August, 2012

Reliability of the Water Supply for the Yakima Basin

Introduction

The Yakima Basin Storage Alliance (YBSA) is a local grassroots organization" formed to raise the awareness of our Yakima River basin economy and environment on a reliable surface water supply and the need for additional stored water. Since April 2009, YBSA has been a member of a Workgroup of stakeholders involved in developing a comprehensive plan to provide reliable and sustainable water resources for instream and out-of-stream needs. The result is a Yakima River Basin Integrated Water Resources Management Plan (Integrated Plan) of seven elements: a water surface storage element of Wymer Dam and Reservoir, Kachess Reservoir Inactive Storage, and Bumping Lake Reservoir Enlargement, and six complementary elements.

YBSA supports the Integrated Plan concept but is deeply concerned with what we see as shortcomings of the surface water storage element. This paper provides background information on the existing Yakima Project and its operation and, using data prepared by contractors for the Bureau of Reclamation and the Washington State Department of Ecology, looks at the capability to provide a reliable surface water supply with climate change imposed on the Yakima River basin's historical precipitation and water runoff patterns.

Background

The five major reservoirs of the Yakima Project – Keechelus, Kachess, Cle Elum, Bumping, and Rimrock – with a total capacity of 1,045,000 acre-feet store and release water for the purposes of irrigation, fish and wildlife, flood control, and recreation within the Yakima River basin. These five reservoirs are operated by the Bureau of Reclamation as a pooled system with no reservoir storage space designated for a specific purpose or to a specific entity. Water released for irrigation from the upstream reservoirs is generally conveyed by the mainstem Yakima and Naches rivers for diversion into canal systems operated by the entities for delivery to their water users.

The water supply provided from the Yakima Project to the irrigation entities consists of stored water from the natural inflow of tributaries feeding into the reservoirs, the natural (unregulated) flows entering the mainstream rivers below the reservoirs, and the surface and subsurface return flows accruing to the mainstem rivers from the irrigated lands. The Yakima Project irrigation operation is keyed to using the natural (unregulated) flows and return flows to the extent possible to meet irrigation demands prior to releasing stored water. Generally these natural (unregulated) flows and return flows are adequate to meet the irrigation needs and instream flow maintenance requirements from the beginning of the irrigation season in April through June; stored water releases then begin (storage control) and continue until the end of the irrigation season in mid-October. [1]

A "sixth reservoir", snowpack in the higher elevations of the Yakima River basin and the timing of snowmelt runoff is critical to the reliability of the Yakima Project's water supply. The desirable condition is a good snowpack with an extended period of snowmelt filling the reservoirs by about mid-June and providing natural (unregulated) runoff for irrigation diversions and instream flow needs through the spring months.

The volume of water available from the Yakima Project to meet instream and out-of-stream needs above the Parker gaging system on the Yakima River, a short distance below the Sunnyside Diversion Dam, for the period of April through September is estimated annually beginning April 1 and continuing each month based on the water supply conditions. This estimate of the Total Water Supply Available (TWSA) is used as the basis for distributing the supply to instream and out-of-stream uses, and if necessary irrigation proration if the TWSA is not sufficient to meet the irrigation demands. Any deficiency in irrigation supply is first assessed against the junior (proratable) irrigation water rights, and then if necessary against the senior (nonproratable) irrigation water rights; to date senior irrigation water rights have received a full supply in dry years. The Acquavella Adjudication Court has mandated that the rights of the Yakama Nation to instream flows for anadromous fishery are time immemorial and senior to all other water rights within the Yakima River basin.

The TWSA estimate is comprised of four components: (1) the stored water in the five reservoirs on April 1; (2) the forecasted April-July natural runoff; (3) the projected August-September natural runoff; and (4) the useable return flows upstream of Parker. To illustrate the effects that snowmelt and carryover storage has on the reliability of the Yakima Project water supply, actual water supply information for two periods during the 1990s is provided in Table 1. The first period is the five years of 1990-1994 (the last three years of which are a three-year dry cycle), and the second period is the three years of 1995-1997 (following the dry years culminating with one of the years of maximum water supply).

[1] The date when stored water releases are required is referred to as "the storage control date".

Table 1 - - Total Water Supply Available for 1990-1995 and 1995-1997 [2]							
Year	Components of Total Water Supply Available Estimate			April 1 Total Water Supply Available Estimate	September 30 Storage		Storage Control Date
	April 1 Storage Contents	April–June Natural Flow	April-September Return Flow		Contents	Percent of Total Capacity	
	(acre-feet)						
Years Culminating with a Three-Year Dry Cycle							
1990	717,300	2,107,700	375,000	3,200,000	401,000	38	July 2
1991	335,600	1,532,400	350,000	2,818,000	483,800	46	July 8
1992	816,300	1,186,600	350,000	2,352,900	91,000	9	May 17
1993	354,900	1,295,500	350,000	2,000,000	85,000	8	June 13
1994	296,000	1,369,700	350,000	2,015,700	87,400	8	June 14
Years Culminating with One of the Maximum Water Supply Years							
1995	678,600	1,990,000	375,000	3,040,000	284,600	27	July 1
1996	911,400	1,586,500	375,000	2,871,900	286,400	27	June 26
1997	729,600	3,436,000	375,000	4,541,100	585,000	56	July 21

In 1992-1994, the irrigation proration level was 58, 67, and 37 percent respectively. During 1993 and 1994, the unregulated natural flow and return flows downstream of the five reservoirs was voluntarily shared by the five Yakima Project irrigation divisions in April and May with the official proration date beginning mid-June with storage control.

Beginning in 1995, following the passage of the Act of October 31, 1994, which included instream target flows at Sunnyside and Prosser diversion dams, the total demand placed against the TWSA in a normal water year was about 2.7 million acre-feet.

The two lowest April 1 TWSA estimates occurred in 1993 and 1994. The natural flows for these years were the lowest that had occurred in the 60 years of 1940-1999, and the low carryover storage from the prior year compounded the water supply conditions. In 1992, the natural flow was lower than that of 1993 and 1994, but the carryover storage from 1991 was significantly greater and together with inflow to the reservoirs they were within 200,000 acre-feet of filling by April 1.

Improving the reliability of the water supply requires the concurrent actions of increasing the efficiency of water use by water conservation measures to reduce the demand and providing additional storage for the carryover of stored water in good water years for use in dry years. With instream and out-of-stream use competing for the available water supply, a policy which allows the intermittent depletion of carryover storage for other uses poses a risk to water delivery

[2] Information from Final Review Draft Watershed Assessment, Yakima River Basin, June 2000, pages 3-27 to 3-29, Tables 3-6 and 3-7. The “storage control date” shown in the table is from the Draft Interim Comprehensive Operating Plan of May 15, 2002. Pages 30-31, Table 5-9.

commitments. Further, if the “watershed is taxed” to the maximum extent to meet the needs the effectiveness of refilling the reservoir system is a major challenge.

The effects of climate change on the Yakima River basin and the accomplishments of the Integrated Plan considering three climate change scenarios are discussed in the following section. The Integrated Plan includes seven elements to improve water resources; one of the elements is surface water storage consisting of Wymer Dam and Reservoir, Kachess Reservoir Inactive Storage, and Bumping Lake Reservoir Enlargement.

Climate Change

The background and details of the process used by Reclamation and Ecology in developing the hydrologic evaluation modeling tools, the application of the model simulating reservoir and river operations and the overview process of the Workgroup are provided in the Modeling of Reliability and Flows Technical Memorandum of June 2011.

The simulated operation of the existing Yakima Project with the proposed additional storage projects, water conservation measures, operational modifications, etc. reflects a 25-year (of 1981-2005) historical period of precipitation and runoff. Model results of this simulated operation represent the Integrated Plan accomplishments in meeting irrigation needs, addressing instream flow objectives, and providing future domestic and municipal water assuming a similar 25-year hydrologic cycle.

Recent climate change studies indicate that the Yakima River basin watershed, dominated by fall rain and spring snowmelt, will be most affected by climate change. Climate change studies to assess the risks to water supply in the Yakima River basin include those conducted by the Climate Impacts Group at the University of Washington, working with the U.S. Fish and Wildlife Service and other federal agencies. To assess the impacts of climate change on the Integrated Plan three scenarios comprised of a range of assumptions about future greenhouse gas emissions and a range of different global climate change models were used. The scenarios represent the following climate change conditions that may occur during the 2040s:

- Less adverse - - 2040s less warming/wetter; average temperature increase of 1.8 degree centigrade and average precipitation increase of 13.4 percent.
- Moderately adverse - - 2040s central change; average temperature increase of 1.7 degree centigrade and average precipitation increase of 3.7 percent.
- More Adverse - - 2040s more warming/dryer; average temperature increase of 2.8 degree centigrade and average precipitation decrease of 2.5 percent.

Data from each scenario was used to adjust the 25-year period of historical precipitation and runoff. The hydrologic model was then used to estimate the potential water supply impacts on the accomplishments of the Integrated Plan. The following results are described in the Final Programmatic Environmental Impact Statement (FPEIS):[3]

> *Changes in Snowpack - - Increased air temperatures from climate change would cause more precipitation to fall as rain rather than snow in the Cascade Mountains. This would reduce snowpack in the headwater of the Yakima River system. Also, higher air temperatures would cause snowpack to melt earlier that under current conditions. Studies have shown that the Yakima River basin is likely to have a 12 percent decrease in snowmelt volume given a 1 degree centigrade rise in air temperature and a 27 percent decrease in snowmelt volume given a 2 degree centigrade rise.*
>
> *Changes in Quantity and Time of Runoff - - Changes in runoff in the Yakima River basin due to climate change are expected to be significant. For all three climate change scenarios, spring and summer runoff is expected to decrease (ranging from 12 to 71 percent of exiting runoff) and fall and winter runoff is expected to increase (ranging from 4 to 74 percent of existing runoff). The shifts in runoff quantity and timing would cause significant risks to water supply. .Fall and winter inflow will increase but the reservoir system may not have sufficient capacity to be able to capture and hold enough winter and spring flow for release to meet needs during the high-demand and lower inflow period of the summer. Additionally, a decrease in spring and summer flows will cause water stored in reservoirs to be depleted at a faster rate to meet demand. The combined effects will likely cause a decrease in overall water supply during the high-demand period.*

Climate Change Water Supply Impacts

Impacts on TWSA **- -** Table 2 provides information on the April 1 TWSA estimate for the Integrated Plan assuming no climate change and the Integrated Plan with the three climate change scenarios.[4]

Table 2 - - Climate Change Scenarios

Period	No Climate Change	Climate Change Scenarios		
		Less Adverse	Moderately Adverse	More Adverse
	(million acre-feet)			
25-Year Average	3.00	2.79	2.47	2.02
Wet Year (1997)	4.73	4.27	3.98	2.95
Dry-Year (2001)	2.22	2.24	1.60	1.43

Decreases in TWSA affect the water supply available for out-of-stream and instream uses. As a result the irrigation water supply available for junior (proratable) supply must be prorated in more years, the Title XII target flows over Sunnyside and Prosser diversion dams which are based on the TWSA estimate decrease and the instream flow objectives proposed in the Integrated Plan in the mainstem rivers and tributaries may not be met.

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3 Final Programmatic Environmental Impact Statement of March 2012, pages 3-75 and 3-79.

4 Modeling of Reliability and Flows Technical Memorandum of June 2011, Appendix B, page 1 of 22 and Appendices D-1, D-2, and D-3, pages 3 of 22.

Impacts on the Irrigation Proration Level - - The irrigation proration level is an indicator of the extent of the water supply available for diversion. It is expressed as a percent of the proratable irrigation water supply that can be provided in relation to the proratable water entitlement. A full water supply is represented by 100 percent.

The irrigation objective of the Integrated Plan is to provide not less than a 70 percent water supply in dry years for the three irrigation divisions (Kittitas, Roza, and Wapato) that have expressed a willingness to participate in the supplemental dry-year irrigation water supply from the Integrated Plan. When the additional surface water storage projects are incorporated into the Yakima Project two proration values will need to be calculated in the future. The first is based on the existing Yakima Project system and its water supply which is available to the five irrigation divisions and the smaller districts and canal companies diverting above the Parker gage. [5] The second is based on the Integrated Plan and represents that associated with the supplemental supply which will be available only to Kittitas, Roza, and Wapato to improve their dry-year proratable supply.

The estimated irrigation proration level each year of the 25-year period for these three irrigation divisions when the climate change scenarios are considered is shown in Figure 1.[6] Identified in the lower right-hand side is the number of years the irrigation proration level falls within the specified percentage. For the Integrated Plan without climate change there are four dry years (1993, 1994, 2001, and 2005) when the irrigation proration level is 70 percent. With the climate change scenarios the number of dry years increase and the 70 percent proration level may not be met in some years as follows:

- Less Adverse: Seven dry years with the irrigation proration level at 70 percent for each year.
- Moderately Adverse: Fourteen dry years and the 70 percent proration level criteria are violated in every year.
- More Adverse: 24 dry years and the 70 percent criteria is violated in 22 of these years.

It appears that the irrigation proration level of the Tieton and Sunnyside Divisions which opted not to participate in the supplemental dry-year water supply of the Integrated Plan and the smaller irrigation districts and canal companies who have senior and some junior water rights is representative of the future without Integrated Plan condition with climate change. For a dry

[5] The sixth irrigation division, Kennewick, diverts downstream of the Parker gage and natural flows and return flows have generally been adequate to meets its irrigation demands.

[6] Ibid, pages 21 of 22.

Figure 1- - Irrigation Proration Level for Each Year of the 25-Year Historical Period (1981-2005)

Code		Percent Proration			1981	1982	1983	1984	1985	1986	1987	1988	1989	
Less			>70											
Mod			70											
More			60											
			50											
			40											
			30											
			20											
			10											

		Percent Proration		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	
			>70											
			70											
			60											
			50											
			40											
			30											
			20											
			10											

		Percent Proration		2000	2001	2002	2003	2004	2005		Number of Years at %			
			>70								18	11	1	
			70								7	0	2	
			60								0	12	12	
			50								0	1	3	
			40								0	0	3	
			30								0	0	0	
			20								0	1	2	
			10								0	0	2	

year like 1994 the irrigation proration level is as follows: less adverse 32 percent; moderately adverse 9 percent; and more adverse 0 percent (no proratable water supply available).

Impacts on Instream Flow Objectives - - Instream flow objectives are identified by mainstem river and tributary reaches as high-priority or lower priority needs. The needs are expressed as an increase or decrease in the current flow regime for a specific period (cfs). A specific volume of water (acre-feet) is not identified to meet these flow objectives and the impacts of climate change require the review of hydrographs of the simulated operation studies. A narrative description of the climate change scenarios impacts on these instream flow objectives is not provided in the documents supporting the Integrated Plan.

As an illustration, the FPEIS indicates that with the moderately adverse climate change scenario "the Bumping Lake Reservoir enlargement will be needed to make major water supply deliveries in an additional 10 years out of 25 years, compared with operations not impacted by climate change".[7] The impact of this operation on the Bumping River flow regime is a significant flow increase during September; contrary to the flow objective of decreasing the current flow of about 190 cfs by 70 to 100 cfs. Figure 2 is a hydrograph of this operation for the moderately adverse climate change scenario showing a September flow of about 1,400 cfs; the more adverse scenario results in a flow of 900 to 1,100 cfs from mid-August through September.[8] Note: Ignore the green line in the hydrographs in Figure 2 as this is the future without Integrated Plan.

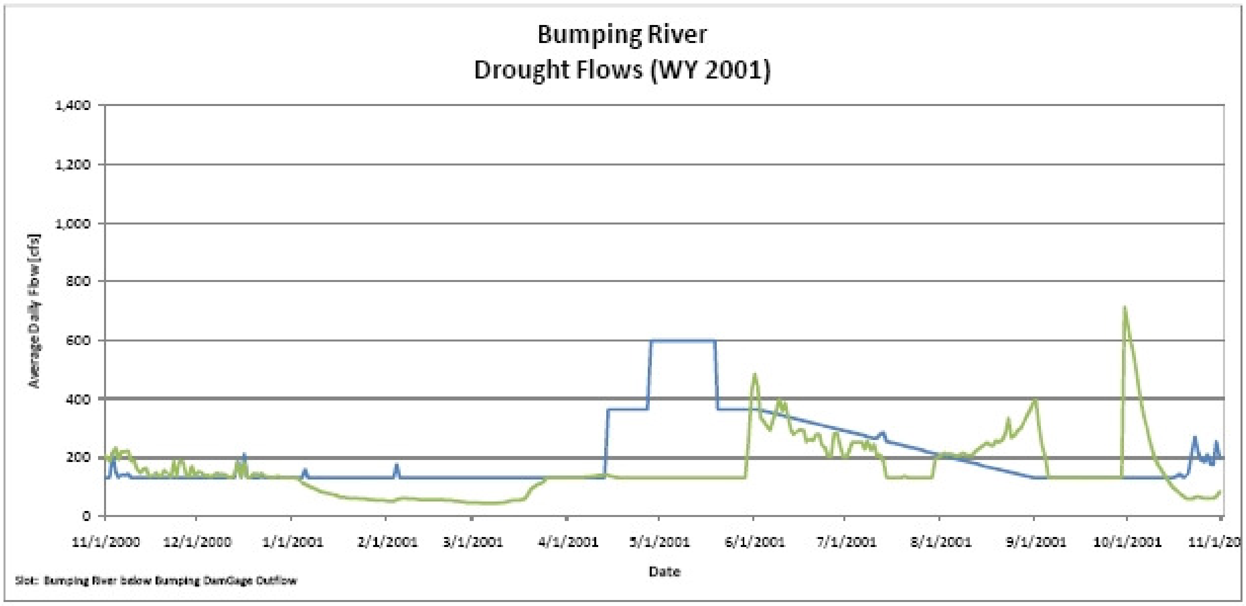
[7] FPEIS, page 5-84

[8] Modeling of Reliability and Flows Technical Memorandum of June 2011, Appendix B, page 6 of 22.

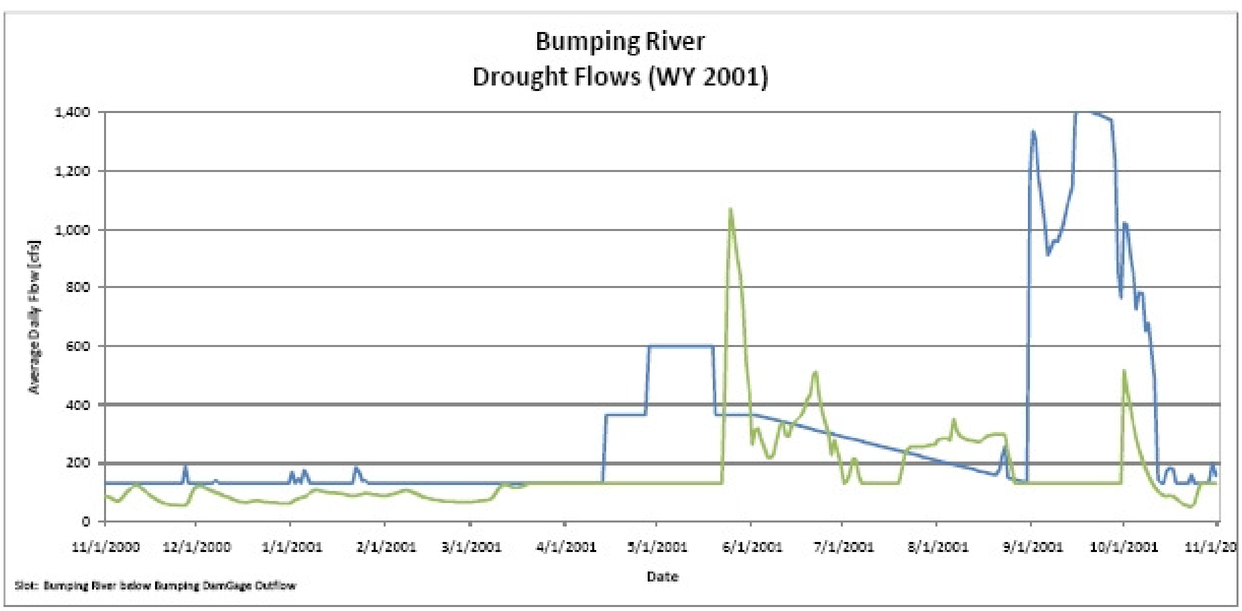
Figure 2

Bumping River Hydrograph Integrated Plan with No Climate Change

Dry-Year 2001



Bumping River Hydrograph Integrated Plan with Moderately Adverse Climate Change
Dry-Year 2001



Carryover Storage and Reservoir Refill - - The carryover storage from good water years for use in water deficient years and the ability of the reservoir system to refill is vital to the reliability of the Integrated Plan in meeting future water demands. The end-of-month storage contents of the three major storage projects of the Integrated Plan are shown in Figure 3 for the Integrated Plan with no climate change and the Integrated Plan with climate change.[9] Storage contents are generally at their maximum at the end of June and their minimum at the end of September. [Note: Ignore the green line in the hydrograph as this is the future without Integrated Plan].

Table 3 provides a summary of the number of years of the 25-year period (1981-2005) that the three major water storage projects of the Integrated Plan refill to the indicated capacity.

Table 3 - - Number of Years integrated Plan Reservoirs Refill to Indicated Capacity

Reservoir	Integrated Plan With No Climate Change	Climate Change Scenario		
		Less Adverse	Moderately Adverse	More Adverse
Kachess				
Active (200,000 acre-feet)	20	17	8	3
Inactive (200,000 acre-feet)	25	25	17	17
Bumping (190,000 acre-feet)	22	24	18	11
Wymer				
Instream Flow (82,500 acre-feet)	23	22	14	13
Dry-Year Irrigation (80,000 acre-feet)	25	25	25	24

Conclusions

The seven elements of the Integrated Plan are purported to "provide a comprehensive framework to protect water resources and habitat that can support the Secretary (of the Interior) in development of strategies to mitigate impacts associated with climate change". However, the operational modeling results summarized herein question the capability of the surface storage element of the Integrated Plan to ensure a reliable water supply to sustain the Yakima River basin's irrigated agricultural economy and ecosystem, and to provide for future municipal and domestic needs with the advent of climate change and its impacts on water supply.

The Integrated Plan includes an "adaptation process that would begin in 2015 intended to further refine measures for potential plan adjustments through time". It also includes a future study of the potential for an interbasin transfer of Columbia River water as a source to meet additional water supply needs contingent on how the Yakima River basin's economy develops over time and the timing of, and manner in which climate change affects water supply capability.

On the other hand, the Final Programmatic Environmental Impact Statement indicates that "Reclamation and Ecology with the input from the Workgroup, determined that there was no reasonable certainty that a pump exchange project was environmentally or economically feasible

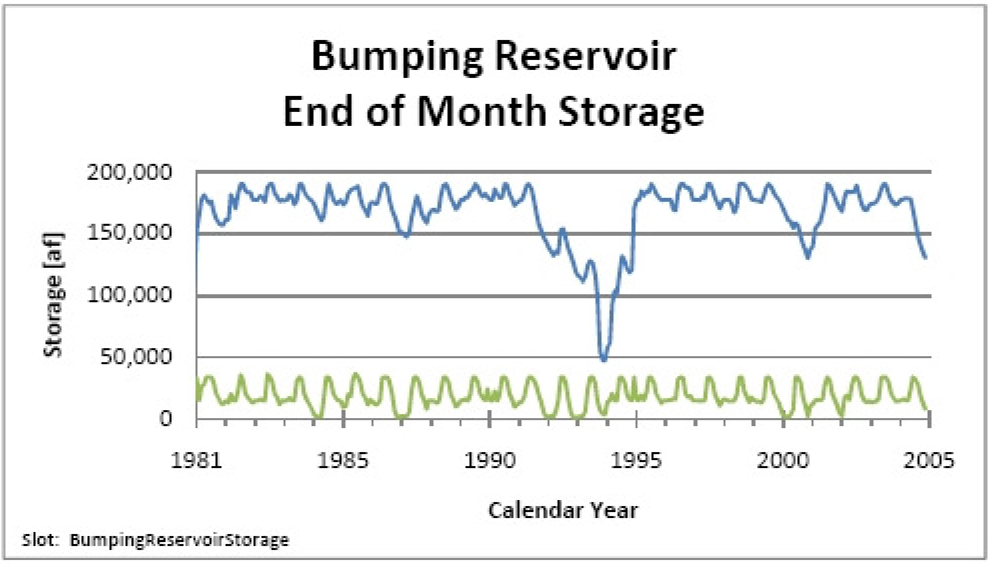
[9] Ibid, Appendices B, D-1, D-2, and D-3, pages 19 and 20 of 22.

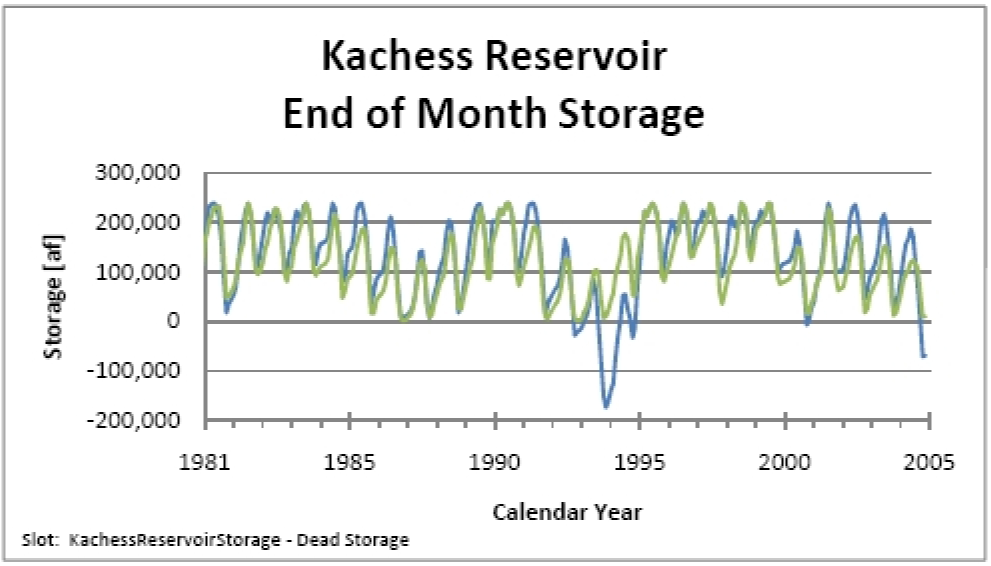
at this time to meet the Purpose and Need". Consequently, the only water storage projects considered were Wymer Dam and Reservoir, Kachess Reservoir Inactive Storage, and Bumping Lake Reservoir Enlargement. Ironically these projects are being strongly promoted while their environmental and economic feasibility have yet to be determined.

With the time immemorial Treaty right of the Yakama Nation for instream flows to sustain anadromous fisheries being senior to all other water rights, and with climate change having the potential to seriously affect the reliability of in-basin stored water supplies, we are faced with the reality that a Columbia River pump exchange is the only source of "new water" to supplement our over-appropriated Yakima River system. Yet, this source may become even more limited for out-of-stream diversions when Columbia River Treaty discussions which commence in 2014 are completed.

While the Integrated Plan has some desirable attributes, it falls short in addressing water storage by providing a short-term vision to a long-term problem. The risk is too great! The need for an in-depth and open discussion of our surface water supply options is now, not "down the road" when we are facing a crisis of our own making.

Figure 3
Integrated Plan with No Climate Change





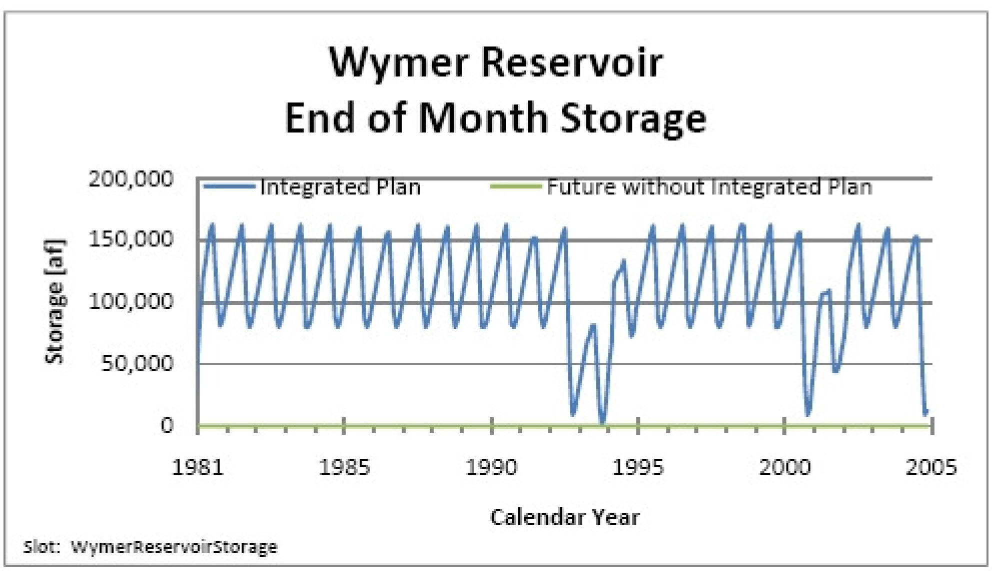
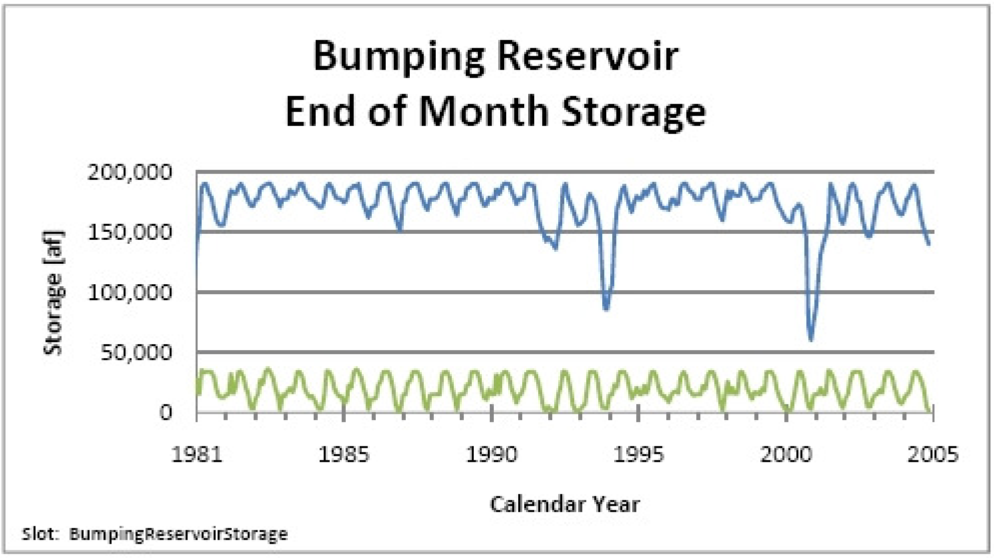
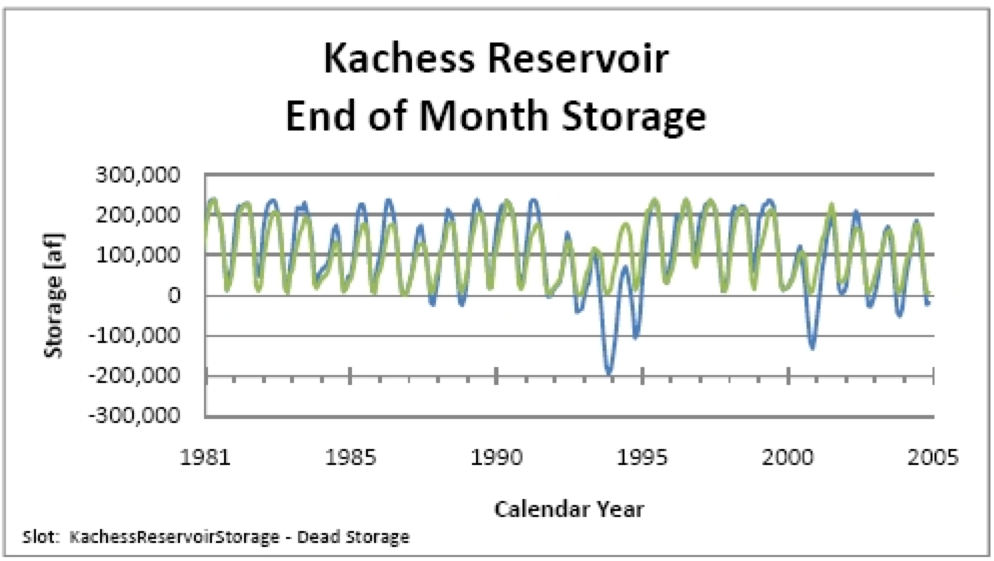


Figure 3
Less Adverse Climate Change Scenario





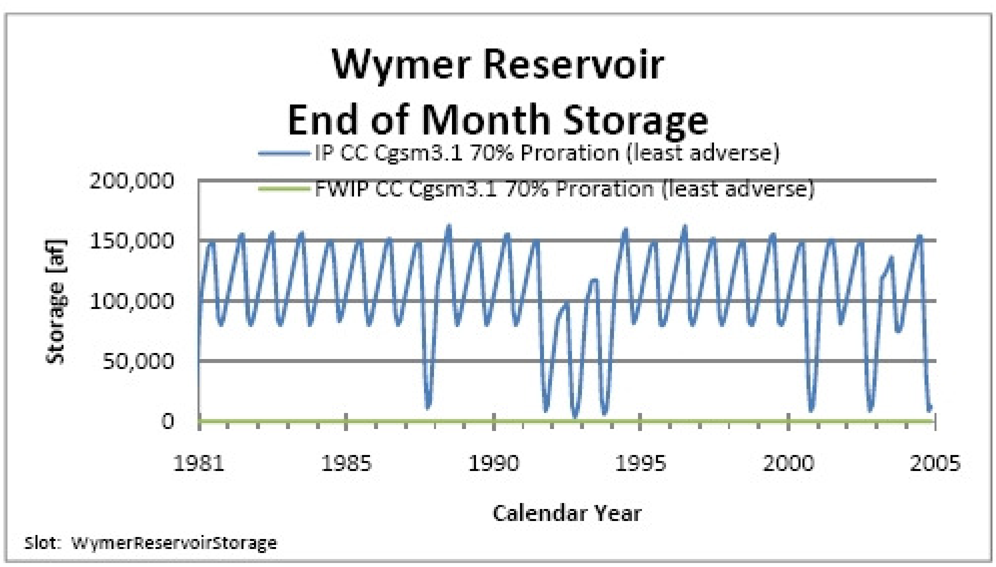
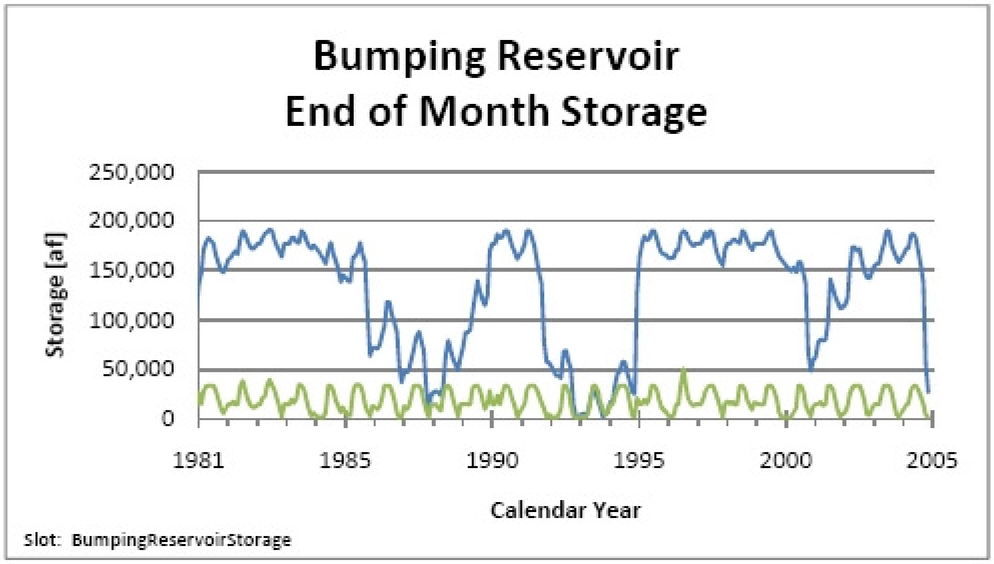
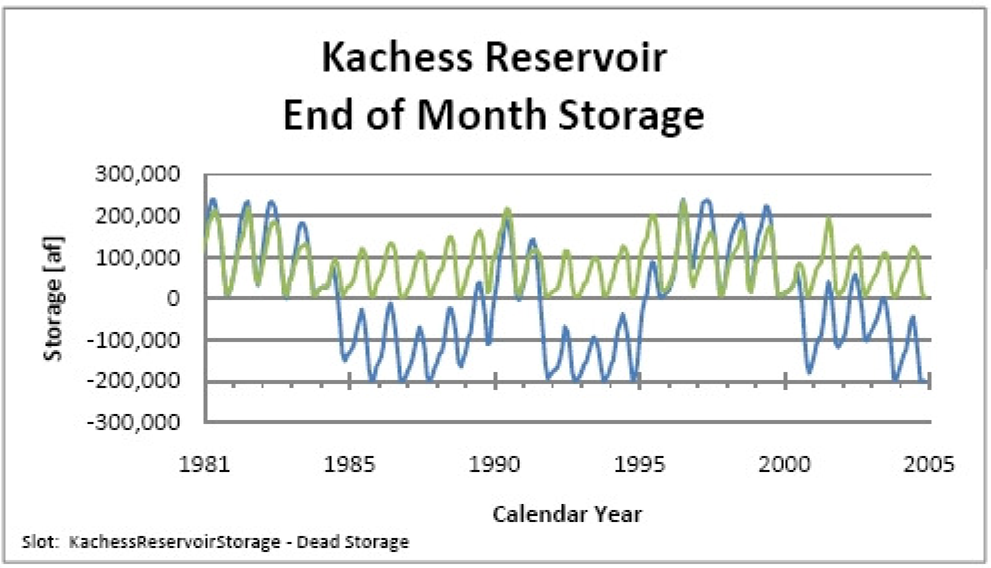


Figure 3
Moderately Adverse Climate Change Scenario





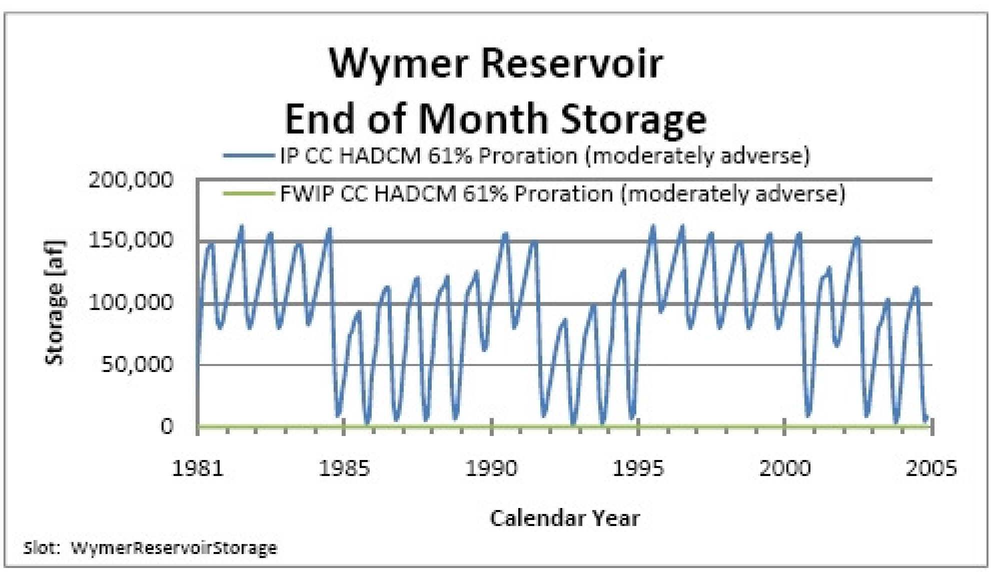


Figure 3
More Adverse Climate Change Scenario