US Army Corps of Engineers
Portland District

Willamette Basin Review Feasibility Study

APPENDIX G

ResSim Analysis for Base Year 2020, No Action Alternative 2070, and Agency Recommended Plan 2070

July 2019

Appendix G

WBR – ResSim Analyses for Base Year 2020, No Action 2070, and Agency Recommended Plan 2070

This Appendix documents the five HEC-ResSim analyses for the Willamette Basin Review (WBR). It is organized into sections describing the watershed elements common to all five WBR analyses and separate sections for each analysis. The general descriptions of the five analyses for the WBR described in this appendix are the following:

- Base Year 2020 simulation, which is the estimated year new contracts could start,
- No Action simulation using peak demands in 2070,
- No Action simulation using expected demands in 2070, which is considered the Future Without Project (FWOP) simulation,
- Agency Recommended Plan (ARP) simulation using the peak demands in 2070, and
- ARP simulation using the expected demands in 2070, which is considered the Future With Project simulation.

This appendix is supporting documentation for the main feasibility report, "Willamette Basin Review Feasibility Study, Integrated Feasibility Report and Environmental Assessment". The main report contains all of the documentation for the alternatives evaluated and the descriptions that lead to the selection of the ARP. This ResSim modeling appendix documents the methodology used to generate the supporting simulations for the WBR.

Other appendices to the main report document detailed information for the simulations documented in this Appendix. This appendix will refer to other project documents quite often, rather than repeating detailed information covered by other reports. A key to the primary information used from other reports in the WBR is:

a) The main report documents the alternatives evaluated, the selection of the allocation option, and the recommended water management plan. It also summarizes the municipal and industrial (M&I) and the agricultural irrigation (AI) demand estimated for the project. The development of the future M&I demands are documented in Appendix A and the AI demands are documented in Appendix B.
b) Appendix C documents the calculations performed with the Baseline simulation results to determine how much stored water is used to meet the fish and wildlife (F&W) demands.
c) Appendix D documents the flow dataset used for all ResSim analyses of the project.

d) Appendix E documents the Baseline simulation in great detail. It contains a thorough description of how the fish and wildlife (F&W) demands are modeled. Note that the simulations documented here in Sections 6 through 10 do not make any changes to how F&W demands are modeled, so Appendix E should be referred to for all information regarding ResSim particulars on meeting F&W demands. F&W demands do not change in the ARP.
e) Appendix F is titled "ResSim WVP and Live Flow Diversions for Base Year 2020, No Action 2070, and Agency Recommended Plan 2070 Model Runs", and documents all the specific categories of demand increases utilized for the five ResSim analyses documented in this appendix.
f) Appendix K provides a discussion of the possible impacts of climate change on demands in the system. It is supporting documentation for the ARP simulation, as it provides a qualitative estimate for how much more stored water from the basin reservoirs might be needed in the future to meet F&W demands.

Contents

1 Introduction

This appendix details the ResSim analyses inputs (and their developments) for five conditions: one condition to define a base year, two conditions where there is no re-allocation of stored water in the basin, and two conditions with reallocation of storage. These five conditions were modeled in HEC-ResSim, the reservoir simulation program used by USACE, producing five simulations and five sets of results. This appendix documents all five simulations. Refer to the main Feasibility Report and Appendices A and B for all documentation regarding how demands were estimated and why these five simulations were necessary for the Willamette Basin Review (WBR).

Purpose of Appendix G – The purpose of this appendix is to fully document the details for all the ResSim analyses for the five simulations needed for the WBR. The common differences between these simulations and the 2008 Baseline are described in Sections 1 through 5 of this appendix. The Baseline simulation is fully documented in Appendix E, "Willamette Basin Review – ResSim Analysis for 2008 Baseline Flow Dataset" (referred to here as the Model Documentation Report). The variations between the five WBR simulations are only in different diversions for stream reaches and how the projects release water for those diversions, with the differences for each of the simulations outlined in five different sections (Sections 6 through 10). (See Appendix F for a full description of the different demands for the five simulations.)

Purpose of the Base Year 2020 – Documents the ResSim simulation details for the Base Year 2020, in Section 6. The flow dataset used for analysis represents 2008 levels of depletion for an 80 year Period of Record (POR) and is described in Appendix D. The Baseline analysis (Appendix E) documented the simulation of reservoir operations for that flow dataset with no additional depletions. The Base Year 2020 simulation adjusts for the increases in BOR stored water contracts and M&I already permitted live flow demand from 2008 to the year 2020, representing the Existing Condition. The year 2020 is used because it is the estimated year that contracts could start.

Purpose of Peak No Action 2070 – Documents the ResSim simulation details for No Action in 2070 using peak demand values, in Section 7. Demand values represent peak increases from 2020 to 2070.

Purpose of Expected No Action 2070 – Documents the ResSim simulation details for No Action in 2070 using expected demand values, rather than peak demand values, and is the Future Without Project (FWOP) condition. This simulation is described in Section 8. Demand values represent expected increases from 2020 to 2070.

Purpose of Peak ARP 2070 – Documents the ResSim simulation details for the ARP in 2070 using peak demand values, in Section 9. Demand values represent peak increases from 2020 to 2070, although these values differ from those of the Peak No Action simulation.

Purpose of Expected ARP 2070– Documents the ResSim simulation details for the ARP in 2070 using expected demand values, in Section 10. Demand values represent expected increases from 2020 to 2070. The demand increases differ from those of the Expected No Action simulation.

Figure 1.1 shows network screen shots from two ResSim watersheds. The network on the left of the figure is from the Baseline simulation, and the network on the right is for the watershed used for the simulations described above. All of the small black arrows in the network image on the right of the figure are the diversions and return flows that have been added to the Baseline network in order to model diversions for the simulations described in the attachments.

Table 1.1 lists the specifics for the simulations described in these attachments. The version of ResSim used is specified first, and then the watershed, network, and configuration are listed. The alternative is made of the operation set used for each project, the initial conditions used (the lookback elevations and flows), and the specification of any time series to be used. The simulation name will be different for each of the cases documented in Sections 6 - 10, but all other items from Table 1.1 will be the same for each simulation, including the starting and ending dates, lookback date, alternative used, and time step used. The diversion magnitudes and project releases are also different for the five simulations, but those changes will be described in each analysis section. Note that the project names in the table below are given by their three letter descriptions used in the water management reservoir regulation section (DET=Detroit, BCL=Big Cliff, GPR=Green Peter, FOS=Foster, CGR=Cougar, BLU=Blue River, HCR=Hills Creek, LOP=Lookout Point, DEX=Dexter, FAL=Fall Creek, COT=Cottage Grove, DOR=Dorena, and FRN=Fern Ridge).

The HEC-ResSim watershed used for the WBR is different than the one used for the Baseline (Appendix E), but it started as a copy of the Baseline watershed. The steps used to set up the WBR network were:

1) Created the Baseline operations set for each project and ran a simulation for the full Period of Record flow dataset. This is documented in Appendix E, and this simulation is used in Appendix C to calculate the stored water volume released for meeting BiOp flow objectives.
2) Created a watershed to use specifically for the diversions necessary to model for the WBR study, with all project operation the same as in the Baseline watershed, although some *names* differ between the two watersheds.
3) Added 32 diversions to the network for the WBR watershed, 16 of which take water out of the system and 16 of which provide the estimated return flows. This is the watershed used for the five WBR simulations.
4) Input the diversion rules and the new project release rules for each WBR simulation using the same flow dataset as the Baseline.

Figure 1.1. ResSim network used for the WBR simulations with diversions.

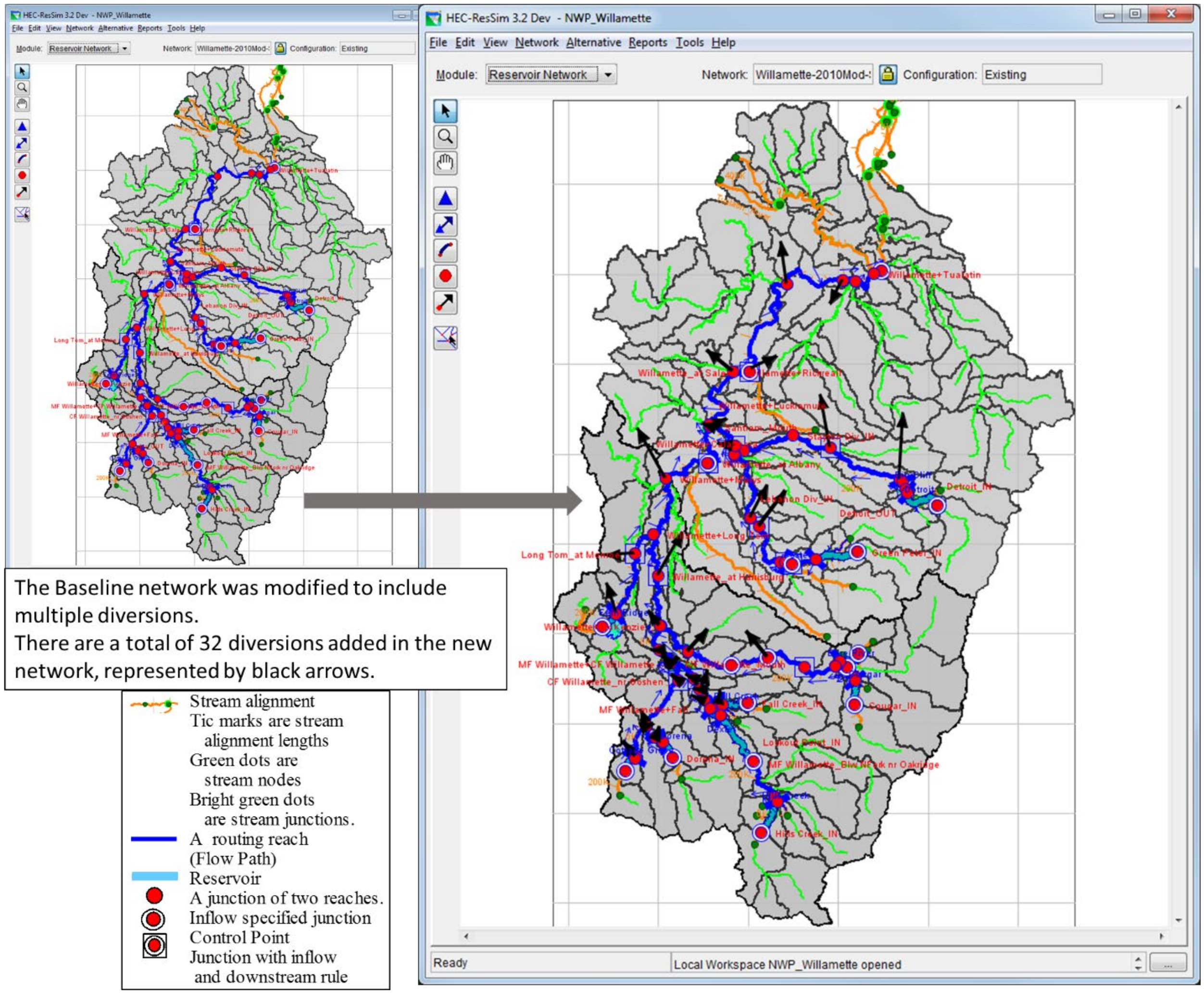


Table 1.1. Summary of the specifics for the simulations documented in this Appendix.

ResSim Version	HEC-ResSim_3.2.0.1197_Dev_Build_64-bit		
Watershed	NWP_Willamette		
Network	Willamette-2010Mod-SSARR		
Configuration	Existing		
Alternative	NewBase		
Inflow File Name	Final Flows WBR – from 2010 Mod Flows and Hybrids.dss		
Rule Curve File	Willamette_Rule_Curves.dss		
External Variables File	Water Year Type for 2010 Mod Flows.dss		
Simulation Name	*(See Attachments F1 through F5 for simulation names)*		
Simulation Start	04 Oct 1928 at 2400		
Simulation Lookback	01 Oct 1928 at 2400		
Simulation Ending	30 Sep 2008 at 2400		
Time Step	1 day		
Project	**Operation Set**	**Lookback Elevation**	**Lookback Flows (cfs)**
DET	Revised Temp Ops Det	Rule Curve	Power Plant 1500.0, Spillway and ROs 0.0
BCL	Early Imp	1193.0 ft	Power Plant 1500.0, Spillway 0.0
GPR	GPR new FOS rules	Rule Curve	Power Plant 1500.0, Spillway and RO 0.0
FOS	Revised FOS	Rule Curve	Power Plant 1500.0, Spillway 0.0
CGR	FIS Flood OPs & Early Imp	Rule Curve	Power Plant 400.0, Spillway and RO 0.0
BLU	FIS Flood OPs & Early Imp	Rule Curve	RO 50.0, Spillway 0.0
HCR	FIS Flood OPs & Early Imp	Rule Curve	Power Plant 400.0, Spillway and ROs 0.0
LOP	FIS Flood OPs & Early Imp	Rule Curve	Power Plant 1200.0, Spillway and ROs 0.0
DEX	Early Imp	693.0 ft	Power Plant 1200.0, Spillway 0.0
FAL	FIS and Early Imp 728	Rule Curve	RO 200.0, Spillway 0.0
COT	FIS Flood OPs & Early Imp	Rule Curve	RO 50.0, Spillway 0.0
DOR	FIS Flood OPs & Early Imp	Rule Curve	RO 100.0, Spillway 0.0
FRN	Improved Baseline	Rule Curve	RO 30.0, Spillway and Sluice Gate 0.0

Special Note on the WBR Watershed –The addition of so many diversions to a pre-existing network caused many problems in ResSim. Normally, a network is fully created, and then Operation Sets and rules are written for reservoirs in the model, Alternatives are created using combinations of Operation Sets, and then Simulations run for Alternatives. The network for the WBR had all the diversions added after Operations Sets, rules, and Alternatives were already created, and this caused corruption issues in the WBR watershed whenever an Operation Set or Alternative was duplicated, whenever an Alternative had changes made to it, or whenever new time series were added to a rule or diversion. In the end, the only way to prevent corruption of the WBR watershed was to change each rule as needed and running the same Alternative with those new rules. This means that only the simulations in the WBR watershed preserve the rules and diversions used in the analysis, not the Operation Sets in the Network. This detail is only needed for those analysts that have a need to run a variation of any of the WBR analyses, but it should not be overlooked or the WBR watershed will become corrupted again. Table 1.2 below outlines the differences.

Table 1.2. Summary of the differences in working with the Baseline and WBR Watersheds.

Hypothetical Change & Result	**Baseline Watershed**	**WBR Watershed**
Increase the minimum outflow from Project A	1. Duplicate the desired operation set from Project A, then 2. Create a new minimum flow rule in the new Operation Set, then 3. Position the new rule where it belongs and remove the old min flow rule from this new Operation Set, then 4. Duplicate an Alternative and specify the new Operation set. 5. Now run a new simulation.	1. Go into the desired operation set at Project A and just change the minimum outflow rule to the new value. 2. Using the same Alternative as before, run a new simulation.
Resulting Operation Sets for Project A	The original Operation Set for Project A contains the rule with the original min outflow. The new Operation Set is the same except it has a different min outflow rule with its own name. Comparisons between the two Operations Sets are available in the Reservoir Network.	The Operations Set has been changed since a rule within it has been changed. The min outflow rule still has the same name, so the Reservoir Network only shows the latest version of that Operation Set. The original Operation Set and original min outflow rule are no longer shown.
Resulting Alternatives	Two different Alternatives are used for separate simulations.	The Alternative did not change names (it was not duplicated) so it is now defined with the new min outflow rule.
Resulting Simulations	Separate simulations show the effects of an increase in the min outflow at Project A. Each Alternative used is noted in the simulation output file Fpart, which are different in the two simulations.	Separate simulations show the effects of an increase in the min outflow at Project A. The Alternative noted in the simulation output file Fpart is the same for both simulations.
Future Users of the Watershed	Can easily follow what was done in the past and what min outflow went with which Alternative. Differences in inputs are easy to trace back while in the Reservoir Network.	Can only determine the difference between two simulations by opening each one and looking at the rule specifics. Everything is named the same in both simulations but min outflows from A are different for the two runs.

2 The Period of Record Flows Used for the five WBR Simulations

The flow dataset used for the five WBR simulations is the same as that used for the 2008 Baseline analysis, the 2010 Level Modified Streamflows. This flow dataset is documented for the WBR in Appendix D, "Willamette Basin Review – Flow Dataset Used for ResSim Analyses", and it includes a description about the level of irrigation and return flows embedded into every year of the flow dataset.

The flow dataset is 80 years (1928-2008) of historical flows in the Willamette Basin, with all years adjusted to represent the 2008 level of irrigation in the basin. The Baseline analysis for current reservoir operations using this flow dataset produced quantitative results for system performance. The use of the same dataset for the five WBR analyses produce quantitative results that can be compared directly with each other. The effects of the increased diversions (irrigation and M&I) and stored water releases can be assessed for system impacts by direct comparison.

The use of the same flow dataset for the WBR simulations does not account for the impacts of projected changes in climate on streamflows – it quantifies what the system performance would be right now if the increased demands were already present. The assessment of climate impacts on streamflows, Appendix K, "Willamette Basin Review – Discussion of Climate Change Impact on Future Regulation", documents those increased demands on the system. Therefore, comparisons between the Baseline and WBR analyses do not include the effects of climate change.

The water year classifications for the WBR simulations remain the same as the Baseline analysis. This is because the flow dataset is identical, so there should be no difference in the amount of water coming into the system.

The flow dataset uses the 2008 level of irrigation for all years in the record. This means that the flow records in the dataset for any particular year, say for example 1932, do not reproduce the observed flows in 1932, because they have been adjusted to represent 2008 levels of depletions. The record for 1932 produces the flows that would have happened in 2008 if the observed weather patterns of 1932 occurred in 2008. Therefore, the Baseline simulation assumes the same amount of irrigated acres and consumptive use rates for all years of the flow dataset. There is no adjustment to the depletions to account for extra dry or extra wet years – all years have the same depletions included in the flow dataset. This represents a theoretical irrigation demand, not an actual irrigation demand, as all years are treated the same. The five WBR simulations, which include additional municipal and industrial (M&I) and agricultural irrigation (AI) demands, include the *increases* in demand from the 2008 level. All increases in demand and diversions are covered in Section 3.

3 Diversions in the Network for the five WBR Simulations

The various increases in demand on the system, as documented in the main Feasibility Report and Appendices A, B, and F, are summarized in Table 3.1. The table shows the demand increase for all five WBR simulations, with the demand increases broken out by row. A description for each row in the tables is provided below, with the descriptions broken out into two groups. The first group is the increased demand to the year 2020, and is common to all five WBR simulations. The second group is the increase in demands after the year 2020 to the year 2070, with each simulation having a different set of demand levels. All values shown in Table 3.1 are from Appendix F, "ResSim WVP and Live Flow Diversions for Base Year 2020, No Action 2070, and Agency Recommended Plan 2070 Model Runs". Appendix F also lists the specific table in that report to find the break-down of the total demand by reach in the basin, and each of the referenced tables in that document are shown at the end of the descriptions below in parentheses, for example (AI 1).

1. The increases in demand to the year 2020 that are common to all five simulations, which are separated by bold lines in Table 3.1 from the 2050 demands, are:

- *Increase in BOR stored water contracts for 2008-2020* – the additional BOR contracts on stored water in the basin. (AI 1)
- *Increase in M&I demand, already permitted live flow, 2008-2020, for June through September* – many M&I permits already in place for live flows were not fully utilized in 2008. This row documents the increased use of these existing permits in 2020. This row documents only the volumes for June through September. (MI 1)
- *Increase in M&I demand, already permitted live flow, 2008-2020, for April through May* - many M&I permits already in place for live flow were not fully utilized in 2008. This row documents the increased use of these existing permits in 2020 for April and May. (MI 2)

2. The increases in demand after the year 2020 to the year 2070 vary for each of the four 2070 simulations. These demands are described below.

- *Increase in BOR stored water contracts for 2020-2070* – this total is broken into two sub-categories, based on the 95 Kaf volume described in the BiOp documents. (USACE operations do not change for stored water contract releases that total less than 95 Kaf.) Note that this value is the sum of the two rows beneath it.
  - *Portion of increase that reaches 95Kaf of BOR contracts* – the same for all four 2070 simulations. (AI 2)
  - *Portion of increase that is above the 95Kaf of BOR contracts* – this varies based on the peak or expected value and the No Action and ARP cases. (AI 3 or AI 4 for Peak and Expected No Action, respectively, AI 5 and AI 6 for Peak and Expected ARP, respectively.)
- *Increase in M&I demand, already permitted live flow, 2020-2050, for June through September* - many M&I permits already in place for live flows were not fully utilized in 2020. This row documents the increased use of these existing permits by the permit holders in 2070. This row documents only the volumes for June through September, which changes only for the peak or expected demand. (MI 3 and MI 4)
- *Increase in M&I demand, already permitted live flow, 2020-2070, for April through May* - many M&I permits already in place for live flows were not fully utilized in 2020. This row documents the increased use of these existing permits by the permit holders in 2070 for April and May. This value is the same for all four 2070 cases. (MI 5)

- *Increase in M&I demand, already permitted live flow, 2020-2070, through intertie supplies* - some M&I permits already in place for live flows are not expected to be fully utilized in 2070 by the permit holders, who may sell their permitted water to others. This would require the construction of interties in order for others to use that already permitted water. The peak and expected use demands are different in 2070, and this category is not expected to be cost efficient if reservoir storage is reallocated. (MI 6 and MI 7)
- *Increase in M&I demand due to system deficits, from stored water through re-allocation, 2020-2070* – this category only applies to the ARP cases, and is different for peak and expected demand levels. (MI 8 and MI 9)
- *Increase in M&I demand for SSI deficits, from stored water through reallocation, 2020-2070* – this category only applies to the ARP cases, and is the same for both the peak and expected use demand levels. (MI 10)

The total volume of the demand increases above the 2008 levels is totaled at the bottom of Table 3.1 for each of the five WBR simulations.

The demands in Table 3.1 are broken out in such detail because the way that each demand is modeled in ResSim depends on whether the water is from a live flow permit or from stored water, and also how each demand might be restricted or cut back in low water years. Table 3.2 lists only those demands from Table 3.1 that are from stored water contracts. These are demands for which Willamette projects specifically release stored water to cover in ResSim simulations. Table 3.3 lists only those demands from Table 3.1 that are from live flow permits. These are demands that are not supposed to come from stored water in the reservoirs, but if the diversion of live flows depletes the mainstem below minimum BiOp target flows, then reservoir storage may still need to be released as supplemental flow. Note that the last row of Table 3.2 plus the last row of Table 3.3 equals the last row of Table 3.1 for each of the five simulations.

Some of the demands listed in Table 3.1 for each simulation are assumed to be regulated or reduced in low water years, under the recommended water management plan, while some of the demands would not be subject to these reductions. Those demands that are modeled by reduced diversions in lower water years are listed in Table 3.4. The methodology for the reduced diversions is outlined in Section 3.1.

All of the M&I and AI demand increases from 2008 levels were developed by reach, with the reaches numbered according to the Water Service Contracts Reach Map shown in Figure 3.1. The contracts map identifies the reservoirs that can supply stored water to each reach – for example, only Cottage Grove can supply stored water in Reach 15, but both Cottage Grove and Dorena can supply stored water in Reach 13. Reach 1 includes all stretches of the Willamette River downstream of the confluence with the Santiam River and all reservoirs can contribute stored water to any location on Reach 1.

Table 3.1. Summary of increased demands in the WBR simulations. (See Appendix F for more descriptions.)

WBR Simulation	Base Year 2020	No Action 2070 with Peak Demand	No Action 2070 with Expected Demand	ARP 2070 with Peak Demand	ARP 2070 with Expected Demand
Purpose of Simulation:	Existing Conditions	USACE water supply policy	Future without Project	USACE water supply policy	Future with Project
Demand volume units:	ac-ft	ac-ft	ac-ft	ac-ft	ac-ft
2008 Level demands	In flow dataset	In flow dataset	In flow dataset	In flow dataset	In flow dataset
Increase in BOR stored water contracts for 2008-2020	22,854	22,854	22,854	22,854	22,854
Increase in M&I demand, already permitted live flow, 2008-2020, for June through September	18,780	18,780	18,780	18,780	18,780
Increase in M&I demand, already permitted live flow, 2008-2020, for April through May	7,541	7,541	7,541	7,541	7,541
Increase in BOR stored water contracts for 2020-2070		124,264	87,298	184,193	100,128
Portion of increase that reaches 95Kaf of BOR contracts		*13,626*	*13,626*	*13,626*	*13,626*
Portion of increase that is above the 95Kaf of BOR contracts		*100,637*	*73,672*	*170,567*	*86,502*
Increase in M&I demand, already permitted live flow, 2020-2070, for June through September		90,227	54,469	90,227	54,469
Increase in M&I demand, already permitted live flow, 2020-2070, for April through May		27,246	27,246	27,246	27,246
Increase in M&I demand, already permitted live flow, 2020-2070, through intertie supplies		28,901	14,075	0	0
Increase in M&I demand due to system deficits, from stored water through re-allocation, 2020-2070.		0	0	103,152	38,682
Increase in M&I demand for SSI deficits, from stored water through re-allocation, 2020-2070.		0	0	17,950	17,950
Total volume of demand increase from 2008 levels:	**49,175**	**319,813**	**232,263**	**471,942**	**287,650**

Table 3.2. Demands in the WBR simulations that are from stored water contracts.

WBR Simulation	Base Year 2020	No Action 2070 with Peak Demand	No Action 2070 with Expected Demand	ARP 2070 with Peak Demand	ARP 2070 with Expected Demand
Purpose of Simulation:	Existing Conditions	USACE water supply policy	Future without Project	USACE water supply policy	Future with Project
2008 Level demands	In flow dataset	In flow dataset	In flow dataset	In flow dataset	In flow dataset
Increase in BOR stored water contracts for 2008-2020	22,854	22,854	22,854	22,854	22,854
Increase in M&I demand, already permitted live flow, 2008-2020, for June through September					
Increase in M&I demand, already permitted live flow, 2008-2020, for April through May					
Increase in BOR stored water contracts for 2020-2070		124,264	87,298	184,193	100,128
Portion of increase that reaches 95Kaf of BOR contracts		*13,626*	*13,626*	*13,626*	*13,626*
Portion of increase that is above the 95Kaf of BOR contracts		*100,637*	*73,672*	*170,567*	*86,502*
Increase in M&I demand, already permitted live flow, 2020-2070, for June through September					
Increase in M&I demand, already permitted live flow, 2020-2070, for April through May					
Increase in M&I demand, already permitted live flow, 2020-2070, through intertie supplies					
Increase in M&I demand due to system deficits, from stored water through re-allocation, 2020-2070.				103,152	38,682
Increase in M&I demand for SSI deficits, from stored water through re-allocation, 2020-2070.				17,950	17,950
Total volume of demand increase on stored water from 2008 levels:	**22,854**	**147,118**	**110,152**	**328,149**	**179,614**

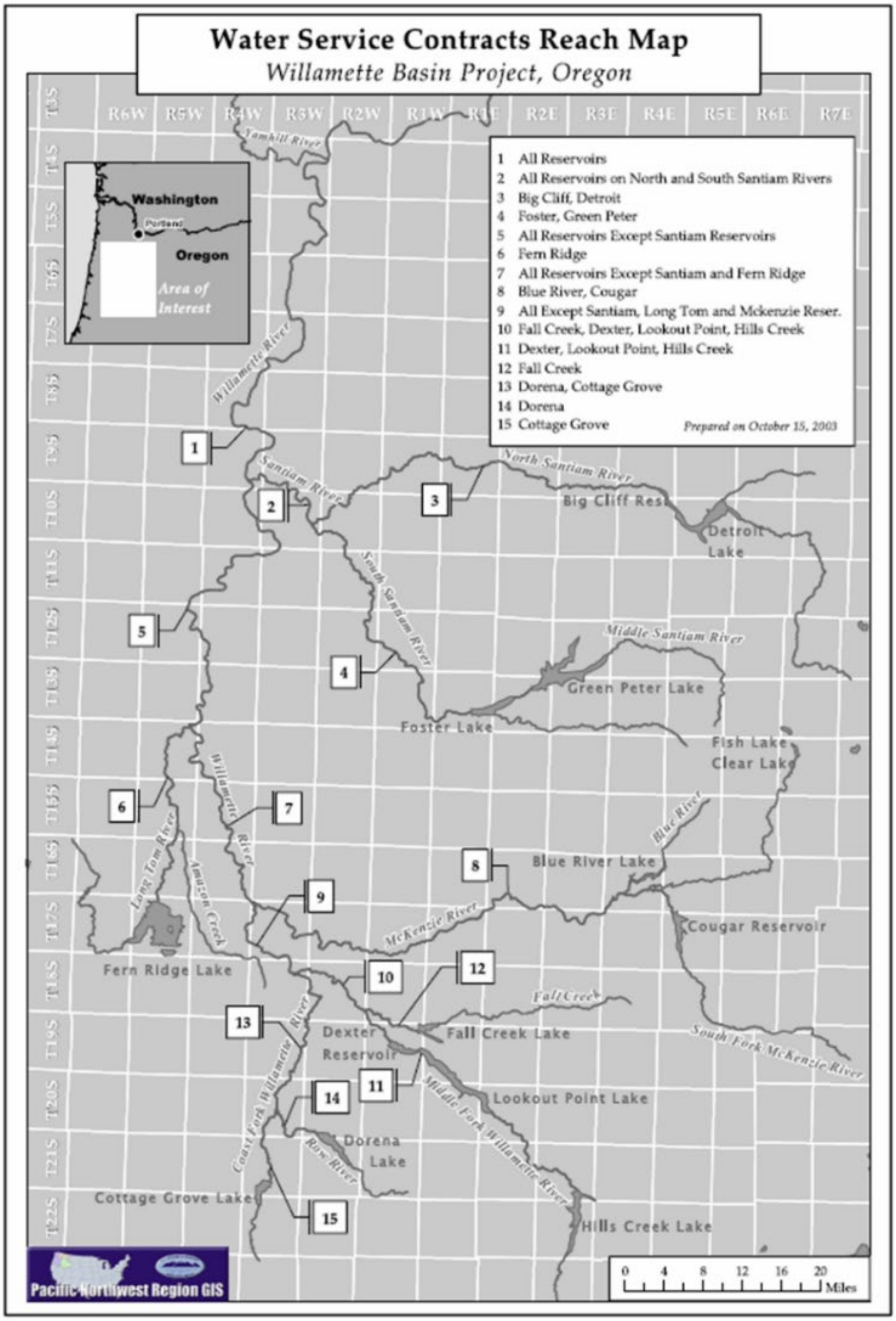
Table 3.3. Demands in the WBR simulations that are from live flow permits.

WBR Simulation	Base Year 2020	No Action 2070 with Peak Demand	No Action 2070 with Expected Demand	ARP 2070 with Peak Demand	ARP 2070 with Expected Demand
Purpose of Simulation:	Existing Conditions	USACE water supply policy	Future without Project	USACE water supply policy	Future with Project
2008 Level demands	In flow dataset	In flow dataset	In flow dataset	In flow dataset	In flow dataset
Increase in BOR stored water contracts for 2008-2020					
Increase in M&I demand, already permitted live flow, 2008-2020, for June through September	18,780	18,780	18,780	18,780	18,780
Increase in M&I demand, already permitted live flow, 2008-2020, for April through May	7,541	7,541	7,541	7,541	7,541
Increase in BOR stored water contracts for 2020-2070					
Portion of increase that reaches 95Kaf of BOR contracts					
Portion of increase that is above the 95Kaf of BOR contracts					
Increase in M&I demand, already permitted live flow, 2020-2070, for June through September		90,227	54,469	90,227	54,469
Increase in M&I demand, already permitted live flow, 2020-2070, for April through May		27,246	27,246	27,246	27,246
Increase in M&I demand, already permitted live flow, 2020-2070, through intertie supplies		28,901	14,075	0	0
Increase in M&I demand due to system deficits, from stored water through re-allocation, 2020-2070.					
Increase in M&I demand for SSI deficits, from stored water through re-allocation, 2020-2070.					
Total volume of demand increase on live flows from 2008 levels:	**26,321**	**172,695**	**122,111**	**143,794**	**107,946**

Table 3.4. Demands in the WBR simulations that will be modeled with supply reductions based on water year type in order to approximate the recommended water management strategy. Values from Table 3.1 not listed below are modeled to be supplied in full.

WBR Simulation	Base Year 2020	No Action 2070 with Peak Demand	No Action 2070 with Expected Demand	ARP 2070 with Peak Demand	ARP 2070 with Expected Demand
Purpose of Simulation:	Existing Conditions	USACE water supply policy	Future without Project	USACE water supply policy	Future with Project
2008 Level demands	In flow dataset	In flow dataset	In flow dataset	In flow dataset	In flow dataset
Increase in BOR stored water contracts for 2008-2020		22,854	22,854	22,854	22,854
Increase in M&I demand, already permitted live flow, 2008-2020, for June through September					
Increase in M&I demand, already permitted live flow, 2008-2020, for April through May					
Increase in BOR stored water contracts for 2020-2070		124,264	87,298	184,193	100,128
Portion of increase that reaches 95Kaf of BOR contracts		*13,626*	*13,626*	*13,626*	*13,626*
Portion of increase that is above the 95Kaf of BOR contracts		*100,637*	*73,672*	*170,567*	*86,502*
Increase in M&I demand, already permitted live flow, 2020-2070, for June through September		90,227		90,227	
Increase in M&I demand, already permitted live flow, 2020-2070, for April through May					
Increase in M&I demand, already permitted live flow, 2020-2070, through intertie supplies		28,901			
Increase in M&I demand due to system deficits, from stored water through re-allocation, 2020-2070.				103,152	
Increase in M&I demand for SSI deficits, from stored water through re-allocation, 2020-2070.				17,950	17,950
Volume of demand increase from 2008 levels subject to reduced supply based on water year type:	**0**	**266,246**	**110,152**	**418,376**	**140,932**

Figure 3.1. Reach Numbering system used is the same as the Water Service Contract Map.*



*From: Appendix D – Willamette Project Supplemental Biological Assessment.

Table 3.5 is a list of the reaches from Figure 3.1, with their tributary or river name, and a list of the storage reservoirs that could supply water to that reach. Reach 1 has been sub-divided into three sub-reaches for the purposes of this study, one from the Willamette/Santiam confluence to Salem (Reach 1c), from Salem to Oregon City above Willamette Falls (Reach 1b), and from Willamette Falls to the

Columbia River (Reach 1a) that includes the city of Portland, Oregon. The sub-division of Reach 1 was done to more explicitly define where the diversions would occur and because the Willamette River below Willamette Falls is not part of the ResSim model.

Table 3.5. Summary of river reaches, their location, and the storage reservoir(s) that can supply water to that reach. Note that the division of Reach 1 into sub-reaches is for the WBR Feasibility report only.

Reach	Tributary or River	Reservoirs that Apply
Reach 1	Willamette River (from confluence with the Santiam River to the Columbia River)	HCR, LOP, FAL, COT, DOR, CGR, BLU, FRN, GPR, FOS, & DET
Reach 1a	Willamette River (Willamette Falls to Columbia River)	
Reach 1b	Willamette River (Salem to Willamette Falls)	
Reach 1c	Willamette River (Santiam River to Salem)	
Reach 2	Santiam River	GPR, FOS, DET
Reach 3	North Santiam River	DET
Reach 4	South Santiam River	GPR & FOS
Reach 5	Willamette River	HCR, LOP, FAL, COT, DOR, CGR, BLU, & FRN
Reach 6	Long Tom River	FRN
Reach 7	Willamette River	HCR, LOP, FAL, COT, DOR, CGR, & BLU
Reach 8	McKenzie River	CGR & BLU
Reach 9	MF Willamette River	HCR, LOP, FAL, COT, & DOR
Reach 10	MF Willamette River	HCR, LOP, & FAL
Reach 11	MF Willamette River	HCR & LOP
Reach 12	Fall Creek	FAL
Reach 13	CF Willamette River	COT & DOR
Reach 14	Row River	DOR
Reach 15	CF Willamette River	COT

*Note: Big Cliff (BCL) and Dexter (DEX) not included as these reservoirs do not contain conservation storage.

3.1 Reduced Diversions in Lower Water Years in the WBR Simulations

The WBR Feasibility Report proposes guidelines for managing stored water in times of shortages. In higher water years, the Corps can meet the BiOp minimum flow targets in the basin for fish and wildlife and the 2008 levels of BOR irrigation contracts, and live flows are high enough to meet permitted live M&I contract use in 2008. However, the WBR recommended water management plan will also include an operational strategy for lower water years.

The main study report outlines the recommended water management strategy for reservoir regulation in the basin after the reallocation of storage space occurs. The strategy applies when reservoirs only partially fill or inflows are low and involves spreading the shortage of water supply among the allocated storage types. The general idea is that when there is not enough stored water to meet the full needs of all uses, then fish and wildlife, M&I, and AI would all receive equal percentage cuts. The M&I and AI reductions are represented in ResSim by decreased stored water releases and diversion withdrawals, and the reductions to fish and wildlife are represented by reduced BiOp minimum targets in Deficit and Insufficient water years.

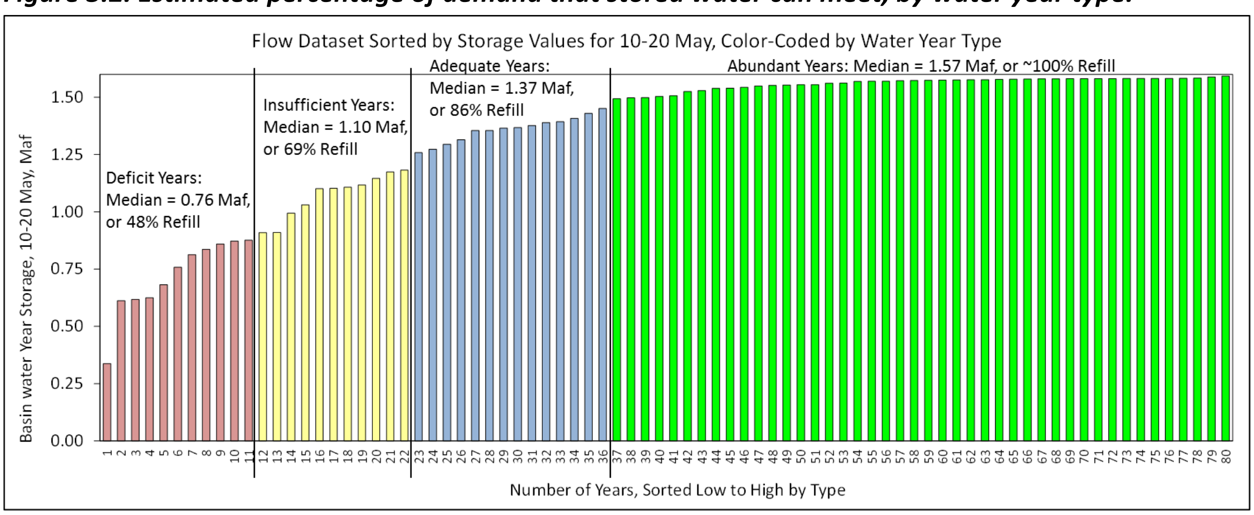
Although the recommended water management strategy would actually be based on a given year's current and forecasted hydrologic conditions and the most beneficial overall regulation consistent with that year's conservation plan, it is not feasible to model each year differently in ResSim. The WBR simulations will instead represent the water management strategy by using water year types.

The percentage reductions in demand for Adequate, Insufficient, and Deficit water years were obtained by using the data in Table 3.1 of Appendix C, "WBR – Calculation of Water Volumes Required to Meet Willamette BiOp Minimum Flows for April through October". That table presented the total basin conservation storage maximum value for 10-20 May each year in the flow dataset to classify each year by type, as described in the 2008 NMFS BiOp. The mid-May storage values for each year type were grouped together and sorted from low to high values in the graph below, Figure 3.2. These values are characterized by the following:

- Abundant water years in the flow dataset have a median value of 1.57 Maf for their 10-20 May conservation storage. This value is approximately 100% of refill.
- Adequate water years in the flow dataset have a median value of 1.37 Maf for their 10-20 May conservation storage. This value is 86% of the refill storage.
- Insufficient water years in the flow dataset have a median value of 1.10 Maf for their 10-20 May conservation storage. This value is 69% of the refill storage.
- Deficit water years in the flow dataset have a median value of 0.76 Maf for their 10-20 May conservation storage. This value is 48% of the refill storage.

The recommended water management strategy is to supply 100% of the Table 3.4 demands in Abundant water years, 86% of those demands in Adequate, 69% of those demands in Insufficient years, and 48% of those demands in Deficit years.

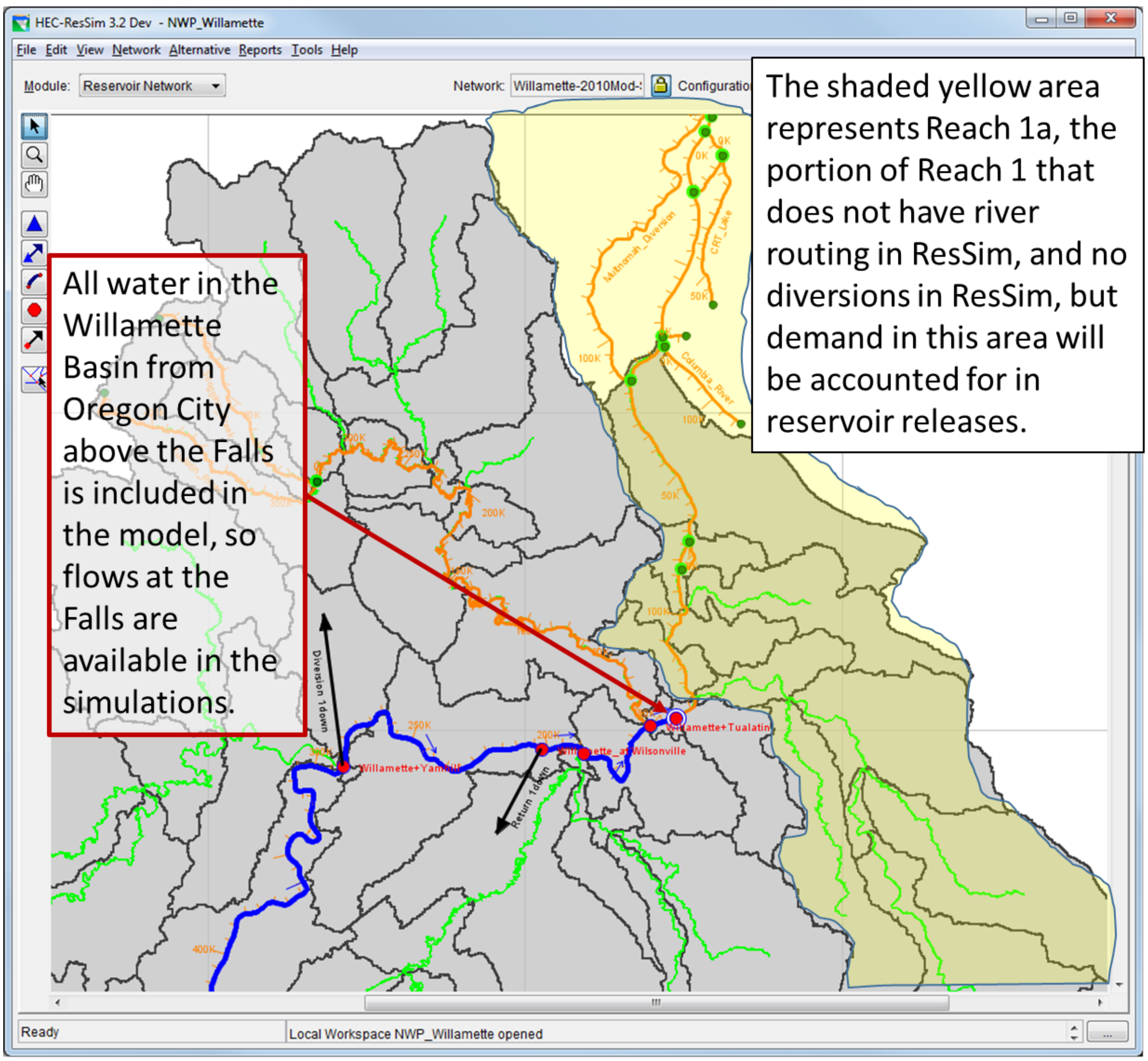
Figure 3.2. Estimated percentage of demand that stored water can meet, by water year type.



3.2 Diverted Flows in the WBR Simulations

There are 16 diversions in the WBR Network that represent demand, for Reaches 2 through 15 and the two Sub-Reaches 1b and 1c. Reach 1a is below Willamette Falls, and that reach is not modeled in the watershed (See Appendix E). The stored water released for Reach 1a is included in the operation set rules described in later sections, but the diversion for the demand in that sub-reach is not included in the model. The area not included in the model is shown in yellow in Figure 3.3. Note all water to the Falls itself is included, so flows at Oregon City above the Falls are available in the simulations.

Figure 3.3. The WBR network does not have any diversions in Reach 1a, Willamette River from Willamette Falls at Oregon City to the confluence with the Columbia River. This area of the watershed is roughly shaded in the figure below. Note that the watershed does not include sub-basins all the way to the Columbia, which were not necessary to add since no routings were used. Note that Oregon City above the Falls, and all inflows to that location, are included in the model. Willamette River flows at the Falls are available from the simulations.



Each diversion in ResSim is a flexible rule type where the amount of water pulled from the reach is dependent on two factors, the month of the year and the water year type. (Note that Section 3.1 outlined the use of water year type reductions in demand, a ResSim modeling simplification of the recommended water management strategy, instead of modelling every year in the flow dataset differently.) The water year types (Abundant, Adequate, Insufficient, and Deficit) were defined in Section 2.2 of Appendix E, the Baseline Model Documentation Report, with each year specifically identified in Table 2.4 of that report. An external file in the ResSim watershed (*Water Year Type for 2010 Mod Flows.dss*) is read by the program to determine the water year type of the current time step. This file contains a time series record with every day of each year having the value of stored water listed in Table 2.4 of the Model Documentation Report.

Flow withdrawals –The diversions in ResSim are flows, not volumes. The conversion calculation for volume to flow is:

$$\textit{Volume (ac-ft)} * 43560\ (ft^3/ac\text{-}ft) / [\#\ days * 24\ (hrs/day) * 3600\ (sec/hr)] = flow\ (ft^3/sec)$$

Return flows–Withdrawals for both M&I and AI have returns to the system associated with them. These returns are accounted for in the WBR simulation as well. It is estimated that 55% of the withdrawn M&I volume is returned (GSI memo, dated 7/16/2013). The M&I return estimate is simplified in the model to be on the same day as the water was withdrawn. The return volume is converted to flow using the same equation as above.

The AI return flows were estimated the same way as the 2010 Level Modified Streamflows estimated return flows for the Willamette River basin, which is 20% of the irrigation volume withdrawn in a reach returned to that reach. Distribution of the returned 20% volume was spread throughout the year as a shaped return rather than a flat rate (see the 2010 Level Modified Streamflow report):

- 4% of the 20% of AI volume is returned each month in December through April,
- 5% of the 20% of AI volume is returned in May,
- 12% of the 20% of AI volume is returned in June,
- 17% of the 20% of AI volume is returned in July,
- 18% of the 20% of AI volume is returned in August,
- 13% of the 20% of AI volume is returned in September,
- 9% of the 20% of AI volume is returned in October,
- and 6% of the 20% of AI volume returned is in November.

These monthly percentages sum to 100%, but it is 100% of the 20% volume that is returned. The 20% return is based on assuming most irrigation is from sprinklers in the Willamette, as documented in the 2010 Level Modified Streamflows report.

The return flows are given a negative sign in ResSim since they will actually be input as diversions, but the negative diversion in ResSim means that flow is being added to the river.

3.3 Diversions in the WBR Simulation

Each of the reaches listed in Table 3.5 has a flow withdrawal rule and a return flow rule associated with it, with the rule names summarized in Table 3.6. These rule names are the same for all the WBR simulations, but the flow values used in the rules will vary for each simulation. Sections 6 through 10 document both diversions and returns for each simulation.

Table 3.6. Summary of river reach flow withdrawal and return flow rule names in the ARP simulation.

Reach	Flow Withdrawal Rule Name	Return Flow Rule Name
Reach 1		
Reach 1a	N/A	N/A
Reach 1b	Diversion 1down	Return 1down
Reach 1c	Diversion 1up	Return 1up
Reach 2	Diversion 2	Return 2
Reach 3	Diversion 3	Return 3
Reach 4	Diversion 4	Return 4
Reach 5	Diversion 5	Return 5
Reach 6	Diversion 6	Return 6
Reach 7	Diversion 7	Return 7
Reach 8	Diversion 8	Return 8
Reach 9	Diversion 9	Return 9
Reach 10	Diversion 10	Return 10
Reach 11	Diversion 11	Return 11
Reach 12	Diversion 12	Return 12
Reach 13	Diversion 13	Return 13
Reach 14	Diversion 14	Return 14
Reach 15	Diversion 15	Return 15

4 Reservoir Regulation Changes from the Baseline for all the WBR Simulations

Section 4 of the Model Documentation Report described a number of different types of rules and parameters used in the Baseline simulation at each dam. The only changes in the WBR simulations from the Baseline in the project rule sets are in the minimum project outflows, which need to release more water to cover the diversions from stored water contracts. Below is a summary of the specific categories that are the same as the Baseline.

- Reservoir zones and rule curves
- Reregulating dams – they just pass inflow from upstream dams
- Preferred release outlets at all projects
- All rules related to minimum gate openings and outlet capacities
- Induced surcharge rules
- Downstream maximum flow rules (all Flood Risk Management rules stay the same)
- Control points on the Willamette River mainstem, Albany and Salem, have the BiOp minimum flow targets for supplemental flows from upstream reservoirs – in other words, the fish and wildlife flow targets remain the same for both watersheds, and are modeled in the same way
- Ramping rate rules and rate of change rules
- Maximum outflow rules at all projects

The minimum project outflows used for each project in the Baseline simulation, documented in the Model Documentation Report (Appendix E), represent the BiOp tributary minimum flows. Two projects, Detroit and Fern Ridge, also included some specific irrigation releases in addition to the minimum tributary flows, which were for the 2008 level of BOR contracts on Reach 3 for Detroit and Reach 6 for Fern Ridge. All five WBR simulations include diversions for increased M&I and irrigation demand, so the minimum project outflows must increase from those of the Baseline to accommodate the release of stored water to cover increases in Ag and M&I stored water contracts.

5 Project Operation Set Rule Changes from the Baseline

The project specific Sub-Sections 5.1 through 5.11 show screen shots of each Baseline project operation set and the WBR project operation set with red arrows indicating differences between the Baseline and WBR simulations. Each project sub-section contains a table summarizing the differences. Note in particular that the downstream minimum flow rules at Salem and Albany (the BiOp mainstem targets) do not change between the Baseline and the WBR simulations – all BiOp targets are the same in both watersheds.

5.1 Blue River

Figure 5.1. ResSim Screen Shots of the Blue River operation set used for the Baseline simulation on the left and all WBR simulations on the right. The red arrows indicate the rules in the WBR network that are different than those from the Baseline.

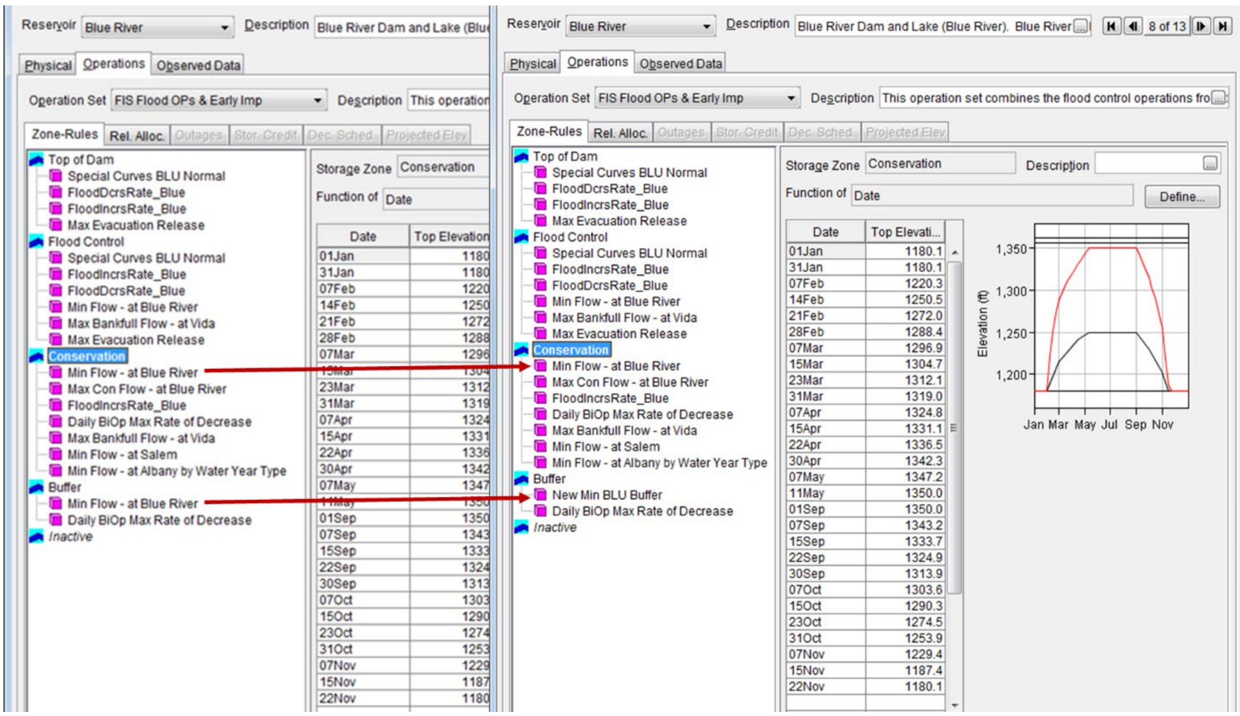


Table 5.1. Differences between watersheds for Blue River.

Watershed	Baseline	WBR
Operation Set Name:	FIS Flood OPs & Early Imp	FIS Flood OPs & Early Imp
Conservation Zone min outflow rule name:	Min Flow – at Blue River	Min Flow – at Blue River
Conservation Zone min outflow rule value:	BiOp minimum tributary flow	BiOp minimum tributary flow + more* based on water year type
Buffer Zone min outflow rule name:	Min Flow – at Blue River	New Min BLU Buffer
Buffer Zone min outflow rule value:	BiOp minimum tributary flow	BiOp minimum tributary flow + more* based on Deficit water year

**The amount of additional water specified in the release is different for each WBR simulation, and is defined for those simulations in Sections 6 through 10.*

5.2 Cougar

Figure 5.2. ResSim Screen Shots of the Cougar operation set used for the Baseline simulation on the left and all WBR simulations on the right. The red arrows indicate the rules in the WBR network that are different than those from the Baseline.

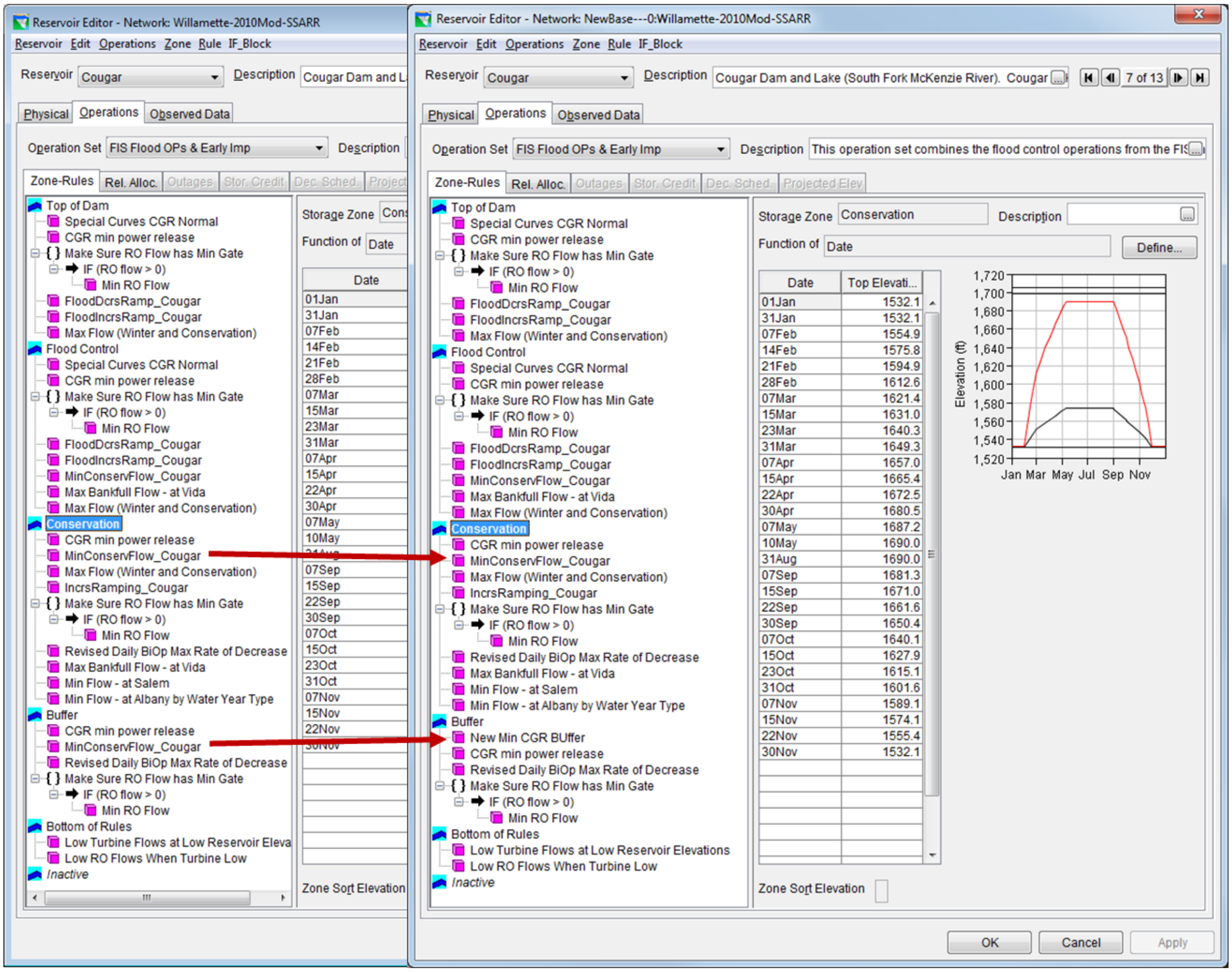


Table 5.2. Differences between watersheds for Cougar.

Watershed	Baseline	WBR
Operation Set Name:	FIS Flood OPs & Early Imp	FIS Flood OPs & Early Imp
Conservation Zone min outflow rule name:	MinConservflow_Cougar	MinConservflow_Cougar
Conservation Zone min outflow rule value:	BiOp minimum tributary flow	BiOp minimum tributary flow + more* based on water year type
Buffer Zone min outflow rule name:	MinConservflow_Cougar	New Min CGR BUffer
Buffer Zone min outflow rule value:	BiOp minimum tributary flow	BiOp minimum tributary flow + more* based on Deficit water year

**The amount of additional water specified in the release is different for each WBR simulation, and is defined for those simulations in Sections 6 through 10.*

5.3 Dorena

Figure 5.3. ResSim Screen Shots of the Dorena operation set used for the Baseline simulation on the left and all WBR simulations on the right. The red arrows indicate the rules in the WBR network that are different than those from the Baseline.

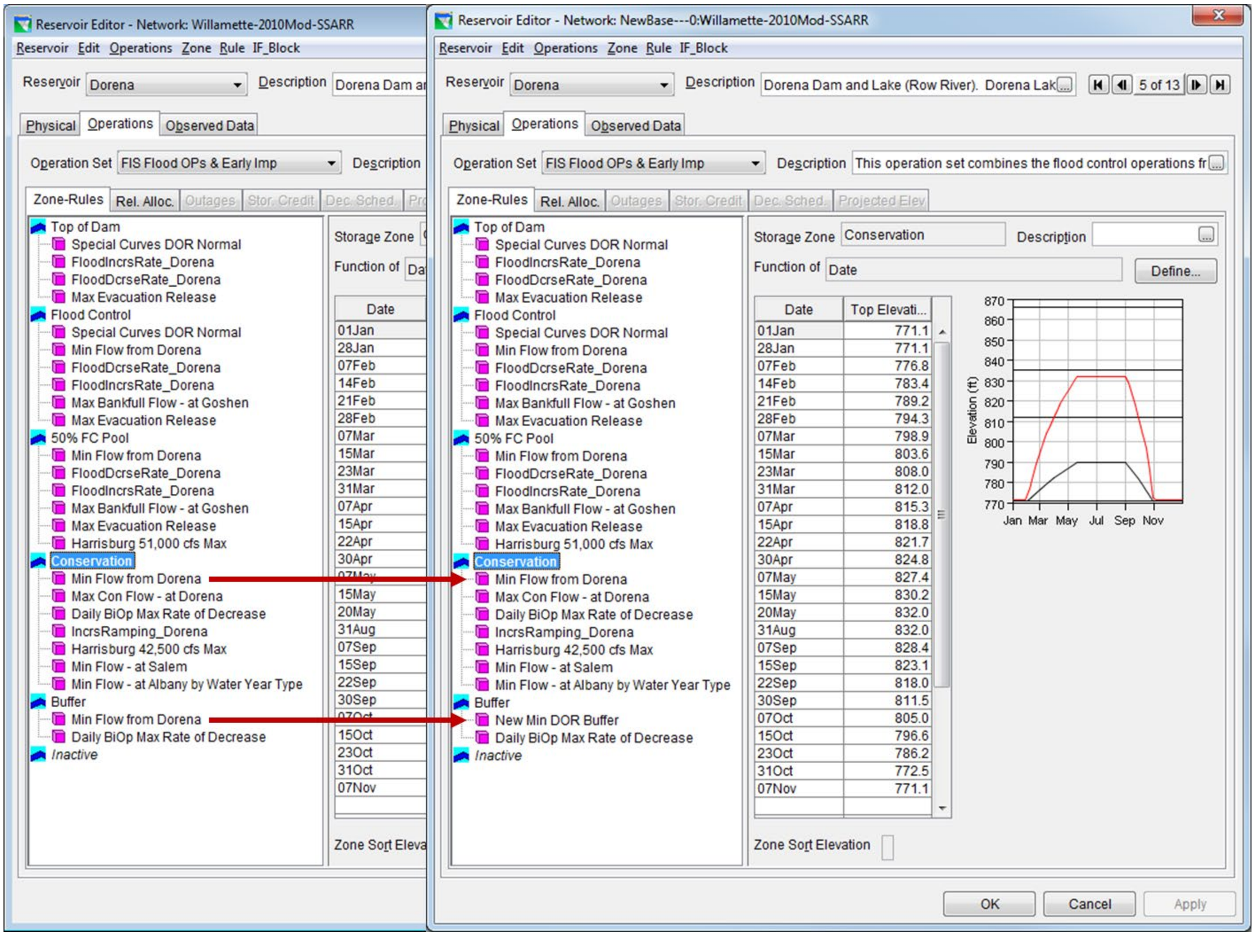


Table 5.3. Differences between watersheds for Dorena.

Watershed	Baseline	WBR
Operation Set Name:	FIS Flood OPs & Early Imp	FIS Flood OPs & Early Imp
Conservation Zone min outflow rule name:	Min Flow from Dorena	Min Flow from Dorena
Conservation Zone min outflow rule value:	BiOp minimum tributary flow	BiOp minimum tributary flow + more* based on water year type
Buffer Zone min outflow rule name:	Min Flow from Dorena	New Min DOR Buffer
Buffer Zone min outflow rule value:	BiOp minimum tributary flow	BiOp minimum tributary flow + more* based on Deficit water year

**The amount of additional water specified in the release is different for each WBR simulation, and is defined for those simulations in Sections 6 through 10.*

5.4 Cottage Grove

Figure 5.4. ResSim Screen Shots of the Cottage Grove operation set used for the Baseline simulation on the left and all WBR simulations on the right. The red arrows indicate the rules in the WBR network that are different than those from the Baseline.

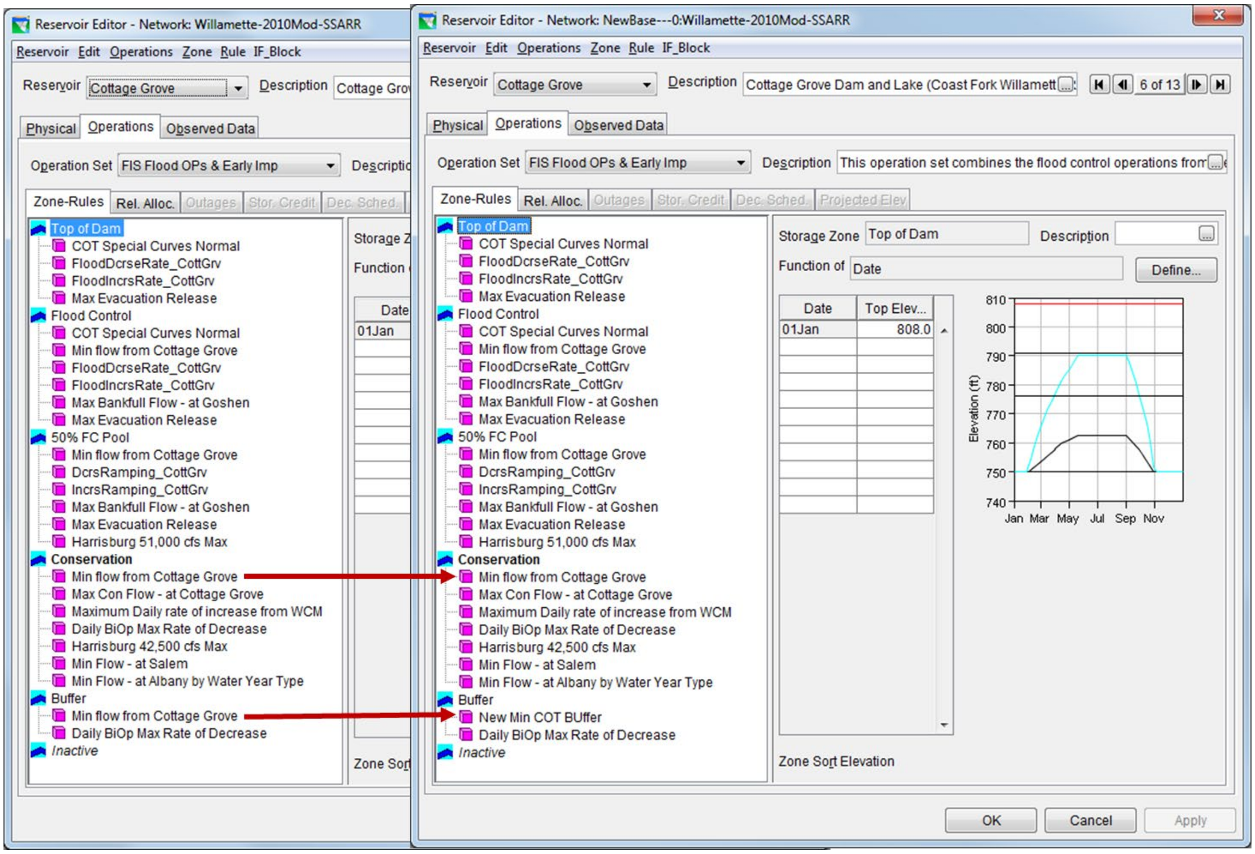


Table 5.4. Differences between watersheds for Cottage Grove.

Watershed	**Baseline**	**WBR**
Operation Set Name:	FIS Flood OPs & Early Imp	FIS Flood OPs & Early Imp
Conservation Zone min outflow rule name:	Min Flow from Cottage Grove	Min Flow from Cottage Grove
Conservation Zone min outflow rule value:	BiOp minimum tributary flow	BiOp minimum tributary flow + more* based on water year type
Buffer Zone min outflow rule name:	Min Flow from Cottage Grove	New Min COT BUffer
Buffer Zone min outflow rule value:	BiOp minimum tributary flow	BiOp minimum tributary flow + more* based on Deficit water year

**The amount of additional water specified in the release is different for each WBR simulation, and is defined for those simulations in Sections 6 through 10.*

5.5 Fall Creek

Figure 5.5. ResSim Screen Shots of the Fall Creek operation set used for the Baseline simulation on the left and all WBR simulations on the right. The red arrows indicate the rules in the WBR network that are different than those from the Baseline.

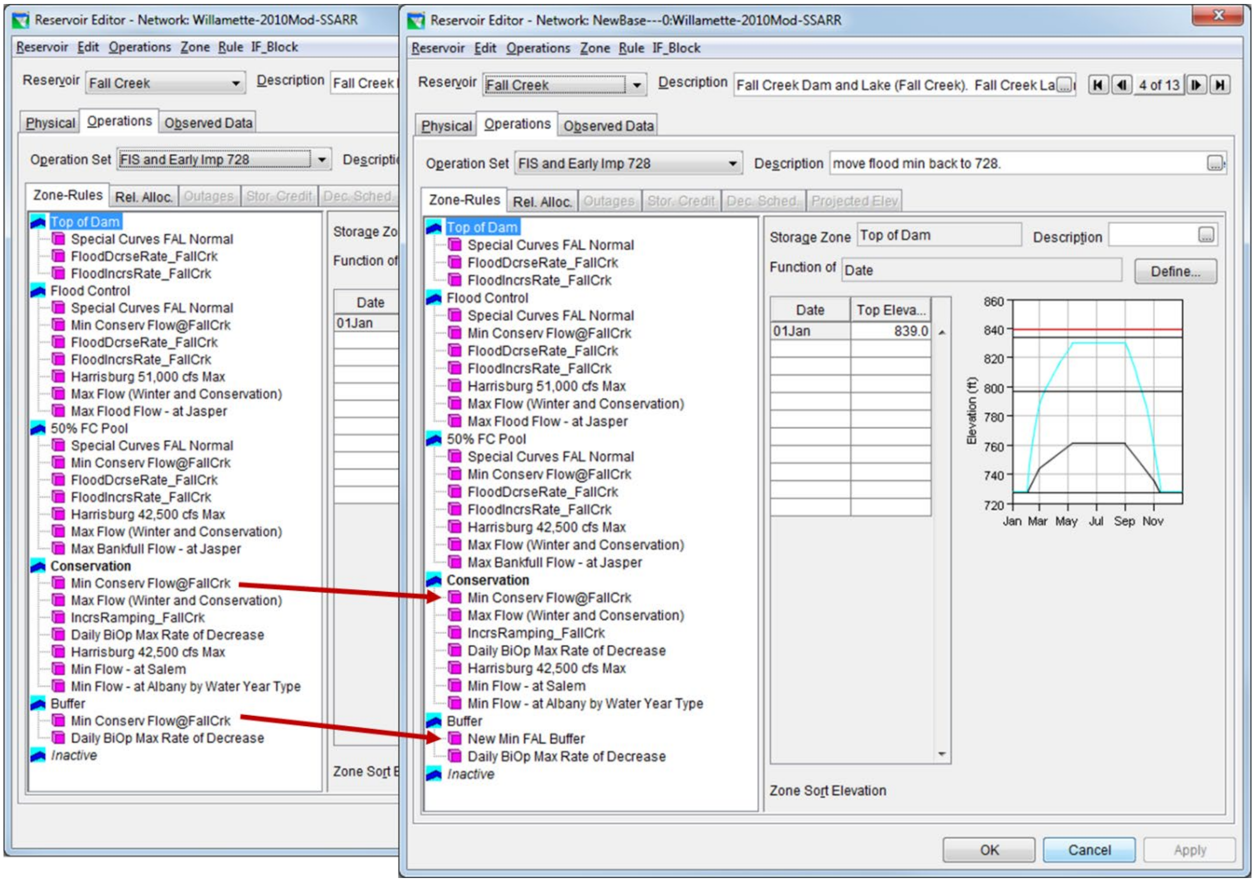


Table 5.5. Differences between watersheds for Fall Creek.

Watershed	**Baseline**	**WBR**
Operation Set Name:	FIS and Early Imp 728	FIS and Early Imp 728
Conservation Zone min outflow rule name:	MinConservflow@FallCrk	MinConservflow@FallCrk
Conservation Zone min outflow rule value:	BiOp minimum tributary flow	BiOp minimum tributary flow + more* based on water year type
Buffer Zone min outflow rule name:	MinConservflow@FallCrk	New Min FAL Buffer
Buffer Zone min outflow rule value:	BiOp minimum tributary flow	BiOp minimum tributary flow + more* based on Deficit water year

**The amount of additional water specified in the release is different for each WBR simulation, and is defined for those simulations in Sections 6 through 10.*

5.6 Hills Creek

Figure 5.6. ResSim Screen Shots of the Hills Creek operation set used for the Baseline simulation on the left and all WBR simulations on the right. The red arrows indicate the rules in the WBR network that are different than those from the Baseline.

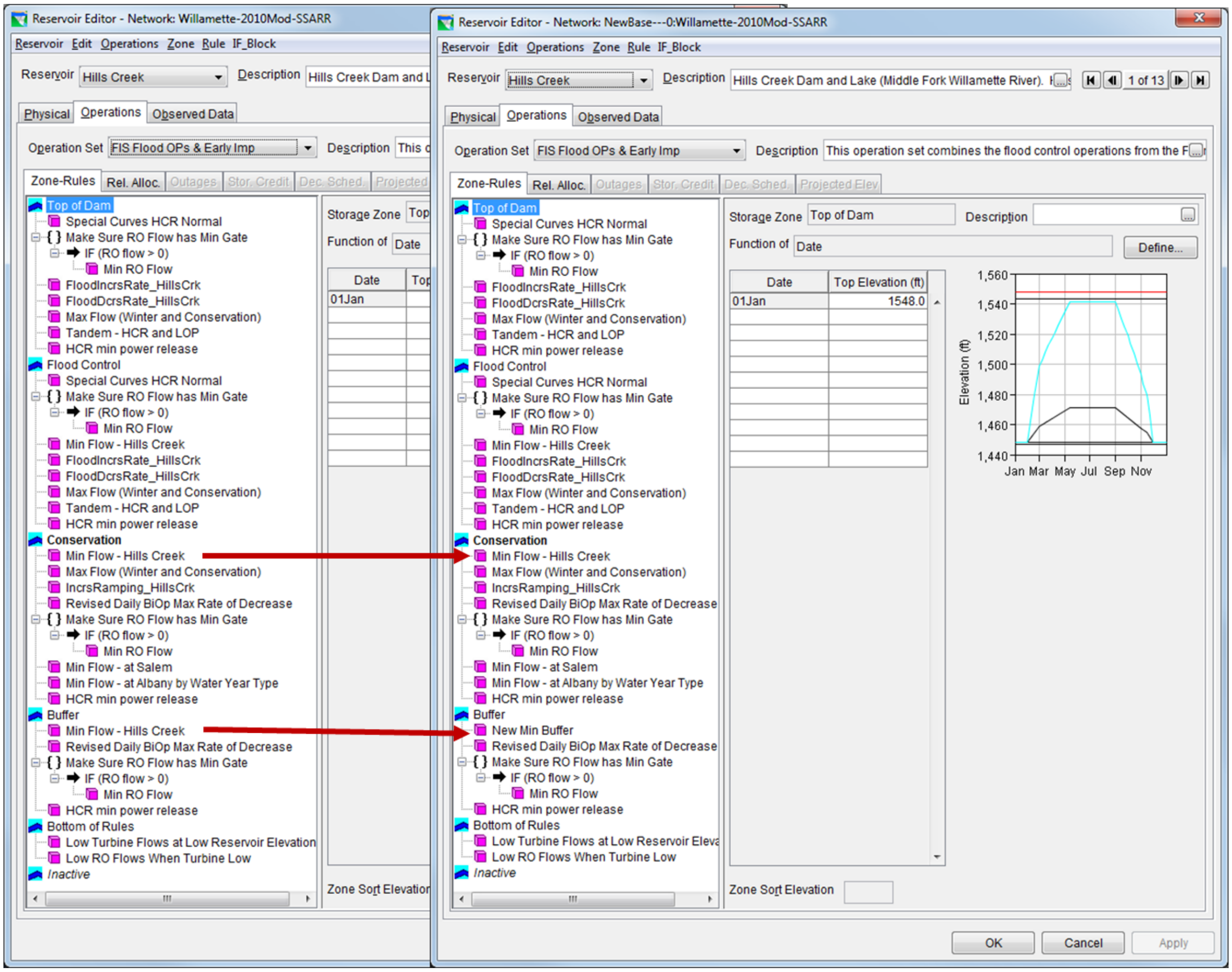


Table 5.6. Differences between watersheds for Hills Creek.

Watershed	Baseline	WBR
Operation Set Name:	FIS Flood OPs & Early Imp	FIS Flood OPs & Early Imp
Conservation Zone min outflow rule name:	Min Flow – Hills Creek	Min Flow – Hills Creek
Conservation Zone min outflow rule value:	BiOp minimum tributary flow	BiOp minimum tributary flow + more* based on water year type
Buffer Zone min outflow rule name:	Min Flow – Hills Creek	New Min Buffer
Buffer Zone min outflow rule value:	BiOp minimum tributary flow	BiOp minimum tributary flow + more* based on Deficit water year

**The amount of additional water specified in the release is different for each WBR simulation, and is defined for those simulations in Sections 6 through 10.*

5.7 Lookout Point

Figure 5.7. ResSim Screen Shots of the Lookout Point operation set used for the Baseline simulation on the left and all WBR simulations on the right. The red arrows indicate the rules in the WBR network that are different than those from the Baseline.

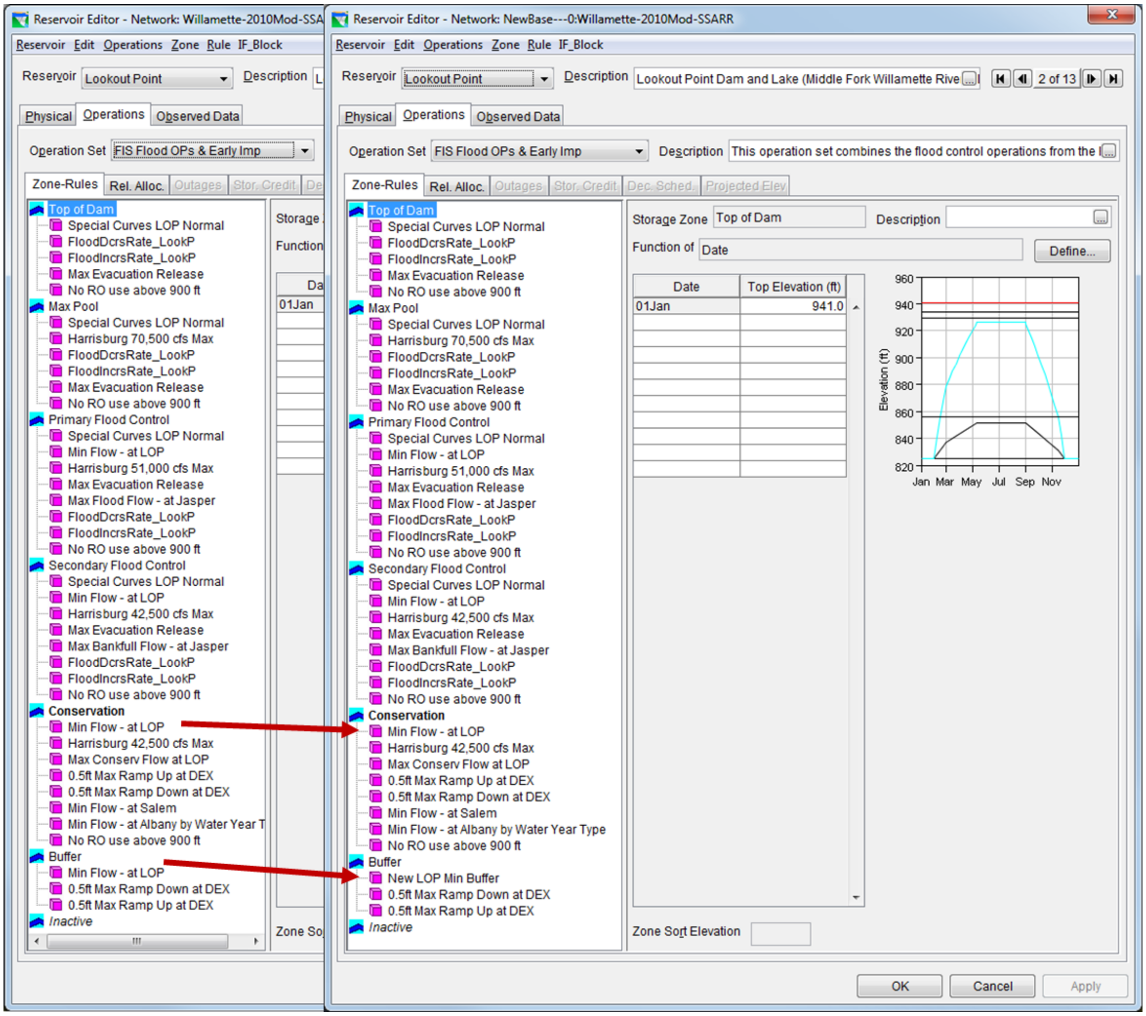


Table 5.7. Differences between watersheds for Lookout Point.

Watershed	Baseline	WBR
Operation Set Name:	FIS Flood OPs & Early Imp	FIS Flood OPs & Early Imp
Conservation Zone min outflow rule name:	Min Flow – at LOP	Min Flow – at LOP
Conservation Zone min outflow rule value:	BiOp minimum tributary flow	BiOp minimum tributary flow + more* based on water year type
Buffer Zone min outflow rule name:	Min Flow – at LOP	New LOP Min Buffer
Buffer Zone min outflow rule value:	BiOp minimum tributary flow	BiOp minimum tributary flow + more* based on Deficit water year

**The amount of additional water specified in the release is different for each WBR simulation, and is defined for those simulations in Sections 6 through 10.*

5.8 Fern Ridge

Figure 5.8. ResSim Screen Shots of the Fern Ridge operation set used for the Baseline simulation on the left and all WBR simulations on the right. The red arrows indicate the rules in the WBR network that are different than those from the Baseline.

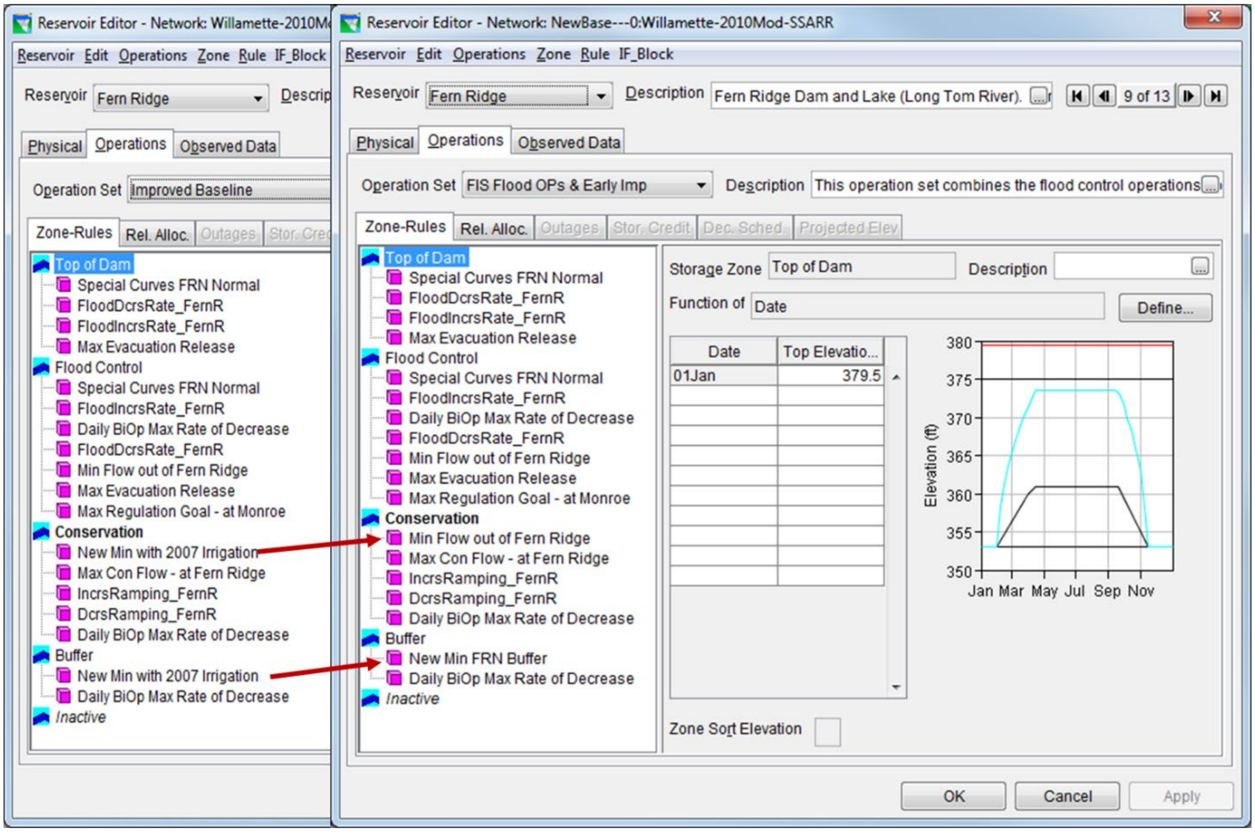


Table 5.8. Differences between watersheds for Fern Ridge.

Watershed	Baseline	WBR
Operation Set Name:	Improved Baseline	FIS Flood OPs & Early Imp
Conservation Zone min outflow rule name:	New Min with 2007 irrigation	Min Flow out of Fern Ridge
Conservation Zone min outflow rule value:	BiOp minimum tributary flow + more for 2008 level BOR contracts on Reach 6	BiOp minimum tributary flow + more for 2008 level BOR contracts on Reach 6 + more* based on water year type
Buffer Zone min outflow rule name:	New Min with 2007 irrigation	New Min FRN Buffer
Buffer Zone min outflow rule value:	BiOp minimum tributary flow + more for 2008 level BOR contracts on Reach 6	BiOp minimum tributary flow + more for 2008 level BOR contracts on Reach 6 + more* based on Deficit water year

**The amount of additional water specified in the release is different for each WBR simulation, and is defined for those simulations in Sections 6 through 10.*

5.9 Green Peter

Figure 5.9. ResSim Screen Shots of the Green Peter operation set used for the Baseline simulation on the left and all WBR simulations on the right.

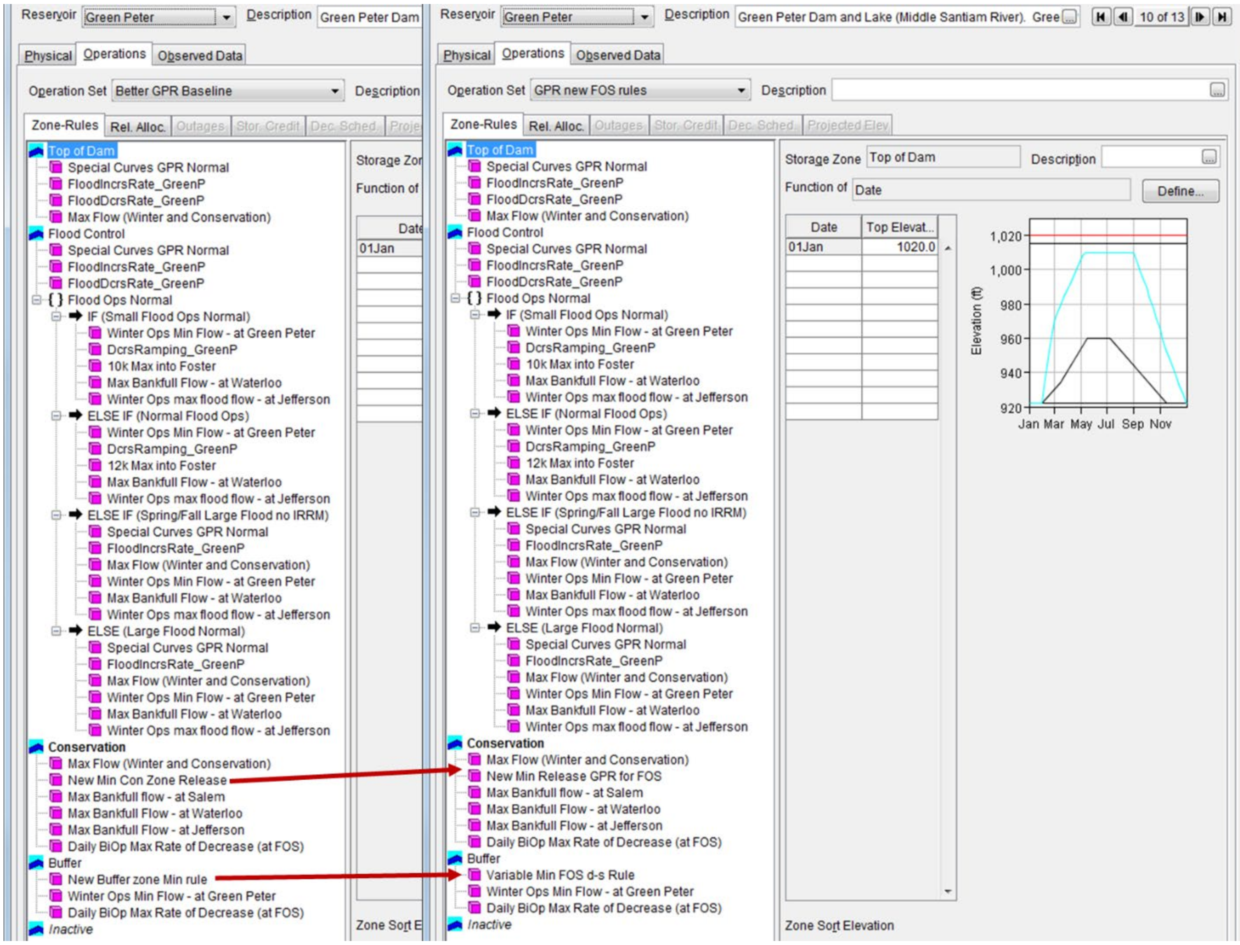


Table 5.9. Differences between watersheds for Green Peter**.

Watershed	Baseline	WBR
Operation Set Name:	Better GPR Baseline	GPR new FOS rules
Conservation Zone min outflow rule name:	New Min Con Zone Release	New Min Release GPR for FOS
Conservation Zone min outflow rule value:	Downstream min rule for FOS outflow to be the BiOp minimum tributary flow	Downstream min rule for FOS outflow to be the BiOp minimum tributary flow + more* based on water year type
Buffer Zone min outflow rule name:	New Buffer zone Min rule	Variable Min FOS d-s Rule
Buffer Zone min outflow rule value:	GPR releases BiOp minimum tributary flow so FOS can pass it	Downstream min rule for FOS outflow to be the BiOp minimum tributary flow + more* based on Deficit water year

**The amount of additional water specified in the release is different for each WBR simulation, and is defined for those simulations in Sections 6 through 10.*

***Foster's share of withdrawals are incorporated into Green Peter's share, and Foster rules just pass Green Peters inflows in most cases. This modeling choice is unique among the eleven storage projects, and was modeled this way to better represent conservation season operations at Foster.*

5.10 Foster

Figure 5.10. ResSim Screen Shots of the Foster operation set used for the Baseline simulation on the left and all WBR simulations on the right. The red arrows indicate the rules in the WBR network that are different than those from the Baseline.

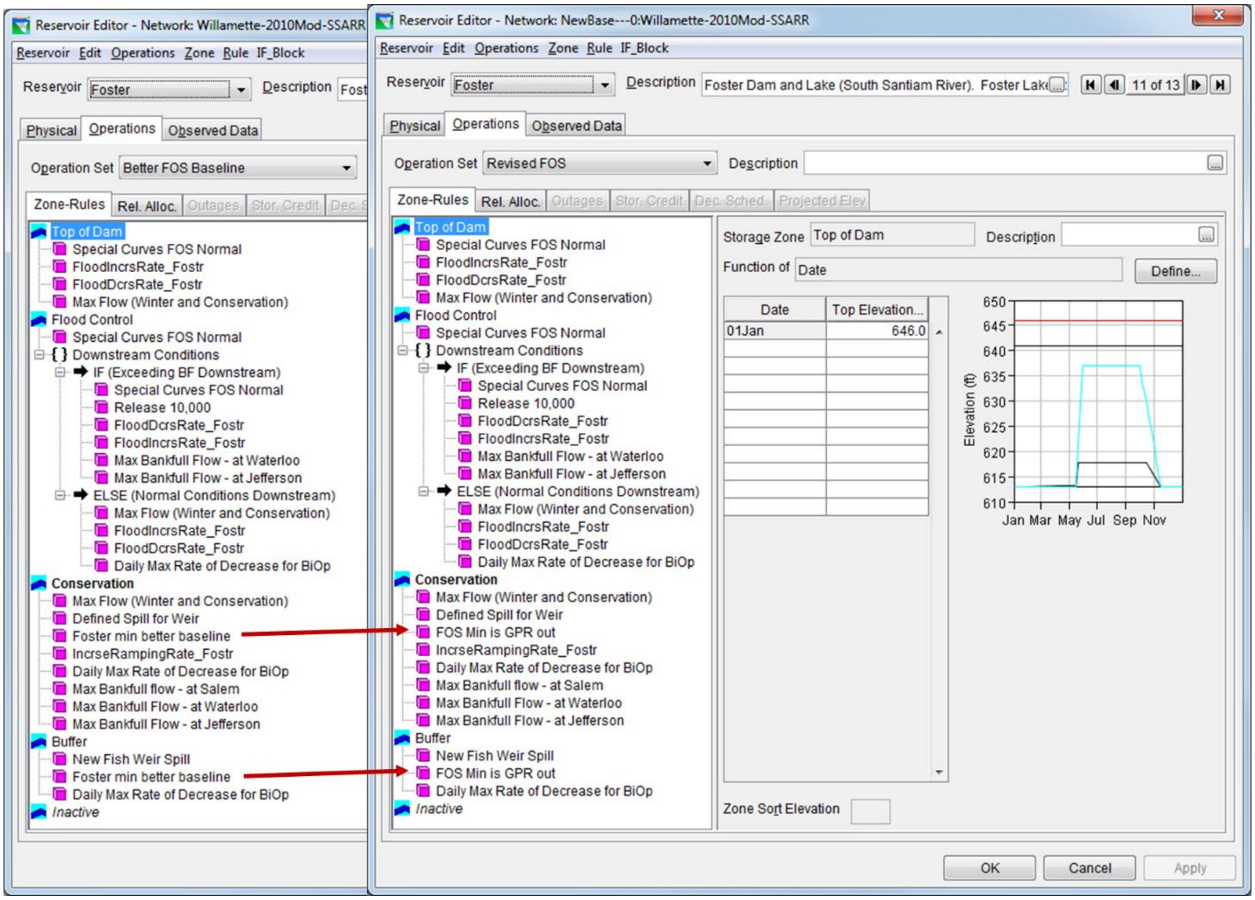


Table 5.10. Differences between watersheds for Foster**.

Watershed	**Baseline**	**WBR**
Operation Set Name:	Better FOS Baseline	Revised FOS
Conservation Zone min outflow rule name:	Foster min better baseline	FOS Min is GPR out
Conservation Zone min outflow rule value:	FOS releases a min equal to GPR outflow, which includes the BiOp minimum tributary flow	FOS releases a min equal to GPR outflow, which includes the BiOp minimum tributary flow + more* based on water year type
Buffer Zone min outflow rule name:	Foster min better baseline	FOS Min is GPR out
Buffer Zone min outflow rule value:	FOS releases a min equal to GPR outflow, which includes the BiOp minimum tributary flow	FOS releases a min equal to GPR outflow, which includes the BiOp minimum tributary flow + more* based on Deficit water year

**The amount of additional water specified in the release is different for each WBR simulation, and is defined for those simulations in Sections 6 through 10.*

***See note for Green Peter for special modeling that applies to Green Peter and Foster.*

5.11 Detroit

Figure 5.11. ResSim Screen Shots of the Detroit operation set used for the Baseline simulation on the left and all WBR simulations on the right. The red arrows indicate the rules in the WBR network that are different than those from the Baseline.

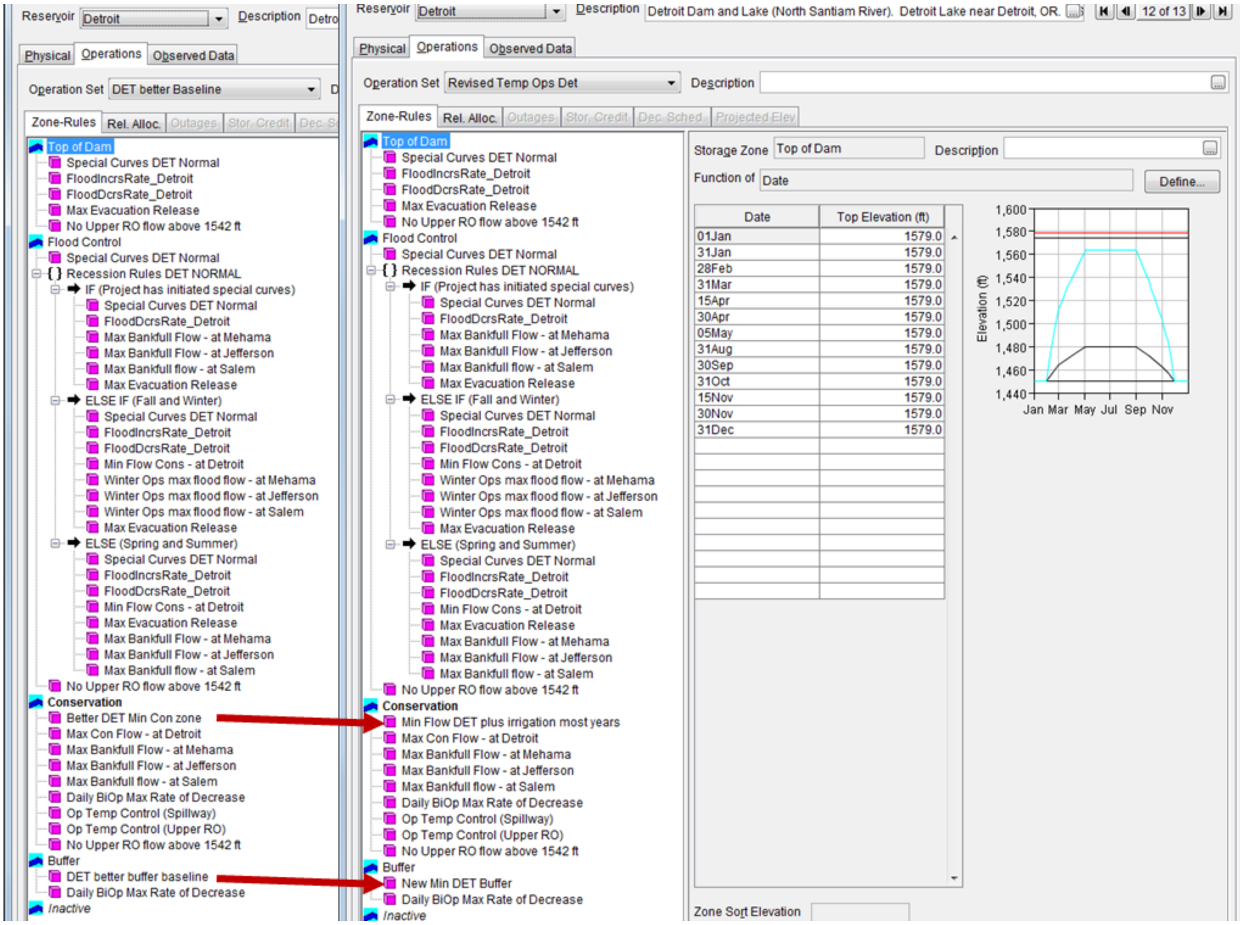


Table 5.11. Differences between watersheds for Detroit.

Watershed	**Baseline**	**WBR**
Operation Set Name:	DET better Baseline	Revised Temp Ops Det
Conservation Zone min outflow rule name:	Better DET Min Con zone	Min Flow DET plus irrigation most years
Conservation Zone min outflow rule value:	BiOp minimum tributary flow + more for 2008 level BOR contracts on Reach 3	BiOp minimum tributary flow + more for 2008 level BOR contracts on Reach 3 + more* based on water year type
Buffer Zone min outflow rule name:	DET better buffer baseline	New Min DET Buffer
Buffer Zone min outflow rule value:	BiOp minimum tributary flow + more for 2008 level BOR contracts on Reach 3. September values lower than when in Con zone.	BiOp minimum tributary flow + more for 2008 level BOR contracts on Reach 3 + more* based on Deficit water year, lower Sep mins

**The amount of additional water specified in the release is different for each WBR simulation, and is defined for those simulations in Sections 6 through 10.*

6 Base Year 2020 ResSim Analysis

The simulation name for this analysis is ***Base-Year-2020-29Aug2017*** (see Table 1.1 for all other specifics for the simulation).

6.1 Diversions and Return Flows

Table 3.1 shows a total increase in Willamette Basin demands of 49,175 ac-ft from 2008 levels to reach the Base Year of 2020. The total increase was from three categories (see tables referenced from Appendix F):

- an increase in BOR stored water contracts (22,854 ac-ft) (Table AI 1),
- an increase in M&I use from live flow permits that were already in place in 2008, but not fully utilized, for June through September (18,780 ac-ft) (Table MI 1),
- and an increase in M&I use from live flow permits that were already in place in 2008, but not fully utilized, for April through May (7541 ac-ft) (Table MI 2).

The AI demand increases from Table AI 1 of Appendix F are shown here in Table 6.1a. The irrigation demands developed for the WBR were for May through September, while the irrigation demand embedded within the flow dataset is for April through October. Both distributions are shown for total irrigation volumes in Table 6.1b. The monthly percentages of demand distribution from the 2010 Modified Flows (left side of Table 6.1b, from Table 5.2 in Appendix D) were applied to each reach of Table 6.1a to give an April through October distribution for the irrigation demand for the Base Year 2020, shown in Table 6.2. This re-distribution of irrigation demand was to use the same return flow shaping that was used in the 2010 Modified Flows.

Table 6.3 lists the increases in M&I demand from 2008 levels to the year 2020, with the June through September values repeated from Table MI 1 and the April and May values repeated from Table MI 2, both from Appendix F.

Table 6.4 is the total diversion volume by reach and month for the Base Year 2020, which is the sum of Tables 6.2 and 6.3. These diversion volumes are converted to daily flow rates as described in Section 3.2, with the diverted flow values listed for each reach and month in Table 6.5. The flows for each reach and month in Table 6.5 are input to the diversion rules in the WBR network, where the rule names for each reach are shown in Table 3.6 under the heading "Flow Withdrawal Rule Name".

Return flows were calculated using the reach Total volumes in Tables 6.2 and 6.3 and the monthly return percentages listed in Table 6.6. For example, M&I April return volume for Reach 1b = Reach 1b Total Diversion Volume (Table 6.3) * 55% (Annual return percentage) * 13% (April return percentage). The volume is then converted to flow in cfs using the equation: Flow (cfs) = Volume (acre-feet) * (43560/days in month/24/3600). Note that return flows in ResSim are still diversions, so the negative sign in the diversion results in an inflow for each reach. The return flows for each reach and month in Table 6.7 are input to the diversion rules in the WBR network, where the rule names for each reach are shown in Table 3.6 under the heading "Return Flow Rule Name".

Note that the Base Year 2020 simulation does not make any diversion reductions based on water year type, as described in Section 3.1, since currently the system is not operated according to the recommended water management strategy.

Table 6.1a. The incremental increases in BOR irrigation contracts from stored water between 2008 and 2020, from Table AI 1 in Appendix F.

Reach	Increased AI Demand Volume in acre-feet					
	May	**June**	**July**	**August**	**September**	**Total**
Reach 1	682	1359	2242	1791	891	6964
Reach 1a	30	59	98	78	39	305
Reach 1b	524	1044	1723	1376	685	5352
Reach 1c	128	255	421	336	167	1307
Reach 2	7	14	24	19	9	74
Reach 3	340	677	1117	893	444	3471
Reach 4	27	54	90	72	36	279
Reach 5	466	929	1533	1224	609	4761
Reach 6	589	1174	1937	1547	770	6016
Reach 7	22	45	74	59	29	229
Reach 8	53	106	174	139	69	541
Reach 9	0	0	0	0	0	0
Reach 10	27	54	89	71	36	278
Reach 11	3	5	9	7	4	28
Reach 12	0	1	1	1	0	3
Reach 13	17	35	57	46	23	177
Reach 14	2	3	5	4	2	16
Reach 15	2	3	6	4	2	17
Total all Reaches	2236	4459	7358	5877	2924	**22854**

Table 6.1b. The irrigation volume distribution by month for the Willamette Basin in the 2010 Modified Flows (on the left) and for the Base Year 2020 irrigation volume (on the right).

Month	Demand Volume Percentage Each Month			
	2010 Level Modified Flows, ac-ft	**% of Total**	**AI 1 values from above, ac-ft**	**% of Total**
April	860	0.31%	0	0.0%
May	18,056	6.49%	2236	9.8%
June	46,773	16.80%	4459	19.5%
July	90,107	32.37%	7358	32.2%
August	84,261	30.27%	5877	25.7%
September	37,488	13.47%	2924	12.8%
October	860	0.31%	0	0.0%
Total:	278,405	100.00%	22,854	100.0%

Table 6.2. The incremental increases in BOR irrigation contracts from stored water between 2008 and 2020, from Table AI 1 in Appendix F, reshaped according to Table 6.1b.

Reach	Increased AI Demand in acre-feet							
	April	May	June	July	Aug.	Sept.	Oct.	Total
Reach 1	22	452	1170	2254	2108	938	22	6966
Reach 1a	1	20	51	99	92	41	1	305
Reach 1b	17	347	899	1733	1620	721	17	5353
Reach 1c	4	85	220	423	396	176	4	1308
Reach 2	0	5	12	24	22	10	0	74
Reach 3	11	225	583	1124	1051	468	11	3472
Reach 4	1	18	47	90	84	38	1	279
Reach 5	15	309	800	1541	1441	641	15	4762
Reach 6	19	390	1011	1947	1821	810	19	6017
Reach 7	1	15	38	74	69	31	1	229
Reach 8	2	35	91	175	164	73	2	541
Reach 9	0	0	0	0	0	0	0	0
Reach 10	1	18	47	90	84	37	1	278
Reach 11	0	2	5	9	8	4	0	28
Reach 12	0	0	1	1	1	0	0	3
Reach 13	1	12	30	57	54	24	1	177
Reach 14	0	1	3	5	5	2	0	16
Reach 15	0	1	3	6	5	2	0	17
Total all Reaches	71	1483	3839	7398	6918	3078	71	**22858***

*Note round-off error from displaying reshaped volumes as integers.

Table 6.3. The increases in M&I between 2008 and 2020, from Table MI 1 (June-Sept) and MI 2 (April and May) in Appendix F.

Reach	Increased M&I Demand Volume in acre-feet							
	April	May	June	July	Aug.	Sept.	Oct.	Total
Reach 1	2342	2783	2303	3267	3345	2559	0	16599
Reach 1a	664	790	630	894	915	700	0	4593
Reach 1b	1595	1895	1557	2208	2261	1730	0	11246
Reach 1c	83	98	116	165	169	129	0	760
Reach 2	5	6	0	0	0	0	0	11
Reach 3	542	645	688	976	999	765	0	4615
Reach 4	37	44	46	65	66	51	0	309
Reach 5	154	183	205	291	298	228	0	1359
Reach 6	0	0	0	0	0	0	0	0
Reach 7	16	19	24	34	35	26	0	154
Reach 8	99	118	130	184	188	144	0	863
Reach 9	232	275	347	492	504	386	0	2236
Reach 10	0	0	0	0	0	0	0	0
Reach 11	1	1	1	2	2	1	0	8
Reach 12	3	4	4	6	6	5	0	28
Reach 13	5	6	7	9	9	7	0	43
Reach 14	10	12	15	21	22	17	0	97
Reach 15	0	0	0	0	0	0	0	0
Total all Reaches	3446	4096	3770	5347	5474	4189	0	**26322***
Percent of Total	13%	16%	14%	20%	21%	16%	0%	**100%**

*Note round-off error from displaying all volumes as integers.

Table 6.4. The total demand increases from 2008 levels diverted in the Base Year 2020 simulation.

Reach	Increased Total Demand in acre-feet							
	April	May	June	July	Aug.	Sept.	Oct.	Total
Reach 1	2364	3235	3473	5521	5453	3497	22	23565
Reach 1a	665	810	681	993	1007	741	1	4898
Reach 1b	1612	2242	2456	3941	3881	2451	17	16599
Reach 1c	87	183	336	588	565	305	4	2068
Reach 2	5	11	12	24	22	10	0	85
Reach 3	553	870	1271	2100	2050	1233	11	8087
Reach 4	38	62	93	155	150	89	1	588
Reach 5	169	492	1005	1832	1739	869	15	6121
Reach 6	19	390	1011	1947	1821	810	19	6017
Reach 7	17	34	62	108	104	57	1	383
Reach 8	101	153	221	359	352	217	2	1404
Reach 9	232	275	347	492	504	386	0	2236
Reach 10	1	18	47	90	84	37	1	278
Reach 11	1	3	6	11	10	5	0	36
Reach 12	3	4	5	7	7	5	0	31
Reach 13	6	18	37	66	63	31	1	220
Reach 14	10	13	18	26	27	19	0	113
Reach 15	0	1	3	6	5	2	0	17
Total all Reaches	3517	5579	7609	12745	12392	7267	71	**49180***

*Note round-off error from displaying all volumes as integers.

Table 6.5. Total Diverted flow withdrawals by reach, in cfs, as increases from the 2008 levels to the Base Year 2020.

Reach	Daily Flow Withdrawal Rate, in cfs, by month.											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1b	0.00	0.00	0.00	27.09	36.47	41.28	64.09	63.12	41.19	0.27	0.00	0.00
1c	0.00	0.00	0.00	1.46	2.97	5.64	9.57	9.18	5.13	0.07	0.00	0.00
2	0.00	0.00	0.00	0.08	0.18	0.21	0.39	0.36	0.17	0.00	0.00	0.00
3	0.00	0.00	0.00	9.29	14.15	21.36	34.15	33.33	20.71	0.17	0.00	0.00
4	0.00	0.00	0.00	0.64	1.01	1.56	2.52	2.45	1.49	0.01	0.00	0.00
5	0.00	0.00	0.00	2.84	8.00	16.89	29.80	28.28	14.61	0.24	0.00	0.00
6	0.00	0.00	0.00	0.32	6.35	16.98	31.67	29.61	13.62	0.30	0.00	0.00
7	0.00	0.00	0.00	0.29	0.55	1.05	1.76	1.69	0.95	0.01	0.00	0.00
8	0.00	0.00	0.00	1.70	2.49	3.71	5.84	5.72	3.64	0.03	0.00	0.00
9	0.00	0.00	0.00	3.90	4.47	5.83	8.00	8.20	6.49	0.00	0.00	0.00
10	0.00	0.00	0.00	0.02	0.29	0.78	1.46	1.37	0.63	0.01	0.00	0.00
11	0.00	0.00	0.00	0.02	0.05	0.10	0.18	0.17	0.08	0.00	0.00	0.00
12	0.00	0.00	0.00	0.05	0.07	0.08	0.12	0.12	0.08	0.00	0.00	0.00
13	0.00	0.00	0.00	0.10	0.28	0.62	1.08	1.02	0.52	0.01	0.00	0.00
14	0.00	0.00	0.00	0.17	0.21	0.30	0.42	0.43	0.32	0.00	0.00	0.00
15	0.00	0.00	0.00	0.00	0.02	0.05	0.09	0.08	0.04	0.00	0.00	0.00

Table 6.6. Return flow volume example calculation for M&I and AI demands between 2008 and 2020.

Month	Calculation and Distribution of Return Flow Volume for Total Demands			
	Total M&I	26,322 ac-ft*	Total AI	22,854 ac-ft*
	55% Return	14,477 ac-ft	20% Return	4571 ac-ft
	How the 14,477 ac-ft is returned:		How the 4571 ac-ft is returned:	
	Percent of Return each Month**	Return Volume Each Month (ac-ft)	Percent of Return each Month***	Return Volume Each Month (ac-ft)
Jan	0%	0	4%	183
Feb	0%	0	4%	183
Mar	0%	0	4%	183
Apr	13%	1882	4%	183
May	16%	2316	5%	229
Jun	14%	2027	12%	549
Jul	20%	2895	17%	777
Aug	21%	3040	18%	823
Sep	16%	2316	13%	594
Oct	0%	0	9%	411
Nov	0%	0	6%	274
Dec	0%	0	4%	183
Total ac-ft:	100%	14,476	100%	4572****

*Volumes from Tables 6.3 and 6.2, respectively.

**Monthly return percent is from the bottom of Table 6.3, where the total 100% returned M&I volume equals 55% of the withdrawn M&I volume.

***Monthly return percent is from Section 3.2 discussion.

****Note round-off error from displaying all volumes as integers.

Table 6.7. Return flow by reach, in cfs, using M&I and AI distributions from Table 6.6 and Reach Volumes from Tables 6.2 and 6.3

Reach	Daily Flow Return Rate, in cfs, by month, for M&I and Ag Demands that can be supported.											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1b	-0.70	-0.70	-0.70	-14.23	-16.52	-16.50	-23.39	-24.05	-18.27	-1.57	-1.04	-0.70
1c	-0.17	-0.17	-0.17	-1.09	-1.27	-1.48	-2.10	-2.18	-1.63	-0.38	-0.26	-0.17
2	-0.01	-0.01	-0.01	-0.02	-0.03	-0.04	-0.06	-0.06	-0.05	-0.02	-0.01	-0.01
3	-0.45	-0.45	-0.45	-6.01	-6.99	-7.27	-10.31	-10.62	-8.04	-1.02	-0.68	-0.45
4	-0.04	-0.04	-0.04	-0.41	-0.48	-0.50	-0.72	-0.74	-0.56	-0.08	-0.05	-0.04
5	-0.62	-0.62	-0.62	-2.27	-2.67	-3.60	-5.10	-5.32	-3.95	-1.39	-0.93	-0.62
6	-0.78	-0.78	-0.78	-0.81	-0.98	-2.35	-3.33	-3.52	-2.54	-1.76	-1.17	-0.78
7	-0.03	-0.03	-0.03	-0.22	-0.25	-0.29	-0.41	-0.42	-0.32	-0.07	-0.04	-0.03
8	-0.07	-0.07	-0.07	-1.11	-1.29	-1.32	-1.87	-1.92	-1.46	-0.16	-0.11	-0.07
9	0.00	0.00	0.00	-2.69	-3.11	-2.86	-4.06	-4.16	-3.18	0.00	0.00	0.00
10	-0.04	-0.04	-0.04	-0.04	-0.05	-0.11	-0.15	-0.16	-0.12	-0.08	-0.05	-0.04
11	0.00	0.00	0.00	-0.01	-0.02	-0.02	-0.03	-0.03	-0.02	-0.01	-0.01	0.00
12	0.00	0.00	0.00	-0.03	-0.04	-0.04	-0.05	-0.05	-0.04	0.00	0.00	0.00
13	-0.02	-0.02	-0.02	-0.08	-0.09	-0.12	-0.18	-0.18	-0.14	-0.05	-0.03	-0.02
14	0.00	0.00	0.00	-0.12	-0.14	-0.13	-0.18	-0.19	-0.14	0.00	0.00	0.00
15	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	0.00

6.2 ResSim Rule Changes

The increase in AI demand through the BOR contract increases listed in Table 6.2 are demands on stored water from the Willamette reservoirs. However, the total amount of BOR contracts from Table 3.1a (22,854 ac-ft) and the BOR contracts embedded in the flow dataset at 2008 levels (58,520 ac-ft) are less than 95,000 ac-ft. This is the level of stored water contracts that USACE has previously set as the volume limit for which no reservoir operations would change, with the exception of Detroit and Fern Ridge dams. (See Appendices C and E, the Phase 1 COP report, and the BiOp documents.)

The increased M&I shown in Table 6.3 applies to water diverted from the system, but without planned increases in reservoir releases to cover them, since the increases are from live flow permits, not stored water.

The WBR watershed still has the BiOp minimum flow target rules at Albany and Salem, so whenever flows at either control point would be lower than the target flow, additional reservoir releases are made above any specified minimum releases to cover the shortage. If any of the additional diversions cause flow at the mainstem control points to drop below the targets, then reservoir releases would supplement the difference. See Appendix E for details about how the model meets the BiOp mainstem targets through downstream minimum rules.

Section 5, Tables 5.1 through 5.11, identified the rules in the WBR watershed that would change for each of the five simulations. Since the total volume of BOR contracts for stored water in 2020 is still less than 95,000 ac-ft, and no M&I contracts are for stored water, the BiOp minimum tributary flows are still used as the project minimum releases for all projects except Fern Ridge and Detroit. (The WBR watershed rules listed in Tables 5.1 through 5.7 and Tables 5.9 and 5.10 are equal to the Baseline watershed rules.) Only the WBR watershed rules listed in Tables 5.8 and 5.11 are changed for the Base Year 2020.

Table 6.8 summarizes the minimum flow release at Fern Ridge in the Base Year 2020 simulation. The table breaks out the BiOp minimum tributary flow, the Baseline release values for BOR contracts for the year 2008, and the additional releases required for BOR contract increases between 2008 and 2020. Table 6.9 provides similar information for Detroit.

Table 6.8. Minimum project releases for the BiOp and BOR contracts through 2020 for Fern Ridge. Total values used in both rules "Min Flow out of Fern Ridge" and "New Min FRN Buffer" from Table 5.8.

	Minimum Project Release, in cfs											
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
BiOp*	30.00	50.00	50.00	50.00	50.00	50.00	30.00	30.00	30.00	30.00	30.00	30.00
Baseline (2008)												
All Years	0.00	0.00	0.00	0.00	25.11	51.74	82.63	66.00	33.93	0.00	0.00	0.00
2008-2020												
All Years	0.00	0.00	0.00	0.36	7.24	19.38	36.13	33.79	15.54	0.35	0.00	0.00
Total**												
All Years	30.00	50.00	50.00	50.36	82.36	121.12	148.77	129.79	79.49	30.35	30.00	30.00

*Note: "BiOp" means the BiOp minimum tributary flow target for this project.
**Total outflow minimum from Fern Ridge includes BOR contracts in 2008 as well as the additional contracts after 2008.

Table 6.9. Minimum project releases for the BiOp and BOR contracts through 2020 for Detroit. Total values used in both rules "Revised Temp Ops Det" and "New Min DET Buffer" from Table 5.11.

	Minimum Project Release, in cfs								
	Apr	May	Jun	1 Jul	15 Jul	Aug	Sep	1 Oct	16 Oct
BiOp*	1500	1500	1200	1200	1000	1000	1500	1500	1200
Baseline (2008)									
All Years	0.00	14.49	29.86	47.68	47.68	38.09	19.58	0.00	0.00
2008-2020									
All Years	0.25	5.00	13.38	24.96	24.96	23.34	10.73	0.24	0.24
Total**									
All Years	1501.25	1519.49	1243.25	1272.64	1072.64	1061.43	1530.31	1500.24	1200.24

*Note: "BiOp" means the BiOp minimum tributary flow target for this project.
**Total outflow minimum from Detroit includes BOR contracts in 2008 as well as the additional contracts after 2008.
Minimum Flows for months not shown are all BiOp minimums: Jan = 1200 cfs, Feb = 1000 cfs, 1 Mar = 1000 cfs, 16 Mar = 1500 cfs, Nov = 1200 cfs, Dec = 1200 cfs.

6.3 Simulation Results

The Base Year 2020 pool elevation non-exceedance graphs for each storage project are shown in Figures 6.1 and 6.2. These non-exceedance graphs are described in detail in Section 16 of Appendix E, in particular Figure 16.1 of that Appendix.

The graphs in Figures 6.3a through 6.3c are period average flows at Salem for every year in the POR, color coded by water year type. The periods are monthly for April, May, July, September, and October, when the Salem BiOp minimum targets are constant over each of those months, and for half month periods for June and August, when the BiOp minimum targets change midway through those months. These graphs highlight the result that regulated Salem flows are often well above the target minimum values. The main Feasibility report documents the occurrences for regulated Salem flows being below minimum flow targets, but does not show the frequency that the regulated flows exceed the minimum flow targets. The period average flow values plotted in Figures 6.3a to 6.3c are listed in Table 6.10a for 1929 through 1970 and Table 6.10b for 1971 through 2008.

The regulated flows at Albany, Salem, and Oregon City above Willamette Falls are shown in Figures 6.4 through 6.6. In each figure, the non-exceedance percentiles of the regulated flows are shown in the top graph (with a blue background), and the remaining four graphs in each figure show the regulated flow for one water year of each type, using 1966 (Adequate), 1967 (Insufficient), 1968 (Deficit), and 1969 (Abundant). The flow targets at Albany and Salem are shown in Figures 6.4 and 6.5, respectively, for the wetter years (Abundant and Adequate) and for Deficit years. The targets shown in Figure 6.6 are Salem targets (shown as dashed lines) for comparison. There are no official BiOp flow minimum targets at Willamette Falls, but a flow equivalent to that at Salem is desirable.

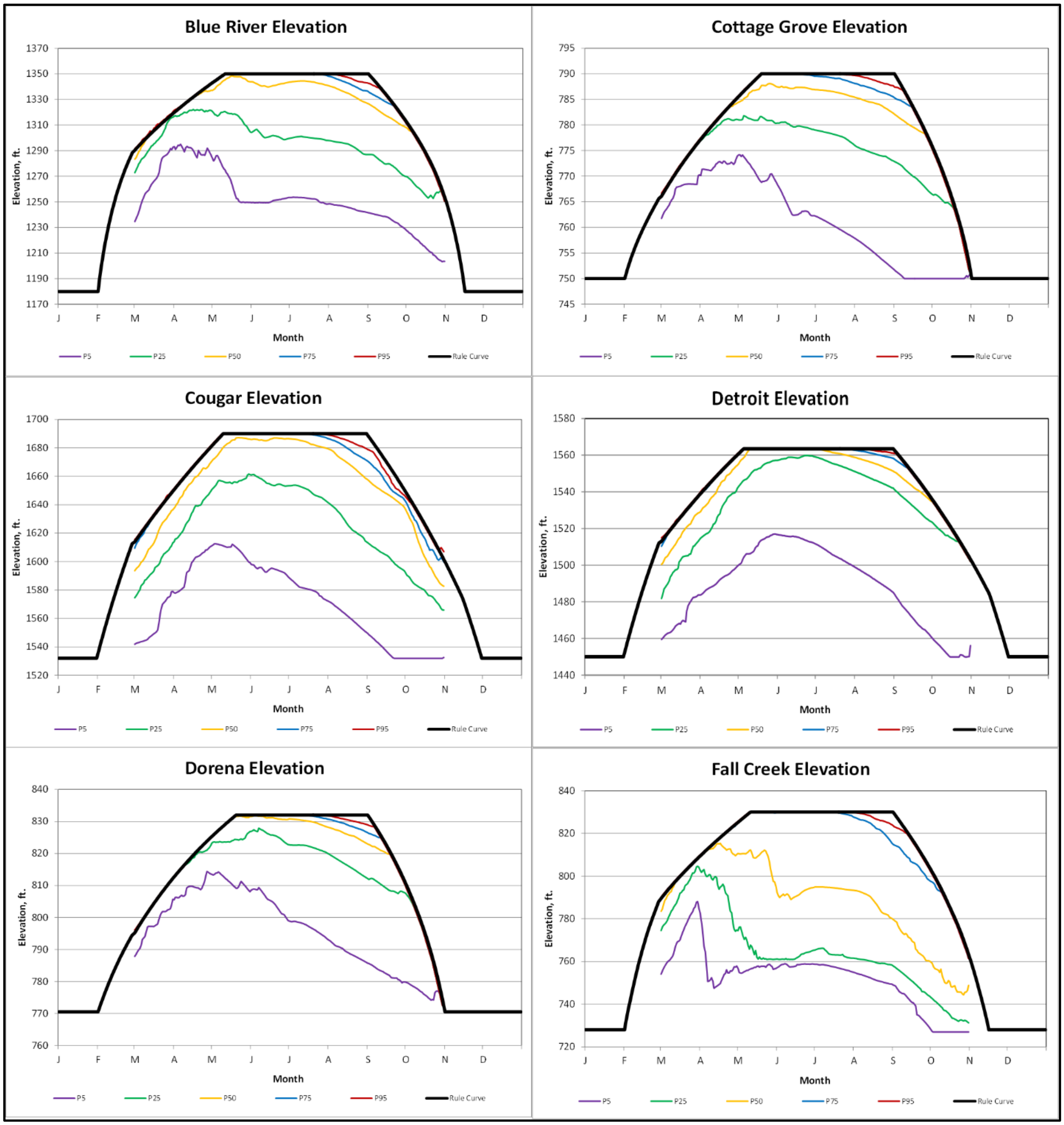


Figure 6.1. Pool elevation non-exceedance percentiles for the Base Year 2020 for Blue River, Cottage Grove, Cougar, Detroit, Dorena, and Fall Creek in color lines. See Figure 16.1 in Appendix E for non-exceedance value descriptions.

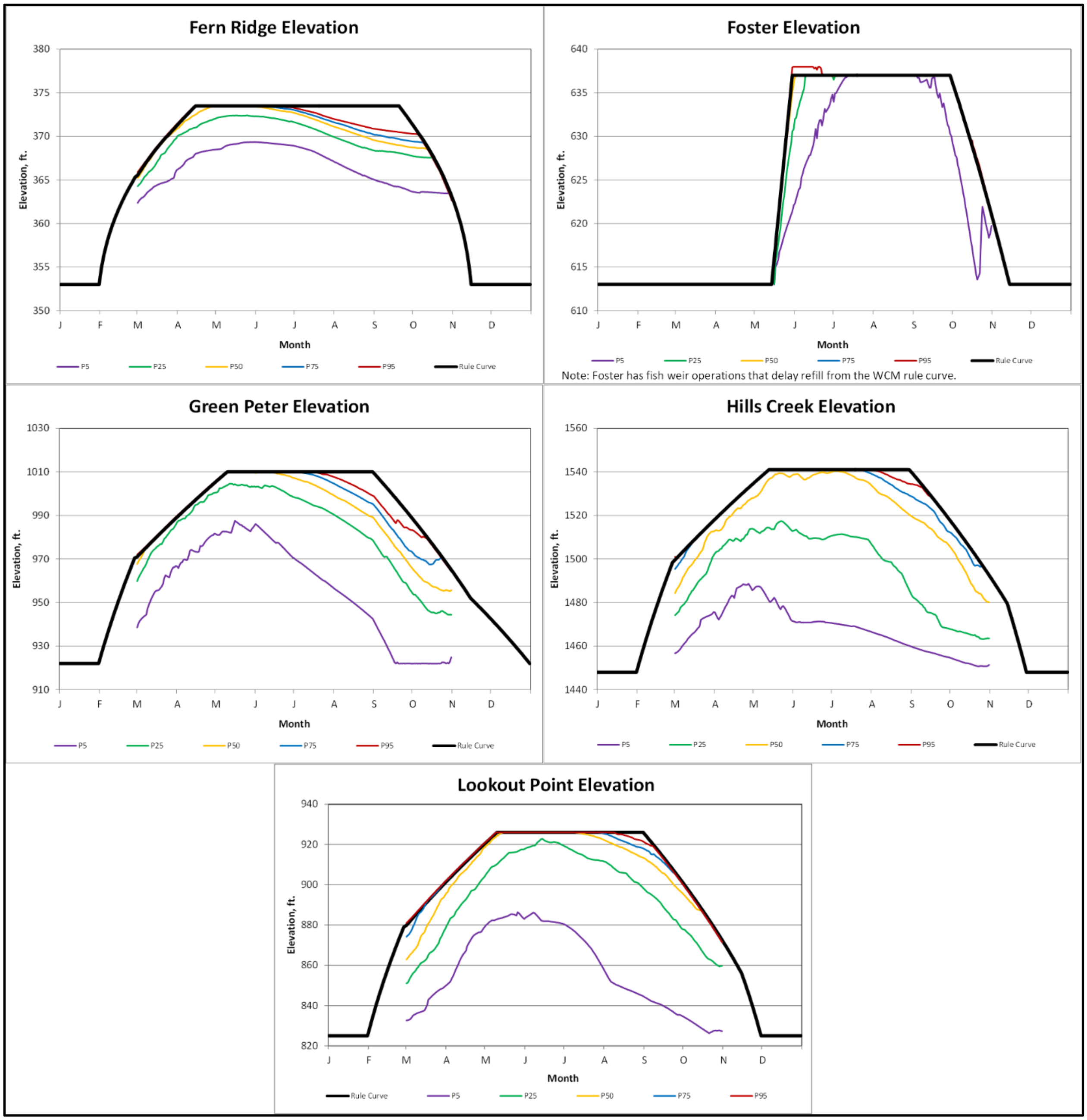


Figure 6.2. Pool elevation non-exceedance percentiles for the Base Year 2020 for Fern Ridge, Foster, Green Peter, Hills Creek, Fall Creek, and Lookout Point in color lines. See Figure 16.1 in Appendix E for non-exceedance value descriptions.

Base Year 2020, Period Average Flows at Salem

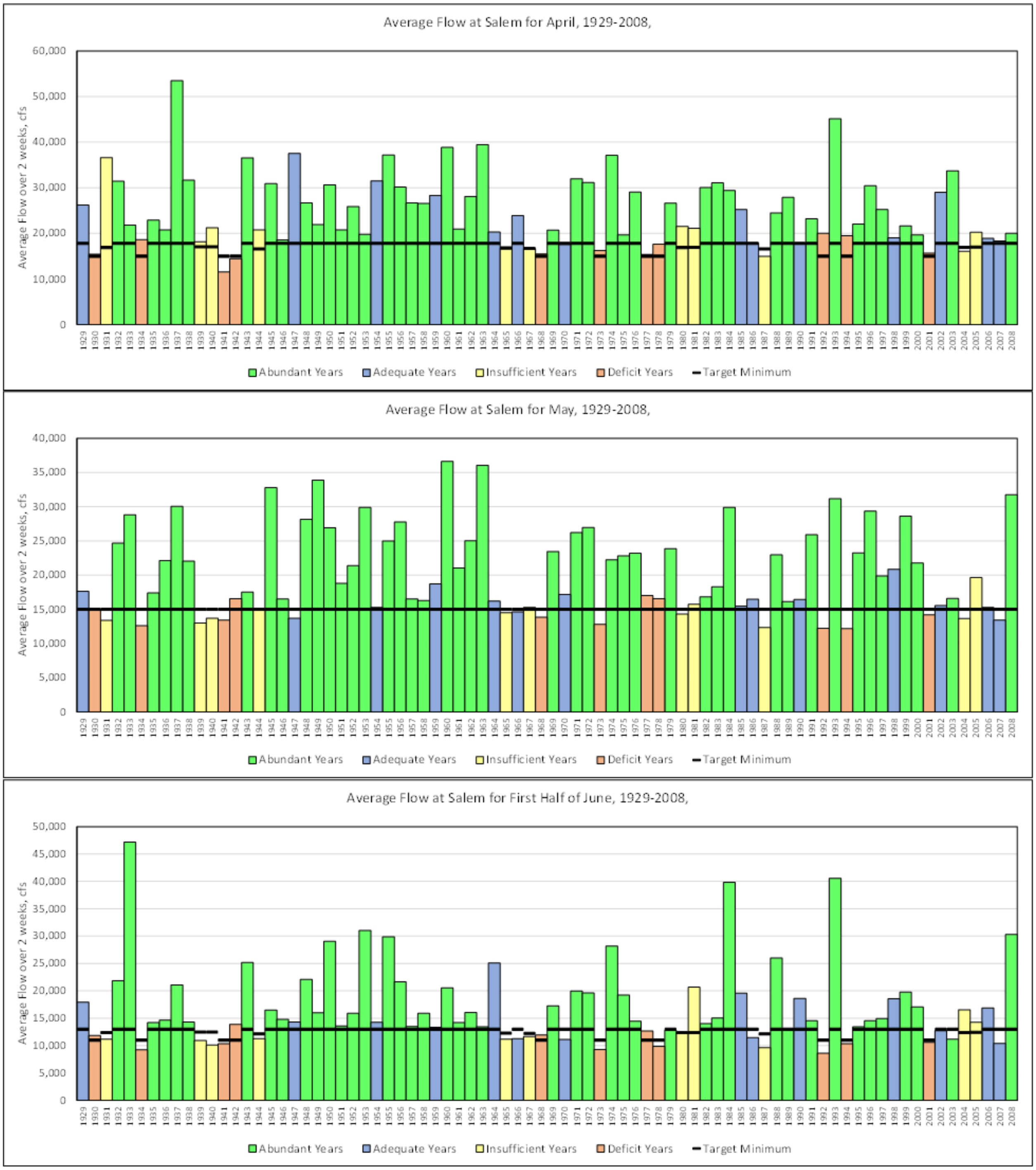


Figure 6.3a. Period average flows at Salem for all years in the POR for April (top), May (middle), and the first half of June (bottom), with flow target for that period and year shown as the solid black bar. Each year is color coded by water year type. Graphs show that Abundant water year average flows often significantly exceed the minimum flow targets at Salem while Deficit year average flows can miss the target. Adequate and Insufficient water years fall in between.

Base Year 2020, Period Average Flows at Salem

Figure 6.3b. Period average flows at Salem for all years in the POR for the second half of June (top), July (middle), and the first half of August (bottom), with flow target for that period and year shown as the solid black bar. Each year is color coded by water year type. Graphs show that Abundant water year average flows often exceed the minimum flow targets at Salem while Deficit year average flows can miss the target. Adequate and Insufficient water years fall in between.

Base Year 2020, Period Average Flows at Salem

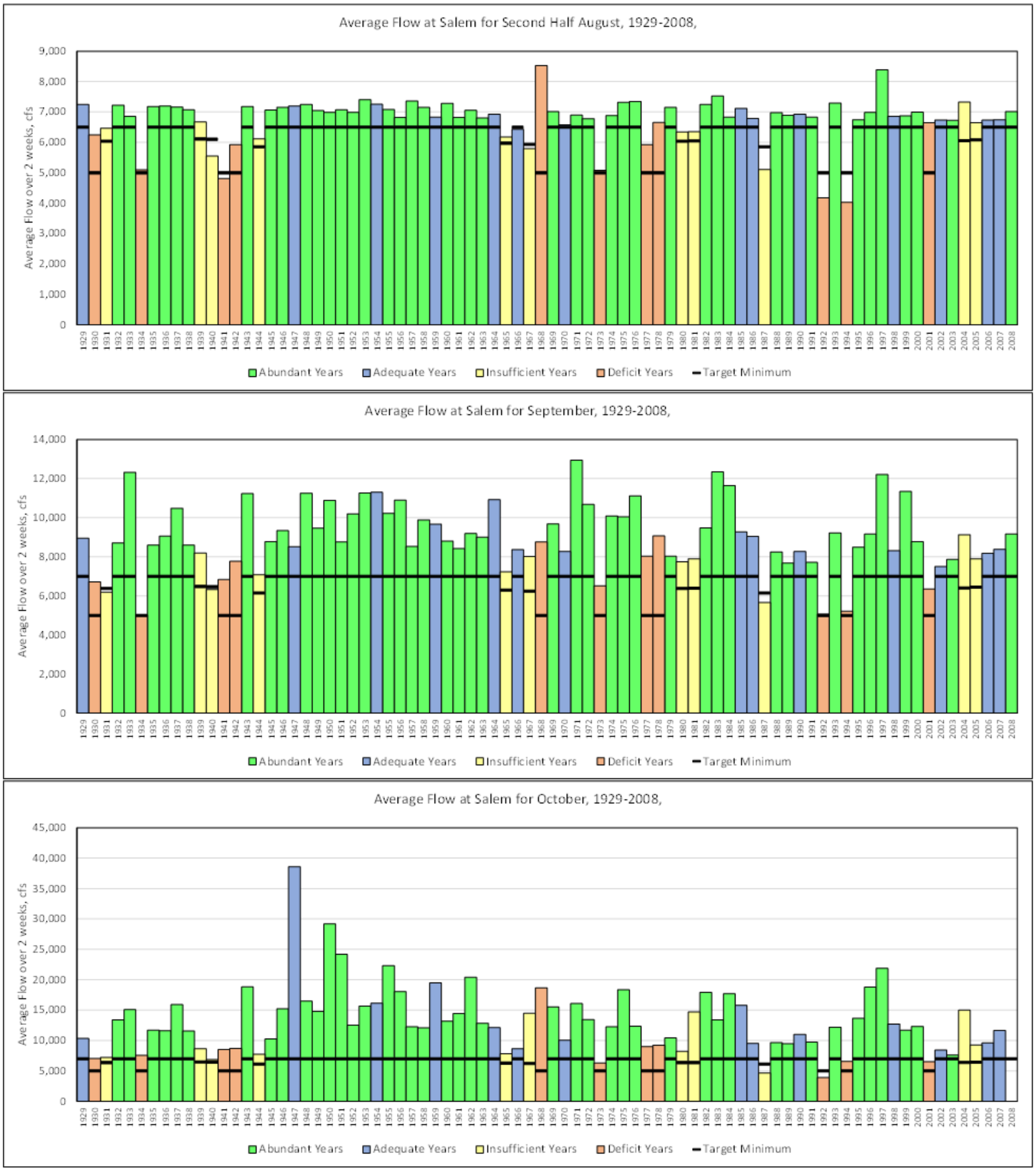


Figure 6.3c. Period average flows at Salem for all years in the POR for the second half of August (top), September (middle), and October (bottom), with flow target for that period and year shown as the solid black bar. Each year is color coded by water year type. Graphs show that Abundant water year average flows often exceed the minimum flow targets at Salem while Deficit year average flows can miss the target. Adequate and Insufficient water years fall in between. Note fall drafting begins in September.

Table 6.10a. Period average flows at Salem for all years in the POR, for 1929 to 1970. Average flow values are all in cfs.

Year	Average Flow at Salem over Period, in cfs.								
	Apr	May	1-15 Jun	16-30 Jun	July	1-15 Aug	16-30 Aug	Sep	Oct
1929	26214	17620	17963	17224	7137	6849	7247	8945	10329
1930	15443	15003	11868	8248	6457	6371	6243	6718	7018
1931	36624	13376	11164	9222	7107	6775	6464	6185	7232
1932	31406	24655	21854	14258	7974	7288	7221	8709	13386
1933	21822	28812	47166	27012	11820	7058	6852	12322	15071
1934	18603	12627	9212	7237	6025	5447	5103	5006	7564
1935	22889	17389	14206	9794	7423	7258	7180	8592	11731
1936	20776	22117	14651	12795	7365	7067	7191	9051	11615
1937	53498	30044	21092	36459	10296	7167	7157	10483	15914
1938	31673	22043	14295	9159	6626	6803	7074	8597	11563
1939	18140	12982	10949	9761	6797	6482	6671	8192	8661
1940	21247	13688	10122	8471	7114	6289	5550	6317	6859
1941	11541	13429	10344	8630	6280	5458	4811	6834	8511
1942	14442	16563	13897	11232	7546	6073	5927	7764	8684
1943	36562	17515	25185	15993	9517	7079	7177	11230	18818
1944	20782	14982	11258	8421	6597	6206	6115	7080	7745
1945	30900	32772	16498	9319	6684	6918	7061	8778	10265
1946	18583	16494	14824	12247	7886	7311	7153	9342	15228
1947	29399	13690	14291	10483	7763	7254	7192	8512	38579
1948	26701	28143	22116	14090	8136	7128	7244	11250	16488
1949	21942	33866	16002	10783	7170	7000	7043	9462	14772
1950	30616	26921	29060	22835	10308	6893	6982	10876	29174
1951	20756	18798	13574	9198	6822	6889	7069	8755	24172
1952	25880	21363	15896	14370	11213	7004	6985	10196	12518
1953	19773	29877	31039	17393	9293	6978	7405	11255	15660
1954	26386	15265	14254	14803	8398	7100	7251	11293	16127
1955	37153	24998	29869	16594	10141	7196	7082	10217	22299
1956	30126	27750	21653	18877	9044	7061	6819	10899	18046
1957	26646	16516	13522	9818	6715	7379	7358	8534	12277
1958	26549	16280	15910	10974	7494	7215	7150	9886	12080
1959	22940	18712	13356	9302	6973	7019	6825	9666	19469
1960	38846	36604	20555	11480	6841	7030	7284	8803	13174
1961	20952	21023	14232	9291	6629	6504	6817	8418	14451
1962	28104	25009	16070	11196	7167	7303	7054	9188	20419
1963	39424	36026	13466	9288	7242	6535	6804	9003	12849
1964	19388	16193	25117	17081	8013	6499	6930	10916	12120
1965	16705	14489	11183	7853	6456	6481	6177	7221	7804
1966	21092	14622	11244	8955	6695	6574	6427	8366	8654
1967	16627	15286	11672	8519	5866	5595	5798	8017	14456
1968	15451	13840	11931	7968	6432	6107	8526	8757	18661
1969	20715	23446	17270	19165	10091	7019	7011	9676	15534
1970	17396	17156	11109	9230	6569	6290	6578	8267	10054

Table 6.10b. Period average flows at Salem for all years in the POR, for 1971 to 2008. Average flow values are all in cfs.

Year	Average Flow at Salem over Period, in cfs.								
	Apr	May	1-15 Jun	16-30 Jun	July	1-15 Aug	16-30 Aug	Sep	Oct
1971	31990	26213	19955	18778	9240	6850	6893	12944	16070
1972	31122	26939	19597	12002	7439	6538	6778	10675	13443
1973	16265	12800	9310	8252	6186	5408	5085	6513	6317
1974	37106	22241	28199	18259	9350	6678	6883	10087	12249
1975	19689	22812	19245	11608	8125	6783	7315	10044	18346
1976	29019	23178	14469	11144	7431	7082	7345	11108	12338
1977	15355	17001	12684	7574	5959	5515	5919	8027	9019
1978	17600	16548	11383	8378	6550	5852	6651	9067	9230
1979	26627	23870	12747	9139	6647	6806	7151	8027	10430
1980	21524	14308	12423	8813	6697	6079	6336	7737	8210
1981	21107	15726	20663	14217	7266	6326	6350	7898	14702
1982	30026	16815	13998	10941	7717	7328	7245	9468	17933
1983	31084	18289	15017	11400	12059	7816	7524	12339	13406
1984	29413	29862	39811	21273	9356	6424	6829	11645	17690
1985	22115	15451	19564	10033	7188	7175	7117	9262	15779
1986	17369	16475	11486	9212	7161	6700	6786	9041	9529
1987	14958	12310	9650	7473	6922	6341	5105	5664	4658
1988	24484	22961	25995	10643	7129	7019	6976	8243	9669
1989	27884	16121	12915	9251	6615	6735	6890	7670	9458
1990	22183	16425	18622	10754	6891	6621	6930	8269	11020
1991	23200	25894	14542	9742	6728	6553	6833	7713	9743
1992	20016	12221	8597	7296	5680	4489	4178	5061	3916
1993	45113	31147	40572	15857	8511	7367	7296	9213	12180
1994	19515	12186	10369	7828	5811	4942	4031	5222	6574
1995	22045	23256	13426	11112	6937	6635	6744	8489	13668
1996	30458	29349	14561	9595	7028	7004	6985	9157	18770
1997	25203	19855	14922	11092	9031	8320	8388	12211	21889
1998	18626	20859	18545	10410	7311	6819	6857	8315	12711
1999	21643	28598	19769	16784	8967	6933	6875	11339	11676
2000	19685	21757	17051	11848	7348	7081	6993	8778	12322
2001	15698	14179	10611	7859	6525	6714	6642	6351	6532
2002	28573	15528	12732	9497	6946	6788	6739	7500	8435
2003	33695	16585	11151	9096	7029	6933	6721	7864	7602
2004	16067	13654	16565	9841	7027	6762	7325	9126	14996
2005	20261	19633	14281	10099	7132	6713	6644	7892	9274
2006	20223	15288	16888	10403	7253	6733	6735	8182	9585
2007	18438	13415	10411	8976	6675	6402	6744	8382	11647
2008	19994	31733	30307	19112	8702	6714	7015	9164	N/A

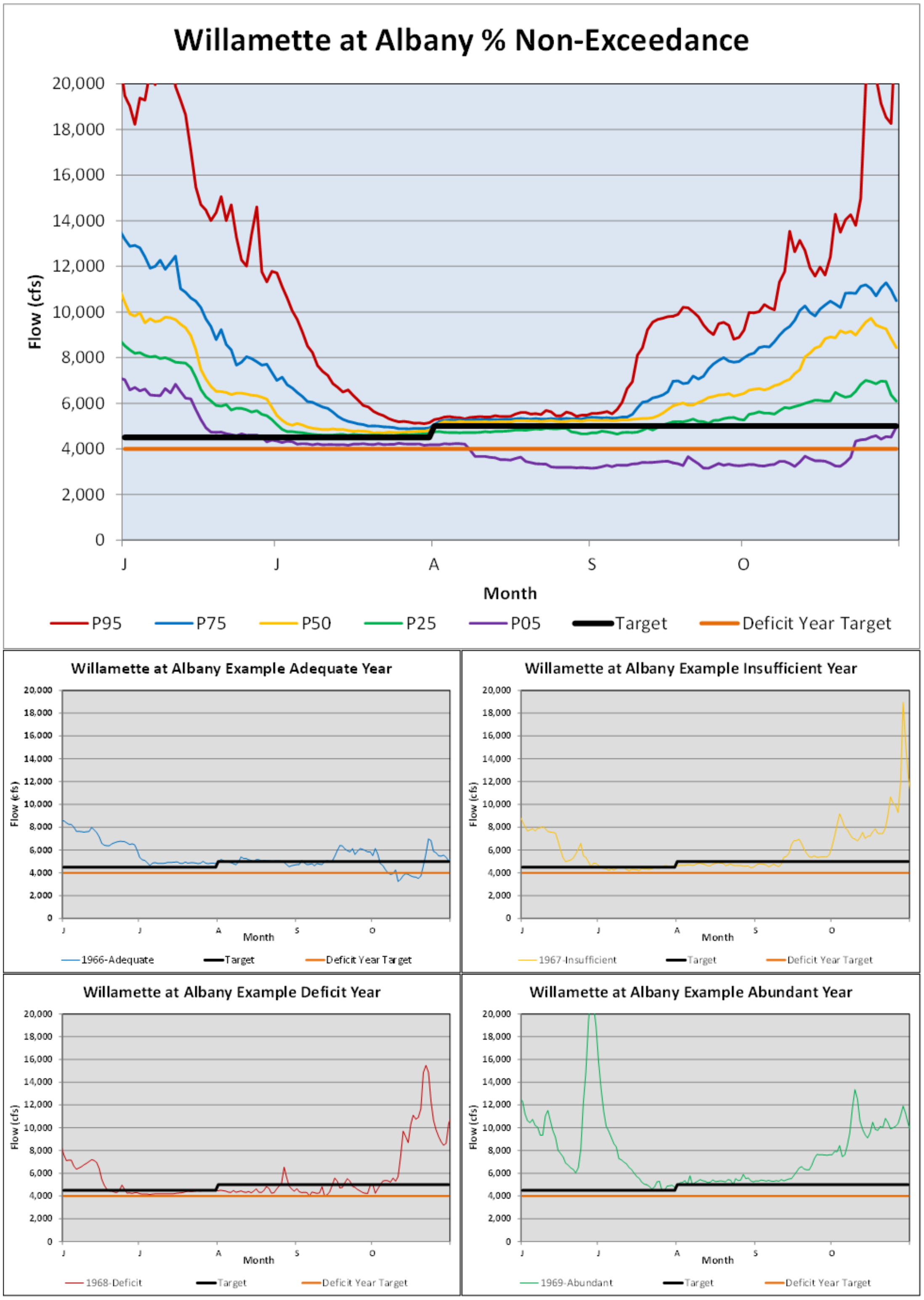


Figure 6.4. Non-exceedance percentiles for the Base Year 2020 for regulated flow at Albany in top graph (with blue background). Albany flow for selected years: 1966 (Adequate) at middle left, 1967 (Insufficient) at middle right, 1968 (Deficit) at bottom left, and 1969 (Abundant) at bottom right.

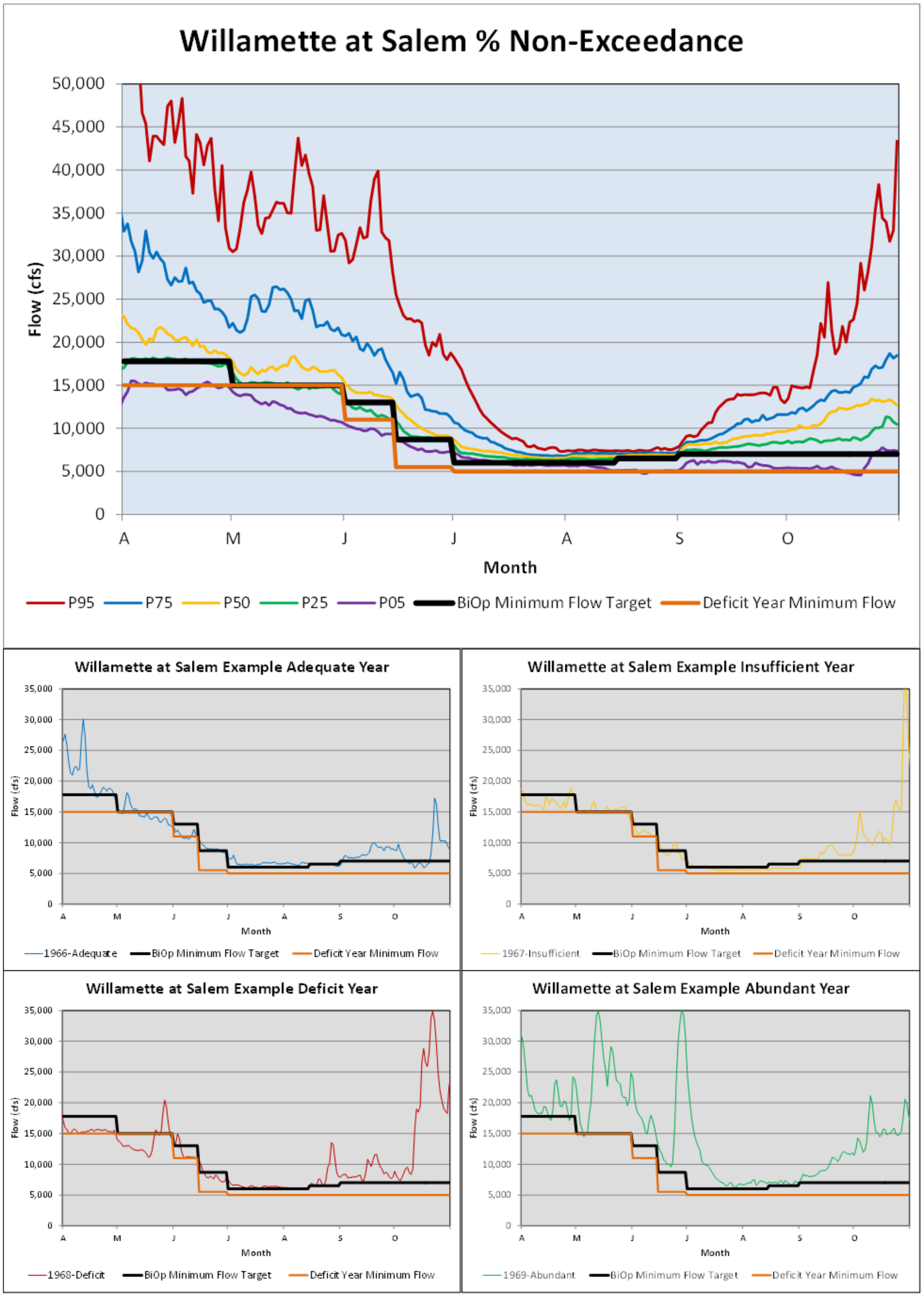


Figure 6.5. Non-exceedance percentiles for the Base Year 2020 for regulated flow at Salem in top graph (with blue background). Salem flow for selected years: 1966 (Adequate) at middle left, 1967 (Insufficient) at middle right, 1968 (Deficit) at bottom left, and 1969 (Abundant) at bottom right.

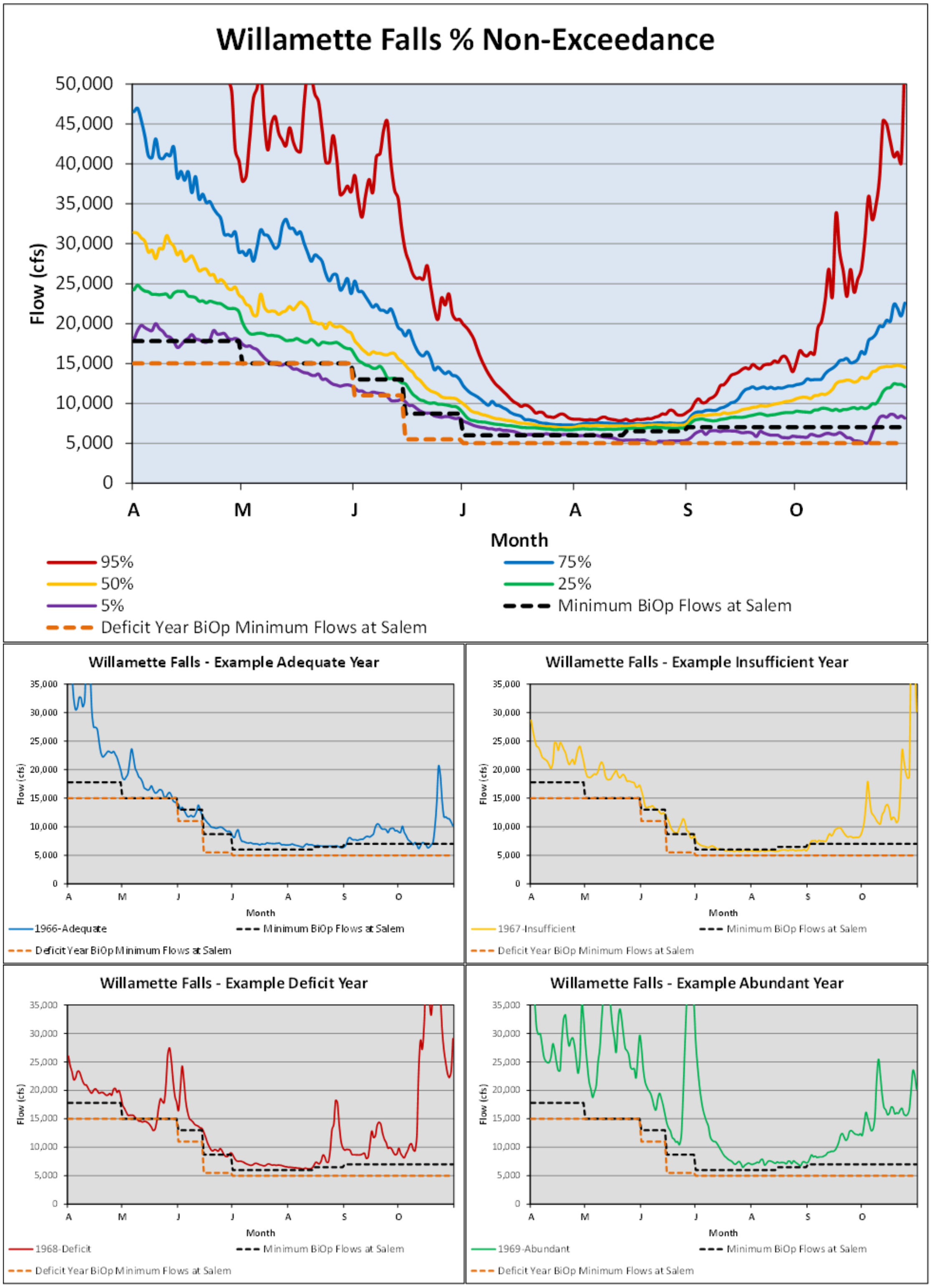


Figure 6.6. Non-exceedance percentiles for the Base Year 2020 for regulated flow at Oregon City above the Falls in top graph (with blue background). Flow for selected years: 1966 (Adequate) at middle left, 1967 (Insufficient) at middle right, 1968 (Deficit) at bottom left, and 1969 (Abundant) at bottom right.

7 Peak No Action 2070 ResSim Analysis

The simulation name for this analysis is ***Peak-No-Action-2070-22Mar2018*** (see Table 1.1 for all other specifics for the simulation).

7.1 Diversions and Return Flows

Table 3.1 shows a total increase in Willamette Basin demands of 379,742 ac-ft from 2008 levels. The total increase was from seven categories, which were given separately for increases from 2008 to 2020 (for the Base Year analysis) and from 2020 to 2070. The demand increase for the two time windows are (see tables referenced from Appendix F):

1. Demand Increases for 2008 to 2020, which were included in the Base Year 2020 analysis:

- an increase in BOR stored water contracts (22,854 ac-ft) (Table AI 1),
- an increase in M&I use from live flow permits that were already in place in 2008, but not fully utilized, for June through September (18,780 ac-ft) (Table MI 1),
- and an increase in M&I use from live flow permits that were already in place in 2008, but not fully utilized, for April through May (7541 ac-ft) (Table MI 2).

2. Demand Increases for 2020 to 2070, with values representing peak use:

- an increase in BOR stored water contracts (124,264 ac-ft), which is subdivided into the increase that brings the total BOR contract in the basin to 95,000 ac-ft (13,626 ac-ft) (Table AI 2) and the portion that is above 95,000 ac-ft (110,637 ac-ft) (Table AI 3), with the importance of the 95,000 ac-ft contract level described below as the two portions are modeled differently in ResSim,
- an increase in M&I use from live flow permits that were already in place in 2008, but not fully utilized, for June through September (90,227 ac-ft) (Table MI 3),
- an increase in M&I use from live flow permits that were already in place in 2008, but not fully utilized, for April through May (27,246 ac-ft) (Table MI 5),
- and an increase in M&I use from live flow permits that were already in place in 2008, but not fully utilized, and supplied to others through interties (28,901 ac-ft) (Table MI 6).

Table 3.2 indicates which categories from the seven increases above are from stored water (total volume is 207,047 ac-ft), and Table 3.3 indicates which categories are from live flow permits (total volume is 172,695 ac-ft). This distinction is relevant because increases from stored water are used to determine the minimum outflow required at each project, while increases from live flows are not. In this analysis, no M&I contracts are supplied by stored water.

All of the demands listed above are accounted for in the ResSim model by diverting water from the appropriate river reaches. Since all water diverted has the potential to decrease flows on the mainstem of the Willamette River, if demands from non-storage sources deplete the flows at Albany and Salem below the BiOp minimum flow targets, then more stored water is released to supplement the shortage.

All BOR stored water contracts up to the 95,000 ac-ft level are satisfied through reservoir releases equal to each project's minimum tributary flows, with the exceptions of Detroit and Fern Ridge, which release additional water above their minimum tributary flows to cover the BOR contracts. This contract level of 95 Kaf is documented in Appendices C and E, the Phase 1 COP report, and the BiOp documents. All BOR stored water contracts above 95 Kaf have increased reservoir releases to meet those demands. The details of how the demands are covered in this simulation are developed in this section, which also includes how water is supplied during lower water years through the recommended water management strategy. See Table 3.4 for a list of the demands that are modeled with supply reductions (total volume in year with reductions is 326,175 ac-ft).

The development of the diversions and return flows for the 2070 analyses is more complicated than that of the Base Year 2020 analysis because the seven categories of demand listed at the beginning of this section need to be individually assessed to determine if the recommended water management strategy applies to a category, and if so to determine what the reduced diversion would be. If a category is assessed as not applicable to the recommended water management strategy, then no diversion reduction is applied. Furthermore, diversions for AI and M&I are developed separately since the return flows of the two diversion types are calculated differently.

The development of the diversions and return flows are broken into the following sub-sections:

Section 7.1.1 develops the diversion water volumes by reach for AI from the BOR contracts. All of these diversions are reduced in lower water years based on the recommended water management strategy that USACE will implement by 2070, so all reductions are also developed in this section as well.

Section 7.1.2 develops the diversion water volumes by reach for M&I increased demands from live flows that are already permitted live flow contracts. This section includes the categories for which supply reductions in lower water years would apply, which is from two of the seven categories listed at the beginning of Section 7.1. The reduced diversions for these M&I demands are included here.

Section 7.1.3 develops the diversion water volumes by reach for M&I increased demands from live flows that are already permitted live flow contracts that are not reduced in lower water years.

Section 7.1.4 shows the total diversion water volumes by reach, including reductions for lower water years, used in the ResSim simulation. These totals come from Sections 7.1.1 through 7.1.3. The water volumes diverted are converted to flow rates, which is the method to specify diversions in ResSim.

Section 7.1.5 shows the total return flows from the diversions which are used in the ResSim simulation.

Section 7.1.6 summarizes how the diversions rules are input to ResSim using Reach 6 as an example.

Sections 7.1.1 through 7.1.5 reference many tables from Appendix F, where the by-reach demands were developed. Tables from Appendix F are referenced like AI 1 or MI 3.

7.1.1 AI Diversions

The AI diversions in this simulation are the 22,854 ac-ft and 184,193 ac-ft volumes listed in Table 3.1. These volumes are broken out by reach in Appendix F in Tables AI 1 for the 22,854 ac-ft diversions and in Tables AI2 and AI 3 for the 184,193 ac-ft diversions. The total of these AI diversions by reach is shown in Table 7.1a below. Note that the total for all reaches is 207,047 ac-ft, which matches the total volume shown in Table 3.2 for stored water contracts for the Peak No Action 2070 column.

The irrigation volumes developed for May through September for this analysis (Table 7.1a), and the monthly percentages for the 2010 Modified Flows are shown in Table 7.1b. Note the similarities between Tables 6.1b and 7.1b – the monthly percentages on the left and right sides are the same for the two tables, so the remaining simulation discussions in Sections 8 through 10 will not repeat this data. Following the description from Section 6.1, the irrigation volumes are re-distributed from April through October and shown in Table 7.2.

These irrigation volumes in Table 7.2 are for the full demand level, or the basis for supply in Abundant water years, as outlined in Section 3.1, where the approximate implementation of the recommended water management strategy is described for the ResSim analyses.

Section 3.1 provides the basis for the AI diversions in lower water years as:

- 86% for Adequate water years,
- 69% for Insufficient water years,
- and 48% for Deficit water years.

As mentioned above, Table 7.2 shows the full AI diversions as the basis for the Abundant years, and Tables 7.3 through 7.5 show the reduced AI diversions based on the above percentages for Adequate, Insufficient, and Deficit water years.

Note that Tables 7.2 through 7.5 break out Reach 1 into the sub-reaches 1a, 1b, and 1c, where Reach 1a is from Oregon City above Willamette Falls to the confluence with the Columbia River. Reach 1a values are included in the tables so that the total amount of demand in the Willamette Basin is accounted for, and reservoir releases for Reach 1a demands were calculated, but Reach 1a values are not diverted or returned in the network. Therefore, the calculated flow withdrawals and return flows required as inputs to ResSim do not include Reach 1a.

(Note that the above discussion regarding Reach 1 applies to the simulation discussions in Sections 8 through 10 and will not be repeated there.)

Table 7.1a. The incremental increases in BOR irrigation contracts from stored water between 2008 and 2070, from Tables AI 1, AI 2, and AI 3 in Appendix F.

Reach	Increased AI Demand Volume in acre-feet					
	May	**June**	**July**	**August**	**September**	**Total**
Reach 1	4360	8693	14,343	11,456	5700	44,551
Reach 1a	191	380	628	501	249	1949
Reach 1b	3350	6680	11023	8804	4381	34,238
Reach 1c	818	1632	2692	2150	1070	8363
Reach 2	46	92	152	122	61	473
Reach 3	2263	4513	7446	5947	2959	23,128
Reach 4	175	348	574	459	228	1783
Reach 5	2980	5942	9805	7831	3897	30,456
Reach 6	3766	7508	12389	9895	4924	38,482
Reach 7	143	285	471	376	187	1462
Reach 8	339	675	1114	890	443	3460
Reach 9	0	0	0	0	0	0
Reach 10	174	347	572	457	227	1778
Reach 11	18	35	58	46	23	180
Reach 12	2	4	7	6	3	22
Reach 13	111	221	365	292	145	1135
Reach 14	10	19	32	26	13	100
Reach 15	11	21	35	28	14	110
Total all Reaches	14,396	28,705	47,363	37,830	18,823	**147,117**

Table 7.1b. The irrigation volume distribution by month for the Willamette Basin in the 2010 Modified Flows (on the left) and for the Peak No Action 2070 irrigation volume (on the right).

Month	Demand Volume Percentage Each Month			
	2010 Level Modified Flows, ac-ft	**% of Total**	**AI 1 values from above ac-ft**	**% of Total**
April	860	0.31%	0	0.0%
May	18,056	6.49%	14,396	9.8%
June	46,773	16.80%	28,705	19.5%
July	90,107	32.37%	47,363	32.2%
August	84,261	30.27%	37,830	25.7%
September	37,488	13.47%	18,823	12.8%
October	860	0.31%	0	0.0%
Total:	278,405	100.00%	147,117	100.0%

Table 7.2. The incremental increases in BOR irrigation contracts from stored water between 2008 and 2070, from Tables AI 1, AI 2, and AI 3 in Appendix F, reshaped according to Table 7.1b, used as the basis for Abundant water year AI diversions.

Reach	Increased AI Demand in acre-feet							
	April	May	June	July	Aug.	Sept.	Oct.	Total
Reach 1	134	2891	7484	14,421	13,485	6001	134	**44,551**
Reach 1a	6	127	327	631	590	263	6	1949
Reach 1b	103	2222	5752	11,083	10,364	4612	103	34,238
Reach 1c	25	543	1405	2707	2531	1126	25	8363
Reach 2	1	31	79	153	143	64	1	473
Reach 3	69	1501	3886	7487	7001	3115	69	23,128
Reach 4	5	116	300	577	540	240	5	1783
Reach 5	91	1977	5117	9859	9219	4102	91	30,456
Reach 6	115	2497	6465	12,457	11,648	5183	115	38,482
Reach 7	4	95	246	473	443	197	4	1462
Reach 8	10	225	581	1120	1047	466	10	3460
Reach 9	0	0	0	0	0	0	0	0
Reach 10	5	115	299	575	538	239	5	1778
Reach 11	1	12	30	58	54	24	1	180
Reach 12	0	1	4	7	7	3	0	22
Reach 13	3	74	191	367	343	153	3	1135
Reach 14	0	6	17	32	30	13	0	100
Reach 15	0	7	18	36	33	15	0	110
Total all Reaches	441	9548	24,716	47,622	44,532	19,817	441	**147,117**

Table 7.3. The incremental increases in BOR irrigation contracts from stored water between 2008 and 2070, from Tables AI 1, AI 2, and AI 3 in Appendix F, reshaped according to Table 7.1b, used as the basis for Adequate water year AI diversions.

Reach	Increased AI Demand in acre-feet							
	April	May	June	July	Aug.	Sept.	Oct.	Total
Reach 1	115	2487	6437	12,402	11,597	5161	115	38,313
Reach 1a	5	109	282	543	507	226	5	1676
Reach 1b	88	1911	4947	9531	8913	3966	88	29,445
Reach 1c	22	467	1208	2328	2177	969	22	7192
Reach 2	1	26	68	132	123	55	1	407
Reach 3	60	1291	3342	6438	6021	2679	60	19,890
Reach 4	5	100	258	496	464	207	5	1534
Reach 5	79	1700	4400	8478	7928	3528	79	26,192
Reach 6	99	2148	5560	10,713	10,018	4458	99	33,094
Reach 7	4	82	211	407	381	169	4	1258
Reach 8	9	193	500	963	901	401	9	2975
Reach 9	0	0	0	0	0	0	0	0
Reach 10	5	99	257	495	463	206	5	1529
Reach 11	0	10	26	50	47	21	0	154
Reach 12	0	1	3	6	6	3	0	19
Reach 13	3	63	164	316	295	131	3	976
Reach 14	0	6	14	28	26	12	0	86
Reach 15	0	6	16	31	29	13	0	95
Total all Reaches	380	8211	21,256	40,955	38,298	17,042	380	**126,521**

Table 7.4. The incremental increases in BOR irrigation contracts from stored water between 2008 and 2070, from Tables AI 1, AI 2, and AI 3 in Appendix F, reshaped according to Table 7.1b, used as the basis for Insufficient water year AI diversions.

Reach	Increased AI Demand in acre-feet							
	April	May	June	July	Aug.	Sept.	Oct.	Total
Reach 1	92	1995	5164	9950	9305	4141	92	30,740
Reach 1a	4	87	226	435	407	181	4	1345
Reach 1b	71	1533	3969	7647	7151	3182	71	23,625
Reach 1c	17	374	969	1868	1747	777	17	5770
Reach 2	1	21	55	106	99	44	1	326
Reach 3	48	1036	2681	5166	4831	2150	48	15,958
Reach 4	4	80	207	398	372	166	4	1230
Reach 5	63	1364	3530	6802	6361	2831	63	21,015
Reach 6	80	1723	4461	8595	8037	3577	80	26,552
Reach 7	3	65	170	327	305	136	3	1009
Reach 8	7	155	401	773	723	322	7	2387
Reach 9	0	0	0	0	0	0	0	0
Reach 10	4	80	206	397	371	165	4	1227
Reach 11	0	8	21	40	38	17	0	124
Reach 12	0	1	3	5	5	2	0	15
Reach 13	2	51	132	253	237	105	2	783
Reach 14	0	4	12	22	21	9	0	69
Reach 15	0	5	13	25	23	10	0	76
Total all Reaches	305	6588	17,054	32,859	30,727	13,674	305	**101,511**

Table 7.5. The incremental increases in BOR irrigation contracts from stored water between 2008 and 2070, from Tables AI 1, AI 2, and AI 3 in Appendix F, reshaped according to Table 7.1b, used as the basis for Deficit water year AI diversions.

Reach	Increased AI Demand in acre-feet							
	April	May	June	July	Aug.	Sept.	Oct.	Total
Reach 1	64	1388	3593	6922	6473	2880	64	21,384
Reach 1a	3	61	157	303	283	126	3	936
Reach 1b	49	1067	2761	5320	4975	2214	49	16,434
Reach 1c	12	261	674	1299	1215	541	12	4014
Reach 2	1	15	38	73	69	31	1	227
Reach 3	33	720	1865	3594	3360	1495	33	11,101
Reach 4	3	56	144	277	259	115	3	856
Reach 5	44	949	2456	4732	4425	1969	44	14,619
Reach 6	55	1199	3103	5979	5591	2488	55	18,471
Reach 7	2	46	118	227	212	95	2	702
Reach 8	5	108	279	538	503	224	5	1661
Reach 9	0	0	0	0	0	0	0	0
Reach 10	3	55	143	276	258	115	3	853
Reach 11	0	6	14	28	26	12	0	86
Reach 12	0	1	2	3	3	1	0	11
Reach 13	2	35	91	176	165	73	2	545
Reach 14	0	3	8	15	14	6	0	48
Reach 15	0	3	9	17	16	7	0	53
Total all Reaches	212	4583	11,864	22,859	21,376	9512	212	**70,616**

7.1.2 M&I Diversions with Reductions in Lower Water Years

The M&I diversions in this simulation that were reduced in lower water years are the 90,227 ac-ft and 28,901 ac-ft volumes listed in Table 3.1. These volumes are broken out by reach in Appendix F in Table MI 3 for the 90,227 ac-ft demand and in Table MI 6 for the 28,901 ac-ft demand. The total of these M&I demands for all reaches is 119,128 ac-ft, which is a portion of the total volume of 172,695 ac-ft of live flow permits shown in Table 3.3 for the Peak No Action 2070 column. The remaining 53,567 ac-ft of live flow demands are described in Section 7.1.3, since those demands will not be reduced in lower water years. Reductions follow the percentages shown in Section 3.1 and 7.1.1.

Table 7.6 below shows the M&I diversions as the basis for the Abundant years, Table 7.7 for Adequate years, Table 7.8 for Insufficient years, and Table 7.9 for Deficit years.

Table 7.6. The incremental increases in M&I Peak demands from already permitted live flow contracts, 2008 and 2070, from Tables MI 3 and MI 6 in Appendix F, used as the basis for Abundant water year M&I diversions.

Reach	Increased M&I Demand in acre-feet							
	April	May	June	July	Aug.	Sept.	Oct.	Total
Reach 1	0	0	13,037	18,489	18,927	14,488	0	64,940
Reach 1a	0	0	2946	4177	4276	3273	0	14,673
Reach 1b	0	0	9252	13,121	13,432	10,281	0	46,086
Reach 1c	0	0	839	1190	1219	933	0	4181
Reach 2	0	0	0	0	0	0	0	0
Reach 3	0	0	3945	5594	5727	4384	0	19,649
Reach 4	0	0	251	357	365	279	0	1253
Reach 5	0	0	1524	2162	2213	1694	0	7593
Reach 6	0	0	14	20	20	15	0	69
Reach 7	0	0	162	230	235	180	0	808
Reach 8	0	0	645	915	936	717	0	3213
Reach 9	0	0	4176	5922	6063	4641	0	20,802
Reach 10	0	0	0	0	0	0	0	0
Reach 11	0	0	19	27	28	21	0	95
Reach 12	0	0	62	88	90	69	0	309
Reach 13	0	0	33	47	48	37	0	166
Reach 14	0	0	46	66	67	52	0	231
Reach 15	0	0	0	0	0	0	0	0
Total all Reaches	0	0	23,915	33,916	34,720	26,576	0	**119,128**

Table 7.7. The incremental increases in M&I Peak demands from already permitted live flow contracts, 2008 and 2070, from Tables MI 3 and MI 6 in Appendix F, used as the basis for Adequate water year M&I diversions.

Reach	Increased M&I Demand in acre-feet							
	April	May	June	July	Aug.	Sept.	Oct.	Total
Reach 1	0	0	11,212	15,900	16,277	12,459	0	55,849
Reach 1a	0	0	2533	3593	3678	2815	0	12,619
Reach 1b	0	0	7957	11,284	11,551	8842	0	39,634
Reach 1c	0	0	722	1024	1048	802	0	3596
Reach 2	0	0	0	0	0	0	0	0
Reach 3	0	0	3392	4811	4925	3770	0	16,898
Reach 4	0	0	216	307	314	240	0	1077
Reach 5	0	0	1311	1859	1903	1457	0	6530
Reach 6	0	0	12	17	17	13	0	59
Reach 7	0	0	139	198	202	155	0	695
Reach 8	0	0	555	787	805	616	0	2763
Reach 9	0	0	3591	5093	5214	3991	0	17,890
Reach 10	0	0	0	0	0	0	0	0
Reach 11	0	0	16	23	24	18	0	82
Reach 12	0	0	53	76	78	59	0	266
Reach 13	0	0	29	41	42	32	0	143
Reach 14	0	0	40	57	58	44	0	199
Reach 15	0	0	0	0	0	0	0	0
Total all Reaches	0	0	20,567	29,168	29,860	22,856	0	**102,450**

Table 7.8. The incremental increases in M&I Peak demands from already permitted live flow contracts, 2008 and 2070, from Tables MI 3 and MI 6 in Appendix F, used as the basis for Insufficient water year M&I diversions.

Reach	Increased M&I Demand in acre-feet							
	April	May	June	July	Aug.	Sept.	Oct.	Total
Reach 1	0	0	8995	12,757	13,060	9996	0	44,809
Reach 1a	0	0	2032	2882	2951	2259	0	10,124
Reach 1b	0	0	6384	9053	9268	7094	0	31,799
Reach 1c	0	0	579	821	841	644	0	2885
Reach 2	0	0	0	0	0	0	0	0
Reach 3	0	0	2722	3860	3951	3025	0	13,558
Reach 4	0	0	174	246	252	193	0	864
Reach 5	0	0	1052	1492	1527	1169	0	5239
Reach 6	0	0	10	14	14	11	0	48
Reach 7	0	0	112	159	162	124	0	557
Reach 8	0	0	445	631	646	495	0	2217
Reach 9	0	0	2881	4087	4183	3202	0	14,354
Reach 10	0	0	0	0	0	0	0	0
Reach 11	0	0	13	19	19	15	0	66
Reach 12	0	0	43	61	62	48	0	213
Reach 13	0	0	23	33	33	26	0	115
Reach 14	0	0	32	45	46	36	0	159
Reach 15	0	0	0	0	0	0	0	0
Total all Reaches	0	0	16,501	23,402	23,957	18,338	0	**82,199**

Table 7.9. The incremental increases in M&I Peak demands from already permitted live flow contracts, 2008 and 2070, from Tables MI 3 and MI 6 in Appendix F, used as the basis for Deficit water year M&I diversions.

Reach	Increased M&I Demand in acre-feet							
	April	May	June	July	Aug.	Sept.	Oct.	Total
Reach 1	0	0	6258	8875	9085	6954	0	31,171
Reach 1a	0	0	1414	2005	2053	1571	0	7043
Reach 1b	0	0	4441	6298	6447	4935	0	22,121
Reach 1c	0	0	403	571	585	448	0	2007
Reach 2	0	0	0	0	0	0	0	0
Reach 3	0	0	1893	2685	2749	2104	0	9432
Reach 4	0	0	121	171	175	134	0	601
Reach 5	0	0	732	1038	1062	813	0	3645
Reach 6	0	0	7	9	10	7	0	33
Reach 7	0	0	78	110	113	87	0	388
Reach 8	0	0	310	439	449	344	0	1542
Reach 9	0	0	2005	2843	2910	2228	0	9985
Reach 10	0	0	0	0	0	0	0	0
Reach 11	0	0	9	13	13	10	0	46
Reach 12	0	0	30	42	43	33	0	148
Reach 13	0	0	16	23	23	18	0	80
Reach 14	0	0	22	32	32	25	0	111
Reach 15	0	0	0	0	0	0	0	0
Total all Reaches	0	0	11,479	16,280	16,666	12,757	0	**57,182**

7.1.3 M&I Diversions Supplied in Full for all Water Years

The M&I demands in this simulation that are not reduced in lower water years are the 18,780 and 7541 ac-ft volumes for the 2008 to 2020 increases (Tables MI 1 and MI 2, respectively) and the 27,246 ac-ft volume for the 2020 to 2070 increase (Table MI 5). The volumes are listed in Table 3.1, and the tables referenced in parentheses are from Appendix F where the volumes are broken out by reach. The total of these M&I demands for all reaches is the remaining live flow demand described in Section 7.1.2.

Table 7.10 below shows the M&I diversions that apply for all water year types.

Table 7.10. The incremental increases in M&I Peak demands from already permitted live flow contracts, 2008 and 2070, from Tables MI 1, MI 2, and MI 5 in Appendix F.

Reach	Increased M&I Demand in acre-feet							
	April	May	June	July	Aug.	Sept.	Oct.	Total
Reach 1	10,168	12,083	2303	3267	3345	2559	0	**33,724**
Reach 1a	2617	3111	630	894	915	700	0	8867
Reach 1b	7087	8421	1557	2208	2261	1730	0	23,264
Reach 1c	464	550	116	165	169	129	0	1593
Reach 2	26	31	0	0	0	0	0	57
Reach 3	3004	3571	688	976	999	765	0	10,004
Reach 4	180	214	46	65	66	51	0	622
Reach 5	779	926	205	291	298	228	0	2727
Reach 6	1	2	0	0	0	0	0	3
Reach 7	75	89	24	34	35	26	0	283
Reach 8	470	559	130	184	188	144	0	1675
Reach 9	1100	1307	347	492	504	386	0	4136
Reach 10	0	0	0	0	0	0	0	0
Reach 11	5	5	1	2	2	1	0	16
Reach 12	15	18	4	6	6	5	0	54
Reach 13	24	29	7	9	9	7	0	85
Reach 14	48	57	15	21	22	17	0	181
Reach 15	0	0	0	0	0	0	0	0
Total all Reaches	15,896	18,891	3770	5347	5474	4189	0	**53,568**

*Note slight round-off error from showing all demands as integers.

7.1.4 Total Diversions by Reach and by Water Year Type

The total water volumes diverted in this simulation are shown below in Tables 7.11 through 7.14. These diversions depend on water year type, and determined from:

- Table 7.11, for Abundant water years, is the total of Tables 7.2, 7.6 and 7.10.
- Table 7.12, for Adequate water years, is the total of Tables 7.3, 7.7, and 7.10.
- Table 7.13, for Insufficient water years, is the total of Tables 7.4, 7.8, and 7.10.
- Table 7.14, for Deficit water years, is the total of Tables 7.5, 7.9, and 7.10.

The conversion of demand volumes by reach and by month (Tables 7.11 to 7.14) to daily average flow rates (using the volume to flow conversion from Section 3.2) are shown in Tables 7.15 through 7.18 for Abundant, Adequate, Insufficient, and Deficit water years. (As noted previously, Reach 1a is not included.)

Table 7.11. The incremental increases in all demands, 2008 and 2070, from Sections 7.1.1 to 7.1.3, used as the basis for Abundant water year diversions.

Reach	Increased Total Demand in acre-feet							
	April	May	June	July	Aug.	Sept.	Oct.	Total
Reach 1	10,301	14,974	22,824	36,177	35,758	23,048	134	143,215
Reach 1a	2623	3238	3903	5702	5782	4236	6	25,490
Reach 1b	7189	10,643	16,561	26,412	26,057	16,623	103	103,588
Reach 1c	489	1093	2360	4062	3919	2188	25	14,137
Reach 2	28	62	79	153	143	64	1	530
Reach 3	3074	5072	8518	14,057	13,727	8264	69	52,781
Reach 4	185	330	597	999	971	571	5	3658
Reach 5	871	2903	6846	12,311	11,730	6024	91	40,776
Reach 6	117	2499	6479	12,476	11,669	5199	115	38,554
Reach 7	79	184	432	737	713	403	4	2553
Reach 8	481	784	1356	2219	2172	1327	10	8348
Reach 9	1100	1307	4523	6414	6567	5027	0	24,938
Reach 10	5	115	299	575	538	239	5	1778
Reach 11	5	17	50	87	84	46	1	291
Reach 12	15	20	70	101	103	77	0	386
Reach 13	28	103	231	424	401	197	3	1386
Reach 14	48	64	78	119	119	82	0	511
Reach 15	0	7	18	36	33	15	0	110
Total all Reaches	16,338	28,439	52,401	86,885	84,727	50,582	441	**319,813**

*Note slight round-off error from showing all demands as integers.

Table 7.12. The incremental increases in all demands, 2008 and 2070, from Sections 7.1.1 to 7.1.3, used as the basis for Adequate water year diversions.

Reach	Increased Total Demand in acre-feet							
	April	May	June	July	Aug.	Sept.	Oct.	Total
Reach 1	10,283	14,569	19,951	31,569	31,220	20,179	115	127,887
Reach 1a	2622	3220	3445	5029	5100	3741	5	23,163
Reach 1b	7175	10,332	14,460	23,023	22,725	14,538	88	92,343
Reach 1c	485	1017	2046	3517	3394	1900	22	12,381
Reach 2	27	58	68	132	123	55	1	464
Reach 3	3064	4862	7422	12,225	11,945	7214	60	46,792
Reach 4	185	313	520	868	844	498	5	3233
Reach 5	858	2626	5916	10,628	10,129	5213	79	35,449
Reach 6	101	2150	5572	10,730	10,035	4471	99	33,157
Reach 7	79	171	375	639	618	350	4	2235
Reach 8	479	752	1185	1934	1894	1161	9	7414
Reach 9	1100	1307	3938	5585	5718	4377	0	22,025
Reach 10	5	99	257	495	463	206	5	1529
Reach 11	5	15	43	75	73	40	0	252
Reach 12	15	20	61	88	89	67	0	339
Reach 13	27	92	200	366	346	170	3	1204
Reach 14	48	63	69	105	106	73	0	465
Reach 15	0	6	16	31	29	13	0	95
Total all Reaches	16,276	27,103	45,593	75,470	73,631	44,087	380	**282,539**

Table 7.13. The incremental increases in all demands, 2008 and 2070, from Sections 7.1.1 to 7.1.3, used as the basis for Insufficient water year diversions.

Reach	Increased Total Demand in acre-feet							
	April	May	June	July	Aug.	Sept.	Oct.	Total
Reach 1	10,260	14,078	16,463	25,975	25,710	16,696	92	109,273
Reach 1a	2621	3198	2888	4212	4273	3140	4	20,337
Reach 1b	7158	9954	11,910	18,909	18,680	12,006	71	78,688
Reach 1c	481	925	1665	2854	2757	1550	17	10,248
Reach 2	27	52	55	106	99	44	1	384
Reach 3	3052	4607	6091	10002	9781	5939	48	39,520
Reach 4	184	294	426	709	690	410	4	2716
Reach 5	842	2290	4787	8585	8186	4227	63	28,981
Reach 6	81	1725	4470	8609	8051	3587	80	26,603
Reach 7	78	155	305	519	503	286	3	1849
Reach 8	477	714	976	1588	1557	960	7	6279
Reach 9	1100	1307	3228	4579	4687	3588	0	18,489
Reach 10	4	80	206	397	371	165	4	1227
Reach 11	5	13	35	61	59	32	0	205
Reach 12	15	19	49	72	73	55	0	283
Reach 13	27	80	162	295	279	138	2	983
Reach 14	48	62	59	89	89	62	0	409
Reach 15	0	5	13	25	23	10	0	76
Total all Reaches	16,201	25,479	37,325	61,608	60,158	36,200	305	**237,277**

Table 7.14. The incremental increases in all demands, 2008 and 2070, from Sections 7.1.1 to 7.1.3, used as the basis for Deficit water year diversions.

Reach	Increased Total Demand in acre-feet							
	April	May	June	July	Aug.	Sept.	Oct.	Total
Reach 1	10,232	13,471	12,153	19,064	18,903	12,394	64	86,280
Reach 1a	2620	3172	2201	3202	3251	2397	3	16,846
Reach 1b	7136	9488	8759	13,826	13,683	8879	49	61,820
Reach 1c	476	811	1193	2036	1969	1117	12	7614
Reach 2	27	46	38	73	69	31	1	284
Reach 3	3038	4292	4446	7255	7108	4364	33	30,537
Reach 4	182	269	311	513	500	300	3	2079
Reach 5	823	1875	3393	6061	5785	3010	44	20,991
Reach 6	57	1201	3110	5989	5601	2495	55	18,508
Reach 7	77	135	220	372	360	207	2	1373
Reach 8	475	667	719	1161	1140	712	5	4878
Reach 9	1100	1307	2352	3335	3414	2614	0	14,121
Reach 10	3	55	143	276	258	115	3	853
Reach 11	5	11	25	43	41	23	0	148
Reach 12	15	19	36	52	52	40	0	213
Reach 13	26	64	115	208	197	98	2	710
Reach 14	48	60	45	68	69	48	0	339
Reach 15	0	3	9	17	16	7	0	53
Total all Reaches	16,108	23,474	27,113	44,485	43,515	26,458	212	**181,366**

Table 7.15. Diversion withdrawals as daily average flow rates by reach, based on volumes from Table 7.11, the basis for Abundant water years.

Reach	Daily Flow Withdrawal Rate, in cfs, by month.											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1b	0.00	0.00	0.00	1.73	173.10	278.31	429.55	423.78	279.36	1.67	0.00	0.00
1c	0.00	0.00	0.00	0.42	17.78	39.67	66.07	63.74	36.78	0.41	0.00	0.00
2	0.00	0.00	0.00	0.02	1.01	1.34	2.49	2.33	1.07	0.02	0.00	0.00
3	0.00	0.00	0.00	1.17	82.49	143.15	228.61	223.24	138.88	1.13	0.00	0.00
4	0.00	0.00	0.00	0.09	5.36	10.03	16.24	15.79	9.59	0.09	0.00	0.00
5	0.00	0.00	0.00	1.54	47.21	115.05	200.22	190.77	101.24	1.49	0.00	0.00
6	0.00	0.00	0.00	1.94	40.65	108.88	202.91	189.77	87.37	1.88	0.00	0.00
7	0.00	0.00	0.00	0.07	2.99	7.26	11.99	11.60	6.78	0.07	0.00	0.00
8	0.00	0.00	0.00	0.17	12.74	22.79	36.08	35.32	22.30	0.17	0.00	0.00
9	0.00	0.00	0.00	0.00	21.25	76.01	104.32	106.80	84.48	0.00	0.00	0.00
10	0.00	0.00	0.00	0.09	1.88	5.02	9.36	8.75	4.02	0.09	0.00	0.00
11	0.00	0.00	0.00	0.01	0.28	0.84	1.42	1.37	0.78	0.01	0.00	0.00
12	0.00	0.00	0.00	0.00	0.32	1.17	1.65	1.67	1.29	0.00	0.00	0.00
13	0.00	0.00	0.00	0.06	1.67	3.88	6.89	6.52	3.31	0.06	0.00	0.00
14	0.00	0.00	0.00	0.01	1.04	1.31	1.93	1.94	1.38	0.00	0.00	0.00
15	0.00	0.00	0.00	0.01	0.12	0.31	0.58	0.54	0.25	0.01	0.00	0.00

Table 7.16. Diversion withdrawals as daily average flow rates by reach, based on volumes from Table 7.12, the basis for Adequate water years.

Reach	Daily Flow Withdrawal Rate, in cfs, by month.											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1b	0.00	0.00	0.00	1.48	168.04	243.01	374.44	369.59	244.32	1.44	0.00	0.00
1c	0.00	0.00	0.00	0.36	16.54	34.39	57.20	55.20	31.93	0.35	0.00	0.00
2	0.00	0.00	0.00	0.02	0.94	1.15	2.14	2.00	0.92	0.02	0.00	0.00
3	0.00	0.00	0.00	1.00	79.07	124.73	198.83	194.26	121.24	0.97	0.00	0.00
4	0.00	0.00	0.00	0.08	5.10	8.74	14.12	13.73	8.37	0.07	0.00	0.00
5	0.00	0.00	0.00	1.32	42.71	99.42	172.85	164.74	87.60	1.28	0.00	0.00
6	0.00	0.00	0.00	1.67	34.96	93.64	174.50	163.20	75.14	1.61	0.00	0.00
7	0.00	0.00	0.00	0.06	2.78	6.30	10.39	10.05	5.89	0.06	0.00	0.00
8	0.00	0.00	0.00	0.15	12.23	19.91	31.45	30.80	19.51	0.15	0.00	0.00
9	0.00	0.00	0.00	0.00	21.25	66.19	90.84	93.00	73.56	0.00	0.00	0.00
10	0.00	0.00	0.00	0.08	1.61	4.32	8.05	7.53	3.46	0.07	0.00	0.00
11	0.00	0.00	0.00	0.01	0.25	0.73	1.22	1.18	0.67	0.01	0.00	0.00
12	0.00	0.00	0.00	0.00	0.32	1.02	1.43	1.45	1.12	0.00	0.00	0.00
13	0.00	0.00	0.00	0.05	1.50	3.36	5.95	5.63	2.86	0.05	0.00	0.00
14	0.00	0.00	0.00	0.00	1.02	1.16	1.71	1.72	1.22	0.00	0.00	0.00
15	0.00	0.00	0.00	0.00	0.10	0.27	0.50	0.47	0.21	0.00	0.00	0.00

Table 7.17. Diversion withdrawals as daily average flow rates by reach, based on volumes from Table 7.13, the basis for Insufficient water years.

Reach	Daily Flow Withdrawal Rate, in cfs, by month.											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1b	0.00	0.00	0.00	1.19	161.89	200.15	307.52	303.80	201.77	1.15	0.00	0.00
1c	0.00	0.00	0.00	0.29	15.04	27.97	46.42	44.83	26.05	0.28	0.00	0.00
2	0.00	0.00	0.00	0.02	0.85	0.92	1.72	1.61	0.74	0.02	0.00	0.00
3	0.00	0.00	0.00	0.80	74.92	102.36	162.66	159.07	99.81	0.78	0.00	0.00
4	0.00	0.00	0.00	0.06	4.78	7.16	11.54	11.23	6.88	0.06	0.00	0.00
5	0.00	0.00	0.00	1.06	37.24	80.45	139.62	133.13	71.04	1.03	0.00	0.00
6	0.00	0.00	0.00	1.34	28.05	75.13	140.00	130.94	60.29	1.30	0.00	0.00
7	0.00	0.00	0.00	0.05	2.51	5.13	8.45	8.18	4.81	0.05	0.00	0.00
8	0.00	0.00	0.00	0.12	11.61	16.40	25.82	25.32	16.13	0.12	0.00	0.00
9	0.00	0.00	0.00	0.00	21.25	54.26	74.46	76.23	60.30	0.00	0.00	0.00
10	0.00	0.00	0.00	0.06	1.29	3.46	6.46	6.04	2.78	0.06	0.00	0.00
11	0.00	0.00	0.00	0.01	0.22	0.59	0.99	0.95	0.54	0.01	0.00	0.00
12	0.00	0.00	0.00	0.00	0.31	0.83	1.17	1.18	0.92	0.00	0.00	0.00
13	0.00	0.00	0.00	0.04	1.30	2.72	4.80	4.54	2.32	0.04	0.00	0.00
14	0.00	0.00	0.00	0.00	1.01	0.98	1.44	1.45	1.04	0.00	0.00	0.00
15	0.00	0.00	0.00	0.00	0.08	0.21	0.40	0.37	0.17	0.00	0.00	0.00

Table 7.18. Diversion withdrawals as daily average flow rates by reach, based on volumes from Table 7.14, the basis for Deficit water years.

Reach	Daily Flow Withdrawal Rate, in cfs, by month.											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1b	0.00	0.00	0.00	0.83	154.30	147.20	224.86	222.53	149.21	0.80	0.00	0.00
1c	0.00	0.00	0.00	0.20	13.19	20.05	33.11	32.02	18.78	0.20	0.00	0.00
2	0.00	0.00	0.00	0.01	0.75	0.64	1.20	1.12	0.51	0.01	0.00	0.00
3	0.00	0.00	0.00	0.56	69.80	74.72	117.99	115.60	73.35	0.54	0.00	0.00
4	0.00	0.00	0.00	0.04	4.38	5.22	8.35	8.14	5.05	0.04	0.00	0.00
5	0.00	0.00	0.00	0.74	30.49	57.01	98.57	94.09	50.59	0.71	0.00	0.00
6	0.00	0.00	0.00	0.93	19.52	52.26	97.39	91.09	41.94	0.90	0.00	0.00
7	0.00	0.00	0.00	0.04	2.19	3.69	6.04	5.86	3.48	0.03	0.00	0.00
8	0.00	0.00	0.00	0.08	10.85	12.08	18.88	18.54	11.96	0.08	0.00	0.00
9	0.00	0.00	0.00	0.00	21.25	39.52	54.24	55.53	43.92	0.00	0.00	0.00
10	0.00	0.00	0.00	0.04	0.90	2.41	4.49	4.20	1.93	0.04	0.00	0.00
11	0.00	0.00	0.00	0.00	0.18	0.41	0.70	0.67	0.38	0.00	0.00	0.00
12	0.00	0.00	0.00	0.00	0.31	0.60	0.84	0.85	0.66	0.00	0.00	0.00
13	0.00	0.00	0.00	0.03	1.04	1.92	3.38	3.21	1.65	0.03	0.00	0.00
14	0.00	0.00	0.00	0.00	0.98	0.76	1.11	1.12	0.81	0.00	0.00	0.00
15	0.00	0.00	0.00	0.00	0.06	0.15	0.28	0.26	0.12	0.00	0.00	0.00

7.1.5 Total Return Flows by Reach and by Water Year Type

The monthly shaping percentages from Table 6.6 are used to get the monthly volume of return flows for M&I and AI, and then the monthly volumes are converted to daily average return flows for each reach (using the volume to flow conversion from Section 3.2). The return flows used for the simulation are shown in Tables 7.19 through 7.22. Note that return flows in ResSim are still diversions, so the negative sign in the diversion results in an inflow for each reach.

Table 7.19. Return daily average flow by reach used for Abundant water years.

Reach	Daily Flow Return Rate, in cfs, by month, for M&I and Ag Demands that can be supported.											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1b	-4.5	-4.5	-4.5	-61.6	-73.4	-112.8	-160.0	-164.4	-125.0	-10.0	-6.7	-4.5
1c	-1.1	-1.1	-1.1	-5.8	-7.0	-11.5	-16.4	-16.9	-12.7	-2.4	-1.6	-1.1
2	-0.1	-0.1	-0.1	-0.1	-0.1	-0.3	-0.4	-0.4	-0.3	-0.1	-0.1	-0.1
3	-3.0	-3.0	-3.0	-27.4	-32.8	-51.5	-73.1	-75.3	-57.0	-6.8	-4.5	-3.0
4	-0.2	-0.2	-0.2	-1.8	-2.1	-3.4	-4.8	-4.9	-3.7	-0.5	-0.3	-0.2
5	-4.0	-4.0	-4.0	-12.5	-15.1	-26.7	-37.8	-39.3	-29.3	-8.9	-5.9	-4.0
6	-5.0	-5.0	-5.0	-5.1	-6.3	-15.1	-21.4	-22.7	-16.4	-11.3	-7.5	-5.0
7	-0.2	-0.2	-0.2	-1.1	-1.3	-2.1	-3.0	-3.1	-2.4	-0.4	-0.3	-0.2
8	-0.5	-0.5	-0.5	-4.5	-5.3	-8.4	-11.9	-12.2	-9.3	-1.0	-0.7	-0.5
9	0.0	0.0	0.0	-20.5	-24.4	-35.8	-50.7	-51.9	-39.7	0.0	0.0	0.0
10	-0.2	-0.2	-0.2	-0.2	-0.3	-0.7	-1.0	-1.0	-0.8	-0.5	-0.3	-0.2
11	0.0	0.0	0.0	-0.1	-0.1	-0.2	-0.3	-0.3	-0.3	-0.1	0.0	0.0
12	0.0	0.0	0.0	-0.3	-0.4	-0.5	-0.8	-0.8	-0.6	0.0	0.0	0.0
13	-0.1	-0.1	-0.1	-0.4	-0.4	-0.8	-1.1	-1.2	-0.9	-0.3	-0.2	-0.1
14	0.0	0.0	0.0	-0.4	-0.4	-0.6	-0.9	-0.9	-0.7	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	-0.1	0.0	0.0	0.0	0.0

Table 7.20. Return daily average flow by reach used for Adequate water years.

Reach	Daily Flow Return Rate, in cfs, by month, for M&I and Ag Demands that can be supported.											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1b	-3.8	-3.8	-3.8	-61.2	-72.9	-99.3	-140.7	-144.7	-110.0	-8.6	-5.7	-3.8
1c	-0.9	-0.9	-0.9	-5.7	-6.8	-10.0	-14.2	-14.7	-11.1	-2.1	-1.4	-0.9
2	-0.1	-0.1	-0.1	-0.1	-0.1	-0.2	-0.3	-0.4	-0.3	-0.1	-0.1	-0.1
3	-2.6	-2.6	-2.6	-27.1	-32.4	-45.3	-64.2	-66.1	-50.1	-5.8	-3.9	-2.6
4	-0.2	-0.2	-0.2	-1.7	-2.1	-3.0	-4.2	-4.3	-3.3	-0.4	-0.3	-0.2
5	-3.4	-3.4	-3.4	-11.8	-14.3	-23.1	-32.8	-34.1	-25.4	-7.7	-5.1	-3.4
6	-4.3	-4.3	-4.3	-4.4	-5.5	-13.0	-18.4	-19.5	-14.1	-9.7	-6.5	-4.3
7	-0.2	-0.2	-0.2	-1.1	-1.3	-1.9	-2.6	-2.7	-2.0	-0.4	-0.2	-0.2
8	-0.4	-0.4	-0.4	-4.4	-5.3	-7.4	-10.4	-10.7	-8.1	-0.9	-0.6	-0.4
9	0.0	0.0	0.0	-20.1	-23.9	-30.7	-43.6	-44.6	-34.2	0.0	0.0	0.0
10	-0.2	-0.2	-0.2	-0.2	-0.2	-0.6	-0.8	-0.9	-0.6	-0.4	-0.3	-0.2
11	0.0	0.0	0.0	-0.1	-0.1	-0.2	-0.3	-0.3	-0.2	0.0	0.0	0.0
12	0.0	0.0	0.0	-0.3	-0.4	-0.5	-0.6	-0.7	-0.5	0.0	0.0	0.0
13	-0.1	-0.1	-0.1	-0.3	-0.4	-0.7	-1.0	-1.0	-0.8	-0.3	-0.2	-0.1
14	0.0	0.0	0.0	-0.4	-0.4	-0.6	-0.8	-0.8	-0.6	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	-0.1	0.0	0.0	0.0	0.0

Table 7.21. Return daily average flow by reach used for Insufficient water years.

Reach	Daily Flow Return Rate, in cfs, by month, for M&I and Ag Demands that can be supported.											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1b	-3.1	-3.1	-3.1	-60.7	-72.4	-82.8	-117.4	-120.6	-91.7	-6.9	-4.6	-3.1
1c	-0.8	-0.8	-0.8	-5.4	-6.5	-8.2	-11.7	-12.1	-9.1	-1.7	-1.1	-0.8
2	0.0	0.0	0.0	-0.1	-0.1	-0.2	-0.3	-0.3	-0.2	-0.1	-0.1	0.0
3	-2.1	-2.1	-2.1	-26.8	-31.9	-37.7	-53.5	-55.0	-41.7	-4.7	-3.1	-2.1
4	-0.2	-0.2	-0.2	-1.7	-2.0	-2.5	-3.5	-3.6	-2.7	-0.4	-0.2	-0.2
5	-2.7	-2.7	-2.7	-11.1	-13.3	-18.8	-26.7	-27.8	-20.7	-6.2	-4.1	-2.7
6	-3.5	-3.5	-3.5	-3.5	-4.4	-10.4	-14.8	-15.6	-11.3	-7.8	-5.2	-3.5
7	-0.1	-0.1	-0.1	-1.0	-1.2	-1.5	-2.1	-2.2	-1.7	-0.3	-0.2	-0.1
8	-0.3	-0.3	-0.3	-4.4	-5.2	-6.1	-8.7	-8.9	-6.8	-0.7	-0.5	-0.3
9	0.0	0.0	0.0	-19.4	-23.0	-24.7	-35.0	-35.9	-27.4	0.0	0.0	0.0
10	-0.2	-0.2	-0.2	-0.2	-0.2	-0.5	-0.7	-0.7	-0.5	-0.4	-0.2	-0.2
11	0.0	0.0	0.0	-0.1	-0.1	-0.2	-0.2	-0.2	-0.2	0.0	0.0	0.0
12	0.0	0.0	0.0	-0.3	-0.3	-0.4	-0.5	-0.5	-0.4	0.0	0.0	0.0
13	-0.1	-0.1	-0.1	-0.3	-0.4	-0.6	-0.8	-0.8	-0.6	-0.2	-0.2	-0.1
14	0.0	0.0	0.0	-0.4	-0.4	-0.5	-0.7	-0.7	-0.5	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

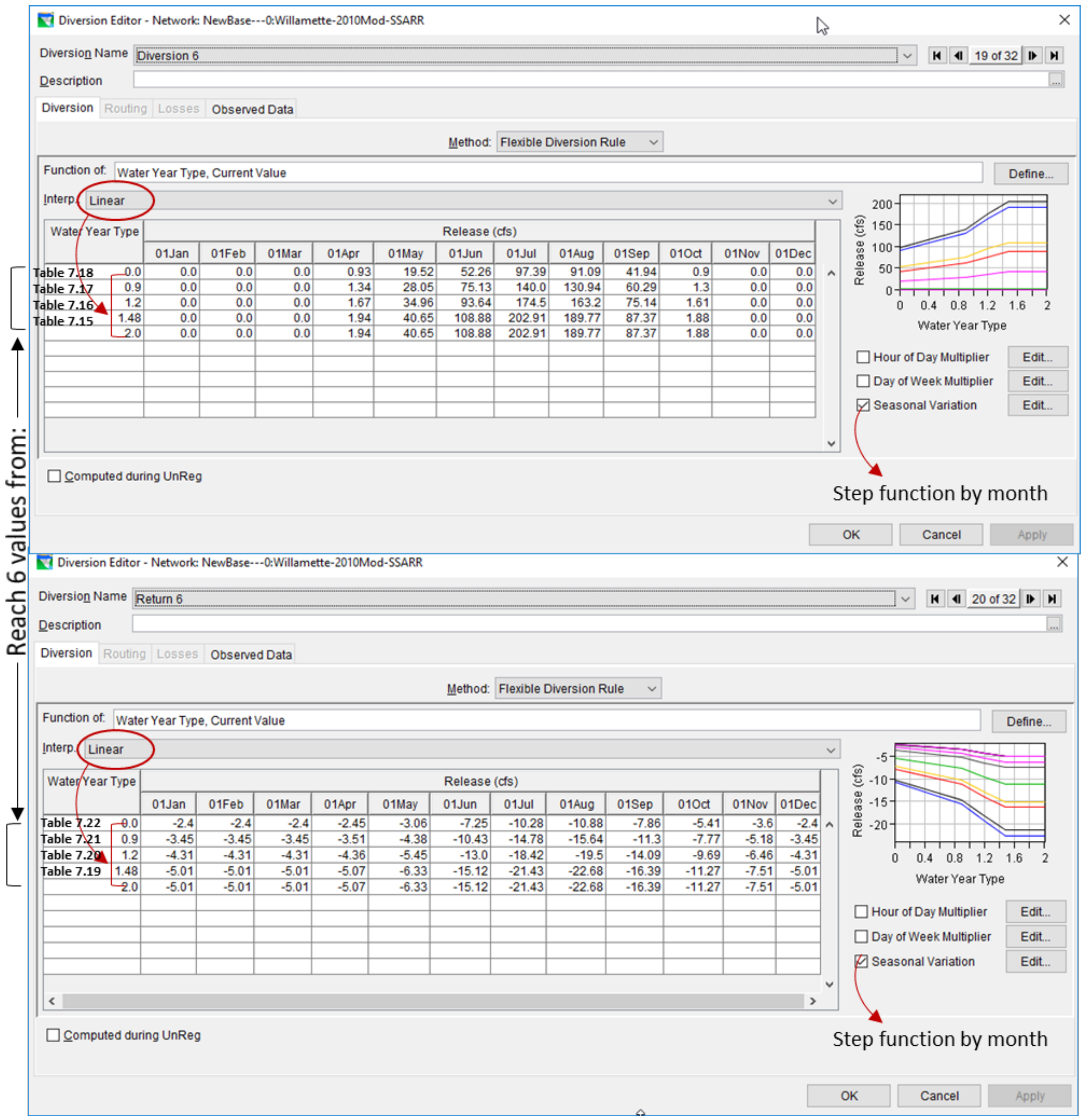
Table 7.22. Return daily average flow by reach used for Deficit water years.

Reach	Daily Flow Return Rate, in cfs, by month, for M&I and Ag Demands that can be supported.											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1b	-2.1	-2.1	-2.1	-60.4	-71.9	-62.3	-88.4	-90.8	-69.1	-4.8	-3.2	-2.1
1c	-0.5	-0.5	-0.5	-5.1	-6.1	-6.0	-8.5	-8.8	-6.6	-1.2	-0.8	-0.5
2	0.0	0.0	0.0	-0.1	-0.1	-0.2	-0.2	-0.2	-0.2	-0.1	0.0	0.0
3	-1.4	-1.4	-1.4	-26.4	-31.5	-28.3	-40.1	-41.3	-31.3	-3.2	-2.2	-1.4
4	-0.1	-0.1	-0.1	-1.7	-2.0	-1.8	-2.6	-2.7	-2.0	-0.3	-0.2	-0.1
5	-1.9	-1.9	-1.9	-10.1	-12.1	-13.6	-19.2	-20.0	-14.9	-4.3	-2.9	-1.9
6	-2.4	-2.4	-2.4	-2.4	-3.1	-7.3	-10.3	-10.9	-7.9	-5.4	-3.6	-2.4
7	-0.1	-0.1	-0.1	-1.0	-1.1	-1.1	-1.6	-1.6	-1.2	-0.2	-0.1	-0.1
8	-0.2	-0.2	-0.2	-4.3	-5.2	-4.6	-6.5	-6.7	-5.1	-0.5	-0.3	-0.2
9	0.0	0.0	0.0	-18.1	-21.5	-17.4	-24.7	-25.3	-19.3	0.0	0.0	0.0
10	-0.1	-0.1	-0.1	-0.1	-0.1	-0.3	-0.5	-0.5	-0.4	-0.2	-0.2	-0.1
11	0.0	0.0	0.0	-0.1	-0.1	-0.1	-0.2	-0.2	-0.1	0.0	0.0	0.0
12	0.0	0.0	0.0	-0.3	-0.3	-0.3	-0.4	-0.4	-0.3	0.0	0.0	0.0
13	-0.1	-0.1	-0.1	-0.3	-0.3	-0.4	-0.6	-0.6	-0.5	-0.2	-0.1	-0.1
14	0.0	0.0	0.0	-0.4	-0.5	-0.4	-0.5	-0.5	-0.4	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

7.1.6 Diversion Rule Example

The final flow specifications for the diversion withdrawals (Tables 7.15 to 7.18) and the diversion return flows (Tables 7.19 to 7.22) were input to ResSim with flexible diversion rules for each reach. Figure 7.1 is an example of the withdrawal and return flow rules for Reach 6, noting which tables were used for each water year type volume entry. The water year types are defined in Appendix E, Table 2.4. Rules for all diversions specified in Table 3.6 are applied in the same way.

Figure 7.1. Reach 6 Diversion Rules: at top is the withdrawal rule (Diversion Name = Diversion 6) and at bottom is the return flow rule (Diversion Name = Return 6). Note that flow rate is calculated based on a linear interpolation of the water year type volume and a step function by month. Entries for flow rates are annotated at left edge of figure for table reference number.



7.2 ResSim Rule Changes

Each project for the Peak No Action 2070 analysis needs to release more water than the Baseline since more BOR contracts for stored water are represented in the simulation, with the increased volumes for each water year type shown in Tables 7.2 to 7.5. Each project operation set has a rule to specify the minimum release, and this section shows the development of the project releases to cover the BOR contract demands at each project.

The increased M&I demands described in Section 7.1 apply to water diverted from the system, but without planned increases in reservoir releases to cover them because those increases are from live flow permits, not stored water. However, if those diversions deplete the flow at Albany or Salem below the BiOp target minimum flows, then reservoir releases would supplement the difference through the use of the downstream minimum flow rules. See Appendix E for details about how the model meets the BiOp mainstem targets. All of the BiOp minimum flow target rules are the same in the Peak No Action 2050 simulation as in the Baseline and the Base Year 2020 analyses.

The minimum project outflows used for each project in the Baseline simulation, documented in the Model Documentation Report (Appendix E), represented the BiOp tributary minimum flows. Two projects, Detroit and Fern Ridge, also included some specific irrigation releases in addition to the minimum tributary flows, at the 2008 level of BOR contracts. The increases in BOR contracts from 2008 to 2050 at Detroit and Fern Ridge will be in addition to the releases at those two projects for 2008 levels.

In order to meet the new demands on stored water, it was assumed that a project should contribute stored water for a reach proportionally based on reservoir size of the storage projects. Table 7.23 lists each storage project, the acre-feet of space in that project's conservation zone, and the ratio of that project's conservation space to the total conservation space in the Willamette projects.

Some reaches can only receive stored water from a single project, such as Reach 15, which is downstream of Cottage Grove dam before the confluence with the Row River. No other dams can supply water to Reach 15. Some reaches, such as Reach 1, are downstream of all reservoirs, so all projects can contribute to Reach 1 or its sub-reaches 1a, 1b, or 1c. Table 7.24 indicates which storage projects can supply flows to each reach, and the proportional amount that each of those projects should contribute is listed as well. So Reach 15 has Cottage Grove supplying all the water (proportional share is one), and Reach 1 has each projects' proportional share equal to the values in Table 7.23. All proportional shares in a reach (a row in Table 7.24) sum to one.

Table 7.25 documents the increased project releases needed each month to cover the increased stored water demands (Tables 7.2 to 7.5) using the values in Table 7.24 to proportion the share of demand by reach and by project. Table 7.25 shows the values calculated for each of the four water year types.

These increases in project releases by month and water year type were added to the minimum releases specified for the Baseline (Appendices E). The project specific releases are shown in Tables 7.26 through 7.36. Each project's minimum release rule in the conservation zone is dependent on the water year type, while each project's minimum release in the buffer zone is specified as the Deficit year minimum from the tables. (See Section 5 for more details on the project minimum release rules.)

Several projects have some special notes on project releases below their tables. These are Cougar, Lookout Point, Foster, Fern Ridge, Detroit, and Green Peter. Cougar minimum releases due to some hydraulic design issues are slightly higher than the BiOp releases, so this is noted below Table 7.27. The Lookout Point minimum release must also include the project share from Hills Creek, as noted below Table 7.32, and Foster releases must pass Green Peter's share as well, as noted in Table 7.35. Fern Ridge minimum releases need to include the BOR contracts in 2008, as noted in Table 7.33, and the same is true of Detroit, as noted below Table 7.36. Green Peter minimum releases are the same as the Foster minimum, as noted below Table 7.34, in order to model Foster operations more realistically.

Table 7.23. Total storage space in the conservation zones at each Willamette storage project and the ratio of that space to the total conservation storage space in the basin.

Project	Conservation Zone Space, ac-ft	Portion of Total Conservation Space at Project
COT	28,661	0.018
DOR	64,745	0.041
HCR	194,600	0.122
LOP	324,200	0.204
FAL	115,865	0.071
CGR	136,800	0.086
BLU	78,829	0.050
FRN	94,498	0.059
GPR	249,900	0.157
FOS	24,800	0.016
DET	281,600	0.177
Total:	1,591,498	1.000

Table 7.24. Individual project contribution share of flow to meet demand in each reach.

Reach	**Project's Share of Meeting Demand in Reach**										
	HCR	**LOP**	**CGR**	**GPR**	**FOS**	**DET**	**FAL**	**COT**	**DOR**	**BLU**	**FRN**
1	0.122	0.204	0.086	0.157	0.016	0.177	0.071	0.018	0.041	0.050	0.059
2				0.449	0.045	0.506					
3						1.000					
4				0.910	0.090						
5	0.188	0.313	0.132				0.109	0.028	0.063	0.076	0.091
6											1.000
7	0.207	0.345	0.145				0.120	0.030	0.069	0.084	
8			0.634							0.366	
9	0.268	0.447					0.156	0.040	0.089		
10	0.308	0.513					0.179				
11	0.375	0.625									
12							1.000				
13								0.307	0.693		
14									1.000		
15								1.000			

Table 7.25. Individual project flow contributions each month to meet the increased demands in all reaches for each water year type for increases in BOR contracts between 2008 and 2070, for the Peak No Action 2070 analysis.

Month	Project's release to meet increased share of demand in all reaches, in cfs, Abundant years										
	HCR	LOP	CGR	GPR	FOS	DET	FAL	COT	DOR	BLU	FRN
Apr	0.61	1.02	0.52	0.45	0.04	1.58	0.35	0.11	0.24	0.30	2.21
May	12.76	21.26	10.83	9.32	0.92	32.98	7.38	2.27	4.96	6.24	46.34
Jun	34.13	56.87	28.97	24.93	2.47	88.23	19.75	6.07	13.28	16.69	123.96
Jul	63.65	106.04	54.02	46.49	4.61	164.52	36.82	11.31	24.76	31.13	231.15
Aug	59.52	99.16	50.52	43.47	4.31	153.84	34.44	10.58	23.16	29.11	216.15
Sep	27.37	45.60	23.23	19.99	1.98	70.74	15.83	4.86	10.65	13.39	99.39
Oct	0.59	0.98	0.50	0.43	0.04	1.52	0.34	0.10	0.23	0.29	2.14
Month	Project's release to meet increased share of demand in all reaches, in cfs, Adequate years										
	HCR	LOP	CGR	GPR	FOS	DET	FAL	COT	DOR	BLU	FRN
Apr	0.52	0.87	0.44	0.38	0.04	1.35	0.30	0.09	0.20	0.26	1.90
May	10.97	18.28	9.31	8.02	0.80	28.37	6.35	1.95	4.27	5.37	39.86
Jun	29.36	48.91	24.92	21.44	2.13	75.88	16.98	5.22	11.42	14.36	106.61
Jul	54.74	91.19	46.46	39.98	3.97	141.48	31.67	9.73	21.30	26.77	198.79
Aug	51.19	85.28	43.44	37.38	3.71	132.31	29.61	9.10	19.91	25.03	185.89
Sep	23.54	39.21	19.98	17.19	1.71	60.84	13.62	4.18	9.16	11.51	85.48
Oct	0.51	0.85	0.43	0.37	0.04	1.31	0.29	0.09	0.20	0.25	1.84
Month	Project's release to meet increased share of demand in all reaches, in cfs, Insufficient years										
	HCR	LOP	CGR	GPR	FOS	DET	FAL	COT	DOR	BLU	FRN
Apr	0.42	0.70	0.36	0.31	0.03	1.09	0.24	0.07	0.16	0.21	1.53
May	8.81	14.67	7.47	6.43	0.64	22.76	5.09	1.56	3.43	4.31	31.98
Jun	23.55	39.24	19.99	17.20	1.71	60.88	13.63	4.19	9.16	11.52	85.54
Jul	43.92	73.17	37.28	32.08	3.18	113.52	25.41	7.80	17.09	21.48	159.49
Aug	41.07	68.42	34.86	29.99	2.98	106.15	23.76	7.30	15.98	20.09	149.14
Sep	18.88	31.46	16.03	13.79	1.37	48.81	10.93	3.36	7.35	9.24	68.58
Oct	0.41	0.68	0.35	0.30	0.03	1.05	0.24	0.07	0.16	0.20	1.48
Month	Project's release to meet increased share of demand in all reaches, in cfs, Deficit years										
	HCR	LOP	CGR	GPR	FOS	DET	FAL	COT	DOR	BLU	FRN
Apr	0.29	0.49	0.25	0.21	0.02	0.76	0.17	0.05	0.11	0.14	1.06
May	6.13	10.20	5.20	4.47	0.44	15.83	3.54	1.09	2.38	3.00	22.25
Jun	16.38	27.30	13.91	11.97	1.19	42.35	9.48	2.91	6.37	8.01	59.50
Jul	30.55	50.90	25.93	22.31	2.21	78.97	17.68	5.43	11.89	14.94	110.95
Aug	28.57	47.60	24.25	20.87	2.07	73.84	16.53	5.08	11.12	13.97	103.75
Sep	13.14	21.89	11.15	9.59	0.95	33.96	7.60	2.33	5.11	6.43	47.71
Oct	0.28	0.47	0.24	0.21	0.02	0.73	0.16	0.05	0.11	0.14	1.03

Table 7.26. Minimum project releases for the BiOp and BOR contracts for Blue River. Totals for all water year types used in rule "Min Flow – at Blue River" and total for Deficit year values used in rule "New Min BLU Buffer".

	Minimum Project Release, in cfs											
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
BiOp*	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
2008-2070												
Deficit	0.00	0.00	0.00	0.14	3.00	8.01	14.94	13.97	6.43	0.14	0.00	0.00
Insufficient	0.00	0.00	0.00	0.21	4.31	11.52	21.48	20.09	9.24	0.20	0.00	0.00
Adequate	0.00	0.00	0.00	0.26	5.37	14.36	26.77	25.03	11.51	0.25	0.00	0.00
Abundant	0.00	0.00	0.00	0.30	6.24	16.69	31.13	29.11	13.39	0.29	0.00	0.00
Total												
Deficit	50.00	50.00	50.00	50.14	53.00	58.01	64.94	63.97	56.43	50.14	50.00	50.00
Insufficient	50.00	50.00	50.00	50.21	54.31	61.52	71.48	70.09	59.24	50.20	50.00	50.00
Adequate	50.00	50.00	50.00	50.26	55.37	64.36	76.77	75.03	61.51	50.25	50.00	50.00
Abundant	50.00	50.00	50.00	50.30	56.24	66.69	81.13	79.11	63.39	50.29	50.00	50.00

*Note: "BiOp" means the BiOp minimum tributary flow target for this project.

Table 7.27. Minimum project releases for the BiOp and BOR contracts for Cougar. Totals for all water year types used in rule "MinConservFlow_Cougar" and total for Deficit year values used in rule "New Min CGR BUffer".

	Minimum Project Release, in cfs											
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
BiOp*	300.0	300.0	300.0	300.0	300.0	400.0	300.0	300.0	300.0	300.0	300.0	300.0
2008-2070												
Deficit	0.00	0.00	0.00	0.25	5.20	13.91	25.93	24.25	11.15	0.24	0.00	0.00
Insufficient	0.00	0.00	0.00	0.36	7.47	19.99	37.28	34.86	16.03	0.35	0.00	0.00
Adequate	0.00	0.00	0.00	0.44	9.31	24.92	46.46	43.44	19.98	0.43	0.00	0.00
Abundant	0.00	0.00	0.00	0.52	10.83	28.97	54.02	50.52	23.23	0.50	0.00	0.00
Total												
Deficit	400.0	400.0	400.0	400.0	400.0	413.9	400.0	400.0	400.0	400.0	400.0	400.0
Insufficient	400.0	400.0	400.0	400.0	400.0	420.0	400.0	400.0	400.0	400.0	400.0	400.0
Adequate	400.0	400.0	400.0	400.0	400.0	424.9	400.0	400.0	400.0	400.0	400.0	400.0
Abundant	400.0	400.0	400.0	400.0	400.0	429.0	400.0	400.0	400.0	400.0	400.0	400.0

*Note: "BiOp" means the BiOp minimum tributary flow target for this project. While this minimum value is 300 cfs most of the time, the minimum turbine flow without causing cavitation is higher than 300 cfs, so 400 cfs is used for the minimum release most of the time. If the increased project release to cover the downstream BOR contracts plus the 300 cfs BiOp min is still less than 400 cfs, the project will still release 400 cfs as a minimum.

Table 7.28. Minimum project releases for the BiOp and BOR contracts for Dorena. Totals for all water year types used in rule "Min Flow from Dorena" and total for Deficit year values used in rule "New Min DOR Buffer".

	Minimum Project Release, in cfs											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
BiOp*	100.0	190.0	190.0	190.0	190.0	190.0	100.0	100.0	100.0	100.0	100.0	100.0
2008-2070												
Deficit	0.00	0.00	0.00	0.11	2.38	6.37	11.89	11.12	5.11	0.11	0.00	0.00
Insufficient	0.00	0.00	0.00	0.16	3.43	9.16	17.09	15.98	7.35	0.16	0.00	0.00
Adequate	0.00	0.00	0.00	0.20	4.27	11.42	21.30	19.91	9.16	0.20	0.00	0.00
Abundant	0.00	0.00	0.00	0.24	4.96	13.28	24.76	23.16	10.65	0.23	0.00	0.00
Total												
Deficit	100.0	190.0	190.0	190.1	192.4	196.4	111.9	111.1	105.1	100.1	100.0	100.0
Insufficient	100.0	190.0	190.0	190.2	193.4	199.2	117.1	116.0	107.3	100.2	100.0	100.0
Adequate	100.0	190.0	190.0	190.2	194.3	201.4	121.3	119.9	109.2	100.2	100.0	100.0
Abundant	100.0	190.0	190.0	190.2	195.0	203.3	124.8	123.2	110.6	100.2	100.0	100.0

*Note: "BiOp" means the BiOp minimum tributary flow target for this project.

Table 7.29. Minimum project releases for the BiOp and BOR contracts for Cottage Grove.

	Minimum Project Release, in cfs											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
BiOp*	50.0	75.0	75.0	75.0	75.0	75.0	50.0	50.0	50.0	50.0	50.0	50.0
2008-2070												
Deficit	0.00	0.00	0.00	0.05	1.09	2.91	5.43	5.08	2.33	0.05	0.00	0.00
Insufficient	0.00	0.00	0.00	0.07	1.56	4.19	7.80	7.30	3.36	0.07	0.00	0.00
Adequate	0.00	0.00	0.00	0.09	1.95	5.22	9.73	9.10	4.18	0.09	0.00	0.00
Abundant	0.00	0.00	0.00	0.11	2.27	6.07	11.31	10.58	4.86	0.10	0.00	0.00
Total												
Deficit	50.00	75.00	75.00	75.05	76.09	77.91	55.43	55.08	52.33	50.05	50.00	50.00
Insufficient	50.00	75.00	75.00	75.07	76.56	79.19	57.80	57.30	53.36	50.07	50.00	50.00
Adequate	50.00	75.00	75.00	75.09	76.95	80.22	59.73	59.10	54.18	50.09	50.00	50.00
Abundant	50.00	75.00	75.00	75.11	77.27	81.07	61.31	60.58	54.86	50.10	50.00	50.00

*Note: "BiOp" means the BiOp minimum tributary flow target for this project.

Table 7.30. Minimum project releases for the BiOp and BOR contracts for Fall Creek.

	Minimum Project Release, in cfs											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	1Oct	16Oct	Nov/Dec
BiOp*	50.0	50.0	50.0	80.0	80.0	80.0	80.0	80.0	200.0	200.0	50.0	50.0
2008-2070												
Deficit	0.00	0.00	0.00	0.17	3.54	9.48	17.68	16.53	7.60	0.16	0.16	0.00
Insufficient	0.00	0.00	0.00	0.24	5.09	13.63	25.41	23.76	10.93	0.24	0.24	0.00
Adequate	0.00	0.00	0.00	0.30	6.35	16.98	31.67	29.61	13.62	0.29	0.29	0.00
Abundant	0.00	0.00	0.00	0.35	7.38	19.75	36.82	34.44	15.83	0.34	0.34	0.00
Total												
Deficit	50.0	50.0	50.0	80.2	83.5	89.5	97.7	96.5	207.6	200.2	50.16	50.0
Insufficient	50.0	50.0	50.0	80.2	85.1	93.6	105.4	103.8	210.9	200.2	50.24	50.0
Adequate	50.0	50.0	50.0	80.3	86.3	97.0	111.7	109.6	213.6	200.3	50.29	50.0
Abundant	50.0	50.0	50.0	80.4	87.4	99.7	116.8	114.4	215.8	200.3	50.34	50.0

*Note: "BiOp" means the BiOp minimum tributary flow target for this project.

Table 7.31. Minimum project releases for the BiOp and BOR contracts for Hills Creek.

	Minimum Project Release, in cfs											
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
BiOp*	400.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0
2008-2070												
Deficit	0.0	0.0	0.0	0.3	6.1	16.4	30.6	28.6	13.1	0.3	0.0	0.0
Insufficient	0.0	0.0	0.0	0.4	8.8	23.6	43.9	41.1	18.9	0.4	0.0	0.0
Adequate	0.0	0.0	0.0	0.5	11.0	29.4	54.7	51.2	23.5	0.5	0.0	0.0
Abundant	0.0	0.0	0.0	0.6	12.8	34.1	63.6	59.5	27.4	0.6	0.0	0.0
Total												
Deficit	400.0	400.0	400.0	400.3	406.1	416.4	430.6	428.6	413.1	400.3	400.0	400.0
Insufficient	400.0	400.0	400.0	400.4	408.8	423.6	443.9	441.1	418.9	400.4	400.0	400.0
Adequate	400.0	400.0	400.0	400.5	411.0	429.4	454.7	451.2	423.5	400.5	400.0	400.0
Abundant	400.0	400.0	400.0	400.6	412.8	434.1	463.6	459.5	427.4	400.6	400.0	400.0

*Note: "BiOp" means the BiOp minimum tributary flow target for this project.

Table 7.32. Minimum project releases for the BiOp and BOR contracts for Lookout Point.

	Minimum Project Release, in cfs											
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
BiOp*	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200
HCR share 2008-2070												
Deficit	0.0	0.0	0.0	0.3	6.1	16.4	30.6	28.6	13.1	0.3	0.0	0.0
Insufficient	0.0	0.0	0.0	0.4	8.8	23.6	43.9	41.1	18.9	0.4	0.0	0.0
Adequate	0.0	0.0	0.0	0.5	11.0	29.4	54.7	51.2	23.5	0.5	0.0	0.0
Abundant	0.0	0.0	0.0	0.6	12.8	34.1	63.6	59.5	27.4	0.6	0.0	0.0
LOP share 2008-2070												
Deficit	0.0	0.0	0.0	0.5	10.2	27.3	50.9	47.6	21.9	0.5	0.0	0.0
Insufficient	0.0	0.0	0.0	0.7	14.7	39.2	73.2	68.4	31.5	0.7	0.0	0.0
Adequate	0.0	0.0	0.0	0.9	18.3	48.9	91.2	85.3	39.2	0.8	0.0	0.0
Abundant	0.0	0.0	0.0	1.0	21.3	56.9	106.0	99.2	45.6	1.0	0.0	0.0
Total												
Deficit	1200	1200	1200	1201	1216	1244	1281	1276	1235	1201	1200	1200
Insufficient	1200	1200	1200	1201	1223	1263	1317	1309	1250	1201	1200	1200
Adequate	1200	1200	1200	1201	1229	1278	1346	1336	1263	1201	1200	1200
Abundant	1200	1200	1200	1202	1234	1291	1370	1359	1273	1202	1200	1200

*Note: "BiOp" means the BiOp minimum tributary flow target for this project.
Minimum release must also include Hills Creek share.

Table 7.33. Minimum project releases for the BiOp and BOR contracts for Fern Ridge.

	Minimum Project Release, in cfs											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
BiOp*	30.00	50.00	50.00	50.00	50.00	50.00	30.00	30.00	30.00	30.00	30.00	30.00
Baseline (2008)												
Deficit	0.00	0.00	0.00	0.00	25.11	51.74	82.63	66.00	33.93	0.00	0.00	0.00
Insufficient	0.00	0.00	0.00	0.00	25.11	51.74	82.63	66.00	33.93	0.00	0.00	0.00
Adequate	0.00	0.00	0.00	0.00	25.11	51.74	82.63	66.00	33.93	0.00	0.00	0.00
Abundant	0.00	0.00	0.00	0.00	25.11	51.74	82.63	66.00	33.93	0.00	0.00	0.00
2008-2070												
Deficit	0.00	0.00	0.00	1.06	22.25	59.50	110.95	103.75	47.71	1.03	0.00	0.00
Insufficient	0.00	0.00	0.00	1.53	31.98	85.54	159.49	149.14	68.58	1.48	0.00	0.00
Adequate	0.00	0.00	0.00	1.90	39.86	106.61	198.79	185.89	85.48	1.84	0.00	0.00
Abundant	0.00	0.00	0.00	2.21	46.34	123.96	231.15	216.15	99.39	2.14	0.00	0.00
Total**												
Deficit	30.00	50.00	50.00	51.06	97.36	161.25	223.59	199.75	111.64	31.03	30.00	30.00
Insufficient	30.00	50.00	50.00	51.53	107.09	187.28	272.13	245.14	132.51	31.48	30.00	30.00
Adequate	30.00	50.00	50.00	51.90	114.97	208.35	311.42	281.89	149.41	31.84	30.00	30.00
Abundant	30.00	50.00	50.00	52.21	121.45	225.71	343.78	312.15	163.32	32.14	30.00	30.00

*Note: "BiOp" means the BiOp minimum tributary flow target for this project.

**Total outflow minimum from Fern Ridge includes BOR contracts in 2008 as well as the additional contracts after 2008.

Table 7.34. Minimum project releases for the BiOp and BOR contracts for Green Peter.

	Minimum Project Release, in cfs								
	Apr	1 May	16 May	Jun	Jul	Aug	Sep	1 Oct	16 Oct
BiOp*	1500	1500	1100	1100	800	800	1500	1100	1500
2008-2070									
Deficit	0.21	4.47	4.47	11.97	22.31	20.87	9.59	0.21	0.21
Insufficient	0.31	6.43	6.43	17.20	32.08	29.99	13.79	0.30	0.30
Adequate	0.38	8.02	8.02	21.44	39.98	37.38	17.19	0.37	0.37
Abundant	0.45	9.32	9.32	24.93	46.49	43.47	19.99	0.43	0.43
Total**									
Deficit	1500.23	1504.92	1104.92	1113.15	824.53	822.94	1510.55	1500.23	1100.23
Insufficient	1500.34	1507.07	1107.07	1118.91	835.26	832.97	1515.16	1500.33	1100.33
Adequate	1500.42	1508.81	1108.81	1123.57	843.95	841.09	1518.90	1500.41	1100.41
Abundant	1500.49	1510.25	1110.25	1127.40	851.10	847.78	1521.97	1500.47	1100.47

*Note: "BiOp" means the BiOp minimum tributary flow target for this project. This is the flow required out of Foster.

**Total outflow minimum from Green Peter uses the Foster minimum flows, from next table.

Minimum Flows for months not shown are all BiOp minimums: Jan = 1100 cfs, Feb = 800 cfs, 1 Mar = 800 cfs, 16 Mar = 1500 cfs, Nov = 1100 cfs, Dec = 1100 cfs.

Table 7.35. Minimum project releases for the BiOp and BOR contracts for Foster.

	Minimum Project Release, in cfs								
	Apr	**1 May**	**16 May**	**Jun**	**Jul**	**Aug**	**Sep**	**1 Oct**	**16 Oct**
BiOp*	1500	1500	1100	1100	800	800	1500	1100	1500
2008-2050									
Deficit	0.02	0.44	0.44	1.19	2.21	2.07	0.95	0.02	0.02
Insufficient	0.03	0.64	0.64	1.71	3.18	2.98	1.37	0.03	0.03
Adequate	0.04	0.80	0.80	2.13	3.97	3.71	1.71	0.04	0.04
Abundant	0.04	0.92	0.92	2.47	4.61	4.31	1.98	0.04	0.04
GPR 2008-2070									
Deficit	0.21	4.47	4.47	11.97	22.31	20.87	9.59	0.21	0.21
Insufficient	0.31	6.43	6.43	17.20	32.08	29.99	13.79	0.30	0.30
Adequate	0.38	8.02	8.02	21.44	39.98	37.38	17.19	0.37	0.37
Abundant	0.45	9.32	9.32	24.93	46.49	43.47	19.99	0.43	0.43
Total									
Deficit	1500.23	1504.92	1104.92	1113.15	824.53	822.94	1510.55	1500.23	1100.23
Insufficient	1500.34	1507.07	1107.07	1118.91	835.26	832.97	1515.16	1500.33	1100.33
Adequate	1500.42	1508.81	1108.81	1123.57	843.95	841.09	1518.90	1500.41	1100.41
Abundant	1500.49	1510.25	1110.25	1127.40	851.10	847.78	1521.97	1500.47	1100.47

*Note: “BiOp” means the BiOp minimum tributary flow target for this project.

Minimum Flows for months not shown are all BiOp minimums: Jan = 1100 cfs, Feb = 800 cfs, 1 Mar = 800 cfs, 16 Mar = 1500 cfs, Nov = 1100 cfs, Dec = 1100 cfs.

Table 7.36. Minimum project releases for the BiOp and BOR contracts for Detroit.

	Minimum Project Release, in cfs								
	Apr	**May**	**Jun**	**1 Jul**	**15 Jul**	**Aug**	**Sep**	**1 Oct**	**16 Oct**
BiOp*	1500	1500	1200	1200	1000	1000	1500	1500	1200
Baseline (2008)									
Deficit	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Insufficient	0.00	14.49	29.86	47.68	47.68	38.09	19.58	0.00	0.00
Adequate	0.00	14.49	29.86	47.68	47.68	38.09	19.58	0.00	0.00
Abundant	0.00	14.49	29.86	47.68	47.68	38.09	19.58	0.00	0.00
2008-2070									
Deficit	0.76	15.83	42.35	78.97	78.97	73.84	33.96	0.73	0.73
Insufficient	1.09	22.76	60.88	113.52	113.52	106.15	48.81	1.05	1.05
Adequate	1.35	28.37	75.88	141.48	141.48	132.31	60.84	1.31	1.31
Abundant	1.58	32.98	88.23	164.52	164.52	153.84	70.74	1.52	1.52
Total**									
Deficit	1500.76	1515.83	1242.35	1278.97	1078.97	1073.84	1533.96	1500.73	1200.73
Insufficient	1501.09	1537.25	1290.74	1361.20	1161.20	1144.24	1568.39	1501.05	1201.05
Adequate	1501.35	1542.86	1305.74	1389.17	1189.17	1170.39	1580.42	1501.31	1201.31
Abundant	1501.58	1547.48	1318.09	1412.20	1212.20	1191.93	1590.32	1501.52	1201.52

*Note: “BiOp” means the BiOp minimum tributary flow target for this project.

**Total outflow minimum from Detroit includes BOR contracts in 2008 as well as the additional contracts after 2008.

Minimum Flows for months not shown are all BiOp minimums: Jan = 1200 cfs, Feb = 1000 cfs, 1 Mar = 1000 cfs, 16 Mar = 1500 cfs, Nov = 1200 cfs, Dec = 1200 cfs.

7.3 Simulation Results

The Peak No Action 2070 pool elevation non-exceedance graphs for each storage project are shown in Figures 7.2 and 7.3. These non-exceedance graphs are described in detail in Section 16 of Appendix E, in particular Figure 16.1 of that Appendix.

The graphs in Figures 7.4a through 7.4c are period average flows at Salem for every year in the POR, color coded by water year type. The periods are monthly for April, May, July, September, and October, when the Salem BiOp minimum targets are constant over each of those months, and for half month periods for June and August, when the BiOp minimum targets change midway through those months. These graphs highlight the result that regulated Salem flows are often well above the target minimum values. The main Feasibility report documents the occurrences for regulated Salem flows being below minimum flow targets, but does not show the frequency that the regulated flows exceed the minimum flow targets. The period average flow values plotted in Figures 7.4a to 7.4c are listed in Table 7.37a for 1929 through 1970 and Table 7.37b for 1971 through 2008.

The regulated flows at Albany, Salem, and Oregon City above Willamette Falls are shown in Figures 7.4 through 7.6. In each figure, the non-exceedance percentiles of the regulated flows are shown in the top graph (with a blue background), and the remaining four graphs in each figure show the regulated flow for one water year of each type, using 1966 (Adequate), 1967 (Insufficient), 1968 (Deficit), and 1969 (Abundant). The flow targets at Albany and Salem are shown in Figures 7.4 and 7.5, respectively, for the wetter years (Abundant and Adequate) and for Deficit years. The targets shown in Figure 7.6 are Salem targets (shown as dashed lines) for comparison. There are no official BiOp flow minimum targets at Willamette Falls, but a flow equivalent to that at Salem is desirable.

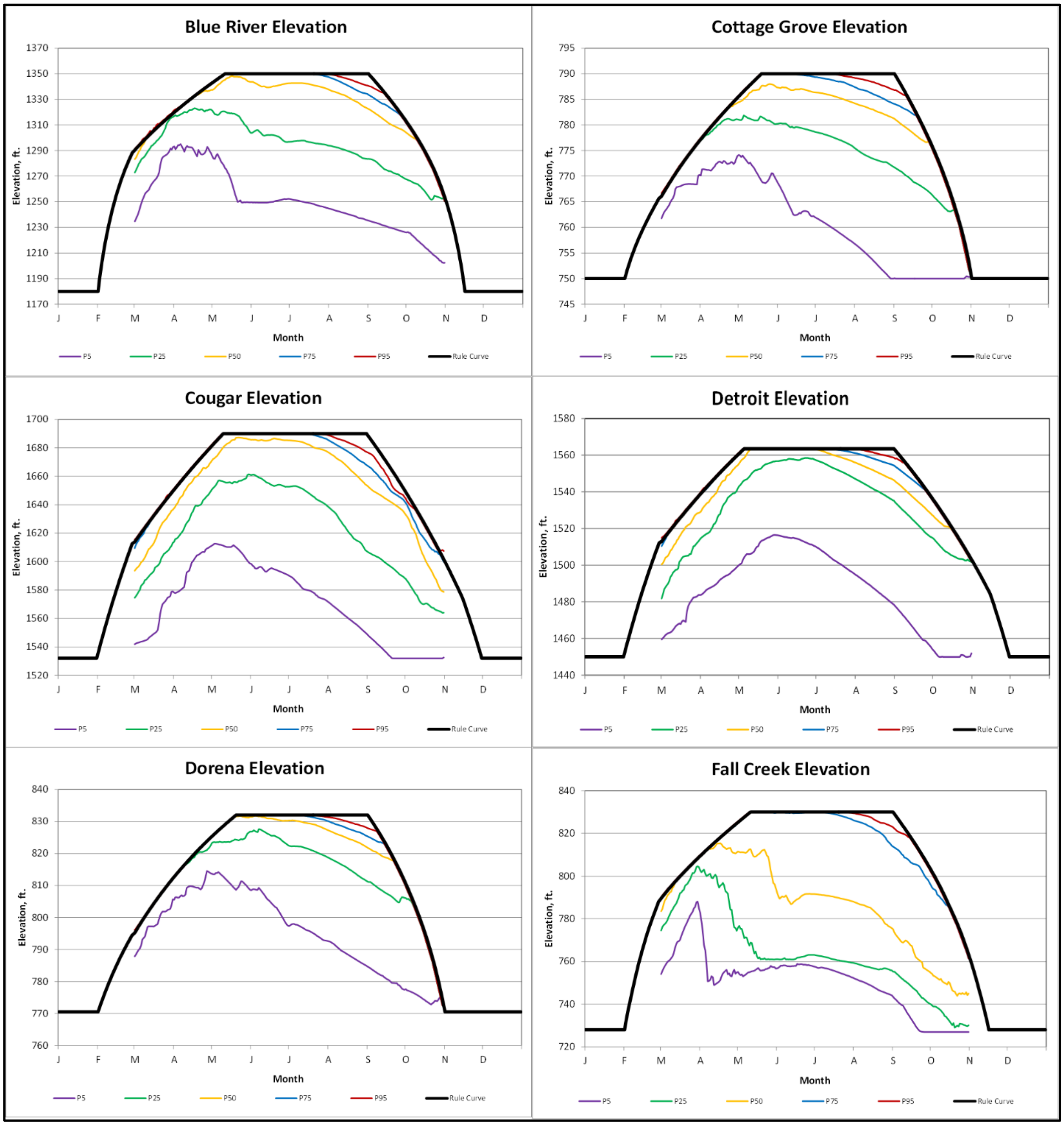


Figure 7.2. Pool elevation non-exceedance percentiles for the Peak No Action 2070 for Blue River, Cottage Grove, Cougar, Detroit, Dorena, and Fall Creek. See Figure 16.1 in Appendix E for non-exceedance value descriptions.

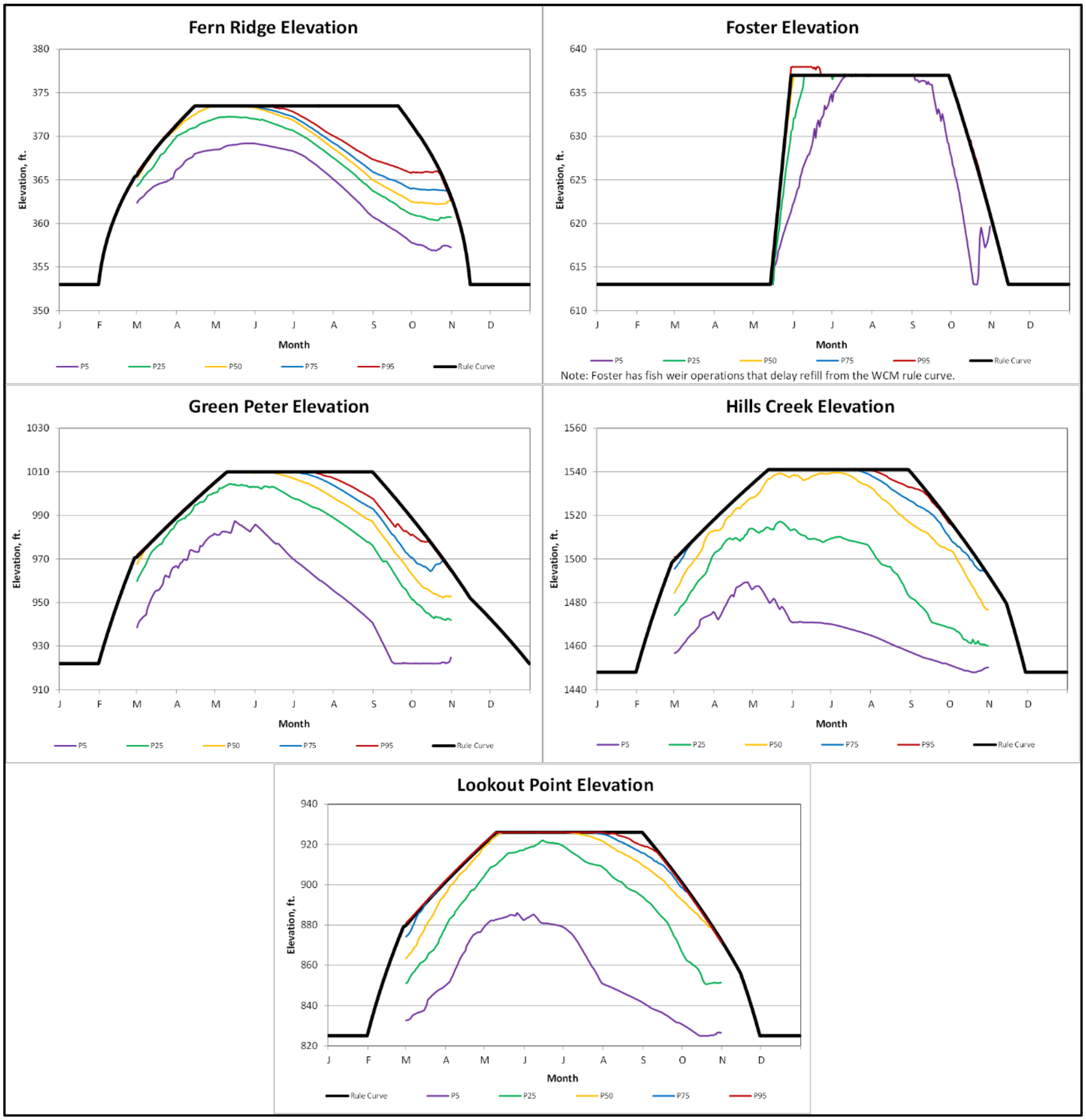


Figure 7.3. Pool elevation non-exceedance percentiles for the Peak No Action 2070 for Fern Ridge, Foster, Green Peter, Hills Creek, Fall Creek, and Lookout Point. See Figure 16.1 in Appendix E for non-exceedance value descriptions.

Peak No Action 2070, Period Average Flows at Salem

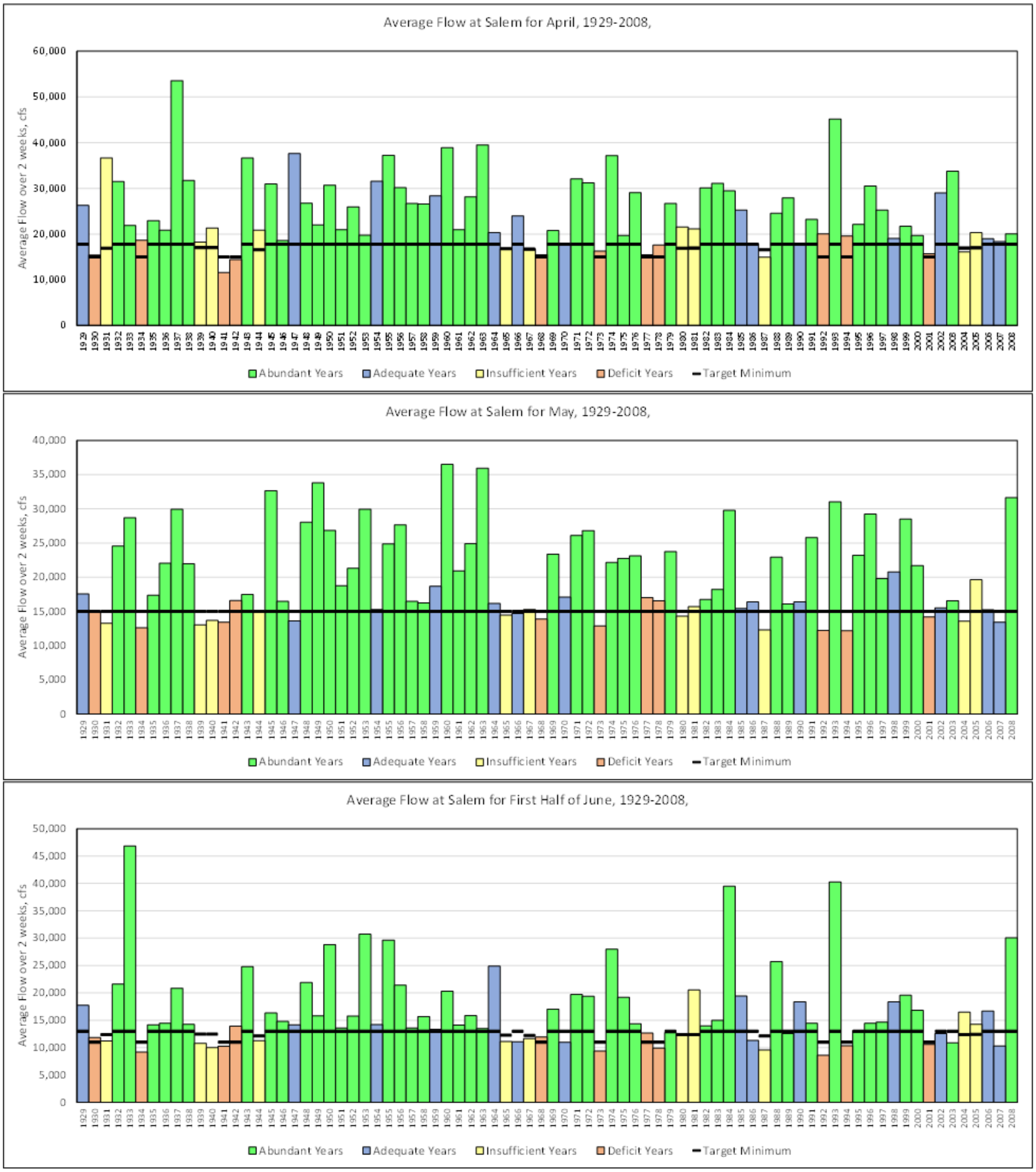


Figure 7.4a. Period average flows at Salem for all years in the POR for April (top), May (middle), and the first half of June (bottom), with flow target for that period and year shown as the solid black bar. Each year is color coded by water year type. Graphs show that Abundant water year average flows often significantly exceed the minimum flow targets at Salem while Deficit year average flows can miss the target. Adequate and Insufficient water years fall in between.

Peak No Action 2070, Period Average Flows at Salem

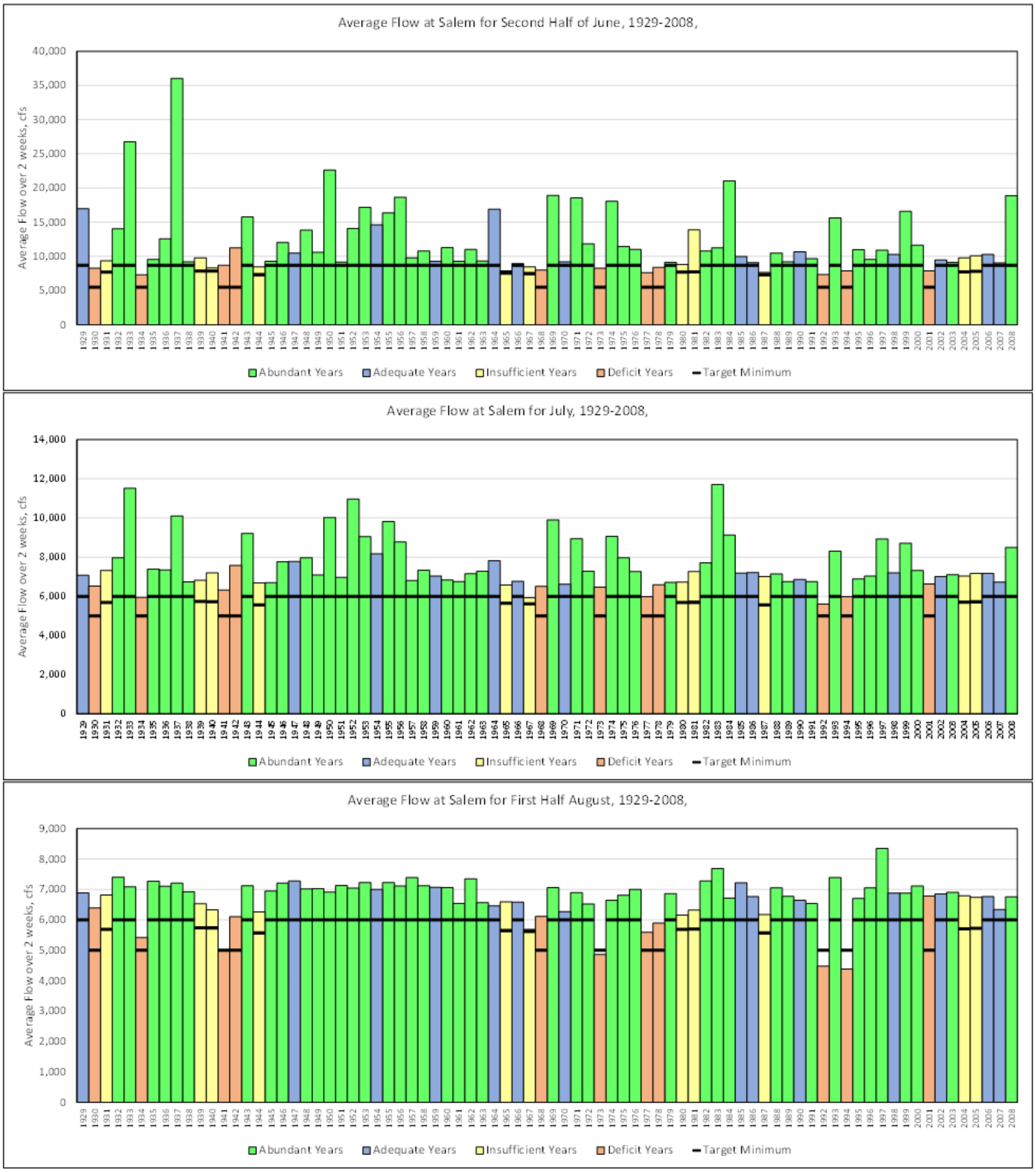


Figure 7.4b. Period average flows at Salem for all years in the POR for the second half of June (top), July (middle), and the first half of August (bottom), with flow target for that period and year shown as the solid black bar. Each year is color coded by water year type. Graphs show that Abundant water year average flows often exceed the minimum flow targets at Salem while Deficit year average flows can miss the target. Adequate and Insufficient water years fall in between.

Peak No Action 2070, Period Average Flows at Salem

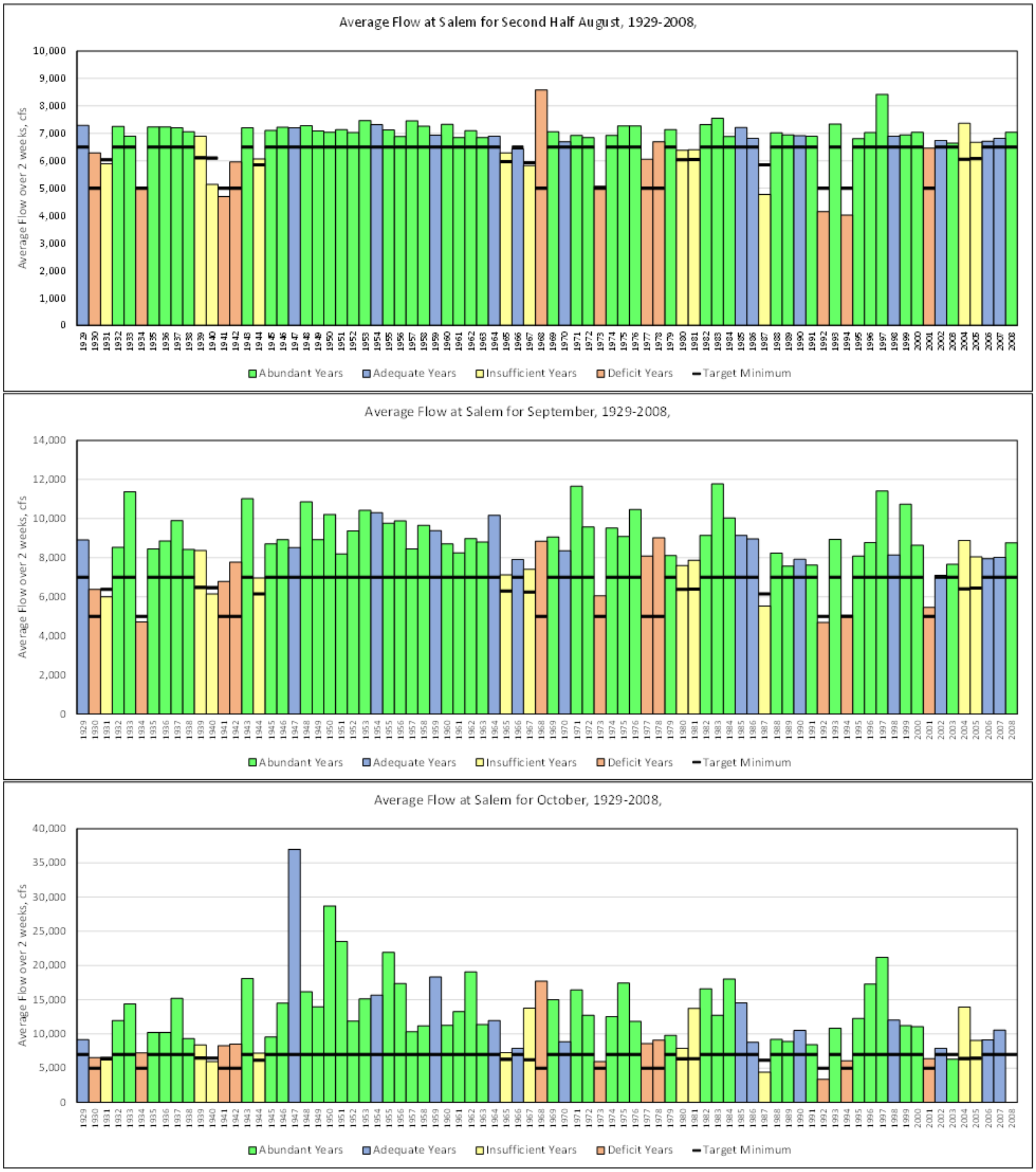


Figure 7.4c. Period average flows at Salem for all years in the POR for the second half of August (top), September (middle), and October (bottom), with flow target for that period and year shown as the solid black bar. Each year is color coded by water year type. Graphs show that Abundant water year average flows often exceed the minimum flow targets at Salem while Deficit year average flows can miss the target. Adequate and Insufficient water years fall in between. Note fall drafting begins in September.

Table 7.37a. Period average flows at Salem for all years in the POR, for 1929 to 1970. Average flow values are all in cfs.

Year	Average Flow at Salem over Period, in cfs.								
	Apr	May	1-15 Jun	16-30 Jun	July	1-15 Aug	16-30 Aug	Sep	Oct
1929	26257	17577	17751	16994	7072	6885	7291	8902	9145
1930	15421	14990	11866	8280	6527	6391	6292	6376	6518
1931	36653	13278	11226	9350	7320	6818	5890	5990	6557
1932	31459	24532	21588	14054	7974	7406	7255	8529	11953
1933	21860	28700	46843	26768	11525	7088	6899	11372	14379
1934	18662	12603	9197	7315	5949	5423	5044	4718	7230
1935	22946	17338	14177	9542	7389	7270	7231	8454	10211
1936	20822	22045	14450	12574	7352	7108	7232	8859	10206
1937	53553	29921	20858	36027	10104	7209	7205	9897	15173
1938	31727	21951	14240	9194	6738	6924	7060	8427	9297
1939	18269	13027	10786	9802	6822	6534	6896	8367	8371
1940	21338	13673	10020	8324	7201	6327	5146	6148	5966
1941	11593	13407	10246	8705	6328	4981	4701	6786	8278
1942	14441	16591	13912	11254	7583	6107	5955	7773	8514
1943	36616	17481	24780	15760	9215	7125	7204	11014	18086
1944	20820	14982	11268	8450	6690	6265	6070	6964	7210
1945	30955	32648	16332	9288	6702	6948	7105	8704	9532
1946	18591	16467	14778	12032	7764	7214	7224	8923	14489
1947	29436	13600	14173	10469	7777	7276	7203	8516	36991
1948	26755	28019	21887	13856	7970	7023	7280	10854	16167
1949	21984	33799	15809	10606	7094	7030	7088	8917	13946
1950	30667	26821	28827	22609	10019	6914	7038	10210	28713
1951	20975	18743	13586	9164	6973	7135	7130	8194	23509
1952	25932	21291	15772	14088	10959	7047	7028	9370	11870
1953	19763	29953	30720	17162	9046	7230	7465	10423	15102
1954	26420	15274	14195	14632	8179	7006	7317	10298	15677
1955	37210	24876	29641	16371	9815	7223	7122	9752	21933
1956	30180	27642	21426	18647	8779	7114	6883	9878	17351
1957	26680	16457	13579	9801	6799	7393	7458	8455	10302
1958	26572	16257	15677	10805	7327	7128	7258	9653	11182
1959	22961	18660	13343	9280	7040	7071	6932	9377	18307
1960	38900	36477	20307	11296	6833	7065	7325	8694	11276
1961	20971	20940	14133	9268	6749	6543	6850	8238	13250
1962	28151	24893	15851	11005	7154	7354	7092	8978	19048
1963	39481	35933	13483	9302	7283	6566	6847	8794	11381
1964	19410	16163	24903	16889	7826	6463	6901	10170	11947
1965	16744	14463	11098	7892	6574	6595	6291	7117	7258
1966	21172	14670	11067	8953	6759	6586	6432	7905	7881
1967	16653	15272	11643	8455	5927	5688	5829	7403	13768
1968	15484	13870	11939	7993	6504	6115	8587	8841	17718
1969	20764	23374	17041	18918	9903	7058	7058	9056	15007
1970	17457	17085	10983	9216	6621	6272	6693	8354	8855

Table 7.37b. Period average flows at Salem for all years in the POR, for 1971 to 2008. Average flow values are all in cfs.

Year	Average Flow at Salem over Period, in cfs.								
	Apr	May	1-15 Jun	16-30 Jun	July	1-15 Aug	16-30 Aug	Sep	Oct
1971	32043	26090	19715	18548	8941	6896	6930	11652	16426
1972	31176	26816	19399	11827	7282	6525	6842	9562	12696
1973	16280	12867	9393	8287	6469	4861	5074	6052	5964
1974	37155	22137	27968	18044	9054	6649	6927	9512	12510
1975	19702	22732	19209	11464	7971	6811	7272	9085	17426
1976	29075	23114	14368	11016	7268	7003	7271	10465	11836
1977	15453	17020	12674	7613	5984	5597	6055	8082	8582
1978	17595	16553	11374	8406	6594	5894	6695	9018	9101
1979	26683	23747	12718	9137	6710	6863	7142	8100	9795
1980	21564	14302	12458	8826	6724	6165	6382	7597	7881
1981	21157	15688	20520	13900	7270	6321	6399	7868	13743
1982	30082	16740	13973	10794	7705	7282	7317	9133	16593
1983	31107	18235	14972	11263	11700	7691	7549	11773	12703
1984	29458	29746	39499	21044	9127	6712	6886	10029	18026
1985	22149	15415	19417	9966	7186	7220	7213	9130	14534
1986	17425	16386	11322	9103	7219	6766	6814	8962	8761
1987	14907	12308	9591	7656	7014	6174	4777	5531	4419
1988	24523	22907	25731	10486	7145	7055	7025	8228	9219
1989	27921	16102	12590	9215	6746	6774	6941	7566	8890
1990	22203	16394	18389	10683	6862	6644	6916	7917	10516
1991	23227	25801	14485	9690	6756	6541	6889	7628	8437
1992	20049	12223	8601	7354	5609	4480	4149	4693	3363
1993	45167	31024	40248	15614	8304	7393	7338	8930	10824
1994	19549	12187	10366	7862	5981	4380	4018	5054	6079
1995	22077	23206	13111	10981	6892	6702	6810	8074	12265
1996	30512	29230	14440	9547	7035	7052	7026	8778	17302
1997	25255	19785	14652	10917	8928	8345	8423	11406	21209
1998	18690	20787	18348	10291	7204	6879	6899	8143	12004
1999	21689	28496	19565	16584	8710	6879	6941	10724	11222
2000	19674	21714	16820	11652	7317	7118	7039	8638	11063
2001	15721	14181	10603	7877	6637	6786	6460	5452	6396
2002	28607	15503	12566	9474	7015	6849	6745	7098	7887
2003	33748	16549	10877	9140	7096	6909	6646	7657	6303
2004	16093	13583	16476	9780	7039	6795	7363	8880	13910
2005	20293	19623	14272	10107	7169	6744	6675	8042	9064
2006	20267	15253	16712	10290	7170	6770	6712	7948	9133
2007	18438	13431	10302	9041	6726	6339	6816	8013	10543
2008	20039	31631	30077	18886	8492	6758	7043	8766	N/A

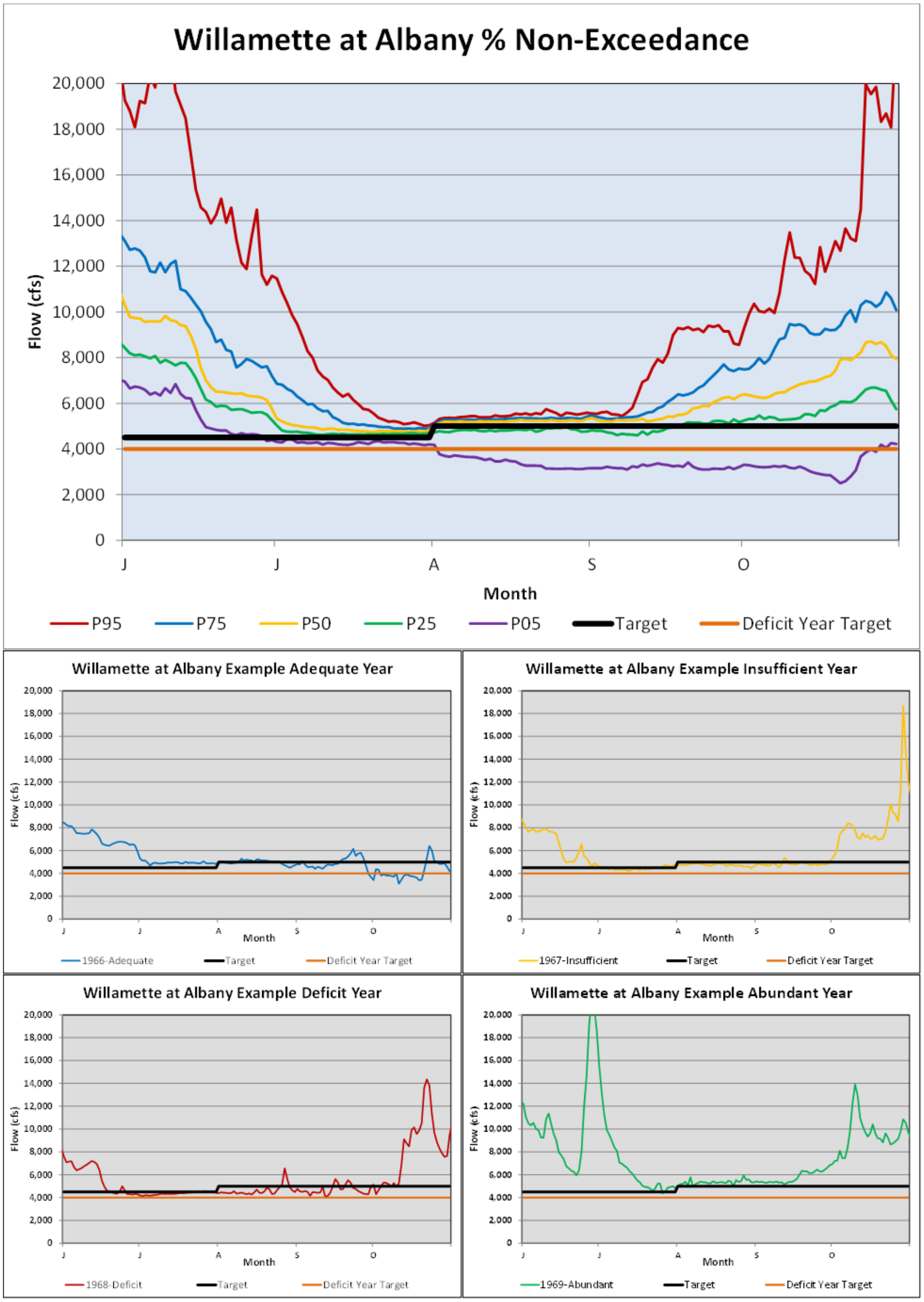


Figure 7.4. Non-exceedance percentiles for the Peak No Action 2070 for regulated flow at Albany in top graph (with blue background). Albany flow for selected years: 1966 (Adequate) at middle left, 1967 (Insufficient) at middle right, 1968 (Deficit) at bottom left, and 1969 (Abundant) at bottom right.

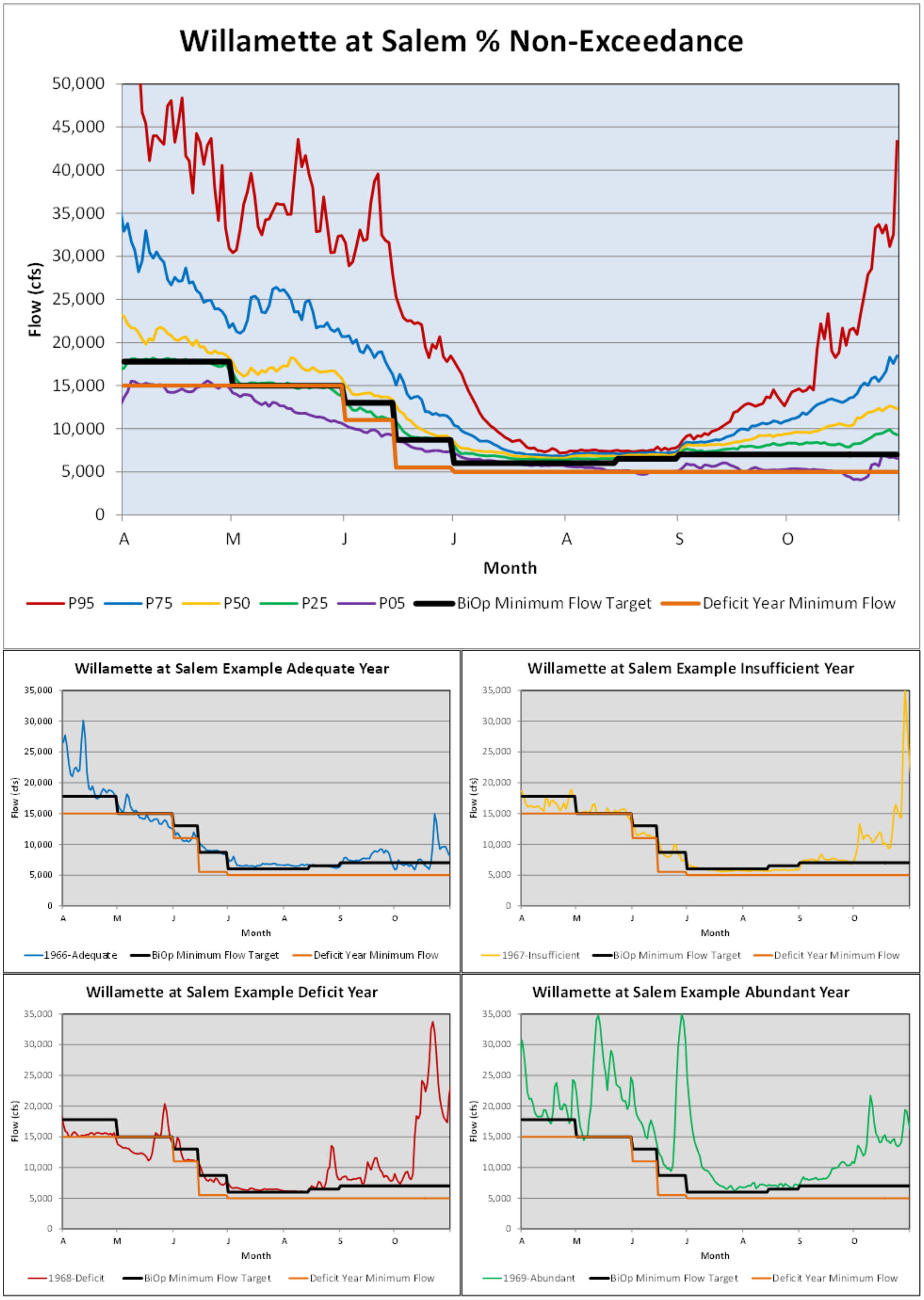


Figure 7.5. Non-exceedance percentiles for the Peak No Action 2070 for regulated flow at Salem in top graph (with blue background). Salem flow for selected years: 1966 (Adequate) at middle left, 1967 (Insufficient) at middle right, 1968 (Deficit) at bottom left, and 1969 (Abundant) at bottom right.

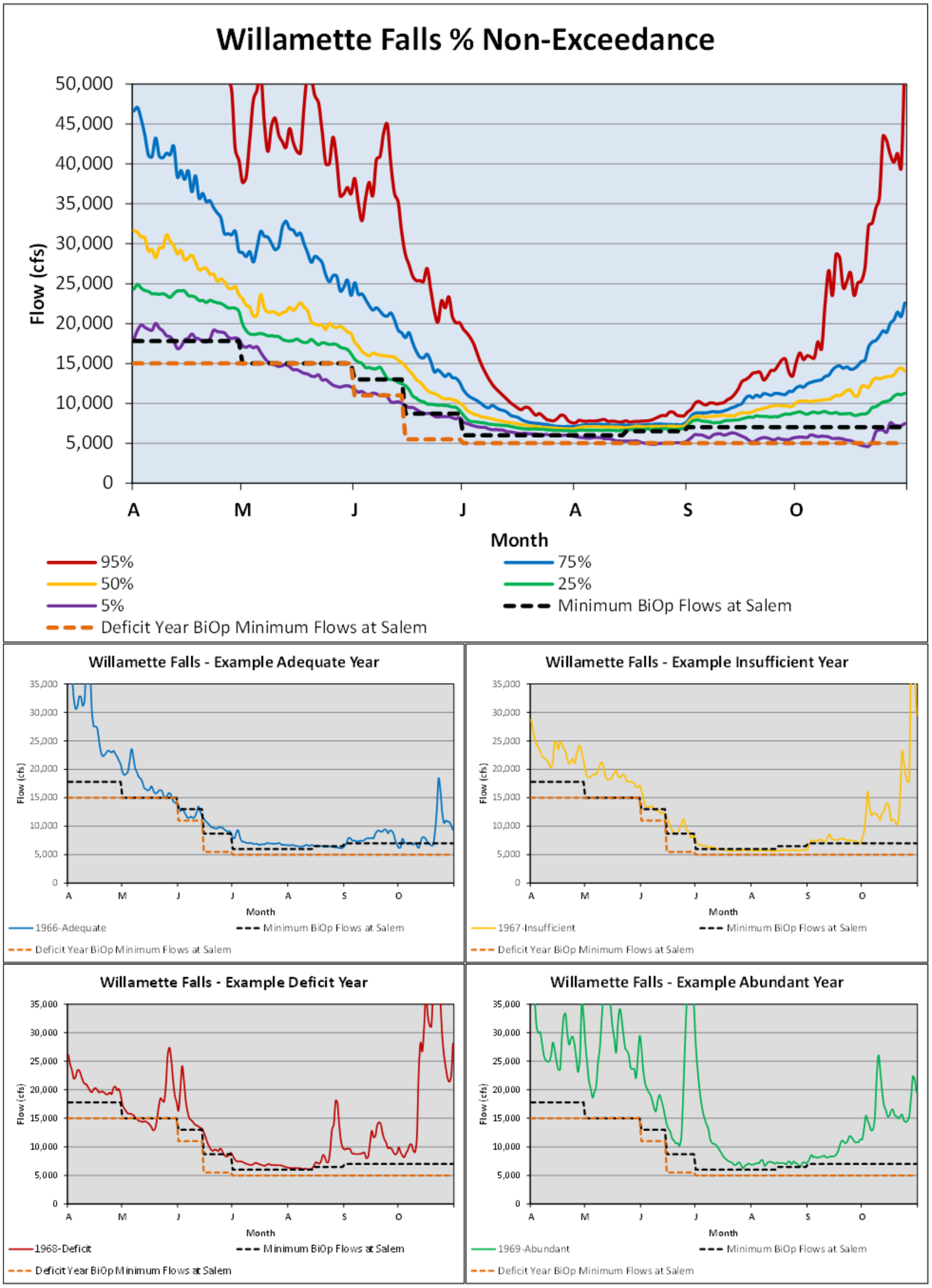


Figure 7.6. Non-exceedance percentiles for the Peak No Action 2070 for regulated flow at Oregon City above the Falls in top graph (with blue background). Flow for selected years: 1966 (Adequate) at middle left, 1967 (Insufficient) at middle right, 1968 (Deficit) at bottom left, and 1969 (Abundant) at bottom right.

8 Expected No Action 2070 ResSim Analysis

The simulation name for this analysis is ***Expected-No-Action-2050-27Mar2018*** (see Table 1.1 for all other specifics for the simulation).

8.1 Diversions and Return Flows

Table 3.1 shows a total increase in Willamette Basin demands of 232,263 ac-ft from 2008 levels for this analysis. The total increase was from seven categories, which were given separately for demand increases from 2008 to 2020 (for the Base Year analysis) and from 2020 to 2070. The demand increase for the two time windows are (see tables referenced from Appendix F):

1. Demand Increases for 2008 to 2020, which were included in the Base Year 2020 analysis:

- an increase in BOR stored water contracts (22,854 ac-ft) (Table AI 1),
- an increase in M&I use from live flow permits that were already in place in 2008, but not fully utilized, for June through September (18,780 ac-ft) (Table MI 1),
- and an increase in M&I use from live flow permits that were already in place in 2008, but not fully utilized, for April through May (7541 ac-ft) (Table MI 2).

2. Demand Increases for 2020 to 2070, with values representing expected use:

- an increase in BOR stored water contracts (87,298 ac-ft), which is subdivided into the increase that brings the total BOR contract in the basin to 95,000 ac-ft (13,626 ac-ft) (Table AI 2) and the portion that is above 95,000 ac-ft (73,672 ac-ft) (Table AI 4), with the importance of the 95,000 ac-ft contract level described below as the two portions are modeled differently in ResSim,
- an increase in M&I use from live flow permits that were already in place in 2008, but not fully utilized, for June through September (54,469 ac-ft) (Table MI 4),
- an increase in M&I use from live flow permits that were already in place in 2008, but not fully utilized, for April through May (27,246 ac-ft) (Table MI 5),
- and an increase in M&I use from live flow permits that were already in place in 2008, but not fully utilized, and supplied to others through interties (14,075 ac-ft) (Table MI 7).

Table 3.2 indicates which categories from the seven increases above are from stored water (total volume is 110,152 ac-ft), and Table 3.3 indicates which categories are from live flow permits (total volume is 122,111 ac-ft). This distinction is relevant because increases from stored water are used to determine the minimum outflow required at each project, while increases from live flows are not. In this analysis, no M&I contracts are supplied by stored water.

The development of the diversions and return flows for this simulation follows the same order of sub-sections described for the Peak No Action case, Section 7.

8.1.1 AI Diversions

The AI diversions in this simulation are the 22,854 ac-ft and 87,298 ac-ft volumes listed in Table 3.1. These volumes are broken out by reach in Appendix F in Tables AI 1 for the 22,854 ac-ft diversions and in Tables AI2 and AI 4 for the 87,298 ac-ft diversions. The total of these AI diversions by reach for May through September is shown in Table 8.1. Note that the total for all reaches is 110,152 ac-ft, which matches the total volume shown in Table 3.2 for stored water contracts for the Expected No Action 2070 column.

Following the description from Section 7.1, the irrigation volumes are re-distributed to April through October (using the 2010 Modified Flow percentages in Table 7.1b) in Table 8.2 for the full demand level, or the basis for supply in Abundant water years. Using the reductions by water year type described in Section 7.1.1, the April through October irrigation volumes are shown for Adequate years in Table 8.3, Insufficient years in Table 8.4, and Deficit years in Table 8.5.

Table 8.1. The incremental increases in BOR irrigation contracts from stored water between 2008 and 2070, from Tables AI 1, AI 2, and AI 4 in Appendix F.

Reach	Increased AI Demand Volume in acre-feet					
	May	June	July	August	September	Total
Reach 1	2179	5639	10,866	10,161	4522	33,568
Reach 1a	144	287	473	378	188	1469
Reach 1b	2524	5034	8305	6634	3301	25,798
Reach 1c	617	1229	2029	1620	806	6301
Reach 2	35	70	115	92	46	356
Reach 3	1637	3264	5386	4302	2140	16,729
Reach 4	131	262	433	346	172	1344
Reach 5	2246	4477	7388	5901	2936	22,948
Reach 6	2837	5657	9335	7456	3710	28,995
Reach 7	108	215	355	283	141	1102
Reach 8	255	509	839	670	334	2607
Reach 9	0	0	0	0	0	0
Reach 10	131	261	431	344	171	1339
Reach 11	13	26	44	35	17	135
Reach 12	2	3	5	4	2	17
Reach 13	84	167	275	220	109	855
Reach 14	7	15	24	19	10	75
Reach 15	8	16	27	21	11	83
Total all Reaches	10,779	21,492	35,462	28,324	14,094	**110,152**

*Note round-off error from displaying all volumes as integers.

Table 8.2. The incremental increases in BOR irrigation contracts from stored water between 2008 and 2070, from Tables AI 1, AI 2, and AI 4 in Appendix F, reshaped according to Table 7.1b, used as the basis for Abundant water year AI diversions.

Reach	Increased AI Demand in acre-feet							
	April	**May**	**June**	**July**	**Aug.**	**Sept.**	**Oct.**	**Total**
Reach 1	101	2179	5639	10,866	10,161	4522	101	33,568
Reach 1a	4	95	247	475	445	198	4	1469
Reach 1b	77	1674	4334	8351	7809	3475	77	25,798
Reach 1c	19	409	1059	2040	1907	849	19	6301
Reach 2	1	23	60	115	108	48	1	356
Reach 3	50	1086	2811	5415	5064	2253	50	16,729
Reach 4	4	87	226	435	407	181	4	1344
Reach 5	69	1489	3855	7428	6946	3091	69	22,948
Reach 6	87	1882	4871	9386	8777	3906	87	28,995
Reach 7	3	72	185	357	334	148	3	1102
Reach 8	8	169	438	844	789	351	8	2607
Reach 9	0	0	0	0	0	0	0	0
Reach 10	4	87	225	434	405	180	4	1339
Reach 11	0	9	23	44	41	18	0	135
Reach 12	0	1	3	5	5	2	0	17
Reach 13	3	55	144	277	259	115	3	855
Reach 14	0	5	13	24	23	10	0	75
Reach 15	0	5	14	27	25	11	0	83
Total all Reaches	330	7149	18,505	35,656	33,343	14,837	330	**110,152**

*Note round-off error from displaying all volumes as integers.

Table 8.3. The incremental increases in BOR irrigation contracts from stored water between 2008 and 2070, from Tables AI 1, AI 2, and AI 4 in Appendix F, reshaped according to Table 7.1b, used as the basis for Adequate water year AI diversions.

Reach	Increased AI Demand in acre-feet							
	April	**May**	**June**	**July**	**Aug.**	**Sept.**	**Oct.**	**Total**
Reach 1	87	1874	4850	9345	8738	3889	87	28,868
Reach 1a	4	82	212	409	382	170	4	1263
Reach 1b	67	1440	3727	7182	6716	2988	67	22,186
Reach 1c	16	352	910	1754	1640	730	16	5419
Reach 2	1	20	51	99	93	41	1	306
Reach 3	43	934	2417	4657	4355	1938	43	14,387
Reach 4	3	75	194	374	350	156	3	1156
Reach 5	59	1281	3315	6388	5974	2658	59	19,735
Reach 6	75	1618	4189	8072	7548	3359	75	24,936
Reach 7	3	61	159	307	287	128	3	948
Reach 8	7	145	377	726	679	302	7	2242
Reach 9	0	0	0	0	0	0	0	0
Reach 10	3	75	194	373	349	155	3	1152
Reach 11	0	8	20	38	35	16	0	116
Reach 12	0	1	2	5	4	2	0	14
Reach 13	2	48	124	238	223	99	2	735
Reach 14	0	4	11	21	20	9	0	65
Reach 15	0	5	12	23	22	10	0	71
Total all Reaches	284	6148	15,915	30,664	28,675	12,760	284	**94,730**

Table 8.4. The incremental increases in BOR irrigation contracts from stored water between 2008 and 2070, from Tables AI 1, AI 2, and AI 4 in Appendix F, reshaped according to Table 7.1b, used as the basis for Insufficient water year AI diversions.

Reach	Increased AI Demand in acre-feet							
	April	**May**	**June**	**July**	**Aug.**	**Sept.**	**Oct.**	**Total**
Reach 1	69	1503	3891	7497	7011	3120	69	23,162
Reach 1a	3	66	170	328	307	137	3	1013
Reach 1b	53	1155	2990	5762	5388	2398	53	17,800
Reach 1c	13	282	730	1407	1316	586	13	4348
Reach 2	1	16	41	80	74	33	1	246
Reach 3	35	749	1939	3737	3494	1555	35	11,543
Reach 4	3	60	156	300	281	125	3	927
Reach 5	48	1028	2660	5125	4793	2133	48	15,834
Reach 6	60	1298	3361	6476	6056	2695	60	20,006
Reach 7	2	49	128	246	230	102	2	760
Reach 8	5	117	302	582	544	242	5	1799
Reach 9	0	0	0	0	0	0	0	0
Reach 10	3	60	155	299	280	124	3	924
Reach 11	0	6	16	30	28	13	0	93
Reach 12	0	1	2	4	3	2	0	11
Reach 13	2	38	99	191	179	79	2	590
Reach 14	0	3	9	17	16	7	0	52
Reach 15	0	4	10	19	17	8	0	57
Total all Reaches	228	4933	12,769	24,603	23,007	10,238	228	**76,005**

Table 8.5. The incremental increases in BOR irrigation contracts from stored water between 2008 and 2070, from Tables AI 1, AI 2, and AI 4 in Appendix F, reshaped according to Table 7.1b, used as the basis for Deficit water year AI diversions.

Reach	Increased AI Demand in acre-feet							
	April	**May**	**June**	**July**	**Aug.**	**Sept.**	**Oct.**	**Total**
Reach 1	48	1046	2707	5216	4877	2170	48	16,112
Reach 1a	2	46	118	228	213	95	2	705
Reach 1b	37	804	2080	4008	3748	1668	37	12,383
Reach 1c	9	196	508	979	916	407	9	3025
Reach 2	1	11	29	55	52	23	1	171
Reach 3	24	521	1349	2599	2431	1082	24	8030
Reach 4	2	42	108	209	195	87	2	645
Reach 5	33	715	1850	3566	3334	1484	33	11,015
Reach 6	42	903	2338	4505	4213	1875	42	13,917
Reach 7	2	34	89	171	160	71	2	529
Reach 8	4	81	210	405	379	169	4	1251
Reach 9	0	0	0	0	0	0	0	0
Reach 10	2	42	108	208	195	87	2	643
Reach 11	0	4	11	21	20	9	0	65
Reach 12	0	1	1	3	2	1	0	8
Reach 13	1	27	69	133	124	55	1	410
Reach 14	0	2	6	12	11	5	0	36
Reach 15	0	3	7	13	12	5	0	40
Total all Reaches	159	3431	8883	17,115	16,005	7122	159	**52,873**

8.1.2 M&I Diversions with Reductions in Lower Water Years

There are no M&I diversions in this simulation that are reduced in lower water years.

8.1.3 M&I Diversions Supplied in Full for all Water Years

The M&I diversions in this simulation that are not reduced in lower water years are the 18,780 and 7541 ac-ft volumes for the 2008 to 2020 increases (Tables MI 1 and MI 2, respectively), the 54,469 ac-ft from increased use of existing live flow permits for June through September (Table MI 4), the 27,246 ac-ft volume for the 2020 to 2070 increase (Table MI 5), and the 14,075 ac-ft for interties for already existing permits on live flow (Table MI 7). Table 8.6 totals these volumes by reach and by month. The volumes above are listed in Table 3.1, and the tables referenced are from Appendix F where the volumes are broken out by reach. The total of these M&I demands for all reaches is the remaining live flow demand described in Section 3.2.

Table 8.6. The incremental increases in M&I Expected demands from already permitted live flow contracts, 2008 and 2070, from Tables MI 1, MI 2, MI 4, MI 5, and MI 7 in Appendix F.

Reach	Increased M&I Demand in acre-feet							
	April	May	June	July	Aug.	Sept.	Oct.	Total
Reach 1	10,168	12,083	9994	14,175	14,511	11,106	0	72,037
Reach 1a	2617	3111	2307	3273	3350	2564	0	17,222
Reach 1b	7087	8421	6995	9920	10156	7773	0	50,353
Reach 1c	464	550	692	982	1005	769	0	4461
Reach 2	26	31	0	0	0	0	0	57
Reach 3	3004	3571	3812	5406	5534	4236	0	25,563
Reach 4	180	214	222	315	322	247	0	1500
Reach 5	779	926	996	1413	1446	1107	0	6667
Reach 6	1	2	1	2	2	2	0	10
Reach 7	75	89	114	161	165	126	0	731
Reach 8	470	559	616	874	894	684	0	4097
Reach 9	1100	1307	1647	2336	2391	1831	0	10,611
Reach 10	0	0	0	0	0	0	0	0
Reach 11	5	5	6	9	9	6	0	40
Reach 12	15	18	20	28	29	23	0	133
Reach 13	24	29	31	44	44	34	0	206
Reach 14	48	57	71	101	103	79	0	460
Reach 15	0	0	0	0	0	0	0	0
Total all Reaches	15,896	18,891	17,530	24,862	25,452	19,481	0	**122,112**

8.1.4 Total Diversions by Reach and by Water Year Type

The total water volumes diverted in this simulation are shown below in Tables 8.7 through 8.10. These diversions depend on water year type.

The demand volumes by reach and by month are converted to daily average flow rates, shown in Tables 8.11 through 8.14 for Abundant, Adequate, Insufficient, and Deficit water years.

Table 8.7. The incremental increases in all demands, 2008 to 2070, used as the basis for Abundant water year diversions. (Table 8.2 + Table 8.6)

Reach	Increased Total Demand in acre-feet							
	April	May	June	July	Aug.	Sept.	Oct.	Total
Reach 1	10,268	14,261	15,634	25,040	24,672	15,628	101	105,604
Reach 1a	2622	3207	2554	3748	3795	2762	4	18,691
Reach 1b	7164	10,095	11,329	18,271	17,965	11,248	77	76,151
Reach 1c	483	959	1750	3021	2912	1618	19	10,762
Reach 2	27	54	60	115	108	48	1	414
Reach 3	3055	4657	6622	10,821	10,598	6490	50	42,292
Reach 4	184	301	448	750	729	428	4	2843
Reach 5	848	2415	4851	8841	8393	4198	69	29,615
Reach 6	88	1884	4873	9388	8779	3907	87	29,005
Reach 7	78	161	299	518	499	274	3	1833
Reach 8	478	728	1054	1717	1683	1035	8	6704
Reach 9	1100	1307	1647	2336	2391	1831	0	10,611
Reach 10	4	87	225	434	405	180	4	1339
Reach 11	5	14	29	53	50	25	0	175
Reach 12	15	19	23	34	34	25	0	150
Reach 13	27	84	175	320	303	149	3	1061
Reach 14	48	62	84	125	126	89	0	535
Reach 15	0	5	14	27	25	11	0	83
Total all Reaches	16,227	26,040	36,036	60,518	58,794	34,318	330	**232,264**

Table 8.8. The incremental increases in all demands, 2008 to 2070, used as the basis for Adequate water year diversions. (Table 8.3 + Table 8.6)

Reach	Increased Total Demand in acre-feet							
	April	May	June	July	Aug.	Sept.	Oct.	Total
Reach 1	10,254	13,956	14,844	23,519	23,250	14,995	87	100,905
Reach 1a	2621	3193	2519	3681	3732	2734	4	18,485
Reach 1b	7153	9861	10,722	17,102	16,872	10,762	67	72,539
Reach 1c	480	902	1602	2736	2645	1499	16	9880
Reach 2	27	51	51	99	93	41	1	364
Reach 3	3048	4505	6229	10,063	9889	6174	43	39,950
Reach 4	183	289	416	689	672	403	3	2655
Reach 5	839	2207	4311	7801	7420	3765	59	26,402
Reach 6	76	1620	4191	8074	7550	3360	75	24,946
Reach 7	78	151	273	468	452	254	3	1678
Reach 8	477	705	993	1599	1572	986	7	6339
Reach 9	1100	1307	1647	2336	2391	1831	0	10,611
Reach 10	3	75	194	373	349	155	3	1152
Reach 11	5	13	25	46	44	22	0	156
Reach 12	15	19	22	33	33	25	0	147
Reach 13	26	77	155	282	267	133	2	942
Reach 14	48	62	82	121	123	88	0	525
Reach 15	0	5	12	23	22	10	0	71
Total all Reaches	16,180	25,039	33,445	55,526	54,126	32,241	284	**216,843**

Table 8.9. The incremental increases in all demands, 2008 to 2070, used as the basis for Insufficient water year diversions. (Table 8.4 + Table 8.6)

Reach	Increased Total Demand in acre-feet							
	April	**May**	**June**	**July**	**Aug.**	**Sept.**	**Oct.**	**Total**
Reach 1	10,237	13,586	13,885	21,672	21,522	14,226	69	95,198
Reach 1a	2620	3177	2477	3601	3657	2700	3	18,236
Reach 1b	7140	9576	9986	15,682	15,544	10,171	53	68,154
Reach 1c	477	833	1422	2389	2321	1355	13	8809
Reach 2	27	47	41	80	74	33	1	303
Reach 3	3039	4320	5751	9142	9028	5791	35	37,106
Reach 4	183	274	378	615	603	372	3	2427
Reach 5	827	1954	3656	6538	6239	3240	48	22,501
Reach 6	61	1300	3362	6478	6058	2696	60	20,017
Reach 7	77	138	242	408	396	228	2	1491
Reach 8	476	676	918	1456	1438	927	5	5896
Reach 9	1100	1307	1647	2336	2391	1831	0	10,611
Reach 10	3	60	155	299	280	124	3	924
Reach 11	5	11	21	39	37	19	0	133
Reach 12	15	19	22	32	32	24	0	145
Reach 13	26	67	130	234	223	114	2	796
Reach 14	48	61	80	117	119	86	0	512
Reach 15	0	4	10	19	17	8	0	57
Total all Reaches	16,124	23,824	30,299	49,465	48,458	29,718	228	**198,117**

Table 8.10. The incremental increases in all demands, 2008 to 2070, used as the basis for Deficit water year diversions. (Table 8.5 + Table 8.6)

Reach	Increased Total Demand in acre-feet							
	April	**May**	**June**	**July**	**Aug.**	**Sept.**	**Oct.**	**Total**
Reach 1	10,216	13,128	12,701	19,390	19,388	13,276	48	88,149
Reach 1a	2619	3157	2426	3501	3563	2659	2	17,927
Reach 1b	7124	9225	9076	13,929	13,905	9441	37	62,736
Reach 1c	473	747	1200	1961	1920	1176	9	7486
Reach 2	27	42	29	55	52	23	1	228
Reach 3	3029	4092	5161	8005	7964	5318	24	33,593
Reach 4	182	256	331	524	517	334	2	2145
Reach 5	812	1641	2846	4978	4781	2591	33	17,682
Reach 6	43	905	2340	4507	4215	1876	42	13,928
Reach 7	77	123	203	333	326	197	2	1260
Reach 8	474	640	826	1279	1273	853	4	5348
Reach 9	1100	1307	1647	2336	2391	1831	0	10,611
Reach 10	2	42	108	208	195	87	2	643
Reach 11	5	10	17	30	29	15	0	105
Reach 12	15	19	21	31	31	24	0	141
Reach 13	25	56	100	176	169	89	1	617
Reach 14	48	60	77	112	114	84	0	496
Reach 15	0	3	7	13	12	5	0	40
Total all Reaches	16,055	22,323	26,413	41,977	41,456	26,603	159	**174,985**

Table 8.11. Diversion withdrawals as daily average flow rates by reach, based on volumes from Table 8.7, the basis for Abundant water years.

Reach	Daily Flow Withdrawal Rate, in cfs, by month.											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1b	0.0	0.0	0.0	1.3	164.2	190.4	297.2	292.2	189.0	1.3	0.0	0.0
1c	0.0	0.0	0.0	0.3	15.6	29.4	49.1	47.4	27.2	0.3	0.0	0.0
2	0.0	0.0	0.0	0.0	0.9	1.0	1.9	1.8	0.8	0.0	0.0	0.0
3	0.0	0.0	0.0	0.8	75.7	111.3	176.0	172.4	109.1	0.8	0.0	0.0
4	0.0	0.0	0.0	0.1	4.9	7.5	12.2	11.8	7.2	0.1	0.0	0.0
5	0.0	0.0	0.0	1.2	39.3	81.5	143.8	136.5	70.6	1.1	0.0	0.0
6	0.0	0.0	0.0	1.5	30.6	81.9	152.7	142.8	65.7	1.4	0.0	0.0
7	0.0	0.0	0.0	0.1	2.6	5.0	8.4	8.1	4.6	0.1	0.0	0.0
8	0.0	0.0	0.0	0.1	11.8	17.7	27.9	27.4	17.4	0.1	0.0	0.0
9	0.0	0.0	0.0	0.0	21.2	27.7	38.0	38.9	30.8	0.0	0.0	0.0
10	0.0	0.0	0.0	0.1	1.4	3.8	7.1	6.6	3.0	0.1	0.0	0.0
11	0.0	0.0	0.0	0.0	0.2	0.5	0.9	0.8	0.4	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.3	0.4	0.5	0.6	0.4	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	1.4	2.9	5.2	4.9	2.5	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	1.0	1.4	2.0	2.1	1.5	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.1	0.2	0.4	0.4	0.2	0.0	0.0	0.0

Table 8.12. Diversion withdrawals as daily average flow rates by reach, based on volumes from Table 8.8, the basis for Adequate water years.

Reach	Daily Flow Withdrawal Rate, in cfs, by month.											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1b	0.0	0.0	0.0	1.1	160.4	180.2	278.1	274.4	180.9	1.1	0.0	0.0
1c	0.0	0.0	0.0	0.3	14.7	26.9	44.5	43.0	25.2	0.3	0.0	0.0
2	0.0	0.0	0.0	0.0	0.8	0.9	1.6	1.5	0.7	0.0	0.0	0.0
3	0.0	0.0	0.0	0.7	73.3	104.7	163.7	160.8	103.8	0.7	0.0	0.0
4	0.0	0.0	0.0	0.1	4.7	7.0	11.2	10.9	6.8	0.1	0.0	0.0
5	0.0	0.0	0.0	1.0	35.9	72.5	126.9	120.7	63.3	1.0	0.0	0.0
6	0.0	0.0	0.0	1.3	26.3	70.4	131.3	122.8	56.5	1.2	0.0	0.0
7	0.0	0.0	0.0	0.0	2.4	4.6	7.6	7.4	4.3	0.0	0.0	0.0
8	0.0	0.0	0.0	0.1	11.5	16.7	26.0	25.6	16.6	0.1	0.0	0.0
9	0.0	0.0	0.0	0.0	21.2	27.7	38.0	38.9	30.8	0.0	0.0	0.0
10	0.0	0.0	0.0	0.1	1.2	3.3	6.1	5.7	2.6	0.1	0.0	0.0
11	0.0	0.0	0.0	0.0	0.2	0.4	0.8	0.7	0.4	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.3	0.4	0.5	0.5	0.4	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	1.2	2.6	4.6	4.3	2.2	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	1.0	1.4	2.0	2.0	1.5	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.1	0.2	0.4	0.4	0.2	0.0	0.0	0.0

Table 8.13. Diversion withdrawals as daily average flow rates by reach, based on volumes from Table 8.9, the basis for Insufficient water years.

Reach	Daily Flow Withdrawal Rate, in cfs, by month.											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1b	0.0	0.0	0.0	0.9	155.7	167.8	255.1	252.8	170.9	0.9	0.0	0.0
1c	0.0	0.0	0.0	0.2	13.5	23.9	38.9	37.7	22.8	0.2	0.0	0.0
2	0.0	0.0	0.0	0.0	0.8	0.7	1.3	1.2	0.6	0.0	0.0	0.0
3	0.0	0.0	0.0	0.6	70.3	96.6	148.7	146.8	97.3	0.6	0.0	0.0
4	0.0	0.0	0.0	0.0	4.5	6.4	10.0	9.8	6.2	0.0	0.0	0.0
5	0.0	0.0	0.0	0.8	31.8	61.4	106.3	101.5	54.4	0.8	0.0	0.0
6	0.0	0.0	0.0	1.0	21.1	56.5	105.4	98.5	45.3	1.0	0.0	0.0
7	0.0	0.0	0.0	0.0	2.3	4.1	6.6	6.4	3.8	0.0	0.0	0.0
8	0.0	0.0	0.0	0.1	11.0	15.4	23.7	23.4	15.6	0.1	0.0	0.0
9	0.0	0.0	0.0	0.0	21.2	27.7	38.0	38.9	30.8	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	1.0	2.6	4.9	4.5	2.1	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.2	0.4	0.6	0.6	0.3	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.3	0.4	0.5	0.5	0.4	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	1.1	2.2	3.8	3.6	1.9	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	1.0	1.3	1.9	1.9	1.5	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.1	0.2	0.3	0.3	0.1	0.0	0.0	0.0

Table 8.14. Diversion withdrawals as daily average flow rates by reach, based on volumes from Table 8.10, the basis for Deficit water years.

Reach	Daily Flow Withdrawal Rate, in cfs, by month.											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1b	0.0	0.0	0.0	0.6	150.0	152.5	226.5	226.1	158.7	0.6	0.0	0.0
1c	0.0	0.0	0.0	0.2	12.1	20.2	31.9	31.2	19.8	0.1	0.0	0.0
2	0.0	0.0	0.0	0.0	0.7	0.5	0.9	0.8	0.4	0.0	0.0	0.0
3	0.0	0.0	0.0	0.4	66.6	86.7	130.2	129.5	89.4	0.4	0.0	0.0
4	0.0	0.0	0.0	0.0	4.2	5.6	8.5	8.4	5.6	0.0	0.0	0.0
5	0.0	0.0	0.0	0.6	26.7	47.8	81.0	77.7	43.5	0.5	0.0	0.0
6	0.0	0.0	0.0	0.7	14.7	39.3	73.3	68.5	31.5	0.7	0.0	0.0
7	0.0	0.0	0.0	0.0	2.0	3.4	5.4	5.3	3.3	0.0	0.0	0.0
8	0.0	0.0	0.0	0.1	10.4	13.9	20.8	20.7	14.3	0.1	0.0	0.0
9	0.0	0.0	0.0	0.0	21.2	27.7	38.0	38.9	30.8	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.7	1.8	3.4	3.2	1.5	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.2	0.3	0.5	0.5	0.3	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.3	0.4	0.5	0.5	0.4	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.9	1.7	2.9	2.7	1.5	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	1.0	1.3	1.8	1.9	1.4	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.2	0.1	0.0	0.0	0.0

8.1.5 Total Return Flows by Reach and by Water Year Type

The monthly shaping percentages from Table 6.6 are used to obtain the monthly volume of return flows for M&I and AI, and then the monthly volumes are converted to daily average return flows for each reach (using the volume to flow conversion from Section 3.2). The return flows used for the simulation are shown in Tables 8.15 through 8.18. Note that return flows in ResSim are still diversions, so the negative sign in the diversion results in an inflow for each reach.

Table 8.15. Return daily average flow by reach, used for Abundant water years.

Reach	Daily Flow Return Rate, in cfs, by month, for M&I and Ag Demands that can be supported.											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1b	-3.36	-3.36	-3.36	-61.99	-73.88	-74.73	-105.97	-108.98	-82.76	-7.55	-5.03	-3.36
1c	-0.82	-0.82	-0.82	-6.01	-7.20	-8.19	-11.61	-12.01	-9.03	-1.84	-1.23	-0.82
2	-0.05	-0.05	-0.05	-0.11	-0.14	-0.21	-0.30	-0.32	-0.23	-0.10	-0.07	-0.05
3	-2.18	-2.18	-2.18	-31.94	-38.10	-39.36	-55.80	-57.45	-43.55	-4.90	-3.26	-2.18
4	-0.17	-0.17	-0.17	-1.92	-2.29	-2.45	-3.47	-3.58	-2.71	-0.39	-0.26	-0.17
5	-2.99	-2.99	-2.99	-10.75	-12.96	-17.52	-24.83	-25.87	-19.22	-6.72	-4.48	-2.99
6	-3.77	-3.77	-3.77	-3.78	-4.73	-11.33	-16.05	-16.99	-12.27	-8.49	-5.66	-3.77
7	-0.14	-0.14	-0.14	-0.99	-1.19	-1.37	-1.94	-2.01	-1.51	-0.32	-0.22	-0.14
8	-0.34	-0.34	-0.34	-5.11	-6.09	-6.28	-8.90	-9.16	-6.95	-0.76	-0.51	-0.34
9	0.00	0.00	0.00	-12.36	-14.68	-13.63	-19.32	-19.78	-15.14	0.00	0.00	0.00
10	-0.17	-0.17	-0.17	-0.17	-0.22	-0.52	-0.74	-0.78	-0.57	-0.39	-0.26	-0.17
11	-0.02	-0.02	-0.02	-0.06	-0.08	-0.10	-0.15	-0.15	-0.11	-0.04	-0.03	-0.02
12	0.00	0.00	0.00	-0.16	-0.19	-0.18	-0.25	-0.26	-0.20	0.00	0.00	0.00
13	-0.11	-0.11	-0.11	-0.35	-0.42	-0.60	-0.85	-0.89	-0.66	-0.25	-0.17	-0.11
14	-0.01	-0.01	-0.01	-0.55	-0.65	-0.62	-0.88	-0.90	-0.69	-0.02	-0.01	-0.01
15	-0.01	-0.01	-0.01	-0.01	-0.01	-0.03	-0.05	-0.05	-0.04	-0.02	-0.02	-0.01

Table 8.16. Return daily average flow by reach, used for Adequate water years.

Reach	Daily Flow Return Rate, in cfs, by month, for M&I and Ag Demands that can be supported.											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1b	-2.89	-2.89	-2.89	-61.52	-73.29	-73.32	-104.0	-106.9	-81.23	-6.49	-4.33	-2.89
1c	-0.71	-0.71	-0.71	-5.90	-7.05	-7.84	-11.12	-11.49	-8.66	-1.59	-1.06	-0.71
2	-0.04	-0.04	-0.04	-0.11	-0.13	-0.19	-0.27	-0.29	-0.21	-0.09	-0.06	-0.04
3	-1.87	-1.87	-1.87	-31.64	-37.71	-38.44	-54.51	-56.08	-42.56	-4.21	-2.81	-1.87
4	-0.15	-0.15	-0.15	-1.90	-2.26	-2.38	-3.37	-3.47	-2.63	-0.34	-0.23	-0.15
5	-2.57	-2.57	-2.57	-10.33	-12.44	-16.26	-23.06	-23.98	-17.86	-5.78	-3.85	-2.57
6	-3.24	-3.24	-3.24	-3.26	-4.07	-9.75	-13.81	-14.62	-10.56	-7.30	-4.87	-3.24
7	-0.12	-0.12	-0.12	-0.97	-1.17	-1.31	-1.85	-1.92	-1.44	-0.28	-0.18	-0.12
8	-0.29	-0.29	-0.29	-5.06	-6.03	-6.14	-8.70	-8.95	-6.79	-0.66	-0.44	-0.29
9	0.00	0.00	0.00	-12.36	-14.68	-13.63	-19.32	-19.78	-15.14	0.00	0.00	0.00
10	-0.15	-0.15	-0.15	-0.15	-0.19	-0.45	-0.64	-0.67	-0.49	-0.34	-0.22	-0.15
11	-0.02	-0.02	-0.02	-0.06	-0.07	-0.10	-0.14	-0.14	-0.11	-0.03	-0.02	-0.02
12	0.00	0.00	0.00	-0.16	-0.19	-0.18	-0.25	-0.26	-0.20	0.00	0.00	0.00
13	-0.10	-0.10	-0.10	-0.34	-0.41	-0.55	-0.78	-0.82	-0.61	-0.22	-0.14	-0.10
14	-0.01	-0.01	-0.01	-0.54	-0.65	-0.62	-0.87	-0.90	-0.68	-0.02	-0.01	-0.01
15	-0.01	-0.01	-0.01	-0.01	-0.01	-0.03	-0.04	-0.04	-0.03	-0.02	-0.01	-0.01

Table 8.17. Return daily average flow by reach, used for Insufficient water years.

Reach	Daily Flow Return Rate, in cfs, by month, for M&I and Ag Demands that can be supported.											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1b	-2.32	-2.32	-2.32	-60.95	-72.57	-71.61	-101.5	-104.3	-79.38	-5.21	-3.47	-2.32
1c	-0.57	-0.57	-0.57	-5.76	-6.88	-7.43	-10.53	-10.86	-8.20	-1.27	-0.85	-0.57
2	-0.03	-0.03	-0.03	-0.10	-0.12	-0.17	-0.24	-0.25	-0.19	-0.07	-0.05	-0.03
3	-1.50	-1.50	-1.50	-31.27	-37.25	-37.33	-52.94	-54.42	-41.36	-3.38	-2.25	-1.50
4	-0.12	-0.12	-0.12	-1.87	-2.23	-2.29	-3.24	-3.34	-2.53	-0.27	-0.18	-0.12
5	-2.06	-2.06	-2.06	-9.82	-11.80	-14.74	-20.90	-21.70	-16.21	-4.64	-3.09	-2.06
6	-2.60	-2.60	-2.60	-2.61	-3.27	-7.82	-11.08	-11.73	-8.47	-5.86	-3.90	-2.60
7	-0.10	-0.10	-0.10	-0.95	-1.13	-1.24	-1.75	-1.81	-1.36	-0.22	-0.15	-0.10
8	-0.23	-0.23	-0.23	-5.00	-5.96	-5.96	-8.46	-8.69	-6.61	-0.53	-0.35	-0.23
9	0.00	0.00	0.00	-12.36	-14.68	-13.63	-19.32	-19.78	-15.14	0.00	0.00	0.00
10	-0.12	-0.12	-0.12	-0.12	-0.15	-0.36	-0.51	-0.54	-0.39	-0.27	-0.18	-0.12
11	-0.01	-0.01	-0.01	-0.06	-0.07	-0.09	-0.12	-0.13	-0.10	-0.03	-0.02	-0.01
12	0.00	0.00	0.00	-0.16	-0.19	-0.18	-0.25	-0.26	-0.19	0.00	0.00	0.00
13	-0.08	-0.08	-0.08	-0.32	-0.38	-0.50	-0.70	-0.73	-0.54	-0.17	-0.12	-0.08
14	-0.01	-0.01	-0.01	-0.54	-0.65	-0.61	-0.87	-0.89	-0.68	-0.02	-0.01	-0.01
15	-0.01	-0.01	-0.01	-0.01	-0.01	-0.02	-0.03	-0.03	-0.02	-0.02	-0.01	-0.01

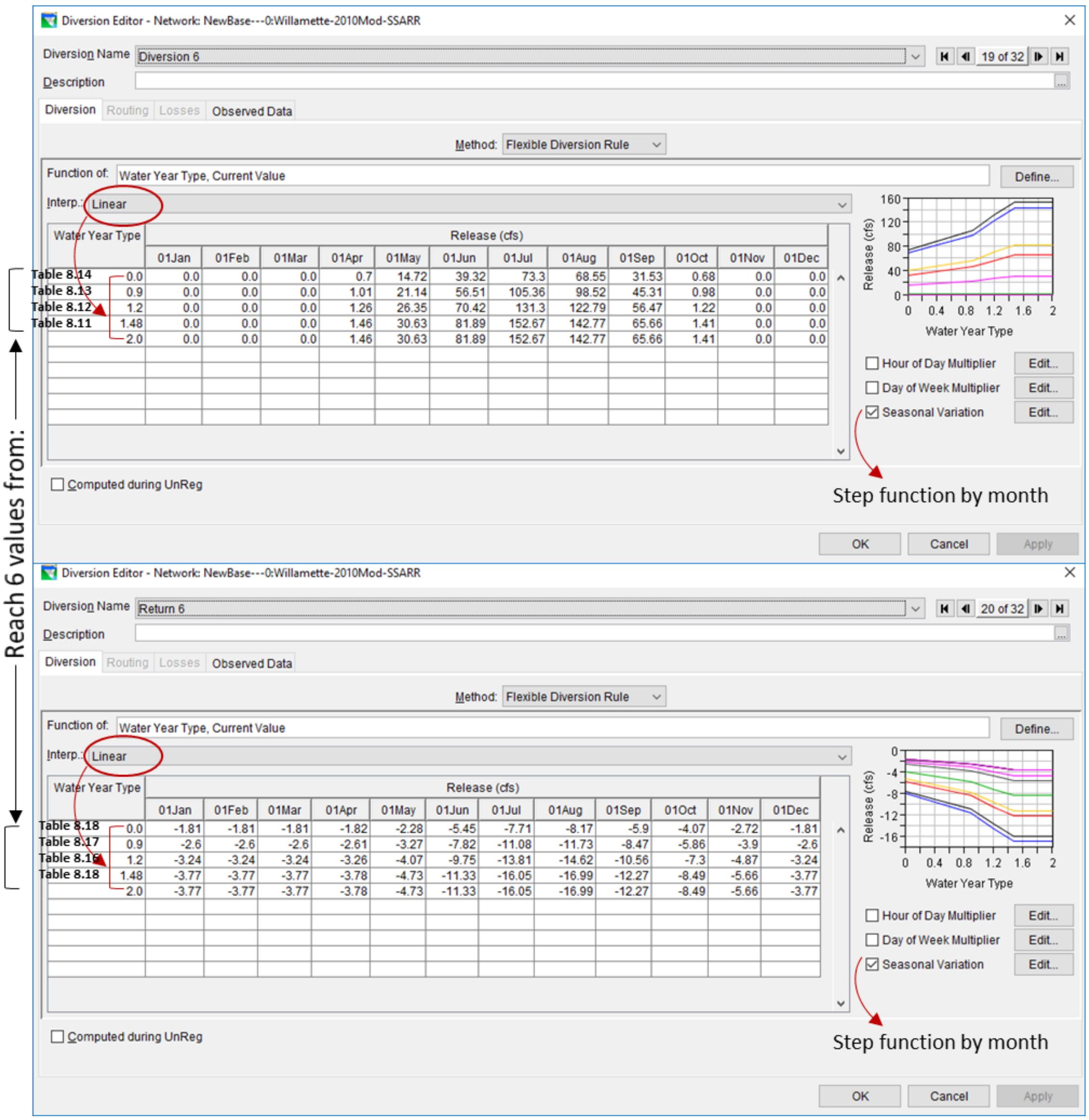
Table 8.18. Return daily average flow by reach, used for Deficit water years.

Reach	Daily Flow Return Rate, in cfs, by month, for M&I and Ag Demands that can be supported.											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1b	-1.61	-1.61	-1.61	-60.24	-71.69	-69.49	-98.55	-101.1	-77.09	-3.62	-2.42	-1.61
1c	-0.39	-0.39	-0.39	-5.59	-6.67	-6.91	-9.80	-10.09	-7.65	-0.89	-0.59	-0.39
2	-0.02	-0.02	-0.02	-0.09	-0.11	-0.14	-0.20	-0.21	-0.15	-0.05	-0.03	-0.02
3	-1.04	-1.04	-1.04	-30.81	-36.68	-35.96	-50.99	-52.36	-39.87	-2.35	-1.57	-1.04
4	-0.08	-0.08	-0.08	-1.83	-2.18	-2.18	-3.09	-3.17	-2.41	-0.19	-0.13	-0.08
5	-1.43	-1.43	-1.43	-9.20	-11.02	-12.86	-18.23	-18.88	-14.17	-3.22	-2.15	-1.43
6	-1.81	-1.81	-1.81	-1.82	-2.28	-5.45	-7.71	-8.17	-5.90	-4.07	-2.72	-1.81
7	-0.07	-0.07	-0.07	-0.92	-1.10	-1.14	-1.62	-1.67	-1.27	-0.15	-0.10	-0.07
8	-0.16	-0.16	-0.16	-4.93	-5.87	-5.75	-8.15	-8.37	-6.38	-0.37	-0.24	-0.16
9	0.00	0.00	0.00	-12.36	-14.68	-13.63	-19.32	-19.78	-15.14	0.00	0.00	0.00
10	-0.08	-0.08	-0.08	-0.08	-0.10	-0.25	-0.36	-0.38	-0.27	-0.19	-0.13	-0.08
11	-0.01	-0.01	-0.01	-0.05	-0.07	-0.08	-0.11	-0.11	-0.08	-0.02	-0.01	-0.01
12	0.00	0.00	0.00	-0.16	-0.19	-0.17	-0.25	-0.25	-0.19	0.00	0.00	0.00
13	-0.05	-0.05	-0.05	-0.29	-0.35	-0.43	-0.60	-0.63	-0.47	-0.12	-0.08	-0.05
14	0.00	0.00	0.00	-0.54	-0.64	-0.60	-0.86	-0.88	-0.67	-0.01	-0.01	0.00
15	-0.01	-0.01	-0.01	-0.01	-0.01	-0.02	-0.02	-0.02	-0.02	-0.01	-0.01	-0.01

8.1.6 Diversion Rule Example

The final flow specifications for the diversion withdrawals (Tables 8.11 to 8.14) and the diversion return flows (Tables 8.15 to 8.18) were input to ResSim with flexible diversion rules for each reach. Figure 8.1 is an example of the withdrawal and return flow rules for Reach 6, noting which tables were used for each water year type volume entry. The water year types are defined in Appendix E, Table 2.4. Rules for all diversions specified in Table 3.6, Appendix F, are applied in the same way.

Figure 8.1. Reach 6 Diversion Rules: at top is the withdrawal rule (Diversion Name = Diversion 6) and at bottom is the return flow rule (Diversion Name = Return 6). Note that flow rate is calculated based on a linear interpolation of the water year type volume and a step function by month. Entries for flow rates are annotated at left edge of figure for table reference number.



	Water Year Type	01Jan	01Feb	01Mar	01Apr	01May	01Jun	01Jul	01Aug	01Sep	01Oct	01Nov	01Dec
Table 8.14	0.0	0.0	0.0	0.0	0.7	14.72	39.32	73.3	68.55	31.53	0.68	0.0	0.0
Table 8.13	0.9	0.0	0.0	0.0	1.01	21.14	56.51	105.36	98.52	45.31	0.98	0.0	0.0
Table 8.12	1.2	0.0	0.0	0.0	1.26	26.35	70.42	131.3	122.79	56.47	1.22	0.0	0.0
Table 8.11	1.48	0.0	0.0	0.0	1.46	30.63	81.89	152.67	142.77	65.66	1.41	0.0	0.0
	2.0	0.0	0.0	0.0	1.46	30.63	81.89	152.67	142.77	65.66	1.41	0.0	0.0

	Water Year Type	01Jan	01Feb	01Mar	01Apr	01May	01Jun	01Jul	01Aug	01Sep	01Oct	01Nov	01Dec
Table 8.18	0.0	-1.81	-1.81	-1.81	-1.82	-2.28	-5.45	-7.71	-8.17	-5.9	-4.07	-2.72	-1.81
Table 8.17	0.9	-2.6	-2.6	-2.6	-2.61	-3.27	-7.82	-11.08	-11.73	-8.47	-5.86	-3.9	-2.6
Table 8.16	1.2	-3.24	-3.24	-3.24	-3.26	-4.07	-9.75	-13.81	-14.62	-10.56	-7.3	-4.87	-3.24
Table 8.18	1.48	-3.77	-3.77	-3.77	-3.78	-4.73	-11.33	-16.05	-16.99	-12.27	-8.49	-5.66	-3.77
	2.0	-3.77	-3.77	-3.77	-3.78	-4.73	-11.33	-16.05	-16.99	-12.27	-8.49	-5.66	-3.77

8.2 ResSim Rule Changes

The development of the additional reservoir releases follows the same steps as described in Section 7.2, using each reservoir's percentage of total conservation storage from Table 7.23 and the project share distributions from Table 7.24. (See Table 8.19.) The increased releases were added to the minimum releases specified for the Baseline (Appendices E). The project specific releases are shown in Tables 8.20 through 8.30. Each project's minimum release rule in the conservation zone is dependent on the water year type, while each project's minimum release in the buffer zone is specified as the Deficit year minimum from the tables. (See Section 5 for more details on the project minimum release rules.)

Table 8.19. Project flow contributions to meet increased demands, Expected No Action 2070.

Month	Project's release to meet increased share of demand in all reaches, in cfs, Abundant years										
	HCR	LOP	CGR	GPR	FOS	DET	FAL	COT	DOR	BLU	FRN
Apr	0.5	0.8	0.4	0.3	0.0	1.2	0.3	0.1	0.2	0.2	1.7
May	9.6	16.0	8.2	7.0	0.7	24.1	5.6	1.7	3.7	4.7	34.9
Jun	25.7	42.8	21.8	18.8	1.9	64.5	14.9	4.6	10.0	12.6	93.4
Jul	48.0	79.9	40.7	35.0	3.5	120.3	27.7	8.5	18.7	23.5	174.2
Aug	44.8	74.7	38.1	32.8	3.3	112.5	25.9	8.0	17.4	21.9	162.9
Sep	20.6	34.4	17.5	15.1	1.5	51.7	11.9	3.7	8.0	10.1	74.9
Oct	0.4	0.7	0.4	0.3	0.0	1.1	0.3	0.1	0.2	0.2	1.6
Month	Project's release to meet increased share of demand in all reaches, in cfs, Adequate years										
	HCR	LOP	CGR	GPR	FOS	DET	FAL	COT	DOR	BLU	FRN
Apr	0.4	0.7	0.3	0.3	0.0	1.0	0.2	0.1	0.2	0.2	1.4
May	8.3	13.8	7.0	6.0	0.6	20.7	4.8	1.5	3.2	4.0	30.0
Jun	22.1	36.8	18.8	16.2	1.6	55.5	12.8	3.9	8.6	10.8	80.3
Jul	41.2	68.7	35.0	30.1	3.0	103.4	23.9	7.3	16.0	20.2	149.8
Aug	38.6	64.3	32.7	28.2	2.8	96.7	22.3	6.9	15.0	18.9	140.1
Sep	17.7	29.5	15.1	13.0	1.3	44.5	10.3	3.2	6.9	8.7	64.4
Oct	0.4	0.6	0.3	0.3	0.0	1.0	0.2	0.1	0.1	0.2	1.4
Month	Project's release to meet increased share of demand in all reaches, in cfs, Insufficient years										
	HCR	LOP	CGR	GPR	FOS	DET	FAL	COT	DOR	BLU	FRN
Apr	0.3	0.5	0.3	0.2	0.0	0.8	0.2	0.1	0.1	0.2	1.2
May	6.6	11.1	5.6	4.8	0.5	16.6	3.8	1.2	2.6	3.2	24.1
Jun	17.7	29.6	15.1	13.0	1.3	44.5	10.3	3.2	6.9	8.7	64.4
Jul	33.1	55.1	28.1	24.2	2.4	83.0	19.1	5.9	12.9	16.2	120.2
Aug	30.9	51.6	26.3	22.6	2.2	77.6	17.9	5.5	12.0	15.1	112.4
Sep	14.2	23.7	12.1	10.4	1.0	35.7	8.2	2.5	5.5	7.0	51.7
Oct	0.3	0.5	0.3	0.2	0.0	0.8	0.2	0.1	0.1	0.1	1.1
Month	Project's release to meet increased share of demand in all reaches, in cfs, Deficit years										
	HCR	LOP	CGR	GPR	FOS	DET	FAL	COT	DOR	BLU	FRN
Apr	0.2	0.4	0.2	0.2	0.0	0.6	0.1	0.0	0.1	0.1	0.8
May	4.6	7.7	3.9	3.4	0.3	11.6	2.7	0.8	1.8	2.3	16.8
Jun	12.3	20.6	10.5	9.0	0.9	31.0	7.1	2.2	4.8	6.0	44.8
Jul	23.0	38.3	19.5	16.8	1.7	57.7	13.3	4.1	9.0	11.3	83.6
Aug	21.5	35.9	18.3	15.7	1.6	54.0	12.5	3.8	8.4	10.5	78.2
Sep	9.9	16.5	8.4	7.2	0.7	24.8	5.7	1.8	3.9	4.8	35.9
Oct	0.2	0.4	0.2	0.2	0.0	0.5	0.1	0.0	0.1	0.1	0.8

Table 8.20. Minimum project releases for the BiOp and BOR contracts for Blue River.

	Minimum Project Release, in cfs											
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
BiOp*	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
2008-2070												
Deficit	0.00	0.00	0.00	0.11	2.26	6.04	11.26	10.53	4.84	0.10	0.00	0.00
Insufficient	0.00	0.00	0.00	0.15	3.24	8.68	16.18	15.13	6.96	0.15	0.00	0.00
Adequate	0.00	0.00	0.00	0.19	4.04	10.82	20.17	18.86	8.67	0.19	0.00	0.00
Abundant	0.00	0.00	0.00	0.22	4.70	12.58	23.45	21.93	10.09	0.22	0.00	0.00
Total												
Deficit	50.00	50.00	50.00	50.11	52.26	56.04	61.26	60.53	54.84	50.10	50.00	50.00
Insufficient	50.00	50.00	50.00	50.15	53.24	58.68	66.18	65.13	56.96	50.15	50.00	50.00
Adequate	50.00	50.00	50.00	50.19	54.04	60.82	70.17	68.86	58.67	50.19	50.00	50.00
Abundant	50.00	50.00	50.00	50.22	54.70	62.58	73.45	71.93	60.09	50.22	50.00	50.00

*Note: "BiOp" means the BiOp minimum tributary flow target for this project.

Table 8.21. Minimum project releases for the BiOp and BOR contracts for Cougar.

	Minimum Project Release, in cfs											
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
BiOp*	300.0	300.0	300.0	300.0	300.0	400.0	300.0	300.0	300.0	300.0	300.0	300.0
2008-2070												
Deficit	0.00	0.00	0.00	0.19	3.92	10.48	19.54	18.27	8.40	0.18	0.00	0.00
Insufficient	0.00	0.00	0.00	0.27	5.63	15.06	28.09	26.26	12.08	0.26	0.00	0.00
Adequate	0.00	0.00	0.00	0.34	7.02	18.77	35.01	32.73	15.05	0.32	0.00	0.00
Abundant	0.00	0.00	0.00	0.39	8.16	21.83	40.70	38.06	17.50	0.38	0.00	0.00
Total												
Deficit	400.0	400.0	400.0	400.0	400.0	410.5	400.0	400.0	400.0	400.0	400.0	400.0
Insufficient	400.0	400.0	400.0	400.0	400.0	415.1	400.0	400.0	400.0	400.0	400.0	400.0
Adequate	400.0	400.0	400.0	400.0	400.0	418.8	400.0	400.0	400.0	400.0	400.0	400.0
Abundant	400.0	400.0	400.0	400.0	400.0	421.8	400.0	400.0	400.0	400.0	400.0	400.0

*Note: "BiOp" means the BiOp minimum tributary flow target for this project. While this minimum value is 300 cfs most of the time, the minimum turbine flow without causing cavitation is higher than 300 cfs, so 400 cfs is used for the minimum release most of the time. If the increased project release to cover the downstream BOR contracts plus the 300 cfs BiOp min is still less than 400 cfs, the project will still just release 400 cfs as a minimum.

Table 8.22. Minimum project releases for the BiOp and BOR contracts for Dorena.

	Minimum Project Release, in cfs											
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
BiOp*	100.0	190.0	190.0	190.0	190.0	190.0	100.0	100.0	100.0	100.0	100.0	100.0
2008-2070												
Deficit	0.00	0.00	0.00	0.09	1.80	4.80	8.96	8.38	3.85	0.08	0.00	0.00
Insufficient	0.00	0.00	0.00	0.12	2.58	6.90	12.87	12.04	5.54	0.12	0.00	0.00
Adequate	0.00	0.00	0.00	0.15	3.22	8.61	16.05	15.01	6.90	0.15	0.00	0.00
Abundant	0.00	0.00	0.00	0.18	3.74	10.01	18.66	17.45	8.02	0.17	0.00	0.00
Total												
Deficit	100.0	190.0	190.0	190.1	191.8	194.8	109.0	108.4	103.9	100.1	100.0	100.0
Insufficient	100.0	190.0	190.0	190.1	192.6	196.9	112.9	112.0	105.5	100.1	100.0	100.0
Adequate	100.0	190.0	190.0	190.2	193.2	198.6	116.0	115.0	106.9	100.1	100.0	100.0
Abundant	100.0	190.0	190.0	190.2	193.7	200.0	118.7	117.4	108.0	100.2	100.0	100.0

*Note: "BiOp" means the BiOp minimum tributary flow target for this project.

Table 8.23. Minimum project releases for the BiOp and BOR contracts for Cottage Grove.

	Minimum Project Release, in cfs											
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
BiOp*	50.0	75.0	75.0	75.0	75.0	75.0	50.0	50.0	50.0	50.0	50.0	50.0
2008-2070												
Deficit	0.00	0.00	0.00	0.04	0.82	2.19	4.09	3.82	1.76	0.04	0.00	0.00
Insufficient	0.00	0.00	0.00	0.06	1.18	3.15	5.88	5.50	2.53	0.05	0.00	0.00
Adequate	0.00	0.00	0.00	0.07	1.47	3.93	7.33	6.85	3.15	0.07	0.00	0.00
Abundant	0.00	0.00	0.00	0.08	1.71	4.57	8.52	7.97	3.66	0.08	0.00	0.00
Total												
Deficit	50.00	75.00	75.00	75.04	75.82	77.19	54.09	53.82	51.76	50.04	50.00	50.00
Insufficient	50.00	75.00	75.00	75.06	76.18	78.15	55.88	55.50	52.53	50.05	50.00	50.00
Adequate	50.00	75.00	75.00	75.07	76.47	78.93	57.33	56.85	53.15	50.07	50.00	50.00
Abundant	50.00	75.00	75.00	75.08	76.71	79.57	58.52	57.97	53.66	50.08	50.00	50.00

*Note: "BiOp" means the BiOp minimum tributary flow target for this project.

Table 8.24. Minimum project releases for the BiOp and BOR contracts for Fall Creek.

	Minimum Project Release, in cfs											
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**1Oct**	**16Oct**	**Nov/Dec**
BiOp*	50.0	50.0	50.0	80.0	80.0	80.0	80.0	80.0	200.0	200.0	50.0	50.0
2008-2070												
Deficit	0.00	0.00	0.00	0.13	2.67	7.14	13.32	12.45	5.73	0.12	0.12	0.00
Insufficient	0.00	0.00	0.00	0.18	3.84	10.27	19.15	17.90	8.23	0.18	0.18	0.00
Adequate	0.00	0.00	0.00	0.23	4.78	12.80	23.86	22.31	10.26	0.22	0.22	0.00
Abundant	0.00	0.00	0.00	0.27	5.56	14.88	27.75	25.95	11.93	0.26	0.26	0.00
Total												
Deficit	50.00	50.00	50.00	80.13	82.67	87.14	93.32	92.45	205.73	200.12	50.12	50.00
Insufficient	50.00	50.00	50.00	80.18	83.84	90.27	99.15	97.90	208.23	200.18	50.18	50.00
Adequate	50.00	50.00	50.00	80.23	84.78	92.80	103.86	102.31	210.26	200.22	50.22	50.00
Abundant	50.00	50.00	50.00	80.27	85.56	94.88	107.75	105.95	211.93	200.26	50.26	50.00

*Note: "BiOp" means the BiOp minimum tributary flow target for this project.

Table 8.25. Minimum project releases for the BiOp and BOR contracts for Hills Creek.

	Minimum Project Release, in cfs											
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
BiOp*	400.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0
2008-2070												
Deficit	0.00	0.00	0.00	0.22	4.62	12.35	23.02	21.53	9.90	0.21	0.00	0.00
Insufficient	0.00	0.00	0.00	0.32	6.63	17.75	33.09	30.94	14.23	0.31	0.00	0.00
Adequate	0.00	0.00	0.00	0.39	8.27	22.12	41.24	38.57	17.73	0.38	0.00	0.00
Abundant	0.00	0.00	0.00	0.46	9.62	25.72	47.96	44.85	20.62	0.44	0.00	0.00
Total												
Deficit	400.0	400.0	400.0	400.2	404.6	412.3	423.0	421.5	409.9	400.2	400.0	400.0
Insufficient	400.0	400.0	400.0	400.3	406.6	417.7	433.1	430.9	414.2	400.3	400.0	400.0
Adequate	400.0	400.0	400.0	400.4	408.3	422.1	441.2	438.6	417.7	400.4	400.0	400.0
Abundant	400.0	400.0	400.0	400.5	409.6	425.7	448.0	444.8	420.6	400.4	400.0	400.0

*Note: "BiOp" means the BiOp minimum tributary flow target for this project.

Table 8.26. Minimum project releases for the BiOp and BOR contracts for Lookout Point.

	Minimum Project Release, in cfs											
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
BiOp*	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200
HCR share 2008-2070												
Deficit	0.00	0.00	0.00	0.22	4.62	12.35	23.02	21.53	9.90	0.21	0.00	0.00
Insufficient	0.00	0.00	0.00	0.32	6.63	17.75	33.09	30.94	14.23	0.31	0.00	0.00
Adequate	0.00	0.00	0.00	0.39	8.27	22.12	41.24	38.57	17.73	0.38	0.00	0.00
Abundant	0.00	0.00	0.00	0.46	9.62	25.72	47.96	44.85	20.62	0.44	0.00	0.00
LOP share 2008-2070												
Deficit	0.00	0.00	0.00	0.37	7.69	20.57	38.35	35.86	16.49	0.36	0.00	0.00
Insufficient	0.00	0.00	0.00	0.53	11.05	29.56	55.13	51.55	23.70	0.51	0.00	0.00
Adequate	0.00	0.00	0.00	0.66	13.78	36.85	68.71	64.25	29.55	0.64	0.00	0.00
Abundant	0.00	0.00	0.00	0.77	16.02	42.85	79.90	74.71	34.35	0.74	0.00	0.00
Total												
Deficit	1200.0	1200.0	1200.0	1200.6	1212.3	1232.9	1261.4	1257.4	1226.4	1200.6	1200.0	1200.0
Insufficient	1200.0	1200.0	1200.0	1200.8	1217.7	1247.3	1288.2	1282.5	1237.9	1200.8	1200.0	1200.0
Adequate	1200.0	1200.0	1200.0	1201.1	1222.0	1259.0	1310.0	1302.8	1247.3	1201.0	1200.0	1200.0
Abundant	1200.0	1200.0	1200.0	1201.2	1225.6	1268.6	1327.9	1319.6	1255.0	1201.2	1200.0	1200.0

*Note: "BiOp" means the BiOp minimum tributary flow target for this project.

Minimum release must also include Hills Creek share.

Table 8.27. Minimum project releases for the BiOp and BOR contracts for Fern Ridge.

	Minimum Project Release, in cfs											
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
BiOp*	30.00	50.00	50.00	50.00	50.00	50.00	30.00	30.00	30.00	30.00	30.00	30.00
Baseline (2008)												
Deficit	0.00	0.00	0.00	0.00	25.11	51.74	82.63	66.00	33.93	0.00	0.00	0.00
Insufficient	0.00	0.00	0.00	0.00	25.11	51.74	82.63	66.00	33.93	0.00	0.00	0.00
Adequate	0.00	0.00	0.00	0.00	25.11	51.74	82.63	66.00	33.93	0.00	0.00	0.00
Abundant	0.00	0.00	0.00	0.00	25.11	51.74	82.63	66.00	33.93	0.00	0.00	0.00
2008-2070												
Deficit	0.00	0.00	0.00	0.80	16.76	44.83	83.60	78.17	35.95	0.77	0.00	0.00
Insufficient	0.00	0.00	0.00	1.15	24.09	64.45	120.17	112.38	51.67	1.11	0.00	0.00
Adequate	0.00	0.00	0.00	1.43	30.03	80.33	149.78	140.06	64.41	1.39	0.00	0.00
Abundant	0.00	0.00	0.00	1.67	34.92	93.40	174.16	162.86	74.89	1.61	0.00	0.00
Total**												
Deficit	30.00	50.00	50.00	50.80	91.87	146.58	196.23	174.17	99.88	30.77	30.00	30.00
Insufficient	30.00	50.00	50.00	51.15	99.20	166.19	232.81	208.37	115.60	31.11	30.00	30.00
Adequate	30.00	50.00	50.00	51.43	105.14	182.07	262.41	236.06	128.34	31.39	30.00	30.00
Abundant	30.00	50.00	50.00	51.67	110.03	195.15	286.80	258.86	138.82	31.61	30.00	30.00

*Note: "BiOp" means the BiOp minimum tributary flow target for this project.

**Total outflow minimum from Fern Ridge includes BOR contracts in 2008 as well as the additional contracts after 2008.

Table 8.28. Minimum project releases for the BiOp and BOR contracts for Green Peter.

	Minimum Project Release, in cfs								
	Apr	**1 May**	**16 May**	**Jun**	**Jul**	**Aug**	**Sep**	**1 Oct**	**16 Oct**
BiOp*	1500	1500	1100	1100	800	800	1500	1100	1500
2008-2070									
Deficit	0.16	3.37	3.37	9.02	16.81	15.72	7.23	0.16	0.16
Insufficient	0.23	4.85	4.85	12.96	24.17	22.60	10.39	0.22	0.22
Adequate	0.29	6.04	6.04	16.15	30.12	28.17	12.95	0.28	0.28
Abundant	0.34	7.02	7.02	18.78	35.03	32.75	15.06	0.32	0.32
Total**									
Deficit	1500.18	1503.71	1103.71	1109.91	818.48	817.28	1507.95	1500.17	1100.17
Insufficient	1500.25	1505.33	1105.33	1114.25	826.57	824.84	1511.42	1500.25	1100.25
Adequate	1500.32	1506.64	1106.64	1117.76	833.11	830.96	1514.24	1500.31	1100.31
Abundant	1500.37	1507.72	1107.72	1120.65	838.50	836.00	1516.56	1500.36	1100.36

*Note: "BiOp" means the BiOp minimum tributary flow target for this project. This is the flow required out of Foster.

**Total outflow minimum from Green Peter uses the Foster minimum flows, from next table.

Minimum Flows for months not shown are all BiOp minimums: Jan = 1100 cfs, Feb = 800 cfs, 1 Mar = 800 cfs, 16 Mar = 1500 cfs, Nov = 1100 cfs, Dec = 1100 cfs.

Table 8.29. Minimum project releases for the BiOp and BOR contracts for Foster.

	Minimum Project Release, in cfs								
	Apr	**1 May**	**16 May**	**Jun**	**Jul**	**Aug**	**Sep**	**1 Oct**	**16 Oct**
BiOp*	1500	1500	1100	1100	800	800	1500	1100	1500
2008-2070									
Deficit	0.02	0.33	0.33	0.89	1.67	1.56	0.72	0.02	0.02
Insufficient	0.02	0.48	0.48	1.29	2.40	2.24	1.03	0.02	0.02
Adequate	0.03	0.60	0.60	1.60	2.99	2.80	1.29	0.03	0.03
Abundant	0.03	0.70	0.70	1.86	3.48	3.25	1.49	0.03	0.03
GPR 2008-2070									
Deficit	0.16	3.37	3.37	9.02	16.81	15.72	7.23	0.16	0.16
Insufficient	0.23	4.85	4.85	12.96	24.17	22.60	10.39	0.22	0.22
Adequate	0.29	6.04	6.04	16.15	30.12	28.17	12.95	0.28	0.28
Abundant	0.34	7.02	7.02	18.78	35.03	32.75	15.06	0.32	0.32
Total									
Deficit	1500.18	1503.71	1103.71	1109.91	818.48	817.28	1507.95	1500.17	1100.17
Insufficient	1500.25	1505.33	1105.33	1114.25	826.57	824.84	1511.42	1500.25	1100.25
Adequate	1500.32	1506.64	1106.64	1117.76	833.11	830.96	1514.24	1500.31	1100.31
Abundant	1500.37	1507.72	1107.72	1120.65	838.50	836.00	1516.56	1500.36	1100.36

*Note: "BiOp" means the BiOp minimum tributary flow target for this project.

Minimum Flows for months not shown are all BiOp minimums: Jan = 1100 cfs, Feb = 800 cfs, 1 Mar = 800 cfs, 16 Mar = 1500 cfs, Nov = 1100 cfs, Dec = 1100 cfs.

Table 8.30. Minimum project releases for the BiOp and BOR contracts for Detroit.

	Minimum Project Release, in cfs								
	Apr	**May**	**Jun**	**1 Jul**	**15 Jul**	**Aug**	**Sep**	**1 Oct**	**16 Oct**
BiOp*	1500	1500	1200	1200	1000	1000	1500	1500	1200
Baseline (2008)									
Deficit	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Insufficient	0.00	14.49	29.86	47.68	47.68	38.09	19.58	0.00	0.00
Adequate	0.00	14.49	29.86	47.68	47.68	38.09	19.58	0.00	0.00
Abundant	0.00	14.49	29.86	47.68	47.68	38.09	19.58	0.00	0.00
2008-2070									
Deficit	0.55	11.58	30.97	57.74	57.74	53.99	24.83	0.54	0.54
Insufficient	0.79	16.64	44.51	83.00	83.00	77.61	35.69	0.77	0.77
Adequate	0.99	20.74	55.48	103.45	103.45	96.74	44.48	0.96	0.96
Abundant	1.15	24.12	64.51	120.29	120.29	112.48	51.72	1.11	1.11
Total**									
Deficit	1500.55	1511.58	1230.97	1257.74	1057.74	1053.99	1524.83	1500.54	1200.54
Insufficient	1500.79	1531.13	1274.38	1330.68	1130.68	1115.70	1555.27	1500.77	1200.77
Adequate	1500.99	1535.23	1285.34	1351.13	1151.13	1134.83	1564.06	1500.96	1200.96
Abundant	1501.15	1538.61	1294.37	1367.97	1167.97	1150.57	1571.30	1501.11	1201.11

*Note: "BiOp" means the BiOp minimum tributary flow target for this project.

**Total outflow minimum from Detroit includes BOR contracts in 2008 as well as the additional contracts after 2008.

Minimum Flows for months not shown are all BiOp minimums: Jan = 1200 cfs, Feb = 1000 cfs, 1 Mar = 1000 cfs, 16 Mar = 1500 cfs, Nov = 1200 cfs, Dec = 1200 cfs.

8.3 Simulation Results

The Expected No Action 2050 pool elevation non-exceedance graphs for each storage project are shown in Figures 8.2 and 8.3. These non-exceedance graphs are described in detail in Section 16 of Appendix E, in particular Figure 16.1 of that Appendix.

The graphs in Figures 8.4a through 8.4c are period average flows at Salem for every year in the POR, color coded by water year type. The periods are monthly for April, May, July, September, and October, when the Salem BiOp minimum targets are constant over each of those months, and for half month periods for June and August, when the BiOp minimum targets change midway through those months. These graphs highlight the result that regulated Salem flows are often well above the target minimum values. The main Feasibility report documents the occurrences for regulated Salem flows being below minimum flow targets, but does not show the frequency that the regulated flows exceed the minimum flow targets. The period average flow values plotted in Figures 8.4a to 8.4c are listed in Table 8.31a for 1929 through 1970 and Table 8.31b for 1971 through 2008.

The regulated flows at Albany, Salem, and Oregon City above Willamette Falls are shown in Figures 8.4 through 8.6. In each figure, the non-exceedance percentiles of the regulated flows are shown in the top graph (with a blue background), and the remaining four graphs in each figure show the regulated flow for one water year of each type, using 1966 (Adequate), 1967 (Insufficient), 1968 (Deficit), and 1969 (Abundant). The flow targets at Albany and Salem are shown in Figures 8.4 and 8.5, respectively, for the wetter years (Abundant and Adequate) and for Deficit years. The targets shown in Figure 8.6 are Salem targets (shown as dashed lines) for comparison. There are no official BiOp flow minimum targets at Willamette Falls, but a flow equivalent to that at Salem is desirable.

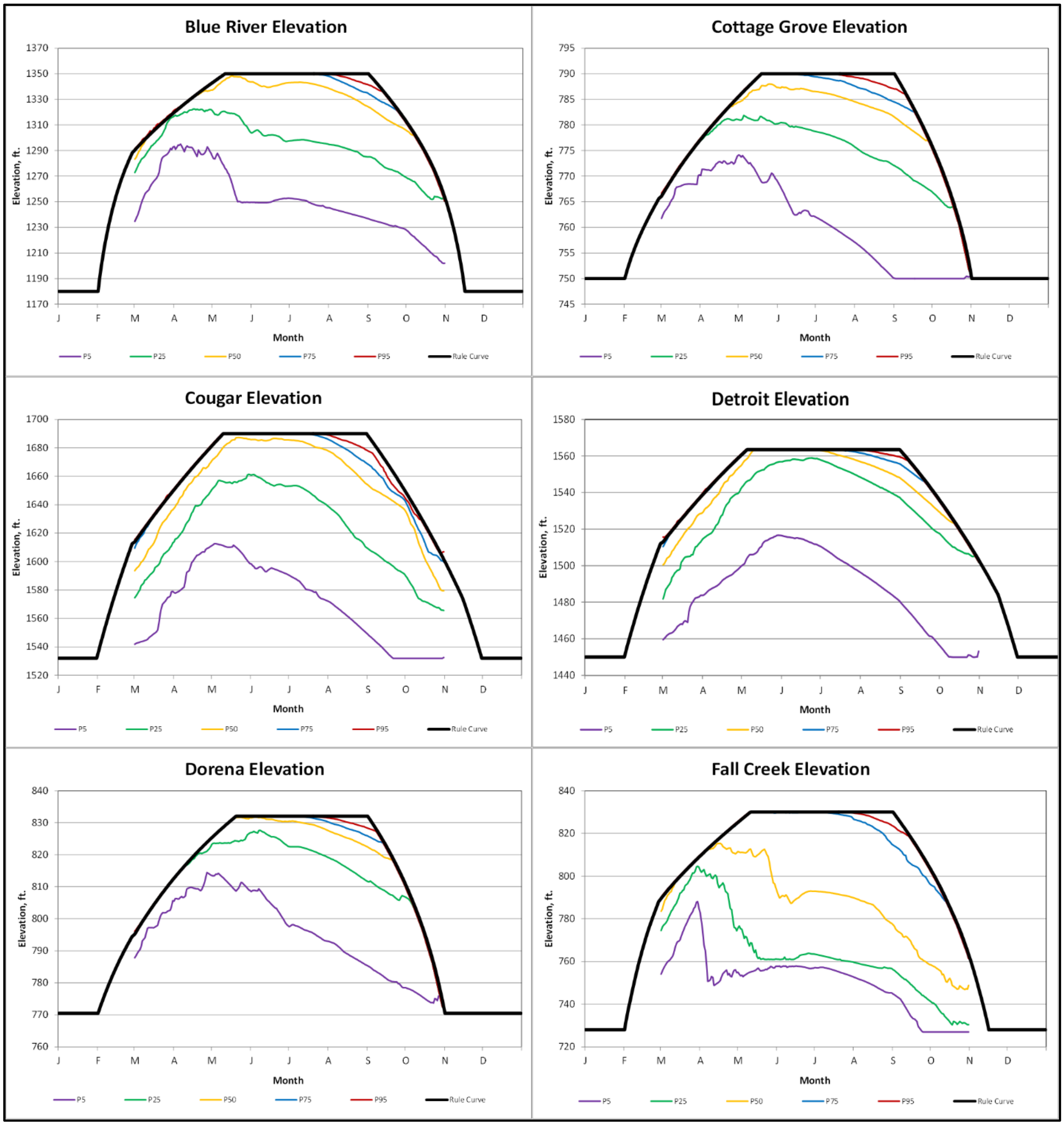


Figure 8.2. Pool elevation non-exceedance percentiles for the Expected No Action 2050 for Blue River, Cottage Grove, Cougar, Detroit, Dorena, and Fall Creek. See Figure 16.1 in Appendix E for non-exceedance value descriptions.

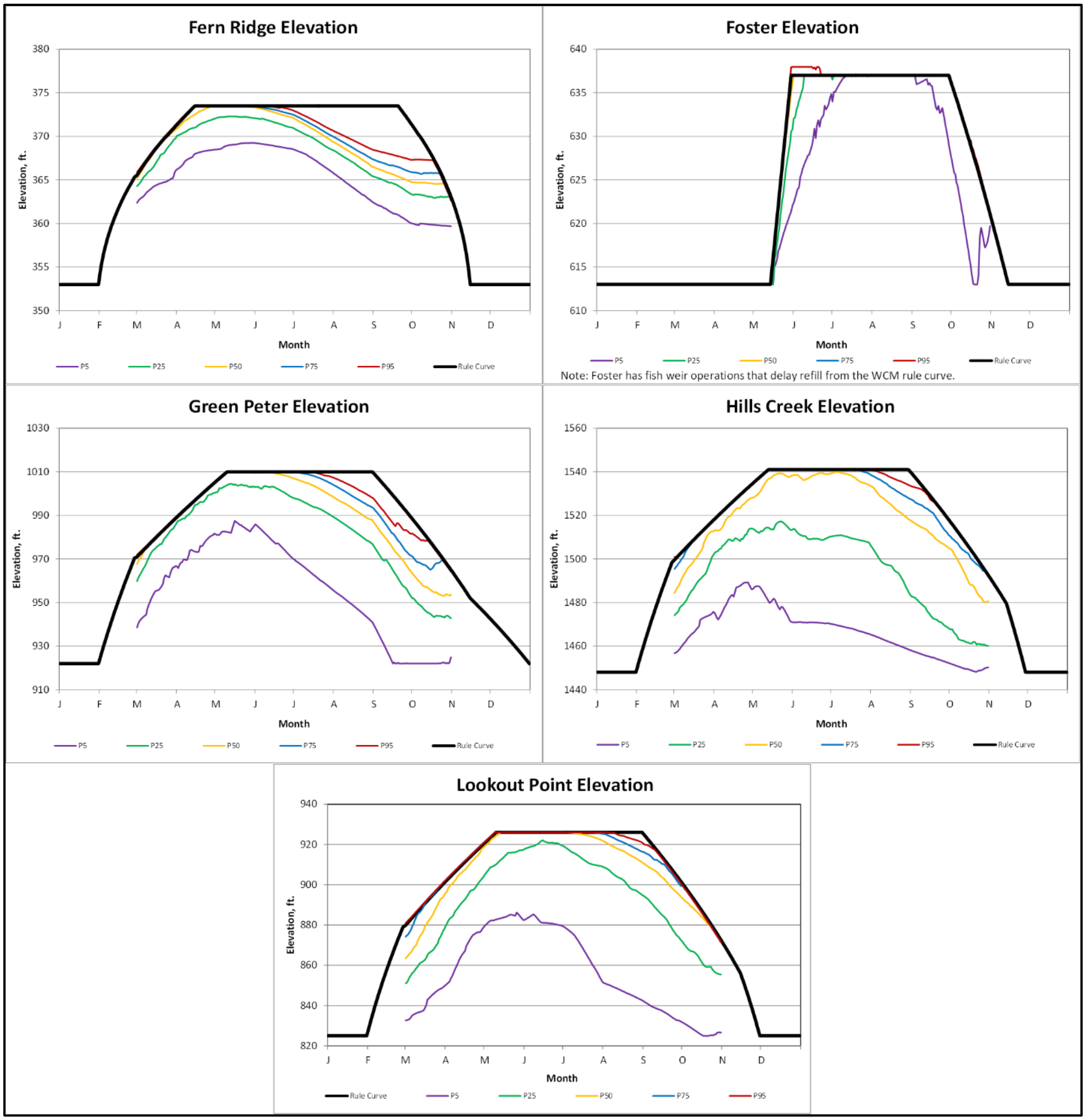


Figure 8.3. Pool elevation non-exceedance percentiles for the Expected No Action 2050 for Fern Ridge, Foster, Green Peter, Hills Creek, Fall Creek, and Lookout Point. See Figure 16.1 in Appendix E for non-exceedance value descriptions.

Expected No Action 2070, Period Average Flows at Salem

Figure 8.4a. Period average flows at Salem for all years in the POR for April (top), May (middle), and the first half of June (bottom), with flow target for that period and year shown as the solid black bar. Each year is color coded by water year type. Graphs show that Abundant water year average flows often significantly exceed the minimum flow targets at Salem while Deficit year average flows can miss the target. Adequate and Insufficient water years fall in between.

Expected No Action 2070, Period Average Flows at Salem

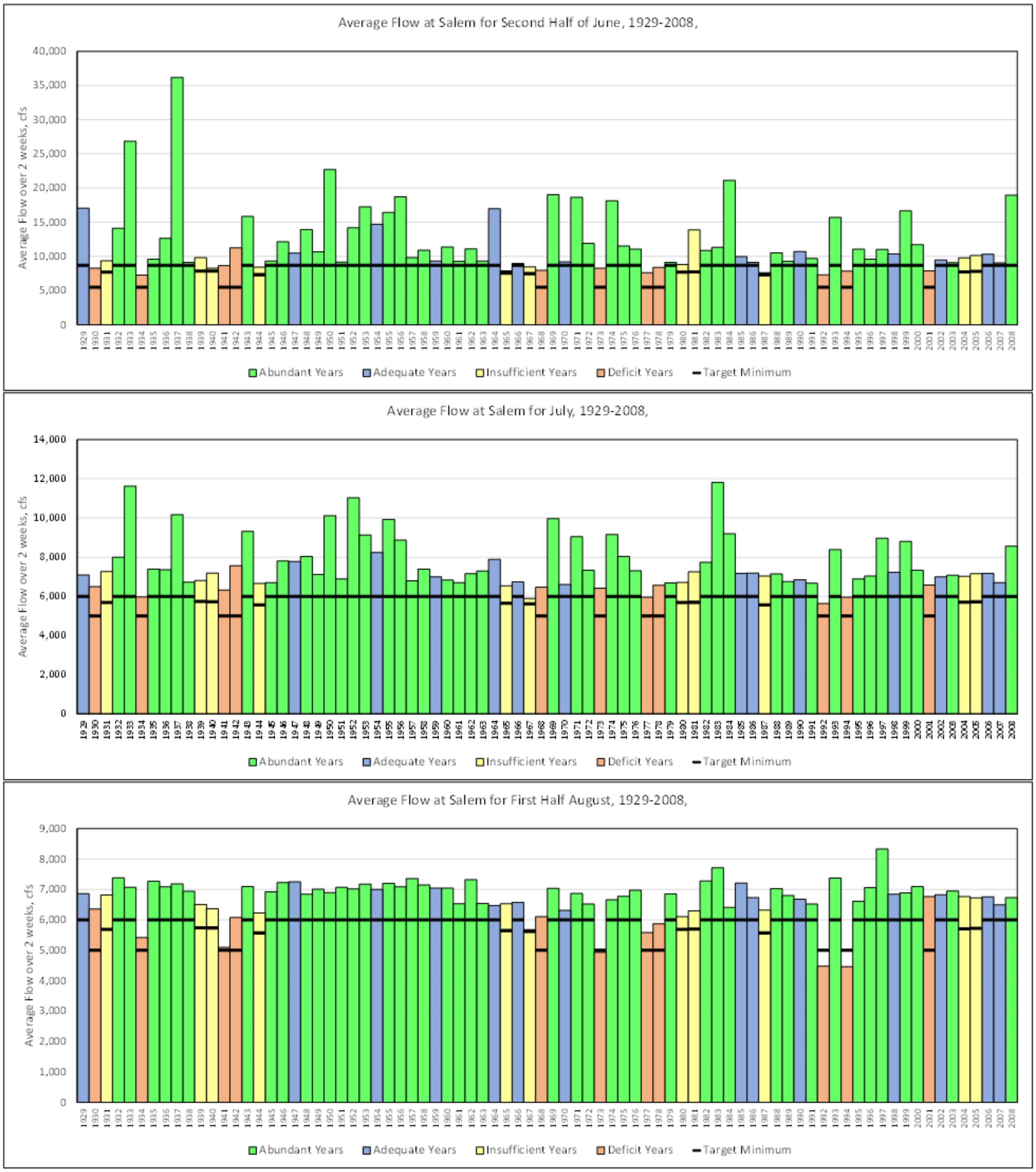


Figure 8.4b. Period average flows at Salem for all years in the POR for the second half of June (top), July (middle), and the first half of August (bottom), with flow target for that period and year shown as the solid black bar. Each year is color coded by water year type. Graphs show that Abundant water year average flows often exceed the minimum flow targets at Salem while Deficit year average flows can miss the target. Adequate and Insufficient water years fall in between.

Expected No Action 2070, Period Average Flows at Salem

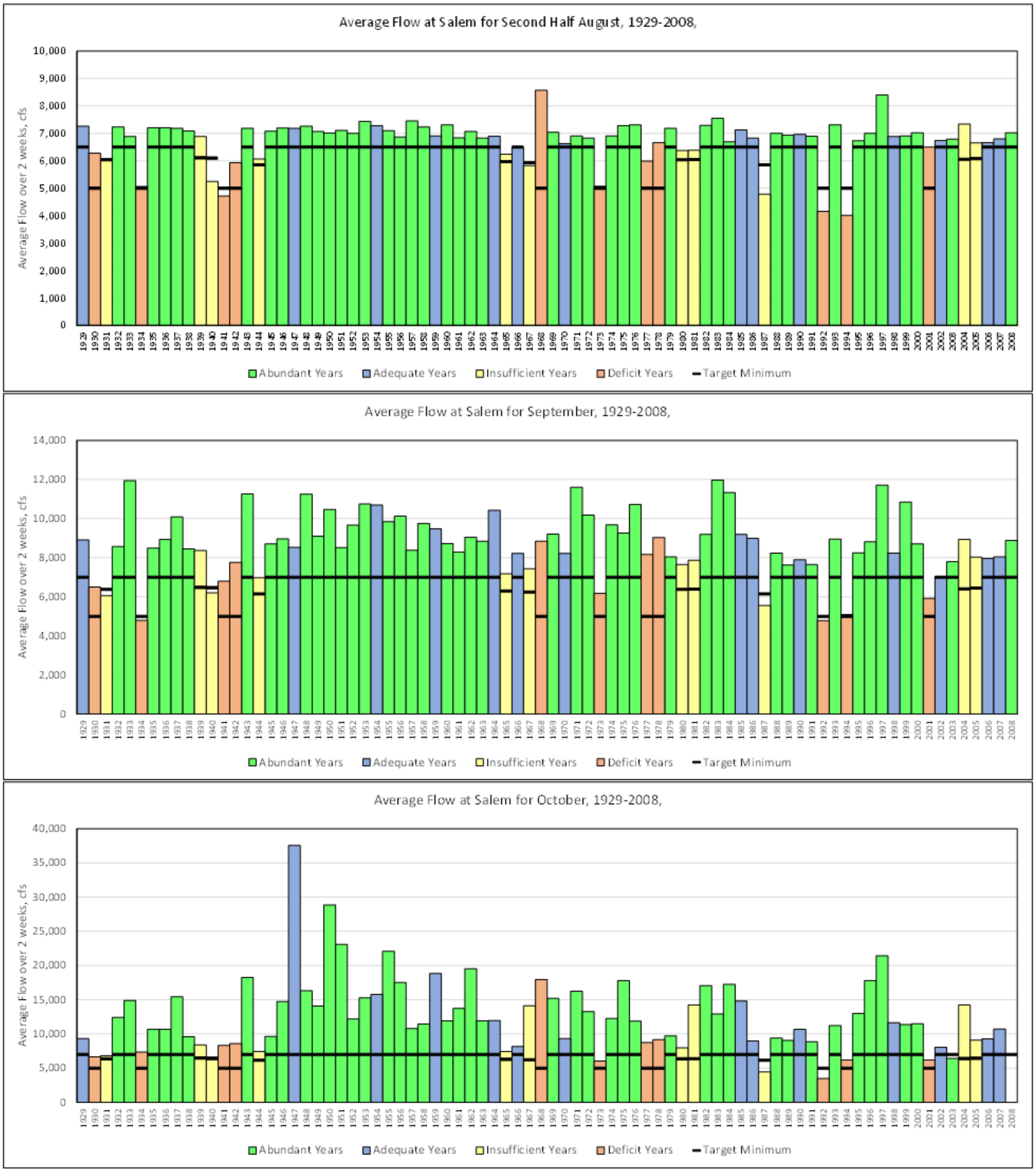


Figure 8.4c. Period average flows at Salem for all years in the POR for the second half of August (top), September (middle), and October (bottom), with flow target for that period and year shown as the solid black bar. Each year is color coded by water year type. Graphs show that Abundant water year average flows often exceed the minimum flow targets at Salem while Deficit year average flows can miss the target. Adequate and Insufficient water years fall in between. Note fall drafting begins in September.

Table 8.31a. Period average flows at Salem for all years in the POR, for 1929 to 1970. Average flow values are all in cfs.

Year	Average Flow at Salem over Period, in cfs.								
	Apr	May	1-15 Jun	16-30 Jun	July	1-15 Aug	16-30 Aug	Sep	Oct
1929	26253	17583	17830	17075	7093	6863	7266	8912	9314
1930	15420	14986	11861	8266	6498	6362	6277	6492	6652
1931	36652	13277	11185	9340	7262	6816	6065	6049	6807
1932	31455	24555	21677	14129	8000	7382	7237	8569	12409
1933	21857	28723	46945	26851	11627	7074	6888	11934	14884
1934	18661	12597	9186	7267	5968	5418	5066	4789	7343
1935	22940	17344	14168	9578	7391	7268	7201	8486	10666
1936	20818	22054	14517	12658	7362	7085	7208	8932	10683
1937	53549	29943	20940	36166	10174	7186	7181	10081	15424
1938	31723	21966	14236	9124	6729	6942	7088	8452	9614
1939	18269	13034	10836	9818	6801	6508	6888	8362	8374
1940	21336	13675	10052	8283	7189	6369	5245	6207	6234
1941	11590	13414	10240	8646	6320	5098	4719	6790	8305
1942	14440	16584	13901	11241	7566	6078	5934	7756	8575
1943	36623	17478	24902	15844	9319	7103	7188	11256	18262
1944	20818	14981	11264	8440	6664	6232	6063	6975	7414
1945	30951	32671	16382	9298	6697	6927	7080	8712	9641
1946	18590	16472	14787	12141	7808	7231	7193	8964	14744
1947	29433	13601	14226	10481	7773	7251	7186	8527	37554
1948	26751	28042	21963	13941	8033	6845	7266	11250	16316
1949	21980	33808	15876	10675	7119	7010	7064	9092	14092
1950	30663	26837	28910	22690	10118	6896	7011	10466	28848
1951	20972	18751	13583	9148	6895	7069	7110	8515	23078
1952	25928	21301	15834	14202	11033	7017	7006	9666	12180
1953	19768	29882	30825	17244	9127	7178	7436	10737	15262
1954	26417	15267	14231	14695	8235	7005	7284	10690	15757
1955	37205	24898	29722	16451	9927	7205	7100	9842	22077
1956	30176	27660	21506	18729	8873	7091	6866	10122	17523
1957	26677	16465	13531	9805	6788	7360	7454	8379	10775
1958	26570	16252	15666	10892	7391	7149	7232	9751	11445
1959	22959	18668	13348	9299	6997	7042	6912	9470	18827
1960	38896	36501	20390	11367	6835	7044	7305	8724	11889
1961	20970	20957	14121	9259	6692	6536	6839	8280	13729
1962	28147	24915	15926	11078	7153	7321	7071	9045	19527
1963	39476	35949	13486	9304	7294	6545	6831	8841	11906
1964	19408	16167	24968	16958	7894	6472	6900	10425	11953
1965	16743	14448	11120	7890	6538	6527	6242	7177	7440
1966	21119	14566	11130	8968	6737	6581	6494	8221	8163
1967	16651	15272	11644	8476	5892	5684	5822	7428	14100
1968	15483	13848	11934	7981	6467	6108	8573	8833	17965
1969	20753	23390	17118	19009	9965	7039	7037	9199	15179
1970	17452	17083	11021	9219	6602	6316	6622	8216	9331

Table 8.31b. Period average flows at Salem for all years in the POR, for 1971 to 2008. Average flow values are all in cfs.

Year	Average Flow at Salem over Period, in cfs.								
	Apr	May	1-15 Jun	16-30 Jun	July	1-15 Aug	16-30 Aug	Sep	Oct
1971	32039	26112	19798	18631	9041	6868	6912	11597	16253
1972	31171	26838	19469	11896	7331	6521	6828	10178	13281
1973	16279	12861	9384	8271	6418	4929	5075	6173	6045
1974	37151	22155	28050	18122	9159	6659	6912	9678	12242
1975	19702	22746	19220	11522	8033	6779	7284	9256	17813
1976	29070	23126	14406	11061	7313	6977	7309	10723	11871
1977	15481	16998	12673	7608	5958	5579	5990	8166	8733
1978	17593	16555	11377	8398	6568	5874	6669	9034	9177
1979	26678	23760	12735	9141	6686	6851	7183	8033	9705
1980	21561	14310	12395	8807	6706	6101	6373	7650	7984
1981	21154	15687	20511	13900	7252	6299	6387	7868	14230
1982	30077	16754	13991	10854	7734	7282	7290	9191	17068
1983	31105	18251	14989	11321	11816	7713	7549	11973	12924
1984	29454	29768	39602	21126	9204	6414	6691	11327	17257
1985	22146	15463	19429	9972	7173	7213	7128	9184	14799
1986	17423	16383	11363	9108	7188	6734	6828	8979	8971
1987	14936	12308	9499	7622	7035	6319	4789	5553	4440
1988	24519	22916	25815	10541	7137	7031	7002	8231	9395
1989	27918	16105	12674	9259	6752	6805	6940	7618	9064
1990	22202	16396	18452	10717	6851	6680	6968	7899	10657
1991	23225	25821	14500	9702	6670	6522	6898	7645	8844
1992	20046	12217	8596	7329	5629	4477	4157	4779	3471
1993	45163	31046	40356	15695	8381	7374	7313	8944	11202
1994	19547	12180	10366	7851	5958	4461	4017	5093	6171
1995	22074	23217	13121	11043	6895	6613	6734	8250	12982
1996	30508	29251	14476	9562	7037	7062	7001	8809	17798
1997	25251	19796	14711	10999	8968	8332	8404	11707	21408
1998	18689	20760	18402	10339	7223	6848	6882	8231	11639
1999	21686	28515	19641	16658	8804	6883	6908	10844	11390
2000	19696	21707	16897	11726	7327	7091	7022	8707	11468
2001	15720	14175	10601	7866	6585	6772	6498	5923	6191
2002	28612	15510	12615	9467	6995	6831	6739	7047	8066
2003	33744	16548	11097	9101	7073	6951	6793	7794	6440
2004	16091	13587	16505	9804	7016	6768	7338	8936	14228
2005	20290	19620	14277	10111	7150	6721	6656	8019	9088
2006	20264	15256	16778	10318	7168	6762	6659	7966	9265
2007	18442	13432	10364	9057	6703	6494	6798	8045	10718
2008	20035	31648	30158	18968	8563	6733	7021	8880	N/A

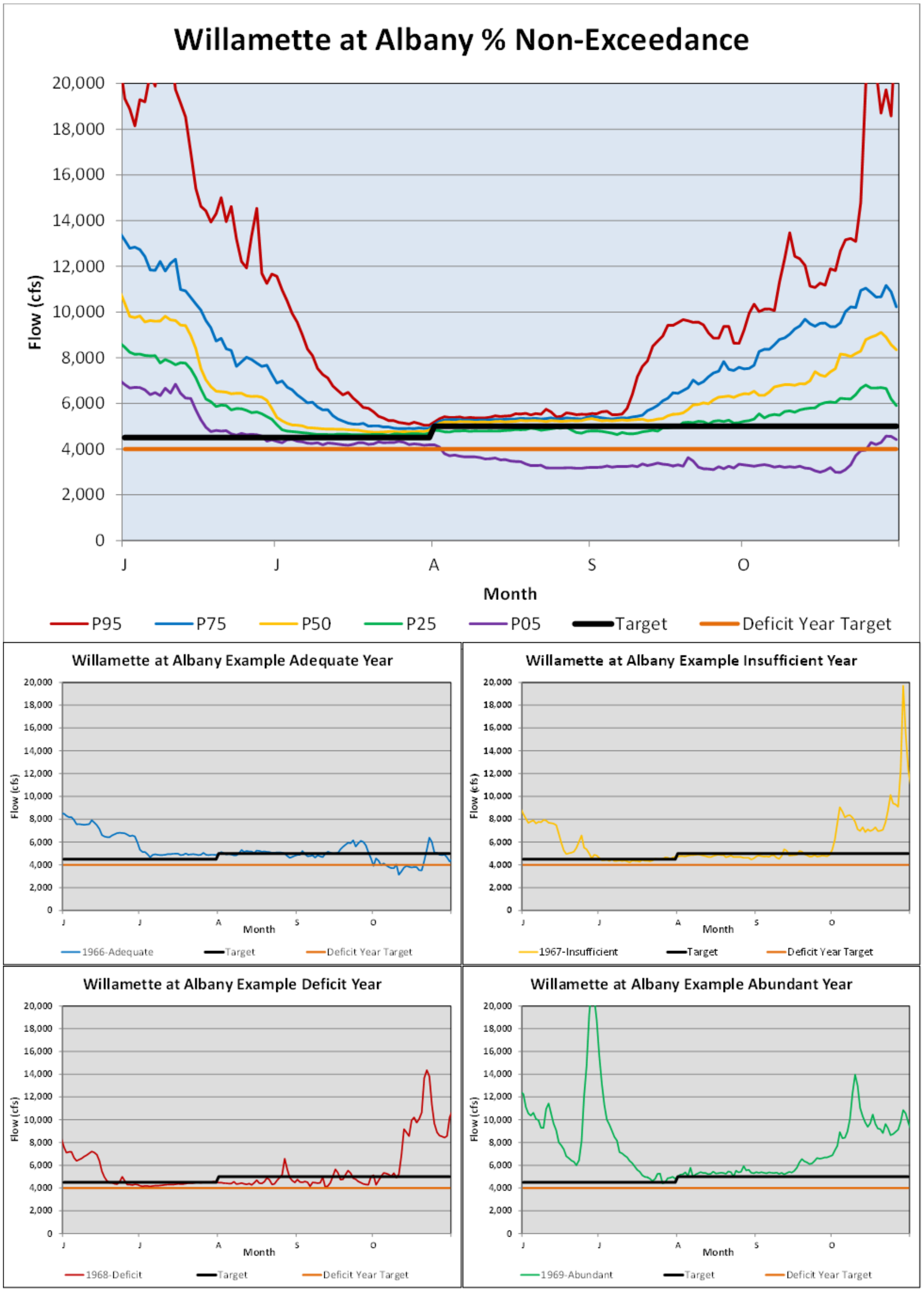


Figure 8.4. Non-exceedance percentiles for the Expected No Action 2070 for regulated flow at Albany in top graph (with blue background). Albany flow for selected years: 1966 (Adequate) at middle left, 1967 (Insufficient) at middle right, 1968 (Deficit) at bottom left, and 1969 (Abundant) at bottom right.

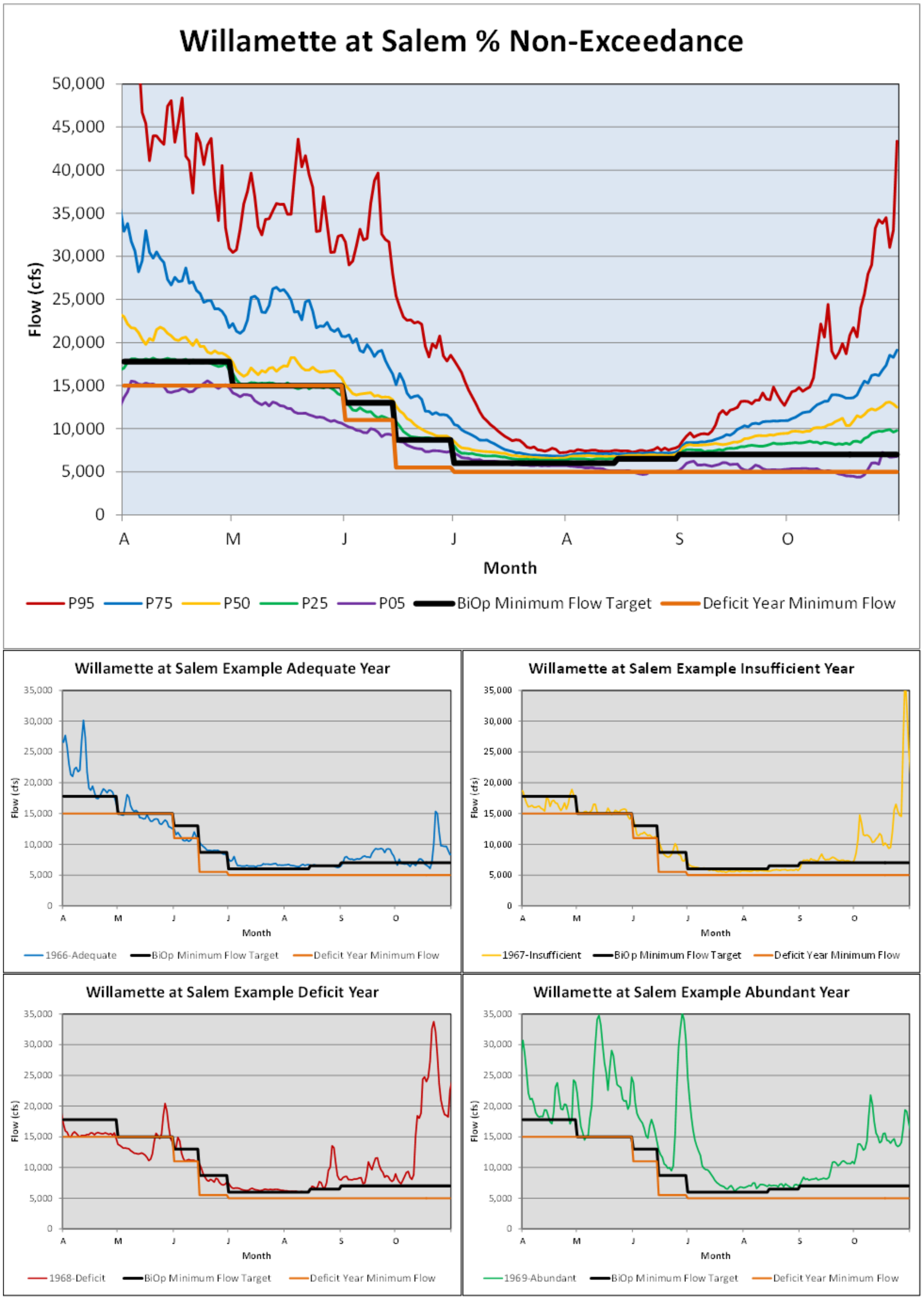


Figure 8.5. Non-exceedance percentiles for the Expected No Action 2070 for regulated flow at Salem in top graph (with blue background). Salem flow for selected years: 1966 (Adequate) at middle left, 1967 (Insufficient) at middle right, 1968 (Deficit) at bottom left, and 1969 (Abundant) at bottom right.

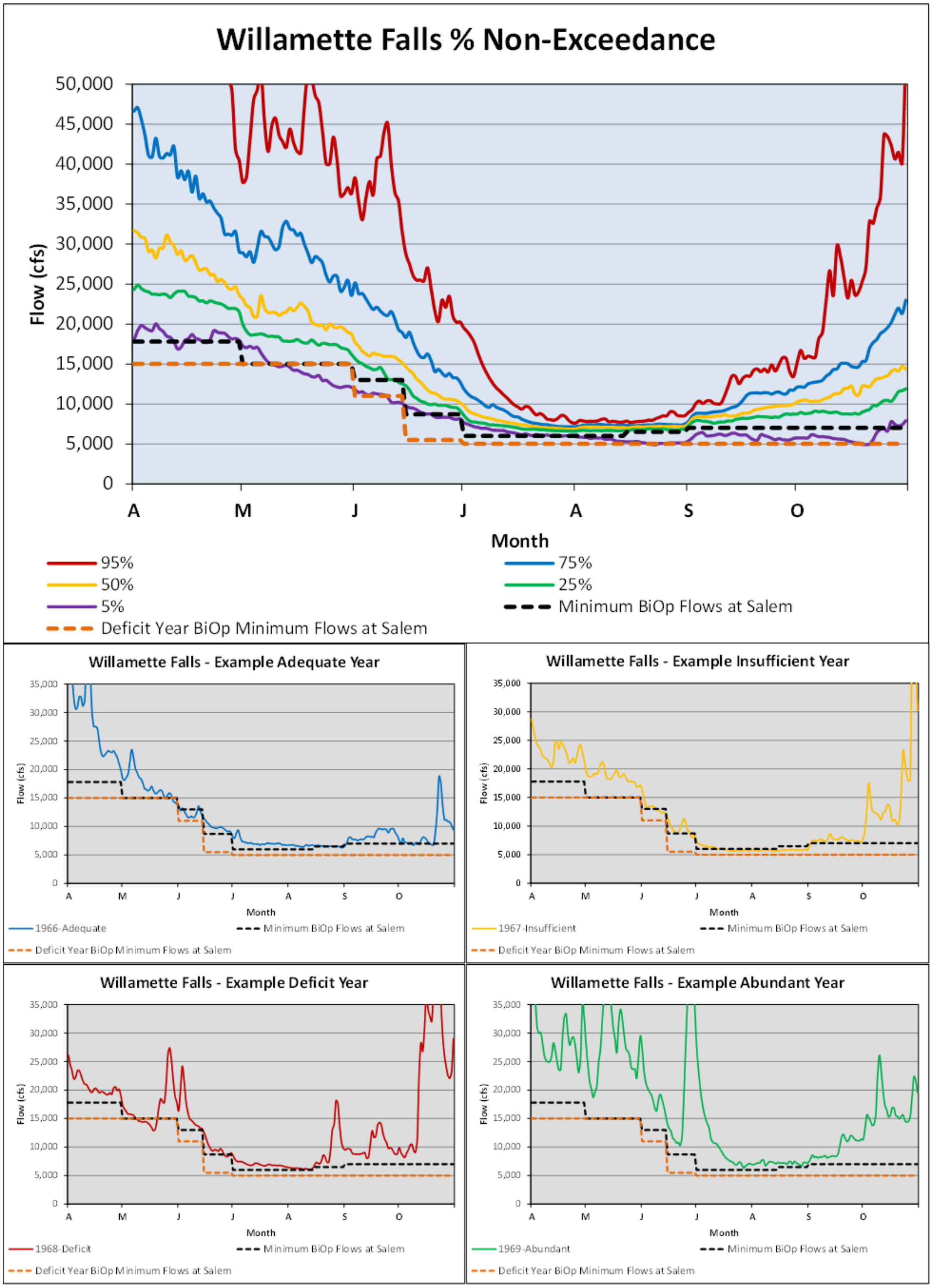


Figure 8.6. Non-exceedance percentiles for the Expected No Action 2070 for regulated flow at Oregon City above the Falls in top graph (with blue background). Flow for selected years: 1966 (Adequate) at middle left, 1967 (Insufficient) at middle right, 1968 (Deficit) at bottom left, and 1969 (Abundant) at bottom right.

9 Peak ARP 2070 ResSim Analysis

The simulation name for this analysis is ***Peak-ARP-2070-21Mar2018*** (see Table 1.1 for all other specifics for the simulation).

9.1 Diversions and Return Flows

Table 3.1 shows a total increase in Willamette Basin diversions of 471,942 ac-ft from 2008 levels for this analysis. The total increase was from eight categories, which were given separately for demand increases from 2008 to 2020 (for the Base Year analysis) and from 2020 to 2070. The demand increase for the two time windows are1

1. Demand Increases for 2008 to 2020, which were included in the Base Year 2020 analysis:

- an increase in BOR stored water contracts (22,854 ac-ft) (Table AI 1),
- an increase in M&I use from live flow permits that were already in place in 2008, but not fully utilized, for June through September (18,780 ac-ft) (Table MI 1),
- and an increase in M&I use from live flow permits that were already in place in 2008, but not fully utilized, for April through May (7541 ac-ft) (Table MI 2).

2. Demand Increases for 2020 to 2070, with values representing peak use:

- an increase in BOR stored water contracts (184,193 ac-ft), which is subdivided into the increase that brings the total BOR contract in the basin to 95,000 ac-ft (13,626 ac-ft) (Table AI 1) and the portion that is above 95,000 ac-ft (170,567 ac-ft) (Table AI 5), with the importance of the 95,000 ac-ft contract level described below as the two portions are modeled differently in ResSim,
- an increase in M&I use from live flow permits that were already in place in 2008, but not fully utilized, for June through September (90,227 ac-ft) (Table MI 3),
- an increase in M&I use from live flow permits that were already in place in 2008, but not fully utilized, for April through May (27,246 ac-ft) (Table MI 5),
- new M&I use from stored water due to system deficits (103,152 ac-ft) (Table MI 8),
- and new M&I use from stored water due to SSI deficits (17,950 ac-ft) (Table MI 10).

Table 3.2 indicates which categories from the eight increases above are from stored water (total volume is 328,149 ac-ft), and Table 3.3 indicates which categories are from instream flow permits (total volume is 143,794 ac-ft).

The development of the diversions and return flows for this simulation follows the same order of sub-sections described for the Peak No Action case, Section 7.

9.1.1 AI Diversions

The AI diversions in this simulation are the 22,854 ac-ft and 184,193 ac-ft volumes listed in Table 3.1. These volumes are broken out by reach in Appendix F in Tables AI 1 for the 22,854 ac-ft diversions and in Tables AI2 and AI 5 for the 184,193 ac-ft diversions. The total of these AI diversions by reach for May through September is shown in Table 9.1. Note that the total for all reaches is 207,047 ac-ft for AI demand, which leaves a remaining 121,102 ac-ft of demand from the total volume shown in Table 3.2 for stored water contracts for the Peak ARP 2070 column. The remaining 121,102 ac-ft of demand for stored water is from M&I demands on reallocated storage and is included in Section 9.1.2.

Following the description from Section 7.1, the irrigation volumes were re-distributed to April through October (using the 2010 Modified Flow percentages in Table 7.1b) in Table 9.2 for the full demand level, or the basis for supply in Abundant water years. Using the reductions by water year type described in Section 7.1.1, the April through October irrigation volumes are shown for Adequate years in Table 9.3, Insufficient years in Table 9.4, and Deficit years in Table 9.5.

Table 9.1. The incremental increases in BOR irrigation contracts from stored water between 2008 and 2070, from Tables AI 1, AI 2, and AI 5 in Appendix F.

Reach	Increased AI Demand Volume in acre-feet					
	May	June	July	August	September	Total
Reach 1	12,013	23,953	39,522	31,567	15,707	122,761
Reach 1a	526	1048	1729	1381	687	5372
Reach 1b	9232	18,408	30,374	24,260	12,071	94,346
Reach 1c	2255	4496	7419	5926	2948	23,044
Reach 2	605	1207	1991	1590	791	6185
Reach 3	1175	2343	3867	3088	1537	12,010
Reach 4	1000	1994	3289	2627	1307	10,217
Reach 5	1515	3020	4983	3980	1981	15,479
Reach 6	1631	3252	5365	4285	2132	16,665
Reach 7	654	1303	2151	1718	855	6681
Reach 8	500	997	1645	1314	654	5109
Reach 9	5	9	15	12	6	48
Reach 10	211	420	693	554	275	2153
Reach 11	789	1573	2595	2072	1031	8060
Reach 12	14	28	46	37	18	143
Reach 13	137	273	451	360	179	1401
Reach 14	10	21	34	27	14	106
Reach 15	3	5	9	7	4	27
Total all Reaches	20,261	40,398	66,657	53,240	26,491	207,046

*Note slight round-off error from showing all demands as integers.

Table 9.2. The incremental increases in BOR irrigation contracts from stored water between 2008 and 2070, from Tables AI 1, AI 2, and AI 5 in Appendix F, reshaped according to Table 7.1b, used as the basis for Abundant water year AI diversions.

Reach	Increased AI Demand in acre-feet							
	April	May	June	July	Aug.	Sept.	Oct.	Total
Reach 1	368	7967	20,624	39,738	37,160	16,536	368	122,761
Reach 1a	16	349	902	1739	1626	724	16	5372
Reach 1b	283	6123	15,850	30,540	28,558	12,708	283	94,346
Reach 1c	69	1496	3871	7459	6975	3104	69	23,044
Reach 2	19	401	1039	2002	1872	833	19	6185
Reach 3	36	779	2018	3888	3636	1618	36	12,010
Reach 4	31	663	1717	3307	3093	1376	31	10,217
Reach 5	46	1005	2601	5011	4686	2085	46	15,479
Reach 6	50	1082	2800	5395	5045	2245	50	16,665
Reach 7	20	434	1122	2163	2022	900	20	6681
Reach 8	15	332	858	1654	1546	688	15	5109
Reach 9	0	3	8	15	14	6	0	48
Reach 10	6	140	362	697	652	290	6	2153
Reach 11	24	523	1354	2609	2440	1086	24	8060
Reach 12	0	9	24	46	43	19	0	143
Reach 13	4	91	235	454	424	189	4	1401
Reach 14	0	7	18	34	32	14	0	106
Reach 15	0	2	5	9	8	4	0	27
Total all Reaches	621	13,437	34,784	67,021	62,673	27,889	621	**207,046**

*Note slight round-off error from showing all demands as integers.

Table 9.3. The incremental increases in BOR irrigation contracts from stored water between 2008 and 2070, from Tables AI 1, AI 2, and AI 5 in Appendix F, reshaped according to Table 7.1b, used as the basis for Adequate water year AI diversions.

Reach	Increased AI Demand in acre-feet							
	April	May	June	July	Aug.	Sept.	Oct.	Total
Reach 1	317	6852	17,737	34,175	31,958	14,221	317	105,575
Reach 1a	14	300	776	1495	1398	622	14	4620
Reach 1b	243	5266	13,631	26,264	24,560	10,929	243	81,137
Reach 1c	59	1286	3329	6415	5999	2669	59	19,818
Reach 2	16	345	894	1722	1610	716	16	5319
Reach 3	31	670	1735	3343	3127	1391	31	10,329
Reach 4	26	570	1476	2844	2660	1184	26	8787
Reach 5	40	864	2236	4309	4030	1793	40	13,312
Reach 6	43	930	2408	4639	4338	1931	43	14,332
Reach 7	17	373	965	1860	1739	774	17	5745
Reach 8	13	285	738	1422	1330	592	13	4394
Reach 9	0	3	7	13	12	6	0	41
Reach 10	6	120	311	599	560	249	6	1851
Reach 11	21	450	1164	2244	2098	934	21	6931
Reach 12	0	8	21	40	37	17	0	123
Reach 13	4	78	202	390	365	162	4	1205
Reach 14	0	6	15	29	27	12	0	91
Reach 15	0	2	4	8	7	3	0	24
Total all Reaches	534	11,556	29,914	57,638	53,899	23,985	534	**178,059**

Table 9.4. The incremental increases in BOR irrigation contracts from stored water between 2008 and 2070, from Tables AI 1, AI 2, and AI 5 in Appendix F, reshaped according to Table 7.1b, used as the basis for Insufficient water year AI diversions.

Reach	Increased AI Demand in acre-feet							
	April	May	June	July	Aug.	Sept.	Oct.	Total
Reach 1	254	5497	14,231	27,419	25,640	11,410	254	84,705
Reach 1a	11	241	623	1200	1122	499	11	3706
Reach 1b	195	4225	10,937	21,072	19,705	8769	195	65,099
Reach 1c	48	1032	2671	5147	4813	2142	48	15,900
Reach 2	13	277	717	1381	1292	575	13	4268
Reach 3	25	538	1392	2683	2508	1116	25	8287
Reach 4	21	458	1184	2282	2134	950	21	7050
Reach 5	32	693	1794	3457	3233	1439	32	10,681
Reach 6	34	746	1932	3722	3481	1549	34	11,499
Reach 7	14	299	774	1492	1395	621	14	4610
Reach 8	11	229	592	1141	1067	475	11	3525
Reach 9	0	2	6	11	10	4	0	33
Reach 10	4	96	250	481	450	200	4	1485
Reach 11	17	361	934	1800	1683	749	17	5561
Reach 12	0	6	17	32	30	13	0	99
Reach 13	3	63	162	313	293	130	3	967
Reach 14	0	5	12	24	22	10	0	73
Reach 15	0	1	3	6	6	3	0	19
Total all Reaches	429	9272	24,001	46,244	43,244	19,243	429	**142,861**

Table 9.5. The incremental increases in BOR irrigation contracts from stored water between 2008 and 2070, from Tables AI 1, AI 2, and AI 5 in Appendix F, reshaped according to Table 7.1b, used as the basis for Deficit water year AI diversions.

Reach	Increased AI Demand in acre-feet							
	April	May	June	July	Aug.	Sept.	Oct.	Total
Reach 1	177	3824	9899	19,074	17,837	7937	177	58,926
Reach 1a	8	167	433	835	780	347	8	2578
Reach 1b	136	2939	7608	14,659	13,708	6100	136	45,286
Reach 1c	33	718	1858	3580	3348	1490	33	11,061
Reach 2	9	193	499	961	899	400	9	2969
Reach 3	17	374	969	1866	1745	777	17	5765
Reach 4	15	318	824	1588	1485	661	15	4904
Reach 5	22	482	1248	2405	2249	1001	22	7430
Reach 6	24	519	1344	2589	2421	1078	24	7999
Reach 7	10	208	539	1038	971	432	10	3207
Reach 8	7	159	412	794	742	330	7	2452
Reach 9	0	1	4	7	7	3	0	23
Reach 10	3	67	174	335	313	139	3	1033
Reach 11	12	251	650	1252	1171	521	12	3869
Reach 12	0	4	12	22	21	9	0	69
Reach 13	2	44	113	218	204	91	2	673
Reach 14	0	3	9	16	15	7	0	51
Reach 15	0	1	2	4	4	2	0	13
Total all Reaches	298	6450	16,696	32,170	30,083	13,387	298	**99,382**

9.1.2 M&I Diversions with Reductions in Lower Water Years

The M&I diversions in this simulation that are reduced in lower water years are the 90,227 ac-ft, the 103,152 ac-ft, and the 17,950 ac-ft volumes listed in Table 3.1. These volumes are broken out by reach in Appendix F in Table MI 3 for the 90,227 ac-ft demand, in Table MI 8 for the 103,152 ac-ft demand, and Table MI 10 for the 17,950 ac-ft demand. The total of these M&I demands for all reaches is 211,329 ac-ft, which is greater than the total volume of 143,794 ac-ft of instream flow permits shown in Table 3.3 for the Peak ARP 2070 column because some of the 211,329 ac-ft volume is from stored water. The 53,568 ac-ft of instream flow demands that are not reduced in lower water years are described in Section 9.1.3.

Table 9.6 below shows the M&I diversions as the basis for the Abundant years, Table 9.7 for Adequate years, Table 9.8 for Insufficient years, and Table 9.9 for Deficit years, using the percentage reductions described in Section 3.1.

Table 9.6. The incremental increases in M&I Peak demands from already permitted live flow contracts and new stored water contracts, 2008 and 2070, from Tables MI 3, MI 8, and MI 10 in Appendix F, used as the basis for Abundant water year M&I diversions.

Reach	Increased M&I Demand in acre-feet							
	April	May	June	July	Aug.	Sept.	Oct.	Total
Reach 1	0	0	28,798	39,382	40,236	31,596	0	140,011
Reach 1a	0	0	8843	11,867	12,112	9640	0	42,462
Reach 1b	0	0	19,075	26,289	26,870	20,986	0	93,220
Reach 1c	0	0	879	1225	1253	971	0	4329
Reach 2	0	0	96	136	139	107	0	478
Reach 3	0	0	5836	8251	8445	6478	0	29,011
Reach 4	0	0	480	583	591	506	0	2161
Reach 5	0	0	2279	3144	3214	2508	0	11,145
Reach 6	0	0	14	20	21	16	0	71
Reach 7	0	0	510	596	603	531	0	2241
Reach 8	0	0	1314	1864	1908	1460	0	6546
Reach 9	0	0	3849	5318	5436	4239	0	18,842
Reach 10	0	0	3	3	3	3	0	12
Reach 11	0	0	19	27	28	21	0	96
Reach 12	0	0	62	88	90	69	0	309
Reach 13	0	0	33	47	48	37	0	166
Reach 14	0	0	48	68	70	53	0	239
Reach 15	0	0	0	0	0	0	0	0
Total all Reaches	0	0	43,343	59,527	60,832	47,626	0	**211,329**

Table 9.7. The incremental increases in M&I Peak demands from already permitted live flow contracts and new stored water contracts, 2008 and 2070, from Tables MI 3, MI 8, and MI 10 in Appendix F, used as the basis for Adequate water year M&I diversions.

Reach	Increased M&I Demand in acre-feet							
	April	May	June	July	Aug.	Sept.	Oct.	Total
Reach 1	0	0	24,766	33,868	34,603	27,173	0	120,410
Reach 1a	0	0	7605	10,206	10,416	8290	0	36,517
Reach 1b	0	0	16,405	22,609	23,109	18,048	0	80,170
Reach 1c	0	0	756	1054	1078	835	0	3723
Reach 2	0	0	83	117	120	92	0	411
Reach 3	0	0	5019	7096	7263	5571	0	24,949
Reach 4	0	0	413	501	509	436	0	1858
Reach 5	0	0	1960	2704	2764	2157	0	9585
Reach 6	0	0	12	17	18	14	0	61
Reach 7	0	0	439	513	519	457	0	1927
Reach 8	0	0	1130	1603	1641	1256	0	5629
Reach 9	0	0	3311	4573	4675	3645	0	16,204
Reach 10	0	0	3	3	3	3	0	10
Reach 11	0	0	17	24	24	18	0	83
Reach 12	0	0	53	76	78	59	0	266
Reach 13	0	0	29	41	42	32	0	143
Reach 14	0	0	41	59	60	46	0	205
Reach 15	0	0	0	0	0	0	0	0
Total all Reaches	0	0	37,275	51,193	52,316	40,958	0	**181,743**

Table 9.8. The incremental increases in M&I Peak demands from already permitted live flow contracts and new stored water contracts, 2008 and 2070, from Tables MI 3, MI 8, and MI 10 in Appendix F, used as the basis for Insufficient water year M&I diversions.

Reach	Increased M&I Demand in acre-feet							
	April	May	June	July	Aug.	Sept.	Oct.	Total
Reach 1	0	0	19,870	27,173	27,763	21,801	0	96,608
Reach 1a	0	0	6102	8188	8357	6651	0	29,299
Reach 1b	0	0	13,162	18,139	18,541	14,480	0	64,322
Reach 1c	0	0	607	846	865	670	0	2987
Reach 2	0	0	66	94	96	74	0	330
Reach 3	0	0	4027	5693	5827	4470	0	20,017
Reach 4	0	0	331	402	408	349	0	1491
Reach 5	0	0	1573	2169	2217	1731	0	7690
Reach 6	0	0	10	14	14	11	0	49
Reach 7	0	0	352	411	416	367	0	1546
Reach 8	0	0	907	1286	1316	1008	0	4517
Reach 9	0	0	2656	3669	3751	2925	0	13,001
Reach 10	0	0	2	2	2	2	0	8
Reach 11	0	0	13	19	19	15	0	66
Reach 12	0	0	43	61	62	48	0	213
Reach 13	0	0	23	33	33	26	0	115
Reach 14	0	0	33	47	48	37	0	165
Reach 15	0	0	0	0	0	0	0	0
Total all Reaches	0	0	29,907	41,074	41,974	32,862	0	**145,817**

Table 9.9. The incremental increases in M&I Peak demands from already permitted live flow contracts and new stored water contracts, 2008 and 2070, from Tables MI 3, MI 8, and MI 10 in Appendix F, used as the basis for Deficit water year M&I diversions.

Reach	Increased M&I Demand in acre-feet							
	April	May	June	July	Aug.	Sept.	Oct.	Total
Reach 1	0	0	13,823	18,903	19,313	15,166	0	67,205
Reach 1a	0	0	4245	5696	5814	4627	0	20,382
Reach 1b	0	0	9156	12,619	12,898	10,073	0	44,746
Reach 1c	0	0	422	588	602	466	0	2078
Reach 2	0	0	46	65	67	51	0	229
Reach 3	0	0	2801	3961	4054	3110	0	13,925
Reach 4	0	0	231	280	284	243	0	1037
Reach 5	0	0	1094	1509	1543	1204	0	5350
Reach 6	0	0	7	10	10	8	0	34
Reach 7	0	0	245	286	290	255	0	1076
Reach 8	0	0	631	895	916	701	0	3142
Reach 9	0	0	1848	2553	2609	2034	0	9044
Reach 10	0	0	1	1	1	1	0	6
Reach 11	0	0	9	13	13	10	0	46
Reach 12	0	0	30	42	43	33	0	148
Reach 13	0	0	16	23	23	18	0	80
Reach 14	0	0	23	33	33	26	0	115
Reach 15	0	0	0	0	0	0	0	0
Total all Reaches	0	0	20,805	28,573	29,199	22,860	0	**101,438**

9.1.3 M&I Diversions Supplied in Full for all Water Years

The M&I diversions in this simulation that are not reduced in lower water years are the 18,780 and 7541 ac-ft volumes for the 2008 to 2020 increases (Tables MI 1 and MI 2, respectively) and the 27,246 ac-ft volume for the 2020 to 2070 increase (Table MI 5). The volumes are listed in Table 3.1 of Appendix F, and the tables referenced in parentheses are from Appendix F where the volumes are broken out by reach. The total of these M&I demands for all reaches is the remaining instream flow demand described in Section 9.1.2.

Table 9.10 below shows the M&I diversions that apply for all water year types.

Table 9.10. The incremental increases in M&I Peak demands from already permitted live flow contracts, 2008 and 2070, from Tables MI 1, MI 2, and MI 5 in Appendix F.

Reach	Increased M&I Demand in acre-feet							
	April	May	June	July	Aug.	Sept.	Oct.	Total
Reach 1	10,168	12,083	2303	3267	3345	2559	0	33,724
Reach 1a	2617	3111	630	894	915	700	0	8867
Reach 1b	7087	8421	1557	2208	2261	1730	0	23,264
Reach 1c	464	550	116	165	169	129	0	1593
Reach 2	26	31	0	0	0	0	0	57
Reach 3	3004	3571	688	976	999	765	0	10,004
Reach 4	180	214	46	65	66	51	0	622
Reach 5	779	926	205	291	298	228	0	2727
Reach 6	1	2	0	0	0	0	0	3
Reach 7	75	89	24	34	35	26	0	283
Reach 8	470	559	130	184	188	144	0	1675
Reach 9	1100	1307	347	492	504	386	0	4136
Reach 10	0	0	0	0	0	0	0	0
Reach 11	5	5	1	2	2	1	0	16
Reach 12	15	18	4	6	6	5	0	54
Reach 13	24	29	7	9	9	7	0	85
Reach 14	48	57	15	21	22	17	0	181
Reach 15	0	0	0	0	0	0	0	0
Total all Reaches	15,896	18,891	3770	5347	5474	4189	0	**53,568**

*Note slight round-off error from showing all demands as integers.

9.1.4 Total Diversions by Reach and by Water Year Type

The total water volumes diverted in this simulation are shown below in Tables 9.11 through 9.14. These diversions depend on water year type.

The demand volumes by reach and by month are converted to daily average flow rates, shown in Tables 9.15 through 9.18 for Abundant, Adequate, Insufficient, and Deficit water years.

Table 9.11. The incremental increases in all demands, 2008 and 2070, used as the basis for Abundant water year diversions.

Reach	Increased Total Demand in acre-feet							
	April	May	June	July	Aug.	Sept.	Oct.	Total
Reach 1	10,536	20,050	51,725	82,387	80,740	50,691	368	296,497
Reach 1a	2633	3460	10,376	14,500	14,653	11,063	16	56,701
Reach 1b	7370	14,544	36,482	59,037	57,690	35,424	283	210,830
Reach 1c	533	2046	4866	8850	8398	4204	69	28,966
Reach 2	45	433	1135	2138	2011	940	19	6720
Reach 3	3040	4351	8542	13,115	13,080	8861	36	51,025
Reach 4	211	877	2243	3955	3750	1934	31	13,000
Reach 5	826	1931	5085	8446	8197	4821	46	29,352
Reach 6	51	1083	2814	5415	5065	2261	50	16,739
Reach 7	95	523	1656	2793	2661	1457	20	9205
Reach 8	486	891	2302	3701	3642	2292	15	13,330
Reach 9	1100	1310	4204	5825	5955	4631	0	23,025
Reach 10	6	140	365	700	655	293	6	2165
Reach 11	29	528	1374	2638	2470	1108	24	8172
Reach 12	15	28	90	140	139	93	0	507
Reach 13	28	120	276	510	482	233	4	1653
Reach 14	49	64	81	123	124	85	0	525
Reach 15	0	2	5	9	8	4	0	27
Total all Reaches	16,517	32,329	81,897	131,895	128,979	79,704	621	**471,942**

Table 9.12. The incremental increases in all demands, 2008 and 2070, used as the basis for Adequate water year diversions.

Reach	Increased Total Demand in acre-feet							
	April	May	June	July	Aug.	Sept.	Oct.	Total
Reach 1	10,484	18,935	44,806	71,310	69,905	43,953	317	259,709
Reach 1a	2631	3411	9011	12,595	12,729	9612	14	50,005
Reach 1b	7330	13,687	31,593	51,081	49,930	30,707	243	184,571
Reach 1c	523	1837	4201	7634	7246	3633	59	25,134
Reach 2	42	376	976	1839	1730	808	16	5787
Reach 3	3035	4242	7442	11,415	11,389	7728	31	45,282
Reach 4	206	784	1935	3411	3234	1670	26	11,267
Reach 5	819	1790	4402	7304	7091	4178	40	25,624
Reach 6	44	932	2420	4657	4356	1944	43	14,396
Reach 7	92	462	1428	2406	2293	1257	17	7956
Reach 8	483	844	1998	3209	3159	1992	13	11,698
Reach 9	1100	1309	3664	5079	5192	4037	0	20,381
Reach 10	6	120	314	602	563	252	6	1862
Reach 11	25	455	1182	2269	2124	953	21	7030
Reach 12	15	26	78	122	121	81	0	443
Reach 13	28	107	238	440	415	201	4	1433
Reach 14	48	63	72	109	109	75	0	477
Reach 15	0	2	4	8	7	3	0	24
Total all Reaches	16,430	30,447	70,959	114,178	111,688	69,132	534	**413,369**

Table 9.13. The incremental increases in all demands, 2008 and 2070, used as the basis for Insufficient water year diversions.

Reach	Increased Total Demand in acre-feet							
	April	May	June	July	Aug.	Sept.	Oct.	Total
Reach 1	10,422	17,580	36,404	57,860	56,748	35,770	254	215,038
Reach 1a	2628	3352	7355	10,282	10,394	7851	11	41,873
Reach 1b	7282	12,646	25,656	41,420	40,507	24,979	195	152,685
Reach 1c	511	1582	3394	6157	5847	2941	48	20,480
Reach 2	39	308	783	1475	1388	648	13	4655
Reach 3	3029	4109	6107	9352	9335	6351	25	38,308
Reach 4	201	671	1562	2749	2608	1350	21	9163
Reach 5	811	1619	3572	5918	5748	3397	32	21,098
Reach 6	36	748	1942	3736	3495	1560	34	11,551
Reach 7	89	388	1150	1938	1847	1014	14	6439
Reach 8	481	788	1629	2611	2571	1626	11	9717
Reach 9	1100	1309	3009	4172	4265	3315	0	17,170
Reach 10	4	96	252	483	452	202	4	1494
Reach 11	21	366	949	1821	1705	765	17	5644
Reach 12	15	25	63	99	98	66	0	366
Reach 13	27	92	192	355	335	163	3	1167
Reach 14	48	62	60	92	92	64	0	418
Reach 15	0	1	3	6	6	3	0	19
Total all Reaches	16,325	28,163	57,677	92,665	90,692	56,294	429	**342,246**

Table 9.14. The incremental increases in all demands, 2008 and 2070, used as the basis for Deficit water year diversions.

Reach	Increased Total Demand in acre-feet							
	April	May	June	July	Aug.	Sept.	Oct.	Total
Reach 1	10,344	15,907	26,025	41,244	40,495	25,662	177	159,855
Reach 1a	2625	3279	5308	7425	7509	5674	8	31,828
Reach 1b	7223	11,360	18,321	29,486	28,867	17,903	136	113,296
Reach 1c	497	1268	2396	4334	4119	2085	33	14,732
Reach 2	35	224	545	1026	965	451	9	3255
Reach 3	3022	3945	4458	6803	6798	4651	17	29,694
Reach 4	195	532	1100	1932	1834	955	15	6563
Reach 5	802	1408	2547	4205	4090	2433	22	15,507
Reach 6	25	521	1351	2599	2431	1085	24	8036
Reach 7	85	297	808	1358	1295	713	10	4565
Reach 8	478	718	1173	1872	1846	1175	7	7270
Reach 9	1100	1308	2199	3052	3120	2424	0	13,203
Reach 10	3	67	175	336	314	141	3	1039
Reach 11	16	256	660	1267	1186	532	12	3931
Reach 12	15	23	45	70	70	47	0	271
Reach 13	26	73	136	249	236	115	2	838
Reach 14	48	61	47	70	71	49	0	346
Reach 15	0	1	2	4	4	2	0	13
Total all Reaches	16,194	25,341	41,271	66,090	64,756	40,436	298	**254,387**

Table 9.15. Diversion withdrawals as daily average flow rates by reach, used for Abundant water years.

Reach	Daily Flow Withdrawal Rate, in cfs, by month.											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1b	0.00	0.00	0.00	4.76	236.54	613.11	960.14	938.24	595.32	4.60	0.00	0.00
1c	0.00	0.00	0.00	1.16	33.27	81.78	143.93	136.58	70.65	1.12	0.00	0.00
2	0.00	0.00	0.00	0.31	7.03	19.07	34.77	32.71	15.79	0.30	0.00	0.00
3	0.00	0.00	0.00	0.61	70.76	143.55	213.29	212.72	148.92	0.59	0.00	0.00
4	0.00	0.00	0.00	0.52	14.26	37.69	64.33	60.99	32.50	0.50	0.00	0.00
5	0.00	0.00	0.00	0.78	31.40	85.45	137.35	133.31	81.03	0.76	0.00	0.00
6	0.00	0.00	0.00	0.84	17.62	47.29	88.06	82.38	37.99	0.81	0.00	0.00
7	0.00	0.00	0.00	0.34	8.50	27.84	45.42	43.27	24.49	0.33	0.00	0.00
8	0.00	0.00	0.00	0.26	14.49	38.69	60.20	59.23	38.53	0.25	0.00	0.00
9	0.00	0.00	0.00	0.00	21.30	70.66	94.74	96.84	77.83	0.00	0.00	0.00
10	0.00	0.00	0.00	0.11	2.27	6.13	11.38	10.65	4.92	0.11	0.00	0.00
11	0.00	0.00	0.00	0.41	8.59	23.10	42.91	40.17	18.62	0.39	0.00	0.00
12	0.00	0.00	0.00	0.01	0.45	1.51	2.28	2.27	1.57	0.01	0.00	0.00
13	0.00	0.00	0.00	0.07	1.95	4.63	8.29	7.83	3.91	0.07	0.00	0.00
14	0.00	0.00	0.00	0.01	1.04	1.36	2.00	2.01	1.42	0.01	0.00	0.00
15	0.00	0.00	0.00	0.00	0.03	0.08	0.14	0.14	0.06	0.00	0.00	0.00

Table 9.16. Diversion withdrawals as daily average flow rates by reach, used for Adequate water years.

Reach	Daily Flow Withdrawal Rate, in cfs, by month.											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1b	0.00	0.00	0.00	4.09	222.60	530.94	830.75	812.03	516.04	3.96	0.00	0.00
1c	0.00	0.00	0.00	1.00	29.87	70.61	124.15	117.84	61.06	0.97	0.00	0.00
2	0.00	0.00	0.00	0.27	6.12	16.40	29.90	28.13	13.58	0.26	0.00	0.00
3	0.00	0.00	0.00	0.52	68.98	125.07	185.65	185.22	129.87	0.50	0.00	0.00
4	0.00	0.00	0.00	0.44	12.75	32.52	55.47	52.60	28.07	0.43	0.00	0.00
5	0.00	0.00	0.00	0.67	29.11	73.97	118.79	115.33	70.22	0.65	0.00	0.00
6	0.00	0.00	0.00	0.72	15.16	40.67	75.73	70.84	32.67	0.70	0.00	0.00
7	0.00	0.00	0.00	0.29	7.51	24.00	39.14	37.29	21.12	0.28	0.00	0.00
8	0.00	0.00	0.00	0.22	13.73	33.58	52.19	51.37	33.47	0.21	0.00	0.00
9	0.00	0.00	0.00	0.00	21.29	61.58	82.60	84.43	67.84	0.00	0.00	0.00
10	0.00	0.00	0.00	0.09	1.95	5.27	9.79	9.16	4.23	0.09	0.00	0.00
11	0.00	0.00	0.00	0.35	7.40	19.87	36.91	34.55	16.02	0.34	0.00	0.00
12	0.00	0.00	0.00	0.01	0.43	1.31	1.98	1.96	1.36	0.01	0.00	0.00
13	0.00	0.00	0.00	0.06	1.74	4.00	7.15	6.76	3.38	0.06	0.00	0.00
14	0.00	0.00	0.00	0.00	1.03	1.20	1.77	1.78	1.26	0.00	0.00	0.00
15	0.00	0.00	0.00	0.00	0.02	0.07	0.12	0.12	0.05	0.00	0.00	0.00

Table 9.17. Diversion withdrawals as daily average flow rates by reach, used for Insufficient water years.

Reach	Daily Flow Withdrawal Rate, in cfs, by month.											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1b	0.00	0.00	0.00	3.28	205.67	431.16	673.63	658.78	419.78	3.18	0.00	0.00
1c	0.00	0.00	0.00	0.80	25.73	57.03	100.14	95.09	49.42	0.78	0.00	0.00
2	0.00	0.00	0.00	0.22	5.01	13.16	23.99	22.57	10.90	0.21	0.00	0.00
3	0.00	0.00	0.00	0.42	66.83	102.63	152.09	151.82	106.74	0.40	0.00	0.00
4	0.00	0.00	0.00	0.36	10.92	26.25	44.71	42.42	22.69	0.34	0.00	0.00
5	0.00	0.00	0.00	0.54	26.33	60.03	96.24	93.49	57.10	0.52	0.00	0.00
6	0.00	0.00	0.00	0.58	12.17	32.63	60.76	56.84	26.21	0.56	0.00	0.00
7	0.00	0.00	0.00	0.23	6.31	19.33	31.51	30.03	17.03	0.22	0.00	0.00
8	0.00	0.00	0.00	0.18	12.81	27.38	42.46	41.82	27.33	0.17	0.00	0.00
9	0.00	0.00	0.00	0.00	21.28	50.56	67.85	69.36	55.71	0.00	0.00	0.00
10	0.00	0.00	0.00	0.07	1.57	4.23	7.85	7.35	3.40	0.07	0.00	0.00
11	0.00	0.00	0.00	0.28	5.96	15.94	29.62	27.72	12.86	0.27	0.00	0.00
12	0.00	0.00	0.00	0.00	0.40	1.07	1.60	1.59	1.11	0.00	0.00	0.00
13	0.00	0.00	0.00	0.05	1.49	3.23	5.77	5.45	2.74	0.05	0.00	0.00
14	0.00	0.00	0.00	0.00	1.01	1.01	1.49	1.50	1.07	0.00	0.00	0.00
15	0.00	0.00	0.00	0.00	0.02	0.05	0.10	0.09	0.04	0.00	0.00	0.00

Table 9.18. Diversion withdrawals as daily average flow rates by reach, used for Deficit water years.

Reach	Daily Flow Withdrawal Rate, in cfs, by month.											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1b	0.00	0.00	0.00	2.28	184.76	307.90	479.54	469.48	300.87	2.21	0.00	0.00
1c	0.00	0.00	0.00	0.56	20.63	40.27	70.48	66.99	35.04	0.54	0.00	0.00
2	0.00	0.00	0.00	0.15	3.64	9.16	16.69	15.70	7.58	0.14	0.00	0.00
3	0.00	0.00	0.00	0.29	64.17	74.92	110.63	110.56	78.16	0.28	0.00	0.00
4	0.00	0.00	0.00	0.25	8.65	18.49	31.43	29.83	16.04	0.24	0.00	0.00
5	0.00	0.00	0.00	0.37	22.90	42.81	68.39	66.51	40.88	0.36	0.00	0.00
6	0.00	0.00	0.00	0.40	8.47	22.70	42.27	39.54	18.24	0.39	0.00	0.00
7	0.00	0.00	0.00	0.16	4.83	13.57	22.09	21.07	11.98	0.16	0.00	0.00
8	0.00	0.00	0.00	0.12	11.68	19.71	30.45	30.02	19.75	0.12	0.00	0.00
9	0.00	0.00	0.00	0.00	21.27	36.95	49.64	50.75	40.73	0.00	0.00	0.00
10	0.00	0.00	0.00	0.05	1.09	2.94	5.46	5.11	2.36	0.05	0.00	0.00
11	0.00	0.00	0.00	0.20	4.17	11.10	20.61	19.30	8.95	0.19	0.00	0.00
12	0.00	0.00	0.00	0.00	0.37	0.76	1.15	1.14	0.80	0.00	0.00	0.00
13	0.00	0.00	0.00	0.03	1.18	2.29	4.06	3.84	1.94	0.03	0.00	0.00
14	0.00	0.00	0.00	0.00	0.99	0.78	1.14	1.15	0.83	0.00	0.00	0.00
15	0.00	0.00	0.00	0.00	0.01	0.04	0.07	0.06	0.03	0.00	0.00	0.00

9.1.5 Total Return Flows by Reach and by Water Year Type

The monthly shaping percentages from Table 6.6 are used to obtain the monthly volume of return flows for M&I and AI, and then the monthly volumes are converted to daily average return flows for each reach (using the volume to flow conversion from Section 3.2). The return flows used for the simulation are shown in Tables 9.19 through 9.22. Note that return flows in ResSim are still diversions, so the negative sign in the diversion results in an inflow for each reach.

Table 9.19. Return daily average flow by reach, used for Abundant water years.

Reach	Daily Flow Return Rate, in cfs, by month, for M&I and Ag Demands that can be supported.											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1b	-12.3	-12.3	-12.3	-56.9	-68.4	-231.2	-317.7	-326.5	-253.1	-27.6	-18.4	-12.3
1c	-3.0	-3.0	-3.0	-7.3	-8.9	-17.8	-25.1	-26.1	-19.5	-6.7	-4.5	-3.0
2	-0.8	-0.8	-0.8	-0.9	-1.1	-3.4	-4.7	-5.0	-3.7	-1.8	-1.2	-0.8
3	-1.6	-1.6	-1.6	-30.9	-36.8	-62.5	-87.3	-89.5	-68.9	-3.5	-2.3	-1.6
4	-1.3	-1.3	-1.3	-3.2	-3.9	-8.2	-11.5	-12.0	-9.0	-3.0	-2.0	-1.3
5	-2.0	-2.0	-2.0	-12.2	-14.6	-26.7	-37.4	-38.5	-29.4	-4.5	-3.0	-2.0
6	-2.2	-2.2	-2.2	-2.2	-2.8	-6.6	-9.4	-9.9	-7.2	-4.9	-3.3	-2.2
7	-0.9	-0.9	-0.9	-1.9	-2.4	-6.8	-9.4	-9.7	-7.4	-2.0	-1.3	-0.9
8	-0.7	-0.7	-0.7	-5.5	-6.6	-14.9	-20.6	-21.2	-16.3	-1.5	-1.0	-0.7
9	0.0	0.0	0.0	-21.4	-25.5	-32.0	-45.1	-46.2	-35.5	0.0	0.0	0.0
10	-0.3	-0.3	-0.3	-0.3	-0.4	-0.9	-1.2	-1.3	-0.9	-0.6	-0.4	-0.3
11	-1.0	-1.0	-1.0	-1.2	-1.4	-3.3	-4.7	-4.9	-3.6	-2.4	-1.6	-1.0
12	0.0	0.0	0.0	-0.4	-0.5	-0.6	-0.8	-0.8	-0.6	0.0	0.0	0.0
13	-0.2	-0.2	-0.2	-0.4	-0.5	-0.9	-1.3	-1.3	-1.0	-0.4	-0.3	-0.2
14	0.0	0.0	0.0	-0.4	-0.5	-0.6	-0.9	-0.9	-0.7	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 9.20. Return daily average flow by reach, used for Adequate water years.

Reach	Daily Flow Return Rate, in cfs, by month, for M&I and Ag Demands that can be supported.											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1b	-10.6	-10.6	-10.6	-56.1	-67.4	-201.5	-277.0	-284.6	-220.6	-23.8	-15.8	-10.6
1c	-2.6	-2.6	-2.6	-6.9	-8.4	-15.5	-21.7	-22.6	-16.9	-5.8	-3.9	-2.6
2	-0.7	-0.7	-0.7	-0.8	-0.9	-2.9	-4.1	-4.3	-3.2	-1.6	-1.0	-0.7
3	-1.3	-1.3	-1.3	-30.5	-36.3	-54.5	-76.2	-78.1	-60.2	-3.0	-2.0	-1.3
4	-1.1	-1.1	-1.1	-3.0	-3.6	-7.1	-10.0	-10.4	-7.8	-2.6	-1.7	-1.1
5	-1.7	-1.7	-1.7	-11.8	-14.1	-23.1	-32.3	-33.3	-25.4	-3.9	-2.6	-1.7
6	-1.9	-1.9	-1.9	-1.9	-2.4	-5.7	-8.0	-8.5	-6.2	-4.2	-2.8	-1.9
7	-0.7	-0.7	-0.7	-1.8	-2.2	-5.8	-8.1	-8.4	-6.4	-1.7	-1.1	-0.7
8	-0.6	-0.6	-0.6	-5.4	-6.4	-12.9	-17.9	-18.4	-14.2	-1.3	-0.9	-0.6
9	0.0	0.0	0.0	-20.8	-24.8	-27.5	-38.8	-39.7	-30.5	0.0	0.0	0.0
10	-0.2	-0.2	-0.2	-0.2	-0.3	-0.7	-1.0	-1.1	-0.8	-0.5	-0.4	-0.2
11	-0.9	-0.9	-0.9	-1.0	-1.3	-2.8	-4.0	-4.2	-3.1	-2.0	-1.4	-0.9
12	0.0	0.0	0.0	-0.4	-0.4	-0.5	-0.7	-0.7	-0.5	0.0	0.0	0.0
13	-0.2	-0.2	-0.2	-0.4	-0.5	-0.8	-1.1	-1.1	-0.8	-0.4	-0.2	-0.2
14	0.0	0.0	0.0	-0.4	-0.5	-0.5	-0.8	-0.8	-0.6	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 9.21. Return daily average flow by reach, used for Insufficient water years.

Reach	Daily Flow Return Rate, in cfs, by month, for M&I and Ag Demands that can be supported.											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1b	-8.5	-8.5	-8.5	-55.5	-66.5	-165.4	-227.4	-233.7	-181.1	-19.1	-12.7	-8.5
1c	-2.1	-2.1	-2.1	-6.4	-7.7	-12.6	-17.7	-18.4	-13.8	-4.7	-3.1	-2.1
2	-0.6	-0.6	-0.6	-0.6	-0.8	-2.4	-3.3	-3.4	-2.6	-1.2	-0.8	-0.6
3	-1.1	-1.1	-1.1	-30.0	-35.7	-44.9	-62.7	-64.3	-49.5	-2.4	-1.6	-1.1
4	-0.9	-0.9	-0.9	-2.7	-3.3	-5.8	-8.1	-8.4	-6.3	-2.1	-1.4	-0.9
5	-1.4	-1.4	-1.4	-11.2	-13.4	-18.7	-26.2	-27.0	-20.6	-3.1	-2.1	-1.4
6	-1.5	-1.5	-1.5	-1.6	-1.9	-4.6	-6.5	-6.8	-4.9	-3.4	-2.2	-1.5
7	-0.6	-0.6	-0.6	-1.6	-2.0	-4.7	-6.5	-6.8	-5.1	-1.3	-0.9	-0.6
8	-0.5	-0.5	-0.5	-5.2	-6.3	-10.6	-14.6	-15.0	-11.6	-1.0	-0.7	-0.5
9	0.0	0.0	0.0	-19.9	-23.7	-22.1	-31.2	-31.9	-24.5	0.0	0.0	0.0
10	-0.2	-0.2	-0.2	-0.2	-0.2	-0.6	-0.8	-0.9	-0.6	-0.4	-0.3	-0.2
11	-0.7	-0.7	-0.7	-0.8	-1.0	-2.3	-3.2	-3.4	-2.5	-1.6	-1.1	-0.7
12	0.0	0.0	0.0	-0.3	-0.4	-0.4	-0.5	-0.5	-0.4	0.0	0.0	0.0
13	-0.1	-0.1	-0.1	-0.4	-0.4	-0.6	-0.9	-0.9	-0.7	-0.3	-0.2	-0.1
14	0.0	0.0	0.0	-0.4	-0.5	-0.5	-0.7	-0.7	-0.5	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

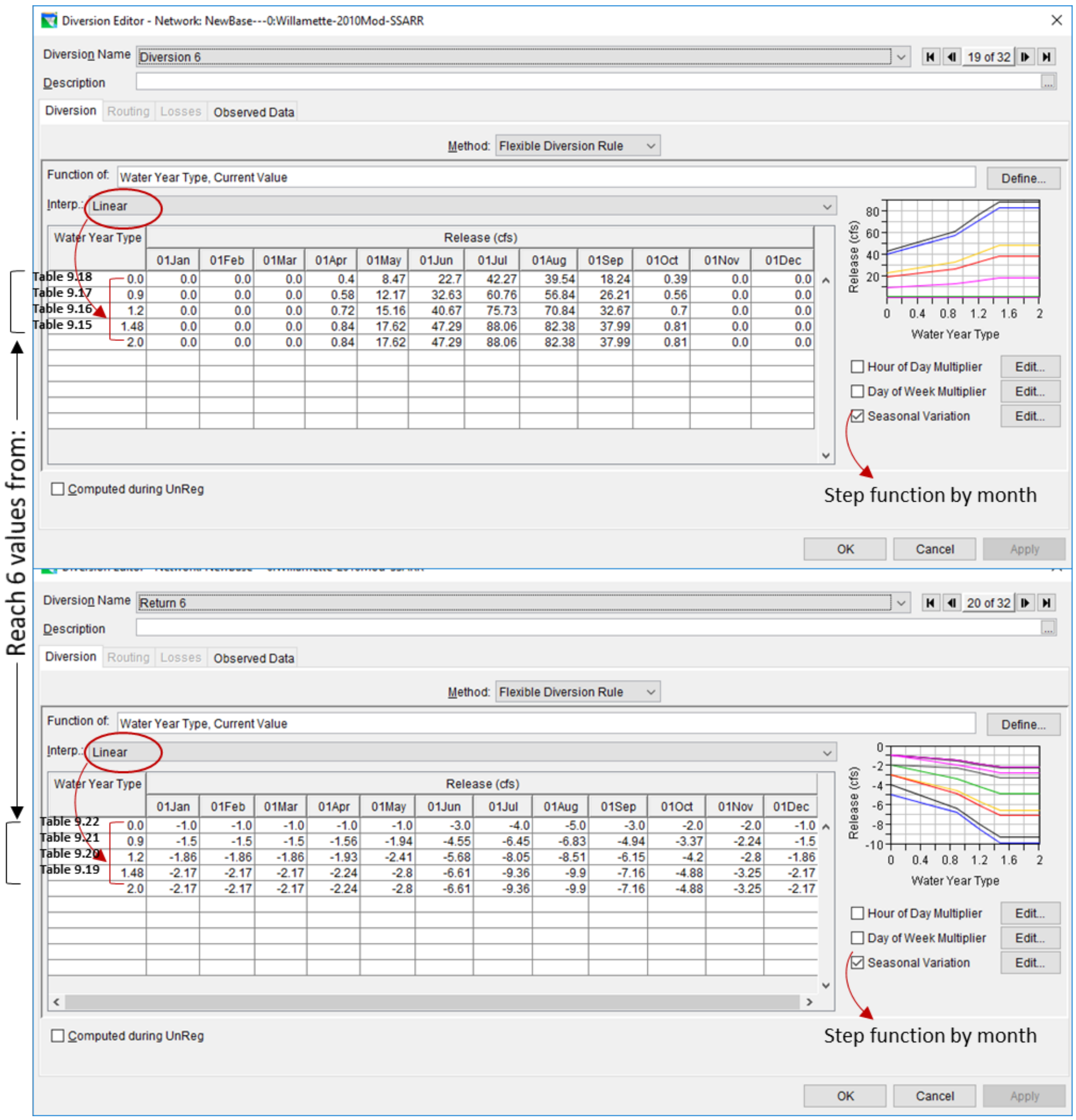
Table 9.22. Return daily average flow by reach, used for Deficit water years.

Reach	Daily Flow Return Rate, in cfs, by month, for M&I and Ag Demands that can be supported.											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1b	-5.9	-5.9	-5.9	-55.4	-66.2	-120.4	-165.8	-170.3	-131.9	-13.3	-8.8	-5.9
1c	-1.4	-1.4	-1.4	-5.7	-6.9	-9.1	-12.8	-13.3	-9.9	-3.2	-2.2	-1.4
2	-0.4	-0.4	-0.4	-0.5	-0.6	-1.7	-2.3	-2.4	-1.8	-0.9	-0.6	-0.4
3	-0.8	-0.8	-0.8	-29.3	-34.8	-33.0	-46.1	-47.3	-36.4	-1.7	-1.1	-0.8
4	-0.6	-0.6	-0.6	-2.4	-2.9	-4.1	-5.8	-6.0	-4.5	-1.4	-1.0	-0.6
5	-1.0	-1.0	-1.0	-10.3	-12.3	-13.4	-18.8	-19.3	-14.8	-2.2	-1.5	-1.0
6	-1.0	-1.0	-1.0	-1.1	-1.4	-3.2	-4.5	-4.7	-3.4	-2.3	-1.6	-1.0
7	-0.4	-0.4	-0.4	-1.4	-1.7	-3.3	-4.6	-4.8	-3.6	-0.9	-0.6	-0.4
8	-0.3	-0.3	-0.3	-5.0	-6.0	-7.6	-10.6	-10.9	-8.4	-0.7	-0.5	-0.3
9	0.0	0.0	0.0	-18.4	-21.9	-15.6	-22.1	-22.6	-17.3	0.0	0.0	0.0
10	-0.1	-0.1	-0.1	-0.1	-0.2	-0.4	-0.6	-0.6	-0.4	-0.3	-0.2	-0.1
11	-0.5	-0.5	-0.5	-0.6	-0.7	-1.6	-2.2	-2.4	-1.7	-1.1	-0.8	-0.5
12	0.0	0.0	0.0	-0.3	-0.4	-0.3	-0.4	-0.4	-0.3	0.0	0.0	0.0
13	-0.1	-0.1	-0.1	-0.3	-0.4	-0.5	-0.6	-0.7	-0.5	-0.2	-0.1	-0.1
14	0.0	0.0	0.0	-0.4	-0.5	-0.4	-0.5	-0.5	-0.4	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

9.1.6 Diversion Rule Example

The final flow specifications for the diversion withdrawals (Tables 9.15 to 9.18) and the diversion return flows (Tables 9.19 to 9.22) were input to ResSim with flexible diversion rules for each reach. Figure 9.1 is an example of the withdrawal and return flow rules for Reach 6, noting which tables were used for each water year type volume entry. The water year types are defined in Appendix E, Table 2.4. Rules for all diversions specified in Table 6.6 are applied in the same way.

Figure 9.1. Reach 6 Diversion Rules: at top is the withdrawal rule (Diversion Name = Diversion 6) and at bottom is the return flow rule (Diversion Name = Return 6). Note that flow rate is calculated based on a linear interpolation of the water year type volume and a step function by month. Entries for flow rates are annotated at left edge of figure for table reference number.



Water Year Type	01Jan	01Feb	01Mar	01Apr	01May	01Jun	01Jul	01Aug	01Sep	01Oct	01Nov	01Dec
0.0	0.0	0.0	0.0	0.4	8.47	22.7	42.27	39.54	18.24	0.39	0.0	0.0
0.9	0.0	0.0	0.0	0.58	12.17	32.63	60.76	56.84	26.21	0.56	0.0	0.0
1.2	0.0	0.0	0.0	0.72	15.16	40.67	75.73	70.84	32.67	0.7	0.0	0.0
1.48	0.0	0.0	0.0	0.84	17.62	47.29	88.06	82.38	37.99	0.81	0.0	0.0
2.0	0.0	0.0	0.0	0.84	17.62	47.29	88.06	82.38	37.99	0.81	0.0	0.0

Water Year Type	01Jan	01Feb	01Mar	01Apr	01May	01Jun	01Jul	01Aug	01Sep	01Oct	01Nov	01Dec
0.0	-1.0	-1.0	-1.0	-1.0	-1.0	-3.0	-4.0	-5.0	-3.0	-2.0	-2.0	-1.0
0.9	-1.5	-1.5	-1.5	-1.56	-1.94	-4.55	-6.45	-6.83	-4.94	-3.37	-2.24	-1.5
1.2	-1.86	-1.86	-1.86	-1.93	-2.41	-5.68	-8.05	-8.51	-6.15	-4.2	-2.8	-1.86
1.48	-2.17	-2.17	-2.17	-2.24	-2.8	-6.61	-9.36	-9.9	-7.16	-4.88	-3.25	-2.17
2.0	-2.17	-2.17	-2.17	-2.24	-2.8	-6.61	-9.36	-9.9	-7.16	-4.88	-3.25	-2.17

9.2 ResSim Rule Changes

The development of the additional reservoir releases follows the same steps as described in Section 7.2, using each reservoir's percentage of total conservation storage from Table 7.23 and the project share distributions from Table 7.24. (See Table 9.23.) The increased releases were added to the minimum releases specified for the Baseline (Appendices E). The project specific releases are shown in Tables 9.24 through 9.34. Each project's minimum release rule in the conservation zone is dependent on the water year type, while each project's minimum release in the buffer zone is specified as the Deficit year minimum from the tables. (See Section 5 for more details on the project minimum release rules.)

Table 9.23. Project flow contributions to meet increased demands, Expected No Action 2050.

Month	Project's release to meet increased share of demand in all reaches, in cfs, Abundant years										
	HCR	LOP	CGR	GPR	FOS	DET	FAL	COT	DOR	BLU	FRN
Apr	1.16	1.93	0.85	1.58	0.16	1.86	0.59	0.17	0.38	0.49	1.28
May	24.28	40.45	17.74	33.09	3.28	38.91	12.38	3.49	7.92	10.22	26.78
Jun	113.00	188.26	87.32	147.90	14.68	198.85	60.99	16.40	37.19	50.32	93.65
Jul	182.83	304.58	140.68	241.37	23.95	319.52	97.56	26.47	60.07	81.06	162.23
Aug	176.20	293.55	136.03	232.19	23.04	309.65	94.27	25.53	57.92	78.39	154.17
Sep	104.26	173.70	81.62	135.48	13.44	187.44	56.82	15.16	34.37	47.03	81.46
Oct	1.12	1.87	0.82	1.53	0.15	1.80	0.57	0.16	0.37	0.47	1.24
Month	Project's release to meet increased share of demand in all reaches, in cfs, Adequate years										
	HCR	LOP	CGR	GPR	FOS	DET	FAL	COT	DOR	BLU	FRN
Apr	1.00	1.66	0.73	1.36	0.13	1.60	0.51	0.14	0.33	0.42	1.10
May	20.88	34.78	15.26	28.46	2.82	33.46	10.65	3.00	6.81	8.79	23.03
Jun	97.18	161.90	75.10	127.20	12.62	171.01	52.45	14.10	31.99	43.27	80.54
Jul	157.23	261.94	120.98	207.58	20.60	274.79	83.90	22.77	51.66	69.71	139.52
Aug	151.53	252.45	116.99	199.69	19.82	266.30	81.07	21.95	49.81	67.41	132.58
Sep	89.66	149.38	70.20	116.51	11.56	161.20	48.87	13.04	29.56	40.45	70.05
Oct	0.97	1.61	0.71	1.32	0.13	1.55	0.49	0.14	0.31	0.41	1.06
Month	Project's release to meet increased share of demand in all reaches, in cfs, Insufficient years										
	HCR	LOP	CGR	GPR	FOS	DET	FAL	COT	DOR	BLU	FRN
Apr	0.80	1.33	0.58	1.09	0.11	1.28	0.41	0.11	0.26	0.34	0.88
May	16.75	27.91	12.24	22.83	2.27	26.85	8.54	2.40	5.46	7.05	18.47
Jun	77.97	129.90	60.25	102.05	10.13	137.20	42.08	11.32	25.66	34.72	64.62
Jul	126.15	210.16	97.07	166.55	16.53	220.47	67.31	18.27	41.45	55.93	111.94
Aug	121.58	202.55	93.86	160.21	15.90	213.66	65.04	17.61	39.96	54.09	106.37
Sep	71.94	119.85	56.32	93.48	9.28	129.33	39.21	10.46	23.72	32.45	56.21
Oct	0.77	1.29	0.57	1.06	0.10	1.24	0.39	0.11	0.25	0.33	0.85
Month	Project's release to meet increased share of demand in all reaches, in cfs, Deficit years										
	HCR	LOP	CGR	GPR	FOS	DET	FAL	COT	DOR	BLU	FRN
Apr	0.56	0.93	0.41	0.76	0.08	0.89	0.28	0.08	0.18	0.23	0.61
May	11.65	19.41	8.52	15.88	1.58	18.68	5.94	1.67	3.80	4.91	12.85
Jun	54.24	90.36	41.92	70.99	7.05	95.45	29.28	7.87	17.85	24.15	44.95
Jul	87.76	146.20	67.52	115.86	11.50	153.37	46.83	12.71	28.83	38.91	77.87
Aug	84.58	140.90	65.30	111.45	11.06	148.63	45.25	12.25	27.80	37.63	74.00
Sep	50.05	83.37	39.18	65.03	6.45	89.97	27.28	7.28	16.50	22.58	39.10
Oct	0.54	0.90	0.39	0.73	0.07	0.86	0.27	0.08	0.18	0.23	0.59

Table 9.24. Minimum project releases for the BiOp and BOR contracts for Blue River.

	Minimum Project Release, in cfs											
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
BiOp*	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
2008-2070												
Deficit	0.00	0.00	0.00	0.23	4.91	24.15	38.91	37.63	22.58	0.23	0.00	0.00
Insufficient	0.00	0.00	0.00	0.34	7.05	34.72	55.93	54.09	32.45	0.33	0.00	0.00
Adequate	0.00	0.00	0.00	0.42	8.79	43.27	69.71	67.41	40.45	0.41	0.00	0.00
Abundant	0.00	0.00	0.00	0.49	10.22	50.32	81.06	78.39	47.03	0.47	0.00	0.00
Total												
Deficit	50.00	50.00	50.00	50.23	54.91	74.15	88.91	87.63	72.58	50.23	50.00	50.00
Insufficient	50.00	50.00	50.00	50.34	57.05	84.72	105.93	104.09	82.45	50.33	50.00	50.00
Adequate	50.00	50.00	50.00	50.42	58.79	93.27	119.71	117.41	90.45	50.41	50.00	50.00
Abundant	50.00	50.00	50.00	50.49	60.22	100.32	131.06	128.39	97.03	50.47	50.00	50.00

*Note: “BiOp” means the BiOp minimum tributary flow target for this project.

Table 9.25. Minimum project releases for the BiOp and BOR contracts for Cougar.

	Minimum Project Release, in cfs											
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
BiOp*	300.0	300.0	300.0	300.0	300.0	400.0	300.0	300.0	300.0	300.0	300.0	300.0
2008-2070												
Deficit	0.00	0.00	0.00	0.41	8.52	41.92	67.52	65.30	39.18	0.39	0.00	0.00
Insufficient	0.00	0.00	0.00	0.58	12.24	60.25	97.07	93.86	56.32	0.57	0.00	0.00
Adequate	0.00	0.00	0.00	0.73	15.26	75.10	120.98	116.99	70.20	0.71	0.00	0.00
Abundant	0.00	0.00	0.00	0.85	17.74	87.32	140.68	136.03	81.62	0.82	0.00	0.00
Total												
Deficit	400.0	400.0	400.0	400.0	400.0	441.9	400.0	400.0	400.0	400.0	400.0	400.0
Insufficient	400.0	400.0	400.0	400.0	400.0	460.3	400.0	400.0	400.0	400.0	400.0	400.0
Adequate	400.0	400.0	400.0	400.0	400.0	475.1	421.0	417.0	400.0	400.0	400.0	400.0
Abundant	400.0	400.0	400.0	400.0	400.0	487.3	440.7	436.0	400.0	400.0	400.0	400.0

*Note: “BiOp” means the BiOp minimum tributary flow target for this project. While this minimum value is 300 cfs most of the time, the minimum turbine flow without causing cavitation is higher than 300 cfs, so 400 cfs is used for the minimum release most of the time. If the increased project release to cover the downstream BOR contracts plus the 300 cfs BiOp min is still less than 400 cfs, the project will still just release 400 cfs as a minimum.

Table 9.26. Minimum project releases for the BiOp and BOR contracts for Dorena.

	Minimum Project Release, in cfs											
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
BiOp*	100.0	190.0	190.0	190.0	190.0	190.0	100.0	100.0	100.0	100.0	100.0	100.0
2008-2070												
Deficit	0.00	0.00	0.00	0.18	3.80	17.85	28.83	27.80	16.50	0.18	0.00	0.00
Insufficient	0.00	0.00	0.00	0.26	5.46	25.66	41.45	39.96	23.72	0.25	0.00	0.00
Adequate	0.00	0.00	0.00	0.33	6.81	31.99	51.66	49.81	29.56	0.31	0.00	0.00
Abundant	0.00	0.00	0.00	0.38	7.92	37.19	60.07	57.92	34.37	0.37	0.00	0.00
Total												
Deficit	100.0	190.0	190.0	190.2	193.8	207.9	128.8	127.8	116.5	100.2	100.0	100.0
Insufficient	100.0	190.0	190.0	190.3	195.5	215.7	141.4	140.0	123.7	100.3	100.0	100.0
Adequate	100.0	190.0	190.0	190.3	196.8	222.0	151.7	149.8	129.6	100.3	100.0	100.0
Abundant	100.0	190.0	190.0	190.4	197.9	227.2	160.1	157.9	134.4	100.4	100.0	100.0

*Note: “BiOp” means the BiOp minimum tributary flow target for this project.

Table 9.27. Minimum project releases for the BiOp and BOR contracts for Cottage Grove.

	Minimum Project Release, in cfs											
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
BiOp*	50.0	75.0	75.0	75.0	75.0	75.0	50.0	50.0	50.0	50.0	50.0	50.0
2008-2070												
Deficit	0.00	0.00	0.00	0.08	1.67	7.87	12.71	12.25	7.28	0.08	0.00	0.00
Insufficient	0.00	0.00	0.00	0.11	2.40	11.32	18.27	17.61	10.46	0.11	0.00	0.00
Adequate	0.00	0.00	0.00	0.14	3.00	14.10	22.77	21.95	13.04	0.14	0.00	0.00
Abundant	0.00	0.00	0.00	0.17	3.49	16.40	26.47	25.53	15.16	0.16	0.00	0.00
Total												
Deficit	50.00	75.00	75.00	75.08	76.67	82.87	62.71	62.25	57.28	50.08	50.00	50.00
Insufficient	50.00	75.00	75.00	75.11	77.40	86.32	68.27	67.61	60.46	50.11	50.00	50.00
Adequate	50.00	75.00	75.00	75.14	78.00	89.10	72.77	71.95	63.04	50.14	50.00	50.00
Abundant	50.00	75.00	75.00	75.17	78.49	91.40	76.47	75.53	65.16	50.16	50.00	50.00

*Note: "BiOp" means the BiOp minimum tributary flow target for this project.

Table 9.28. Minimum project releases for the BiOp and BOR contracts for Fall Creek.

	Minimum Project Release, in cfs											
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**1Oct**	**16Oct**	**Nov/Dec**
BiOp*	50.0	50.0	50.0	80.0	80.0	80.0	80.0	80.0	200.0	200.0	50.0	50.0
2008-2070												
Deficit	0.00	0.00	0.00	0.28	5.94	29.28	46.83	45.25	27.28	0.27	0.27	0.00
Insufficient	0.00	0.00	0.00	0.41	8.54	42.08	67.31	65.04	39.21	0.39	0.39	0.00
Adequate	0.00	0.00	0.00	0.51	10.65	52.45	83.90	81.07	48.87	0.49	0.49	0.00
Abundant	0.00	0.00	0.00	0.59	12.38	60.99	97.56	94.27	56.82	0.57	0.57	0.00
Total												
Deficit	50.00	50.00	50.00	80.28	85.94	109.28	126.83	125.25	227.28	200.27	50.27	50.00
Insufficient	50.00	50.00	50.00	80.41	88.54	122.08	147.31	145.04	239.21	200.39	50.39	50.00
Adequate	50.00	50.00	50.00	80.51	90.65	132.45	163.90	161.07	248.87	200.49	50.49	50.00
Abundant	50.00	50.00	50.00	80.59	92.38	140.99	177.56	174.27	256.82	200.57	50.57	50.00

*Note: "BiOp" means the BiOp minimum tributary flow target for this project.

Table 9.29. Minimum project releases for the BiOp and BOR contracts for Hills Creek.

	Minimum Project Release, in cfs											
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
BiOp*	400.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0
2008-2070												
Deficit	0.00	0.00	0.00	0.56	11.65	54.24	87.76	84.58	50.05	0.54	0.00	0.00
Insufficient	0.00	0.00	0.00	0.80	16.75	77.97	126.15	121.58	71.94	0.77	0.00	0.00
Adequate	0.00	0.00	0.00	1.00	20.88	97.18	157.23	151.53	89.66	0.97	0.00	0.00
Abundant	0.00	0.00	0.00	1.16	24.28	113.00	182.83	176.20	104.26	1.12	0.00	0.00
Total												
Deficit	400.0	400.0	400.0	400.6	411.7	454.2	487.8	484.6	450.0	400.5	400.0	400.0
Insufficient	400.0	400.0	400.0	400.8	416.8	478.0	526.1	521.6	471.9	400.8	400.0	400.0
Adequate	400.0	400.0	400.0	401.0	420.9	497.2	557.2	551.5	489.7	401.0	400.0	400.0
Abundant	400.0	400.0	400.0	401.2	424.3	513.0	582.8	576.2	504.3	401.1	400.0	400.0

*Note: "BiOp" means the BiOp minimum tributary flow target for this project.

Table 9.30. Minimum project releases for the BiOp and BOR contracts for Lookout Point.

	Minimum Project Release, in cfs											
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
BiOp*	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200
HCR share 2008-2070												
Deficit	0.00	0.00	0.00	0.56	11.65	54.24	87.76	84.58	50.05	0.54	0.00	0.00
Insufficient	0.00	0.00	0.00	0.80	16.75	77.97	126.15	121.58	71.94	0.77	0.00	0.00
Adequate	0.00	0.00	0.00	1.00	20.88	97.18	157.23	151.53	89.66	0.97	0.00	0.00
Abundant	0.00	0.00	0.00	1.16	24.28	113.00	182.83	176.20	104.26	1.12	0.00	0.00
LOP share 2008-2070												
Deficit	0.00	0.00	0.00	0.93	19.41	90.36	146.20	140.90	83.37	0.90	0.00	0.00
Insufficient	0.00	0.00	0.00	1.33	27.91	129.90	210.16	202.55	119.85	1.29	0.00	0.00
Adequate	0.00	0.00	0.00	1.66	34.78	161.90	261.94	252.45	149.38	1.61	0.00	0.00
Abundant	0.00	0.00	0.00	1.93	40.45	188.26	304.58	293.55	173.70	1.87	0.00	0.00
Total												
Deficit	1200	1200	1200	1201	1231	1345	1434	1425	1333	1201	1200	1200
Insufficient	1200	1200	1200	1202	1245	1408	1536	1524	1392	1202	1200	1200
Adequate	1200	1200	1200	1203	1256	1459	1619	1604	1439	1203	1200	1200
Abundant	1200	1200	1200	1203	1265	1501	1687	1670	1478	1203	1200	1200

*Note: "BiOp" means the BiOp minimum tributary flow target for this project.

Minimum release must also include Hills Creek share.

Table 9.31. Minimum project releases for the BiOp and BOR contracts for Fern Ridge.

	Minimum Project Release, in cfs											
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
BiOp*	30.00	50.00	50.00	50.00	50.00	50.00	30.00	30.00	30.00	30.00	30.00	30.00
Baseline (2008)												
Deficit	0.00	0.00	0.00	0.00	25.11	51.74	82.63	66.00	33.93	0.00	0.00	0.00
Insufficient	0.00	0.00	0.00	0.00	25.11	51.74	82.63	66.00	33.93	0.00	0.00	0.00
Adequate	0.00	0.00	0.00	0.00	25.11	51.74	82.63	66.00	33.93	0.00	0.00	0.00
Abundant	0.00	0.00	0.00	0.00	25.11	51.74	82.63	66.00	33.93	0.00	0.00	0.00
2008-2070												
Deficit	0.00	0.00	0.00	0.61	12.85	44.95	77.87	74.00	39.10	0.59	0.00	0.00
Insufficient	0.00	0.00	0.00	0.88	18.47	64.62	111.94	106.37	56.21	0.85	0.00	0.00
Adequate	0.00	0.00	0.00	1.10	23.03	80.54	139.52	132.58	70.05	1.06	0.00	0.00
Abundant	0.00	0.00	0.00	1.28	26.78	93.65	162.23	154.17	81.46	1.24	0.00	0.00
Total**												
Deficit	30.00	50.00	50.00	50.61	87.96	146.70	190.51	170.00	103.03	30.59	30.00	30.00
Insufficient	30.00	50.00	50.00	50.88	93.59	166.36	224.58	202.37	120.14	30.85	30.00	30.00
Adequate	30.00	50.00	50.00	51.10	98.14	182.28	252.16	228.58	133.99	31.06	30.00	30.00
Abundant	30.00	50.00	50.00	51.28	101.89	195.39	274.87	250.16	145.39	31.24	30.00	30.00

*Note: "BiOp" means the BiOp minimum tributary flow target for this project.

**Total outflow minimum from Fern Ridge includes BOR contracts in 2008 as well as the additional contracts after 2008.

Table 9.32. Minimum project releases for the BiOp and BOR contracts for Green Peter.

	Minimum Project Release, in cfs								
	Apr	**1 May**	**16 May**	**Jun**	**Jul**	**Aug**	**Sep**	**1 Oct**	**16 Oct**
BiOp*	1500	1500	1100	1100	800	800	1500	1100	1500
2008-2070									
Deficit	0.76	15.88	15.88	70.99	115.86	111.45	65.03	0.73	0.73
Insufficient	1.09	22.83	22.83	102.05	166.55	160.21	93.48	1.06	1.06
Adequate	1.36	28.46	28.46	127.20	207.58	199.69	116.51	1.32	1.32
Abundant	1.58	33.09	33.09	147.90	241.37	232.19	135.48	1.53	1.53
Total**									
Deficit	1500.83	1517.46	1117.46	1178.04	927.36	922.51	1571.48	1500.81	1100.81
Insufficient	1501.20	1525.10	1125.10	1212.18	983.08	976.11	1602.76	1501.16	1101.16
Adequate	1501.49	1531.28	1131.28	1239.82	1028.18	1019.50	1628.07	1501.45	1101.45
Abundant	1501.74	1536.37	1136.37	1262.58	1065.33	1055.24	1648.92	1501.68	1101.68

*Note: "BiOp" means the BiOp minimum tributary flow target for this project. This is the flow required out of Foster.

**Total outflow minimum from Green Peter uses the Foster minimum flows, from next table.

Minimum Flows for months not shown are all BiOp minimums: Jan = 1100 cfs, Feb = 800 cfs, 1 Mar = 800 cfs, 16 Mar = 1500 cfs, Nov = 1100 cfs, Dec = 1100 cfs.

Table 9.33. Minimum project releases for the BiOp and BOR contracts for Foster.

	Minimum Project Release, in cfs								
	Apr	**1 May**	**16 May**	**Jun**	**Jul**	**Aug**	**Sep**	**1 Oct**	**16 Oct**
BiOp*	1500	1500	1100	1100	800	800	1500	1100	1500
2008-2070									
Deficit	0.08	1.58	1.58	7.05	11.50	11.06	6.45	0.07	0.07
Insufficient	0.11	2.27	2.27	10.13	16.53	15.90	9.28	0.10	0.10
Adequate	0.13	2.82	2.82	12.62	20.60	19.82	11.56	0.13	0.13
Abundant	0.16	3.28	3.28	14.68	23.95	23.04	13.44	0.15	0.15
GPR 2008-2070									
Deficit	0.76	15.88	15.88	70.99	115.86	111.45	65.03	0.73	0.73
Insufficient	1.09	22.83	22.83	102.05	166.55	160.21	93.48	1.06	1.06
Adequate	1.36	28.46	28.46	127.20	207.58	199.69	116.51	1.32	1.32
Abundant	1.58	33.09	33.09	147.90	241.37	232.19	135.48	1.53	1.53
Total									
Deficit	1500.83	1517.46	1117.46	1178.04	927.36	922.51	1571.48	1500.81	1100.81
Insufficient	1501.20	1525.10	1125.10	1212.18	983.08	976.11	1602.76	1501.16	1101.16
Adequate	1501.49	1531.28	1131.28	1239.82	1028.18	1019.50	1628.07	1501.45	1101.45
Abundant	1501.74	1536.37	1136.37	1262.58	1065.33	1055.24	1648.92	1501.68	1101.68

*Note: "BiOp" means the BiOp minimum tributary flow target for this project.

Minimum Flows for months not shown are all BiOp minimums: Jan = 1100 cfs, Feb = 800 cfs, 1 Mar = 800 cfs, 16 Mar = 1500 cfs, Nov = 1100 cfs, Dec = 1100 cfs.

Table 9.34. Minimum project releases for the BiOp and BOR contracts for Detroit.

	Minimum Project Release, in cfs								
	Apr	May	Jun	1 Jul	15 Jul	Aug	Sep	1 Oct	16 Oct
BiOp*	1500	1500	1200	1200	1000	1000	1500	1500	1200
Baseline (2008)									
Deficit	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Insufficient	0.00	14.49	29.86	47.68	47.68	38.09	19.58	0.00	0.00
Adequate	0.00	14.49	29.86	47.68	47.68	38.09	19.58	0.00	0.00
Abundant	0.00	14.49	29.86	47.68	47.68	38.09	19.58	0.00	0.00
2008-2070									
Deficit	0.89	18.68	95.45	153.37	153.37	148.63	89.97	0.86	0.86
Insufficient	1.28	26.85	137.20	220.47	220.47	213.66	129.33	1.24	1.24
Adequate	1.60	33.46	171.01	274.79	274.79	266.30	161.20	1.55	1.55
Abundant	1.86	38.91	198.85	319.52	319.52	309.65	187.44	1.80	1.80
Total**									
Deficit	1500.89	1518.68	1295.45	1353.37	1153.37	1148.63	1589.97	1500.86	1200.86
Insufficient	1501.28	1541.34	1367.07	1468.15	1268.15	1251.75	1648.91	1501.24	1201.24
Adequate	1501.60	1547.95	1400.87	1522.47	1322.47	1304.39	1680.77	1501.55	1201.55
Abundant	1501.86	1553.40	1428.71	1567.20	1367.20	1347.74	1707.02	1501.80	1201.80

*Note: "BiOp" means the BiOp minimum tributary flow target for this project.

**Total outflow minimum from Detroit includes BOR contracts in 2008 as well as the additional contracts after 2008.

Minimum Flows for months not shown are all BiOp minimums: Jan = 1200 cfs, Feb = 1000 cfs, 1 Mar = 1000 cfs, 16 Mar = 1500 cfs, Nov = 1200 cfs, Dec = 1200 cfs.

9.3 Simulation Results

The Peak ARP 2070 pool elevation non-exceedance graphs for each storage project are shown in Figures 9.2 and 9.3. These non-exceedance graphs are described in detail in Section 16 of Appendix E, in particular Figure 16.1 of that Appendix.

The graphs in Figures 9.4a through 9.4c are period average flows at Salem for every year in the POR, color coded by water year type. The periods are monthly for April, May, July, September, and October, when the Salem BiOp minimum targets are constant over each of those months, and for half month periods for June and August, when the BiOp minimum targets change midway through those months. These graphs highlight the result that regulated Salem flows are often well above the target minimum values. The main Feasibility report documents the occurrences for regulated Salem flows being below minimum flow targets, but does not show the frequency that the regulated flows exceed the minimum flow targets. The period average flow values plotted in Figures 9.4a to 9.4c are listed in Table 9.35a for 1929 through 1970 and Table 9.35b for 1971 through 2008.

The regulated flows at Albany, Salem, and Oregon City above Willamette Falls are shown in Figures 9.4 through 9.6. In each figure, the non-exceedance percentiles of the regulated flows are shown in the top graph (with a blue background), and the remaining four graphs in each figure show the regulated flow for one water year of each type, using 1966 (Adequate), 1967 (Insufficient), 1968 (Deficit), and 1969 (Abundant). The flow targets at Albany and Salem are shown in Figures 9.4 and 9.5, respectively, for the wetter years (Abundant and Adequate) and for Deficit years. The targets shown in Figure 9.6 are Salem targets (shown as dashed lines) for comparison. There are no official BiOp flow minimum targets at Willamette Falls, but a flow equivalent to that at Salem is desirable.

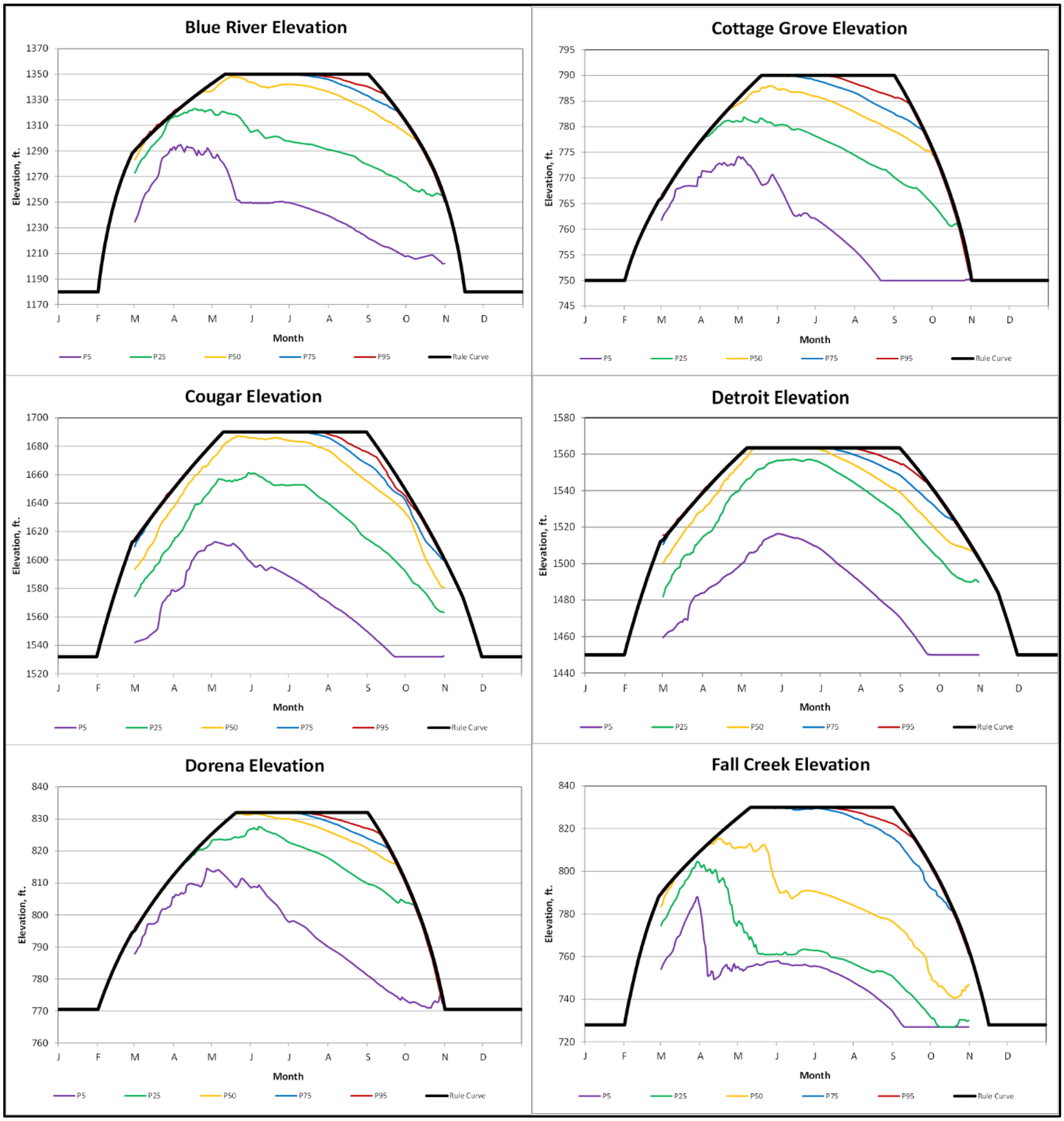


Figure 9.2. Pool elevation non-exceedance percentiles for the Peak ARP 2070 for Blue River, Cottage Grove, Cougar, Detroit, Dorena, and Fall Creek. See Figure 16.1 in Appendix E for non-exceedance value descriptions.

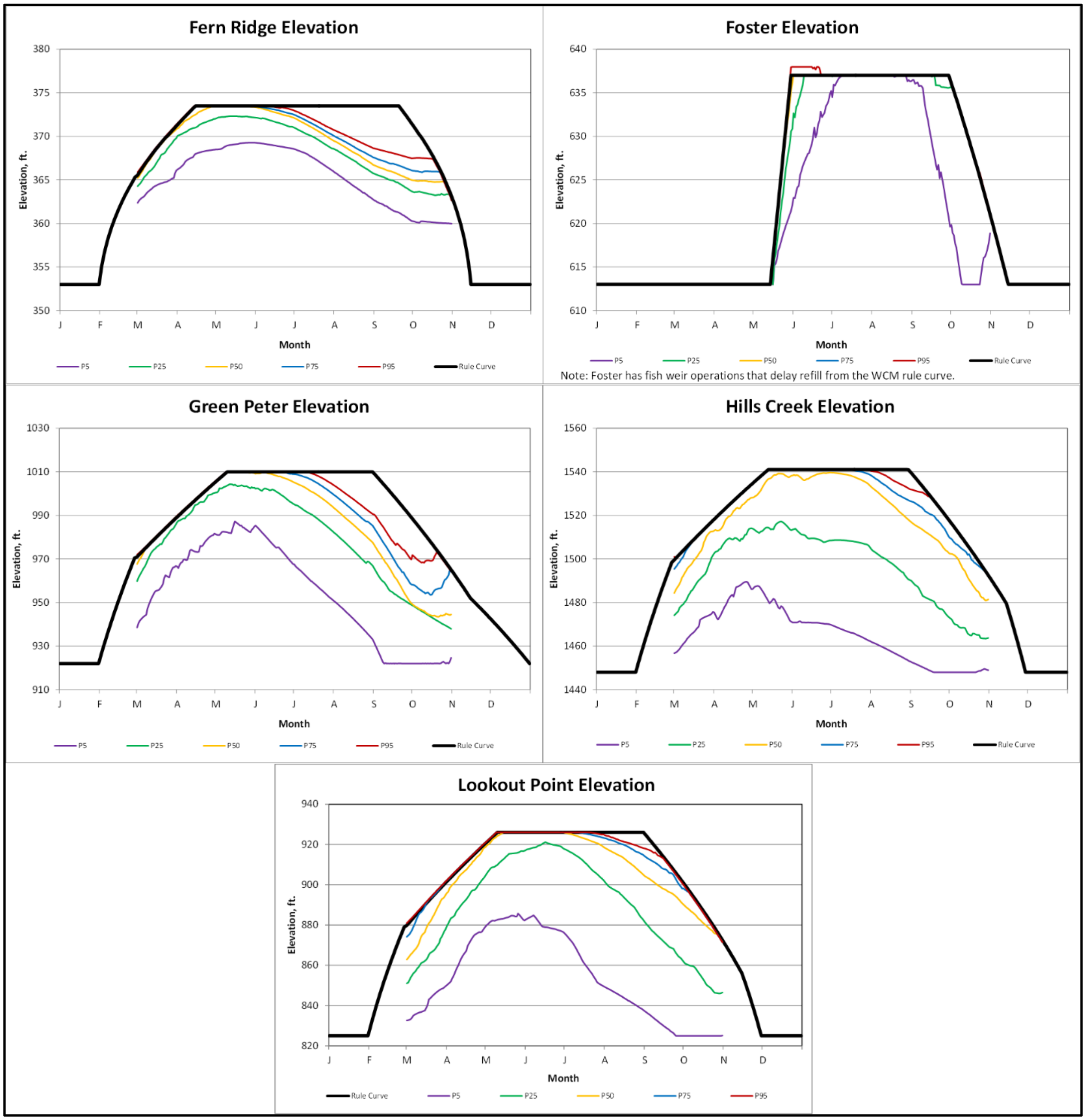


Figure 9.3. Pool elevation non-exceedance percentiles for the Peak ARP 2070 for Fern Ridge, Foster, Green Peter, Hills Creek, Fall Creek, and Lookout Point. See Figure 16.1 in Appendix E for non-exceedance value descriptions.

Peak ARP 2070, Period Average Flows at Salem

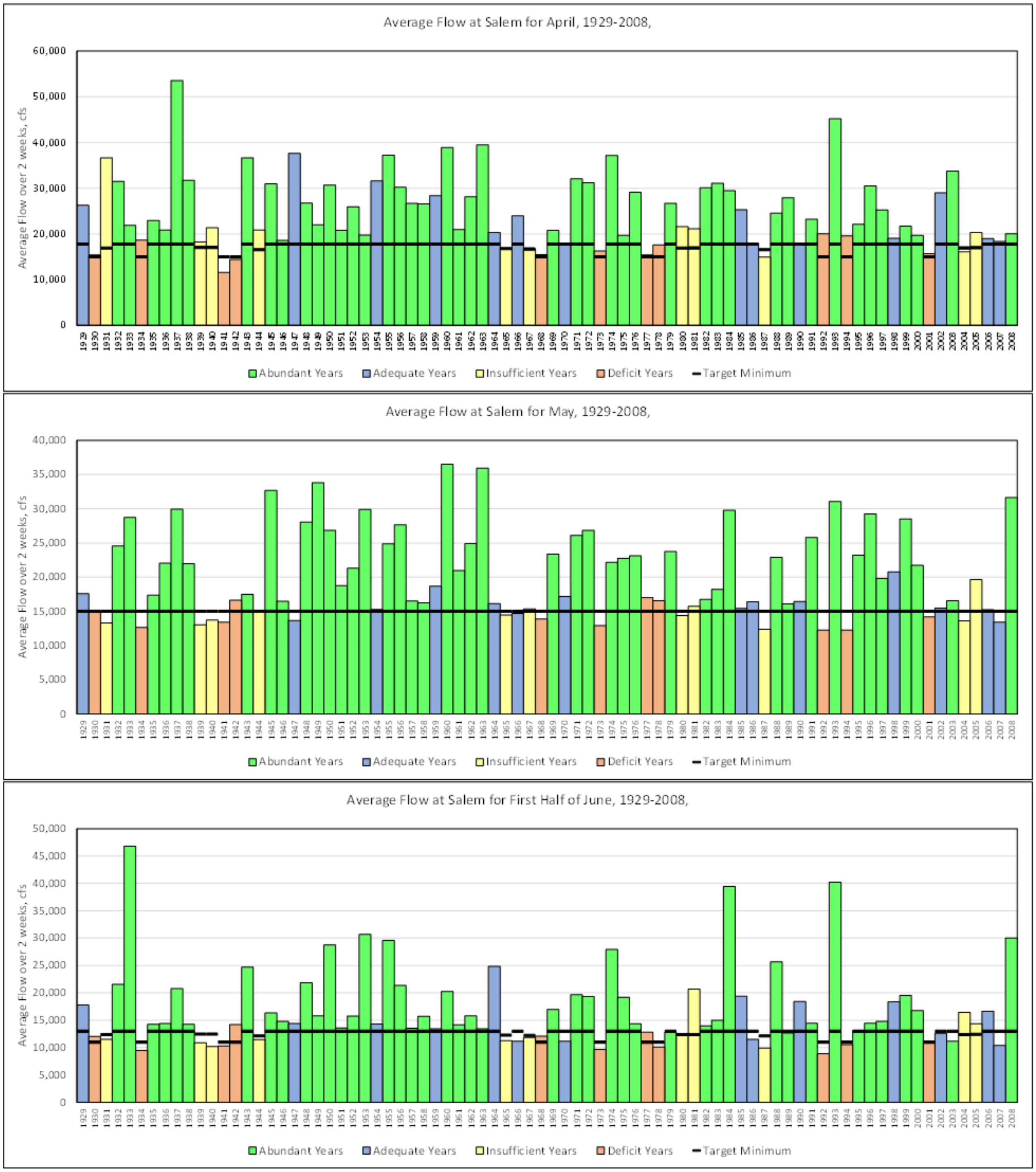


Figure 9.4a. Period average flows at Salem for all years in the POR for April (top), May (middle), and the first half of June (bottom), with flow target for that period and year shown as the solid black bar. Each year is color coded by water year type. Graphs show that Abundant water year average flows often significantly exceed the minimum flow targets at Salem while Deficit year average flows can miss the target. Adequate and Insufficient water years fall in between.

Peak ARP 2070, Period Average Flows at Salem

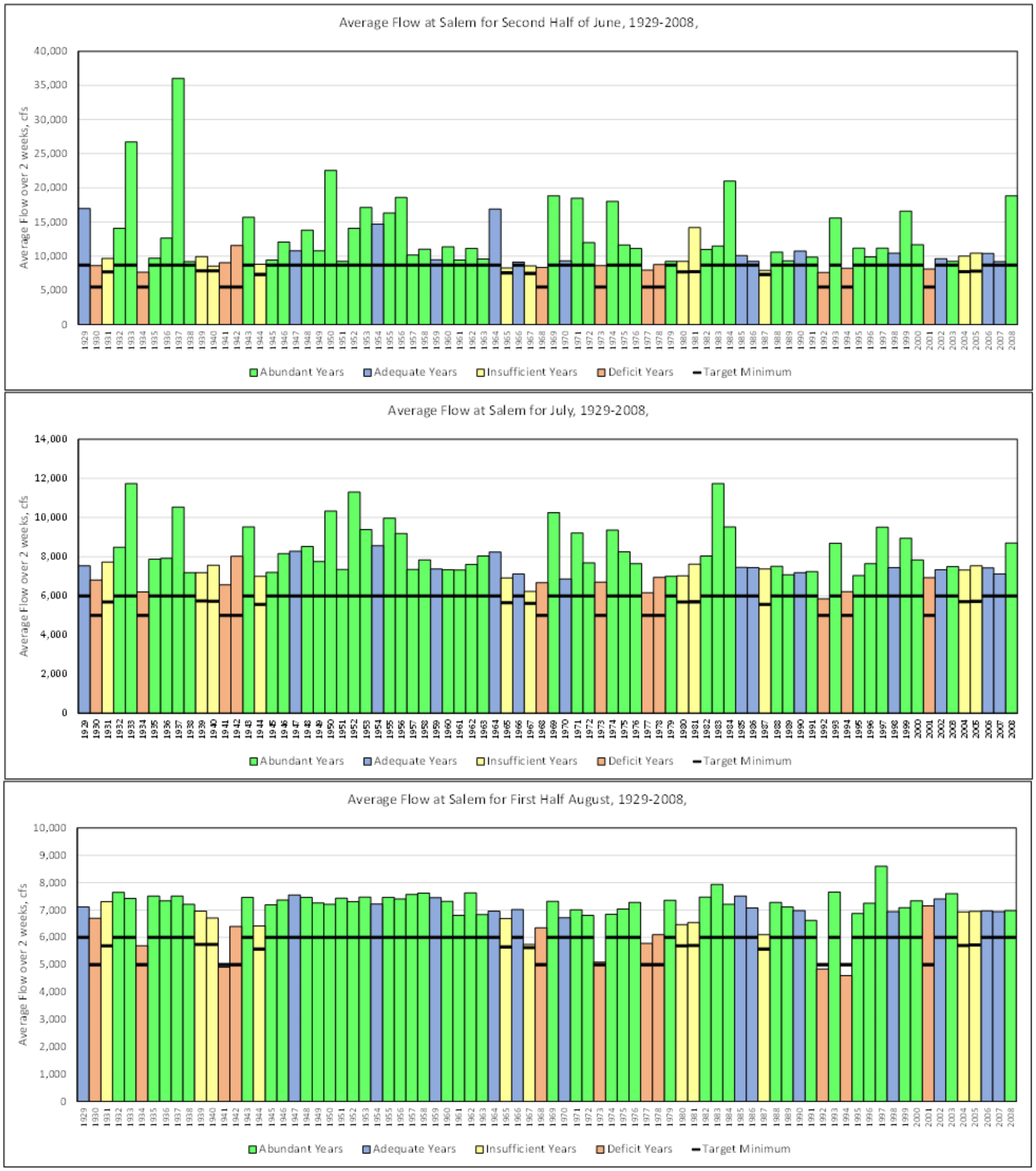


Figure 9.4b. Period average flows at Salem for all years in the POR for the second half of June (top), July (middle), and the first half of August (bottom), with flow target for that period and year shown as the solid black bar. Each year is color coded by water year type. Graphs show that Abundant water year average flows often exceed the minimum flow targets at Salem while Deficit year average flows can miss the target. Adequate and Insufficient water years fall in between.

Peak ARP 2070, Period Average Flows at Salem

Figure 9.4c. Period average flows at Salem for all years in the POR for the second half of August (top), September (middle), and October (bottom), with flow target for that period and year shown as the solid black bar. Each year is color coded by water year type. Graphs show that Abundant water year average flows often exceed the minimum flow targets at Salem while Deficit year average flows can miss the target. Adequate and Insufficient water years fall in between. Note fall drafting begins in September.

Table 9.35a. Period average flows at Salem for all years in the POR, for 1929 to 1970. Average flow values are all in cfs.

Year	Average Flow at Salem over Period, in cfs.								
	Apr	May	1-15 Jun	16-30 Jun	July	1-15 Aug	16-30 Aug	Sep	Oct
1929	26262	17580	17793	16952	7535	7114	7527	9026	8552
1930	15399	15018	12040	8606	6809	6701	6616	5843	6386
1931	36657	13315	11533	9681	7719	7306	5659	5977	5981
1932	31465	24542	21537	14085	8485	7641	7499	8597	11306
1933	21865	28713	46801	26708	11734	7417	7147	11053	14185
1934	18664	12641	9476	7663	6198	5697	5069	3988	7027
1935	22953	17343	14235	9724	7869	7511	7478	8209	10326
1936	20826	22038	14399	12623	7909	7338	7469	8985	9593
1937	53560	29931	20801	36018	10535	7510	7445	10562	14394
1938	31734	21956	14245	9195	7182	7207	7335	8031	9173
1939	18270	13044	10892	9941	7192	6961	7430	8080	7915
1940	21340	13715	10180	8548	7560	6704	5336	5783	5403
1941	11597	13415	10330	9032	6561	4911	4853	6816	7818
1942	14444	16644	14200	11575	8018	6398	6126	7553	8207
1943	36622	17495	24703	15697	9528	7461	7492	10663	17722
1944	20825	14983	11465	8823	6991	6417	6178	6332	6684
1945	30962	32658	16313	9420	7205	7189	7342	8537	9281
1946	18591	16465	14782	12085	8158	7366	7391	8738	14159
1947	29440	13668	14377	10794	8284	7550	7422	8578	35707
1948	26762	28030	21846	13829	8517	7458	7547	10415	15680
1949	21989	33794	15822	10783	7750	7259	7341	8592	13682
1950	30673	26821	28767	22553	10329	7211	7268	9786	28449
1951	20761	18736	13584	9235	7351	7427	7576	7939	22060
1952	25938	21288	15782	14083	11299	7311	7276	9311	11875
1953	19766	29878	30684	17126	9379	7472	7745	10310	15011
1954	26424	15281	14301	14712	8566	7215	7436	10383	14929
1955	37218	24882	29583	16327	9971	7461	7362	9397	21692
1956	30186	27645	21367	18588	9188	7406	7101	9599	17218
1957	26683	16487	13559	10151	7342	7569	7621	8158	9814
1958	26574	16247	15736	11019	7840	7619	7696	8485	9721
1959	22960	18691	13426	9464	7371	7454	7364	9661	16545
1960	38906	36488	20263	11379	7328	7320	7577	8768	10987
1961	20971	20953	14185	9409	7317	6804	6914	8014	12735
1962	28156	24905	15812	11135	7606	7627	7358	9004	18132
1963	39489	35939	13477	9567	8033	6831	7008	8912	10903
1964	19413	16141	24877	16879	8241	6954	6839	10168	11651
1965	16748	14475	11277	8271	6917	6692	6518	7085	7047
1966	21169	14672	11146	9136	7109	7016	6976	7113	7437
1967	16657	15343	11841	8595	6232	5743	5957	6896	12197
1968	15485	13880	12087	8337	6673	6347	8990	9359	16839
1969	20768	23369	16995	18847	10251	7321	7246	8964	14297
1970	17467	17147	11164	9320	6865	6715	6931	7472	8861

Table 9.35b. Period average flows at Salem for all years in the POR, for 1971 to 2008. Average flow values are all in cfs.

Year	Average Flow at Salem over Period, in cfs.								
	Apr	May	1-15 Jun	16-30 Jun	July	1-15 Aug	16-30 Aug	Sep	Oct
1971	32050	26100	19659	18486	9211	7008	7121	11166	15756
1972	31182	26826	19356	11962	7684	6802	7006	9617	12287
1973	16282	12904	9658	8620	6698	5093	5182	5647	5571
1974	37160	22143	27917	18026	9357	6842	7086	9744	12460
1975	19705	22742	19210	11627	8256	7038	7556	9536	17029
1976	29082	23113	14344	11111	7644	7283	7613	9338	11054
1977	15439	17019	12806	7936	6160	5775	6172	7970	8178
1978	17571	16574	11443	8762	6948	6097	7152	9160	8932
1979	26689	23753	12769	9237	7001	7358	7483	8304	9681
1980	21569	14390	12603	9224	7025	6463	6493	7775	7498
1981	21163	15719	20700	14187	7621	6541	6543	8011	12711
1982	30088	16747	13965	10973	8031	7471	7427	8947	16706
1983	31110	18236	15013	11500	11733	7939	7794	10970	12889
1984	29463	29757	39459	20981	9521	7208	7084	9518	17347
1985	22153	15419	19380	10092	7455	7515	7669	9275	13395
1986	17437	16407	11512	9256	7438	7081	7000	8814	8553
1987	14909	12375	9905	7932	7376	6096	5125	5545	3800
1988	24528	22903	25664	10606	7506	7279	7268	8337	8805
1989	27925	16083	12693	9319	7074	7110	7190	7659	8633
1990	22205	16414	18434	10757	7189	6979	7396	8368	9823
1991	23230	25815	14465	9851	7243	6615	6955	7647	7853
1992	20053	12263	8902	7625	5841	4844	4383	3956	3008
1993	45174	31034	40217	15580	8685	7655	7572	9065	10603
1994	19553	12235	10532	8229	6215	4598	4410	4725	5611
1995	22081	23215	13138	11149	7041	6869	7096	8146	11912
1996	30519	29239	14437	9900	7648	7247	7290	8706	16318
1997	25261	19795	14807	11175	9505	8601	8685	11019	20415
1998	18692	20765	18375	10456	7437	6938	7184	8322	10632
1999	21694	28506	19541	16591	8943	7090	7177	9509	11151
2000	19675	21730	16779	11687	7832	7340	7283	8647	10406
2001	15724	14195	10847	8126	6927	7150	6750	5694	5252
2002	28595	15474	12615	9638	7337	7405	7062	7635	6966
2003	33755	16555	11145	9225	7493	7598	7216	6745	6247
2004	16097	13607	16449	10019	7321	6929	7614	9085	12860
2005	20298	19637	14375	10449	7541	6946	6880	7984	9037
2006	20326	15251	16654	10380	7432	6967	7004	7949	8535
2007	18437	13425	10416	9213	7119	6941	7156	7735	9345
2008	20045	31634	30015	18831	8701	6975	7281	8536	N/A

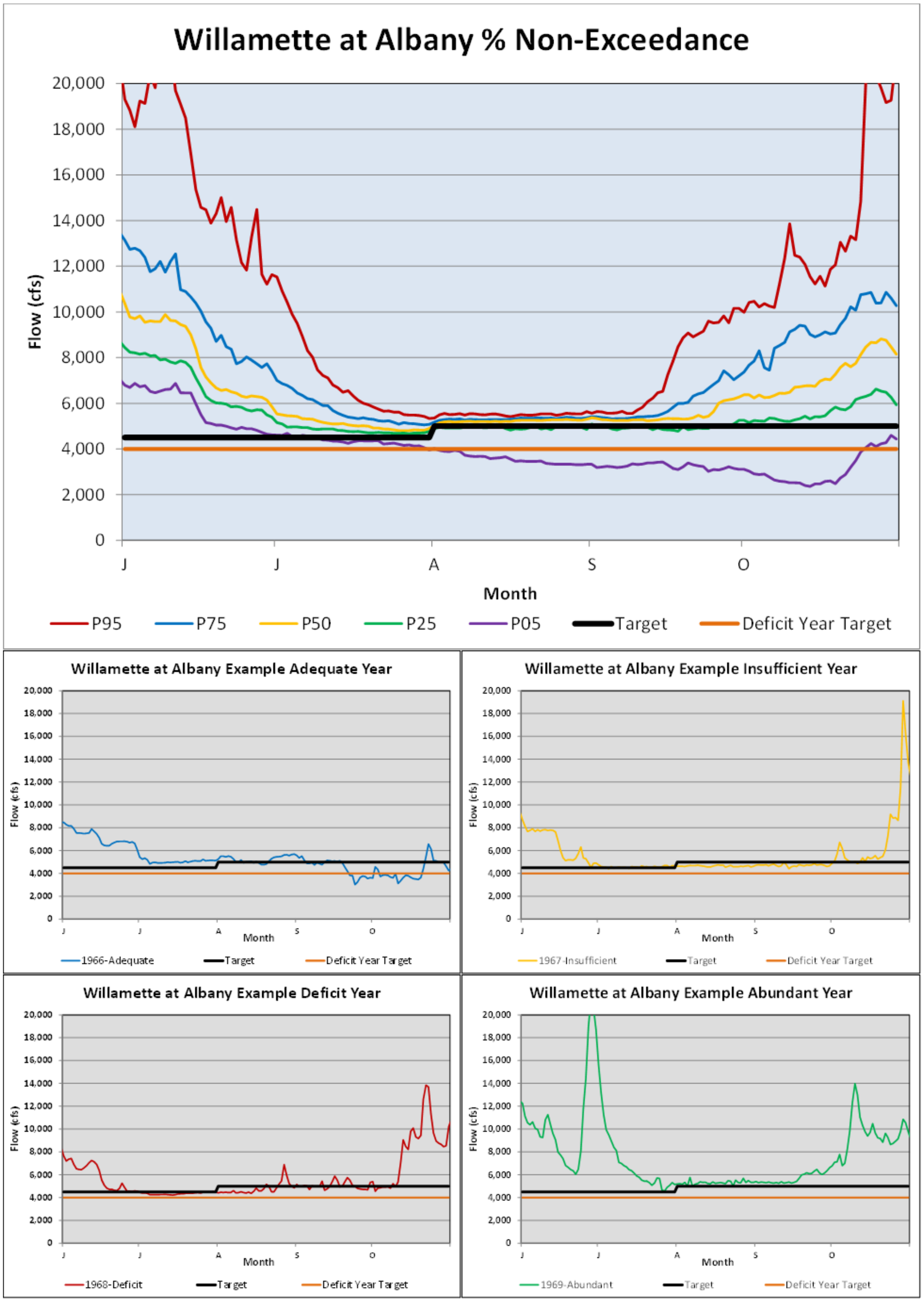


Figure 9.4. Non-exceedance percentiles for the Peak ARP 2070 for regulated flow at Albany in top graph (with blue background). Albany flow for selected years: 1966 (Adequate) at middle left, 1967 (Insufficient) at middle right, 1968 (Deficit) at bottom left, and 1969 (Abundant) at bottom right.

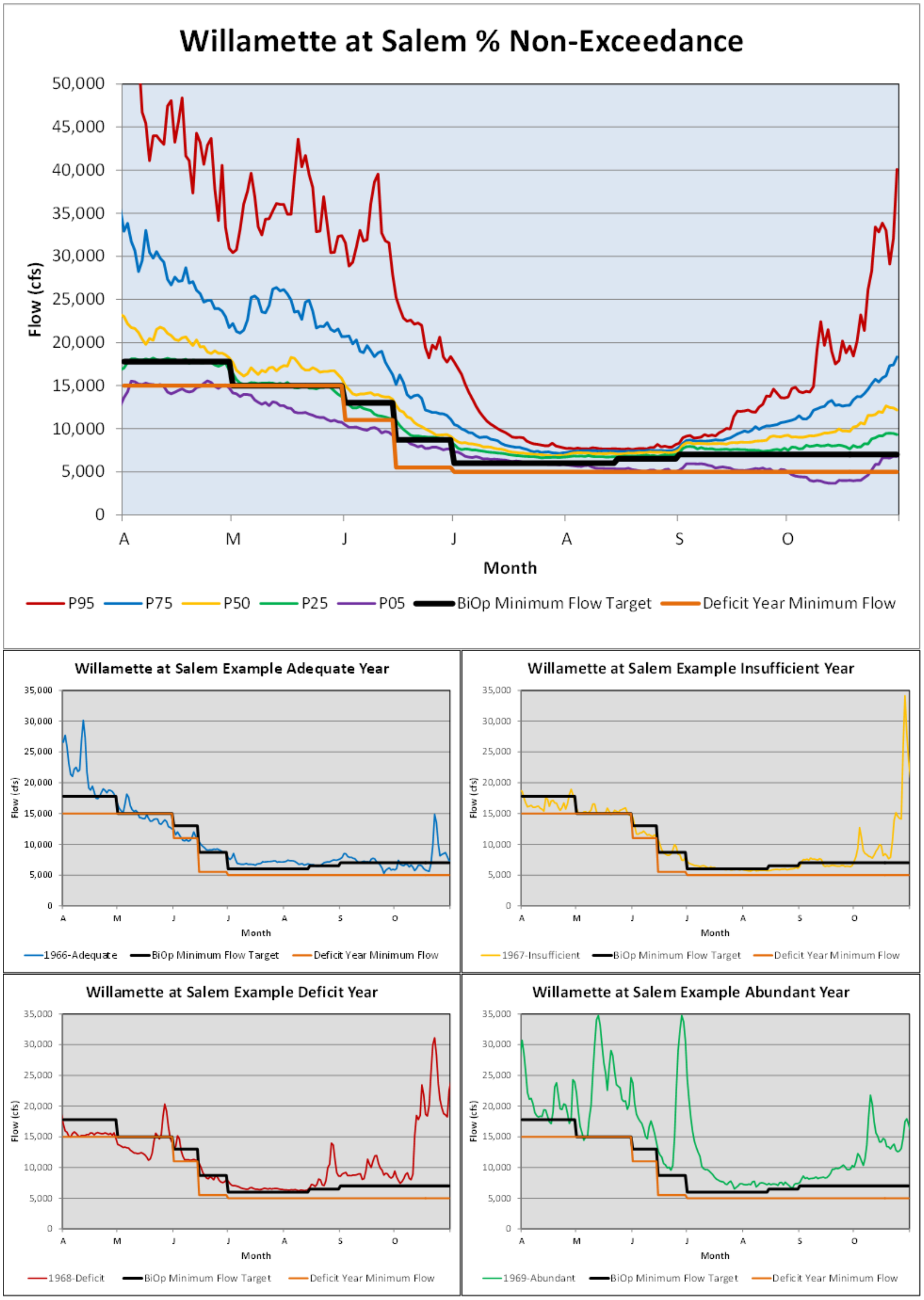


Figure 6.5. Non-exceedance percentiles for the Peak ARP 2070 for regulated flow at Salem in top graph (with blue background). Salem flow for selected years: 1966 (Adequate) at middle left, 1967 (Insufficient) at middle right, 1968 (Deficit) at bottom left, and 1969 (Abundant) at bottom right.

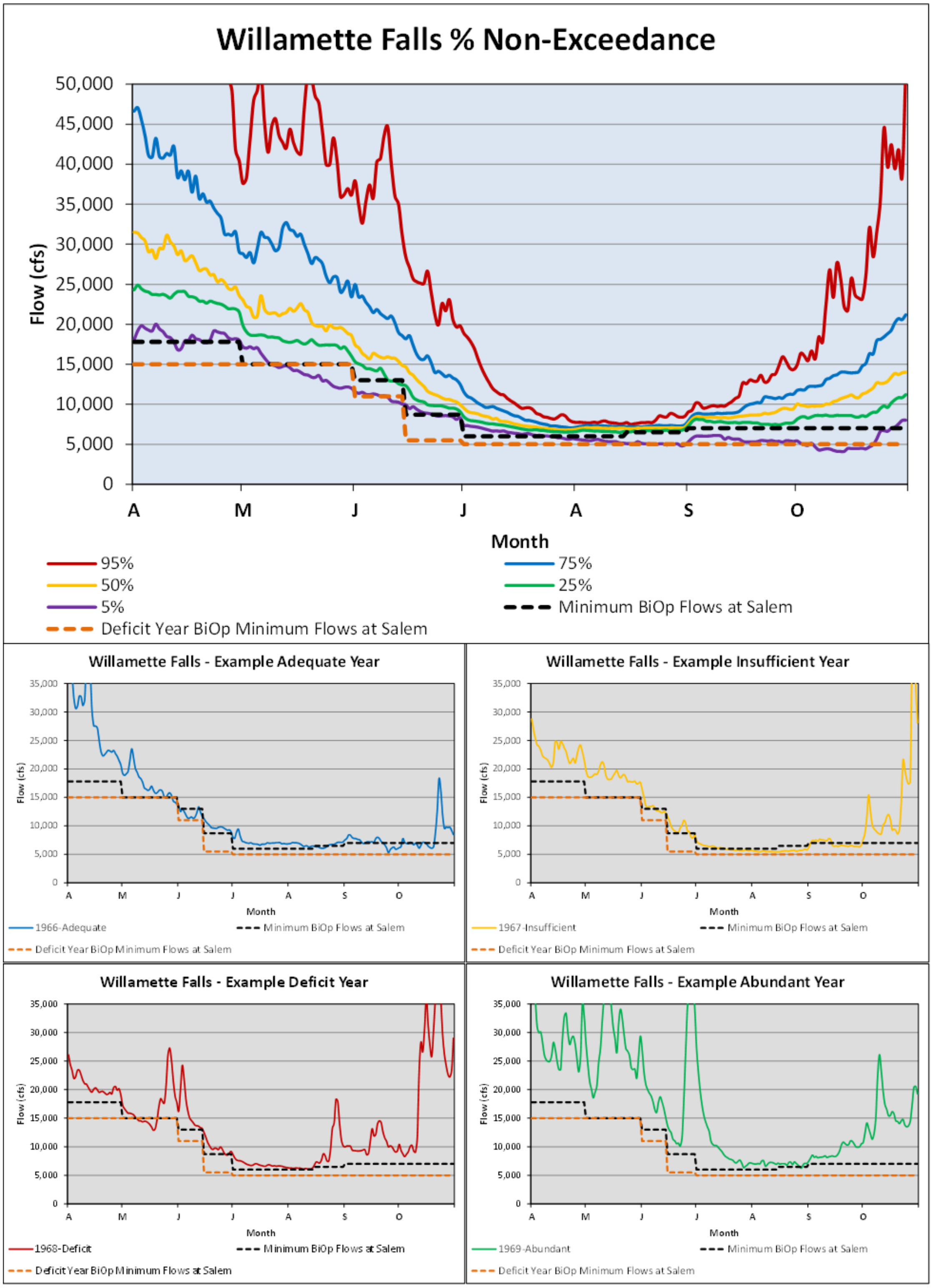


Figure 9.6. Non-exceedance percentiles for the Peak ARP 2070 for regulated flow at Oregon City above the Falls in top graph (with blue background). Flow for selected years: 1966 (Adequate) at middle left, 1967 (Insufficient) at middle right, 1968 (Deficit) at bottom left, and 1969 (Abundant) at bottom right.

10 Expected ARP 2070 ResSim Analysis

The simulation name for this analysis is ***Expected-ARP-2070-23Mar2018*** (see Table 1.1 for all other specifics for the simulation).

10.1 Diversions and Return Flows

Table 3.1 shows a total increase in Willamette Basin diversions of 287,650 ac-ft from 2008 levels for this analysis. The total increase was from eight categories, which were given separately for demand increases from 2008 to 2020 (for the Base Year analysis) and from 2020 to 2070. The demand increase for the two time windows are:

1. Demand Increases for 2008 to 2020, which were included in the Base Year 2020 analysis:

- an increase in BOR stored water contracts (22,854 ac-ft) (Table AI 1),
- an increase in M&I use from live flow permits that were already in place in 2008, but not fully utilized, for June through September (18,780 ac-ft) (Table MI 1),
- and an increase in M&I use from live flow permits that were already in place in 2008, but not fully utilized, for April through May (7541 ac-ft) (Table MI 2).

2. Demand Increases for 2020 to 2070, with values representing expected use:

- an increase in BOR stored water contracts (100,128 ac-ft), which is subdivided into the increase that brings the total BOR contract in the basin to 95,000 ac-ft (13,626 ac-ft) (Table AI 2) and the portion that is above 95,000 ac-ft (86,502 ac-ft) (Table AI 6), with the importance of the 95,000 ac-ft contract level described below as the two portions are modeled differently in ResSim,
- an increase in M&I use from live flow permits that were already in place in 2008, but not fully utilized, for June through September (54,469 ac-ft) (Table MI 4),
- an increase in M&I use from live flow permits that were already in place in 2008, but not fully utilized, for April through May (27,246 ac-ft) (Table MI 5),
- new M&I use from stored water due to system deficits (38,682 ac-ft) (Table MI 9),
- and new M&I use from stored water due to SSI deficits (17,950 ac-ft) (Table MI 10).

Table 3.2 indicates which categories from the eight increases above are from stored water (total volume is 179,614 ac-ft), and Table 3.3 indicates which categories are from instream flow permits (total volume is 107,946 ac-ft).

The development of the diversions and return flows for this simulation follows the same order of sub-sections described for the Peak No Action case, Section 7.

10.1.1 AI Diversions

The AI diversions in this simulation are the 22,854 ac-ft and 100,128 ac-ft volumes listed in Table 3.1. These volumes are broken out by reach in Appendix F in Tables AI 1 for the 22,854 ac-ft diversions and in Tables AI2 and AI 6 for the 100,128 ac-ft diversions. The total of these AI diversions by reach for May through September is shown in Table 10.1. Note that the total for all reaches is 122,982 ac-ft for AI demand, which leaves a remaining 56,632 ac-ft of demand from the total volume shown in Table 3.2 for stored water contracts for the Expected ARP 2070 column. The remaining 56,632 ac-ft is from M&I demands on reallocated storage described in Sections 10.1.2 and 10.1.3.

Following the description from Section 7.1, the irrigation volumes are re-distributed to April through October (using the 2010 Modified Flow percentages in Table 7.1b) in Table 10.2 for the full demand level, or the basis for supply in Abundant water years. Using the reductions by water year type described in Section 7.1.1, the April through October irrigation volumes are shown for Adequate years in Table 10.3, Insufficient years in Table 10.4, and Deficit years in Table 10.5.

Table 10.1. The incremental increases in BOR irrigation contracts from stored water between 2008 and 2070, from Tables AI 1, AI 2, and AI 6 in Appendix F.

Reach	Increased AI Demand Volume in acre-feet					
	May	June	July	August	September	Total
Reach 1	6472	12,904	21,291	17,006	8462	66,133
Reach 1a	283	565	932	744	370	2894
Reach 1b	4974	9917	16,363	13,069	6503	50,825
Reach 1c	1215	2422	3997	3192	1588	12,414
Reach 2	350	698	1152	920	458	3577
Reach 3	826	1648	2719	2172	1081	8445
Reach 4	651	1299	2143	1712	852	6656
Reach 5	883	1761	2905	2321	1155	9025
Reach 6	1166	2326	3838	3065	1525	11,920
Reach 7	419	836	1380	1102	548	4286
Reach 8	372	742	1224	977	486	3801
Reach 9	3	6	9	8	4	29
Reach 10	138	275	454	363	180	1410
Reach 11	641	1278	2108	1684	838	6548
Reach 12	11	22	37	29	15	114
Reach 13	92	183	302	241	120	938
Reach 14	7	14	23	18	9	71
Reach 15	3	5	9	7	4	27
Total all Reaches	12,034	23,996	39,593	31,624	15,735	**122,982**

Table 10.2. The incremental increases in BOR irrigation contracts from stored water between 2008 and 2070, from Tables AI 1, AI 2, and AI 6 in Appendix F, reshaped according to Table 7.1b, used as the basis for Abundant water year AI diversions.

Reach	Increased AI Demand in acre-feet							
	April	**May**	**June**	**July**	**Aug.**	**Sept.**	**Oct.**	**Total**
Reach 1	198	4292	11,110	21,407	20,019	8908	198	66,133
Reach 1a	9	188	486	937	876	390	9	2894
Reach 1b	152	3299	8539	16,452	15,385	6846	152	50,825
Reach 1c	37	806	2086	4018	3758	1672	37	12,414
Reach 2	11	232	601	1158	1083	482	11	3577
Reach 3	25	548	1419	2734	2556	1138	25	8445
Reach 4	20	432	1118	2155	2015	897	20	6656
Reach 5	27	586	1516	2921	2732	1216	27	9025
Reach 6	36	774	2003	3859	3608	1606	36	11,920
Reach 7	13	278	720	1388	1297	577	13	4286
Reach 8	11	247	639	1230	1150	512	11	3801
Reach 9	0	2	5	9	9	4	0	29
Reach 10	4	92	237	456	427	190	4	1410
Reach 11	20	425	1100	2120	1982	882	20	6548
Reach 12	0	7	19	37	34	15	0	114
Reach 13	3	61	158	304	284	126	3	938
Reach 14	0	5	12	23	21	10	0	71
Reach 15	0	2	5	9	8	4	0	27
Total all Reaches	369	7982	20,661	39,809	37,227	16,566	369	**122,982**

Table 10.3. The incremental increases in BOR irrigation contracts from stored water between 2008 and 2070, from Tables AI 1, AI 2, and AI 6 in Appendix F, reshaped according to Table 7.1b, used as the basis for Adequate water year AI diversions.

Reach	Increased AI Demand in acre-feet							
	April	**May**	**June**	**July**	**Aug.**	**Sept.**	**Oct.**	**Total**
Reach 1	171	3691	9555	18,410	17,216	7661	171	56,875
Reach 1a	7	162	418	806	753	335	7	2489
Reach 1b	131	2837	7343	14,149	13,231	5888	131	43,710
Reach 1c	32	693	1794	3456	3232	1438	32	10,676
Reach 2	9	200	517	996	931	414	9	3077
Reach 3	22	471	1220	2351	2199	978	22	7263
Reach 4	17	372	962	1853	1733	771	17	5724
Reach 5	23	504	1304	2512	2349	1045	23	7761
Reach 6	31	665	1722	3318	3103	1381	31	10,251
Reach 7	11	239	619	1193	1116	497	11	3686
Reach 8	10	212	549	1058	989	440	10	3269
Reach 9	0	2	4	8	8	3	0	25
Reach 10	4	79	204	393	367	163	4	1213
Reach 11	17	365	946	1823	1705	759	17	5631
Reach 12	0	6	16	32	30	13	0	98
Reach 13	2	52	136	261	244	109	2	807
Reach 14	0	4	10	20	18	8	0	61
Reach 15	0	2	4	8	7	3	0	24
Total all Reaches	317	6864	17,768	34,236	32,015	14,246	317	**105,765**

Table 10.4. The incremental increases in BOR irrigation contracts from stored water between 2008 and 2070, from Tables AI 1, AI 2, and AI 6 in Appendix F, reshaped according to Table 7.1b, used as the basis for Insufficient water year AI diversions.

Reach	Increased AI Demand in acre-feet							
	April	May	June	July	Aug.	Sept.	Oct.	Total
Reach 1	137	2962	7666	14,771	13,813	6147	137	45,632
Reach 1a	6	130	335	646	604	269	6	1997
Reach 1b	105	2276	5892	11,352	10,616	4724	105	35,070
Reach 1c	26	556	1439	2773	2593	1154	26	8566
Reach 2	7	160	415	799	747	332	7	2468
Reach 3	17	378	979	1886	1764	785	17	5827
Reach 4	14	298	772	1487	1390	619	14	4593
Reach 5	19	404	1046	2016	1885	839	19	6227
Reach 6	25	534	1382	2662	2490	1108	25	8225
Reach 7	9	192	497	957	895	398	9	2958
Reach 8	8	170	441	849	794	353	8	2622
Reach 9	0	1	3	7	6	3	0	20
Reach 10	3	63	163	315	295	131	3	973
Reach 11	14	293	759	1463	1368	609	14	4518
Reach 12	0	5	13	25	24	11	0	79
Reach 13	2	42	109	210	196	87	2	647
Reach 14	0	3	8	16	15	7	0	49
Reach 15	0	1	3	6	6	3	0	19
Total all Reaches	255	5507	14,256	27,468	25,686	11,430	255	**84,858**

Table 10.5. The incremental increases in BOR irrigation contracts from stored water between 2008 and 2070, from Tables AI 1, AI 2, and AI 6 in Appendix F, reshaped according to Table 7.1b, used as the basis for Deficit water year AI diversions.

Reach	Increased AI Demand in acre-feet							
	April	May	June	July	Aug.	Sept.	Oct.	Total
Reach 1	95	2060	5333	10,276	9609	4276	95	31,744
Reach 1a	4	90	233	450	420	187	4	1389
Reach 1b	73	1583	4099	7897	7385	3286	73	24,396
Reach 1c	18	387	1001	1929	1804	803	18	5959
Reach 2	5	111	288	556	520	231	5	1717
Reach 3	12	263	681	1312	1227	546	12	4054
Reach 4	10	207	537	1034	967	430	10	3195
Reach 5	13	281	728	1402	1311	584	13	4332
Reach 6	17	371	961	1852	1732	771	17	5722
Reach 7	6	134	346	666	623	277	6	2057
Reach 8	5	118	306	591	552	246	5	1824
Reach 9	0	1	2	5	4	2	0	14
Reach 10	2	44	114	219	205	91	2	677
Reach 11	9	204	528	1017	951	423	9	3143
Reach 12	0	4	9	18	17	7	0	55
Reach 13	1	29	76	146	136	61	1	450
Reach 14	0	2	6	11	10	5	0	34
Reach 15	0	1	2	4	4	2	0	13
Total all Reaches	177	3831	9917	19,108	17,869	7952	177	**59,031**

10.1.2 M&I Diversions with Reductions in Lower Water Years

The M&I diversions in this simulation that are reduced in lower water years is only the 17,950 ac-ft volume listed in Table 3.1. This volume demand is broken out by reach in Appendix F in Table MI 10. The remainder of the M&I demands are described in Section 10.1.3, since those demands will not be modeled as being reduced in lower water years for the Expected TSP analysis.

Table 10.6 below shows the M&I diversions as the basis for the Abundant years, Table 10.7 for Adequate years, Table 10.8 for Insufficient years, and Table 10.9 for Deficit years, using the percentage reductions described in Section 3.1.

Table 10.6. The incremental increases in M&I Expected demands from already permitted live flow contracts and new stored water contracts, 2008 and 2070, from Table MI 10 in Appendix F, used as the basis for Abundant water year M&I diversions.

Reach	Increased M&I Demand in acre-feet							
	April	May	June	July	Aug.	Sept.	Oct.	Total
Reach 1	0	0	3398	3360	3360	3370	0	13,489
Reach 1a	0	0	1570	1553	1553	1558	0	6234
Reach 1b	0	0	1778	1758	1758	1764	0	7059
Reach 1c	0	0	49	49	49	49	0	196
Reach 2	0	0	0	0	0	0	0	0
Reach 3	0	0	59	58	58	59	0	234
Reach 4	0	0	229	226	226	227	0	908
Reach 5	0	0	206	204	204	205	0	819
Reach 6	0	0	0	0	0	0	0	2
Reach 7	0	0	296	293	293	294	0	1177
Reach 8	0	0	0	0	0	0	0	1
Reach 9	0	0	329	326	326	327	0	1307
Reach 10	0	0	3	3	3	3	0	12
Reach 11	0	0	0	0	0	0	0	1
Reach 12	0	0	0	0	0	0	0	0
Reach 13	0	0	0	0	0	0	0	0
Reach 14	0	0	0	0	0	0	0	0
Reach 15	0	0	0	0	0	0	0	0
Total all Reaches	0	0	4522	4471	4471	4485	0	**17,950**

Table 10.7. The incremental increases in M&I Expected demands from already permitted live flow contracts and new stored water contracts, 2008 and 2070, from Table MI 10 in Appendix F, used as the basis for Adequate water year M&I diversions.

Reach	Increased M&I Demand in acre-feet							
	April	May	June	July	Aug.	Sept.	Oct.	Total
Reach 1	0	0	2922	2890	2890	2898	0	11,600
Reach 1a	0	0	1351	1335	1335	1339	0	5361
Reach 1b	0	0	1529	1512	1512	1517	0	6071
Reach 1c	0	0	43	42	42	42	0	169
Reach 2	0	0	0	0	0	0	0	0
Reach 3	0	0	51	50	50	50	0	201
Reach 4	0	0	197	195	195	195	0	781
Reach 5	0	0	177	175	175	176	0	704
Reach 6	0	0	0	0	0	0	0	1
Reach 7	0	0	255	252	252	253	0	1012
Reach 8	0	0	0	0	0	0	0	1
Reach 9	0	0	283	280	280	281	0	1124
Reach 10	0	0	3	3	3	3	0	10
Reach 11	0	0	0	0	0	0	0	1
Reach 12	0	0	0	0	0	0	0	0
Reach 13	0	0	0	0	0	0	0	0
Reach 14	0	0	0	0	0	0	0	0
Reach 15	0	0	0	0	0	0	0	0
Total all Reaches	0	0	3889	3845	3845	3857	0	**15,437**

Table 10.8. The incremental increases in M&I Expected demands from already permitted live flow contracts and new stored water contracts, 2008 and 2070, from Table MI 10 in Appendix F, used as the basis for Insufficient water year M&I diversions.

Reach	Increased M&I Demand in acre-feet							
	April	May	June	July	Aug.	Sept.	Oct.	Total
Reach 1	0	0	2345	2318	2318	2325	0	9307
Reach 1a	0	0	1084	1071	1071	1075	0	4301
Reach 1b	0	0	1227	1213	1213	1217	0	4871
Reach 1c	0	0	34	34	34	34	0	135
Reach 2	0	0	0	0	0	0	0	0
Reach 3	0	0	41	40	40	40	0	162
Reach 4	0	0	158	156	156	157	0	627
Reach 5	0	0	142	141	141	141	0	565
Reach 6	0	0	0	0	0	0	0	1
Reach 7	0	0	205	202	202	203	0	812
Reach 8	0	0	0	0	0	0	0	1
Reach 9	0	0	227	225	225	225	0	902
Reach 10	0	0	2	2	2	2	0	8
Reach 11	0	0	0	0	0	0	0	1
Reach 12	0	0	0	0	0	0	0	0
Reach 13	0	0	0	0	0	0	0	0
Reach 14	0	0	0	0	0	0	0	0
Reach 15	0	0	0	0	0	0	0	0
Total all Reaches	0	0	3120	3085	3085	3095	0	**12,386**

Table 10.9. The incremental increases in M&I Expected demands from already permitted live flow contracts and new stored water contracts, 2008 and 2070, from Table MI 10 in Appendix F, used as the basis for Deficit water year M&I diversions.

Reach	Increased M&I Demand in acre-feet							
	April	May	June	July	Aug.	Sept.	Oct.	Total
Reach 1	0	0	1631	1613	1613	1618	0	6475
Reach 1a	0	0	754	745	745	748	0	2992
Reach 1b	0	0	854	844	844	847	0	3388
Reach 1c	0	0	24	23	23	24	0	94
Reach 2	0	0	0	0	0	0	0	0
Reach 3	0	0	28	28	28	28	0	112
Reach 4	0	0	110	109	109	109	0	436
Reach 5	0	0	99	98	98	98	0	393
Reach 6	0	0	0	0	0	0	0	1
Reach 7	0	0	142	141	141	141	0	565
Reach 8	0	0	0	0	0	0	0	1
Reach 9	0	0	158	156	156	157	0	627
Reach 10	0	0	1	1	1	1	0	6
Reach 11	0	0	0	0	0	0	0	1
Reach 12	0	0	0	0	0	0	0	0
Reach 13	0	0	0	0	0	0	0	0
Reach 14	0	0	0	0	0	0	0	0
Reach 15	0	0	0	0	0	0	0	0
Total all Reaches	0	0	2171	2146	2146	2153	0	**8616**

10.1.3 M&I Diversions Supplied in Full for all Water Years

The M&I diversions in this simulation that are not reduced in lower water years are the 18,780 and 7541 ac-ft volumes for the 2008 to 2020 increases (Tables MI 1 and MI 2, respectively), and the 54,469 ac-ft for June through September already permitted live flow (Table MI 4), the 27,246 ac-ft volume for the April and May already permitted live flow (Table MI 5), and the 38,682 ac-ft from reallocated storage (Table MI 9) for the 2020 to 2070 increases. The above volumes are from Table 3.1, and the tables referenced in parentheses are from Appendix F where the volumes are broken out by reach. The total of these M&I demands for all reaches is the remaining instream flow demand described in Section 10.1.2.

Table 10.10 below shows the M&I diversions that apply for all water year types.

Table 3.10. The incremental increases in M&I Expected demands from already permitted live flow contracts, 2008 and 2070, from Tables MI 1, MI 2, MI 4, MI 5, and MI 9 in Appendix F.

Reach	Increased M&I Demand in acre-feet							
	April	**May**	**June**	**July**	**Aug.**	**Sept.**	**Oct.**	**Total**
Reach 1	10,167	12,082	14,837	21,042	21,541	16,488	0	96,157
Reach 1a	2618	3111	4015	5693	5828	4461	0	25,726
Reach 1b	7086	8421	10,170	14,423	14,765	11,302	0	66,166
Reach 1c	463	551	653	926	947	725	0	4265
Reach 2	26	31	52	74	76	58	0	318
Reach 3	3005	3571	3812	5406	5534	4236	0	25,562
Reach 4	180	214	222	315	322	246	0	1498
Reach 5	779	926	1035	1469	1503	1151	0	6863
Reach 6	2	2	2	2	2	2	0	12
Reach 7	75	89	114	161	165	126	0	730
Reach 8	470	559	622	882	903	691	0	4126
Reach 9	1100	1307	1647	2336	2391	1830	0	10,611
Reach 10	0	0	0	0	0	0	0	0
Reach 11	5	5	6	9	9	7	0	40
Reach 12	15	18	20	28	29	22	0	133
Reach 13	24	29	31	44	45	34	0	207
Reach 14	48	57	71	101	103	79	0	460
Reach 15	0	0	0	0	0	0	0	0
Total all Reaches	15,896	18,890	22,470	31,867	32,623	24,971	0	**146,718**

*Note slight round-off error from showing all demands as integers.

10.1.4 Total Diversions by Reach and by Water Year Type

The total water volumes diverted in this simulation are shown below in Tables 10.11 through 10.14. These diversions depend on water year type.

The demand volumes by reach and by month are converted to daily average flow rates, shown in Tables 10.15 through 10.19 for Abundant, Adequate, Insufficient, and Deficit water years.

Table 10.11. The incremental increases in all demands, 2008 and 2070, used for Abundant water year diversions.

Reach	Increased Total Demand in acre-feet							
	April	May	June	July	Aug.	Sept.	Oct.	Total
Reach 1	10,366	16,374	29,346	45,809	44,919	28,766	198	175,779
Reach 1a	2626	3299	6071	8183	8257	6409	9	34,854
Reach 1b	7239	11,720	20,487	32,633	31,908	19,911	152	124,050
Reach 1c	500	1356	2788	4993	4754	2446	37	16,875
Reach 2	37	263	654	1232	1159	540	11	3895
Reach 3	3030	4119	5289	8198	8148	5432	25	34,242
Reach 4	200	646	1569	2695	2563	1370	20	9063
Reach 5	806	1512	2758	4594	4439	2571	27	16,707
Reach 6	38	776	2005	3861	3611	1608	36	11,934
Reach 7	87	367	1130	1842	1756	998	13	6193
Reach 8	482	806	1260	2112	2053	1203	11	7928
Reach 9	1100	1309	1981	2671	2726	2161	0	11,947
Reach 10	4	92	240	459	430	193	4	1422
Reach 11	24	430	1106	2128	1991	889	20	6589
Reach 12	16	26	39	65	64	38	0	247
Reach 13	27	90	188	347	329	161	3	1145
Reach 14	49	62	83	124	125	89	0	531
Reach 15	0	2	5	9	8	4	0	27
Total all Reaches	16,265	26,872	47,654	76,148	74,321	46,022	369	**287,650**

Table 10.12. The incremental increases in all demands, 2008 and 2070, used for Adequate water year diversions.

Reach	Increased Total Demand in acre-feet							
	April	May	June	July	Aug.	Sept.	Oct.	Total
Reach 1	10,338	15,773	27,314	42,342	41,646	27,047	171	164,632
Reach 1a	2625	3272	5783	7834	7917	6136	7	33,576
Reach 1b	7217	11,258	19,042	30,084	29,508	18,706	131	115,946
Reach 1c	495	1243	2489	4423	4221	2205	32	15,109
Reach 2	35	230	569	1070	1008	473	9	3395
Reach 3	3027	4042	5082	7807	7782	5264	22	33,027
Reach 4	197	585	1380	2362	2249	1213	17	8004
Reach 5	803	1430	2517	4156	4028	2372	23	15,329
Reach 6	33	667	1724	3321	3106	1383	31	10,265
Reach 7	86	328	988	1607	1533	876	11	5428
Reach 8	480	771	1171	1940	1892	1131	10	7395
Reach 9	1100	1309	1934	2624	2679	2115	0	11,760
Reach 10	4	79	206	395	370	166	4	1223
Reach 11	21	371	952	1832	1714	766	17	5672
Reach 12	16	25	37	60	59	35	0	231
Reach 13	27	81	166	305	289	143	2	1014
Reach 14	49	61	81	121	122	87	0	521
Reach 15	0	2	4	8	7	3	0	24
Total all Reaches	16,213	25,754	44,128	69,949	68,483	43,074	317	**267,920**

Table 10.13. The incremental increases in all demands, 2008 and 2070, used for Insufficient water year diversions.

Reach	Increased Total Demand in acre-feet							
	April	May	June	July	Aug.	Sept.	Oct.	Total
Reach 1	10,304	15,044	24,848	38,131	37,672	24,960	137	151,096
Reach 1a	2624	3240	5434	7411	7504	5805	6	32,024
Reach 1b	7191	10,697	17,289	26,988	26,593	17,242	105	106,106
Reach 1c	489	1106	2126	3732	3574	1913	26	12,966
Reach 2	33	191	467	873	823	391	7	2786
Reach 3	3022	3949	4831	7332	7338	5061	17	31,551
Reach 4	194	512	1151	1957	1868	1022	14	6718
Reach 5	798	1330	2224	3625	3529	2131	19	13,656
Reach 6	26	536	1384	2665	2492	1110	25	8238
Reach 7	83	281	815	1321	1263	728	9	4499
Reach 8	478	729	1062	1731	1697	1044	8	6749
Reach 9	1100	1308	1878	2567	2622	2058	0	11,533
Reach 10	3	63	166	317	297	133	3	981
Reach 11	18	299	765	1471	1377	616	14	4559
Reach 12	16	23	33	54	53	33	0	212
Reach 13	26	71	140	253	241	122	2	855
Reach 14	49	61	79	117	118	86	0	509
Reach 15	0	1	3	6	6	3	0	19
Total all Reaches	16,151	24,398	39,847	62,421	61,395	39,496	255	**243,961**

Table 10.14. The incremental increases in all demands, 2008 and 2070, used for Deficit water year diversions.

Reach	Increased Total Demand in acre-feet							
	April	May	June	July	Aug.	Sept.	Oct.	Total
Reach 1	10,262	14,142	21,801	32,930	32,762	22,382	95	134,375
Reach 1a	2622	3201	5002	6888	6994	5396	4	30,108
Reach 1b	7159	10,004	15,122	23,164	22,993	15,434	73	93,950
Reach 1c	481	937	1677	2878	2775	1551	18	10,318
Reach 2	31	142	341	630	596	290	5	2035
Reach 3	3017	3834	4521	6746	6789	4810	12	29,728
Reach 4	189	421	868	1457	1398	786	10	5129
Reach 5	792	1207	1862	2969	2913	1832	13	11,588
Reach 6	19	373	963	1855	1735	773	17	5735
Reach 7	81	222	602	968	929	545	6	3352
Reach 8	476	677	928	1472	1455	937	5	5951
Reach 9	1100	1308	1807	2497	2552	1989	0	11,252
Reach 10	2	44	115	221	206	93	2	683
Reach 11	14	209	534	1026	960	430	9	3184
Reach 12	15	22	29	46	46	30	0	188
Reach 13	26	58	107	190	181	95	1	658
Reach 14	48	60	77	112	113	84	0	494
Reach 15	0	1	2	4	4	2	0	13
Total all Reaches	16,073	22,721	34,558	53,122	52,638	35,075	177	**214,366**

Table 10.15. Diversion withdrawals as daily average flow rates by reach, used for Abundant water years.

Reach	Daily Flow Withdrawal Rate, in cfs, by month.											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1b	0.00	0.00	0.00	2.56	190.60	344.29	530.73	518.93	334.62	2.48	0.00	0.00
1c	0.00	0.00	0.00	0.63	22.06	46.85	81.20	77.32	41.11	0.61	0.00	0.00
2	0.00	0.00	0.00	0.18	4.28	10.98	20.04	18.85	9.08	0.17	0.00	0.00
3	0.00	0.00	0.00	0.43	66.99	88.89	133.32	132.52	91.28	0.41	0.00	0.00
4	0.00	0.00	0.00	0.34	10.50	26.37	43.84	41.68	23.02	0.32	0.00	0.00
5	0.00	0.00	0.00	0.45	24.59	46.35	74.71	72.20	43.21	0.44	0.00	0.00
6	0.00	0.00	0.00	0.60	12.62	33.69	62.80	58.73	27.02	0.58	0.00	0.00
7	0.00	0.00	0.00	0.22	5.97	19.00	29.96	28.55	16.77	0.21	0.00	0.00
8	0.00	0.00	0.00	0.19	13.10	21.18	34.35	33.39	20.22	0.19	0.00	0.00
9	0.00	0.00	0.00	0.00	21.29	33.29	43.44	44.33	36.31	0.00	0.00	0.00
10	0.00	0.00	0.00	0.07	1.49	4.03	7.47	6.99	3.24	0.07	0.00	0.00
11	0.00	0.00	0.00	0.33	7.00	18.59	34.62	32.38	14.94	0.32	0.00	0.00
12	0.00	0.00	0.00	0.01	0.42	0.66	1.06	1.03	0.63	0.01	0.00	0.00
13	0.00	0.00	0.00	0.05	1.46	3.17	5.65	5.35	2.70	0.05	0.00	0.00
14	0.00	0.00	0.00	0.00	1.01	1.39	2.01	2.03	1.49	0.00	0.00	0.00
15	0.00	0.00	0.00	0.00	0.03	0.08	0.14	0.14	0.06	0.00	0.00	0.00

Table 10.16. Diversion withdrawals as daily average flow rates by reach, used for Adequate water years.

Reach	Daily Flow Withdrawal Rate, in cfs, by month.											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1b	0.00	0.00	0.00	2.20	183.09	320.02	489.27	479.90	314.36	2.13	0.00	0.00
1c	0.00	0.00	0.00	0.54	20.22	41.82	71.94	68.65	37.06	0.52	0.00	0.00
2	0.00	0.00	0.00	0.16	3.75	9.57	17.41	16.39	7.94	0.15	0.00	0.00
3	0.00	0.00	0.00	0.37	65.74	85.41	126.97	126.57	88.47	0.35	0.00	0.00
4	0.00	0.00	0.00	0.29	9.52	23.20	38.42	36.58	20.38	0.28	0.00	0.00
5	0.00	0.00	0.00	0.39	23.25	42.30	67.60	65.51	39.87	0.38	0.00	0.00
6	0.00	0.00	0.00	0.52	10.85	28.98	54.01	50.51	23.24	0.50	0.00	0.00
7	0.00	0.00	0.00	0.19	5.33	16.60	26.13	24.93	14.72	0.18	0.00	0.00
8	0.00	0.00	0.00	0.16	12.54	19.68	31.55	30.77	19.01	0.16	0.00	0.00
9	0.00	0.00	0.00	0.00	21.28	32.51	42.67	43.57	35.54	0.00	0.00	0.00
10	0.00	0.00	0.00	0.06	1.28	3.47	6.43	6.01	2.79	0.06	0.00	0.00
11	0.00	0.00	0.00	0.28	6.03	16.00	29.79	27.87	12.86	0.27	0.00	0.00
12	0.00	0.00	0.00	0.00	0.40	0.61	0.98	0.96	0.60	0.00	0.00	0.00
13	0.00	0.00	0.00	0.04	1.32	2.80	4.96	4.70	2.40	0.04	0.00	0.00
14	0.00	0.00	0.00	0.00	1.00	1.37	1.96	1.98	1.47	0.00	0.00	0.00
15	0.00	0.00	0.00	0.00	0.02	0.07	0.12	0.12	0.05	0.00	0.00	0.00

Table 10.17. Diversion withdrawals as daily average flow rates by reach, used for Insufficient water years.

Reach	Daily Flow Withdrawal Rate, in cfs, by month.											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1b	0.00	0.00	0.00	1.77	173.97	290.54	438.92	432.50	289.77	1.71	0.00	0.00
1c	0.00	0.00	0.00	0.43	17.99	35.72	60.69	58.13	32.15	0.42	0.00	0.00
2	0.00	0.00	0.00	0.12	3.10	7.85	14.21	13.39	6.57	0.12	0.00	0.00
3	0.00	0.00	0.00	0.29	64.22	81.19	119.25	119.34	85.05	0.28	0.00	0.00
4	0.00	0.00	0.00	0.23	8.32	19.35	31.83	30.39	17.17	0.22	0.00	0.00
5	0.00	0.00	0.00	0.31	21.63	37.38	58.95	57.39	35.81	0.30	0.00	0.00
6	0.00	0.00	0.00	0.41	8.72	23.25	43.34	40.53	18.65	0.40	0.00	0.00
7	0.00	0.00	0.00	0.15	4.56	13.70	21.48	20.53	12.23	0.14	0.00	0.00
8	0.00	0.00	0.00	0.13	11.86	17.85	28.15	27.59	17.55	0.13	0.00	0.00
9	0.00	0.00	0.00	0.00	21.28	31.55	41.75	42.64	34.59	0.00	0.00	0.00
10	0.00	0.00	0.00	0.05	1.03	2.78	5.16	4.82	2.24	0.05	0.00	0.00
11	0.00	0.00	0.00	0.23	4.86	12.86	23.93	22.39	10.34	0.22	0.00	0.00
12	0.00	0.00	0.00	0.00	0.38	0.56	0.88	0.86	0.55	0.00	0.00	0.00
13	0.00	0.00	0.00	0.03	1.16	2.35	4.12	3.92	2.04	0.03	0.00	0.00
14	0.00	0.00	0.00	0.00	0.99	1.33	1.90	1.92	1.44	0.00	0.00	0.00
15	0.00	0.00	0.00	0.00	0.02	0.05	0.10	0.09	0.04	0.00	0.00	0.00

Table 10.18. Diversion withdrawals as daily average flow rates by reach, used for Deficit water years.

Reach	Daily Flow Withdrawal Rate, in cfs, by month.											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1b	0.00	0.00	0.00	1.23	162.70	254.13	376.72	373.95	259.38	1.19	0.00	0.00
1c	0.00	0.00	0.00	0.30	15.24	28.19	46.80	45.13	26.07	0.29	0.00	0.00
2	0.00	0.00	0.00	0.09	2.31	5.73	10.25	9.69	4.87	0.08	0.00	0.00
3	0.00	0.00	0.00	0.20	62.35	75.98	109.71	110.41	80.83	0.20	0.00	0.00
4	0.00	0.00	0.00	0.16	6.85	14.59	23.70	22.73	13.21	0.16	0.00	0.00
5	0.00	0.00	0.00	0.22	19.63	31.30	48.28	47.37	30.80	0.21	0.00	0.00
6	0.00	0.00	0.00	0.29	6.07	16.19	30.16	28.21	12.99	0.28	0.00	0.00
7	0.00	0.00	0.00	0.10	3.61	10.11	15.74	15.10	9.15	0.10	0.00	0.00
8	0.00	0.00	0.00	0.09	11.01	15.60	23.94	23.66	15.74	0.09	0.00	0.00
9	0.00	0.00	0.00	0.00	21.27	30.37	40.60	41.50	33.42	0.00	0.00	0.00
10	0.00	0.00	0.00	0.03	0.71	1.94	3.59	3.36	1.56	0.03	0.00	0.00
11	0.00	0.00	0.00	0.16	3.41	8.98	16.69	15.62	7.23	0.15	0.00	0.00
12	0.00	0.00	0.00	0.00	0.35	0.49	0.75	0.74	0.50	0.00	0.00	0.00
13	0.00	0.00	0.00	0.02	0.95	1.79	3.08	2.95	1.60	0.02	0.00	0.00
14	0.00	0.00	0.00	0.00	0.97	1.29	1.82	1.85	1.40	0.00	0.00	0.00
15	0.00	0.00	0.00	0.00	0.01	0.04	0.07	0.06	0.03	0.00	0.00	0.00

10.1.5 Total Return Flows by Reach and by Water Year Type

The monthly shaping percentages from Table 6.6 are used to obtain the monthly volume of return flows for M&I and AI, and then the monthly volumes are converted to daily average return flows for each reach (using the volume to flow conversion from Section 3.2). The return flows used for the simulation are shown in Tables 10.19 through 10.22. Note that return flows in ResSim are still diversions, so the negative sign in the diversion results in an inflow for each reach.

Table 10.19. Return daily average flow by reach, used for Abundant water years.

Reach	Daily Flow Return Rate, in cfs, by month, for M&I and Ag Demands that can be supported.											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1b	-6.6	-6.6	-6.6	-54.9	-65.6	-135.4	-180.8	-185.5	-146.8	-14.9	-9.9	-6.6
1c	-1.6	-1.6	-1.6	-7.0	-8.4	-10.5	-14.8	-15.4	-11.6	-3.6	-2.4	-1.6
2	-0.5	-0.5	-0.5	-0.5	-0.7	-2.0	-2.7	-2.8	-2.1	-1.0	-0.7	-0.5
3	-1.1	-1.1	-1.1	-34.7	-41.4	-34.9	-49.4	-50.7	-38.6	-2.5	-1.6	-1.1
4	-0.9	-0.9	-0.9	-2.8	-3.4	-6.2	-8.5	-8.8	-6.7	-1.9	-1.3	-0.9
5	-1.2	-1.2	-1.2	-9.9	-11.9	-13.6	-19.0	-19.6	-14.9	-2.6	-1.8	-1.2
6	-1.6	-1.6	-1.6	-1.6	-2.0	-4.7	-6.6	-7.0	-5.1	-3.5	-2.3	-1.6
7	-0.6	-0.6	-0.6	-1.5	-1.8	-4.8	-6.5	-6.7	-5.2	-1.3	-0.8	-0.6
8	-0.5	-0.5	-0.5	-5.9	-7.0	-6.5	-9.2	-9.5	-7.2	-1.1	-0.7	-0.5
9	0.0	0.0	0.0	-14.0	-16.6	-15.5	-21.5	-22.0	-17.1	0.0	0.0	0.0
10	-0.2	-0.2	-0.2	-0.2	-0.2	-0.6	-0.8	-0.9	-0.6	-0.4	-0.3	-0.2
11	-0.9	-0.9	-0.9	-0.9	-1.1	-2.6	-3.7	-3.9	-2.8	-1.9	-1.3	-0.9
12	0.0	0.0	0.0	-0.2	-0.2	-0.2	-0.3	-0.3	-0.2	0.0	0.0	0.0
13	-0.1	-0.1	-0.1	-0.4	-0.5	-0.6	-0.9	-0.9	-0.7	-0.3	-0.2	-0.1
14	0.0	0.0	0.0	-0.6	-0.7	-0.6	-0.8	-0.9	-0.7	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 10.20. Return daily average flow by reach, used for Adequate water years.

Reach	Daily Flow Return Rate, in cfs, by month, for M&I and Ag Demands that can be supported.											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1b	-5.7	-5.7	-5.7	-53.9	-64.4	-130.2	-174.8	-179.3	-141.5	-12.8	-8.5	-5.7
1c	-1.4	-1.4	-1.4	-6.8	-8.1	-9.8	-13.8	-14.3	-10.8	-3.1	-2.1	-1.4
2	-0.4	-0.4	-0.4	-0.5	-0.6	-1.8	-2.4	-2.6	-1.9	-0.9	-0.6	-0.4
3	-0.9	-0.9	-0.9	-34.6	-41.2	-34.3	-48.6	-49.9	-38.1	-2.1	-1.4	-0.9
4	-0.7	-0.7	-0.7	-2.7	-3.3	-5.6	-7.7	-8.0	-6.1	-1.7	-1.1	-0.7
5	-1.0	-1.0	-1.0	-9.8	-11.7	-12.9	-18.0	-18.6	-14.2	-2.3	-1.5	-1.0
6	-1.3	-1.3	-1.3	-1.4	-1.7	-4.0	-5.7	-6.0	-4.4	-3.0	-2.0	-1.3
7	-0.5	-0.5	-0.5	-1.4	-1.7	-4.3	-5.8	-6.0	-4.6	-1.1	-0.7	-0.5
8	-0.4	-0.4	-0.4	-5.8	-6.9	-6.3	-9.0	-9.2	-7.0	-1.0	-0.6	-0.4
9	0.0	0.0	0.0	-14.0	-16.6	-15.1	-21.1	-21.6	-16.7	0.0	0.0	0.0
10	-0.2	-0.2	-0.2	-0.2	-0.2	-0.5	-0.7	-0.7	-0.5	-0.4	-0.2	-0.2
11	-0.7	-0.7	-0.7	-0.8	-1.0	-2.2	-3.2	-3.4	-2.4	-1.6	-1.1	-0.7
12	0.0	0.0	0.0	-0.2	-0.2	-0.2	-0.3	-0.3	-0.2	0.0	0.0	0.0
13	-0.1	-0.1	-0.1	-0.4	-0.5	-0.6	-0.8	-0.8	-0.6	-0.2	-0.2	-0.1
14	0.0	0.0	0.0	-0.6	-0.7	-0.6	-0.8	-0.8	-0.6	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 10.21. Return daily average flow by reach, used for Insufficient water years.

Reach	Daily Flow Return Rate, in cfs, by month, for M&I and Ag Demands that can be supported.											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1b	-4.6	-4.6	-4.6	-52.8	-63.0	-123.9	-167.6	-171.8	-135.0	-10.3	-6.8	-4.6
1c	-1.1	-1.1	-1.1	-6.5	-7.8	-8.9	-12.6	-13.0	-9.8	-2.5	-1.7	-1.1
2	-0.3	-0.3	-0.3	-0.4	-0.5	-1.5	-2.1	-2.2	-1.7	-0.7	-0.5	-0.3
3	-0.8	-0.8	-0.8	-34.4	-40.9	-33.7	-47.8	-49.0	-37.4	-1.7	-1.1	-0.8
4	-0.6	-0.6	-0.6	-2.6	-3.1	-4.8	-6.7	-6.9	-5.3	-1.3	-0.9	-0.6
5	-0.8	-0.8	-0.8	-9.6	-11.4	-12.0	-16.8	-17.3	-13.2	-1.8	-1.2	-0.8
6	-1.1	-1.1	-1.1	-1.1	-1.4	-3.2	-4.6	-4.8	-3.5	-2.4	-1.6	-1.1
7	-0.4	-0.4	-0.4	-1.3	-1.6	-3.6	-4.9	-5.1	-3.9	-0.9	-0.6	-0.4
8	-0.3	-0.3	-0.3	-5.7	-6.8	-6.1	-8.6	-8.9	-6.7	-0.8	-0.5	-0.3
9	0.0	0.0	0.0	-14.0	-16.6	-14.6	-20.6	-21.0	-16.2	0.0	0.0	0.0
10	-0.1	-0.1	-0.1	-0.1	-0.2	-0.4	-0.6	-0.6	-0.4	-0.3	-0.2	-0.1
11	-0.6	-0.6	-0.6	-0.6	-0.8	-1.8	-2.6	-2.7	-2.0	-1.3	-0.9	-0.6
12	0.0	0.0	0.0	-0.2	-0.2	-0.2	-0.3	-0.3	-0.2	0.0	0.0	0.0
13	-0.1	-0.1	-0.1	-0.4	-0.4	-0.5	-0.7	-0.7	-0.6	-0.2	-0.1	-0.1
14	0.0	0.0	0.0	-0.6	-0.7	-0.6	-0.8	-0.8	-0.6	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

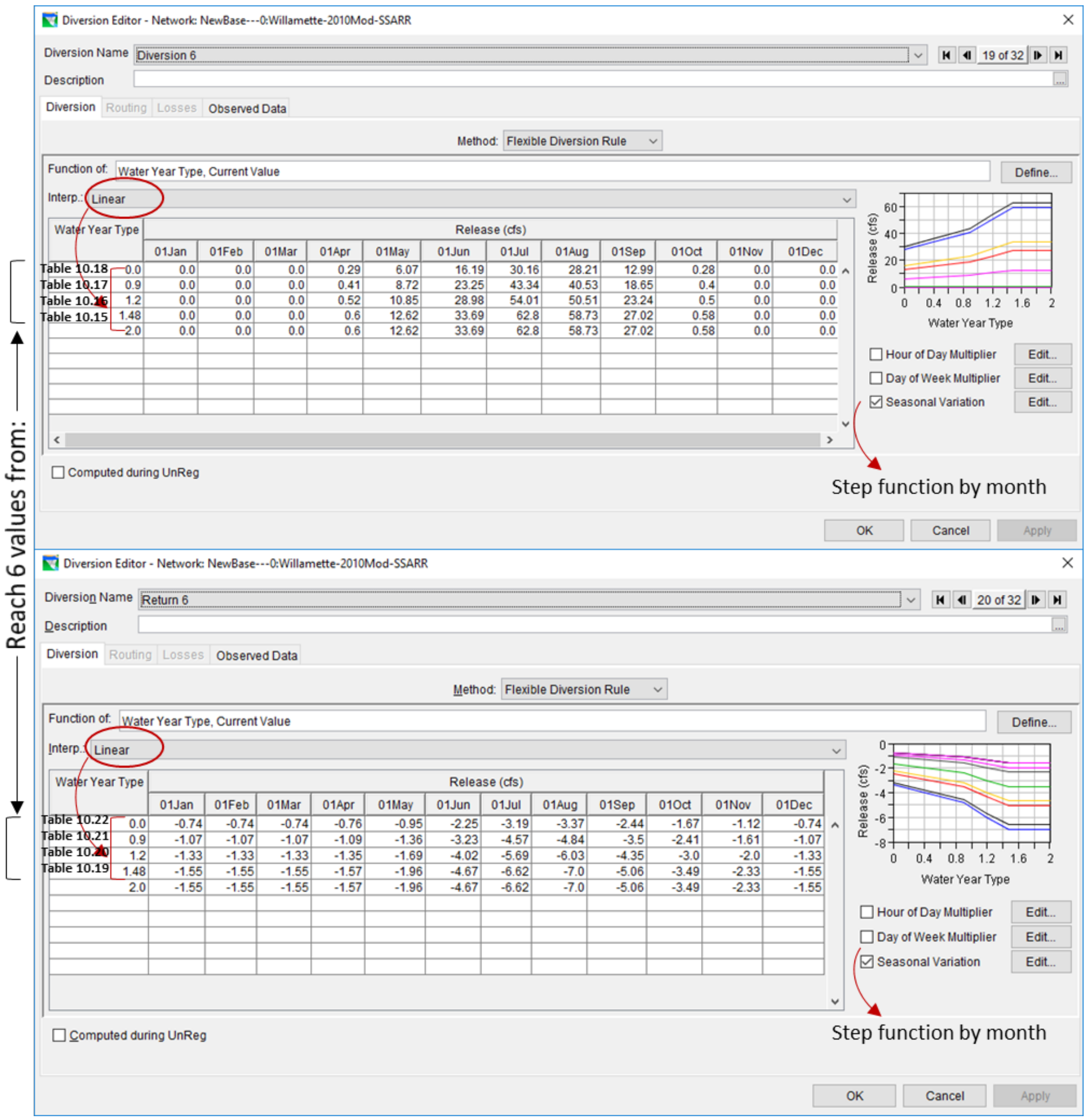
Table 10.22. Return daily average flow by reach, used for Deficit water years.

Reach	Daily Flow Return Rate, in cfs, by month, for M&I and Ag Demands that can be supported.											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1b	-3.2	-3.2	-3.2	-51.4	-61.3	-116.0	-158.7	-162.6	-127.0	-7.1	-4.8	-3.2
1c	-0.8	-0.8	-0.8	-6.2	-7.4	-7.8	-11.0	-11.4	-8.6	-1.7	-1.2	-0.8
2	-0.2	-0.2	-0.2	-0.3	-0.4	-1.2	-1.7	-1.8	-1.3	-0.5	-0.3	-0.2
3	-0.5	-0.5	-0.5	-34.2	-40.6	-32.9	-46.7	-47.8	-36.5	-1.2	-0.8	-0.5
4	-0.4	-0.4	-0.4	-2.4	-2.9	-3.9	-5.4	-5.6	-4.3	-0.9	-0.6	-0.4
5	-0.6	-0.6	-0.6	-9.3	-11.1	-10.9	-15.4	-15.8	-12.1	-1.3	-0.8	-0.6
6	-0.7	-0.7	-0.7	-0.8	-0.9	-2.2	-3.2	-3.4	-2.4	-1.7	-1.1	-0.7
7	-0.3	-0.3	-0.3	-1.2	-1.5	-2.8	-3.8	-3.9	-3.0	-0.6	-0.4	-0.3
8	-0.2	-0.2	-0.2	-5.6	-6.7	-5.8	-8.2	-8.4	-6.4	-0.5	-0.4	-0.2
9	0.0	0.0	0.0	-14.0	-16.6	-14.1	-19.9	-20.4	-15.6	0.0	0.0	0.0
10	-0.1	-0.1	-0.1	-0.1	-0.1	-0.3	-0.4	-0.4	-0.3	-0.2	-0.1	-0.1
11	-0.4	-0.4	-0.4	-0.5	-0.6	-1.3	-1.8	-1.9	-1.4	-0.9	-0.6	-0.4
12	0.0	0.0	0.0	-0.2	-0.2	-0.2	-0.3	-0.3	-0.2	0.0	0.0	0.0
13	-0.1	-0.1	-0.1	-0.3	-0.4	-0.4	-0.6	-0.6	-0.5	-0.1	-0.1	-0.1
14	0.0	0.0	0.0	-0.6	-0.7	-0.6	-0.8	-0.8	-0.6	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

10.1.6 Diversion Rule Example

The final flow specifications for the diversion withdrawals (Tables 10.15 to 10.18) and the diversion return flows (Tables 10.19 to 10.22) were input to ResSim with flexible diversion rules for each reach. Figure 10.1 is an example of the withdrawal and return flow rules for Reach 6, noting which tables were used for each water year type volume entry. The water year types are defined in Appendix E, Table 2.4. Rules for all diversions specified in Table 3.6 are applied in the same way.

Figure 10.1. Reach 6 Diversion Rules: at top is the withdrawal rule (Diversion Name = Diversion 6) and at bottom is the return flow rule (Diversion Name = Return 6). Note that flow rate is calculated based on a linear interpolation of the water year type volume and a step function by month. Entries for flow rates are annotated at left edge of figure for table reference number.



Diversion 6 — Release (cfs)

	Water Year Type	01Jan	01Feb	01Mar	01Apr	01May	01Jun	01Jul	01Aug	01Sep	01Oct	01Nov	01Dec
Table 10.18	0.0	0.0	0.0	0.0	0.29	6.07	16.19	30.16	28.21	12.99	0.28	0.0	0.0
Table 10.17	0.9	0.0	0.0	0.0	0.41	8.72	23.25	43.34	40.53	18.65	0.4	0.0	0.0
Table 10.16	1.2	0.0	0.0	0.0	0.52	10.85	28.98	54.01	50.51	23.24	0.5	0.0	0.0
Table 10.15	1.48	0.0	0.0	0.0	0.6	12.62	33.69	62.8	58.73	27.02	0.58	0.0	0.0
	2.0	0.0	0.0	0.0	0.6	12.62	33.69	62.8	58.73	27.02	0.58	0.0	0.0

Return 6 — Release (cfs)

	Water Year Type	01Jan	01Feb	01Mar	01Apr	01May	01Jun	01Jul	01Aug	01Sep	01Oct	01Nov	01Dec
Table 10.22	0.0	-0.74	-0.74	-0.74	-0.76	-0.95	-2.25	-3.19	-3.37	-2.44	-1.67	-1.12	-0.74
Table 10.21	0.9	-1.07	-1.07	-1.07	-1.09	-1.36	-3.23	-4.57	-4.84	-3.5	-2.41	-1.61	-1.07
Table 10.20	1.2	-1.33	-1.33	-1.33	-1.35	-1.69	-4.02	-5.69	-6.03	-4.35	-3.0	-2.0	-1.33
Table 10.19	1.48	-1.55	-1.55	-1.55	-1.57	-1.96	-4.67	-6.62	-7.0	-5.06	-3.49	-2.33	-1.55
	2.0	-1.55	-1.55	-1.55	-1.57	-1.96	-4.67	-6.62	-7.0	-5.06	-3.49	-2.33	-1.55

10.2 ResSim Rule Changes

The development of the additional reservoir releases follows the same steps as described in Section 7.2, using each reservoir's percentage of total conservation storage from Table 7.23 and the project share distributions from Table 7.24. (See Table 10.23.) The increased releases were added to the minimum releases specified for the Baseline (Appendices E). The project specific releases are shown in Tables 10.24 through 10.34. Each project's minimum release rule in the conservation zone is dependent on the water year type, while each project's minimum release in the buffer zone is specified as the Deficit year minimum from the tables. (See Section 5 for more details on the project minimum release rules.)

Table 10.23. Project flow contributions to meet increased demands, Expected No Action 2070.

Month	Project's release to meet increased share of demand in all reaches, in cfs, Abundant years										
	HCR	LOP	CGR	GPR	FOS	DET	FAL	COT	DOR	BLU	FRN
Apr	0.68	1.14	0.50	0.91	0.09	1.11	0.33	0.10	0.22	0.29	0.84
May	14.32	23.86	10.46	19.05	1.89	23.18	6.92	1.99	4.51	6.03	17.60
Jun	64.36	107.22	45.30	84.05	8.34	96.34	33.62	9.16	20.73	26.11	58.49
Jul	102.96	171.52	73.42	135.25	13.42	158.12	52.81	14.58	32.98	42.31	101.90
Aug	98.84	164.66	70.40	129.76	12.88	151.38	50.87	14.01	31.69	40.57	96.46
Sep	58.45	97.37	40.96	76.14	7.56	86.55	30.93	8.36	18.90	23.60	49.99
Oct	0.66	1.10	0.48	0.88	0.09	1.07	0.32	0.09	0.21	0.28	0.81
Month	Project's release to meet increased share of demand in all reaches, in cfs, Adequate years										
	HCR	LOP	CGR	GPR	FOS	DET	FAL	COT	DOR	BLU	FRN
Apr	0.59	0.98	0.43	0.78	0.08	0.95	0.28	0.08	0.19	0.25	0.72
May	12.32	20.52	9.00	16.38	1.63	19.93	5.95	1.71	3.88	5.18	15.13
Jun	57.57	95.91	40.53	75.17	7.46	86.11	30.21	8.21	18.57	23.36	51.38
Jul	91.59	152.59	65.30	120.28	11.94	140.45	47.19	12.99	29.38	37.63	89.12
Aug	88.12	146.81	62.75	115.65	11.48	134.76	45.56	12.51	28.30	36.16	84.47
Sep	52.74	87.86	36.97	68.69	6.82	78.05	28.03	7.55	17.07	21.30	44.19
Oct	0.57	0.95	0.42	0.76	0.08	0.92	0.28	0.08	0.18	0.24	0.70
Month	Project's release to meet increased share of demand in all reaches, in cfs, Insufficient years										
	HCR	LOP	CGR	GPR	FOS	DET	FAL	COT	DOR	BLU	FRN
Apr	0.47	0.79	0.34	0.63	0.06	0.76	0.23	0.07	0.15	0.20	0.58
May	9.88	16.46	7.22	13.14	1.30	15.99	4.78	1.38	3.11	4.16	12.14
Jun	49.33	82.18	34.74	64.39	6.39	73.68	26.06	7.05	15.94	20.02	42.75
Jul	77.80	129.61	55.43	102.10	10.13	118.99	40.36	11.06	25.01	31.94	73.59
Aug	75.12	125.14	53.46	98.52	9.78	114.58	39.11	10.69	24.17	30.81	69.91
Sep	45.80	76.30	32.13	59.65	5.92	67.73	24.52	6.57	14.86	18.51	37.15
Oct	0.46	0.76	0.33	0.61	0.06	0.74	0.22	0.06	0.14	0.19	0.56
Month	Project's release to meet increased share of demand in all reaches, in cfs, Deficit years										
	HCR	LOP	CGR	GPR	FOS	DET	FAL	COT	DOR	BLU	FRN
Apr	0.33	0.55	0.24	0.44	0.04	0.53	0.16	0.05	0.10	0.14	0.40
May	6.87	11.45	5.02	9.14	0.91	11.12	3.32	0.96	2.17	2.89	8.45
Jun	39.15	65.22	27.58	51.07	5.07	58.33	20.93	5.62	12.70	15.89	32.09
Jul	60.75	101.21	43.25	79.64	7.90	92.49	31.92	8.67	19.60	24.92	54.42
Aug	59.05	98.37	41.99	77.36	7.68	89.65	31.15	8.43	19.07	24.20	51.93
Sep	37.23	62.03	26.15	48.47	4.81	54.98	20.17	5.36	12.12	15.07	28.45
Oct	0.32	0.53	0.23	0.42	0.04	0.51	0.15	0.04	0.10	0.13	0.39

Table 10.24. Minimum project releases for the BiOp and BOR contracts for Blue River.

	Minimum Project Release, in cfs											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
BiOp*	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
2008-2070												
Deficit	0.00	0.00	0.00	0.14	2.89	15.89	24.92	24.20	15.07	0.13	0.00	0.00
Insufficient	0.00	0.00	0.00	0.20	4.16	20.02	31.94	30.81	18.51	0.19	0.00	0.00
Adequate	0.00	0.00	0.00	0.25	5.18	23.36	37.63	36.16	21.30	0.24	0.00	0.00
Abundant	0.00	0.00	0.00	0.29	6.03	26.11	42.31	40.57	23.60	0.28	0.00	0.00
Total												
Deficit	50.00	50.00	50.00	50.14	52.89	65.89	74.92	74.20	65.07	50.13	50.00	50.00
Insufficient	50.00	50.00	50.00	50.20	54.16	70.02	81.94	80.81	68.51	50.19	50.00	50.00
Adequate	50.00	50.00	50.00	50.25	55.18	73.36	87.63	86.16	71.30	50.24	50.00	50.00
Abundant	50.00	50.00	50.00	50.29	56.03	76.11	92.31	90.57	73.60	50.28	50.00	50.00

*Note: "BiOp" means the BiOp minimum tributary flow target for this project.

Table 10.25. Minimum project releases for the BiOp and BOR contracts for Cougar.

	Minimum Project Release, in cfs											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
BiOp*	300.0	300.0	300.0	300.0	300.0	400.0	300.0	300.0	300.0	300.0	300.0	300.0
2008-2070												
Deficit	0.00	0.00	0.00	0.24	5.02	27.58	43.25	41.99	26.15	0.23	0.00	0.00
Insufficient	0.00	0.00	0.00	0.34	7.22	34.74	55.43	53.46	32.13	0.33	0.00	0.00
Adequate	0.00	0.00	0.00	0.43	9.00	40.53	65.30	62.75	36.97	0.42	0.00	0.00
Abundant	0.00	0.00	0.00	0.50	10.46	45.30	73.42	70.40	40.96	0.48	0.00	0.00
Total												
Deficit	400.0	400.0	400.0	400.0	400.0	427.6	400.0	400.0	400.0	400.0	400.0	400.0
Insufficient	400.0	400.0	400.0	400.0	400.0	434.7	400.0	400.0	400.0	400.0	400.0	400.0
Adequate	400.0	400.0	400.0	400.0	400.0	440.5	400.0	400.0	400.0	400.0	400.0	400.0
Abundant	400.0	400.0	400.0	400.0	400.0	445.3	400.0	400.0	400.0	400.0	400.0	400.0

*Note: "BiOp" means the BiOp minimum tributary flow target for this project. While this minimum value is 300 cfs most of the time, the minimum turbine flow without causing cavitation is higher than 300 cfs, so 400 cfs is used for the minimum release most of the time. If the increased project release to cover the downstream BOR contracts plus the 300 cfs BiOp min is still less than 400 cfs, the project will still just release 400 cfs as a minimum.

Table 10.26. Minimum project releases for the BiOp and BOR contracts for Dorena.

	Minimum Project Release, in cfs											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
BiOp*	100.0	190.0	190.0	190.0	190.0	190.0	100.0	100.0	100.0	100.0	100.0	100.0
2008-2070												
Deficit	0.00	0.00	0.00	0.10	2.17	12.70	19.60	19.07	12.12	0.10	0.00	0.00
Insufficient	0.00	0.00	0.00	0.15	3.11	15.94	25.01	24.17	14.86	0.14	0.00	0.00
Adequate	0.00	0.00	0.00	0.19	3.88	18.57	29.38	28.30	17.07	0.18	0.00	0.00
Abundant	0.00	0.00	0.00	0.22	4.51	20.73	32.98	31.69	18.90	0.21	0.00	0.00
Total												
Deficit	100.0	190.0	190.0	190.1	192.2	202.7	119.6	119.1	112.1	100.1	100.0	100.0
Insufficient	100.0	190.0	190.0	190.1	193.1	205.9	125.0	124.2	114.9	100.1	100.0	100.0
Adequate	100.0	190.0	190.0	190.2	193.9	208.6	129.4	128.3	117.1	100.2	100.0	100.0
Abundant	100.0	190.0	190.0	190.2	194.5	210.7	133.0	131.7	118.9	100.2	100.0	100.0

*Note: "BiOp" means the BiOp minimum tributary flow target for this project.

Table 10.27. Minimum project releases for the BiOp and BOR contracts for Cottage Grove.

	Minimum Project Release, in cfs											
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
BiOp*	50.0	75.0	75.0	75.0	75.0	75.0	50.0	50.0	50.0	50.0	50.0	50.0
2008-2070												
Deficit	0.00	0.00	0.00	0.05	0.96	5.62	8.67	8.43	5.36	0.04	0.00	0.00
Insufficient	0.00	0.00	0.00	0.07	1.38	7.05	11.06	10.69	6.57	0.06	0.00	0.00
Adequate	0.00	0.00	0.00	0.08	1.71	8.21	12.99	12.51	7.55	0.08	0.00	0.00
Abundant	0.00	0.00	0.00	0.10	1.99	9.16	14.58	14.01	8.36	0.09	0.00	0.00
Total												
Deficit	50.00	75.00	75.00	75.05	75.96	80.62	58.67	58.43	55.36	50.04	50.00	50.00
Insufficient	50.00	75.00	75.00	75.07	76.38	82.05	61.06	60.69	56.57	50.06	50.00	50.00
Adequate	50.00	75.00	75.00	75.08	76.71	83.21	62.99	62.51	57.55	50.08	50.00	50.00
Abundant	50.00	75.00	75.00	75.10	76.99	84.16	64.58	64.01	58.36	50.09	50.00	50.00

*Note: “BiOp” means the BiOp minimum tributary flow target for this project.

Table 10.28. Minimum project releases for the BiOp and BOR contracts for Fall Creek.

	Minimum Project Release, in cfs											
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**1Oct**	**16Oct**	**Nov/Dec**
BiOp*	50.0	50.0	50.0	80.0	80.0	80.0	80.0	80.0	200.0	200.0	50.0	50.0
2008-2070												
Deficit	0.00	0.00	0.00	0.16	3.32	20.93	31.92	31.15	20.17	0.15	0.15	0.00
Insufficient	0.00	0.00	0.00	0.23	4.78	26.06	40.36	39.11	24.52	0.22	0.22	0.00
Adequate	0.00	0.00	0.00	0.28	5.95	30.21	47.19	45.56	28.03	0.28	0.28	0.00
Abundant	0.00	0.00	0.00	0.33	6.92	33.62	52.81	50.87	30.93	0.32	0.32	0.00
Total												
Deficit	50.00	50.00	50.00	80.16	83.32	100.93	111.92	111.15	220.17	200.15	50.15	50.00
Insufficient	50.00	50.00	50.00	80.23	84.78	106.06	120.36	119.11	224.52	200.22	50.22	50.00
Adequate	50.00	50.00	50.00	80.28	85.95	110.21	127.19	125.56	228.03	200.28	50.28	50.00
Abundant	50.00	50.00	50.00	80.33	86.92	113.62	132.81	130.87	230.93	200.32	50.32	50.00

*Note: “BiOp” means the BiOp minimum tributary flow target for this project.

Table 10.29. Minimum project releases for the BiOp and BOR contracts for Hills Creek.

	Minimum Project Release, in cfs											
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
BiOp*	400.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0
2008-2070												
Deficit	0.00	0.00	0.00	0.33	6.87	39.15	60.75	59.05	37.23	0.32	0.00	0.00
Insufficient	0.00	0.00	0.00	0.47	9.88	49.33	77.80	75.12	45.80	0.46	0.00	0.00
Adequate	0.00	0.00	0.00	0.59	12.32	57.57	91.59	88.12	52.74	0.57	0.00	0.00
Abundant	0.00	0.00	0.00	0.68	14.32	64.36	102.96	98.84	58.45	0.66	0.00	0.00
Total												
Deficit	400.0	400.0	400.0	400.3	406.9	439.1	460.8	459.0	437.2	400.3	400.0	400.0
Insufficient	400.0	400.0	400.0	400.5	409.9	449.3	477.8	475.1	445.8	400.5	400.0	400.0
Adequate	400.0	400.0	400.0	400.6	412.3	457.6	491.6	488.1	452.7	400.6	400.0	400.0
Abundant	400.0	400.0	400.0	400.7	414.3	464.4	503.0	498.8	458.4	400.7	400.0	400.0

*Note: “BiOp” means the BiOp minimum tributary flow target for this project.

Table 10.30. Minimum project releases for the BiOp and BOR contracts for Lookout Point.

	Minimum Project Release, in cfs											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
BiOp*	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200
HCR share 2008-2070												
Deficit	0.00	0.00	0.00	0.33	6.87	39.15	60.75	59.05	37.23	0.32	0.00	0.00
Insufficient	0.00	0.00	0.00	0.47	9.88	49.33	77.80	75.12	45.80	0.46	0.00	0.00
Adequate	0.00	0.00	0.00	0.59	12.32	57.57	91.59	88.12	52.74	0.57	0.00	0.00
Abundant	0.00	0.00	0.00	0.68	14.32	64.36	102.96	98.84	58.45	0.66	0.00	0.00
LOP share 2008-2070												
Deficit	0.00	0.00	0.00	0.55	11.45	65.22	101.21	98.37	62.03	0.53	0.00	0.00
Insufficient	0.00	0.00	0.00	0.79	16.46	82.18	129.61	125.14	76.30	0.76	0.00	0.00
Adequate	0.00	0.00	0.00	0.98	20.52	95.91	152.59	146.81	87.86	0.95	0.00	0.00
Abundant	0.00	0.00	0.00	1.14	23.86	107.22	171.52	164.66	97.37	1.10	0.00	0.00
Total												
Deficit	1200	1200	1200	1201	1218	1304	1362	1357	1299	1201	1200	1200
Insufficient	1200	1200	1200	1201	1226	1332	1407	1400	1322	1201	1200	1200
Adequate	1200	1200	1200	1202	1233	1353	1444	1435	1341	1202	1200	1200
Abundant	1200	1200	1200	1202	1238	1372	1474	1463	1356	1202	1200	1200

*Note: “BiOp” means the BiOp minimum tributary flow target for this project.
Minimum release must also include Hills Creek share.

Table 10.31. Minimum project releases for the BiOp and BOR contracts for Fern Ridge.

	Minimum Project Release, in cfs											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
BiOp*	30.00	50.00	50.00	50.00	50.00	50.00	30.00	30.00	30.00	30.00	30.00	30.00
Baseline (2008)												
Deficit	0.00	0.00	0.00	0.00	25.11	51.74	82.63	66.00	33.93	0.00	0.00	0.00
Insufficient	0.00	0.00	0.00	0.00	25.11	51.74	82.63	66.00	33.93	0.00	0.00	0.00
Adequate	0.00	0.00	0.00	0.00	25.11	51.74	82.63	66.00	33.93	0.00	0.00	0.00
Abundant	0.00	0.00	0.00	0.00	25.11	51.74	82.63	66.00	33.93	0.00	0.00	0.00
2008-2070												
Deficit	0.00	0.00	0.00	0.40	8.45	32.09	54.42	51.93	28.45	0.39	0.00	0.00
Insufficient	0.00	0.00	0.00	0.58	12.14	42.75	73.59	69.91	37.15	0.56	0.00	0.00
Adequate	0.00	0.00	0.00	0.72	15.13	51.38	89.12	84.47	44.19	0.70	0.00	0.00
Abundant	0.00	0.00	0.00	0.84	17.60	58.49	101.90	96.46	49.99	0.81	0.00	0.00
Total**												
Deficit	30.00	50.00	50.00	50.40	83.56	133.83	167.05	147.93	92.38	30.39	30.00	30.00
Insufficient	30.00	50.00	50.00	50.58	87.25	144.50	186.23	165.91	101.08	30.56	30.00	30.00
Adequate	30.00	50.00	50.00	50.72	90.24	153.13	201.75	180.47	108.12	30.70	30.00	30.00
Abundant	30.00	50.00	50.00	50.84	92.71	160.24	214.54	192.46	113.92	30.81	30.00	30.00

*Note: “BiOp” means the BiOp minimum tributary flow target for this project.
**Total outflow minimum from Fern Ridge includes BOR contracts in 2008 as well as the additional contracts after 2008.

Table 10.32. Minimum project releases for the BiOp and BOR contracts for Green Peter.

	Minimum Project Release, in cfs								
	Apr	**1 May**	**16 May**	**Jun**	**Jul**	**Aug**	**Sep**	**1 Oct**	**16 Oct**
BiOp*	1500	1500	1100	1100	800	800	1500	1100	1500
2008-2070									
Deficit	0.44	9.14	9.14	51.07	79.64	77.36	48.47	0.42	0.42
Insufficient	0.63	13.14	13.14	64.39	102.10	98.52	59.65	0.61	0.61
Adequate	0.78	16.38	16.38	75.17	120.28	115.65	68.69	0.76	0.76
Abundant	0.91	19.05	19.05	84.05	135.25	129.76	76.14	0.88	0.88
Total**									
Deficit	1500.48	1510.05	1110.05	1156.14	887.55	885.03	1553.28	1500.46	1100.46
Insufficient	1500.69	1514.45	1114.45	1170.78	912.23	908.29	1565.56	1500.67	1100.67
Adequate	1500.86	1518.01	1118.01	1182.63	932.21	927.13	1575.51	1500.83	1100.83
Abundant	1501.00	1520.94	1120.94	1192.39	948.67	942.63	1583.70	1500.97	1100.97

*Note: "BiOp" means the BiOp minimum tributary flow target for this project. This is the flow required out of Foster.

**Total outflow minimum from Green Peter uses the Foster minimum flows, from next table.

Minimum Flows for months not shown are all BiOp minimums: Jan = 1100 cfs, Feb = 800 cfs, 1 Mar = 800 cfs, 16 Mar = 1500 cfs, Nov = 1100 cfs, Dec = 1100 cfs.

Table 10.33. Minimum project releases for the BiOp and BOR contracts for Foster.

	Minimum Project Release, in cfs								
	Apr	**1 May**	**16 May**	**Jun**	**Jul**	**Aug**	**Sep**	**1 Oct**	**16 Oct**
BiOp*	1500	1500	1100	1100	800	800	1500	1100	1500
2008-2070									
Deficit	0.04	0.91	0.91	5.07	7.90	7.68	4.81	0.04	0.04
Insufficient	0.06	1.30	1.30	6.39	10.13	9.78	5.92	0.06	0.06
Adequate	0.08	1.63	1.63	7.46	11.94	11.48	6.82	0.08	0.08
Abundant	0.09	1.89	1.89	8.34	13.42	12.88	7.56	0.09	0.09
GPR 2008-2070									
Deficit	0.44	9.14	9.14	51.07	79.64	77.36	48.47	0.42	0.42
Insufficient	0.63	13.14	13.14	64.39	102.10	98.52	59.65	0.61	0.61
Adequate	0.78	16.38	16.38	75.17	120.28	115.65	68.69	0.76	0.76
Abundant	0.91	19.05	19.05	84.05	135.25	129.76	76.14	0.88	0.88
Total									
Deficit	1500.48	1510.05	1110.05	1156.14	887.55	885.03	1553.28	1500.46	1100.46
Insufficient	1500.69	1514.45	1114.45	1170.78	912.23	908.29	1565.56	1500.67	1100.67
Adequate	1500.86	1518.01	1118.01	1182.63	932.21	927.13	1575.51	1500.83	1100.83
Abundant	1501.00	1520.94	1120.94	1192.39	948.67	942.63	1583.70	1500.97	1100.97

*Note: "BiOp" means the BiOp minimum tributary flow target for this project.

Minimum Flows for months not shown are all BiOp minimums: Jan = 1100 cfs, Feb = 800 cfs, 1 Mar = 800 cfs, 16 Mar = 1500 cfs, Nov = 1100 cfs, Dec = 1100 cfs.

Table 10.34. Minimum project releases for the BiOp and BOR contracts for Detroit.

	Minimum Project Release, in cfs								
	Apr	**May**	**Jun**	**1 Jul**	**15 Jul**	**Aug**	**Sep**	**1 Oct**	**16 Oct**
BiOp*	1500	1500	1200	1200	1000	1000	1500	1500	1200
Baseline (2008)									
Deficit	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Insufficient	0.00	14.49	29.86	47.68	47.68	38.09	19.58	0.00	0.00
Adequate	0.00	14.49	29.86	47.68	47.68	38.09	19.58	0.00	0.00
Abundant	0.00	14.49	29.86	47.68	47.68	38.09	19.58	0.00	0.00
2008-2070									
Deficit	0.53	11.12	58.33	92.49	92.49	89.65	54.98	0.51	0.51
Insufficient	0.76	15.99	73.68	118.99	118.99	114.58	67.73	0.74	0.74
Adequate	0.95	19.93	86.11	140.45	140.45	134.76	78.05	0.92	0.92
Abundant	1.11	23.18	96.34	158.12	158.12	151.38	86.55	1.07	1.07
Total**									
Deficit	1500.53	1511.12	1258.33	1292.49	1092.49	1089.65	1554.98	1500.51	1200.51
Insufficient	1500.76	1530.48	1303.54	1366.68	1166.68	1152.67	1587.30	1500.74	1200.74
Adequate	1500.95	1534.42	1315.97	1388.14	1188.14	1172.85	1597.62	1500.92	1200.92
Abundant	1501.11	1537.67	1326.20	1405.81	1205.81	1189.47	1606.12	1501.07	1201.07

*Note: "BiOp" means the BiOp minimum tributary flow target for this project.

**Total outflow minimum from Detroit includes BOR contracts in 2008 as well as the additional contracts after 2008.

Minimum Flows for months not shown are all BiOp minimums: Jan = 1200 cfs, Feb = 1000 cfs, 1 Mar = 1000 cfs, 16 Mar = 1500 cfs, Nov = 1200 cfs, Dec = 1200 cfs.

10.3 Simulation Results

The Expected ARP 2070 pool elevation non-exceedance graphs for each storage project are shown in Figures 10.2 and 10.3. These non-exceedance graphs are described in detail in Section 16 of Appendix E, in particular Figure 16.1 of that Appendix.

The graphs in Figures 10.4a through 10.4c are period average flows at Salem for every year in the POR, color coded by water year type. The periods are monthly for April, May, July, September, and October, when the Salem BiOp minimum targets are constant over each of those months, and for half month periods for June and August, when the BiOp minimum targets change midway through those months. These graphs highlight the result that regulated Salem flows are often well above the target minimum values. The main Feasibility report documents the occurrences for regulated Salem flows being below minimum flow targets, but does not show the frequency that the regulated flows exceed the minimum flow targets. The period average flow values plotted in Figures 10.4a to 10.4c are listed in Table 10.35a for 1929 through 1970 and Table 10.35b for 1971 through 2008.

The regulated flows at Albany, Salem, and Oregon City above Willamette Falls are shown in Figures 10.4 through 10.6. In each figure, the non-exceedance percentiles of the regulated flows are shown in the top graph (with a blue background), and the remaining four graphs in each figure show the regulated flow for one water year of each type, using 1966 (Adequate), 1967 (Insufficient), 1968 (Deficit), and 1969 (Abundant). The flow targets at Albany and Salem are shown in Figures 10.4 and 10.5, respectively, for the wetter years (Abundant and Adequate) and for Deficit years. The targets shown in Figure 10.6 are Salem targets (shown as dashed lines) for comparison. There are no official BiOp flow minimum targets at Willamette Falls, but a flow equivalent to that at Salem is desirable.

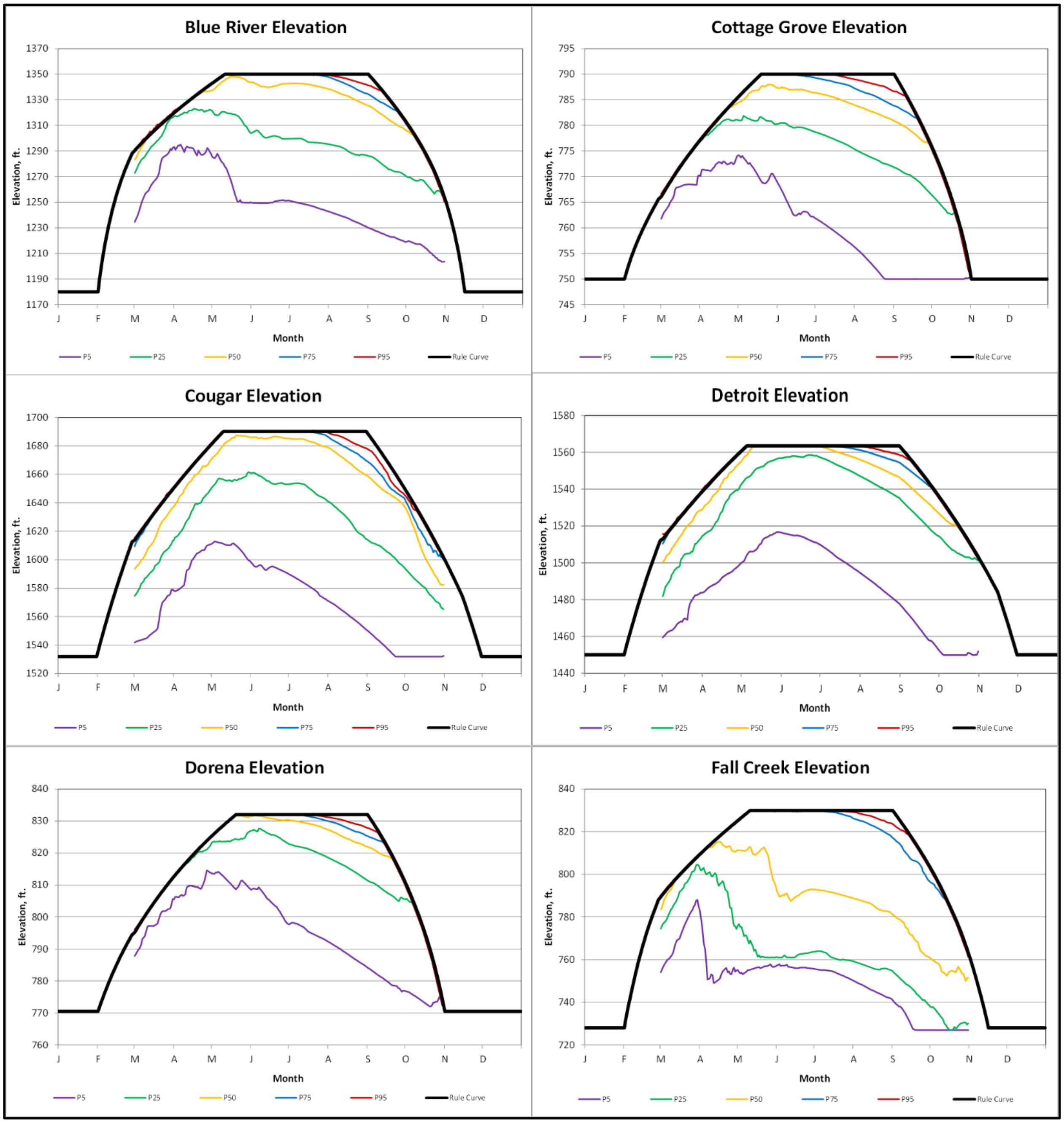


Figure 10.2. Pool elevation non-exceedance percentiles for the Expected ARP 2070 for Blue River, Cottage Grove, Cougar, Detroit, Dorena, and Fall Creek. See Figure 16.1 in Appendix E for non-exceedance value descriptions.

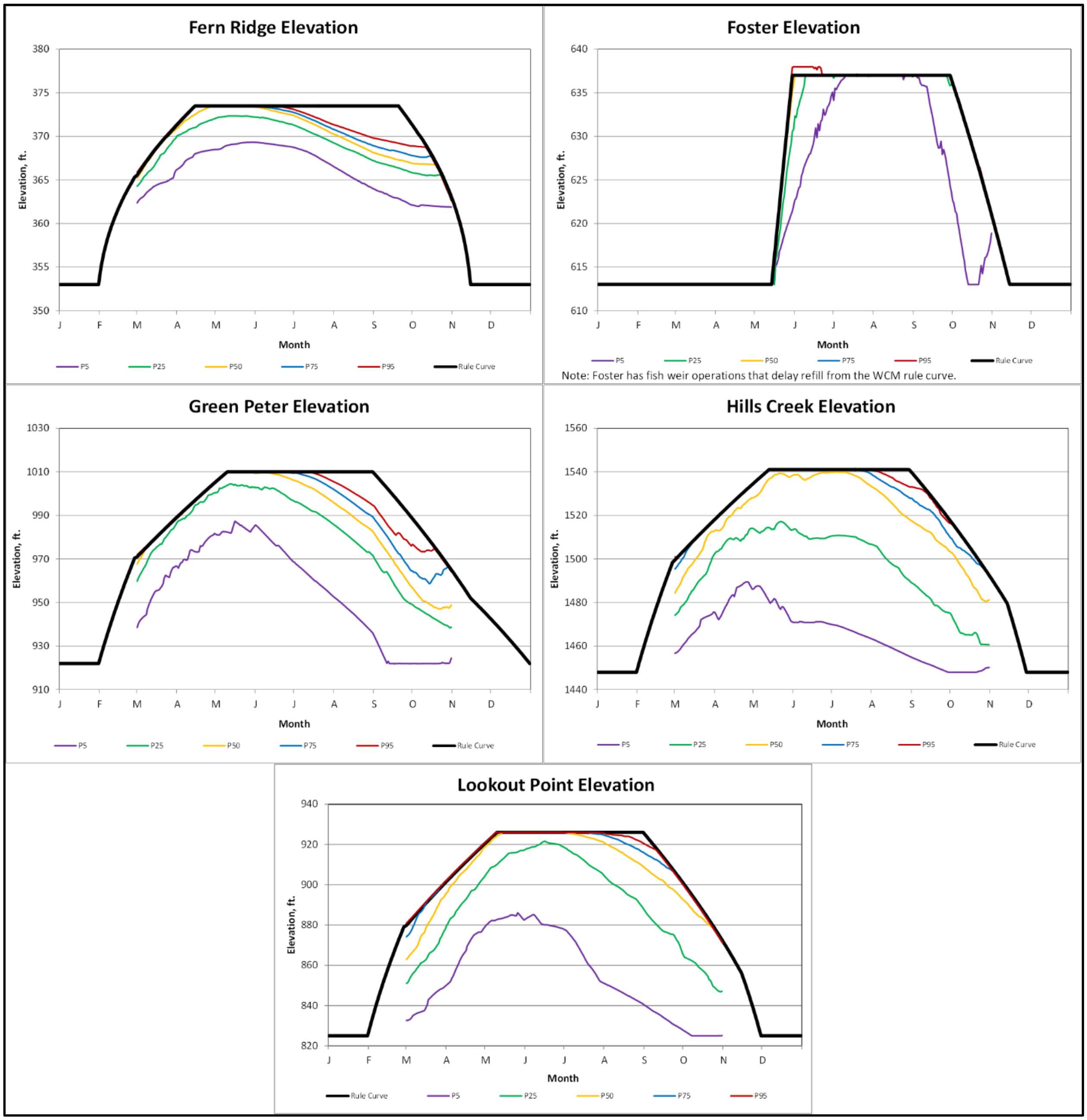
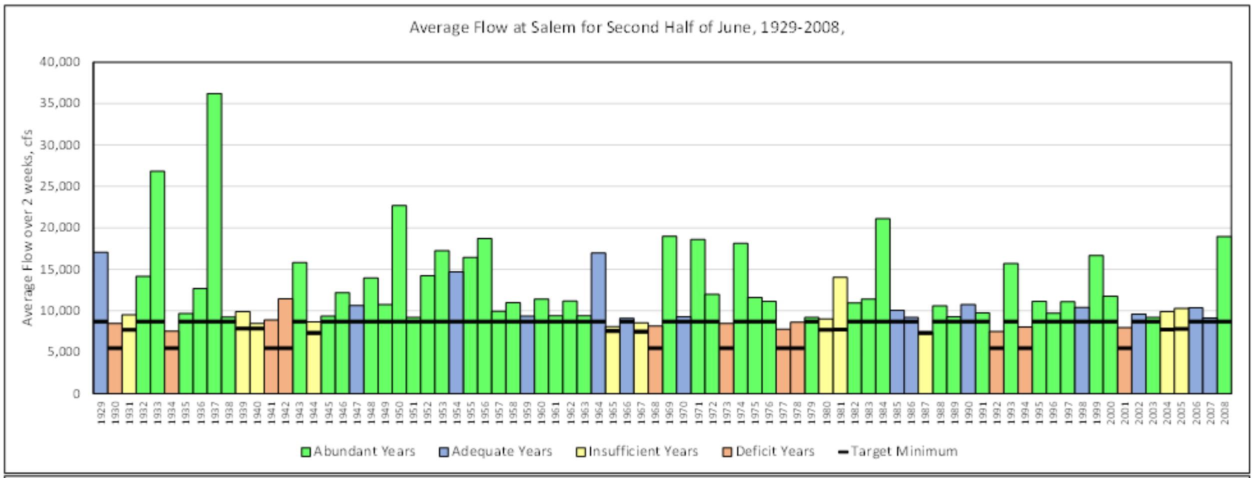


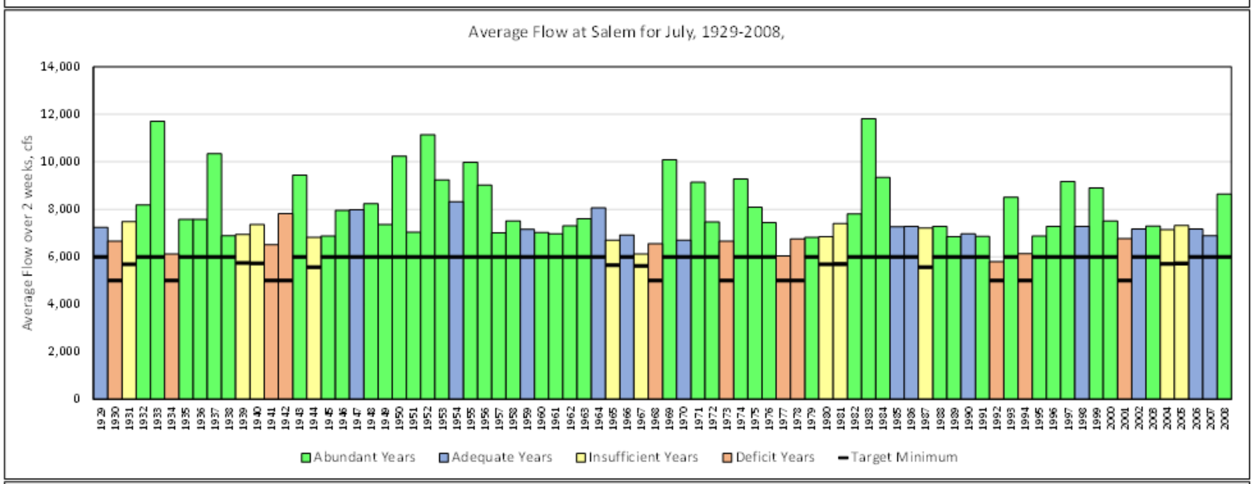
Figure 10.3. Pool elevation non-exceedance percentiles for the Expected ARP 2070 for Fern Ridge, Foster, Green Peter, Hills Creek, Fall Creek, and Lookout Point. See Figure 16.1 in Appendix E for non-exceedance value descriptions.

Expected ARP 2070, Period Average Flows at Salem

Figure 10.4a. Period average flows at Salem for all years in the POR for April (top), May (middle), and the first half of June (bottom), with flow target for that period and year shown as the solid black bar. Each year is color coded by water year type. Graphs show that Abundant water year average flows often significantly exceed the minimum flow targets at Salem while Deficit year average flows can miss the target. Adequate and Insufficient water years fall in between.

Expected ARP 2070, Period Average Flows at Salem





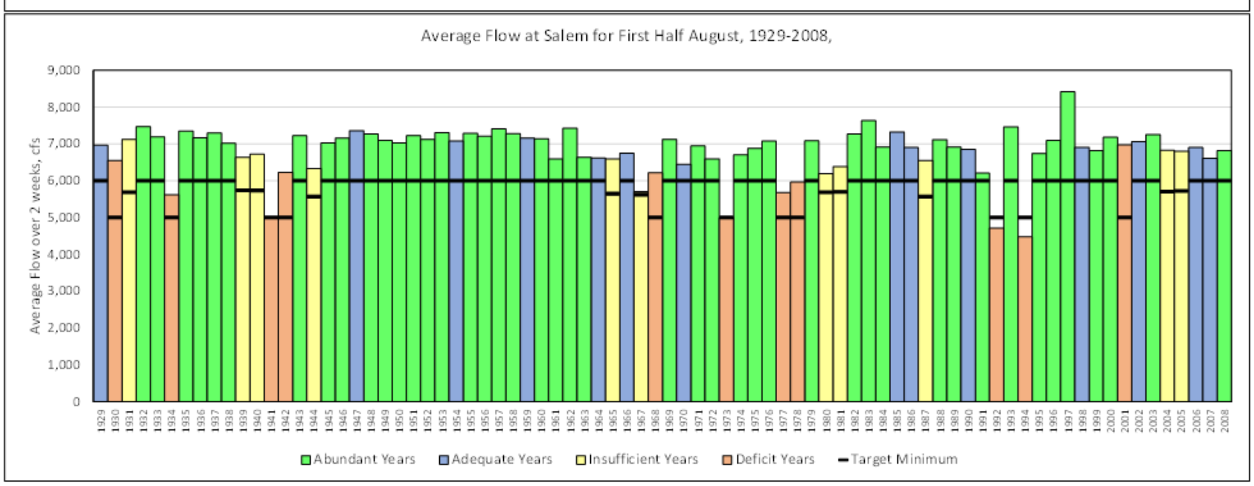


Figure 10.4b. Period average flows at Salem for all years in the POR for the second half of June (top), July (middle), and the first half of August (bottom), with flow target for that period and year shown as the solid black bar. Each year is color coded by water year type. Graphs show that Abundant water year average flows often exceed the minimum flow targets at Salem while Deficit year average flows can miss the target. Adequate and Insufficient water years fall in between.

Expected ARP 2070, Period Average Flows at Salem

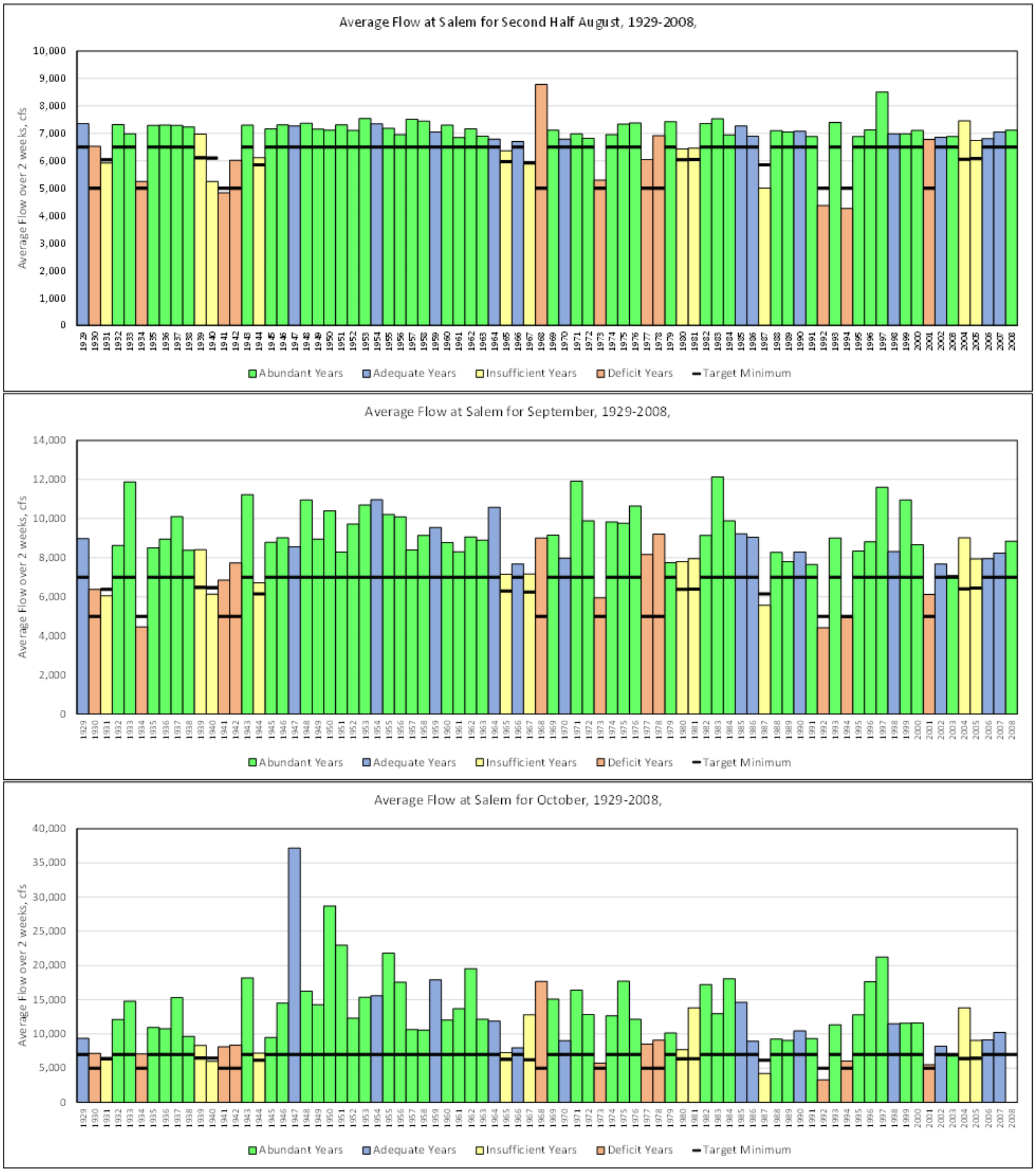


Figure 10.4c. Period average flows at Salem for all years in the POR for the second half of August (top), September (middle), and October (bottom), with flow target for that period and year shown as the solid black bar. Each year is color coded by water year type. Graphs show that Abundant water year average flows often exceed the minimum flow targets at Salem while Deficit year average flows can miss the target. Adequate and Insufficient water years fall in between. Note fall drafting begins in September.

Table 10.35a. Period average flows at Salem for all years in the POR, for 1929 to 1970. Average flow values are all in cfs.

Year	Average Flow at Salem over Period, in cfs.								
	Apr	May	1-15 Jun	16-30 Jun	July	1-15 Aug	16-30 Aug	Sep	Oct
1929	26257	17582	17835	17065	7243	6965	7353	8967	9342
1930	15398	15001	11971	8460	6664	6550	6526	6373	7153
1931	36655	13289	11415	9520	7485	7124	5917	6046	6539
1932	31460	24574	21673	14155	8190	7472	7318	8624	12112
1933	21860	28745	46959	26837	11708	7194	6986	11868	14776
1934	18663	12617	9362	7531	6112	5624	5244	4456	7064
1935	22947	17352	14189	9676	7582	7355	7295	8498	10925
1936	20821	22058	14505	12686	7584	7169	7298	8949	10768
1937	53555	29963	20926	36215	10341	7298	7291	10100	15289
1938	31728	21979	14236	9252	6888	7021	7230	8382	9648
1939	18270	13049	10897	9907	6947	6639	6977	8400	8317
1940	21338	13701	10140	8468	7365	6723	5244	6140	5989
1941	11596	13417	10319	8887	6514	4997	4834	6851	8108
1942	14443	16629	14074	11434	7819	6230	6021	7730	8344
1943	36617	17486	24916	15825	9436	7224	7299	11220	18175
1944	20822	14986	11379	8650	6821	6331	6116	6715	7207
1945	30956	32690	16380	9365	6878	7030	7163	8782	9474
1946	18591	16467	14788	12187	7959	7160	7306	9021	14526
1947	29437	13666	14324	10628	7976	7362	7273	8553	37151
1948	26756	28062	21952	13945	8237	7271	7370	10946	16237
1949	21984	33813	15885	10756	7357	7095	7156	8939	14282
1950	30668	26848	28893	22674	10241	7025	7116	10395	28707
1951	20785	18756	13574	9197	7037	7227	7311	8286	22986
1952	25932	21304	15839	14232	11145	7121	7103	9712	12314
1953	19763	29891	30838	17235	9243	7308	7544	10690	15358
1954	26421	15254	14292	14681	8320	7082	7350	10961	15571
1955	37211	24915	29706	16438	9980	7294	7191	10209	21791
1956	30181	27673	21489	18712	9013	7208	6952	10085	17545
1957	26680	16491	13534	9955	7005	7412	7515	8394	10626
1958	26573	16254	15791	10965	7514	7282	7447	9142	10557
1959	22961	18690	13418	9366	7154	7161	7045	9541	17893
1960	38901	36521	20386	11413	7028	7141	7296	8773	12021
1961	20971	20972	14158	9373	6975	6597	6849	8294	13663
1962	28152	24935	15919	11147	7303	7430	7172	9057	19541
1963	39482	35964	13486	9398	7606	6637	6892	8891	12162
1964	19411	16164	24972	16962	8064	6616	6789	10577	11871
1965	16745	14477	11195	8089	6704	6591	6367	7146	7273
1966	21173	14686	11190	9086	6920	6748	6700	7670	7980
1967	16655	15343	11765	8526	6113	5705	5880	7159	12807
1968	15484	13886	12050	8164	6554	6219	8779	8998	17658
1969	20764	23388	17107	18985	10089	7127	7114	9149	15060
1970	17458	17090	11107	9272	6704	6449	6792	7975	9002

Table 10.35b. Period average flows at Salem for all years in the POR, for 1971 to 2008. Average flow values are all in cfs.

Year	Average Flow at Salem over Period, in cfs.								
	Apr	May	1-15 Jun	16-30 Jun	July	1-15 Aug	16-30 Aug	Sep	Oct
1971	32045	26132	19786	18612	9139	6949	6979	11911	16414
1972	31177	26857	19459	11975	7466	6598	6817	9888	12824
1973	16281	12880	9548	8476	6656	4997	5300	5940	5711
1974	37156	22170	28037	18122	9273	6702	6959	9821	12632
1975	19704	22762	19222	11612	8082	6883	7336	9759	17684
1976	29076	23131	14391	11141	7434	7080	7376	10643	12147
1977	15436	17015	12748	7780	6043	5677	6049	8166	8510
1978	17597	16560	11395	8600	6751	5961	6918	9200	9071
1979	26684	23778	12750	9195	6812	7085	7425	7743	10113
1980	21565	14315	12482	9026	6841	6198	6430	7800	7704
1981	21159	15693	20655	14030	7402	6386	6467	7944	13818
1982	30082	16777	13982	10954	7806	7267	7360	9133	17198
1983	31108	18258	15024	11414	11816	7634	7528	12131	12945
1984	29459	29788	39609	21107	9339	6920	6948	9882	18060
1985	22149	15453	19438	10052	7263	7328	7271	9211	14629
1986	17432	16394	11454	9183	7286	6902	6891	9045	8927
1987	14908	12320	9741	7394	7218	6550	5002	5563	4200
1988	24523	22920	25796	10595	7278	7118	7099	8270	9253
1989	27921	16086	12754	9257	6853	6915	7048	7798	9038
1990	22203	16411	18480	10764	6963	6857	7075	8288	10433
1991	23227	25842	14497	9765	6862	6209	6881	7652	9327
1992	20051	12235	8773	7483	5795	4714	4372	4415	3287
1993	45169	31066	40372	15694	8505	7463	7403	9001	11332
1994	19551	12207	10463	8053	6133	4482	4260	4948	6043
1995	22078	23232	13155	11128	6872	6745	6885	8332	12804
1996	30514	29270	14484	9708	7282	7095	7129	8811	17641
1997	25256	19808	14849	11073	9172	8419	8505	11593	21237
1998	18690	20804	18439	10423	7275	6911	6978	8304	11492
1999	21690	28533	19638	16672	8901	6820	6987	10942	11567
2000	19674	21751	16888	11756	7505	7183	7104	8662	11618
2001	15722	14197	10742	7980	6770	6973	6782	6127	5462
2002	28598	15488	12634	9607	7174	7064	6857	7674	8204
2003	33749	16563	11141	9196	7294	7255	6882	7086	6781
2004	16093	13596	16493	9918	7137	6830	7460	9012	13816
2005	20294	19627	14325	10279	7319	6805	6747	7931	9049
2006	20273	15256	16763	10355	7163	6904	6810	7948	9106
2007	18438	13436	10427	9142	6896	6607	7053	8231	10219
2008	20040	31661	30141	18952	8642	6821	7112	8842	N/A

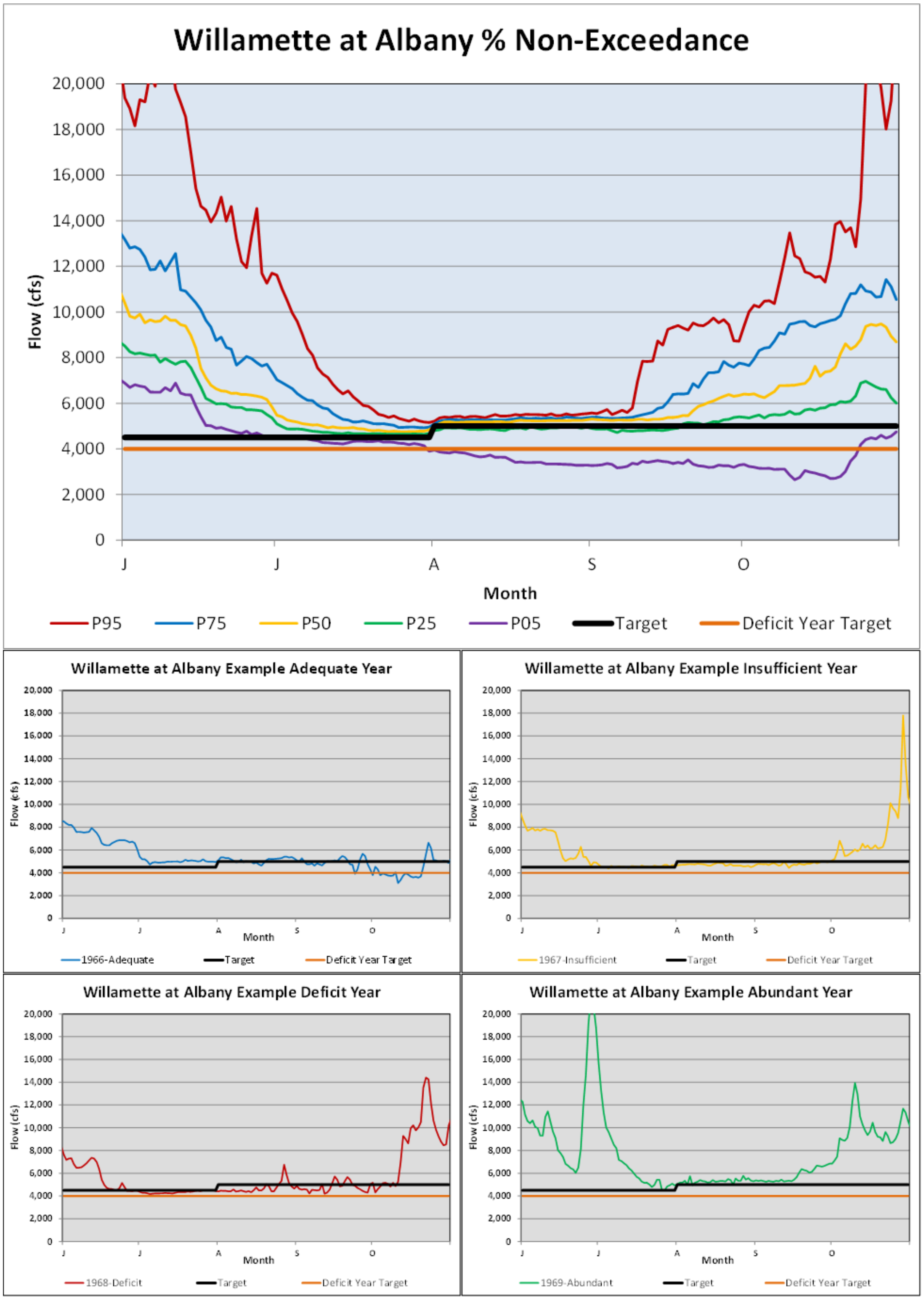


Figure 10.4. Non-exceedance percentiles for the Expected ARP 2070 for regulated flow at Albany in top graph (with blue background). Albany flow for selected years: 1966 (Adequate) at middle left, 1967 (Insufficient) at middle right, 1968 (Deficit) at bottom left, and 1969 (Abundant) at bottom right.

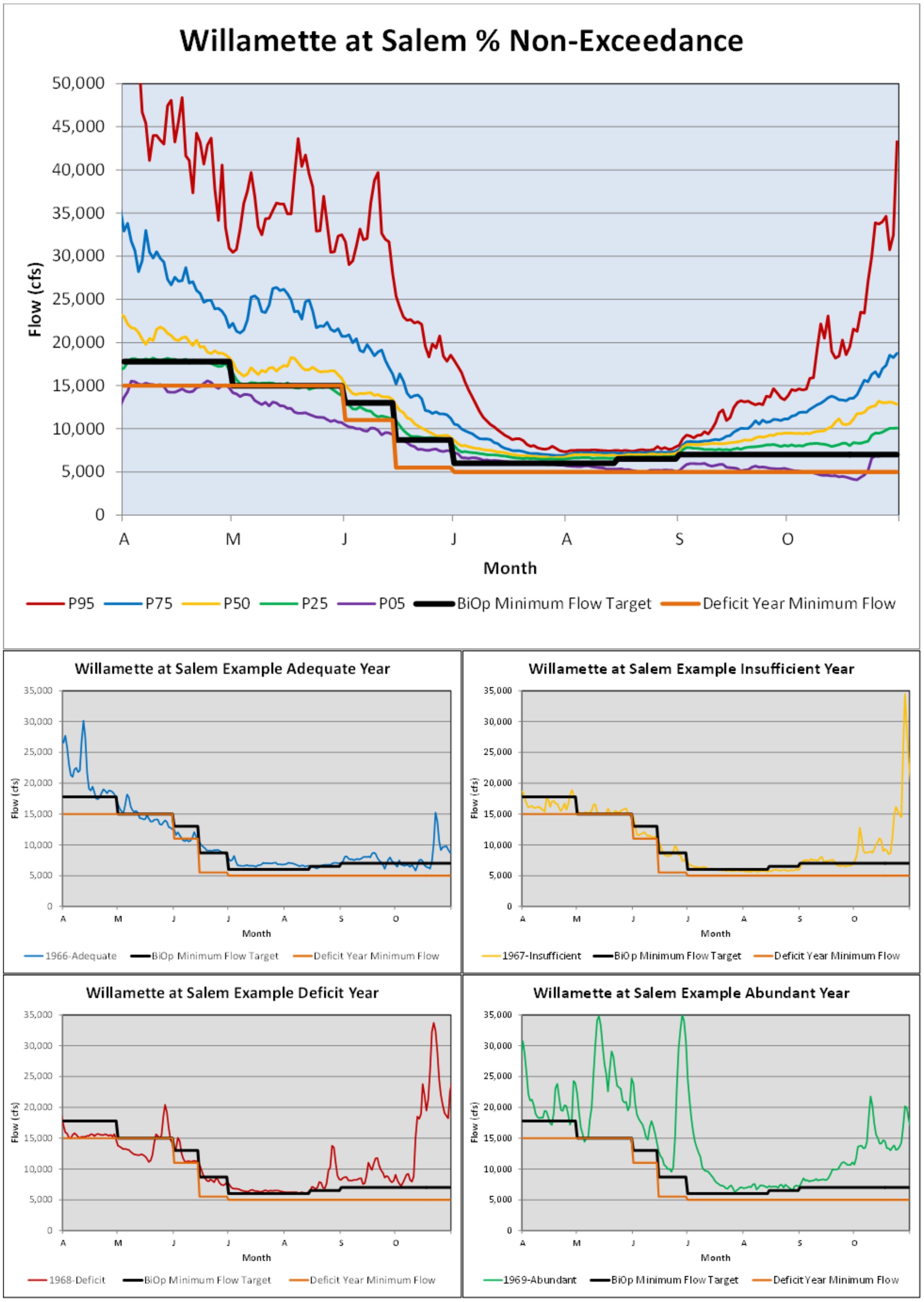


Figure 10.5. Non-exceedance percentiles for the Expected ARP 2070 for regulated flow at Salem in top graph (with blue background). Salem flow for selected years: 1966 (Adequate) at middle left, 1967 (Insufficient) at middle right, 1968 (Deficit) at bottom left, and 1969 (Abundant) at bottom right.

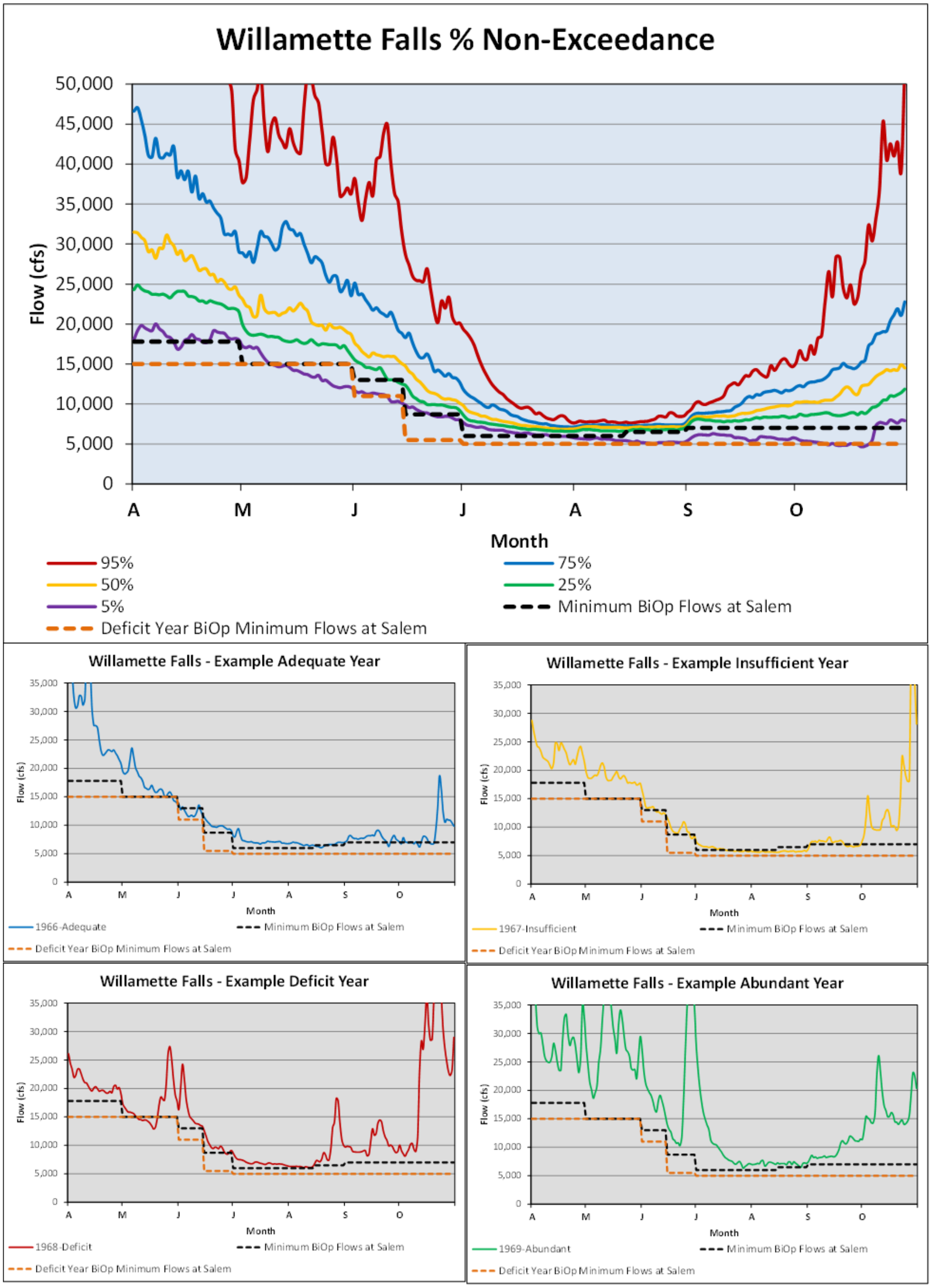


Figure 10.6. Non-exceedance percentiles for the Expected ARP 2070 for regulated flow at Oregon City above the Falls in top graph (with blue background). Flow for selected years: 1966 (Adequate) at middle left, 1967 (Insufficient) at middle right, 1968 (Deficit) at bottom left, and 1969 (Abundant) at bottom right.

11 Peak ARP 2070 Comparison to Peak No Action 2070

The Future with Project (the Agency Recommended Plan) can be compared to the Future without Project (the No Action Plan) by comparing the simulation results from the two ResSim analyses. The regulated flows at both Salem and Oregon City above Willamette Falls will be used for this comparison, as well as the total system conservation storage.

Figure 11.1 shows a comparison of the ResSim analysis results for the Peak ARP 2070 regulated flows at Salem to those of the Peak No Action 2070 results. The top graph shows the percentile non-exceedance flow levels for the ARP case in the color lines and the No Action case in the gray scale area plots. The lower four graphs are the regulated Salem flows for the selected four year examples that were shown in the previous sections, with the ARP case plotted as solid lines and the No Action case plotted as dashed lines of the same color. The Salem BiOp flow targets are shown in all graphs as well. Figure 11.2 shows regulated flows in the same way for Oregon City above Willamette Falls.

The agricultural irrigation and municipal and industrial demands are modeled within ResSim by reach, with all demands for water in the basin down to Salem modeled as diversions in Reaches 2 through 15 plus Reach 1c, while the demands between Salem and Willamette Falls are modeled as a diversion in Reach 1b. (Figure 3.1 is the reach numbering schematic with reach descriptions in Table 3.5.) The diversion volumes for each reach are shown in Tables 7.11 – 7.14 for the Peak No Action analysis and Tables 9.11 – 9.14 for the Peak ARP analysis, which show the different demand levels assumed for the four different water year types. (Equivalent flow rates for diversions are shown in Tables 7.15 – 7.18 and Tables 9.15 – 9.18.) There is a local flow component into the Willamette River between Salem and Willamette Falls, so the regulated flow at Willamette Falls is higher than the regulated flow at Salem, even with the additional diversions in Reach 1b.

The regulated flows in all graphs of Figures 11.1 and 11.2 are similar in the early months of spring, and then diverge from each other. The Salem percentile non-exceedance graph shows the color lines diverging from the gray scale areas around mid-June or later, with the ARP percentile flows slightly higher than the No Action percentile flows. By September, the situation is reversed, with the ARP percentile flows slightly lower than the No Action flows. This trend is also visible in the individual year examples.

Figure 11.3 shows the total system conservation storage for each day of April through October for the four example water years (1966-1969). The ARP and the No Action storages diverge from each other around mid-June, generally with the ARP storage level being slightly lower than the No Action storage level for the rest of the conservation season.

The close similarities of the regulated flows at Salem and Willamette Falls for the ARP and the No Action cases, along with the example year system conservation storage, show that the ARP analysis used slightly more stored water than the No Action case.

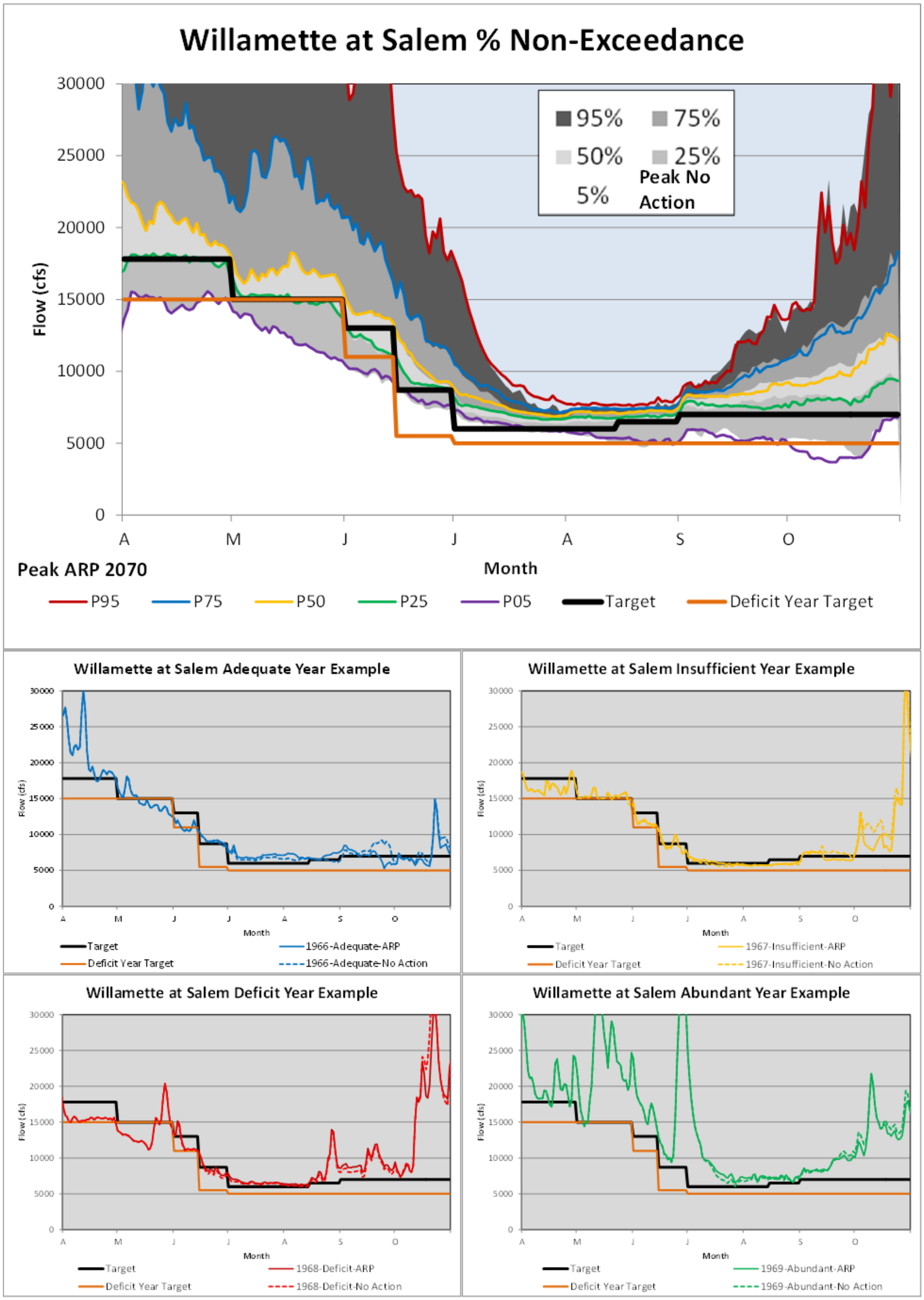


Figure 11.1. Non-exceedance percentile comparisons for Peak ARP versus Peak No Action regulated flow at Salem in top graph (ARP in color lines and No Action in gray scale areas). Flow for selected years: 1966 (Adequate) at middle left, 1967 (Insufficient) at middle right, 1968 (Deficit) at bottom left, and 1969 (Abundant) at bottom right, ARP in solid lines and No Action in dashed lines.

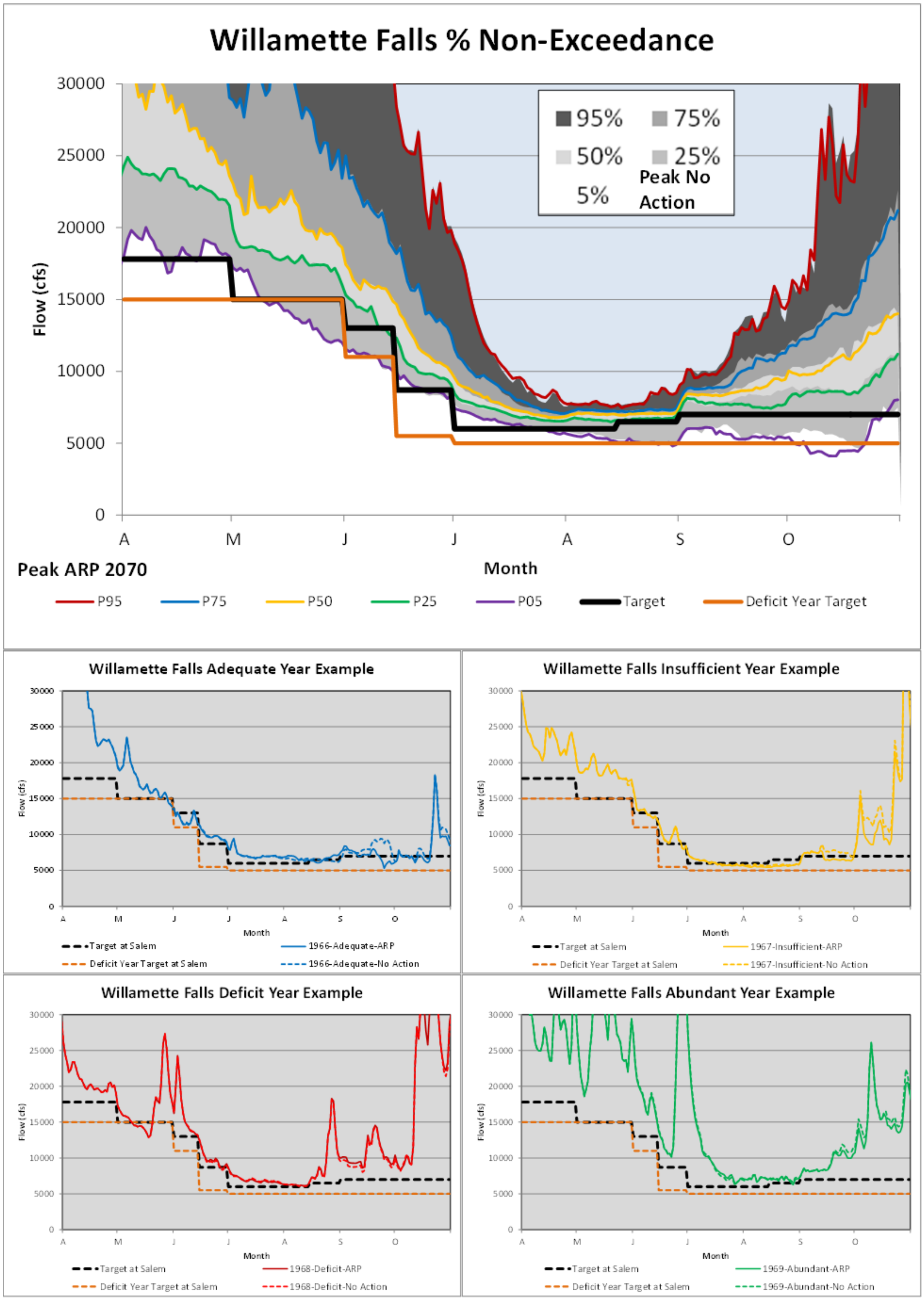


Figure 11.2 Non-exceedance percentile comparisons for Peak ARP versus Peak No Action regulated flow at Oregon City above Willamette Falls in top graph (ARP in color lines and No Action in gray scale areas). Flow for selected years: 1966 (Adequate) at middle left, 1967 (Insufficient) at middle right, 1968 (Deficit) at bottom left, and 1969 (Abundant) at bottom right, ARP in solid lines and No Action in dashed lines.

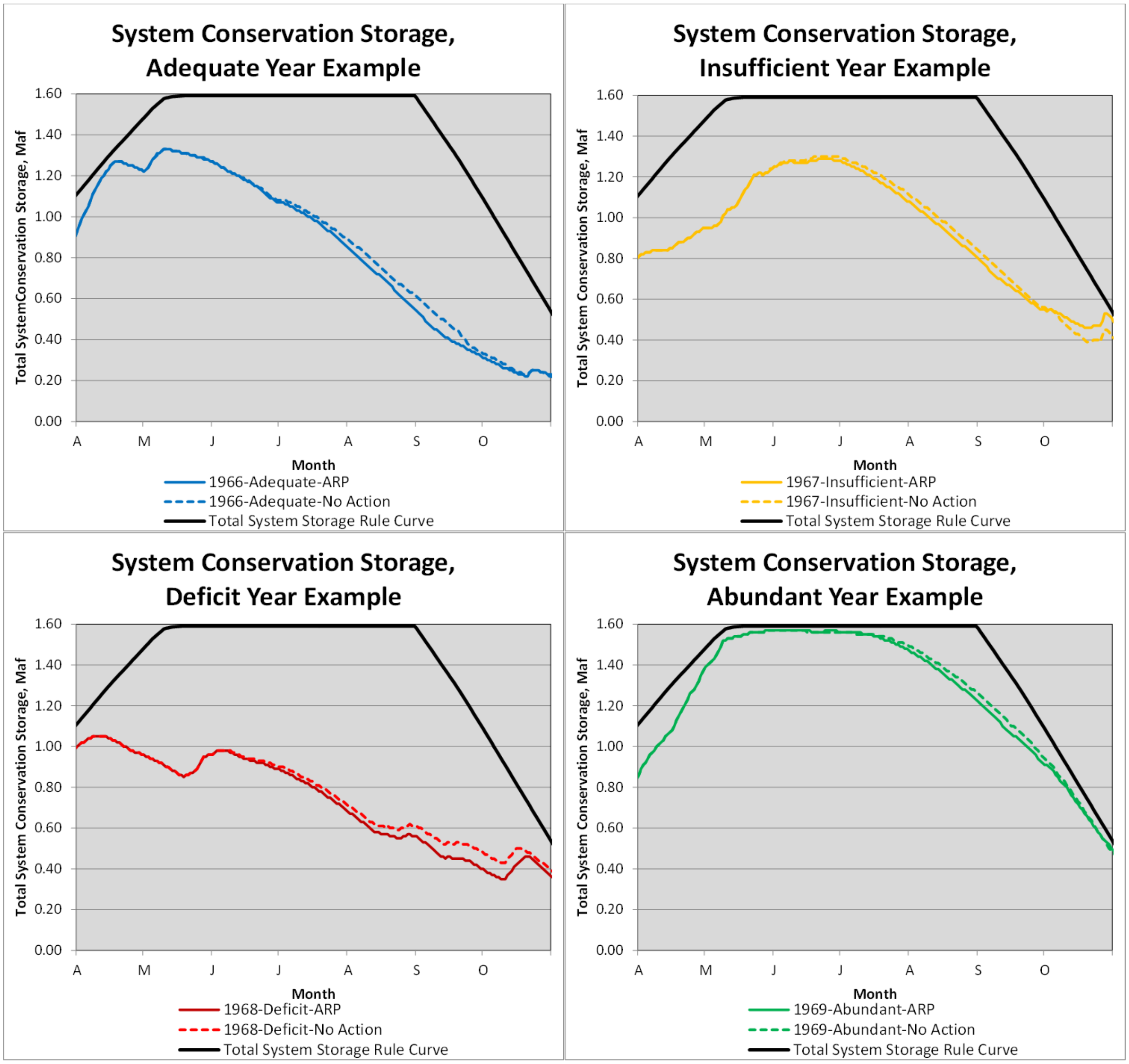


Figure 11.3. Non-exceedance percentiles for the Expected ARP 2070 for regulated flow at Oregon City above the Falls in top graph (with blue background). Flow for selected years: 1966 (Adequate) at middle left, 1967 (Insufficient) at middle right, 1968 (Deficit) at bottom left, and 1969 (Abundant) at bottom right.

12 References.

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Excel files used for the various data tables and graphs are listed in separate tables below for each analysis case.

Reference Table 11.1. Spreadsheets and script files created by USACE for Base Year 2020.

Excel File Name	Description
Ag shaping Base Year 2020 Table AI 1.xlsx	Takes the data from Appendix F table AI 1 and distributes the diverted volumes to April through October.
MI for base year 2020.xlsx	Takes the data from Appendix F tables MI 1 and MI 2 and sums a total by reach.
Ag plus MI Diversions Base Year 2020.xlsx	Uses data from the first two spreadsheets and produces both the volume and flow proportions for each reservoir to supply (where only DET and FRN have additional flow releases), and calculates the diversions and return flows for each reach for the base year.
Diversion and Return Rules – Base Year 2020.xlsx	Takes diversions and returns from the above spreadsheet and puts them into a format that can be copied and pasted into ResSim diversion and return flow rules.
Project Release Rules - Base Year 2020.xlsx	Takes the data from the third spreadsheet and puts the reservoir releases requirements into a format that can be copied and pasted in ResSim rules for each reservoir (just DET and FRN for the Base Year 2020).
Total Base Year 2020 demand.xlsx	Totals the diversion volumes in different ways for use in tables in Section 6.
Exceedance_Graph_Base Year 2020.xlsx & Salem flows over mins Base Year 2020.xlsx	Used for all simulation results in Section 6. (Graphs and Tables)
Pull CF McK FRN FAL BiOp data.txt	Script file used in HEC-DSSVue to pull and rename about half of the needed data records to compute the stored water released for BiOp Need.
Pull Sant MF Main BiOp data.txt	Script file used in HEC-DSSVue to pull and rename the other half of the needed data records to compute the stored water released for BiOp Need.
WHMPP Macros 1928-2008.xlsm	Macro file used for processing simulation results into the spreadsheets for graphs and data.

Reference Table 11.2. Spreadsheets created by USACE for Peak No Action 2070.

Excel File Name	Description
Ag shaping Peak No Action 2070 Tables AI 1 2 3.xlsx	Takes the data from Appendix F tables AI 1, AI 2, and AI 3, distributes the diverted volumes to April through October, and sums up the BOR contract data for all reaches with the specified reduced percentages in lower water years.
MI for Tables MI 1 2 3 5 6 Peak No Action 2070.xlsx	Takes the data from Appendix F tables MI 1, MI 2, MI 3, MI 5, and MI 6, sorts into which demands are supplied in full in all water year types and which are reduced (and reduces them) in lower water years.
Ag plus MI Diversions Peak No Action 2070 Abundant.xlsx	Uses data from the first two spreadsheets for Abundant water years and M&I by live flow or stored water, produces both the volume and flow proportions for each reservoir to supply, and calculates the diversions and return flows for each reach for this water year type.
Ag plus MI Diversions Peak No Action 2070 Adequate.xlsx	Uses data from the first two spreadsheets for Adequate water years and M&I by live flow or stored water, produces both the volume and flow proportions for each reservoir to supply, and calculates the diversions and return flows for each reach for this water year type.
Ag plus MI Diversions Peak No Action 2070 Insufficient.xlsx	Uses data from the first two spreadsheets for Insufficient water years and M&I by live flow or stored water, produces both the volume and flow proportions for each reservoir to supply, and calculates the diversions and return flows for each reach for this water year type.
Ag plus MI Diversions Peak No Action 2070 Deficit.xlsx	Uses data from the first two spreadsheets for Deficit water years and M&I by live flow or stored water, produces both the volume and flow proportions for each reservoir to supply, and calculates the diversions and return flows for each reach for this water year type.
Diversion and Return Rules - Peak No Action 2070.xlsx	Takes diversions and returns from the above four spreadsheets and puts them into a format that can be copied and pasted into ResSim diversion and return flow rules.
Project Release Rules - Peak No Action 2070.xlsx	Takes the data from the four water year type specific files and puts the reservoir releases requirements into a format that can be copied and pasted in ResSim rules for each reservoir.
Total diversion volumes peak no action 2070.xlsx	Totals the diversion volumes in different ways for use in tables in Section 7.
NEWBASE---0.xls	Excel file of all the data pulled from the simulation.dss file, sorted into the matrix format used for spreadsheet processing. Simulations for all WBR cases documented in Sections 6-10 have the same name for this file, but the data differs by simulation.
Exceedance_Graph_Peak No Action 2070.xlsx and Salem flows over mins Peak No Action 2070.xlsx	Used for graphs and tables in Section 7.
WHMPP Macros 1928-2008.xlsm	Macro file used for processing simulation results into the spreadsheets for graphs and data.

Reference Table 11.3. Spreadsheets created by USACE for Expected No Action 2070.

Excel File Name	Description
Ag shaping Expected No Action 2070 Tables AI 1 2 4.xlsx	Takes the data from Appendix F tables AI 1, AI 2, and AI 4, distributes the diverted volumes to April through October, and sums up the BOR contract data for all reaches with the specified reduced percentages in lower water years.
MI for Tables MI 1 2 4 5 7 Expected No Action 2070.xlsx	Takes the data from Appendix F tables MI 1, MI 2, MI 4, MI 5, and MI 7, sorts into which demands are supplied in full in all water year types and which are reduced (and reduces them) in lower water years.
Ag plus MI Diversions Expected No Action 2070 Abundant.xlsx	Uses data from the first two spreadsheets for Abundant water years and M&I by live flow or stored water, produces both the volume and flow proportions for each reservoir to supply, and calculates the diversions and return flows for each reach for this water year type.
Ag plus MI Diversions Expected No Action 2070 Adequate.xlsx	Uses data from the first two spreadsheets for Adequate water years and M&I by live flow or stored water, produces both the volume and flow proportions for each reservoir to supply, and calculates the diversions and return flows for each reach for this water year type.
Ag plus MI Diversions Expected No Action 2070 Insufficient.xlsx	Uses data from the first two spreadsheets for Insufficient water years and M&I by live flow or stored water, produces both the volume and flow proportions for each reservoir to supply, and calculates the diversions and return flows for each reach for this water year type.
Ag plus MI Diversions Expected No Action 2070 Deficit.xlsx	Uses data from the first two spreadsheets for Deficit water years and M&I by live flow or stored water, produces both the volume and flow proportions for each reservoir to supply, and calculates the diversions and return flows for each reach for this water year type.
Diversion and Return Rules - Expected No Action 2070.xlsx	Takes diversions and returns from the above four spreadsheets and puts them into a format that can be copied and pasted into ResSim diversion and return flow rules.
Project Release Rules - Expected No Action 2070.xlsx	Takes the data from the four water year type specific files and puts the reservoir releases requirements into a format that can be copied and pasted in ResSim rules for each reservoir.
Total diversion volumes expected no action 2070.xlsx	Totals the diversion volumes in different ways for use in tables in Section 8.
NEWBASE---0.xls	Excel file of all the data pulled from the simulation.dss file, sorted into the matrix format used for spreadsheet processing. Simulations for all WBR cases documented in Sections 6-10 have the same name for this file, but the data differs by simulation.
Exceedance_Graph_Expected No Action 2070.xlsx and Salem flows over mins Expected No Action 2070.xlsx	Used for all graphs and tables in Section 8.
WHMPP Macros 1928-2008.xlsm	Macro file used for processing simulation results into the spreadsheets for graphs and data.

Reference Table 11.4. Spreadsheets created by USACE for this Peak ARP 2070.

Excel File Name	Description
Ag shaping ARP Peak 2070 Tables AI 1 2 5.xlsx	Takes the data from Appendix F tables AI 1, AI 2, and AI 5, distributes the diverted volumes to April through October, and sums up the BOR contract data for all reaches with the specified reduced percentages in lower water years.
MI for Tables MI 1 2 3 5 8 10 ARP Peak 2070.xlsx	Takes the data from Appendix F tables MI 1, MI 2, MI 3, MI 5, MI 8, and MI 10, sorts into which demands are supplied by live flow and stored water, and also separately sorts into which demands are supplied in full in all water year types and which are reduced (and reduces them) in lower water years.
Ag plus MI Diversions ARP 2070 Peak Abundant.xlsx	Uses data from the first two spreadsheets for Abundant water years and M&I by live flow or stored water, produces both the volume and flow proportions for each reservoir to supply, and calculates the diversions and return flows for each reach for this water year type.
Ag plus MI Diversions ARP 2070 Peak Adequate.xlsx	Uses data from the first two spreadsheets for Adequate water years and M&I by live flow or stored water, produces both the volume and flow proportions for each reservoir to supply, and calculates the diversions and return flows for each reach for this water year type.
Ag plus MI Diversions ARP 2070 Peak Insufficient.xlsx	Uses data from the first two spreadsheets for Insufficient water years and M&I by live flow or stored water, produces both the volume and flow proportions for each reservoir to supply, and calculates the diversions and return flows for each reach for this water year type.
Ag plus MI Diversions ARP 2070 Peak Deficit.xlsx	Uses data from the first two spreadsheets for Deficit water years and M&I by live flow or stored water, produces both the volume and flow proportions for each reservoir to supply, and calculates the diversions and return flows for each reach for this water year type.
Diversion and Return Rules - ARP Peak 2070.xlsx	Takes diversions and returns from the above four spreadsheets and puts them into a format that can be copied and pasted into ResSim diversion and return flow rules.
Project Release Rules - ARP Peak 2070.xlsx	Takes the data from the four water year type specific files and puts the reservoir releases requirements into a format that can be copied and pasted in ResSim rules for each reservoir.
Total diversion volumes peak ARP 2070.xlsx	Totals the diversion volumes in different ways for use in tables in Section 9.
NEWBASE---0.xls	Excel file of all the data pulled from the simulation.dss file, sorted into the matrix format used for spreadsheet processing. Simulations for all WBR cases documented in Sections 6-10 have the same name for this file, but the data differs by simulation.
Exceedance_Graph_Peak ARP Action 2070.xlsx and Salem flows over mins Peak ARP 2070.xlsx	Used for all graphs and tables in Section 9.
WHMPP Macros 1928-2008.xlsm	Macro file used for processing simulation results into the spreadsheets for graphs and data.

Reference Table 11.5. Spreadsheets created by USACE for Expected ARP 2070.

Excel File Name	Description
Ag shaping ARP Expected 2070 Tables AI 1 2 6.xlsx	Takes the data from Appendix F tables AI 1, AI 2, and AI 6, distributes the diverted volumes to April through October, and sums up the BOR contract data for all reaches with the specified reduced percentages in lower water years.
MI for Tables MI 1 2 4 5 9 10 ARP Expected 2070.xlsx	Takes the data from Appendix F tables MI 1, MI 2, MI 4, MI 5, MI 9, and MI 10, sorts into which demands are supplied by live flow and stored water, and also separately sorts into which demands are supplied in full in all water year types and which are reduced (and reduces them) in lower water years.
Ag plus MI Diversions Expected ARP Abundant.xlsx	Uses data from the first two spreadsheets for Abundant water years and M&I by live flow or stored water, produces both the volume and flow proportions for each reservoir to supply, and calculates the diversions and return flows for each reach for this water year type.
Ag plus MI Diversions Expected ARP Adequate.xlsx	Uses data from the first two spreadsheets for Adequate water years and M&I by live flow or stored water, produces both the volume and flow proportions for each reservoir to supply, and calculates the diversions and return flows for each reach for this water year type.
Ag plus MI Diversions Expected ARP Insufficient.xlsx	Uses data from the first two spreadsheets for Insufficient water years and M&I by live flow or stored water, produces both the volume and flow proportions for each reservoir to supply, and calculates the diversions and return flows for each reach for this water year type.
Ag plus MI Diversions Expected ARP Deficit.xlsx	Uses data from the first two spreadsheets for Deficit water years and M&I by live flow or stored water, produces both the volume and flow proportions for each reservoir to supply, and calculates the diversions and return flows for each reach for this water year type.
Diversion and Return Rules - Expected ARP.xlsx	Takes diversions and returns from the above four spreadsheets and puts them into a format that can be copied and pasted into ResSim diversion and return flow rules.
Project Release Rules - Expected ARP.xlsx	Takes the data from the four water year type specific files and puts the reservoir releases requirements into a format that can be copied and pasted in ResSim rules for each reservoir.
Total diversion volumes Expected ARP 2070.xlsx	Totals the diversion volumes in different ways for use in tables in Section 10.
NEWBASE---0.xls	Excel file of all the data pulled from the simulation.dss file, sorted into the matrix format used for spreadsheet processing. Simulations for all WBR cases documented in Sections 6-10 have the same name for this file, but the data differs by simulation.
Exceedance_Graph_Expected ARP 2070.xlsx and Salem flows over mins Expected ARP 2070.xlsx	Used for graphs and tables in Section 10.
WHMPP Macros 1928-2008.xlsm	Macro file used for processing simulation results into the spreadsheets for graphs and data.