YBIP Hydrology & Economic Analysis: Supply, Costs & Impact Insights

Public Perspectives Session

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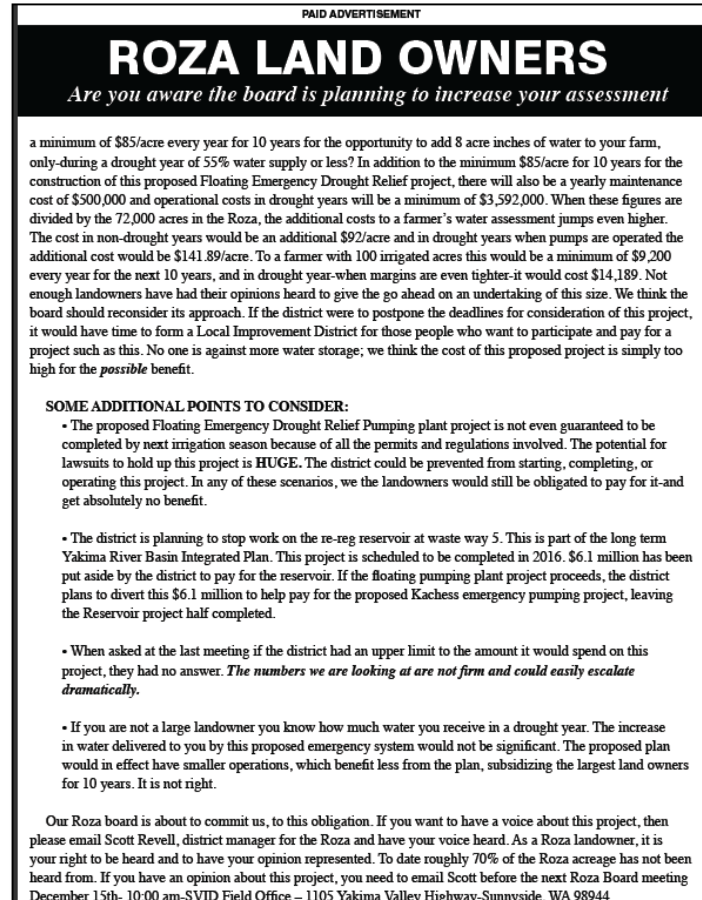
June 21st, 2017

Roza farmers and WA taxpayers have the same questions about KDRPP…

1. How much water will the project deliver?
2. How much will it cost?
3. Is this good for farmers (and taxpayers)?
4. Are the projections accurate and objective?

… And they need simple, direct answers from the Work Group



PAID ADVERTISEMENT

ROZA LAND OWNERS

Are you aware the board is planning to increase your assessment

a minimum of $85/acre every year for 10 years for the opportunity to add 8 acre inches of water to your farm, only-during a drought year of 55% water supply or less? In addition to the minimum $85/acre for 10 years for the construction of this proposed Floating Emergency Drought Relief project, there will also be a yearly maintenance cost of $500,000 and operational costs in drought years will be a minimum of $3,592,000. When these figures are divided by the 72,000 acres in the Roza, the additional costs to a farmer's water assessment jumps even higher. The cost in non-drought years would be an additional $92/acre and in drought years when pumps are operated the additional cost would be $141.89/acre. To a farmer with 100 irrigated acres this would be a minimum of $9,200 every year for the next 10 years, and in drought year-when margins are even tighter-it would cost $14,189. Not enough landowners have had their opinions heard to give the go ahead on an undertaking of this size. We think the board should reconsider its approach. If the district were to postpone the deadlines for consideration of this project, it would have time to form a Local Improvement District for those people who want to participate and pay for a project such as this. No one is against more water storage; we think the cost of this proposed project is simply too high for the *possible* benefit.

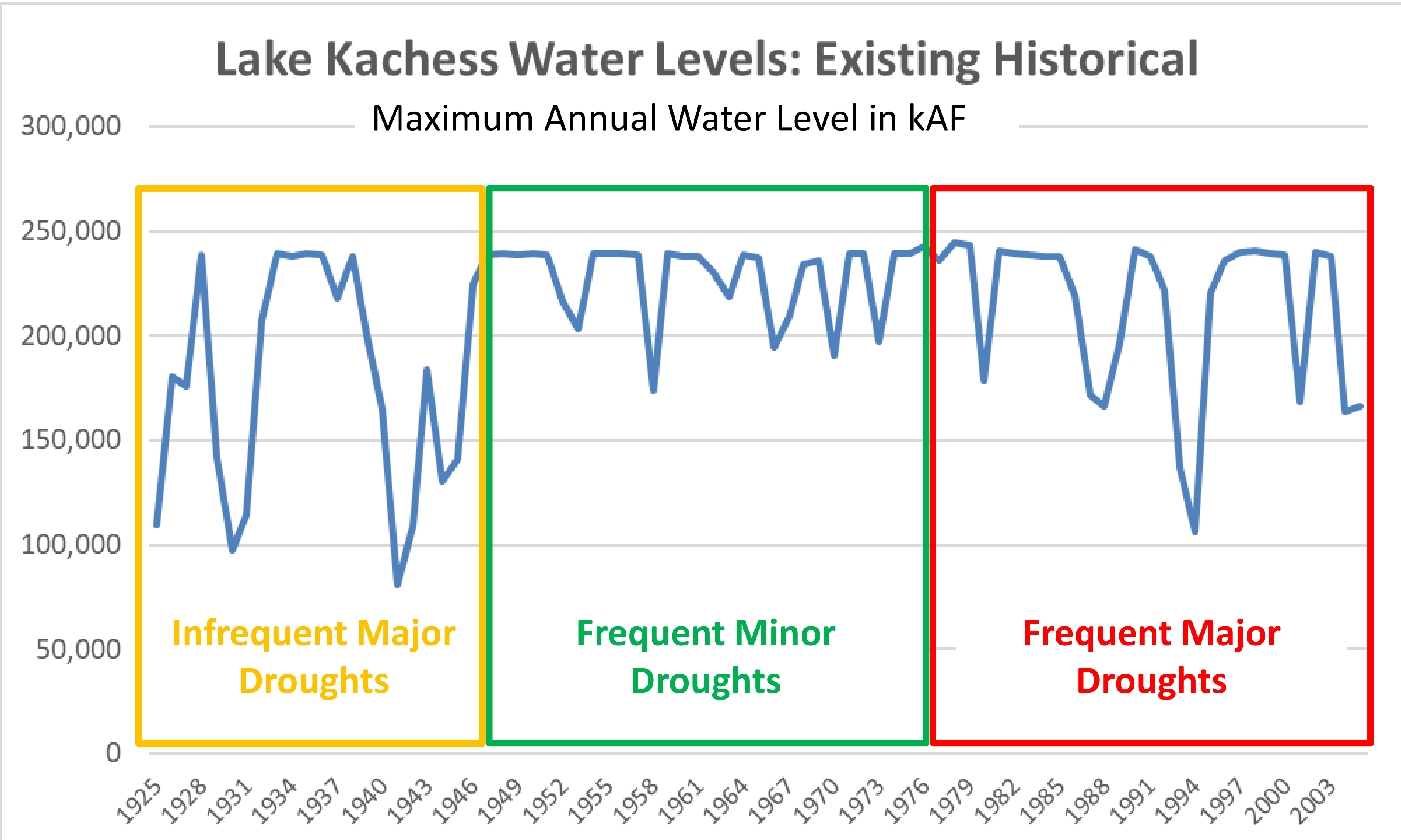
SOME ADDITIONAL POINTS TO CONSIDER:

- The proposed Floating Emergency Drought Relief Pumping plant project is not even guaranteed to be completed by next irrigation season because of all the permits and regulations involved. The potential for lawsuits to hold up this project is **HUGE.** The district could be prevented from starting, completing, or operating this project. In any of these scenarios, we the landowners would still be obligated to pay for it-and get absolutely no benefit.
- The district is planning to stop work on the re-reg reservoir at waste way 5. This is part of the long term Yakima River Basin Integrated Plan. This project is scheduled to be completed in 2016. $6.1 million has been put aside by the district to pay for the reservoir. If the floating pumping plant project proceeds, the district plans to divert this $6.1 million to help pay for the proposed Kachess emergency pumping project, leaving the Reservoir project half completed.
- When asked at the last meeting if the district had an upper limit to the amount it would spend on this project, they had no answer. ***The numbers we are looking at are not firm and could easily escalate dramatically.***
- If you are not a large landowner you know how much water you receive in a drought year. The increase in water delivered to you by this proposed emergency system would not be significant. The proposed plan would in effect have smaller operations, which benefit less from the plan, subsidizing the largest land owners for 10 years. It is not right.

Our Roza board is about to commit us, to this obligation. If you want to have a voice about this project, then please email Scott Revell, district manager for the Roza and have your voice heard. As a Roza landowner, it is your right to be heard and to have your opinion represented. To date roughly 70% of the Roza acreage has not been heard from. If you have an opinion about this project, you need to email Scott before the next Roza Board meeting December 15th- 10:00 am-SVID Field Office – 1105 Yakima Valley Highway-Sunnyside, WA 98944

Ad courtesy Yakima Herald

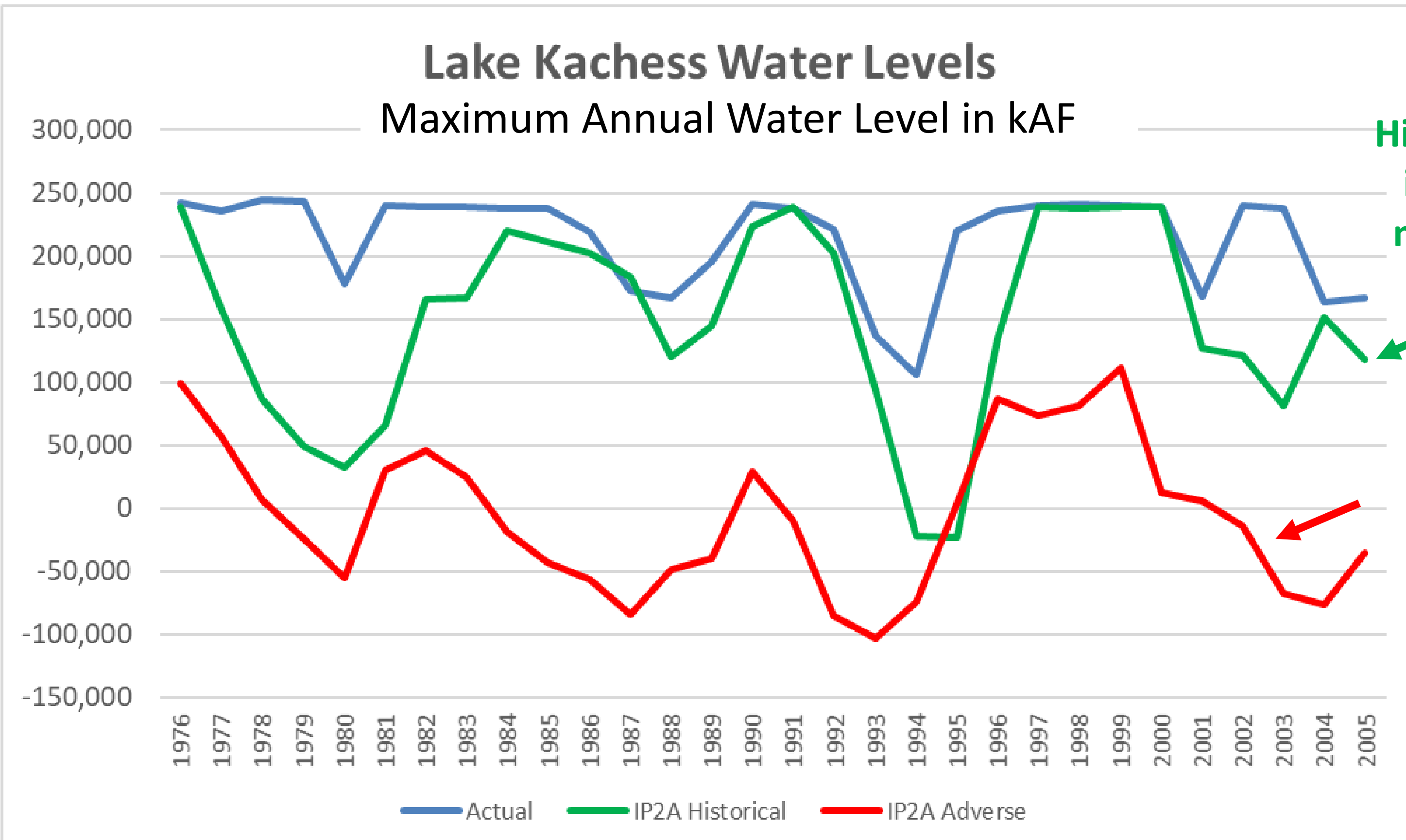
Let’s first focus on the right historical period: 1976-2006 vs the entire historical period



How much water would this project deliver?

It depends greatly on one's view of climate change

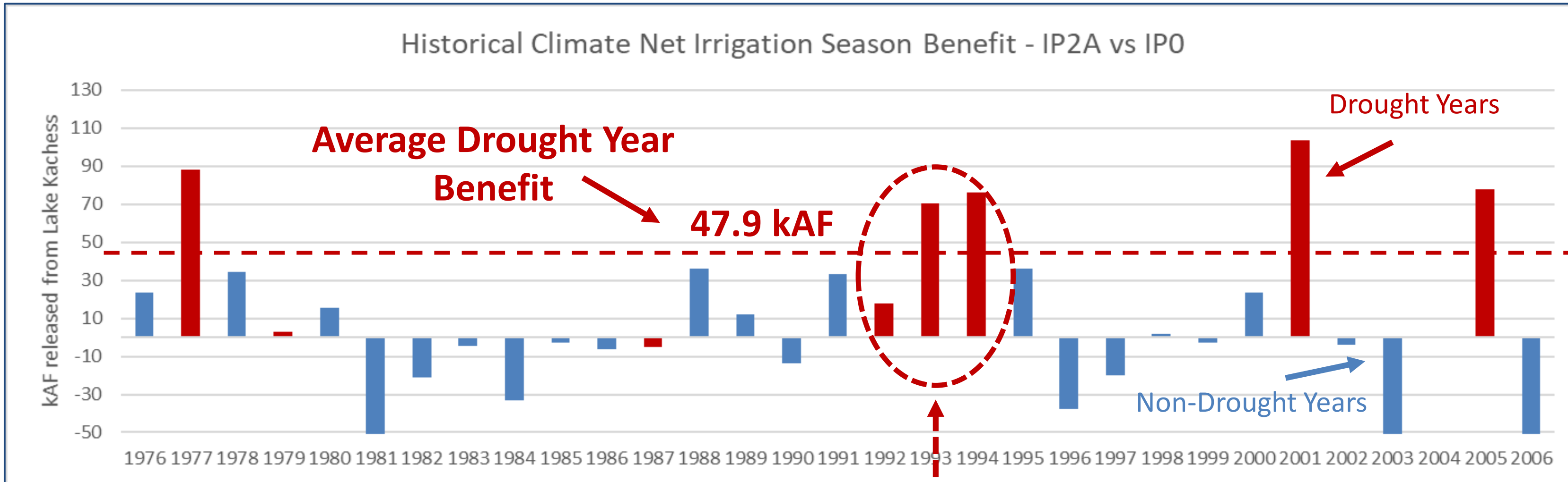
- No one supports "history will repeat itself" yet there is a lack of consensus on the most likely trajectory of "climate change"

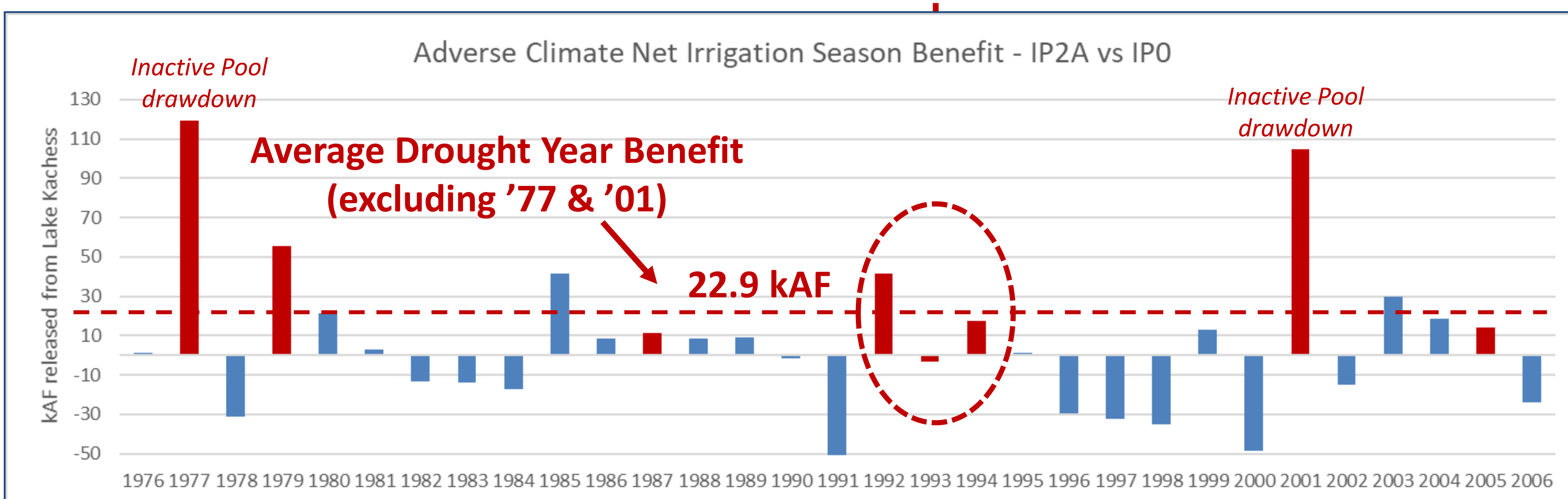


Historical Climate – increased usage modestly curtails future benefits

dverse Climate – limited supply nificantly curtails uture benefits

Depending on "Climate Change", KDRPP is either a modest benefit or a complete failure





So what's the true water supply impact of KDRPP?

Water Supply Impact	Historical Climate	Adverse Climate
Average Drought Year Benefit	48 kAF	23 kAF
Impact on Average TWSA (per BoR = 2,547 kAF)	1.8%	0.9%
Impact on Average ID Deliveries (per BoR = 1,580 kAF)	3.0%	1.5%
Impact on Average Roza ID Deliveries (per BoR = 286.2 kAF)	16.8%	8.0%
Impact on '92-'94 Drought (average across 3 Yrs)	54.6 kAF per year	18.7 kAF per year

"Projects in addition to KCC, KDRPP, and CEPR would be needed to meet the goal in all years"

– Phase 3 Technical Memorandum p. 54

How much does the water cost?

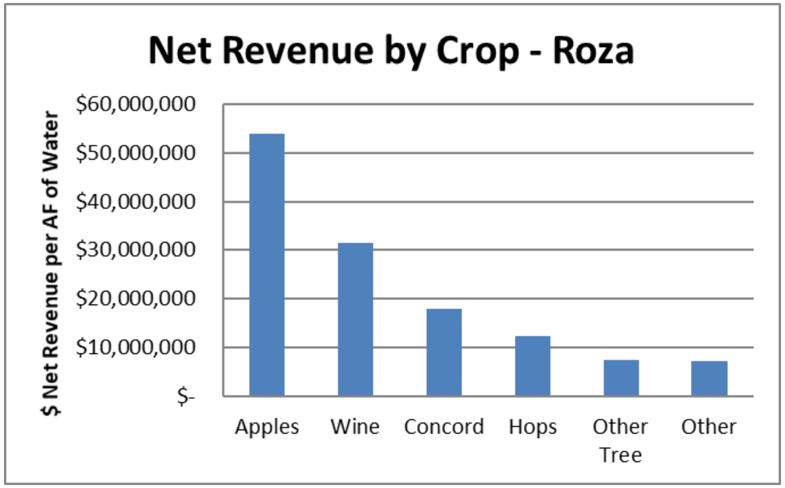
90-Year KDRPP Cost Projections ($M)								
KDRPP Project Costs	Initial Construction	Replacement	Non-Drought Year OpEx	Additional Drought Year OpEx	Total Cost	Annual Debt Payments on $200M Construction Loan	Average Annual Operating Costs	Average Annual Costs
Total Cost	**$ 200.0**	**$ 150.0**	**$ 220.0**	**$ 165.0**	**$ 735.0**	**$ 13.01**	**$ 4.28**	**$17.29**
Present Value	**$ 191.1**	**$ 40.7**	**$ 72.7**	**$ 56.2**	**$ 360.7**			
Assumptions:		*$50M every 30 Yrs*	*$2.5M per Yr*	*$5M per drought Yr*	*PV @ 3% Interest*	*5% Interest; 30 Yrs*		

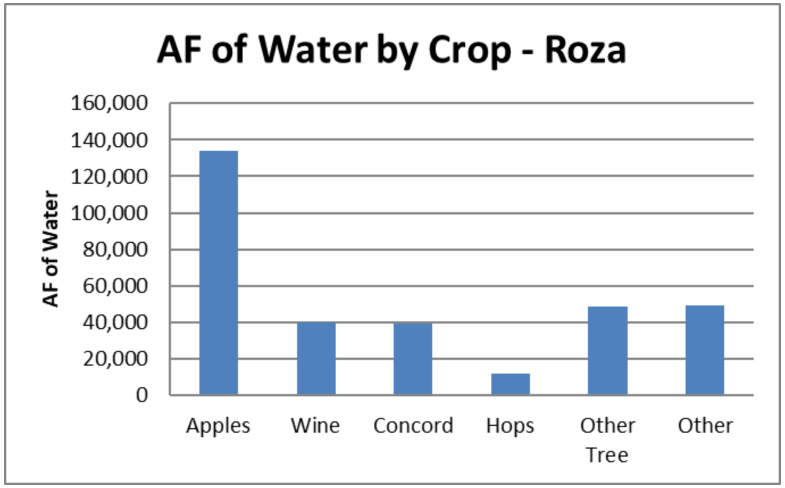
***N**ote: Does not include Mitigation, Litigation & Contingency Costs*

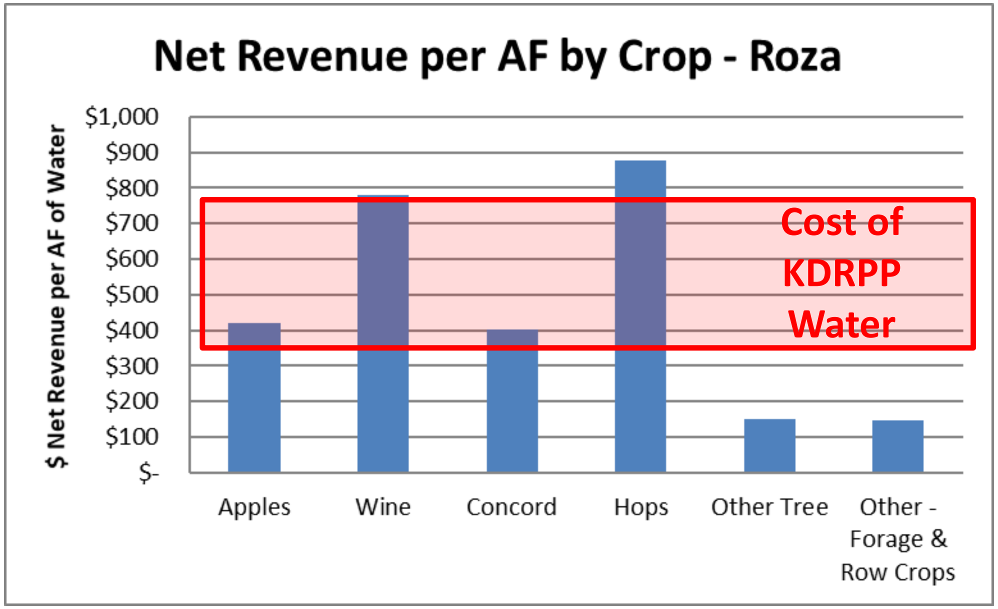
Water Supply Impact	Historical Climate	Adverse Climate
Average Drought Year Benefit	48 kAF	23 kAF
Cost per Acre Foot of Water	$361	$755
Annual Cost per Roza ID Irrigated Acre (per RID = 72k kAF)	$240	$240
Annual Cost per 80 Acre Roza Farm	$19,209	$19,209

Is it good for farmers (and taxpayers)?

Not all farmers will want to pay for it … And WA taxpayers will struggle to see the value





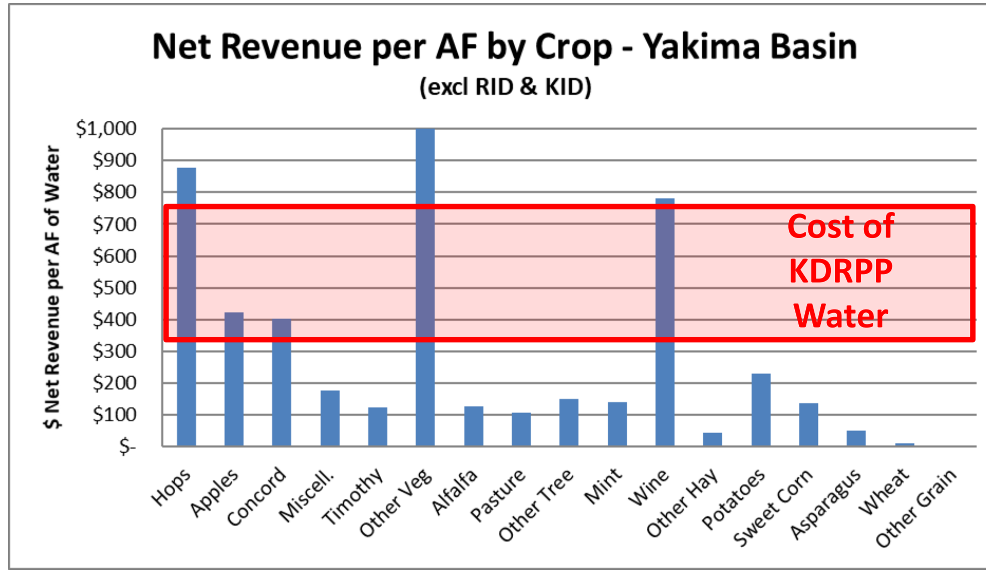


- Wine & Hops Profits are cut in half
- $400+ water wipes out profits for all other crops

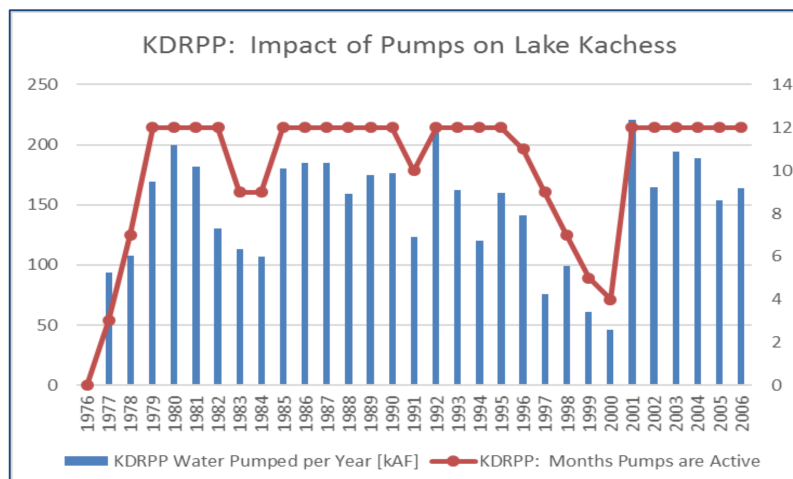
Is it good for the other (non-Roza) farmers?

Once again, not all farmers will want to or be able to pay for it …

Apples	180,725	$ 421	$ 78,695,736
Miscell.	206,284	$ 175	$ 35,794,430
Other Veg	15,097	$ 1,407	$ 20,728,306
Pasture	153,854	$ 107	$ 16,411,498
Mint	66,513	$ 141	$ 9,330,420
Other Hay	86,109	$ 45	$ 3,846,960
Sweet Corn	8,624	$ 138	$ 1,188,972
Wheat	80,961	$ 10	$ 824,360



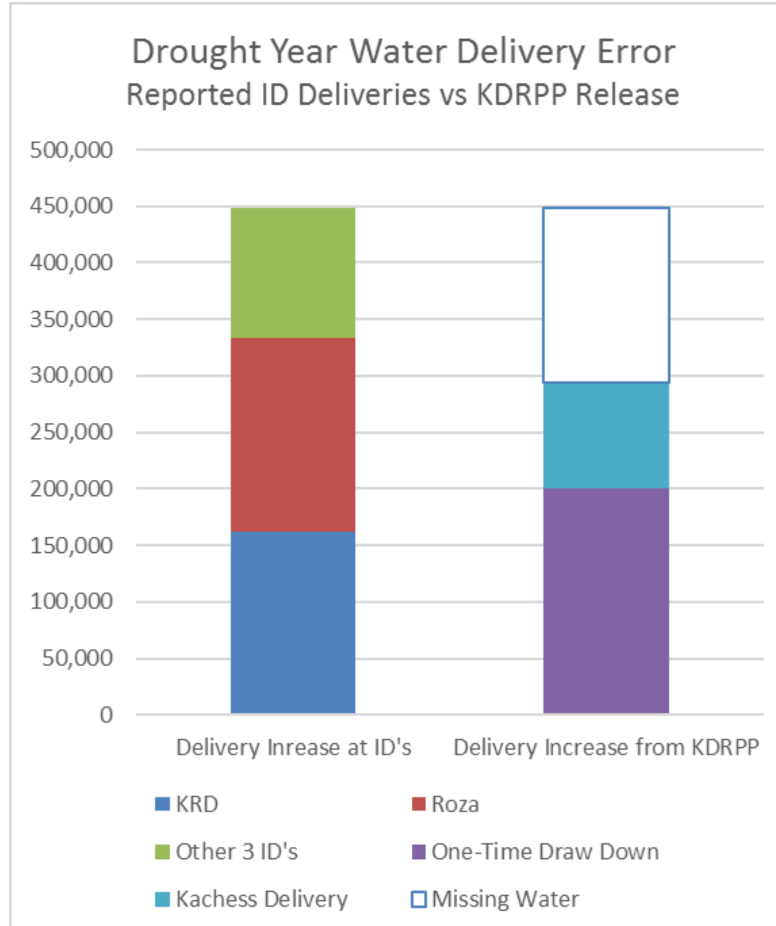
And what happens when ID's believe previous KDRPP deliveries should belong to them?

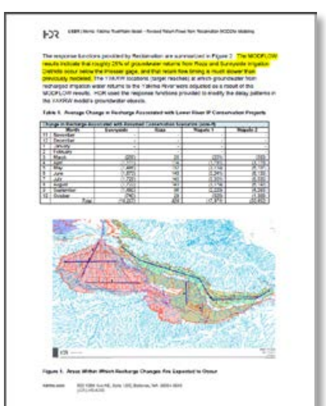


Are the projections accurate? – Return Flow Issue

The importance of accurate "return flow" projections is critical

- Irrigation Districts (ID's) are being promised 52% more water than the KDRPP project actually delivers
- "Phase 3" TM modeling reduced lower basin return flows by over 25 kAF per year
  - *"the updated Phase 3 YAKRW Model results show that return flows occur more slowly and exhibit less fluctuation throughout the year"*
  - *"RID would recapture 50 percent of return flows in average years and 67 percent of return flows in drought years"*





	Sunnyside	Roza	Wapato 1
Total	(10,207)	826	(17,971)

Are the projections accurate? – Phase 3 Updates

In addition to the Return Flow changes, a number of updates were done to the YAKRW model …

1. Inflow changes based on Regression Analysis vs historic data

> HDR concluded that older, calculated local inflows are not the same as would occur today under modern irrigation practices. Therefore HDR decided to calculate local inflows for the period before 2004 by regression, rather than by using measured streamflows.

2. Conservation programs in the IP0 scenario

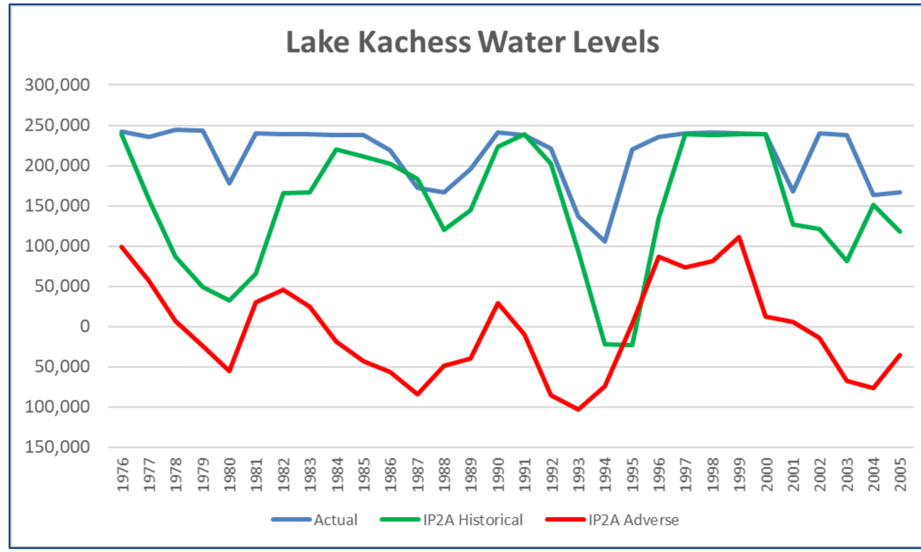
> or WIP improvements. Although some of these projects may be outdated, they were included in this modeling effort to represent additional potential water conservation in the Yakima River basin assuming all known conservation projects are implemented. These

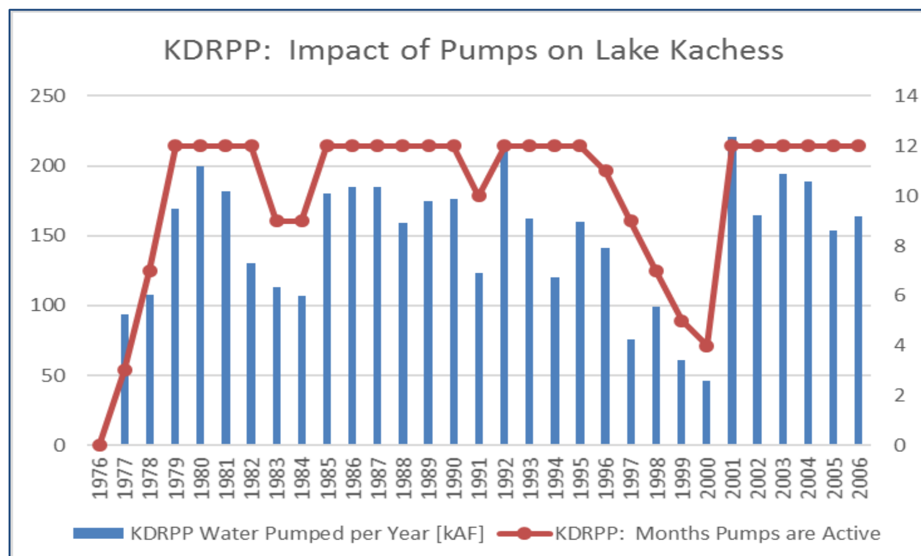
3. These changes result in the following adjustments to KDRPP impact (in the Adverse Climate Scenario 1976-2006):
    - Increases ID Deliveries by 993 kAF
    - Decreases KDRPP pumping plant deliveries by 936 kAF
    - Need to better understand these assumption changes and their impact

What's the Impact?

Lake Kachess is a limited solution to a significant, long-term problem

- Due to the deficit watershed, Lake Kachess is of limited long-term value
- In the Adverse Climate scenario the Lake never recovers above the current minimum pool (i.e. -5k average high-water level)
- In only 6 years (out of 31) does the lake recover above 50 kAF of storage
- The KDRPP "floating pump" requires nearly permanent, year-round use of the pumps … but for fish, not crops





Next Steps

1. Continue to review TM hydrology & economic data to ensure accuracy and completeness
2. Discuss the need for 3rd Party "peer-review" to affirm objectivity of the assumptions and analysis
   - Hydrology
   - Economics
   - Fish Recovery
   - Community Impact
3. Explore collaborative and creative options for more productive engagement and constructive disagreement
4. Problem-solve around improved water strategy/use vs defaulting to expanded storage

Appendix & Backup Data

The following data and sources support the previous slides and were presented at the BoR Technical Session on 4/5/17

3 Basic Questions - YBIP Hydrology & Economic Analysis: Errors & Omissions

Review of Phase I Hydrology & Economic Impact of the KDRPP & KKC

with Annotation Details

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April 5th, 2017

Overview – YBIP, KDRPP & the 2016 Hydrology report

https://www.usbr.gov/pn/programs/yrbwep/2011integratedplan/2016hydromodeling.pdf

- The primary water storage/security projects of the Initial Phase of the YBIP are the Kachess Drought Relief Pumping Plant (KDRPP) and Keechelus to Kachess Conveyance (KKC)
- The Bureau of Reclamation's July 2016 Hydrology Technical Memorandum (TM) is the first detailed review of the impact of the KDRPP (and KKC) on Lake Kachess and the YB Irrigation Districts
- Based on the detailed review of the BoR's data provided in the TM, an in-depth analysis of the benefits and concerns of the KDRPP & KKC is possible
- All of the hydrology data provided in the following report comes from the BoR TM and provides a clear indication of the errors and omissions inherent in the KDRPP & KKC conclusions presented to date
- Accordingly, irrigators and public officials should be very concerned about the "promises" made in regard to KDRPP & KKC … they are not aligned with the facts

Simply put, it is an "over-promise and under-deliver" political play that will leave irrigators and the public paying too much for too little water

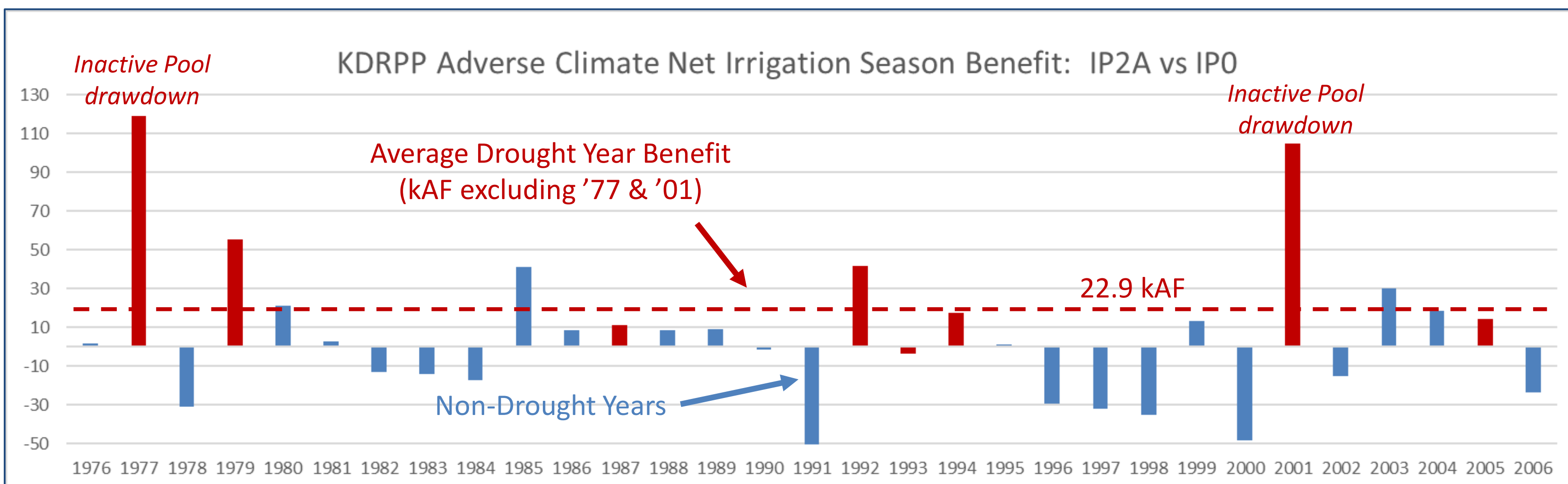
3 Basic Questions – For Any Water Storage Project

The Basic Questions	Data Driven Answers	The "So-What"
How much irrigation water will the project provide? (especially in droughts when we most need it?)	• During droughts, actual long-term KDRPP benefits average less than 23 KAF (less than 0.13% of Yakima Basin Irrigation District use) • Irrigation Districts (ID's) are being promised 52% more water than the KRDPP project actually delivers	• Ignore the PR, look for the data and the facts. The long-term benefit is trivial at best • And it will be too late by the time we realize it … the $ will have been spent
How much will it cost? (And is it a good investment?)	• The KDRPP project will cost irrigators and the public well over $500 per AF; only the top 3 crops can afford it	• Irrigators can't afford it on their own and the public shouldn't support it
What will the impact be on Lake Kachess?	• The impact of the KDRPP project on Lake Kachess is absolute devastation • KKC provides no meaningful water storage benefit for Lake Kachess	• The ancient lake will never recover due to the "deficit" water shed above it • KKC simply supports fish & habitat, not water storage or security

How Much Water?

Other than the one-time 200 kAF draw down of the inactive pool, KDRPP benefits are trivial (<23 kAF in drought years)

- The projected benefits of the KDRPP project are limited at best and primarily depend on a one-time use ~200 kAF from the inactive pool
  - Excluding the 2 years where the inactive storage water is used, drought year benefits average less than 23 kAF, a net increase of 137 kAF in total and a less than 1% impact on TWSA (Total Water Supply Available)
  - Over the 31 year history, KDRPP shifts 361 kAF to drought years and withholds 158 kAF from non-drought years.
- Given the limited refill capacity of Lake Kachess, KDRPP is unable to materially affect water security in over 60% of drought events
  - For example, the multi-year drought of 1992-1994 is not materially impacted with KDRPP only able to provide a total of 56 kAF of additional water across all three years
  - **For 1994, the worst year of the drought, KDRPP only adds 18 kAF and in 1993, it reduces deliveries by -3 kAF**
  - In all, only 3 of the 8 drought years see a material benefit; in 4 of 8 droughts KDRPP has no fundamental impact



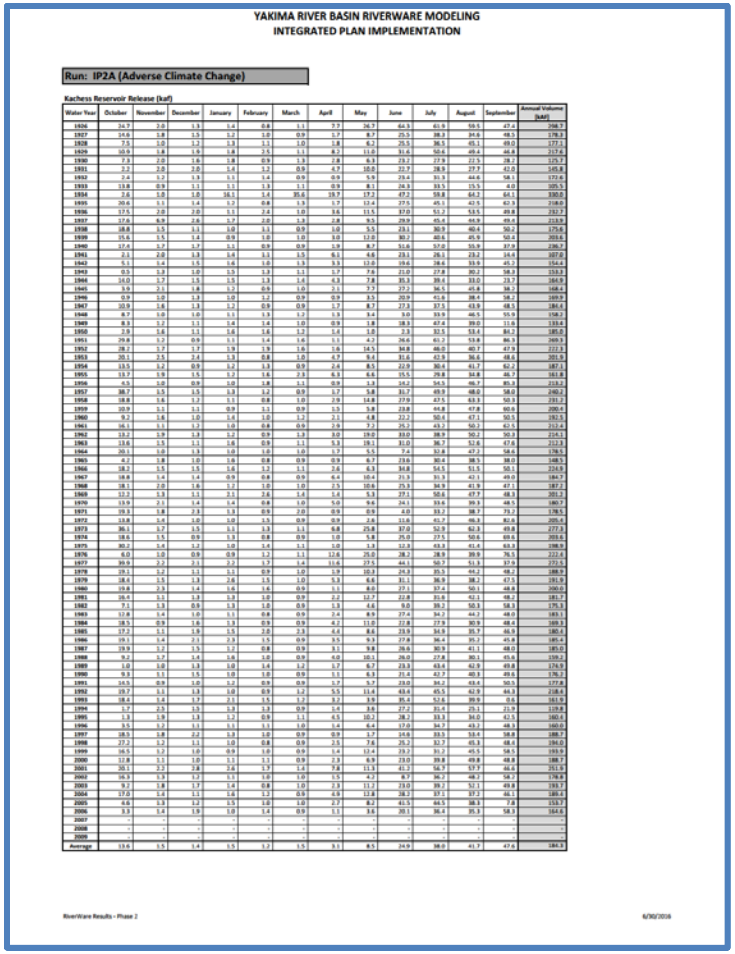
See Appendix 1 A & B

How Much Water?

Technical Memorandum Data: Kachess Reservoir Release

Annotation Details

Page 593 (IP2A Adverse April - Sept) - Page 541 (IP0 Adverse April - Sept)



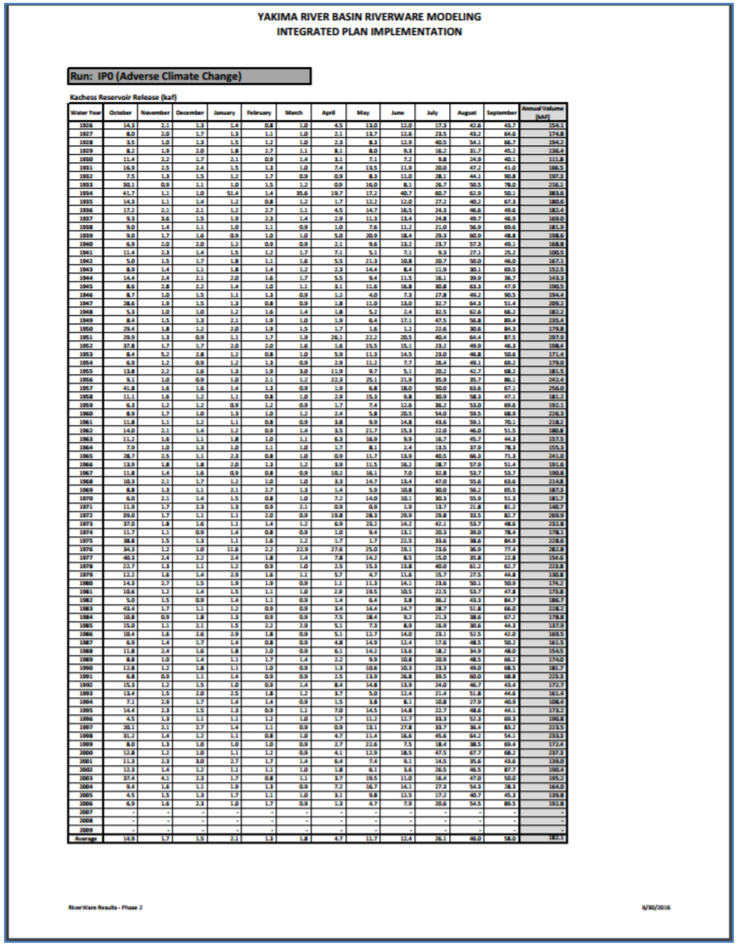
YAKIMA RIVER BASIN RIVERWARE MODELING
INTEGRATED PLAN IMPLEMENTATION

Run: IP2A (Adverse Climate Change)

Kachess Reservoir Release (kaf)

Water Year	October	November	December	January	February	March	April	May	June	July	August	September	Annual Volume (kaf)
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

RiverWare Results - Phase 2



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INTEGRATED PLAN IMPLEMENTATION

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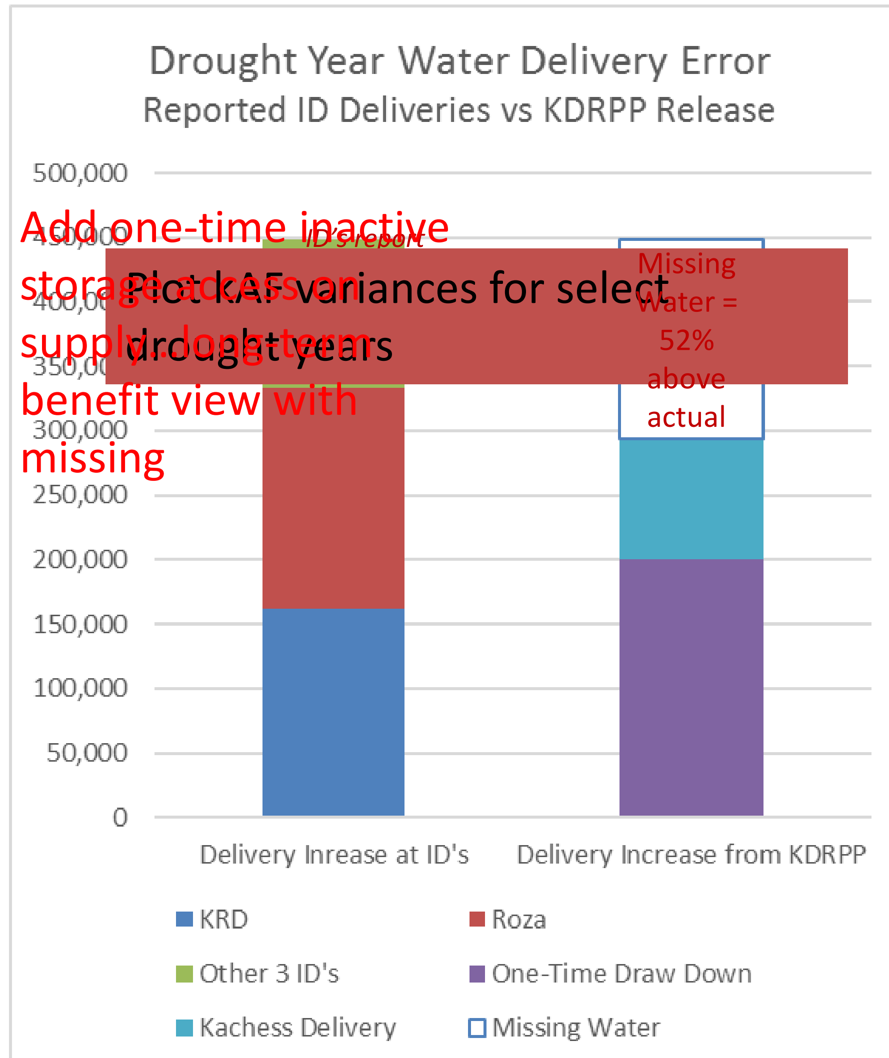
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

RiverWare Results - Phase 2

Irrigator's won't get the water they are being "promised" as ID water deliveries exceed KDRPP releases by 52%

In Adverse IP2A, KRDPP is the only active water storage change, so deliveries from KDRPP should align with Irrigation District impact

- In the 8 drought years between 1976 – 2006, Irrigation Districts are promised ~450 kAF of additional water with KDRPP
- Yet the KDRPP produces less than 300 kAF of additional water, and most of this is from the one-time use of the inactive pool
- Given the significant difference, the BoR needs to explain (especially to the Irrigation Districts) a 52% distortion

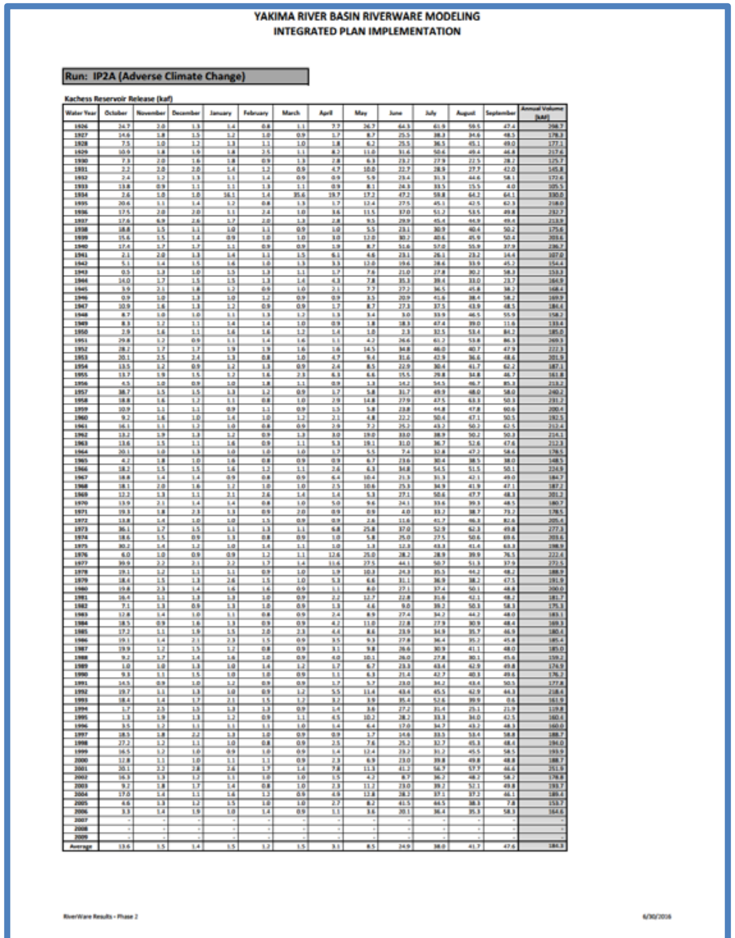


See Appendix 2

Technical Memorandum Data: Kachess Reservoir Release vs Irrigation District Deliveries

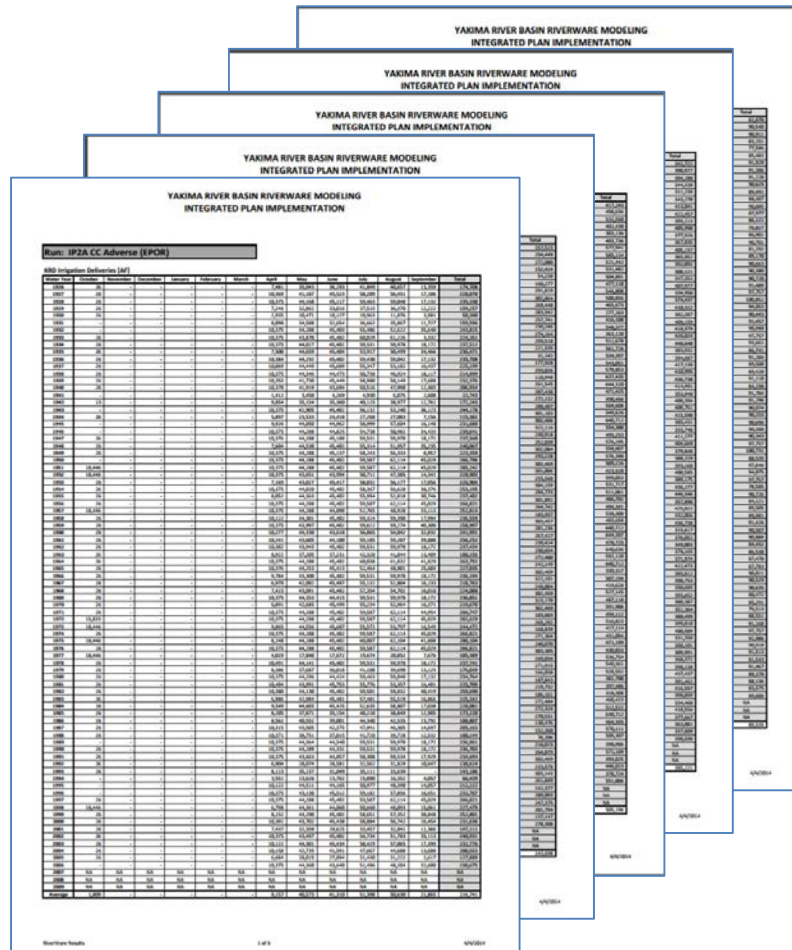
Annotation Details

Page 593 (IP2A Adverse Kachess Reservoir Release April - Sept) vs **Pages 599-603** (IP2A Adverse Irrigation District deliveries April - Sept)


YAKIMA RIVER BASIN RIVERWARE MODELING
INTEGRATED PLAN IMPLEMENTATION

Run: IP2A (Adverse Climate Change)

Kachess Reservoir Release (kaf)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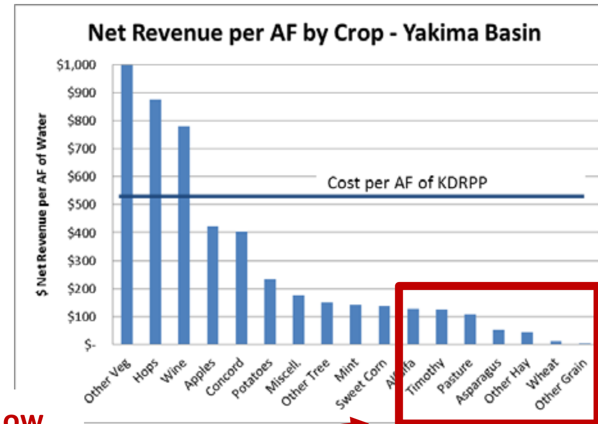
Given the likely life-time costs of the KDRPP project, KDRPP will cost irrigators and the public well over $500 per acre foot of water

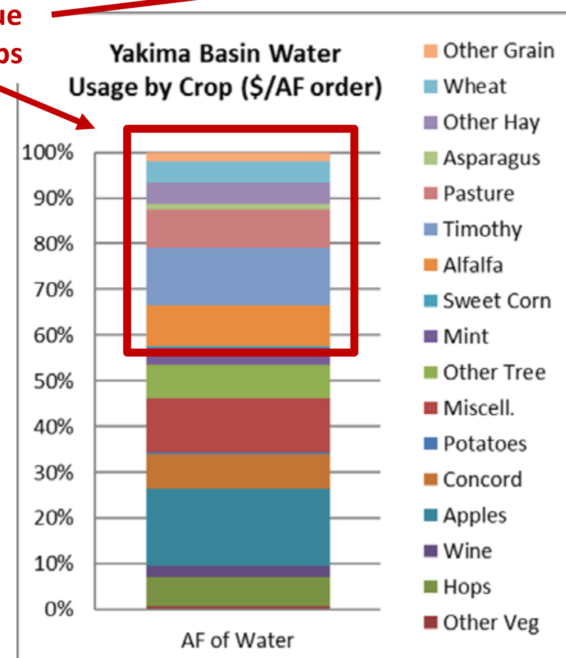
- Assuming a life-time cost of $350M and total KDRPP benefit of ~680 kAF (90 year project life), cost per AF equals $513
  - The year-round use and economic life of the pumps will also require relatively frequent replacement, adding to costs
  - At this point, no detail cost data has been made public
  - And, significant mitigation costs are not included
- In most all cases, KDRPP water is far more expensive than the value of the crops on which it is used
  - Only 3 crops in the entire Yakima Basin earn profits in excess of $500 per AF (Vegetables, Hops, Wine), so the benefit-cost economics are very unattractive
  - Currently, over 40% of YB water is used for low value crops that don't even earn $120 per AF of water

High Level KDRPP Economics: 90 Year Projection		
Total 31 Year Drought Year Benefit (kAF)		361
Less: One time use of inactive storage (kAF)		200
Net Ongoing Benefit for future 30 Year periods (kAF)		161
2x Ongoing Benefit (kAF)		322
Total ~90 Year Benefit (kAF)		683
Projected Lifetime Cost ($M)	$	350
KDRPP Cost per AF	$	513

Note: Existing estimates are in excess of $800+M = $1,000+ per kAF



Low Value Crops



See Appendix 3 a, b & c

KDRPP 90 Year Cost Estimate: Illustrative Economics

	Initial Construction	Replacement	Non-Drought Year OpEx	Additional Drought Year OpEx	Total Cost
Total Cost	**$ 180,000,000**	**$ 150,000,000**	**$ 220,000,000**	**$ 165,000,000**	**$ 715,000,000**
Present Value	**$ 172,212,273**	**$ 141,430,568**	**$ 77,151,134**	**$ 103,828,959**	**$ 341,857,028**

Year	Initial Construction	Replacement	Non-Drought Year OpEx	Additional Drought Year OpEx	Total Cost
1	$ 90,000,000				$ 90,000,000
2	$ 90,000,000				$ 90,000,000
3			$ 2,500,000	$ 5,000,000	$ 7,500,000
4			$ 2,500,000		$ 2,500,000
5			$ 2,500,000		$ 2,500,000
6			$ 2,500,000	$ 5,000,000	$ 7,500,000
7			$ 2,500,000		$ 2,500,000
8			$ 2,500,000		$ 2,500,000
9			$ 2,500,000	$ 5,000,000	$ 7,500,000
10			$ 2,500,000	$ 5,000,000	$ 7,500,000
11			$ 2,500,000	$ 5,000,000	$ 7,500,000
12			$ 2,500,000		$ 2,500,000
13			$ 2,500,000		$ 2,500,000
14			$ 2,500,000		$ 2,500,000
15			$ 2,500,000	$ 5,000,000	$ 7,500,000
16			$ 2,500,000		$ 2,500,000
17			$ 2,500,000		$ 2,500,000
18			$ 2,500,000		$ 2,500,000
19			$ 2,500,000	$ 5,000,000	$ 7,500,000
20			$ 2,500,000		$ 2,500,000
21			$ 2,500,000		$ 2,500,000
22			$ 2,500,000	$ 5,000,000	$ 7,500,000
23			$ 2,500,000		$ 2,500,000
24			$ 2,500,000		$ 2,500,000
25		$ 50,000,000	$ 2,500,000	$ 5,000,000	$ 57,500,000
26			$ 2,500,000		$ 2,500,000
27			$ 2,500,000		$ 2,500,000
28			$ 2,500,000	$ 5,000,000	$ 7,500,000
29			$ 2,500,000	$ 5,000,000	$ 7,500,000
30			$ 2,500,000	$ 5,000,000	$ 7,500,000
31			$ 2,500,000		$ 2,500,000
32			$ 2,500,000		$ 2,500,000
33			$ 2,500,000		$ 2,500,000
34			$ 2,500,000	$ 5,000,000	$ 7,500,000
35			$ 2,500,000		$ 2,500,000
36			$ 2,500,000		$ 2,500,000
37			$ 2,500,000		$ 2,500,000
38			$ 2,500,000	$ 5,000,000	$ 7,500,000
39			$ 2,500,000		$ 2,500,000
40			$ 2,500,000		$ 2,500,000
41			$ 2,500,000	$ 5,000,000	$ 7,500,000
42			$ 2,500,000		$ 2,500,000
43			$ 2,500,000		$ 2,500,000
44			$ 2,500,000	$ 5,000,000	$ 7,500,000
45			$ 2,500,000		$ 2,500,000

Year	Initial Construction	Replacement	Non-Drought Year OpEx	Additional Drought Year OpEx	Total Cost
46			$ 2,500,000		$ 2,500,000
47			$ 2,500,000	$ 5,000,000	$ 7,500,000
48			$ 2,500,000	$ 5,000,000	$ 7,500,000
49			$ 2,500,000	$ 5,000,000	$ 7,500,000
50		$ 50,000,000	$ 2,500,000		$ 52,500,000
51			$ 2,500,000		$ 2,500,000
52			$ 2,500,000		$ 2,500,000
53			$ 2,500,000	$ 5,000,000	$ 7,500,000
54			$ 2,500,000		$ 2,500,000
55			$ 2,500,000		$ 2,500,000
56			$ 2,500,000		$ 2,500,000
57			$ 2,500,000	$ 5,000,000	$ 7,500,000
58			$ 2,500,000		$ 2,500,000
59			$ 2,500,000		$ 2,500,000
60			$ 2,500,000	$ 5,000,000	$ 7,500,000
61			$ 2,500,000		$ 2,500,000
62			$ 2,500,000		$ 2,500,000
63			$ 2,500,000	$ 5,000,000	$ 7,500,000
64			$ 2,500,000		$ 2,500,000
65			$ 2,500,000		$ 2,500,000
66			$ 2,500,000	$ 5,000,000	$ 7,500,000
67			$ 2,500,000	$ 5,000,000	$ 7,500,000
68			$ 2,500,000	$ 5,000,000	$ 7,500,000
69			$ 2,500,000		$ 2,500,000
70			$ 2,500,000		$ 2,500,000
71			$ 2,500,000		$ 2,500,000
72			$ 2,500,000	$ 5,000,000	$ 7,500,000
73			$ 2,500,000		$ 2,500,000
74			$ 2,500,000		$ 2,500,000
75		$ 50,000,000	$ 2,500,000		$ 52,500,000
76			$ 2,500,000	$ 5,000,000	$ 7,500,000
77			$ 2,500,000		$ 2,500,000
78			$ 2,500,000		$ 2,500,000
79			$ 2,500,000	$ 5,000,000	$ 7,500,000
80			$ 2,500,000		$ 2,500,000
81			$ 2,500,000		$ 2,500,000
82			$ 2,500,000	$ 5,000,000	$ 7,500,000
83			$ 2,500,000		$ 2,500,000
84			$ 2,500,000		$ 2,500,000
85			$ 2,500,000	$ 5,000,000	$ 7,500,000
86			$ 2,500,000	$ 5,000,000	$ 7,500,000
87			$ 2,500,000	$ 5,000,000	$ 7,500,000
88			$ 2,500,000		$ 2,500,000
89			$ 2,500,000		$ 2,500,000
90			$ 2,500,000		$ 2,500,000

What's the Cost?

Washington Water Research Center Data: Yakima Basin Crop Water Usage and Net Revenue

Annotation Details

Page 32 *Crop by district values for net revenue per acre, water use per acre, and total acres*

Table 5. Crop by district values for net revenue per acre, water use per acre, and total acres.

Crop Group	Net Revenue $/ac	Af/ acre Roza	Af/ acre WIP	Af/ acre KRD	Af/ acre SVID	Af/ acre YTID	Af/ acre KSR	Acres Roza	Acres WIP	Acres KRD	Acres SVID	Acres YTID	Acres KSR
Alfalfa	678	4.7	6	5	4.8	3.1	5	2,878	12,939	1,778	12,219	124	1,800
Apples	2,248	5.6	7	6	6	3.7	6	23,969	10,445	548	6,720	17,288	6
Asparagus	238	4.2	5	0	4.4	0	0	635	1,831	0	2,657	0	0
Concord	1,509	3.3	4.7	0	3.8	0	0	11,913	4,954	0	20,784	0	0
Hops	3,481	3.4	4.3	0	3.7	0	0	3,540	15,350	0	10,955	0	0
Mint	804	4.9	6.1	0	5.1	0	0	578	9,424	0	1,770	0	411
Miscell.	785	3.9	5	4.7	4	3.3	4.7	3,613	24,017	81	21,050	355	95
Other Grain	3	3	4	4.6	3.2	2.1	4.6	2,670	662	1,963	3,246	21	2,182
Other Hay	240	4.8	6.2	5.5	5	3.2	5.5	431	3,204	4,971	3,719	1,058	3,077
Other Tree	833	5.5	6.7	5.3	5.8	3.6	5.3	8,797	3,211	256	9,534	2,729	1
Other Veg	5,422	2.5	4.1	4.1	3	0	4.1	270	3,286	6	525	0	6
Pasture	479	3.8	4.8	4.5	3.7	0	4.5	62	1,960	13,129	1,141	0	18,032
Potatoes	1,155	4.2	5.1	4.3	0	0	4.3	72	1,161	89	0	0	0
Sweet Corn	436	3.1	3.3	3.1	2.8	0	3.1	173	912	1,368	39	0	408
Timothy	701	0	6.4	5.6	0	0	5.6	0	126	29,607	0	0	12,468
Wheat	40	3	4	4.4	3.2	0	4.4	1,333	15,621	1,710	2,892	0	386
Wine	2,630	3.3	4.7	3.1	3.8	2.1	3.1	11,998	12	10	1,992	0	9

https://wrc.wsu.edu/documents/2014/12/ybip_bca_swwrc_dec2014.pdf

3a: Yakima Basin Crop Net Revenue and Water Usage: Average Year

Appendix 3a
Appendix 5a

Yakima Basin Crop Net Revenue & Water Usage				
Source: State of Washington Water Research Center - BENEFIT-COST ANALYSIS OF THE YAKIMA BASIN INTEGRATED PLAN PROJECTS (Dec 2014)				
Crop	$ Net Revenue	Acres	AF of Water	$ Net Revenue per AF of Water
Other Veg	$ 22,192,246	4,093	15,772	$ 1,407.08
Hops	$ 103,890,445	29,845	118,575	$ 876.16
Wine	$ 36,875,230	14,021	47,278	$ 779.96
Apples	$ 132,578,048	58,976	314,951	$ 420.95
Concord	$ 56,815,359	37,651	141,576	$ 401.31
Potatoes	$ 1,526,910	1,322	6,606	$ 231.13
Miscell.	$ 38,630,635	49,211	220,374	$ 175.30
Other Tree	$ 20,431,824	24,528	136,381	$ 149.81
Mint	$ 9,795,132	12,183	69,346	$ 141.25
Sweet Corn	$ 1,264,400	2,900	9,161	$ 138.02
Alfalfa	$ 21,518,364	31,738	168,086	$ 128.02
Timothy	$ 29,582,901	42,201	236,426	$ 125.13
Pasture	$ 16,441,196	34,324	154,090	$ 106.70
Asparagus	$ 1,219,274	5,123	23,513	$ 51.86
Other Hay	$ 3,950,400	16,460	88,178	$ 44.80
Wheat	$ 877,680	21,942	84,960	$ 10.33
Other Grain	$ 32,232	10,744	40,156	$ 0.80
Total	$ 497,622,276	397,262	1,875,429	$ 265.34

3c: Yakima Basin Crop Water Usage: Average Year by Irrigation District

Appendix 3c
Appendix 5c

Yakima Basin Crop Net Revenue & Water Usage by Irrigation District

Source: State of Washington Water Research Center - BENEFIT-COST ANALYSIS OF THE YAKIMA BASIN INTEGRATED PLAN PROJECTS (Dec 2014)

	AF of Water: Average Use (non-drought years)						
Crop	Roza	WIP	KRD	SVID	YTID	KSR: Kittitas Senior Rights	Total
Other Veg	675	13,473	25	1,575	-	25	15,772
Hops	12,036	66,005	-	40,534	-	-	118,575
Wine	39,593	56	31	7,570	-	28	47,278
Apples	134,226	73,115	3,288	40,320	63,966	36	314,951
Concord	39,313	23,284	-	78,979	-	-	141,576
Potatoes	302	5,921	383	-	-	-	6,606
Miscell.	14,091	120,085	381	84,200	1,172	447	220,374
Other Tree	48,384	21,514	1,357	55,297	9,824	5	136,381
Mint	2,832	57,486	-	9,027	-	-	69,346
Sweet Corn	536	3,010	4,241	109	-	1,265	9,161
Alfalfa	13,527	77,634	8,890	58,651	384	9,000	168,086
Timothy	-	806	165,799	-	-	69,821	236,426
Pasture	236	9,408	59,081	4,222	-	81,144	154,090
Asparagus	2,667	9,155	-	11,691	-	-	23,513
Other Hay	2,069	19,865	27,341	18,595	3,386	16,924	88,178
Wheat	3,999	62,484	7,524	9,254	-	1,698	84,960
Other Grain	8,010	2,648	9,030	10,387	44	10,037	40,156
Total	322,496	565,949	287,369	430,411	78,776	190,429	1,875,429

3b: Yakima Basin Crop Net Revenue and Water Usage: Average Year by Irrigation District

Appendix 3b
Appendix 5b

Yakima Basin Crop Net Revenue & Water Usage by Irrigation District

Source: State of Washington Water Research Center - BENEFIT-COST ANALYSIS OF THE YAKIMA BASIN INTEGRATED PLAN PROJECTS (Dec 2014)

				Net Revenue $						
Crop	Acres	Net Revenue $ per Acre	**$ Net Revenue per AF of Water**	Roza	WIP	KRD	SVID	YTID	KSR: Kittitas Senior Rights	Total
Other Veg	31,738	$ 5,422.00	**$ 1,407.08**	$ 1,463,940	$ 17,816,692	$ 32,532	$ 2,846,550	$ -	$ 32,532	$ 22,192,246
Hops	37,651	$ 3,481.00	**$ 876.16**	$ 12,322,740	$ 53,433,350	$ -	$ 38,134,355	$ -	$ -	$ 103,890,445
Wine	10,744	$ 2,630.00	**$ 779.96**	$ 31,554,740	$ 31,560	$ 26,300	$ 5,238,960	$ -	$ 23,670	$ 36,875,230
Apples	29,845	$ 2,248.00	**$ 420.95**	$ 53,882,312	$ 23,480,360	$ 1,231,904	$ 15,106,560	$ 38,863,424	$ 13,488	$ 132,578,048
Concord	58,976	$ 1,509.00	**$ 401.31**	$ 17,976,717	$ 7,475,586	$ -	$ 31,363,056	$ -	$ -	$ 56,815,359
Potatoes	34,324	$ 1,155.00	**$ 231.13**	$ 83,160	$ 1,340,955	$ 102,795	$ -	$ -	$ -	$ 1,526,910
Miscell.	49,211	$ 785.00	**$ 175.30**	$ 2,836,205	$ 18,853,345	$ 63,585	$ 16,524,250	$ 278,675	$ 74,575	$ 38,630,635
Other Tree	2,900	$ 833.00	**$ 149.81**	$ 7,327,901	$ 2,674,763	$ 213,248	$ 7,941,822	$ 2,273,257	$ 833	$ 20,431,824
Mint	1,322	$ 804.00	**$ 141.25**	$ 464,712	$ 7,576,896	$ -	$ 1,423,080	$ -	$ 330,444	$ 9,795,132
Sweet Corn	5,123	$ 436.00	**$ 138.02**	$ 75,428	$ 397,632	$ 596,448	$ 17,004	$ -	$ 177,888	$ 1,264,400
Alfalfa	4,093	$ 678.00	**$ 128.02**	$ 1,951,284	$ 8,772,642	$ 1,205,484	$ 8,284,482	$ 84,072	$ 1,220,400	$ 21,518,364
Timothy	16,460	$ 701.00	**$ 125.13**	$ -	$ 88,326	$ 20,754,507	$ -	$ -	$ 8,740,068	$ 29,582,901
Pasture	42,201	$ 479.00	**$ 106.70**	$ 29,698	$ 938,840	$ 6,288,791	$ 546,539	$ -	$ 8,637,328	$ 16,441,196
Asparagus	14,021	$ 238.00	**$ 51.86**	$ 151,130	$ 435,778	$ -	$ 632,366	$ -	$ -	$ 1,219,274
Other Hay	12,183	$ 240.00	**$ 44.80**	$ 103,440	$ 768,960	$ 1,193,040	$ 892,560	$ 253,920	$ 738,480	$ 3,950,400
Wheat	21,942	$ 40.00	**$ 10.33**	$ 53,320	$ 624,840	$ 68,400	$ 115,680	$ -	$ 15,440	$ 877,680
Other Grain	24,528	$ 3.00	**$ 0.80**	$ 8,010	$ 1,986	$ 5,889	$ 9,738	$ 63	$ 6,546	$ 32,232
Total	397,262	$ 1,252.63	**$ 265.34**	$ 130,284,737	$ 144,712,511	$ 31,782,923	$ 129,077,002	$ 41,753,411	$ 20,011,692	$ 497,622,276
Average Net Revenue per AF			**$ 265.34**	**$ 403.99**	**$ 255.70**	**$ 110.60**	**$ 299.89**	**$ 530.03**	**$ 105.09**	**$ 265.34**

Economics and the Law of Marginal Utility: *How to maximize the economic value of an AF of Water*

Run: Baseline

KRD Irrigation Deliveries [AF]

Water Year	October	April	May	June	July	Augus	Septe	Total
Average	11,737	10,288	44,339	45,666	58,420	59,409	39,341	269,200

Run: Baseline

Roza Irrigation Deliveries [AF]

Water Year	October	April	May	June	July	Augus	Septe	Total
Average	12,663	31,635	42,209	47,944	53,942	53,168	35,011	286,184

Run: Baseline

KRD Irrigation Deliveries [AF]

Water Year	October	April	May	June	July	Augus	Septe	Total
1926	19,317	9,875	33,802	34,229	38,418	37,505	12,451	185,597
1927	23	10,865	46,379	47,545	62,399	65,046	47,154	279,411
1968	23	10,865	46,379	47,545	62,399	65,046	47,154	279,411
1969	19,317	10,865	46,379	47,545	62,399	65,046	47,154	298,704
1970	19,317	10,865	46,379	47,545	60,544	58,700	39,931	283,281
1971	23	10,865	46,379	47,545	62,399	65,046	47,154	279,411
1972	19,317	10,865	46,379	47,545	62,399	65,046	47,154	298,704
1973	19,317	7,203	44,585	47,545	53,405	49,763	33,999	255,817
1974	23	10,865	46,379	47,545	62,399	65,046	47,154	279,411
1975	19,317	10,865	46,379	47,545	62,399	65,046	47,154	298,704
1976	19,317	10,865	46,379	47,545	62,399	65,046	47,154	298,704
1977	19,317	7,652	35,968	36,980	42,244	40,314	13,128	195,602
1978	23	10,865	46,379	47,545	62,399	65,046	47,154	279,411
1979	19,317	7,611	45,670	47,545	54,662	50,908	34,722	260,434
1980	23	10,865	45,498	45,166	61,876	61,234	41,650	266,313
1981	23	8,235	46,379	47,545	59,239	56,673	38,567	256,661
1982	23	10,865	46,379	47,545	62,399	65,046	47,154	279,411
1983	19,317	10,865	46,379	47,545	62,399	65,046	47,154	298,704
1984	19,317	10,865	46,379	47,545	62,399	65,046	47,154	298,704
1985	19,317	10,865	46,379	47,545	62,399	65,046	47,154	298,704
1986	19,317	10,069	45,525	47,545	59,510	57,085	38,892	277,943
1987	23	10,862	43,943	47,545	60,682	60,190	18,738	241,983
1988	23	10,865	43,461	47,545	52,061	48,392	33,148	235,497
1989	23	10,865	46,363	47,545	62,000	61,570	41,770	270,136
1990	23	10,865	46,379	47,545	62,399	65,046	47,154	279,411
1991	19,317	10,865	46,379	47,545	62,399	65,046	47,154	298,704
1992	19,317	6,720	46,078	47,545	59,637	57,215	16,683	253,195
1993	23	9,370	43,733	47,062	54,857	53,033	16,962	223,129
1994	23	10,769	25,475	23,453	25,631	26,405	9,397	121,154
1995	23	10,865	46,379	47,545	62,399	65,046	47,154	279,411
1996	19,317	10,865	46,379	47,545	62,399	65,046	47,154	298,704
1997	19,317	10,865	46,379	47,545	62,399	65,046	47,154	298,704
1998	19,317	10,865	46,379	47,545	62,399	65,046	47,154	298,704
1999	19,317	10,865	46,379	47,545	62,399	65,046	47,154	298,704
2000	19,317	10,865	46,379	47,545	62,399	65,046	47,154	298,704
2001	19,317	7,206	33,150	33,879	38,382	37,092	12,313	181,339
2002	23	10,865	46,379	47,545	62,399	65,046	47,154	279,411
2003	19,317	10,865	43,730	47,545	60,232	58,521	39,927	280,137
2004	23	10,227	43,940	47,545	62,342	63,356	42,908	270,342
2005	23	7,595	35,506	36,405	41,651	40,457	13,368	175,004
2006	23	10,865	46,379	47,545	62,399	65,046	47,154	279,411
2007	19,317	10,865	46,379	47,545	62,399	65,046	47,154	298,704
2008	19,317	10,865	46,379	47,545	62,399	65,046	47,154	298,704
2009	19,317	8,433	46,379	47,545	62,152	61,947	41,905	287,677
Average	11,737	10,288	44,339	45,666	58,420	59,409	39,341	269,200

Run: Baseline

Roza Irrigation Deliveries [AF]

Water Year	October	April	May	June	July	Augus	Septe	Total
1926	20,218	31,139	24,791	28,230	28,696	28,628	18,446	189,762
1927	986	32,940	45,487	51,245	58,682	57,914	38,362	295,230
1967	20,218	32,940	45,487	51,245	58,744	58,032	37,837	314,118
1968	986	32,940	45,487	51,245	58,682	57,914	38,362	295,230
1969	20,218	32,940	45,487	51,245	58,682	57,914	38,362	314,462
1970	20,218	32,940	45,487	51,245	58,829	58,141	37,699	314,174
1971	986	32,940	45,487	51,245	58,682	57,914	38,362	295,230
1972	20,218	32,940	45,487	51,245	58,682	57,914	38,362	314,462
1973	20,218	29,357	43,463	51,554	53,708	52,129	33,752	293,795
1974	986	32,940	45,487	51,245	58,682	57,914	38,362	295,230
1975	20,218	32,940	45,487	51,245	58,682	57,914	38,362	314,462
1976	20,218	32,940	45,487	51,245	58,682	57,914	38,362	314,462
1977	20,218	17,744	24,834	30,844	31,947	31,080	20,027	186,309
1978	986	32,940	45,487	51,245	58,682	57,914	38,362	295,230
1979	20,218	31,025	44,311	51,409	55,175	53,453	34,393	299,597
1980	986	31,794	45,206	49,365	58,686	57,939	38,140	291,730
1981	986	32,537	45,558	51,245	59,059	58,252	37,146	294,397
1982	986	32,940	45,487	51,245	58,682	57,914	38,362	295,230
1983	20,218	32,940	45,487	51,245	58,682	57,914	38,362	314,462
1984	20,218	32,940	45,487	51,245	58,682	57,914	38,362	314,462
1985	20,218	32,940	45,487	51,245	58,682	57,914	38,362	314,462
1986	20,218	32,781	45,049	51,245	59,016	58,261	37,312	313,496
1987	986	32,985	43,263	50,165	49,757	48,431	31,690	266,891
1988	986	32,744	42,529	51,563	52,157	50,682	33,081	273,356
1989	986	32,527	45,489	51,245	58,682	57,933	38,161	294,637
1990	986	32,940	45,487	51,245	58,682	57,914	38,362	295,230
1991	20,218	32,940	45,487	51,245	58,682	57,914	38,362	314,462
1992	20,218	26,747	38,042	47,995	47,533	46,632	30,662	267,444
1993	986	32,143	35,461	42,327	42,874	41,299	26,863	231,568
1994	986	32,372	18,260	18,384	18,205	19,244	12,186	129,251
1995	986	32,940	45,487	51,245	58,682	57,914	38,362	295,230
1996	20,218	32,940	45,487	51,245	58,682	57,914	38,362	314,462
1997	20,218	32,940	45,487	51,245	58,682	57,914	38,362	314,462
1998	20,218	32,940	45,487	51,245	58,682	57,914	38,362	314,462
1999	20,218	32,940	45,487	51,245	58,682	57,914	38,362	314,462
2000	20,218	32,940	45,487	51,245	58,682	57,914	38,362	314,462
2001	20,218	17,222	22,598	27,897	28,648	28,267	18,136	172,599
2002	986	32,940	45,487	51,245	58,682	57,914	38,362	295,230
2003	20,218	32,940	44,055	51,245	58,886	58,161	37,685	312,805
2004	986	32,996	44,769	51,245	58,682	57,914	38,350	294,558
2005	986	17,621	24,469	30,296	31,439	31,231	20,594	166,251
2006	986	32,940	45,487	51,245	58,682	57,914	38,362	295,230
2007	20,218	32,940	45,487	51,245	58,682	57,914	38,362	314,462
2008	20,218	32,940	45,487	51,245	58,682	57,914	38,361	314,462
2009	20,218	32,748	45,129	50,842	58,220	57,474	37,963	312,134
Average	12,663	31,635	42,209	47,944	53,942	53,168	35,011	286,184

D: The previous Benefit-Cost analysis includes significant scientific & economic errors; an updated review is needed

- Independent scientific and economic policy experts (WRC, Normandeau) universally discredit the Four Accounts Analysis
  - *The overly-aggressive calculations and weak assumptions are simply unsupportable*.
- Correcting assumption and calculation errors reduces total benefits by over $6B (primary issues are incorrect fish population starting points and overly optimistic fish growth rates)
- Cost allocations are filled with overly agriculture-friendly (and incorrect) assumptions in order to drive a positive Benefit/Cost ratio for irrigation projects – reality is a significantly negative B-to-C
- According to the Water Research Center study, only fish passage clears basic Benefit-Cost thresholds
- As the project approach has shifted significantly, the forthcoming revised DEIS should materially address the above concerns (and the specific ones detailed on the next page)

D (cont): Specific calculation & assumption errors in the Four Accounts Analysis – the “published” B-C is not accurate

Overview: Present Value Preliminary Cost Allocation – 2012: With Adjustments

		Project Purposes			
		Ecological Restoration	Agriculture	Municipal & Domestic	Total ($M)
	4AA Benefits	**6,200**	**800**	**395**	**7,395**
	Adjustments to 4AA Benefits	**(5,300)**	**(600)**	**(355)**	**(6,255)**
1	Correct Calculation Errors				**(3,255)**
	Adjust for 200k higher initial fish populations and their corresponding lower incremental WTP values (See WRC page 95)	(2,700)			(2,700)
	Adjust for present value impact of not including fish benefits until fish projects are actually completed (See WRC page 97)	(200)			(200)
	Correct lease vs purchase price and calculation errors for Municipal Water Use (See WRC page 79 & 82)			(355)	(355)
2	Adjust for Flawed Assumptions				**(3,000)**
	Remove potential for Fish Populations to increase above 181k fish (See WRC page 93 & 96)	(1,200)			(1,200)
	Adjust PV due to 30 additional years to achieve 181k fish population totals (See WRC page 96)	(1,200)			(1,200)
	Correct for future climate scenario, reduce from 8x worse than historical to 4x worse (50% reduction) (See WRC page 66 & 68; JJS Analysis)		(400)		(400)
	Correct for overly constrained water trade assumption of 10%; Allow for 50% inter-district trade reducing 4AA Benefits by 50% (See WRC pages 69-73 & JJS Analysis)		(200)		(200)
	Revised Total Benefits	**900**	**200**	**40**	**1,140**
	4AA Total Cost Allocation	**2,440**	**729**	**351**	**3,520**
3	Adjustments/Reallocations to 4AA Costs	**(477)**	**679**	**(203)**	**0**
	Correct Footnote 3 error: limiting SPA costs to the maximum of total benefits is an incorrect cost accounting step (JJS Analysis)	(209.7)	247.9	(38.2)	0
	Correct SPA allocations for Wymer and Bumping Lake to include 50% allocation for Agricultural Use; Also use full cost of projects (JJS Analysis)	(267.0)	431.3	(164.3)	0
	Cost Increases: KDRPP/KKC has increased over 300% from $276M to $850M+	?	?	?	?
	Revised Total Cost Allocation: Does not include an additional $600M for KDRPP/KKC	**1,963**	**1,408**	**148**	**3,520**

Water Research Center Analysis

	Ecological Restoration	Agriculture	Municipal & Domestic	Total ($M)
Revised Total Benefit-Cost	**(1,063)**	**(1,208)**	**(108)**	**(2,380)**
Revised Total Benefit-Cost Ratio	**0.46**	**0.14**	**0.27**	**0.32**

	Ecological Restoration	Agriculture	Municipal & Domestic	Total ($M)
4AA Projected Total Benefit-Cost	**3,760**	**71**	**44**	**3,875**
4AA Projected Total Benefit-Cost Ratio	**2.54**	**1.10**	**1.13**	**2.10**

Agenda – Economics Next Steps

Technical Review of the YBIP Hydrology & Economic Analysis

- Economic Analysis
  - Review B-C approach vs Impact Analysis
  - Review need for analysis of each project independently
  - Review specific alternatives up for consideration
  - Discuss KDRPP projected Costs and economics of various YB crops
  - Discuss Four Accounts Analysis deficiencies and plan to correct
  - Discuss ID Water Allocation strategies vs Water Markets and how to present these issues in the EIS process

Agenda – Hydrology Next Steps

<u>Technical Review of the YBIP Hydrology & Economic Analysis</u>

- Hydrology Review
    - Impact on Water Supply – K Projects
        - Adverse Climate
        - Historical Climate
    - Impact on Lake Kachess
        - Adverse Climate
        - Historical Climate
        - USBR Operational Options to Mitigate
    - Impact of KKC on Lake Kachess Storage
    - Discussion of Updated Baseline and IP0 Scenarios
        - Include CEPR in Baseline
        - Include budgeted "Conservation" projects in Baseline
        - Run IP0 (unbudgeted "Conservation" projects) as a stand-alone option, remove it from other stand-alone alternatives (i.e. IP1, IP2, IP2A, etc).
    - Discussion on how to incorporate Climate Change in USBR EIS process – how do we identify the essential facts and make sure they are appropriately high-lighted in the EIS reports

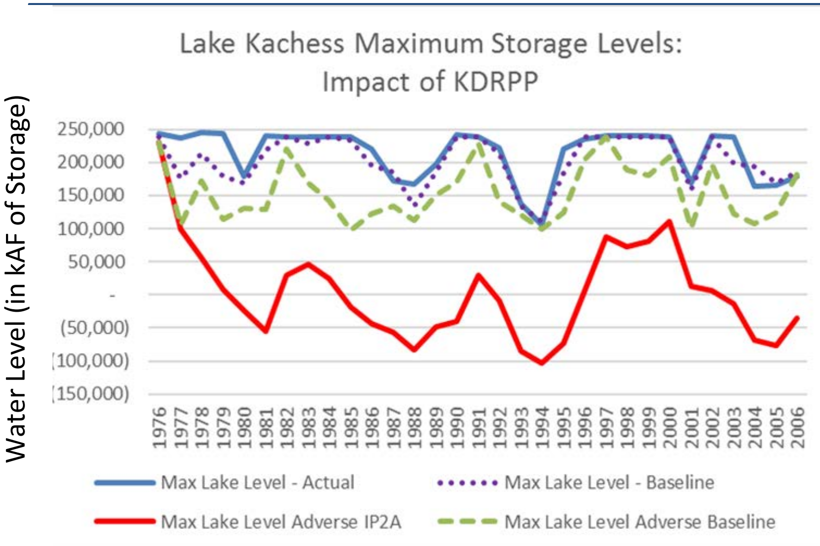
3 Basic Questions – For Any Water Storage Project

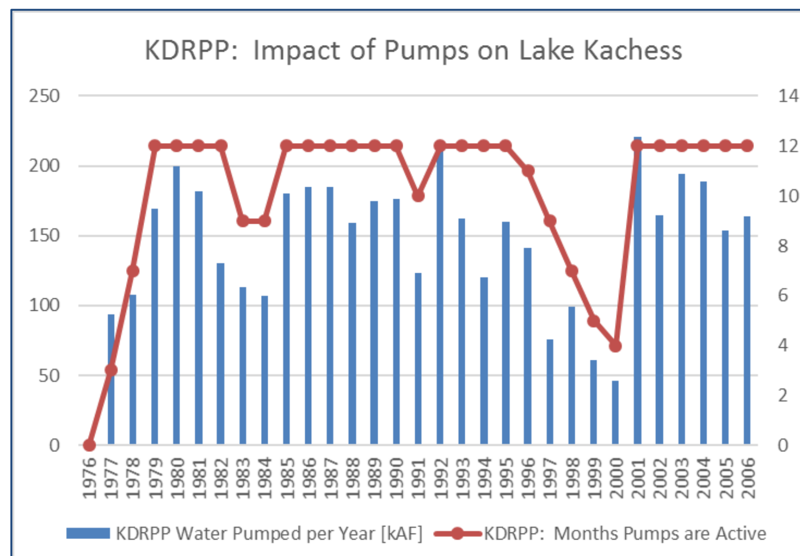
The Basic Questions	Data Driven Answers	The "So-What"
How much irrigation water will the project provide? (especially in droughts when we most need it?)	• During droughts, actual long-term KDRPP benefits average less than 23 KAF (less than 0.13% of Yakima Basin Irrigation District use) • Irrigation Districts (ID's) are being promised 52% more water than the KRDPP project actually delivers	• Ignore the PR, look for the data and the facts. The long-term benefit is trivial at best • And it will be too late by the time we realize it … the $ will have been spent
How much will it cost? (And is it a good investment?)	• The KDRPP project will cost irrigators and the public well over $500 per AF; only the top 3 crops can afford it	• Irrigators can't afford it on their own and the public shouldn't support it
What will the impact be on Lake Kachess?	• The impact of the KDRPP project on Lake Kachess is absolute devastation • KKC provides no meaningful water storage benefit for Lake Kachess	• The ancient lake will never recover due to the "deficit" water shed above it • KKC simply supports fish & habitat, not water storage or security

The impact of the KDRPP project on Lake Kachess is absolute devastation

- Average water levels drop over 200 kAF (nearly 80 feet in elevation) and never recover
  - In only 6 years (out of 31) does the lake recover above 50 kAF of storage, the typical low water mark for the last 100 years
  - The Kachess "water-shed" is already maxed-out, so more water delivery simply drops the Lake; turning it into an inaccessible mud-pit with cliff-like walls
  - The economic, recreational, environmental and fire hazard impacts are substantial and well known
  - Prior EIS, Work Group and BoR analysis and documents have failed to materially address these issues
- The KDRPP "floating pump" approach requires nearly permanent, year-round use of the pumps
  - The pumps will be running 12 months in 20 of 31 years modeled and average 10.5 months per year; Average pump withdrawals are 150 kAF, all from below the current "minimum pool"
  - The noise pollution and visual blight from the pumps will be significant
- Despite the impact to the lake, the Lake Kachess community has been systematically blocked from materially participating in the process
  - Federal FACA process which requires active participation from "adversely affected parties" was clearly side-stepped

See Appendix 4

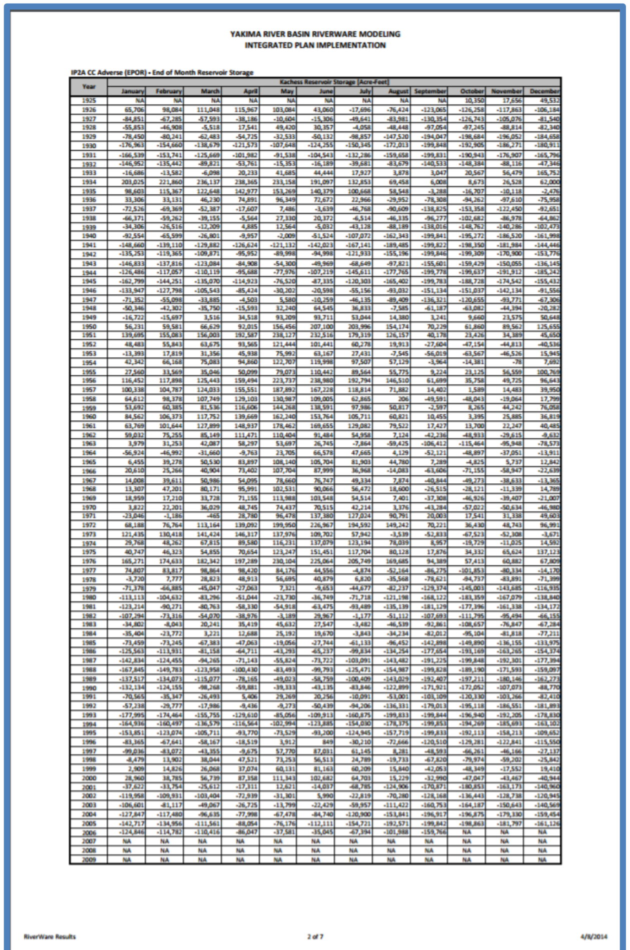




Technical Memorandum Data: Kachess Reservoir Storage Levels & KDRPP Pump Deliveries

Annotation Details

Page 606 (IP2A Adverse End of Month Kachess Reservoir Storage)

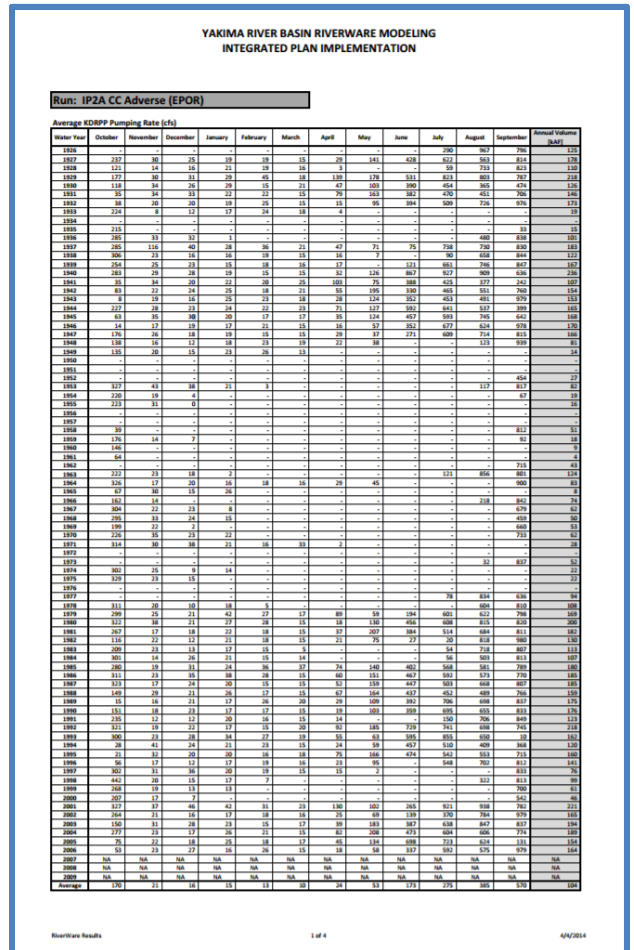

YAKIMA RIVER BASIN RIVERWARE MODELING
INTEGRATED PLAN IMPLEMENTATION

IP2A CC Adverse (EPOR) - End of Month Reservoir Storage

Kachess Reservoir Storage (Acre-Feet)

RiverWare Results — 2 of 7 — 4/8/2014

Page 595 (IP2A Adverse KDRPP Pumping Rate)


YAKIMA RIVER BASIN RIVERWARE MODELING
INTEGRATED PLAN IMPLEMENTATION

Run: IP2A CC Adverse (EPOR)

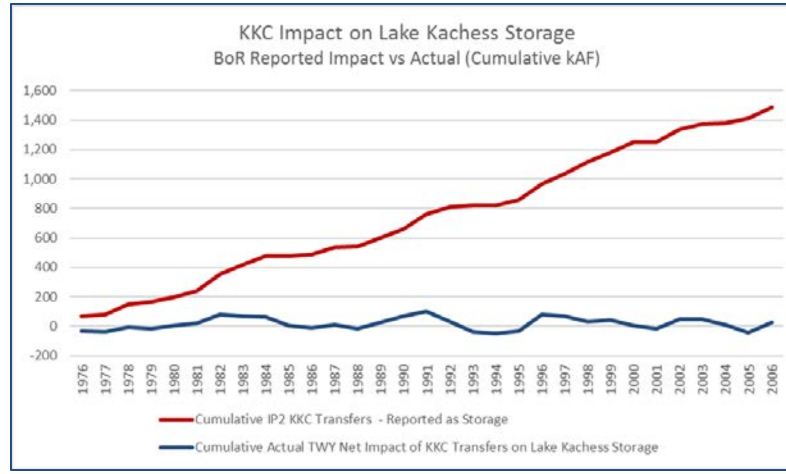
Average KDRPP Pumping Rate (cfs)

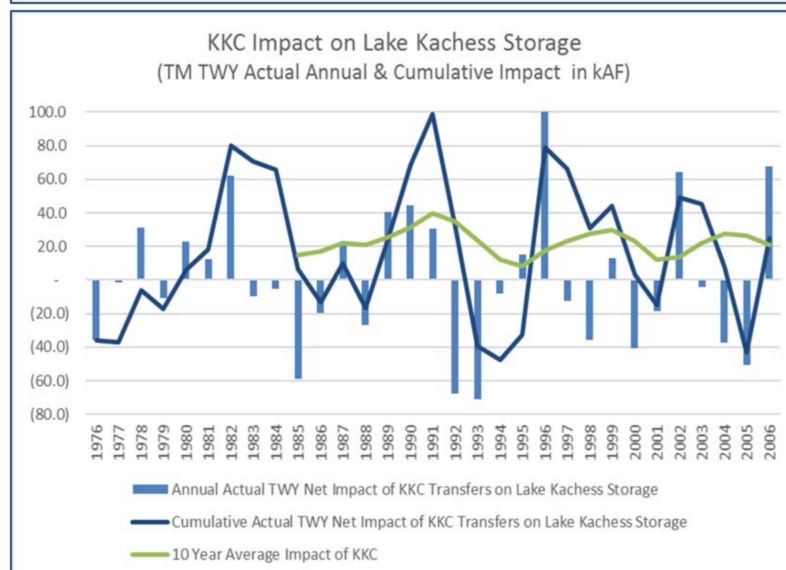
RiverWare Results — 1 of 4 — 4/4/2014

What's the Impact?

KKC provides no meaningful water storage benefit for Lake Kachess and the BoR's analysis is materially misleading

- As stated in numerous BoR documents, the primary (yet unquantified) benefit of KKC is fish and habitat conservation along the Keechelus Reach
  - Over time nearly all of the water transferred thru the KKC is simply bypass water, not storage water
- BoR needs to explain it's characterization of nearly 1,500 kAF of KKC transfers as "Storage"
  - BoR categorizes any transfer not meant for immediate release (i.e. bypass) as "storage" water, even if it will be released within days of the transfer
  - When viewed on a cumulative Total Water Year basis, BoR's supposed 1,485 kAF of "storage" benefit shrinks to 24.7 kAF
- While the KKC is positioned as a way to help enhance storage in Lake Kachess, the BoR's own data shows the long-term benefits to be negligible
  - Over 31 years, the KKC delivers 539.1 kAF of water but also increases water released from Lake Kachess by 514.4 kAF for a net storage impact of 24.7 kAF
  - The average annual benefit to Lake Kachess is only 0.8 kAF, making the KKC project highly unattractive from a storage/security benefit-cost perspective





See Appendix 5

What's the Impact?

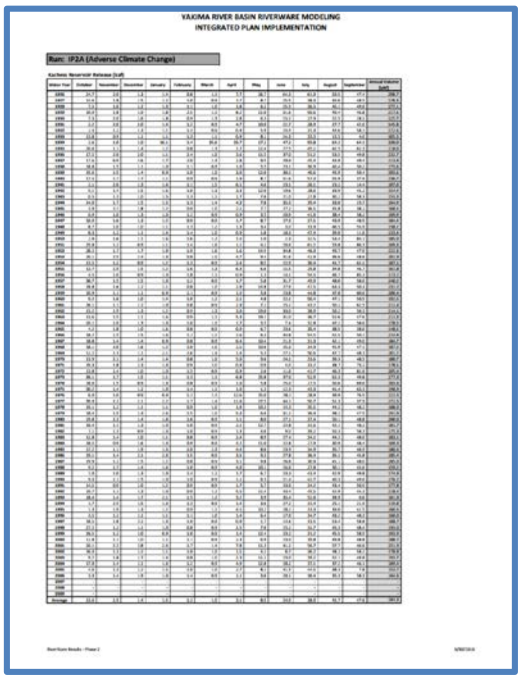
Technical Memorandum Data: Impact of KKC - Kachess Reservoir Release with and without integrated KKC

Annotation Details

Page 593 (IP2A Adverse Kachess Reservoir Release)

Page 622 & 623 (IP2 Adverse KKC Transfer Rate & Storage Transfer Rate)

Page 619 (IP2 Adverse Kachess Reservoir Release with integrated KKC)



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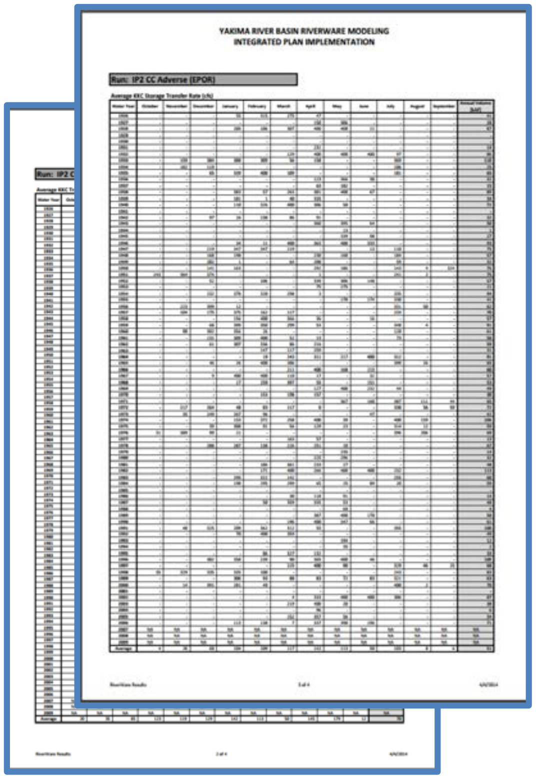

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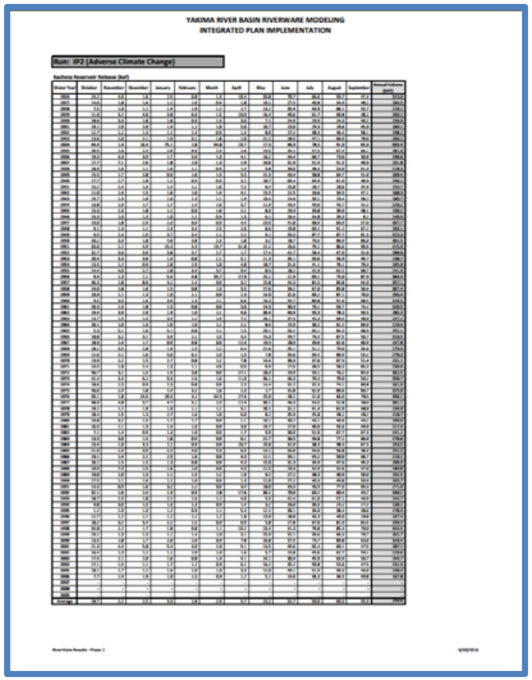


Next Steps

- Share with legislators, government agencies, media and groups/individuals engaged in YBIP oversight and funding
- Request BoR and WA Ecology to appropriately identify and address these errors and omissions in any and all future interactions regarding the YBIP
- Meet with Yakima Basin irrigators to share the conclusions and gather feedback
- As appropriate, share conclusions with the Work Group and ask for detailed responses to the specific concerns

Technical Overview

- As the primary water security emphasis of the Integrated Plan is to expand water storage, especially in light of potential adverse climate change, the appropriate focus is the data and conclusions from the Adverse Climate Change scenarios

- Additionally, given the Integrated Plan's emphasis on increased drought frequency, the 31 year period from 1976 – 2006 provides the best proxy period for projected Adverse Climate Change conditions

- While the Historical Climate Scenarios are included in the Technical Memorandum, the water security needs under the historical context are insufficient to warrant increased storage, so they have not been included in this analysis

- The Data Appendix provides detailed support and references to the BoR Technical Memorandum for the Key Insights of this report. The Technical Appendix provides data addressing the overall analytic and economic approach

Data Appendix

- 1A: Summary Lake Kachess Irrigation Season Flow Data: Actual History vs Baseline, Adverse Baseline, Adverse IP0 and Adverse IP2A scenarios
- 1B: Detailed Lake Kachess Irrigation Season Flow Data: Actual History vs Baseline, Adverse Baseline, Adverse IP0 and Adverse IP2A scenarios
- 2: Drought Year Water Delivery Error: Reported ID Deliveries vs KDRPP Release
- 3a: Yakima Basin Crop Net Revenue and Water Usage: Average Year
- 3b: Yakima Basin Crop Net Revenue and Water Usage: Average Year by Irrigation District
- 3c: Yakima Basin Crop Water Usage: Average Year by Irrigation District
- 4: Impact of KDRPP on Lake Kachess: Water Levels and Pump Operations
- 5: Impact of KKC on Lake Kachess TWY storage – Adverse Climate

1A: Summary Lake Kachess Irrigation Season Flow Data: Actual History vs Baseline, Adverse Baseline, Adverse IP0 and Adverse IP2A scenarios

IMPACT CAPTURED	**Actual Lake Kachess Historical Outflows**	**Modeled Operations Optimization**	**Climate Change**	**Conservation Impact from IP0**	**TM Adverse Climate IP0 Lake Kachess Outflows**	**Percent Impact of Optimization, Climate Change & Conservation vs Actual**	**Net Impact of KDRPP**	**Cumulative Net Impact of KDRPP vs IP0**	**KDRPP Adverse Climate Outflows**	**Net Impact of Modeling Optimization, Climate Change. Conservation & KDRPP vs Actual**	**Cumulative Net Impact of KDRPP vs Actual**

Appendix 1-A

Lake Kachess Irrigation Season Outflows & Impact of KDRPP in Adverse Climate Change

Source: BoR Hydromet Data; BoR Hydrology TM (July 2016); BoR Cost Estimates from the 2015 DEIS & the KEDRPP process

1976-2006	Actual Irrigation Season (kAF)	Actual to TM Historical Baseline Change (kAF)	Historical Baseline to TM Adverse Baseline Change (kAF)	TM Adverse Baseline to TM Adverse IP0 Change (kAF)	TM Adverse IP0 Outflows (kAF)	Actual to TM Adverse IP0 % Change	TM Adverse IP0 to TM Adverse IP2A Change (kAF)	TM Adverse IP0 to TM Adverse IP2A Cumulative Change (kAF)	TM IP2A Adverse Irrigation Season (kAF)	Net Change: Actual to TM Adverse IP2A	Cumulative Net Change: Actual to TM Averse IP2A
Overall Average	181.8	(2.9)	(19.5)	(1.4)	158.0	-13%	6.6	203.3	164.6	(17.2)	(534.0)
Drought Year Average	190.5	(13.3)	(56.0)	2.7	123.9	-35%	45.1	360.9	169.0	(21.5)	(172.3)
Drought Year Average (Exl '77 & '01)	188.0	(12.3)	(47.9)	0.5	128.4	-32%	22.9	137.2	151.2	(36.8)	(220.8)
Non-Drought Year Average	178.8	0.7	(6.8)	(2.8)	169.9	-5%	(6.9)	(157.6)	163.1	(15.7)	(361.7)

1B: Detailed Lake Kachess Irrigation Season Flow Data: Actual History vs Baseline, Adverse Baseline, Adverse IP0 and Adverse IP2A scenarios

Appendix 1-B

Lake Kachess Irrigation Season Outflows & Impact of KDRPP in Adverse Climate Change

Source: BoR Hydromet Data; BoR Hydrology TM (July 2016); BoR Cost Estimates from the 2015 DEIS & the KEDRPP process

	Impact Captured								
	Actual Lake Kachess Historical Outflows	Modeled Operations Optimization	Climate Change	Conservation Impact from IP0	TM Adverse Climate IP0 Lake Kachess Outflows	Percent Impact of Optimization & Climate Change vs Actual	Net Impact of KDRPP	KDRPP Adverse Climate Outflows	Net Impact of Modeling Optimization, Climate Change & KDRPP vs Actual
Year (WY)	Actual Irrigation Season (kAF)	Actual to Baseline Change (kAF)	Baseline to Adverse Baseline Change (kAF)	Adverse Baseline to Adverse IP0 Change (kAF)	Baseline to Adverse IP0 Outflows (kAF)	Actual to Adverse IP0 % Change	Adverse IP0 to Adverse IP2A Change (kAF)	IP2A Adverse Irrigation Season (kAF)	Net Change
1976	162.8	39	27	(19)	209.6	29%	1.5	211.1	48
1977	193.4	10	(110)	10	104.1	-46%	119	223.1	30
1978	141.9	(5)	57	1	195.5	38%	(31)	164.4	22
1979	271.8	(100)	(60)	(2)	110.0	-60%	56	165.6	(106)
1980	92.7	54	5	(1)	151.1	63%	21	172.5	80
1981	188.2	6	(37)	(1)	156.9	-17%	3	159.6	(29)
1982	199.3	(40)	37	(20)	175.8	-12%	(13)	162.7	(37)
1983	191.5	(8)	(3)	(1)	179.0	-7%	(14)	165.1	(26)
1984	212.7	(27)	(17)	(7)	162.2	-24%	(17)	145.2	(67)
1985	229.9	(42)	(87)	12	113.1	-51%	41	154.4	(76)
1986	221.2	(36)	(44)	8	149.4	-32%	9	158.0	(63)
1987	163.2	25	(35)	(4)	148.4	-9%	11	159.5	(4)
1988	154.9	(3)	(17)	0	135.0	-13%	9	143.6	(11)
1989	139.2	11	5	3	158.5	14%	9	167.8	29
1990	160.5	35	(21)	(12)	163.0	2%	(2)	161.4	1
1991	190.3	5	17	(1)	211.5	11%	(53)	158.5	(32)
1992	225.9	7	(91)	9	151.2	-33%	42	193.0	(33)
1993	165.3	(4)	(29)	6	138.9	-16%	(3)	135.6	(30)
1994	134.5	(15)	(24)	(3)	93.0	-31%	18	110.6	(24)
1995	138.8	(0)	13	0	151.7	9%	1	152.7	14
1996	301.3	(92)	(14)	(14)	180.5	-40%	(30)	151.0	(150)
1997	211.6	23	(42)	3	195.1	-8%	(32)	162.9	(49)
1998	178.6	35	(23)	6	196.6	10%	(35)	161.7	(17)
1999	197.6	(16)	(13)	(10)	159.1	-19%	13	172.2	(25)
2000	188.3	33	(15)	12	218.9	16%	(48)	170.6	(18)
2001	202.5	(43)	(51)	8	116.6	-42%	105	221.3	19
2002	134.4	18	40	(21)	172.2	28%	(15)	157.0	23
2003	206.4	(22)	(36)	(1)	147.6	-29%	30	177.6	(29)
2004	158.3	22	(36)	3	147.9	-7%	18	166.3	8
2005	167.4	13	(49)	(3)	128.6	-23%	14	143.0	(24)
2006	112.4	26	46	(6)	178.5	59%	(24)	154.8	42
Average	181.8	(2.9)	(19.5)	(1.4)	158.0	-13%	6.6	164.6	(17.2)
Absolute Variance		816.0	1,098.6	205.3		25.7%	203.3		(534.0)

2: Drought Year Water Delivery Error: Reported ID Deliveries vs KDRPP Release

Appendix 2					
Drought Year Water Delivery Error: Reported ID Deliveries vs KDRPP Release					
Source: BoR Hydromet Data, BoR Hydrology TM (July 2016)					
Year	**TM Adv Baseline ID (5 Districts) Deliveries**	**TM Adv IP2A ID (5 Districts) Deliveries**	**Net TM ID Delivery Change**	**Actual Delivery Change: Adverse IP2A KDRPP Outflow vs Adverse IP0**	**Unexplained Error from Actual Delivery Change (+ surplus water; - missing water)**
1976	1,865,491	1,744,497	-54,752	1,500	56,252
1977	721,251	942,511	192,682	119,000	-73,682
1978	1,544,000	1,477,005	-59,757	-31,100	28,657
1979	1,038,685	1,197,630	131,822	55,600	-76,222
1980	1,483,357	1,500,943	25,025	21,400	-3,625
1981	1,416,436	1,414,852	4,689	2,700	-1,989
1982	1,804,237	1,668,800	-73,956	-13,100	60,856
1983	1,619,441	1,452,607	-162,037	-13,900	148,137
1984	1,610,231	1,506,457	-93,989	-17,000	76,989
1985	997,734	1,191,509	143,274	41,300	-101,974
1986	1,212,095	1,249,934	23,520	8,600	-14,920
1987	1,331,397	1,343,951	10,421	11,100	679
1988	1,233,640	1,237,305	-1,153	8,600	9,753
1989	1,564,833	1,524,719	-32,784	9,300	42,084
1990	1,656,403	1,539,727	-97,447	-1,600	95,847
1991	1,694,755	1,524,920	-138,868	-53,000	85,868
1992	924,071	1,063,622	99,699	41,800	-57,899
1993	1,127,501	1,128,424	-13,940	-3,300	10,640
1994	836,502	850,647	9,612	17,600	7,988
1995	1,346,724	1,345,583	5,950	1,000	-4,950
1996	1,647,961	1,499,414	-137,605	-29,500	108,105
1997	1,807,044	1,745,196	699	-32,200	-32,899
1998	1,550,882	1,409,870	-136,524	-34,900	101,624
1999	1,734,499	1,633,570	-53,660	13,100	66,760
2000	1,591,958	1,491,564	-85,021	-48,300	36,721
2001	897,440	1,096,397	160,652	104,700	-55,952
2002	1,780,431	1,604,156	-131,993	-15,200	116,793
2003	1,324,580	1,441,222	112,153	30,000	-82,153
2004	1,273,253	1,299,587	25,572	18,400	-7,172
2005	1,064,859	1,064,944	-65	14,400	14,465
2006	1,739,930	1,548,193	-163,302	-23,700	139,602
Average	1,401,343	1,378,702	-15,841	6,558	22,399
Drought Years	5,571,624	6,146,545	448,640	294,200	-154,440

4: Impact of KDRPP on Lake Kachess: Water Levels and Pump Operations

Appendix 4
Appendix 3

Impact of KDRPP on Lake Kachess Storage: Adverse Climate Change

Source: BoR Hydromet Data, BoR Hydrology TM (July 2016)

Year	Max Lake Level - Actual (kAF)	Max Lake Level - Baseline (kAF)	Max Lake Level - Adverse Baseline (kAF)	Max Lake Level Adverse IP2A (kAF)	Total Water Pumped by Floating Pumps (kAF)	Months Pumps are Active
1976	242,800	238,980	230,404	230,104	-	-
1977	236,040	174,623	106,521	98,864	94	3
1978	244,672	212,861	171,310	56,695	108	7
1979	243,074	179,019	113,339	7,321	169	12
1980	178,295	168,315	129,885	(23,730)	200	12
1981	240,391	218,004	128,989	(54,330)	182	12
1982	239,127	238,980	219,814	29,967	130	12
1983	238,633	228,032	169,296	45,632	113	9
1984	238,212	238,980	141,744	25,192	107	9
1985	237,665	232,845	97,348	(19,056)	180	12
1986	219,489	195,246	122,162	(43,293)	185	12
1987	171,986	186,154	133,641	(55,824)	185	12
1988	166,492	134,127	112,369	(83,493)	159	12
1989	196,213	185,230	150,497	(49,023)	175	12
1990	241,342	238,697	169,955	(39,333)	176	12
1991	237,755	238,795	228,114	29,269	123	10
1992	221,750	214,227	140,409	(9,273)	218	12
1993	136,910	134,349	120,624	(85,056)	162	12
1994	106,040	110,388	99,956	(102,994)	120	12
1995	220,640	183,240	124,080	(73,529)	160	12
1996	235,945	238,612	203,080	3,912	141	11
1997	239,935	238,980	238,980	87,031	76	9
1998	240,754	238,384	188,760	73,253	99	7
1999	239,567	238,980	180,640	81,163	61	5
2000	238,935	238,691	208,385	111,343	46	4
2001	168,009	159,305	100,111	12,621	221	12
2002	240,295	238,980	196,689	5,990	165	12
2003	237,710	198,381	122,773	(13,799)	194	12
2004	163,570	194,162	107,792	(67,478)	189	12
2005	166,330	168,506	123,907	(76,176)	154	12
2006	178,380	185,267	181,452	(35,045)	164	12
Average	**213,128**	**202,882**	**153,646**	**2,159**	**148.5**	**10.5**

5: Impact of KKC on Lake Kachess TWY storage – Adverse Climate

Appendix 5
Appendix 4

Impact of KKC on Lake Kachess Storage: Adverse Climate change

Source: BoR Hydromet Data, BoR Hydrology TM (July 2016)

Water Year	IP2A Delivery TWY	IP2 KKC Transfer to Lake Kachess TWY	Sum of IP2A & IP2 KKC Transfers: Total Water Available	IP2 TWY Lake Kachess Delivery	Net TWY Impact of KKC on Lake Kachess Storage	Cumulative Impact of KKC on Lake Kachess Storage
1976	222.4	132.0	354.4	390.1	(35.7)	(35.7)
1977	272.5	27.0	299.5	301.1	(1.6)	(37.3)
1978	188.9	77.0	265.9	234.9	31.0	(6.3)
1979	191.9	16.0	207.9	218.7	(10.8)	(17.1)
1980	200.0	32.0	232.0	209.0	23.0	5.9
1981	181.7	48.0	229.7	217.4	12.3	18.2
1982	175.3	128.0	303.3	241.2	62.1	80.3
1983	183.1	84.0	267.1	276.6	(9.5)	70.8
1984	169.3	79.0	248.3	253.5	(5.2)	65.6
1985	180.4	13.0	193.4	252.3	(58.9)	6.7
1986	185.4	14.0	199.4	219.2	(19.8)	(13.1)
1987	185.0	48.0	233.0	209.9	23.1	10.0
1988	159.2	4.0	163.2	189.8	(26.6)	(16.6)
1989	174.9	58.0	232.9	192.5	40.4	23.8
1990	176.2	72.0	248.2	203.7	44.5	68.3
1991	177.8	124.0	301.8	271.0	30.8	99.1
1992	218.4	54.0	272.4	340.2	(67.8)	31.3
1993	161.9	12.0	173.9	244.7	(70.8)	(39.5)
1994	119.8	2.0	121.8	130.1	(8.3)	(47.8)
1995	160.4	33.0	193.4	178.3	15.1	(32.7)
1996	160.0	119.0	279.0	167.4	111.6	78.9
1997	188.7	98.0	286.7	299.4	(12.7)	66.2
1998	194.0	114.0	308.0	343.5	(35.5)	30.7
1999	193.9	82.0	275.9	262.7	13.2	43.9
2000	188.7	91.0	279.7	320.4	(40.7)	3.2
2001	251.9	17.0	268.9	287.2	(18.3)	(15.1)
2002	178.8	106.0	284.8	220.6	64.2	49.1
2003	193.7	47.0	240.7	244.7	(4.0)	45.1
2004	189.4	6.0	195.4	232.9	(37.5)	7.6
2005	153.7	34.0	187.7	238.4	(50.7)	(43.1)
2006	164.6	71.0	235.6	167.8	67.8	24.7
Average	185.2	59.4	244.6	243.8	0.80	
Total		1,842.0		Total Increases	539.1	
				Total Decreases	(514.4)	
				Net Impact	24.7	

Technical Appendix – Key Insights

A. **The RiverWare model significantly distorts history & is significantly biased in support of the IP** ➡ **The conclusions are unsupportable**

B. **1976-2006 is the best available proxy period for understanding Adverse Climate Change** ➡ **So focusing there is the most appropriate basis of analysis**

C. **Over 65% of the time, modeled Irrigation District benefits do not align with actual storage deliveries** ➡ **It's an over-promise and under-deliver approach**

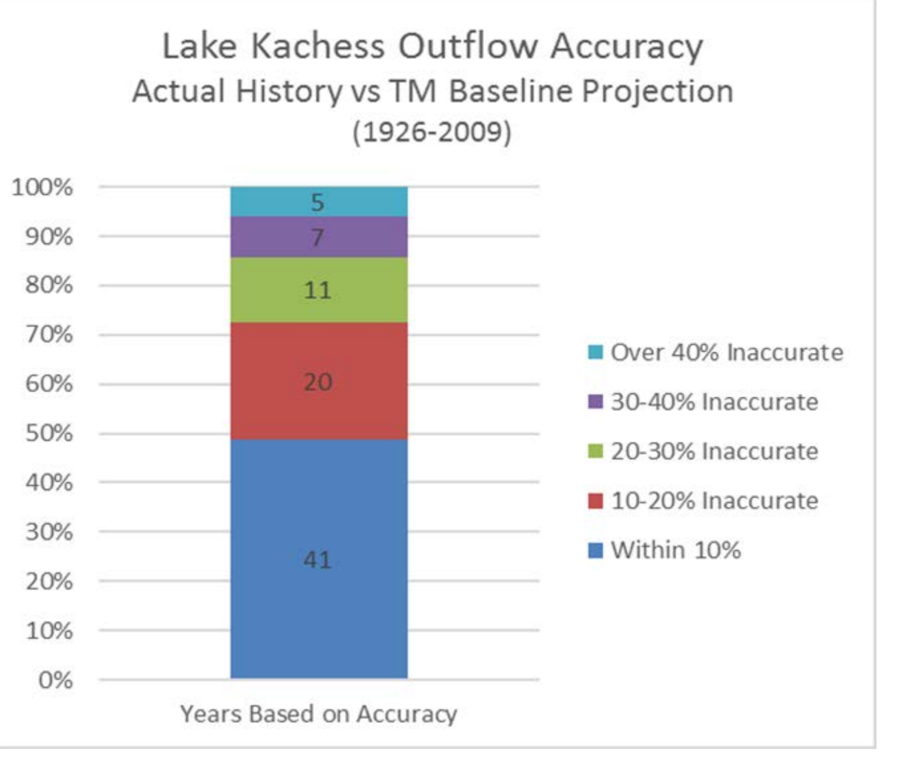
D. **The previous Benefit-Cost analysis includes significant scientific & economic errors; an updated review is needed** ➡ **And an objective and unbiased review process is needed**

Technical Appendix – BoR Data

- A: Lake Kachess Outflow data: Actual History vs Technical Memorandum Baseline projections
- B: TWSA & Proration History (1976-2016) from the BoR Yakima Office
- C: TM Adverse Climate - Lake Kachess Outflows vs Irrigation District Deliveries: Unexplained Variance
- D: Adjustments to the Four Accounts Benefit-Cost Analysis

A: The RiverWare model is well intended but given its complexity, the model significantly distorts history

- The RiverWare model is complex and very challenging to calibrate
  - Only calibrated at a broad level on a limited # of points (e.g. Parker Gauge flows)
  - Other than the broad calibration points, it does not recreate history at specific points (e.g. flows from Lake Kachess)
  - It is at extreme risk for inaccurate results at any specific point
- When compared to actual historical flows at Lake Kachess, the model is significantly wrong over 50% of the time
  - Only 49% of the time is it even within 10% accurate
  - It is off by more than 30% over 27% of the time
  - It cannot be relied upon for accuracy in portraying the impact on Lake Kachess nor should it be for water deliveries to irrigation districts



"It's certainly not perfect, but it is the best we have" BoR Staff

A (cont): The limited accuracy significantly biases the RiverWare model results in favor of the Working Group agenda

- Even worse, the model is significantly biased in favor of the Work Group's agenda
  - The model shifts 658 kAF into low water years, making it look more attractive than historical actuals
  - This represents a nearly 16% distortion in the potential benefits
- Unfortunately, this is the best we have, but it in no way represents an accurate or unbiased data set
  - The BoR should be much more transparent regarding the limited potential of the RiverWare model
  - Legislators and policy makers should understand the limited accuracy and irrigator bias of the model when investing public resources

Appendix A					
Lake Kachess Outflow Accuracy **Actual History vs TM Baseline Projection (1926-2009)**					
Source: BoR Hydromet Data, BoR Hydrology TM (July 2016)					
Time Frame	**Average Actual Annual Outflow from Hydromet Data [kAF]**	**Average TM - Baseline Historical Annual Outlfow Projection [kAF]**	**Average Outflow Error: TM Baseline vs Actual [kAF]**	**Percent Error**	**Total Outflow Error [kAF]**
Best 28 Water Years	**273.9**	**252.5**	**-21.4**	**-7.8%**	**-598.3**
Middle 28 Water Years	**213.7**	**213.6**	**-0.1**	**0.0%**	**-2.7**
Worst 28 Water Years	**147.5**	**171.0**	**23.5**	**15.9%**	**658.5**

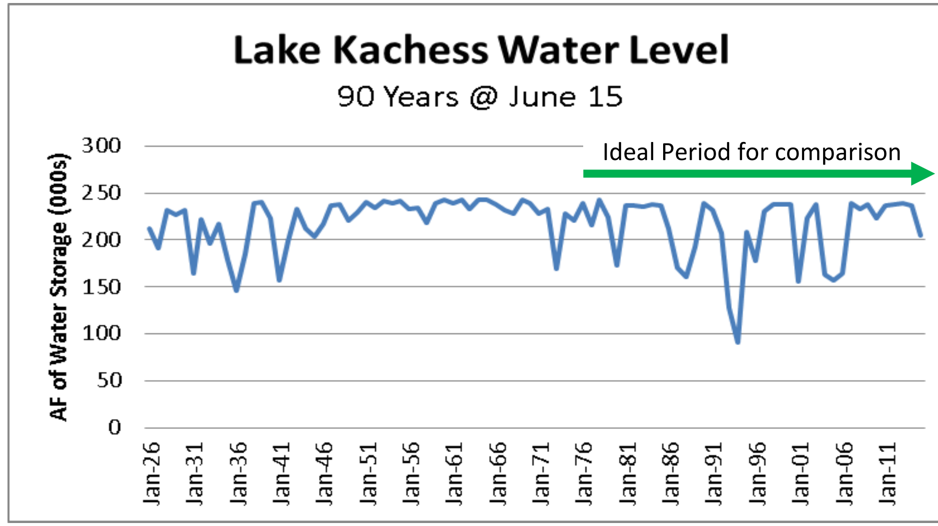
A (cont): Lake Kachess Outflow data: Actual History vs Technical Memorandum Baseline projections

Appendix A				
Lake Kachess Outflow Accuracy Actual History vs TM Baseline Projection (1926-2009)				
Source: BoR Hydromet Data, BoR Hydrology TM (July 2016)				
Year	Actual Annual Outflow from Hydromet Data [kAF]	TM -Baseline Historical Annual Outflow Projection [kAF]	Error: TM Baseline vs Actual [kAF]	Percent Error
1926	215.0	247.6	32.6	13.2%
1927	117.1	138.4	21.3	15.4%
1928	244.9	242.8	-2.1	-0.9%
1929	104.3	212.6	108.3	50.9%
1930	242.5	143.9	-98.6	-68.5%
1931	174.0	149.0	-25.0	-16.8%
1932	146.4	148.7	2.3	1.5%
1933	297.6	229.8	-67.8	-29.5%
1934	321.5	422.4	100.9	23.9%
1935	249.0	176.3	-72.7	-41.2%
1936	211.5	221.3	9.8	4.4%
1937	160.6	173.5	12.9	7.4%
1938	167.9	201.2	33.3	16.6%
1939	203.2	222.8	19.6	8.8%
1940	158.1	192.8	34.7	18.0%
1941	134.2	115.9	-18.3	-15.8%
1942	161.8	149.7	-12.1	-8.1%
1943	112.4	135.6	23.2	17.1%
1944	234.1	194.8	-39.3	-20.2%
1945	94.5	157.9	63.4	40.1%
1946	227.2	143.8	-83.4	-58.0%
1947	213.5	241.2	27.7	11.5%
1948	232.9	219.6	-13.3	-6.0%
1949	302.7	215.5	-87.2	-40.4%
1950	250.6	288.6	38.0	13.2%
1951	269.6	295.7	26.1	8.8%
1952	202.0	192.9	-9.1	-4.7%
1953	154.6	198.3	43.7	22.0%
1954	241.0	218.9	-22.1	-10.1%
1955	228.5	205.5	-23.0	-11.2%
1956	301.4	320.8	19.4	6.0%
1957	273.1	275.4	2.3	0.8%
1958	159.3	205.3	46.0	22.4%
1959	229.9	196.4	-33.5	-17.0%
1960	291.4	287.6	-3.8	-1.3%
1961	254.4	239.9	-14.5	-6.0%
1962	197.9	200.2	2.3	1.1%
1963	199.9	213.9	14.0	6.6%
1964	173.4	144.1	-29.3	-20.3%
1965	252.1	269.2	17.1	6.4%
1966	156.3	190.6	34.3	18.0%
1967	184.3	185.6	1.3	0.7%

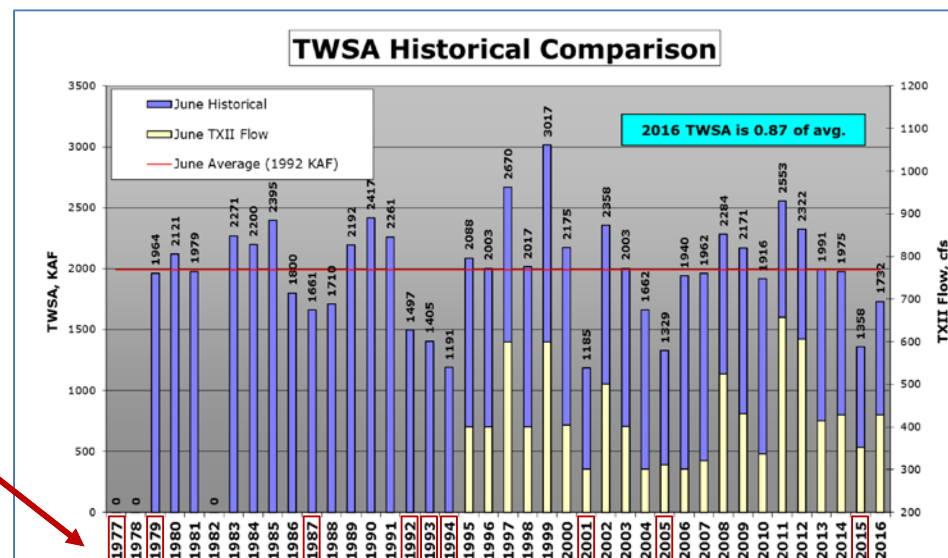
Appendix A				
Lake Kachess Outflow Accuracy Actual History vs TM Baseline Projection (1926-2009)				
Source: BoR Hydromet Data, BoR Hydrology TM (July 2016)				
Year	Actual Annual Outflow from Hydromet Data [kAF]	TM -Baseline Historical Annual Outflow Projection [kAF]	Error: TM Baseline vs Actual [kAF]	Percent Error
1968	238.1	223.5	-14.6	-6.5%
1969	188.4	235.0	46.6	19.8%
1970	215.5	199.1	-16.4	-8.2%
1971	208.1	169.1	-39.0	-23.1%
1972	280.5	327.2	46.7	14.3%
1973	339.1	264.8	-74.3	-28.1%
1974	249.0	181.0	-68.0	-37.6%
1975	153.5	250.3	96.8	38.7%
1976	277.7	295.2	17.5	5.9%
1977	226.1	243.9	17.8	7.3%
1978	143.4	143.7	0.3	0.2%
1979	293.6	212.2	-81.4	-38.3%
1980	103.5	166.2	62.7	37.7%
1981	200.2	204.4	4.2	2.1%
1982	209.7	167.4	-42.3	-25.3%
1983	212.1	217.2	5.1	2.4%
1984	234.9	220.4	-14.5	-6.6%
1985	243.5	227.2	-16.3	-7.2%
1986	230.6	222.3	-8.3	-3.7%
1987	172.2	196.4	24.2	12.3%
1988	160.9	178.2	17.3	9.7%
1989	144.7	162.8	18.1	11.1%
1990	194.2	203.9	9.7	4.8%
1991	301.7	270.3	-31.4	-11.6%
1992	270.8	273.4	2.6	0.9%
1993	170.1	171.9	1.8	1.1%
1994	140.4	132.1	-8.3	-6.2%
1995	142.0	155.4	13.4	8.6%
1996	397.8	300.7	-97.1	-32.3%
1997	212.4	296.0	83.6	28.3%
1998	219.4	240.5	21.1	8.8%
1999	241.5	221.6	-19.9	-9.0%
2000	234.5	260.8	26.3	10.1%
2001	247.7	200.0	-47.7	-23.9%
2002	138.2	180.4	42.2	23.4%
2003	247.9	226.8	-21.1	-9.3%
2004	182.9	192.6	9.7	5.0%
2005	203.4	191.1	-12.3	-6.4%
2006	119.8	148.6	28.8	19.4%
2007	213.6	223.4	9.8	4.4%
2008	182.6	195.4	12.8	6.5%
2009	247.0	219.0	-28.0	-12.8%

B: 1976-2006 is the best proxy period for understanding Adverse Climate Change assumptions and insights

- Detailed TWSA data prior to 1976 is limited and/or incomplete
- 1944-1975 are years of record water surplus with very limited droughts; so it is very biased and should not be included
- With 8 years of drought over 31 years, 1976-2006 represent a good proxy for Adverse Climate assumptions
  - Integrated Plan Adverse Climate assumptions include a drought every 5 years and a multi-year drought every 20 years for a total of 7 droughts
  - Accordingly, 1976-2006 provides a strong fit to projected Adverse Climate drought frequency and severity conditions



Yakima Basin TWSA - Drought Years (1976-2006)				
Source: BoR TWSA Historical Data (Provided by the YFO)				
Year	July Proratable Water Supply from BoR TWSA [kAF]	Avg Proration July-Sept	Drought Level	Lake Kachess Irrigation Season Outflow [kAF]
1977	461.1	70.0%	Modest	193.5
1979	395.2	68.7%	Modest	271.8
1987	461.1	68.7%	Modest	163.2
1992	382.0	58.0%	Significant	225.9
1993	421.6	66.7%	Modest	165.4
1994	256.9	38.3%	Severe	134.5
2001	224.0	36.0%	Severe	202.5
2005	270.1	41.7%	Severe	167.4
Full Proratable Right	658.7			
2015	289.8	46.0%	Severe	212.3



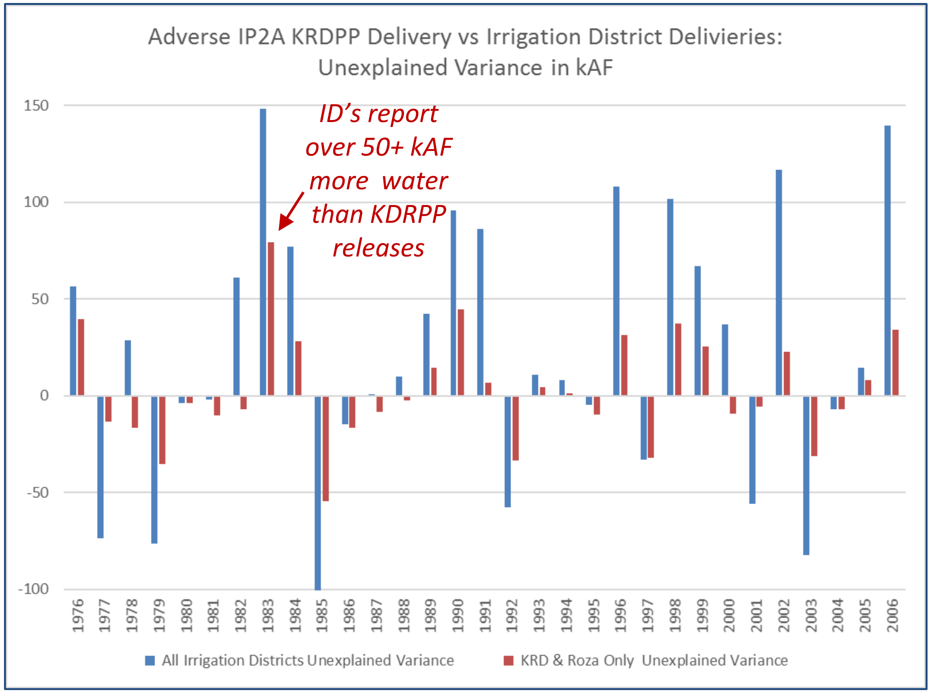
B (cont): TWSA & Proration History (1976-2016) from the BoR Yakima Office

TWSA Estimates (KAF) (period is Month to End of TWSA season) & Prorationing, % (period is start of Prorationing to End of TWSA season).														
YEAR	**Mar's Apr**	**Proration**	**Apr**	**Proration**	**May**	**Proration**	**Jun**	**Proration**	**Jul**	**Proration**	**Aug**	**Proration**	**Sep**	**Proration**
1977			2037	20%		32%		50%		70%		70%		70%
1978	3088		2678		2341				1433		920			
1979	2770		2657		2460		1964	75%		60%		46%		100%
1980	3268		3147		2705		2121							
1981	2690		2367		2296		1979							
1982	3433		3256		3005									
1983	3453		3392		2941		2271							
1984	2956		2786		2501		2200							
1985	3106		3111		2868		2395		1529		899			
1986	3061		2668		2284		1800		1367					
1987	2558		2559		2297		1661	73%	1301	70%		68%		68%
1988	2377		2253		2065		1710		1349	82%		90%		90%
1989	2946		3071		2666		2192							
1990	3446		3268		2824		2417		1717					
1991	2938		2962		2742		2261		1854					
1992	2853		2422		2268	58%	*1497*	58%	*1155*	58%	*788*	58%	*324*	58%
1993	2062		1974	85%	1842	85%	*1405*	56%	*1126*	64%	*774*	67%	415	69%
1994	2169		2016		1691	41%	*1191*	34%	*934*	39%	*593*	39%	283	37%
1995	3284		3044		2666		2088		1572					
1996	3268		2872		2530		2003		1463					
1997	4055		4542		3836		2670		1935					
1998	3193		2982		2548		2017		1536					
1999	4179		4198		3649		3017		1913					
2000	3319		3305		2691		2175		1615					
2001	1820		1678		1557	29%	*1185*	30%	*930*	34%	*609*	37%	*319*	37%
2002	3121		3316		2879		2358		1631					
2003	2492		2644		2437		2003	97%	*1321*	97%	*869*	86%		92%
2004	2879		*2553*		*2076*		*1662*	82%	*1255*	82%	*854*	90%	*507*	92%
2005	*1700*		*1715*	34%	*1491*	38%	*1329*	40%	*1032*	41%	*705*	42%	*365*	42%
2006	3213		3082		*2565*		*1940*		*1517*		*1052*		*411*	
2007	3434		3071		*2681*		*1962*		*1466*		*1070*		*322*	
2008	3241		3142		*2725*		*2284*		*1693*					
2009	2910		3132		*2766*		*2171*		*1502*					
2010	2359		2313	71%	2074	78%	*1916*	90%	*1571*	100%	*1144*	100%		100%
2011	2945		3361		2989		*2553*		*1789*					
2012	3357		3555		3093		*2322*		*1705*					
2013	2945		2792		2593		*1991*		*1538*					
2014	2848		3024		2611		*1975*		*1489*					
2015	2294	73%	2110	60%	1688	47%	*1358*	46%	*1015*	44%	*711*	47%	*400*	47%
2016	3187		3118		2223		*1732*		*1363*		*974*		*576*	
Avg	2969		2867		2547		2020		1475		*856*		*368*	
TWSA does not include October water from April 1993 onward.														
Prorationing is based on the TWSA beginning when Prorationing begins and ending on September 30. This is different from the TWSA's reported here.														

C: Over 65% of the time, modeled Irrigation District impact (i.e. water delivery) does not align with actual Kachess deliveries

In Adverse IP2A, KRDPP is the only active water storage change, so deliveries from KDRPP should align with Irrigation District impact

- The RiverWare model suffers from significant unexplained errors for water delivered to Irrigation Districts
  - In 20 of 31 years, total Irrigation District deliveries are off by more than 30 kAF when compared to actual Kachess deliveries
  - The average absolute error is 55 kAF and over 33% of reported Kachess flows
- Limiting the analysis to just KRD & Roza, the unexplained error is still significant
  - 10 of 31 Years; 22 kAF Average
  - Given that the average KDRPP annual benefit was only 23 kAF, an unexplained error of 22 kAF is a significant data integrity issue
- BoR needs to explain (especially to the Irrigation Districts) a 33% total distortion
  - In the 8 drought years, the error level climbs to 52%



	(Reflects the overall accuracy of the data set)		
	Average Error	Average Percent Error	Years are off by more than 30 kAF (out of 31)
All Districts	**55.5**	**33.7%**	**20**
KRD & Roza Only	**21.7**	**13.2%**	**10**

C (cont): TM Adverse Climate - Lake Kachess Outflows vs Irrigation District Deliveries: Unexplained Error

Appendix C

Lake Kachess Outflows vs Irrigation District Deliveries: Unexplained Error
TM Adverse Climate Scenario IP2A: KDRPP releases vs ID deliveries (1976-2006)

Source: BoR Hydromet Data, BoR Hydrology TM (July 2016)

Year	TM Adv IP0 ID (5 Districts) Deliveries	TM Adv IP2A ID (5 Districts) Deliveries	TM Change from IP0 to IP2A	Actual KDRPP Delivery Change: Adverse IP2A KDRPP Outflow vs Adverse IP0	Unexplained Error from Actual Delivery Change: KRD & Roza Only (+ surplus water; - missing water)	Unexplained Error as a percent of KDRPP Adverse IS IP2A Delivery
1976	1,799	1,744	-54.8	1.5	56.3	26.6%
1977	750	943	192.7	119.0	-73.7	-33.0%
1978	1,537	1,477	-59.8	-31.1	28.7	17.4%
1979	1,066	1,198	131.8	55.6	-76.2	-46.0%
1980	1,476	1,501	25.0	21.4	-3.6	-2.1%
1981	1,410	1,415	4.7	2.7	-2.0	-1.2%
1982	1,743	1,669	-74.0	-13.1	60.9	37.4%
1983	1,615	1,453	-162.0	-13.9	148.1	89.7%
1984	1,600	1,506	-94.0	-17.0	77.0	53.0%
1985	1,048	1,192	143.3	41.3	-102.0	-66.0%
1986	1,226	1,250	23.5	8.6	-14.9	-9.4%
1987	1,334	1,344	10.4	11.1	0.7	0.4%
1988	1,238	1,237	-1.2	8.6	9.8	6.8%
1989	1,558	1,525	-32.8	9.3	42.1	25.1%
1990	1,637	1,540	-97.4	-1.6	95.8	59.4%
1991	1,664	1,525	-138.9	-53.0	85.9	54.2%
1992	964	1,064	99.7	41.8	-57.9	-30.0%
1993	1,142	1,128	-13.9	-3.3	10.6	7.8%
1994	841	851	9.6	17.6	8.0	7.2%
1995	1,340	1,346	6.0	1.0	-5.0	-3.2%
1996	1,637	1,499	-137.6	-29.5	108.1	71.6%
1997	1,744	1,745	0.7	-32.2	-32.9	-20.2%
1998	1,546	1,410	-136.5	-34.9	101.6	62.8%
1999	1,687	1,634	-53.7	13.1	66.8	38.8%
2000	1,577	1,492	-85.0	-48.3	36.7	21.5%
2001	936	1,096	160.7	104.7	-56.0	-25.3%
2002	1,736	1,604	-132.0	-15.2	116.8	74.4%
2003	1,329	1,441	112.2	30.0	-82.2	-46.3%
2004	1,274	1,300	25.6	18.4	-7.2	-4.3%
2005	1,065	1,065	-0.1	14.4	14.5	10.1%
2006	1,711	1,548	-163.3	-23.7	139.6	90.2%
Average	1,395	1,379	-15.8	6.6	22.4	13.6%

Average Absolute Variance (Reflects the overall accuracy of the data set)	**55.5**	**33.7%**

20 of 31 Years are off by more than 30 kAF

Appendix C

Lake Kachess Outflows vs KRD & Roza Irrigation District Deliveries: Unexplained Error
TM Adverse Climate Scenario IP2A: KDRPP releases vs KRD & Roza ID deliveries (1976-2006)

Source: BoR Hydromet Data, BoR Hydrology TM (July 2016)

Year	Actual KDRPP Delivery Change: Adverse IP2A KDRPP Outflow vs Adverse IP0	TM IP2A vs IP0 Delivery Change for KRD & Roza Only	Unexplained Error from Actual Delivery Change: KRD & Roza Only (+ surplus water; - missing water)	Unexplained Error as a percent of KDRPP Adverse IS IP2A Delivery
1976	1.5	-38.1	39.6	18.7%
1977	119.0	132.6	-13.6	-6.1%
1978	-31.1	-14.4	-16.7	-10.1%
1979	55.6	90.9	-35.3	-21.3%
1980	21.4	25.1	-3.7	-2.2%
1981	2.7	13.0	-10.3	-6.4%
1982	-13.1	-6.1	-7.0	-4.3%
1983	-13.9	-93.0	79.1	47.9%
1984	-17.0	-44.9	27.9	19.2%
1985	41.3	96.0	-54.7	-35.4%
1986	8.6	25.4	-16.8	-10.6%
1987	11.1	19.6	-8.5	-5.3%
1988	8.6	10.9	-2.3	-1.6%
1989	9.3	-5.2	14.5	8.6%
1990	-1.6	-45.9	44.3	27.5%
1991	-53.0	-59.8	6.8	4.3%
1992	41.8	75.3	-33.5	-17.4%
1993	-3.3	-7.7	4.4	3.2%
1994	17.6	16.3	1.3	1.1%
1995	1.0	10.7	-9.7	-6.4%
1996	-29.5	-61.0	31.5	20.9%
1997	-32.2	0.0	-32.2	-19.8%
1998	-34.9	-72.1	37.2	23.0%
1999	13.1	-12.4	25.5	14.8%
2000	-48.3	-38.9	-9.4	-5.5%
2001	104.7	110.3	-5.6	-2.5%
2002	-15.2	-37.8	22.6	14.4%
2003	30.0	61.1	-31.1	-17.5%
2004	18.4	25.3	-6.9	-4.1%
2005	14.4	6.5	7.9	5.6%
2006	-23.7	-57.7	34.0	22.0%
Average	6.6	4.0	2.6	1.6%

Average Absolute Variance (Reflects the overall accuracy of the data set)	**21.7**	**13.2%**

10 of 31 Years are off by more than 30 kAF for just KRD and Roza alone