36 through 2007/08) Differences: ALT1 vs NAA.

	DET	BCL	COU	GRP	FOS	HCR	LOP	DEX	Combined WVS Projects
OCT	34	1	0	12	1	-1	-7	-2	39
NOV	19	1	2	10	6	3	3	1	45
DEC	-1	0	0	0	0	-1	-2	0	-4
JAN	-1	0	0	0	-2	0	-2	0	-5
FEB	0	0	0	0	-3	0	2	1	-1
MAR	-3	-1	0	-2	-1	0	-2	0	-11
APR1	-5	-2	-4	-2	2	-7	-7	-2	-26
APR2	-3	-1	-5	-3	2	-7	-9	-2	-29
MAY	3	0	-3	0	2	-3	-6	-2	-9
JUN	27	0	0	-2	-2	2	-2	-1	22
JUL	15	-1	4	-2	-4	7	7	2	30
AUG1	14	0	0	-2	-4	4	7	2	21
AUG2	13	0	-1	-2	-6	1	9	2	17
SEP	10	0	1	-12	-11	2	1	0	-9

Critical Water Year (1937) Average Generation Differences: ALT1 vs NAA.

	DET	BCL	COU	GRP	FOS	HCR	LOP	DEX	Combined WVS Projects
OCT	30	1	-2	2	-2	-1	-16	-4	8
NOV	12	0	2	21	7	4	5	1	52
DEC	0	0	0	-1	-3	2	-8	1	-9
JAN	0	0	2	0	-3	2	-7	0	-6
FEB	0	0	0	0	-4	0	-6	0	-10
MAR	-5	-2	0	0	1	0	-1	0	-7
APR1	-5	-2	0	0	5	0	-1	0	-3
APR2	10	2	0	0	3	5	3	1	24
MAY	1	0	0	0	4	0	0	0	5

	DET	BCL	COU	GRP	FOS	HCR	LOP	DEX	Combined WVS Projects
JUN	48	0	0	0	2	0	0	0	50
JUL	20	0	1	-1	-3	1	2	0	20
AUG1	17	0	3	-3	-4	2	2	0	17
AUG2	16	0	-1	-3	-6	-5	7	2	10
SEP	16	0	1	-15	-11	6	-7	-2	-12

73 Year Average Generation (Water Years 1935/36 through 2007/08) Differences: ALT2A vs NAA.

	DET	BCL	COU	GRP	FOS	HCR	LOP	DEX	Combined WVS Projects
OCT	27	-1	2	-13	9	5	8	2	38
NOV	19	1	2	-47	2	3	6	2	-13
DEC	-1	0	-2	-43	-4	-2	-2	0	-53
JAN	-1	0	-1	-19	-5	-1	-3	0	-30
FEB	0	0	0	-4	-4	0	1	1	-7
MAR	-3	-1	0	-3	-1	0	-3	0	-12
APR1	-5	-2	-4	-3	2	-6	-7	-2	-26
APR2	-1	-1	-4	-15	3	-7	-9	-2	-36
MAY	3	0	-2	-17	3	-2	-5	-1	-21
JUN	29	1	2	-12	1	4	2	0	28
JUL	21	1	0	-4	1	0	1	0	20
AUG1	19	2	0	-4	1	0	-2	-1	14
AUG2	18	2	-2	1	-2	-2	-2	0	12
SEP	3	-2	1	11	1	3	-2	-1	15

Critical Water Year (1937) Average Generation Differences: ALT2A vs NAA.

	DET	BCL	COU	GRP	FOS	HCR	LOP	DEX	Combined WVS Projects
OCT	17	-2	2	-15	5	6	3	1	17
NOV	12	0	1	-13	-1	3	4	1	7
DEC	0	0	-5	-17	-5	6	3	2	-16
JAN	0	0	1	-8	-3	2	0	0	-8
FEB	0	0	0	-4	-4	-1	-1	0	-10
MAR	-5	-2	0	-29	-6	0	-1	0	-43
APR1	-5	-2	0	-2	5	-2	0	0	-6
APR2	11	2	0	-20	3	1	1	2	0
MAY	1	0	0	-32	5	0	0	0	-26
JUN	48	0	0	-23	2	0	0	0	27
JUL	25	1	0	-4	2	0	1	0	25
AUG1	23	2	-1	-7	1	-3	-6	-2	7
AUG2	22	2	1	-7	-1	-7	-4	-1	5
SEP	6	-2	1	15	4	3	-4	-1	22

73 Year Average Generation (Water Years 1935/36 through 2007/08) Differences: ALT2B vs NAA.

	DET	BCL	COU	GRP	FOS	HCR	LOP	DEX	Combined WVS Projects
OCT	27	-1	-14	-13	9	0	3	1	13
NOV	19	1	-18	-47	2	0	1	1	-41
DEC	-1	0	-16	-43	-4	-1	-2	0	-67
JAN	-1	0	-8	-19	-5	-1	-2	0	-36
FEB	0	0	2	-4	-4	-1	1	0	-6
MAR	-4	-1	-10	-3	-1	0	-2	0	-22
APR1	-5	-2	-17	-3	3	-7	-7	-2	-39
APR2	-1	-1	-19	-15	3	-7	-9	-2	-50
MAY	3	0	-20	-17	3	-1	-4	-1	-39
JUN	29	1	-18	-12	1	4	2	0	8
JUL	21	1	-14	-4	1	2	2	1	9
AUG1	19	2	-15	-4	1	2	1	0	6
AUG2	18	2	-16	1	-2	0	1	0	3
SEP	3	-2	-10	11	1	3	1	0	6

Critical Water Year (1937) Average Generation Differences: ALT2B vs NAA.

	DET	BCL	COU	GRP	FOS	HCR	LOP	DEX	Combined WVS Projects
OCT	17	-2	-14	-15	5	4	-1	0	-6
NOV	12	0	-20	-13	-1	-3	-5	0	-30
DEC	0	0	-9	-17	-5	9	5	3	-14
JAN	0	0	-5	-8	-3	2	0	0	-14
FEB	0	0	-7	-4	-4	-1	-1	0	-17
MAR	-5	-2	-10	-29	-6	-1	-1	0	-54
APR1	-5	-2	-19	-2	5	-2	0	0	-25
APR2	11	2	-23	-20	3	-9	-7	0	-43
MAY	1	0	-24	-32	5	0	0	0	-50
JUN	48	0	-19	-23	2	0	0	0	8
JUL	25	1	-13	-4	2	0	1	0	12
AUG1	23	2	-8	-7	1	0	-2	-1	8
AUG2	22	2	-7	-7	-1	-5	-1	0	3
SEP	6	-2	0	15	4	3	-2	0	24

73 Year Average Generation (Water Years 1935/36 through 2007/08) Differences: ALT3A vs NAA.

	DET	BCL	COU	GRP	FOS	HCR	LOP	DEX	Combined WVS Projects
OCT	-20	-6	-10	-13	8	-11	-31	0	-83
NOV	-53	-4	-13	-47	-1	-15	-49	-2	-182
DEC	-47	-2	-8	-43	-4	-8	-34	-2	-148
JAN	-17	-2	0	-19	-3	-2	-16	-2	-60
FEB	11	4	6	-4	-1	-2	0	3	17
MAR	-28	8	-4	-3	-1	2	-10	8	-28
APR1	-42	5	-10	-3	0	-6	-28	4	-80
APR2	-43	5	-12	-15	0	-14	-34	3	-111
MAY	-60	-13	-14	-17	0	-12	-50	-12	-177
JUN	-24	-11	-12	-12	1	-6	-45	-10	-119
JUL	-15	-2	-9	-4	4	-1	-25	-1	-53
AUG1	-13	-1	-12	-4	3	0	-26	-3	-55
AUG2	-13	-1	-13	1	3	-2	-23	-3	-52
SEP	-30	-5	-8	11	6	-4	-24	-4	-59

Critical Water Year (1937) Average Generation Differences: ALT3A vs NAA.

	DET	BCL	COU	GRP	FOS	HCR	LOP	DEX	Combined WVS Projects
OCT	-15	-7	-8	-15	6	-8	-35	-1	-83
NOV	-35	-10	-18	-13	-1	-19	-40	-8	-144
DEC	-21	-2	-4	-17	-3	-1	-10	0	-58
JAN	-13	1	2	-8	-2	2	-8	0	-26
FEB	-19	0	7	-4	0	0	-13	0	-29
MAR	-28	8	-2	-29	-4	0	-18	8	-65
APR1	-36	5	-11	-2	0	2	-28	7	-63
APR2	-40	5	-15	-20	0	-6	-15	2	-89
MAY	-101	-18	-16	-32	0	-14	-92	-16	-289
JUN	-34	-17	-10	-23	0	-14	-83	-16	-197
JUL	-6	-1	-8	-4	5	-5	-11	-1	-31
AUG1	-4	1	-6	-7	3	-12	-18	-3	-46
AUG2	-7	0	-6	-7	4	-19	-20	-3	-58
SEP	-25	-4	-2	15	8	7	-25	-4	-30

73 Year Average Generation (Water Years 1935/36 through 2007/08) Differences: ALT3B vs NAA.

	DET	BCL	COU	GRP	FOS	HCR	LOP	DEX	Combined WVS Projects
OCT	-3	3	-14	-19	-4	-11	-30	2	-77
NOV	-52	-1	-18	-47	-2	-15	-50	-2	-187
DEC	-47	-2	-16	-41	-3	-7	-39	-3	-159
JAN	-17	-2	-8	-17	-3	-1	-18	-2	-68
FEB	-4	0	2	20	6	8	6	1	38
MAR	-7	-2	-10	-5	9	-6	7	1	-11
APR1	-9	-2	-17	-28	6	-14	4	1	-59
APR2	-22	-1	-19	-25	4	-15	-22	0	-100
MAY	-32	-13	-20	-29	0	-17	-31	-12	-154
JUN	-1	-11	-18	-22	-3	-13	-27	-10	-106
JUL	3	2	-14	-13	0	-10	-14	1	-44
AUG1	6	2	-15	-15	-1	-13	-17	0	-54
AUG2	18	2	-16	-15	-3	-15	-13	0	-43
SEP	17	2	-10	-28	-9	-10	-3	1	-39

Critical Water Year (1937) Average Generation Differences: ALT3B vs NAA.

	DET	BCL	COU	GRP	FOS	HCR	LOP	DEX	Combined WVS Projects
OCT	-2	5	-14	-19	-7	-8	-30	1	-74
NOV	-35	-5	-20	-13	-2	-19	-40	-8	-142
DEC	-21	-2	-9	-17	-4	0	-10	0	-63
JAN	-13	0	-5	-8	0	2	-8	0	-32
FEB	-19	0	-7	-2	0	4	-13	0	-37
MAR	-18	-2	-10	-22	5	1	-6	0	-52
APR1	-12	-3	-19	-62	3	-1	10	2	-82
APR2	-35	-5	-23	-38	8	-9	-25	3	-124
MAY	-60	-18	-24	-56	-1	-23	-53	-16	-251
JUN	0	-17	-19	-42	-7	-23	-56	-16	-180
JUL	6	3	-13	-1	2	-7	-14	1	-23
AUG1	5	2	-8	-4	0	-11	-22	-1	-39
AUG2	21	2	-7	-6	0	-17	-25	-1	-33
SEP	26	3	0	-25	-6	-1	-2	2	-3

73 Year Average Generation (Water Years 1935/36 through 2007/08) Differences: ALT4 vs NAA.

	DET	BCL	COU	GRP	FOS	HCR	LOP	DEX	Combined WVS Projects
OCT	27	-1	2	-14	-3	5	8	2	26
NOV	19	1	2	-13	1	3	6	2	20
DEC	-1	0	-1	-1	0	-2	-3	0	-8
JAN	-1	0	-1	0	-2	-1	-3	0	-7
FEB	0	0	0	0	-3	0	2	1	0
MAR	-3	-1	0	-2	-1	0	-2	0	-11
APR1	-5	-2	-4	-3	3	-6	-7	-2	-25
APR2	-1	-1	-4	-16	3	-6	-9	-2	-37
MAY	3	0	-2	-17	2	-2	-5	-1	-22
JUN	29	1	2	-12	1	5	2	0	27
JUL	21	1	0	-4	1	0	1	0	19
AUG1	19	2	0	-3	1	0	-2	-1	14
AUG2	18	2	-2	1	-2	-2	-2	0	13
SEP	3	-2	1	-9	-7	3	-2	-1	-14

Critical Water Year (1937) Average Generation Differences: ALT4 vs NAA.

	DET	BCL	COU	GRP	FOS	HCR	LOP	DEX	Combined WVS Projects
OCT	17	-2	1	-13	-3	7	2	1	10
NOV	12	0	1	-4	1	3	4	1	18
DEC	0	0	-5	-13	-6	5	-4	2	-21
JAN	0	0	1	-6	-3	2	-5	0	-11
FEB	0	0	0	0	-4	0	-4	0	-8
MAR	-5	-2	0	1	1	0	-1	0	-6
APR1	-5	-2	0	-7	5	-2	-1	0	-12
APR2	11	2	0	-27	3	5	4	2	0
MAY	1	0	0	-36	4	0	0	0	-31
JUN	48	0	0	-29	2	0	0	0	21
JUL	25	1	0	-5	1	0	1	0	23
AUG1	23	2	-2	-7	1	-2	-6	-1	8
AUG2	22	2	1	-7	-1	-9	-5	-1	2
SEP	6	-2	1	-12	-7	3	-6	-1	-18

73 Year Average Generation (Water Years 1935/36 through 2007/08) Differences: NEAR-TERM OPERATIONS MEASURE vs NAA.

	DET	BCL	COU	GRP	FOS	HCR	LOP	DEX	Combined WVS Projects
OCT	26	-1	0	-7	0	7	-32	3	-5
NOV	-19	1	-9	-46	-3	7	-49	1	-119
DEC	-29	0	-8	-43	-4	1	-39	-2	-124
JAN	-28	0	-7	-18	-3	-3	-15	-2	-76
FEB	-16	0	-2	3	-5	0	-1	0	-20
MAR	-7	-1	-3	-16	-5	5	-12	-4	-43
APR1	-14	-2	-9	-18	-3	-7	-34	-9	-95
APR2	-22	-1	-10	-14	-3	-10	-40	-10	-110
MAY	-32	0	-11	3	-3	-7	-33	-6	-88
JUN	-1	1	-7	2	-3	1	-2	0	-9
JUL	1	1	2	8	0	1	-9	1	5
AUG1	3	2	-2	5	-1	0	-23	-1	-16
AUG2	7	2	-4	5	-3	0	-23	-1	-17
SEP	-3	-2	7	8	-5	0	-25	0	-19

Critical Water Year (1937) Average Generation Differences: NEAR-TERM OPERATIONS MEASURE vs NAA.

	DET	BCL	COU	GRP	FOS	HCR	LOP	DEX	Combined WVS Projects
OCT	17	-2	4	-11	-2	15	-35	3	-11
NOV	-15	0	-15	-13	-2	6	-40	-3	-82
DEC	-13	0	-9	-17	-4	7	-10	1	-45
JAN	-8	0	-3	-8	-2	2	-8	0	-27
FEB	-12	0	-3	-3	-4	-5	-13	0	-40
MAR	-12	-2	-2	-17	-8	7	-6	-3	-43
APR1	-5	-2	-10	-44	-8	9	-16	-6	-82
APR2	-24	2	-13	-20	-4	-9	-61	-11	-140
MAY	-57	0	-4	0	-5	-11	-60	-8	-145
JUN	0	0	0	0	-5	-1	-8	0	-14
JUL	2	1	8	12	0	1	-5	1	20
AUG1	3	2	11	9	-1	-5	-25	-2	-8
AUG2	2	2	7	8	-3	-9	-27	-2	-22
SEP	1	-2	14	17	-4	7	-30	1	4

US Army Corps of Engineers®
Portland District

WILLAMETTE VALLEY SYSTEM OPERATIONS AND MAINTENANCE

DRAFT PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT

APPENDIX H: DAM SAFETY

TABLE OF CONTENTS

LIST OF TABLES

EXECUTIVE SUMMARY

This appendix provides a qualitative assessment of the proposed alternatives as they relate to the existing understanding of dam safety risk at each project. There are on-going dam safety risk assessments for each of the WVS dams. At several dams, potential failures modes (PFMs) have been identified that are potentially actionable from a societal risk perspective based on USACEs tolerable risk guidelines (TRGs).

The potential effects due to dam safety are considered for individual dams based on the current understanding of each dam’s risk driving failure modes and any new PFMs due to the construction or implementation of the proposed measures. Several measures will require a dam safety risk assessment and mitigation measures. In accordance with the USACE principle “Do No Harm,” the final implementation of the selected alternative shall have no increase to dam safety risk.

CHAPTER 1 - ENVIRONMENTAL CONSEQUENCES FOR DAM SAFETY

1.1 METHODOLOGY

This section discusses the potential effects to dam safety of the measures within the action alternatives that were analyzed. The discussion includes the methodology and the effects of proposed measures to dam safety.

Although final implementation of the selected alternative shall not increase dam safety risk for any individual dam, the potential effects to dam safety risk can be evaluated on a qualitative scale of potential effects which is directly correlate with the level of dam safety risk assessment and mitigation measures that would be required for implementation.

For the purposes of this assessment, “minor” effects to dam safety are those that over long term may result in erosion, degradation, or aging of equipment due to increased usage. Some measures result in increased usage of outlets and more operational cycles than would normally occur. This may cause increased rates of wear and tear to the project outlets/mechanical electrical operating equipment and structural features such as stilling basins. Mitigation for these effects would typically consist of more frequent dam safety monitoring, inspections, and repairs. Other minor effects to dam safety are measures that have small drawdowns below current winter pool elevations that have the potential to initiate landslides around the reservoir rims. There should be a qualitative landslide assessment prior to implementing any of these operational measures; however, based on the existing landslide assessments that have been conducted to date, the effects to dam safety are generally considered “minor”.

Table 1-1 describes the evaluation criteria for the effect factors (magnitude, duration, and extent), and provides a definition for the scale of each effect factor. Table 1-2 provides a summary of the effects to dam safety for each alternative. These effects are discussed in greater detail in Section 1.1.1.

Table 1-1. Evaluation Criteria for Potential Effects to Dam Safety

Effect Factors and Scale	Definition
None/Negligible	No measurable effects to dam safety.
Minor	Some measures will result in increased operations/usage of ROs/Spillways/Stilling Basins which will result measurable erosion or equipment fatigue over long durations. Minor effects would require a need for more frequent dam safety monitoring, inspection, and repairs.
Moderate	Changes to the resource would be measurable. Changes have the potential to result in increased dam safety risk or operational reliability and would need further assessment prior

Effect Factors and Scale	Definition
	to implementation. Mitigation measures may be necessary to reduce potential adverse effects.
Major	Changes would be readily measurable and would have substantial effects to dam safety. The changes result in increased dam safety risk. Operational or structural measures increase the risk of existing potential failure modes or create new potential failure modes. Mitigation measures would be necessary to reduce potential adverse effects.

Table 1-2. Summary of Effects to Dam Safety Under Each Alternative

Alternative	Short-Term Effects	Medium-Term Effects	Long-Term Effects
NAA	Negligible adverse effects for LOP, HCR, CGR, and BLR	Negligible adverse effects for LOP, HCR, CGR, and BLR	Permanent negligible adverse effects for LOP, HCR, CGR, and BLR
1	Minor adverse effects for FOS	Minor adverse effects for LOP, CGR, DET, GRP, DEX	Permanent minor adverse effects to LOP, HCR, CGR, DET
2a, 2b, and 5	Moderate adverse effects to CGR, FOS, GPR	Minor adverse effects to LOP, DET, GRP	Permanent and/or recurring major adverse effects to LOP, CGR, DET
3a	Moderate adverse effects to LOP, HCR, CGR, BLR, DET, GRP	Minor adverse effects to BLR, HCR, GRP	Permanent and/or recurring major adverse effects to LOP, HCR, CGR, BLR, DET
3b	Moderate adverse effects to LOP, HCR, CGR, BLR, DET, GRP	Minor adverse effects to BLR, HCR, GRP	Permanent and/or recurring major adverse effects to LOP, HCR, CGR, BLR, DET
4	Minor adverse effects to FOS	Minor adverse effects to HCR, LOP, CGR, DET, DEX	Permanent minor adverse effects to LOP, HCR, CGR, DET

In the following subsections, the effects are discussed in greater detail for the No Action Alternative, for the measures analyzed in the action alternatives, and for each of the action alternatives.

1.1.1 Discussion of Dam Safety Effects by Alternative

The effects to dam safety are considered on an individual dam basis in the context of the individual measures. The alternatives are different combinations of measures that may also include different combinations of projects for which the measures are to be implemented.

In general, measures that reduce the quantity and/or duration of stored water (by dipping below minimum power pool or releasing more water) will generally result in increased flood storage and a dam safety risk reduction. Structural measures such as construction of a water temperature control tower or fish collection structures would likely require excavation and construction adjacent to the dam and alteration of the dams' foundations. A qualitative dam safety risk assessment should be performed for any structural measures; this may result in constraints and criteria that would be required to be incorporated into the proposed design or implementation of these measures. In general, the effects to dam safety and changes to the designs are considered to have Moderate impact, but some alternatives may present Major impacts or unacceptable risks to dam safety. For example, Measure 720 to use the diversion tunnel at Cougar Dam has potential for major adverse effects to dam safety. Implementation of that alternative would require further analysis and a quantitative risk assessment.

1.1.2 No Action Alternative

All of the effected WVS dams are currently subject to on-going dam safety risk assessments as discussed in Chapter 2. Several dams have Interim Risk Reduction Measures (IRRMs) in place to reduce dam safety risk while the dam's risk is being further studied. The NAA is not expected to affect any risk driving failure modes or existing IRRMs since NAA does not include proposed operational or structural changes to the dams.

1.1.2.1 Climate Change

Appendix F describes projected climate change trends likely to be experienced in the WVS. Modeled changes applicable to dam safety include decreases to snowpack as more winter precipitation falls as rain instead of snow. Because precipitation is not stored as snow upstream of the reservoirs, fall and winter inflows are likely to increase which could result in more frequent flood risk management operations and demand on the flood risk management storage within the reservoirs. Flood risk contribution from the annual spring snow melt a may be reduced, especially in higher elevation reservoirs that are presently influenced by snowpack, like Cougar, Hills Creek and Blue River Dams. However, flood risk at these projects is still primarily driven by rainfall and rain-on-snow events. Lower elevation basin projects like Fern Ridge and Cottage Grove, with little or no snowpack are projected to experience higher wintertime inflow volumes, but similar peak runoff timing compared to historical baselines. Overall, the effects of climate change to dam safety are expected to be similar across alternatives and have a minor effect of possible increased flood operations during the winter.

1.1.3 Alternative 1 – Improve Fish Passage Through Storage-Focused Measures

Alternative 1 combines measures 105, 174, 304, 718, 723, 392, 52, 639, and 722. Overall, the effects to dam safety for implementation of this alternative are considered to be minor to major depending on the measure and dam. Further details of the effects to dam safety by measure are discussed above in Section 1.1.1.

This alternative includes structural measures 105, 174, and 392. All of the structural modifications have the potential for moderate effects to existing dam safety risk and would require project specific potential failure modes analyses (PFMAs) when more design details are developed. Based on the PFMAs, mitigation measures or alteration of the designs may be required. Construction of temperature towers at Lookout Point, Green Peter and Detroit would involve some amount of foundation excavation and modification of the existing dam structures. There has been very little design of the development of construction details of these structures through the EIS process. The design and modifications to spillways or regulating outlets to reduce TDG at Dexter, Lookout Point, Cougar, Foster, Green Peter, Big Cliff, and Detroit would need to consider impacts to flow capacity/performance and not impact the ability to pass flood flows and safely pass low and moderate flows. Modification of the existing outlets at Foster for temperature control under this alternative would involve modifying the concrete non-overflow monolith section and the spillway. There are potential major adverse effects to dam safety that would need to be addressed in the risk informed design process. Design, construction, and operation of one of these structural improvements would require significant involvement and review from a dam safety perspective. Construction of downstream fish passages at Lookout Point, Foster, Green Peter, and Detroit will likely require significant excavation adjacent to the dams' foundations and modifications to existing structures. Overall, these structural improvements have a moderate to major potential for effects to dam safety that would need to be mitigated through the design, construction, and implementation.

Alternative 1 also includes measures 304 and 718 to drawdown below the power pool and respective rule curves for several dams which has a minor beneficial impact by providing additional flood storage for the winter season. However, there is also the potential for slope stability concerns along the upstream embankment slopes and reservoir rims that would need to be evaluated, although the effects to dam safety are expected to be minor. There is a moderate effect to dam safety for Green Peter (Measure 304) which impacts the dam's primary and backup power sources for operating outlet gates which would require mitigation with an additional backup power source.

Measure 723 to reduce minimum flows to congressionally authorized minimum flow requirements is proposed only for Alternative 1 for the following dams: Fern Ridge, Cottage Grove, Dorena, Lookout Point, Fall Creek, Hills Creek, Cougar, Blue River, Green Peter, and Detroit. This measure will allow the reservoir to capture more spring runoff and increase the probability of refilling to follow the water control diagrams. However, this measure does not include the benefit of higher late spring/early summer outflows as outlined in Measure 30. Therefore, more water will be stored at the projects during the spring/summer. The measure only allows for refilling within the existing operational range in accordance with the respective water control diagrams for each project, so the measure will have a minor effect to dam safety risk.

1.1.4 Alternative 2a– Integrated Water Management Flexibility and ESA-Listed Fish Alternative

Alternative 2a combines measures 105, 166, 721, 30, 304, 718, 40, 392, 714, 52, and 722. Overall, the effects to dam safety for implementation of this alternative are considered to be minor to moderate depending on the measure and dam. Further details of the effects to dam safety by measure are discussed above in Section 1.1.1.

This alternative includes several structural measures 105 and 392. All of the structural modifications have the potential for moderate effects to existing dam safety risk and would require project specific potential failure modes analyses (PFMAs) when more design details are developed. Based on the PFMAs, mitigation measures or additional design considerations may be required. Construction of a temperature tower at Detroit would involve some amount of foundation excavation and modification of the existing dam structures. At this point, there has been minimal development of construction details of these structures. Modification of the existing outlets at Foster for temperature control under this alternative would involve modifying the concrete non-overflow monolith section and the spillway. There are potential major adverse effects to dam safety that would need to be addressed in the risk informed design process. Design, construction, and implementation of one of these structural improvements would require significant review and input from a dam safety perspective. Construction of downstream fish passages at Lookout Point, Cougar, Foster, and Detroit will likely require significant foundation excavation adjacent to the dam and modifications to existing structures. Overall, these structural improvement projects have a moderate to major potential for effects to dam safety that would need to be mitigated through the design, construction, and operation.

Alternative 2a also includes measures 304, 718, and 40 to drawdown below the power pool and respective rule curves for several projects which has a minor benefit of providing additional flood storage for the winter season. There is also the potential for slope stability concerns along the upstream embankment slopes and reservoir rims that would need to be evaluated although the effects to dam safety are expected to be minor. There is a moderate effect to dam safety for Green Peter (Measures 304 and 40) which impacts the dam’s primary and backup power sources for operating outlet gates which would need to be mitigated with an additional backup power source.

1.1.4.1 Evaluation of Near-Term Operations

The Near-Term Operations Measure is summarily described in Chapter 2 and in detail in Appendix A. The potential effects to dam safety for the Near-Term Operations Measure are considered qualitatively for Alternatives 2a, 2b, 3a, 3b, 4, and 5 for the temporal scope of the EIS (30 years).

In general, the near-term operations measure will result in higher usage of some dam components such as ROs, stilling basins, or spillways. Therefore, there are minor effects to dam safety and increased monitoring/surveys. Since the effects are expected to be minor (incremental amounts of erosion or equipment fatigue), the monitoring frequency may be reduced after initial surveys and evaluations of the dams are completed. Additionally, several measures include deep drawdowns and require a slope stability evaluation similar to some of the existing alternative measures.

Table 1-3. Evaluation of Near-Term Operations effects on Dam Safety

Description	Dam Safety Effects
Detroit	
Spring downstream fish passage and operational downstream temperature management	No dam safety impacts expected.
Nighttime RO prioritization for improved downstream fish passage	The LROs at Detroit are rarely used. Historically, the operation of the LROs resulted in severe cavitation damage to the concrete conduit, which had to be repaired. Stilling basin and baffle block damage was also observed due to LRO usage. Therefore, dam safety monitoring for this action will consist of an inspection of the LROs and a hydrosurvey of the stilling basin.
Big Cliff	
Spread spill across spillbays to reduce downstream TDG exceedances	No dam safety impacts expected.
Green Peter	
Outplanting plan for reintroduction of adult Chinook salmon above Green Peter Dam	No dam safety impacts expected.
Utilize spillway for improved downstream fish passage in the spring; perform spill operation until 01 May or for 30 days, whichever is longer	Green Peter's stilling basin has existing areas of erosion primarily attributed to usage of the north RO. Monitoring will consist of a hydrosurvey of the stilling basin following the spring spill operation.
Deep drawdown and RO prioritization for improved downstream fish passage	No dam safety impacts expected.
Foster	
Delay refill and utilize spillway in the spring for improved downstream fish passage; use the fish weir in the summer for improved downstream temperature management and upstream fish migration/passage	No dam safety impacts expected.
Utilize the spillway for improved downstream fish passage in the fall	No dam safety impacts expected.
Cougar	
Deep drawdown and RO prioritization for improved downstream fish passage	The Cougar fall drawdown and spring delayed refill implemented in Fall 2021 required additional visual monitoring and weekly evaluation of dam safety instrumentation data (piezometers, weirs) as well as a set of inclinometer readings during the drawdown.

Description	Dam Safety Effects
	Cougar Dam has a past performance history of differential settlement since original construction and first filling that has increased during previous drawdowns below the minimum conservation pool. However, this measure only requires a drawdown 20 feet below current minimum conservation pool and the dam safety impacts are expected to be minimal. (Note that deeper drawdowns for Cougar Reservoir considered in other measures have potentially major impacts to dam safety.)
Delayed reservoir refill and RO prioritization for improved downstream fish passage	No dam safety impacts expected.
Hills Creek	
Nighttime RO prioritization for improved downstream fish passage	No dam safety impacts expected.
Lookout Point	
Utilize spillway for improved downstream fish passage in the spring; RO use in the fall for downstream temperature management	No dam safety impacts expected.
Deep drawdown and RO prioritization for improved downstream fish passage	For Lookout Point, a landslide assessment of the reservoir rim area was conducted, and recommended monitoring be performed along portions of the reservoir during implementation of this operation. Impacts to dam safety are expected to be minor for this operation.
Fall Creek	
Extended deep drawdown and RO prioritization for improved downstream fish passage	For Fall Creek drawdown in fall FY21, Additional visual monitoring and inspection was performed during the initial deep drawdown. Compared to previous drawdown inspections, additional erosion adjacent to the RO intake training walls was observed. Impacts to dam safety could be moderate if this operation were continued for the next 30 years due to the continued erosion around the RO outlets a major repair may be needed if the operation were continued.
Delayed reservoir refill and RO prioritization for improved downstream fish passage	No dam safety impacts expected.

1.1.5 Alternative 2b – Integrated Water Management Flexibility and ESA-Listed Fish Alternative

Alternative 2b combines measures 105, 166, 721, 30, 304, 718, 40, 392, 714, 720, 52, and 722. Overall, the effects to dam safety for implementation of this alternative are considered to be minor to major depending on the measure and project. Further details of the effects to dam safety by measure are discussed above in Section 1.1.1.

This alternative includes several structural measures 105 and 392. All of the structural modifications have the potential for moderate effects to existing dam safety risk and would require project specific potential failure modes analyses (PFMAs) as more design details are developed. Based on the PFMAs, mitigation measures or additional design considerations may be required. Construction of a temperature tower at Detroit would involve some amount of foundation excavation and modification of the existing dam structures. At this time, there has been minimal development of construction details of these structures. Modification of the existing outlets at Foster for temperature control under this alternative would involve modifying the concrete non-overflow monolith section and the spillway. There are potential major adverse effects to dam safety that would need to be addressed in the risk informed design process. Design, construction, and implementation of one of these structural improvements would require significant review from a dam safety perspective. Construction of downstream fish passages at Lookout Point, Foster, and Detroit will likely require significant foundation excavation adjacent to the dam and modifications to existing structures. Overall, these structural improvement projects have a moderate to major potential for effects to dam safety that would need to be mitigated through the design, construction, and implementation.

Alternative 2b also includes measures 304, 718, and 40 to drawdown below the power pool and respective rule curves for several projects which has a minor beneficial of providing additional flood storage for the winter season. There is also the potential for slope stability concerns along the upstream embankment slopes and reservoir rims that would need to be evaluated although the effects to dam safety are expected to be minor. There is a moderate effect to dam safety for Green Peter (Measures 304 and 40) which impacts the dam’s primary and backup power sources for operating outlet gates which would need to be mitigated with an additional backup power source.

Measures 720 to use the diversion tunnel at Cougar Dam has the potential for major adverse effects to dam safety. Modification of Cougar’s diversion tunnel would require a drawdown to streambed and construction of an upstream tower. There are settlement and other related dam safety concerns for deep drawdowns at Cougar. Implementation of this alternative would require further analysis and a quantitative risk assessment.

1.1.5.1 Evaluation of Near-Term Operations Measures

See Alternative 2A, 1.1.4, for description of effects due to the Near-Term Operations Measure.

1.1.6 Alternative 3a – Operations-Focused Fish Passage Alternative

Alternative 3a combines measures 166, 721, 30, 304, 718, 40, 714, 720, 52, 670, and 722. Overall, the effects to dam safety for implementation of this alternative are considered to be minor to major depending on the measure and project. Further details of the effects to dam safety by measure are discussed above in Section 1.1.1.

Measure 720 to use the diversion tunnel at Cougar Dam would have potential for major adverse effects to dam safety. Modification of Cougar's diversion tunnel would require a drawdown to streambed and construction of an upstream tower. There are settlement and other related dam safety concerns for deep drawdowns at Cougar. Implementation of those alternatives would require further analysis and a quantitative risk assessment.

Measures 721 and 714 under this alternative also includes modifying existing spillway structures at Hills Creek and Blue River and measure 40 includes modifying the lower ROs at Detroit. Hills Creek would need to be modified to accommodate flows passing through the spillway and the associated flip bucket. Spillway flows have been identified as having the potential for flooding of the powerhouse. Additionally, an existing rock gully that extends from the end of the left spillway training wall has been identified as a knickpoint for erosion and would need to be evaluated further. Blue River has an unlined spillway downstream of the apron and mitigation for erosion concerns would need to be considered. Additionally, there are concerns for the existing vegetation downstream of the spillway that would need to be considered. Re-lining of Detroit lower ROs will have a minor direct beneficial effect on dam safety. For both Hills Creek and Blue River there are potentially moderate adverse effects to dam safety which would require PFMAs and possible mitigation measures or changes to the designs.

Measure 720 under this alternative also includes a drawdown to the ROs at Lookout Point and Detroit. A spring reservoir drawdown would reduce the amount of water stored behind the dams in the summer which has a minor beneficial effect to dam safety risk. However, there is also the potential for slope stability concerns along the upstream embankment slopes and reservoir rims that would need to be evaluated although the effects are expected to be minor.

This alternative includes measures 304, 718, and 40 to drawdown below the power pool and respective rule curves for several projects which has a minor beneficial of providing additional flood storage for the winter season. There is also the potential for slope stability concerns along the upstream embankment slopes and reservoir rims that would need to be evaluated although the effects to dam safety are expected to be minor. There is a moderate effect to dam safety for Green Peter (Measures 304 and 40) which impacts the dam's primary and backup power sources for operating outlet gates which would need to be mitigated with an additional backup power source.

Alternative 3a includes measures 721 and 714 which include using the spillways at Hills Creek and Fall Creek which are typically only for emergency flood risk management use and would require some additional modifications and increased monitoring; therefore, the effects to dam safety are considered moderate for these projects. For Hills Creek, there would need to be significant modifications to the existing spillway structures to accommodate flows passing through the spillway and the associated flip bucket. Spillway flows have been identified as having the potential for flooding of the powerhouse. Additionally, an existing rock gully extends from the end of the left spillway training wall has been identified as a potential area for erosion and would need to be evaluated. Fall Creek spillways would need some plunge pool and spillway channel modifications.

1.1.6.1 Evaluation of Near-Term Operations Measures

See Alternative 2A, Section 1.1.4, for description of effects due to the Near-Term Operations Measure.

1.1.7 Alternative 3b – Operations-Focused Fish Passage Alternative (using diversion tunnel at COU)

Alternative 3b combines measures 166, 721, 30, 304, 718, 40, 714, 720, 52, 670, and 722. Overall, the effects to dam safety for implementation of this alternative are considered to be minor to major depending on the measure and project. Further details of the effects to dam safety by measure are discussed above in Section 1.1.1.

Measures 720 to use the diversion tunnel at Cougar Dam would have potential for major adverse effects to dam safety. Modification of Cougar's diversion tunnel would require a drawdown to streambed and construction of an upstream tower. There are settlement and other related dam safety concerns for deep drawdowns at Cougar. Implementation of this alternative would require further analysis and a quantitative risk assessment.

Measures 721 and 714 under this alternative also includes modifying existing spillway structures at Hills Creek and Blue River and measure 40 includes modifying the lower ROs at Detroit. Hills Creek would need to be modified to accommodate flows passing through the spillway and the associated flip bucket. Spillway flows have been identified as having the potential for flooding of the powerhouse. Additionally, an existing rock gully that extends from the end of the left spillway training wall has been identified as a knickpoint for erosion and would need to be evaluated further. Blue River has an unlined spillway downstream of the apron and mitigation for erosion concerns would need to be considered. Additionally, there are some concerns for vegetation downstream of the spillway that would need to be considered. Re-lining of Detroit lower ROs will have a minor direct beneficial effect on dam safety. For both Hills Creek and Blue River there are potentially moderate adverse effects to dam safety which would require PFMAs and possible mitigation measures or additional considerations to the designs.

Measure 720 under this alternative also includes a drawdown to the ROs at Hills Creek and Green Peter. A spring reservoir drawdown would reduce the amount of water stored behind the dams in the summer which has a minor beneficial effect to dam safety risk. However, there is also the potential for slope stability concerns along the upstream embankment slopes and reservoir rims that would need to be evaluated although the effects are expected to be minor. There is a moderate effect to dam safety for Green Peter (Measure 304) which impacts the dam's primary and backup power sources for operating outlet gates which would need to be mitigated with an additional backup power source.

This alternative includes measures 304, 718, and 40 to drawdown below the power pool and respective rule curves for several projects which has a minor beneficial of providing additional flood storage for the winter season. There is also the potential for slope stability concerns along the upstream embankment slopes and reservoir rims that would need to be evaluated although the effects to dam safety are expected to be minor. There is a moderate effect to dam safety for Green Peter (Measures 304 and 40) which impacts the dam's primary and backup power sources for operating outlet gates which would need to be mitigated with an additional backup power source.

Alternative 3b includes measures 721 which includes using the spillway at Hills Creek which is typically only for emergency flood risk management use and would require some additional modifications and monitoring; therefore, the effects to dam safety are considered moderate for these projects. There would need to be significant modifications to the existing spillway structures to accommodate flows passing through the spillway and the associated flip bucket. Spillway flows have been identified as having the potential for flooding of the powerhouse. Additionally, an existing rock gully extends from the end of the left spillway training wall has been identified as a potentially area for erosion and would need to be evaluated further.

1.1.7.1 Evaluation of Near-Term Operations Measures

See Alternative 2A Section 1.1.4, for description of effects due to the Near-Term Operations Measure.

1.1.8 Alternative 4 – Structures-Based Fish Passage Alternative

Alternative 4 combines measures 105, 166, 174, 721, 30, 304, 718, 392, 52, 639, and 722. Overall, the effects to dam safety for implementation of this alternative are considered to be minor to major depending on the measure and project. Further details of the effects to dam safety by measure are discussed above in Section 1.1.1.

This alternative includes some structural measures: construction of a temperature control tower at Lookout Point, Hills Creek, and Detroit; construction of downstream fish passages at Lookout Point, Hills Creek, Cougar, Foster, and Detroit; structural improvements for TRG; and modification of existing outlets. These structural modifications have the potential for moderate effects to existing dam safety risk and would require project specific potential failure modes analyses (PFMAs) when more design details are developed. Based on the PFMAs, mitigation measures or alteration of the designs may be required.

Alternative 4 also includes measures 304 and 718 to drawdown below the power pool and respective rule curves for several projects which has a minor beneficial of providing additional flood storage for the winter season. There is also the potential for slope stability concerns along the upstream embankment slopes and reservoir rims that would need to be evaluated although the effects to dam safety are expected to be minor. There is a moderate effect to dam safety for Green Peter (Measure 304) which impacts the dam's primary and backup power sources for operating outlet gates which would need to be mitigated with an additional backup power source.

Alternative 3b includes measures 721 which includes using the spillway at Hills Creek which is typically only for emergency flood risk management use and would require some additional modifications and monitoring; therefore, the effects to dam safety are considered moderate for these projects. There would need to be significant modifications to the existing spillway structures to accommodate flows passing through the spillway and the associated flip bucket. Spillway flows have been identified as having the potential for flooding the powerhouse. Additionally, an existing rock gully extends from the end of the left spillway training wall has been identified as a potentially area for erosion and would need to be evaluated further.

1.1.9 Alternative 5 – Refined Hybrid Integrated Water Management Flexibility and ESA-Listed Fish Alternative

Alternative 5 combines measures 105, 166, 721, 30, 304, 718, 40, 392, 714, 52, and 722. Alternative 5 is exactly the same as Alternative 2b except that the integrated temperature and habitat flow regime (Measure 30a) has been replaced by the refined integrated temperature and habitat flow regime (Measure 30b). Overall, the effects to dam safety for implementation of this alternative are considered to be minor to moderate depending on the measure and dam and are identical to those described for Alternative 2b, Section 1.1.5.

1.1.9.1 Evaluation of Near-Term Operations Measures

See Alternative 2A, 1.1.4, for description of effects due to the Near-Term Operations Measure.

CHAPTER 2 - CUMMULATIVE EFFECTS FOR DAM SAFETY

USACE performs risk assessments as part of an ongoing dam safety program and to assist in the prioritization of investment for aging infrastructure. The risk assessments evaluate the life safety risks associated with the dams to determine if risk reduction actions are needed and, if so, what actions should be taken. The assessments consider a wide range of hazard scenarios from the most likely to the most extreme and unlikely. USACE is conducting advanced risk assessments, called Issue Evaluation Studies (IESs) on several Willamette Valley dams. As of the writing of this report in Spring 2022, there are currently five ongoing IESs at the following projects: Foster, Blue River, Cougar, Lookout Point, and Hills Creek. For Detroit, Fall Creek, and Fern Ridge, some initial risk assessment and screening of structural failure modes has been assessed and advanced risk assessments (IESs) are pending.

Preliminary results for Lookout Point, Hills Creek, and Detroit identified unacceptable risk for seismic failure modes resulting in the implementation of interim risk reduction measures (IRRMs). According to the studies, an earthquake could cause the spillway gates and the concrete supports on either side to become damaged. In additional to the spillway gates and piers, the rockfill embankment at Hills Creek has the potential for settlement during an earthquake event. If this occurs when the reservoir is at its highest, the damaged gates/embankment may no longer be able to hold back the water, allowing a high volume of outflows that could cause flooding of areas downstream.

Interim risk reduction measures (IRRMs) were implemented in Spring 2020 at Lookout Point and Hills Creek and Spring 2021 at Detroit to reduce life-safety risk while issues are studied further. These measures include reducing the maximum conservation pool (summer refill target) by 5 feet at Lookout Point and Detroit and 10 feet at Hills Creek. IRRMs are typically in-place for 3 years; however, the timelines of the advanced studies may exceed 3 years requiring the summer pool restrictions to remain in place for longer timelines. The pool restrictions do not have an effect on any of the proposed or implemented operational measures beyond the existing effect of the NAA.

At this time, pool restrictions have not been determined beneficial for the remaining Willamette Valley Dams. Both Foster Dam and Lookout Point Dam have risk that significantly exceeds USACE tolerable risk guidelines (TRGs) and are in a queue for dam safety modification studies (DSMS). The first DSMS for Foster Dam is scheduled to initiate in FY24. Further analysis of the remaining Willamette Valley dams will determine if they need a DSMS. Dam modifications to reduce risk will vary by project and will consider a range of alternatives including permanent pool restrictions, rebuilding spillways, or even dam removal.

US Army Corps of Engineers®
Portland District

WILLAMETTE VALLEY SYSTEM OPERATIONS AND MAINTENANCE

DRAFT PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT

APPENDIX I: SOCIOECONOMICS

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER 1 - SOCIOECONOMICS

1.1 INTRODUCTION

This appendix presents an estimate of the socioeconomic impacts of construction spending on proposed projects for the Willamette Valley System Operations and Maintenance Draft Programmatic Environmental Impact Statement.

The U.S. Army Corps of Engineers (USACE) Institute for Water Resources, Louis Berger, and Michigan State University have developed a regional economic impact modeling tool, RECONS (Regional ECONomic System), that provides estimates of jobs and other economic measures such as labor income, value added, and sales that are supported by USACE programs, projects, and activities. This modeling tool automates calculations and generates estimates of jobs, labor income, value added, and sales through the use of IMPLAN®'s multipliers and ratios, customized impact areas for USACE project locations, and customized spending profiles for USACE projects, business lines, and work activities. RECONS allows the USACE to evaluate the regional economic impact and contribution associated with USACE expenditures, activities, and infrastructure.

RECONS output tables are presented by alternative, with project construction effects aggregated to the river in which they are located. For example, Green Peter and Foster reservoirs are located along the South Fork Santiam River. Therefore, results for these two reservoirs are presented together.

Adding other socioeconomic environmental effects presented in Chapter 3.11, such as demographic tables, to this appendix would be redundant as they present the information in the chapter the same way it would be presented in the appendix. The RECONS data is summarized in Chapter 3.11 with more specific tables presented in this appendix.

1.2 REGIONIAL EFFECTS OF PROPOSED CONSTRUCTION SPENDING SUMMARY DATA

Table 1-1. Alternatives Comparison – Construction Spending Value Added

Alternatives Comparison - Value Added									
	Local Impacts			State Impacts			US Impacts		
	Direct	Secondary	Total	Direct	Secondary	Total	Direct	Secondary	Total
Alt 1	$674,382	$823,367	$1,497,749	$763,254	$1,099,978	$1,863,232	$782,868	$1,963,692	$2,746,560
Alt 2A	$500,734	$549,682	$1,050,417	$559,128	$753,164	$1,312,291	$572,380	$1,342,681	$1,915,061
Alt 2B	$543,452	$503,334	$1,046,786	$596,658	$688,005	$1,284,663	$607,810	$1,221,736	$1,829,546
Alt3A	$175,165	$171,905	$347,070	$193,022	$220,122	$413,144	$196,446	$390,911	$587,356
Alt 3B	$233,661	$230,668	$464,329	$257,265	$293,255	$550,520	$261,813	$520,782	$782,596
Alt 4	$556,303	$517,853	$1,074,156	$610,459	$703,600	$1,314,058	$621,836	$1,249,422	$1,871,258

Values shown in $1,000s

Table 1-2. Alternatives Comparison – Construction Spending Labor Income

Alternatives Comparison - Labor Income									
	Local Impacts			State Impacts			US Impacts		
	Direct	Secondary	Total	Direct	Secondary	Total	Direct	Secondary	Total
Alt 1	$1,194,700	$482,900	$1,677,600	$1,287,200	$656,100	$1,943,300	$1,307,600	$1,136,100	$2,443,700
Alt 2A	$857,900	$320,800	$1,178,700	$903,800	$448,300	$1,352,100	$917,700	$776,100	$1,693,700
Alt 2B	$830,600	$291,800	$1,122,500	$873,500	$407,300	$1,280,800	$886,900	$704,300	$1,591,300
Alt3A	$255,000	$100,600	$355,500	$278,900	$130,300	$409,200	$283,700	$225,400	$509,000
Alt 3B	$339,600	$134,900	$474,600	$371,600	$173,600	$545,200	$378,000	$300,200	$678,200
Alt 4	$848,900	$300,300	$1,149,200	$893,400	$416,600	$1,309,900	$907,100	$720,300	$1,627,400

Values shown in $1,000s

Table 1-3. Alternatives Comparison – Construction Spending Jobs Supported

Alternatives Comparison - Jobs Supported									
	Local Impacts			State Impacts			US Impacts		
	Direct	Secondary	Total	Direct	Secondary	Total	Direct	Secondary	Total
Alt 1	16.9	8.9	25.9	17.4	10.8	28.2	17.4	17.0	34.4
Alt 2A	11.8	6.0	17.8	12.4	7.4	19.8	12.5	11.6	24.1
Alt 2B	12.4	5.4	17.8	12.9	6.7	19.6	13.0	10.5	23.5
Alt3A	3.7	1.8	5.5	4.1	2.1	6.2	4.2	3.4	7.5
Alt 3B	4.9	2.5	7.4	5.4	2.8	8.3	5.6	4.5	10.0
Alt 4	12.6	5.6	18.2	13.2	6.8	20.0	13.3	10.7	24.0

Values shown in $1,000s

Table 1-4. Alternatives Comparison – Construction Spending Output

Alternatives Comparison - Output									
	Local Impacts			State Impacts			US Impacts		
	Direct	Secondary	Total	Direct	Secondary	Total	Direct	Secondary	Total
Alt 1	$1,503,900	$1,440,800	$2,944,700	$1,556,900	$1,932,600	$3,489,600	$1,557,000	$3,657,000	$5,214,000
Alt 2A	$1,046,000	$969,000	$2,015,000	$1,083,400	$1,322,000	$2,405,500	$1,083,600	$2,498,500	$3,582,100
Alt 2B	$998,000	$885,600	$1,883,500	$1,033,800	$1,204,500	$2,238,300	$1,034,300	$2,268,400	$3,302,700
Alt3A	$319,800	$297,400	$617,200	$330,700	$385,400	$716,100	$330,900	$725,800	$1,056,700
Alt 3B	$426,000	$398,700	$824,700	$440,600	$513,400	$954,100	$440,900	$966,900	$1,407,800
Alt 4	$1,020,600	$910,100	$1,930,700	$1,057,200	$1,231,800	$2,289,000	$1,057,700	$2,319,800	$3,377,500

Values shown in $1,000s

Table 1-5. Alternatives Comparison – Local Capture

Alternatives Comparison - Local Capture			
	Local	State	US
Alt 1	$1,503,900	$1,556,900	$1,557,000
Alt 2A	$1,046,000	$1,083,400	$1,083,600
Alt 2B	$998,000	$1,033,800	$1,034,300
Alt3A	$319,800	$330,700	$330,900
Alt 3B	$426,000	$440,600	$440,900
Alt 4	$1,020,600	$1,057,200	$1,057,700

Values shown in $1,000s

1.3 ALTERNATIVE 1 - REGIONIAL EFFECTS OF PROPOSED CONSTRUCTION SPENDING

Alt 1 - South Santiam River Sub-Basin Projects

Table 1-6. Alt 1 South Santiam River Local Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				
56	Construction of other new nonresidential structures	$53,741,399	650.9	$42,320,411	$20,536,651
463	Environmental and other technical consulting services	$485,203	5.4	$315,565	$286,994
470	Office administrative services	$1,874,700	30.4	$1,496,165	$541,562
544	* Employment and payroll of federal govt, non-military	$4,218,075	18.3	$2,888,259	$4,218,075
	Direct Impact	**$60,319,377**	**704.9**	**$47,020,399**	**$25,583,282**
	Secondary Impact	**$46,071,545**	**291.0**	**$14,892,521**	**$25,167,335**
	Total Impact	**$106,390,923**	**995.9**	**$61,912,920**	**$50,750,618**

* Jobs are presented in full-time equivalence (FTE)

Table 1-7. Alt 1 South Santiam River State Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				
56	Construction of other new nonresidential structures	$53,741,400	650.9	$45,113,873	$23,615,884
463	Environmental and other technical consulting services	$620,953	6.9	$449,450	$405,063
470	Office administrative services	$2,499,600	40.5	$2,000,173	$962,307
544	* Employment and payroll of federal govt, non-military	$5,624,100	26.7	$3,851,012	$5,624,100
	Direct Impact	**$62,486,053**	**724.9**	**$51,414,509**	**$30,607,353**
	Secondary Impact	**$77,560,711**	**432.4**	**$26,330,282**	**$44,146,332**
	Total Impact	**$140,046,764**	**1157.3**	**$77,744,790**	**$74,753,685**

* Jobs are presented in full-time equivalence (FTE)

Table 1-8. Alt 1 South Santiam River U.S. Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				
56	Construction of other new nonresidential structures	$53,741,400	650.9	$45,113,873	$24,226,798
463	Environmental and other technical consulting services	$624,241	6.9	$488,676	$432,927
470	Office administrative services	$2,499,600	40.5	$2,661,075	$1,135,679
544	* Employment and payroll of federal govt, non-military	$5,624,100	26.7	$4,030,118	$5,624,100
	Direct Impact	**$62,489,341**	**724.9**	**$52,293,742**	**$31,419,505**
	Secondary Impact	**$146,768,893**	**682.8**	**$45,595,547**	**$78,810,521**
	Total Impact	**$209,258,233**	**1407.7**	**$97,889,290**	**$110,230,026**

* Jobs are presented in full-time equivalence (FTE)

Alt 1 - North Santiam River Sub-Basin Projects

Table 1-9. Alt 1 North Santiam River Local Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				
56	Construction of other new nonresidential structures	$609,181,000	7002.9	$516,004,448	$251,914,647
463	Environmental and other technical consulting services	$5,132,533	50.3	$3,636,137	$3,277,648
470	Office administrative services	$21,250,500	315.1	$18,154,881	$7,425,629
544	* Employment and payroll of federal govt, non-military	$47,813,625	251.6	$32,739,611	$47,813,625
	Direct Impact	**$683,377,658**	**7619.8**	**$570,535,076**	**$310,431,549**
	Secondary Impact	**$638,090,131**	**3917.9**	**$209,346,244**	**$359,531,377**
	Total Impact	**$1,321,467,789**	**11537.7**	**$779,881,320**	**$669,962,926**

* Jobs are presented in full-time equivalence (FTE)

Table 1-10. Alt 1 North Santiam River State Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				
56	Construction of other new nonresidential structures	$609,181,000	7002.9	$516,004,448	$267,695,809
463	Environmental and other technical consulting services	$7,038,761	69.0	$5,094,703	$4,591,555
470	Office administrative services	$28,334,000	420.1	$24,206,507	$10,908,143
544	* Employment and payroll of federal govt, non-military	$63,751,500	335.4	$43,652,815	$63,751,500
	Direct Impact	**$708,305,261**	**7827.4**	**$588,958,474**	**$346,947,007**
	Secondary Impact	**$879,182,741**	**4901.3**	**$298,464,634**	**$500,416,936**
	Total Impact	**$1,587,488,002**	**12728.8**	**$887,423,108**	**$847,363,943**

* Jobs are presented in full-time equivalence (FTE)

Table 1-11. Alt 1 North Santiam River U.S. Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				
56	Construction of other new nonresidential structures	$609,181,000	7002.9	$516,004,448	$274,620,782
463	Environmental and other technical consulting services	$7,076,024	69.4	$5,539,343	$4,907,403
470	Office administrative services	$28,334,000	420.1	$30,164,384	$12,873,395
544	* Employment and payroll of federal govt, non-military	$63,751,500	335.4	$45,683,060	$63,751,501
	Direct Impact	**$708,342,524**	**7827.8**	**$597,391,235**	**$356,153,081**
	Secondary Impact	**$1,663,686,111**	**7739.8**	**$516,844,390**	**$893,349,856**
	Total Impact	**$2,372,028,636**	**15567.5**	**$1,114,235,625**	**$1,249,502,938**

* Jobs are presented in full-time equivalence (FTE)

Alt 1 – Middle Fork Willamette River Sub-Basin Projects

Table 1-12.Alt 1 Middle Fork Willamette River Local Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				
56	Construction of other new nonresidential structures	$658,330,000	7722.7	$503,897,418	$264,337,737
463	Environmental and other technical consulting services	$7,218,758	83.2	$4,458,065	$4,153,558
470	Office administrative services	$22,965,000	311.6	$18,189,593	$9,295,404
544	* Employment and payroll of federal govt, non-military	$51,671,250	262.8	$35,381,057	$51,671,249
	Direct Impact	**$740,185,008**	**8380.2**	**$561,926,134**	**$329,457,947**
	Secondary Impact	**$736,738,943**	**4588.6**	**$251,866,290**	**$427,118,446**
	Total Impact	**$1,476,923,951**	**12968.8**	**$813,792,423**	**$756,576,393**

* Jobs are presented in full-time equivalence (FTE)

Table 1-13. Alt 1 Middle Fork Willamette River State Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				
56	Construction of other new nonresidential structures	$658,330,000	7722.7	$552,643,141	$289,293,628
463	Environmental and other technical consulting services	$7,606,651	87.6	$5,505,746	$4,962,004
470	Office administrative services	$30,620,000	429.2	$24,502,043	$12,393,872
544	* Employment and payroll of federal govt, non-military	$68,895,000	350.4	$47,174,744	$68,895,000
	Direct Impact	**$765,451,651**	**8590.0**	**$629,825,674**	**$375,544,504**
	Secondary Impact	**$950,189,035**	**5301.1**	**$322,544,896**	**$540,790,801**
	Total Impact	**$1,715,640,686**	**13891.1**	**$952,370,570**	**$916,335,306**

* Jobs are presented in full-time equivalence (FTE)

Table 1-14. Alt 1 Middle Fork Willamette River U.S. Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				
56	Construction of other new nonresidential structures	$658,330,000	7722.7	$552,643,141	$296,777,311
463	Environmental and other technical consulting services	$7,646,921	88.1	$5,986,260	$5,303,335
470	Office administrative services	$30,620,000	429.2	$32,598,060	$13,912,026
544	* Employment and payroll of federal govt, non-military	$68,895,000	350.4	$49,368,790	$68,895,001
	Direct Impact	**$765,491,921**	**8590.4**	**$640,596,251**	**$384,887,674**
	Secondary Impact	**$1,797,913,063**	**8365.4**	**$558,543,630**	**$965,425,729**
	Total Impact	**$2,563,404,984**	**16955.9**	**$1,199,139,881**	**$1,350,313,403**

* Jobs are presented in full-time equivalence (FTE)

Alt 1 – McKenzie River Sub-Basin Projects

Table 1-15. Alt 1 McKenzie River Local Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				
56	Construction of other new nonresidential structures	$17,802,000	208.8	$13,625,965	$7,147,996
463	Environmental and other technical consulting services	$195,204	2.3	$120,551	$112,317
470	Office administrative services	$621,000	8.4	$491,868	$251,358
544	* Employment and payroll of federal govt, non-military	$1,397,250	7.1	$956,744	$1,397,250
	Direct Impact	**$20,015,454**	**226.6**	**$15,195,129**	**$8,908,922**
	Secondary Impact	**$19,922,268**	**124.1**	**$6,810,754**	**$11,549,774**
	Total Impact	**$39,937,721**	**350.7**	**$22,005,883**	**$20,458,695**

* Jobs are presented in full-time equivalence (FTE)

Table 1-16.Alt 1 McKenzie River State Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				
56	Construction of other new nonresidential structures	$17,802,000	208.8	$14,944,106	$7,822,832
463	Environmental and other technical consulting services	$205,693	2.4	$148,882	$134,178
470	Office administrative services	$828,000	11.6	$662,563	$335,145
544	* Employment and payroll of federal govt, non-military	$1,863,000	9.5	$1,275,659	$1,863,000
	Direct Impact	**$20,698,693**	**232.3**	**$17,031,210**	**$10,155,155**
	Secondary Impact	**$25,694,204**	**143.4**	**$8,721,985**	**$14,623,605**
	Total Impact	**$46,392,896**	**375.6**	**$25,753,195**	**$24,778,760**

* Jobs are presented in full-time equivalence (FTE)

Table 1-17. Alt 1 McKenzie River U.S. Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				
56	Construction of other new nonresidential structures	$17,802,000	208.8	$14,944,106	$8,025,200
463	Environmental and other technical consulting services	$206,782	2.4	$161,875	$143,408
470	Office administrative services	$828,000	11.6	$881,489	$376,197
544	* Employment and payroll of federal govt, non-military	$1,863,000	9.5	$1,334,989	$1,863,000
	Direct Impact	$20,699,782	232.3	$17,322,459	$10,407,805
	Secondary Impact	$48,617,636	226.2	$15,103,662	$26,106,222
	Total Impact	$69,317,418	458.5	$32,426,121	$36,514,027

* Jobs are presented in full-time equivalence (FTE)

1.4 ALTERNATIVE 2A - REGIONIAL EFFECTS OF PROPOSED CONSTRUCTION SPENDING

Alt 2A - South Santiam River Sub-Basin Projects

Table 1-18.Alt 2A South Santiam River Local Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				
56	Construction of other new nonresidential structures	$69,012,419	835.8	$54,346,071	$26,372,294
463	Environmental and other technical consulting services	$623,077	6.9	$405,235	$368,545
470	Office administrative services	$2,407,410	39.0	$1,921,311	$695,451
544	* Employment and payroll of federal govt, non-military	$5,416,672	23.5	$3,708,979	$5,416,672
	Direct Impact	**$77,459,579**	**905.2**	**$60,381,597**	**$32,852,963**

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Secondary Impact	**$59,163,119**	**373.7**	**$19,124,342**	**$32,318,822**
	Total Impact	**$136,622,697**	**1278.9**	**$79,505,939**	**$65,171,785**

* Jobs are presented in full-time equivalence (FTE)

Table 1-19. Alt 2A South Santiam River State Impacts

Table 8 - State Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				
56	Construction of other new nonresidential structures	$69,012,420	835.8	$57,933,317	$30,326,513
463	Environmental and other technical consulting services	$797,402	8.8	$577,165	$520,165
470	Office administrative services	$3,209,880	52.0	$2,568,537	$1,235,753
544	* Employment and payroll of federal govt, non-military	$7,222,230	34.2	$4,945,306	$7,222,230
	Direct Impact	**$80,241,932**	**930.9**	**$66,024,325**	**$39,304,661**
	Secondary Impact	**$99,600,166**	**555.3**	**$33,812,228**	**$56,690,842**
	Total Impact	**$179,842,097**	**1486.1**	**$99,836,553**	**$95,995,503**

* Jobs are presented in full-time equivalence (FTE)

Table 1-20. Alt 2A South Santiam River U.S. Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				
56	Construction of other new nonresidential structures	$69,012,420	835.8	$57,933,317	$31,111,024
463	Environmental and other technical consulting services	$801,623	8.9	$627,537	$555,946
470	Office administrative services	$3,209,880	52.0	$3,417,239	$1,458,391
544	* Employment and payroll of federal govt, non-military	$7,222,230	34.2	$5,175,307	$7,222,230
	Direct Impact	**$80,246,153**	**930.9**	**$67,153,400**	**$40,347,591**
	Secondary Impact	**$188,474,369**	**876.8**	**$58,551,862**	**$101,205,119**
	Total Impact	**$268,720,522**	**1807.7**	**$125,705,262**	**$141,552,710**

* Jobs are presented in full-time equivalence (FTE)

Alt 2A - North Santiam River Sub-Basin Projects

Table 1-21. Alt 2A North Santiam River Local Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				
56	Construction of other new nonresidential structures	$604,881,000	6953.4	$512,362,149	$250,136,468
463	Environmental and other technical consulting services	$5,096,304	50.0	$3,610,471	$3,254,512
470	Office administrative services	$21,100,500	312.9	$18,026,732	$7,373,214
544	* Employment and payroll of federal govt, non-military	$47,476,125	249.8	$32,508,513	$47,476,125
	Direct Impact	**$678,553,929**	**7566.1**	**$566,507,864**	**$308,240,319**
	Secondary Impact	**$633,586,072**	**3890.2**	**$207,868,541**	**$356,993,568**
	Total Impact	**$1,312,140,001**	**11456.3**	**$774,376,405**	**$665,233,887**

* Jobs are presented in full-time equivalence (FTE)

Table 1-22. Alt 2A North Santiam River State Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				
56	Construction of other new nonresidential structures	$604,881,000	6953.4	$512,362,149	$265,806,236
463	Environmental and other technical consulting services	$6,989,077	68.5	$5,058,742	$4,559,145
470	Office administrative services	$28,134,000	417.2	$24,035,642	$10,831,146
544	* Employment and payroll of federal govt, non-military	$63,301,500	333.1	$43,344,685	$63,301,500
	Direct Impact	**$703,305,577**	**7772.2**	**$584,801,218**	**$344,498,027**
	Secondary Impact	**$872,976,891**	**4866.7**	**$296,357,874**	**$496,884,664**
	Total Impact	**$1,576,282,468**	**12638.9**	**$881,159,092**	**$841,382,691**

* Jobs are presented in full-time equivalence (FTE)

Table 1-23. Alt 2A North Santiam River U.S. Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				
56	Construction of other new nonresidential structures	$604,881,000	6953.4	$512,362,149	$272,682,328
463	Environmental and other technical consulting services	$7,026,077	68.9	$5,500,243	$4,872,764
470	Office administrative services	$28,134,000	417.2	$29,951,464	$12,782,526
544	* Employment and payroll of federal govt, non-military	$63,301,500	333.1	$45,360,599	$63,301,501
	Direct Impact	**$703,342,577**	**7772.5**	**$593,174,455**	**$353,639,119**
	Secondary Impact	**$1,651,942,721**	**7685.1**	**$513,196,162**	**$887,044,006**
	Total Impact	**$2,355,285,298**	**15457.7**	**$1,106,370,617**	**$1,240,683,124**

* Jobs are presented in full-time equivalence (FTE)

Alt 2A – Middle Fork Willamette River Sub-Basin Projects

Table 1-24. Alt 2A Middle Fork Willamette River Local Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				
19	Support activities for agriculture and forestry	$26,237,170	323.4	$24,626,069	$23,307,982
56	Construction of other new nonresidential structures	$81,575,000	956.9	$62,438,947	$32,754,623
463	Environmental and other technical consulting services	$1,183,480	13.6	$730,878	$680,956
470	Office administrative services	$3,765,000	51.1	$2,982,095	$1,523,936
544	* Employment and payroll of federal govt, non-military	$8,471,250	43.1	$5,800,552	$8,471,250
	Direct Impact	**$121,231,900**	**1388.1**	**$96,578,541**	**$66,738,746**
	Secondary Impact	**$115,487,063**	**711.9**	**$39,228,488**	**$67,043,371**
	Total Impact	**$236,718,963**	**2100.0**	**$135,807,029**	**$133,782,118**

Table 1-25. Alt 2A Middle Fork Willamette River State Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				
19	Support activities for agriculture and forestry	$26,237,170	446.8	$24,626,069	$23,307,982
56	Construction of other new nonresidential structures	$81,575,000	956.9	$68,479,128	$35,846,958
463	Environmental and other technical consulting services	$1,247,073	14.4	$902,640	$813,496
470	Office administrative services	$5,020,000	70.4	$4,016,991	$2,031,915
544	* Employment and payroll of federal govt, non-military	$11,295,000	57.5	$7,734,070	$11,295,000
	Direct Impact	**$125,374,243**	**1546.0**	**$105,758,897**	**$73,295,351**
	Secondary Impact	**$146,081,690**	**810.7**	**$49,399,999**	**$83,438,772**

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Total Impact	**$271,455,933**	**2356.7**	**$155,158,896**	**$156,734,123**

Table 1-26. Alt 2A Middle Fork Willamette River U.S. Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				
19	Support activities for agriculture and forestry	$26,294,139	483.1	$24,679,540	$23,358,591
56	Construction of other new nonresidential structures	$81,575,000	956.9	$68,479,128	$36,774,276
463	Environmental and other technical consulting services	$1,253,676	14.4	$981,418	$869,456
470	Office administrative services	$5,020,000	70.4	$5,344,293	$2,280,809
544	* Employment and payroll of federal govt, non-military	$11,295,000	57.5	$8,093,773	$11,295,000
	Direct Impact	**$125,437,815**	**1582.3**	**$107,578,152**	**$74,578,132**
	Secondary Impact	**$275,113,731**	**1272.3**	**$85,422,259**	**$148,171,898**
	Total Impact	**$400,551,546**	**2854.5**	**$193,000,411**	**$222,750,030**

Alt 2A – McKenzie River Sub-Basin Projects

Table 1-27.Alt 2A McKenzie River Local Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				
19	Support activities for agriculture and forestry	$36,522,976	450.2	$34,280,272	$32,445,453
56	Construction of other new nonresidential structures	$113,555,000	1332.1	$86,917,004	$45,595,479
463	Environmental and other technical consulting services	$1,647,442	19.0	$1,017,406	$947,912

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
470	Office administrative services	$5,241,000	71.1	$4,151,172	$2,121,368
544	* Employment and payroll of federal govt, non-military	$11,792,250	60.0	$8,074,554	$11,792,250
	Direct Impact	**$168,758,669**	**1932.3**	**$134,440,407**	**$92,902,462**
	Secondary Impact	**$160,761,672**	**990.9**	**$54,607,306**	**$93,326,510**
	Total Impact	**$329,520,341**	**2923.2**	**$189,047,713**	**$186,228,972**

Table 1-28. Alt 2A McKenzie River State Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				
19	Support activities for agriculture and forestry	$36,522,976	622.0	$34,280,272	$32,445,453
56	Construction of other new nonresidential structures	$113,555,000	1332.1	$95,325,128	$49,900,108
463	Environmental and other technical consulting services	$1,735,966	20.0	$1,256,504	$1,132,413
470	Office administrative services	$6,988,000	98.0	$5,591,779	$2,828,490
544	* Employment and payroll of federal govt, non-military	$15,723,000	80.0	$10,766,072	$15,723,000
	Direct Impact	**$174,524,942**	**2152.0**	**$147,219,756**	**$102,029,465**
	Secondary Impact	**$203,350,368**	**1128.6**	**$68,766,373**	**$116,149,431**
	Total Impact	**$377,875,310**	**3280.6**	**$215,986,129**	**$218,178,895**

* Jobs are presented in full-time equivalence (FTE)

Table 1-29. Alt 2A McKenzie River U.S. Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				
19	Support activities for agriculture and forestry	$36,602,280	672.4	$34,354,706	$32,515,903
56	Construction of other new nonresidential structures	$113,555,000	1332.1	$95,325,128	$51,190,964
463	Environmental and other technical consulting services	$1,745,156	20.1	$1,366,165	$1,210,310
470	Office administrative services	$6,988,000	98.0	$7,439,427	$3,174,959
544	* Employment and payroll of federal govt, non-military	$15,723,000	80.0	$11,266,790	$15,723,000
	Direct Impact	**$174,613,436**	**2202.5**	**$149,752,216**	**$103,815,137**
	Secondary Impact	**$382,967,082**	**1771.0**	**$118,910,507**	**$206,260,004**
	Total Impact	**$557,580,518**	**3973.6**	**$268,662,724**	**$310,075,141**

* Jobs are presented in full-time equivalence (FTE)

1.5 ALTERNATIVE 2B - REGIONIAL EFFECTS OF PROPOSED CONSTRUCTION SPENDING

Alt 2B - South Santiam River Sub-Basin Projects

Table 1-30. Alt 2B South Santiam River Local Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				
19	Support activities for agriculture and forestry	$16,737,514	296.6	$14,955,768	$14,047,273
56	Construction of other new nonresidential structures	$52,160,549	631.7	$41,075,519	$19,932,548
463	Environmental and other technical consulting services	$623,077	6.9	$405,235	$368,545
470	Office administrative services	$2,407,410	39.0	$1,921,311	$695,451
544	* Employment and payroll of federal govt, non-military	$5,416,672	23.5	$3,708,979	$5,416,672

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impact	**$77,345,223**	**997.7**	**$62,066,812**	**$40,460,490**
	Secondary Impact	**$56,198,520**	**349.8**	**$17,968,395**	**$30,790,055**
	Total Impact	**$133,543,743**	**1347.5**	**$80,035,207**	**$71,250,544**

* Jobs are presented in full-time equivalence (FTE)

Table 1-31. Alt 2B South Santiam River State Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				
19	Support activities for agriculture and forestry	$16,737,514	296.6	$15,348,383	$14,143,438
56	Construction of other new nonresidential structures	$52,160,550	631.7	$43,786,809	$22,921,202
463	Environmental and other technical consulting services	$797,402	8.8	$577,165	$520,165
470	Office administrative services	$3,209,880	52.0	$2,568,537	$1,235,753
544	* Employment and payroll of federal govt, non-military	$7,222,230	34.2	$4,945,306	$7,222,230
	Direct Impact	**$80,127,576**	**1023.4**	**$67,226,201**	**$46,042,787**
	Secondary Impact	**$93,363,181**	**516.5**	**$31,575,240**	**$53,331,203**
	Total Impact	**$173,490,757**	**1539.9**	**$98,801,441**	**$99,373,990**

* Jobs are presented in full-time equivalence (FTE)

Table 1-32. Alt 2B South Santiam River U.S. Impacts

Table 9 - US Impacts					
IMPLAN Sectors	**Industries**	**Output**	**Jobs***	**Labor Income**	**Value Added**
	Direct Impacts				
19	Support activities for agriculture and forestry	$16,812,954	308.9	$15,417,562	$14,207,186
56	Construction of other new nonresidential structures	$52,160,550	631.7	$43,786,809	$23,514,146

Table 9 - US Impacts					
IMPLAN Sectors	**Industries**	**Output**	**Jobs***	**Labor Income**	**Value Added**
463	Environmental and other technical consulting services	$801,623	8.9	$627,537	$555,946
470	Office administrative services	$3,209,880	52.0	$3,417,239	$1,458,391
544	* Employment and payroll of federal govt, non-military	$7,222,230	34.2	$5,175,307	$7,222,230
	Direct Impact	**$80,207,238**	**1035.7**	**$68,424,454**	**$46,957,899**
	Secondary Impact	**$175,912,762**	**813.4**	**$54,620,558**	**$94,743,827**
	Total Impact	**$256,119,999**	**1849.1**	**$123,045,012**	**$141,701,726**

* Jobs are presented in full-time equivalence (FTE)

Alt 2B - North Santiam River Sub-Basin Projects

Table 1-33. Alt 2B North Santiam River Local Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				
19	Support activities for agriculture and forestry	$147,117,242	2741.3	$133,859,218	$122,247,182
56	Construction of other new nonresidential structures	$457,177,500	5255.5	$387,250,462	$189,056,633
463	Environmental and other technical consulting services	$5,096,304	50.0	$3,610,471	$3,254,512
470	Office administrative services	$21,100,500	312.9	$18,026,732	$7,373,214
544	* Employment and payroll of federal govt, non-military	$47,476,125	249.8	$32,508,513	$47,476,125
	Direct Impact	**$677,967,671**	**8609.4**	**$575,255,395**	**$369,407,665**
	Secondary Impact	**$598,214,975**	**3632.1**	**$195,341,094**	**$338,349,911**
	Total Impact	**$1,276,182,647**	**12241.5**	**$770,596,489**	**$707,757,577**

* Jobs are presented in full-time equivalence (FTE)

Table 1-34. Alt 2B North Santiam River State Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				
19	Support activities for agriculture and forestry	$147,117,242	2741.3	$134,907,235	$124,316,161
56	Construction of other new nonresidential structures	$457,177,500	5255.5	$387,250,462	$200,900,062
463	Environmental and other technical consulting services	$6,989,077	68.5	$5,058,742	$4,559,145
470	Office administrative services	$28,134,000	417.2	$24,035,642	$10,831,146
544	* Employment and payroll of federal govt, non-military	$63,301,500	333.1	$43,344,685	$63,301,500
	Direct Impact	**$702,719,319**	**8815.5**	**$594,596,765**	**$403,908,015**
	Secondary Impact	**$818,699,396**	**4529.1**	**$276,879,331**	**$467,662,832**
	Total Impact	**$1,521,418,715**	**13344.6**	**$871,476,096**	**$871,570,847**

* Jobs are presented in full-time equivalence (FTE)

Table 1-35. Alt 2B North Santiam River U.S. Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				
19	Support activities for agriculture and forestry	$147,362,412	2745.8	$135,132,057	$124,523,333
56	Construction of other new nonresidential structures	$457,177,500	5255.5	$387,250,462	$206,097,108
463	Environmental and other technical consulting services	$7,026,077	68.9	$5,500,243	$4,872,764
470	Office administrative services	$28,134,000	417.2	$29,951,464	$12,782,526
544	* Employment and payroll of federal govt, non-military	$63,301,500	333.1	$45,360,599	$63,301,501
	Direct Impact	**$703,001,489**	**8820.4**	**$603,194,824**	**$411,577,233**
	Secondary Impact	**$1,541,842,572**	**7129.2**	**$478,739,012**	**$830,411,986**
	Total Impact	**$2,244,844,062**	**15949.6**	**$1,081,933,836**	**$1,241,989,219**

* Jobs are presented in full-time equivalence (FTE)

Alt 2B – Middle Fork Willamette River Sub-Basin Projects

Table 1-36. Alt 2B Middle Fork Willamette River Local Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				
19	Support activities for agriculture and forestry	$26,237,170	323.4	$24,626,069	$23,307,982
56	Construction of other new nonresidential structures	$81,575,000	956.9	$62,438,947	$32,754,623
463	Environmental and other technical consulting services	$1,183,480	13.6	$730,878	$680,956
470	Office administrative services	$3,765,000	51.1	$2,982,095	$1,523,936
544	* Employment and payroll of federal govt, non-military	$8,471,250	43.1	$5,800,552	$8,471,250
	Direct Impact	**$121,231,900**	**1388.1**	**$96,578,541**	**$66,738,746**
	Secondary Impact	**$115,487,063**	**711.9**	**$39,228,488**	**$67,043,371**
	Total Impact	**$236,718,963**	**2100.0**	**$135,807,029**	**$133,782,118**

* Jobs are presented in full-time equivalence (FTE)

Table 1-37. Alt 2B Middle Fork Willamette River State Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				
19	Support activities for agriculture and forestry	$26,237,170	446.8	$24,626,069	$23,307,982
56	Construction of other new nonresidential structures	$81,575,000	956.9	$68,479,128	$35,846,958
463	Environmental and other technical consulting services	$1,247,073	14.4	$902,640	$813,496
470	Office administrative services	$5,020,000	70.4	$4,016,991	$2,031,915
544	* Employment and payroll of federal govt, non-military	$11,295,000	57.5	$7,734,070	$11,295,000

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impact	**$125,374,243**	**1546.0**	**$105,758,897**	**$73,295,351**
	Secondary Impact	**$146,081,690**	**810.7**	**$49,399,999**	**$83,438,772**
	Total Impact	**$271,455,933**	**2356.7**	**$155,158,896**	**$156,734,123**

* Jobs are presented in full-time equivalence (FTE)

Table 1-38. Alt 2B Middle Fork Willamette River U.S. Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				
19	Support activities for agriculture and forestry	$26,294,139	483.1	$24,679,540	$23,358,591
56	Construction of other new nonresidential structures	$81,575,000	956.9	$68,479,128	$36,774,276
463	Environmental and other technical consulting services	$1,253,676	14.4	$981,418	$869,456
470	Office administrative services	$5,020,000	70.4	$5,344,293	$2,280,809
544	* Employment and payroll of federal govt, non-military	$11,295,000	57.5	$8,093,773	$11,295,000
	Direct Impact	**$125,437,815**	**1582.3**	**$107,578,152**	**$74,578,132**
	Secondary Impact	**$275,113,731**	**1272.3**	**$85,422,259**	**$148,171,898**
	Total Impact	**$400,551,546**	**2854.5**	**$193,000,411**	**$222,750,030**

* Jobs are presented in full-time equivalence (FTE)

Alt 2B – McKenzie River Sub-Basin Projects

Table 1-39. Alt 2B McKenzie River Local Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				
19	Support activities for agriculture and forestry	$26,278,982	323.9	$24,665,313	$23,345,126
56	Construction of other new nonresidential structures	$81,705,000	958.5	$62,538,451	$32,806,821

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
463	Environmental and other technical consulting services	$1,185,366	13.7	$732,043	$682,041
470	Office administrative services	$3,771,000	51.2	$2,986,848	$1,526,365
544	* Employment and payroll of federal govt, non-military	$8,484,750	43.2	$5,809,796	$8,484,750
	Direct Impact	**$121,425,098**	**1390.3**	**$96,732,451**	**$66,845,103**
	Secondary Impact	**$115,671,106**	**713.0**	**$39,291,004**	**$67,150,213**
	Total Impact	**$237,096,204**	**2103.3**	**$136,023,455**	**$133,995,316**

* Jobs are presented in full-time equivalence (FTE)

Table 1-40. Alt 2B McKenzie River State Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				
19	Support activities for agriculture and forestry	$26,278,982	447.5	$24,665,313	$23,345,126
56	Construction of other new nonresidential structures	$81,705,000	958.5	$68,588,258	$35,904,084
463	Environmental and other technical consulting services	$1,249,061	14.4	$904,079	$814,793
470	Office administrative services	$5,028,000	70.5	$4,023,392	$2,035,153
544	* Employment and payroll of federal govt, non-military	$11,313,000	57.5	$7,746,395	$11,313,000
	Direct Impact	**$125,574,043**	**1548.4**	**$105,927,437**	**$73,412,156**
	Secondary Impact	**$146,314,489**	**812.0**	**$49,478,724**	**$83,571,743**
	Total Impact	**$271,888,532**	**2360.4**	**$155,406,161**	**$156,983,899**

* Jobs are presented in full-time equivalence (FTE)

Table 1-41. Alt 2B McKenzie River U.S. Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				
19	Support activities for agriculture and forestry	$26,336,042	483.8	$24,718,870	$23,395,816
56	Construction of other new nonresidential structures	$81,705,000	958.5	$68,588,258	$36,832,881
463	Environmental and other technical consulting services	$1,255,673	14.5	$982,982	$870,842
470	Office administrative services	$5,028,000	70.5	$5,352,810	$2,284,444
544	* Employment and payroll of federal govt, non-military	$11,313,000	57.5	$8,106,671	$11,313,000
	Direct Impact	**$125,637,716**	**1584.8**	**$107,749,591**	**$74,696,982**
	Secondary Impact	**$275,552,159**	**1274.3**	**$85,558,390**	**$148,408,028**
	Total Impact	**$401,189,875**	**2859.1**	**$193,307,982**	**$223,105,010**

* Jobs are presented in full-time equivalence (FTE)

1.6 ALTERNATIVE 3A - REGIONIAL EFFECTS OF PROPOSED CONSTRUCTION SPENDING

Alt 3A - South Santiam River Sub-Basin Projects

Table 1-42.Alt 3A South Santiam River Local Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				
19	Support activities for agriculture and forestry	$6,788,489	120.3	$6,065,839	$5,697,367
56	Construction of other new nonresidential structures	$21,155,550	256.2	$16,659,625	$8,084,347
463	Environmental and other technical consulting services	$252,711	2.8	$164,357	$149,477
470	Office administrative services	$976,410	15.8	$779,256	$282,065
544	* Employment and payroll of federal govt, non-military	$2,196,922	9.5	$1,504,307	$2,196,922

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impact	**$31,370,082**	**404.6**	**$25,173,384**	**$16,410,178**
	Secondary Impact	**$22,793,291**	**141.9**	**$7,287,716**	**$12,487,992**
	Total Impact	**$54,163,373**	**546.5**	**$32,461,100**	**$28,898,170**

* Jobs are presented in full-time equivalence (FTE)

Table 1-43. Alt 3A South Santiam River State Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				
19	Support activities for agriculture and forestry	$6,788,489	120.3	$6,225,078	$5,736,370
56	Construction of other new nonresidential structures	$21,155,550	256.2	$17,759,284	$9,296,501
463	Environmental and other technical consulting services	$323,414	3.6	$234,090	$210,971
470	Office administrative services	$1,301,880	21.1	$1,041,761	$501,203
544	* Employment and payroll of federal govt, non-military	$2,929,230	13.9	$2,005,743	$2,929,230
	Direct Impact	**$32,498,563**	**415.1**	**$27,265,956**	**$18,674,276**
	Secondary Impact	**$37,866,729**	**209.5**	**$12,806,452**	**$21,630,349**
	Total Impact	**$70,365,293**	**624.6**	**$40,072,408**	**$40,304,625**

* Jobs are presented in full-time equivalence (FTE)

Table 1-44. Alt 3A South Santiam River U.S. Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				
19	Support activities for agriculture and forestry	$6,819,086	125.3	$6,253,136	$5,762,225
56	Construction of other new nonresidential structures	$21,155,550	256.2	$17,759,284	$9,536,991

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
463	Environmental and other technical consulting services	$325,127	3.6	$254,520	$225,484
470	Office administrative services	$1,301,880	21.1	$1,385,982	$591,502
544	* Employment and payroll of federal govt, non-military	$2,929,230	13.9	$2,099,028	$2,929,230
	Direct Impact	**$32,530,873**	**420.1**	**$27,751,950**	**$19,045,431**
	Secondary Impact	**$71,347,622**	**329.9**	**$22,153,293**	**$38,426,699**
	Total Impact	**$103,878,495**	**750.0**	**$49,905,243**	**$57,472,131**

* Jobs are presented in full-time equivalence (FTE)

Alt 3A - North Santiam River Sub-Basin Projects

Table 1-45. Alt 3A North Santiam River Local Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				
19	Support activities for agriculture and forestry	$282,375	5.3	$256,927	$234,640
56	Construction of other new nonresidential structures	$877,500	10.1	$743,283	$362,873
463	Environmental and other technical consulting services	$9,782	0.1	$6,930	$6,247
470	Office administrative services	$40,500	0.6	$34,600	$14,152
544	* Employment and payroll of federal govt, non-military	$91,125	0.5	$62,396	$91,125
	Direct Impact	**$1,301,282**	**16.5**	**$1,104,137**	**$709,036**
	Secondary Impact	**$1,148,205**	**7.0**	**$374,935**	**$649,424**
	Total Impact	**$2,449,487**	**23.5**	**$1,479,072**	**$1,358,460**

* Jobs are presented in full-time equivalence (FTE)

Table 1-46. Alt 3A North Santiam River State Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				
19	Support activities for agriculture and forestry	$282,375	5.3	$258,939	$238,611
56	Construction of other new nonresidential structures	$877,500	10.1	$743,283	$385,605
463	Environmental and other technical consulting services	$13,415	0.1	$9,710	$8,751
470	Office administrative services	$54,000	0.8	$46,134	$20,789
544	* Employment and payroll of federal govt, non-military	$121,500	0.6	$83,195	$121,500
	Direct Impact	**$1,348,789**	**16.9**	**$1,141,261**	**$775,255**
	Secondary Impact	**$1,571,400**	**8.7**	**$531,438**	**$897,625**
	Total Impact	**$2,920,189**	**25.6**	**$1,672,699**	**$1,672,881**

* Jobs are presented in full-time equivalence (FTE)

Table 1-47.Alt 3A North Santiam River U.S. Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				
19	Support activities for agriculture and forestry	$282,845	5.3	$259,371	$239,008
56	Construction of other new nonresidential structures	$877,500	10.1	$743,283	$395,580
463	Environmental and other technical consulting services	$13,486	0.1	$10,557	$9,353
470	Office administrative services	$54,000	0.8	$57,488	$24,535
544	* Employment and payroll of federal govt, non-military	$121,500	0.6	$87,064	$121,500
	Direct Impact	**$1,349,331**	**16.9**	**$1,157,764**	**$789,975**
	Secondary Impact	**$2,959,391**	**13.7**	**$918,885**	**$1,593,881**

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Total Impact	**$4,308,722**	**30.6**	**$2,076,648**	**$2,383,856**

* Jobs are presented in full-time equivalence (FTE)

Alt 3A – Middle Fork Willamette River Sub-Basin Projects

Table 1-48. Alt 3A Middle Fork Willamette River Local Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				
19	Support activities for agriculture and forestry	$27,491,536	338.8	$25,803,410	$24,422,308
56	Construction of other new nonresidential structures	$85,475,000	1002.7	$65,424,076	$34,320,581
463	Environmental and other technical consulting services	$1,240,061	14.3	$765,820	$713,511
470	Office administrative services	$3,945,000	53.5	$3,124,666	$1,596,794
544	* Employment and payroll of federal govt, non-military	$8,876,250	45.1	$6,077,869	$8,876,250
	Direct Impact	**$127,027,847**	**1454.5**	**$101,195,842**	**$69,929,443**
	Secondary Impact	**$121,008,357**	**745.9**	**$41,103,954**	**$70,248,632**
	Total Impact	**$248,036,204**	**2200.4**	**$142,299,796**	**$140,178,075**

* Jobs are presented in full-time equivalence (FTE)

Table 1-49.Alt 3A Middle Fork Willamette River State Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				
19	Support activities for agriculture and forestry	$27,491,536	468.2	$25,803,410	$24,422,308
56	Construction of other new nonresidential structures	$85,475,000	1002.7	$71,753,030	$37,560,757
463	Environmental and other technical consulting services	$1,306,694	15.1	$945,794	$852,389

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
470	Office administrative services	$5,260,000	73.7	$4,209,038	$2,129,058
544	* Employment and payroll of federal govt, non-military	$11,835,000	60.2	$8,103,826	$11,835,000
	Direct Impact	**$131,368,231**	**1619.9**	**$110,815,099**	**$76,799,511**
	Secondary Impact	**$153,065,675**	**849.5**	**$51,761,752**	**$87,427,877**
	Total Impact	**$284,433,906**	**2469.4**	**$162,576,852**	**$164,227,388**

* Jobs are presented in full-time equivalence (FTE)

Table 1-50. Alt 3A Middle Fork Willamette River U.S. Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				
19	Support activities for agriculture and forestry	$27,551,229	506.2	$25,859,438	$24,475,336
56	Construction of other new nonresidential structures	$85,475,000	1002.7	$71,753,030	$38,532,409
463	Environmental and other technical consulting services	$1,313,612	15.1	$1,028,339	$911,024
470	Office administrative services	$5,260,000	73.7	$5,599,797	$2,389,852
544	* Employment and payroll of federal govt, non-military	$11,835,000	60.2	$8,480,726	$11,835,000
	Direct Impact	**$131,434,842**	**1657.9**	**$112,721,331**	**$78,143,621**
	Secondary Impact	**$288,266,579**	**1333.1**	**$89,506,192**	**$155,255,813**
	Total Impact	**$419,701,421**	**2991.0**	**$202,227,522**	**$233,399,434**

* Jobs are presented in full-time equivalence (FTE)

Alt 3A – McKenzie River Sub-Basin Projects

Table 1-51.Alt 3A McKenzie River Local Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				
19	Support activities for agriculture and forestry	$34,641,426	427.0	$32,514,259	$30,773,965
56	Construction of other new nonresidential structures	$107,705,000	1263.5	$82,439,311	$43,246,542
463	Environmental and other technical consulting services	$1,562,571	18.0	$964,992	$899,078
470	Office administrative services	$4,971,000	67.4	$3,937,316	$2,012,082
544	* Employment and payroll of federal govt, non-military	$11,184,750	56.9	$7,658,578	$11,184,750
	Direct Impact	**$160,064,747**	**1832.8**	**$127,514,456**	**$88,116,416**
	Secondary Impact	**$152,479,731**	**939.9**	**$51,794,108**	**$88,518,619**
	Total Impact	**$312,544,479**	**2772.6**	**$179,308,564**	**$176,635,035**

* Jobs are presented in full-time equivalence (FTE)

Table 1-52. Alt 3A McKenzie River State Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				
19	Support activities for agriculture and forestry	$34,641,426	590.0	$32,514,259	$30,773,965
56	Construction of other new nonresidential structures	$107,705,000	1263.5	$90,414,275	$47,329,410
463	Environmental and other technical consulting services	$1,646,534	19.0	$1,191,773	$1,074,075
470	Office administrative services	$6,628,000	92.9	$5,303,708	$2,682,775
544	* Employment and payroll of federal govt, non-military	$14,913,000	75.9	$10,211,437	$14,913,000
	Direct Impact	**$165,533,961**	**2041.2**	**$139,635,452**	**$96,773,224**

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Secondary Impact	**$192,874,390**	**1070.4**	**$65,223,744**	**$110,165,774**
	Total Impact	**$358,408,351**	**3111.6**	**$204,859,196**	**$206,938,998**

* Jobs are presented in full-time equivalence (FTE)

Table 1-53. Alt 3A McKenzie River U.S. Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				
19	Support activities for agriculture and forestry	$34,716,644	637.8	$32,584,859	$30,840,785
56	Construction of other new nonresidential structures	$107,705,000	1263.5	$90,414,275	$48,553,765
463	Environmental and other technical consulting services	$1,655,251	19.1	$1,295,785	$1,147,959
470	Office administrative services	$6,628,000	92.9	$7,056,170	$3,011,395
544	* Employment and payroll of federal govt, non-military	$14,913,000	75.9	$10,686,360	$14,913,000
	Direct Impact	**$165,617,895**	**2089.1**	**$142,037,449**	**$98,466,904**
	Secondary Impact	**$363,237,811**	**1679.8**	**$112,784,608**	**$195,634,131**
	Total Impact	**$528,855,706**	**3768.9**	**$254,822,057**	**$294,101,036**

* Jobs are presented in full-time equivalence (FTE)

1.7 ALTERNATIVE 3B - REGIONIAL EFFECTS OF PROPOSED CONSTRUCTION SPENDING

Alt 3B - South Santiam River Sub-Basin Projects

Table 1-54. Alt 3B South Santiam River Local Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				
19	Support activities for agriculture and forestry	$6,788,489	120.3	$6,065,839	$5,697,367

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
56	Construction of other new nonresidential structures	$21,155,550	256.2	$16,659,625	$8,084,347
463	Environmental and other technical consulting services	$252,711	2.8	$164,357	$149,477
470	Office administrative services	$976,410	15.8	$779,256	$282,065
544	* Employment and payroll of federal govt, non-military	$2,196,922	9.5	$1,504,307	$2,196,922
	Direct Impact	**$31,370,082**	**404.6**	**$25,173,384**	**$16,410,178**
	Secondary Impact	**$22,793,291**	**141.9**	**$7,287,716**	**$12,487,992**
	Total Impact	**$54,163,373**	**546.5**	**$32,461,100**	**$28,898,170**

* Jobs are presented in full-time equivalence (FTE)

Table 1-55. Alt 3B South Santiam River State Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				
19	Support activities for agriculture and forestry	$6,788,489	120.3	$6,225,078	$5,736,370
56	Construction of other new nonresidential structures	$21,155,550	256.2	$17,759,284	$9,296,501
463	Environmental and other technical consulting services	$323,414	3.6	$234,090	$210,971
470	Office administrative services	$1,301,880	21.1	$1,041,761	$501,203
544	* Employment and payroll of federal govt, non-military	$2,929,230	13.9	$2,005,743	$2,929,230
	Direct Impact	**$32,498,563**	**415.1**	**$27,265,956**	**$18,674,276**
	Secondary Impact	**$37,866,729**	**209.5**	**$12,806,452**	**$21,630,349**
	Total Impact	**$70,365,293**	**624.6**	**$40,072,408**	**$40,304,625**

* Jobs are presented in full-time equivalence (FTE)

Table 1-56. Alt 3B South Santiam River U.S. Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				
19	Support activities for agriculture and forestry	$6,819,086	125.3	$6,253,136	$5,762,225
56	Construction of other new nonresidential structures	$21,155,550	256.2	$17,759,284	$9,536,991
463	Environmental and other technical consulting services	$325,127	3.6	$254,520	$225,484
470	Office administrative services	$1,301,880	21.1	$1,385,982	$591,502
544	* Employment and payroll of federal govt, non-military	$2,929,230	13.9	$2,099,028	$2,929,230
	Direct Impact	**$32,530,873**	**420.1**	**$27,751,950**	**$19,045,431**
	Secondary Impact	**$71,347,622**	**329.9**	**$22,153,293**	**$38,426,699**
	Total Impact	**$103,878,495**	**750.0**	**$49,905,243**	**$57,472,131**

* Jobs are presented in full-time equivalence (FTE)

Alt 3B - North Santiam River Sub-Basin Projects

Table 1-57. Alt 3B North Santiam River Local Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				
19	Support activities for agriculture and forestry	$282,375	5.3	$256,927	$234,640
56	Construction of other new nonresidential structures	$877,500	10.1	$743,283	$362,873
463	Environmental and other technical consulting services	$9,782	0.1	$6,930	$6,247
470	Office administrative services	$40,500	0.6	$34,600	$14,152
544	* Employment and payroll of federal govt, non-military	$91,125	0.5	$62,396	$91,125
	Direct Impact	**$1,301,282**	**16.5**	**$1,104,137**	**$709,036**
	Secondary Impact	**$1,148,205**	**7.0**	**$374,935**	**$649,424**

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Total Impact	**$2,449,487**	**23.5**	**$1,479,072**	**$1,358,460**

* Jobs are presented in full-time equivalence (FTE)

Table 1-58. Alt 3B North Santiam River State Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				
19	Support activities for agriculture and forestry	$282,375	5.3	$258,939	$238,611
56	Construction of other new nonresidential structures	$877,500	10.1	$743,283	$385,605
463	Environmental and other technical consulting services	$13,415	0.1	$9,710	$8,751
470	Office administrative services	$54,000	0.8	$46,134	$20,789
544	* Employment and payroll of federal govt, non-military	$121,500	0.6	$83,195	$121,500
	Direct Impact	**$1,348,789**	**16.9**	**$1,141,261**	**$775,255**
	Secondary Impact	**$1,571,400**	**8.7**	**$531,438**	**$897,625**
	Total Impact	**$2,920,189**	**25.6**	**$1,672,699**	**$1,672,881**

* Jobs are presented in full-time equivalence (FTE)

Table 1-59. Alt 3B North Santiam River U.S. Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				
19	Support activities for agriculture and forestry	$282,845	5.3	$259,371	$239,008
56	Construction of other new nonresidential structures	$877,500	10.1	$743,283	$395,580
463	Environmental and other technical consulting services	$13,486	0.1	$10,557	$9,353
470	Office administrative services	$54,000	0.8	$57,488	$24,535

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
544	* Employment and payroll of federal govt, non-military	$121,500	0.6	$87,064	$121,500
	Direct Impact	**$1,349,331**	**16.9**	**$1,157,764**	**$789,975**
	Secondary Impact	**$2,959,391**	**13.7**	**$918,885**	**$1,593,881**
	Total Impact	**$4,308,722**	**30.6**	**$2,076,648**	**$2,383,856**

* Jobs are presented in full-time equivalence (FTE)

Alt 3B – Middle Fork Willamette River Sub-Basin Projects

Table 1-60. Alt 3B Middle Fork Willamette River Local Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				
19	Support activities for agriculture and forestry	$32,718,064	403.3	$30,709,002	$29,065,332
56	Construction of other new nonresidential structures	$101,725,000	1193.3	$77,862,113	$40,845,406
463	Environmental and other technical consulting services	$1,475,814	17.0	$911,414	$849,160
470	Office administrative services	$4,695,000	63.7	$3,718,709	$1,900,367
544	* Employment and payroll of federal govt, non-military	$10,563,750	53.7	$7,233,358	$10,563,750
	Direct Impact	**$151,177,628**	**1731.0**	**$120,434,595**	**$83,224,014**
	Secondary Impact	**$144,013,748**	**887.7**	**$48,918,394**	**$83,603,885**
	Total Impact	**$295,191,376**	**2618.7**	**$169,352,989**	**$166,827,900**

* Jobs are presented in full-time equivalence (FTE)

Table 1-61. Alt 3B Middle Fork Willamette River State Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
19	Support activities for agriculture and forestry	$32,718,064	557.2	$30,709,002	$29,065,332
56	Construction of other new nonresidential structures	$101,725,000	1193.3	$85,394,291	$44,701,585
463	Environmental and other technical consulting services	$1,555,116	17.9	$1,125,603	$1,014,440
470	Office administrative services	$6,260,000	87.8	$5,009,235	$2,533,822
544	* Employment and payroll of federal govt, non-military	$14,085,000	71.6	$9,644,477	$14,085,000
	Direct Impact	**$156,343,180**	**1927.8**	**$131,882,609**	**$91,400,179**
	Secondary Impact	**$182,165,613**	**1011.0**	**$61,602,389**	**$104,049,146**
	Total Impact	**$338,508,793**	**2938.8**	**$193,484,998**	**$195,449,325**

* Jobs are presented in full-time equivalence (FTE)

Table 1-62. Alt 3B Middle Fork Willamette River U.S. Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				
19	Support activities for agriculture and forestry	$32,789,106	602.4	$30,775,681	$29,128,442
56	Construction of other new nonresidential structures	$101,725,000	1193.3	$85,394,291	$45,857,962
463	Environmental and other technical consulting services	$1,563,348	18.0	$1,223,840	$1,084,222
470	Office administrative services	$6,260,000	87.8	$6,664,398	$2,844,196
544	* Employment and payroll of federal govt, non-military	$14,085,000	71.6	$10,093,032	$14,085,000
	Direct Impact	**$156,422,454**	**1973.1**	**$134,151,241**	**$92,999,822**
	Secondary Impact	**$343,070,111**	**1586.5**	**$106,522,578**	**$184,772,127**
	Total Impact	**$499,492,565**	**3559.6**	**$240,673,820**	**$277,771,950**

* Jobs are presented in full-time equivalence (FTE)

Alt 3B – McKenzie River Sub-Basin Projects

Table 1-63. Alt 3B McKenzie River Local Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				
19	Support activities for agriculture and forestry	$52,411,621	646.0	$49,193,270	$46,560,247
56	Construction of other new nonresidential structures	$162,955,000	1911.6	$124,728,637	$65,430,948
463	Environmental and other technical consulting services	$2,364,132	27.2	$1,460,009	$1,360,283
470	Office administrative services	$7,521,000	102.0	$5,957,062	$3,044,230
544	* Employment and payroll of federal govt, non-military	$16,922,250	86.1	$11,587,239	$16,922,250
	Direct Impact	$242,174,002	2772.9	$192,926,217	$133,317,958
	Secondary Impact	$230,698,061	1422.0	$78,363,203	$133,926,480
	Total Impact	$472,872,063	4194.9	$271,289,420	$267,244,437

* Jobs are presented in full-time equivalence (FTE)

Table 1-64.Alt 3B McKenzie River State Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				
19	Support activities for agriculture and forestry	$52,411,621	892.6	$49,193,270	$46,560,247
56	Construction of other new nonresidential structures	$162,955,000	1911.6	$136,794,560	$71,608,226
463	Environmental and other technical consulting services	$2,491,166	28.7	$1,803,123	$1,625,048
470	Office administrative services	$10,028,000	140.6	$8,024,379	$4,058,973
544	* Employment and payroll of federal govt, non-military	$22,563,000	114.8	$15,449,652	$22,563,000
	Direct Impact	**$250,448,787**	**3088.2**	**$211,264,984**	**$146,415,494**
	Secondary Impact	**$291,814,180**	**1619.5**	**$98,681,911**	**$166,678,089**

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Total Impact	**$542,262,967**	**4707.7**	**$309,946,895**	**$313,093,583**

* Jobs are presented in full-time equivalence (FTE)

Table 1-65.Alt 3B McKenzie River U.S. Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				
19	Support activities for agriculture and forestry	$52,525,424	965.0	$49,300,085	$46,661,345
56	Construction of other new nonresidential structures	$162,955,000	1911.6	$136,794,560	$73,460,646
463	Environmental and other technical consulting services	$2,504,354	28.9	$1,960,490	$1,736,834
470	Office administrative services	$10,028,000	140.6	$10,675,811	$4,556,166
544	* Employment and payroll of federal govt, non-military	$22,563,000	114.8	$16,168,198	$22,563,000
	Direct Impact	**$250,575,778**	**3160.7**	**$214,899,145**	**$148,977,990**
	Secondary Impact	**$549,569,820**	**2541.5**	**$170,640,322**	**$295,989,600**
	Total Impact	**$800,145,598**	**5702.2**	**$385,539,467**	**$444,967,590**

* Jobs are presented in full-time equivalence (FTE)

1.8 ALTERNATIVE 4 - REGIONIAL EFFECTS OF PROPOSED CONSTRUCTION SPENDING

Alt 4 - South Santiam River Sub-Basin Projects

Table 1-66.Alt 4 South Santiam River Local Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				
19	Support activities for agriculture and forestry	$13,608,890	241.1	$12,160,193	$11,421,516
56	Construction of other new nonresidential structures	$42,410,549	513.6	$33,397,565	$16,206,699

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
463	Environmental and other technical consulting services	$506,610	5.6	$329,487	$299,656
470	Office administrative services	$1,957,410	31.7	$1,562,174	$565,456
544	* Employment and payroll of federal govt, non-military	$4,404,172	19.1	$3,015,686	$4,404,172
	Direct Impact	**$62,887,632**	**811.2**	**$50,465,105**	**$32,897,499**
	Secondary Impact	**$45,693,731**	**284.4**	**$14,609,691**	**$25,034,689**
	Total Impact	**$108,581,363**	**1095.6**	**$65,074,796**	**$57,932,188**

* Jobs are presented in full-time equivalence (FTE)

Table 1-67. Alt 4 South Santiam River State Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				
19	Support activities for agriculture and forestry	$13,608,890	241.1	$12,479,419	$11,499,706
56	Construction of other new nonresidential structures	$42,410,550	513.6	$35,602,053	$18,636,705
463	Environmental and other technical consulting services	$648,349	7.2	$469,279	$422,934
470	Office administrative services	$2,609,880	42.3	$2,088,419	$1,004,763
544	* Employment and payroll of federal govt, non-military	$5,872,230	27.8	$4,020,915	$5,872,230
	Direct Impact	**$65,149,899**	**832.1**	**$54,660,086**	**$37,436,337**
	Secondary Impact	**$75,911,466**	**420.0**	**$25,673,106**	**$43,362,381**
	Total Impact	**$141,061,366**	**1252.0**	**$80,333,192**	**$80,798,718**

* Jobs are presented in full-time equivalence (FTE)

Table 1-68. Alt 4 South Santiam River U.S. Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				
19	Support activities for agriculture and forestry	$13,670,229	251.1	$12,535,667	$11,551,538
56	Construction of other new nonresidential structures	$42,410,550	513.6	$35,602,053	$19,118,814
463	Environmental and other technical consulting services	$651,781	7.2	$510,236	$452,027
470	Office administrative services	$2,609,880	42.3	$2,778,479	$1,185,784
544	* Employment and payroll of federal govt, non-military	$5,872,230	27.8	$4,207,924	$5,872,230
	Direct Impact	**$65,214,670**	**842.1**	**$55,634,358**	**$38,180,393**
	Secondary Impact	**$143,030,642**	**661.3**	**$44,410,726**	**$77,034,038**
	Total Impact	**$208,245,312**	**1503.5**	**$100,045,084**	**$115,214,432**

* Jobs are presented in full-time equivalence (FTE)

Alt 4 - North Santiam River Sub-Basin Projects

Table 1-69.Alt 4 North Santiam River Local Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				
19	Support activities for agriculture and forestry	$148,163,075	2760.8	$134,810,802	$123,116,217
56	Construction of other new nonresidential structures	$460,427,500	5292.9	$390,003,362	$190,400,605
463	Environmental and other technical consulting services	$5,132,533	50.3	$3,636,137	$3,277,648
470	Office administrative services	$21,250,500	315.1	$18,154,881	$7,425,629
544	* Employment and payroll of federal govt, non-military	$47,813,625	251.6	$32,739,611	$47,813,625
	Direct Impact	**$682,787,232**	**8670.6**	**$579,344,791**	**$372,033,724**
	Secondary Impact	**$602,467,588**	**3658.0**	**$196,729,742**	**$340,755,185**

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Total Impact	**$1,285,254,820**	**12328.6**	**$776,074,533**	**$712,788,909**

* Jobs are presented in full-time equivalence (FTE)

Table 1-70.Alt 4 North Santiam River State Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				
19	Support activities for agriculture and forestry	$148,163,075	2760.8	$135,866,268	$125,199,905
56	Construction of other new nonresidential structures	$460,427,500	5292.9	$390,003,362	$202,328,228
463	Environmental and other technical consulting services	$7,038,761	69.0	$5,094,703	$4,591,555
470	Office administrative services	$28,334,000	420.1	$24,206,507	$10,908,143
544	* Employment and payroll of federal govt, non-military	$63,751,500	335.4	$43,652,815	$63,751,500
	Direct Impact	**$707,714,835**	**8878.2**	**$598,823,656**	**$406,779,331**
	Secondary Impact	**$824,519,396**	**4561.3**	**$278,847,621**	**$470,987,371**
	Total Impact	**$1,532,234,232**	**13439.5**	**$877,671,277**	**$877,766,702**

* Jobs are presented in full-time equivalence (FTE)

Table 1-71. Alt 4 North Santiam River U.S. Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				
19	Support activities for agriculture and forestry	$148,409,987	2765.4	$136,092,689	$125,408,549
56	Construction of other new nonresidential structures	$460,427,500	5292.9	$390,003,362	$207,562,219
463	Environmental and other technical consulting services	$7,076,024	69.4	$5,539,343	$4,907,403
470	Office administrative services	$28,334,000	420.1	$30,164,384	$12,873,395

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
544	* Employment and payroll of federal govt, non-military	$63,751,500	335.4	$45,683,060	$63,751,501
	Direct Impact	**$707,999,012**	**8883.1**	**$607,482,838**	**$414,503,068**
	Secondary Impact	**$1,552,803,279**	**7179.8**	**$482,142,289**	**$836,315,249**
	Total Impact	**$2,260,802,291**	**16063.0**	**$1,089,625,127**	**$1,250,818,317**

* Jobs are presented in full-time equivalence (FTE)

Alt 4 – Middle Fork Willamette River Sub-Basin Projects

Table 1-72. Alt 4 Middle Fork Willamette River Local Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				
19	Support activities for agriculture and forestry	$22,014,135	271.3	$20,662,351	$19,556,418
56	Construction of other new nonresidential structures	$68,445,000	802.9	$52,389,013	$27,482,564
463	Environmental and other technical consulting services	$992,992	11.4	$613,239	$571,352
470	Office administrative services	$3,159,000	42.9	$2,502,109	$1,278,649
544	* Employment and payroll of federal govt, non-military	$7,107,750	36.2	$4,866,918	$7,107,750
	Direct Impact	**$101,718,877**	**1164.7**	**$81,033,628**	**$55,996,733**
	Secondary Impact	**$96,898,707**	**597.3**	**$32,914,421**	**$56,252,327**
	Total Impact	**$198,617,584**	**1762.0**	**$113,948,049**	**$112,249,060**

* Jobs are presented in full-time equivalence (FTE)

Table 1-73.Alt 4 Middle Fork Willamette River State Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
19	Support activities for agriculture and forestry	$22,014,135	374.9	$20,662,351	$19,556,418
56	Construction of other new nonresidential structures	$68,445,000	802.9	$57,456,989	$30,077,169
463	Environmental and other technical consulting services	$1,046,349	12.1	$757,355	$682,559
470	Office administrative services	$4,212,000	59.0	$3,370,431	$1,704,866
544	* Employment and payroll of federal govt, non-military	$9,477,000	48.2	$6,489,223	$9,477,000
	Direct Impact	**$105,194,484**	**1297.1**	**$88,736,350**	**$61,498,012**
	Secondary Impact	**$122,568,940**	**680.2**	**$41,448,764**	**$70,008,787**
	Total Impact	**$227,763,424**	**1977.4**	**$130,185,114**	**$131,506,798**

* Jobs are presented in full-time equivalence (FTE)

Table 1-74. Alt 4 Middle Fork Willamette River U.S. Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				
19	Support activities for agriculture and forestry	$22,061,935	405.3	$20,707,216	$19,598,882
56	Construction of other new nonresidential structures	$68,445,000	802.9	$57,456,989	$30,855,229
463	Environmental and other technical consulting services	$1,051,889	12.1	$823,453	$729,512
470	Office administrative services	$4,212,000	59.0	$4,484,096	$1,913,699
544	* Employment and payroll of federal govt, non-military	$9,477,000	48.2	$6,791,030	$9,477,000
	Direct Impact	**$105,247,824**	**1327.6**	**$90,262,784**	**$62,574,321**
	Secondary Impact	**$230,832,477**	**1067.5**	**$71,673,019**	**$124,322,716**
	Total Impact	**$336,080,301**	**2395.1**	**$161,935,803**	**$186,897,037**

* Jobs are presented in full-time equivalence (FTE)

Alt 4 – McKenzie River Sub-Basin Projects

Table 1-75.Alt 4 McKenzie River Local Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				
19	Support activities for agriculture and forestry	$37,495,110	462.1	$35,192,712	$33,309,056
56	Construction of other new nonresidential structures	$116,577,500	1367.5	$89,230,479	$46,809,096
463	Environmental and other technical consulting services	$1,691,292	19.5	$1,044,486	$973,143
470	Office administrative services	$5,380,500	73.0	$4,261,664	$2,177,832
544	* Employment and payroll of federal govt, non-military	$12,106,125	61.6	$8,289,474	$12,106,125
	Direct Impact	**$173,250,528**	**1983.7**	**$138,018,815**	**$95,375,252**
	Secondary Impact	**$165,040,675**	**1017.3**	**$56,060,792**	**$95,810,587**
	Total Impact	**$338,291,203**	**3001.0**	**$194,079,607**	**$191,185,839**

* Jobs are presented in full-time equivalence (FTE)

Table 1-76. Alt 4 McKenzie River State Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				
19	Support activities for agriculture and forestry	$37,495,110	638.6	$35,192,712	$33,309,056
56	Construction of other new nonresidential structures	$116,577,500	1367.5	$97,862,403	$51,228,302
463	Environmental and other technical consulting services	$1,782,172	20.5	$1,289,949	$1,162,554
470	Office administrative services	$7,174,000	100.6	$5,740,616	$2,903,777
544	* Employment and payroll of federal govt, non-military	$16,141,500	82.1	$11,052,633	$16,141,500
	Direct Impact	**$179,170,283**	**2209.3**	**$151,138,312**	**$104,745,189**
	Secondary Impact	**$208,762,956**	**1158.6**	**$70,596,732**	**$119,240,987**

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Total Impact	**$387,933,239**	**3367.9**	**$221,735,044**	**$223,986,175**

* Jobs are presented in full-time equivalence (FTE)

Table 1-77. Alt 4 McKenzie River U.S. Impacts

IMPLAN Sectors	Industries	Output	Jobs*	Labor Income	Value Added
	Direct Impacts				
19	Support activities for agriculture and forestry	$37,576,525	690.3	$35,269,127	$33,381,381
56	Construction of other new nonresidential structures	$116,577,500	1367.5	$97,862,403	$52,553,517
463	Environmental and other technical consulting services	$1,791,607	20.6	$1,402,529	$1,242,525
470	Office administrative services	$7,174,000	100.6	$7,637,442	$3,259,467
544	* Employment and payroll of federal govt, non-military	$16,141,500	82.1	$11,566,679	$16,141,500
	Direct Impact	**$179,261,132**	**2261.2**	**$153,738,180**	**$106,578,391**
	Secondary Impact	**$393,160,539**	**1818.2**	**$122,075,555**	**$211,750,039**
	Total Impact	**$572,421,671**	**4079.4**	**$275,813,735**	**$318,328,429**

* Jobs are presented in full-time equivalence (FTE)

WILLAMETTE VALLEY SYSTEM OPERATIONS AND MAINTENANCE

DRAFT PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT

APPENDIX J: WATER SUPPLY

TABLE OF CONTENTS

List of Figures

LIST OF TABLES

CHAPTER 1 - INTRODUCTION

1.1 BACKGROUND

Water is critical for the sustenance and continued growth of the Willamette Valley, which is home to more than 70% of the population of Oregon. The Oregon Water Resources Department is the state entity responsible for managing water in the state, including issuing water rights to use the water, be it for consumptive uses, instream purposes, or storing water for future use. Water users in the Willamette Basin rely on natural river flow, groundwater, and stored water released from reservoirs to satisfy state issued water rights for many types of uses. The two main consumptive uses of water from rivers are municipal and industrial (M&I) water supply and agricultural irrigation. This appendix describes how effects to these two uses would be affected by the array of alternatives for the continued operation and maintenance of the WVS.

Use of water in the state of Oregon is governed by the Oregon Water Resources Department, which issues water rights for entities to be able to withdraw water from Oregon waterways, including groundwater wells. Oregon operates under the doctrine of prior appropriation, which means the person who first applies for use of water has first priority. The right to use water isn’t attached to the land adjacent to a waterbody. The priority date of the water right is what governs the priority of the use of water, not the type of use. Water rights include the source of the water, typically the stream name, and are for the natural or live flow of the river.

Water rights can also be issued for the purpose of storing water for later use. When the stored water is released, or discharged, from a reservoir, that water is considered stored flow and is treated as a different source of water on the water right even when the water is withdrawn from a naturally flowing stream reach. (OWRD, 2018)

1.1.1 Irrigation

The expansion of agricultural irrigation (AI) in the Willamette River Basin was slow until the 1940s. There were about 1,000 irrigated acres of farmland in the WRB in 1911 and 3,000 irrigated acres in 1920. By 1930, the basin contained 5,000 irrigated acres, which increased to 27,000 acres by 1940. A dramatic increase in the number of irrigated acres occurred in the WRB during the postwar decades. In 1964, approximately 194,000 acres were irrigated in the basin (OWRB, 1967). Irrigated acreage increased to about 300,000 acres by 2007, while irrigated acreage reported for 2012 decreased to a level of 250,000 acres (2007 and 2012 reported values from the U.S. Department of Agriculture, Census of Agriculture).

AI was recognized as a project purpose in the Willamette Valley System (WVS) authorizing legislation, and irrigation was thought to be the largest future use of WVS stored water at the time when the WVS was originally authorized. However, agricultural irrigation water demand in the Willamette Valley has not grown at the rate foreseen in the authorizing documents. Water use and conservation practices employed by the agricultural community also have changed since the WVS was authorized. WVS conservation storage totals approximately 1,590,000 acre-feet. Of this total, only 82,815 acre-feet of stored water (less than 5 percent of the conservation storage volume) is currently (as of October 2022) contracted through Reclamation for irrigation use, though it should be noted that the vast majority of AI is not reliant on Reclamation water service contracts. At the current low level of use for water service contracts it is typically not necessary for the Corps to make special operational adjustments (i.e., increasing WVS releases) to meet current contract requirements, with the exception being at Detroit Dam on the North Santiam River and Fern Ridge Dam on the Long Tom River where there are operational adjustments to satisfy Reclamation's water service contracts.

Oregon's 2015 Statewide Long Term Water Demand Forecast provides a 2015 estimate of 605,700 acre-feet of water per year diverted for AI use within the Willamette River basin, and an estimate of 708,400 acre-feet of water per year by the year 2050 under hotter-drier conditions (a 35-year increase of 102,700 acre-feet of water per year) (OWRD 2015). This study looked only at the amount of water that may be needed under a future climate scenario for existing lands currently covered by irrigation water rights and did not include irrigation use new lands brought into agricultural production.

Irrigation water rights in Oregon identify a season of use, a rate, and a duty of water, which vary by location within the state. The season is the period of the year in which the right can be exercised, which typically corresponds to the growing season. The rate is the maximum amount of water that may be diverted or pumped, which is normally expressed in cfs. Duty is the volume of water that can be applied over the course of the season associated with the water right, which is normally expressed in acre-feet of water applied per acre. The maximum rate cannot typically be sustained on a full-time basis without exceeding the duty; from a practical water-use accounting standpoint, few water rights holders measure their rates, or their duties.

Based on the forecasted demand for stored water for agricultural irrigation in Corps' affected river reaches as detailed in the WBR, a total of 327,650 acre-feet was reallocated to the specific use of irrigation in the Water Resources Development Act of 2020 (WRDA) (USACE 2019).

Table 1-1 below lists the water rights (live flow and stored water) for irrigation purposes on rivers affected by USACE operations. The mainstem Willamette River has the largest number of water rights by quantity of cfs diversions, with the North Santiam River and Long Tom River the next highest. It is important to note that the Long Tom River is much smaller than the North Santiam River yet has a high number of irrigation water rights on it.

Table 1-1. Irrigation Water Rights in USACE affected waterways

Reach	Irrigation Surface Water Diversions (number)	Irrigation Surface Water Diversions (cfs)
Coast Fork Willamette River	169	94.16
Row River	38	5.23
Middle Fork Willamette River	71	13.46

Reach	Irrigation Surface Water Diversions (number)	Irrigation Surface Water Diversions (cfs)
Fall Creek	27	8.25
McKenzie River	309	102.42
Long Tom River	250	181.43
North Santiam River	359	192.55
South Santiam River	205	67.34
Santiam River	181	137.51
Willamette River	53	1277

1.1.2 Municipal and Industrial

The Willamette River and its tributaries are a major source of water for municipal and industrial needs. Table 1-2 lists the number of water rights and associated flow in cfs of municipal and industrial water rights in reaches downstream of USACE dams, including the mainstem Willamette River. As population increases throughout the basin, M&I system needs increase – putting pressure on existing water supplies. To date, M&I systems rely on natural streamflow and groundwater wells in the Willamette Basin, though population growth is leading to a demand for water that exceeds existing supplies for many M&I systems throughout the basin. This need was one of the factors that led to the Willamette Basin Review Feasibility Study project, which resulted in a total of 159,750 acre-feet of conservation storage reallocated to the purpose of municipal and industrial water supply. To date, there are no agreements for using storage from any of the Willamette Project reservoirs for M&I water supply, but there is significant interest in pursuing new agreements among water suppliers in the Willamette Basin.

Table 1-2. Municipal and Industrial Water Supply water rights in USACE affected waterways.

Reach	Municipal Surface Water Diversions (number)	Municipal Surface Water Diversions (cfs)	Industrial Surface Water Diversions (number)	Industrial Surface Water Diversions (cfs)
Coast Fork Willamette River	26	3.91	15	4.53
Row River	7	10.92	0	0
Middle Fork Willamette River	4	6.95	8	4.65
Fall Creek	0	0	0	0
McKenzie River	30	409.56	19	198.48
Long Tom River	4	1.49	2	0.36
North Santiam River	22	68.92	23	15.11
South Santiam River	20	218.11	18	21.45

Reach	Municipal Surface Water Diversions (number)	Municipal Surface Water Diversions (cfs)	Industrial Surface Water Diversions (number)	Industrial Surface Water Diversions (cfs)
Santiam River	7	6.51	1	0.67
Willamette River	92		53	

M&I systems must fully incorporate future population growth and peak season water supply demand in their long-term planning. As a result, M&I systems apply for water rights that are in excess of water presently needed so that an adequate supply would be ensured when sufficient numbers of ratepayers live in a community to justify and pay for the construction work on new diversion, conveyance, and treatment facilities. M&I systems are almost never in a position to complete full build-out of their water systems when they apply for a permit, as they lack the immediate need and ratepayer support. Still, the core mission for every M&I supplier is to secure a safe, adequate, and reliable water supply to meet current and future demand. By its nature, then, municipal water supply planning dictates identification of water supplies to meet projected needs decades into the future.

Municipalities are often given preferential treatment under the Oregon water rights system because of the public safety component of municipal water use, which is called the “Growing Communities Doctrine.” The following are the components of municipal water use preferences in Oregon, which make up the Growing Communities Doctrine:

- Municipalities are not required to initiate construction of surface water diversion works within one year of being issued a water right permit (systems have up to 20 years to initiate construction plus an opportunity for extension); (FN: ORS 537.230);
- If the water right permit is to store water for municipal use, municipalities have ten years to begin and complete construction of diversion or storage works; however, systems may apply for extensions in ten-year increments; (FN: ORS 537.248);
- A municipality can certificate a portion of its water right permit without cancellation of the remaining portion of water authorized to be diverted under the right. To do so, the municipality must “perfect”, or use, at least 25 percent of the amount authorized on the permit; (FN: ORS 537.260(4));
- A municipal water right generally is not subject to forfeiture. Although a water right that is unused for five consecutive years is presumed forfeited, the presumption is overcome by showing that the use was for a municipal purpose; (FN: ORS 540.610(2)(a));
- Water rights issued to a municipality may be used on lands to which the right is not appurtenant, under certain circumstances; and
- Municipal uses for human consumption may take preference over other types of senior instream water rights established through the permitting process (as opposed to conversion

or acquisition) if Oregon Water Resources Department (OWRD) determines that this would be in the public interest.

Taken together, this means that there are undeveloped municipal water rights throughout the basin because use and population for some municipalities have not yet grown to the extent reflected in their existing water right permits. It is important to note that undeveloped municipal uses are considered by OWRD when water availability calculations are conducted.

1.1.3 Storage Allocations

The *Willamette Basin Review (WBR) Feasibility Study* (USACE 2019) started in 1996 to investigate the demand for stored water in the Willamette Basin and how to best utilize the water stored in the WVS reservoirs to meet that demand. USACE and the Oregon Water Resources Department (OWRD) were the federal and non-federal sponsors, respectively, for the WBR. The study was put on hold in 2000 pending completion of Endangered Species Act consultation process for the continued operation of the WVS. It wasn't until 2015 that the study was re-initiated with the specific goal to reallocate conservation storage for the benefit of ESA-listed fish, agricultural irrigation, and municipal and industrial water supply, while continuing to fulfill other project purposes. The WBR study analyzed current water uses in the basin for the project purposes and proposed a combined conservation storage reallocation and water management plan that would provide the greatest public benefit within the bounds of the policies and regulations of USACE and the State of Oregon (USACE 2019).

The study proposed a volume of conservation storage that would be dedicated to irrigation, M&I, and fish and wildlife, all Congressionally authorized purposes of the WVS. The WVS is operates as a system of reservoirs, with operations shaping flow levels from each reservoir depending downstream needs and how much water is available in each reservoir based on general water management seasonal goals. Due to the system-wide nature of the WVS, the decision was made to reallocate storage on a system-wide basis rather than at each individual reservoir, maintaining operational flexibility of the system.

USACE consulted with the National Marine Fisheries Service (NMFS) on the proposed reallocation volumes and subsequent use of the M&I allocation volumes. NMFS issued a Biological Opinion (WBR BiOp) in June 2019 (NMFS 2019), concluding that the reallocation and subsequent use of the M&I and irrigation volumes was likely to jeopardize the continued existence of ESA-listed Upper Willamette River Chinook salmon and Upper Willamette River Steelhead. As part of the WBR BiOp, NMFS provided a Reasonable and Prudent Alternative (RPA) to offset the effects of the proposed reallocation and use of the water. The RPA included five reasonable and prudent measures, including a cap of 11,000 acre-feet on the USACE issuance of M&I water storage agreements until NMFS determines that instream flows are adequately protected by the state of Oregon (RPA Measure 2), and adaptive management of available water supply that prioritizes releases of water for instream purposes (F&W) over M&I and irrigation in dry water years (RPA Measures 3 and 4).

Congress authorized the reallocation of conservation storage as proposed in the WBR in the Water Resources Development Act of 2020. WRDA also gave the USACE the ability to reallocate up to 10% of the total storage volume to fish and wildlife purpose as long as that volume didn't come from a single purpose based on the outcome of the ongoing ESA Section 7 Consultation for the operation and maintenance of the WVS.

Table 1-3 below lists the acre-feet of storage space reallocated from joint-use to each specific use on a system-wide basis.

Table 1-3. WBR Reallocation Volumes and Percent of the Conservation Pool

Allocation Category	Allocation Volume (acre-feet)	Percent of Conservation Pool (%)
Municipal and Industrial	159,750	10
Irrigation	327,650	21
Fish and Wildlife	1,102,600	69

1.2 AREA OF ANALYSIS

The USACE dams and reservoirs are not on all of the tributaries of the Willamette River basin and hence cannot affect all the waterways in the basin. This analysis focuses on the river reaches downstream of WVS dams and reservoirs and on the mainstem Willamette River upstream of Willamette Falls.

CHAPTER 2 - METHODS

2.1 OVERVIEW

The source of water is listed on water rights issued by the State of Oregon and includes surface water and groundwater. Surface water includes the natural flow in the stream, or live flow, or stored water, i.e., water released from a storage reservoir.

This analysis uses ResSim output flow data at control points downstream of dams to assess effects to live flow water rights.

As noted in Chapter 1 above, use of stored water released from USACE reservoirs is currently withdrawn from the rivers for irrigation purposes, and in the future will be withdrawn to serve municipal and industrial demands. This analysis uses the modeled peak system-wide storage achieved by May 20 with a non-exceedance of 75% to assess impacts to storage allocations, and hence stored water users.

2.2 DATA COLLECTION AND PREPARATION

2.2.1 Water Rights

OWRD maintains the Water Rights Information System (WRIS) database for water rights in Oregon. The water rights query tool was used to find water rights for municipal and industrial and irrigation uses as of July 2021. Data was grouped by sub-basin, e.g., North Santiam River Basin. Water rights data were analyzed for duplicate point of diversion to ensure flows were not double counted

2.2.2 ResSim Data

ResSim flow data at the control points downstream of dams and on the mainstem was used to compare flows between the action alternatives and the no action alternative to quantitatively assess impacts to live flow water rights downstream of the dams. Non-exceedance plots are used to illustrate the general trends between an action alternative and the no action alternative.

Effects to M&I water supply agreements and irrigation water service contracts was assessed by evaluating the amount of water stored system-wide in the conservation pool by mid-May, at a 75% non-exceedance level.

2.3 ALTERNATIVE ANALYSIS

The analysis in Chapter 3 uses modeled output from ResSim to assess effects of the alternative operations and maintenance alternatives for the WVS.

The ResSim model includes a hard coded set of additional releases for consumptive uses, withdrawals of these same volumes, and a set of return flows associated with these withdrawals. Appendix B contains the full details of the ResSim model setup, including the rules for the consumptive uses. Each project releases a proportionate share of the M&I and irrigation stored water use. While the NAA ResSim model codes each year based on available storage and includes reductions in releases and withdrawals for consumptive uses based on the water year type determination, the action alternatives do not. Due to limitations with available rules in ResSim, the model was set up so that the full demand was released from the reservoirs when each individual reservoir elevation was above minimum conservation pool and the full demand was always withdrawn from the river reaches downstream of USACE dams, even if water was not being released to meet this withdrawal. Return flows associated with the demands were also included in the model. This condition is present in all action alternatives.

The NAA continues the current water management objectives, which attempt to manage reservoir levels to balance the needs of all authorized purposes. Water would be released from the reservoirs to satisfy demands of stored water for municipal and industrial uses at the 2050 demand level as the Corps assumed requirements in the WBR BiOp RPA were met and the cap of 11,000 acre-feet of contracts would no longer be in effect. See Appendix B for further details on distribution of these demands. There would be no increased releases for irrigation water service contracts as the NAA assumes the current cap of 95,000 acre-feet on these contracts from the 2008 NMFS BiOp remains in place.

All action alternatives include the same level of M&I uses as the NAA, but include an increase of irrigation demand for stored water. The 2050 demands level was also selected for irrigation demands in line with the M&I level of demand. The volume evaluated in the action alternatives is considered the existing level of irrigation use present in the hydrology dataset (which includes 50,231 acre-feet of BOR water service contracts), existing withdrawals for which the live flow water right would be junior to newly converted instream water rights (62,050 acre-feet), plus the 2050 level of demand for new BOR water service contracts (110,520 acre-feet), for a total of 222,801 acre-feet.

As noted in Appendix B, Sections 2.3 and 2.4, the ResSim model used the 2010 Modified Flow dataset with an extension of the hydrology dataset to 2019. This extension kept the same level of irrigation as in the 2010 dataset, therefore did not show an increase in irrigation use, be it from live flow water rights or stored water associated with a BOR water service contract. The current volume of BOR contracts is 82,815, a difference of 32,584 acre-feet. This volume equates to a daily average of 76 cfs throughout the course of the contract. The majority of the contracts are on the mainstem Willamette River, downstream of Salem, where flows in the summer are approximately 6,000 during the lowest flow period of the summer. The difference in flows from 2008 to 2022 would be approximately 1.3 percent of the total flow in the river, which is less than what is considered an excellent gage error value by the USGS. Therefore, while the model itself quantitatively only considers effects of 222,201 acre-feet, the Corps is considering the effects of 255,385 acre-feet of stored water used for irrigation in the analyses contained in the PEIS.

The irrigation storage allocation included 62,050 acre-feet for current irrigation water rights that would become junior to instream water rights once the minimum perennial streamflows are converted to instream water rights and would therefore need a secondary source of water in years of low live flow. This volume is not added into the ResSim model as the effects of the irrigation withdrawals are already included in the hydrology dataset, as well as the release of stored water to meet instream flow targets.

2.3.1 Storage Allocations

The change in peak mid-May system-wide stored water volumes between the NAA and action alternative was calculated to assess effects to stored water users.

How often allocations would be affected is also related to how often biologically based minimum flow targets are met or not met. RPA 2 of the WBR BiOp requires the USACE to notify users how much available stored water will be available to meet storage agreements in any given year. This RPA is applicable to all alternatives, including the NAA. As noted above, since the withdrawals for consumptive uses are hard coded into the model, water may be withdrawn in the model when it would not be available for withdrawal if flow targets are not being met.

2.3.2 Live Flow Water Rights

Effects to live flow water rights is based modeled flow changes at control points downstream of the USACE dams. As each year will be a different hydrologic regime, it is not possible to calculate effects to specific water rights, it also speculative for USACE to determine which water rights would be curtailed and when, as each decision is made on a case-by-case basis and adaptively based on real time in season adjustments and changes.

CHAPTER 3 - PHYSICAL EFFECTS ANALYSIS

3.1 NO ACTION ALTERNATIVE

3.1.1 Storage Allocations

Figure 3-1 shows that 75% of the time, the maximum total volume of water stored in the WVS reservoirs would be at least 1.3 million acre-feet, resulting in enough stored water to meet the M&I and irrigation demands in most years. Stored water would not be available to meet all M&I storage agreements and irrigation water service contracts in the driest years. The amount available would be determined on an annual basis based on realized storage volumes across the system.

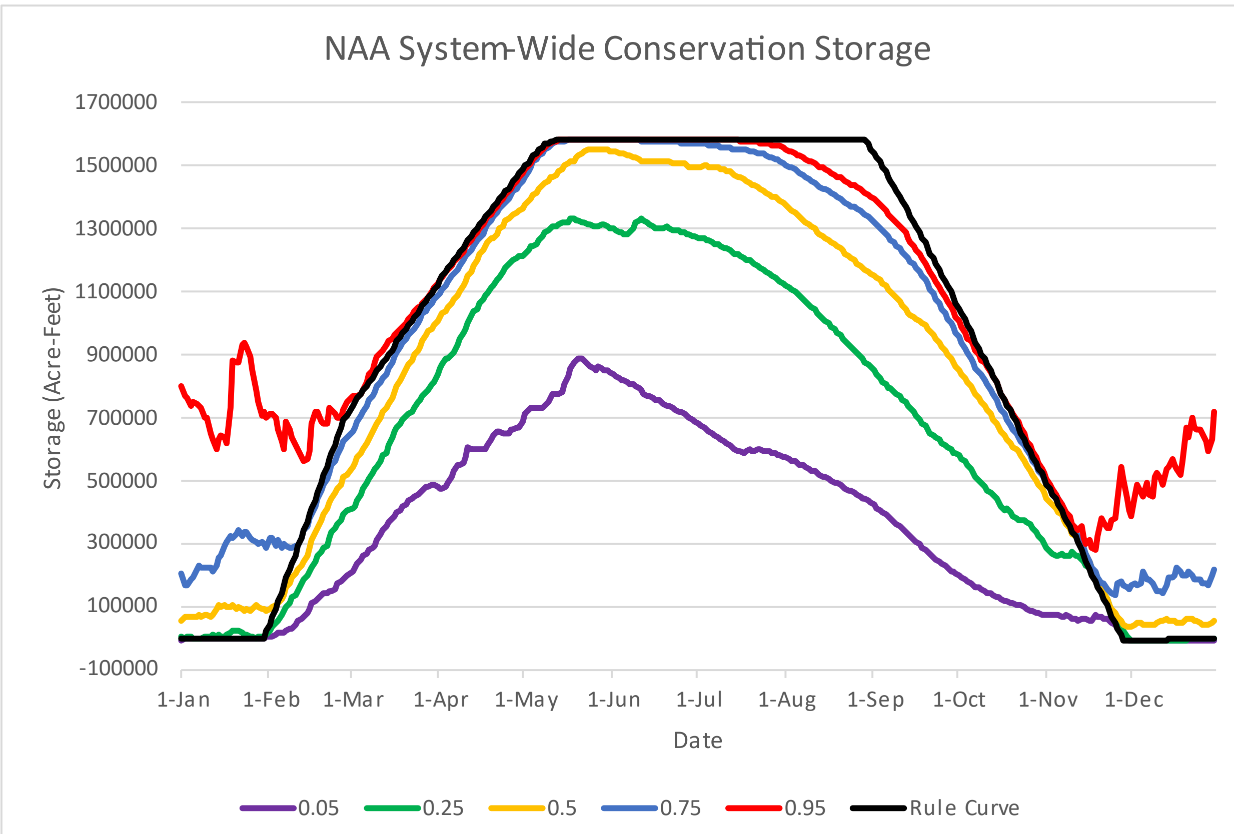


Figure 3-1.System Wide Conservation Storage for the No Action Alternative

3.1.2 Live Flow Water Rights

Flows downstream of the WVS dams would continue to support existing water rights in the same frequency as they do today. Not all live flow water rights are fully met in all years and in all months under existing conditions and this would continue under the NAA due to hydrologic conditions beyond the control of the USACE. Figure 3-2 through Figure 3-9 show the non-exceedance flows for the calendar year for the river reaches affected by WVS dams.

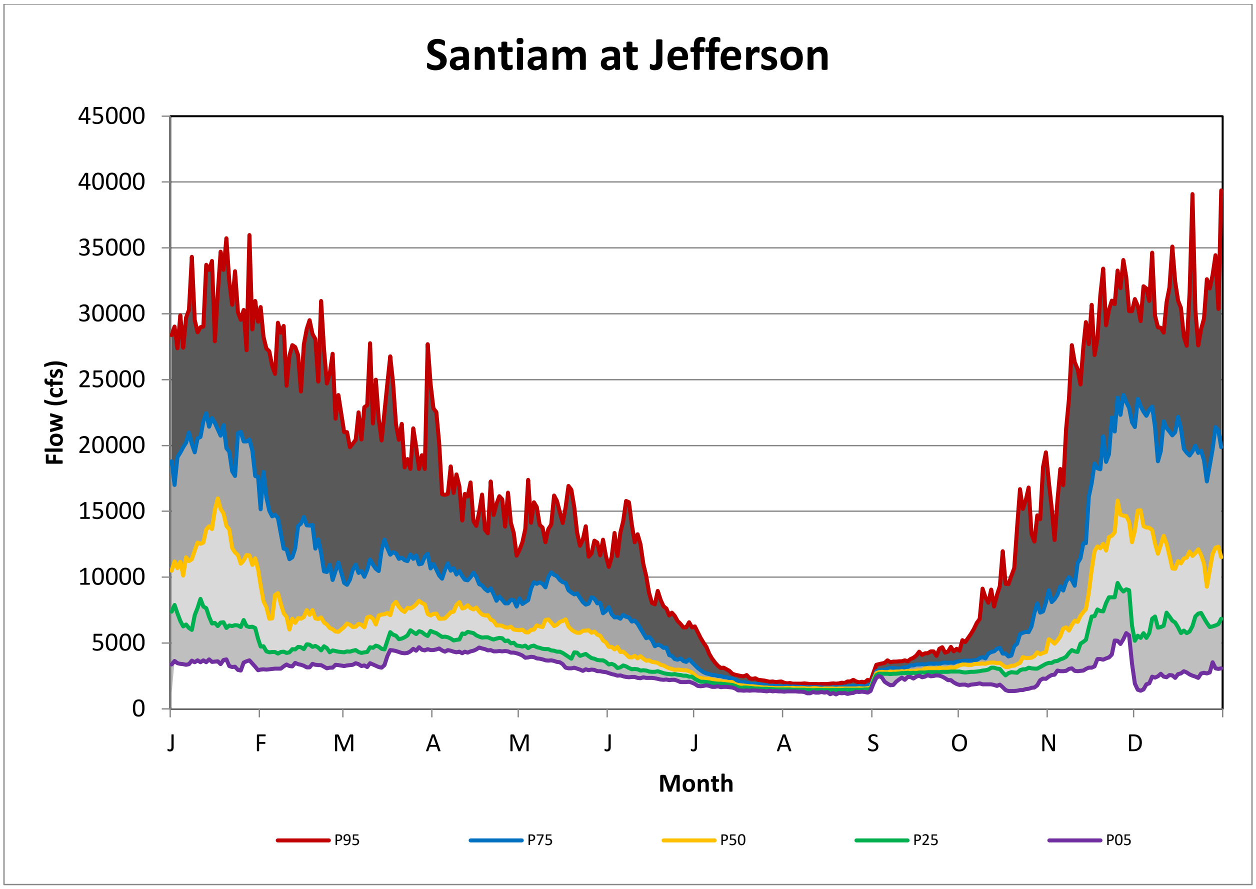


Figure 3-2. Non-Exceedance Flows at Jefferson on the Santiam River under the No Action Alternative

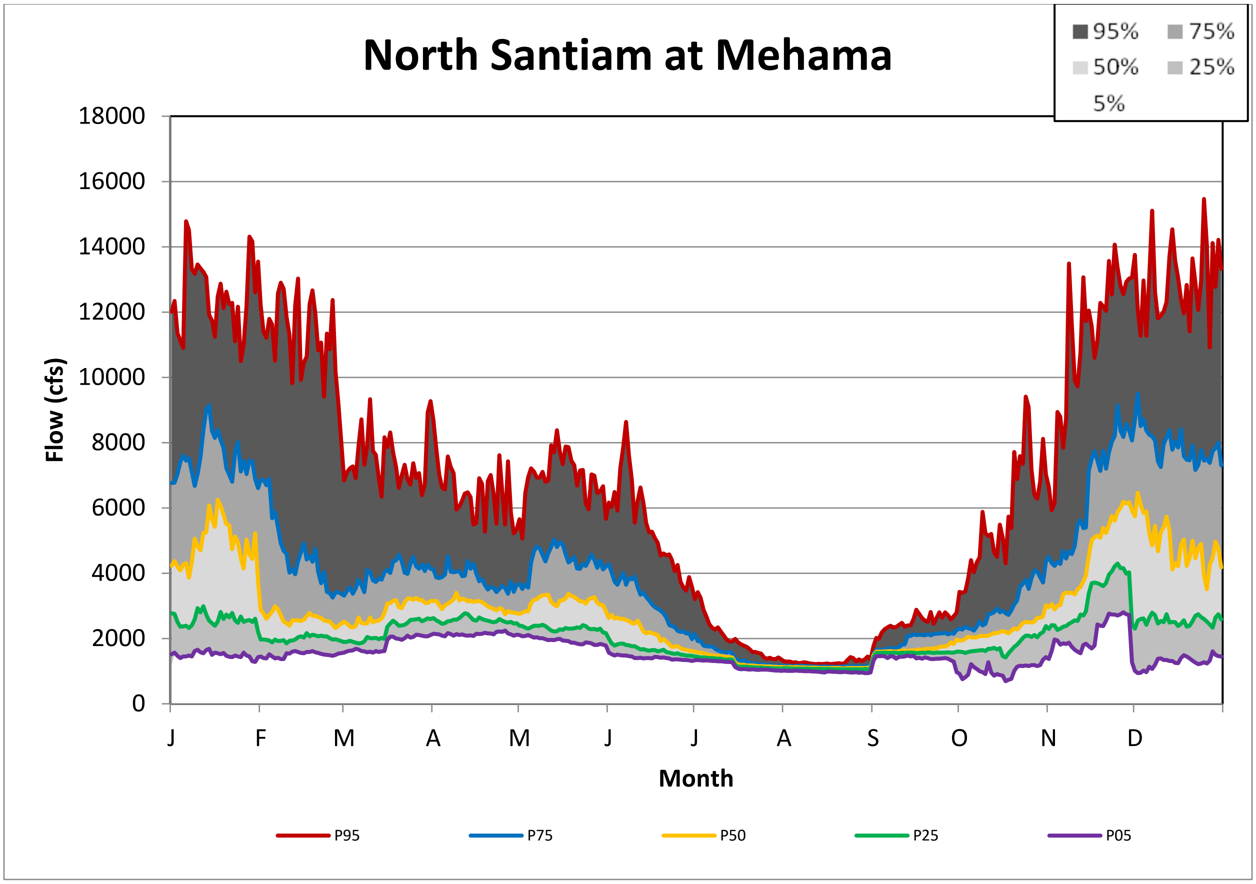


Figure 3-3. Non-Exceedance Flows at Mehama on the North Santiam River under the No Action Alternative

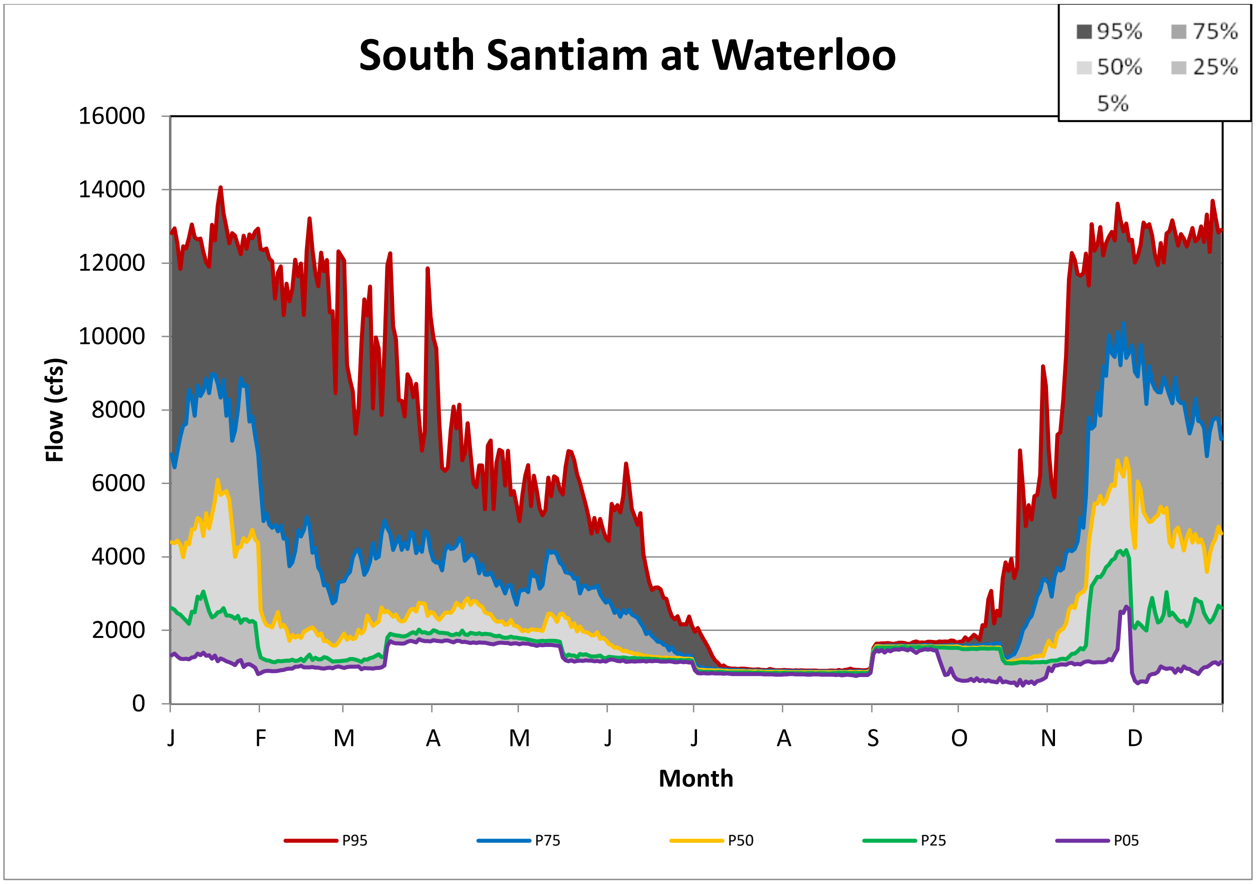


Figure 3-4. Non-Exceedance Flows at Waterloo on the South Santiam River under the No Action Alternative

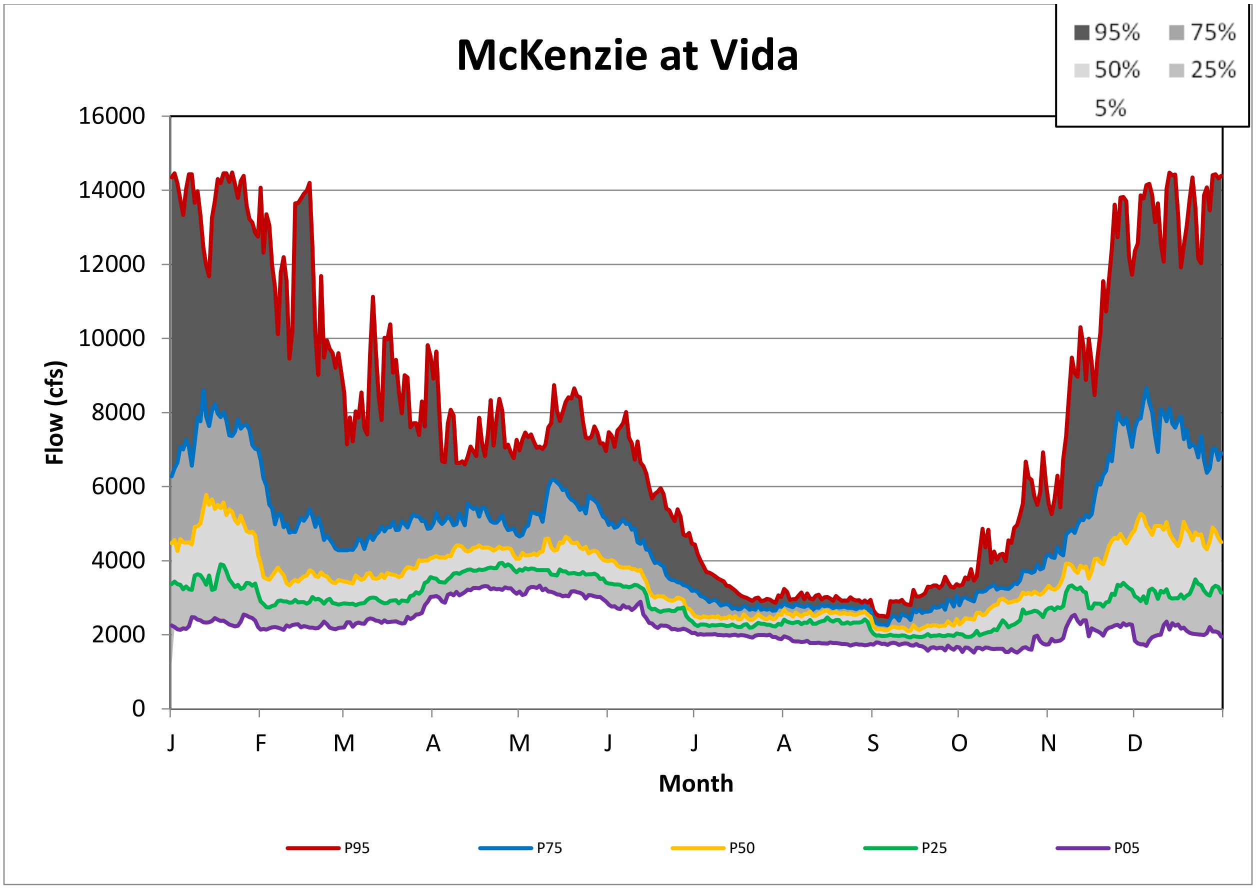


Figure 3-5. Non-Exceedance Flows at Vida on the McKenzie River for the No Action Alternative

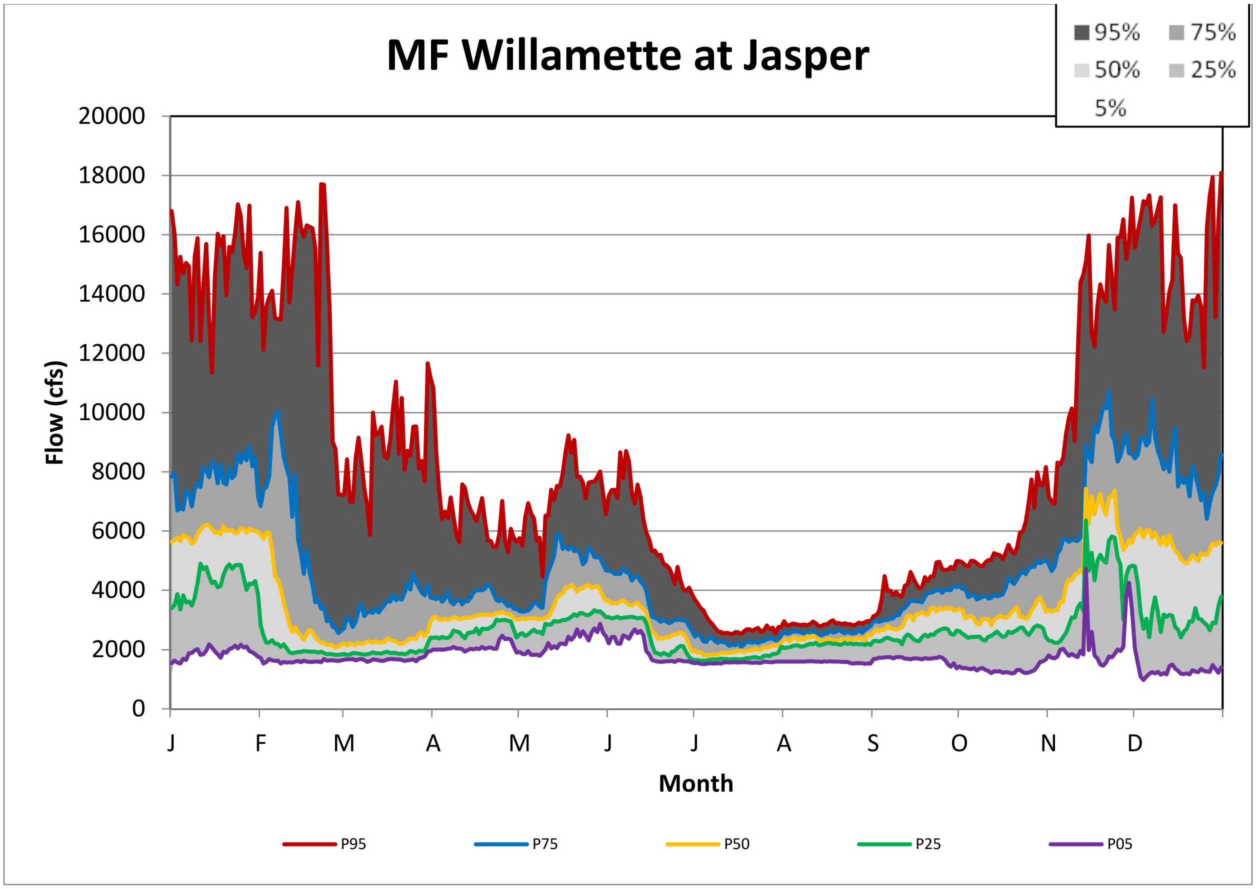


Figure 3-6. Non-Exceedance Flows at Jasper on the Middle Fork Willamette River for the No Action Alternative

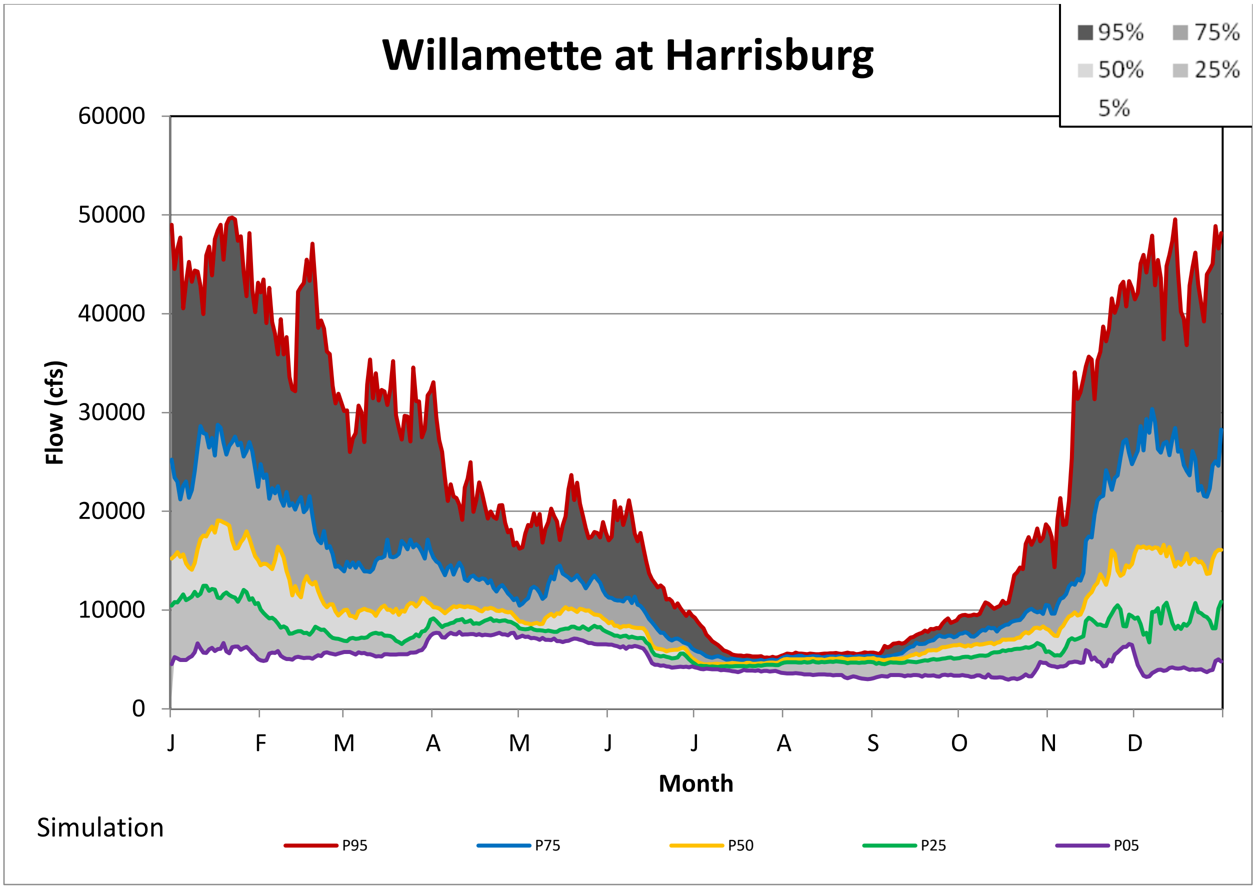


Figure 3-7. Non-Exceedance Flows at Harrisburg on the Willamette River under the No Action Alternative

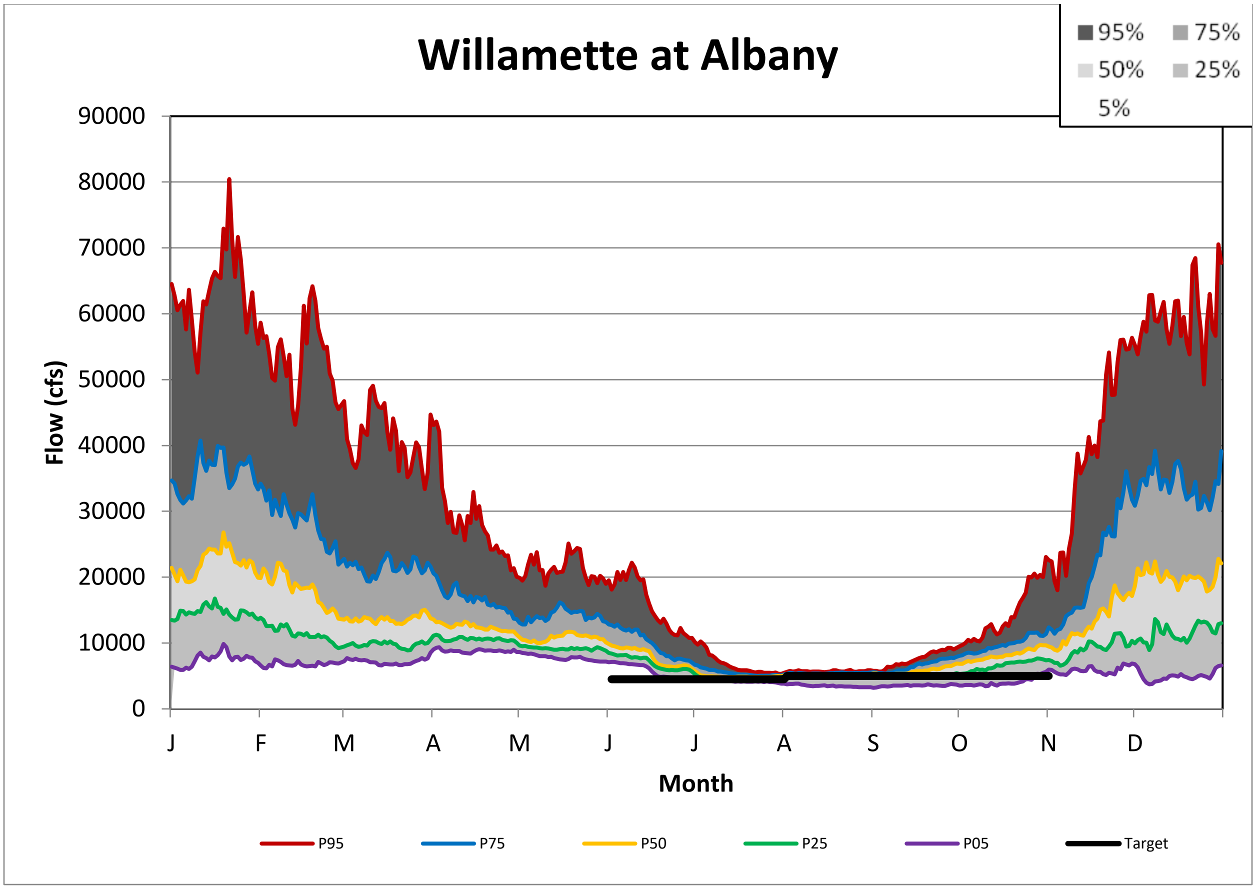


Figure 3-8. Non-Exceedance Flows at Albany on the Willamette River under the No Action Alternative

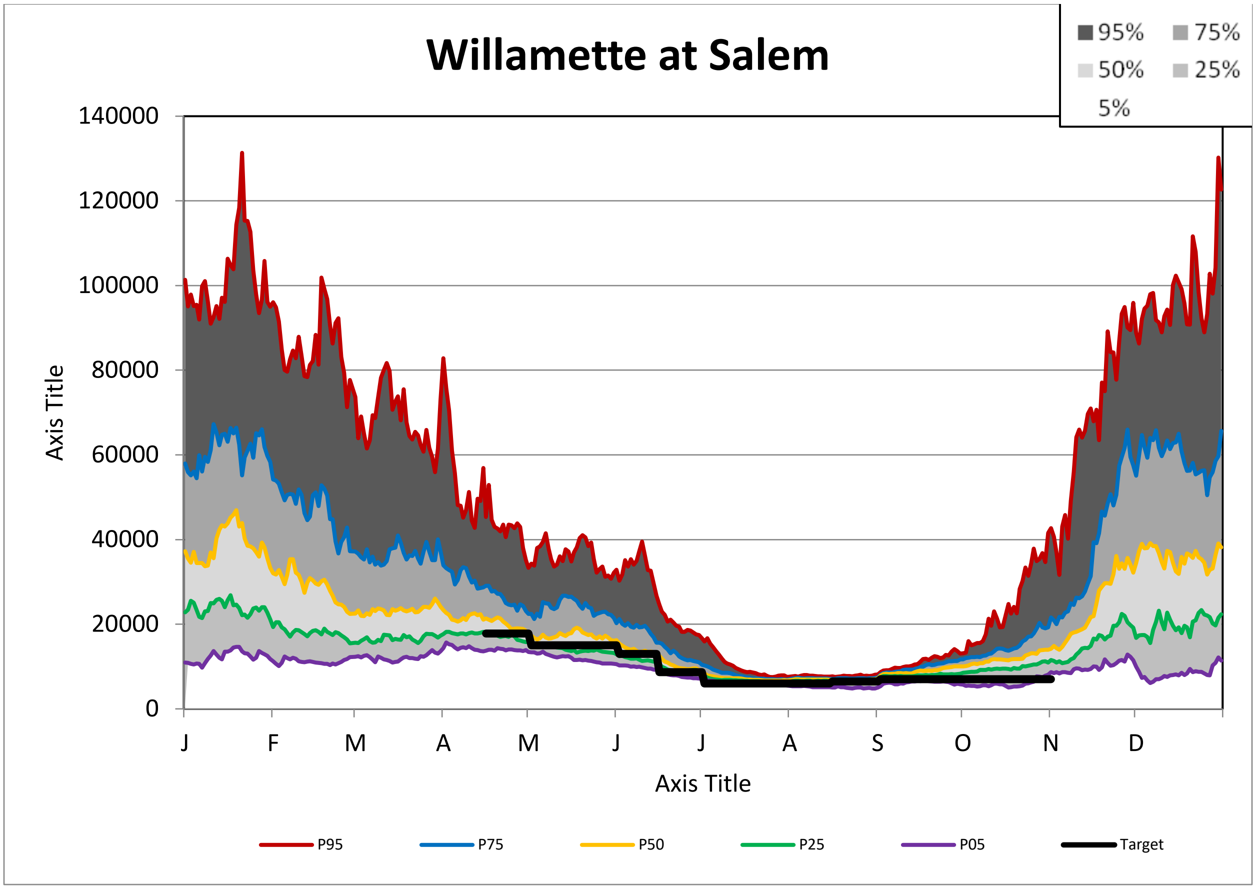


Figure 3-9. Non-Exceedance Flows at Salem on the Willamette River under the No Action Alternative

3.2 ALTERNATIVE 1

3.2.1 Storage Allocations

Figure 3-10 shows that peak water stored in the conservation pool at the 75% non-exceedance level would be approximately 1,497,000 acre-feet, an increase of 168,000 acre-feet in the dry years relative to the NAA, resulting in a **moderate** beneficial effect to system-wide storage allocations and the municipal and industrial water supply and irrigation users relying on stored water. Stored water would still not be available to meet all M&I storage agreements and irrigation water service contracts in the driest years, but to a lesser extent than in the NAA. The amount available would be determined on an annual basis based on realized storage volumes across the system.

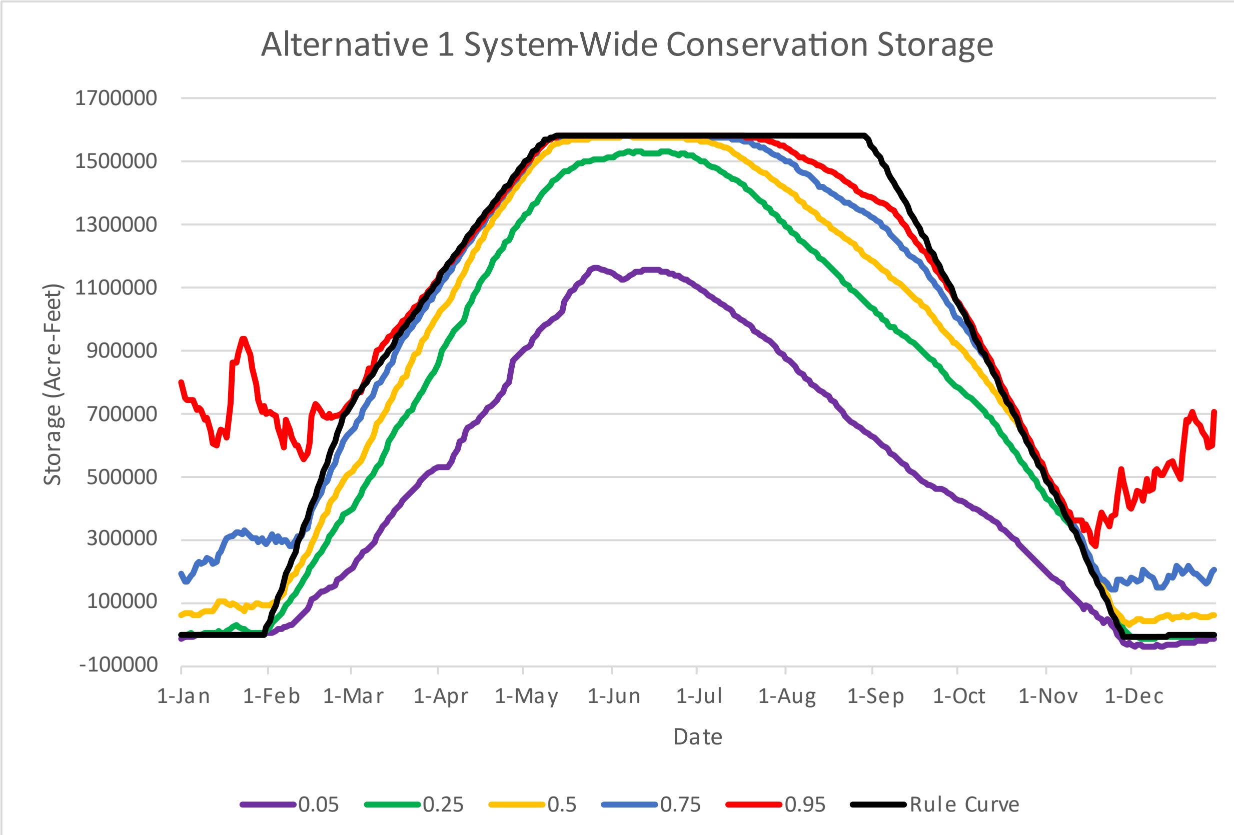


Figure 3-10. System Wide Conservation Storage for Alternative 1

3.2.2 Live Flow Water Rights

3.2.2.1 Santiam River

Flows at Jefferson on the Santiam, downstream of the confluence of the North and South Santiam Rivers, are lower than the NAA from mid-March through June and again in September in dry years, and nearly equal in the summer and all years. As the flows are lower during a portion of the spring and summer in the dry years, Alternative 1 would have a minor adverse effect on water supply in the Santiam River.

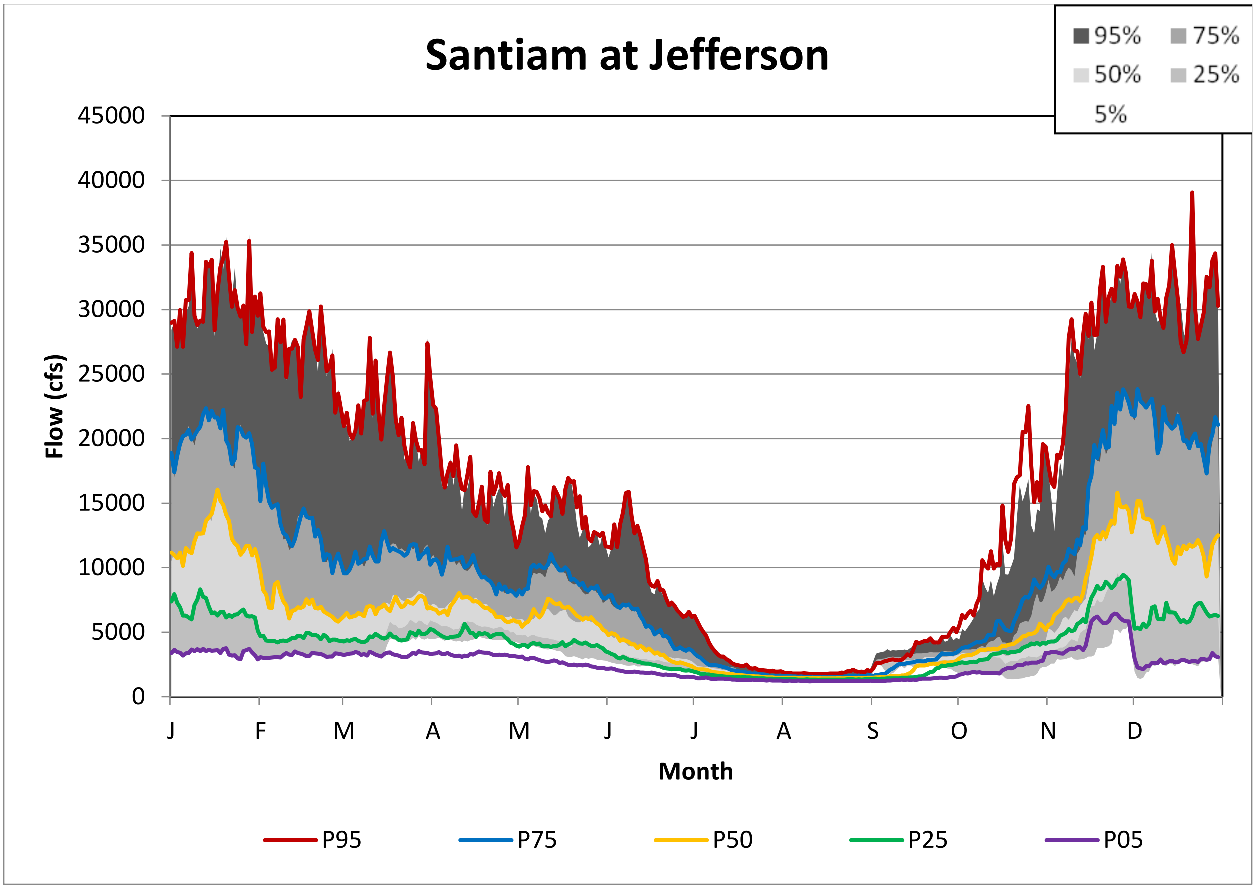


Figure 3-11. Non-Exceedance Flows at Jefferson on the Santiam River under Alternative 1

North Santiam River

Operations affecting water supply in the North Santiam Basin include releasing flow according to the original House Document 531 flow regimes, which are less than the 2008 BiOp flow targets used currently and under the NAA.

Flow at Mehama, a key indicator for water supply users on the North Santiam, is lower in the spring as compared to the NAA, reflecting the lower spring target flows compared to the NAA. Flows drop close to 1000 cfs during parts of the spring and summer during the driest years, resulting in Detroit Reservoir filling higher than in the NAA. The reservoir would reach minimum conservation pool later in the year, following the rule curve. Real time water management of the reservoir would be capable of managing flows in the North Santiam River, as to result in only a minor adverse effect to users relative to existing conditions. This effect would be local and occur only in drier years.

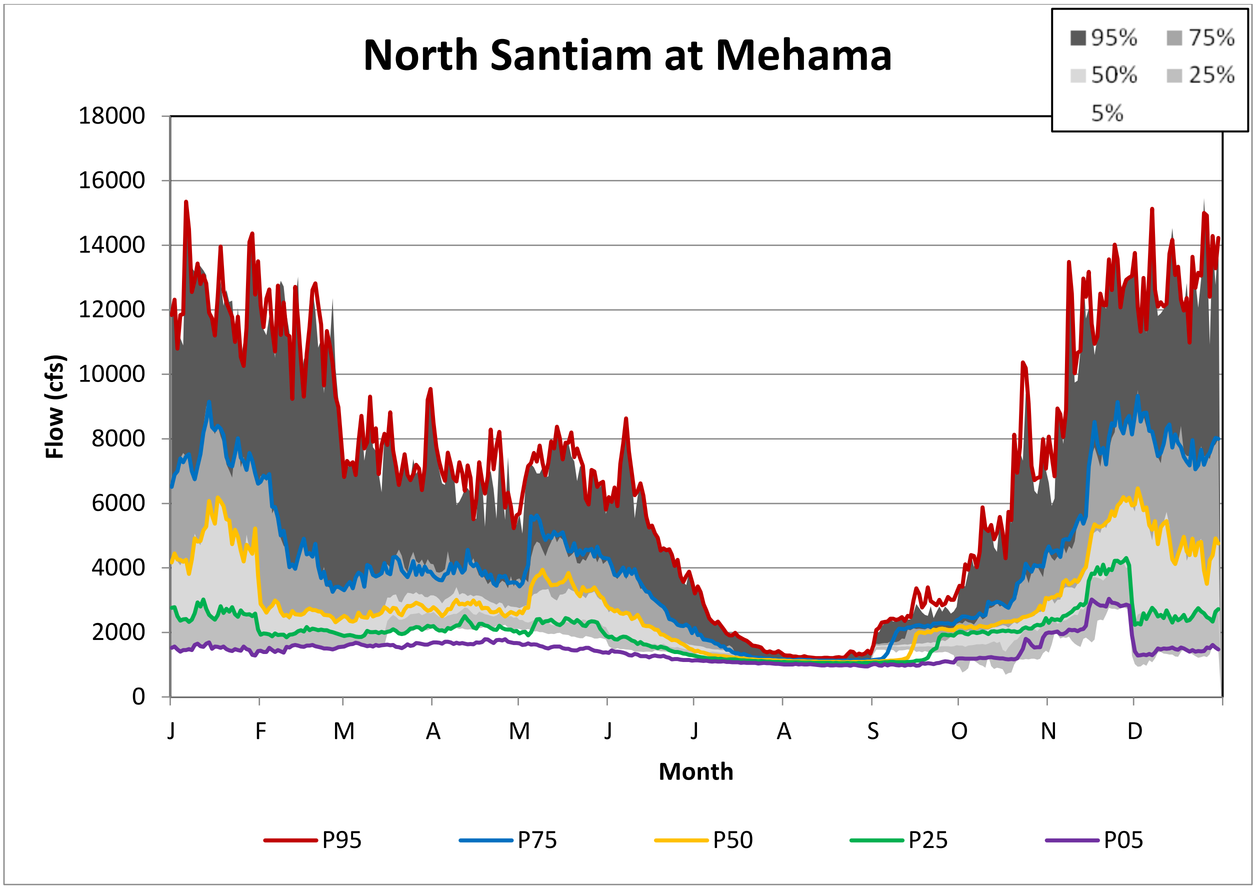


Figure 3-12. Non-Exceedance Flows at Mehama on the North Santiam River under Alternative 1

South Santiam River

Operations affecting water supply in the South Santiam Basin include releasing flow according to the original House Document 531 flow regimes.

Flows at Waterloo on the South Santiam are lower than the NAA from mid-March through June in drier years, but nearly equal during the summer most years. As the flows are lower during the spring in drier years, Alternative 1 would have a minor adverse effect on water supply in the South Santiam River.

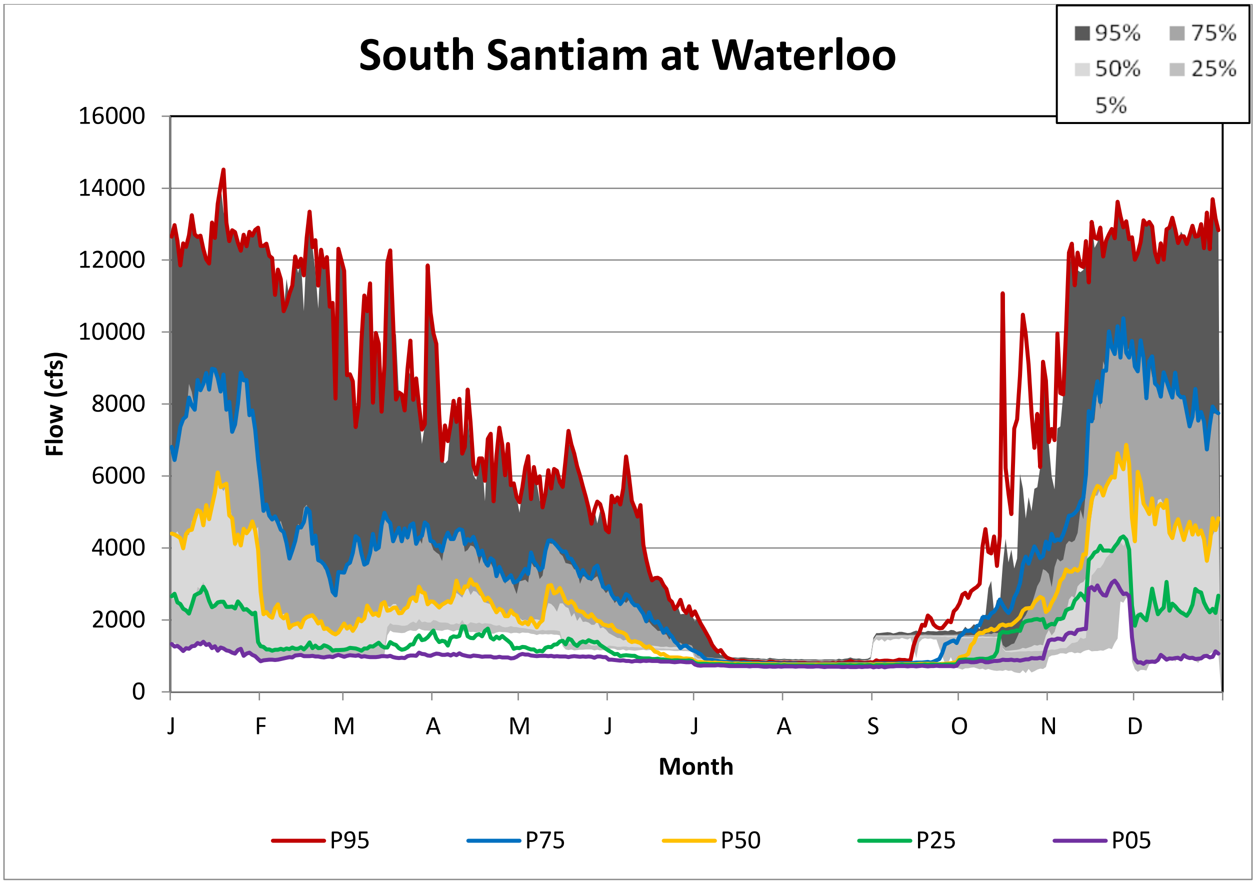


Figure 3-13. Non-Exceedance Flows at Waterloo on the South Santiam River under Alternative 1

3.2.2.2 McKenzie River

Operations affecting water supply in the McKenzie Basin include releasing flow according to the original House Document 531 flow regimes.

Flows at Vida on the McKenzie River are lower than the NAA from April through mid-June but slightly higher mid-June through September in the dry years. As the flows are lower during a portion of the spring but higher during critical summer months in dry years, Alternative 1 would have a negligible effect on water supply in the McKenzie River.

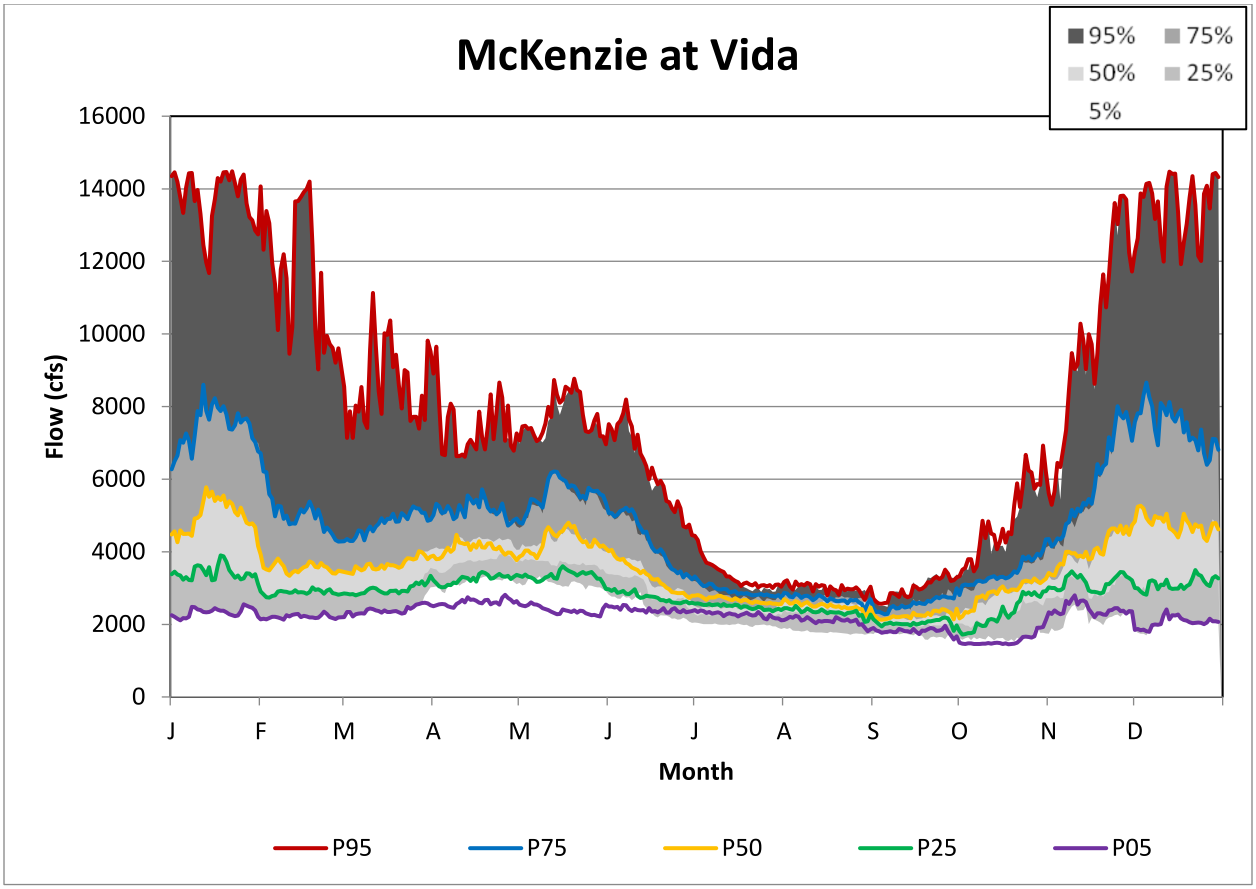


Figure 3-14. Non-Exceedance Flows at Vida on the McKenzie River under Alternative 1

3.2.2.3 Middle Fork Willamette

Flows at Jasper on the Middle Fork Willamette River, downstream of Hills Creek, Lookout Point, and Fall Creek reservoirs, are lower than the NAA from April through mid-June about 50% of the time, but higher than the NAA during the summer months. As the flows are only lower during a portion of the spring, and only in drier years, but higher during later summer, Alternative 4 would have a **negligible** effect on water supply in the Middle Fork Willamette River.

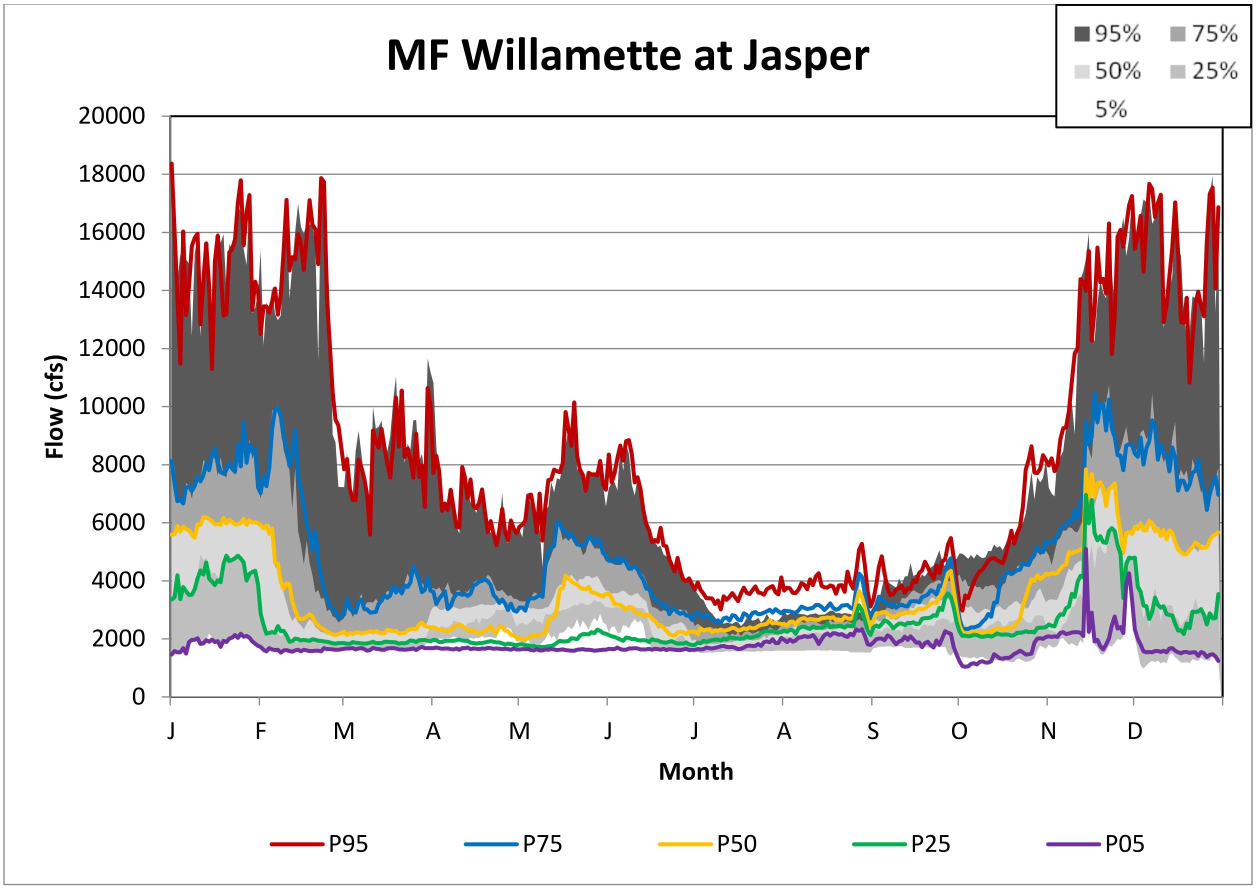


Figure 3-15. Non-Exceedance Flows at Jasper on the Middle Fork Willamette River under Alternative 1

3.2.2.4 Mainstem Willamette

Operations affecting water supply on the mainstem Willamette River include releasing flow according to the original House Document 531 flow regimes.

Flows at Harrisburg on the Willamette River, downstream of the McKenzie River confluence, are lower than the NAA from April through mid-June about 25% of the time, but higher or equal to the NAA during the summer months. As the flows are only lower during a portion of the spring, still staying above 4000 cfs, and only in the drier years, Alternative 1 would have a negligible effect on water supply in the Willamette River above Harrisburg.

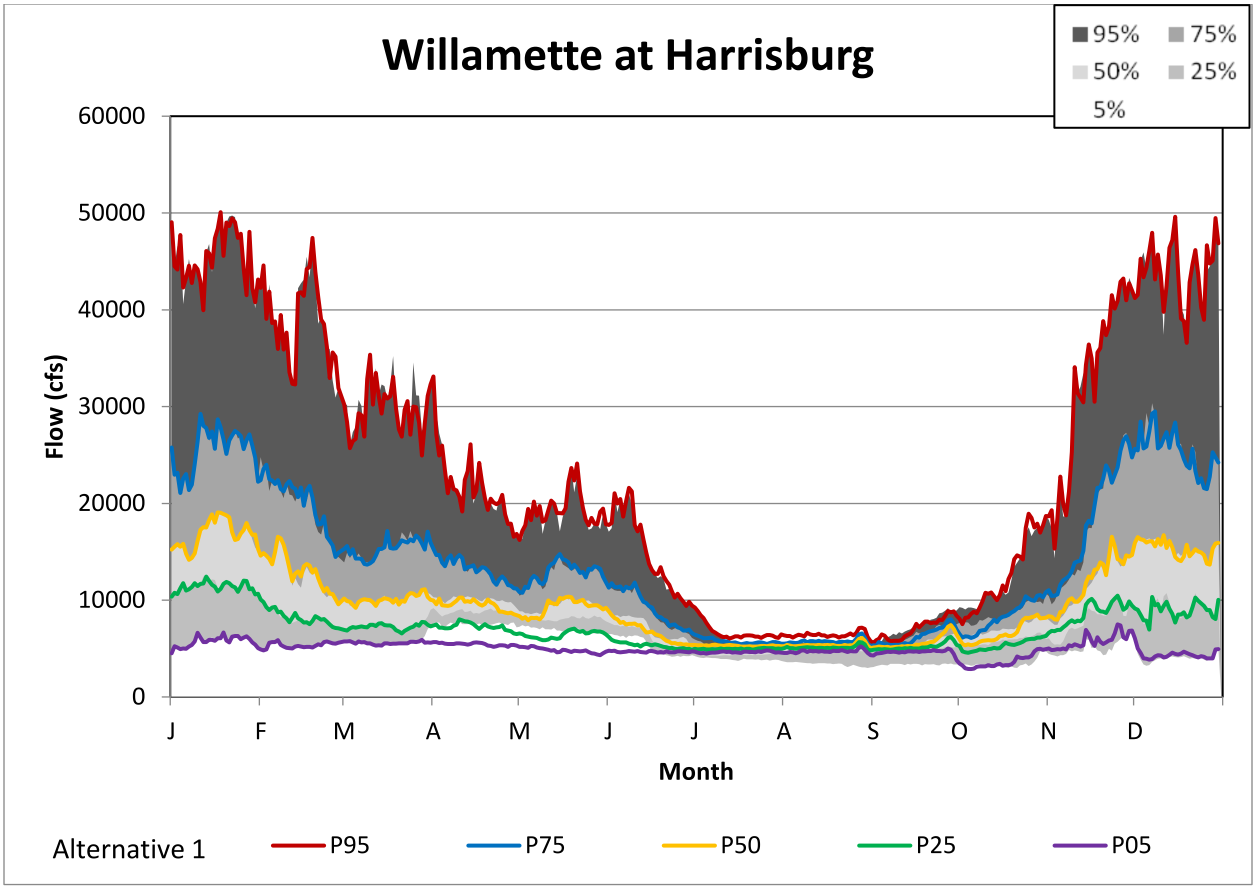


Figure 3-16. Non-Exceedance Flows at Harrisburg on the Willamette River under Alternative 1

Flows at Albany on the Willamette River, upstream of the Santiam River confluence, are lower than the NAA from April through mid-June about 25% of the time, but higher than in the NAA during the summer months. As are higher during the summer months when water supplies are often at critical limits, Alternative 1 would have a minor beneficial effect on water supply in the Willamette River above and immediately downstream of Albany.

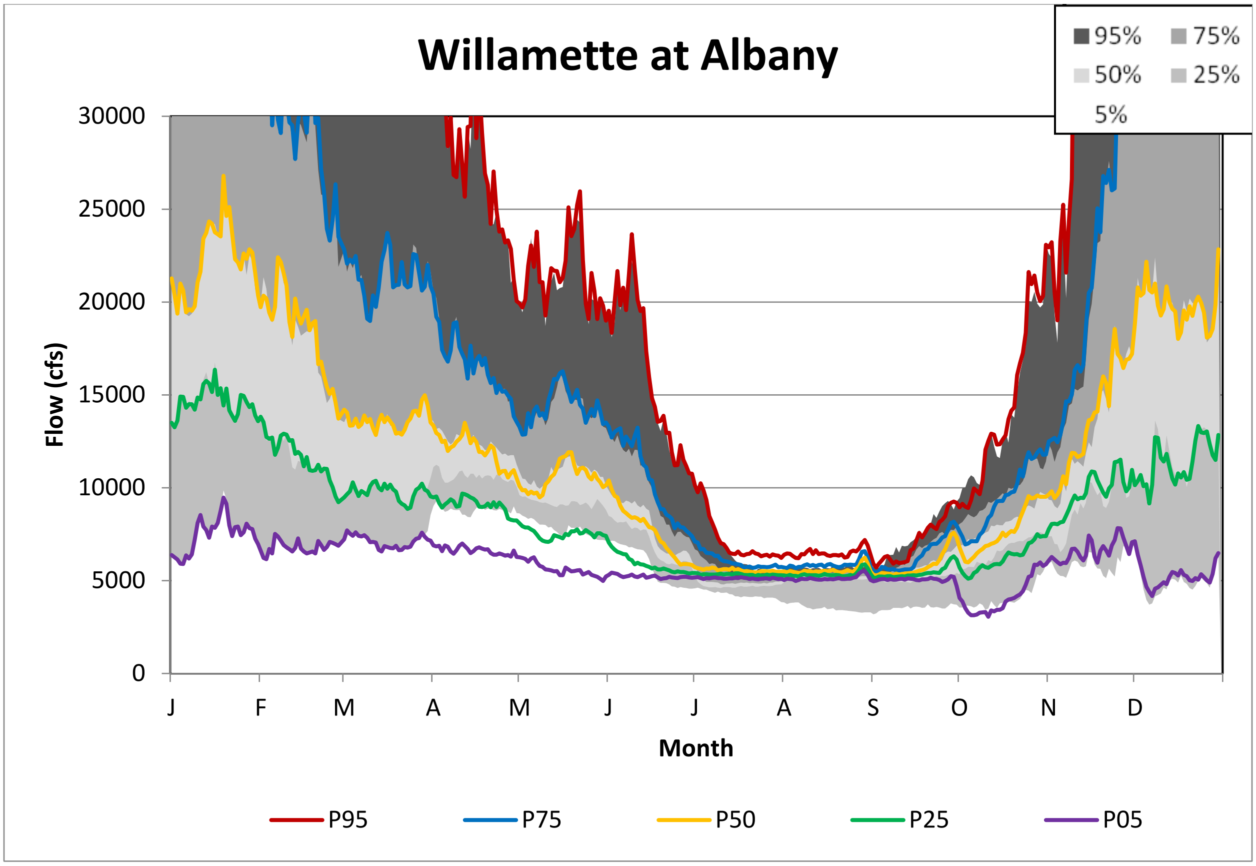


Figure 3-17. Non-Exceedance Flows at Albany on the Willamette River under Alternative 1

Flows at Salem on the Willamette River, downstream of the Santiam River confluence, are lower than the NAA from April through mid-June about 25% of the time, but higher or equal to the NAA during the summer months. As flows are higher during the summer months when water supplies are often at critical limits, Alternative 1 would have a minor beneficial effect on water supply in the Willamette River near and downstream of Salem.

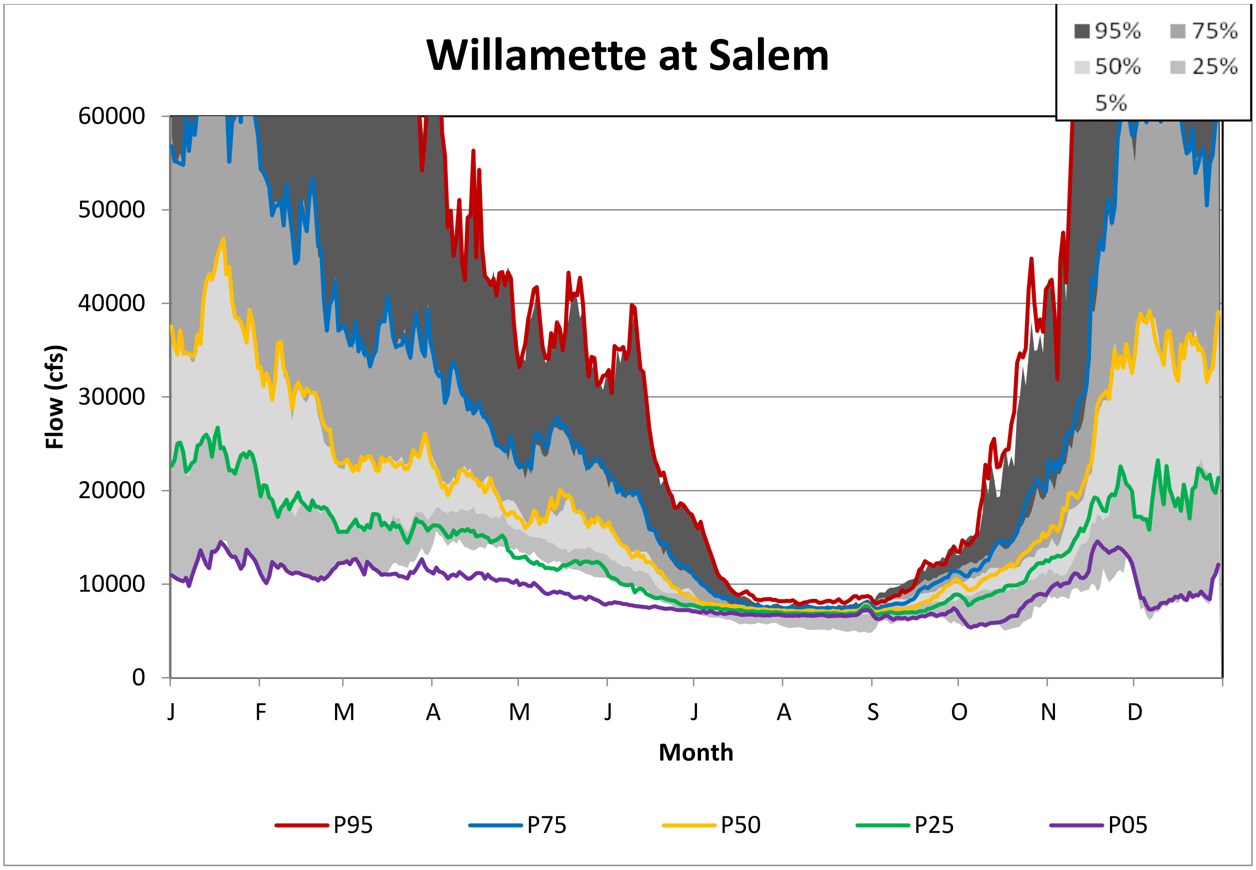


Figure 3-18. Non-Exceedance Flows at Salem on the Willamette River under Alternative 1

3.3 ALTERNATIVE 2A

3.3.1 Storage Allocations

Figure 3-19 shows that under Alternative 2A peak water stored in the conservation pool at the 75% non-exceedance level would be approximately 1,451,000 acre-feet, an increase of 122,000 acre-feet in the dry years relative to the NAA, resulting in a **minor** beneficial effect to system-wide storage allocations and the municipal and industrial water supply and irrigation users of the conservation storage. Stored water would still not be available to meet all M&I storage agreements and irrigation water service contracts in the driest years, but to a lesser extent than in the NAA. The amount available would be determined on an annual basis based on realized storage volumes across the system.

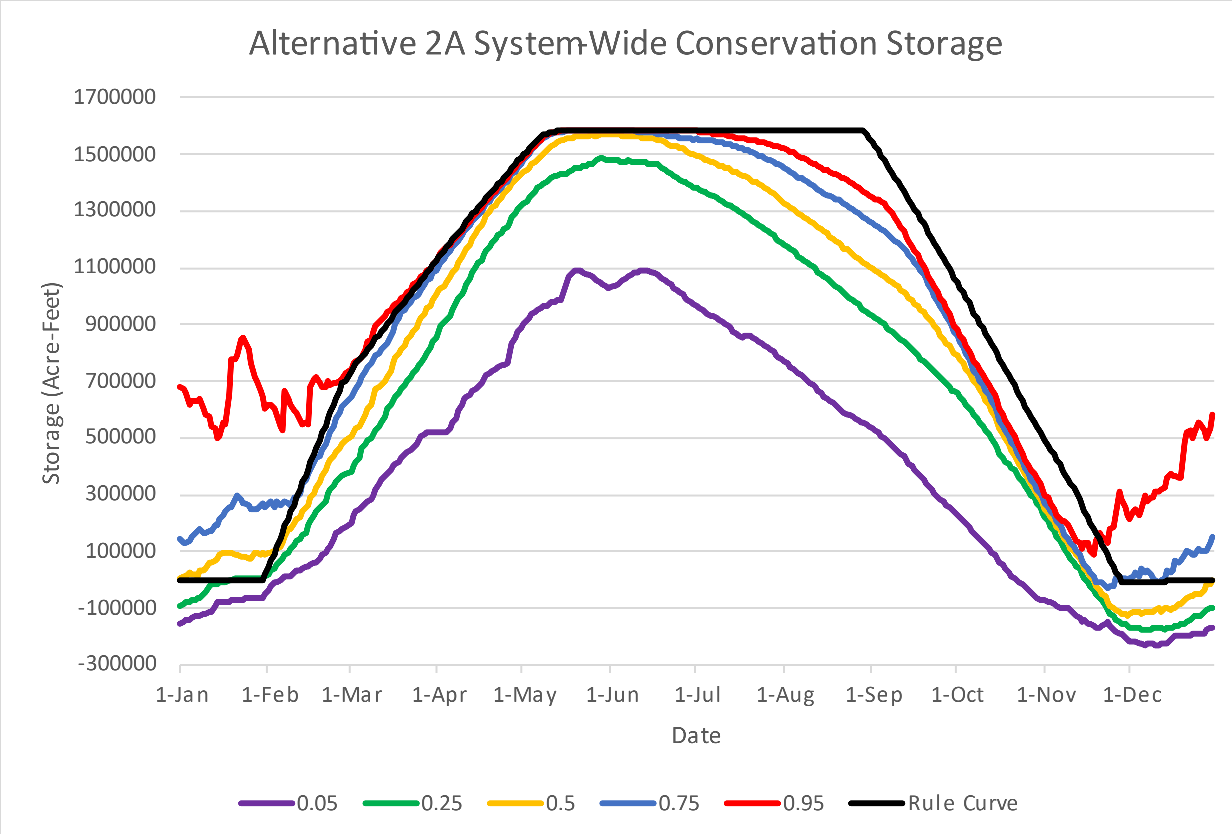


Figure 3-19. System Wide Conservation Storage for Alternative 2A

3.3.2 Live Flow Water Rights

3.3.2.1 Santiam River

Flows at Jefferson on the Santiam, downstream of the confluence of the North and South Santiam Rivers, are lower than the NAA from mid-March to mid-May in the driest years, but higher in the summer and fall in most years due to the fall drawdown operation at Green Peter Dam, as indicated in Appendix B, Figure B-164. As the flows are only lower during a portion of the spring and only in the driest years, Alternative 2A would have a negligible effect on water supply in the Santiam River.

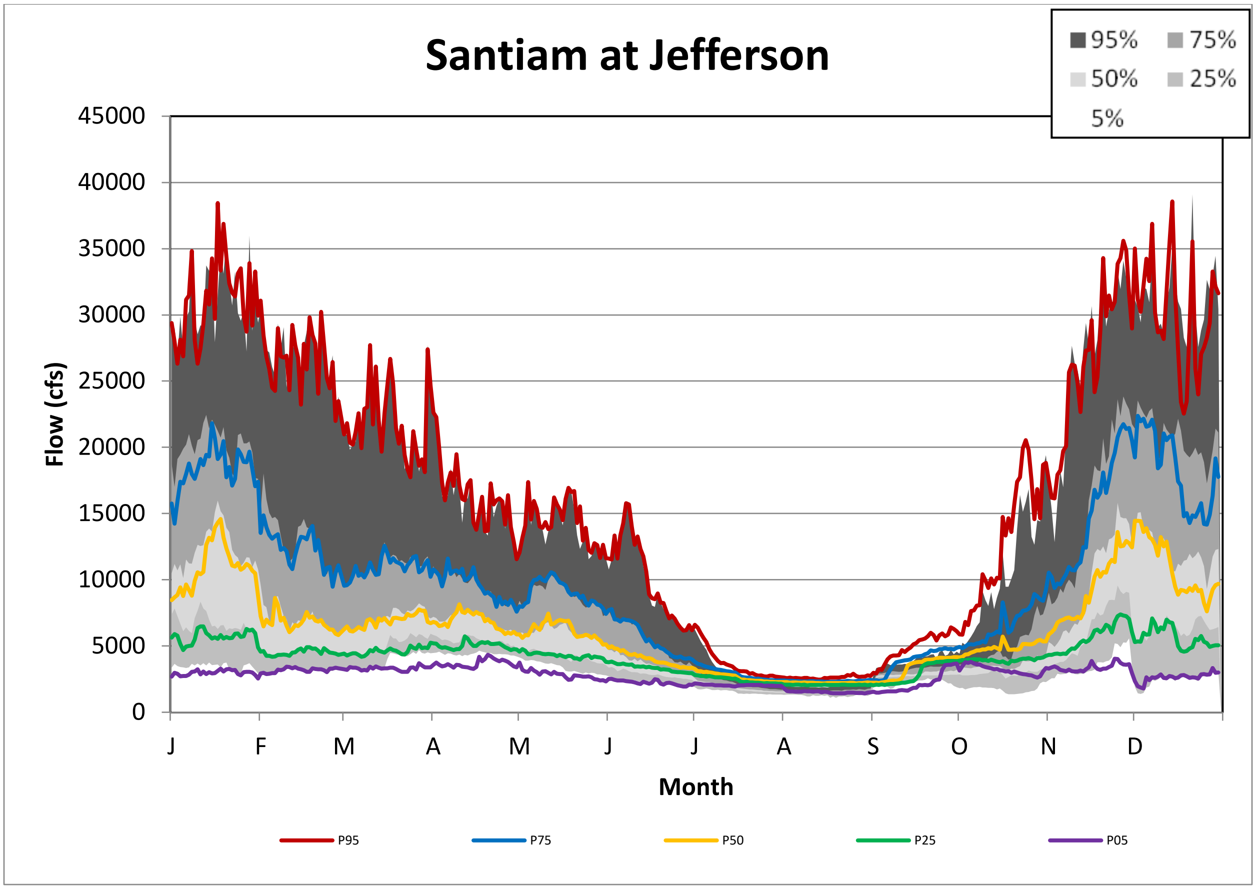


Figure 3-20. Non-Exceedance Flows at Jefferson on the Santiam River under Alternative 2A

North Santiam

Operations affecting water supply in the North Santiam Basin include releasing water for the integrated temperature and habitat flow regime and augmenting these flows with water from the power pool, as necessary.

Flow at Mehama, a key indicator for water supply users on the North Santiam, is slightly lower in the spring and late summer, dropping close to 1000 cfs during the late summer during the driest years, as compared to the NAA, reflecting the lower spring target flows from Detroit as compared to the NAA. Detroit Reservoir fills higher in these years and would reach minimum conservation pool later in the year, following the rule curve. Real time water management of the reservoir would be capable of managing flows in the North Santiam River, as to result in only a minor adverse effect to users relative to the NAA. This effect would be local and occur only in the driest years.

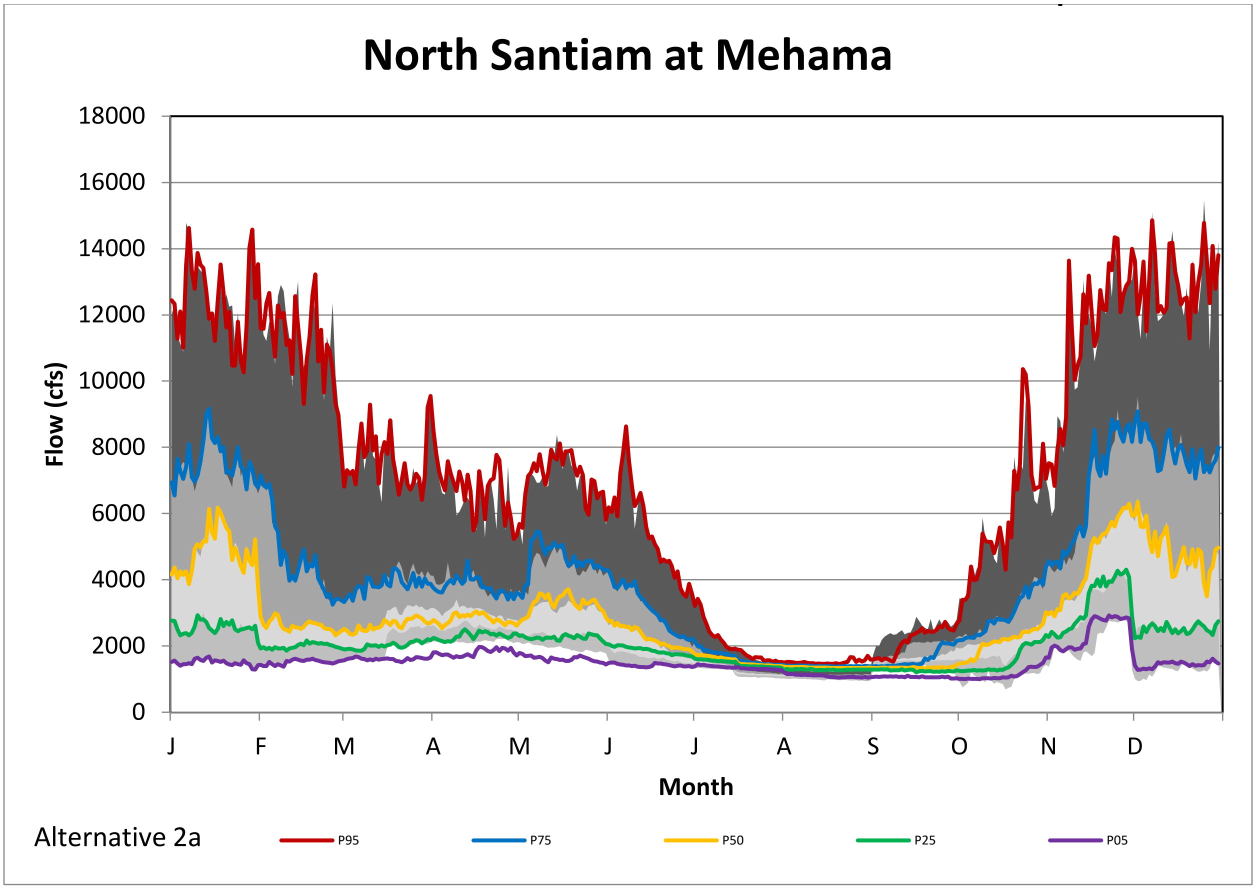


Figure 3-21. Non-Exceedance Flows at Mehama on the North Santiam River under Alternative 2A

South Santiam

Operations affecting water supply in the South Santiam Basin include releasing water for the integrated temperature and habitat flow regime, augmenting these flows with water from the power pool, as necessary, and a fall draw down operation for fish passage.

Flows at Waterloo on the South Santiam are lower than the NAA from mid-March to early-June in the driest years, but higher in fall in all years due to the fall drawdown operation at Green Peter Dam, as indicated in Appendix B, Figure B-165. As the flows are only lower during a portion of the spring and only in the driest years, Alternative 2A would have a negligible effect on water supply in the South Santiam River.

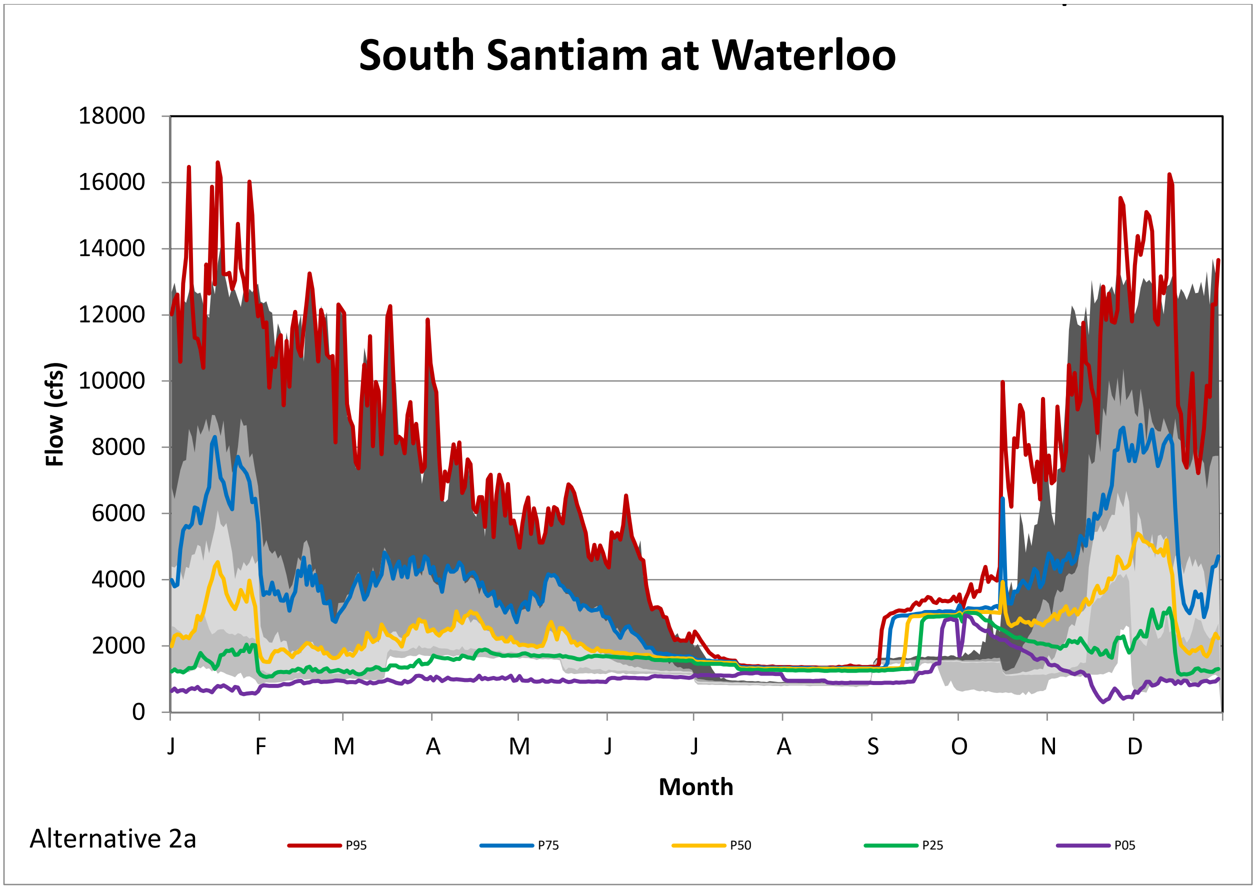


Figure 3-22 Non-Exceedance Flows at Waterloo on the South Santiam River under Alternative 2A

3.3.2.2 McKenzie River

Operations affecting water supply in the McKenzie Basin include releasing water for the integrated temperature and habitat flow regime and augmenting these flows with water from the power pool, as necessary.

Flows at Vida on the McKenzie River are lower than the NAA from April through mid-June but slightly higher in August and September in the driest years. As the flows are only lower during a portion of the spring and only in the driest years, Alternative 2A would have a negligible effect on water supply in the McKenzie River.

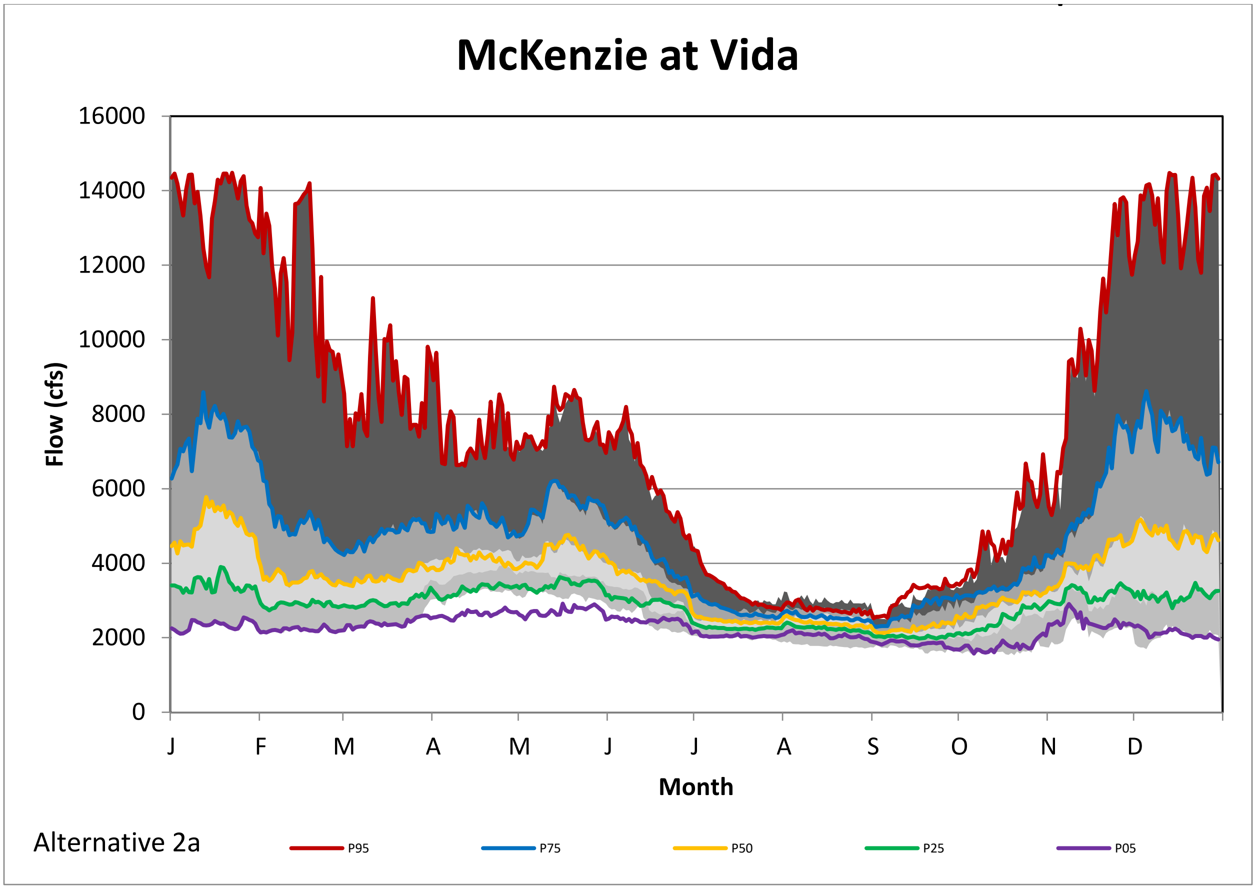


Figure 3-23. Non-Exceedance Flows at Vida on the McKenzie River under Alternative 2A

3.3.2.3 Middle Fork Willamette

Operations affecting water supply in the Middle Fork Willamette sub-basin include releasing water for the integrated temperature and habitat flow regime and augmenting these flows with water from the power pools at Lookout Point and Hills Creek, as necessary.

Flows at Jasper on the Middle Fork Willamette River, downstream of Hills Creek, Lookout Point, and Fall Creek reservoirs, are lower than the NAA from April through mid-June in most years, but higher than the NAA during the summer months. As the flows are only lower during a portion of the spring and only in drier years, Alternative 2A would have a negligible effect on water supply in the Middle Fork Willamette River.

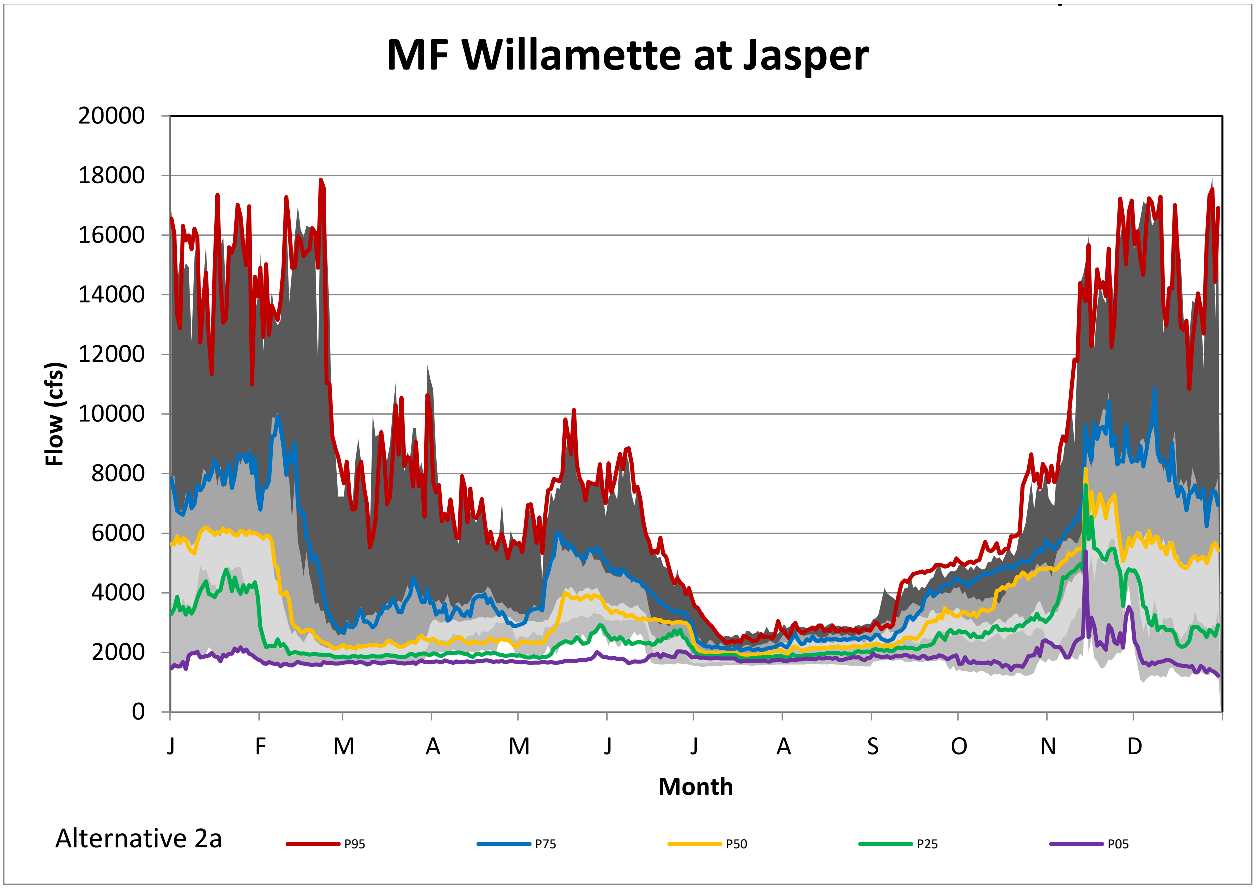


Figure 3-24. Non-Exceedance Flows at Jasper on the Middle Fork Willamette River under Alternative 2A

3.3.2.4 Mainstem Willamette

Operations affecting water supply on the mainstem Willamette River include releasing water for the integrated temperature and habitat flow regime, augmenting these flows with water from the inactive and power pools, as necessary and available, and the fall drawdown at Green Peter for fish passage.

Flows at Harrisburg on the Willamette River, downstream of the McKenzie River confluence, are lower than the NAA from April through mid-June about 25% of the time, but higher or equal to the NAA during the summer months. As the flows are only lower during a portion of the spring, still staying above 5000 cfs, and only in the driest years, Alternative 2A would have a negligible effect on water supply in the Willamette River above Harrisburg.

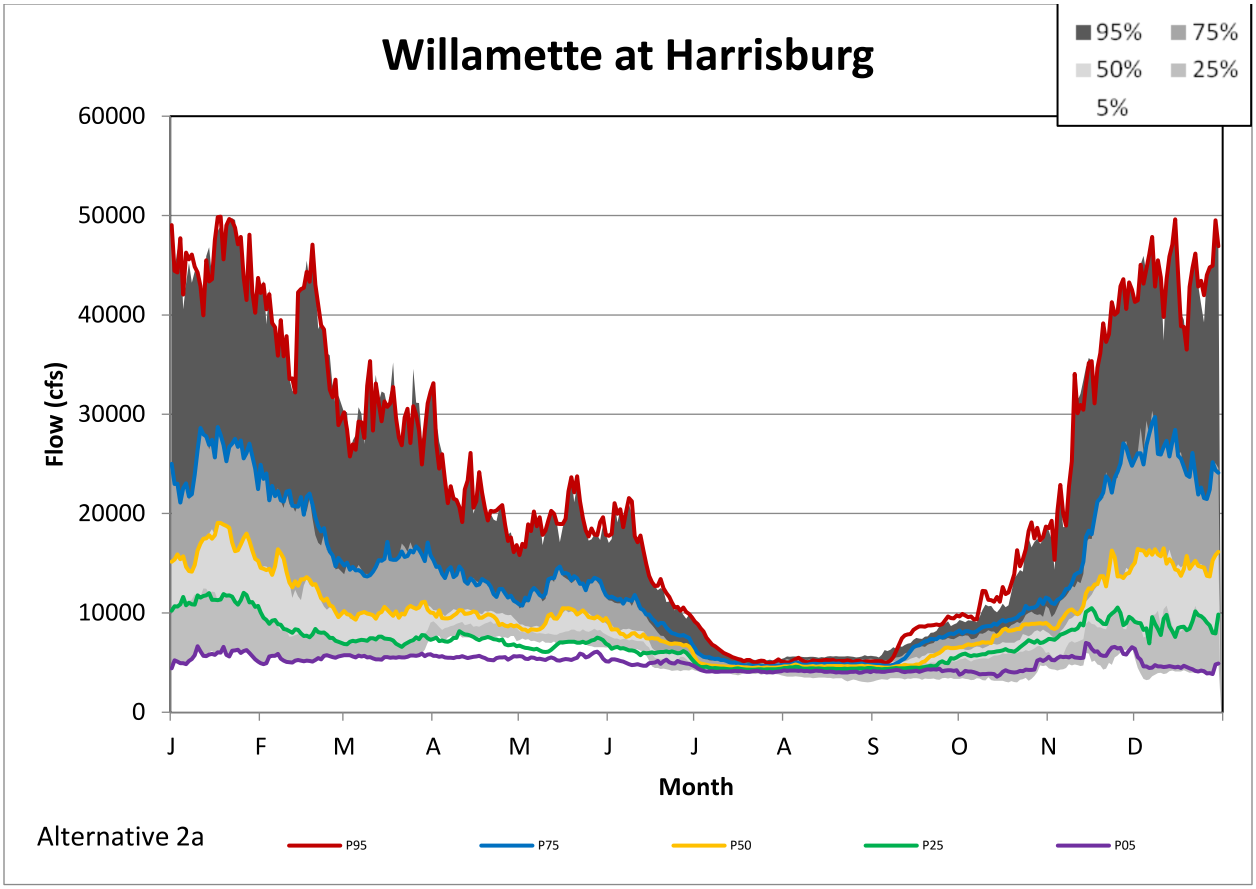


Figure 3-25. Non-Exceedance Flows at Harrisburg on the Willamette River under Alternative 2A

Flows at Albany on the Willamette River, upstream of the Santiam River confluence, are lower than the NAA from April through mid-June in the drier years, but higher than in the NAA during the summer months. As the flows are only lower during a portion of the spring, still staying above 5500 cfs, and only in the driest years, Alternative 2A would have a negligible effect on water supply in the Willamette River above and immediately downstream of Albany.

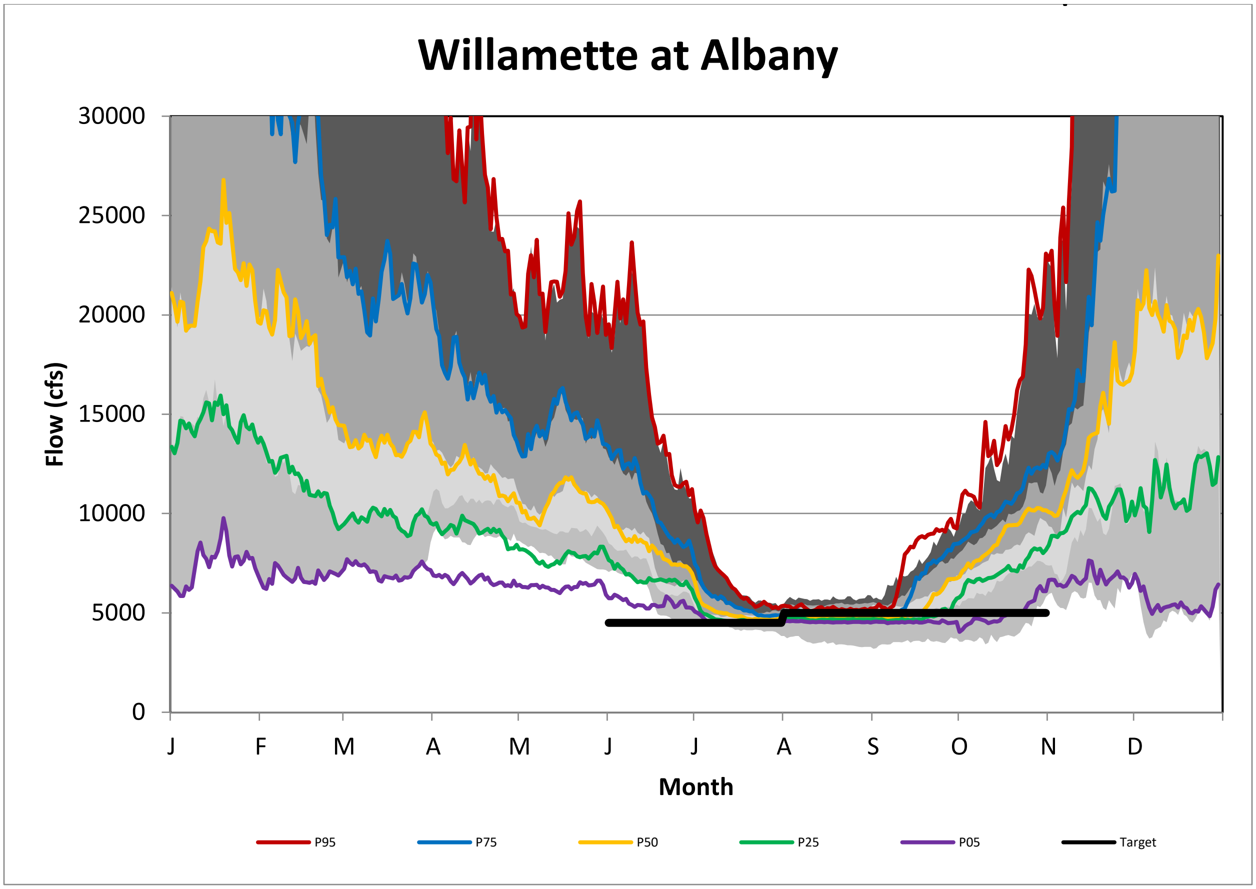


Figure 3-26. Non-Exceedance Flows at Albany on the Willamette River under Alternative 2A

Flows at Salem on the Willamette River, downstream of the Santiam River confluence, are lower than the NAA from April through mid-June about 25% of the time, but higher or equal to the NAA during the summer months. As the flows are only lower during a portion of the spring, still staying above 6000 cfs, and only in the driest years, Alternative 2A would have a negligible effect on water supply in the Willamette River near and downstream of Salem.

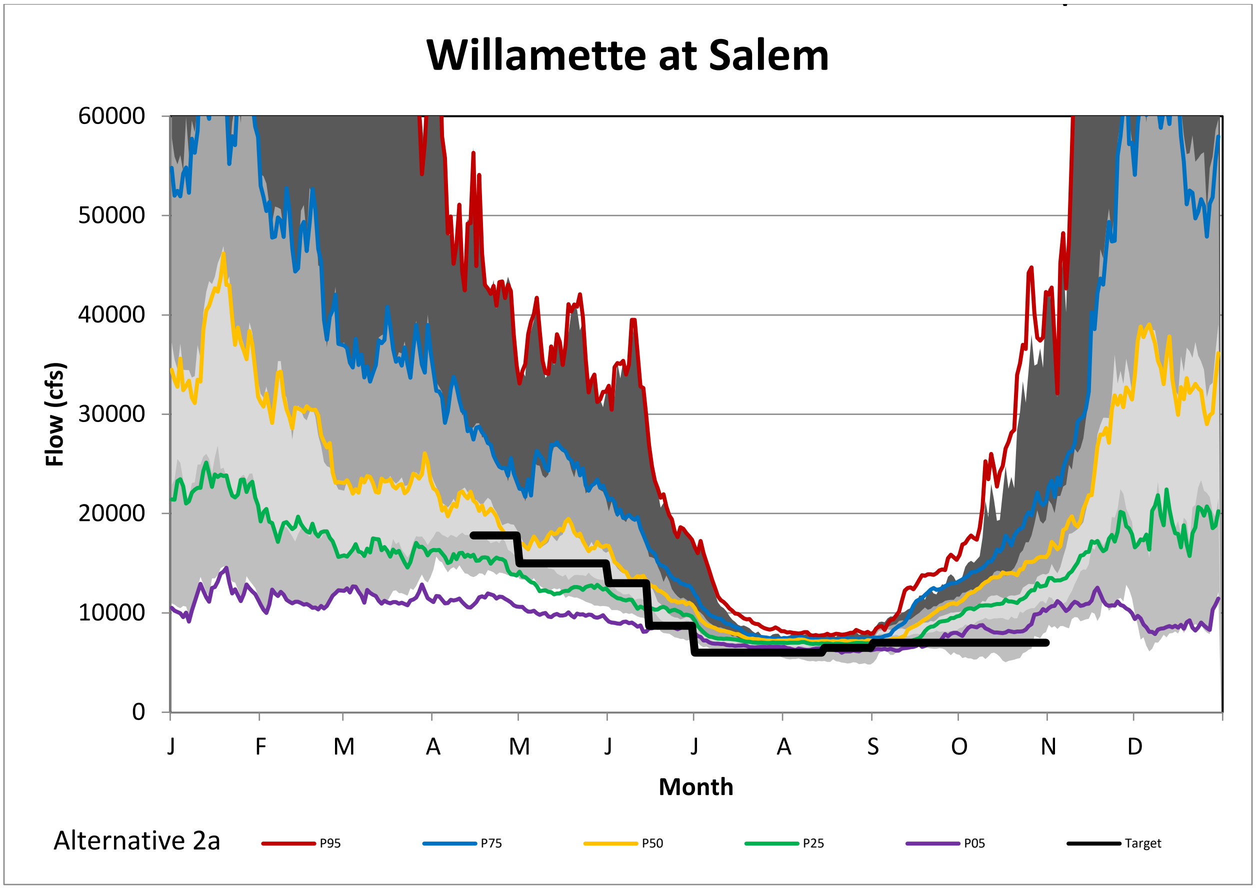


Figure 3-27. Non-Exceedance Flows at Salem on the Willamette River under Alternative 2A

3.4 ALTERNATIVE 2B

3.4.1 Storage Allocations

Figure 3-28 shows that under Alternative 2B peak water stored in the conservation pool at the 75% non-exceedance level would be approximately 1,265,000 acre-feet, a decrease of 64,000 acre-feet in the dry years relative to the NAA. The small decrease in system-wide conservation storage would have a **minor** adverse effect to municipal and industrial water supply and irrigation users of the conservation storage. Due to the expected limited level of demand for stored water on the McKenzie River, Alternative 2B would be expected to have only a **minor** adverse effect on storage allocations, mostly in the McKenzie sub-basin. Stored water would not be available to meet all M&I storage agreements and irrigation water service contracts in the driest years. The amount available would be determined on an annual basis based on realized storage volumes across the system.

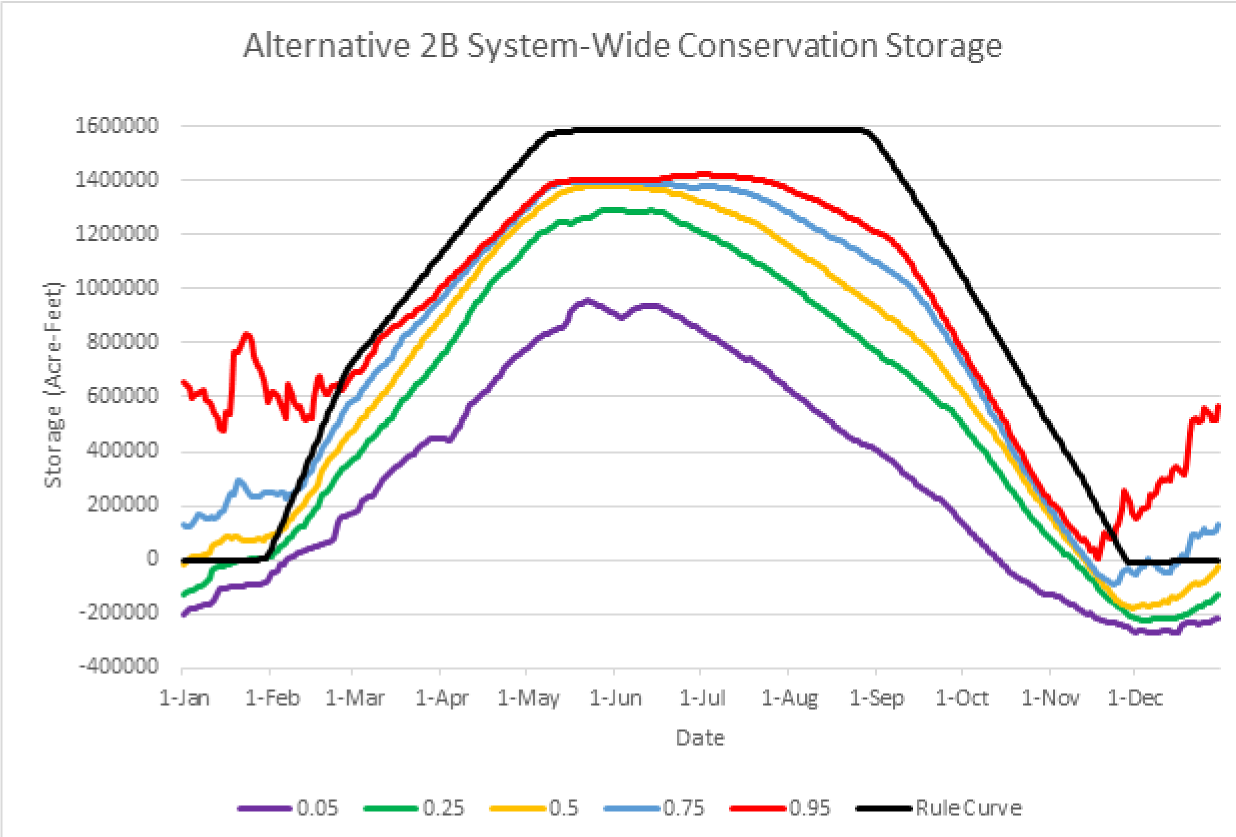


Figure 3-28. System Wide Conservation Storage for Alternative 2B

3.4.2 Live Flow Water Rights

3.4.2.1 Santiam River

Flows at Jefferson on the Santiam, downstream of the confluence of the North and South Santiam Rivers, are lower than the NAA from mid-March to mid-May in the driest years, but higher in the summer and fall in most years due to the fall drawdown operation at Green Peter Dam. As the flows are only lower during a portion of the spring and only in the driest years, Alternative 2B would have a negligible effect on water supply in the Santiam River.

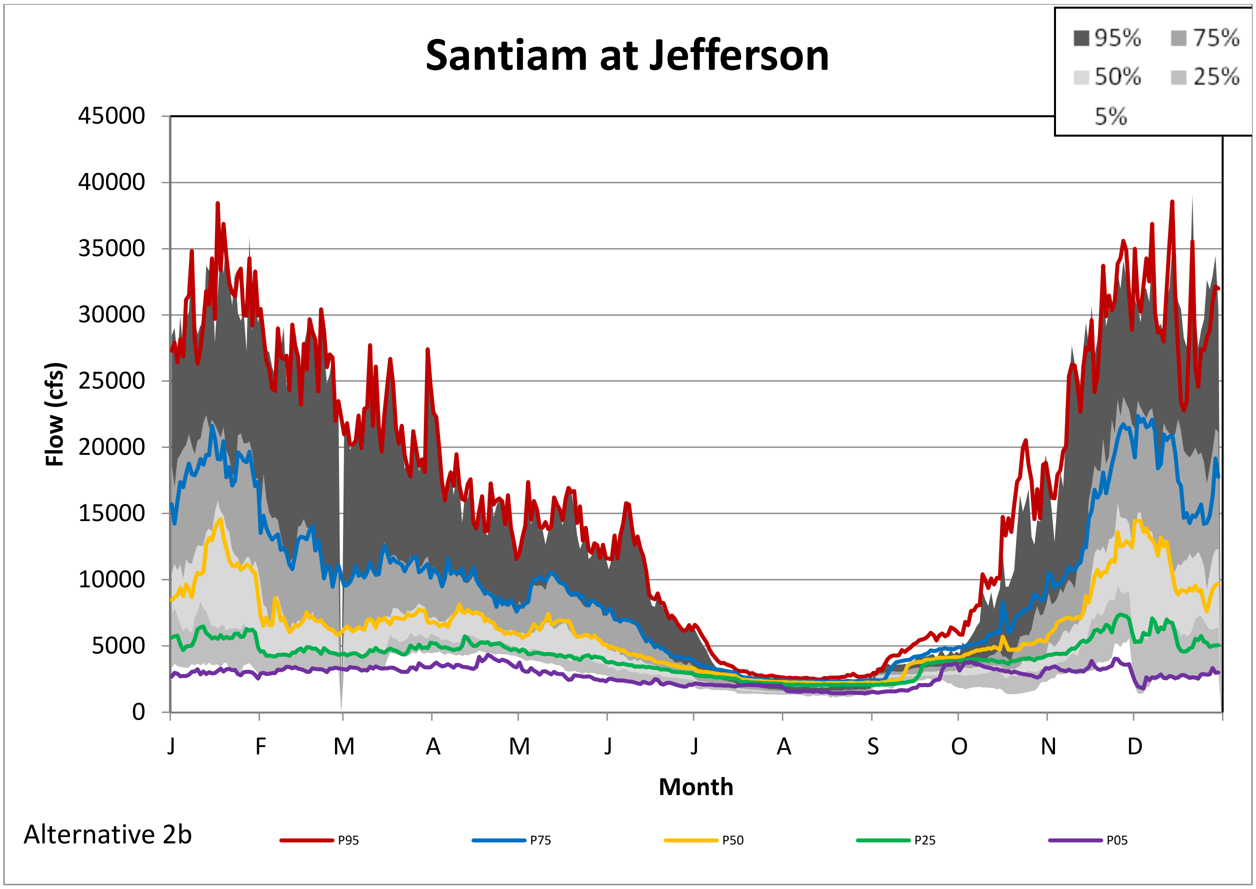


Figure 3-29. Non-Exceedance Flows at Jefferson on the Santiam River under Alternative 2B

North Santiam

Operations affecting water supply in the North Santiam Basin include releasing water for the integrated temperature and habitat flow regime and augmenting these flows with water from the power pool, as necessary.

Flow at Mehama, a key indicator for water supply users on the North Santiam, is slightly lower in the spring and late summer, dropping close to 1000 cfs during the late summer during the driest years, as compared to the NAA, reflecting the lower spring target flows from Detroit as compared to the NAA. Detroit Reservoir fills higher in these years and would reach minimum conservation pool later in the year, following the rule curve. Real time water management of the reservoir would be capable of managing flows in the North Santiam River, as to result in only a minor adverse effect to users relative to the NAA. This effect would be local and occur only in the driest years.

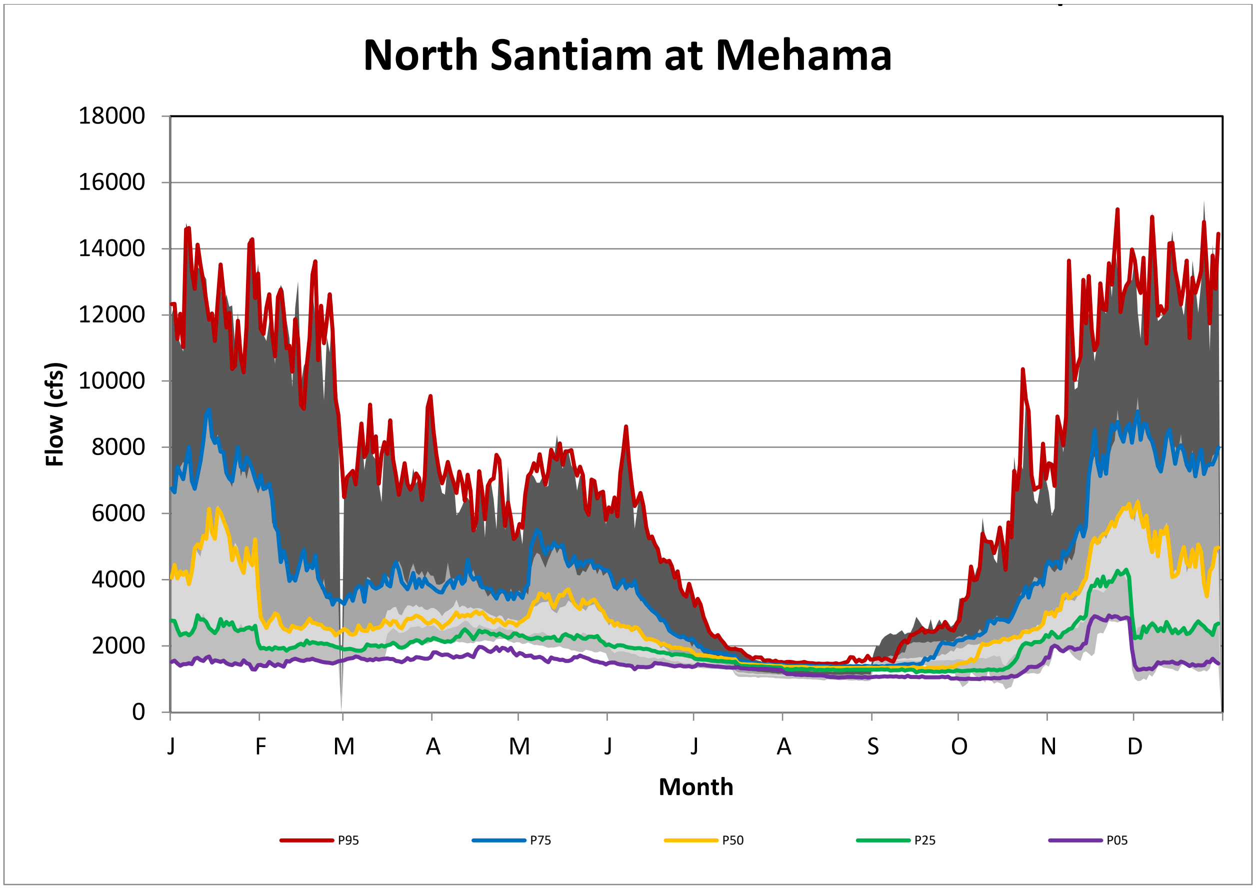


Figure 3-30. Non-Exceedance Flows at Mehama on the North Santiam River under Alternative 2B

South Santiam

Operations affecting water supply in the South Santiam Basin include releasing water for the integrated temperature and habitat flow regime, augmenting these flows with water from the power pool, as necessary, and a fall draw down operation for fish passage.

Flows at Waterloo on the South Santiam are lower than the NAA from mid-March to early-June in the driest years, but higher in the summer and fall in all years due to the fall drawdown operation at Green Peter Dam, as indicated in Appendix B, Figure B-165. As the flows are only lower during a portion of the spring and only in the driest years, Alternative 2B would have a negligible effect on water supply in the South Santiam River.

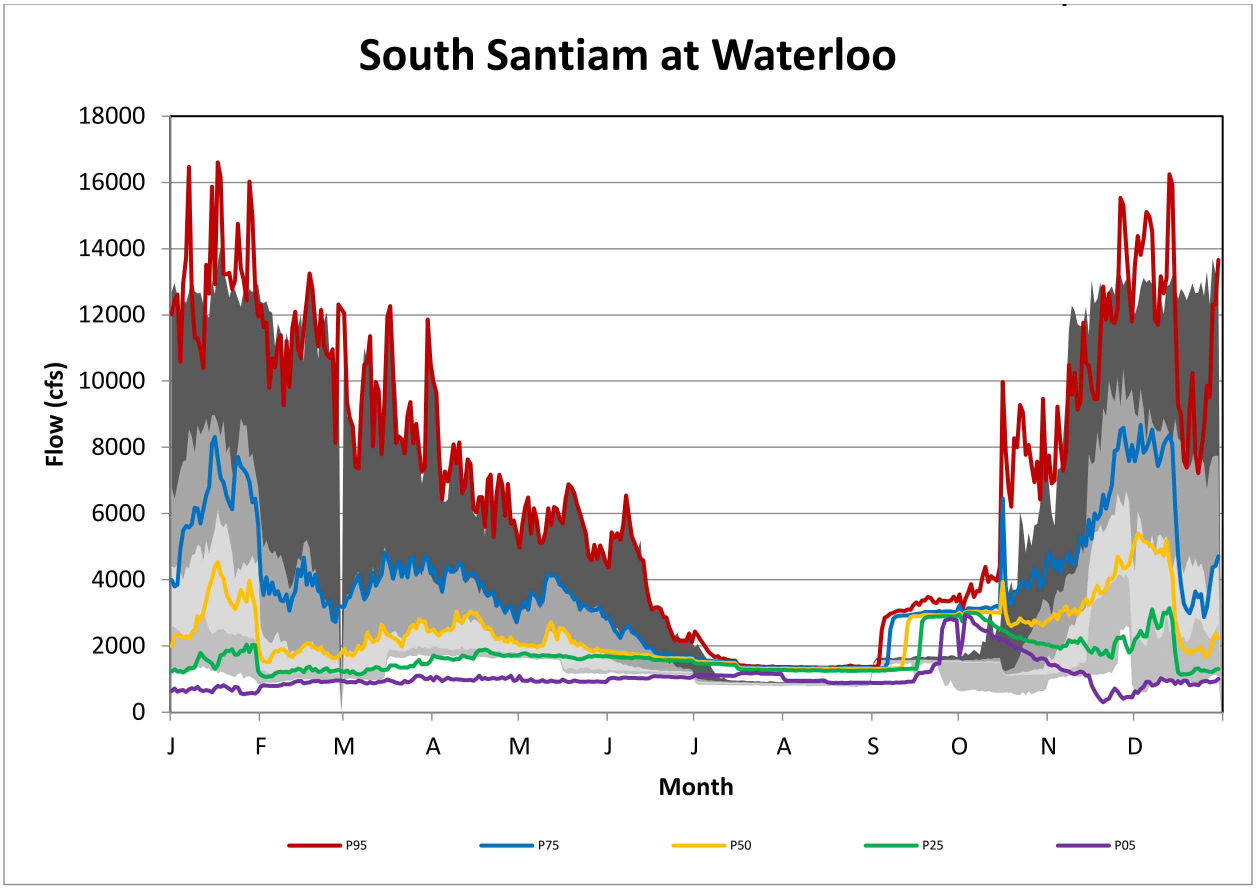


Figure 3-31. Non-Exceedance Flows at Waterloo on the South Santiam River under Alternative 2B

3.4.2.2 McKenzie

Operations affecting water supply in the McKenzie Basin include releasing water for the integrated temperature and habitat flow regime and drawing down the reservoir to the diversion tunnel in the spring and fall for fish passage.

The spring drawdown at Cougar affects the flow at Vida on the McKenzie River differently by season and by hydrologic conditions. Flows at Vida in the driest years are lower than the NAA from April through late summer. During wetter years, flows at Vida will be higher than the NAA until late May. As there would be no conservation storage to augment flows, summer flows would be lower than the NAA in the wettest years but nearly equal during most years. As the flows are only lower during a portion of the spring and only in the driest years, Alternative 2B would have a negligible effect on water supply in the McKenzie River.

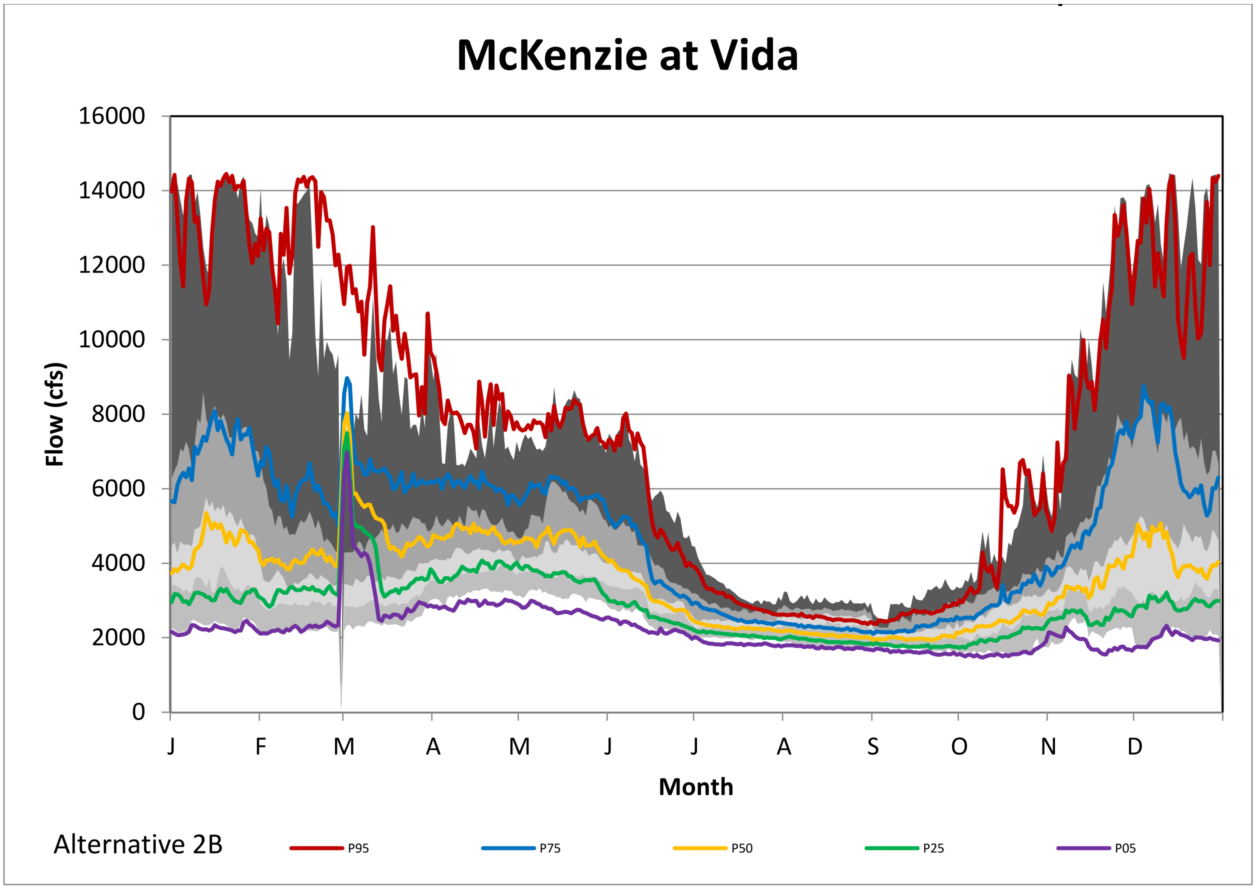


Figure 3-32. Non-Exceedance Flows at Vida on the McKenzie River under Alternative 2B

3.4.2.3 Middle Fork Willamette

Operations affecting water supply in the Middle Fork Willamette sub-basin include releasing water for the integrated temperature and habitat flow regime and augmenting these flows with water from the power pools at Lookout Point and Hills Creek, as necessary.

Flows at Jasper on the Middle Fork Willamette River, downstream of Hills Creek, Lookout Point, and Fall Creek reservoirs, are lower than the NAA from April through mid-June in most years, but higher than the NAA in the driest years, and nearly equal most years, during the summer months. As the flows are only lower during a portion of the spring and only in drier years, Alternative 2B would have a negligible effect on water supply in the Middle Fork Willamette River.

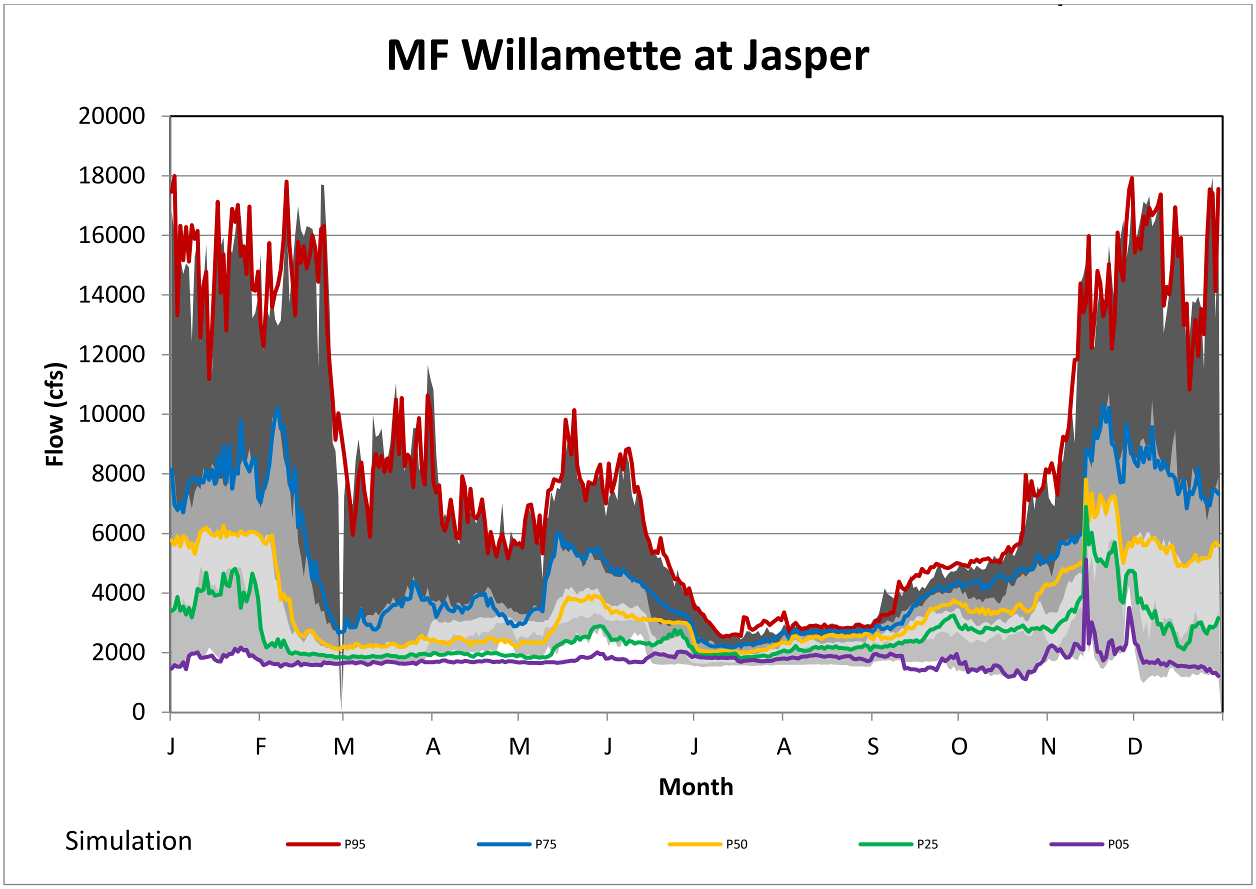


Figure 3-33. Non-Exceedance Flows at Jasper on the Middle Fork Willamette River under Alternative 2B

3.4.2.4 Mainstem Willamette

Operations affecting water supply on the mainstem Willamette River include releasing water for the integrated temperature and habitat flow regime, augmenting these flows with water from the inactive and power pools, as necessary and available, fall drawdown at Green Peter for fish passage, and spring and fall drawdowns at Cougar for fish passage.

Flows at Harrisburg on the Willamette River, downstream of the McKenzie River confluence, are lower than the NAA from April through mid-June during the driest years, but higher or equal to the NAA during the summer months. As the flows are only lower during a portion of the spring, still staying above 5000 cfs, and only in the driest years, Alternative 2B would have a negligible effect on water supply in the Willamette River above Harrisburg.

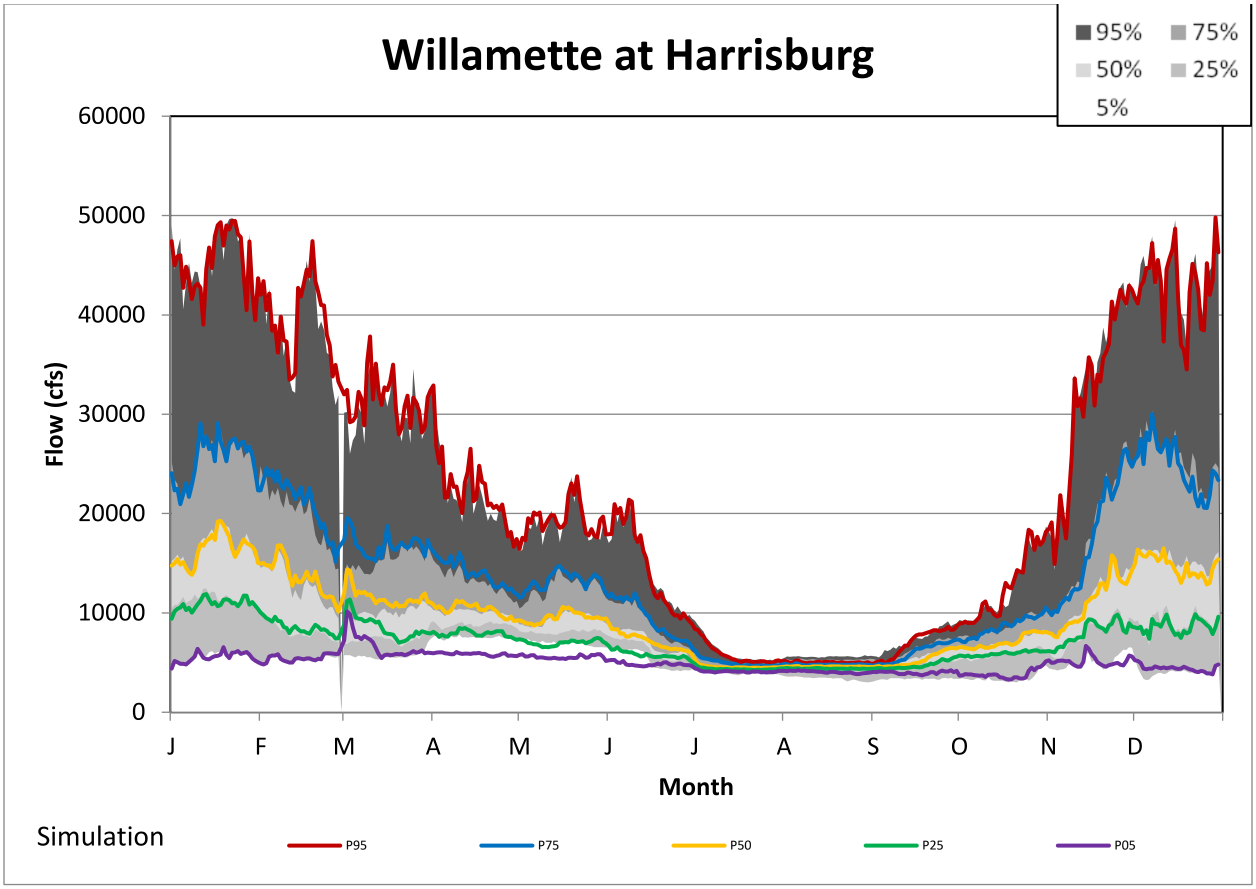


Figure 3-34. Non-Exceedance Flows at Harrisburg on the Willamette River under Alternative 2B

Flows at Albany on the Willamette River, upstream of the Santiam River confluence, are lower than the NAA from April through mid-June about 25% of the time, but higher than in the NAA during the summer months. As the flows are only lower during a portion of the spring, still staying above 4500 cfs, and only in the driest years, Alternative 2B would have a negligible effect on water supply in the Willamette River above and immediately downstream of Albany.

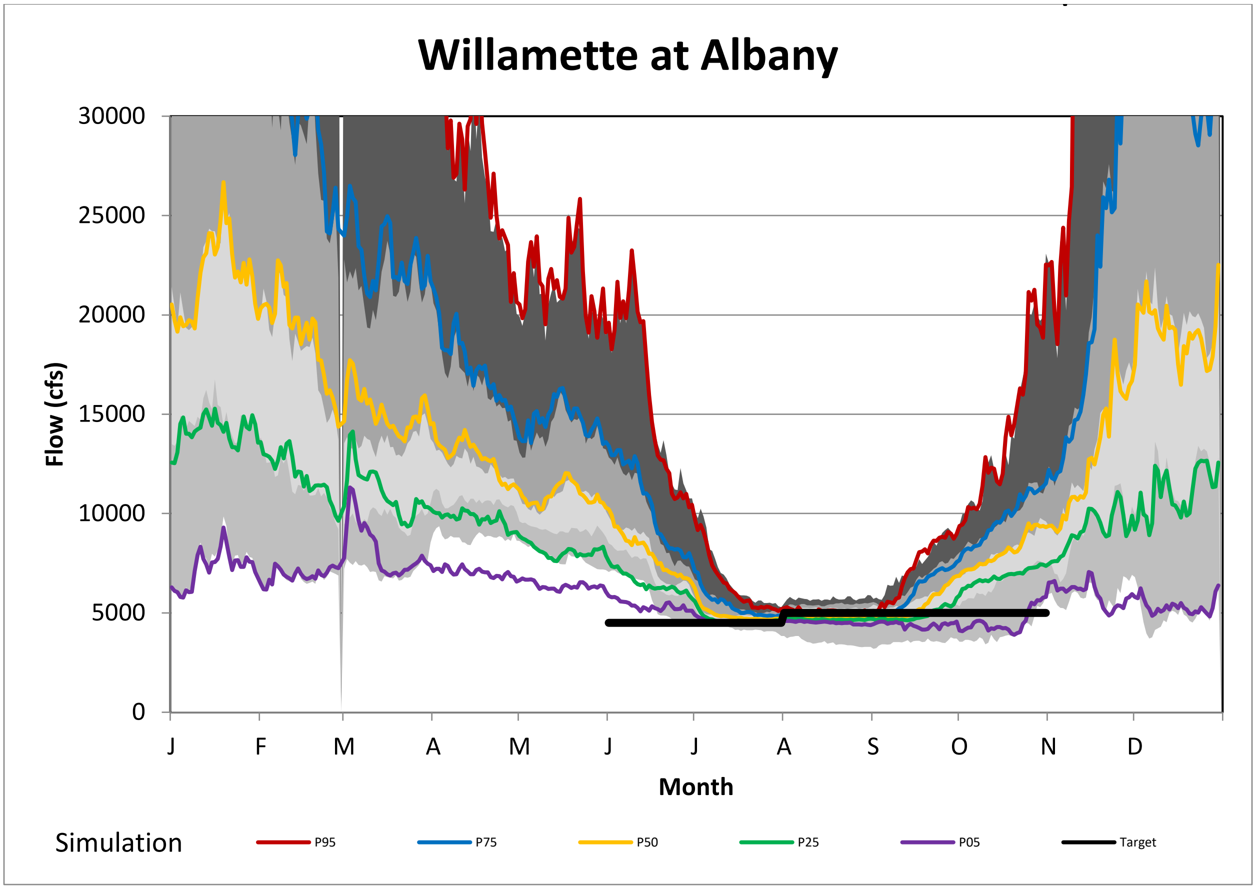


Figure 3-35. Non-Exceedance Flows at Albany on the Willamette River under Alternative 2B

Flows at Salem on the Willamette River, downstream of the Santiam River confluence, are lower than the NAA from April through mid-June about 25% of the time, but higher or equal to the NAA during the summer months. As the flows are only lower during a portion of the spring, still staying above 6000 cfs, and only in the driest years, Alternative 2B would have a negligible effect on water supply in the Willamette River near and downstream of Salem.

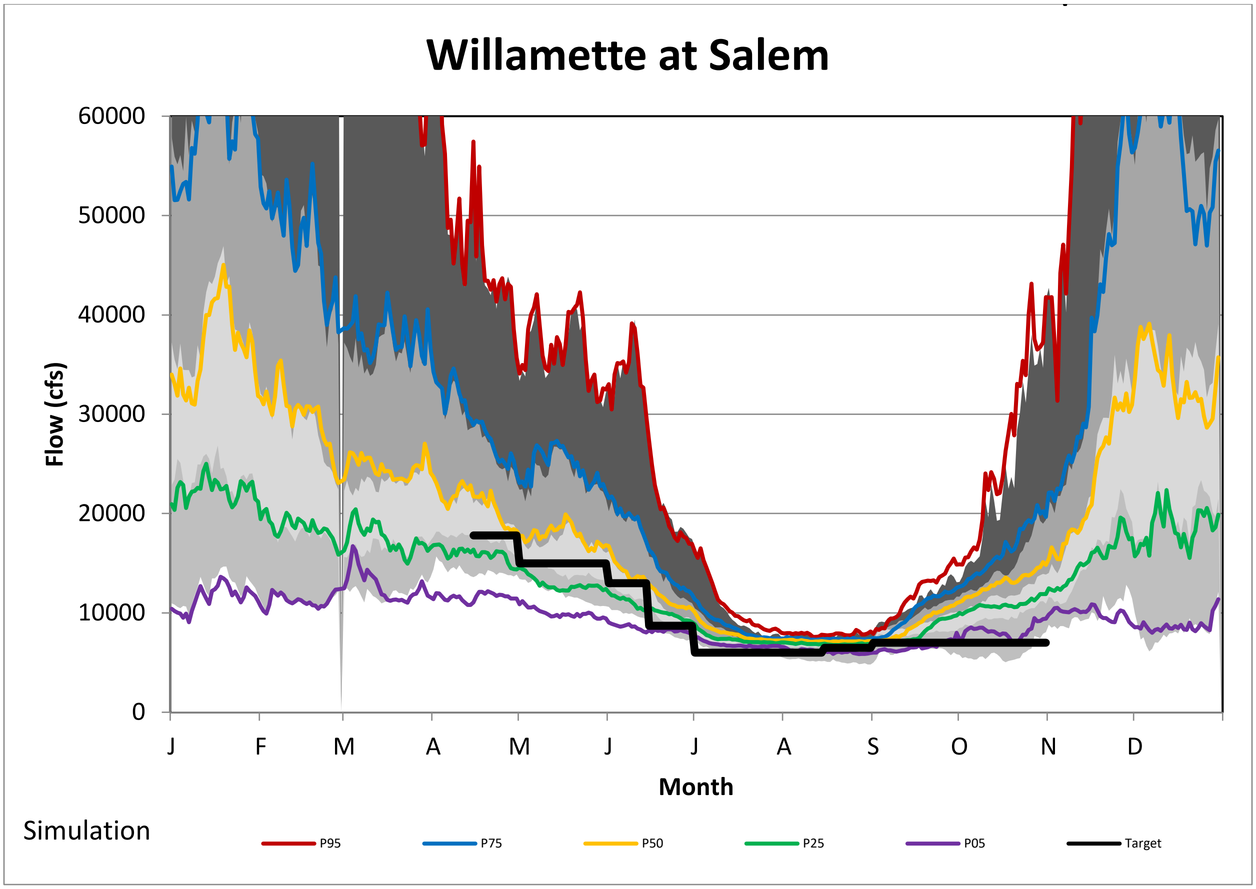


Figure 3-36. Non-Exceedance Flows at Salem on the Willamette River under Alternative 2B

3.5 ALTERNATIVE 3A

3.5.1 Storage Allocations

Alternative 3A is an operational fish passage alternative, combining spring spill and drawdowns with fall drawdowns at 6 of the 11 storage projects. These combined operations significantly affect system-wide refill of the conservation storage, resulting in system-wide stored water being only 44% of the refill volume in the NAA, or 590,000 acre-feet, as shown below in Figure 3-37. Stored water would not be available to meet all M&I storage agreements and irrigation water service contracts in the driest years. This lack of storage is significantly higher under alternatives 3A and 3B. The amount available would be determined on an annual basis based on realized storage volumes across the system but will have a more pronounced effect. Therefore, Alternative 3A would have a **major** adverse effect to the storage allocations and M&I water supply and irrigation users of conservation storage.

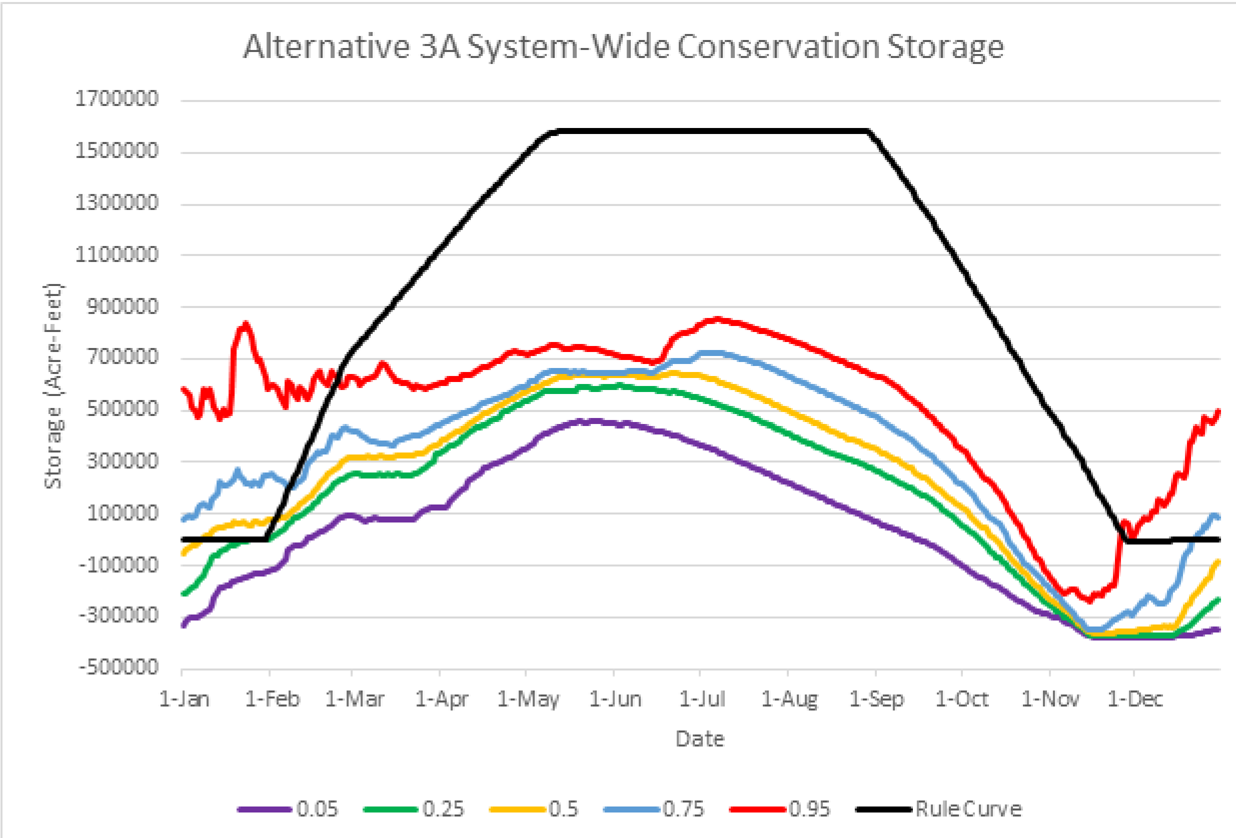


Figure 3-37. System Wide Conservation Storage for Alternative 3A

3.5.2 Live Flow Water Rights

3.5.2.1 Santiam

Flows at Jefferson on the Santiam, downstream of the confluence of the North and South Santiam Rivers, in Alternative 3A are affected by the combination of a spring drawdown operation at Detroit and fall drawdown operations at both Detroit and Green Peter. Flows are slightly higher than the NAA from mid-March to mid-June except in the driest years. Flows in the summer are nearly equal to the NAA. Flows in the fall are lower than the NAA about half the time. As the flows are nearly equal during the critical low flow summer season, Alternative 3A would have a negligible effect on water supply in the Santiam River.

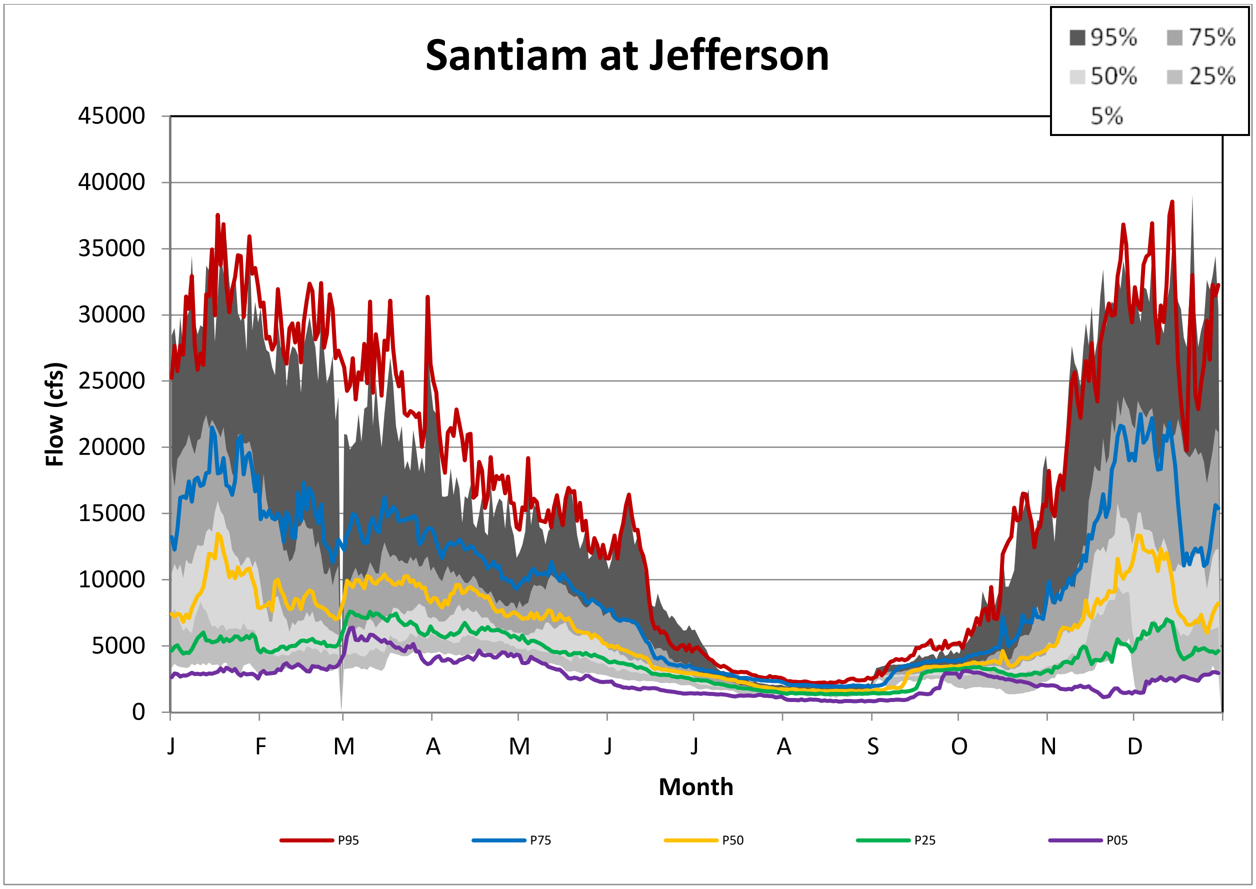


Figure 3-38. Non-Exceedance Flows at Jefferson on the Santiam River under Alternative 3A

North Santiam

Operations affecting water supply in the North Santiam Basin include releasing water for the integrated temperature and habitat flow regime, augmenting these flows with water from the power pool, as necessary, and drawing down the reservoir in the spring and fall for fish passage.

Under Alternative 3A, Detroit reservoir would be held below minimum conservation pool and as noted in Section 3.2.5.5., would very rarely fill into the conservation pool, nearly eliminating the ability to augment naturally low flows. Due to the spring drawdown and need to pass inflows instead of storing water, flows at Mehama in the spring, from March through early to late May, depending on the type of water year, are higher under Alternative 3A as compared to the NAA. Starting in June, flows drop lower than in the NAA as there is little to no water in the conservation pool to augment naturally low flows. Flows at Mehama could drop to less than 750 cfs for extended periods about 50% of the time. This could cause curtailment of water rights for M&I water supply and irrigation and would cause issues at the City of Salem's drinking water intake facility, which requires a minimum flow of 750 cfs for the intake structure to operate. Therefore, Alternative 3A would have a major adverse effect to M&I water supply and irrigation. This effect would be long term in that it would occur in most years and during the critically low flow season.

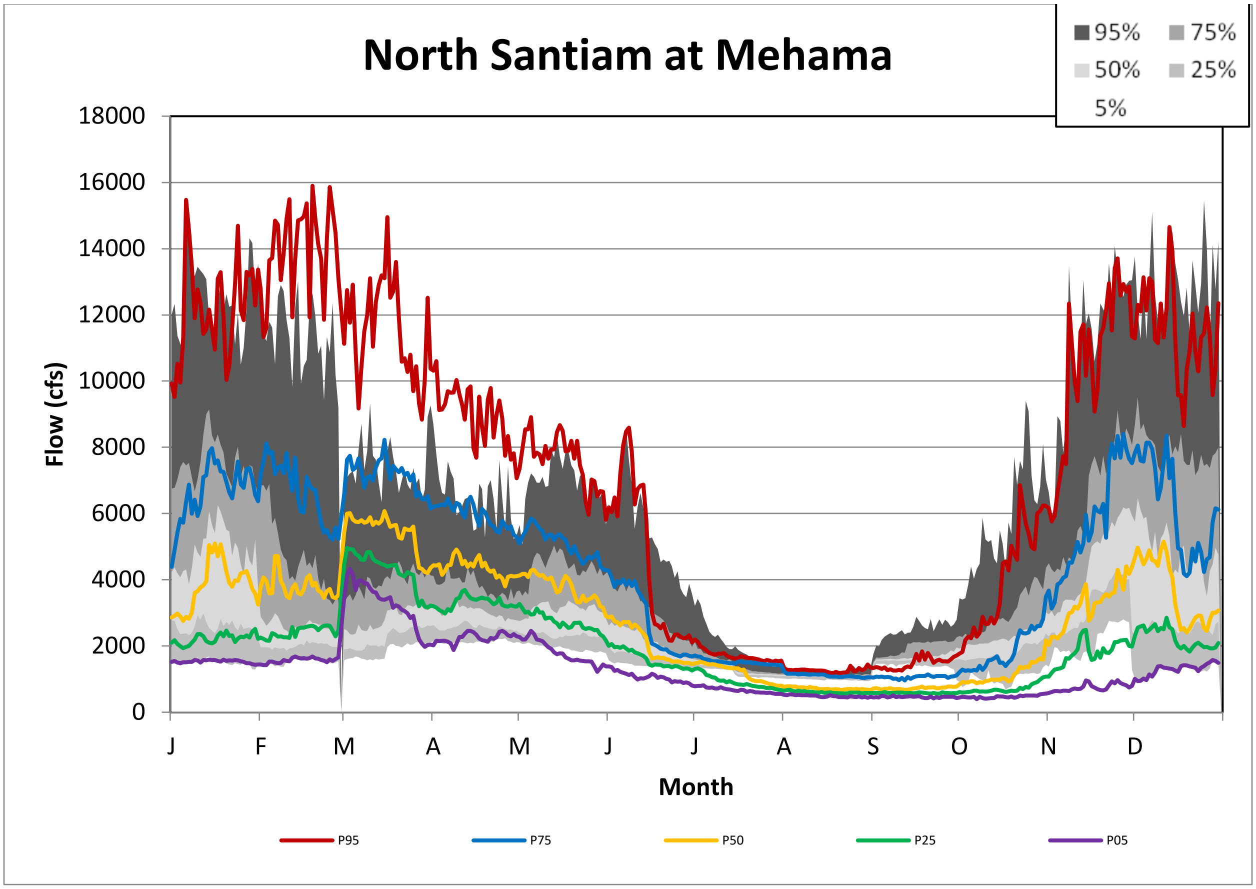


Figure 3-39. Non-Exceedance Flows at Mehama on the North Santiam River under Alternative 3A

South Santiam

Operations affecting water supply in the South Santiam Basin include releasing water for the integrated temperature and habitat flow regime, augmenting these flows with water from the power pool, as necessary, and a fall draw down operation for fish passage.

Flows at Waterloo on the South Santiam are lower than the NAA from mid-March to early-June in the driest years due to reduced flow targets, but higher in the summer and fall in all years due to the fall drawdown operation at Green Peter Dam. As the flows are only lower during a portion of the spring and only in the driest years, Alternative 3A would have a negligible effect on water supply in the South Santiam River.

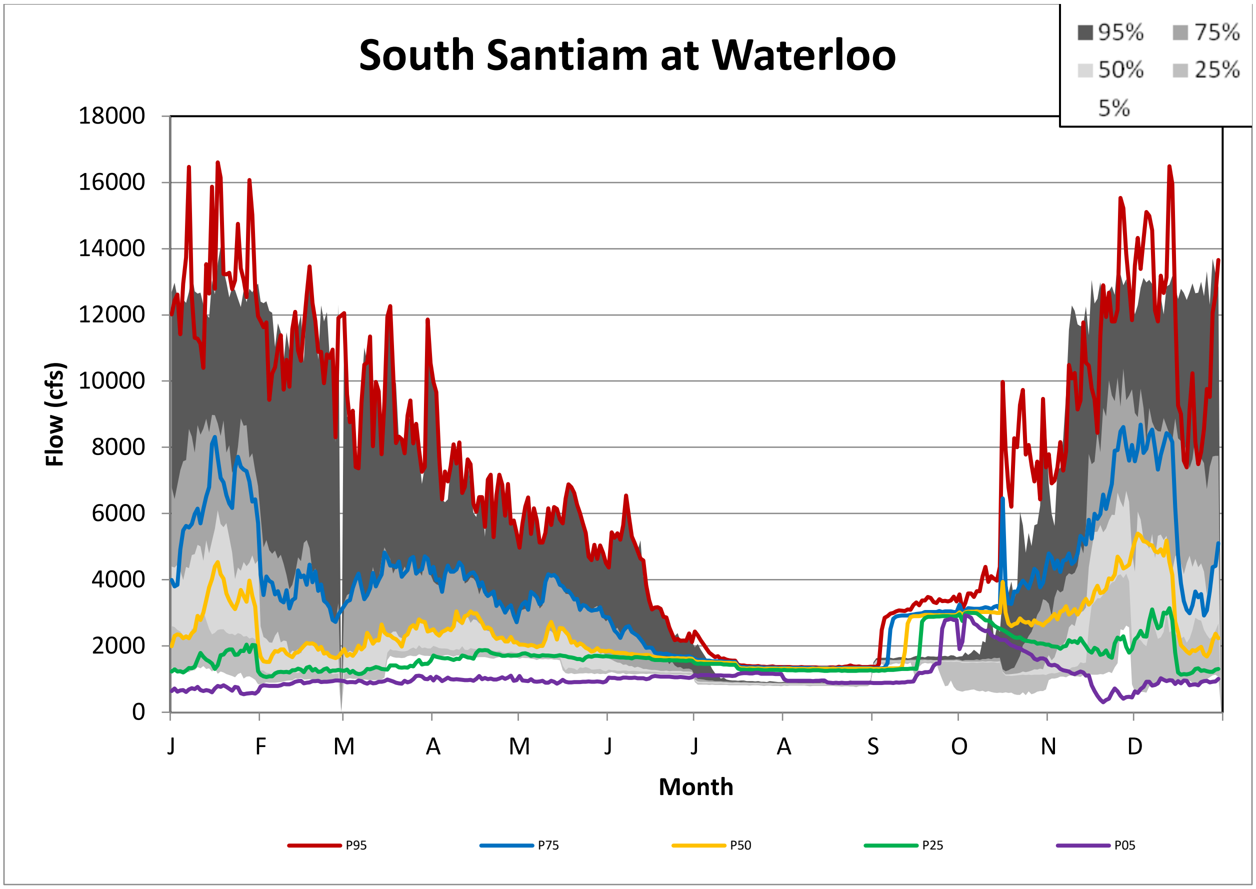


Figure 3-40. Non-Exceedance Flows at Waterloo on the South Santiam River under Alternative 3A

3.5.2.2 McKenzie

Operations affecting water supply in the McKenzie Basin include releasing water for the integrated temperature and habitat flow regime, augmenting these flows with water from the power pool, as necessary, and drawing down the reservoir to the regulating outlets in the spring and fall for fish passage.

Flows at Vida are higher in the spring than in the NAA for all but the driest years, as the reservoir needs to pass inflows to keep the pool drawn down for the fish passage operation in both the spring and fall. Flows in the summer are nearly equal to the NAA, but lower in the fall. This is due to not needing to empty the reservoir in preparation for the winter flood management season. As flows are nearly equal, especially for drier years, during the low flow season Alternative 3A would have a negligible effect on water supply in the McKenzie River.

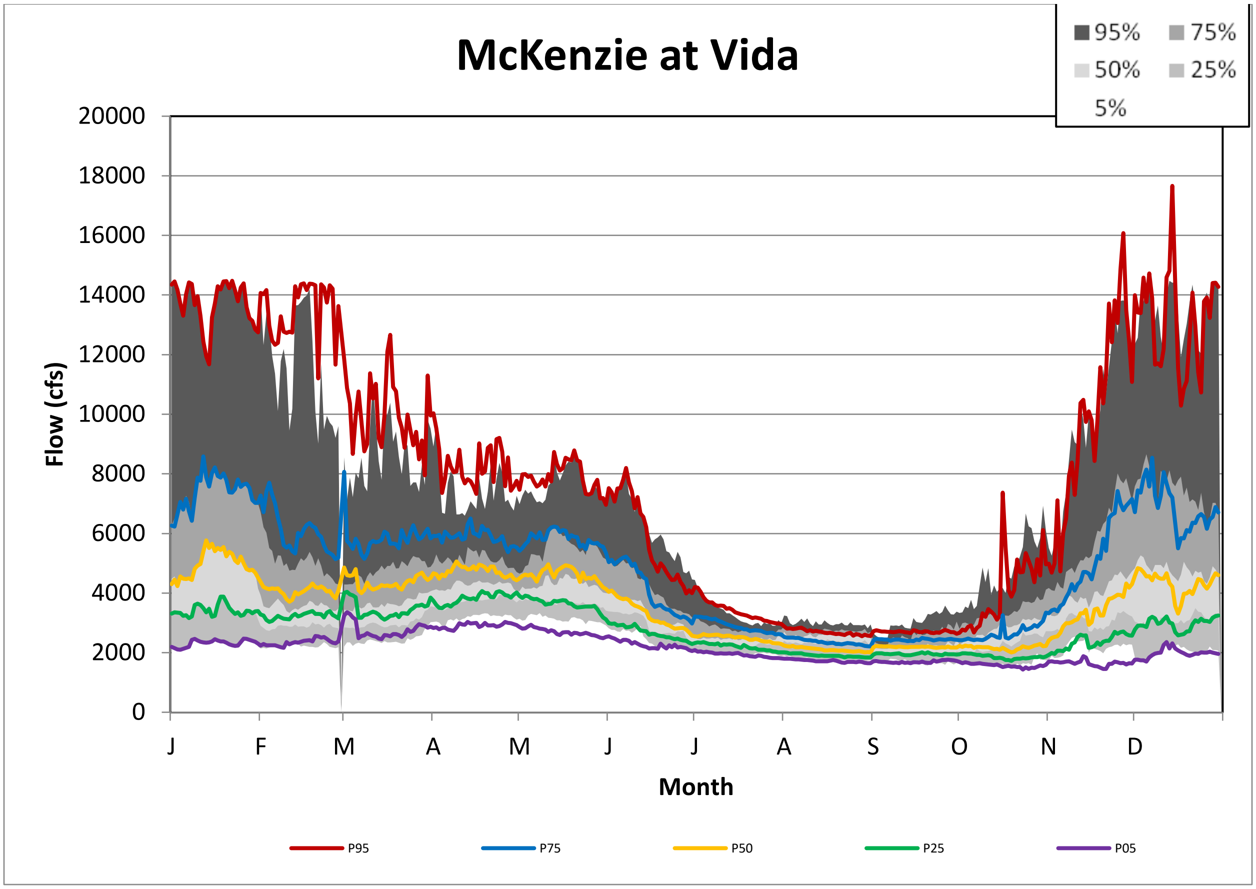


Figure 3-41. Non-Exceedance Flows at Vida on the McKenzie River under Alternative 3A

3.5.2.3 Middle Fork Willamette

Operations affecting water supply in the Middle Fork Willamette sub-basin include releasing water for the integrated temperature and habitat flow regime, augmenting these flows with water from the power pools at Lookout Point and Hills Creek, as necessary and available, and drawing down Lookout Point reservoir in the spring and fall and drawing down Hills Creek reservoir in the fall for fish passage.

Flows at Jasper are higher than in the NAA through mid-May for all years, and through mid-June for wetter years, due to the spring drawdown operation at Lookout Point which prevents storing of water into the conservation pool until mid-June. When the reservoir does start storing water, flows in the Middle Fork Willamette drop drastically most years, closer to what would be realized during dry years in both Alternative 3A and the NAA. Flows during the driest years are nearly equal to the NAA conditions during spring and most of summer, until September when there isn't water in the conservation pools to supplement naturally very low flows. As the flows are lower during the summer, approaching existing dry year conditions, Alternative 3A would have a moderate adverse effect on water supply in the Middle Fork Willamette River.

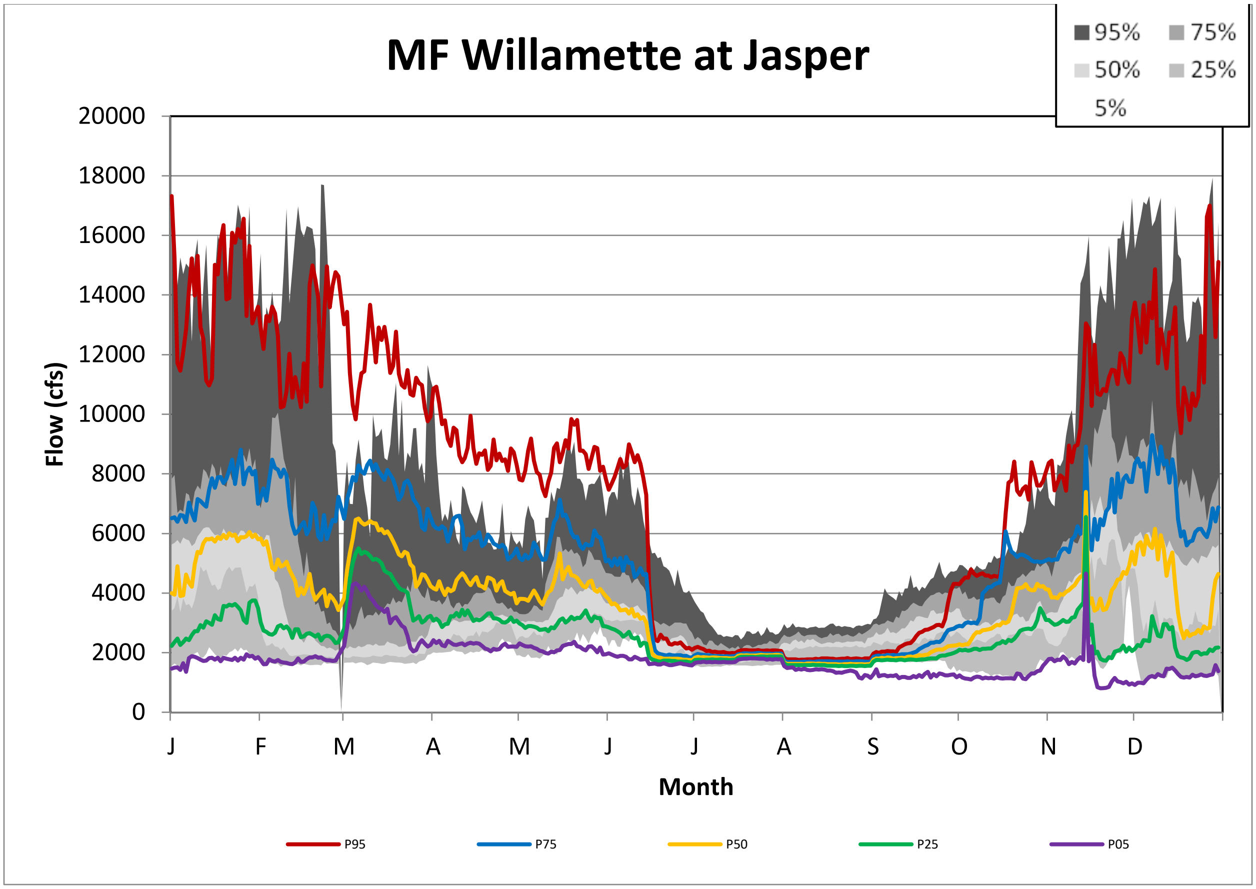


Figure 3-42. Non-Exceedance Flows at Jasper on the Middle Fork Willamette River under Alternative 3A

3.5.2.4 Mainstem Willamette

Operations affecting water supply on the mainstem Willamette River include releasing water for the integrated temperature and habitat flow regime, augmenting these flows with water from the inactive and power pools, as necessary and available, drawing down Detroit, Cougar, and Lookout Point reservoirs in the spring and fall for fish passage, and drawing down Green Peter and Hills Creek reservoir in the fall for fish passage.

Flows at Harrisburg on the Willamette River, downstream of the McKenzie River confluence, are lower than the NAA from April through mid-June during the driest years, but higher or equal to the NAA during the summer months. As the flows are only lower during a portion of the spring, still staying above 5000 cfs, and only in the driest years, Alternative 3A would have a negligible effect on water supply in the Willamette River above Harrisburg.

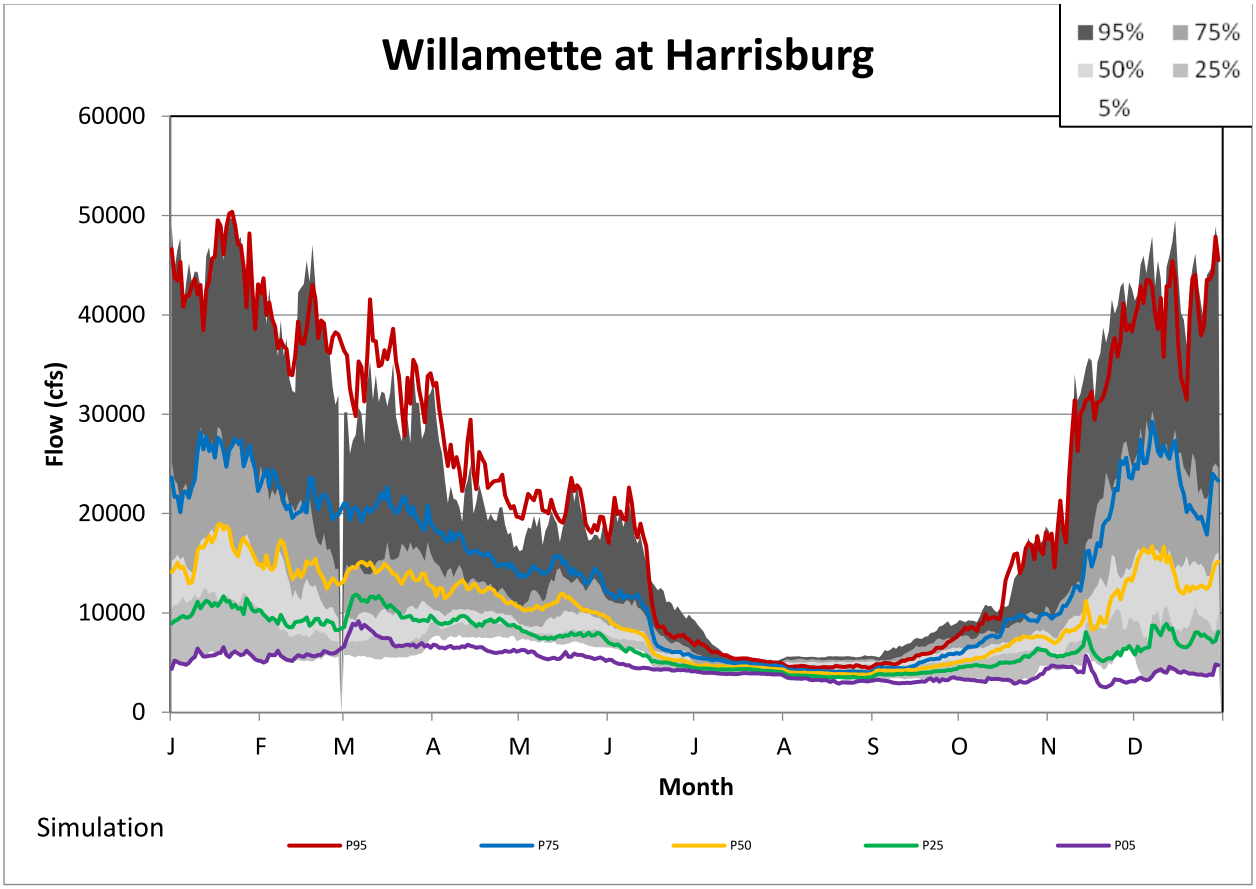


Figure 3-43. Non-Exceedance Flows at Harrisburg on the Willamette River under Alternative 3A

Flows at Albany on the Willamette River, upstream of the Santiam River confluence, are lower than the NAA from April through mid-June during the driest years and nearly equal to the NAA flows during the summer months. As the flows are only lower during a portion of the spring, staying above 3000 cfs, and only in the driest years, Alternative 3A would have a negligible effect on water supply in the Willamette River above and immediately downstream of Albany.

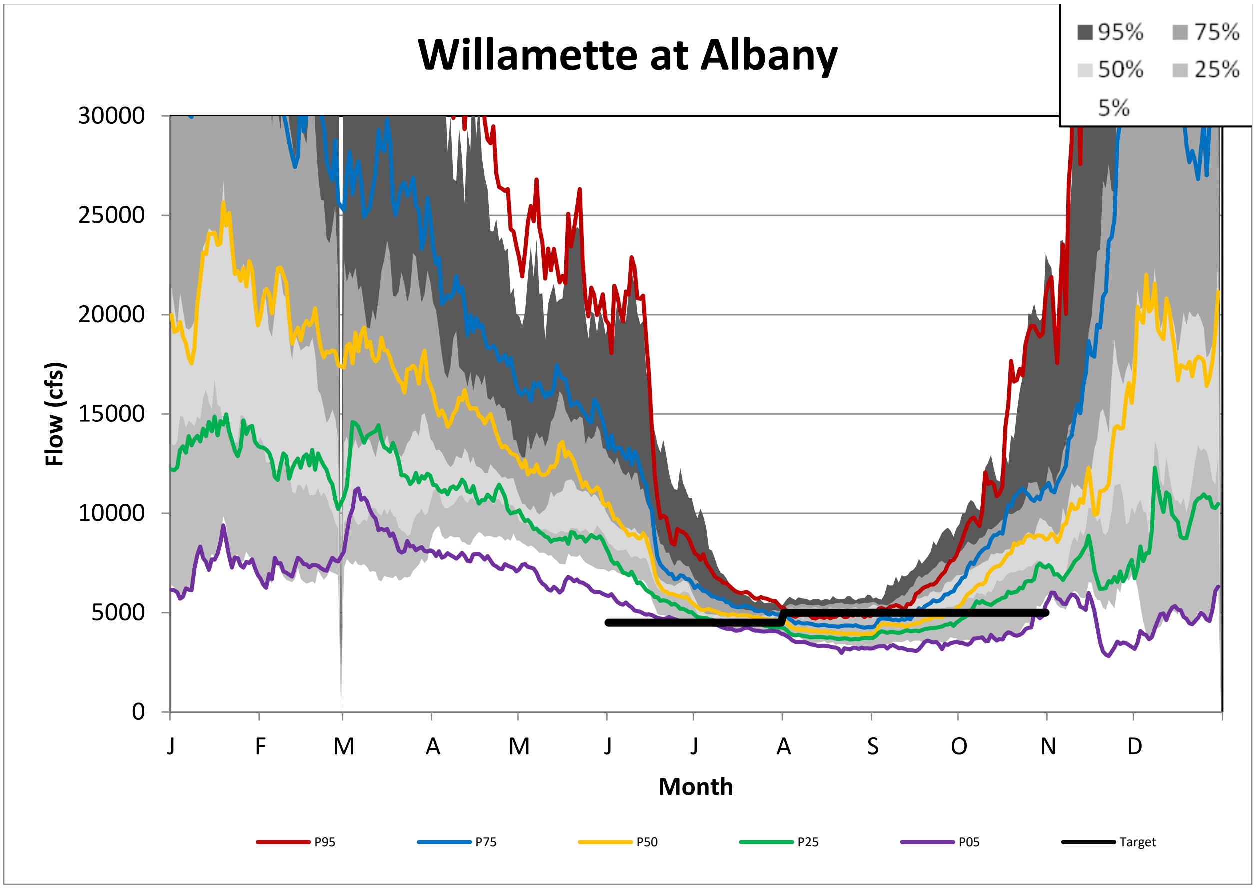


Figure 3-44. Non-Exceedance Flows at Albany on the Willamette River under Alternative 3A

Flows at Salem on the Willamette River, downstream of the Santiam River confluence, are lower than the NAA from April through mid-June during the driest years and lower during the summer for most years. As the flows would still stay above 6000 cfs most of the time, Alternative 3A would have a negligible effect on water supply in the Willamette River near and downstream of Salem.

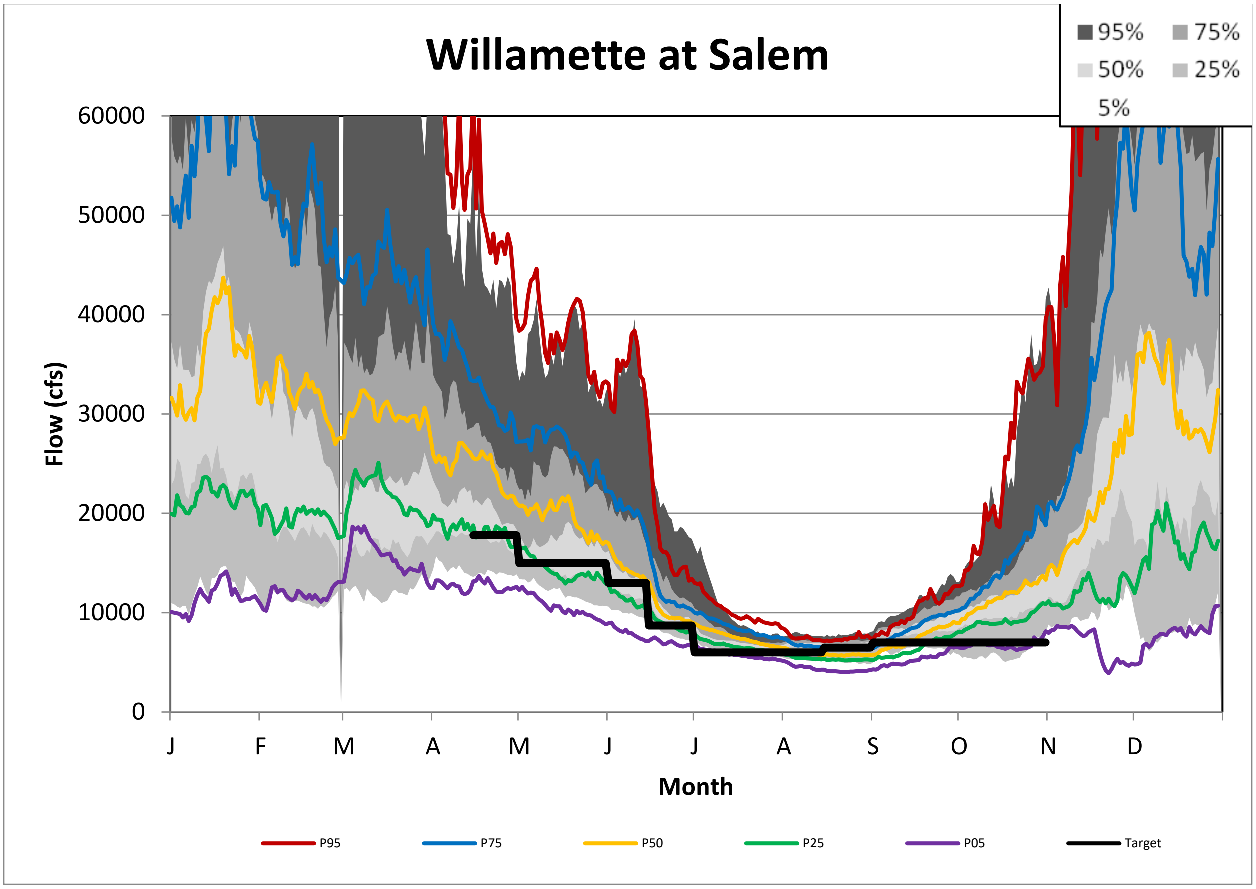


Figure 3-45. Non-Exceedance Flows at Salem on the Willamette River under Alternative 3A

3.6 ALTERNATIVE 3B

3.6.1 Storage Allocations

Alternative 3B is also an operational fish passage alternative, combining spring spill and drawdowns with fall drawdowns at 6 of the 11 storage projects. These combined operations significantly affect system-wide refill of conservation storage, resulting in system-wide stored water being only 50% of the refill volume in the NAA, or 669,000 acre-feet, as indicated in Figure 3-46. Stored water would not be available to meet all M&I storage agreements and irrigation water service contracts in the driest years. This lack of storage is significantly higher under alternatives 3A and 3B. The amount available would be determined on an annual basis based on realized storage volumes across the system but will have a more pronounced effect. This would result in a **major** adverse effect to the storage allocations and users relying on the stored water for M&I water supply and irrigation.

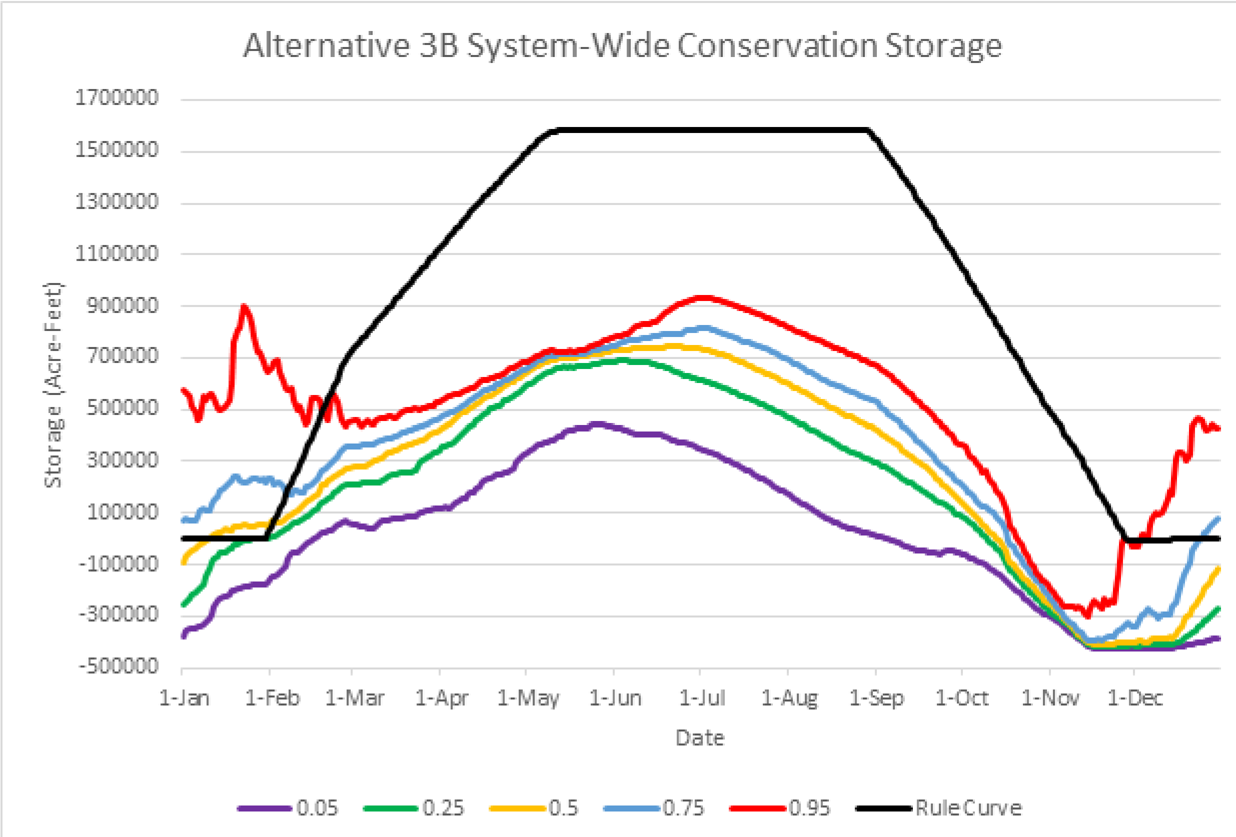


Figure 3-46. System Wide Conservation Storage for Alternative 3B

3.6.2 Live Flow Water Rights

3.6.2.1 Santiam

Flows at Jefferson on the Santiam, downstream of the confluence of the North and South Santiam Rivers, in Alternative 3B are affected by the combination of a spring drawdown operation at Green Peter and fall drawdown operations at both Detroit and Green Peter. Flows are very similar to those expected under Alternative 3A: slightly higher than the NAA from mid-March to mid-June except in the driest years when flows would be lower than the NAA starting in late April. Flows in the summer are nearly equal to the NAA. Flows in the fall are lower than the NAA about half the time. As the flows are slightly lower than during the critical low flow summer season, Alternative 3B would have a minor adverse effect on water supply in the Santiam River.

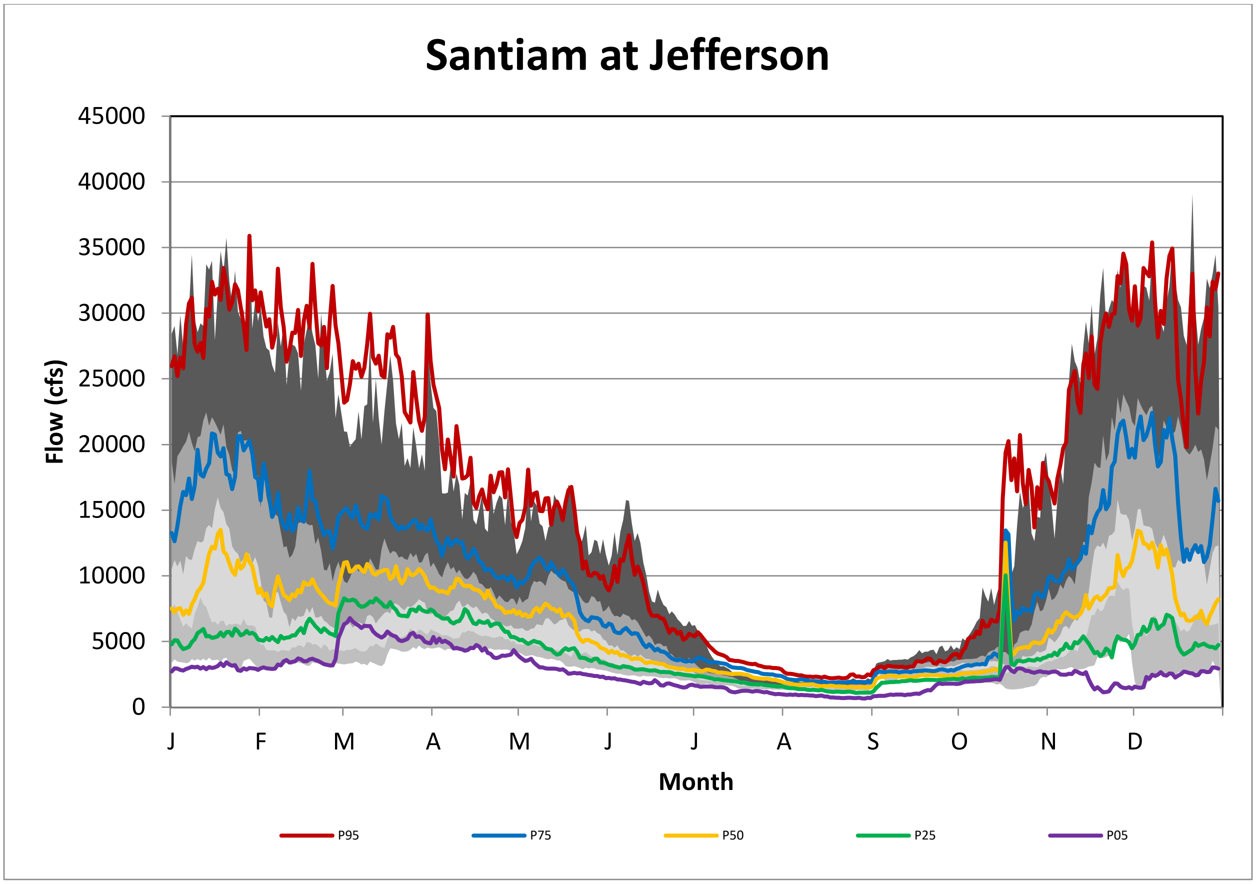


Figure 3-47. Non-Exceedance Flows at Jefferson on the Santiam River under Alternative 3B

North Santiam

Flow at Mehama, a key indicator for water supply users on the North Santiam, is slightly lower in the spring and late summer, dropping close to 1000 cfs during the late summer during the driest years, as compared to the NAA, reflecting the lower spring target flows from Detroit as compared to the NAA. Flows in September would be higher in all but the driest years as the reservoir is drafted for the fall drawdown operation for fish passage. Real time water management of the reservoir would be capable of managing flows in the North Santiam River in the driest years to minimize adverse effects; therefore, Alternative 3B would only have a minor adverse effect to users relative to the NAA. This effect would be local and occur only in the driest years.

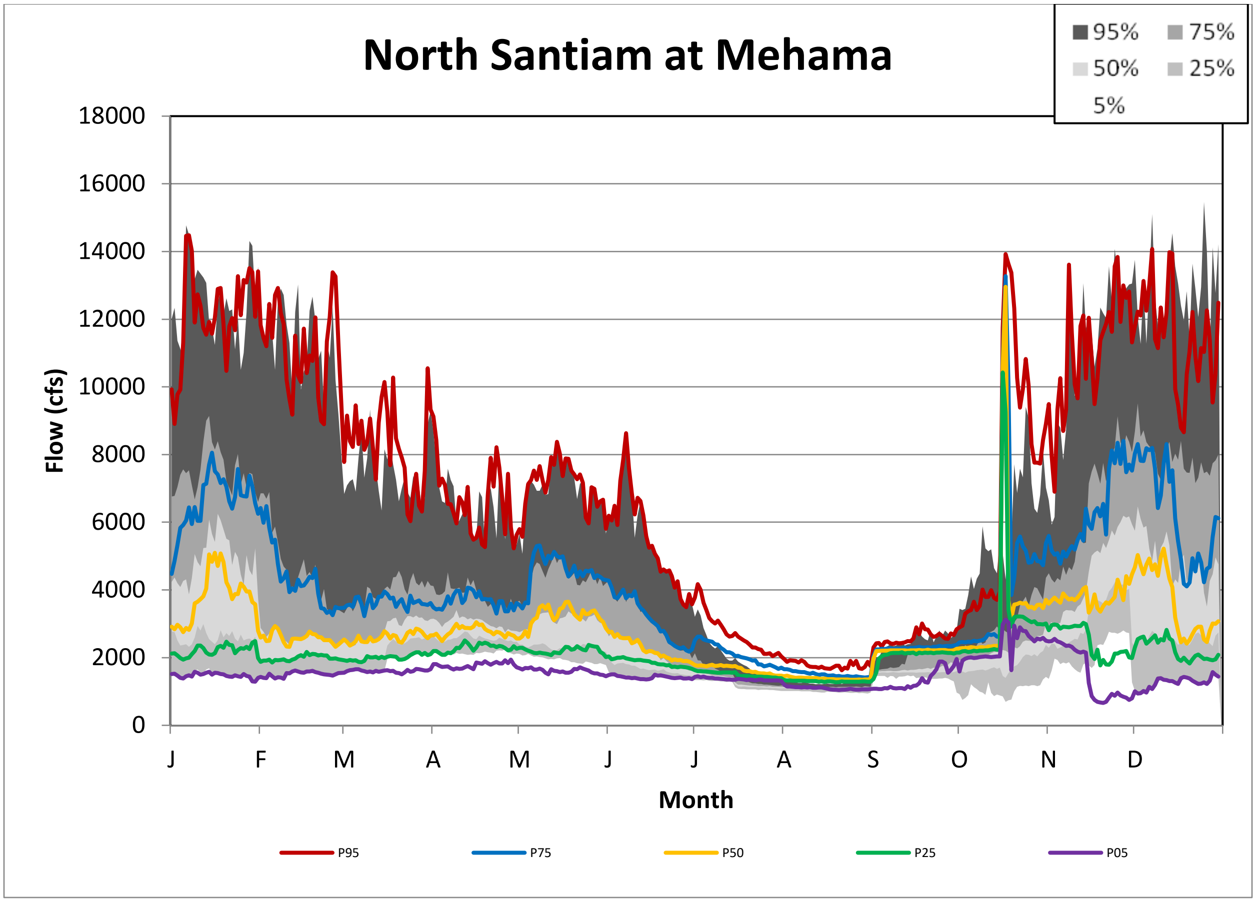


Figure 3-48. Non-Exceedance Flows at Mehama on the North Santiam River under Alternative 3B

South Santiam

Under Alternative 3B, Green Peter reservoir would be held below minimum conservation pool, rarely filling into the conservation pool, nearly eliminating the ability to augment naturally low flows in the summer. Due to the spring drawdown and need to pass inflows instead of storing water, flows at Waterloo in the spring, from March through early to late May, depending on the type of water year, are higher under Alternative 3B as compared to the NAA. Starting in June (May for driest years), flows drop lower than in the NAA as there is little to no water in the conservation pool to augment naturally low flows. Flows at Waterloo could drop to near 100 cfs for extended periods about 25% of the time. This could cause curtailment of water rights. Therefore, Alternative 3B would have a major adverse effect to M&I water supply and irrigation on the South Santiam River. This effect would be long term in that it would occur in most years and during the critically low flow season.

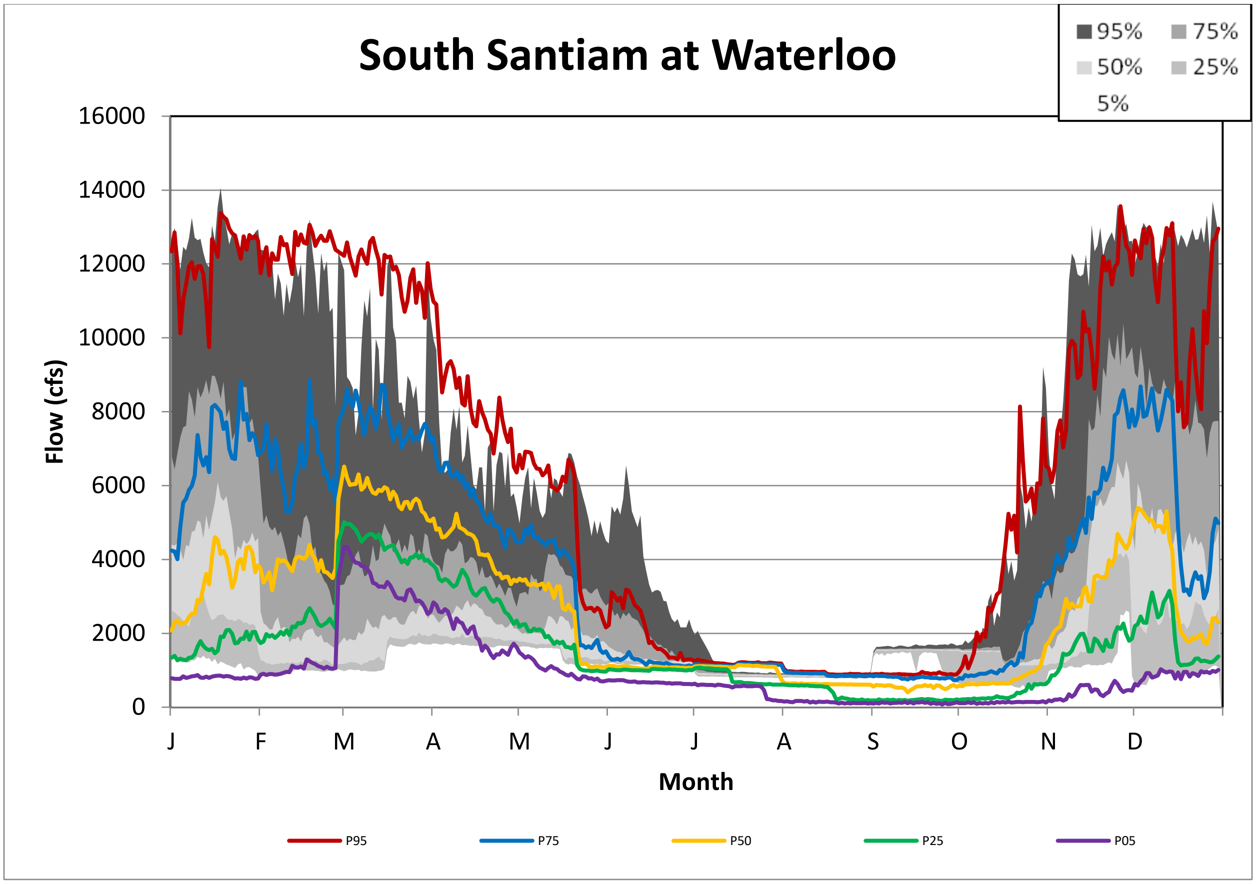


Figure 3-49. Non-Exceedance Flows at Waterloo on the South Santiam River under Alternative 3B

3.6.2.2 McKenzie

Even though Alternative 3B has a more deeper spring drawdown operation at Cougar reservoir, flows at Vida are very similar to those expected to occur under Alternative 3A, i.e., higher in the spring than in the NAA for all but the driest years, as the reservoir needs to pass inflows to keep the pool drawn down for the fish passage operation in both the spring and fall. Flows in the summer are nearly equal to the NAA, but lower in the fall. This is due to not needing to empty the reservoir in preparation for the winter flood management season. As flows are nearly equal, especially for drier years, during the low flow season Alternative 3B would have a negligible effect on water supply in the McKenzie River.

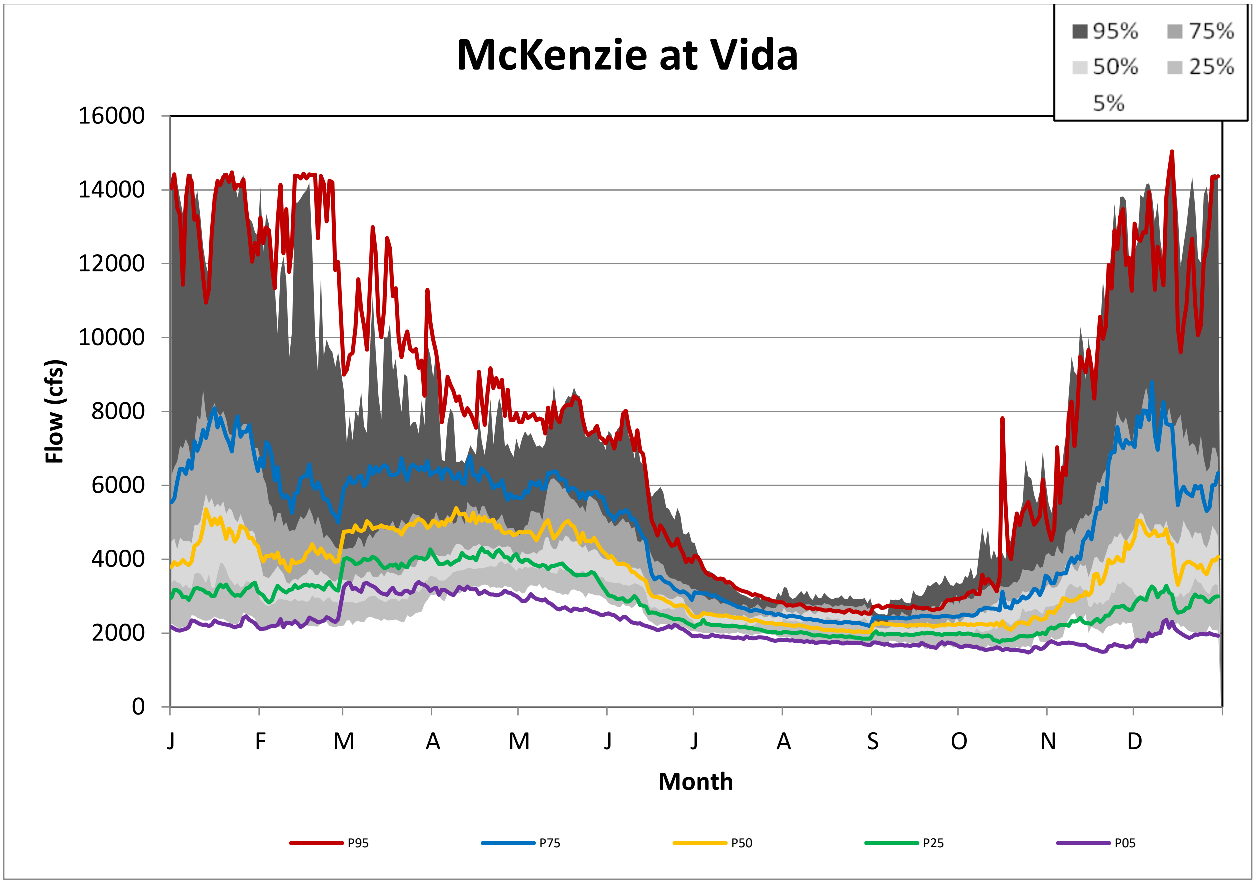


Figure 3-50. Non-Exceedance Flows at Vida on the McKenzie River under Alternative 3B

3.6.2.3 Middle Fork Willamette

Operations affecting water supply in the Middle Fork Willamette sub-basin include releasing water for the integrated temperature and habitat flow regime, augmenting these flows with water from the power pools at Lookout Point and Hills Creek, as necessary and available, and drawing down Lookout Point reservoir in fall and drawing down Hills Creek reservoir in the spring and fall for fish passage.

Flows at Jasper would be higher than in the NAA spring through fall in about 50% of years. For drier years, flows would be slightly less than the NAA April through mid-June, but then slightly higher until late August. During the driest years, flow would again be lower than then NAA, going down close to 1000 cfs at times. As the flows are lower during late summer and early fall, Alternative 3B would have a minor adverse effect on water supply in the Middle Fork Willamette River.

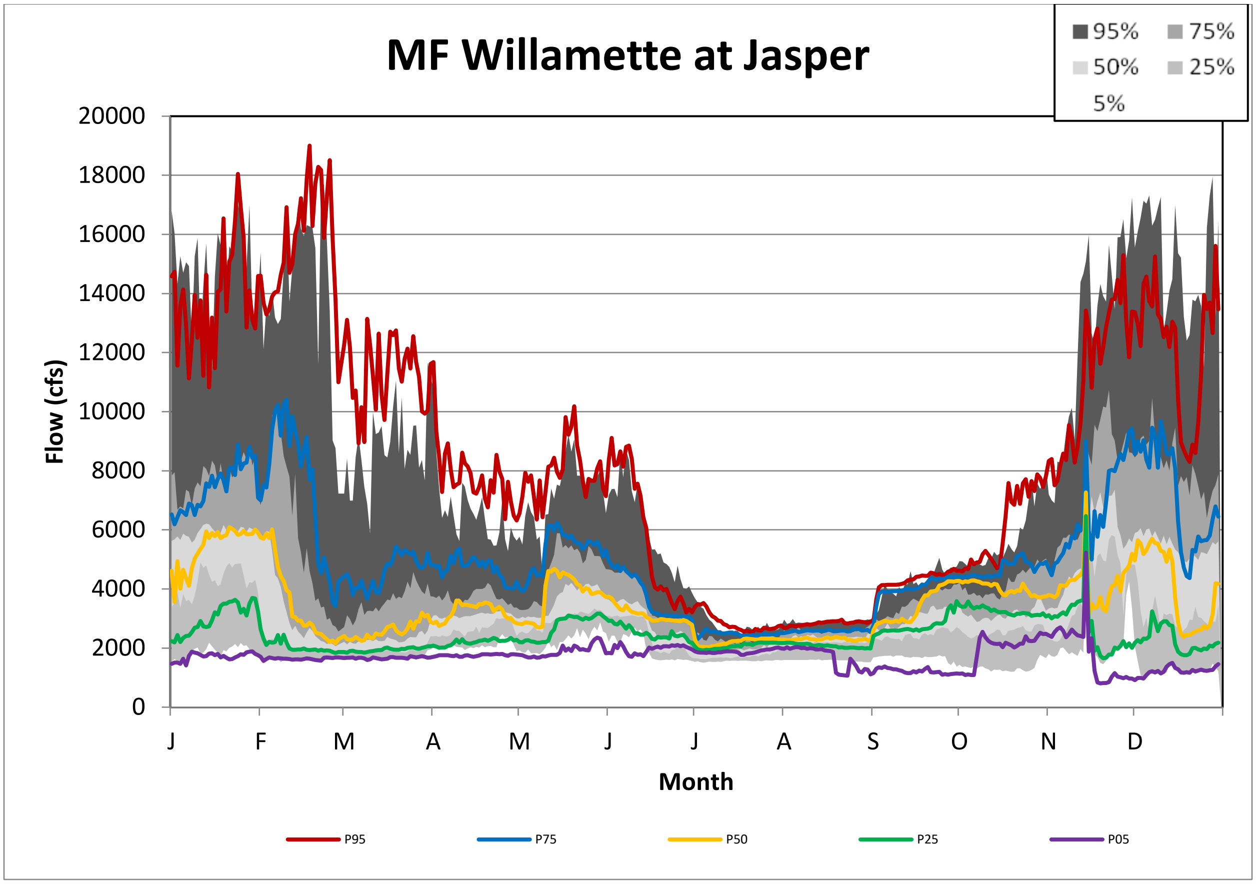


Figure 3-51. Non-Exceedance Flows at Jasper on the Middle Fork Willamette River under Alternative 3B

3.6.2.4 Mainstem Willamette

Operations affecting water supply on the mainstem Willamette River include releasing water for the integrated temperature and habitat flow regime, augmenting these flows with water from the inactive and power pools at Lookout Point and Hills Creek, as necessary and available, drawing down Detroit and Lookout Point reservoirs in the fall for fish passage, and drawing down Green Peter, Cougar, and Hills Creek reservoirs in the spring and fall for fish passage.

Flows at Harrisburg on the Willamette River, downstream of the McKenzie River confluence, are lower than the NAA from April through mid-June during the driest years, but higher or equal to the NAA during the summer months for all years. As flows are only lower during a portion of the spring, still staying above 5000 cfs during that time-period, and only in the driest years, Alternative 3B would have a negligible effect on water supply in the Willamette River above and immediately downstream of Harrisburg.

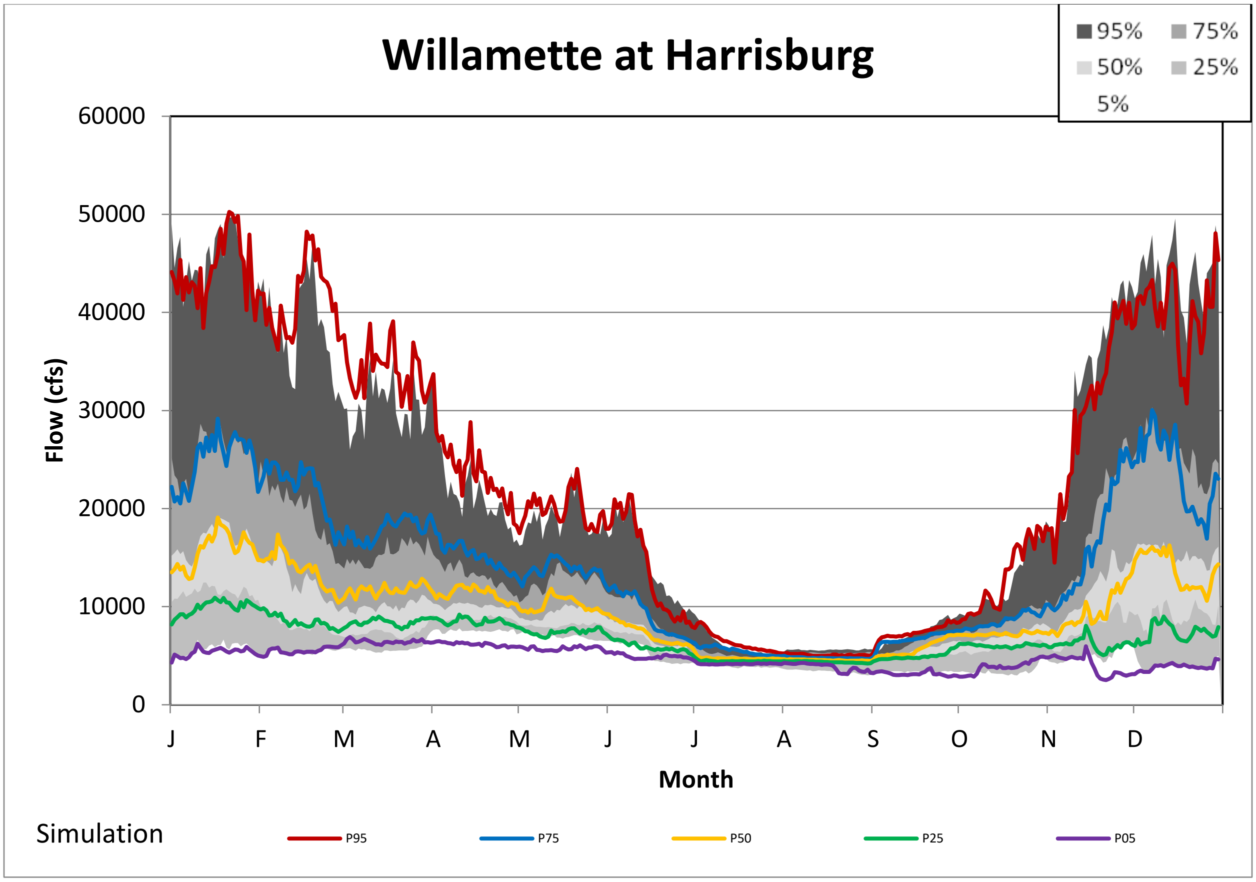


Figure 3-52. Non-Exceedance Flows at Harrisburg on the Willamette River under Alternative 3B

Flows at Albany on the Willamette River, upstream of the Santiam River confluence, are lower than the NAA from April through mid-June during drier years. Flows in the summer would be equal to or higher than in the NAA during the summer months, with flows dipping below NAA levels sporadically in late September and early October. As the flows are only lower during a portion of the spring, staying above 6000 cfs during this period, and only in the driest years, Alternative 3B would have a negligible effect on water supply in the Willamette River above and immediately downstream of Albany.

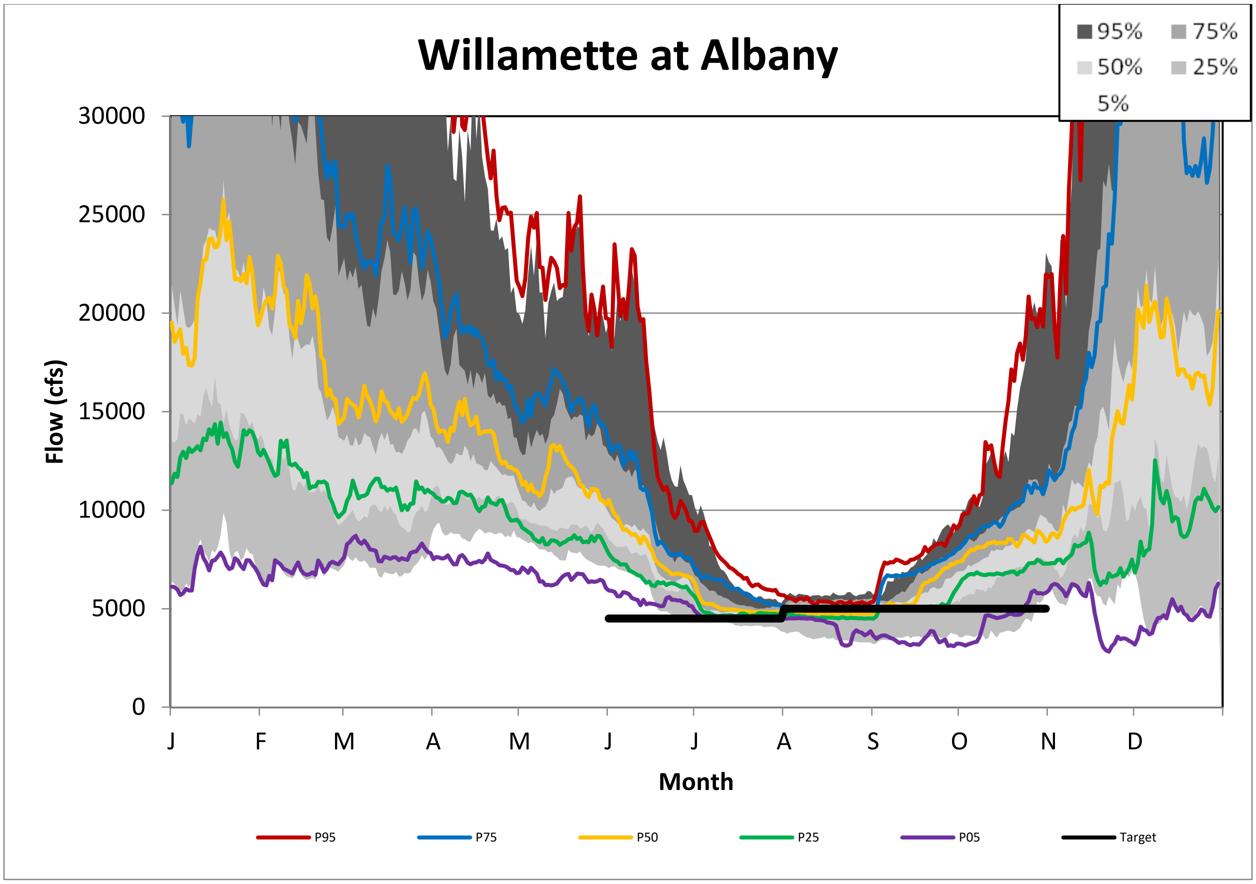


Figure 3-53. Non-Exceedance Flows at Albany on the Willamette River under Alternative 3B

Flows at Salem on the Willamette River, downstream of the Santiam River confluence, are lower than the NAA from April through mid-June and September during the driest years. As the flows would still stay above 6000 cfs most of the time, Alternative 3B would have a negligible effect on water supply in the Willamette River near and downstream of Salem.

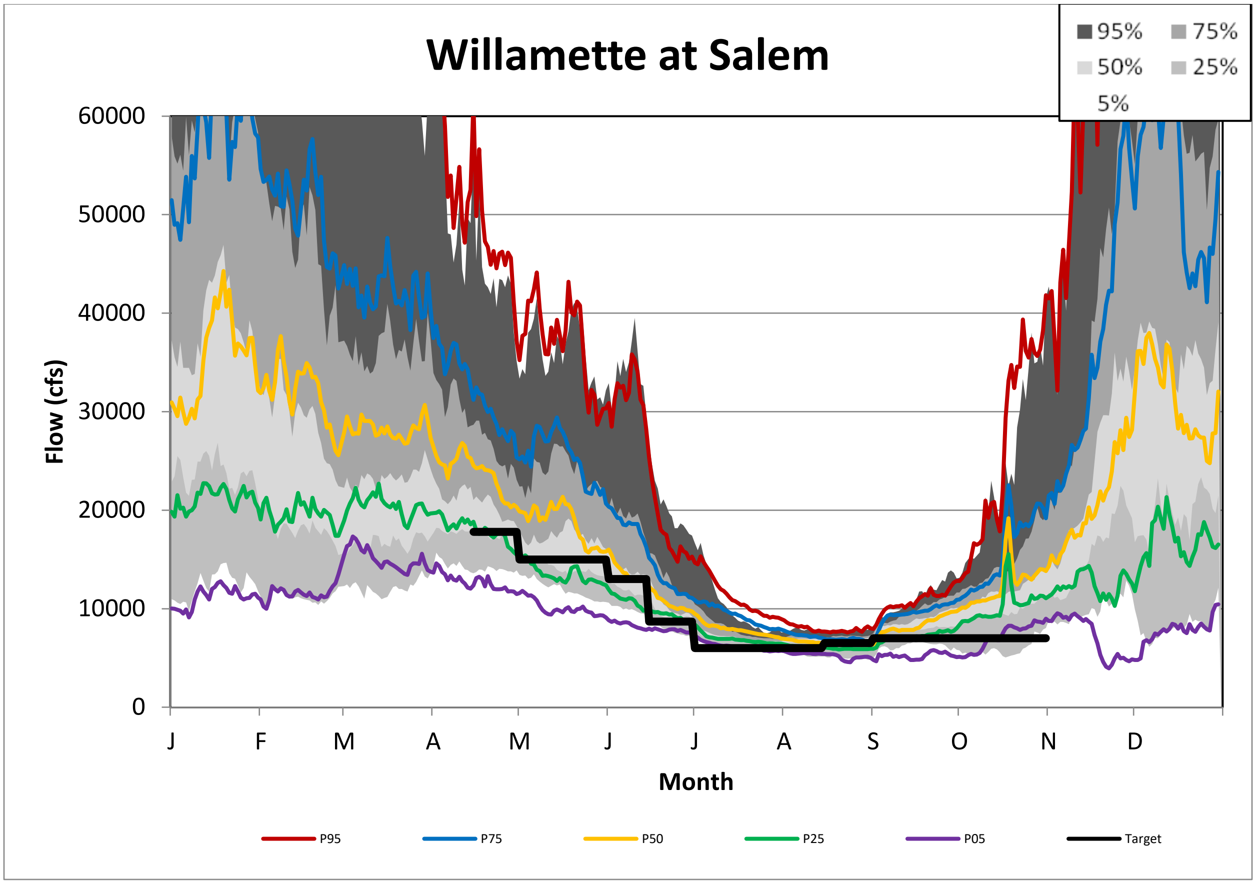


Figure 3-54. Non-Exceedance Flows at Salem on the Willamette River under Alternative 3B

3.7 ALTERNATIVE 4

3.7.1 Storage Allocations

Figure 3-55 shows system-wide stored water would be 1,451,000 acre-feet, an increase of 122,000 acre-feet at the 75% exceedance level compared to the NAA, resulting in more reliable use of stored water, including for municipal and industrial water supply and irrigation than realized in the NAA. Stored water would still not be available to meet all M&I storage agreements and irrigation water service contracts in the driest years, but to a lesser extent than in the NAA. The amount available would be determined on an annual basis based on realized storage volumes across the system. Alternative 4 would have a **minor** beneficial effect to system-wide storage allocations. This effect would be realized **long term** and basin-wide.

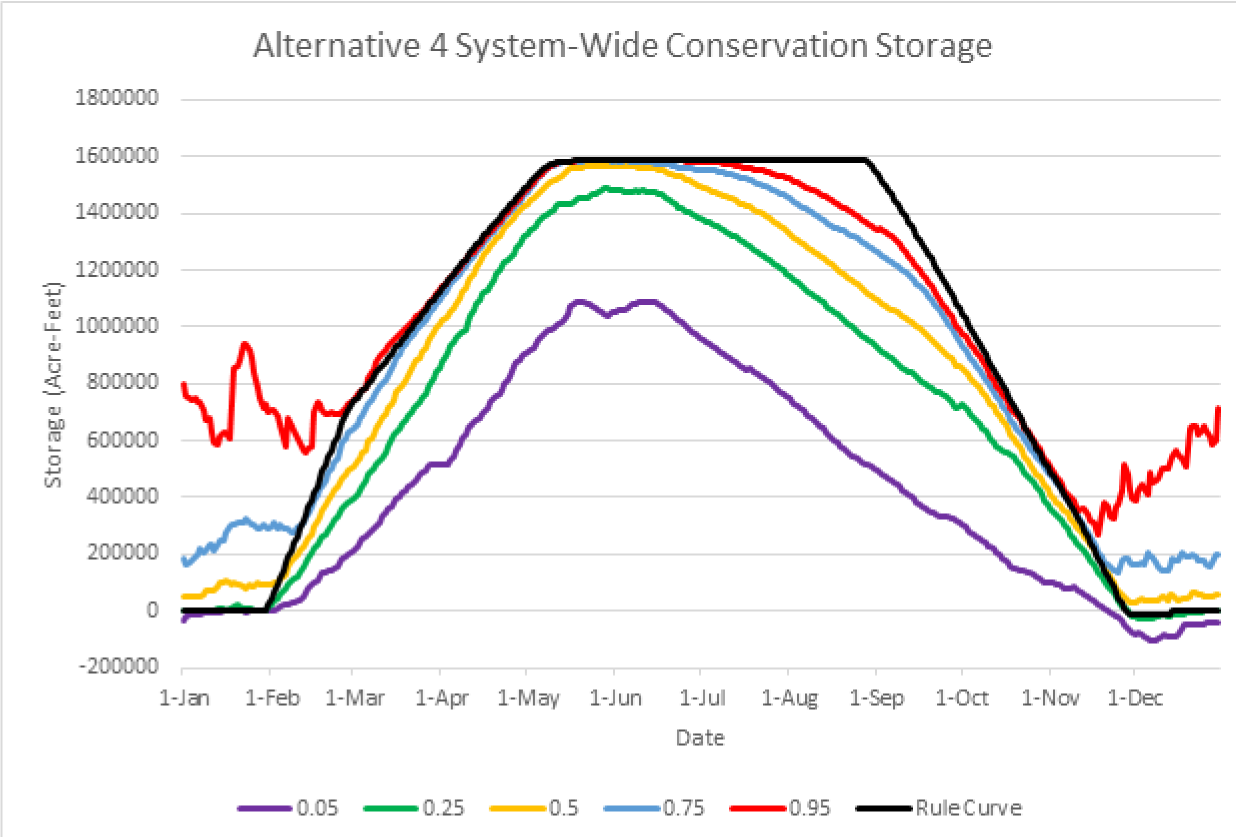


Figure 3-55. System Wide Conservation Storage for Alternative 4

3.7.2 Live Flow Water Rights

3.7.2.1 Santiam

Flows at Jefferson on the Santiam, downstream of the confluence of the North and South Santiam Rivers, are lower than the NAA from mid-March to mid-May in the driest years, but higher, or nearly equal, in the summer and fall in most years. As the flows are only lower during a portion of the spring and only in the driest years, Alternative 4 would have a negligible effect on water supply in the Santiam River.

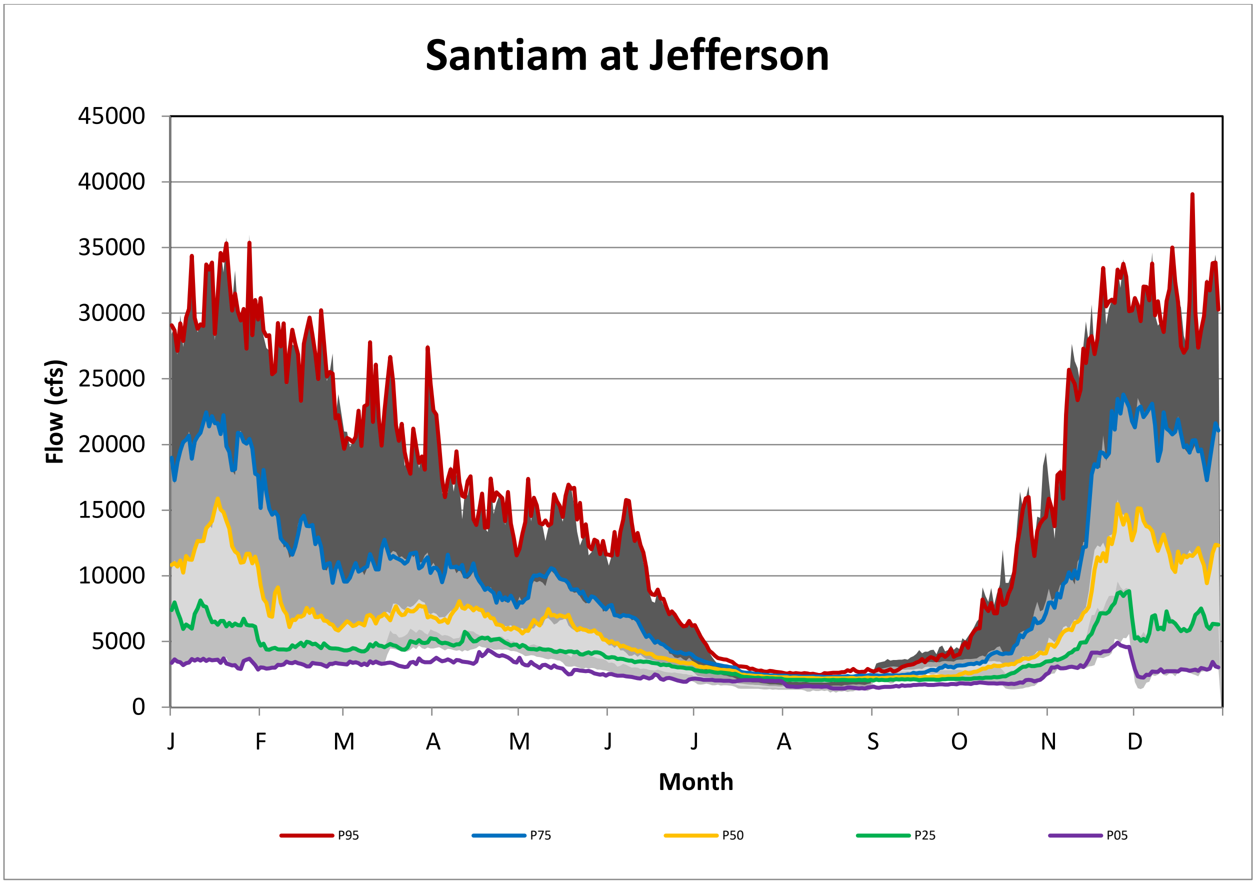


Figure 3-56. Non-Exceedance Flows at Jefferson on the Santiam River under Alternative 4

North Santiam

Flow at Mehama, a key indicator for water supply users on the North Santiam, is slightly lower in the spring and late summer, dropping close to 1000 cfs during the late summer during the driest years, as compared to the NAA, reflecting the lower, dry year target flows from Detroit as compared to the NAA. Detroit Reservoir fills higher in these years and would reach minimum conservation pool later in the year, following the rule curve. Real time water management of the reservoir would be capable of managing flows in the North Santiam River, as to result in only a minor adverse effect to users relative to the NAA. This effect would be local and occur only in the driest years.

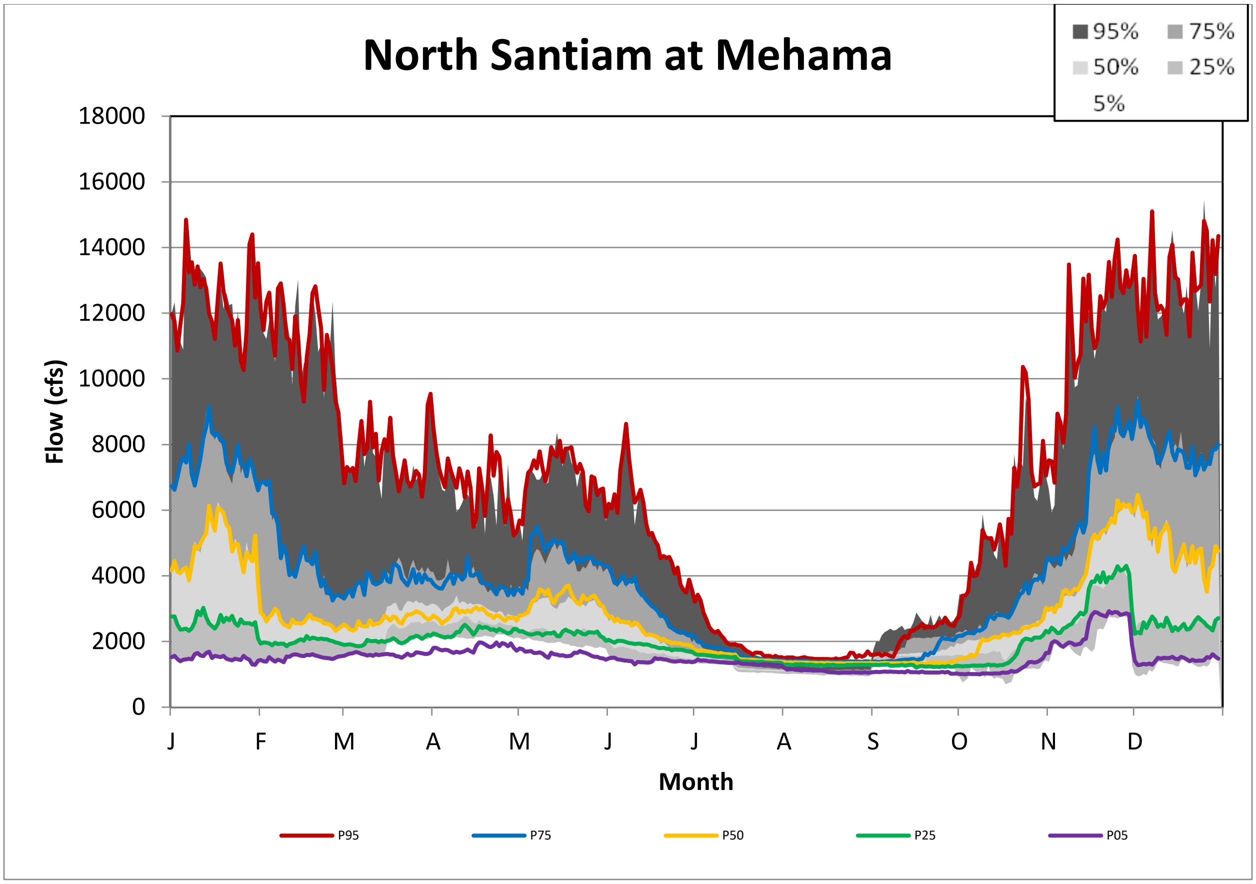


Figure 3-57. Non-Exceedance Flows at Mehama on the North Santiam River under Alternative 4

South Santiam

Flows at Waterloo on the South Santiam are lower than the NAA from mid-March to early-June in the driest years, but higher through the summer during most years. As the flows are only lower during a portion of the spring and only in the driest years, Alternative 4 would have a negligible effect on water supply in the South Santiam River.

Flows at Waterloo on the South Santiam are lower than the NAA from mid-March to early-June in the driest years due to reduced tributary flow target, higher in the summer most years due to a higher flow target than in the NAA, and much higher in September and the first half of October in all years due to the fall drawdown operation at Green Peter Dam. As the flows are only lower during a portion of the spring and only in the driest years, Alternative 5 would have a negligible effect on water supply in the South Santiam River.

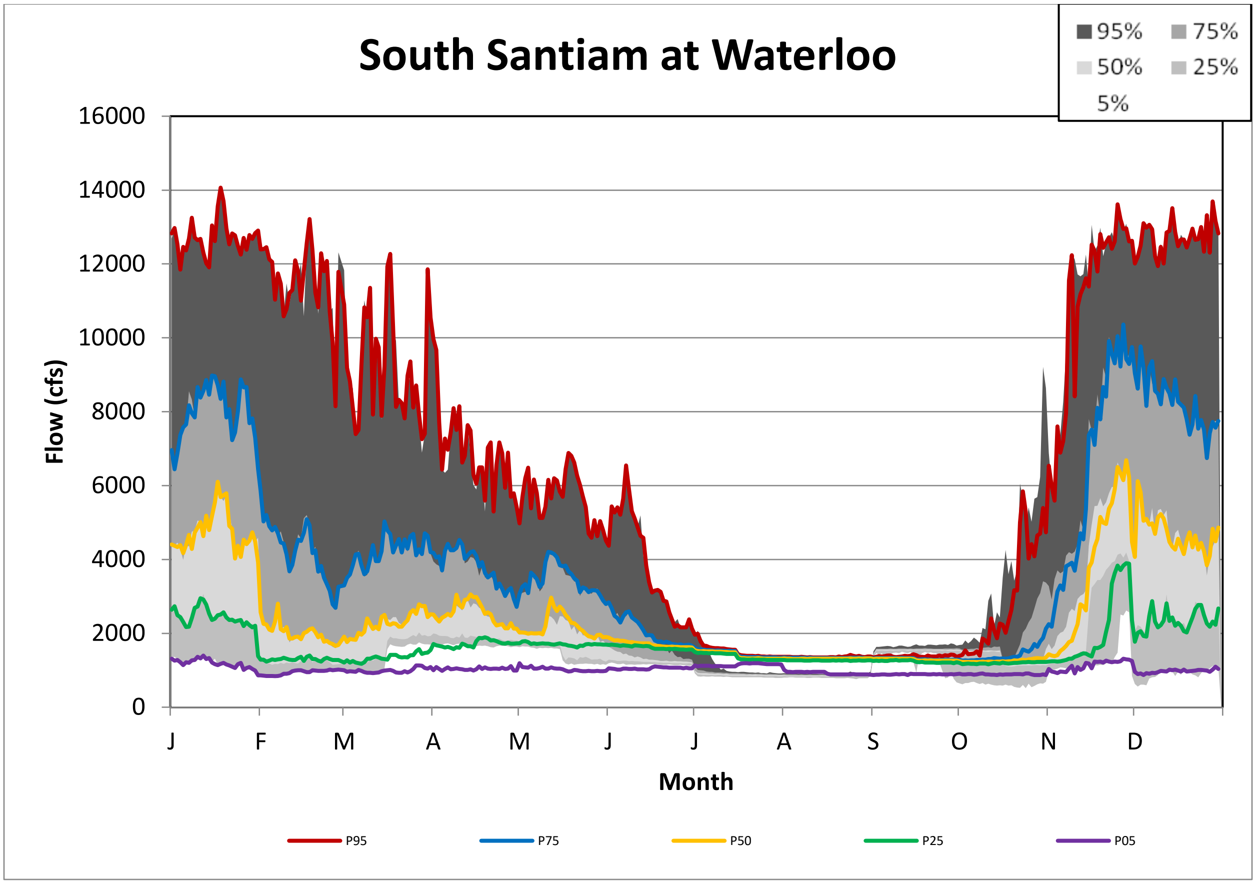


Figure 3-58. Non-Exceedance Flows at Waterloo on the South Santiam River under Alternative 4

3.7.2.2 McKenzie

Operations affecting water supply in the McKenzie Basin include releasing water for the integrated temperature and habitat flow regime and augmenting these flows with water from the power pool, as necessary.

Flows at Vida on the McKenzie River are lower than the NAA from April through mid-June but slightly higher in August and September in the driest years. As the flows are only lower during a portion of the spring and only in the driest years, Alternative 4 would have a negligible effect on water supply in the McKenzie River.

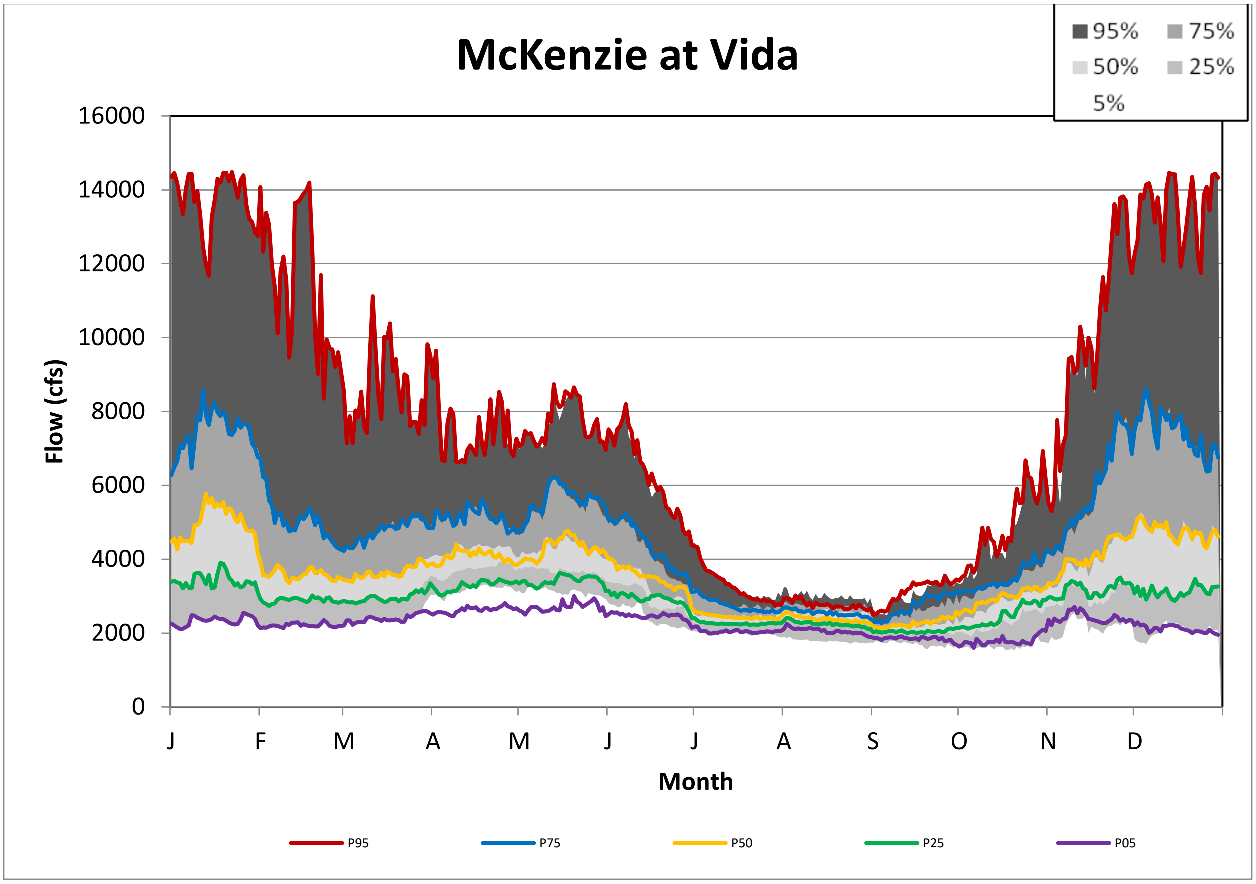


Figure 3-59. Non-Exceedance Flows at Vida on the McKenzie River under Alternative 4

3.7.2.3 Middle Fork Willamette

Operations affecting water supply in the Middle Fork Willamette sub-basin include releasing water for the integrated temperature and habitat flow regime and augmenting these flows with water from the power pools at Lookout Point and Hills Creek, as necessary.

Flows at Jasper on the Middle Fork Willamette River, downstream of Hills Creek, Lookout Point, and Fall Creek reservoirs, are lower than the NAA from April through mid-June in most years, but higher than the NAA during the summer months. As the flows are only lower during a portion of the spring and only in drier years, Alternative 4 would have a negligible effect on water supply in the Middle Fork Willamette River.

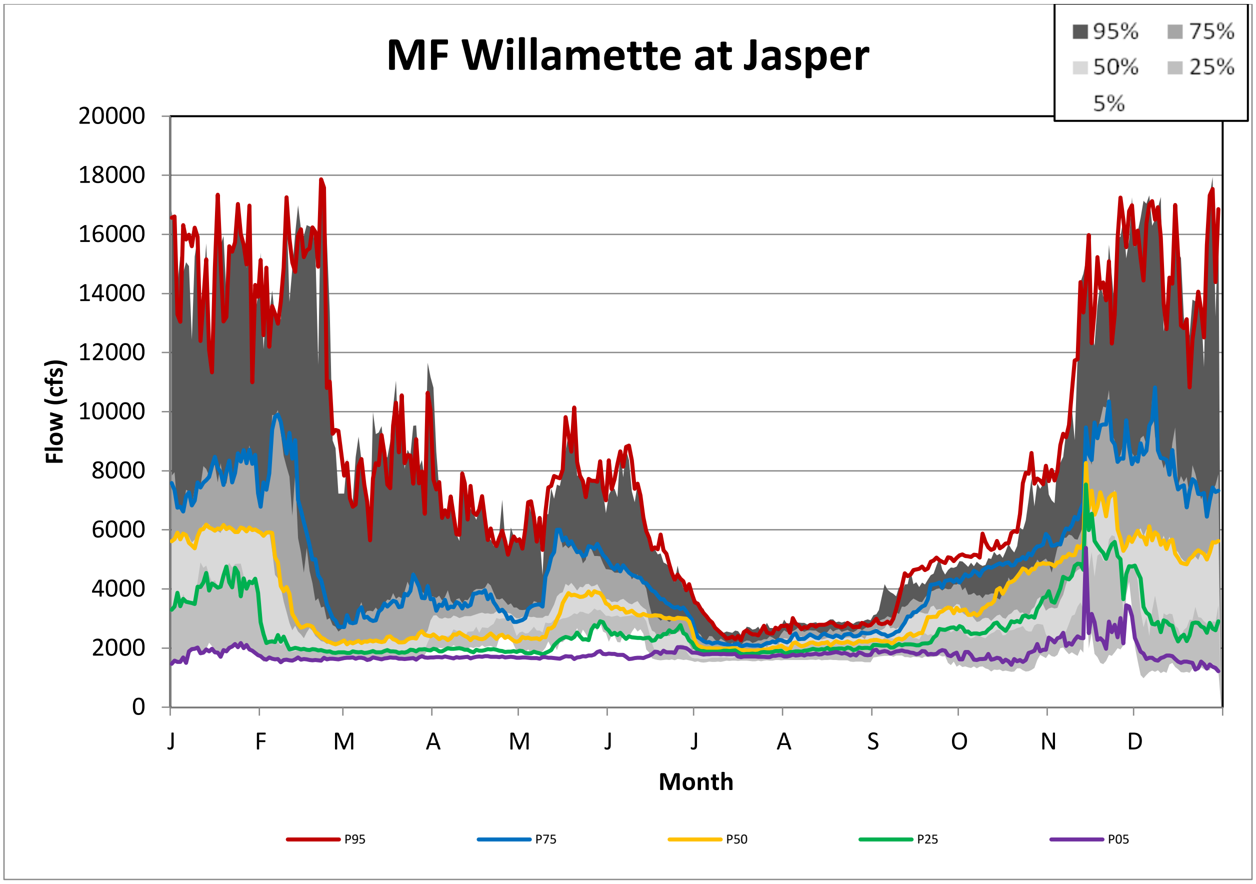


Figure 3-60. Non-Exceedance Flows at Jasper on the Middle Fork Willamette River under Alternative 4

3.7.2.4 Mainstem Willamette

Operations affecting water supply on the mainstem Willamette River include releasing water for the integrated temperature and habitat flow regime and augmenting these flows with water from the inactive and power pools, as necessary and available.

Flows at Harrisburg on the Willamette River, downstream of the McKenzie River confluence, are lower than the NAA from April through mid-June about 25% of the time, but higher or equal to the NAA during the summer months. As the flows are only lower during a portion of the spring, still staying above 4000 cfs, and only in the driest years, Alternative 4 would have a negligible effect on water supply in the Willamette River above Harrisburg.

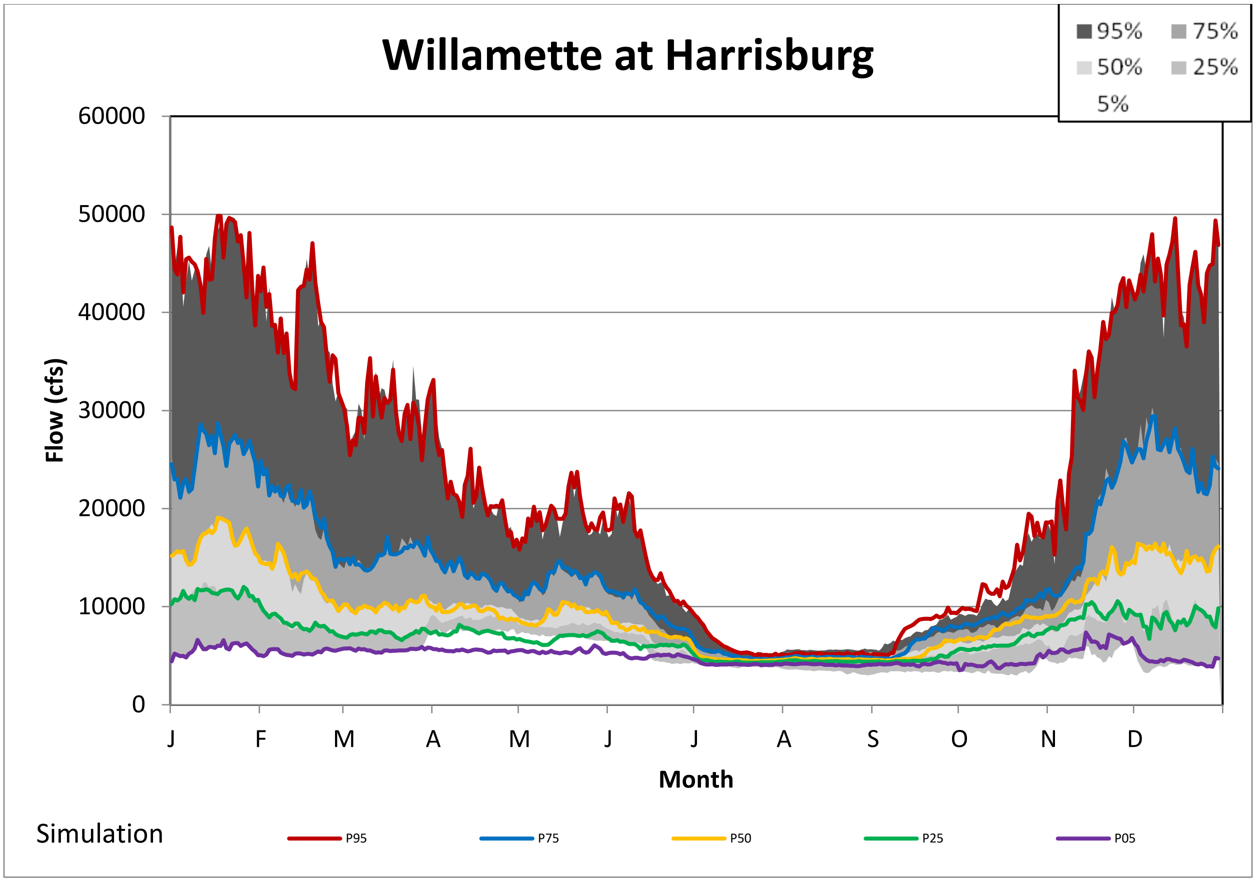


Figure 3-61. Non-Exceedance Flows at Harrisburg on the Willamette River under Alternative 4

Flows at Albany on the Willamette River, upstream of the Santiam River confluence, are lower than the NAA from April through mid-June about 25% of the time, but higher than in the NAA during the summer months. As the flows are only lower during a portion of the spring, still staying above 4500 cfs, and only in the driest years, Alternative 4 would have a negligible effect on water supply in the Willamette River above and immediately downstream of Albany.

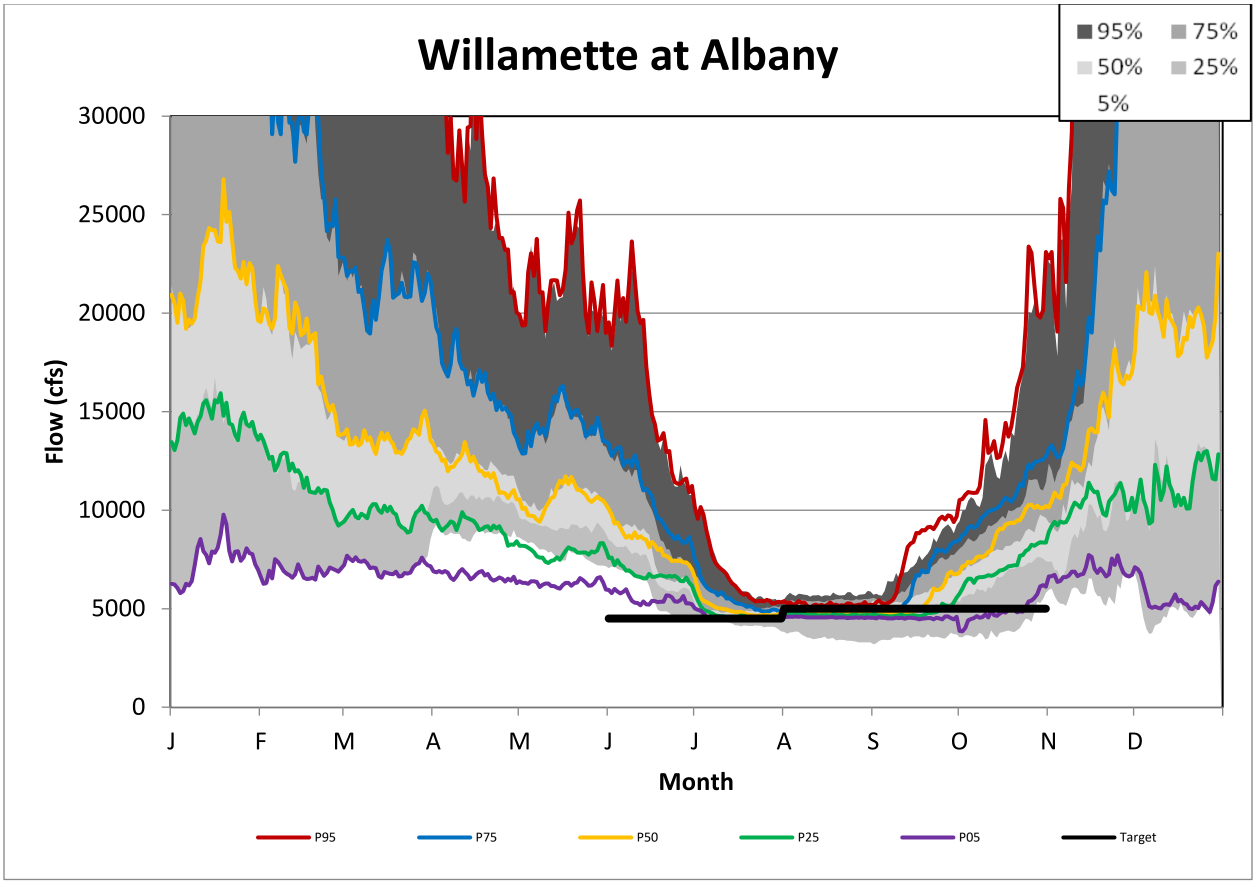


Figure 3-62. Non-Exceedance Flows at Albany on the Willamette River under Alternative 4

Flows at Salem on the Willamette River, downstream of the Santiam River confluence, are lower than the NAA from April through mid-June about 25% of the time, but higher or equal to the NAA during the summer months. As the flows are only lower during a portion of the spring, still staying above 6000 cfs, and only in the driest years, Alternative 4 would have a negligible effect on water supply in the Willamette River near and downstream of Salem.

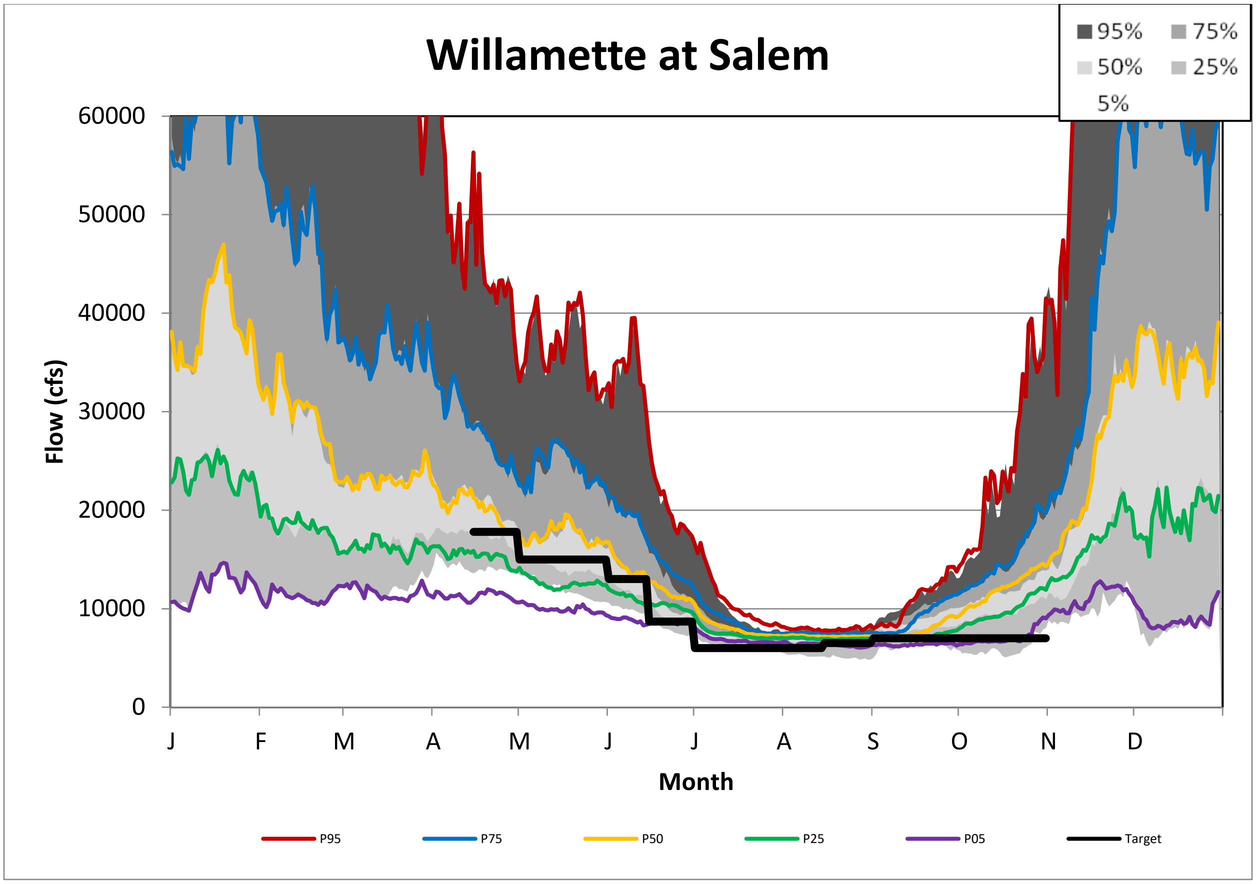


Figure 3-63. Non-Exceedance Flows at Salem on the Willamette River under Alternative 4

3.8 ALTERNATIVE 5

3.8.1 Storage Allocations

Figure 3-64 shows system-wide stored water would be approximately 1,230,000 acre-feet, a decrease of 98,536 acre-feet at the 75% exceedance level compared to the NAA. Stored water would not be available to meet all M&I storage agreements and irrigation water service contracts in the driest years. The amount available would be determined on an annual basis based on realized storage volumes across the system. The small decrease in stored water would have a **minor** adverse effect to municipal and industrial water supply and irrigation users of the conservation storage. Due to the expected limited level of demand for stored water on the McKenzie River, Alternative 5 would be expected to have only a **minor** adverse effect to system-wide storage allocations.

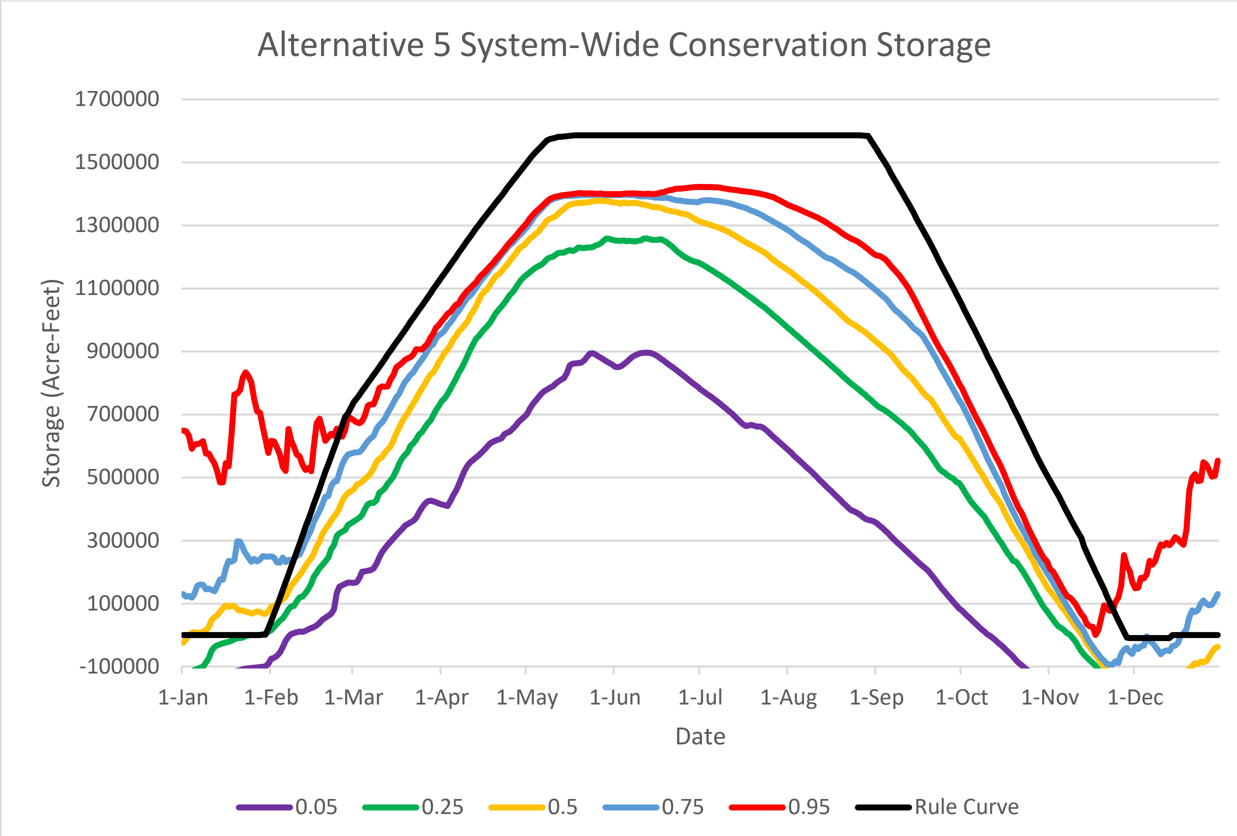


Figure 3-64. System Wide Conservation Storage for Alternative 5

3.8.2 Live Flow Water Rights

3.8.2.1 Santiam

Flows at Jefferson on the Santiam, downstream of the confluence of the North and South Santiam Rivers, are lower than the NAA from mid-March to mid-May in the driest years, but higher in the summer due to higher summer flow targets, and higher in fall in most years due to the fall drawdown operation at Green Peter Dam. As the flows are only lower during a portion of the spring and only in the driest years, Alternative 5 would have a negligible effect on water supply in the Santiam River.

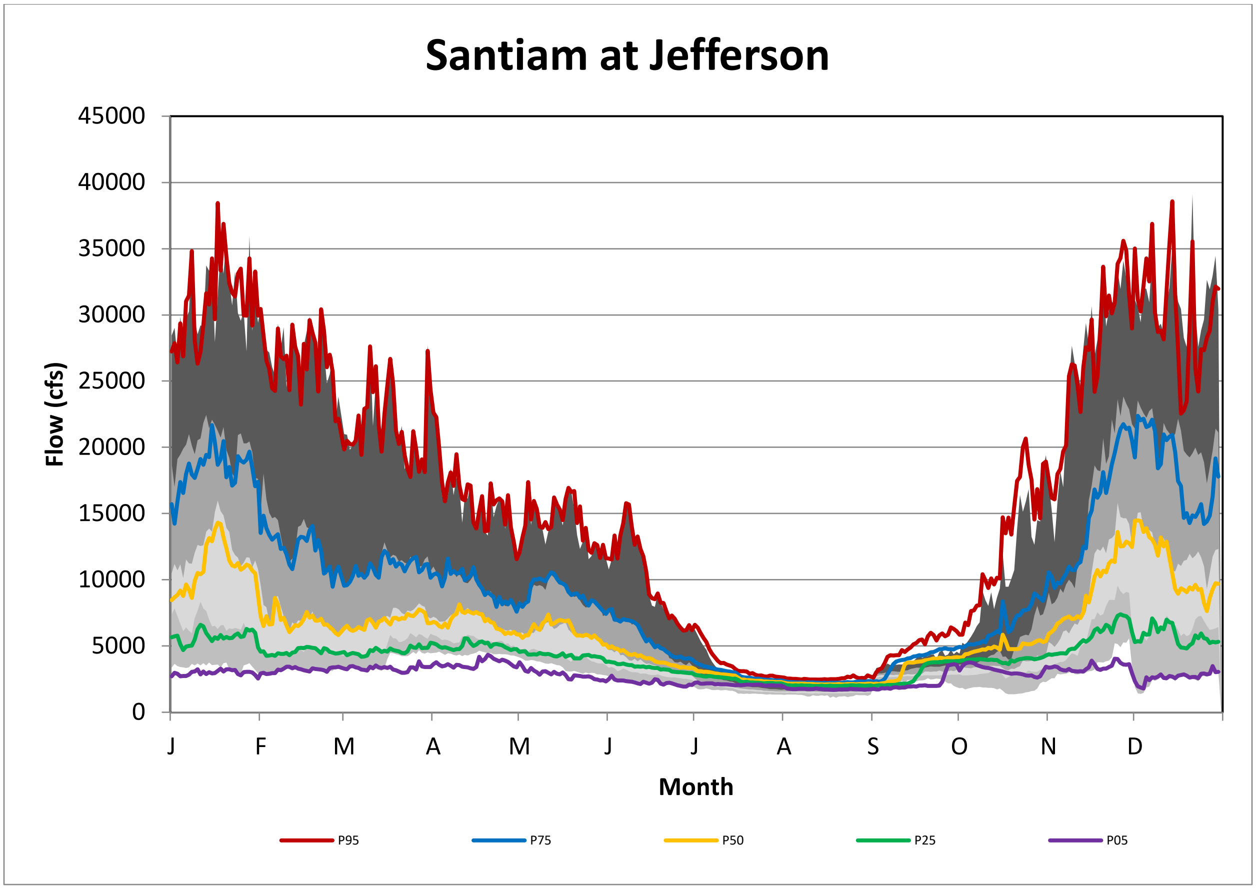


Figure 3-65. Non-Exceedance Flows at Jefferson on the Santiam River under Alternative 5

North Santiam

Operations affecting water supply in the North Santiam Basin include releasing water for the modified integrated temperature and habitat flow regime and augmenting these flows with water from the power pool, as necessary.

Flow at Mehama, a key indicator for water supply users on the North Santiam, is slightly lower in the spring and late summer, dropping close to 1000 cfs during the late summer during the drier years, as compared to the NAA, reflecting the lower spring target flows from Detroit as compared to the NAA for dry years. Detroit Reservoir fills higher in these years and would reach minimum conservation pool later in the year, following the rule curve. Real time water management of the reservoir would be capable of managing flows in the North Santiam River, as to result in only a minor adverse effect to users relative to the NAA. This effect would be local and occur only in the driest years.

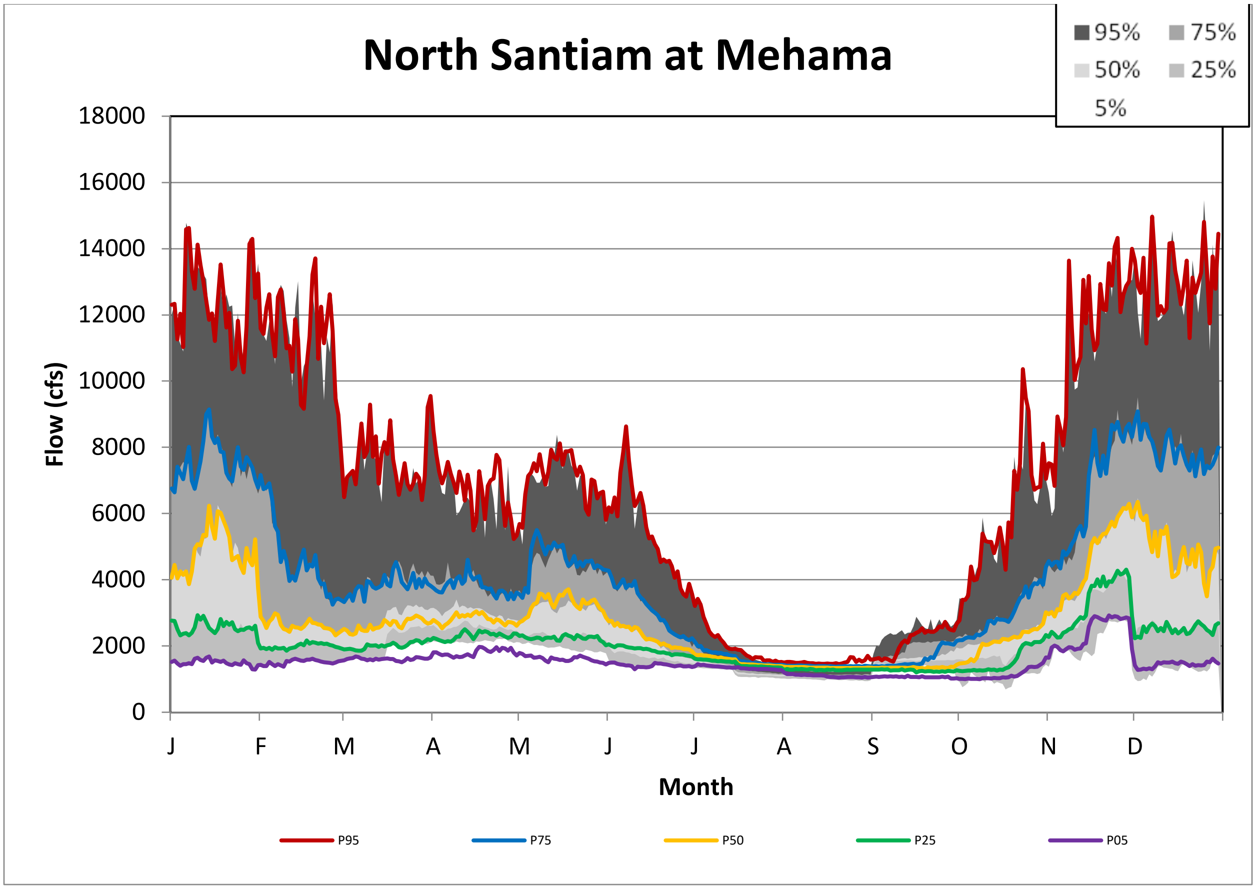


Figure 3-66. Non-Exceedance Flows at Mehama on the North Santiam River under Alternative 5

South Santiam

Operations affecting water supply in the South Santiam Basin include releasing water for the modified integrated temperature and habitat flow regime and augmenting these flows with water from the power pool, as necessary.

Flows at Waterloo on the South Santiam are lower than the NAA from mid-March to early-June in the driest years due to reduced tributary flow target, higher in the summer most years due to a higher flow target than in the NAA, and much higher in September and the first half of October in all years due to the fall drawdown operation at Green Peter Dam. As the flows are only lower during a portion of the spring and only in the driest years, Alternative 5 would have a negligible effect on water supply in the South Santiam River.

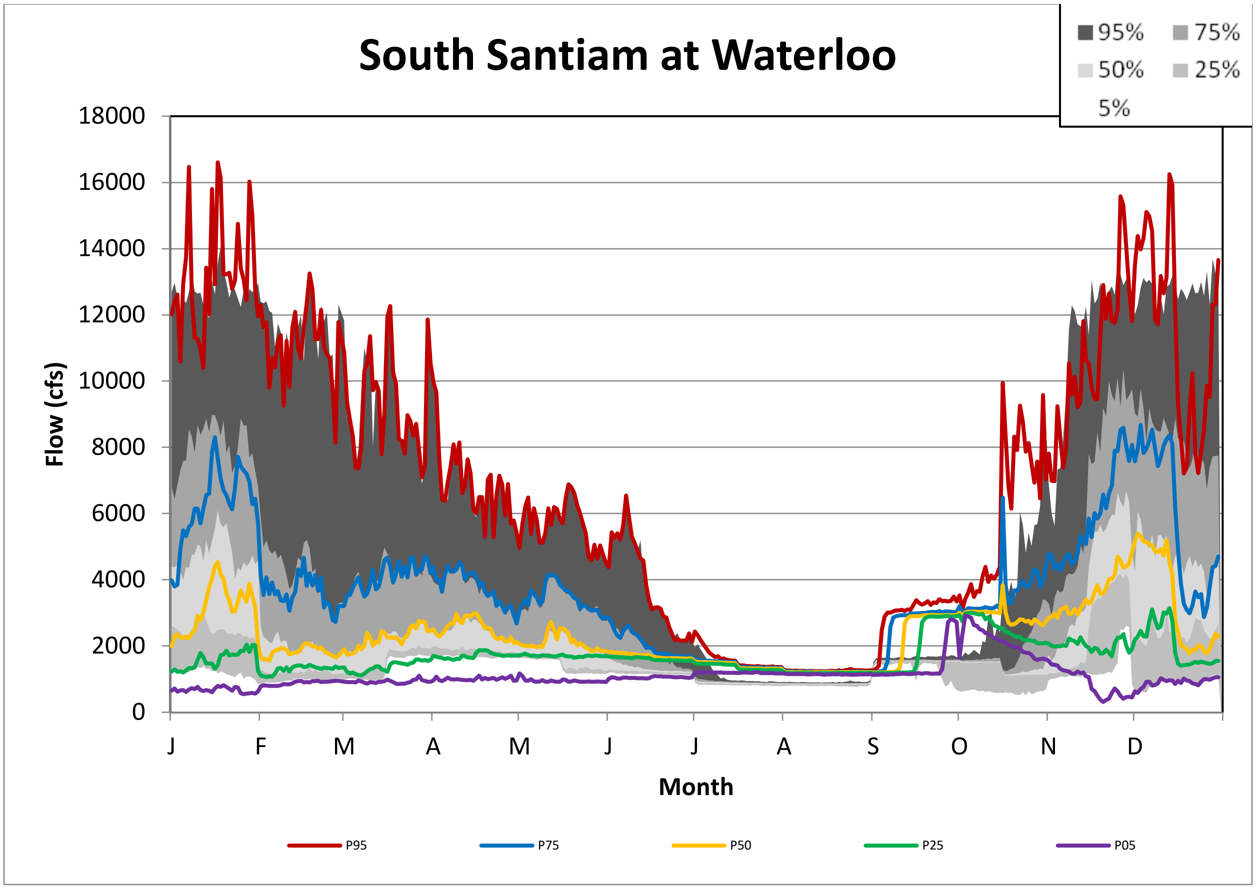


Figure 3-67. Non-Exceedance Flows at Waterloo on the South Santiam River under Alternative 5

3.8.2.2 McKenzie

Operations affecting water supply in the McKenzie Basin include releasing water for the modified integrated temperature and habitat flow regime and drawing down the reservoir to the diversion tunnel in the spring and fall for fish passage.

The spring drawdown at Cougar affects the flow at Vida on the McKenzie River differently by season and by hydrologic conditions. Flows at Vida in the driest years are lower than the NAA from April all year except for about the first two weeks of March when the Cougar reservoir is drafted for the spring drawdown operation for fish passage. During wetter years, flows at Vida will be higher than the NAA until early June when Cougar reservoir is nearly empty and there is not stored water available to augment streamflow on the McKenzie nor in the mainstem Willamette River. As there would be no conservation storage to augment flows, summer flows would be lower than the NAA in the wettest years but same as the NAA during most years. As the flows are only lower during a portion of the spring and only in the driest years, Alternative 5 would have a negligible effect on water supply in the McKenzie River.

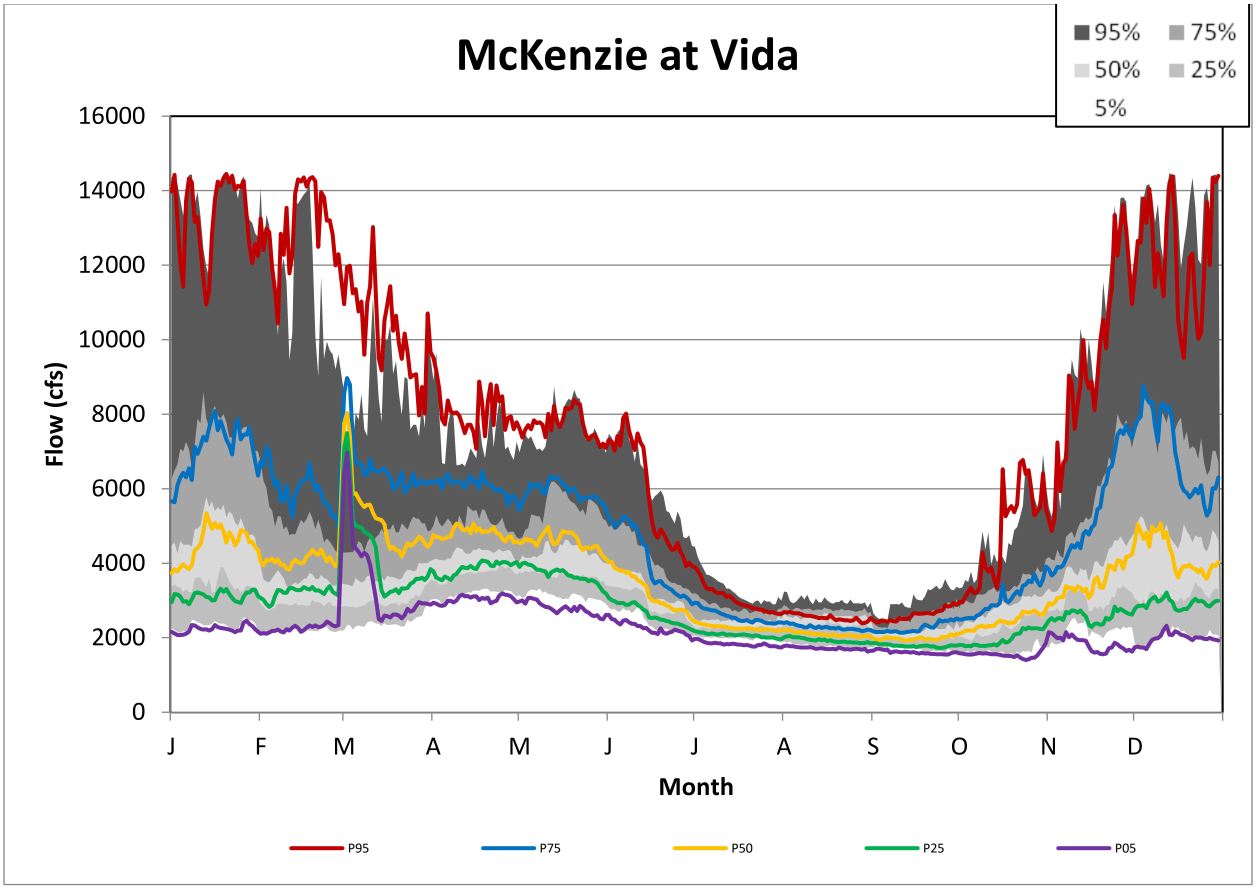


Figure 3-68. Non-Exceedance Flows at Vida on the McKenzie River under Alternative 5

3.8.2.3 Middle Fork Willamette

Operations affecting water supply in the Middle Fork Willamette sub-basin include releasing water for the modified integrated temperature and habitat flow regime and augmenting these flows with water from the power pools at Lookout Point and Hills Creek, as necessary.

Flows at Jasper on the Middle Fork Willamette River, downstream of Hills Creek, Lookout Point, and Fall Creek reservoirs, are lower than the NAA from April through mid-June in most years, but higher than the NAA in the driest years, and nearly equal most years, during the summer months. As the flows are only lower during a portion of the spring and only in drier years and higher in the summer, Alternative 5 would have a negligible effect on water supply in the Middle Fork Willamette River.

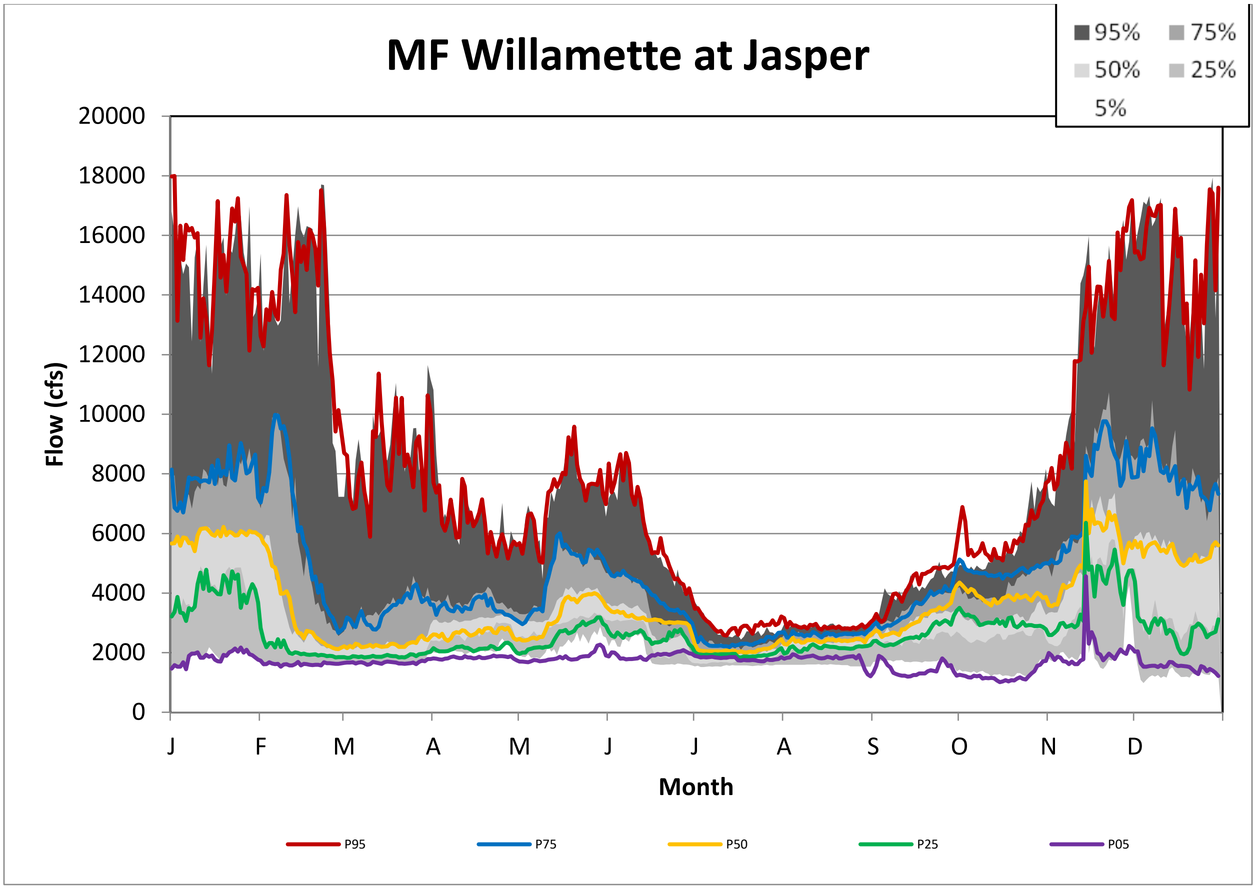


Figure 3-69. Non-Exceedance Flows at Jasper on the Middle Fork Willamette River under Alternative 5

3.8.2.4 Mainstem Willamette

Operations affecting water supply on the mainstem Willamette River include releasing water for the modified integrated temperature and habitat flow regime and augmenting these flows with water from the inactive and power pools, as necessary and available.

Flows at Harrisburg on the Willamette River, downstream of the McKenzie River confluence, are lower than the NAA from April through mid-June during drier years, but higher or equal to the NAA during the summer months, except for the wettest years when the flows in the late summer are slightly less than in the NAA. As the low flows are only lower during a portion of the spring, still staying above 5000 cfs, and only in the driest years, Alternative 5 would have a negligible effect on water supply in the Willamette River above and around Harrisburg.

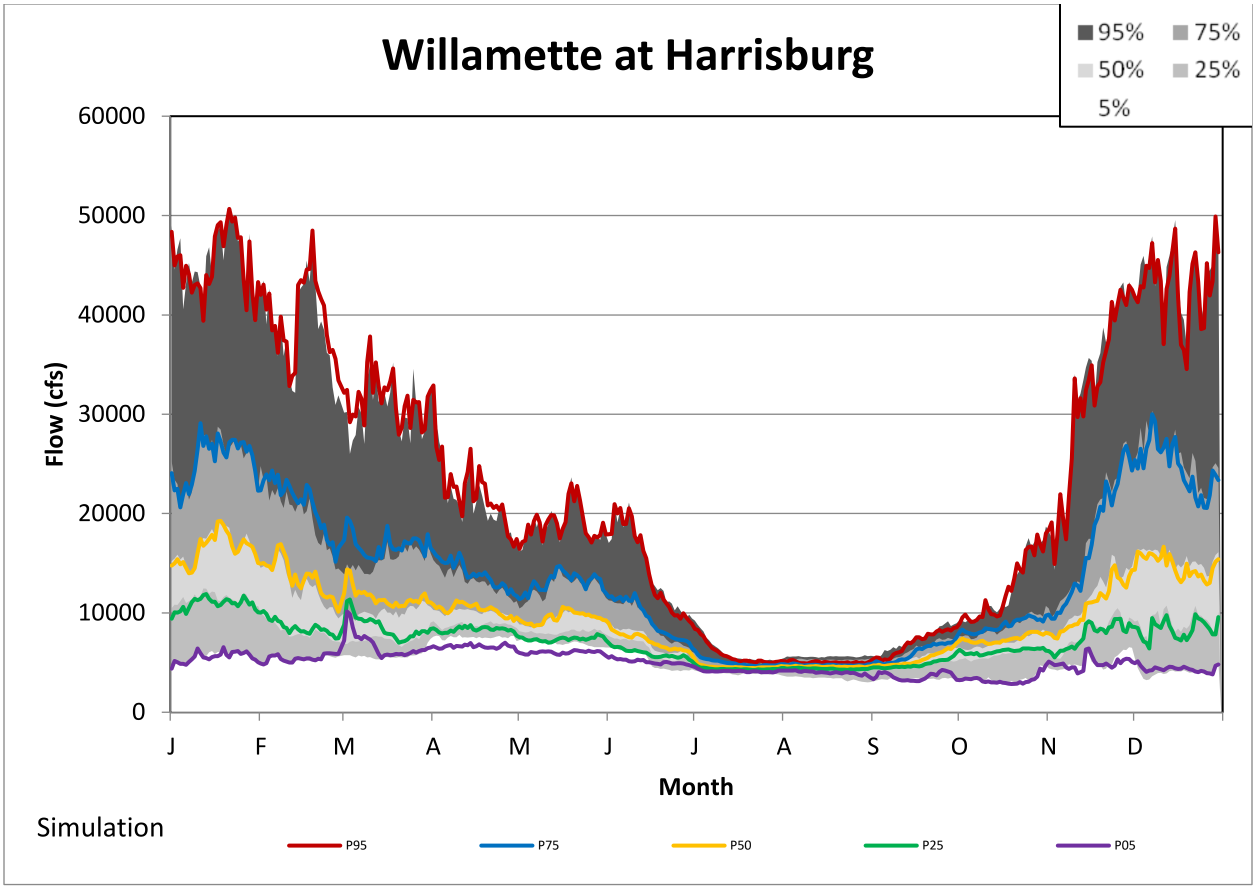


Figure 3-70. Non-Exceedance Flows at Harrisburg on the Willamette River under Alternative 5

Flows at Albany on the Willamette River, upstream of the Santiam River confluence, are lower than the NAA from April through mid-June about 25% of the time, but higher than in the NAA during the summer months. As the flows are only lower during a portion of the spring, still staying above 5000 cfs, and only in the driest years, Alternative 5 would have a negligible effect on water supply in the Willamette River above and immediately downstream of Albany.

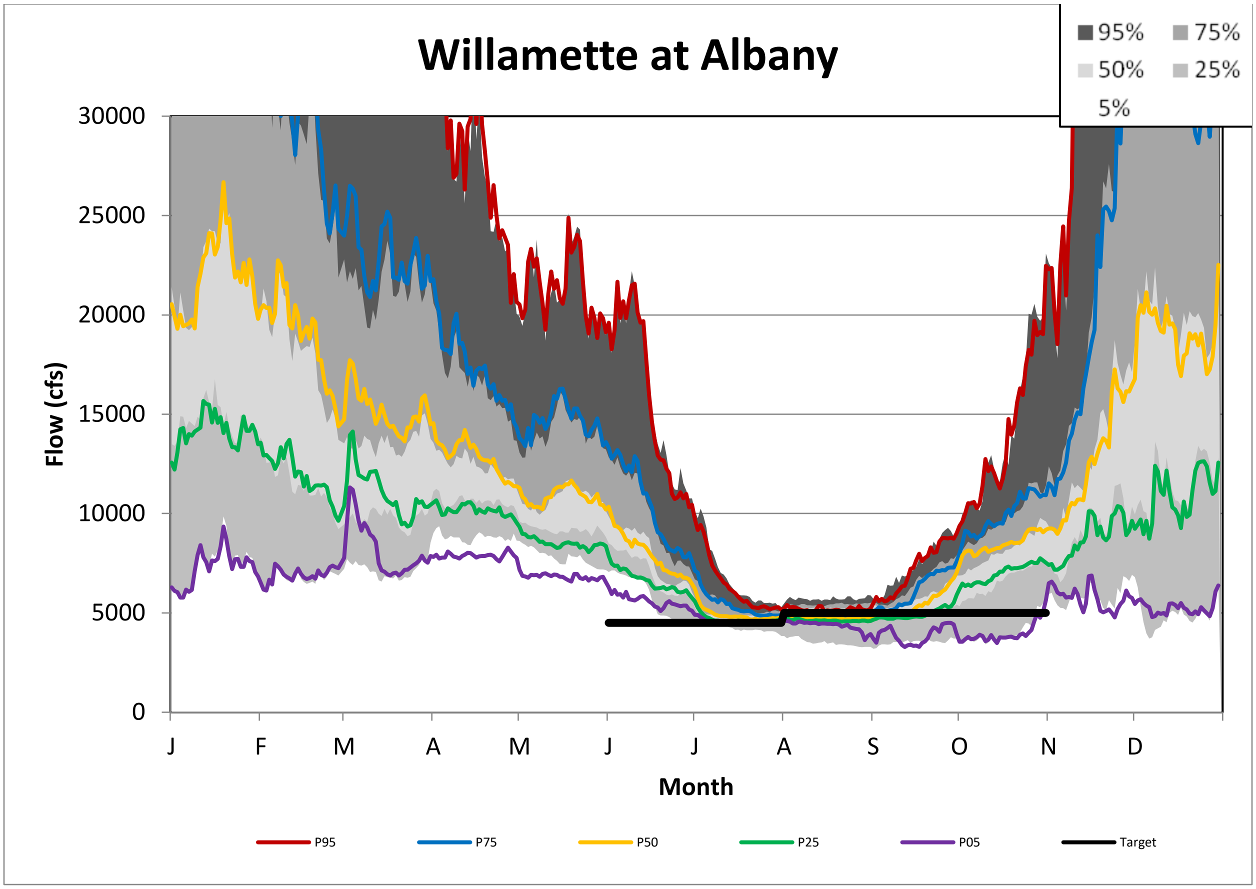


Figure 3-71. Non-Exceedance Flows at Albany on the Willamette River under Alternative 5

Flows at Salem on the Willamette River, downstream of the Santiam River confluence, are lower than the NAA from April through mid-June about 25% of the time, but higher or equal to the NAA during the summer months. As the flows are only lower during a portion of the spring, still staying above 6000 cfs, and only in the driest years, Alternative 5 would have a negligible effect on water supply in the Willamette River near and downstream of Salem.

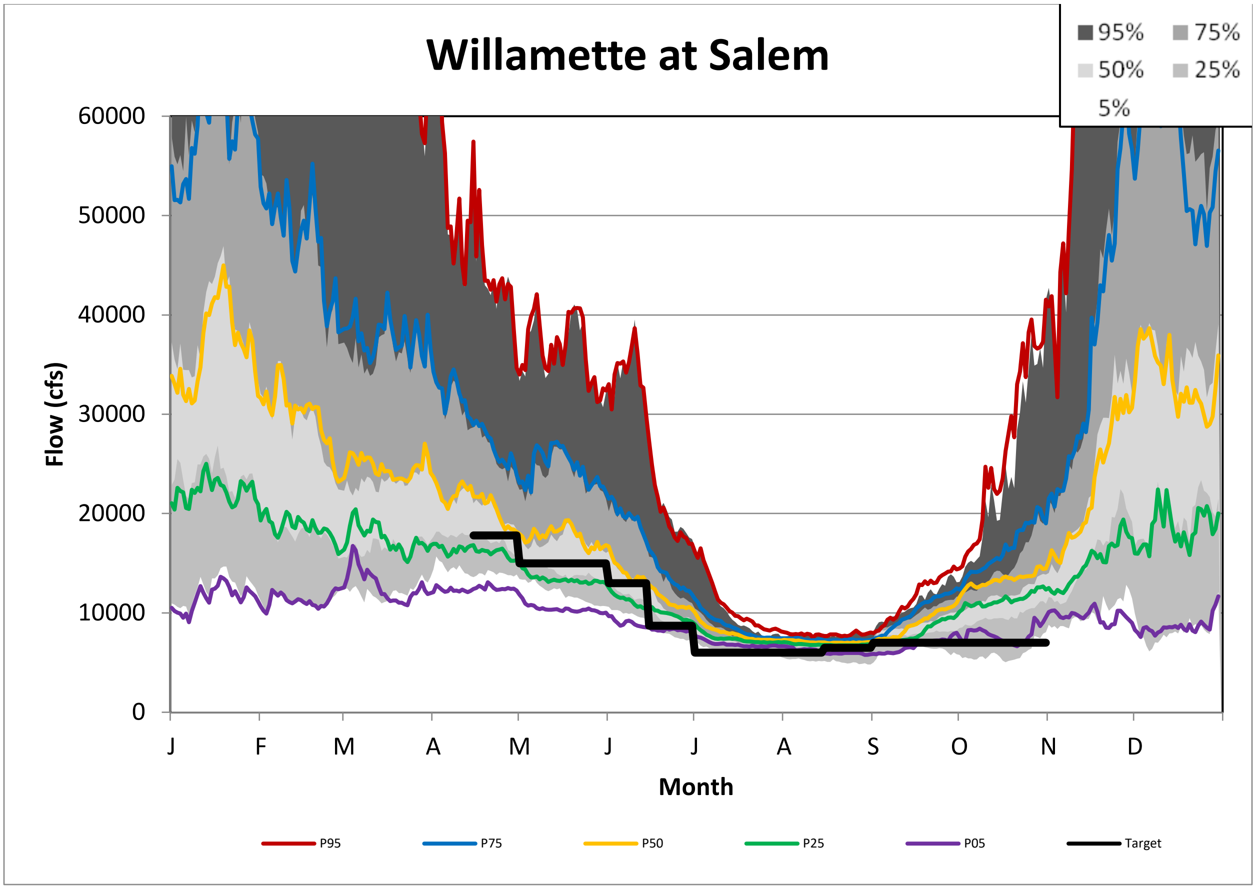


Figure 3-72. Non-Exceedance Flows at Salem on the Willamette River under Alternative 5

References

OWRD. 2018. Water Rights in Oregon, an Introduction to Oregon's Water Laws. Oregon Water Resources Department. Salem, OR.

OWRB, 1967

USACE. 2019. *Willamette Basin Review* Feasibility Study. Integrated Feasibility Report and Environmental Assessment. December 2019. US Army Corps.

US Army Corps of Engineers®
Portland District

WILLAMETTE VALLEY SYSTEM OPERATIONS AND MAINTENANCE

DRAFT PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT

APPENDIX K: RECREATION

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

EXECUTIVE SUMMARY

As shown in Recreation Environmental Consequences Chapter 3, no significant affects to recreation are expected under the Preferred Alternative scenario for the Willamette Basin as a whole when compared to the No Action Alternative. However, there are expected to be some moderate to major effects for particular locations for some alternative scenarios. National Economic Development (NED) account recreation affects were analyzed using U.S. Army Corps of Engineers' (USACE) Visitation Estimation Reporting System (VERS), Unit-Day-Value (UDV) data, as well as USACE Hydrologic Engineering Center (HEC) Reservoir System Simulation (ResSim) software modeled reservoir elevation data. The results of the NED analysis, particularly reservoir annual visitations, were used as inputs into the Regional Economic Development (RED) account model to analyze changes in economic activity. For riverine recreation activities downstream of reservoirs, a qualitative analysis was done using HEC-ResSim modeled flows at several river gage locations across the hydrologic period of record. On an annual basis, there are no significant effects expected for any of the river gage location/alternative combinations. On a seasonal basis, there are several location/season/alternative combinations that show both positive and negative moderate (+/-5%-20%) and major effects (+/- >20%) compared to the No Action Alternative.

CHAPTER 1 – RECREATION ANALYSIS INPUTS

1.1 VISITATION

Visitation to Willamette Valley System Reservoirs is estimated using the USACE VERS (USACE, 2022) data for 2019. A visitation is defined as the entry of one person into a recreation area or site to carry on one or more recreational activities. Average visitation estimates were indexed to 2021 using U.S. Census population data (USCB 2016, USCB 2021e) for the county in which the project is located. It is recognized that using U.S. Census county population estimates to index 2016 visitation data to 2021 assumes that most visits are by local people. However, it is unknown whether or not this is actually the case. If most visits are actually by non-local people, the visitation estimates in this appendix may be somewhat overstated.

Visitations are tracked by VERS using various tools such as vehicle meters and the National Recreation Reservation System. For instances where a particular recreation activity at a project is not estimated by the VERS, existing visitation and other data were used to estimate visitation for the activity. For example, where number of camping visits data was not available, but campsites are known to exist and are published typically by the U.S. Forest Service, a ratio of campers per campsite was calculated using data where both number of campsites and estimated camping visits were available. This resulted in an estimate of 118.053 campers per campsite per year.

Because VERS data only provides estimated visitation figures for campgrounds located on USACE Federal Government fee-owned land, state and county owned campgrounds as well as other known campgrounds within 10 miles of USACE reservoirs were identified using Open

Street Map geospatial data (MGC, No Date) and are included in the number of estimated camper visitations. Two known dispersed campgrounds, one each near Cougar Lake and Blue River Lake were included in the data. For these dispersed camping areas, aerial imagery was used to estimate the number of campsites. After examination of several past years of imagery via Google Earth, no images of actual campers could be seen, even though the published dispersed camping areas did look to exist, judging from road access and scattered open and forested areas. It was therefore estimated by best professional judgement that 15 sites exist at each of these locations. It is assumed that many visitors to these nearby campgrounds plan to make the <10- mile journey to the larger reservoir but may under some circumstances choose to forego plans to camp at all if the reservoir is at an undesirably low water elevation. Non-fee owned land campgrounds added to this analysis by reservoir are shown in the table below.

Reservoir	Camping Areas	Campsites 1	Est Annual Campers
Blue River Lake OR	2	37	4,486
Cougar Lake OR	1	15	1,771
Detroit Lake	5	398	46,986
Fall Creek Lake OR	4	27	3,187
Green Peter Lake	3	39	4,604
Hills Creek Lake	4	188	22,194
Lookout Point Lake OR	1	24	2,833
Total	20	728	86,061

[1] (USFS, No Date-c through USFS, No Date-m, OSP, Linn County No Date-a)

Other visitation categories where data was unavailable included boater and water skiers for some areas. For the water skiers, the same ratio methodology described in the preceding paragraph was used to calculate a .62 water skier per boater ratio. To estimate boaters where no data was available, the following table of known values and Figure 1-1 were created that shows the polynomial equation used to estimate the unknown number of boaters where only water skier data is available.

Table 1-1 Water Skiers and Boater Estimates

–	Water Skier VERS Estimate	Boater VERS Estimate
Blue River Lake	652	687
Lookout Point Lake	8,369	10,223
Dorena Lake	23,652	28,595
Dexter Lake	40,514	49,026
Fern Ridge Lake	88,722	173,594
Total	161,909	262,125

(USACE 2016e, USACE 2016p, USACE 2016j, USACE 2016i, USACE 2016l)

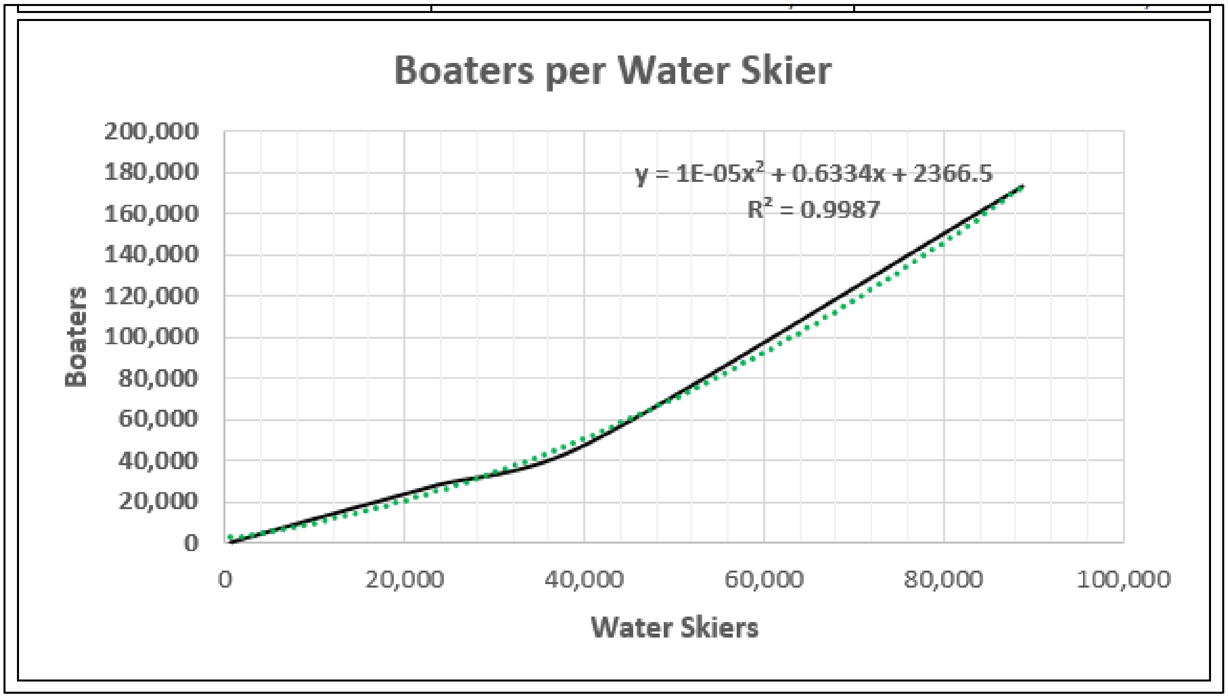


Figure 1-1. Boater Visitation Regression

Estimating visitations in general and particularly by activity is a difficult task for any agency given the limitations of human resources that typically serve the public better in other ways such as keeping facilities clean and safe. Methodologies are continually being improved upon using non-human tools to gather data. This means that visitation data is not always consistent or complete. The important concept for this analysis is that the data is consistent across the alternatives and therefore provides a relative comparison between them.

For this analysis, 2016 visitation numbers were indexed to approximate 2021 values using Lane, Linn, and Marion County population change data from the U.S. Census Bureau. The table below shows data that was used for indexing visitation values to approximate 2021 levels.

Table 1-2. County Population Change Rate -2016 to 2021

	2016 Pop Est.	2021 Pop Est.	2016 to 2021 Index
Lane County	369,519	383,189	1.0370
Linn County	122,814	129,839	1.0572
Marion County	336,316	347,119	1.0321

(USCB 2016, USCB 2021e)

The following tables show visitation estimates for WVS reservoirs included in the recreation effects analysis. Visitation figures are shown at the published 2016 values, as well as the indexed 2021 values.

Table 1-3. Annual Visitation Estimates – Green Peter Lake

Green Peter Lake	2016 Estimated Visits [1]	2021 Estimated Visits [2]
Picnickers	11,493	12,150
Campers	9,092	9,612
Swimmers	15,390	16,270
Water Skiers	19,185	20,282
Boaters	15,673	16,570
Sightseers	57,073	60,338
Anglers	41,809	44,200
Hunters	1,265	1,337

[1] Source: (USACE 2016n)

[2] Estimated adjusted visits are indexed from 2016 to 2021 using data from U.S. Census Bureau 1-Year American Community Survey County level data. Source: (USCB 2016), (USCB 2021e)

Table 1-4. Annual Visitation Estimates – Cottage Grove Lake

Cottage Grove Lake	2016 Estimated Visits [1]	2021 Estimated Visits [2]
Picnickers	57,125	59,238
Campers	3,323	3,446
Swimmers	49,990	51,839
Water Skiers	55,532	57,586
Boaters [3]	0	70,908
Sightseers	27,012	28,011
Anglers	43,010	44,601
Hunters	9,115	9,452

[1] Source: (USACE 2016f)

[2] Estimated adjusted visits are indexed from 2016 to 2021 using data from U.S. Census Bureau 1-Year American Community Survey County level data. Source: (USCB 2016), (USCB 2021e)

[3] Number of boaters are estimated for 2021 using regression analysis as described in Section 1.1 of Technical Appendix K -Recreation.

Table 1-5. Annual Visitation Estimates – Dorena Lake

Dorena Lake OR	2016 Estimated Visits [1]	2021 Estimated Visits [2]
Picnickers	34,778	36,065
Campers	11,751	12,186
Swimmers	24,108	25,000
Water Skiers	23,652	24,527

Dorena Lake OR	2016 Estimated Visits [1]	2021 Estimated Visits [2]
Boaters	28,595	29,653
Sightseers	17,403	18,047
Anglers	47,336	49,087
Hunters	6,759	7,009

[1] Source: (USACE 2016j)

[2] Estimated adjusted visits are indexed from 2016 to 2021 using data from U.S. Census Bureau 1-Year American Community Survey County level data. Source: (USCB 2016), (USCB 2021e)

Table 1-6. Annual Visitation Estimates – Blue River Lake

Blue River Lake	2016 Estimated Visits [1]	2021 Estimated Visits [2]
Picnickers	1,501	1,557
Campers [3]	0	4,652
Swimmers	627	650
Water Skiers	652	676
Boaters	687	712
Sightseers	8,033	8,330
Anglers	3,179	3,297
Hunters	428	444

[1] Source: (USACE 2016e)

[2] Estimated adjusted visits are indexed from 2016 to 2021 using data from U.S. Census Bureau 1-Year American Community Survey County level data. Source: (USCB 2016), (USCB 2021e)

[3] Number of campers are estimated for 2021 using GIS tools and data as well as local, county, and state data as described in Section 1.1 of Technical Appendix K -Recreation.

Table 1-7. Annual Visitation Estimates – Cougar Lake

Cougar Lake	2016 Estimated Visits [1]	2021 Estimated Visits [2]
Picnickers	5,963	6,184
Campers [3]	1,378	3,265
Swimmers	3,908	4,053
Water Skiers	3,098	3,213
Boaters [4]	0	4,588
Sightseers	18,428	19,110
Anglers	8,100	8,400
Hunters	1,106	1,147

[1] Source: (USACE 2016g)

[2] Estimated adjusted visits are indexed from 2016 to 2021 using data from U.S. Census Bureau 1-Year American Community Survey County level data. Source: (USCB 2016), (USCB 2021e)

[3] Number of campers are estimated for 2021 using GIS tools and data as well as local, county, and state data as described in Section 1.1 of Technical Appendix K -Recreation.

[4] Number of boaters are estimated for 2021 using regression analysis as described in Section 1.1 of Technical Appendix K -Recreation.

Table 1-8. Annual Visitation Estimates – Fern Ridge Lake

Fern Ridge Lake	2016 Estimated Visits [1]	2021 Estimated Visits [2]
Picnickers	177,556	184,125
Campers	14,598	15,138
Swimmers	105,121	109,010
Water Skiers	88,722	92,004
Boaters	173,594	180,016
Sightseers	81,682	84,704
Anglers	118,870	123,267
Hunters	25,183	26,115

[1] Source: (USACE 2016l)

[2] Estimated adjusted visits are indexed from 2016 to 2021 using data from U.S. Census Bureau 1-Year American Community Survey County level data. Source: (USCB 2016), (USCB 2021e)

Table 1-9. Annual Visitation Estimates – Fall Creek Lake

Fall Creek Lake	2016 Estimated Visits [1]	2021 Estimated Visits [2]
Picnickers	43,083	44,677
Campers [3]	515	3,839
Swimmers	60,089	62,312
Water Skiers	47,595	49,356
Boaters	33,278	34,509
Sightseers	3,799	3,940
Anglers	26,883	27,878
Hunters	19	20

[1] Source: (USACE 2016k)

[2] Estimated adjusted visits are indexed from 2016 to 2021 using data from U.S. Census Bureau 1-Year American Community Survey County level data. Source: (USCB 2016), (USCB 2021e)

[3] Number of campers are estimated for 2021 using GIS tools and data as well as local, county, and state data as described in Section 1.1 of Technical Appendix K -Recreation.

Table 1-10. Annual Visitation Estimates – Lookout Point Lake

LOOKOUT POINT LAKE	2016 Estimated Visits [1]	2021 Estimated Visits [2]
Picnickers	13,873	14,386
Campers [3]	0	2,938
Swimmers	18,981	19,683
Water Skiers	8,369	8,679
Boaters	10,223	10,601
Sightseers	12,662	13,130
Anglers	30,011	31,121
Hunters	514	533

[1] Source: (USACE 2016p)

[2] Estimated adjusted visits are indexed from 2016 to 2021 using data from U.S. Census Bureau 1-Year American Community Survey County level data. Source: (USCB 2016), (USCB 2021e)

[3] Number of campers are estimated for 2021 using GIS tools and data as well as local, county, and state data as described in Section 1.1 of Technical Appendix K -Recreation.

Table 1-11. Annual Visitation Estimates – Dexter Lake

DEXTER LAKE	2016 Estimated Visits [1]	2021 Estimated Visits [2]
Picnickers	32,872	34,088
Campers	0	0
Swimmers	29,608	30,703
Water Skiers	40,514	42,013
Boaters	49,026	50,840
Sightseers	28,375	29,425
Anglers	67,479	69,975
Hunters	1,861	1,930

[1] Source: (USACE 2016i)

[2] Estimated adjusted visits are indexed from 2016 to 2021 using data from U.S. Census Bureau 1-Year American Community Survey County level data. Source: (USCB 2016), (USCB 2021e)

Table 1-12. Annual Visitation Estimates – Hills Creek Lake

Hills Creek Lake	2016 Estimated Visits [1]	2021 Estimated Visits [2]
Picnickers	53	55
Campers [3]	0	23,015
Swimmers	8	8
Water Skiers [4]	0	11,554

Hills Creek Lake	2016 Estimated Visits [1]	2021 Estimated Visits [2]
Boaters [4]	0	11,059
Sightseers	1,032	1,070
Anglers	335	347
Hunters	1	1

[1] Source: (USACE 2016o)

[2] Estimated adjusted visits are indexed from 2016 to 2021 using data from U.S. Census Bureau 1-Year American Community Survey County level data. Source: (USCB 2016), (USCB 2021e)

[3] Number of campers are estimated for 2021 using GIS tools and data as well as local, county, and state data as described in Section 1.1 of Technical Appendix K -Recreation.

[4] Number of boaters and water skiers are estimated for 2021 using regression analysis as described in Section 1.1 of Technical Appendix K -Recreation.

Table 1-13. Annual Visitation Estimates – Foster Lake

Foster Lake	2016 Estimated Visits [1]	2021 Estimated Visits [2]
Picnickers	49,661	52,502
Campers	10,127	10,706
Swimmers	33,944	35,886
Water Skiers	27,806	29,397
Boaters	87,287	92,280
Sightseers	180,244	190,554
Anglers	63,465	67,095
Hunters	0	0

[1] Source: (USACE 2016m)

[2] Estimated adjusted visits are indexed from 2016 to 2021 using data from U.S. Census Bureau 1-Year American Community Survey County level data. Source: (USCB 2016), (USCB 2021e)

Table 1-14. Annual Visitation Estimates – Detroit Lake

Detroit Lake	2016 Estimated Visits [1]	2021 Estimated Visits [2]
Picnickers	16,979	17,524
Campers	20,992	44,961
Swimmers	15,218	15,707
Water Skiers	14,961	15,442
Boaters	0	14,533
Sightseers	38,991	40,243
Anglers	22,913	23,649

Detroit Lake	2016 Estimated Visits [1]	2021 Estimated Visits [2]
Hunters	5,596	5,776

[1] Source: (USACE 2016h)

[2] Estimated adjusted visits are indexed from 2016 to 2021 using data from U.S. Census Bureau 1-Year American Community Survey County level data. Source: (USCB 2016), (USCB 2021e)

[3] Number of campers are estimated for 2021 using GIS tools and data as well as local, county, and state data as described in Section 1.1 of Technical Appendix K -Recreation.

[4] Number of boaters are estimated for 2021 using regression analysis as described in Section 1.1 of Technical Appendix K -Recreation.

1.2 UNIT DAY VALUES

Unit Day Values (UDV) are determined each year by the USACE and represent a general dollar value that can be placed on a visit to a recreation facility. UDV's for this analysis are taken from USACE Economic Guidance Memorandum 22-03, "Unit Day Values for Recreation for Fiscal Year 2022" (USACE, 2022-A), and are weighted per project by recreational experience, opportunity, carrying capacity, accessibility, and environmental. Weights per reservoir across these elements were provided by the USACE Recreation Budget Evaluation System (Rec-BEST). The table below shows an example of the UDV weightings for Detroit Reservoir.

Table 1-15. Unit Day Value General Recreation Scoring Example – Detroit Lake

UDV Weight Description	Rating	Scoring Criteria (Scoring range)	–	–	–	–
UDV1 Recreation Experience	4	Two general activities (0-4)	Several general activities (5-10)	Several general activities: one high quality value activity (11-16)	Several general activities: more than one high quality high activity (17-23)	Numerous high quality value activities; some general activities (24-30)
UDV2 Availability of Opportunity	2	Several within 1 hour travel time; a few within 30 minutes travel time (0-3)	Several within 1 hour travel time; none within 30 minutes travel time	One or two within 1 hour travel time; none within 45 minutes travel time (7-10)	None within 1 hours travel time (11-14)	Non within 2 hours travel time (15-18)

UDV Weight Description	Rating	Scoring Criteria (Scoring range)	–	–	–	–
			(4-6)			
UDV3 Carrying Capacity	4	Minimum facility for development for public health and safety (0-2)	Basic facility to conduct activities (3-5)	Adequate facilities to conduct without deterioration of the resource or activity experience (6-8)	Optimum facilities to conduction activity at site potential (9-11)	Ultimate facilities to achieve intent of selected alternative 12-14)
UDV4 Accessibility	12	Limited access by any means to site or within the site (0-3)	Fair access, poor quality roads to site; limited access within the site (4-6)	Fair access, fair road to site; fair access, good roads within the site (7-10)	Good access, good roads to site; fair access, good roads within the site (11-14)	Good access, high standard road to site; good access within the site (15-18)
UDV5 Environmental	6	Low esthetic factors that significantly lower quality (0-2)	Average esthetic quality: factors exist that lower quality to minor degree (3-6)	Above average esthetic quality: any limiting factors can be reasonable rectified (7-10)	High esthetic quality: no factors exist that lower quality (11-15)	Outstanding esthetic quality: no factors exist that lower quality (16-20)

UDV’s were also separate into two classes, General Hunting and Fishing, as well as General Recreation that includes picnickers, campers, swimmers, boaters, water skiers, and sightseers. The UDV dollar value between these two classes is somewhat different and is shown in Table 1-14 that is taken from EGM 20-03. The point values in the first column represent the scoring value total across the recreation experience, opportunity, carrying capacity, accessibility, and environmental categories. Point values are interpolated in one-point increments but for brevity are not shown below. For example, the Detroit Lake scoring in the table above totals to 28 points. This interpolates to a dollar value per visit of $6.16 for General Recreation and $8.00 for General Hunting and Fishing per the table below.

Table 1-16. Unit Day Value Dollar Values from EGM 20-03

Point Values	General Recreation Values	General Fishing and Hunting Values
0	$4.21	$6.06
10	$5.00	$6.85
20	$5.53	$7.37
30	$6.32	$8.16
40	$7.90	$8.95
50	$8.95	$9.74
60	$9.74	$10.80
70	$10.27	$11.32
80	$11.32	$12.11
90	$12.11	$12.38
100	$12.64	$12.64

Applying separate UDV dollar values to the number of days boat ramps are usable versus unusable, as described in the Hydrologic Inputs and Recreation Effects on an Annual Basis sections of this appendix, requires an assumed percentage loss of visitation when boat ramps are unusable. These assumptions per recreational activity are based on professional judgement through discussions between PDT economists. The general rationale is that when boat ramps become unusable, a reservoir is less attractive to visitors both physically and esthetically because of low water levels that often expose steep bank terrain with little or no vegetation. The assumed loss per activity is shown in the table below.

Table 1-17. Assumed Percent Recreational Activity Lost When Boat Ramps are Unusable

Visitation Category	Percent Visitation Loss When Boat Ramps Unusable
Picnickers	25%
Campers	25%
Swimmers	25%
Water Skiers	100%
Boaters	90%
Sightseers	25%
Fishermen	90%
Hunters	0%

The final step toward applying a UDV to each day that a boat ramp is usable versus unusable during the peak recreation season of May 15 to September 15 was to calculate a total annual visitation value for each reservoir respectively, and then divide this number by the 124 days of the peak recreation season to derive a daily average UDV value. For example, Detroit Reservoir visitations for all activities tally up to 154,971, 125,464 of which are in the General Recreation category and 29,507 of which are in the General Hunting and Fishing category. Divided by 124, this equals a daily average of 1,012 and 238 for general recreation and general hunting and fishing visits, respectively. These daily visitation values were then multiplied by the $6.58 and $8.55 values per visit as discussed previously in this subsection, the products summed, and the sum divided by 124. This resulted in a daily UDV total for each reservoir. The results of the calculations described in this paragraph are shown in the tables below for each reservoir with and without boat ramp usability.

Table 1-18. UDV Values by Reservoir With Boat Ramp Usability

With Boat Ramp Usability									
Reservoir	Total Annual Visits	Annual Visits Gen Rec	Annual Visits Gen Hunt/Fish	UDV Gen Rec	UDV Gen Hunt/Fish	Total General Rec Value	Total Annual Gen Hunt/Fish Rec Value	Total Annual Rec Value	Daily Avg Rec Value
Green Peter	180,760	135,222	45,538	$6.24	$8.08	$843,922	$367,991	$1,211,913	$9,773
Cottage Grove	325,083	271,029	54,053	$8.64	$9.50	$2,340,338	$513,669	$2,854,006	$23,016
Dorena	201,573	145,477	56,096	$8.53	$9.42	$1,240,917	$528,651	$1,769,567	$14,271
Blue River	20,318	16,577	3,740	$5.77	$7.61	$95,602	$28,454	$124,055	$1,000
Cougar	49,959	40,412	9,547	$6.16	$8.00	$249,021	$76,392	$325,413	$2,624
Fern Ridge	814,378	664,996	149,382	$7.11	$8.56	$4,728,124	$1,277,964	$6,006,087	$48,436
Fall Creek	226,529	198,632	27,897	$6.48	$8.24	$1,286,738	$229,845	$1,516,584	$12,231
Lookout Point	101,072	69,417	31,654	$6.95	$8.48	$482,590	$268,301	$750,891	$6,056
Dexter	258,974	187,069	71,905	$5.85	$7.69	$1,093,603	$552,663	$1,646,266	$13,276
Hills Creek	47,110	46,762	348	$6.16	$8.00	$288,145	$2,788	$290,933	$2,346
Foster	478,419	411,324	67,095	$8.32	$9.27	$3,422,215	$621,704	$4,043,919	$32,612
Detroit	177,836	148,411	29,425	$6.16	$8.00	$914,508	$235,457	$1,149,965	$9,274
Total	2,882,010	2,335,329	546,681	–	–	16,985,722	4,703,878	21,689,601	174,916

Table 1-19. UDV Values by Reservoir Without Boat Ramp Usability

Without Boat Ramp Usability									
Reservoir	Total Annual Visits	Annual Visits Gen Rec	Annual Visits Gen Hunt/Fish	UDV Gen Rec	UDV Gen Hunt/Fish	Total General Rec Value	Total Annual Gen Hunt/Fish Rec Value	Total Annual Rec Value	Daily Avg Rec Value
Green Peter	81,192	75,435	5,757	$6.24	$8.08	$470,788	$46,526	$517,314	$4,172
Cottage Grove	127,904	113,992	13,912	$8.64	$9.50	$984,320	$132,209	$1,116,529	$9,004
Dorena	83,356	71,438	11,918	$8.53	$9.42	$609,366	$112,313	$721,679	$5,820
Blue River	12,236	11,463	773	$5.77	$7.61	$66,106	$5,884	$71,990	$581
Cougar	26,904	24,917	1,987	$6.16	$8.00	$153,541	$15,899	$169,440	$1,366
Fern Ridge	351,175	312,734	38,441	$7.11	$8.56	$2,223,537	$328,866	$2,552,403	$20,584
Fall Creek	92,334	89,526	2,807	$6.48	$8.24	$579,952	$23,131	$603,082	$4,864

Without Boat Ramp Usability									
Reservoir	Total Annual Visits	Annual Visits Gen Rec	Annual Visits Gen Hunt/Fish	UDV Gen Rec	UDV Gen Hunt/Fish	Total General Rec Value	Total Annual Gen Hunt/Fish Rec Value	Total Annual Rec Value	Daily Avg Rec Value
Lookout Point	42,308	38,663	3,645	$6.95	$8.48	$268,788	$30,896	$299,684	$2,417
Dexter	84,673	75,746	8,927	$5.85	$7.69	$442,811	$68,616	$511,427	$4,124
Hills Creek	19,253	19,217	36	$6.16	$8.00	$118,417	$286	$118,703	$957
Foster	233,173	226,464	6,710	$8.32	$9.27	$1,884,177	$62,170	$1,946,348	$15,696
Detroit	98,421	90,280	8,141	$6.16	$8.00	$556,307	$65,142	$621,449	$5,012
Total	1,252,931	1,149,876	103,055	–	–	8,358,111	891,937	9,250,048	74,597

The Daily Total UDV values shown in the tables above were multiplied by the number of boat ramp usable and non-usable days during the peak recreation season for each year of the period of record. More details on this methodology are provided in the Recreation Effects on an Annual Basis section of this appendix.

1.3 HYDROLOGIC INPUTS

Daily reservoir pool elevation data for each of 83 water years from the HEC-ResSim model was used to determine the percentage of time that boat ramps were available during the peak recreation season of May 15 through September 15. A boat ramp was considered to be usable when the ramp elevation fell below the reservoir pool elevation and unusable when the boat ramp elevation was above the pool elevation. Even though this may not always be exactly the case, as there may be locations where towing vehicles can travel below the boat ramp to launch vessels into the water, it provides an equal comparison across all alternatives. The charts below show examples for Lookout Point Reservoir of how each alternative pool elevation scenario compares to boat ramp elevations during the peak recreation season using 5-number summary statistics compiled from the 83-year water year period of record. The charts are based on non-exceedance probability data. For example, the P25 (Dry Year) chart is saying that “25 percent of the time the pool elevation will not exceed these values and 75 percent of the time it will exceed these values”.

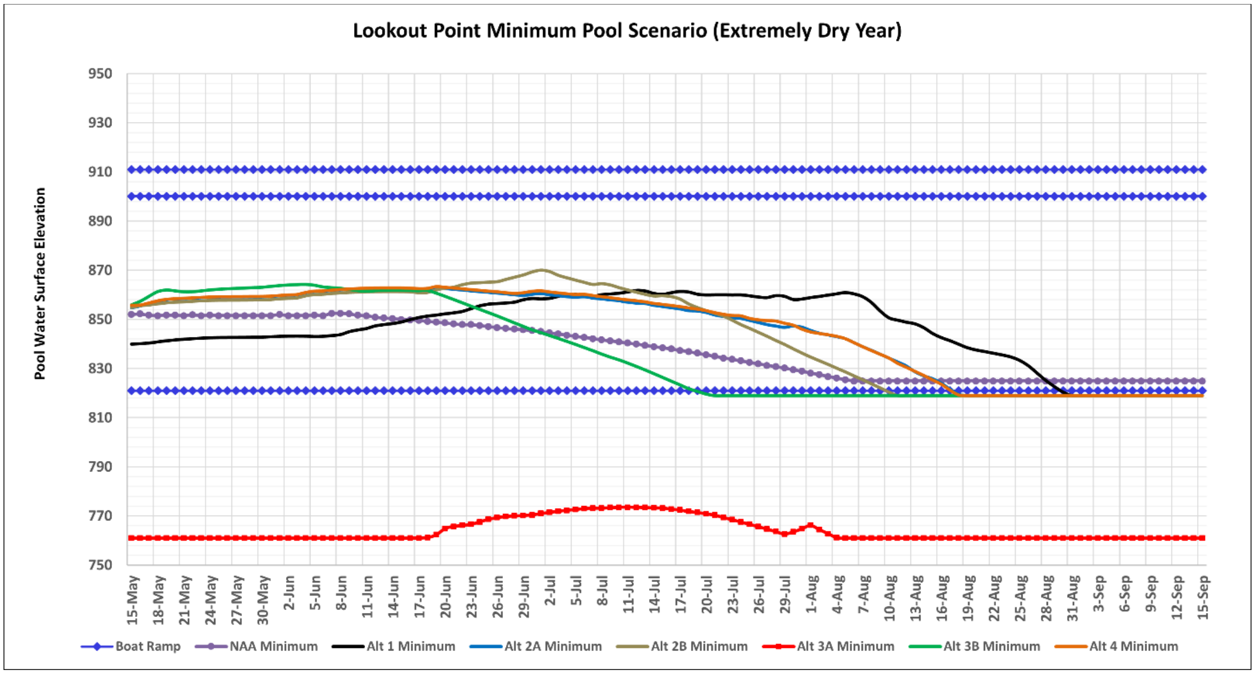


Figure 1-2. Boat Ramp Estimated Availability Chart – Extremely Dry Year – Lookout Point Reservoir

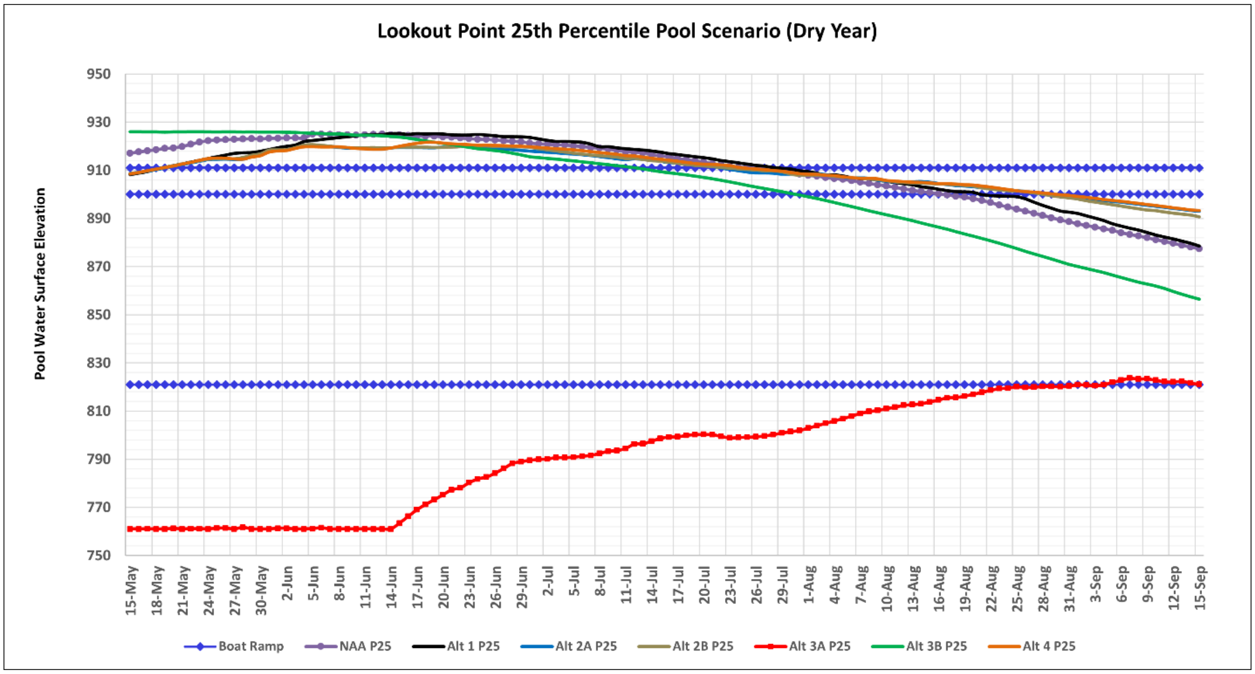


Figure 1-3. Boat Ramp Estimated Availability Chart – Dry Year – Lookout Point Reservoir

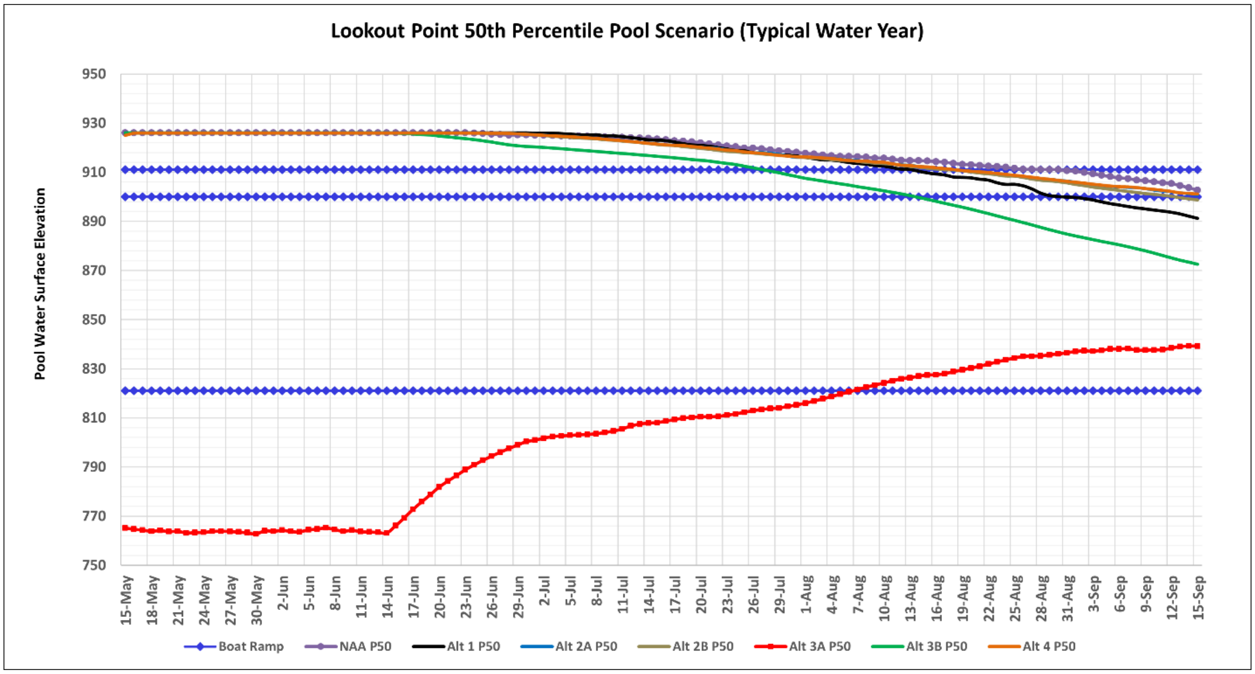


Figure 1-4. Boat Ramp Estimated Availability Chart – Median Year – Lookout Point Reservoir

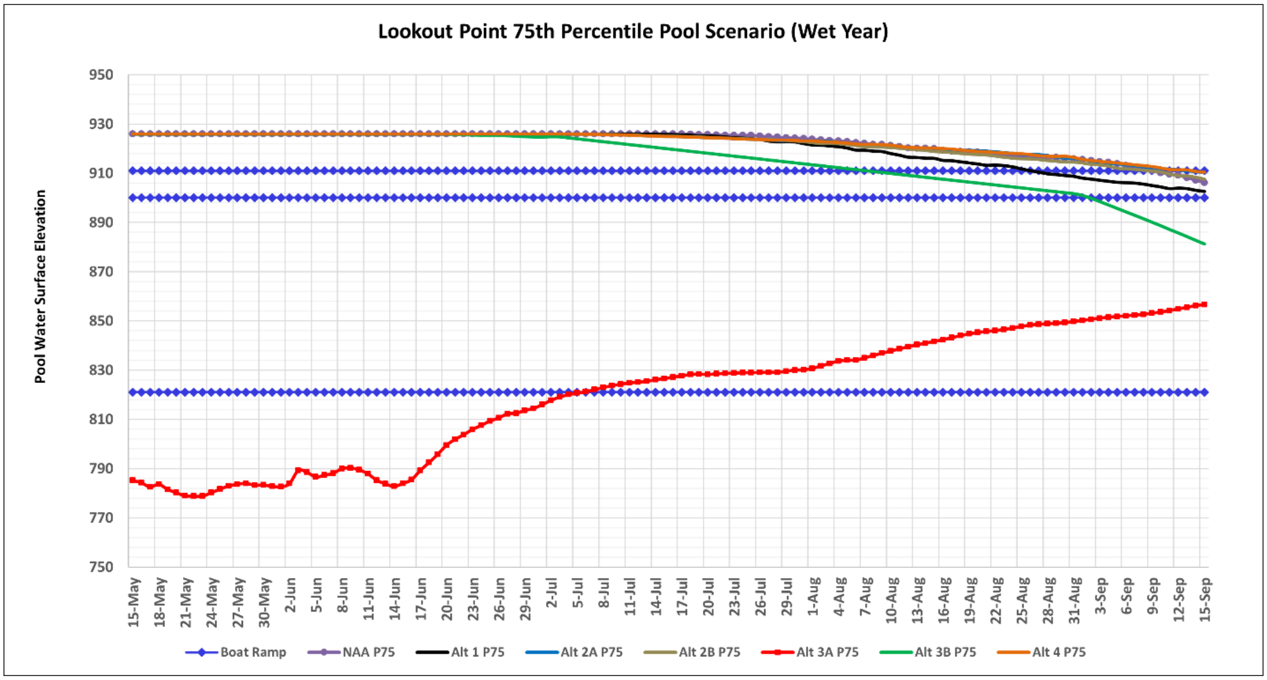


Figure 1-5. Boat Ramp Estimated Availability Chart – Wet Year – Lookout Point Reservoir

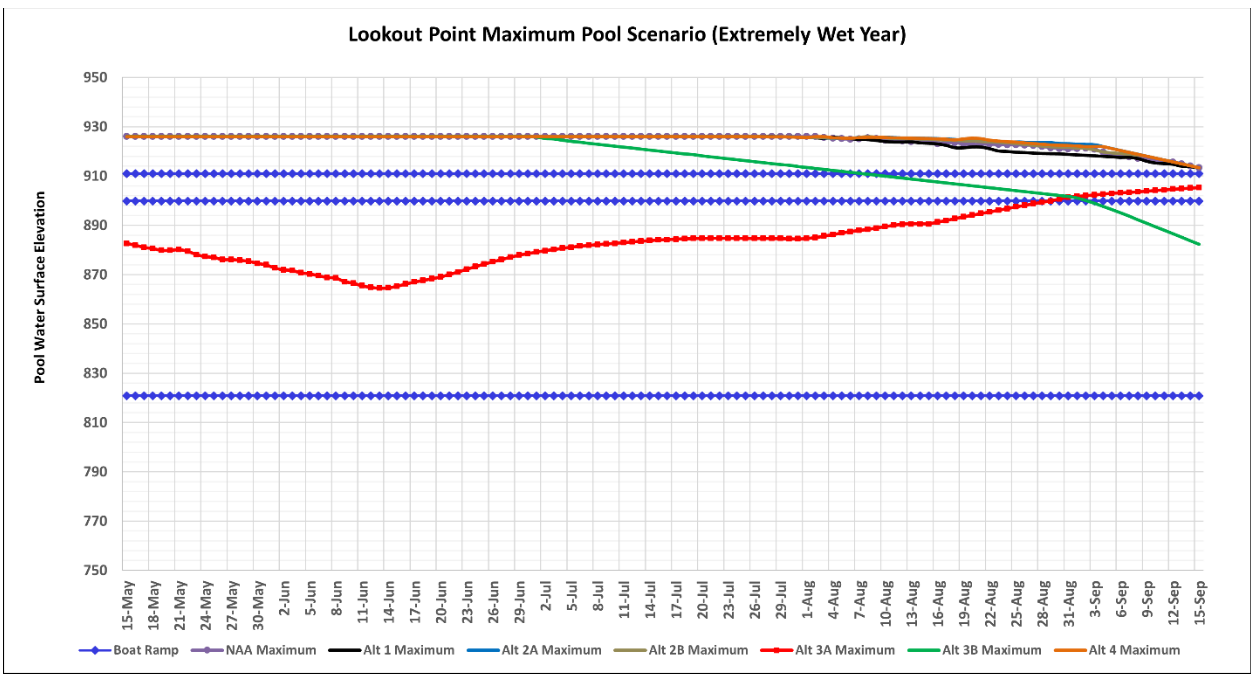


Figure 1-6. Boat Ramp Estimated Availability Chart – Extremely Wet Year – Lookout Point Reservoir

Alternative 3A is shown on the red line in the charts above and stands out as falling below the lowest boat ramp elevation much of the time. This is indicative of Measure 720 where low elevation outlets could be used to pass fish in spring by delaying refill of reservoirs each year until June 15.

CHAPTER 2 - RECREATION EFFECTS – NATIONAL ECONOMIC DEVELOPMENT

2.1 ASSUMPTIONS

The following assumptions were used for this analysis:

1. The peak recreation season at reservoirs is May 15 to September 15 each year.
2. The vast majority of recreation visits to reservoirs occur during the peak recreation season. No attempt was made to separate annual visitation data into separate time periods. All visits are binned into the peak recreation season.
3. A boat ramp is considered usable if its elevation falls below the water surface elevation of the reservoir and is considered to be unusable if its elevation is above the water surface elevation of the reservoir.
4. The general assumption for this analysis is that when reservoir water levels are low enough to prevent boat launching safely via constructed boat ramps, it will discourage the public from going to the reservoir for both the physical and esthetic reasons. However, people who do choose to visit a reservoir for recreational purposes when water levels are low value the experience and create the same economic activity as they would any other time.
5. For riverine recreation areas, water flows that are consistent with past flows are directly related to the amount of utility most river recreationists enjoy.

2.2 METHODOLOGY

To estimate the annual effects of each of the alternatives on recreation, each of the 83 simulated water year outputs from HEC-ResSim were compared to each boat ramp to calculate an annual availability of the ramps based on whether the boat ramp elevation was above or below the daily pool elevation. The availability of individual ramps at each reservoir were then averaged with each other to determine the average annual availability for each reservoir. The annual average number of available (aka "usable") and unavailable (aka "unusable") days were multiplied appropriately by the UDV Daily Average Recreation Values figures shown in far-right column in Table 1-16 of this appendix. Summing the products of annual usable/unusable day visitations and annual usable/unusable average daily UDV values provides recreation benefit estimates in dollar terms, that are then averaged across all reservoir boat ramps to determine the average annual recreation benefit for the reservoir. It should be noted that even though visitation overall decreases in some alternatives, the UDV values for the reservoirs with positive visitation impacts are higher than the UDV values at the reservoirs negatively impacted.

2.3 AVERAGE ANNUAL EFFECTS

Results examples from the annual effects to recreation analysis are shown in Table 2-1 and Table 2-2.

Table 2-1. Average Annual Recreation Value Example – Hills Creek Reservoir – Alternative 1

Sub-basin	Reservoir	Boat Ramp	Elevation (NAVD 88)	Avg. Annual Usable Days [1]	Avg. Annual Unusable Days [1]	Avg. Daily Rec Value – Usable Days	Avg. Daily Rec Value – Unusable Days	Average Annual Rec Benefit
Middle Fork Willamette	Hills Creek	Bingham Landing	1520	85.23	38.77	$199,969	37,114	$237,083
Middle Fork Willamette	Hills Creek	CT Beach Park	1507	101.7	23.3	$238,612	$22,305	$260,917
Middle Fork Willamette	Hills Creek	Packard Creek	1441	120.46	3.54	$282,627	$33.89	$282,661
–	–	–	Average	102.13	21.87	$240,403	$21,793	$262,195

Note: Because table values are rounded to two digits, Avg Annual Rec Benefits may not calculate exactly equal to what is shown.

[1] Averaged across 83 water years using HEC-ResSim model pool elevation data and NWP District boat ramp elevation data.

Average Annual Effects

Results examples from the annual effects to recreation analysis are shown in Table 2-1 and Table 2-2.

Table 2-1 for Hills Creek Alternative 1 were calculated for each alternative/reservoir combination. The action alternatives were then compared to the no action alternative to estimate the change in value (aka "benefits") that is anticipated to occur under each alternative scenario. Table 2-2 shows an example of all economic values across all alternatives for Hills Creek Reservoir.

Table 2-2. Average Annual Recreation Benefits Example – Hills Creek Reservoir – All Alternatives

Figures in Thousands	No Action	Alt 1	Alt 2A	Alt 2B	Alt 3A	Alt 3B	Alt 4	Alt 5
Average Annual Visits	25	28	29	28	25	17	29	40
Change in Visits from No Action	0	3	3	3	0	-9	3	1

Figures in Thousands	No Action	Alt 1	Alt 2A	Alt 2B	Alt 3A	Alt 3B	Alt 4	Alt 5
Total Annual Benefits	$12,987	$14,581	$14,694	$14,320	$13,021	$8,471	$14,697	$20,357
Average Annual Benefits	$157	$176	$177	$173	$157	$102	$177	$245
Change in Benefits from No Action	$0	$19	$21	$1	$0	-$54	$21	$7
Percent Change from No Action Benefits	0.00%	12.27%	13.10%	10.22%	0.26%	-34.76%	13.16%	2.85%
Effects Scale[1]	None	Moderate	Moderate	Moderate	None	Major	Moderate	Minor

[1] Effects Scale descriptions shown in Table 2-3

Note: Because table values are rounded, other dependent values may not calculate exactly equal to what is shown.

The effects scale used in this analysis is shown in Table 2-3.

Table 2-3. Environmental Effects Scale Descriptions

Effect Scale	Criteria
None/ Negligible	Effects are not measurable or change <1% from the No Action Alternative
Minor	Effects change from 1% to 5% (+/-) from the No Action Alternative
Moderate	Effects change from 5% to 20% (+/-) from the No Action Alternative
Major	Effects change more than 20% (+/-) from the No Action Alternative

CHAPTER 3 - UNCERTAINTY IN RESERVOIR RECREATION ANALYSIS RESULTS

Uncertainty in the average annual visitors and total recreation value results were measured utilizing the variability in the HEC-ResSim model outputs. HEC-ResSim outputs several stage and flow statistical values based on individual Monte Carlo simulation results. These statistics range from simulated minimum to maximum values. The 25th percentile leans toward the minimum value and represents a drier year, while the 75th percentile leans toward the maximum value and represents a wetter year. These statistics were used to construct the charts in Figure 1-2 **Error! Reference source not found.** Through Figure 1-6 **Error! Reference source not found.** as well as Table 3-1 and Table 3-3 below.

Table 3-1. Annual Visitation Uncertainty Statistics – All Reservoirs - All Alternatives

Reservoir	Statistic	No Action	Alt 1	Alt 2A	Alt 2B	Alt 3A	Alt 3B	Alt 4	Alt 5
Green Peter	Statistic	No Action	Alt 1	Alt 2A	Alt 2B	Alt 3A	Alt 3B	Alt 4	Alt 4
–	25 Percentile	175,512	178,838	168,096	168,096	168,101	80,774	168,284	168,354
–	Average	176,678	179,744	170,486	170,486	170,491	82,605	170,723	170,723
–	Median	177,217	180,230	171,274	171,274	171,279	82,510	171,485	171,470
–	75th Percentile	178,153	180,777	173,268	173,268	173,273	84,762	173,486	173,493
Cottage Grove	Statistic	No Action	Alt 1	Alt 2A	Alt 2B	Alt 3A	Alt 3B	Alt 4	Alt 5
–	25 Percentile	305,382	312,334	312,304	311,760	307,113	309,805	311,848	311,782
–	Average	306,317	313,252	313,137	312,649	308,262	310,829	312,706	312,706
–	Median	306,716	313,675	313,475	313,026	308,818	311,263	313,066	313,108
–	75th Percentile	307,406	314,338	314,114	313,684	309,593	312,024	313,710	313,779
Dorena	Statistic	No Action	Alt 1	Alt 2A	Alt 2B	Alt 3A	Alt 3B	Alt 4	Alt 5
–	25 Percentile	176,572	189,325	185,565	185,019	182,456	184,864	185,181	185,104
–	Average	177,314	190,041	186,235	185,737	183,363	185,661	185,867	185,867
–	Median	177,505	190,375	186,384	185,918	183,676	185,887	186,036	186,047
–	75th Percentile	178,109	190,900	187,050	186,599	184,445	186,616	186,707	186,752
Blue River	Statistic	No Action	Alt 1	Alt 2A	Alt 2B	Alt 3A	Alt 3B	Alt 4	Alt 5
–	25 Percentile	18,400	19,131	19,182	19,075	18,191	12,086	12,170	12,155
–	Average	18,518	19,259	19,288	19,193	18,383	12,236	12,236	12,236
–	Median	18,578	19,333	19,350	19,263	18,470	12,261	12,276	12,282
–	75th Percentile	18,647	19,407	19,411	19,329	18,613	12,346	12,315	12,328
Cougar	Statistic	No Action	Alt 1	Alt 2A	Alt 2B	Alt 3A	Alt 3B	Alt 4	Alt 5
–	25 Percentile	44,427	47,047	46,996	26,245	26,753	26,243	47,070	46,124
–	Average	44,719	47,457	47,302	26,904	26,904	26,904	47,378	47,378
–	Median	44,890	47,669	47,426	27,170	26,937	27,171	47,503	47,887
–	75th Percentile	45,031	47,894	47,652	27,437	26,992	27,438	47,727	48,372
Fern Ridge	Statistic	No Action	Alt 1	Alt 2A	Alt 2B	Alt 3A	Alt 3B	Alt 4	Alt 5
–	25 Percentile	798,885	798,723	798,723	798,723	798,723	798,723	798,723	798,723
–	Average	800,314	800,156	800,156	800,156	800,156	800,156	800,156	800,156
–	Median	800,719	800,558	800,558	800,558	800,558	800,558	800,558	800,558

Reservoir	Statistic	No Action	Alt 1	Alt 2A	Alt 2B	Alt 3A	Alt 3B	Alt 4	Alt 5
–	75th Percentile	801,835	801,682	801,682	801,682	801,682	801,682	801,682	801,682
Fall Creek	Statistic	No Action	Alt 1	Alt 2A	Alt 2B	Alt 3A	Alt 3B	Alt 4	Alt 5
–	25 Percentile	207,233	210,091	210,967	210,657	209,553	209,947	211,259	209,826
–	Average	207,932	210,822	211,569	211,300	210,287	210,665	211,865	210,483
–	Median	208,382	211,291	212,006	211,745	210,744	211,126	212,303	210,942
–	75th Percentile	208,874	211,796	212,424	212,187	211,270	211,627	212,723	211,384
Lookout Point	Statistic	No Action	Alt 1	Alt 2A	Alt 2B	Alt 3A	Alt 3B	Alt 4	Alt 5
–	25 Percentile	88,292	86,362	87,909	87,007	47,602	80,482	88,037	88,035
–	Average	88,933	86,921	88,433	87,586	49,147	81,695	88,568	88,678
–	Median	89,252	87,346	88,683	87,881	49,356	82,165	88,816	88,943
–	75th Percentile	89,661	87,687	89,076	88,278	50,409	83,161	89,213	89,402
Dexter	Statistic	No Action	Alt 1	Alt 2A	Alt 2B	Alt 3A	Alt 3B	Alt 4	Alt 5
–	25 Percentile	258,974	258,974	258,974	258,974	258,974	258,974	258,974	258,974
–	Average	258,974	258,974	258,974	258,974	258,974	258,974	258,974	258,974
–	Median	258,974	258,974	258,974	258,974	258,974	258,974	258,974	258,974
–	75th Percentile	258,974	258,974	258,974	258,974	258,974	258,974	258,974	258,974
Hills Creek	Statistic	No Action	Alt 1	Alt 2A	Alt 2B	Alt 3A	Alt 3B	Alt 4	Alt 5
–	25 Percentile	38,486	41,832	42,225	41,342	38,170	28,416	42,235	39,470
–	Average	38,635	42,196	42,450	41,615	38,710	28,539	42,457	39,723
–	Median	38,714	42,373	42,503	41,707	38,899	28,577	42,510	39,817
–	75th Percentile	38,785	42,575	42,707	41,931	39,318	28,616	42,714	40,017
Foster	Statistic	No Action	Alt 1	Alt 2A	Alt 2B	Alt 3A	Alt 3B	Alt 4	Alt 5
–	25 Percentile	476,661	478,419	478,419	478,419	478,420	421,695	478,419	478,419
–	Average	476,768	478,419	478,419	478,419	478,419	424,926	478,419	478,419
–	Median	476,819	478,419	478,419	478,419	478,420	426,625	478,419	478,419
–	75th Percentile	476,877	478,419	478,419	478,419	478,420	428,143	478,419	478,419
Detroit	Statistic	No Action	Alt 1	Alt 2A	Alt 2B	Alt 3A	Alt 3B	Alt 4	Alt 5
–	25 Percentile	160,772	168,740	159,092	159,091	98,009	152,456	159,085	159,091
–	Average	161,167	169,070	159,817	159,816	98,557	153,387	159,810	159,816
–	Median	161,355	169,302	160,120	160,120	98,620	153,769	160,113	160,120

Reservoir	Statistic	No Action	Alt 1	Alt 2A	Alt 2B	Alt 3A	Alt 3B	Alt 4	Alt 5
–	75th Percentile	161,705	169,495	160,657	160,655	98,896	154,522	160,648	160,655

Table 3-2. Annual Visitation Uncertainty Statistics – Total for All Reservoirs - All Alternatives

Statistic	No Action	Alt 1	Alt 2A	Alt 2B	Alt 3A	Alt 3B	Alt 4	Alt 5
25 Percentile	2,749,597	2,789,814	2,768,453	2,744,408	2,632,065	2,564,465	2,761,285	2,756,058
Average	2,756,267	2,796,313	2,776,267	2,752,835	2,641,653	2,576,577	2,769,160	2,765,160
Median	2,759,121	2,799,545	2,779,172	2,756,054	2,644,751	2,580,887	2,772,058	2,768,566
75th Percentile	2,764,057	2,803,944	2,785,434	2,762,443	2,651,885	2,589,910	2,778,318	2,775,258

Table 3-3 shows uncertainty statistics for all reservoirs combined for each of the proposed alternatives. There is ~.5% difference between the 25th and 75th percentile interquartile values for each alternative. This indicates that there is minimal uncertainty in the pool elevation at the reservoirs when operating according to the rule curve, assuming that there is adequate natural water to supply sufficient reservoir inflows.

Table 3-3. Annual Recreation Value Uncertainty Statistics – All Reservoirs - All Alternatives

Reservoir	Statistic	No Action	Alt 1	Alt 2A	Alt 2B	Alt 3A	Alt 3B	Alt 4	Alt 5
Green Peter	Statistic	No Action	Alt 1	Alt 2A	Alt 2B	Alt 3A	Alt 3B	Alt 4	Alt 5
–	25 Percentile	$1,175,629	$1,198,749	$1,124,256	$1,124,256	$1,124,289	$515,483	$1,125,580	$1,126,045
–	Average	$1,183,433	$1,204,827	$1,140,240	$1,140,240	$1,140,274	$527,167	$1,141,893	$1,141,893
–	Median	$1,187,048	$1,208,082	$1,145,512	$1,145,512	$1,145,546	$526,565	$1,146,988	$1,146,889
–	75th Percentile	$1,193,318	$1,211,748	$1,158,850	$1,158,849	$1,158,883	$540,933	$1,160,374	$1,160,421
Cottage Grove	Statistic	No Action	Alt 1	Alt 2A	Alt 2B	Alt 3A	Alt 3B	Alt 4	Alt 5
–	25 Percentile	$2,680,443	$2,741,698	$2,741,430	$2,736,638	$2,695,707	$2,719,419	$2,737,418	$2,736,840
–	Average	$2,688,649	$2,749,761	$2,748,748	$2,744,443	$2,705,784	$2,728,406	$2,744,950	$2,744,950
–	Median	$2,692,152	$2,753,468	$2,751,713	$2,747,755	$2,710,670	$2,732,219	$2,748,108	$2,748,473
–	75th Percentile	$2,698,210	$2,759,293	$2,757,318	$2,753,533	$2,717,468	$2,738,896	$2,753,764	$2,754,371
Dorena	Statistic	No Action	Alt 1	Alt 2A	Alt 2B	Alt 3A	Alt 3B	Alt 4	Alt 5
–	25 Percentile	$1,548,029	$1,661,067	$1,627,736	$1,622,897	$1,600,199	$1,621,529	$1,624,329	$1,623,653
–	Average	$1,554,532	$1,667,344	$1,633,609	$1,629,197	$1,608,155	$1,628,519	$1,630,351	$1,630,351
–	Median	$1,556,206	$1,670,276	$1,634,919	$1,630,787	$1,610,898	$1,630,504	$1,631,831	$1,631,931

Reservoir	Statistic	No Action	Alt 1	Alt 2A	Alt 2B	Alt 3A	Alt 3B	Alt 4	Alt 5
–	75th Percentile	$1,561,503	$1,674,883	$1,640,762	$1,636,756	$1,617,642	$1,636,903	$1,637,715	$1,638,115
Blue River	Statistic	No Action	Alt 1	Alt 2A	Alt 2B	Alt 3A	Alt 3B	Alt 4	Alt 5
–	25 Percentile	$111,746	$116,454	$116,778	$116,092	$110,422	$71,108	$116,838	$116,694
–	Average	$112,458	$117,236	$117,418	$116,809	$111,590	$71,990	$117,479	$117,479
–	Median	$112,823	$117,687	$117,796	$117,233	$112,117	$72,134	$117,856	$117,919
–	75th Percentile	$113,244	$118,137	$118,169	$117,639	$112,989	$72,635	$118,230	$118,362
Cougar	Statistic	No Action	Alt 1	Alt 2A	Alt 2B	Alt 3A	Alt 3B	Alt 4	Alt 5
–	25 Percentile	$288,071	$305,819	$305,450	$165,285	$168,489	$165,274	$305,952	$299,804
–	Average	$289,966	$308,485	$307,439	$169,440	$169,440	$169,440	$307,955	$307,955
–	Median	$291,073	$309,863	$308,241	$171,115	$169,644	$171,120	$308,764	$311,258
–	75th Percentile	$291,988	$311,330	$309,711	$172,793	$169,993	$172,799	$310,222	$314,414
Fern Ridge	Statistic	No Action	Alt 1	Alt 2A	Alt 2B	Alt 3A	Alt 3B	Alt 4	Alt 5
–	25 Percentile	$5,890,689	$5,889,481	$5,889,481	$5,889,481	$5,889,481	$5,889,481	$5,889,481	$5,889,481
–	Average	$5,901,222	$5,900,047	$5,900,047	$5,900,047	$5,900,047	$5,900,047	$5,900,047	$5,900,047
–	Median	$5,904,212	$5,903,010	$5,903,010	$5,903,010	$5,903,010	$5,903,010	$5,903,010	$5,903,010
–	75th Percentile	$5,912,435	$5,911,297	$5,911,297	$5,911,297	$5,911,297	$5,911,297	$5,911,297	$5,911,297
Fall Creek	Statistic	No Action	Alt 1	Alt 2A	Alt 2B	Alt 3A	Alt 3B	Alt 4	Alt 5
–	25 Percentile	$1,385,313	$1,404,771	$1,410,719	$1,408,613	$1,401,108	$1,403,792	$1,412,707	$1,412,338
–	Average	$1,389,985	$1,409,659	$1,414,748	$1,412,914	$1,406,020	$1,408,594	$1,416,760	$1,416,760
–	Median	$1,392,994	$1,412,794	$1,417,670	$1,415,888	$1,409,076	$1,411,673	$1,419,691	$1,419,849
–	75th Percentile	$1,396,286	$1,416,173	$1,420,461	$1,418,845	$1,412,593	$1,415,021	$1,422,500	$1,422,826
Lookout Point	Statistic	No Action	Alt 1	Alt 2A	Alt 2B	Alt 3A	Alt 3B	Alt 4	Alt 5
–	25 Percentile	$652,948	$640,590	$654,426	$648,105	$328,587	$594,394	$655,350	$654,519
–	Average	$657,686	$644,742	$658,322	$652,414	$339,250	$603,357	$659,297	$659,297
–	Median	$660,044	$647,892	$660,184	$654,611	$340,692	$606,827	$661,143	$661,266
–	75th Percentile	$663,066	$650,418	$663,110	$657,570	$347,961	$614,185	$664,098	$664,677
Dexter	Statistic	No Action	Alt 1	Alt 2A	Alt 2B	Alt 3A	Alt 3B	Alt 4	Alt 5
–	25 Percentile	$1,646,266	$1,646,266	$1,646,266	$1,646,266	$1,646,266	$1,646,266	$1,646,266	$1,646,266
–	Average	$1,646,266	$1,646,266	$1,646,266	$1,646,266	$1,646,266	$1,646,266	$1,646,266	$1,646,266
–	Median	$1,646,266	$1,646,266	$1,646,266	$1,646,266	$1,646,266	$1,646,266	$1,646,266	$1,646,266

Reservoir	Statistic	No Action	Alt 1	Alt 2A	Alt 2B	Alt 3A	Alt 3B	Alt 4	Alt 5
–	75th Percentile	$1,646,266	$1,646,266	$1,646,266	$1,646,266	$1,646,266	$1,646,266	$1,646,266	$1,646,266
Hills Creek	Statistic	No Action	Alt 1	Alt 2A	Alt 2B	Alt 3A	Alt 3B	Alt 4	Alt 5
–	25 Percentile	$237,613	$258,302	$260,733	$255,274	$235,665	$175,358	$260,795	$260,502
–	Average	$238,532	$260,554	$262,122	$256,957	$239,001	$176,113	$262,166	$262,166
–	Median	$239,020	$261,647	$262,451	$257,526	$240,166	$176,350	$262,490	$262,790
–	75th Percentile	$239,464	$262,894	$263,710	$258,910	$242,750	$176,588	$263,754	$264,112
Foster	Statistic	No Action	Alt 1	Alt 2A	Alt 2B	Alt 3A	Alt 3B	Alt 4	Alt 5
–	25 Percentile	$4,028,956	$4,043,919	$4,043,919	$4,043,919	$4,043,926	$3,561,044	$4,043,919	$4,043,919
–	Average	$4,029,863	$4,043,919	$4,043,919	$4,043,919	$4,043,919	$3,588,328	$4,043,919	$4,043,919
–	Median	$4,030,294	$4,043,919	$4,043,919	$4,043,919	$4,043,926	$3,602,682	$4,043,919	$4,043,919
–	75th Percentile	$4,030,788	$4,043,919	$4,043,919	$4,043,919	$4,043,926	$3,615,494	$4,043,919	$4,043,919
Detroit	Statistic	No Action	Alt 1	Alt 2A	Alt 2B	Alt 3A	Alt 3B	Alt 4	Alt 5
–	25 Percentile	$1,036,545	$1,089,499	$1,025,376	$1,025,372	$618,893	$981,267	$1,025,329	$1,025,328
–	Average	$1,039,091	$1,091,629	$1,030,050	$1,030,043	$622,351	$987,258	$1,029,999	$1,029,999
–	Median	$1,040,305	$1,093,127	$1,032,003	$1,031,998	$622,755	$989,716	$1,031,956	$1,031,954
–	75th Percentile	$1,042,556	$1,094,371	$1,035,462	$1,035,447	$624,495	$994,562	$1,035,402	$1,035,403

Table 3-4. Annual Recreation Value Uncertainty Statistics – Total for All Reservoirs - All Alternatives

Statistic	No Action	Alt 1	Alt 2A	Alt 2B	Alt 3A	Alt 3B	Alt 4	Alt 5
25 Percentile	$20,682,247	$20,996,614	$20,846,569	$20,682,198	$19,863,032	$19,344,415	$20,843,962	$20,835,388
Average	$20,731,683	$21,044,471	$20,902,930	$20,742,689	$19,932,097	$19,435,485	$20,901,083	$20,901,083
Median	$20,752,437	$21,068,030	$20,923,683	$20,765,621	$19,954,765	$19,469,065	$20,922,020	$20,925,524
75th Percentile	$20,789,124	$21,100,728	$20,969,035	$20,811,825	$20,006,262	$19,535,580	$20,967,540	$20,974,180

Table 3-4 shows uncertainty statistics for all reservoirs combined for each of the proposed alternatives. There is ~.5% difference between the 25th and 75th percentile interquartile values for each alternative. This indicates that there is minimal uncertainty in the pool elevation at the reservoirs when operating according to the rule curve, assuming that there is adequate natural water to supply sufficient reservoir inflows.

Table 3-5 through Table 3-23 below display the results in which the Chapter 3 environment consequences discussions are based on.

Table 3-5. Recreation Results by Reservoir – Detroit Reservoir

Metric	No Action	Alt 1	Alt 2A	Alt 2B	Alt 3A	Alt 3B	Alt 4	Alt 5
Average Annual Visits	161	169	160	160	99	153	160	160
Change in Visits from No Action	0	8	-1	-1	-63	-8	-1	-1
Total Annual Benefits	$86,245	$90,605	$85,494	$85,494	$51,655	$81,942	$85,490	$85,494
Average Annual Benefits	$1,039	$1,092	$1,030	$1,030	$622	$987	$1,030	$1,030
Change in Benefits from No Action	$0	$53	-$9	-$9	-$417	-$52	-$9	-$9
Percent Change in Benefits from No Action	0.00%	5.05%	-0.87%	-0.88%	- 40.10%	-4.99%	-0.88%	-0.88%
Effects Scale	None	Moderate	None	None	Major	Minor	None	None

Note that the figures are in 1,000s of dollars and the dollar values are at 2022 price level. Effects Scales are described in Table 2-3 of Appendix K.

Table 3-6. Recreation Results by Reservoir – Foster Reservoir

Metric	No Action	Alt 1	Alt 2A	Alt 2B	Alt 3A	Alt 3B	Alt 4	Alt 5
Average Annual Visits	477	478	478	478	478	425	478	478
Change in Visits from No Action	0	2	2	2	2	-52	2	2
Total Annual Benefits	$334,479	$335,645	$335,645	$335,645	$335,645	$297,831	$335,645	$335,645
Average Annual Benefits	$4,030	$4,044	$4,044	$4,044	$4,044	$3,588	$4,044	$4,044
Change in Benefits from No Action	$0	$14	$14	$14	$14	-$442	$14	$14
Percent Change in Benefits from No Action	0.00%	0.35%	0.35%	0.35%	0.35%	-10.96%	0.35%	0.35%
Effects Scale	None	None	None	None	None	Moderate	None	None

Note that the figures are in 1,000s of dollars and the dollar values are at 2022 price level. Effects Scales are described in Table 2-3 of Appendix K.

Table 3-7. Recreation Results by Reservoir – Green Peter Reservoir

Metric	No Action	Alt 1	Alt 2A	Alt 2B	Alt 3A	Alt 3B	Alt 4	Alt 5
Average Annual Visits	177	180	171	171	171	83	171	171
Change in Visits from No Action	0	3	-6	-6	-6	-94	-6	-6
Total Annual Benefits	$98,225	$100,001	$94,640	$94,640	$94,643	$43,755	$94,777	$94,685
Average Annual Benefits	$1,183	$1,205	$1,140	$1,140	$1,140	$527	$1,142	$1,141
Change in Benefits from No Action	$0	$21	-$43	-$43	-$43	-$656	-$42	-$43
Percent Change in Benefits from No Action	0.00%	1.81%	-3.65%	-3.65%	-3.64%	-55.45%	-3.51%	-3.60%
Effects Scale	None	Minor	Minor	Minor	Minor	Major	Minor	Minor

Note that the figures are in 1,000s of dollars and the dollar values are at 2022 price level. Effects Scales are described in Table 2-3 of Appendix K.

Table 3-8. Recreation Results by Reservoir – Cougar Reservoir

Metric	No Action	Alt 1	Alt 2A	Alt 2B	Alt 3A	Alt 3B	Alt 4	Alt 5
Average Annual Visits	45	48	47	27	27	27	47	27
Change in Visits from No Action	0	3	3	-18	-18	-18	3	-18
Total Annual Benefits	$24,067	$25,604	$25,517	$14,064	$14,064	$14,064	$25,560	$14,064
Average Annual Benefits	$290	$309	$307	$169	$169	$169	$308	$169
Change in Benefits from No Action	$0	$19	$17	-$121	-$121	-$121	$18	-$121
Percent Change in Benefits from No Action	0.00%	6.38%	6.00%	-41.59%	-41.59%	-41.59%	6.21%	-41.59%
Effects Scale	None	Moderate	Moderate	Major	Major	Major	Moderate	Major

Note that the figures are in 1,000s of dollars and the dollar values are at 2022 price level. Effects Scales are described in Table 2-3 of Appendix K.

Table 3-9. Recreation Results by Reservoir – Blue River Reservoir

Metric	No Action	Alt 1	Alt 2A	Alt 2B	Alt 3A	Alt 3B	Alt 4	Alt 5
Average Annual Visits	19	19	19	19	18	12	12	12
Change in Visits from No Action	0	1	1	1	0	-6	-6	-6

Metric	No Action	Alt 1	Alt 2A	Alt 2B	Alt 3A	Alt 3B	Alt 4	Alt 5
Total Annual Benefits	$9,334	$9,731	$9,746	$9,695	$9,262	$5,975	$9,751	$9,568
Average Annual Benefits	$113	$117	$117	$117	$112	$72	$118	$115
Change in Benefits from No Action	$0	$5	$5	$4	-$1	-$41	$5	$3
Percent Change in Benefits from No Action	0.00%	4.18%	4.36%	3.82%	-0.80%	-36.00%	4.44%	2.49%
Effects Scale	None	Minor	Minor	Minor	None	Major	Minor	Minor

Note that the figures are in 1,000s of dollars and the dollar values are at 2022 price level. Effects Scales are described in Table 2-3 of Appendix K.

Table 3-10. Recreation Results by Reservoir – Lookout Point Reservoir

Metric	No Action	Alt 1	Alt 2A	Alt 2B	Alt 3A	Alt 3B	Alt 4	Alt 5
Average Annual Visits	89	87	88	88	49	82	89	89
Change in Visits from No Action	0	-2	-1	-1	-40	-7	0	2
Total Annual Benefits	$54,588	$53,514	$54,641	$54,150	$28,158	$50,079	$54,722	$54,785
Average Annual Benefits	$658	$645	$658	$652	$339	$603	$659	$660
Change in Benefits from No Action	$0	-$13	$1	-$5	-$319	-$54	$2	$2
Percent Change in Benefits from No Action	0.00%	-1.98%	0.09%	-0.81%	-48.43%	-8.26%	0.24%	0.36%
Effects Scale	None	Minor	None	None	Major	Moderate	None	None

Note that the figures are in 1,000s of dollars and the dollar values are at 2022 price level. Effects Scales are described in Table 2-3 of Appendix K.

Table 3-11. Recreation Results by Reservoir – Hills Creek Reservoir

Metric	No Action	Alt 1	Alt 2A	Alt 2B	Alt 3A	Alt 3B	Alt 4	Alt 5
Average Annual Visits	39	42	43	42	39	29	43	40
Change in Visits from No Action	0	4	4	3	0	-10	4	1
Total Annual Benefits	$19,798	$21,626	$21,756	$21,327	$19,837	$14,617	$21,760	$20,357
Average Annual Benefits	$239	$261	$262	$257	$239	$176	$262	$245

Metric	No Action	Alt 1	Alt 2A	Alt 2B	Alt 3A	Alt 3B	Alt 4	Alt 5
Change in Benefits from No Action	$0	$22	$24	$19	$1	-$62	$24	$7
Percent Change in Benefits from No Action	0.00%	9.27%	9.90%	7.76%	0.21%	-26.16%	9.94%	2.85%
Effects Scale	None	Moderate	Moderate	Moderate	None	Major	Moderate	Minor

Note that the figures are in 1,000s of dollars and the dollar values are at 2022 price level. Effects Scales are described in Table 2-3 of Appendix K.

Table 3-12. Recreation Results by Reservoir – Dexter Reservoir

Metric	No Action	Alt 1	Alt 2A	Alt 2B	Alt 3A	Alt 3B	Alt 4	Alt 5
Average Annual Visits	259	259	259	259	259	259	259	259
Change in Visits from No Action	0	0	0	0	0	0	0	0
Total Annual Benefits	$136,640	$136,640	$136,640	$136,640	$136,640	$136,640	$136,640	$136,640
Average Annual Benefits	$1,646	$1,646	$1,646	$1,646	$1,646	$1,646	$1,646	$1,646
Change in Benefits from No Action	$0	$0	$0	$0	$0	$0	$0	$0
Percent Change in Benefits from No Action	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Effects Scale	None	None	None	None	None	None	None	None

Note that the figures are in 1,000s of dollars and the dollar values are at 2022 price level. Effects Scales are described in Table 2-3 of Appendix K.

Table 3-13. Recreation Results by Reservoir – Fall Creek Reservoir

Metric	No Action	Alt 1	Alt 2A	Alt 2B	Alt 3A	Alt 3B	Alt 4	Alt 5
Average Annual Visits	208	211	212	211	210	211	212	211
Change in Visits from No Action	0	3	4	3	2	3	4	3
Total Annual Benefits	$115,369	$117,002	$117,424	$117,272	$116,700	$116,913	$117,591	$116,810
Average Annual Benefits	$1,390	$1,410	$1,415	$1,413	$1,406	$1,409	$1,417	$1,407
Change in Benefits from No Action	$0	$20	$25	$23	$16	$19	$27	$17

Metric	No Action	Alt 1	Alt 2A	Alt 2B	Alt 3A	Alt 3B	Alt 4	Alt 5
Percent Change in Benefits from No Action	0.00%	1.42%	1.78%	1.65%	1.15%	1.34%	1.93%	1.25%
Effects Scale	None	Minor	Minor	Minor	Minor	Minor	Minor	Minor

Note that the figures are in 1,000s of dollars and the dollar values are at 2022 price level. Effects Scales are described in Table 2-3 of Appendix K.

Table 3-14. Recreation Results by Reservoir – Dorena Reservoir

Metric	No Action	Alt 1	Alt 2A	Alt 2B	Alt 3A	Alt 3B	Alt 4	Alt 5
Average Annual Visits	177	190	186	186	183	186	186	182
Change in Visits from No Action	0	13	9	8	6	8	9	5
Total Annual Benefits	$129,026	$138,390	$135,590	$135,223	$133,477	$135,167	$135,319	$132,722
Average Annual Benefits	$1,555	$1,667	$1,634	$1,629	$1,608	$1,629	$1,630	$1,599
Change in Benefits from No Action	$0	$113	$79	$75	$54	$74	$76	$45
Percent Change in Benefits from No Action	0.00%	7.26%	5.09%	4.81%	3.45%	4.76%	4.88%	2.87%
Effects Scale	None	Moderate	Moderate	Minor	Minor	Minor	Minor	Minor

Note that the figures are in 1,000s of dollars and the dollar values are at 2022 price level. Effects Scales are described in Table 2-3 of Appendix K.

Table 3-15. Recreation Results by Reservoir – Cottage Grove Reservoir

Metric	No Action	Alt 1	Alt 2A	Alt 2B	Alt 3A	Alt 3B	Alt 4	Alt 5
Average Annual Visits	306	313	313	313	308	311	313	310
Change in Visits from No Action	0	7	7	6	2	5	6	4
Total Annual Benefits	$223,158	$228,230	$228,146	$227,789	$224,580	$226,458	$227,831	$225,701
Average Annual Benefits	$2,689	$2,750	$2,749	$2,744	$2,706	$2,728	$2,745	$2,719
Change in Benefits from No Action	$0	$61	$60	$56	$17	$40	$56	$31
Percent Change in Benefits from No Action	0.00%	2.28%	2.24%	2.08%	0.64%	1.48%	2.09%	1.14%
Effects Scale	None	Minor	Minor	Minor	None	Minor	Minor	Minor

Note that the figures are in 1,000s of dollars and the dollar values are at 2022 price level. Effects Scales are described in Table 2-3 of Appendix K.

Table 3-16. Recreation Results by Reservoir – Fern Ridge Reservoir

Metric	No Action	Alt 1	Alt 2A	Alt 2B	Alt 3A	Alt 3B	Alt 4	Alt 5
Average Annual Visits	800	800	800	800	800	800	800	800
Change in Visits from No Action	0	0	0	0	0	0	0	0
Total Annual Benefits	$489,179	$489,071	$489,071	$489,071	$489,071	$489,071	$489,071	$489,071
Average Annual Benefits	$5,901	$5,900	$5,900	$5,900	$5,900	$5,900	$5,900	$5,900
Change in Benefits from No Action	$0	-$1	-$1	-$1	-$1	-$1	-$1	-$1
Percent Change in Benefits from No Action	0.00%	-0.02%	-0.02%	-0.02%	-0.02%	-0.02%	-0.02%	-0.02%
Effects Scale	None	None	None	None	None	None	None	None

Note that the figures are in 1,000s of dollars and the dollar values are at 2022 price level. Effects Scales are described in Table 2-3 of Appendix K.

Table 3-17. Recreation Results – All Reservoirs

Metric	No Action	Alt 1	Alt 2A	Alt 2B	Alt 3A	Alt 3B	Alt 4	Alt 5
Average Annual Visits	2,756	2,796	2,776	2,753	2,642	2,577	2,769	2,738
Change in Visits from No Action	0	40	20	-4	-115	-180	13	-18
Total Annual Benefits	$1,720,107	$1,746,058	$1,734,310	$1,721,010	$1,653,731	$1,612,512	$1,734,157	$1,715,541
Average Annual Benefits	$20,732	$21,045	$20,903	$20,743	$19,932	$19,436	$20,901	$20,677
Change in Benefits from No Action	$0	$313	$171	$11	-$800	-$1,296	$169	-$55
Percent Change in Benefits from No Action	0.00%	1.51%	0.83%	0.05%	-3.86%	-6.25%	0.82%	-0.26%
Effects Scale	None	Minor	None	None	Minor	Moderate	None	None

Note that the figures are in 1,000s of dollars and the dollar values are at 2022 price level. Effects Scales are described in Table 2-3 of Appendix K.

Table 3-18. Recreation Results by Alternative – No Action Alternative

Reservoir	Average Annual Visits	Change in Visits from No Action	Total Annual Benefits	Average Annual Benefits	Change in Benefits from No Action	Percent Change in Benefits from No Action	Effects Scale
Detroit	161	0	$86,245	$1,039	0	0.00%	None
Foster	477	0	$334,479	$4,030	0	0.00%	None
Green Peter	177	0	$98,225	$1,183	0	0.00%	None
Cougar	45	0	$24,067	$290	0	0.00%	None
Blue River	19	0	$9,334	$113	0	0.00%	None
Lookout Point	89	0	$54,588	$658	0	0.00%	None
Hills Creek	39	0	$19,798	$239	0	0.00%	None
Dexter	259	0	$136,640	$1,646	0	0.00%	None
Fall Creek	208	0	$115,369	$1,390	0	0.00%	None
Dorena	177	0	$129,026	$1,555	0	0.00%	None
Cottage Grove	306	0	$223,158	$2,689	0	0.00%	None
Fern Ridge	800	0	$489,179	$5,901	0	0.00%	None
Total	**2,756**	**0**	**1,720,108**	**20,732**	**0**	**0.00%**	**None**

Note that the figures are in 1,000s of dollars and the dollar values are at 2022 price level. Effects Scales are described in Table 2-3 of Appendix K.

Table 3-19. Recreation Results by Alternative – Alternative 1

Reservoir	Average Annual Visits	Change in Visits from No Action	Total Annual Benefits	Average Annual Benefits	Change in Benefits from No Action	Percent Change in Benefits from No Action	Effects Scale
Detroit	169	8	$90,605	$1,092	53	5.05%	Moderate
Foster	478	2	$335,645	$4,044	14	0.35%	None
Green Peter	180	3	$100,001	$1,205	21	1.81%	Minor
Cougar	48	3	$25,604	$309	19	6.38%	Moderate
Blue River	19	1	$9,731	$117	5	4.18%	Minor
Lookout Point	87	-2	$53,514	$645	-13	-1.98%	Minor
Hills Creek	42	4	$21,626	$261	22	9.27%	Moderate
Dexter	259	0	$136,640	$1,646	0	0.00%	None
Fall Creek	211	3	$117,002	$1,410	20	1.42%	Minor
Dorena	190	13	$138,390	$1,667	113	7.26%	Moderate

Reservoir	Average Annual Visits	Change in Visits from No Action	Total Annual Benefits	Average Annual Benefits	Change in Benefits from No Action	Percent Change in Benefits from No Action	Effects Scale
Cottage Grove	313	7	$228,230	$2,750	61	2.28%	Minor
Fern Ridge	800	0	$489,071	$5,900	-1	-0.02%	None
Total	**2,796**	**40**	**1,746,059**	**21,044**	**313**	**1.51%**	**Minor**

Note that the figures are in 1,000s of dollars and the dollar values are at 2022 price level. Effects Scales are described in Table 2-3 of Appendix K.

Table 3-20. Recreation Results by Alternative – Alternative 2A

Reservoir	Average Annual Visits	Change in Visits from No Action	Total Annual Benefits	Average Annual Benefits	Change in Benefits from No Action	Percent Change in Benefits from No Action	Effects Scale
Detroit	160	-1	$85,494	$1,030	-9	-0.87%	None
Foster	478	2	$335,645	$4,044	14	0.35%	None
Green Peter	171	-6	$94,640	$1,140	-43	-3.65%	Minor
Cougar	47	3	$25,517	$307	17	6.00%	Moderate
Blue River	19	1	$9,746	$117	5	4.36%	Minor
Lookout Point	88	-1	$54,641	$658	1	0.09%	None
Hills Creek	43	4	$21,756	$262	24	9.90%	Moderate
Dexter	259	0	$136,640	$1,646	0	0.00%	None
Fall Creek	212	4	$117,424	$1,415	25	1.78%	Minor
Dorena	186	9	$135,590	$1,634	79	5.09%	Moderate
Cottage Grove	313	7	$228,146	$2,749	60	2.24%	Minor
Fern Ridge	800	0	$489,071	$5,900	-1	-0.02%	None
Total	**2,776**	**20**	**1,734,310**	**20,903**	**171**	**0.82%**	**None**

Note that the figures are in 1,000s of dollars and the dollar values are at 2022 price level. Effects Scales are described in Table 2-3 of Appendix K.

Table 3-21. Recreation Results by Alternative – Alternative 2B

Reservoir	Average Annual Visits	Change in Visits from No Action	Total Annual Benefits	Average Annual Benefits	Change in Benefits from No Action	Percent Change in Benefits from No Action	Effects Scale
Detroit	160	-1	$85,494	$1,030	-9	-0.88%	None
Foster	478	2	$335,645	$4,044	14	0.35%	None

Reservoir	Average Annual Visits	Change in Visits from No Action	Total Annual Benefits	Average Annual Benefits	Change in Benefits from No Action	Percent Change in Benefits from No Action	Effects Scale
Green Peter	171	-6	$94,640	$1,140	-43	-3.65%	Minor
Cougar	27	-18	$14,064	$169	-121	-41.59%	Major
Blue River	19	1	$9,695	$117	4	3.82%	Minor
Lookout Point	88	-1	$54,150	$652	-5	-0.81%	None
Hills Creek	42	3	$21,327	$257	19	7.76%	Moderate
Dexter	259	0	$136,640	$1,646	0	0.00%	None
Fall Creek	211	3	$117,272	$1,413	23	1.65%	Minor
Dorena	186	8	$135,223	$1,629	75	4.81%	Minor
Cottage Grove	313	6	$227,789	$2,744	56	2.08%	Minor
Fern Ridge	800	0	$489,071	$5,900	-1	-0.02%	None
Total	**2,753**	**-3**	**1,721,010**	**20,743**	**11**	**0.05%**	**None**

Note that the figures are in 1,000s of dollars and the dollar values are at 2022 price level. Effects Scales are described in Table 2-3 of Appendix K.

Table 3-22. Recreation Results by Alternative – Alternative 3A

Reservoir	Average Annual Visits	Change in Visits from No Action	Total Annual Benefits	Average Annual Benefits	Change in Benefits from No Action	Percent Change in Benefits from No Action	Effects Scale
Detroit	99	-63	$51,655	$622	-417	-40.10%	Major
Foster	478	2	$335,645	$4,044	14	0.35%	None
Green Peter	171	-6	$94,643	$1,140	-43	-3.64%	Minor
Cougar	27	-18	$14,064	$169	-121	-41.59%	Major
Blue River	18	0	$9,262	$112	-1	-0.80%	None
Lookout Point	49	-40	$28,158	$339	-319	-48.43%	Major
Hills Creek	39	0	$19,837	$239	1	0.21%	None
Dexter	259	0	$136,640	$1,646	0	0.00%	None
Fall Creek	210	2	$116,700	$1,406	16	1.15%	Minor
Dorena	183	6	$133,477	$1,608	54	3.45%	Minor
Cottage Grove	308	2	$224,580	$2,706	17	0.64%	None
Fern Ridge	800	0	$489,071	$5,900	-1	-0.02%	None
Total	**2,642**	**-114**	**1,653,732**	**19,932**	**-800**	**-3.86%**	**Minor**

Note that the figures are in 1,000s of dollars and the dollar values are at 2022 price level. Effects Scales are described in Table 2-3 of Appendix K.

Table 3-23. Recreation Results by Alternative – Alternative 3B

Reservoir	Average Annual Visits	Change in Visits from No Action	Total Annual Benefits	Average Annual Benefits	Change in Benefits from No Action	Percent Change in Benefits from No Action	Effects Scale
Detroit	153	-8	$81,942	$987	-52	-4.99%	Minor
Foster	425	-52	$297,831	$3,588	-442	-10.96%	Moderate
Green Peter	83	-94	$43,755	$527	-656	-55.45%	Major
Cougar	27	-18	$14,064	$169	-121	-41.59%	Major
Blue River	12	-6	$5,975	$72	-41	-36.00%	Major
Lookout Point	82	-7	$50,079	$603	-54	-8.26%	Moderate
Hills Creek	29	-10	$14,617	$176	-62	-26.16%	Major
Dexter	259	0	$136,640	$1,646	0	0.00%	None
Fall Creek	211	3	$116,913	$1,409	19	1.34%	Minor
Dorena	186	8	$135,167	$1,629	74	4.76%	Minor
Cottage Grove	311	5	$226,458	$2,728	40	1.48%	Minor
Fern Ridge	800	0	$489,071	$5,900	-1	-0.02%	None
Total	**2,577**	**-180**	**1,612,512**	**19,436**	**-1,296**	**-6.25%**	**Moderate**

Note that the figures are in 1,000s of dollars and the dollar values are at 2022 price level. Effects Scales are described in Table 2-3 of Appendix K.

Table 3-24. Recreation Results by Alternative – Alternative 4

Reservoir	Average Annual Visits	Change in Visits from No Action	Total Annual Benefits	Average Annual Benefits	Change in Benefits from No Action	Percent Change in Benefits from No Action	Effects Scale
Detroit	160	-1	$85,490	$1,030	-9	-0.88%	None
Foster	478	2	$335,645	$4,044	14	0.35%	None
Green Peter	171	-6	$94,777	$1,142	-42	-3.51%	Minor
Cougar	47	3	$25,560	$308	18	6.21%	Moderate
Blue River	12	-6	$9,751	$118	5	4.44%	Minor
Lookout Point	89	0	$54,722	$659	2	0.24%	None
Hills Creek	43	4	$21,760	$262	24	9.94%	Moderate
Dexter	259	0	$136,640	$1,646	0	0.00%	None
Fall Creek	212	4	$117,591	$1,417	27	1.93%	Minor
Dorena	186	9	$135,319	$1,630	76	4.88%	Minor
Cottage Grove	313	6	$227,831	$2,745	56	2.09%	Minor

Reservoir	Average Annual Visits	Change in Visits from No Action	Total Annual Benefits	Average Annual Benefits	Change in Benefits from No Action	Percent Change in Benefits from No Action	Effects Scale
Fern Ridge	800	0	$489,071	$5,900	-1	-0.02%	None
Total	**2,769**	**13**	**1,734,157**	**20,901**	**170**	**0.82%**	**None**

Note that the figures are in 1,000s of dollars and the dollar values are at 2022 price level. Effects Scales are described in Table 2-3 of Appendix K.

Table 3-25. Recreation Results by Alternative – Alternative 5

Reservoir	Average Annual Visits	Change in Visits from No Action	Total Annual Benefits	Average Annual Benefits	Change in Benefits from No Action	Percent Change in Benefits from No Action	Effects Scale
Detroit	160	-1	$85,494	$1,030	-9	-0.88%	None
Foster	478	2	$335,645	$4,044	14	0.35%	None
Green Peter	171	-6	$94,685	$1,141	-43	-3.60%	Minor
Cougar	27	-18	$14,064	$169	-121	-41.59%	Major
Blue River	12	-6	$9,568	$115	3	2.49%	Minor
Lookout Point	89	2	$54,785	$660	2	0.36%	None
Hills Creek	40	1	$20,357	$245	7	2.85%	Minor
Dexter	259	0	$136,640	$1,646	0	0.00%	None
Fall Creek	211	3	$116,810	$1,407	17	1.25%	Minor
Dorena	182	5	$132,722	$1,599	45	2.87%	Minor
Cottage Grove	310	4	$225,701	$2,719	31	1.14%	Minor
Fern Ridge	800	0	$489,071	$5,900	-1	-0.02%	None
Total	**2,738**	**-16**	**1,715,542**	**20,677**	**-55**	**-0.26%**	**None**

Note that the figures are in 1,000s of dollars and the dollar values are at 2022 price level. Effects Scales are described in Table 2-3 of Appendix K.

CHAPTER 4 - RECREATION EFFECTS – RIVERINE RECREATION

Because riverine recreation in the Willamette Valley System is widespread and abundant, with no visitor tracking data available, a qualitative analysis was done to estimate general effects on recreation to riverine areas across the alternatives. Using HEC-ResSim model simulated flow data for various river gage locations across the 83-year period of record, daily flows at each gage location were compared for the action and no action alternatives. The same reservoir effects scale shown in Table 2-3 of this appendix was used for riverine area effect estimations. Figure 4-1 shows the location of river gages that were used.

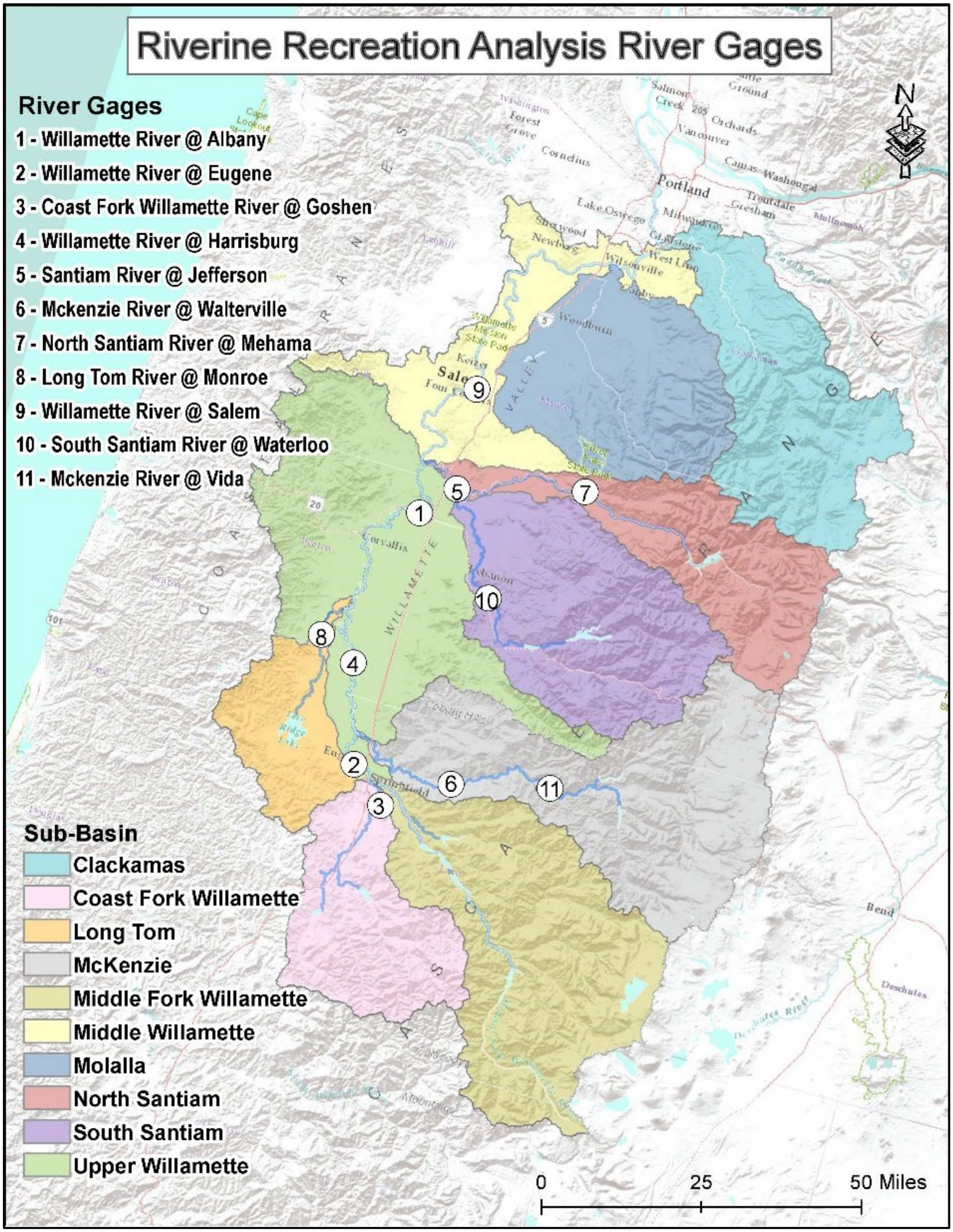


Figure 4-1. River Gages Used for Riverine Recreation Analysis

Table 4-1 through Table 4-6shows river gage/season/alternative statistics. Combinations showing estimated average flows that are plus or minus five percent of the no action alternative flows are colored in green (+) and red (-), respectively.

Table 4-1.Riverine Flow Uncertainty Statistics - Alternative 1

Alternative 1 Average Daily Flows Summary	–	–	–	–
Control Point (gage) and Season	25% Non-exceedance (Dry Year)	Average	Median	75% Non-exceedance (Wet Year)
Albany	–	–	–	–
Annual	-2.71%	-0.03%	0.20%	0.75%
Winter (12/21-03/20)	0.33%	0.28%	0.74%	0.08%
Spring (03/21-06/20)	-14.86%	-4.31%	-2.40%	0.78%
Summer (06/21-09/20)	6.41%	7.70%	5.32%	6.15%
Fall (09/21-12/20)	1.19%	0.52%	-0.42%	0.11%
Eugene	–	–	–	–
Annual	-4.78%	-0.04%	-0.53%	1.56%
Winter (12/21-03/20)	-0.77%	0.75%	1.55%	1.80%
Spring (03/21-06/20)	-27.24%	-8.33%	-9.60%	0.40%
Summer (06/21-09/20)	11.17%	13.19%	10.27%	11.61%
Fall (09/21-12/20)	1.99%	0.15%	-1.11%	-1.48%
Goshen	–	–	–	–
Annual	-3.64%	-0.02%	-0.49%	0.68%
Winter (12/21-03/20)	-0.02%	-0.05%	-0.05%	-0.04%
Spring (03/21-06/20)	-21.78%	-3.54%	-4.54%	2.47%
Summer (06/21-09/20)	10.55%	5.80%	6.49%	4.14%

Alternative 1 Average Daily Flows Summary	–	–	–	–
Fall (09/21-12/20)	6.25%	1.93%	0.35%	0.17%
Harrisburg	–	–	–	–
Annual	-3.24%	-0.03%	0.21%	0.95%
Winter (12/21-03/20)	-0.09%	0.36%	1.01%	0.42%
Spring (03/21-06/20)	-17.06%	-5.10%	-3.53%	0.95%
Summer (06/21-09/20)	7.87%	8.24%	5.98%	6.67%
Fall (09/21-12/20)	1.07%	0.62%	-0.25%	-0.41%
Jasper	–	–	–	–
Annual	-4.93%	-0.03%	-1.54%	1.40%
Winter (12/21-03/20)	-0.96%	1.18%	1.35%	2.80%
Spring (03/21-06/20)	-28.09%	-10.00%	-16.17%	-1.26%
Summer (06/21-09/20)	11.34%	14.01%	10.78%	12.93%
Fall (09/21-12/20)	0.85%	-0.42%	-0.06%	-3.17%
Jefferson	–	–	–	–
Annual	-3.94%	-0.06%	-0.26%	1.23%
Winter (12/21-03/20)	-0.87%	-0.22%	0.00%	0.49%
Spring (03/21-06/20)	-10.19%	-1.93	-0.17%	1.83%
Summer (06/21-09/20)	-21.35%	-13.60%	-16.71%	-9.95%
Fall (09/21-12/20)	5.90%	5.12%	4.02%	4.06%
Mehama	–	–	–	–
Annual	-2.95%	-0.06%	-0.71%	1.09%
Winter (12/21-03/20)	-1.08%	-0.39%	-0.74%	0.10%

Alternative 1 Average Daily Flows Summary	–	–	–	–
Spring (03/21-06/20)	-9.36%	-1.99%	-2.14%	1.77%
Summer (06/21-09/20)	-11.59%	-4.78%	-6.61%	-1.01%
Fall (09/21-12/20)	6.28%	3.63%	2.77%	2.29%
Monroe	–	–	–	–
Annual	-0.03%	0.00%	0.01%	0.00%
Winter (12/21-03/20)	0.00%	0.00%	0.00%	0.00%
Spring (03/21-06/20)	0.19%	0.06%	0.11%	0.02%
Summer (06/21-09/20)	0.40%	0.21%	0.24%	0.07%
Fall (09/21-12/20)	-0.16%	-0.03%	-0.01%	0.00%
Salem	–	–	–	–
Annual	-2.84%	-0.04%	0.25%	0.72%
Winter (12/21-03/20)	0.06%	0.12%	0.58%	-0.07%
Spring (03/21-06/20)	-13.10%	-3.31%	-1.10%	1.09%
Summer (06/21-09/20)	-0.51%	1.52%	-0.30%	1.18%
Fall (09/21-12/20)	3.19%	2.14%	1.17%	1.54%
Vida	–	–	–	–
Annual	-1.67%	-0.02%	0.19%	0.83%
Winter (12/21-03/20)	-0.01%	-0.02%	-0.05%	0.08%
Spring (03/21-06/20)	-9.64%	-3.12%	-2.04%	1.41%
Summer (06/21-09/20)	3.92%	3.01%	2.19%	0.82%
Fall (09/21-12/20)	2.25%	1.56%	1.64%	1.12%
Waterloo	–	–	–	–

Alternative 1 Average Daily Flows Summary	–	–	–	–
Annual	-7.55%	-0.07%	0.13%	1.26%
Winter (12/21-03/20)	-2.11%	-0.22%	-0.40%	-0.21%
Spring (03/21-06/20)	-19.33%	-2.53%	4.28%	3.64%
Summer (06/21-09/20)	-29.19%	-21.64%	-25.52%	-21.06%
Fall (09/21-12/20)	7.34%	8.45%	6.74%	6.44%

Table 4-2.Riverine Flow Uncertainty Statistics - Alternative 2A

Alternative 2A Average Daily Flows Summary	–	–	–	–
Control Point (gage) and Season	25% Non-exceedance (Dry Year)	Average	Median	75% Non-exceedance (Wet Year)
Albany	–	–	–	–
Annual	-2.20%	-0.1%	0.14%	0.73%
Winter (12/21-03/20)	-0.07%	0.13%	0.61%	0.34%
Spring (03/21-06/20)	-11.69%	-3.30%	-1.58%	0.70%
Summer (06/21-09/20)	-2.53%	-0.70%	-3.00%	-2.14%
Fall (09/21-12/20)	5.85%	3.07%	2.39%	2.28%
Eugene	–	–	–	–
Annual	-3.78%	-0.03%	0.08%	1.46%
Winter (12/21-03/20)	-2.07%	0.33%	1.54%	1.72%
Spring (03/21-06/20)	-21.06%	-6.32%	-6.82%	0.67%
Summer (06/21-09/20)	-1.69%	-1.72%	-4.06%	-3.68%

Alternative 2A Average Daily Flows Summary	–	–	–	–
Fall (09/21-12/20)	8.88%	5.17%	5.35%	3.51%
Goshen	–	–	–	–
Annual	-3.18%	-0.02%	0.03%	0.50%
Winter (12/21-03/20)	-0.03%	-0.02%	0.06%	-0.08%
Spring (03/21-06/20)	-17.04%	-2.24%	-1.23%	2.53%
Summer (06/21-09/20)	-0.24%	0.11%	-2.82%	0.29%
Fall (09/21-12/20)	6.64%	1.83%	1.53%	0.14%
Harrisburg	–	–	–	–
Annual	-2.68%	-0.02%	0.24%	0.80%
Winter (12/21-03/20)	-0.72%	0.17%	0.61%	0.44%
Spring (03/21-06/20)	-13.46%	-3.84%	-1.88%	1.02%
Summer (06/21-09/20)	-1.55%	-0.89%	-3.02%	-2.22%
Fall (09/21-12/20)	6.38%	3.67%	3.30%	2.18%
Jasper	–	–	–	–
Annual	-3.26%	-0.03%	-0.34%	0.91%
Winter (12/21-03/20)	-3.59%	0.51%	1.27%	1.77%
Spring (03/21-06/20)	-20.83%	-7.71%	-12.61%	-0.98%
Summer (06/21-09/20)	-0.72%	-1.98%	-4.30%	-5.39%
Fall (09/21-12/20)	10.54%	6.22%	9.22%	4.08%
Jefferson	–	–	–	–
Annual	0.04%	0.03%	-0.36%	-1.28%
Winter (12/21-03/20)	-9.90%	-6.20%	-9.65%	-8.13%

Alternative 2A Average Daily Flows Summary	–	–	–	–
Spring (03/21-06/20)	-2.64%	-0.75%	0.26%	0.90%
Summer (06/21-09/20)	22.83%	22.00%	25.87%	24.19%
Fall (09/21-12/20)	4.81%	3.42%	3.13%	0.88%
Mehama	–	–	–	–
Annual	-1.54%	0.01%	-0.45%	0.70%
Winter (12/21-03/20)	-1.42%	-0.50%	-1.00%	0.04%
Spring (03/21-06/20)	-4.95%	-1.12%	-1.92%	0.98%
Summer (06/21-09/20)	8.56%	5.63%	8.90%	4.17%
Fall (09/21-12/20)	-3.85%	-0.45%	-2.24%	0.18%
Monroe	–	–	–	–
Annual	-0.03%	0.00%	0.01%	0.00%
Winter (12/21-03/20)	0.00%	0.00%	0.00%	0.00%
Spring (03/21-06/20)	0.19%	0.06%	0.11%	0.02%
Summer (06/21-09/20)	0.42%	0.22%	0.25%	0.08%
Fall (09/21-12/20)	-0.16%	-0.03%	-0.01%	0.00%
Salem	–	–	–	–
Annual	-1.63%	-0.01%	-0.13%	-0.04%
Winter (12/21-03/20)	-2.58%	-1.86%	-2.66%	-2.77%
Spring (03/21-06/20)	-9.31%	-2.34%	-0.75%	0.59%
Summer (06/21-09/20)	4.08%	5.74%	5.51%	5.84%
Fall (09/21-12/20)	5.33%	3.15%	2.17%	2.17%
Vida	–	–	–	–

Alternative 2A Average Daily Flows Summary	–	–	–	–
Annual	-1.19%	-0.01%	0.01%	0.43%
Winter (12/21-03/20)	-0.05%	0.00%	0.14%	-0.01%
Spring (03/21-06/20)	-7.43%	-2.20%	-1.32%	1.13%
Summer (06/21-09/20)	0.09%	-0.13%	-1.19%	-1.70%
Fall (09/21-12/20)	4.71%	2.48%	2.25%	1.41%
Waterloo	–	–	–	–
Annual	4.65%	0.06%	-0.58%	-3.67%
Winter (12/21-03/20)	-25.41%	-15.98%	-28.20%	-21.42%
Spring (03/21-06/20)	2.01%	-0.45%	4.99%	1.32%
Summer (06/21-09/20)	34.49%	37.75%	42.79%	49.55%
Fall (09/21-12/20)	18.89%	8.59%	9.44%	1.94%

Table 4-3.Riverine Flow Uncertainty Statistics - Alternative 2B

Alternative 2B Average Daily Flows Summary	–	–	–	–
Control Point (gage) and Season	25% Non-exceedance (Dry Year)	Average	Median	75% Non-exceedance (Wet Year)
Albany	–	–	–	–
Annual	-1.71%	0.00%	0.37%	0.73%
Winter (12/21-03/20)	1.38%	1.27%	1.98%	0.34%
Spring (03/21-06/20)	-6.72%	0.28%	3.33%	0.70%
Summer (06/21-09/20)	-3.57%	-3.01%	-4.41%	-2.14%

Alternative 2B Average Daily Flows Summary	–	–	–	–
Fall (09/21-12/20)	0.62%	-1.15%	-2.70%	2.28%
Eugene	–	–	–	–
Annual	-3.20%	-0.01%	0.13%	1.46%
Winter (12/21-03/20)	-1.32%	0.41%	0.70%	1.72%
Spring (03/21-06/20)	-20.50%	-6.14%	6.22%	0.67%
Summer (06/21-09/20)	4.10%	4.31%	4.78%	-3.68%
Fall (09/21-12/20)	6.24%	2.53%	2.04%	3.51%
Goshen	–	–	–	–
Annual	-3.19%	-0.01%	-0.03%	0.50%
Winter (12/21-03/20)	-0.05%	-0.07%	-0.08%	-0.08%
Spring (03/21-06/20)	-17.14%	-2.27%	-1.31%	2.53%
Summer (06/21-09/20)	2.78%	1.88%	0.39%	0.29%
Fall (09/21-12/20)	5.63%	1.67%	0.95%	0.14%
Harrisburg	–	–	–	–
Annual	-2.41%	0.0%	0.54%	0.80%
Winter (12/21-03/20)	1.34%	1.83%	2.51%	0.44%
Spring (03/21-06/20)	-8.38%	0.29%	3.71%	1.02%
Summer (06/21-09/20)	-2.80%	-3.29%	-4.44%	-2.22%
Fall (09/21-12/20)	-0.17%	-1.43%	-2.52%	2.18%
Jasper	–	–	–	–
Annual	-3.10%	-0.02%	-0.05%	0.91%
Winter (12/21-03/20)	-2.64%	0.67%	1.09%	1.77%

Alternative 2B Average Daily Flows Summary	–	–	–	–
Spring (03/21-06/20)	-20.00%	-7.46%	-12.20%	-0.98%
Summer (06/21-09/20)	5.31%	4.51%	5.35%	-5.39%
Fall (09/21-12/20)	5.59%	2.78%	4.92%	4.08%
Jefferson	–	–	–	–
Annual	0.02%	0.03%	-0.38%	-1.28%
Winter (12/21-03/20)	-9.92%	-6.18%	-9.68%	-8.13%
Spring (03/21-06/20)	-2.70%	-0.79%	0.26%	0.90%
Summer (06/21-09/20)	22.83%	22.00%	25.86%	24.19%
Fall (09/21-12/20)	4.83%	3.44%	3.11%	0.88%
Mehama	–	–	–	–
Annual	-1.59%	0.02%	-0.43%	0.70%
Winter (12/21-03/20)	-1.42%	-0.46%	-.93%	0.04%
Spring (03/21-06/20)	-5.14%	-1.22%	-1.99%	0.98%
Summer (06/21-09/20)	8.56%	5.63%	8.90%	4.17%
Fall (09/21-12/20)	-3.83%	-0.41%	-2.21%	0.18%
Monroe	–	–	–	–
Annual	-0.03%	0.00%	0.01%	0.00%
Winter (12/21-03/20)	0.00%	0.00%	0.00%	0.00%
Spring (03/21-06/20)	0.19%	0.06%	0.11%	0.02%
Summer (06/21-09/20)	0.42%	0.22%	0.25%	0.08%
Fall (09/21-12/20)	-0.16%	-0.03%	-0.01%	0.00%
Salem	–	–	–	–

Alternative 2B Average Daily Flows Summary	**–**	**–**	**–**	**–**
Annual	-1.35%	-0.01%	-0.05%	-0.04%
Winter (12/21-03/20)	-1.60%	-1.21%	-2.22%	-2.77%
Spring (03/21-06/20)	-6.20%	-0.12%	-2.52%	0.59%
Summer (06/21-09/20)	3.07%	4.12%	4.54%	5.84%
Fall (09/21-12/20)	2.10%	0.66%	-0.79%	2.17%
Vida	**–**	**–**	**–**	**–**
Annual	-1.69%	-0.01%	0.06%	0.43%
Winter (12/21-03/20)	6.11%	0.00%	4.44%	-0.01%
Spring (03/21-06/20)	-4.37%	-2.20%	11.68%	1.13%
Summer (06/21-09/20)	-12.02%	-0.13%	-11.72%	-1.70%
Fall (09/21-12/20)	-9.96%	2.48%	-10.61%	1.41%
Waterloo	**–**	**–**	**–**	**–**
Annual	4.65%	0.06%	-0.58%	-3.67%
Winter (12/21-03/20)	-25.41%	-15.99%	-28.21%	-21.42%
Spring (03/21-06/20)	2.01%	-0.45%	4.99%	1.32%
Summer (06/21-09/20)	34.49%	37.75%	42.79%	49.55%
Fall (09/21-12/20)	18.89%	8.59%	9.44%	1.94%

Table 4-4.Riverine Flow Uncertainty Statistics - Alternative 3A

Alternative 3A Average Daily Flows Summary	–	–	–	–
Control Point (gage) and Season	25% Non-exceedance (Dry Year)	Average	Median	75% Non-exceedance (Wet Year)
Albany	–	–	–	–
Annual	-4.17%	0.00%	1.53%	1.95%
Winter (12/21-03/20)	4.27%	3.75%	5.88%	3.62%
Spring (03/21-06/20)	1.05%	7.25%	13.29%	13.48%
Summer (06/21-09/20)	-15.24%	-12.88%	-13.24%	-11.81%
Fall (09/21-12/20)	-15.98%	-7.87%	-9.52%	-5.92%
Eugene	–	–	–	–
Annual	-4.76%	0.00%	2.85%	3.97%
Winter (12/21-03/20)	8.07%	7.06%	13.55%	8.88%
Spring (03/21-06/20)	3.17%	13.84%	21.41%	26.44%
Summer (06/21-09/20)	-13.72%	-21.19%	-20.68%	-26.33%
Fall (09/21-12/20)	-20.47%	-11.06%	-12.12%	-6.56%
Goshen	–	–	–	–
Annual	-2.25%	0.00%	0.21%	0.30%
Winter (12/21-03/20)	0.15%	0.03%	0.14%	-0.13%
Spring (03/21-06/20)	-17.70%	-2.34%	-1.56%	2.78%
Summer (06/21-09/20)	27.33%	13.03%	20.32%	5.07%
Fall (09/21-12/20)	0.89%	-0.44%	-2.50%	-1.41%
Harrisburg	–	–	–	–
Annual	-4.61%	0.00%	1.71%	2.57%

Alternative 3A Average Daily Flows Summary	**–**	**–**	**–**	**–**
Winter (12/21-03/20)	6.14%	5.42%	8.49%	6.26%
Spring (03/21-06/20)	0.44%	8.36%	14.90%	15.94%
Summer (06/21-09/20)	-13.87%	-13.77%	-13.88%	-14.20%
Fall (09/21-12/20)	-18.14%	-9.53%	-11.65%	-7.45%
Jasper	–	–	–	–
Annual	-4.19%	0.00%	1.85%	5.04%
Winter (12/21-03/20)	11.00%	11.06%	17.80%	16.58%
Spring (03/21-06/20)	9.84%	19.33%	24.11%	34.24%
Summer (06/21-09/20)	-16.06%	-25.07%	-24.36%	-30.55%
Fall (09/21-12/20)	-22.21%	-14.43%	-15.43%	-10.42%
Jefferson	–	–	–	–
Annual	-1.60%	0.05%	-1.28%	0.13%
Winter (12/21-03/20)	0.08%	-0.60%	-4.36%	-3.27%
Spring (03/21-06/20)	11.18%	10.44%	15.41%	14.20%
Summer (06/21-09/20)	-7.31%	-0.31%	3.01%	9.65%
Fall (09/21-12/20)	-13.75%	-7.64%	-12.38%	-7.87%
Mehama	–	–	–	–
Annual	-5.35%	0.08%	-1.71%	4.41%
Winter (12/21-03/20)	21.85%	14.56%	13.28%	13.95%
Spring (03/21-06/20)	22.57%	22.39%	29.11%	29.74%
Summer (06/21-09/20)	-38.78%	-28.63%	-28.84%	-14.81%

Alternative 3A Average Daily Flows Summary	–	–	–	–
Fall (09/21-12/20)	-40.38%	-24.68%	-31.89%	-20.23%
Monroe	–	–	–	–
Annual	-0.03%	0.00%	0.01%	0.00%
Winter (12/21-03/20)	0.00%	0.00%	0.00%	0.00%
Spring (03/21-06/20)	0.19%	0.06%	0.11%	0.02%
Summer (06/21-09/20)	0.42%	0.22%	0.25%	0.08%
Fall (09/21-12/20)	-0.16%	-0.03%	-0.01%	0.00%
Salem	–	–	–	–
Annual	-3.24%	-0.01%	-0.85%	1.11%
Winter (12/21-03/20)	2.79%	1.83%	1.83%	0.95%
Spring (03/21-06/20)	3.71%	8.12%	14.45%	12.73%
Summer (06/21-09/20)	-13.55%	-8.98%	-8.22%	-5.07%
Fall (09/21-12/20)	-14.44%	-7.35%	-9.39%	-6.38%
Vida	–	–	–	–
Annual	-3.38%	0.00%	-0.71%	0.95%
Winter (12/21-03/20)	6.67%	7.14%	7.04%	8.49%
Spring (03/21-06/20)	-0.14%	4.60%	7.74%	8.95%
Summer (06/21-09/20)	-8.29%	-5.88%	-6.12%	-4.80%
Fall (09/21-12/20)	-15.14%	-10.30%	-15.61%	-12.93%
Waterloo	–	–	–	–
Annual	4.68%	0.06%	-0.58%	-3.56%
Winter (12/21-03/20)	-25.25%	-15.99%	-28.24%	-21.25%

Alternative 3A Average Daily Flows Summary	–	–	–	–
Spring (03/21-06/20)	1.99%	-0.45%	5.02%	1.32%
Summer (06/21-09/20)	34.48%	37.75%	42.79%	49.56%
Fall (09/21-12/20)	18.84%	8.59%	9.44%	2.07%

Table 4-5.Riverine Flow Uncertainty Statistics - Alternative 3B

Alternative 3B Average Daily Flows Summary	–	–	–	–
Control Point (gage) and Season	25% Non-exceedance (Dry Year)	Average	Median	75% Non-exceedance (Wet Year)
Albany	–	–	–	–
Annual	-4.77%	0.02%	0.63%	2.18%
Winter (12/21-03/20)	-1.55%	1.86%	2.56%	2.57%
Spring (03/21-06/20)	-1.64%	5.37%	9.87%	10.57%
Summer (06/21-09/20)	-6.07%	-4.80%	-7.04%	-2.52%
Fall (09/21-12/20)	-12.40%	-6.07%	-7.51%	-3.91%
Eugene	–	–	–	–
Annual	-8.91%	0.04%	-0.44%	4.75%
Winter (12/21-03/20)	-13.82%	-0.33	-2.48%	4.51%
Spring (03/21-06/20)	-12.06%	3.30%	4.84%	11.92%
Summer (06/21-09/20)	7.88%	6.75%	7.18%	9.01%
Fall (09/21-12/20)	-10.63%	-4.78%	-5.44%	-1.35%
Goshen	–	–	–	–
Annual	-2.59%	-0.01%	-0.33%	0.48%

Alternative 3B Average Daily Flows Summary	**–**	**–**	**–**	**–**
Winter (12/21-03/20)	-1.52$	-0.36%	-0.94%	0.06%
Spring (03/21-06/20)	-18.29%	-2.41%	-1.39%	2.68%
Summer (06/21-09/20)	7.98%	5.22%	8.35%	3.43%
Fall (09/21-12/20)	10.35%	1.70%	-0.23%	-0.77%
Harrisburg	–	–	–	–
Annual	-5.63%	0.02%	0.35%	2.95%
Winter (12/21-03/20)	-2.11%	2.78%	2.72%	5.01%
Spring (03/21-06/20)	-2.26%	6.24%	11.09%	12.46%
Summer (06/21-09/20)	-5.49%	-5.14%	-6.28%	-3.12%
Fall (09/21-12/20)	-14.16%	-7.45%	-9.32%	-5.53%
Jasper	–	–	–	–
Annual	-8.76%	0.06%	-2.06%	5.72%
Winter (12/21-03/20)	-18.29%	-0.21%	-7.72%	7.76%
Spring (03/21-06/20)	-9.57%	5.29%	3.59%	15.59%
Summer (06/21-09/20)	8.80%	6.84%	8.05%	9.12%
Fall (09/21-12/20)	-10.98%	-6.93%	-6.28%	-4.37%
Jefferson	–	–	–	–
Annual	0.90%	0.01%	0.02%	0.23%
Winter (12/21-03/20)	6.66%	1.26%	-0.73%	-1.11%
Spring (03/21-06/20)	11.30%	6.49%	13.45%	8.47%
Summer (06/21-09/20)	-9.00%	0.43%	4.36%	10.38%

Alternative 3B Average Daily Flows Summary	–	–	–	–
Fall (09/21-12/20)	-11.97%	-7.17%	-11.30%	-6.25%
Mehama	–	–	–	–
Annual	2.32%	0.00%	-3.12%	-1.15%
Winter (12/21-03/20)	-9.87%	-9.02%	-16.98%	-12.64%
Spring (03/21-06/20)	-6.13%	-2.43%	-3.29%	-1.39%
Summer (06/21-09/20)	23.10%	23.25%	26.21%	29.23%
Fall (09/21-12/20)	10.88%	3.77%	-0.28%	3.06%
Monroe	–	–	–	–
Annual	-0.03%	0.00%	0.01%	0.00%
Winter (12/21-03/20)	0.00%	0.00%	0.00%	0.00%
Spring (03/21-06/20)	0.19%	0.06%	0.11%	0.02%
Summer (06/21-09/20)	0.42%	0.22%	0.25%	0.08%
Fall (09/21-12/20)	-0.16%	-0.03%	-0.01%	0.00%
Salem	–	–	–	–
Annual	-2.81%	0.00%	0.39%	1.16%
Winter (12/21-03/20)	1.04%	1.31%	0.90%	1.05%
Spring (03/21-06/20)	2.13%	5.61%	11.06%	8.97%
Summer (06/21-09/20)	-7.34%	-3.13%	-3.20%	1.41%
Fall (09/21-12/20)	-11.64%	-6.12%	-8.54%	-5.03%
Vida	–	–	–	–
Annual	-2.46%	0.04%	0.25%	2.27%
Winter (12/21-03/20)	11.53%	10.22%	10.69%	12.26%

Alternative 3B Average Daily Flows Summary	–	–	–	–
Spring (03/21-06/20)	9.24%	11.34%	16.84%	17.03%
Summer (06/21-09/20)	-19.83%	-17.46%	-17.78%	-16.64%
Fall (09/21-12/20)	-19.34%	-14.27%	-18.28%	-14.09%
Waterloo	–	–	–	–
Annual	-0.29%	0.05%	6.41%	2.95%
Winter (12/21-03/20)	33.43%	13.09%	20.20%	12.41%
Spring (03/21-06/20)	38.92%	19.65%	46.97%	23.52%
Summer (06/21-09/20)	-45.37%	-30.20%	-23.74%	-10.97%
Fall (09/21-12/20)	-40.67%	-21.90%	-25.46%	-19.40%

Table 4-6.Riverine Flow Uncertainty Statistics - Alternative 4

Alternative 4 Average Daily Flows Summary	–	–	–	–
Control Point (gage) and Season	25% Non-exceedance (Dry Year)	Average	Median	75% Non-exceedance (Wet Year)
Albany	–	–	–	–
Annual	-2.09%	-0.01%	0.15%	0.66%
Winter (12/21-03/20)	-0.03%	0.11%	0.66%	0.23%
Spring (03/21-06/20)	-11.70%	-3.32%	-1.94%	0.86%
Summer (06/21-09/20)	-2.50%	-0.71%	-2.95%	-2.27%
Fall (09/21-12/20)	6.26%	3.12%	2.67%	2.09%
Eugene	–	–	–	–
Annual	-3.56%	-0.03%	0.38%	1.24%

Alternative 4 Average Daily Flows Summary	**–**	**–**	**–**	**–**
Winter (12/21-03/20)	-167%	0.30%	1.82%	1.17%
Spring (03/21-06/20)	-21.09%	-6.35%	-7.16%	1.20%
Summer (06/21-09/20)	-1.59%	-1.77%	-4.04%	-4.28%
Fall (09/21-12/20)	9.22%	5.25%	6.26%	3.32%
Goshen	**–**	**–**	**–**	**–**
Annual	-2.14%	-0.02%	0.35%	0.18%
Winter (12/21-03/20)	-0.51%	-0.17%	-0.24%	0.11%
Spring (03/21-06/20)	-16.89%	-2.26%	-1.25%	2.44%
Summer (06/21-09/20)	1.62%	1.36%	-0.88%	1.99%
Fall (09/21-12/20)	11.23%	1.90%	2.89%	-1.57%
Harrisburg	**–**	**–**	**–**	**–**
Annual	-2.55%`	-0.02%	0.28%	0.58%
Winter (12/21-03/20)	-0.62%	0.15%	0.65%	0.08%
Spring (03/21-06/20)	-13.41%	-3.86%	-2.27%	1.12%
Summer (06/21-09/20)	-1.48%	-0.92%	-2.96%	-2.39%
Fall (09/21-12/20)	6.68%	3.73%	3.72%	1.87%
Jasper	**–**	**–**	**–**	**–**
Annual	-2.86%	-0.04%	-0.46%	1.01%
Winter (12/21-03/20)	-2.84%	0.55%	1.61%	1.89%
Spring (03/21-06/20)	-20.85%	-7.75%	-12.94%	-0.50%
Summer (06/21-09/20)	-0.88%	-2.18%	-4.52%	-5.95%

Alternative 4 Average Daily Flows Summary	–	–	–	–
Fall (09/21-12/20)	11.34%	6.30%	8.89%	4.17%
Jefferson	–	–	–	–
Annual	-70%	0.00%	0.31%	0.64%
Winter (12/21-03/20)	-0.51%	-0.27%	-0.13%	0.25%
Spring (03/21-06/20)	-2.65%	-0.50%	0.80%	0.99%
Summer (06/21-09/20)	19.23%	15.28%	18.88%	14.75%
Fall (09/21-12/20)	-7.39%	-3.06%	-4.80%	-2.01%
Mehama	–	–	–	–
Annual	-1.51%	0.01%	-0.23%	0.68%
Winter (12/21-03/20)	-1.12%	-0.43%	-0.86%	0.08%
Spring (03/21-06/20)	-5.15%	-1.15%	-1.97%	0.93%
Summer (06/21-09/20)	8.56%	5.63%	8.87%	4.17%
Fall (09/21-12/20)	-3.84%	-0.51%	-1.63%	0.11%
Monroe	–	–	–	–
Annual	-0.03%	0.00%	0.01%	0.00%
Winter (12/21-03/20)	0.00%	0.00%	0.00%	0.00%
Spring (03/21-06/20)	0.19%	0.06%	0.11%	0.02%
Summer (06/21-09/20)	0.42%	0.22%	0.25%	0.08%
Fall (09/21-12/20)	-0.16%	-0.03%	-0.01%	0.00%
Salem	–	–	–	–
Annual	-1.74%	-0.01%	0.37%	0.50%
Winter (12/21-03/20)	0.00%	0.00%	0.60%	-0.05%

Alternative 4 Average Daily Flows Summary	–	–	–	–
Spring (03/21-06/20)	-9.26%	-2.27%	-0.65%	0.76%
Summer (06/21-09/20)	3.55%	4.01%	3.78%	3.18%
Fall (09/21-12/20)	1.29%	0.71%	-0.31%	0.43%
Vida	–	–	–	–
Annual	-1.16%	-0.01%	0.02%	0.46%
Winter (12/21-03/20)	0.02%	0.00%	0.10%	-0.02%
Spring (03/21-06/20)	-7.42%	-2.22%	-1.32%	1.16%
Summer (06/21-09/20)	0.11%	-0.17%	-1.30%	-1.81%
Fall (09/21-12/20)	4.76%	2.53%	2.39%	1.58%
Waterloo	–	–	–	–
Annual	1.22%	-0.01%	2.01%	0.29%
Winter (12/21-03/20)	-0.36%	-0.32%	-0.21%	-0.40%
Spring (03/21-06/20)	2.50%	0.22%	6.35%	1.57%
Summer (06/21-09/20)	28.79%	23.52%	29.14%	27.27%
Fall (09/21-12/20)	-13.20%	-6.82%	-8.10%	-5.90%

Note: N.E. = non-exceedance.

Note: NE = non-exceedance

Each of the values in Table 4-1 through Table 4-6 was calculated using an average flow from the No Action Alternative and a flow from the corresponding gage/season/alternative. For example, the average annual No Action Alternative flow for the Waterloo gage at the 25th percentile is 1,605.9 cubic feet per second (cfs) and 1,681.0 cfs for Alternative 3A. This equates to a change of +4.68% for Alternative 1 compared to the No Action Alternative as is shown in Table 4-1 in the Waterloo-Annual-25% N.E. cell. The abbreviation “N.E.” is short for “non-exceedance”. The 25% non-exceedance probability means that there is a 25% chance that the value will not be exceeded in a given year and a 75% chance that it will be exceeded.

CHAPTER 5 - RECREATION EFFECTS – REGIONAL ECONOMIC DEVELOPMENT

5.1 ASSUMPTIONS AND METHODOLOGY

Using the NED methodology and spatial framework of evaluating impacts to lake-borne activities, the PDT is able to reasonably ascertain how the impacts from reservoir elevation will translate into a loss (or gain) in user occasions at any given Project site. The loss or gain in participation will translate into a dollar total that will then produce a multiplier. This multiplier is defined as "A factor that quantifies the change in total economic activity as compared to the injection of capital investments or revenues." This resulting output produced by the multiplier will typically manifest as economic contributions spurred on by economic activity (output, labor income, value added, and employment) associated with the new or already occurring economic conditions and resulting stimulus to an economy.

To accomplish the evaluation, visitation numbers, produced in the NED analysis were input in the USACE Regional Economic System (RECONS), developed by the USACE Institute for Water Resources (IWR). RECONS estimates the regional economic impacts of USACE direct investment spending and annual project and program expenditures across eight Civil Works (CW) program budget business lines. These activities and expenditures support economic output, jobs, earnings, and value added.

For the purposes of this Regional Economic analysis, the value of the Regional output is predicated on the average visitation. The multiplier effect associated with results of the uncertainty analysis do not produce significant variance from the average value of site visitation.

5.2 RESULTS BY ALTERNATIVE

Table 5-1. Average Regional Economic Output, No Action Alternative

No Action	Average Annual Visits (1,000s)	Change in Average Annual Visits from No Action (1,000s)	Total Full Time Employment with Alternative[1]	Change in Full Time Employment from No Action with this Alternative	Regional Economic Value Added with this Alternative ($1,000s)	Total Regional Economic Value Added with Alternative ($1,000)[2]	Percent Change in Regional Value Added by this Alternative
Detroit	139	0	33.4	0	$2,169	$2,169	0%
Foster	472	0	147.2	0	$8,808	$8,808	0%
Green Peter	175	0	47.4	0	$2,597	$2,597	0%
Cougar	43	0	0	0	$0	$0	0%
Blue River	19	0	4.8	0	$300	$300	0%
Lookout Point	89	0	30.6	0	$2,034	$2,034	0%
Hills Creek	25	0	6.6	0	$451	$451	0%
Dexter	259	0	82	0	$5,429	$5,429	0%
Fall Creek	205	0	74.9	0	$4,996	$4,996	0%
Dorena	178	0	64.7	0	$4,196	$4,196	0%
Cottage Grove	307	0	60.6	0	$3,882	$3,882	0%
Fern Ridge	801	0	262.6	0	$3	$3	0%
–	–	–	–	–	–	–	–
Total	**2,712**	**0**	**814.8**	**0**	**$34,865**	**$34,865**	**0.0%**

[1]Full Time Employment with Alternative is the full-time employment in place under the No Action Alternative plus the incremental employment as a result of implementing the alternative

[2]The Total Regional Economic Value Added with Alternative is the No Action Alternative economic value added plus the incremental economic value added by the alternative

Note: Full Time Employment is shown as "Full Time Equivalence" (FTE) units. (1 FTE = 40 hours/week of labor annually)

Table 5-2. Average Regional Economic Output, Alternative 1

Alternative 1	Average Annual Visits (1,000s)	Change in Average Annual Visits from No Action (1,000s)	Total Full Time Employment with Alternative[1]	Change in Full Time Employment from No Action with this Alternative	Regional Economic Value Added with this Alternative ($1,000s)	Total Regional Economic Value Added with Alternative ($1,000)[2]	Percent Change in Regional Value Added by this Alternative
Detroit	146	7	35.2	1.8	$114	$2,283	5.3%
Foster	474	2	147.7	0.5	$30	$8,838	0.3%
Green Peter	178	3	48.2	0.8	$45	$2,642	1.7%
Cougar	46	3	0	0	$0	$0	0.0%
Blue River	20	1	5	0.2	$12	$311	3.9%
Lookout Point	87	-2	29.9	-0.7	-$46	$1,988	-2.3%
Hills Creek	28	3	7.4	0.8	$55	$506	12.3%
Dexter	259	0	82	0	$0	$5,429	0.0%
Fall Creek	208	3	76	1.1	$70	$5,066	1.4%
Dorena	190	13	69.3	4.6	$301	$4,497	7.2%
Cottage Grove	314	7	62.9	2.3	$145	$4,027	3.7%
Fern Ridge	801	0.0	262.5	-0.1	-$3	$0	0.0%
–	–	–	–	–	–	–	–
Total	**2,751**	**40**	**826.1**	**11.3**	**$724**	**$35,589**	**2.1%**

[1]Full Time Employment with Alternative is the full-time employment in place under the No Action Alternative plus the incremental employment as a result of implementing the alternative

[2]The Total Regional Economic Value Added with Alternative is the No Action Alternative economic value added plus the incremental economic value added by the alternative

Note: Full Time Employment is shown as "Full Time Equivalence" (FTE) units. (1 FTE = 40 hours/week of labor annually)

Table 5-3. Average Regional Economic Output, Alternative 2A

Alternative 2A	Average Annual Visits (1,000s)	Change in Average Annual Visits from No Action (1,000s)	Total Full Time Employment with Alternative[1]	Change in Full Time Employment from No Action with this Alternative	Regional Economic Value Added with this Alternative ($1,000s)	Total Regional Economic Value Added with Alternative ($1,000)[2]	Percent Change in Regional Value Added by this Alternative
Detroit	138	-1	33.1	-0.3	-$20	$2,149	-0.9%
Foster	474	2	147.7	0.5	$30	$8,838	0.3%
Green Peter	169	-6	45.7	-1.7	-$91	$2,506	-3.5%
Cougar	46	3	0	0	$0	$0	0.0%
Blue River	20	1	5	0.2	$12	$312	4.1%
Lookout Point	89	-1	30.4	-0.2	-$12	$2,023	-0.6%
Hills Creek	29	3	7.5	0.9	$59	$510	13.1%
Dexter	259	0	82	0	$0	$5,429	0.0%
Fall Creek	209	4	76.2	1.3	$88	$5,084	1.8%
Dorena	187	9	69.3	4.6	$301	$4,497	7.2%
Cottage Grove	314	7	62.9	2.3	$145	$4,027	3.7%
Fern Ridge	801	0	262.5	-0.1	-$3	$0	0.0%
–	–	–	–	–	–	–	–
Total	2,735	21	822.3	7.5	$511	$35,376	1.5%

[1]Full Time Employment with Alternative is the full-time employment in place under the No Action Alternative plus the incremental employment as a result of implementing the alternative

[2]The Total Regional Economic Value Added with Alternative is the No Action Alternative economic value added plus the incremental economic value added by the alternative

Note: Full Time Employment is shown as "Full Time Equivalence" (FTE) units. (1 FTE = 40 hours/week of labor annually)

Table 5-4. Average Regional Economic Output, Alternative 2B

Alternative 2B	Average Annual Visits (1,000s)	Change in Average Annual Visits from No Action (1,000s)	Total Full Time Employment with Alternative[1]	Change in Full Time Employment from No Action with this Alternative	Regional Economic Value Added with this Alternative ($1,000s)	Total Regional Economic Value Added with Alternative ($1,000)[2]	Percent Change in Regional Value Added by this Alternative
Detroit	138	-1	33.1	-0.3	-$20	$2,149	-0.9%
Foster	474	2	147.7	0.5	$30	$8,838	0.3%
Green Peter	169	-6	45.7	-1.7	-$91	$2,506	-3.5%
Cougar	26	-17	0	0	$0	$0	0.0%
Blue River	20	1	5	0.2	$11	$310	3.6%
Lookout Point	88	-1	30.1	-0.5	-$31	$2,003	-1.5%
Hills Creek	28	3	7.3	0.7	$46	$497	10.3%
Dexter	259	0	82	0	$0	$5,429	0.0%
Fall Creek	208	3	76.1	1.2	$82	$5,078	1.6%
Dorena	187	9	67.8	3.1	$199	$4,395	4.7%
Cottage Grove	313	6	62.7	2.1	$133	$4,015	3.4%
Fern Ridge	801	0	262.5	-0.1	-$3	$0	0.0%
–	–	–	–	–	–	–	–
Total	2,711	-1	820	5.2	$356	$35,221	1.0%

[1]Full Time Employment with Alternative is the full-time employment in place under the No Action Alternative plus the incremental employment as a result of implementing the alternative

[2]The Total Regional Economic Value Added with Alternative is the No Action Alternative economic value added plus the incremental economic value added by the alternative

Note: Full Time Employment is shown as "Full Time Equivalence" (FTE) units. (1 FTE = 40 hours/week of labor annually)

Table 5-5. Average Regional Economic Output, Alternative 3A

Alternative 3A	Average Annual Visits (1,000s)	Change in Average Annual Visits from No Action (1,000s)	Total Full Time Employment with Alternative[1]	Change in Full Time Employment from No Action with this Alternative	Regional Economic Value Added with this Alternative ($1,000s)	Total Regional Economic Value Added with Alternative ($1,000)[2]	Percent Change in Regional Value Added by this Alternative
Detroit	81	-58	19.4	-14	-$905	$1,264	-41.7%
Foster	474	2	147.7	0.5	$30	$8,838	0.3%
Green Peter	169	-6	45.7	-1.7	-$90	$2,507	-3.5%
Cougar	26	-17	0	0	$0	$0	0.0%
Blue River	19	0	4.8	0	-$2	$297	-0.7%
Lookout Point	49	-40	16.9	-13.7	-$910	$1,124	-44.7%
Hills Creek	25	0	6.6	0	-$1	$450	-0.3%
Dexter	259	0	82	0	$0	$5,429	0.0%
Fall Creek	207	2	76.1	1.2	$66	$5,062	1.3%
Dorena	184	6	66.9	2.2	$198	$4,394	4.7%
Cottage Grove	309	2	61.2	0.6	$94	$3,976	2.4%
Fern Ridge	801	0	262.5	-0.1	-$3	$0	0.0%
–	–	–	–	–	–	–	–
Total	2,603	-109	789.8	-25	-$1,523	$33,342	-4.4%

[1]Full Time Employment with Alternative is the full-time employment in place under the No Action Alternative plus the incremental employment as a result of implementing the alternative

[2]The Total Regional Economic Value Added with Alternative is the No Action Alternative economic value added plus the incremental economic value added by the alternative

Note: Full Time Employment is shown as “Full Time Equivalence” (FTE) units. (1 FTE = 40 hours/week of labor annually)

Table 5-6. Average Regional Economic Output, Alternative 3B

Alternative 3B	Average Annual Visits (1,000s)	Change in Average Annual Visits from No Action (1,000s)	Total Full Time Employment with Alternative[1]	Change in Full Time Employment from No Action with this Alternative	Regional Economic Value Added with this Alternative ($1,000s)	Total Regional Economic Value Added with Alternative ($1,000)[2]	Percent Change in Regional Value Added by this Alternative
Detroit	132	-7	31.7	-1.7	-$113	$2,056	-5.2%
Foster	421	-51	131.2	-16	-$958	$7,850	-10.9%
Green Peter	82	-93	22.2	-25.2	-$1,383	$1,214	-53.3%
Cougar	26	-17	0	0	$0	$0	0.0%
Blue River	13	-6	3.2	-1.6	-$100	$199	-33.5%
Lookout Point	82	-7	28.1	-2.5	-$166	$1,869	-8.1%
Hills Creek	16	-9	4.3	-2.3	-$157	$294	-34.8%
Dexter	259	0	82	0	$0	$5,429	0.0%
Fall Creek	208	3	75.9	1	$66	$5,062	1.3%
Dorena	186	8	67.7	3	$198	$4,394	4.7%
Cottage Grove	312	5	62.1	1.5	$94	$3,976	2.4%
Fern Ridge	801	0	262.5	-0.1	-$3	$0	0.0%
–	–	–	–	–	–	–	–
Total	2,538	-174	770.9	-43.9	-$2,522	$32,343	-7.2%

[1]Full Time Employment with Alternative is the full-time employment in place under the No Action Alternative plus the incremental employment as a result of implementing the alternative

[2]The Total Regional Economic Value Added with Alternative is the No Action Alternative economic value added plus the incremental economic value added by the alternative

Note: Full Time Employment is shown as "Full Time Equivalence" (FTE) units. (1 FTE = 40 hours/week of labor annually)

Table 5-7. Average Regional Economic Output, Alternative 4

Alternative 4	Average Annual Visits (1,000s)	Change in Average Annual Visits from No Action (1,000s)	Total Full Time Employment with Alternative[1]	Change in Full Time Employment from No Action with this Alternative	Regional Economic Value Added with this Alternative ($1,000s)	Total Regional Economic Value Added with Alternative ($1,000)[2]	Percent Change in Regional Value Added by this Alternative
Detroit	138	-1	33.1	-0.3	-$20	$2,149	-0.9%
Foster	474	2	147.7	0.5	$30	$8,838	0.3%
Green Peter	169	-6	45.8	-1.6	-$88	$2,509	-3.4%
Cougar	46	3	0	0	$0	$0	0.0%
Blue River	13	-6	3.2	-1.6	-$100	$199	-33.5%
Lookout Point	89	0	30.5	-0.1	-$8	$2,026	-0.4%
Hills Creek	28	3	7.5	0.9	$59	$510	13.2%
Dexter	259	0	82	0	$0	$5,429	0.0%
Fall Creek	209	4	76.3	1.4	$95	$5,091	1.9%
Dorena	187	9	67.8	3.1	$202	$4,398	4.8%
Cottage Grove	313	6	62.7	2.1	$134	$4,016	3.5%
Fern Ridge	801	0	262.5	-0.1	-$3	$0	0.0%
–	–	–	–	–	–	–	–
Total	2,726	14	819.1	4.3	$302	$35,167	0.9%

[1]Full Time Employment with Alternative is the full-time employment in place under the No Action Alternative plus the incremental employment as a result of implementing the alternative

[2]The Total Regional Economic Value Added with Alternative is the No Action Alternative economic value added plus the incremental economic value added by the alternative

Note: Full Time Employment is shown as “Full Time Equivalence” (FTE) units. (1 FTE = 40 hours/week of labor annually)

US Army Corps
of Engineers ®
Portland District

WILLAMETTE VALLEY SYSTEM OPERATIONS AND MAINTENANCE

DRAFT PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT

APPENDIX L: COOPERATING AGENCIES

TABLE OF CONTENTS

1.1 CONFEDERATED TRIBES OF GRAND RONDE COMMUNITY OF OREGON

The Confederated Tribes of Grand Ronde Community of Oregon is one of nine federally recognized tribes in the state of Oregon and includes approximately 5,400 enrolled tribal members from over 30 tribes and bands from western Oregon, northern California, and southwest Washington. The entire WVS lies within the ceded lands of the 1855 treaties with the tribes and bands who were moved to the Grand Ronde reservation. The tribes' 11,500-acre reservation is in the Grand Ronde Valley at the western edge of the Willamette Valley in Yamhill County, Oregon. Members of the tribe also live in communities across the region. The Grand Ronde Natural Resources Department conducts surveys for threatened and endangered species that may occur on the Reservation and any other tribal trust properties. The Tribe is working with USACE to seek ways of improving fish habitat and populations in Reservation streams, in part for subsistence fishing purposes (CTGR 2020).

1.2 CONFEDERATED TRIBES OF WARM SPRINGS

The Confederated Tribes of Warm Springs is a federally recognized tribe and includes the Warm Springs, Wasco, and Paiute Native American Tribes. The tribes' 640,000-acre reservation is located primarily in Wasco and Jefferson Counties approximately 100 miles east of the Willamette River, and tribal members harvest Pacific lamprey at Willamette Falls (CTWS 2015). Tribal members worked with USACE to ensure that potential effects to lamprey were properly considered in the PEIS. Water quality, climate change, streamflow for fish and wildlife, and tribal cultural resources (including salmon and lamprey), as well as cumulative effects from other ongoing projects in the WRB were also discussed.

1.3 CONFEDERATED TRIBES OF SILETZ INDIANS

The Confederated Tribes of Siletz is a federally recognized tribe made up of a confederation of 30 bands, originating from Northern California to Southern Washington. The 3,666-acre reservation is located in Lincoln County, Oregon, approximately 50 miles west of the Willamette River. The Confederated Tribes rear coho salmon in the Lhuuke Illahee Tribal fish hatchery and maintain tribal fishing sites (CTSI 2022).

Pacific lamprey are collected by Tribal members a few times each year during the spring months at Willamette Falls on the Willamette River. The Siletz people's traditional harvest of Pacific lamprey used to occur mainly on the Siletz River, which is not a tributary of the Willamette River or in the WRB; however, local Pacific lamprey runs have become low or non-existent in some traditional areas. The Siletz have long been concerned with WVS effects on Pacific lamprey (CTSI 2022).

1.4 NATIONAL MARINE FISHERIES SERVICE AND U.S. FISH AND WILDLIFE SERVICE

The Services share responsibility for administering the ESA. Generally, NMFS manages marine and anadromous species, including salmon, and USFWS is responsible for administering the ESA for terrestrial and freshwater species. The Services work with other federal agencies, including USACE, to protect threatened and endangered species and their habitats.

Details regarding ESA history affecting the WVS and this PEIS are provided in PEIS Section 1.1.2 and PEIS Section 3.8.

1.5 U.S. BUREAU OF RECLAMATION

BOR holds water rights for conservation storage in the WVS and contracts with irrigators for portions of the water stored in the impoundments in the WVS for agricultural purposes. Of the approximately 1,590,000 acre-feet of conservation storage, about 83,000 acre-feet of stored water (approximately 5 percent of total conservation storage) is currently contracted by BOR for irrigation.

BOR markets the water stored by USACE in the WVS reservoirs for the purpose of supporting irrigation needs. Contracts are executed pursuant to Federal Reclamation law, in particular: §9(e) of the Reclamation Project Act of August 4, 1939 (53 Stat. 1187); §8 of the FCA of December 22, 1944 (58 Stat. 887, 891); the FCA of 1938 (52 Stat. 1222); and the FCA of 1950 (64 Stat. 170). Contracts are established between the contractor (user) and the BOR that specify the amount of stored water that the user may request be released from the reservoir. As of October 2022, there were 266 contracts, for a total of 82,815 acre-feet, 25 percent of the reservoir storage space allocated to irrigation in the WVS reservoirs. The 2008 NMFS BiOp placed a cap of 95,000 acre-feet of stored water available for irrigation, with no net increase to contracts in the Santiam Basin (USACE 2019a).

BOR worked closely with USACE to develop the draft PEIS to discern potential changes to its water marketing program under each alternative.

1.6 BONNEVILLE POWER ADMINISTRATION

The BPA is a nonprofit, federal, power marketing administration. It is part of the U.S. Department of Energy but is self-funded through sales of its products and services. BPA maintains more than 15,000 circuit miles of high-voltage transmissions line in Idaho, Oregon, Washington, western Montana, and small parts of surrounding areas.

BPA is the federal expert in determining the market value and cost-effectiveness of energy produced by the FCRPS, including energy generated at the Willamette Valley System dams. BPA markets electricity generated at the eight WVS hydroelectric dams (BPA 2019) and works closely with USACE to determine power generation capabilities in relation to reservoir operations. While USACE is ultimately responsible for O&M of the WVS, it operates this system in coordination with BPA and regional federal, state, and tribal agencies, as well as other partners through the Willamette Fish Passage Operations & Maintenance (WFPOM) coordination team.

1.7 UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

The Environmental Protection Agency (EPA) works to ensure that Americans have clean air, land, and water. The EPA worked with USACE throughout the development of the PEIS to ensure that potential effects were adequately addressed for water quality, geomorphology and hydrologic connectivity, air quality, climate, environmental justice, ecosystem services, and cumulative effects. The EPA is also responsible for administering Section 402 of the Clean Water Act (CWA) and has a role in Section 404 of the CWA, which was delegated by Congress to USACE to administer. EPA Region 10 provided input throughout the PEIS planning process and is responsible for review and comment of the draft PEIS.

1.8 OREGON DEPARTMENT OF AGRICULTURE

The Oregon Department of Agriculture (ODA) works to ensure the provision of healthy natural resources, environment, and economy through inspection and certification, regulation, and promotion of agriculture and food in the state (ODA, 2020).. ODA provided input on potential effects from decreased water storage capacity and the expected increase in irrigation withdrawals throughout the PEIS planning process, including during workshops to develop the proposed alternatives.

1.9 OREGON DEPARTMENT OF ENVIRONMENTAL QUALITY

The Oregon Department of Environmental Quality (DEQ) is involved in permitting; regulating; programming; providing technical assistance; and conducting other responsibilities related to air quality, water quality, solid and hazardous waste management, and other environmental issues (DEQ 2020). DEQ has worked with USACE to ensure effects to water quality including, but not limited to temperatures and TDG, are adequately covered in the PEIS. DEQ provided input throughout the PEIS planning process, including during workshops to develop the proposed alternatives.

1.10 OREGON DEPARTMENT OF FISH AND WILDLIFE

The mission of the Oregon Department of Fish and Wildlife (ODFW) is to protect and enhance Oregon’s fish and wildlife and their habitats for use and enjoyment by present and future generations (ODFW, 2020). As the primary fisheries co-managing agency in the WRB, ODFW coordinated with USACE, BPA, and BOR during the development of the 2007 Supplemental BA (USACE et al., 2007).

The ODFW and NMFS 2011 Upper Willamette Chinook and Steelhead Recovery Plan serves as both a federal recovery plan under the ESA and as a State of Oregon Conservation Plan under Oregon’s Native Fish Conservation Policy (ODFW and NMFS, 2011). ODFW also operates all facilities associated with the Willamette Hatchery mitigation program and collaborated with USACE in the development of Hatchery Genetic Management Plans (HGMPs), the standards and performance targets of which drive hatchery management goals.

Given the history of collaboration, coordination, and inherently intertwined work with USACE in the WRB, the ODFW provided input throughout the PEIS planning process, including during workshops to develop the proposed alternatives.

1.11 OREGON WATER RESOURCES DEPARTMENT

The Oregon Water Resources Department (OWRD) works to directly address Oregon's water supply needs and to restore and protect stream flows and watersheds in order to ensure the long-term sustainability of Oregon's ecosystems, economy, and quality of life (OWRD, 2020a). The State of Oregon considers water to be a public resource, and the OWRD issues water rights for the use of surface and groundwater sources (OWRD, 2020b).

USACE and the OWRD were the federal and non-federal sponsors, respectively, for the Willamette Basin Review (WBR) Feasibility Study (USACE, 2019a). The WBR study analyzed current water uses in the basin for the project purposes, and proposed a conservation storage reallocation for AI, M&I, and fish and wildlife (USACE, 2019a), which was authorized by Congress in WRDA 2020. Given the history of collaboration and coordination with USACE, OWRD provided input throughout the PEIS planning process, including during workshops to develop the proposed alternatives.

US Army Corps of Engineers®
Portland District

WILLAMETTE VALLEY SYSTEM OPERATIONS AND MAINTENANCE

DRAFT PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT

APPENDIX M: COSTS

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1 - INTRODUCTION

The purpose of the cost analysis is to provide an estimate of the total cost for implementing, operating, and maintaining the system under each of the Willamette Valley Environmental Impact Statement (WV EIS) alternatives. The emphasis of the cost analysis is to understand the cost difference between alternative, particularly between the proposed WV EIS action alternatives, Preferred Alternative (PA), and the No Action Alternative (NAA). Implementation costs include the costs of design construction of proposed structural measures under the action alternatives. All alternatives including the NAA have costs associated with operating and maintaining the Willamette Valley System (WVS) as well as costs that may change relative to the structural and/or operational measures included under an action alternative. These ongoing future costs include capital investments, routine and non-routine operations costs. Costs are focused on 13 Federal multiple purpose dams (projects) and reservoirs in the Willamette Valley System in Oregon.

The Preferred Alternative (aka Alternative 5) and Alternative 2b are essentially the same. The only difference is that the flow regime (measure 30) is slightly refined in Alternative 5. It has a negligible effect on hydrologic processes that is summarized in Chapter 5.

This cost appendix also presents annual costs over the 50-year period of analysis in 2021 dollars. The FY2022 Federal water resources discount rate of 2.25% (Corps, 2019) is used in the discounting process and to amortize the costs to annual-equivalent costs. The first of these economics tables is Table 3-2. It should be noted that the 50-year “period of analysis” is not always the same as the planning horizon. Costs for proposed projects are annualized over the period of analysis based on a standard "expected project life", which for new construction is commonly set at 50 years, though it can be as high as 100 years for full multi-purpose dam facilities. In a project justification context, the annual costs are used against the annual monetary benefits or non-monetary benefits, or a combination of monetary and non-monetary benefits to determine a benefit-cost ratio or most cost-effective plan. In contrast, the planning horizon is the amount of time the PDT can reasonably foresee effects into the future with regards to who/what may be affected by project alternatives.

CHAPTER 2 - OVERVIEW

USACE operations, cost engineering, budget, asset management, project-specific specialists, fish, and hydropower provided input to the cost appendix. The objective was to obtain the costs to operate the WVS under the NAA and how these costs would change under the WV EIS action alternatives. Costs are broken into the categories of capital (including construction), design and engineering during construction (EDC), and annual operations and maintenance (OMRRR) costs.

The costs to operate the system are funded through multiple mechanisms including federal tax dollars appropriated to cover system costs, as well as revenue generated through the marketing and sale of hydropower. The Corps receives annual Congressional appropriations to fund system capital, and operations and maintenance activities.

2.1 NO ACTION ALTERNATIVE

The No Action Alternative provides a baseline for understanding the costs associated with operating and maintaining the WVS. The No Action Alternative also provides a starting point for determining how costs will change as various structural or operational changes or both are made under action alternatives. Under the No Action Alternative, it was assumed the WVS would continue to be operated in a similar manner to current operations, balancing operations for congressionally authorized purposes across the WVS. Under the No Action Alternative, agencies will continue to maintain system infrastructure, while routine O&M costs would occur for hydropower, cultural resources, recreation, fish and wildlife, and other routine costs. The No Action Alternative was developed to provide an accounting of costs to operate and maintain the WVS.

2.2 CAPITAL/CONSTRUCTION COSTS

Cost estimates for each of the structural measures included in the action alternatives were developed by the cost engineers at the Portland District. Given the uncertainty associated with the planning level design for structural measures, an abbreviated risk analysis was performed with assistance from the Mandatory Center of Expertise in Cost Engineering at Walla Walla District to develop a contingency for each measure. Based on historic Corps cost engineering estimates, 44 percent of the construction and contingency cost was included to account for design, supervision, administration, and engineering during construction.

The structural measures only include measures that are unique additions under an action alternative. For example, under the No Action Alternative, the co-lead agencies will continue to invest in power-related capital improvements, additions, replacements, and fund O&M, as needed.

2.3 OPERATIONS AND MAINTENANCE COSTS

The Operations, Maintenance, Repair, Replacement and Rehabilitation (OMRRR) costs include costs to operate and maintain the projects. O&M costs have been estimated for each action alternative based upon the specific structural and operational measures included. An estimate of measure specific OMRRR costs were developed by operations and programs staff as well as PDT members, based upon their knowledge of system operations.

2.4 Risk and Uncertainty

There are multiple areas of risk and uncertainty related to the development of the cost analysis. Risk and uncertainty are inherent with any estimates that are developed and used for water resource planning. Much of the risk and uncertainty associated with modeling the costs stem from the assumptions that historic activities and costs would reflect cost estimates in the future. There are uncertainties in terms of the needs and timing of operations and maintenance, construction costs, and capital requirements. Future costs can also be affected by technological advancements and cost efficiencies although any future changes in technologies are speculative.

For this draft report, an abbreviated risk analysis was facilitated by the Walla Walla District Mandatory Center of Expertise for Cost Engineering. During the analysis, the Project Delivery Team discussed the level or project definition, status of the design, and various elements of project risk to establish high and low variance from the estimated project cost. Table 2-1 shows a summary of this risk assessment at the alternative level. This summary is the percent change in across all measures within the alternative. Uncertainty in cost estimations will be displayed in greater detail, such as by project and/or measure in the final EIS report. The values shown in Table 2-1 were used in the development of the economics table high and low estimates, such as Table 3-2 of this appendix.

Table 2-1.Estimated Variance in Capital and Design by Alternative

Alternative	Low-Cost Range	High-Cost Range
1	-32%	+59%
2a	-31%	+61%
2b	-32%	+69%
3a	-21%	+43%
3b	-20%	+68%
4	-33%	+63%

Due to a complex federal study approval and project appropriation process, the actual implementation timeframe for each alternative is uncertain. Assuming a shorter timeframe reduces the effect of discounting for costs that may not actually occur for several years, therefore increasing the annualized costs associated with the alternatives. The cost analysis presents annual costs over the 50-year period of analysis in 2021 dollars. For consistency in calculating interest during construction across alternatives, construction of the structural measures under each action alternative is assumed to occur over a two-year period.[6] Project first costs include construction costs, as well as contingency, supervision and administration, planningengineering and design, and engineering during construction.

CHAPTER 3 - Cost Estimates

3.1 CAPITAL AND OMRRR COST ESTIMATES

This section provides estimates of the capital costs, as well as operations, maintenance, repair, replacement, and rehabilitation (OMRRR) costs under the No Action Alternative and action alternatives.

3.2 No Action Alternative

The NAA includes some proposed funding increases in routine O&M activities at Detroit/Big Cliff, Foster, Cougar, Lookout Point/Dexter, and Fall Creek reservoirs. Measure numbers, descriptions of measure, and cost estimates for O&M by project under the NAA are as follows:

1. **Detroit/Big Cliff - $2,110,000**

   M714 - Use spillway to pass fish in spring - $0

   M721 - Use spillway for surface spill in summer – $10,000

   M722 - Adult Fish Facility Operation (Minto) – $658,000

   M719 - Implement hatchery transition plan - $1,442,000

2. **Foster - $2,459,000**

   M714 - Use spillway to pass fish in spring - $20,000

   M722 - Adult Fish Facility Operation – $339,000

   M719 - Implement hatchery transition plan - $2,100,000

3. **Cougar - $2,350,000**

   M722 - Adult Fish Facility Operation – $250,000

   M719 - Implement hatchery transition plan - $2,100,000

4. **Lookout Point/Dexter – $2,110,000**

   M721 - Use spillway for surface spill in summer – $10,000

   M714 - Use spillway to pass fish in spring - $0

   M719 - Implement hatchery transition plan - $2,100,000

5. **Fall Creek - $250,000**

   M166 - Use lowest ROs to discharge colder water during drawdown operations in fall and winter to reduce water temperatures below dams - $0

   M40 - Deeper fall drawdowns to RO for downstream passage - $0

   M722 - Adult Fish Facility Operation – $250,000

Table 3-1 summarizes the total OMRRR costs for the No Action Alternative.

Table 3-1. Capital and OMRRR Annual Cost Estimates for the No Action Alternative, Figures in thousands at 2021 Price Level

Project	Annual OMRRR [1]
Detroit/Big Cliff	$2,110
Foster	$2,459
Cougar	$2,350
Lookout Point/Dexter	$2,110
Fall Creek	$250
Total	$9,279

[1] OMRRR is Operations, Maintenance, Repair, Replacement and Rehabilitation.

3.3 ALTERNATIVE 1

Alternative 1 includes estimated funding increases for additional expected routine O&M activities brought on by new capital investments. Capital investments are included in Alternative 1 at Detroit/Big Cliff, Foster, Green Peter, Fern Ridge, Cougar, Blue River, and Lookout Point/Dexter. These capital investments would require design as well as engineering during construction costs.

Uncertainty for Alternative 1 was developed through an abbreviated risk assessment conducted

Measure numbers, descriptions of measure, and cost estimates for capital, design, engineering during construction, and O&M (in addition to the NAA) by project under Alternative 1 are as follows:

1. **Detroit/Big Cliff – Total - $896,438,000**

   M105 - Construct temperature control structure - $432,638,000

   Capital - $362,000,000

   Design/EDC – $70,590,000

   OMRRR - $48,000

   M174 - Structural improvements to reduce TDG - $7,200,000

   Capital - $5,000,000

   Design/EDC – $2,200,000

   OMRRR - $0

   M392 - Construct structural downstream passage - $453,980,000

   Capital - $341,000,000

   Design/EDC – $109,120,000

   OMRRR - $3,860,000

M384 - Gravel augmentation below dams - $520,000

Capital - $350,000

Design/EDC – $70,000

OMRRR - $100,000

M719 - Implement hatchery transition plan - $1,442,000

OMRRR - $1,442,000

M722 - Adult Fish Facility Operation (Minto) – $658,000

OMRRR - $658,000

M723 - Reduce minimum flows to Congressionally authorized minimum flow requirements-updated to address physical constraints - $0

M304 - Augment flows by tapping power pool – $0

M9 - Bioengineering (nature-based) methods for revetments – $0

2. Foster – Total - $87,017,000

M479 - Foster Fish Ladder Temperature Improvement - $32,688,000

Capital - $22,700,000

Design/EDC – $9,988,000

M174 - Structural improvements to reduce TDG - $7,200,000

Capital - $5,000,000

Design/EDC – $2,200,000

M714 - Use spillway to pass fish in spring - $20,000

OMRRR - $20,000

M392 - Construct structural downstream passage - $36,080,000

Capital - $25,000,000

Design/EDC – $11,000,000

OMRRR - $80,000

M722 - Adult Fish Facility Operation – $339,000

OMRRR - $339,000

M723 - Reduce minimum flows to Congressionally authorized minimum flow requirements-updated to address physical constraints - $0

M9 - Bioengineering (nature-based) methods for revetments – $8,070,000

Capital - $6,700,000

Design/EDC – $1,340,000

OMRRR - $30,000

M384 - Gravel augmentation below dams - $520,000

Capital - $350,000

Design/EDC – $70,000

OMRRR - $100,000

M719 - Implement hatchery transition plan - $2,100,000

OMRRR - $2,100,000

3. Green Peter – Total - $398,670,000

M174 - Structural improvements to reduce TDG - $7,200,000

Capital - $5,000,000

Design/EDC – $2,200,000

M392 - Construct structural downstream passage - $355,220,000

Capital - $244,000,000

Design/EDC – $107,360,000

OMRRR - $3,860,000

M722 – Construct Adult Fish Facility – $36,250,000

Capital - $25,000,000

Design/EDC – $11,000,000

OMRRR - $250,000

M723 - Reduce minimum flows to Congressionally authorized minimum flow requirements - $0

M304 - Augment flows by tapping power pool - $0

4. Fern Ridge – Total - $8,064,000

M639 - Restore upstream and downstream passage at drop structures- $8,064,000

Capital - $5,600,000

Design/EDC – $2,464,000

5. Cougar – Total - $28,138,000

M174 - Structural improvements to reduce TDG - $7,200,000

Capital - $5,000,000

Design/EDC – $2,200,000

M722 - Adult Fish Facility Operation – $250,000

OMRRR - $250,000

M723 - Reduce minimum flows to Congressionally authorized minimum flow requirements- updated to address physical constraints - $0

M9 - Bioengineering (nature-based) methods for revetments – $18,068,000

Capital - $15,000,000

Design/EDC – $3,000,000

OMRRR - $68,000

M384 - Gravel augmentation below dams - $520,000

Capital - $350,000

Design/EDC – $70,000

OMRRR - $100,000

M719 - Implement hatchery transition plan - $2,100,000

OMRRR - $2,100,000

M304 - Augment flows by tapping power pool - $0

M52 - Provide Pacific lamprey passage and infrastructure at adult traps where possible - $0

6. **Blue River – Total - $520,000**

M384 - Gravel augmentation below dams - $520,000

Capital - $350,000

Design/EDC – $70,000

OMRRR - $100,000

M9 - Bioengineering (nature-based) methods for revetments – $0

7. **Hills Creek – Total - $0**

M723 - Reduce minimum flows to Congressionally authorized minimum flow requirements- updated to address physical constraints - $0

M304 - Augment flows by tapping power pool - $0

8. **Lookout Point – Total - $1,016,270,000**

M105 - Construct temperature control structure where needed - $512,160,000

Capital - $388,000,000

Design/EDC – $124,160,000

M174 - Structural improvements to reduce TDG - $7,200,000

Capital - $5,000,000

Design/EDC – $2,200,000

M723 - Reduce minimum flows to Congressionally authorized minimum flow requirements- updated to address physical constraints - $0

M304 - Augment flows by tapping power pool - $0

M392 - Construct structural downstream passage - $486,980,000

Capital - $366,000,000

Design/EDC – $117,120,000

OMRRR - $3,860,000

M9 - Bioengineering (nature-based) methods for revetments – $7,830,000

Capital - $6,500,000

Design/EDC – $1,300,000

OMRRR - $30,000

M719 - Implement hatchery transition plan - $2,100,000

OMRRR - $2,100,000

9. Fall Creek – Total - $0

M723 - Reduce minimum flows to Congressionally authorized minimum flow requirements-updated to address physical constraints - $0

M718 - Augment instream flows by using inactive pool - $0

M40 - Deeper fall drawdowns to RO for downstream passage - $0

Table 3-2 summarizes the estimated capital/design/engineering (First Cost) and OMRRR costs for Alternative 1. Lookout Point/Dexter and Detroit/Big Cliff have the highest overall costs under Alternative 1, with estimated annual costs of $40.6million and $36.6 million, respectively.

Table 3-2. Capital and OMRRR Cost Estimates for Alternative 1, Figures in thousands at 2021 Price Level

Project	Annual OMRRR [1]	Estimated First Cost [2]	Estimated Annual Cost	Interest During Construction	Estimated Total Annual Cost
Detroit/Big Cliff	–	–	–	–	–
Low Value	–	$663,151	$22,709	$14,348	$28,817
Best Estimate Value	$6,108	$890,330	$30,488	$19,264	$36,596
High Value	–	$1,310,168	$44,865	$28,348	$50,973
Foster	–	–	–	–	–
Low Value	–	$65,185	$2,232	$1,410	$4,901
Best Estimate Value	$2,669	$84,348	$2,888	$1,825	$5,557
High Value	–	$119,762	$4,101	$2,591	$6,770
Green Peter	–	–	–	–	–
Low Value	–	$306,684	$10,502	$6,636	$14,612
Best Estimate Value	$4,110	$394,560	$13,511	$8,537	$17,621
High Value	–	$556,959	$19,072	$12,051	$23,182
Fern Ridge	–	–	–	–	–
Low Value	–	$6,268	$215	$136	$215
Best Estimate Value	$0	$8,064	$276	$174	$276

Project	Annual OMRRR [1]	Estimated First Cost [2]	Estimated Annual Cost	Interest During Construction	Estimated Total Annual Cost
High Value	–	$11,383	$390	$246	$390
Cougar	–	–	–	–	–
Low Value	–	$19,093	$654	$413	$3,172
Best Estimate Value	$2,518	$25,620	$877	$554	$3,395
High Value	–	$37,681	$1,290	$815	$3,808
Blue River	–	–	–	–	–
Low Value	–	$308	$11	$7	$111
Best Estimate Value	$100	$420	$14	$9	$114
High Value	–	$627	$21	$14	$121
Hills Creek	–	–	–	–	–
Low Value	–	$0	$0	$0	$0
Best Estimate Value	$0	$0	$0	$0	$0
High Value	–	$0	$0	$0	$0
Lookout Point/Dexter	–	–	–	–	–
Low Value	–	$764,772	$26,189	$16,547	$32,179
Best Estimate Value	$5,990	$1,010,280	$34,596	$21,859	$40,586
High Value	–	$1,463,991	$50,132	$31,676	$56,122
Fall Creek	–	–	–	–	–
Low Value	–	$0	$0	$0	$250
Best Estimate Value	$250	$0	$0	$0	$250
High Value	–	$0	$0	$0	$250
Total	–	–	–	–	–
Low Value	–	$1,825,462	$62,510	$39,497	$84,255
Best Estimate Value	$21,745	$2,413,622	$82,651	$52,223	$104,396
High Value	–	$3,500,572	$119,872	$75,741	$141,617

[1]OMRRR is Operations, Maintenance, Repair, Replacement and Rehabilitation in addition to the NAA.

[2]Estimated Construction First Cost includes engineering, design, construction, and contingencies.

Notes:

a) Annual Construction Cost includes Interest During Construction and is calculated using the FY 2022 Federal Water Resources Discount Rate of 2.25% and a 50-year period of analysis. Interest During Construction assumes a 24-month construction period.

b) Cost estimate for NAA does not include measure 722 (new DEX AFF)

c) Sub-basin totals assume no change in annual hatchery mitigation costs. This should be revised once a fish passage implementation schedule is established.

d) Some O&M costs for NAA were not available as of the release of this draft.

3.4 ALTERNATIVE 2A

Alternative 2a includes estimated funding increases for additional expected routine O&M activities brought on by new capital investments. Capital investments are included in

Alternative 2a at Detroit/Big Cliff, Foster, Green Peter, Cougar, Blue River, and Lookout Point/Dexter. These capital investments would require design as well as engineering during construction costs. Measure numbers, descriptions of measure, and cost estimates for capital, design, engineering during construction, and O&M (in addition to the NAA) by project under Alternative 2a are as follows:

1. Detroit/Big Cliff – Total - $889,238,000

M105 - Construct temperature control structure - $432,638,000

Capital - $362,000,000

Design/EDC – $70,590,000

OMRRR - $48,000

M392 - Construct structural downstream passage - $453,980,000

Capital - $341,000,000

Design/EDC – $109,120,000

OMRRR - $3,860,000

M384 - Gravel augmentation below dams - $520,000

Capital - $350,000

Design/EDC – $70,000

OMRRR - $100,000

M719 - Implement hatchery transition plan - $1,442,000

OMRRR - $1,442,000

M722 - Adult Fish Facility Operation (Minto) – $658,000

OMRRR - $658,000

M304 - Augment flows by tapping power pool – $0

M30 - Change flows to provide effective biological benefit – $0

M9 - Bioengineering (nature-based) methods for revetments – $0

2. Foster – Total - $47,109,000

M392 - Construct structural downstream passage - $36,080,000

Capital - $25,000,000

Design/EDC – $11,000,000

OMRRR - $80,000

M722 - Adult Fish Facility Operation – $339,000

OMRRR - $339,000

M719 - Implement hatchery transition plan - $2,100,000

OMRRR - $2,100,000

M9 - Bioengineering (nature-based) methods for revetments – $8,070,000

Capital - $6,700,000

Design/EDC – $1,340,000

OMRRR - $30,000

M384 - Gravel augmentation below dams - $520,000

Capital - $350,000

Design/EDC – $70,000

OMRRR - $100,000

3. **Green Peter – Total - $36,767,000**

M166 - Use lowest ROs to discharge colder water during drawdown operations in fall and winter to reduce water temperatures below dams - $497,000

Capital - $497,000

M 721 - Use spillway for surface spill in summer - $20,000

OMRRR - $20,000

M722 – Construct Adult Fish Facility – $36,250,000

Capital - $25,000,000

Design/EDC – $11,000,000

OMRRR - $250,000

M723 - Reduce minimum flows to Congressionally authorized minimum flow requirements - $0

M304 - Augment flows by tapping power pool - $0

M40 - Deeper fall drawdowns to RO for downstream passage - $0

4. **Cougar – Total - $214,803,000**

M30 - Change flows to provide effective biological benefit - $0

M722 - Adult Fish Facility Operation – $250,000

OMRRR - $250,000

M9 - Bioengineering (nature-based) methods for revetments – $18,068,000

Capital - $15,000,000

Design/EDC – $3,000,000

OMRRR - $68,000

M392 - Construct structural downstream passage - $193,865,000

Capital - $159,000,000

Design/EDC – $31,005,000

OMRRR - $3,860,000

M719 - Implement hatchery transition plan - $2,100,000

OMRRR - $2,100,000

M52 - Provide Pacific lamprey passage and infrastructure at adult traps where possible - $0

M384 - Gravel augmentation below dams - $520,000

Capital - $350,000

Design/EDC – $70,000

OMRRR - $100,000

5. **Blue River – Total - $520,000**

M384 - Gravel augmentation below dams - $520,000

Capital - $350,000

Design/EDC – $70,000

OMRRR - $100,000

M9 - Bioengineering (nature-based) methods for revetments – $0

6. **Hills Creek – Total - $0**

M30 - Change flows to provide effective biological benefit - $0

M304 - Augment flows by tapping power pool - $0

7. **Lookout Point – Total - $178,020,000**

M166 - Use lowest ROs to discharge colder water during drawdown operations in fall and winter to reduce water temperatures below dams - $0

M721 - Use spillway for surface spill in summer - $10,000

OMRRR - $10,000

M30 - Change flows to provide effective biological benefit - $0

M304 - Augment flows by tapping power pool - $0

M392 - Construct structural downstream passage - $168,080,000

Capital - $119,000,000

Design/EDC – $45,220,000

OMRRR - $3,860,000

M9 - Bioengineering (nature-based) methods for revetments – $7,830,000

Capital - $6,500,000

Design/EDC – $1,300,000

OMRRR - $30,000

M719 - Implement hatchery transition plan - $2,100,000

OMRRR - $2,100,000

8. **Fall Creek – Total - $0**

   M40 - Deeper fall drawdowns to RO for downstream passage- $0

Table 3-3 summarizes the estimated capital/design/engineering (First Cost) and OMRRR costs for Alternative 2a. Detroit/Big Cliff and Cougar have the highest capital costs under Alternative 2a, with estimated annual costs of $36.4 million and $13.5 million, respectively.

Table 3-3. Capital and OMRRR Cost Estimates for Alternative 2a, Figures in thousands at 2021 Price Level

Project	Annual OMRRR [1]	Estimated First Cost [2]	Estimated Annual Cost	Interest During Construction	Estimated Total Annual Cost
Detroit/Big Cliff	–	–	–	–	–
Low Value	–	$666,179	$22,812	$14,414	$28,920
Best Estimate Value	$6,108	$883,130	$30,242	$19,108	$36,350
High Value	–	$1,313,148	$44,967	$28,412	$51,075
Foster	–	–	–	–	–
Low Value	$2,649	$34,574	$1,184	$748	$3,833
Best Estimate Value	$2,649	$44,460	$1,522	$962	$4,171
High Value	$2,649	$64,055	$2,193	$1,386	$4,842
Green Peter	–	–	–	–	–
Low Value	$270	$28,632	$980	$620	$1,250
Best Estimate Value	$270	$36,497	$1,250	$790	$1,520
High Value	$270	$52,086	$1,784	$1,127	$2,054
Fern Ridge	–	–	–	–	–
Low Value	$0	$0	$0	$0	$0
Best Estimate Value	$0	$0	$0	$0	$0
High Value	$0	$0	$0	$0	$0
Cougar	–	–	–	–	–
Low Value	$6,378	$154,646	$5,296	$3,346	$11,674
Best Estimate Value	$6,378	$208,425	$7,137	$4,510	$13,515
High Value	$6,378	$315,020	$10,787	$6,816	$17,165
Blue River	–	–	–	–	–
Low Value	$100	$312	$11	$7	$111
Best Estimate Value	$100	$420	$14	$9	$114
High Value	$100	$634	$22	$14	$122
Hills Creek	–	–	–	–	–
Low Value	$0	$0	$0	$0	$0
Best Estimate Value	$0	$0	$0	$0	$0
High Value	$0	$0	$0	$0	$0
Lookout Point/Dexter	–	–	–	–	–

Project	Annual OMRRR [1]	Estimated First Cost [2]	Estimated Annual Cost	Interest During Construction	Estimated Total Annual Cost
Low Value	$6,000	$133,309	$4,565	$2,884	$10,565
Best Estimate Value	$6,000	$172,020	$5,891	$3,722	$11,891
High Value	$6,000	$248,749	$8,518	$5,382	$14,518
Fall Creek	–	–	–	–	–
Low Value	$0	$0	$0	$0	$0
Best Estimate Value	$0	$0	$0	$0	$0
High Value	$0	$0	$0	$0	$0
Total	–	–	–	–	–
Low Value	–	$1,017,652	$34,848	$22,019	$56,353
Best Estimate Value	$21,505	$1,344,952	$46,056	$29,100	$67,561
High Value	–	$1,993,692	$68,271	$43,137	$89,776

[1]OMRRR is Operations, Maintenance, Repair, Replacement and Rehabilitation in addition to the NAA.

[2]Estimated Construction First Cost includes engineering, design, construction, and contingencies.

Notes:

a) Annual Construction Cost includes Interest During Construction and is calculated using the FY 2022 Federal Water Resources Discount Rate of 2.25% and a 50-year period of analysis. Interest During Construction assumes a 24-month construction period.

b) Cost estimate for NAA does not include measure 722 (new DEX AFF)

c) Sub-basin totals assume no change in annual hatchery mitigation costs. This should be revised once a fish passage implementation schedule is established.

d) Some O&M costs for NAA were not available as of the release of this draft.

3.5 ALTERNATIVE 2B

Alternative 2b includes estimated funding increases for additional expected routine O&M activities brought on by new capital investments. Capital investments are included in Alternative 2b at Detroit/Big Cliff, Foster, Green Peter, Cougar, Blue River, and Lookout Point/Dexter. These capital investments would require design as well as engineering during construction costs. Measure numbers, descriptions of measure, and cost estimates for capital, design, engineering during construction, and O&M (in addition to the NAA) by project under Alternative 2b are as follows:

1. **Detroit/Big Cliff – Total - $889,238,000**

M105 - Construct temperature control structure - $432,638,000

Capital - $362,000,000

Design/EDC – $70,590,000

OMRRR - $48,000

M392 - Construct structural downstream passage - $453,980,000

Capital - $341,000,000

Design/EDC – $109,120,000

OMRRR - $3,860,000

M384 - Gravel augmentation below dams - $520,000

Capital - $350,000

Design/EDC – $70,000

OMRRR - $100,000

M719 - Implement hatchery transition plan - $1,442,000

OMRRR - $1,442,000

M722 - Adult Fish Facility Operation (Minto) – $658,000

OMRRR - $658,000

M304 - Augment flows by tapping power pool – $0

M30 - Change flows to provide effective biological benefit – $0

M9 - Bioengineering (nature-based) methods for revetments – $0

2. Foster – Total - $47,109,000

M392 - Construct structural downstream passage - $36,080,000

Capital - $25,000,000

Design/EDC – $11,000,000

OMRRR - $80,000

M722 - Adult Fish Facility Operation – $339,000

OMRRR - $339,000

M719 - Implement hatchery transition plan - $2,100,000

OMRRR - $2,100,000

M9 - Bioengineering (nature-based) methods for revetments – $8,070,000

Capital - $6,700,000

Design/EDC – $1,340,000

OMRRR - $30,000

M384 - Gravel augmentation below dams - $520,000

Capital - $350,000

Design/EDC – $70,000

OMRRR - $100,000

3. Green Peter – Total - $36,767,000

M166 - Use lowest ROs to discharge colder water during drawdown operations in fall and winter to reduce water temperatures below dams - $497,000

Capital - $497,000

M 721 - Use spillway for surface spill in summer - $20,000

OMRRR - $20,000

M722 – Construct Adult Fish Facility – $36,250,000

Capital - $25,000,000

Design/EDC – $11,000,000

OMRRR - $250,000

M723 - Reduce minimum flows to Congressionally authorized minimum flow requirements - $0

M304 - Augment flows by tapping power pool - $0

M40 - Deeper fall drawdowns to RO for downstream passage - $0

4. **Cougar – Total - $179,387,000**

M30 - Change flows to provide effective biological benefit - $0

M722 - Adult Fish Facility Operation – $250,000

OMRRR - $250,000

M9 - Bioengineering (nature-based) methods for revetments – $18,068,000

Capital - $15,000,000

Design/EDC – $3,000,000

OMRRR - $68,000

M40b - Deeper fall drawdowns to DT for downstream passage - $49,000

OMRRR - $49,000

M720b - Spring drawdown to DT for downstream passage- $158,400,000

Capital - $110,000,000

Design/EDC – $48,400,000

M52 - Provide Pacific lamprey passage and infrastructure at adult traps where possible - $0

M384 - Gravel augmentation below dams - $520,000

Capital - $350,000

Design/EDC – $70,000

OMRRR - $100,000

M719 - Implement hatchery transition plan - $2,100,000

OMRRR - $2,100,000

5. **Blue River – Total - $520,000**

M384 - Gravel augmentation below dams - $520,000

Capital - $350,000

Design/EDC – $70,000

OMRRR - $100,000

6. **Hills Creek – Total - $0**

M30 - Change flows to provide effective biological benefit - $0

M304 - Augment flows by tapping power pool - $0

7. **Lookout Point – Total - $178,020,000**

M166 - Use lowest ROs to discharge colder water during drawdown operations in fall and winter to reduce water temperatures below dams - $0

M721 - Use spillway for surface spill in summer - $10,000

OMRRR - $10,000

M30 - Change flows to provide effective biological benefit - $0

M304 - Augment flows by tapping power pool - $0

M392 - Construct structural downstream passage (FSC) - $168,080,000

Capital - $119,000,000

Design/EDC – $45,220,000

OMRRR - $3,860,000

M9 - Bioengineering (nature-based) methods for revetments – $7,830,000

Capital - $6,500,000

Design/EDC – $1,300,000

OMRRR - $30,000

M719 - Implement hatchery transition plan - $2,100,000

OMRRR - $2,100,000

8. **Fall Creek – Total - $0**

M40 - Deeper fall drawdowns to RO for downstream passage- $0

Table 3-4 summarizes the capital and OMRRR costs for Alternative 2b. Detroit/Big Cliff and Lookout Point/Dexter have the highest capital costs under Alternative 2b, with estimated annual costs of $36.4 million and $11.9 million, respectively.

Table 3-4. Capital and OMRRR Cost Estimates for Alternative 2b, Figures in thousands at 2021 Price Level

Project	Annual OMRRR [1]	Estimated First Cost [2]	Estimated Annual Cost	Interest During Construction	Estimated Total Annual Cost
Detroit/Big Cliff	–	–	–	–	–
Low Value	–	$658,663	$22,555	$14,251	$28,663
Best Estimate Value	$6,108	$883,130	$30,242	$19,108	$36,350
High Value	–	$1,368,089	$46,848	$29,601	$52,956
Foster	–	–	–	–	–
Low Value	–	$23,232	$796	$503	$3,445
Best Estimate Value	$2,649	$33,460	$1,146	$724	$3,795
High Value	–	$55,558	$1,903	$1,202	$4,552
Green Peter	–	–	–	–	–
Low Value	–	$28,360	$971	$614	$1,241
Best Estimate Value	$270	$36,497	$1,250	$790	$1,520
High Value	–	$54,077	$1,852	$1,170	$2,122
Fern Ridge	–	–	–	–	–
Low Value	–	$0	$0	$0	$0
Best Estimate Value	$0	$0	$0	$0	$0
High Value	–	$0	$0	$0	$0
Cougar	–	–	–	–	–
Low Value	–	$136,816	$4,685	$2,960	$7,252
Best Estimate Value	$2,567	$176,820	$6,055	$3,826	$8,622
High Value	–	$263,249	$9,015	$5,696	$11,582
Blue River	–	–	–	–	–
Low Value	–	$308	$11	$7	$111
Best Estimate Value	$100	$420	$14	$9	$114
High Value	–	$661	$23	$14	$123
Hills Creek	–	–	–	–	–
Low Value	–	$0	$0	$0	$0
Best Estimate Value	$0	$0	$0	$0	$0
High Value	–	$0	$0	$0	$0
Lookout Point/Dexter	–	–	–	–	–
Low Value	–	$131,968	$4,519	$2,855	$10,519
Best Estimate Value	$6,000	$172,020	$5,891	$3,722	$11,891
High Value	–	$258,552	$8,854	$5,594	$14,854
Fall Creek	–	–	–	–	–
Low Value	–	$0	$0	$0	$0
Best Estimate Value	$0	$0	$0	$0	$0

Project	Annual OMRRR [1]	Estimated First Cost [2]	Estimated Annual Cost	Interest During Construction	Estimated Total Annual Cost
High Value	–	$0	$0	$0	$0
Total	–	–	–	–	–
Low Value	–	$979,347	$33,536	$21,190	$51,230
Best Estimate Value	$17,694	$1,302,347	$44,597	$28,178	$62,291
High Value	–	$2,000,187	$68,494	$43,277	$86,188

[1]OMRRR is Operations, Maintenance, Repair, Replacement and Rehabilitation in addition to the NAA.

[2]Estimated Construction First Cost includes engineering, design, construction, and contingencies.

Notes:

a) Annual Construction Cost includes Interest During Construction and is calculated using the FY 2022 Federal Water Resources Discount Rate of 2.25% and a 50-year period of analysis. Interest During Construction assumes a 24 month construction period.

b) Cost estimate for NAA does not include measure 722 (new DEX AFF)

c) Sub-basin totals assume no change in annual hatchery mitigation costs. This should be revised once a fish passage implementation schedule is established.

d) Some O&M costs for NAA were not available as of the release of this draft.

As discussed in the overview at the beginning of this appendix, the Preferred Alternative (aka Alternative 5) and Alternative 2b are essentially the same. The only difference is that the flow regime (measure 30) is slightly refined in Alt 5. It has a negligible effect on hydrologic processes that is summarized in Chapter 5.

3.6 ALTERNATIVE 3A

Alternative 3a includes estimated funding increases for additional expected routine O&M activities brought on by new capital investments. Capital investments are included in Alternative 3a at Detroit/Big Cliff, Foster, Green Peter, Cougar, Blue River, Hills Creek, and Lookout Point/Dexter. These capital investments would require design as well as engineering during construction costs. Measure numbers, descriptions of measure, and cost estimates for capital, design, engineering during construction, and O&M (in addition to the NAA) by project under Alternative 3a are as follows:

1. Detroit/Big Cliff – Total - $4,080,000

M166 - Use lowest ROs to discharge colder water during drawdown operations in fall and winter to reduce water temperatures below dams - $1,450,000

Capital - $1,000,000

Design/EDC – $440,000

OMRRR - $10,000

M721 - Use spillway for surface spill in summer - $10,000

OMRRR - $10,000

M40 - Deeper fall drawdowns to RO for downstream passage - $0

M714 - Use spillway to pass fish in spring Detroit and Big Cliff) - $0

M720 - Spring drawdown to lowest outlet for downstream passage (Detroit) - $0

M722 - Adult Fish Facility Operation (Minto) – $658,000

OMRRR - $658,000

M384 - Gravel augmentation below dams - $520,000

Capital - $350,000

Design/EDC – $70,000

OMRRR - $100,000

M719 - Implement hatchery transition plan - $1,442,000

OMRRR - $1,442,000

M9 - Bioengineering (nature-based) methods for revetments – $0

2. Foster – Total - $11,029,000

M721 - Use spillway for surface spill in summer - $0

M30 - Change flows to provide effective biological benefit - $0

M722 - Adult Fish Facility Operation – $339,000

OMRRR - $339,000

M719 - Implement hatchery transition plan - $2,100,000

OMRRR - $2,100,000

M9 - Bioengineering (nature-based) methods for revetments – $8,070,000

Capital - $6,700,000

Design/EDC – $1,340,000

OMRRR - $30,000

M384 - Gravel augmentation below dams - $520,000

Capital - $350,000

Design/EDC – $70,000

OMRRR - $100,000

3. Green Peter – Total - $36,767,000

M166 - Use lowest ROs to discharge colder water during drawdown operations in fall and winter to reduce water temperatures below dams - $497,000

Capital - $497,000

M 721 - Use spillway for surface spill in summer - $20,000

OMRRR - $20,000

M722 – Construct Adult Fish Facility – $36,250,000

Capital - $25,000,000
Design/EDC – $11,000,000
OMRRR - $250,000

M30 - Change flows to provide effective biological benefit - $0

M304 - Augment flows by tapping power pool - $0

M40 - Deeper fall drawdowns to RO for downstream passage - $0

M720 - Spring drawdown to lowest outlet for downstream passage - $0

4. **Cougar – Total - $56,987,000**

M40a - Deeper fall drawdowns to RO for downstream passage - $49,000
OMRRR - $49,000

M720a - Spring drawdown to lowest outlet for downstream passage - $36,000,000
Capital - $25,000,000
Design/EDC – $11,000,000

M722 - Adult Fish Facility Operation – $250,000
OMRRR - $250,000

M9 - Bioengineering (nature-based) methods for revetments – $18,068,000
Capital - $15,000,000
Design/EDC – $3,000,000
OMRRR - $68,000

M384 - Gravel augmentation below dams - $520,000
Capital - $350,000
Design/EDC – $70,000
OMRRR - $100,000

M719 - Implement hatchery transition plan - $2,100,000
OMRRR - $2,100,000

5. **Blue River – Total - $180,770,000**

M721 - Use spillway for surface spill in summer- $144,000,000
Capital - $100,000,000
Design/EDC – $44,000,000

M722 - Construct adult fish facility - $36,250,000
Capital - $25,000,000
Design/EDC – $11,000,000
OMRRR - $250,000

M384 - Gravel augmentation below dams - $520,000
  Capital - $350,000
  Design/EDC – $70,000
  OMRRR - $100,000

M30 - Change flows to provide effective biological benefit - $0

M718 - Augment instream flows by using inactive pool - $0

M40 - Deeper fall drawdowns to RO for downstream passage – $0

M52 - Provide Pacific lamprey passage and infrastructure at adult traps where possible - $0

M9 - Bioengineering (nature-based) methods for revetments - $0

6. **Hills Creek – Total - $180,250,000**

M721 - Use spillway for surface spill in summer - $144,000,000
  Capital - $100,000,000
  Design/EDC – $44,000,000

M30 - Change flows to provide effective biological benefit - $0

M304 - Augment flows by tapping power pool - $0

M40 - Deeper fall drawdowns to RO for downstream passage – $0

M714 - Use spillway to pass fish in spring - $0

M52 - Provide Pacific lamprey passage and infrastructure at adult traps where possible - $0

M722 - Construct adult fish facility - $36,250,000
  Capital - $25,000,000
  Design/EDC – $11,000,000
  OMRRR - $250,000

7. **Lookout Point – Total - $9,940,000**

M166 - Use lowest ROs to discharge colder water during drawdown operations in fall and winter to reduce water temperatures below dams - $0

M721 - Use spillway for surface spill in summer - $10,000
  OMRRR - $10,000

M30 - Change flows to provide effective biological benefit - $0

M304 - Augment flows by tapping power pool - $0

M714 - Use spillway to pass fish in spring - $0

M720 - Spring drawdown to lowest outlet for downstream passage - $0

M9 - Bioengineering (nature-based) methods for revetments – $7,830,000

Capital - $6,500,000

Design/EDC – $1,300,000

OMRRR - $30,000

M719 - Implement hatchery transition plan - $2,100,000

OMRRR - $2,100,000

8. **Fall Creek – Total - $0**

M40 - Deeper fall drawdowns to RO for downstream passage- $0

M30 - Change flows to provide effective biological benefit - $0

M718 - Augment instream flows by using inactive pool - $0

M714 - Use spillway to pass fish in spring - $0

Table 3-5 summarizes the capital and OMRRR costs for Alternative 3a. Blue River and Hills Creek have the highest capital costs under Alternative 3a, with estimated annual costs of $6.5 million and $6.4 million, respectively.

Table 3-5. Capital and OMRRR Cost Estimates for Alternative 3a, Figures in thousands at 2021 Price Level

Project	Annual OMRRR [1]	Estimated First Cost [2]	Estimated Annual Cost	Interest During Construction	Estimated Total Annual Cost
Detroit/Big Cliff	–	–	–	–	–
Low Value	–	$1,574	$54	$34	$2,274
Best Estimate Value	$2,220	$1,860	$64	$40	$2,284
High Value	–	$2,444	$84	$53	$2,304
Foster	–	–	–	–	–
Low Value	–	$6,964	$238	$151	$2,807
Best Estimate Value	$2,569	$8,460	$290	$183	$2,859
High Value	–	$11,512	$394	$249	$2,963
Green Peter	–	–	–	–	–
Low Value	–	$31,087	$1,065	$673	$1,335
Best Estimate Value	$270	$36,497	$1,250	$790	$1,520
High Value	–	$47,535	$1,628	$1,029	$1,898
Fern Ridge	–	–	–	–	–
Low Value	–	$0	$0	$0	$0
Best Estimate Value	$0	$0	$0	$0	$0
High Value	–	$0	$0	$0	$0
Cougar	–	–	–	–	–
Low Value	–	$45,859	$1,570	$992	$4,137
Best Estimate Value	$2,567	$54,420	$1,864	$1,177	$4,431

Project	Annual OMRRR [1]	Estimated First Cost [2]	Estimated Annual Cost	Interest During Construction	Estimated Total Annual Cost
High Value	–	$71,889	$2,462	$1,555	$5,029
Blue River	–	–	–	–	–
Low Value	–	$153,824	$5,267	$3,328	$5,617
Best Estimate Value	$350	$180,420	$6,178	$3,904	$6,528
High Value	–	$234,687	$8,037	$5,078	$8,387
Hills Creek	–	–	–	–	–
Low Value	–	$153,478	$5,144	$0	$5,394
Best Estimate Value	$250	$180,000	$6,164	$3,895	$6,414
High Value	–	$234,116	$8,017	$5,065	$8,267
Lookout Point/Dexter	–	–	–	–	–
Low Value	–	$6,421	$220	$139	$2,360
Best Estimate Value	$2,140	$7,800	$267	$169	$2,407
High Value	–	$10,614	$363	$230	$2,503
Fall Creek	–	–	–	–	–
Low Value	–	$0	$0	$0	$0
Best Estimate Value	$0	$0	$0	$0	$0
High Value	–	$0	$0	$0	$0
Total	–	–	–	–	–
Low Value	–	$399,207	$13,559	$5,317	$23,925
Best Estimate Value	$10,366	$469,457	$16,076	$10,157	$26,442
High Value	–	$612,797	$20,984	$13,259	$31,350

[1]OMRRR is Operations, Maintenance, Repair, Replacement and Rehabilitation in addition to the NAA.

[2]Estimated Construction First Cost includes engineering, design, construction, and contingencies.

Notes:

a) Annual Construction Cost includes Interest During Construction and is calculated using the FY 2022 Federal Water Resources Discount Rate of 2.25% and a 50-year period of analysis. Interest During Construction assumes a 24 month construction period.

b) Cost estimate for NAA does not include measure 722 (new DEX AFF)

c) Sub-basin totals assume no change in annual hatchery mitigation costs. This should be revised once a fish passage implementation schedule is established.

d) Some O&M costs for NAA were not available as of the release of this draft.

3.7 ALTERNATIVE 3B

Alternative 3b includes estimated funding increases for additional expected routine O&M activities brought on by new capital investments. Capital investments are included in Alternative 3b at Detroit/Big Cliff, Foster, Green Peter, Cougar, Blue River, Hills Creek, and Lookout Point/Dexter. These capital investments would require design as well as engineering during construction costs. Measure numbers, descriptions of measure, and cost estimates for capital, design, engineering during construction, and O&M (in addition to the NAA) by project under Alternative 3b are as follows:

1. **Detroit/Big Cliff – Total - $4,080,000**

M166 - Use lowest ROs to discharge colder water during drawdown operations in fall and winter to reduce water temperatures below dams - $1,450,000

Capital - $1,000,000

Design/EDC – $440,000

OMRRR - $10,000

M721 - Use spillway for surface spill in summer - $10,000

OMRRR - $10,000

M40 - Deeper fall drawdowns to RO for downstream passage - $0

M30 - Change flows to provide effective biological benefit - $0

M304 - Augment flows by tapping power pool - $0

M714 - Use spillway to pass fish in spring Detroit and Big Cliff) - $0

M722 - Adult Fish Facility Operation (Minto) – $658,000

OMRRR - $658,000

M384 - Gravel augmentation below dams - $520,000

Capital - $350,000

Design/EDC – $70,000

OMRRR - $100,000

M719 - Implement hatchery transition plan - $1,442,000

OMRRR - $1,442,000

M9 - Bioengineering (nature-based) methods for revetments – $0

2. **Foster – Total - $11,029,000**

M721 - Use spillway for surface spill in summer - $0

M30 - Change flows to provide effective biological benefit - $0

M722 - Adult Fish Facility Operation – $339,000

OMRRR - $339,000

M719 - Implement hatchery transition plan - $2,100,000

OMRRR - $2,100,000

M9 - Bioengineering (nature-based) methods for revetments – $8,070,000

Capital - $6,700,000

Design/EDC – $1,340,000

OMRRR - $30,000

M384 - Gravel augmentation below dams - $520,000

Capital - $350,000

Design/EDC – $70,000

OMRRR - $100,000

3. Green Peter – Total - $36,786,000

M166 - Use lowest ROs to discharge colder water during drawdown operations in fall and winter to reduce water temperatures below dams - $497,000

Capital - $497,000

M 721 - Use spillway for surface spill in summer - $20,000

OMRRR - $20,000

M722 – Construct Adult Fish Facility – $36,250,000

Capital - $25,000,000

Design/EDC – $11,000,000

OMRRR - $250,000

M30 - Change flows to provide effective biological benefit - $0

M304 - Augment flows by tapping power pool - $0

M52 - Provide Pacific lamprey passage and infrastructure at adult traps where possible- $19,000

OMRRR - $19,000

4. Cougar – Total - $179,387,000

M40b - Deeper fall drawdowns to DT for downstream passage - $49,000

OMRRR - $49,000

M720b - Spring drawdown to DT for downstream passage - $158,400,000

Capital - $110,000,000

Design/EDC – $48,400,000

M722 - Adult Fish Facility Operation – $250,000

OMRRR - $250,000

M9 - Bioengineering (nature-based) methods for revetments – $18,068,000

Capital - $15,000,000

Design/EDC – $3,000,000

OMRRR - $68,000

M384 - Gravel augmentation below dams - $520,000

Capital - $350,000

Design/EDC – $70,000

OMRRR - $100,000

M719 - Implement hatchery transition plan - $2,100,000

OMRRR - $2,100,000

5. **Blue River – Total - $180,770,000**

M721 - Use spillway for surface spill in summer- $144,000,000

Capital - $100,000,000

Design/EDC – $44,000,000

M722 - Construct adult fish facility - $36,250,000

Capital - $25,000,000

Design/EDC – $11,000,000

OMRRR - $250,000

M384 - Gravel augmentation below dams - $520,000

Capital - $350,000

Design/EDC – $70,000

OMRRR - $100,000

M30 - Change flows to provide effective biological benefit - $0

M718 - Augment instream flows by using inactive pool - $0

M40 - Deeper fall drawdowns to RO for downstream passage – $0

M52 - Provide Pacific lamprey passage and infrastructure at adult traps where possible - $0

M9 - Bioengineering (nature-based) methods for revetments - $0

6. **Hills Creek – Total - $180,250,000**

M721 - Use spillway for surface spill in summer - $144,000,000

Capital - $100,000,000

Design/EDC – $44,000,000

M30 - Change flows to provide effective biological benefit - $0

M304 - Augment flows by tapping power pool - $0

M40 - Deeper fall drawdowns to RO for downstream passage – $0

M720 - Spring drawdown to lowest outlet for downstream passage- $0

M52 - Provide Pacific lamprey passage and infrastructure at adult traps where possible - $0

M722 - Construct adult fish facility - $36,250,000

Capital - $25,000,000

Design/EDC – $11,000,000

OMRRR - $250,000

7. **Lookout Point – Total - $9,940,000**

M166 - Use lowest ROs to discharge colder water during drawdown operations in fall and winter to reduce water temperatures below dams - $0

M721 - Use spillway for surface spill in summer - $10,000

OMRRR - $10,000

M30 - Change flows to provide effective biological benefit - $0

M304 - Augment flows by tapping power pool - $0

M714 - Use spillway to pass fish in spring - $0

M40 - Deeper fall drawdowns to RO for downstream passage - $0

M9 - Bioengineering (nature-based) methods for revetments – $7,830,000

Capital - $6,500,000

Design/EDC – $1,300,000

OMRRR - $30,000

M719 - Implement hatchery transition plan - $2,100,000

OMRRR - $2,100,000

8. **Fall Creek – Total - $0**

M40 - Deeper fall drawdowns to RO for downstream passage- $0

M30 - Change flows to provide effective biological benefit - $0

M718 - Augment instream flows by using inactive pool - $0

Table 3-6 summarizes the capital and OMRRR costs for Alternative 3b. Cougar, Blue River, and Hills Creek have the highest capital costs under Alternative 3b, with annual costs of $8.6 million, $6.5 million, and $6.4 million, respectively.

Table 3-6. Capital and OMRRR Cost Estimates for Alternative 3b, Figures in thousands at 2021 Price Level

Project	Annual OMRRR [1]	Estimated First Cost [2]	Estimated Annual Cost	Interest During Construction	Estimated Total Annual Cost
Detroit/Big Cliff	–	–	–	–	–
Low Value	–	$1,583	$54	$34	$2,274
Best Estimate Value	$2,220	$1,860	$64	$40	$2,284
High Value	–	$2,779	$95	$60	$2,315
Foster	–	–	–	–	–
Low Value	–	$7,016	$240	$152	$2,809
Best Estimate Value	$2,569	$8,460	$290	$183	$2,859

Project	Annual OMRRR [1]	Estimated First Cost [2]	Estimated Annual Cost	Interest During Construction	Estimated Total Annual Cost
High Value	–	$13,261	$454	$287	$3,023
Green Peter	–	–	–	–	–
Low Value	–	$31,273	$1,071	$677	$1,360
Best Estimate Value	$289	$36,497	$1,250	$790	$1,539
High Value	–	$53,859	$1,844	$1,165	$2,133
Fern Ridge	–	–	–	–	–
Low Value	–	$0	$0	$0	$0
Best Estimate Value	$0	$0	$0	$0	$0
High Value	–	$0	$0	$0	$0
Cougar	–	–	–	–	–
Low Value	–	$151,138	$5,176	$3,270	$7,743
Best Estimate Value	$2,567	$176,820	$6,055	$3,826	$8,622
High Value	–	$262,177	$8,978	$5,673	$11,545
Blue River	–	–	–	–	–
Low Value	–	$154,738	$5,299	$3,348	$5,649
Best Estimate Value	$350	$180,420	$6,178	$3,904	$6,528
High Value	–	$265,777	$9,101	$5,751	$9,451
Hills Creek	–	–	–	–	–
Low Value	–	$154,390	$5,175	$0	$5,425
Best Estimate Value	$250	$180,000	$6,164	$3,895	$6,414
High Value	–	$265,118	$9,079	$5,736	$9,329
Lookout Point/Dexter	–	–	–	–	–
Low Value	–	$5,168	$177	$112	$2,317
Best Estimate Value	$2,140	$7,800	$267	$169	$2,407
High Value	–	$12,226	$419	$265	$2,559
Fall Creek	–	–	-	–	–
Low Value	–	$0	$0	$0	$0
Best Estimate Value	$0	$0	$0	$0	$0
High Value	–	$0	$0	$0	$0
Total	–	–	–	–	–
Low Value	–	$505,307	$17,192	$7,593	$27,577
Best Estimate Value	$10,385	$591,857	$20,267	$12,806	$30,652
High Value	–	$875,197	$29,970	$18,936	$40,355

[1]OMRRR is Operations, Maintenance, Repair, Replacement and Rehabilitation in addition to the NAA.

[2]Estimated Construction First Cost includes engineering, design, construction, and contingencies.

Notes:

a) Annual Construction Cost includes Interest During Construction and is calculated using the FY 2022 Federal Water Resources Discount Rate of 2.25% and a 50-year period of analysis. Interest During Construction assumes a 24-month construction period.

b) Cost estimate for NAA does not include measure 722 (new DEX AFF)

c) Sub-basin totals assume no change in annual hatchery mitigation costs. This should be revised once a fish passage implementation schedule is established.

d) Some O&M costs for NAA were not available as of the release of this draft.

3.8 ALTERNATIVE 4

Alternative 4 includes estimated funding increases for additional expected routine O&M activities brought on by new capital investments. Capital investments are included in Alternative 4 at Detroit/Big Cliff, Foster, Green Peter, Fern Ridge, Cougar, Blue River, Hills Creek, and Lookout Point/Dexter. These capital investments would require design as well as engineering during construction costs. Measure numbers, descriptions of measure, and cost estimates for capital, design, engineering during construction, and O&M (in addition to the NAA) by project under Alternative 4 are as follows:

1. **Detroit/Big Cliff – Total - $896,438,000**

M105 - Construct temperature control structure - $432,638,000

Capital - $362,000,000

Design/EDC – $70,590,000

OMRRR - $48,000

M174 - Structural improvements to reduce TDG - $7,200,000

Capital - $5,000,000

Design/EDC – $2,200,000

M392 - Construct structural downstream passage - $453,980,000

Capital - $341,000,000

Design/EDC – $109,120,000

OMRRR – 3,860,000

M30 - Change flows to provide effective biological benefit- $0

M722 - Adult Fish Facility Operation (Minto) – $658,000

OMRRR - $658,000

M384 - Gravel augmentation below dams - $520,000

Capital - $350,000

Design/EDC – $70,000

OMRRR - $100,000

M719 - Implement hatchery transition plan - $1,442,000

OMRRR - $1,442,000

M9 - Bioengineering (nature-based) methods for revetments – $0

2. **Foster – Total - $86,997,000**

M479 - Foster Fish Ladder Temperature Improvement - $32,688,000

Capital - $22,700,000

Design/EDC – $9,988,000

M174 - Structural improvements to reduce TDG - $7,200,000

Capital - $5,000,000

Design/EDC – $2,200,000

M30 - Change flows to provide effective biological benefit - $0

M392 - Construct structural downstream passage - $36,080,000

Capital - $25,000,000

Design/EDC – $11,000,000

OMRRR – $80,000

M722 - Adult Fish Facility Operation – $339,000

OMRRR - $339,000

M719 - Implement hatchery transition plan - $2,100,000

OMRRR - $2,100,000

M9 - Bioengineering (nature-based) methods for revetments – $8,070,000

Capital - $6,700,000

Design/EDC – $1,340,000

OMRRR - $30,000

M384 - Gravel augmentation below dams - $520,000

Capital - $350,000

Design/EDC – $70,000

OMRRR - $100,000

3. **Green Peter – Total - $7,717,000**

M166 - Use lowest ROs to discharge colder water during drawdown operations in fall and winter to reduce water temperatures below dams - $497,000

Capital - $497,000

M 721 - Use spillway for surface spill in summer - $20,000

OMRRR - $20,000

M174 - Structural improvements to reduce TDG where needed – $7,200,000

Capital - $5,000,000

Design/EDC – $2,200,000

4. **Cougar – Total - $219,133,000**

    M174 - Structural improvements to reduce TDG where needed – $7,200,000

    Capital - $5,000,000

    Design/EDC – $2,200,000

    M392 - Construct structural downstream passage - $193,865,000

    Capital - $159,000,000

    Design/EDC – $31,005,000

    OMRRR – $3,860,000

    M52 - Provide Pacific lamprey passage and infrastructure at adult traps where possible - $0

    M9 - Bioengineering (nature-based) methods for revetments – $18,068,000

    Capital - $15,000,000

    Design/EDC – $3,000,000

    OMRRR - $68,000

5. **Blue River – Total - $520,000**

    M384 - Gravel augmentation below dams - $520,000

    Capital - $350,000

    Design/EDC – $70,000

    OMRRR - $100,000

    M9 - Bioengineering (nature-based) methods for revetments - $0

6. **Fern Ridge – Total - $8,064,000**

    M639 - Restore upstream and downstream passage at drop structures - $8,064,000

    Capital - $5,600,000

    Design/EDC – $2,464,000

7. **Hills Creek – Total - $427,470,000**

    M105 - Construct temperature control structure - $216,000,000

    Capital - $150,000,000

    Design/EDC – $66,000,000

    M30 - Change flows to provide effective biological benefit - $0

    M304 - Augment flows by tapping power pool - $0

    M52 - Provide Pacific lamprey passage and infrastructure at adult traps where possible - $0

    M722 - Construct adult fish facility - $36,250,000

    Capital - $25,000,000

    Design/EDC – $11,000,000

OMRRR - $250,000

M392 - Construct structural downstream passage - $175,220,000

Capital - $119,000,000

Design/EDC – $52,360,000

OMRRR – $3,860,000

8. Lookout Point – Total - $1,008,440,000

M105 - Construct temperature control structure - $512,160,000

Capital - $388,000,000

Design/EDC – $124,160,000

M174 - Structural improvements to reduce TDG where needed – $7,200,000

Capital - $5,000,000

Design/EDC – $2,200,000

M30 - Change flows to provide effective biological benefit - $0

M392 - Construct structural downstream passage (FSS) - $486,980,000

Capital - $366,000,000

Design/EDC – $117,120,000

OMRRR – $3,860,000

M304 - Augment flows by tapping power pool - $0

M719 - Implement hatchery transition plan - $2,100,000

OMRRR - $2,100,000

9. Fall Creek – Total - $0

M40 - Deeper fall drawdowns to RO for downstream passage- $0

M30 - Change flows to provide effective biological benefit - $0

M718 - Augment instream flows by using inactive pool - $0

Table 3-7 summarizes the capital and OMRRR costs for Alternative 4. Lookout Point/Dexter and Detroit/Big Cliff have the highest capital costs under Alternative 4, with annual costs of $40.3 million and $36.6 million, respectively.

Table 3-7. Capital and OMRRR Cost Estimates - Alternative 4, Figures in thousands at 2021 Price Level

Project	Annual OMRRR [1]	Estimate d First Cost [2]	Estimated Annual Cost	Interest During Construction	Estimated Total Annual Cost
Detroit/Big Cliff	–	–	–	–	–
Low Value	–	$658,599	$22,553	$14,250	$28,661
Best Estimate Value	$6,108	$890,330	$30,488	$19,264	$36,596
High Value	–	$1,337,649	$45,806	$28,942	$51,914
Foster	–	–	–	–	–
Low Value	–	$64,801	$2,219	$1,402	$4,868
Best Estimate Value	$2,649	$84,348	$2,888	$1,825	$5,537
High Value	–	$122,080	$4,180	$2,641	$6,829
Green Peter	–	–	–	–	–
Low Value	–	$5,899	$202	$128	$222
Best Estimate Value	$20	$7,697	$264	$167	$284
High Value	–	$11,168	$382	$242	$402
Fern Ridge	–	–	–	–	–
Low Value	–	$6,232	$213	$135	$213
Best Estimate Value	$0	$8,064	$276	$174	$276
High Value	–	$11,600	$397	$251	$397
Cougar	–	–	–	–	–
Low Value	–	$156,647	$5,364	$3,389	$9,292
Best Estimate Value	$3,928	$215,205	$7,369	$4,656	$11,297
High Value	–	$328,242	$11,240	$7,102	$15,168
Blue River	–	–	–	–	–
Low Value	–	$306	$10	$7	$110
Best Estimate Value	$100	$420	$14	$9	$114
High Value	–	$641	$22	$14	$122
Hills Creek	–	–	–	–	–
Low Value	–	$327,180	$10,967	$0	$15,077
Best Estimate Value	$4,110	$423,360	$14,497	$9,160	$18,607
High Value	–	$609,019	$20,855	$13,177	$24,965
Lookout Point/Dexter	–	–	–	–	–
Low Value	–	$754,180	$25,826	$16,318	$31,786
Best Estimate Value	$5,960	$1,002,480	$34,329	$21,690	$40,289
High Value	–	$1,481,784	$50,742	$32,061	$56,702
Fall Creek	–	–	–	–	–
Low Value	–	$0	$0	$0	$0
Best Estimate Value	$0	$0	$0	$0	$0
High Value	–	$0	$0	$0	$0

Project	Annual OMRRR [1]	Estimate d First Cost [2]	Estimated Annual Cost	Interest During Construction	Estimated Total Annual Cost
Total	–	–	–	–	–
Low Value	–	$1,973,844	$67,354	$35,628	$90,229
Best Estimate Value	$22,875	$2,631,904	$90,126	$56,946	$113,001
High Value	–	$3,902,184	$133,625	$84,430	$156,500

[1]OMRRR is Operations, Maintenance, Repair, Replacement and Rehabilitation in addition to the NAA.

[2]Estimated Construction First Cost includes engineering, design, construction, and contingencies.

Notes:

a) Annual Construction Cost includes Interest During Construction and is calculated using the FY 2022 Federal Water Resources Discount Rate of 2.25% and a 50-year period of analysis. Interest During Construction assumes a 24 month construction period.

b) Cost estimate for NAA does not include measure 722 (new DEX AFF)

c) Sub-basin totals assume no change in annual hatchery mitigation costs. This should be revised once a fish passage implementation schedule is established.

d) Some O&M costs for NAA were not available as of the release of this draft.

CHAPTER 4 - Summary of All Costs

This chapter presents a summary of the annual costs for all alternatives. Table 4-1 summarizes the annual costs by alternative. The figures in Table 4-1 include the uncertainty factors shown in Table 2-1 that are used to calculate the low and high values for each alternative. As stated in the overview at the beginning of this appendix, Alternative 2b is synonymous with the Preferred Alternative (aka Alternative 5).

Table 4-1. Annual Cost Summary by Alternatives, Figures in thousands at 2021 Price Level

Project	Annual OMRRR [1]	Estimated First Cost [2]	Estimated Annual Cost	Interest During Construction	Estimated Total Annual Cost
No Action Alternative	–	–	–	–	–
Low Value	$9,279	–	–	–	$9,279
Best Estimate Value	$9,279	–	–	–	$9,279
High Value	$9,279	–	–	–	$9,279
Alternative 1	–	–	–	–	–
Low Value	$21,745	$1,825,462	$62,510	$39,497	$84,255
Best Estimate Value	$21,745	$2,413,622	$82,651	$52,223	$104,396
High Value	$21,745	$3,500,572	$119,872	$75,741	$141,617
Alternative 2a	–	–	–	–	–
Low Value	$21,505	$1,017,652	$34,848	$22,019	$56,353
Best Estimate Value	$21,505	$1,344,952	$46,056	$29,100	$67,561
High Value	$21,505	$1,993,692	$68,271	$43,137	$89,776
Alternative 2b	–	–	–	–	–
Low Value	$17,694	$979,347	$33,536	$21,190	$51,230

Project	Annual OMRRR [1]	Estimated First Cost [2]	Estimated Annual Cost	Interest During Construction	Estimated Total Annual Cost
Best Estimate Value	$17,694	$1,302,347	$44,597	$28,178	$62,291
High Value	$17,694	$2,000,187	$68,494	$43,277	$86,188
Alternative 3a	–	–	–	–	–
Low Value	$10,366	$399,207	$13,559	$5,317	$23,925
Best Estimate Value	$10,366	$469,457	$16,076	$10,157	$26,442
High Value	$10,366	$612,797	$20,984	$13,259	$31,350
Alternative 3b	–	–	–	–	–
Low Value	$10,385	$505,307	$17,192	$7,593	$27,577
Best Estimate Value	$10,385	$591,857	$20,267	$12,806	$30,652
High Value	$10,385	$875,197	$29,970	$18,936	$40,355
Alternative 4	–	–	–	–	–
Low Value	$22,875	$1,973,844	$67,354	$35,628	$90,229
Best Estimate Value	$22,875	$2,631,904	$90,126	$56,946	$113,001
High Value	$22,875	$3,902,184	$133,625	$84,430	$156,500

[1]OMRRR is Operations, Maintenance, Repair, Replacement and Rehabilitation.

[2]Estimated Construction First Cost includes engineering, design, construction, and contingencies.

Notes:

a) Annual Construction Cost and Interest During Construction are calculated using the FY 2022 Federal Water Resources Discount Rate of 2.25% and a 50-year period of analysis. Interest During Construction assumes a 24 month construction period.

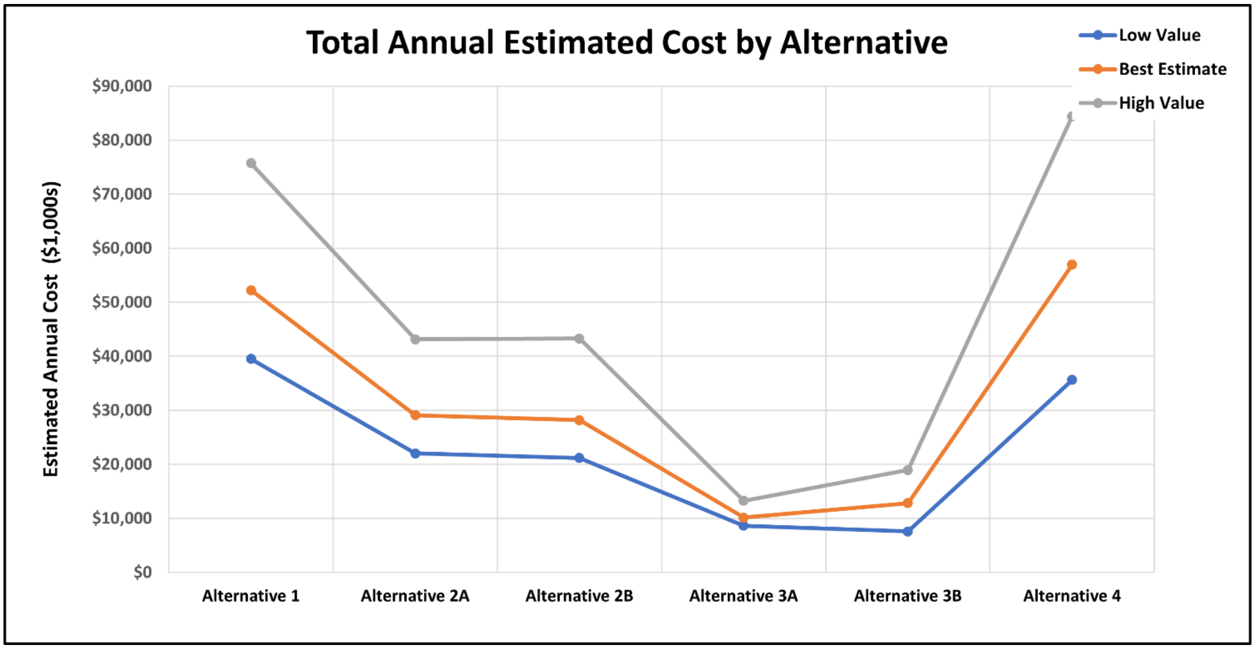
b) Cost estimate for NAA does not include measure 722 (new DEX AFF)

c) Sub-basin totals assume no change in annual hatchery mitigation costs. This should be revised once a fish passage implementation schedule is established.

d) Some O&M costs for NAA were not available as of the release of this draft.

Figure 4-1 shows a comparison in estimated annual costs by alternative using the same data shown in Table 4-1. Alternative 4 and Alternative 1 have the highest estimated costs at $113 million and $104.4 million, respectively. Alternative 2b, which is also the Preferred Alternative, has an estimated annual cost of $62.3 million.

Figure 4-1. Total Annual Cost by Alternative



REFERENCES

Corps, 2019. Economic Guidance Memorandum 22-01, Federal Interest Rates for Corps of Engineers Projects for Fiscal Year 2022. 31 October 2021. Available online at: https://planning.erdc.dren.mil/toolbox/library/EGMs/EGM22-01.pdf.

US Army Corps of Engineers®
Portland District

WILLAMETTE VALLEY SYSTEM OPERATIONS AND MAINTENANCE

DRAFT PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT

APPENDIX N: IMPLEMENTATION AND ADAPTIVE MANAGEMENT PLAN

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1 - INTRODUCTION

The Draft Implementation and Adaptive Management Plan was developed to accompany the Draft Programmatic Environmental Impact Statement (PEIS) for operation and maintenance (O&M) of the Willamette Valley System (WVS), a combination of 13 multipurpose dams and reservoirs (impoundments), riverbank protection projects, fish passage facilities, adult fish collection facilities, and hatchery programs in the Willamette River Basin (WRB). This Draft Implementation and Adaptive Management Plan [referred to separately herein as the Implementation Plan (IP) or the Adaptive Management Plan (AMP)] is the proposed framework for implementing, monitoring, and evaluating the actions that are included in the proposed action documented in the Biological Assessment used for consultation under Section 7(a)(2) of the Endangered Species Act (ESA).

1.1 BACKGROUND ON WILLAMETTE VALLEY SYSTEM

The WRB is an approximately 11,478-square-mile drainage area around the Willamette River, which flows north through a fertile valley in the State of Oregon (USACE, 2019a). The WRB is located entirely within the State of Oregon, beginning south of Cottage Grove and extending approximately 187 miles to the north where it flows into the Columbia River. The Willamette River is the 13th largest river in the conterminous United States (U.S.) in terms of streamflow and produces more runoff per unit area than any of the 12 larger rivers (EPA, 2013). The WRB averages 75 miles in width and encompasses approximately 12 percent of the total area of the state (USACE, 2019a).

The WRB is bound by three mountain ranges: the Cascade Range to the east; the Coast Range to the west; and the Calapooya Mountains to the south. Maximum elevations exceed 10,000 feet in the Cascade Range, 4,000 feet in the Coast Range, and 6,000 feet in the Calapooya Mountains. Major Cascade Range tributaries include the Santiam, McKenzie, Middle Fork Willamette, Molalla, and Clackamas rivers. The Willamette River is also fed by major tributaries from the Coast Range, including the Long Tom, Marys, Luckiamute, Yamhill, and Tualatin rivers. At the south end of the basin, the Coast Fork of the Willamette River emerges from the Calapooya Mountains and joins the mainstem Willamette River near the City of Springfield (USACE, 2019a).

The WRB encompasses 12 sub-basins, or smaller basins within the larger WRB. These are the Lower Willamette, Tualatin, Molalla-Pudding, Yamhill, Clackamas, South Santiam, North Santiam, Middle Willamette, McKenzie, Coast Fork Willamette, Middle Fork Willamette, and Upper Willamette. Six of these sub-basins – Middle Fork Willamette, Coast Fork Willamette, McKenzie River, Long Tom, South Santiam, and North Santiam – contain dams; these sub-basins comprise the WVS.

In the 1930s, Congress authorized USACE to construct, operate, and maintain the WVS for flood control purposes. The WVS was originally authorized by three Flood Control Acts (FCAs) passed in 1938, 1950, and 1960. Between 1932 and 1972, USACE constructed 13 dams and extensive bank protection revetments along the Willamette River and its tributaries, creating the WVS.

Since their completion, the dams have cumulatively prevented more than $25 billion in flood damages to the Willamette Valley. The 1938 FCA authorized the following dam construction projects: Fern Ridge on the Long Tom River, Dorena and Cottage Grove in the Coast Fork Willamette sub-basin, Lookout Point on the Middle Fork Willamette River, Detroit on the North Santiam River, and Green Peter on the Middle Santiam River. The 1950 FCA reauthorized Green Peter and authorized Big Cliff on the North Santiam, Cougar and Blue River dams on the McKenzie River, Hills Creek and Dexter on the Middle Fork Willamette River and Fall Creek on Fall Creek.

House Document (HD) 531 is the overall guiding legislation that provides the basic the authorized purposes of the WVS. Existing water control manuals provide guidance regarding the regulation of the individual projects in compliance with those purposes. USACE continues to operate and maintain the WVS, which today consists of a combination of 13 multipurpose reservoirs, riverbank protection projects, fish passage facilities, adult fish collection facilities, and hatchery programs within the WRB. Eleven of the 13 dams are multipurpose and three are re-regulating (i.e., used to even out peak discharges of water used for power generation at an upstream dam, thereby controlling downstream river level fluctuations). Eight of the 13 dams are hydropower dams (USACE, 2019b). The WVS includes 100 miles of revetments along the mainstem and tributaries of the Willamette River. The WVS also includes five fish hatcheries.

The locations of the 13 dams and reservoirs in the WVS are shown in Figure 1.1-1. Dams with or without hydropower are indicated, as well as which dams are re-regulating dams. Adult fish collection facilities, hatcheries, and control points of the dams are also shown. Control points are United States Geological Survey (USGS)-gaged locations which contain instrumentation that collects information on water surface elevations. This information helps determine the amount of stored water that can or should be released from upstream reservoirs to meet minimum and maximum flow requirements targeted by dam operators. The downstream control points in the WRB are in the towns of Goshen, Monroe, Vida, Jasper, Mehama, Jefferson, Waterloo, Albany, Harrisburg, and Salem, Oregon.

The WVS is currently operated and maintained to accomplish the various purposes established by Congress when the WVS was initially authorized for construction or in subsequent authorizations. Authorized purposes are purposes assigned to a project by Congress. While the WVS is operated as a whole, each dam and reservoir (or “project”) within the WVS is authorized for a specific set of purposes. For WVS projects, authorized purposes include flood risk management; irrigation; navigation; hydropower; fish and wildlife; water quality; recreation; and water supply.

The geographic scope of the Draft PEIS is the WRB; that is, the 13 dams and reservoirs on the Willamette River and the six sub-basins containing dams that comprise the WVS, including the Middle Fork Willamette, Coast Fork Willamette, McKenzie River, Long Tom, South Santiam, and North Santiam, riverbank protection projects, fish passage facilities, fish hatcheries, adult fish collection facilities, and communities and populations within the WRB.

Formatting refers to a document's appearance, including the font, spacing, margins, layout, and table style. Formatting is not the same as the outline. This style guide is an example of how the EIS will be formatted.

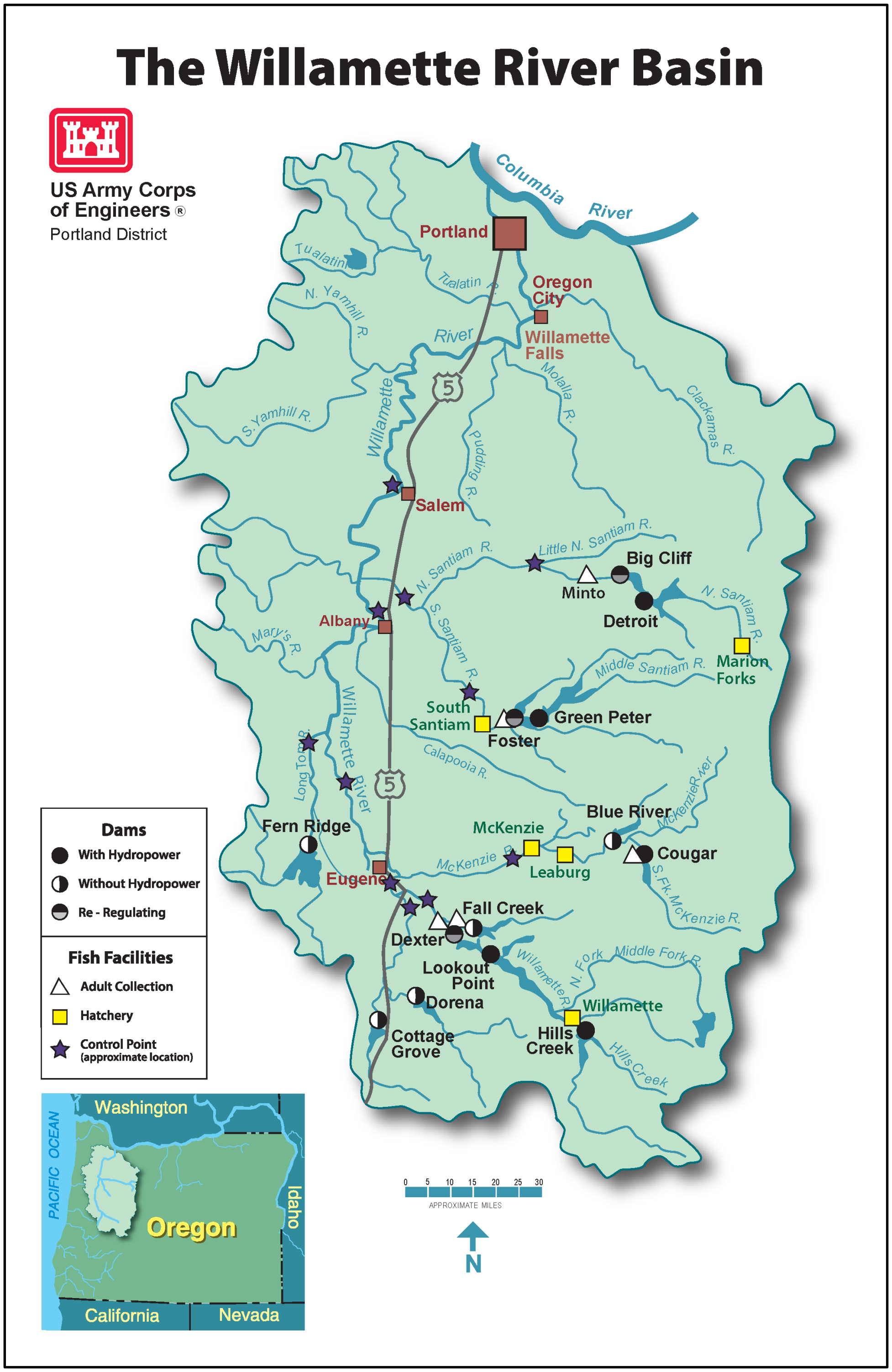


Figure 1-1. The Willamette River Basin

1.2 PURPOSE OF PROPOSED ACTION

As stated in Chapter 1 of the Draft PEIS, the project's purpose, or the goal of the project, is to continue to operate and maintain the WVS for the authorized purposes of flood risk management, hydropower generation, irrigation, navigation, recreation, fish and wildlife, water supply, and water quality. The last PEIS that evaluated WVS systems and operations was completed in 1980. Over the four decades following completion of the 1980 PEIS (1980 – 2022), operations have been modified and structural measures for fish passage and temperature control have been implemented to improve conditions for ESA-listed fish species. New information relevant to the environmental effects of operating the WVS has also been acquired, including information related to ESA-listed fish species.

As mentioned previously, the 2008 National Marine Fisheries Service (NMFS) Biological Opinion (BiOp) determined that the proposed continuation of operations of the WVS would jeopardize UWR Chinook salmon and UWR steelhead (NMFS, 2008). Therefore, the need for the project, or the need to which USACE is responding, is to continue to operate and maintain the WVS in accordance with its authorized purposes, but to do so without jeopardizing ESA-listed species and/or destroying or adversely modifying their designated critical habitat within the WVS.

1.3 SCOPE OF IMPLEMENTATION AND ADAPTIVE MANAGEMENT PLAN

The Draft PEIS evaluates a range of action alternatives in addition to the No Action alternative. The Draft IP and AMP have been developed based on the Preferred Alternative identified in the Draft PEIS; however, the concepts and framework for long-term implementation and adaptive management (AM) described would be applicable to any action alternative if selected in a record of decision. All management measures included in the Preferred Alternative are considered. The Preferred Alternative includes near-term operations measures that were ordered by the Court as part of an interim injunction in NEDC V. USACE. In addition, the Court has ordered three structural measures including the construction of the Dexter Adult Fish Facility, Big Cliff Total Dissolved Gas (TDG) Abatement, and Cougar Regulating Outlet (RO) Chute Resurfacing. These three structural measures have been included within the scope of this Draft Implementation and Adaptive Management Plan as they will be completed after the ROD.

The IP component identifies a prioritization of measures for implementation, a timeline for their implementation, and implementation criteria that must be met prior to initiating implementation. The AMP component outlines the governance structure to be used for adaptive decision-making, the annual adaptive management process for engaging with stakeholders and incorporating new learning into management priorities, and outlines the decision criteria including performance metrics, targets, and decision triggers relevant to monitoring and evaluating the success of management measures at achieving stated objectives.

CHAPTER 2 - IMPLEMENTATION PLAN

The Implementation Plan can be considered a roadmap that lays out a strategy and schedule for implementation of the actions developed through the programmatic EIS process. Considerations such as basin-wide priorities, risk and uncertainty, data gaps and other factors have been used to shape this plan and develop a schedule that is aggressive while being reasonable and implementable, given the presently available information.

This plan links immediate actions (e.g., Near-Term (NT) Operations) to the longer-term actions, such as the upstream and downstream fish passage construction projects and identifies when check-ins, or points along the implementation timeline where course correction (on-ramps/off-ramps) may be necessary. These check-ins are discussed in more detail below.

2.1 NEAR-TERM OPERATIONS MEASURE

As part of the PA, four downstream fish passage structures and one selective withdrawal structure for downstream water temperature management will be constructed. These structures will be complex, costly, and may take multiple years to design and construct. In the interim, NT operations will be implemented to provide immediate benefit to the species while longer-term solutions are developed and/or constructed. In addition, other actions such as outplanting, propagation via the hatchery program, gravel augmentation, etc. will also be carried out.

Many of the NT operations were ordered by the Court as part of the injunctive relief. So, many of the NT Operations described in this plan have already been implemented and will continue to be implemented until long-term actions are constructed/finalized. It should be expected that as these NT operations continue to be implemented, additional refinements may be necessary. Adaptability to changing conditions (e.g., climate change, changes in priorities or changes in operations due to structures coming online) may also be necessary. The NT operations are listed in Figure 2.1-1.

In addition to the NT operations, the Court order required the evaluation of two structural measures including Big Cliff Total Dissolved Gas (TDG) Abatement and Cougar Regulating Outlet (RO) Modifications, as well as the completion of the design/construction of the Dexter Adult Fish Facility. While these actions are tracked in this Implementation Plan, the structural injunction measure will undergo a separate NEPA process that will assess the direct, indirect, and cumulative impacts of their effects on the human environment. These measures are not included in Chapter 3 of this EIS; however, Chapter 4, cumulative effects, analyzes construction, operations, and maintenance impacts of these measures.

North Santiam

- Use mix of spillway, regulating outlets, and turbines for temperature and passage in spring (DET)
- Split RO and turbine use for passage in fall (DET)
- Spread spill for TDG reduction (BCL)

South Santiam

- Outplant fish above Green Peter
- Use spillway to pass fish in spring (GPR)
- Drawdown to ROs in fall passage (GPR)
- Delay refill and use fish weir in spring (FOS)
- Fall drawdown and spill (FOS)

McKenzie

- Spring and fall drawdown to RO for fish passage (CGR)

Middle Fork

- Prioritize ROs at night in fall and winter for fish passage (HCR)
- Drawdown to ROs in the fall and winter for fish passage (LOP)
- Use spillway to pass fish in spring (LOP)
- Use ROs in the summer and fall for temperature management (LOP)
- Drawdown in fall, winter, and spring for fish passage (FAL)

Figure 2-1. Specific Actions as Included in the Near-Term Operations Measure

2.2 ACTIONS IN THE PREFERRED ALTERNATIVE (PA)

Alternative 5, "Integrated Water Management Flexibility and ESA-Listed Fish Alternative" was identified as the PA in the Draft PEIS (Figure 2.2-1). This alternative is comprised of a mix of operational and structural measures to be implemented across the basin. The Implementation Plan and timeline lays out the schedule for completing various actions in the PA at the different USACE projects over the next thirty years.

	Upstream Passage	Downstream Passage	Temperature	Total Dissolved Gas (TDG)	Measures Common to All Alternatives
DEX	Adult Fish Facility (AFF) Improvement				Integrated Temperature and Habitat Flow Regime Gravel Augmentation Adapt Hatchery Program Maintain Revetments using Nature-based Engineering Methods Maintain Fish Release Locations above Dams (Outplanting) Near-term Operations
LOP		*Structure: Floating Surface Collector (FSC)			
HCR					
FCR	AFF	Operation: Fall Draw Down			
CGR	AFF	*Diversion Tunnel Operation (requires structural improvements)	Temperature Tower		
BLU					
FOS	AFF	Combination of Operations & a Small Structure	Pipe Warm Water to AFF		
GPR	Construct AFF w/ Lamprey Passage	Operation: Spring Spill & Fall Draw Down	Operation		
BCL	AFF			Structure to improve TDG	
DET		*Structure: FSS	*Structure: Temperature Tower		

Figure 2-2. Main Measures in the Preferred Alternative

2.3 PRIORITIZATION OF ACTIONS FOR IMPLEMENTATION

Even though each measure within the PA is considered a priority, it is infeasible to carry out all actions simultaneously. Therefore, careful consideration was given to the timing of implementation considering the following set of priorities:

- Prioritize projects in subbasins with multi-species benefit.
- Prioritize projects that are closest to construction phase.
- Prioritize injunction-related projects.
- Lean out on study design and funding documentation where possible.
- Allow for necessary time to resolve data gaps and operational research needs.
- Consider impacts to system storage/water management/water supply.

Once the above set of prioritizations and potential conflicts were considered, the measures were organized into three categories including: (1) actions that could legally and feasibly start prior to the ROD; (2) actions that could be implemented immediately after the ROD is signed; and (3) long-term solutions that could take many years to complete either due to their high complexity or the need for further study or congressional approval (Figure 2.3-1). An Implementation Timeline was developed based on the application of these categories to the measures.

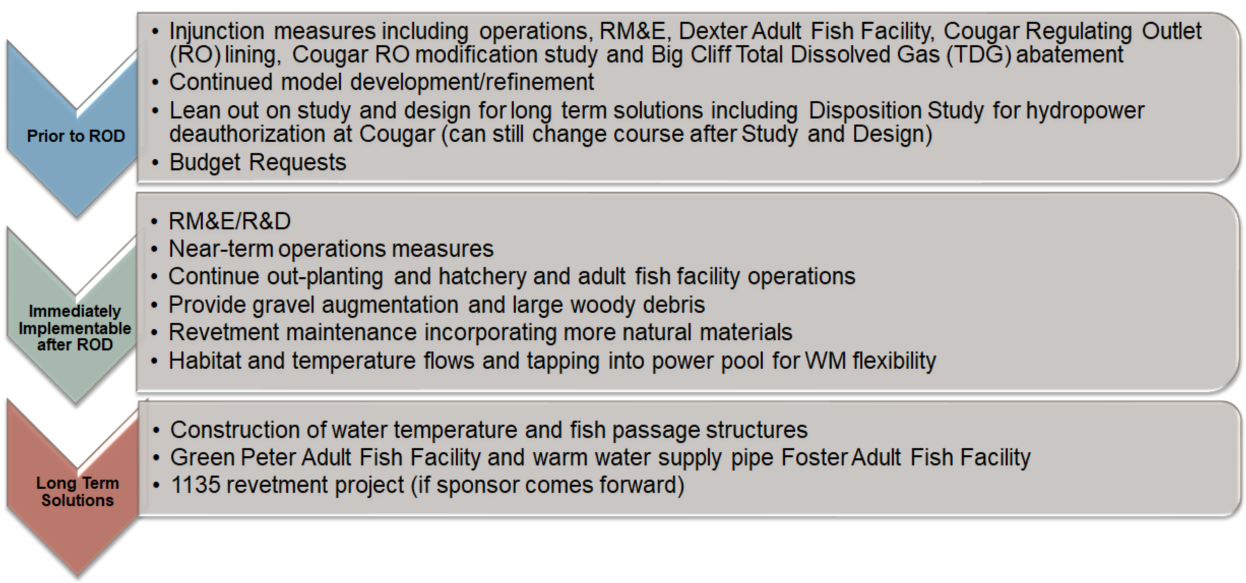


Figure 2-3. Implementation Phases

2.4 IMPLEMENTATION TIMELINE

The Implementation Timeline is broken out by project and extends from present (2022) through 2054 (Figure 4). This timeline includes the major operational and structural measures selected as part of the PA. What is not shown in this timeline are the measures common to all alternatives:

- Integrated Temperature and Habitat Flow Regime
- Gravel Augmentation
- Adaptive Hatchery Program
- Maintain Revetments using Nature-based Engineering Methods
- Maintain Fish Release Locations above Dams (outplanting)
- Continued Sustainable Rivers Program and Implementation of Environmental Flows
- Water Management Flexibility (i.e., use of power pools)

These measures will begin after the ROD is signed and will continue until system operations are reevaluated. Continued RM&E, new RM&E, and post-construction evaluations are also not included in the Implementation Timeline but will be carried out as appropriate.

The following sections describe the Implementation Timeline in greater detail and by project. As shown in Figure 2.4-1, each phase of each construction project is identified including the Engineering Design Report (EDR) or alternatives study phase, the Detailed Design Report (DDR) phase, Plans and Specifications (P&S), Contract Award and Construction. Potential risks and uncertainties and major check-ins are also noted.

2.4.1 Cougar Dam

Several actions will be taken at Cougar prior to the ROD, as required by a court order, they include the continued implementation of operations which informed the near-term operations for improved fall, winter and spring downstream fish passage and survival, the resurfacing of the Cougar RO chute and the completion of the Cougar RO Modifications EDR. In 2023 and once the EDR is complete, the first major check-in (represented by the yellow start in Figure 2.4-1) will occur. During this check-in, a decision will be made regarding further modifications to the Cougar RO to improve downstream fish passage and survival. This implementation schedule assumes that additional improvements will be construction, with completion of modifications by the end of 2027.

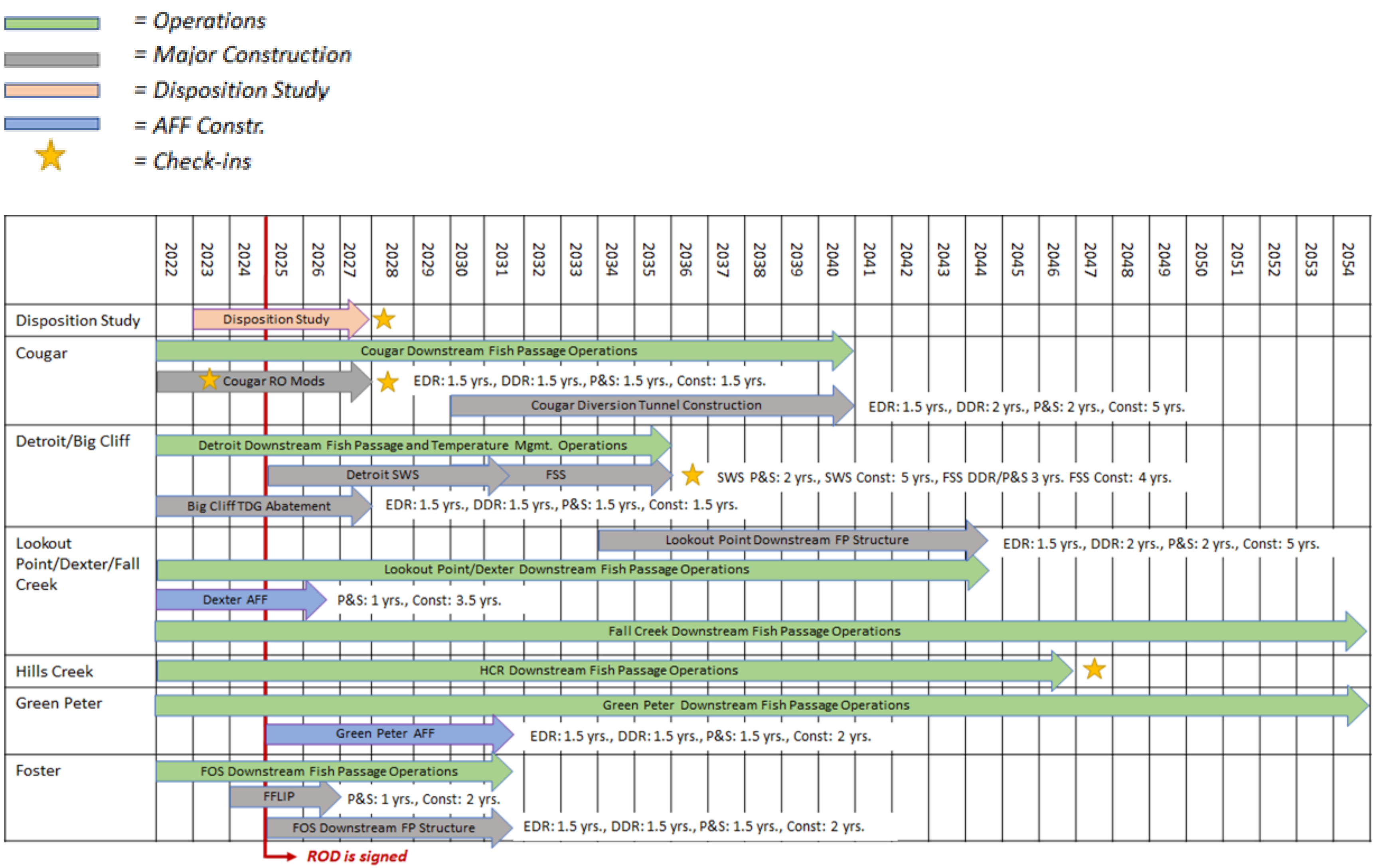


Figure 2-4. Implementation Timeline

USACE will also lean out in implementation prior to the ROD by beginning the disposition process to evaluate the potential to deauthorize hydropower at Cougar. At present, the timing, scope. and scale of the Disposition Study is unknown, so refinements to the Implementation Timeline, specifically for Cougar, should be anticipated. This study will result in a formal recommendation to Congress on whether to deauthorize power at Cougar, which would allow for the utilization of the Diversion Tunnel for fish passage, which Congress will also have to fund prior to USACE initiating the EDR phase of project.

Post the ROD and the Cougar RO modifications, a second major check-in will take place. During this check-in, information from the Disposition Study, in conjunction with post-construction evaluation data from the RO modifications and/or the determination by Congress to deauthorize hydropower and fund the diversion tunnel will be used to inform the next steps at Cougar Dam. By 2028, a determination will be made as to whether USACE will continue with the Diversion Tunnel EDR or if it will use an off ramp to not pursue the Cougar Diversion Tunnel Construction Project and continue to use the modified Cougar ROs and operations strategy for long-term fish passage. This off ramp would signal a change in direction from the current proposed action and preferred alternative triggering the need for additional legal and environmental compliance.

2.4.2 Detroit Dam

Operational changes are being carried out prior to the ROD as part of the injunction. These operations will be continued after the ROD as part of the NT measures. These operations focus on the improved fall, winter and spring downstream fish passage and downstream water temperature management. As RM&E informs the success or shortfalls of these operations adjustments mat be necessary. Adjustments may result in the need for additional legal and environmental compliance.

Once the ROD is signed, USACE will begin the P&S phase of the Detroit Selective Withdrawal Structure (SWS) and Floating Screen Structure (FSS), followed by construction. Due to the limited physical space on the dam, the structures will be constructed in two phases with the SWS constructed first, then the FSS. Anticipated completion of all construction is 2035. The Implementation Timelines does not include post-construction evaluation timelines, but it is anticipated that RM&E would continue for at least 3-5 years post-construction.

2.4.3 Big Cliff Dam

USACE developed a reasonable timeline for design and construction and has started an EDR for constructing a structural solution for mitigating excess TDG levels below Big Cliff Dam during spill operations, as required by court order. The implementation plan assumes that USACE would continue with the design and construction of a TDG abatement structure at Big Cliff Dam with completion set for 2027.

2.4.4 Green Peter Dam

Prior to the ROD, USACE will change current operations at Green Peter Dam to improve downstream fish passage in the spring through a surface spill operation and prioritization of the spillway, and a fall operation which includes a deep drawdown and prioritization of the regulating outlets, as required by court order. Continuation of this operation is part of the preferred alternative so after the ROD the operation will continue, though as RM&E is conducted on the operation potential modifications to the operation may be necessary. Adjustments may result in the need for additional legal and environmental compliance.

In addition, an Adult Fish Facility (AFF) will be constructed at the base of Green Peter Dam to support upstream migration and the outplanting of fish in Quartzville Creek and the Middle Santiam River above the dam. The Green Peter AFF project, including the design phase, would start once the ROD is signed, with anticipated completion of a facility by 2031. Until then, fish collected at the Foster AFF will be used for outplanting purposes.

2.4.5 Foster Dam

As shown in Figure 2.4-1, immediate actions at Foster Dam include the NT measures for fall and spring downstream fish passage and summer water temperature management operations through use of the Foster fish weir, and the continued design work for the Foster fish ladder warm water supply pipe (FFLIP project). Once the ROD is signed, USACE will start construction of the FFLIP, which is estimated to take two-years to complete. During this time, USACE would begin the EDR phase of a structural downstream fish passage solution at Foster Dam. Once funded, the EDR and DDR phase for the downstream fish passage structure is estimated to take a total of three years to complete, with P&S and construction taking an additional 3.5 years. Completion of a downstream fish passage structure is expected by 2031. It should be noted that the downstream fish passage structure at Foster Dam is anticipated to be a simpler structure as compared to the structures at Detroit or Lookout Point Dam, therefore the timeframe for completion is shorter.

2.4.6 Lookout Point Dam

Prior to the ROD, USACE will implement operations for improved fall, winter and spring downstream fish passage and downstream water temperature management in the summer through prioritized use of the ROs, as required by the court order. Once the ROD is signed, USACE will continue these operations as part of the NT operations measure and will continue them until construction of a downstream fish passage structure makes it infeasible, while starting the EDR and alternatives analysis for long-term structural downstream fish passage. During the EDR phase, further review of existing fish passage data and the identification of further RM&E needs will be completed. A major check-in will occur at the conclusion of the EDR, and USACE will decide whether to move forward with the DDR phase of Lookout Point downstream fish passage design or wait for additional RM&E and/or the post-construction evaluation of the Detroit Dam FSS to be completed so that lessons learned from Detroit can be applied to Lookout Point.

The current assumption is that the Lookout Point DDR will start in 2034, allowing for additional RM&E and the post-construction evaluation of the Detroit Dam FSS. Currently, construction of a downstream fish passage structure at Lookout Point Dam is set for completion in 2044. In the interim, immediate improvements to downstream fish passage and survival are expected from the implementation of the deep winter drawdown of Lookout Point Reservoir. While this operation is not yet fully developed, it is assumed that the reservoir will be drawn down to El. 750 ft. or approximately 25 feet above the ROs during the winter; the ROs will be prioritized and used as a surface outlet for downstream passage. This measure is expected to start in 2023 and continue until a structural solution is fully constructed and operational.

2.4.7 Dexter Dam

Prior to the ROD, USACE will implement operations for spring downstream fish passage at Lookout Point Dam includes spill releases at Dexter Dam and continue to work towards completion of P&S and construction of the Dexter AFF, as required by the court order. Completion of this structure anticipated in 2026.

2.4.8 Fall Creek Dam

As described in the PA, NT measures for improved downstream fish passage and survival will be implemented at Fall Creek Dam through the term of the EIS/BiOp. These operations include improved downstream fish passage in the spring through a delayed refill and prioritized RO operation, and a fall deep drawdown (i.e., run-of-river) operation. No new structures are planned.

2.4.9 Hills Creek Dam

Prior to the ROD, USACE will continue to operate to provide passage by prioritizing use of the ROs while the reservoir is <El.1460 ft, as required by the court order. This operation would continue immediately after the ROD until all the major construction projects in the preferred alternative are operational or until the decision of whether to pursue alternative operational and/or structural upstream and/or downstream fish passage at Hills Creek Dam is made as denoted in the Implementation Plan as a major check in. Specific criteria for determining whether an additional structure should be constructed will be laid out in the AM plan and the decision will be based on the decision and information gathered as part of RM&E efforts. This major check-in does not preclude the continuation of RM&E and the on-going evaluation of fish passage at Hills Creek Dam at the regional level. Adaptive decision-making is critical to the future success of the Willamette Valley System and the achievement of shared objectives.

2.4.10 Risk and Uncertainty

The Implementation Timeline is based on the information available to USACE at present and modifications or changes to this timeline are possible due to an imperfect understanding of biological condition, performance and outcome, as well as a number of risks and uncertainties.

Discussion of some of these risks and uncertainties follows:

Funding

While the uncertainty in funding was not used to shape or drive the Implementation Timeline, funding constraints could impact schedule and the completion of major construction projects into the future. If funding constraints are identified, adjustments to schedule and a prioritization of future work will be discussed on a regional level as described in the Adaptive Management Plan.

Disposition Study

At present, the scope and scale of the Disposition Study is unknown. For now, a five-year timeline is being assumed as a conservative placeholder for the Disposition Study. Adjustments to the duration of this study will be made as necessary, which could impact the timing of follow-on actions.

Congressional Authorization – Cougar Diversion Tunnel

USACE will continue to make improvements to Cougar Dam through RO modifications while the Disposition Study is being completed. Information from the Disposition Study, in conjunction with post-construction evaluation data from additional Cougar RO modifications will be used to affirm USACE decision to use the Diversion Tunnel to pass fish as Cougar Dam. If data warrants moving forward with the Cougar Diversion Tunnel Construction Project, congressional approval and funding will be required prior to the start of the EDR phase of the project. At present, the timing, scope and scale of the Disposition Study is unknown, so refinements to the Implementation Timeline, specifically for Cougar should be anticipated.

Adaptive Management

The RM&E program will continue while the Implementation Plan is carried out. New information gathered through RM&E will likely lead to a new understanding and refinement of models which may warrant adjustments to the Implementation Timeline and current set of assumptions and priorities. Adjustments to the Implementation Timeline are possible, and steps for such adjustments are discussed in greater details in the Adaptive Management Plan.

Water Management

Impacts to USACE's flood risk management mission should be considered during the design and planning phase of each construction project. While construction during the rainy season can be challenging, USACE can mitigate for risks by drawing reservoirs down to gain more reservoir storage, capture more water and reduce the risk of flooding construction sites or downstream areas. Drawing down reservoirs, however, can impact refill and the ability to meet instream and mainstem flow targets during the summer season, so impacts should be carefully weighed. In some cases, constructing "in the wet", meaning constructing structures without a reservoir drawdown may be warranted, but even this option can come with considerable risks not only to schedule but to overall construction costs as well. As each project's design is finalized, some adjustments to construction timelines may be necessary and the Implementation Timeline will be adjusted to reflect these changes.

2.4.11 NEPA Compliance

NEPA, in combination with the Council on Environmental Quality (CEQ) and USACE regulations, require the USACE to prepare an EIS evaluating the impacts of a proposed Federal action that will significantly affect the human environment so that an informed decision can be made in selecting an alternative for implementation. Due to the complex nature of the interrelated Federal actions in the WVS, USACE employed a programmatic EIS. The benefit of a programmatic EIS is that it allows future site-specific projects to be tiered from the overarching programmatic EIS analysis to help streamline future environmental reviews. CEQ regulations allow this tiering, with the policy or program EIS covering "general matters" and subsequent tiers or separable projects being allowed a narrower environmental analysis that focuses on the project-specific impacts important to the decision maker. This approach is well suited to the WVS, as it integrates very well with AM. A programmatic EIS facilitates responsiveness when monitoring indicates change to Federal actions because objectives are not being met or new scientific understanding dictates alternative strategies, thus strengthening the implementation of the plan. Implementation of specific projects or management measures may require subsequent analysis that can be tiered from the EIS. If the AM process provides new and significant information that requires actions not included within the range of impacts and alternatives considered in this EIS, additional NEPA analysis will be required. Table 2.4-1 identifies those measures that are currently anticipated to require tiered NEPA reviews prior to implementation.

Table 2-1. Measures Anticipated to Require Tiered NEPA Reviews

Measure Category	Subtype	Measure #	Measure Name
Temperature	Structural	105	Construct water temperature control tower
Temperature	Structural	479	Foster Fish Ladder Temperature Improvement
Temperature	Operational	721	Use spillway for surface spill in summer
TDG	Structural	174	Structural improvements to reduce TDG
Downstream Passage	Operational	40	Deeper fall reservoir drawdowns for downstream fish passage
Downstream Passage	Structural	392	Construct structural downstream fish passage
Downstream Passage	Operational	714	Pass water over spillway in spring for downstream fish passage
Downstream Passage	Operational	720	Spring reservoir drawdown for downstream fish passage

Measure Category	Subtype	Measure #	Measure Name
Upstream passage	Structural	52	Provide Pacific lamprey passage and infrastructure
Upstream passage	Structural	639	Restore upstream and downstream passage at drop structures
Upstream passage	Structural	722	Construct adult fish facility
Common to All	Structural	384	Gravel Augmentation
Common to All	Structural	9	Maintain Revetments using nature-based engineering or alter revetments for aquatic ecosystem restoration
Common to All	Operational / Structural	726	Maintain adult fish release locations above dams
Existing Operations Continued Forward Common to All Alternatives	Operational		Operation, Maintenance, Repair, Replacement and Rehabilitation

CHAPTER 3 - OVERVIEW OF ADAPTIVE MANAGEMENT

3.1 ADAPTIVE MANAGEMENT DEFINED

USACE's adaptive management technical guide (USACE, 2019c) defines adaptive management (AM) as a formal, science-based, risk management strategy that permits implementation of actions despite uncertainties. Knowledge gained from monitoring and evaluating results is used to adjust and direct future decisions. Simply stated, AM is learning while doing in the face of uncertain outcomes.

The conceptual basis for the USACE definition of AM derives from the following description provided by the National Research Council in its report Adaptive Management for Water Resources Project Planning (NRC, 2004):

> Adaptive management [is a decision process that] promotes flexible decision making that can be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood. Careful monitoring of these outcomes both advances scientific understanding and helps adjust policies or operations as part of an iterative learning process. Adaptive management also recognizes the importance of natural variability in contributing to ecological resilience and productivity. It is not a 'trial and error' process, but rather emphasizes learning while doing. Adaptive management does not represent an end in itself, but rather a means to more effective decisions and enhanced benefits. Its true measure is in how well it helps meet environmental, social, and economic goals, increases scientific knowledge, and reduces tensions among stakeholders.

These AM concepts are consistent with those presented in the U.S. Department of Interior's AM technical guide (Williams et al. 2009).

As summarized in USACE (2019c), certain characteristics are common to most definitions of AM. Adaptive management:

- Involves the accumulation of understanding over time (i.e., learning) and adjustment of management decisions over time (i.e., adaptation) to better achieve goals and objectives.
- It demands the clear statement of objectives, identification of management alternatives, predictions of management consequences, and recognition of uncertainties.
- Includes stakeholder engagement, monitoring of resource response, and modeling.
- It requires a governance process that ensures new knowledge is operationalized through decision making.

To be an adaptive decision process, all these activities must be present in a framework tailored to meet the decision needs. Figure 3.1-1 illustrates the steps in an adaptive management cycle compatible with USACE projects.

This AMP is being developed during Step 1, Plan/Design, concurrently with the Draft PEIS. Although some near-term operations measures are currently being implemented as part of the injunction, the long-term AM described in this plan would not take effect until a ROD is signed. As described previously, some measures would remain in Step 1 until certain implementation criteria are met as described in Chapter 2 (e.g., completion of tiered NEPA reviews, Disposition Study). Some measures would be implemented immediately (Step 2) following a ROD, which would initiate the long-term AM cycle.

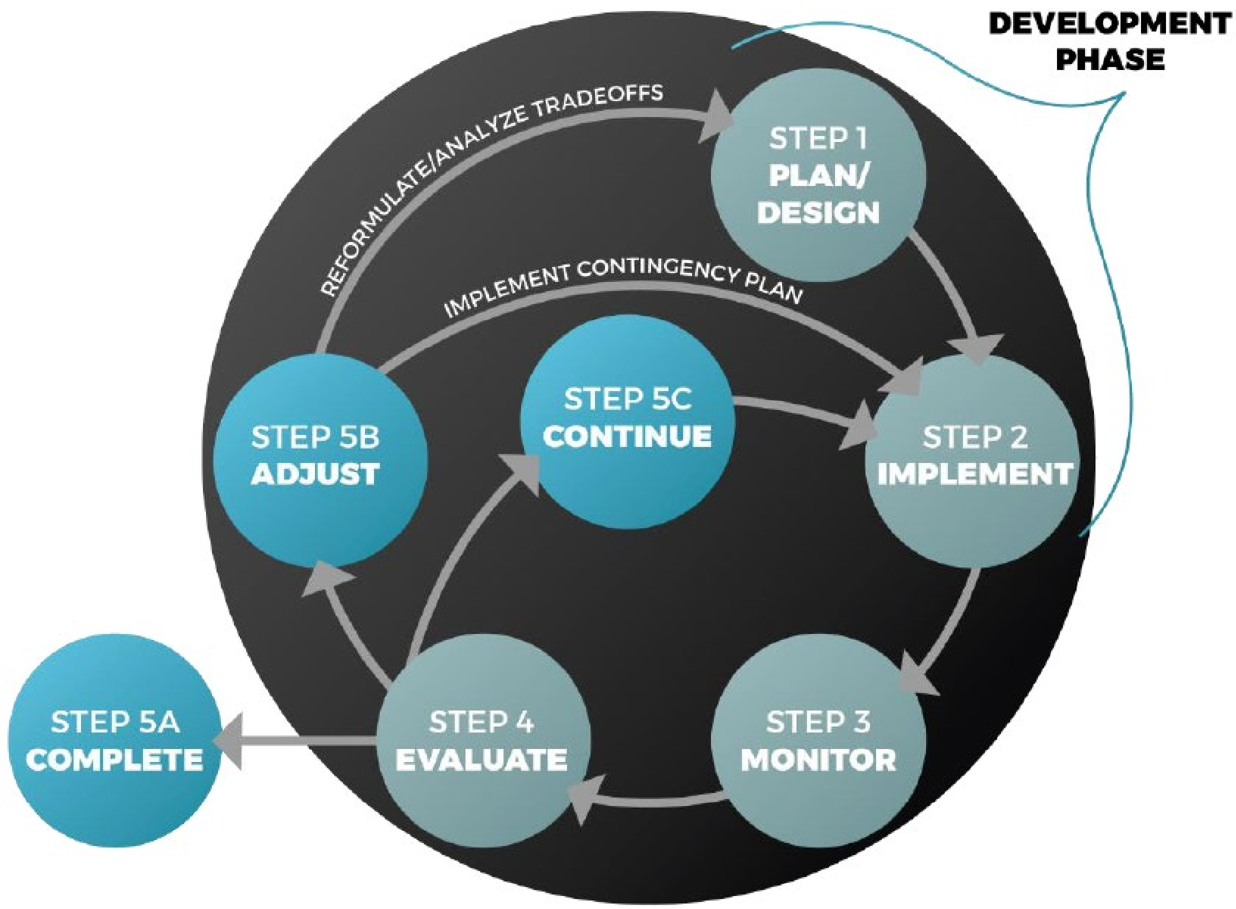


Figure 3-1. Adaptive Management Cycle

3.2 ADAPTIVE MANAGEMENT TERMS

The following terms are used throughout the remainder of this document and are important features of the AMP (definitions taken from USACE 2019c).

- Monitoring – This is Step 3 of the AM cycle and is the process of measuring attributes of the ecological, social, or economic system. Monitoring has many potential purposes, including: to provide a better understanding of spatial and temporal variability, to confirm the status of a system component, to assess trends in a system component, to improve models, to confirm that an action was implemented as planned, to provide the data used to test a hypothesis or evaluate the effects of a management action, and to provide an understanding of a system attribute that could potentially confound the evaluation of action effectiveness.

- Decision Criteria – A broad reference to the set of pre-determined criteria used to make AM decisions. Performance metrics, targets, and decision triggers are different types of decision criteria. They can be qualitative or quantitative based on the nature of the performance metric and the level of information necessary to decide.
- Performance metric – A specific metric or quantitative indicator that is monitored and can be used to estimate and report consequences of management alternatives with respect to a particular objective.
- Target – A specific value or range of performance metric that defines success. Targets can be quantitative values or overall trends (directional or trajectory).
- Evaluation – Conduct analyses to compare measured results with anticipated outcomes related to decision criteria for specific management actions to determine whether the implementation should be continued, adjusted, or completed.
- Decision Trigger – A pre-defined commitment (population or habitat metric for a specific objective) that triggers a change in a management action. Decision triggers are addressed in the Evaluate step (Step 4 of the AM process) and specify the metrics and actions that will be taken if monitoring indicates performance metrics are or are not reaching target values. In some cases, a decision trigger may be learning a new piece of information that triggers the Continue/Adjust/Complete step (Step 5 of the AM process).
- Adaptive Action – A course of action to be implemented as defined in the Adjust step (Step 5b of the AM process) if the performance of a particular management action is not as anticipated and requires correction. In cases where the action is pre-defined, it is referred to as a "contingency action."
- Contingency Action – A pre-evaluated adaptive action that is implemented when triggered by defined decision criteria without the need for further deliberation or decision.
- Risk – An uncertainty coupled with an adverse consequence, ideally expressed as the product of the two components, with uncertainty represented as a probability.
- Uncertainty – Circumstances in which information is deficient. Learning while doing under the AM process provides a framework for reducing program uncertainties over time.

CHAPTER 4 - ADAPTIVE MANAGEMENT GOVERNANCE

4.1 WHAT IS GOVERNANCE?

Although several definitions of governance are available, a broadly held view is that it includes a consideration of authority, administration, decision-making, and accountability. Governance of an AM program includes the approach for converting knowledge into improved management through decision making, identifying:

- **what** decisions need to be made,
- **who** is involved in the decision process,
- **how** decisions are made, and
- **when** decisions are required.

The role of adaptive governance is to establish and promote frameworks by which decision makers can discuss, identify, and approve decisions to adjust management policies, plans, and actions.

4.2 DECISION NEEDS FOR WILLAMETTE VALLEY ADAPTIVE MANAGEMENT

Planning, implementing, and adaptively managing the Preferred Alternative requires hundreds of decisions ranging from relatively mundane issues like what type of net to use for sampling to significant and potentially contentious issues like whether to adjust flow releases from a reservoir. Decisions are required at many points in the process and by multiple entities.

The USACE Portland District Commander (CENWP) is ultimately responsible for most of these decisions. However, the sheer volume demands that many decisions be delegated to others within the agency. USACE's senior leadership relies on recommendations from subordinate staff familiar with the issues and from subject-matter experts engaged for that purpose. They also rely on input from the Willamette Action Team for Ecosystem Restoration (WATER), other agencies, Tribes and the public, where appropriate, when making decisions. It is important to understand that personnel structures and programs evolve thus the positions described herein are subject to change.

The NMFS and U.S. Fish and Wildlife Service (USFWS) are responsible for compliance-related decisions, including policy determinations regarding the application of AM to the ESA. As knowledge about species and their responses to management is gained through implementation, it may be necessary to adjust the targets, decision triggers, and/or required management measures.

WATER provides input and recommendations that may influence agency decisions. WATER may provide recommendations regarding any aspect of the Preferred Alternative, and discussions that occur through the collaborative engagements outlined in this AMP help frame agency actions. AM demands the commitment of time, resources, and active engagement of stakeholders, as well as their commitment to actively engage in the governance process and provide the necessary input to decision makers.

Importantly, certain parties are explicitly excluded from decision-making roles. Facilitators promote group participation, trust, mutual understanding, and shared responsibility for decisions, but are not themselves decision makers, so must maintain a neutral posture on any decision. Similarly, outside technical experts play an important role by helping to link objectives and management decisions to system understanding, but are not themselves stakeholders, so should not be involved in objective/value development or decision making. These entities must be viewed by agencies and stakeholders as neutral third parties and must be capable of performing as such.

4.2.1 Scope of Adaptive Management Decisions

The most evident and essential function of governance for an AM program is to facilitate effective, transparent decision making. The design of the governance structure and processes should anticipate the wide range of decisions needed to incorporate knowledge gained about the outcomes of management measures or new information about the system and species into effective and acceptable management. Governance design should also promote decision making at the lowest practicable level and be sufficiently flexible to allow for efficient, timely decisions, accommodate unanticipated decision needs, and to grow/change over time.

Table 4.2-1 includes examples of the decisions required for AM of the Preferred Alternative. Information presented in Table 4.2-1 is meant as a general guide; appropriate decision authority will be at the agencies' prerogative except where specifically prescribed by policy or other agreements and may necessarily change over time. Decisions for implementation of the Preferred Alternative would be made at three general levels of authority (defined herein as Oversight, Program Management, and Adaptive Management Implementation Team).

1. The Oversight level includes agency senior leaders, who are responsible for decisions related to Federal policies and protocols and other issues that may significantly affect stakeholder interests or authorized purposes, and therefore involve collaboration with stakeholders and/or the public. These decisions are primarily made during the Plan/Design step (Step 1) of the AM cycle as the Preferred Alternative is developed, but because they are periodically revisited, could occur during the Adjust/Continue step (Step 5).

2. The Program Management level, which includes agency program and project managers, develops updates to the implementation plan and makes decisions regarding resource allocation, reporting and communication, and collaboration. Management-level decisions are primarily made at the Plan/Design and Implementation steps (Steps 1 and 3) of the AM cycle but can include decisions at each step of the process.

3. The Adaptive Management Implementation Team-level decisions include the wide ranging and numerous judgments needed for the day-to-day operation and implementation of the Preferred Alternative. These include how monitoring is implemented, how assessments are

conducted and reported, how projects are implemented, etc. Note, however, that the real-time flow management decisions are made by the USACE Portland District Reservoir Regulation and Water Quality.

Table 4-1. Example Adaptive Management Decision Needs

Decision Need	Step in AM Cycle	Recommending Entity	Primary Decision Level
What are the objectives?	Plan/Design	Implementation	Oversight
What measures/actions are included for implementation?	Plan/Design	Management	Oversight
What is the priority of the measures for implementation?	Plan/Design	Management	Oversight
What are the performance metrics and targets?	Plan/Design	Implementation	Oversight
What monitoring will be conducted?	Plan/Design	Implementation	Management
What research is needed and how should it be prioritized?	Plan/Design	Implementation	Management
How will learning be incorporated into decisions?	Plan/Design	Implementation	Management
How will status and decisions be reported and communicated?	Plan/Design	Implementation	Management
How will conflicts be resolved?	Plan/Design	Management	Oversight
How will resources be allocated to program components?	Adjust/Continue	Implementation	Management
What within year flow adjustments should be made?	Implementation	Implementation	Management
How will science updates be incorporated?	Evaluation	Implementation	Management
When should a near-term operations measure be stopped?	Evaluation	AMT	Oversight

4.2.2 Timing

Several outside policies and processes impose important constraints on scheduling and execution. The most significant constraint is the USACE annual budget process for Civil Works, a two-year development process that can be generally summarized as a develop-defend-execute cycle (Figure 4.2-1). USACE budgets and executes its mission on a Fiscal Year (FY) basis. The FY begins October 1 and ends September 30 the following year. Funding availability affects the ability to execute the Preferred Alternative.

The year-round budget process engaged in by USACE occurs on a timetable that affects other considerations in the AMP. Congress generally authorizes numerous new USACE site-specific activities and provides policy direction in an omnibus USACE authorization bill, typically called the Water Resources Development Act (WRDA). The WRDAs do not provide funds to conduct activities, nor are they reauthorization bills. Federal funding for USACE civil works activities is provided in annual Energy and Water Development appropriations acts or supplemental appropriations acts.

In the absence of congressional passage of an agency-specific appropriation, Civil Works annual funding is generally included in an all-encompassing "omnibus" bill. If a bill has not passed at the start of the FY, Congress typically passes a Continuing Resolution Authority (CRA), which allows the USACE to continue operations until such time as an appropriations bill is passed or the CRA expires. Under a CRA, funding is typically provided on a month-to-month basis (or other similar timeframe) based on the previous year's funding level and no new projects may be started.

Activities within the current FY or the next FY (FY+1) may be subject to minor adjustment only given the budgets are already fixed, actions planned, and mechanisms to shift those actions limited. Emphasis should therefore be placed on establishing needs to set the future direction and budget. Defining needs for FY+2 would be the focus of USACE working with WATER on an ongoing, annual basis.

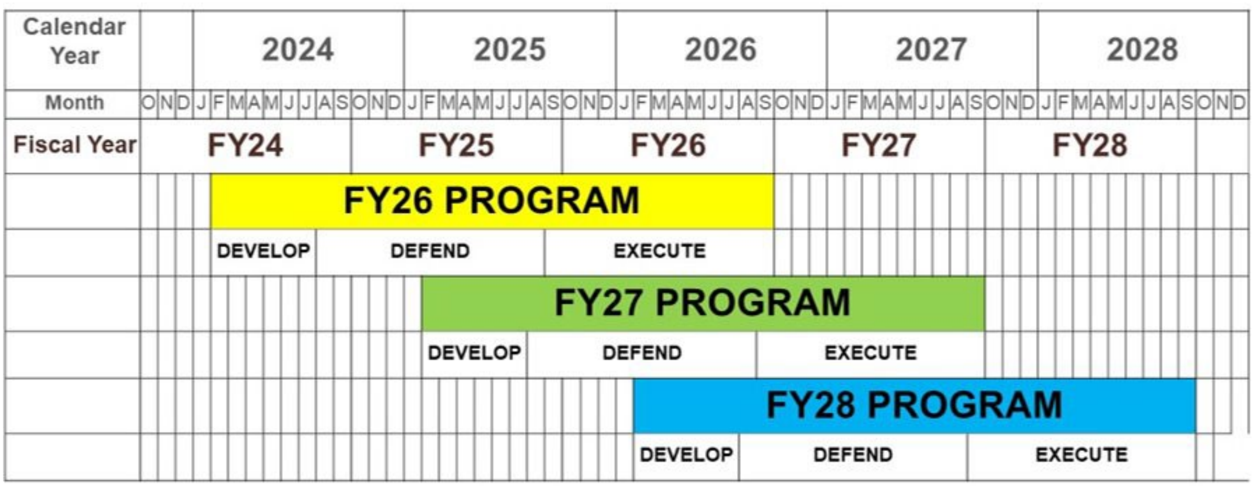


Figure 4-1. Example of USACE Civil Works Budget Development Cycle

Timing of decisions for implementing management measures and/or adjustments is influenced by the operational planning for the conservation release season, which begins with the January water supply forecast and continues through October. The conservation season is approximately from March through October, including the filling season (spring) and the release season (summer). A document titled "Willamette Basin Project Conservation Release Season Operating Plan" (Conservation Plan) is prepared annually to provide flow requirements based on the basin water supply for that year. The Conservation Plan identifies flow and storage needs for each tributary and USACE reservoir in the WVS and mainstem Willamette control points based on the anticipated total system storage in mid-May, from the April forecast.

4.2.3 Role of Decision Criteria

The term "decision criteria" refers to the set of pre-determined conditions that trigger or guide a decision or the implementation of a contingency plan. They can be qualitative or quantitative based on the nature of the performance metric and the available information to support a decision and occur in a variety of forms. A recent study of judicial decisions on AM programs cited the lack of decision criteria as one of three key deficiencies leading to possible overturning by the courts of agency practice (Fischman and Ruhl, 2016).

Decision criteria would play several roles in implementing the Preferred Alternative; they are designed to:

- define requirements for compliance purposes (e.g., ESA, NEPA, USACE's policies)
- ensure that decisions incorporate best available science
- facilitate complex decisions, or decisions that must be made quickly during implementation
- provide a roadmap for participants (i.e., they define the decision space).

Decision criteria used herein may take various forms, including quantitative triggers, decision trees, planning rubrics, heuristics, and schedules and Gantt charts or flowcharts. Criteria cannot be developed for every decision faced in executing the Preferred Alternative. Some decision criteria may elude development during the initial planning stages; useful criteria cannot be developed until details of actions are known in some cases. As knowledge grows, it will likely become apparent that some criteria need to be changed. To address these realities, the draft AMP includes a suite of objectives and principles along with a process to guide the development/revision, review, and approval of decision criteria in the future.

4.2.4 NEPA, ESA, and Authority Considerations

Adjusting management actions would necessitate decisions be made on additional NEPA review. The CEQ NEPA Regulations require agencies to prepare supplements to their final EISs under two circumstances: (1) "the agency makes substantial changes to the proposed action that are relevant to environmental concerns", or (2) "if there are significant new circumstances or information relevant to environmental concerns and bearing on the proposed action or its impacts" (40 CFR 1502.9(c)). If AM provides significant new information affecting selection of the Preferred Alternative and the actions and potential impacts are not within the range of impacts and alternatives considered in the Draft PEIS, supplemental NEPA analysis would be required. Implementation of actions not contemplated in the Draft PEIS or based on a decision not to supplement the EIS, would require a separate NEPA process. This process would be initiated and conducted according to appropriate CEQ and USACE regulations and policies associated with NEPA. It is possible that USACE may decide to adjust to an action that was adequately assessed in the Draft PEIS but was not part of the selected alternative. In this case, USACE may issue a new decision document to reflect the change.

4.2.5 Quality Assurance and Independent Science Review

Government-wide standards for the peer-review requirements of scientific information outline the types of peer review that should be considered (OMB, 2004). The USACE employs robust, multi-level product review and quality assurance processes (i.e., District Quality Control and Agency Technical Review) and the traditional independent external product review (IEPR) process. These processes would likely be sufficient to assess products of many AM efforts. However, management may determine that a particular topic or issue could benefit from a targeted independent science review that provides objective input to the AM process.

4.3 ANNUAL ADAPTIVE MANAGEMENT PROCESS

The annual AM process would revolve around science updates and the generation and sharing of information about Preferred Alternative performance, then using that information for near-term adjustments of the Implementation Plan (i.e., next 3 to 5 years). Table 4.3-1 summarizes the process, which would recur each year. The following description outlines the basic process. It should be noted that the science update and Near-Term Implementation Plan update processes described are in addition to, not a replacement of, the regular within year WATER collaboration that USACE engages in as part of real-time flow management and fish passage O&M.

4.3.1 Science Update Process

The Science Update process includes a set of activities that begins when system-wide and action-specific monitoring data becomes available each fall/winter and culminates in the annual AM Workshop, which generates input to the implementation plan update process. The following "typical" events as characterized are intended to guide the process only; deviation in some years will be required for various reasons.

- **Compilation of Information (October through February)** – USACE science and implementation staff compile information on work completed during the prior field season and other information relevant to the management measures in preparation for a Science Meeting.
- **Science Meeting (February)** – This meeting would be hosted annually by USACE to provide a regularly scheduled, focused opportunity for technical personnel engaged in research, studies, or monitoring and assessment to discuss technical aspects of the science and AM implementation efforts. The meeting provides opportunities for field crews to share initial observations regarding system conditions, project performance, and monitoring activities. The Science Meeting may be conducted using webinars and/or in-person meetings as dictated by needs each year, but typically consists of technical presentations with opportunities to discuss implications of the presentations. The Science Meeting would be used to initially identify key issues that could affect the Preferred Alternative’s direction,

and that serve as a basis for further investigation and discussion at the Adaptive Management Workshop. It is anticipated that the Science Meeting would be attended by members of the USACE Adaptive Management Team, agencies and/or contractors engaged in research or monitoring efforts, and WATER representatives. It is also anticipated that the interested public would be invited. The Science Meeting serves as a critical engagement point for WATER representatives to learn about scientific findings relevant to the Preferred Alternative implementation. A meeting summary would be prepared as documentation.

- **Adaptive Management Workshop (March)** – A workshop would be held each year for USACE technical staff, program managers, senior leaders, and WATER representatives to discuss results of research and monitoring efforts for the previous year and collaborate on their implications with respect to the Preferred Alternative's direction. The workshop follows the Science Meeting, which serves as a basis for the discussions, and prior to the update of the Implementation Plan, which will incorporate workshop outcomes.

  Objectives of the AM Workshop include the following: (1) Report out on project and program performance, actions, monitoring and research, and projections; (2) Discuss implications of findings and emerging issues relative to strategic direction of the Preferred Alternative; and (3) Facilitate interactions necessary for the technical and implementation teams to develop their respective input and products needed to support the Implementation Plan.

  The AM Workshop would be organized around meetings of the WATER Technical Teams. Status updates may be provided on the Implementation Plan, Conservation Plan, and budget in a plenary session, and the key topics identified for the engagement may be reviewed. Teams may then meet individually to deliberate on the performance of measures in the Preferred Alternative, status of the science relative to their technical team's needs, risks and management strategies, new technical developments, and future priorities. Teams may meet in a plenary closing session to report out on their discussions, address topics of overlapping interest, and identify next steps.

- **Adaptive Management Workshop Summary (April/May)** – The USACE or a Facilitation Team (if used) would prepare an AM Workshop Summary that outlines the primary presentations, issues, and outcomes and shares this product with WATER teams after the meeting.

Table 4-2. Summary of Annual Adaptive Management (AM) Science Update Process

Meeting/Product	Description	Timeframe
Science Meeting	A science meeting would be held for agency technical staff, WATER representatives, and the public to be briefed on research and monitoring findings.	February
Annual AM Workshop	Annual meeting where primary exchange of information between scientists and decision	March

Meeting/Product	Description	Timeframe
	makers occurs. Includes close collaboration with WATER Technical Teams. Focus is on updates to the Implementation Plan given implications of new knowledge and implementation progress.	
AM Workshop Summary	Documents topics, issues, and outcomes discussed during the AM Workshop. Provides documentation to support any further discussions within WATER teams and drafting of the Implementation Plan update.	April/May

Table 4-3. Summary of Annual Adaptive Management (AM) Near-Term Implementation Plan Update Process

Meeting/Product	Description	Timeframe
WATER Recommendations	WATER may develop recommendations on the Implementation Plan. Recommendations should focus on FY+2 needs and direction for the program (FY+3 and FY+4) but can include suggested adjustments to other years.	June/July
Draft Updates to Near-Term Implementation Plan	The draft Implementation Plan will be updated to incorporate science updates and associated WATER recommendations and sent out to the Management Team for review.	Nov/Dec
Final Near-Term Implementation Plan Update	The Implementation Plan will reflect annual implementation progress and any additional adjustments to outyears.	January

4.3.2 Near-Term Implementation Plan Update

The IP described in Chapter 2 provides the long-term strategy for implementation of management measures included in the Preferred Alternative. Following signing of a ROD, USACE would begin implementing measures based on the IP. Program Management would also need to account for necessary research, monitoring, and evaluation (RM&E) of management measures and research aimed at reducing uncertainty into near-term budget requests. However, implementation is highly dependent on the appropriation of funds and variability in budgets from year to year. In addition, new learning or emerging issues identified through the science update process could lead USACE in collaboration with WATER to adjust the prioritization reflected in the IP. To account for these necessary adjustments, USACE would maintain a rolling 3 to 5-year implementation plan that incorporates any updates necessitated by implementation progress and/or science updates. The “typical” events in the near-term implementation plan update process would be as follows:

- **WATER Recommendations** – USACE would collaborate with WATER to assess if the group has interest in submitting recommendations to USACE regarding any adjustments to prioritization or inclusion of actions in the IP.
- **Draft Updates to Near-Term Implementation Plan** – Based on the outcomes of the AM Workshop and any WATER Recommendations, the Near-Term IP would be updated to reflect any necessary changes in program implementation and prioritization. A draft Near-Term IP will be provided to WATER for review.
- **Final Near-Term Implementation Plan Update** – By January, USACE would finalize updates to the Near-Term IP and incorporate this information in its budget planning.

4.4 GOVERNANCE STRUCTURE, ROLES, AND RESPONSIBILITIES

As stated in Section 4.2.1, decisions for the Preferred Alternative would be made at three general levels of authority: Oversight, Program Management, and AM Implementation Team (Figure 4.4-1). This section further describes the responsibilities of each level as it relates to AM decision-making (Table 4.4-1). The roles and responsibilities of WATER are described as well.

4.4.1 Oversight Level

Oversight of the Preferred Alternative implementation is provided by the USACE Portland District Commander and WATER Managers' Forum. The USACE District Commander establishes clear boundaries for the program, makes major policy decisions, and resolves disputes that cannot be realized at lower levels. The USACE District Commander is also ultimately responsible for decisions regarding scheduling, staffing, and other resourcing; planning, engineering and design of management measures; management and execution of research, monitoring, and evaluation; and other corresponding activities undertaken at the USACE District office.

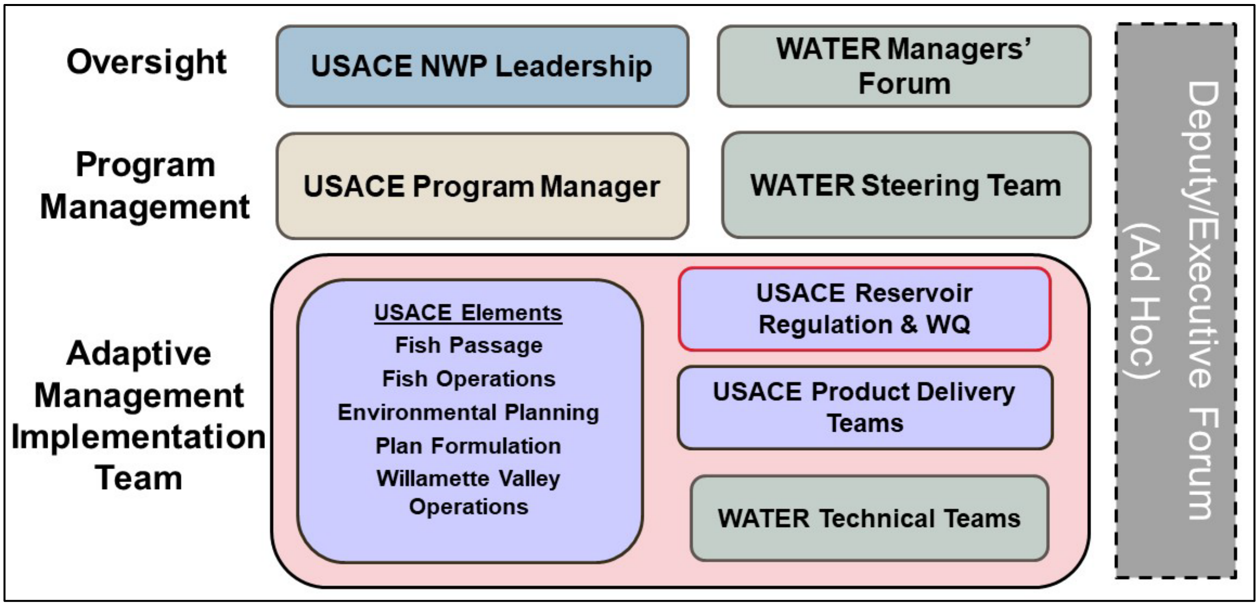


Figure 4-2. Adaptive Management Governance Structure

The USACE Portland District Commander may elect to delegate decisions to senior leaders within the command. Decisions regarding the real-time operations of the reservoirs in the Willamette Valley are typically delegated to the Chief of the Reservoir Regulation and Water Quality Section, for example. The CENWP Deputy District Engineer for Programs & Project Management (DPM) is typically the NWP Commander's delegate for general oversight of the program. The DPM represents USACE in meetings with WATER and/or NMFS/USFWS and may make decisions related to the update of the Implementation Plan, scheduling, resource allocation, and other similar programmatic issues. The DPM may rely upon the Senior Program and Project Managers and/or senior NWP staff to represent the program on day-to-day issues and for interactions with WATER.

WATER provides guidance and recommendations to the USACE regarding program implementation and adaptive management. The roles and responsibilities of the WATER are discussed further in Section 4.4.4. In addition to input from WATER, decisions at the Oversight level are informed by recommendations from the Management Team. Oversight may seek input from independent review on science matters and their decisions are also informed by Tribes and Federal or state agencies as required by applicable laws and regulations, as well as by public input.

4.4.2 Program Management Team

The Program Management Team is responsible for annual updates to the Implementation Plan, development of Strategic Plans to support internal USACE budget processes, development of resource allocation recommendations and oversight of Program implementation. They participate in the annual Science Meeting and the AM Workshop, using these engagements for

Table 4-4. Governance Level Primary Responsibilities

Governance Level	USACE Elements	WATER	Primary Responsibilities
Oversight	Portland District Commander Deputy District Engineer for Programs & Project Management	Manager's Forum	Make decisions or recommendations about priorities Make decisions or recommendations about objectives and decision criteria Make decisions or recommendations about program structure and changes Resolve disputes
Program Management	Program Manager	Steering Team	Make recommendations on action and research prioritization USACE prepares and WATER reviews Draft Near-Term Implementation Plan updates annually Recommend changes to program components and governance
Adaptive Management Implementation Team	Product Delivery Teams Reservoir Management and Water Quality Fish Passage Environmental Planning Plan Formulation Fish Operations Willamette Valley Operations	Technical Teams	Complete planning and design reviews necessary to support implementation of measures Conduct annual assessment of monitoring data, study reports, research results and other relevant information. Evaluate decision criteria and provide information in support of annual science update process Execute and/or review studies, conduct research, develop and apply models to predict habitat, species demographics, etc. Review changing field conditions to identify long-term trends that may necessitate adjustments to implementation Identify decision-relevant studies or analyses that may be necessitated by emerging issues or considerations Identify issues that may warrant targeted independent review

discussions with the Technical and Implementation Team that inform adjustments to the Implementation Plan.

The Program Management Team provides input into the prioritization of implementation actions and reviews the draft Implementation Plan update each year. During various check-points during the federal annual budget cycle, the Management Team will provide input on prioritization of projects based on available funding and identify priority actions based on program needs for FY+2 through 4, including study proposals, proposed changes to components of the AMP, and other recommendations for consideration by WATER and agency leaders.

The Program Management Team makes recommendations to senior leadership on issues requiring Oversight-level decisions, including any issues that merit discussion with WATER. They ensure day-to-day implementation of the program is consistent with direction from senior leadership, the AMP and IP.

4.4.3 Adaptive Management Implementation Team

Implementation of the Preferred Alternative is informed by teams comprised of management and technical staff from the USACE, NMFS, and USFWS, and others via WATER. The AMIT is responsible for development of and updates to the AMP, planning, design, and implementation of management measures, managing data, assessing monitoring results, making recommendations to decision makers, identifying adjustments to actions or the plan, and reporting and communicating results. They assess the strategic direction of the program through regular interactions associated with the science and implementation planning processes. The AMIT discuss strategic science, technical, and implementation considerations that relate to the Program's objectives. Appropriate participation by USACE staff across disciplines will be required to ensure that efficient and effective adjustments and communication occurs both within USACE and to WATER and other affected parties.

USACE representatives to the AMIT will include staff members chairing or participating in the WATER teams or processes, and other technical experts such as reservoir regulators, environmental planners, and fish biologists. Personnel familiar with budgeting, project operations, or other specialized technical topics may participate as needed to advance understanding and knowledge surrounding a particular issue, or for those staff to understand the larger context surrounding decisions and discussions. These representatives and staff would participate in WATER technical team discussions relating to their expertise and position of authority.

Some of the USACE technical experts will by necessity be part of project-specific Product Delivery Teams (PDTs). PDTs are used to organize large projects, specifically design and construction of large or complex structures. Several PDTs would likely be employed for implementation of the Preferred Alternative. The PDT process follows the guidelines and policies set forth in ER 5-1-11, Management – U.S. Army Corps of Engineers Business Process. The PDT consists of everyone necessary for successful development and execution of all phases of a project. These PDTs, through one or more PDT representatives, would coordinate their work through the WATER process as appropriate for input on such products as design features, document reviews, and construction times.

4.4.4 Willamette Action Team for Ecosystem Restoration

The purpose of the Willamette Action Team for Ecosystem Restoration (WATER) is to provide a forum for coordination and recommendations among the sovereign governments (federal/state/tribal) working to implement strategies for Endangered Species Act (ESA) compliance associated with the Willamette Project. Establishment of WATER was a core feature of the adaptive management strategy in the 2008 Reasonable and Prudent Alternative (RPA) developed during consultation on the Willamette Project. Participation in WATER does not alter the duty of these agencies in other interactions. WATER is not intended to make decisions for the participating agencies, it is intended to aid in decision making. All decisions under the authority of the federal government will continue to be made by the appropriate federal agency with the statutory authority to make such decisions.

The tiered system of WATER will clearly define decision authority and provide a vehicle for elevating conflict resolution associated with the efforts to implement the proposed action. WATER is intended to have 3 tiers comprised of a Manager's Forum, Steering Team and focused Technical Teams, as outlined in Figure 4.4-2. It is USACE's recommendation that each tier of WATER is supported by a different individual from each participating organization to ensure proper oversight and reduce the perception of conflicts of interest at the Steering Team Level and Management Level. An USACE representative chair each WATER forum or team.

By its very nature WATER is meant to evolve and adapt based on multiple factors including but not limited to:

- Stage of implementation of the preferred alternative
- Agency resources including funding and personnel
- Advances in understanding the state of available science

The purpose and goals of WATER are to:

- Provide a forum for information sharing and discussion of operation and configuration of the Willamette Project as they relate to compliance with the ESA through implementation of the Willamette BiOps;
- Seek consensus on actions implemented for the Willamette BiOps, including system configuration and water quality.
- Provide a process for elevating disputes associated with Willamette BiOp implementation to appropriate levels of the involved governmental bodies.

- Promote coordination between implementation of the Willamette BiOps and actions taken under other related regional plans to restore Willamette River Basin fish, such as ESA Recovery Plans or state Conservation Plans.
- Identify opportunities for improved coordination and partnerships to increase efficiencies and avoid unnecessary duplication.
- Increase awareness and include consideration of the implementation of the Willamette BiOps' actions on non-listed species, cultural and other resources, and the multi-purposes of the Willamette Project.
- Facilitate open and transparent communication in making decisions, as well as to track progress and the rationale for decisions.
- Participate and inform long-term adaptive management of the Program through the annual AM cycle established by this AMP.

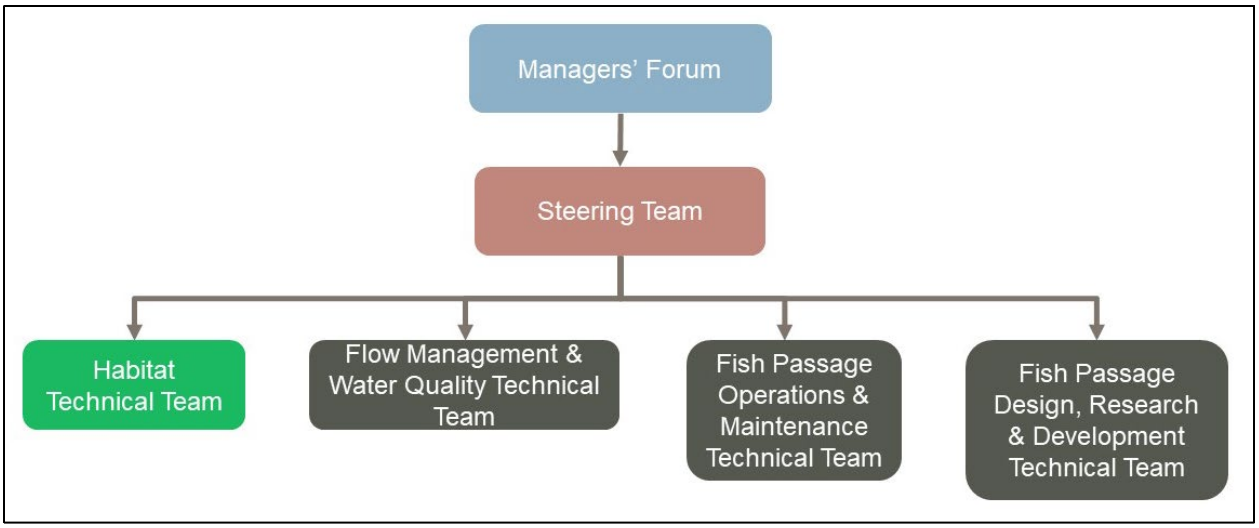


Figure 4-3. Proposed WATER Structure

4.4.4.1 Membership of WATER

Through the precedence of the previous iteration of WATER and in response to the needs of the future iteration of WATER, USACE anticipates the following Agencies will participate at some level. The body of WATER must operate under the constraints of Federal Advisory Committee Act (FACA) which are further outlined in Section 4.5.1 Federal Advisory Committee Act.

Membership includes representatives from the following organizations at various levels of each organization:

- USACE
- Bonneville Power Administration (BPA)
- U.S. Bureau of Reclamation (USBR)

- NMFS
- USFWS
- U.S. Forest Service (USFS)
- Bureau of Land Management (BLM)
- State of Oregon
- Confederated Tribes of the Grand Ronde Community of Oregon (CTGR)

4.4.4.2 Managers' Forum

The Manager's Forum would provide senior management level oversight to the implementation of the Willamette Project Biological Opinions. The Manager's Forum serves as the regional policy and management level body representing the key participating federal agencies with responsibility for operating and maintaining the federal dams in the Willamette Basin (USACE, USBR, BPA).

It is anticipated that the Manager's Forum will continue to consist of senior level management from federal and state agencies and Tribes with fisheries and water resource management responsibilities in the Willamette River Basin. The USACE representative serves as the chair of the forum.

Roles and Responsibilities

The Manager's Forum will provide review, input, and policy guidance related to the development and implementation of actions as they relate to the Willamette BiOps. While most discussions and recommendations will be delegated to lower-level teams, the Manager's Forum serves as the highest body for any disputes or discussions deferred to the management level. Responsibilities include:

- Make final recommendations about priorities
- Make final recommendations about targets and objectives
- Make final recommendations about program structure and changes
- Resolve disputes

WATER managers shall demonstrate leadership and commitment with respect to the outcomes WATER and Adaptive Management by:

- Taking accountability for the effectiveness of the Steering Team and Technical Teams.
- Ensuring that the policy and implementation strategies are compatible with the requirements of the BiOps.
- Promoting the use of the Adaptive Management approach.

4.4.4.3 Steering Team

The Steering Team is the second tier of WATER comprised of senior managers who have the authority from their respective agencies to provide input on management decisions related to BiOp implementation. The Steering Team is responsible for synthesizing recommendations from the Technical Teams into prioritizations based on budgetary, legal, policy constraints, and other considerations. These prioritizations will get incorporated into the Implementation Plan, which the Steering Team will review. The Steering Team is also the level at which the participating entities will seek to resolve disagreements. The Steering Team is integral to providing recommendations on overall strategy and direction for BiOp implementation, keeping the Managers Forum informed of high-priority issues, and providing direction for the technical teams.

Roles and Responsibilities:

- Make recommendations on action and research prioritization. Recommendations should focus on FY+2 needs and direction for the program (FY+3 and FY+4) but can include suggested adjustments to other years.
- Recommend changes to program components and governance.
- Review the Implementation Plan annually and provide comments.
- Consider any recommendations for independent review from the Technical Teams.

4.4.4.4 Technical Teams

The third tier of WATER is comprised of groups of focused technical teams, each of which represents different elements of the implementation of the Willamette BiOps. Technical teams are charged with implementing the actions listed in the BiOps and in providing the Steering Team technical information and considerations that may aid management discussions. WATER technical teams do not supplant existing federal, state or tribal decision-making authorities. Technical teams are critical opportunities for other governmental agencies to jointly explore potential solutions and seek agreement on recommendations to the Action Agencies.

Technical teams will be comprised of key function area technical experts from each of the involved federal and state agencies and Tribes, including the Action Agencies. Experts from academia and consulting firms may also attend meetings as needed to provide relevant information.

General responsibilities for the Technical Team are outlined below. Each team will have additional roles and responsibilities based on their respective areas of responsibilities.

- Participate in the Willamette Fisheries Science Review to understand the latest science and its implications on future technical team direction

- Participate in the Adaptive Management Workshop to discuss the latest technical results and its implication for AM plan implementation.
- Establish workgroups as needed on an ad-hoc or permanent basis.
- Review changing field conditions to identify long-term trends that may necessitate adjustments to implementation.
- Identify relevant studies or analyses that may be necessitated by emerging issues or considerations and provide recommendations to the Steering Team on research priorities.

Flow Management and Water Quality Technical Team

The primary responsibilities of the Flow Management and Water Quality Team (FMWQT) would be the development of the Conservation Plan which outlines the annual priorities and real time flow management priorities and to ensure integration of water quality improvement requirements undertaken by the Action Agencies to address the needs of ESA-listed species with the requirements undertaken to address CWA requirements. FMWQT will be chaired by a representative of the USACE.

The FMWQT will be utilized by USACE to communicate the established flow targets from the BiOp and provide forecasted model information to the participants. USACE will retain ultimate authority for operating reservoir elevations and downstream flows to meet authorized project purposes. These meetings allow for the agencies to have adequate opportunity for providing input and coordination into flow management operations. WATER participants will use this information in addition to balancing priorities to develop the Conservation Plan.

On September 29, 2006 the ODEQ and EPA finalized Willamette Basin TMDL's for temperature, turbidity, mercury, and bacteria. The Willamette TMDL was approved by USEPA in November 2006. In 2021, ODEQ and EPA revised the mercury TMDL criteria for the Willamette Basin. Chapter 14 of the TMDL, Water Quality Management Plan, recommends that the USACE prepare an Implementation Plan to show how it will address the TMDL load allocations for temperature, including compliance and consistency with the pending BiOp for operating the Willamette dams. The ODEQ also recommended that the USACE establish and coordinate TMDL implementation planning through an interagency work group. FMWQT serves as the primary communication and coordination tool for TMDL implementation planning through an interagency work group.

Roles and Responsibilities

- Contribute technical input necessary to support implementation of flow management and water quality measures included in the BiOp.
- Provide information about storage capacity within the system and annual forecast of general hydrologic conditions; communicate USACE adaptive strategies.

- Providing advice and consultation during real-time operations, particularly but not limited to the conservation storage and release season.
- Conducting annual reviews of Willamette Project operations and documenting issues, concerns and opportunities associated with improving operations to better meet ESA and CWA compliance requirements where possible.
- Providing debriefing materials to other WATER forums regarding flow management, water quality operations, and operational fish passage.
- TMDL implementation planning.
- Assisting in development of uniform water quality criteria and standards for CWA and ESA compliance.
- Reviewing and evaluating the latest water quality science.

Willamette Fish Passage Operations and Maintenance Technical Team

The Willamette Fish Passage Operations and Maintenance (WFPOM) forum develops recommendations for ongoing operations and maintenance activities that may affect listed fish species. This forum also includes technical discussions relating to hatchery programs. This forum is responsible for providing input on annual changes to the Willamette Fish Operations Plan, which dictates how facilities must operate to minimize impacts to ESA-listed species.

Roles and Responsibilities

- Coordinate ongoing maintenance and construction activities, both scheduled and unscheduled, as well as any emergency operations that occur.
- Coordinate and review operations required for any future research or construction activities.
- Discuss hatchery program implementation and provide updates on hatchery-related activities
- Provide input to annual revisions of the Willamette Fish Operations Plan (WFOP)

Fish Passage Design, Research, and Development Technical Team

The Fish Facility Design, Research, and Development Team is a technical team comprised of engineers, biologists and other fish facility technical experts. The purpose of this workgroup is to provide technical input and review for engineering fish passage improvements (e.g., fish collection facilities, fish passage systems, etc.). USACE PDT representatives will participate in this forum as needed to provide updates and to seek input on PDT efforts relating to design or research of BiOp-related projects.

The Fish Facility Design, Research, and Development Team will also consider what research and monitoring may be needed to inform future fish passage facility design or fish passage operations in support of BiOp implementation and the AM Plan. Research may also be needed to determine the effectiveness of new fish structures or operations, or to evaluate the impact of changing conditions on the continued effectiveness of facilities or operations. Results from this research will be discussed and recommendations made to PDTs or other WATER technical forums to support the AM process, or to the Steering Team to inform management decisions and funding prioritization.

Roles and Responsibilities

- Review and provide input on fish passage design and construction planning efforts tied to BiOp implementation.
- Provide recommendations on potential research and monitoring needed to inform fish passage structures or operations included in the BiOp as well as the AM Plan.
- Provide data and recommendations to the Steering Team and other WATER teams as appropriate to support management discussions on overall strategy and funding prioritization.

Habitat Technical Team

The Habitat Technical Team (HTT) is responsible for identifying and prioritizing any potential habitat restoration activities that support Willamette BiOp requirements, and determining what actions are needed to support these efforts. Because USACE does not have Congressional authority to fund most habitat restoration actions, BPA is the lead Action Agency and chairs the HTT.

Roles and Responsibilities

- Identify opportunities for habitat restoration and funding.
- Assess progress towards the habitat related BiOp requirements.
- Update the habitat restoration strategy to reflect any new available science and lessons learned.

4.5 OTHER AM CONSIDERATIONS

4.5.1 Federal Advisory Committee Act

USACE (2019c) states that stakeholder engagement is a necessary component of any successful adaptive management process. However, one legal constraint to consider for non-Federal stakeholder involvement is compliance with the Federal Advisory Committee Act (FACA) (5 U.S.C. § 552 [1994]). Under FACA, Federal agencies may not receive advice from a group that the agency has established or that it uses (i.e., manages or controls) unless the agency complies with the provisions of FACA. The FACA is a procedural statute that requires certain actions be taken to set up and operate a committee or similar group that provides group-based (rather than individual) advice to Federal officials. FACA will be a consideration for USACE engagement with WATER throughout the AM process.

4.5.2 Dispute Resolution

Given the large number of considerations and decisions to be addressed in executing the Program, some disputes may arise. Commitment to the rapid and transparent resolution of disputes/conflicts is required from all parties. The approach for resolving conflicts within the Program depends on the nature of the conflict (technical or policy consideration) and the parties involved. USACE would strive to rapidly identify the appropriate path for dispute resolution, while remaining committed to an open, transparent, and collaborative process respective to roles and responsibilities.

If possible, inter-agency conflicts between USACE and another agency should attempt to be resolved using inter-agency engagements; however, any agency has a right to discuss their position within WATER. WATER technical teams may elevate disputes within those teams, with other technical teams, or to the Steering Team for consideration. If deemed appropriate, the Steering Team may elevate a dispute to the Manager’s Forum, who is the final authority for WATER dispute resolution. Agencies are legally prevented from delegating decision-making authority to any other group or individual. Decision making authority is delegated to a specific individual in each organization. Once the appropriate decision maker has been identified the issue should be properly briefed and elevated for resolution by that person.

For disputes of a technical or scientific nature, USACE may consider obtaining input from an independent science review should the Manager’s Forum determine this to be a prudent course of action and funds are available.

4.5.3 Adjustments to Objectives and Decision Criteria

As learning progresses under AM, the need to update objectives, performance metrics, targets, decision triggers or other similar Preferred Alternative benchmarks may become necessary. These are factors that fundamentally guide the AM and relate to ESA compliance so they should be rigorously analyzed and deliberated, including full coordination between the USACE, NMFS, and USFWS and with opportunity for input by WATER. Recommendations for adjustments to these items can be initiated by USACE, NMFS, USFWS, or by WATER. Recommendations should be provided in the form of a white paper outlining (a) the specific objective, performance metric, target or criterion to be reconsidered, (b) the basis for the proposed change (studies, reports, monitoring results, data, etc.), and (c) a summary of the rationale and benefits of the change. The merits of recommended changes should be discussed as agenda items at the annual AM Workshop. Following the AM Workshop, the Action Agencies along with the Services will discuss the recommended changes and make decisions following their agency jurisdictions.

4.5.4 Addressing New Information

Review of occasional "new information" may be needed that originates outside the Program but could significantly influence its direction. The procedure outlined in this section is intended to ensure that the Program is using the best available and verifiable science information in informing AM decisions and that it is not subject to change driven by incomplete or unsubstantiated data or research.

Any concerned party may bring to their respective WATER Technical Team new data or other information on the ecology and behavior of the listed species, resources, and habitat attributes that effect those species including environmental stressors, ecosystem processes that are known or suspected to contribute to the survival and recovery of those species, and human factors that may affect the listed species. The identifying entity can initiate a review process to assess that new information by submitting to either of the WATER Technical Team chairs an issue paper that concisely explains the rationale for introducing new science information. This paper does not need to document all available information; the intent is to illustrate the importance of the issue and motivate a more-detailed analysis. The paper should include a description of the information and its source, an explanation of its management relevance, and pertinence to purpose of the Program and stated objectives. The WATER Technical Team chair would discuss with the full Technical Team to arrive at an initial determination on whether the new information may have relevance and importance to decision making. A written evaluation will be provided to the submitter. If the initial determination does not support a detailed evaluation of the issue, the submitter will be given an opportunity to provide additional information.

If the initial determination identifies merit in the issue, the WATER Technical Team chair would elevate it for consideration by the Steering Team. The Steering Team will deliberate on the initial determination from the Technical Team and determine the appropriate next steps of review or research to determine if and how the AM process should accommodate the new information. Anticipated courses of action could include:

- Note the issue but take no further action (based on lack of merit, no clear relationship to management actions, etc.).
- Recommend additional study (including identification of additional data or scientific information/analyses required to clarify the issue).
- Refer the issues for independent review.

In the event further consideration does not resolve the issue, or if the submitting entity disagrees with the outcome, the issue may be elevated to the Manager's Forum.

CHAPTER 5 - ADAPTIVE MANAGEMENT OF THE PREFERRED ALTERNATIVE

The primary purpose for AM in the USACE is to ensure a project or program achieves its goals and objectives (USACE, 2019c). The objectives established for the project planning serve as the objectives for adaptive management as well. The following seven primary objectives were developed for the Willamette Valley System O&M Draft PEIS:

1. Allow greater flexibility in water management (related to refill, drawdown timing, and other water management measures).

2. Increase opportunities for the creation of nature-based structures during maintenance of USACE-owned revetments (structures that help prevent bank erosion).

3. Allow greater flexibility in hydropower production.

4. Increase anadromous ESA-listed fish passage survival at WVS dams.

5. Improve water management during the conservation season to benefit anadromous ESA-listed fish and other authorized project purposes.

6. Reduce pollutant levels to restore impaired water quality associated with the WVS dams to benefit anadromous ESA-listed species.

7. Reduce spawning and rearing habitat competition and genetic effects caused by hatchery fish.

The following sections of this chapter describe the proposed performance metrics, targets, and decision triggers for the measures in the Preferred Alternative. Where applicable, the constraints, risks, and uncertainties associated with each measure are described. Measure-specific decision-making considerations and engagements are also described.

5.1 BASIN-WIDE FLOW MEASURES

5.1.1 Definition and Function

This section combines adaptive management considerations for three flow measures: integrated temperature and habitat flow regime (Measure 30), flow augmentation by tapping the power pool (Measure 304), and flow augmentation by using the inactive pool (Measure 718). These measures are addressed collectively for adaptive management purposes because they function together to facilitate meeting downstream minimum flow and mainstem temperature requirements (additional measures address tributary water temperature management and are discussed in their respective sub-basin sections of this chapter). Measure 30 proposed operations would include all Willamette basin projects. Measure 304 is proposed at Lookout Point, Hills Creek, Cougar, Green Peter, and Detroit. Measure 718 is proposed at Fall Creek and Blue River.

Physical habitat provided by streamflow is only of value when it is within thermal biologic tolerances. A primary function of the fish flow management regime is to help avoid exceeding high water temperature thresholds to improve available habitat. The proposed flow measure is based on two components: 1) minimum flows that incorporate magnitude, seasonal variation and are responsive to annual hydrologic conditions and 2) water releases for real-time water temperature management.

5.1.2 Constraints

- The measure should not result in a reduction of USACE ability to operate the WVS for the flood risk management authorized purpose.
- Annual hydrologic variability has the potential to constrain any flow and water temperature management measure.

5.1.3 Performance Metrics and Targets

Operations for river flow management measures include minimum and maximum flow values as well as 7-day average maximum water temperature values (Table 5.1-1). These operational targets direct how flow would be managed in any given year and are described in Chapter 2 and Appendix A of the Draft PEIS. Monitoring the flow measures will consist of measuring flow and water temperature daily in each management reach. Observed daily flow and water temperatures will be summarized and reported annually, along with the percentage of days flows are below minimum values, the percentage contribution to the observed flows from conservation storage, and the percentage of time water temperatures are outside target ranges.

Table 5-1. Performance Metrics and Targets for Proposed Flow Measures.

Monitoring Metrics	Targets	Assessment
Flow (cfs)	Flows > minimum values for each management reach	Summarize below dam flows at points of discharge and downstream control points: % days below reach target % conservation storage contribution to river flow
Temperature (C)	7-day Average of the Daily Max (7dADM) at Salem	Summarize below dam water temperatures at Salem: % days below reach target range % change in water temperatures at Salem when pulses released

5.1.4 Research, Monitoring, and Evaluation

Minimum flow values included in the Draft PEIS were developed with application of integrated decision support models which were used to evaluate the effect of flows on two life history stages of Chinook salmon and winter steelhead (Deweber and Peterson, 2020; Peterson et al. 2022). These models are regionally referred to as the Science of Willamette Instream Flows Team (SWIFT) models. The four fundamental objectives associated with the SWIFT models are shown on Figure 5.1-1. Fish habitat time series input into the SWIFT models were estimated using habitat sub-models prepared by USGS (J. White, In Press).

These models rely on relationships between biological responses and physical aquatic conditions (flow and water temperatures) to estimate fish survival. Research and analysis may be necessary to reduce uncertainty and unacceptable levels of risks for decision makers. Sensitivity analysis of the current SWIFT models indicated models were most sensitive to water temperature. Effects of water temperatures on spring Chinook and winter steelhead are generally understood, and therefore investing in research regarding water temperature at this time may not be warranted. Although not identified as a sensitivity parameter in the model, re-assessing flow and fish habitat relationships may be warranted. New information is being developed by USGS on the relationship between flows and tributary habitat for spring Chinook and winter steelhead. If significant differences are found between flow/habitat relationships when compared to those previously applied in the SWIFT models, then this information can be incorporated during the performance assessment. As a third example, the SWIFT models also include an assumption that when juvenile habitat units fill to capacity, then additional juveniles will move downstream to the next available habitat unit. This assumption is based on published literature from outside the Willamette Basin. Additional research may be warranted in the first ten years of implementation to inform this assumption. As this process proceeds, additional critical information needs may be identified. Consideration of additional research will be raised through the WATER Technical and Steering teams. Prioritization of any new research needs proposed should consider information needs which reduce uncertainty for those attributes which are likely to have significant influence on the fundamental biological objectives targeted by the management actions.

USGS gage control points through the basin provide continuous flow (cfs) and water temperature data that would support evaluation of the flow measures.

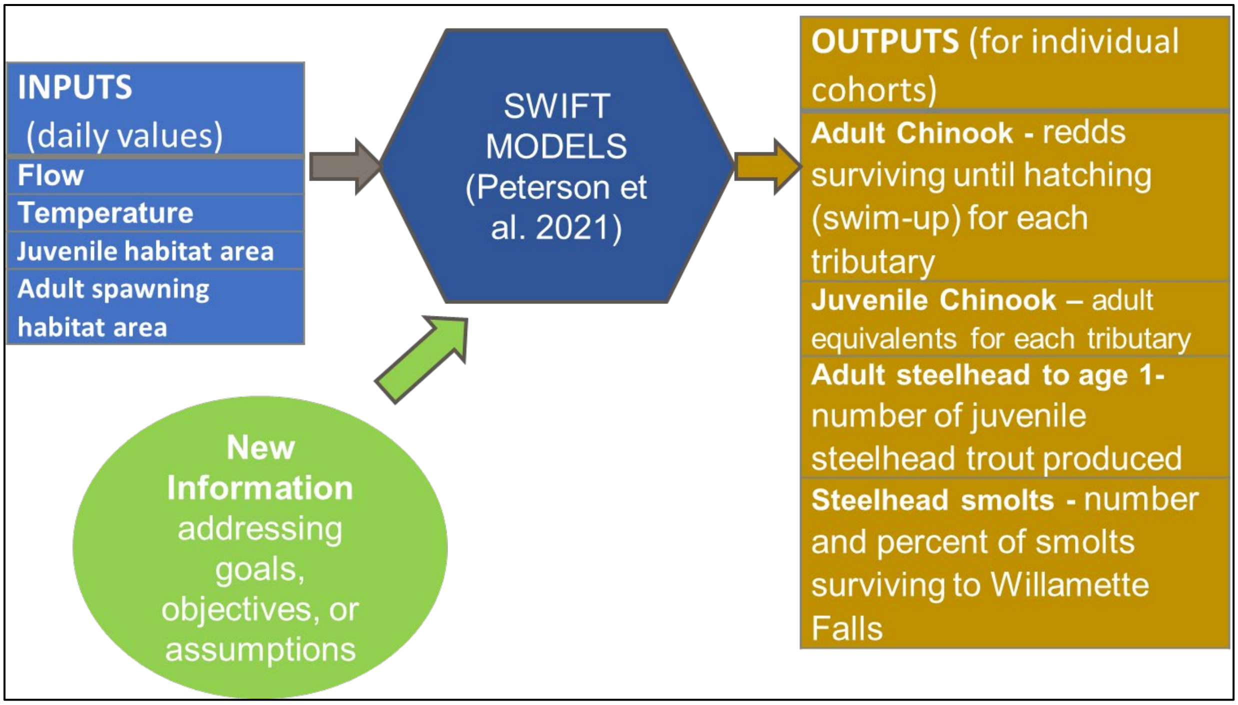


Figure 5-1. Conceptual diagram showing application of SWIFT models for adaptive management of WVS flows to address WVS effects to spring Chinook and winter steelhead

5.1.5 Risks and Uncertainties

Potential risks to successful implementation of the flow measures include:

- Natural water inflows directly affect annual conservation storage volumes in each reservoir and therefore the ability to supplement stream flows downstream of dams to meet tributary flow minimum values.
- Near-term operations may affect conservation storage volumes in reservoirs and therefore the ability to supplement stream flows downstream of dams to meet tributary flow minimum values at particular times in some years.
- It may not be possible to implement downstream fish passage operations and other measures while simultaneously meeting the operational targets of the flow measures in drier water years. A trade-off may be necessary in these years between operations for fish passage or operations for downstream instream flow objectives for fish.

As described in the previous section, there are known areas of scientific uncertainty that are relevant to the variables and relationships in the SWIFT models. The following would be priority research topics to reduce uncertainty for assessing response of spring Chinook and winter steelhead to flow management:

1. Habitat availability: Do new flow/habitat relationships show significant differences from flow/habitat relationships applied in the WVS PEIS?

2. Juvenile Chinook and winter steelhead movements and distribution at high density. Does high density result in movement to other habitat units?

Climate change represents both a risk to successful implementation of measures included in the Preferred Alternative and an area of high uncertainty. USACE completed a climate change assessment that documents the qualitative effects of climate change on hydrology in the region (Appendix F to the Draft PEIS). Qualitative assessment of climate change impacts is required by USACE Engineering and Construction Bulletin (ECB) 2018-14 (revision 1, expires 10-Sep 2022), Guidance for Incorporating Climate Change Impacts to Inland Hydrology in Civil Works Studies, Designs, and Projects.

USACE response to climate change is adaptation centric and a guiding tenet is to incorporate climate change information and considerations early into the formulation process, with the goal of increasing resilience in its measures and alternatives. A more resilient feature is one that is conceptually more resistant to likely future conditions, and/or possesses inherent flexibility to adapt successfully to projected changes. As described in Appendix F to the Draft PEIS, while the climate change assessment did not indicate a statistically significant influence effect from changing climate on historical observed streamflows, future projections estimate that the WVS will experience generally wetter winter flood seasons with less snow and more rain, as well as warmer and drier summer/conservation seasons. The uncertainty associated with a given future projection of hydrologic conditions is large. To address very high uncertainty of a single climate change scenario, USACE policy is to leverage ensembles of the best available and accepted GCM scenario hydroclimate and hydrologic datasets. Determinations can then be made by inferring trends in terms of the statistical distribution metrics (e.g., median shifts, standard deviation etc.) the climate change scenario ensemble.

Measure 30 was designed to be flexible and responsive in real-time to hydrologic conditions. The measure includes two minimum flow schedules and releases to help manage Willamette River water temperatures. Conservation storage conditions are to be reviewed every two weeks between February and June to determine which minimum flow schedule will be applied. Measures 304 and 718 are also employed if reservoirs are drafted to the conservation pool levels and releases are needed to supplement downstream flows.

Real-time water management also has the flexibility to accommodate historical annual hydrologic variation. Reservoirs must be drawn down to minimum conservation pool elevations each fall to meet flood risk reduction objectives. To accomplish draw down, the timing and magnitude of discharges can be adjusted in real-time between spring and fall. Managers each year will prepare a water management plan describing how water will be released from reservoirs to meet instream flow objectives serving fish and wildlife needs and other authorized purposes, and drawdown reservoirs to minimum conservation pool elevations by December 1 annually.

Incorporating updates to future climate change assessments and monitoring variables focused on the relevant climate change factors (see section 3.1.5 and Appendix F) and vulnerabilities identified in Appendix F, is recommended. Evaluation of AM steps is also recommended and important to determine how projected trends manifest themselves in future observations. Such monitoring would allow for a proactive response from USACE, should the risk to successful implementation of measures increase substantially over the long-term. Resilience principles espoused in Engineering and Construction Bulletin, ECB-2020-6 (revision 1, May 2022, expires May 2024), Implementation of Resilience Principles in the Engineering & Construction Community of Practice, should be adhered to and implemented in future adaptive management and monitoring activities.

Updates to the climate change assessments could coincide and follow the Intergovernmental Panel on Climate Change's (IPCC) latest General Circulation Model (GCM) result releases, on average every 6 to 7 years. This frequency of update would align with informing the 10-year evaluation periods outlined for the flow measures. It is also recommended that the update cycle consider the lag time between detection of trends and time to act. More frequent updates may be warranted and should be considered as part of the annual Science Update and AM Workshop process described in Chapter 4. More frequent updates may be precipitated by the availability of new climate change data or improved spatial resolution and statistical analyses that would better outline expected trends.

5.1.6 Decision Triggers and Adaptive Actions

Assessing the performance of flow management will occur every 10 years (or more frequent if significant new information or management issues warrant). Monitoring metrics will be summarized as described previously to assess target achievement. SWIFT models, or other appropriate tools for assessing biological response to WVS flow management, will be applied with relevant new information to assess the biological response to the implemented flow management. Figure 5.1-2 summarizes a conceptual decision tree for long-term AM of the flow measures, illustrating a progression from demonstrating operational effectiveness, to adequately reducing uncertainty in models used for evaluation, to ultimately making decisions based on biological response.

Based on summarization of flow and temperature metrics, and modeled biological response, decision makers will consider continuing, adjusting or reformulating flow management targets. Critical information needs to reduce uncertainties and risks of making changes will be identified. If there is a consideration of adjusting or reformulating, hypotheses for improving flow management will be developed. To support hypothesis development, candidate flow and water temperature regimes may be input into models to predict the potential outcomes. Where biologically significant benefits changes are predicted and are within the management flexibility and authority of USACE to implement, then changes will be implemented and then re-assessed during the next management cycle (e.g., subsequent 10 years).

No contingency actions are identified for the flow measures. By the nature of these measures being a flow operation, there are not pre-determined contingency actions that could be employed outside of the defined operations in the measures. Potential adjustments or major adjustments include:

Adjustments

- Modifying timing, magnitude and/or duration of water releases to ensure minimum flow target values are achieved or exceeded
- Modifying timing, magnitude and/or duration of water releases for achieving mainstem temperature targets

Major Adjustments

- Modifying minimum flow values to address critical biological effects of the WVS
- Modify flow releases for management of mainstem temperatures to address critical biological effects of the WVS

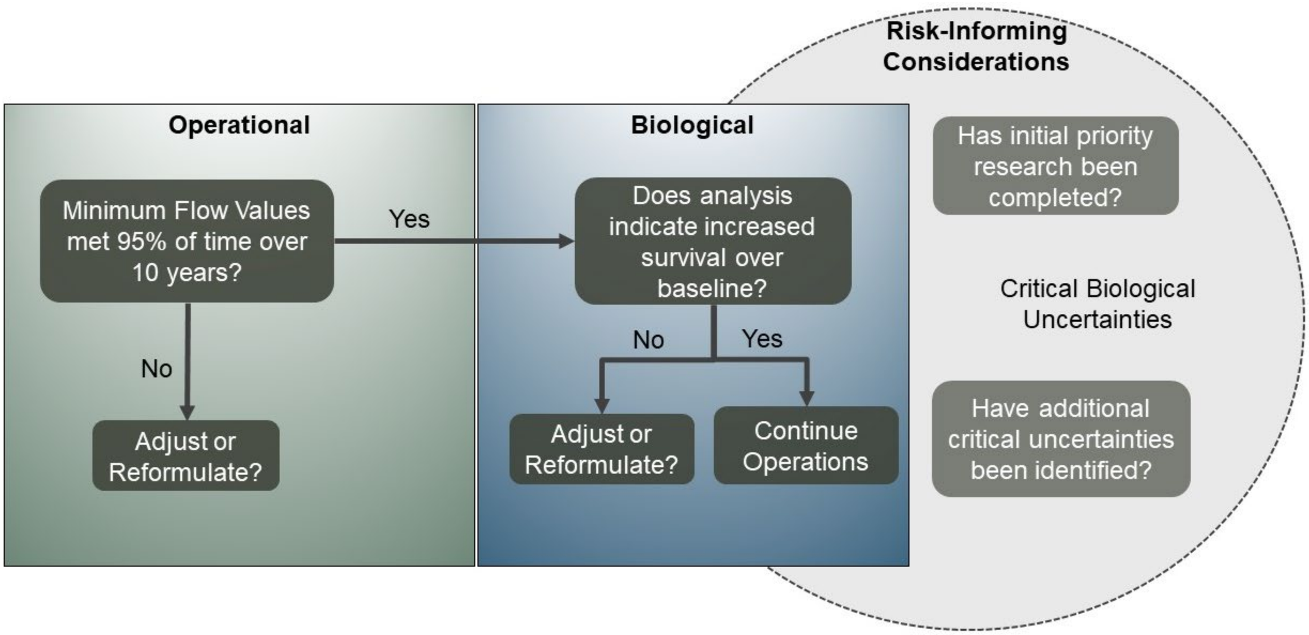


Figure 5-2. Conceptual Decision Tree for Evaluating Flow Measures.

5.1.7 Decision-Making and Collaboration

The primary means of collaboration on real-time water management associated with the proposed flow measures would be through the WATER Flow Management and Water Quality Technical Team, consistent with existing standard practice. The frequency of those engagements is driven by conditions in any given conservation season. It is expected that results of annual operations would be reported on at the annual Science Meeting.

5.2 NORTH SANTIAM

5.2.1 Detroit Near-Term Operations

5.2.1.1 Definition and Function

Near-term operations at Detroit include provision of downstream fish passage by prioritizing flow releases through the upper regulating outlets (UROs) during the fall/winter once the Detroit Reservoir elevation is less than 100 feet over the turbine intakes (1419 ft); target el. 1450 -1500 ft. The timing of the operation results in approximately 60% of the daily flow going through the upper regulating outlet and approximately 40% through the penstock and turbines. Provision of downstream fish passage in the spring and water temperature management throughout late spring and summer at Detroit and Big Cliff Dams would occur through strategic use of the spillway, turbines and regulating outlets. Spillway operations would start when the reservoir reaches spillway crest elevation (El. 1541.0 ft) and continue until the reservoir is drafted below the spillway crest. From there, a combination of turbine and regulating outlet (RO) discharges would be implemented until water temperature management is no longer possible due to reservoir turnover.

5.2.1.2 Constraints

Implementation should not:

- Result in a reduction of USACE ability to operate the dam for flood risk management authorized purpose
- Violate USACE dam safety requirements.

5.2.1.3 Performance Metrics and Targets

Near-term operations at Detroit are anticipated to be implemented until the Detroit Selective Withdrawal Structure (SWS) and Floating Screen Structure (FSS) are constructed and operational. USACE selected the SWS/FSS as the long-term solution to downstream fish passage at Detroit.

Performance Metrics:

The following performance metrics will be used to evaluate the near-term operations at Detroit:

- Dam outlets operated during the defined near-term operational period
- Pool elevations during the defined near-term operational period
- Gate openings and discharge from each outlet operated
- Daily average water temperatures below dam summarized by water year

- Daily estimate of juvenile Chinook passing dam downstream during the date range targeted for fish passage
- Lengths of juvenile Chinook passing dam downstream during the date range targeted for fish passage

Targets:

- Flow releases prioritized through the upper regulating outlets (UROs) during the fall/winter once the Detroit Reservoir elevation is less than 100 feet over the turbine intakes (1419 ft); target elevation 1450 -1500 ft.
- Strategic use of the spillway, turbines and regulating outlets at Detroit and Big Cliff Dams, with spillway operations starting when the reservoir reaches spillway crest elevation (El. 1541.0 ft) and continue until the reservoir is drafted below the spillway crest. From there, a combination of turbine and RO discharges would be implemented until water temperature management is no longer possible due to reservoir turnover.
- Daily water temperatures as defined in Table 5.2-1.
- Increase in the number of juveniles passing as compared to previous operational conditions (baseline/NAA).
- Increase in the distribution of fish lengths passing downstream as compared to previous operational conditions (baseline/NAA).

Table 5-2. Detroit / Big Cliff Dams downstream water temperature 2020 resource agency (RA) targets (daily average)* and ODEQ's 2006 TMDL targets (seven-day average).

Month	Current RA Target Temperature Range Maximum / Minimum °F *		Prior RA Target Temperature Range Maximum / Minimum °F		ODEQ 2006 TMDL Target Temperatures °F
January	42	38	40.1	40.1	No Allocation Needed
February	42	38	42.1	41.0	No Allocation Needed
March	44	42	42.1	41.0	No Allocation Needed
April	46	42	45.1	43.2	41.7
May	50	46	49.1	46.0	45.1
June	54	48	56.1	51.1	49.5
July	55	52	61.2	54.1	55.0
August	55	52	60.3	54.1	55.0
September	54	48	56.1	52.3	51.6
October	52	46	<50.0	<50.0	45.9
November	46	42	<50.0	<50.0	45.9
December	46	41	41.0	41.0	No Allocation Needed

*Daily average 2020 RA target temperatures proposed by ODFW (2017) and approved in 2017 and 2018 by the North Santiam temperature task group (USACE, BPA, ODFW, NMFS, USFWS and ODEQ) for downstream of the Detroit and Big Cliff Dams. On July 20, 2018, the maximum 2018 RA targets were revised to 60 °F through August.

5.2.1.4 Research, Monitoring, and Evaluation

Near-term actions were designed in collaboration with NMFS and other parties to operate the dams as best as feasible using existing facilities until long-term actions are implemented. Due to the effects of annual hydrologic variability in meeting near-term operational objectives and resulting variability in water quality and fish passage conditions expected to occur within and across years, multiple years of monitoring are anticipated to be needed to understand if operations are achieving objectives and targets or if changes are warranted. Monitoring results will be reported and reviewed annually. If targets are not met, decision makers will determine each year if any adjustments should be made to meet the operational objectives or water quality targets, or if additional monitoring or uncertainty research should be conducted. For fish passage, a 5-year check-in will be conducted to review if targets were achieved. This is due to the seasonal and annual variability that occurs and resulting need for multiple years of data to evaluate if targets were achieved. Check-ins can also occur more often if information warrants, however caution should be taken before implementing operational changes for fish passage before multiple years of data are collected.

Study designs and methodology to assess the defined metrics will be determined during implementation so that the best available scientific approaches and methods can be applied. The AM process will be followed to annually prioritize research and monitoring activities, and to complete technical review of proposed monitoring plans for assessing the metrics against the defined targets.

5.2.1.5 Risks and Uncertainties

Potential risks to successful implementation include:

- Near-term operations for fish passage and water quality may influence the ability to meet tributary flow targets in some years.
- Meeting tributary flow targets may influence the ability to achieve near-term operations for fish passage and water quality in some years.

5.2.1.6 Decision Triggers and Adaptive Actions

Decision Criteria:

- If operational objectives or targets are met, continue with near-term operation.
- If operational objectives or targets are not achieved for reasons other than hydrologic limitations or FRM operations, then implement adjustments to operations expected to improve achievement of targets which are feasible and authorized.
- If there are potential feasible and authorized adjustments, but uncertainty if those adjustments can improve the ability to achieve targets, then conduct uncertainty research and implement if results indicate improvement in likelihood of achieving targets.

5.2.1.7 Decision-Making and Collaboration

The Action Agencies (USACE and BPA) will prepare annual reports documenting operations and summarizing the results in comparison to the defined targets. Annual check-ins will occur to assess how well targets have been achieved for water quality. A 5-year check-in will be conducted to review fish passage results to assess how well targets have been achieved. Check-ins on fish passage performance can also occur more often if adequate information is available and warrants review. Where targets are not achieved, the Action Agencies will propose changes to improve achievement of the operation where feasible and authorized. If changes that could improve achieving targets are not apparent, Action Agencies may instead propose uncertainty research to inform what changes may lead to achievement of the targets. The WATER Technical Teams will review the reported results from the operation, and any proposed changes to achieve the operational targets. The Action Agencies will ensure evaluations are carried out and reports are made available for NMFS and WATER review within timelines necessary to inform AM decisions outlined in this document.

5.2.2 Detroit Selective Withdrawal Structure (105)

5.2.2.1 Definition and Function

This measure would use a temperature control structure, assumed to be a selective withdrawal structure (SWS), to achieve Clean Water Act (CWA), total maximum daily load (TMDL), and ESA water temperature requirements below Detroit Dam. Temperature control structures include outlet works that allow for selective withdrawal of water at various temperatures that could be blended to improve downstream water temperature. Structural fixes could allow releases from various elevations in the reservoir, send this water through the powerhouse, and continue to generate power while meeting downstream water quality targets. Water temperature simulations assume outlet details and temperature targets align with those used in previous studies (Buccola et.al, 2012; Buccola et.al, 2016; Buccola, 2017; USACE, 2019d; USACE 2019e).

5.2.2.2 Constraints

Constraints associated with the Detroit SWS will be identified as part of the project-specific planning documents developed prior to implementation. However, two known constraints relating to this measure is that implementation should not:

- Result in a reduction of USACE ability to operate the dam for flood risk management authorized purpose, and
- Violate USACE dam safety requirements.

5.2.2.3 Performance Metrics and Targets

Performance Metric:

- Water temperature: 7-day running average of downstream water temperature

Targets:

Table 5.2-1 identifies the existing water temperature targets for the North Santiam. Evaluation and/or refinement of these targets may be necessary in the future, which would be coordinated through the WATER Flow Management and Water Quality Technical Team.

Table 5-3. Detroit / Big Cliff Dams downstream water temperature 2020 resource agency (RA) targets (daily average)* and ODEQ's 2006 TMDL targets (seven-day average).

Month	Current RA Target Temperature Range Maximum / Minimum °F *		Prior RA Target Temperature Range Maximum / Minimum °F		ODEQ 2006 TMDL Target Temperatures °F
January	42	38	40.1	40.1	No Allocation Needed
February	42	38	42.1	41.0	No Allocation Needed
March	44	42	42.1	41.0	No Allocation Needed
April	46	42	45.1	43.2	41.7
May	50	46	49.1	46.0	45.1
June	54	48	56.1	51.1	49.5
July	55	52	61.2	54.1	55.0
August	55	52	60.3	54.1	55.0
September	54	48	56.1	52.3	51.6
October	52	46	<50.0	<50.0	45.9
November	46	42	<50.0	<50.0	45.9
December	46	41	41.0	41.0	No Allocation Needed

*Daily average 2020 RA target temperatures proposed by ODFW (2017) and approved in 2017 and 2018 by the North Santiam temperature task group (USACE, BPA, ODFW, NMFS, USFWS and ODEQ) for downstream of the Detroit and Big Cliff Dams. On July 20, 2018, the maximum 2018 RA targets were revised to 60 °F through August.

5.2.2.4 Research, Monitoring, and Evaluation

North Santiam water temperature is measured upstream and downstream of Detroit and Big Cliff Reservoirs throughout each year. USACE continues to fund the USGS to measure and report continuous flow, temperature and TDG. The downstream gage that would be used to evaluate this measure is located 0.75 mile below Big Cliff Reservoir near Niagara (BCLO). Flow, stage, temperature, and TDG data are published real-time by the USGS on publicly accessible websites. The USGS station number, which corresponds to the USACE identification, i.e., BCLO, is 14181500.

5.2.2.5 Risks and Uncertainties

Risks and uncertainties associated with this measure would be described during the site-specific planning and design process. There are occasions when potential conflicts may arise between operating to meet the downstream fish temperature targets and the TMDLs. When this occurs, there is a trade-off decision that must be made in real-time.

5.2.2.6 Decision Triggers and Adaptive Actions

The success of the SWS would be evaluated against the ability to manage flows to meet the downstream water temperature targets. The extent to which operations of the SWS could be adjusted to ensure performance would be described in future planning and design documentation. Specifically, the Design Documentation Report or associated Engineering Documentation Report would describe the operation, maintenance, repair, replacement, and rehabilitation requirements for the structure.

5.2.3 Detroit Floating Screen Structure (392)

5.2.3.1 Definition and Function

The measure provides a structural solution to improve downstream fish passage in the form of a Floating Screen Structure (FSS; gravity fed flow which may include pumps for supplementing inflow). A temperature tower is needed to accommodate mooring of the FSS and receiving the gravity fed outflow from the FSS.

5.2.3.2 Constraints

Constraints associated with the Detroit FSS will be identified as part of the project-specific planning documents developed prior to implementation. However, two known constraints relating to this measure is that implementation should not:

- Result in a reduction of USACE ability to operate the dam for flood risk management authorized purpose, and
- Violate USACE dam safety requirements.

5.2.3.3 Performance Metrics and Targets

Performance Metrics:

The following performance metrics will be used to evaluate the passage at Detroit once the FSS is operational:

- Juvenile Fish Dam Passage Survival (DPS = DPE * CS)
  - Sub-metric: Dam-passage efficiency (DPE), the proportion of total fish passing the dam relative to the number of total fish detected in the near forebay of the dam and therefore available to pass.
  - Sub-metric: Fish passage efficiency (FPE), the proportion of fish passing via a non-turbine route, relative to the number of total fish in the near forebay and available to pass.
  - Sub-metric: Fish collector efficiency (FCE), defined as the proportion of fish passing (collected by) the FSS, relative to the number of total fish passing the dam via any route.

- Sub-metric: Concrete Survival (CS), the proportion surviving passage through each route weighted by the number passing through each route

- Above-Dam Cohort Replacement Rate (CRR)

Targets:

- DPS: DPS rate needed to support replacement of spawners above dams as estimated using life cycle models, such as those developed for the Draft WVS PEIS and ESA consultation.
- Cohort Replacement Rate = ≥1.0

Figure 5-3. Detroit Dam tailrace, forebay, and near forebay zone (gray) showing approximate area to be used for measuring fish passage metrics.

5.2.3.4 Research, Monitoring, and Evaluation

Dam passage survival (calculated as DPS = DPE * CS) will be measured in two separate years which are representative of typical operating conditions (i.e., water years within 95% of normal hydrological conditions in the period of record). The precision needed about annual DPS estimates will be determined at the time of the assessment to evaluate passage to provide reasonable certainty bounds acceptable to decision makers.

DPE will be measured as the proportion of fish that exit the reservoir downstream (or are transported downstream) divided by the total number of fish in the near forebay area (i.e., fish approaching the dam). For Detroit the near forebay area will be defined as from the dam upstream to approximately the log boom in the upstream boundary of the dam forebay (Array 6 as defined by Beeman et al. 2015).

Test period(s): Times of the year representative of when most juvenile salmon migrants are actively moving downstream. These test periods likely will cover portions of spring and fall/winter and could be one longer test period or two separate seasonal periods within a year.

CS will be measured as the number of fish that survive from Detroit Dam to the downstream CS measurement boundary divided by the total number of fish that pass downstream. The CS downstream measurement boundary will be located near the river confluence with the mainstem Willamette River (or nearest feasible location upstream of the confluence for assessing survival). In the North Santiam River below Detroit Dam, previous survival estimates used detection arrays at Minto Dam and Salem Oregon (USGS, 2015), and these locations will be reconsidered to produce comparable survival estimates. Bennett dams are an additional option for placing a marked fish detection array for assessing CS.

5.2.3.5 Risks and Uncertainties

- FSS Entrance rejection by juvenile Chinook and steelhead
- Reservoir influence on steelhead passage rates and residualism (i.e., juveniles choose not to emigrate downstream but mature in the reservoir or upstream.
- Seasonal variation in flow rates (from hydrology or dam operations) influencing fish attraction and collection
- Uncertainty in survival rate associated with copepod infection
- Difference in survival between volitional passage and truck transport downstream.
- Effectiveness of structural passage given scale of reservoir fluctuation at Detroit Dam
- Large forebay area impacting guidance and attraction to the FSS entrance. Design has used the dam as a guidance structure. Entrance oriented along longitudinal face of the dam. Could influence the number of fish attracted to entrance point.
- Climate change – see discussion under Basin Flow Measures (Section 5.1.1.5).

5.2.3.6 Decision Triggers and Adaptive Actions

Contingency actions to operation of the FSS are expected to be made in real-time during the first few years. Once field study to assess performance metrics begins, no in-season changes will be made to support evaluation. However, operational treatments for study may be considered at this time to simultaneously evaluate different conditions where information supports such treatments. Once two representative study years of FSS operation are completed, additional contingency actions will be implemented if results warrant, which are within the design capacity of the FSS. However, actions requiring additional funding or engineering will not be considered until after three CRR estimates are available (after year 7).

Successful fish passage would be defined by achieving either the DPS or the CRR target.

Examples of contingency actions for the FSS include:

- Structural: adjusting baffles, and other tuning of the existing facility; changing debris management practices, changing fish handling/holding/transport using existing facilities, guide nets or lead nets.
- Operational FSS: longer or shorter operational periods of FSS, increasing or decreasing entrance flows, operating barrels above criteria, bypass flows, etc.
- Operational dam and reservoir: changes to operating intake gates of temperature tower, increasing or decreasing total or proportional through RO or turbine, changes in refill pattern, operating dam with pulses, operating at lower pool level during conservation season, changing rate of reservoir drawdown through summer and fall.

The extent to which operations of the FSS could be adjusted to ensure performance would be described in future planning and design documentation. This would include both contingency actions as well as adjustments that may require additional environmental compliance or planning/design activities prior to implementation. Specifically, the Design Documentation Report or associated Engineering Documentation Report would describe the operation, maintenance, repair, replacement, and rehabilitation requirements for the structure.

5.2.3.7 Decision-Making and Collaboration

The Action Agencies (USACE and BPA) will fund post-construction evaluations of DPS and fish survival through the FSS. The WATER Fish Passage Design, Research, and Development Technical Team and other WATER Technical Teams, either jointly or separately will review study designs for assessing the performance metrics. It is also anticipated that study designs may benefit from a targeted independent science review. The Action Agencies will address the comments to improve the study design for assessing the performance metrics. If NMFS and the Action Agencies’ technical staff do not concur on final study designs, the dispute will be elevated for resolution following Federal Family and WATER procedures and protocols. The Action Agencies will ensure evaluations are carried out and reports are made available for NMFS and WATER team review within timelines necessary to inform adaptive management decisions outlined in this document.

5.2.4 Minto Adult Fish Facility

5.2.4.1 Definition and Function

Continued operation of the Minto adult fish facility (AFF) for transport of adult spring Chinook and steelhead above Detroit Dam.

5.2.4.2 Constraints

Implementation should not:

- Result in a reduction of USACE ability to operate the dam for flood risk management authorized purpose, and
- Violate USACE dam safety requirements.

5.2.4.3 Performance Metrics and Targets

Performance Metrics:

The following performance metrics will be used to evaluate operation of the Minto AFF:

Adult fish collection and handling, and adult fish transport and outplanting protocols defined in the current Willamette Fish Operations Plan. At a minimum, the following protocols will be evaluated:

- Timing of fish collection and outplanting relative to natural run timing
- Injury rates from handling and sorting
- Mortality rates for fish while in the AFF or during truck transport
- Health condition of fish outplanted
- Health condition of fish taken for brood
- Number and locations of outplanted fish
- Sex ratio of outplanted fish
- Fish densities when in holding at AFF and in transport trucks
- Water temperatures and oxygen levels in the AFF and transport trucks
- Cumulative temperature exposure when in the AFF and transport trucks
- Temperature exposure when water temperatures need to be tempered prior to release of outplanted fish

Targets:

Compliance with the adult fish collection and handling, and adult fish transport and outplanting protocols defined in the 2022 Willamette Fish Operations Plan.

5.2.4.4 Research, Monitoring, and Evaluation

Upstream passage metrics will be summarized annually, and reports provided to WATER for review. Information on most metrics listed above will be collected commensurate with operation of the AFF. Discharge and water temperatures below Detroit Dam will also be continuously monitored.

5.2.4.5 Risks and Uncertainties

- Effects of variation in Detroit Dam discharges (from hydrologic conditions, FRM, hydropower, etc.) on upstream migration of adult fish to Detroit Dam tailrace and adult collection in the AFF.
- Effects of water temperatures discharged from Detroit Dam or from the AFF on adult attraction and collection in the AFF.

5.2.4.6 Decision Triggers and Adaptive Actions

Minor changes to operation of the AFF (i.e., operational feasible, and within USACE authority, and not requiring additional funding) are expected to be made in real-time to maintain compliance with the WFOP protocols. Reports of operations will be reviewed annually to determine areas where minor changes may be needed. If compliance cannot be maintained with minor changes, then adjustments or modifications will be assessed. Depending on the potential solutions, engineering studies or biological studies may be planned as funding is available. The timeframe for implementation of adjustments of modifications to the AFF will depend on the specific actions identified for implementation.

5.2.5 Big Cliff Spread Spill for TDG Abatement (Injunction Measure 10b)

5.2.5.1 Definition and Function

Spread spill across multiple spill bays at Big Cliff Dam, when operating the spillway, to reduce TDG levels. When spill is necessary at Big Cliff Dam, some benefit can be realized from spreading spill across the spillway, using multiple spill bays.

5.2.5.2 Constraints

Minimum gate opening constraints preclude USACE from spreading spill under many flow regimes. Additionally, TDG is generated by Detroit Dam operations, particularly when a non-turbine unit is used to discharge water. In this case, spreading spill at Big Cliff Dam does not prevent/abate TDG levels that are generated by Detroit Dam.

5.2.5.3 Performance Metrics and Targets

Performance Metric:

- Daily average TDG

Target:

- TDG <110%; hatchery receiving waters < 105%

5.2.5.4 Research, Monitoring, and Evaluation

USACE continues to fund the USGS to measure and report continuous flow, temperature and TDG. The downstream gage that would be used to evaluate this measure is located 0.8 miles below Big Cliff Reservoir near Niagara (BCLO). Flow, stage, temperature, and TDG data are published real-time by the USGS on publicly accessible websites. The USGS station number, which corresponds to the USACE identification, i.e., BCLO, is 14181500.

5.2.5.5 Risks and Uncertainties

Potential conflict between downstream water temperature management, downstream fish passage operations, downstream fish hatchery TDG target, and meeting a target of 110% TDG.

5.2.5.6 Decision Triggers and Adaptive Actions

It is anticipated that this measure would be implemented until the Big Cliff TDG Abatement Structure is operational. As a result, decision triggers and adaptive actions are not applicable to this measure.

5.2.6 Big Cliff TDG Abatement Structure (Injunction Measure 10b)

5.2.6.1 Definition and Function

USACE has established a PDT to evaluate alternative concepts for a TDG abatement structural solution at Big Cliff. Although the function of any structural solution would be to reduce TDG downstream of Big Cliff, the specific structural solution that will be selected for implementation has not yet been determined.

5.2.6.2 Constraints

Constraints would be documented as part of the planning and design reports.

5.2.6.3 Performance Metrics and Targets

Performance Metric:

- Daily average TDG

Target:

- TDG <110%; hatchery receiving waters < 105%

5.2.6.4 Research, Monitoring, and Evaluation

USACE continues to fund the USGS to measure and report continuous flow, temperature and TDG. The downstream gage that would be used to evaluate this measure is located 0.8 miles below Big Cliff Reservoir near Niagara (BCLO). Flow, stage, temperature, and TDG data are published real-time by the USGS on publicly accessible websites. The USGS station number, which corresponds to the USACE identification, i.e., BCLO, is 14181500.

5.2.6.5 Risks and Uncertainties

To be determined as part of project-specific planning and design.

5.2.6.6 Decision Triggers and Adaptive Actions

Decision triggers would be defined following selection of the preferred structural solution for TDG abatement at Big Cliff. However, it is likely that if TDG exceedances occurred following implementation of the structural project that would necessitate the need to adjust. A potential adjustment given that scenario would be to resume the Big Cliff spill spread measure. Timing of the decision to adjust would also need to account for when the Detroit SWS/FSS was constructed and operational.

5.3 SOUTH SANTIAM

5.3.1 Green Peter Pass Water Over Spillway in Spring (714) and Deep Fall Reservoir Drawdown to Regulating Outlets (40)

5.3.1.1 Definition and Function

Discharge water via the surface spillway in spring and early summer to increase the number and survival of juvenile salmon and steelhead passing downstream of Green Peter Dam. Drawdown Green Peter Reservoir in fall to 25 feet over the ROs. Juvenile salmonids are known to pass if a surface route is available, particularly in spring and fall. Providing surface spill in spring and then decreasing reservoir elevations to near ROs in fall would increase the number of fish passing and their survival rate.

5.3.1.2 Constraints

Constraints relating to this measure is that implementation should not:

- Result in a reduction of USACE ability to operate the dam for flood risk management authorized purpose, and
- Violate USACE dam safety requirements.

5.3.1.3 Performance Metrics and Targets

The following performance metrics will be used to evaluate fish passage operations at Green Peter Dam:

- Juvenile Fish Dam Passage Survival (DPS = DPE * CS)

- Sub-metric: Dam-passage efficiency (DPE), the proportion of total fish passing the dam relative to the number of total fish detected in the near forebay of the dam and therefore available to pass.
- Sub-metric: Fish passage efficiency (FPE), the proportion of fish passing via a non-turbine route, relative to the number of total fish in the near forebay and available to pass.
- Sub-metric: Concrete Survival (CS), the proportion surviving passage through each route weighted by the number passing through each route

- Above-Dam Cohort Replacement Rate (CRR)

Targets:

- DPS: DPS rate needed to support replacement of spawners above dams as estimated using life cycle models, such as those developed for the WVS EIS and ESA consultation.
- Cohort Replacement Rate = ≥1.0

Figure 5-4. Green Peter Dam tailrace, forebay, and near forebay zone (gray) showing approximate area to be used for measuring fish passage metrics.

5.3.1.4 Research, Monitoring, and Evaluation

Annual dam passage survival (calculated as DPS = DPE * CS) will be measured in two separate years which are representative of typical operating conditions (i.e., water years within 95% of normal hydrological conditions in the period of record). The precision needed about annual DPS estimates will be determined at the time of the assessment to evaluate passage to provide reasonable certainty bounds acceptable to decision makers.

DPE will be measured as the proportion of fish that exit the reservoir from the near forebay zone downstream, divided by the total number of fish in the near forebay zone (i.e., fish approaching the dam). For Green Peter the near forebay zone will be defined as from the dam upstream to approximately the log boom, comparable with the upstream boundary used by Beeman et al. (2015) for assessment of downstream passage metrics at Detroit Dam.

Test period(s): Times of the year representative of when most juvenile salmon migrants are actively moving downstream. These test periods likely will cover portions of spring and fall/winter and could be one longer test period or two separate seasonal periods within a year.

CS will be measured as the number of fish that survive from Green Peter Dam to the downstream to one of two CS measurement boundaries, each divided by the total number of fish that pass downstream. Two CS measurement boundaries are necessary to assess passage survival at Green Peter Dam separately from the combine passage survival for both Green Peter and Foster dams. The first CS measure boundary will be upstream of Foster Dam, either at the head of Foster Reservoir, or in the forebay of Foster Dam (or potentially both locations). The second CS downstream measurement boundary will be located near the river confluence with the mainstem Willamette River (or nearest feasible location upstream of the confluence for assessing survival). In the South Santiam River, previous survival estimates utilized detection arrays at Lebanon Dam (Liss et al., 2020), and these locations will be reconsidered to produce comparable survival estimates.

5.3.1.5 Risks and Uncertainties

- Annual hydrologic variability limiting or effecting timing of surface spill, resulting in low fish passage efficiency in spring
- Reservoir influence on steelhead passage rates and residualism (i.e., juveniles choose not to emigrate downstream but mature in the reservoir or upstream.
- Uncertainty in survival rate associated with spillway or RO passage
- Uncertainty in survival rate associated with copepod infection
- Climate change – see discussion under Basin Flow Measures (Section 5.1.1.5).

5.3.1.6 Decision Triggers and Adaptive Actions

Once two representative study years of fish passage operations are completed, contingency actions or adjustments will be implemented if results warrant, which are within the operational capacity of Green Peter Dam. However, actions requiring additional funding or engineering will not be considered until after three CRR estimates are available (after year 7).

Successful fish passage would be defined by achieving either the DPS or the CRR target.

5.3.2 Green Peter Surface Spill when available in the spring and summer to improve downstream water temperatures (721), and Use regulating outlets to discharge colder water during drawdown operations in fall and winter to reduce water temperatures below dams (166)

5.3.2.1 Definition and Function

Use the spillway when available in the spring and summer to improve downstream water temperatures from spring through autumn. By extending the use of the spillway, a larger volume of warm surface water from the reservoir can be released and cold deep water can be reserved for later in the fall/early winter when necessary for fish incubation. In the fall, the deeper regulating outlets (ROs) can release a limited amount of cooler water at Green Peter. At Green Peter, this measure would consist of using up to 60% of total release through spillway as soon as available in May to provide attraction temperatures for upstream migrant adult Chinook. Use up to 60% of total release through ROs in the fall to reduce temperatures for egg incubation downstream of Foster.

5.3.2.2 Constraints

Constraints relating to this measure is that implementation should not:

- Result in a reduction of USACE ability to operate the dam for flood risk management authorized purpose, and
- Violate USACE dam safety requirements.

5.3.2.3 Performance Metrics and Targets

Performance Metric:

- Water temperature: 7-day running average of downstream water temperature

Targets:

Table 5.3-1 identifies the existing water temperature targets for the South Santiam. Evaluation and/or refinement of these targets may be necessary in the future, which would be coordinated through the WATER Flow Management and Water Quality Technical Team.

Table 5-4. Green Peter and Foster Dams downstream water temperature targets from resource agencies (daily average)* and ODEQ's 2006 TMDL targets (seven-day average).

Month	RA Target Temperature Range Maximum / Minimum °F*		ODEQ 2006 TMDL Target Temperatures °F
January	40.1	40.1	No Allocation Needed
February	42.1	41.0	No Allocation Needed
March	42.1	41.0	No Allocation Needed
April	45.1	43.2	43.0
May	49.1	46.0	46.8
June	56.1	51.1	54.3
July	61.2	54.1	65.1
August	60.3	54.1	64.4
September	56.1	52.3	59.9
October	<50.0	<50.0	54.7
November	<50.0	<50.0	54.7
December	41.0	41.0	No Allocation Needed

*Daily average target temperatures originally developed by the resource agencies (NMFS, USFWS, ODFW) for the McKenzie River below Cougar Dam (October and November slightly modified for the North / South Santiam River).

5.3.2.4 Research, Monitoring, and Evaluation

Water temperature data would be measured upstream and downstream of Green Peter and Foster Dams by the USACE funded USGS gages including:

- Middle Santiam River upstream of Green Peter Reservoir (MSCO)
- Quartzville Creek upstream of Green Peter Reservoir (QCCO)
- Middle Santiam downstream of Green Peter Reservoir (GPRO)
- South Santiam River near the town of Cascadia (SSCO)
- South Santiam River downstream of Foster Reservoir (SSFO)

5.3.2.5 Risks and Uncertainties

Content In Development

5.3.2.6 Decision Triggers and Adaptive Actions

Content In Development

5.3.3 Green Peter Adult Fish Facility (722)

5.3.3.1 Definition and Function

Construct adult fish facility (AFF) at Green Peter Dam for transport of adult spring Chinook and steelhead above Green Peter Dam. Provide adult upstream passage above Green Peter Dam for adult fish, including spring Chinook and steelhead.

5.3.3.2 Constraints

Constraints associated with the Green Peter Dam AFF will be identified as part of the project-specific planning documents developed prior to implementation. However, two known constraints relating to this measure is that implementation should not:

- Result in a reduction of USACE ability to operate the dam for flood risk management authorized purpose, and
- Violate USACE dam safety requirements.

5.3.3.3 Performance Metrics and Targets

Performance Metrics:

The following performance metrics will be used to evaluate operation of the AFF at Green Peter Dam:

Adult fish collection and handling, and adult fish transport and outplanting protocols defined in the current Willamette Fish Operations Plan. At a minimum, the following protocols will be evaluated:

- Timing of fish collection and outplanting relative to natural run timing
- Injury rates from handling and sorting
- Mortality rates for fish while in the AFF or during truck transport
- Health condition of fish outplanted
- Health condition of fish taken for brood
- Number and locations of outplanted fish
- Sex ratio of outplanted fish
- Fish densities when in holding at AFF and in transport trucks
- Water temperatures and oxygen levels in the AFF and transport trucks
- Cumulative temperature exposure when in the AFF and transport trucks

- Temperature exposure when water temperatures need to be tempered prior to release of outplanted fish

Targets:

Compliance with the adult fish collection and handling, and adult fish transport and outplanting protocols defined in the 2022 Willamette Fish Operations Plan.

5.3.3.4 Research, Monitoring, and Evaluation

Upstream passage metrics will be summarized annually, and reports provided to WATER for review. Information on most metrics listed above will be collected commensurate with operation of the AFF. Discharge and water temperatures below Green Peter Dam will also be continuously monitored.

5.3.3.5 Risks and Uncertainties

- Effects of variation in Green Peter Dam discharges (from hydrologic conditions, FRM, hydropower, etc.) on upstream migration of adult fish to Green Peter Dam tailrace and adult collection in the AFF.
- Effects of water temperatures discharged from Green Peter Dam or from the AFF on adult attraction and collection in the AFF.

5.3.3.6 Decision Triggers and Adaptive Actions

Minor changes to operation of the AFF (i.e., operational feasible, and within USACE authority, and not requiring additional funding) are expected to be made in real-time to maintain compliance with the WFOP protocols. Reports of operations will be reviewed annually to determine areas where minor changes may be needed. If compliance cannot be maintained with minor changes, then adjustments or modifications will be assessed. Depending on the potential solutions, engineering studies or biological studies may be planned as funding is available. The timeframe for implementation of adjustments of modifications to the AFF will depend on the specific actions identified for implementation.

5.3.4 Foster Near-Term Operations (13a/13b)

5.3.4.1 Definition and Function

The near-term operations at Foster are intended to improve fish passage by increasing passage of fish over spillways, reducing passage through penstocks and improving water temperatures in the tailrace to support collection of adult Chinook at the Foster AFF. From February 1 – May 15, delay the refill of Foster Reservoir and hold at minimum conservation pool (El. 613-615 ft.). The spillway would be operated at night from one hour before sunset to one-half hour after sunrise; one turbine unit would be operated for station service (~300 cfs) to reduce/balance TDG levels created by the spill operation. From May 16 – June 15, Foster Reservoir would refill.

The night spillway-only operations would continue with flows from one turbine as described above.

Starting on June 16, the fish weir would be installed and operated. The fish weir provides warmer surface water from the reservoir to raise river temperatures and aid in attracting adult salmon to the Foster AFF for collection, from June 16 to mid/late July. The fish weir would be operated at a 300 cfs flow with the duration of operation depending on storage in both Green Peter and Foster Reservoirs, and biological need (i.e., numbers of adult Chinook collected at the AFF). Starting just after Labor Day weekend, gradually draw down Foster reservoir to target a forebay elevation of 620-625 ft by October 1. Beginning on October 1, use the spillway to pass fish at night, while generation occurs during the day. Carry out through December 15.

5.3.4.2 Constraints

Implementation should not:

- Result in a reduction of USACE ability to operate the dam for flood risk management authorized purpose
- Violate USACE dam safety requirements.

5.3.4.3 Performance Metrics and Targets

Performance Metrics:

- Daily estimate of juvenile Chinook passing dam downstream during the date range targeted for fish passage
- Lengths of juvenile Chinook passing dam downstream during the date range targeted for fish passage

Targets:

- Increase in the number of juveniles passing as compared to previous operational conditions (baseline/NAA).
- Increase in the distribution of fish lengths passing downstream as compared to previous operational conditions (baseline/NAA).

5.3.4.4 Research, Monitoring, and Evaluation

Near-term actions were designed in collaboration with NMFS and other parties to operate the dams as best as feasible using existing facilities until long-term actions are implemented. Due to the effects of annual hydrologic variability in meeting near-term operational objectives and resulting variability in water quality and fish passage conditions expected to occur within and across years, multiple years of monitoring are anticipated to be needed to understand if operations are achieving objectives and targets or if changes are warranted. Monitoring results will be reported and reviewed annually. If targets are not met, decision makers will determine each year if any adjustments should be made to meet the operational objectives or water quality targets, or if additional monitoring or uncertainty research should be conducted. For fish passage, a 5-year check-in will be conducted to review if targets were achieved. This is due to the seasonal and annual variability that occurs and resulting need for multiple years of data to evaluate if targets were achieved. Check-ins can also occur more often if information warrants, however caution should be taken before implementing operational changes fish passage before multiple years of data are collected.

Study designs and methodology to assess the defined metrics will be determined during implementation so that the best available scientific approaches and methods can be applied. The AM process will be followed to annually prioritize research and monitoring activities, and to complete technical review proposed monitoring plans for assessing the metrics against the defined targets.

5.3.4.5 Risks and Uncertainties

Potential risks to successful implementation include:

- Near-term operations for fish passage and water quality may influence the ability to meet tributary flow targets in some years.
- meet tributary flow targets may influence the ability to achieve near-term operations for fish passage and water quality in some years.

5.3.4.6 Decision Triggers and Adaptive Actions

The Action Agencies (USACE and BPA) will prepare annual reports documenting operations and summarizing the results in comparison to the defined targets. Annual check-ins will occur to assess how well targets have been achieved for water quality. A 5-year check-in will be conducted to review fish passage results to assess how well targets have been achieved. Check-ins on fish passage performance can also occur more often if adequate information is available and warrants review. Where targets are not achieved, the Action Agencies will propose changes to improve achievement of the operation where feasible and authorized. If changes that could improve achieving targets are not apparent, Action Agencies may instead propose uncertainty research to inform what changes may lead to achievement of the targets. The WATER Technical Teams will review the reported results from the operation, and any proposed changes to achieve the operational targets. The Action Agencies will ensure evaluations are carried out and reports are made available for NMFS and WATER review within timelines necessary to inform AM decisions outlined in this document.

5.3.5 Foster Downstream Fish Passage (392)

5.3.5.1 Definition and Function

The measure provides a structural solution to improve downstream fish passage in the form of a modified fish weir or dedicated fish pipe. The design will provide fish downstream passage through a surface route with a flow rate of 500-800 cfs.

5.3.5.2 Constraints

Constraints associated with the Foster Downstream Fish Passage Structure will be identified as part of the project-specific planning documents developed prior to implementation. However, two known constraints relating to this measure is that implementation should not:

- Result in a reduction of USACE ability to operate the dam for flood risk management authorized purpose, and
- Violate USACE dam safety requirements.

5.3.5.3 Performance Metrics and Targets

Performance Metrics:

The following performance metrics will be used to evaluate the Foster Downstream Fish Passage Structure once operational:

- Juvenile Fish Dam Passage Survival (DPS = DPE * CS)
    - Sub-metric: Dam-passage efficiency (DPE), the proportion of total fish passing the dam relative to the number of total fish detected in the near forebay of the dam and therefore available to pass.
    - Sub-metric: Fish passage efficiency (FPE), the proportion of fish passing via a non-turbine route, relative to the number of total fish in the near forebay and available to pass.
    - Sub-metric: Fish collector efficiency (FCE), defined as the proportion of fish passing (collected by) the FSS, relative to the number of total fish passing the dam via any route.
    - Sub-metric: Concrete Survival (CS), the proportion surviving passage through each route weighted by the number passing through each route
- Above-Dam Cohort Replacement Rate (CRR)

Targets:

- DPS: DPS rate needed to support replacement of spawners above dams as estimated using life cycle models, such as those developed for the WVS EIS and ESA consultation.
- Cohort Replacement Rate = ≥1.0

Figure 5-5. Foster Dam tailrace, forebay, and near forebay zone (gray) showing approximate area to be used for measuring fish passage metrics.

5.3.5.4 Research, Monitoring, and Evaluation

Annual dam passage survival (calculated as DPS = DPE * CS) will be measured in two separate years which are representative of typical operating conditions (i.e., water years within 95% of normal hydrological conditions in the period of record). The precision needed about annual DPS estimates will be determined at the time of the assessment to evaluate passage to provide reasonable certainty bounds acceptable to decision makers.

DPE will be measured as the proportion of fish that exit the reservoir downstream divided by the total number of fish in the near forebay area (i.e., fish approaching the dam). For Foster, the near forebay area will be defined as from the dam upstream approximately a quarter mile to the log boom, consistent with previous survival studies completed by Liss et al. (2020).

Test period(s): Times of the year representative of when most juvenile salmon migrants are actively moving downstream. These test periods likely will cover portions of spring and fall/winter and could be one longer test period or two separate seasonal periods within a year.

CS will be measured as the number of fish that survive from Foster Dam to the downstream CS measurement boundary divided by the total number of fish that pass downstream. The CS downstream measurement boundary will be located near the river confluence with the mainstem Willamette River (or nearest feasible location upstream of the confluence for assessing survival). In the South Santiam River, previous survival estimates utilized detection arrays at Lebannon Dam (see Liss et al., 2020), and these locations will be reconsidered in order to produced comparable survival estimates.

5.3.5.5 Risks and Uncertainties

- Low FCE of juvenile Chinook and steelhead (i.e., fish passage facility rejection)
- Reservoir influence on steelhead passage rates and residualism (i.e., juveniles choose not to emigrate downstream but mature in the reservoir or upstream).
- Seasonal variation in flow rates (from hydrology or dam operations) influencing fish attraction and collection
- Uncertainty in survival rate associated with copepod infection
- Uncertainty in injury or mortality from structural fish passage
- Climate change – change in hydrology that would influence flow rates through the structure and downstream water temperatures

5.3.5.6 Decision Triggers and Adaptive Actions

Minor changes to operation of the Foster Downstream Fish Passage Structure are expected to be made in real-time during the first few years. Once field study to assess performance metrics begins, no in-season changes will be made in order to support evaluation. However, operational treatments for study may be considered at this time to simultaneously evaluate different conditions where information supports such treatments. Once two representative study years of operation are completed, additional minor changes or adjustments will be implemented if results warrant, which are within the design capacity of Foster Dam facilities, FRM operations, and USACE authority. However, actions requiring additional funding or engineering will not be considered until after three CRR estimates are available (after year 7).

Successful fish passage would be defined by achieving either the DPS or the CRR target.

5.3.5.7 Decision-Making and Collaboration

The Action Agencies (USACE and BPA) will fund post-construction evaluations of DPS at Foster Dam. The WATER and an Independent Science Review body will review study designs for assessing the performance metrics. The Action Agencies will address the comments to improve the study design for assessing the performance metrics. If NMFS and the Action Agencies' technical staff do not concur on final study designs, the dispute will be elevated for resolution following Federal Family and WATER procedures and protocols. The Action Agencies will ensure evaluations are carried out and reports are made available for NMFS and WATER team review within timelines necessary to inform adaptive management decisions outlined in this document.

5.3.6 Foster Fish Ladder Temperature Improvement (479)

5.3.6.1 Definition and Function

This measure would provide improved water temperature control for water discharged from Foster Dam forebay and used in the Foster AFF fish ladder. Under this measure, a structural modification to Foster Dam would be implemented to reduce delay of upstream-migrating spring Chinook salmon and winter steelhead by increasing the water temperature in the fish ladder. During the later spring and summer months, the Foster forebay is stratified in terms of temperature. The existing water supply for the fish ladder is located at the powerhouse intakes, below the thermocline, and as a result, the temperature of the flow issuing from the pre-sort pool at the top of the fish ladder and from the ladder entrances is too cold to attract adult Chinook salmon to enter the AFF fish ladder from the Foster Dam tailrace.

The major feature of this measure is construction of a new Forebay Warm Water Supply (FWWS) pipe that would draw warm water from above the thermocline in the Foster forebay. The existing water supply pipe would remain in use and a network of pipes and valves would allow the two water sources to be mixed to achieve desired temperatures at adult fish facility. The temperature targets were developed as a function of the upstream South Santiam River, with maximum target temperatures constrained by needs for fish health. A juvenile fish exclusion screen would be provided upstream of the FWWS intake to keep juvenile fish from entering the pipe.

The purpose of the FWWS is to reduce delay of upstream-migrating spring Chinook salmon at FOS. Successful adult passage needs: 1) warm water in the lower river to move fish into the tailrace; and 2) warmer ladder temperatures to move fish from the tailrace into the ladder. The first item is beyond the scope of the FFLIP project. The goal of the FWWS design is to address the second aspect of successful fish passage, namely warming up the water in the fish ladder and discharging from its entrances during the later spring and summer so that any fish in the tailrace can be collected with minimal delay. Water temperatures less than 52°F/11.1°C are too cold to attract upstream movement of adult Chinook into adult fish facilities.

The USACE FWWS PDT developed water temperature targets for the FOS fish ladder in consultation with NMFS and ODFW. The targets are based on water temperatures in the South Santiam River above Foster, which were determined to be appropriate for encouraging upstream migration of Chinook salmon. The temperature targets were established based on the 75 percent, 50 percent, or 25 percent quartiles based on the time of year. In spring, when the South Santiam River is cooler, the 75 percent quartile was used as a target to attract fish into the fish ladder. In the late summer, when the South Santiam River is warmer, the 25 percent quartile was used. The quartile selection was based on knowledge that salmon migrate when water temperatures are at or above 52 °F (11.1 °C) and that temperatures above 60 °F (15.6 °C) may become stressful. Although the South Santiam River temperature rises above 60 °F (15.6 °C) every year, a summer maximum target temperature of 60 °F (15.6 °C) was established for the period of 01 July to 30 August to minimize temperature stress on fish. The selection was approved by ODFW and NMFS (May 7, 2019 and June 4, 2019 WFFDWG meetings).

Table 5-5. Water Temperature Targets for the FOS Fish Ladder

DD-MM	FOS Fish Ladder Target	Explanation (based on 2008 to 2019 data from USGS 14185000 South Santiam below Cascadia)
01-May	51°F (10.6 °C)	75th %
15-May	53 °F (11.7 °C)	75th %
01-Jun	55 °F (12.8 °C)	Average of 15 May 75th % and 15 Jun 75th %
15-Jun	57 °F (13.9 °C)	50th %
01-Jul to 30-Aug	60 °F (15.6 °C)	Summer maximum
01-Sep	58 °F (14.4 °C)	25th %
15-Sep	55 °F (12.8 °C)	25th %

5.3.6.2 Constraints

Constraints associated with the Foster Downstream Fish Passage Structure will be identified as part of the project-specific planning documents developed prior to implementation. However, two known constraints relating to this measure is that implementation should not:

- Result in a reduction of USACE ability to operate the dam for flood risk management authorized purpose, and
- Violate USACE dam safety requirements.

5.3.6.3 Performance Metrics and Targets

Performance Metric:

- Daily average water temperature as measure at the fish ladder points of discharge to the Foster Dam tailrace.

Targets:

- Water temperature targets listed in Table 5.3-2, +/- 2°F.

Any refinement of these targets will be coordinated through the WATER Technical Teams.

5.3.6.4 Research, Monitoring, and Evaluation

Temperature data loggers will be operated in the Foster AFF fish ladder near the points of discharge into the Foster Dam tailrace and recording at least hourly water temperatures. Daily average water temperature will be summarized annually.

5.3.6.5 Risks and Uncertainties

Risks and uncertainties associated with the Foster Fish Ladder will be documented as part of the site-specific engineering design process.

5.3.6.6 Decision Triggers and Adaptive Actions

Decision Criteria:

- If fish ladder water temperature targets are met, continue with operation of the Foster AFF to achieve the water temperature targets in the fish ladder.
- If targets are not achieved for reasons other than hydrologic limitations or FRM operations, then implement adjustments or modifications expected to improve achievement of targets which are feasible and authorized.
- If there are potential feasible and authorized adjustments, but uncertainty if those adjustments can improve the ability to achieve targets, then conduct uncertainty research and implement if results indicate that improvement is likelihood of achieving targets.

5.3.7 Foster Adult Fish Facility

5.3.7.1 Definition and Function

Continued operation of the Foster AFF for transport of adult spring Chinook and steelhead above Foster Dam. Provide adult upstream passage above Foster Dam for adult fish, including spring Chinook and steelhead.

5.3.7.2 Constraints

Implementation should not:

- Result in a reduction of USACE ability to operate the dam for flood risk management authorized purpose, and
- Violate USACE dam safety requirements.

5.3.7.3 Performance Metrics and Targets

Performance Metrics:

The following performance metrics will be used to evaluate operation of the Foster AFF:

Adult fish collection and handling, and adult fish transport and outplanting protocols defined in the current Willamette Fish Operations Plan. At a minimum, the following protocols will be evaluated:

- Timing of fish collection and outplanting relative to natural run timing
- Injury rates from handling and sorting
- Mortality rates for fish while in the AFF or during truck transport
- Health condition of fish outplanted
- Health condition of fish taken for brood
- Number and locations of outplanted fish
- Sex ratio of outplanted fish
- Fish densities when in holding at AFF and in transport trucks
- Water temperatures and oxygen levels in the AFF and transport trucks
- Cumulative temperature exposure when in the AFF and transport trucks
- Temperature exposure when water temperatures need to be tempered prior to release of outplanted fish

Targets:

Compliance with the adult fish collection and handling, and adult fish transport and outplanting protocols defined in the 2022 Willamette Fish Operations Plan.

5.3.7.4 Research, Monitoring, and Evaluation

Upstream passage metrics will be summarized annually, and reports provided to WATER for review. Information on most metrics listed above will be collected commensurate with operation of the AFF. Discharge and water temperatures below Foster Dam will also be continuously monitored.

5.3.7.5 Risks and Uncertainties

- Effects of variation in Foster Dam discharges (from hydrologic conditions, FRM, hydropower, etc.) on upstream migration of adult fish to Foster Dam tailrace and adult collection in the AFF.

- Effects of water temperatures discharged from Foster Dam or from the AFF on adult attraction and collection in the AFF.

5.3.7.6 Decision Triggers and Adaptive Actions

Minor changes to operation of the AFF (i.e., operational feasible, and within USACE authority, and not requiring additional funding) are expected to be made in real-time to maintain compliance with the WFOP protocols. Reports of operations will be reviewed annually to determine areas where minor changes may be needed. If compliance cannot be maintained with minor changes, then adjustments or modifications will be assessed. Depending on the potential solutions, engineering studies or biological studies may be planned as funding is available. The timeframe for implementation of adjustments of modifications to the AFF will depend on the specific actions identified for implementation.

5.4 MCKENZIE

5.4.1 Cougar Near-Term Operations (14/15a)

5.4.1.1 Definition and Function

The Cougar near-term operation is intended to improve fish passage. In the fall, Cougar Reservoir would be drawn down below minimum conservation pool to provide a surface-oriented flow through the ROs. The RO would be prioritized throughout the implementation of this operation. However, some station service (a 150 cfs release through the turbine unit) may be required early on to ensure no loss of remote flood risk management capability due to issues with the operability of the emergency diesel generator, which is the only automatic back-up power source for the facility in the event of an unanticipated loss of line power. Refill begins in December and operations would transition to nighttime RO releases and daytime generation.

During storms and flood risk reduction events, USACE and NMFS may jointly decide to allow the reservoir to fill rather than use the turbines to increase outflows out of Cougar Dam and develop a strategy to manage water releases following this and future storm events. Once the storm passes, RO discharges will be increased to draw the reservoir back to the targeted elevation of 1505 ft. as quickly as possible.

The RO at Cougar Dam is known to produce elevated downstream TDG when releases are more than 800 cfs. Modest increases in downstream TDG are expected to be less detrimental to the life history stages in the reach downstream of Cougar at that time of year than passing juvenile fish through the turbine units.

Cougar will be allowed to refill back to elevation 1532 ft. starting on December 15, along with nighttime RO usage and daytime generation.

On February 1, the refill of Cougar Reservoir will be delayed until May or June depending on water conditions (i.e., wet, average, dry). In dry years, Cougar Reservoir may be refilled as early as May 1, while in wet years, refill may not begin until June 1. The goal is to start refill early enough that the reservoir can reach elevation 1571 ft. by summer so that the Cougar Water Temperature Control Tower (WTCT) weirs can be used for downstream water temperature management. On June 2, switch to all powerhouse. Cougar Reservoir should not be drawn down below the elevation of the saddle dam during fish passage operations.

5.4.1.2 Constraints

Implementation should not:

- Result in a reduction of USACE ability to operate the dam for flood risk management authorized purpose
- Violate USACE dam safety requirements.

5.4.1.3 Performance Metrics and Targets

Performance Metrics:

The following performance metrics will be used to evaluate the near-term operations at Cougar:

- Dam outlets operated during the defined near-term operational period
- Pool elevations during the defined near-term operational period
- Gate openings and discharge from each outlet operated
- Daily estimate of juvenile Chinook passing dam downstream during the date range targeted for fish passage
- Lengths of juvenile Chinook passing dam downstream during the date range targeted for fish passage

Targets:

- In autumn, Cougar Reservoir was draw down below minimum conservation pool, with the ROs prioritized for use over the turbine penstocks throughout the implementation of this operation. Pool refill began in December and operations transitioned to nighttime RO releases and daytime generation. Cougar was allowed to refill back to El. 1532 ft. starting on December 15, along with nighttime RO usage and daytime generation.
- Beginning February 1, the refill of Cougar Reservoir was delayed until May or June depending on water conditions (i.e., wet, average, dry). In dry years, Cougar Reservoir may be refilled as early as May 01, while in wet years, refill may not begin until June 01. The goal is to start refill early enough that the reservoir can reach El. 1571 ft. by summer so that the Cougar WTCT weirs can be used for downstream water temperature management. On June 2, operations were switched to all powerhouse. Cougar Reservoir was not drawn down below the elevation of the saddle dam during fish passage operations.

- Increase in the number of juveniles passing as compared to previous operational conditions (baseline/NAA).
- Increase in the distribution of fish lengths passing downstream as compared to previous operational conditions (baseline/NAA).

5.4.1.4 Research, Monitoring, and Evaluation

Near-term actions were designed in collaboration with NMFS and other parties to operate the dams as best as feasible using existing facilities until long-term actions are implemented. Due to the effects of annual hydrologic variability in meeting near-term operational objectives and resulting variability in water quality and fish passage conditions expected to occur within and across years, multiple years of monitoring are anticipated to be needed to understand if operations are achieving objectives and targets or if changes are warranted. Monitoring results will be reported and reviewed annually. If targets are not met, decision makers will determine each year if any adjustments should be made to meet the operational objectives or water quality targets, or if additional monitoring or uncertainty research should be conducted. For fish passage, a 5-year check-in will be conducted to review if targets were achieved. This is due to the seasonal and annual variability that occurs and resulting need for multiple years of data to evaluate if targets were achieved. Check-ins can also occur more often if information warrants, however caution should be taken before implementing operational changes fish passage before multiple years of data are collected.

Study designs and methodology to assess the defined metrics will be determined during implementation so that the best available scientific approaches and methods can be applied. The AM process will be followed to annually prioritize research and monitoring activities, and to complete technical review proposed monitoring plans for assessing the metrics against the defined targets.

5.4.1.5 Risks and Uncertainties

- Risk: There is a trade-off in some water years between achieving the operational targets of these flow measures vs meeting other objectives (e.g. downstream minimum flow values)
- Risk: Hydrologic variability limiting the ability to achieve the near-term operation in a given year

5.4.1.6 Decision Triggers and Adaptive Actions

Decision Criteria:

- If operational objectives or targets are met, continue with near-term operation.
- If operational objectives or targets are not achieved for reasons other than hydrologic limitations or FRM operations, then implement adjustments to operations expected to improve achievement of targets which are feasible and authorized.

- If there are potential feasible and authorized adjustments, but uncertainty if those adjustments can improve the ability to achieve targets, then conduct uncertainty research and implement if results indicate that improvement is likelihood of achieving targets.

5.4.1.7 Decision-Making and Collaboration

The Action Agencies (USACE and BPA) will prepare annual reports documenting operations and summarizing the results in comparison to the defined targets. Annual check-ins will occur to assess how well targets have been achieved for water quality. A 5-year check-in will be conducted to review fish passage results to assess how well targets have been achieved. Check-ins on fish passage performance can also occur more often if adequate information is available and warrants review. Where targets are not achieved, the Action Agencies will propose changes to improve achievement of the operation where feasible and authorized. If changes that could improve achieving targets are not apparent, Action Agencies may instead propose uncertainty research to inform what changes may lead to achievement of the targets. The WATER Technical Teams will review the reported results from the operation, and any proposed changes to achieve the operational targets. The Action Agencies will ensure evaluations are carried out and reports are made available for NMFS and WATER review within timelines necessary to inform AM decisions outlined in this document.

5.4.2 Cougar Regulating Outlet Chute Resurfacing (15b)

5.4.2.1 Definition and Function

Recoat the Cougar RO chute no later than September 1, 2023, to reduce injuries and increase survival of fish passing downstream through the RO.

5.4.2.2 Constraints

Constraints associated with the Cougar RO Chute Resurfacing will be identified as part of the project-specific planning documents developed prior to implementation.

5.4.2.3 Performance Metrics and Targets

Performance Metrics:

- External injury rates of juvenile Chinook salmon passing through the RO into the stilling basin.
- Survival rates of juvenile Chinook salmon passing through the RO into the stilling basin.

Targets:

- External injury rates of juvenile Chinook salmon passing through the RO into the stilling basin are lower than before resurfacing of the RO.

- Survival rates of juvenile Chinook salmon passing through the RO into the stilling basin are higher than before resurfacing of the RO.

5.4.2.4 Research, Monitoring, and Evaluation

Near-term actions were designed in collaboration with NMFS and other parties to operate the dams as best as feasible using existing facilities until long-term actions are implemented. One-year of study is expected to be adequate unless unique or extreme operational conditions occur during the testing period. In which case additional study may be needed. Monitoring results will be reported and reviewed once available. If targets are not met, decision makers will determine if any adjustments should be made to meet the targets, or if additional monitoring or uncertainty research should be conducted.

Study designs and methodology to assess the defined metrics will be determined during implementation so that the best available scientific approaches and methods can be applied. The AM process will be followed to annually prioritize research and monitoring activities, and to complete technical review proposed monitoring plans for assessing the metrics against the defined targets.

5.4.2.5 Risks and Uncertainties

Injury and survival of juvenile passing downstream through the Cougar RO relates to multiple factors in addition to the surface conditions of the RO. The extent to which injury rates can be reduced or survival rates can be increased is uncertain.

5.4.2.6 Decision Triggers and Adaptive Actions

Decision Criteria:

- If operational objectives or targets are met, continue with near-term operation.
- If operational objectives or targets are not achieved for reasons other than hydrologic limitations or FRM operations, then implement adjustments to operations expected to improve achievement of targets which are feasible and authorized.
- If there are potential feasible and authorized adjustments, but uncertainty if those adjustments can improve the ability to achieve targets, then conduct uncertainty research and implement if results indicate that improvement in likelihood of achieving targets.

5.4.3 Cougar Deep Reservoir Drawdown to Diversion Tunnel (720) in Spring and Fall

5.4.3.1 Definition and Function

The measure involves drafting Cougar Reservoir elevation to 25 ft over the top of the Cougar Diversion Tunnel and hold at this elevation to increase the number and the survival of juvenile Chinook salmon passing downstream of Cougar dam in fall and spring.

5.4.3.2 Constraints

Implementation should not:

- Result in a reduction of USACE ability to operate the dam for flood risk management authorized purpose,
- Violate USACE dam safety requirements.

5.4.3.3 Performance Metrics and Targets

Performance Metrics:

The following performance metrics will be used to evaluate the downstream passage at Cougar Dam once the deep drawdown is implemented:

- Juvenile Fish Dam Passage Survival (DPS = DPE * CS)
    - Sub-metric: Dam-passage efficiency (DPE), the proportion of total fish passing the dam relative to the number of total fish detected in the near forebay of the dam and therefore available to pass.
    - Sub-metric: Fish passage efficiency (FPE), the proportion of fish passing via a non-turbine route, relative to the number of total fish in the near forebay and available to pass.
    - Sub-metric: Concrete Survival (CS), the proportion surviving passage through each route weighted by the number passing through each route
- Above-Dam Cohort Replacement Rate (CRR)

Targets:

- DPS: DPS rate needed to support replacement of spawners above dams as estimated using life cycle models, such as those developed for the WVS EIS and ESA consultation.
- Cohort Replacement Rate = ≥1.0

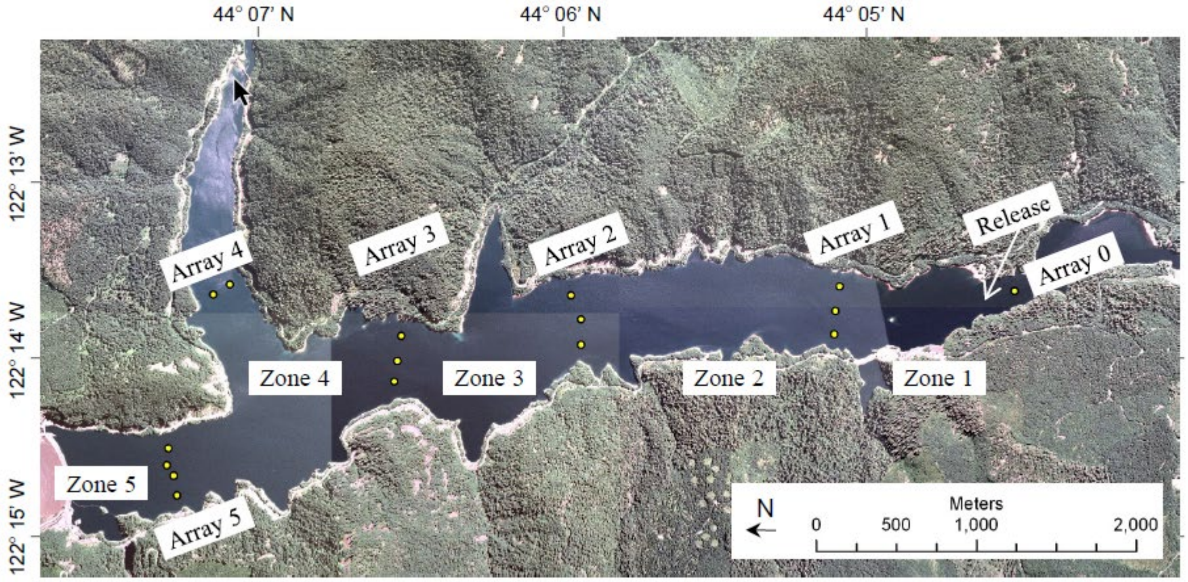


Figure 5-6. Cougar Dam tailrace, forebay, and near forebay zone (gray) showing approximate area to be used for measuring fish passage metrics. Image copied from Figure 3 from Beeman et al. (2014).

5.4.3.4 Research, Monitoring, and Evaluation

Annual dam passage survival (calculated as DPS = DPE * CS) will be measured in two separate years which are representative of typical operating conditions (i.e., water years within 95% of normal hydrological conditions in the period of record). The precision needed about annual DPS estimates will be determined at the time of the assessment to evaluate passage to provide reasonable certainty bounds acceptable to decision makers.

DPE will be measured as the proportion of fish that exit the reservoir downstream (or are transported downstream) divided by the total number of fish in the near forebay area (i.e., fish approaching the dam). The near forebay area at Cougar will be defined as from the dam and diversion tunnel outlet upstream to Array 3 as defined by Beeman et al. (2014a). The specific location may need adjustment from Array 3 as defined by Beeman et al. (2014a) due to the deep reservoir draft, however the intent is to define an area within a similar proximity to the diversion tunnel as was used by Beeman et al. (2014a) for assessing passage at the dam using Array 5.

DPS will be measured in two separate years which are representative of typical operating conditions (i.e., water years within 95% of normal hydrological conditions in the period of record) to evaluate fish passage efficiency and survival. The precision needed about annual DPS would be determined at the time of the assessment to evaluate passage. Observed performance would be compared to downstream passage survival rates estimated to support replacement.

Test period(s): Times of the year representative of when most juvenile salmon migrants are actively moving downstream. These test periods likely will cover portions of spring and fall/winter and could be one longer test period or two separate seasonal periods within a year.

CS will be measured as the number of fish that survive from Cougar Dam to the downstream CS measurement boundary divided by the total number of fish that pass downstream. The CS downstream measurement boundary will be located near the river confluence with the mainstem Willamette River (or nearest feasible location upstream of the confluence for assessing survival). In the McKenzie River below Cougar Dam, previous survival estimates utilized detection arrays at Leaburg Dam (see Beeman et al. 2014b), and these locations will be reconsidered to produced comparable survival estimates.

5.4.3.5 Risks and Uncertainties

- Seasonal variation in flow rates and pool elevations (from hydrology or dam operations) influencing fish attraction and passage rates
- Uncertainty in survival rate passing through the diversion tunnel
- Uncertainty in survival rate associated with copepod infection
- Climate change – change in hydrology that would influence flow rates through the FSS and downstream water temperatures

5.4.3.6 Decision Triggers and Adaptive Actions

Minor changes to operations expected to be made in real-time during the first few years. Once field study to assess performance metrics begins, no in-season changes will be made to support evaluation. However, operational treatments for study may be considered at this time to simultaneously evaluate different conditions where information supports such treatments. Once two representative study years of operations are completed, additional minor changes or adjustments will be implemented if results warrant, which are within the design capacity of the dam and outlet works, FRM, and USACE authority. However, actions requiring additional funding or engineering will not be considered until after three CRR estimates are available (after year 7).

Successful fish passage would be defined by achieving either the DPS or the CRR target.

5.4.3.7 Decision-Making and Collaboration

The Action Agencies (USACE and BPA) will fund post-construction evaluations of DPS and fish survival through the FSS. The WATER and an Independent Science Review body will review study designs for assessing the performance metrics. The Action Agencies will address the comments to improve the study design for assessing the performance metrics. If NMFS and the Action Agencies’ technical staff do not concur on final study designs, the dispute will be elevated for resolution following Federal Family and WATER procedures and protocols. The Action Agencies will ensure evaluations are carried out and reports are made available for

NMFS and WATER team review within timelines necessary to inform adaptive management decisions outlined in this document.

5.4.4 Cougar Adult Fish Facility

5.4.4.1 Definition and Function

Continued operation of the Cougar AFF for transport of adult spring Chinook above Cougar Dam.

5.4.4.2 Constraints

Implementation should not:

- Result in a reduction of USACE ability to operate the dam for flood risk management authorized purpose, and
- Violate USACE dam safety requirements.

5.4.4.3 Performance Metrics and Targets

Performance Metrics:

The following performance metrics will be used to evaluate operation of the Cougar AFF:

Adult fish collection and handling, and adult fish transport and outplanting protocols defined in the current Willamette Fish Operations Plan. At a minimum, the following protocols will be evaluated:

- Timing of fish collection and outplanting relative to natural run timing
- Injury rates from handling and sorting
- Mortality rates for fish while in the AFF or during truck transport
- Health condition of fish outplanted
- Health condition of fish taken for brood
- Number and locations of outplanted fish
- Sex ratio of outplanted fish
- Fish densities when in holding at AFF and in transport trucks
- Water temperatures and oxygen levels in the AFF and transport trucks
- Cumulative temperature exposure when in the AFF and transport trucks
- Temperature exposure when water temperatures need to be tempered prior to release of outplanted fish

Targets:

Compliance with the adult fish collection and handling, and adult fish transport and outplanting protocols defined in the 2022 Willamette Fish Operations Plan.

5.4.4.4 Research, Monitoring, and Evaluation

Upstream passage metrics will be summarized annually, and reports provided to WATER for review. Information on most metrics listed above will be collected commensurate with operation of the AFF. Discharge and water temperatures below Cougar Dam will also be continuously monitored.

5.4.4.5 Risks and Uncertainties

- Effects of variation in Cougar Dam discharges (from hydrologic conditions, FRM, hydropower, etc.) on upstream migration of adult fish to Cougar Dam tailrace and adult collection in the AFF.
- Effects of water temperatures discharged from Cougar Dam or from the AFF on adult attraction and collection in the AFF.

5.4.4.6 Decision Triggers and Adaptive Actions

Minor changes to operation of the AFF (i.e., operational feasible, and within USACE authority, and not requiring additional funding) are expected to be made in real-time to maintain compliance with the WFOP protocols. Reports of operations will be reviewed annually to determine areas where minor changes may be needed. If compliance cannot be maintained with minor changes, then adjustments or modifications will be assessed. Depending on the potential solutions, engineering studies or biological studies may be planned as funding is available. The timeframe for implementation of adjustments of modifications to the AFF will depend on the specific actions identified for implementation.

5.5 MIDDLE FORK WILLAMETTE

5.5.1 Dexter Adult Fish Facility (18)

5.5.1.1 Definition and Function

Design and construct upgrades to the Dexter adult fish facility.

5.5.1.2 Constraints

Constraints associated with the Dexter AFF upgrade will be identified as part of the project-specific planning documents developed prior to implementation. However, two known constraints relating to this measure is that implementation should not:

- Result in a reduction of USACE ability to operate the dam for flood risk management authorized purpose, and
- Violate USACE dam safety requirements.

5.5.1.3 Performance Metrics and Targets

Performance Metrics:

The following performance metrics will be used to evaluate operation of the AFF at Dexter:

Upstream Passage Metrics: Adult fish collection and handling, and adult fish transport and outplanting protocols defined in the current Willamette Fish Operations Plan. At a minimum, the following protocols will be evaluated:

- Timing of fish collection and outplanting relative to natural run timing
- Injury rates from handling and sorting
- Mortality rates for fish while in the AFF or during truck transport
- Health condition of fish outplanted
- Health condition of fish taken for brood
- Number and locations of outplanted fish
- Sex ratio of outplanted fish
- Fish densities when in holding at AFF and in transport trucks
- Water temperatures and oxygen levels in the AFF and transport trucks
- Cumulative temperature exposure when in the AFF and transport trucks
- Temperature exposure when water temperatures need to be tempered prior to release of outplanted fish

Targets:

Compliance with the adult fish collection and handling, and adult fish transport and outplanting protocols defined in the current Willamette Fish Operations Plan

5.5.1.4 Research, Monitoring, and Evaluation

Upstream passage metrics will be summarized annually, and reports provided to WATER for review. Information on most metrics listed above will be collected commensurate with operation of the AFF. Discharge and water temperatures below Dexter Dam will also be continuously monitored.

5.5.1.5 Risks and Uncertainties

- Effects of variation in Dexter Dam discharges (from hydrologic conditions, FRM, hydropower, etc.) on upstream migration of adult fish to Dexter Dam tailrace and adult collection in the AFF.
- Effects of water temperatures discharged from Dexter Dam or from the AFF on adult attraction and collection in the AFF.
- Effects of water temperatures discharged from Dexter Reservoir into the Dexter AFF on the health of adults collected at Dexter AFF.

5.5.1.6 Decision Triggers and Adaptive Actions

Minor changes to operation of the AFF (i.e., operational feasible, and within USACE authority, and not requiring additional funding) are expected to be made in real-time to maintain compliance with the WFOP protocols. Reports of operations will be reviewed annual to determine areas where minor changes may be needed. If compliance cannot be maintained with minor changes, then adjustments or modifications will be assessed. Depending on the potential solutions, engineering studies or biological studies may be planned as funding is available. The timeframe for implementation of adjustments of modifications to the AFF will depend on the specific actions identified for implementation.

5.5.2 Lookout Point Near-Term Operations (16/17)

5.5.2.1 Definition and Function

Use storage from Hills Creek Reservoir to begin refilling Lookout Point Reservoir in early March. Once Lookout Point Reservoir elevation is 2.5 feet over spillway crest (El. 890 ft.), start continuous, ungated spill using as many gates (5 are available) as needed to approximate the rate of inflow to maintain the reservoir level between El. 890-893 ft. for as long as water conditions allow, for at least 30 days at both Lookout Point and Dexter dams. Operate the Lookout Point powerhouse only as needed to remain within the desired reservoir elevation limits, or to control downstream TDG. After that initial 30-day period, refill pool as hydrology allows and spill (gated) at night at both projects, with generation during the day, for as long as water is available and downstream conditions allow. Then manage Lookout Point Reservoir to achieve elevation 887.5 ft by July 15 and operate the regulating outlets as needed to reduce downstream water temperatures when water temperatures downstream of Dexter Dam near 60 degrees. The near-term operations at Lookout Point include a drawdown of the reservoir, starting in July, to reach a target elevation of 761 feet in mid-November.

The near-term operations are intended to improve downstream passage conditions for juvenile Upper Willamette River Chinook salmon by encouraging juvenile fish passage through the ROs instead of the turbines during periods when juvenile fish are most likely to be migrating downstream.

5.5.2.2 Constraints

Implementation should not:

- Result in a reduction of USACE ability to operate the dam for flood risk management authorized purpose
- Violate USACE dam safety requirements.

5.5.2.3 Performance Metrics and Targets

Performance Metrics:

- Daily estimate of juvenile Chinook passing dam downstream during the date range targeted for fish passage
- Lengths of juvenile Chinook passing dam downstream during the date range targeted for fish passage

Targets:

- Increase in the number of juveniles passing as compared to previous operational conditions (baseline/NAA).
- Increase in the distribution of fish lengths passing downstream as compared to previous operational conditions (baseline/NAA).

5.5.2.4 Research, Monitoring, and Evaluation

Near-term actions were designed in collaboration with NMFS and other parties to operate the dams as best as feasible using existing facilities until long-term actions are implemented. Due to the effects of annual hydrologic variability in meeting near-term operational objectives and resulting variability in water quality and fish passage conditions expected to occur within and across years, multiple years of monitoring are anticipated to be needed to understand if operations are achieving objectives and targets or if changes are warranted. Monitoring results will be reported and reviewed annually. If targets are not met, decision makers will determine each year if any adjustments should be made to meet the operational objectives or water quality targets, or if additional monitoring or uncertainty research should be conducted. For fish passage, a 5-year check-in will be conducted to review if targets were achieved. This is due to the seasonal and annual variability that occurs and resulting need for multiple years of data to evaluate if targets were achieved. Check-ins can also occur more often if information warrants, however caution should be taken before implementing operational changes fish passage before multiple years of data are collected.

Study designs and methodology to assess the defined metrics will be determined during implementation so that the best available scientific approaches and methods can be applied. The AM process will be followed to annually prioritize research and monitoring activities, and to complete technical review proposed monitoring plans for assessing the metrics against the defined targets.

5.5.2.5 Risks and Uncertainties

- Risk: There is a trade-off in some water years between achieving the operational targets of these measures vs meeting other objectives (e.g. downstream minimum flow values)
- Risk: Hydrologic variability limiting the ability to achieve the near-term operation in a given year

5.5.2.6 Decision Triggers and Adaptive Actions

Decision Criteria:

- If operational objectives or targets are met, continue with near-term operation.
- If operational objectives or targets are not achieved for reasons other than hydrologic limitations or FRM operations, then implement adjustments to operations expected to improve achievement of targets which are feasible and authorized.
- If there are potential feasible and authorized adjustments, but uncertainty if those adjustments can improve the ability to achieve targets, then conduct uncertainty research and implement if results indicate that improvement is likelihood of achieving targets.

5.5.2.7 Decision-Making and Collaboration

The Action Agencies (USACE and BPA) will prepare annual reports documenting operations and summarizing the results in comparison to the defined targets. Annual check-ins will occur to assess how well targets have been achieved for water quality. A 5-year check-in will be conducted to review fish passage results to assess how well targets have been achieved. Check-ins on fish passage performance can also occur more often if adequate information is available and warrants review. Where targets are not achieved, the Action Agencies will propose changes to improve achievement of the operation where feasible and authorized. If changes that could improve achieving targets are not apparent, Action Agencies may instead propose uncertainty research to inform what changes may lead to achievement of the targets. The WATER Technical Teams will review the reported results from the operation, and any proposed changes to achieve the operational targets. The Action Agencies will ensure evaluations are carried out and reports are made available for NMFS and WATER review within timelines necessary to inform AM decisions outlined in this document.

5.5.3 Lookout Point Downstream Fish Passage Structure (392)

5.5.3.1 Definition and Function

The measure provides a structural solution to improve downstream fish passage in the form of a Floating Surface Collector (FSC; pumped inflow operated independent of dam outlets).

5.5.3.2 Constraints

Constraints associated with the Lookout Point FSC will be identified as part of the project-specific planning documents developed prior to implementation. However, two known constraints relating to this measure is that implementation should not:

- Result in a reduction of USACE ability to operate the dam for flood risk management authorized purpose, and
- Violate USACE dam safety requirements.

5.5.3.3 Performance Metrics and Targets

Performance Metrics:

The following performance metrics will be used to evaluate the passage at Lookout Point once the FSC is operational:

- Juvenile Fish Dam Passage Survival (DPS = DPE * CS)
  - Sub-metric: Dam-passage efficiency (DPE), the proportion of total fish passing the dam relative to the number of total fish detected in the near forebay of the dam and therefore available to pass.
  - Sub-metric: Fish passage efficiency (FPE), the proportion of fish passing via a non-turbine route, relative to the number of total fish in the near forebay and available to pass.
  - Sub-metric: Fish collector efficiency (FCE), defined as the proportion of fish passing (collected by) the FSS, relative to the number of total fish passing the dam via any route.
  - Sub-metric: Concrete Survival (CS), the proportion surviving passage through each route weighted by the number passing through each route
- Above-Dam Cohort Replacement Rate (CRR)

Targets:

- DPS: DPS rate needed to support replacement of spawners above dams as estimated using life cycle models, such as those developed for the Draft WVS PEIS and ESA consultation.
- Cohort Replacement Rate = ≥1.0

Figure 5-7. Lookout Point Dam tailrace, forebay, and near forebay zone (gray) showing approximate area to be used for measuring fish passage metrics.

5.5.3.4 Research, Monitoring, and Evaluation

Dam passage survival (calculated as DPS = DPE * CS) will be measured in two separate years which are representative of typical operating conditions (i.e., water years within 95% of normal hydrological conditions in the period of record). The precision needed about annual DPS estimates will be determined at the time of the assessment to evaluate passage to provide reasonable certainty bounds acceptable to decision makers.

DPE will be measured as the proportion of fish that exit the reservoir downstream (or are transported downstream) divided by the total number of fish in the near forebay area (i.e., fish approaching the dam). For Lookout Point the near forebay area will be defined as from the dam upstream to approximately the log boom in the upstream boundary of the dam forebay (Array 6 as defined by Beeman et al. 2015).

Test period(s): Times of the year representative of when most juvenile salmon migrants are actively moving downstream. These test periods likely will cover portions of spring and fall/winter and could be one longer test period or two separate seasonal periods within a year.

CS will be measured as the number of fish that survive from Lookout Point Dam to the downstream CS measurement boundary divided by the total number of fish that pass downstream. The CS downstream measurement boundary will be located near the river confluence with the mainstem Willamette River (or nearest feasible location upstream of the confluence for assessing survival).

5.5.3.5 Risks and Uncertainties

- FSC Entrance rejection by juvenile Chinook and steelhead

- Reservoir influence on steelhead passage rates and residualism (i.e., juveniles choose not to emigrate downstream but mature in the reservoir or upstream.
- Seasonal variation in flow rates (from hydrology or dam operations) influencing fish attraction and collection
- Uncertainty in survival rate associated with copepod infection
- Difference in survival between volitional passage and truck transport downstream.
- Effectiveness of structural passage given scale of reservoir fluctuation at Lookout Point Dam
- Large forebay area impacting guidance and attraction to the FSC entrance. Design has used the dam as a guidance structure. Entrance oriented along longitudinal face of the dam. Could influence the number of fish attracted to entrance point.
- Climate change – see discussion under Basin Flow Measures (Section 5.1.1.5).

5.5.3.6 Decision Triggers and Adaptive Actions

Contingency actions to operation of the FSC are expected to be made in real-time during the first few years. Once field study to assess performance metrics begins, no in-season changes will be made to support evaluation. However, operational treatments for study may be considered at this time to simultaneously evaluate different conditions where information supports such treatments. Once two representative study years of FSC operation are completed, additional contingency actions will be implemented if results warrant, which are within the design capacity of the FSC. However, actions requiring additional funding or engineering will not be considered until after three CRR estimates are available (after year 7).

Successful fish passage would be defined by achieving either the DPS or the CRR target.

Examples of contingency actions for the FSC include:

- Structural: adjusting baffles, and other tuning of the existing facility; changing debris management practices, changing fish handling/holding/transport using existing facilities, guide nets or lead nets.
- Operational FSC: longer or shorter operational periods of FSC, increasing or decreasing entrance flows, operating barrels above criteria, bypass flows, etc.
- Operational dam and reservoir: increasing or decreasing flow through dam outlets, changes in refill pattern, operating dam with pulses, operating at lower pool level during conservation season, changing rate of reservoir drawdown through summer and fall.

The extent to which operations of the FSC could be adjusted to ensure performance would be described in future planning and design documentation. This would include both contingency actions as well as adjustments that may require additional environmental compliance or planning/design activities prior to implementation. Specifically, the Design Documentation Report or associated Engineering Documentation Report would describe the operation, maintenance, repair, replacement, and rehabilitation requirements for the structure.

5.5.3.7 Decision-Making and Collaboration

The Action Agencies (USACE and BPA) will fund post-construction evaluations of DPS and fish survival through the FSS. The WATER Fish Passage Design, Research, and Development Technical Team will review study designs for assessing the performance metrics. It is also anticipated that study designs may benefit from a targeted independent science review. The Action Agencies will address the comments to improve the study design for assessing the performance metrics. If NMFS and the Action Agencies' technical staff do not concur on final study designs, the dispute will be elevated for resolution following Federal Family and WATER procedures and protocols. The Action Agencies will ensure evaluations are carried out and reports are made available for NMFS and WATER team review within timelines necessary to inform adaptive management decisions outlined in this document.

5.5.4 Fall Creek Near-Term Operations (19/20) and Long-Term Operations

5.5.4.1 Definition and Function

Operate Fall Creek AFF to collect and transport adult spring Chinook upstream of Fall Creek Reservoir. For downstream fish passage in fall and winter, drawdown Fall Creek reservoir in the late fall, to elevation 690 ft; refill slightly to 700 ft; starting in mid-December and hold until March 15. For downstream fish passage in spring, starting mid-March, refill reservoir to minimum conservation pool elevation, 728 ft and hold until May 15. Refill reservoir, as hydrology allows, starting May 16. Operate dam intake gates in a manner that maximizes fish passage survival at all times. Maintain sufficient discharge to operate the adult trap while refilling the reservoir to the extent possible. Blend releases through the various horns to control downstream water temperatures. Manage stored water to ensure a high probability of being able to operate the adult trap through September 30. USACE may need to provide flushing flows to clear the tailrace.

5.5.4.2 Constraints

Implementation should not:

- Result in a reduction of USACE ability to operate the dam for flood risk management authorized purpose
- Violate USACE dam safety requirements.

5.5.4.3 Performance Metrics and Targets

Fall Creek Reservoir Deep Drawdown in fall - This measure has been implemented and evaluated (e.g., Nesbit et al. 2012). Numbers of adult Chinook collected at the Fall Creek AFF and outplanted above Fall Creek Reservoir will annually be summarized and reported.

Fall Creek Reservoir Delayed Refill in spring –

Performance Metrics:

- Daily estimate of juvenile Chinook passing dam downstream during the date range targeted for fish passage
- Lengths of juvenile Chinook passing dam downstream during the date range targeted for fish passage
- Above-Dam Cohort Replacement Rate (CRR)

Targets:

- Increase in the number of juveniles passing as compared to previous operational conditions (baseline/NAA).
- Increase in the distribution of fish lengths passing downstream as compared to previous operational conditions (baseline/NAA).
- Above-Dam Cohort Replacement Rate (CRR) $\geq$ 1

5.5.4.4 Research, Monitoring, and Evaluation

Fall Creek Reservoir Deep Drawdown in fall - This measure has been implemented and evaluated (e.g., Nesbit et al. 2012). Numbers of adult Chinook collected at the Fall Creek AFF and outplanted above Fall Creek Reservoir will annually be summarized and reported.

Fall Creek Reservoir Delayed Refill in spring – Near-term actions were designed in collaboration with NMFS and other parties to operate the dams as best as feasible using existing facilities until long-term actions are implemented. Due to the effects of annual hydrologic variability in meeting near-term operational objectives and resulting variability in water quality and fish passage conditions expected to occur within and across years, multiple years of monitoring are anticipated to be needed to understand if operations are achieving objectives and targets or if changes are warranted. Monitoring results will be reported and reviewed annually. If targets are not met, decision makers will determine each year if any adjustments should be made to meet the operational objectives or water quality targets, or if additional monitoring or uncertainty research should be conducted. For fish passage, a 5-year check-in will be conducted to review if targets were achieved. This is due to the seasonal and annual variability that occurs and resulting need for multiple years of data to evaluate if targets were achieved. Check-ins can also occur more often if information warrants, however caution should be taken before implementing operational changes fish passage before multiple years of data are collected.

Adult returns will be tissue sample and used to assess cohort replacement rates. CRR will be calculated to determine if targets are being achieved and used to help assess if spring delayed refill operations are positively or negatively affecting CRR.

5.5.4.5 Risks and Uncertainties

- Risk: There is a trade-off in some water years between achieving the operational targets of these measures vs meeting other objectives (e.g. downstream minimum flow values)
- Risk: Hydrologic variability limiting the ability to achieve the near-term operation in a given year

5.5.4.6 Decision Triggers and Adaptive Actions

Fall Creek Reservoir Deep Drawdown in fall - This measure has been implemented and evaluated (e.g., Nesbit et al. 2012). Therefore, no decision criteria are included for this measure.

Fall Creek Reservoir Delayed Refill in spring Decision Criteria:

- If operational objectives or targets are met, continue with near-term operation.
- If operational objectives or targets are not achieved for reasons other than hydrologic limitations or FRM operations, then implement adjustments to operations expected to improve achievement of targets which are feasible and authorized.

If there are potential feasible and authorized adjustments, but uncertainty if those adjustments can improve the ability to achieve targets, then conduct uncertainty research and implement if results indicate that improvement is likelihood of achieving targets.

5.5.5 Fall Creek Adult Fish Facility

5.5.5.1 Definition and Function

Continued operation of the Fall Creek AFF for transport of adult spring Chinook above Fall Creek Dam.

5.5.5.2 Constraints

Implementation should not:

- Result in a reduction of USACE ability to operate the dam for flood risk management authorized purpose, and
- Violate USACE dam safety requirements.

5.5.5.3 Performance Metrics and Targets

Performance Metrics:

The following performance metrics will be used to evaluate operation of the Fall Creek AFF:

Adult fish collection and handling, and adult fish transport and outplanting protocols defined in the current Willamette Fish Operations Plan. At a minimum, the following protocols will be evaluated:

- Timing of fish collection and outplanting relative to natural run timing
- Injury rates from handling and sorting
- Mortality rates for fish while in the AFF or during truck transport
- Health condition of fish outplanted
- Health condition of fish taken for brood
- Number and locations of outplanted fish
- Sex ratio of outplanted fish
- Fish densities when in holding at AFF and in transport trucks
- Water temperatures and oxygen levels in the AFF and transport trucks
- Cumulative temperature exposure when in the AFF and transport trucks
- Temperature exposure when water temperatures need to be tempered prior to release of outplanted fish

Targets:

Compliance with the adult fish collection and handling, and adult fish transport and outplanting protocols defined in the 2022 Willamette Fish Operations Plan.

5.5.5.4 Research, Monitoring, and Evaluation

Upstream passage metrics will be summarized annually, and reports provided to WATER for review. Information on most metrics listed above will be collected commensurate with operation of the AFF. Discharge and water temperatures below Fall Creek Dam will also be continuously monitored.

5.5.5.5 Risks and Uncertainties

- Effects of variation in Fall Creek Dam discharges (from hydrologic conditions, FRM, hydropower, etc.) on upstream migration of adult fish to Fall Creek Dam tailrace and adult collection in the AFF.
- Effects of water temperatures discharged from Fall Creek Dam or from the AFF on adult attraction and collection in the AFF.

5.5.5.6 Decision Triggers and Adaptive Actions

Minor changes to operation of the AFF (i.e., operational feasible, and within USACE authority, and not requiring additional funding) are expected to be made in real-time to maintain compliance with the WFOP protocols. Reports of operations will be reviewed annually to determine areas where minor changes may be needed. If compliance cannot be maintained with minor changes, then adjustments or modifications will be assessed. Depending on the potential solutions, engineering studies or biological studies may be planned as funding is available. The timeframe for implementation of adjustments of modifications to the AFF will depend on the specific actions identified for implementation.

5.5.6 Hills Creek Adaptive Management Approach

5.5.6.1 Definition and Function

The only Preferred Alternative measure at Hills Creek is a near-term operation to prioritize discharges through the regulating outlets at night rather than through the turbines. This near-term operation is intended to improve downstream passage conditions for juvenile Upper Willamette River Chinook salmon by encouraging juvenile fish passage through the ROs instead of the turbines during periods when juvenile fish are most likely to be migrating downstream. USACE will implement regulating outlet spill operations daily from 6:00 PM to 10:00 PM at Hills Creek Dam once the reservoir elevation is 50 feet or less above the regulating outlets in the fall through March 1.

However, NMFS and USFWS have expressed the need for addressing downstream passage at Hills Creek with a more permanent solution. A structural passage solution at Hills Creek is not included in the Preferred Alternative. This section describes the adaptive management framework that the USACE would follow to determine if an adjustment to other downstream passage measures at Hills Creek is warranted in the future.

5.5.6.2 Constraints

Consistent with other measures, the Hills Creek near-term operation measure as well as any future solutions for fish passage should not:

- Result in a reduction of USACE ability to operate the dam for the flood risk management authorized purpose, and
- Violate USACE dam safety requirements.

5.5.6.3 Performance Metrics and Targets

Content in Development

5.5.6.4 Research, Monitoring, and Evaluation

Content in Development

5.5.6.5 Risks and Uncertainties

Content in Development

5.5.6.6 Decision Triggers and Adaptive Actions

Content in Development

5.6 HATCHERY MEASURE (719)

Existing HGMPs describe how hatchery Chinook are currently being used to support reintroduction of spring Chinook above WVS dams, as well as a framework for reducing or ending hatchery supplementation above WVS dams as effective fish passage is achieved and unmarked adults increase. The HGMPs recognize that Federal hatchery mitigation obligations will be reduced based upon a crediting system once fish passage is improved, but do not include a crediting system or process for establishment of that system.

The overall goal of the measure is to adjust production of WVS hatcheries for mitigation obligations and conservation needs after demonstrated improvements to fish access to habitat above dams. Each sub-basin hatchery program will be considered separately according to the metrics and protocols described herein.

5.6.1 Spring Chinook Salmon Crediting After Dam Passage is Improved

Before passage is improved, hatchery juvenile spring Chinook releases (Table 5.6-1) and outplanting (Table 5.6-2) of adult spring Chinook hatchery fish above dams will occur according to the HGMPs and NMFS associated 2019 Biological Opinion.

After passage improvement at a dam (years 0-5), hatchery-origin returns (HORs) would continue to supplement natural-origin returns (NORs) outplanted in order to meet but not exceed the abundance thresholds as defined in the HGMPs (Table 5.6-2). For projects at which only natural origin fish are currently outplanted above a project (i.e., Foster Dam), this plan would remain consistent with strategies to maintain hatchery production below the dam.

Table 5.6-2 provides the adult Chinook outplanting thresholds from the associated HGMPs and NMFS' 2019 BiOp except for the South Santiam. When the number of natural origin (unmarked) Chinook spawner returns are below these levels, hatchery origin returns will be used to supplement to achieve the thresholds. The South Santiam HGMP indicates 600 total, if needed, however up to 800 hatchery adult Chinook will begin being outplanted above Green Peter Dam in 2022. Currently, no hatchery origin (marked) fish are outplanted above Foster so the outplant number for South Santiam in Table 5.6-1 is for fish intended for reintroduction above Green Peter.

PHASE 1 - Years 1-7 following improved fish passage conditions:

Following the implementation of downstream fish passage improvements, hatchery spring Chinook production will remain at production levels as defined in the HGMPs. Annual dam passage survival (DPS, i.e., dam passage efficiency * dam passage survival) will be measured in two separate years which are representative of typical operating conditions (i.e., water years within 95% of normal hydrological conditions in the period of record) to evaluate fish passage efficiency and survival at the dam. The precision needed about annual DPS will be determined at the time of the assessment to evaluate passage. Observed performance will be compared to downstream passage survival rates estimated to support the replacement criteria.

PHASE 2 - After Year 7 following a fish passage improvement – production crediting based on adult return rates:

Recognizing several factors can affect adult Chinook returns, cohort replacement rate (CRR) serves as a basis for evaluating overall population performance. CRR will be estimated as:

$$CRR = \frac{\text{Number of } \textbf{unmarked} \text{ 3, 4 and 5 year old returns produced by outplants (males and females) in Year X}}{\text{Number of spawners } (\textbf{marked and unmarked}) \text{ in Year X}}$$

CRR is calculated using the above equation; and uses the entirety of the spawning population in the reach above the dam regardless of the origin of the parents. In other words, adults of hatchery origin used to supplement the number of spawners is considered part of the cohort parentage. The HGMP thresholds define the minimum abundance levels for assessing CRR above each dam because outplanted adults will continue to be supplemented with hatchery fish until natural origin fish meet or exceed the HGMP thresholds (Table 5.6-2).

After 7 years CRR will be calculated for three separate cohorts accounting for adult returns in years 3-5, 4-6 and 5-7. If the CRR for Chinook is >1 based on a geometric mean of replacement rates for the three cohorts returning in years 3-5, 4-6 and 5-7, then the full credit for fish passage improvements will be applied to the spring Chinook hatchery production for the sub-basin in which returns are being assessed. In this case, Chinook production will be reduced over a period of five years to a Reduced Level of Production (see below). This gradual reduction strategy allows economic interests to adjust and provides the State of Oregon additional time to seek funding for additional hatchery production if desired. The basin-specific NOR thresholds will be the same as the outplanting thresholds indicated in the Table 5.6-2.

If CRR < 1, and DSP criteria not met, then mitigation credit reductions will not occur at this time and instead be re-assessed again after year 14. After re-assessment, if the geometric mean of CRR is >1.0 for cohorts returning in years 12, 13 and 14, then reductions to Chinook release will be reduced over a period of five years to the Reduced Level of Production.

If the geometric mean of CRR is still <1.0 for cohorts returning in years 12, 13 and 14, and the DSP target is met, non-project effects will be evaluated. There have been several methods proposed in similar programs for quantifying non-project effects for the purpose of demonstrating reduced impact to ESA-listed salmonids. For example, the Lewis River

Hydroelectric Projects M&E Plan (2010) describes the number of ocean recruits (i.e., Total Adult Production; TAP), and adult escapement to traps accounting for harvest removals. Another possible metric may include examining the ratio of adults observed at Willamette Falls to those observed at traps when enroute mortality is accounted for (e.g., Keefer et al. 2017). Extensive modeling of hydrologic conditions relative to available habitat are ongoing as part of the SWIFT project (Peterson et al. 2021), passage modeling by the University of British Columbia, among other efforts may be applied to assess the effect of project management on juvenile out-migration and adult returns compared to off-project effects (e.g., ocean conditions, poor hydrologic conditions, harvest, etc.). UBC has shown that marine survival alone can impact the effects of perfect passage in poor marine years. If these available methods indicate substantial non-project effects on replacement, credit for dam fish passage improvements will be determined through further review and discussion among the State of Oregon, USACE and NMFS following the same process as outlined in the Reduced Hatchery Production section and take into consideration the effectiveness of the dam passage conditions, other project effects, and other non-project effects. Based on this assessment, outcomes could include:

- No changes to mitigation production, with further actions to address project effects. CRR would then be reassessed after 7 years following implementation of additional action.
- Changes to mitigation production due to recognized impacts from the hatchery program constraining natural production, with alternative mitigation implemented.
- Mitigation credit due to recognition of improved passage conditions and non-project effects constraining CRR. In this scenario mitigation production for passage could be fully reduced, while maintaining some Reduced Level of Spring Chinook Salmon Production (see below) to mitigate for any remaining, non-passage, project effects identified.

Reduced Level of Spring Chinook Salmon Production

The purpose of the Reduced Level of Production is to maintain some mitigation production, to be developed with the State of Oregon and NMFS, recognizing 1) some project effects may remain that require mitigation after successful fish passage is implemented and assessed, 2) hatchery production may need to be maintained for conservation/safety net purposes recognizing uncertainty in reintroduction success, and 3) increases in natural origin returns when still below the CRR of 1 may warrant reductions in hatchery production and releases to help increase natural productivity. The Reduced Hatchery Production levels will be based on the passage assessment leading to habitat access as referenced in HD 531. Alternative mitigation may also need to be considered where there are effects on ESA-listed species from the production and release of hatchery mitigation fish. If CRR is improved by passage, yet remains below a CRR of 1, brood take needed to support conservation outplanting should be assessed as part of determining reduced levels of production. The deficit in replacement value (in number of consensus spawners) will be used to calculate a potential new production level (Ppost) intended for meeting conservation (outplanting) needs in years 9-142:

$$P_{Post} = \frac{\#\ of\ outplants_y - \#\ of\ returns_{y5}}{SAR_{harv}}$$

Where SARharv is the estimated smolt to adult return rate assuming harvest and y is the brood year and y5 is all of the progeny that can reasonably be assigned to brood year y. For purposes of calculating a new conservation production level, changes in the SAR from increased levels of natural origin brood should be considered.

5.6.2 Rainbow Trout Crediting

As for spring Chinook and summer steelhead, trout hatchery mitigation needs after fish passage improvements at WVS dams will be developed with the State of Oregon. The initial authorization for game fish mitigation related to construction and operation of the WVS was based on concerns about the productivity of resident fish given impoundment and inundation by authorized projects. Trout mitigation changes as it relates to passage improvements at WVS may be important to consider given these assumptions about productivity of resident trout in reservoirs, addressing effects of ongoing hatchery trout stocking on ESA-listed fish reintroduction and natural production (including local fisheries for hatchery stocked trout), and/or to account for other mitigation credits that have or are continuing to occur (e.g. BPA is directly addressing the mitigation for inundation through the Wildlife Enhancement Memorandum of Agreement; BPA & ODFW 2010). Impacts to ESA-listed fish from rainbow trout is recognized and the current HGMPs describe approaches to limit overlap of rainbow trout and ESA-listed fish. USACE anticipates that further changes may need to be made once passage is implemented to limit impacts on reintroduced populations.

5.6.3 Summer Steelhead Crediting

In association with improved fish passage conditions at WVS dams, any changes to the mitigation hatchery production of summer steelhead as funded by USACE will also be developed with the State of Oregon. Non-native hatchery summer steelhead are produced to mitigate for the effects of the WVS on native ESA-listed winter steelhead. Plans for any reintroduction of winter steelhead above WVS dams (including within the Winter Steelhead Distinct Population Segment; DPS) have not been developed. Summer steelhead provide no conservation value to support winter steelhead reintroduction above WVS dams and are known to have negative impacts on winter steelhead in the Willamette Basin (e.g., fitness effects associated with introgression). It also may not be feasible to assess winter steelhead CRR. Oncorhynchus Mykiss progeny can become either resident (rainbow trout) or anadromous (steelhead). Recent work indicates that non-anadromy may be an adaptive strategy in response to reservoir inundation with lack of adequate passage and that these strategies are plastic, i.e., anadromous females can breed with non-anadromous males with documented success of anadromous progeny as summarized in McAllister et al. (2022 in draft). Estimates of CRR for steelhead are uncertain given some offspring will remain in freshwater and mature as rainbow trout, and some adult steelhead returns will be progeny of rainbow trout.

Table 5-6. Willamette Hatchery Mitigation Program production goals for UWR spring Chinook salmon in each sub-basin according to the Hatchery Genetics Management Plans.

Sub-basin	ESA Conservation Purpose (per HGMP)	USACE-funded Non-Conservation Release (per HGMP)	ODFW-funded Release per HGMP	Total Hatchery Release
North Santiam	630,000	74,000	0	704,000
South Santiam	350,000	289,000	382,000	1,021,000
McKenzie	604,750	0	0	604,750
Middle Fork Willamette	NA	2,039,000	0	2,039,000

Table 5.6-2. Willamette Spring Chinook Salmon Natural Origin Thresholds Required Prior to Crediting (Outplant Numbers Taken from HGMPs).

Sub-basin	Natural-origin fish threshold*	Natural-origin female fish threshold*	Natural-origin male fish threshold*
McKenzie	600	400	200
Middle Fork	2,450	–	–
South Santiam	800	–	–
North Santiam	1,500	750	750

5.6.4 Decision-Making and Collaboration

The Action Agencies (USACE and BPA) will prepare reports documenting results from assessment of Chinook DPS and CRR following passage improvements as described in previously within Section 5.6. The WATER Technical Teams will review the reported results, and any proposed changes to hatchery production developed consistent with targets and the decision framework described in Section 5.6. The Action Agencies will ensure evaluations are carried out and reports are made available for NMFS and WATER review within timelines necessary to inform AM decisions outlined in this document.

5.7 GRAVEL AUGMENTATION

5.7.1 Definition and Function

Improving downstream streambeds with gravel would occur in the North Santiam, South Santiam, and McKenzie River Basins below Big Cliff, Foster, Cougar, and Blue River dams. The WVS is restricting sediment transport and subsequently degrading habitat for ESA-listed and other native fish below its dams. Clean round river gravel would be added to the areas of wetted streambeds to improve river substrate conditions for spawning and rearing of native fish species downstream of WVS dams. Gravel would be sized appropriately for use by spawning UWR Chinook salmon and UWR steelhead, and to the maximum extent feasible, locally sourced. Placed gravel would be expected to transport, abrade to smaller material, and deposit for longer term storage in bars and backwaters over time. An ongoing program of annual or semiannual sediment placement is proposed to maintain long term spawning gravel bars and beds downstream of the dams.

5.7.2 Constraints

Site-specific design and environmental compliance documentation would be prepared for each location prior to implementation of gravel augmentation. Constraints of gravel augmentation at each location would be specified in this site-specific documentation.

5.7.3 Performance Metrics and Targets

It is anticipated that performance metrics for gravel augmentation would consist of a combination of metrics associated with successful design/operations of the gravel augmentation process and habitat-based/biological response metrics. This assumption is based on USACE experience with gravel augmentation at other locations including the Green River below Howard Hanson Dam and the Trinity River below Lewiston Dam. Performance metrics related to the successful design/operations of the placed gravel augmentation would likely focus on the mobilization of placed material relative to different flow events. Habitat-based/biological response metrics would likely be based on achieving an increase in spawning habitat quality or quantity for Chinook salmon and steelhead. Performance metrics and targets would be location-specific and therefore would be developed during the completion of site-specific design and environmental compliance documentation.

5.7.4 Research, Monitoring, and Evaluation

It is anticipated that baseline surveys below the dams would be necessary to determine where gravel placement could increase usable spawning areas while considering channel bathymetry, water temperature, hydrology, and hydraulics. Anticipated monitoring activities may likely include channel surveys, geomorphic and habitat inventories, sediment transport and channel stability monitoring. Specifics of research, monitoring, and evaluation would be developed as part of site-specific design and environmental compliance documentation.

5.7.5 Risks and Uncertainties

Location-specific risks and uncertainties would be identified during the development of site-specific design and environmental compliance documentation. However, the following general questions relative to gravel augmentation are likely to be of focus:

- Is gravel augmentation effectively providing spawning gravels to the river each year?
- What is the rate of gravel transport through the reach?
- How does gravel size affect transport?
- How is substrate composition changing downstream?

- What is the effect of gravel nourishment on Chinook salmon and steelhead trout spawning?

5.7.6 Decision Triggers and Adaptive Actions

Based on previous experience with USACE gravel augmentation programs, it is anticipated that adaptive actions would typically include:

- Adjustments to the location and manner of gravel placement
- Adjustments to the timing of when gravel is placed
- Adjustments to the amount of gravel placed
- Adjustments to the grain size of gravel placed

Decision triggers that would result in specific adjustments would be developed as part of site-specific design and environmental compliance documentation.

CHAPTER 6 - REFERENCES CITED

Beeman, J.W., Hansel, H.C., Hansen, A.C., Evans, S.D., Haner, P.V., Hatton, T.W., Kofoot, E.E., Sprando, J.M., and Smith, C.D. 2014a. Behavior and dam passage of juvenile Chinook salmon at Cougar Reservoir and Dam, Oregon, March 2012–February 2013: U.S. Geological Survey Open-File Report 2014-1177, 52 p., http://dx.doi.org/10.3133/ofr201

Beeman, J.W., Evans, S.D., Haner, P.V., Hansel, H.C., Hansen, A.C., Smith, C.D., and Sprando, J.M. 2014b. Passage and survival probabilities of juvenile Chinook salmon at Cougar Dam, Oregon, 2012:: U.S. Geological Survey OpenFile Report 2014-1038, 64 p., http://dx.doi.org/10.3133/ofr20141038/.

Beeman, J.W., and Adams, N.S., eds., 2015, In-reservoir behavior, dam passage, and downstream migration of juvenile Chinook salmon and juvenile steelhead from Detroit Reservoir and Dam to Portland, Oregon, February 2013–February 2014: U.S. Geological Survey Open-File Report 2015-1090, 92 p., http://dx.doi.org/10.3133/ofr20151090.

Buccola, N.L, Rounds, S.A., Sullivan, A.B., and Risley, J.C., 2012, Simulating potential structural and operational changes for Detroit Dam on the North Santiam River, Oregon, for downstream temperature management: U.S. Geological Survey Scientific Investigations Report 2012–5231, 68 p.

Buccola, N.L., Turner, D.F., and Rounds, S.A., 2016, Water temperature effects from simulated dam operations and structures in the Middle Fork Willamette River, western Oregon: U.S. Geological Survey Open-File Report 2016–1159, 39 p., http://dx.doi.org/10.3133/ofr20161159.

Buccola, N.L., 2017, Water temperature effects from simulated changes to dam operations and structures in the Middle and South Santiam Rivers, Oregon: U.S. Geological Survey Open-File Report 2017–1063, 19 p., https://doi.org/10.3133/ofr20171063.

DeWeber, J.T. and Peterson, J.T. 2020. Comparing Environmental Flow Implementation Options with Structured Decision Making: Case Study from the Willamette River, Oregon. Journal of the American Water Resources Association 56 (4): 599– 614. https://doi.org/10.1111/1752-1688.12845.

Environmental Protection Agency. 2013. Watershed Modeling to Assess the Sensitivity of Streamflow, Nutrient, and Sediment Loads to Potential Climate Change and Urban Development in 20 U.S. Watersheds. EPA/600/R-12/058F. National Center for Environmental Assessment, Office of Research and Development, Washington, D.C.

Fischman, R.L., and J.B. Ruhl. 2016. Judging Adaptive Management Practices of U.S. Agencies. Conservation Biology 30(2):268-75. doi: 10.1111/cobi.12616. Epub 2015 Nov 2.

Keefer, M.L., M.A. Jepson, G.P. Naughton, T.J. Blubaugh, T.S. Clabough and C.C. Caudill. 2017. Condition-Dependent En Route Migration Mortality of Adult Chinook Salmon in the Willamette River Main Stem, North American Journal of Fisheries Management, 37:2, 370-379, DOI: 10.1080/02755947.2016.1269032

Liss S.A., K.R. Znotinas, J.S. Hughes, B..J Bellgraph, C.R. Vernon, R.A. Harnish, E.S. Fischer, and S.E. Blackburn. 2020. Evaluation of Foster Dam Juvenile Fish Passage, 2018. PNNL-29587. Final report submitted by the Pacific Northwest National Laboratory to the U.S. Army Corps of Engineers, Portland, Oregon.

McAllister et al. (2022 in draft)

National Marine Fisheries Service. 2008. Endangered Species Act Section 7(a)(2) Consultation Biological Opinion & Magnuson-Stevens Fishery Conservation & Management Act Essential Fish Habitat Consultation on the Willamette River Basin Flood Control Project.

National Research Council 2004. Adaptive Management for Water Resources Project Planning. Washington, DC: The National Academies Press. https://doi.org/10.17226/10972.

Nesbit et al. 2012

Office of Management and Budget. 2004. Final Information Quality Bulletin for Peer Review. Issued via Memorandum M-05-03 on December 16, 2004.

Peterson et al. 2021

Peterson, J. T., Pease, J. E., Whitman, L., White, J., Stratton-Garvin, L., Rounds, S., and Wallick, R. 2022. Integrated tools for identifying optimal flow regimes and evaluating alternative minimum flows for recovering at-risk salmonids in a highly managed system. River Research and Applications, 38(2), 293– 308. https://doi.org/10.1002/rra.3903

United States Army Corps of Engineers (USACE). 2019a. Willamette Basin Review Feasibility Study. Final Integrated Feasibility Report and Environmental Assessment. Prepared by USACE Portland District.

USACE. 2019b. Detroit Dam Downstream Fish Passage and Temperature Control Draft Environmental Impact Statement. Willamette River Basin North Santiam River, Oregon. Prepared by USACE Portland District.

USACE. 2019c. A Systems Approach to Ecosystem Adaptive Management, A USACE Technical Guide. Report # ERDC/EL SR-19-9. Prepared by USACE Engineer Research and Development Center.

USACE. 2019d. Design Documentation Report No. 8 Detroit Dam and Reservoir, Willamette River Basin, North Santiam River, Oregon, Phase 1 Downstream Fish Passage – Selective Withdrawal Structure, 90 Percent Design Documentation Report, February 2019.

USACE. 2019e. Design Documentation Report No. 24 90% Final, Cougar Dam Downstream Fish Passage, Willamette River Basin, South Fork McKenzie River, Oregon, 5 April 2019.

USGS 2015

J. White, In Press

Williams, B. K., R. C. Szaro, and C. D. Shapiro. 2009. Adaptive Management: The U.S. Department of the Interior Technical Guide. Adaptive Management Working Group, U.S. Department of the Interior, Washington, DC.

US Army Corps of Engineers®
Portland District

WILLAMETTE VALLEY SYSTEM OPERATIONS AND MAINTENANCE

DRAFT PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT

APPENDIX O: TRIBAL COORDINATION AND PERSPECTIVES

TABLE OF CONTENTS

LIST OF TABLES

1.1 INTRODUCTION

The tribal coordination and perspectives appendix provides a record of coordination between the Corps and various interested Indian tribes throughout the NEPA process. The Corps also reached out to the tribes to request that they provide additional information they felt the Corps should consider as it relates to their various interests. These perspectives will provide critical insight to decisionmakers on how the alternatives may impact tribal interests beyond just the resource categories identified in the PEIS like fish, aquatic vertebrates, and aquatic habitat, cultural resources, recreation, vegetation, wetlands, water quality, wildlife, birds, and terrestrial habitat, etc. as discussed in the Tribal Resources Section 3.24. Actions the agency is considering may have direct or indirect effects to each tribe's interests in different ways. The Corps anticipates being able to continue to work with the tribes to better understand these impacts and the tribal perspectives on actions in the EIS between now and the final document through continued coordination on the EIS and through meaningful consultation. Ultimately providing the decision maker with a better understanding before signing the ROD.

1.2 RECORD OF COORDINATION

The Corps has initiated consultation with ten federally recognized Indian tribes including:

- Confederated Tribes and Bands of the Yakama Nation (Yakama)
- Confederated Tribes of Coos, Lower Umpqua, and Siuslaw Indians (CTCLUSI)
- Confederated Tribes of Grand Ronde Community of Oregon (Grand Ronde),
- Confederated Tribes of Siletz Indians (Siletz),
- Confederated Tribes of the Umatilla Indian Reservation (Umatilla)
- Confederated Tribes of Warm Springs (Warm Springs)
- Coquille Indian Tribe (Coquille)
- Cow Creek Band of Umpqua Tribe of Indians (Cow Creek)
- Klamath Tribes (Klamath)
- Nez Perce Tribe (Nez Perce)

Three tribes became cooperating agencies and three tribes initially deferred involvement with the project. The Corps will continue to work with all interested tribes either through the NEPA process or its Tribal Trust responsibilities, as appropriate.

Table 1-1 provides a list of treaties that serve as the legal foundations that connect the other seven federally recognized tribes with the Willamette Valley. The tribes have distinct but sometimes overlapping interests. Of note, for this Draft PEIS, the Grand Ronde, Siletz, and Cow Creek tend to have interests that are centered within the Willamette Valley, though interests expand beyond the Willamette River Basin. The Yakama, Umatilla, and Nez Perce are centered in the Columbia River and Plateau. The Warm Springs have interests that extend to both the Columbia River and Willamette Valley.

Table 1-1. Affected Indian Tribes and WRB-Relevant Treaties

Federally-Recognized Tribes	Treaties
Confederated Tribes of Grand Ronde Community of Oregon	Rogue River Treaty, September 10, 1853 Treaty with Cow Creek Band of Umpqua, September 19, 1853 Rogue River Treaty, November 15, 1854 Treaty with the Chasta, Scoton, and Umpqua, November 18, 1854 Treaty with the Umpqua and Kalapuya, November 29, 1854 Willamette Valley Treaty, January 22, 1855 Treaty with the Molalla, December 21, 1855
Cow Creek Band of Umpqua Tribe of Indians	Cow Creek Band of Umpqua Treaty, September 19, 1853
Confederated Tribes and Bands of the Yakama Nation	Yakama Treaty, June 9, 1855
Nez Perce Tribe	Nez Perce Treaty, June 11, 1855
Confederated Tribes of the Umatilla Indian Reservation	Walla Walla Treaty, June 9, 1855
Confederated Tribes of Warm Springs	Treaty of 1855 (also Treaty with the Tribes of Middle Oregon, June 25, 1855)
Confederated Tribes of Siletz Indians	Rogue River Treaty, September 10, 1853

One area of noticeable overlap is the historic and continued use of Willamette Falls. All of the tribes with the exception of the Cow Creek tribe, claim the falls as ceded lands or ancestral territory and continue to procure salmon and lamprey there today.

The Corps routinely consults with the Cow Creek, Grand Ronde, Siletz, and Warm Springs tribes for WVS actions that require NEPA review and undertakings that require National Historic Preservation Act compliance. These actions typically occur within the footprint of the 13 multipurpose dam and reservoir project areas. As part of the planning process, all four tribes were consulted regarding project initiation, in a letter dated December 3, 2018, and were also invited to participate as Cooperating Agencies in the development of the PEIS in letters dated

December 3, 2018, and January 18, 2019. The Corps sent a third letter to Warm Springs due to extended conversations with Warm Springs representatives (dated September 13, 2019).

The Grand Ronde tribe is actively participating as a Cooperating Agency in the development of this EIS. The Corps and tribe executed a MOU to this effect on February 28, 2020. Also, in a letter dated June 2, 2020, Grand Ronde provided comments to the Corps acting in their capacity as a Cooperating Agency. The comments were specific to the alternatives and measure for the WVS EIS.

Staff from the Siletz and Warm Springs have also participated in cooperator meetings. Both tribes expressed interest in acting as Cooperating Agencies, and engaged with the Corps in multiple meetings, phone calls, and emails to discuss the potential but have not signed an MOU with the Corps. The Cow Creek have requested to receive updates as the PEIS progresses, but declined to participate as a Cooperating Agency, on January 31, 2019, via email.

The Corps, in partnership with the Cow Creek, Grand Ronde, Siletz, and Warm Springs tribes, as well as several federal and state partners and other interested parties, recently executed a program-level programmatic agreement that modifies the Section 106 process to follow a streamlined and standardized approach to manage historic properties that have the potential to be impacted by Corps' undertakings related to the current and future operations of the WVS. The Corps continues to work with these partners to meet the requirements of the programmatic agreement, part of which includes drafting a historic properties management plan.

Given the area of analysis for the Fish, Aquatic Invertebrates, and Aquatic Habitat terminates where the Willamette River meets the Columbia River, the Corps has also included four Columbia River tribes who are members of the Columbia River Inter-Tribal Fish Commission (CRITFC). These tribes include the Yakama, Umatilla, Warm Springs, and Nez Perce. CRITFC provided a letter, dating June 28, 2019, as part of the public scoping, asserting the Columbia Plateau tribe's treaty rights and potential concerns and recommendations related to the operations and maintenance of the WVS.

In a letter dated September 30, 2021, the Corps offered to provide a project update and asked for a POC for further engagement, to nine of the ten previously listed tribes. The Corps did not send this letter to the Grand Ronde tribe because they are actively engaged as a Cooperating Agency. Representatives from the CTCLUSI, Coquille, and Klamath tribes declined to consult on the EIS and deferred to other tribes. Umatilla tribe has provided a POC for continued discussion and asked that CRITFC staff be engaged for technical expertise. The Corps is still conducting outreach to engage in discussions with Yakama, Nez Perce, and Warm Springs, based on this, September 2021, letter.

As part of this fall 2021 engagement, the Corps has been reaching out by phone, email, and meeting to Cow Creek, Grand Ronde, Siletz, Nez Perce, Umatilla, Warm Springs, and Yakama representatives to provide tribal perspective narratives that would be collated verbatim in this appendix. The intent of this outreach is to ensure that the tribes have the opportunity to voice concerns, issues, and interests that are unique, unfiltered, and specific to each tribe regarding the operations and maintenance of the WVS. The Corps recognizes that the analysis provided by the Corps does not convey a tribal perspective that is unique to each tribe on how their community would be impacted by Corps actions and proposed alternatives discussed in the PEIS. The Corps will continue to conduct outreach through the development of the PEIS.

Tables 1-2 to 1-8 provide a list of key past and current coordination efforts between the Corps and the tribes who have not declined or deferred engagement in the development of the PEIS. The table is not an exhaustive list of all emails, phone calls, and meetings that occurred. This is due to the varying levels of coordination (between staff and managers) as well as the frequency of these communications between the Corps and tribal staff and managers.

Table 1-2. Record of Coordination with the Cow Creek Tribe

Date of Contact	Level of Contact	Entity Contacted	Intent	Medium
12/3/2018	G2G	Cow Creek	Project initiation and request to participate as a Cooperating Agency	Hard Copy Letter
1/18/2019	G2G	Cow Creek	USACE invites tribe to participate as a Cooperating Agency	Hard Copy Letter, also emailed to tribal staff
1/31/2019	Staff	USACE	Tribe opts to not engage as a Cooperating Agency, but requests continued project updates	Email
2/1/2019	Staff	Cow Creek	Project coordination on NHPA compliance and request to meet	Email
2/11/2019	Staff	Cow Creek	Continued Project coordination on NHPA and tribal area of interest which includes Cottage Grove and Dorena Project areas	Email
4/5/2019	Staff	Cow Creek	Project update on NOI	Email
9/30/2021	G2G	Cow Creek	Project update and request to engage with the tribe	Hard Copy Letter, also emailed to tribal staff
12/3/2021	Staff	Cow Creek	Request to engage with the tribe and follow up from September 30, 2021, hard copy letter sent to Tribal Council	Email
6/3/2022	Staff	Cow Creek	Request for meeting to provide project briefing and engage on a Tribal Perspectives narrative for the PEIS	Email
7/21/2022	Staff	Cow Creek	Voicemail left to follow up for meeting to provide project briefing and engage on a Tribal Perspectives narrative for the PEIS	Phone

Table 1-3. Record of Coordination with the Grand Ronde Tribe

Date of Contact	Level of Contact	Entity Contacted	Intent	Medium
12/3/2018	G2G	Grand Ronde	Project initiation and request to participate as a Cooperating Agency	Hard Copy Letter
1/18/2019	G2G	Grand Ronde	USACE invites tribe to participate as a Cooperating Agency	Hard Copy Letter, also emailed to tribal staff
2/12/2019	Staff	Grand Ronde, USACE	Project overview, Cooperating Agency status, and steps forward to engage tribe in process	Meeting, In-person
2/28/2020	G2G	Grand Ronde, USACE	Cooperating Agency MOU executed	Email
6/10/2020	Staff	Grand Ronde	Letter submittal regarding alternatives and measures, also recognition of participation in Cooperating Agency meetings	Email
6/3/2022	Staff	Grand Ronde	Request for meeting to provide project briefing and engage on a Tribal Perspectives narrative for the PEIS	Email
6/30/2022	Staff	Grand Ronde, USACE	Meeting to discuss a Tribal Perspectives Narrative, tribe also asked about how previous comments have been incorporated and addressed	Meeting, Virtual
6/30/2022	Staff	Grand Ronde, USACE	Continued discussion on Tribal Perspectives discussion	Phone
7/18/2022	Staff	Grand Ronde	Follow up on Tribal Perspectives section	Email
7/28/2022	Staff	USACE	Tribal staff are mulling over potential for Tribal Perspectives section.	Email
8/17/2022	Staff	Grand Ronde, USACE	Brief follow up at the end of a meeting to ask if the tribe has thought more about the Tribal Perspectives narrative previously discussed	Meeting, Virtual

Table 1-4. Record of Coordination with the Siletz Tribe

Date of Contact	Level of Contact	Entity Contacted	Intent	Medium
12/3/2018	G2G	Siletz	Project initiation and request to participate as a Cooperating Agency	Hard Copy Letter
1/18/2019	G2G	Siletz	USACE invites tribe to participate as a Cooperating Agency	Hard Copy Letter, also emailed to tribal staff
3/15/2019	Staff	Siletz	Follow up on Letter sent to Tribal Council, request to participate as a Cooperating Agency, and invitation to meet	Email
3/26/2019	Staff	USACE	Request for USACE to brief Siletz in person	Email
4/4/2019	Staff	Siletz	Project coordination, NOI, and request to meet	Email
4/25/2019	Staff	Siletz	Project coordination and request for Siletz to participate as a Cooperating Agency	Meeting, In-person
6/26/2019	Staff	Siletz, USACE	Project coordination and request for Siletz to participate as a Cooperating Agency	Meeting, In-person
6/28/2019	Staff	USACE	Provided meeting follow up and MOU template with request to review and return to USACE	Email
7/23/2019	Staff	Siletz	Confirmation that the Tribal Council agrees for the Siletz to participate as a Cooperating Agency	Email
7/26/2019	Staff	USACE	Project coordination and request for Siletz comments on MOU (already provided) for Cooperating Agency status	Email
10/28/2019	G2G	Warm Springs, USACE	In-person briefing by USACE managers and staff to Tribal Council, request for tribe to participate as a Cooperating Agency	Meeting, In-person
11/18/2019	Staff	Warm Springs	Email to update tribal staff of USACE briefing to Tribal Council and Tribal Council agreement to participate as a Cooperating Agency, request to meet to discuss how the tribe would engage	Email
12/4/2019	Staff	Warm Springs	Follow up on Cooperating Agency status	Email
12/5/2019	Staff	USACE	Follow up on Cooperating Agency status, continued discussion on how the tribe would represent	Email
6/29/2021	Staff	Siletz, USACE	During field visit to Long Tom River, staff discussed continued engagement in project and tentative interest in USACE providing a briefing to tribal staff	Meeting, In-person

Date of Contact	Level of Contact	Entity Contacted	Intent	Medium
9/30/2021	G2G	Siletz	Project update and request to engage with the tribe	Hard Copy Letter, also emailed to tribal staff
12/3/2021	Staff	Siletz	Request to engage with the tribe and follow up from September 30, 2021, hard copy letter sent to Tribal Council	Email
6/3/2022	Staff	Siletz	Request for meeting to provide project briefing and engage on a Tribal Perspectives narrative for the PEIS	Email
7/12/2022	Staff	Siletz, USACE	Discussed Tribal Perspectives narrative and agreed to a project briefing, but date to be determined	Phone
8/10/2022	Staff	Siletz	Request for meeting to provide project briefing and engage on a Tribal Perspectives narrative for the PEIS	Email
7/23/2019	Staff	Siletz	Confirmation that the Tribal Council agrees for the Siletz to participate as a Cooperating Agency	Email
7/26/2019	Staff	USACE	Project coordination and request for Siletz comments on MOU (already provided) for Cooperating Agency status	Email

Table 1-5. Record of Coordination with the Nez Perce Tribe

Date of Contact	Level of Contact	Entity Contacted	Intent	Medium
9/30/2021	G2G	Nez Perce	Project update and request to engage with the tribe.	Hard Copy Letter, also emailed to tribal staff
12/3/2021	Staff	Nez Perce	Request to engage with the tribe and follow up from September 30, 2021, hard copy letter sent to Tribal Council	Email
6/3/2022	Staff	Nez Perce	Request for meeting to provide project briefing and engage on a Tribal Perspectives narrative for the PEIS	Email
7/21/2022	Staff	Nez Perce	Voicemail left to follow up for meeting to provide project briefing and engage on a Tribal Perspectives narrative for the PEIS	Phone
8/10/2022	Staff	Nez Perce	Request for meeting to provide project briefing and engage on a Tribal Perspectives narrative for the PEIS	Email

Table 1-6. Record of Coordination with the Umatilla Tribe

Date of Contact	Level of Contact	Entity Contacted	Intent	Medium
9/30/2021	G2G	Umatilla	Project update and request to engage with the tribe	Hard Copy Letter, also emailed to tribal staff
12/3/2021	Staff	Umatilla	Request to engage with the tribe and follow up from September 30, 2021, hard copy letter sent to Tribal Council	Email
12/5/2021	Staff	USACE	Umatilla provides POC to engage on project	Email
5/4/2022	Staff	Umatilla	Request for meeting to provide project briefing and engage on a Tribal Perspectives narrative for the PEIS	Email
6/3/2022	Staff	Umatilla	Continued discussion to engage with the tribe on a meeting to provide a project briefing and a Tribal Perspectives narrative for the PEIS	Email
6/3/22	Staff	Umatilla	Request for Corps to contact CRITFC for technical communication and identify new Umatilla POC	Phone
7/7/22	Staff	CRITFC	Follow up to provide project update to CRITFC as requested by Umatilla during 6/3/22 telephone call	Email
8/10/2022	Staff	Umatilla	Follow up on request to meet with the tribe to provide a project briefing and discuss a Tribal Perspectives narrative for the PEIS.	Email

Table 1-7. Record of Coordination with the Warm Springs Tribe

Date of Contact	Level of Contact	Entity Contacted	Intent	Medium
12/3/2018	G2G	Warm Springs	Project initiation and request to participate as a Cooperating Agency	Hard Copy Letter
1/18/2019	G2G	Warm Springs	USACE invites tribe to participate as a Cooperating Agency	Hard Copy Letter, also emailed to tribal staff
2/21/2019	Staff	Warm Springs, USACE	Project coordination and request for tribe to participate as a Cooperating Agency	Meeting, Virtual (original scheduled in-person, but

Date of Contact	Level of Contact	Entity Contacted	Intent	Medium
				cancelled due to winter weather)
8/21/2019	Staff	Warm Springs, USACE	Project discussion including potential for tribe to participate as a Cooperating Agency	Meeting, In-person
8/27/2019	G2G	Warm Springs, USACE	Site visit with Willamette Valley Project Operations Manager and Tribal Council Representative to Cougar Dam to see project area, discuss fish passage, discussion of WVS operations and maintenance EIS and potential for tribe to participate as a Cooperating Agency. A Tribal Council representative requested that USACE send a letter to the Tribal Council to engage on potential Cooperating Agency status.	Meeting, In-person
9/13/2019	G2G	Warm Springs	Request to Tribal Council to participate as a Cooperating Agency	Hard Copy Letter, also emailed to tribal staff
4/30/2021	Staff	Warm Springs	Request to meet with Warm Springs staff to discuss Tribal Resources section of the PEIS.	Email
9/30/2021	G2G	Warm Springs	Project update and request to engage with the tribe	Hard Copy Letter, also emailed to tribal staff
12/3/2021	Staff	Warm Springs	Request to engage with the tribe and follow up from September 30, 2021, hard copy letter sent to Tribal Council	Email
6/3/2022	Staff	Warm Springs	Request for meeting to provide project briefing and engage on a Tribal Perspectives narrative for the PEIS	Email
7/6/2022	Staff	Warm Springs	Attempted phone call, but phone lines are down	Phone
7/20/2022	Staff	War	Follow up on request for meeting to provide project briefing and engage on a Tribal Perspectives narrative for the PEIS	Email
7/28/2022	Staff	Warm Springs	Follow up on request for meeting to provide project briefing and engage on a Tribal Perspectives narrative for the PEIS	Email
8/19/2022	Staff	Warm Springs	Follow up on request for meeting to provide project briefing and engage on a Tribal Perspectives narrative for the PEIS	Email

Table 1-8. Record of Coordination with the Yakama Tribe

Date of Contact	Level of Contact	Entity Contacted	Intent	Medium
4/17/2019	Staff	USACE	Yakama response to USACE scoping notice, request for engagement, and POC provided. Also, noted potential concerns with project and topics relevant to Yakama	Electronic Letter submitted through USACE project scoping digital clearinghouse
4/21/2021	Staff	Yakama	Request for information related to a Tribal Resources section of the PEIS	Email
9/30/2021	G2G	Yakama	Project update and request to engage with the tribe	Hard Copy Letter, also emailed to tribal staff
12/3/2021	Staff	Yakama	Request to engage with the tribe and follow up from September 30, 2021, hard copy letter sent to Tribal Council	Email
6/3/2022	Staff	Yakama	Request for meeting to provide project briefing and engage on a Tribal Perspectives narrative for the PEIS	Email
7/6/2022	Staff	Yakama	Left voicemail to follow up on meeting request	Phone
7/12/2022	Staff	Yakama	Request for meeting to provide project briefing and engage on a Tribal Perspectives narrative for the PEIS	Email
8/3/2022	Staff	Yakama	Request for meeting to provide project briefing and engage on a Tribal Perspectives narrative for the PEIS	Email

Tables 1-9 to 1-11 provide a list of coordination efforts between the Corps and the tribes who deferred engagement in the development of the PEIS to other tribes.

Table 1-9. Record of Coordination with the Coquille Tribe

Date of Contact	Level of Contact	Entity Contacted	Intent	Medium
9/30/2021	G2G	Coquille	Project update and request to engage with the tribe	Hard Copy Letter, also emailed to tribal staff
10/12/2021	Staff	USACE	Deferring involvement in the project to other tribes	Email
11/19/2021	Staff	Coquille	Confirmed receipt of tribe's deferral	Email

Date of Contact	Level of Contact	Entity Contacted	Intent	Medium
12/3/2021	Staff	Coquille	Request to engage with the tribe and follow up from September 30, 2021, hard copy letter sent to Tribal Council	Email
12/3/2021	Staff	Coquille	Confirmation of receipt of THPO email deferring involvement in the project, requesting if that goes for natural resources and other tribal interests	Email
12/3/2021	Staff	USACE	THPO indicating they will follow up with Coquille Natural Resources Division to see if there are concerns or interest in project participation	Email

Table 1-10. Record of Coordination with the CTCLUSI Tribe

Date of Contact	Level of Contact	Entity Contacted	Intent	Medium
9/30/2021	G2G	CTCLUSI	Project update and request to engage with the tribe	Hard Copy Letter, also emailed to tribal staff
10/7/2021	Staff	USACE	Defer involvement in the project to other tribes	Email
11/19/2021	Staff	CTCLUSI	Confirm receipt of deferral	Email
12/3/2021	Staff	CTCLUSI	Request to engage with the tribe and follow up from September 30, 2021, hard copy letter sent to Tribal Council	Email

Table 1-11. Record of Coordination with the Klamath Tribe

Date of Contact	Level of Contact	Entity Contacted	Intent	Medium
9/30/2021	G2G	Klamath	Project update and request to engage with the tribe	Hard Copy Letter, also emailed to tribal staff
10/31/2021	Staff	USACE	Klamath deferring involvement in the project to other tribes	Email

The Confederated Tribes of Grand Ronde Community of Oregon

9615 Grand Ronde Rd
Grand Ronde, OR 97347

Oh behalf of the Confederated Tribes of the Grand Ronde Community of Oregon ("Grand Ronde" or "Tribe"), thank you for the opportunity to share as part of the Willamette Valley System Environmental Impact Statement ("EIS"). The Tribe has served as a cooperating agency on this project, and Grand Ronde reserves the right to consult on the EIS on an ongoing basis, and to make additional and/or updated comments beyond those contained in and attached to this letter. Grand Ronde Tribal Council reserves the right to make and/or update any and all statements of Tribal policy or position on an ongoing basis.

Procedural Interactions and Connections between Grand Ronde and the U.S. Army Corps of Engineers ("USACE")

Grand Ronde staff have met with USACE staff directly about the EIS multiple times over the history of the EIS. The Tribe appreciates the willingness of USACE and its staff to answer questions and provide information to Tribal staff. Many of the comments Grand Ronde submits in writing today have been communicated verbally and in writing throughout our meetings.

To date, there has not been any formal government-to-government consultation between USACE and Grand Ronde. Though we have been in regular contact as a cooperating agency and been given the option to comment on drafts of the EIS, we would appreciate that any references in the EIS to "consultation" or "government-to-government consultation" with Grand Ronde, either directly or as one of several "interested tribes", be removed from the EIS to avoid confusion as to whether government-to-government consultation with Grand Ronde has happened at all.

Grand Ronde Tribal History and Interests in the Project Area

Treaties
Rogue River 1853 & 1854 ~ Umpqua-Cow Creek 1853 ~ Chasta 1854 ~ Umpqua & Kalapuya 1854 ~ Willamette Valley 1855 ~ Molalla 1855

Grand Ronde is a sovereign Tribal nation with a special trust relationship with the U.S. Government and Federal agencies. Grand Ronde also has a government-to-government relationship with the State of Oregon and its agencies. Grand Ronde is made up of more than 30 antecedent tribes and bands with homelands in Oregon, southwest Washington, and northern

California. Grand Ronde and its antecedent tribes and bands have hunted, fished, and gathered in the entire EIS area since time immemorial. The Willamette Valley Treaty of January 22, 1855, which ceded the entire Willamette Basin to the U.S. in exchange for certain rights and benefits, was signed by representatives of the Kalapuya and Northern Molalla tribes. The Yoncalla Kalapuya signed the Treaty with the Umpqua and Kalapuya of November 29, 1854, which ceded a large portion of the Umpqua Basin to the U.S. in exchange for certain rights and benefits. All the Kalapuya and Molalla bands were subsequently, forcefully removed to the Grand Ronde Indian Reservation where they became members of the Confederated Tribes of Grand Ronde. Please see Attachment 1, Grand Ronde Ceded Lands Map.

All cultural, environmental, and natural resources located in or otherwise connected to the areas within and surrounding the Willamette Valley System are impacted by the continued presence and operation of the 13 dams; they are likewise impacted by the cumulative effects of related/connected construction and development. It is hard to overstate the impact these dams have had upon our people, natural and cultural resources, and ways of life since their creation in the heart of our Ceded Lands. Water quality and aquatic species health are core Tribal cultural and natural resources, and ones upon with other Tribal resources rely for their survival and integrity.

Grand Ronde seeks to protect, enhance, and restore Tribal cultural, environmental, and natural resources potentially affected by the Willamette Valley System itself and all related/connected cumulative impacts. These resources include but are not limited to:

- Archaeological values
- Historic values
- Aesthetic/visual values
- Tribal Cultural Landscapes as defined by the Tribe
- Quality and integrity of water, air and soil
- All native habitats, regardless of current land ownership or status
- All native species, whether they have any special status under federal or state law, and regardless of current management responsibility.

Tribal Comments and Concerns

Grand Ronde appreciates the outreach from USACE regarding the EIS, and the participation of staff from USACE in continued engagement and site visits to the Willamette Valley System properties. Coordination among sovereigns and sharing of relevant information are guiding principles of effective Tribal consultation. Other guiding principles include but are not limited to:

- Due diligence must be fully exercised in identifying Tribal resources before USACE may be said to have fully analyzed impacts to cultural resources.
- Impacts to Tribal resources, once identified and analyzed, should be avoided to the extent possible.
- If avoidance is not entirely possible, then impacts to Tribal resources should be minimized to the extent possible.

- Impacts to Tribal resources that have not been fully addressed through avoidance or minimization must be fully mitigated to the maximum extent.

In applying these principles, Grand Ronde has ongoing concerns regarding Tribal cultural and natural resources that are affected by the Willamette Valley System, particularly with regards to the noted significant adverse effects to cultural resources listed in all of the considered alternatives in the EIS, including the preferred alternative. Please find our direct comments on the cooperating agency draft version of the EIS, previously delivered to USACE staff in writing, attached to this letter. Please note that most natural resources are also considered cultural resources of the Tribe. Unless and until these concerns are fully addressed to the Tribe's satisfaction, Grand Ronde considered the EIS to be inadequate and respectfully requests that USACE not issues a final EIS; Grand Ronde would further request that the U.S. Environmental Protection Agency (EPA) not approve this EIS on the grounds of inadequate analyses under the National Environmental Policy Act.

Thank you once again for the opportunity to comment, and for already acknowledging many of the Grand Ronde comments that have been previously submitted to USACE staff.

________________ Date 11/2/22

Torey Wakeland

Ceded Lands Program Manager

Confederated Tribes of Grand Ronde

The Confederated Tribes of the Grand Ronde Community of Oregon
Ceded Lands / Usual and Accustomed Areas in Oregon, Washington and California