The background of the slide is a light gray gradient with several realistic water droplets of various sizes scattered across it. The droplets have highlights and shadows, giving them a three-dimensional appearance.

# **Colorado River Risk Study Phase III**

An Update for the 4 West Slope Basin Round Table Meeting

Grand Junction, Colorado

June 20, 2019

*Disclaimer: The findings presented herein are for discussion purposes only, and do not represent the official position of any entity with respect to factual or legal matters concerning the Colorado River.*

*All Results Presented herein are Preliminary and Subject to Change*

# Colorado River Risk Study

- Originated from joint West Slope BRT discussions and reflection on DCP process
- Funding via Colorado River District, Southwestern, West Slope BRTs (CWCB)
- Principle 4 of the IBCC Conceptual Framework from the Colorado Water Plan: *A collaborative program that protects against involuntary curtailment is needed for existing uses and some reasonable increment of future development in the Colorado River system, but it will not cover a new TMD.*
- Phase I completed Fall 2016; Phase II completed Fall 2018
- Takeaways thus far:
  1. Under current conditions and operating policies, the likelihood of reaching critical elevations or a compact deficit is low, but impacts could be significant
  2. Hydrology and amount of future growth in the Upper Basin are key drivers of risk
  3. It is not just a Lower Basin / Structural Deficit problem (hence the UB DCP plan)

*Disclaimer Part 2:*

- 1. All Models are Wrong, some are Useful – George Box*
- 2. Any opinions expressed herein are my own*
- 3. Don't shoot the messenger*

# Lake Powell and the Colorado River Compact

## Upper Basin Objectives:

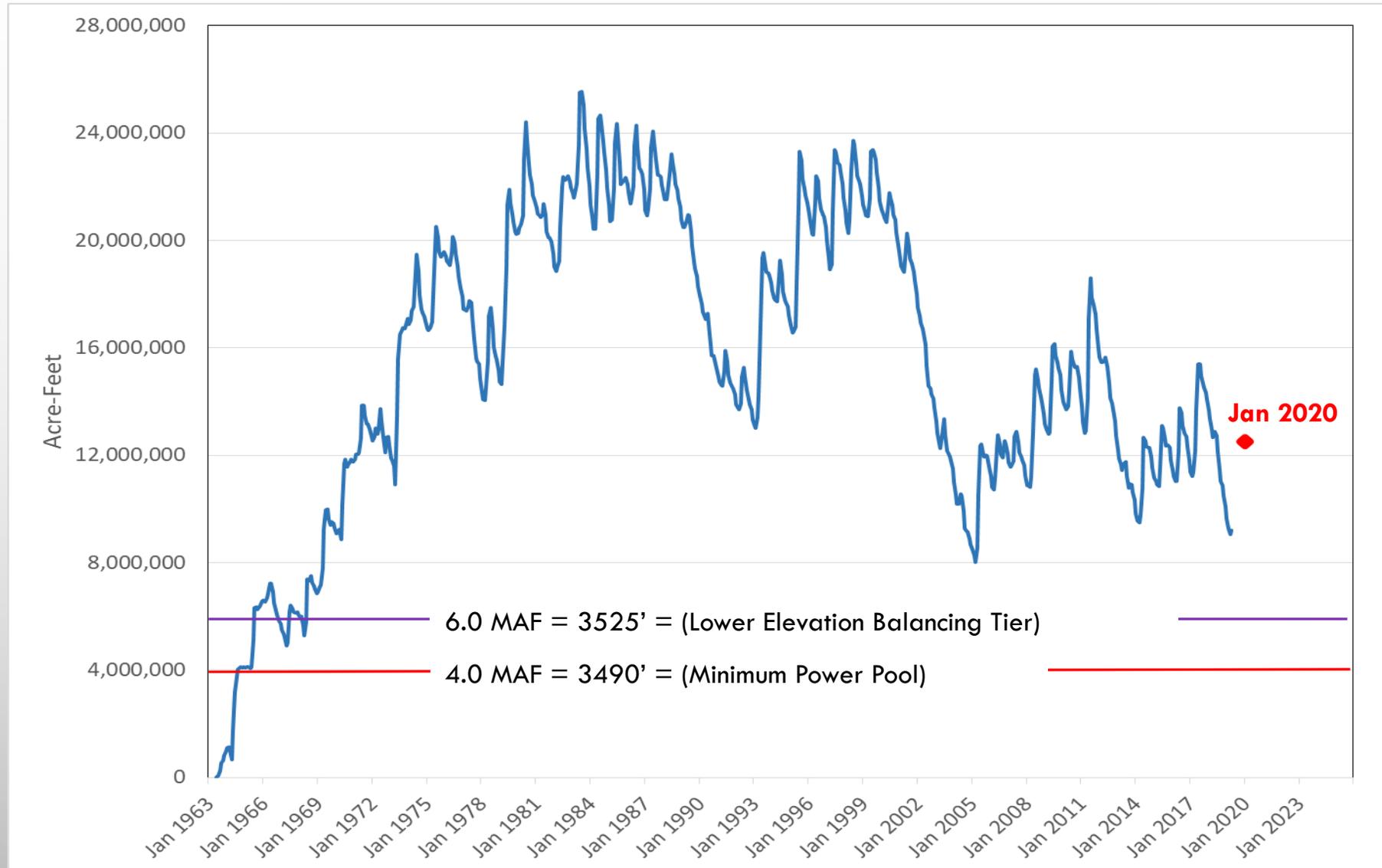
1. Avoid Compact Deficit which *might* lead to curtailment
2. Protect Lake Powell (Elevation 3525' is threshold for Lower Elevation Balancing Tier. 3490' is minimum power pool)

## Risk Drivers:

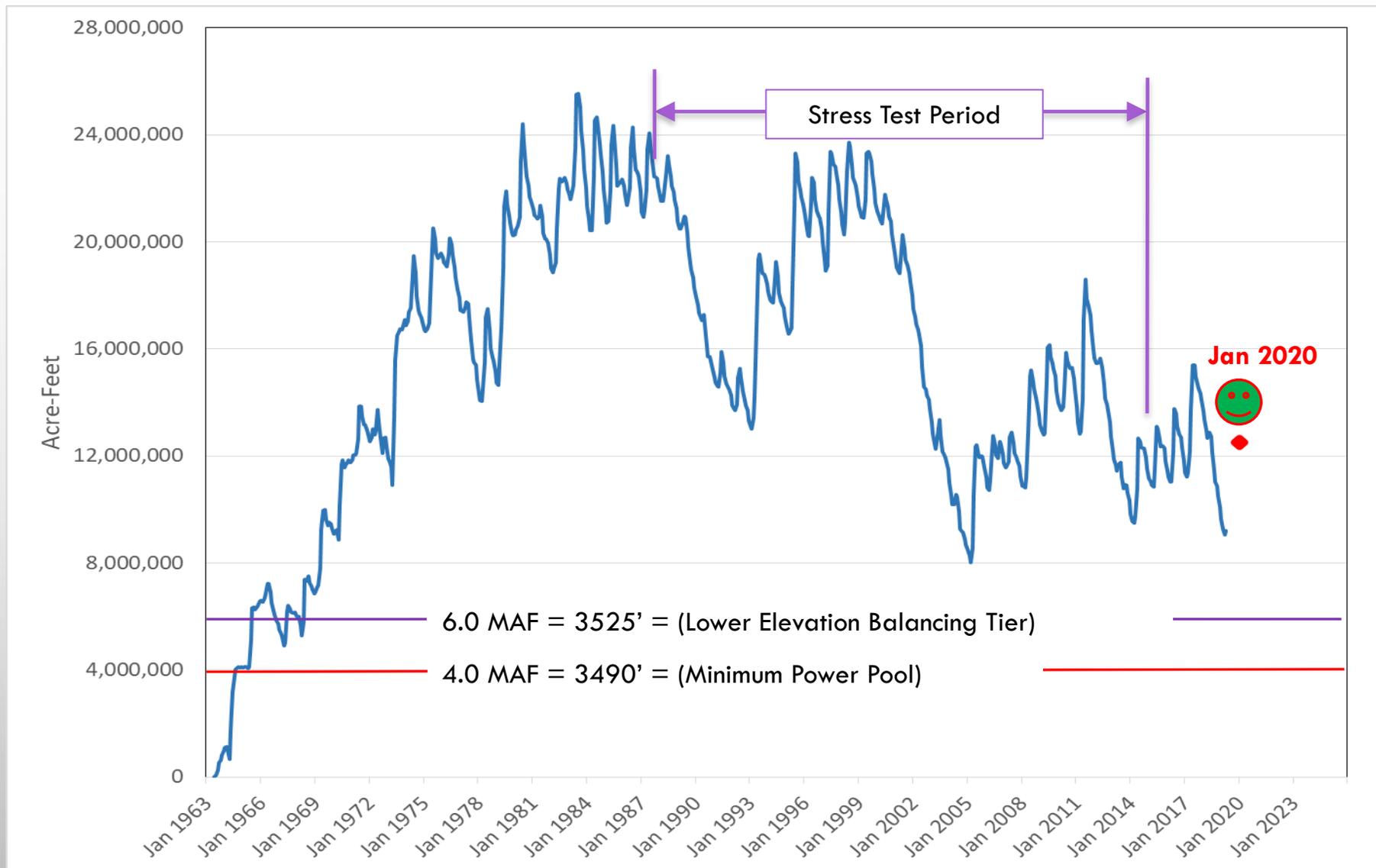
- Hydrology
- Consumptive Use
- Low Reservoir Storage Conditions



# Lake Powell Storage



# Lake Powell Storage



# What does Modeling tell us about Risk?

Model analysis from Phase III of the Risk Study using the 1988-2015 Stress Test Hydrology indicates:

1. The likelihood of Lake Powell Dropping below 3525' at some point in the next 25 years is ~ 39% (11 of 28 traces).
2. The likelihood of the 10-year running average Lee Ferry volume dropping below 82.5 Maf is ~ 46% (13 of 28 traces)
3. The likelihood of the 10-year running average Lee Ferry volume dropping below 75 Maf is ~ 0%\* (0 of 28 traces)

An increase in annual Upper Basin Consumptive Use averaging 11.5% (approximately 500 Kaf)\*\* roughly doubles the risk of #1 and #2.

*\*Note that previous Risk Study simulations and Reclamation runs have shown likelihoods greater than zero at the 75 Maf threshold (Model assumptions matter!)*

*\*\*The UCRC Demand Schedule anticipates reaching that level of use by ~2037.*

# Pre-Emptive Water Management Options

The recently approved Drought Contingency Plans (DCPs) provide a mechanism for protecting critical elevations at both Lake Powell and Lake Mead.

The Upper Basin DCP has three components intended to reduce or eliminate the risk of reaching critically low Lake Powell levels:

1. Cloud Seeding and Phreatophyte Control (Ongoing)
2. Drought Operations of CRSP storage facilities (Subject to consultation between UB States and Reclamation)
3. Exploration of voluntary and compensated Demand Management program, including use of 500,000 af water bank in one or more CRSP facilities

If these (and possibly other) pre-emptive actions are insufficient to protect Lake Powell levels, and if as a result Lake Powell was unable to release sufficient water past Lee Ferry, a Compact Deficit could result.

# A Compact Deficit could result in Involuntary Curtailment

## *Questions:*

- How much Colorado River water does the State of Colorado use?
- How much of Colorado's depletions are pre-compact?
  - How is this volume split up across the west slope basins (including TMDs)?
  - How much post-compact use could be called out?
  - Where are those post-compact uses?
- What are potential approaches to "Sharing the Pain"?

## Colorado's Consumptive Use of Colorado River Water

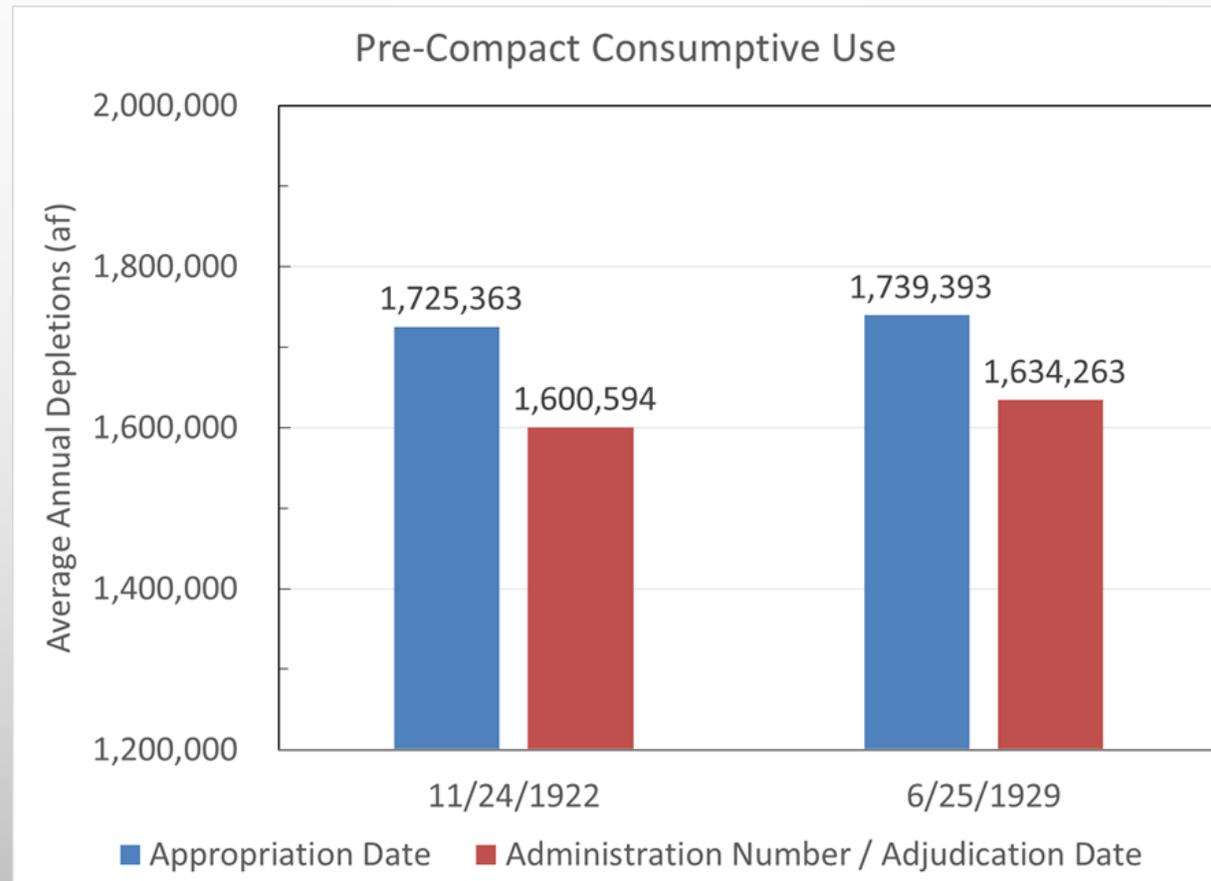
<i>Basin</i>	Annual Depletions (acre-feet)		
	Minimum	Average	Maximum
Yampa	173,547	196,982	215,193
White	48,550	62,060	70,397
Colorado	1,117,487	1,220,386	1,345,192
<i>In-Basin</i>	<i>650,887</i>	<i>669,397</i>	<i>692,333</i>
<i>TMDs</i>	<i>466,600</i>	<i>550,989</i>	<i>652,859</i>
Gunnison	481,626	552,418	601,030
Southwest	335,365	500,717	556,627
Total	2,156,575	2,532,564	2,788,439

## Key Question: How Much Consumptive Use is Pre-Compact?

- Boulder Canyon Project Act (6/25/1929): U.S. Congress approves Colorado River Compact, which was signed by 6 of the 7 basin states on November 24, 1922.
  - Article VIII of the 1922 Compact: “Present perfected rights to the beneficial use of waters of the Colorado River System are unimpaired by this compact...”
- States of the upper basin would most likely attempt to maximize the amount of pre-compact consumptive use
- A point of contention regarding pre-compact rights is likely to be the quantification of “present perfected use” as of 1922.

# Appropriation Dates vs. Administration Dates

- Administration of water rights in Colorado is generally based on adjudication dates (represented by admin numbers in StateMod)
- Modeling a Compact Call using appropriation dates yields more pre-compact consumptive use than using administration numbers/dates.

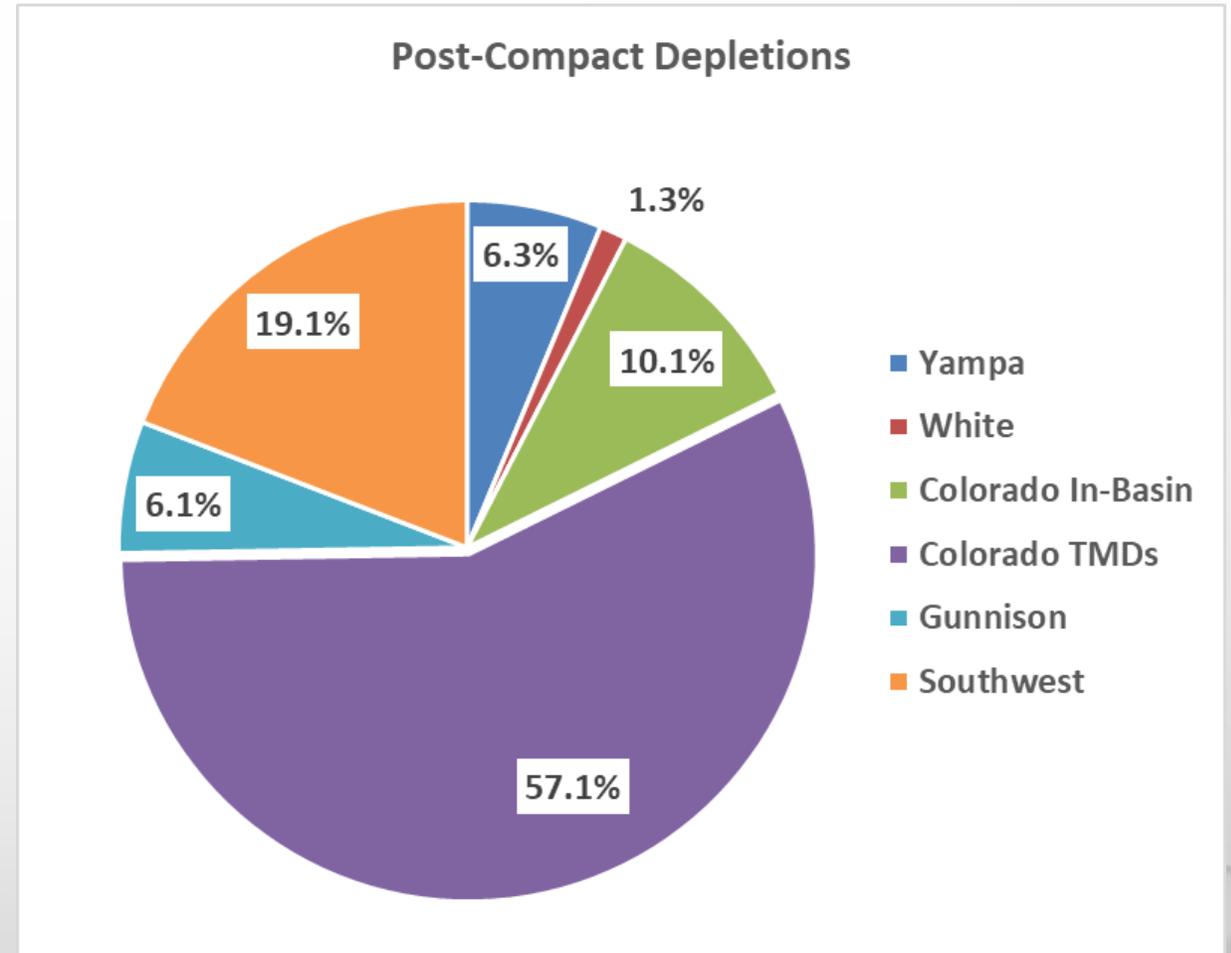


## A Closer Look at Pre/Post Compact Depletions

<i>Basin</i>	Average Annual Depletions (acre-feet)		
	All Users	Pre-Compact	%Pre-Compact
Yampa	196,982	138,544	70%
White	62,060	50,173	81%
Colorado	1,220,386	594,169	49%
<i>In-Basin</i>	<i>669,397</i>	<i>574,997</i>	<i>86%</i>
<i>TMDs</i>	<i>550,989</i>	<i>19,173</i>	<i>3%</i>
Gunnison	552,418	495,147	90%
Southwest	500,717	322,561	64%
Total	2,532,564	1,600,594	63%

# Who is Impacted by Curtailment of all Post-Compact Rights?

<i>Basin</i>	Average Annual Depletions (af)	
	Post-Compact	% of Total
Yampa	58,438	6.3%
White	11,887	1.3%
Colorado	626,216	67.2%
<i>In-Basin</i>	<i>94,400</i>	<i>10.1%</i>
<i>TMDs</i>	<i>531,816</i>	<i>57.1%</i>
Gunnison	57,271	6.1%
Southwest	178,157	19.1%
Total	931,969	100.0%



# What if Curtailment of all Post-Compact Rights is not the only Option?

*Q: How deep would administrative call be in order to yield a given volume?*

Assume different target volumes for reduced consumptive use:

- 100,000 af
- 300,000 af
- 600,000 af

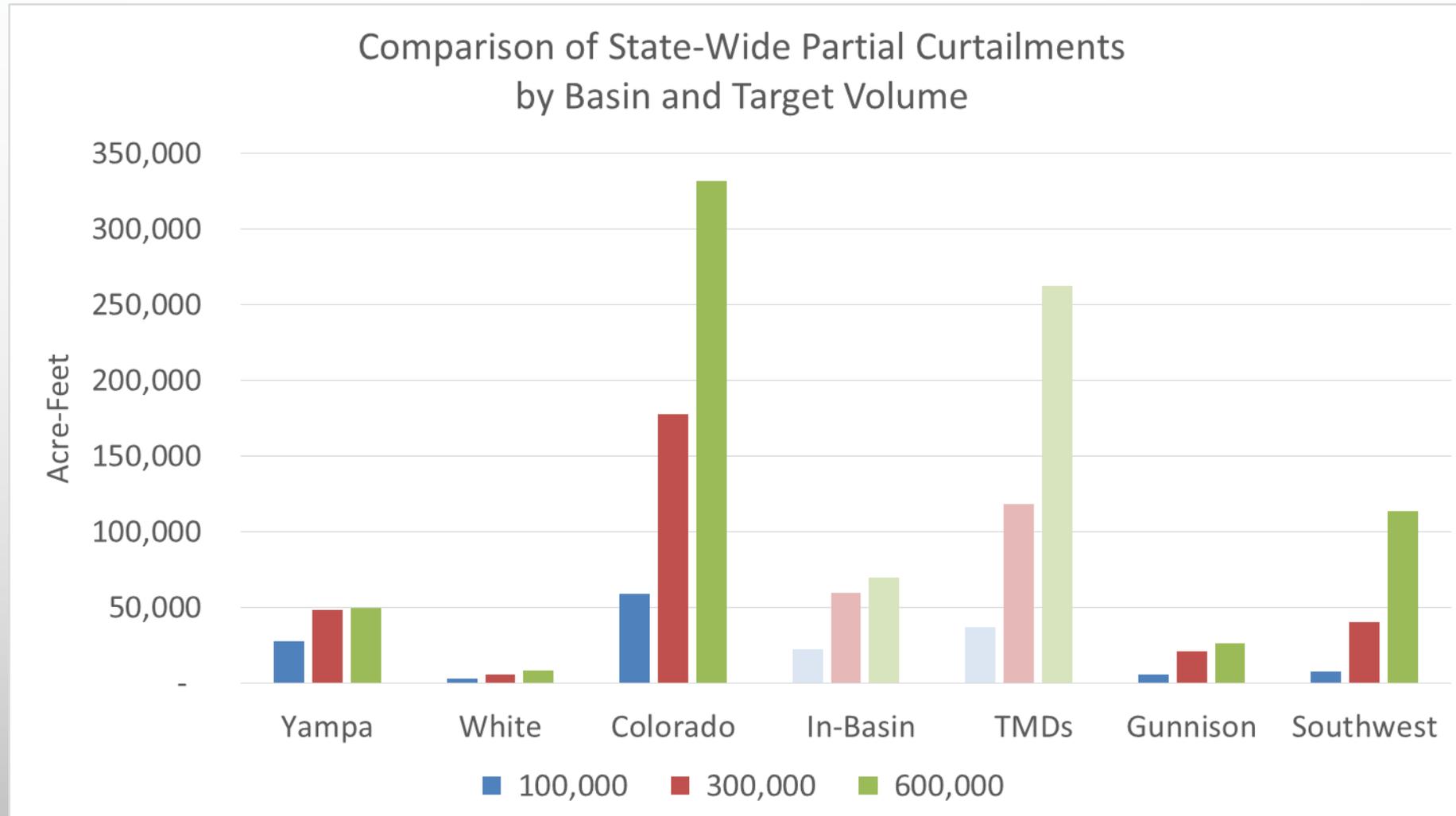
Recall that a “full” compact call yields about 932,000 af on average

Target Volume (acre-feet/yr)	All Colorado River Rights
100,000	Jul 1957
300,000	Sep 1940
600,000	Aug 1935
<b>932,000</b>	<b>Nov 1922</b>

## Impact of a Single State-Wide Partial Call on each Sub-Basin

Target Volume (acre-feet/yr)	Yampa	White	Colorado	<i>In-Basin</i>	<i>TMDs</i>	Gunnison	Southwest
<b>100,000</b> <b>(Jul 1957)</b>	28%	3%	59%	22%	37%	6%	8%
	27,627	2,753	59,124	22,309	36,815	5,925	7,528
<b>300,000</b> <b>(Sep 1940)</b>	16%	2%	59%	20%	39%	7%	13%
	47,987	5,325	177,976	59,918	118,058	20,862	40,233
<b>600,000</b> <b>(Aug 1935)</b>	8%	1%	55%	12%	44%	4%	19%
	49,679	8,478	331,556	69,452	262,105	26,163	113,862
<b>Full</b>	6%	1%	66%	10%	56%	8%	19%
	58,440	11,888	626,171	94,403	531,834	57,273	178,163

# Impact of a Single State-Wide Partial Call on each Sub-Basin



# What if Curtailment According to a Single State-Wide Priority Date is not the only option?

Purpose: Investigate different assumptions regarding the volume and distribution of mandatory curtailment actions *other than* total curtailment.

Examples: Agree to reduce consumptive use via a pro-rata basis. What if\*:

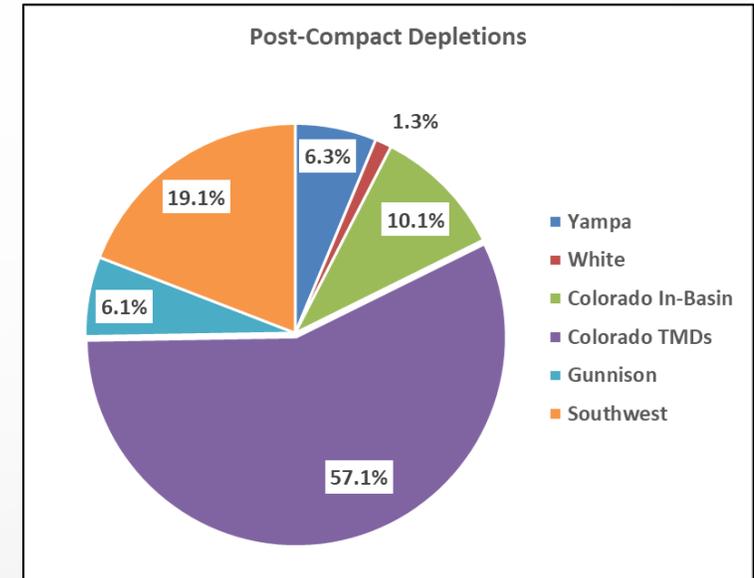
1. We distribute the mandatory reductions based on each sub-basin's percentage of post-compact water use relative to the State as a whole?
2. We distribute the mandatory reductions between in-basin uses and TMDs based on each group's percentage of post-compact water relative to the State as a whole?
3. The in-basin / TMD split is based only on relative uses in the mainstem Colorado (where the vast majority of TMDs occur)?

*\*These scenarios should NOT be construed as advocating for a particular approach to Compact administration. The intent is to quantify and better understand a variety of possible options.*

# Partial Curtailment – by Sub-Basin

Q: How deep would the calls be in each basin to yield these volumes?

Assume that each sub-basin is responsible for reducing consumptive use by a volume of water based on the post-compact depletions *in that sub-basin* relative to the State as a whole



Target Volume (acre-feet/yr)	Yampa	White	Colorado	<i>In-Basin</i>	<i>TMDs</i>	Gunnison	Southwest
	6.3%	1.3%	67.2%	10.1%	57.1%	6.1%	19.1%
100,000	6,270	1,276	67,186	10,129	57,064	6,145	19,116
300,000	18,811	3,827	201,557	30,387	171,191	18,436	57,348
600,000	37,622	7,653	403,114	60,774	342,382	36,871	114,697
932,000	58,440	11,888	626,171	94,403	531,834	57,273	178,163

## Partial Curtailment - by Sub-Basin

Example: If Colorado needed to generate 300,000 af annually, the Yampa basin portion of that volume would be ~18,811 af. To reduce average annual consumptive use in the Yampa by that amount would require calling out all rights junior to August 1962

*A statewide call to yield 300,000 af requires a September 1940 call*

Target Volume (acre-feet/yr)	Yampa	White	Colorado	<i>In-Basin</i>	<i>TMDs</i>	Gunnison	Southwest
	6.3%	1.3%	67.2%	10.1%	57.1%	6.1%	19.1%
100,000	6,270	1,276	67,186	10,129	57,064	6,145	19,116
300,000	18,811	3,827	201,557	30,387	171,191	18,436	57,348
600,000	37,622	7,653	403,114	60,774	342,382	36,871	114,697
932,000	58,440	11,888	626,171	94,403	531,834	57,273	178,163

# Sub-Basin Distribution

For a given target volume, administration dates are developed for each sub-basin

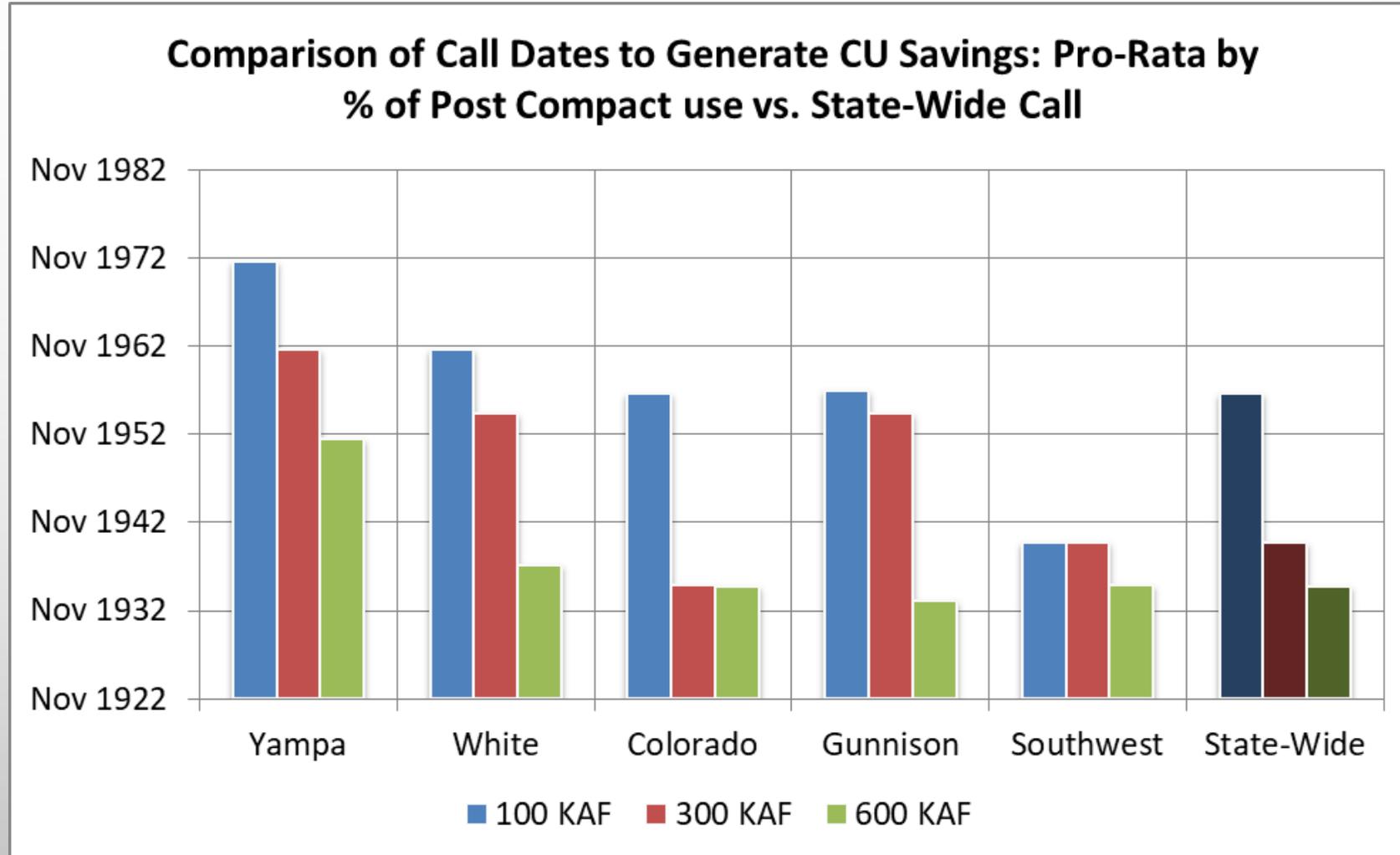
Target Volume (acre-feet/yr)	Yampa	White	Colorado	Gunnison	Southwest
	6.3%	1.3%	67.2%	6.1%	19.1%
100,000	6,270	1,276	67,186	6,145	19,116
	Jul 1972	Jul 1962	Jul 1957	Nov 1957	Sep 1940
300,000	18,811	3,827	201,557	18,436	57,348
	Aug 1962	May 1955	Nov 1935	Apr 1955	Sep 1940
600,000	37,622	7,653	403,114	36,871	114,697
	Jun 1952	Jan 1938	Aug 1935	Dec 1933	Nov 1935

# Colorado Mainstem In-Basin/TMD Split

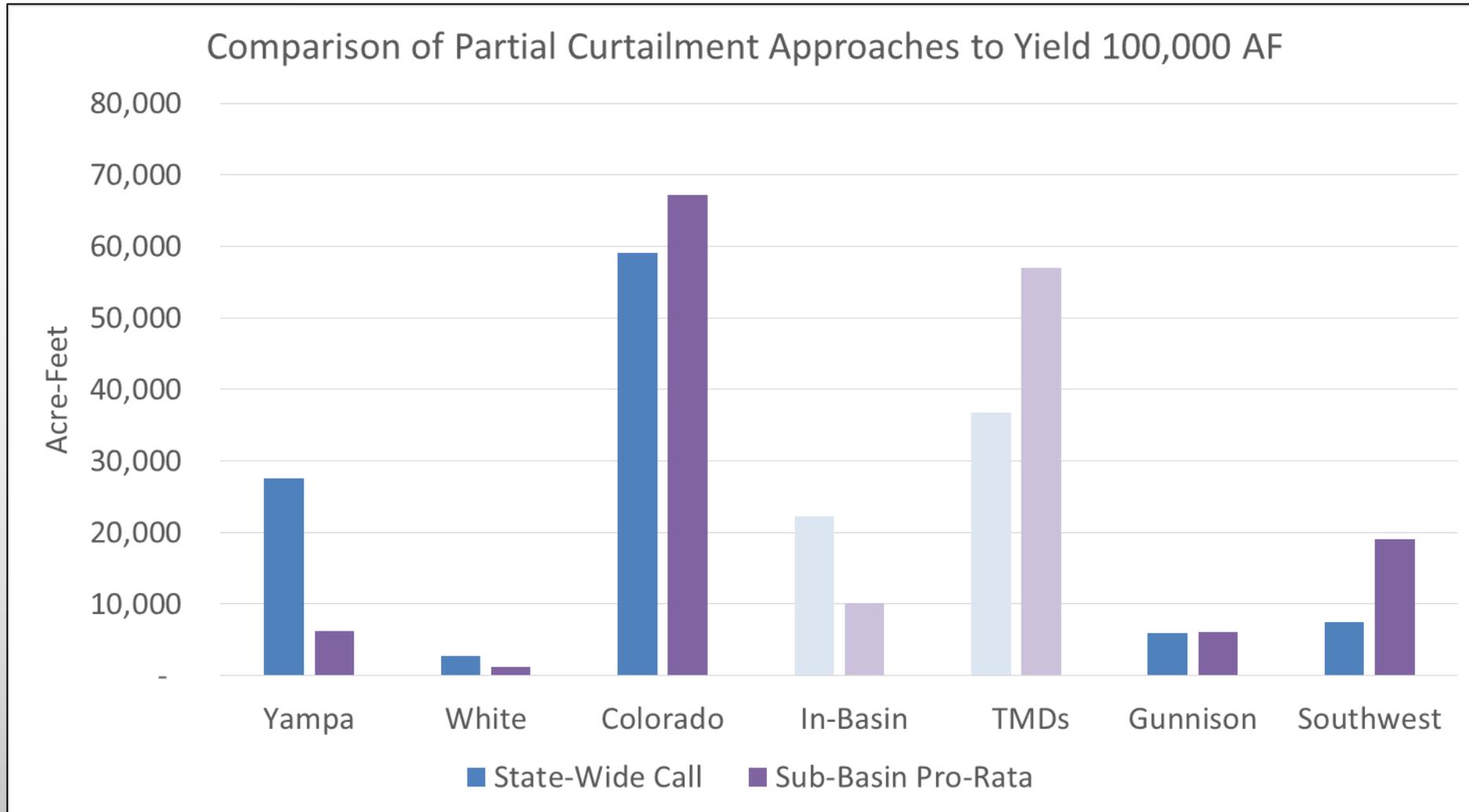
Splitting the mainstem Colorado into in-basin and TMD users relieves some in-basin administration, but TMD call remains essentially the same:

Target Volume (acre-feet/yr)	Colorado	<i>In-Basin</i>	<i>TMDs</i>
	67.2%	10.1%	57.1%
100,000	67,186	10,129	57,064
	Jul 1957	Jan 1981	Jul 1957
300,000	201,557	30,387	171,191
	Nov 1935	Jul 1957	Aug 1935
600,000	403,114	60,774	342,382
	Aug 1935	Jul 1941	Aug 1935

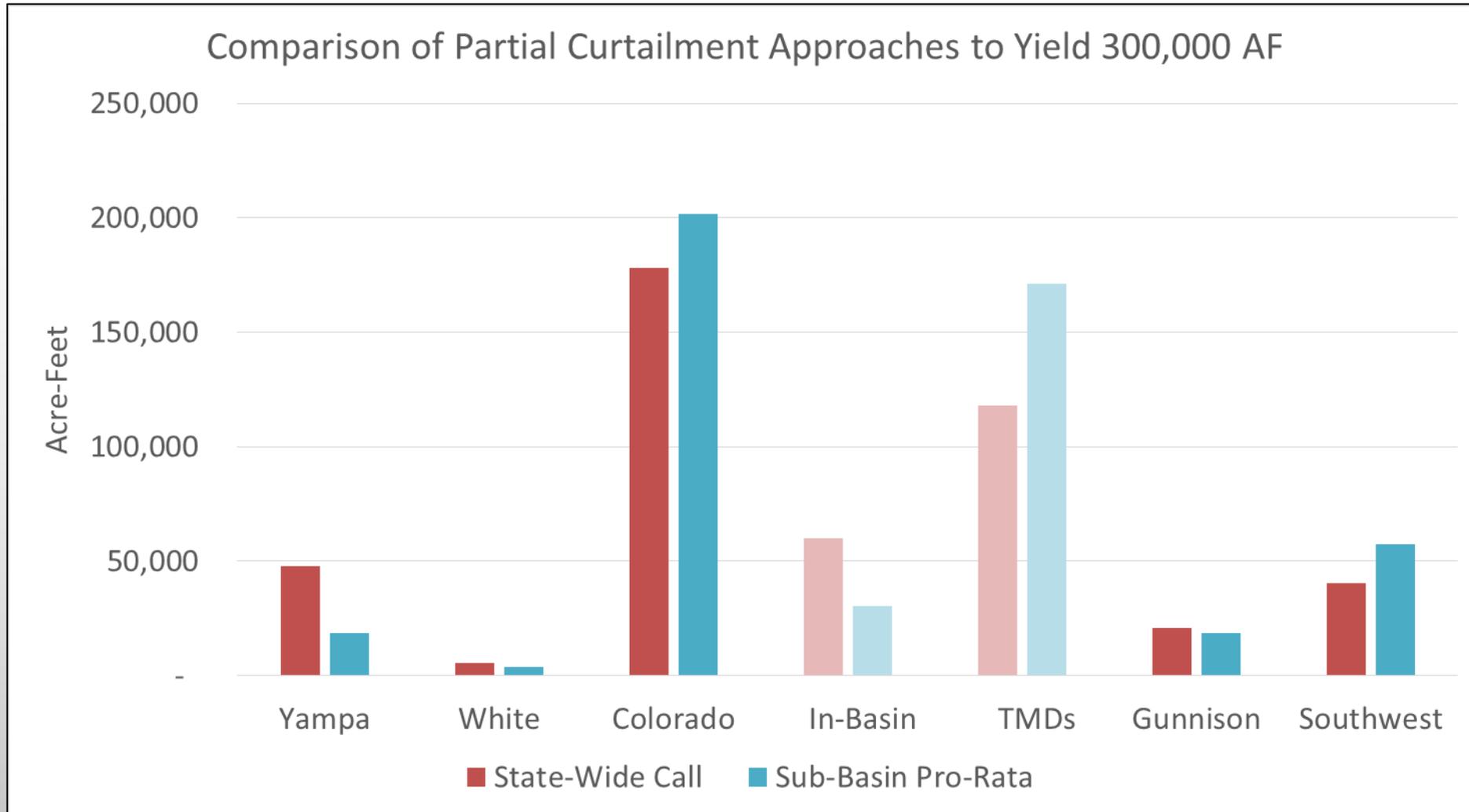
# How would a Call vary across Sub-Basins (Pro-Rata) Compared to a State-Wide Call?



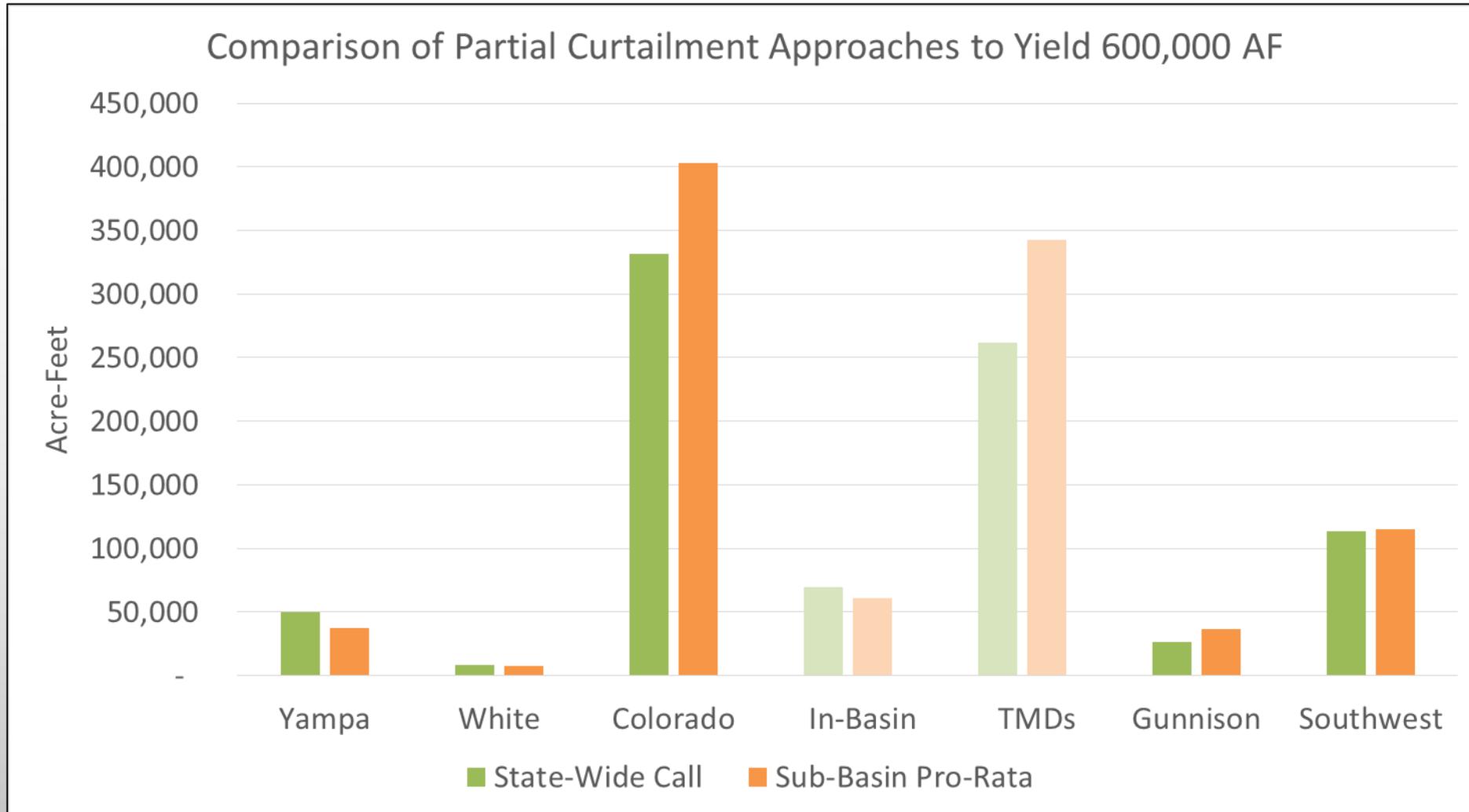
# Comparison of State-Wide vs Sub-Basin Approaches to Curtailment



# Comparison of State-Wide vs Sub-Basin Approaches to Curtailment



# Comparison of State-Wide vs Sub-Basin Approaches to Curtailment



# GENERAL OBSERVATIONS

1. Of Colorado's ~2.5 Maf of average annual consumptive use, approximately ~1.6 Maf is attributable to Pre-Compact rights, and ~900 Kaf is Post-Compact
2. TMDs constitute over half of the Post-Compact depletions (~56%)
3. Because of #2, the Colorado Mainstem users comprise 2/3 of all Post-Compact uses
4. The large TMDs often end up being the swing call, even across different volumetric reductions
5. Allocating deficit volumes pro-rata by sub-basin depletions results in substantially different administration dates for certain sub-basins when compared to a state-wide curtailment of all Colorado River water users.

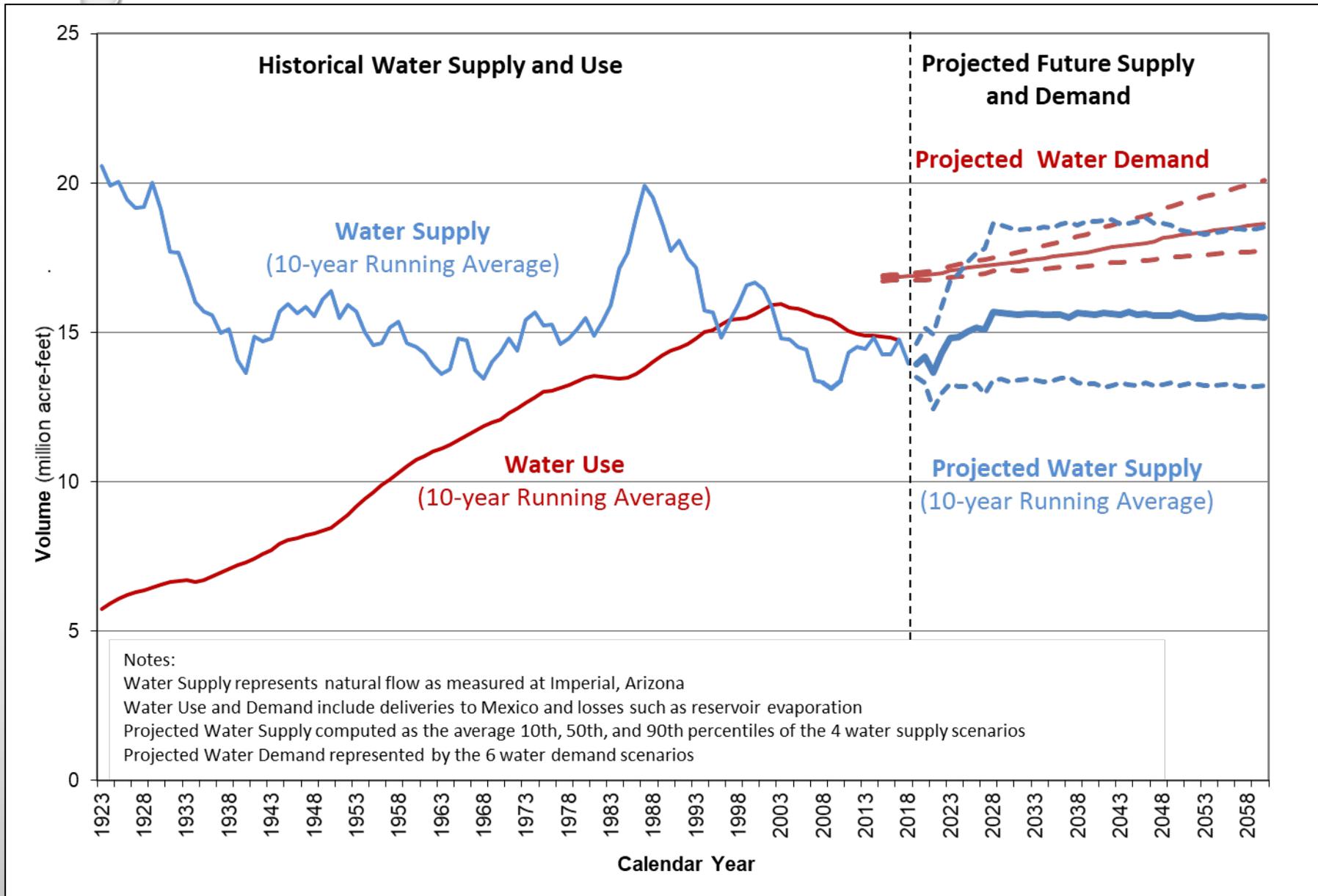
# NEXT STEPS (?)

END



**Lake Powell Operational Tiers**  
(subject to April adjustments or mid-year review modifications)

Lake Powell Elevation (feet)	Lake Powell Operational Tier	Lake Powell Active Storage (maf)
3,700	<b>Equalization Tier</b> equalize, avoid spills or release 8.23 maf	24.32
3,636 – 3,666  (see table below)	<hr style="border-top: 1px dashed black;"/> <b>Upper Elevation Balancing Tier</b> release 8.23 maf; if Lake Mead < 1,075 feet, balance contents with a min/max release of 7.0 and 9.0 maf	15.54 – 19.29  (2008 – 2026)
3,575	<hr style="border-top: 1px dashed black;"/> <b>Mid-Elevation Release Tier</b> release 7.48 maf; if Lake Mead < 1,025 feet, release 8.23 maf	9.52
3,525	<hr style="border-top: 1px dashed black;"/> <b>Lower Elevation Balancing Tier</b> balance contents with a min/max release of 7.0 and 9.5 maf	5.93
3,370		0



# FUTURE USE SCENARIO DEMANDS

StateMod Linked Model	Future Use Depletions (AF/yr)		
	Average Yield of New Depletions	Average Increase in Basin Depletions	Input Demand
Yampa	29,506	29,485	30,104
White	61,839	61,787	65,000
Upper Colorado & Front Range	86,077	82,425	120,450
Gunnison	31,053	31,100	37,900
Southwest	81,104	82,355	130,499
<b>StateWide</b>	<b>289,578</b>	<b>287,153</b>	<b>383,953</b>